ESA Announcement Opportunity soliciting for proposals for “Human Research experiments during short-duration missions on-board the International Space Station”

AO-2019-ISS_SDM

1 INTRODUCTION

ESA's "Science in Space Environment" (SciSpacE) programme – which is part of ESA's overall European Exploration Envelope (E3P) programme – includes scientific activities on research platforms such as ground-based space analogues (e.g. bedrest studies, research on Antarctic stations, radiation facilities, drop tower, sounding rockets, parabolic flights), as well as an ambitious research programme on-board the International Space Station (ISS). The SciSpacE programme activities cover science in the domains of Human Research, Biology (including Astrobiology) and Physical Sciences, with an emphasis on scientific excellence, space research- and exploration-relevance, innovation and timely delivery. Its research results will advance Europe's knowledge base, support its economy and help prepare future human and robotic space exploration. In addition to gaining fundamental knowledge, the research carried out within ESA's SciSpacE programme is helping to deliver solutions to problems back on Earth, e.g. developing innovative materials to manufacture products, removing pollutants from water, improving engine efficiency, testing new medical techniques and support equipment for the elderly and disabled.
This document provides an overview on the research opportunity offered within this announcement as well as on the sequence of events starting from submission of the research proposal to selection, definition and implementation of successful experiments.

2 OBJECTIVE OF THIS OPPORTUNITY

In March 2015, ESA's American and Russian International Space Station (ISS) partners expanded on-going collaborations on-board the ISS: two crewmembers of the respective space agencies resided on-board the ISS for one year. After successful implementation of the first 1YM, the American and Russian ISS partners are planning towards additional 1YMs as of 2020, linked to such 1YMs there will be missions of shorter duration, i.e. between 14 days and 4 weeks. In anticipation and preparation of those future 1YMs, ESA is releasing this research opportunity to solicit for dedicated experiments making optimal use of such short-duration missions.
It is known the space environment has immediate impact on the entire body and that even short exposure to microgravity and the space environment can impair or impact astronauts' performance and efficiency. Research on the immediate effects of spaceflight on the human body or organ systems (such as cardiovascular changes, re-distribution of bodily fluids leading to balance disorders, increase in intracranial pressure, space adaptation syndrome etc.) will therefore benefit the most from such missions and will therefore provide valuable insights into all those processes and will contribute to advancing knowledge relevant to the effects of space in the field of Human Research, with the overarching aim of contributing to safe and sustainable space exploration with human crews in low earth orbit and beyond. An overview of key questions to be addressed with this opportunity can be found in Annex 1. Applicants are strongly invited to address one (or more) of the topics outlined in Annex 1 of this document with their proposed experiments.

3 THE FACILITY TARGETED WITH THIS OPPORTUNITY

The International Space Station (ISS) is the largest human-made body located in Low Earth Orbit and continuously manned since 2000. The station is currently the only manned research platform that can provide long-duration spaceflight conditions, making it a very valuable platform for space exploration-relevant research, especially in the area of Human Research, where crewmembers act as operators of the experiments and/or as subjects themselves (for Human Research).
In view of the dense ISS research programme carried out by all its participating international partners, it is strongly recommended to design experiments and investigations as simple as possible, using existing and available hardware and facilities and requiring as little crewtime as possible. A detailed description of the constraints when implementing Human Research experiments on-board the ISS can be found in the "Flight Experiment Information Package (FEIP)" in Annex 2, a list of available hardware can be found in Annex 3.

4 APPLICATION PROCESS

4.1. Who can apply

The scientific institution for which the coordinator of a proposal is working must be located in one of the ESA member or associated member states that contribute to the SciSpacE programme: Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Poland, Romania, Spain, Sweden, Switzerland, United Kingdom. Scientists from other ESA Member States that do not contribute to the SciSpacE Programme and scientists from other European countries having a cooperation agreement with ESA are encouraged to enquire with their national space organisation about the conditions for their participation in proposals to ESA.

