eROSITA

extended ROentgen Survey with an Imaging Telescope Array

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CCD-Camera: N. Meidinger, R. Hartmann, G. Schächner, J. Elbs, S. Ebermayer
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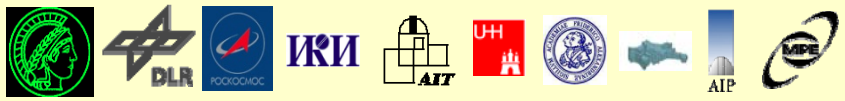
Laboratory, PUMA, Tests: M. Vongehr, R. Gaida, K. Dittrich, F. Schrey
Ground Software, Simulation: H. Brunner, N. Cappelluti, G. Lamer, M. Mühlegger, J. Wilms, I. Kreykenbohm, Chr. Schmid
Mission Planning: J. Schmitt, J. Robrade

Institutes:
Max-Planck-Institut für extraterrestrische Physik, Garching/D
Space Research Institute IKI, Moscow/Ru
Univ. Tübingen/D
Univ. Hamburg/D
Univ. Erlangen-Nürnberg/D
Astrophysikalisches Institut Potsdam/D
Max-Planck-Institut für Astrophysik/D



Industry:

Media Lario/I	Mirrors, Mandrels
Kayser-Threde/D	Mirror Mechanics
Carl Zeiss/D	Mirror Mandrels
Invent/D	Telescope Structure
pnSensor/D	CCDs
EHP/B	Cooling
RUAG/A	Mechanisms, MLI

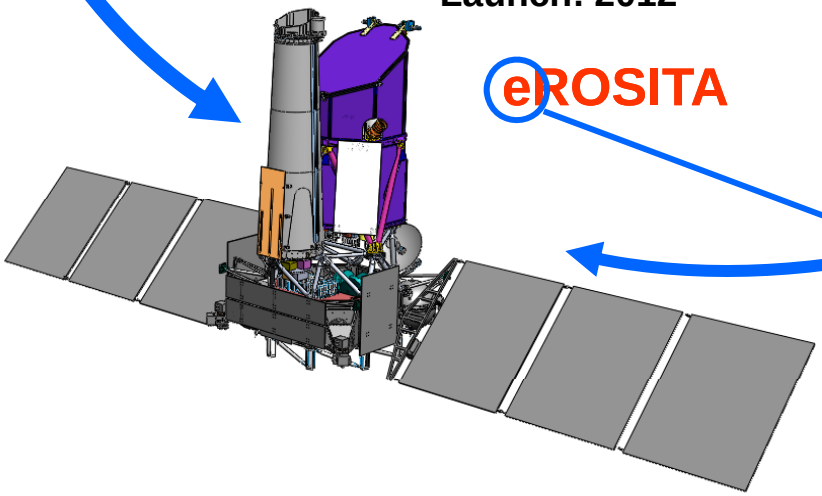
...

Historical Development

Negotiations between Roskosmos and ESA on a "new" Spectrum-XG mission (2005)

MoU between Roskosmos and DLR (2007)

Spektr-RG
Launch: 2012



eROSITA

10^5 Clusters of Galaxies

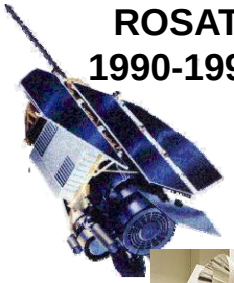
Dark Energy

DUO
2004

ABRIXAS science on the International Space Station

Bundle of 7 small telescopes
To extend the all-sky survey towards higher energies

First X-ray all-sky survey with an imaging telescope



ROSAT
1990-1998

Design Driving Science

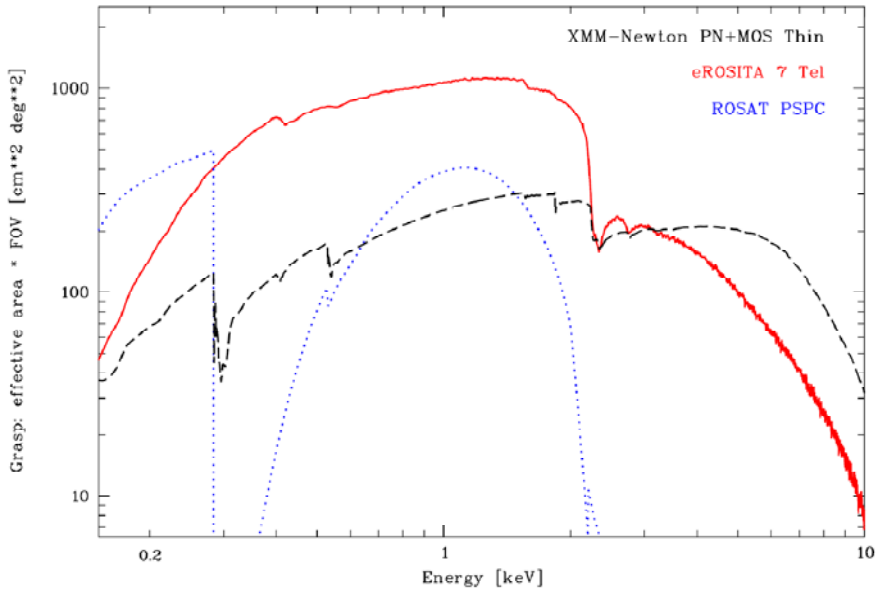
ABRIXAS → **eROSITA**

- **obscured AGN in the local universe**
- **6000 clusters (DUO)**
- **"secondary science"**

- **7 mirror modules, f = 1600mm**
- **Ø = 17cm, 27 shells**
  →eff. area ~ 80cm^2
- **30 arcsec HEW**
- **pnCCD, 2cm × 2cm, 41 arcmin**

