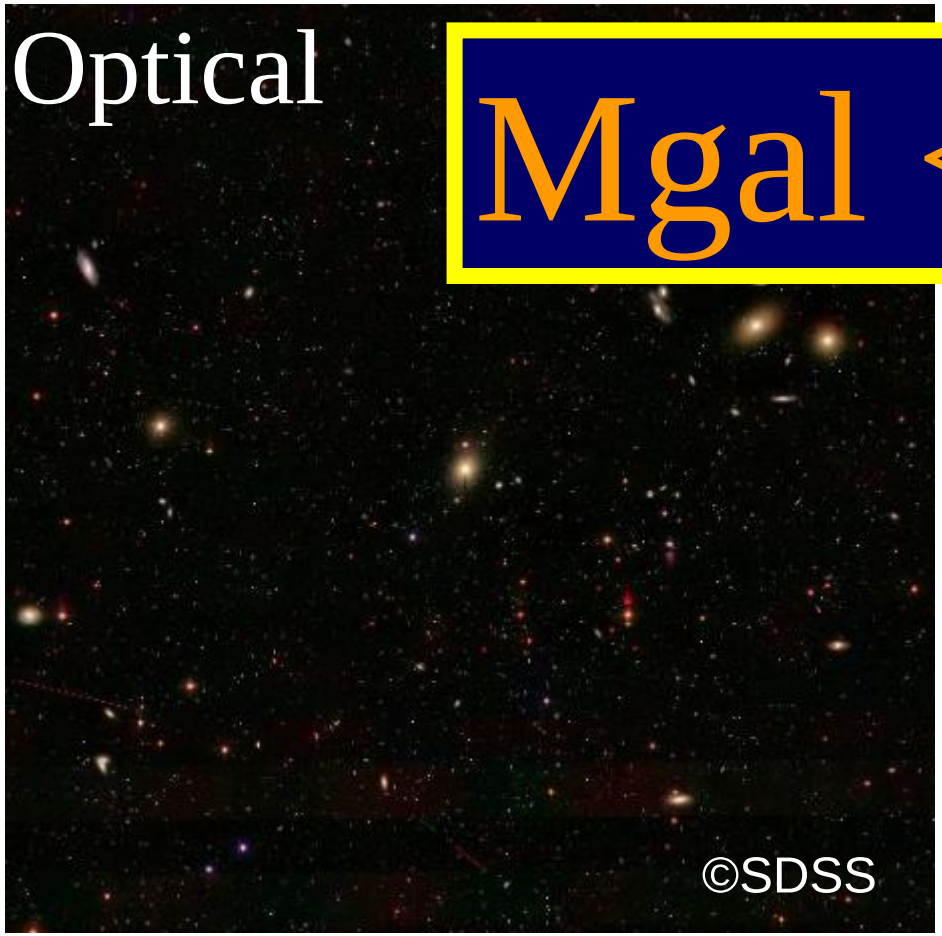
The ASTRO-H project

Hiro MATSUMOTO (Nagoya University)
on behalf of the ASTRO-H team

Outline

- X-ray astronomy
- ASTRO-H
  - Precise Soft X-ray Spectroscopy
    - Soft X-ray Telescope (SXT) +Soft X-ray Spectrometer (SXS)
  - Soft X-ray Imaging Spectroscopy
    - SXT + Soft X-ray Imager (SXI)
  - Hard X-ray Imaging Spectroscopy
    - Hard X-ray Telescope (HXT) + Hard X-ray Imager (HXI)
  - Soft Gamma-ray Observation
    - Soft Gamma-ray Detector (SGD)
- Summary

X-ray Universe



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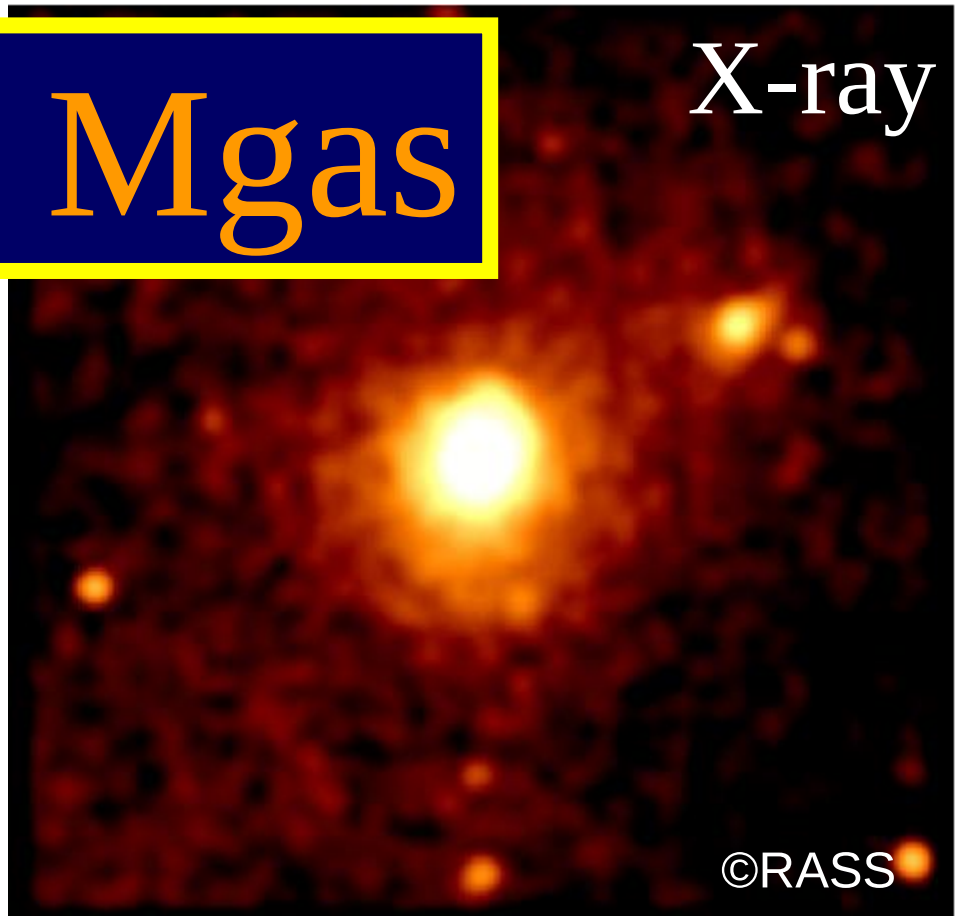
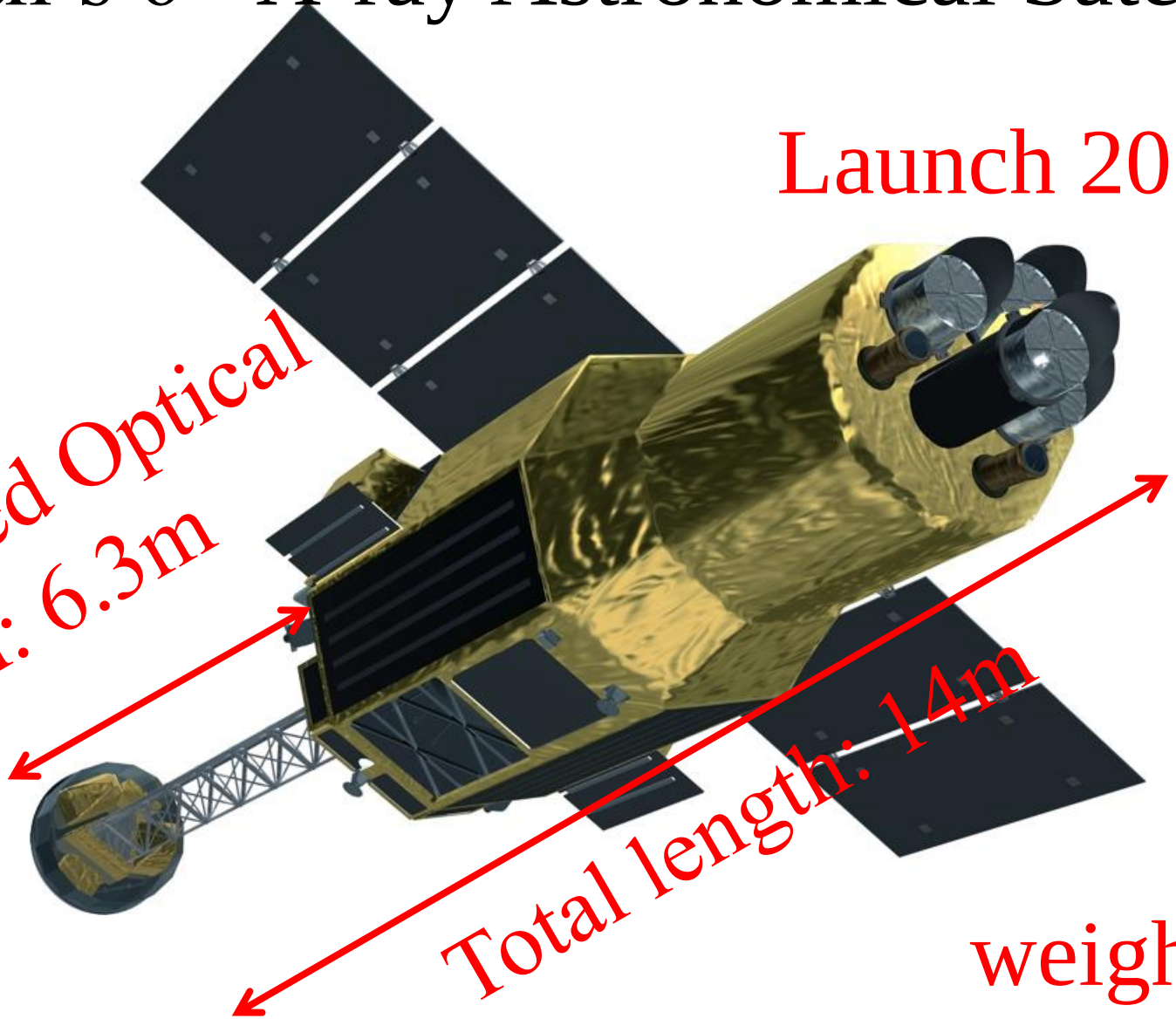


Cluster of galaxies hot gas

We would overlook real face without X-rays.

