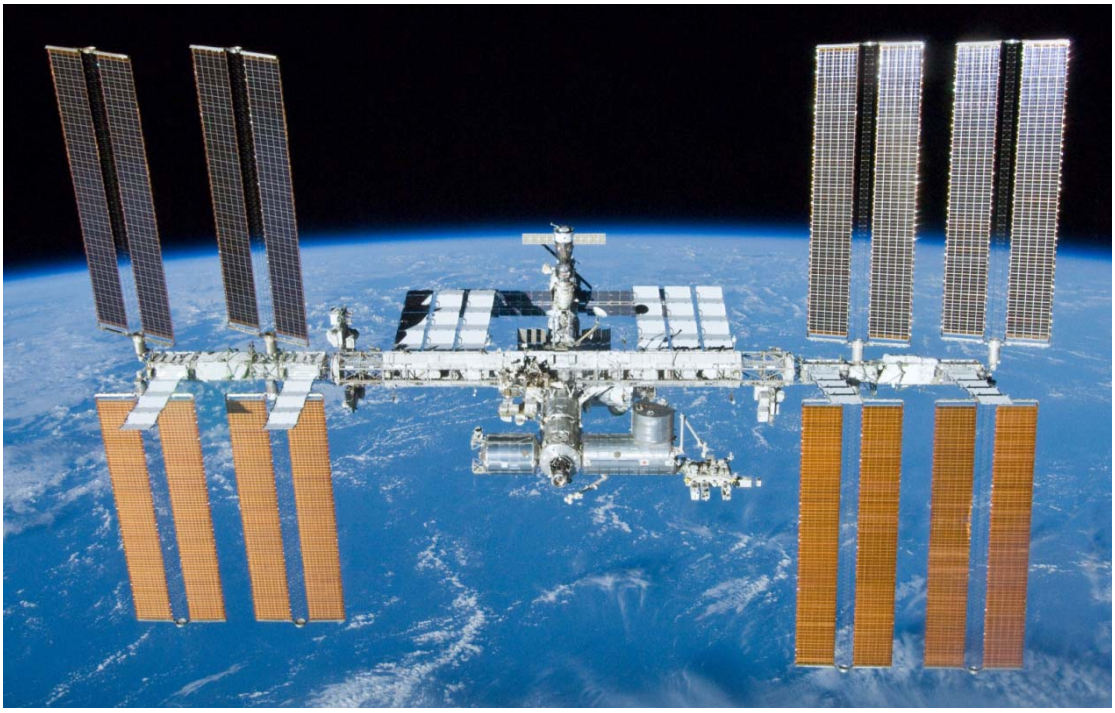
# European Space Agency
# Research Announcement for International Space Station Experiments relevant to study of Global Climate Change



**Letters of Intent due:**

**9th September 2011**

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**Proposal due:**

**4th November 2011**

## 1. Summary of the Announcement

ESA issues an announcement of opportunity for climate change related flight experiments using the International Space Station (ISS) from 2014 onwards. It is recommended that proposed projects be consistent with the on-going ESA Earth observation programmes and research goals as described in *ESA SP-1304, The Changing Earth: New Scientific Challenges for ESA's Living Planet Programme*. This includes research topics associated with climate change in studies of the

- Atmosphere,
- Oceans,
- Land surface,
- Cryosphere and
- Solid Earth

Furthermore, proposed projects should complement on-going and planned climate change and Earth observations from dedicated satellite, airborne and terrestrial platforms. Potential thematic areas of interest include, but are not limited to, the following:

- GNSS Reflectometry (GNSSR)
- Vegetation measurements
- Hyperspectral imagers
- Atmospheric science measurements
- Thermal IR measurements

The primary focus of the AO is for Earth observation experiments related to climate change research, complementing the on-going ESA Earth observation programmes and research goals. Proposals to use of ISS for general Earth observation are not excluded, although these will be given lower priority than climate change related projects.

The ISS is in a 51.6° inclination, 330-460 km altitude orbit (typically maintained in the 340-385km altitude range). Experiments can be accommodated either externally on ISS (outside of modules or on the Truss) or internally (observing through a window). In addition to standard experiment / instrument development there is an opportunity for "fast track" development and implementation of instruments which have demonstrated a technology readiness (TRL) level greater than 6 in environment representative of that onboard the ISS and require limited resource for implementation.

