

LA FY2024 Request for Pre-Proposals for



NASA EPSCoR

Rapid Response Research (R3) Opportunity

TIMETABLE:

Notice of Opportunity Released: **Thursday, September 14, 2023**

Notice of Intent (required) Due: **Thursday, October 19, 2023**

Last day for Q&A about this solicitation: **Thursday, November 30, 2023**

Pre-Proposals due: Thursday, December 14, 2023

Anticipated Notification of Selection(s): **January 2024**

Anticipated RFP Release from NASA: November 2023

Anticipated Selected Proposals due to NASA: February 2024



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 2024 (FY24) NASA Established Program to Stimulate Competitive Research (EPSCoR) Rapid Response Research (R3) program during the fall of 2023 with submissions from jurisdictions due in February of 2024.

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 Thursday, October 19, 2023.**

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 Thursday, December 14, 2023.**

The Pre-Proposals will be reviewed by an external panel and for FY24 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 designated PI through the Louisiana Board of Regents by February 26, 2024. 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 NASA Open Science Data Management Plan (OSDMP) Requirement

The guidance for this section has been strengthened to reflect the provisions set forth in the [NASA Plan for Increasing Access to the Results of Scientific Research](#). Please reference the NASA SMD [Science Information Policy](#) for examples on how to implement these provisions in your proposal. In particular, all proposals shall include an Open Science and Data Management Plan (OSDMP) that addresses three major objectives:

- 1) As-accepted manuscript versions of publications that derive from NASA funding must be publicly available at the time of publication;
- 2) Data and software developed using NASA funding in support of a peer-reviewed publication shall be made publicly available at the time of publication; and
- 3) Scientifically useful data and software developed during the award that was not already published must be made publicly available by the end of the award.

Note that a project may not need a detailed OSDMP, but a detailed explanation as to why no scientifically useful data will be generated needs to be discussed. Possible reasons include 1) the proposed work is inexorably linked to the handling of already available data (e.g. from remote sensing platforms) so the OSDMP is part of the page-limited Science, Technical, & Management section of the proposal; 2) instrument development and technology development programs generally do not generate “scientifically useful data;” or 3) data is subject to ITAR (International Traffic in Arms Regulations) restrictions. In any event where the project produces “no data” or only data specifically exempted, the OSDMP must state that no data preservation or data sharing is needed and explain why.

When an OSDMP is required the plan 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.

The OSDMP is limited to 4000 characters including spaces (which equates roughly to 500 words / ~2 pages double spaced) and is included as a separate component in the proposal following the Cover Page and prior to the Table of Contents. See section II.C Pre-proposal Elements. Note that if funds are required for data management activities, these shall be included in the budget and budget justification sections of the proposal.

The following links provide additional information about the NASA strategy for increasing access to NASA funded project results, more detailed discussion on how to create an OSDMP, and some illustrative OSDMP templates for particular NASA SMD divisions. Note that not all of the material in all of the references below will apply to your specific project, but are listed here to provide examples of the kind of information NASA will want to see in your OSDMP.

NASA Plan for Increasing Access to the Results of Scientific Research:

https://www.nasa.gov/sites/default/files/atoms/files/206985_2015_nasa_plan-for-web.pdf

NASA SMD Science Information Policy:

<https://science.nasa.gov/researchers/science-data/science-information-policy>

How to Create and Maintain a Data Management Plan for Proposals – Earth Science Division:

<https://www.earthdata.nasa.gov/engage/dmp-earth-science>

Data Management Guidance for Earth Science Division Researchers:

<https://www.earthdata.nasa.gov/engage/data-management-guidance>

Earth Science specific OSDMP template – MS Word document:

<https://www.earthdata.nasa.gov/s3fs-public/2023-02/Earth%20Science%20Division%20OSDMP%20Template.docx?VersionId=fBxuNKFmklk3VCK4rhWKpKGgVyZwrhJE>

Heliophysics Division OSDMP template – MS Word document:

https://science.nasa.gov/files/atoms/files/HPD_DMP_Template_022820.docx

Planetary Science Division OSDMP template --- MS Word document:

<https://science.nasa.gov/files/atoms/files/PSD%20Open%20Science%20%20and%20Data%20Management%20Plan%20TEMPLATE.docx>

I.E 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 FY23 NASA EPSCoR R3 Notice of Funding Opportunity (NOFO) and are anticipated to apply as well to the FY24 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.** 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.F Assessment of Pre-proposals and Preparation of Full Proposals

We hope to notify the PIs of the pre-proposals selected by the panel in January; 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 conforming 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.G Timetable (*Dates may change, subject to requirements of FY2024 R3 NOFO*)

Thursday, October 19, 2023	Pre-Proposal Notice of Intent due
Thursday, November 30, 2023	Last day to submit questions about this solicitation
Thursday, December 14, 2023	Pre-proposals due
January 2024	Notice of LA Selection

I.H 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 Thursday, November 30th. 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.I 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.

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 **Thursday October 19, 2023**. **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 2023](#). 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 FY23 NASA EPSCoR R3 NOFO which is anticipated to be very similar to the FY24 R3 NOFO. However, development of the proposal for submission to NASA will confirm to the requirements listed in the FY24 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
Open Science Data Management Plan ¹	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 ²	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 <i>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.</i>	
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**Open Science Data Management Plan:** See section I.E for detailed requirements and guidance for this plan.

²Institution 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.) **Thursday, December 14, 2023**. 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

REVISED

List of NASA Mission Directorate and Center Priority Tasks for the
FY24 NASA EPSCoR R3 Solicitation

Released by NASA, Thursday, September 7, 2023

Appendix 3 : Research Focus Areas (RFAs)

3.1 Electrified Vertical Takeoff and Landing (eVTOL), Material Characterization and Modeling

Aeronautic Research Mission Directorate (ARMD)

NASA Glenn Research Center

Research Focus Area: Safe and Efficient Electro-mechanical Powertrains for Electrified Vertical Takeoff and Landing (eVTOL) Vehicles

Research Identifier: **RFA-001**

POC: Timothy Krantz, timothy.l.krantz@nasa.gov
Dr. Mark J. Valco, mark.j.valco@nasa.gov

Research Focus Area: Electric motor technologies appropriate for eVTOL with high torque density and, concurrently, such motors being free of partial discharge and having a continuous power rating in the range 50 – 400 kW.

Research Identifier: **RFA-002**

POC: Timothy Krantz, timothy.l.krantz@nasa.gov
Dr. Mark J. Valco, mark.j.valco@nasa.gov

Research Focus Area: High reliability, robustness, and fault-tolerance for inverter-motor systems as needed for safety-critical eVTOL propulsion.

Research Identifier: **RFA-003**

POC: Timothy Krantz, timothy.l.krantz@nasa.gov
Dr. Mark J. Valco, mark.j.valco@nasa.gov

Research Focus Area: Lubrication and cooling technologies specifically optimized for long life and highly efficient eVTOL motors, including interest in single-fluid approaches for inverters, motors, and gearboxes.

Research Identifier: **RFA-004**

POC: Timothy Krantz, timothy.l.krantz@nasa.gov
Dr. Mark J. Valco, mark.j.valco@nasa.gov

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 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 electro-mechanical powertrains for electrified vertical takeoff and landing (eVTOL) vehicles. The focus is safety and efficiency, 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 includes electric motors and associated power electronics, possibly combined with mechanical or magnetically-gearred transmissions. Research topics of particular interest are those that focus on:

- 1) reliable, efficient, high power density electro-mechanical powertrain technology for eVTOL
- 2) electric motor technologies appropriate for eVTOL with high torque density and, concurrently, such motors being free of partial discharge (refs. 7,8) and having a continuous power rating in the range 50 – 400 kW
- 3) high reliability, robustness, and fault-tolerance for inverter-motor systems as needed for safety-critical eVTOL propulsion
- 4) lubrication and cooling technologies specifically optimized for long life and highly efficient eVTOL motors, including interest in single-fluid approaches for inverters, motors, and gearboxes

The target application is eVTOL vehicles sized to carrying four to six passengers with missions as described in References 1-6. Challenges related to insulation of motor windings and the phenomena of partial discharge are discussed in the literature (examples: references 7,8).

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.
- 8) Petri, T., Keller, M. and Parspour, N. "The Insulation Resilience of inverter-fed Low Voltage Traction Machines: Review, Challenges, Opportunities." IEEE Access (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 Rate and Temperature Dependent Composite Material Properties for the LS-DYNA MAT213 Model

Research Identifier: **RFA-005**

Mission Directorate: ARMD

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.

The MAT213 model has the ability to incorporate both rate dependency and temperature dependency in the material response, which, potentially, could be important aspects of the

dynamic and impact response of composites. To date, very little has been done to assess the effectiveness of the rate- and temperature-dependence modeling approaches, or to assess the importance of incorporating these effects in dynamic crush and impact problems. In dynamic crush problems, such as drop weight tests on composite structures, differences in response at different loading rates have been observed [6,7]. In ballistic impact tests of composite panels significant temperature rises have been documented [8]. But a fundamental understanding of the effect of strain rate and temperature is needed.

For this task we are focused on developing techniques and recommended approaches to characterize the rate dependent material parameters required for input into MAT 213 using tests at the coupon scale or similar fundamental types of tests at higher structural scales. In addition, we would like to characterize the effects of temperature changes under dynamic loading to assess the need for incorporating temperature dependence in dynamic models. To carry out this task, we are interested in having NASA-supplied composite materials and structures tested at high loading rates and/or potentially varying temperatures representative of what would exist in crash and impact events. It is expected that the tests will be conducted at the proposer's facility. NASA will attempt to provide a material for which quasi-static room temperature data are available.

A particular additional area of interest is in characterizing the post-peak material response, which can be important in simulating the response of actual structures. Currently, in many cases post peak material parameters are correlated based on the results of structural level tests. A need exists to develop capabilities and methods to characterize material parameters based on lower scale tests that are applicable for the analysis of full structures.

Research Requirements

Coupon Level Testing. Specific tests at a range of strain rates and/or temperatures that are of interest could include the following:

- Tension in the 1-direction
- Compression in the 1-direction
- Tension in the 2-direction
- Compression in the 2-direction
- Shear in the 12-direction
- Shear in the 21-direction
- 45 degrees off axis tension

Note that other tests may be conceived and conducted to develop methods to fully characterize the material of interest and to meet the goals of the project. Within the constraints of time and budget it may be necessary to prioritize tests where rate effects are expected to be more important.

Test Requirements

- i. Test coupons will be machined by the grant recipient from flat panels supplied by NASA.

- ii. For all tests the full set of test data must be recorded and supplied in electronic tabular format. For the tension, compression and shear tests that are conducted, the tabulated stress-strain curve, all the way to failure, must be provided. 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 appropriate and relevant rate and 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

Deliverables

- a. Full tabulated data supplied in electronic tabular format
- b. All DIC images and associated calibration files
- c. A final report detailing the procedures and results.

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.
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6. Chambe, J.-E., Bouvet, C., Dorival, O., Rivallant, S. and Ferrero, J.-F. "Effects of dynamics and trigger on energy absorption of composite tubes during axial crushing", *Int. J. Crashworthiness*, 26(5), 2021.
7. Haluza, R., "Measurement and explicit finite element modeling of dynamic crush behavior of carbon fiber reinforced polymer composites", Ph.D. Dissertation, Pennsylvania State University, 2022
8. Johnston, J. P., Pereira, J. M., Ruggeri, C. R., & Roberts, G. D. (2018). High-speed infrared thermal imaging during ballistic impact of triaxially braided composites. *Journal of*

Composite Materials, 52(25), 3549-3562.

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: Multiscale Modeling of Heterogeneous Materials with NASMAT

Research Identifier: **RFA-006**

Mission Directorate: ARMD

POC: Trenton M. Ricks, PhD trenton.m.ricks@nasa.gov

Dr. Steven M. Arnold steven.m.arnold@nasa.gov

Research Overview: The NASA Multiscale Analysis Tool (NASMAT) is a versatile platform for performing computationally efficient multiscale analyses of heterogeneous materials. NASMAT offers the user flexibility to define an arbitrary number of length scales (levels) where a variety of micromechanics theories can be implemented at each level [1]. Micromechanics theories can be selected to balance accuracy and computational efficiency and range from analytical (Mori-Tanaka) to several semi-analytical (method of cells) formulations. NASMAT can also be coupled with external software and used to perform multiscale analyses of more complex structures. For example, if NASMAT is coupled with a finite element software, NASMAT effectively acts as an anisotropic, evolving, nonlinear material model which is called at individual integration points within the elements.

Submitters are encouraged to review recent publications from the development team prior to submitting a proposal [1-4]. The selected publications are intended to provide a broad background of current NASMAT activities and should not be interpreted as providing direction on proposed topics. Backends to incorporate user-defined features within NASMAT will be provided by the development team if required. Alternatively, developed models may be incorporated into the open-source MatLab code (<https://github.com/nasa/Practical-Micromechanics>) accompanying Ref. [5]. Proposed topics should be aligned with one or more Key Elements outlined in the Vision 2040 study [6].

