Two mirror modules

- 133 layers of grazing incidence shells with multilayer coating
- the inner 66 layers are comprised of 6 segments with 12 pieces of glass per layer
- while the outer 67 layers are comprised of 12 segments with 24 pieces of glass per layer
- Each unit is 47.2 cm) long and, upon completion, will be 19.1
- weigh 31 kg

About 5000 segments produced via hot slumping at Goddard and coated at DTU

First light images of Cygnus X-1 on June 28th.

HEW compliant with ground calibrations (60 arcsec)

Technology Demonstrator of SIMBOL-X/NHXM

3 mirror shells,
600 mm length,
10m focal length:

	#1	#2	#3
Diameter	286	291	297
thickness	0.25	0.25	0.25
Multi-layer	90 W-Si	200 W-Si	200 W-Si

Mechanical structure: 2 spiders with 20 spokes

Integration of three mirror shell

PANTER tests

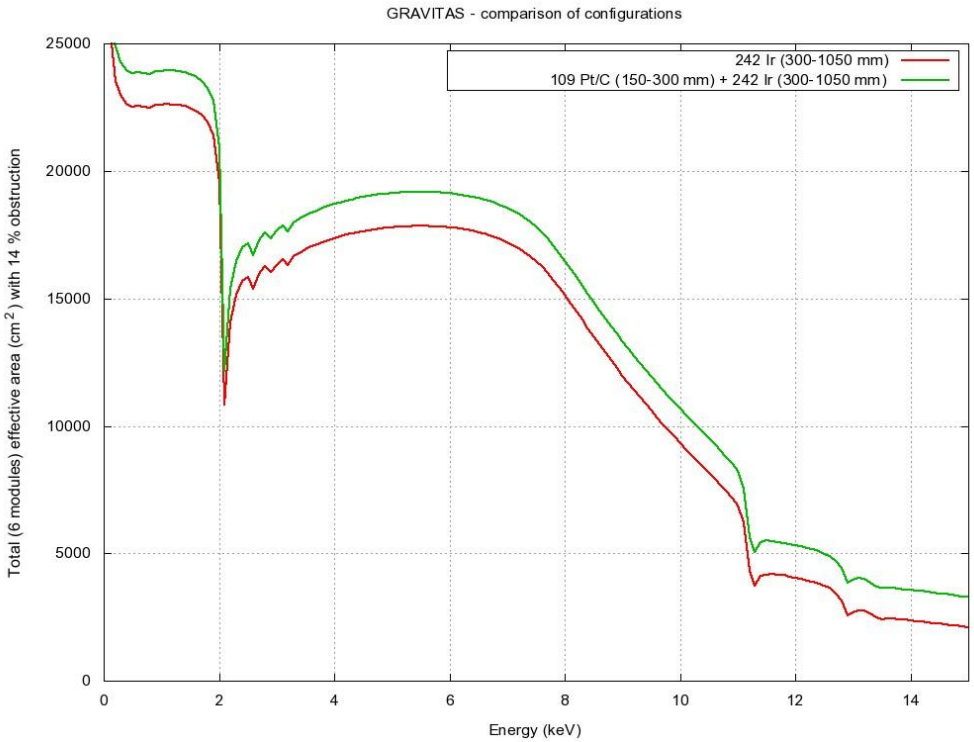
NHXG (NEW HARD X-RAY GRAVITAS)

1 single module = 1 NHXM + 1 GRAVITAS units (nested together)

Mirror material: Ni/glass segments

MASS (1 MODULE)≈ 200 kg

+

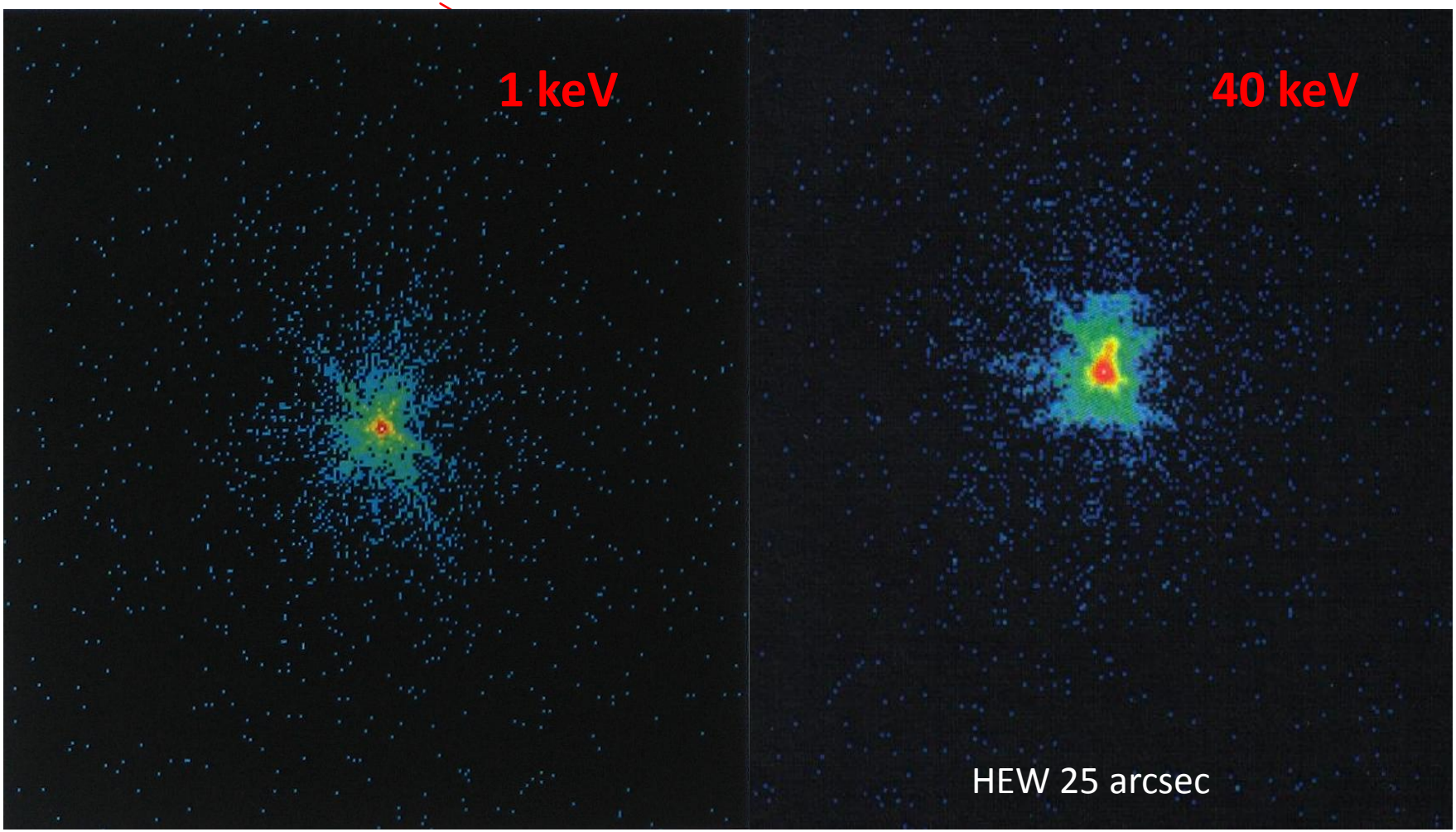


6 mirror modules

HEW ➔ 10-20 arcsec

NB: Possible improvement with polarimetry and extension of the band with Bragg crystals

