

NASA SMALL INNOVATIVE MISSIONS FOR PLANETARY EXPLORATION (SIMPLE_x)

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Abstract

In the planetary decadal report, *Visions and Voyages*, “The committee unequivocally recommends that a substantial program of planetary exploration technology development should be reconstituted and carefully protected against all incursions that would deplete its resources. This program should be consistently funded at approximately 6 to 8 percent of the total NASA Planetary Science Division budget.” In addition, the reports states, “The committee recommends that the Planetary Science Division’s technology program should accept the responsibility, and assign the required funds, to continue the development of **the most important technology items** through TRL 6.”

In 2016, a National Academies Report concluded that CubeSats have proven their ability to produce high-value science. In particular, CubeSats are useful as targeted investigations to augment the capabilities of larger missions or to make a highly-specific measurement.

The Planetary Science Division has released a revolving Announcement of Opportunity as a Program Element Appendix J (PEA-J) to the Third Stand Alone Missions of Opportunity Notice (SALMON-3) for the purpose of soliciting proposals for Small Innovative Missions for Planetary Exploration (SIMPLE_x) as small complete mission of opportunity (SCM) science investigations.

SALMON-3 PEA-J describes the requirements for Small Complete Mission of Opportunity proposal opportunities and documents specific requirements for SIMPLE_x. Through this PEA, NASA Science Mission Directorate, Planetary Science Division (SMD/PSD) solicits investigations in which a secondary payload small spacecraft is built and deployed from a primary spacecraft mission, followed by production of high quality and highly

useful science data from that SmallSat, analysis of the data and publication of scientific results, and delivery of the data to an appropriate NASA archive.

Participation in this opportunity is open to all categories of organizations (U.S. and non-U.S.), including educational institutions, industry, not-for-profit organizations, Federally Funded Research and Development Centers, NASA Centers, the Jet Propulsion Laboratory, and other Government agencies. This paper will introduce this program and present the specifics for proposals specially in the case of non-U.S. institutions.

1. Introduction

The Third Stand Alone Missions of Opportunity Notice (SALMON-3) AO is an omnibus Announcement of Opportunity that provides the overall structure, guidelines and requirements for several types of Mission of Opportunity (MO) solicitations. Each new opportunity is announced through a Program Element Appendix (PEA) that details the solicitation and may include additional guidelines and requirements.

The NASA Science Mission Directorate, Planetary Science Division (SMD/PSD) has solicited SmallSat investigations in response to the technology findings described in *Visions and Voyages*, the PSD decadal report, as well as the *2016 National Academies’ Report*. The solicitation is in the form of a PEA to the SALMON-3 for the purpose of inviting proposals for Small Innovative Missions for Planetary Exploration (SIMPLE_x) as small complete mission of opportunity (SCM) science investigations. Proposed investigations may target any planetary science scientific investigation that advances the objectives outlined in NASA’s strategic objective in planetary science. Investigations that address NASA goals in other areas, such as astrophysics, Earth science, or

heliophysics, are not solicited. Investigations of extrasolar planets are not solicited in this PEA.

Selected missions will launch as a secondary payload on one of the specific flight opportunities described in the PEA. The PEA will be amended as new launch opportunities become available. Proposals will be accepted at any time, but there is a cut-off date for each specified launch opportunity nominally four years before its expected launch readiness date (LRD).

1.1 SmallSats

SmallSats are defined as ESPA-Class or smaller, including CubeSats built from a set of standardized subunits that each measure 10x10x10 cm with a mass of 1.33 kg (designated '1U'). Allowable configurations in this SIMPLEx PEA include 1U, 2U, 3U (nominally 4kg), 6U (2Ux3U - up to nominally 12 kg) and 12U (2Ux6U, 3Ux4U, or 1x12U - up to nominally 24 kg) satellites. ESPA-Class SmallSats are defined as spacecraft that can be launched from a standard evolved expendable launch vehicle (EELV) secondary payload adaptor (ESPA). The dimensions of an ESPA-Class SmallSat must be no larger than 61x71x97 cm. For launch opportunities that allow an ESPA Grande or Propulsive ESPA ring (See Table A-1), the volume constraints are 106x116x96 cm. For all three ESPA cases, the total wet mass of the proposed SmallSat must not exceed 180 kg.

2. SIMPLEx Goals and Objectives

The goal of SIMPLEx is to increase the science return of future missions by launching secondary payloads to conduct planetary science that would otherwise not be possible, for instance, either because of cost constraints or by providing the opportunity to make simultaneous measurements at multiple locations. SIMPLEx secondary payloads are limited to SmallSats and will be cost capped. SIMPLEx missions will be science focused, not technology demonstrations, however SIMPLEx missions will accept technical risks that might not be acceptable on larger, higher cost primary missions.

