Educational Program
Students | University
NP-2004-07-375-HQ

GSRP: Graduate Student Research Program

FY 2005 NASA Program Announcement

Release Date:	October 8, 2004
Proposals Due:	February 1, 2005
Selection Announcement:	May 2005

http://fellowships.hq.nasa.gov/GSRP/

INTRODUCTION

This solicitation and the corresponding web site http://fellowships.hq.nasa.gov/gsrp/ provide information about the Graduate Student Research Program (GSRP), eligibility, and the application process. Please spend a few minutes exploring the research opportunities provided in this solicitation. Students are invited to select up to two (2) of the research opportunities.

Inquiries

Questions concerning policy matters should be directed to the Graduate Student Research Program (GSRP) National Program Manager:

Dr. Katie E. Blanding
Office of Education
NASA Headquarters
Washington, DC 20546
Phone: (202) 358-0402
Fax: (202) 358-3032
katie.blanding@nasa.gov

General questions about how to submit the on-line application may be referred to gsrp@nasaprs.com or (202) 479-9376. Technical and scientific questions about specific research opportunities should be directed to the GSRP Program Managers listed for each Center and Mission Directorate on pages 2-3**.**

Important Program Dates

Solicitation Release Date:	**Friday, October 8, 2004**
Application Packets Due:	**Tuesday, February 1, 2005**
Selection Period:	**May - August 2005**
Announcements:	**June – August 2005**

GSRP Homepage and Announcement Access: http://fellowships.hq.nasa.gov/gsrp/

Overview of the Application Process:

The submission process consists of the following:

1. On-line submission of GSRP application and required documents, and
2. Mail-in submission of official transcript, Faculty Adviser letter of recommendation, and signature form

All GSRP materials, including the electronic application and all accompanying mail-in materials must be received at either the NASA Centers or NASA Peer Review Services (NPRS), no later than **5:00 PM Eastern Standard Time (EST) on Tuesday, February 1, 2005**. Mail-in application materials such as letters of recommendation, transcripts, and signature forms should be addressed and sent to the Center Program Manager listed below, if you are applying through the Centers.

If you are applying to the Mission Directorates or JPL, materials should be mailed to NPRS:

NASA Peer Review Services (NPRS)
Attn: Code N
Graduate Student Research Program (GSRP)
500 E Street, SW, Suite 200
Washington, DC 20024-2760
Tel: 202-479-9030

Note that the NASA Mission Directorates and the Jet Propulsion Laboratory (JPL) manage their programs separately from the NASA Center GSRP Programs. The Mission Directorates and JPL awards are managed by NPRS for NASA Headquarters. Awards sponsored by NASA Centers are procured by the Center Procurement Officers.

GSRP PROGRAM MANAGERS

GSRP PROGRAM MANAGERS FOR THE NASA MISSION DIRECTORATES AND THE JET PROPULSION LABORATORY	
Ms. Debra R. Spears **Human Systems Research & Technology Program Support Specialist** NASA Headquarters Exploration System Mission Directorate Washington, DC 20546-0001 Phone: (202) 358-1952 Fax: (202) 358-4168 **debra.r.spears@nasa.gov**	**Ms. Anne N. Crouch** **Science Mission Directorate** **Office of Earth Science** NASA Headquarters Washington, DC 20546-0001 Phone: (202) 358-0855 Fax: (202) 358-2770 **anne.n.crouch@nasa.gov**
Ms. Dolores Holland **Science Mission Directorate** **Office of Space Science** NASA Headquarters Washington, DC 20546-0001 Phone: (202) 358-0734 Fax: (202) 358-3094 **dolores.holland@nasa.gov**	**Ms. Debbie Brown-Biggs** **Manager, Education Flight Projects Office** **Space Operations Mission Directorate** **Office of Space Flight** NASA Headquarters Washington, DC 20546-0001 Phone: 202-358-1517 **dbrown4@hq.nasa.gov**
Ms. Linda Rodgers **NASA Jet Propulsion Laboratory** Mail Stop 180-109 4800 Oak Grove Drive Pasadena, CA 91109-8099 Phone: (818) 354-3274 Fax: (818) 393-4977 Linda.L.Rodgers@jpl.nasa.gov	

GSRP PROGRAM MANAGERS AT NASA CENTERS

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Fax: (216) 433-3687
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Marshall Space Flight Center, AL 35812
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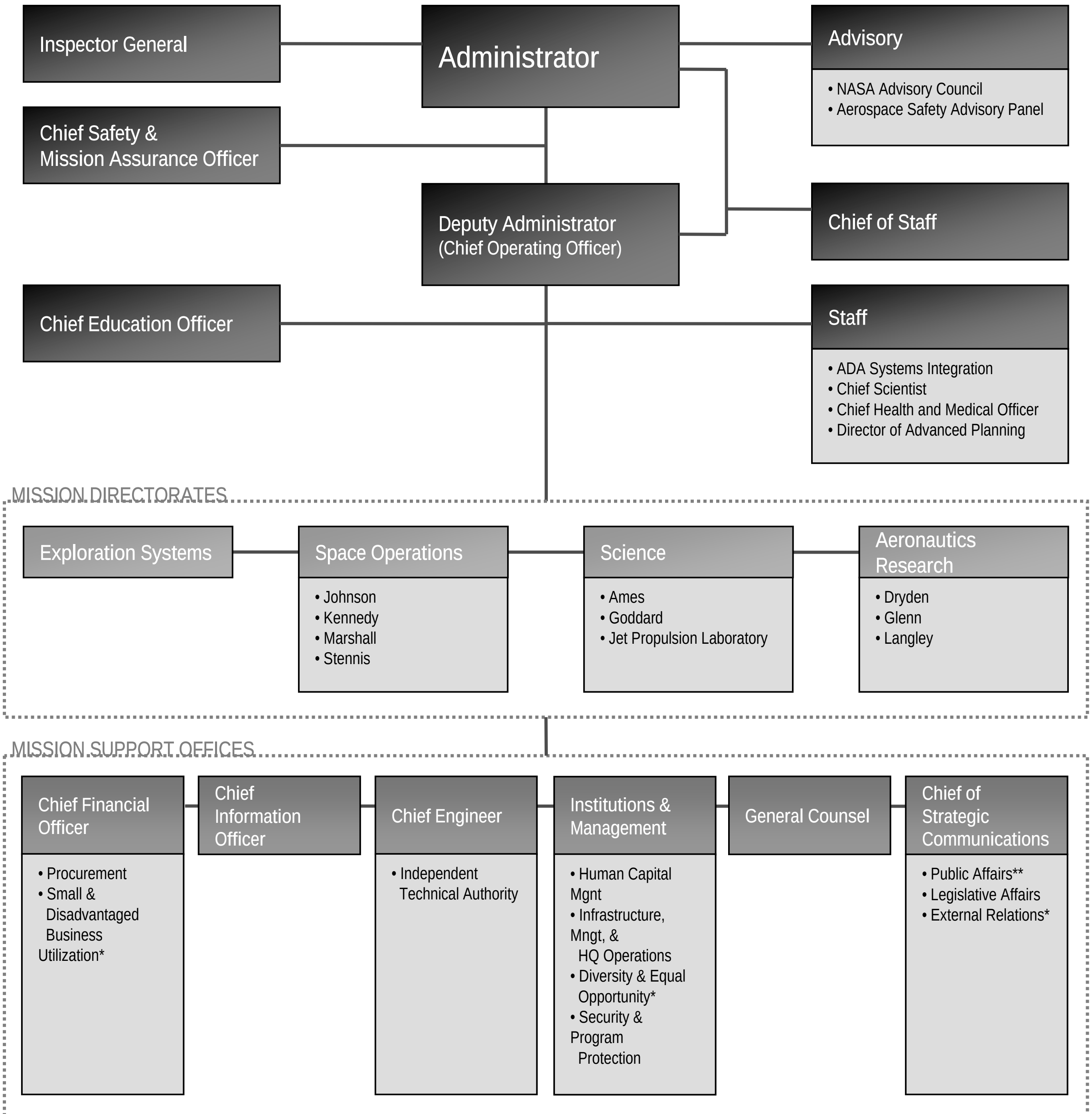
NEW NASA STRUCTURE



* In accordance with law, the Offices of Diversity and Equal Opportunity and Small and Disadvantaged Business Utilization maintain reporting relationships to the Deputy and the Administrator.

** Including a new emphasis on internal communications.

NASA MISSION DIRECTORATES, CENTERS AND FACILITIES

NASA has recently transformed its organizational structure to align with the Agency's "Vision for Space Exploration" (full text version available at http://www.nasa.gov/missions/solarsystem/bush_vision.html. Recognizing the need for a more integrated approach to science requirements, management, and implementation of systems development and exploration missions, NASA created a leaner and more focused Agency. "Our task is to align Headquarters to eliminate the 'stove pipes,' promote synergy across the agency, and support the long-term exploration vision in a way that is sustainable and affordable," said Administrator Sean O'Keefe. "We need to take these critical steps to streamline the organization and create a structure that affixes clear authority and accountability."

This transformation fundamentally restructures NASA's Strategic Enterprises into Mission Directorates to better align with the Vision. It also restructures Headquarters support functions and clarifies organizational roles and responsibilities. The Mission Directorate organizational structure includes:

- Aeronautics Research: Researches and develops aeronautical technologies for safe, reliable and efficient aviation systems
- Science: Carries out the scientific exploration of the Earth, Moon, Mars and beyond; charts the best route of discovery; and reaps the benefits of Earth and space exploration for society. A combined organization is best able to establish an understanding of the Earth, other planets and their evolution, bring the lessons of our study of Earth to the exploration of the Solar System, and ensure the discoveries made here will enhance our work there
- Exploration Systems: Develops capabilities and supporting research and technology that enable sustained and affordable human and robotic exploration; includes the biological and physical research necessary to ensure the health and safety of crew during long duration space flight
- Space Operations: Directs space flight operations, space launches and space communications, as well as the operation of integrated systems in low-Earth orbit and beyond

To support these four Mission Directorates, NASA operates nine Centers nationwide, the contractor-operated Jet Propulsion Laboratory, and the Wallops Flight Facility. Each Mission Directorate covers a major area of the Agency's research and development efforts. The overarching functions of these Mission Directorates and specific research opportunities that exist within these Mission Directorates are described in this solicitation.

AERONAUTICS RESEARCH MISSION DIRECTORATE

The mission of the Aeronautics Research Mission Directorate is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. It is responsible for guiding and managing NASA's aeronautics research, and defining the investments that NASA makes on behalf of the Nation. These investments, by definition, are for long-term high-risk undertakings that are beyond the scope, capacities, or risk limits of others to perform.

The Mission Directorate focuses on research, technology, and operation of advanced aeronautics applications and technologies to advance the Exploration agenda. The existing programs continue to be a major Agency pursuit and will involve activities that will conduct a comprehensive array of critical aviation and advanced space transportation research activities. For example, the Mission Directorate is committed to developing tools and technologies that can help to transform how the air transportation system operates, how new aircraft are designed and manufactured, and how our Nation's air transportation system can reach unparalleled levels of safety and security. Specific research topics include:

- Improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical vehicles;
- Long-range studies of the problems involved in the utilization of aeronautical activities for peaceful purposes; and
- Preservation of the role of the United States as a leader in aeronautical technology.

Aeronautics Research Mission Directorate R&D activities promote national security and economic growth by advancing a safe, efficient national aviation system and an affordable, reliable space transportation capability. The plans and goals of the Mission Directorate directly support national policy in both aeronautics and space, as documented in the President's “Goals for a National Partnership in Aeronautics Research and Technology,” and the “National Space Transportation Policy.” It is uniquely positioned to promote innovation in both fields of aeronautics and space transportation.

Please visit http://www.aerospace.nasa.gov for more information on the Aeronautics Research Mission Directorate.

SCIENCE MISSION DIRECTORATE

The Office of Earth Science and Office of Space Science have been integrated to form the Science Mission Directorate. The Science Mission Directorate will carry out the scientific exploration of the Earth, Moon, Mars and beyond with the goal of reaping the benefits of Earth and space exploration for society. A combined organization is best able to establish an understanding of the Earth, other planets and their evolution, bring the lessons of our study of

Earth to the exploration of the Solar System, and ensure the discoveries made here will enhance our work there.

The Science Mission Directorate seeks to chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planetary bodies and life; and to yield knowledge of substantial practical value to society in weather and climate forecasting, agriculture, natural resource management in urban and regional planning, and elsewhere. This Mission Directorate has program components that regularly offer universities, laboratories, and other domestic institutions opportunities to openly compete for awards to conduct space science missions or research projects.

Please visit http://www.nasa.gov/home/hqnews/2004/jul/HQ_04214_mcnally_figueroa.html for more information on the Science Mission Directorate.

Science Mission Directorate – Office of Earth Science: NASA's vision to improve life here starts with the Office of Earth Science. By studying the planet Earth from space, it seeks to understand and protect our home planet by advancing Earth-system science. The Office of Earth Science is composed of two themes:

- Earth System Science
- Earth Science Applications

See http://www.earth.nasa.gov for more information on the Office of Earth Science.

Science Mission Directorate – Office of Space Science: The Office of Space Science seeks to answer fundamental questions about life in the universe: how it arose, what its mechanisms are, where in the solar system life may have originated or may exist today, and whether there are similar planetary environments around other stars where the signature of life can be found. The Office of Space Science is composed of five themes:

- Solar System Exploration
- Mars Exploration
- Astronomical Search for Origins
- Structure and Evolution of the Universe
- Sun-Earth Connection

See http://spacescience.nasa.gov for more information on the Office of Space Science.

EXPLORATION SYSTEMS MISSION DIRECTORATE

The Exploration Systems Mission Directorate is a new organization within NASA dedicated to creating a constellation of new capabilities, supporting technologies, and foundational research that enables sustained and affordable human and robotic exploration. It results from integrating the responsibility of both the Office of Exploration Systems and the Office of Biological and Physical Research, including research and development efforts focused on crew health and life-support systems, countermeasures, and radiation protection. The Mission Directorate will address strategic technical challenges and minimize the health and safety risks for the crew of any space vehicle

Specific capabilities and supporting research and technology development will evolve over time. Presently, the Mission Directorate has been tasked with developing a Crew Exploration Vehicle that will be used by astronauts to travel in space. It is developing nuclear technologies that will enable long-duration space travel and evaluating plans for a new capability that may service, repair, and eventually de-orbit the Hubble Space Telescope. It is also conducting research to ensure the health and safety of astronauts during long-duration space exploration far from Earth and is actively engaged in promoting new approaches that will substantially involve industry and universities in these efforts. The Centennial Challenges Program, which offers prizes to stimulate innovation, is one example of a novel approach.

Please visit http://exploration.nasa.gov for additional information on the Exploration Systems Mission Directorate.

*Exploration Systems Mission Directorate: Office of Biological and Physical Research***:**
The space environment offers a unique laboratory in which to study biological and physical processes. Access to laboratories in space allows scientists to conduct research under conditions that have no parallel in the history in of science. Experiments that take advantage of this announcement extend from basic biology to quantum mechanics as well as from fundamental research to research with near-term application in medicine and industry. The Office of Biological and Physical Research has a primary role to play in encouraging and engaging the next generation of explorers, and it supports direct student participation in space research from the graduate level down through the primary-school level. Three themes comprise the Office of Biological and Physical Research:

- Physical Science Research
- Biological Sciences Research
- Research Partnerships and Flight Support

See http://spaceresearch.nasa.gov for more information on the Office of Biological and Physical Research.

SPACE OPERATIONS MISSION DIRECTORATE

The Space Operations Mission Directorate provides many critical enabling capabilities that make possible much of the science, research, and exploration achievements of the rest of

NASA. It does this through the three themes of International Space Station, Space Shuttle Program, and Flight Support:

- The International Space Station (ISS) establishes a permanent human presence in Earth orbit. The ISS provides a long-duration, habitable laboratory for science and research activities investigating the limits of human performance, expanding human experience in living and working in space, and enabling the commercial development of space.

- The Space Shuttle Program builds on the Shuttle's primacy as the world's most reliable and versatile launch system. The Shuttle, first launched in 1981, provides the only capability in the United States for human access to space.

- Flight Support consists of Space Communications, Launch Services, and Rocket Propulsion Testing.

The Space Operations Mission Directorate aims to expand the frontiers of space by exploring, using, and enabling the development of space for humans.

- Please visit http://www.hq.nasa.gov/osf/ to learn more about the Space Operations Mission Directorate.

GSRP PROGRAM DESCRIPTION

The NASA Graduate Student Research Program (GSRP) awards fellowships for graduate study leading to masters or doctoral degrees in the fields of science, mathematics, and engineering related to NASA research and development.

The goal of NASA's GSRP is to cultivate research ties to the academic community, to help to meet the continuing needs of the Nation's aeronautics and space effort by increasing the number of highly trained scientists and engineers in aeronautics and space-related disciplines, and to broaden the base of students pursuing advanced degrees in science, mathematics, and engineering. The GSRP is inextricably tied to NASA's mission of preparing the next generation of explorers, and NASA Research and Development Centers are uniquely designed to provide excellence in aeronautics and space research. Research opportunities stated in this solicitation are assessed and updated annually to complement the mission requirements of NASA. Research areas are in disciplines that lead to aeronautics and space careers.

The program supports approximately 300 graduate students annually. NASA's discipline scientists and technologists evaluate applications based upon the academic transcripts, research proposal, Faculty Research Adviser's recommendation, and the proposed utilization of NASA Center or university research facilities.

Award Description

A student receiving support under the GSRP does not incur any formal obligation to the U.S. Government. The objectives of this program will be served best if the student actively pursues research, teaching, employment in space science and aeronautics industries, or other NASA-related fields after completion of graduate studies.

Amount and Duration: Fellowships are awarded for one year as training grants in the amount of $24,000. This amount includes an $18,000 student stipend, a student allowance of $3,000, and a $3,000 university allowance. Awards are renewable up to three years based on satisfactory academic advancement, research progress, and available funding. The Program Manager and the Technical Adviser at the NASA Center or Mission Directorate Office must approve renewals. All applications are due annually, by the deadline posted on the GSRP Website. The deadline for the 2005 applications is 5:00 PM EST on Tuesday, February 1, 2005.

Allowable Expenses: The student stipend of $18,000 may cover tuition, room and board, books, software, meal plans, school and laboratory supplies, and other related expenses. The $3,000 Student Allowance may be used for additional program related travel, and other expenses agreed upon by the student and the Faculty Research Adviser. The University Allowance of $3,000 is a discretionary award made to the Research Adviser. The NASA Program Manager must approve alternative uses of GSRP funding. The GSRP is a Fellowship grant to support graduate education, and does not provide University overhead.

GSRP grant funds may not be used for the purchase of any equipment, including computers.

Travel: A request for international travel must be submitted to the GSRP Center or Mission Directorate Program Manager and must have the concurrence of the Faculty Research Adviser. Requests should be submitted 15-30 days prior to the proposed travel. For each international trip, the student or faculty research adviser must submit a written request on university letterhead stating the purpose of the travel, estimated cost, travel dates, and GSRP grant number.

Unused Funds and Transfer of Award to Another Student: If a student withdraws **within the first half of the award year**, the university may request a replacement student with similar achievement and research objectives to complete the remaining months of the current award. Since this is a highly competitive program, replacement students will be recommended from NASA's current database of alternate applicants who have passed the review process.

The Faculty Research Adviser and the University Authorizing Official must provide a statement to the NASA Program Manager advising of any change in the student's enrollment status.

Replacement students are not considered as renewals for subsequent awards. Upon expiration of the replacement award, students must submit an application and compete for future GSRP awards. Replacement students must follow the guidelines for "new applicants" to apply for future awards.

Tax Questions: All questions concerning taxes should be directed to the Internal Revenue Service. Refer to IRS Publication 520, "Scholarships and Fellowships," and Publication 508, "Tax Benefits for Work-Related Education," for further information. Both publications can be accessed at the following web site address http://www.irs.gov/prod/forms_pubs/pubs/.

General Eligibility Requirements

- Applicants must be currently enrolled or accepted as a full-time graduate student in an accredited U.S. college or university.
- Applicants must be U.S. citizens.
- Students may apply at any time during their graduate program, or prior to receiving their baccalaureate degree, provided they have been accepted to an accredited graduate program at a U.S. college or university.
- All applicants must have a Faculty Adviser from the institution where they plan to receive their graduate degree. Graduating seniors accepted by a graduate school must contact their graduate school department and request an adviser to support the NASA research funded under the GSRP.

  Identification of an Adviser is important, since the awards are made to the Research Adviser at the university on behalf of the student.

Individuals accepting this award may not concurrently receive other Federal fellowships or traineeships. The exception to this policy is Section 178(a) of Title 38, U.S. Code, which allows a student to receive concurrent educational benefits from the Department of Veterans Affairs.

Underrepresented minorities, women, and persons with disabilities are strongly urged to apply to the GSRP.

Reporting Requirements

It is the responsibility of the institution receiving a NASA GSRP award to ensure submission of a final report on the fellow's research and academic progress. This report is due immediately (within 30 days) after the termination date of the award. The report must include the degree granted, important student achievements (e.g., thesis title, other published papers, presentations, awards, honors), and employment or other future plans. This report should be submitted to the appropriate NASA Mission Directorate or NASA Center Program Manager.

All students must complete a student profile within the first 90 days of accepting the award. Instructions for completing the profile are at: https://ehb2/gsfc.nasa.gov/edcats/urls/nw/gsrp_profile.html. An annual update and additional feedback should be completed at the end of each year between June and July. The update and feedback form is located at https://ehb2.gsfc.nasa.gov/edcats/urls/nw/gsrp_feedback.html.

APPLICATION SUBMISSION GUIDELINES

Application Submission

All new and renewal applicants must follow the on-line application process. This process requires applicants to complete the on-line GSRP application form and to upload other required documents. Some documents cannot be submitted electronically and must be mailed. These include official transcripts, Faculty Research Adviser's letter of recommendation, and the Signature Form. The NASA Centers or NPRS must receive **one copy of** these accompanying materials **no later than 5:00 PM EST, Tuesday, February 1, 2005**. The complete submission process is outlined below:

Step 1: Electronic Submission of GSRP Application: To access, complete, and submit the on-line application, go to http://fellowships.hq.nasa.gov/grsp/. Select the "APPLY ONLINE" option and follow the instructions. **New applicants** must upload the following documents: the research proposal, a biographical sketch of the student and a biographical sketch of the Faculty Research Adviser. **Renewal applicants** only need to upload their progress report. The final step in the electronic portion of the application process is to print out the GSRP Signature Form. Applicants must collect original signatures on this form and submit it by mail (see step 2).

Step 2: Mail In Required Documentation: The following documents must be received at The NASA Centers or NPRS **no later than 5:00 PM EST, February 1, 2005**. The addresses for the NASA Center Program Managers are provided under the "GSRP Program Managers" section of this solicitation on page 3. The NPRS address is provided under number 3 of this section below. Applicants may go to the GSRP website located at http://fellowships.hq.nasa.gov/grsp/ at any time during the application process to check the status of their application.

1. GSRP Signature Form. This form must be completed in full and bear the original signatures of the applicant, Faculty Adviser, and the university's authorizing official.

2. Faculty Adviser Letter of Recommendation. A letter of recommendation must be provided from your graduate university research adviser who will serve as the Principal Investigator for your proposed research. This letter must be signed by the Research Adviser. It may be submitted with other mail-in documents, or under separate cover.

3. Recall that the NASA Mission Directorates and the Jet Propulsion Laboratory (JPL) manage their GSRP separately from the NASA Centers. Mail-In documents for the Mission Directorates and the JPL must be mailed directly to the following address:

   NASA Peer Review Services (NPRS)
   Attn: Code N
   Graduate Student Research Program (GSRP)
   500 E Street, SW, Suite 200
   Washington, DC 20024-2760

Mail-In documents for the Centers must be mailed directly to the Program Managers indicated on pages 2-3 of this solicitation.

4. Official Transcript. An official transcript that lists all university coursework (undergraduate and graduate) is required from **new applicants**. **Renewal applicants** must provide an official transcript that lists all courses taken since the previous GSRP award. Students should request their transcripts and recommendations well in advance of the deadline to ensure arrival at the selected NASA Centers or NPRS office **(no later than 5:00 PM EST on February 1, 2005).**

Checklist: New Applicant *(Includes Recent College Graduates and Graduating Seniors)*

1. Electronic Submission of Application (including contact information, abstract, budget figures, and description of anticipated use of Center or university research facilities).
2. Electronic Upload of five-page Proposal/Project Description.
3. Electronic Upload of Biographical Sketches of Faculty Adviser and Student.
4. Official University Transcripts from all undergraduate institutions attended.
5. Letter of Recommendation from the Faculty Adviser.
6. GSRP Signature Form.

Checklist: Renewal Applicant

1. Electronic Submission of Application (including contact information, abstract, budget figures, and description of changes from previous year of anticipated use of Center or university research facilities).
2. Electronic Upload of Progress Report.
3. Official University Transcript from the Student's Institution.
4. Electronic Upload of Biographical Sketches of Faculty Adviser and Student.
5. Letter of Recommendation from the Faculty Adviser.
6. GSRP Signature Form.

To ensure the preparation of a competitive proposal, students must collaborate with a faculty advisor **and** with a potential NASA Technical Adviser to identify a project. NASA Technical Advisers are listed at the end of each research opportunity in the 2005 GSRP Solicitation. Students are advised to solicit guidance, review, and commentary on the proposal from their Faculty Adviser prior to submission. The "student" must write the GSRP proposal. For a complete explanation of required materials for both new and renewal applicants, see the section below on "Proposal Preparation."

New awards are scheduled to begin the first of July, August, or September 2005. Incomplete or late proposals may not be accepted or reviewed. The starting date for renewal awards will be one year from the start date of the original fellowship.

Evaluation Criteria

NASA Headquarters, Centers, and the Jet Propulsion Laboratory will review applications and make selections for participation in this program. Selection is based on:

1. A five page research proposal in response to the Research Opportunities listed in this solicitation;
2. Transcripts. New applicants must provide transcripts showing undergraduate and graduate coursework. Renewals must provide a transcript showing all courses taken since the previous GSRP award;
3. The proposed utilization of Center or University research facilities; and
4. The recommendation of the Faculty Adviser.

Fellows selected by Centers must spend some time in residence at the Center, taking advantage of the unique research facilities of the installation and working with Center personnel. The projected use of NASA Center facilities is an important factor in the selection of Center Fellows.

Proposal Preparation

Applicants may respond to no more than two research opportunities in response to this solicitation. Each proposal must address a single research topic. Proposals should be coordinated with a NASA Technical Adviser to determine appropriateness for NASA research and development. Applicants should clearly indicate which Mission Directorates and/or Centers you are interested in by checking the appropriate selection on the application. Program Managers at NASA Centers and Mission Directorates will have electronic access and capability for on-line review of proposals.

General Formatting Guidelines:

- A 5-page proposal in response to the Research Opportunities announced in the 2005 GSRP Solicitation.
- Submitted (uploaded) reports (Anticipated Use of Research Facilities Report, Proposal/Project Description or Research Progress Reports, and Biographical Sketches) should not exceed the page limits (including associated tables, forms, charts, graphics, and appendices or references).
- Documents uploaded should be formatted with one-inch margins (top, bottom, left and right), and 12-point font. Single spacing is recommended.

A complete package for ***new applicants*** must contain the following items:

APPLICATION MATERIALS—NEW APPLICANTS

1. **Application—**The application must be completed on-line and includes the following components:

   Abstract—Proposal abstracts should concisely summarize the proposed research and its relationship to the NASA mission. The abstract should not exceed 100 words in length. The abstract is in addition to the 5-page proposal.

   Budget Figures—The award includes a student stipend, a student allowance, and a university allowance. The student stipend of $18,000 may cover tuition, room and board, books, software, meal plans, school and laboratory supplies, and other related expenses. No equipment may be purchased with these funds. The $3,000 Student Allowance may be used for additional program related travel, and other expenses agreed upon by the student and the Faculty Research Adviser. The University Allowance of $3,000 is a discretionary award to the Research Adviser. The NASA Program Manager must approve alternative uses of GSRP funding. The GSRP is a Fellowship grant to support graduate education, and does not provide University overhead.

   Anticipated Use of Center or University Facilities and Resources—All students must indicate the NASA or University facilities and resources to be used in support of the research, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate NASA Technical Adviser listed for the proposed research area or their Faculty Adviser to coordinate these activities.

2. **Proposal/Project Description**—Upload. A five-page proposal that is authored by the applicant must be submitted online. The proposal should describe the student's proposed or ongoing research.

3. **Biographical Sketches of the Faculty Adviser and Student**—Upload. For new applications, background information on the Faculty Adviser and student is required. Provide short biographical sketches from each (not to exceed two pages) that list the following information: name, current position, title, department, university address, phone number, and principal publications. The sketches should include relevant career experience, research, awards, scholarships, and other relevant accomplishments. This requirement includes all applicants (new applicants, graduating seniors, and renewals).

4. **Official Transcript**—Mail. New applicants are required to submit an official transcript that lists all university coursework (undergraduate and graduate).

5. **Letter of Recommendation**—Mail. The Faculty Adviser must provide a signed one-page letter of recommendation on behalf of the student. The letter must include a statement indicating the level of assistance provided to the student in the preparation of the GSRP proposal.

6. **Signature Form**—Mail. Proposals will not be accepted without these required signatures: student signature, Faculty Adviser signature, and institutional authorizing official signature. By signing, the authorizing official commits the university and confirms that the Certification Requirements have been met. Certifications of Compliance with Applicable Executive Orders and U.S. Code are listed below. (See also pages 17-22.)

   (i) Privacy Act Statement
   (ii) Certification Regarding Debarment, Suspension, and Other Responsibility Matters,
   (iii) Certification Regarding Drug-Free Workplace Requirements,
   (iv) Certification Regarding Lobbying for Contracts, Grants, Loans, and
   (v) Assurance of Compliance with NASA Regulations Pursuant to

   Nondiscrimination in Federally Assisted Programs.

A complete package for ***renewal applicants*** must contain the following items:

APPLICATION MATERIALS—RENEWAL APPLICANTS
1. Application—The application must be completed online and includes the following components: **Abstract**—Proposal abstracts should concisely summarize the ongoing research and its relationship to the NASA mission. The abstract should not exceed 100 words in length. **Budget Figures**—The award includes a student stipend, a student allowance, and a university allowance. The student stipend of $18,000 may cover tuition, room and board, books, software, meal plans, school and laboratory supplies, and other related expenses. No equipment may be purchased with these funds. The $3,000 Student Allowance may be used for additional program related travel, and other expenses agreed upon by the student and the Faculty Research Adviser. The University Allowance of $3,000 is a discretionary award to the Research Adviser. The NASA Program Manager must approve alternative uses of GSRP funding. The GSRP is a Fellowship to support graduate education, and does not provide University Overhead. **Anticipated Use of Center or University Facilities and Resources**—All students must indicate the NASA or University facilities and resources to be used in support of the research, including an estimate of any computer time required. Indicate any change in your requirements for use of facilities and resources.
2. Research Progress Report—Upload. A report that is authored by the applicant discussing the status of the research must be provided for renewal. This report must describe the status of the GSRP funded research during the previous year of support. The report should indicate research plans to be supported with renewal funding. This statement should not exceed five pages in length.
3. Official Transcript—Mail. Renewal applicants are required to submit an official transcript that lists all courses taken since the previously submitted application.
4. Letter of Recommendation—Mail. The Faculty Adviser must provide a signed one-page letter of recommendation on behalf of the student. The letter must include a statement indicating the level of assistance provided to the student in the preparation of the GSRP proposal.
5. Signature Form—Mail. Proposals will not be accepted without these required signatures: student signature, Faculty Adviser signature, and institutional authorizing official signature. By signing, the authorizing official commits the university and confirms that the Certification Requirements have been met. Certifications of Compliance with Applicable Executive Orders and U.S. Code are listed below. (See also pages 17-22.) (i) Privacy Act Statement (ii) Certification Regarding Debarment, Suspension, and Other (iii) Responsibility Matters, (iv) Certification Regarding Drug-Free Workplace Requirements, (v) Certification Regarding Lobbying for Contracts, Grants, Loans, and (vi) Assurance of Compliance with NASA Regulations Pursuant to (vii) Nondiscrimination in Federally Assisted Programs.

GSRP RESEARCH AREAS FOR 2005

The following chart shows research disciplines that are supported by the 2005 GSRP solicitation.

	ARC	DFRC	GRC	GSFC	KSC	JPL	JSC	LaRC	MSFC	SSC
Aeronautical	x	x	x	x			x	x	x	
Chemical	x	x	x		x	x	x	x		x
Electrical		x	x	x	x	x	x	x		x
Mechanical		x	x	x	x		x	x	x	x
Metallurgy/ Materials	x		x		x		x	x	x	
Engineering	x	x	x	x	x	x	x	x	x	x
Astronomy	x			x		x			x	
Chemistry	x		x		x	x		x		
Physics	x		x	x	x	x		x	x	x
Physical Science	x		x	x	x	x			x	x
Mathematics	x		x		x			x		
Computer Science	x		x		x	x	x	x		x
Math/Comp	x		x	x	x	x		x	x	
Biological Science	x		x		x				x	x
Life Science	x				x	x	x			
Social Science	x								x	
Atmospheric Science	x			x		x		x	x	
Geol Science	x			x		x		x		x
Oceano-graphy				x		x				x
Environ-mental Science	x			x	x				x	x
Psychology	x						x	x		
Other Sciences	x		x	x	x	x	x	x	x	x

DFRC	Dryden Flight Research Center	**JSC**	Johnson Space Center
GRC	Glenn Research Center	**LARC**	Langley Research Center
GSFC	Goddard Space Flight Center	**MSFC**	Marshall Space Flight Center
KSC	Kennedy Space Center	**SSC**	Stennis Space Center
ARC	Ames Research Center	**JPL**	Jet Propulsion Laboratory

GSRP APPLICATION AND CERTIFICATIONS

The following pages contain <u>sample</u> forms to support the GSRP application, including the application page, the signature form for the University Authorizing Official and the Faculty Adviser, and full-text versions of all applicable certifications.

- NASA Application for the Graduate Student Research Program (GSRP)
- Signature Form
- Certification of Compliance with Applicable Executive Orders and U. S. Code
- Privacy Act Statement
- Certification Regarding Debarment, Suspension, and Other Responsibility Matters
- Certification Regarding Drug-Free Workplace Requirements Grantees Other Than Individuals
- Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements
- Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

By signing the GSRP Signature Form, the Institutional Authorizing Official confirms that he/she has read the abovementioned certifications and further confirms compliance with all the provisions, rules, and stipulations set forth in the certifications contained in this solicitation.

NASA GSRP Sample Application

STUDENT INFORMATION

Last Name ________________ First Name __________________ MI ____ Birth Date __________

Birth City/Town and State ______________________ Birth Country ____________________________

Permanent Contact Information	**Departmental Contact Information**	**Hours Completed**		
	Institution:	Bachelor	Master's	Doctorate
Street:	**Department:**			
City:	**Street:**	**GPA (4.0 Scale)**		
State:	**City:**	Bachelor	Master's	Doctorate
Zip:	**State:** **Zip:**			
Phone:	**Phone:**	**Expected Date of Graduation:**		
Email:	**Email:**	Bachelor	Master's	Doctorate
Fax:	**Fax:**			

Degree to be supported by this award (indicate one): MS PhD

Academic Major:

Colleges or Universities Attended ***(list current institution first)***

Institution	Location	Dates		Degree	Major

Applicant Background

Gender ☐ Male ☐ Female | Individual with Disabilities ☐ Yes ☐ No

Race/Ethnicity (Check all that apply)
☐ White or Caucasian
☐ Native Hawaiian or Other Pacific Islander
☐ African American or Black
☐ Native American Indian or Alaskan Native
☐ Hispanic or Latino
☐ Asian

Proposal Information

Type of Proposal	☐ **New**	☐ Second Year	☐ Third Year	☐ Other	

If Renewal, enter the Grant Number: NGT ______ | Proposed Start/Renewal Date: ______/______/______

Research Title:

Submission Information (Check no more than 2 boxes)

Headquarters	☐	Space Sciences	☐	Biological and Physical Research	☐	Earth Science

NASA Centers										
	☐	Ames (ARC)	☐	Dryden (DFRC)	☐	Glenn (GRC)	☐	Goddard (GSFC)	☐	Jet Propulsion Lab. (JPL)
	☐	Johnson (JSC)	☐	Kennedy (KSC)	☐	Langley (LaRC)	☐	Marshall (MSFC)	☐	Stennis (SSC)

Enter the name of the Center Research Adviser: ____________

NASA's office of Education is evaluating its complete suite of programs, and would like to know if you have ever participated in other NASA education programs, (whether K-12, informal or Higher Education). If yes, please list programs in which you have participated.

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To apply, please visit http://fellowships.hq.nasa.gov.

GSRP SIGNATURE FORM

Applicant's Institution:

APPLICANT:	**FACULTY ADVISER:**	**INSTITUTIONAL AUTHORIZING OFFICIAL:**
Name:	**Name:**	**Name:**
Major:	**Department:**	**Title:**
Street:	**Street:**	**Street:**
City:	**City:**	**City:**
State:	**State:**	**State:**
ZIP:	**ZIP:**	**ZIP:**
Phone:	**Phone:**	**Phone:**
Email:	**Email:**	**Email:**

APPLICANT CERTIFICATION

I certify that I am a citizen of the United States and that I am or will be a full-time graduate student at the university during the period for which this application/proposal is made. I certify that the statements made in this application are true and complete to the best of my knowledge. I also certify that I am the principal author of the proposal submitted in response to the GSRP Announcement and that it was composed in accordance with the policies at my institution.

Signature: ______________________________ **Date:** ______________________________

FACULTY ADVISER CERTIFICATION

I certify that the student named above is the principal author of the proposal submitted in response to the GSRP Announcement and that it was composed in accordance with the policies at this institution.

Signature: **Date:**

INSTITUTIONAL AUTHORIZING OFFICIAL CERTIFICATION

Certification of Compliance with Applicable Executive Orders and U.S. Code

By signing and submitting the proposal identified in this GSRP Application/Proposal Cover Sheet in response to the request for a proposal under the Graduate Student Research Program, the Authorizing Official of the proposing institution, as identified below:

- Certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- Agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- Confirms compliance with all provisions, rules, and stipulations set forth in the four Certifications contained in this solicitation [namely, (1) Certification Regarding Debarment, Suspension, and Other Responsibility Matters-Primary Covered Transactions; (2) Certification Regarding Drug-Free Workplace Requirements Grantees Other Than Individuals; and (3) Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements; and (4) Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

I understand that full-text versions of the above certifications are available at http://fellowships.hq.nasa.gov/gsrp/certifications

Institutional Authorizing Official: ________________________________**Date:** ____________________

Certification of Compliance with Applicable Executive Orders and U.S. Code

The following supplements are the full text of certifications related to NASA grant awards. Please read the certifications carefully. By signing and submitting the proposal identified in the GSRP Application/Proposal Cover Sheet, (see Appendix A), in response to the request for a proposal under the Graduate Student Research Program, the Authorizing Official of the proposing institution, as identified below:

1. Certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
2. Agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal.

Privacy Act Statement

General
Pursuant to Public Law 93-579, Privacy Act of 1974, as amended (5U.S.C.§552a), the following information is being provided to persons who are asked to provide information to obtain a NASA Graduate Student fellowship.

Authority
This information is collected under the authority of the National Aeronautics and Space Act. Publication 85-568, as amended, 42 U.S.C.§2451, et. seq.

Purposes and Uses
This information requested on the application form will be used to determine your eligibility for participation in the NASA Graduate Student Research Program. The information requested regarding your ethnic/racial/disability status will be used to determine the degree to which members of each ethnic/racial/disability group are being reached by NASA's announcement of this program, and will not affect your application. Additionally, NASA may disclose this information to other organizations, and other governmental agencies, as well as Congressional offices in response to an inquiry made on your behalf. Disclosure may also be made to concerned parties in the course of litigation, to law enforcement agencies, and to other Federal agencies in exchanging information pertinent to an agency decision.

Effects of Nondisclosure
Furnishing the information on the application form is voluntary, but failure to do so may result in NASA's inability to determine eligibility for participation and selection for award in the Graduate Student Research Program. However, your application will not be affected if you choose not to provide information on your ethnic, racial, or disability status.

Definitions for Applicant Background

- American Native or Alaskan American: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.
- Hispanic: A person of Mexican, Puerto Rican, Cuban, or South American or other Spanish culture or origin, regardless of race.
- Asian: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea, and Vietnam.
- Pacific Islander: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.
- African American, not of Hispanic origin: A person having origins in any of the black racial groups of Africa.
- White, not of Hispanic Origin: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.
- Individual with Disabilities: An individual having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160 - 19211). Copies of the regulation may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, SW (Room 3633 GSA Regional Office Building No. 3), Washington, DC 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620). This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about
  (1) the dangers of drug abuse in the workplace;
  (2) the grantee's policy of maintaining a drug-free workplace;
  (3) any available drug counseling, rehabilitation, and employee assistance programs, and
  (4) the penalties that may be imposed upon employees for drug abuse violations in the work place;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will (1) Abide by the terms of the statement; and (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted -

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted;

  (1) Taking appropriate personnel action against such an employee, up to and including termination; or
  (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certificate shall be subject to a civil penalty of not less than $10,000, and not more than $100,000 for each such failure.

Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called “Applicant” HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (PL 88-352), Title IX of the Education Amendments of 1962 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter call “NASA”) issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and HEREBY GIVE ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

NASA FORM 1206 AUG 97 PREVIOUS EDITIONS ARE OBSOLETE

NASA HEADQUARTERS SPONSORED OPPORTUNITIES:

EXPLORATION SYSTEMS MISSION DIRECTORATE

Program Administrator:
Ms. Debra R. Spears
Human System Research & Technology Program Support Specialist
NASA Headquarters
Exploration Systems Mission Directorate
300 E. Street, S.W.
Washington, DC 20546-0001
Phone: (202) 358-1952
Fax: (202) 358-4168
debra.r.spears@nasa.gov

As part of NASA's recent transformation, the Office of Biological and Physical Research (OBPR) was merged into what is now the Exploration Systems Mission Directorate (ESMD). The ESMD is a new organization within NASA dedicated to creating a constellation of new capabilities, supporting technologies, and foundational research that enables sustained and affordable human and robotic exploration. Presently, our organization has been tasked with developing a Crew Exploration Vehicle that will be used by astronauts to travel in space. We are also developing nuclear technologies that will enable long-duration space travel and evaluating plans for a new capability that may service, repair, and eventually de-orbit the Hubble Space Telescope. We are conducting research to ensure the health and safety of astronauts during long-duration space exploration far from Earth. We are actively engaged in promoting new approaches that will substantially involve industry and universities in these efforts. The melding of the former OBPR programs into the new ESMD programs includes research and development efforts focused on crew health and life-support systems, countermeasures, and radiation protection. By merging the two organizations, we will work together to address strategic technical challenges and minimize the health and safety risks for the crew of any space vehicle. Focused Research and Development along with an approach to research and technology development that is based on strategic challenges, the ESMD will create focused research and development programs for those key areas that we now know have great potential to transform the course of exploration. One key focus area is human system research and technology development. Our research ensures that the crew, a critical system for space flight, will be safe and productive during long-duration human exploration in locations far from Earth. We identify, assess, and mitigate critical health risks associated with human space exploration in a manner that involves all of our partners. These risks are documented in the Bioastronautics Critical Path Roadmap (http:// criticalpath.jsc.nasa.gov).

RESEARCH FOCUS: Crew Health - As the boundaries of human space flight are expanded, the need for autonomous performance by the crew and their medical care systems becomes increasingly important. The pathway to autonomy requires a systematic approach to develop the capacity to provide medical care and perform research with less input from people on Earth. The primary challenge is to ensure that the necessary medical procedures, tools, systems, and training are developed to support missions of increasing duration and distance from Earth. Crewmembers in space can experience many of the medical problems that individuals experience on Earth, including illness and accidents. In addition, microgravity sets in motion a range of physiological responses that are not necessarily problematic during a gravitational environment or during extravehicular activity. Other hazards are environmental in nature and include exposure of the crew to space radiation and contamination of the spacecraft and its life-support systems. Soft tolerance limits and operating bands must be established for the crew during the mission. This includes setting mission-specific and lifetime health standards that protect astronauts from any adverse biomedical effects caused by space flight. Our research strategy for assuring human health and performance will invoke outcome-driven, product-oriented experimentation in humans, animal models, and cell-based systems, using the most advanced approaches in biomedical research.

RESEARCH FOCUS: Radiation - Radiation exposure will be limited according to the highest ethical standards and best practices for radiation protection. Space radiation poses special risks to crew health and safety during a mission and also has clinically relevant implementations for crew life expectancy. Space radiation differs substantially from the radiation environment on Earth, and consists mainly of high-energy protons and atomic nuclei of the heavier elements. The results of research on radiation are targeted to allow crewmembers to participate in long-duration missions beyond low-Earth orbit.

RESEARCH FOCUS: Advanced Life Support - Exploration beyond low-Earth orbit and making use of resources discovered in new environments require the basic tools already developed on Earth for energy production and the recycling of essential life-support components, such as air and water. These basic tools have been developed and optimized on Earth, but biological and physical processes often perform quite differently in reduced-gravity environments. Over the next 10-15 years, the enabling knowledge and technology base will be built for exporting the technology processes developed on Earth to new, reduced-gravity environments. The primary challenge for life- support systems is to move from largely open systems that require frequent resupply to closed systems that recycle air, water, and waste. It is also important to reduce the size and complexity of life support systems with a thorough understanding of sensitivity to gravity, multiphase flow, microbial dynamics, and heat and mass transport processes. The resulting systems must require less power than current systems, be highly reliable and autonomous, and be physically smaller than current systems. Another challenge is to develop advanced extravehicular activity systems, including a protective suit optimized for use on planetary surfaces. It will be critical to develop portable life- support systems for extravehicular activity that save consumables and meet requirements for carbon dioxide, humidity, and trace contaminant removal, with regenerable closed-loop thermal control, passive and active radiation shielding, and monitoring capabilities. CONTACT: Ms. Debra R. Spears, Exploration Systems Mission Directorate, NASA Headquarters, Washington, DC, 20546-0001, Phone: 202-358-1952, Fax: 202-358-4168, Debra.R.Spears@nasa.gov

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Crew Health - As the boundaries of human space flight are expanded, the need for autonomous performance by the crew and their medical care systems becomes increasingly important. The pathway to autonomy requires a systematic approach to develop the capacity to provide medical care and perform research with less input from people on Earth. The primary challenge is to ensure that the necessary medical procedures, tools, systems, and training are developed to support missions of increasing duration and distance from Earth. Crewmembers in space can experience many of the medical problems that individuals experience on Earth, including illness and accidents. In addition, microgravity sets in motion a range of physiological responses that are not necessarily problematic during a gravitational environment or during extravehicular activity. Other hazards are environmental in nature and include exposure of the crew to space radiation and contamination of the spacecraft and its life-support systems. Soft tolerance limits and operating bands must be established for the crew during the mission. This includes setting mission-specific and lifetime health standards that protect astronauts from any adverse biomedical effects caused by space flight. Our research strategy for assuring human health and performance will invoke outcome-driven, product-oriented experimentation in humans, animal models, and cell-based systems, using the most advanced approaches in biomedical research.

Contact: **Ms. Debra R. Spears**, (202) 358-1952, Debra.R.Spears@nasa.gov

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Radiation - Radiation exposure will be limited according to the highest ethical standards and best practices for radiation protection. Space radiation poses special risks to crew health and safety during a mission and also has clinically relevant implementations for crew life expectancy. Space radiation differs substantially from the radiation environment on Earth, and consists mainly of high- energy protons and atomic nuclei of the heavier elements. The results of research on radiation are targeted to allow crewmembers to participate in long-duration missions beyond low-Earth orbit.

Contact: **Ms. Debra R. Spears**, (202) 358-1952, Debra.R.Spears@nasa.gov

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Advanced Life Support - Exploration beyond low-Earth orbit and making use of resources discovered in new environments require the basic tools already developed on Earth for energy production and the recycling of essential life-support components, such as air and water. These basic tools have been developed and optimized on Earth, but biological and physical processes often perform quite differently in reduced-gravity environments. Over the next 10-15 years, the enabling knowledge and technology base will be built for exporting the technology processes developed on Earth to new, reduced-gravity environments. The primary challenge for life- support systems is to move from largely open systems that require frequent resupply to closed systems that recycle air, water, and waste. It is also important to reduce the size and complexity of life support systems with a thorough understanding of sensitivity to gravity, multiphase flow, microbial dynamics, and heat and mass transport processes. The resulting systems must require less power than current systems, be highly reliable and autonomous, and be physically smaller than current systems. Another challenge is to develop advanced extravehicular activity systems, including a protective suit optimized for use on planetary surfaces. It will be critical to develop portable life- support systems for extravehicular activity that save consumables and meet requirements for carbon dioxide, humidity, and trace contaminant removal, with regenerable closed-loop thermal control, passive and active radiation shielding, and monitoring capabilities.

Contact: **Ms. Debra R. Spears**, (202) 358-1952, Debra.R.Spears@nasa.gov

SCIENCE MISSION DIRECTORATE – EARTH SCIENCE

Program Administrator:
Ms. Anne N. Crouch
Science Mission Directorate
Earth Science
NASA Headquarters
Washington, DC 20546-0001
Phone: (202) 358-0855
Fax: (202) 358-2770
anne.n.crouch@nasa.gov

Using the unique vantage points from space, aircraft, and in situ platforms, NASA's Office of Earth Science is dedicated to developing a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. Applying NASA's system engineering approach and the research results, the ESE also supports the development of decision-making tools, predictions, and analysis for policy and management decisions.

The key research topics for the Office of Earth Science fall largely into three categories: forcings, responses, and the processes that link the two and provide feedback mechanisms. The following question represent one of our guiding research questions:

How is the Earth changing and what are the consequences for life on Earth?

Further details about the Earth Science Strategic Plan, the Research Strategy for 2000-2010, and the Application Strategy for 2002-2012 are available at http://w ww.earth.nasa.gov/visions/inde x.html

The Office of Earth Science participates in the GSRP, and in addition offers the Earth System Science (ESS) Fellowship Program (http://resear ch.hq.nasa.gov/code_y/code_y.c fm). The terms for both programs are essentially the same except for the schedule; the deadline for applying to the GSRP is February 1 each year, and the deadline for applying to the ESS Fellowship Program is March 15. The GSRP applications received under "Headquarters" and "Earth Science" are reviewed together with the applications received for the ESS fellowship program, and the selections are announced at the end of June each year. (Applicants cannot concurrently receive more than one Federal fellowship or traineeship.)

