NOTICE: Amended on March 6, 2018. This amendment releases final text for this program element. This program element requests a notice of intent (NOI) from proposers but also uses a binding two-Step process in which successful 25-page Step-1 proposals will be funded for a five-month (<$500K) Instrument Concept Study Phase (see Section 6) culminating a Concept Study Phase reports in 2019 that will serve as Step-2 proposals from which instruments may be selected and funded for development. Data management plans will not be collected on the NSPIRES cover pages as the planned enhanced data products are part of the proposals (see Sections 4 & 6) and evaluation criteria (see Section 7). Optional NOIs are requested by June 1, 2018, Step-1 proposals are due August 1, 2018 and NASA will communicate directly with those selected regarding the submission concepts study reports as Step-2 proposals ~March 2019.

Table of Contents

1. Highlights Of Next Generation Science Instrumentation 3
2. SOFIA Project Overview 4
3. Overview Of The Solicitation 5
   3.1 Notices Of Intent 5
   3.2 The Two-Phase Instrument Development Process 6
   3.3 Management Of Solicitation 6
   3.4 Additional Documentation Needed For Solicitation 6
4. The Next Generation Science Instrument (NGSI) 7
   4.1 Motivation For Instrument 7
   4.2 The Legacy Science Program (LSP) 7
   4.3 Anticipated Requirements, Activities and Timeline From Development to Acceptance 9
      4.3.1 Requirements for Commissioning 9
      4.3.2 Science Exploitation Period Following Commissioning 9
      4.3.3 Instrument Transition to SOFIA 10
5. Requirements for Step-1 Proposals 10
   5.1 Science Requirements for Step-1 Proposals 11
   5.2 Technical Requirements for Step-1 Proposals 11
6. Anticipated Requirements for ICS Phase Reports 13
   6.1 Reporting / Status updates / QandA during the ICS Phase 15
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Evaluation of the ICS Phase Reports</td>
<td>16</td>
</tr>
<tr>
<td>9. Eligibility and Conflicts of Interest</td>
<td>16</td>
</tr>
<tr>
<td>10. Public Engagement and Communications</td>
<td>17</td>
</tr>
<tr>
<td>11. Remediation, Termination, or Cancellation</td>
<td>18</td>
</tr>
<tr>
<td>12. Submission Process and Requirements</td>
<td>18</td>
</tr>
<tr>
<td>12.1 Pre-Proposal Workshops</td>
<td>19</td>
</tr>
<tr>
<td>12.2 Proposal Formatting</td>
<td>19</td>
</tr>
<tr>
<td>12.3 International Agreements</td>
<td>19</td>
</tr>
<tr>
<td>13. Award Administration and Funding</td>
<td>19</td>
</tr>
<tr>
<td>14. Summary of Key Information</td>
<td>20</td>
</tr>
</tbody>
</table>
1. **Highlights of Next Generation Science Instrumentation Call**

This program element requests proposals for scientific investigations that would develop and use scientific instrumentation capable of achieving the goals of NASA’s Stratospheric Observatory for Infrared Astronomy (SOFIA). The intent is to select and execute development of one or more new SOFIA science instruments and/or upgrades to existing instruments. The anticipated timeline is as follows:

![TIMELINE FOR SOFIA’s NEXT GENERATION INSTRUMENTATION](image)

### 1.1 Key Dates:
- November 3, 2017 - Draft program element was published
- March, 2018 - Final program element is released (this document)
- April 3, April 16, May 17, 2018 – Pre-proposal workshops
- June 1, 2018 – Due date for Notices of Intent to propose (NOIs) to expedite the review process
- August 1, 2018 - Due date for Step-1 Proposals
- ~ October 2018 - Selections announced / Instrument Concept Study (ICS) phase kickoff
- ~ March 2019 - Due date for ICS phase reports (Step-2 proposals)
- ~ Spring 2019 – Astrophysics Senior Review, including SOFIA
- ~ July 2019 - Instrument(s) selected for development
- ~ July 2022 – Nominal instrument(s) delivery (earlier delivery encouraged; longer or shorter timescale for optimal science return acceptable); Legacy Science Program (LSP) observations start
- ~ NLT July 2024, Instrument transitions to SOFIA, nominal completion and delivery of LSP

### 1.2 Philosophy for Solicitation of New SOFIA Instrumentation
- Motivate the next generation science instruments (NGSI) by compelling science
- Execute and deliver a well-defined Legacy Science Program (LSP) by the selected
team(s).

- Prioritize instruments that enable broad community usage and/or data of high archival value, but also allow for agile, “niche” instruments to solve important / outstanding science questions
- Allow for new instruments or upgrades/modifications to existing instruments; also allow for flexibility for future enhancements and modifications to NGSI
- Allow for a nominal three-year development period after funding begins but also allow for longer or shorter development timescales for optimal science return
- Allow for schedule and budget flexibility; make selections based on science return on investment
- Streamline requirements for the ICS phase
- Streamline instrument development / acceptance process

2. SOFIA Project Overview

The Stratospheric Observatory for Infrared Astronomy (SOFIA) consists of a German-built 2.7-meter (2.5-meter useable aperture) telescope with a suite of imaging, polarimetry and spectroscopy instruments, mounted in a Boeing 747-SP aircraft supplied and modified by NASA. Operations costs and observing time are shared by the United States (80%) and Germany (20%). Flying at altitudes up to 45,000 feet, SOFIA observes from above more than 99 percent of Earth’s atmospheric water vapor, thereby opening up wavelengths for astrophysical observations not available from the ground.