eROSITA Sensitivity

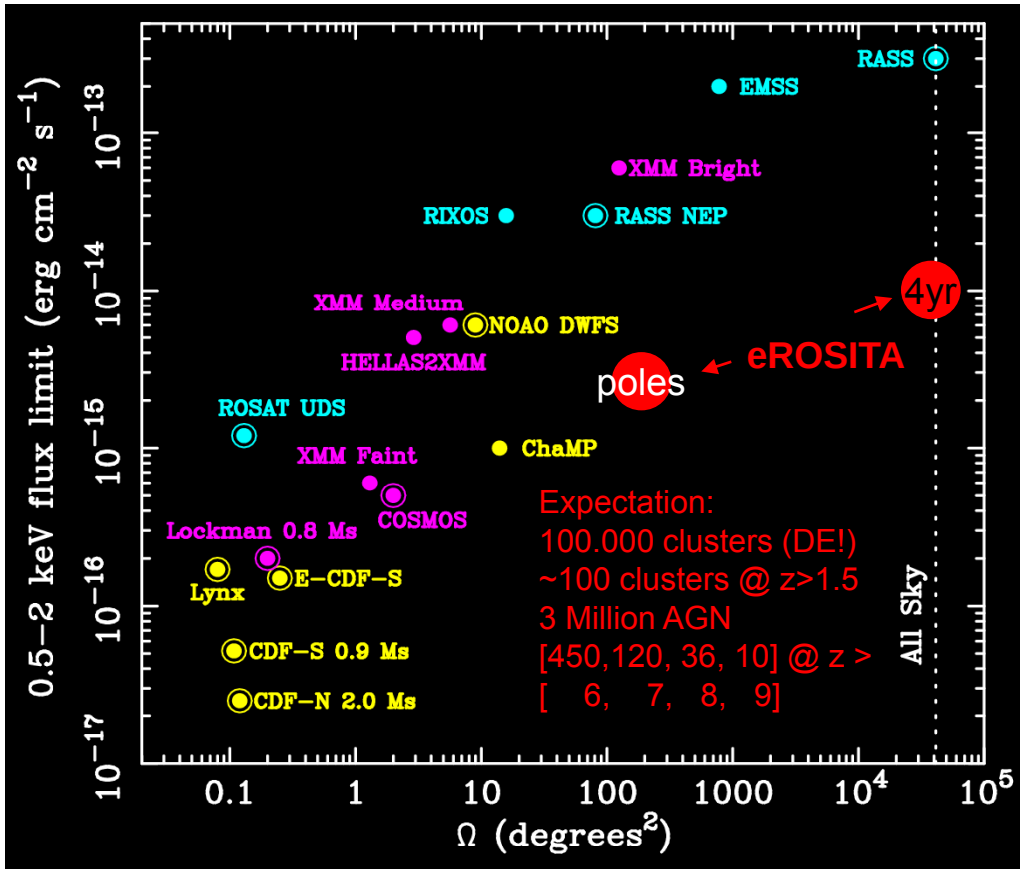
Grasp



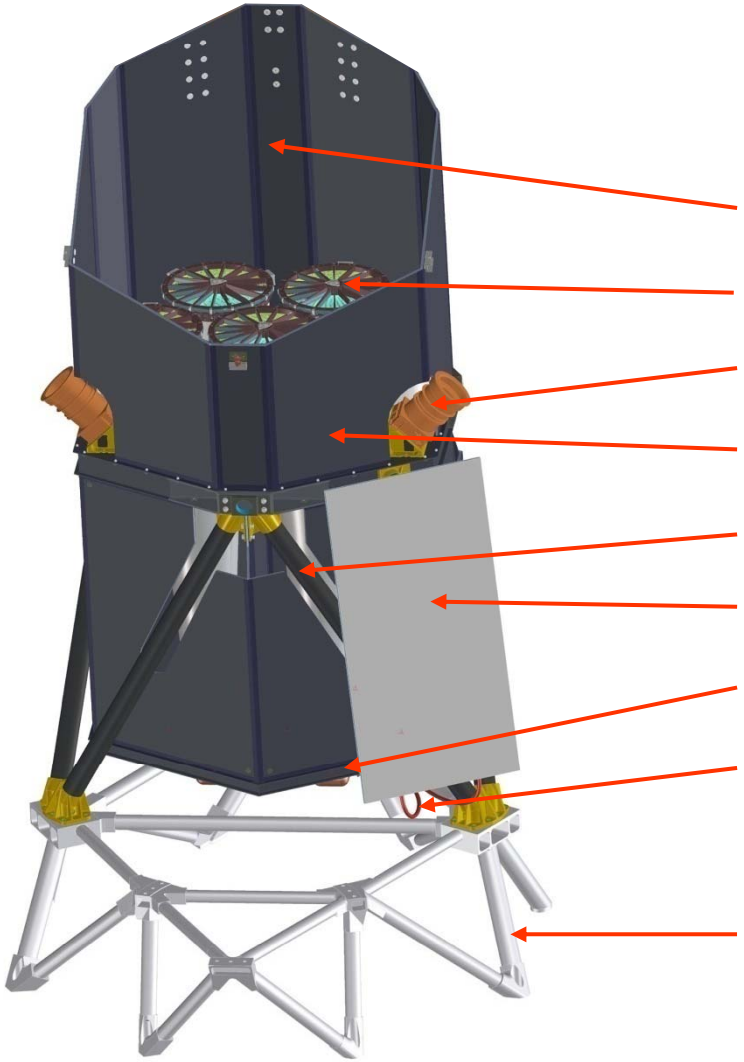
7 telescopes, 350 cm^2 each
large field of view (61 arcmin Ø)

~ 2 × XMM-Newton (MOS+PN)

F/Ω



eROSITA Instrument



- sunshield
- 7 mirror modules + baffles
- 2 (redundant) startrackers
- CFRP-telescope structure
- hexapod mounting for stability
- radiator for cooling cameras
- 7 pn-CCD cameras
- passive cooling system

  compr. loop-heatpipes, latent cold storage
- S/C truss

Programmatic Status

- June 2006 — Proposal to DLR
- Mar. 2007 — MoU between Roskosmos & DLR
- April 2007 — eROSITA approved and funded by DLR

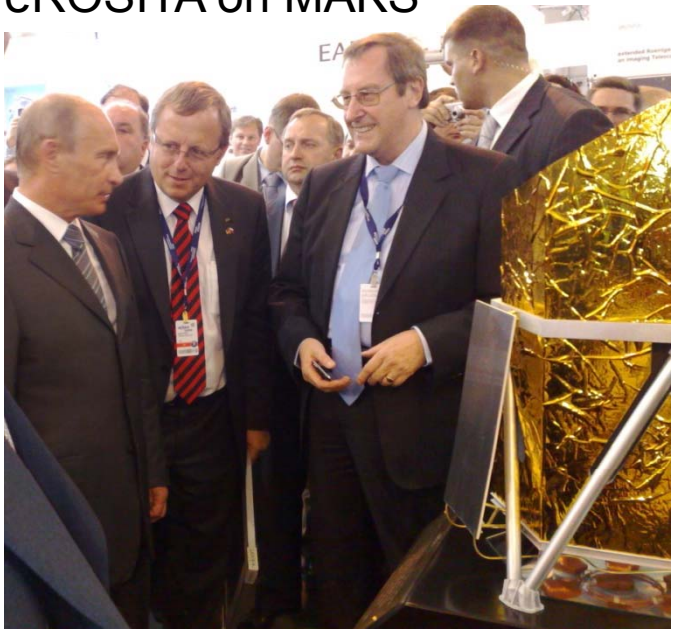
- **Summer 2008: Nothing but problems...**
  Mirrors, Payload, Costs

- September 2008 — Roskosmos decision on payload, orbit & launch
  ART-XC, L2-orbit, 2012 with Soyuz-Fregat from Baikonur
- May 2009 — Mirror-FM contract
  Media Lario Technologies, (Kayser-Threde, Zeiss)
- June 2009 — Additional Funding by MPG
- July 2009 — Additional Funding by DLR
- **August 2009 — Contract between Roskosmos and DLR**
- **Now — Fully in Phase C, D**
  → Flight hardware beeing Manufactured and tested

Detailed Agreement

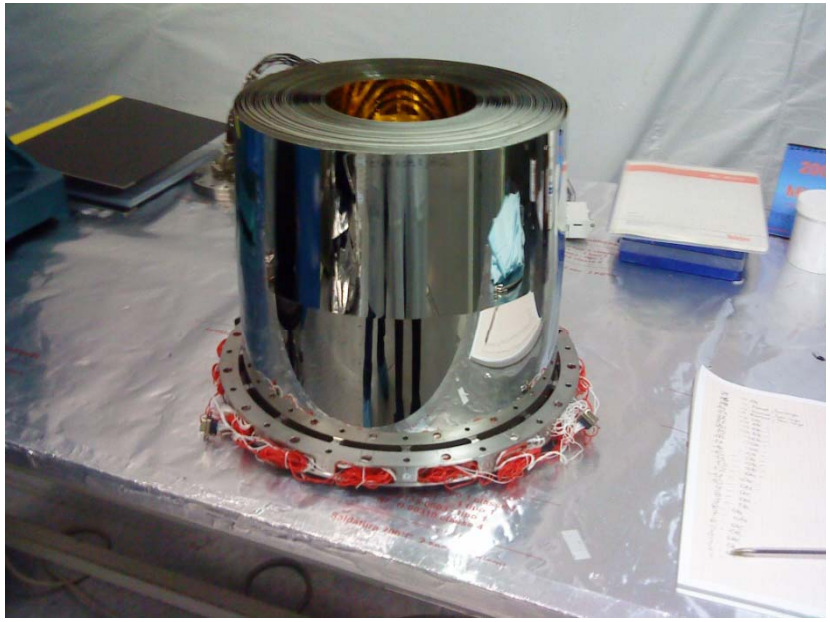
Signature of the "Detailed Agreement"
(Reichle, Wörner, Perminov)

eROSITA on MAKS



Mr. Putin gets informed
about Dark Energy...