Applications are considered for the research themes listed above and may be in atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, geophysics, and information science and engineering, provided that the specific research topic is relevant to NASA's Earth remote sensing science, process studies, modeling and analysis in support of the U.S. Global Change Research Program (USGCRP). The Office of Earth Science discourages submission of paleo-climate or paleo-ecology related applications to this program. Proposals that address the molecular biology, biochemistry, development, physiology, or evolution of living organisms, but do not focus on ecosystems (terrestrial or marine) and their role in the Earth system functioning, should be submitted to other appropriate elements of this GSRP (e.g., Office of Biological and Physical Research, Office of Space Science, etc.) Additional information about Earth Sciences is available at http://www.earth.nasa.gov/.

Students admitted to or already enrolled in a full- time MS and/or Ph.D. program at accredited U.S. universities are eligible to apply. Students may enter the program at any time during their graduate work. Students may also apply in their senior year prior to receiving their baccalaureate degree, but must be admitted and enrolled in a MS and/or Ph.D. program at a U.S. university at the time of the award. United States citizens and resident aliens will be given preference, although the program is not restricted to them. Students with disabilities and from underrepresented minority groups are urged to apply. No applicant shall be denied consideration or appointment as a NASA Earth System Science fellow on grounds of race, creed, color, national origin, age, or sex.

The announcement for ESS Fellowship applications is made in mid-December each year, with proposals due in mid-March and selections made at the end of June of the following year. The announcement, including a detailed description of the submission procedure, is available under "Office of Earth Science" at http://research.hq.nasa. gov/.

Water and Energy Cycles - Characterize and predict trends and changes in the global water and energy cycles. Mission activities that support this theme element include TRMM, GRACE, Cloudsat, and GPM.

Goddard Space Flight Center and Langley Research Center play primary role in supporting SMD - Earth Science in this theme element; Jet Propulsion Laboratory, and Marshall Space Flight Center have supporting role.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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Carbon Cycle and Ecosystems - Understand and predict changes in the Earth's terrestrial and marine ecosystems and biogeochemical cycles. Mission activities that support this theme element include Landsat and Landsat Continuity, NPP, OCO, Terra, and Aqua.

Goddard Space Flight Center plays primary role in supporting SMD - Earth Science in this theme element; Jet Propulsion Laboratory, Stennis Space Center, Ames Research Center, and Marshall Space Flight Center have supporting role.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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Weather - Develop the technology, observational and modeling capacity needed to improve daily and extreme weather forecasting (e.g., hurricanes, tornadoes). Mission activities that support this theme element include TRMM, Quikscat, GPM, and Aqua.

Goddard Space Flight Center and Marshall Space Flight Center play primary role in supporting SMD - Earth Science in this theme element; Jet Propulsion Laboratory has supporting role.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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Climate Variability and Change - Develop integrated models of the ocean, air, cryosphere and land surface, and apply to retrospective and future studies of climate variability and change. Mission activities that support this theme element include Terra, Aqua, Cloudsat, ICEsat, Glory, Aquarius, and OCO.

Goddard Space Flight Center and Jet Propulsion Laboratory play primary role in supporting SMD - Earth Science in this theme element; Langley Research Center, Ames Research Center, and Marshall Space Flight Center have supporting role.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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Atmospheric Composition - Understand the trace constituent and particulate composition of the Earth's atmosphere and predict its future evolution. Mission activities that support this theme element include SAGE, UARS, TOMS, Aura, Glory, OCO, and Calipso.

Goddard Space Flight Center, Jet Propulsion Laboratory, Ames Research Center, and Langley Research Center play primary role in supporting SMD - Earth Science in this theme element.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

Earth Surface and Interior - Utilize state-of-the-art measurements and advanced modeling techniques to understand and predict changes on the Earth's surface and in its interior. Mission activities that support this theme element include GRACE, ICEsat, and the Geodetic Network.

Jet Propulsion Laboratory plays primary role in supporting SMD - Earth Science in this theme element; Goddard Space Flight has supporting role.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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Earth Science Applications - The source of inputs (scientific knowledge, observations, and predictions) to the Earth Science Application program is the Earth System Science program. NASA research and development of Earth System Science has yielded significant accomplishments in the form of an armada of remote sensing satellites, a comprehensive data and information management system, and realistic Earth system models of complex and dynamic Earth processes and their predictions of key types of information. These remote sensing systems and science models, along with the scientific knowledge, observations, and prediction are inputs - from the standpoint of our partners - to the decision support systems. The outcomes of Earth Science Applications are improved decision support tools generating positive impacts on national policy and management decisions in a range of activities from coastal evacuations due to hurricanes to positioning of fire fighting resources in national forests. The target impacts are improvements to the quality and effectiveness of operations and policy management by enabling decision makers to benefit from decreasing uncertainties associated with complex and dynamic Earth system processes. SMD - Earth Science has identified twelve applications of national priority: carbon management, public health, energy management, aviation, water management, homeland security, coastal management, disaster management, agricultural efficiency, invasive species, ecological forecasting, and air quality.

Contact: **Ms. Anne N. Crouch**, (202) 358-0855, anne.n.crouch@nasa.gov

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SPACE OPERATIONS MISSION DIRECTORATE

Program Administrator:

Ms. Debbie Brown-Biggs
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The NASA Headquarters Office of Space Flight (OSF) supports basic and applied research in human exploration and development of space. All OSF research programs and opportunities are offered and managed directly through the NASA OSF Centers (JSC, KSC, MSFC, and SSC). Refer to the research opportunities at Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and Stennis Space Center for contact names and detailed information regarding each research opportunity. Be sure to direct any inquiries you may have to the Center contacts.

Johnson Space Center (JSC)

- Advanced Life Support Systems
- Orbital Debris Hazard Assessment

Kennedy Space Center (KSC)

- Fluid System Technologies
- Spaceport Structures and Materials
- Process and Human Factors Engineering
- Command, Control, and Monitoring Technologies
- Range Technologies
- Plant and Microbiological Science

Marshall Space Flight Center (MSFC)

- Propulsion Research Center
- Propulsion Research Center/Plasma Propulsion
- Propulsion Research Center/Gasdynamic Mirror Fusion Propulsion Engine Experiment
- Propulsion Research Center
- Propulsion Research Center

Stennis Space Center (SSC)

- Thrust Measurement System
- Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems
- Vehicle Health Management/Rocket Exhaust Plume Diagnostics
- Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters
- Ground Test Facilities Technology
- Intelligent Monitoring and Diagnosis of Sensors, Processes, and Equipment in Rocket Test- Stands
- Advanced Propulsion Systems Testing
- Propulsion Test Research in Thermal and Acoustic Environment- Prediction and Control

SCIENCE MISSION DIRECTORATE – SPACE SCIENCE

Program Administrator:
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The NASA Headquarters Science Mission Directorate (SMD) supports basic and applied research in space science. The SMD research program includes the development of major space flight missions; analysis of data from prior missions; and the Supporting Research and Technology (SR&T) program which includes development of instruments for suborbital flights and potential missions, detector development, complementary laboratory research, and theoretical studies.

The fundamental questions and goals for NASA's space science research activities are given in the Space Science Strategic Plan and can be accessed at the web site: http://www.hq. nasa.gov/office/codez/plans/SSE00plan.pdf. Interested proposers are advised that historically the response to this GSRP program has been extremely high, with a selection ratio of about one out of five, and that a key criterion for proposal evaluation and selection is the relevance of the proposed investigation to the NASA mission as described in this Space Science Strategic Plan. Therefore, regardless of the quality of their academic records, students should consider applying to this program only if they can present valid lines of reasoning that their intended research is clearly relevant to NASA SMD space science research programs and/or missions and/or strategic objectives. Programmatic factors may also affect selection (for example, see specific priorities in the Universe Division listed below). The program should present a well-defined problem and justification of its scientific significance, as well as a detailed approach for its solution.

Research that exploits analysis of data collected by spacecraft-borne instruments, relevant ground-based data and laboratory experiments, and theoretical modeling is solicited. Emphasis is placed on the development and implementation of a multifaceted program of space- based and suborbital (airborne, sounding rocket, and balloons) missions. Investigations that support instrumentation development relevant to future missions in the above areas, the analysis of data from ongoing and past missions, and laboratory and theoretical investigations that support the interpretation of relevant space-based observations are invited. Individuals are strongly encouraged to make their proposals directly relevant to the mission of the SMD space science research themes and to clearly indicate which theme area they are proposing to. In particular, recent successful proposals have concentrated on developing hardware or modeling tools and carrying out essential observations for specific NASA-supported missions.

Structure and Evolution of the Universe (SEU) - Addresses cosmology, large scale structure of the universe, evolution of stars and galaxies, including the Milky Way, and objects with extreme physical conditions. Questions of interest are: What is the universe? How did it come into being? How does it work? What is its ultimate fate? Research in the Structure and Evolution of the Universe theme is focused into campaigns targeted towards the search for dark energy and its effects on the expansion of the Universe, the identification of dark matter and its influence on the shape of galaxies and clusters of galaxies; finding out where and when chemical elements were made; understanding of the cycles in which matter, energy, and magnetic field are exchanged between stars and interstellar gas; discovery of how gas flows in disks and formation of cosmic jets; identification of sources of gamma-ray bursts and high- energy cosmic rays; measurement of strong gravity near black holes and its affects on the early Universe.

Contact: **Ms. Dolores Holland**, (202) 358-0734, dolores.holland@hq.nasa.gov

Astronomical Search for Origins (ASO) - Addresses the origins of galaxies, stars, protoplanetary disks, extra- solar planetary systems, Earth-like planets and the origin of life. Questions of interest are: How were galaxies born? How do stars and solar systems form? Are there other Earth-like planets? Research in the Astronomical Search for Origins theme is focused on determining the fate of the baryonic matter; measuring the luminosities, forms, and environment of galaxies back to the epoch of their formation; trace the chemical evolution of the universe from the birth of the first stars; follow the journey of the heavy chemical elements after their birth to the formation of dust, new generations of stars, and planetary systems; search for evidence of planet formation in disks around young stars; determine how planetary-system forming disks evolve; search for other planetary systems around a variety of stars and determine their characteristics; reconstruct the environmental history of Earth in the first billion years when life arose; characterize the traits of the universal common ancestor through phylogenetic analyses; characterize the range of atmospheric compositions that might be produced by microbal ecosystems; develop theoretical models for the compositional evolution of early Earth's atmosphere through to the accumulation of significant O2; and to predict possible global biosignatures of planets around other stars. Because of the oversubscription of excellent proposals in the program, the Universe Division (which includes both the SEU and ASO themes) has set specific programmatic priorities. The priorities to be applied, starting with the highest, are: 1. Work in support of technology for future SEU and ASO missions not supported by technology funding; 2. Work in support of suborbital flights or possible future explorers addressing the objectives of the two themes; 3. Analysis and interpretation of data for SEU and ASO flight missions not otherwise supported with adequate resources for users outside the experiment teams; 4. Correlative observations for current SEU and ASO flight missions; 5. Theoretical investigations in support of future or ongoing flight missions within the two themes; 6. Other analyses or theoretical studies related to the general objectives of the two themes. 7. Other work in support of the SEU and ASO goals of Space Science Strategic Plan.

Contact: **Ms. Dolores Holland**, (202) 358-0734, dolores.holland@hq.nasa.gov

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Solar System Exploration (SSE) - Addresses scientific activities that pertain to the solar system, including planets, moons, rings, asteroids, and comets. Questions of interest are: What is the origin of the solar system and how did it evolve to its current diverse state? What characteristics of the solar system make planetary bodies habitable? Has life ever existed on other planetary bodies in the solar system? What is the ultimate fate of the solar system? What threat is posed by the potential for collisions with Earth- approaching objects? Acceptable research topics in the Solar System Exploration theme include studies of the planets, rings, moons, comets, asteroids, meteorites, and cosmic dust. Areas of research interest include planetary geology, geophysics, geochemistry, atmospheres, astronomy, and astrobiology. Research using data collected by missions to explore our solar system is encouraged. The data are available through the Planetary Data System at http://pds.jpl.nasa.gov/. Projects that involve theoretical modeling or laboratory experiments to aid in interpreting planetary data and understanding planetary processes are also appropriate.

Contact: **Ms. Dolores Holland**, (202) 358-0734, dolores.holland@hq.nasa.gov

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The Sun-Earth Connection (SEC) - Addresses the understanding of the Sun, heliosphere, and planetary environments as a single connected system. Questions of interest are: Why does the Sun vary? How do the planets respond to solar variations? How do the Sun and galaxy interact? How does solar variability affect life and society? Research in the Sun-Earth Connections (SEC) theme focuses on investigations of the physics of the Sun, both as a nearby star and as a source of variable outputs of solar wind, energetic particles, and electromagnetic radiation that influence the Earth and its space environment; on the heliosphere and its interaction with the local interstellar medium; and on all planetary environments within the heliosphere. Studies of the planetary environments include investigations of the coupling between the variable Sun and the magnetosphere, ionosphere, thermosphere, and mesosphere of the Earth and other planets. The program also involves investigations of the origin, evolution, and physics of astrophysical plasmas, electromagnetic fields, and energetic particles in the heliosphere. The theme also supports theory and modeling programs related to the above topics. Use of data is encouraged from SEC missions, which include SOHO, TRACE, RHESSI, Voyager, Ulysses, ACE, IMAGE, Cluster, TIMED, and others. The proposer should make clear that arrangements have been made to obtain the data.

Contact: **Ms. Dolores Holland**, (202) 358-0734, dolores.holland@hq.nasa.gov

Information Systems - Information Systems research applies new developments in computer science and information technology to benefit space science endeavors. This includes a broad range of areas, including: science data management and archiving; software technology; data analysis, mining, and exploration; visualization; computational methods and algorithms; knowledge management and synthesis; collaborative environments; and autonomous systems.

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CENTER SPONSORED GSRP OPPORTUNITIES FOR 2005

AMES RESEARCH CENTER (ARC)

Program Administrator:
Ms. Brenda Collins
University Affairs Officer
NASA Ames Research Center
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Moffett Field, CA 94035-1000
Phone: (650) 604-3540
Fax: (650) 604-0978

Ames is the NASA designated Center of Excellence for Information Technology and has Agency lead mission responsibility for Astrobiology, Aviation Operations Systems, and Aviation System Capacity. Other areas of research excellence include human factors, autonomous systems, nanotechnology and device modeling, high-performance computing and communications, gravitational biology, infrared astronomy, rotorcraft technology, and thermal protection systems. Ames is home to three national wind tunnel complexes (including the world's largest), several advanced flight simulators, supercomputers, arc jets, and a suite of centrifuges that serve as a national resource. Ames has unique resources for studying vertical takeoff aircraft in collaboration with the Army. The close juxtaposition with Silicon Valley and world-class universities make Ames a stimulating place to work.

In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.

Earth Atmospheric Chemistry and Dynamics - Research in this area includes the development of models and the use of airborne platforms and spacecraft to study chemical and transport processes that determine atmospheric composition, dynamics, and climate. These processes include the effects of natural and man-made perturbations.

Contact: **Steve Hipskind**, (650) 604-5076, shipskind@mail.arc.nasa.gov

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Ecosystem Science - Research in this area is directed to advanced understanding of the physical and chemical processes of biogeochemical cycling and ecosystem dynamics of terrestrial and aquatic ecosystems through the utilization of aerospace technology.

Contact: **James A. Brass**, (650) 604-5232, jbrass@mail.arc.nasa.gov

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Aerospace Technology - In aerospace, Ames concentrates on aviation systems including air traffic control and the simulation and modeling of aviation systems, thermal protection systems; runway independent aircraft technologies; integrated vehicle health management systems; systems analysis; and vehicle aeromechanics, controls, and crew interface systems.

Contact: **Thomas A Edwards**, (650) 604-4465, Thomas.A.Edwards@nasa.gov

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Air Traffic Management - Projected demands on the nation's air transportation system necessitate continued research to develop information systems and automation that will provide increased system capacity while maintaining safety. NASA is working to develop technology for the FAA and airspace users that enables more efficient air traffic management by predicting aircraft positions and conflicts so automated advisories can be generated to optimize schedules and resolve conflicts. The research also emphasizes human factors and advance display development to facilitate the human/automation systems interfaces.

Contact: **Heinz Erzberger**, (650) 604-5425, herzberger@mail.arc.nasa.gov

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Modeling of Air Traffic Management System Concepts - Air traffic management systems globally are transitioning and changing in order to cope with the existing and predicted growth of the air transportation system. NASA is working to define alternative system-level concepts for the national air transportation system and to develop a simulation and modeling capability for design and tradeoff studies of these concepts. The research includes the development and validation of an integrated suite of air traffic system component models that include the airspace, varying levels of automation, and human performance. The research also emphasizes assessments of automation tools, concept elements such as traffic flow management and self-separation, and system-wide concepts.

Contact: **Karlin Roth**, (650) 604-6678, kroth@mail.arc.nasa.gov

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Runway Independent Aircraft (RIA) Technologies - Effective response to the long-term demand for dramatic increases in air transportation (both passenger and cargo) requires the timely introduction of advanced aircraft configurations that are capable of making optimal use of airport infrastructure and land area. In collaboration with RIA operations, interest in this research area includes performance and control of new short take-off and landing vehicle concepts, integrated optimization of vehicle characteristics and operational procedures, safety with emphasis on take-off/climb and approach/landing, and environmental compatibility with emphasis on minimization of community noise. The approach to this research includes systems studies, computational modeling, and ground-based simulations.

Contact: **Lawrence E. Olson**, (650) 604-6681, lolson@arc.nasa.gov

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Distributed Sensing - The use of wireless distributed embedded systems for measurement, analysis, and control of processes will form the basis of advanced transportation systems that exhibit exceptional levels of safety, robustness, and efficiency. In addition, such systems are required to support the development of advanced biologically based systems. Research is required to develop the required advanced sensor technology; techniques to power such systems; software for data processing, compression and fault detection; and communications, networks, and architectures.

Contact: **James C. Ross**, (650) 604-6722, jcross@arc.nasa.gov

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Conceptual Design and Systems Analysis - The ability to develop new concepts and assess their overall characteristics from a systems point of view is essential to optimize the selection of new concepts for development to achieve the required levels of performance and to minimize life cycle costs. To achieve the desired level of fidelity, new conceptual design and systems analysis tools are required to account for broader range of disciplines being considered such as maintenance, safety, uncertainty, risk management, integrated system health management, and life cycle costs. In addition, research is required into the application of such systems analysis techniques to a larger spectrum of disciplines such as air traffic control and information technologies.

Contact: **Mary Livingston**, (650) 604-0148, mlivingston@arc.nasa.gov

Aircraft Controls and Displays - Design and evaluation of human-centered cockpit technologies for aircraft, flight control theory, control system design procedures and design tools, cockpit display and symbology design principles, guidance and navigation, vehicle and human performance modeling, simulation and flight investigations and demonstrations.

Contact: **Jeffery Schroeder**, (650) 604-4037, jschroeder@mail.arc.nasa.gov

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Aeromechanics of Vertical Flight - Experimental and theoretical research programs to improve performance, vibration, and noise of advanced vertical flight aircraft. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames/Army 7x10-foot wind tunnel and in the National Full-Scale Aerodynamics Complex, which includes the 40x80-foot and 80x120-foot wind tunnels.

Contact: **Gloria Yamauchi**, (650) 604-6719, gyamauchi@mail.arc.nasa.gov

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Aerothermodynamics - Provides aerothermodynamic flowfield computational capability to analyze and design advanced space transportation concepts including launch and planetary entry vehicles. Core capability in modeling arc-jet flow for high enthalpy ground testing and traceability to flight.

Contact: **Dean Kontinos**, (650) 604-4283, dkontinos@mail.arc.nasa.gov

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Thermal Protection Materials and Systems - Develops lightweight, reusable ceramic Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes. Materials include ultrahigh temperature ceramics for leading edge applications, improved ceramic tiles, coatings, and high heat flux ablators for high speed Earth and planetary entry missions. Research is also carried out in self-healing TPS, rapid and reliable TPS inspection technology for Shuttle and future RLV's, and Superthermal insulation. The Branch develops and characterizes materials, and also fabricates flight hardware.

Contact: **Sylvia Johnson**, (650) 604-2646, smjohnson@mail.arc.nasa.gov

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Integrated Tools for Aerothermodynamic Analysis to Support Thermal Protection System Design - Core capabilities in developing design tools, processes, and information for integration of high-fidelity modeling into the design process. Emphasis towards high end computing for simulation of high enthalpy flows and development of methods for leveraging multiple simulations to generate design information.

Contact: **Dean Kontinos**, (650) 604-4283, dkontinos@mail.arc.nasa.gov

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High Enthalpy Flow Instrumentation Development - Performance of research of new instrumentation measurements devices for use in high enthalpy arc jet facilities. Devices would measure conditions relevant to determination of the operations of the facilities, the facility aerothermal environments, or the response and interaction with test articles in the facility.

Contact: **Joe Hartman**, 650-604-5269, jhartman@mail.arc.nasa.gov

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Computational Chemistry - Application of molecular structure, molecular dynamics and molecular modeling techniques to a wide range of problems of NASA interest. Current research activities focus on nanotechnology, device modeling high-energy density materials, combustion research, polymers, astrophysics, aerothermodynamics, and atmospheric chemistry. Specifically, we are interested in computing accurate thermodynamic properties, vibrational frequencies and intensities, molecular line strengths, reaction rates, electron-molecule cross sections, transport properties and spectroscopic constants. We are also interested in porting and extending code for current and next generation parallel architectures.

Contact: **Winifred Huo**, (650) 604-6161, whuo@mail.arc.nasa.gov

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Applied Computational Fluid Dynamics - This area deals with the development of new computational methodology and tools involving aerodynamic and/or fluid dynamic application associated with incompressible, subsonic, transonic, and supersonic speeds. Computational tools are constructed and evaluated for applications associated with steady and unsteady flows, flows with aeroelastic effects, and optimization. Computational flow simulation codes are integrated with information technology tools to provide capability for high-fidelity analysis involving development of aircraft and/or spacecraft components and systems.

Contact: **Dochan Kwak**, (650) 604-6743, dkwak@mail.arc.nasa.gov

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Turbulence Physics - Study of the fundamental physics of turbulent and transitional flows through numerical simulations and experiments. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated, databases, developing turbulence models for engineering applications, and performing experiments to understand flow physics and support turbulence model validation.

Contact: **Nagi Mansour**, (650) 604-6420, nmansour@mail.arc.nasa.gov

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Systems Health and Safety - The primary focus of this research is to demonstrate information processing algorithms of a generic nature that may be used in next generation aerospace vehicles to detect, isolate, or rectify imminent or foreseeable component malfunctions. This work will be explored within the framework of advanced avionics architectures to improve aircrew caution/warning advisories, provide input to onboard adaptive flight/propulsion control systems, or trigger on-condition ground maintenance. The coordinated technical efforts involved include: model-based signal analysis, machine pattern classification, multivariate sensor fusion, testability analysis, multi-signal modeling, flowgraph analysis, damage trajectory modeling, optimal decision-making, design analysis, and manufacturing variations.

Contact: **Edward Huff**, (650) 604-4870, ehuff@mail.arc.nasa.gov

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Information Physics - The objectives of this research are to explore new insights into physical laws that may be gained by adopting a viewpoint of 'information' and 'computation' in analyzing experiments, as well as the design and analysis of information storage, processing, and transmission systems that must be carried out within the framework of physical laws. Work in this area is designed to explore and exploit the fundamental relationships between physics and information along both of these avenues. In both of these endeavors, the ultimate goal is to meet future mission needs for advanced technologies capable of handling extremely difficult information storage and processing tasks by a minimum expenditure of physical resources.

Contact: **Dogan Timucin**, (650) 604-1262, timucin@ptolemy.arc.nasa.gov

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Artificial Intelligence - Basic and applied research is conducted in the framework of aerospace domains including space transportation, space science, and aerospace. Three research areas are emphasized: Planning (including both goal- and resource-driven approaches); machine learning (entire spectrum from empirical to knowledge-intensive); and the design of and reasoning about large-scale physical systems

(including work in knowledge acquisition, knowledge base maintenance, and all applications to the design process).

Contact: **Mark Shirley**, (650) 604-3389, shirley@ptolemy.arc.nasa.gov

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Applied Information Technology - As an expert center for computer security and workgroup/workflow, Ames will play a considerable role in developing and integrating the “Office of the Future” into the NASA environment. Taking advanced technologies from Ames' Information Technology Center of Excellence and from industry, engineers and computer scientists will adapt these concepts to desktops throughout the Agency.

Contact: **Scott Santiago**, (650) 604-5015, ssantiago@mail.arc.nasa.gov

Information Power Grid - This research is directed toward a wide-area, heterogeneous, high performance computing, communications, and data environment for aerospace applications. Includes architecting seamless grids of high-end resources, scheduling, programming services, problem solving environments, metadirectories, and multiauthority security for a scalable infrastructure of services.

Contact: **Jerry Yan** , (650) 604-4381, yan@nas.nasa.gov

Neuroelectric Technologies for Augmented Human-System Interaction - Neuroelectric technologies will add completely new modes of interaction that operate in parallel with keyboards, speech, or other manual controls, thereby increasing the bandwidth of human-system interaction. Current research is focused on brain-computer interface development using electroencephalographic (EEG) methods, which bypass muscle activity and draw control signals directly from the human nervous system. A second focus lies in human performance optimization. This work includes estimation or prediction of human perception and performance from electrical measures of brain function such as event-related potentials. In both areas, there is a strong emphasis on the development of new methods for biomedical signal processing.

Contact: **Leonard Trejo**, (650) 604-2187, ltrejo@mail.arc.nasa.gov

Human Performance Modeling - The Cognition Laboratory conducts research into human cognition and information processing with the goal of improving operator performance and operational safety. Research concentrates on aerospace applications such as air traffic control and launch operations. Field and laboratory studies are integrated into computational models of the human operator that predict performance in complex dynamic environments. We have developed a computational architecture, Apex, that simulates operator multitasking behavior and provides support for building models of human cognition.

Contact: **Roger Remington**, (650) 604-6243, rremington@mail.arc.nasa.gov

Virtual Environments - Research is conducted on the physiological and psychological phenomena that constrain human performance in virtual environment and augmented environments (see-through head mounted displays). Emphasis is placed on operator interaction with virtual objects and improving the perceptual and motor fidelity through geometric, dynamic and symbolic enhancement of the computer graphics, which are used to produce the virtual environments and virtual objects.

Contact: **Stephen Ellis**, (650) 604-6147, sellis@mail.arc.nasa.gov

Spatial Auditory Displays - The NASA Ames Spatial Auditory Displays Laboratory conducts basic and applied research in spatial auditory perception and localization with the goal of successfully implementing virtual acoustic displays for improved operator efficiency and safety in aerospace applications. The Lab's work is also concerned with the human factors of auditory displays in general, including speech communications systems, non-speech warnings and information displays.

Contact: **Elizabeth Wenzel**, (650) 604-6290, bwenzel@mail.arc.nasa.gov

Visual Displays for Aerospace - NASA Ames Research Center is investigating displays for cockpit situational awareness, with the intention of assisting the implementation of free flight. This work is in to the RTCA Task Force 3 Report on Free Flight Implementation, which identified cockpit situational awareness displays as a key component of the next generation air traffic management (ATM) system. This report states "The architecture and technology on which the emerging ATM system is based makes increasingly heavy use of new displays that provide flight crews with real time situational awareness." Therefore, the RTCA report recommends the immediate initiation of "the development of standards for a cockpit situational awareness display of traffic information (CDTI)." Determining these standards requires a detailed human factors evaluation, where the nature and format of the displayed information are examined. The Cockpit Situational Display Research Team has been assigned to assess this task.

Contact: **Walter Johnson**, (650) 604-3667, wjohnson@mail.arc.nasa.gov

Vision Science - Experimental and theoretical research on human vision and applications of this research to coding, analysis, and display of visual information.

Contact: **Andrew Watson**, (650) 604-5419, abwatson@mail.arc.nasa.gov

Image Processing - Basic and applied research on computational algorithms for automatically extracting information from still images and video data. Current projects in the computational vision laboratory at Ames Research Center include automatic detection of air traffic using airborne cameras, locating features in close-up images of the human eye for movement tracking, and computational assessment of the visual quality of coded or compressed images. These and other applications employ fundamental image processing techniques such as spatial and temporal filtering, registration, and warping.

Contact: **Jeffrey Mulligan**, (650) 604-3745, jmulligan@mail.arc.nasa.gov

Infrared Astronomy Projects and Technology Development - Current research is focused on the integration of the design tools to allow full system simulation prior to SOFIA operation. The technology tasks include IR detectors and cryogenics. Multi-element IR detector arrays are developed and characterized for space astronomy. Advanced efficiency cooling techniques are developed for space.

Contact: **Diane Wooden**, (650) 604-5522, Diane.H.Wooden@nasa.gov

Infrared Observational Astronomy and Instrumentation - Young stars, circumstellar disks, and the interstellar medium are being studied with observations conducted from ground- and space-based observatories. These data are interpreted in collaboration with Ames theorists and laboratory astrochemists. Advanced infrared instruments are also being studied and developed for use on SOFIA, the Next Generation Space Telescope, and other NASA observatories.

Contact: **Tom Greene**, (650) 604-5520, Thomas.P.Greene@nasa.gov

Theoretical Astrophysics - Research is being conducted on star formation, circumstellar disks, the physics and chemistry of the interstellar medium, and the formation and dynamical evolution of galaxies. Theoretical models involve the application of computational techniques to problems in astrophysical gas dynamics, radioactive transfer, and many-body systems.

Contact: **David Hollenbach**, (650) 604-4164, dhollenbach@mail.arc.nasa.gov

Planetary Science - Research in this area focuses on objects in our solar system—the atmospheres, surfaces, and rings of both terrestrial and gas giant planets and their satellites. Spacecraft and ground-based observations and theoretical modeling are being conducted.

Contact: **Jeff Cuzzi**, (650) 604-6343, jcuzzi@mail.arc.nasa.gov

Planetary Science - The wealth of information returned by the Galileo, Cassini, and Mars Global Surveyor spacecraft continues to advance theories of surface formation and evolution. Our research focuses on the geomorphological evidence for processes that have shaped the surfaces and interiors of solid bodies over the age of the solar system. Comparative studies of planetary systems are utilized to understand the geological histories and petrology of icy bodies (Europa, Ganymede, Callisto, Triton, Pluto/Charon) and other planets (Mars, etc.). Geochemical and geophysical modeling of the internal processes shaping the surfaces of Mars, the Galilean and Saturnian satellites, and other objects are combined with remotely sensed data sets to provide qualitative and quantitative understanding of the forces that shaped these worlds.

Contact: **Jeff Moore**, (650) 604-5529, jmoore@mail.arc.nasa.gov

Exobiology - Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and Earth's surface environments.

Contact: **David Des Marais**, (650) 604-3220, ddesmarais@mail.arc.nasa.gov

Planet Formation and Detection of Extrasolar Planets - Several aspects of planetary growth are being modeled: Agglomeration of dust into planetesimals; dynamical interactions of planetesimals and their accretion into terrestrial planets and giant planet cores; and accumulation of giant planet atmospheres. Planets around other stars are being searched for using the photometric (transit) and Doppler (radial velocity) techniques.

Contact: **Jack Lissauer**, (650) 604-2293, lissauer@ringside.arc.nasa.gov

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Astronomical Data Analysis - Development of new analysis methods for time series and other data streams from NASA's Great Observatories, including high-energy missions such as gamma-ray and x-ray telescopes. The new algorithms under study include wavelet methods, time frequency distributions, Bayesian statistics and related methods (including implementation of Markov Chain Monte Carlo integrations). In addition, simulations of the dynamical systems thought to underlie the astronomical objects and their luminosity variability are highly informative.

Contact: **Jeff Scargle**, (650) 604-6330, jeffrey@cosmic.arc.nasa.gov

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Space Biology - Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms.

Contact: **Ruth Globus**, (650) 604-5247, rglobus@mail.arc.nasa.gov

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Neurosciences - Research in neurosciences examines how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability can be enhanced. To elucidate mechanisms underlying adaptation, neurosciences research includes neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and experimental and physiological psychology. State-of-the-art facilities include: human and animal centrifuges, linear motion devices, an animal care facility, a human bed-rest facility, and NASA's Vestibular Research Facility.

Contact: **Malcolm Cohen**, (650) 604-6441, mmcohen@mail.arc.nasa.gov

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Space Physiology - Multidisciplinary research in space physiology emphasizes the effects of hypergravity, gravity and microgravity on cardiovascular, musculoskeletal, and regulatory systems of humans and animals. Actual microgravity and ground-based models of simulated microgravity are used to investigate basic mechanisms of adaptation to space and readaptation to Earth. Physiological, biomechanical, cellular, and biochemical factors are also studied to develop appropriate countermeasures for maintaining health, well being, and performance of humans in space.

Contact: **Charles Wade**, (650) 604-3943, cwade@mail.arc.nasa.gov

Life Support - Research is conducted in the broad area of regenerative life support for space: the conservation and reuse of materials consumed by space crews. Issues of interest include the use of physical and chemical devices for air regeneration, water purification, waste management and oxidation and atmosphere contaminant control. Also of interest are systems control, systems modeling and simulation, and the potential role of biological systems in life support supplementation.

Contact: **Mark Kliss**, (650) 604-6246, mkliss@mail.arc.nasa.gov

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Atmospheric Physics - Research in this area advances the scientific knowledge and understanding of the physical processes that determine the behavior of the atmosphere on Earth and other solar system bodies. Experimental and theoretical research is conducted in the areas of aerosol and cloud microphysics, atmospheric modeling, atmospheric radiation, and high-resolution infrared spectroscopy with the main focus on current environment and climatic issues. By utilizing cutting-edge and information technologies and unique instrumentation, research techniques are developed to implement these research goals.

Contact: **Warren Gore**, (650) 604-5533, wgore@mail.arc.nasa.gov

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Ecosystem Science and Technology - Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered.

Contact: **James A. Brass**, (650) 604-5232, jbrass@mail.arc.nasa.gov

Genome Research - NASA Ames Genome Research Facility (www.phenomorph.arc.nasa.gov) was established in 2002 with a capital grant of $2 million from the NASA Fundamental Biology Program and the Center for Nanotechnology to support NASA research needs in Genome Science and Nanotechnology. The Facility is a state-of-the-art research laboratory designed to provide service in large-scale genome research to government, public and private organizations, and to advance NASA research objectives in genomics and bio-sensor technology development through collaborative projects with academic and industry partners. It is an excellent resource for training highly motivated young investigators in an emerging interdisciplinary filed of fusion between biological science and nanotechnology. With the rapid accumulation of sequenced genomes and the development of technologies to analyze these DNA sequences, Genomics is emerging as an independent field of science.

Technology development is central to Genome Science. In addition to development of faster and less expensive DNA sequencing technologies, advances in the ability to assay functionality of genes and proteins on a genome-wide scale have revolutionized the biological sciences. Future advances in Genomics will include DNA sequencing with speeds that are orders of magnitudes beyond our current capabilities, development of technologies to probe the functions of entire genomes rapidly and with high accuracy, development of computational approaches for analyzing and modeling complex biological systems, and development of technologies to engineer genomes and organisms through gene and chromosome synthesis. These developments are essential to achieve the goals of the new NASA Exploration Initiative. This goal cuts across many areas of expertise, including molecular genetics, computer science, engineering and physics. It also is of great interest to a wide range of institutions, both public and private. Some of the most exciting advances in Genome Science can be realized through collaborative interactions among institutions with complementary expertise, and under programs that stimulate intellectual and technical exchange. It is with the intention of stimulating such an inter-institutional and inter-disciplinary collaboration explicitly in mind that the NASA Ames Genome Research Facility proposes to support a post-doctoral training program in collaboration with academic centers of excellence (such as Baylor College of Medicine, Stanford University, University of California, Berkeley, University of Wisconsin-Madison, and Yale University (see http://phenomorph.arc.nasa.gov/collaborators.php) for developing the most promising young researchers in the field of Genome Science and Nanotechnology. Post-doctoral fellows will be trained in bio-informatics (development of computational algorithms for DNA sequence and whole-genome functional data mining), molecular biology (design and use of high-density-oligonucleotide arrays for whole genome functional analysis), genetics (whole-genome parallel mutagenesis and functional analysis with molecular barcodes), chemistry (oligonucleotide synthesis, sequencing and gene assembly using novel oligonucleotide high-density array synthesis methods), and nanotechnology (development of a nanopore DNA sequencing device using electron beam and ion beam sculpting methodology and electro-physiology). For current research projects at the NASA Ames Genome Research Facility, which include development of a reader for single molecules of nucleic acids, decoding DNA sequence variations in any organism, and applications of functional genomic assays to determine molecular information processing functions in model organisms, please review http://phenomorph.arc.nasa.gov/index.php.

Contact: **Viktor Stolc**, (650) 604-0018, Viktor.Stolc-1@nasa.gov

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Genomics - The NASA Ames Genome Research Facility supports genome research and genetic discovery across the entire biological spectrum, from viruses, bacteria, fungi, to plants, animals and humans. NASA Ames Origin 3000 super-computer is used with in-house software development to accelerate the gene function discovery process. By genetic modification of genomes in model organisms and by use of natural products for chemical genetics, we seek to observe phenotypes that provide insights into gene function. Identification of genome-wide phenomena, such as RNA processing and splicing, and detection and correlation of DNA sequence variation with phenotype are the broad subjects under investigation.

Contact: **Viktor Stolc, Ph.D.**, (650) 604-0018 , vstolc@mail.arc.nasa.gov

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Electro-physiology/ion channel - Computational modeling and patch clamp experimental studies of the flux and interactions of nucleic acids with ions, water, and walls of a solid-state nanopore channel for optimization of nanopore structure and signal recognition of nucleic acids is the broad subject under investigation

Contact: **Viktor Stolc, Ph.D**, (650) 604-0018 , vstolc@mail.arc.nasa.gov

Engineering for Complex Systems - The ultimate goal of the research is to help NASA achieve ultra-high levels of safety and mission success through improved understanding of system and organizational risk, improved trade-space analysis capabilities, more complete knowledge acquisition and communication, and more adequate assessment and control strategies.

Contact: **David A. Maluf**, (650) 604-0611, Dmaluf@mail.arc.nasa.gov

DRYDEN FLIGHT RESEARCH CENTER (DFRC)

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Within the concept of NASA's Mission, Dryden is a leader in implementing the Aeronautics Research Mission Directorate's program strategies and fulfilling key support roles for other Mission Directorates. We build partnerships and alliances with the scientific and technology communitites, academia, and industry, tapping into each other's strengths, for our continuing journey of exploration. We use our programs' content to nurture developing minds. We seek and develop new knowledge that promises to improve lives, enhance security, and stimulate economic growth. We will use our resources to do those things that Dryden is uniquely qualified to do, particularly complementing the capabilities of the other Centers. We are committed to innovation and the origination of transformational technologies needed to further enable NASA's ability to achieve its Mission objectives.

A wide range of research activities are in progress at NASA Dryden Flight Research Center at any one point in time, ranging from validation of advanced aeronautical and control systems concepts and atmospheric flight testing of future space-access technology demonstrators to Earth science experiments.

Dynamics and Controls-Advanced Digital Flight Controls - A wide range of research activities are in progress at NASA Dryden Flight Research Center at any one point in time, ranging from validation of advanced aeronautical and control systems concepts and atmospheric flight testing of future space-access technology demonstrators to Earth science experiments. Most of these programs and projects are in keeping with the "Revolutionary Vehicles" element of NASA's Aeronautics Blueprint, an integrated strategy that addresses the challenges in aviation by developing technology solutions to create environmentally compatible aircraft with revolutionary capabilities for unprecedented levels of performance and safety.

The following are research areas in Dynamics and Controls: Modeling, simulation, and flight testing of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.

Contact: **Joe Pahle**, (661) 276-3185, Joe.Pahle@nasa.gov

Flight Systems: Vehicle Ultra-reliable Flight Control Systems - Research into the analysis and design of flight control and other flight critical systems to increase reliability of these systems by one or more orders of magnitude is of interest at NASA Dryden. Promoting overall vehicle reliability, reducing vehicle operating cost, and improving mission effectiveness are the goals to be achieved through this research. Advancements in component, redundancy, and architectural approaches as well as others are sought in this research area. One application of near term interest is the inclusion of these technologies in ultra-long duration flight at high altitudes for addressing the required increase of reliability while avoiding large penalties for increased weight and power requirements.

Contact: **Bob Antoniewicz**, (661) 276-3800, bob.antoniewicz@nasa.gov

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Dynamics and Controls - Flight Dynamics - The following are research areas in Flight Dynamics: Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.

Contact: **Joe Pahle**, (661) 276-3185, joe.pahle@nasa.gov

Flight Instrumentations - The following are research areas in Flight Instrumentation: Flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, and digital data processing.

Contact: **Ron Young**, (661) 276-3741, Ronald.M.Young@nasa.gov

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Aerodynamics - The following are research areas in Aerodynamics: laminar and turbulent flow boundary-layer drag reduction, configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number research technology, high angle of attack aerodynamics, advanced instrumentation development research, Aero-Gravity Assist simulation, rapid prototyping of aerodynamic simulation model databases and atmospheric processes research.

Contact: **Al Bowers**, (661) 276-3716, Al.Bowers@nasa.gov

Propulsion and Performance - The following research areas in Propulsion and Performance are: Propulsion controls, integrated propulsion/airframe systems, and vehicle performance measurement.

Contact: **Dave Lux**, (661) 276-3695, david.p.lux@nasa.gov

Aerostructures - Dynamics - The following are research areas in Aerostructures: Vibration and flutter prediction by finite element based aeroelastic and aeroservoelastic analysis, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, active control of structural resonances, and advanced flight test technique development.

Contact: **Larry.Reardon**, (661) 276-3024, Larry.Reardon@dfrc.nasa.gov

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Dynamics and Controls - Aircraft Automation - The following are the research areas in Aircraft Automation: Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/ implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, and robotic aircraft.

Contact: **Joe Pahle**, (661) 276-3185, joe.pahle@nasa.gov

Aircraft Simulation - The following are current research areas in Aircraft Simulation: high-fidelity generic aircraft modeling of aerodynamics, propulsion and structural dynamics for a wide range of classes of aircraft; and a data collection and analysis software suite for simulation and verification and validation support."

Contact: **Jeanette Le**, (661) 276-2044, Jeanette.H.Le@nasa.gov

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Aerostructure: Modeling, Indentification and Control - Aerostructural Modeling, Identification, and Control Safer and more efficient design of advanced aerospace vehicles requires advancement in current predictive design and analysis tools. Aeroservoelastic testing is often extensive and time consuming for careful and safe envelope expansion. Aeroservoelastic models are subject to errors resulting from simplifications in structural, aerodynamic, and control system modeling. Robust estimation methods to identify and generate models describing nonlinear phenomena is extremely important to NASA Dryden and the flight test community for stability estimation and control objectives. Research is in progress to investigate methods of aeroservoelastic modeling with uncertainty descriptions consistent with the data. Dryden is also studying linear and nonlinear identification algorithms and methodologies for in-flight aeroservoelastic robust stability determination. Use of advanced data-adaptive analysis methods are being encouraged for more informative data acquisition. Intelligent data processing and analysis routines are required to accomplish the goal of accurate stability and performance determination during flight. This integrated research effort requires innovative data processing, modeling, identification, and robust system theory applications. Control objectives include feasible and realistic boundary layer and laminar flow control, aeroelastic maneuver performance and load control including smart actuation and active aerostructural concepts, autonomous health monitoring for stability and performance, and drag minimization for high efficiency and range performance.

Contact: **Marty Brenner**, 661-276-3793, Marty.Brenner@nasa.gov

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Flight Systems - Vehicle Health Monitoring/Management - Advancement of the monitoring and management of the health status of vehicle subsystems and the synergistic integration of health information from the variety of vehicle subsystems are of significant interest at NASA Dryden. These technologies are important in decreasing the cost of operation of commercial and military aircraft, and are of critical importance to the deployment of UAVs. This information is necessary for advanced vehicle management systems and mission planning in order to maximize mission effectiveness. Research in the areas of wiring systems health monitoring, propulsion health monitoring, actuator health monitoring, and other subsystem health monitoring as well as the integration of these subsystem health monitoring technologies to identify and isolate broader system issues are of interest in Flight Systems.

Contact: **Bob Antoniewicz**, (661) 276-3800, bob.antoniewicz@nasa.gov

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Aerostructures - Advanced Structure Concepts - The following are research areas for Advanced Structure Concepts: Flight Loads Research, Test Technique Development, Structural Dynamics Test and Analysis Research, Structural Health Monitoring, Aero/Thermal/Structural Test and Analysis Research.

Contact: **Larry Reardon**, 661-276-3024, Larry.Reardon@dfrc.nasa.gov

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Within NASA, Glenn Research Center is designated as the lead Center for Aeropropulsion from subsonic to hypersonic speed. In this capacity it is Glenn's role to develop, verify, and transfer aeropropulsion technologies to U.S. industry. Glenn is, also, a designated Center of Excellence in Turbomachinery. The role here is to develop new and innovative turbomachinery technology to improve the reliability and performance, efficiency and affordability, capacity and environmental compatibility of future aeronautical and space propulsion systems. Other Glenn primary areas of expertise embody a broad array of research and technology development efforts in the areas of aerospace power, aerospace communications, and biological and physical research, including combustion science and fluid physics. Brief descriptions of some of the major research activities at Glenn follow.

Propulsion Systems Analysis - Advanced propulsion system concepts are conceived and analyzed to estimate performance for typical and advanced, futuristic flight vehicle applications, determine relative merits compared with present and future proposed alternative propulsion systems, and derive optimum designs of systems integrated with a vehicle. Also, analytical and numerical models that predict performance, noise, weight and cost of complete propulsion systems, components and technologies are developed, along with models of flight vehicles.

Contact: **Christopher A. Snyder**, (216) 977-7018, Christopher.A.Snyder@nasa.gov

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Advanced Sensors, Electronics and MEMS/Nano Technology - Research and development in advanced smart sensing concepts, sensor and biosensor technology, high temperature electronics materials and devices, MEMS and nanofabrication, integration and applications. Emphasis is on developing advanced capabilities for measurement and control of harsh aerospace propulsion systems. Specific areas of work include extreme high temperature sensors for surface temperature and strain measurements, pressure sensors, heat flux gages, chemical species sensors, silicon carbide crystal growth, modeling, and all areas of electronic device fabrication technology, MEMS micromachining, micro- and nanofabrication, microsystem integration, testing and harsh environment application.

Contact: **Lawrence G. Matus**, (216) 433-3650, Lawrence.G.Matus@nasa.gov

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Optical Instrumentation and NDE Technology - Research and development of optical measurement technology for smart aerospace propulsion and power systems, including system monitoring, diagnostics, and testing. This technology includes laser-based imaging techniques, micro-optics, sensor webs, quantum optics, nanotechnology and biomimetics. Biomedical applications of these technologies are also sought. New systems for both high spatial resolution and high temporal resolution of parameters such as velocity, temperature, pressure, damage and species concentration are conceived and developed in the division laboratories and applied in Center research facilities. Also, research and development in Nondestructive evaluation (NDE) science to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include nondestructive materials characterization for composite and monolithic advanced materials. These methods are used to assess quality, monitor degradation of components, aid life prediction models, and for structural health monitoring. Methods used and developed include ultrasonic guided and bulk wave methods, acoustics, x-ray microcomputed tomography, digital x-ray, and thermographic imaging.

Contact: **George Y. Baaklini**, (216) 433-6016, George.Y.Baaklini@nasa.gov

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Controls and Dynamics Technology - Development and demonstration of technologies for advanced control concepts, health management, and dynamic modeling that enhance performance, safety, environmental compatibility, reliability and durability of aerospace propulsion systems. Specific areas of controls research include fault diagnostics, health management, active combustion control, active stall control, active control of turbine tip clearance, turbomachinery system stability management, intelligent engine control, integrated flight/propulsion control, nonlinear and robust multivariable control synthesis techniques, and life extending control. Dynamic modeling research is focused on advanced propulsion concepts and components including turbomachinery, pulse detonation engines, and high-speed inlets.

Contact: **Sanjay Garg**, (216) 433-2685, Sanjay.Garg-1@nasa.gov

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Ceramic-Matrix Composites - Description: Development of structure/processing/property relationships of ceramic-matrix composites including fibers and fiber coatings for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications (e.g., SiC/SiC, C/SiC, and oxide/oxide). Various processing approaches, including polymer pyrolysis, melt infiltration, and sol- gel processing, are being pursued. Properties of interest include interface stability, flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack. In addition, novel approaches for ceramic toughening, such as interpenetrating networks, are being pursued by conventional ceramic processing and crystal growth. Applications include various hot section components for aircraft and rocket engines, zirconia fuel cells and high temperature piezoelectrics.

Contact: **Serene Farmer**, (216) 433-3289, Serene.C.Farmer@nasa.gov

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Durability and Protective Coatings - Research studies are conducted to investigate the mechanisms of degradation and to establish and predict the thermochemical stability limits for advanced materials in the high and ultrahigh temperature, hostile environments encountered in advanced aerospace propulsion and power systems. Oxidation, corrosion, diffusion, erosion, wear and material compatibility of metals, ceramics, polymers and composite materials are studied in air, inert and simulated aerospace environments, under both isothermal and cyclic conditions. Various testing and characterization approaches, at the laboratory and subcomponent scale, are used to evaluate performance and guide the development of the materials and protective coatings to improve durability, through extension of useful life and/or maximum use-temperature. Barrier coatings are frequently required to protect the structural material from life- limiting degradation effects induced by thermal, environmental, diffusion, and/or erosion and wear issues, of the targeted application(s). The coatings are typically deposited as overlays, via plasma spray, vapor deposition techniques, or by using solution-based methods. Also, coatings produced by a wide variety of other techniques are typically evaluated and characterized for their protective ability. Environmental life prediction and process modeling is an important component of this work. The research area is interdisciplinary by nature, involving high temperature chemistry, physics, materials science, mathematics, as well as chemical, mechanical, and materials engineering.

Contact: **Leslie A. Greenbauer-Seng**, (216) 433-6781, Leslie.A.Greenbauer-Seng@nasa.gov

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Metallic Materials - Development of structural metallic materials for aerospace propulsion systems. Intermetallic compounds, superalloys, copper alloys, refractory metals, aluminum alloys and composites are being studied for improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being developed and experimentally verified. Advanced analytical and microscopy techniques are employed.