ASTRO-H Satellite

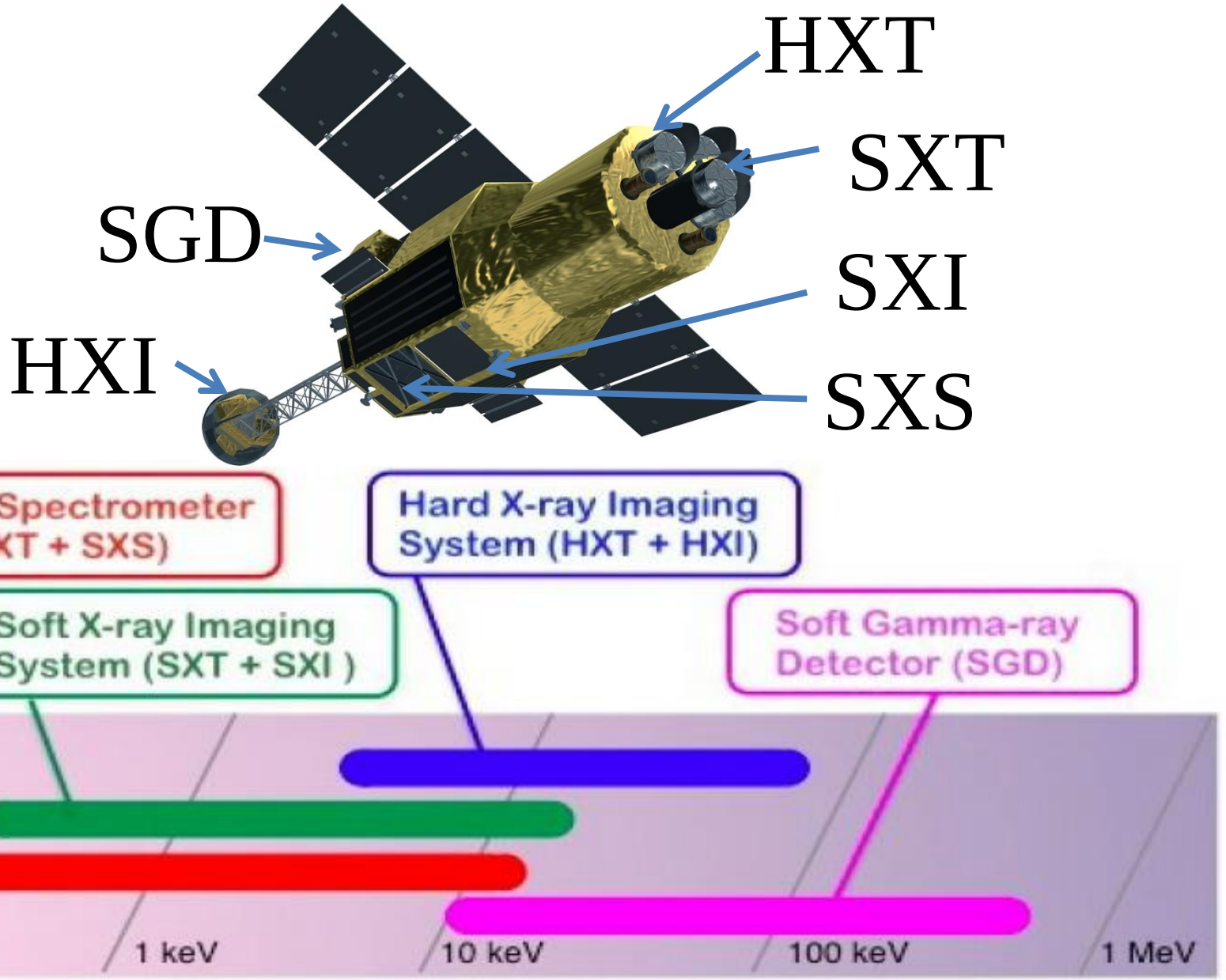
Japan's 6th X-ray Astronomical Satellite



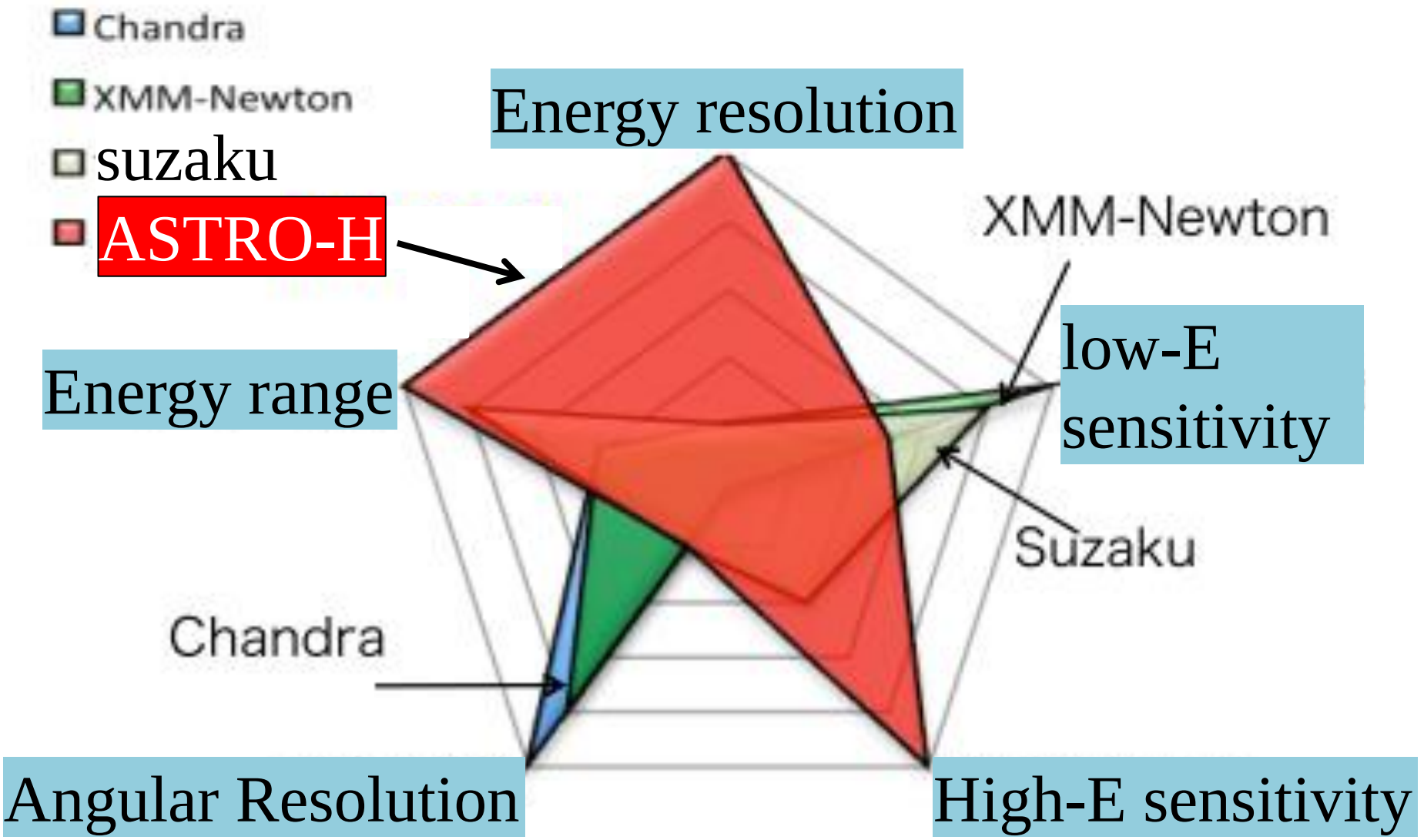
International collaboration

More than 160 scientists from Japan/USA/Europe

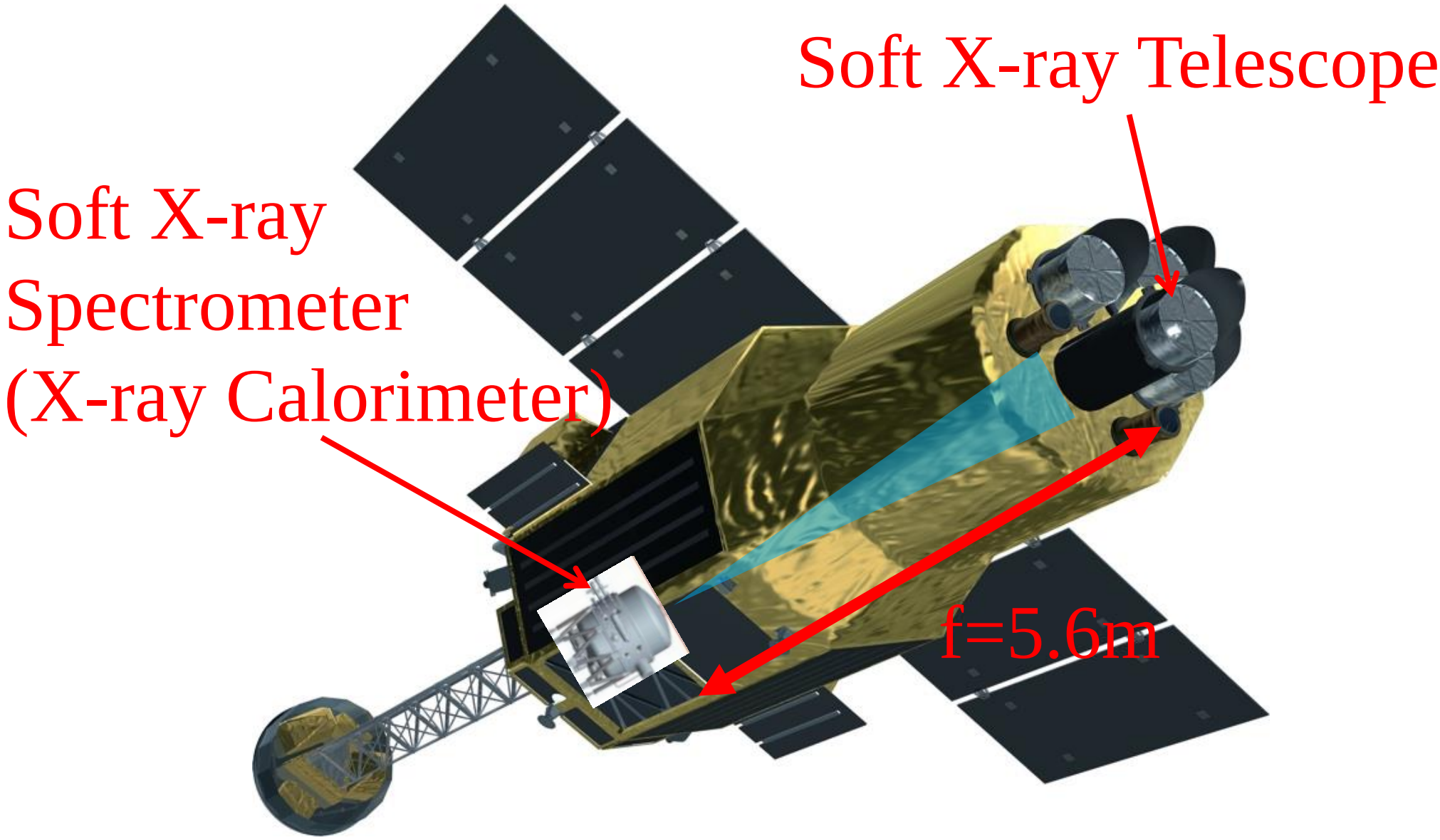
Wide energy range (0.3—600keV)



