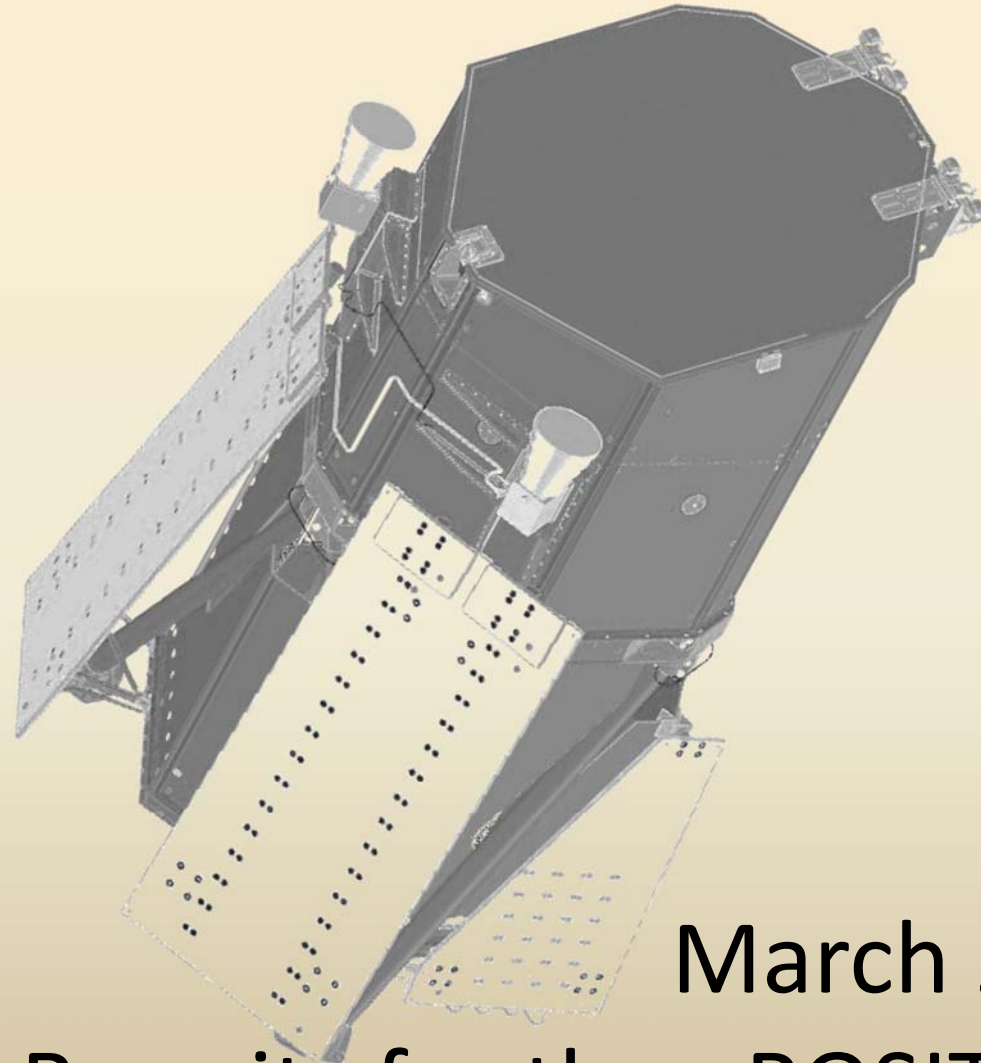


# Status of the eROSITA Mission



IACHEC

March 25, 2013

Vadim Burwitz for the eROSITA Team <sup>1</sup>

# eROSITA Collaboration

## **Core Institutes (DLR funding):**

MPE, Garching/D  
Universität Erlangen-Nürnberg/D  
IAAT (Universität Tübingen)/D  
SB (Universität Hamburg)/D  
Astrophysikalisches Institut Potsdam/D

## **Associated Institutes:**

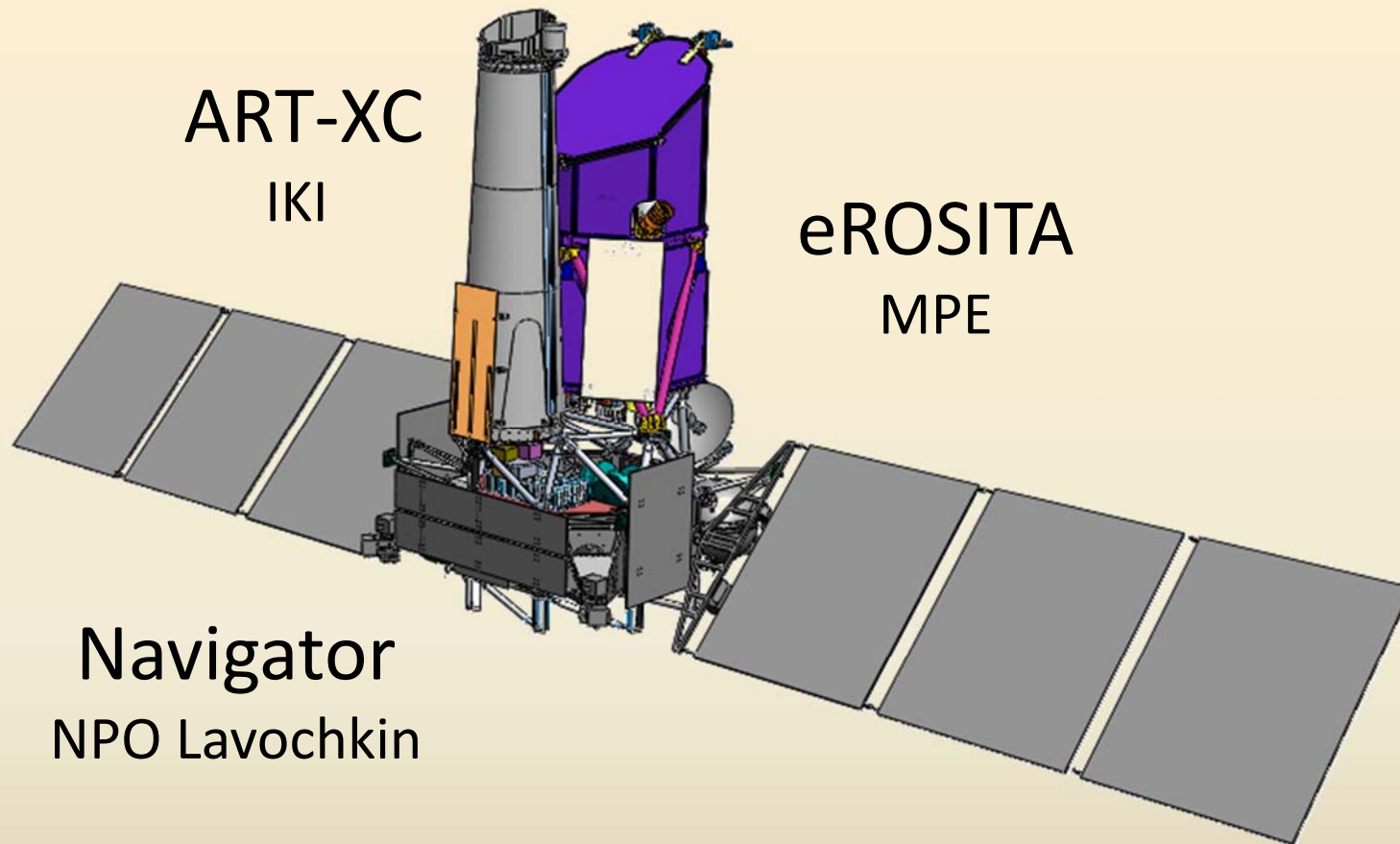
MPA, Garching/D  
IKI, Moscow/Ru  
USM (Universität München)/D  
AIA (Universität Bonn)/D

## **Industry:**

Media Lario/I	Mirrors, Mandrels
Kayser-Threde/D	Mirror Structures
Carl Zeiss/D	ABRIXAS-Mandrels
Invent/D	Telescope Structure
pnSensor/D	CCDs
IberEspacio/E	Heatpipes
RUAG/A	Mechanisms
HPS/D,P	MLI
+ many small companies	

**MPE: Scientific Lead Institute, Project Management**  
Instrument Design, Manufacturing, Integration & Test  
Data Handling & Processing, Archive etc.