4.2 Preparing and submitting the proposal

The schedule for this Announcement of Opportunity is as follows:

Letter of Intent due:	March 15th, 2019
Announcement of Opportunity Workshop:	April 1st and 2nd, 2019
Proposals due:	June 1st, 2019

A workshop for this Announcement of Opportunity will be held on April 1st, 2019 (to be extended to April 2, 2019 in case of high interest for participation) at ESA/ESTEC, Keplerlaan 1, Noordwijk, The Netherlands. Please indicate your interest in participating in this workshop to the below dedicated eMail address, for planning, registration and logistical information distribution purposes, at the latest by March 15th, 2019.
During the workshop, ESA will provide general information about this opportunity as well as the opportunity to conduct "Pre- and post-flight experiments making use of the ISS environment" that has been released in parallel, in addition to information on the

characteristics and constraints of implementing experiments on-board the ISS. The workshop will also provide an opportunity for scientists to network and potentially start collaborations, Letters of Intent will serve as preparatory input to the workshop.

To facilitate timely proposal processing (e.g. organisation of peer review), potential submitting proposers are requested to confirm their plans to submit a proposal in response to this Announcement of Opportunity via (non-binding) Letters of Intent. The Letters of Intent will be distributed to the participants of the proposal workshop to facilitate possible cooperations. This should be taken into account when formulating the Letter of Intent, e.g. by avoiding inclusion of unpublished data. The Letters of Intent shall be prepared using the template found on this website and shall be submitted as PDF file to the below dedicated eMail address.

The proposals shall be submitted electronically as one single file to:

ISS-SDM@esa.int

An acknowledgement of receipt will be sent to the submitting proposer upon receipt and confirmation of completeness of the proposal.
ESA strongly advises all submitting proposers to contact their national representatives to investigate possible national funding procedures and timelines as well as probability of funding in order to identify alternative funding sources if necessary. As a minimum, it is recommended to submit the proposal to their national bodies in parallel with their application in response to this Announcement of Opportunity, in order to initiate applying for national funding as early as possible.

4.3 Evaluation of proposals

ESA will make use of independent experts for the relevance and scientific merit evaluation of proposals. The evaluation criteria that will be applied for evaluation of the proposals are:

- **Research Platform Relevance:** Is this study appropriate to the proposed research platform, *i.e.* can the objectives and protocol be achieved adequately within the capabilities and constraints of the platform?

- **Scientific Merit**

    - Significance (30%): Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?
    - Approach (25%): Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Does a flight proposal build upon a successful foundation of ground studies? Is the

proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?

- Innovation (20%): Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
- Personnel (15%): Does the scientific team have the appropriate level of experience, are sufficient & appropriate personnel dedicated to the project. Is there evidence of the science team's satisfactory productivity?
- Environment (10%): Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

After the peer review evaluation, proposals with a relevance and science merit score above the threshold considered for selection will be subject to a detailed technical feasibility review, which will be performed in-house. The objectives of this review are the following:

- Assess the compatibility of the proposed project objectives and requirements with ISS capabilities;
- Assess the hardware technical complexity and the relevant potential costs for development as required to fulfil the project requirements;
- Identify and rank the areas of technical risk or uncertainty;
- Perform the preliminary assessment of resources required for implementation and operation of the proposed project.

It should be noted that there may be cases where proposals which pass the science merit threshold are not selected as they are considered unfeasible from the technical or resource requirement standpoint. In these cases, the rationale for not selecting these proposals will be clearly identified.

The proposed selection, with rationale for threshold will be presented to the appropriate ESA Science Advisory bodies for comment and endorsement. Following approval of the proposed selection, the proposers will be individually informed of the outcome of the review in a confidential letter. This will include the report of the scientific peer review with overall scoring, technical review summary and programmatic assessment.

The results of the selection will be final and not open to appeal.