Research Requirements

Submitters are encouraged (but not required) to develop tools, methods, models (e.g., deformation or damage) and software that could be incorporated into NASMAT by the development team in the future. Topics of interest include, damage/failure modeling, multiscale model hand-shaking, evolving microstructures, multi-physics modeling, approaches to enable massively multiscale modeling, and experimental techniques to generate sub-coupon scale validation data. Proposals associated with primarily determining effective elastic properties will not be favorably viewed. Possible material systems include ceramic and polymer matrix composites and metallic systems with applications including unidirectional, woven, nano-reinforced, or short-fiber composites, additive manufacturing, and shape-memory alloys. Proposals demonstrating the need of multiscale modeling for structural problems (e.g.,

thermos-mechanical loading) are encouraged.

A. Deliverables

1. A final report detailing the models, procedures, and results
2. Model results to be provided in a suitable electronic format
3. Source code for any developed modeling approaches
4. Raw and processed experimental digital data (if applicable)
5. Detailed documentation of new experimental equipment (if applicable)

References:

1. Pineda, E. J., Bednarczyk, B. A., Ricks, T. M., Arnold, S.M., Henson, G. (2021). Efficient multiscale recursive micromechanics of composites for engineering applications. *International Journal for Multiscale Computational Engineering*, 19(4), 77-105.
2. Ricks, T. M., Pineda, E. J., Bednarczyk, B. A., McCorkle, L. S., Miller, S. G., Murthy, P. L., & Segal, K. N. (2022). Multiscale Progressive Failure Analysis of 3D Woven Composites. *Polymers*, 14(20), 4340.
3. Bednarczyk, B. A., Ricks, T. M., Pineda, E. J., Murthy, P. L., Mital, S. K., Hu, Z., & Gustafson, P. A. (2022). Multiscale Recursive Micromechanics of Three-Dimensional Woven Composite Thermal Protection Materials Thermal Conductivities. *AIAA Journal*, 60(12), 6506-6519.
4. Gustafson, P. A., Pineda, E. J., Ricks, T. M., Bednarczyk, B. A., Hearley, B. L., & Stuckner, J. (2023). Convolutional Neural Network for Enhancement of Localization in Granular Representative Unit Cells. *AIAA Journal*, 1-13.
5. J. Aboudi, S.M. Arnold, B.A. Bednarczyk (2021). *Practical Micromechanics of Composite Materials Course Textbook*, Elsevier
6. X. Liu, Furrer, D., Kusters, J., & Holmes, J. (2018). Vision 2040: a roadmap for integrated, multiscale modeling and simulation of materials and systems. NASA/CR-2018-219771.

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.

3.2 Clean Energy, Climate Change and Orbital Debris

Space Technology Mission Directorate (STMD)

STMD rapidly develops, demonstrates, and infuses revolutionary, high-payoff technologies through transparent, collaborative partnerships, expanding the boundaries of the aerospace enterprise. STMD employs a merit-based competition model with a portfolio approach, spanning a range of discipline areas and technology readiness levels. By investing in bold,

broadly applicable, disruptive technology that industry cannot tackle today, STMD seeks to mature the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost for other government agencies and commercial space activities.

Research Focus Area: Clean Energy and Emissions Technologies

Research Identifier: **RFA-007**

POC: John Scott, PhD. john.h.scott@nasa.gov

Clean energy and emissions mitigation technology projects focusing on the research and development, demonstration, or deployment of systems, processes, best practices, and sources that reduce the amount of greenhouse gas emitted to, or concentrated in, the atmosphere.

Research Focus Area: U.S. Climate Change Research Program

Research Identifier: **RFA-008**

POC: John Scott, PhD. john.h.scott@nasa.gov

Research Focus Area: Earth-observing capabilities to support breakthrough science and National efforts to reduce greenhouse gas emissions (including CO₂, CH₄, N₂O, HFCs).

Research Identifier: **RFA-009**

POC: Sweterlitsch, Jeffrey, Ph.D. jeffrey.j.sweterlitsch@nasa.gov

Research Focus Area: U.S. Climate Change Research Program focusing on carbon capture and Utilization

Research Identifier: **RFA-010**

POC: Sweterlitsch, Jeffrey, Ph.D. jeffrey.j.sweterlitsch@nasa.gov

Research Focus Area: Addressing Orbital Debris: Control the long-term growth of debris population.

Research Identifier: **RFA-011**

POC: Bo Naasz, Ph.D. Bo.j.naasz@nasa.gov

3.3 Space Technology / Aeronautic Research

Space Technology Mission Directorate (STMD)

Aeronautics Research Mission Directorate (ARMD)

NASA Glenn Research Center

Research Focus Area: Development of advanced soft magnetic materials for high-power

electronic systems

Research Identifier: **RFA-012**

POC: Dr. Ronald Noebe ronald.d.noebe@nasa.gov

Description: NASA is interested in the development of advanced soft magnetic materials for use in high-efficiency, high-power electrical systems for power conversion, conditioning, and filtering. Such materials will be enabling in future electrical propulsion systems for aircraft and nuclear electric power and propulsion systems. Topic areas of interest include the investigation of new materials and processing methods for soft magnetic materials with improved performance at frequencies covering the kHz to MHz range, capable of operating at 200 - 400 °C without cooling. A primary goal for inductors and transformers would be a material capable of operating with switching frequencies in the range of 10 – 100 kHz with an induction field around 0.8 T, and have the ability to store at least 20 kW·kg⁻¹.

Research Focus Area: Development of high-temperature refractory alloys and coating systems

Research Identifier: **RFA-013**

POC: Dr. Ronald Noebe ronald.d.noebe@nasa.gov

Description: NASA is interested in the development of alloys for use at temperatures between 1200 and 2000 °C for structural components in high-speed aircraft, space nuclear power and propulsion applications, surface fission power, high-temperature heat pipes and thermal radiators, and other applications involving extreme temperatures and environments. Topic areas of interest include:

- Alloy development for W-, Mo-, Ta-, Nb-based alloys, refractory metal medium and high entropy alloys, and multi-principal element silicides
- Understanding of processing-microstructure-property relationships
- Effect of alloying on intrinsic deformation and fracture mechanisms
- Development of powder processing techniques
- Additive manufacturing of components made from refractory materials
- Environmental effects and development of protective coatings for refractory alloys or development of refractory alloys with inherent environmental resistance
- High-temperature mechanical properties and development of high-temperature test techniques for refractory materials

Research Focus Area: Development of materials for extreme environments

Research Identifier: **RFA-014**

POC: Dr. Ronald Noebe ronald.d.noebe@nasa.gov

Description: NASA is interested in the development of new materials for use in extreme environments such as those encountered in nuclear applications, extreme operating temperature environments such as encountered during re-entry and propulsion systems, and harsh environments such as those encountered during interplanetary exploration such as Venus and other extra-terrestrial environments. The goal would be to enable new NASA missions that

are not possible with current technologies. Topics of interest would include development of new materials, composites and processing technologies, investigation of processing-structure-property relationships, material durability, and characterization of properties relevant to the extreme environment being addressed.

3.4 In Space Manufacturing /On Demand Manufacturing of Electronics (ODME)

Space Operations Mission Directorate (SOMD)

Exploration Systems Development Mission Directorate (ESDMD)

Space Technology Mission Directorate (STMD)

As NASA prepares for long-duration manned space missions, there is a need for in-space manufacturing technologies that can support mission activities and allow crew members to fabricate new structures and devices and make necessary repairs. One such manufacturing technology of interest is printable sensors and electronics. At NASA Ames Research Center, we are exploring a variety of printing technologies including, but limited to, roll to roll processing, ink jet printing, 3D printing, plasma printing and microcontact printing. The devices may include the use of nanomaterials to improve overall performance. Device structures can be, but are not limited to spacecraft health monitoring sensors, environmental monitoring sensors, human health monitoring sensors, energy harvesting devices, energy storage devices and supporting hardware. This position is intended for the development or improvement of in-space manufacturing approaches, functional material development, and/or device prototyping and validation.

Research Focus Area: Advanced Manufacturing of Sensors and Electronics

Research Identifier: **RFA-015**

POC: Jessica Koehne, Ph.D. Jessica.E.Koehne@nasa.gov

Research Focus Area: Additive manufacturing and additive manufacturing of electronics

Research Identifier: **RFA-016**

POC: Curtis Hill curtis.w.hill@nasa.gov

Research Focus Area: LEO manufacturing support (additive, advanced materials, thin layer processing)

Research Identifier: **RFA-017**

POC: Curtis Hill curtis.w.hill@nasa.gov

Research Focus Area: Lunar manufacturing of solar cells and sensors

Research Identifier: **RFA-018**

POC: Curtis Hill curtis.w.hill@nasa.gov

Research Focus Area: Materials development for additive manufacturing

Research Identifier: **RFA-019**

POC: Curtis Hill curtis.w.hill@nasa.gov

3.5 Center for Design and Space Architecture

Exploration Systems Development Mission Directorate (ESDMD)

Space Technology Mission Directorate (STMD)

NASA Contacts:

Center for Design and Space Architecture

NASA Johnson Space Center

Research Focus Area: Crew-worn restraints and mobility aids for microgravity spacecraft cabin environments

Research Identifier: **RFA-020**

POC: Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov

Explanation: Traditionally, microgravity spacecraft cabins have included restraints and mobility aids such as handrails and foot restraints to enable crew to navigate the interior of the vehicle in the weightless conditions of orbital spaceflight. This focus area is concerned with alternatives to vehicle-based restraints and mobility aids. Instead, this research area investigates passive (non-powered) restraints and mobility aids that are worn on the crew members' clothing or carried on their person, such that the spacecraft does not need to provide any hardware to enable crew restraint and mobility.

POC: Robert L. Howard, Jr., Ph.D.

Research Focus Area: Crew quarters internal architectures compatible with both microgravity and fractional gravity domains

Research Identifier: **RFA-021**

POC: Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov

Explanation: NASA and commercial industry are developing plans for human missions to destinations including the Moon, Mars, and deep space. Traditionally, each destination has been viewed in isolation, with spacecraft designed uniquely for that environment. Additionally,

there are very few NASA standards that govern the design of crew quarters. This focus area investigates common designs for crew quarters that can be used across lunar habitats, Mars habitats, and deep space habitats, including the definition of functions and capabilities to be included in crew quarters, as well as the design and layout of components needed to implement these functions and capabilities.

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

Research Identifier: **RFA-022**

PC: Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov

Research Overview: 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 combining 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.

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

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.

2) **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.

3) **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.

4) **Other NASA-Coordinated Contributions to Proposed Work**

The following contributions will be provided to the proposed work that would be in addition to NASA EPSCoR awarded funding, and in the event of an award.

a. **From NASA organization other than EPSCoR**

None.

b. **From Organization partnering with NASA**

None.

5) **Additional Agreement Clauses applicable to Cooperative Agreements awarded for this Call Area**

Nonadditional.

6) **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.

7) **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.

3.6 Astrophysics

Science Mission Directorate (SMD)

Research Focus Area: Astrophysics Technology Development

Research Identifier: RFA-023

POCs: Dr. Hashima Hasan hhasan@nasa.gov
Dr. Mario Perez mario.perez@nasa.gov

NASA's strategic objective in astrophysics is to discover how the universe works, explore how it began and evolved, and search for life on planets around other stars. Three broad scientific questions flow from this objective:

- How does the universe work?
- How did we get here?
- Are we alone?

Each of these questions is accompanied by a science goal that shapes the Astrophysics Division's efforts towards fulfilling NASA's strategic objective:

- Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter and gravity
- Explore the origin and evolution of the galaxies, stars and planets that make up our universe
- Discover and study planets around other stars, and explore whether they could harbor life

To address these Astrophysics goals, the Astrophysics Research Analysis and Technology Program invites a wide range of astrophysics science investigations from space that can be broadly placed in the following categories.

(i) The development of new technology covering all wavelengths and fundamental particles, that can be applied to future space flight missions. This includes, but is not limited to, detector development, and optical components such as primary or secondary mirrors, coatings, gratings, filters, and spectrographs.

(ii) New technologies and techniques that may be tested by flying them on suborbital platforms such as rockets and balloons that are developed and launched by commercial suborbital flight providers or from NASA's launch range facilities, or by flying them on small and innovative orbital platforms such as cubesats.

(iii) Studies in laboratory astrophysics. Examples of these studies could include atomic and molecular data and properties of plasmas explored under conditions approximating those of astrophysical environments.

(iv) Theoretical studies and simulations that advance the goals of the astrophysics program

(v) Analysis of data that could lead to original discoveries from space astrophysics missions. This could include the compilations of catalogs, statistical studies, algorithms and pattern recognition, artificial intelligence applications, development of data pipelines, etc.

