Hard X-ray Response and its developments in Japan

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Science with HXT/HXI

Evolution of Massive Black Holes
- without biases due to absorption

Resolving point sources of CXB in 10-60 keV

Higher S/N ratio in Hard X-rays
- better determination of continuum spectra
- better time resolution of variability

Mapping diffuse hard X-ray sources
- on Galactic plane
- cluster of galaxies

Hard X-ray Imaging telescopes

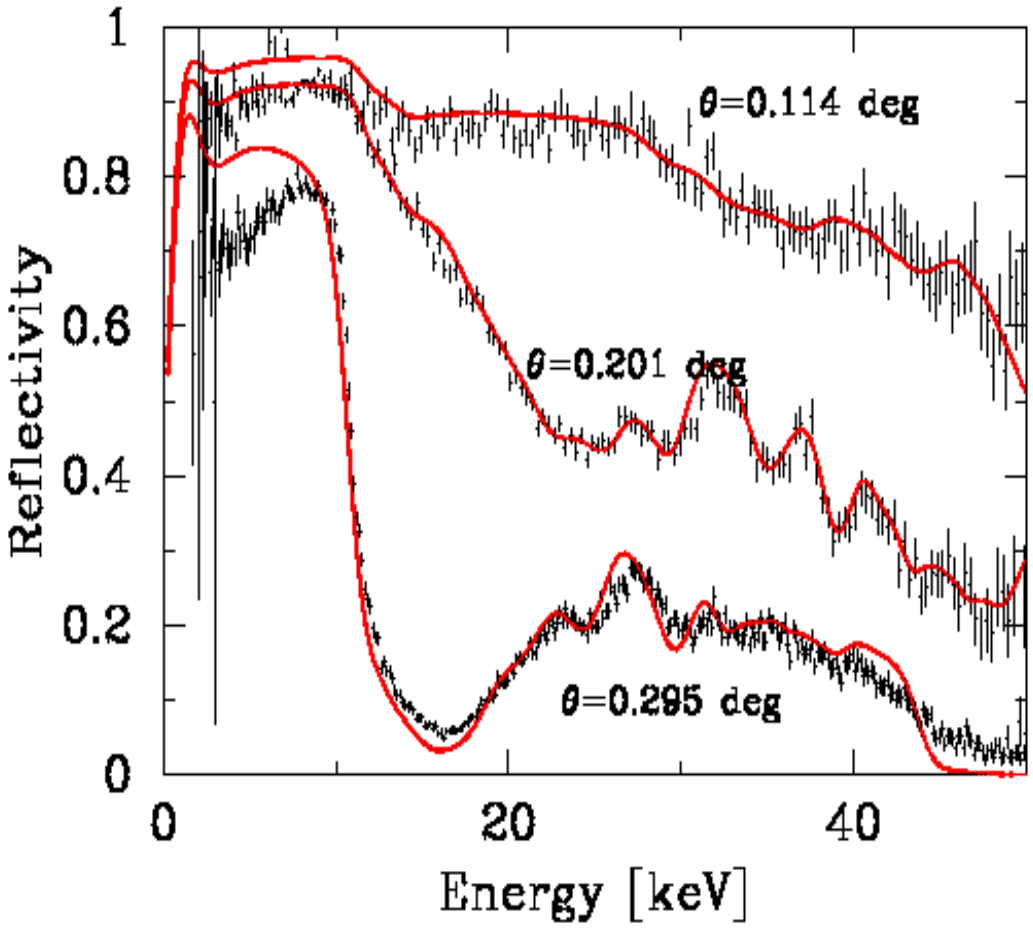
Hard X-ray response

1. Small incident angles -->Long EOB
   <--> low efficiency(obscuration by t~0.2mm)
2. Multilayer coatings
   design and implementation
   Stress?

Image quality

90” --> 10”
Necessary for resolving point sources
Utilize same optics?