5 IMPLEMENTATION OF THE SELECTED PROPOSALS

After positive selection of the peer-reviewed proposal, the Principal Investigator of the experiment will be notified and the proposal will be added to the candidate pool of ISS experiments. The Principal Investigator will be required to confirm the availability of resources 6 weeks from notification by ESA, including (but not limited to) funding for her/his team's work in the project, as well as support to conduct all pre- and post-flight baseline data collection sessions, provision of their required equipment and consumables, science team travel to/from BDC locations. It is recommended that the experimenter requests for funding in parallel to their application in response to this announcement, in order to commence applying for national funding as early as possible or to seek for alternative funding sources if necessary.

ESA reserves the right to select only a part of a proposed project if this portion is still of high scientific merit. The applicant will be given the choice to accept or decline such a partial opportunity. If two or more proposals address similar problems and/or adopt similar approaches, it may be requested that the science teams consolidate specific parts of their projects into a single project and work as one team.

It should be noted that the acceptance of a proposal is not a guarantee for implementation. Implementation will be confirmed after a detailed definition phase, for which science teams will be assigned an ESA Project Scientist to support in defining the experiment-specific scientific, hardware, software, and operational requirements. Once considered feasible and selected for implementation, the science team will continue working with the ESA Project Scientist as well as with ESA functions to prepare the experiment for implementation.

6 DATA RIGHTS

6.1 General

The general data policies of ESA's Directorate for Human and Robotic Exploration Programmes will apply to all data resulting from the experiments in the context of this Research Announcement. Specifically, ESA shall be the owner of all the Raw and Calibrated Data directly resulting from experiments implemented in the context of this opportunity, ESA shall thus be entitled to use (i.e. disseminate, valorise, preserve) the Raw and Calibrated Data resulting from the Experiments for its own purposes in the field of space research and technology and their space applications. ESA will grant the Investigator an exclusive right of prior access to the raw and calibrated Data. The duration of the exclusive right ("Period of Prior Access") shall be six (6) months from the provision by ESA of the data to the Investigator in a form suitable for analysis. This provision by ESA includes all the agreed science deliverables upon the completion of the science acquisition process, resulting from the execution phase. After this exclusivity period – unless otherwise agreed upon -, data will be made publicly accessible and available.
Final results of the study shall be made available by the scientific teams to the scientific community through publication in appropriate journals or other established channels as soon as practicable and consistent with good scientific practice. In the event such reports or publications are copyrighted, ESA shall have a royalty-free right under the copyright to reproduce, distribute, and use such copyrighted work for their purposes.

6.2 The Erasmus Experiment Archive (EEA)

The EEA covers both physical and life sciences, and can be found at the following URL: http://eea.spaceflight.esa.int The EEA is an ESA service to the international scientific community. Abstracts, from all ESA microgravity experiments performed to date are collected in this database. Experimenters sponsored by ESA have the obligation to provide these abstracts themselves. Special emphasis is placed on the completeness of the list of references of articles where the experiment results can be found.

Scientists in Europe are encouraged to either provide an abstract on each of their experiments, or to provide information enabling the updating of their existing abstracts, in particular the list of articles published.

ANNEX 1: SCISPACE ROADMAPS

The Science Department of ESA's Human Spaceflight and Exploration Directorate recently undertook an extensive exercise to create a new strategy, focusing on a set of newly defined goals to help to positively shape the future research programme of the Directorate and maximize research potential.