SOFIA is a near-space observatory that returns to base after every flight. Therefore, unlike most space missions, its scientific instruments can be exchanged periodically to accommodate changing science requirements and to incorporate new technologies, which is a tremendous advantage over space-based observatories. A key part of the SOFIA project has always been to include an instrumentation program that would periodically introduce new technologies in order to enable new scientific frontiers to be explored. NASA is soliciting proposals for compelling science investigations that are enabled by the development of one or more new Science Instruments (SI) and/or upgrades to existing science instruments.

The SOFIA observatory has been designed to support observations at wavelengths from 0.3μm to 1.6 mm. The observatory is capable of high-resolution spectroscopy (R > 10^7) in discrete wavelength bands at wavelengths between 5 and 600μm with its existing instruments. SOFIA produces the sharpest images of any current or planned IR telescope operating at wavelengths from 30 to 320 μm. The current SOFIA suite of instruments (EXES, FIFI-LS, FORCAST, FPI+, GREAT, HAWC+, and HIRMES) has a wide range of imaging, spectroscopy, and polarimetry capabilities (http://www.sofia.usra.edu/Science/instruments/).

A sample of science programs that might be undertaken with SOFIA is described in The Science Vision for the Stratospheric Observatory for Infrared Astronomy, available at http://www.sofia.usra.edu/Science/science_cases/. SOFIA science results in the literature are available at https://www.sofia.usra.edu/science/publications/sofia-publications. SOFIA data are archived and available via the SOFIA Data Cycle system
Starting in 2018, the SOFIA data archive will begin a transition to the NASA/IPAC Infrared Science Archive (IRSA, https://irsa.ipac.caltech.edu/frontpage/). It is anticipated that data from the next generation science instruments will be ingested in and served to the community via IRSA.

SOFIA is a project within the Astrophysics Division of the NASA Science Mission Directorate. The SOFIA Project is managed by Ames Research Center (ARC). The execution of the SOFIA Project is carried out under three management directors, coordinated by the SOFIA Project Manager at ARC: the Science Mission Operations (SMO) Director, whose staff is responsible for science observing proposal solicitation, evaluation and selection, science flight planning, pipeline processing of the science data, and operation of the SOFIA Facility Instruments; the Operations Director, whose staff is responsible for the aircraft operations and the Armstrong Flight Research Center (AFRC) ground facilities; and the Observatory Systems Director, whose staff is responsible for observatory improvements and new science instrument development (after science instruments are selected by NASA Headquarters).

3. Overview of this Program Element

This program element specifically requests proposals for compelling scientific investigations that require development and use of a next generation science instrument (see Section 4) or upgrades/modifications to an existing instrument for SOFIA. The scientific investigations must be aligned with NASA’s astrophysics strategic goals (see D.1 of ROSES-2018 the Astrophysics Research Program Overview). This program element is specifically not requesting (and will not accept):

- Proposals for only an individual’s scientific research or development projects;
- Proposals for technology development or demonstration projects; and
- Proposals for ground-based technology test beds.

Investigators interested in technology development or technology demonstrations projects with SOFIA may contact the point-of-contact (POC) listed in Section 14 at any time – these activities are not relevant for this program element but NASA welcomes discussion of such ideas separately.

3.1 Notices of Intent

A brief Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this program element. The information contained in an NOI is used to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. To be of maximum value, NOIs should be submitted by the Principal Investigator (PI) via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES, located at https://nspires.nasaprs.com) by June 1, 2018. It is understood that PIs may need to update their co-investigators after the submission of the NOI and this is allowed under this program element. Changes to the Co-investigator list after the submission of the NOI may be emailed to the main point of contact listed in the Summary Table of Key Information (Section 14).
3.2 The Two-Phase Instrument Development Process

Proposals submitted in response to this program element will be evaluated and selected through a two-phase competitive process:

- **Phase I:** In this phase all compliant proposals submitted in response to this program element will be subject to a scientific and a top level technical peer review. Requirements for Step-1 proposals are listed in Section 5. Evaluation criteria for this phase are listed in Section 7. Based on the results of that review, one or more proposals may be selected for a funded Instrument Concept Study (ICS) phase.

- **Phase II:** Through the rest of this document we refer to Phase II as the ICS Phase. Requirements for the ICS phase are listed in Section 6. At the end of the ICS Phase, organizations that received a grant for an ICS must submit a final ICS phase study report, which will serve as the Step-2 proposal for an instrument development contract. There will be a second review which will focus primarily on the technology, management and cost aspects of the instrument. Evaluation criteria for the ICS phase study evaluations are listed in Section 8. At that point, one or more instruments may be selected for further development following the approximate timeline shown above in Section 1 (see also Figures 1 and 2).

3.3 Management of Program Element

This program element and review of the proposals submitted in response to NASA (including Instrument Concept Study phase reports) are managed by the Astrophysics Division within the Science Mission Directorate (SMD) at NASA Headquarters, with programmatic and technical support from the SOFIA staff at the NASA Ames Research Center (ARC), SOFIA Mission Operations (SMO), and the NASA Armstrong Flight Research Center (AFRC). In accordance with this role, a conflict avoidance plan (see also Section 9) has been implemented to prevent any ARC, SMO, and AFRC personnel involved in the evaluation process from having had any involvement with proposers and proposing teams.

The SOFIA Science Instrument Development (SI Dev) team has a key role in the development and delivery of new science instruments and upgrades to the SOFIA observatory. The SI Dev team consists of approximately eight scientists, astronomers, and engineers within the SOFIA project who provide critical support during the solicitation process and later in the instrument development, commissioning and acceptance process.

