

# DOCUMENT

## Announcement of Opportunity for the operations and scientific exploitation of the SPICE instrument on board the Solar Orbiter mission

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## **1 GENERAL INFORMATION**

### **1.1 Summary and Scope**

The European Space Agency (ESA) solicits proposals for the provision of the operations and scientific exploitation of the SPICE instrument on board the Solar Orbiter mission.

Solar Orbiter is the first M-class mission of ESA's Cosmic Vision programme. The mission is devoted to solar and heliospheric physics and will provide unprecedented close-up and high-latitude observations of the Sun and inner heliosphere. The mission is carried out as an ESA mission, in collaboration with NASA, open to the worldwide science community.

Solar Orbiter will be used to examine how the Sun creates and controls the heliosphere, the vast bubble of charged particles blown by the solar wind into the interstellar medium. The spacecraft will combine in situ and remote sensing observations to gain new information about the solar wind, the heliospheric magnetic field, solar energetic particles, transient interplanetary disturbances and the Sun's magnetic field.

The Solar Orbiter baseline configuration consists of a 3-axis stabilised spacecraft that will be launched from Cape Canaveral on a NASA-provided Evolved Expendable Launch Vehicle (EELV). The launch is planned for October 2018.

The mission will provide close-up, high-latitude observations of the Sun. Solar Orbiter will have a highly elliptic orbit – between 0.9AU at aphelion and 0.28AU at perihelion. It will reach its operational orbit around 3 years after launch by using gravity assist manoeuvres (GAMs) at Earth and Venus. Subsequent GAMs at Venus will increase its inclination to the solar equator over time, reaching up to 25° at the end of the nominal mission (approximately 7 years after launch) and up to 34° in the extended mission phase.

Being close to the Sun allows for observations of solar surface features and their connection to the heliosphere for much longer periods than from near-Earth vantage points. The view of the solar poles will help us to understand how dynamo processes generate the Sun's magnetic field.

The science payload of Solar Orbiter comprises both remote-sensing and in situ instruments. The in situ instruments will operate continuously. During each orbit, the complete instrument suite will be operated around closest approach, and at the minimum and maximum heliographic latitudes – the segments of the orbit where Solar Orbiter will be farthest below and above the solar equator. Since the orbital characteristics will change in the course of the mission, individual orbits will be dedicated to specific science questions.

The in-situ instruments are:

- EPD (Energetic Particle Detector): it will measure the composition, timing and distribution functions of suprathermal and energetic particles. Scientific topics to be addressed include the sources, acceleration mechanisms, and transport processes of these particles.
- MAG (Magnetometer): it will provide in situ measurements of the heliospheric magnetic field with high precision. This will facilitate detailed studies into the way the Sun's magnetic field links into space and evolves over the solar cycle; how particles are accelerated and propagate around the Solar System, including to the Earth; how the corona and solar wind are heated and accelerated.
- RPW (Radio and Plasma Waves): this experiment is unique amongst the Solar Orbiter instruments in that it makes both in situ and remote-sensing measurements. RPW will measure magnetic and electric fields at high time resolution using a number of sensors/antennas, to determine the characteristics of electromagnetic and electrostatic waves in the solar wind.
- SWA (Solar Wind Plasma Analyser): it consists of a suite of sensors that will measure the ion and electron bulk properties (including, density, velocity, and temperature) of the solar wind, thereby characterising the solar wind between 0.28 and 1.4 AU from the Sun. In addition to determining the bulk properties of the wind, SWA will provide measurements of solar wind ion composition for key elements (e.g. the C, N, O group and Fe, Si or Mg).

The remote-sensing instruments are:

- EUI (Extreme Ultraviolet Imager): it will provide image sequences of the solar atmospheric layers above the photosphere, thereby providing an indispensable link between the solar surface and outer corona that ultimately shapes the characteristics of the interplanetary medium. EUI will also provide the first-ever UV images of the Sun from an out-of-ecliptic viewpoint (up to 34° of solar latitude during the extended mission phase).
- METIS (Coronagraph): it will simultaneously image the visible and ultraviolet emission of the solar corona and diagnose, with unprecedented temporal coverage and spatial resolution, the structure and dynamics of the full corona in the range from 1.4 to 3.0 (from 1.7 to 4.1) solar radii from Sun centre, at minimum (maximum) perihelion during the nominal mission. This is a region that is crucial in linking the solar atmospheric phenomena to their evolution in the inner heliosphere.
- PHI (Polarimetric and Helioseismic Imager): it will provide high-resolution and full-disc measurements of the photospheric vector magnetic field and line-of-sight (LOS)

velocity as well as the continuum intensity in the visible wavelength range. The LOS velocity maps will have the accuracy and stability to allow detailed helioseismic investigations of the solar interior, in particular of the solar convection zone.

