AstroSat – Ninth AO cycle

AO document

AstroSat Mission

Announcement of Opportunity (AO) soliciting proposals for

Ninth AO cycle observations

Criteria for applying:

This announcement is open to Indian scientists/ researchers residing and working at institutes/Universities/colleges in India for 55% of time and to Non-Indian scientists/ researchers, Non-Resident Indians (NRIs), working at space agencies/ institutes/ Universities/ colleges around the globe for 20% time, who

- are involved in research in the area of astronomy and
- are equipped to submit proposals as Principal Investigators (PIs) for specific target observations with necessary scientific and technical justification and
- can analyse the data, if the target is observed based on approvals.

1. Introduction and Schedule

AstroSat is the first dedicated Indian astronomy mission aimed at studying celestial sources in X-ray and UV spectral bands simultaneously, thus providing a space astronomy observatory operated by the Indian Space Research Organisation (ISRO). The satellite is at 650 km near-equatorial orbit with 6-degree orbital inclination.

AstroSat will be completing four years at the end of September 2019 in orbit. Currently, the fifth/sixth AO cycle proposals are being executed. Proposers can refer to the Redbook in the ISSDC website for the list of observed targets.

The details on the mission and payloads are available in the ISRO website. The technical details of payloads are described in the AstroSat Handbook.

A significant amount of AstroSat's observing time is made available to PIs of proposals, both Indian and International. The availability of AstroSat time will be made through Announcements of Opportunity (AO). Electronic submission of proposals through AstroSat Proposal Processing System (APPS) software at ISSDC website will be required to submit a proposal in response to this AO. Submitted proposals will be reviewed by the AstroSat Time Allocation Committee (ATAC) and AstroSat Technical Committee (ATC) for scientific merit and technical feasibility.

The observations will be planned as per mission scheduling. The PI will be informed, after the completion of successful observation for the downloading of processed Level-1 data. After the 12 months proprietary period, which starts from the day Level-1 is made available to the PI, the archived data will be open to registered users and will be available in ISSDC.

This AO soliciting proposals for the Ninth AO cycle is for Indian as well as international proposers as Principal Investigators (PIs) to utilise AstroSat observatory time. The observations will be carried out in the period between April to September 2020 (approximately six months).

All announcements regarding exact dates and proposal submission will be available at the Indian Space Science Data Centre (ISSDC) website (http://www.issdc.gov.in) and AstroSat science Support Cell (ASC) website (http://astrosat-ssc.iucaa.in/).

For all matters related to a proposal, the Principal Investigator (PI) of the proposal is the single point of contact for ISRO. The PI will be informed through e-mail about the status of the submitted proposals. It is expected that necessary facilities for carrying out the AO project will be provided by respective host institutions.

The deadline for submission of proposals will be announced in ISSDC and ASC websites.

2. <u>Observing cycles</u>

In this Ninth AO cycle, 55% of observing time is available for Indian AO proposals and 20% of observing time is for International AO proposals. Rest of the time in this cycle is allotted for calibration, Targets of Opportunity and Legacy proposals.

AO cycle

AstroSat is operated in a pre-planned manner i.e proposers are not present at Mission Operations Complex during the execution of their observations. Thus, all observations must be specified in full details in advance.

- The percentage of observing time for executing AO proposals during March 2020 – September 2020 is 87% and is termed as Ninth AO cycle.
- Out of 87%, 55% time is exclusive for Indian proposers as Principal Investigators (PIs) to utilise AstroSat observatory time. They could be interested researchers, scientists and astronomy community at large, involved in scientific research in the field of astronomy and are equipped to submit proposals as Principal Investigators (PIs) for specific target observations with necessary scientific and technical justification and can analyse the data, if the target is observed based on approvals. In addition, 20% of the time is for international proposers from the global astronomy community.

- All the selected AO proposals will be inserted into the observing schedule. However, few observations approved in this AO cycle may be scheduled outside of the above period, in case there is operations requirement, which will be provided by AstroSat Mission.

- Proposers are requested not to duplicate any of the planned observations and should carefully justify duplications if any, with performed observations. Proposers

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have to check the list of objects and instrument parameters for observations already/ being carried out using AstroSat. A Red book containing these targets will be made available in the ISSDC website. Proposers wishing to observe any of these targets should justify why it is important to do so and what additional information will come from the proposed observations.