Multilayer design for Hard X-ray Telescopes

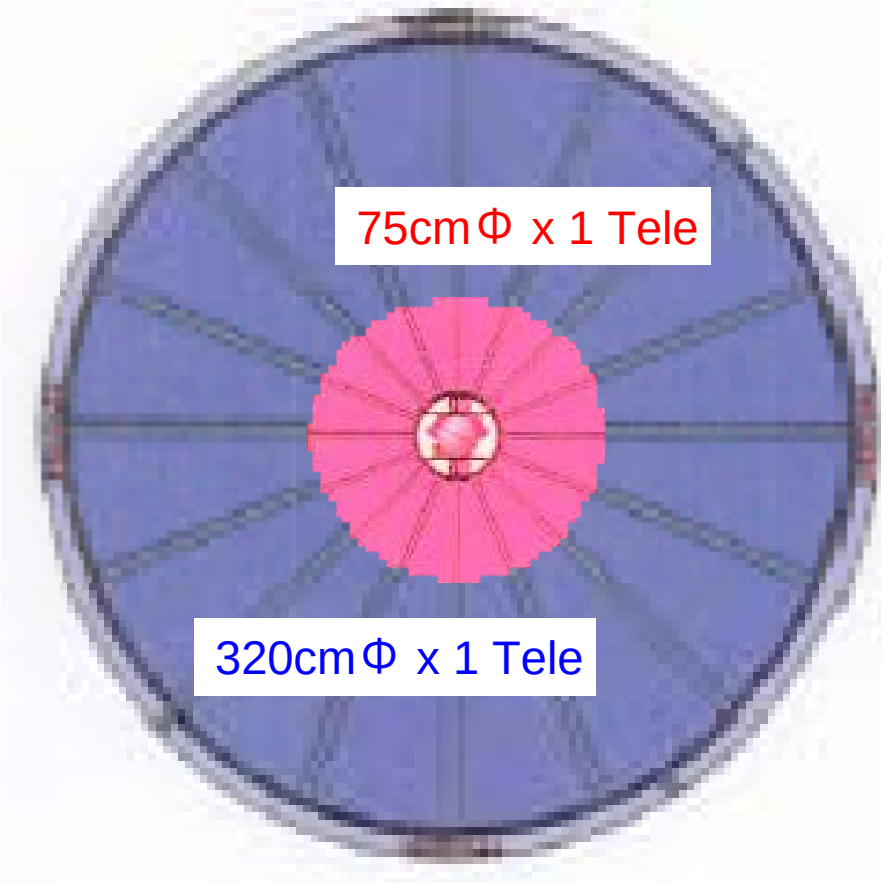


θ(deg)	N	d_{max}(Å)	d_{min}(Å)
0.110	28	126.4	46.2
0.123	37	117.8	40.0
0.135	56	117.8	35.3
0.152	79	117.8	31.6
0.169	93	117.8	28.6
0.187	121	106.5	26.1
0.208	138	98.5	24.0
0.230	138	98.5	24.0
0.253	123	88.5	24.0
0.280	123	88.5	24.0
0.310	108	77.4	24.0
0.342	108	24.0	24.0

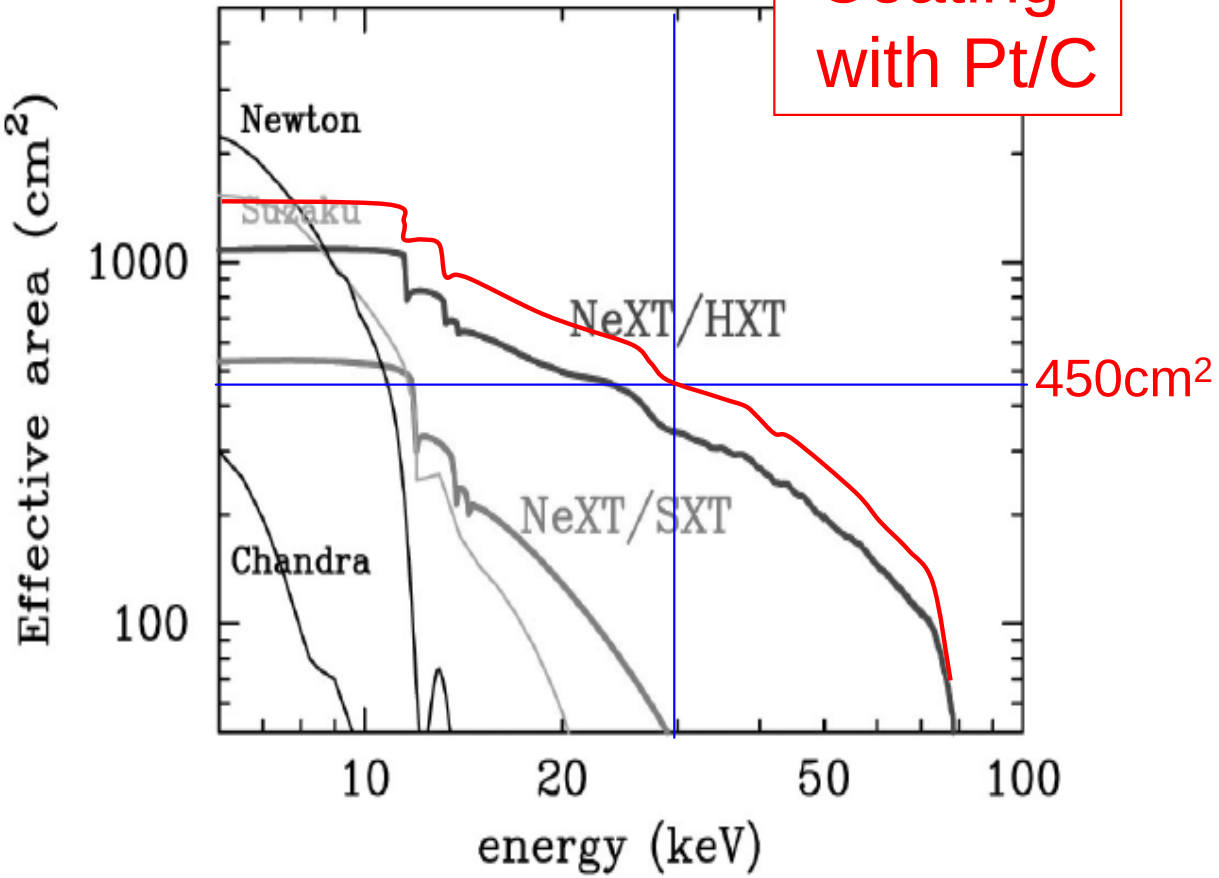
$\theta \leqq 0.3$ degrees ⟸ d ≥ 25 Å

Hard X-ray Telescopes for IXO

Characteristic	Value
Aperture annulus radii	**0.10 - 0.375 m**
Grazing reflection angles	**0.07 - 0.27 degree**
Focal length	**20 m**



