LA FY2023 Request for Pre-Proposals for

NASA EPSCoR

Rapid Response Research (R3) Opportunity

TIMETABLE:

Notice of Opportunity Released: **Monday, August 1, 2022**
Notice of Intent (required) Due: **Monday, August 29, 2022**
Pre-Proposals due: Friday, September 30, 2022
Anticipated Notification of Selection(s): **October 2022**
Anticipated Selected Proposals due to NASA: **December 15, 2022**

LA EPSCoR

LOUISIANA ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

Louisiana Board of Regents
1201 North Third Street, Suite 6-200
Baton Rouge, Louisiana 70802
(225) 342-4253

I. PROGRAM DESCRIPTION

I.A Overview

NASA's Office of STEM Engagement (OSTEM), anticipates soliciting proposals for the fiscal year 2023 (FY23) NASA Established Program to Stimulate Competitive Research (EPSCoR) Rapid Response Research (R3) program during the last quarter of 2022.

The NASA Authorization Act for Fiscal Year 1993, Public Law 102-588, and its Reauthorization Act of 2017 (Public Law 114-329 Section 103) authorizes NASA to initiate NASA EPSCoR to strengthen the research capability of jurisdictions that have not historically participated equably in competitive aerospace research activities. The goal of NASA EPSCoR is to provide funding that will enable jurisdictions to develop a research enterprise directed toward long-term, self-sustaining, nationally-competitive capabilities in aerospace and aerospace-related research. This capability will, in turn, contribute to the jurisdiction's economic viability and expand the nation's base for aerospace research and development.

The NASA EPSCoR R3 is a collaborative effort between NASA EPSCoR in collaboration with the Aeronautics Research Mission Directorate (ARMD), Science Mission Directorate (SMD) Planetary Science Division, Biological and Physical Sciences Division, Astrophysics Division (APD), Computational and Information Sciences and Technology Office (CISTO), Earth Science Division (ESD), and the Human Exploration and Operations Mission Directorate (HEOMD) Commercial Space Capabilities Office (CSCO), along with the Marshall Spaceflight Center (MSFC), Ames Research Center(ARC),and the Office of the Chief Health and Medical Officer (OCHMO). The goals of R3 are to provide a streamlined method to address research issues important to NASA, and to enable NASA EPSCoR researchers to work with NASA to solve research issues impacting the Agency's programs/missions.

This La NASA EPSCoR R3 Pre-Proposal solicitation seeks proposals from Louisiana researchers that explicitly detail an answer to a specific research focus area as listed in Appendix A of this solicitation. These proposals are not part of an open research competition and a generalized project in the area of the task is not a compliant response. **Each NOI / Pre-proposal can only address one research focus area and each PI can only submit one Pre-proposal. There is no restriction on the number of Pre-proposals that can be submitted per research focus area or by a particular institution.**

Pre-Proposals will be accepted only from researchers that have submitted a required Notice of Intent (NOI) as described in section II.A. The NOI must explicitly identify the task to be addressed as well as the NASA point of contact (POC) who you discussed the relevance of your proposed effort; include the date of your discussion. **The NOI must use the current version templates attached here and must be submitted to the Louisiana Board of Regents EPSCoR office through their online system, https://laepscor.piestar-rfx.com/opportunities, by Monday, August 29, 2022**.

The Pre-Proposal must use the current version template attached here and conform to all technical and budgetary requirements. Note that your science budget is limited to a maximum of $90,000 for a one-year period of performance. No cost-share is required, and the Board of Regents will not provide a match. Note also that NASA EPSCoR funding is intended to strengthen the aerospace research infrastructure within Louisiana. **Any NASA EPSCoR funding being sent outside of Louisiana will need to be fully justified as to how this funding results in new or improved research infrastructure IN Louisiana.** Without a full justification detailing the benefit to the state, it is unlikely the proposal will review well. Also note that no funding can be sent to a non-EPSCoR jurisdiction institution. Further, see Eligibility requirements in section I.B. **The pre-proposals must be submitted to the Louisiana Board of Regents EPSCoR office through their online system, https://laepscor.piestar-rfx.com/opportunities, by Friday, September 30, 2022.**

The Pre-Proposals will be reviewed by an external panel and for FY23 the six (6) most meritorious pre-proposals will be selected for further development. Selected proposals will be developed in collaboration with the LaSPACE/EPSCoR Management team at LSU and submitted to NASA by the LA Board of Regents with the Louisiana Space Grant / NASA EPSCoR Director, T. Gregory Guzik, as Principal Investigator (PI). The Pre-Proposal Principal Investigator will, in turn, be the Science Investigator (Science-I) on the LA BOR submission to NASA. The PI will provide leadership and administrative direction for the team from an oversight role. The Science Investigator (Sci-I) is responsible for the scientific direction and day-to-day management of the proposed work. The PI and Sci-I work together to ensure compliance with NASA requirements and the timely reporting of the team's progress and accomplishment of its work.

It is anticipated that the proposal will be submitted by the PI through the Louisiana Board of Regents by December 15, 2022. However, the precise due date has not yet been released by NASA. In the event the proposal is selected by NASA for award, NASA will issue the award to the Board of Regents and the BoR will issue a subaward to the Science Investigator's institution.

I.B Eligibility

Individuals holding a tenured, tenure-track, or research faculty position at any of Louisiana's public institutions of higher education, as well as accredited independent institutions of higher education that are members of the Louisiana Association of Independent Colleges and Universities, are eligible to submit pre-proposals under this solicitation. Individuals who are not employed by these institutions may serve as consultants; however, they may not be listed as investigators and must not be cited on the cover sheet of the pre-proposal. **Direct labor costs will be allowed exclusively for faculty, staff, students, and visiting researchers at Louisiana Institutions. Proposals which include funding for individuals employed outside of Louisiana will be rejected for non-compliance.** A faculty member may submit only one pre-proposal in response to this solicitation as Principal Investigator (PI) but may be a co-investigator on additional pre-proposals. Also see section I.E for other funding restrictions.

I.C Certifications, Waivers, and Institution Letter of Commitment

When preparing a proposal that involves the use of human subjects, animals, hazardous materials, select agents, recombinant DNA, or any other issue requiring institution certification, waiver, or approval the proposers will need to address applicable compliance issues in advance. **All necessary internal approvals from the lead and collaborator institutions must be secured and documented in writing.** An appropriate letter template is provided in Appendix C. This template should be modified for the lead and each collaborator institution and submitted no later than 5 weeks following the pre-proposal due date. Even though extra time is allowed to submit the commitment document, the letter is considered to be part of the pre-proposal and will be included as an appendix in the subaward contract from the Board of Regents. Failure to provide this commitment in the approved time frame may result in disqualification and selection of a runner-up proposal at an alternate institution.

I.D Financial Consideration and Restrictions

Based on the funding levels stipulated in the previous NASA EPSCoR R3 NOFO, each proposal may request NASA funding of $100,000 for a one-year project. No cost sharing is required by NASA and the BoR will not provide cost sharing. Of the $100,000 in NASA funds, $10,000 will be reserved for management of the project; therefore, for each proposed research project, the Science PI may request a maximum of $90,000 in NASA funds.

Note that this program is designed to improve aerospace research capability in Louisiana and, consequently, funding should support effort within the state. Note that Subawards using NASA EPSCoR funds can only be issued to institutions in NASA EPSCoR jurisdictions. Funding allocated outside of the state must be justified in detail and shown how such an expenditure will significantly enhance aerospace research infrastructure in Louisiana. **Direct labor costs will be allowed exclusively for faculty, staff, students, and visiting researchers at Louisiana Institutions.**

Note that this Pre-Proposal solicitation is for new NASA EPSCoR R3 projects and not for renewals of currently funded R3 awards. Renewals of existing awards will be addressed separately. Note that NASA EPSCoR funds will not be used to support renewal projects so any such proposal will require a letter from the appropriate NASA Office committing to provide the project support funds.

The following restrictions were specifically identified in the FY22 NASA EPSCoR R3 Notice of Funding Opportunity (NOFO) and are anticipated will apply as well to the FY23 R3 NOFO. Per the NASA Guidebook for Proposers, Title 2 CFR Parts 200 and 1800, and the NASA Grant and Cooperative Agreement Manual (GCAM), the following restrictions govern the use of the NASA-provided EPSCoR funds:

- Funds shall not be used to fund research carried out by non-U.S. institutions. However, U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources. Subject to export control restrictions, a foreign national may receive remuneration through a NASA award for the conduct of research while employed either full or part time by a U.S. institution. For additional guidance on foreign participation, see Section 3.2 of the NASA Guidebook for Proposers and the NASA FAR Supplement (NFS) Part 1835.016-70.

- Domestic travel, defined as travel that does not require a passport, does not have a funding limit and shall be appropriate and reasonable to conduct the proposed research.
- NASA EPSCoR funding shall not be used to purchase general purpose equipment, e.g. desktop workstations, office furnishings, reproduction and printing equipment as a direct charge. Special purpose equipment purchases (i.e., equipment that is used only for research, scientific, and technical activities directly related to the proposed research activities) are allowed and can be reflected as a direct charge as per cost principles cited in the GCAM Appendix D, Equipment and Other Property. Per 2 CFR 200.439, special purchase equipment items with a unit cost of $5,000 or more must have the prior written approval of the Federal awarding agency (i.e., the NASA Grants Officer).
- **NASA EPSCoR funding shall not be used to support NASA civil service participation (i.e., full time equivalents (FTEs)) in a research project**. That funding is provided through a funding vehicle between the jurisdiction and NASA Center, such as a Space Act Agreement or other reimbursable agreement. NASA EPSCoR may set aside funding from an award to send to a Center for contractor support (including travel) and/or services as identified by the proposer.
- **NASA EPSCoR funds shall be expended only on NASA EPSCoR institutions**. Further, La BoR funds shall be expended only on Louisiana institutions. If a Co- Investigator (Sc-I/Co-I) with an NASA EPSCoR award transfers to a non-EPSCoR institution, the EPSCoR funding amount, or the portion of it that remains unobligated at the time of Sc-I/Co-I transfer, shall not be transferred to the non-EPSCoR institution.
- All proposed funds shall be allowable, allocable and reasonable. Funds may only be used for the EPSCoR project. All activities charged under indirect cost shall be allowed under the cost principles included in 2 CFR 200.
- Grants and Cooperative Agreements shall not provide for the payment of fee or profit to the recipient.
- Non-Federal entities may use one of the methods of procurement as prescribed in 2 CFR 200.320. As defined in 2 CFR 200.67, the micro-purchase threshold for acquisitions of supplies or services made under grant and cooperative agreement awards issued to institutions of higher education, or related or affiliated nonprofit entities, or to nonprofit research organizations or independent research institutes, is $10,000; or such higher threshold as determined appropriate by the head of the relevant executive agency and consistent with audit findings under chapter 75 of Title 31, United States Code, internal institutional risk assessment, or State law.
- Unless as otherwise directed in 2 CFR 200, for changes to the negotiated indirect cost rate that occur throughout the project period, the proposer/recipient shall apply the rate negotiated for that year, whether higher or lower than at the time the budget and application was awarded.
- Proposals shall not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

- Cost sharing is not required, however, any funds used for voluntary matching or cost- sharing shall be allowable under 2 CFR 200.
- Procurement contracts shall not be awarded in conjunction with this solicitation.
- The proposer shall use one of the methods of procurement as prescribed in 2 CFR 200.320. As defined in 2 CFR 200.67, the micro-purchase threshold for acquisitions of supplies or services made under grant and cooperative agreement awards issued to institutions of higher education, or related or affiliated nonprofit entities, or to nonprofit research organizations or independent research institutes is $10,000; or such higher threshold as determined appropriate by the head of the relevant executive agency and consistent with audit findings under chapter 75 of Title 31, United States Code, internal institutional risk assessment, or State law.

I.E Assessment of Pre-proposals and Preparation of Full Proposals

We hope to notify the PIs of the pre-proposals selected by the panel by late October; we plan to also provide feedback from the panel reviewers and a plan for revisions and development of the final proposal. The PI of a successful pre-proposal is required to work closely with the NASA EPSCoR Project Director and Assistant Director (T. Gregory Guzik and Colleen H. Fava) and BoR staff to prepare the final proposal for submission by the BoR to NASA. Note that the Louisiana NASA EPSCoR Director, T. Gregory Guzik, will serve as the managing Principal Investigator (PI) for the award, providing leadership and administrative direction for the team from an oversight role. The Pre-Proposal PI will, in turn, serve as the Science-I and will be responsible for the scientific direction and day-to-day management of the proposed work. Together the PI and Science-I will be responsible for confrming to NASA / BoR requirements and reporting on project progress to the BoR and NASA. This organizational structure should be considered when developing the Pre-Proposal Management Plan. Full proposals completed by this team (with budgets approved by the Science-PI's office of sponsored programs) will be due at the BoR on a date to be determined based on the due date for proposal submission to NASA (a minimum of 5 business days prior to the NASA due date).

All revisions to the pre-proposal will be made based on programmatic expertise from the LA NASA EPSCoR Management team and/or driven by recommendations from the review panel. **Substantial changes driven by the PI or PI's institution will not be allowed.** Significant change requests could result in deselection and reducing the pre-proposal priority.

I.F. Timetable *(Dates may change, subject to requirements of FY2023 R3 NOFO)*

Monday August 29, 2022	Pre-Proposal Notice of Intent due
Wednesday, September 21, 2022	Last day to submit questions about this solicitation
Friday, September 30, 2022	Pre-proposals due
Late October 2022	Notice of LA Selection

I.G. Questions about this solicitation

Specific questions concerning this solicitation and the requirements set forth herein should be directed in writing to Ms. Jessica Patton, Federal Programs Administrator, by email to jessica.patton@laregents.edu. Questions will be accepted and answered on an ongoing basis through Wednesday, September 21th. Questions regarding this solicitation sent to anyone other than Ms. Patton or after the Q&A period closing date will not be answered.

A running compilation of all questions asked about this RFP and all answers provided in response to those questions will be periodically posted on the BoR website at https://web.laregents.org.

I.H. RFP Downloads

Files associated with this RFP can be found on the Louisiana Board of Regents' Office of Sponsored Programs website (https://web.laregents.org/) and on the Louisiana NASA EPSCoR website: http://lanasaepscor.lsu.edu/rapid-response-research/. These guidelines, the notice of intent, the pre-proposal template, and the budget form will all be available to download. Additionally, several critical supporting documents have been posted to the Louisiana NASA EPSCoR website page linked above.

II. PRE-PROPOSAL SUBMISSION AND FORMAT REQUIREMENTS

II.A Notice of Intent (Required)

Before a pre-proposal will be accepted, a notice of intent (NOI) in portable document format (pdf) must be submitted by the PI no later than the close of business (4:30 p.m.) on **Monday, August 29, 2022. The NOI form included in this document must be used (Appendix B). No other NOI formats will be accepted.** Note that the NOI must identify the specific task with the Research Identifier Number from Appendix A that will be address by the pre-proposal, plus the name of the NASA contact with whom the PI discussed the relevance of the proposed research and the date of said discussion. The NOI must be submitted to the Louisiana Board of Regents EPSCoR office through their online system, https://laepscor.piestar-rfx.com/opportunities. Proposal titles and exact team composition may be modified for the final proposal.

II.B Type Size and Formatting

Formatting guidelines for this proposal must follow the **NASA Guidebook for Proposers.**
Standard proposal format requirements are copied here

- Required page size is 8.5x11 inches.
    - Pages shall have at least 1-inch (2.5 cm) margins on all sides.
    - Proposals shall adhere to the page limits listed in the NOFO.
- Proposals shall be single-spaced, in 12-point font, English-language text, and formatted using one column.
- The font size for symbols in equations shall be consistent with this guideline.
    - Proposers may not adjust or otherwise condense a font or line from its default appearance.
- While text within figures and tables may use a smaller font, it shall, in the reviewers' judgment, be legible without magnification.
- Figure and table captions shall follow the same font requirements and restrictions as the main proposal text.
- Expository text necessary for the proposal may not be located solely in figures or tables, or in their captions.
- Units shall report in the common standard for the relevant discipline.
    - Fold-out pages, illustrations, and/or photographs are allowed, for the display of unique and critically essential proposal data. Fold-out pages will count as multiple pages, dependent on the number of fold-out sections, against the required page limit.
- For example, a three-section fold-out is considered equal to three pages counted towards the page limitation.
- Only non-proposal material, e.g., page numbers, section titles, disclaimers, are permitted in headers and footers.
- Proposals shall include references to published papers and other products to demonstrate, for example, that the methodology has passed peer review, but shall not include references to materials outside the proposal (e.g., published articles and sites on

the internet) for information or material needed to either complete or understand the proposal. Peer reviewers have no obligation to read materials outside of the proposal

II.C Pre-Proposal Elements

Required elements of the proposal are described below and shall be submitted as one or more PDF documents that are uploaded for proposal submission. All information needed to respond to this solicitation is contained in this announcement and in the NASA Guidebook for Proposers Please identify in the Proposal Title the task the applicant is proposing against (See Appendix A of this solicitation).

A proposal template with further details about the pre-proposal elements is provided in Appendix C. **We strongly suggest** you use this template to ensure all requirements are met and to allow for a greater uniformity of submissions. Note that this list of elements, and the Appendix C template, is based on the FY22 NASA EPSCoR R3 NOFO which is anticipated to be very similar to the FY23 R3 NOFO. However, development of the proposal for submission to NASA will confirm to the requirements listed in the FY23 R3 NOFO after it is released.