- SoloHI (Heliospheric Imager): it will image both the quasi-steady flow and transient disturbances in the solar wind over a wide field of view by observing visible sunlight scattered by solar wind electrons. It will provide unique measurements to pinpoint coronal mass ejections.
- SPICE (Spectral Imaging of the Coronal Environment): it will perform extreme ultraviolet imaging spectroscopy to remotely characterize plasma properties of the Sun's on-disc corona. This will enable matching in-situ composition signatures of solar wind streams to their source regions on the Sun's surface.
- STIX (X-ray Spectrometer/Telescope): it will provide imaging spectroscopy of solar thermal and non-thermal X-ray emission. STIX will provide quantitative information on the timing, location, intensity, and spectra of accelerated electrons as well as of high temperature thermal plasmas, mostly associated with flares and/or microflares.

The SPICE instrument is being procured under ESA's responsibility and ESA's role will end with the in-flight commissioning.

This Announcement of Opportunity (AO) is intended to select the Consortium for the provision of the operations and scientific exploitation of the SPICE instrument.

The top-level tasks to be covered are:

- Planning of SPICE operations and providing operational inputs to ESA, as well as providing support to the Science Working Team (SWT) and Science Operations Working Group (SOWG) so that operations of all Solar Orbiter instruments are carried out in a coordinated fashion.
- Providing ESA with a data processing pipeline for the production of SPICE low latency data at the Science Operations Centre (SOC) so these data can be used for the planning of Solar Orbiter operations.
- Setting up and operating a data pipeline to process raw telemetry (TM) into calibrated data products and deliver these data products to ESA.
- Maintaining the SPICE instrument, including monitoring and troubleshooting instrument health and safety.
- Providing software and support to the scientific community to work with SPICE data.

The schedule for the AO cycle is given in Table 1.

Date	Event
June 27, 2016	Release of AO for the operations and scientific exploitation of the SPICE instrument
July 20, 2016 (12:00 CEST - noon)	Deadline for submission of mandatory Letters of Intent
September 26, 2016 (12:00 CEST - noon)	Proposals due
October - November, 2016	Proposal evaluation
End of 2016	Expected selection of the Consortium for the operations and scientific exploitation of the SPICE instrument

**Table 1. SPICE AO cycle**

Only Consortia that will submit a Letter of Intent (LoI) by the deadline reported in Table 1 will be allowed to submit a Proposal.

The Proposal Information Package (PIP) and all relevant documentation (including this Announcement of Opportunity) can be downloaded from the following link

<http://www.cosmos.esa.int/web/call-for-spice-operations/home>

## 1.2 Proposals Information Package

The Proposal Information Package (PIP) contains, in addition to this AO, the following documents:

- [AD.1] Solar Orbiter SPICE Instrument Description – SOL-EST-TN-14155 – I1 – R0 15/06/2016 (hereafter referred to as SPI-Desc)
- [AD.2] Solar Orbiter SPICE Operations Phase: Required Tasks – SOL-EST-RS-14183 - I1 – R5 17/06/2016 (hereafter referred to as SPI-OPs-Req)
- [AD.3] Solar Orbiter Science Management Plan – SOL-EST-PL-00880 – I2 – R2 16/02/2012 (hereafter referred to as SMP)
- [AD.4] Solar Orbiter Science Requirements Document – SOL-EST-RS-1858 – I2 – R0 29/10/2010 (hereafter referred to as Sci-RD)
- [AD.5] Solar Orbiter Experiment Interface Document – Part A – only Section 5 – SOL-EST-RCD-0050 – I5 – R0 16/03/2016 (hereafter referred to as EID-A)
- [AD.6] Solar Orbiter Science Implementation Requirements Document – SOL-EST-RS-4514 – I1 - R2 04/09/2014 (hereafter referred to as SIRD)
- [AD.7] Product Assurance Requirements for Instruments – SOL-EST-RS-1937 – I2 – R1 15/04/2011 (hereafter referred to as PA-Req)

All previous documents should be considered in preparing the content of the proposals (see Section 3). In addition the following document should be considered as reference:

[RD.1] Solar Orbiter Science Operations Concept Document – SOL-SGS-PL-0001 - I2  
Ro 05/09/2014

A summary of the mission overview and a recapitulation of the investigators' duties and responsibilities can be found in the SMP.

Letters of Intent and Proposals must be prepared and submitted according to the indications provided in Section 2 and Section 3, respectively.