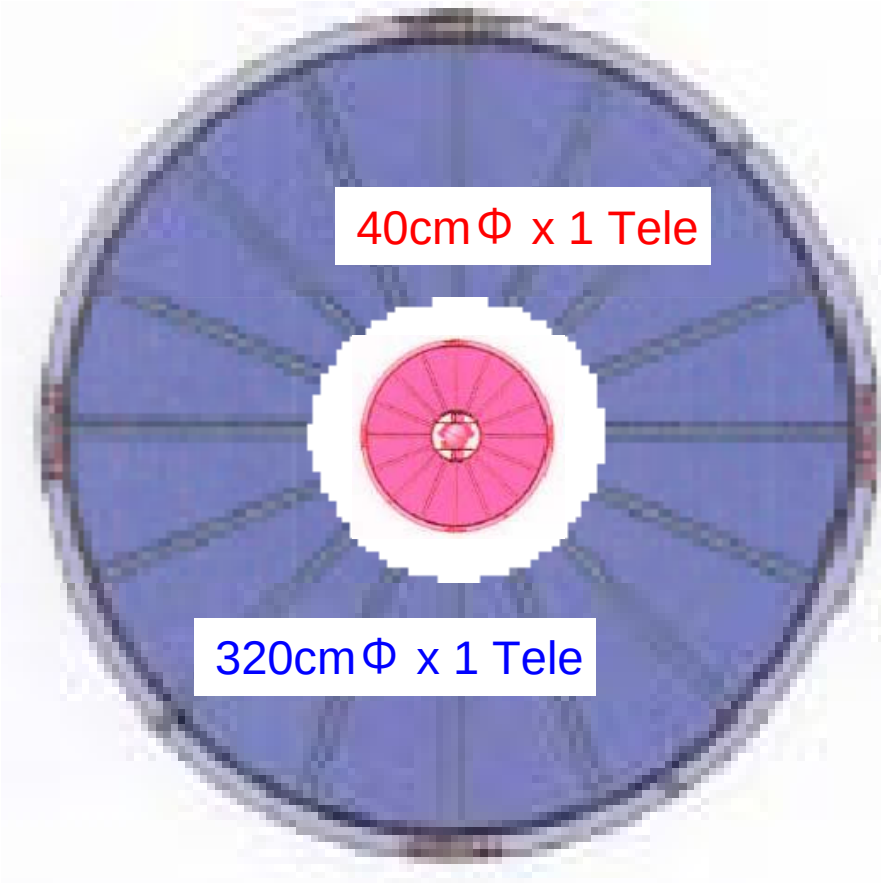
Multilayer Coating with Pt/C

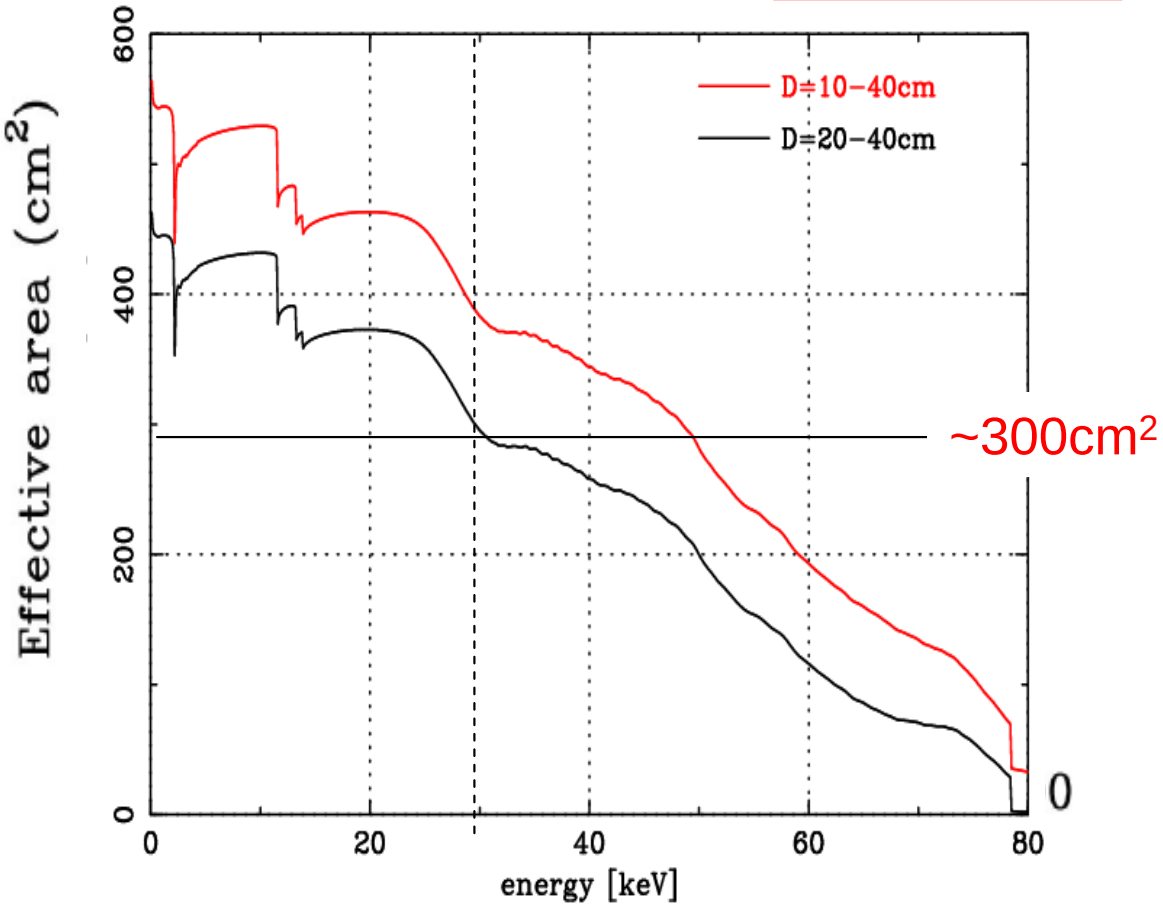


Hard X-ray Telescopes for IXO

Characteristic	Value
Aperture annulus radii	**0.10 - 0.20 m**
Grazing reflection angles	**0.07 - 0.14 degree**
Focal length	**20 m**