ASTRO-H vs other observatories



SXT + SXS (0.3—12keV)

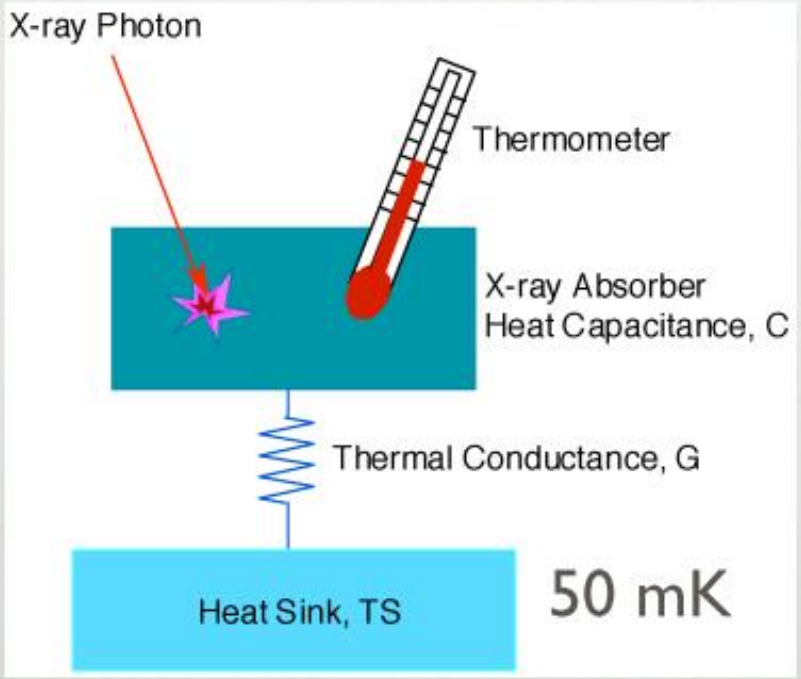


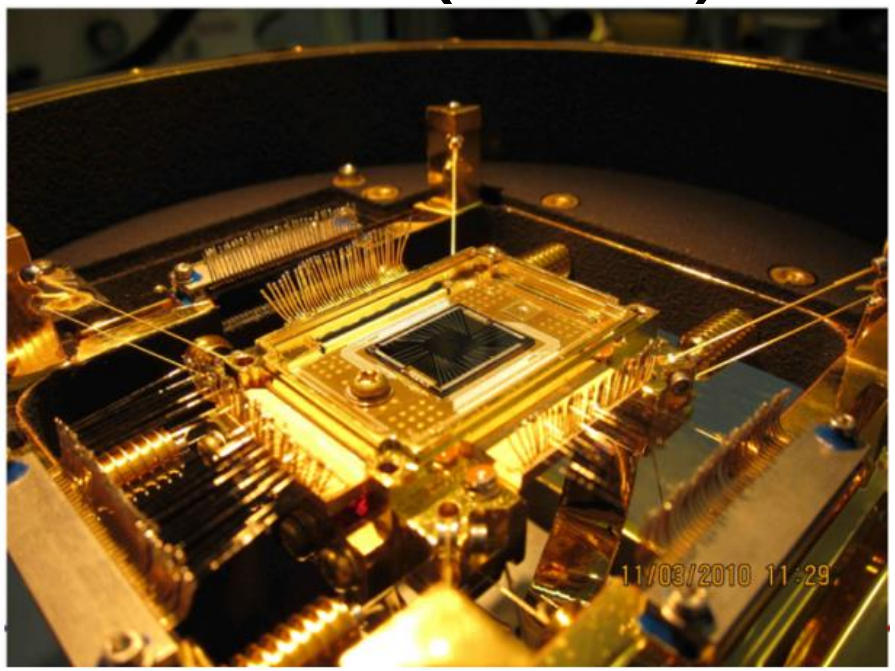
Soft X-ray Spectrometer (SXS)

Microcalorimeters

High quantum efficiency

Imaging capability





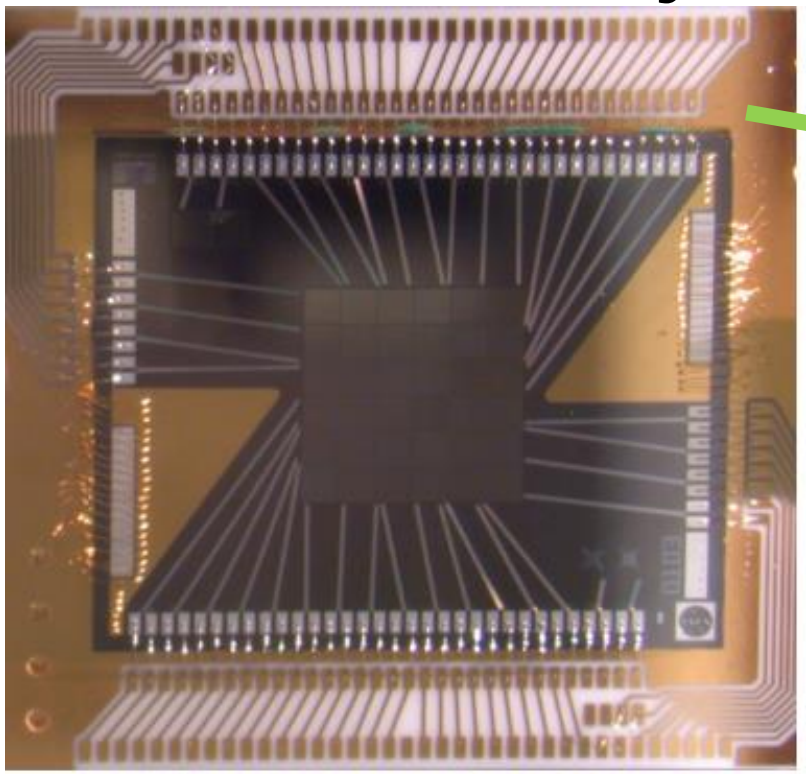
$\Delta E < 7\text{eV}$

(goal < 4eV)

High-energy resolution even for spatially extended objects (cf. gratings)