Submitted proposals will undergo a peer review selection process and technical evaluation. Selected proposals will be subject to a feasibility study (phase A), the results of which will be used to prioritise projects. Therefore, proposed projects should have a sufficient level of technical maturity to proceed directly to a phase A study (TRL≥4 for standard projects; TRL≥6 for fast track projects). Final selection and development of projects for flight (phase B/C/D/E) is contingent on available budget and ISS resources

The announcement of opportunity is open to all ESA Member states and ESA Associate Member states, Co-lead investigators and co-investigators from non-ESA member states are permitted on proposals, but the proposal should have a lead investigator from a European institution.

**Important dates:**

| | |
|---|---|
| Letters of interest (non binding) due: | **9th September 2011** |
| Proposers workshop (ESTEC, Netherlands): | **7th October 2011** |
| Proposal deadline: | **4th November 2011** |

**Point of contact:**
For questions related to this Announcement of Opportunity please contact:

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Submission of letters of intent and proposals should be made in e-mail to the following address:

**iss-climatechange@esa.int**

## Contents

## 2. Introduction

Climate relevant global change deals with large and small scale processes that modify the Earth's atmosphere, land and ocean, and drive changes in the Earth System on decadal to millennial timescales. One major element of global climate change is an increase in mean sea surface and near-surface air temperature, driven in part by increasing emissions of greenhouse gases into the atmosphere. Global change is apparent through a range of phenomena, such as a rising sea level and reduced snow and sea-ice cover. Many of these phenomena feed back into the climate system via modifications in albedo, biogeochemical cycles, ocean circulation, etc., leading to global and regional effects that are often poorly understood and hard to predict.

Understanding and predicting the climate consequences of global changes in Earth's environment is a major challenge for humanity in the coming decades and centuries. Various natural physical processes modify the atmosphere, oceans and land surfaces on short and long term scales. However, in the past 150 years human activities have resulted in significant changes in many aspects of Earth's environment, including increasing greenhouse gas concentrations, modification of the nitrogen and phosphorous cycle and major alterations of land use (e.g. deforestation). It is crucial that we understand the interaction of anthropogenic environmental changes with natural changes to predict future changes in the Earth's environment. In turn this information will assist sustainable development in relation to human activities, while minimising degradation of the environment and limiting the vulnerability of society to global changes.

ESA currently has an extensive programme of current and planned dedicated Earth observation missions which support studies of global change. This includes the Living Planet (Earth Explorer) and Global Monitoring for Environment and Security (GMES) Programmes. Each of the individual satellite missions under these programmes has a specialised instrumentation to address specific scientific and mission objectives of either a scientific or operational nature.

The International Space Station (ISS) is an orbiting multi-user research platform with a permanent crew of 6 persons in a 51.6°, 330-460km altitude orbit (typically maintained in the 340-385km altitude range). In 2008 the ESA Columbus module was added to the ISS complex, which provides several multi-user experiment facilities inside the pressurised compartment, as well as locations to mount instruments on the exterior of the module. Currently, research activities by ESA and the other international partners on ISS are performed in the areas of human physiology, fluid / materials sciences, biology, exobiology, technology tests and Earth / space observation. Potentially, the ISS can be used as an Earth observation platform, supplementing on-going and planned global climate change and Earth observations from dedicated satellite, airborne and terrestrial platforms. An example of an Earth science relevant instrument under development is the

Atmosphere Space Interactions Monitor (ASIM) for Columbus that is planned to be deployed on the ISS Columbus module in 2014.

## 3. Announcement Objectives

The objective of the announcement opportunity is to solicit proposals for flight experiments relevant to global climate change using the International Space Station (ISS) from 2014 onwards through the lifetime of the ISS (at least until 2020 and possibly until 2028).

