Hard X-ray Imaging and Telescope options

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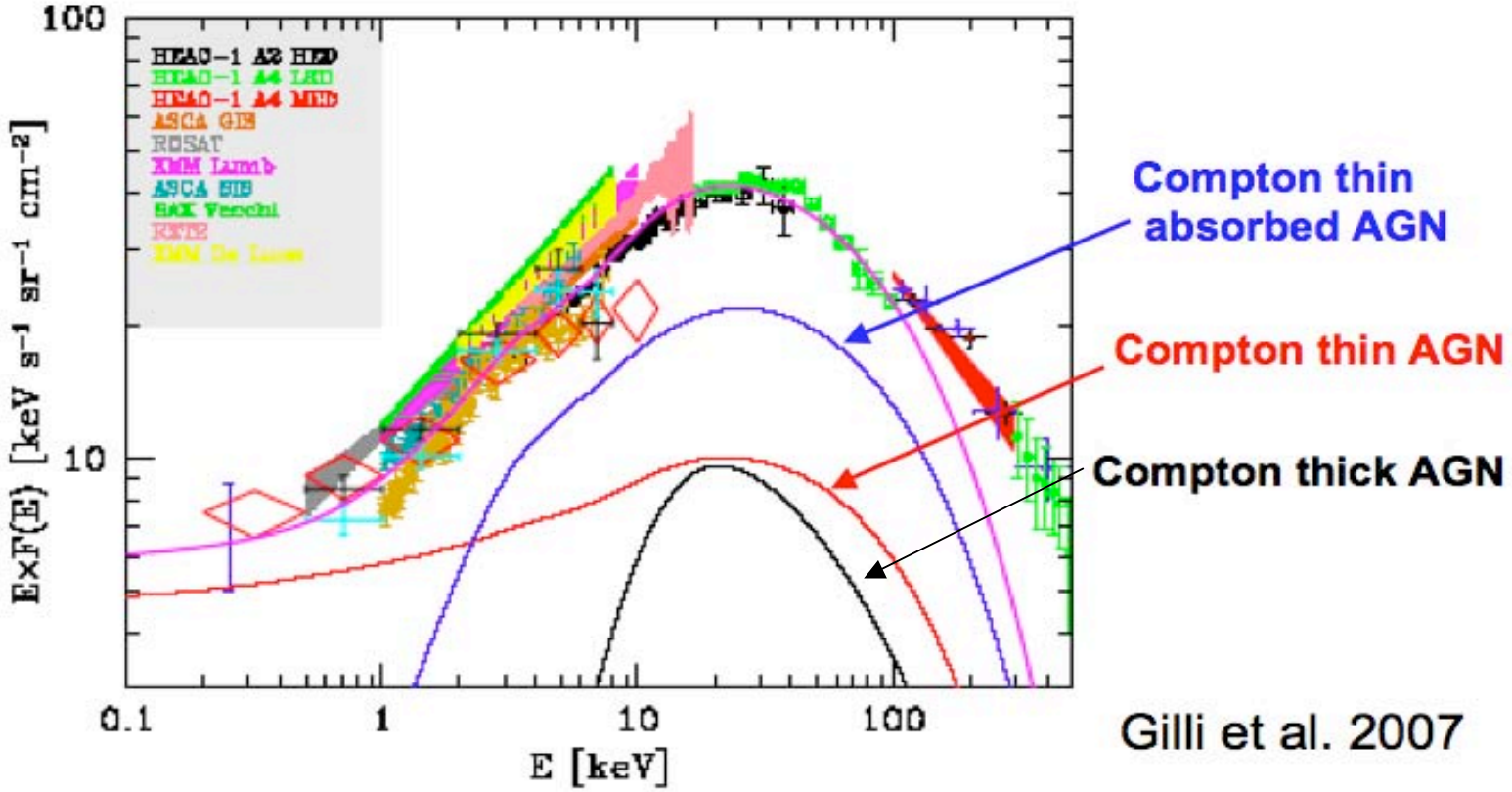
Cosmic X-ray Background above 10 keV

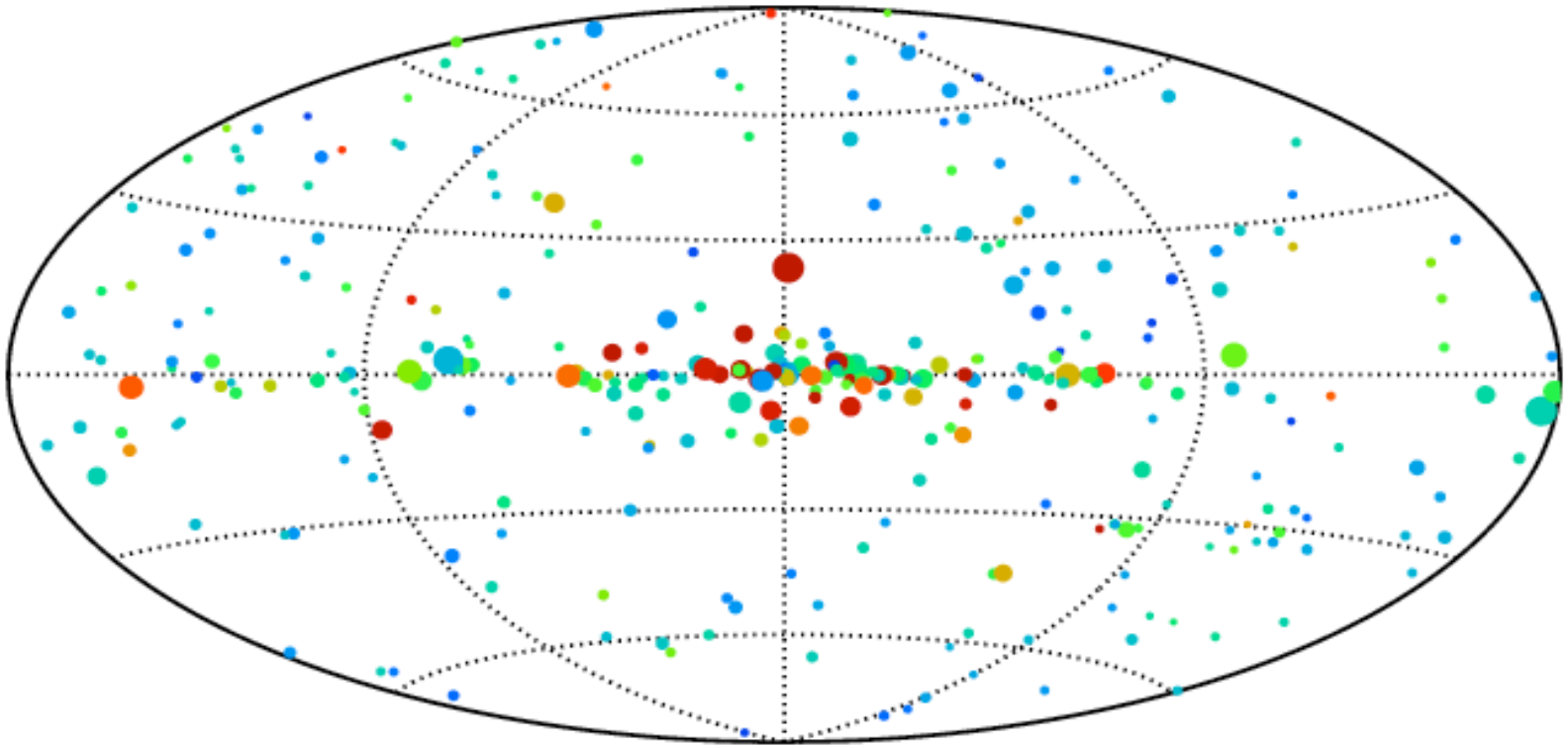


Absorbed AGN are necessary to explain CXB(E>10 keV)

