Overview of the ART-XC/SRG Mission

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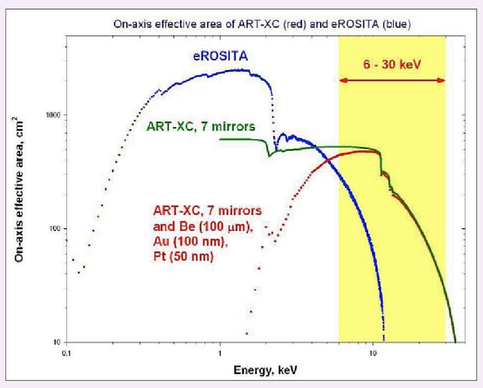
The Astronomical Roentgen Telescope – X-ray Concentrator (ART-XC) instrument on board the Spectrum-Roentgen-Gamma (SRG) mission is currently scheduled for launch in 2019. ART-XC is an X-ray grazing incidence mirror telescope array developed by the Russian Space Research Institute (IKI) and the All-Russian Scientific Research Institute for Experimental Physics (VNIIEF). NASA's Marshall Space Flight Center (MSFC) developed and fabricated the X-ray mirrors. ART-XC is composed of seven mirror modules co-aligned with seven CdTe double-sided strip focal plane detectors. ART-XC will operate over the energy range of 4–30 keV, with an angular resolution of <1′ on-axis, a field of view of ~0.3 square degree and an energy resolution of about 9% at 14 keV. The ART-XC primary mission will be to perform a four-year all-sky survey simultaneously with the other SRG instrument, eROSITA, followed by three years of pointed observations[1].

The Spectrum- Roentgen-Gamma Mission

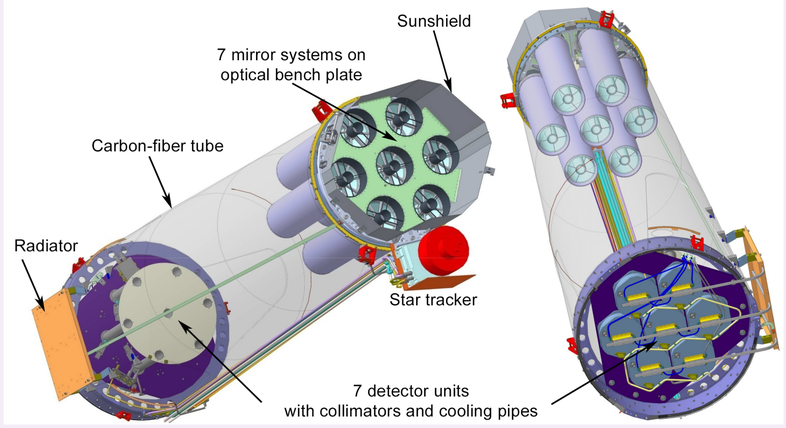
The SRG is shown (***right***) on its side in preparation for shipment to the launch facility. The Russian-built ART-XC hard X-ray telescope (black) is co-aligned with the German-built eROSITA soft X-ray telescope (silver) and both are mounted on a Russian-supplied spacecraft bus (gold). ART-XC adds hard X-ray capabilities to SRG with over 400 cm^2 effective area at 8 keV (***below***).



SRG will launch from Baikonur, Kazakhstan, and be delivered into a halo orbit at Sun-Earth L2. SRG will then execute a 4-year all-sky survey by orbiting approximately about the Sun-Earth axis with a 4-hr period. After this survey, SRG will spend 3 years on pointed observations of selected celestial objects including galaxy clusters, active galactic nuclei, and Galactic sources.

The Astronomical Roentgen Telescope – X-ray Concentrator(ART-XC) Payload

The 2.7 m focal length ART-XC telescope (***right***) consists of 7 mirror modules co-aligned to 7 CdTe double-sided strip detectors. Not shown is the spacecraft bus that attaches at the detector end of the telescope assembly.



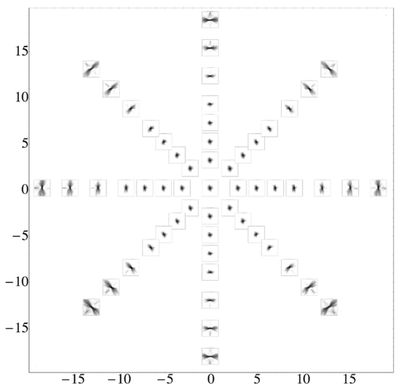
Energy Range	4-30 keV	Effective Area	>400 cm^2 @ Fe K
Field of View	0.3 deg^2	Grasp	43 deg^2 cm^2 @ 7.6 keV
Angular Resolution	< 1’ on axis	Energy Resolution	9% @ 14 keV