(vi) Citizen Science programs, which are a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process, are also invited. The current SMD Policy (<https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/atoms/files/SPD%2033%20Citizen%20Science.pdf>) on citizen science describes standards for evaluating proposed and funded SMD citizen science projects. For more information see the <https://science.nasa.gov/citizenscience> webpage, that provides information about existing SMD-funded projects.

(vii) Great Observatory Maturation Program (GOMAP): : <https://science.nasa.gov/astrophysics/programs/gomap>

Proposals should address the goals of the Science Mission Directorate's (SMD) Astrophysics Research Program, defined in SMD's *Science 2020-2024: A Vision for Scientific Excellence* (available at <http://science.nasa.gov/about-us/science-strategy>). Proposers are encouraged to read this *NASA Science Plan*, the *Astrophysics Roadmap* (available at <https://science.nasa.gov/astrophysics/documents/astrophysics-roadmap>), and the report of National Academy of Sciences Decadal Survey on Astronomy and Astrophysics 2020, *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*, (available at <https://www.nap.edu/catalog/26141/pathways-to-discovery-in-astronomy-and-astrophysics-for-the-2020s>)

Investigations submitted to the Astrophysics research program should explicitly support past, present, or future NASA astrophysics missions. These investigations can include theory, simulation, data analysis, and technology development. Information on the Astrophysics research program and missions is available at <https://science.nasa.gov/astrophysics>.

3.7 NASA Biological and Physical Sciences (BPS)

Science Mission Directorate (SMD)

NASA Headquarters Biological and Physical Sciences Division

Research Focus Area: Fundamental Physics

Research Identifier: **RFA-024**

POC: Mike Robinson michael.p.robinson@nasa.gov

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.

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 interferometry or atomic clocks, and the creation of exotic quantum matter than cannot exist on Earth.

Research Focus: 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: 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: Soft Matter Physics

Research Identifier: **RFA-025**

POC: Mike Robinson michael.p.robinson@nasa.gov

Research Overview: Granular material is one of the key focus areas of research in the field of soft matter. The fundamental understanding of physics of granular materials under different gravity condition is of key importance for deep space exploration and long-term habitation to sample collection from asteroids to improving the understanding of granular material handling on earth. Also, fundamental understanding of granular materials can help us understand motions in large bodies on earth (e.g.- landslides) that can help us save lives in case of natural emergencies.

Research Focus: This research topic focuses on developing fundamental knowledge base in the field of-

- Rheology of granular materials (both wet and dry)
 - Impact of anisotropy and structure
 - Impact of electrostatic charging
- In depth understanding of stress distribution in granular materials
- Dynamics of interparticle interaction and short range forces in granular materials

Both experimental and theoretical/numerical work will be in scope.

Additional Information: 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: Fluid Physics

Research Identifier: **RFA-026**

POC: Brad Carpenter bcarpenter@nasa.gov

Research Overview: The goal of the microgravity fluid physics program is to understand fluid behavior of physical systems in space, providing a foundation for predicting, controlling, and improving a vast range of technological processes. Specifically, in reduced gravity, the absence of buoyancy and the stronger influence of capillary forces can have a dramatic effect on fluid behavior. For example, capillary flows in space can pump fluids to higher levels than those achieved on Earth. In the case of systems where phase-change heat transfer is required, experimental results demonstrate that bubbles will not rise under pool boiling conditions in microgravity, resulting in a change in the heat transfer rate at the heater surface. The microgravity experimental data can be used to verify computational fluid dynamics models. These improved models can then be utilized by future spacecraft designers to predict the performance of fluid conditions in space exploration systems such as air revitalization, solid waste management, water recovery, thermal control, cryogenic storage and transfer, energy conversion systems, and liquid propulsion systems.

Research Focus: The research area of fluid physics includes the following themes:

- Adiabatic two-phase flow
- Boiling and condensation
- Capillary flow
- Interfacial phenomena
- Cryogenic propellant storage and transfer

Additional Information: 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

Research Identifier: **RFA-027**

POC: Brad Carpenter bcarpenter@nasa.gov

Research Overview: One of the goals of the microgravity combustion science research program is to improve combustion processes, leading to added benefits to human health, comfort, and

safety. NASA's microgravity combustion science research focuses on effects that can be studied in the absence of buoyancy-driven flows caused by Earth's gravity. Research conducted without the interference of buoyant flows can lead to an improvement in combustion efficiency, producing a considerable economic and environmental impact. Combustion science is also relevant to a range of challenges for long-term human exploration of space that involve reacting systems in reduced and low gravity. These challenges include: spacecraft fire prevention; fire detection and suppression; thermal processing of regolith for oxygen and water production; thermal processing of the Martian atmosphere for fuel and oxidizer production; and processing of waste and other organic matter for stabilization and recovery of water, oxygen and carbon. Substantial progress in any of these areas will be accelerated significantly by an active reduced-gravity combustion research program.

Research Focus: The research area of combustion science includes the following themes:

Spacecraft fire safety

Droplets

Gaseous – premixed and non-premixed

High pressure – transcritical combustion and supercritical reacting fluids

Solid fuels

Additional Information: 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>

NASA Biological and Physical Sciences (BPS)

NASA Marshall Space Flight Center (MSFC) / EM41

Research Focus Area: Materials Science

Research Identifier: **RFA-028**

POC: Brad Carpenter bcarpenter@nasa.gov

Research Overview: The goal of the microgravity materials science program is to improve the understanding of materials properties that will enable the development of higher-performing materials and processes for use both in space and on Earth. The program takes advantage of the unique features of the microgravity environment, where gravity-driven phenomena, such as sedimentation and thermosolutal convection, are nearly negligible. On Earth, natural convection leads to dendrite deformation and clustering, whereas in microgravity, in the absence of buoyant flow, the dendritic structure is nearly uniform. Major types of research that can be investigated include solidification effects and the resulting morphology, as well as accurate and precise measurement of thermophysical property data. These data can be used to develop computational models. The ability to predict microstructures accurately is a promising computational tool for advancing materials science and manufacturing.

Research Focus: The research area of materials science includes the following themes:

Glasses and ceramics
Granular materials
Metals
Polymers and organics
Semiconductors

Additional Information: 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: Growth of plants in inhospitable “deep space-relevant” Earth soils or conditions

Research Identifier: **RFA-029**

POC: Sharmila Bhattacharya SpaceBiology@nasaprs.com

Research Overview: As human exploration beings to move further out beyond Low Earth Orbit (BLEO), exploration missions will need to become increasingly self-sufficient, and will not be able to rely as heavily on resupply efforts from Earth, as they now do within Low Earth Orbit (LEO). The NASA Space Biology Program, therefore, as part of its initiative to enable organisms to Thrive in DEep Space (TiDES), is particularly interested in basic research that will ultimately translate into the ability to grow edible plants and crops in deep space environments. Research supported by our program has already demonstrated that 1) edible plants can be grown in the LEO environment of the International Space Station (Massa et al., 2017), and that 2) model (non-edible) plant organisms can germinate from seeds planted in lunar regolith obtained from the Apollo 11, 12, and 17 missions (Paul et al. 2022; for a historic perspective refer to Ferl and Paul, 2010). While both these results are very promising, there is still much work that needs to be done to move exploration efforts to the point where astronauts can begin to think about practicing agriculture in harsh deep space environments such as the lunar and Martian surfaces.

While much of Space Biology’s funded plant research efforts have focused on experiments conducted in spacecraft, or in the presence of simulated spaceflight/deep-space stressors, the program is interested in exploring another potential niche that exists here on Earth that may provide important insights into how both plants and the surrounding environment can be manipulated to support crop growth under harsh, inhospitable conditions. As early humans spread out across the globe, they have repeatedly encountered extreme environments that were far from being innately supportive of agriculture and settlement. Despite these challenges, humans have often found ways to live and even flourish in such environments, either by finding food sources that were robust enough to grow under such conditions, and/or by altering the terrain through irrigation and natural farming (soil modification with natural composts, crop rotation, etc.) to enable crop growth. Therefore, for this opportunity, Space Biology is soliciting proposals that will provide insights into how plants grow and continue to adapt to Earth’s extreme geochemically diverse environments, as well as how these

environments can be manipulated to support such growth.

Research Focus: This Space Biology Research Emphasis requests proposals for hypothesis-driven studies that will either provide a better understanding of the mechanisms by which some plants are able to grow and thrive in extreme or geochemically diverse environments on Earth or will identify plants and/or alternative methods that can be used to facilitate plant/crop growth in such extreme environments. Ideally, pilot studies funded from this opportunity will lead to additional future funded research that may translate to improved agricultural methods and tools that can be utilized in extreme environments on earth and eventually in harsh environments of the lunar and Martian surfaces.

Such topics of study may include, but are not limited to:

- Characterizing the molecular and/or biological mechanisms by which plants already known for their agricultural robustness are able to grow in soil types found in Earth's more extreme environments, including volcanic soils and sands (deserts), clay, etc. Particular emphasis may be given to edible plants.
- Identifying new plants that are able to grow in such soil samples and characterizing their growth and vitality.
- Genetic modification of plants to improve growth and robustness in such soils.
- Identifying or engineering microbiomes that will optimize plant growth and vitality in such soils.
- Testing or developing new composting methods or other natural methods of enrich such soils which will enable them to better support plant growth.

If logistics and costs permit, proposed studies may be conducted on location directly in the types of environments mentioned above, however, proposed studies may also use soil samples collected (or purchased) from these environments. It will be up to the proposer to identify the extreme environment/soil samples they will use for their studies, as well as provide justification in their proposal as to why these environments/soils were chosen and have relevance to space exploration.

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>).

References:

Ferl RJ, Paul AL. Lunar plant biology--a review of the Apollo era. *Astrobiology*. 2010 Apr;10. [doi/10.1089/ast.2009.04173](https://doi.org/10.1089/ast.2009.04173):261-73. doi: 10.1089/ast.2009.0417.

Massa GD, Dufour NF, Carver JA, Hummerick ME, Wheeler RM, Morrow RC, Smith TM. VEG-01: Veggie hardware validation testing on the International Space Station. Open Agriculture. 2017 Feb;2(1):33-41. doi.org/10.1515/opag-2017-0003 , Feb-2017.

Paul AL, Elardo SM, Ferl R. Plants grown in Apollo lunar regolith present stress-associated transcriptomes that inform prospects for lunar exploration. Commun Biol. 2022 May 12;5(1):382. doi: [10.1038/s42003-022-03334-8](https://doi.org/10.1038/s42003-022-03334-8). PMID: 35552509; PMCID: PMC9098553.

Research Focus Area: Commercially Enabled Rapid Space Science Project (CERISS)

Research Identifier: **RFA-030**

POC: Dr. Lisa Carnell; lisa.a.scottcarnell@nasa.gov

Research Overview: The Commercially Enabled Rapid Space Science initiative (CERISS) will develop transformative research capabilities with commercial space industry to dramatically increase the pace of research. Long-range goals include conducting scientist astronaut missions on the International Space Station and commercial low-earth orbit (LEO) destinations and develop automated hardware for experiments beyond low Earth orbit, such as to the lunar surface.

The benefits will include a 10-to-100-fold faster pace of research for a wide range of research sponsored by Biological and Physical Sciences Division, the NASA Human Research Program, other government agencies, and industry. Another benefit will be the increased demand for research and development in low earth orbit, facilitating growth of the commercial space industry.

Research Focus: Advancement of capabilities in the following areas are of particular interest:

Sample preparation; characterization of materials (e.g. differential scanning calorimetry, x-ray diffraction, fourier transform infrared spectroscopy, etc.); and analysis of samples (e.g. fluorescent activated cell sorting, protein and -omics, imaging, etc.)

Additional Information: All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences (BPS). Further information on CERISS is available at: <https://science.nasa.gov/biological-physical/commercial>.

3.8 Commercial Space Capabilities (CSC)

Space Operations Mission Directorate (SOMD)

NASA Johnson Space Center

The Commercial Space Capabilities (CSC) Research Interest area supports the Commercial Low Earth Orbit Development Program of NASA's Space Operations Mission Directorate (SOMD). This area's 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 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 TRL3. U.S. commercial spaceflight industry can then assess and determine implementation.

The overall goal of this 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.

Research Focus Area: In-Space Welding

Research Identifier: **RFA-031**

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: **RFA-032**

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: **RFA-033**

POC: Warren Ruummele 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 (-40°C), thruster temperature (600°C), and cathode temperature (1100°C).
 - 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: **RFA-034**

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: **RFA-035**

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: **RFA-036**

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

NASA is receptive to topics in this Research 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 the Intent and goal of this CSC Area.
- 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 CSC Interest Area (RFA-031 through RFA-036):

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.)