Contact: **Michael V. Nathal** , (216) 433-9516, Michael.V.Nathal@nasa.gov

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Polymers and Polymer Matrix Composites - Development of advanced polymers and polymer matrix composites for use in aerospace propulsion and power and space transportation systems. Areas of research include polymer synthesis, characterization, and processing (including thermal and radiation curing); composite processing, characterization and evaluation; interface studies; polymer/composite aging and life prediction; determination of structure/property relationships; and the application of nanotechnology and biotechnology in the development of new organic/polymeric materials. Key areas of interest include high use temperature polymeric materials, carbon nanotube based polymeric materials, polymer-clay nanocomposites, aerogel hybrid materials, battery electrolytes, fuel cell membranes, “smart” polymers, and single molecule sensors for biological and chemical species. Research is interdisciplinary and involves work in organic and polymer chemistry, physics, chemical engineering, materials science and engineering, and mechanical engineering.

Contact: **Michael A. Meador**, (216) 433-9518, Michael.A.Meador@nasa.gov

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Combustion Science, Fluid Physics, Biomedicine, and Biology - Investigations devised to utilize a microgravity environment to develop technologies enabling human space exploration in the areas of combustion science, fluid physics, biomedicine, and biology research. NASA Glenn Research Center has a world-class and unique suite of ground-based microgravity research facilities that include: a 2.2-second drop tower, a 5-second zero- gravity facility, and a reduced-gravity aircraft. These facilities are utilized for 1) developing longer- duration space flight experiments to be conducted on the Space Shuttle and the International Space Station, and 2) conducting enabling research for NASA's missions to the Moon and Mars. Focused research investigations are in the specific areas of spacecraft fire safety, advanced life-support systems, and in-situ resource utilization. Well- equipped state-of-the-art laboratories are used to develop new diagnostic techniques/instruments especially suited for use in space and microgravity environments. The investigations provide new knowledge that is used to improve processes and equipment (energy, environment, manufacturing, and medical) used for the exploration of space both robotically and by long-duration manned missions.

Contact: **David L. Urban**, (216) 433-2835, David.Urban@nasa.gov

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Electrochemical Systems - Development of advanced technology to increase the life, performance, specific energy, and energy density of energy storage systems and fuel cells. Emphasis is on near-term lithium-based systems and hydrogen-oxygen primary and regenerative fuel cell systems, with exploratory efforts being given to nanotechnology and more advanced high-temperature ionic conductor systems. Pre-prototypes of advanced battery systems are being designed, built and tested. Development efforts include basic research, modeling and analysis, and system design and evaluation of advanced electrochemical systems.

Contact: **Michelle A. Manzo**, (216) 433-5261, Michelle.A.Manzo@nasa.gov

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On-Board Propulsion - Research and development efforts on high performance electric and chemical propulsion system concepts that are candidates for applications ranging from precision positioning of microspacecraft to primary propulsion for manned planetary exploration. For electric propulsion, electrothermal, electromagnetic, and electrostatic thruster systems are considered with an emphasis on high power, high efficiency missions. The low thrust chemical effort focuses on high performance storable bipropellant engines, green monopropellant and bipropellant systems, and miniaturized systems for microspacecraft. Efforts range from basic research to focused development. In addition to thruster system development, heavy emphasis is placed on the identification and resolution of integration issues critical to the user community.

Contact: **Robert Jankovsky**, (216) 977-7515, Robert.S.Jankovsky@nasa.gov

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Photovoltaic Cells - Fundamental and applied research to increase the efficiency, reduce the weight, and extend the life of solar cells for space applications. Emphasis is on III-V compound solar cells, high bandgap materials, and thin film materials. Activities include chemical processing and deposition; materials studies; investigations of radiation damage effects; device design, fabrication, and testing; and the development of related component technologies such as cell contact metallurgy and optical concentrators.

Contact: **Roshanak Hakimzadeh**, (216) 433-8738, Hakimzadeh@nasa.gov

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Power Systems Surfaces and Materials Technology - Development of new or improved environmentally durable power materials, high emittance radiator surfaces, high reflectance or transmittance solar concentrators, high thermal conductivity materials and high electrical conductivity composites. Power materials and surfaces are developed by means of intercalation techniques, surface modification technology, and development of thin film coatings using various deposition techniques. Evaluations of functional performance and durability are conducted for exposure to atomic oxygen, ultraviolet radiation, vacuum thermal cycling and simulated lunar and Martian environments.

Contact: **Bruce A. Banks,** (216) 433-2308, Bruce.A.Banks@nasa.gov

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Space Solar Arrays - Development of advanced planar and concentrator array technologies, components, and concepts for small spacecraft that are efficient, stowable, lightweight, long-lived, and less costly than present systems. Array design features of interest include optical, electrical, thermal, and mechanical elements. Test, analysis and development activities can also support large spacecraft arrays including structural analysis of deployment mechanisms, testing system operation in simulated space environments, and studies of new array concepts.

Contact: **Roshanak Hakimzadeh,** (216) 433-8738, Hakimzadeh@nasa.gov

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Space Environmental Interactions - Research on radiation damage and electrostatic and electromagnetic effects in space systems and instrumentation (induced by interaction with space plasma and field environments) and on the characterization of local plasma and field environments around large space systems. Effects include surface and bulk dielectric charging, plasma sheath development, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines: plasma, solid- state, and surface physics, electromagnetism, and space system design fundamentals, and development of computer programs for simulation and modeling of spacecraft environment interactions.

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Space Power Management and Distribution Technology - Research and technology development to control the generation and distribution of electrical energy in aerospace systems and to define enabling technology for future aerospace power systems. Technologies being pursued include the development of intelligent modular converter technologies using semiconductor power electronic building blocks and advanced digital signal processors to facilitate the development of plug and play power systems. Furthermore, advanced magnetics and capacitor technology are being investigated along with silicon carbide semiconductor to enhance the overall converter power density and operating temperature range. In addition, work is also being done on high voltage space power systems including switchgear and converters to move to higher power space systems. These technologies will provide the foundation for the next generation of power distribution systems and advanced motor drives for future actuation and flywheel systems for aerospace application. Finally, some work is being done in the Integrated Vehicle Health Monitoring (IVHM) to utilize advanced automation techniques to detect and correct faults within the power management and distribution system.

Contact: **James F. Soeder,** (216) 433-5328, James.F.Soeder@grc.nasa.gov

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Thermo-Mechanical Systems Technologies - Develop technologies for high efficiency conversion of thermal energy (solar or nuclear) to electric power and thermal management. Emphasis on advances in free-piston Stirling power conversion and associated subsystems such as thermal transport and electric controllers. Stirling application is intended to be conversion of heat from isotope for deep space applications and Mars rovers, although solar applications are of interest. Also have effort in Brayton cycle conversion technology for space-based applications. Optical technologies include solar inflatable solar concentrators and an advanced refractive secondary concentrator. Thermal management involves the theoretical and experimental feasibility study of advanced lightweight survivable, deployable radiator concepts, advanced high performance technologies to cool electronics, thus providing high-density packaging and advanced cooling and refrigerator/freezer systems. Systems analysis to guide the advanced space power technologies and to support mission planning through the Virtual Design Centers is also conducted.

Contact: **Richard K. Shaltens,** (216) 433-6138, Richard.K.Shaltens@grc.nasa.gov

Antenna, Microwave, and Optical Systems Branch - Research and advanced development of phased arrays for space communication systems in support of NASA missions and commercial applications. Traditional areas of R&D include development of X-, Ku-, K-, Ka-band and higher frequency arrays and array feeds in which distributed Monolithic Microwave Integrated Circuit (MMIC) devices provide amplitude and phase weighting; but alternate, potentially lower cost space-fed active array approaches are also of interest. Principal thrusts are in characterization of MMIC phased-arrays, beam forming/combining networks, dynamic BER and fiber optic links in arrays. Emphasis is given to development of novel alternative antenna technologies such as thin film ferroelectric phase shifters and frequency agile devices and subsystems. Micro-electro-mechanical systems (MEMS) based reconfigurable patch antennas are being actively investigated. Systems and technologies for multiple beams such as space fed lens antennas, smart antennas, evolvable antennas, and digital beam forming are actively investigated. Optical antenna systems technologies for fine beam steerability and wavefront correction, as well as Optical Phase Array (OPA) antenna technology are investigated. Signal propagation studies at RF and optical frequencies are also investigated. Investigation of nanofibers for nanoantennas and nanoFETs arrays are also underway, as well as development of antenna technologies for wireless biomedical applications. State-of-the-art antenna metrology facilities as well as microwave and mm-wave R&D laboratories are available. Access to optical subsystem test beds is also available.

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Digital Communications Technology - Conducts research and technology development of digital communications, navigation, and surveillance technologies required for aeronautical and space systems applications. Research focuses on increasing information throughput and quality of service, improving bandwidth and power efficiency, minimizing hardware implementation complexity, reducing power consumption, and maximizing performance and reliability for aviation and space users requiring integrated communications, navigation, and surveillance (CNS) systems. Specific technologies include software radios; low power, reconfigurable transceivers; network interface controllers, hubs, and routers for space; bandwidth- and power-efficient digital modems; miniaturized, integrated optoelectronic devices. Research and technology development is conducted in-house and through contracts, grants, cooperative and Space Act agreements with universities, industry, and other government agencies. State-of-the-art computer simulation tools, FPGA design tools, proof-of-concept fabrication, and experimental testing (ground or flight) are used to perform these efforts.

Contact: **Gene Fujikawa**, (216) 433-3495, Gene.Fujikawa@nasa.gov

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Satellite Networks and Architectures - Conducts research and development of advanced aerospace communications network architectures, protocols, standards, technologies and network-based applications to enhance the capabilities of NASA Enterprises to accomplish their missions and objectives. Major research endeavors include: 1) simulation and modeling of next generation network architectures, protocols and topologies for aeronautics and space-based platforms and environments,
2) research into Internet-based protocols, standards, and algorithms to mitigate effects of high delay-bandwidth products, dynamic path delays and variable signal delays, 3) development of advanced test beds to benchmark and evaluate Internet-based protocols, standards and technologies for application to NASA missions, 4) active participation in the Internet Engineering Task Force workgroups that are applicable to the development and utilization of Internet- based protocols in aerospace environments, and 5) design and implementation of advanced hybrid network architectures to support NASA applications. Some specific areas of interest are TCP modifications and enhancements to mitigate variable delays and high latency, next generation transport protocol(s), mobile-IP/ routing, ad hoc networking, and quality-of-service protocols.

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Electron Device Technology - Research and development of innovative microwave/millimeter-wave vacuum and solid-state electron devices/circuits to meet NASA Enterprise mission requirements. We envision investigating devices based on IV-IV and III-V semiconductor materials, device physics, device modeling/simulation and characterization, and device reliability. In addition areas of particular interest include molecular electronics, quantum devices, nanoelectronics, high temperature superconducting microwave circuits, high temperature solid-state devices/circuits for wireless communications, cryogenic devices/circuits for low noise applications, and RF microelectromechanical systems (RF-MEMS) for phase shifters in phased arrays. State-of-the-art facilities include 1500 square feet class 100 clean room for device/circuit fabrication, automatic microwave/millimeter-wave vector network analyzers, and room/cryogenic temperature RF probe stations. Furthermore, the microwave vacuum electronics effort is directed towards improving the efficiency of traveling wave tube amplifiers for space communications. Specific technologies of interest are electron emission (including thermionic, field and secondary emission), electron beam formation and control, electromagnetic/electrodynami c computer modeling and design, application of microfabrication to vacuum devices, and microwave power modules. State-of-the-art computational facilities are available. Recently, we have included in our research interests photonic devices and circuits for satellite laser communications, and wide bandgap semiconductor devices for millimeter-wave solid-state power amplifiers.

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Probabilistic Space Biomechanics - Research shall be conducted for the development of probabilistic space biomechanics. There is an intensive research in biomechanics in recent years. The majority of the present research is simply an adaptation of what the mechanicians have been doing throughout their careers; for space, they consider the effects of microgravity. However, in all that research quantification of the uncertainties that are associated with the participating parameters, identified herein as primitive variables (PV), have not been pursued or even recognized. The proposed program will formulate space biomechanics by using the most fundamental variables by borrowing concepts from our composite micro and macro mechanics and by including space environmental effects. Subsequently, the PV's will be cast probabilistically by using the concepts that have been so successful in the development of probabilistic methods over the past two decades. The method will quantify the uncertainties at the bio-nanoscale and propagate those uncertainties in progressively higher scales all the way up to the scale that observations are made, or felt, in space environments. An example of the use of composite micromechanics is the blood flow in arteries and veins while in space. These two can be simulated by flexible hollow fibers of progressively smaller diameter with probable space effects and with the accompanying pressure provided by the heart. Reduction in blood pressure can be simulated by the viscosity of the hollow fiber walls as well as by the osmosis from the artery/vein to the adjacent muscle and from any probable space arteries/veins effects. The blood osmosis can be simulated by the inverse matrix temperature/moisture effect around a fiber for arteries. For veins it will be similar to the moisture and temperature simulation.

Contact: **Christos C. Chamis**, (216) 433-3252, Christos.C.Chamis@nasa.gov

Aeroacoustics - Analytical and experimental investigations of the aeroacoustics for air breathing propulsion systems for subsonic and supersonic civil transports. Advanced analyses are developed, applied and validated with experimental data. Model scale tests are conducted in anechoic wind tunnels to identify noise sources and explore new noise reduction concepts. Concepts are developed that reduce aircraft engine noise with minimal impact on aerodynamic performance. Current research emphasis is on fan and jet noise reduction.

Contact: **Dennis L. Huff**, (216) 433-3913, Dennis.L.Huff@nasa.gov

Computational Structures Technology - Development, integration, and demonstration of technology to enhance the role of computational modeling in the design and development process for propulsion and power system structural components. Both efficiency and credibility of computational modeling are of concern, so technologies that streamline the design/analysis process as well as improve the fidelity of computational predictions are of interest. Specific areas of interest include computer-integrated simulation, multidisciplinary computational mechanics, design optimization, and artificial intelligence. Simulation includes object- oriented technology, information models, product schema, distributed computing, virtual reality, and human interfaces. Computational mechanics includes fundamental mechanics principles, discrete solution methods, and parallel computing algorithms. Design optimization includes mathematical programming and optimality algorithms, heuristic methodology, and multidisciplinary design. Artificial intelligence includes expert systems and neural network applications.

Contact: **Dale A. Hopkins**, (216) 433-3260, Dale.A.Hopkins@nasa.gov

Probabilistic Nanomechanics - Research for developing methods and computer codes to predict probabilistic nanoscale mechanical behavior shall be conducted. There has been a "revolution" in nanotechnology. A part of that technology is directed towards the nanomechanics. However, the uncertainties associated with the variables that are essential to any nanomechanics are not even formally included. Because of the research and success that we have had in using probabilistic computational simulations methods during the last two decades, there is no good reason to suspect that those methods will not be equally applicable to nanomechanics. Therefore, the proposed research will concentrate on the development of probabilistic nanomechanics. Probabilistic methods in general are based on deterministic models where all the variables, identified herein as primitive variables (PV), are easily recognizable with their respective uncertainties. Subsequently, the probabilistic methods are applied to the deterministic model and the mechanics propagate those uncertainties to progressively higher scales. The uncertainties of the variable at each of the higher scales are included so that nanomechanics scale uncertainties can be probabilistically evaluated up to the structured scale where the loads and boundary conditions are usually applied.

Contact: **Christos C. Chamis**, (216) 433-3252, Christos.C.Chamis@nasa.gov

Deformation and Damage Mechanics - Research focuses on developing 1) advanced constitutive equations, 2) numerical algorithms for analysis and design, and 3) experimental validation of proposed theories and characterization of material response. Materials under investigation include advanced metallics, polymeric matrix composites, metal and intermetallic matrix composites, and ceramic matrix composites. The aim is to develop strain-based design methods, which predict useful life in components subjected to extreme thermomechanical loading conditions. Deformation mechanisms of interest include plasticity, creep, and relaxation, and material response is further complicated by the presence of multiaxial stress states and complex mission cycles. Damage evolution and failure definition under these conditions are component specific and material specific, and proper consideration needs to be given to thermomechanical effects, environmental effects, and their possible interaction. The theoretical work is supported by research at the mircostructural level to develop a detailed understanding of key deformation and damage mechanisms.

Contact: **John R. Ellis**, (216) 433-3340, John.R.Ellis@nasa.gov

Experimental Methods - Research focuses on providing experimental support to theoretical studies developing advanced constitutive models, life prediction models, and reliability models. Materials under investigation include monolithic alloys and ceramics, and also a range of composite materials, optimized and tailored for high temperature propulsion and power application. The type of experimental support provided falls into three categories; 1) exploratory tests are conducted at the coupon level to support early formulation of theoretical models by identifying key mechanisms, 2) characterization tests are conducted at the coupon level to fully define theoretical models for specific materials and design applications, and 3) validation tests are conducted at the subelement or subcomponent level to check the accuracy of theoretical predictions made for material in scaled-up form. Fully equipped, computer-controlled test systems are used to investigate material behavior under uniaxial and biaxial stress states. Large capacity test systems are available for tests on subelements and subcomponents. Also, advanced scanning electron microscopes, transmission electron microscopes, and microprobe facilities are available to investigate deformation and damage mechanisms at the microstructural level.

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Drive Systems Technology - Drive systems technology improvements are required for aerospace applications including advanced gas turbine engines, rotorcraft, and even planetary exploration vehicles. Systems having higher reliability, longer life and ultra-safe operation, higher power-to-weight ratio, lower noise, lower cost, and higher efficiency are highly desirable. Areas under study include health and usage monitoring systems, advanced drive system concepts, new gear arrangements and tooth forms, and advanced gear materials, surface treatments, lubrication, and cooling technologies. Full-scale rotorcraft transmission test rigs are available for experimental investigations, as well as component test facilities such as spur gear, spiral bevel gear, and face gear fatigue rigs.

Contact: **Robert F. Handschuh**, (216) 433-3969, Robert.F.Handschuh@grc.nasa.gov

Probabilistic Corrosion/Erosion of Composites - Research shall be conducted on the development of methods and computer codes for predicting corrosion/erosion in composites. Corrosion and erosion in composites has not been a mainstream investigation. There are a few papers here and there on some specific experimental investigations. A fundamental theory is sorely missing. One reason that this is the case may be the quantification of the many uncertainties that are present in that formulation. Therefore, the proposed investigation deals with the quantification of the uncertainties in predicting composite structural survivability in corrosive/erosive environments. The quantification of uncertainties is based on fundamental formulations where all the participating variables, primitive variables (PV), are readily identified and their independence can be easily observed. Subsequently, the probabilistic description is applied to the PVs and the probabilistic simulation proceeds progressively up the higher scales and to the scale that the response will be measured. There is no reason to assume that this approach will not work since it has worked successfully for all other but similar application during the past two decades.

Contact: **Christos C. Chamis,** (216) 433-3252, Christos.C.Chamis@nasa.gov

Structural Mechanics and Dynamics - Development of advanced programs for analyzing, predicting, and controlling the stability and dynamic response of aerospace propulsion and power systems. This work includes analytical and experimental studies of the aeroelastic response of bladed disk systems, and both active and passive damping and mistuning methods for controlling the vibration and stability of high-speed turbomachinery. Actively controlled rotors with magnetic suspension are being developed to apply to energy storage flywheel and a more electric gas turbine engine. Ultra-high power density electric motors for pollution-free aircraft are also being developed. Innovative computational methods for analyzing multi-component dynamic systems such as an engine/airframe system are being applied. Ballistic Impact experiments and structural analyses for engine containment, probabilistic analyses and design optimization methods are also being developed.

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Structural Integrity - Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by structural health monitoring of components, structures, material morphology, and other relevant factors. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.

Contact: **John P. Gyekenyesi**, (216) 433-3210, John.P.Gyekenyesi@nasa.gov

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Brittle Material Design Methodology - Analytical and experimental research programs are conducted to develop new design techniques and appropriate failure criteria for predicting structural response of high temperature, brittle materials to mechanical and thermal loading. Monolithic and composite advanced ceramics and intermetallics possess brittleness, anisotropy, and unavoidably contain a large number of processing flaws. These material characteristics lead to great variability in observed fracture strength and life, and thus to low reliability. In addition, ceramic structural integrity can depend on material volume or area under stress. Traditional deterministic design methods are unable to account for these phenomena; consequently, probabilistic approaches incorporating damage mechanics, weakest link and bundle theories must be used. For monolithic materials, both fast-fracture and time-dependent, subcritical-crack growth predictions are made using statistical and mechanistic failure concepts. The existence of several flaw populations is assumed along with coupled Weibull distributions. Theory is implemented through the development of a general purpose reliability computer program, which predicts the failure probability of any engine structure under specified load conditions and duration. For composite ceramics, both fast-fracture and time-dependent, residual strength predictions are made using statistical and damage mechanics concepts. Theory is implemented through the development of computer programs, which predicts the residual strength of composite components under specified duration, load, and temperature. Examples include the design of ceramic vanes and combustor liners for turbomachinery, and single crystal windows for the international space station combustion facility. In addition to macromechanics modeling, micromechanics modeling of composites is implemented in a variety of computer codes in order to tailor the architecture of composite materials, and to predict the mechanical properties of composites in orientations that are difficult to test.

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Tribology and Surface Science - Research to gain a fundamental understanding of the lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and high temperature demands of advanced aerospace propulsion and power systems. Liquid and solid lubricants for extended space exploration are formulated and characterized. Novel foil air-bearing designs and advanced solid lubricant formulations for use with these high temperature air bearings are investigated. Surface and interface chemistries and morphologies as well as tribological behavior are examined using a variety of techniques, including Auger electron and x-ray photoelectron spectroscopies, infrared and Raman microspectroscopies, scanning electron and atomic force microscopies and non-contact profilometry.

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Advanced Seals Technology - Advanced structural/thermal barrier seal technologies for current and future generation launch vehicles are being developed. Areas under study include development of resilient and durable seal concepts, development of analytical models to predict flow and thermal properties, and experimental testing of concepts in simulated launch and re-entry environments. New state-of-the-art structural seal test facilities are available to simulate compression, temperature, and control surface scrub conditions of current and future space launch vehicles. In addition, turbine engine seal technology is being developed for next generation aircraft engines having higher power- to-weight ratio, longer life, higher reliability, and higher efficiency. Areas under study include new contacting and non-contacting seal concepts, design optimization, and performance and durability tests under engine-simulated conditions (up to 1500°F). A state-of-the-art turbine engine seal test rig has been installed to test seals under all temperature, speed and pressure conditions envisioned for next generation commercial and military turbine engines.

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Aerospace Propulsion Combustion Technology - Research to better understand the basic physical and chemical processes in selected liquid rocket engine technologies that are synergistic to aeronautic propulsion. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, performance, and combustion stability. Of particular interest are the fundamentals involved in combustion; cooling; nontoxic and in situ propellant combustion component technologies; micro-combustor technologies including diagnostics and flow analysis; gas-gas injector technology including stability, performance, and compatibility; laser, combustion wave, and catalytic ignition; low cost combustion devices design; and non-intrusive diagnostics including quantitative supercritical spray characterization. Work is conducted through detailed analytical and experimental programs to determine feasibility or applicability and to develop and validate models to describe the processes.

Contact: **Chi-Ming Lee**, (216) 433-3413, Chi-Ming.Lee@nasa.gov

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Aircraft Icing - Analytical and experimental research directed at enhancing safety of flight and developing simulation tools to aid in design efforts associated with flight in icing. Technology elements of interest include: novel concepts for aircraft ice protection/detection; computational and experimental methods for simulation of aircraft icing; fundamental experiments to understand and model the physics of ice formations; computational and experimental methods for quantifying changes in aircraft performance with ice buildup on unprotected components; and novel concepts for remote detection of icing conditions. Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surfaces, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipped Twin Otter aircraft and in the Glenn Icing Research Tunnel, the largest refrigerated icing tunnel in the world.

Contact: **Thomas H. Bond**, (216) 433-3900, Thomas.H.Bond@nasa.gov

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Emissions Technology - Experimental and analytical research to advance the understanding of emissions formation in combustion processes in subsonic and supersonic gas turbine aircraft engines. Emittants concerned include oxides of nitrogen, speciation of hydrocarbons and sulfur oxides, and carbon-based gaseous or liquid particulates. Experimental work includes emission characterization in flame tube and sector combustors using advanced diagnostics. Analytical work includes the development of new analytical models for processes such as turbulence-chemistry interaction or the use of advanced computer codes to predict combustion emissions and compare with experimental results. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

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Engine Systems Technology - Analytical and experimental research in propulsion systems for subsonic, supersonic, hypersonic, and space applications. Advanced concepts currently of interest include rocket and turbine-based combined cycles and pulse detonation engines. These are developed through systems studies identifying critical component and component integration issues followed by experiments and additional analyses. Research also includes development and application of new techniques, such as advanced numerical methods, grid generation, and turbulence modeling, for analysis of aerospace propulsion systems. Advanced computational technologies, including parallel processing, interactive graphics, database technology and object-oriented techniques, are applied to propulsion system simulation to reduce the time and cost of system design. Optimization and inverse design methods are also of interest.

Contact: **Richard A. Blech**, (216) 433-3657, Richard.A.Blech@nasa.gov

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Inlet Fluid Mechanics - Experimental and computational efforts devoted to the fluid mechanics of inlets for aerospace propulsion systems for vehicles ranging from subsonic through supersonic and up to hypersonic. Experiments are intended to demonstrate overall inlet performance, investigate specific inlet flowfield phenomena, provide data sets for the validation of computational methods, and increase the understanding of fundamental inlet fluid physics. Computational research involves application of advanced methods to predict inlet aerodynamic performance, development of improved computational models, and development of new methods to improve computational accuracy and convergence rates. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

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Nozzle Technology - Analytical, computational and experimental research to advance the state-of-the-art in nozzle technology for aeronautical and space propulsion applications. Technology covers subsonic, supersonic and hypersonic propulsion systems, for commercial and/or military applications. Work involves design, analysis and experimental investigation of nozzle performance, mixing enhancement and noise reduction. Experiments are performed in small test rigs, wind tunnels, and as required, in large-scale engine and flight system tests. Data from experiments are used to calibrate and validate advanced computational fluid dynamics (CFD) codes with emphasis on advancement of turbulence modeling. The CFD capabilities are extended for the design and analysis of future nozzle concepts.

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Propellant Systems Technology - Research to advance the technology of aerospace propulsion propellant systems from ground support equipment to flight and into the low gravity environment. Disciplines include fluid dynamics, heat transfer, thermodynamics and high energy propellant chemistry. Of particular interest are the fundamentals applied to storage, supply and transfer of sub critical cryogens during launch and coast orbits and production, handling and ignition of densified propellants. Work involves development and usage of prediction codes to describe the processes and detailed experimental programs to validate the models.

Contact: **Michael L. Meyer**, (216) 977-7492, Michael.L.Meyer@nasa.gov

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Turbine Research and Technology - Research involving the development, assessment, and application of computational fluid dynamics tools and models for turbine design and analysis, and the acquisition and analysis of experimental measurements of flow and heat transfer in turbines. The computational emphasis involves the development and validation of advanced computer codes and models, modification of codes and models to extend range and accuracy, application of codes and models to practical problems. Measurements involve both simplified and realistic, complex geometries, and are used both for the validation of advanced numerical flow and heat transfer analysis codes and for the development of new physical models.

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Electric Propulsion - Research and development efforts on high performance electric propulsion system concepts that are candidates for applications ranging from precision positioning of spacecraft to primary propulsion for manned planetary exploration. Electrothermal, electromagnetic, and electrostatic thruster systems are considered with an emphasis on high power, high efficiency and long life. Efforts range from basic research to focused development. In addition to thruster system development, heavy emphasis is placed on the identification and resolution of integration issues critical to the user community.

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Compressor Research and Technology - Research involving the development, assessment, and application of computational fluid dynamics tools and models for fan and compressor design and analysis, and the acquisition and analysis of experimental measurements of flow in compressors. Focus is on compressors for aeronautical turbine engines for commercial and/or military applications, as well as compressors and pumps for space propulsion and power systems. The computational emphasis involves the development and validation of advanced computer codes and models, modification of codes and models to extend stable operating flow range and accuracy, application of codes and models to practical problems in the area of axial and centrifugal compressors and pumps. Measurements involve traditional instrumentation as well as laser and hot wire techniques, and are used both for the validation of advanced numerical flow analysis codes and for the development of new physical models.

Contact: **Joseph P. Veres**, (216) 433-2436, Joseph.P.Veres@nasa.gov

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Aerospace Power Management and Distribution Technology - Research opportunities in this subject deal with developing technologies that control electrical energy generation and distribution in aerospace power systems and define new enabling power technologies for future Aeronautics and Exploration initiatives. Current research and development topics are: semiconductor power electronic building blocks; advanced digital signal processors for plug- and-play power systems; magnetics, capacitors, and silicon carbide semiconductors to enhance converter power density and operating temperature range; high-voltage switchgear and converters for high-power aerospace systems; flywheel and associated motor drive technologies for peak power; Integrated Vehicle Health Monitoring to detect and correct faults; and advanced actuation systems for the next generation vehicles. These technologies will provide the foundation for the next generation of advanced power distribution systems.

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Thermal Energy Conversion Technologies - Plans, conducts and directs research and technology development to advance the state-of-the art in a variety of thermal systems for aerospace, as well as non-aerospace applications. The systems-to-energy conversion of interest include thermal energy conversion for space power systems and solar thermal propulsion systems. The effort involves working at the component-level to develop the technology, the subsystem-level to verify the performance of the technology, and the system level to ensure that the appropriate system-level impact is achieved with the integrated technology. Thermal system analysis is used to identify high-impact technology areas, define the critical aspects of the technology that need to be developed and characterize the system level impact of the technology. Research involves four basic areas: space power system analysis, advanced dynamic power generation, Stirling-engine and closed Brayton cycle development, and thermal management. System analysis involves component modeling of the heat source (nuclear, chemical, solar), the power conversion unit (Brayton, Rankine, Stirling, thermionic, thermoelectric, photovoltaic, thermophotovoltaic), the energy storage, and thermal management for space power systems in the tens of watts to the megawatt range. Current power systems include the 100 W class Radioisotope Power Systems and 100 kW class Nuclear Electric Propulsion power systems for near term and future NASA missions. The Stirling and Brayton development program involves advanced component development in the areas of heat exchangers, oscillating flow heat transfer, high- temperature magnetics, power conditioning integration, alternator improvements, and hydrodynamic and hydrostatic gas bearings. Thermal management involves the theoretical and experimental feasibility study of advanced lightweight, survivable, deployable radiator concepts and state-of-the-art technologies to cool electronics, thus providing high-density packaging. The tasks support NASA's mission by providing dynamic power system technologies for missions to the Earth, Moon, Mars, and Beyond for Project Prometheus and Project Constellation.

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GODDARD SPACE FLIGHT CENTER (GSFC)

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The mission of Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies. As NASA's lead center for the Earth Observing System, the central component of the Earth Sciences, Goddard's six major laboratories include a broad range of Earth science activities (atmospheres, hydrology, biology and geophysics) related to understanding the Earth as a total ecosystem, as well as a full spectrum of space sciences (astronomy, astrophysics, planetary studies, and space physics) keyed primarily to observations from Earth-orbiting platforms. Strong engineering, flight dynamics, mission operations, communications, data, and computing facilities support these science objectives, allowing Goddard to carry out all aspects of a space-borne science mission from initial concept to final data archiving.

Located on a 1,100-acre campus in suburban Maryland just outside of Washington, DC, Goddard is home to over 4,000 civil servants and 8,000 on-site contractors. Scientific collaborations and industrial partnerships make Goddard the hub of a national and international arena spanning all aspects of science from space.

Graduate Student Research Program opportunities are available in the Space Sciences Directorate, the Earth Sciences Directorate, and the Applied Engineering and Technology Directorate, and the Flight Programs and Projects Directorate. Research opportunities at Goddard's two remote facilities - the Goddard Institute for Space Studies in New York City and the Wallops Flight Facility on Wallops Island, VA - are included in these listings. Qualified applicants are strongly encouraged to explore areas of interests with the contacts listed prior to submitting a proposal.

Laboratory for Astronomy and Solar Physics - The Laboratory for Astronomy and Solar Physics (LASP) conducts a broad program of research in experimental and theoretical astrophysics. Astrophysical phenomena in the Sun, stars, and galaxies, as well as the medium between them, are studied with emphasis on their structure, origin, and evolution. Groups in the Laboratory are actively investigating areas such as active galactic nuclei, galaxy evolution, young stellar objects, solar coronal mass ejections, and the cosmic microwave background. Two instruments for the Hubble Space Telescope (HST) have been provided by LASP: the Goddard High Resolution Spectrograph (GHRS), and its replacement, the Space Telescope Imaging Spectrograph (STIS). The STIS science team is exploring fundamental problems in high spatial and spectral resolution spectroscopy of quasars, the intergalactic medium, circumstellar disks and evolved stars. The Laboratory is NASA's scientific center for development of the James Webb Space Telescope (JWST), a large aperture (6.5 m) cooled (50 K) near infrared space telescope. The primary goal of this telescope, to be launched in 2011, is to detect light from the first galaxies in the universe. The Laboratory also operates the Wilkinson Microwave Anisotropy Probe (WMAP) and is actively involved in developing future space observations of the cosmic microwave background and the high redshift universe in the far infrared. The Laboratory operates the Solar and Heliospheric Observatory (SOHO) in close coordination with the Transition Region and Coronal Explorer (TRACE), the Ramaty High Energy Solar Spectroscopic Imager (RHESSI) and other satellites in the Sun-Earth Connection program. LASP also operates the Solar Data Analysis Center, a major online source of solar and solar-terrestrial data. The Goddard Space Flight Center is the lead NASA Center for the "Living With a Star" Program and is heavily involved with the development of the Solar Dynamics Observatory. A new sounding rocket payload, the Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS), is now in fabrication to replace the highly successful Solar Extreme Ultraviolet Rocket Telescope and Spectrograph (SERTS). The EUNIS/SERTS program is based in the Laboratory. The Laboratory operates a strong instrument development program in support of rocket and balloon flights devoted to studying the solar corona, a variety of UV sources, and the cosmic infrared and microwave backgrounds. In addition, imaging, spectroscopic, and interferometric instrumentation is being developed for ground-based observatories including the Keck Interferometer, the Stratospheric Observatory for Infrared Astronomy (SOFIA), and the Space Infrared Telescope Facility (SIRTF), and the Far-Infrared and Submillimeter Telescope (FIRST). With partner institutions, we are actively pursuing instrumentation opportunities for the JWST and the Space Ultraviolet-Visible Observatory (SUVO) concept, among others. There will be many opportunities for technical studies of new instrumentation, new telescope designs, and next generation spacecraft operations. There are several archival research programs in progress based on data from the Infrared Astronomy Satellite (IRAS), Infrared Space Observatory (ISO), Cosmic Background Explorer (COBE), SOHO, International Ultraviolet Explorer (IUE), Galaxy Evolution Explorer (GALEX), GHRS, and STIS.

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Laboratory for High Energy Astrophysics - High Energy Astrophysics is the study, by way of X-rays, gamma rays, energetic particles and gravitational waves, of cosmic systems and sites and the physical processes operating therein. Studies of the mechanisms that release energy and accelerate particles, and of the thermal and nonthermal mechanisms that convert the kinetic energy of these particles into observable radiation, are the essential ingredients of high-energy astrophysics. High energy observations and theory address some of the most fundamental problems in physics and astrophysics: the search for the character and location of "dark matter", testing general relativity in the strong gravity limit, the origin and evolution of heavy nuclei, and the ultimate fate of matter. Studies are made of the accretion disks around, and magnetospheres of, compact objects such as neutron stars and black holes; abundance distributions of cosmic rays and hot astrophysical plasmas such as stellar atmospheres, supernova remnants, the interstellar medium, and intercluster gas; the origin of gamma-ray bursts; the natural acceleration of particles in space; the central engines of Active Galactic Nuclei; and the nature of large-scale extragalactic structures. A broad program of experimental and theoretical research is conducted in all phases of astrophysics associated with high-energy particles and the quanta produced in the interactions with their environments. The observables are features such as compositions, time variability, spatial structures, and spectral features of the X-ray, gamma- ray and gravitational-wave emissions and particle populations. Experiments are designed, built, tested, and flown on balloons, suborbital rockets, Earth-orbiting satellites and deep space probes. The resulting data are analyzed and interpreted by Laboratory scientists and their associates in the larger high-energy astrophysics community. These studies of the physics of solar, stellar, galactic, and metagalactic high-energy processes lead to development of theoretical models of the origins and histories of these particles and quanta, and provide understanding of the objects and environments in which they arise. Large-scale computations using supercomputers are used to model environments of astrophysical sources to compare with data taken and prepare for future missions.

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Space Science Data Operations Office - This organization offers exceptional opportunities for computer scientists seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include massive on-line data management, web-based user interfaces, computer networks, heterogeneous multisource databases, and data visualization. Research is conducted on advanced data systems for scientific data management using expert systems, database machines, mass storage systems and computer visualization, and on developing interactive scientific data systems integrating data archiving, catalog, retrieval, data and image manipulation, and transmission techniques into distributed systems.

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Space Physics Data Facility - This organization is engaged in a range of science research and information technology development efforts with missions such as IMAGE, Wind, Polar, and Geotail. Science areas of current interest include coordinated studies of magnetospheric structure and dynamics, trapped radiation modeling, low-energy cosmic ray studies and imaging of the Earth's magnetosphere with radio waves. The organization is active in data standards and the definition, implementation and operation of data systems supporting data acquisition and analysis from current and future space physics missions.

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Global Change Data Center - The Global Change Data Center's mission is to provide systems, data products, and information management services to maximize the availability and utility of NASA's Earth science data. The specific objectives are: (1) Support Earth science missions by developing and operating systems to generate, archive, and distribute data products and information; (2) Develop innovative information systems for processing, archiving, accessing, visualizing and communicating Earth science data; and (3) Develop value-added products and services to promote broader utilization of Earth science data and information. The ultimate product of the GCDC activities is access to data and information to support research, education and public policy. The GCDC is organized by projects. The major ongoing projects include Global Change Master Directory (GCMD), Goddard Earth Sciences Data Information Systems Center, TRMM Science Data and Information System (TSDIS). The Global Change Master Directory (GCMD) provides descriptions of Earth science data sets and services relevant to global change research. Locating and documenting all of NASA's Earth science data is a priority goal. It assists the scientific community in the discovery of and linkage to Earth science data, as well as provides data holders a means to advertise their data to the Earth science community. (http://gcmd.gsfc.nasa.gov) The Goddard Earth Sciences (GES) Data and Information Systems Center (DISC). The DISC provides data and services for global change research and education. The GES DISC maximizes the investment of the Office of Earth Science by providing data and services that enable people to realize the scientific, educational, and application potential of global climate data. As a source of information for atmospheric, hydrologic, land biosphere and ocean color data, the GES DISC facilitates the study of natural and human processes that influence Earth's climate, by processing, archiving, distributing, and providing user and value added data management services. (http://daac.gsfc.nasa.gov) TSDIS is the data and information processing facility for the Tropical Rainfall Measuring Mission (TRMM). TSDIS processes data from the three TRMM satellite instruments: the Visible and Infrared Scanner (VIRS), the TRMM

Microwave Imager (TMI), and the Precipitation Radar (PR). TSDIS also provides science support to the TRMM algorithm developers. This support includes evaluation of algorithms in the TSDIS Integration & Test Environment (ITE) and development of data display tools. (http://tsdis.gsfc.nasa.gov)

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Laboratory for Atmospheres - This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our ability to predict the weather and climate of the Earth's atmosphere; advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, mesosphere, and thermosphere; determining the role of natural and anthropogenic processes on the ozone balance and climate change; and advancing our understanding of the physical properties of the atmospheres of the Earth and other planets.

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Data Assimilation Office - Data assimilation combines information from observations with information from prognostic models to produce optimal time series estimates of the Earth. This Office advances the state-of-the-art of data assimilation and the use of data in a wide variety of Earth system problems, develops global data sets that are physically and dynamically consistent, provides operational support for NASA field missions and Space Shuttle science, and provides model-assimilated data sets for the Office of Earth Science.

Contact: **Robert Atlas**, (301) 614-6140, ratlas@dao.gsfc.nasa.gov

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Mesoscale Atmospheric Processes Branch - This branch performs research on a broad range of meteorological problems ranging from cloud scale to the global scale. The research emphasis is on cloud systems, especially on precipitating cloud systems and the remote measurement of precipitation but also including non-precipitating clouds, aerosols and the associated mesoscale processes. Specific topics include tropical and mid- latitude convective precipitation systems, fronts and gravity waves, tropical and extratropical cyclones, air-surface interactions, global precipitation analysis, cirrus cloud systems and aerosols and their effects. Scientists in the branch employ theoretical and numerical modeling methods and observational analyses. They develop advanced sensors for the measurement of precipitation, clouds, aerosols, water vapor and winds, with special emphasis on using radar and lidar systems. Branch scientists also formulate and participate in field measurement activities using ground-based, airborne and satellite sensors.

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Climate and Radiation Branch - This branch conducts basic and applied research with the goal of improving the fundamental understanding of regional and global climate on a wide range of spatial and temporal scales. Emphasis is placed on the physical processes involving atmospheric radiation and dynamics, in particular, processes leading to the formation of clouds and precipitation and their effects on the water and energy cycles of the Earth. Currently, the major research thrusts of the Branch are: climate diagnostics, remote sensing applications, hydrologic processes and radiation, aerosol/climate interactions, and modeling seasonal-to-interannual variability of climate.

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Atmospheric Experiment Branch - This Branch conducts experimental research in terrestrial, cometary and planetary atmospheres concerning chemical composition, atmospheric structure and dynamics. Scientists and engineers in the Branch participate in scientific investigations from experiment conception through flight hardware development, space flight and data analysis and interpretation. Neutral, ion, and gas chromatograph mass spectrometers are developed to measure atmospheric gases from entry probes and orbiting satellites.

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Atmospheric Chemistry and Dynamics Branch - This Branch conducts research aimed at understanding the radiation-chemistry-dynamics interaction in the troposphere-stratosphere-mesosphere system. Branch scientists develop remote-sensing techniques to measure ozone and other atmospheric trace constituents important for atmospheric chemistry and climate studies, develop models for use in the analysis of observations, incorporate analysis results to improve the predictive capabilities of models, and provide predictions of the impact of trace gas emissions on the ozone layer.

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Laboratory for Terrestrial Physics - The Laboratory for Terrestrial Physics (LTP) advances the scientific knowledge of the Earth and planetary solid-body physics. In the scientific branches, research is pursued on the distribution of mass within the Earth-ocean-atmosphere system, the origin of the Earth's magnetic field, the nature of the movement of the tectonic plates which form the Earth's crust, the effect of variation in the momentum of the atmosphere and changes in the hydrosphere on the Earth's rotation rate, the role of vegetation in the carbon cycle, the most efficient dataset required to detect and interpret change at the ecosystem level, and the nature of the surface topography and crustal interior structure of the Earth, Moon, and planets especially Mars and Venus. The Laboratory has a significant capability to design, develop and test laser and electro-optic remote sensing instruments. The LTP has designed and managed several spacecraft instruments.

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ART - Tetrahedra-based Reconfigurable Robotics - Research into the structural dynamics and control issues of the Addressable Reconfigurable Technology (ART) structures, which include an innovative robotic rover for exploring rugged planetary terrains. The basic building block of ART is a reconfigurable tetrahdron with nodes connected by variable-length struts. Multiple tetrahdra can be connected together to form highly complex functional structures. Control of the structural mesh can be centralized or distributed.

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Laboratory for Extraterrestrial Physics - The Laboratory for Extraterrestrial Physics (LEP) performs experimental and theoretical research on the physical properties of and dynamical processes occurring in the interplanetary and interstellar media, magnetospheres and atmospheres of the planets, including Earth. The Laboratory proposes, develops, fabricates, and integrates experiments on Earth-orbiting, planetary and interplanetary spacecraft, and sounding rockets. A major effort in the LEP is the analysis of data from spacecraft experiments flown on NEAR, ACE, Ulysses, Cassini, IMP-8, Geotail, Wind, Polar, Mars Global Surveyor, IMAGE, Lunar Prospector, and suborbital rocket payloads. Space physics research focuses on plasmas, magnetic fields, electric fields, and radio waves located in planetary magnetospheres and the interplanetary medium. A program in infrared astronomy includes the study of spectra of the outer planets to deduce atmospheric properties. Studies of planetary atmospheres and the solar spectrum in the infrared are also conducted. An extensive program of research, including spectroscopy and physical chemistry related to astronomical objects, studies of molecules and chemical reactions of astrophysical and aeronomic importance are also conducted in special laboratory facilities. Research related to the chemistry and physics of planetary stratospheres and tropospheres, and solar system matter including meteorites, asteroids, comet, and planets also forms an important component of the LEP research. A strong theoretical program exists which includes the study of solar wind turbulence, the modeling of the magnetosphere, the nonlinear dynamics of the magnetosphere and the development of the next generation of adaptive grid MHD simulation codes.

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Geodynamics - Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity and magnetic fields, the study of the lithosphere through magnetic anomalies, the rotational parameters of the Earth and planets, the measurement of Earth and planetary topography with altimeters and the study of planetary landforms and surface processes as related to crustal evolution.

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Terrestrial Information Systems - Advances research programs and institutional administrative activities through research in and applications of information technology. Activities include development of data systems to process and distribute information from Earth observing satellites, aircraft sensors, ground-based networks and field experiments, develop software for visualization, analysis, and presentation of scientific data.

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Biospheric Studies - Biospheric studies include research on terrestrial ecosystem-atmosphere interactions, and ecological patterns and processes occurring at local, regional and continental spatial scales, as well as basic remote sensing research. A wide variety of remote sensing models and passive and active instruments are used to develop a fundamental understanding of the interaction of electromagnetic radiation with terrestrial surfaces. Laboratory, field, aircraft, and satellite investigations are used to characterize the spectral distribution, bi- directional reflectance, and polarization response of terrain features at visible, infrared and microwave frequencies. Techniques are developed to create, process, and analyze multiyear global datasets. Time series of satellite data are used to study the seasonal dynamics of global vegetation, interannual variations in production of semi-arid grasslands, tropical forest alteration, boreal ecosystem change and to provide improved surface characterization for carbon and ecosystem models.

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Laser Instruments - Designs and develops advanced electro-optic and laser sensors for ground-based, airborne and spaceborne Earth and planetary science investigations. Work includes laser and detector research, sensor development research and conceptual design, performance calculations, sensor engineering and fabrication, as well as calibration and integration. Sensors are used for measurements of Earth and planetary surfaces and of the Earth's atmosphere and oceans. The branch also develops advanced laser sensors, including laser altimeters and lidar systems, for airborne and spaceborne use.

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Space Geodesy - Space Geodesy research studies the motion of the Earth on its axis, the kinematics of plate motion and deformation of the crust, the Earth and ocean tides, variations in sea level, core dynamics, and models of the gravity fields of the Earth and planets. Data comes from precise geodetic methods, including laser ranging and very long baseline interferometry, altimetry, data from highly accurate tracking systems such as GPS and doppler, gradiometry and satellite-to-satellite tracking.

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Laboratory for Hydrospheric Processes - The Laboratory performs theoretical and experimental research on various components of hydrology and its role in the complete Earth science system. The program is aimed at observing, understanding, and modeling the global oceans and ice, surface water, and mesoscale atmospheric processes. The Laboratory conducts research on Earth observational systems and techniques associated with remote and in-situ sensing.

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Oceans and Ice Branch - This Branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the Earth's climate. Research focuses on problems in biological, physical, and polar oceanography; glaciology; and marginal ice zones, air-sea interactions, and coupled climate modeling. Interdisciplinary studies on problems such as those involving productivity and carbon fluxes, seasonal-to-interannual prediction, upper ocean and thermohaline circulation of the oceans; ice/ocean coupling; and ice sheet dynamics are conducted. The branch is involved in a number of ongoing and planned NASA satellite missions, as well as field campaigns.

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Observational Science Branch (Wallops Island, VA) - This Branch conducts theoretical and experimental research to validate, calibrate and extend measurements made by Earth Science satellite sensors, as well as explores and develops new technology for improving measurements made not only from satellite but also from aircraft and ground-based instrumentation. It enables science by monitoring satellite altimeters such as TOPEX and quality controlling data they collect. The Branch also conducts fundamental research on Earth Science processes both in the laboratory and in worldwide field campaigns. The Branch does so by maintaining and operating research facilities which include: Air-Sea Interaction Facility (NASIF), Rain-Sea Interaction Facility (NRSIF), Rain Simulation Facility (RSF) and instrumentation systems which include: Airborne Oceanographic Lidar (AOL), Airborne Topographic Mapper (ATM), Scanning Radar Altimeter (SRA), Radar Ocean Wave Spectrometer (ROWS), the Experimental Advanced Airborne Research Lidar (EAARL), the TOGA C-band research weather radar and the new dual polarization weather research S-band (NPOL) Radars, Dobson spectrophotometer, and balloon-borne ozone and meteorological sensors. The Branch is located at the NASA GSFC Wallops Flight Facility at Wallops Island, VA.

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Hydrological Sciences Branch - Water sustains life on Earth unifying the land, oceans, and atmosphere into an integrated physical system. The movement of water in its various phases (gaseous, liquid, solid) across the Earth constitutes the global hydrological cycle, and the exchanges of energy associated with these phase changes are a fundamental driving force for our weather and climate systems. Despite its importance, some scientific aspects of the global hydrological cycle and its underlying physics are still poorly understood. That lack of knowledge prevents accurate estimates of global hydrological processes and limits our ability to understand and to predict the response of global hydrology to anthropogenic and/or natural climate change. The Hydrological Sciences Branch (code 974) at Goddard Space Flight Center is the only organization within NASA dedicated exclusively to the understanding, quantification, and analysis of the different components of the global hydrological cycle, with particular emphasis on land surface hydrological processes and their interaction with the atmosphere. Research activities focus on both 1) interpretation of remotely sensed data and 2) land surface hydrological, meteorological and climatological modeling. The integrating properties of remote sensing techniques provide a potential for complete hydrological measurements over multiple time and space scales. To realize this potential, the Branch is developing, testing, and applying algorithms for translating remotely sensed measurements into soil moisture content, snow mass, precipitation, evapotranspiration, vegetation density and other relevant hydrological quantities at the land/atmosphere interface. In addition, hydrological and atmospheric models are being developed concurrently that utilize remote sensing data for input, calibration, and validation within a wide range of temporal and spatial contexts. All of these studies serve to improve our understanding of how the various components of the hydrological cycle interact, and provide us with important information about the current structure of global hydrology and how mankind is changing the hydrological environment.