It is recommended that proposals be consistent with the on-going ESA Earth observation programmes and the research goals described in *ESA SP-1304, The Changing Earth: New Scientific Challenges for ESA's Living Planet Programme*. Research fields may include, but are not limited to, the following:

- **Atmosphere**
  - Variability and causes of changes in the Earth global climate system
  - Life cycles of clouds and aerosols
  - Dynamics of atmospheric circulation and associated chemistry
  - Modelling and forecast of atmospheric composition and air quality
  - Troposphere/Stratosphere/Mesosphere/Thermosphere/Ionosphere coupling processes
- **Oceans**
  - Physical, biological and chemical processes of air/sea interactions
  - Understanding land / ocean interactions and anthropogenic influences
  - Marine ecosystem variability
  - Interaction between variations in ocean dynamics, thermohaline circulation, sea level and climate
- **Land surface**
  - Interaction of terrestrial ecosystems with other components of the Earth system, particularly associated with climate variability
  - Influence of anthropogenic factors on land surfaces (use of natural resources and land-use change) and impact on ecosystems
  - Effect of land surface status on terrestrial carbon cycle
- **Cryosphere**
  - Role of snow and glaciers on global water cycle and role in climate change
- **Solid Earth**
  - Identification of physical and chemical impact of volcanic activity
  - Role of magnetic-field variability on the distribution of ionised particles in the atmosphere and their possible climate impact

Potential thematic areas of interest relevant to the above research fields for ISS based studies include, but are not limited to, the following:

- GNSS Reflectometry (GNSSR)
- Vegetation measurements
- Hyperspectral imaging
- Atmospheric science measurements
- Thermal IR measurements

Additionally, projects in other related areas may be proposed. The primary focus of the AO is for Earth observation experiments with an explicit connection to global climate change research. However, proposals to use of ISS for general Earth observation are not excluded , although these will be given lower priority than climate change projects. . Proposal related to demonstrations of future monitoring instruments shall describe what are the novel approaches and/or new scientific insights into climate relevant processes that would be enabled.

**The proposals shall explain in detail what aspects of climate change or Earth science themes are addressed and how the proposed observations from ISS would complement on-going or planned measurements from other ESA and other international partner space platforms, airborne or terrestrial instrument networks.**

Details of ESA's Earth Observation Programme and missions can be found on the following webpage;
http://www.esa.int/esaEO/index.html

Technical information on the ISS capabilities, environment and operations can be found in Annex 1.

## 4. Scope of call and boundary conditions

The ISS is in a 51.6° inclination, 330-460 km altitude orbit (typically maintained in the 340-385km altitude range). Experiments can be accommodated either externally on ISS (outside of modules or on the Truss) or internally (observing through a window – see Annex 1 for transmission characteristics). In addition to standard experiment / instrument development approach, there is an opportunity for "fast track (<3 years)" development and implementation of instruments which have demonstrated a technology readiness (TRL) level ≥6 in environment representative of that onboard the ISS and require limited resource for implementation.

Submitted proposals will be selected based on a scientific peer review selection process and technical evaluation. Selected proposals will undergo a phase A feasibility study, the results of which will be used to prioritise projects for further possible development. Therefore, proposed projects should have a sufficient level of technical maturity to proceed directly to a phase A study (TRL≥4 for standard projects; TRL≥6 for fast track projects). Proposers should have the necessary to ensure a realistic assessment of the technical maturity

of the proposed space experiments. In this context it should be noted that procurement procedures for any element of an experiment funded by ESA must comply with the procurement rules of the agency. The same applies to intellectual property rights, which in no circumstances will be accepted as a reason not to involve the wider scientific community or to restrict the allocation of industrial work.

The feasibility of the experiment candidates selected through this AO will be established during Phase-A studies. It is expected that up to 5 candidates may be selected on the basis of technical and scientific merit. This will include refinement of the scientific or technology demonstration requirements, detailed design of the instrument and operational scenario. Data collection, pre-processing and distribution will be assessed, as well as specific scientific studies and support activities required for realisation of the project.

Final down selection and development of flight hardware (phase B/C/D) is contingent on the future available budget, which will be decided at the ESA council at Ministerial level in 2012, ISS resources and possibly also national funding. Therefore, full development of selected projects to flight implementation cannot be guaranteed at this time.