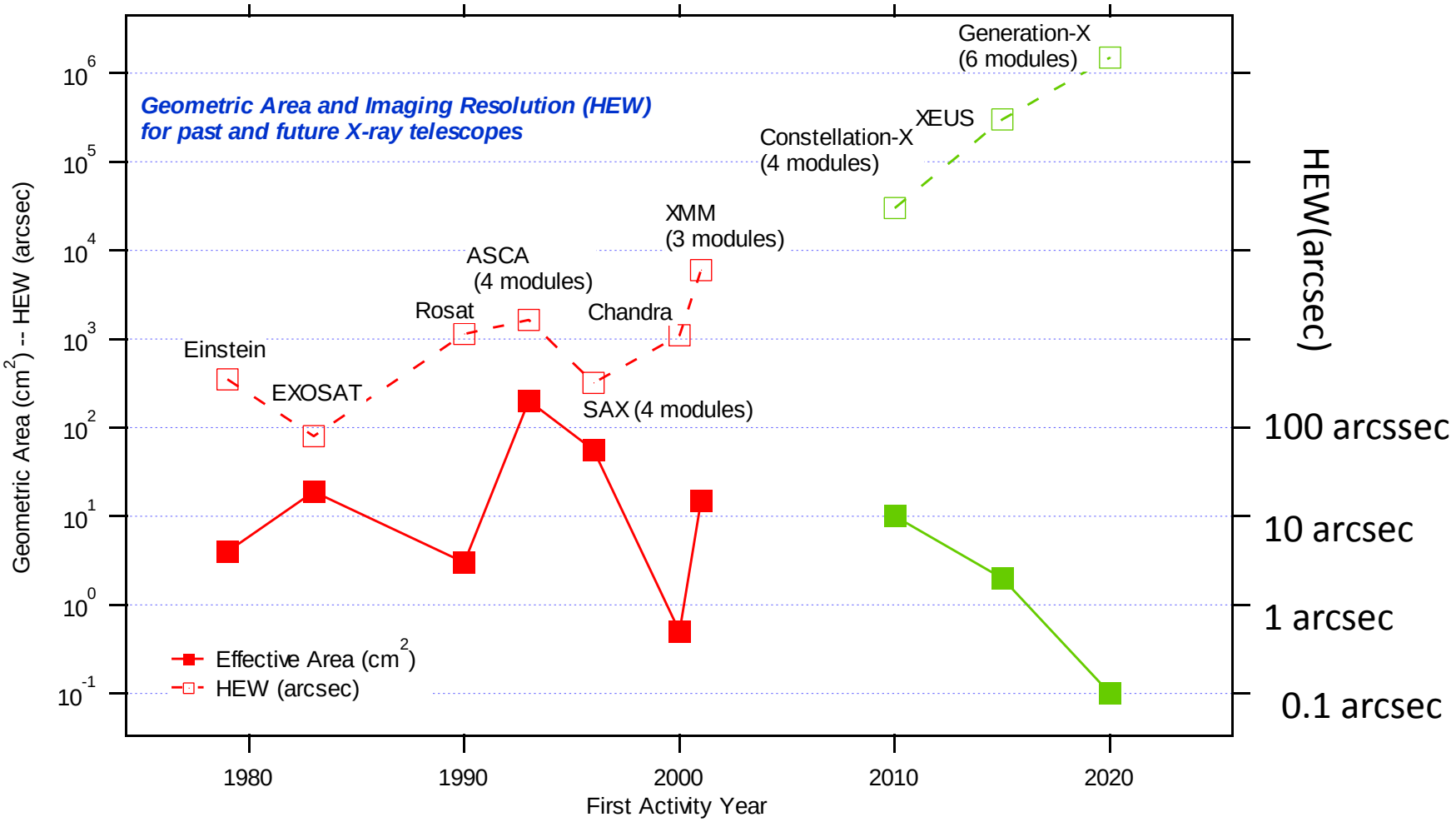
Optics calibration @ Panter/MPE

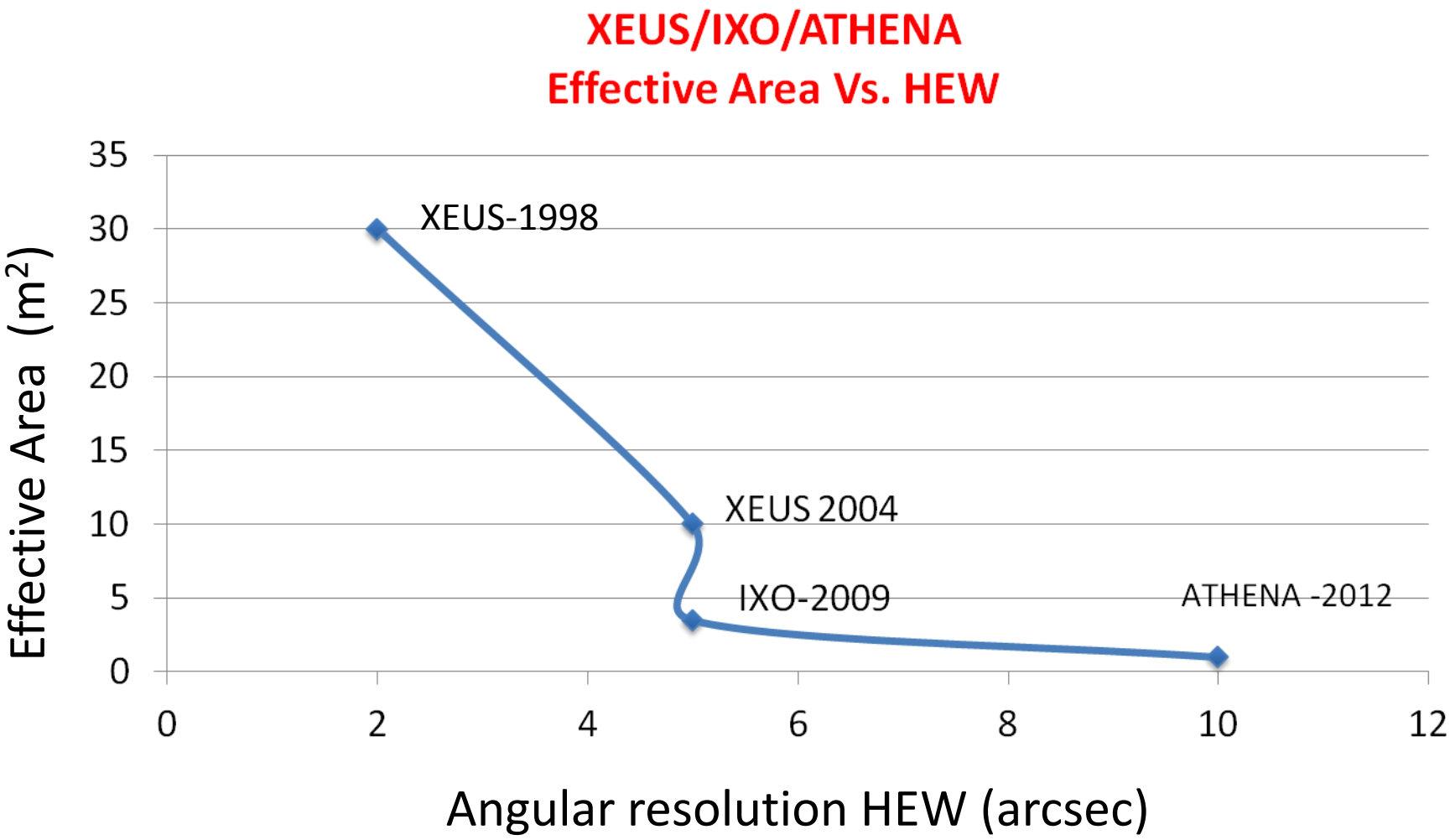


Angular resolution for Hard X-ray Experiments & Telescopes

Experiment - Telescope	Year	"Imaging" technique	Angular resolution
SAX-PDS	1996	Rocking collimator	> 3600 arcsec (collimator pitch)
INTEGRAL-IBIS	2002	Coded mask	720 arcsec (mask pitch)