# SRG



ART-XC  
IKI

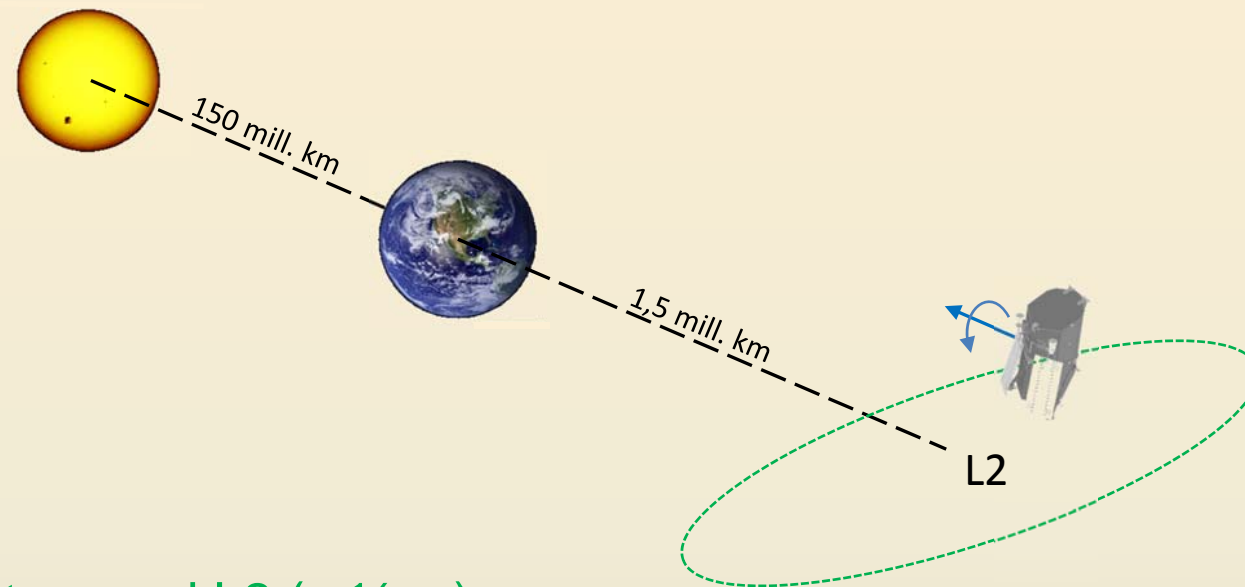
eROSITA  
MPE

Navigator  
NPO Lavochkin

Launch from Baikonur with Zenit-Fregat, 2014

Zenit-Fregat-Navigator = standard configuration, also used for  
Elektro-L (Jan 2011) and Radiastron (Jul 2011).

# Mission Profile

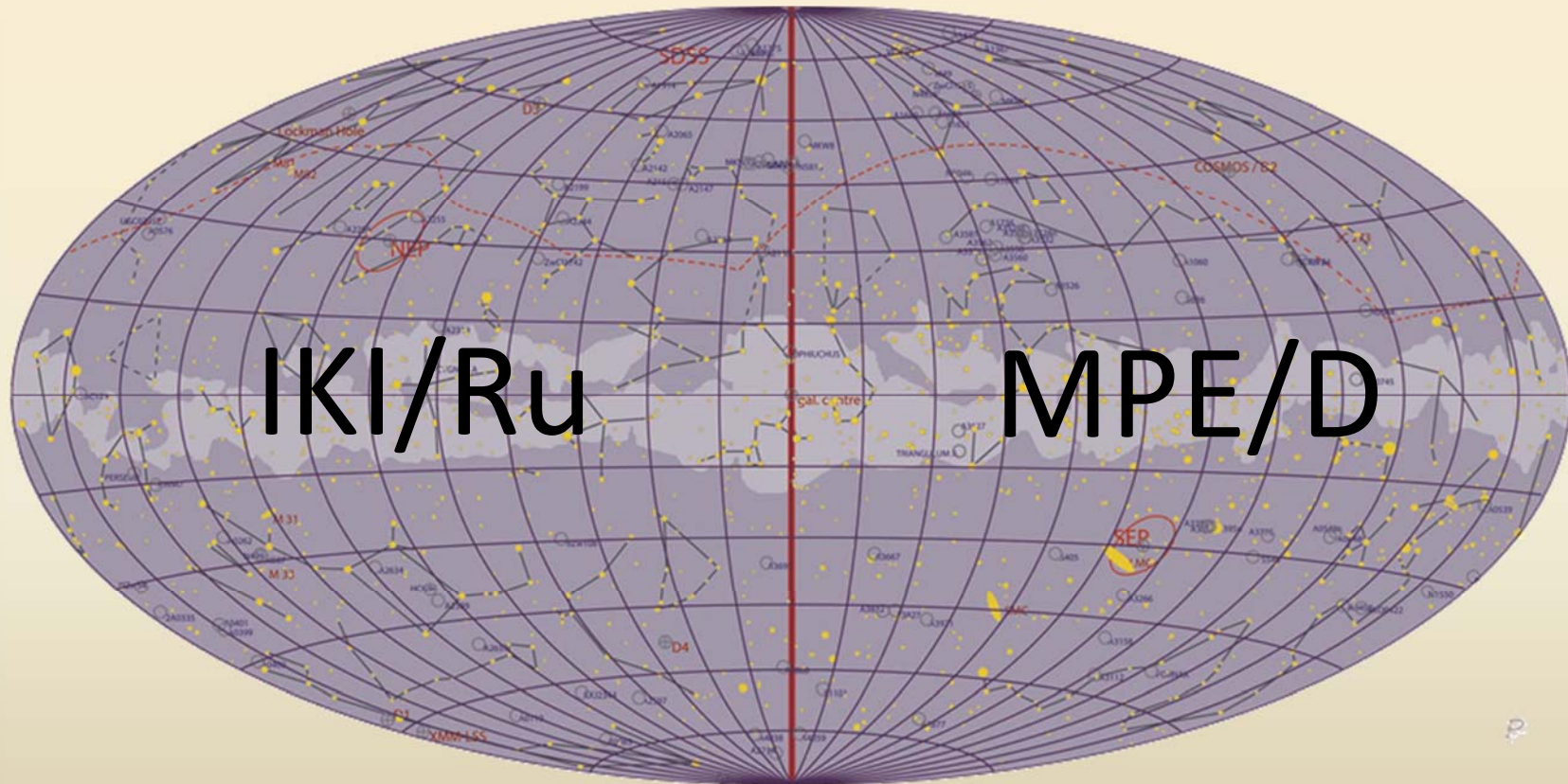


Orbit around L2 ( $\sim \frac{1}{2}$  yr)

