C.23 PLANETARY SCIENCE DEEP SPACE SMALLSAT STUDIES

NOTICE: This program element does not use the two-step proposal submission process. Notices of intent to propose are requested by September 30, 2016, and proposals are due by November 18, 2016. No data management plans are required with submissions to this program element.

1. Scope of Program

This program element supports the study of spaceflight mission concepts that can be accomplished using small spacecraft, including CubeSats. All proposed investigations must be responsive to the goals of the Planetary Science Division, as described in the *2014 NASA Science Plan*. Additionally, proposals may address the operational requirements of the Planetary Defense Coordination Office in conducting surveys for potential Near Earth Objects (NEO's) and characterization of known NEO's as documented in the National Research Council study, "Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies Final Report," released in 2010.

NASA's Planetary Science Program is considering including small secondary payloads on every future planetary science launch. As such, studies performed under this program element will provide valuable information to assist future Announcement of Opportunity planning and NASA's development of small spacecraft technologies relevant to deep space science investigations.

In order to advance the objectives outlined in the Science Plan, proposed investigations may target any body in the Solar System, including near Earth objects (NEO's), except for the Earth and Sun. Investigations of extra-solar planets are not included in this program element.

The Planetary Science Deep Space SmallSat Studies (PSDS3) program is intended to capitalize on the creativity in the planetary science community to envision science enabled by smaller and significantly lower cost deep space missions. NASA expects to make awards for mission concept studies that will explore the breadth of missions possible that are enabled by CubeSat/SmallSat technologies. Mission design assistance, if required, for these mission concepts will be offered by NASA during the six-month studies. NASA Headquarters will also use the results of these studies when considering expanding the provisions and capabilities of future Announcements of Opportunity for technology development.

2. Background

Recently, small satellites have been suggested as a means to execute scientific missions at far lower cost and complexity than typical space science missions. CubeSats are an example of these small satellites and are built from a set of standardized subunits that each measure 10x10x10 cm and weigh 1.33 kg (designated '1U'). Common configurations include 1U, 2U, 3U, and 6U (2Ux3U) spacecraft. 12U and 24U configurations are also being developed, although they are not yet fully documented as standard formats. NASA has previously developed several 3U CubeSat missions that have flown in low-Earth orbit (e.g., GeneSat, PharmaSat, O/OREOS).

Proposals to this program element may propose to use CubeSat form factors from 1U up to 12U and 24U or larger Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) mounted satellites up to 180kg. Hosted payloads are not solicited at this time. This program element requires the submission of investigations that would operate in interplanetary space and, therefore, must meet more demanding engineering and environmental requirements than have been experienced by missions in low Earth orbit.

It is expected that the proposed science investigations would, by necessity, push the current technology state-of-the-art, and involve innovative thinking, advanced engineering, and technology development for instruments and/or spacecraft systems. As such, NASA seeks to make study awards across a range of mission concepts requiring new technologies that will enable smaller missions in deep space. Mission cost ranges (Phases A through F) to be explored are $10M to $100M and mass ranges from 1U (~1.3kg) to ESPA class (180kg) over a variety of form factors.

For information on NASA's small satellite platform technologies, visit the NASA Small Satellite Technology Program.

3. Requirements

As in all NASA Planetary competed missions, the studies are to be led by a designated Principal Investigator (PI) with a small science team. Mission design will be a critical part of these studies as teams make trades, explore feasibility, and refine the mission concept.

Proposals should include team members with experience in mission design and/or a statement that they have made arrangements to partner with an appropriate NASA mission design team. Since some science teams may lack access to the necessary mission design capability, if needed, NASA field centers will provide study teams access to mission design assistance. It is up to the proposing team to contact one of the field center contacts in Section 3.1 to determine the cost associated with the support required. The negotiated cost is to be included in the proposal as a separate line item. For evaluation purposes, the design assistance cost will be considered part of the entire cost of the study.

3.1 SmallSat/CubeSat Design Assistance Points of Contact

Ames Research Center - Mission Design Center
http://www.nasa.gov/centers/ames/engineering/divisions/missiondesign/
Scott Richey charles.s.richey@nasa.gov 650-604-0333

Glenn Research Center - COMPASS Lab
https://re.grc.nasa.gov/compass/
Steve Oleson steven.r.oleson@nasa.gov 216-977-7426

Goddard Space Flight Center - Integrated Design Center
https://idc.nasa.gov/mdl/index.php
Jennifer Bracken jennifer.m.bracken@nasa.gov 301-286-5127

Jet Propulsion Laboratory - TeamX-C
http://www.jpl.nasa.gov/cubesat/
John Baker john.d.baker@jpl.nasa.gov 818-354-5004

Johnson Space Center - Partnerships Office
http://www.nasa.gov/centers/johnson/partnerships/JSC-Partnership-Gateway
Mark Dillard mark.a.dillard@nasa.gov 281-244-8640

Kennedy Space Center - Launch Services Program
http://www.nasa.gov/mission_pages/smallsats/elana/
Robbie Ashley robert.l.ashley@nasa.gov 321-867-6037

Marshall Space Center - Advanced Concepts Office
http://www.nasa.gov/centers/marshall/capabilities/adv_capabilities.html
Jack Mulqueen jack.mulqueen@nasa.gov 256-544-0534

Successful proposers will be expected to produce a publicly releasable mission concept study summary/fact sheet and present a summary of their study at a special session of a domestic Planetary Science Conference, to be arranged by NASA after awards are made. Additionally, a full written report to NASA is required (see Section 6.3).

Short proposals (up to ten pages) are solicited that clearly summarize the mission concept, science target(s) and objectives, relevance to NASA Planetary Science objectives, and the nature of the science advancement expected from the mission.