3.4 Additional Documentation

NASA intends to maintain an essential degree of insight into instrument development to ensure that the implementation is responsive to requirements and constraints of the observatory, and remains within cost and schedule. NASA requirements and constraints are spelled out in a SOFIA Instrument Developer's Handbook, which is part of a final and complete set of documentation (collectively called "the SOFIA Instrument Development Library") located at https://www.sofia.usra.edu/science/instrument-call.

Proposers to this program element are strongly encouraged to review the contents of
the SOFIA Instrument Development Library as it contains the safety, reliability and quality assurance requirements, as well as Observatory policies and requirements, for the next generation instrument.

4. The Next Generation Science Instrument (NGSI)

4.1 Motivation for Instrument

The proposed SOFIA instrument must fundamentally be motivated by a compelling science investigation. The proposing team must propose a Legacy Science Program (LSP, see section 4.2) of high scientific value that requires the use of the instrument it builds and delivers. Instruments that will be of use to a broad scientific community and promise to deliver data of high archival value are encouraged. Niche, agile instruments that may be developed on a shorter time scale, presumably at a lower cost, to address specific, if narrow, scientific questions may also be proposed. An LSP is required for such niche, agile instruments; however, an LSP is not required (but is welcome) for upgrades or modifications to existing instruments.

4.2 The Legacy Science Program (LSP)

The LSP is a scientifically ambitious, coherent investigation, not reproducible by any reasonable number of or combination of smaller guest observer investigations. The LSP should have general and lasting value to the broad astronomical community with the SOFIA data yielding a substantial and coherent database. The proposing team may design an LSP that makes use of other available instruments on SOFIA for a coherent investigation of long-lasting value. Teams are encouraged (but not required) to design an LSP that utilizes existing data or planned observations from other ground- or space-based observatories to increase the impact and utilization of SOFIA data by the broader astrophysics community.

The LSP is a core requirement for this proposal and hence teams are encouraged to appoint a science lead to oversee the assembly and management of the science team and deliverables, as well as an instrument lead to oversee the planning and development of the instrument hardware and software. The science and instrument leads may be the same person.

The LSP should be akin to major coherent observing programs that have been carried out at other NASA astrophysics observatories, e.g. Spitzer Legacy Programs, see http://irsa.ipac.caltech.edu/data/SPITZER/docs/spitzemission/observingprograms/legacy/, or Hubble Treasury Programs, see http://archive.stsci.edu/hst/treasury.html that significantly advance NASA’s strategic objectives in astrophysics.

The proposal’s description if an LSP must contain a detailed scientific justification and an observing plan which clearly describes the science targets, instrument modes and the time required to achieve the scientific goals, as well as the roles and expertise of the science team that will execute the LSP. The proposal must describe any planned enhanced data products (e.g. reduced images, spectra, maps, catalogs and appropriate documentation), as well as the anticipated scientific impact including a schedule for planned publications, presentations, science workshops and/or conferences, and any
other planned involvement of the astrophysics community. The planned scientific output by the team(s) is defined as the delivery product of the LSP. An initial high-level budget commensurate with this plan should also be included.

The LSP observing plan time request should be commensurate with the compelling nature of the science investigation, and to its legacy value and impact. Under exceptional and well justified circumstances, SOFIA will accommodate observing plans that require up to half of the available U.S. observing time in any given year for all LSP observations. The final LSP will be reviewed and allocated time after commissioning tests have demonstrated instrument capabilities. SOFIA will aim to execute the majority of the observations within the two-year period following commissioning.

Nominally LSP data have no period of exclusive use and the data will be made immediately public and available to the community via the SOFIA data archive at NASA/IPAC Infrared Science Archive (IRSA). If there is a strong justification for a very short period of exclusive use, the proposals must fully describe such a request.

In the ICS phase, the proposing team(s) may refine the needed observing time (possibly based on a better understanding of the instrument) but shall not change the scope of the scientific investigation. In this phase, the teams may add any other details to clarify the scope of the work to execute the LSP. The ICS report must also fully describe the funding and any other resources needed to execute and deliver the LSP with sufficient justification.

Following commissioning, upon better understanding of the instrument performance (and to allow for changes in the scientific landscape), as well as programmatic constraints at the time, the team(s), or NASA, or the SMO Director may revisit and request a re-negotiation of the LSP request. All such requests should be aimed at increasing and optimizing the science return from SOFIA. Also following commissioning, the LSP observing time request and science plan will be reviewed and authorized by the SMO Director, in concurrence with NASA.

---

**Figure 2. TIMELINE / ACTIVITIES AFTER SELECTION**

**Deliverables**
- Commissioning Report
- Users Guide for community use
- Functional pipeline or algorithms for science-ready data

**Science Exploitation:**
- Execution & delivery of LSP + General Community Use

**NGSI transitions to SOFIA:**
- Support by SOFIA to PI for documentation / certification

**Nominal ~3 Years**

**2 YEARS after commissioning**

D.14-8
4.3 Anticipated Requirements, Activities and Timeline from Development to Acceptance

4.3.1 Requirements for Commissioning

- The Next Generation Science Instrument(s) (NGSIs) developed by the selected team(s) should plan for commissioning approximately three years after the development funding starts. Instruments that require a longer or shorter development time scale may be proposed with an adequate and compelling justification.
- The funds available for instrument development are anticipated to be ~$15--20M over three years (total for all NGSIs) which may be adjusted for the selected instrument(s) funding and schedule profile.
- Each instrument team must deliver a commissioning report immediately following the commissioning flights.
- The commissioning report must describe the instrument status and performance, operational modes, expected sensitivities in all modes and best practices for the use of the instrument for science.
- A "Users Guide" for the general community must be delivered at the end of commissioning.
- The team(s) must also provide a functional pipeline for science-ready data products at the end of commissioning such that the data may be expeditiously processed and ingested into IRSA; currently data are ingested into the archive within 2 weeks after the end of a flight series.