## 5. Proposals: What to submit, how and eligibility

### Letter of Intent

Potential investigators are requested to confirm their plans to submit a proposal in response to this Announcement by submitting a Letter of Intent (LOI). The LOI is not mandatory nor binding.and should be submitted on the form in **Annex 2** by e-mail to the following e-mail address;

**iss-climatechange@esa.int**

**The deadline for Letter of Intent submission is 9th September 2011**

The letters of intent will be used by ESA to define the composition of the scientific and technical panels who will review the proposals, to ensure an appropriate level of expertise in the panels. In addition proposers who submit a LOI will receive an invitation to attend the proposer workshop at ESA-ESTEC (scheduled for the 7th October 2011). The goal of the proposer workshop is to address questions concerning the AO and to encouraging networking between research teams

## Proposal Submissions

Proposals may be either be standard experiment proposals or "fast track" proposals as described below. Detailed requirements for proposal preparation and submission are described in Section 9 of this document. Proposals should be submitted via e-mail to the following address;

**iss-climatechange@esa.int**

**The Deadline for proposal submission is 4th November 2011**

***Proposals received after the deadline or not following the proposal guidelines will not be accepted for evaluation***

## Standard proposals

Standard experiment proposals are experiments or instruments which are expected to be developed according to a normal development cycle, ie. with an initial phase A/B definition and possibly breadboard development, followed by phase C/D flight experiment development. A TRL of ≥4 is required for all critical elements at the proposal stage, in order to ensure a sufficient level of maturity to initiate a phase A study. Standard experiments may be accommodated either externally or internally within the constraints of the ISS platform. Standard experiment proposals are expected to require at least 3-5 years between selection and launch for flight hardware development and mission implementation.

## Fast track proposals

Fast-track experiment proposals are experiments or instruments which, thanks to their very high TRL level can be potentially implemented in a short time frame (eg. <3 years from selection for development until launch). Therefore, fast track candidate proposals must satisfy the following criterion;

- The proposed instrument must have a very high technology readiness level (TRL ≥6). Typically this implies a demonstrated operation in a representative environment or is based on an established flight hardware heritage
- Limited ISS resource requirements, specifically low upload mass, crewtime requirements and modest data rates. Specifically;
    - <30kg upload mass
    - <10h crewtime total in one year
    - Continuous data rates <1Mb/s, preferably data transmitted in blocks of a maximum of a few hours / week
- Internally mounted instruments, viewing through a window such as those in Cupola or the Destiny WORF appear most appropriate for fast track experiments (see Annex 1 for the specifications of the windows). However, simple externally mounted instruments may be considered if the resources required to deploy the instrument may be limited.

## 6. Proposer Eligibility

The Announcement of Opportunity is open to teams from all ESA Member states, and ESA associate member states. Please note that for any proposal selected as a response to this AO, ESA will not provide funding for any science team grants, laboratory or field work, necessary for ground based research to prepare experiments, or support for participation in meetings, test and launch campaigns for the development of instruments sponsored by ESA Therefore, ESA strongly advises investigators to submit their proposal to their national bodies in parallel with their application in response to this Research Announcement, in order to initiate the application for national funding as early as possible after proposal selection. If the proposed experiment is selected, a proof of appropriate funding is mandatory in order to commence the definition phase. A list of national points of contact is provided with this announcement.

**Co-investigators from non-ESA member states are permitted on proposals, but the proposal should have a lead investigator from an European institution.** Non ESA / European researchers should contact their national space agency / organisation concerning conditions for their participation in the proposal to ESA.

## 7. Proposal Evaluation Criteria

**Scientific Criteria:** The following criteria will be used for the scientific evaluation

1. **Relevance to the climate change aspects of ESA research objectives for Earth Observation -** for this criterion reference must be made to climate change aspects the general and specific research objectives set in the post 2006 time frame in the document *ESA SP-1304: The Changing Earth: New Scientific Challenges for ESA's Living Planet Programme*. These objectives take full account of scientific and public concerns and seek to advance knowledge of the Earth and to contribute to the preservation of Earth and its environment.
2. **Need, usefulness and excellence -** this must take account not only of scientific requirements and/or the importance of an experiment or instrument viewed as a precursor but also the extent to which the requirements, including those of space/time sampling, can be met by the proposed implementation aboard ISS.
3. **Uniqueness and complementarity -** this must take account of other (i.e. non space) means of addressing the mission requirements as well as the activities and plans of other national and international bodies for space missions. Specific advantages of performing the experiment onboard the ISS rather than on another platform shall be clearly described.
4. **Degree of innovation and contribution to the advancement of European Earth Observation capabilities -** this relates to technical/industrial aspects as well as to user interests.