Continuously rotating during Survey,  $\sim 4$  hours / revolution

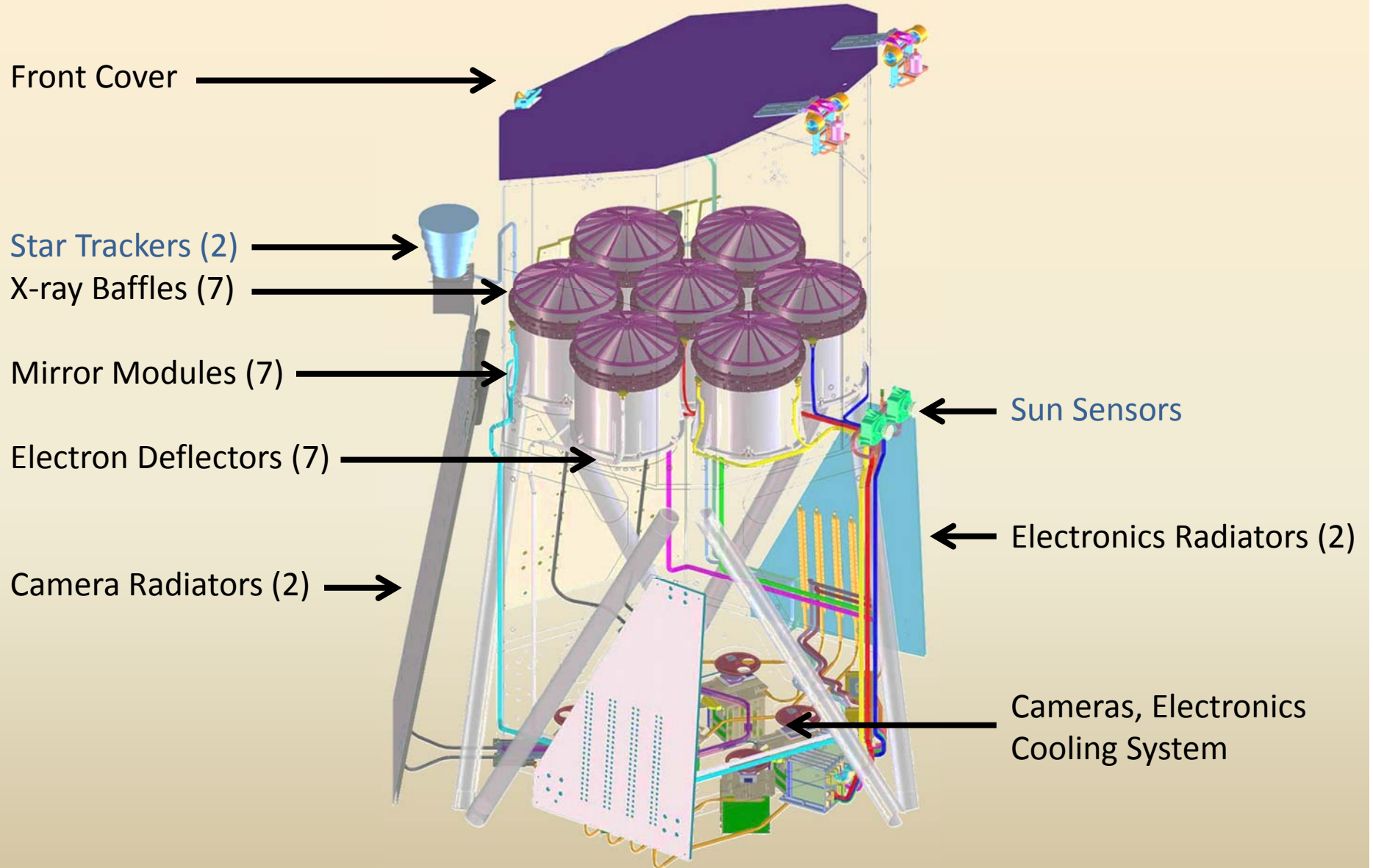
4 years all-sky survey, 3 years pointing