Multilayer Coating with Pt/C





Hard X-ray telescopes

Multilayer on Si wafers

Si wafers for XEUS from ESTEC

10 x 100 x 1 mm^3

Standard Pt/C Multilayers

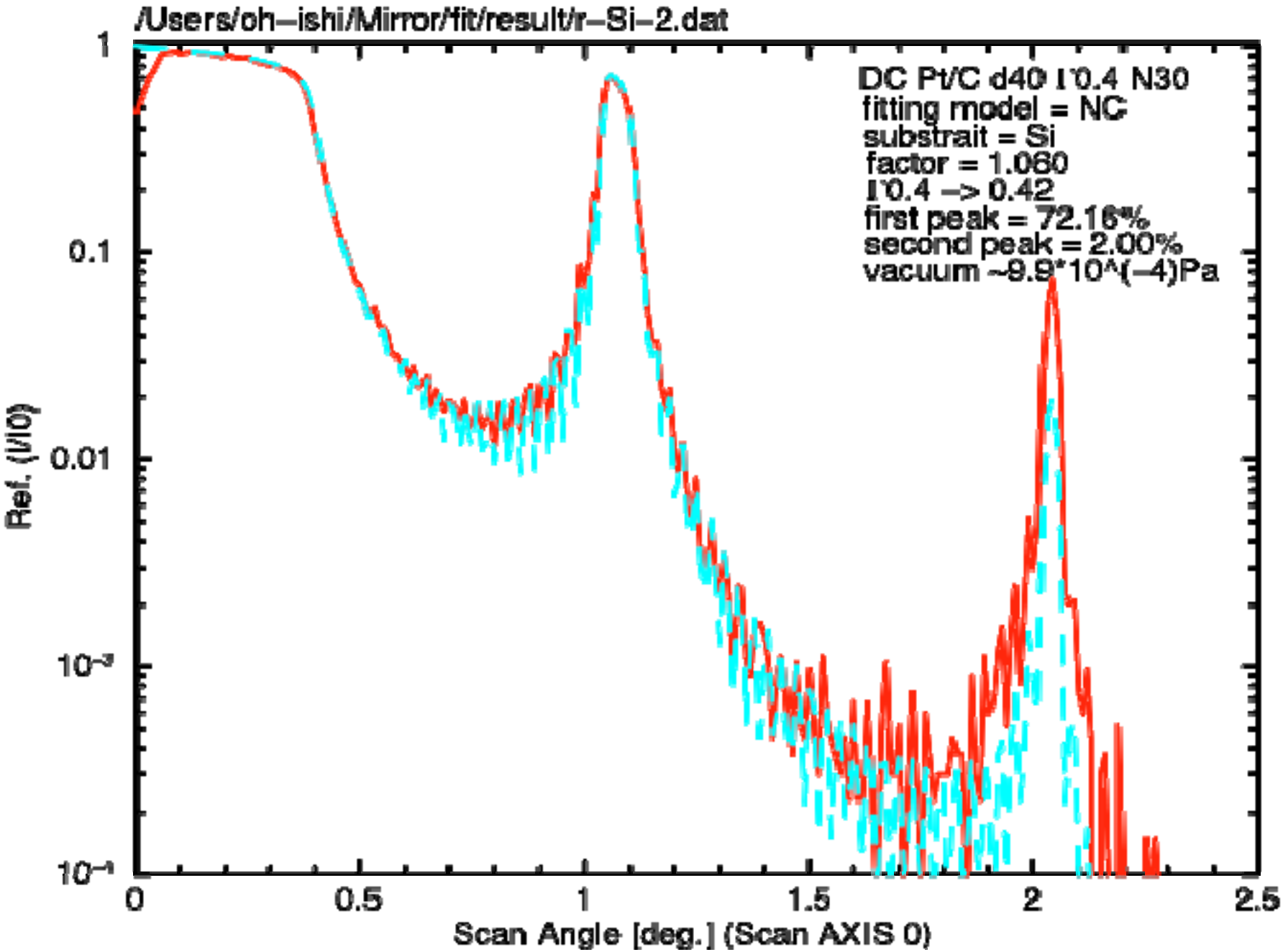
d = 5 nm, N = 30 layer pairs

Float glass plate as a reference

First Bragg peak reflectivity
Si ~ Float glass

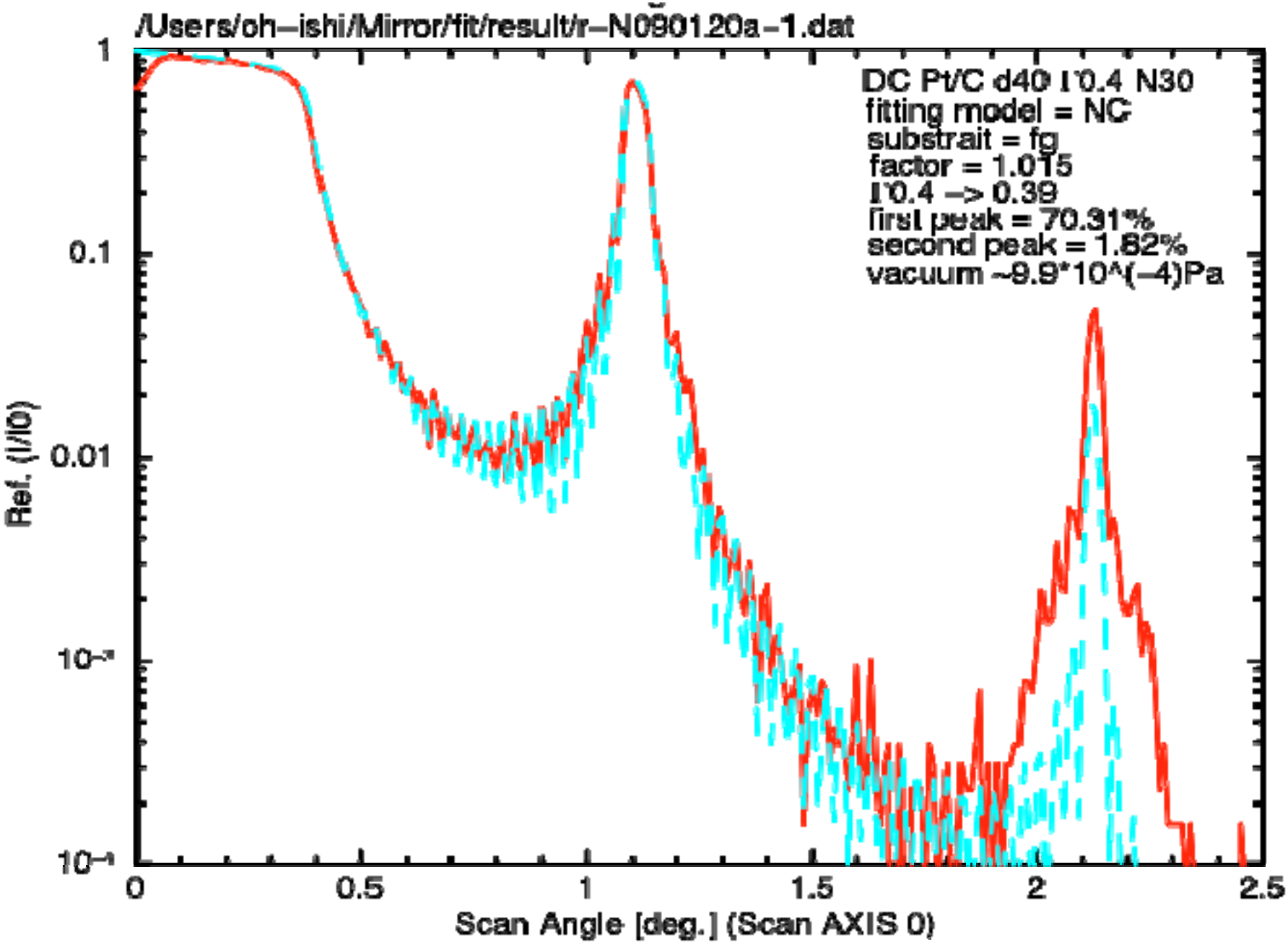
Cu-K

Reflectivity of ML on Si surface



Cu-K