5. **Science Team:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the Lead Investigator(s) and any Co-investigators? Is the evidence of the investigator's productivity satisfactory?
6. **Institutional Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

**Technical Evaluation Criteria:** The following criteria will be used for the evaluation

1. **Feasibility and level of maturity -** this encompasses the technical constraints, with a particular emphasis on the technology readiness, as well as the status of the associated user community within ESA member states and the maturity of the observation requirements, also in terms of their traceability to scientific objectives. The TRL of all elements shall be justified according to the established ESA classification.
2. **Timeliness -** this must take account not only of the timeliness of the experiment from the point of view of user needs but also with regard to implementation constraints.
3. **Programmatics -** in addition to the considerations of development schedule, cost, risk, etc., this addresses the implications of possible cooperation with other bodies taking account of the planned availability of relevant data from other observing systems. Any specific advantage of deploying the proposed experiment /instrument onboard of the ISS should be clearly identified.
4. **Compatibility with the ISS operating environment –** Is it shown that it is feasible to perform the experiment onboard of the ISS? This takes into consideration the general issues of payload development for the ISS, ISS environment, accommodation, interfaces and operations.

## 8. Overall Schedule

The major milestones for the announcement of opportunity are as follows:

| | |
|---|---|
| Letters of interest (non binding) due: | **9th September 2011** |
| Proposers workshop: | **7th October 2011** |
| Proposal deadline: | **4th November 2011** |
| Announcement of results of evaluation of proposals: | **May-June 2012** |

All proposals must conform to the format specified in Section 9 of this document (guidelines for proposal preparation) and must be submitted via the Announcement website e-mail by the deadline indicated above. ***Proposals received after the deadline or not following the proposal guidelines will not be accepted for evaluation***

# 9: Guidelines for proposal preparation

## 9.1: General Instructions for Proposal Preparation

Proposals should be submitted via e-mail to the following address by the closing date of the call;

**iss-climatechange@esa.int**

A template for the proposal document is provided in Annex 3 to facilitate preparation in the correct format.

All proposals submitted by proposers must be contained in one single and non-protected PDF document,. Receipt of submitted proposals will be acknowledged by e-mail.

The following material should be provided, in this order:

1. Project abstract
2. Project Description
    a. Science Project Proposal
    b. Technical Assumptions and Requirements
    c. Programmatic Elements
3. Management Approach
4. Biographical Sketches
5. Appendices, if any; reviewers are not required to consider information presented in appendices

The Science description section is limited to twenty (20) pages. Pages beyond the 20-page limit in this section will not be reviewed.

There is no specific page limitation on other sections of submitted proposals, including the technical description. However, every effort should be made to keep proposals as concise as possible. The name of the Science Team Coordinator should appear in the upper right hand corner of each page of the proposal, except on the forms in this document where special places are provided for this information.

The following paragraphs provide instructions for completing the applications.

## 9.2: Submission forms

Proposers will be asked to fill in the names and full contact details of the Science Team Coordinator and all Science Team Members, specifying the members' institutional affiliations. Mandatory fields are specified in the forms. A signature version of thie front page of this form should be provided Furthermore proposers must provide an abstract and proposal acronym, and specify relevant keywords and research areas. The information requested in this part of the form is essential to the review of the proposal.

### 9.3: Proposal abstract

A concise resume of not more than 300 words, describing: the scientific objectives and their climate change relevance, the experiment requirements in terms of the science parameters to be retrieved, as well as a broad justification for the experiment requirements.
The Agency shall be allowed to use the abstract for public distribution. The rest of the proposal will be treated confidentially.

### 9.4: Project Description

The project description should include a science project proposal and technical description The length of the science description section of the proposal should not exceed twenty (20) pages using regular (12 point) type. The proposal should contain sufficient detail to enable a reviewer to make informed judgments about the overall merit of the proposed research and the probability that the investigators will be able to accomplish their stated objectives. This should include as a minimum the following