# Sky Division

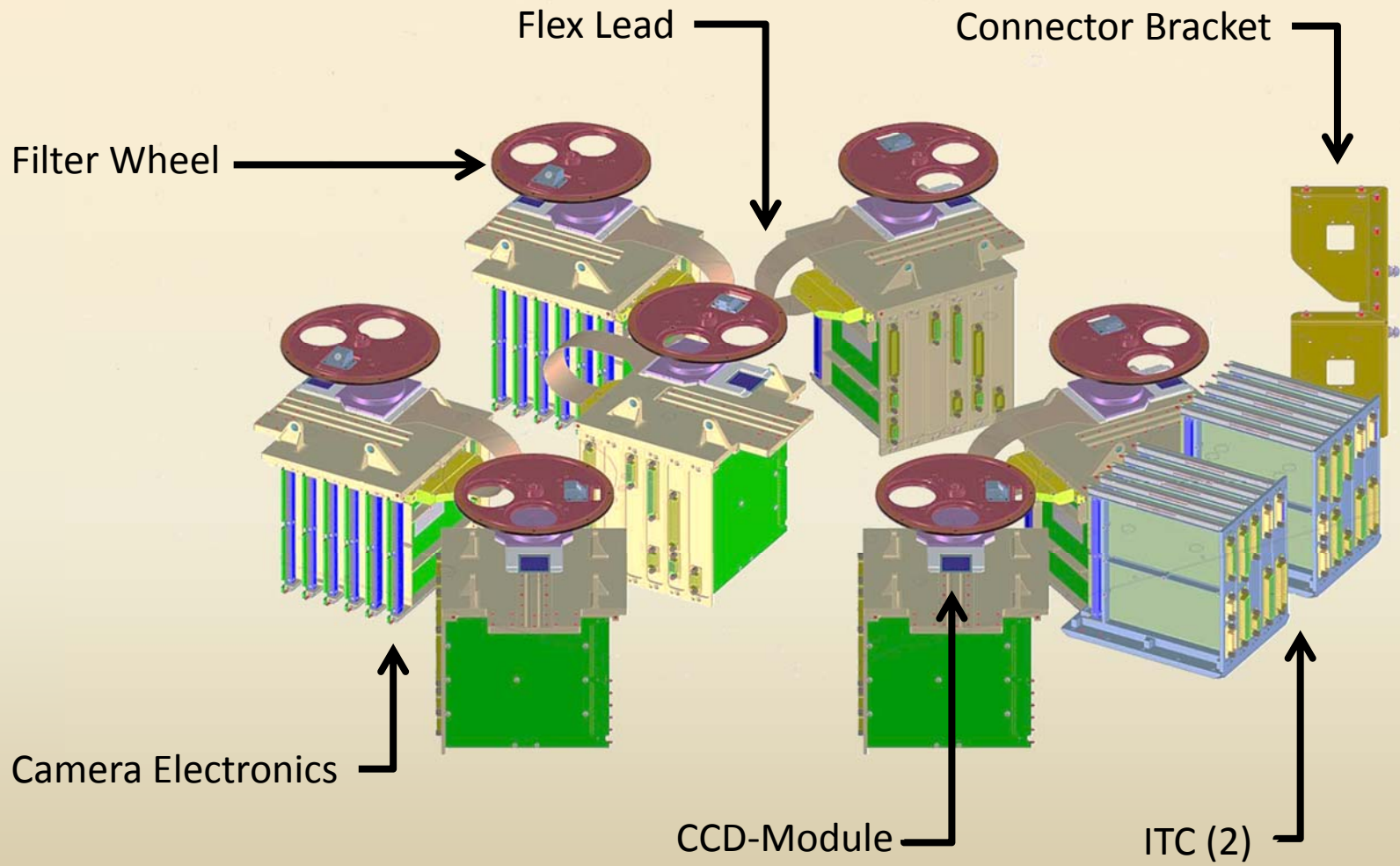




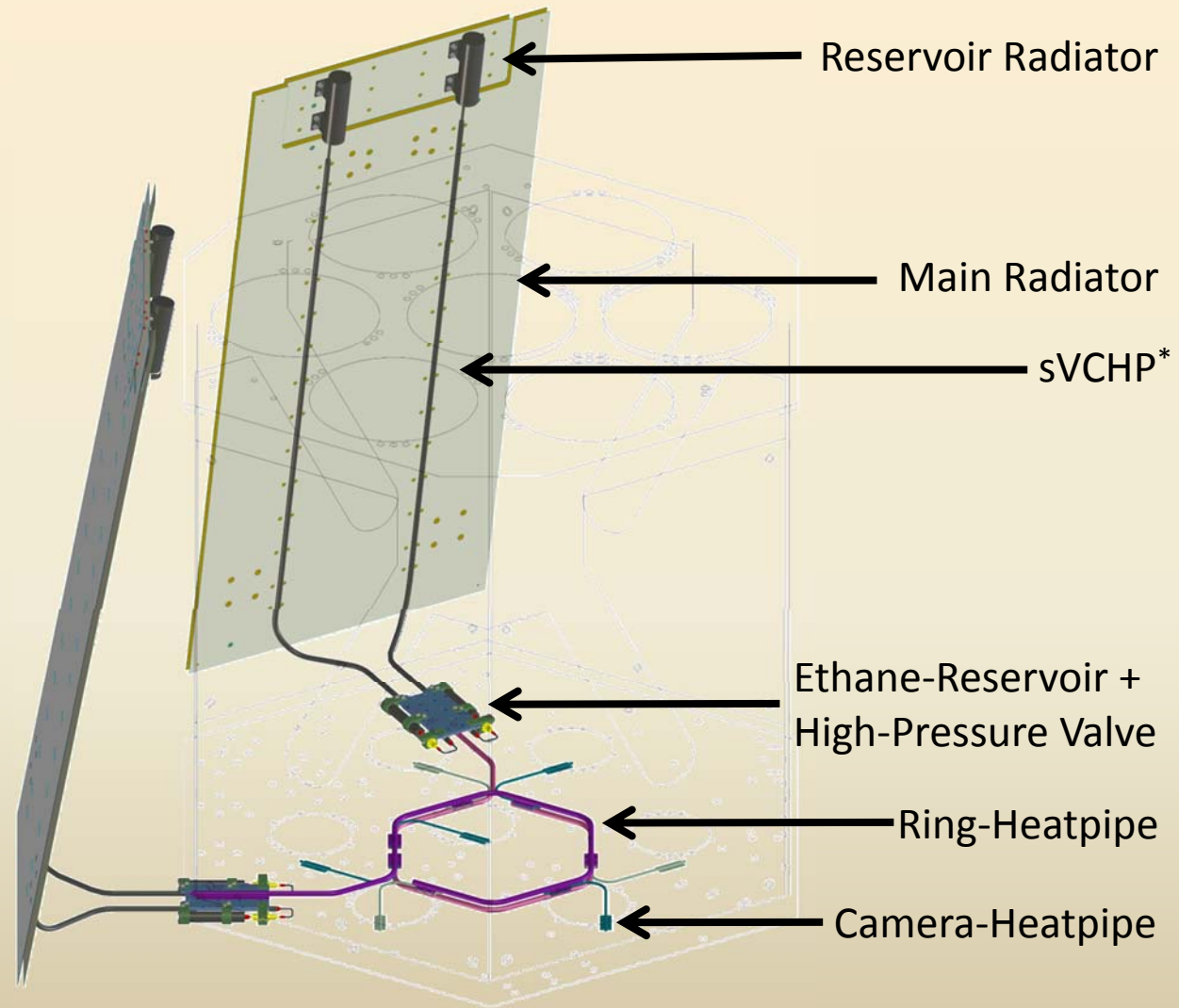
# Scheme: Telescope



# Scheme: Cameras



# Scheme: Cooling System



\* switchable Variable Conductance Heatpipe



# HW-Status: Overview

	QM, EM, STM, TM, DM	FM-readiness
Structure	Qualified (Vb)	100%
Mirror Modules	Qualified (Vb, TV, X)	82%
CCD-Cameras	Qualified (Vb, TV, X, P)	100%
Cooling System	Qualified (Vb, TV, C)	100% (parts)
X-ray Baffles	Qualified (Vb, TV, X)	30%
Electron Deflectors	Qualified (Vb, TV, ED)	100%
Filterwheels	Qualified (Vb, AC, TV)	100% (parts)
Electronics	Qualified (Vb, TV) TM ready (del. to NPOL) EM in test	80% (parts, ITAR)
PFM-Telescope	Qualified (MP, Vb, TV, AC, PS), waiting for TV	
GSE	ready	

Vb = vibration, TV = thermal vacuum, AC = acoustic noise, X = x-ray, P = proton radiation damage, C = cooling, ED = electron deflection, MP = mass properties, PS = pyro shock

# The MPE PANTER X-ray Test Facility

- **The X-ray test Facility**

- Is located in Neuried, south west of Munich
- 120 m X-ray beamline, 1 m diameter
- 12 m instrument chamber, 3.5 m diameter
- Large cleanroom for handling X-ray optics
- Movable 10 m extension with 0.25 m diameter and 3 m instrument chamber, 1.2 m diameter

- **Detectors**

- PSPC : Position Sensitive Proportional Counter
- TRoPIC : Single photon counting CCD camera
- PIXI : Integrating CCD Camera

- **X-ray Sources**

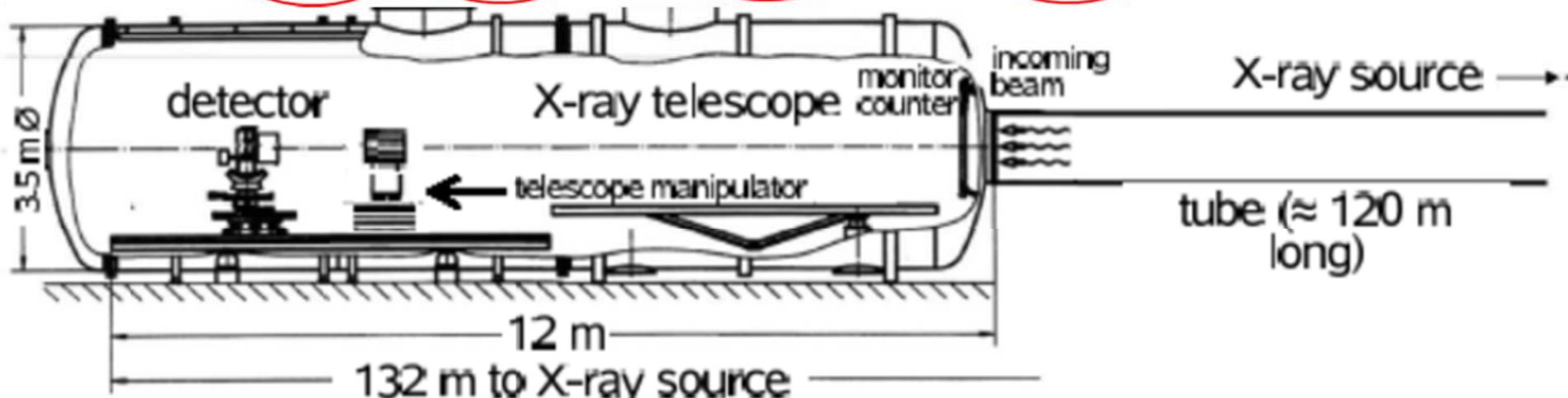
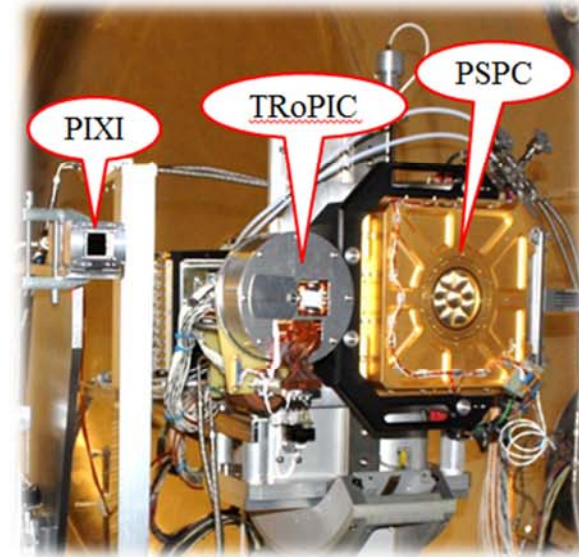
- Multi target electron impact source
- Seifert closed X-ray source
- X-ray Monochromators