The final requirements for successful commissioning, the commissioning report, and timeline for delivery will be negotiated between the PI, NASA, and the Science Missions Operations Director towards the end of the instrument development process.

4.3.2 Science Exploitation Period Following Commissioning

Following commissioning, for up to two years, the team(s) will exploit the NGSI for science as follows during a Science Exploitation Period:

- The team(s) must execute and deliver on their Legacy Science Program.
  - The LSP observing plan will be approved at an LSP Kickoff Review anticipated to be held ~6 months prior to commissioning to allow SOFIA sufficient time to schedule the observations. A second review will be done post-commissioning, after the instrument performance is verified at which point the SMO Director will formally authorize the observations, in concurrence with NASA.
  - If the Legacy Science Program observations cannot be accommodated in two years, a phased execution plan will be considered that will most expeditiously execute the LSP to maximize the impact of the LSP science.
  - An annual review will be organized by the SMO, in consultation with NASA to evaluate progress and authorize continuation of the LSP.
- The team(s) must make their instrument available for general community use during the Science Exploitation Period, which may be on a collaborative basis, i.e.,
  - The team(s) must provide needed support for the community use of the instrument.
○ In return, the team(s) may request reasonable participation in the community proposed science General Observer (GO) programs with the NGSI.

- It is understood that the NGSI data reduction pipeline may evolve and become more refined over these two years as the instrument is exercised for science.
- At any time during this two-year period, the PI may propose to enhance, modify and make upgrades to the instrument to improve / optimize its performance. The SOFIA project may choose to conduct an independent review of such requests to determine the potential impact on science (e.g. non-availability of instrument while being enhanced/upgraded versus community demand). Such a request will also be evaluated within constraints of the budget and other programmatic considerations.

4.3.3 Instrument Transition to SOFIA

At the end of the Science Exploitation Period, the NGSI must formally transition to the SOFIA project following the formal acceptance process that is detailed in the SOFIA Instrument Development Library. After this point, the instrument will become a facility class instrument. A facility class instrument is one wholly owned, maintained and operated by the SOFIA project. The intent of this transition period is to make the process smoother and easier by allowing for the transition to occur over a two-year period following commissioning and with support from the project as follows:

- Throughout the entire instrument development process, but especially towards the end of the development process and through the transition period, the selected team(s) are expected to work closely with the SI Dev team and the SMO with the goal of having common shared knowledge about the instrument hardware and performance, the software needed for operations, and the associated data reduction and analysis pipeline.
- At any time during development or after commissioning, the selected team(s) may request support from the SI Dev and/or the SMO team. For instance, the team(s) may request support to help with such things as airworthiness certification or other documentation.
- During the transition period after commissioning, the SI Dev and SMO team will work closely with the selected team(s) for the needed documentation and certifications to ensure a smooth transition of the instrument from the proposing teams to SOFIA.

5. Requirements for Step-1 Proposals

Although the discussion above has described some of the necessary information needed for selection, this section lays out the requirements for Step-1 proposals. Section 6 lays out the anticipated requirements for Step-2 proposals, the ICS Report. Requirements on standard proposal content and format are provided in Table 1 and Section IV(b)ii of the ROSES-2018 Summary of Solicitation. Budgets are required for these Step-1 proposals, see below. Proposals submitted in response to this program element must address all aspects of this next generation instrument program element, including, but not limited, to the following requirements listed in Sections 5.1 and 5.2. These requirements will be considered in the evaluation as described in Section 7.
5.1 Science Requirements for Step-1 Proposals

The proposal must include, but not be limited to, the following elements:

- A substantial and compelling science investigation that drives the need to develop the next generation science instrument on SOFIA. Describe how the science fits into fulfilling one or more of NASA's strategic astrophysics objectives.

- An LSP plan, consistent with Section 4.2, that clearly describes the coherent scientific investigation, team's scientific objectives for the requested LSP time, and a plan for achieving the scientific goals. As part of this plan, provide a realistic description of the necessary observations (i.e., a high level observing plan estimating the needed number of flights, number of targets, etc.), any enhanced data products to be delivered, schedule of planned science output (e.g. papers, presentations, conferences, community engagement, etc.), and a high-level estimate of the funding and other resource requirements.

- A discussion of other scientific investigations that may be undertaken by the general scientific community with the new instrument assuming it shall be available for at least ~5 years after commissioning. Connect these plausible investigations to NASA's strategic astrophysics objectives and discuss whether investigations enabled by the NGSI could be preparatory or complementary to those possible with current or upcoming astrophysics facilities such as the James Webb Space Telescope (JWST), Wide-Field Infrared Survey Telescope (WFIRST), Transiting Exoplanet Survey Satellite (TESS), Atacama Large Millimeter/submillimeter Array (ALMA), etc.

- A high-level community usage plan describing how the team will support science with the instrument by the general community and needed resources for this effort during the two-year time period after commissioning and before the formal transition of the instrument to the project (consistent with Section 4 and see specifically sections 4.3.1 and 4.3.2).

- Required instrument performance (in context of the science enabled).