- Checks for duplications will be performed by ATAC while processing the proposals during the scientific review.

3. Overview of proposal preparation, validation, submission and selection

PIs of proposals will have to submit proposals to ISRO by the deadline given in the ISSDC website using AstroSat Proposal Processing System (APPS) software. APPS is available online through http://www.issdc.gov.in. APPS is not downloadable and cannot be used off-line. An APPS proposer's guide is available in ISSDC and ASC websites which elaborates on the proposal submission procedure. A summary is provided in this section.

3.1 Brief instructions for proposal preparation

Proposers will need to use the AstroSat Proposal Processing System (website: https://apps.issdc.gov.in/apps/auth/login.jsp) to create, prepare and submit proposals. The AstroSat proposers guide available online at http://astrosat-ssc.iucaa.in/?q=proposal_preparation provides a detailed description of various steps in proposal preparation. A brief description of these steps is given below.

Depending on the scientific requirement, proposals to AstroSat can be submitted for observation with a single or more instruments. Proposals are to be made as per APPS proposer's guide and this procedures document. Proposers can refer to Redbook for the list of observed targets.

1. Before preparing the proposal, decide on your target list, and ensure that the targets can be observed with AstroSat as described below.

2. Ensure that the targets are visible to AstroSat for the A09 cycle observing period (March to September 2020). Proposers can use the source AstroSat visibility tool "astroviewer" available at http://issdc.gov.in/astroviewer/index.html. If there is a difficulty in using the astroviewer tool, proposers can also use the simpler visibility tool "Avis" available online at the AstroSat Science Support Cell (ASSC) website http://astrosat-ssc.iucaa.in:8080/AstroVisCal/. If your science case (NOT the visibility windows) requires time constraints, ensure that the time constraints are covered by the visibility windows. Output in the pdf format from one of the visibility tool will need to be uploaded in the APPS.

3. If you want to observe with UVIT, it is mandatory to establish a safety check as described in the mandatory safety-check document available at ASSC (http://astrosat-ssc.iucaa.in/uploads/APPS/Guidelines_for_proposal_submission_8.pdf). First, find the safe FUV filters for your target using the online tool available at UVIT POC website

(http://uvit.iiap.res.in/Software/gaia/). Save the output by printing in the pdf format. It is necessary to use VIS channel for tracking if you are using FUV channel. If FUV is safe for your target, find the safe VIS filter(s) using the online tool at UVIT POC website http://uvit.iiap.res.in/Software/theia/.

The pdf outputs of FUV and VIS filter check tools should be merged and attached in APPS as the "UVIT Bright Source list". FUV gratings can be used when the count rate in FUV CaF2 filter is less than 892 in the full window of 512x512 pixels, please check the output obtained from the run of the UV filter check tool. Proposers also need to check for scattered light from nearby ultra-bright sources as described in the mandatory safety-check document. If your target is within +/-30 degrees of Galactic latitude and no Galex images are available, you will need to first establish the safety by proposing a UVIT safety check ToO proposal. Please see the AstroSat Proposers Guide for more details.

4. For observations with LAXPC, the source should be fainter than 2 Crabs. SXT data will be severely piled-up if there is a very bright optical source with V magnitude less than about 4 magnitude (see AstroSat Handbook available at ASSC website).

5. Estimate exposure time, count rates and signal-to-noise etc. using the online exposure time calculators: UVIT (https://uvit.iiap.res.in/Software/etc), X-ray instruments (http://astrosat-ssc.iucaa.in:8080/WebPIMMS_ASTRO/index.jsp) or Spectral simulation tools such as XSPEC, Sherpa, ISIS. Perform scientific feasibility study with simulations as needed.

6. Prepare scientific and technical justification pdf files using Latex templates available at the ASSC website and following the instructions given in the latex templates. Proposals are evaluated based on the importance of science, choice of targets, justification of exposure time, technical and scientific feasibility. Hence these sections need to be carefully prepared. The scientific feasibility should be established based on spectral/timing simulations, signal-to-noise calculations, surface brightness above the background for the study of diffuse UV sources, etc. as per the case may be.

