SMALL EXPLORER AND MISSIONS OF OPPORTUNITY
ANNOUNCEMENT OF OPPORTUNITY
NNH07ZDA003O

AMENDMENT 1
FOCUSED OPPORTUNITY FOR SOLAR ORBITER

Amendment 1 – Focused Opportunity for Solar Orbiter. This Focused Opportunity for Solar Orbiter (FOSO) amendment adds Section 10 to the Small Explorer (SMEX) and Missions of Opportunity AO.

The FOSO adds a new class of solicitation to this AO. NASA is soliciting science investigations that require the provision of flight hardware to the ESA-led Solar Orbiter mission. With the exception of any requirements that are specified in this amendment, FOSO proposals have the same requirements as Missions of Opportunity proposals. This includes the requirements for standard content and format for a proposal as described in Appendix B.

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10.0 FOCUSED OPPORTUNITY FOR THE SOLAR ORBITER

10.1 Description of the Opportunity

10.1.1 Background

The study of solar and heliospheric physics has a long and active history in the science communities of both Europe and the United States through missions such as the Solar and Heliospheric Observatory (SOHO), Ulysses, and the Solar Terrestrial Relations Observatory (STEREO). These two communities have been studying future solar and heliospheric space missions under the auspices of the International Living With a Star (ILWS) initiative since 2001.

The science requirements for the European Space Agency (ESA)-led Solar Orbiter mission are detailed in the March 2005 report, *Solar Orbiter Science Requirements Document*, as well as the October 2007 report, *Solar Orbiter Payload Definition Document*, available in the FOSO section of the Explorer Program Library (hereafter the EPL; see Appendix C for the location of the Explorer Program Library). Solar Orbiter's destination is near the Sun and out of the ecliptic plane. It has both *in situ* measurements and remote sensing observations.

The NASA Living With a Star (LWS) Solar Sentinels mission is synergistic with Solar Orbiter, and its Science and Technology Definition Team (STDT) report, *Solar Sentinels: Report of the Science and Technology Definition Team*, was issued in August 2006 (http://sentinels.gsfc.nasa.gov/; available in the EPL). The Solar Sentinels mission is comprised of four spacecraft that are located at several radial distances and azimuthal locations in the near-ecliptic plane of the Sun. Each spacecraft makes *in situ* measurements and remote sensing observations. The Solar Orbiter and Solar Sentinels missions have capabilities that the other lacks but needs in order to maximize the scientific return. That is, Solar Orbiter provides the remote sensing capability that Solar Sentinels requires if its *in situ* measurements are to be unambiguously related to structures on the Sun, while the Solar Sentinels mission — with the Solar Orbiter serving as a fifth Sentinel — provides the multipoint perspective needed to resolve the spatial and temporal features of transients and other solar wind structures.

Early in 2007, ESA and NASA combined the two missions into a single joint collaboration because of the synergy between the missions. They formed a Joint Science and Technology Definition Team (JSTDT) for the combined science of the two missions and charged it with defining and prioritizing the science goals for the joint collaboration. The JSTDT renamed the merged Solar Orbiter/Solar Sentinels missions as the HELiophysical EXplorers (HELEX) collaboration. A prepublication version of the JSTDT report, *HELEX: Heliophysical Explorers: Solar Orbiter and Sentinels*, is available at http://sentinels.gsfc.nasa.gov/ and in the EPL. HELEX will answer fundamental questions about the Sun-heliosphere linkage by combining multipoint, *in situ* measurements using new instrument capabilities with remote sensing observations from the inner heliosphere.

10.1.2 Opportunity for Proposals

This Focused Opportunity for Solar Orbiter (FOSO) applies only to NASA contributions for the ESA-led Solar Orbiter mission. The FOSO invites scientific investigation proposals that require the provision of flight instruments to carry out the Solar Orbiter component of this joint collaboration. To fulfill the high priority science of linking the in-situ Sentinels observations to the environment of the inner heliosphere, NASA solicits proposals for a wide angle coronagraph/heliospheric imager.