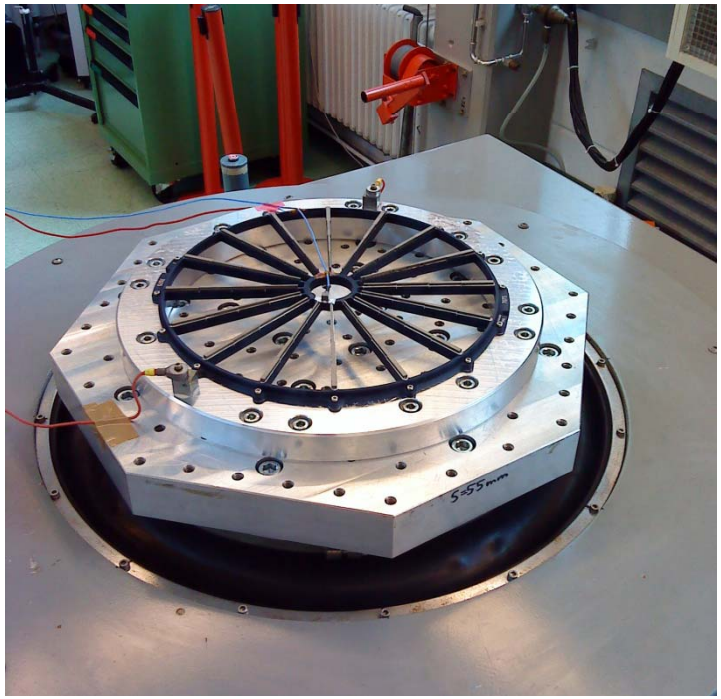
Mirror-Module
Engineering Model



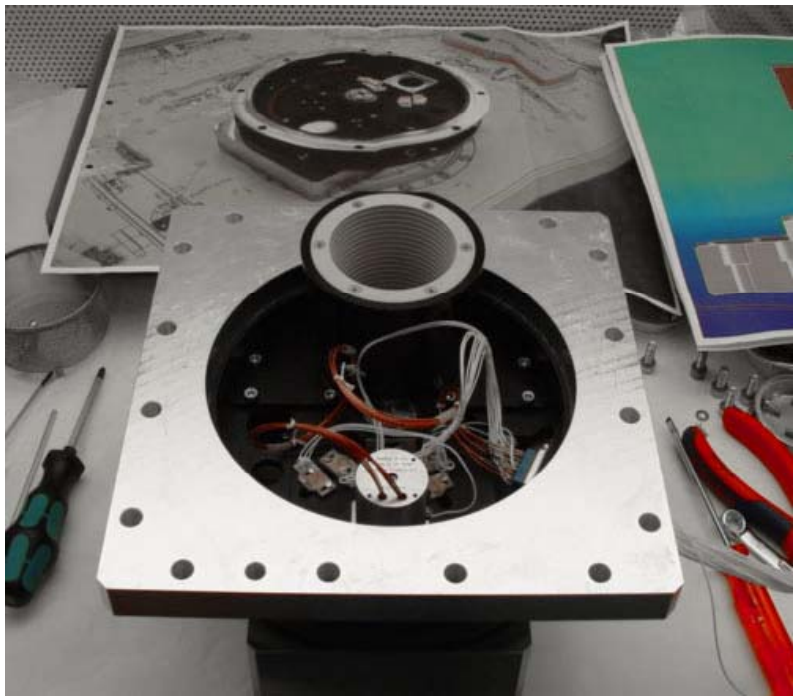
Mirror-EM at MLT

Mirror-EM
on shaker at MPE

Hardware Development

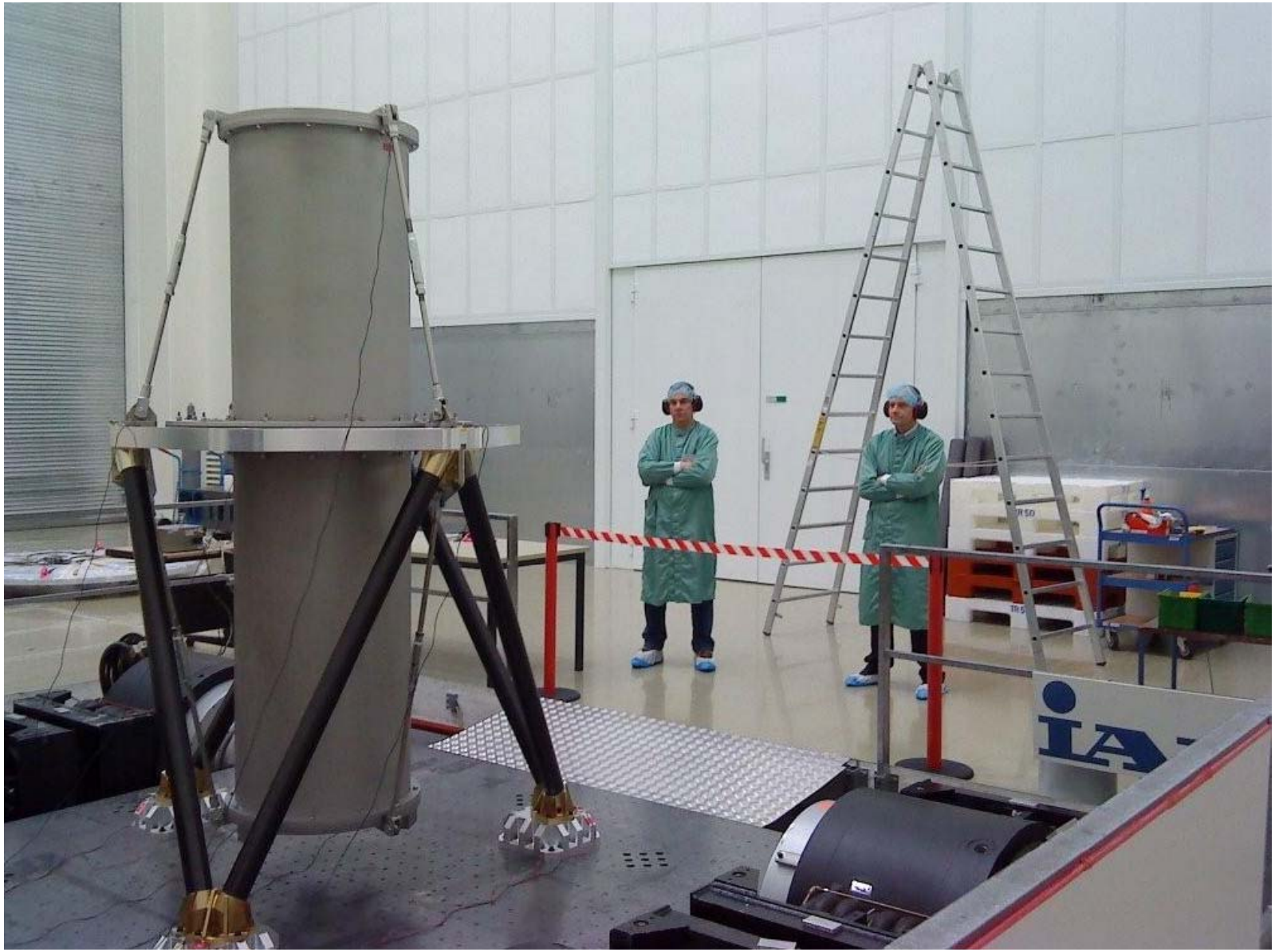


Electron Deflector
on shaker at MPE



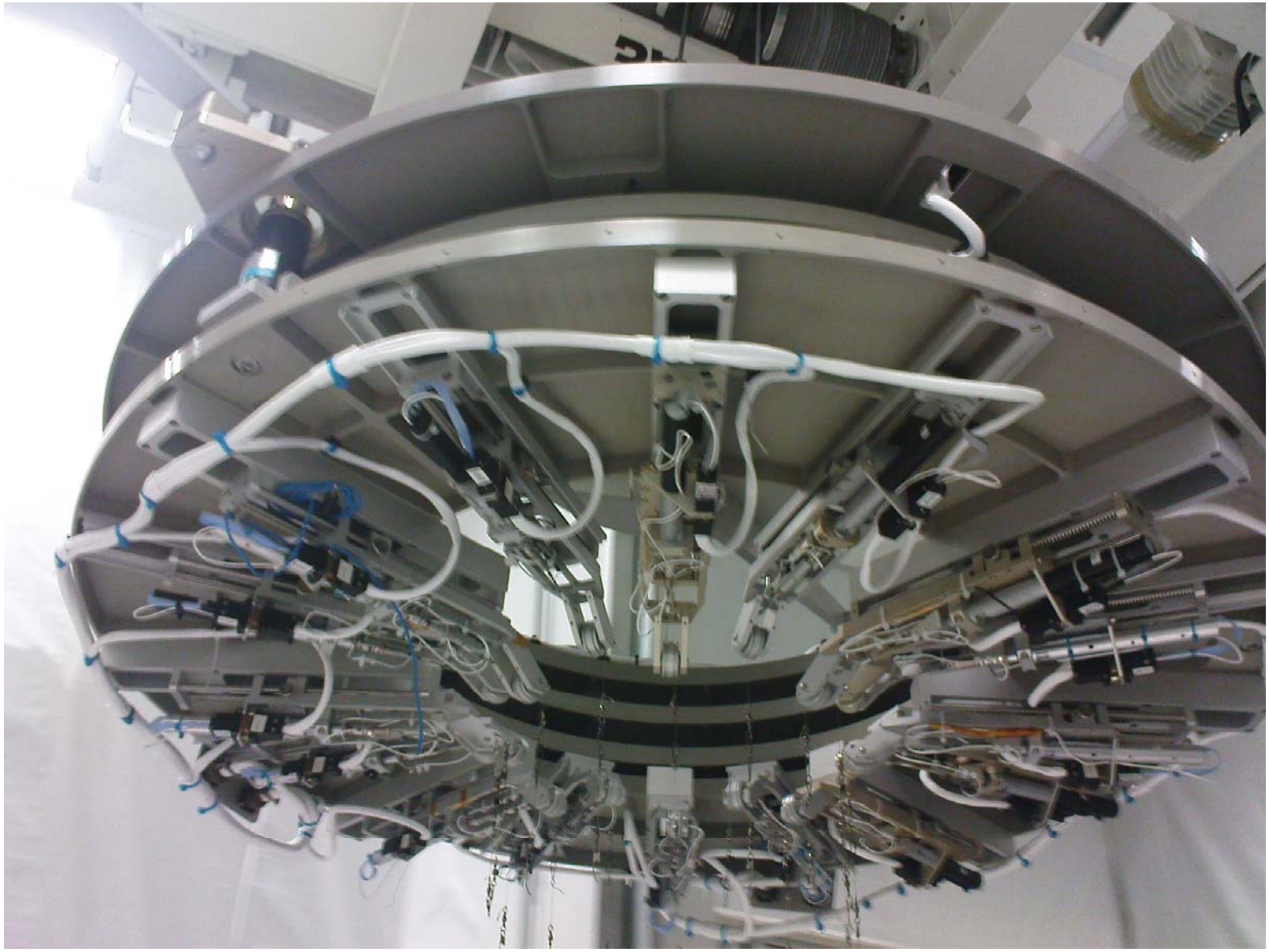
Filter Wheel
in preparation
for qualification tests