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Microwave Sensors Branch - This Branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and in-situ data for research in the areas of the oceans, ecology, weather, climate, and hydrology. The Branch performs basic theoretical, laboratory and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems. Branch members contribute to the development of microwave science and engineering for the Tropical Rainfall Measurement Mission (TRMM), the Earth Observing System (EOS), and various airborne campaigns.

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SeaWiFS Project - The Sea-viewing Wide-Field-of-view Sensor (SeaWiFS), was successfully launched on Orbital Sciences Corporation's SeaStar satellite on August 1, 1997, and is providing global observations of ocean color for NASA. These data are being used to assess phytoplankton abundance, ocean productivity, and the ocean's role in the global carbon cycle. In addition, the observations are useful for visualizing ocean dynamics and the relationships between ocean physics and large-scale patterns of productivity. The SeaWiFS Project is responsible for the validation of the data products that include the sensor calibration, atmospheric correction, and bio-optical algorithms.

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SIMBIOS Project - The Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project will develop a methodology and capability to combine data products from various ocean color satellite instruments, e.g., SeaWiFS, OCTS, POLDER, and MODIS, in a manner that ensures the best possible global coverage. This work requires evaluations of the sensor characteristics and calibrations, and the atmospheric correction and bio-optical algorithms used by each flight project. The project is supported by the SIMBIOS Science Team who collects much of the field data used for product evaluation. The developed merged data set will improve the ability to capture short term changes in the ocean more effectively than any individual ocean color mission. The data will then be used to assess phytoplankton abundance and model ocean primary productivity and associated atmospheric-ocean carbon transfer.

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Earth and Space Data Computing Division - The Earth and Space Data Computing Division (ESDCD) enables NASA-supported scientists to increase their understanding of Earth and its environment, the Solar System, and the Universe through the computational use of space-borne observations and computer modeling. To help assure the research success of NASA- and Goddard Space Flight Center (GSFC)-related projects and programs, we are committed to providing the science community with access to state-of-the-art high performance computing, leading-edge mass storage technologies, advanced information systems, and the computational science expertise of a staff dedicated to supporting that community. The ESDCD manages and operates the NASA Center for Computational Sciences (NCCS), a primary supercomputing and data storage center for support of NASA missions and programs, and, on a national basis, for approved programs of the external NASA and university communities. The ESDCD utilizes state-of-the-art computational equipment and data systems to provide end-to-end support of computational research conducted by the Earth and Space Sciences Directorates at GSFC and to a somewhat lesser extent external NASA approved research investigators. Specifically, the ESDCD meets its science-driven requirements by providing specialized computational processing and archival services for approved projects and individual scientists as well. In addition, the ESDCD provides support in the areas of sensor algorithms for direct ground communications readout of satellite transmissions, information processing, discipline data base management systems, high performance computing and parallel processing, high speed local and wide area network support, and advanced science data visualizations systems. The NCCS engages in the application of advanced computer system architectures, and scalable parallel machines, to support complex computational physics modeling efforts. These modeling efforts involve, for example, studies of coupled multidimensional ocean and atmospheric systems, multidimensional magnetospheric-ionospheric systems, and astrophysical processes. Specific research opportunities exist for development of new numerical algorithms in computational physics that utilize advanced computer architectures, development of advanced scientific visualization, algorithms for visualization of space and Earth science processes, and the development of advanced techniques for managing decaterabyte mass data storage and delivery systems.

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Planetary Atmospheres - Concerned with investigations of Jupiter, Saturn, Venus, Mars, and the Earth. The observational phase of the program includes imaging and polarization measurements from the Pioneer Venus Orbiter, radiation-budget, temperature-sounding, photometric, and polarization measurements from the Galileo Jupiter Orbiter, temperature mapping from Mars Climate Orbiter, Cassini imaging of the Jupiter-Saturn system, and Titan wind measurements from the Huygens probe. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and analytical and numerical models of planetary circulations. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets.

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Cloud and Water Vapor Feedbacks in a Changing Climate - This research program uses satellite data sets and global climate models to understand the nature of cloud and water feedbacks that represent the primary uncertainties in estimates of the global sensitivity of climate to external perturbations. The data component involves analysis techniques that isolate cloud dynamical objects or processes in ISCCP, TRMM, Terra, and Aqua datasets and reveal their dependence on varying environmental conditions. Similar techniques are applied to the GISS Global Climate Model to gain insights into the fidelity of the model's parameterizations and feedback processes.

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Remote Sensing of Clouds and Aerosols - Remote Sensing of Clouds and Aerosols is concerned with the development and application of techniques to infer cloud and aerosol properties from satellite radiance measurements as part of the International Satellite Cloud Climatology Project (ISCCP), the Global Aerosol Climatology Project (GACP) and the Earth Observing System (EOS). This program includes the validation of the retrieval products through the correlative analysis of in situ, ground-based, airborne and satellite data; the development and application of algorithms designed to fully exploit the information content of multispectral radiance and polarization data and the analysis of multisensor satellite data sets. Essential to this program is the analysis of the role of clouds in climate and the evaluation of aerosol direct and indirect radiative forcings. This program also includes theoretical studies of single and multiple scattering of electromagnetic radiation by cloud and aerosol particles.

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Interdisciplinary Research - Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when climate and atmospheric CO_2 are expected to be changing. Related research topics involve impacts of climate variability and change in integrated biophysical and socioeconomical systems.

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Applied Engineering and Technology Directorate (AETD) - The AETD has the full range of discipline engineering capability required to support all phases of NASA's current Earth and Space Science missions and implements a broad range of advanced technology initiatives required to enable and enhance a new generation Space and Earth Science missions.

AETD provides discipline engineering expertise in the areas of information systems; electrical systems; mechanical systems; guidance, navigation and control; mission systems engineering; and scientific instrument development. AETD designs, develops, and tests components, subsystems, scientific instruments, and spacecraft for NASA programs and projects including the Microwave Anisotropy Probe, the Earth Orbiter 1, the Hubble Space Telescope, and many others. The Directorate also provides the engineering and technical discipline expertise required to development spacecraft (such as, the Geostationary Operational Environmental Satellite series) for external customers like the National Oceanographic and Atmospheric Administration.

AETD conducts innovative technology research and development for scientific space applications in a number of focus areas including:

- Large Aperture Systems (synthetic aperture, segment/adaptive optics, large lightweight deployables, thermal control surfaces, etc.)
- Advanced Instruments (optical components, laser sensing, cryogenic coolers, radiation detectors, microwave sensors, etc.)
- Distributed Observatories (micro/nano satellites, formation flying, platform subsystem component technologies, etc.)
- Rapid Formulation/Execution Environment (collaborative & virtual environments; intelligent Systems; advanced simulation tools, etc.)
- End-to-End Science Information Systems (autonomy, software tools, data processing, communications, reconfigurable computing, etc.)

These technologies are developed for future NASA programs and projects, including Next Generation Space Telescope, Nanosat Constellation Trailblazer, Earth Observing System, and many others.

In fulfilling Goddard's mission, AETD also provides engineering and technology development support to other NASA Centers, other government agencies, national laboratories, industry, and academia. The Directorate partners with others to accomplish the Nations space objectives in the most effective manner possible while transferring knowledge and technology to enhance the Nation's scientific and technological literacy as well as its economic well being.

Integrated Design Capability - The IDC is a human and technology resource that provides rapid space system analysis and conceptual designs. Skilled engineers and scientists utilize the IDC's collaborative process and sophisticated tools to produce detailed space mission, remote sensing instrument, and/or technology applications design concepts. The IDC has two dedicated facilities where the IDC design teams and the customers collaborate in an environment that promotes rapid development and efficient trade studies of space system architectures, applications and concepts. The Integrated Mission Design Center (IMDC) is the mission design facility and the Instrument Synthesis and Analysis Laboratory (ISAL) is the instrument design facility.

By focusing a resident team of expert engineers and a variety of computer-based simulation models, the IMDC is able to analyze a variety of mission concepts and technology alternatives in a fraction of the time needed to complete a traditional mission study effort. The typical IMDC study involves analysis of spacecraft propulsion, electrical power, mechanical, communications, thermal, attitude control systems, flight software, and mission operations scenarios as well as orbital dynamics and grounds-up and parametric cost estimating. The IMDC continues to be in a continuous state of evolution as new analytical tools and technologies are introduced, and existing ones are refined.

The ISAL focuses on individual scientific instruments. This laboratory was created to provide end-to-end capabilities for modeling, analysis and simulation for Earth and Space science remote sensing instruments. Design and analysis tools are integrated to facilitate quick and efficient analyses covering areas such as structural, thermal, optical, jitter, mechanisms, electronics, detailed radiometry, spectrometry, hyperspectral, and interferometry. Performance modeling (physics based functional modeling) and integrated physical or geometric modeling (structural, optical, thermal, etc.) will be accomplished for both performance analyses and for time-domain simulations. This capability allows efficient trade off of instrument concepts and architectures, including cost and performance validation.

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Systems Engineering Services and Advanced Concepts (SESAC) Branch - The SESAC Branch is devoted to delivering services and products to the systems engineering community and its customers. The branch leads the development of advanced mission concepts and provides core capability of end-to-end systems engineering for programs, missions, and projects including innovative concepts, system architectures and systems for new missions, technologies and concepts. The branch establishes and delivers a core set of systems engineering services to our customers, through assembling a cadre of experts in the various systems engineering disciplines and functions. These services include risk management and assessment, requirements development and analysis, operations concept development, formal and informal reviews support, integrated systems analysis, modeling and simulation, verification and validation planning, cost modeling and analysis, technology planning, as well as others. SESAC develops implementation and risk mitigation strategies for the infusion of technologies, ensuring that systems technology advancements are carried from concept through final design. The branch also provides direct support to science and engineering teams in the development of advanced concepts (pre-formulation activities). SESAC is also responsible for the development and deployment of advanced engineering tools, environments and capabilities, and for the evolution and development of existing capabilities and facilities, including the Integrated Mission Design Center (IMDC), Instrument Synthesis and Analysis Laboratory (ISAL), and the NGST “Wolf Works.” The branch embraces rapidly emerging technologies to create, enhance, and integrate advanced engineering tools and virtual collaborative environments and infuse them into practice. SESAC provides a liaison function and performs tasks in the areas of standards and processes, interfacing with various Agency, national and international organizations. SESAC also implements rigorous mentoring and training systems and opportunities in order to sustain critical core competencies in systems engineering.

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Mechanical Engineering Branch - The Mechanical Engineering Branch performs structural and mechanical design for STS and ELV launched spacecraft, instruments, and mechanical ground support equipment. These designs include spacecraft primary and secondary structures; deployable appendages such as solar arrays and antennas and extendible optical benches; inflatables structures technology; flight mechanisms such as actuators, hinges and release mechanisms; instrument structures including optical benches and flexural mounts; and mechanical ground support equipment such as lift slings, dollies, containers, and g-negation hardware. The Branch provides support for the fabrication, assembly, integration, and testing of both spacecraft and instrument structures including structural design research and design optimization of advanced composite materials. The Branch also provides advanced development for maintaining state-of-the-art concurrent engineering technology.

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Electromechanical Systems Branch - The Electromechanical Systems Branch develops precision structures and mechanisms for use in space-flight instruments and spacecrafts. Structures such as telescope assemblies, mounts for optical components and optical benches are developed. Mechanisms and the associated instrumentation and control system are also developed for applications requiring positioning or scanning optical components or assemblies in an instrument. Precision deployed systems such as segmented mirrors for large aperture telescope assemblies are also developed. The group also conducts applied research and development in micro-electromechanical systems, lightweight and smart structures, vibration and motion control systems, magnetic bearings, sensors, actuators and mechanisms for use in cryogenic environments. The group has state of the art laboratories for the fabrication and testing of precision structures, mechanisms and the associated control and instrumentation equipment.

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Thermal Development Branch - This branch is responsible for the development of new thermal control technology for future NASA spacecraft. Current work efforts focus on such technologies as cryogenic two-phase heat transport devices, two-phase capillary pumped loops and loop heat pipes, variable emittance coatings, and heat pumps. The scope of the work encompasses concept development, analytical modeling, breadboard to prototype testing, and conduction of flight experiments. The 7000 square foot laboratory/office area has numerous test loops and is equipped with modern instrumentation, data collection/processing, and other support equipment.

Contact: **Jentung Ku**, (301) 286-3130, jku@mscmail.gsfc.nasa.gov

Optics Branch - The Optics Branch conducts research and development programs in the optical sciences and engineering to support flight experiment development in the areas of high energy astrophysics, solar and stellar astronomy, atmospheric sciences, and ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing. Modern laboratory facilities are equipped for optical property studies in the far infrared to soft x-ray, optical component performance at cryogenic temperatures, optical fabrication, and precision metrology. In addition, extensive computer facilities are available to support optical design and analysis studies.

Contact: **David Content**, (301) 286-7382, dcontent@pop500.gsfc.nasa.gov

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Cryogenic Technology Development - The Cryogenics and Fluids Branch actively conducts research and development programs in low temperature physics in support of NASA's Earth and Space Science goals and instruments. General research objectives are the development of low temperature technology that advances the state of the art in magnetic refrigeration, cryocoolers (or mechanical coolers), and sub-Kelvin temperature thermometry. The Branch is also involved in the development of low temperature detectors. The group has ancillary interest in the areas of superconductivity, superconducting magnets, magnetic shielding, and related technologies. Modern laboratory facilities include several cryogenic workstations capable of cooling to temperatures of tens of millikelvin. These are used for characterization of materials, detectors, and other cryogenic devices, such as heat switches. Instrumentation includes SQUID's as well as resistive, magnetic, and noise thermometry systems.

Contact: **Edgar Canavan**, (301) 286-5405, ecanavan@code552.gsfc.nasa.gov

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Detectors Systems Branch - This branch develops detector technology and instruments for space science and earth science applications. Current work is focused on cryogenic detectors and readouts for use in the submillimiter to x-ray, CdZnTe detectors for hard x-ray and gamma-ray, micro-electro-mechanical systems (MEMS), quantum-well infrared photodetectors (QWIPS), GaN solar blind detectors, and ground based and airborne instruments. Facilities include a Class 10 semiconductor fabrication laboratory, detector/electronics testing labs, clean room packaging lab and cryogenic test labs.

Contact: **Carl Stahle,** (301) 286-0968, cms@lheamail.gsfc.nasa.gov

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Lasers & Electro-optics Branch - The Lasers and Electro-optics Branch conducts applied research in electro-optics including high power semiconductor lasers, diode pumped solid state lasers, tunable filters, interferometers, and photon counting detectors for remote sensing instruments. Major areas are the investigation of the use of laser diodes as the transmitter source for active remote sensing instruments and Fabry-Perot interferometers for active and passive instruments. Both the physics and engineering aspects of these systems are under investigation. Instrumentation is being developed and demonstrated for ground-based and flight observational research from ultraviolet to infrared wavelengths.

Contact: **William Heaps**, (301) 286-5106, wheaps@pop500.gsfc.nasa.gov

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Microwave Instrument Technology Branch - This Branch provides engineering and technology expertise to instrument development teams, study teams and proposal teams for end-to-end conceptualization and development of microwave systems. Emphasis is placed on the development of new capabilities that require innovation and present significant challenges in meeting specifications derived from science requirements. Advanced technologies and concepts are demonstrated which enable new measurements, improved performance, and reduced cost, size, and mass of sensors. This Branch also integrates and tests microwave instrument systems, performs system analysis, and supports experimental field campaigns, airborne and space missions.

Contact: **Catherine Long**, (301) 286-8493, long@jazzman.gsfc.nasa.gov

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Instrument Systems Branch - The Instrument Systems Branch provides end-to-end technical management and systems engineering for advanced space and Earth science flight instrument developments. The Branch provides technical leadership for the full life cycle instrument development, which includes development of innovative new measurement concepts and techniques, development of advanced instrument concepts, generation of scientific instrument proposals, instrument system definition, analysis, and implementation. In this role, it is responsible for developing programmatic risk mitigation strategies for the infusion of leading-edge technologies into flight instruments and ensuring that technology advancements are carried from concept through final development. Current technology developments include x-ray, visible, infrared, submillimeter, and microwave components and subsystems that are necessary to enable the scientific measurements.

Contact: **Felicia Jones-Selden**, (301) 286-6076, Felicia.L.Jones-Selden.1@gsfc.nasa.gov

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Flight Electronics Branch - The Flight Electronics Branch is responsible for providing the technical expertise in the development of Flight Data Systems and its related components, and in the discipline area of Command and Data Handling systems engineering. Research areas include flight qualified network hardware, advanced data systems architectures, novel instrument/spacecraft data buses, radiation-hardened microprocessors and free space optical data transfer between spacecraft components.

Contact: **Bob Stone**, (301) 286-5659, rstone@mscmail.gsfc.nasa.gov

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Component Technologies Branch - The Component Technologies Branch provides unique and essential parts and advanced technology support to internal and external customers and partners to meet mission reliability, cost, and schedule goals in the areas of flight project support and applied research. Current research areas include space effects of space environment on electronics parts and advanced electronic packaging methods. The applied research aspects of the branch support efforts in parts and technology issues, development and extension of device and environment models, novel materials, and microelectronics developments, emerging photonics.

Contact: **Darryl Lakins**, (301) 286-6631, dlakins@pop500.gsfc.nasa.gov

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Power Systems Branch - The Power Systems Branch provides technical expertise in the field of electrical power for space applications. Power subsystem engineering is provided to support all phases of scientific instrument, special payload, and spacecraft flight programs from conceptual design, through hardware development and test, to end-of-life operations. Current research areas include Li-Ion battery development, Li-polymer battery development, and small highly efficient power systems for nano-satellite and multifunctional structural batteries. Other areas of interest include advance energy storage technologies with longer life, and higher energy density for spaceflight applications, higher efficiency solar cell arrays for spaceflight applications, efficient, low noise, high and low voltage power regulators and converters for scientific instruments, and spacecraft.

Contact: **Marlon Enciso**, (301) 286-5845, menciso@pop700.gsfc.nasa.gov

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Microelectronics and Signal Processing Branch - The Microelectronics and Signal Processing Branch designs, develops and infuses leading edge micro-electronic devices and components for flight and ground customer applications. This includes front-end electronics interface, analog signal filtering and conditioning, analog cryo temperature control systems, analog multiplexing and A/D conversion, digital signal processing and compression. Current Research areas include Data compression, Advanced modulation and coding, parallel computing and VLSI devices for flight and ground applications.

Contact: **Bob Kasa**, (301) 286-8043, rkasa@pop700.gsfc.nasa.gov

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Ground Systems Hardware Branch is responsible for the design - The Ground Systems Hardware Branch is responsible for the design, acquisition, integration, and engineering of custom ground hardware components and systems that support the development and operation of flight instruments and spacecraft. This includes the development of accelerated science data processing technologies, prototype electronics, test- beds, integration and test systems, subsystem and component bench test equipment, interface simulators, tracking & relay stations, and network control centers. Research areas include hybrid CPU-FPGA-DSP based computing systems for flight and ground science data processing applications, including hyper-spectral image processing.

Contact: **Tom Flatley**, (301) 286-7029, Thomas.P.Flatley@nasa.gov

Electrical Systems Branch - The Branch designs and develops orbital, suborbital and carrier electrical systems and selected flight components such as harnesses, flight fiber optic networks, and special purpose interface hardware. It provides electrical systems leads to Instruments and for Project teams who develop electrical interfaces, performance requirements, functional test procedures, and electrical specifications for in-house space programs or provide oversight and electrical systems expertise to out-of-house space programs. The Branch develops mission critical range instrumentation systems by employing new technology insertion to improve the functions necessary to meet the requirements of the sub-orbital, low earth-orbit, and balloon flight projects. It provides new payload development, timing, command, radar and telemetry tracking, and Science Data Products. The Branch develops project unique electromagnetic compatibility requirements and generates the criteria and test approach needed to insure the electromagnetic compatibility of instrument and spacecraft hardware. It provides Electrical Leads to Science Principle Investigators to support unusual, quick reaction missions or proposal development.

Contact: **Paul Bryant**, (301) 286-7897, pbryant@pop700.gsfc.nasa.gov

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Microwave & Communication Systems Branch - The Microwave and Communication Systems Branch is responsible for conception, analysis, design, development and engineering of state-of-the- art RF, microwave, millimeter wave, and higher frequency components and systems for GSFC communications and instrument applications. It also provides communications and microwave instrument discipline support to other GSFC organizational elements and flight projects. The Branch develops space communication systems using current and advanced technology. Architecture studies, experimental investigations, technology developments and specific implementations are proposed and executed in support of mission responsibilities. Current research areas include future deep space, lunar, and near Earth communications architectures as well as software-defined radio, spread spectrum communications, solid-state RF power amplifiers, phased array antennas, spectrum- efficient modulation and coding techniques, high performance data compression, and free-space laser communications.

Contact: **Kenneth Perko**, (301) 286-5936, Kenneth.L.Perko@nasa.gov

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Flight Dynamics Analysis Branch (FDAB) - The Flight Dynamics Analysis Branch (FDAB) provides spacecraft orbit and attitude related analysis for various flight projects. The branch also maintains an active technology development program to advance methods of attitude/orbit determination and control. The FDAB analysis responsibilities require technical expertise in the following areas: attitude determination, attitude control, attitude dynamics, orbital dynamics, spacecraft navigation, mission design and trajectory control. Currently, research and analysis items active within the organization include: Studies related to analyzing attitude sensor performance and calibrations; Advanced attitude estimation techniques; Development of new techniques and algorithms for sensor/instrument calibration; Studies related to the performance characterization and improvement of attitude control systems; Advanced orbit determination algorithm development and analysis (such as on-board or ground processing with TDRS, ground trackers and GPS); Development of new targeting techniques and algorithms for trajectory optimization and control (such as lunar swingbys and libration orbits, automated maneuver control, and formation flying); and Analysis for development of algorithms for generation of orbit related planning products (such as automated acquisition data).

Contact: **Thomas Stengle**, (301) 286-5478, tstengle@pop500.gsfc.nasa.gov

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Software Engineering Laboratory (SEL) - The SEL aims to provide a center for Software Engineering excellence, focusing on a range of applied research topics of interest to GSFC, in particular, and NASA as a whole. Of particular interest are techniques and approaches that will enable the development of high-quality software systems for application within NASA missions. In the past, the SEL has studied software engineering process and product improvement approaches within the Information Systems Center. It continues to do this with the objective of understanding and characterizing the environment, assessing, refining and infusing new technologies identified as having the potential to improve the environment process; and to package the results of the assessment for the benefit of organization and NASA. Current and previous areas of expertise include: object- oriented design, Cleanroom, Verification and Validation, formal methods for system design, COTS, automatic code generation, and testing techniques.

Contact: **Mike Hinchey**, (301) 286-9057, Michael.G.Hinchey@nasa.gov

Mission Applications Branch (MAB) - The Mission Applications Branch develops software systems and applications that are used by Flight Operations Teams and mission analysts to support NASA Earth and Space science missions. The applications typically include non-realtime functions in the domains of guidance, navigation, and control, mission planning and scheduling, and command management, and are operated within targeted Mission Operations Centers. The branch also provides software support to GSFC's Earth and Space Science Directorates for analysis and data processing applications, developing tools to execute within the scientist's desktop environment. The MAB provides end-to-end software development support of its products, including project management, requirements analysis, design, implementation, testing, and sustaining engineering. Branch personnel often participate in teams with flight project personnel, principal investigators, contractors, and other AETD engineers to develop integrated hardware and software systems for operations support. Branch products include custom capabilities, integrated GOTS/COTS systems, documentation, training, and consultation. Branch personnel apply well-established processes and procedures, as well as state-of-the-art development technologies, to develop cost-effective solutions, which meet customer needs. The MAB also partners with government, commercial, and academic organizations to develop and explore the applicability of new technologies for its products.

Contact: **Henry Murray**, (301) 286-6347, hmurray@pop500.gsfc.nasa.gov

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Real-Time Software Engineering (RTSE) Branch - The Real-Time Software Engineering Branch develops ground data systems for integration and test and on- orbit operations of Earth and space science missions. Branch personnel participate in teams with flight projects, principal investigators, other Divisions and other organizations to develop integrated hardware and software systems for real- time mission support both at Goddard's Greenbelt, Maryland facility. The system functionality includes spacecraft, instrument, and ground system monitoring and control, launch and tracking services, and data display and analysis. Branch personnel provide system engineering, system planning, conceptualization, requirements analysis, design, implementation, verification and mission-life sustaining engineering for its products. Branch products include assembled Commercial off-the-shelf (COTS) systems, custom capabilities, components, consulting and brokering on behalf of customers. The branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners to advance the state-of-the-art in implementation of its functions and related technologies. Research opportunities exist in the following areas: 1. Real-time data processing technologies and methods: real-time computer resource allocation and data distribution (POC: John Donohue, john.t.donohue@nasa.gov, 301- 286-2058) 2. Data trending and analysis for constellation or multi-spacecraft missions (POC: Jeffrey Ferrara, Jeffrey.F.Ferrara.1@nasa.gov, 301-286-6886) 3. "Lights-out", low cost mission operations architectures and technologies: secure, remote mission operations, remote real-time or near real-time access to mission data. (POC: John Donohue, John.T.Donohue@nasa.gov, 301- 286-6149)

Contact: **John Donohue**, (301) 286-6149, john.t.donohue@nasa.gov

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Computing Environments and Technology Branch - The Branch researches, designs, develops, configures, implements a range of information management and knowledge management solutions for the Information Systems Center and the Applied Engineering and Technology Directorate at GSFC. Rapid advances in information technology offer unprecedented opportunities to improve the way we capture, organize, distribute, and access NASA's knowledge base. As part of our core capabilities, the Branch pursues the expansion of web-based technology (portal, data mining, datamarts, electronic communities, web-crawling agents, etc.) to make relevant information available quickly and easily for people to use productively. Additionally the Branch investigates the use of portal technologies for introduction into organizational applications. The Branch assesses the state of knowledge management in industry and Government today to determine the issues and trends and where knowledge management will be in 3–5 years. The Branch compiles and makes available a discipline/vendor survey of what is currently being developed in knowledge management and introduced into the market place. Based on this, the Branch downsizes the survey results for applicability to the AETD/ISC current strategic direction. The Branch identifies, selects, and pilots activities for inclusion into the AETD/ISC information and knowledge architecture.

Contact: **Howard Eiserike**, (301) 286-7784, heiserik@pop500.gsfc.nasa.gov

Science Data Systems Branch - The Science Data Systems Branch develops and/or provides consultative services for developing data systems to support Earth and space science missions. Branch personnel team with flight projects and principal investigators in the Earth and Space Sciences Directorates to develop systems for operational data capture, level zero and higher level data processing, and data archival, distribution and information management. The systems process various levels of science and telemetry data starting from the point the data reach the ground until they are delivered to scientific users for analysis. The branch is interested in new technologies which can reduce the costs of developing, operating, and maintaining such systems while also addressing the technical challenges associated with shorter system life cycles, increasing data rates, constellations, on-board processing, event-responsive decision-making, larger storage needs, and distributed archives. The branch also wants to provide additional tools for expediting the scientific discovery process. Technical areas where technological advances are needed include Data Distribution, Science Data Formats, Data Mining, Data Visualization, Data Modeling, Data Processing, Data Capture, Information Services, and Data Storage/Archival.

Contact: **Michael Seablom**, (301) 286-2406, mseablom@pop900.gsfc.nasa.gov

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Advanced Data Management And Analysis Branch - The Advanced Data Management and Analysis Branch supports the Earth and Space Science Communities by providing a wide range of high-end data systems solutions in response to technical requirements. Branch personnel partner with projects and principal investigators in the Earth and Space Science Directorates to develop systems that addresses data display, data analysis, data visualization, data archiving and storage. The Branch also provides support for algorithm development, science data analysis programming, data mining, data retrieval, fusion and dissemination, scientific mission proposal development and support for large and small scale software system configuration, sizing, and development methodologies utilizing recognized techniques and scientific data format standards.

Contact: **Mary Ann Esfandiari**, (301) 286-6663, mesfandi@pop500.gsfc.nasa.gov

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Advanced Architectures and Automation Branch - The Advanced Architectures and Automation Branch explores and infuses advanced software technologies into next generation mission management and information systems with the objective of reducing cost, improving operational performance, and increasing quality science research. The primary focus is the exploration and application of technology to space-ground automation (e.g., lights-out) system and advance software and data system architectures. Key technologies foci are artificial intelligence, distributed systems, and human-computer interaction. Branch members produce concepts, prototypes, and tools that can be used to support mission engineering, design, development, and operations as well as evaluations of relevant COTS and GOTS. The Branch performs its work through collaborations with partners. The Branch actively pursues and assists in the transfer and commercialization of the advanced technologies.

Contact: **Julia Loftis,** (301) 286-5049, Julia.W.Loftis@nasa.gov

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Earth Science Technology Office - The Earth Science Technology Office (ESTO) has the responsibility for integrating Earth science technology development programs into a single comprehensive program for the Mission Directorate, to effectively address Earth systems science questions in the near-mid-far future, and to help stimulate new technology driven science programs necessary to meet future ESE goals. ESTO develops investment strategies and roadmaps for ESE technology programs and provides oversight and management of focused technology development programs in advanced information systems, advanced instruments and component (sensor and detector) technologies. It maintains planning tools to manage technology requirements and development activities and coordinates its activities with NASA Headquarters, participating centers, academia, industry and other relevant technology program developers.

Contact: **George Komar**, 301-286-0007, George.J.Komar.1@gsfc.nasa.gov

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Sounding Rockets Program - This program provides "cradle to grave" support to an investigator by designing and analyzing a mission to meet the science requirements; designing, fabricating, and testing the spacecraft; integrating the spacecraft with a suborbital rocket system; and providing project management and launch operations support from numerous worldwide launch locations. Research opportunities include development of new or improved flight vehicle or spacecraft systems that improve science return, new mission concepts involving suborbital rocket systems, increased reliability and safety, and lower mission cost.

Contact: **Phil Eberspeaker**, (757) 824-1268, Philip.J.Eberspeaker.1@gsfc.nasa.gov

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Balloon Program – This program provides the science community with access to the upper atmosphere for extended durations from numerous worldwide locations. The SSOPD manages the overall program and performs research and development activities. A major research focus is the development of balloon systems capable of remaining aloft and supporting science requirements for approximately 100 days. Research opportunities include materials studies, balloon station-keeping and steering, advanced power and data subsystem development, and innovative concept development for new uses of balloons.

Contact: **David L. Pierce**, (757) 824-1453, David.L.Pierce@nasa.gov

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Aircraft Projects - This activity utilizes aircraft as a platform to carry scientific equipment, principally in support of Earth Science related programs. The SSOPD provides the project and engineering management necessary to conduct scientific measurements including the integration of experiments on aircraft, modifications of aircraft structures, and safety certification. Research opportunities include development of systems that provide aircraft and environmental information to airborne science experiments. A growing focus is on technology developments associated with uninhabited aerial vehicles that increase their usefulness as an airborne science platform.

Contact: **George Postell**, (757) 824-1529, George.W.Postell.1@gsfc.nasa.gov

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International Space Station Research Program - This organization serves as a facilitator to the Space and Earth Science communities who may be interested in conducting research aboard the International Space Station. The office defines opportunities available for researchers and assists with technical issues.

Contact: **Betsy Park**, (301) 286-7062, Elizabeth.A.Park.1@gsfc.nasa.gov

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Wallops Research Range - In support of NASA science and technology programs, the SSOPD maintains and operates a Research Range consisting of an integrated launch range and research airport. Test Range resources also include transportable systems capable of conducting launch operations in remote locations. Projects include suborbital and orbital rocket launches, balloon flights, and piloted and unpiloted aerial vehicles for NASA, Department of Defense, and commercial industry. Wallops provides mission management, telemetry and radar tracking, communications, range safety, ordnance handling, data reduction, supporting infrastructure, and other support services necessary to a range user. Research topics include development of advanced technologies and processes related to lower cost operations, increased capabilities, and improved safety.

Contact: **Jay Pittman**, (757) 824-1955, Thomas.J.Pittman.1@gsfc.nasa.gov

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Project and Range Safety - The Suborbital and Special Orbital Projects Directorate (SSOPD) Safety Office provides safety analysis, review and approval for Wallops flight projects including suborbital rocket, balloon, aircraft, and Shuttle payloads. It performs these same functions for operations conducted by the Wallops Research Range, including field campaigns at worldwide locations. Additionally, the office provides operational support for these same Research Range missions including ground hazard monitoring, wind measurement and compensation, ship and aircraft surveillance, and flight termination, when necessary. Research areas include new analytical or computational safety techniques in the review of flight projects, safety system reliability determination, and advanced concepts that increase the safety of operations and/or minimize/streamline the impacts of safety requirements on flight projects.

Contact: **Les McGonigal**, (757) 824-2518, Lester.A.McGonigal.1@gsfc.nasa.gov

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Propellant Hazards Research - WSTF performs extensive research on liquid propellant hazards associated with the Space Shuttle, International Space Station (ISS), and other aerospace systems. This creates a wide range of related research opportunities. Current projects include development of chemical kinetic models of liquid rocket propellant explosive reactions and comparison of the models to actual explosive test data using simulated spacecraft systems. Additionally, students may propose new research concerning conventional or advanced propellants that would be of benefit to NASA programs as the Second Generation Reusable Launch Vehicle. Appropriate background in chemistry, engineering, or physics and computer simulations is generally required.

Contact: **Regor Saulsberry**, 505-524-5518, rsaulsbe@wstf.nasa.gov

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Advanced Pyrovalve Development - Design new pyrotechnic actuated valves using an extensive pyrotechnic database and technical expertise at the WSTF. Fabricate concept valves and then test the hardware in a specialized pyrotechnic laboratory that uses "state of the art" instruments and equipment. Capabilities include a mass spectrometer and similar instruments to measure and characterize pyrotechnic blow-by; various pressure, temperature, shock, photo-electric sensors and associated high speed data acquisition systems to measure operational perimeters; and a laser Velocity Interferometer for Any Reflector (VISAR) to characterize actuator acceleration, deceleration and velocity. Appropriate background in engineering, chemistry, or physics and design is required.

Contact: **Regor Saulsberry**, 505-524-5518, rsaulsbe@wstf.nasa.gov

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Contamination Control Instrumentation - critical. This project seeks to design and evaluate a system capable of accurately and cost-effectively performing particle counts on hardware sampled in accordance with NASA document, JPG 5322. The project should investigate new, more automated techniques to perform surface cleanliness measurements (particle counts and non-volatile residue) with minimum human intervention and should operate in a Class 100 clean room environment. Appropriate background in chemistry, engineering, or physics is required.

Contact: **Barry Plante**, 505-524-5539, bplante@wstf.nasa.gov

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Process Measurement Assurance - Design programs for qualifying measurement processes in field environments using standard artifacts and statistical process control techniques. Includes determination of methods for controlling measurement uncertainty and evaluating measurement traceability in calibration processes. Appropriate background in engineering or physics and statistics is required.

Contact: **Barry Plante**, 505-524-5539, bplante@wstf.nasa.gov

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Depot Workflow Optimization - WSTF is currently expanding capabilities to refurbish, repair, and perform acceptance tests on Shuttle and ISS flight components. The current planning is based on the procedures and equipment used at various vendor facilities, and may not provide the optimum use of equipment or personnel. This project will examine the requirements for each of the various components and determine a methodology to optimize workflow for the most efficient use of personnel and equipment. A market survey will be accomplished to identify software packages that allow optimization of the workflow, and several of these packages will be evaluated. Schedules for the component arrival and shipment will be constantly changing, as well as requirements as a result of in-line testing. The scheduling effort will involve several workstations in the component test facility, several independent laboratories located on site, and use of one or more propulsion test stands for acceptance testing. Appropriate background in Industrial or other engineering and statistics is required.

Contact: **David Harris**, 505-524-5525, dharris@wstf.nasa.gov

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Propulsion Test Workflow Study - WSTF is constantly receiving a wide range of requirements for propulsion system and component testing. The projects vary in size and scope, and costs range from a few thousand dollars to millions. Requirements for on-site resources vary from one part-time person to hundreds of people from all disciplines on site. This project will be to perform a time and motion study of several projects and determine a methodology to optimize workflow for the most efficient use of personnel and equipment. Test schedules and requirements will be constantly changing, both from the customer and test results. The products of this study will be an identification of the good and bad points of the current workflow, and recommendations for improvement. Appropriate background in Industrial or other engineering and statistics is required.

Contact: **David Harris**, 505-524-5525, dharris@wstf.nasa.gov

Altitude Simulation System Design - Spacecraft engine and systems development/qualification being accomplished at WSTF requires testing under altitude conditions (at vacuum). One of the test objectives is to maintain the vacuum environment around the spacecraft during engine firing and subsequent heat soakback period. Due to the variety of tests continuously performed, system modifications and new systems must be designed and fabricated creating many associated design, analysis, and testing opportunities. This involves such equipment as high-volume vacuum pumps, supersonic centerbody diffusers, heat exchanger, vacuum ducting systems, and water supply systems to mention a few. Analysis skills need to be exercised in the following areas: supersonic aerodynamic performance, heat transfer, and stress analysis. The systems are also outfitted with instrumentation and control points to allow health monitoring, and automatic and manual control. Final design drawings will be performed by the WSTF Draftsmen, however the form in which the drawing is given to the draftsmen can vary from pencil drawings to an AutoCAD or Pro Engineer file. Appropriate background in engineering or physics and design required.

Contact: **David Harris**, 505-524-5525, dharris@wstf.nasa.gov

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Autonomous Nano Technology Swarm (ANTS) - Research into intelligent systems that enable a totally autonomous mission architecture - ANTS. ANTS hardware and software are reconfigurable, adaptable and evolvable. They are controlled by a synthetic neural system with bi-level intelligence that integrates the high-level heuristics with low-level autonomic functions.

Contact: **Steven Curtis**, 301-286-9188, steven.a.curtis@nasa.gov

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JET PROPULSION LABORATORY (JPL)

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The primary role of the Jet Propulsion Laboratory (JPL) within NASA is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft and instruments. JPL scientists, technologists and engineers engage in Earth atmosphere and geosciences, oceanography, planetary studies (including asteroid and comet), and solar, interplanetary, interstellar, and astrophysical disciplines. Opportunities for graduate student researchers exist in all technical divisions of JPL. These technical divisions encompass almost all JPL engineering and science resources. Each technical division is concerned with planning, design, development engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the cooperation among the functions of research, science, advanced technology, and engineering of these operating divisions.

Mission and Systems Architecture - Includes flight mission architecture development, advanced flight mission and system planning, flight project launch approval planning, design of end-to-end information systems, and flight project and information system engineering. Also performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and manned space projects and military and civilian ground-based programs. Performs system level design, integration, and development of information systems, including computer hardware and software and large distributed near real time ground data processing.

Contact: **Anthony Freeman**, (818) 354-1887, anthony.freeman@jpl.nasa.gov

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Navigation and Mission Design - Includes interplanetary spacecraft trajectory design, launch vehicle trajectory analysis, and software development to support scientific spacecraft trajectory design. Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiomemtric and optical techniques. Plans mission timelines to accommodate science requirements. Designs propulsive maneuvers to place spacecraft on correct trajectories, develops software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary, comet, and asteroid orbital dynamics, gravitational radiation and planetary masses and gravity fields using spacecraft radio tracking data.

Contact: **Michael Watkins**, (818) 354-7514, michael.m.watkins@jpl.nasa.gov

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Flight Systems Engineering - Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. Provides design integration of major instrument systems. Conducts studies and analyses of advanced future spacecraft designs, and analyzes the performance of spacecraft in flight. Also performs planning, management and performance of test, integration and launch activities for major systems, including spacecraft, science instruments, ground data systems and ground support equipment. Conducts research and development for integration and test technologies, and operates and manages JPL's major Spacecraft Assembly Facility.

Contact: **Doug Bernard**, (818) 354-2597, douglas.e.bernard@jpl.nasa.gov

Mission Systems Engineering - Supports JPL flight projects in the development of plans for the operation of interplanetary spacecraft in flight, in the design of ground data systems for flight operations, and in managing the configuration of large data systems. Develops the software models and detailed sequences to be executed by interplanetary spacecraft, plans the commands required to carry out the sequences, and develops the software that keeps track of the command sequences and that ensures the commands will safely perform the desired functions. Provides support to science activity development and implementation. Conducts research related to planning and sequencing software technology.

Contact: **Kathryn Weld**, (818) 354-2143, kathryn.r.weld@jpl.nasa.gov

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Astrobiology - The Astrobiology program at JPL is a program strongly based in environmental microbiology and microbial ecology, with a focus on the mechanisms whereby life survives in extreme conditions. The environments of study will be alkaline lakes, cold lakes, dry cold environments, and deep subglacial lakes. The studies include field work in these environments, identification of the organisms present, their metabolism, and the potential relationship of these environments and their organisms to extraterrestrial environments that might harbor (or have harbored) life. The ultimate goal is to develop a suite of biosignatures that will allow us to unambiguously identify life in samples on and off Earth, even when the signals of life are very subtle.

Contact: **Cliff Heindl**, (818) 354-4603, clifford.j.heindl@jpl.nasa.gov

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Oceanography - Altimetry for determining currents and tides; air-sea interactions including, fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.

Contact: **Lee-Leung Fu**, (818) 354-8167, lee-leung.fu@jpl.nasa.gov

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Earth Atmosphere - Laboratory research, field measurements, and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data, including temperature profiles, humidity, clouds, winds, and pressure.

Contact: **James Margitan**, (818) 354-2170, james.j.margitan@jpl.nasa.gov

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Planetary Atmospheres - Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure, and dynamics; long-term study of seasonal and inter-annual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.

Contact: **Jay Goguen**, (818) 354-8748, jay.d.goguen@jpl.nasa.gov

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Earth Geoscience - Characterization of exposed rocks, sediments, and soils on the Earth's surface to understand the evolution of the continents; examination of the state and dynamics of biological land cover for assessment of the role of biota in global processes; tectonic plate motion; volcanology; paleoclimatology.

Contact: **Ronald Blom**, (818) 354-4681, ronald.g.blom@jpl.nasa.gov

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Planetology - Observations of the surface of the inner planets, the satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwaves; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.

Contact: **Bruce Banerdt**, (818) 354-5413, william.b.banerdt@jpl.nasa.gov

Space Physics - Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets. Development of space plasma instruments.

Contact: **Bruce Goldstein**, (818) 354-7366, bruce.e.goldstein@jpl.nasa.gov

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Astrophysics - Galactic and extragalactic astronomy and the development of instrumentation in the infrared, visible, and gamma-ray regions of the spectrum, measurement of the cosmic microwave background, composition and chemistry of interstellar clouds, origins of planetary systems, gravitational wave physics and the detection of gravitational waves

Contact: **Harold Yorke**, (818) 354-7366, Harold.w.yorke@jpl.nasa.gov

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Astrophysics - Observational and theoretical research into the nature of radio emissions from quasars, galaxies, and stars.

Contact: **Robert Preston**, (818) 354-6895, robert.a.preston@jpl.nasa.gov

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Planetary Atmospheres and Interplanetary Media - Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.

Contact: **Richard Woo**, (818) 354-3945, richard.woo@jpl.nasa.gov

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Planetary Dynamics - Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.

Contact: **Robert Preston**, (818) 354-6895, robert.a.preston@jpl.nasa.gov

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Lunar Dynamics - Use lunar laser ranges to measure lunar rotation and orbit for the study of lunar science and relativity theory.

Contact: **James Williams**, (818) 354-6466, james.j.williams@jpl.nasa.gov

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Geodynamics - Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).

Contact: **Jean Dickey**, (8l8) 354-3235, jean.o.dickey@jpl.nasa.gov

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Information Theory and Coding - Theoretical research in information theory, channel and source coding with special emphasis on deep space communications. Design of codes, decoding architectures, and data compression systems, including on-board science processing. Combined coding and modulation for bandlimited channels. Quantum information theory and communications. Evaluation of end-to-end performance of the communication system.

Contact: **Jon Hamkins**, (818) 354-4764, jon.hamkins@jpl.nasa.gov

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Optical Communication - Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such item lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.

Contact: **Hamid Hemmati**, (818) 354-4960, hamid.hemmati@jpl.nasa.gov

Frequency Standards Research - Experimental investigations in the area of quantum electronics and quantum optics, including ion and atom trapping and tooling, for the development of ultra-stable sources of microwave and optical reference frequencies.

Contact: **Lute Maleki**, (818) 354-3688, lute.maleki@jpl.nasa.gov

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Planetary Radar Astronomy - Experimental and theoretical research in planetary surfaces, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground-based Goldstone radar system, the Very Large Array, and Arecibo Observatory to form images of terrestrial planets, asteroids, and comets

Contact: **Martin Slade**, (818) 354-2765, martin.a.slade@jpl.nasa.gov

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Radar Remote Sensing of the Earth - Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.

Contact: **Yunjin Kim**, (818) 354-9500, yunjin.kim@jpl.nasa.gov

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Microwave Antenna Holography - Experimental and theoretical research in microwave antenna holography and related topics. These include: phase retrieval, prescription retrieval, antenna design and optimization techniques, and advanced development of antenna measurement and instrumentation.

Contact: **David Rochblatt**, (818) 354-3516, david.j.rochblatt@jpl.nasa.gov

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Atmospheric Remote Sensing - Experimental and theoretical investigations of water vapor in the Earth's atmosphere. Emphasis on providing active calibration of the delay imposed on radio and optical remote sensing techniques.

Contact: **George M. Resch** , (818) 354-2789, George.m.resch@jpl.nasa.gov

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Advanced Spacecraft Control Systems - System architectures, sensors, actuators, and algorithms for autonomous rendezvous, docking, aerobraking, and landing. Development of concepts to enable high bandwidth control of flexible space structures and to provide active space control. Development of concepts to enable space interferometry missions.

Contact: **Tooraj Kia**, (818) 354-5165, tooraj.kia@jpl.nasa.gov

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Multimission Spacecraft Avionics Core - Develop and design an avionics core for instruments and interplanetary spacecraft. Establish requirements and minimum core architecture that is scalable. Architecture must allow reuse of software, documentation and development tools across multiple missions.

Contact: **Tooraj Kia**, (818) 354-5165, tooraj.kia@jpl.nasa.gov

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Spacecraft Autonomy - Architecture for robust and testable highly autonomous spacecraft. Includes supervisory or goal-directed ground-based control. On-board task planning and scheduling. Robust, fault-tolerant on-board sequence or plan execution. Autonomous position determination, autonomous guidance laws. Autonomous attitude maneuvers and propulsive maneuvers, autonomous target acquisition and tracking, autonomous spacecraft resource management, autonomous fault detection, isolation, and recovery. Operations approaches for highly autonomous systems. Testing approaches for highly autonomous systems.

Contact: **Douglas Bernard**, (818) 354-2597, douglas.e.bernard@jpl.nasa.gov

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Autonomous Control Systems - Development of advanced control methods and concepts for autonomous spacecraft stabilization, pointing and tracking. Integration of miniature/feature trackers, gyros and advanced metrology systems. Inflight identification, estimation and control strategies for space interferometers. Development of a new generation of control design, modeling, and simulation tools.

Contact: **David Bayard**, (818) 354-8208, david.s.bayard@jpl.nasa.gov

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Precision Landing - Research in advanced autonomous control concepts, architectures, design methodologies and algorithms for high precision landing on large and small planetary bodies. Image-based pointing and control.

Contact: **Fred Y. Hadaegh**, (818) 354-8777, fred.y.hadaegh@jpl.nasa.gov

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Formation Flying Control - Research in advanced control architectures, algorithms, simulations and testbeds for autonomous high precision control of formation flying of spacecraft. Design of optimal maneuvers for targeting and formation reconfigurations. Advanced algorithms and design concepts for autonomous multiple bodies rendezvous and docking with emphasis on image based pointing and tracking.

Contact: **Fred Y. Hadaegh**, (818) 354-8777, fred.y.hadaegh@jpl.nasa.gov

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GPS Receivers - Extend capabilities of BlackJack GPS receivers. Anticipated areas are atmospheric sounding, bistatic radar, and autonomous spacecraft operations enabled by onboard GPS.

Contact: **Larry Young**, (818) 354-5018, lawrence.e.young@ jpl.nasa.gov

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Control of Inflatable Antennas - Research in modeling, pointing control, vibration control, and shape control of large, inflatable systems. Analysis and control of optical/RF performance and structural dynamics.

Contact: **Sam Sirlin**, (818) 354-8484, samuel.w.sirlin@jpl.nasa.gov

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Interferometric Metrology Systems - Development and testing of space-qualifiable systems and system components for interferometric metrology applications. Frequency stabilized laser sources, integrated optics components, fiberoptic components.

Contact: **Serge Dubovitsky**, (818) 354-9796, serge.dubovitsky@jpl.nasa.gov

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Autonomous Vehicles - Real-time path planning in uncertain terrains; locomotion and mobility, computer vision for rover control, and combined mobility and manipulation.

Contact: **Brian Wilcox**, (818) 354-4625, brian.h.wilcox@jpl.nasa.gov

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Rover Technology - Rover navigation in uncertain terrains, rover localization, sample acquisition from small rovers, intelligent rover based science experiments, and web-based operator interfaces

Contact: **Dr. Samad Hayati**, (818) 354-8273, samad.a.hayati@jpl.nasa.gov

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Robot Arm Control - Research in advanced manipulator control, adaptive arm control, control of redundant arms, cooperative multiarm control, force and impedance control, motion planning and control of robotic vehicles, robot control architectures, task-level control, sensor-based motion planning and control, intelligent control of robots.

Contact: **Homayoun Seraji**, (818) 354-4839, homayoun.seraji@jpl.nasa.gov

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Robotics Man-Machine Systems - Development of controls, sensing, manual and graphics-based user interfaces for telerobotic operations and telepresence. Applications to robotic space servicing and exploration and medical robotics.

Contact: **Homayoun Seraji**, (818) 354-4839, homayoun.seraji@jpl.nasa.gov

Optical/Digital Pattern Recognition - Research and technology development in algorithm, architecture, hardware implementation of pattern recognition systems using both optical and digital implementations. Processing methodologies of interest include: correlation, wavelet transforms, mathematical morphology and neural networks. Hardware implementations will be emphasized on Fourier optics and customized DSP.

Contact: **Tien-Hsin Chao**, (818) 354-8614, tien-hsin.chao@jpl.nasa.gov

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Machine Vision Systems - Development of algorithms for visual shape and motion estimation, object recognition, and pose estimation for applications in space flight and planetary exploration. Such applications include autonomous rendezvous and docking, autonomous landing, robotic maintenance of earth-orbiting spacecraft, and planetary rovers. Also interested in development of advanced imagers and high performance, low power, onboard computing hardware for these applications

Contact: **Larry Matthies**, (818) 354-3722, larry.h.matthies@jpl.nasa.gov

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Vis/UV/X-ray Sensor Technology - Investigation of advanced materials and devices for the detection of electromagnetic radiation in the visible through low-energy x-ray wavelength regime. Development of high-performance backside-illuminated charge-coupled devices, rejection and anti reflection coatings, and space science instrument concepts. Research on wide bandgap semiconductor materials for solar-blind detectors.