In addition, this FOSO solicits proposals for science investigations in two categories,

- Instrument investigations, where NASA funds an investigation that has a NASA-funded PI leading the development of an instrument suite; and
- Sensor investigations, where NASA funds an investigation that has a NASA-funded PI providing a sensor for an ESA-led instrument suite.

One or more FOSO investigations may be selected within a $65M budget allocated for instrument and sensor investigations. NASA anticipates spending approximately 45 percent of its available funding on a wide field coronagraph/ heliospheric imager.

One or more additional investigations may be designated as a unfunded backups until all selected investigations pass or fail their Initial Confirmation Reviews to enter Phase B, in case one of them is unable to meet its technical, cost, or schedule commitments, and with no guarantee of being approved for continuing into subsequent development phases.

For the purpose of this AO, FOSO investigations are treated like Mission of Opportunity proposals except as specified in this amendment.

10.1.3 Available NASA Resources

Proposing organizations must recognize that NASA's resources available for this FOSO are constrained and propose accordingly. As a guideline, the total cost to NASA of <u>all</u> FOSO investigations selected through this AO from Phase A through Phase E is approximately $65M in real year dollars with approximately $2M of that amount allocated for Phase A contracts (in the range of $300-600K for each investigation based on the complexity of the proposed investigation). The amount of funding provided for this Phase A study may vary depending on the nature of the selected investigation(s). In any event, the continuation of any aspect of this program shall be contingent upon the availability of appropriated funds through the yearly U.S. Federal Government budget process.

10.1.4 ESA/NASA HELEX Elements

The HELEX collaboration is based on major program contributions from both ESA and NASA. The current plan is subject to formalizing the collaboration in a formal Memorandum of Understanding (MoU). Lead and contributing agencies for contributions to the Solar Orbiter mission are summarized in Table 10-1.

Table 10-1. Lead and contributing agencies for contributions to the Solar Orbiter mission

Contributions	Lead Agency	Contributing Agency	Comment
Overall Mission	ESA	NASA	
Procurement and development of the Observatory	ESA		Includes spacecraft development, integration(including instruments) and testing in Europe
Instruments	ESA	NASA	ESA Member States provide instrument suites; NASA may provide sensors for ESA-led instrument suites
Instruments	NASA	ESA	NASA provides instrument suites; ESA Member States may provide sensors for NASA-led instrument suites
Prelaunch integration and processing of observatory, launch vehicle, and launch	NASA	ESA	Evolved Expendable Launch Vehicle (EELV) at Kennedy Space Center (KSC), Cape Canaveral, FL
Mission Operations	ESA	NASA	ESA provides the Mission Operations Center
Science Operations Centers	ESA and NASA	ESA and NASA	ESA provides a Science Operations Centers (SOC) for ESA-led instrument suites and NASA provides SOC for NASA-led instrument suites
Data analysis and Dissemination	ESA	NASA	ESA distributes science data and telemetry to SOC; open data policy for all science data

10.1.5 Schedules for Selection and Development

The schedule for the selection of FOSO investigations is coupled to the schedule for the evaluation and selection of SMEX investigations. The overall schedule for the selection of investigations is given in Table 10-2.

Table 10-2. Overall Schedule for FOSO Selections

Event	Date
Issue of this FOSO	October 22, 2007
SMEX preproposal conference	November 6, 2007
Notice of Intent to Propose Due	November 16, 2007
Proposals due at NASA	February 1, 2008
FOSO selections announced (target)	June 30, 2008

The dates that are important for the development of instruments and sensors for the NASA Solar Orbiter Collaboration project are shown in Table 10-3.