Reflectivity of ML on Float glass surface



Synchrotron Beam at SPring-8
E<200 keV

8 GeV

2πR= 1436 m

Power User
(Machine time is reserved for calibration)

QuickTimeý Ç²
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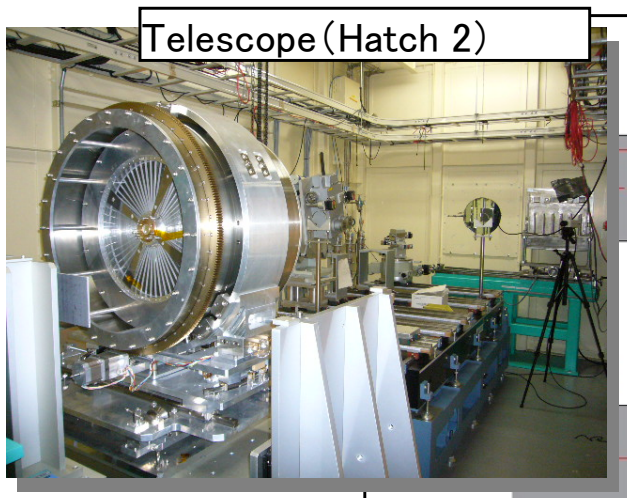
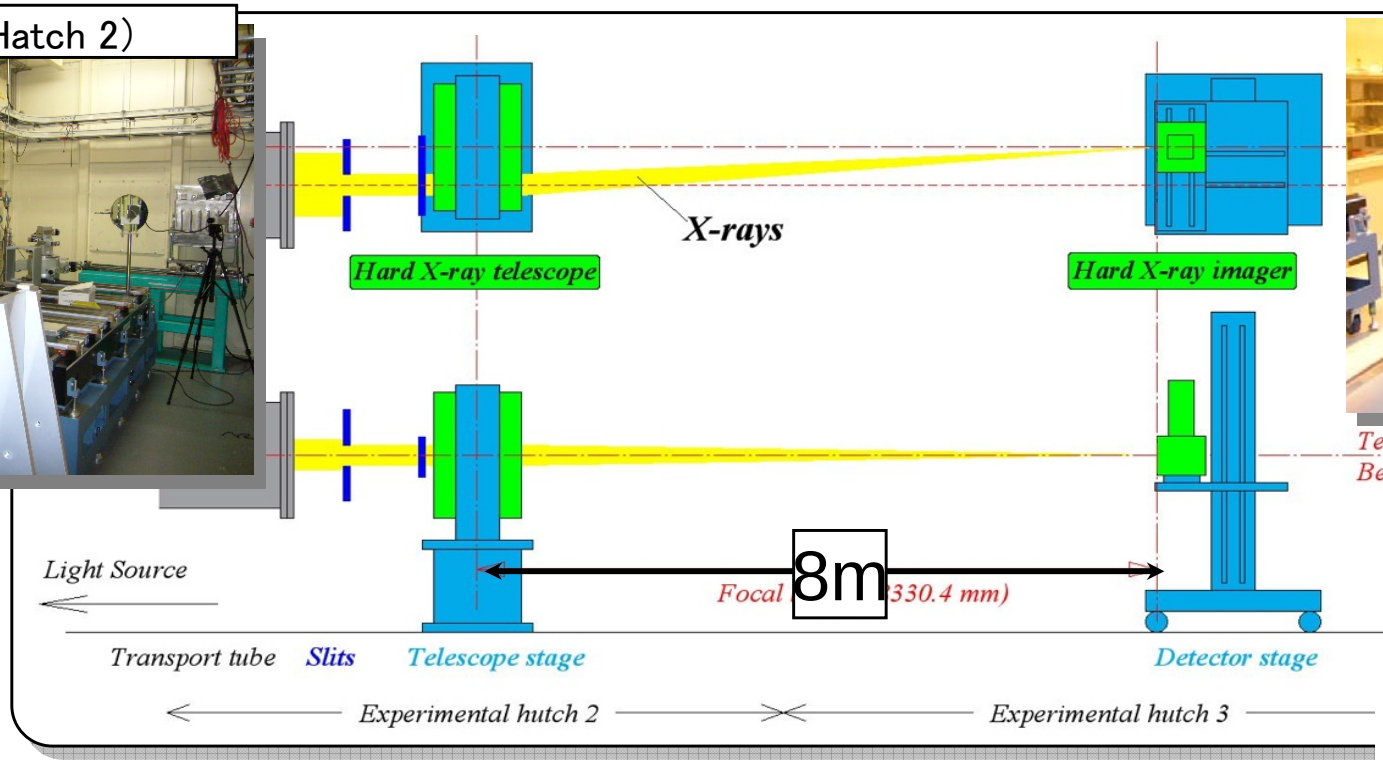
Yasushi Ogasaka et al.
Japanese Journal of Applied Physics
Vol. 47, No. 7, 2008, pp. 5743–5754

