

# ART-XC Instrument on board of the SRG Mission

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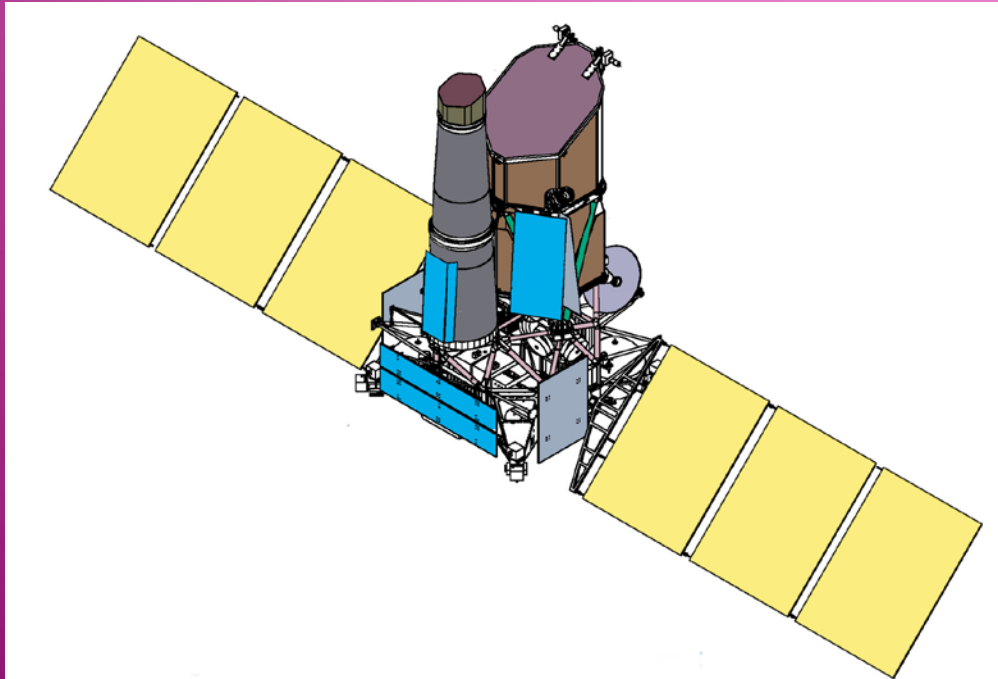
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# Spectrum-R-Gamma Scientific Payload



eROSITA – **e**xtended **R**Oentgen **S**urvey with an **I**maging **T**elescope **A**rray (MPE, Germany), 7 mirror systems

Energy range 0.2 – 12.0 keV,

FOV  $\sim 1^\circ$ , PSF  $\sim 20''$  (FOV averaged) and  $\sim 15''$  on axis,

Energy resolution 130 eV at 6 keV, effective area 2500 cm<sup>2</sup>,

Grasp of  $\sim 700$  cm<sup>2</sup> deg<sup>2</sup> at 1 keV;

– ART-XC – **A**stronomical **R**oentgen **T**elescope – **X**-ray **C**oncentrator (IKI, Russia), 7 mirror systems.

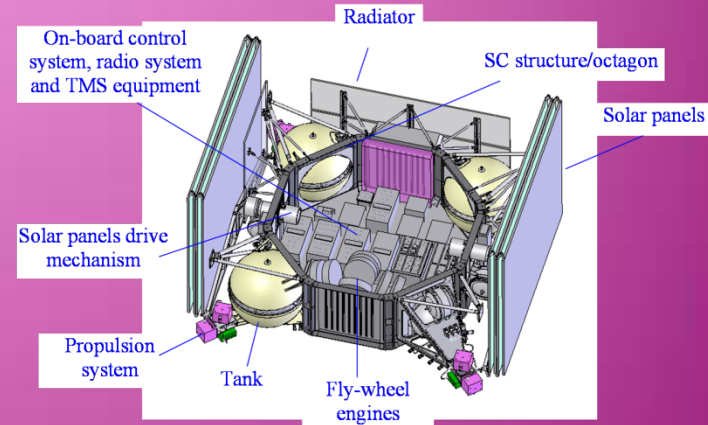
Energy range 6 – 30 keV,

FOV  $\sim 32'$ , energy resolution  $\sim 10\%$  keV at 14 keV,

Effective area  $\sim 510$  cm<sup>2</sup> at 7 keV, a Grasp of  $\sim 45$  cm<sup>2</sup> deg<sup>2</sup> at 7 keV.

