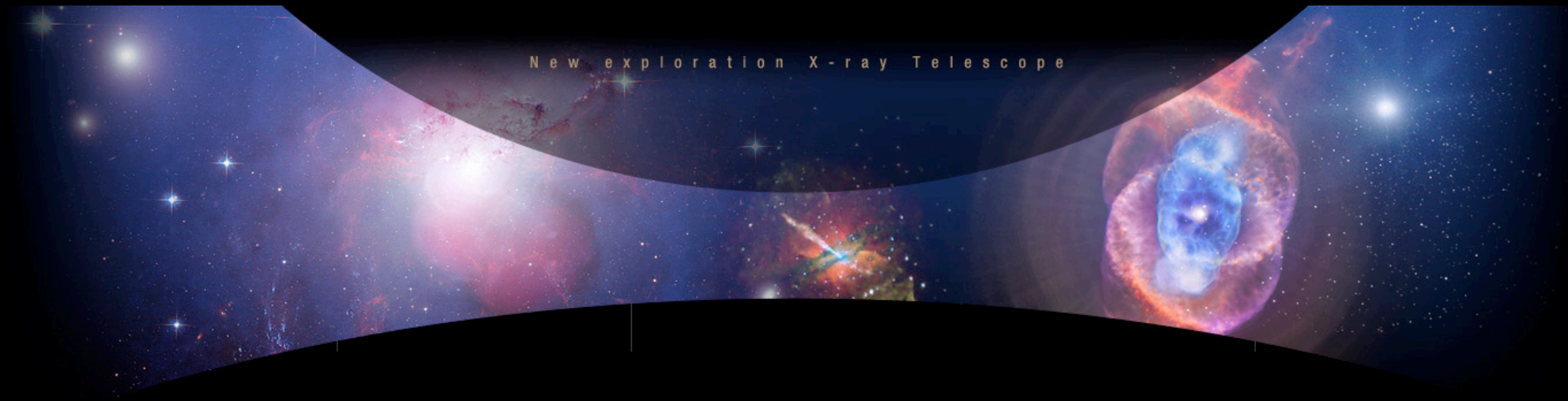


ASTRO-H

and future missions in JAXA program

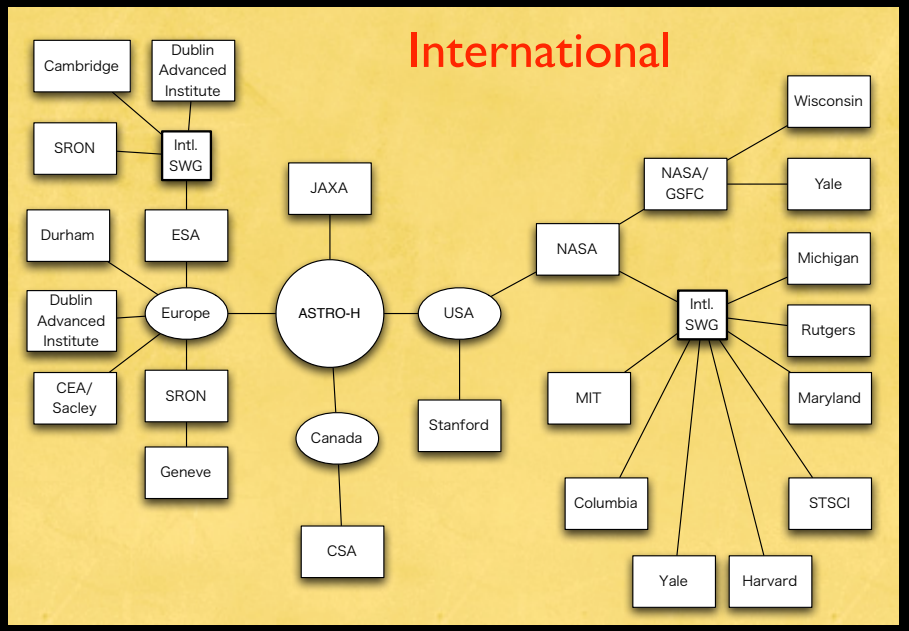
Tadayuki Takahashi
PI/Project Manager
on behalf of the ASTRO-H team