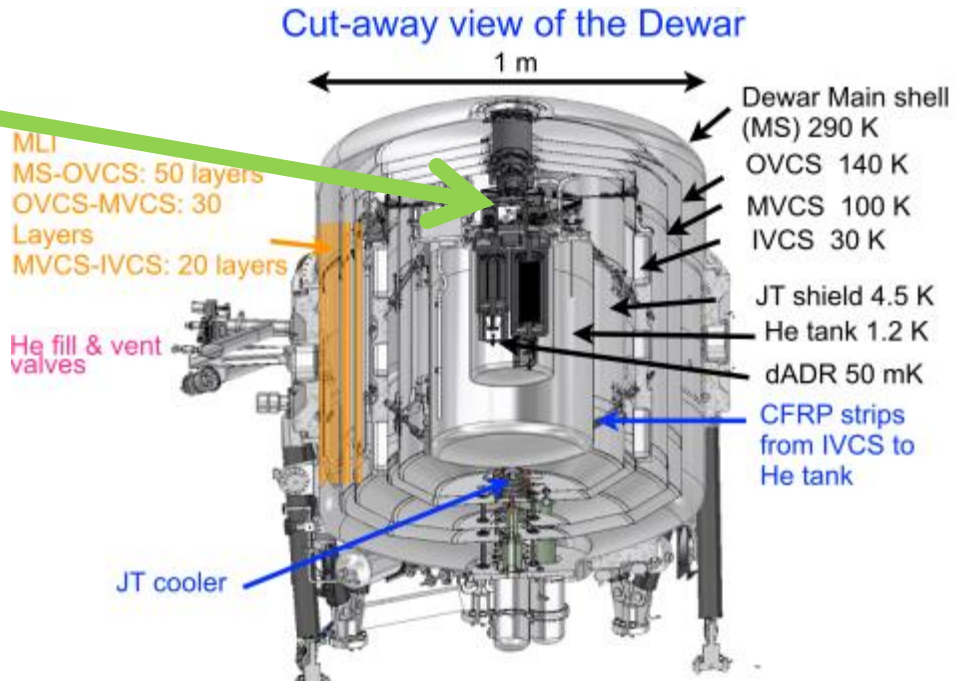
SXS

Detector array



6 × 6 pixels
FOV 3′ × 3′

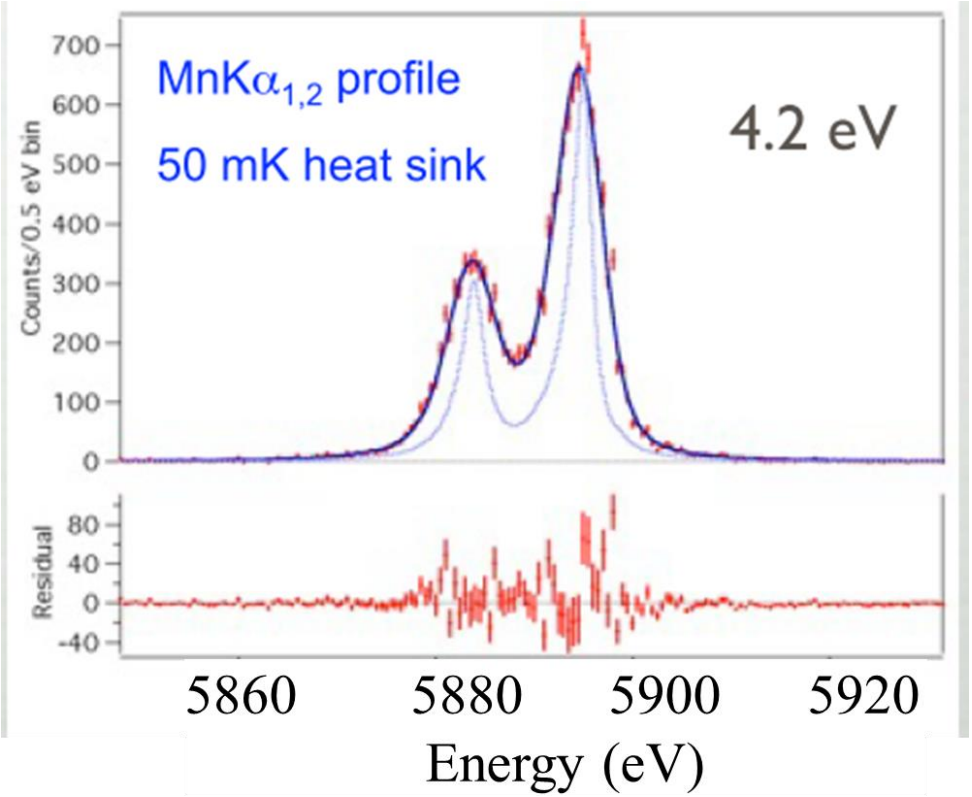
Cooling system



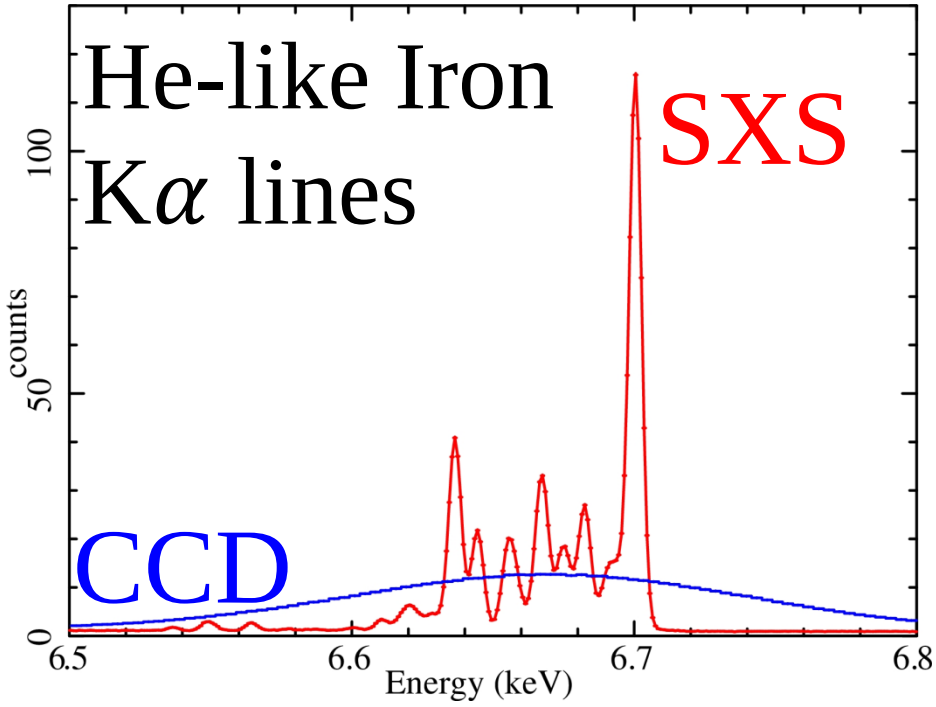
He+JT+ST
Life time > 3yrs
(goal >5yrs)

SXS Energy resolution

Ground Experiment



Simulation



SXS can distinguish fine structure

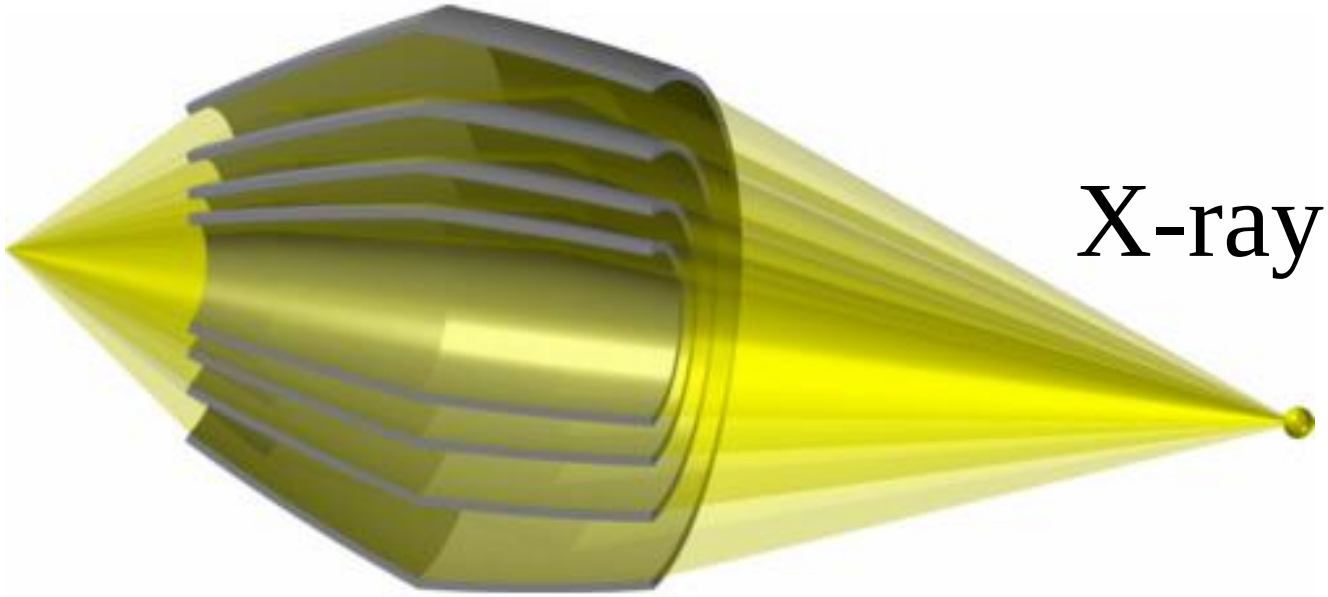
→ Measure physical parameters of plasma directly.

ASTRO-H XRT (SXT, HXT)

Wolter-I optics

"Year ring" of foils

focus

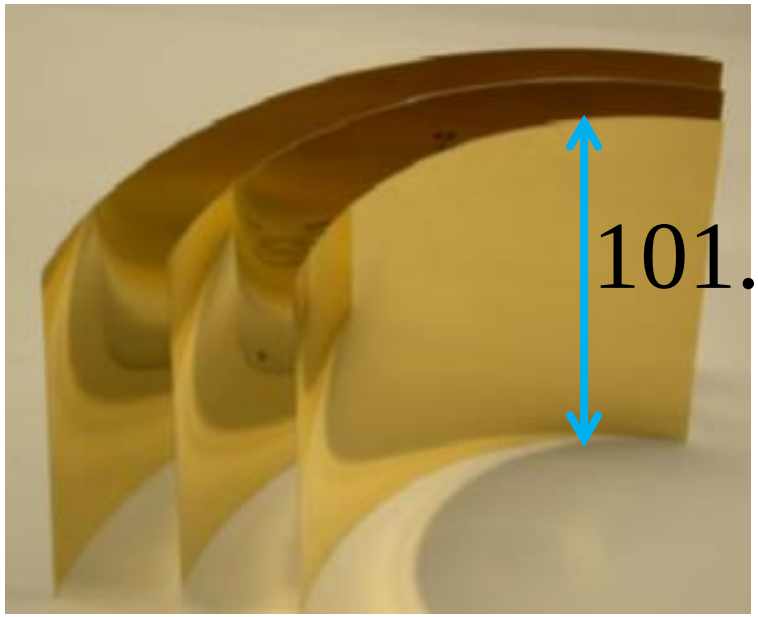


X-ray source

Soft X-ray Telescope (SXT)