NUSTAR	**2012**	**Multilayer Wolter I mirrors**	**60 arcsec HEW**
NHXM/SIMBOL-X-like?	?	Multilayer Wolter I Optics	> / >> 20 arcsec HEW

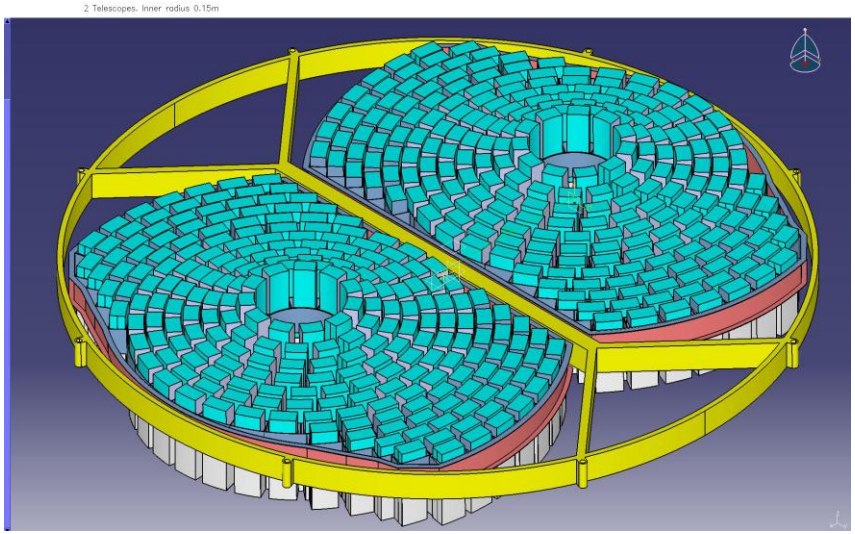
Geometric Area and Angular resolution for past and future X-ray telescopes



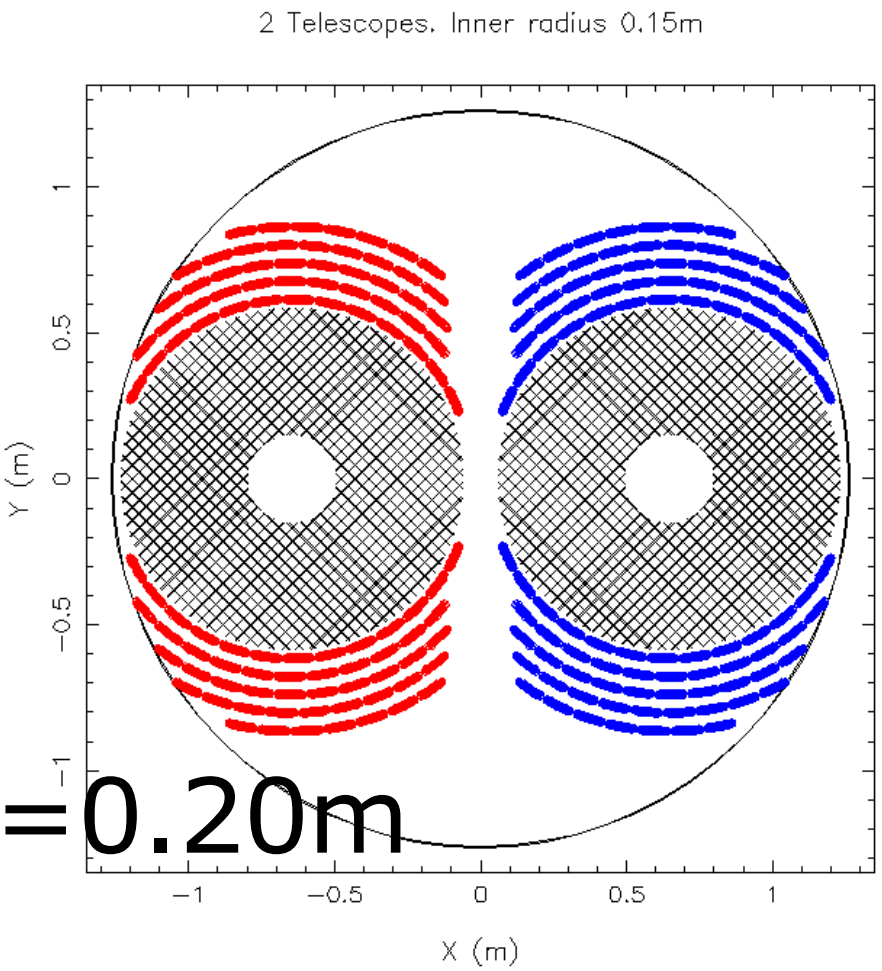


Is the science case changed across the time?