Simulated Performance & Data Analysis

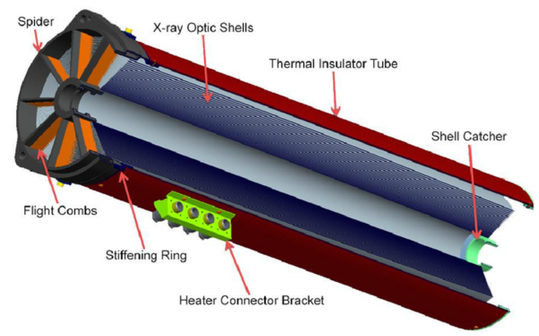
The team at Marshall Space Flight Center is developing various tools to aid ART-XC enthusiasts in estimating ART-XC scientific performance. These include modules for, e.g., the sixte[4] simulator and the PIMMS[5] portable interactive multi-mission simulator tool and various CalDB files and documentation. These will be made available from the website https://wwwastro.msfc.nasa.gov/art in the near future.

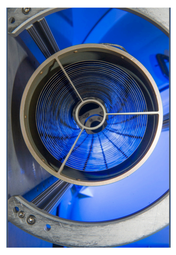
X-Ray Optics

Each ART mirror module has 28 nested Ni/Co mirror shells of length 580 mm and ranging in diameter from 49 mm to 145 mm. Each shell is coated with 10 nm Ir to improve high energy reflectivity[2].



Left is shown images of a point-like source of X-rays captured at MSFC’s 104 m Stray Light Facility at a range of off-axis angles and azimuths showing the 0.5’ performance on-axis and roughly 1.7’ at 15 arcminutes off axis[2,3].

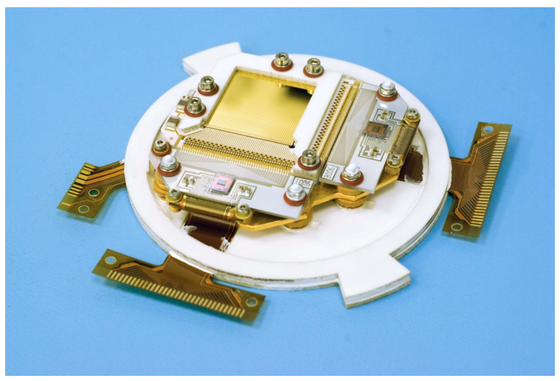


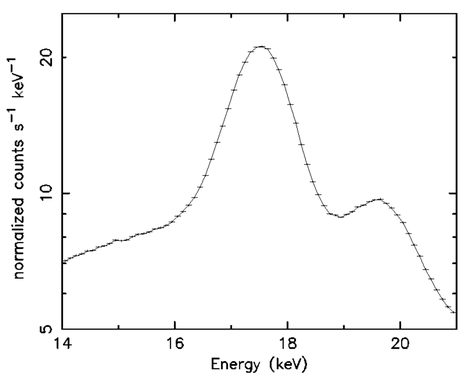


Above is a cut-away schematic of one of 7 identical mirror modules. **Left** is a photo of a module viewed along the optical axis

X-Ray Detectors

Each ART focal plane detector[6] is built around a high quality ~30x30x1 mm CdTe crystal manufactured by Acrorad of Japan. The IKI-built electrode configuration is double-sided strips forming a Schottky barrier diode with anode (top) and cathode strip layers oriented perpendicular to each other providing 48x48 ‘pixels’ of 595 micron pitch (~45”). Two VA64TA1 ASICs, designed by Gamma Medica-Ideas of Norway, are used to read out the two sets of 48 channels. A 100 micron thick Be window protects each detector.





Each ART focal plane detector (***above***) is held within a ceramic housing along with front-end electronics (ASICs) located on two edges that are coupled to flexible circuit boards. Spectral resolution (***left***) is about 7% at Mo-Ka, scales as sqrt(E) at higher energies but degrades somewhat at energies below ~10 keV.

References:

[1] Pavlinsky, M., et al. 2018, SPIE 10699, 106991Y, “ART-XC/SRG Overview”

[2] Gubarev, M., et al. 2014, SPIE 9144, 9144U, “The calibration of flight mirror modules for the ART-XC instrument”

[3] Krivonos, R. et al. 2018, Exp. Astron. 44, 147, “Calibration of the ART-XC mirror modules at MSFC”

[4] Mukai, K. 1993, Legacy 3, 21, “PIMMS and Viewing: proposal preparation tools”

[5] https://www.sternwarte.uni-erlangen.de/research/sixte/

[6] Levin, V., et al. 2014 SPIE 9144, 914413-1, “ART-XC/SRG status of the x-ray focal plane detector development”