Status

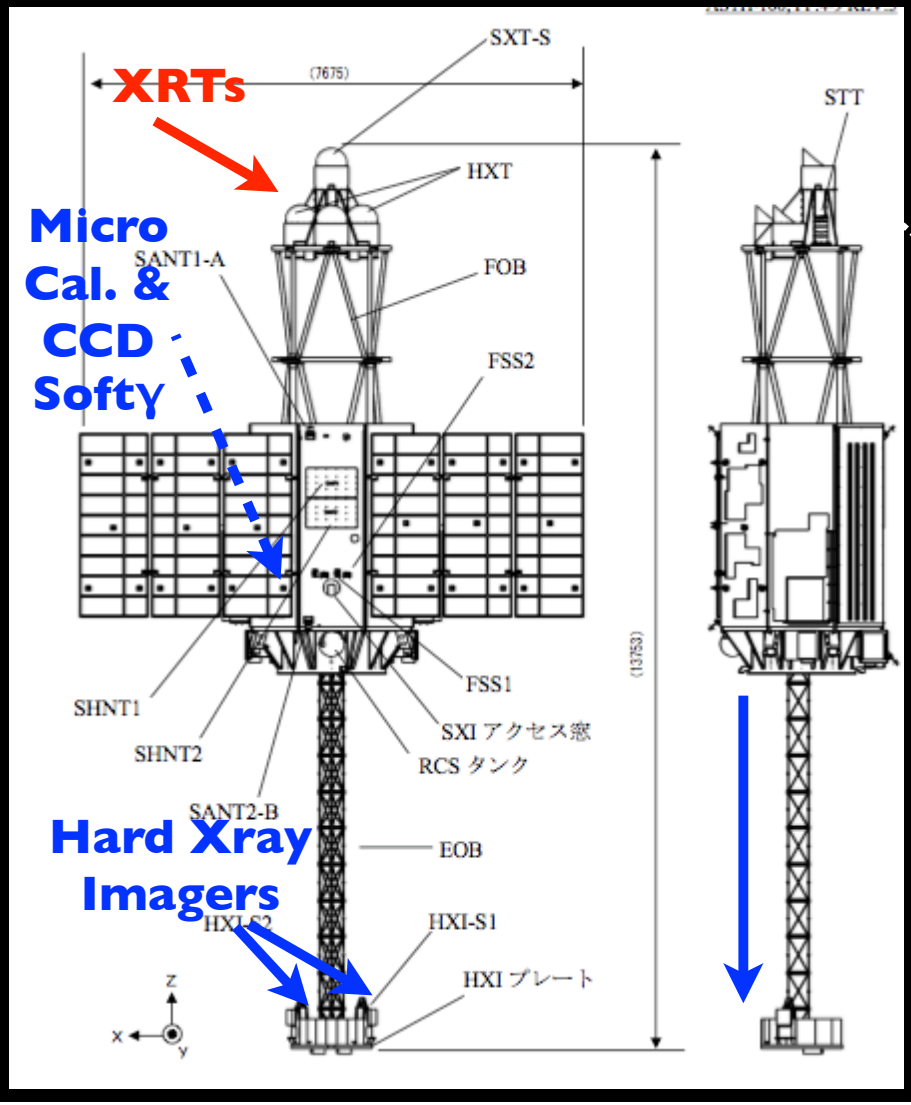
- **The ASTRO-H Project is in Phase B, since 2008 Oct. (JAXA)**

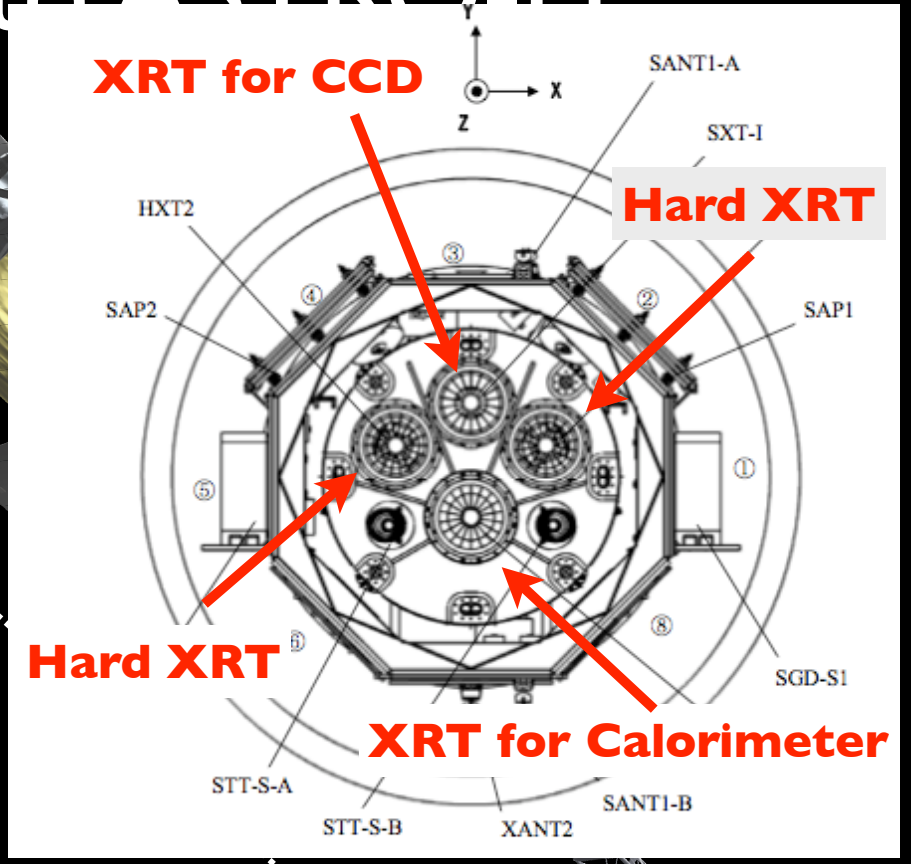
2009/Jan-Feb : Science Working Group members (science advisors) selected by NASA(8), ESA(3) and JAXA(2), Chair: A. Fabian
2009/Feb. 25-27 : 1st Collaboration Meeting (Science Meeting/3rd Design Meeting)
2009/June 4-5 : 4th Design Meeting (with two days splinter meeting)
2009/June 16: NASA entered Phase B