5.2 Technical Requirements for Step-1 Proposals

The Step-1 proposals must contain enough technical detail to provide sufficient confidence that the preliminary instrument design can meet the required performance to meet the science goals, and that the final instrument can be successfully completed within the technical, schedule, and cost goals proposed. Proposals may accomplish this task by explicitly identifying the areas that will be the topic of further development in the ICS phase, i.e., the Step-1 proposal may present less detail on technical, management, and cost, as these aspects are to be defined and detailed in the report provided at the end of the ICS phase.

The proposal must include, but not be limited to, the following elements:

1. A list of performance requirements that the science instrument shall achieve in order to enable the LSP and broader scientific investigations. These minimum performance requirements will form the basis of the top-level science and technical performance requirements.

2. A description of instrument design and fabrication, including a high-level
preliminary schedule and cost estimate for the NGSI and/or enhancements/upgrades to a current instrument.

- If modifying or upgrading an existing instrument, indicate the down time when that instrument would not be available for observations on SOFIA
- Include a description of what components or aspects of the design are subject to further definition or identification during the funded ICS phase concept study
- Describe development of instrument control software and data reduction and analysis pipeline software
- If applicable, provide a discussion of possible future upgrades/continued improvement of the instrument capabilities to push the scientific boundaries and discovery space.

3. Identify all enabling technologies and define and justify the claimed NASA Technology Readiness Level (TRL), establishing confidence that the instrument design can be adequately developed within the proposed budget and timescale of the concept study. Details of the technical architecture will be further developed in the ICS phase.

4. A detailed budget, not exceeding $500K over five months, for the ICS phase must be entered into the NSPIRES cover page budget form and uploaded as a "Total Budget" PDF. The Step-1 proposal must include a budget justification for conducting the instrument concept study (see Section 6 below for requirements) but consistent with Section IV(b)(iii) of the ROSES-2018 Summary of Solicitation, salary, fringe and overhead should not be included in the proposal, which will be peer reviewed.

5. The budget justification section must include a separate appropriately labeled section with a high-level cost plan for the instrument development phase with an appropriate funding profile that does not exceed ~$15-20M over three years from the start of instrument development (i.e., from the end of the ICS phase). If the cost is higher than this, adequate justification must be provided in the proposal. Note that this is the total anticipated funding for one or more instrument(s) selected for development.

6. Potential, high-level de-scope options to the instrument, when such de-scopes could be exercised, along with the associated anticipated science impacts.

7. A high-level development, implementation, and commissioning plan with estimates for all costs associated through commissioning. The commissioning plan will be further developed in the ICS phase.

8. A high-level estimate of the scope of work and funding required to support the community usage (consistent with Section 4.3.2). The proposing team(s) are required to provide the needed support for broad community use as well as the data reduction pipeline that will provide users with science-ready data and data products. The community usage plan may be refined in the ICS phase upon better understanding of the instrument.

9. A high-level plan for the scope of work in transitioning the instrument to the SOFIA project for formal acceptance within the (up to two year) transition period after commissioning. This plan must detail how the team(s) propose to
collaborate with SI Dev team and the SMO to smooth the transition of the instrument for acceptance by the project.

10. Brief discussion of the methodology and rationale used to develop the proposed estimated cost of the instrument development (including a brief discussion of sources of cost uncertainties) and provide a discussion on the proposed management approaches for controlling cost growth.

11. If a proposal includes contributions from other institutions that are essential to the success of the proposed instrument development or are in the critical path, the proposal must include: (i) demonstrations of clear and simple technical and management interfaces in the proposed cooperative arrangements, (ii) explicit evidence that the proposed contributions are within the contributor’s scientific and technical capabilities, and (iii) contingency plans for coping with potential failures of proposed cooperative arrangements or, where no mitigation is possible, an explicit acknowledgement to that effect and an explicit rationale for accepting the risk. A letter of commitment clearly describing the partner institutions role and commitment must be included in the proposal.

6. Anticipated Requirements for ICS Phase Reports

The ICS phase is expected to last approximately 5 months. We anticipate that teams will be required to include the following items in their final ICS report (Step-2):

1. A list of the science requirements and their flow-down to SI performance requirements including sensitivity/error budgets. The requirements do not need to be flowed down at the level of a System Requirements Review (SRR). But they should be specified in enough detail that a technical review panel is able to judge the scope of the development effort. The SRR is described in more detail in the SOFIA Instrument Development Library (see Section 3.4).

2. A proposed design, including hardware, electronics, software, and data analysis that could achieve these requirements, given in enough detail that the technical review panel can evaluate whether this design would be adequate. This does not, however, have to be at a Preliminary Design Review (PDR) level of design. The PDR is described in more detail in the SOFIA Instrument Development Library (see Section 3.4). The report should present enough information of the design and its required reviews to demonstrate to the technical review panel that the proposal team fully understands what is necessary to have an airworthy and reliable instrument flying on SOFIA.

3. Any technology development work that would be needed before a final design can be developed (e.g., raising TRLs of enabling technology).

4. Any outstanding design trades.

5. Possible de-scopes and their consequences.

6. A detailed work breakdown structure (WBS), with accurate labor and the required skill-set estimates for each WBS element.

7. Apportionment of the WBS elements among the different institutions in the proposal, with detailed letters of commitment from each institution.

8. An integration and test plan in enough detail that the technical review panel can
judge its feasibility, including any required documentation submissions to the SOFIA Project for their review.

9. A plan for developing the data reduction pipeline in collaboration with the SMO that will be ready for use at the end of commissioning. A clear plan with milestones must be provided on how the pipeline will be developed, tested, verified and delivered. The plan should also include any contemplated modifications, upgrades or refinement in the future.