Himeji, JAPAN

Synchrotron Beam at SPring-8
E<200 keV

BL20B2： 6 x10^6 photon s^{-1} mA^{-1} mm^{-2}@30keV





Scintillator
+lens+CCD

47.2x31mm^2
dX=11.8 μm

Si DCM E/dE=10^4

111 (5.0 to 37.5 keV), 311 (8.4 to 72.5 keV), and 511 (13.5 to 113.3 keV)

Hard X-ray Measurements

Astro-H HXT on stages

Hard X-ray Imager (Image Intensifier)

Study Activities in Japan

1. Conceptual Design of the Mission
   <== DSC study in XEUS

2. Extensible Optical Bench
   <== ASCA/Suzaku Heritage

3. X-ray telescope and Imager
   Hard X-ray Response+Calibration
   <== Astro-H HXT/HXI

4. Cryogenics
   <== XRS of Suzaku/Astro-H,,,,,,

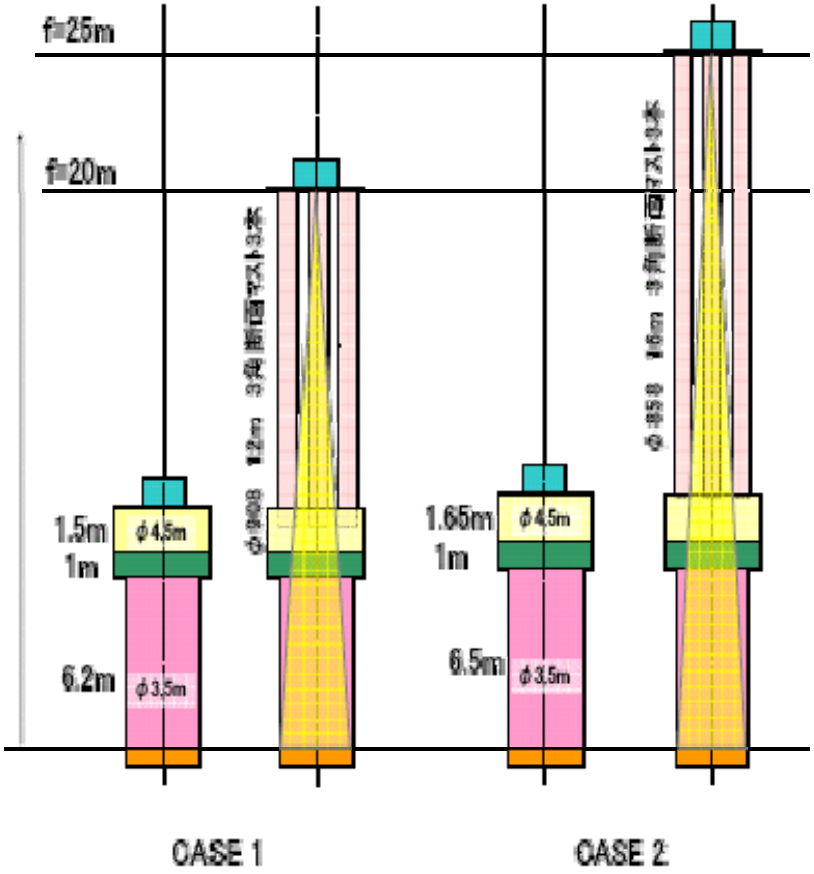
3. EOB Comparison of Mirror/Detector at 20/25m