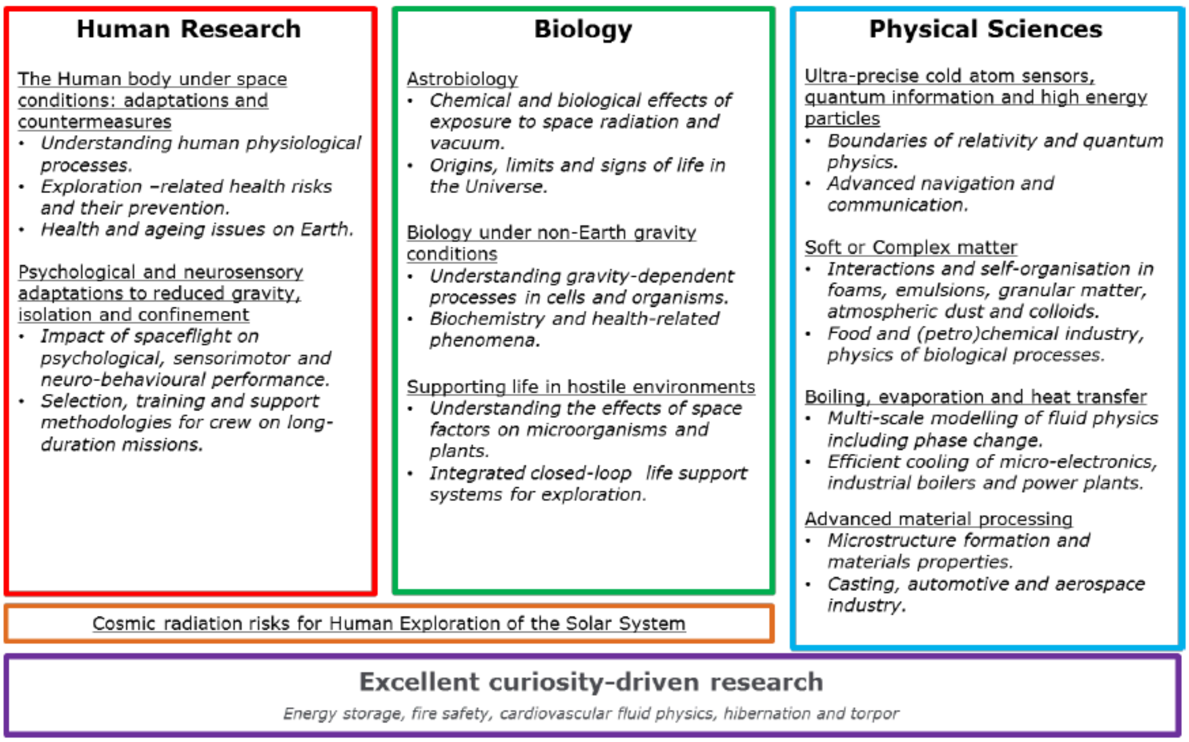

Figure 1. ESA Roadmaps

Figure 1 gives a graphical overview of ESA's Science Roadmap questions; the detailed roadmaps can be found at:
https://www.esa.int/Our_Activities/Human_Spaceflight/Research/Research_Announcements on ESA's Research Announcement website.
Submitting proposers are strongly invited to address one of the topics outlined above on the Human Research part with their research proposal.

ANNEX 2: Flight Experiment Information Package (FEIP)

Implementation of human research experiments before, during and after spaceflight is limited by various constraints such crew availability (before, during, and after flight), crewtime during flight, up- and down mass of required equipment and consumables, and cold stowage. Experiments that require few of these resources will be more feasible to implement.

This Flight Experiment Information Package (FEIP) will provide basic information and guidelines for investigators proposing human research studies during short-duration missions to the International Space Station (ISS). It will provide investigators with additional information about the most constrained resources and provide an indication of how much of a given resource is likely to be perceived as "too much" and would therefore be difficult to implement. In each case below, the values given for what is difficult to implement are provided as a guideline only; each investigation will be assessed for technical feasibility in its entirety.

Investigators should carefully consider the constraints outlined in this document when developing their protocol requirements, keeping in mind that (technical) feasibility aspects will be considered in the selection process. Technical feasibility will be primarily determined based on the data provided in the "Detailed Experiment Information" part of the proposal submission template, and care should be taken to ensure this is accurately and thoroughly filled out in its entirety.

A. Flight Hardware and Software

Background: There are many research facilities available to investigators who wish to conduct human research on ISS. More information on the equipment available on-board ISS can be found in Annex 3.