10. A plan for management of data products (commissioning, GO, and LSP data) so that they are expeditiously available for ingestion into IRSA, which will serve the data to all users. The data products must conform to standard requirements used by IRSA for serving the data to the scientific community for analysis.

11. A schedule for the development effort, explicitly showing the location and duration of any funded schedule reserve, as well as the times and locations of any reviews.

12. A Master Equipment List (MEL) including the costs, supported by quotes, of all of the major procurements.

13. Identification of the key personnel, with statements of commitment for their time as specified in the WBS.

14. A risk plan for those items that are threats to the successful completion of the development effort on time and within cost.

15. A cost plan, broken down into enough detail with skill-sets and rates so that the technical review panel can gain confidence that the final costs are realistic.

16. A description of the facilities that will be used in the development program, including any test facilities, with letters of commitment that they will be available during the time periods shown in the development schedule.

17. A description of the organizational structure, include authority and lines of reporting.

18. A concept of operations for the instrument.

19. A detailed commissioning plan with an estimate of the number of flight research hours required to verify their instrument’s performance, commission the instrument for use by GOs, and obtain any required generic calibration data. Observing time estimates do not need to include observatory overhead values (for telescope set-up and initial source acquisition), but should include observation overheads (time on target, time off-target for background subtraction via chop and/or nod, etc.). The estimated number of 'line operations observing hours' (observations with telescope operational and the aircraft parked on the ground) required to commission the instrument shall also be estimated. The number of hours proposed for commissioning the instrument and for line operations should be kept as small as practical and should be well-justified. Commissioning data that can also lead to publication of scientific results will be viewed as a strength of the proposal - therefore a carefully crafted commissioning plan at the end of the ICS is recommended. Offers to provide the larger astrophysics community with commissioning data and/or other help for full exploitation of the instrument will be considered a strength.
20. A further detailed estimate (if needed) of the schedule and resources needed for the execution and delivery (science ready data products, enhanced products, papers, presentations, conferences, community engagement, etc.) of the LSP.

21. Any minor refinements of the needed observing time for the LSP (based only on a better understanding of the instrument) but without changing the scope of the scientific investigation. Any other details to clarify the scope of the work to execute the LSP such as the funding to execute the LSP.

22. Refinement of the community usage plan from Phase I describing how the proposing team will ensure the maximum exploitation of science for programs from the broader science community. The plan should describe how the team plans to support the community and describe with justification their request for any desired participation in the community’s proposed science GO programs with the NGSI. The funding needed to support the community should be described with adequate justification.

23. If applicable, a discussion of plausible future upgrades / updates to the instrument or software, estimated cost of the upgrades and their impact on the observatory and the science.

6.1 Reporting / Status updates / Q and A during the ICS Phase

During the ICS phase, the selected instrument teams should anticipate providing the SOFIA project with a monthly progress/status report. All teams may ask questions or clarifications during this phase - answers will be posted for all teams on a public web page since the ICS phase is a competitive phase.


The evaluation of proposals submitted in response to this program element will be in accordance with the evaluation factors stated in Section VI(a) of the ROSES Summary of Solicitation and the NASA Guidebook for Proposers, as well as consideration of the requirements described above.

- The evaluation criterion "intrinsic merit" will include consideration of the scientific merit of the proposed investigation and feasibility of technical success. The greatest weight will be placed on the compelling nature of the proposed LSP, the clarity of its goals and objectives, and the potential for fundamental progress, as well as filling gaps in our knowledge relative to the current state of art. Additional factors that will be evaluated are the expertise of the team, appropriateness of the instrument to address the goals and objectives, scientific potential of the instrument for the broader community including the community usage plan, data reduction and analysis pipeline plan, the archival value of data expected from the instrument, technical feasibility of the instrument, and the overall science return on the investment.
- The evaluation criterion "relevance" will include consideration of the scientific relevance of the proposed LSP and broader science enabled by the NGSI to NASA, with an emphasis on the degree to which the proposed instrument is able to uniquely advance the scientific capabilities of SOFIA.
The evaluation criterion "cost realism and cost reasonableness" will include consideration of the implementation and cost risks factors such as: the feasibility and maturity of the design, the probability of technical success including de-scope options, the technology readiness level, the probability of meeting cost and schedule, the adequacy and costs of the ICS phase study plan. Also included in this criterion will be factors such as the proposed management plan and schedule, probability to conform and meet SOFIA Observatory requirements, the merits of the implementation and commissioning plans as well as the team’s plan for transitioning the NGSI to SOFIA. The adequacy of the costs for executing the LSP and the community usage effort will also be considered in this criterion.

The evaluations will be used for the development of a selection recommendation by the POC for presentation to the selecting official (the Director, Astrophysics Division, Science Mission Directorate). The selection recommendation and selection decision may also include consideration of programmatic factors, such as the availability of funds, total cost, anticipated operational date, implementation and management risk, and potential benefit to other NASA missions.

8. Evaluation of the ICS Phase Reports

The evaluation of the ICS Phase reports (Step-2 proposals) will be done by a technical review panel. The science will not be judged again unless changed from what was originally proposed. The review will focus on the technical feasibility of the instrument as well as the feasibility and adequacy of its planned development schedule, costs and risks. The evaluation criteria for the ICS Phase reports will be described at a ICS kickoff meeting anticipated to be held soon after the selections are announced in ~October 2018.

