ESA XRISM Guest Observer Announcement of Opportunity (AO) – Cycle 1

1 SCOPE OF PROGRAM

1.1 Overview

ESA solicits proposals in the framework of the Guest Observer (GO) program, to conduct space science observations using the XRISM X-ray observatory. The XRISM mission is led by the Institute of Space and Astronautical Science of the Japan Aerospace Exploration Agency (ISAS/JAXA), with significant contributions from National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA). The primary goal of the XRISM mission is to investigate the nature and physics of astrophysical objects as revealed through detailed observations of their high-energy emission. A broad range of astrophysical sources will be studied, including stars, X-ray binaries, diffuse galactic emission, active galactic nuclei, and clusters of galaxies.

According to the Memorandum of Understanding between ESA and JAXA, no less than 8% of the total GO time shall be allocated to ESA, *i.e.* to scientists affiliated in ESA Member and Cooperating States[1]. These observations will be allocated competitively according to the rules specified in this announcement. Allocation of the JAXA observing time will be the responsibility of ISAS/JAXA. Allocation of NASA observing time will be the responsibility of NASA. *Scientists affiliated to Canadian institutions shall submit their proposals though the NASA observing time.* The proposal shall ask for observations using one or both instruments comprising the XRISM scientific payload. *Proposals requesting support of complementary observations using other space-based or ground-based observatories or theoretical investigations are not solicited in this AO.*

Proposals submission and review will be conducted in one stage. Proposals shall be submitted via the ARK/RPS system. They will be peer reviewed for scientific and technical merit (see Section 2.2.1).

1.2 The XRISM Mission

1.2.1 Overview

XRISM is a collaborative mission between ISAS/JAXA and GSFC/NASA, with contributions from ESA and over 70 institutions in Japan, the U.S., Canada, and Europe. As the host country, Japan provides the spacecraft, launch, operations, and contributes to the development of both scientific instruments. XRISM is Japan's seventh X-ray Astronomy mission. XRISM, with the unprecedented combination of spectral resolution/sensitivity of the *Resolve* instrument, will execute a diverse and exciting program of astrophysical research.

The mission is divided into three distinct operational phases: In-orbit Checkout ("IOC"; ~4 months), Performance Verification ("PV"; ~6 months), and General Observations ("GO"; see section 1.3.1).

[1] https://www.esa.int/About_Us/Corporate_news/Member_States_Cooperating_States

At the time of issue of this solicitation, the mission is in the IOC phase. It includes the spacecraft and payload commissioning, the execution of the in-flight calibration program, and of a small set of science observation leading to the release of "Early Release Science" products to support the preparation of the GO proposals. Upon its completion, the international XRISM Science Team will execute the PV observing program, followed by initiation of the Cycle 1 GO program. Contingent upon the successful completion of the IOC and PV phase activities, Cycle 1 will commence on or about July 1, 2024, and last for a period of approximately 12 months. Future GO AOs will cover until the nominal operations of the mission.

1.2.2 The XRISM Observatory

The XRISM scientific payload consists of two co-aligned instruments covering the energy band between ~0.3 and 12 keV: the *Resolve* Soft X-ray Spectrometer and the *Xtend* Soft X-ray Imager at the focal plane of two almost identical X-ray Mirror Assemblies (XMAs). The latter, one for *Resolve* and one for *Xtend*, are lightweight foil telescopes similar in design to those flown on ASCA and *Suzaku*, but with an improved half-power diameter (HPD) of ~1.3 arcmin. The cryogenically cooled 6 x 6 pixel microcalorimeter array of *Resolve* covers a field of view (FOV) of 3 x 3 arcmin^2 with a spectral resolution of approximately 7 eV over its 0.3 -12 keV bandpass. The latter capability is the best yet achieved at energies above 3 keV for observations of celestial sources outside the Solar System; in addition, unlike grating instruments, Resolve can observe spatially extended X-ray sources with the same spectral resolution as a function of energy across the FOV. The CCD-based *Xtend* at the focus of the second XMA has a wide (38 x 38 arcmin^2) FOV over the 0.3 -12 keV energy range.

For detailed information about the instruments and the currently available data relevant to their in-orbit performance, proposers should consult the XRISM Technical Description, which may be accessed from the ESA XRISM web site: https://www.cosmos.esa.int/web/xrism .