ATHENA - "Owl Eyes" Design

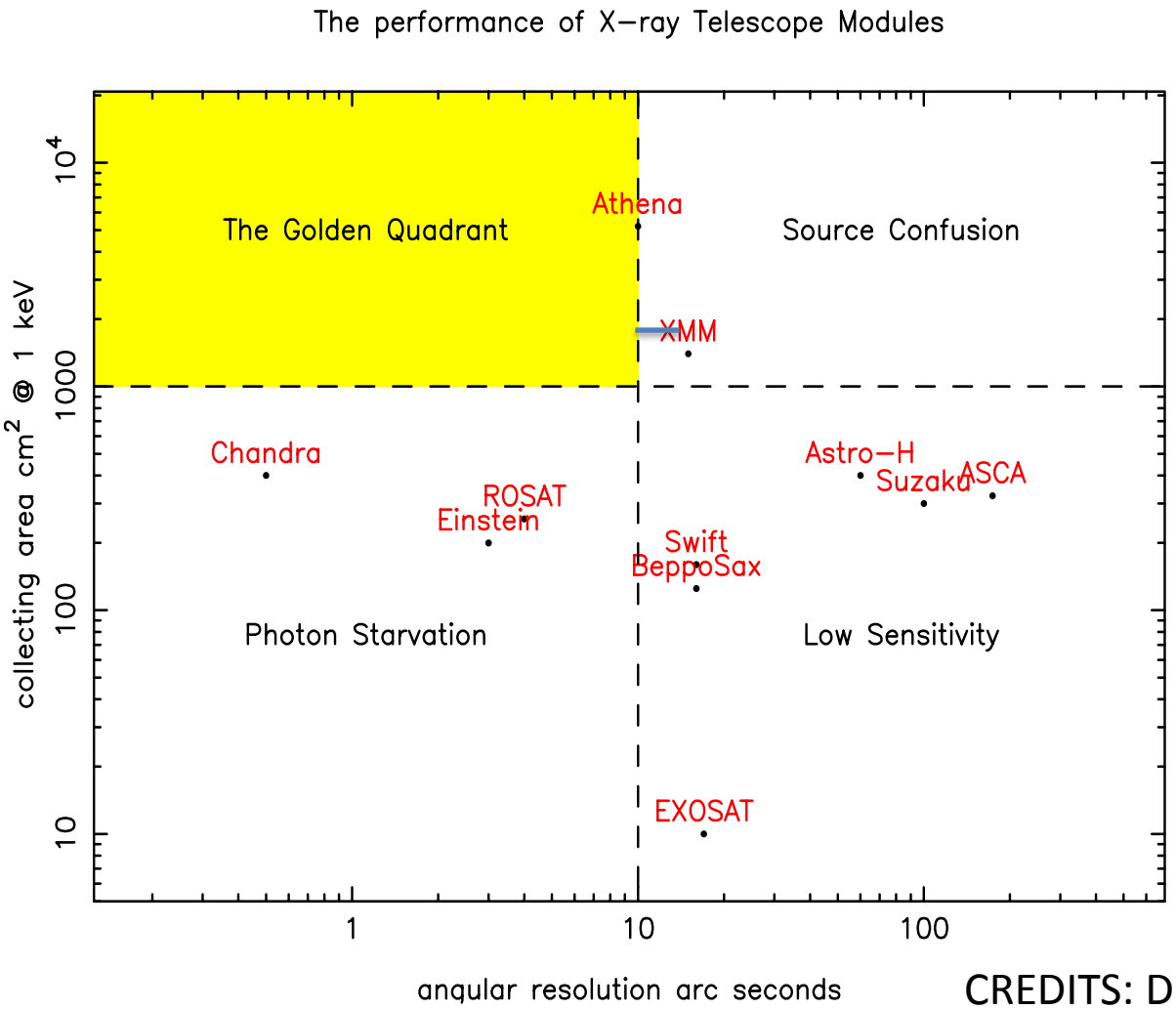


HEW requirement = 10 arcsec



F=11.5m and Rin=0.20m

Athena Telescope Area and Resolution



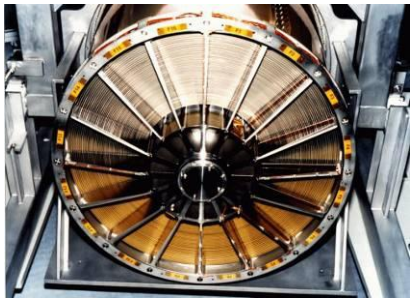
CREDITS: Dick Willingale

CHANDRA

0.5 arcsec

Aeff = 0.078 m²

18500 kg/m²
Aeff @ 1 keV

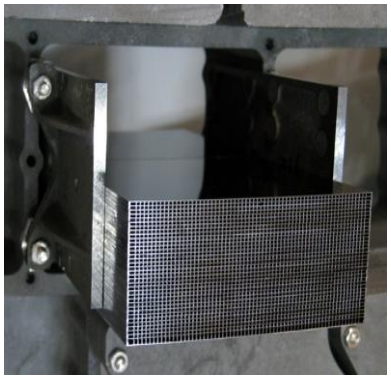