REQUIRED CONSTITUENT PARTS OF A PROPOSAL (in order of assembly)	**PAGE LIMIT**
Proposal Cover Page	Pre-proposal cover page is included in the template at the end of this document
Proposal Summary (abstract)	4,000 characters including spaces
Data Management Plan	4,000 characters, including spaces
Table of Contents	As needed
1. Scientific/Technical/Management Plan	2 ½ *
2. References and Citations	As needed
3. Biographical Sketches for:	
Principal Investigator (PI)	2
The Science Investigator (Sc-I)	2
Each Co-Investigator (Co-I)	1
4. Current and Pending Support	As needed
5. Statements of Commitment and Letters of Support	As needed
Institution Letter[1]	Required by LA NASA EPSCoR, see template
6. Proposal Budget Justification	As needed
The Table of Personnel and Work Effort	As needed
Facilities and Equipment	As needed
Cost Methodology	As needed
Budget Narrative and Details	
Includes proposed budget, itemized list detailing expenses within major budget categories, detailed subawards and summary of personnel (User's Guide section 3.18 and Appendix C). See template for further details.	
Budget Form (single year)	Forms as provided in template
** includes all illustrations, tables, and figures, where each "n-page" fold-out counts as n-pages and each side of a sheet containing text or an illustration counts as a page.*	

[1]**Institution Letter:** All necessary internal approvals from the lead and collaborator institutions must be secured and documented in writing. A letter (see sample in the attachments section of these guidelines) signed by the authorized organization representative certifying that all reviews and waivers relevant to the proposal have been completed must be submitted with the proposal.

Required elements of the proposal are described in the table as well as the attached proposal template. The proposal shall be submitted as one or more PDF documents that are uploaded for proposal submission. In the NASA Guidebook for Proposers, please refer to Section 3.6 (provides guidelines for style formats) and Section 3.7 (provides guidelines for proposal content).

Note for Selected Proposals: NASA is implementing a process to collect demographic data from grant applicants for the purpose of analyzing demographic differences associated with its award processes. Information collected will include name, gender, race, ethnicity, disability status, and citizenship status. Submission of the information is voluntary and is not a precondition of award.

II.D Evaluation Criteria

Proposals will be evaluated based on the proposed research approach (intrinsic merit) that addresses the research presented in the appendices, management, and budget. Successful R3 proposals shall provide sound contributions to both immediate and long-term scientific and technical needs of NASA as explicitly expressed in current NASA documents and communications. **Proposals will be evaluated based on the following criteria: Intrinsic Merit, Management, and Budget Justification: Narrative and Details.** The bulleted lists after each criterion below should not be construed as any indication of priority or relative weighting. Rather, the bullets are provided for clarity and facilitation of proposal development.

II.D.1 Intrinsic Merit (65% of score)

- Proposed Research should have clear goals and objectives; address the expectations described in the announcement; and be consistent with the budget, effectively utilize the program management, and demonstrate a high probability for successful implementation.
- Proposals shall provide a narrative of the proposed research activity, including the scientific and/or technical merit of the proposed research, unique and innovative methods, approaches, concepts, or advanced technologies, and the potential impact of the proposed research on its field.
- Existing Research Proposals shall provide baseline information about current research activities in the proposed research area currently funded under NASA EPSCoR R3.

II.D.2 Management (20% of score)

- The proposal Project Management shall describe the proposed program management structure in reasonable detail.
- Proposals shall describe the use of NASA content, people, or facilities in the execution of the research activities. They should describe current and/or previous interactions, partnerships, and meetings with NASA researchers, engineers, and scientists in the area of the proposed research, and discuss how future partnerships between the institution's researchers and personnel at the Mission Directorates and/or Centers will be fostered. The name(s) and

title(s) of NASA researchers with whom the proposers will partner shall be included. NASA shall consider the utilization of NASA venues for recipients to publish their accomplishments.

II.D.3 Budget (15% of score)

- The proposed budget shall be adequate, appropriate, reasonable, and realistic, and demonstrate the effective use of funds that align with the content and text of the proposed project. Preparation guidelines for the budget can be found in the NASA Guidebook for Proposers, Section 3.18 and appendix C.
- The budget will be evaluated based upon the clarity and reasonableness of the funding request. A budget narrative shall be included that discusses relevant budgetary issues such as the extent and level of jurisdiction, industrial, and institutional commitment and financial support, including resources (staff, facilities, laboratories, indirect support, waiver of indirect costs, etc.).

II.E Submission of the Pre-Proposal

The pre-proposal must be submitted by the PI to the Board of Regents through the LA EPSCoR online submission system, https://laepscor.piestar-rfx.com/opportunities, no later than the close of business (4:30 p.m.) **Friday, September 30, 2022**. Deadlines listed in the RFP are absolute. The proposal submission system will automatically close at 4:30 p.m. Central on the deadline date.

All proposals must include a letter from the sponsored programs office indicating that the proposal has been reviewed and approved by the submitting institution's authorized representative. In addition, when preparing a proposal that involves the use of human subjects, animals, hazardous materials, select agents, recombinant DNA, or any other issue requiring institution certification, waiver or approval the proposers will need to address applicable compliance issues in advance. All necessary internal approvals from the institutions must be secured and documented in the approval letter. A letter model is provided in the Appendix C proposal template.

APPENDIX A

List of NASA Mission Directorate and Center Priority Tasks for the FY23 NASA EPSCoR R3 Solicitation

Table 1: Research Focus Area and Point of Contacts

<table>
<tr><th colspan="3">Aeronautic Research Mission Directorate / Advanced Air Vehicles Program / Revolutionary Vertical Lift Technology Project</th></tr>
<tr><th>Research Focus Area</th><th>Point of Contact</th><th>Id</th></tr>
<tr><td>Safety of Electro-mechanical Powertrains for Electrified Vertical Takeoff and Landing (eVTOL) Vehicles</td><td>Timothy Krantz,
timothy.l.krantz@nasa.gov</td><td>A-001</td></tr>
<tr><td>High power density power grids, power electronics, motors, and electro-mechanical powertrains</td><td>Timothy Krantz,
timothy.l.krantz@nasa.gov</td><td>A-002</td></tr>
<tr><td>High reliability and robustness for safety-critical propulsion systems including but not limited to: a) arc fault protection; b) EMI/filtering; c) fault tolerant architectures; d) power management</td><td>Timothy Krantz,
timothy.l.krantz@nasa.gov</td><td>A-003</td></tr>
<tr><td>Novel thermal management of the propulsion components and/or of the propulsion system</td><td>Timothy Krantz,
timothy.l.krantz@nasa.gov</td><td>A-004</td></tr>
<tr><td>Application of advanced materials and manufacturing to achieve above 3 items.</td><td>Timothy Krantz,
timothy.l.krantz@nasa.gov</td><td>A-005</td></tr>
<tr><td>Development of Characterization Techniques to Determine Key Composite Material Properties for the LS-DYNA MAT213 Model</td><td>Robert Goldberg
robert.goldberg@nasa.gov
Justin Littell
justin.d.littell@nasa.gov
Mike Pereira
mike.pereira@nasa.gov</td><td>A-006</td></tr>
<tr><th colspan="3">Astrophysics</th></tr>
<tr><th>Research Focus Area</th><th>Point of Contact</th><th>Id</th></tr>
<tr><td>Astrophysics Technology Development</td><td>Hashima Hasan hhasan@nasa.gov
Mario Perez
mario.perez@nasa.gov</td><td>A-007</td></tr>
</table>

Biological and Physical Sciences

Research Focus Area	Point of Contact	Id
Fundamental Physics - Quantum Science	Brad Carpenter bcarpenter@nasa.gov	B-001
Complex Fluids/Soft Matter - Soft Matter-Based Materials	Brad Carpenter bcarpenter@nasa.gov	B-002
Fluid Physics - Oscillating Heat Pipes (OHP)	John McQuillen john.b.mcquillen@nasa.gov	B-003
Combustion Science - High Pressure Transcritical Combustion (HPTC)	Daniel L. Dietrich Daniel.L.Dietrich@nasa.gov	B-004
Materials Science - Extraction and Utilization of Materials from Regolith	Michael SanSoucie michael.p.sansoucie@nasa.gov	B-005
Effects of Regolith Simulant on Growth, Survival, and Fitness of Animal Models	Sharmila Bhattacharya SpaceBiology@nasaprs.com	B-006
Effects of Space-Associated Stressors on Plant and Microbial Interactions	Sharmila Bhattacharya SpaceBiology@nasaprs.com	B-007

Center for Design and Space Architecture

Research Focus Area	Point of Contact	Id
Repair, Manufacturing, And Fabrication (RMAF) Facility for the Common Habitat Architecture	Robert L. Howard, Jr. robert.l.howard@nasa.gov	C-001

Commercial Space Capabilities

Research Focus Area	Point of Contact	Id
In-Space Welding	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-002
Materials and Processes Improvements for Chemical Propulsion State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-003
Materials and Processes Improvements for Electric Propulsion State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-004
Improvements to Space Solar Power State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-005
Small Reentry Systems	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-006
Other Commercial Space Topic	Warren Ruemmele warren.p.ruemmele@nasa.gov	C-007

Computational and Information Sciences and Technology Office (CISTO) Program		
Research Focus Area	**Point of Contact**	**Id**
Document the Current State-of-the-Art/Practice of Ethical Decision Making by Humans in Operational Systems.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-008
Explore and document the parameters in play in the transition of ethical decision making from humans to autonomous systems.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-009
Current & projected autonomous performance capabilities and limitations.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-010
Current & projected autonomous performance capabilities and limitations.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-011
Policy/Standards/Law Making Assessment.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-012

Design, Development, & Implementation of Highly Automated / Autonomous Systems to abide by ethical decision-making policy, standards, guidelines, and laws.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-013
Societal ramifications of ethical decision-making models.	James Harrington james.l.harrington@nasa.gov Edward McLarney Edward.l.mclarney@nasa.gov Yuri Gawdiak yuri.o.gawdiak@nasa.gov Nikunj Oza nikunj.c.oza@nasa.gov	C-014

Earth Science

Research Focus Area	Point of Contact	Id
Synthesis activities that combine multiple data sets to analyze the vulnerability and resilience of Arctic and boreal ecosystems in the Arctic Boreal Vulnerability Experiment (ABoVE) domain, across North America, and across the circumpolar region.	Allison K. Leidner allison.k.leidner@nasa.gov Laura Lorenzoni laura.lorenzoni@nasa.gov	E-001
Research that contributes to furthering our understanding of climate change impacts in high-latitude drainage basins, including coastal zones, and advance humanity's understanding of the potential feedback(s) of naturally- or anthropogenically-driven change in such zones.	Allison K. Leidner allison.k.leidner@nasa.gov Laura Lorenzoni laura.lorenzoni@nasa.gov	E-002
Integration of research results and remote sensing data from ABoVE into a coherent modeling framework to diagnose and predict the impacts of environmental change on ecosystem dynamics and the consequent impacts on ecosystem services and society.	Allison K. Leidner allison.k.leidner@nasa.gov Laura Lorenzoni laura.lorenzoni@nasa.gov	E-003
Filling critical research gaps in our understanding of how environmental change impacts the dynamics of boreal and Arctic ecosystems within the ABoVE domain.	Allison K. Leidner allison.k.leidner@nasa.gov Laura Lorenzoni laura.lorenzoni@nasa.gov	E-004

Entry Systems Modeling Project

Research Focus Area	Point of Contact	Id
Entry Systems Modeling - Nitrogen/Methane Plasma Experiments Relevant to Titan Entry	Aaron Brandis aaron.m.brandis@nasa.gov	E-005
Entry Systems Modeling - Thermal Conductivity Heat Transfer of Porous TPS Materials	Aaron Brandis aaron.m.brandis@nasa.gov	E-006
Entry Systems Modeling - Deposition of Ablation/Pyrolysis Products on Optical Windows	Aaron Brandis aaron.m.brandis@nasa.gov	E-007
Entry Systems Modeling - Predictive Modeling of Plasma Physics Relevant to High Enthalpy Facilities	Aaron Brandis aaron.m.brandis@nasa.gov	E-008

Human Research Program (Space Radiation, Precision Health Initiative)

Research Focus Area	Point of Contact	Id
Tissue and Data sharing for space radiation risk and mitigation strategies	Robin Elgart shona.elgart@nasa.gov Janice Zawaski janice.zawaski@nasa.gov	H-001
Space radiation sex-differences	Robin Elgart shona.elgart@nasa.gov	H-002
Compound screening techniques to assess efficacy in modulating responses to radiation exposure	Robin Elgart shona.elgart@nasa.gov Brock Sishc brock.j.sishc@nasa.gov	H-003
Inflammasome role in radiation-associated health impacts	Robin Elgart shona.elgart@nasa.gov Janapriya Saha janapriya.saha@nasa.gov	H-004
Portable, non-ionizing radiation based, high resolution disease detection imaging	Robin Elgart shona.elgart@nasa.gov Janice Zawaski janice.zawaski@nasa.gov	H-005
Pilot studies to adopt terrestrial precision health solutions for astronauts	Corey Theriot corey.theriot@nasa.gov Carol Mullenax carol.a.mullenax@nasa.gov	H-006

Pilot studies to demonstrate the utilization of full systems biology approaches in addressing human spaceflight risks	Corey Theriot corey.theriot@nasa.gov Carol Mullenax carol.a.mullenax@nasa.gov	H-007
Development and elaboration of Functional aids and testing paradigms to measure activity for use by parastronauts during spaceflight	Victor S. Schneider vschneider@nasa.gov Kristin Fabre kristin.m.fabre@nasa.gov	H-008
Evaluation space capsule and spacesuit activity in stable and fit lower or upper extremity amputees and compare their responses to non-amputee fit individuals	Victor S. Schneider vschneider@nasa.gov Kristin Fabre kristin.m.fabre@nasa.gov	H-009

Planetary Science

Research Focus Area	Point of Contact	Id
High-Temperature Subsystems and Components for Long-Duration (months) Surface Operations	Adriana Ocampo aco@nasa.gov	P-001
Aerial Platforms for Missions to Measure Atmospheric Chemical and Physical Properties	Adriana Ocampo aco@nasa.gov	P-002
Extreme Environment Aerobot	Adriana Ocampo aco@nasa.gov	P-003

Planetary Protection

Research Focus Area	Point of Contact	Id
Addressing Knowledge Gaps in Planetary Protection for Crewed Mars Mission Concepts	J Nick Benardini James.N.Benardini@nasa.gov	P-004
Natural Transport of Contamination on Mars	J Nick Benardini James.N.Benardini@nasa.gov	P-005

Aeronautic Research Mission Directorate / Advanced Air Vehicles Program / Revolutionary Vertical Lift Technology Project

Aeronautic Research Mission Directorate
NASA Glenn Research Center

POC: Timothy Krantz, timothy.l.krantz@nasa.gov

Research Focus Area: Safety of Electro-mechanical Powertrains for Electrified Vertical Takeoff and Landing (eVTOL) Vehicles
Research Identifier**:** **A-001**

Research Focus Area: **H**igh power density power grids, power electronics, motors, and electro-mechanical powertrains
Research Identifier**:** **A-002**

Research Focus Area: High reliability and robustness for safety-critical propulsion systems including but not limited to a) arc fault protection; b) EMI/filtering; c) fault tolerant architectures; d) power management.
Research Identifier**:** **A-003**

Research Focus Area: Novel thermal management of the propulsion components and/or of the propulsion system.
Research Identifier**:** **A-004**

Research Focus Area: Application of advanced materials and manufacturing to achieve above
Research Identifier**:** **A-005**

Research Overview:

With their unique ability to take off and land from any spot, as well as hover in place, vertical lift vehicles are increasingly being contemplated for use in new ways that go far beyond those considered when thinking of traditional helicopters. NASA's Revolutionary Vertical Lift Technology (RVLT) project is working with partners in government, industry, and academia to develop critical technologies that enable revolutionary new air travel options, especially those associated with Advanced Air Mobility (AAM) such as large cargo-carrying vehicles and passenger-carrying air taxis.

These new markets are forecast to rapidly grow during the next ten years, and the vertical lift industry's ability to safely develop and certify innovative new technologies, lower operating costs, and meet acceptable community noise standards will be critical in opening these new markets.

NASA is conducting research and investigations in Advanced Air Mobility (AAM) aircraft and operations. AAM missions are characterized by ranges below 300 nm, including rural and urban operations, passenger carrying as well as cargo delivery. Such vehicles will require increased automation and innovative propulsion systems, likely electric or hybrid-electric that may need advanced electro-mechanical powertrain technology.

Research Focus: Analytical and/or experimental fundamental research is sought for power grids and electro–mechanical powertrains for electrified vertical takeoff and landing (eVTOL) vehicles. The focus is safety, and overall goals are to obtain high power-to-weight with long life and higher reliability than the current state of the art. The scope of interest includes high-voltage (>540 V) bus and high-voltage DC protection devices, electric motors and associated power electronics, and mechanical or magnetically-geared powertrains and the associated sub-components and materials technologies. Research topics of particular interest are those that focus on:

1) high power density power grids, power electronics, motors, and electro-mechanical powertrains.
2) high reliability and robustness for safety-critical propulsion systems including but not limited to a) arc fault protection; b) EMI/filtering; c) fault tolerant architectures; d) power management.
3) novel thermal management of the propulsion components and/or of the propulsion system.
4) application of advanced materials and manufacturing to achieve items 1), 2) or 3).

The target application is eVTOL vehicles sized to carry four to six passengers with missions as described in References 1-6.

Reference 7 discusses Urban Air Mobility Electric Motor Winding Insulation Reliability Challenges.