1. 2009 Sep-Jan: Sub System Level Review
2. 2010 Feb-Mar: System Level PDR
3. 2010 Nov-2011 April : MTM - TTM
4. 2011 Feb-Mar: CDR
5. 2013 Feb-Oct: Integration Test
6. 2014 Jan-Feb.: Launch (Planned)



From Suzaku to ASTRO-H

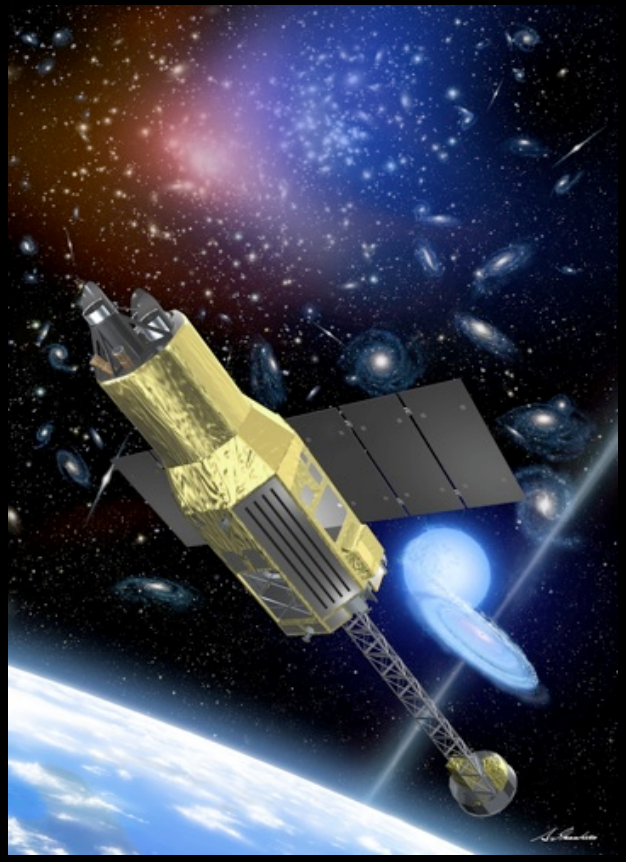


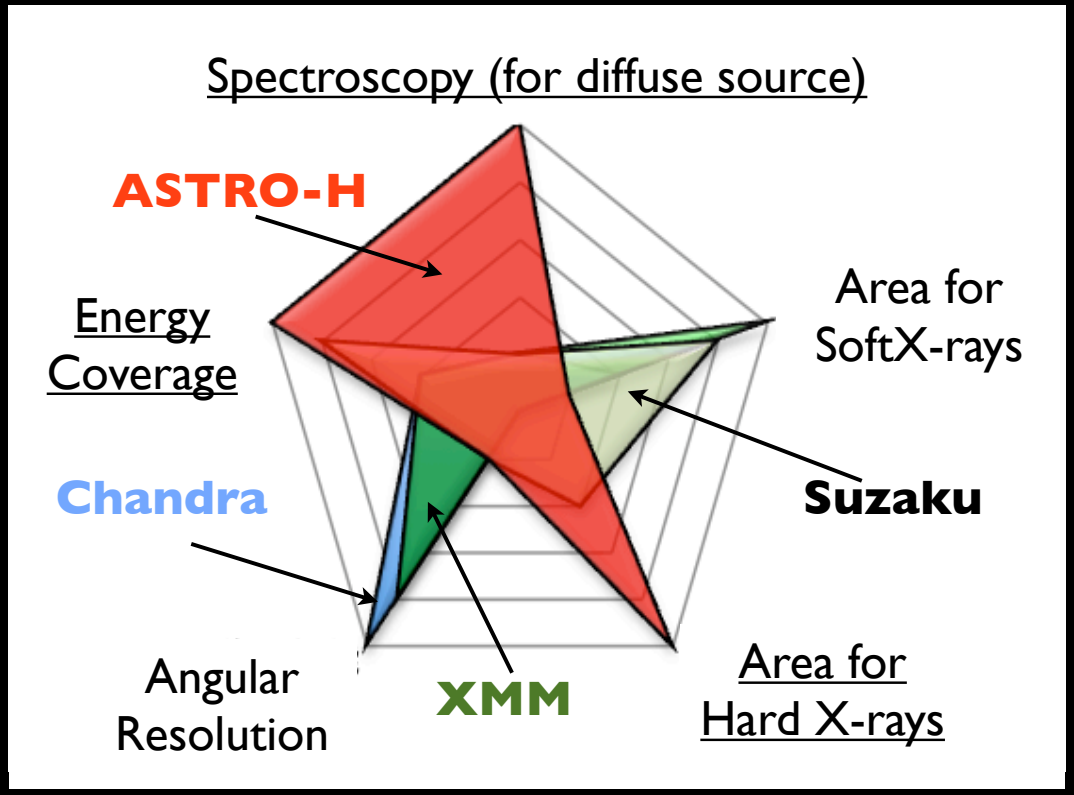


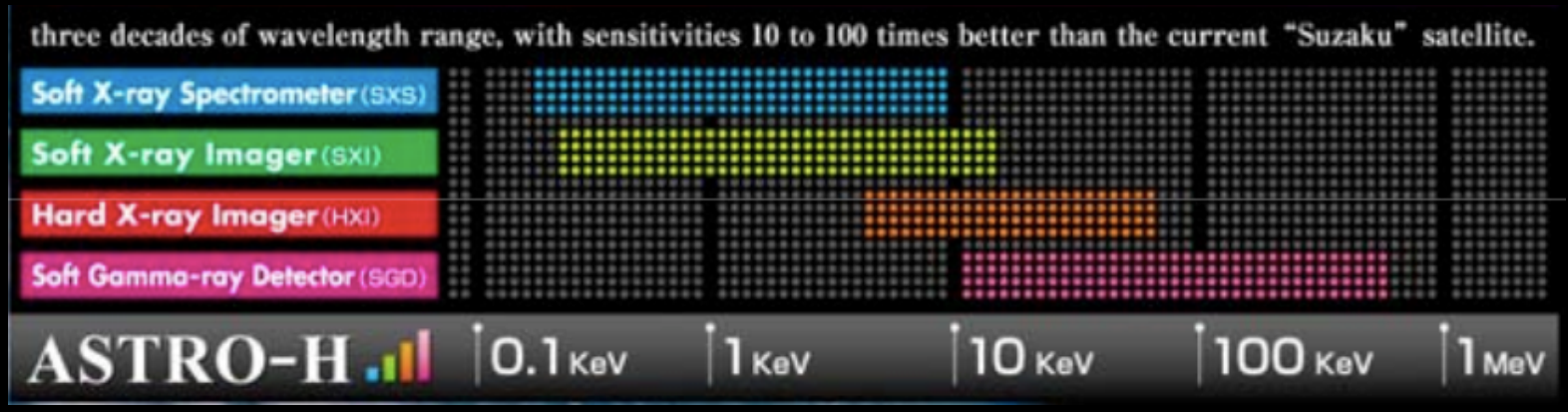
14 m

ASTRO-H

ASTRO-H Features...