Table 10-3. Important milestones for NASA investigators proposing to provide instrument suites or sensors for the Solar Orbiter mission

Event	Date
FOSO selections announced (target)	June 30, 2008
Start of Phase A (Contract through start of Phase B)	October 1, 2008
Initial Confirmation Review	June 1, 2009
Initial Confirmation	September 30, 2009
Start Phase B	October 1, 2009
Confirmation Review	June 1, 2010
Confirmation to Begin Development	September 30, 2010
Begin Phase C/D	October 1, 2010
Ship Sensors on ESA Member State-led instrument suites to the Member States for integration onto the instrument suites	May 1, 2012
Ship NASA-led instrument suites to ESA for integration onto observatory	May 1, 2013
Integration and test of instruments with spacecraft bus	July 2, 2013 -- November 30, 2014
Ship observatory to KSC for launch operations	August 2014
Launch Readiness Date	May 1, 2015
Commissioning	May 1 -- July 31, 2015
Prime Mission Operations	August 1, 2015 -- July 31, 2020
Data Analysis and Archiving for Prime Mission	August 1, 2020 -- July 31, 2021

10.2 Science Objectives

10.2.1 Introduction

The primary objective of the FOSO is to solicit science investigations for the Solar Orbiter mission, which as one component of the HELEX collaboration will explore the near-Sun environment, determine how the Sun generates the dynamic heliosphere, and elucidate the fundamental plasma physical processes operating near the Sun and their coupling across multiple scales.

10.2.2 Solar Orbiter Mission

The Solar Orbiter (SO) observatory is a three-axis stabilized spacecraft equipped with instruments for both *in situ* measurements and remote-sensing observations. The spacecraft bus and instrument integration will occur at ESA; the observatory will be launched at Kennedy Space Center, Cape Canaveral, FL; and ESA will operate the mission. After launch, Solar Orbiter will be placed into a low-C3 inner heliospheric orbit that will require two Earth-encounter gravity assist maneuvers and up to seven Venus gravity assist maneuvers to reduce the perihelion distance and to change the inclination of the orbital plane. The reference trajectory will bring the observatory as close as about 0.22 Astronomical Units (AU) by the end of the transfer phase,

and, through progressive raising of the inclination, to heliolatitudes of 27.5 degrees by the end of the nominal prime mission phase of 6.2 years and to about 34 degrees by the end of ten years.

As one component of HELEX, Solar Orbiter will explore the near-Sun environment, determine how the Sun generates the dynamic heliosphere, and elucidate the fundamental plasma physical processes operating near the Sun and their coupling across multiple scales. Details of the Solar Orbiter mission are provided in the *Solar Orbiter Assessment Phase Final Report* available in the Explorer Program Library.

10.2.3 Inner Heliospheric Sentinels Mission

NASA's Inner Heliospheric Sentinels (IHS) mission is one of three flight elements of the Living with a Star (LWS) Solar Sentinels program defined in the August 2006 report, *Solar Sentinels: Report of the Science and Technology Definition Team* (http://sentinels.gsfc.nasa.gov/ and in the EPL).

The other two flight elements discussed in the report are a Near-Earth Sentinel, which would carry a UV spectroscopic coronagraph and a white-light coronagraph with an FOV out to 60 R_S and a Farside Sentinel equipped with a magnetograph for measurement of the photospheric magnetic field. The remote-sensing capabilities supplied by these two spacecraft will be provided in the merged mission by Solar Orbiter.

Inner Heliospheric Sentinels mission will place four spin-stabilized spacecraft into an elliptical heliocentric orbit with perihelia near 0.25 AU and aphelia near 0.75 AU. The orbit will remain within a few degrees of the ecliptic. The four Sentinels will be identically instrumented to make comprehensive *in situ* measurements of the inner heliospheric plasma and energetic particle environment, as well as to perform x-ray imaging of electron acceleration sites and detect gamma-ray/neutron bursts from ion acceleration associated with flares and other transients.