Telescope Support Structure Test

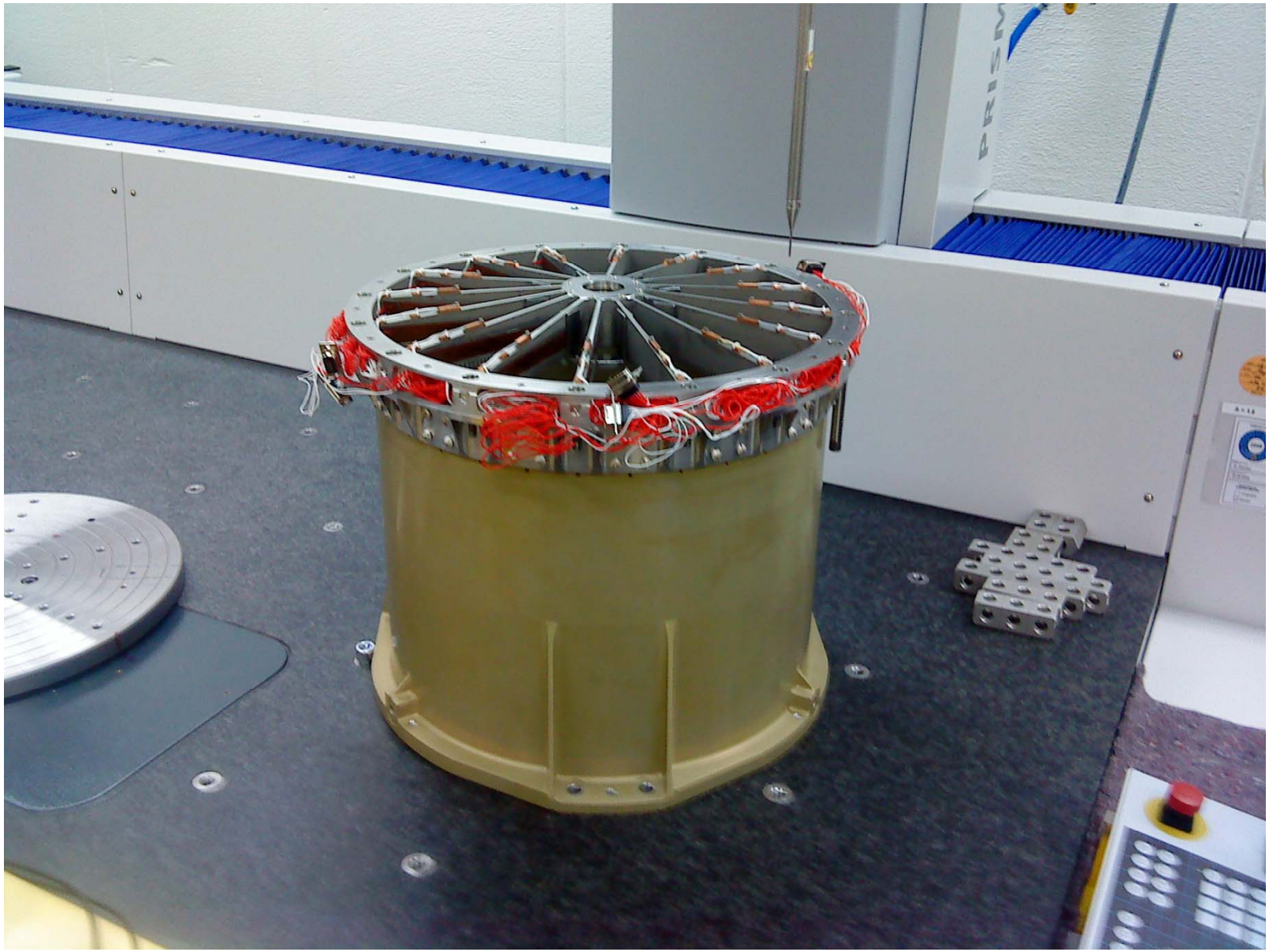


eROSITA wrapped in MLI

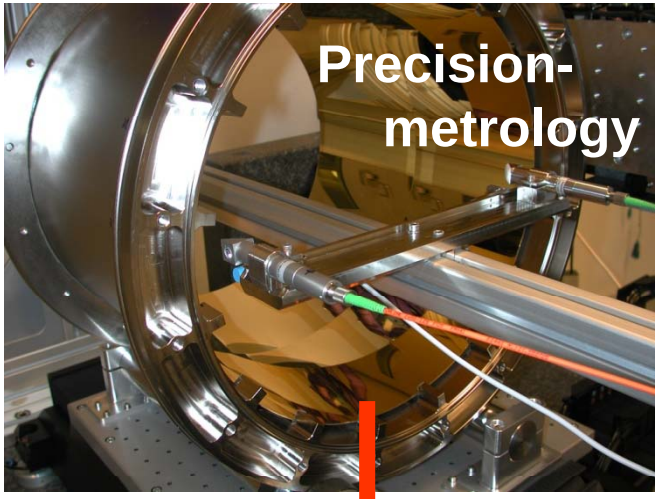
Mirror Manipulator at MLT



Measuring the Mirror Module



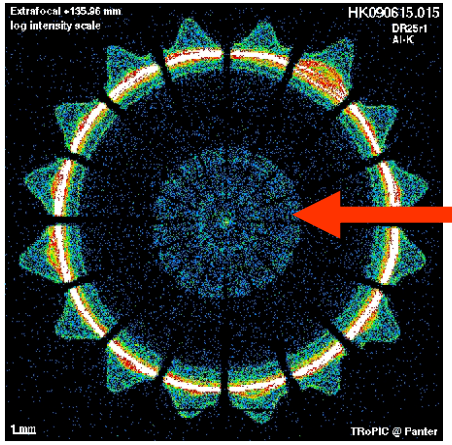
Laboratories

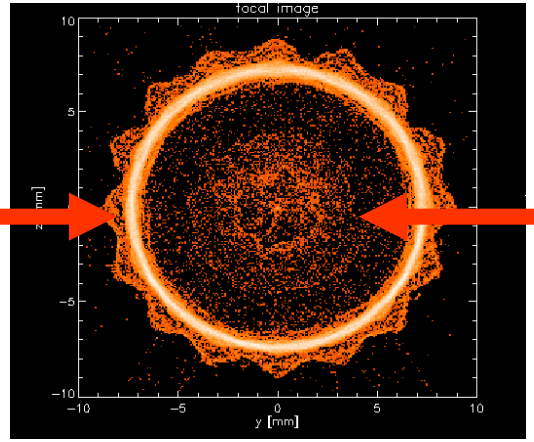


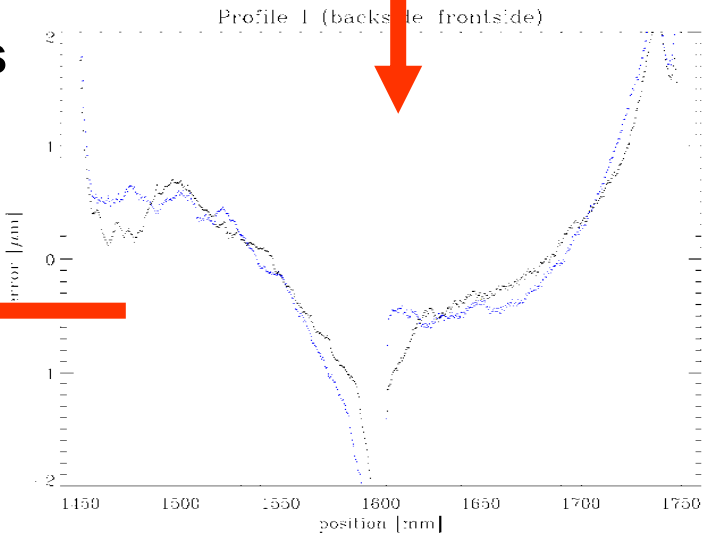
X-ray measurements