This research opportunity is relevant to aerospace propulsion and is of mutual interest to NASA, FAA, DoD, and the US vertical lift vehicle industry.

References:

1) Silva, C.; Johnson, W.; and Solis, E. "Multidisciplinary Conceptual Design for Reduced-Emission Rotorcraft." American Helicopter Society Technical Conference on Aeromechanics Design for Transformative Vertical Flight, San Francisco, CA, January 2018.
2) Johnson, W.; Silva, C.; and Solis, E. "Concept Vehicles for VTOL Air Taxi Operations." American Helicopter Society Technical Conference on Aeromechanics Design for Transformative Vertical Flight, San Francisco, CA, January 2018.
3) Patterson, M.D.; Antcliff, K.R.; and Kohlman, L.W. "A Proposed Approach to Studying Urban Air Mobility Missions Including an Initial Exploration of Mission Requirements." American Helicopter Society 74th Annual Forum, Phoenix, AZ, May 2018.
4) Silva, C.; Johnson, W.; Antcliff, K.R.; and Patterson, M.D. "VTOL Urban Air Mobility Concept Vehicles for Technology Development." AIAA Paper No. 2018-3847, June 2018.
5) Antcliff, K. Whiteside, S., Silva, C. and Kohlman, L. "Baseline Assumptions and Future Research Areas for Urban Air Mobility Vehicles," AIAA Paper No. 2019-0528, January 2019.
6) Silva, C., and Johnson, W. "Practical Conceptual Design of Quieter Urban VTOL Aircraft." Vertical Flight Society 77th Annual Forum, May 2021.
7) Tallerico, T., Salem, J., Krantz, T. and Valco, M., "Urban Air Mobility Electric Motor Winding Insulation Reliability: Challenges in the Design and Qualification of High Reliability Electric Motors and NASA's Research Plan." NASA TM-20220004926, 2022.

Intellectual Property Rights: All data and analysis methods will be publicly available and no intellectual property rights will be assigned to any of the parties involved in this research.

Research Focus Area: Development of Characterization Techniques to Determine Key Composite Material Properties for the LS-DYNA MAT213 Model

Research Identifier**:** **A-006**

POC: Robert Goldberg robert.goldberg@nasa.gov
Justin Littell justin.d.littell@nasa.gov
Mike Pereira mike.pereira@nasa.gov

Research Overview: Overview of MAT213 - MAT213 is an orthotropic macroscopic three-dimensional material model designed to simulate the impact response of composites which has been implemented in the commercial transient dynamic finite element code LS-DYNA [1-5]. The material model is a combined plasticity, damage and failure model suitable for use with both solid and shell elements. The deformation/plasticity portion of the model utilizes an orthotropic yield function and flow rule. A key feature of the material model is that the evolution of the deformation response is computed based on input tabulated stress-strain curves in the various coordinate directions.

The damage model employs a semi-coupled formulation in which applied plastic strains in one coordinate direction are assumed to lead to stiffness reductions in multiple coordinate directions. The evolution of the damage is also based on tabulated input from a series of load-unload tests. A tabulated failure model has also been implemented in which a failure surface is represented by tabulated single valued functions. While not explicitly part of MAT213, when using the model, interlaminar failure is modeled using either tie-break contacts or cohesive elements.

There are several key material parameters required for input to the MAT 213 material model that are challenging to obtain via traditional coupon level testing techniques. Specifically, due to the fact that the plasticity flow law in the deformation portion of the material model is not coupled to the yield function, determining the coefficients required for the flow rule function requires the measurement of complex parameters such as the plastic Poisson's ratio. Developing a more straightforward and reproduceable approach to determining these flow rule coefficients would significantly improve the usability of the material model. Furthermore, to appropriate capture the full response of a composite under dynamic loading conditions, the ability to account for stress degradation after peak loading conditions are reached is required. Currently, however, the parameters required to characterize this post-peak stress degradation response are determined based on correlation with structural level impact and/or crush tests. Research is required to develop a methodology to characterize this stress-degradation response based on lower scale experiments such as coupon level tests.

For this task we are focused on developing techniques and recommended approaches to characterize the material parameters described above using tests at the coupon scale or similar fundamental types of tests. To carry out this task, we are interested in having a composite material or materials that will defined and supplied by NASA tested. The focus of the effort is to develop test methods and conduct detailed tests to characterize the flow rule coefficients and the post-peak stress degradation response. Fundamental characterization data obtained from standard tension, compression and shear tests should be available for the chosen material. The primary focus of this task will be to characterize the material to a sufficient degree to allow for simulations of the material to be conducted using shell elements.

Required Tests

Specific tests will have to be developed and carried out to appropriately characterize the flow rule coefficients and the post-peak stress degradation response. However, it is expected that the following standard set of tests could provide a baseline from which the needed parameters can be determined. For the shell element version of MAT213, at a minimum, seven fundamental tests are required to appropriately characterize the material response. The loading directions are as follows:

a. Tension in the 1-direction
b. Compression in the 1-direction
c. Tension in the 2-direction
d. Compression in the 2-direction
e. Shear in the 12-direction
f. Shear in the 21-direction
g. 45 degree off axis tension

While some or all of the tests listed above could form the basis of determining the flow rule coefficients and the post-peak stress degradation response, it is acknowledged that additional tests to be determined over the course of the research will likely be required to characterize the specified parameters.

Test Requirements

i. Test coupons will be machined by the grant recipient from flat panels supplied by NASA.
ii. For all tests the tabulated full stress-strain curve, all the way to failure, must be recorded and supplied in electronic tabular format. Raw data such as loads must also be supplied.
iii. All specimens must be measured and weighed prior to testing
iv. Testing is to be conducted at nominal room temperature conditions
v. The test environmental conditions must be recorded and documented
vi. A minimum of three repeats for each loading condition must be conducted
vii. Full Field Digital Image Correlation (DIC) must be used to measure deformations and strains
viii. The tests should be based on ASTM Standard Test Methods if possible, but it is acknowledged that modifications to the standard methods may be required to obtain the specific data required to characterize the flow rule coefficients and the post-peak stress degradation response.
ix. Testing at different strain rates is encouraged but not required

Deliverables

b. Full tabulated stress strain data to failure supplied in electronic tabular format
c. All DIC images and associated calibration files
d. A proposed approach to characterize the plasticity flow rule coefficients based on coupon or similar low scale test data.
e. A proposed approach to characterize the post-peak stress degradation based on coupon level or similar low scale test data

References:

1. Khaled, B., Shyamsunder, L., Schmidt, N. Hoffarth, C. and Rajan, S., "Development of a Tabulated Material Model for Composite Material Failure, MAT213. Part 2: Experimental Tests to Characterize the Behavior and Properties of T800-F3900 Toray Composite", DOT/FAA/TC-19/51, Nov. 2018
2. T. Achstetter, "Development of a composite material shell-element model for impact applications", *PhD Dissertation,* George Mason University, 2019
3. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Harrington, J; Rajan, S.; and Blankenhorn, G.: "Development of an Orthotropic Elasto-Plastic Generalized Composite Material Model Suitable for Impact Problems", *Journal of Aerospace Engineering*, Vol. 29, no. 4, 04015083, 2016.
4. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Rajan, S.; and Blankenhorn, G.: "Analysis and Characterization of Damage Utilizing a Generalized Composite Material Model Suitable for Impact Problems", *Journal of Aerospace Engineering*, Volume 31, Issue 4, 10.1061/(ASCE)AS.1943-5525.0000854, 04018025, 2018.
5. Goldberg, R.K.; Carney, K.S.; DuBois, P.; Hoffarth, C.; Khaled, B.; Shyamsunder, L.; Rajan, S.; and Blankenhorn, G.: "Implementation of a tabulated failure model into a generalized composite material model", *Journal of Composite Materials*, Vol. 52, Issue 25, pp. 3445-3460.

Intellectual Property Rights: All data and analysis methods will be publicly available and no intellectual property rights will be assigned to any of the parties involved in this research.

Astrophysics

Research Focus Area: Astrophysics Technology Development

Research Identifier: **A-007**

POCs: Dr. Hashima Hasan, hhasan@nasa.gov, (202) 358-0692
Dr. Mario Perez, mario.perez@nasa.gov, 202.358.1535

TECHNOLOGY:

- Astrophysics Technology Development: https://apd440.gsfc.nasa.gov/technology.html
- Technology Highlights: https://science.nasa.gov/technology/technology-highlights?topic=11
- Astrophysics Technology Database: http://www.astrostrategictech.us/

ASTROPHYSICS DATA CENTERS:

- https://science.nasa.gov/astrophysics/astrophysics-data-centers

DOCUMENTS:

- strophysics Documents: https://science.nasa.gov/astrophysics/documents

DECADAL SURVEY 2020:

- Decadal Survey on Astronomy and Astrophysics 2020 (Astro 2020): https://www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020

CITIZEN SCIENCE PROJECTS:

- Current projects: https://science.nasa.gov/citizenscience

RESEARCH SOLICITATIONS:

- Omnibus NASA Research Announcement (NRA): https://science.nasa.gov/researchers/sara/grant-solicitations/roses-2021/schedule-research-opportunities-space-and-earth-sciences-roses-2021

NASA Biological and Physical Sciences (BPS)

NASA Headquarters Biological and Physical Sciences Division

Research Focus Area: Fundamental Physics - Quantum Science

Research Identifier**:** **B-001**

POC: Brad Carpenter bcarpenter@nasa.gov (202) 358-0826

Research Overview: Quantum mechanics is one of the most successful theories in physics. It describes the very small, such as atoms and their formation into the complex molecules necessary for life, to structures as large as cosmic strings. The behavior of exotic matter such as superfluids and neutron stars is explained by quantum mechanics, as are everyday phenomena such as the transmission of electricity and heat by metals.

The frontline of modern quantum science involves cross-cutting fundamental and applied research. For example, world-wide efforts concentrate on harnessing quantum coherence and entanglement for applications such as the enhanced sensing of electromagnetic fields, secure communications, and the exponential speed-up of quantum computing. This area is tightly coupled to research on the foundations of quantum mechanics, which involves exotica such as many-worlds theory and the interface between classical and quantum behavior. Another frontier encompasses understanding how novel quantum matter—such as high-temperature superconductivity and topological states—emerges from the interactions between many quantum particles. Quantum science is also central to the field of precision measurement, which seeks to expand our knowledge of the underlying principles and symmetries of the universe by testing ideas such as the equivalence between gravitational and inertial mass.

Research Focus: Quantum physics is a cornerstone of our understanding of the universe. The importance of quantum mechanics is extraordinarily wide ranging, from explaining emergent phenomena such as superconductivity, to underpinning next-generation technologies such as quantum computers, quantum communication networks, and sensor technologies. Laser-cooled cold atoms are a versatile platform for quantum physics on Earth, and one that can greatly benefit from space-based research. The virtual elimination of gravity in the reference frame of a free-flying space vehicle enables cold atom experiments to achieve longer observation times and colder temperatures than are possible on Earth. The NASA Fundamental Physics program plans to support research in quantum physics that will lead to transformational outcomes, such as the discovery of phenomena at the intersection of quantum mechanics and general relativity that inform a unified theory, the direct detection of dark matter via atom inte **ion Sciences** rferometry or atomic clocks, and the creation of exotic quantum matter than cannot exist on Earth. Proposals are sought for ground-based theory and experimental research that may help to develop concepts for future flight experiments. Research in field effects in quantum superposition and entanglement are of particular interest. Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Research Focus Area: Complex Fluids/Soft Matter - Soft Matter-Based Materials

Research Identifier**:** **B-002**

POC: Brad Carpenter bcarpenter@nasa.gov (202) 358-0826

Research Overview: Soft matter research examines materials with properties governed by relatively weak (compared to atomic bonds) interactions between the constituent particles. Classic soft matter systems include colloids, granular materials, polymers, and liquid crystals. Newer developments in soft matter physics include studies of cooperativity and self-assembly in non-equilibrium systems.

Research Focus: The focus of soft matter research in the Biological and Physical Sciences Division is the development and execution of concepts that use the unique characteristics of the space environment, in this case, near-absence of perceived gravity, to achieve results of transformative significance for science and technology. Research supported by the program must clearly identify how the work is related to past, current, or potential future space experiments.
Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences (BPS).

Research Focus Area: Fluid Physics - Oscillating Heat Pipes (OHP)

Research Identifier**:** **B-003**

POC: John McQuillen john.b.mcquillen@nasa.gov 216-433-2876
NASA Glenn Research Center
Low-Gravity Exploration Technology Branch

Research Overview: NASA has a growing need for improved passive thermal management of electronics, batteries, high capability sensors, power system heat rejection, etc. for future spacecraft and planetary habitat systems. Due to the potential to extract heat at significantly higher heat flux levels, oscillating heat pipes (OHP) offer the promise of significantly higher efficiencies compared to conventional heat pipes used on today's spacecraft. However, the underlying liquid-vapor fluid dynamics (distinct liquid plugs and vapor plugs), interfacial phenomena, and two-phase heat transfer in the pulsating flows of OHPs are not well understood.

Research Focus: It is imperative that a physical model that can predict the performance of an OHP be developed. As a first step, NASA is seeking proposals for an instrumented, ground-based OHP experiment to provide insight into the mechanisms, fundamental processes and governing equations. The resulting high-fidelity data will be used for computational fluid dynamics model validation to better predict OHP performance and limits of operation. NASA is currently funding the development of an advanced OHP computer model at JPL. The experimental data from this project will be provided to the JPL OHP numerical modeling team. Specifically, NASA is interested in fundamental experimental research to address some or all of the topics below. The list of needs is given in a somewhat prioritized order. Please note: all OHP proposals **must** include liquid film characterization.

- Liquid film characterization:
  - Liquid film on the wall surrounding vapor plugs
  - Dynamics and heat transfer of the liquid film trailing an advancing liquid slug in adiabatic, heated and cooled, slug plug flow. Establish a method to predict liquid film thickness in OHPs with given channel geometry and operational conditions. This may include direct or indirect measurement and theoretical modeling of the liquid film.
- Oscillation Characteristics: frequency, velocity, etc.
- Measurement of the ratio of the net heat transfer attributable to latent heat transfer as compared to that from sensible heat transfer.
- Nucleate boiling characterization, including frequency measurements, and physics in a closed isochoric system.
- Experimental research that supports or refutes the OHP operational limits published by Drolen and Smoot.[1] This includes the effect of viscous losses on OHP operation, the OHP

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[1] B.L. Drolen and C.D. Smoot, "The Performance Limits of Oscillating Heat Pipes: Theory and Validation," Journal of Thermophysics and Heat Transfer, 31, 4, 2017, pp. 920-936.

sonic limit, the swept length limit where the amplitude of oscillation is significantly smaller than the evaporator length, the heat flux limit, and the vapor inertia limit which attempts to define the maximum flow velocity that the slug meniscus can support.

- Experimental and physical research into OHP startup including the effects of surface roughness and initial fluid distribution prior to startup

All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences (BPS).
Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Research Focus Area: Combustion Science - High Pressure Transcritical Combustion (HPTC)

Research Identifier**: B-004**

POC: Daniel L. Dietrich Daniel.L.Dietrich@nasa.gov, (216) 433-8759
NASA Glenn Research Center

Research Overview: Fundamental discoveries made by NASA researchers over the last 50 years has helped enable advances in fundamental combustion including low-temperature hydrocarbon oxidation, soot formation and flame stability, to name a few. Two areas of fundamental research that NASA wishes to emphasize in the future are high pressure, transcritical combustion (HPTC) and the combustion of carbon-neutral and/or bio-derived fuels. These topics include transformative research to enable the design of future internal combustion engines that are moving to higher operating pressures (increasing efficiency while simultaneously reducing pollutant emissions) and using more environmental friendly fuels. It also includes novel applications such as supercritical water oxidation (SCWO) for waste incineration.

The microgravity environment provides an ideal experimental backdrop for probing many of the questions raised in high pressure supercritical research and providing fundamental data on renewable, carbon-neutral fuels. Since the buoyant force scales with pressure squared, fundamental combustion studies in terrestrial laboratories are increasingly difficult because of the dominance of the buoyant force. The microgravity environment allows for extended length and/or time scales without the intrusion of a dominant buoyant flow. This in turn enables diagnostic techniques, that otherwise prove intractable in 1-g environments, to obtain transformative insights into supercritical phenomena. Using well designed experiments the aforementioned research topics can successfully be explored in microgravity and will serve to greatly enhance the developmental pace of a number of important technologies for both terrestrial and extraterrestrial application.

Research Focus: This Combustion Science Emphasis requests proposals for hypothesis-driven experiments and/or analysis that that will help determine: 1) fundamental phase change and transport processes in the injection of a subcritical fluid into an environment in which it is supercritical; 2) ignition and combustion of hydrocarbons under these conditions; 3) ignition and combustion characteristics of bio-derived or carbon neutral fuels and 4) how to optimize SCWO systems for waste management in extraterrestrial habitats.

Additional Information: Proposers are encouraged to include the use of drop tower facilities in their proposals. For more information about these facilities, they can contact Eric Neumann (eric.s.neumann@nasa.gov ; 216-433-2608). These facilities provide either 2.2 or 5.2 seconds of low-gravity. The possibility exists (and proposals encouraged) that investigators could take advantage of an existing experimental apparatus for the 5.2 second drop tower. Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences Division

Research Focus Area: Materials Science - Extraction and Utilization of Materials from Regolith

Research Identifier: **B-005**

POC: Michael SanSoucie michael.p.sansoucie@nasa.gov 256-544-5269
NASA Marshall Space Flight Center (MSFC) / EM41

Research Overview: NASA is successfully advancing the mission of returning humans to the Lunar surface and establishing a long-term presence. Critical to success of sustaining a human presence on the Lunar surface is the utilization of natural resources. Extraction of materials (e.g., metals, glasses, and water ice) from extra-terrestrial regolith and the subsequent use in manufacturing key infrastructure will enable humans to thrive on extra-terrestrial surfaces. The extracted materials could be used as feedstock for additive manufacturing processes to produce outfitting for habitats, to build infrastructure, for example, habitats, roads, walls, and landing pads, or to fabricate tools or other hardware. The water ice from regolith material could be used to augment life support systems for extended stay missions or produce liquid hydrogen and liquid oxygen for propellant production.