- **Beam Monitors**

- Proportional counters
- Drift Chamber

- **Manipulators**

- X, Y, Z translation stages
- Tip-tilt, rotation stages



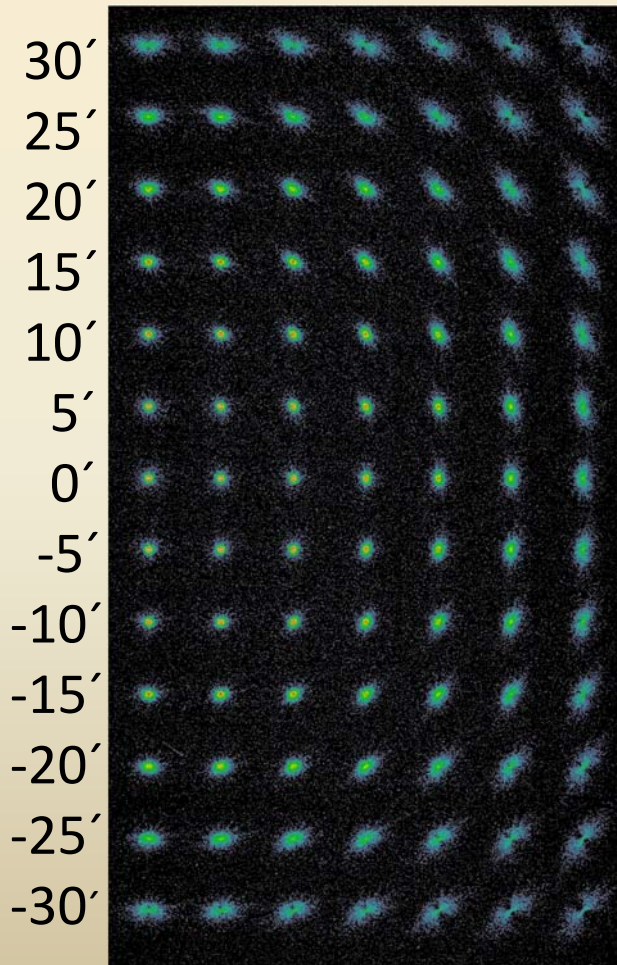




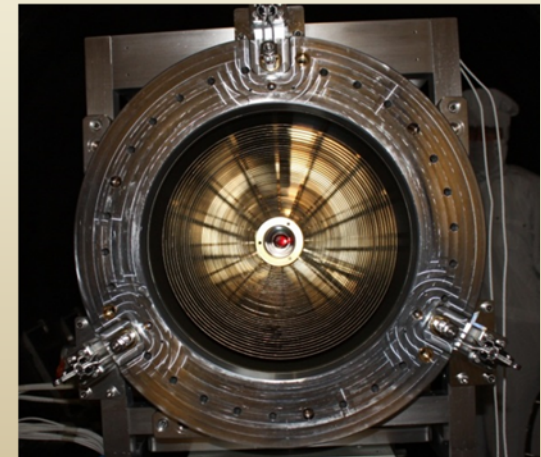
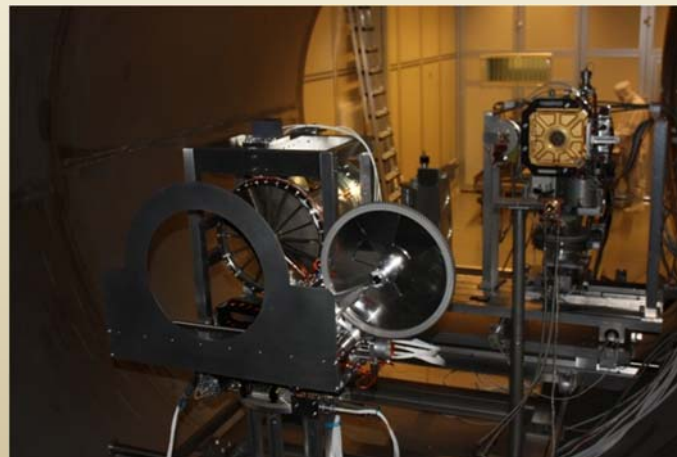
# Status: Mirror System

FM2 off-axis measured  
PSF over the field of view

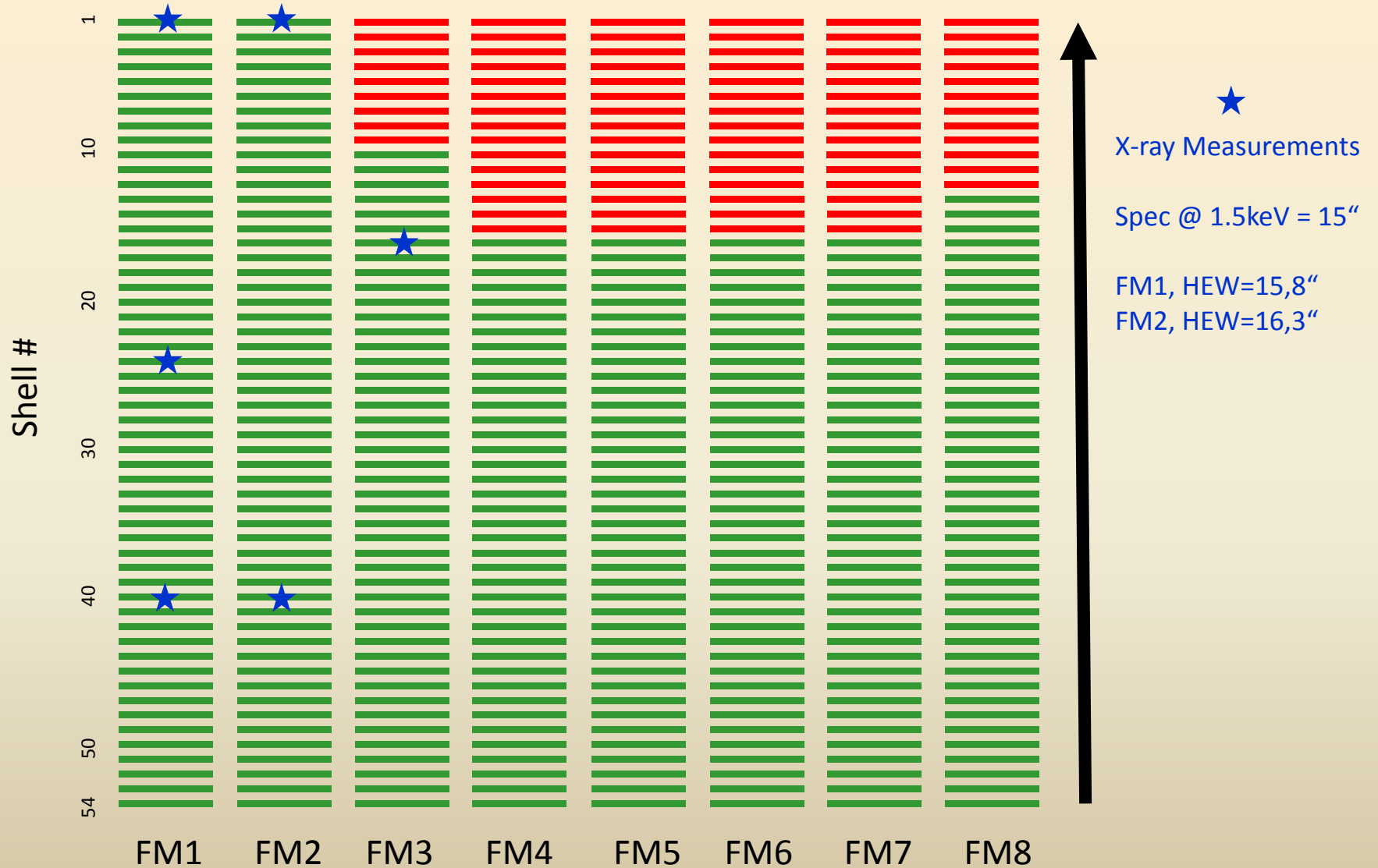
0' 5' 10' 15' 20' 25' 30'



- DM-Mirror delivered 12/2009
  - Qualification tests (TV, Vib, X-ray, early 2010)
  - Together with X-ray Baffle, late 2011
  - Part of QM-Telescope tests (2012)
- FM-Program
  - All mechanical parts (spider, MIS) ready since 2010
  - FM Shell integration started in 2011
  - Witness X-ray measurement: in spec (HEW = 15")
  - FMs completed, delivered, and tested in PANTER
  - FM-1 (12/2012-01/2013)
  - FM-2 (03/2013)