3.9 NASA Digital Transformation (DT)

Science Mission Directorate (SMD)

Jill Marlow, NASA Digital Transformation Officer

Marlowe, Jill M (HQ-JA000) jill.marlowe@nasa.gov

Patrick Murphy, NASA Digital Transformation – Portfolio Integration

PATRICK MURPHY patrick.murphy@nasa.gov

NASA DIGITAL TRANSFORMATION

NASA Digital Transformation is an agency strategic initiative that aims to accelerate our efforts to modernize and transform NASA using digital advances — by synchronizing DT investments across NASA and catalyzing DT progress by attacking cross-cutting barriers to technology readiness & adoption.

Since 1958, NASA's enduring purpose centers around a mission to discover, explore, innovate,

and advance solutions to the problems of flight, within and outside the Earth's atmosphere, for the benefit of humankind. With each new technological revolution, our agency continued to deliver on this mission. Now, the wide-scale adoption of numerous digital advances—cloud computing, data analytics, artificial intelligence, augmented/virtual reality, and others—calls for us to rise to the occasion yet again.

It is vital for us to undergo fundamental digital transformation in order to thrive in a more competitive digital workplace, become more efficient with our resources, and ensure safety from increasing digital threats. In late 2020, NASA established an Enterprise Digital Transformation (DT) agency-level strategic initiative to carry out such an endeavor. NASA's DT Strategic Framework and Implementation Plan outlines the DT initiative's approach for digitally transforming NASA. By transforming Engineering, Discovery, Operations and Decision Making, we will reach outcomes ensuring continued mission success well into the future. Our world is changing—and so must NASA.

Research Focus Area: Zero Trust, Cybersecurity Mesh Architecture, and Leveraging Artificial Intelligence for Realtime Cyber Defense

Research Identifier: **RFA-037**

NASA Digital Transformation – Zero Trust Foundations; Strategy and Architecture Office (SAO)
NASA Langley Research Center

POC: Mark Stanley, mark.a.stanley-1@nasa.gov

Cybersecurity Engineering Office (CSE)

NASA Headquarters

POC: Dennis daCruz dennis.m.dacruz@nasa.gov

Research Overview: The National Institute of Standards and Technology (NIST), in its Special Publication (SP) 800-207, “Zero Trust Architecture,” refers to the increasingly complex enterprise which has “led to the development of a new model for cybersecurity known as “zero trust” (ZT). A ZT approach is primarily focused on data and service protection but can and should be expanded to include all enterprise assets (devices, infrastructure components, applications, virtual and cloud components) and subjects (end users, applications and other nonhuman entities that request information from resources).” While the Zero Trust Framework evolved from its roots in the original Cybersecurity and Infrastructure Security Agency (CISA) Maturity Model to the latest Forrester Research-defined Zero Trust eXtended Framework, another construct emerged; namely, Cybersecurity Mesh Architecture (CSMA). Gartner defines CSMA as “a composable and scalable approach to extending security controls, even to widely distributed assets. Its flexibility is especially suitable for increasingly modular approaches consistent with hybrid multi-cloud architectures. CSMA enables a more composable, flexible and resilient security ecosystem. Rather than every security tool running in a silo, a cybersecurity mesh enables tools to interoperate through several supportive layers, such as consolidated policy management, security intelligence and identity fabric.” With a move to an

ever more integrated cybersecurity ecosystem, the volume of information, in both mass and speed, that could be leveraged to properly secure and defend the information environment will exceed the human capacity to be effective.

Research Focus: Conduct research on how to optimize a representative Zero Trust information environment to morph into a CSMA and benchmark the potential network operations and cybersecurity telemetry needed to identify, protect, detect, respond, and recover in the event of adversary activity. Then, research the best way in which artificial intelligence, to include machine learning and robotic process automation, could be leveraged to secure and defend the information environment in real time.

Research Focus Area: Applied AI Ethics

Research Identifier: **RFA-038**

NASA Digital Transformation – AI/ML Foundation

NASA Langley Research Center

POC: Ed McLarney, edward.l.mclarney@nasa.gov

Research Overview: There is limited research on trustworthy, responsible, ethical Artificial Intelligence (AI) among a wide variety of government, industry, academic, and international organizations.

Research Focus: Conduct benchmarking research regarding trustworthy, responsible, ethical AI among a wide variety of government, industry, academic, and international organizations. Provide a summary of key AI ethics principles relevant specifically to NASA but also generalizable to other government research, development & scientific organizations. Include the topic of beginning to measure AI ethics characteristics, leveraging existing metrics best practices, and including direct & indirect, subjective and objective measures. Beyond principles and metrics, provide recommendations for behaviors and mechanisms to make application of AI ethics concrete for AI practitioners. NASA will provide documentation of NASA approaches to AI ethics, AI governance, etc. as partial data for this research.

Research Focus Area: Scaled Video ML Object Detection and Alerts

Research Identifier: **RFA-039**

NASA Digital Transformation – AI/ML Foundation

NASA Langley Research Center , JSC, KSC

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Research Overview: There is limited research in mechanisms for optimizing video stream data flow for ML image analysis, reduction of full-system image recognition latencies to 3-5 seconds

or less, training mechanisms to recognize additional conditions / images, robustness against inclement weather, aggregation & visualization of key information, human factors considerations for consuming the outputs, ability to train / correct ML object recognition algorithms, and ability to archive results for post-launch analysis.

Research Focus: Conduct research into mechanisms to scale machine learning object recognition and alerts to hundreds of video streams. Possible use case: monitoring video streams for space launch facilities to warn of people in danger areas or anomalies in countdown sequences. Current practices include human monitoring of key launch video streams, or small numbers of ML-assisted video streams. Research would include mechanisms for optimizing video stream data flow for ML image analysis, reduction of full-system image recognition latencies to 3-5 seconds or less, training mechanisms to recognize additional conditions / images, robustness against inclement weather, aggregation & visualization of key information, human factors considerations for consuming the outputs, ability to train / correct ML object recognition algorithms, and ability to archive results for post-launch analysis. NASA will provide guidance for the research and representative launch videos. Note: this project is not about individual ML video stream object recognition; rather it is about scaling ML video object recognition to hundreds of streams.

Research Focus Area: Verification of AI/ML algorithms for Spacecraft.

Research Identifier: **RFA-040**

NASA Digital Transformation – AI/ML Foundation

NASA MSFC

POC: Scott Tashakkor scott.b.tashakkor@nasa.gov

Research Overview: AI/ML algorithms are non-deterministic by nature, they are statistical algorithms that take inputs and run through multiple nodes for output. Without the determinism and/or guarantee that the algorithm will respond in certain ways, AI/ML will be limited to only supplementary functions in Spacecraft (or aircraft). This is due to the safety of humans and space assets as well as the costs associated with these. Scientists would/could miss significant data or spacecraft can be lost.

Research Focus: Therefore, techniques for V&V of AI/ML algorithms needs to be researched and developed. AI/ML training in space assets suffers similar restrictions, and the hardware that is radiation tolerant (beyond LEO) is not developed yet. Conduct research into techniques for V&V of AI/ML algorithms, training in space assets suffers similar restrictions, and the hardware that is radiation tolerant.

Research Focus Area: Augmenting and Analyzing Requirements with Natural Language Processors.

Research Identifier: **RFA-041**

NASA Digital Transformation – AI/ML Foundation

NASA MSFC

POC: Scott Tashakkor scott.b.tashakkor@nasa.gov

Research Overview: Requirements are the basis to every project; Natural Language Process (NLP) solutions can help remove the ambiguity in requirements or help people identify which requirements need to be focused on. Determining techniques to identify missing requirements needs to be studied as well. Creating higher quality requirements can be augmented with NLP to identify better language to be used and with generative AI methods can write some of the basic requirements.

Research Focus: Conduct research into creation and understanding the quality of requirements augmented with NLP to identify better language to be used and with generative AI methods.

Research Focus Area: AI/ML algorithms to obtain and improve 3-dimensional remote sensing of the Earth's aerosols, clouds, oceans and lands using advanced lidar and polarimeter data.

Research Identifier: **RFA-042**

NASA Digital Transformation – AI/ML Foundation

NASA LaRC

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Research Overview: High-spectral-resolution lidars, such as the NASA High-Spectral-Resolution Lidar (HSRL-1 and HSRL-2 and HALO), and multiangle, multispectral polarimeters, such as the NASA Research Scanning Polarimeter, the PolCube polarimeter, and SPEXone and HARP2 onboard the NASA PACE mission, can provide unprecedented 3-D information about the Earth's aerosols, clouds, oceans and lands.

Research Focus: Conduct research in AI/ML remote sensing algorithms to rapidly and accurately process high-spectral-resolution lidars. AI/ML algorithms are sought that can quantitatively retrieve aerosol/cloud optical and microphysical properties including aerosol/cloud optical depth (AOD), absorbing aerosols (aerosol single-scattering albedo), aerosol/cloud size (effective radius) and size distribution width (effective variance). In addition to aerosol/cloud properties, AI/ML algorithms for cloud detection, ocean and land feature detection, water-leaving radiance, surface reflectance, and albedo are also sought. An emphasis is placed on AI/ML algorithms that can make use of combined lidar and polarimeter data, or combined polarimeter and hyperspectral data. Synergistic analysis of such combined data with AI/ML algorithms can provide additional information that is difficult to retrieve using traditional methods, such as for example aerosol/cloud number concentration or PM_{2.5}. Also,

AI/ML techniques can take advantage of combined passive and active sensors to fill observation gaps between the horizontal sparsity of active sensors and the vertical sparsity of passive sensors, to improve real-time 3-D monitoring and modeling of the Earth's surface and atmosphere. AI/ML algorithms that can improve climate models, regional dynamical models, or air quality forecasting models, by learning to optimize location, time and frequency of aerosol and cloud property observations, are also sought.

Research Focus Area: ICAN-C-Obscured Vision Enhancement

Research Identifier: **RFA-043**

NASA Digital Transformation – AI/ML Foundation

NASA MSFC

POC: Kelsey Buckles kelsey.d.buckles@nasa.gov

Research Overview: AI/ML can be used to see through dust and debris, and image processing, providing instantaneous clarity of ambient environment capability.

Research Focus: Conduct research to create a software/hardware capability to reduce visual noise. Primary objective is to reduce visual noise of blowing regolith during lunar landing.

Research Focus Area: Lox Methane HS Video Analysis.

Research Identifier: **RFA-044**

NASA Digital Transformation – AI/ML Foundation

NASA MSFC

POC: Kelsey Buckles kelsey.d.buckles@nasa.gov

Research Overview: There is limited research in utilizing AI/ML software to identify small scale motion detection in order to analyze a blast and characterize vapor cloud shape/position vs. time in space.

Research Focus: Conduct research to create AI/ML software that identifies small scale motion detection in order to analyze a blast and characterize vapor cloud shape/position vs. time in space. Primary function is to provide verification for Consolidated Operations, Management, Engineering and Test (COMET), Lightning Mapping Array (LMA), and Computational Fluid Dynamics (CFD). Other potential uses include structural health monitoring, foreign objects and debris clearing, and military asset recovery.

Research Focus Area: Motion Mag in the Dark.

Research Identifier: **RFA-045**

NASA Digital Transformation – AI/ML Foundation

NASA MSFC

POC: Kelsey Buckles kelsey.d.buckles@nasa.gov

Research Overview: There is limited research in determining the feasibility of using motion magnification, in place of the Integrated Modal Test (IMT).

Research Focus: Conduct research to determine the feasibility of using motion magnification, in place of the Integrated Modal Test (IMT). Primary objective is the potential replacement of IMT on Artemis II, using custom Long Wave Infrared (LWIR) cameras and lenses to encompass the entire stack. (Kelsey Buckles)

Research Focus Area: Foreign Object Debris (FOD) Detection Using Computer Vision.
Research Identifier: **RFA-046**

NASA Digital Transformation – AI/ML Foundation
NASA MSFC

POC: Kelsey Buckles kelsey.d.buckles@nasa.gov

Research Overview: There is limited research with software/hardware capabilities to detect and record the location and shape of Foreign Object Debris (FOD).

Research Focus: Conduct research to create a software/hardware capability to detect and record the location and shape of FOD. Primary function would be to use in place of a FOD walk, provide debris location data for analysis, monitor airfields and launch complexes. Using a drone equipped with custom Long Wave Infrared (LWIR) cameras and lenses, with onboard image recognition software. (Kelsey Buckles)

Research Focus Area: Using Multispectral Neural Radiance Fields (NeRFs) for Ground Detection & Characterization of Lunar Micro Cold Traps
Research Identifier: **RFA-047**

NASA Digital Transformation – AI/ML Foundation
NASA Ames

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Research Overview: High-resolution, near-real-time modeling is crucial for lunar science and exploration missions, particularly in identifying icy targets. Our proposal aims to generate intricate models of micro-cold-trap topography, temperatures, and water content to streamline target identification in dynamic, low-light polar environments. By applying Neural Radiance Fields (NeRFs) to data acquired from Artemis III and VIPER missions, we plan to enhance 3D mapping techniques, supporting science operations in future NASA expeditions. Micro cold traps, small and cold regions where ice remains thermally stable, are believed to contain

approximately 20% of the Moon's water ice. These traps are scattered across the lunar landscape and are safer and more accessible than permanently shadowed regions (PSRs). Despite their importance for lunar exploration, we lack prior knowledge of their locations and compositions due to their minute size.