Contact: **Siamak Forouhar**, (818) 354-4967, siamak.forouhar@jpl.nasa.gov

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Infrared Detectors - Investigation of III-V based new device structures for infrared radiation detection. The research involves studying intersubband absorption, interband absorption and carrier transport properties in III-V superlattices and multiquantum well structures.

Contact: **Sarath Gunapala**, (818) 354-1880 , sarath.d.gunapala@jpl.nasa.gov

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Advanced In-Situ Sensors and Devices - Design, research, and development of advanced miniaturized sensors for planetary exploration and earth monitoring. Technologies under development include physical sensors (micromachined seismometers, hygrometers, electron probes, micro Lidars and dust analyzers, geochronological dating methods, pressure transducers, IR thermal detectors) and chemical sensors (Micro-NMR, capillary electropheresis on a chip, amino acid and fatty acid detection, X-ray diffraction and micro-spectroscopic analysis). This also includes the systems necessary for sample collection, calibration, and data collection.

Contact: **Timothy Krabach**, (818) 354-9654, timothy.n.krabach@jpl.nasa.gov

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MEMS Technology - Research and development in micromachining technology, modeling, reliability, and integration. The microfabrication facilities in MDL are used extensively to develop innovative fabrication approaches to demonstrate next-generation micromechanical devices for a variety of micro-sensors and micro-actuators

Contact: **William C. Tang**, (818) 354-2052, william.c.tang@jpl.nasa.gov

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Integrated Space Microsystems - Research and development of advanced microelectronics computing and avionics systems technologies, including: Semiconductor technologies for scaled voltage, power, and feature size; Ultra Low Power devices, architectures, and systems; Radiation Tolerant electronics, architectures and systems design; Advanced flight computer design, performance modeling, Integrated systems on a chip, including integrated power management, data storage and processing, sensor technology, and RF communication technology. Advanced computing concepts, including quantum computing, quantum dots, innovative computer architectures, biologically inspired systems, molecular nanotechnology, atomic scale technology, etc.benchmarking and evaluation; Memory systems for both volatile and nonvolatile storage (SRAM/DRAM/Flash, Holographic storage, etc.); Low Power I/O architectures; high-speed interconnect networks; commercial off the shelf architectures for low-cost system applications; Fault Tolerant systems, including hardware and software fault-tolerance using off-the-shelf components; Modeling and analysis of FT systems. Design Automation techniques for Design for Testability and Built In Self Test; Advanced Microelectronics Packaging, such as chip stacking in 3D, MCM's, and MCM stacking in 3D; Collaborative engineering, integration and testing.

Contact: **Leon Alkalai**, (818) 354-5988, leon.alkalai@jpl.nasa.gov

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Advanced MultiMode Avionic Design - Development of advanced designs that incorporate analog/ digital optoelectronics and/or RF on one substrate. Development of the design tools necessary for such devices. Development of specific avionic equipment utilizing such devices (I/O interfaces, switching circuitry, etc.).

Contact: **Mark Underwood**, (818) 354-9731, mark.l.underwood@jpl.nasa.gov

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Data Storage Technology - Investigation of hybrid magnetic-semiconductor memory devices for the development of memory and data storage modules for space applications. Development of design, simulation and experimental capabilities to validate technologies for space data storage applications. Investigation of magneto-optical and optical data storage technologies, including holographic data storage, for space mass-storage applications.

Contact: **John Klein**, (818) 354-2603, john.w.klein@jpl.nasa.gov

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Magnetic Device Technology - Investigation of magnetic devices such as microinductors, microtransformers, and magnetically actuated devices for space applications.

Contact: **John Klein**, (818) 354-2603, john.w.klein@jpl.nasa.gov

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Concurrent Processing Using Analog/Digital Hardware - Research in architectures and algorithms related to neural networks, fuzzy logic, genetic algorithms, cellular automata, evolvable hardware, and other similar VLSI-based armlog and digital parallel processing devices.

Contact: **Taher Daud**, (818) 354-5782, taher.daud@jpl.nasa.gov

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Advanced Computing Technologies - Research in algorithms, architectures, and technology related to artificial neural networks, fuzzy logic, genetic algorithms, evolvable hardware, expert rule processor, and other similar VLSI-based analog and digital parallel processing devices. In addition, research in biocomputing architectures and technology development are also of interest. Applications to target and image processing, on-board adaptation, 3-dimensional VLSI architectures, and similar high speed and low power multichip module technology approaches are of keen interest as well.

Contact: **David Rochblatt**, (818) 354-3516, david.j.rochblatt@jpl.nasa.gov

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Neural Network Algorithms - Advanced neural algorithms for spacecraft control, autonomous rendezvous, docking, and landing. Development of feature extraction and tracking algorithms for small body spin vector and shape estimation. Application of neural networks to multisensor integration.

Contact: **Benny Toomarian,** (818) 354-7945, nikzad.toomarian@jpl.nasa.gov

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The Information Systems Development and Operations - The Information Systems Development and Operations Division performs research, development, planning, and operations related to ground-based information systems for spacecraft missions and other tasks in the national interest. Activities include: (1) mission operations engineering, technology, control, and data management, (2) information systems engineering, technology, and services, (3) ground data systems applications engineering and development, (4) space and institutional networks engineering, and (5) advanced information systems technology development and applications. Research areas include: (1) advanced automation for spacecraft and ground system operations, (2) machine learning and applications, (3) simulation, modeling, and expert systems, (4) high-rate, high-capacity distributed information systems, (5) software productivity and reliability, (6) high-performance computing and supercomputing, and (7) low-cost mission operations.

Contact: **David Atkinson**, (818) 393-2769, david.j.atkinson@jpl.nasa.gov

Interferometry Systems & Technology - To be the world leader in the development of advanced space and ground-based interferometry and large optics systems and associated technologies to meet the technology, engineering, and science needs of the related JPL tasks, projects and programs. This includes interferometer and optical systems/subsystems engineering; requirements definition; architecture design; system and sybsystem modeling; performance prediction, analysis, and validation, and instrument development; design, analyze, develop, integrate, and evaluate technology, embedded/real-time and end user software development, electronics design and optics

Contact: **Steve Macenka**, (818) 354-6066, steven.a.macenka@jpl.nasa.gov

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Space Microsensors Technology - Research and development in in-situ sensors, superconducting materials and devices, semiconductor lasers, quantum Well Infrared Photodetectors (QWIPS) and focal plane arrays, diffractive optics, Microelectromechnical Systems (MEMS), UV focal plane arrays, and nanostructures. Specific research topics include efforts in microfluidics, carbon nanotube-based devices, bionanotechnology, superconducting detectors, spin-based semiconductor devices, quantum computing, LIGA, micro-electroplating, micro valves and actuators, microgyroscopes, MEMS-based adaptive optics, bio-MEMS, low-energy particle detection, micropropulsion, antimonide detectors and lasers, and pick-spacecraft. Facilities include a 38,000 square foot state-of-the-art microdevice fabrication facility and a high-resolution JEOL electron beam lithography system.

Contact: **Carl Ruoff**, (818) 354-3599, carl.f.ruoff-jr@jpl.nasa.gov

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Imaging and Spectrometry Systems - Technology development and application for advanced imagers, spectrometers and analytical instruments for remote sensing and in-situ environments. Provides technology and tools for end-to-end modeling/Simulation of missions and experiments. Develops advanced algorithms and software for scientific data visualization, analysis and modeling calculation, including state-of-the-art work in parallel and network computing. The Section is in the forefront in research and advanced development of instruments for in-situ analysis of chemical species including mass spectrometry, scanning electron microscopy, X-ray diffractrometry.

Contact: **Ray Wall**, (818) 354-5016, ray.j.wall@jpl.nasa.gov

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Microwave, Lidar, and Interferometer Technology - Provide technology and research instrument development as well as flight instrument engineering. Expertise, ranging from device physics to system-level operations of flight instruments, responds to NASA needs for improved remote and in-situ sensing instruments for terrestrial, planetary, and astrophysical observations. Development of state-of-the-art technology needed by JPL/NASA for microwave, millimeter-wave, and submillimeter-wave observational instruments, as well as for laser observational instruments. Also conducts experiments with the advanced technology instruments and analyzes their performance capabilities.

Contact: **Bob Menzies**, (818) 354-4317, robert.t.menzies@jpl.nasa.gov

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Space Instruments Implementation - Conception, design development and implementation of remote and in-situ sensing systems to enable both NASA and other agencies space science investigations and observations. Specifically, the lead organization responsible for space flight hardware implementation of observational systems. Performs engineering development, test and calibration for flight instrument systems, including optical imaging and spectrometer systems, microwave and submillimeter radiometer systems, and in-situ chemical analysis and electron microscopy instruments for remote and landed science investigations.

Contact: **Valerie Duval**, (818) 354-5786, valerie.g.duval@jpl.nasa.gov

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Science Data Processing Systems - Provides the unique combination of expertise in information technology and the physical sciences to develop end-to-end science data processing systems in support of Planetary, Earth, and Origins missions. Software and systems are developed to meet the data processing requirements of the science instrument life-cycle – from test and calibration through flight and data archive.

Contact: **Sue Lavoie**, (818) 354-5677, susan.k.lavoie@jpl.nasa.gov

Science Data Management and Archiving - Design, develop and operate science data systems for producing archive data products from data generated by NASA's observational instruments. Design, develop and operate data catalog and data access systems using DBMS and hypertext based technologies (such as those underlying the World Wide Web). Implement NASA's educational outreach objectives through the development of multimedia-based educational products available on CD-ROMs or on the WEB. Lead in R&D for archive product and distribution technologies such as CD-ROMs and access to massive data archives.

Contact: **Yolanda Oliver**, (818) 393-2575, yolanda.j.oliver@jpl.nasa.gov

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Microelectronic Radiation Hardness Assurance - Work is focused on research and testing of the reliability of electronic parts in the harsh radiation environments experienced by NASA spacecraft. Current activities include investigations into radiation effects in electronics and photonics caused by heavy ions characteristic of galactic cosmic rays, electrons, protons and 60Co gamma rays; simulation of single event effects (SEE) by 252Cf; and radiation testing of parts for NASA flight projects. In addition, evaluations are performed of test methodologies and process technologies used to produce reliable, radiation-tolerant microelectronic circuits such as application specific integrated circuits (ASIC's), field programmable gate arrays (FPGAs) and large memories (SRAM's, DRAM's).

Contact: **Charles Barnes**, (818) 354-4467, charles.e.barnes@jpl.nasa.gov

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Systems Assurance - Systems Assurance conducts research in wide range of areas concerned with the quality and reliability of spacecraft systems. Research opportunities exist in the modeling, analysis, and simulation of the natural and induced spacecraft mission environments and of their effects on spacecraft systems, subsystems, and individual components. Software reliability analyses and metrics definition are other areas of rapidly growing research. Specific issues associated with software, spacecraft sensors, control systems, and other flight hardware are of interest.

Contact: **A. G. Brejcha**, (818) 354-3080, albert.g.brejcha@jpl.nasa.gov

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Reliability Engineering - Develops reliability and environmental design, analysis, and test requirements for all JPL flight projects. Reliability activities include electrical and mechanical analyses and environmental requirements activities include: thermal, dynamics, electromagnetic compatibility, and natural space environments. Natural environments include solar and planetary thermal conditions, micrometeoroids and space debris, and space plasma. Induced environments include vibration, acoustic, pyrotechnic shock, and thermal loads, electromagnetic effects, spacecraft charging, etc.

Contact: **J. F. Clawson**, (818) 354-7021, james.f.clawson@jpl.nasa.gov

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Software Product Assurance - Software Product Assurance has the objective to help ensure the operational integrity of the software developed for JPL systems, and evaluates the operational requirements, the acceptability and readiness of all software prior to delivery. It also researches advanced techniques in software engineering, human computer interface, software safety, and metrics, and performs technology transfer to techniques tailored for the JPL and NASA environment to improve the quality of software within JPL and NASA.

Contact: **R. Santiago**, (818) 354-2452, richard.santiago@jpl.nasa.gov

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HPCC/Earth and Space Sciences (ESS) Project - JPL is interested in research that will lead to new parallel computational methods for distributed memory supercomputing architectures. Areas of particular interest include parallel visualization and analysis of massive data sets, methods for writing portable parallel applications and algorithms, performance optimization, and novel parallel numerical techniques. This work is in support of ESS Grand Challenge science applications, which include multidisciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

Contact: **Robert D. Ferraro**, (818) 354-1340, robert.d.ferraro@ jpl.nasa.gov

JOHNSON SPACE CENTER (JSC)

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The mission of the Johnson Space Center is the expansion of a human presence in space through exploration and utilization for the benefit of all. The Center is also responsible for leadership in the field of astromaterials. JSC is the Center of Excellence for Human Operations in Space. This means that JSC provides national leadership and technological preeminence in those capabilities and technologies that support human operations in space. Principal areas include:

- Human spacecraft and habitat design and development
- Human space life sciences
- Flight crew operations
- Mission operations and training
- Planetary surface systems for human operations
- Astromaterials collections, curation, and analysis

JSC is the Lead Center for Space Shuttle Program, International Space Station Program, Space Operations, Biomedical Research and Countermeasures Program, and the Advanced Human Support Technology Program. Agency-wide assignments include Extravehicular Activity (EVA), Robotics Technology Associated with Human Activities, Space Medicine, Technology Utilization on International Space Station and Exploration Mission Planning and Design.

Advanced Life Support Systems - Current research involves development of regenerative (low use of expendables) human life support systems for long duration space missions including the International Space Station as well as other near-Earth exploration locations. Research must address either or both microgravity and hypogravity environments of vehicles or planetary surfaces. Such systems will consist of components that utilize both physicochemical and biological processes to perform the life support functions. Included in these functions is air revitalization, which includes carbon dioxide removal, oxygen generation, and trace gas contaminant control. Water recovery functions include urine treatment, hygiene water processing, and potable water polishing. Food production functions involve crop production using both hydroponics and solid substrate culturing systems. Solid waste processing involves de-watering, volume reduction, and safe storage as well as recovery of other resources from solid wastes generated in space-based human vehicles and habitats. Thermal control research areas include light weight, high efficiency heat pumps and unique heat rejection devices to aid in room temperature heat rejection for advanced missions; theoretical studies and analysis techniques for advanced two phase thermal management systems; and automated monitoring and control, and fault detection methods for advanced two phase thermal management systems. Additionally, integration of these systems into a functioning regenerative life support system via highly automated control and monitoring systems is critical to current development efforts. Research opportunities exist in chemistry, physics, horticulture and plant physiology, soil science, water chemistry, and environmental, chemical, biological, mechanical, computer, and systems engineering disciplines. Opportunities exist for studies of dynamic computer analysis and simulation methodology for hybrid physicochemical and biological systems and development of mathematical models of candidate processes to be integrated into regenerative life-support systems.

Contact: **D. L. Henninger**, (281) 483-5034, donald.l.henninger@nasa.gov

Guidance Navigation and Control - Research opportunities exist for the development of tools and techniques for the design and analysis of integrated guidance and control systems. Of particular interest is the analysis of the stability and control interaction between the guidance algorithm and the flight control algorithm for a lifting body vehicle while flying a reentry trajectory.

Contact: **Mark Hammerschmidt**, (281) 483-8302, mark.m.hammerschmidt1@jsc.nasa.gov

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Landing Hazard Avoidance - Design a landing hazard avoidance system for spacecraft landers. Selected landing sites may exhibit hazards such as slopes, ravines, rocks, etc., which should be detected and avoided autonomously. Development of sensor systems, actuator requirements, avoidance maneuver guidance and control algorithms, and landing performance assessment is required. Systems should be demonstrated using simulation and subscale flight tests. Sensitivity analyses to system errors and environmental dispersions should be performed.

Contact: **Chris Cerimele**, christopher.j.cerimele@nasa.gov

Nanotechnology - Revolutionary designs and concepts are sought for using the extraordinary properties of nanostructured materials (single wall carbon nanotubes, ceramic nanofibers, etc.) toward applications such as thermal protection and thermal management materials, power and energy storage devices, radiation protection and monitoring, electromagnetic shielding materials, advanced life support systems, and lightweight, high-strength multi-functional materials. Research areas may cover nanomaterial growth, synthesis, and production as well as novel characterization and processing strategies. Proposals should make a direct link between the research objectives and the benefits to human and robotic space exploration.

Contact: **Leonard Yowell**, (281) 483-2811, leonard.yowell-1@nasa.gov

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Fluid and Vehicle Attitude Control Systems - Attitude control systems research in the areas of: (1) low gravity earth storable and cryogenic fluid behavior, acquisition, and fluid quantity/flow gauging; (2) pulsing engine design, combustion modeling, and stability analysis; (3) high temperature combustion compatible materials; (4) on-orbit component and system health monitoring; and (5) high performance/long life fluid control components and sensors.

Contact: **Eric Hurlbert**, (281) 483-9016, eric.a.hurlbert1@jsc.nasa.gov

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Electro-Mechanical Systems (EMAs) - Research into electro-mechanical systems (EMA) for aerodynamic surface control, mechanical system actuation (i.e., doors, umbilicals, etc.), fluid component actuation, and electrical auxiliary power units for hydraulic systems. This research includes high performance electrical motors, controllers, gear trains, fault tolerance, and associated instrumentation.

Contact: **Landon Moore**, (281) 483-9002, landon.moore1@jsc.nasa.gov

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Electrical Power Systems - Research area includes electrical power generation (energy conversion), energy storage, and electrical power distribution and control. Specific topics may include: (1) safe application of high density, long life, battery chemistries for manned spacecraft; (2) high current density, long life fuel cells for manned spacecraft applications; (3) specification of stability requirements on source and load converters for large, manned spacecraft regulated power distribution systems, including topologies.

Contact: **Bob Egusquiza**, (281) 483-8284, roberto.m.egusquiza1@jsc.nasa.gov

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Robotic Technologies - Development of emerging robotic technologies, such as (1) robotic end effectors and manipulators with special emphasis on small scale, highly-dexterous, and/or anthropomorphic robots; (2) human-robotic interfaces for telepresence control of robots, including tactile/force feedback techniques, helmet mounted vision displays, stereoscopic vision displays, and visual and non-visual techniques for following human operator input commands; (3) robotic control software including force/torque feedback, adaptive control, grasping techniques and multiarm control (for both kinematically sufficient and redundant systems); (4) robotic sensors including contact and proximity sensors for collision detection and avoidance, limiting forces, mapping, etc.; and (5) machine vision and perception including pattern recognition, feature extraction, pose estimation, object tracking, image registration, visual inspection, and landmark navigation. Application of these technologies will be applied to current technology projects including the development of free flying robotic inspection space vehicles, dexterous maintenance and servicing robots and robotic assistants to suited astronauts during planetary science exploration.

Contact: **Dr. Robert Ambrose**, (281) 244-5561, Robert.O.Ambrose@nasa.gov

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Intelligent Systems for Robotics - Development of intelligent systems technologies to support the design, development and operation of space robotic systems, such as (1) Computer Software Architectures to Support Intelligent Robotic Systems for Human/Robot Teams In Space; (2) Realtime Intelligent System Monitoring and Control; (3) Failure Detection, Diagnosis and Reconfiguration; (4) Intelligent System Modeling and Analysis; (5) Automated Design Knowledge Capture; (6) Automated Planning and Scheduling; (7) Fault Tolerant Robotic Control and Adaptive Control of Multimodal High Degree of Freedom and Nonlinear Systems; (8) Intelligent Pattern Recognition and Trend Monitoring; (9) Realtime Expert Systems; and (10) Adaptive and Intelligent Control (including Machine Learning, Neural Networks, Fuzzy Logic). Application of these technologies will be applied to current technology projects including the development of free flying robotic inspection space vehicles, dexterous anthromorphic maintenance and servicing robots and robotic assistants to suited astronauts during planetary science exploration.

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Aerothermodynamics - Research opportunities also exist in the technical field of aero-thermodynamics as applied to the modeling of environments on ascent or entry vehicles. Numerous analytical techniques and codes exist for producing high fidelity results, including distributed pressures and aerodynamic heating over the surface of the vehicle. The research involves developing and maturing analytical math models or techniques that produce rapid high fidelity results. Validation of the methods with flight or wind tunnel test data is expected. Technologies involved include aerodynamics, heat transfer, fluid dynamics, ground and flight tests, computer coding, and computational fluid dynamics.

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Communications and Tracking System Design - RESTRICTED ELIGIBILITY: This research is open only to US citizens and Legal Permanent Residents. This research task will involve the design of end-to-end communications and tracking systems for use in a growth Space Station and lunar/Mars/Earth links. These systems will require many types of communications links carrying scientific data, as well as voice, television, and text and graphics. The tracking requirements will include rendezvous radar, traffic-control radar, proximity-operations radar, and automatic-docking measurements. The techniques/systems to be considered include (1) radio-frequency interference/ electromagnetic interference mitigation, (2) digital voice/High Definition television data processing and distribution, (3) voice recognition synthesis, (4) multiple-function/multiple-beam antenna configurations and waveguide arrays, (5) frequency-reuse and spectrum-efficient modulation schemes, (6) automated vehicle-terminal guidance systems, (7) multiple-object radar-tracking techniques, and (8) programmable transceivers. The research under this task will concentrate on systems design involving technology/techniques in communications/tracking hardware and signal processing.

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Millimeter-Wave Technology of Advanced Antenna Systems - This research task will involve laboratory research and systems analyses of millimeter-wave technology as applied to spaceborne communications and antenna systems. This task is directed towards hardware breadboard design and testing of antennas, and associated front-end (microwave integrated circuits/monolithic microwave integrated circuits) electronics. Applications include multiple-beam antennas for communicating with low-Earth-orbiting satellites or geosynchronous relay satellites and high-resolution, orbital debris radar-tracking antennas. The results of this research will aid in the design of advanced antenna/electronic systems to be used on future space vehicles and the Space Station.

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Nutritional Biochemistry Laboratory - Space flight alters the metabolism and/or utilization of several nutrients. These alterations, observed during both real and simulated (e.g., bed rest) space flight, appear to be related to other physiologic changes that occur during space flight (e.g., bone loss, muscle loss) and thus may indicate shifts in metabolism that affect nutrient requirements. Research and operational efforts are focused on human nutritional requirements for extended-duration space flight. Areas of particular interest include the consequences of microgravity-induced changes in bone and calcium metabolism; alterations in micronutrient metabolism and requirements during long-term space flight;

interactions of radiation with nutrition (e.g., antioxidants); the influence of exercise on nutritional requirements; and alterations in the intake, digestion, and absorption of nutrients in space. The Nutritional Biochemistry Laboratory facility has the capability to analyze substances for all major nutrients and biochemical analytes. Standard laboratory techniques and procedures are available, including inductively coupled plasma-mass spectrometry, high-pressure liquid chromatography, atomic absorption spectrophotometry, ion chromatography, enzyme-linked immunoassay and radioimmunoasasay. Research efforts are underway to determine the changes in calcium metabolism during real and simulated space flight.

Countermeasure evaluations are a key component of these efforts. A comprehensive nutritional assessment protocol is also implemented as a medical requirement for long-duration crewmembers. Efforts are ongoing to develop appropriate techniques to measure changes in nutrition and metabolism during space flight. The laboratory is particularly concerned with defining these changes, determining when they may be detrimental to crewmembers, and developing appropriate countermeasures for any detrimental changes. When appropriate, research will be directed to the amelioration of space flight induced physiological changes through nutritional countermeasures. Although Space Shuttle and International Space Station flight-experiment opportunities are available to develop and verify related experimental support protocols, the resources for these platforms are extremely limited. The laboratory coordinates its efforts with both intramural and extramural collaborators. Other in-house teams include biochemistry, hematology, immunology, endocrinology, and exercise-physiology laboratories.

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High-Pressure Studies of Planetary Interiors - The origin and evolution of planetary interiors, though remote from us both temporally and spatially, can be elucidated through high- pressure and temperature laboratory experiments. This research is conducted in Johnson's high-pressure experimental petrology facility, which features hydraulic presses fitted with multiple anvil and piston cylinder devices that can achieve high pressures (0.1 to 25.0 GPa) and high temperatures (up to 2,500 C) in relatively large sample volumes. This capability allows the laboratory observation of mineral and magma properties at conditions equivalent to a depth of 700 km in the Earth and Venus, 2,000 km in Mars, and pressures exceeding the Moon's central core at 1,700 km. Current research includes studies of the physics and chemistry of core formation in the Moon, Earth, Mars, and asteroids; the timing of differentiation of terrestrial planets; the geochemistry of the platinum group elements; and the nature of planetary basaltic magmatism.

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Microbiology and Immunology - The primary concern of the Space Microbiology Program is to ensure the health, safety, and productivity of astronauts. This requires careful diagnostic evaluation of astronauts and their environments before and after missions. Developing microbiological diagnostic technologies for use during a space mission is another important aspect of maintaining crew health and productivity. Microbial analysis of the air, surfaces, water, food, experimental animals, and payloads is included in the environmental assessment. The Microbiology Laboratory defines requirements, develops specifications, and evaluates candidate hardware in the areas of clinical and environmental microbiology for use on board manned space systems, including the space shuttle and space station programs. Intense research areas include developing simple, rapid, and direct methods to diagnose infectious diseases and to determine the effects of different microbial loads on human health in a closed system; investigating the effects of spaceflight on microbial population dynamics, structure, and function; pathogenicity; and susceptibility to antibiotics. In preparation for longer duration missions, vigorous research focuses on the effect of spaceflight and related factors on the human immune response, particularly the immunology of infectious diseases. Experimental and clinical studies will be used to investigate the effect of spaceflight on the three major arms of the immune system: cellular, humoral, and innate immunity. Specific areas of investigation include neutrophil and monocyte function (e.g., chemotaxis, adhesion), natural killer cell and T-cytoxic cell function, antibody response to specific antigen challenges, and reactivation of herpes viruses in response to spaceflight.

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Cell Science and Immunology - The cellular and molecular mechanisms by which space flight alters human physiology are poorly understood. Crewmembers experience immune system changes, muscle and bone loss, neurological alterations, and other changes in body systems. To optimally develop techniques that prevent or alleviate the deleterious effects of space flight, we must determine which cellular processes are altered by microgravity. JSCs Cellular/molecular Research Laboratories focus on the effects of space flight on immune cell function both in vivo and in vitro. We also investigate the response of other types of cultured cells (e.g., bone cells and endothelial cells) to altered gravity environments. The laboratory is equipped for tissue culture and general biochemistry/molecular biology studies, and contains two flow cytometers, light/fluorescence microscopes, digital image systems, and two scanning electron microscopes. In addition, the laboratory has direct access to a confocal microscope.

Results from previous studies have indicated a dysregulation of the immune system associated with space flight. Observations in several laboratories have demonstrated significant alterations in circulating lymphocyte populations following space flight. Functional studies are being initiated to investigate the effect of these alterations on immune competence. These studies will include the examination of T- and B-cell activity, accessory cell function, and changes in immunoregulatory factors and lymphocyte trafficking. In addition, a number of investigators have shown depressed in vitro activation of lymphocytes with space flight. Detailed studies of the effects mechanical forces on the cell-cell interactions, signal transduction pathways, and transcriptional changes involved in lymphocyte activation are under way to delineate the mechanisms that are altered in microgravity. These studies utilize hypergravity and clinorotation (a microgravity model system) models to examine the effects of gravity and mechanical forces at the cellular and molecular level. Understanding the role of such forces in signal transduction, cytoskeletal function, and cell cycle regulation will provide knowledge relevant to cellular activation, movement, shape, adhesion, movement of organelles, gene expression, and proliferation. Knowledge of gravity-induced alterations in these characteristics at a cellular level will provide a mechanistic foundation to improve our understanding of the physiological effects observed during space flight.

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Biotechnology Cell Science Program - The NASA JSC Biotechnology program supports NASA's human exploration of space by developing biotechnologies that advance our knowledge of (i) the effect of space and planetary environment stressors (radiation, chemicals, and gases) on humans at the cellular and tissue level, and (ii) the selective pressure of space on cells and tissues that have evolved in the 1G environment of Earth. The Program develops advanced space bioreactor systems that meet science and low-gravity operation requirements, and meet the resource constraints of spacecraft (limited mass, power, consumables) by utilizing advances in microfabrication and micro- and nano-technologies. The Program develops advanced biosentinels for acute and long-term environment monitoring that are comprised of living bioreporters, microanalytical systems, and bioinformatic and telemetric systems. The Program develops both prokaryotic and eukarytoic bioreporters using genetic engineering to design panels of benchmarked living bioreporters. The Program conducts low-gravity testing and validation of biotechnologies in a suite of microgravity analog bioreactors, drop towers, and KC 135 aircraft. Three-dimensional tissue-like models have been developed for many normal tissues and cancers. Mammalian cells cultured in our microgravity analog bioreactors grow into three-dimensional arrays, and the cultured cells display differentiation markers similar to those found in corresponding mammalian tissue. Ground-based studies using the NASA bioreactors have demonstrated that both normal and neoplastic cells and tissues recreate many of the characteristics that they display in vivo. The Program has three major goals concerning mammalian tissues culture: (1) to accelerate the development of a three-dimensional tissue culture system using rotating-wall bioreactors, (2) to define and characterize mammalian cells and tissues that benefit from a low shear environment, and (3) to use the microgravity environment of space as necessary to surmount gravity-induced obstacles to the propagation of complex tissues.

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Chronotherapeutics - Space travelers experience ultra-short day/night cycles as the shuttle orbits the Earth every 90 minutes. Medical records and personal communications by astronauts and cosmonauts suggest that sleep disruption is a common occurrence during flights. Extended mission duration and work demands often over-extend crew schedules during flights. Reports of fatigue-related performance decrements in shift workers and other sleep-deprived groups indicate that spaceflight crews may be subjected to similar decreased operational efficiency resulting from alterations in their work-rest efficiency. JSC's pharmacology research group evaluates methods for the assessment of sleep deficits and resulting decrements in work-time alertness and performance. Laboratory activities also focus on designing and developing ground-based and inflight countermeasure strategies for improving sleep quality and health during spaceflight. Our goal is to generate information and identify ground-based models that can assist in the development of practical, appropriate, reliable, and effective intervention technologies and regiments that can augment health and well being to support sleep-work activity schedules of long duration flights and for a prolonged stay in the microgravity environment. Specific objectives of this investigation are to identify and characterize changes in the physiological and biochemical indices of circadian adjustments during space flights, and to develop and validate effective operational monitoring tools and countermeasures that will improve performance and maintain health of crew members during short and long duration missions.

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Pharmacokinetic Research - Spaceflight induces a number of physiological changes including fluid shifts and cardiovascular deconditioning. While some of these changes were evaluated on earlier missions, others (e.g., changes in gastrointestinal and hepatic function) have not been investigated. Availability of sensitive and flight-suitable methods of evaluation limits implementation of these studies in space. Identification and evaluation of these physiological parameters and resulting changes in the pharmacokinetics and pharmacodynamics of therapeutic agents administered during spaceflight are essential for designing and developing effective treatment regimes for the space medical operations. Gastrointestinal and hepatic function research focuses on developing simple, noninvasive techniques to conduct these studies in space. We will use ground-based simulation models of microgravity (e.g., antiorthostatic bed rest) to evaluate and validate these techniques for their flight suitability. Using these validated, noninvasive methods, we can also evaluate changes in gastrointestinal and hepatic function during spaceflight. Pharmacokinetics research includes (1) development of simple and noninvasive drug-monitoring methods that are flight suitable, (2) evaluation of pharmacokinetic changes of drugs during antiorthostatic bed rest, (3) pharmacodynamic implications of these changes, and (4) other changes such as protein binding and metabolism of drugs. Inflight pharmacokinetics and pharmacodynamics are characterized using methods developed in ground-based research. Research in the area of pharmaceutical development involves designing and testing noninvasive and nonparenteral drug dosage forms that are suitable for use in space. We also evaluate sustained release and intranasal dosage forms of antimotion sickness drugs.

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Space Human Factors Research - With permanent human presence onboard the International Space Station (ISS), astronauts are living and working in microgravity for long durations, facing novel situations for which there is inadequate knowledge of human capabilities. In addition to weightlessness, the confined and isolated nature of a spacecraft environment results in human factors challenges in habitability, workload and human performance. Thus, determining the appropriate set of human factors engineering requirements and identifying critical factors and level of impacts on habitability, workload and human performance are crucial to astronauts' well-being and productivity. In order to achieve this goal, the primary research areas include: (1) human performance modeling and analysis, (2) tools and methods for quantifying and monitoring habitability, (3) human-system design considerations, (4) communications and information management, and (5) training strategies and performance assessments. The Space Human Factors Laboratory (SHFL) at Johnson Space Center supports applied human factors activities for Space Shuttle, ISS and future flight missions and conducts research funded through the NASA Research Announcements process. It consists of facilities for usability testing, human modeling, anthropometric and biomechanical analysis, and lighting evaluations. These facilities have access to simulated analog environments, such as NASA's Reduced gravity aircraft, as well as means of conducting assessments on board Space Shuttle.

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Human Modeling in Virtual Environments - The objective of virtual environment research at the Graphics Research and Analysis Facility is to develop a computer software system for use in the design and evaluation of complex space structures. Its special features include an immersive user interface, which will allow the graphics model of a structure to be perceived as a virtual environment; and the incorporation of anthropometrically correct graphics models of humans, which can be used to investigate human factors issues such as reachability, fit, and visibility in the virtual environment. By allowing a designed structure to be seen and evaluated "from the inside" at the beginning of the design cycle, long before it is feasible to build a mockup of the structure, the system will lead to earlier recognition of potential problems and make it easier to evaluate alternate designs, resulting in considerable savings in time and funds.

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Research on Computer Biomechanical Modeling - One of the goals in human modeling at the Graphics Research and Analysis Facility (GRAF) is to create a task-oriented human figure model which emulates the physical characteristics of the actual human counterpart as closely as possible. Currently, GRAF's human model is used to solve problems and make predictions related to anthropometry and kinematics. Our overall goal is to extend the current strength model with a systematic and comprehensive assessment of strength for all major joints of the human, and to build a task-oriented modeling system with the astronaut characterized in terms of his/her strength/fatigue and reach limitations. The research requires that a biomechanical modeling system be built which incorporates dynamics, human strength, stamina, range of motion, workload, and fatigue. This model should extend human factors support to operational areas and emphasize the improvement of processes and products.

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Neurosciences - This laboratory, which functions under the auspices of the Life Sciences Research Laboratories, is engaged in a wide-ranging program of ground-based and space flight studies to investigate the effects of unique space flight environmental variables, particularly microgravity, on man's nervous system. As a result of data obtained from the Apollo, Skylab, Shuttle, and Mir missions, attention is being given to studies that attempt to elucidate those neurosensory, sensorimotor, and related physiological mechanisms underlying space-adaptation (space motion-sickness, spatial orientation, and perceptual processes) syndrome and readaptation to Earth. Included are investigations of semicircular-canal and otolith-organ interaction processes, vestibulospinal reflex responses, visual-vestibular interaction processes, vestibular-autonomic interaction processes, eye-hand coordination, and psychophysiological responses to stressful, gravitoinertial stimuli, and postural and locomotion control processes. The primary focus is operational research directed toward developing reliable predictive techniques and effective countermeasures for space motion sickness, "Earth sickness", and neurosensory, and sensorimotor disturbances during and after flight. Research on countermeasures centers primarily on visual and vestibular adaptation training, centrifugation, and evaluations of new pharmaceuticals for motion sickness and orthostatic intolerance. Another major focus of the laboratory is the effects of extended duration flight on visual/vestibular function, autonomic function, posture, gait, and other sensory systems. In addition, the development of countermeasures to ensure the safe return and egress of flight crews is an area of critical concern. Work is under way to develop new and improved vestibular-response measurement analysis and modeling techniques. Laboratory facilities have recently undergone considerable expansion to accommodate increased efforts to investigate etiological factors and autonomic nervous system responses underlying both motion sickness and orthostatic tolerance. Extensive laboratory instrumentation is available for the generation and control of stimuli and the recording and analysis of a variety of responses.

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Exercise Physiology - One objective is to refine currently available procedures for the measurement of very small changes in bone and muscle mass. Four major physical-measurement systems are being studied: single-axis gamma-ray absorptiometry, x-ray computed tomography, nuclear magnetic resonance, and low-level radioactive counting of activated calcium. Additional indices of acute change are identified through collaborative programs in endocrinology and biochemistry. The major emphasis is directed toward the quantification of bone mineral by computer tomography and selective rectilinear scanning techniques (oscalsis and lumbar spine). Trabecular bone shows changes in mineralization much faster than cortical bone. Selective rectilinear scanning has now been developed to determine the mineral distribution in a bone section based on measurements of the transmission of gamma rays from an isotope source using a precision scanning instrument. Whole-body x-ray CT scanning of the spine to determine density is now available. One aspect of the research effort will be to miniaturize the scanning instrument and computer for use on a space station. Magnetic resonance imaging is being used regularly to document the atrophy of the leg muscles in individuals exposed to microgravity and bed-rest simulations of microgravity. Advance-imaging techniques have been developed and are being used routinely. Measurements of changes in water content of the muscles of posture and ambulation are being made before and after periods of bed rest. High-energy phosphates are being measured in vivo and the changes in bone marrow content after bed rest are being followed.

Computer enhancement of the images is under way using methods developed for Earth-observation satellites. NASA has available three different magnetic-imaging machines for use in advanced studies of muscle change. The objectives of this research are to refine current methods of measuring biochemical factors that influence the musculoskeletal system and to correlate these factors with musculoskeletal changes during bed rest and space flight with and without countermeasures. Specific subtasks include

(1) quantifying biomechanical loads during exercise using methods that require minimal operating space in flight, (2) automating signal acquisition and processing methods, (3) performing stress analysis on the skeleton for the exercises measured using finite element analysis, (4) measuring musculoskeletal changes during bed rest and space flight, (5) refining techniques to measure changes in trabecular architecture and material properties using acoustic or magnetic resonance imaging methods, and (6) correlating these changes with the exercises and stresses during exercise countermeasures. The goal of the exercise countermeasure program is to maintain crew members' neuromuscular capability, systemic aerobic and anaerobic performance, skeletal muscle function, and bone integrity during space flight missions. Laboratories supporting this research contain comprehensive facilities in the areas of biomechanics, exercise physiology, neuromuscular, and hardware development. In addition, the design and development of space flight exercise equipment is a fundamental aspect of the exercise countermeasure program for both the space shuttle and space station. Operational and ground-based research is conducted. Operational research takes place during space flight missions, while ground-based research is performed in (1) laboratory settings, (2) underwater-thus attaining neutral buoyancy in the Neutral Buoyancy Laboratory, and (3) on board NASA's KC 135 aircraft, where short duration zero gravity is achieved by flying parabolic maneuvers.

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Microgravity Associated Skeletal Muscle Atrophy - Human space explorers undergo a variety of physiologic adaptations to the microgravity environment to which they are subjected during space flight. In both astronauts and cosmonauts, atrophy of skeletal muscle with a concomitant reduction in functional capacity when returning to the normal terrestrial gravitational environment has been documented. Reductions in calf circumference, development of negative nitrogen balance, increased urinary excretion of muscle protein-derived amino acids, decrements in strength and force-velocity relationships in selected muscles, and loss of muscle volume as verified by magnetic resonance imaging have all demonstrated muscle atrophy is a consequence of space flight.

A variety of studies in astronauts/cosmonauts, human test subjects under conditions of simulated microgravity (bed rest and/or limb suspension), and in hypokinesia/hypodynamia animal models are in progress to elucidate the mechanism of microgravity associated muscle atrophy in order to devise, implement, and test the efficacy of countermeasures to prevent or attenuate its occurrence. The following approaches are proposed for future studies: (1) histochemical and histomorphometric evaluation of muscle biopsies from flight crew members, bed rest test subjects, or animal models; (2) quantitative image analysis of magnetic resonance images from muscles suspected of being susceptible to atrophy; (3) development and study of in vitro (tissue culture) models of muscle atrophy; (4) analysis of possible muscle atrophy markers; (5) study of structure/function relationships of muscle mitochondria and capillaries; and (6) development and testing of countermeasures. Techniques used in these studies will include muscle enzyme and lectin histochemistry, monoclonal immunohistochemistry, and morphometric analysis by digital planimetry; diagnostic medical imaging and quantitative image analysis; tissue culture and two-dimensional gel electrophoresis; spectrophotometric, spectrofluorimetric, and turbidimetric biochemical assays; in situ hybridization; and subcellular fractionation.

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Exercise Countermeasures for Space Flight - Regular exercise is the most important countermeasure modality for the mitigation of loss of bone, muscle, and cardiovascular function during space flight. Exercise Countermeasure research conducted by the Exercise Physiology Laboratory is directed at: assessment of astronaut pre- flight, in-flight, and post- flight aerobic capacity; assessment of pre-flight and post-flight muscle strength; evaluation of in-flight daily exercise patterns; assessment of maximal exercise as a countermeasure to orthostatic intolerance and reduced exercise capacity; development of exercise devices and related hardware for use in-flight; evaluation of changes in muscle morphology as a result of space flight; evaluation of combined treadmill exercise and lower body negative pressure, and resistive exercise as countermeasures to orthostatic intolerance and decreased muscle strength and aerobic capacity; characterization of cardiopulmonary and thermoregulatory responses to egress performance while wearing the LES or ACES prior to and immediately after space flight; and development of appropriate aerobic and resistive exercise countermeasures.

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Space Plasma Physics - Magnetohydrodynamic Turbulence - This research area is related to understanding the fundamental nonlinear processes that occur in space plasmas and in plasma propulsion systems. This space environment includes radiation belts, magnetospheres, the solar wind and, more generally, astrophysical phenomena. High-power plasma propulsion systems, in turn, may contain internal or external turbulent flow. Research in magnetohydrodynamic turbulence involves the use of analytical methods and numerical techniques to study the basic properties of turbulent magneto-fluids. Anyone interested in this opportunity is welcome to contact me directly for further discussion.

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Orbital Debris Hazard Assessment - NASA Johnson Space Center has a program to better understand the character of the man-made orbital debris environment, the implications of this environment on the design and operations of spacecraft, and the development of national and international standards to minimize the future orbital debris environment. This program consists of four major components: (1) modeling of the environment; (2) measurements of the environment; (3) hypervelocity impact testing to determine the consequences of the environment and the design of shielding; and (4) consulting with industry, other government agencies, and other space-faring nations for making cost- effective recommendations to minimize the hazard to future spacecraft. Predictions of the flux resulting from the orbital debris environment are made from both source and sink models, which include spacecraft traffic models, satellite breakup models, and atmospheric drag models. We test these predictions against environmental measurements. Such measurements include the relatively large (>10 cm) objects maintained in the US Space Command catalog, intermediate sized (1 mm to 10 cm) that are sampled by ground telescopes and high- frequency ground radars, and small objects (<1 mm) that are sampled through hypervelocity impacts on recovered spacecraft surfaces. JSC obtains data using the Haystack and Haystack Auxiliary radars, maintains samples from several recovered satellite surfaces, and maintains laboratories to measure the characteristics and chemistry of impact craters. To date, the measurements program has identified sources of orbital debris that were not included in previous models. The risk that a spacecraft will fail to function because of an orbital debris or meteoroid impact can be reduced with specially designed shielding. JSC has played a critical role in designing shields for the International Space Station and developing effective modifications to reduce Shuttle meteoroid/debris risks. In an effort to minimize the shielding weight for these and other spacecraft, hypervelocity (velocities greater than 5 km/sec) tests are conducted on various spacecraft materials and configurations. Results from hypervelocity impact tests and from numerical simulations of hypervelocity impact are used to update software that is maintained by JSC to assess spacecraft damage and failure risk from meteoroid/debris impact. JSC has prepared a NASA safety standard, which includes guidelines and procedures for limiting orbital debris. We also conduct regular meetings with other US agencies and the "Inter-Agency Space Debris Coordination Committee" (with members from the US, Europe, Russia, China, India, Ukraine, and Japan). The purpose of these meetings is to coordinate research and reach a common consensus for the international standards of limiting orbital debris.

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Planetary Materials Analysis and Process Simulation - One very important approach to deciphering geologic history is through experimental simulation of the processes involved in basalt generation and crystallization. Towards this end, we subject basaltic melts to temperatures and pressures that they might have experienced on their parent bodies and compare the resulting synthetic basalts with natural lunar samples or basaltic meteorites. Emphasis has been placed on minerals and liquid compositions believed to have played an important role in the geochemical evolution of the lunar crust and mantle, in petrogenesis of Martian meteorites, and in the petrogenesis of the very primitive angrite meteorites. However, studies of other compositional systems having relevance to planetary science are also encouraged. Equipment includes one-atmosphere, gas-mixing furnaces capable of reaching 1,500oC, internally and externally heated pressure vessels covering conditions to 10 kbars and 1,200oC, and a piston-cylinder apparatus covering conditions to 40 kbars. Modern electron microprobe and electron microscope facilities are also available.

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Chondrule formation processes - The identification of chondrule precursors in unequilibrated chondrites and the partial melting of these precursors to form porphyritic chondrules is an important new area of interest. Recent studies have shown that partial melting of chondrule precursors to form porphyritic chondrules is more common than previously thought. I have started an extensive experimental study of the kinetics of partial melting of chondrule precursor like material with the intent of placing new constraints on the formation process. The student researcher would participate in this study in two ways.

1) Conducting experiments to determine the nature of the partial melting process with emphasis on the rate of destruction of relict materials during the heating event and the overall time constraints that can be placed on the duration of the chondrule forming event. 2) Examination of thin sections from the meteorite collection to find examples of relict materials in chondrules or precursor aggregates and porphyritic chondrules formed by partial melting for comparison with the experimentally produced products. It is important to determine what kinds of relict material are most common and what kinds of contrasting textures exist between these materials. Ultimately we would like to establish criteria to determine what is relict and what is not and what aggregates are possible chondrule precursors. Mineral fragments of widely disparate composition and physical appearance are readily identified, but how do we determine whether minerals similar those in the chondrule are relict? How might partial melting textures on whole chondrules be identified when the chondrule is not incorporated into another chondrule, but was simply slightly melted and cooled a second time. All these questions lead to an increased understanding of the complexity of the chondrule-forming event.

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Soil Chemistry and Mineralogy - The objectives of this research topic are to search for and identify chemical weathering and/or aqueous alteration products on the surface of Mars using data returned from current and future robotic missions (e.g., Odyssey, 2003 Mars Exploration Rovers, Mars Reconnaissance Orbiter, 2007 Mars Scout, etc.). Studies are also underway to establish datasets on the mineralogical, chemical, magnetic, spectral, and physical properties of Mars analog materials to aid in the interpretation of data returned from Mars robotic missions. The overall intent of this research topic is to provide a better understanding of the geologic processes responsible for the formation of "soils" and other potential chemical weathering or alteration products (e.g., phyllosilicates, sulfates, Fe- oxyhydroxides, zeolites) on the surface of Mars. The identification of and understanding the formation processes for chemical weathering or alteration phases are keys to defining the environmental conditions under which these phases have formed. Research projects in soil chemistry and mineralogy are encouraged, especially clay mineralogy, zeolite chemistry and mineralogy, and mineral synthesis studies. In addition to Mars surface studies, several studies are underway to determine the possible geologic (or biologic) processes responsible for the formation of secondary phases found in the SNC meteorites (e.g., carbonates and magnetite in Martian meteorite ALH84001). Experimental and analytical facilities include x-ray diffraction analysis, infrared spectroscopy, electron microscopy (e.g., scanning transmission electron microscopy, scanning electron microscopy, and electron microprobe), differential scanning calorimetry, and atomic absorption spectroscopy.

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Experimental Trace-Element Partitioning and Petrogenesis of Extraterrestrial Igneous Rocks - One very important approach to deciphering geologic history is through the study of trace-element abundances in rocks. Reliable interpretation of such abundance data requires knowledge of the effects of geological processes on trace-element abundances. In order to contribute to this knowledge, we are studying the partitioning of various trace elements between silicate melts and several geologically important minerals in controlled laboratory experiments. Effects of mineral and melt composition are being systematically investigated. Emphasis has been placed on minerals and liquid compositions believed to have played an important role in the geochemical evolution of the lunar crust and mantle, in petrogenesis of Martian meteorites, and in the petrogenesis of the very primitive angrite meteorites. However, studies of other compositional systems having relevance to planetary science are also encouraged. Equipment includes one-atmosphere, gas-mixing furnaces capable of reaching 1,500oC, internally and externally heated pressure vessels covering conditions to 10 kbars and 1,200oC, and a piston-cylinder apparatus covering conditions to 40 kbars. Modern electron microprobe and electron microscope facilities are also available.

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Physicochemical State of the Martian Surface - The general objective of this continuing research program is to understand the nature and constitution of surficial material on Mars and to determine the weathering processes that evolved the surface to its current state. Specific tasks include (1) studies of geologic samples that have been weathered in terrestrial environments considered to be analogous in some important respects to those on Mars, (2) theoretical and experimental studies of the optical properties of pure and substituted iron-bearing compounds, and (3) instrument development. Emphasis is placed on multidisciplinary analyses of samples to maximize comparison with the database available for Mars from the Viking, Phobos-2, and Mars Pathfinder missions and telescopic observations.

Experimental and analytical facilities include ferromagnetic resonance spectroscopy, vibrating sample magnetometer, Mössbauer spectroscopy, and ultraviolet-visible-infrared spectroscopy. Instrument development includes a backscatter Mössbauer spectrometer for planetary applications.

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Analytical Studies of Space Weathering Effects on Lunar and Asteroid Surfaces - A long-term program is underway to analyze and interpret many of the characteristics of lunar soils, cores, and regolith breccias. Lunar soils have formed by complex processes including impacts, solar wind implantation and radiation effects, and volcanic processes that were active in earlier lunar history. Ancient lunar soils are preserved in some regolith breccias and in some of the returned core material. A challenging research task is to decode the record in these ancient regoliths using clues from current ones, and to determine something about the meteorite flux; meteorite composition; solar wind, flare, and early volcanic activity; and general lunar evolution over the course of lunar geologic history. A major objective is to quantify the physical, chemical, and optical effects of space "weathering" on exposed lunar soils and possible asteroid regolith material (interplanetary dust particles). Research techniques include optical and scanning electron microscopy petrographic analysis; electron microprobe analysis; scanning electron microscopy studies of grain surfaces and textures; transmission electron microscopy studies of textures including radiation and shock damage; quantitative analysis of grain sizes, grain shapes, and surface features; and population studies of mineral and glass phases. Experience in petrology, scanning electron microscope analysis, transmission electron microscope analysis (including high-resolution work), image analysis, and geochemistry would be useful for this project.