Raytracing -
Analysis

Profile Errors

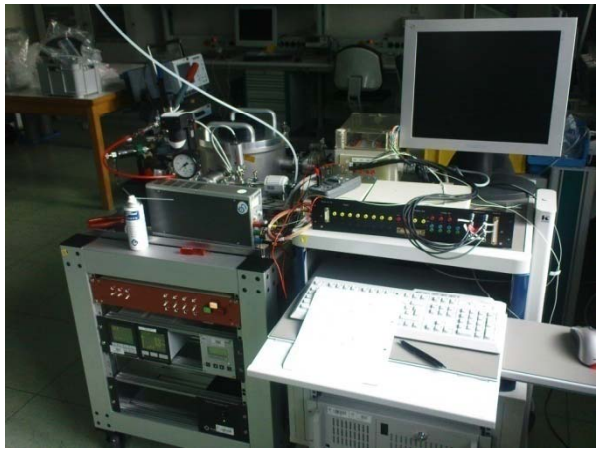




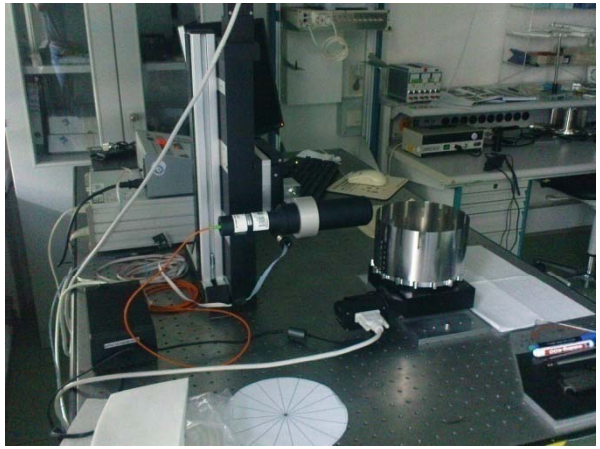


Laboratories

electron deflector test at PUMA



cryogenics

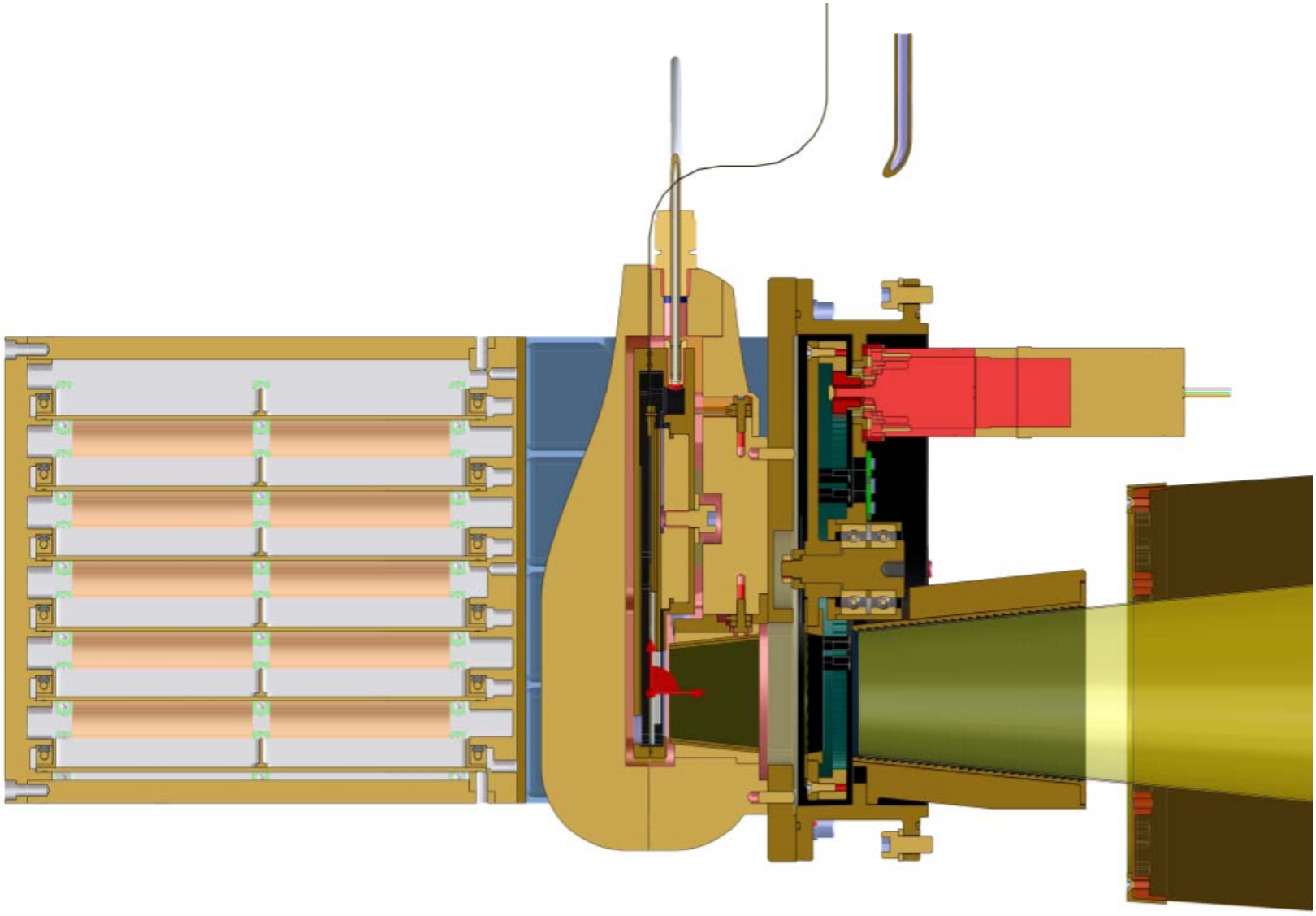


X-ray baffle metrology

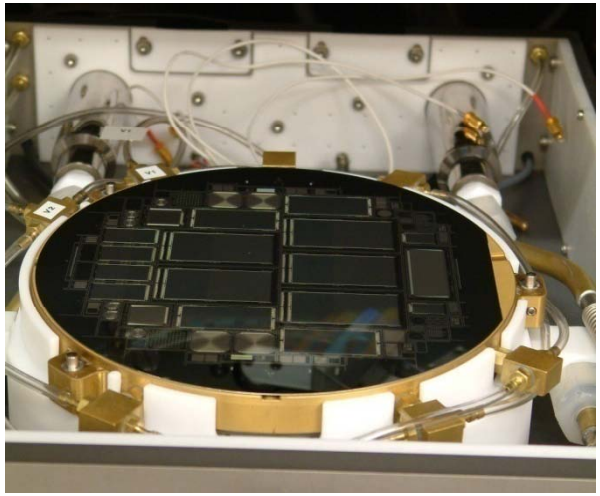
glue shrinkage tests

mirror shell
screening device

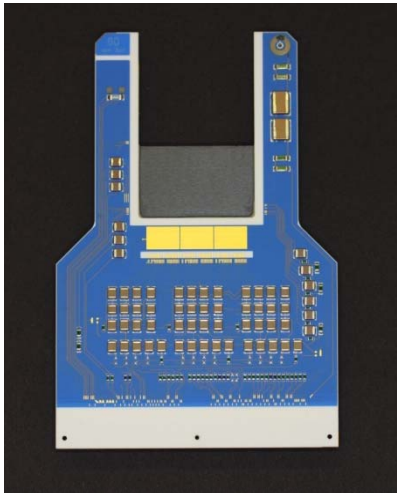