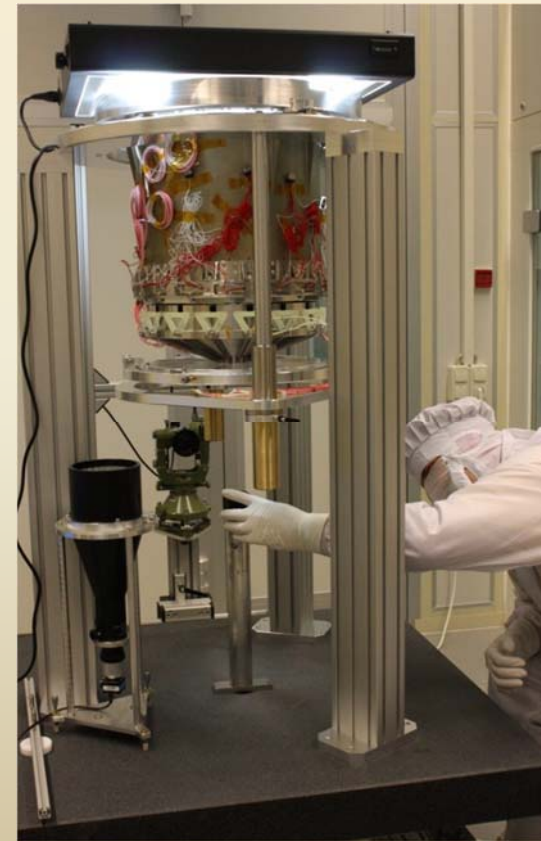
# Mirror Shell Integration





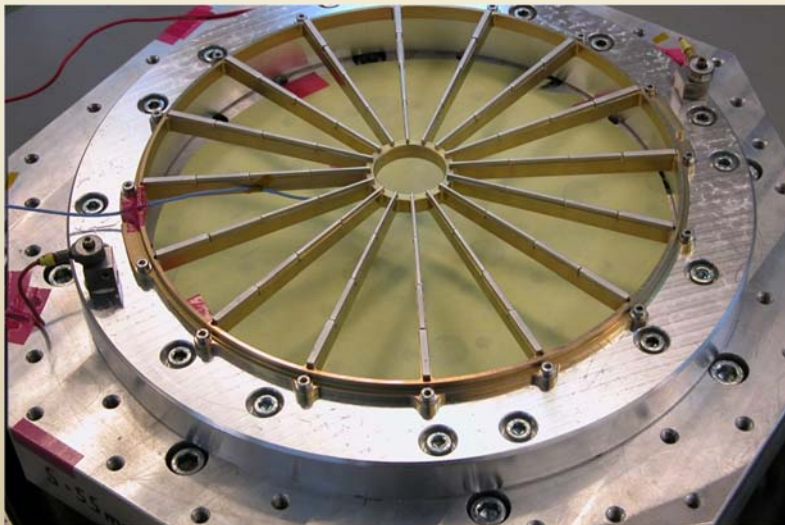
# Status: X-ray Baffle

- 7 Baffles, each with 54 invar cylinders in front of Mirror Modules
  - Process qualified (cutting, bending, welding, integration)
  - Accuracy  $< 50\mu\text{m}$
  - Qualification (Vibration, Thermal Vacuum, X-ray tests)
- FM-Program
  - FM-1 and FM-3 completed
  - Integration of FM-4 and FM-5 started
  - Integration of FM-2 on hold (separate tests for removing damaged shell)



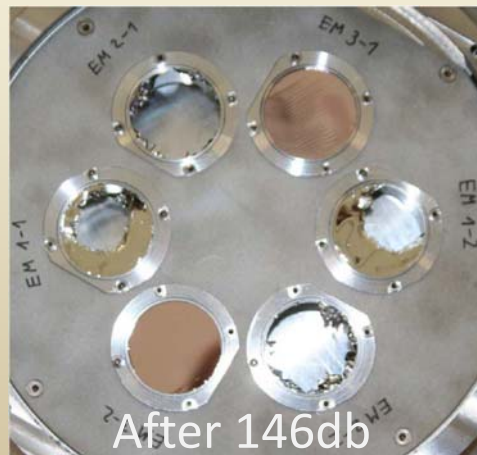
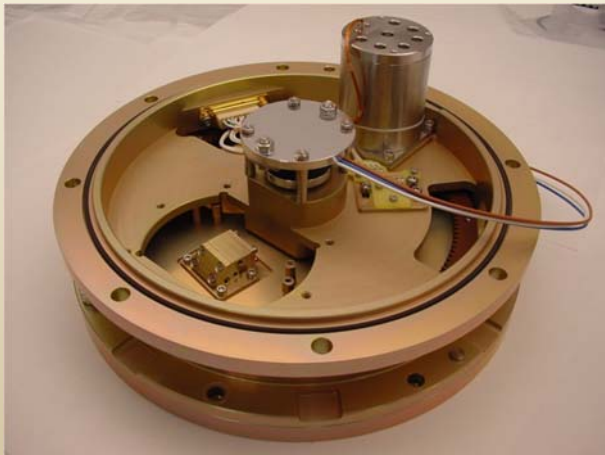
# Status: Electron Deflector

- 7 spider wheels with permanent magnets behind Mirror Modules
  - Qualified (Vibration, Thermal Vacuum, Electron Deflection)
- FM-Program
  - FM 1-6 manufacturing completed
  - FM 7-8 waiting for magnets bonding
  - FM 1,2 acceptance tested (Vib, outgassing, TV)
  - FM 3-6 outgassed, TV-tested



# Status: Filterwheel

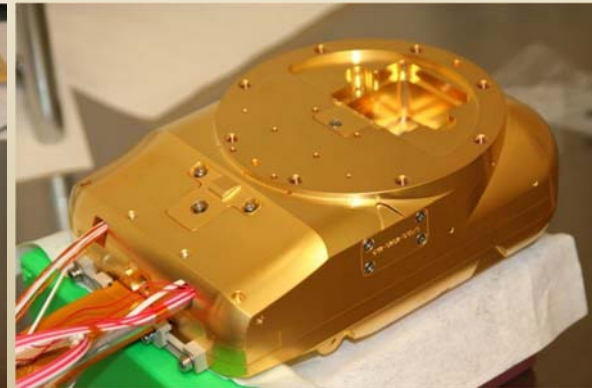
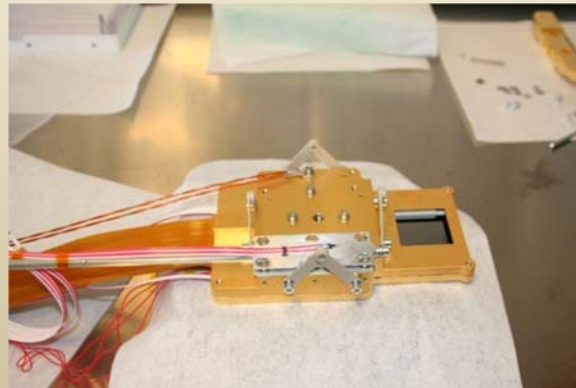
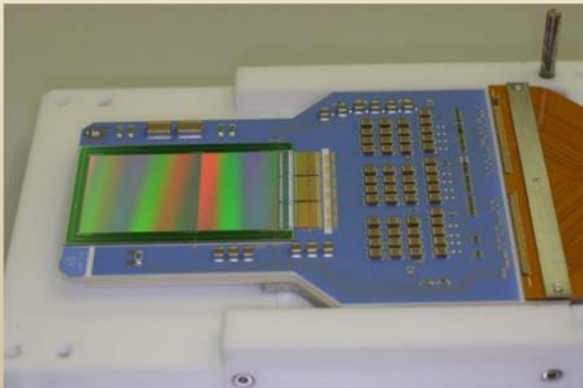
- 7 motor driven wheels in front of cameras
  - 4 positions: Open, Closed, Filter,  $\text{Fe}^{55}$  calibration source
  - Qualified (Vibration, Thermal Vacuum, Acoustic Noise)
  - Lifetime test OK, (3 months, vacuum, 3000 cycles)
  - Purge test OK (4 months, 5x nominal flow)
- FM-Program
  - All parts (motors!) in stock
  - Purchasing of  $\text{Fe}^{55}$  targets (1Mbeq) as late as possible



But after a slight redesign:  
Everything OK!

# Status: Camera

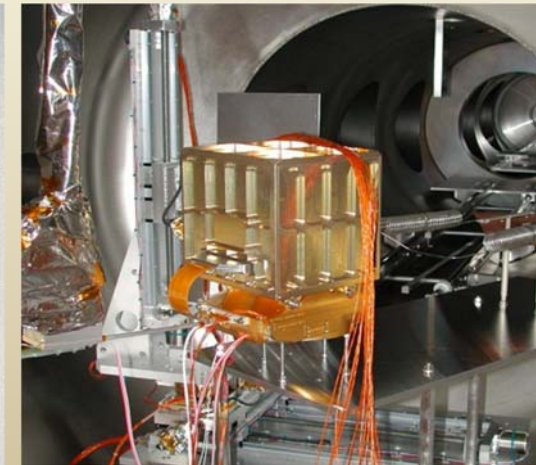
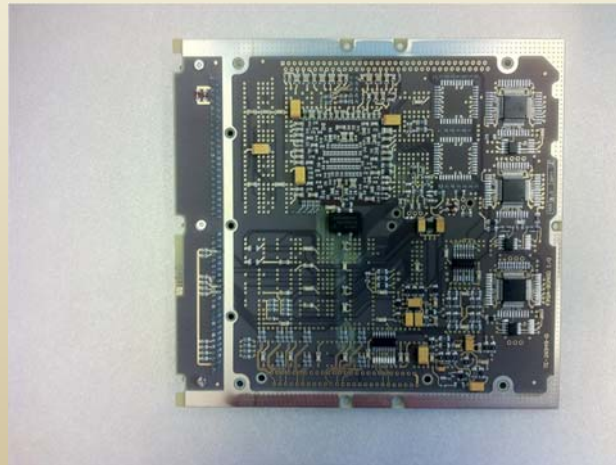
- 7 pnCCDs on front-end ceramic PCBs, cooled to  $-95^{\circ}\text{C}$ 
  - Prototype camera in operation since early 2007 („TRoPIC“ in PANTER)
  - eROSITA-CCDs in stock since early 2010
  - EM-Camera in X-ray test since late 2010
  - Proton radiation damage tests in 2010 and 2011
- FM-Program
  - All CCDs and CAMEXs manufactured, screened, tested
  - All PCBs manufactured, mounting pending
  - Mechanical parts:
    - All cold casings ready
    - Proton shields pending





# Status: Electronics

- 7 Camera Electronics Boxes + 2 Interface & Thermal Controllers
  - Qualified (Vibration, Thermal Vacuum)
  - All PCBs designed, layouted, manufactured (EM)
  - EM in test
- FM-Program
  - 80% of components in stock, but still some ITAR issues.