Research Focus: Conduct research to remedy this by potentially employing custom-built NeRFs on multi-spectral ground-based data during mission operations. This research advancement would revolutionize surface science operations by facilitating the measurement and integration of micro-cold trap topography, temperature, and water content into augmented reality systems, thus assisting in identifying scientific targets.

Unlike traditional methods, NeRFs can maintain the full spectral range and resolution during scene optimization, potentially retaining spectral context throughout the 3D reconstruction process. By utilizing intelligent priors and leveraging knowledge about light sources and sparse point clouds of target regions, the optimization in the NeRF could be constrained. This would result in accurate 3D reconstructions across various wavelengths, especially those diagnostic of water ice. Our proposed NeRFs will be rigorously tested using the SSERVI Lunar Regolith Testbeds at NASA Ames.

Note: NASA Ames is in collaboration with UC Berkeley, with potential NSF funding being directed to Professor Angjoo Kanazawa of the department of Electrical Engineering and Computer Sciences (EECS). Her pioneering research in 3D vision, specifically related to neural volumetric rendering and Neural Radiance Fields, will be instrumental in driving this project forward.

Research Focus Area: High-Resolution 3D Mapping of Lunar Shadowed Regions Using Neural Radiance Fields (NeRFs)

Research Identifier: RFA- **RFA-048**

NASA Digital Transformation – AI/ML Foundation

NASA Ames

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Research Overview: With upcoming missions like Artemis and Commercial Lunar Payload Services (CLPS) aiming to study these lunar polar regions, designing safe traverses into, within, and out of permanently shadowed regions (PSRs) for robots and astronauts poses a primary challenge due to the lack of high-resolution and high signal-to-noise Digital Terrain Models (DTMs) of these areas.

Research Focus: Conduct research to overcome this, and determine if utilizing Neural Radiance Fields (NeRFs) will generate high-resolution 3D models of PSRs for efficient mission planning, safe operations, and maximizing scientific returns.

NeRFs, a novel technique in 3D reconstruction, outperform traditional methods like Multi-View Stereo (MVS) in handling complex lighting conditions typical of lunar polar regions. Recent developments in NeRF pipelines, including Sat-NeRF, RAWNeRF, StructNeRF, and DS-NeRF, present promising opportunities for our applications. We intend to leverage these advancements in neural 3D reconstruction as well ray tracing techniques to simulate secondary illumination in PSRs to develop an hybrid MVS/NeRF-based mapping method for PSR reconstruction.

Note: NASA Ames is in collaboration with UC Berkeley, with potential NSF funding being directed to Professor Angjoo Kanazawa of the department of Electrical Engineering and Computer Sciences (EECS). Her pioneering research in 3D vision, specifically related to neural volumetric rendering and Neural Radiance Fields, will be instrumental in driving this project forward.

Research Focus Area: Study the deployment of Large Language Models (LLMs) for Systems Engineering and Project Management at NASA

Research Identifier: RFA- **RFA-049**

NASA Digital Transformation – AI/ML Foundation
NASA Ames

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Research Overview: As the complexity of projects at NASA increases, more sophisticated tools are required for efficient systems engineering and project management. Large Language Models (LLMs) can offer potential advantages in these domains. However, due to their statistical nature, reliability and transparency concerns may hinder their adoption. Thorough verification and validation processes are vital to ensure their trustworthy and robust implementation in mission-critical planning and execution.

Research Focus: Conduct research on LLMs focuses on: (1) Identifying potential applications and benefits of LLMs in enhancing systems engineering and project management processes. (2) Establishing robust techniques for the verification and validation of LLMs within these contexts. (3) Recognizing and mitigating potential risks and limitations, addressing transparency and bias issues inherent in LLMs. The objective is to enable the integration of LLMs into NASA's operations to improve project management efficiency, reduce planning complexities, and facilitate more effective communication and information processing, paving the way for the next generation of space mission planning and execution.

Research Focus Area: Collaborative platforms for capturing data analytics workflows.

Research Identifier: **RFA-050**

NASA Digital Transformation – AI/ML Foundation

NASA Ames

POC: Nikunj Oza nikunj.c.oz@nasa.gov

Research Overview: Platforms are needed that allow for individuals and groups to perform the many steps needed to transform raw data into domain-relevant insights and publications and capture these steps into workflows that can be shared, revised, and compared. Users must be able to use the tools that they are accustomed to using, such as Jupyter notebooks, MATLAB, Python libraries, various databases, and/or others. However, the various steps that users take need to be captured in a form to where they can be readily re-run, individual steps can be changed, the resulting new workflows can be re-run, and the results compared to the previous workflows. Such workflow capture systems and Machine Learning can be used as the basis for a recommender system for new users to recommend key steps in new workflows that they create. Such systems can also be used to flag publications that may need to be revised because earlier data processing or analytics steps have been revised. Such a system can also serve as an “honest broker” that can instantly make a record of who produced a given result so that others may use that result immediately, without waiting for a publication, and while automatically giving the creator due credit.

Research Focus: Conduct research to properly understand how experts in different domains perform data analytics and develop components of a workflow capture system that will work as described above while using the tools of those domains as much as possible and not impeding the experts’ work. Research is also needed to identify interface standards that are general enough to allow the tool interoperability described here and demonstrate whether productivity is improved due to the components and systems developed.

Research Focus Area: Uses of generative AI to dynamically create Photo realistic 3D content in real-time for use in XR applications.

Research Identifier: **RFA-051**

NASA Digital Transformation – AI/ML Foundation

NASA Ames/JSC

POC: Jules Casuga jules.casuga@nasa.gov
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Research Overview: XR environments (virtual reality, augmented reality, and mixed reality) are being used to train crew, support operations, augment collaboration, improve the planning

process, support complex data visualization, and support public and education outreach activities. One of the biggest challenges developing these applications is having access to high fidelity, realistic 3D models that are combined to create realistic and immersive applications. An active area of research is to use generative A.I. to, in real-time, create and insert 3D models into a virtual scene dynamically using a simple and intuitive user interface.

Emerging AI generative technologies currently being researched in this field include Neural Radiance Fields (NeRFs) and GANS to support the creation of 3D assets. An investigation into a Language Models (LLM) to generate natural language description of 3D assets can potentially be used in combination with NeRFs to speed up the process of 3D asset generation for XR applications.

Research Focus: Conduct research the feasibility of creating high fidelity 3D models dynamically (using a simple interface to define their properties) and insert them into a live XR session within acceptable time-frames, so that the user does not experience a degradation in frame rate that detracts from the immersive experience? Best validation methods to assure the assets created are representative of what would be expected. Optimum way(s) to interact with the system (voice, keyboard, other)?

Research Focus Area: Use of a Brain Computer Interface (BCI) system as a novel computer interface

Research Identifier: **RFA-052**

NASA Digital Transformation – AI/ML Foundation

NASA Ames/JSC

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Research Overview: The mantle of human to computer interaction for decades has been the keyboard and mouse. Recently technologies such as voice recognition and body/limb/finger tracking have also been used to provide inputs to computers. Of course, the ultimate computer input device would allow a person to interface their mind directly with a computer. The idea that people's thoughts could be read and manipulated has been a theme in science fiction for decades. Conceptually, the brain would be communicating with a computer the same way it communicates with other parts of the body, but instead of using eyes, hands and fingers directly, a person would just have to think what they want the computer to carry out.

Research Focus: Conduct research the feasibility of creating a functional BCI system and the level of interactions/commands that a brain computer interface can provide; What biometric devices are best suited for this type of application. Best methods to incorporate this type of system into an XR environment?

Research Focus Area: Cognitive State Determination System to Support Training, Education, and Real-Time Operations in an XR environment.

Research Identifier: **RFA-053**

NASA Digital Transformation – AI/ML Foundation

NASA Ames/JSC

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Research Overview: There is limited research on how we can use advanced computer science methods to develop correlation algorithms that use autonomic responses in the vision system (pupil dilation), autonomic response related to the conductance of the skin (galvanic skin response), the vascular system (heart rate and heart rate variability), electrochemical patterns in the brain (using EEG), hemoglobin-concentration changes in the brain (using Functional Near-Infrared Spectroscopy - FNIR), Electrical activity in the muscles (EMG), and vocal biomarkers. The system could use all of the biometric modalities mentioned above, or just a subset to carry a determination of a person's mental state. The states of primary interest include: cognitive underload, adequate cognitive workload, high cognitive workload, and cognitive overload. The system should also provide a confidence level for each prediction. A Cognitive State Determination System (CSDS) can significantly improve applications related to education, training, medicine, marketing, aeronautics, transportation, etc. For initial wide range usage, this type of system would require the use of non-intrusive sensors that are easy to use.

Note: An example of a CSDS system for training and education could allow for the educator/trainer to modulate the information being provided based on the trainee's cognitive state. If the trainee is bored, then additional elements to make the tasks more engaging could be added. If the person is getting close to cognitive overload, easier elements could be incorporated. Another example is the usage of a CSDS system to support real-time operations. Providing cognitive state information to support personnel or to the individual themselves would be valuable. This system can be used to support a wide range of activities from operating a spacecraft, flying an airplane, to driving a car. Coupling a cognitive state determination system with an AI/ML system would allow for the creation of an adaptable human interface that can modulate the information being provided to a user based on their cognitive state.

Research Focus: Conduct research on the feasibility to create a system that can accurately determine a person mental state. Specially its' ability to determine when a person is experiencing cognitive underload, adequate cognitive workload, high cognitive workload, and cognitive overload; Variability and performance differences between individuals; Study into the optimum set of biometric sensors needed for this type of system.

Research Focus Area: Automatic XR friendly procedure creation using videos

Research Identifier: **RFA-054**

NASA Digital Transformation – AI/ML Foundation
NASA Ames/JSC

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Research Overview: NASA and many other organizations use procedures to support a wide variety of applications that range from maintaining a simple system, to carrying complex operations in dangerous environments. Depending on the use-case, developing procedures can require significant resource investments by many people with different skill bases. These individuals are scarce and always in demand. The desire is to have the ability to create XR friendly procedures automatically by capturing and analyzing training videos of specific tasks. Additionally, capturing and analyzing context specific to NASA's (or other companies) terms/vocabulary from the video voice or written instructional documentation is a challenging, but necessary component to create accurate and useable procedure content. Finally, in order for the virtual procedure assistance to serve its purpose to its full extent, it must be able to adapt to the user's expertise by presenting the information to them in a user customized manner. Another area of research is how to best incorporate this capability in an immersive XR system.

Research Focus: Conduct research to determine the feasibility of creating a system that can automatically develop accurate procedures using video.; Optimum ways to interact with such a system; Ability for a system to customize procedure content to meet an individual's expertise.

Research Focus Area: Video based mocap system
Research Identifier: **RFA-055**

NASA Digital Transformation – AI/ML Foundation
NASA Ames/JSC

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Research Overview: VR Motion Capture (Mocap) Systems are an important part of an XR system. Technology specific challenges that would be researched include the overall performance and viability of a video based Mocap system. In the near-term, R&D will benefit from automation of analytical workflows for engineering design and contribute toward research and the evaluation of options for in-flight crew data collections on the ISS. Comparing how an astronaut is ambulating over time, when carrying out an activity, can be used to determine changes in the musculoskeletal system that may be caused by fatigue or injury. Identifying and looking for ways to mitigate these types of changes is important to assure that astronauts are always performing in an optimum state.

Furthermore, contactless mocap system can support the development of a personal coach that can instruct a person when they are not performing exercises correctly. This could be done by using a pre-trained A.I. system that knows the positions of a person's limbs, torso and head while exercising and comparing them to optimum positions for the activity. Investigating ways that the system can interact with a person is another research area.

Research Focus: Conduct research to determine the feasibility of creating a system that can automatically determine a person's pose based on video. Performance metrics and limitations of such a system.

Research Focus Area: Retrieval Augmented Dialog LLM
Research Identifier: **RFA-056**

NASA Digital Transformation – AI/ML Foundation
NASA HQ
POCs: David Meza david.meza-1@nasa.gov

Research Overview: NASA policy, strategic documents, SOPs, and other important information are split across many diverse and disparate documents. Currently it is highly time consuming and difficult for NASA employees to determine the correct policy or SOP relevant to their situation. NASA employees lack a simple tool for them to quickly get answers to their questions in a seamless, natural way. Large Language Models (LLMs) provide a potential simple interface for employees to get answers, but current models require NASA questions and information to be provided to a 3rd party as part of the Generative AI process threatening the security of NASA's information. Existing Generative AI tools also suffer from hallucinations where they provide highly convincing, but inaccurate responses.