Research Focus: The goal of this NASA Physical Sciences Program research emphasis is to develop and increase understanding of extraction techniques to generate useful materials (e.g., metals, glasses, water ice) from Lunar or Martian regolith.

Proposed studies are expected to generate and test specific hypotheses to the extent possible in a terrestrial lab. Investigations should be proposed that would study one or more of the following topics:

a) Refinement of existing techniques to extract materials from regolith.
b) Development of new techniques for extraction of materials from regolith.
c) Studies of the extracted material to determine its properties or to investigate novel ways of utilizing it to support NASA's exploration goals.
d) Investigations to determine manufacturing processes using regolith or materials extracted from regolith to produce infrastructure and/or outfitting critical to sustaining life on extra-terrestrial surfaces.

It is expected that regolith simulant, or equivalent, will be used for the proposed experiments. For example, crushed basalt could potentially be used in lieu of Lunar regolith simulant. Proposals are encouraged to use existing hardware.

More information on NASA's exploration goals can be found in the Decadal Survey (http://www.nap.edu/catalog/13048.html), specifically Translation to Space Exploration Systems (TSES) number 16 (TSES16). Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences (BPS).

Research Focus Area: Effects of Regolith Simulant on Growth, Survival, and Fitness of Animal Models

Research Identifier**:** **B-006**

POC: Sharmila Bhattacharya SpaceBiology@nasaprs.com
NASA Head Quarters, Space Biology Program

Research Overview: As human exploration prepares to go beyond Earth Orbit, Space Biology is advancing its research priorities towards work that will enable organisms to Thrive In DEep Space (TIDES). These efforts will focus on determining the effects of deep-space stressors, including exposure to regolith, ionizing radiation, and reduced gravity, on multiple organisms. Space Biology-supported animal research will enable the study of the effects of environmental stressors in spaceflight on model animal systems, that will both inform future basic science work, as well as provide valuable information that will better enable human exploration of deep space. The ultimate goal of the TIDES initiative is to enable long-duration space missions and improve life on Earth through innovative research.

While some of the of the stressors associated with spaceflight in Low Earth Orbit, such as microgravity, are also found in deep space, stressors such as increased levels of space radiation and potentially toxic regolith are exclusive to deep space. The focus of this research element, therefore, is to gain a better understanding of how these deep space stressors, specifically regolith, impact the survival and fitness of animal models.

Research Focus: This Space Biology Research Emphasis requests proposals for hypothesis-driven experiments that will determine the effects of regolith (simulant) exposure on invertebrate or vertebrate animal model systems or cellular systems derived from such models. Studies may use lunar or Martian regolith simulant, or both. Proposed studies may be conducted over multiple generations but are not required to do so, and both acute and long/term consequences of regolith exposure will be characterized at the molecular and/or physiological levels.

Proposers can incorporate other deep space stressors into their experimental design if they choose, including the use of simulated micro/partial gravity and/or ionizing radiation, if feasible. While not required, applicants may propose to examine the effect that regolith exposure has on host/microbe interactions. Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Biology Program. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list. All omics data obtained from this study shall be uploaded to the NASA GeneLab (https://genelab.nasa.gov).

Research Focus Area: Effects of Space-Associated Stressors on Plant and Microbial Interactions

Research Identifier: **B-007**

POC: Sharmila Bhattacharya SpaceBiology@nasaprs.com
NASA Head Quarters, Space Biology Program

Research Overview: Fundamental discoveries made by NASA researchers over the last 50 years has helped enable successful growth of plants in spacecraft, as is demonstrated through current work being done on the ISS. Despite these advances, additional fundamental plant biology research is still needed. There is still much to learn about how plants respond to the spaceflight environments both in Low Earth Orbit (LEO) and in deep space, and what it will take to support long-duration, multiple generation plant growth and cultivation during extended space exploration missions. To fully support NASA's goals of conducting extended lunar and planetary exploration missions, it will be necessary to utilize the resources found within these environments, including regolith, to grow and cultivate plants.

One area of fundamental research that NASA wishes to focus on is the impact of the spaceflight environment on plant and microbial interactions. While the microbial contamination of plants grown in the closed environment of a spacecraft is always a potential concern, the interactions of these plants with beneficial microbes, may also be altered in the spaceflight-environment. Additionally, the impact of spacecraft-associated stressors on plant/microbial interactions, coupled with the use of regolith as a growth substrate, are topics of major interest to NASA.

The goal of this NASA Space Biology Program research emphasis, therefore, is to build a better understanding of the effects of spaceflight on microbial and plant ecosystems found both on spacecraft such as the ISS, and in deep space environments, which in turn will help us prepare for future exploration missions far from Earth.

Research Focus: This Space Biology Research Emphasis requests proposals for hypothesis-driven experiments that will help determine: 1) the effects of space-associated stressors on plant-microbial interactions; 2) the long-term, multigenerational effects of space-associated stressors on plant-microbial population dynamics; and 3) how to optimize plant-microbial systems for growing and sustaining plants in spacecraft and in deep space, including the lunar and Martian surfaces. Fundamental plant-microbial biology research is needed to specifically identity the driving space environmental factors or combination of factors that impact plant-microbial interactions.

Proposers are encouraged incorporate at least one of the following space-associated stressors in their experimental design: growth in regolith simulant, the use of microgravity analogs that simulate the effects of spaceflight (or partial gravity), and/or exposure to ionizing radiation. Investigators may also characterize the long terms effects of other spaceflight relevant stressors, including increased levels of CO_2 concentrations (e.g., 4000ppm) as experienced in enclosed space habitats etc.

The intention of the Space Biology Program is that awarded projects produce preliminary data for an application to future NASA Life Sciences funding opportunities. Additional information on BPS can be found at: https://science.nasa.gov/biological-physical

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA Space Biology Program. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list. All omics data obtained from this study shall be uploaded to the NASA GeneLab (https://genelab.nasa.gov).

Center for Design and Space Architecture

NASA Johnson Space Center

Missions beyond LEO are challenging for traditional survivability paradigms such as redundancy management, reliability, sparing, orbital replacement, and mission aborts. Distances, transit durations, crew time limitations, onboard expertise, vehicle capabilities, and other factors significantly limit the ability of human spaceflight crews to respond to in-flight anomalies. There is a need for a Repair, Manufacturing, and Fabrication (RMAF) facility to increase the capability of the crew to recover from spacecraft component failures by combing aspects of machine shop, soft goods lab, and repair shop into an IVA capability for both microgravity and surface spacecraft. An RMAF is responsible for restoring damaged components to working order (repair), keeping components in service or properly functioning (maintenance), and creating new components from raw or scavenged materials (fabrication). This responsibility extends not only to the habitat, but to all other elements sharing the same destination environment (e.g., landers, rovers, robots, power systems, science instruments, etc.). The RMAF serves both the physical operability needs of the architectural systems and contributes in two ways to the psychological well-being of the crew: one the peace of mind from understanding the capacity to respond to failures, and two, the capacity to fabricate items that serve recreational or relaxation purposes. The RMAF has potential applicability to a wide variety of in-space habitation needs.

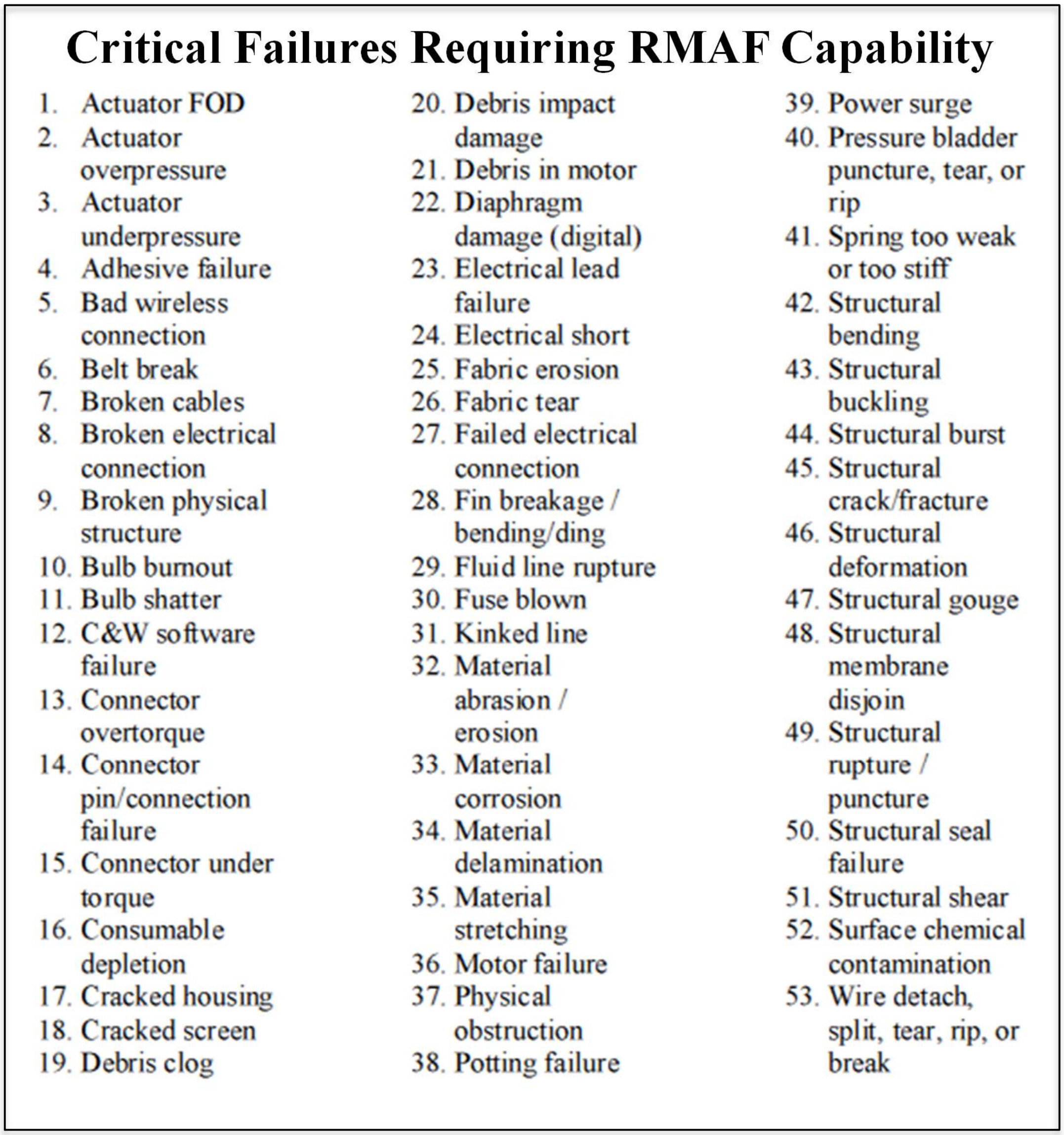
NASA is exploring space architectures that can serve as next steps to build upon the current Artemis program. The Common Habitat Architecture Study is based on a suite of common spacecraft elements that can be used for long-duration human spaceflight in multiple destinations, including the Moon, Mars, and deep space. NASA is seeking engineering and architectural research to aid in the development of an RMAF facility capable of packaging within mid deck of the Common Habitat, a Skylab-like habitat that uses the Space Launch System (SLS) core stage liquid oxygen tank as the primary structure, with a horizontal orientation. Because most habitats intended for use beyond LEO do not return to Earth, yet may operate for decades, it can be assumed that even low probability failures will eventually occur and there must be a way to recover from them and continue the mission. Thus, the Common Habitat must include the RMAF capability. The RMAF speaks to an overarching gap of inability to mitigate spacecraft component failures. Limited in-space experiments have been conducted with 3D printing, welding, soldering, and other RMAF tools, but they have yet to be integrated into an operable spacecraft facility. The RMAF goes beyond the replacement of failed components with spares and focuses on the capabilities to restore failed components to working order, making them effectively the new spare.

Research Focus Area: Repair, Manufacturing, And Fabrication (RMAF) Facility for the Common Habitat Architecture

Research Identifier: **C-001**

POC: Robert Howard robert.l.howard@nasa.gov

Research Focus: Proposed studies will assess the needs of an RMAF system for long-duration, deep space habitation and create one design solution to increase crew and vehicle survivability. Prior research has identified a list of 53 component-level critical failures that could render a subsystem or element inoperable. Fourteen repair, maintenance, and fabrication functions have been identified as collectively being able to recover a system from any of these failures. This establishes the target capability of the RMAF. Proposers will design a workspace within the volume limitations of the Common Habitat, while still accommodating these fourteen functions and will determine the associated mass impacts.



Critical Failures Requiring RMAF Capability

1. Actuator FOD
2. Actuator overpressure
3. Actuator underpressure
4. Adhesive failure
5. Bad wireless connection
6. Belt break
7. Broken cables
8. Broken electrical connection
9. Broken physical structure
10. Bulb burnout
11. Bulb shatter
12. C&W software failure
13. Connector overtorque
14. Connector pin/connection failure
15. Connector under torque
16. Consumable depletion
17. Cracked housing
18. Cracked screen
19. Debris clog
20. Debris impact damage
21. Debris in motor
22. Diaphragm damage (digital)
23. Electrical lead failure
24. Electrical short
25. Fabric erosion
26. Fabric tear
27. Failed electrical connection
28. Fin breakage / bending/ding
29. Fluid line rupture
30. Fuse blown
31. Kinked line
32. Material abrasion / erosion
33. Material corrosion
34. Material delamination
35. Material stretching
36. Motor failure
37. Physical obstruction
38. Potting failure
39. Power surge
40. Pressure bladder puncture, tear, or rip
41. Spring too weak or too stiff
42. Structural bending
43. Structural buckling
44. Structural burst
45. Structural crack/fracture
46. Structural deformation
47. Structural gouge
48. Structural membrane disjoin
49. Structural rupture / puncture
50. Structural seal failure
51. Structural shear
52. Surface chemical contamination
53. Wire detach, split, tear, rip, or break

Generic RMAF Functions to Repair Critical Failures

1. Soldering
2. Drilling
3. Metal cutting and bending
4. Metallurgical analysis
5. Bonding metal, composite, and other surfaces
6. Electronics analysis and repair
7. Computer/Avionics inspection/testing and repair
8. CAD Modeling / Software Coding / Computer Analysis
9. Material Handling (inclusive of the range from large ORUs and small fasteners)
10. Precision Maintenance (manipulation, inspection, repair of small/delicate components)
11. 3D Printing (metal, plastic, and printed circuit board)
12. Soft goods (including thermoplastics, sewing, cutting, and patching)
13. Dust/Particle/Fume Mitigation
14. Welding

A design solution should include a mass equipment list (MEL), CAD model, and Concept of Operations document. CAD models must be in a format capable of being opened by Rhino 7 and must also be suitable for incorporation in Virtual Reality using the Unreal Engine 5. Physical prototyping and iterative human-in-the-loop (HITL) testing are encouraged but are not required.

References:

[1] Howard, Robert, "Opportunities and Challenges of a Common Habitat for Transit and Surface Operations," in 2019 IEEE Aerospace, Big Sky, MT, 2019.
[2] Howard, Robert, "Stowage Assessment of the Common Habitat Baseline Variants," in 2020 AIAA ASCEND, Virtual Conference, 2020.
[3] Howard, Robert, “Design Variants of a Common Habitat for Moon and Mars Exploration,” 2020 AIAA ASCEND, AIAA, Virtual Conference, 2020.
[4] Howard, Robert, "A Multi-Gravity Docking and Utilities Transfer System for a Common Habitat Architecture," in 2021 AIAA ASCEND, Las Vegas, NV + Virtual, 2021.
[5] Howard, Robert, "A Two-Chamber Multi-Functional Airlock for a Common Habitat Architecture," in 2021 AIAA ASCEND, Las Vegas, NV + Virtual, 2021.
[6] Howard, Robert, "A Common Habitat Base camp for Moon and Mars Surface Operations," in 2021 AIAA ASCEND, Las Vegas, NV + Virtual, 2021.
[7] Howard, Robert, "A Common Habitat Deep Space Exploration Vehicle for Transit and Orbital Operations," in 2021 AIAA ASCEND, Las Vegas, NV + Virtual, 2021.
[8] Howard, Robert. "A Safe Haven Concept for the Common Habitat in Moon, Mars, and Transit Environments." 2021 AIAA ASCEND. Las Vegas, NV + Virtual. November 8-17, 2021.
[9] Howard, Robert, "Down-Selection of Four Common Habitat Variants," in 2022 IEEE Aerospace, Big Sky, MT, 2022.

[10] Howard, Robert, "Internal Architecture of the Common Habitat," in 2022 IEEE Aerospace Conference, Big Sky, Montana, 2022.

Proposer-Coordinated Contributions to Proposed Work: Proposer to indicate any contributions to the proposed work that the Proposer has arranged, in the event of a NASA award, and that would be in addition to NASA EPSCoR awarded funding. This may include funding or other in-kind contributions such as materials or services (Proposal should indicate the estimated value of the latter)

a. **From Jurisdiction or Organization that would partner with the Jurisdiction** Encouraged but None are required. Proposer shall indicate if any has been arranged for the proposed work.