Camera + Electronics



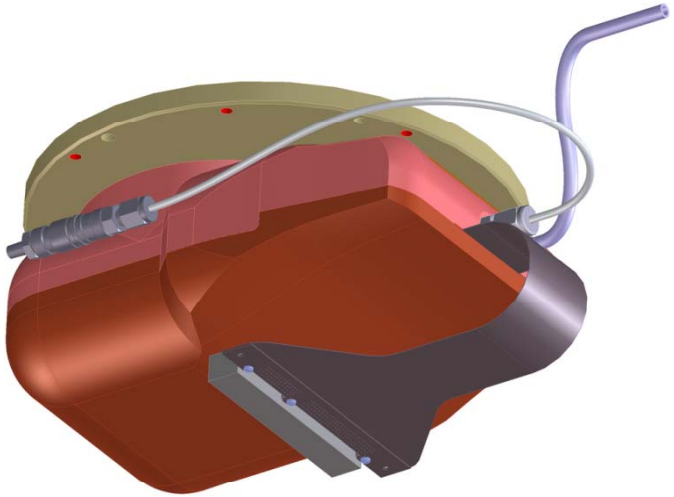
CCD - Camera



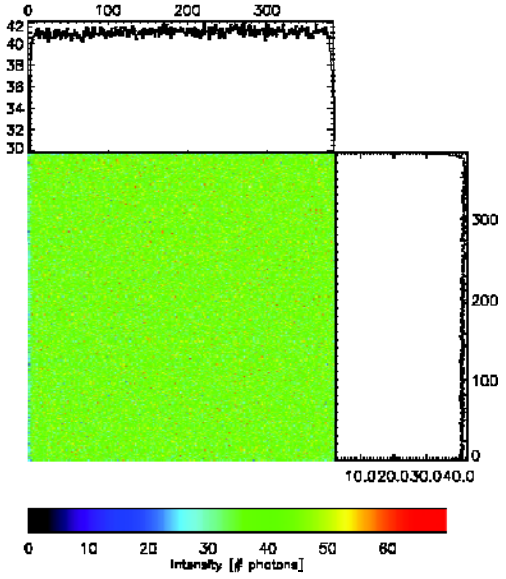
pn-CCDs on wafer in test

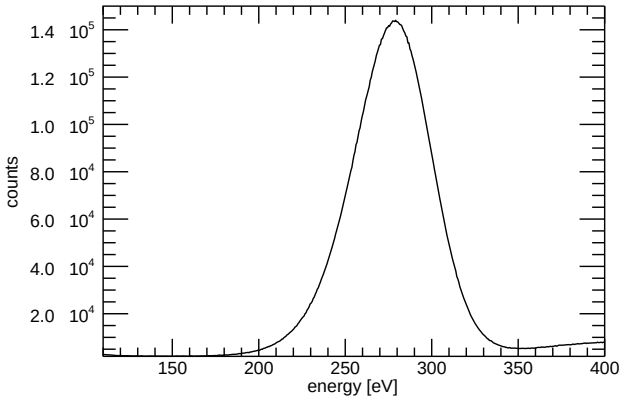


front-end ceramics



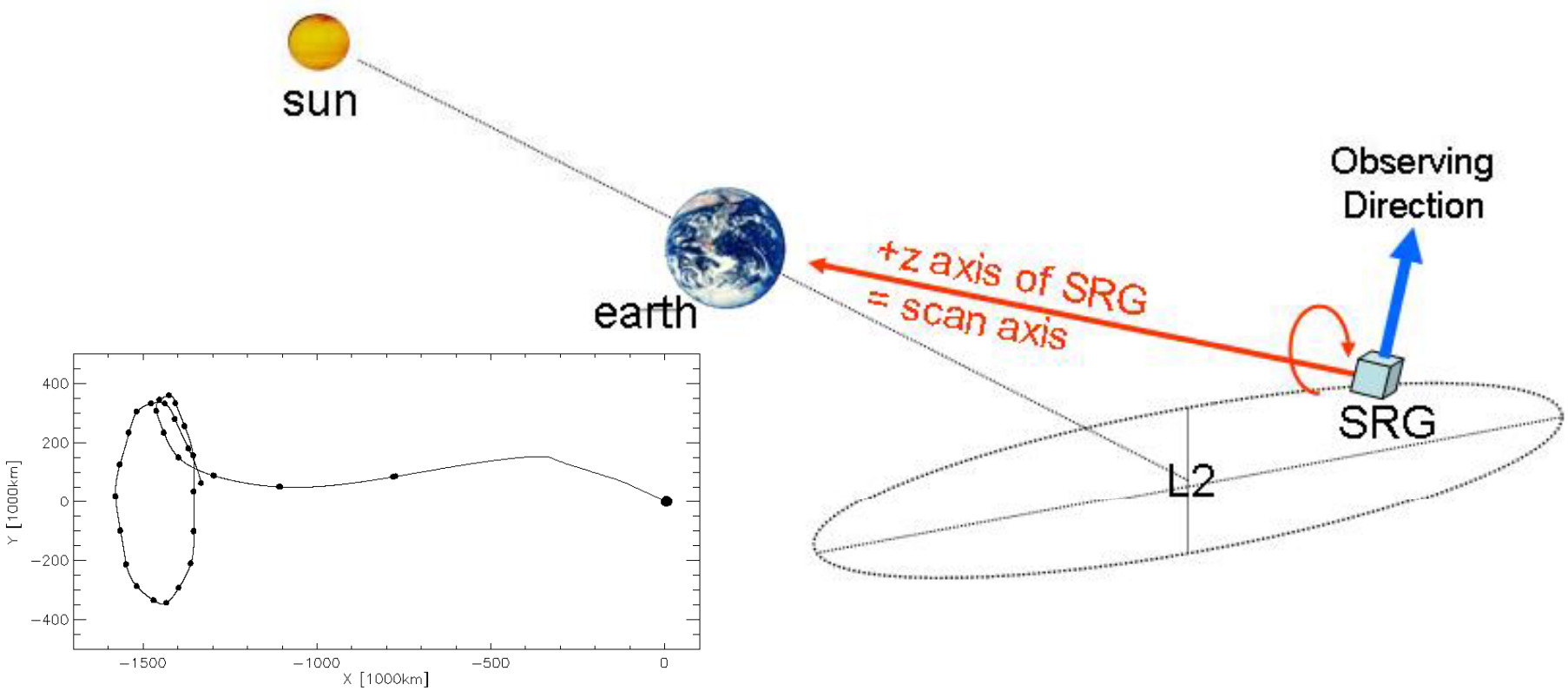
camera housing





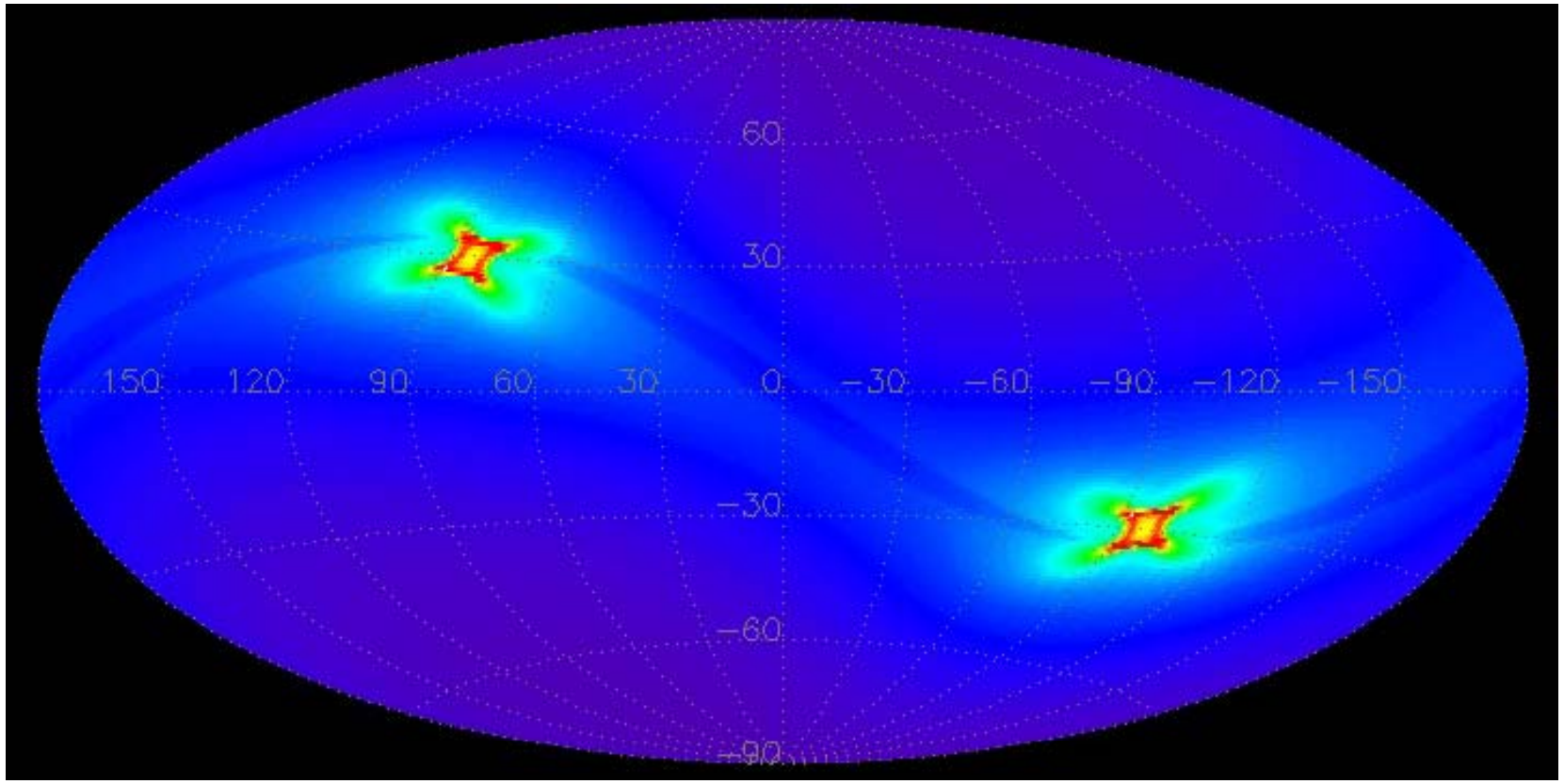
performance (flat field, E-resolution)