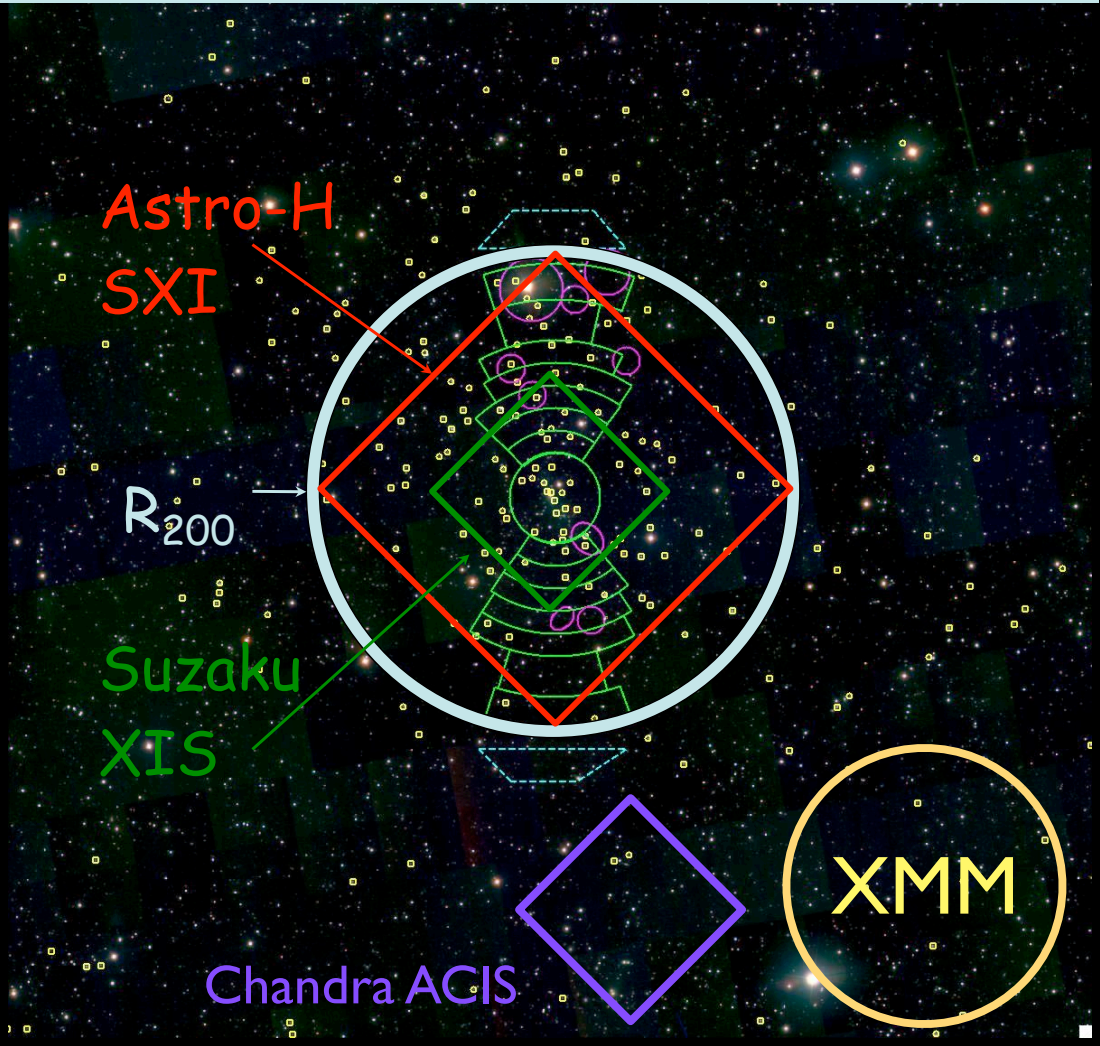
Design Parameters of Instruments

	Specifications **(Requirement)**
Hard X-ray Imaging System (HXT+HXI) 5-80 keV	Effective area : 300 cm^2 (@30 keV) Spatial resolution : 1.7 arcmin (HPD) Energy resolution : 2 keV Field of view : 9 $arcmin^2$ @30 keV
Soft X-ray Spectrometer System (SXT-S+SXS) 0.3-10 keV	Energy resolution : 7 eV Spatial resolution : 1.7 arcmin (HPD) Effective area : 210 cm^2 (@6 keV) Field of view : 3 $arcmin^2$ @6 keV
Soft X-ray Imaging System (SXT-I+SXI) 0.5-12 keV	Spatial resolution : 1.7 arcmin (HPD) Effective area : 360 cm^2 @6 keV Energy resolution : 150 eV Field of view : 38 $arcmin^2$ @6 keV
Soft γ-ray detector (SGD) 10-600 keV	Effective area : 100cm^2 @100 keV Energy resolution : 2 keV @40 keV Astrometric accuracy : <0.6 arcdeg (E<150 keV)

1. Soft X-ray Imager (SXI)

Large FOV CCD (F.L. 5.6m)