# Launcher, buster, platform, orbit and observation strategy of the SRG Mission

- The Spectrum-Roentgen-Gamma mission will be launched with the Zenit launcher and the Fregat buster from Baikonur in September 2013
- SRG utilizes the newly-developed Navigator platform
- The SRG observatory will be launched to L2 point.
- The SRG observing program is divided into three stages over the 7-year mission lifetime.
- The first 3-month during the transit to the L2 point, will be devoted to initial check-up and in-flight calibration.
- The next 4 years will be devoted to the all-sky survey. During this time the SRG observatory will rotate around the axis pointed to Sun, with a period of several hours. SRG will observe the whole sky every half year due to Earth's rotation around the Sun.
- Next 3 year, will be spent on pointed observations of selected objects from the most interesting galaxy clusters, AGNs and galaxy sources.



The Navigator platform

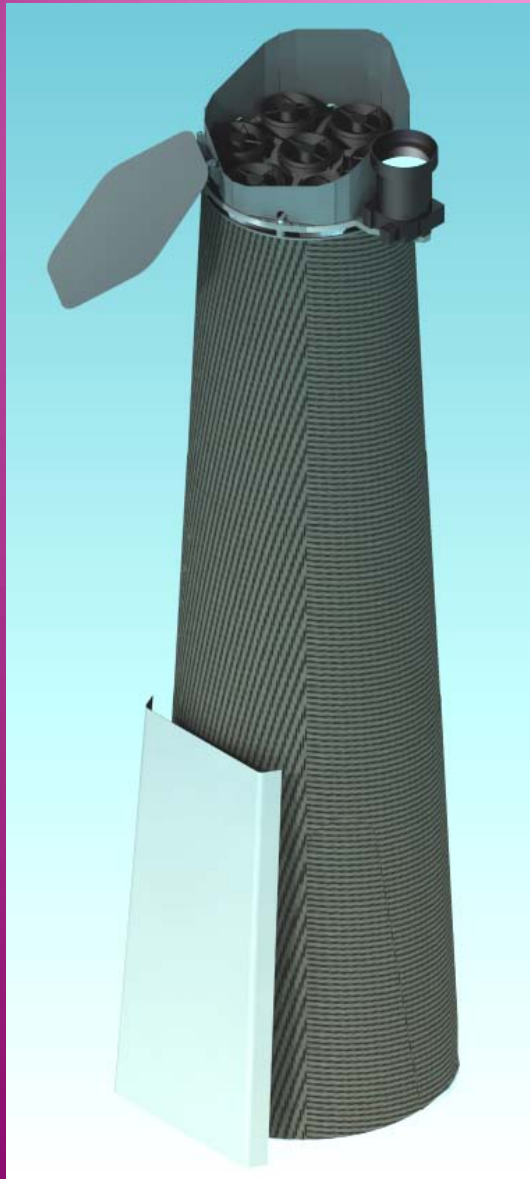


The Fregat booster

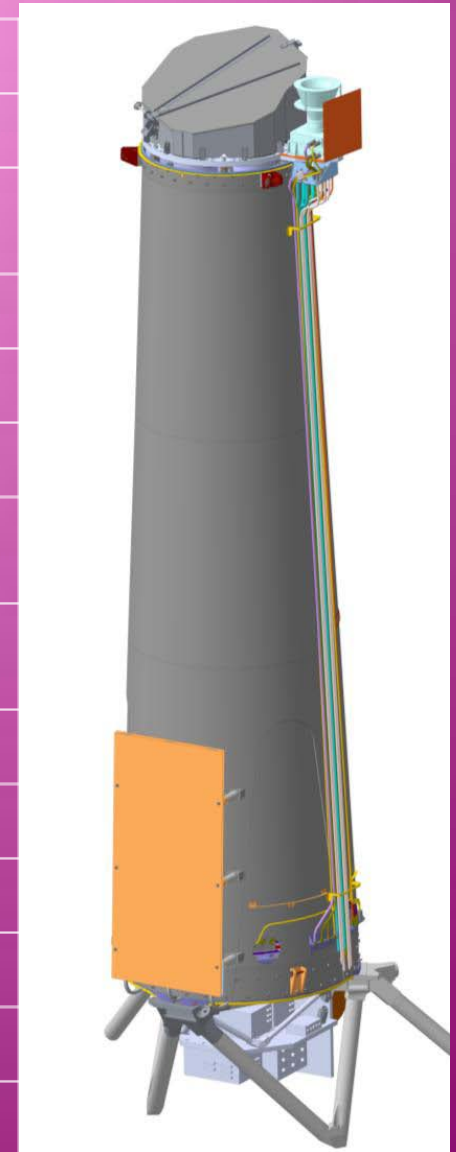
# ART-XC Scientific goals

- All-sky X-ray survey at 6 – 11 keV energy region with sensitivity  $\leq 3 \times 10^{-13}$  erg s<sup>-1</sup> cm<sup>-2</sup> keV<sup>-1</sup>, discovery in course of survey at local Universe several thousands new active galaxies nucleus (AGNs);
- Study of intrinsically heavily absorbed/Compton thick AGNs ( $N_{\text{H}} \geq 3 \times 10^{23}$  cm<sup>-2</sup>);
- Study of massive nearby galaxies clusters with  $T \geq 4$  keV in pointing observation mode;
- Study heavily obscured galactic X-ray binary systems;
- Study broad band spectra of Galactic objects (including binary systems, anomalous pulsars, supernova remnants) up to 30 keV, spectroscopy and timing of point sources;
- Study non-thermal component in the Galaxy diffuse emission.
- Search for cyclotron lines features X-ray pulsars spectra