Intellectual Property Rights: All technologies developed through this research will be submitted through NASA's New Technology Reporting System prior to any public dissemination. Unless otherwise determined by the NASA New Technology Office, all data and analysis methods will be publicly available and no intellectual property rights will be assigned to any of the parties involved in this research. Proposer to indicate any specific intellectual property considerations in the Proposal.

Additional Information: NASA will support a telecon with the Proposer prior to the submission of Proposals, to answer Proposer's questions and discuss Proposers anticipated approach towards this Research Request. Contact information is provided in section (5). NASA welcomes opportunities to co-publish results proposed by EPSCoR awardee. NASA goal is for widest possible eventual dissemination of the results from this work when other restrictions allow.

Commercial Space Capabilities (CSC)

Scope of the Commercial Space Capabilities (CSC) Research Interest Area
The Commercial Space Capabilities area is under the NASA Space Operations Mission Directorate (SOMD), and its purpose is to harness the capabilities of the U.S. research community to advance research and perform initial proofs / validations, that improve technologies of interest to the U.S. commercial spaceflight industry. The overall scope of the CSC area is to encourage and facilitate a robust and competitive U.S. low Earth orbit economy. Efforts that primarily benefit near-Earth commercial activities but that may also be extensible Moon and/or Mars are also in scope.

The intent is to address the commercially riskiest portion of implementing new and improved technologies ("Innovation Valley of Death") to advance science and technologies from TRL1 through to TRL4. U.S. commercial spaceflight industry can then assess and determine implementation.

Research Focus Area: In-Space Welding

Research Identifier**:** **C-002**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

Research Overview: Research and initially demonstrate (in 1g) metal welding suitable for being directly exposed to space vacuum/0g. Metals of interest are those typically used for spacecraft structures and plumbing. (Extensibility to being used while exposed to Moon vac/g, and/or Mars atm/g environments could be a secondary interest.) Potential applications include the in-space assembly of very large structures that are too bulky or heavy to launch in one piece, and insitu repair or modifications. Consider weld processes suitable for incorporation into a robotic or EVA crew tool. A related secondary interest is for a metal cutting operation suitable for incorporation into a robotic or EVA crew tool. For cutting operations consider debris generation and how to control.

Research Focus Area: Materials and Processes Improvements for Chemical Propulsion State of Art (SoA)

Research Identifier**: C-003**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

Research Overview: Propose and demonstrate improvements for launch, entry, and/or in-space chemical propulsion (of any type), to improve performance, reduce cost, enable new capabilities, and/or improve/simplify manufacturing. For this topic, when a current SoA exists, identify the shortcoming in the current SoA that the improvement addresses. NASA is specifically interested in proposed work in two subtopics:

Increase the knowledgebase of methane/natural gas/oxygen/air characteristics and combustion, pertinent to spaceflight applications. For this subtopic the Proposer should identify any current knowledge gaps that the work would try to address.

Develop new computational simulation tool(s) for Methane / Natural Gas Plume Combustibility modelling specifically for spaceflight applications. Tool would use inputs for: vehicle/storage tank dimensions/ shape (e.g. IGES file), vent locations / separation distance, venting rate, species (Methane and Natural Gas mixtures, Oxygen, air) characteristics, and total propellant masses. Tool would then perform thermophysical calculations to estimate potential of developing combustible / explosive mixtures and the potential explosive force / quantity distance, and considering the effects of: ambient wind and atmospheric condition. Petroleum Industry and Governmental standards / procedures should also be considered. Scenarios to assess are:

Launch vehicle boiloff of cryogenic propellants while on pad prior to launch.

Launch site storage tank boiloff of liquified methane/natural gas and oxygen.

Research Focus Area: Materials and Processes Improvements for Electric Propulsion State of Art (SoA)

Research Identifier**: C-004**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

Research Overview: Propose and demonstrate improvements for solar powered electric propulsion suitable for cislunar application, to improve performance, reduce cost, enable new capabilities, and/or improve/simplify manufacturing. For this topic; i) Proposer may contact NASA to schedule a pre-proposal telecon to discuss approach and understand details. ii) Proposer must describe the existing personnel skill and expertise, and facility capabilities to perform the work such as material finishing/processing, testing, inspection, and failure analysis.

NASA is specifically interested in proposed work to any of these three subtopics:

1) Material Properties: An evaluation of the bulk mechanical, thermal, and electrical properties of several common commercially available grades of material in environments relevant to thruster designs.
    a. Specific grades and in some cases samples can be provided by NASA and may include graphite, ceramics, refractories, aluminum, titanium, stainless steel, Inconel, Kovar, and other materials commonly used in thruster designs.
    b. Properties of interest include mechanical strength (flexural and compressive), low cycle fatigue, high cycle fatigue, toughness, slow crack growth, elastic modulus, Poisson's ratio, thermal conductivity, electrical conductivity, emissivity, thermal expansion, and outgas properties.
    c. Environments of interest include ambient temperature, low temperature (-40ºC), thruster temperature (600ºC), and cathode temperature (1100ºC).
    d. This work is intended to help fill gaps in open literature for common properties and materials used by the electric propulsion community to aid in design and analysis.

2) Material Deposition: An evaluation of material deposition resulting from ion beam sputtering of commonly used EP materials onto common spacecraft materials. Data shall include the following:
    a. Phase of the material deposited
    b. Whether the deposits are conductive or insulating
    c. Deposition rate compared to sputter yield based predictions,
    d. When/if spalling of the deposition occur.

3) Krypton Sputter Erosion: An evaluation of the sputter erosion of common thruster, spacecraft, and related materials from Krypton ion bombardment. The materials will be exposed to Krypton ion beams and the following will be determined:
    a. The dependence of the total yield with ion energies in the general range of tens to volts up to 1 kV

b. Dependence of the total yield with ion incidence angles from normal to near grazing, and/or
c. Differential yield profiles at various energies and incidence angles.

Materials of interest include graphite, ceramics, coverglass, kapton, composites, and/or anodized coatings. This effort may be combined with the Material Deposition effort as appropriate including possibly measurement of sticking coefficients of the sputtered products

Research Focus Area: Improvements to Space Solar Power State of Art (SoA)

Research Identifier: **C-005**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

Research Overview: Propose and demonstrate improvements for solar power generation (of any type) suitable for cis-lunar in-space application (e.g. space stations, satellites, power beaming), to improve performance, reduce cost, enable new capabilities, and/or improve/simplify manufacturing. NASA is especially interested in these two subtopics:

1) Improvements for in-space photovoltaics compared to current spaceflight solar array SoA.
2) Engineering trade studies of other solar power production methods (e.g. concentrators, thermodynamic cycles, etc) compared to current SoA space photovoltaic systems. Considerations would include: Technology readiness and gaps, launch volume and mass with respect to current US launch vehicles, peak/steady state power and characteristics, efficiency, operational considerations, in-space lifetime/performance degradation, energy storage, orbit and distance, and identifying break points and sweet spots.

Research Focus Area: Small Reentry Systems

Research Identifier: **C-006**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

Research Overview: Design and demonstrate reentry systems that can be deployed from low Earth orbit to perform a self-guided intact reentry to return small cargo contained inside them intact to Earth. Cargo might include science samples, space-manufactured items, etc. An alternate use is to recover flight data recorders from destructively reentering technology demonstrators to allow retrieving large amounts of telemetry without the use of communications satellites. Passively guided systems are preferred. Such reentry systems might need to be safely storable inside crewed in-space platforms so preference is to not use hazardous materials. Hazards for people/property on the Earth resulting from reentry must be considered. Landing on ground is preferred to simplify and expedite recovery.

Research Focus Area: Other Commercial Space Topic

Research Identifier: **C-007**

POC: Warren Ruemmele warren.p.ruemmele@nasa.gov

NASA is receptive to topics in this Interest Area that it may not have already identified if a strong case can be made for these. The Proposer may therefore propose other topics as follows:

1) The proposed Topic must be consistent with sections 1 and 3 of this call.
2) The proposal must include a strong letter of support from a U.S. commercial company that describes the company's need for the work and any arrangements with the Proposer.
3) Before submitting the proposal for such a topic the Proposer must discuss with NASA per CSC NASA Contact listed in the following page.

Additional Instructions for Proposals in this Interest Area (C-001 through C-006):

A. Content

1. Proposals should discuss how the effort is anticipated to align with U.S. commercial spaceflight company interest(s). Proposers are encouraged to contact U.S. commercial spaceflight companies to understand current research challenges.
2. Proposals should identify the estimated starting and end point of the currently proposed effort in terms of Technology Readiness Level (TRL) https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf), and what subsequent work might be anticipated to achieve TRL5.
3. If there is an existing SoA, state how proposed work would address an identified need/shortcoming (not just a "nice to have").
4. Describe proposing Institution's and Co-I/Sci-I's relevant capabilities and prior work. Compare and contrast proposed work against prior and existing work by others. (Weblinks preferred. Does not count against the Technical page limit.)
5. Work must produce a final report and delivery of developed design concept and data (as applicable).
6. Proposers can assume that technically knowledgeable NASA engineers and scientists will be reviewing the Proposal – so Proposer should focus on technical/scientific specifics.
7. NASA anticipates that depending on the specifics of the proposed work, the Proposer *may* need to implement Export Controls (e.g. EAR or ITAR). Proposer should identify in their proposal whether they believe Export Control would apply, and identify (e.g. weblink) institutional export control methods/policy in the proposal's Data Management Plan. Proposer may contact NASA PoC to discuss prior to submitting proposal.
8. For Rapid Response Research (R3) proposals to this CSC interest area, the Technical portion of the proposal may be up to five (5) pages.

B. Contributions to Proposed Work other than NASA EPSCoR

Proposer-coordinated contributions from Jurisdiction, or Organizations (especially US commercial entities) that would partner with the Jurisdiction, are welcomed but not required. If there are such contributions then the Proposer must state what has been arranged, include funding or other in-kind contributions such as materials or services and indicate the estimated value of these.

C. Intellectual Property

Proposer to indicate any intellectual property considerations in the Proposal.

D. Publishing of Results

NASA welcomes opportunities to co-publish results as proposed by EPSCoR awardee, and its goal is for widest possible eventual dissemination of the results of the Researcher(s) work, to the extent other restrictions (e.g. Export Control) allow. For results that must be controlled, NASA will work with Researcher to present accordingly, and make data available in access controlled databases such as MAPTIS database https://maptis.nasa.gov/ .

E. **NASA** Contact

The CSC NASA Contact will support a telecon with the Proposer prior to the submission of their Proposal, to answer questions and discuss anticipated approach towards this Research Request. NASA Contact will coordinate support from within NASA as needed to provide subject matter expertise/limited consultation in event of award. (If Proposer has already discussed with and NASA or JPL personnel please identify so they might be able to support telecon.)

NASA SMD Computational and Information Sciences and Technology Office (CISTO)

NASA Goddard Space Flight Center
Ethical/Inclusive AI Research Opportunity
James Harrington james.l.harrington@nasa.gov 301-286-4063

Research Overview: Computational and Information Sciences and Technology Office (CISTO) Computational and Technological Advances for Scientific Discovery via AI/ML Modeling and Development implementing an open science approach.
NASA open science promotes the availability of original source code and data to be available on the public domain to be repurposed for easier collaborations to be born among different groups or teams to work towards solving scientific problems that can benefit society.
NASA SMD communicates a VISION via the SMD Big Data Working Group (Strategy for Data Management and Computing for Groundbreaking Science 2019-2024 Report) to enable transformational open science through continuous evolution of science data and computing systems for NASA's Science Mission Directorate. SMD requests that NASA EPSCoR include research opportunities for data analysis that provide tools and training to diverse communities to be better able to collaborate with all types of computational and computer scientists that enables the funding of successful collaborations, including Artificial Intelligence and Machine Learning (AI/ML).

Artificial intelligence technology is rapidly growing in capability, impact and influence. As designers and developers of AI systems, it is an imperative to understand the ethical considerations of our work. A tech-centric focus that solely revolves around improving the capabilities of an intelligent system doesn't sufficiently consider human needs. (credit: IBM everyday ethics)

In 2019, a representative poll across NASA revealed over one hundred agency applications of AI in the past three years, with hundreds of AI projects planned across various missions, centers, and mission support activities from 2020 to 2022 and beyond. In November and December of 2020, the White House and Office of Management and Budget (OMB) published guidance3 regarding AI principles, policy, and governance. As an enthusiastic and forward leaning AI adopter, NASA must create and apply an evolving, living set of AI policies, principles, and guidelines to provide AI practitioners an ethical framework for their work.

NASA Framework for the Ethical Use of Artificial Intelligence (AI) TM RDP Fillable 298.pdf (nasa.gov).

The executive summary from the NASA Framework for the Ethical Use of AI guides the focus of this research opportunity:
The initial framework for NASA's ethical use of AI includes considerations applicable to today's simple Artificial Narrow Intelligence (ANI), as well as future human-level Artificial General Intelligence (AGI), and beyond to Artificial Super Intelligence (ASI). Considerations also include

the ways humans may interact with machines, from using them as tools to augmenting humans with implants, to more speculative further-term topics such as the merging or melding of human and machine. This NASA framework draws from principles and frameworks of many other leading organizations, relating them to NASA's specific needs to provide an initial set of six ethical AI principles:

Fair. AI systems must include considerations of how to treat people, including scrubbing solutions to mitigate discrimination and bias, preventing covert manipulation, and supporting diversity and inclusion.

Explainable and Transparent. Solutions must clearly state if, when, and how an AI system is involved, and AI logic and decisions must be explainable. AI solutions must protect intellectual property and include risk management in their construction and use. AI systems must be documented.

Accountable. Organizations and individuals must be accountable for the systems they create, and organizations must implement AI governance structures to provide oversight.

Secure and Safe. AI systems must respect privacy and do no harm. Humans must monitor and guide machine learning processes. AI system risk tradeoffs must be considered when determining benefit of use.

Human-Centric and Societally Beneficial. AI systems must obey human legal systems and must provide benefits to society. At the current state of AI humans must remain in charge, though future advancements may cause reconsideration of this requirement.

Scientifically and Technically Robust. AI systems must adhere to the scientific method NASA applies to all problems, be informed by scientific theory and data, robustly tested in implementation, well-documented, and peer reviewed in the scientific community.

Need for involvement of underrepresented communities

A common issue of interest is the need for direct involvement of underrepresented communities in building, using, and testing datasets for bias and AI applications for fairness and disparate impact. Some specific questions noted include the following:

- How do we reach underrepresented communities?
- Can we involve underrepresented communities into user-centered design at every stage of data collection and AI design and usage?
- How do we support the need for creativity in identifying potential biases?
- How do we keep data secure so that people will trust data collection?
- Can we involve underrepresented communities to correct bias in AI apps and use "human-in-the-loop?

Supporting increasing diversity

Methods and suggestions for involving underserved communities in STEM and development of technical skills to increase diversity of AI developers:

- Include / recruit from diverse institutions - HBCUs, HSIs, and MSIs
- Involve Subject Matters Experts (e.g., social scientists, not just technologists) for diversity of thought

Increasing awareness of inequitable impact and use of review/testing

- Adopt equity impact assessments
- Educate developers in testing for inclusive AI
- Involve acquisition in training to spot inclusive AI
- Assign dedicated roles for reviewing AI applications for equity (e.g, scientific review officers)

Today's markets, including NASA missions, are relying every more increasingly on highly automated and autonomous systems for the wide range of benefits they provide. Many of these systems have or will be taking over some of roles that human previously were responsible for. Some of those key roles include independent decision-making and learning. Independent, autonomous decision-making & learning carry with them significant implications, both of which include ensuring ethical behavior and beliefs.

At this time, there are no formal ethics standards with detailed parameters highly automated and autonomous systems to use. Executive Order 13960 and the Federal Data Strategy Action Plan provide a starter set of Federal AI ethics principles, and direct Federal organizations to begin taking action to guide responsible use of AI.

This current gap in ethical standards for highly automated and autonomous system means that industry and agencies need interim approaches to provide the best possible means of ensuring ethical behaviors and learning from our advanced systems until standards have been adopted. The goal of the research is to help provide key information to support formulation of such interim approached. Exploration of ethics challenges in designing, testing, implementing, and maintaining highly automated and autonomous systems.

Note: While holistic research across all the above topics is encouraged, applicants may propose research into focused subsets of the overall AI ethics solution space. NASA seeks both depth and breadth of research into this emerging area.

In all cases a report should be provided that documents the findings; identifies key risks and possible mitigations; and proposes possible next steps.