SXT-1 FM

203 nested shells

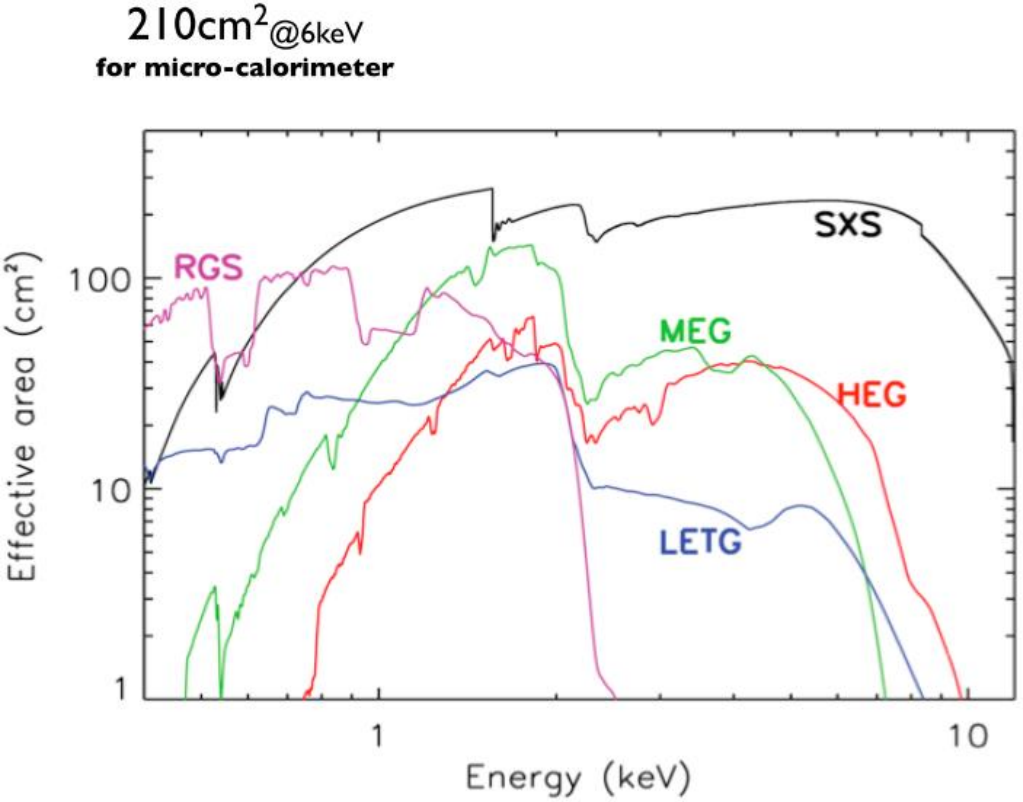


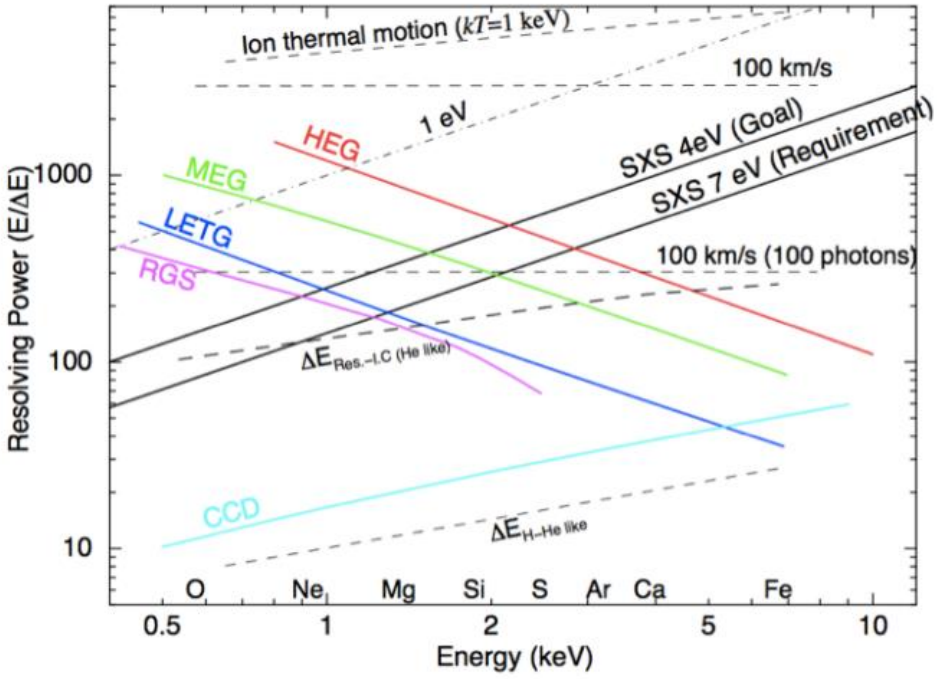
Au-coated Al foils

Total reflection

Angular resolution~ 1.3′

SXT+SXS vs other gratings

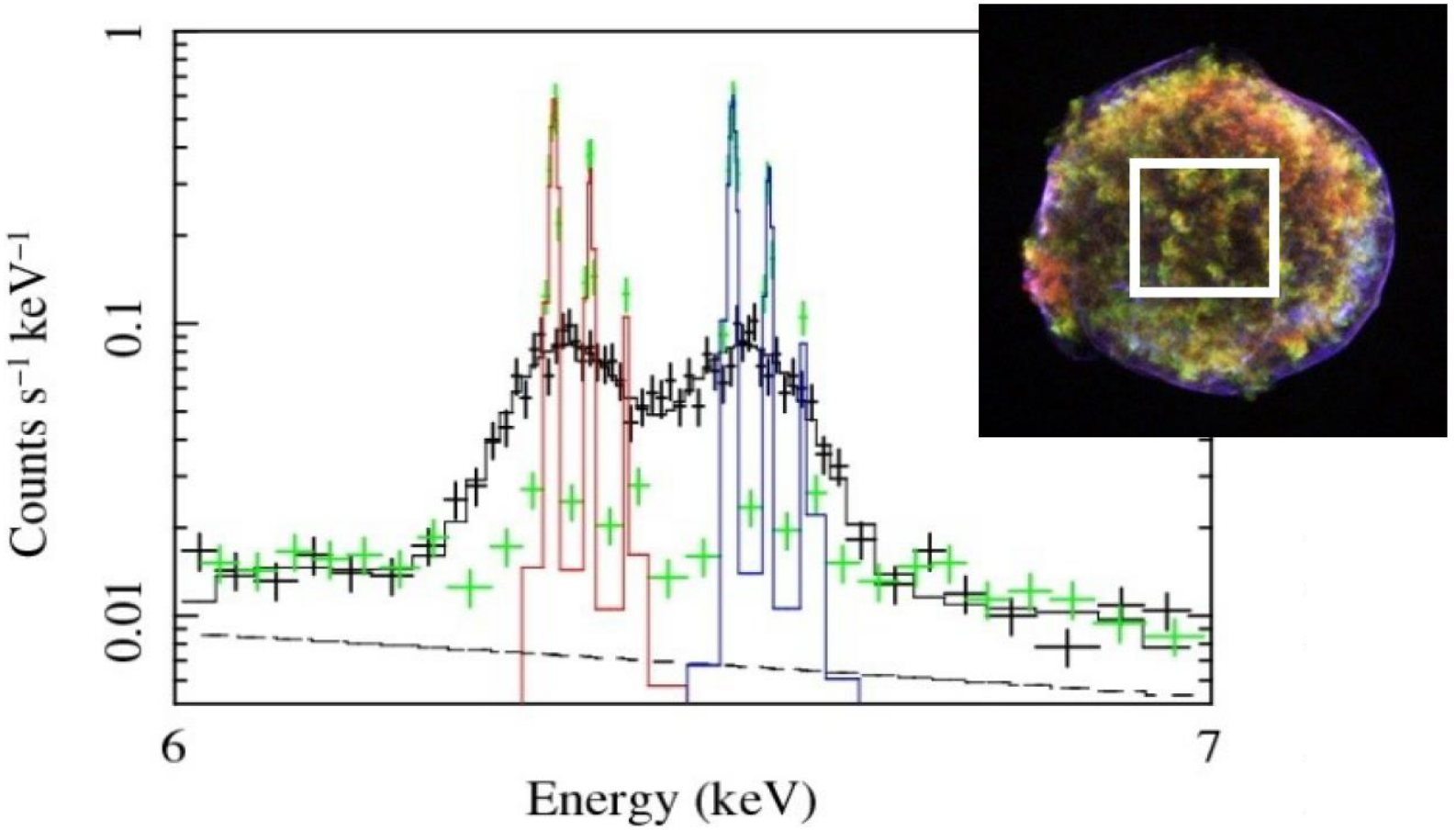




Good for dim objects, high-energy X-rays

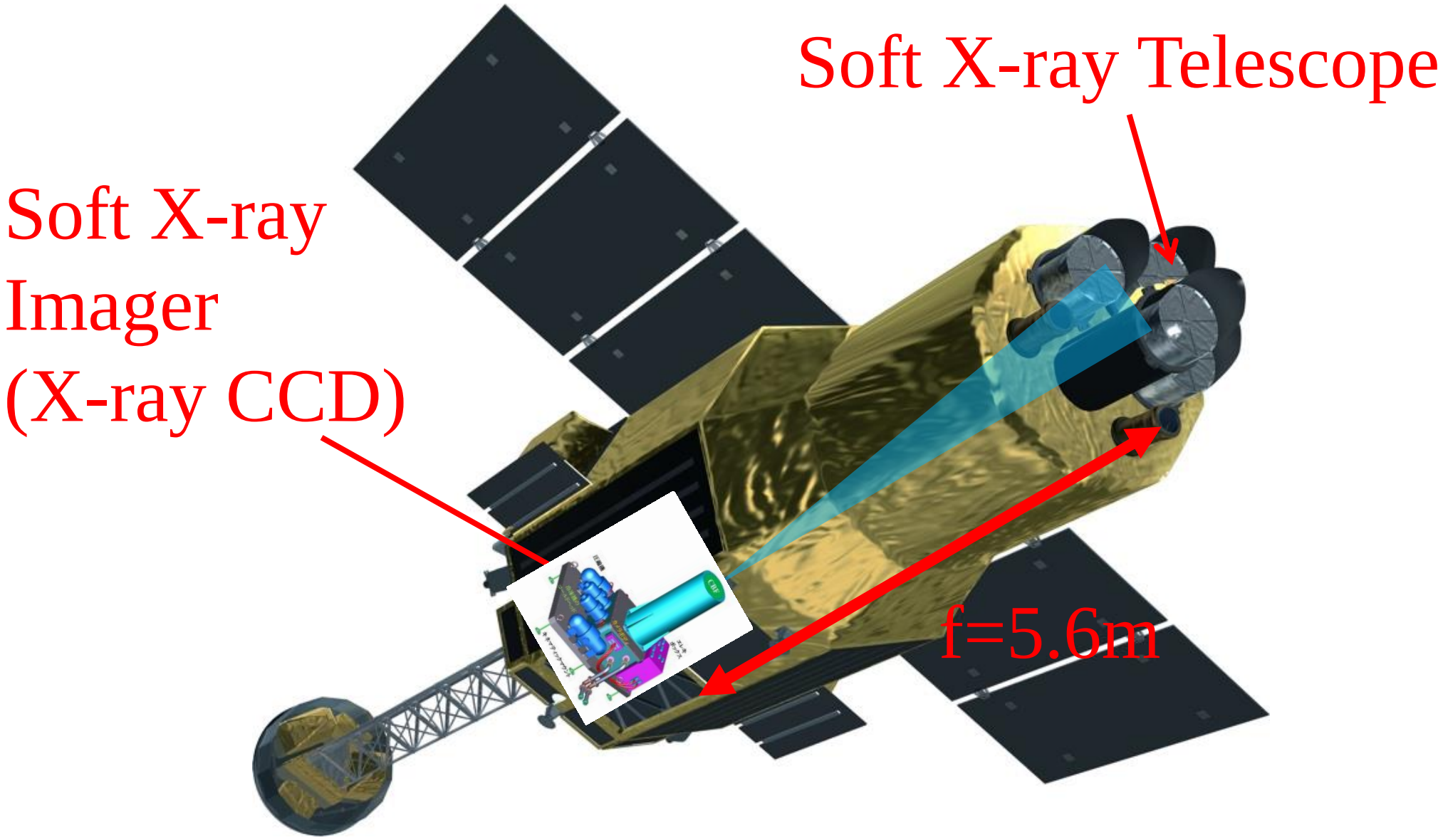
See Dynamic Universe!

Tycho SNR simulation



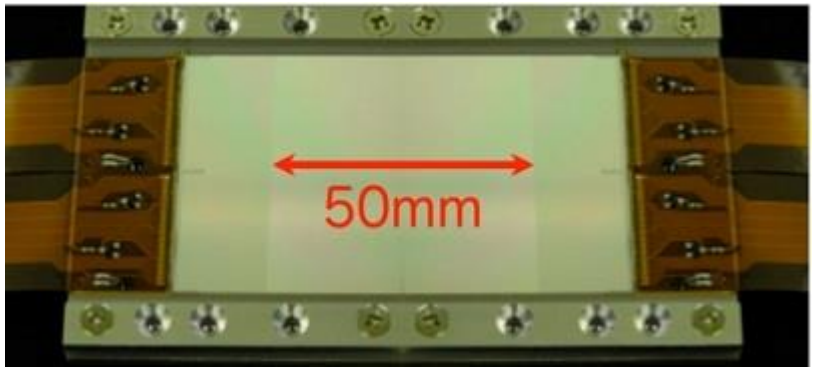
Gas expansion speed, ion temperature

SXT + SXI (0.3—12keV)



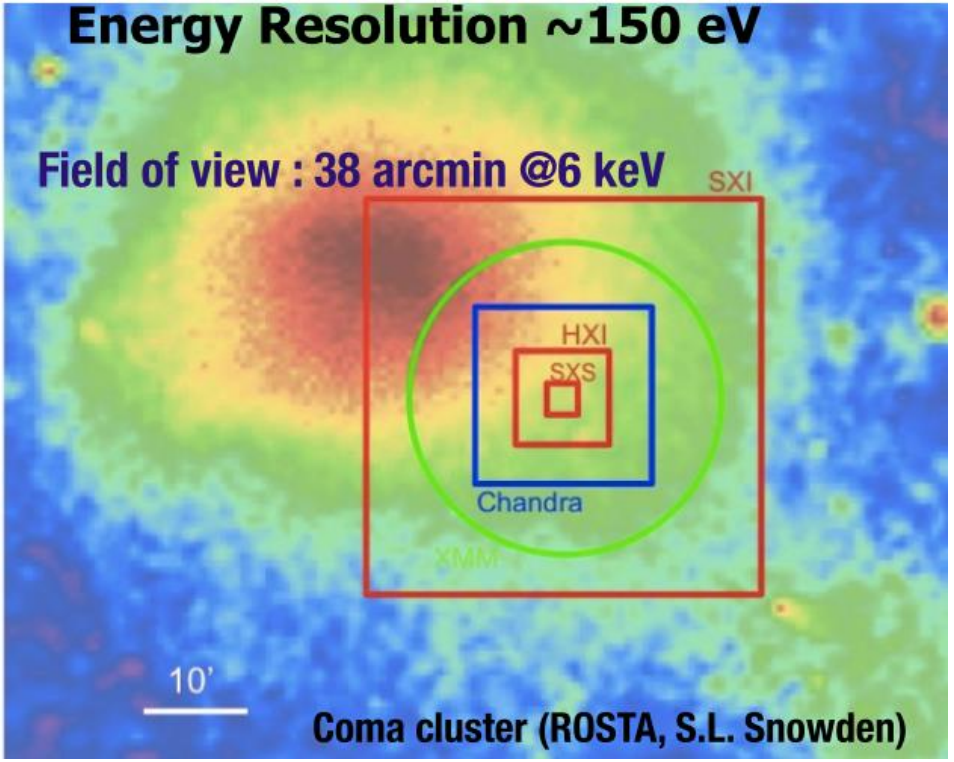
Soft X-ray Imager (SXI)