7. Login to APPS and create a proposal for A09 cycle. Select one of the proposal types Regular pointing, Monitoring or Anticipated ToO proposals as per the requirement.

8. Fill the mandatory fields such as the title, abstract, investigators, scientific category etc.

9. In the "Target list and Instrument configuration page", add target(s). Use target names recognized by NED/Simbad if available. Enter source size, V magnitude and 2-10 keV flux. In the instrument configuration page, choose a primary instrument which is most critical for your science case. Configure the instruments for each target considering the safety of the instruments.

10. Upload the technical and science justification pdf files. For each target, upload the AstroSat visibility information either from astroviewer or Avis tool as the Astroviewer Output file and merged VIS/UV filter check pdf output as UVIT BSC.

11. Check and verify pdf copy of the proposal cover page and the attachments, edit the proposal if needed, and recheck and submit.

3.2 APPS Instructions

Instructions to fill various entries within APPS to prepare proposals are available online. APPS proposer's guide can also be referred for this purpose. Queries on APPS can be mailed to astrosathelp@iucaa.in for proposal preparation and submission. Queries will be answered on best effort basis.

3.3 Proposal Preparation Tools

Proposers can use the following tools in order to prepare an AstroSat proposal.

- Astroviewer (http://issdc.gov.in/astroviewer/index.html) to determine Astrosat visibility period for a target of interest.
  Proposers can also use the simpler visibility tool "Avis" available online at the AstroSat Science Support Cell (ASSC) website http://astrosat-ssc.iucaa.in:8080/AstroVisCal/.

- PIMMS(http://astrosat-ssc.iucaa.in:8080/WebPIMMS_ASTRO/index.jsp) to estimate source count rates.

- UVIT Exposure Time Calculator (http://uvit.iiap.res.in/Software/etc) to estimate required exposure time for an astronomical source.

- UVIT Bright Source Warning Tool (http://uvit.iiap.res.in/Software/bswt to set filters of the VIS channel for ensuring:

  1. safety of the detector against overexposure,
  2. adequacy of signal from stars in the field for tracking drift of the S/C.

- AstroSat Schedule viewer (https://astro.issdc.gov.in:9321/MCAP/) to check Tentative/Confirmed Target Schedule of Astrosat.

3.3.1 ASTROVIEWER - Tool to aid Celestial Source Viewing

The tool gives view periods of a selected celestial source for a prolonged period of one year maximum. Also, the view periods that satisfy all the constraints are provided orbit-wise so that the PIs of proposals can plan their observations more accurately and also season-wise. For UVIT payload users, view duration timings during eclipse that satisfies all

envisaged constraints are available in a separate file as UVIT is expected to observe only in eclipse. The Tool has been designed to use the latest orbit information available on a daily basis and provides the various constraint angle characteristics in graphical plots so that GO can visualize the situation while planning for observations. The view period of the selected source is stored orbit wise and is made available in tabular form for the GO to use. Since the ram angle constraint for certain sources are on and off due to the closeness to the orbit inclination, this output contains flags '0' for satisfying the constraint and '1' for violating the constraint in the table. A Graphical User Interface program allows the user to interact remotely and obtain the required details. Additional information like Eclipse and occult Entry/Exit is also made available.

Geometrical Constraints

- RAM angle (+ROLL and velocity vector) > 12°
- Terminator (+ROLL and Bright Earth Limb) > 12°
- Sun Angle (+ROLL and SUN) > 65°
- Angle b/w +YAW and SUN > 90°, Angle b/w Star Sensor and SUN > 50°
- Angle b/w +ROLL and Albedo > 12°

3.3.2 Portable Interactive Multi-Mission Simulator (PIMMS)

The AstroSat PIMMS package (downloadable from http://astrosat-ssc.iucaa.in/ or accessed online at http://astrosat-ssc.iucaa.in:8080/WebPIMMS_ASTRO/index.jsp) is an implementation of the Portable Interactive Multi-Mission Simulator package, originally distributed from NASA/GSFC High Energy Astrophysics Science Archive Research Centre (HEASARC). This implementation includes the effective area of AstroSat X-ray instruments and can be used to estimate source count rates in LAXPC, SXT, CZTI and SSM for a variety of input spectral models. A user manual is distributed in the downloadable version, and online help is available for the WebPIMMS version.