# Status: Thermal

- Cooling of cameras
  - 2 Radiators, 4 sVCHPs, 2 „Ring-HPs“, 7 Camera-HPs
  - Qualified (Vibration, Thermal Balance Test in PANTER)
- Cooling of electronics
  - 2 Radiators, 9 standard ammonia heatpipes
  - Qualified parts (HPs), SS-Qualification at QM-Tests
- Thermal system of telescope
  - MLI insulation
  - Thermal baffle in front of mirror system
  - Heating of mirror modules
  - Partly qualified, SS-qualification at QM-tests



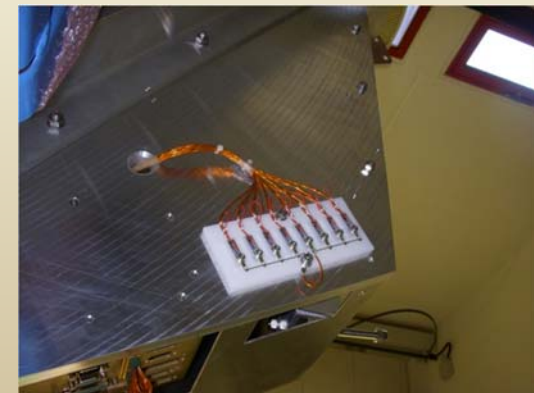
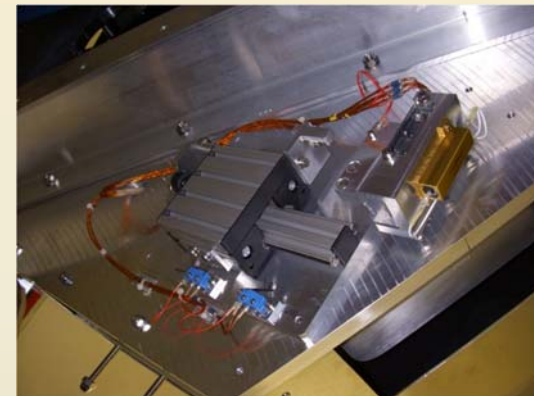
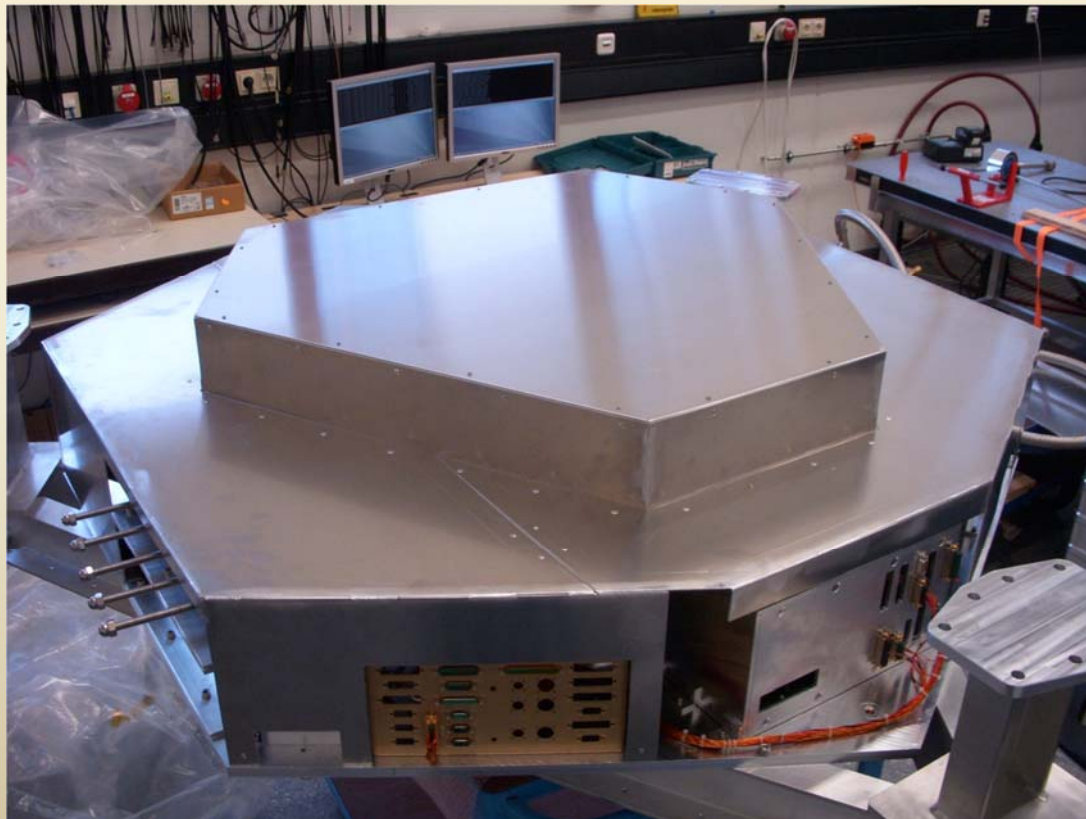
# Status: Telescope Structure



- CFRP Structure
  - Hexapod
  - Optical Bench
  - Sunshield
  - Cover
- Complete (FM)
- Qualified
  - Vibration
  - Acoustic Noise
  - Cover mechanism
  - Space Simulation pending
- Refurbishment after test campaign

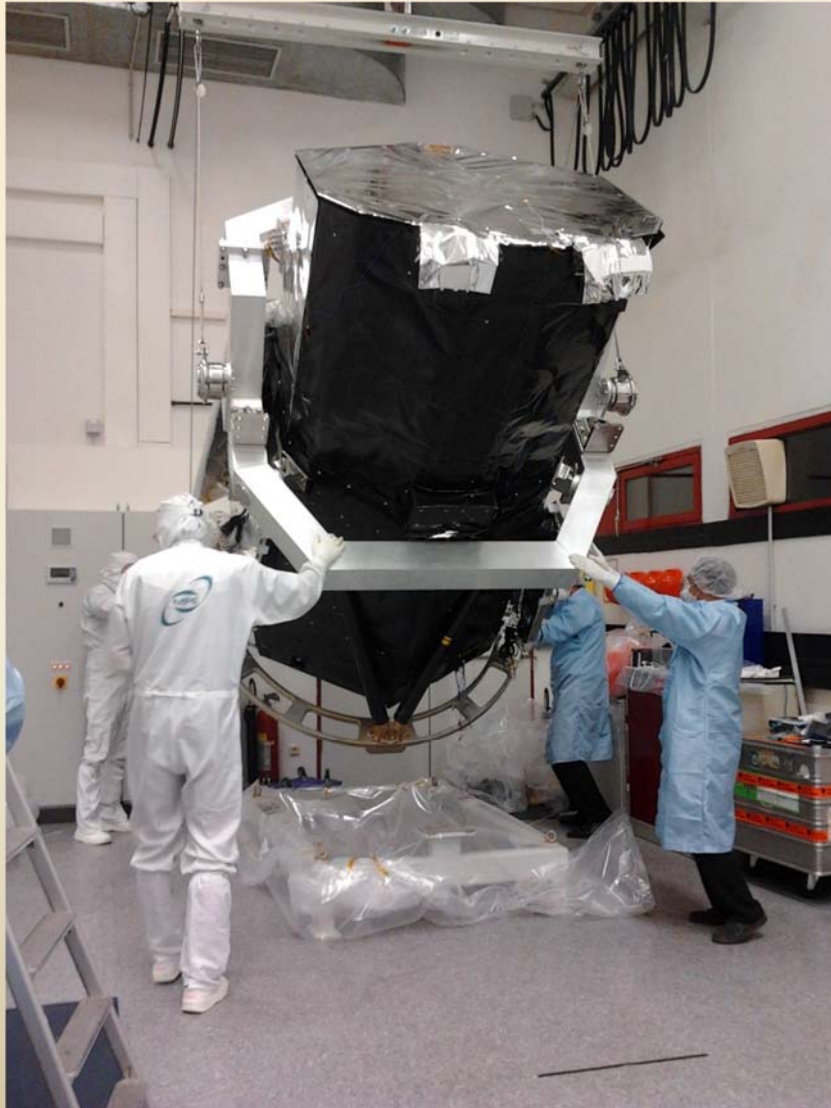
# Status: Technological Model

- Model for testing mechanical and electrical interface to S/C
  - Just arrived in Moscow for testing





