

Announcement of Opportunity

PROBA 3 Coronagraph

Reference	D/SRE/DJS/PhE/og/25728
issue	Issue 1.1
Revision	
Date of issue	17 August 2009

European Space Agency
Agence spatiale européenne

Headquarters - Siège

8-10 rue Mario Nikis - F - 75738 Paris Cedex 15
Tel +33 (0)1 53 69 74 68 or 33 (0)1 53 69 71 08 - Fax. + 33 (0)1 53 69 72 36 or 7751

D I S T R I B U T I O N

name	Organisation

CHANGE LOG

date	issue	Revi sion	pages	reason for change
8 May 09	Draft 1			
18 June 09	Draft 2			
23 June 09	Draft 3			
28 June 09	Draft 4			
7 July 09	Issue 1	0		
17 Aug 09	Issue 1	1		- Absolute Radiometer and Sun Sensor added to AO - PROBA 3 Environmental Specification document added to reference list

T A B L E O F C O N T E N T S

1	GENERAL INFORMATION	5
1.1	Summary and Scope.....	5
1.2	Proposal Information Package	6
1.3	Responsibilities of Funding Agencies.....	7
1.3.1	Funding Agency.....	7
1.4	Responsibility of Instrument Consortia	7
1.5	Contact with ESA.....	8
2	CONTENTS OF THE PROPOSAL	9
2.1	Executive summary	9
2.2	Part I: Scientific and Technical Plan	10
2.2.1	Scientific Objectives	10
2.2.2	Instrument Performance.....	10
2.2.3	Technical Description and Design.....	11
2.2.4	Summary of Experiment Interfaces	11
2.2.5	On-ground and in-flight test and calibration plans	11
2.2.6	Flight Operations Concept.....	12
2.2.7	Data Reduction, Scientific Analysis and Archival support	12
2.3	Part II: Management Plan.....	13
2.4	Part III: Instrument Financial Plan.....	14
2.5	Letter of Endorsement.....	15
3	Submission of the proposal	15
	<u>ACRONYMS</u>	17

1 GENERAL INFORMATION

1.1 Summary and Scope

The European Space Agency (ESA) solicits proposals for the provision of a coronagraph and an Absolute Radiometer and Sun Sensor (ARaSS) for the PROBA 3 mission. This Announcement of Opportunity (AO) is open to scientists from the Member States of ESA and other communities with which reciprocity or specific agreements exist.

PROBA 3 is a mission to demonstrate new technologies from the ESA Directorate of Technical and Quality Management at ESTEC. It is the 3rd mission of the PROBA (Project for Onboard Autonomy) line.

PROBA 3 is an experimental mission devoted to the in-orbit demonstration of formation flying techniques and technologies. The high level objectives of the PROBA 3 project are:

- The development to technology readiness level (TRL) 9, in-orbit demonstration, of the formation flying techniques and associated technologies,
- The development and validation of the engineering approach, ground verification tools and facilities required by formation flying.
- The observation of the solar corona as part of the demonstration of formation flying

The mission will be implemented with a pair of small spacecraft, which together form a coronagraph. One spacecraft will carry the main optical bench and associated detectors, electronics, etc., while the second spacecraft will carry the occulter. Each spacecraft will be able to manoeuvre itself. The typical separation distance between the spacecraft will be about 150 m.

The mission design is based on a highly elliptical orbit for a mission life time of two years. The spacecraft will fly in formation requiring relative positioning to millimetre accuracy and relative navigation consistently more precise. The mission will also demonstrate manoeuvres, position and pointing accuracies required by future missions.

The spacecraft are of the “mini-satellite” type. They accommodate propulsion, metrology and guidance navigation and control technologies required by the coronagraph mission and by future formation flying missions.

Advanced spacecraft architecture and development techniques, used in mini-satellite developments, will be also re-used (powerful centralised avionics, miniaturised star sensors, auto-coding approach ...).

The PROBA 3 coronagraph is conceived so as to fully exploit the unprecedented access to the inner solar corona offered by formation flight. Conceptually, it is a classical, white light, externally-occulted Lyot coronagraph, but adapted to the formation flying configuration: the coronal imager/coronagraph is carried by one spacecraft entirely protected from direct sunlight by remaining in the shadow of the occulting disk hosted by the other spacecraft. The inter-satellite distance of 150 m allows reaching the corona close to the solar limb with very low stray light and almost no vignetting that otherwise degrades the spatial resolution.