Pch X-ray CCD



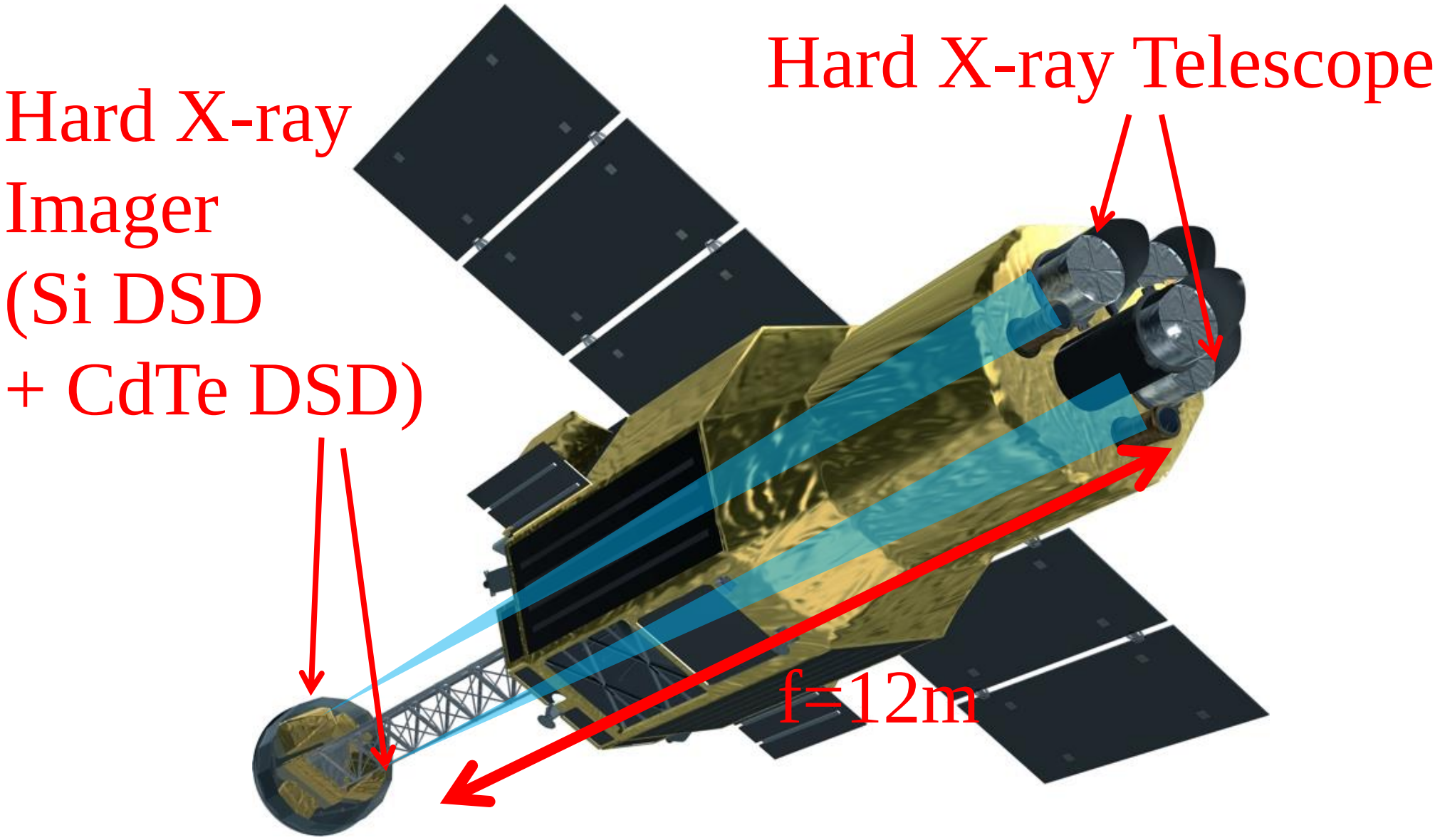
Thick depletion layer
~200um

Moderate ΔE
(~150eV@6keV)



Largest FOV
$38' \times 38'$

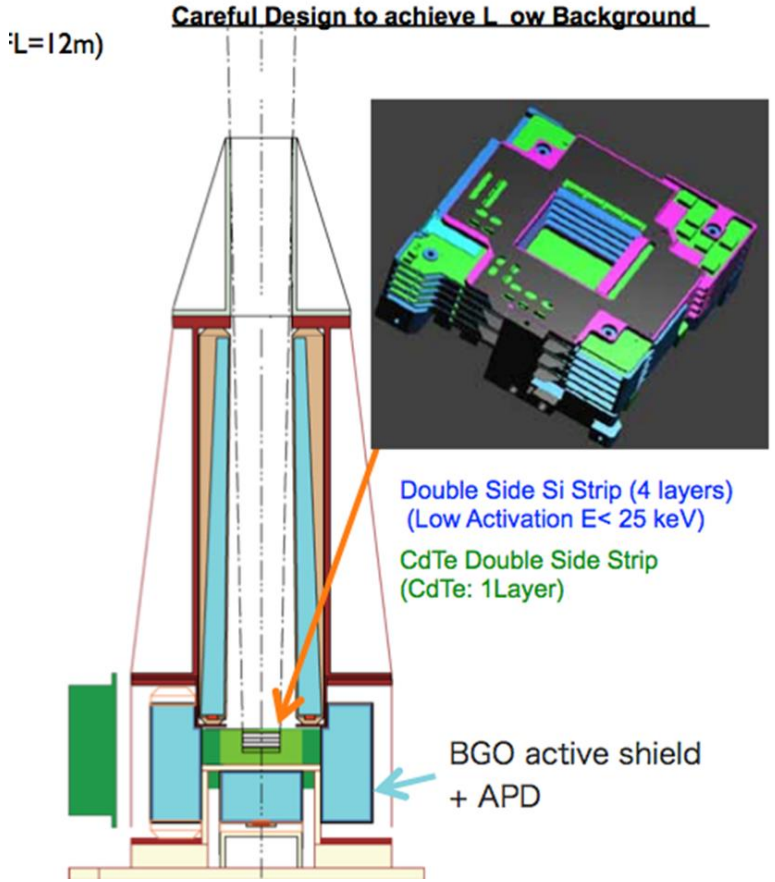
HXT + HXI (5—80keV)

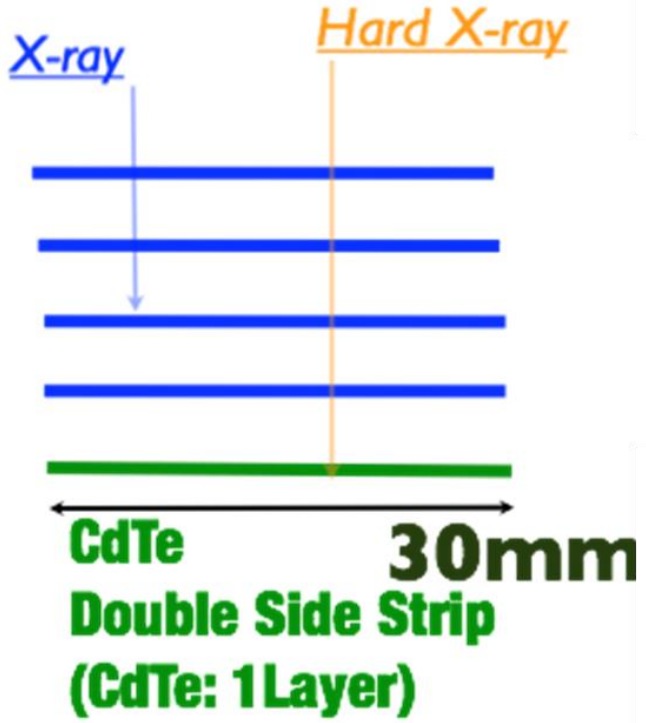


Hard X-ray Imager (HXI)