Response files: Response Matrix files and estimated background spectra are provided for LAXPC, SXT and CZTI payloads at the website http://astrosat-ssc.iucaa.in. These may be used to carry out spectral simulations for X-ray sources, for example with the fakeit command in HEASOFT XSPEC.

3.3.3 UVIT Exposure Time Calculator (ETC)

Help Page: http://uvit.iiap.res.in/Software/etc/Help Present Version: 2.0.0 (03 May, 2016). The UVIT Exposure Time Calculator (ETC) will help assess the feasibility of an observation. It calculates the expected count rate from a source in various UVIT filters, followed by either i) The Signal-to-Noise Ratio (SNR) achieved for a given observation

time, or ii) The time required to reach a given SNR. Users may choose from a range of astronomical sources/spectra such as a star, black-body, galaxy, power law, etc. or choose to upload their own source spectrum.

3.3.4 Bright Source Warning Tool (BSWT)

Help Page:http://uvit.iiap.res.in/Software/bswt/Help Present Version 2.0.0 (26 April 2017). Aim of the tool is to inform the proposer whether the region of the sky around a science target is safe / un-safe for UVIT to take observations. The program scans for stars brighter than the safety threshold and lists out the count rates of these bright stars in all the 10 filters in the FUV and NUV telescopes. This program identifies all the bright stars within 20 arcmin radius of the target object. See also guidelines document at the same website. Please note that as per the latest process used by UVIT this output is only used to check for filters of VIS (320-550 nm) channel; the checks for NUV/FUV filters are not made with this list. Hence the following mandatory checks are necessary.

Mandatory checks to be done for UVIT observations

The UVIT is not designed to observe very bright sources and the presence of a bright source in the UVIT field of observation can cause "Bright Object Trigger" in the hardware that would switch OFF all three detectors. In addition, the presence of an ultra-bright source near the UVIT field of view will scatter excessive radiation beyond the allowed limit. One of the UVITs, the VIS channel is primarily used for the spacecraft tracking. It is the proposers' responsibility to ensure smooth tracking during their proposed observations. Hence the proposers need to exercise extra caution in preparing a proposal for UVIT observations. It is strongly recommended that the proposers follow the guideline described in detail in the document (please refer:
http://astrosat-ssc.iucaa.in/uploads/APPS/AstroSat_proposers_guide_6March2018.pdf,
v1.3, 03 March 2018) for mandatory checks to be done for UVIT observations.

3.4 Preparing an ASTROSAT proposal

First time proposers will need to register into the APPS before they can prepare proposals. Proposers may go through the APPS help document regarding submission of proposals.

3.5 Proposal handling in APPS

The receipt of each incoming proposal will be automatically acknowledged. At the end of submission date, the APPS will forward them to the ATAC for scientific review, while

performing some assessments and preparing overall statistics on the response. All the committees are constituted by Chairman, ISRO.

The ATAC will assign priorities to each proposal as A, B and C (and, as needed, grade individual observations within a proposal). The ATAC may ask some proposers to reduce the observing time or the number of targets in a proposal. Such proposals will be made available for revision to the PIs. The proposers will be able to submit a revised proposal before the set deadline only for changes recommended by the ATAC. Such proposals, if not revised before the deadline, will be excluded from the list of successful proposal.

The technical feasibility of making the observations will be conducted by AstroSat Technical Committee (ATC) with support from Mission operations team.

One of the parameters used to plan which observations will be carried out during a particular orbit, is the priority of the observations as allocated by the ATAC and ATC. However, for operational reasons, no guarantee can be given that a particular observation will in fact be executed, regardless of its grade.

4. Aspects of duplication

The general policy of the AstroSat is to avoid repeating the same observation, i.e. to avoid duplication.