1.2.3 Science Operations

The XRISM spacecraft has a mass of 2,300 kg and was launched on September 7, 2023 (JST), from the Tanegashima Space Center (TNSC) in Japan. A JAXA H-IIA rocket placed the observatory into an approximately circular orbit with an inclination of ~31 degrees and an altitude of ~575 km. XRISM operations are managed by scientists and engineers at ISAS/JAXA. The operations team is responsible for scheduling of the observations, command/control of the satellite, collection of the data, and monitoring of the health of the spacecraft and scientific payload. Spacecraft operations are carried out from Sagamihara Spacecraft Operation Center using tracking stations of Uchinoura Space Center (USC) in Japan, JAXA Global Network stations, and NASA Near Earth Network stations. The observation data are downlinked at USC, where direct contact with the satellite is possible for five orbits per day. It is anticipated that typical observations will last 1 – 2 days. The onboard data recorder has a capacity of 12 Gbits, and telemetry can be downlinked to USC at a rate of 8 Mbps for approximately 500 s per contact. The data are routed to ISAS/JAXA, where pre-processing tasks are performed, including FITS conversion and generation of orbit and attitude files. The resultant data are transmitted to the processing pipeline at NASA/GSFC, where calibration data will be applied to the pre-processed science data. Subsequently, the processed data will be copied to identical mission archives at ISAS/JAXA and NASA/GSFC in an encrypted form, at which time their address and the decryption key will be made available to the Principal Investigator (PI) of the observation. At the end of the 1-year proprietary period, the associated data files in the archive will

be decrypted and made publicly accessible. It is anticipated that XRISM will generate ~1 Tbyte of data per year, although the total daily data volume rate may approach 8 Gbytes.

1.3 XRISM Cycle 1 GO Program

Proposals for investigations based upon observations of celestial sources utilizing the XRISM observatory will be solicited and executed on an annual basis. Cycle 1 observations will be initiated on or about July 1, 2024, and will last for a period of approximately 12 months.

The relative time allocations for the various categories of Cycle 1 observing time are as follows:

- Observatory time (Calibration, Director's Reserve, Target of Opportunity (TOO)- 10%;
- Science Team (Carryover of remaining PV observations from Phase 1) - 15%; and,
- GO time - 75%.

The Cycle 1 allocation of GO time among the mission partners is as follows:

- U.S. investigations (including Canadian partners) - 44%;
- ESA investigations – 8%;
- Japanese investigations (including all other partners) - 48%.

Each recommended GO target will be assigned a priority grade of A, B, or C by the International Merging Panel based on the recommendation by the Science peer review panel (see 2.2.1). Note that multiple targets accepted through a single proposal may be assigned different priority grades. Priority A and B targets are guaranteed to be observed; best efforts will be made to schedule such targets within the Cycle 1 period. Those Priority A/B targets that cannot be scheduled during Cycle 1 will automatically be carried over to the subsequent cycle. Note, however, that this practice does not apply to TOO targets: observations of such targets that are unable to be scheduled during Cycle 1 must be re-proposed to a future observing cycle. Priority C targets will have lowest priority for scheduling; observations of such targets that are not scheduled during Cycle 1 must be resubmitted to a future observing cycle. The available Cycle 1 GO time will be allocated as follows: Priority A = 50%, Priority B = 40%, and priority C = 50%, resulting in an oversubscription of 40% of the nominal total GO time. Accordingly, C targets will nominally have a 20% probability of being observed during a given cycle, although the actual fraction may be greater if the observing efficiency is higher than predicted.

The PV target list was published in February 2021 and is available at the following website: https://www.cosmos.esa.int/web/xrism/performance-verification-target-list. It is anticipated that the Science Team carryover time during the GO program will be dedicated primarily to the completion of observations of targets initiated during the PV phase. A small number of PV targets have been designated Priority C for which scheduling of the corresponding observations is not guaranteed. General Observers may propose to observe unscheduled Priority C PV targets during Cycle 1; however, if the observation is subsequently scheduled during the GO phase, the data rights will remain with the Science Team.

Note that, as a general policy, proposals for scheduled observations of PV Phase A or C targets are permitted. Such proposals must provide a convincing justification for the need of additional observations of the target, *e.g.*, observations during a different binary phase or source state, or of different locations within extended sources. Similarly, proposers may request multiple observations of the same target for a specific investigation. However, such requests will be approved only if a

clear scientific and logistical justification of the need for separate observations is provided in the proposal.