XMM-NEWTON

10 arcsec

Aeff = 0.43 m²

2300 kg/m²
Aeff @ 1 keV



Silicon Pore Optics

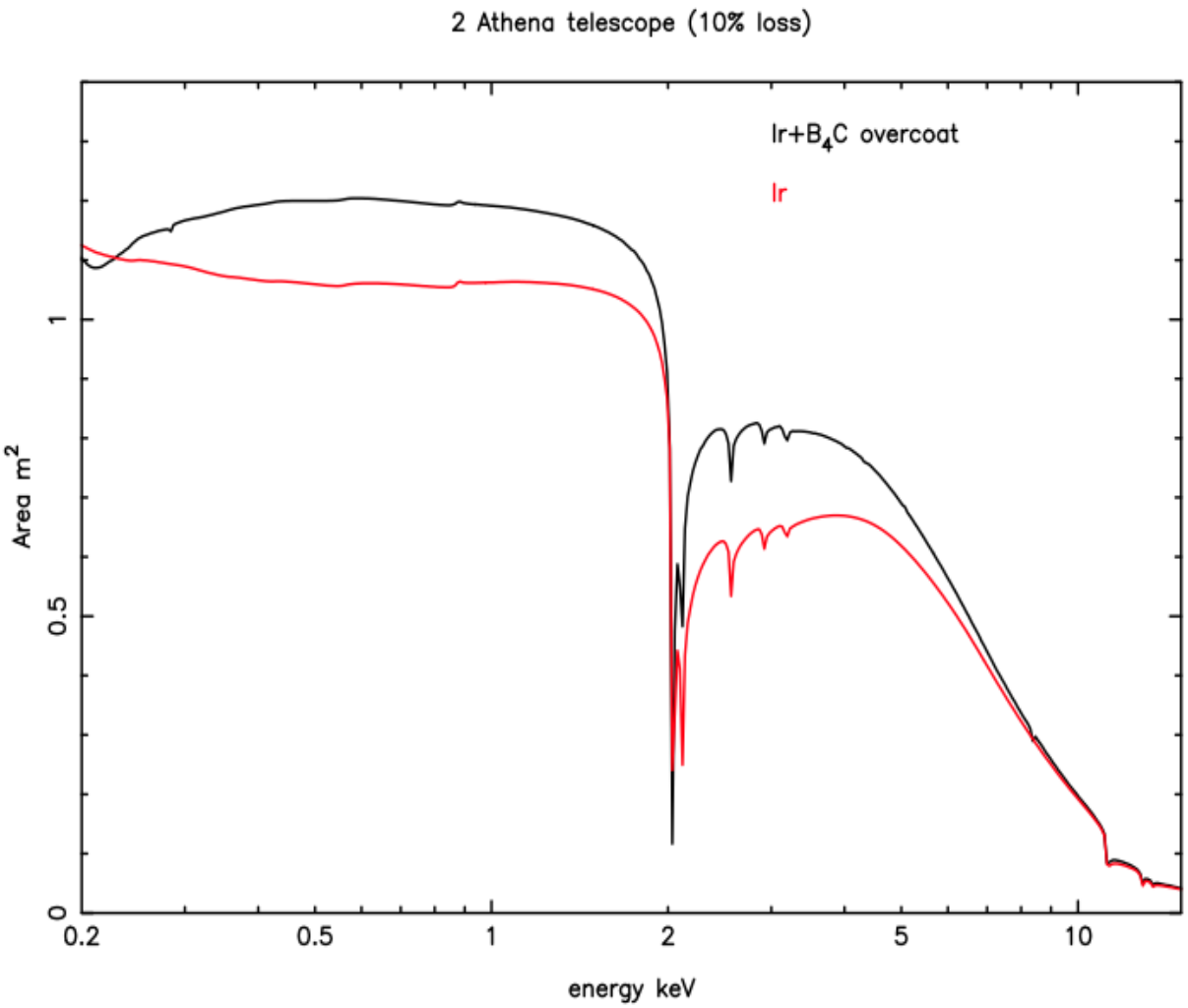
10 (5) arcsec

Aeff = 1 m²

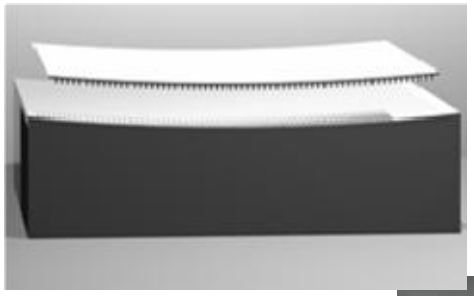
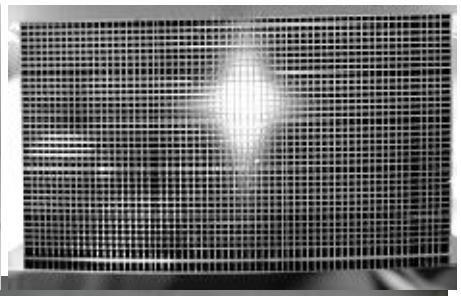
<240 kg/m² (mirror module)
2500 kg/m² mirror system
Aeff @ 1 keV