The coronagraph is therefore designed to obtain high-resolution images of the solar corona (continuum and coronal emission lines) over a field of view of $1.04\text{--}3 R_{\text{sol}}$ (with a goal $1.02\text{--}4 R_{\text{sol}}$) in both unpolarized and polarized light, as well as 2-dimensional spectroscopy of several visible coronal emission lines to perform diagnostic measurements of the properties of the coronal plasma. The coronagraph should be capable of detecting low contrast features and emission lines in the corona.

The Absolute Radiometer and Sun Sensor (ARaSS) will be an experiment on board of the Occulter spacecraft and with the scientific goal to achieve high accuracy and long-term stability measurement of the Total Solar Irradiance. The absolute scale to measure Total Solar Irradiance is given by Space Absolute Radiometric Reference (SARR) and which is today represented by the experiment VIRGO on SOHO. This scale was challenged by the space experiment TIM on SORCE, which is using another measurement principle. ARaSS for PROBA3 will be able to be operated in both modes of measurement and will lead to a fundamental improvement of the uncertainty of the solar constant.

1.2 Proposal Information Package

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

- PROBA 3 Mission Requirements Document (MRD) (P3-EST-RS-1006)
- PROBA 3 Payload Requirements and Definition Document (PRDD) (P3-EST-RP-7007)
- Absolute Radiometer and Sun Sensor Definition Document (P3-EST-TN-7003)
- PROBA 3 Science Management Plan (SMP) (Draft)
- PROBA 3 Mission Analysis Report (P3-EST-TN-7002)
- PROBA 3 Environmental Specification (P3-EST-RS-6003)
- PROBA 3 Product Assurance Requirements (P3-EST-RS-1005)
- PROBA 3 Example of cost estimate (Excel file)

The above documents can be downloaded from: http://sci.esa.int/proba_3_AO

The proposal shall clearly identify a Principal Investigator (PI) (see SMP) for the proposed instrument. Responses 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 instrument consortium. The proposals shall comply with the technological, scientific and operational objectives of the mission and with the programme definition and constraints (see MRD and PRDD).

The coronagraph and the Absolute Radiometer and Sun Sensor (ARaSS) as defined in the Payload Requirement and Definition Document (PRDD) have been studied to fulfil the PROBA 3 technological and scientific requirements.

After receipt of the responses to this AO a Payload Review Committee (PRC) will perform a full review of all AO responses and recommend the payload for selection which optimises the overall scientific return within the available resources. Agency staff will assist the PRC in their task with respect to technical, programmatic and financial matters. A proposal may be amended after discussions between the proposing consortium and the PRC or ESA.

1.3 Responsibilities of Funding Agencies

1.3.1 Funding Agency

The proposing PI will select the Funding Agency for the instrument that will take the financing responsibility of the PI contribution. The PI is expected to take full responsibility for the development and timely delivery of the instrument. All proposals in response to this AO shall therefore be submitted by a PI, with full transparency to the corresponding Funding Agency, and shall include a Letter of Endorsement (LOE) from this Agency.

National Funding Agencies representing other members in an instrument consortium (e.g. Co-PIs or Co-Is, see definition in 1.4) shall guarantee the funding of the respective Co-PI/Co-I contribution. LOE from these Funding Agencies shall be submitted to ESA.

1.4 Responsibility of Instrument Consortia

The proposing instrument consortium shall be headed by a single person, the Principal Investigator (PI). The PI is the single-point formal interface to the ESA Project Office.

In some exceptional circumstances and particularly with respect to agencies of non-member states, a Co-PI may be appointed. Co-PIs are expected to provide a substantial contribution to the development of the instrument. The PI will however

remain the formal single-point interface to the Project Office.

Members of the PI-led instrument consortium may be proposed as Co-Investigators (Co-Is). Each Co-I must have a well-defined role either with regard to hardware/software delivery or with regard to scientific support of the investigations within the instrument consortium. The PI-led instrument consortium may review the status of its members regularly and implement changes if required.

Specific Provisions for Principal Investigators

The PI shall nominate an Experiment Manager with appropriate hardware, software and procurement expertise, and establish with her/him an efficient management scheme, especially if several institutes provide subassemblies or subsystems.