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Characterization of Possible Biomarkers in Mars Meteorites - The field of Astrobiology was galvanized by our report in 1996 of possible evidence for life in Mars Meteorites ALH84001. We are currently studying several other Mars meteorites. A total of at least 15 Mars meteorites are known and about half of them are in the Antarctic meteorite collection at JSC. Each of these meteorites should be investigated for possible biomarkers. We are currently using FEGSEM, TEM, electron microprobe for chemical mapping and quantitative analysis, fluorescence microscope imaging for specific organic compounds and TOFSIMS for organic compound detection, characterization, and mapping. We are also developing an immunological assay technique using array technology. This technique will be incorporated into a possible flight instrument to be landed on Mars to search for organics and possible biomarkers in the Martian soil and subsurface as sampled by drills and cores. In addition, we anticipate that the immunological array will be used to help check returned Mars samples for possible biomarkers. We are developing a microbiology laboratory for culturing and studying extremophiles from earth. We are also interested in experimental fossilization studies for microbes and viruses. Students interested in these topics could work directly on Mars meteorites, terrestrial analogs, technique and instrument development for Mars robotic missions, experimental fossilization studies, or culturing and DNA/RNA characterization of appropriate microprobes from various terrestrial environments. Students should have background or interest in any of the following broad topics: biology, geology, astrobiology, Mars planetology, immunology, and instrumental microanalysis.

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Isotopic and Chemical Studies of the Evolution of Solid Objects in the Solar System - Laboratory analyses of lunar, meteoritic, and terrestrial samples are conducted to provide isotopic, chronological, and chemical constraints for the evolution of solid objects in the solar system. Current emphasis centers on lunar sample and meteorite analysis. Research on related terrestrial evolutionary analogs will also be considered. Facilities include clean laboratories for physical and chemical preparation of samples and two thermal-emission mass spectrometers for sample analysis. One of these is a multisample, seven-collector, late-generation instrument. The laboratory's lunar sample analysis program emphasizes the geochemical evolution of lunar mare basalts and highland rocks as recorded in their isotopic systematics. The meteorite analysis program applies isotopic constraints to the chronology and petrogenesis of basaltic meteorites, the formation of the solar system, and to stellar nucleosynthesis. Research that emphasizes laboratory or theoretical investigations of lunar-basalt genesis, genesis of basaltic rocks on other planetary objects, or categorization and interpretation of nucleosynthetic components in primitive meteorites is especially appropriate for our program. Research that focuses on planetary crustal development also is appropriate, as are studies that seek to unravel the cratering history of planetary surfaces or the history of meteorites in space by measuring cosmic ray-produced nuclides.

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Noble-Gas Isotopic Abundances in Planetary Materials - Isotopic abundance determinations of the noble-gas elements (He, Ne, Ar, Kr, and Xe) in meteorites and lunar samples furnish important information on a variety of planetary problems. Some problems recently addressed by our laboratory include (1) the isotopic composition and origin of various volatile components in the solar system, including the atmospheres of Mars and other planets, solar wind species implanted into the lunar regolith, and ancient energetic solar emissions; (2) the 39Ar-40Ar chronology of the formation and metamorphism of various meteorite types, including Martian meteorites, and of the early lunar crust; and (3) the history of collisional breakup events among meteorite parent bodies and the ages of lunar surface features using noble gases produced by energetic cosmic ray protons and by 39Ar-40Ar dating. Most types of isotopic measurements of noble gases are possible, including those on irradiated samples. Available equipment includes two high-sensitivity noble gas mass spectrometers with computer control, low-blank induction-heated furnaces equipped with thermocouples, an infrared laser equipped with a focusing and imaging system, a gas calibration system, and low-blank vacuum systems.

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Space-Radiation Environment - Space-radiation environment is a significant consideration in planning any long-duration mission both in low-Earth orbit and in interplanetary space. To maintain our ability to assess the environment and to minimize the risk to humans in space, an active program entails computer modeling of radiation received by the human body and careful measurements of the radiation environment both outside and inside the space shuttle. Research concerns advanced concepts of dosimetry, including identification of the elemental composition, energy, and direction of incident radiation, as well as real-time calculations and display of radiobiological effectiveness. This currently involves the design and construction of a solid-state charged particle telescope and acquisition of data on the inner radiation belt and galactic cosmic rays (GCR) through its operation on Shuttle flights and Mir flights. Other activities include improvements of GCR models and inner belt models to account for variations caused by the 22-year solar cycle.

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Geochemistry of Lunar Rocks, Achondrites, and Terrestrial Analogs - Lunar highland igneous and metamorphic rocks are products of early lunar differentiation that have been broken and reheated by meteorite impact. Achondritic meteorites are fragments resulting from differentiation and impact on smaller, usually asteroidal parent bodies. Some achondrites are igneous meteorites blasted off the surface of Mars. Terrestrial igneous rocks, both volcanic and plutonic, result from differentiation on the much larger and more complex planet Earth. Studies of the four types of materials may lead to a broader understanding of planetary differentiation. Major and trace-element analyses by neutron activation are coupled with petrologic studies of the planetary fragments and experimental studies of analogs in order to look through these impact processes to the precursor igneous rocks and evaluate planetary differentiation. Studies of terrestrial analogs to lunar and meteoritic igneous rocks are valuable in constraining the processes of igneous differentiation.

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Mineralogy of Fine-Grained Extraterrestrial Materials - The early history of the solar system is being explored through detailed characterization of the minerals and noncrystalline phases composing primitive extraterrestrial materials. As these materials are typically very fine grained, this research is being performed principally by analytical electron microscopy and high-resolution transmission electron microscopy, as complemented by standard petrographic and electron-beam techniques. We are currently examining carbonaceous chondrites, as well as interplanetary dust particles (IDP) collected from the stratosphere and from Greenland and Antarctic Ice. Of particular interest are the primitive carbonaceous chondrites, which potentially contain very primitive nebula condensates and/or presolar materials and the record of low-temperature planetary alteration processes, as revealed by the paragenesis of the matrix phases. We are also developing sample handling techniques for the Stardust Discovery Mission to Comet Wild II and the Muses-C Mission asteroid sample return mission, and are characterizing aqueous fluid inclusions found in meteorites.

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Experimental Investigations of Planetary Processes - Experiments delineating the geochemical behaviors of chemical elements during planetary processes are important for understanding the elemental abundance patterns that are observed in planetary materials. Specifically, geochemical behaviors of elements change with temperature (T), pressure (P), oxygen fugacity (f02), and bulk chemical composition of the system (?Ci). Laboratory experiments are performed to better understand the detailed geochemical behaviors of trace elements in planetary processes such as core formation and basalt genesis. The results of these studies are then used to understand the origin of meteorites, the Earth, and the Moon. Because the conditions that pertained during laboratory experiments are seldom identical to those occurring in nature, it is also important to have means of extrapolating laboratory results to different (P, T, f02, ?Ci) conditions. Thus, our research objectives are (1) to determine the geochemical behaviors of elements in the laboratory, (2) to use these experiments and standard thermodynamic techniques to extrapolate from the laboratory to natural systems, and (3) to use the extrapolated experimental data to constrain the nature of planetary processes.

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Surface Compositional Studies of Planets and Asteroids - The surface mineralogical composition of solar-system bodies has been studied by observing the reflected sunlight in the visible- and near-infrared (IR) spectral ranges and in the thermal-IR emissions of longer wavelengths. Changes in the surface material's mineralogic composition appear as variations in the reflectance spectrum. Research in this area will concentrate on studying the surface composition and properties of near-Earth asteroid 25143 Itokawa, the target asteroid of the Japanese Hayabusa spacecraft mission (currently ennroute); UV/blue evidence for space weathering on atmosphereless planetary bodies; and surface composition of low-albedo objects possibly indicting aqueous alteration. Planetary surfaces research is supported by an image- processing system, ground- based telescopic data, and imagery obtained from unmanned space probes.

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Planetary Impact Processes - Impact is the only major geological process common to all solid bodies in the Solar System. As a result of this single pervasive mechanism, craters and regoliths are formed on planetary-scale objects, asteroids and satellites are disrupted, and particles are supplied to the interplanetary dust complex. Many aspects of impact cratering and collisional disruption fall within the purview of the Experimental Impact Laboratory. Although such experiments can be performed with either of the other two guns in the laboratory, cratering and collisional-disruption experiments are primarily conducted with a vertical gun. Projectiles of various compositions ranging between 3 and 20 mm in diameter can be launched at velocities of tens of meters per second to nearly 3 km/s. In addition, target materials can be varied as dictated by experimental objectives; a refrigerated target chamber permits the use of ice and other low-temperature targets. Recent investigations have included disruption of various rock and ice targets, the physical and chemical evolution of "experimental regoliths", measurement of ejection velocities, disruption and repetitive impact of a chondritic meteorite, and the chemistry and petrography of agglutinate-like particles created during the regolith- evolution experiments. Theoretical and observational studies of these processes are encouraged.

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Remote Sensing and Modeling of Biomass Burning - NASA JSC research on mapping global biomass burning was initiated in 1990 and has yielded significant results. The imagery from Space Shuttle and the International Space Station cameras and other unmanned satellites is used to model the biomass burning processes and investigate their implications for atmospheric processes. The detection of fires, aerosols and their behavior in an ecosystem context is a major focus of this research.

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Earth Observations Database - The NASA Space Shuttle Earth Observations Database is a valuable source of data for research of Earth's recent environmental history, and thus for assessment of the human impact on global Earth processes. This data source, although having the longest length on record of any space derived global change database, has not been fully exploited by scientists studying the global changes. The database contains over 400,000 images of earth with global sites some of which have been repeatedly photographed (e.g., Lake Chad In Africa; Aral sea in Kazakhstan). The focus is to develop change detection profiles using these datasets.

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Command and Control Systems Real-time Vehicle Processing - Research opportunities exist for the utilization of industry standards or advanced architectures in performing real-time analysis of data (1000 plus samples per second) in support of mission critical operations. The architectures and technologies should enable distributed command and control amongst various control centers and with the locus of control shifting between the control centers and the space vehicle.

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Integrated Space Vehicle and Ground System Network - Research opportunities exist for the following areas of interest: Developing methodologies and systems that allow for wide area communications, even across satellites and deep space, that look transparent to the end user. This research would have to take into account signal degradation, latency, and loss of signal while maintaining consistent and reliable information and data exchange for critical mission support.

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Platform Independent Software Components for the Exploration of Space (PISCES) - Research opportunities exist for the following areas of interest: Assist in the design and development of reusable and extendable mission design and analysis algorithms supporting future human mission design. Participate in the development of object- oriented software components using a collaborative effort between JSC and universities to demonstrate state-of-the- art distributed programming and mission design and analysis. In particular algorithmic development is focused on providing trajectory and subsystem- related components in JAVA for detailed mission analysis involving future orbital and rendezvous operations.

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Virtual Reality interface for Space Exploration Missions - Research opportunities exist for the following areas of interest: Developing Virtual reality interfaces into the command and control systems of exploration vehicles for command, control and status of mission systems. This research would look at alternate methods of crew interaction with the exploration vehicles that will not require them to be tethered to a computer display. Research opportunities also exist for Virtual communication between the exploration crew and the community on earth.

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Advanced Training Technologies - Proposals are sought that advance the state of the art in technologies that support training of NASA astronauts and ground based personnel, including simulations. NASA has a special interest in technologies that will reduce the cost and/or enhance the effectiveness of training and training development. In addition to training, proposals are also sought which could lead to the development of intelligent applications for retrieval, management and understanding of text and other Internet and/or intranet information. Proposals are strongly encouraged that demonstrate a high probability of dual use in industry and/or education for the developed technologies.

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Risk Management - Opportunities exist for research in areas related to reliability and safety of space vehicles. Multivariate models, such as logistic regression and proportional hazards models, and system reliability models that make use of dependencies between component failure events are specific topics of interest in statistical reliability. Probabilistic fatigue and other physics of failure modeling, which may include simulation studies using finite element models, are safety topics of interest.

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KENNEDY SPACE CENTER (KSC)

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The John F. Kennedy Space Center (KSC), located on Merritt Island, Florida, is NASA's primary launch site. The Center's mission includes space launch operations and spaceport and range technologies. KSC personnel contribute operational expertise to the design and development of new payloads and launch vehicles and partners with a wide range of entities to develop new technologies for future space initiatives. The Center's focus is expanding from primarily operations to one of increasing emphasis in testing, development and applied research. Spaceport and range technology activities are built around our Center of Excellence recognition in Launch and Payload Processing Systems. KSC and the USAF/45th Space Wing in partnership with the Florida Space Authority, the U.S. Fish & Wildlife Service, National Park Service, and the Department of the Navy provide the leadership for our evolution to become the leading Spaceport in the universe. It is within these broad areas that we focus our research effort on the development initiatives listed under "Research Opportunities". Additional technical information may be obtained from the technical personnel listed next to the Kennedy Space Center Technology Thrust Areas.

Fluid System Technologies - Fluid system technologies form the foundation of the modern spaceport and will continue to have a prominent place in spaceport operations for the foreseeable future. The fluid systems used on spacecrafts range from propellants (hypergols, liquid hydrogen, liquid oxygen, kerosene, hydrogen peroxide, alcohol) to gases (helium, nitrogen), to other vehicle servicing fluids (e.g., hydraulic fluids, helium, hydrogen and oxygen gases) to heat transport and firex (anti-freeze, water, ammonia, and freon) to fluids for crew (water, oxygen and nitrogen gases, wastes). The large numbers of fluids required by modern spacecraft dictate flexibility and efficiency in fluids operation. Fluid system technology will seek to develop the means to reduce thermal losses associated with cryogenic fuels, minimize maintenance and process monitoring costs, and provide for safe operation of the space port. The ultimate goal of this technology thrust area would be to create efficient technologies that can be quickly adapted to the changing fluid needs of future spacecrafts residing at the spaceport.

Description of Fluid System Technology Focus Areas: 1) Storage and Distribution Technologies: Providing fluid servicing systems concepts that greatly reduce recurring costs by reduction of hardware and support sub- systems. Systems will also possess greater thermal efficiency and greatly improved system dependability. 2) Production, Recovery & Disposal Technologies: Technology for the efficient use, production, recovery, recycling, and disposal of spaceport fluid commodities. 3) Vehicle Interface Technologies: Provide vehicle autonomous servicing systems that greatly reduce recurring costs by reducing labor and improving safety with less exposure of personnel. Greatly improved system dependability including automated process verification. 4) Fluid Safety Technologies: Development of systems designed to safely monitor and deal with cryogenic and toxic fluid systems with an emphasis on reducing the operation costs of these systems and expanding their role to full system coverage. These systems increase personnel and flight vehicle safety during hazardous operations at the spaceport. 5) Expendable and Reusable Launch Vehicles (ELV & RLV) Thermal/Fluids. 6) Environments & Management: Development of new technologies that improve the understanding and control of the thermal/fluids environments experienced by spacecraft from launch to separation. Benefits include lower costs, higher reliability, and/or greater thermal design freedom for launch vehicles and spacecraft. High-priority projects include: A) Advanced cryogenic loading technologies: Advanced cryogenic loading technologies, including systems that combine advances in component health management, automated process control, instrumentation, and resource conservation. B) Payload Thermal & Fluid Environment Modeling and Prediction Capabilities. C) Extended Propellant Storage Capabilities. D) Automated Umbilical Systems Advanced, highly reliable, designed for safety, automated umbilical systems for all ground system to flight vehicle interfaces, including payload interfaces (smart umbilicals). E) Improved GN2 Pipeline Gas Filtration Capabilities Non-intrusive helium flow rate/quantity measurements. Purge gas processes that reduce/eliminate the use of helium.

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Command Control and Monitoring - Command, Control, and Monitoring (CCM) Technologies form the lifeblood of spaceport operations. These technologies span the gamut from preparing a spacecraft for launch to simulating procedures to ensure accurate process execution. The CCM Technology Thrust Area (TTA) also focuses on monitoring the status of space flight hardware in order to ensure safety for crews and ground personnel. CCM technologies would lead to increased intelligence in spacecraft and more advanced network infrastructures to support the intelligence systems embedded in the vehicles. The ultimate goal of this TTA is to create an integrated system that provides seamless connectivity between ground and avionics capabilities. Automation of CCM functions would reduce costs by accessing expert intervention as needed. The higher level of automation would also provide for more accurate status updates and targeted maintenance to maintain optimum performance of launch structures and vehicles.

Description of Command, Control, and Monitoring Technology Focus Areas: 1. Smart Sensors and Acquisition: Advanced CCM systems will require new sensors and instrumentation that have the ability to diagnose their own health, reducing the frequency of removal for calibration. These sensors will operate at lower power reducing system thermal loads. These Smart Sensors will integrate seamlessly into new ground data acquisition systems that will provide a ground health monitoring system that is analogous to vehicle health monitoring systems. This will reduce overall operating costs of the ground processing infrastructure. 2. Spaceport Systems Health Management: The use of advanced instrumentation systems, sensing techniques and software algorithms to improve vehicle and ground system safety and reliability by providing faster identification of failures, the prediction of failures, and reduced human error through pre-programmed responses. 3. Advanced Control System Technologies: Development of advanced launch and landing operations control test beds to mature range and CCM technologies and to develop advanced operational concepts and work methods. 4. Advanced Data Processing and Distribution: Investigate techniques and technology for providing improved real time, reliable data delivery over scalable distributed architectures 5. High Reliability Software Development: Develop techniques for improved software validation and automated regression testing to reduce error rates. 6. Chemical Detection: Space flight has always required the use of specialized chemicals to achieve its goals. Exposure to these chemicals can create a safety hazard or damage the health of personnel. A robust chemical detection instrumentation development program is necessary to protect personnel and meet the increasingly more stringent EPA chemical exposure requirements. 7. Field Inspection and Measurement: As the Shuttle and its ground support infrastructure continue to age, it is imperative that tools and techniques be developed to determine the health of system components. It is essential that these system inspections be carried out in a non- destructive manner. Many of the inspections must be conducted in the field. As each subsystem provides a unique set of inspection challenges, various field inspection technologies will have to be developed to meet program needs. High-priority projects include: A) Development of a Small Rugged Mass Spectrometer The goal of the project is to develop a system that is small and rugged enough to be hand held and used aboard the Shuttle and ISS. The system will monitor all compounds on the NASA Spacecraft Maximum Allowable Contamination (SMAC). The work will focus on developing unique mass analyzers, pumps, electronics, and inlets. KSC has a wide range of mass analyzers, vacuum chambers, and control devices. There is access to an electrical and machine shop. Special Skills: Mechanical Engineer needs to understand high vacuum systems. A basic knowledge of Mass Spectrometry is helpful, but not necessarily required. POC: Dr. Timothy Griffin, (321) 867-6755, Timothy.P.Griffin@nasa.gov. B) Leak Detection Technologies/capabilities for better (remote, wireless) leak detection of hazardous gases (examples: MMH, UDMH, N_2O_4) used on the Shuttle, ELV s, payloads, and associated ground support equipment (GSE). Improved leak detection, leak visualization, and non- destructive evaluation (NDE)- related remote sensing technologies (general longer- term need). Portable, hand- held mass spectrometers (specific near-term need). C) Integrated Health Management Systems Integrated health management systems (GSE, facilities, equipment, and spacecraft systems) supporting spacecraft processing that allow more efficient, lower cost operations and earlier detection of problems that could adversely affect hardware and software assets. Prognostic and diagnostic tools supporting system repairs and scheduled/unscheduled maintenance. D) Flight Readiness Verification Tasks Tools and techniques to perform flight readiness verification tasks and troubleshoot anomalies without disassembling or further invalidating the vehicle or GSE. E) Analytical Mission Analysis Tools Analytical tools to help perform mission analysis more effectively and efficiently (including flight dynamics, controls, thermal/fluids, structural dynamics and environments, structures/stress, EMC/RF). F) Communications technology upgrades for effective information dissemination. Communications technologies/infrastructure for geographically distributed test and checkout teams, including efficient document/information sharing. Basic infrastructure technology needs: wiring and network upgrades, transmission system upgrades, cabling upgrades, etc. Includes associated security and configuration management technologies with some processing speed issues, but not high data exchange rate. G) High Data Exchange Rate Technologies Technologies/capabilities for high data exchange rate communication. H) Support Technologies: Technologies to support seamless coordination between multiple types of launch vehicles, payloads, and a common ground infrastructure to support spaceport operations. I) Advanced Cryogenic Loading Technologies Advanced cryogenic loading technologies, including systems that combine advances in component health management, automated process control, instrumentation, and resource conservation. J) Payload Testing and Verification Techniques Technologies to enable payload testing and verification at customer's site. Remote testing of payload from KSC test systems. Requires more advanced technologies and processes than communication technology upgrades due to security issues associated with commanding payloads from remote sites. Benefits from high data rate communication capabilities. K) Improved Technologies and Methods to Measure Flight Environments Improved technologies and methods to measure flight environments (instrumentation and measurement techniques), non-intrusive, more complete field of view of environment. L) Wireless Avionics Networks

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Process and Human Factors Engineering - Process and Human Factors Engineering within the context of spaceports covers research on process efficiency, overall system performance, risk assessment and life cycle engineering. Process engineering for spaceports also focuses on the human aspects of process engineering including ergonomics, human factors, human error analysis (HEA), and human reliability analysis (HRA). Process and human factors engineering activities focus on benchmarking and improving existing processes used in spaceport activities, using a combination of simulation, human factors analysis, and process data collection. The ultimate goal is to create efficient processes that can be quickly adapted to the changing needs of future spaceports. Description of Process and Human Factors Technology Focus Areas: 1. Modeling and Simulation: Evaluation of discrete and continuous processes used at spaceports and ranges through the use of simulators in order to increase cycles of learning, improve efficiency, and reduce costs. 2. Human Factors and Ergonomics: Research of the human factors and ergonomic layouts impacting safety, process efficiency, productivity, and overall system performance and development of methods and techniques to improve system performance. 3. Task Analysis Technologies: New technology will provide advanced tools to collect data, and evaluate, design and enhance operations. Process and Operations Analysis: Sub-system integration, statistical process control, process simulation, process measurement, root cause analysis, and process re- engineering activities leading to process optimization in regards to cost, schedule, and performance factors. 4. Life Cycle Systems Engineering: Developing methods and capabilities to evaluate the cost of ownership (including initial investment plus maintenance and process costs over its entire lifetime) of a spacecraft and tracing costs to choices during the design phase. 5. Scheduling and Risk Assessment Technologies: technologies to assess risks and schedule activities, resulting in safe and efficient spaceport operations.

High-priority projects include: A) Advanced Planning and Scheduling Technologies Technologies/ capabilities to improve or automate planning, scheduling, and asset allocation functions for spaceports and ranges. Resource (people, hardware, equipment, facilities, etc.) management and allocation. Schedule optimization technologies. B) Spaceport/Range Operations Management Technologies Spaceport/range operations management technologies for test, maintenance, and verification tasks. Paperless work control, work authorizing document, and problem reporting and corrective action systems. Advanced human factors and process analysis technologies supporting work instruction authoring, task execution, and post-task data trend analysis. Intelligent work instruction systems with automated task duration, resource, and hazard data collection. Technologies to improve quality assurance documentation. Tools and methods to ensure quality assessments are valid and root cause identifications provide actionable information to improve quality and safety of current spaceport/range operations and future space transportation system designs and operations. C) Simulation and Modeling Technologies Technologies and tools for modeling spacecraft (vehicle and payload) and spaceport flows, tasks, and processes. Cost-effective technologies for simulating and streamlining processes to improve safety performance, life cycle cost performance, and responsiveness. Models of launch and landing scenarios. D) Component/Personnel Tracking System Technologies/capabilities to automatically record the entrance and exit of all components within critical areas, from an item such as a small drill bit to large GSE; i.e., automatic parts/tools/equipment identification and tracking system. Electronic identification for area access, equipment checkout/control, and personnel identification. E) Statistical Process Analysis of Manufacturing Defects and Operational Wear & Tear Technologies for streamlined processes and automated systems to recognize, measure, record, and perform statistical process analysis on dings/chips in nozzles and thermal insulation damaged during manufacturing, processing, and/or flight. F) Thermal Protection System (TPS) Process Analysis and Automation Process improvements to thermal protection system (TPS) water proofing and densification processes that reduce hazard levels to personnel (specific near- term need). Automate spaceport TPS processes and support development of new thermal protection systems that do not require waterproofing or densification (general longer-term need). G) Advanced Character Recognition Inspection Systems Character recognition inspection systems for vehicle and ground system inspections (using technologies such as automation, robotics, expert systems, and neural networks). H) Human Factors Modeling Technologies Predictive technologies to model human factors and the effects of potential human errors on spaceport and range operations. Technologies supporting human error analysis for investigating the combinations of factors contributing to degradation of worker abilities to perform tasks successfully. Technologies for analysis and quantification of human reliability in spaceport and range operations. Advanced methods to quantify human error probabilities in novel tasks and new situations with no previous experience base.

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Range Technologies - Range Technologies are used in the range support facilities and equipment required to provide control, supply measurement data, and ensure safety of launch and test operations. Examples of these technologies include range safety analysis data processing equipment, telemetry reception and processing equipment, command destruct systems, weather systems, radar systems and displays, optical tracking and recording equipment, control centers, and communications centers. Significant capital investment is required to build this capability, and, as a result, these assets have traditionally been slow to modernize. In addition, the costs associated with this infrastructure have been difficult to quantify. Future spaceport operations will require flexible range technologies to accommodate the latest technological advances. These technologies must also be able to adapt to different space flight hardware designs and reduce the degree of customization required. Range technologies will also be needed to support multiple vehicles and multiple spaceports, simultaneously. The ultimate goal of this technology thrust area is to create range technologies that provide for integrated range operation of all spaceports at lower costs and higher safety than is currently possible.

Description of Range Technology Focus Areas: 1) Weather Instrumentation: Systems are required to rapidly detect, evaluate, and communicate to vehicles, crews, and decision makers, in near real time, those weather parameters, forecasts and warnings which are key to safe, efficient operations. Operations include ground processing, ascent, flight, and recovery. Weather parameters include upper level winds for vehicle loads and trajectory shaping, surface winds, thermal structure and natural lightning for ground processing and toxic hazard decisions; triggered lightning potential to protect sensitive electronics; and cloud thickness, coverage and height, and precipitation for visibility and thermal protection systems. All weather data must be archived to permit accurate assessments of system design and operational issues. Ensuring weather impacts and capabilities are properly considered is essential to reducing the impact of atmospheric phenomena on Range and Spaceport customers. 2) Range Tracking and Surveillance Technologies: Range tracking systems consist of the hardware, software, & equipment required to transmit, receive, process & display time, space, and position information (TSPI) required for Range Safety purposes, for engineering flight analysis, and for debris recovery & failure analysis in the event of a mishap. This includes real-time TSPI on flight vehicles and/or debris from on-board, ground- based, or space based assets through all phases of flight where the vehicle can pose a hazard to property or people. Area surveillance includes detection of people & vehicles in those land, sea, and air areas where toxic &/or debris hazards may exist as a result range- supported operations. Clearance of such areas may be required to ensure that transient people, ships, aircrafts, or other vehicles do not increase hazard levels beyond acceptable bounds during range- supported operations. 3) Range Telemetry Technologies: Hardware and software to receive, process, archive, and display data received from launch vehicles and their payloads during ground processing and flight. 4) Decision Modeling and Analysis: This is the expertise and technologies that provide “readiness” of flight preparations and real- time flight safety operations for launch, Return to Launch Site (RTLS), and landing. Flight preparations include flight plan analysis and approval and generation of instrumentation coverage plan. Real-time flight safety operations use inputs from weather, tracking, telemetry, area surveillance, USSPACECOM satellite catalog, and FAA Air Traffic Control systems to generate situational awareness of the flight vehicle and other objects within the hazard area and ascertain acceptability of the in-flight vehicle’s path. 5) Range Command & Control: The Range Command Control System (CCS) consists of the vehicle and ground hardware, software and other resources required to safe/terminate launch vehicle flight in order to ensure public and personnel safety and interface with the National Airspace System (NAS). The CCS provides the Mission Flight Control Officer (MFCO) with the capability to safe/terminate launch vehicle flight if flight safety parameters are violated or mission rules call for MFCO action. The Range CCS may also provide remote guidance, attitude or payload control and other uplink communications functions for select launch vehicles. High-priority projects include: A) Technologies/capabilities for automated mission data feedback (including vehicle performance data, payload performance data, and weather and atmospheric information). B) Weather Forecasting Capabilities Localized weather forecasting capabilities supporting pre- launch, launch, landing, and range operations. Mesoscale comprehensive weather/hazard assessment models. C) TDRSS Compatible Transceiver TDRSS compatible transceiver that can be used on existing and future launch vehicles to receive flight termination commands transmitted through space-based assets (digital command receiver decoder). D) Reentry Landing Systems and Airspace Management Techniques Reentry landing systems and airspace management techniques, including the desired tracking and monitoring systems.

Contact: **Darin Skelly**, (321) 861-3639, Darin.M.Skelly@nasa.gov

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Biological Sciences - This area involves: (1) Bioregenerative life support, (2) Spaceport biological research, and (3) Spaceport ecosystem sciences. 1. Bioregenerative Life Support: Bioregenerative Life Support encompasses research and technology development activities that will enable the development of a bioregenerative life support system for long duration space missions. The research and technology development approach will address the questions and challenges of a bioregenerative life support system components by performing ground tests along with flight experiments to understand the effects of microgravity on the operation of each component. One subsystem will be the controlled biomass production component made up of elements (plants) which will utilize the basic photosynthetic process to produce life support components required by the crew (food, air, water). The second subsystem is the resource recovery component that will recycle solid and liquid waste to water, carbon dioxide, and inorganic minerals required by the biomass production component in order to maintain a regenerative life support system. And the final component of a bioregenerative life support system are the advanced life support technologies that comprise the physical system such as efficient lighting systems, environmental control system, nutrient solution delivery systems and advanced sensors. Research and technology development efforts are now being directed towards reducing the energy demands of the systems, automation of their operations, and the refinement of data on subsystems and the whole so that predictive productivity models can be developed.

2. Spaceport Biological Research: Spaceport Biological Research includes research to examine gravity's role in the development and evolution of organisms and ecological systems, as well as how plants and microbes react and adjust to the effects of different gravity levels. Ground-based research is essential for evaluating and testing preliminary hypotheses about gravitational effects. Such experiments help define studies that require space-based research to provide definitive results. Three categories have been defined within this science area: A) plant research which performs basic research to determine if the physiology of the plant is altered by microgravity and spaceflight environments, B) microbial research which performs experiments that determine the stability of microbial populations including any observed interactions between organisms in both terrestrial and space conditions, and C) multi-species integration which conducts experiments on the physiology and community development and evolution of multiple species within a controlled environment.

3. Spaceport Ecosystem Sciences: Spaceport Ecosystem Sciences performs research to provide the scientific understanding and technologies needed to support the sound management and conservation of our Center's ecological resources. Fulfilling this mission depends on effectively balancing the immediate need for information to guide management of ecological resources with the need for technical assistance and long-range, strategic information to understand and predict emerging patterns and trends in ecological systems. Ecological Research is the primary means of monitoring the ecological resources and conducting experiments as well as examining spatial and temporal trends in ecological systems through the use of scientific methods. Ecological Technology Development and Application will develop and deploy cutting edge technologies to assist the scientists in the field in collecting this enormous amount of data. All of the data need to be archived and made available to all interested parties in databases with decision support tool development. Ecosystem management utilizes these databases and tools to assist in the decision support area to guide the Center in managing its resources.

Contact: **John Sager**, (321) 861-2949, John.C.Sager@nasa.gov

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Spaceport Structures and Materials - New materials development is critical to achieving the goals of reduced costs, increased reliability, and higher flight rates for future spaceports. Spaceport structures and materials technology development areas include corrosion abatement, static charge dissipation, non-destructive evaluation (NDE), and non-flammability. Sources of corrosion and material degradation include humid salt-water environments surrounding launch structures and aggressive ozone and hard radiation environments of Earth orbit. Static charge build-up on payloads, spacecraft, and launch structures can present significant safety issues for personnel and equipment. Advanced flammable materials are desirable to enhance the safety of crew and ground personnel during operations. Non-destructive evaluation technologies are critical to obtaining rapid status analysis of flight hardware. Since materials are ubiquitous in spaceflight, the reach of this technology thrust area will encompass launch structures, payload processing, spacecraft design, and vehicle maintenance.

Description of Spaceport Structures and Materials Technology Focus Areas: 1) Launch Structures and Mechanisms: Reduce costs and increase the safety, reliability, availability, and maintainability of launch structures and mechanisms exposed to rocket launch environments. 2) Corrosion Science and Technology: Prevention, detection, mitigation, or control of corrosion on systems such as space flight hardware, ground support equipment, or facility infrastructure to improve the safety and reliability and to reduce maintenance costs. 3) Electromagnetic Physics: Electromagnetic analyses and materials characterization to assist in the detection, mitigation, and prevention of electrostatic generation on surfaces of systems such as space flight hardware, ground support equipment, or facility infrastructure to improve the safety and reliability of operations. 4) Materials Science and Technology: The research, development, and use of advanced materials to meet the needs of future spaceport technologies. 5) Nondestructive Evaluation Technologies: The detection and characterization of flaws or material properties that affect operations or maintenance processing without adversely affecting the part.

High-priority projects include: A) The absorption of water in composite materials. It is well known that these materials can absorb as much as 3% of their weight in water and normally this is not an issue. But in applications where excessive heating can occur, it appears that the water can boil and damage the composite. A significant effort is under way to research and develop Thermal Protection Systems Detection Technologies to measure water content in current and future thermal protection systems, including tiles, blankets, graphite epoxy, and composite materials. The Kennedy Space Center is interested in putting together a team of fellows (2 or 3) to collaborate to achieve significant results in this area. For additional technical information contact Dr. Robert Youngquist at 321-867-2137 (Robert.C.Youngquist@nasa.gov) B) Electrostatic Discharge of Surfaces in Gases This project seeks to understand the electrostatic discharge of insulator and metal surfaces in different gaseous environments and its relationship to frictional and contact electrification. The project will also seek to determine the ionic species responsible for the discharge mechanism. Special Skills: Faculty with Ph.D. in experimental physics with several years of research experience. Graduate Student in experimental physics. Undergraduate student in physics POC: Dr. Carlos Calle, (321) 867-3274, Carlos.I.Calle@nasa.gov. C) Electrochemical Evaluation of the Corrosion Behavior of Alloys in the Space Shuttle Launch Environment At the Kennedy Space Center, NASA relies on stainless steel tubing to supply the gases and fluids required to launch the space shuttle. 300 series stainless steel tubing has been used for decades but the highly corrosive environment at the launch pad has proven to be detrimental to these alloys. An upgrade with higher alloy content materials has become necessary in order to provide a safer and long lasting launch facility. This project involves the use of electrochemical techniques including DC and EIS to study the corrosion behavior of several alloys under conditions similar to those at the Kennedy Space Center Launch Pad. Special Skills: The candidate should be familiar with the application of electrochemistry to the field of corrosion and be able to analyze and interpret DC and EIS data. POC: Luz Marina Calle, (321) 867-3278, Luz.M.Calle@nasa.gov D) Improved Wire Inspection Technologies and Self- Healing Wire Insulation New methods and technologies to detect potential wiring problems. E) Composite Materials Defect Detention Tools and techniques for defect detection in composite materials. Non-destructive methods to determine structural integrity of bonded assemblies, especially non-metallic composites. F) Surface Preparation and Contamination Reduction Techniques Clean, non-abrasive surface preparation and contamination reduction techniques. Technologies for maintaining clean systems. Technologies to clean surfaces of vacuum systems. Tools and techniques to remove dust from surfaces of sensitive equipment used in clean rooms, payloads, solar panels, etc. G) Contamination Detection Technologies: Technologies for low-cost, simple, reliable contamination detection for spacecraft (vehicle and payload) processing. H) Thermal Protection Systems Detection Technologies: Technologies to detect water in current and future thermal protection systems, including tile, blankets, and composite materials. I) Smart, Non-Corrosive, Self-Healing and/or Robust Structures. J) Technologies and Systems Enabling Payload Acoustics Technologies and systems enabling payload acoustics environment predictions and reductions. K) Advanced, Reusable, Highly Reliable, Designed for Safety, Non-Pyrotechnic. L) Vehicle/Propellant System Interface and Separation Systems. M) Improved

Spacecraft Transportation & Handling Technologies and systems Mechanical assembly of spacecraft elements to support rapid response and high flight rates. N) Electrostatic charge monitoring technologies. Technologies to monitor the electrostatic charge buildup on surfaces that could adversely affect flight hardware, cause safety hazards to personnel, and raise operations costs. Technologies to accurately evaluate electrostatic charge decay properties of materials used for payload processing and spacecraft transportation/handling. Simple and reliable tools/techniques to determine the size, charge, and concentration of electrostatically charged dust contaminants.

Contact: **Carolyn Mizell**, (321) 867-8814, Carolyn.A.Mizell@nasa.gov

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Discrete Element Modeling of Granular Cryogenic Insulation Material - We will quantify the shearing, compaction and crushing behaviors of a novel insulation material composed of non-cohesive microscopic hollow glass beads by using Discrete Element Modeling (DEM) software. This is work that KSC/YA-C3 is tasked to do in conjunction with related research by the Florida Solar Energy Center. We will simulate biaxial shearing and hydrostatic compaction of a finite cell of the material and quantify the crushing of individual beads. Data harvested from the DEM simulations will also be analyzed to compare against a new statistical mechanical theory of granular materials. The student will work under the direction of a physicist who specializes in granular statistical mechanics.

Contact: **Phillip Metzger**, (321) 867-6052, philip.T.Metzger@nasa.gov

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Emulsion-based Cleanup Technologies for Contaminant Removal - This research is focused on the development of emulsion systems for contaminant removal from natural media and man-made materials. A graduate student will be involved in emulsion formulation and evaluation using standard laboratory procedures. The student will be responsible for analytical evaluation of the media using a gas chromatograph, mass spectrometer and electron capture device. The student will propose emulsion structure and prepare test procedures for field-scale evaluation of the technology for commercial use.

Contact: **Jacqueline Quinn, Ph.D.**, (321) 867-8410, Jacqueline.W.Quinn@nasa.gov

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S0004 Simulation Project - Develop S0004 related models using Pro-E software. Complete handling fixture models. Integrate Point Cloud models with Pro-E models and use in S0004 Simulation predictive Analysis Tool.

Contact: **Frank Kapr**, (321) 861-3968, frank.j.kapr@nasa.gov

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RF Propagation and Multipath Effects to the Space Shuttles - Analyze various RF propagation models to characterize atmospheric and structural multipath effects to the Space Shuttle S-Band communications link between the launch pads and MILA. Also, characterize the ground- bounce multipath effects to the Ku-band Microwave Scanning Beam Landing System (MSBLS) ground stations. We are looking for an Electrical Engineer with a RF or Telecommunications specialization.

Contact: **Bruce Ledford**, (321) 861-3747, bruce.ledford@nasa.gov

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Kennedy Space Center (KSC) Insignificant Air Emissions Inventory and Assessment - Compile an inventory of the air emission sources at KSC and estimate the emission rates for each source. This will involve identifying all emission sources at KSC (including insignificant sources), gathering the necessary operating information and data on the emission sources, calculating the emission rates for the emission sources using current emission factors and guidance, and developing and inputting the operational and emissions data into a spreadsheet and/or database of the calculations. The goal of this project is to have a working record of emission sources to be updated as needed and to be used by the Air Quality Program at KSC. We are looking for a Civil, Chemical or Environmental Engineering candidate.

Contact: **Denise De La Pascua**, (321) 867-1599, denise.r.delapascua@nasa.gov

Advanced Engineering Environment: Collaborative Tools and Needs Baseline - Potential candidates: Industrial Engineering, Modeling and Simulation 1. Identify NASA internal best practices in simulation and related Advanced Engineering Environment (AEE) tools to determine if it is the quality of the tool, the organizational culture, or a combination of both that promotes effective and efficient distributed collaboration across NASA teams. 2. Recommend and publish ranked and prioritized AEE collaborative tools baseline including criteria for tools and organizational processes, methods, capabilities etc.). It is assumed that this should be designed to prompt follow-on actions: (1): a process for facilitation methods, including organizational and staff development, based on the ability of NASA to train its teams, enabling the Collaboration of the Integrated Planning Team (IPT) to deliver necessary functionality to

NASA within a framework of best and successful resources and practices (2) a future study of external best practices, tools and culture in AEE to verify, modify, add to AEE success factors. Rationale: Little but anecdotal information, industry advertising, and sporadic but unmeasured experience exists to enable NASA to determine how best to proceed in terms of simulation tools for the AEE. Validation and verification are uneven. Experience, at times, unexamined. Research to date is limited and provides an unparalleled opportunity for innovative contributions addressing advanced technology implementation, measurement, concerns, issues and value. Method: PI would serve as a team member and advisor on NASA AEE tools and collaboration, enabling others to see the added value of the study. The PI will gather information from NASA AEE personnel as to prioritized needs and will, in collaboration with NASA personnel, develop definitions, identify existing NASA small and mid- sized successful distributed collaborative teams. The PI will develop a methodology for investigation (including survey materials) and working with the NASA team will identify and analyze tools and methods, including successful teams, to reach necessary conclusions and develop criteria against which to measure success. The PI will publish and present findings and recommendations. Benefits: The investigation would not only provide a collaborative needs and tools baseline but also support on- going NASA efforts to develop and apply simulation that is increasingly true to life, sensory rich, robust, low- cost, but also easy to use, accessible, seamless, interoperable, timely and up- to-date but capable of sustaining a long-life and enabling successful collaboration and interaction among teams. Special Skills: Aptitude and interest in cutting edge technology for use in NASA to support initiatives in Advanced Engineering Environments- and in related organizational development interests vital to technical and management decision- making related to complex systems vital to the future of space exploration

Contact: **Priscilla Elfrey**, (321) 867-9153, priscilla.r.elfrey@nasa.gov

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Metrics for scheduled processing operations - Looking for a Graduate Level Industrial Engineer. Participant will review the current processing metrics and will study daily, weekly, and monthly scheduled processing operations in the Space Station Processing Facility. The intent of the study will be to: 1) assess the effectiveness of the current metrics, 2) provide suggestions on how to improve the current metrics, 3) suggest additional metrics that would improve processing operations, and 4) provide a plan to implement the improved and/or additional metrics.

Contact: **Ben Jimenea**, (321) 867-6141, benjamin.G.Jimenea@nasa.gov

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Optimization Techniques for Determining Modeling Parameters from Test Data for use in NASA/SwRI Nutation Time Constant Fluid Slosh Model - Looking for candidates with expertise in the following areas: Mathematics, Optimization, Simulation, Dynamics, Modeling of Mechanical Systems. Develop techniques using MATLAB Optimization functions to determine model parameters for the NASA Expendable Launch Vehicle (ELV) Nutation Time Constant model. NASA ELV has developed a simulation model used to predict the rate of nutation (wobble) growth a spacecraft attached to a spinning upper stage will exhibit after separation from the second stage. Too rapid of a growth in nutation can lead to loss of mission. NASA ELV and Southwest Research Institute in San Antonio, Texas currently operate a test facility used to determine the fluid slosh behavior of full scale spacecraft fuel tanks. Energy dissipation from sloshing fuel is the primary driver of nutation growth. Improved methods of relating test measurements to simulation parameters are desired. The simulation is currently written in MATLAB/Simulink/SimMechanics. Using the specialized features of the MATLAB Optimization Toolbox is seen as a likely route to an integrated, robust and accurate method to further automate our test and modeling efforts.

Contact: **James E. Sudrmann**, (321) 476-3669, james.e.sudermann@nasa.gov

Carrier Tracking System Development - We need the support of an industrial Engineering Graduate Student. The project will result in an integrated infrastructure which will enable life cycle analysis for carrier availability, effective carrier selection, fast and accurate cost estimation, carrier tracking and knowledge capture.

Contact: **Maria Lopez-Tellado**, (321) 867-9494, Maria.Lopez-Tellado@nasa.gov

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LANGLEY RESEARCH CENTER (LaRC)

Program Administrator:
Mr. Lloyd B. Evans
Program Manager
NASA Langley Research Center
Mail Stop 400
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The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. The following information provides, by Competency, an overview of the current disciplines in the Langley program. Specific research activities associated with each discipline are also included.

NASA Langley Research Center requires all new GSRP applicants to specify a Center Research Adviser on the GSRP application. Applicants are strongly encouraged to contact the proposed Center Research Adviser prior to submitting the application.

Aerospace Systems, Concepts, and Analysis Competency (ASCAC) - The Aerospace Systems Concepts and Analysis Competency (ASCAC) mission is to explore advanced aerospace mission capabilities important to NASA, to identify the revolutionary systems and vehicles concepts needed, and to perform the systems analyses and trades to identify the key enabling technologies needed to perform these future missions. ASCAC also applies top-down systems analysis to derive systems technology requirements for future research and technology planning strategies and bottoms-up technology assessment to support planning of specific technology programs. Areas of expertise include aerospace advanced concepts development, aerospace systems analysis, advanced analysis methods development and application, and technology benefit assessment.

Areas of systems analysis studies include studies of atmospheric flight systems (commercial and military), earth-to-orbit launch vehicle systems (rocket and airbreathing), on-orbit spacecraft and systems and innovative infrastructure concepts, and planetary entry concepts (ballistic, controlled, and aircraft concepts).

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Cynthia C. Lee**, (757) 864-1933, c.c.lee@larc.nasa.gov

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Structures and Materials Competency (SMC) - The Structures and Materials Competency conducts research on advanced materials and nondestructive evaluation (NDE) technologies for aircraft and spacecraft structures. Materials research includes development of high-performance polymers, light alloys and composites, and the processing and manufacturing technologies required to improve performance and reduce weight and cost of aerospace structures. Service life testing is performed to establish durability of these materials under simulated aircraft and spacecraft service conditions. Analyses and modeling are performed to predict structural integrity and develop a fundamental understanding of failure mechanisms. Nondestructive evaluation techniques and methodologies are developed to inspect aircraft and space launch vehicle structures.

The Competency also conducts a wide variety of analytical and experimental research aimed toward the development of more efficient structures for aircraft and space vehicles. Research studies focusing on analytical methods for improving structural analysis and design are developed and validated by laboratory experiments. New structural concepts for both metal and composite structures are also developed and evaluated through laboratory testing. Additional research is conducted in integrating advanced structural and active-control concepts to enhance structural performance. Studies of landing and impact dynamics focus on increasing safety during ground operations and crash impact. Research in the aeroelasticity area ranges from unsteady aerodynamics for current and future aircraft and space vehicles to wind tunnel tests of flutter models.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Joycelyn S. Harrison,** (757) 864-4239, j.s.harrison@larc.nasa.gov

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Aerodynamics, Aerothermodynamics, and Acoustics Competency - Opportunities for research exist in the areas of theoretical, computational, and experimental investigations in the areas of aerodynamics for advanced transport and military aircraft; aerothermodynamics for aerospace vehicles and planetary entry systems; hypersonic airbreathing propulsion for hypersonic aircraft and launch vehicles; and fluid mechanics and acoustics for the design of modern aircraft, rotorcraft, missiles, and spacecraft across the speed range. Particular areas of emphasis include configuration aerodynamics; high-lift aerodynamics; component integration; Reynolds number effects; hypersonic aerodynamics and aeroheating; scramjet engine flowpath research; fluid flow physics; high temperature gas dynamics; boundary-layer transition and turbulence; laminar flow control; flow physics; vortical flow control across speed range; aircraft, rotorcraft, and spacecraft noise and its effects on structural integrity, vehicles performance, and passenger and community acceptance; engineering support; advanced concept development; and calibration. Maintains and ensures effective utilization of all Competency wind tunnel facilities. Conducts research and development in the areas of models, instrumentation, data acquisition systems, and test techniques for ground-based labs and wind tunnels to continually enhance wind tunnel productivity, data quality, and customer satisfaction.

Contact: **Edgar G. Waggoner**, (757) 864-5058, e.g.waggoner@larc.nasa.gov

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Systems Engineering Competency - The Systems Engineering Competency provides aerospace research facilities, information systems engineering, fabrication, and facility maintenance that enable Agency programs/projects and Center Competencies to meet commitments. The process for systems engineering includes deriving systems requirements from program/project goals, creating design concepts, performing design studies, selecting/implementing design, verifying design, validating design, integrating/testing/activating systems, and maintaining systems.

Contact: **Norman P. Barnes**, (757) 864-1630, n.p.barnes@larc.nasa.gov

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Atmospheric Sciences Competency - The goal of the Atmospheric Sciences Competency is to conduct research that will establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric sciences; and to provide a wellspring of ideas for advanced concepts. These programs include the following disciplines and specific research activities.

Contact: **Lamont R. Poole,** (757) 864-2689, l.r.poole@larc.nasa.gov

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Office of the Chief Information Officer - This NASA Langley business office is responsible for planning, maintaining, and regulating Information Technology (IT) resources at the center. The activities of the OCIO include risk assessment, IT security, granting access to IT resources, firewall management, and access to Scientific and Technical Information (STI).