Each proposal shall clearly identify a Principal Investigator (PI) and a Lead Funding Agency (LFA) for the proposed Consortium. Proposals will clearly need to spell out the character and level of participation together with the nature of the management structure and financial commitments within the Consortium.

Each proposal shall address the requirements as described in SPI-OP-Req and comply with the programme definition, resources, operational conditions and constraints. Proposers are expected to have carried out preliminary design studies, which should enable them to include in the proposal a mature description and strategy on how they intend to achieve the SPICE operation requirements and scientific exploitation goals.

After receipt of the proposals in response to this AO a SPICE Review Panel (SRP) will perform a full review of the proposals and recommend the proposal to be selected. ESA staff will assist the SRP in their task with respect to technical, programmatic and financial matters.

### **1.3 Consortia**

Each proposing Consortium shall be headed by a single person, designated as the PI. The PI is the single point formal interface to ESA Solar Orbiter team.

Co-PIs may be proposed if major development is carried out in countries/institutions different from the one of the PI, but the PI will remain the single interface to ESA Solar Orbiter team.

Members of each Consortium may be proposed as Co-Investigators. Each Co-I should have a well-defined role either with regard to hardware/software delivery or with regard to scientific support of the investigations within the Consortium.

The responsibilities of PI, Co-PIs and Co-Is are further detailed in the SMP.

The PI shall nominate a Project Manager with appropriate hardware, software and procurement expertise, and establish with him an efficient management scheme, especially where several institutes provide sub-assemblies or sub-systems.

## **1.4 Funding Agencies**

### **1.4.1 Lead Funding Agency**

The funding agency of the proposing PI is the Lead Funding Agency (LFA) for the Consortium and has the overall responsibility for the proposed programme. All proposals in response to this AO must be submitted by the proposing PI and must include a Letter of Endorsement (LoE) from the LFA, committing to the financial support on behalf of all institutions participating in the proposal.

### **1.4.2 Other Funding Agencies**

The national funding agency representing a Co-Principal Investigator (Co-PI) or Co-Investigator (Co-I) shall guarantee the funding of the respective Co-PI/Co-I contribution with a formal interagency agreement with the LFA. Indications of the status of interagency agreements shall be submitted to ESA within the proposals. In case there is more than one funding source at national level, the organisation providing the Science Programme Committee (SPC) delegation will be considered as the formal national interface to ESA. It will be the task of this organisation to provide ESA (or the LFA, if applicable) with indications about the financial involvement of other organisations.

## **2 LETTERS OF INTENT**

Prospective proposers must submit a mandatory Letter of Intent (LoI) by the deadline stated in Table 1. Proposals not preceded by a corresponding Letter of Intent will not be considered. LoIs are accepted exclusively in electronic form, in PDF format, using the interface available at

<http://www.cosmos.esa.int/web/call-for-spice-operations/home>

LoIs will allow ESA to perform an initial assessment of the range of proposals, and to prepare for the evaluation process.

LoIs are limited in length to 4 A4 pages (minimum font size 11 pt), and must be structured to contain the following information:

- Proposal title;
- Name and contact information of Principal Investigator;
- Core team members (names and institutions) insofar as known/available;
- Summary of the proposal content;
- Potential consortium composition, and expected main funding agencies involved in the provision of the activities;
- Eventual (if applicable) proposed international collaboration elements for the mission.



It is understood that the proposal's structure and content may evolve between submission of the LoI and submission of the actual proposal, e.g., in terms of technical configuration, payload consortia composition, or presence of possible international partners. The PI and the proposal's title identified in the LoI, however, must remain the same throughout the process.

LoIs will be made available by ESA to Member State agencies, SPC delegations and international partners (if applicable); hence ESA cannot guarantee their confidential treatment.

Any further communication between ESA and the proposing team will only take place through the PI.

Failure to submit a LoI by the deadline stated in Table 1 will prevent teams/proposers from the possibility of submitting a proposal.

### **3 PROPOSALS**

The deadline for submission of proposals in response to the present Call is stated in Table 1. Late submissions will not be considered. Submission of proposals is accepted exclusively in electronic form, in PDF format, using the interface available at

<http://www.cosmos.esa.int/web/call-for-spice-operations/home>

Proposals will be limited in length to 59 A4 pages (not including annexes), with a minimum font size of 11 pt, and a maximum file size of 80 Mbytes. Proposals with file size in excess of this limit will be rejected by the submission system.

The submission deadline will be implemented strictly. Proposers are invited to submit their proposals well in advance of the deadline.

Proposals must contain all the information indicated in Section 3.1. Proposals missing one or more of the indicated elements may fail the initial technical and programmatic screening. The suggested number of pages for each topic is indicative, unless otherwise stated. Proposers are thus free to give more relevance to one topic with respect to other ones. However, the total number of pages in the proposal is a hard limit; proposals exceeding the total page limit will not be considered for evaluation.