10.2.4 Solar Orbiter and IHS combined: HELEX

HELEX combines the capabilities of ESA's Solar Orbiter (near-Sun *in situ* plus remote-sensing observations from a partially co-rotating platform whose orbital inclination gradually rises from near-ecliptic to heliographic mid-latitudes) with those of NASA's LWS/Inner Heliospheric Sentinels (*in situ* observations from multiple platforms arrayed at varying radial distances and azimuthal locations in the near-ecliptic plane) to investigate, characterize, and understand the Sun's influence on the environment of the inner solar system. Such understanding is, of course, also the primary goal of each mission individually, whose science objectives are described in the reports prepared by the respective science and mission definition teams (see the SMEX EPL). The three top level overarching questions to be addressed by the HELEX collaboration are:

- What are the origins of the solar wind streams and the heliospheric magnetic field?
- What are the sources, acceleration mechanisms, and transport processes of solar energetic particles?
- How do coronal mass ejections evolve in the inner heliosphere?

Solar Orbiter will contribute to all three HELEX science objectives, but both missions are necessary to completely address the science questions. The JSTDT recommended significant changes to the original Solar Orbiter and Solar Sentinels payloads and operational modes to optimize them for the joint program. More importantly, synoptic observations were added to the observational strategy for Solar Orbiter, thereby providing the remote-sensing observations needed to link the multipoint *in situ* measurements from Solar Sentinels with features observed on the Sun. Other JSTDT recommendations include the addition of a wide-field coronagraph/inner heliospheric imager to the Solar Orbiter payload to allow concurrent remote imaging of the same regions that are being measured *in situ* by the Solar Sentinels. Finally, the JSTDT prioritized joint program objectives for HELEX. These joint objectives, along with additional information, are available in the FOSO section of the SMEX library.

In order to meet the broad scope of science objectives, as articulated by the JSTDT, the FOSO is soliciting science investigations which address high priority science objectives for Solar Orbiter in the HELEX program, as defined in the JSTDT report, and which complement the plans for the ESA science payload for the Solar Orbiter mission.

10.2.5 Reference Payload

A reference payload against which the current mission design and cost estimates have been made is provided in Table 10-4. A more detailed description of these model instruments are given in the *Solar Orbiter Experiment Interface Document Part A* (available in the EPL). The proposed instruments and sensors should be compatible with the Solar Orbiter observatory design, as described in the JSTDT report, *HELEX: Heliophysical Explorers: Solar Orbiter and Sentinels*.

The exact limits of the Solar Orbiter payload, mass, power, and telemetry bandwidth for instruments are anticipated to be available some time after the negotiation of the NASA-ESA Memorandum of Understanding (MOU) that characterizes the exact nature of the collaboration. Pending this interagency agreement, proposers are cautioned that payload resources are constrained, and in the competitive environment are likely to play a role in the final selection

Nominal accommodation of all the instruments has been defined with the exception of a wide-field heliospheric imager. With the caveats mentioned in the previous paragraph, it is anticipated that the available resources for a wide angle coronagraph/heliospheric imager will be in the range of 5-10 kg in mass, 5-10 W in power, and a telemetry bandwidth of ~20 kbit/s.

Table 10-4. Reference payload for the Solar Orbiter mission from the JSTDT report

Instrument Type	**Instrument**	**Purpose**
In Situ	Plasma suite (ion and electron solar wind analyzers)	Investigate the kinetic properties and composition (mass and charge states) of solar wind plasma
	Fields suite (plasma wave analyzer, magnetometer)	Investigate the solar wind magnetic field and plasma waves including coronal and interplanetary emissions with a reduced number of look directions compared to the Solar Orbiter mission report outside of the HELEX program
	Particles Package (energetic particle detectors)	Investigate the origin, acceleration and propagation of solar energetic particles with a reduced number of look directions compared to the Solar Orbiter mission report outside of the HELEX program
Remote sensing	Visible-light imager and magnetograph	Investigate the magnetic and velocity fields in the photosphere with lower cadence and resolution compared to the Solar Orbiter mission report outside of the HELEX program
	EUV full-Sun and high-resolution imager	Investigate properties of the solar atmosphere compared to the Solar Orbiter mission report outside of the HELEX program
	EUV spectrometer	Investigate the solar atmosphere using high resolution imaging in the extreme ultraviolet (EUV) compared to the Solar Orbiter mission report outside of the HELEX program
	X-ray spectrometer/telescope	Investigate energetic electrons near the Sun, and solar x-ray emission compared to the Solar Orbiter mission report outside of the HELEX program
	Coronagraph	Investigate coronal structures using polarized brightness measurements
	Heliospheric Imager/Wide Field Coronagraph	Investigate outer coronal and inner heliospheric structures using white-light imaging