Difficult to Implement:

- Any new flight hardware required. The extent of how difficult this development will be depends on how much design and development is required for custom-made equipment and how extensive off-the-shelf-equipment will have to be modified.
- Upload of hardware that is not available on-board the station. Up-mass resources will be protected for critical consumables; data should be planned to be uplinked.
- Return of hardware for refurbishment or data retrieval. Down-mass resources will be protected for critical science samples; data should be planned to be down linked and hardware will likely be discarded.
- Requirements for cold stowage that exceed the capabilities of the current on-board cold stowage equipment. Experiment unique refrigerators or freezers will not be developed.
- Software that requires a dedicated computer or operating system.

B. Subject Requirements

Background: Currently, the usual number of crewmembers on board ISS is six; this includes 3 Russian crewmembers and 3 United States Operation Segment (USOS) crewmembers (participants from International Partner agencies: US, Europe, Canada, and Japan). On-orbit durations for this opportunity are up to 2 months. At this time, through this opportunity only investigations that seek participation from USOS crewmembers are solicited.
All crewmembers will be given an informed consent briefing on all proposed human research for their mission at approximately one year prior to launch. There is a large number of human research investigations being performed and it is not possible for one crewmember to participate in all of them, even if they are willing to do it. This is due to the resource limitations as well as science conflicts between investigations. Based on crewmembers' interest or lack thereof, a specific complement of research is developed for them that can be performed within the flight resource constraints.
With a small subject pool and a large number of investigations requiring human subjects, the number of subjects required becomes an important aspect of technical feasibility for flight proposals. In addition to taking a long time to complete, studies that require large subject numbers limit the throughput for overall human spaceflight research. An investigation that has multiple constraints and may effectively reduce the number of other investigations a subject can participate in will not be technically feasible to implement.
Difficult to Implement

- Studies requiring more than 6-8 subjects.
- Studies requiring invasive or complicated procedures that may hinder crew consent.

C. Pre-Flight Baseline Data Collection (BDC) and Training

Background: The availability of ISS crewmembers prior to launch is extremely limited due to a heavy schedule of training and Baseline Data Collections (BDC) for other experiments, which requires a great deal of international travel (Russia, Europe, Japan, US). Especially during the last two months before launch, in Russia, the crew is very busy with preparation activities for launch. Pre-flight BDC should be planned to be completed prior to L-60 when crewmembers are at the Johnson Space Center (JSC) in Houston or at the European Astronaut Centre (EAC) at Cologne. Also, since crew time is very constrained during their trips to Houston and Cologne, the number and length of pre-flight BDC sessions should be minimized as much as possible, and timing and windows of sessions should be as flexible as possible.

Difficult to Implement:

- Total pre-flight BDC requirements of more than 10 hours.
- Single BDC sessions requiring more than 2 hours.
- BDC testing requirements within the two months before launch.
- In-flight procedures that require a high degree of proficiency and training prior to crewmember launch (e.g. requires more than three, 2 hour sessions for one unique procedure/skill; requires refresher session within 60 days of launch).

D. In-flight crewtime

Background: All ISS crewmembers will be launching via the Russian Soyuz spacecraft until a US crew vehicle is available. Depending on the launch profile, the travel can take up to two days before the Soyuz docks with the ISS. The Soyuz is very space-constrained and it is not feasible to perform any in-flight operations prior to docking with ISS. After docking with ISS, crewmembers are typically busy with handover activities, and crewtime for science is extremely limited. Crew time is also limited during periods when other vehicles dock or undock due to required preparation activities, as well as around Extra Vehicular Activities (EVA's). Additionally, during their whole mission, the crew has medical and fitness activities almost every day and routine or specific station maintenance work that need to fit in their daily schedule together with the scientific activities. Weekends are protected as time off for crewmembers, and science is only performed if it is crew preference or as part of voluntary science.
Therefore, in-flight crew time is very restrictive and investigators should provide flexibility in the scheduling requirements for their science.
In addition to the constraints mentioned above, many investigations often have similar in-flight timing requirements, and they all cannot be scheduled during the same time-point. Investigators should clearly state the reasoning for specific timing requirements and explain how flexible the timing is (+/- number of days).