1.5 Contact with ESA

Before submission of proposals, requests for further information and clarification should be addressed to:

C. P. Escoubet
ESTEC (SRE-SM)
P.O. Box 299
2200 AG Noordwijk
The Netherlands
Tel : +31 71 565 3454
Fax : +31 71 565 4697
Email : Philippe.Escoubet@esa.int

D. Mueller
ESA RSSD
c/o NASA GSFC
Mail Code 671.1
Greenbelt, MD 20771
USA
Tel: +1 301 286 6983
Fax: +1 301 286 0264
Email: dmueller@esa.nascom.nasa.gov

Agnes Mestreau-Garreau
ESTEC
P.O. Box 299

2200 AG Noordwijk
The Netherlands
Email: Agnes.Mestreau-Garreau@esa.int

2 CONTENTS OF THE PROPOSAL

The proposal shall respond to the science and mission objectives and programme constraints described in the PIP, and shall provide all requested information to permit a complete evaluation against the criteria listed in Section 3.1.2 of the SMP. The proposal must be written in English; it consists of the following parts:

- Executive summary
- Part I: Scientific and Technical Plan
- Part II: Management Plan
- Part III: Instrument Financial Plan, and letter of endorsement from the Funding Agencies

All pages must be numbered, and all sheets printed on both sides, whenever appropriate. All parts must be bound separately.

Cover Page

Each part has a cover page including:

- The title of the proposal
- The name of Part (Executive Summary, Part I: Scientific and Technical Plan, etc.)
- The names, addresses, telephone (office, alternative and portable) and fax numbers, and e-mail addresses of the PI, Co-PI(s) and Co-Is
- The names of the Funding Agencies associated with the proposal together with the associated contact person with name, address, telephone and fax numbers, and e-mail address

2.1 Executive summary

The executive summary includes the title of the proposal and outlines all aspects of the proposal, especially the following aspects, within a 3-page limit:

- Objective of the proposal
- Performance of the instrument(s) required to fulfill the anticipated goals
- Instrument(s) operations and data analysis plans
- Summary of spacecraft resources
- Requirements (if any) imposed on the spacecraft

- Management scheme
- Funding status

If the proposal violates any of the constraints described in the PIP, a clear statement about each violation, together with its justification, shall be included in the summary. Each violation shall be further detailed in the appropriate sections. The instrument resources and requirements are to be summarized in tabular forms.

2.2 Part I: Scientific and Technical Plan

Part I shall not exceed 40 single-spaced type-written A4 pages, with a character size not smaller than 11 points, including illustrations without reduction, but excluding cover page, executive summary and table of contents. Part I of the response to this AO shall contain the following:

2.2.1 Scientific Objectives

This section shall clearly describe the scientific investigation and the overall capability of the instrument(s), in the light of the investigators' objectives and global mission goals. The anticipated performance of the instrument(s) under nominal orbit conditions will be stated and compared, if relevant, to that of similar instruments flown on other spacecraft or planned for future missions.

Expected results should be outlined and discussed, as far as possible, in both qualitative and quantitative terms. If the proposal contains any violation of the technical or programmatic constraints, the scientific justification should be given in this section.

2.2.2 Instrument Performance

A detailed analysis of the proposed instrument performance is required, including sensitivities and supported by instrument simulations. All assumptions made in this performance analysis shall be provided. In addition, it shall also be stated which degradation in performance is expected if key instrument characteristics turn out to be unachievable during the instrument development programme. Performance simulations must also include evaluations as a function of spacecraft orbital position. Details associated with instrument performance milestones within the instrument development should be indicated and the milestones also incorporated in the instrument development plan (cf. Part III). Instrument performances must be evaluated, not only for the baseline design, but also for options including potentially proposed back-up designs for cases where technology still has to be developed for the baseline.

2.2.3 Technical Description and Design

This section shall include a comprehensive design description of the proposed instrument, including resource budgets and any specific requirements to the spacecraft.

Design principle, mechanical/optical design, and electrical design of the proposed instrument (separately for each component/sensor, if the instrument consists of more than one component/sensor) shall be described together with the maturity and risk associated in any assumption of developing technologies. Detailed description (if necessary) may be given in Annex. New advanced technologies (if any) should be clearly described and identified as alternative options. The impact of these options upon scientific return, interfaces, schedule, etc. should be explained together with an assessment of the associated risk. The extent to which the design utilizes space qualified and space experienced hardware shall be stated.