10.3 Type of Proposals

This FOSO solicits proposals for science investigations in two categories,

- Instrument investigations, where NASA funds an investigation that has a NASA-funded PI leading the development of an instrument suite; and
- Sensor investigations, where NASA funds an investigation that has a NASA-funded PI providing a sensor for an ESA-led instrument suite.

Proposals for science investigations for analysis of data that do not include providing flight articles will be solicited at a later time and are not included in this solicitation. Proposals that provide for joint design of an instrument with a non-U.S. partner are not solicited or appropriate.

It is noteworthy that all the U.S. awardees (i.e., NASA PIs) will be managed as a single (U.S.) Solar Orbiter Collaboration project with project management at the NASA Goddard Space Flight Center.

The selection for FOSO investigations will be a one-step selection; this differs from other proposed investigations submitted in response to the SMEX AO. The project will follow the Key Decision Point gates as described in NASA Procedural Requirement (NPR) 7120.5D, instead of having a competitive Phase A with a down-selection. PIs will be expected to contribute to project documentation, and the project will be subject to an Initial Confirmation Review near the end of Phase A. Each PI must be confirmed to proceed into Phase B and (separately) into development. The project office will negotiate with ESA regarding a data acceptance package and interface control documentation for the U.S. instruments and sensors.

10.4 Program Constraints and Requirements

10.4.1 Science Requirements

Proposed FOSO investigations must address science objectives articulated in the JSTDT report, *HELEX: Heliophysical Explorers: Solar Orbiter and Sentinels*. All proposals must be responsive to the science investigations prioritized in this report.

Proposals must include appropriate provisions for the analysis of data and publication of results in the peer-reviewed scientific literature and for the conduct of an E/PO program. These specific requirements are the same as those for other proposals submitted in response to the SMEX AO.

10.4.2 Cost Requirements and Funding Policies

NASA solicits feasible investigations that minimize the impact on spacecraft resources and achieve high priority science goals for the Solar Orbiter component of HELEX.

One or more FOSO investigations may be selected within a $65M budget allocated for instrument and sensor investigations. FOSO investigations may not be proposed that together exceed $65M in real year dollars for all phases of the investigation. NASA anticipates spending approximately 45 percent of its available funding on a wide field coronagraph/ heliospheric

imager. Within the remaining payload allocation, NASA will consider other high priority science investigations that were identified in the JSTDT report. The level of funding available for each selected proposal will be decided on a case-by-case basis and will be capped at that level. Since NASA would prefer to select multiple FOSO investigations within the allocated budget, proposers are encouraged to keep their budgets low.

NASA's funding for a selected investigation's Phase A will be in the range of $300-600K in real year dollars based on the complexity of the proposed investigation up to an aggregate of $2M for all investigations. The cost of completing Phase A must be budgeted as a part of the initial proposal and must be justified in the proposal. During Phase A, the NASA cost shall not increase by more that 20 percent from that offered in the original proposal and must not exceed the NASA cost cap. At the conclusion of Phase A, each U.S. PI must commit to cost, schedule, and scientific performance for the investigation. If, at any time, the cost, schedule, or scientific performance commitments appear to be in peril, the investigation will be subject to termination or cancellation.

Each proposer must also estimate the total investigation cost for the proposal. Proposals must demonstrate adequate cost reserves as described in Section 4.6.4 of this SMEX AO. For the purpose of this AO, an adequate unencumbered reserve on the PI Mission Cost is measured against the cost to complete through Phases A/B/C/D/E/F and is a minimum of 30% including funded schedule reserve. The specific cost information required for proposals is contained in Appendix B.