Mission Scenario



Angle between sun and Earth max. 13°
Scan-Axis always pointing towards Earth (antenna!)
Scanspeed less than in LEO, ~ 4h/revolution

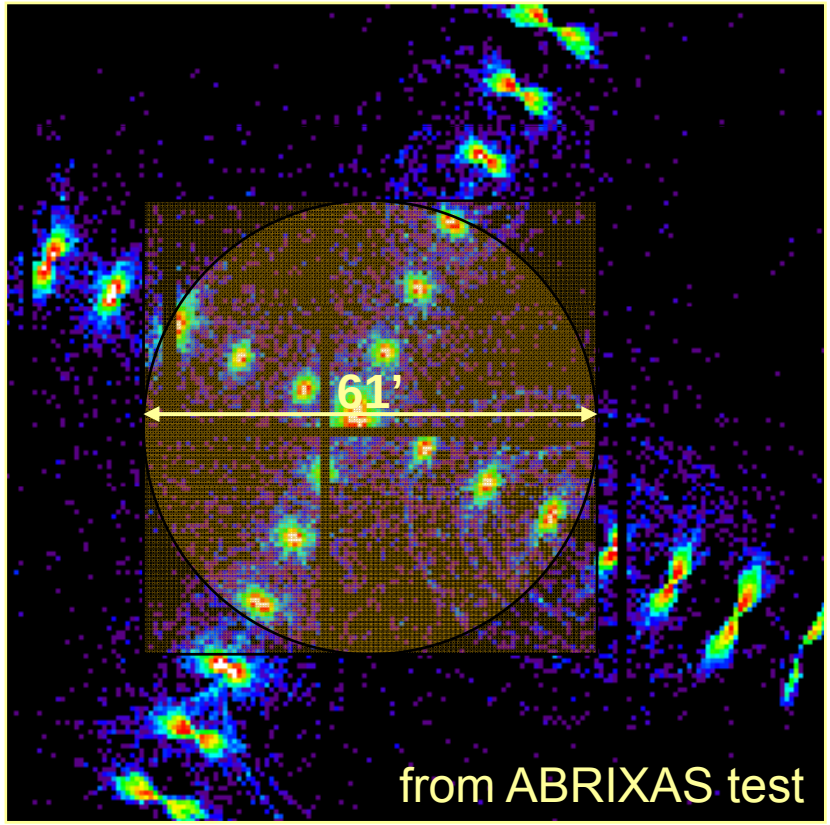
eROSITA Exposure

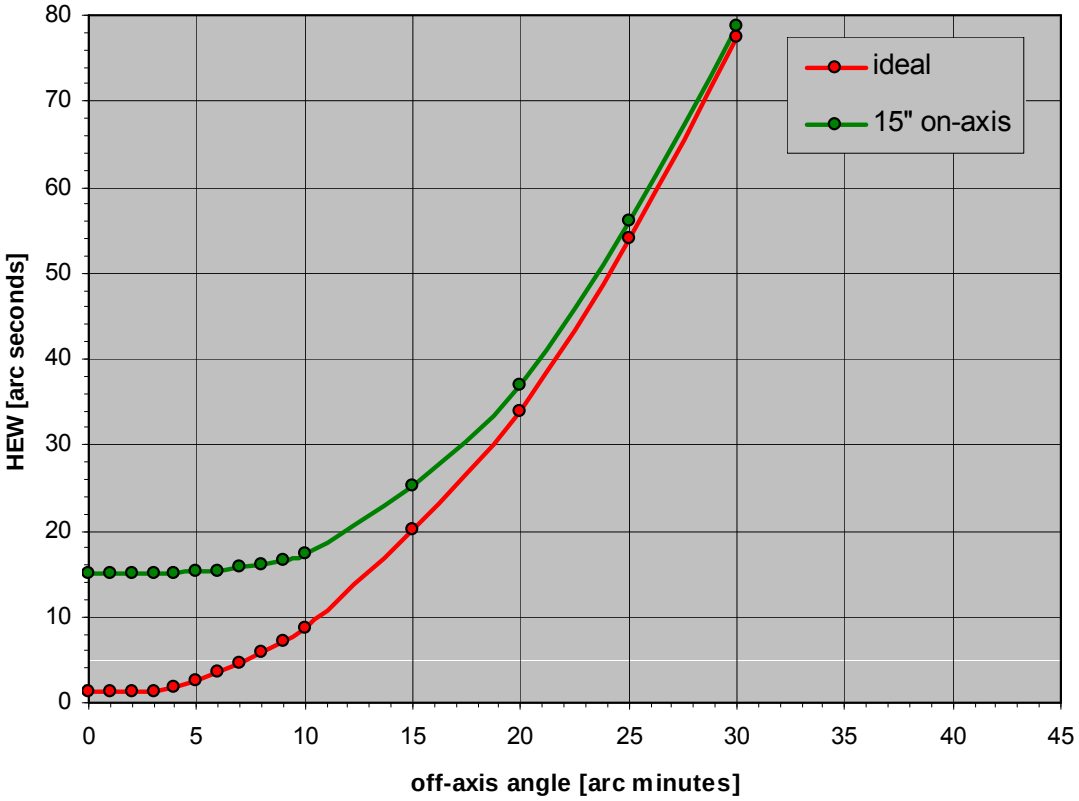


3ksec **5ksec** **30ksec**

After 4 years

Point Spread Function (PSF)





Point Spread Function (PSF)