E<20 keV: Double-sided Si Strip Detector

E>20keV: Double-sided CdTe Strip Detector





FOV: $9' \times 9'$

Hard X-ray Telescope

45cm

49cm

Pt/C multilayer

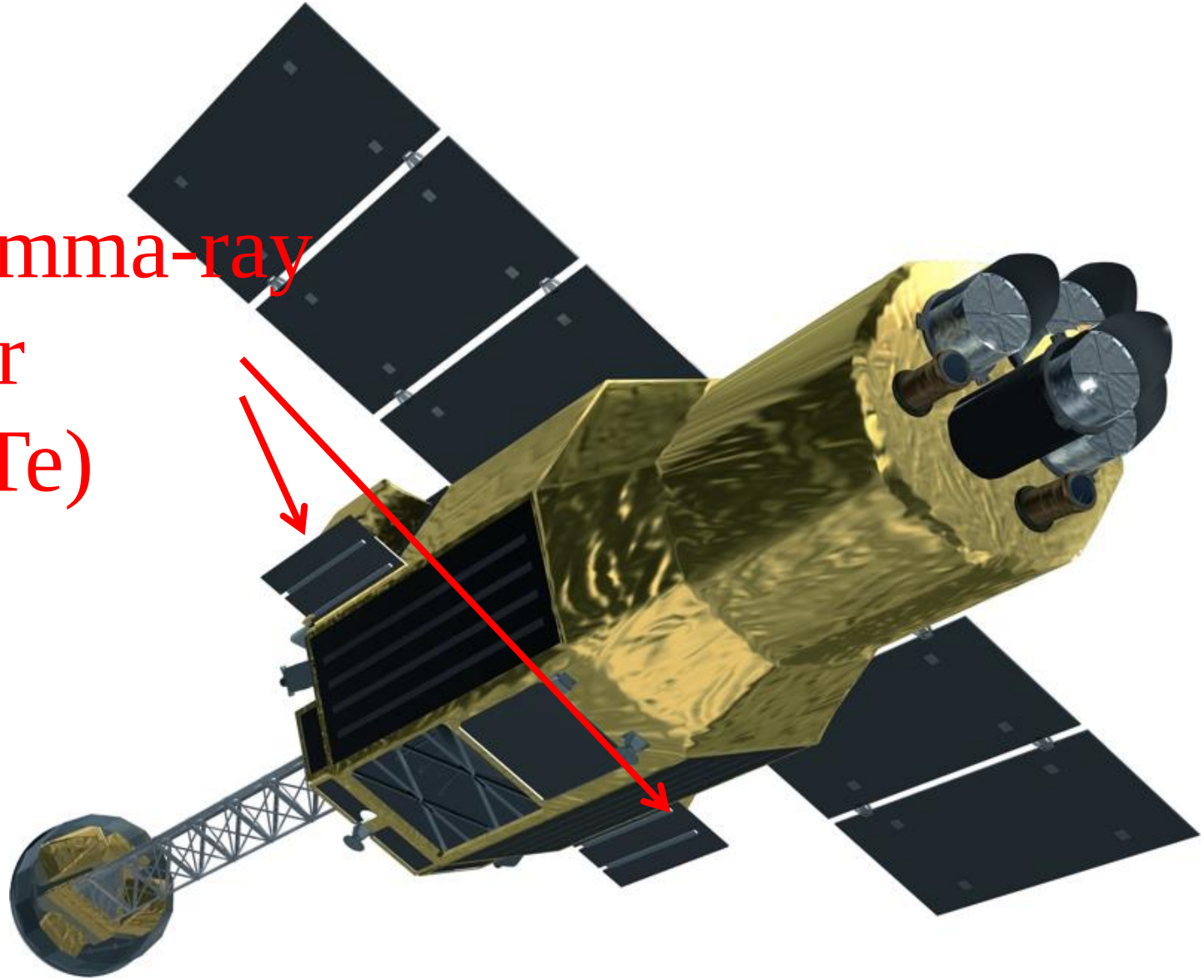
Bragg Reflection
E=5—80keV

HXT-1 FM
213 nested shells

Ang. Res.~ 1.9′

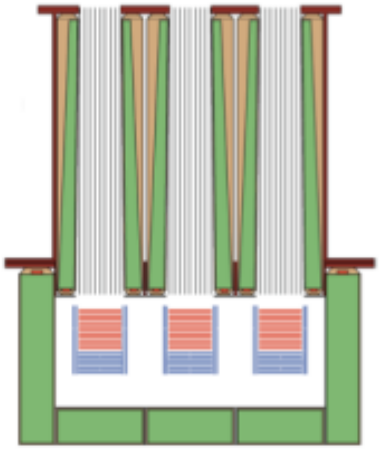
SGD (10—600keV)

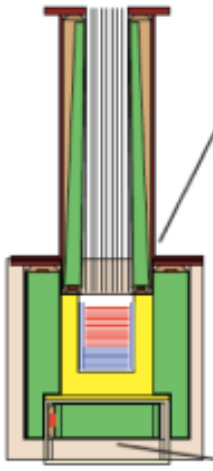
Soft Gamma-ray Detector (Si+CdTe)

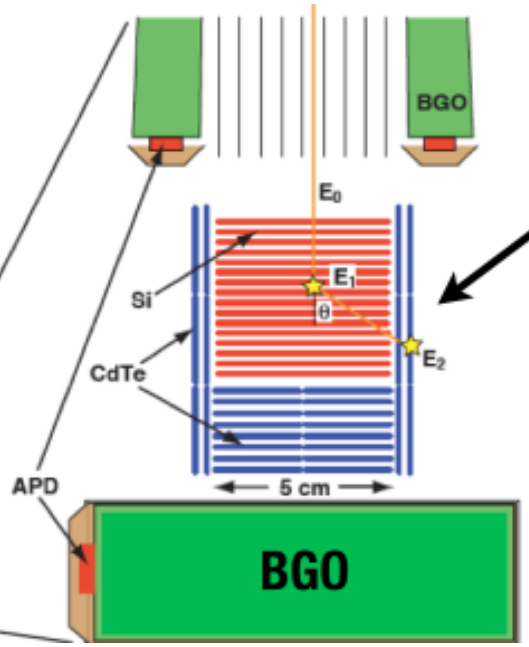


Soft Gamma-ray Detector (SGD)

- Si/CdTe Compton Camera
- Active shield of BGO







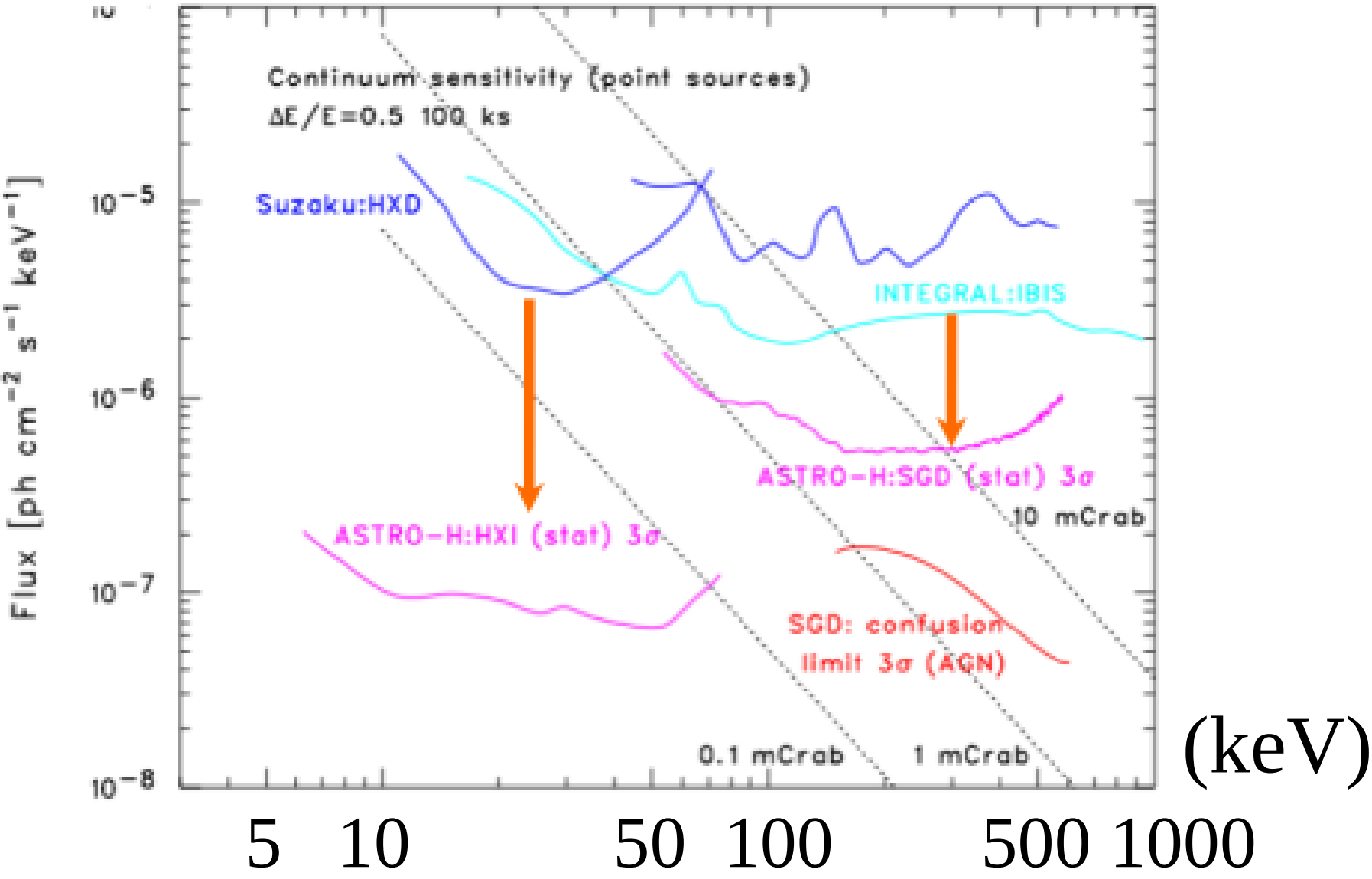
Si/CdTe Compton Camera (only select gamma-rays from the FOV)