AstroH SXI vs Suzaku XIS on A1795

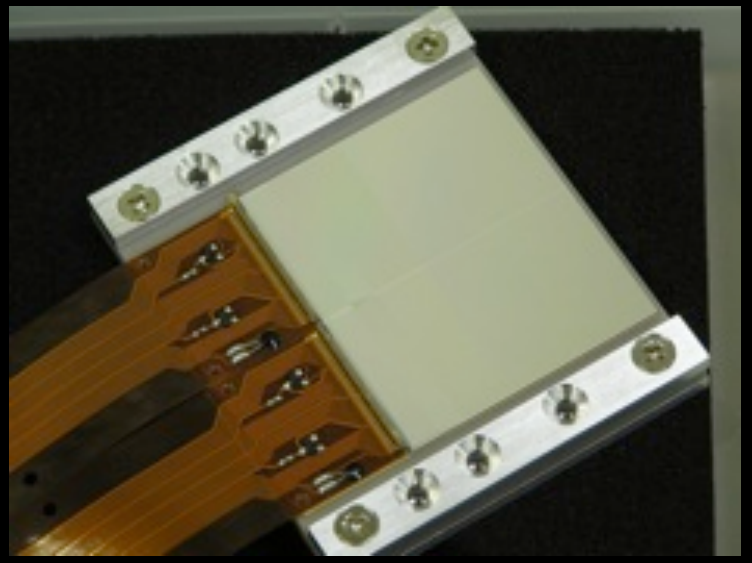


Energy resolution : 150 eV

Field of view : 38 arcmin @6 keV

4CCD chips/62x62mm^2

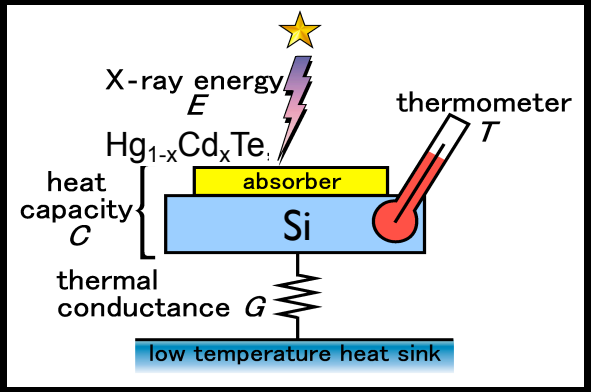
Spatial resolution : 1.7 arcmin (HPD)
(requirement)



Hamamatsu Photonics

2. Soft X-ray Spectrometer (SXS)

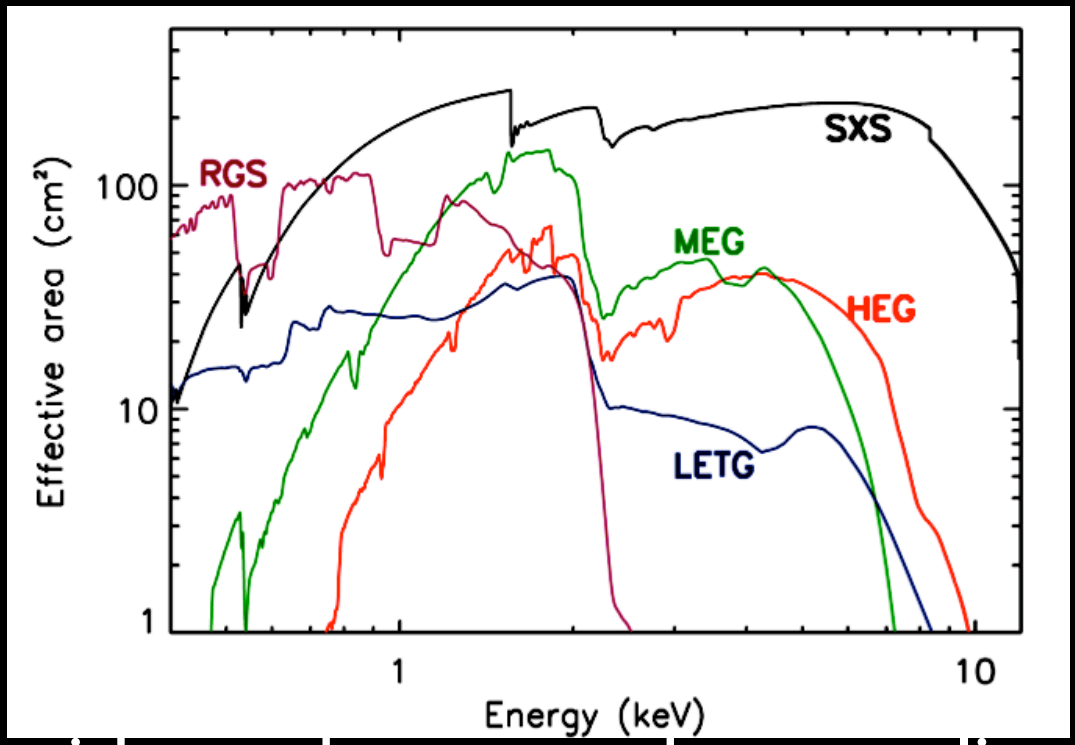
- High Resolution Spectroscopy- by a micro calorimeter array



Effective area : 210 cm^2 (@6 keV)

Field of view : 3 arcmin^2 @6 keV

	Requirements (/Goal)
Energy resolution	7 eV (FWHM) (4 eV(FWHM) Goal)
Energy range	0.3 - 12 keV
Background rate	1.5 x 10^{-3} cts/s/keV
Field of view	2.9 x 2.9 arcmin
Detector array	6 x 6
Absorber size	800 μm
Angular resolution	1.7 arcmin HPD
Effective area	160 / 210 cm^2 (at 1 / 6 keV)
Lifetime	3 years / 5 years
Maximum count rate	150 cts/s
Energy scale accuracy	2 eV