10.4.3 Technical Requirements

Since Solar Orbiter is an international mission, proposers are required to maintain clean interfaces with non-U.S. instruments.

All instruments and sensors should be at a technology readiness level (TRL) of five at the end of Phase A and six by the end of Phase B.

The payload resources listed in Table 10-5 represent the overall estimated resources available at the time of launch, i.e., when all the margins have been consumed. For instruments not having a mature design, a contingency margin greater than 30% should be available before the instrument begins Phase C.

Table 10-5. Resources available for all the Solar Orbiter instruments in the HELEX program

Resource	**Amount**
Mass	150 kilograms (kg)
Power	170 Watts
Volume	TBD
Telemetry type	X and/or Ka band
Telemetry output	83.6 kilobits per second
Data volume per orbit	380 to 430 gigabits
Ground station locations	New Norcia (Australia) or Cebreros (Spain), 35m - Antenna, 4 to 8 hours per day (effective)

10.4.4 Management Requirements

The proposal must describe how the responsibilities in Table 10-6 will be carried out.

Table 10-6. Responsibilities of the PI of a FOSO Investigation

Area	Responsibility
Management	
	Establish an efficient and effective managerial scheme through all phases of instrument development and interface with all contributors to the subject instrument.
	Provide status reporting to the NASA Solar Orbiter Collaboration project office.
	Provide the sole formal managerial and technical interface of the instrument to the NASA Solar Orbiter Collaboration Office. Note that the project office will interface with the ESA project office and provide appropriate information, as described in the ESA Experiment Interface Document (EID) that is available in the FOSO section of the SMEX library.
Science	
	Monitor the compliance of the instrument design to the scientific requirements and support the development of Program-level requirements for the Solar Orbiter Collaboration project.
	Participate in meetings of the Science Working Team, as appropriate.
	Ensure adequate calibration of all parts of the instrument, both on the ground and in space.
	Participate in the definition of the science operations and data handling.
	Make the science results available within three months after receiving the data during nominal prime mission operations.
	Provide the scientific data (raw data, calibrated data, and higher level data), including relevant calibration software and/or products, to the Solar Orbiter archive.
Hardware	
	Define the functional requirements of the instrument and auxiliary test equipment such as ground support equipment (GSE).
	Ensure the development, construction, testing, and delivery of the instrument. This shall be performed in accordance with NPR 7120.5D
	Deliver verification models of the instrument to NASA to verify system interfaces
	Deliver a structural thermal model, an engineering model, flight model, and a flight spare, together with relevant GSE (See *Solar Orbiter Experiment Interface Document - Part A* in the FOSO library for characteristics of the models)
	Support the system level integration and test activities related to and involving the instrument.
	Provide the necessary equipment and algorithms to process the instrument/sensor science data.
Software	
	Ensure the development, testing, and documenting of all software necessary for the control, monitoring, and testing of the instrument.

	Specify, and then support, the development, testing, and documentation of all software necessary for the testing, operation, and data reduction/analysis of any parts of the instrument.
	Ensure the delivery of any instrument-specific software that is required for testing or operations and its documentation.
Product Assurance	
	Provide product assurance functions in compliance with the Solar Orbiter Collaboration Mission Assurance Requirements.
Operations	
	Provide support for preparation and implementation of the mission and science operation up to the end of the mission, including delivery of a user manual and data base inputs.

10.5 Program Management

10.5.1 ESA/NASA Management Organization

The overall responsibility for the management of the HELEX/Solar Orbiter implementation and execution will be the responsibility of the ESA Program Manager located at ESTEC. The GSFC HELEX/Solar Orbiter Project Manager will be responsible for managing the NASA investigations, which includes responsibilities for financial, procurement, technical management, and performance aspects within the overall requirements of the program to be specified in the MoU.