Astrophysics in hard X-ray band

SWIFT BAT Survey Observations

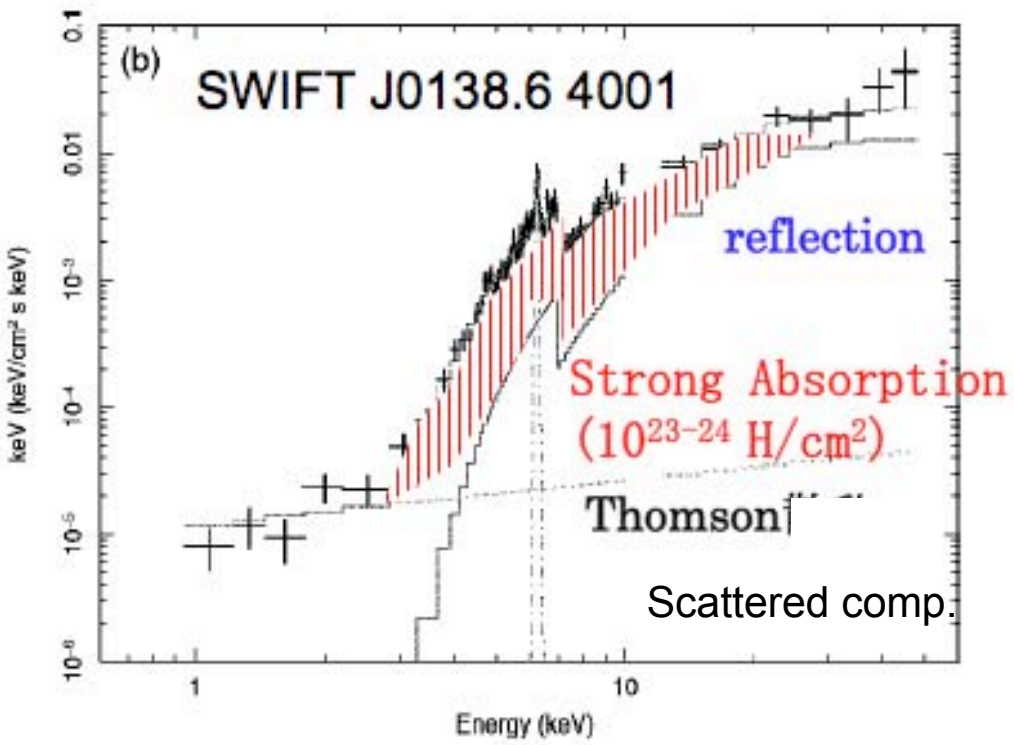
SWIFT BAT



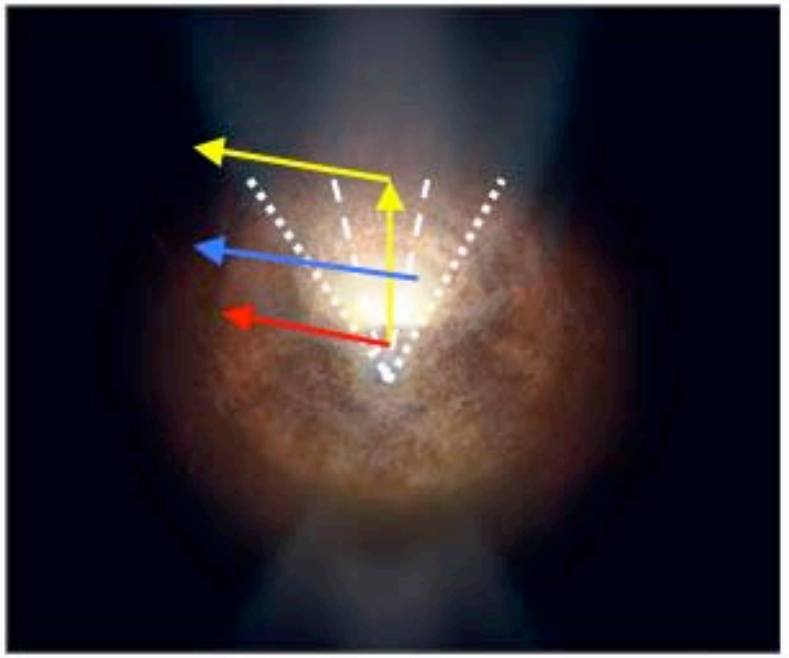
Markwardt, Tueller et al. 2005

Astrophysics in hard X-ray band

Suzaku follow-up Observations



Discovery of strongly absorbed AGN



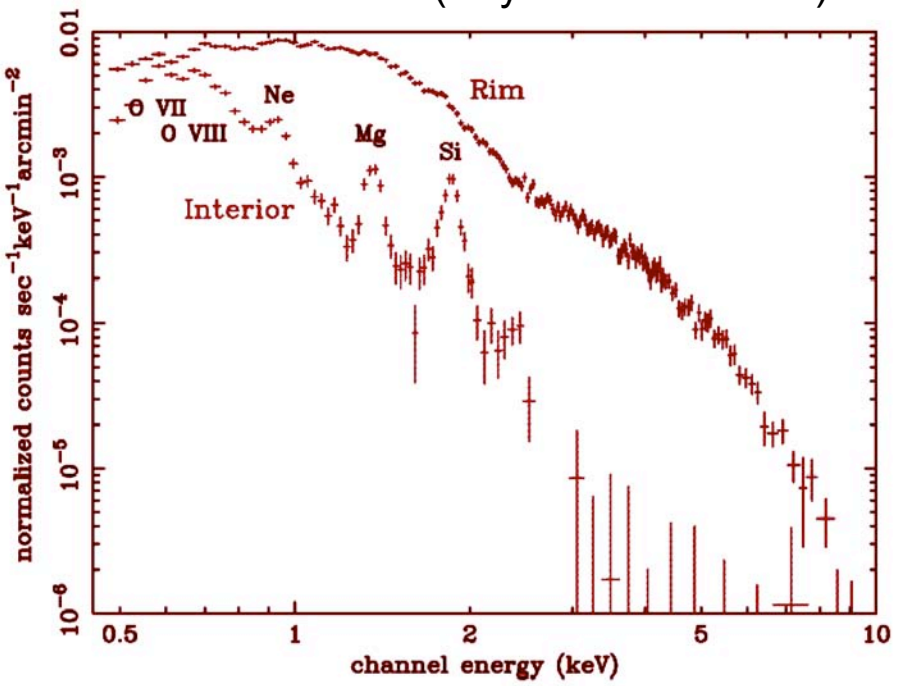
Ueda et al. (2007)