ATHENA baseline

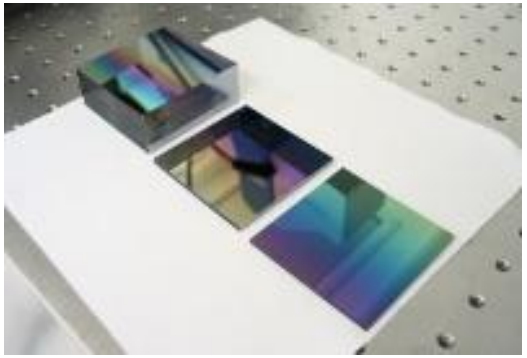
ATHENA's effective area



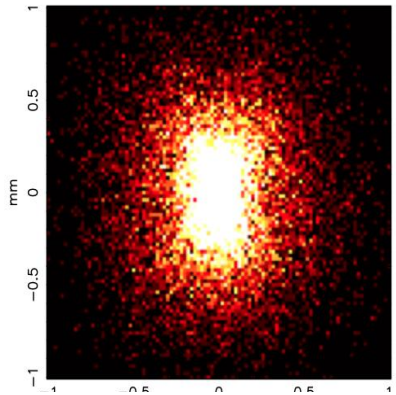
PORE OPTICS TECHNOLOGY



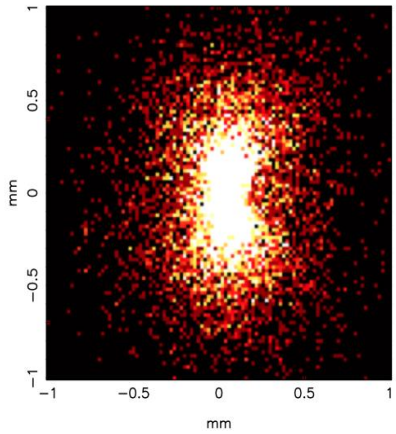


Si-Pore Optics PSF



PSF on-axis at 1.25 keV. The rms major/minor ratio is 1.21

Asymmetry introduced because the aperture is not circular

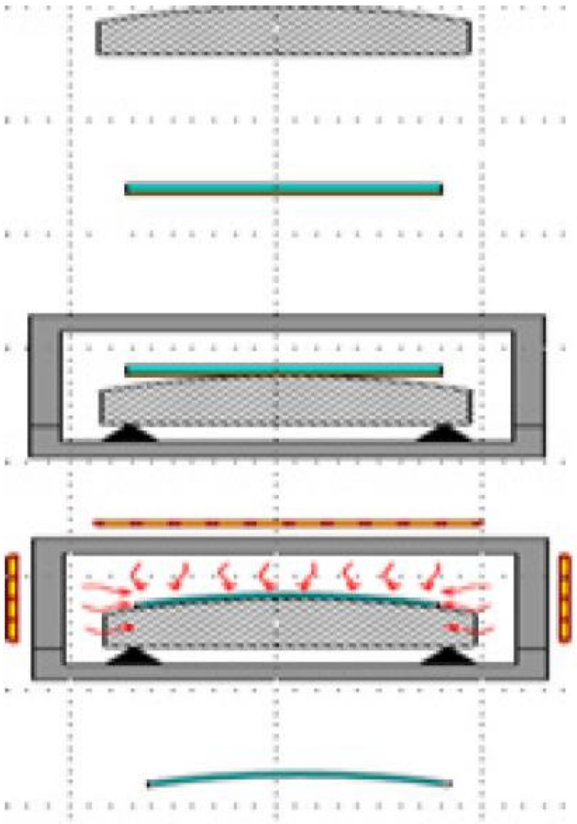


PSF 10 arc minutes off-axis at 1.25 keV. The rms major/minor ratio is 1.45

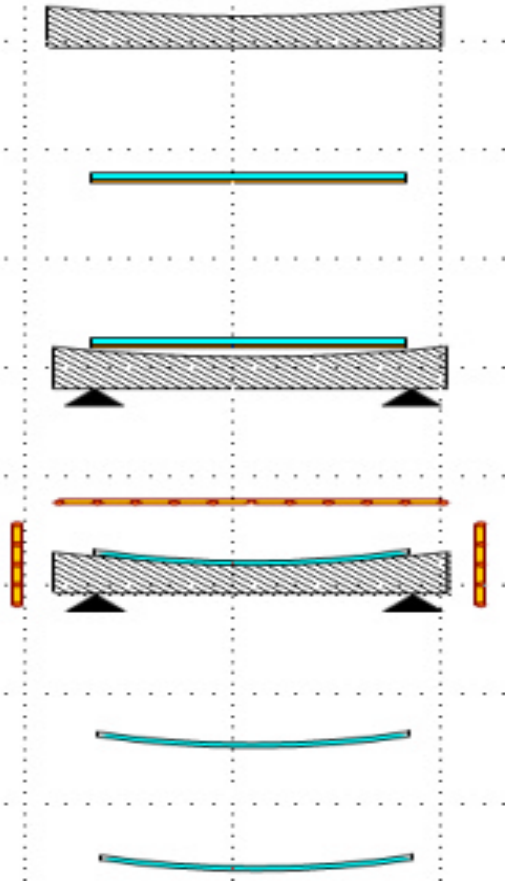
Current calibrations at Panter: 20-25 arcsec HEW for the single unit (about 20 cm^2)
Improvements aiming at reaching 5 – 10 arcsec

Direct & Indirect slumping processes

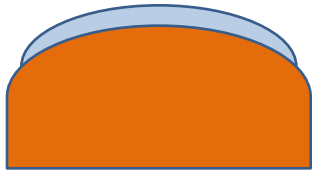
DIRECT



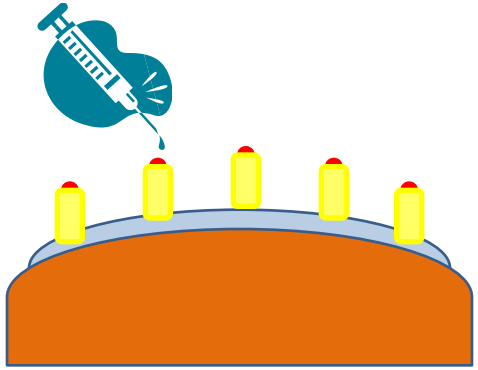
INDIRECT



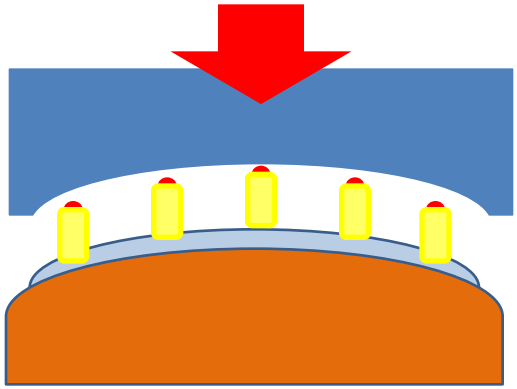
Slumped glass integration



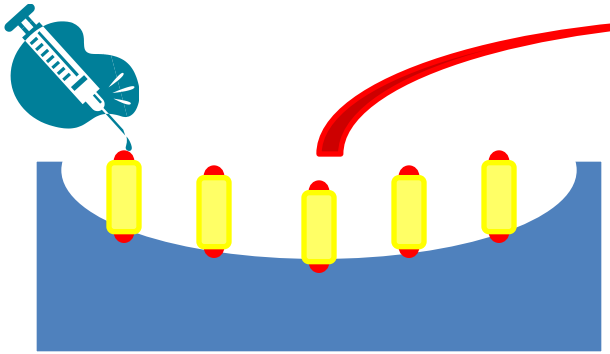
Glass fixed
To the mould



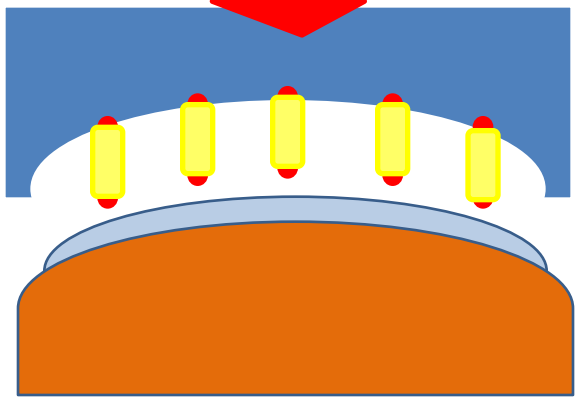
Ribs aligned on the glass
And glue dispensed



Ribs glued to backplane



Glue dispensed on the ribs



Backplane with ribs glued to glass fixed on mould

Slumping Glass results (OAB/ESA)