Contact: **George J. Roncaglia**, (757) 864-2374, g.j.roncaglia@larc.nasa.gov

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Vehicle Analysis Branch (VAB) - The Vehicle Analysis Branch enhances the Aerospace Systems, Concepts and Analysis Competency effort through developing advanced aerospace concepts to meet Agency and National space transportation goals. VAB conducts conceptual analysis of launch vehicle concepts, hypersonic airbreathing systems, and planetary entry systems. It provides technical expertise in the following areas: systems analyses of new and existing aerospace vehicle concepts to improve systems performance, reliability, safety and reduce cost; technology assessments and evaluations to aid in hypersonic and space transportation technology program planning and implementation; aerodynamics and performance database development for near-term flight systems; assessments and improvements to planetary entry flight systems and human exploration of space development activities. VAB provides systems analyses and independent evaluations to the NASA Independent Program Assessment Office and maintains and develops analytical expertise and analytical tools to support the systems analyses activities.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **John W. Paulson, Jr.**, (757) 864-5071, j.w.paulson@larc.nasa.gov

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Spacecraft and Sensors Branch (SSB) - The Spacecraft and Sensors Branch (SSB) enhances the ASCA Competency effort by conducting preliminary designs of spacecraft, instruments and infrastructure required to support them. The Branch performs analysis of mission concepts for the International Space Station (ISS), human and robotic space exploration, as well as mission concepts for revolutionary aerospace systems. SSB provides technical expertise in the following areas: definition and conduct of engineering feasibility studies and technology trades, analysis of spacecraft subsystem performance and interfaces; assessment of critical issues; independent evaluation of flight and ground systems performance; and system requirements analysis. The Branch provides expertise relative to the development of the Synergistic Engineering Environment.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Melvin J. Ferebee, Jr.**, (757) 864-4421, m.j.ferebee@larc.nasa.gov

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Systems Analysis Branch (SAB) - The Systems Analysis Branch (SAB) conducts multidisciplinary studies and analyses of advanced vehicles and the integrated air traffic system. The goals of the Branch are: Ã¢?? Identify high-potential future concepts Ã¢?? Provide analyses in support of major research programs and program planning Ã¢?? Provide assessment of Aeronautics Enterprise investment outcomes Ã¢?? Develop and disseminate advanced system analysis methods and data bases Disciplinary expertise for conceptual studies includes the following areas: Ã¢?? Aerodynamics/stability and control Ã¢?? Propulsion and noise Ã¢?? Performance and sizing Ã¢?? Configuration integration and subsystems Ã¢?? Weights/structures and aeroelastic analysis Ã¢?? Aviation safety Ã¢?? Cost/risk/airspace system and global benefits.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Robert E. McKinley, Jr.**, (757) 864-7572, r.e.mckinley@larc.nasa.gov

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Multidisciplinary Optimization Branch (MDOB) - The Multidisciplinary Optimization Branch is a collection of methodologies for the design of complex engineering systems and subsystems that coherently exploits the synergism of mutually interacting subsystems. Methodologies are borrowed from applied mathematics, design engineering, the traditional aerospace engineering discipline, computer sciences and software engineering, as well as engineering management.
The research program in MDO at NASA LaRC focuses on development of analysis and optimization methodology for (1) cost-effective extension of disciplinary analyses and sensitivity analyses for use in an integrated design process, (2) efficient optimization methods as decision-making tools supporting the design process, (3) best use of modern computer software and hardware technology to support the solution of large design problems in an often distributed design environment, and (4) effective integration of multidisciplinary tools and practices in engineering organizations. Additional details can be found at http://mdob.larc.nasa.gov.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Jean-Francois M. Barthelemy**, (757) 864-2809, j.f.barthelemy@larc.nasa.gov

Aviation Operations and Evaluation - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Lisa O. Rippy**, (757) 864-6259, l.o.rippy@larc.nasa.gov

Dynamics and Control - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **James G. Batterson**, (757) 864-4059, j.g.batterson@larc.nasa.gov

Guidance and Control - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Plesent W. Goode, IV**, (757) 864-6685, p.w.goode@larc.nasa.gov

Projects and Advanced Concepts - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **John H. Koelling**, (757) 864-2232, j.h.koelling@larc.nasa.gov

Crew Systems - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Cornelius J. OConnor**, (757) 864-4662, c.j.oconnor@larc.nasa.gov

Flight Dynamics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Daniel G. Murri**, (757) 864-1160, d.g.murri@larc.nasa.gov

Sensors Research - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Harry F. Benz**, (757) 864-1943, h.f.benz@larc.nasa.gov

Systems Integration - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Plesent W. Goode, IV**, (757) 864-6685, p.w.goode@larc.nasa.gov

Electromagnetics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Roland W. Lawrence**, (757) 864-1821, r.w.lawrence@larc.nasa.gov

Assessment Technology - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Raymond S. Calloway**, (757) 864-6218, r.s.calloway@larc.nasa.gov

Aircraft Systems Branch (ASB) - Basic Aircraft Tools and Equipment; Avionics Equipment; Aircraft Management Aids; Safety Equipment/Tools; Ground Support, Inspection/Test, and Aircraft Stock/Stores Equipment.

Contact: **Tony L. Trexler**, (757) 864-3922, t.l.trexler@larc.nasa.gov

Aircraft Systems Branch (ASB) - Basic Aircraft Tools and Equipment; Avionics Equipment; Aircraft Management Aids; Safety Equipment/Tools; Ground Support, Inspection/Test, and Aircraft Stock/Stores Equipment.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Calvin C. Chandler**, (757) 864-3906, c.c.chandler@larc.nasa.gov

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Aircraft Systems Branch (ASB) - Basic Aircraft Tools and Equipment; Avionics Equipment; Aircraft Management Aids; Safety Equipment/Tools; Ground Support, Inspection/Test, and Aircraft Stock/Stores Equipment.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Dale A. Clark**, (757) 864-3877, d.a.clark@larc.nasa.gov

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Systems Development Branch (SDB) - Applications Software; Development Hardware; Computers; Electronics Subassemblies; Video/Camera Equipment; Simulator Hardware; Specialized Simulation Hardware Systems; Computer-Generated Imaging Systems; Real-time Computer Networks; Simulation Software.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Carey S. Buttrill**, (757) 864-4016, c.s.buttrill@larc.nasa.gov

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Systems Development Branch (SDB) - Applications Software; Development Hardware; Computers; Electronics Subassemblies; Video/Camera Equipment; Simulator Hardware; Specialized Simulation Hardware Systems; Computer-Generated Imaging Systems; Real-time Computer Networks; Simulation Software.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Wendy F. Pennington**, (757) 864-7126, w.f.pennington@larc.nasa.gov

---

Aeroelasticity Branch (AEB) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Boyd Perry III**, (757) 864-1207, b.perry@larc.nasa. gov

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Analytical and Computational Methods Branch (AMCM) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Jonathan B. Ransom**, (757) 864-2907, j.b.ransom@larc.nasa.gov

Metals and Thermal Structures Branch (MTSB) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Stephen J. Scotti**, (757) 864-5431, (757) 864-5431 s.j.scotti@larc.nasa.gov

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Structural Dynamics Branch (SDB) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Howard M. Adelman**, (757) 864-2804, h.m.adelman@larc.nasa.gov

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Configuration Aerodynamics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Laurence D. Leavitt**, (757) 864-3017, l.d.leavitt@larc.nasa.gov

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Computational Modeling and Simulations - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **James L. Thomas**, (757) 864-5578, j.l.thomas@larc.nasa.gov

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Flow Physics and Control - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William L. Sellers, III**, (757) 864-2224, w.l.sellers@larc.nasa.gov

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Aeroacoustics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Joe W. Posey** , (757) 864-7686, j.w.posey@larc.nasa.gov

---

Structural Acoustics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Kevin P. Shepherd**, (757) 864-3583, k.p.shepherd@larc.nasa.gov

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Advanced Measurements and Diagnostics -

Contact: **Michael A. Marcolini**, (757) 864-3629, m.a.marcolini@larc.nasa.gov

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Aerothermodynamics - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Charles G. Miller, III**, (757) 864-5221, c.g.miller@larc.nasa.gov

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Hypersonic Airbreathing Propulsion - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **R. Wayne Guy**, (757) 864-6272, r.w.guy@larc.nasa.gov

Wind Tunnel Operations - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Stephen J. Craft**, (757) 864-3520, j.t.kegelman@larc.nasa.gov

---

Data Acquisition - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Guy T. Kemmerly**, (757) 864-5070, g.t.kemmerly@larc.nasa.gov

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Model Systems - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Paul W. Roberts**, (757) 864-4704, p.w.roberts@larc.nasa.gov

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Instrumentation Systems Development - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Mark A. Hutchinson**, (757) 864-4642, m.a.hutchinson@larc.nasa.gov

---

Research Support (Aerodynamics) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Gary P. Stergin**, (757) 864-5055, m.g.lawrence@larc.nasa.gov

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Research Support (Gas, Fluids, Acoustics) - NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Lynn D. Curtis**, (757) 864-5449, l.d.curtis@larc.nasa.gov

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Solid-State Laser Technology - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Norman P. Barnes**, (757) 864-1630, n.p.barnes@larc.nasa.gov

---

Fabry-Perot Etalon Technology - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William B. Cook**, (757) 864-8331, w.b.cook@larc.nasa.gov

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Solid-State Laser Materials - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of

flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **James C. Barnes**, (757) 864-1637, j.c.barnes@larc.nasa.gov

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Planetary Exploration Systems Development - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **James M. Corliss**, (757) 864-7627, j.m.corliss@larc.nasa.gov

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Lidar Technology - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Upendra N. Singh**, (757) 864-1570, u.n.singh@larc.nasa.gov

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Far-Infrared Sensor Technology & Fourier Transform Spectrometer Technology - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **David G. Johnson**, (757) 864-8580, d.g.johnson@larc.nasa.gov

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Advanced Electronics - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Curtis R. Regan**, (757) 864-1869, c.r.regan@larc.nasa.gov

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In Situ (Aircraft-Based Sensors) - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Glen W. Sachse**, (757) 864-1566, g.w.sachse@larc.nasa.gov

Systems Engineering - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Clayton P. Turner**, (757) 864-7103, c.p.turner@larc.nasa.gov

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Mechanical Systems Development - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William M. Berrios**, (757) 864-7183, william.m.berrios@nasa.gov

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Thermal, Fluids, and Structural Analysis - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William S. Lassiter**, (757) 864-7022, w.s.lassiter@larc.nasa.gov

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Environmental Qualification Testing - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Richard A. Foss**, (757) 864-7049, r.a.foss@larc.nasa.gov

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Advanced/Miniature Actuators - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Elvin L. Ahl, Jr.**, (757) 864-7176, e.l.ahl@larc.nasa.gov

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Microelectronics and Micro-electro Mechanical Systems - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Robert F. Hodson**, (757) 864-2326, r.f.hodson@larc.nasa.gov

Digital Signal Processing - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Michael S. Grant**, (757) 864-3707, m.s.grant@larc.nasa.gov

---

Detector Technology - The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Nural Abedin**, (757) 864-4814, n.abedin@larc.nasa.gov

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Engineering Laboratory - Physical and chemical analytical testing services are needed for the operation of research systems at Langley Research Center (LaRC) and are performed in the Engineering Laboratory. Analytical instrumentation is developed that will advance services at LaRC or will advance technology in aeronautics and space projects. Examples are instrumentation for environmental controls; x-ray fluorescence spectroscopy for lubricant wear metal analysis and for agricultural and planetary geological analysis. Projects such as radiation-induced plasma generation; flow field and temperature visualization for wind tunnel models; carbon nanotube production; and superconductive magnet levitation systems.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Warren C. Kelliher**, (757) 864-4172, w.c.kelliher@larc.nasa.gov

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Scientific Visualization, Image Processing, Grid Generation, Numerical Techniques for High-Performance Scientific Computers - This activity includes computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, data modeling, decision support systems, computer networking technology, user interface development, and mass storage techniques.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Ronnie E. Gillian**, (757) 864-2918, r.e.gillian@larc.nasa.gov

---

Data Management, User Interface Development - This activity includes computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, data modeling, decision support systems, computer networking technology, user interface development, and mass storage techniques.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Kennie H. Jones**, (757) 864-6720, k.h.jones@larc.nasa.gov

---

Scalable Computing Architectures - This activity includes computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, data modeling, decision support systems, computer networking technology, user interface development, and mass storage techniques.
NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Frank C. Thames**, (757) 864-7507, f.c.thames@larc.nasa.gov

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Computer Network Technology - This activity includes computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, data modeling, decision support systems, computer networking technology, user interface development, and mass storage techniques.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Juliet Z. Pao**, (757) 864-7328, j.z.pao@larc.nasa.gov

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Facility Systems Engineering - This organization engineers, designs, constructs, and activates aerospace research facilities and associated institutional facilities. Typical products include low and high speed wind tunnel facilities and equipment, including tunnel pressure shells and support systems, tunnel internals, automated control systems, devices to facilitate test measurements, process systems, model handling equipment, and calibration systems. Other typical products include test cells, simulation equipment, environmental test chambers, clean rooms, laboratories with ancillary systems and equipment, robotics systems, and other specialized research test apparatus/equipment.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **George C. Firth**, (757) 864-6942, g.c.firth@larc.nasa.gov

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Geographic Information Systems - Research and development of databases and techniques to correlate data to spatial coordinates including the development of intuitive interfaces referenced spatially for decision making for planning, design, maintenance, and any activity requiring large sets of data referenced spatially, e.g., atmospheric sciences, flood and terrain maps, etc.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William B. Ball**, (757) 864-7297, w.b.ball@larc.nasa.gov

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Fabrication Technology - This technology area provides conceptual development and application of advanced fabrication technology processes, methods, and solutions for next generation integrated smart aerospace exploration systems, as well as fabrication of aerospace research models, instruments, and flight and related ground system hardware. It administers contracts of major scope for services and tasks relative to the Center's research manufacturing requirements, and formulates, establishes, and maintains a direct charge system for fabrication support.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **S. Stewart Harris, Jr.**, (757) 864-4539, s.s.harris@larc.nasa.gov

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Stratospheric Aerosol and Gas Experiment (SAGE) - Analysis and interpretation of atmospheric aerosol, ozone, nitrogen dioxide, and water vapor measured from SAGE I (1979-81) and SAGE III (2002-present) satellite instruments. Studies are directed toward developing global climatologies of these species and understanding the role these species play in atmospheric processes such as ozone depletion and global warming.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Lamont R. Poole,** (757) 864-2689, l.r.poole@larc.nasa.gov

Radiative Forcing to Climate by Clouds, Aerosols, and the Earth's Surface - Research on the development of retrievals for the radiation budget of the surface and atmosphere (the vertical profile of radiative fluxes), and on the applications of retrievals in climate investigations. A spatially and temporally intensive study is in progress over the Atmospheric Radiation Measurement site in Oklahoma (http://snowdog.larc.nasa.g ov:8081/cagex.html). Earth Radiation Budget Experiment and operational weather satellite data are used with conventional meteorological analyses, surface-based radiometric measurements, and radiative transfer calculations. Radiative forcings are determined and interpreted.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Thomas Charlock**, (757) 864-5687, t.p.charlock@larc.nasa.gov

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Studies of Stratospheric-Troposphere Exchange Processes Using SAGE Observations - The Stratospheric Aerosol and Gas Experiment (SAGE) II provides more than 15 years of high vertical resolution profiles of tropospheric and stratospheric aerosol, ozone, and water vapor measurements on a nearly global basis. A major version of the SAGE data set (Version 6) has significantly improved the quality of these measurements particularly in the region around the tropopause. Therefore, a research opportunity exists to examine these data sets for evidence of exchange of material between the stratosphere and troposphere. We are particularly interested in examining the data set for evidence of the "stratospheric fountain" over Indonesia. While this is often associated with a dry stratosphere, SAGE ozone and multiwavelength aerosol extinction observations may also provide key evidence in this matter. With the extensive data set, it will also be desirable to evaluate the SAGE II data set for evidence that exchange processes are dependent on dynamical processes such as El Niño-Southern Oscillation and the Quasi-biennial oscillation.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Larry Thomason**, (757) 864-6842, l.w.thomason@larc.nasa.gov

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Atmospheric and Combustion Aerosol Characterization - Investigations to characterize the physical and optical properties of atmospheric aerosols and particulate matter generated by turbine engines and biomass burning processes. These studies involve airborne sampling as well as ground-based and laboratory measurements. Numerous objectives are pursued in this work, but the main goal is to understand better how human activities perturb the chemical and radiative character of the background atmosphere. We are also developing new aerosol instruments and providing new measurements for validating the operation of remote sensors.

We maintain a large suite of in situ sampling instruments and aerosol generation equipment for use in these studies. These include sensors for determining the concentration (fine and ultrafine CN counters); size distribution (differential mobility analyzers, optical scattering, and imaging instruments); volatility (sample heaters); scattering and absorption properties (multiwavelength nephelometer and aethelometer); and chemical composition (chromatographs + elemental analysis) of aerosols along with an asperation generator, tube furnace, electrostatic classifiers, a vibrating orifice generator, scale model turbojet engines, and burners for creating test aerosols. Pressure, flow, and temperature control equipment and an extensive array of trace gas monitors are also available.
Qualified applicants may participate in a number of new and ongoing projects including the Global Tropospheric Experiment Program, the Atmospheric Effects of Aviation Project, the SAGE-III and CERES validation experiments, and in-house projects to develop improved sensors for aerosol sizing and composition determination. Tasks associated with these efforts include extensive laboratory tests and calibrations, installation and operation of instruments aboard NASA aircraft (DC-8, OV-10, T-39, and UH1H) or in aircraft run-up facilities, deployments to domestic and foreign locations, reduction and archiving of data, and analysis and reporting of results.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Bruce Anderson**, (757) 864-5850, b.e.anderson@larc.nasa.gov

Carbon Cycle Research - Since 1991, our group has obtained highly precise in situ CO2 measurements from aircraft that have contributed to our understanding of how the Earth system responds to natural and human-induced changes. Our objectives have included quantifying the spatial and temporal variability of CO2 in the background atmosphere as well as assessing the impact that various source/sink processes (e.g., biomass burning, urban pollution, strat/trop and surface exchange, aircraft emissions) have on the tropospheric CO2 budget. In response to the current emphasis on the global carbon cycle, we want to expand our program to the area of remote sensor validation and to foster collaborations with members of the CO2 modeling community. We invite qualified researchers to participate in a number of new and ongoing projects including ground-based and airborne validation of remote CO2 sensors; further development of the capability to perform airborne eddy-correlation CO2 flux determinations; as well as field-experiment and scientific activities associated with the NASA Global Tropospheric Experiment Program. Work associated with these efforts include laboratory tests and calibrations to improve and expand our measurement capability especially in the area of CO2 fluxes, installation and operation of instruments on towers and aircraft, domestic and foreign deployments, reduction and archival of data, and analysis and reporting of results.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Bruce Anderson**, (757) 864-5850, b.e.anderson@larc.nasa.gov

---

Climate Research Program - Theoretical, laboratory, and field investigations of the radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate. Remote and in-situ observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth's radiation balance.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Patrick Minnis**, (757) 864-5671, p.minnis@larc.nasa.gov

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Tropospheric Chemistry Research Program - Assess and understand human impact on the regional-to-global-scale troposphere; define chemical and physical processes governing the global geochemical cycles from empirical and analytical modeling studies, laboratory measurements, technology developments, and field measurements; and exploit unique and critical roles that space observations can provide.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **James H. Crawford,** (757) 864-7231, j.h.crawford@larc.nasa.gov

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Tropospheric Studies - In recent years, a major focus in tropospheric chemistry has been to advance the understanding of processes that impact tropospheric chemistry from local to global scales. Aircraft campaigns such as NASA's Global Tropospheric Experiment missions have collected a broad suite of atmospheric physical and chemical data to characterize regional distributions and chemical interactions of trace species. Assessments of these regional chemical environments by techniques such as diel steady state boxmodel analyses can produce estimates for budget parameters such as regional photochemical tendencies for ozone.

One of the difficulties facing tropospheric chemists is the interpretation of these in situ data on local to regional scales in the context of global satellite data. To address this issue, we are conducting research using a suite of photochemical and transport models on scales from diel steady state point models and lagrangian trajectory boxmodels to regional and global chemical/transport models.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Jennifer Olson**, (757) 864-5327, j.r.olson @larc.nasa.gov

Upper Atmosphere Research Program - Expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere. Includes developing empirical and theoretical models, formulating new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Malcolm K. Ko**, (757) 864-8892, m.k.ko@larc.nasa.gov

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Clouds and the Earth's Radiant System (CERES) - Analysis of measurements from instruments on satellites that provide data on clouds and the Earth's radiation budget for assessing climatic impact of human activities and natural phenomena as well as a better understanding of all climatic parameters, in particular, the radiation budget components on a global scale.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Kory J. Priestley,** (757) 864-8147, k.j.priestly@larc.nasa.gov

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Application of Radiative Transfer Algorithms to Satellite Data Retrievals - The CERES and MODIS instruments aboard the Terra and Aqua spacecrafts will provide a wealth of information that will further our understanding of the physics of the Earth's atmosphere. To take full advantage of the satellite data, radiative transfer algorithms are being developed. Thus, research opportunities are available to work with the group at Langley to create the radiative transfer algorithms that will be used to analyze satellite-retrieved data.

We use a high spectral resolution (monochromatic) algorithm to develop and refine rapid radiative transfer (RRT) algorithms. Because of their high efficiency, the RRT algorithms can be applied to the analysis and validation of large satellite data sets. To further enhance the utility of the RRT algorithms, we are creating surface emissivity maps from the laboratory and satellite (e.g., MODIS and ASTER) data. In addition to being used to create the RRT algorithms, the monochromatic algorithm is also being used to investigate the radiative impacts to observed changes to trace gas abundances, as well as to changes in the cloud and aerosol properties (e.g., amount and distribution). Finally, the monochromatic algorithms are being used in a study to determine the optimal spectral regions for future satellite instruments.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **David Kratz,** (757) 864-5669, d.p.kratz@larc.nasa.gov

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Inversion and Analysis of Remote-Sensing Data - Basic and applied research is being conducted in the development of advanced techniques for retrieving and analyzing atmospheric data from satellite, airborne, and ground-based remote-sensing instruments. Techniques are being developed for processing satellite atmospheric limb scattering and laser-radar measurements and data from existing satellite solar occultation experiments (SAM II, SAGE, SAGE II, and SAGE III), and various LIDAR measurements. Our goal is to retrieve stratospheric and tropospheric constituent concentration profiles and study their influence on atmospheric chemistry and dynamics. Current investigations include the retrieval of tropospheric and stratospheric water vapor, ozone, nitrogen dioxide, and aerosol information from solar extinction and LIDAR data; an assessment of the errors associated with the determination of global ozone trends using solar occultation measurements from satellites; the measurement of atmospheric constituent absorption cross sections at various visible wavelengths for use in converting constituent extinction to concentration information; and the determination of various aerosol optical properties from multiwavelength data. Numerical studies are supported with programming assistance and by a large range of computer facilities (CONVEX, CRAY-2S, SUN, and DEC workstations).

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William Chu**, (757) 864-2675, w.p.chu@larc.nasa.gov

Satellite, Aircraft, and Ground Observed Cloud and Radiative Flux Analyses - Basic and applied research is being conducted in remote sensing of the Earth's cloudiness and radiative fluxes (top of atmosphere, surface, within atmosphere). Clouds are the primary modulators of the radiative energy balance of the Earth's surface and atmosphere on both local and global scales. Data sets from several satellite instruments, including Geostationary Operational Environmental Satellite, Landsat, AVHRR, HIRS, SSM/I, Earth Radiation Budget experiment, TRMM, and new Earth Observing System data from the Terra spacecraft launched in December 1999 will be analyzed and compared. In addition, simultaneous aircraft and/or ground-based laser-radar measurements will be used to examine cloud cover, cloud base and top height, optical depth, reflectance, cloud particle size, liquid and ice water path, and emissivity. Comparisons will be made with theoretical predictions of cloud generation/dissipation and with models of cloud radiative properties such as cloud albedo, bidirectional reflectance, and emissivity. Simulation studies will examine the sampling requirements and cloud measurement capabilities of current and future satellite measurement systems. Use of passive and active microwave observations are of special interest in addressing the problems associated with multilayered cloud systems. Studies are also encouraged that analyze cloud data as large ensembles of cloud systems or "cloud objects": a Lagrangian analog to the more traditional Eulerian monthly averaged gridded climate data.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Bruce Wielicki**, (757) 864-5683, b.a.wielicki@larc.nasa.gov

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Analyses of Satellite Data Sets of the Middle Atmosphere - Data sets from the limb infrared monitor of the stratosphere (LIMS) experiment on Nimbus 7 and from the halogen occultation experiment (HALOE) instrument on the upper atmosphere research satellite (UARS) have been used extensively to characterize the distribution of key chemical species and temperature in the middle atmosphere and the transport processes that affect them. The LIMS data set of 1978/79 has been recently reprocessed to account for algorithm improvements and for updates in the spectroscopic parameters needed for the retrieval of its parameters. The scientific impacts of those changes have yet to be fully explored; however, they include many aspects of the chemistry of ozone and the transport of its several tracer-like parameters. The HALOE measurements span nearly 9 years from 1991 through 2000 and are continuing. HALOE's primary emphasis is on the determination of global trends in its retrieved species and temperature distributions with a goal of connecting them with the data sets of the 1980s and with those to come in the first decade of the 21st century. Thus, the reprocessed LIMS data have been obtained using spectroscopic parameters that are compatible with those that were employed in the retrieval of the middle atmospheric data sets from UARS. In particular, both data sets provide distributions of ozone and temperature that extend from the tropopause to near the mesopause. The HALOE data set can be viewed at http://haloedata.larc.nasa.gov and the LIMS data set can be viewed at http://lims.gats-inc.com.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Ellis Remsberg**, (757) 864-5823, e.e.remsberg@larc.nasa.gov

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Surface Radiation Budget Climatology Program - Analysis of a long-term global time series of satellite measurements to estimate the surface and top-of-atmosphere solar and thermal infrared energy fluxes; comparison of these estimations to long-term surface and satellite measurements; assessment of balance and variability of these energy fluxes to processes in the atmosphere and at the surface toward understanding climate and climate variability on local to global scales; application of parameters to energy related industries and agriculture needs.

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Contact: **Paul W. Stackhouse, Jr.**, (757) 864-5368, p.w.stackhouse@larc.nasa.gov

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Halogen Occultation Experiment (HALOE) - Analysis and interpretation of measurements from this experiment on the Upper Atmosphere Research Satellite to improve understanding of stratospheric

ozone depletion, particularly the impact of chlorofluoromethanes on ozone by analyzing global vertical profile data of O3, HCl, CH4, H2O, NO, NO2, and HF.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **John G. Wells, Jr.,** (757) 864-1859, j.g.wells@larc.nasa.gov

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Studies of the Atmosphere - Research is being conducted in the areas of tropospheric and stratospheric dynamics, radiation, and photochemistry. Theoretical studies are conducted using an extensive hierarchy of analytical models and one-, two-, and three-dimensional numerical models. Satellite data are analyzed and interpreted to identify and quantify natural and perturbed variations in atmospheric properties. Theoretical calculations are compared with existing data to provide scientific insight and a basis for model improvement. Objectives of the research are to provide fundamental knowledge of the atmosphere, to assess manâ's potential impact on the environment, and to provide a sound rationale for satellite experiments. Major emphasis is placed on supporting the Upper Atmosphere Research Satellite and Earth Observing System programs. Numerical studies are supported with programming assistance and by a modern computer complex, including CRAY-2.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **William Grose**, (757) 864-5820, w.l.grose@larc.nasa.gov

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Global Biogeochemical Cycling - Theoretical and field investigations of the biogeochemical cycling of atmospheric gases, with particular emphasis on the global budgets of oxygen, nitrogen, and carbon dioxide to better understand global change. Field measurements include studies of biogenic emissions of atmospheric gases from the soil and oceans and gases produced and released to the atmosphere during biomass burning, i.e., the burning of the world's forests and grasslands.

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Contact: **Joel S. Levine,** (757) 864-5692, j.s.levine@larc.nasa.gov

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LIDAR Atmospheric Measurements of Water Vapor - LIDAR techniques that have important applications in areas of meteorology and atmospheric sciences are being developed for use from airborne and eventual spaceborne platforms. The first steps have been taken in this development by building and flight testing differential absorption LIDAR (DIAL) systems operating in the 720- and 815-nm wavelength regions. These systems use either Alexandrite lasers or Nd:YAG-pumped Ti:Sapphire lasers to produce tunable, narrow-line laser operation for DIAL water vapor measurements. The capability of these airborne DIAL systems will be extended to the 940-nm region, where water vapor absorption lines have line strengths a factor of 20 greater than those in the 720- or 815-nm regions. The increased water vapor absorption will permit investigation of lower water vapor concentrations in the upper troposphere and lower stratosphere.

Different laser techniques for generating 940-nm laser wavelengths will be explored such as Raman shifting of the Alexandrite laser output, the use of Cr:LiSAF lasers, and OPO wavelength shifting of various lasers. Research will include laboratory investigations of laser techniques for generating laser wavelengths in regions of strong water lines. Ground-based DIAL measurements will be performed, and airborne evaluation of potential DIAL laser candidates for water vapor measurements in the 940-nm region will also be conducted. An assessment of these techniques for future space-borne water vapor experiments will be performed.

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Contact: **Edward Bowell**, (757) 864-1273, e.v.browell@larc.nasa.gov

Atmospheric Evolution, Composition, and Photochemistry - Research is being conducted into the coupling between the biogeochemical cycling of compounds and elements, and the photochemistry/chemistry of the atmosphere and how this coupling has varied over geological time. The objective of this research is to better understand the chemical composition of the atmosphere and biospheric-atmospheric coupling past, present, and future. Studies of the photochemistry/chemistry of the atmospheres of the other planets as they impact our understanding of the Earth's atmosphere are included. Experimental facilities include a gas-analysis laboratory for identification of trace atmospheric species and field instrumentation for measurements of the biogenic and biomass burn production of nitric oxide, nitrous oxide, ammonia, carbon dioxide, methane, carbon monoxide, and hydrogen. Field measurements conducted during controlled fires in diverse ecosystems are important components of this research. Numerical biogeochemical and photochemical models are available and operational, supported by a modern computer complex (CDC 6600, CYBER 175, STAR 100, and CRAY-2).

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Contact: **Joel S. Levine,** (757) 864-5692, .s.levine@larc.nasa.gov

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Advanced Satellite Aviation-Weather Products (ASAP) - Utilization of high-resolution satellite data in aviation weather products for ground and airborne users.

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Contact: **John J. Murray**, (757) 864-5883, j.j.murray@larc.nasa.gov

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Planetary Exploration - Understanding the geology and atmospheres of a wide variety of planetary environments via remote sensing investigations.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Joel S. Levine,** (757) 864-5692, j.s.levine@larc.nasa.gov

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Transportation Systems - Future space vehicle concept development, operations, research, and computer-aided design.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **Charles H. Eldred**, (757) 864-4450, l.b.eldred@larc.nasa.gov

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Scientific and Technical Information Program Office (STIPO) - This organization leads NASA's agency-wide program for publishing, collecting, archiving, and disseminating NASA scientific and technical information (STI) and acquires STI from more than 40 countries worldwide. The STI Program maintains the STI Database, which involves 3.5 million bibliographic citations and some full-text documents of STI. This activity involves primarily skills in the areas of Library and Information Science, and Computer Science.

NASA Langley requires that you directly contact this researcher before submitting a proposal for this opportunity. All proposals submitted without a NASA Technical Adviser will be returned.

Contact: **George J. Roncaglia**, (757) 864-2374, g.j.roncaglia@larc.nasa.gov

MARSHALL SPACE FLIGHT CENTER (MSFC)

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Marshall Space Flight Center (MSFC) in Huntsville, Alabama, plays numerous key roles in NASA's mission. MSFC leads the Agency in developing new generations of spacecraft powered by cutting edge propulsion technologies. MSFC manages In-Space Propulsion Technology projects seeking near-term, alternative propulsion technologies to significantly reduce the time and cost required for spacecraft to reach their objectives and allow for more robust science missions throughout the solar system. MSFC also maintains a key role in International Space Station hardware development and science operations, and supports NASA's science and research efforts delivering practical applications of space research and technologies to Earth. NASA's Chandra X-Ray Observatory, the world's most powerful X-Ray observatory, is managed by MSFC and our newest mission is managing the Discovery and New Frontiers Program which provides opportunities for science robotic missions that lay the ground work for future exploration in the solar system and beyond. Marshall offers a broad array of science and engineering research opportunities. Applicants are encouraged to explore areas of interest with the technical contacts listed prior to submitting a proposal.

Advanced Optical Testing Technology - Advanced optical testing techniques and instruments are required to test the next generation of optical components required for NASA missions. For example, testing next generation aspheric optical components is extremely challenging. It requires advances in the area of null lens design and characterization. Specific technical issues include precise mapping of the interferometer data onto the surface under test. This requires advanced fiducialization techniques and pupil distortion mapping. Also, there is a need to increase the spatial sampling information of the acquired data. One solution to these problems requires advanced null lens designs to minimize pupil aberrations. Another solution is using iterative optimization algorithms to simultaneously regress the complete surface distortion function and the mirror surface figure. A second example is the use of a common computer generated hologram (CGH) to test both a diamond turned mandrel and any optics replicated from said mandrel.

Contact: **Philip Stahl**, (256) 544-0445, H.Philip.Stahl@nasa.gov

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Advanced Optical Design and Analysis Tools - Advanced optical design and analysis tools are of interest to NASA. For example, one potential topic is an optical design tool for rapid, automated optics selection from commercial-off- the-shelf optics. Rapid assembly of prototype optical systems typically involves acquiring commercial-off-the- shelf optics. Often, the selection of appropriate COTS optical components to develop complex systems is a long process of trial and error, as existing optical design software does not optimize systems by replacing existing components, but by varying radii, and thicknesses. What we intend to develop is a simplified database of COTS optics which can be sorted, rapidly analyzed, and optimized in an intelligent iterative process given basic system requirements.

Contact: **Philip Stahl**, (256) 544-0445, H.Philip.Stahl@nasa.gov

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Reliability Engineering - Research and analysis are conducted to gain an understanding of complex physics of failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.

Contact: **F. Safie**, (256) 544-5278, fayssal.safie@msfc.nasa.gov

Quality Assurance Office/Software Quality Control/Critical Process Control - Research is performed in areas dealing with software quality control, nondestructive evaluation (e.g., thermography, computed tomography), critical process controls, workmanship standards for state-of-the- art integrated circuit packages used in electronic fabrication, and assessment of critical characteristics in inspection with respect to control of critical items.

Contact: **R. Mize**, (256) 544-2485, Ron.C.Mize@nasa.gov

Systems Safety Engineering - Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.

Contact: **M. Galuska**, (256) 544-3743, mike.galuska@msfc.nasa.gov

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High Energy Astrophysics - Research areas include temporal, imaging, and spectroscopic studies of astrophysical sources using various high energy observatories including (among others) the Chandra X-ray Observatory, XMM-Newton, Rossi XTE, and Swift. Objects of study include prompt and afterglow emission from Gamma Ray Bursts, Magnetars (Soft Gamma Repeaters and Anomalous X-ray Pulsars) and X-ray binaries. Additional areas of study include relativistic jet modeling and simulations and development of an advanced relativistic x-ray timing experiment for a future mission.

Contact: **C. Kouveliotou**, (256)961-7604, Chryssa Kouveliotou-1@nasa.gov

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Propulsion Research Center/Advanced Propulsion Systems - Research and development of advanced propulsion systems and revolutionary technologies that will open up space to ambitious human and robotic exploration. A broad range of challenging projects is underway to achieve dramatic reductions in launch costs, routine transportation between Earth and orbit, rapid travel throughout the solar system, and missions beyond the solar system. Activities focus on analytical and experimental research that will ultimately lead to proof-of-concept demonstrations and flight tests of promising technologies. Principal research areas include advanced combined airbreathing/rocket engine cycles using chemical and nonchemical energy sources, beamed energy propulsion, high-energy electromagnetic and plasmadynamic thrusters, space tethers and sails, and high-power density propulsion systems based on fission, fusion and antimatter energy sources. Opportunities also exist for fundamental physics research, which could possibly lead to revolutionary advances in propulsion and motive capability.

Contact: **S. Rodgers**, (256) 544-0818, stephen.rodgers@msfc.nasa.gov

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Propulsion Research Center/Plasma Propulsion - There are two types of plasma propulsion: direct and indirect drives. For direct drive, the energy from a prime source of energy such as fusion is converted into thrust directly by the interaction of the high-temperature plasma created by the energy source with a magnetic field or other force fields. For indirect drive, the energy is first converted into electrical energy and is then conditioned to power an ion or plasma thruster. The latter is the essence of electric propulsion. At MSFC Propulsion Research Center we are engaged in research in both types of plasma propulsion, in collaboration with other NASA Centers, various university and industrial groups and national laboratories. We are particularly interested in those plasma propulsion schemes which have the potential for scalability to extremely high jet power, from 100s kW to in excess of 100s of MW, and involving the application of stable plasma configurations, such as spheromaks and field-reversed configurations, that have a high degree of self-organization of the plasma flows and the self-generated magnetic fields. The ultimate potential of plasma propulsion may be realized by one driven by a fusion energy source. To that end, we are undertaking basic, exploratory, science-based research to explore the most promising physics and engineering pathways to fusion that are particularly adaptable for propulsion.

Contact: **S. Rodgers**, (256) 544-0818, stephen.rodgers@msfc.nasa.gov

Gasdynamic Mirror Fusion Propulsion Engine Experiment - The Gasdynamic Mirror, or GDM, is an example of a magnetic mirror-based fusion propulsion system. Theoretically, it has been shown that the geometry of the GDM should be effective in preventing the major causes of instability known to plague classical fusion mirror machines. The purpose of the GDM Propulsion Experiment is to confirm the feasibility of the basic concept and to demonstrate many of the operational characteristics of a full-sized engine. This will be accomplished with a small-scale experiment that should determine if a plasma can be confined within the desired physical configuration and still remain stable.

Contact: **B. Emrich,** (256) 544-7504, bill.emrich@msfc.nasa.gov

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Vehicles and Systems Development Department/Guidance and Control Systems - Opportunities for research exist in guidance and control systems analysis and design for launch vehicles, upper stages, various spacecraft, and a variety of space systems. Includes trajectories, orbital mechanics, attitude control, guidance, navigation, automated rendezvous and capture, fine pointing control, microgravity vibration isolation, active optics control, tethered system dynamics and control, POGO stabilization, thermal/process control, and turbomachinery rotordynamic analysis and stabilization. Current interest is particularly strong in subject areas applying to exploration of the solar system.

Contact: **M. West**, (256) 544-1443, mark.e.west@nasa.gov

Vehicle and Systems Development Department/Advanced Flight Control Techniques - Two of NASA's goals for the next 10 years are to reduce launch costs by one order of magnitude and at the same time to increase safety by two orders of magnitude. The only way that these significant reductions in cost and increase in safety will be possible is through flight of robust reusable launch vehicles. Flight of reusable launch vehicles, however, is significantly more complicated than flight of expendable launch vehicles. Research in advanced flight control techniques to increase the safety and reliability of future reusable launch vehicles. The areas of interest include advanced control law development, control allocation and reconfiguration, techniques to accommodate actuator saturation and failure, and techniques to maintain vehicle stability and maneuverability by modifying guidance and control inputs or algorithms based on current vehicle health and status.

Contact: **D. Krupp**, (256) 544-1812, don.krupp@msfc.nasa.gov

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Vehicles and Systems Development Department/Microgravity Vibration Isolation Systems - Microgravity vibration isolation systems and robust control for flexible space structures; g-LIMIT, a microgravity vibration isolation system for the International Space Station Microgravity Science Glovebox.

Contact: **M. Whorton**, (256) 544-1435, mark.whorton@msfc.nasa.gov

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Subsystem and Component Development Department - Activities involve research and development of mechanical subsystems such as propulsion feedlines, turbomachinery, combustion devices, thrust vector control, auxiliary propulsion, valves, actuators, controls, and mechanisms. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.

Contact: **T. Ezell**, (256) 544-3620, tim.ezell@msfc.nasa.gov

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Subsystem and Component Development Department/Experimental Fluid Dynamics - Opportunities to develop and apply state-of-the-art experimental fluid dynamic methods to study launch vehicle aerodynamic characteristics and rocket engine internal flows. Areas of expertise include external aerodynamics, turbomachinery fluid dynamics, nozzle performance and flow physics, injector flow physics, and other fields involving fluid flow. Research is needed in all of the above areas, as well as data analysis techniques and unique diagnostic systems development.

Contact: **W. Bordelon**, (256) 544-1579, wayne.bordelon@msfc.nasa.gov

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Subsystem and Component Development Department/Fluid Dynamics Analysis - Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible, and reacting fluid states, and to provide benchmark CFD comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, chemistry and turbulence modeling, code efficiency, and stability and solution visualization.

Contact: **R. Garcia**, (256) 544-4974, robert.garcia@msfc.nasa.gov

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Subsystem and Component Development Department/Combustion Flow Field Measurement - Theoretical and experimental research activities in the field of the optical diagnostics shall focus on the development of combustion flow field measurement techniques. In the course of theses investigations, a UV laser shall be utilized to gain information of Raman scattering signals of combustion products in rocket chamber flow fields. The results, in turn, will provide accurately quantitative interpretation of combustion environments such as spatial species concentration and temperature distributions. Such a technique shall be fully demonstrated to measure in actual rocket test environments.

Contact: **H. Stinson,** (256) 544-7077, henry.p.stinson@msfc.nasa.gov

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Technology Evaluation Department - Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current areas of interest specifically relate to automate test control systems. A continuing interest exists for new and advanced instrumentation techniques.

Contact: **T. Ezell**, (256) 544-3620, Tim.Ezell@nasa.gov

In-Space Transportation/Tether Architectures - NASA presently has a high level of interest in the use of space tethers as transportation elements for in-space propulsion. The integration of tethers in a space archetecture or 'system- of-systems' for lunar and Mars missions, space asset reboost in Earth orbit, robotic missions to the outer planets and other propulsion applications is desired to be addressed. Systems engineering and advanced space planning are the predominate research fields that should consider the wide trade-space available for tether implementation and operations.

Contact: **K. Sorensen**, (256) 544-4109, Kirk.Sorensen@msfc.nasa.gov

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In-Space Transportation/MXER Tethers - Momentum eXchange Electrodynamic Reboost (MXER) tethers are of prime interest in the Emerging Propulsion Technologies area. This combination of two unique tether approaches appears to archive a high thrust for payloads in low Earth orbit similar to chemical rockets, but uses little or no propellant like solar sails or ion engines. Several research areas still needing investigation are: kinematic and dynamic modeling, electrodynamic tether fabrication/testing, MXER mechanisms design, and neural- network predictor code development.

Contact: **J. Bonometti**, (256) 544-4019, Joeseph.A.Bonometti@msfc.nasa.gov

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Advanced Concepts Department/Design and Analysis of Lauch Vehicle Structures - Conceptual design and analysis of launch vehicle structures and propellant tankage to include sizing, finite element modeling, and configurations. The analysis will be performed in a quick- turnaround systems environment. Configurations will include expendable rockets, fully reusable rockets and air-breathing concepts.

Contact: **N. Brown**, (256) 544-0505, norman.brown@msfc.nasa.gov

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Avionics Department/Instrumentation and Control - Research, design, and development of instrumentation and control systems for use on space related systems. Subjects addressed include sensors, transducers, video/imaging systems, miniature robotics, and guidance, navigation, and control components.

Contact: **Jeri Briscoe**, (256) 544-3480, jeri.briscoe@msfc.nasa.gov

Avionics Department/Audio Systems - Design, development, and evaluation of flight audio communications systems are performed in support of ongoing and future programs. Specific areas of interest include digital signal processing and encoding techniques, voice synthesis and recognition, and the effect on background noise on intelligibility.

Contact: **P. Clark**, (256) 544-3661, porter.clark@msfc.nasa.gov

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Avionics Department/Communications Systems - Test facilities are available to pursue research and development of antenna components and systems. These facilities include a fully automated 800-meter pattern test range and a shielded anechoic chamber with 3.7 meter diameter quiet zone and supporting test equipment operating up to 60 Ghz. Other areas of interest include high-power, solid-state transmitters Tracking and Data Relay Satellite System (TDRSS) transponders, and spread spectrum receivers and Global Positioning System (GPS) receivers. Test facilities are available for Precision

Positioning System (PPS) GPS receiver testing and TDRSS transponder testing. A large collection of RF test equipment is available for research and development.

Contact: **L. Bell**, (256) 544-3678, leon.bell@msfc.nasa.gov

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Avionics Department/Space Flight Software - Areas of high interest are: use soft computing techniques in the development and verification of mission critical space flight software; verification techniques and methodology for mission critical embedded software; software process improvement including the use of the Capability Maturity Model (CMM); software systems engineering; software metrics; reuse of software requirements and design; automated software development and testing techniques and tools.

Contact: **T. Crumbley**, (256) 544-5978, tim.crumbley@msfc.nasa.gov

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Avionics Department/Integrated Devices Laboratory - Produce various MEMS, integrated optics, advanced integrated circuit, and nanotechnology research devices. Collaboration with the academic community in applying electrodes and analysis of the device. Main research task is to develop advanced sensor technologies for space transportation, space exploration, and scientific research. The MEMS technologies have the potential to make a large impact in the space exploration arena.

Contact: **M. Watson**, (256) 544-3186, mike.watson@msfc.nasa.gov

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Structures, Mechanics and Thermal Department/Structural Dynamics - Research and development in aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics, and atmosphere. Probabilistic, as well as deterministic, approaches are used on SGI workstation computers to simulate flight environments and obtain loads data on launch vehicles and propulsion hardware. Enhanced structural dynamic analysis techniques are pursued.

Contact: **J. Brunty**, (256) 544-1489, joseph.brunty@msfc.nasa.gov

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Structures, Mechanics and Thermal Department/Thermal Analysis/Liquid Propulsion Systems - Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/structural analysis of turbine section and rotating components in high-pressure turbomachinery and combustion devices. Analytical results may be correlated to ground test data.

Contact: **B. Tiller**, (256) 544-4695, bruce.tiller@msfc.nasa.gov

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Structures, Mechanics and Thermal Department/Thermal Analysis/Solid Rocket Motor - Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive, and chemically reactive environments.

Contact: **K. McCoy**, (256) 544-7211, ken.mccoy@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Structural Design Optimization/Synthesis - In view of the need for lighter, stiffer, and stronger launch and space vehicle structures, new ways of designing structural systems are being sought. Research on the synergistic effects of assembly of structurally optimized elements and components is needed. Efficient and effective design methods and tools using numerical optimization, trajectory analysis, thermal analysis, loads, stress environments, and other critical criteria are needed.

Contact: **D. Ford**, (256) 544-2454, donald.ford@msfc.nasa.gov

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Structures, Mechanics and Thermal Department/Structural Assessment/Structural Analysis - Opportunities exist for research in strength, stability, fatigue, and fracture mechanics analyses. Computationally intensive methods such as finite and boundary element analyses are used extensively. Practical enhancement methods are sought such as solution adaptive finite element modeling techniques. Technology improvement in analysis and computational methods, which lead to development of practical engineering tools, are encouraged.

Contact: **C. Finnegan**, (256) 544-5447, Charles.J.Finnegan@nasa.gov

Structures, Mechanics and Thermal Department/Strength Analysis/Liquid Propulsion Systems - Opportunities for research exist in structural analysis of liquid propulsion system components, including integrated structural analysis of turbine section and rotating components in high-pressure turbomachinery. Areas of particular interest involve development of structural integrity and life criteria for exotic materials subject to rocket propulsion environments. Analytical results may be correlated to ground test data.

Contact: **G. Swanson**, (256) 544-7191, greg.swanson@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Vibroacoustics - Mechanically and acoustically induced random vibration and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods, high frequency vibration data analysis techniques, and microgravity characterization.

Contact: **P. Harrison**, (256) 544-1521, phillip.harrison@msfc.nasa.gov

Propulsion Research Center/Advanced Chemical Propellants - The Propulsion Research Center at NASA Marshall Space Flight Center is actively engaged in the synthesis, characterization, and testing of advanced chemical propellants, particularly energetic ionic liquids. Propulsion systems based on high-energy-density propellants would enable significantly increased payload fractions on launch vehicles and spacecraft. Requirements for new propellants or propellant ingredients include increased specific impulse and density over the current state of the art, scalability of synthesis to large quantities, reasonable cost by comparison with current propellants, and handling and storage precautions that do not exceed current requirements for analogous systems. Applicants will be expected to have experience in several of the following methods and techniques: the use of inert atmospheres and Schlenk techniques, multinuclear NMR spectrometry, infrared and Raman spectroscopy, differential scanning calorimetry, single-crystal x-ray diffraction, and the safe handling of energetic materials.

Contact: **J. Blevins**, (256) 544-3705, John.A. Blevins@nasa.gov

Propulsion Research Center/In Situ Propellants for Mars Ascent Rocket - NASA Marshall Space Flight Center (MSFC) is currently examining in situ rocket technology for Mars ascent based on the combustion of carbon dioxide with powdered metal fuels such as magnesium or aluminum. In this application, carbon dioxide would be condensed from the Martian atmosphere, thereby reducing the amount of propellant that must be transported from Earth and increasing the effective specific impulse of the ascent stage. This technology could improve the margins and reduce the cost of a Mars sample return mission through the use of space resources. The primary aim of the research is to develop the engineering data needed for the design of a practical rocket and to demonstrate the technology in a prototype flight-like configuration. Initial work is focused on the development of a powdered metal feed system and atmospheric and pressurized research combustors for experimental testing in the Propulsion Research Laboratory at MSFC. An opportunity exists for the development, validation, refinement, and utilization of computational analysis tools to support the experimental effort. It is expected that these analysis tools will be used to make performance estimates, investigate fundamental combustion physics processes, resolve technical operation issues, investigate alternative design configurations, and support performance optimization iterations based on the interplay of detailed simulations and experimental data.

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Propulsion Research Center/Nuclear Thermal Rocket - Missions to the Moon and Mars will almost certainly require propulsion systems with performance levels exceeding those of today's best chemical engines. A strong candidate is the Nuclear Thermal Rocket (NTR). Solid- core NTR engines are expected to have specific impulse in excess of 850 s, which is significantly greater than LOX/hydrogen chemical engines. Whereas great strides were made in nuclear fuel element design during the Rover/NERVA programs of the 1970s, a number of materials problems were never completely resolved, which limited the performance of the nuclear engines. Many of these problems were associated with the high operating temperatures and temperature gradients present during reactor operation coupled with the corrosive effects of hot hydrogen. A new experimental facility is being developed where non- nuclear electrically heated tests of single fuel elements or partial elements will be conducted. The fuel elements will be heavily instrumented to allow detailed observation of their behavior under a variety of conditions. These tests will greatly increase our understanding of fuel element behavior under relevant conditions.

Contact: **B. Emerich**, (256) 544-4158, bill.emerich@nasa.gov

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Propulsion Research Center/Spacecraft Power Conversion - NASA Marshall Space Flight Center (MSFC) is currently examining alternative energy conversion technologies for solar/nuclear spacecraft power plants with the aim of significantly increasing achievable system specific power. Traditionally, design concepts for spacecraft power plants above 500 kWe have been based on Turbo-Brayton or Rankine cycles, but these systems cannot achieve sufficiently high system specific power to significantly impact space exploration because the maximum operating temperature of the highly stressed turbomachinery blades is limited. This constraint results in a low heat rejection temperature for the power plant which leads to excessively large and heavy radiators and low specific power attributes. MSFC is investigating the possibility of utilizing magnetohydrodynamic (MHD) generators for power conversion in order to circumvent this limitation. Magnetohydrodynamic generators have no stressed moving parts and can operate at much higher temperatures than turbomachinery. The primary aim of this research is to develop the engineering data needed for the design of a practical system and to demonstrate the feasibility of the technology in a prototype flight-like configuration.