Difficult to Implement:

- Complicated in-flight sessions (e.g. requires set-up of multiple pieces of equipment followed by testing session of more than an hour; sessions that require privatized voice or video; sessions that require an additional operator with complex procedures; sessions that require extensive privatized resources)
- More than three in-flight sessions
- A single session with one crewmember requiring 4 hours in one day.
- Crew activity that must be performed daily or more than once a week.
- Very precise/inflexible timing requirements for sessions (e.g. +/- window for testing of less than one week, multiple timed blood draws, sessions that are linked to other crew activities like meals, EVA's, etc.).
- Please note that occasional fasting data collections upon crew wake up are not difficult to implement.
- Extended, continuous activities over multiple days that could interfere with other operation.

E. Post-Flight Baseline Data Collection

Background: All crewmembers are currently returned from ISS via the Soyuz spacecraft, landing in Kazakstan. USOS crewmembers are returned directly to the Johnson Space Center (JSC) in Houston or to the European Astronaut Centre (EAC) at Cologne within approximately 24 hours after landing. Due to logistical limitations, it is close to impossible for investigators to gain access to crewmembers until they have returned to Houston or Cologne. The time period from crew landing to crew sleep after return to Houston or Cologne

is considered landing day, or "R+0". The start of R+1d begins after crew wake up the day after their return to Houston or Cologne.
The total amount of time available for science BDC in the first week post-flight (from R+0 to R+7d) is less than 12 hours and must be shared with multiple investigations. Therefore, investigators should only request BDC during this timeframe if it is strictly required and the amount of measurements should be reduced to the bare minimum. In addition, scheduling flexibilities should be noted so that the post-flight schedule can be optimized for scientific return. If testing requires use of a facility not located at JSC in Houston or at EAC in Cologne, travel time to and from the facility must be included in the session time.
The figure below provides a graphical representation of crew time availability in the first week post-flight to further illustrate how constrained this resource is. This is a general representation only; there is flexibility in the scheduling of some of the medical operations times, and an individual schedule is developed for each crewmember.

<u>Difficult to Implement:</u>

- Two or more hours of testing required within the first three days of landing
- More than three hours of total testing in the first week post-flight.
- Strenuous sessions on R+0 or R+1d. Any activity that could be considered strenuous for a healthy normal subject may not be feasible for crewmembers in this time frame.

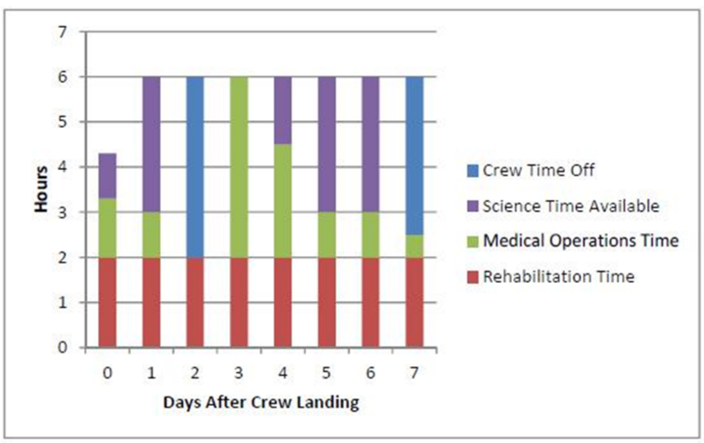

Figure 1: General representation of crewtime availability post-flight

ANNEX 3: available on-orbit hardware

The following hardware is currently on-orbit and might be available for proposed experiments: centrifuge for processing of biological samples, ultrasound, virtual reality equipment, pulmonary function measurement device, station laptops. Collection kits for obtaining biological samples will need to be procured on an individual basis, but are available. Other hardware can be made available through international partner agreements.