2.1.1. Characterization before edge trimming

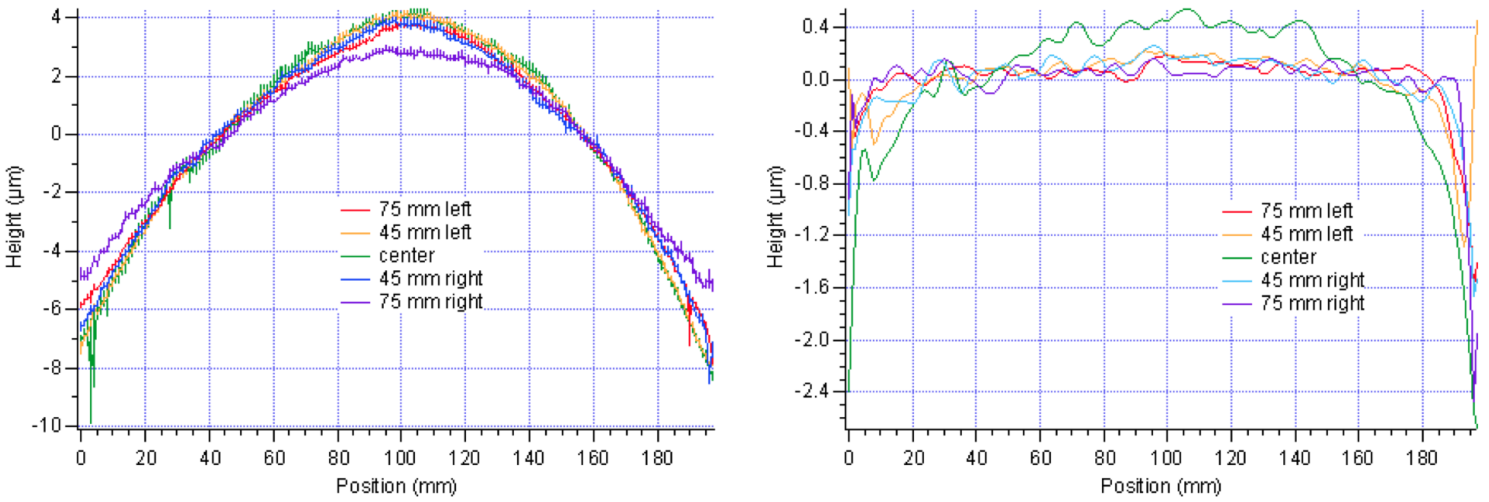
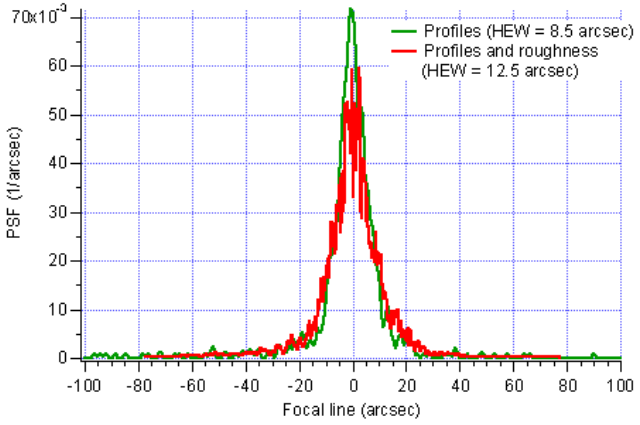
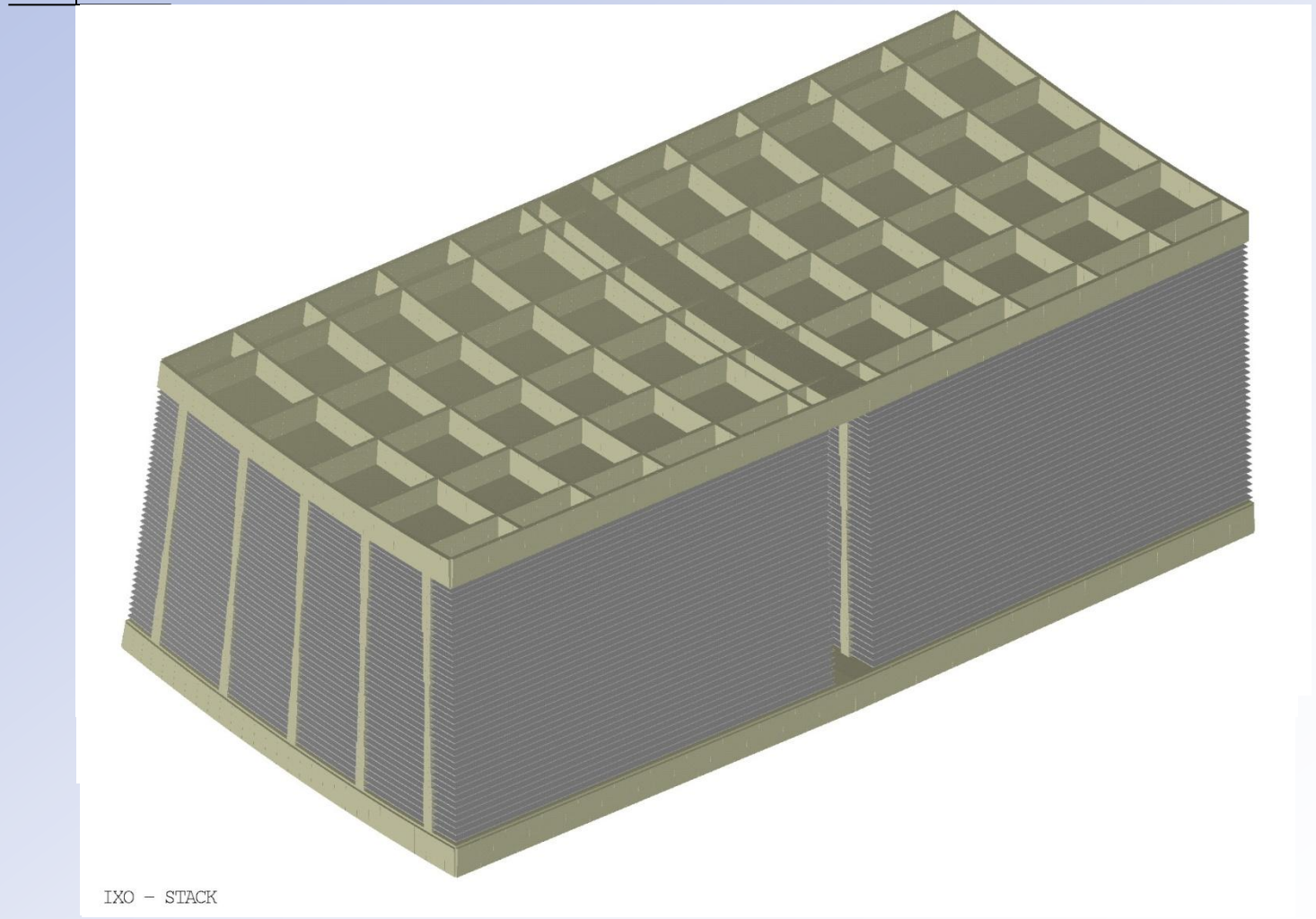


Fig. 1: (left) measured longitudinal of the PS-IXO-196 with the LTP+CHR, over a 200 mm scan length. (right) after simulating the integration effect.