Thermal design concept and possible impact on the spacecraft design shall be given, since thermal design is critical for this mission. Note also that the thermal model shall be submitted later upon request in the review process of the technical part.

Summary of the resource budgets shall be given. If the proposed instrument consists of more than one unit/sensor, each data sheet shall be given in Annex 1.

Different functional operating modes including on-board data reduction concept shall be identified and explained. Modes which place different requirements on scientific operations and data analysis shall be described.

Any specific requirements (mounting, FOV, thermal, purging, EMC, etc.) to the spacecraft system and other instruments shall also be given.

2.2.4 Summary of Experiment Interfaces

The mechanical, optical, thermal, power, data, EMC (Electromagnetic Cleanliness/compatibility) and operational interfaces either to the spacecraft or to other assumed third party provided equipment must be summarised here and specified in detail in the interface document. Assumptions related to this third party equipment with respect to the interfaces shall be clearly indicated. It is expected that these interfaces will need to be iterated with the PROBA 3 Project Office during the proposal-writing period and matured after selection.

2.2.5 On-ground and in-flight test and calibration plans

This section shall describe all test and calibration (ground/pre-launch, cruise and in-orbit) plans and procedures deemed necessary to verify the correct functioning of the instrument(s) and achieve the scientific goals.

The availability of suitable test and calibration facilities (e.g. vacuum, thermal-vacuum, stimulus generator, computer etc.) shall also be demonstrated, including any specific requirements for ESA support. The ground test and check-out equipment to be supplied for each PI instrument shall be described.

2.2.6 Flight Operations Concept

The operational concept of the proposed instrument shall be described. Details (e.g. frequency of calibrations, mode changes etc.) should be provided. Any specific requirement for flight operations support should also be identified. The instrument consortium is required to support the Mission and Science Operations Centres (MOC/SOC) through all mission phases. Specifically the following details should be provided:

- The level and nature of the support to the definition of the science operations pre-launch and during the cruise phase
- The level and nature of the expert support at the MOC and SOC during payload commissioning and critical operations
- The level and nature of the expert support provided for the preparation of the instrument operation timelines prior to and during the science operations phase
- The level and nature of the expert support for monitoring and optimisation of instrument performance prior to and during the science operations phase

2.2.7 Data Reduction, Scientific Analysis and Archival support

A data reduction and scientific analysis plan shall be provided. This plan shall adequately address the technical, managerial and programmatic issues. The level of resources allocated to each of the following phases of the programme shall be indicated.

- Pre-launch data reduction preparations
- Definition of the SOC
- Operations phase
- Science analysis
- Archival phase

It is required that the PI complies with the scientific data policy of the agency. Any non-compliance shall be identified and substantiated in this section. Specifically, the resources and the approaches necessary to conduct the following activities shall be addressed:

- Delivery of raw, calibrated, and high level data, including relevant calibration products and/or software for such data production, to the PROBA 3 ESA scientific data archive, as they become available from the data reduction and dissemination process

- Provision to ESA with unlimited access to all processed and analysed data for public relation purposes
- Provision of summaries of the main scientific results at regular intervals
- Provision of inputs for the definition and implementation of the science operations planning, and data handling and archiving concepts
- The level and nature of the support of the definition and implementation of the PROBA 3 ESA scientific data archive, as part of the pre-launch tasks

2.3 Part II: Management Plan

The management plan should cover all aspects of the proposed investigation for the entire duration of the mission. The PI must show how he/she will establish an efficient and effective management scheme that must include an Instrument Development Manager. The contribution of each institution must be clearly indicated and the responsibilities of each participant described in detail. It is essential to provide a clear management plan, which is adequate with respect to the instrument complexity and the interfaces within the instrument consortium. Emphasis should be placed on a simple management scheme with as few interfaces as necessary.

Organization charts must contain the names of all partners: PI, Co-Is, Instrument Development Manager, and all key personnel. The PI will show, in particular, how he/she will participate in the overall activities. The fraction of time available for the investigation shall be given for each individual throughout the instrument development cycle and the following mission phases

- Instrument development phase
- Science operations phase
- Data reduction and scientific analysis
- Archival phase

For all personnel the qualifications and experience of the team must be clearly indicated along with the fraction of time to be spent on the project.

Furthermore the management plan shall contain all information related to the compliance of management requirements. These requirements address the subjects

- Project phasing and planning control including reporting to ESA
- Reviews
- Configuration management
- Deliverable items
- Instrument schedules

The PI is expected to describe his/her compliance to these requirements and their expected implementation.