Research Focus: By deploying an LLM on the NASA network, NASA employees will be able to ask questions in natural language without risking their data leaving NASA systems. This will ensure their privacy and the protection of NASA information. By breaking NASA documents into small chunks of relevant information and storing those documents as semantic embeddings in a vector database, the relevant pieces of NASA policy can be retrieved to answer each question as it is asked. Through prompt engineering and fine-tuning, the LLM can be guided to answer the questions with the additional information "injected" from the NASA official policies and documents. This ensures the models provide true information and do not hallucinate answers to questions not available in their public training data. This project will pilot creating this tool on NASA infrastructure and determine how the tools and interface must be customized for the NASA environment and use cases. This project will explore, document, and propose a technical path forward to scale the pilot system to a production NASA tool. This solution could be replicated at any Agency or organization.

3.10 Earth Science

Science Mission Directorate (SMD)
NASA SMD Earth Science Division (ESD)

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Research Focus Area: Impacts of human activity on coastal physical, geomorphological and ecological variability

Research Identifier: **RFA-057**

Research Focus Area: Sea level rise, coastal erosion/retreat, and salt-water intrusion, and their impacts on ecosystems;

Research Identifier: **RFA-058**

Research Focus Area: Linkages between aquatic dynamics and land subsidence and its impacts on aquatic ecosystems

Research Identifier: **RFA-059**

Research Focus Area: The role of urban development on land subsidence and aquatic ecosystems; biophysical coupling and feedbacks within the aquatic-land interface

Research Identifier: **RFA-060**

Research Focus Area: Impacts of hazards related to climate extremes, such as storms and heat waves, on biogeophysical aspects of the coast; etc.

Research Identifier: **RFA-061**

Research Focus Area: Impacts of upstream activities on coastal communities

Research Identifier: **RFA-062**

Research Focus Area: Integration of existing and upcoming observational and modeling assets into a conceptual or (better) digital aquatic-land framework that enables the dynamical coupling of key processes within the aquatic-land interface.

Research Identifier: **RFA-063**

Research Focus Area: Exposure and vulnerability to geohazards (e.g., infrastructure and flooding, landslides, etc.), land cover/use change and their impacts on water

Research Identifier: **RFA-064**

Research Overview: NASA SMD Earth Science Division (ESD) seeks topics to address coastal and ecosystem resilience, and equity and environmental justice.

This research focus area seeks to expand and build on the recently-established [Coastal Resilience program](#), selected under ROSES22, and the work solicited under ROSES21 [equity and environmental justice](#) and ROSES22 IDS [environmental and climate justice](#). Climate change impacts all aspects of the Earth and human systems, and highly-populated coastal communities (adjacent to inland water bodies and the ocean) are among those experiencing its most disruptive consequences. Extreme weather events on land (droughts/floods), erosion, loss of marshes and wetlands, rising oceans and other direct human-induced changes threaten coastal communities, ecosystems, national and global economies. Furthermore, land changes from human activities such as groundwater/hydrocarbon extraction/injection, levee construction, river/sediment management, and urban development can have compounding effects with the naturally-occurring land processes such as tectonics, sediment compaction, erosion, etc., with each process modifying the land surface elevation and coastal geomorphology. Combined, these complex and interconnected aquatic-land processes impact biogeochemistry and ecology, affect ecosystem structure and function, and threaten biodiversity.

NASA ESD recognizes a need to develop and learn from relationships with environmental justice (EJ) and climate justice (CJ) and underserved communities, as well as organizations familiar with working alongside these communities. EJ and CJ refer to communities in geographic locations around the globe with significant representation of minoritized populations, low-income persons, and/or indigenous persons or members of Tribal nations, where such individuals experience, or are at risk of experiencing, more adverse human health, environmental, and/or climate change impacts.

NASA Earth Science and satellite-based Earth observations can play an important role in addressing questions at the intersection of Earth observations and EJ/CJ, and are critical to understanding and predicting land/aquatic interface environments that undergo natural and human-induced changes. Understanding both direct and indirect human-induced changes is equally important in informing studies of coastal resilience and addressing high priority EJ/CJ needs.

Proposals seeking to respond to this EPSCoR Research Topic must address research that contributes to furthering support priorities related to coastal resilience and EJ/CJ, and will provide the foundational information and evidence-based knowledge that will help inform solutions to increase resilience of coastal communities and high priority needs as exemplified below. NASA is specifically interested in proposals that make significant use of remote sensing data to advance our understanding of key physical, biological, biogeochemical, geological, and hydrological coastal processes and their interactions within the interface of the aquatic-land-human system, and to enhance our understanding of how these processes will be compounded in rapidly changing coastal environments.

Examples of potential topics suitable for the EPSCoR research on coastal resilience include the exploration of the underlying physical, biological, and/or geological mechanisms within the

aquatic-land framework and potential feedback processes and impacts on coastal ecosystems and underserved communities. Examples of coupled coastal processes may include but are not limited to:

1. Impacts of human activity on coastal physical, geomorphological and ecological variability;
2. Sea level rise, coastal erosion/retreat, and salt-water intrusion, and their impacts on ecosystems;
3. Linkages between aquatic dynamics and land subsidence and its impacts on aquatic ecosystems;
4. The role of urban development on land subsidence and aquatic ecosystems; biophysical coupling and feedbacks within the aquatic-land interface;
5. Impacts of hazards related to climate extremes, such as storms and heat waves, on biogeophysical aspects of the coast; etc.
6. Impacts of upstream activities on coastal communities
7. Integration of existing and upcoming observational and modeling assets into a conceptual or (better) digital aquatic-land framework that enables the dynamical coupling of key processes within the aquatic-land interface.
8. Exposure and vulnerability to geohazards (e.g., infrastructure and flooding, landslides, etc.), land cover/use change and their impacts on water

The proposed investigations should be of regional (beyond local, 1,000+ km) focus, preferably in areas of high potential population growth, e.g. U.S. East, West, or Gulf coasts, Island Nations, and other low-lying regions across the globe that are impacted by climate change and/or socio-economic disadvantages. Proposals must provide a rationale for their region of choice. Proposals targeting the EJ/CJ topics are encouraged to integrate socio-economic data in their proposal.

Proposed investigations must utilize remotely sensed observations (e.g., MODIS, Landsat, etc.) for data analysis and as a primary research tool; however, other NASA data products from airborne campaigns, ground-based stations, or model output may be used for the proposed research. Proposers are also encouraged to use data acquired via the NASA Commercial SmallSat Data Acquisition Program ([CSDAP](https://cisdap.nasa.gov/)). 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.

3.11 Entry Systems Modeling Project

Space Technology Mission Directorate (STMD)

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

Research Identifier: **RFA-065**

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: 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 and in a non-oxidizing environment 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: Predictive Modeling of Plasma Physics Relevant to High Enthalpy Facilities

Research Identifier: **RFA-066**

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.

Research Focus Area: Mechanical Properties of Ablative TPS Materials during Char Formation

Research Identifier: **RFA-067**

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

Research Overview: Provide mechanical property data to enable models that couple pyrolysis and char formation with thermostructural analysis for predicting the stress state of ablative TPS materials of interest to Entry Descent and Landing projects and missions at NASA.

Research Focus: This proposal seeks mechanical and/or strength measurements of ablative, porous thermal protection system (TPS) materials. The properties should be determined as a function of char conversion, with the char conversion occurring under controllable, repeatable conditions. Both degree and rate of char formation on the final properties would be desirable. The data would be made available to the TPS materials modeling groups at NASA to improve coupled ablative and thermostructural models.

3.12 Office of Chief Health and Medical Officer (OCHMO)

Space Operations Mission Directorate (SOMD)

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

Research Identifier: **RFA-068**

POC: Victor S. Schneider vschneider@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: **RFA-069**

POC: Victor S. Schneider vschneider@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.

3.13 Human Research Program

Human Exploration and Operations (HEO) Mission Directorate (HEOMD)

Precision Health Initiative

Research Focus Area: Pilot studies to adopt terrestrial precision health solutions for astronauts
Research Identifier: RFA-070

POC: Corey Theriot corey.theriot@nasa.gov , 281-244-7331

The term “precision health” (similar to precision or personalized medicine in clinical settings) refers to the strategy of collecting and analyzing an individual’s unique health status along with environmental and lifestyle data to identify key factors that can ultimately improve the health and performance of each crewmember in an individualized manner.

The Precision Health Initiative seeks to identify innovative methods 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 vetted and approved precision health techniques from terrestrial settings 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. For this solicitation, the term “technique” encompasses any clinical practice, strategy, test, or process that provides a clinically actionable medical outcome or unique knowledge of an individual’s health status.

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 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.

Systems Biology Translation

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

Research Identifier: **RFA-071**

POC: Corey Theriot corey.theriot@nasa.gov, 281-244-7331

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. 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 to spaceflight. 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 topic 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.

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 system (CNS) changes that impact astronaut health and performance.

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

Research Identifier: **RFA-072**

POC: Robin Elgart shona.elgart@nasa.gov

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: **RFA-073**

POC: Robin Elgart shona.elgart@nasa.gov

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: **RFA-074**

POC: Robin Elgart shona.elgart@nasa.gov
Brock Sishc brock.i.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: **RFA-075**

POC: Robin Elgart shona.elgart@nasa.gov
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: **RFA-076**

POC: Robin Elgart shona.elgart@nasa.gov
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.

3.14 Planetary Division

Science Mission Directorate (SMD)

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: **RFA-077**

POC: Montbach, Erica N. (GRC-MA00) erica.n.montbach@nasa.gov
Michael Lienhard michael.a.lienhard@nasa.gov

Research Overview: Venus has important scientific relevance to understanding Earth, the Solar System formation, and Exoplanets. Venus' highly acidic surface conditions are also a unique extreme environment with temperatures of ~500 C at the surface and pressures of ~90 earth atmospheres (or equivalent to pressures at a depth of 1 km in Earth's oceans). Additional 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/>.

Advances in high-temperature electronics and power generation would enable long-duration missions (months) on the surface of Venus, where the sensors and all other components operate at Venus' surface ambient temperature. Development of high-temperature electronics, memory, transmitters, sensors, actuators, and power sources designed for operating in the Venus ambient would be enabling for future missions. Additional 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

Venus surface landers could investigate a variety of open questions that can be uniquely addressed through in-situ measurements. The Roadmap for Venus Exploration 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: **RFA-078**

POC: Montbach, Erica N. (GRC-MA00) erica.n.montbach@nasa.gov
Michael Lienhard michael.a.lienhard@nasa.gov

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.

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. Sensors for atmospheric chemistry and other science that can be accomplished on aerial platform missions are needed.

Further Information on can be found on the Venus Exploration Analysis Group (VEXAG) website: <https://www.lpi.usra.edu/vexag/> in the “Aerial Platforms for the Scientific Exploration of Venus” and the Venus Technology Roadmap at: https://www.lpi.usra.edu/vexag/documents/reports/VEXAG_Venus_Techplan_2019.pdf

Research Focus Area: In-situ Astrobiology Instruments

Research Identifier: **RFA-079**

POC: Montbach, Erica N. (GRC-MA00) erica.n.montbach@nasa.gov
Michael Lienhard michael.a.lienhard@nasa.gov

Research Overview: The determination of whether other bodies in our solar system are, or were habitable, are important science questions identified in “An Astrobiology Strategy for the Search for Life in the Universe” at <https://nap.nationalacademies.org/catalog/25252/>. [Additional information on promising destination in the solar system towards the search for conditions suitable for life can be found in](#) “Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032 (2022)” at <https://nap.nationalacademies.org/catalog/26522/>.

NASA may employ instruments similar to those used on Earth to detect biomarkers and/or to determine evidence of habitability in the solar system. The concentration of organic material at destinations of interest may be very low, necessitating innovative sample handling and processing techniques to perform sample analysis. Maintaining positive and negative controls,

ensuring that samples are not destroyed or contaminated, and reading highly dilute and/or small samples are also technology challenges in this area. This topic seeks the development of innovative technologies that significantly improve instrument measurement capabilities for future planetary science missions that will look for bio habitability in the search for life.

3.15 Planetary Protection

Science Mission Directorate (SMD)

Exploration Systems Development Mission Directorate (ESDMD)

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: **RFA-080**

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 mission¹.

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.

¹ 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

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.