Weak scattering ⇨ **Tall torus**

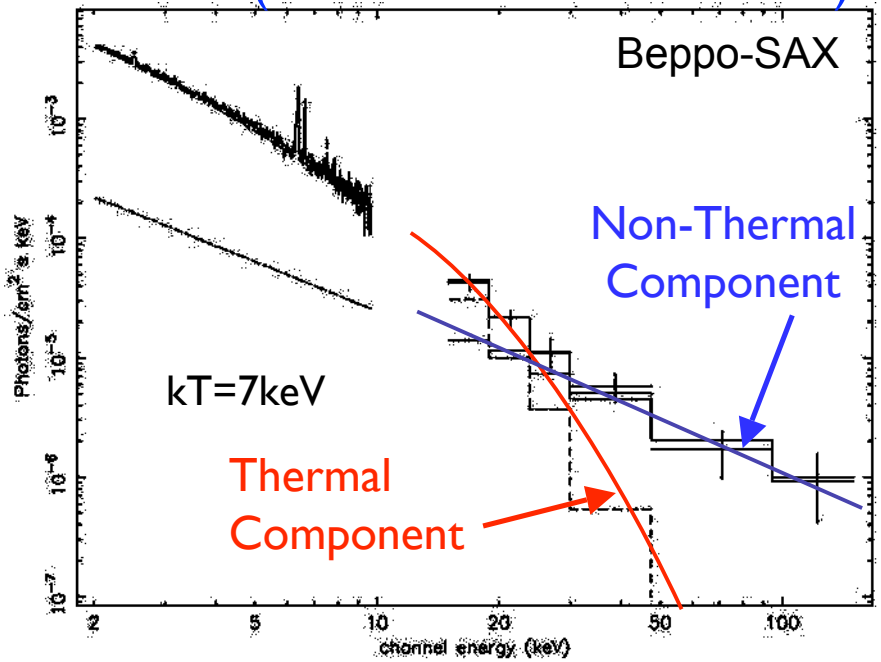
Astrophysics in hard X-ray band

Non-thermal components

SN 1006 (Koyama et al. 1995)



A2256 (Fusco-Femiano et al. 2000)



Acceleration of charged particle

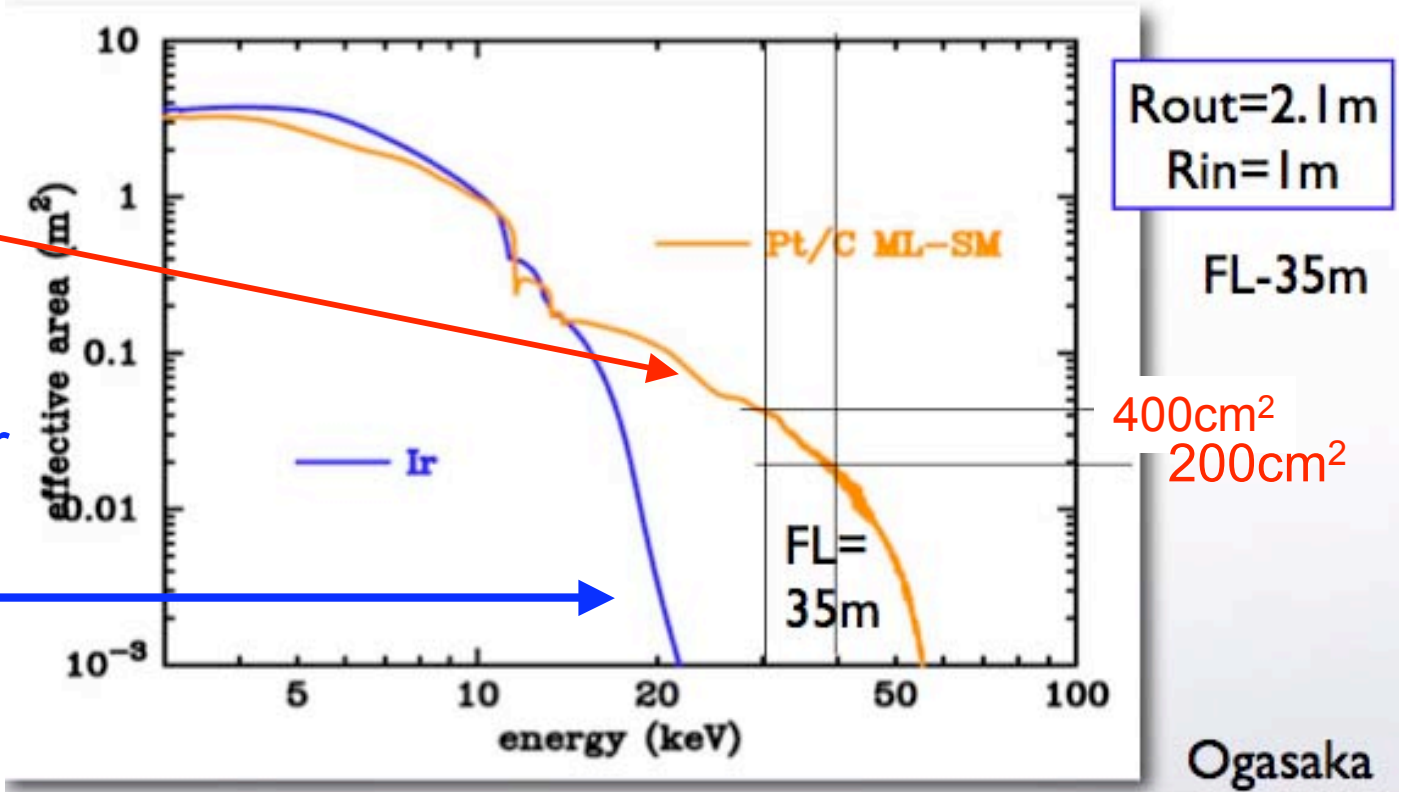
Hard X-ray Telescopes for XEUS

Characteristic	Value
Aperture annulus radii	0.67-2.1 m
Grazing reflection angles	0.27-0.86 degrees
Focal length	35 m