9. Eligibility and Conflicts of Interest

Proposals from any category of organizations or institutions, U.S or non-U.S. (but not German, see below), are welcome to respond to this program element. Specific categories of organizations and institutions that are welcome to respond include, but are not limited to, educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers, the Jet Propulsion Laboratory (JPL), and other Government agencies.

SOFIA is a joint US-German partnership. Co-Investigators (Co-Is) at German institutions are welcome to participate on a no exchange of funds basis in proposals submitted by non-German institutions. Since the Memorandum of Understanding (MOU) between NASA and Deutsches Zentrum für Luft und Raumfahrt (DLR), the German Aerospace Center, gives the authority for selection of German participants in the SOFIA Project to DLR, German institutions are not eligible to submit proposals as PI to NASA in response to this program element (see also Section 12.3)

Any non-U.S. participation in this solicitation is subject to the requirements set forth in the ROSES-2018 Summary of Solicitation, Section III(a).
NASA ARC is eligible to submit and participate in proposals in response to this program element. In order to manage ARC’s two potential roles as both proposers and in its role as SOFIA Science Center, SMD has established functional and organizational firewalls between the SOFIA Project and its associated Science Center, and those components of ARC that might participate in proposals. These firewalls ensure that personnel identified as supporting SMD in the solicitation process will protect all nonpublic information from all proposers, including those at ARC, and will be free of financial and other conflicts of interest with proposers.

Organizational conflicts of interest (OCI) between proposing, evaluating, and executing organizations must be avoided. The approach to avoiding organizational conflicts of interest depends on the unique characteristics and roles of each evaluating organization. For non-Governmental organizations, this requires limiting the extent to which the outside evaluating organizations can participate in proposal development and/or execution of the work proposed.

The NASA contract with Universities Space Research Association (USRA) for SOFIA science and mission operations includes technical evaluation support under this program element. In the event that any business unit of USRA has a proposed role as prime contractor, subcontractor, or participating organization, this support creates an organizational conflict of interest for USRA that cannot be mitigated. Because of this organizational conflict of interest, USRA personnel are precluded from participating in any capacity in support of a respondent under this program element.

Although NASA’s Postdoctoral Project (NPP) is now managed by USRA, NPP fellows are not formally employees of USRA and therefore are eligible to participate in any capacity as principal or co-investigators, or in support of a respondent under this program element. NPPs should not propose as being affiliated with USRA, but instead should participate through another organization (such as their NASA center).

USRA is a private, nonprofit corporation whose current membership consists of 105 universities in the U.S. and abroad that have graduate programs in space-related sciences and/or engineering. NASA has determined that there is a need for USRA employees to perform technical evaluations of proposals for new science instruments due to their unique qualifications. In order to address any apparent or actual organizational conflict of interest that arises between USRA employees and the 105-member universities of USRA, the NASA Assistant Administrator for Procurement has approved a waiver in accordance with FAR 9.504(e) to permit peer review evaluation by USRA employees for all proposals received, including proposals received from the USRA member universities.

10. Public Engagement and Communications

Successful media relation activities require close cooperation between NASA and the selected investigations. All selected investigations shall coordinate media relations and/or public affairs with the SOFIA public affairs office. NASA is to be informed in a timely manner of any newsworthy mission event or issue before public release of information. Strategies for using new and social media shall also be developed
collaboratively to ensure that common and consistent messaging will occur in a timely manner. NASA and the selected investigation will establish and maintain a detailed coordination media relations plan and communication process.

11. Remediation, Termination, or Cancellation

For the ICS report, each selected Principal Investigator (PI) must include a commitment by the PI for the PI-managed instrument development cost, schedule, and award associated with the instrument. To maximize the efficiency of the concept study investment, the selected PI shall work with NASA to develop top-level science and technical performance requirements, including a set of performance metrics for evaluation with NASA. These metrics shall include cost, schedule, and others, as appropriate.

Once an investigation has been selected for implementation following down-select after the ICS phase, failure of the PI to maintain reasonable progress within the committed schedule and cost, and/or failure to operate within other applicable constraints, will require a review by NASA to ascertain if the development should continue. If, at any time, the cost, schedule, or scientific performance commitments made in the ICS concept study report appear to be in peril, the instrument development will be subject to cancellation, accompanied by appropriate award action, which may involve termination of the award.

Overall oversight of the instrument development will be provided by the SI Dev Manager at ARC. Additional independent oversight will be conducted by the SOFIA Chief Engineer’s staff and the SOFIA Safety and Mission Assurance staff.

12. Submission Process and Requirements

Proposers should refer to the PDF entitled "How to submit a Step-1 proposal" under "Other Documents" on the NSPIRES page for this program. The process for preparation and submission of the Step-1 proposals is essentially identical to that associated with any other ROSES proposal, subject to the following program-specific constraints:

a) The Scientific/Technical/Management section of the Step-1 proposal, which consists of text, tables, and figures, must not exceed 25 pages. References do not count against the 25-page limit.

b) Proposals may only be submitted electronically through either NSPIRES (https://nspires.nasaprs.com) or Grants.gov (https://www.grants.gov/). No other submissions types or methods are permitted.

c) All electronic proposal materials must be submitted by 11:59 p.m. Eastern time on the due date given in Tables 2 and 3 of ROSES in order to be eligible for review for this program element.