Angular Resolution Error Budget Summary

- On-Axis PSF: 15” HEW
- Average PSF over the 61’ FOV: 26” HEW

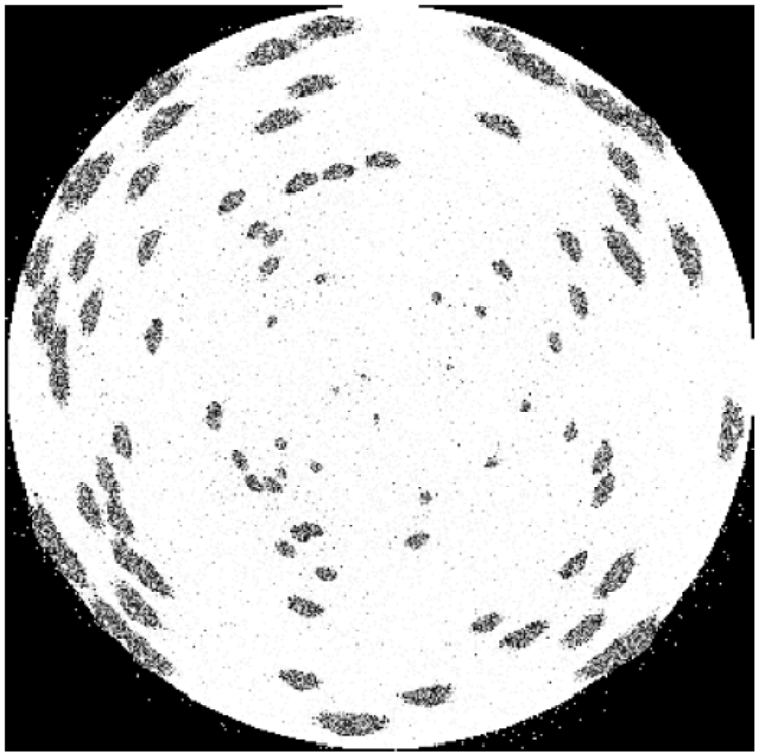
mirror system

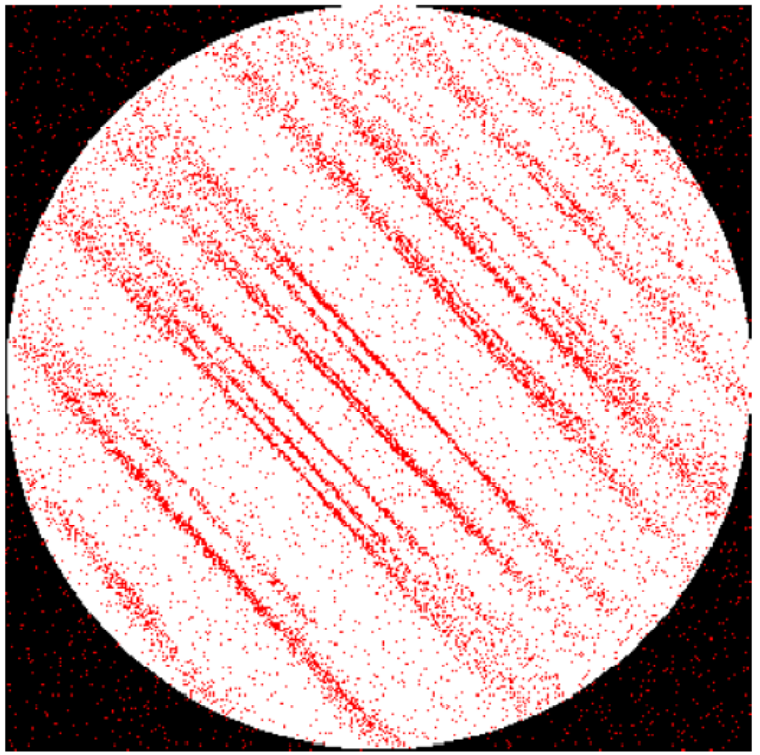
15” → detector, structure, attitude

- Angular resolution of the survey: 30” HEW

eROSITA Simulations

by Chr. Schmid





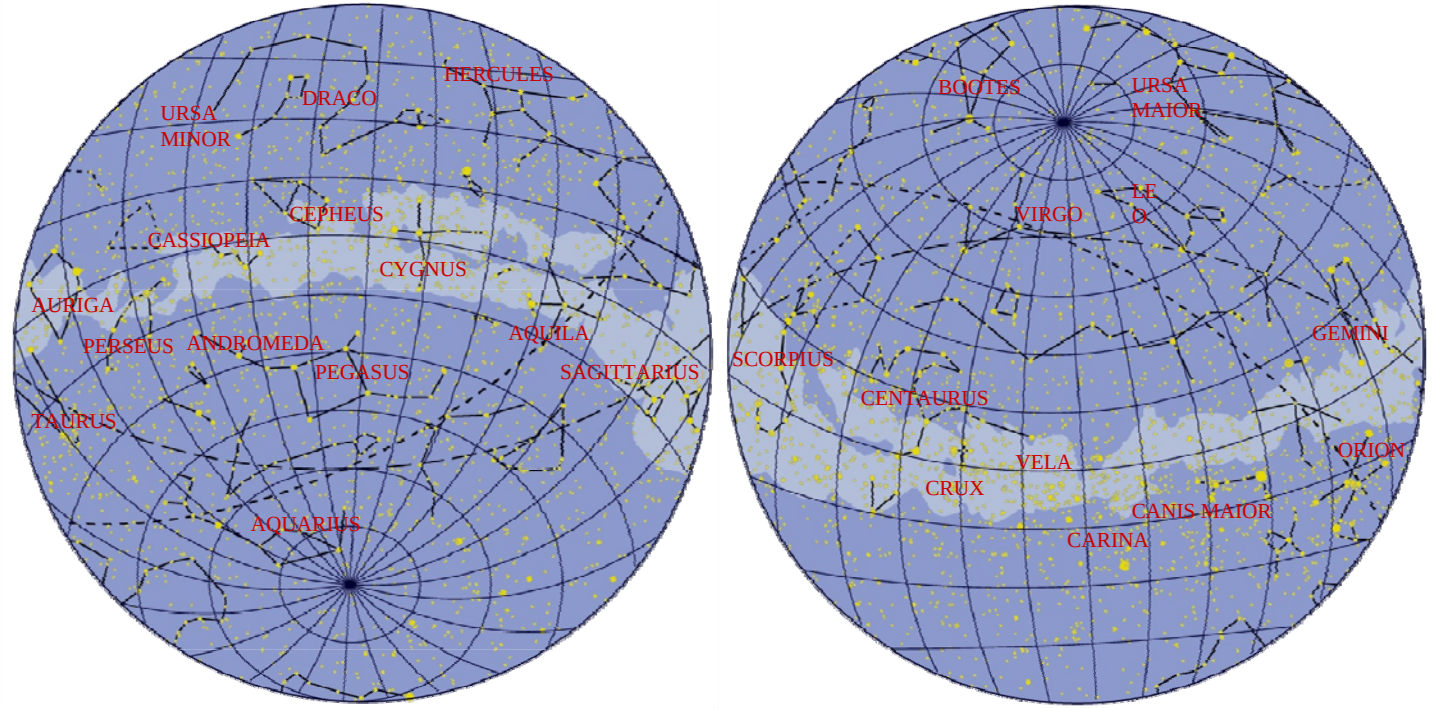
Pointing **Survey**

Off-axis blurring of a Wolter-I telescope →
PSF has to be averaged over the FoV

50:50 Data Share between Ru/D

CAELUM EROSITAE

CUM RETICULO AEQUATORIALI



HEMISPHAERA ORIENTALIS HEMISPHAERA OCCIDENTALIS

INVESTIGATIO RADIORUM CAELIS ROENTGENIENSIS AB ANNO MMXII

Actual definition depends on mission planning

Data policy & release

(PIs very personal view, only D-part)

Maximum science return from the mission

- **Survey:**
  - reprocessing every half year (8 times corr. to 4 years)
  - proprietary phase 1 year (after calibration etc., as usual)
  - analysis by "Working Groups" acc. to topics
    - solar system objects, stars, ... AGN, BKGR
  - invitation to all scientists to join the groups / institutes
  - hope, that Russian partners join that scheme
    - neccessary for topics requiring whole sky

- **Pointing:**
  - AOs every year (as usual)
  - proprietary phase 1 year (as usual)
  - no guaranteed time for hardware institutes, but Deep Survey Phase
  - TOOs, discretionary time, also interruption of survey