Contact: **R. Litchford**, (256) 544-1740, ron.litchford@nasa.gov

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Structures / Probabilistic - Probabilistic analysis of aerospace structures has been an ongoing research effort at NASA for the past 10 years. Several different computer codes have been developed: 1) PFA (probabilistic failure analysis using response surface techniques) developed by the Jet Propulsion Laboratory, 2) NESSUS (Finite Element structural computer code) developed by SwRI and NASA Glenn Research Center, and 3) QRAS (Quantitative Risk Assessment System analysis tool) developed by NASA Headquarters and Marshall. In the past, my research has focused on the development of these design tools. Presently, my research in this area is focused on the application of these tools to real aerospace problems.

Contact: **John Townsend**, (256) 544-1499, john.townsend@msfc.nasa.gov

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Materials Processes and Manufacturing Department/Space Environmental Effects on Materials - Evaluation of material is accomplished in simulated space environments involving vacuum, temperature, electron/proton and UV irradiation, atomic oxygen, and plasma. The effects of outgassing products of materials on weight loss, strength loss, surface properties, and redeposition and condensation on other items are being studied. Studies involving lubrication and surface physics of bearings in space and in rocket propulsion components are also being conducted. Research and development in new nondestructive evaluation (NDE) methods/processes and instrumentation are encouraged.

Contact: **R. Carruth**, (256) 544-7647, ralph.carruth@msfc.nasa.gov

Engineering Systems Department/Environments Group - Performing assessments of the hazard to the International Space Station posed by the Meteoroid and Orbital Debris (M/OD) environment, considering the impact shielding designs on the various modules. Developing the environment definition for the Next Generation Space Telescope, including meteoroids, plasma and ionizing radiation, solar, electromagnetic, and thermal environments.

Contact: **S. Evans**, (256) 544-8072, steve.evans@msfc.nasa.gov

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Materials, Processes and Manufacturing Department/Metallic Materials - Development of advanced materials for special applications in space propulsion systems is ongoing. The materials include aluminum-lithium, metal matrix composites and hydrogen resistant alloys. The effect of high-pressure, high temperature hydrogen on metals is an area of special emphasis. Research in microstructural analysis methods is being accomplished in support of failure analysis and materials characterization programs. Methods are being developed for quantitatively determining the state of corrosion, stress corrosion, and hydrogen embrittlement of alloys. Several development efforts are in progress relative to metals processing, including advanced welding methods, intelligent processing, robotics, and sensor development.

Contact: **B. Bhat**, (256) 544-2596, biliyar.bhat@msfc.nasa.gov

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Materials, Processes and Manufacturing Department/Casting Process Modeling - Research opportunities exist in casting process modeling using procast software. Pressure infiltration casting process will be modeled for metal matrix composites (MMC) to optimize casting parameters. Different MMCs will be evaluated. The models will be validated through controlled experiments.

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Materials, Processes and Manufacturing Department/Fracture Mechanics - Research opportunities exist in advanced modeling and prediction of elastic-plastic fracture in metals. Emphasis will be placed on validation of new computational models within the research codes by comparison with experimental data. Areas of specific interest include advanced cyclic plasticity models, computational models for hydrogen effects on fracture and fatigue, and modeling of fatigue crack growth under elastic-plastic conditions.

Contact: **D. Wells**, (256) 544-3300, doug.wells@msfc.nasa.gov

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Materials, Processes and Manufacturing Department/ Welding Process Modeling - Modeling opportunities exist in friction stir welding (FSW) process. FSW process is being expanded from low melting aluminum alloys to higher melting copper alloys. Modeling will help optimize weld parameters, such as tool speed, applied forces in different directions, and preheating conditions. Models will be validated through controlled experiments.

Contact: **A. Nunes**, (256) 544-2699, arthur.nunes@msfc.nasa.gov

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Materials, Processes and Manufacturing Department/ Nonmetallic Materials Research - Opportunities exist to develop and evaluate various materials for application in adhesives, elastomers, insulators, composite matrices, and molding and extrusion compounds for use in spacecraft hardware and in special environments. Composites utilizing carbon-carbon, carbon-resin, and ceramic matrix are being developed for applications to reduce mass or for high-temperature applications in rocket engines, structures, and leading edges. Research and technology efforts are underway in composite material fabrication, testing, and qualification for flight hardware application including automated filament winding and tape laying, pultrusion, tape wrapping, fiber placement, and hand lay-up. Additional opportunities exist for the development, application, and evaluation of cryogenic and high temperature thermal protection materials used in association with both liquid and solid propellant rocket motors. Also, use of computer aided engineering for process development and optimization including kinematics simulations.

Contact: **C. Clinton**, (256) 544-2682, corky.clinton@msfc.nasa.gov

Engineering Systems Department/Systems and Components Test and Simulation - Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Thermal vacuum testing is conducted in a variety of chambers with capabilities to 1X10-7 torr pressure and temperature ranges from -170ºC to +204ºC. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 518-meter evacuated guide tube.

Contact: **R. Stephens**, (256) 544-1336, randy.stephens@msfc.nasa.gov

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Structures, Mechanics and Thermal Department/Structural Dynamics and Loads - Inflatable and thin-film structures have received renewed emphasis in recent years within NASA, the Air Force, and the aerospace industry. These structures have considerable advantages over conventional structures for space applications due to their light weight, small packaging and launch volume, and relative simplicity of deployment systems. A number of proposed future space missions potentially can benefit from use of thin-film and inflatable structures, including solar sails, solar thermal propulsion vehicles, space solar power systems, large space telescopes, and communications antennas. These future missions fall within MSFC's priorities of Space Transportation and Space Optics. Possible research and development activities that can be performed in this project include the following: a. Investigation of rigidization concepts for inflated thin-film or composite fabric structures, including (4) foam injection, either following inflation on-orbit or used as the means of inflation, (5) foam packaged in-place prior to launch, to be rigidized on-orbit, (6) thin lightweight metal film or wire grid, to be enclosed between layers of film or fabric and rigidized through over-inflation and plastic deformation, and (7) various other approaches for chemical rigidization, such as resin- or gel-impregnated fabrics or resin-coated films. b. Development of linear and nonlinear finite element modeling approaches for structural dynamics, stress, and buckling analyses of thin-film and inflatable systems. c. Investigation of testing techniques for structural dynamics, buckling, and load-to-failure. d. Development of packaging/deployment concepts for thin-film and inflatable structures, and test/analysis methods for deployment characterization.

Contact: **M. Tinker**, (256) 544-4973, mike.tinker@msfc.nasa.gov

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Microgravity Science and Applications Department/Biophysics - An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop a basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction and factors that affect the crystal growth process and quality of crystals obtained.

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Microgravity Science and Applications Department Microgravity Solidification: Contained Solidification of Metals and Alloys - Buoyancy driven convection and sedimentation in the melt during metal and alloy solidification strongly influence the microstructure and thus important physical properties of the solid product. Also, under normal gravity, convection and sedimentation can mask the fundamentals of solidification that must be understood to allow the precise control of microstructure that can tailor materials properties. Current flight and ground experiments study phenomena such as dendritic growth, particle pushing and engulfment by solidifying interfaces, formation of eutectic and monotectic composite structures, and the transition from planar to cellular growth (morphological instability). Better experimental and theoretical methods are needed. Theory for all of the above mention processes must be reconciled with new experimental data. Experimental methods are being improved by such techniques as utilizing solid/liquid interfacial Seebeck measurements for undercooling and X-ray transmission microscopy for real-time imaging of solidifying microstructure and solute concentration in the liquid.

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Microgravity Science and Applications Department/Polymers - Development of nonlinear optical (NLO) polymers and the study of the processing of such polymers into thin fibers by means of solution-based extrusion techniques. The initial phase of the work will be ground-based, but will be followed by microgravity studies on those materials that show the most promise. The research will proceed on two fronts: synthesis and characterization of new materials, and development of fiber extrusion capabilities. The polymers will be diacetylene based because they are known to be excellent NLO materials. The fibers produced in this research project will be tested for their ability to waveguide light, and their ability to process information by all-optical techniques.

Contact: **D. Frazier**, (256) 544-7825, don.frazier@msfc.nasa.gov

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Microgravity Science and Applications Department - Solidification processing, particularly in utilizing controlled directional solidification techniques; studies on monotectic, eutectic, dendritic, and composite solidification, both in metal alloys and in transparent, analogous systems.

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Space Science Department/X-ray Astronomy - Experimental, observational, and theoretical research is conducted in x-ray astronomy and high-energy astrophysics. The experimental program concentrates on development of replicated x-ray optics, polarimeters, and hard-x-ray imaging detectors operating from 1 keV to above 100 keV using microscrip and liquid-xenon technologies. Observational and theoretical specialties comprise the study of compact objects (neutron stars and black holes), cooling flows in clusters of galaxies, and astrophysics of high-temperature plasmas. Opportunities include participation in balloon flights of sensors, CXO and other satellites, theoretical studies of physical processes in high-temperature astrophysical plasmas, and observations of clusters of galaxies and the Sunyaev-Zeldovich effect.

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Space Science Department/Gamma Ray Astronomy - Gamma ray astronomy uses space-borne and balloon-borne experiments to detect hard x-rays and gamma rays above 20 keV. Most of the present research uses data from the Burst and Transient Source Experiment (BATSE) on the Compton Gamma

Ray Observatory, although data from other spacecraft are also used. New detectors for observations of gamma-ray sources >20 MeV are being developed and proposed. These detectors use scintillation fibers as the primary detector. The primary astrophysical sources studied include gamma-ray bursts, galactic jets, black hole systems, accreting pulsars, solar flares, as well as the study of variability and spectra of other sources. Opportunities for participation in the development of a new generation of instruments for future gamma-ray astronomy experiments are also possible.

Contact: **J. Fishman**, (256) 961-7691, jerry.fishman@msfc.nasa.gov

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Space Science Department/Space Plasma and Upper Atmospheric Physics - We seek to better understand, and ultimately to predict the flow of matter, momentum and energy through the region in which the Sun-Earth connection is made: the Earth's magnetosphere and ionosphere. We further seek to better understand basic physical processes that effect the operation of spacecraft in space and that are important in astrophysical plasmas; for example cometary, planetary, and stellar upper atmospheres. Plasma and gas dynamic processes are studied by means of in situ plasma measurements, and by remote optical and electromagnetic sensing of the constituent plasmas and gases. Activities include design, development, and calibration of flight instrumentation, with analysis and interpretation of the resulting data in terms of physical models.

Contact: **P. Craven**, (256) 961-7639, paul.craven.msfc.nasa.gov

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Space Science Department/Space Plasma Physics - Research activities are primarily focused on the study of physical processes involving low energy plasma in near Earth space. Data analysis and modeling has lead to a statistical, static model of thermal plasmas near the Earth, as well as time-dependent simulations. Measurements of the space environment are available from the Dynamics Explorer 1, POLAR, and IMAGE spacecraft. IMAGE is the first to provide global images of space plasmas using ultraviolet light, neutral atoms, and radio sounding. Opportunities exist for supporting data analysis, computer modeling, visualization, and public outreach of science research. Images from the

IMAGE spacecraft are being analyzed to identify features and to derive the distribution of plasma through image inversion.

Contact: **D. Gallagher**, (256) 961-7687, dennis.gallagher@msfc.nasa.gov

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Space Science Department/Solar Physics - The influence of the magnetic field on the development and evolution of solar atmospheric structure, from the photosphere to the outer heliosphere, is studied. The primary data are vector magnetograms obtained at Marshall's Solar Observatory, which are supplemented by data from the Yohkoh, SoHO, Ulysses, TRACE, and the GONG programs. The observations are complemented by theoretical studies to characterize the nonpotential nature of solar magnetic fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large-scale interplanetary phenomena. Instrument development programs in optical polarimetry, grazing and normal incidence X-ray optics, and imaging detectors for the X-ray and UV spectral regions are being pursued.

Contact: **D. Hathaway**, (256) 961-7610, david.hathaway@msfc.nasa.gov

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Space Science Department/Cosmic Ray Research - Cosmic ray research at MSFC emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 1012 eV (TeV). Study of the interactions of heavy cosmic ray nuclei are also carried out to determine the behavior of nucleus interactions and to search for evidence of new states of nuclear matter. The research involves experiments with emulsion chambers and with electronic counters, exposed on balloons at about 40 kilometers altitude for up to two weeks. Research includes laboratory work, data analysis, particle cascade calculations, and calibrations of instruments with particle accelerators.

Contact: **M. Christl,** (256) 544-9496, mark.christl@msfc.nasa.gov

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Space Science Department/Astrobiology - Astrobiology is the scientific study of the origin, distribution, and destiny of life in the universe and the exploration of the spatial, temporal, physical and environmental limits of life on Earth. The analogues developed may shape future space instrumentation and missions searching for evidence of extant or extinct life elsewhere in the Cosmos. Astrobiology also seeks to locate other planets and bodies in the Universe that may presently support (or previously have been capable of supporting) biology. Astrobiology seeks answers to the fundamental question — Is Life a Cosmic Imperative? Activities include the use of advanced Electron Microscopy, X-Ray Spectroscopy, and Computer tools to explore chemical and morphological biomarkers and microfossils in ancient rocks and astromaterials. Ancient viable microorganisms from glaciers, permafrost and the deep ice just above Lake Vostok in Antarctica are being actively explored as models of microbial life that might be found on other Solar System bodies. The study of terrestrial extremophiles is necessary to understand where and how we should search for evidence of microbial life on Mars, Europa, Io, Callisto, asteroids, comets, and other potential habitats of the Cosmos.

Contact: **R. Hoover**, (256) 544-7617, richard.hoover@msfc.nasa.gov

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Space Sciences Department/Astrophysics - Research areas include x-ray astrophysics, using the Chandra X-ray Observatory to perform imaging spectroscopy of clusters of galaxies; experimental cosmology, using interferometric measurements of the Sunyaev-Zeldovich Effect; and development of advanced x-ray optics for future missions.

Contact: **M. Joy**, (256) 544-3423, marshall.joy@msfc.nasa.gov

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Earth Science Department/Aerosol Backscatter and Doppler Wind Lidar Studies - The research focuses on the assessment of regional global and patterns of aerosol backscatter, the calibration and characterization of Doppler Lidar systems, and the development and scientific application of ground-based, airborne, and space-based Doppler Lidars for the determination of regional and global winds relevant to contemporary issues in atmospheric research. Major experimental efforts have included ground-based and airborne Doppler Lidar systems for backscatter and wind fields, intensive field campaigns, and a host of supporting aerosol sensors. Laboratory facilities exist for detailed calibration of short-focal length lidars, and for analysis of the optical properties of artificially generated aerosols resembling those found in nature. A major facility addition is planned to accommodate multiple (active and passive optical) remote sensors as part of a cooperative initiative for regional modeling and assessment studies for air pollution and land use, and inputs to satellite validation.

Contact: **M. Jarzembski**, (256) 961-7964, maurice.jarzembski@msfc.nasa.gov

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Earth Science Department/Severe Storm and Hydrometeorology Studies - This research is directed towards understanding storm and precipitation processes and their relation to the larger scale environmental forcing. Cloud microphysics, lightning, precipitation processes, storm kinematics, and morphology studies are conducted using ground-based and satellite (TRMM, GOES) research data acquired during field campaigns. Ancillary data from satellite and airborne microwave and imaging remote sensor data are used to further describe the convective processes. Data collected from the operational National Weather Service WSR88-D (NEXRAD) network are used to develop instantaneous and climatological rainfall estimates and water budgets to study flash floods and the interannual variability of rainfall and its relation to changes in the synoptic and general circulation. This research will lead to improved understanding of precipitation processes and algorithms developed for new satellite sensor suites.

Contact: **S. Goodman**, (256) 961-7891, steve.goodman@msfc.nasa.gov

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Propulsion Research Center/Storage of Anti Protons as a Non-neutral Plasma for Antimatter Propulsion Experiments - Research involving the trapping and long term storage of antiprotons in a Penning-Malmberg trap and the utilization of antiprotons in propulsion experiments. The High Performance Antiproton Trap (HiPAT) at MSFC is being developed with the goal of trapping antiprotons at a production facility and transporting them to MSFC for use in antimatter propulsion experiments. Work is currently focused on the physics of trapping and storing a non-neutral proton plasma in preparation for trapping and storage of antiprotons. Antimatter propulsion proof-of-concept experiments are also being plammed. Appropriate proposals in these areas could include experimental work in trapping and storage, RF minipulation and diagnostics of the plasma, analytical modeling, PIC or other computational modeling, and design or modeling of proof-of-concept propulsion experiments.

Contact: **B. Pearson**, (256)961-0078, J. Boise.Pearson@nasa.gov

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Investigation of GPS Algorithms for High-G, High-Mach Application - Futures NASA robotic and manned missions to the moon and mars would greatly benefit from improved navigation capabilities.

These missions will use navigation aids such as GPS combined with an Inertial Navigation System (INS). Current state-of-the-art GPS receiver hardware and algorithms have not been optimized for. An urgent research need is to optimize GPS hardware and algorithms for high-G, high-Mach space environments. Research shall also provide realistic simulation tests using programmable GPS recivers using real-time flight test data.

Contact: **J. Chuang**, (256) 544-3114, Jason.C.Chuang@nasa.gov

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Solar Sail Propulsion Guidance, Navigation, & Control - Opportunities for research exist in Guidance, Navigation and Control for Solar Sails. Areas of focus include thrust vector pointing accuracy analysis, spacecraft control, maneuver modeling, sail shape- control coupling, trajectory design, mission analysis and attitude control system characterization and design. Researchers will have access to and be expected to use and provide feedback on recently developed software tools for modeling Solar Sail shape and GN&C. The goals of the research are to provide analysis of current state-of- the-art tools for modeling Sail propulsion and control and develop innovative approaches to solar sail guidance, navigation, and control. The research may also identify and attempt to fill gaps in existing models.

Contact: **A. Heaton or M. Whorton**, (256) 544-3839 (256)544-1435, Andrew.F. Heaton@nasa.gov;Mark.W.Horton@nasa.gov

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Solar Sail Propulsion System Engineering - Opportunities for research exist in the design and analysis of NASA mission applications that require Solar Sail Propulsion using an integrated system engineering approach. Areas of focus include analysis of the expected performance of existing sail propulsion system architecture, optimization of critical subsystems (e. g., thrust vector control, spacecraft interface, deployment methodology, etc.), mission analysis (e. g., GNC performance, trajectory optimization, etc.) and launch vehicle trade studies of accommodation and performance. Researchers will have access to and be expected to use and provide feedback on recently developed solar sail propulsion software tools and models. The goal of this research is to provide analysis of current state-of- the-art tools for providing a detailed and accurate conceptual design of future missions that will employ solar sail propulsion.

Contact: **G. Garbe**, (256) 544-1586, Gregory P. Garbe@nasa.gov

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Biophysics - Understanding and controlling astronaut's health risks from exposure to space radiation relies on accurate quantification of the radiation fields in which they are immersed, and biological effects to the organism. The biological effects of space radiation are extremely complex, and likely dissimilar to any encountered on Earth, in either industrial, medical or research settings. Our research is focused on cell biology with the emphasis on structure and function of proteins, oligonucleotides, and other molecules in the presence of radiation. Considerable attention is given to molecular signaling pathways and interations between all cellular components. In our research we combine techniques of molecular biology, protein chemistry, enzymology and structural biology. In addition, we are interested in developing radiation exposure monitoring strategies for human space missions.

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Multiphysics Code Development - Development and use of a multiphysics tool for conceptual design of advanced propulsion systems. The development will be in one of the physics/engineering modules that comprise the multiphysics tool, which includes but is not limited to fluid mechanics, magnetohydrodynamics, heat transfer, static and dynamic structural analysis, particle in cell development, and neutronics. Combination of these modules with grid generation and data reduction modules will be used to model propulsion concepts from advanced chemical rocket nozzles, electric thrusters, nuclear reactors, fusion propulsion concepts, etc. This work will be conducted in a dynamic team environment where the candidate will interface with engineers conducting analyses of other portions of an in-space vehicle.

Contact: **R. Adams**, (256) 544-3464, Robert.B.Adams@nasa.gov

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Propulsion Research Center/Electric Propulsion Research - The Propulsion Research Center at NASA Marshall Space Flight Center is actively engaged in the research and development of new electric propulsion thrusters. Trip times for planetary missions are strong functions of the spacecraft power/mass ratio, which has been relatively fixed for decades. Whereas it is difficult to envision substantial mass savings many desirable missions would in fact require vehicles with much larger mass than those currently flying increasing propulsive power is well within our reach. At the present time we are particularly interested in concepts that are scalable to input power levels of greater than 100 kW, such as plasmoid and other inductively coupled thrusters, pulsed-plasma thrusters, wave-generated plasma sources and thrusters, and MHD-enhanced accelerators. Specific research topics include: (1) design, construction, characterization, and modeling of plasma sources and accelerators; (2) design, construction, and validation of propellant feed systems and power train components; (3) development and implementation of plasma diagnostics and thruster performance measurement techniques; (4) electrode erosion physics and other plasma-material interactions; and (5) plasma interactions with magnetic fields.

Contact: **J. Sheehy**, (256) 544-2987, jeffrey.sheehy@nasa.gob

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Propulsion Research Center/Advanced Propulsion Research - The Propulsion Research Center at NASA Marshall Space Flight Center is actively engaged in the research, development, and testing of advanced propulsion systems and revolutionary technologies that would enable dramatic reductions in launch costs, routine transportation to low-Earth orbit, and rapid travel throughout the solar system. Activity is focused on analytical and experimental research leading to proof-of- concept demonstrations of promising technologies. Principal propulsion research areas include advanced engine cycles, beamed energy, plasma thrusters, tethers, solar and plasma sails, fission, fusion, and antimatter. Opportunities also exist for fundamental physics research leading to revolutionary advances in propulsion.

Contact: **S. Rodgers**, (256) 544-0818, Stephen.L. Rodgers@nasa.gov

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Earth Science Department/Hydrometeorology/Land Surface Interface - Earth's surface characteristics and their linkages to the atmosphere and hydrologic cycles are being analyzed and modeled using remotely sensed data. Measurements from satellite and aircraft sensors, in conjunction with in situ measurements, are used to study spatial and spectral resolution and temporal variability effects on determination of land surface energy fluxes, hydrometeorological characteristics, and biophysical components. The effects of spatial and temporal scale on land surface interface processes are assessed using mesoscale hydrometeorological and Global Circulation Models. Geographic information systems play an important research role in integrating and modeling remote sensing and ancillary data for analysis of the spatial and temporal dynamics of land surface hydrometeorological interactions.

Contact: **D. Quattrochi**, (256) 961-5887, dale.quattrochi@msfc.nasa.gov

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Earth Science Department/Global Passive Microwave Studies - The Defense Satellite Meteorological Program has launched a series of satellites with passive microwave sensors. These instruments (Special Sensor Microwave Imager, Special Sensor Microwave Temperature-1 and Special Sensor Microwave Temperature- 2) are used to detect and measure atmospheric temperature and moisture profiles, bulk atmospheric water vapor and cloud liquid water amounts, precipitation, and land surface temperature and type. Future research in the usage of one or a combination of these data sets for global multiyear or seasonal assessments of hydrometeorological parameters is desired.

Contact: **M. Goodman**, (256) 961-5890, h.michael.goodman@msfc.nasa.gov

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Earth Science Department/Atmospheric Electricity Studies - Interest in lightning as a remote sensing measurement and variable of global change has grown with the recognition that lightning can convey useful information about many atmospheric processes. In the atmospheric electricity program, lightning relationships and practical algorithms are being pursued for processes within hydrology (e.g., distribution, amount and rate of convective rainfall; ice flux to upper troposphere), atmospheric energetics (e.g., release and transport of latent heat; large-scale circulations), atmospheric chemistry (e.g., production and transport of NOx and other trace gases), and the atmospheric electrical environment (e.g., global electric circuit). Modeling, analytic, and observational approaches are used in these studies, which fuse lightning observations with ancillary measurements. The Optical Transient Detector (OTD), the Lightning Imaging Sensor (LIS) on the Tropical Rainfall Measuring Mission (TRMM) and future space-based instruments play an important role in this research.

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Earth Science Department/Microwave Measurements - Acquisition and analysis of aircraft and satellite microwave radiometer measurements lead to further understanding of the microphysical processes of precipitation systems and aid in monitoring global climate change. In this research, aircraft measurements are used to investigate the spatial and temporal structure of precipitation systems, improve inversion techniques for precipitation estimation, for the polarametric retrieval of surface wind velocity over oceans, and for increasing the understanding of heating profiles in tropical atmospheres. Pioneering work with the multiyear MSU satellite data sets are used for global temperature and precipitation studies.

Contact: **R. Spencer**, (256) 961-7960, roy.spencer@msfc.nasa.gov

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Earth Science Department/Atmospheric Chemistry - Measurements of trace species and temperature in the upper troposphere, stratosphere, and mesosphere have been made from the Space Shuttle and other space platforms. These measurements are utilized to study the interactions between chemistry, dynamics, and radiation that are important in Earth's physical climate system. Especially important are the varying concentrations of stratospheric ozone that are determined by these interactions. This research effort utilizes space-based observations along with detailed models of the atmosphere to better understand the processes that determine stratospheric ozone, the interactions between the troposphere and stratosphere (including the role of water vapor), and the influence that human activities have on the atmosphere through the release of chemicals.

Contact: **T. Miller**, (256) 961-7882, tim.miller@msfc.nasa.gov

Earth Science Department/Climate Diagnostics and the Global Hydrologic Cycle - Observational, numerical modeling, and analytical approaches are used to study the Earth's physical climate system. Diagnostic analyses of space-based observations are used to understand and validate models of global hydrologic cycle. Numerical models ranging in scope from atmospheric general circulation codes to mesoscale and cloud models are used to study water cycle processes and to quantify their role in climate. Sensitivity studies of climate models to surface boundary forcing, i.e., sea surface temperature, albedo and soil moisture anomalies are conducted. Simulations of remote sensors are used to understand how space-based observations can be best applied to studying the Earth as a system.

Contact: **P. Robertson**, (256) 961-7836, pete.robertson@msfc.nasa.gov

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Earth Science Department/The Role of Global Hydrology and Climate Variability in Human Ecology and Archeology - The study of global hydrology and climate change is directed at understanding how changes in climate can be understood and potentially predicted. A study of past climates and cultures documents the effects of human/environmental interaction. Understanding how prehistoric cultures adapted to their environments through resource management and population dynamics is critical for societies today. Using remote sensing and GIS technology, this research investigates the adaptation techniques of prehistoric societies and compares the resultant success and failure of those techniques with the environmental and socioeconomic trends of current populations.

Contact: **T. Sever**, (256) 961-7958, tom.sever@msfc.nasa.gov

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Earth Science Department/Water Vapor, Winds, and Climate Variability - Water vapor is one of the most important greenhouse gases and is a key component of the Earth's hydrologic cycle, yet our inability to accurately measure it and monitor its variability around the globe is a limiting factor in understanding climate processes. This research focuses on the measurement and validation of atmospheric water as measured from satellites and the use of water vapor imagery for the determination of winds on a global and regional basis. Data from U.S., Japanese, Chinese, and European satellites are used for regional and hemispheric analysis in support of climate studies.

Contact: **G. Jedlovec**, (256) 961-7966, gary.jedlovec@msfc.nasa.gov

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Earth Science Department/Retrieval and Use of Land Surface Temperature from Satellite Data - This research focuses on retrieving land surface temperature from satellite radiance measurements for assimilation into numerical forecast models and for use in long-term climate monitoring. Evaporation of water from vegetation controls the physical temperature of the surface and can be monitored from satellite. The change in this temperature throughout the day is related to the flux of moisture from the surface, a parameter that is currently not well specified in regional numerical forecast models. The use of this new satellite information in the models has shown substantial improvement in the prediction of low-level temperature and moisture, cloud fields and subsequent precipitation.

Contact: **R. Suggs**, (256) 961-7895, ron.suggs@msfc.nasa.gov

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Earth Science Department/Thermal Remote Sensing & Surface Energy Budgets - Thermal remote sensing research involving the modeling of forest canopy thermal response using both aircraft and satellite thermal scanners on a landscape scale. These investigations have resulted in the development of a Thermal Response Number (TRN), which quantifies land surface's energy response in terms of kJ m-2 C o -1 which can be used to classify land surfaces in regional surface budget modeling by their energy use. A logical outgrowth of characterizing surface energy budgets of forests is the application of thermal remote sensing to quantify the urban heat island effect. These models provide the ability to quantify the importance of trees in keeping the city cool and determine mitigation strategies to reduce ozone production through the use of high albedo surfaces for roofs and pavements and increasing tree cover in urban areas to cool cities.

Contact: **J. Luvall**, (256) 961-7886, jeff.luvall@msfc.nasa.gov

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Space Science Department/Large Aperture Optics - This research is directed toward developing the next generation of space based optical imaging devices. Current research involves electroforming lightweight astronomical telescope mirrors (<5kg/m2), designing and fabricating ultra-lightweight thin membrane mirrors (<100g/m2), correcting optical figure of lightweight mirrors, and understanding the dynamics of lightweight mirrors and metering structures. Current projects involve the production of super-alloy mirrors, understanding lattice strain in deposited materials, and designing an inflatable space telescope OTA. Research is also being carried out in ION figuring, novel biologically-based radiation dosimeters, zero gravity Atomic Force Microscopy, and other areas in optics and physics

Contact: **R. Jones**, (256) 544-3191, ruth.jones@msfc.nasa.gov

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Space Optics Manufacturing Technology Center/Optical Systems - Opportunities exist for research, development, and application of technology in the following areas: coherent lidar systems (both gas and solid state technologies) target and detector calibration, transmitter evaluation signal processing atmospheric propagation and system modeling; video/film camera systems, including imaging systems development fiber optics video compression, radiometry, film camera and video system evaluation; and optical design, fabrication and testing including stray light analysis and testing, performance analysis, coating metrology, precision engineering and binary optics.

Contact: **J. Bilbro**, (256) 544-3467, james.w.bilbro@msfc.nasa.gov

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Space Optics Manufacturing Technology Center/Precision Engineering, Diamond Turning Research - Developing and proving manufacturing strategies for the production of Wolter Type I x-ray optic mandrels used to produce x-ray optics in support of the Constellation X program. Other important areas of research include: the dynamic effects of diamond turning large pieces needed to produce large aperture, lightweight space optics, diamond turning machine optimization, Fresnel optic mold fabrication [previously for the Shooting Star Program, currently in support of the Orbiting Wide Lens Array (OWL)]. Fresnel optic mold fabrication research is also conducted.

Contact: **D. Lehner**, (256) 544-9033, david.lehner@msfc.nasa.gov

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Training/Training Systems - Training on payload operations is provided for the payload crew, payload flight controllers, and investigators using computer simulations, computer-aided training, mock-ups and/or engineering models. Continuous improvement requires that training methods and tools be assessed and updated on a periodic basis. This includes improving methods to acquire, organize and deliver training materials using recent improvements in multimedia technology and assistance from artificial intelligence technology. These updates are based on improved capabilities/technology, current information relative to pedagogy and lessons learned from previous training.

Contact: **A. Johnston**, (256) 544-4858, alan.johnston@msfc.nasa.gov

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Ground Support Systems - The Huntsville Operations Support Center is the ground facility that supports multi-project flight operations. The design and development function includes communications (voice, video, wideband data handling, and external information transfer), data acquisition and processing, payload and spacecraft commanding user workstation data presentation, and facility support functions. Development includes prototyping new technologies to ensure state-of-the-art capabilities, with special emphasis on remote operations linking multiple ground facilities. The facility is managed and operated in support of project and user requirements.

Contact: **K. Cornett**, (256) 544-4321, keith.cornett@msfc.nasa.gov

Human Factors Engineering/Human-Computer Interfaces/Virtual Reality - Opportunities for research exist in human factors engineering (HFE), human- computer interfaces and interactions (HCI), and applied virtual reality (VR). New tools and techniques, especially computer-aided capabilities, need to be developed and/or validated to enhance/facilitate the application of HFE to the design, development, test, and evaluation of space systems. More effective HCI design methodologies and more efficient, distributed usability evaluation capabilities are needed for International Space Station experiment displays. Improved systems, components, software, and methodologies are needed to apply VR to design analysis, operations development and support, and training.

Contact: **G. Hamilton**, (256) 544-4963, george.s.hamilton@nasa.gov

Expert Systems - New software methods are needed to automate and simplify increasingly complex ground support tasks associated with spacecraft and payload flight operations. Projects in the areas of automated analysis of engineering and operations telemetry, decision support, and trend analysis.

Contact: **M. McElyea**, (256) 544-2034, mark.mcelyea@msfc.nasa.gov

Operations Analysis - Operations analysis in support of flight and ground system development is performed using analytical techniques, mock-ups, and computer simulations. Flight control methods are developed and recommended based upon flight system requirements and objectives.

Contact: **M. McElyea**, (256) 544-2034, mark.mcelyea@msfc.nasa.gov

Propulsion Research /Advanced Chemistry for Propulsion Research - High-Energy Hypergolic Fuels and Heat-Tolerant Monopropellant Catalysts are being designed, synthesized and tested to provide improved performance while utilizing existing propulsion technology. These materials are expected to reduce toxicity associated with chemical propellants, providing easier handling and safety. This activity seeks to develop a theoretical basis for increasing the energy density of fuels, facilitation of hypergolic (spontaneous) ignition of fuel/oxidizer combinations, developing heat tolerance in catalyst structures while enhancing activity of the catalyst surface. Improved understanding of these properties will lead to superior fuel and catalyst materials for use in space transportation applications.

Contact: **R. Gostowski**, (256) 544-0458, rudy.gostowski@nasa.gov

Astrophysics Education - This opportunity calls for the translation of NASA research findings in astrophysics into teaching resources for K-12 educators, including museum educators. Resources developed may include lesson plans, teaching units, teaching aids, web-based learing resources, workshop guides, and student learing resources. Such resources must incorporate national science, mathematics, technology, and geography standards, address varied learning styles and achievement levels, and complement state courses of study and state achievement standards.

Contact: **J. Pruitt**, (256) 961-7948, Jimmy.R.Pruitt@nasa.gov

Cosmic Ray Physics/Space Sciences - Galactic cosmic rays are investigated to find their origin and their connection to other aspects of astrophysics, cosmology and fundamental physics. The data being used currently for these investigations come from two flights of the Advanced Thin Ionization Calorimeter(ATIC) experiment. A third flight of this experiment is planned for 2005. The ATIC experiment measures the spectra of electrons and elemental cosmic ray nuclei from 100 GeV/nuc to 100TeV/nuc. A new experiment, the Extreme Universe Space Observatory, is currently being developed to investigate the highest energy cosmic rays. This experiment will observe extensive air showers using a very large wide-angle camera located on the International Space Station.

Contact: **James H. Adams**, (256) 961-7733, James. H. Adams@nasa.gov

Acousitc Analysis of Propulsion Systems – Research opportunities exist in acoustic analysis of propulsion systems. Advanced analyses are developed, applied, and validated with experimental data. Laboratory experiments are designed to characterize various acoustic phenomena, and results of these experiments are applied to sensor arrays used in rocket engine tests. Concepts are developed that allow novel measurements to be taken to complement and extend current sensor technology. Current research emphasis is on combustion chambers, sense lines and near field acoustic characterization.

Contact: **John Wiley**, (256) 544-1179, John.Wiley@nasa.gov

Microgravity/Optics - Opportunities exist in the Biological and Physical Sciences for Space Research Laboratory for research supporting strategic initiatives in the areas of in-space fabrication and repair, advanced sensors, and advanced propulsion technologies. Research topics include development of high power lasers, novel optical resonators, photonic band-gap materials, nano-optics and plasmonics, enhanced Raman and fluorescence, bio-photonics, quantum and nonlinear optics, and optical trapping. Applications such as biosensing, smart materials, vehicle health management, laser machining, enhanced solar cells, and photonic propulsion are of particular interest.

Contact: **D. Smith**, (256) 544-7778, david.d.smith@nasa.gov

Subsystem and Component Development/Functional Design - Activities involve research and development of advanced combustion devices (main chambers, preburners and gas generators, nozzles, injectors, igniters and thrusters) and turbomachinery. This broad area includes advanced functional designs, advanced manufacturing techniques, operability, reliability, life and cost for both combustion devices and turbomachinery. Other specific areas of need include advanced test diagnostics (e.g, laser diagnostics), advanced design/optimization codes, and advanced combustion stability analysis tools and test techniques.

Contact: **L. Leopard**, (256) 544-3950, Joe.L.Leopard@nasa.gov

Subsystem and Component Development /Mechanical Design - Activities involve research and development of mechanical subsystems such as propulsion feedlines, thrust vector control,valves,actuators,contr ols,and mechanisms. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.

Contact: **K. Ward**, (256) 544-1091, kevin.Ward@nasa.gov

Subsystem and Component Development/Fluid Physics and Dynamics - Opportunities exist to develop and apply state-of- the-art experimental fluid dynamic methods to study launch vehicle aerodynamic characteristics and rocket engine internal flows. Areas of expertise include externalaerodynamics, turbomachinery fluid dynamics, nozzle performance and flow physics, interior flow physics, and other fields involving fluid flow. Research is needed in all of the above areas, as well as data analysis techniques and unique diagnostic systems development

Contact: **E. Daso**, (256) 544-6122, Endwell.O.Daso@nasa.gov

Subsystem and Component Development /Applied Fluid Dynamics Analysis - Opportunities exist to develop and apply state-of- the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible, and reacting fluid states, and to provide benchmark CFD comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, chemistry and turbulence modeling, code efficiency, and stability and solution visualization.

Contact: **R. Garcia**, (256)544-4974, Roberto.Garcia-2@nasa.gov

Vehicle and Systems Development Department/Spacecraft Propulsion Systems - Spacecraft propulsion systems must meet the requirements for the nation's vision for exploration. To do this, technology areas of concern must be matured to a point where the technology is ready to be integrated into the spacecraft propulsion system. Advancements to be addressed in the propellant storage and feed system include: advanced, highly- reliable pressurization system design; devices for acquiring gas-free liquid cryogenic propellants for delivery to a thruster interface; advanced concepts for determination of propellant quantities in low- G, especially for cryogens; technologies for mitigating solubility effects; compressors and gasifiers for cryogens (O_2, H_2, CH_4, etc). Advances in the area of thrusters include: thermal management of cryogenic thrusters and feed systems to minimize heat soakback and vapor formation; low-toxicity mono- and bi-propellant (including gels) thrusters and their components (2-1000 lbf range); thrusters with multiple thrust levels; fast acting valves to enable the use of large thrusters for small impulses; high reliability thruster designs capable of extensive pulse mode operations yet insensitive to thermal cycling.

Contact: **P. McRight**, (256) 544-2613, patrick.s.mcright@nasa.gov

Advanced Materials and Sensors for Space Exploration - Current research efforts involve the development of advanced materials that support NASA's vision for Space Exploration. This includes the development of polymers, fiber reinforced composites, nanocomposites and other materials for use in propulsion systems, spacecraft, and the shielding of crews from cosmic radiation as they travel to Mars. Other areas of interest include the development of sensors and in- space fabrication processes for support of space exploration and research involving in-situ resource utilization.

Contact: **B. Penn**, (256) 544-7809, Benjamin.G.Penndr@nasa.gov

STENNIS SPACE CENTER (SSC)

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For more than four decades, the John C. Stennis Space Center has served as NASA's rocket propulsion testing ground. The center currently provides test services not only for America's space program, but also for the Department of Defense and the private sector.

Today, Stennis Space Center is NASA's program manager for rocket propulsion testing. As such, it manages NASA's rocket propulsion test assets and activities for rocket propulsion testing, including facilities at the Marshall Space Flight Center in Alabama, the White Sands Test Facility in New Mexico, and the Glenn Research Center's Plum Brook Station in Ohio.

Stennis Space Center is also home to NASA's Applied Sciences Directorate, using NASA's unique Earth science research results, remote sensing, and other technical capabilities to enable more informed decisions and to build tools for solving practical problems here on Earth such as disaster management, community planning, environmental quality, and natural resources. Through partnerships with other federal agencies, state, local, and tribal governments, academia and the private sector, the Applied Sciences Directorate at Stennis Space Center is supporting the identification of partner decision support systems that could benefit from NASA's Earth Science capabilities. The Applied Sciences Directorate at Stennis Space Center specializes in four of twelve national applications and leads efforts on five key issues of regional importance: 1) Agricultural Efficiency, 2) Coastal Management, 3) Homeland Security, and 4) Disaster Management.

Stennis Space Center is unique in that NASA and more than 30 resident agencies share the cost of owning and operating the facility, making it more cost- effective for each agency to accomplish its independent mission.

Thrust Measurement System - Research opportunities exist to develop innovative thrust measurement systems. New thrust measurement systems for rocket engine testing need to offer greater flexibility and adaptability to changing test requirements. The current technology requires 18 months or more to design and fabricate thrust measurement systems. Requirements for thrust measurement systems include: Â½% accuracy or better, ability to measure side loads during engine gimbling, and the ease of manufacture, installation and calibration. Three ranges of thrust measurement will be required for future programs: 20,000 to 100,000 pounds, 100,000 to 1,000,000 pounds, and 1,000,000 to 2,000,000 pounds.

Contact: **William St. Cyr**, (228) 688-1134, William.W.St_Cyr@nasa.gov

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Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems - Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the Center. Instrumentation is needed to precisely measure mass flow of cryogen's starting at very low flow rates up to very high flow rates at pressures to 15,000 psi. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and nonintrusive sensors, but especially nonintrusive sensors, are desired.

Contact: **Robert Field**, (228) 688-3735, Robert.E.Field@nasa.gov

Vehicle Health Management/Rocket Exhaust Plume Diagnostics - A large body of UV-Visible emission spectrometry experimentation is being performed during the 30 or more tests conducted each year on the Space Shuttle Main Engine at SSC. Research opportunities are available to quantify failure and wear mechanisms, and related plume code validation. Related topics include combustion stability, mixture ratio, and thrust/power level. Exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectroscopy, and laser induced fluorescence. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

Contact: **Fernando Figueroa**, (228) 688-2482, Fernando.Figueroa-1@nasa.gov

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Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters - The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive nonintrusive remote sensors and active nonintrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multispectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

Contact: **William St. Cyr**, (228) 688-1134, William.W.St_Cyr@nasa.gov

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Ground Test Facilities Technology - SSC is interested in new, innovative ground-test techniques to conduct a variety of required developmental and certification tests for space systems, stages/vehicles, subsystems, and components. Examples include better coupling and integration of computational fluid dynamics modeling tools focused on cryogenic fluids under extreme conditions of pressure and flow; advanced control strategies for non-linear multi-variable systems; structural modeling tools for ground-test programs; low-cost, variable altitude simulation techniques; and uncertainty analysis modeling of test systems.

Contact: **Robert Field**, (228)-688-3735, Robert.E.Field@nasa.gov

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Intelligent Monitoring and Diagnosis of Sensors, Processes, and Equipment in Rocket Test-Stands - We are interested in methodologies to embed intelligence into the various components of rocket engine test-stands. Of particular interest is the extraction of qualitative interpretations from sensor data in order to develop a qualitative assessment of the operation of the various components and processes in the system. The desired outcomes of the research are: (1) to develop intelligent sensor models that are self-calibrating, self-configuring, self- diagnosing, and self-evolving (2) to implement intelligent sensor fusion schemes that allow assessment, at the qualitative level, of the condition of the components and processes, and (3) to develop a monitoring and diagnostic system that uses the intelligent sensor models and fusion schemes to predict future events, to document the operation of the system, and to diagnose any malfunction quickly.

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Advanced Propulsion Systems Testing - Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single-stage-to-orbit rocket plane components, nuclear thermal, nuclear electric, and hybrids rockets. With a shrinking budget and longer lead times to develop new propulsion systems, new approaches must be developed to test future propulsion systems. The solution may be some combination of computational-analytical technique, advanced sensors and instrumentation, predictive methodologies, and possibly subscale tests of aspects of the proposed technology.

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Propulsion Test Research in Thermal and Acoustic Environment - Prediction and Control - Testing of large rocket engines produces damaging thermal and acoustic environments on facilities and the test articles. Advanced prediction and mitigation technologies for these environments are needed. Test programs for rocket propulsion systems employ very large flame deflectors and diffusers to control, deflect, cool, condition, and reduce the sound level of the plume. Innovative thermal protection tiles, coatings, materials, and insulation systems could result in significant savings.

Contact: **Peter Sulyma**, (228) 688-1920, Peter.R.Sulyma@nasa.gov

Marketing Strategies - The design and development of marketing strategies to effectively promote and transfer a variety of technologies to the commercial sector. The design and development of methods/techniques to accurately capture economic impact of technology transfer initiatives.

Contact: **John Bailey**, (228) 688-1660, John.W.Bailey@nasa.gov

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Earth Science Research Applications - The activities that will be conducted in this program support NASA's Science Mission Directorate and include the selection of relevant research and the validation and verification of remote sensing data acquired from a range of sensors that may lead to successful applications in five of twelve national applications areas: Agricultural Efficiency, Coastal Management, Community Growth, Homeland Security, and Disaster Management.

Agricultural Efficiency: A primary factor impacting production and yield on a given field is weather. Weather is a regional phenomenon that can be predicted from global indicators (i.e., El Nino). Improvements in agricultural competitiveness require better understanding of weather and climate, especially prediction of events with increasing accuracy and longer lead times. Solutions serving this application will draw directly from the results of NASA research and development of Earth science and technology that have potential to address weather and climate predictions and observations that can be integrated into local and regional decision support systems used in agriculture management. This national application draws upon, and contributes to, other information solutions associated with early warning for homeland security, water management and conservation, air quality management, carbon management, and invasive species management.

Coastal Management: The US has approximately 95,000 miles of coastline. The coastal zone provides resources for human and natural populations, unique ecosystems, and a range of economic activities. Currently, more than half the US human population lives in coastal counties. The carrying capacity of the coastal zone, effects from human impacts, alternations of food webs, and the mitigation of natural and anthropogenic hazards are of vital importance to the nation. Several interagency programs are developing operational observing systems to identify and monitor changes and potential threats within the coastal zone. Earth science-based solutions to this application involve the use of NASA's measurements, scientific knowledge, data assimilation techniques, and modeling into public and private decision tools to support coastal management, especially issues concerning harmful algal blooms, hypoxia, and coastal inundation. Measurements and information products include temperature, salinity, phytoplankton, hydrology, shoreline changes, bathymetry, and soil moisture. Assessments and predictive capability are needed to predict onset of events that may significantly affect human health, critical wetlands and ecosystems, and economic development.

Community Growth: Community growth for infrastructure development involves two aspects of urban expansion: 1) urban growth and its effect on local/regional environments; and 2) urban growth and its impact on the biophysical characteristics that influence human health. Forecasts and strategies for managing urban dynamics include value indexes for trading development for rural benefits that can assist regional development planners. Land protection, housing stock assessment, revitalization and in-fill development are considered important characteristics of the urban landscape. Forecasts or assessments of urban air quality are an important aspect of the urban/rural interface landscape. Remote detection and monitoring concentrations of ground level ozone, SOX,NOX, and particulate matter less than 10 microns, along with the mapping and visualization of trajectory and dispersion are important to protecting human health.

Homeland Security: Federal, State, and local governments are cooperating to prevent and reduce America's vulnerability to terrorism, minimize possible damage, and recover from attacks that do occur. Agencies are strengthening aviation and border security, preparing the defense against bioterrorism, improving information sharing, and deploying more resources to protect our critical infrastructure. NASA's measurements, observations, and modeling can provide data and information to Homeland Security networks to support risk assessments, vulnerability assessments, and mitigation assessments. Data and information can support decision making to ensure the adequacy of preparing for, preventing against, responding to and recovering from terrorist threats or attacks. Earth science-based solutions can serve this application by drawing on developments in several other applications, such as air quality, water management, public health, and disaster management. This application will focus especially on providing NASA data, information, and models to support governmental decision tools that identify, track, and forecast agents from anthropogenic disasters and terrorism introduced into the air and water.

Prediction of events, hazardous situations, and impacts with increasing accuracy and longer lead times is a significant part of this application.

Disaster Management: Community preparedness for disaster management involves assessments of vulnerability, risk, and response to short- lived phenomena in the Earth's atmosphere, land and oceans. Particular episodic events are of concern such as severe weather (thunderstorms, tornadoes, and hurricanes), as well as tsunamis, river flooding, plain/coastal flooding, volcanic ash, earthquakes, harmful ocean blooms and human-made disasters such as petroleum releases in rivers and oceans. Communities need an increased understanding of the effects of short-term events on the physical, chemical, and biological processes that interact to affect human safety, the environment, and the economy. Improved decision support systems are being developed that may address human life and property damage, meet the requirements of planners, early warning systems, first responders, and contribute to impact assessments, risk communication, mitigation, and implementation of relief efforts. Disaster management applications will evolve in cooperation with federal agencies such as FEMA. The applications will draw upon, and impact other national applications including coastal management, community growth, homeland security, public health and water management.

Contact: **Marco Giardino**, (228) 688-2739, Marco.J.Giardino@nasa.gov

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Remote Sensing in Chemical Oceanography - River plumes carry large loads of colored dissolved organic matter (CDOM), which strongly affect the optical properties of the water column in coastal regions. The presence of CDOM confounds the use of color satellite sensors for the determination of chlorophyll concentrations in seawater. The thrust of the research focuses on the study of changes in concentration and optical properties of CDOM along river plumes, and its effect upon the performance of biooptical algorithms used in the analysis of satellite imagery. My ultimate goal is to improve our understanding on the carbon cycling in coastal regions.

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Remote Sensing in Biological Oceanography - The general goals of this research are to develop remote-sensing techniques, to evaluate their utility in order to improve our understanding of the behavior of oceans, and to assist users with the implementation of operational systems. Specific goals include improving our capability to measure the primary productivity of oceans, their variability, and how they influence the marine food chain and global CO_2 and biogeochemical cycles. We are also interested in improving our capability to determine phytoplankton abundance and primary productivity based on remotely sensed data acquired by spacecraft and aircraft. Primary measurements include ocean color from multispectral scanners and imaging spectrometers; and sea-surface temperature from thermal scanners on aircraft, the advanced very-high resolution radiometer, and other sensors planned for spacecraft. Algorithm development to model marine productivity on global scales through remote sensing will be necessary.

Contact: **Richard L. Miller**, (228) 688-1904 , Richard.L.Miller@nasa.gov

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Remote Sensing Technology - The design and development of low-cost alternatives for multispectral imaging of earth processes especially those related to coastal environments. Design and coding in innovative image processing tools related to earth system science such as data visualization, archiving, and feature extraction.

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