3. SIMPLEx proposals

This PEA solicits planetary science investigations that require a spaceflight mission that can be accomplished using small spacecraft as secondary payloads on future launch opportunities, listed in Appendix A of this PEA. The launch readiness date and initial release trajectory will be individually determined for each primary mission. Proposal due dates for each launch opportunity are listed in Appendix A of this PEA. Proposals for investigations to be launched from Low Earth Orbit (LEO) or Geostationary Transfer Orbit (GTO) will also be considered with no specific deadline imposed.

Proposals submitted in response to this PEA will be selected for flight through a two-step competitive process. Proposals submitted in response to this PEA will be evaluated based on the entire proposed flight project lifecycle (formulation through implementation, Phases A through F). As the outcome of the first step evaluation, NASA intends to fund one or more SCM investigations to proceed to a twelve-month Phase A/B study concluding with a preliminary design review (PDR). In the second step, NASA will conduct an evaluation of the Phase A/B PDR results (KDP-C). From this evaluation, NASA expects to select one or more of the funded SCMs to proceed into implementation. In addition, this program requires a Notice of Intent (NOI). Proposals that are not preceded by the mandatory NOI will be returned without review. No feedback will be provided in response to the NOI.

Proposals in response to this PEA will be accepted at any time. PSD will conduct nominally one review per year. Cut-off dates for specific launch opportunities are given in Appendix A of this PEA. A typical mission development lifetime is described below:

- Launch minus four years (L-4): Cut-off consideration for a specific mission
 - Select and award ~1 year Phase A/B design studies; expected product is PDR-level design
 - Launch Vehicle is unknown
- L-3 years: Down-select secondary mission(s) for specific primary mission
 - May be possible to select multiple secondaries for a given primary mission
 - Selections coordinated with launch vehicle selection
 - Provided for Phase C design/build:

- More detailed launch vehicle trajectory, environments and interfaces
- L-2 years: Build/test secondary payload
- L-1 years: Build/test/integrate secondary payload
- L-3 months: Integrate secondary payload into the launch vehicle (nominal date)
- L: launch

4. SIMPLEx Evaluations

Evaluation and selection of proposals in response to this PEA will be done using a two-step process. This is different from the traditional two-step approach, where NASA funds only Phase A before down-selection. In the SIMPLEx case, NASA funded Phase A/B activities will be conducted by the investigation team(s) selected as a result of the first step of this solicitation.

NASA expects to conduct proposals evaluations nominally once per calendar year. Proposers are encouraged to factor specific launch information into their proposals; however, this solicitation will remain open and proposals that are not selected for one launch opportunity may be considered for subsequent launch opportunities if appropriate, through the next proposal evaluation cycle. In addition, launch opportunities to low Earth and geostationary transfer orbits are frequently available and proposers may target such launches at any time. As part of NASA's Lunar Discovery and Exploration Program, proposals are also sought for CubeSat missions to be launched with expected missions to Earth's moon. These secondary payloads launched with expected lunar missions will be evaluated and funded separately from other proposed missions and must address either lunar science or human exploration objectives.

5. Non-U.S. Participation

Non-U.S. organizations are not eligible to submit proposals to this PEA. In fact, only U.S. organizations are eligible to propose as the sole or lead organization. However, Non-U.S. organizations may participate as non-lead organizations collaborating with U.S. leads. Contributions from sources other than NASA, whether U.S. or non-U.S., are accepted. The sum of non-U.S. contributions of

any kind to the entirety of the investigation is not to exceed one-half (1/2) of the proposed Total Mission Cost. Such contributions will not be counted against the PI-Managed Mission Cost, but they must be included in the calculation and discussion of the Total Mission Cost.

Should a proposal with non-U.S. participation be selected, NASA's Office of International and Interagency Relations will arrange with the non-U.S. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging their respective responsibilities. These arrangements will be documented and affirmed in a legally binding agreement between NASA and the non-U.S. sponsoring agency.

6. Summary and Conclusions

The Small Innovative Missions for Planetary Exploration (SIMPLEx) is a Small Complete Mission of opportunity (SCM) science investigations. It is in the form of a Third Stand Alone Missions of Opportunity Notice (SALMON-3) Program Element Appendix (PEA) that invites proposals for a secondary payload small spacecraft deployed from a primary spacecraft mission. Contributions from sources other than NASA, whether U.S. or non-U.S., are accepted. This paper, describes the SIMPLEx program, its requirements and evaluation process.