Compton Kinematics

$$\cos\theta = 1 - m_e c^2 \left(\frac{1}{E_2} - \frac{1}{E_1 + E_2} \right)$$

$$E_{\mathrm{in}} = E_1 + E_2$$

High Sensitivity for high-E X-rays

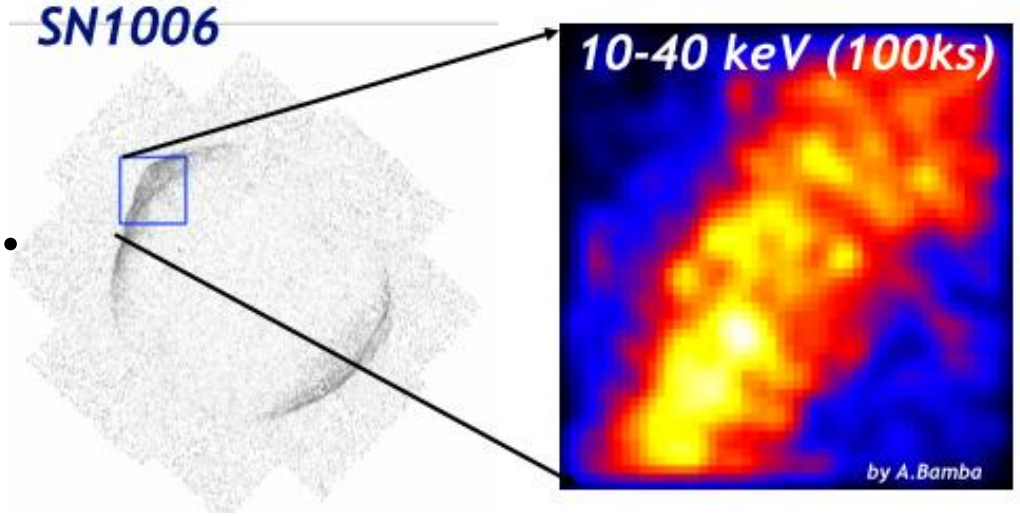


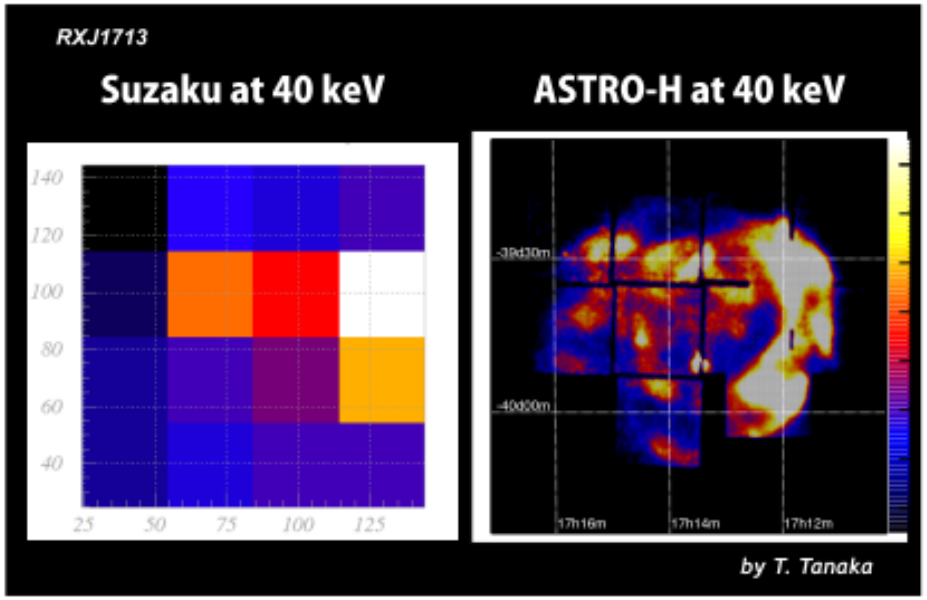
SNRs seen with HXI

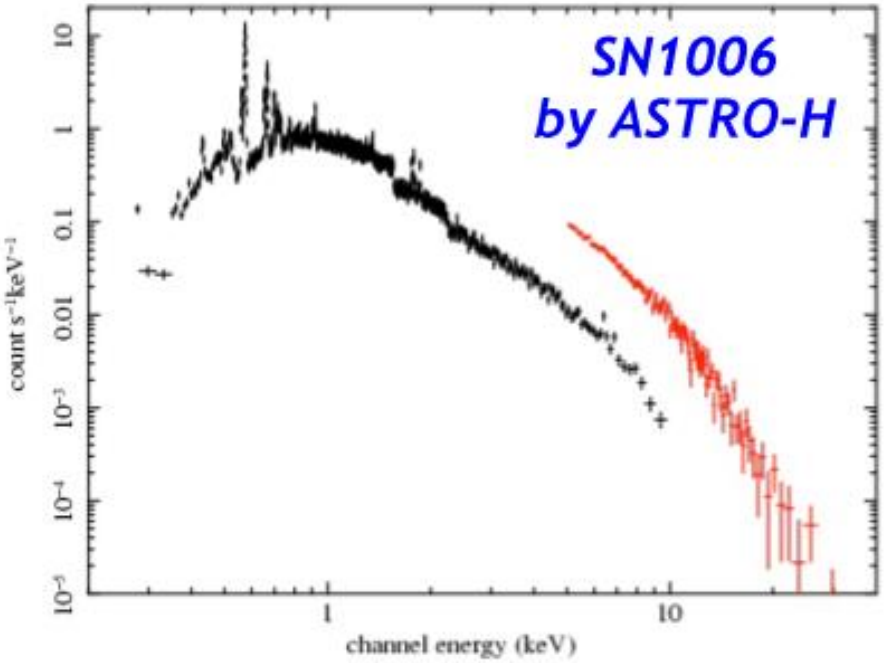
Clarify the mechanism of particle acceleration.

Y. Uchiyama's talk

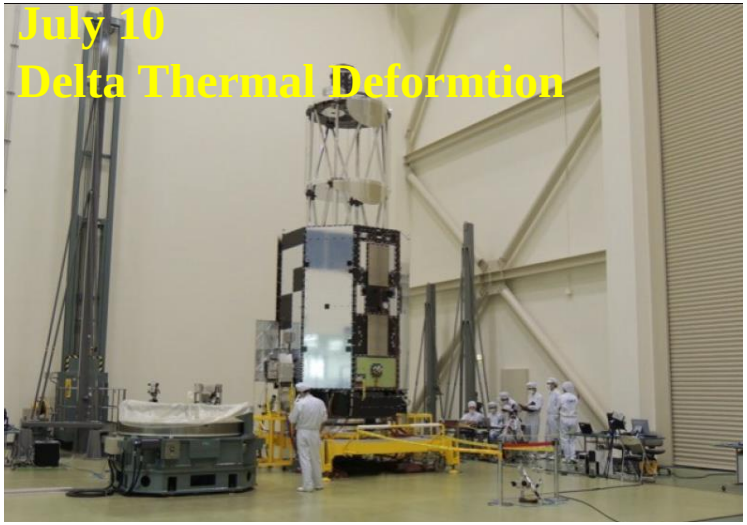
Today's afternoon







ASTRO-H under test



ASTRO-H will be launched in 2015

Summary

- ASTRO-H carries four systems
  - SXT + SXS, SXT+SXI, HXT+HXI, SGD
  - Wide energy range
  - High energy resolution
  - High sensitivity for high-E X-rays
  - Wide FOV
- Many science topics can be addressed
- ASTRO-H will be launched in 2015

Visit http://astro-h.isas.jaxa.jp/index.html.en

backup

Properties	SXS	SXI	HXI	SGD (photo-abs)	SGD (Compton)
Effective area (cm^2)	50/225 (@0.5/6 keV)	214/360 (@0.5/6 keV)	300 (@30 keV)	150 (@30 keV)	20 (@100 keV)
Energy range (keV)	0.3-12.0	0.4-12.0	5-80	10-600	40-600
Angular resolution in HPD (arcmin)	1.3	1.3	1.7	N/A	N/A
Field of view ($arcmin^2$)	3.05x3.05	38x38	9x9	33x33 (<150 keV) 600x600 (>150 keV)	33x33 (<150 keV) 600x600 (>150 keV)
Energy resolution in FWHM (eV)	5	150 (@6 keV)	< 2000 (@60 keV)	2000 (@40 keV)	4000 (@40 keV)
Timing resolution (s)	$8x10^{-5}$	4	several x 10^{-5}	several x 10^{-5}	several x 10^{-5}
Instrumental background (/s/keV/FoV)	$2x10^{-3}/0.7x10^{-3}$ (@0.5/6 keV)	0.1/0.1 (@0.5/6 keV)	$6x10^{-3}/2x10^{-4}$ (@10/50 keV)[1] $2x10^{-3}/4x10^{-5}$ (@10/50 keV)[2]		$1x10^{-4}/1x10^{-5}$ (@100/600 keV)

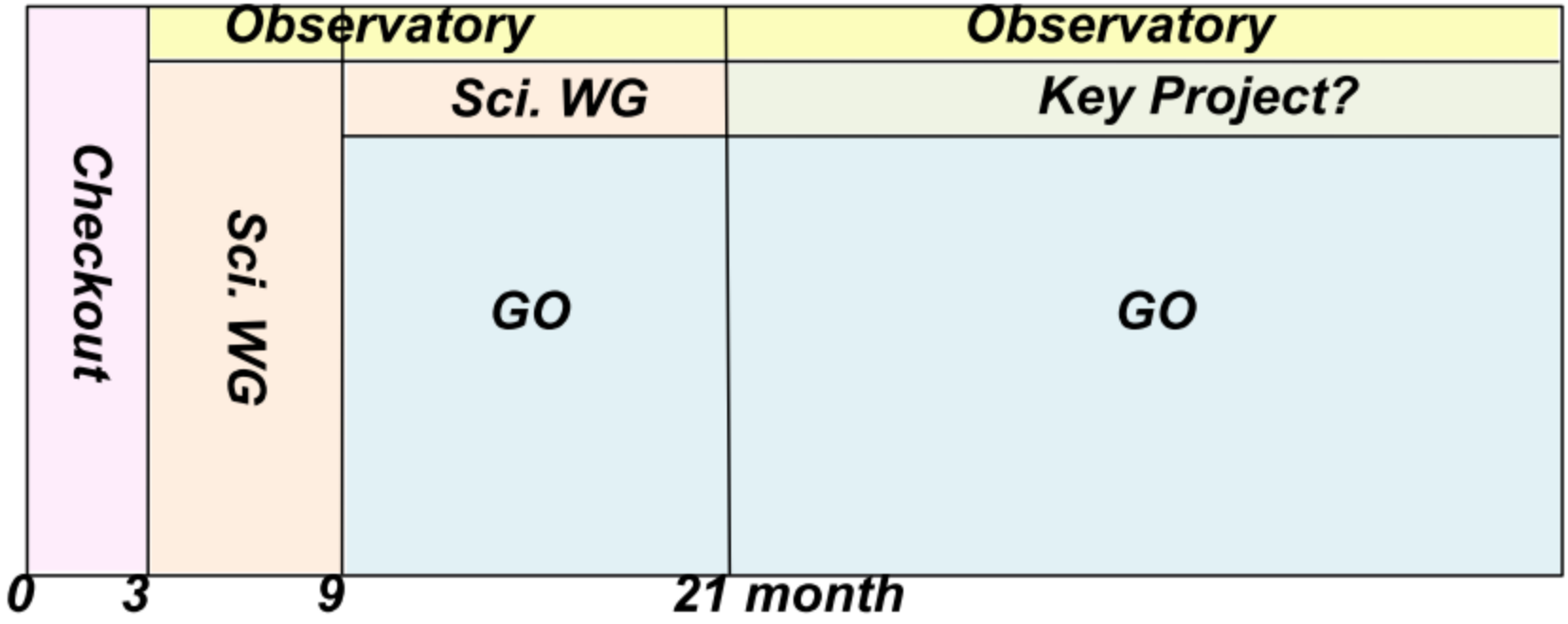
[1]4 layers, [2]1 layer

Properties	SXT	HXT
Diameter (cm)	45	45
Focal length (m)	5.6	12
No. of nested shells	203	213
Reflector coating	Au	Pt/C multilayer
Thermal shield	Al (0.03 μm) + polyimide (0.2 μm)	Al (0.03 μm) + PET(5 μm)

Properties	SXT	HXT
A_{eff} (cm^2)	279/312 (@0.5/6keV)	338 (@30keV)
HPD (arcmin)	1.3	1.7
FoV ($arcmin^2$)	$22.2^2/19.8^2$ (@0.5/6 keV)	$6.4^2/5.3^2$ (@30/50keV)
Stray-light reduction rate	>99 (@30' off-axis)	>99 (@15'-25' off-axis)
Thermal shield transmission (%)	70 (@0.5keV)	92 (@5 keV)

Phase 0 : 3 Months : Satellite/Instruments Check out (including Calibration))
Phase 1 : 6 Months : SWG 90 % (PV Phase) Observatory 10 %
Phase 2 : 12 Months : SWG Carry Over 15 %, GO 75 %, Observatory 10 %
Phase 3 : Rest of the mission : KeyProject 15 % (TBD) , GO 75 %, Observatory 10 %

Observatory 10 % = Calibration + TOO + Director's Time



Data policy among J/Europe/US in the GO time, would be similar to the Suzaku case. But we are planning to introduce key-project type and/or early-data-released type observations from early phase of the mission.