All pages must be numbered. All parts must be produced in a single PDF files.

### 3.1 Topics to be covered in the proposal and page limits

The topics to be covered in the proposals are the following:

- Cover page (1 page, mandatory limit): must clearly indicate the proposal name and the name of the Principal Investigator. Any other information is optional;
- Contact information page (1 page, mandatory limit): must clearly indicate the contact information for the PI. Note that the PI will be the formal point of contact between the Agency and the proposing team;
- Executive summary (2 pages, mandatory limit): should contain a summary of the proposal, allowing the reader to gain a preliminary understanding of the proposal's content upon reading;
- Description of the activities (30 pages, suggested length): should clearly address the requirements indicated in the PIP, in particular this section should describe in detail the activities performed, in compliance with those required in [AD.2];
- Management scheme (10 pages, suggested length): proposers should spell out the proposed procurement scheme for all elements. The consortium organisation and the distribution of tasks and responsibilities (work breakdown structure for the core team with key persons) should be detailed. Proposers should describe the proposed science management plan (data policy, community involvement, etc.);
- Product Assurance (PA) plan (5 pages, suggested length): proposers must provide details as described in the [AD.7] as applicable, about the following topics: a) Product Assurance; b) Quality Assurance; c) Safety Assurance; d) Dependability Assurance; e) Parts and Materials; f) Software Product Assurance;
- Financial plan (10 pages, suggested length): the PI, Co-PIs (if any) and Co-Is shall include separate sections for their own resource provision with the detail of estimated resources for each activity subdivided into the following topics: a) development, test and calibration campaigns (where facility costs are incurred); b) instrument operations (from preparation to in-flight activities); c) science operations (including in-flight calibration); d) planning of payload operations; e) instrument operations monitoring; f) data reduction and science analysis; g) on-board software maintenance. The following details are required: i) internal manpower resources (FTEs) and associated costs; ii) additional manpower resources (FTEs) provided to support the development but not budgeted within the project; iii) other internal institute resources budgeted against the proposal; iv) external contracts; v) capital equipment costs required in the development of the project; vi) risk margin, with appropriate justification; vii) total funding requirements. These details must be provided as a function of the complete development and operation timeline for each contributing party (PI, Co-PI and Co-I), as well as for the total development overall. In addition, the total provisions required from national sources for funds and manpower shall be provided and justified. The Co-I-supported authorities for these resources shall be identified and the current status of their applications indicated, as well as the level of agreement

between them and the LFA. The estimated development cost shall be summarised in tabular form.

- Letters of Endorsement from the Lead Funding Agency and, eventually, from other Member State agencies or from eventual international partner agencies (if applicable) must be part of the Proposal (these pages will not count against the page limits);
- Bibliography: the list of references can be included as Annex; it will not count against the page limits.

ESA will share the proposals with Member State agencies and with SPC delegations, e.g., for the purpose of discussing their commitment, as well as, when applicable, with the proposed international partners. ESA cannot therefore ensure the confidentiality of the submitted material.

## **4 CONTACT WITH ESA**

Requests for further information and clarification should be addressed to:

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## **ACRONYMS**

AO	Announcement of Opportunity
AU	Astronomical Unit
Co-I	Co-Investigator
Co-PI	Co-Principal Investigator
EELV	Evolved Expendable Launch Vehicle
EPD	Energetic Particle Detector
ESA	European Space Agency
EUI	Extreme Ultraviolet Imager
FTE	Full Time Equivalent
GAMs	Gravity Assist Manoeuvres
LFA	Lead Funding Agency
LoE	Letter of Endorsement by funding agency
LoI	Letter of Intent
LOS	Line-Of-Sight
MAG	Magnetometer
METIS	Solar Orbiter Coronagraph
NASA	National Aeronautics and Space Administration
PA	Product Assurance
PHI	Polarimetric and Helioseismic Imager
PI	Principal Investigator
PIP	Proposal Information Package
RPW	Radio and Plasma Waves instrument
Sci-RD	Science Requirements Document
SGS	Science Ground Segment
SIRD	Science Implementation Requirements Document
SMP	Science Management Plan
SOC	Science Operations Centre
SoloHI	Solar Orbiter Heliospheric Imager
SOWG	Science Operations Working Group
SPC	Science Programme Committee
SPICE	Spectral Imaging of the Coronal Environment
SRP	SPICE Review Panel
STIX	X-ray Spectrometer/Telescope
SWA	Solar Wind Plasma Analyser
SWT	Science Working Team
TM	Telemetry
UV	Ultraviolet