For U.S. PIs, all formal communications and agreements concerning HELEX/SO technical and programmatic aspects will be made between the ESA program manager, the NASA SO Project Manager, and the PI. A U.S. PI or U.S. Co-I for a sensor investigation that is providing NASA funded hardware on a non-U.S. instrument shall be required to receive any necessary funding approval from the NASA Solar Orbiter Project Manager prior to making agreements, since NASA GSFC will be responsible for contracts and performance of U.S. instrumentation.

All scientific aspects of the missions will be coordinated by the NASA Solar Orbiter Project Scientist who is the formal interface for scientific matters, in liaison with ESA.

10.5.2 Deliverable Items

Each selected investigator for this FOSO should factor the cost of providing contributions to project deliverables for Key Decision Points, as described in NPR 7120.5D. For Phases A and B, contributions to deliverables given in Table 10-7 are expected.

Table 10-7. Project deliverables for Key Decision Points (KDP) B and C

Solar Orbiter Project Deliverable			NPR 7120.5 D Required Maturity at Initial Confirmation Review (KDP B)	NPR 7120.5 D Required Maturity at Confirmation Review (KDP C)
Project Plan which includes:			Preliminary	Final
	a)	Communications Plan	Preliminary	Final
	b)	Organizational Structure/Chart for project and investigators	Preliminary	Final
	c)	Environmental Management Plan	Preliminary	Final
	d)	Life Cycle Staffing Plan	Preliminary	Final
	e)	Closed Loop Problem Tracking Plan	Preliminary	Final
	f)	Technology Plan	Preliminary	Final
	g)	Interagency and International Agreements	Preliminary	Final
	h)	Project Acquisition Strategy	Preliminary	Final
	i)	Project Acquisition Plan	Preliminary	Final
	j)	Safety and Mission Success Plan	Preliminary	Final
	k)	Verification and Validation Plan	Preliminary	Final
	l)	Export Control Plan	Preliminary	Final
	m)	Risk-Based Life Cycle Cost Estimate	Preliminary	Final
	n)	Project Control Plan for Cost, Schedule, and Technical Content, including Earned Value Management	Preliminary	Final
	o)	Knowledge Capture Plan	Preliminary	Final
Mission Concept of Operations			Preliminary	Final
Science Operations Center Requirements			Preliminary	Final
System Engineering Management Plan			Preliminary	Final
Project Response to Mission Assurance Requirements			Preliminary	Final
Software Management Plan			Preliminary	Final
Mission Requirements Document (MRD)			Preliminary	Final
Configuration Management Plan			Preliminary	Final
Project Review Plan			Preliminary	Final
Integrated Master Schedule			Preliminary	Final
Risk Management Plan			Preliminary	Final

Cost Analysis Data Requirement (CADRe)	Preliminary	Final
Schedule Management Plan	Preliminary	Final
Phase A Report	Final	N/A
Phase B Work Agreements	Final	N/A
Phase B Report	N/A	Final
Phase C/D Work Agreement	N/A	Final
Security Plan	Preliminary	Final
Interface Requirements Document - Spacecraft to Launch Vehicle	Preliminary	Final
Interface Requirements Documents - NASA Instruments and Sensors to Spacecraft	Preliminary	Final
Grass-Roots Cost Estimate	Final	Update
Logistics Plan	Preliminary	Final
Initial Confirmation Review Presentation Package	Baseline	N/A
Contract Data Requirements List and Data Item Descriptions for Phases B, C, and D	Final	Update
Work Breakdown Structure and Dictionary	Final	Update
Compliance Matrix for NPR 7120.5D with waivers identified and approved	Final	Update
Trade Studies Summary	Final	Update
Systems Test Plan	Final	Update

10.6 Evaluation and Selection of FOSO Investigations

10.6.1 Evaluation of FOSO Investigations

Proposals for FOSO investigations will be evaluated in the same manner as SMEX Mission of Opportunity proposals. FOSO proposals will be evaluated and categorized in the same way as the SMEX proposals (see Section 8.1 of this SMEX AO).