#### 9.4.1. Science Project Proposal (20 pages maximum)

- A detailed description of the experiment objectives and their rationale, including the status of the scientific knowledge and the identification of the gaps and open issues that the experiment intends to respond to.
- Applicability of experiment to the ISS platform
- The required duration of experiment operation, the relation to other planned or existing missions and any requirements on data timeliness
- The identification of the geophysical variables and data products, at both level 1 and level 2, required to fulfil the objectives of the mission and the relevant observation requirements (e.g. accuracy, spatial and temporal resolutions)
- The development status of the required geophysical retrieval algorithms, and the approach to the data use and scientific exploitation
- The relevance of the mission to the ESA Living Planet Programme (ESA SP-1304)
- The relevance to other programmes (national and/or international)

#### 9.4.2. Technical Assumptions, Requirements and Architecture

This section of the proposal will present the general experiment / instrument characteristics and the associated technical requirements. This should include the justification of how the proposed technical requirements, proposed instrument concept and architecture allow the fulfilment of the scientific objectives of the experiment, including traceability to level 1 and 2 data product requirements. This section will include:

**A. Technical Assumptions and Requirements**

- The observation techniques relevant to the experiment
- The relevant requirements (e.g., as relevant, observation geometry, required observing conditions, temporal, spatial, spectral and

radiometric requirements, spatial and temporal co-registration requirements)
- Other general requirements (e.g. synergy with other space based missions, airborne or terrestrial networks and relevant co-registration requirements)
- Analysis of the compatibility of the proposed experiment the ISS environment, This includes technical requirements relevant to development, operation and performance of payloads onboard the ISS, including orbit and attitude requirements, constraints for transport to and installation on the ISS, data transmission / storage / retrieval and instrument commanding requirements. **Applicants should read Annex 1 carefully to make certain that they understand the constraints that are associated with ISS flight experiments.**

**B. Proposed Experiment Architecture**

- Detailed description of the payload elements
- Instrument operations concept
- Description of the the Ground Segment (Flight Operation Segment, Payload Data Ground Segment, external interfaces for e.g. auxiliary data and approach to data exploitation), identifying possible adaptations of existing ESA infrastructure or other specific solutions. **It should be assumed that instrument operation (eg, commanding, housekeeping activities) and initial data retrevial would be performed by via an ESA facility responsible User Support Center (USOC)**

The technical description will include a detailed assessment of the maturity of the proposed technical solution (e.g. heritage, re-use of existing hardware/software) and of the relevant key technologies, for which the Technology Readiness Level (TRL) will be analysed according to the established ESA classification ranging from TRL 1 (Basic principles observed and reported) to 9 (Actual system 'flight proven' through successful mission operations). The proposal shall demonstrate sufficient technology readiness, in particular of the payload, and that a minimum TRL of 5 is achievable by the end of Phase-A. A summary of the accepted ESA TRL levels is provided in Section 10 of this document, as defined in “Technology Readiness Levels Handbook for Space Applications” ESA reference TEC-SHS/5551/MG/ap” which can be downloaded from the AO website.

### 9.4.3. Programmatic Elements

This section of the proposal will provide:

- An outline Design, Development and Verification (DD&V) plan addressing the complete system and the development schedule from the start of Phase B up to the acceptance for launch.
- A Rough Order of Magnitude (ROM) Cost Estimate covering industrial development cost for the experiment and the associated experiment specific ground segment operations, but excluding ESA User Support Center (USOC) and ESA internal costs. A description of the cost estimation methodology and all underlying assumptions must also be provided.

### 9.5: Management Approach

Each proposal must specify a single Science Team Coordinator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

### 9.6: Personnel/Biographical Sketches

The Science Team Coordinator is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the lead investigator, including his or her current position title, educational background, a list of major publications, and a description of any exceptional qualifications, must be included. **Do not exceed two pages.** If the list of publications in the last three years exceeds two pages, select the most pertinent publications. Complete this part of the application for other senior professional personnel (Co-investigators) who will be directly associated with the project. Any special industry-university cooperative arrangements should be described.

### 9.7: Letters of Collaboration/Support

Include letters of support from collaborators.

### 9.8: Appendices

Appendices may be included, but investigators should be aware that reviewers are not required to consider information presented in appendices.

### 9.9: Proposal Workshop

As a means to guide proposers to submit a more complete and well written proposal, in addition to improving the possibilities of scientific team formation and networking, a Proposal Workshop will be arranged at ESA/ESTEC, Noordwijk, The Netherlands.