In cases where the same target is selected in more than one national program (JAXA, NASA, ESA), the feasibility of merging the two investigations will be explored. In all instances where feasible, a single observation of the target will be awarded to all proposing teams, a single, Prime PI (PPI) will be designated, and the time will be accounted for based on the nationality of that individual. The PPI will assume the responsibility for planning of the observation and all teams will have access to the processed data. Alternatively, PIs have the option of indicating on their proposal that they do not wish their proposed observation(s) merged. In such cases, if one or both accepted proposals are so marked, only one will be selected for observation. Further details of the merging process may be found at the XRISM ESA web pages.

Following the completion of Cycle 1, subsequent approximately one-year observing cycles will be carried out through the end of the mission. During this period, no time has been reserved for XRISM Science Team observations.

It is anticipated that investigations will be selected that request observations of a range of targets, including Solar System objects, stars, X-ray binaries, supernova remnants, galaxies, active galactic nuclei, clusters of galaxies, and the diffuse X-ray background. Targets that are planned to be observed during the PV phase are available from the XRISM homepage (https://www.cosmos.esa.int/web/xrism/performance-verification-target-list). The scientific justification for additional observations of those sources should be addressed in the proposal.

All European proposals will be evaluated in a single peer review. Note that a target form providing details of the requested observation, including the source coordinates, required exposure time, instrument mode, any observing constraints, etc., must be completed for each target to be observed as part of the proposed investigation.

1.3.1 Observing Constraints

Proposals may be submitted for investigations requesting observations that can be executed within the one-year period of Cycle 1; proposals for investigations requiring observations beyond the period of Cycle 1 will not be accepted under this solicitation. Investigators whose observing proposals are selected for implementation will receive the resultant data in a form suitable for analysis. Best efforts will be made to schedule observations of proposals awarded multiple targets during a contemporaneous time interval; however, this may not be feasible in some cases due to operational constraints. PIs will be granted exclusive access to the data resulting from their approved observations for a period of one year. Subsequently, the data will be placed in a public archive and made available publicly.

It is anticipated that XRISM will typically perform one pointing every 1 – 2 days (exposures of ~50 - 100 ks). This constraint is primarily driven by the need to collect a sufficient number of photons to take advantage of *Resolve*'s high spectral resolution. In order to maintain a satellite observing efficiency of ~50%, the minimum allowable observing time on a particular target is 10 ks (~4 orbits). To maximize the breadth of scientific investigations undertaken with XRISM during Cycle 1, observations will be limited to 200 ks per pointing with the total not to exceed 600 ks per proposal; it is anticipated that these restrictions will be relaxed over succeeding cycles. Subject to

the above constraints, individual proposals may be submitted for observations of a single pointing with a requested observing time of 10 - 200 ks, or for a larger program including multiple pointings with a *net* observing time request not to exceed 600 ks.

Note that as the XRISM Project gains experience in operating the observatory and its instruments, additional operational constraints/clarifications regarding the scheduling of Cycle 1 observations may be issued. In such cases, the change(s) will be posted on the XRISM ESA website.

1.3.2 Time-constrained observations

Time-constrained observations, that is, observations with scheduling constraints imposed either by the nature of the target or the requirement for coordination with other ground- or space-based observatories, place a special burden on XRISM mission planning. The additional constraints associated with the scheduling of an excessive number of time-critical observations would compromise the capability of the mission planning and operations team to effectively execute the complete set of approved programs. To maintain the number of such observations at a manageable level, targets requiring time-constrained observations must receive the highest scheduling and scientific priority. Consequently, time-constrained observations must be designated Priority A.

1.3.3 Target-of-Opportunity (TOO) observations

Observations of classes of targets involving outbursts from previously identified transient sources or changes in the intensity or spectral state of previously identified persistent sources (designated "pre-approved" Target-of-Opportunity observations) constitute another special category of XRISM observations. Proposals for observations of such targets will be permitted in Cycle 1. However, proposals for observations of previously unknown sources, designated as "generic" TOOs, e.g., a previously unknown X-ray nova or Local Group supernova, are *not* solicited in Cycle 1. Each proposal shall provide the pointing direction in the accuracy of *Resolve* field of view. Details regarding the criteria for "triggering" a requested TOO observation, as well as an estimate of the trigger probability during Cycle 1, must be provided in the scientific justification and summarized on the target form. To assist the XRISM team in estimating the total exposure time of approved TOO observations during Cycle 1, the product of the requested exposure time and the trigger probability will be used. Proposers may request observations for up to 10 (TBC) candidate targets, where the proposed and/or accepted number of triggers need not be identical to the total number of candidate objects (e.g., proposers may request "up to three of the following 10 X-ray transients in outburst"). Even in such cases, the 200 ks limit per pointing and the 600 ks limit on the total requested observing time per proposal are applied. The total observing time is to be estimated as the aggregate probability of all candidate targets in a proposal.