Research Focus Area: Document the Current State-of-the-Art/Practice of Ethical Decision Making by Humans in Operational Systems

Research Identifier**:** **C-008**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Document the Current State-of-the-Art/Practice of Ethical Decision Making by Humans in Operational Systems:

1. Document the historical evolution of operations ethical decision scenarios
    a. World and Cultural Views on Ethics and their possible impacts on values and priorities
    b. Evolution of operator and regulator responsibilities and ethical considerations as systems have gotten more complex and more automated.
2. Document current approaches to ethical decision-making training for professional operators:
    a. Pilots
    b. Ship Captains
    c. Train Engineers
    d. Truck Drivers
    e. Doctors
    f. Fire & Rescue
    g. Others as appropriate

Research Focus Area: *Explore and document the parameters in play in the transition of ethical decision making from humans to autonomous systems*

Research Identifier: **C-009**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Explore and document the parameters in play in the transition of ethical decision making from humans to autonomous systems. Human performance capabilities and limitations:

a. Situational Awareness
b. Context/Lessons Learned
c. Training
d. Biological Characterizations
    i. Cognitive Processing Power & Speed (decisions per second)
    ii. Physical Performance Capabilities & Limitations (i.e. reflexes)
    iii. Learning Capabilities
    iv. Social Characteristics

Research Focus Area: *Current & projected autonomous performance capabilities and limitations*

Research Identifier: **C-010**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Current & projected autonomous performance capabilities and limitations

a. Situational Awareness
b. Context Assessment/Lesson Learning Capabilities
c. Design/Implementation Characterizations
    i. Roles & Responsibilities
    ii. Training
    iii. Processing Power Capabilities & Limitations
    iv. Physical Performance Capabilities & Limitations
    v. Learning Capabilities
    vi. Distributed Network Characteristics

Research Focus Area: Document legal ecosphere of ethical decision making in off-nominal scenarios

Research Identifier**:** **C-011**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Document legal ecosphere of ethical decision making in off-nominal scenarios:

a. Multi-Culture/Tradition/Industry Domains
b. Precedents
c. Statutes
d. Laws, Regulations, Guidelines
e. Methods for: Tests, Certifications, Verification & Validations
f. Current Society Performance/Challenges on Ethical Decision Making
    i. Ability to make explicit historically implicit roles and responsibilities in ethical decision making to explicit parameters
    ii. Ability to get consensus on (why do we have 40 million lawsuits a year in the US?):
        1. Values
        2. Beliefs
        3. Fairness
        4. Equitable
        5. Unbiased
        6. Trade-offs/Priorities
        7. Etc.

Research Focus Area: *Policy/Standards/Law Making Assessment*

Research Identifier**:** **C-012**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Policy/Standards/Law Making Assessment

- a. Explore where policy, standards, and laws for Ethical Decision Making for Operations should considered/developed.
- b. Requirements for each venue
- c. Challenges for each venue
- d. Estimated ability of development and schedule for each venue

Research Focus Area: *Design, Development, & Implementation of Highly Automated / Autonomous Systems to abide by ethical decision making policy, standards, guidelines, and laws*

Research Identifier**:** **C-013**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Design, Development, & Implementation of Highly Automated/Autonomous Systems to abide by ethical decision making policy, standards, guidelines, and laws

- a. Availability & challenges of appropriate (certified) data sets
- b. Abstraction & modeling of policy, standards, guidelines, and laws
  - i. Roles, Responsibilities, Liabilities
  - ii. Cross Domain/Industry: Commonalities, Inter-operabilities, Hierarchies, Dependencies, etc..
  - iii. Testing
  - iv. Certification
  - v. Learning Auditing
    - vi. Maintenance

Research Focus Area: Societal ramifications of ethical decision making models

Research Identifier**:** **C-014**

POC:
James Harrington james.l.harrington@nasa.gov 301-286-4063
Edward McLarney Edward.l.mclarney@nasa.gov
Yuri Gawdiak yuri.o.gawdiak@nasa.gov
Nikunj Oza nikunj.c.oza@nasa.gov

Societal ramifications of ethical decision making models

i. Inclusion of Multi-cultural/domain perspectives
ii. Prioritizations of lives and property
iii. Ranking of lives and property
iv. Tradeoffs of lives and property
v. Other collateral effects

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA

Earth Science

NASA SMD Earth Science Division (ESD)

POC: Allison K. Leidner, allison.k.leidner@nasa.gov
Laura Lorenzoni, laura.lorenzoni@nasa.gov

Research Focus Area: Synthesis activities that combine multiple data sets to analyze the vulnerability and resilience of Arctic and boreal ecosystems in the Arctic Boreal Vulnerability Experiment (ABoVE) domain, across North America, and across the circumpolar region.
Research Identifier: **E-001**

Research Focus Area: Research that contributes to furthering our understanding of climate change impacts in high-latitude drainage basins, including coastal zones, and advance humanity's understanding of the potential feedback(s) of naturally- or anthropogenically-driven change in such zones
Research Identifier: **E-002**

Research Focus Area: Integration of research results and remote sensing data from ABoVE into a coherent modeling framework to diagnose and predict the impacts of environmental change on ecosystem dynamics and the consequent impacts on ecosystem services and society.
Research Identifier: **E-003**

Research Focus Area: Filling critical research gaps in our understanding of how environmental change impacts the dynamics of boreal and Arctic ecosystems within the ABoVE domain.
Research Identifier: **E-004**

Research Overview: NASA SMD Earth Science Division (ESD) Research Topics to better understanding climate change impacts on ecosystems and human in the Arctic-Boreal Zone (ABZ).
Climate change in the high northern latitudes of the Arctic-Boreal Zone (ABZ) is occurring faster than anywhere else on Earth, resulting in widespread transformation in landscape structure and ecosystem function. In addition to producing significant feedback to climate through changes in ecosystem processes, environmental change in this region is increasingly affecting ecosystem services, and these changes in services can impact society. For example, increased frequency and intensity of ecological disturbance can negatively influence forest resources and air quality, thawing permafrost can negatively change local water quality and human infrastructure, and alterations to wildlife populations can negatively reshape traditional food sources for local human populations.

To better understand changes is the ABZ and related impacts, the NASA Terrestrial Ecology Program (https://cce.nasa.gov/terrestrial_ecology/) developed the Arctic Boreal Vulnerability Experiment (ABoVE). ABoVE is a 10-year field campaign focused on developing improved abilities to observe, understand, and model the complex, multiscale, and nonlinear processes that drive the region's natural and social systems. ABoVE's overarching science questions are:
1. How vulnerable or resilient are ecosystems and society to environmental change in the Arctic and boreal region of western North America?
2. How can insights gained from previous ABoVE efforts be used to extrapolate to the continental and circumpolar boreal and/or Arctic zones?

More information on ABoVE can be found at: https://above.nasa.gov.

Proposals seeking to respond to this EPSCOR Research Topic must address research that contributes to furthering our understanding of how climate change impacts ecosystems and humans in the ABZ. NASA is specifically interested in proposals that make significant use of remote sensing data to improve understanding of the vulnerability and resilience of ecosystems and society to environmental change in the Arctic and boreal regions of western North America. Examples of potential topics suitable for the EPSCOR research on the ABZ include:

1. Synthesis activities that combine multiple data sets to analyze the vulnerability and resilience of Arctic and boreal ecosystems in the ABoVE domain, across North America, and across the circumpolar region.
2. Research that contributes to furthering our understanding of climate change impacts in high-latitude drainage basins, including coastal zones, and advance humanity's understanding of the potential feedback(s) of naturally- or anthropogenically-driven change in such zones.
3. Integration of research results and remote sensing data from ABoVE into a coherent modeling framework to diagnose and predict the impacts of environmental change on ecosystem dynamics and the consequent impacts on ecosystem services and society.
4. Filling critical research gaps in our understanding of how environmental change impacts the dynamics of boreal and Arctic ecosystems within the ABoVE domain.

Proposed investigations must utilize remotely sensed observations (e.g., MODIS, Landsat, etc.) for data analysis and as a primary research tool. Proposers are also encouraged to use data acquired via the NASA Commercial SmallSat Data Acquisition Program (CSDAP). A description of NASA's fleet of Earth observing satellites and sensors can be found at https://science.nasa.gov/missions-page/, with more details about related airborne missions at https://airbornescience.nasa.gov/. Information about data access and discovery can be found at https://earthdata.nasa.gov/.
This research opportunity will not fund the acquisition of new in situ data, but seeks to further leverage the large quantities of remotely sensed and/or in situ data that NASA has already collected over the years, in particular through the ABoVE program (https://above.nasa.gov).

Entry Systems Modeling Project

NASA SMD Earth Science Division (ESD)

Research Focus Area: Nitrogen/Methane Plasma Experiments Relevant to Titan Entry

Research Identifier: **E-005**

POC: Aaron Brandis aaron.m.brandis@nasa.gov

Research Overview: Provide experimental data to characterize TPS material response under simulated Titan entry conditions.

Research Focus: Data is needed to validate models for the material response of thermal protection system (TPS) materials under simulated Titan entry conditions, with the atmosphere being predominately nitrogen (N2) and a small amount of methane (CH4). The conditions should be traceable to conditions relevant to the upcoming Dragonfly mission. Furthermore, an understanding of how coatings, e.g. NuSil, are impacted (or not) by the presence of methane, but no oxygen is of interest. Relevant facilities for such measurements could include ArcJets or Plasma Torches. Data of interest would include thermocouples imbedded in TPS materials (e.g. PICA, SLA) and non-intrusive surface temperature measurements. Characterization of the post-test materials is also of interest. Understanding the material response of NuSil/PICA in a Titan atmosphere is important to maximize the science return for the DrEAM instrumentation suite.

Research Focus Area: Thermal Conductivity Heat Transfer of Porous TPS Materials

Research Identifier: **E-006**

POC: Aaron Brandis aaron.m.brandis@nasa.gov

Research Overview: Provide data to allow for the development of models for predicting the effective thermal conductivity of TPS materials of interest to Entry Descent and Landing projects and missions at NASA.

Research Focus: This proposal seeks heat transfer measurements that can isolate the contributions of solid conduction, gas conduction, and radiation to the overall effective thermal conductivity of porous thermal protection system (TPS) materials for a range of temperatures. These measurements should allow for the radiative heat transfer to be isolated from the conductive heat transfer through a TPS material, allowing for the contribution of each of these heat transfer mechanisms to be characterized independently. The data would then be made available to the TPS materials modeling groups at NASA to improve thermal conductivity models.

Research Focus Area: Deposition of Ablation/Pyrolysis Products on Optical Windows

Research Identifier: **E-007**

POC: Aaron Brandis aaron.m.brandis@nasa.gov

Research Overview: Provide experimental data to characterize the deposition of ablation/pyrolysis products on radiometer/spectrometer windows that reduce transmissivity.
Research Focus: Mars 2020 carried a radiometer on the backshell of the entry vehicle as part of the MEDLI2 instrumentation suite. Pyrolysis and ablation products can be deposited on the radiometer window during entry, and reduce the transmissivity. This reduction in transmissivity is a function of spectral wavelength, and can reduce the signal level reaching the radiometer sensing element. Such a test could be conducted in an ArcJet or Plasma torch either with a scaled approximate model of Mars 2020, or a simplified geometry (e.g. a wedge, backward facing step). Relevant materials for testing include PICA, RTV and SLA 561V. After products have been deposited on the window during a test, these products need to be characterized and the transmissivity of the window measured. These post-test results could either be measured as part of the proposal, or the post-test models sent back to NASA for characterization.

Research Focus Area: Predictive Modeling of Plasma Physics Relevant to High Enthalpy Facilities

Research Identifier: **E-008**

POC: Aaron Brandis aaron.m.brandis@nasa.gov

Research Overview: Develop predictive models for arc and plasma processes used in the generation of high enthalpy flows in shock tube and arcjet facilities at NASA.
Research Focus: This proposal seeks predictive modeling of processes occurring in facilities that generate high-enthalpy flows at NASA, including Arcs and Plasma Torches. The objectives may differ depending on facilities being modeled. For instance, the Electric Arc Shock tube uses an Arc to produce a high velocity shock waves. Acoustic modes in the arc driver may determine velocity profiles in the tube while ionization processes produce radiating species that may heat driven freestream gases. In plasma torches, studies of recombination of Nitrogen and Air plasma flows have relevance for predicted backshell radiation modeling. Modeling in arc jets may improve estimates of enthalpy profile uniformity and mixing of arc gas with add air.

Human Research Program / Space Radiation

Space radiation exposure is one of numerous hazards astronauts encounter during spaceflight that impact human health. High priority health outcomes associated with space radiation exposure are carcinogenesis, cardiovascular disease (CVD), and central nervous sytem (CNS) changes that impact astronaut health and performance.

Research Focus Area: Tissue and Data sharing for space radiation risk and mitigation strategies

Research Identifier: **H-001**

POC: Robin Elgart shona.elgart@nasa.gov, (281)244-0596
Janice Zawaski janice.zawaski@nasa.gov

Research Overview: Research proposals are sought to accelerate risk characterization for high priority radiation health risks and inform mitigation strategies the NASA Human Research Program (HRP) Space Radiation Element (SRE) by sharing animal tissue samples and data. The proposed work should focus is on translational studies that support priority risk characterization (cancer, CVD, CNS), development of relative biological effectiveness (RBE) values, identification of actionable biomarkers, and evaluation of dose thresholds for relevant radiation-associated disease endpoints. Cross-species comparative analyses of rodent data/samples with higher order species (including human archival data and tissue banks) are highly encouraged.

- Data can include but is not limited to behavioral tasks, tumor data, physiological measurements, imaging, omics', etc. that has already been, or is in the process of being, collected.
- Tissue samples can include, but are not limited to, samples that have already been, or are in the process of, being collected and stored as well as tissues from other external archived banks (e.g., http://janus.northwestern.edu/janus2/index.php).
- Relevant tissue samples and data from other externally funded (e.g., non-NASA) programs and tissue repositories/archives for comparison with high linear energy transfer (LET), medical proton, neutron and other exposures can be proposed.
- A more detailed list of samples and tissues available from SRE can be found at our tissue sharing websites:
    - https://lsda.jsc.nasa.gov/Document/doc_detail/Doc13726
    - https://lsda.jsc.nasa.gov/Document/doc_detail/Doc13766
    - https://lsda.jsc.nasa.gov/Biospecimen by searching "NASA Space Radiation Laboratory (NSRL)" in the payloads field.
    - Instructions for accessing the tissue sharing information are posted at: https://spaceradiation.jsc.nasa.gov/tissue-sharing/.

Research Focus Area: Space radiation sex-differences

Research Identifier: **H-002**

POC: Robin Elgart shona.elgart@nasa.gov, (281)244-0596

Research Overview: Research proposals are sought to define the mechanisms underlying sexual dimorphism following exposure to space radiation. Research should focus on translational biomarkers relevant to changes in cognitive and/or behavioral performance, cardiovascular function, and the development of carcinogenesis **in non-sex-specific organs**. Due to limited time and budget, researchers are encouraged to utilize radiation sources located at home institutions at space relevant doses (0-5 Gy of photons or proton irradiation). A successful proposal will not necessitate the use of the NASA Space Radiation Laboratory (NSRL) at Brookhaven National Laboratory at this phase. Collaborations between investigators and institutions for the sharing of data and tissue samples are highly encouraged. Samples available for use by SRE, can be found at https://lsda.jsc.nasa.gov/Biospecimen by searching "NASA Space Radiation Laboratory (NSRL)" in the payloads field (SRE approval required). Instructions for accessing the tissue sharing information are posted at: https://spaceradiation.jsc.nasa.gov/tissue-sharing/.

Research Focus Area: Compound screening techniques to assess efficacy in modulating responses to radiation exposure

Research Identifier: **H-003**

POC: Robin Elgart shona.elgart@nasa.gov, (281)244-0596
Brock Sishc brock.j.sishc@nasa.gov

Research Overview: Research proposals are sought to establish screening techniques for compound-based countermeasures to assess their efficacy in modulating biological responses to radiation exposure relevant to the high priority health risks of cancer, CVD, and/or CNS. Techniques that can be translated into high-throughput screening protocols are highly desired, however high-content protocols will also be considered responsive.

Research Focus Area: Inflammasome role in radiation-associated health impacts

Research Identifier: **H-004**

POC: Robin Elgart shona.elgart@nasa.gov, (281)244-0596
Janapriya Saha janapriya.saha@nasa.gov

Research Overview: Research proposals are sought to evaluate the role of the inflammasome in the pathogenesis of radiation-associated cardiovascular disease (CVD), carcinogenesis, and/or central nervous system changes that impact behavioral and cognitive function. Although innate inflammatory immune responses are necessary for survival from infections and injury, dysregulated and persistent inflammation is thought to contribute to the pathogenesis of various acute and chronic conditions in humans, including CVD. A main contributor to the development of inflammatory diseases involves activation of inflammasomes. Recently, inflammasome activation has been increasingly linked to an increased risk and greater severity of CVD. Characterization of the role of inflammasome-mediated pathogenesis of disease after space-like chronic radiation exposure can provide evidence to better quantify space radiation risks as well as identify high value for countermeasure development.

Research Focus Area: Portable, non-ionizing radiation based, high resolution disease detection imaging

Research Identifier: **H-005**

POC: Robin Elgart shona.elgart@nasa.gov, (281)244-0596
Janice Zawaski janice.zawaski@nasa.gov

Research Overview: Research proposals are sought to develop portable, non-ionizing radiation based, high resolution imaging technologies for disease detection in rodent models with potential scalability to humans. Conventional imaging modalities including 2D planar x-rays, micro computed tomography (CT), positron emission tomography (PET), magnetic resonance (MR), ultrasound, and bioluminescence/fluorescence imaging require either large-scale equipment that is generally immobile, or require highly trained personnel to accurately identify disease. Furthermore, the resolution of these standard techniques limits detectability of small changes in small-animal models. To accelerate radiation risk characterization and mitigation the NASA Human Research Program Space Radiation Element is seeking development of portable, non-ionizing radiation-based, high resolution imaging modalities for the early detection and continuous monitoring of disease development and progression for use in rodent models with potential scalability to human systems and use in space flight.