Goal: 1000 cm^2 at 40 keV

Multilayer Coating with Pt/C

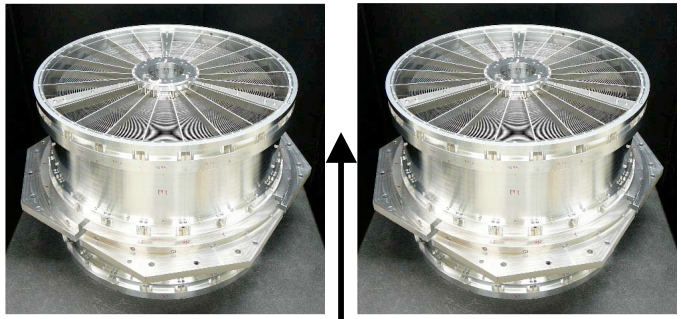
Mono-layer telescope with Ir



Hard X-ray Telescopes for Astro-H

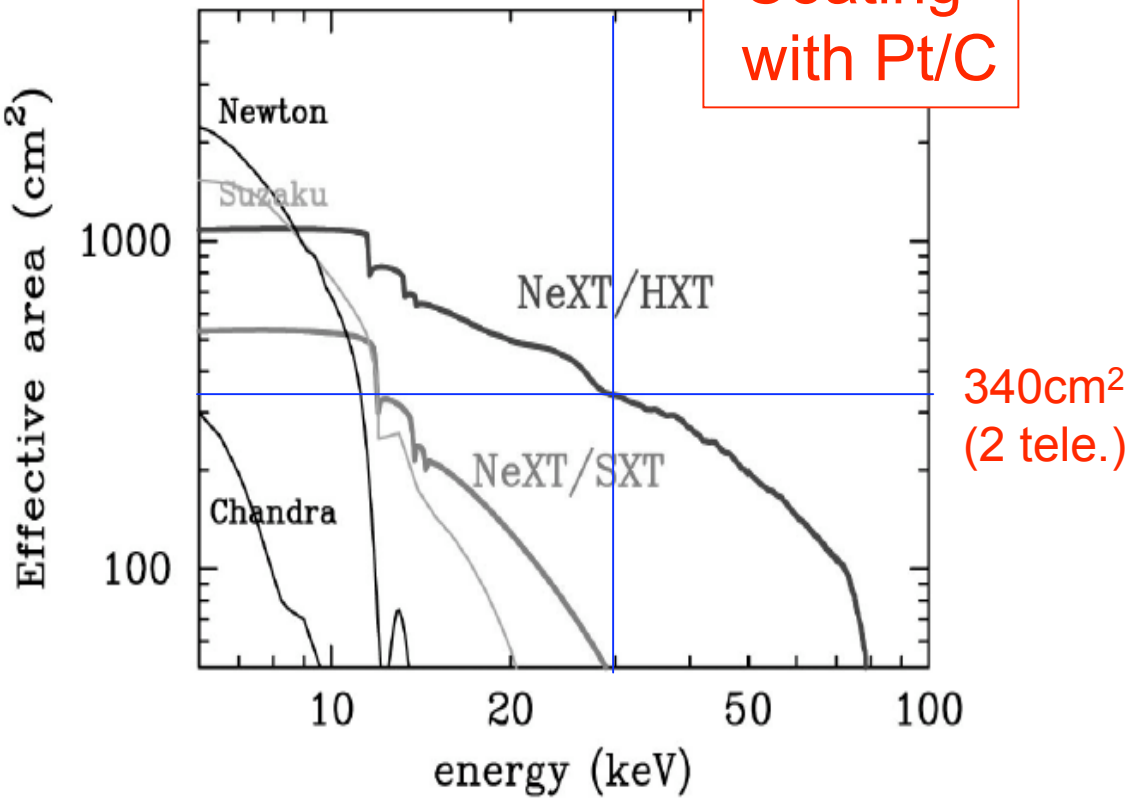
Characteristic	Value
Aperture annulus radii	**0.06 - 0.225 m**
Grazing reflection angles	**0.07 - 0.27 degree**
Focal length	**12 m**

45cmΦ x 2 tele.



F. L. = 12 m

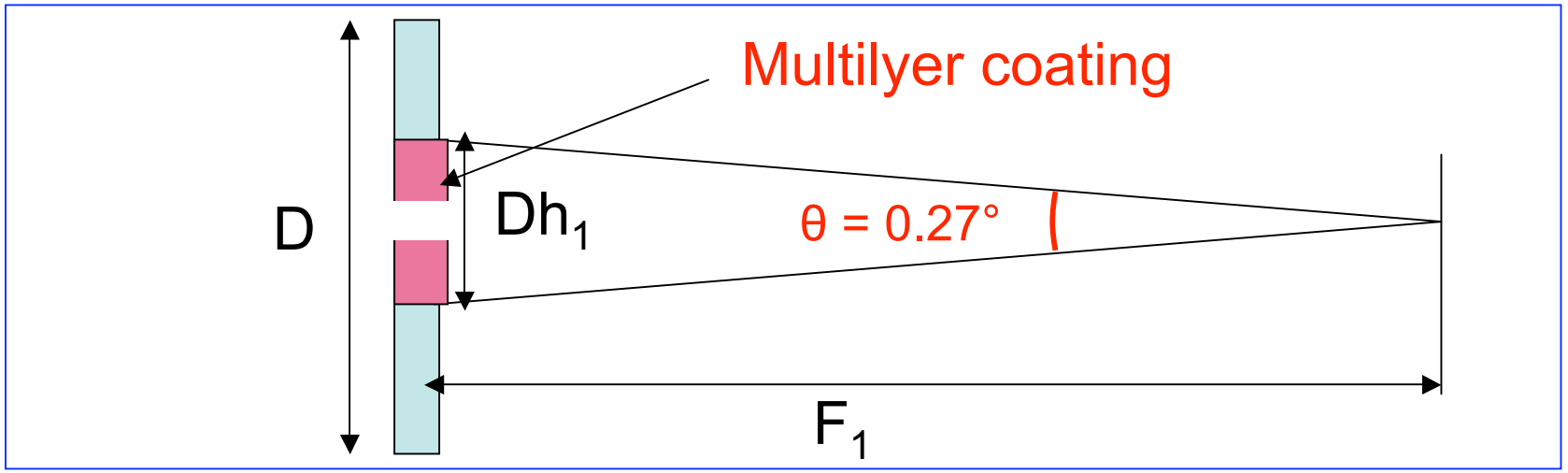
Multilayer Coating with Pt/C

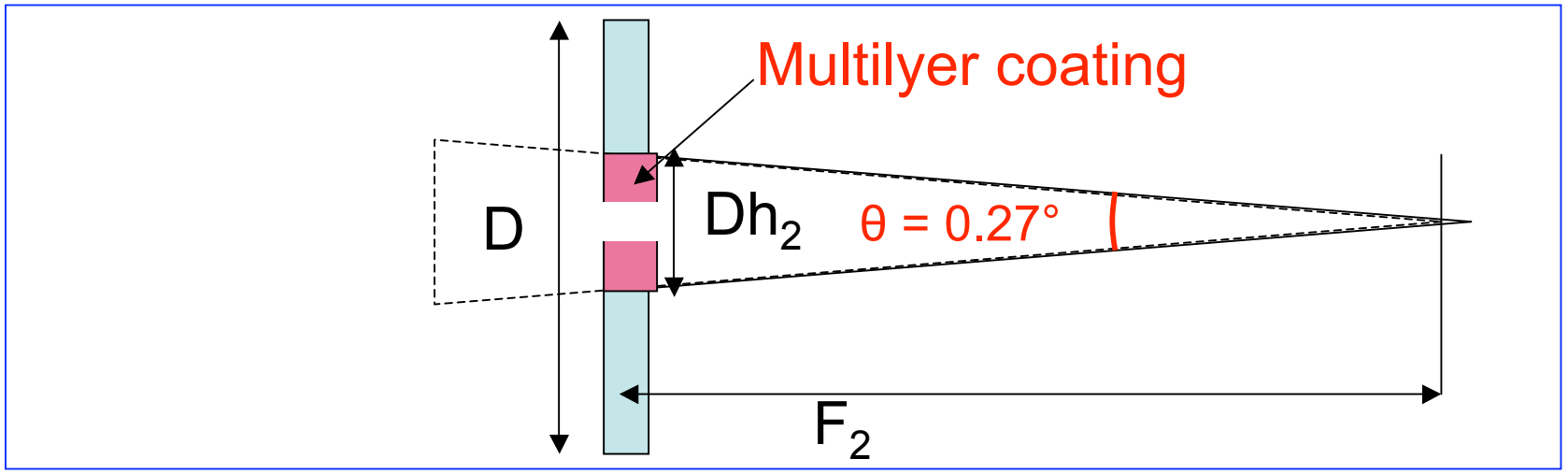


340cm^2 (2 tele.)