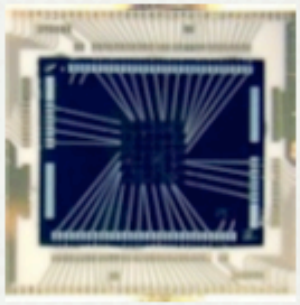


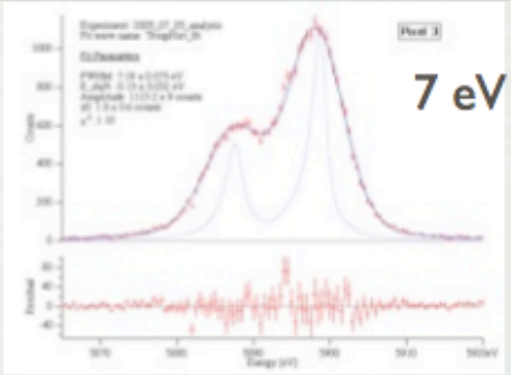
with much more robust cooling system than that of Suzaku

- Improved Resolution for ASTRO-H -

Suzaku XRS flight data

(Kelley+ 2007)

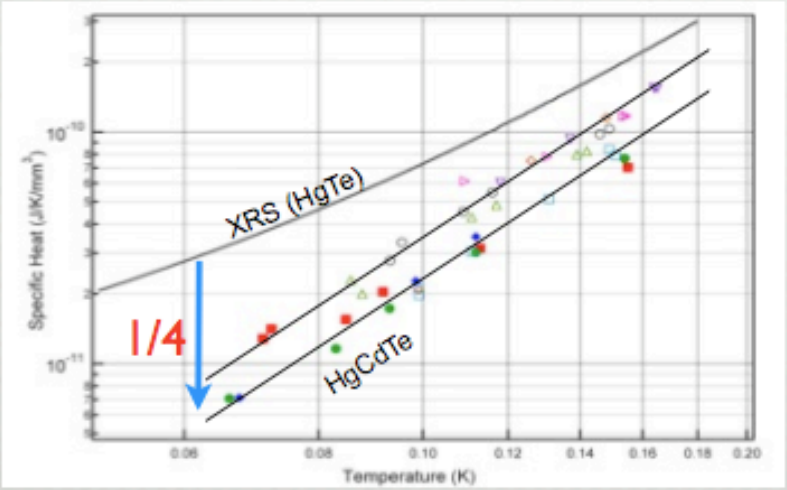




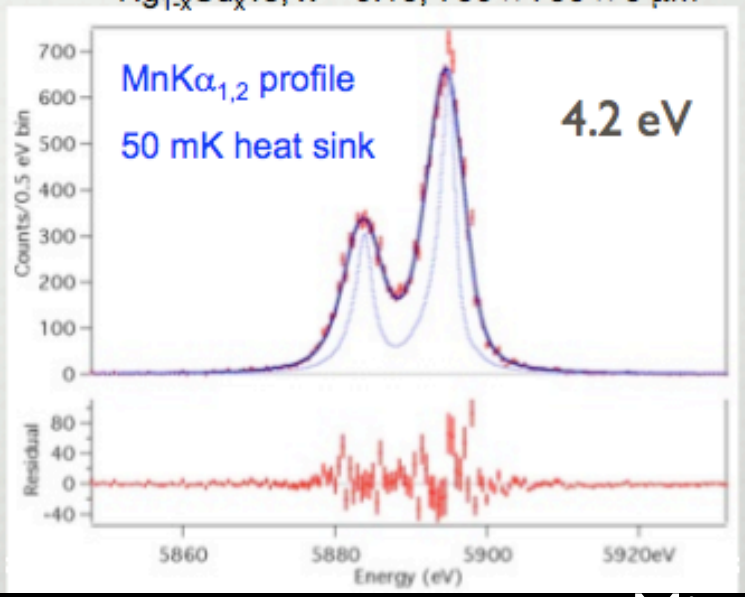
Improvement in energy resolution at laboratory level (Kelley+ 2008)

Lower operating temperature (60mk ➜ 50mK)

Lower Heat Capacity (~factor 4)