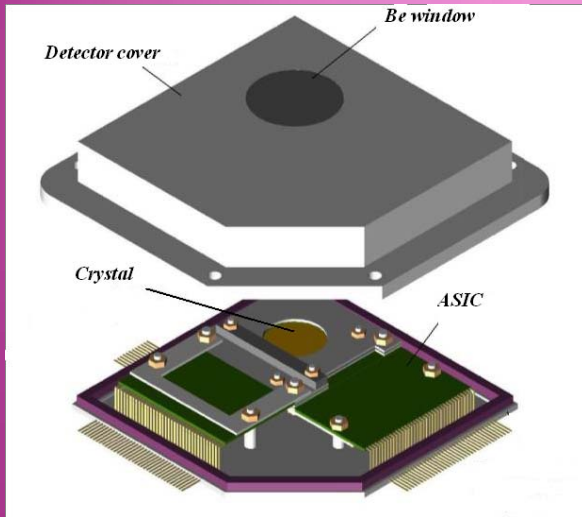
## ART-XC general design



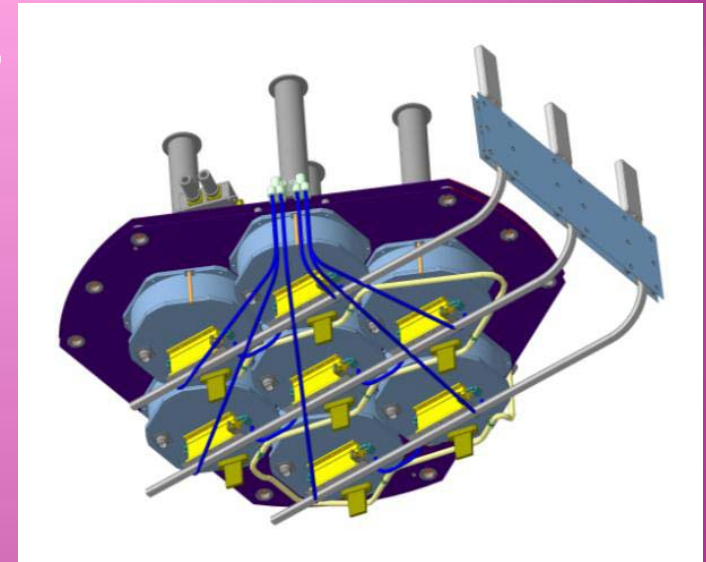
Number of mirror systems	7
Number of nested mirror shells	28
Mirror shells and coating materials	Nickel and Iridium
Focal length	2700 mm
FOV	$\text{Ø}32'$
Angular resolution	$<1'$
Effective Area for Pointed Observations	$510 \text{ cm}^2 @ 7 \text{ keV}$
Grasp for Survey	$45 \text{ deg}^2 \text{ cm}^2 @ 7 \text{ keV}$
Detector type	DSSD CdTe
Size	$25.6 \times 25.6 \text{ mm}^2$
Number of strips	$64 \times 64$
Strip pitch	0.4 mm
Energy range	6 – 30 keV
Energy resolution	10% at 14 keV
Time resolution	1 ms



# Detector



Schematic of the CdTe detector in vacuum tight internal box



Seven detectors with pre-collimators and passive cooling system installed at the focal plane of the ART\_XC telescope.