Hard X-ray Telescope for IXO

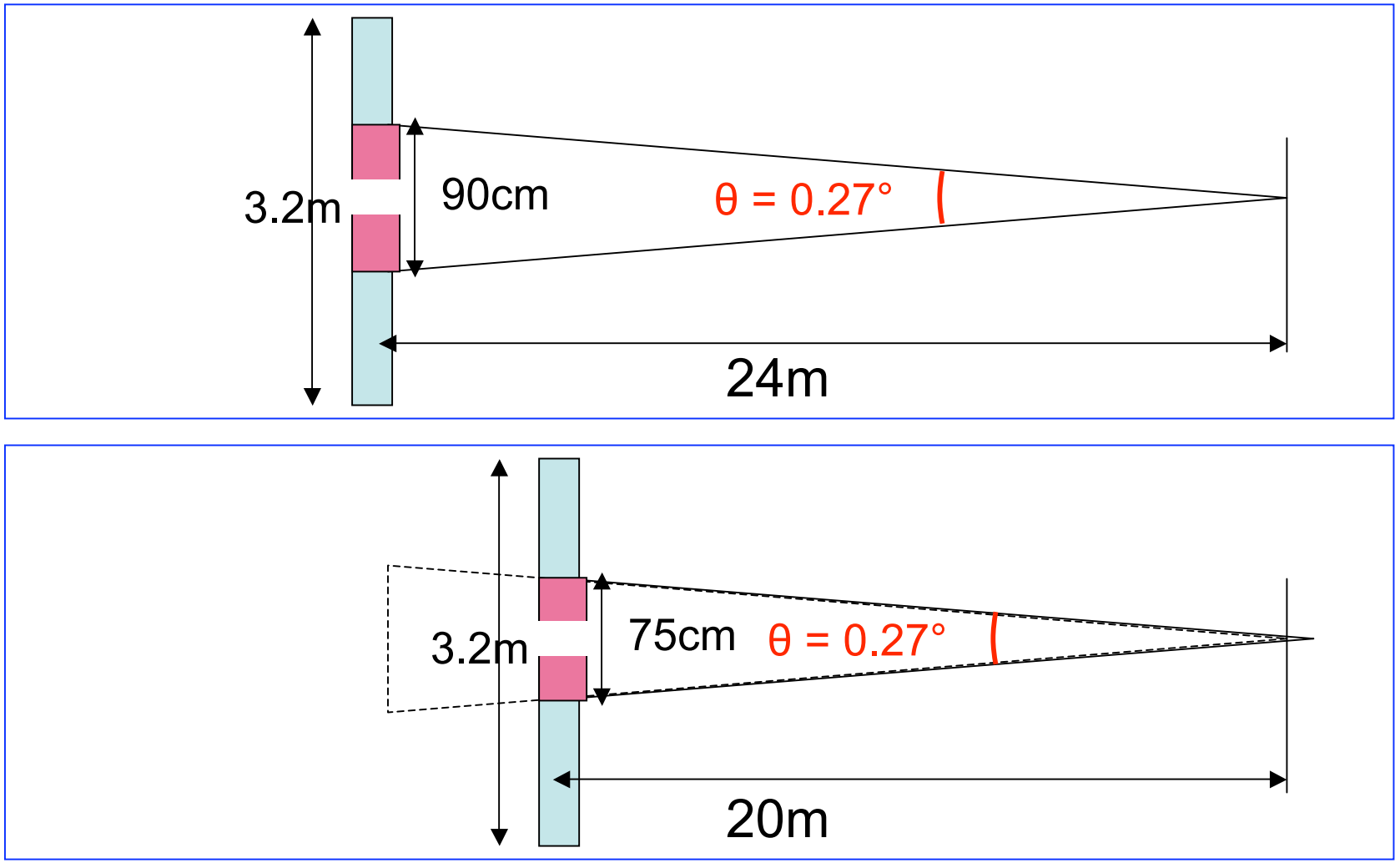
Grazing angle: 0.07 - 0.27 deg (Astro-H)