Human Research Program / Precision Health Initiative

Research Focus Area: Pilot studies to adopt terrestrial precision health solutions for astronauts

Research Identifier**:** **H-006**

POC: Corey Theriot corey.theriot@nasa.gov , 281-244-7331
Carol Mullenax carol.a.mullenax@nasa.gov, 281-244-7068

The term "precision health" (also called personalized medicine, precision medicine, and individualized healthcare in clinical settings) refers to the strategy of collecting and analyzing individual medical data (clinical and molecular measures) along with environmental and lifestyle data to identify key factors that can improve the level of medical care for, and ultimately the health and performance of, the individual crewmember rather than the population. The term "technique" encompasses any clinical practice, strategy, test, or process that provides a clinically actionable medical outcome for an individual.

PHI seeks to maintain an individual astronaut's health and optimal mission performance, requiring in-depth understanding of individual molecular profiles and how they relate to health and performance. The practice of Precision Health encompasses the use of detailed phenotyping of an individual, using both clinical and molecular measures, along with the integrated analyses of those data to draw conclusions about an individual's response to the environment, diet, medications, exercise regimen, etc. **This topic seeks proposals for preliminary pilot studies that identify well-vetted and approved precision health techniques from terrestrial medicine that can be applied with little to no modification to crewmembers that will be exposed to the stressors of spaceflight: space radiation, altered gravity, isolation/confinement, distance from Earth, and hostile/closed environments.**

Research Focus: While most terrestrial precision medicine techniques focus on diagnosis and treatment of disease states, NASA is most interested in preventive measures that maintain crew health and performance during exposure to spaceflight stressors resulting in human health and performance risks as described in the Human Research Roadmap (https://humanresearchroadmap.nasa.gov). Proposed precision health techniques should have compelling evidence of efficacy for the overall crew population and be approved for terrestrial clinical practice by appropriate governing bodies, and proposals should address incorporation into the existing NASA operations, workflow, and infrastructure. Any proposed precision health techniques using genetic information must comply with the Genetic Information Nondiscrimination Act of 2008 (GINA) rules that preclude use of genetic information in employment decisions, which for NASA means that genetic data cannot be used to inform or influence crew selection or crew mission assignments.

Human Research Program / Systems Biology Translation

Research Focus Area: ***Pilot studies to demonstrate the utilization of full systems biology approaches in addressing human spaceflight risks***

Research Identifier**:** **H-007**

POC: Corey Theriot corey.theriot@nasa.gov, 281-244-7331
Carol Mullenax carol.a.mullenax@nasa.gov, 281-244-7068

Research Overview: The environment astronauts are exposed to, particularly during future deep space missions, pose unique risks to human health and performance as well as research challenges that are fundamentally interdisciplinary. Systems biology frameworks offer inclusive approaches for the analysis and simulation of complex biological phenomena that in combination with the onset of new data sources and the availability of new tools for data analysis lead to a natural evolution towards the use of systems biology to understand complex biological responses. The anticipated outcome is a comprehensive understanding of the intricate interactions among biological system responses to spaceflight stressors by leveraging work across multiple disciplines. Additionally, improved identification of critical and influential system pathways corresponding to clinically and experimentally observed symptoms leads to the translation of results to human applications more quickly and economically. To develop these new capabilities and approaches, the NASA Human Research Program is interested in proof of concept development of systems biology research approaches: with particular interest in augmenting an existing HRP risk mitigation plan (such as Spaceflight Associated Neuro-ocular Syndrome) and developing a clean-sheet mitigation approach for a cross-cutting risk factor (such as inflammation). HRP human health and performance risks are described in the Human Research Roadmap (https://humanresearchroadmap.nasa.gov).
This topic seeks proposals for preliminary pilot studies that establish systems biology frameworks that utilize omics datasets, biochemical data, bioinformatics, and computational modeling to evaluate responses in biological systems due to exposure to spaceflight environments.

Research Focus: The research thopic focuses on proposals that establish the use of comprehensive systems biology approaches to understand biological responses to spaceflight. Particular focus should address (but not limited to) one of the following topics:

- Resolving aspects of the Spaceflight Associated Neuro-ocular Syndrome (SANS) risk to include multiple tissue (i.e., ocular and brain) responses.
- Assessment of the cross-risk factor of spaceflight-induced inflammation and inflammatory responses to include systemic as well as tissue specific responses in acute and chronic phases.

Human Research Program

Research Focus Area: *Development and elaboration of Functional aids and testing paradigms to measure activity for use by parastronauts during spaceflight*

Research Identifier: **H-008**

POC: Victor S. Schneider vschneider@nasa.gov
Kristin Fabre kristin.m.fabre@nasa.gov

Research Overview: Development and elaboration of Functional aids and testing paradigms to measure activity for use by parastronauts during spaceflight. This may include egressing and exiting space capsules and donning and doffing spacesuits and other aids for parastronauts. The European Space Agency is establishing a parastronaut feasibility project. Since NASA offers its international partners access to NASA supported spacecraft and the International Space Station, NASA wants to establish appropriate functional testing measures to determine the time it takes fit astronaut-like subjects compared to fit parastronaut subjects to egress and exit simulated space capsules and simulated donning and doffing spacesuit. Research proposals are sought to establish appropriate functional testing.

Research Focus Area: *Evaluation space capsule and spacesuit activity in stable and fit lower or upper extremity amputees and compare their responses to non-amputee fit individuals*

Research Identifier: **H-009**

POC: Victor S. Schneider vschneider@nasa.gov
Kristin Fabre kristin.m.fabre@nasa.gov

Research Overview: Evaluation space capsule and spacesuit activity in stable and fit lower or upper extremity amputees and compare their responses to non-amputee fit individuals. The European Space Agency is establishing a parastronaut feasibility project. Since NASA offers its international partners access to NASA supported spacecraft and the International Space Station, NASA wants to obtain research data measuring the time it takes fit astronaut-like subjects compared to fit parastronaut subject to egress and exit simulated space capsules and simulated donning and doffing spacesuit. Research proposals are sought to obtain data measuring the functional testing indicated.

Planetary Division

SMD requests that EPSCoR includes research opportunities in the area of Extreme Environments applicable to Venus, Io, Earth volcanoes. and deep-sea vents.

Venus has important scientific relevance to understanding Earth, the Solar System formation, and Exoplanets. For EPSCoR technology projects, Venus' highly acidic surface conditions are also a unique extreme environment with temperatures (~900F or 500C at the surface) and pressures (90 earth atmospheres or equivalent to pressures at a depth of 1 km in Earth's oceans). Furthermore, information on Venus' challenging environmental needs for its exploration can be found on the Venus Exploration Analysis Group (VEXAG) website: https://www.lpi.usra.edu/vexag/.

In particular, the technology requirements and challenges related to Venus exploration are discussed in the Venus Technology Roadmap at:

https://www.lpi.usra.edu/vexag/documents/reports/VEXAG_Venus_Techplan_2019.pdf

Research Focus Area: High-Temperature Subsystems and Components for Long-Duration (months) Surface Operations

Research Identifier**:** **P-001**

POC: Adriana Ocampo aco@nasa.gov W:202.358.2152/M:202.372.7058
Michael Lienhard michael.a.lienhard@nasa.gov 216.433.8932

Research Overview: Advances in high-temperature electronics and power generation would enable long-duration missions on the surface of Venus operating for periods as long as a year, where the sensors and all other components operate at Venus' surface ambient temperature. These advances are needed for both the long-duration lander and the lander network. Development of high-temperature electronics, memory, transmitters, sensors, thermal control, actuators, and power sources designed for operating in the Venus ambient would be enabling for future missions.

For example, Venus surface landers could investigate a variety of open questions that can be uniquely addressed through in-situ measurements. The Venus Exploration Roadmap describes a need to investigate the structure of Venus's interior and the nature of current activity, and potentially conduct the following measurements: a. Seismology over a large frequency range to constrain interior structure; b. Heat flow to discriminate between models of current heat loss; and c. Geodesy to determine core size and state.
Landers with sample return capability would be of great interest.

Research Focus Area: Aerial Platforms for Missions to Measure Atmospheric Chemical and Physical Properties

Research Identifier**: P-002**

POC: Adriana Ocampo aco@nasa.gov W:202.358.2152/M:202.372.7058
Michael Lienhard michael.a.lienhard@nasa.gov 216.433.8932

Research Overview: More than three decades ago, two small (3.5 m) VEGA balloons launched by the Soviet Union completed two-day flights around Venus, measuring wind speeds, temperature, pressure, and cloud particle density. The time is ripe for modern NASA efforts to explore the Venus atmosphere with new technology.

Aerial platforms have a broad impact on science for Venus. Examples of science topics to be investigated include:

a. the identity of the unknown UV absorber and atmospheric chemistry (i.e. phosphine);

b. properties of the cloud particles in general;

c. abundances atmospheric gas species (including trace gases and noble gases);

d. the presence of lightning; and

e. properties of the surface mapped aerially.

Aerial vehicles that are able to operate at a variety of high and low altitudes in the middle atmosphere are needed to enable mid-term and far-term Venus missions addressing these issues. A platform able to operate close to the Venusian surface would be able to provide close surface monitoring but would require major development to operate in the hot dense lower atmosphere. Miniaturized guidance and control systems for aerial platform navigation for any altitudes are needed to track probe location and altitude.

Other topics of interest would include high pressure and acidic environments for technology development, which would be of interest to include in the $750K level EPSCoR call.

Research Focus Area: Extreme Environment Aerobot

Research Identifier: **P-003**

POC: Adriana Ocampo aco@nasa.gov W:202.358.2152/M:202.372.7058
Michael Lienhard michael.a.lienhard@nasa.gov 216.433.8932

Research Overview: Venus provides an important scientific link to Earth, Solar System formation, and to Exoplanets. This EPSCoR call is made for technology projects, which take intoconsideration Venus' middle atmosphere conditions and its unique extreme environment. The call concentrates on the challenge to develop an aerial platform that would survive the extreme conditions of the Venusian middle atmosphere. It is worth noting that in the middle atmosphere of Venus (79km to 45Km), the conditions are considerably more benign than its surface conditions. This EPSCoR call will focus on Variable Manurable (horizontally and vertically) altitude balloons or hybrid airship, or aerobots (buoyancy + lift). The top technical parameters to consider for the Extreme Environment Aerobot for Venus conditions are (* see references below):

- Altitude: Maintain 79km to 45km Altitude (avoids high temps)
- Structure: Airframe & Materials compatible with acids (PH -1.3 to 0.5). The cloud pH varies from about 0.5 at the top (65 km) to -1.3 at the base (48 km).
- Power source: Solar and/or Batteries
- Navigation: provide, Guidance & Control concepts
- Science Instruments: for atmosphere and ground remote sensing
- Lifetime: weeks to months
- Pressure and temperature range: 80mb-1.3bar, with pressure at 65 km (245Kelvin or -28C) from Pioneer Large probe measured 80 mb and at 48 km (385 Kelvin or 112C) is approximately 1.3 bar. At 60 deg. latitude the pressure at 65 km is about 70 mb and temperature is about 222 K (-51C).
- Winds: Vertical shear of horizontal wind, up to 5-10 m/s per km

References:

Further Information on Venus's challenging environment needs, for its exploration, can be found on the Venus Exploration Analysis Group (VEXAG) website: https://www.lpi.usra.edu/vexag/.
"Aerial Platforms for the Scientific Exploration of Venus" report (JPL) Aug 2018.
In particular, the technology requirements and challenges related to Venus exploration are discussed in the Venus Technology Roadmap at:

https://www.lpi.usra.edu/vexag/documents/reports/VEXAG_Venus_Techplan_2019.pdf

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Kerzhanovich V. V., and Limaye S. S. (1985) Circulation of the atmosphere from the surface to 100 KM. *Advances in Space Research*, 5: 59-83

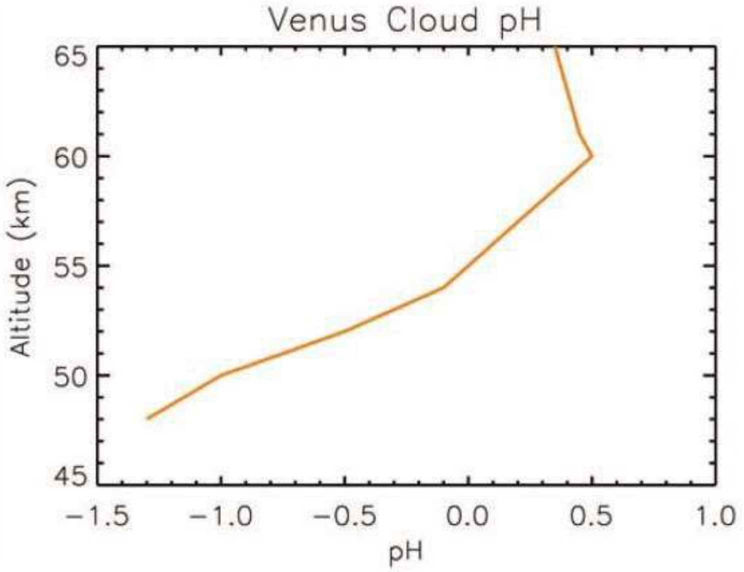

Plate 2. The pH of Venus' clouds as a function of altitude. The relatively water-rich aerosols in the upper cloud have a small range of positive pH, from 0.3 to 0.5. In the lower cloud, with its larger and more water-poor particles, pH can be as low as -1.3. Aerosol H_2SO_4 concentrations were calculated using the cloud model of Bullock and Grinspoon (2001), constrained by PV data. Correction for high activities is from Nordstrum et al. (2000).

Planetary Protection

Office of Safety & Mission Assurance

Research Focus Area: ***Addressing Knowledge Gaps in Planetary Protection for Crewed Mars Mission Concepts - Microbial and Human Health Monitoring***

Research Identifier: **P-004**

POC: J Nick Benardini James.N.Benardini@nasa.gov

Research Overview: Planetary Protection is the practice of protecting solar system bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other solar system bodies. NASA's Office of Planetary Protection (OPP) promotes the responsible exploration of the solar system by implementing and developing efforts that protect the integrity of scientific discovery, the explored environments, and the Earth.

As NASA expands its exploration portfolio to include crewed missions beyond low Earth orbit, including planning for the first crewed Mars mission, a new paradigm for planetary protection is needed. Together with COSPAR, the Committee on Space Research, NASA has been working with the scientific and engineering communities to identify gaps in knowledge that need to be addressed before an end-to-end planetary protection implementation can be developed for a future crewed Mars mission2.

For this EPSCoR Rapid Research Response Topic, NASA is interested in proposals that will address identified knowledge gaps in planetary protection for crewed Mars mission concepts, facilitating a knowledge-based transition from current robotic exploration-focused planetary protection practice to a new paradigm for crewed missions.

Research Focus: The capability to detect, monitor and then (if needed) mitigate the effects of adverse microbial-based events, whether terrestrial or Martian in origin, is critical in the ability to safely complete a crewed return mission to and from the red planet.

OPP is interested in proposals that would be the first steps on a path to develop -omics based approaches (including downstream bioinformatic analyses) for planetary protection decision making, with a particular emphasis on assessing perturbations in the spacecraft microbiome as indicators of key events such as exposure to the Mars environment, or changes in crew or spacecraft health.

Additionally, OPP is interested in technologies and approaches for mitigation of microbial growth in space exploration settings. This includes remediation of microbial contamination (removal, disinfection, sterilization) in spacecraft environments in partial or microgravity as well as on planetary surfaces.

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[2] Further information on the COSPAR meeting series on planetary protection knowledge gaps for crewed Mars missions can be found in the Conference Documents section of the OSMA Planetary Protection web site, in particular the report of the 2018 meeting at: https://sma.nasa.gov/docs/default-source/sma-disciplines-and-programs/planetary-protection/cospar-2019-2nd-workshop-on-refining-planetary-protection-requirements-for-human-missions-and-work-meeting-on-developing-payload-requirements-for-addressing-planetary-protection-gaps-on-nat.pdf?sfvrsn=507ff8f8_8

Research Focus Area: *Addressing Knowledge Gaps in Planetary Protection for Crewed Mars Mission Concepts - Natural Transport of Contamination on Mars*

Research Identifier**:** **P-005**

POC: J Nick Benardini James.N.Benardini@nasa.gov

Research Overview: The threat of harmful biological contamination at Mars is a balance between the release and spread of terrestrial biota resulting from the spacecraft surface operations, and the lethality of the Martian environment to these organisms. To understand and manage the risk of such contamination, the OPP is interested in studies of the following:

- Modeling and experimentation to describe the surface/atmospheric transport of terrestrial microorganisms as they would be released from spacecraft hardware at the Martian surface.
- Modeling and experimentation to describe the subsurface transport of terrestrial microorganisms as they would be released from spacecraft hardware onto the Martian surface.
- Modeling and experimentation to describe the lethality of the Mars environment to terrestrial organisms as they would be released from spacecraft hardware at the Martian surface.

Proposed research could focus in individual (indicator) organisms or populations of organisms. Of particular interest is the resistance of terrestrial organisms to the Martian UV environment under conditions relevant to release from crewed spacecraft (in clumps, attached to dust particles, or as part of a biofilm matrix).

Additional Information: All publications that result from an awarded EPSCoR study shall acknowledge NASA OSMA. If the NASA GeneLab Data Systems (genelab.nasa.gov) is used, GeneLab shall be referenced in the resulting publication and included in the keyword list. All -omics data obtained from these studies shall be uploaded to the NASA GeneLab.