Detector type	CdTe Schottky Diode double sided strip (ACRORAD)
Crystal size	30 x 30 x 1 mm
Strip width	550 micron
Inter-strip distance	75 micron
Number of strips	41 x 41
ASIC	VA64TA
Energy range	6-30 keV
Energy resolution	10% at 14 keV
Operating temperature	-30 to -40 degrees C
Be window thickness	100 micron

# X-ray Optics

- The X-ray modules are fabricated by the VNIIEF (Russia) and MSFC (USA);
- The NASA-IKI Reimbursable Agreement has been signed on February 7 2011 to build 4 flight units;
- NASA is to deliver 4 flight modules for the ART-XC instruments by June 24, 2013;
- The work at the MSFC has been started on March 24 2011.

# Requirements

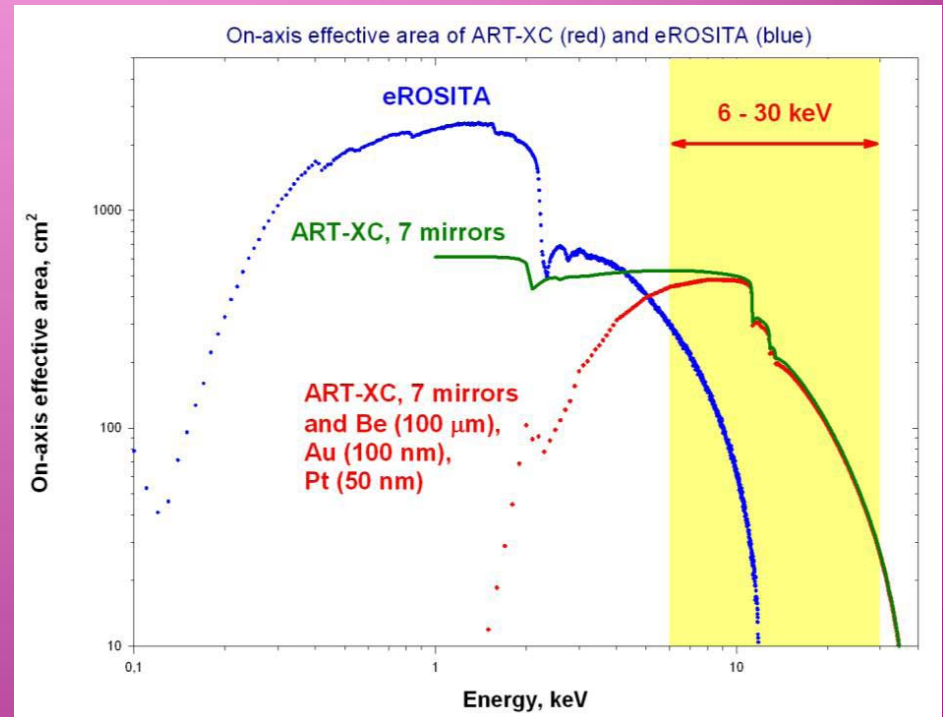
Optical Performance Requirements:

## Encircled Half Energy Width

- On axis Less than 1 mm diameter
- 15'off axis Less than 2.5 mm diameter

**Mirror Module Effective Area  $\geq 65 \text{ cm}^2$**   
at 8 keV (on axis)

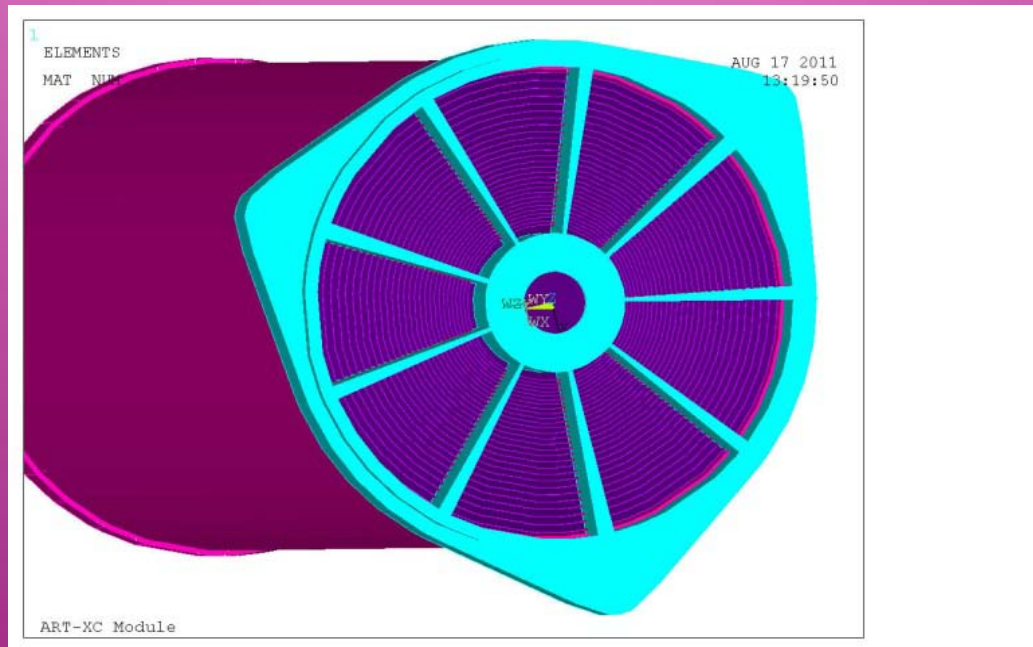
**Weight** Less than 17 kg





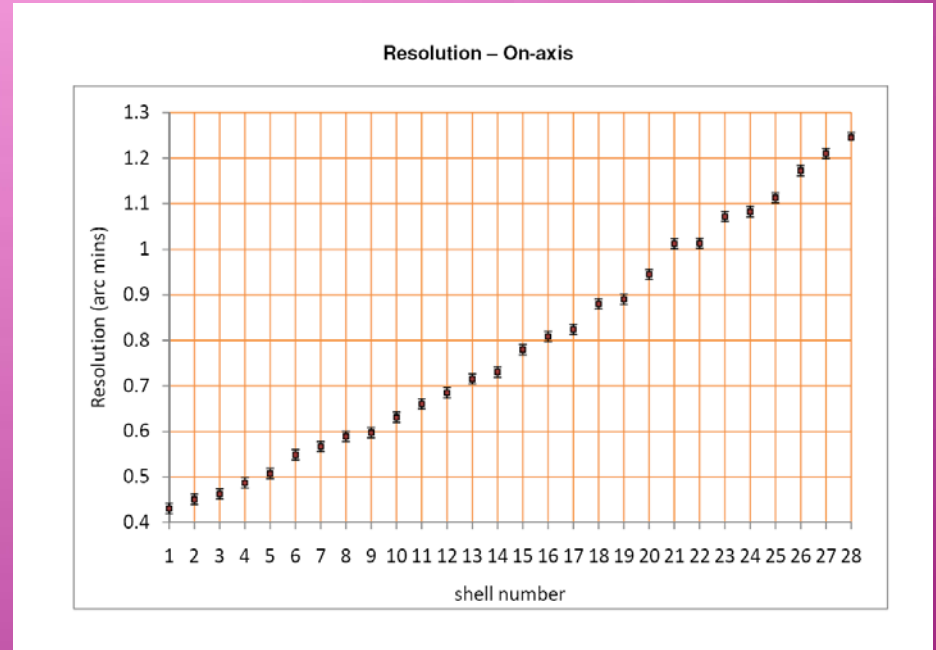
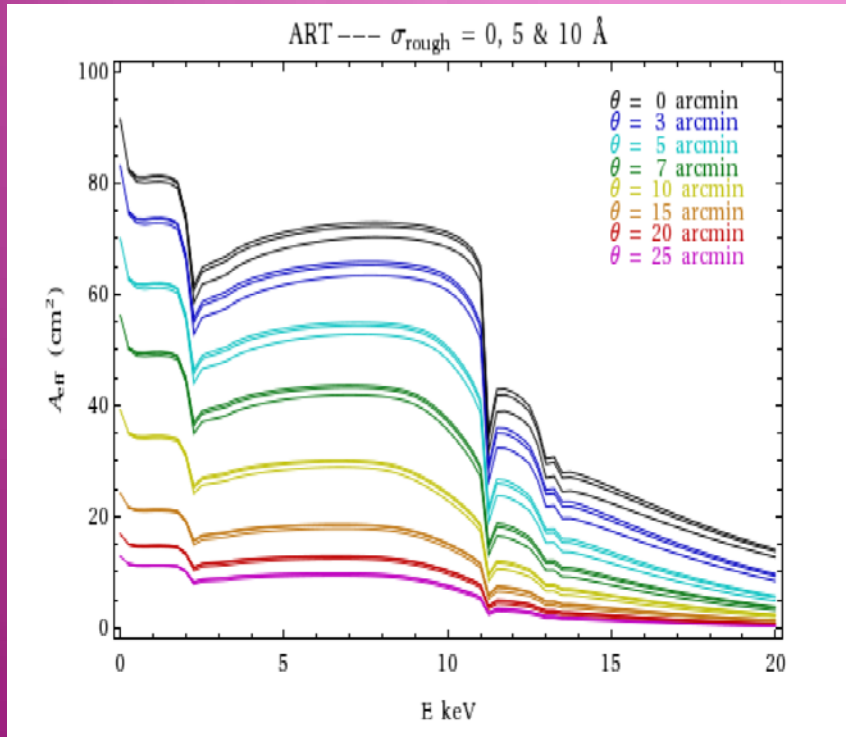
# X-ray optics

- Both the VNIIEF and the MSFC designs are based on the single spider scheme
- The shell diameters vary from 50 to 150 mm
- The VNIIEF x-ray module design calls for the mirror shell thickness of 250 micron. The vibration tests for the qualification unit are in progress;
- The MSFC is exploring the variable thickness option. The design of the ART spider and housing is in progress.



A model view of the current MSFC concept, which will be very close to the final design. The spider is holding 28 mirror shells. The protective cover is also installed on the spider

# Optical performance



To meet the optical angular resolution requirements the shell mirrors need to be fabricated to the Walter prescription.

To meet the effective area requirements the surface roughness of the mirrors has to be below 6 Å.

# Summary of current status

- The SRG Mission is scheduled to be launched in September 2013
- The optics for the ART-XC Instrument to be build by the VNIIEF (Russia) and the MSFC (USA)
- The mandrel fabrication has been started