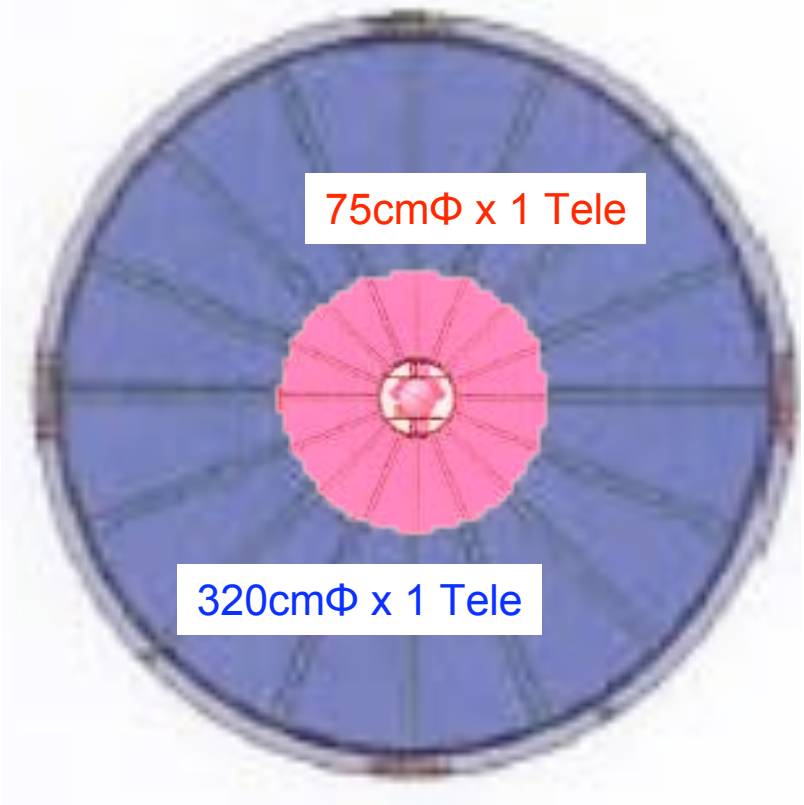
Hard X-ray Telescopes for IXO

Effective radii for hard X-ray option with multilayers

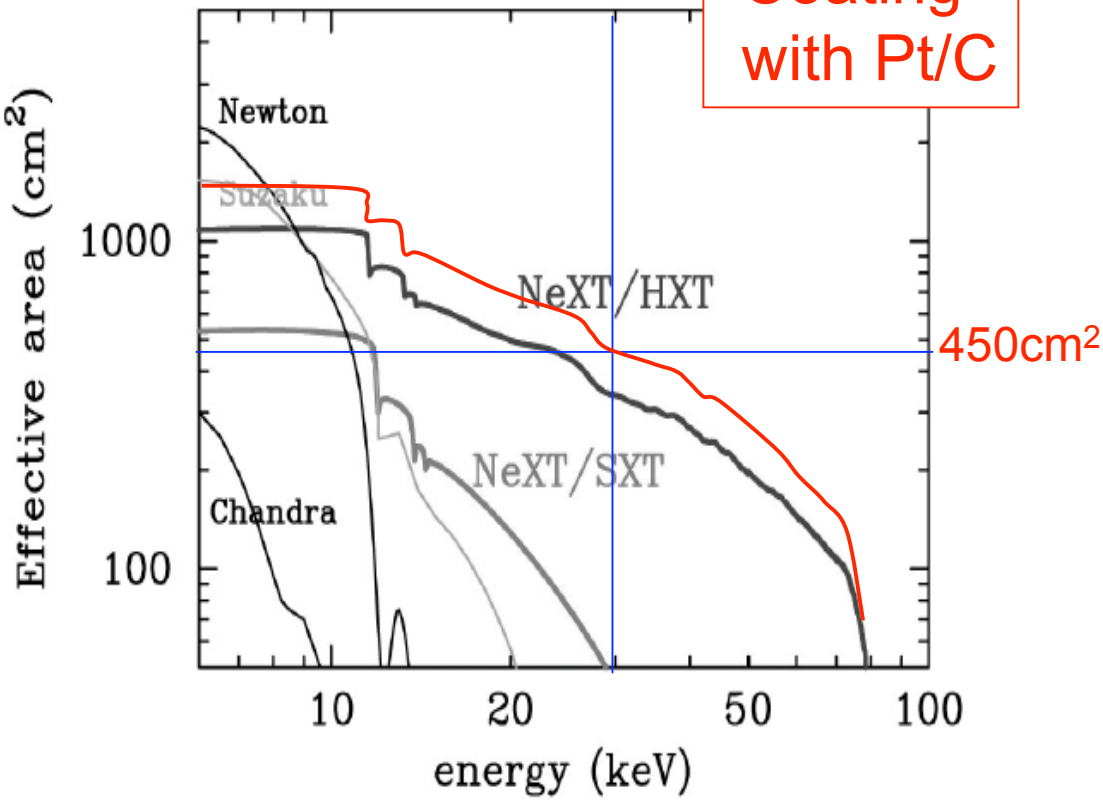


Hard X-ray Telescopes for IXO

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

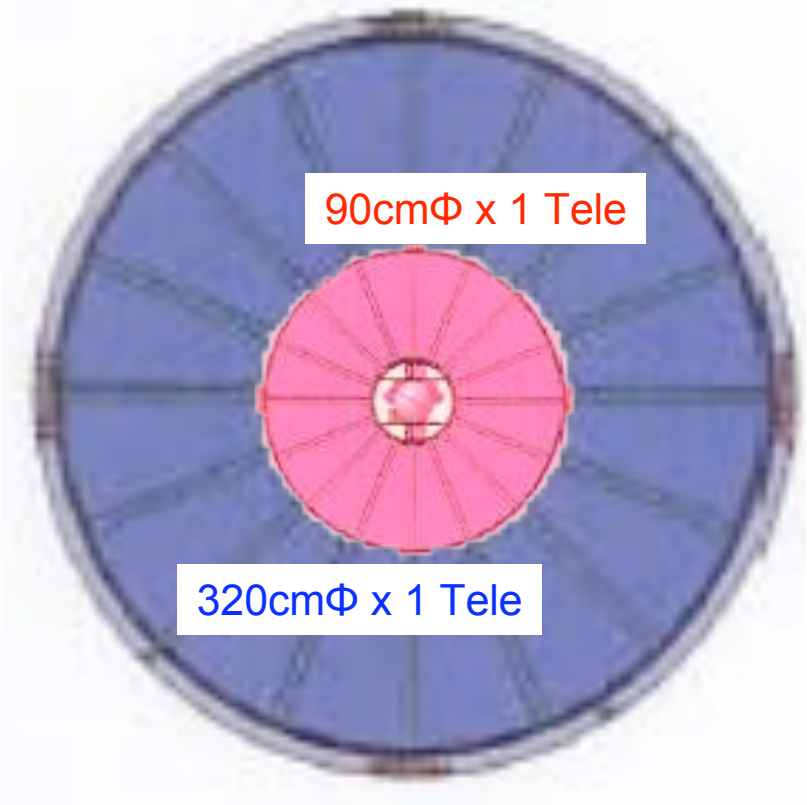


Multilayer Coating with Pt/C

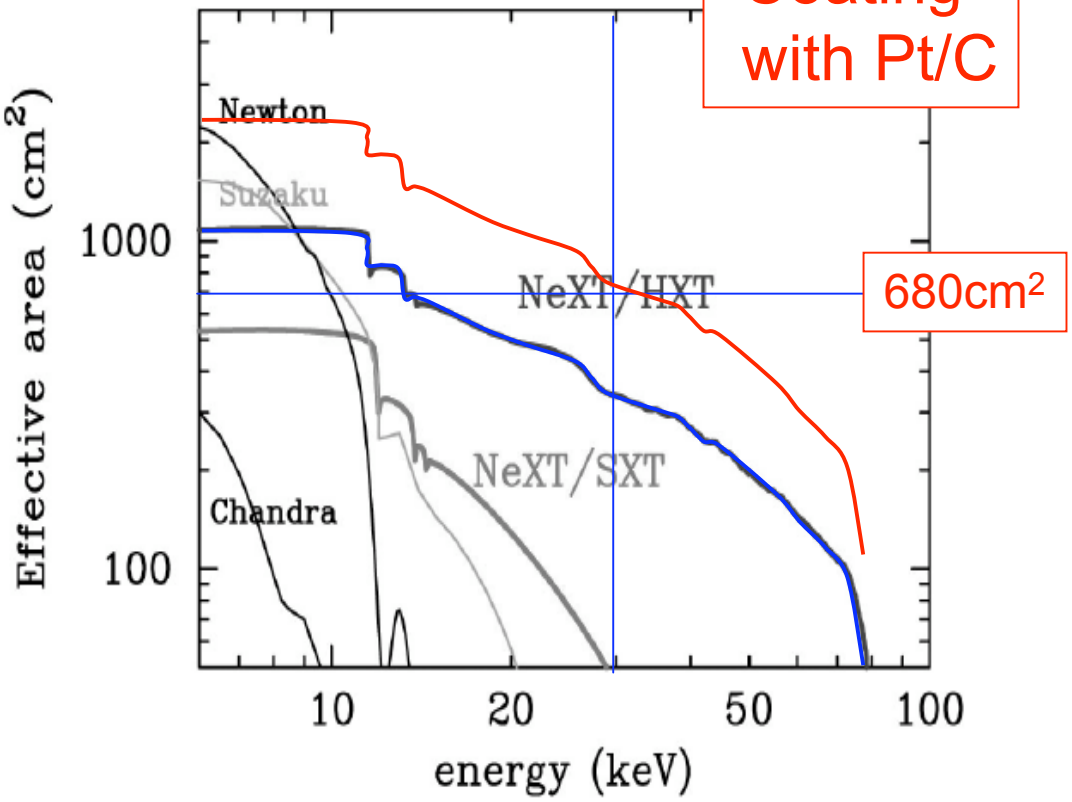


Hard X-ray Telescopes for IXO

Characteristic	Value
Aperture annulus radii	**0.12 - 0.45 m**
Grazing reflection angles	**0.07 - 0.27 degree**
Focal length	**24 m**