# QM-Test: Packing



# QM-Test: Transportation to IABG





# Cleanliness



# QM-Test: Mass Properties

		eRosita QM
Mass [kg]	m	810.3
CoG [mm] (w.r.t. the origin of ordinates)	X	-34.1
	Y	+2.5
	Z	+1260.4
Moi [kgm <sup>2</sup> ] (w.r.t. axes passing through CoG parallel to axis system)	I <sub>xx</sub>	619.8
	I <sub>yy</sub>	621.0
	I <sub>zz</sub>	237.9

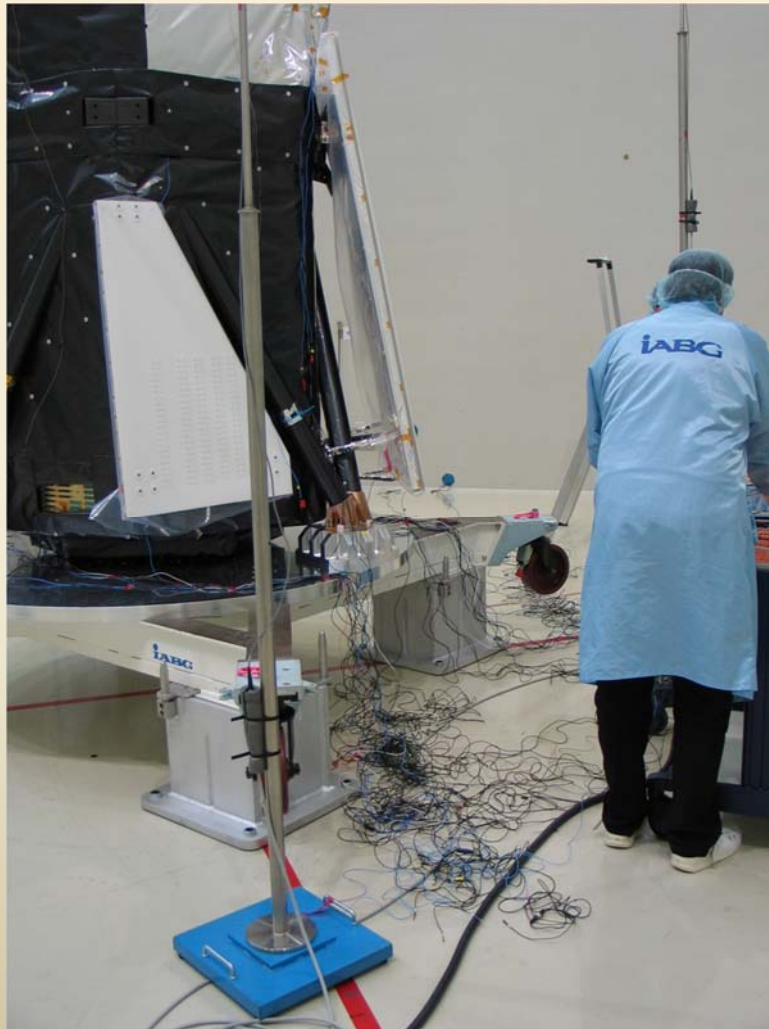
- Mass: includes startrackers and sunsensors
- Possibly 20kg reduction due to actual mirror weight





# QM-Test: Acoustic Noise

- Qualification Level 143db, OK



# QM-Test: Pyro Shock





# QM-Test: Vibration

- Qualification level, all three axes, OK





# QM-Test: Vibration

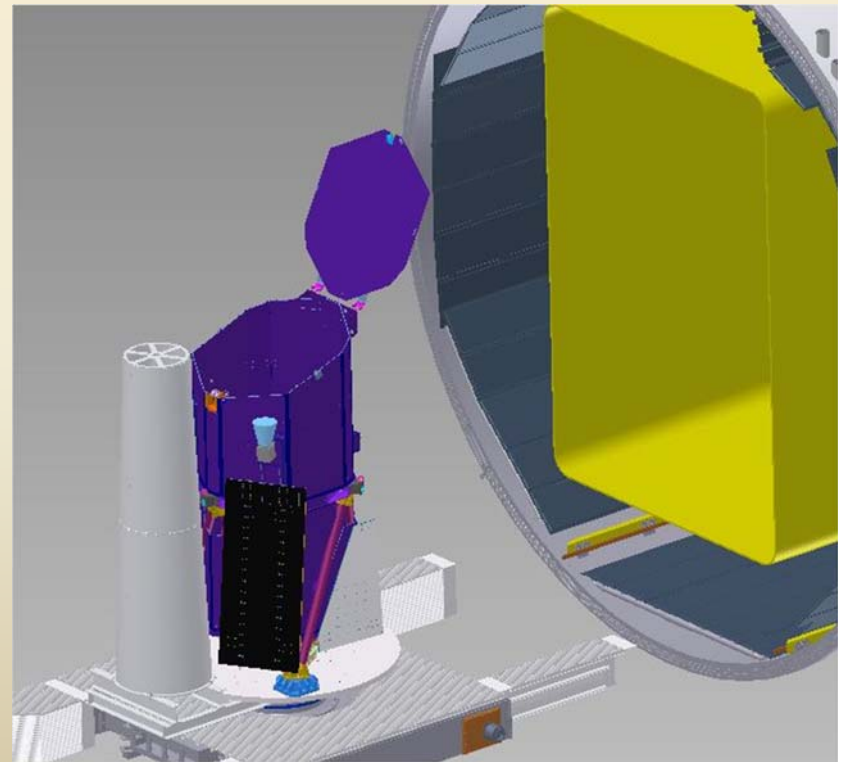
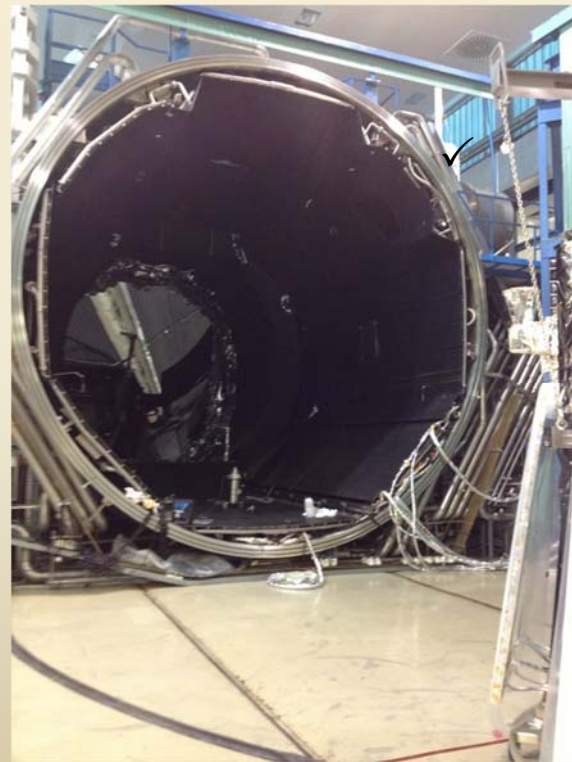


# QM-Test: Cover



# QM-Test: Space Simulation

- Performed in beginning of January
  - 1 dummy startracker replaced by SED26
    - ART-XC dummy installed



# Summary

- Assembly and completion and testing of most of the components of eROSITA are schedule.
- All environmental and space-simulations tests have been
- As most components come in multiples of at least 7 we have still many calibration campaigns ahead of us for both the mirrors and detectors.
- An End-to-End test at PANTER of the complete telescope is planned for early 2014
- The launch is still scheduled for end of 2014
- Next talk will be on eROSITA in-flight calibration