The workshop will take place on

**7th October 2011**

It is the intention that this workshop will allow for

- Answering questions related to the AO and review process, and to the various elements that should be addressed in a proposal
- Addressing technical issues related to the ISS platform
- Clarifying scientific matters
- Identifying potential partners working in the same domain with whom a joint proposal could be prepared.

In relation to the last point, ESA intends to identity at the workshop the key thematic areas (e.g. Atmosphere, Ocean, Land Surface, Cryosphere, Solid Earth) where there may be potential for cooperation between teams, noting the title and point of contact (lead proposer) for each received LOI. The content of each LOI and any associated technical information will be considered confidential.

### 9.10: Data Rights

#### a) Data Rights

The Agency shall grant the Investigators an exclusive right of prior access to the Raw and Calibrated Data. The duration of the exclusive right (Period of Prior Access) shall be one (1) year from the provision by the Agency of the data to the Investigator in a form suitable for analysis.

The exclusive right of prior access shall be granted to the Investigators under the condition that the Investigators shall:

- undertake to furnish the Agency with an analysis of the results obtained and shall take all reasonable steps to publish such results or, alternatively, shall authorise the Agency to do so (such publication shall include a suitable acknowledgement of the services afforded by the Agency); and

- provide the Agency, free of charge, with an agreed number of copies of the publication and, notwithstanding the provisions of the paragraph above, the Agency shall have the right to reproduce and disseminate results that have already been published.

Following the 1-year exclusive access period the raw and calibrated data will be made available to the world-wide Earth Observation research community in accordance with the established ESA Earth Science data policy

Any change to the duration of the Period of Prior Access shall take into account, inter alia:

- the extent and nature of the involvement of the Investigator in the development of the Experiment; and
- the type and complexity of the data to be received from the Experiment.

### 9.11: Proposal Evaluation Process:

Proposals will be evaluated in the following three steps

- Scientific peer review.
- Flight technical feasibility Assessment
- Programmatic assessment

### 9.12: Endorsement of Review Results and Establishment of Research Pool

After the full scientific and feasibility aspects have been reviewed following the procedures outlined in this document, all proposals that successfully passed the criteria are submitted to ESA's Advisory Groups (Earth Science Advisory Committee) for concurrence on selection recommendations and subsequently to ESA's relevant Programme Board for discussion and approval. Proposals thus approved enter the Pool of Research Projects (Research Pool).

Proposers shall be informed immediately as to the formal outcome of the Review process by a letter from ESA, giving the consensus opinion and any relevant comments of the Peer Board as well as the outcome of the Technical Feasibility Assessment. The results of the Review are final and shall not be open to appeal.

### 9.13: Project Implementation

After formal inclusion of a project in the Research Pool, the following steps will be initiated by ESA. As soon as possible, a nominated ESA Project Scientist will initiate the writing up of a detailed Experiment Scientific Requirements (ESR) document together with the science team of a project that was selected and involving as well an instrument developer and an ISS operations manager. Once approved within ESA and signed by the science team, the ESR will become one of the applicable documents to the contract that ESA will place with industry to study its development and implementation. The ESR may evolve in the course of the project realisation, keeping track of all changes agreed to it and including progressively more details of relevance to the following phase of the project (study-manufacture-testing-launch-in orbit operations-exploitation).

The feasibility of the selected experiment candidates will be established during a definition and Phase-A study. This will include detailed refinement of the scientific or technology demonstration requirements, detailed design of the instrument and operational scenario. Data collection, pre-processing and distribution will be assessed, as well as specific scientific studies and support activities required for realisation of the project.

The results of the phase A definition study will be used to prioritise projects for further possible development. Final selection and development of projects for flight (phase B/C/D/E) is contingent on the available budget for instrument development and implementation, which will be decided following the ESA council at Ministerial level in 2012, and ISS resources. Therefore, full development of selected projects to flight implementation cannot be guaranteed at this time.

### 9.16: National Funding Authority

In addition to submitting an on-line application to ESA a paper copy of the Letter of Intent and the Proposal must be sent by the experiment proposer to the *national delegate to the ESA Programme Board of Human Spaceflight, Microgravity and Exploration* of his/her country. This must be done by the same due date as the on-line application. The delegates/agency representatives are listed below.