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

Research Identifier: **RFA-081**

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 4 : Contacts/Inquiries

For inquiries regarding technical and scientific aspects of NASA's Research Focus Areas

in this NOFO, please contact:

Research Focus Area/Point of Contact (POC)		
<p>Electrified Vertical Takeoff and Landing (eVTOL), Material Characterization and Modeling Aeronautic Research Mission Directorate (ARMD)</p> <p>John M. Koudelka, Project Manager john.m.koudelka@nasa.gov NASA Glenn Research Center (GRC) Susan A. Gorton, Project Manager susan.a.gorton@nasa.gov NASA GRC Timothy Krantz, timothy.l.krantz@nasa.gov NASA GRC Dr. Mark J. Valco, mark.j.valco@nasa.gov NASA GRC Robert Goldberg robert.goldberg@nasa.gov NASA GRC Justin Littell justin.d.littell@nasa.gov NASA Langley Research Center (LaRC) Mike Pereira mike.pereira@nasa.gov NASA GRC Trenton M. Ricks, PhD trenton.m.ricks@nasa.gov NASA GRC Dr. Steven M. Arnold steven.m.arnold@nasa.gov NASA GRC</p>		
Research Focus Area	Point of Contact	Id
Safe and Efficient Electro-mechanical Powertrains for Electrified Vertical Takeoff and Landing (eVTOL) Vehicles	Timothy Krantz, timothy.l.krantz@nasa.gov Dr. Mark J. Valco, mark.j.valco@nasa.gov	RFA-001
Electric motor technologies appropriate for eVTOL with high torque density and, concurrently, such motors being free of partial discharge and having a continuous power rating in the range 50 – 400 kW.	Timothy Krantz, timothy.l.krantz@nasa.gov Dr. Mark J. Valco, mark.j.valco@nasa.gov	RFA-002
High reliability, robustness, and fault-tolerance for inverter-motor systems as needed for safety-critical eVTOL propulsion.	Timothy Krantz, timothy.l.krantz@nasa.gov Dr. Mark J. Valco, mark.j.valco@nasa.gov	RFA-003
Lubrication and cooling technologies specifically optimized for long life and highly efficient eVTOL motors, including interest in single-fluid approaches for inverters, motors, and gearboxes.	Timothy Krantz, timothy.l.krantz@nasa.gov Dr. Mark J. Valco, mark.j.valco@nasa.gov	RFA-004

Research Focus Area/Point of Contact (POC)		
Development of Characterization Techniques to Determine Rate and Temperature Dependent Composite Material Properties for the LS-DYNA MAT213 Model	Robert Goldberg robert.goldberg@nasa.gov Justin Littell justin.d.littell@nasa.gov Mike Pereira mike.pereira@nasa.gov	RFA-005
Multiscale Modeling of Heterogeneous Materials with NASMAT	Trenton M. Ricks, PhD trenton.m.ricks@nasa.gov Dr. Steven M. Arnold steven.m.arnold@nasa.gov	RFA-006
<p>Clean Energy, Climate Change and Orbital Debris Space Technology Mission Directorate (STMD)</p> <p>John Scott, PhD. john.h.scott@nasa.gov NASA Johnson Space Center (JSC) Jeffrey Sweterlitsch, PhD jeffrey.j.sweterlitsch@nasa.gov NASA JSC Bo Naasz, PhD Bo.j.naasz@nasa.gov NASA Goddard Space Flight Center (GSFC)</p>		
Research Focus Area	Point of Contact	Id
Clean Energy and Emissions Technologies	John Scott, PhD. john.h.scott@nasa.gov	RFA-007
U.S. Climate Change Research Program	John Scott, PhD. john.h.scott@nasa.gov	RFA-008
Earth-observing capabilities to support breakthrough science and National efforts to reduce greenhouse gas emissions (including CO2, CH4, N2O, HFCs)	Jeffrey Sweterlitsch, PhD jeffrey.j.sweterlitsch@nasa.gov	RFA-009
U.S. Climate Change Research Program focusing on carbon capture and utilization	Jeffrey Sweterlitsch, PhD jeffrey.j.sweterlitsch@nasa.gov	RFA-010
Addressing Orbital Debris: Control the long-term growth of debris population	Bo Naasz, PhD. Bo.j.naasz@nasa.gov	RFA-011
<p>Space Technology / Aeronautic Research Space Technology Mission Directorate (STMD) Aeronautics Research Mission Directorate (ARMD)</p> <p>Dr. Ronald Noebe ronald.d.noebe@nasa.gov NASA Glenn Research Center (GRC)</p>		
Research Focus Area	Point of Contact	Id
Development of advanced soft magnetic materials for high-power electronic systems	Dr. Ronald Noebe ronald.d.noebe@nasa.gov	RFA-012
Development of high-temperature refractory alloys and coating systems	Dr. Ronald Noebe ronald.d.noebe@nasa.gov	RFA-013

Research Focus Area/Point of Contact (POC)		
Development of materials for extreme environments	Dr. Ronald Noebe ronald.d.noebe@nasa.gov	RFA-014
<p>In Space Manufacturing /On Demand Manufacturing of Electronics (ODME) Space Operations Mission Directorate (SOMD) Exploration Systems Development Mission Directorate (ESDMD) Space Technology Mission Directorate (STMD)</p> <p>Jessica Koehne, Ph.D. Jessica.E.Koehne@nasa.gov NASA Ames Research Center (ARC) Curtis Hill curtis.w.hill@nasa.gov NASA Marshall Space Flight Center (MSFC)</p>		
Research Focus Area	Point of Contact	Id
Advanced Manufacturing of Sensors and Electronics	Jessica Koehne, Ph.D. Jessica.E.Koehne@nasa.gov	RFA-015
Additive manufacturing and additive manufacturing of electronics	Curtis Hill curtis.w.hill@nasa.gov	RFA-016
LEO manufacturing support (additive, advanced materials, thin layer processing)	Curtis Hill curtis.w.hill@nasa.gov	RFA-017
Lunar manufacturing of solar cells and sensors	Curtis Hill curtis.w.hill@nasa.gov	RFA-018
Materials development for additive manufacturing	Curtis Hill curtis.w.hill@nasa.gov	RFA-019
<p>Center for Design and Space Architecture Exploration Systems Development Mission Directorate (ESDMD) Space Technology Mission Directorate (STMD)</p> <p>Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov NASA Johnson Space Center (JSC)</p>		
Research Focus Area	Point of Contact	Id
Crew-worn restraints and mobility aids for microgravity spacecraft cabin environments	Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov	RFA-020
Crew quarters internal architectures compatible with both microgravity and fractional gravity domains	Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov	RFA-021
Repair, Manufacturing, And Fabrication (RMAF) Facility for the Common Habitat Architecture	Robert L. Howard, Jr., Ph.D. robert.l.howard@nasa.gov	RFA-022

Research Focus Area/Point of Contact (POC)		
<p>Astrophysics Science Mission Directorate (SMD)</p> <p>Dr. Hashima Hasan, hhasan@nasa.gov NASA Headquarters (HQ) Dr. Mario Perez, mario.perez@nasa.gov NASA HQ</p>		
Research Focus Area	Point of Contact	Id
Astrophysics Technology Development	Dr. Hashima Hasan hhasan@nasa.gov Dr. Mario Perez mario.perez@nasa.gov	RFA-023
<p>NASA Biological and Physical Sciences (BPS) Science Mission Directorate (SMD)</p> <p>NASA Headquarters Biological and Physical Sciences Division NASA Marshall Space Flight Center (MSFC) / EM41</p> <p>Douglas Gruendel Douglas.J.Gruendel@nasa.gov NASA Kennedy Space Center (KSC) Diane Malarik Diane.C.Malarik@nasa.gov NASA Headquarters (HQ) Brad Carpenter bcarpenter@nasa.gov NASA HQ Mike Robinson michael.p.robinson@nasa.gov NASA HQ Sharmila Bhattacharya SpaceBiology@nasaprs.com NASA HQ Dr. Lisa Carnell; lisa.a.scottcarnell@nasa.gov NASA HQ</p>		
Fundamental Physics	Mike Robinson; michael.p.robinson@nasa.gov	RFA-024
Soft Matter Physics	Mike Robinson; michael.p.robinson@nasa.gov	RFA-025
Fluid Physics	Brad Carpenter bcarpenter@nasa.gov	RFA-026
Combustion Science	Brad Carpenter bcarpenter@nasa.gov	RFA-027
Materials Science	Brad Carpenter bcarpenter@nasa.gov	RFA-028
Growth of plants in inhospitable “deep space-relevant” Earth soils or conditions	Sharmila Bhattacharya SpaceBiology@nasaprs.com	RFA-029
Commercially Enabled Rapid Space Science Project (CERISS)	Dr. Lisa Carnell lisa.a.scottcarnell@nasa.gov	RFA-030

Research Focus Area/Point of Contact (POC)

Commercial Space Capabilities (CSC)

Space Operations Mission Directorate (SOMD)

Marc Timm, Program Executive marc.g.timm@nasa.gov NASA Headquarters (HQ)

Warren Ruemmele, Project Executive warren.p.ruemmele@nasa.gov NASA Johnson Space Center (JSC)

Research Focus Area	Point of Contact	Id
In-Space Welding	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-031
Materials and Processes Improvements for Chemical Propulsion State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-032
Materials and Processes Improvements for Electric Propulsion State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-033
Improvements to Space Solar Power State of Art (SoA)	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-034
Small Reentry Systems	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-035
Other Commercial Space Topic	Warren Ruemmele warren.p.ruemmele@nasa.gov	RFA-036

Research Focus Area/Point of Contact (POC)

ASA Digital Transformation (DT)

Science Mission Directorate (SMD)

NASA Digital Transformation Officer

Jill Marlowe jill.marlowe@nasa.gov NASA Headquarters (HQ)

NASA Digital Transformation – Portfolio Integration

Patrick Murphy patrick.murphy@nasa.gov NASA HQ

NASA Digital Transformation – Zero Trust Foundations; Strategy and Architecture Office (SAO)

Mark Stanley mark.a.stanley-1@nasa.gov NASA Langley Research Center (LaRC)

Cybersecurity Engineering Office (CSE)

Dennis daCruz dennis.m.dacruz@nasa.gov NASA HQ

NASA Digital Transformation – AI/ML Foundation

Ed McLarney edward.l.mclarney@nasa.gov NASA LaRC

Martin Garcia martin.garcia@nasa.gov NASA Johnson Space Center (JSC)

Mark Page mark.page@nasa.gov NASA Kennedy Space Center (KSC)

Scott Tashakkor scott.b.tashakkor@nasa.gov NASA Marshall Space Flight Center (MSFC)

Snorre Stamnes snorre.a.stamnes@nasa.gov NASA LaRC

Shan Zeng shan.zeng@nasa.gov NASA LaRC

Yongxiang Hu yongxiang.hu-1@nasa.gov NASA LaRC

Kelsey Buckles kelsey.d.buckles@nasa.gov NASA MSFC

Ignacio López-Francos ignacio.lopez-francos@nasa.gov NASA Ames

Caleb Adams caleb.a.adams@nasa.gov NASA Ames Research Center (ARC)

Ariel Deutsch ariel.deutsch@nasa.gov NASA ARC

Nikunj Oza nikunj.c.oza@nasa.gov NASA ARC

Jules Casuga jules.casuga@nasa.gov NASA ARC

Frank Delgado francisco.i.delgado@nasa.gov NASA JSC

David Meza david.meza-1@nasa.gov NASA HQ

Research Focus Area	Point of Contact	Id
Zero Trust, Cybersecurity Mesh Architecture, and Leveraging Artificial Intelligence for Realtime Cyber Defense	Mark Stanley mark.a.stanley-1@nasa.gov	RFA-037
Applied AI Ethics	Ed McLarney edward.l.mclarney@nasa.gov	RFA-038

Research Focus Area/Point of Contact (POC)		
Scaled Video ML Object Detection and Alerts	Ed McLarney edward.l.mclarney@nasa.gov Martin Garcia martin.garcia@nasa.gov Mark Page mark.page@nasa.gov	RFA-039
Verification of AI/ML algorithms for Spacecraft	Scott Tashakkor scott.b.tashakkor@nasa.gov	RFA-040
Augmenting and Analyzing Requirements with Natural Language Processors	Scott Tashakkor scott.b.tashakkor@nasa.gov	RFA-041
AI/ML algorithms to obtain and improve 3-dimensional remote sensing of the Earth's aerosols, clouds, oceans and lands using advanced lidar and polarimeter data	Snorre Stamnes snorre.a.stamnes@nasa.gov Shan Zeng shan.zeng@nasa.gov Yongxiang Hu yongxiang.hu-1@nasa.gov	RFA-042
ICAN-C-Obscured Vision Enhancement	Kelsey Buckles kelsey.d.buckles@nasa.gov	RFA-043
Lox Methane HS Video Analysis	Kelsey Buckles kelsey.d.buckles@nasa.gov	RFA-044
Motion Mag in the Dark	Kelsey Buckles kelsey.d.buckles@nasa.gov	RFA-045
Foreign Object Debris (FOD) Detection Using Computer Vision	Kelsey Buckles kelsey.d.buckles@nasa.gov	RFA-046
Using Multispectral Neural Radiance Fields (NeRFs) for Ground Detection & Characterization of Lunar Micro Cold Traps	Ignacio López-Francos ignacio.lopez-francos@nasa.gov Caleb Adams caleb.a.adams@nasa.gov Ariel Deutsch ariel.deutsch@nasa.gov	RFA-047
High-Resolution 3D Mapping of Lunar Shadowed Regions Using Neural Radiance Fields (NeRFs)	Ignacio López-Francos ignacio.lopez-francos@nasa.gov Caleb Adams caleb.a.adams@nasa.gov Ariel Deutsch ariel.deutsch@nasa.gov	RFA-048