Instructions provided in this program element supersede the instructions in the ROSES-2018 NRA and in the Guidebook for Proposers.
12.1 Pre-Proposal Workshops

NASA will provide three opportunities to the community to participate in a pre-proposal workshop on the dates noted in Section 14, Summary of Key Information. The workshop will cover the scope and intent of the solicitation, as well as expectations for the Instrument Concept Study, and NASA oversight of the development and commissioning process, and the characteristics of SOFIA. Detailed information on how to connect to the video/teleconference workshop will be provided at least one week prior to each workshop on the web page for this solicitation in NSPIRES and also on the SOFIA project web page. There will be a question and answer session at the workshop which will be recorded and also put on a webpage.

12.2 Proposal Formatting

Formatting of the proposal must conform to the stylistic requirements described in the ROSES-2018 Summary of Solicitation and if not addressed there refer to the 2018 NASA Guidebook for Proposers. There is no minimum requirement for fonts used within figures and tables but all text in figures and tables shall be legible; fonts smaller than 8-point are often illegible. Proposals that do not conform to the page limits and formatting requirements described or referenced in this solicitation will be subject to penalty up to and including decline without review.

12.3 International Agreements

Proposals from scientists employed at non-U.S. institutions will be considered on a no-exchange-of-funds basis. Non-U.S. proposals will be reviewed to the same standards as proposals from U.S. institutions. All foreign investigators, whether proposing as PI from a foreign organization or Co-Is participating on proposals from U.S. organizations, must be endorsed by a funding/sponsoring institution or agency in the foreign country to demonstrate that resources are available to support the proposed investigation. Proposals from non-US participants should adhere to Section III(a) of the ROSES-2018 Summary of Solicitation and the NASA Guidebook for Proposers.

13. Award Administration and Funding

The award types depend on the nature of the work proposed, but it is anticipated that ICS Phase awards (made in response to Step-1 proposals) to non-Federal institutions will be grants and any subsequent (full) awards made in response to Step-2 proposals will be contracts. The initiation of the selected award(s) will take place as soon as possible after notification of selection. If the proposing organization of the instrument selected for implementation is external to the Federal Government, funding for the development, installation, and commissioning of the instrument may be issued as a contract from ARC. If the proposing organization is a NASA Center or other Government agency, funding will be issued through normal internal NASA or interagency processes, for both the ICS phase and post selection.

Once an instrument is selected for implementation (following the ICS phase), the technical oversight and management of the selected next generation SI development will be assigned to the SI Dev manager located at ARC. The responsibilities of this
manager include the overall oversight of the design, development, and implementation of the next generation science instrument. The SOFIA Project will provide system engineering methodology to assist the PI-led team in tracking progress against milestones, decision key points, budget and schedule, and goals and objectives, as well as the program plan, and specific aspects unique to SOFIA, such as airworthiness considerations.

14. Summary of Key Information

<table>
<thead>
<tr>
<th>Expected total program budget</th>
<th>$15M-$20M over three years (higher values need adequate justification).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new awards</td>
<td>One or more proposals selected to conduct ICS</td>
</tr>
<tr>
<td>Maximum duration of awards</td>
<td>ICS phase to be approximately 5 months. The schedule for implementation and delivery of the selected instrument will be determined during the ICS</td>
</tr>
<tr>
<td>Dates for Pre-proposal Workshops</td>
<td>Tuesday, Apr 3, 2018 at 2 pm Eastern Monday, Apr 16, 2018 at 4 pm Eastern Thursday, May 17 2018 at 2 pm Eastern</td>
</tr>
<tr>
<td>Submission of NOIs (not required)</td>
<td>Preferably by Jun 1, 2018</td>
</tr>
<tr>
<td>Due Date for Step-1 proposal</td>
<td>11:59 PM Eastern Time on August 1, 2018 via NSPIRES</td>
</tr>
<tr>
<td>Anticipated due date for invited Instrument Concept Study (Step-2 Proposals)</td>
<td>~ March, 2019</td>
</tr>
<tr>
<td>Planning date for Instrument Concept Study start</td>
<td>~3 months after Step-1 due date</td>
</tr>
<tr>
<td>SOFIA Instrument Development Library</td>
<td><a href="https://www.sofia.usra.edu/science/instrument-call">https://www.sofia.usra.edu/science/instrument-call</a></td>
</tr>
<tr>
<td>SOFIA Project web site</td>
<td><a href="http://www.sofia.usra.edu/">http://www.sofia.usra.edu/</a></td>
</tr>
<tr>
<td>Relevance</td>
<td>This program is relevant to the Astrophysics strategic goals and objectives in NASA’s Strategic Plan. Proposals that are relevant</td>
</tr>
<tr>
<td>General information for this solicitation</td>
<td>to this program are, by definition, relevant to NASA.</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Detailed instructions for the preparation and submission of proposals</td>
<td>See the ROSES-2018 Summary of Solicitation</td>
</tr>
<tr>
<td>Submission medium</td>
<td>Electronic proposal submission is required; no hard copy is required or permitted.</td>
</tr>
<tr>
<td>Web site for submission of electronic proposals via NSPIRES</td>
<td>Please see Section I(g) Order of Precedence and Table 1 of the ROSES-2018 Summary of Solicitation and the NASA Guidebook for Proposers.</td>
</tr>
<tr>
<td>Web site for submission of proposals via Grants.gov</td>
<td>Submission medium</td>
</tr>
<tr>
<td>Funding opportunity number for downloading an application package from Grants.gov</td>
<td>NNH18ZDA001N-S4THG</td>
</tr>
</tbody>
</table>
| NASA point of contact | Kartik Sheth  
Astrophysics Division,  
Science Mission Directorate  
NASA Headquarters  
Washington, DC 20546-0001  
Telephone: 202-358-4805  
Email: Kartik.sheth@nasa.gov |