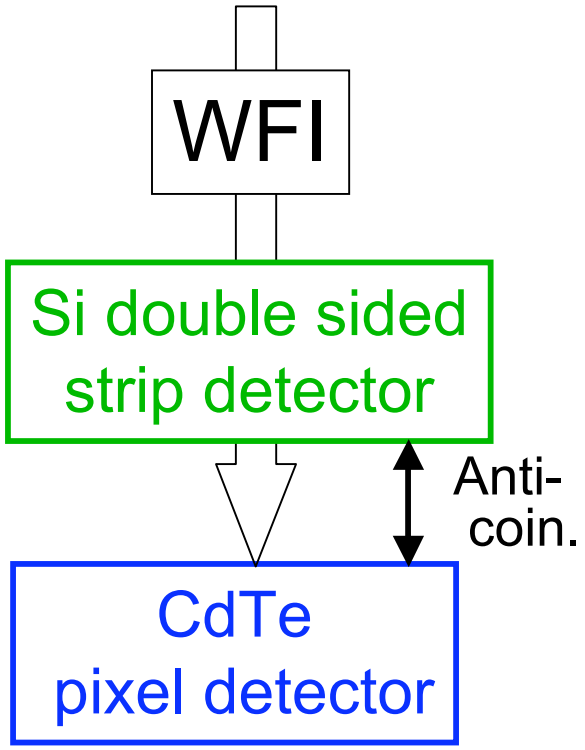


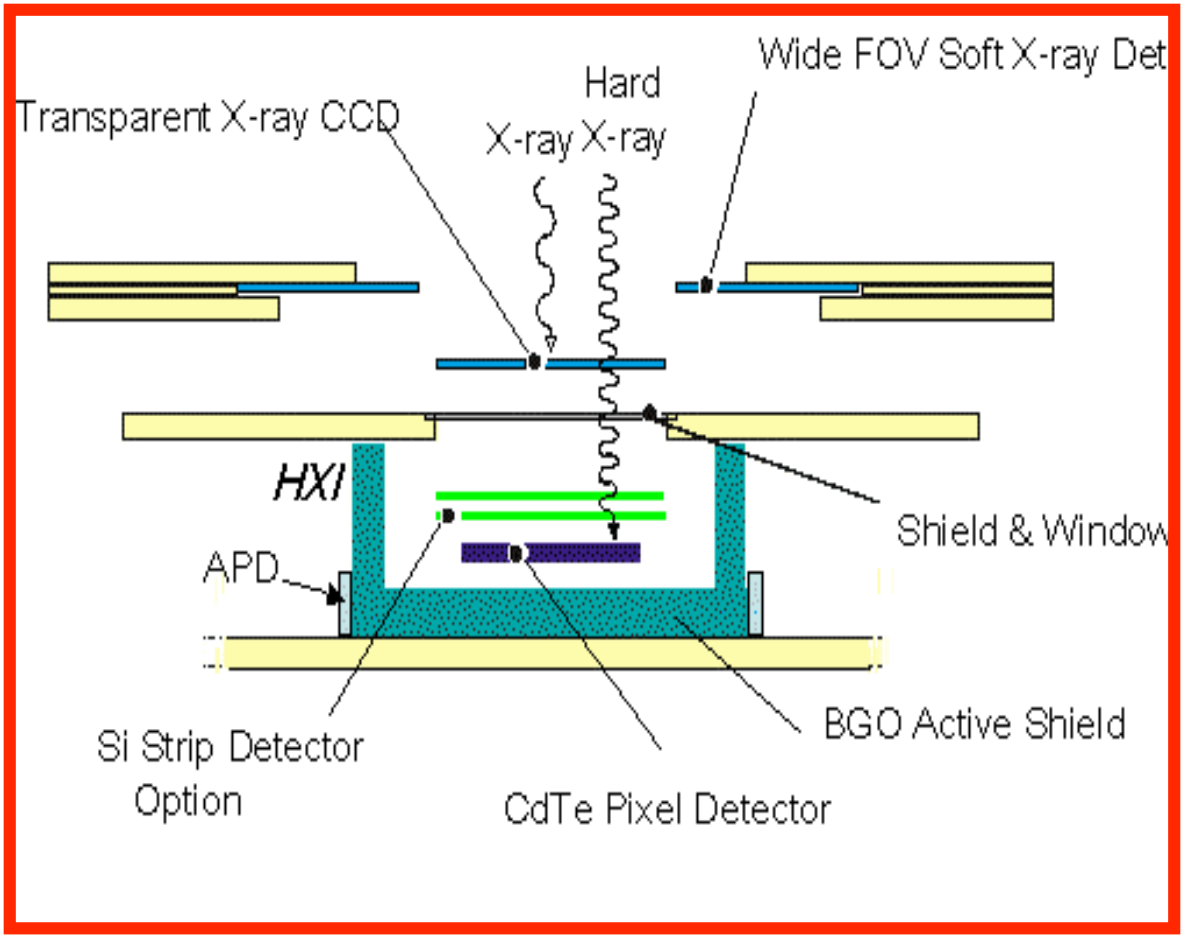
Multilayer Coating with Pt/C



Hard X-ray Imaging Detector

Concept of the Hybrid Imaging Detector for XEUS



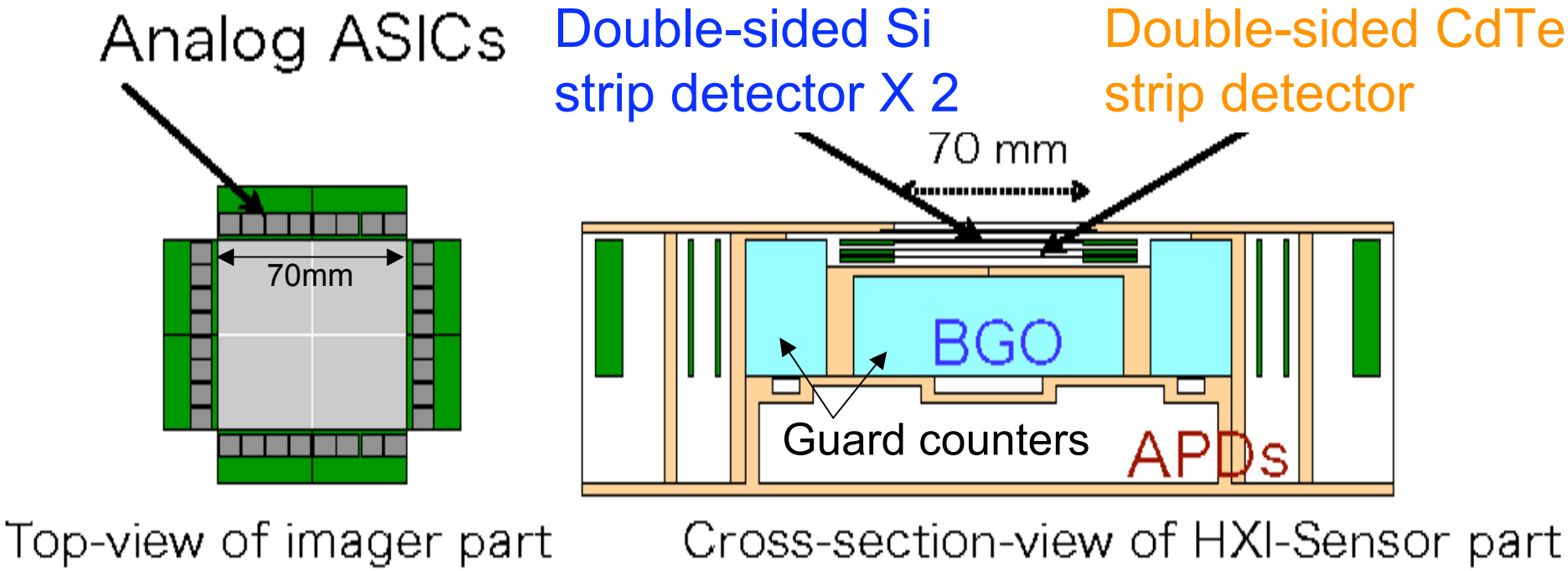


Hard X-ray imaging detector

HXI
new design

A draft design

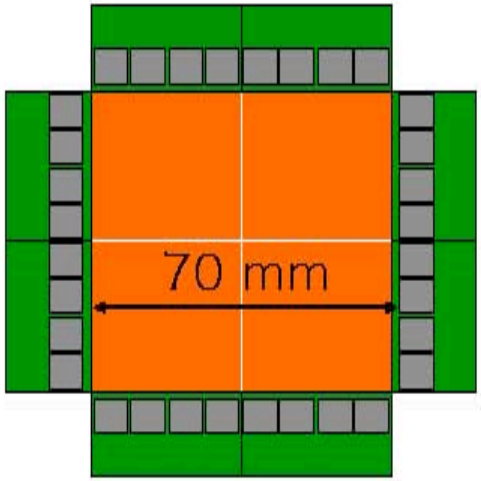
- Detailed design to be done.
- Astro-H HXI EM design (2008-2009) will be incorporated.