Research Focus Area/Point of Contact (POC)		
Study the deployment of Large Language Models (LLMs) for Systems Engineering and Project Management at NASA	Ignacio López-Francos ignacio.lopez-francos@nasa.gov Caleb Adams caleb.a.adams@nasa.gov Ariel Deutsch ariel.deutsch@nasa.gov	RFA-049
Collaborative platforms for capturing data analytics workflows	Nikunj Oza nikunj.c.oza@nasa.gov	RFA-050
Uses of generative AI to dynamically create Photo realistic 3D content in real-time for use in XR applications	Jules Casuga jules.casuga@nasa.gov Frank Delgado francisco.j.delgado@nasa.gov	RFA-051
Use of a Brain Computer Interface (BCI) system as a novel computer interface	Jules Casuga jules.casuga@nasa.gov Frank Delgado francisco.j.delgado@nasa.gov	RFA-052
Cognitive State Determination System to Support Training, Education, and Real-Time Operations in an XR environment	Jules Casuga jules.casuga@nasa.gov Frank Delgado francisco.j.delgado@nasa.gov	RFA-053
Automatic XR friendly procedure creation using videos	Jules Casuga jules.casuga@nasa.gov Frank Delgado francisco.j.delgado@nasa.gov	RFA-054
Video based mocap system	Jules Casuga jules.casuga@nasa.gov Frank Delgado francisco.j.delgado@nasa.gov	RFA-055
Retrieval Augmented Dialog LLM	David Meza david.meza-1@nasa.gov	RFA-056
<p>Earth Science Science Mission Directorate (SMD) NASA SMD Earth Science Division (ESD)</p> <p>Earth Science Remote Sensing Yaitza Luna-Cruz yaitza.luna-cruz@nasa.gov NASA Headquarters (HQ) Laura Lorenzoni laura.lorenzoni@nasa.gov NASA HQ Nancy Searby nancy.d.searby@nasa.gov NASA HQ</p>		
Research Focus Area	Point of Contact	Id

Research Focus Area/Point of Contact (POC)		
Impacts of human activity on coastal physical, geomorphological and ecological variability	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-057
Sea level rise, coastal erosion/retreat, and salt-water intrusion, and their impacts on ecosystems	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-058
Linkages between aquatic dynamics and land subsidence and its impacts on aquatic ecosystems	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-059
The role of urban development on land subsidence and aquatic ecosystems; biophysical coupling and feedbacks within the aquatic-land interface	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-060
Impacts of hazards related to climate extremes, such as storms and heat waves, on biogeophysical aspects of the coast	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-061
Impacts of upstream activities on coastal communities	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-062
Integration of existing and upcoming observational and modeling assets into a conceptual or (better) digital aquatic-land framework that enables the dynamical coupling of key processes within the aquatic-land interface	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-063
Exposure and vulnerability to geohazards (e.g., infrastructure and flooding, landslides, etc.), land cover/use change and their impacts on water	Laura Lorenzoni laura.lorenzoni@nasa.gov Nancy Searby nancy.d.searby@nasa.gov	RFA-064
Entry Systems Modeling Project Space Technology Mission Directorate (STMD)		
Aaron Brandis aaron.m.brandis@nasa.gov NASA Ames Research Center (ARC)		
Research Focus Area	Point of Contact	Id
Nitrogen/Methane Plasma Experiments Relevant to Titan Entry	Aaron Brandis aaron.m.brandis@nasa.gov	RFA-065

Research Focus Area/Point of Contact (POC)		
Predictive Modeling of Plasma Physics Relevant to High Enthalpy Facilities	Aaron Brandis aaron.m.brandis@nasa.gov	RFA-066
Mechanical Properties of Ablative TPS Materials during Char Formation	Aaron Brandis aaron.m.brandis@nasa.gov	RFA-067
Office of Chief Health and Medical Officer (OCHMO) Space Operations Mission Directorate (SOMD) Victor S. Schneider vschneider@nasa.gov NASA Headquarters (HQ)		
Research Focus Area	Point of Contact	Id
Development and elaboration of Functional aids and testing paradigms to measure activity for use by parastronauts during spaceflight	Victor S. Schneider vschneider@nasa.gov	RFA-068
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	RFA-069
Human Research Program Human Exploration and Operations (HEO) Mission Directorate (HEOMD) Space Radiation Precision Health Initiative Systems Biology Translation Corey Theriot corey.theriot@nasa.gov NASA Johnson Space Center (JSC) Robin Elgart shona.elgart@nasa.gov NASA JSC Janice Zawaski janice.zawaski@nasa.gov NASA JSC		
Pilot studies to adopt terrestrial precision health solutions for astronauts	Corey Theriot corey.theriot@nasa.gov	RFA-070
Pilot studies to demonstrate the utilization of full systems biology approaches in addressing human spaceflight risks	Corey Theriot corey.theriot@nasa.gov	RFA-071
Tissue and Data sharing for space radiation risk and mitigation strategies	Robin Elgart shona.elgart@nasa.gov Janice Zawaski janice.zawaski@nasa.gov	RFA-072
Space radiation sex-differences	Robin Elgart shona.elgart@nasa.gov	RFA-073

Research Focus Area/Point of Contact (POC)		
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	RFA-074
Inflammasome role in radiation-associated health impacts	Robin Elgart shona.elgart@nasa.gov Janapriya Saha janapriya.saha@nasa.gov	RFA-075
Portable, non-ionizing radiation based, high resolution disease detection imaging	Robin Elgart shona.elgart@nasa.gov Janice Zawaski janice.zawaski@nasa.gov	RFA-076
<p>Planetary Science Science Mission Directorate (SMD)</p> <p>Glenn Research Center (GRC)</p> <p>Erica Montbach, PhD (<i>she/her</i>) Manager, Planetary Exploration Science Technology Office (PESTO) Planetary Science Division erica.n.montbach@nasa.gov</p> <p>Michael Lienhard, PhD (<i>he/him</i>) Program Officer, Planetary Exploration Science Technology Office (PESTO) Planetary Science Division michael.a.lienhard@nasa.gov</p>		
Research Focus Area	Point of Contact	Id
High-Temperature Subsystems and Components for Long-Duration (months) Surface Operations	Erica Montbach erica.n.montbach@nasa.gov Michael Lienhard michael.a.lienhard@nasa.gov	RFA-077
Aerial Platforms for Missions to Measure Atmospheric Chemical and Physical Properties	Erica Montbach erica.n.montbach@nasa.gov Michael Lienhard michael.a.lienhard@nasa.gov	RFA-078
In-situ Astrobiology Instruments	Erica Montbach erica.n.montbach@nasa.gov Michael Lienhard michael.a.lienhard@nasa.gov	RFA-079

Research Focus Area/Point of Contact (POC)

Planetary Protection

Office of Safety & Mission Assurance

Science Mission Directorate (SMD)

Exploration Systems Development Mission Directorate (ESDMD)

J Nick Benardini James.N.Benardini@nasa.gov NASA Headquarters (HQ)

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	RFA-080
Natural Transport of Contamination on Mars	J Nick Benardini James.N.Benardini@nasa.gov	RFA-081

APPENDIX B

Required Notice of Intent (NOI) for FY2024
NASA / LA BOR EPSCoR Rapid Response Research (R3) NOFO

**REQUIRED NOTICE OF INTENT:
LA NASA EPSCoR Rapid Response Research (R3) FY2024**

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 24 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 Thursday, September 19, 2023.

APPENDIX C

Proposal Template for FY2024
NASA / LA BOR EPSCoR Rapid Response Research (R3) NOFO

Cover Sheet: FY2024 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			TOTAL REQUESTED: \$ Not Applicable
START DATE, YR 1: mm/dd/yy			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.

Open Science 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.

The guidance for this section has been strengthened to reflect the provisions set forth in the [NASA Plan for Increasing Access to the Results of Scientific Research](#). Please reference the NASA SMD [Science Information Policy](#) for examples on how to implement these provisions in your proposal. In particular, all proposals shall include an Open Science and Data Management Plan (OSDMP) that addresses three major objectives:

- 1) As-accepted manuscript versions of publications that derive from NASA funding must be publicly available at the time of publication;
- 2) Data and software developed using NASA funding in support of a peer-reviewed publication shall be made publicly available at the time of publication; and
- 3) Scientifically useful data and software developed during the award that was not already published must be made publicly available by the end of the award.

Note that a project may not need a detailed OSDMP, but a detailed explanation as to why no scientifically useful data will be generated needs to be discussed. Possible reasons include 1) the proposed work is inexorably linked to the handling of already available data (e.g. from remote sensing platforms) so the OSDMP is part of the page-limited Science, Technical, & Management section of the proposal; 2) instrument development and technology development programs generally do not generate “scientifically useful data;” or 3) data is subject to ITAR (International Traffic in Arms Regulations) restrictions. In any event where the project produces “no data” or only data specifically exempted, the OSDMP must state that no data preservation or data sharing is needed and explain why.

When an OSDMP is required the plan 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.

The OSDMP is limited to 4000 characters including spaces (which equates roughly to 500 words / ~2 pages double spaced) and is included as a separate component in the proposal following the Cover Page and prior to the Table of Contents. See section II.C Pre-proposal Elements. Note that if funds are required for data management activities, these shall be included in the budget and budget justification sections of the proposal.

The following links provide additional information about the NASA strategy for increasing access to NASA funded project results, more detailed discussion on how to create an OSDMP, and some illustrative OSDMP templates for particular NASA SMD divisions. Note that not all the material in all of the references below will apply to your specific project but are listed here to provide examples of the kind of information NASA will want to see in your OSDMP.

NASA Plan for Increasing Access to the Results of Scientific Research:

https://www.nasa.gov/sites/default/files/atoms/files/206985_2015_nasa_plan-for-web.pdf

NASA SMD Science Information Policy:

<https://science.nasa.gov/researchers/science-data/science-information-policy>

How to Create and Maintain a Data Management Plan for Proposals – Earth Science Division:

<https://www.earthdata.nasa.gov/engage/dmp-earth-science>

Data Management Guidance for Earth Science Division Researchers:

<https://www.earthdata.nasa.gov/engage/data-management-guidance>

Earth Science specific OSDMP template – MS Word document:

<https://www.earthdata.nasa.gov/s3fs-public/2023-02/Earth%20Science%20Division%20OSDMP%20Template.docx?VersionId=fBxuNKFmklk3VCK4rhWKpKGgVyZwrhJE>

Heliophysics Division OSDMP template – MS Word document:

https://science.nasa.gov/files/atoms/files/HPD_DMP_Template_022820.docx

Planetary Science Division OSDMP template --- MS Word document:

<https://science.nasa.gov/files/atoms/files/PSD%20Open%20Science%20%20and%20Data%20Management%20Plan%20TEMPLATE.docx>

Project Title (Include Specific Appendix)

Table of Contents

1. Scientific / Technical / Management Plan	1
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3. Biographical Sketches	3
4. Current and Pending Support	4
5. Statements of Commitment and Letters of Support	6
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6.4 Budget Forms	11

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:

<p>Status of Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Award Amount (or Annual Rate): \$ _____ Period Covered: _____</p> <p>Location of Activity:</p> <p>Person-Months or % of Effort Committed to the Project: <input type="checkbox"/> Cal Yr <input type="checkbox"/> Acad <input type="checkbox"/> Summ</p>
<p>Status of Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Award Amount (or Annual Rate): \$ _____ Period Covered: _____</p> <p>Location of Activity:</p> <p>Person-Months or % of Effort Committed to the Project: <input type="checkbox"/> Cal Yr <input type="checkbox"/> Acad <input type="checkbox"/> Summ</p>
<p>Status of Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Award Amount (or Annual Rate): \$ _____ Period Covered: _____</p> <p>Location of Activity:</p> <p>Person-Months or % of Effort Committed to the Project: <input type="checkbox"/> Cal Yr <input type="checkbox"/> Acad <input type="checkbox"/> Summ</p>
<p>Status of Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Award Amount (or Annual Rate): \$ _____ Period Covered: _____</p> <p>Location of Activity:</p> <p>Person-Months or % of Effort Committed to the Project: <input type="checkbox"/> Cal Yr <input type="checkbox"/> Acad <input type="checkbox"/> Summ</p>

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. <Institution> 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		
<i>Total Direct Costs</i>		
<i>F&A (Indirect) Costs</i>		
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 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