FOSO investigations will be evaluated against the criteria described in Section 8.2 of this SMEX AO. These evaluation criteria are:

- Scientific merit of the proposed investigation;
- Scientific implementation merit of the proposed investigation; and
- Technical, management, and cost feasibility, including cost risk, of the proposed investigation.

In addition to the evaluation factors given in Section 8.2 of this SMEX AO, the evaluation of scientific merit also includes the following factors:

- The extent to which the proposed investigation addresses high priority science objectives, as defined in the JSTDT report.

In addition to the evaluation factors given in Section 8.2 of this SMEX AO, the evaluation of scientific implementation merit also includes the following factors:

- The extent to which the proposed instruments and sensors are compatible with the Solar Orbiter design; and
- The maturity of the design or the demonstration of a clear path to achieve the necessary TRL on the schedule given in this AO.

In addition to the evaluation factors given in Section 8.2 of this SMEX AO, the evaluation of technical, management, and cost feasibility also includes the following factors:

- The extent to which the proposed instruments and sensors can be achieved within the resources available to Solar Orbiter instruments;
- The demonstration of a realistic plan to carry out all of the management responsibilities.
- The demonstration of a thorough understanding of the accommodation and environmental challenges for the Solar Orbiter mission; and
- The demonstration of a realistic cost and adequate reserves for all phases of the investigation.

10.6.2 Selection of FOSO Investigations

Following categorization of proposals as described in Section 8.1 of this SMEX AO, FOSO proposals will be handled differently from other proposals submitted in response to the SMEX AO. An accommodation study will be conducted jointly by NASA and ESA for all selectable proposals. NASA's responsibility for the joint accommodation study will be led by the HELEX/Solar Orbiter Project at GSFC and will include the participation of a subset of the TMC (technical, management, and cost) peer review panel under the management of the Science Support Office at the NASA Langley Research Center.

The selection of FOSO investigations will be separate from that of other proposals submitted in response to the SMEX AO, and the selection of FOSO investigations will be coordinated with ESA and with ESA's selection of ESA-led Solar Orbiter instruments.

NASA may also designate one or more FOSO investigations as unfunded backups until all selected FOSO investigations pass or fail their Initial Confirmation Reviews to enter Phase B, for possible selection in case one of them runs into technical or cost difficulties. There is no expectation that the alternate will proceed into Phase B and subsequent development phases if the selected investigations proceed without termination; even if a selected investigation is terminated, NASA reserves the right not to go forward with any designated backup investigation.

10.7 Technical and Scientific Inquiries

All technical or scientific inquiries concerning the Focused Opportunity for Solar Orbiter should be directed to the NASA LWS/Solar Orbiter Program Scientist, as designated in this section. Inquiries are preferred in writing and may be sent by E-mail; the character string "FOSO" (without quotes) should be included in the subject line of all transmissions.

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Questions, concerns, or requests for information or clarification regarding this SMEX AO shall be directed only to NASA's formal point of contact, the Explorer Program Scientist, designated in Section 7.1.2 of this SMEX AO. No communications concerning this AO may be made to any other NASA official.

10.8 Summary of Requirements for FOSO Investigations

Proposals submitted in response to the Focused Opportunity for Solar Orbiter of this SMEX AO must comply with all requirements for Mission of Opportunity proposals submitted in response to this SMEX AO, including those requirements in Appendix B of this SMEX AO, except as amended in this Section 10 of this SMEX AO.

The amended requirements include:

- Due date for proposals is different (Section 10.1.5).
- Selection is one step, with no competitive Phase A and no downselect, with different evaluation factors, and with an accommodation study (Sections 10.3, 10.6.1, and 10.6.2).
- Proposed investigations must address HELEX and Solar Orbiter science objectives (Section 10.4.1).
- Cost cap is different (Section 10.4.2).
- There are Solar Orbiter specific technical and management requirements (Sections 10.4.3, 10.4.4, 10.5.2).