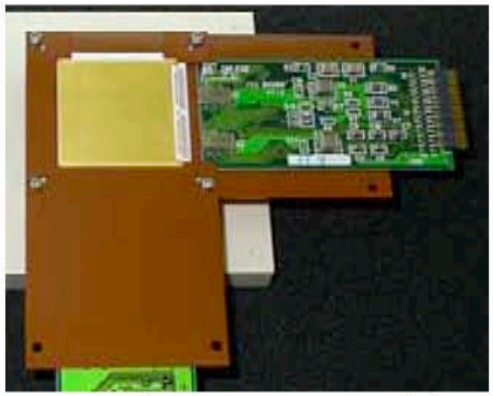
Status of the CdTe imager

Double-sided CdTe strip detector from ACRORAD

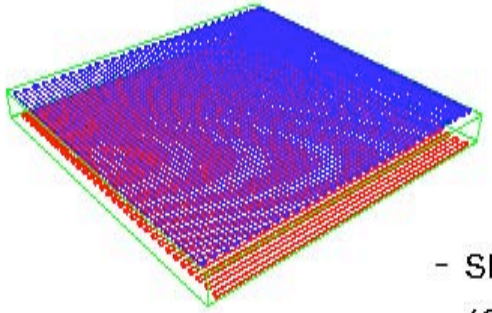
IXO HXI goal



Laboratory experiment

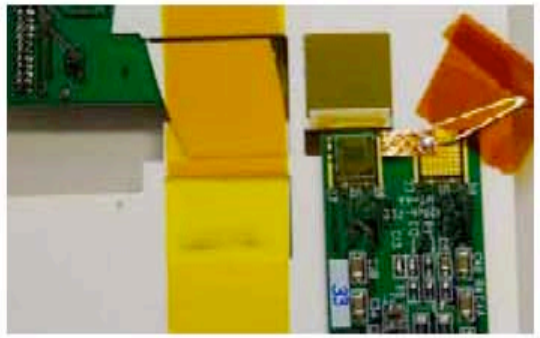


2.5 cm DS-CdTe



Strip detector

- smaller read-out channels (2n instead of n^2)
- 1-dimensional ASIC
- relatively large leak and C



1.3 cm DS-CdTe

Design parameters of Hard X-ray Imager

Characteristics	**Hard X-ray Imager**
Detector Type	**Si** and **CdTe** Schottky Diode double sided strip
Strip pitch	**220 μ m** (for both side)
Number of strips	320 (for both side) total 1280 strips for CdTe Two layers of DSSD are placed in front of CdTe. There exits ~4000 strips in total
Array Size (mm^2)	70 ×70
Field of View	7 ×7 arcmin ^{2}
Energy range	**10-80 keV**
Energy Resolution	**dE < 1 keV**(FWHM)
Non X-Ray detector Background	5×10^{-4} counts keV^{-1} cm^{-2} s^{-1} roughly flat
Count rate/pixel with 10% pile-up	20000 cts s^{-1} independent of the position
Count rate/source with 10% pile-up	20000 cts s^{-1} independent of the position
Timing accuracy	10 ms
Typical/ Max telemetry	10 kbs^{-1} (1 Mbs^{-1} max. for ground calibration)
Operating Temperature	Detector **-20 ± 2 °C** (Minimum temperature -40 °C) Electronics 20± 20 °C
Thermo control to maintain temperature and raise temperature to +5°C, if necessary	
Instrument Power, excluding thermal control	31W
Total Mass	24 kg

As of 2008-4-30

Defocus due to the off-focus plane of HXI

Defocus at HXI

D = 0.75m for F = 20m
D = 0.90m for F = 24m

D/F = 0.0375

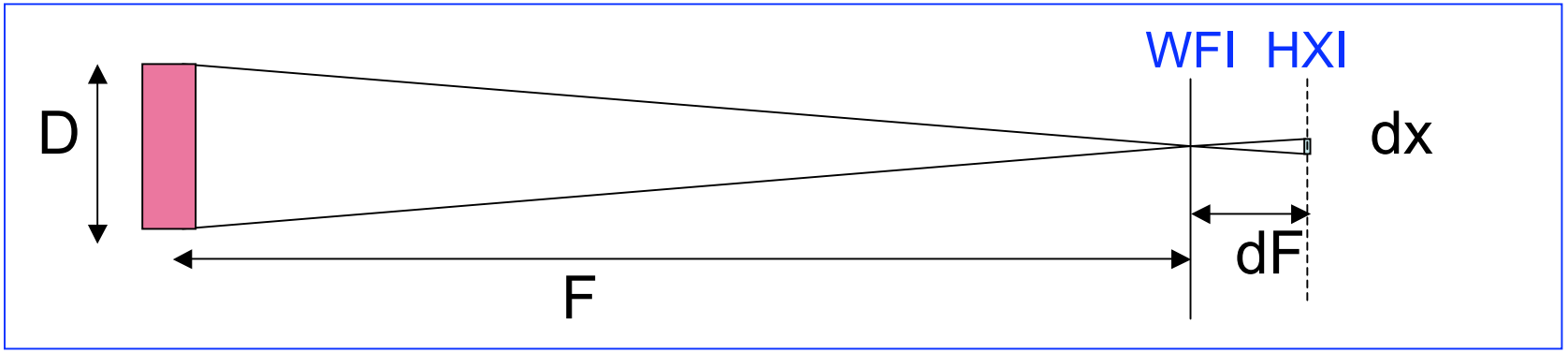


Image blur

$$d\theta = \tan^{-1}\left(\frac{dx}{F}\right) = 5 \text{ arcsec}$$

$$\Rightarrow \begin{cases} dx = 0.58 \text{ mm}(F=24m) \\ dx = 0.48 \text{ mm}(F=20m) \end{cases}$$

$$dx = \frac{D}{F} dF \Rightarrow$$

$$dF = dx/0.0375$$
$$= \mathbf{15.5 \text{ mm } (F=24m)}$$
$$= \mathbf{12.8 \text{ mm } (F=20m)}$$

Strategy and plan

Hard X-ray telescopes
- Multilayer for hard X-rays (>10keV)
- (Multilayer for mid-energies : 5<E<10keV)
- Deposition on Si substrate

Hard X-ray Imaging Detector
- Double sided strip detectors
- BKGD reduction

Developments of
HXT/HXI for Astro-H ==> IXO