APPENDIX B

Required Notice of Intent (NOI) for FY2023 NASA / LA BOR EPSCoR Rapid Response Research (R3) NOFO

REQUIRED NOTICE OF INTENT:
LA NASA EPSCoR Rapid Response Research (R3) FY2023

NAME OF PRINCIPAL INVESTIGATOR (PI):	PI INSTITUTION:
PI DEPARTMENT:	PI PHONE NUMBER and EMAIL ADDRESS:

TITLE OF PROPOSED PROJECT (Include Research Identifier number at end of title):

R3 FY 23 APPENDIX THE PROPOSED RESEARCH WILL FOCUS ON (from Appendix A):

Research Identifier Number:

Research Focus Area Title:

LIST DATE AND NAME OF THE NASA TASK POINT OF CONTACT THAT YOU DISCUSSED YOUR PROPOSED PROJECT WITH:

POC Name:

Date of discussion:

PROJECT ABSTRACT (no more than 250 words)

NOI must be submitted to the Louisiana Board of Regents before 4:30 pm Monday August 29, 2022

APPENDIX C

Proposal Template for FY2022
NASA / LA BOR EPSCoR Rapid Response Research (R3) NOFO

Cover Sheet: FY2023 NASA EPSCoR R3 Proposal

FOR CONSIDERATION BY BOR ORGANIZATION UNITS(S)
Sponsored Programs

PROGRAM ANNOUNCEMENT
NASA EPSCoR R3

NAME OF LEAD ORGANIZATION:	ADDRESS OF LEAD ORGANIZATION, INCLUDING ZIP CODE:
PI DEPARTMENT	PI POSTAL ADDRESS

TITLE OF PROPOSED PROJECT(Include Research Identifier number at end of title)

Research Focus Area and ID (Copy the exact title and research ID number listed for the task you are proposing to complete):

REQUESTED AMOUNT, YR 1: $90,000 START DATE, YR 1: mm/dd/yy			TOTAL REQUESTED: $ Not Applicable TOTAL PERIOD:

LIST PARTICIPATING INSTITUTIONS/CAMPUSES:

LIST PROJECT DISCIPLINES:

NAMES (TYPED)	Highest Degree/ year attained	Telephone Number	Email Address
PRINCIPAL INVESTIGATOR (PI)			
CO-I If applicable			
CO-I If applicable			

Signature of Institution’s Authorized Representative (please also print name)

Proposal Summary (Abstract)

Abstract is limited to 4,000 characters (including spaces) by NASA. This equates to roughly 500 words / 1 page of single-spaced text. The abstract should identify the Research Focus Area and Research Identifier number addressed by this proposal. Note that this abstract is separate component from your proposal that starts after the Table of Contents.

Data Management Plan (DMP)

Data management plan is limited to 4,000 characters (including spaces) by NASA. This equates to roughly 500 words / 1 page of single-spaced text. Note that this DMP is a separate component from your proposal that starts after the Table of Contents.

From the NASA NOFO

Recipients receiving awards under this NOFO shall comply with the provision set forth in the NASA Plan for Increasing Access to the Results of Scientific Research (http://www.nasa.gov/sites/default/files/files/NASA_Data_Plan.pdf) including the responsibility for—

- *Submitting as approved peer-reviewed manuscripts and metadata to a designate repository: and*
- *Reporting publications with the annual and final progress reports.*

All proposals shall include a Data Management Plan (DMP) or an explanation as to why one is not necessary given the nature of the work proposed. The DMP shall be submitted by responding to the NSPIRES cover page question about the DMP (limited to 4000 characters). Any research project in which a DMP is not necessary shall provide an explanation in the DMP block. Example explanations:

- *This is a development effort for flight technology that will not generate any data that my entity can release, so a DMP is not necessary;*
- *The data that our entity will generate will be ITAR; or*
- *Explain why the proposed project is not going to generate data.*

The proposal type that requires a DMP is described in the NASA Plan for Increasing Access to Results of Scientific Research (see above link). The DMP shall contain the following elements, as appropriate to the project:

- *A description of data types, volume, formats, and (where relevant) standards;*
- *A description of the schedule for data archiving and sharing;*
- *A description of the intended repositories for archived data, including mechanisms for public access and distribution;*
- *A discussion of how the plan enables long-term preservation of data; and*
- *A discussion of roles and responsibilities of team members in accomplishing the DMP. (If funds are required for data management activities, these should be included in the budget and budget justification sections of the proposal.).*

Proposers that include a plan to archive data shall allocate suitable time for this task. Unless otherwise stated, this requirement supersedes the data sharing plan included in the NASA Guidebook for Proposers.

In addition, as part of an award term and conditions, researchers submitting NASA-funded articles in peer-reviewed journals or papers from conferences now shall make their work accessible to the public.

Project Title (Include Specific Appendix)

Table of Contents

1. Scientific / Technical / Management Plan

[Section 1 is not to exceed 2 1/2 pages, including all illustrations, tables, and figures]

Include a summary of the overall project, a description of the relevance of this project to NASA and the State of Louisiana, and list the major research tasks, project goals, objectives, and team structure.

Note that the management plan should describe the relationship between the Louisiana Board of Regents, the PI, the science institution, and the Sci I. An example text is as follows.

The proposal is submitted to NASA through the Louisiana Board of Regents with the Louisiana NASA EPSCoR Director, Dr. T. Gregory Guzik, serving as the managing Principal Investigator (PI) for the award. The PI will provide leadership and administrative direction for the team from an oversight role. The Science Investigator (Sci I) is responsible for the scientific direction and day-to-day management of the proposed work. The PI and Sci I work together to ensure the timely reporting of the team's progress and accomplishment of its work. In the event NASA selects the project for award, the Board of Regents will issue a subaward to the Sci I institution.

2. References and Citations

Include references and citations made in the body of the proposal here.

3. Biographical Sketches

[Submit short CVs for key personnel using the following guidelines: **Science-PI:** maximum 2 pages; **Co-I/Institutional-PI :** 1 page] *Note: NASA does not allow Co-PI's in any role.*

Provide the following information for the senior personnel on the project. Begin with the Principal Investigator.
DO NOT EXCEED 2 PAGES PER PERSON.

A. Vitae, listing professional and academic essentials and mailing address.
B. List up to 5 publications most closely related to the proposed project and up to 5 other significant publications, including those being printing. Patents, copyrights, or software systems developed may be substituted for publications. Do not include additional lists of publications, invited lectures, etc. Only the list of up to 10 will be used in merit review.
C. List of persons, other than those cited in the publication list, who have collaborated on a project or a book, article, report or paper within the last 48 months, including collaborators on this proposal. If there are no other collaborators, please indicate that fact.
D. Names of graduate and post-graduate advisors and advisees.

The information in C. and D. is used to help identify potential conflicts or bias in the selection of reviewers.

4. Current and Pending Support

The following information MUST be provided for each investigator and other senior personnel. Use additional sheets as necessary. Complete Form 1001CP, provided on the following page. List support from ALL sources, including BOR Support Fund.

NAME OF INVESTIGATOR:

Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $___________________________ Period Covered:___________________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

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Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $___________________________ Period Covered:___________________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

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Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $___________________________ Period Covered:___________________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

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Status of Support: ___Current ___Pending ___Submission Planned in Near Future

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $___________________________ Period Covered:___________________

Location of Activity:

Person-Months or % of Effort Committed to the Project: _____Cal Yr _____Acad _____Summ

5. Statements of Commitment and Letters of Support

Institutional Commitment to The Project: When preparing a proposal with content that requires internal institutional certification, waiver, or approvals the proposers will need to address applicable compliance issues in advance. All necessary internal approvals from the lead and collaborator institutions must be secured and documented in writing. A letter (see sample in the below) signed by the authorized organization representative certifying that all reviews and waivers relevant to the proposal have been completed prior to issuing the proposal to NASA.

Please use university letterhead.

<*Date*>

Ms. Jessica Patton
Federal Program Administrator
Board of Regents, State of Louisiana
1201 North 3rd Street, Suite 6-200
Baton Rouge, LA 70802

Dear Ms. Patton:

<*Institution*> agrees to participate as a subrecipient in Louisiana Board of Regents' proposed NASA EPSCoR project entitled ***"<Title>."*** The <*institution*> portion of the work as described in the attached proposed scope of work will be under the primary direction of <*Science or Institutional lead investigator, title*>*.*

The amount requested for <*institution*>'s participation in this research project is ***<total budget amount>*** over one year. Please see the attached budget and budget justification for a detailed explanation of costs. <I*nstitution*> has reviewed and approved the budget and budget justification for this proposal.

This letter also acknowledges that the institution has conducted all reviews, and signed all waivers, and certifications associated with the proposed effort so that the project can be immediately implemented following award by the Board of Regents.

We look forward to a rewarding and productive research effort.

Sincerely,
<*Authorized Organization Representative*>
<*Office of Authorized Organization Representative*>
Enclosures: <*Any necessary attachments*>

Note: Additional letters of support should be included in this section as needed.

6. Budget Justification: Narrative and Details

6.1 BUDGET NARRATIVE

[Budget Narrative/Details: All budget line items require detailed explanations without exception. We have created the following budget narrative template with some examples of acceptable descriptions for the various categories. This section must be duplicated for all sub-awardees.]

Include a brief (1-3 paragraph) narrative description of the funding structure and participating institutions, including NASA-EPSCoR, the lead institution, and any sub-award institutions. Include a high-level table identifying contributions of the funding from NASA and Institution cost share (if any) for each of the years of the research project. In developing the project budget note the limitations and requirements as specified in section II of these guidelines. This program is intended to improve research capability in Louisiana and, consequently, costs should primarily support effort within the state. Direct labor costs will be allowed exclusively for faculty, staff, students, and visiting researchers at Louisiana Institutions.

Note that the maximum budget is $90,000 for a one-year period of performance.

6.1.1 Summary of Proposal Personnel and Work Effort

Include a table of anticipated work effort in (person-months). Example Table below.

Name	Role	Person-Months Year 1
Lead Institution Name		
Jane C. Smith	CO-I, Science-I, Institution-PI	1.0
John B. Doe	Co-I	1.0
To be named	Post-doctoral Associate	12
Graduate Students (3 per year)	Student	18
Undergraduate students (up to 5 per year)	Student	15
Sub-Award Institution Name		
James Smith	Co-I, Institution-PI	1.0
Graduate Student (1)	Student	6
Undergraduate Student (3)	Student	6

Note: You must describe exactly how person-months/years are calculated for students

6.1.2 Facilities and Equipment

Existing Facilities and Equipment

Provide a 1-paragraph description of each facility (faculty labs, departmental labs, general department facilities). Follow each paragraph description with a list of all major equipment available to support this project, as needed.

Additional Facilities and Equipment to be Acquired using Project Funds

Identify any additional space or general equipment that will be acquired for this project in a brief narrative description (1 to 3 paragraphs). [Detailed descriptions of all proposed equipment / facility costs must be included in the detailed budget section.]

6.1.3 Cost Methodology

Provide a brief (1-3 sentences) description of the method used to estimate the following cost categories.

- ***Salaries and Wages***
- ***Equipment***
- ***Materials and Supplies***
- ***Travel***
- ***Other Applicable Costs (Operating Services)***

6.2 BUDGET DETAILS – LEAD INSTITUTION

[Dollar amounts proposed with no detailed explanation (e.g., Equipment: $12,000, or Labor: $35,000) will reduce proposal acceptability, or cause delays in funding should the proposal be selected. Each item should be explained in reasonable detail.]

Provide a summary table of the lead institution's budget by major cost category as indicated below.

"Project Title," Lead Institution Name: Budget Summary by Major Category

Category	Year 1	
	NASA	Institution (Not required)
Direct Labor		
Other Direct Costs:		
Supplies & Materials		
Equipment		
Travel Costs		
Sub-Award Costs		
Other Applicable Costs		
Total Direct Costs		
F&A (Indirect) Costs		
Total Project Costs		

Note that in each of the "Detail" subsections below, you need to specify the costs allocated to NASA funds separately from those allocated to the institutional cost share. Your numbers for each year need to be shown to sum to the totals listed on the section 6.4 Budget Form for each column, "NASA Funds Requested", "Non-Federal Match Institutional", for each year.

Direct Labor Detail

Direct labor costs should be separated by titles or disciplines (e.g., Principal Investigator, Co-Investigator, Collaborator, Research Associate, graduate, or undergraduate research assistant, etc.) with estimated hours, hourly rates, or monthly rates and total amounts of each. Identify all faculty, staff, and students to be supported. **Direct labor costs will be allowed exclusively for faculty, staff, and students at Louisiana Institutions.** List amounts for each year for each one you list. Also provide brief summaries of the primary responsibilities for each of the categories. Specifically, mention what each Investigator will be responsible for, what research any post-docs or graduate students will perform, and what kind of work undergraduate students might complete. Document fringe benefits (rates & totals) and lastly, summarize the yearly totals for wages, salaries, and benefits.

Supplies & Materials Detail

Organized by year, identify amounts followed by a brief description (with concrete examples) of typical supplies required to conduct your research project. Pay special attention to high-cost materials and supplies (e.g. Platinum substrates or the like). Cite sources for cost estimates (vendor quote, website price listing, previous orders, etc). Supplies and Material is an area where NASA often requested additional information resulting in delaying implementation of the award.

Therefore, it is highly recommended that you provide as much information here as you reasonably can.

Equipment Detail

Organized by year, identify all equipment to be purchased for this project. For each piece of equipment, included the name of the equipment, model number & brand, supplier cost quote or website price, and 1-2 sentences describing what the equipment does and how it will be used in the project. The source of the cost estimate **must** be included.

Travel Detail

Separate domestic and foreign travel, and then identify fund amounts and funding sources by year. Include visits to NASA Centers and relevant technical conferences. For each trip list: purpose, destination, number of travelers, airfare, per diem, registration, local transportation, and miscellaneous. If exact location of travel is not known, select a probable destination for the estimate.

Requested domestic travel should include purpose, the number of trips and expected location, duration of each trip, airfare, rental vehicle (if needed), and per diem. There is no limit placed on domestic travel. Domestic travel should be appropriate and reasonable to conduct the proposed research.

Foreign travel is allowable up to $3,000/trip and a total of two trips (maximum $6,000) for the entire jurisdiction's EPSCoR proposal (NASA and BOR funds). Requested foreign travel should include justification, purpose, the number of trips and expected location, duration of each trip, airfare, rental vehicle (if needed), and per diem.

Sub-Award Detail

This section should describe all sub-awards anticipated to be funded by the lead institution. Include the institution name, project role, yearly funding level, and total funding level for each collaborating institution receiving an award.

In addition, starting at section 7.4 each sub-award proposed must include a cover sheet, a statement of work for the sub-award institution, and a complete budget section (four total budget forms and the same budget details specified here). Sub-award packages should be approved and signed by the receiving institution prior to submission of the pre-proposal.

Other Applicable Costs Detail

List any additional allowable costs to be covered by NASA, BOR, and/or your institution, such as consultants, preparing manuscripts, and F&A (indirect) costs. Organize by year and identify amounts with funding agencies.

F&A (Indirect) Costs

Include rates and the base, plus total cost. Your campus's federally negotiated rate applies for the funds requested from NASA. Include reference or copy of the letter that specifies your institution's current federally negotiated F&A and fringe benefits rates. If you plan to escalate your fringe or F&A rate over the three years of the proposed budget, that escalation rate should be described in your documentation.

Institutional Contribution

Institutional match funds are not required and should only be included if there is a clear value-add. All institutional contributions need to be listed and described here. Unrecovered F&A used as an institutional contribution must be explained, including a calculation as to how the amount is obtained. All institutional contributions should be sufficiently explained such that evaluators can understand the basis of the proposed costs.

6.3 BUDGET DETAILS – SUBAWARDS

For all anticipated Sub-Award Institutions, the items listed below are to be included on the following pages.

Cover Sheet

With authorized institutional signature.

Statement of Work

Summary of the work to be completed by the collaborating institution.

Budget Details

Budget Details for Subawards must be included just as described in the previous section for the lead institution.

6.4 BUDGET FORMS

[Budget Form: Use the Louisiana NASA EPSCoR Pre-proposal Budget Form that follows this page (this form is also provided in MS Excel as a separate attachment). A budget justification must be included. Use your negotiated federal rate on NASA funds. This section must be duplicated for all sub-awardees.]

Louisiana NASA EPSCoR Pre-proposal Budget Form Year 1

PROJECT TITLE:

PROJECT YEAR: (circle one)

[✓ 1] 2 3 combined

PRINCIPAL INVESTIGATOR:

ORGANIZATION:

1 SALARY COSTS	NASA Funds Requested	Non-Federal Match	
		BOR	Institutional
1		N/A	N/A
2		N/A	N/A
3		N/A	N/A
4		N/A	N/A
5 Graduate Student Support		N/A	N/A
6 Undergraduate Student Support		N/A	N/A
TOTAL PERSONNEL		N/A	N/A
2 FRINGE BENEFITS			
(if charged as direct costs) Specify Rate:		N/A	N/A
3 TOTAL WAGES, SALARIES, BENEFITS			
(1 + 2)		N/A	N/A
4 SUPPLIES & MATERIALS		N/A	N/A
5 EQUIPMENT (List item & dollar amount for items exceeding $1,000)			
Total Permanent Equipment		N/A	N/A
6 TRAVEL COSTS			
Domestic (Incl. Canada & U. S. possessions.)		N/A	N/A
Foreign		N/A	N/A
7 PUBLICATION & REPORT COSTS		N/A	N/A
8 SUBAWARD COSTS		N/A	N/A
9 CONSULTANT COSTS		N/A	N/A
10 COMMUNICATION COSTS		N/A	N/A
11 OTHER DIRECT COSTS		N/A	N/A
12 TOTAL DIRECT COSTS		N/A	N/A
13 INDIRECT COSTS (Specify rates.) 1. Federal: XX% 2. Institutional: (specify rate)			
Total Indirect Costs		N/A	N/A
14 TOTAL PROJECT COSTS (12 + 13)		N/A	N/A