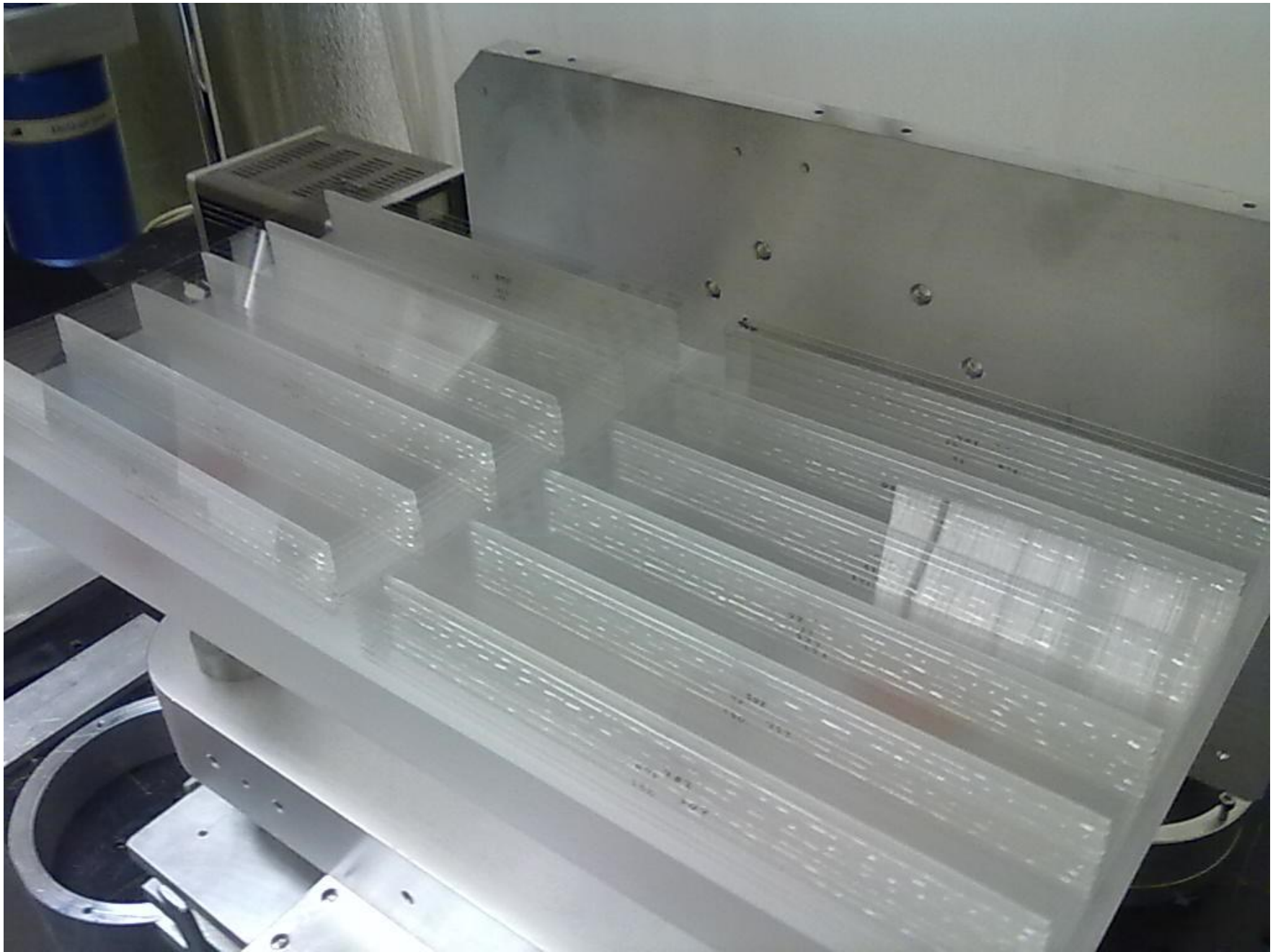
HEW ≈ 10 arcsec



THE INTEGRATION CONCEPT

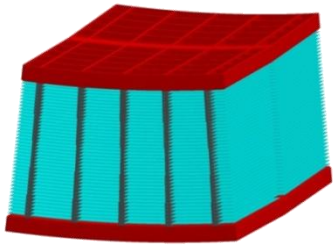


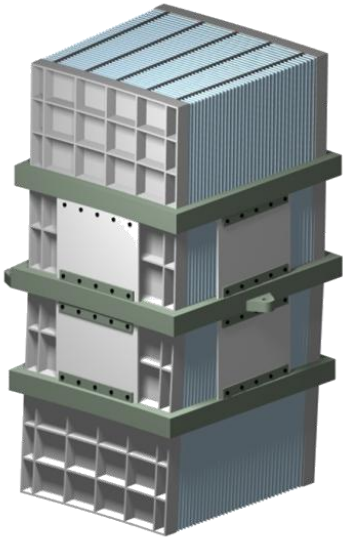
XOU-BB

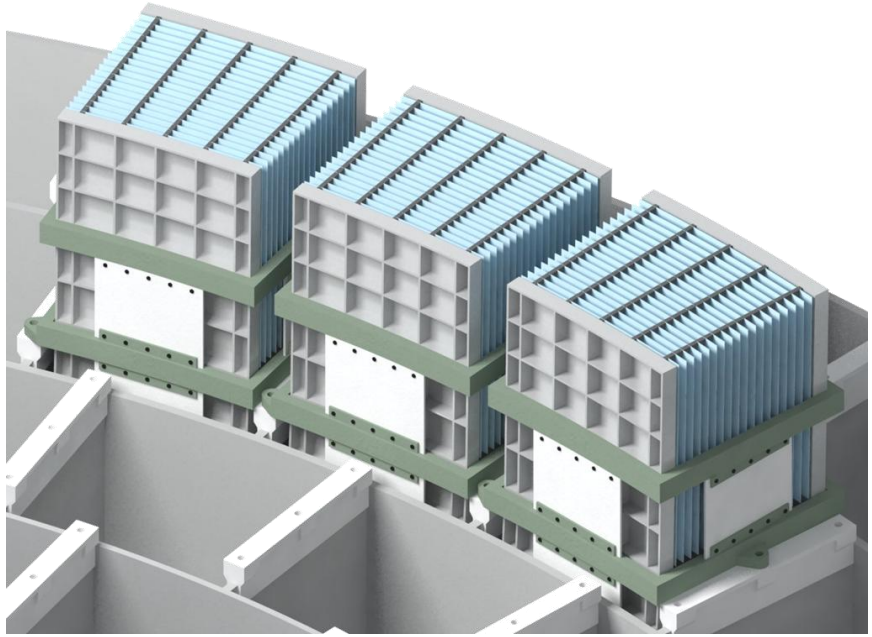


8 plate pairs (PP1, PP2… PP8)

From the double plated stack (with ribbed glass back-plates) to the optics module assembly







Flight Mirror Assembly

Hierarchy principle for fabrication of the complete mirror assembly

Main Parameters for the Telescope Configuration	
Number of MS per XOU	35-60
Number of Rings	9
Number of XOUs	246
MS thickness	0.4mm
Ribs average thicknes	4.2mm
Average XOU mass	~ 10.5 Kg