In general, a duplication is determined by consideration of the target coordinates and of the main observing parameters (especially the instrument(s) and the observing modes). A proposed observation duplicates another one, if the expected science data are essentially the same or of lower requirement (e.g. lower exposure time) and is therefore discouraged. It is, however allowed, to observe the same target with the same instrument configuration several times for variability studies. In addition, in large extended objects several pointings in the vicinity of a source may become necessary e.g., to image Coma Cluster of galaxies out to 2 deg. diameter so as to cover its virial extent, and these may have co-ordinates that are not too different from that of the previous observation of a source.

The responsibility for defining and resolving cases of duplication rests with the ATAC. The ATAC can allow observations of same targets in a proposed observation and an observation of a previous cycle. These should be restricted to proposals which provide convincing evidence that additional data are of scientific relevance.

5. Data processing, data rights and publication

After the completion of observation, the raw data received will be converted to Level-1 data at Indian Space Science Data Center (ISSDC). ISSDC is responsible for governing the in-

gest, Quick look Display (QLD), processing (for level-0/1), archival (all levels, along with the auxiliary data) and dissemination of payload data. The data will be in standard FITS format.

Level-1 data can be downloaded from the ISSDC website by the payload teams or Principal Investigators (PIs) of the proposals for science analysis as well as to produce higher level data products. Sample data, software and utilities are provided in the ASC website.

The PI will be informed, after the completion of successful observation for downloading of processed Level-1 data. The standard pipeline software from Level-1 to Level-2 and any other higher level standard products will be made available to the PIs of proposals through ISSDC website.

5.1 Proprietary period

There shall be a Proprietary period associated with observational data from all AstroSat in-struments and in all phases and years after launch. This "proprietary period" would begin from the date the Level-1 data is made available to the payload teams and/or PIs of AO proposal.

During this proprietary period, the data will NOT BE USED by any persons or teams other than those who submitted the proposal(s) for the observations, except in cases where the PIs of proposals themselves involve such other persons.

The proprietary period for AO cycle data is 12 months. After the proprietary period, all data will be kept in ISSDC public archive which is accessible both nationally and internationally. It is the responsibility of the Payload Operation Centres (POCs) to provide Level-2 products with a quality report to ISSDC. Target of Opportunity (ToO) observations which are taken from ToO observation time will be processed immediately to Level 1 data and will be placed in ISSDC archive. These data are non-proprietary and are open to public immediately after observation.

5.2   Data rights & obligations

The Principal Investigators (PIs) of all the proposals will have exclusive rights to all the data from the instruments he/ she has configured in the proposal amongst the co-aligned instru-ments (namely LAXPC, CZTI, SXT and twin telescope UVIT) for those fields that are ob-served with AstroSat against their proposals,

Data rights for other objects detected within the observed field of observation also belong to the PI of the proposal, unless they communicate not to have it. At present there is no way to separate target data and field data. The proposal PI may collaborate with payload teams (and vice versa) for analysis of data on field objects other than primary target.

The data rights of the instruments not configured by the PI will be made open for piggy back setting by payload teams. Such data will be provided to the payload teams and pro-prietary period remains the same as AO proposal.

Any instrument team or PI has the right to reduce the proprietary period by sending an email to astrosathelp@iucaa.in with copy to ISSDC team (issdc_team@istrac.gov.in) recommending for placing the data in ISSDC data archive before the end of the proprietary period.

5.3 Publication

The proposers shall make available the salient results of the data analysis to the scientific community through publication in appropriate journals. All the publications shall acknowledge the AstroSat data, by including a phrase "AstroSat -along with the name of the payload(s)" whose data is used for analysis/ interpretation in the abstract.

When publishing a paper using AstroSat data, please include the following acknowledgment.

"This publication uses the data from the AstroSat mission of the Indian Space Research Organisation (ISRO), archived at the Indian Space Science Data Centre (ISSDC)".

If a user has used already published AstroSat results and carried out further interpretation or modeling, the following statement may be included in the acknowledgment.

"The research is based (partially or to a significant extent) on the results obtained from the AstroSat mission of the Indian Space Research Organisation (ISRO), archived at the Indian Space Science Data Centre (ISSDC)".

ISRO may use any/all results that are derived from AstroSat data and published through academic papers in journals or any other publications by the user, for its own use, in its reports and publications with due reference/ acknowledgments to such journals and publications.