2.4 Part III: Instrument Financial Plan

The PI 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:

- Technology development, including funding of a back-up development plan (this must also indicate the assumptions with respect to payload technology development conducted within ESA)
- Instrument development
- External test and calibration campaigns (where facility costs are incurred)
- Science operations
- Data reduction and science analysis
- Archival phase

For estimating the necessary resources the following details are required:

- Internal manpower resources (FTEs) and associated costs
- Additional manpower resources (FTEs) provided to support the development but not costed within the project
- Other internal institute resources costed against the proposal
- External contracts
- Capital equipment costs required in the development of the instrument
- Total funding requirements

These details must be provided as a function of the complete instrument development cycle timeline for each contributing party (PI and Co-I) as well as for the total overall development. In addition for the single instrument as proposed in response to this AO 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. The estimated instrument development cost shall be summarised in tabular form.

An Excel cost template as Annex to this AO has been provided for convenience and can be used for identification of the financial cost according to above requirements. The specific labels and numbers in the template are examples only.

2.5 Letter of Endorsement

This Announcement of Opportunity calls for the identification of a Principal Investigator. The PI is responsible for the submission of a complete proposal that must include a Letter of Endorsement from its Funding Agency as well as the Letter of Endorsement of the Funding agencies of his Co-Is. The intention is that this response to the AO will not only establish the technical character and maturity level of the instrument, but also the nature of the management structure and financial commitment.

It should be noted that the financial status of the PI team will be guaranteed by its Funding Agency. Co-I teams will be guaranteed by their Funding Agency.

3 SUBMISSION OF THE PROPOSAL

The proposal shall be submitted by the PI in electronic form to the addresses listed below. ESA also requests the provision of three hardcopy versions as well as 12 copies on CDs (or DVDs) for distribution to the review team. Part III of the proposal (Financial Plan) shall be delivered on separate CDs (6 copies) at the same addresses.

All pages must be numbered, and all sheets printed on both sides, whenever appropriate. All parts must be bound separately.

The proposal must be received not later than:

15 September 2009

The PI shall inform the addressees by e-mail about:

- The mailing date of the hardcopy and CD versions of the proposal
- The submission of the electronic version at http://sci.esa.int/proba_3_AO

ESA will confirm by e-mail the reception of the hardcopy and CD versions of the proposal. The PI should notify ESA if confidentiality is required for Part VI (Financial Plan).

Addresses for Proposal submission	Hardcopy	CD
C. P. Escoubet ESA/ESTEC (SRE-SM) P.O. Box 299	1 complete set	10 + 4 (part III)

2200 AG Noordwijk
The Netherlands
Email: Philippe.Escoubet@esa.int

D. Mueller	1 complete set	1
ESA RSSD		+
c/o NASA GSFC		1 (part III)
Mail Code 671.1		
Greenbelt, MD 20771		
USA		
Email: dmueller@esa.nascom.nasa.gov		

Agnes Mestreau-Garreau	1 complete set	1
ESTEC		+
P.O. Box 299		1 (part III)
2200 AG Noordwijk		
The Netherlands		
Email: Agnes.Mestreau-Garreau@esa.int		

Each hardcopy must consist of the following elements:

- Executive summary
- Part I: Scientific and Technical Plan
- Part II: Management Plan
- Part III: Instrument Financial Plan, and letter of endorsement from the Funding Agencies

ACRONYMS

AO	Announcement of Opportunity
ARaSS	Absolute Radiometer and Sun Sensor
Co-I	Co-Investigator
Co-PI	Co-Principal Investigator
D/SRE	Directorate of the Scientific and Robotic Exploration Programme
EMC	Electromagnetic Cleanliness/compatibility
ESA	European Space Agency
FTE	Full Time Equivalent (man years)
LOE	Letter Of Endorsement by funding agency
MOC	Mission Operations Centre
MRD	Mission Requirement Document
PI	Principal Investigator
PIP	Proposal Information Package
PRC	Payload Review Committee
PRDD	Payload Requirement and Definition Document
PROBA	Project for Onboard Autonomy
RSSD	Research and Scientific Support Department
SMP	Science Management Plan
SOC	Science Operations Centre
TRL	Technology Readiness Level

ANNEX 1 : CORONAGRAPH SCHEDULE (PRELIMINARY)