Note that, as with time-critical observations, TOO targets must be assigned a rating of Priority A to be eligible for scheduling. Approved TOO targets that are not triggered or otherwise unable to be scheduled due to observatory constraints during Cycle 1 will *not* be carried over to the following cycles.

Due to the additional complexity associated with the scheduling of observations of time constrained and TOO targets, a limit will be imposed on the total time awarded to such observations (currently expected to be ~10%). It is anticipated that this limit will be adjusted during future observing cycles as experience in the scheduling of observations is gained over the course of the mission.

In the case of truly unpredictable events, e.g., outburst of a hitherto unknown X-ray transient, a real-time request for a TOO observation may be submitted. Such requests are *not* solicited under the Cycle 1 call; if accepted, the resulting observing time will be charged to the Observatory Time allocation (10%). The procedure for requesting such observations and the relevant data rights policy can be found at https://xrism.isas.jaxa.jp/research/proposer/index.html.

2 PROGRAMMATIC INFORMATION

2.1 Submission and Evaluation of XRISM GO Proposals

The XRISM GO program will utilize a one-stage proposal process. Proposals shall provide a detailed description of the proposed investigation, including the requested XRISM observation(s) and associated scientific/technical justification. All proposal materials shall be submitted electronically.

Individuals submitting proposals to the Cycle 1 XRISM GO Program must adhere to the following proposal submission procedures:

- Proposers must submit their GO proposals (including the accompanying target forms) electronically through the ARK/RPS website at https://xrismrps.esac.esa.int/ark/xrism/ . Instructions for submitting proposals via ARK/RPS are provided at the ESA XRISM web site (https://www.cosmos.esa.int/web/xrism);
- Due to the nature of prospective GO investigations within the XRISM GO program, the scientific and technical section of proposals (a.k.a. "the scientific justification") is limited to **4 pages**. The requirement for a table of contents in the body of the proposal is waived. No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed;
- The scientific justification must be uploaded to the RPS website as a PDF file.

In order to be included in the review of proposals for this cycle of the XRISM GO Program, proposal materials must be submitted electronically by **12:30 p.m. Central European Time** on the due date provided in Section 3 of this document.

GO Proposals will be evaluated by a science peer panel with respect to the criteria specified in the XRISM GO policy document, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The suitability of using the XRISM observatory and associated data products for the proposed investigation, including the degree to which the investigation exploits the unique capabilities of XRISM;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies XRISM observational constraints and the feasibility of the proposed analysis techniques;
- The extent to which the proposed investigation fulfils or enhances the anticipated science return from the XRISM mission;
- The degree to which the proposed observation(s) places demands upon mission resources.

2.2 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the ESA XRISM website (https://www.cosmos.esa.int/web/xrism). This website provides instructions for completing the required proposal forms. A Proposal Observing Guide (POG) is still being updated with the latest results of the instrument commissioning and should be published around the end of the commissioning phase. At that time, the ARK/RPS system shall be open to enable the submission of proposals in response to this call. Prospective proposers can address questions to, and find the answers to frequently asked questions at the ESA XRISM HelpDesk (https://support.cosmos.esa.int/situ-service-desk/servicedesk/customer/portal/8).

3 SUMMARY OF KEY INFORMATION

Due date for proposals	12:30 CET, 22 February 2024
Target for the publication of the POG and the opening of the ARK/RPS	7 December 2023
Page limits for the scientific justification	4
Submission medium	Electronic proposal submission is required in PDF format; no hard copy is required.
Website for submission of proposals (ARK/RPS)	https://xrismrps.esac.esa.int/ark/xrism/
Eligibility	Principal Investigators shall be primarily affiliated with an institution of an ESA Member or Cooperating State (Canada excluded)
Link to instrument responses and background file for simulation (NASA)	https://heasarc.gsfc.nasa.gov/docs/xrism/proposals/index.html
XRISM Proposer's Observing Guide	Not publicly available yet
ESA XRISM web site	https://www.cosmos.esa.int/web/xrism
ESA XRISM HelpDesk	https://support.cosmos.esa.int/situ-service-desk/servicedesk/customer/portal/8