This program element solicits only concept studies for planetary science missions; it does not solicit technology development, flight instrumentation, or any hardware development. Proposals for mission concepts not appropriate for the Planetary Science programs, and those not adhering to the guidelines in Section 4, will not be considered.

4. Mission Concept Parameters

Mission concepts that are proposed should adhere to the following parameters:

- Any Solar System body, including NEO's but excluding the Sun and the Earth, is permitted. Multiple targets are permitted. Mission concepts dealing with extrasolar planets are not permitted under this program.
- Mission concepts may not include the use of radioisotope power systems or heater units.
- Mission concept architectures requiring multiple spacecraft are permitted.
- For mission concepts requiring or providing auxiliary communications relay capability, study teams may assume that NASA will supply the recently developed Iris Communication Cube as Government Furnished Equipment (GFE).
- Mass/Volume of up to 24U CubeSat format or 180kg ESPA ring mounted secondary payload. Studies will examine if new dispenser/deployment designs will be required to accommodate the mission design.
- The mission concepts should target costs of less than $100M, excluding launch and integration into carrier (if required).

Note: While the above establish limits for mass, volume, and cost, NASA desires to significantly reduce the resources required for innovative new missions, and, therefore, intends to award a range of studies across the spectrum of mass, volume, and cost.

5. Programmatic Information

Answers to questions will be posted on the NSPIRES web page for this program element under "Other Documents".

5.1 Compliance Requirements

Proposers should be aware of the following compliance requirements when preparing their proposals:

- Proposal teams must be led by a PI and supported by a small science team. Since proposal teams have the option of being partnered with NASA mission designers, proposal teams are encouraged, but not required, to have members with engineering or mission design expertise.
- Mission concept studies must be completed within six months of award.
- NASA expects to fund a number of studies at a level of $200,000-$500,000 per study that span the range of CubeSat/SmallSat capability and mission cost. Proposals are required to provide a commitment letter from each participating institution (industry, Government, research, or academic) indicating a commitment to conduct the proposed study. Proposals that request funds significantly beyond this amount or that do not provide an institutional commitment are subject to return without review.
- The augmentation of the proposed study by using institutional discretionary funds or partnering with another institution is permitted.
- Proposals must strictly conform to the formatting rules in Section 2.2 of Program Element C.1 The Planetary Science Research Program Overview and Chapter 2 of the *NASA Guidebook for Proposers*. Proposals that violate the rules may be rejected without review.

5.2 Evaluation Criteria

The three basic evaluation criteria for the PSDS3 program are listed in the ROSES Summary of Solicitation Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost realism/reasonableness of the proposed study. Clarifications specific to this program element are listed below.

For this program, the evaluation of merit specifically includes:

- Realism and feasibility of the proposed study plan, and
- Impact and importance of the science advancement expected from the mission, including a description of how and to what extent the proposed research will advance our current state of knowledge.

For this program relevance will be evaluated according to:

- Relevance of the proposed mission concept to PSD objectives as demonstrated by linkages between the mission concept objectives and the *2014 NASA Science Plan*, or

- Relevance of the proposed mission concept to the National Research Council study, "Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies Final Report" as demonstrated by linkages between the mission concept science objectives and the themes defined in the report.

5.3 Proposal Guidelines

Proposals must be submitted by an institution hosting a scientist serving as the Principal Investigator (PI) for the study. Proposals should contain all elements described in Section 2.3 of the *NASA Guidebook for Proposers*. However, the Scientific/Technical/Management section of the proposals is limited to 10 pages rather than 15 pages. This section should be sure to discuss the following elements:

- High level summary of mission concept study (one page)
- Science objectives for the mission concept study, science target(s), and rationale for the mission concept study (two pages; it is recommended that the objectives take a full page)
- Aspects of the mission concept that will be evaluated during the study, with emphasis on the technologies to be assessed. (seven pages)

Proposals should include a mission study fact sheet (one page) that is not counted against the page limit. This fact sheet should include the science objectives, relevance, and importance to PSD science and/or Planetary Defense objectives, mission overview (including mission objectives and major mission characteristics), anticipated payload, mission management (if known), and mission schedule.

5.4 Final Report

It is expected that mission design work during the study will force changes in the original mission concept described in the proposal. Selected studies must provide a final report to NASA describing the final mission concept and the rationale for changes from the original proposed mission concept, including the technological challenges and gaps identified. Reports marked as "Proprietary" will be treated as such. This report is due six months after the start date of the award and must, as a minimum, contain the following elements:

- Science target(s) and rationale
- Level 1 science requirements, traceability to Section 4.3 of the Science Plan or the NRC Near Earth Object final report, and the proposed instrument complement with supporting rationale
- Core science team expertise and traceability to mission objectives
- Mission design/architecture (trajectories, multiple spacecraft, etc.)
- Preliminary instrument complement
- Spacecraft concept, mass budget, power budget, telemetry rates
- Technology needs, quantified gaps, and development required
- Concept of Operations
- Launch vehicle interface and deployment method
- Estimated Mission Costs and explanation of the cost estimation method
- Top mission risks and key mission trades to be studied in the future

A two-page publicly releasable mission fact sheet must be provided with the final report.

Proposers must allocate sufficient travel funds to be able to present their concept and study results at a special session of a domestic Planetary Science Conference, to be arranged by NASA after awards are made.

6. Summary of Key Information

Expected annual program budget for new awards	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 6-15
Maximum duration of awards	6 months
Due date for Notice of Intent to propose (NOI)	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2016.*
Page limit for the central Science-Technical-Management section of proposal	10 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH16ZDA001N-PSDS3
NASA point of contact concerning this program	Carolyn Mercer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1014 E-mail: cmercer@nasa.gov