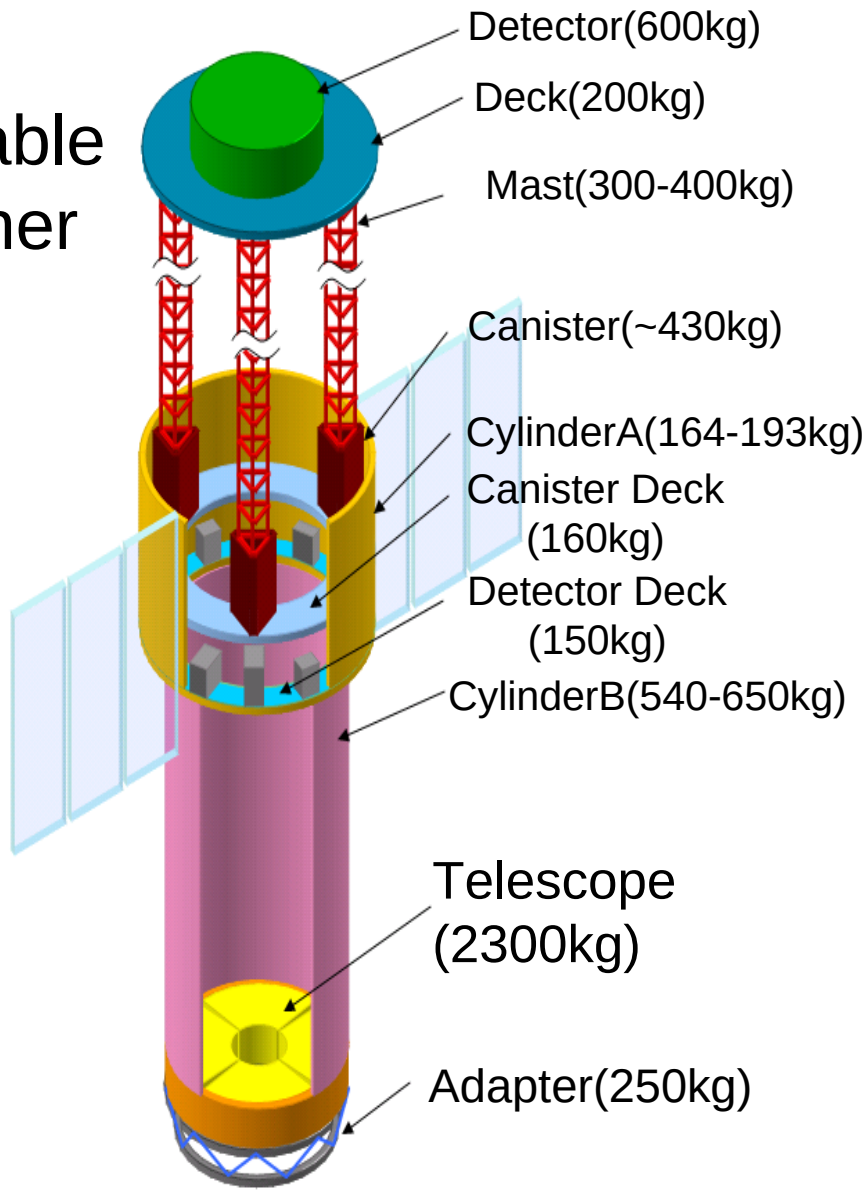
(1) Detector extension

FOB, total weight is comparable

Twist frequency is much higher

(2) 20/25m comparison



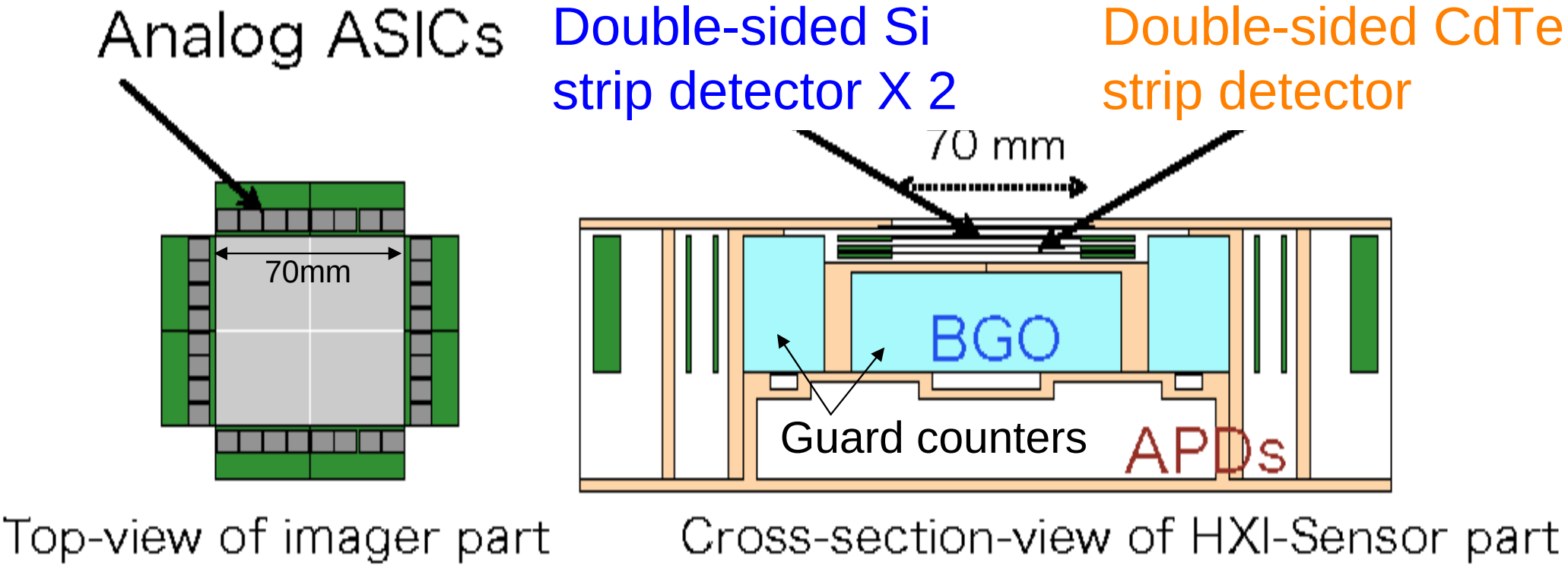


Hard X-ray imaging detector

HXI
new design

A draft design

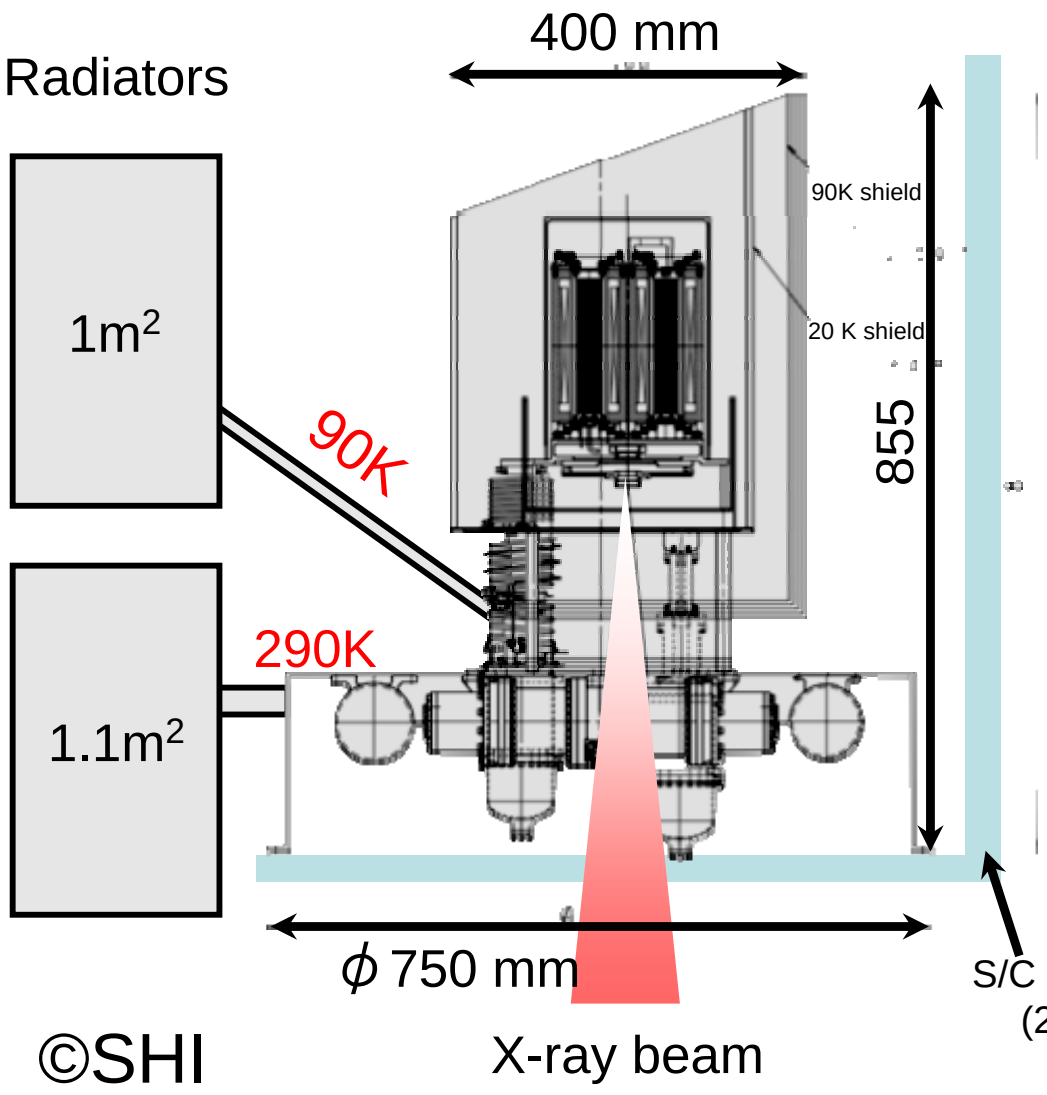
- Detailed design to be done.
- Astro-H HXI EM design (2008-2009) will be incorporated.



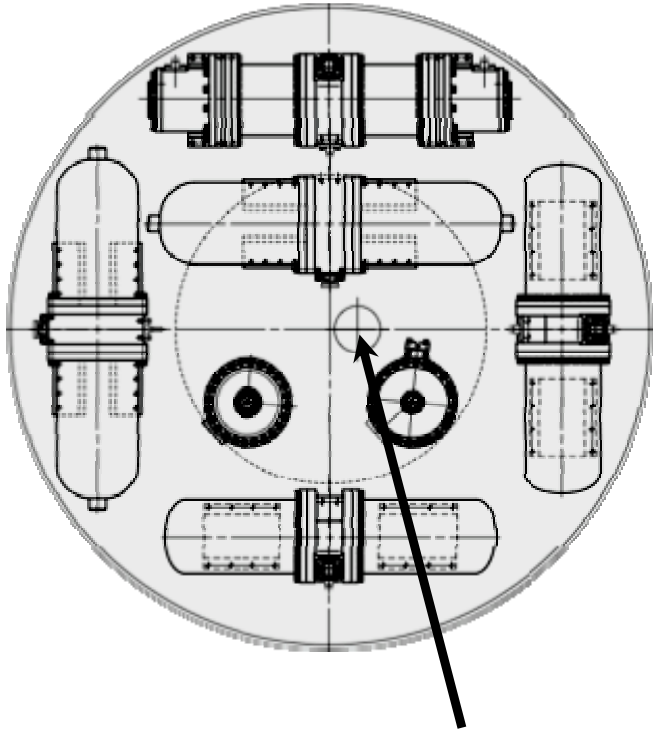
iv) Cryogenic system for IXO: a draft plan

Weight: 132kg
Power: 378W / 398W

Side view



Bottom view



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1. Conceptual Design of the Mission
   <== DSC study in XEUS

   NEC
   MELCO

2. Extensible Optical Bench
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   Nippi

3. X-ray telescope and Imager
   (Hard X-ray Response)
   <== Astro-H HXT/HXI

   Calibration Beam Line at SPring-8

4. Cryogenics
   <== XRS of Suzaku/Astro-H,,,,,,

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5. Detector developments
   CCD, **ASIC, Calibration**,,,,

   Hamamatsu