**AUSTRIA**

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FFG – Aeronautics and Space Agency
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**GREECE**

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General Secretariat for Research and Technology
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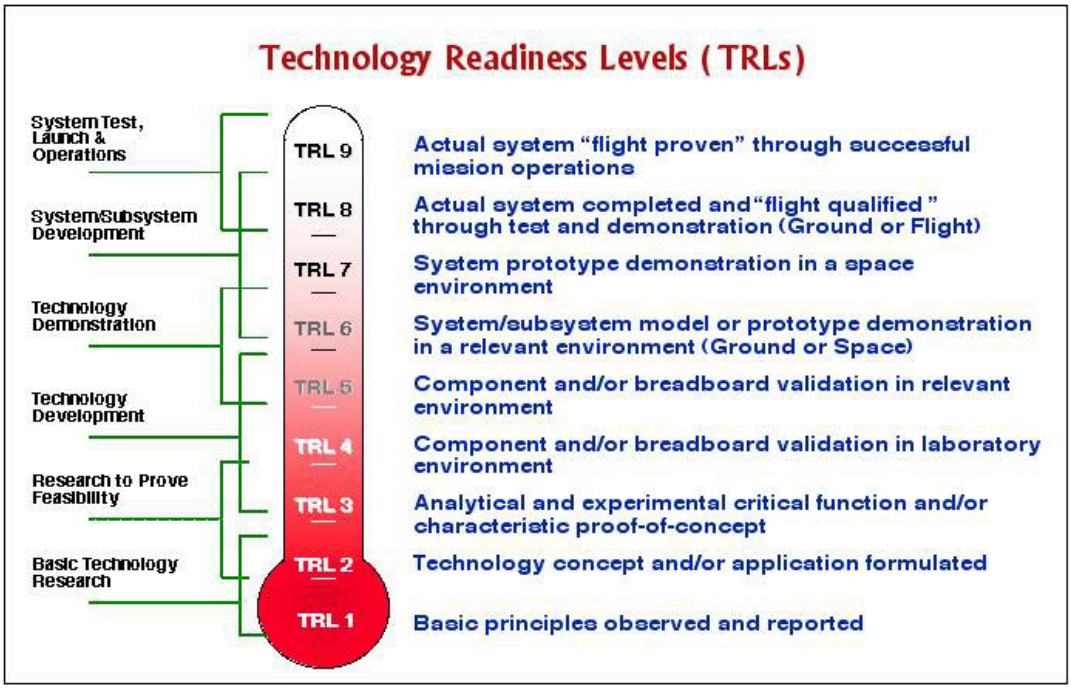
# 10. Technology Readiness Level (TRL)[1]

The TRL is a scale used to describe the maturity of a Technology. The scale goes from Level 1 through Level 9, as shown in the Table below and summarised in the Figure on the following page:

| | | |
|---|---|---|
| TRL 1 | Basic principles observed and reported | Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. |
| TRL 2 | Technology concept and/or application formulated | Once basic principles are observed, practical applications can be invented and R&D started. Applications are speculative and may be unproven. |
| TRL 3 | Analytical and experimental critical function and/or characteristic proof-of-concept | Active research and development is initiated, including analytical / laboratory studies to validate predictions regarding the technology. |
| TRL 4 | Component and/or breadboard validation in laboratory environment | Basic technological components are integrated to establish that they will work together. |
| TRL 5 | Component and/or breadboard validation in relevant environment | The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. |
| TRL 6 | System/subsystem model or prototype demonstration in a relevant environment (ground or space) | A representative model or prototype system is tested in a relevant environment. |
| TRL 7 | System prototype demonstration in a space environment | A prototype system that is near, or at, the planned operational system. |
| TRL 8 | Actual system completed and “flight qualified” through test and demonstration (ground or space) | In an actual system, the technology has been proven to work in its final form and under expected conditions. |
| TRL 9 | Actual system “flight proven” through successful mission operations | The system incorporating the new technology in its final form has been used under actual mission conditions. |

Figure 1: Technology Readiness Levels Thermometer




A more detailed explanation of Technology Readiness Levels can be found in the following ESA document "Technology Readiness Levels Handbook for Space Applications" ESA reference TEC-SHS/5551/MG/ap which can be downloaded from the AO website or via the following link;
https://telecom.esa.int/telecom/media/document/TRL_Handbook.pdf