$Hg_{1-x}Cd_xTe$, x = 0.16, 790 × 790 × 6 μm

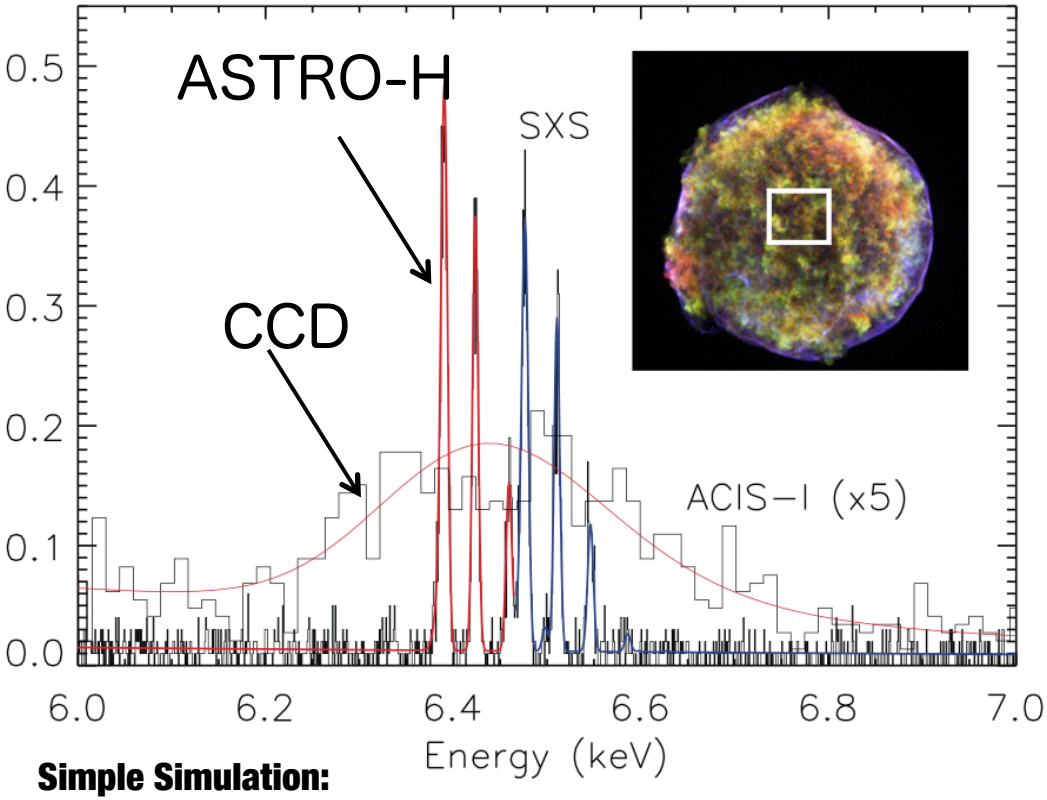


Mitsuda

High Resolution X-ray Spectroscopy of 4-6 eV (FWHM)

Velocity Structure of X-ray lines

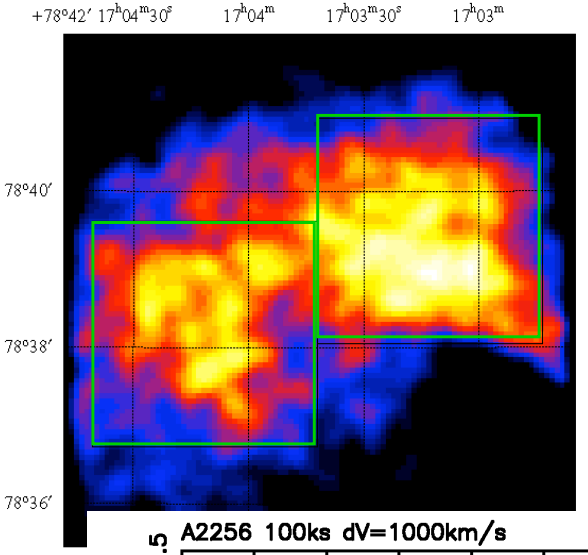
SNR



Simple Simulation:

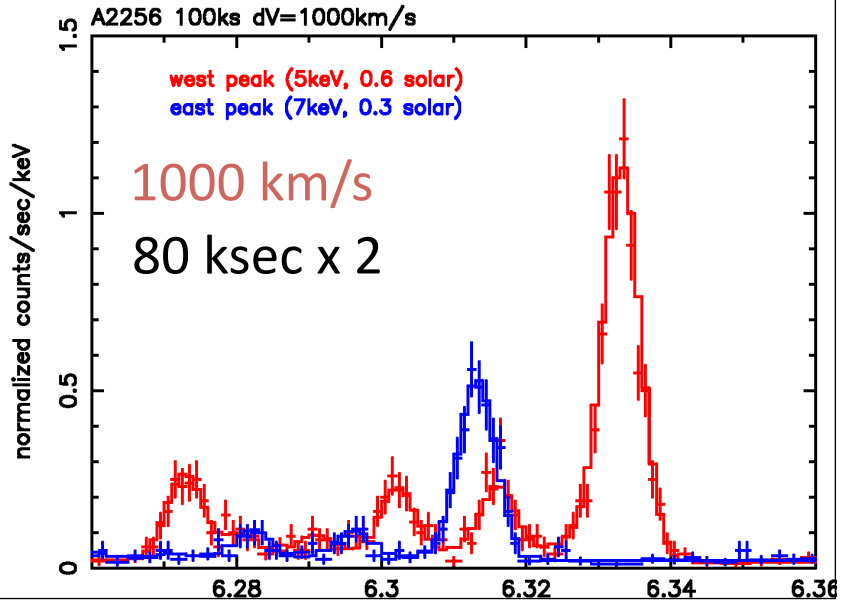
100ks Obs., Tycho SNR :two velocity components, seperated by ±2000km/s (blue and red)

Merging Cluster

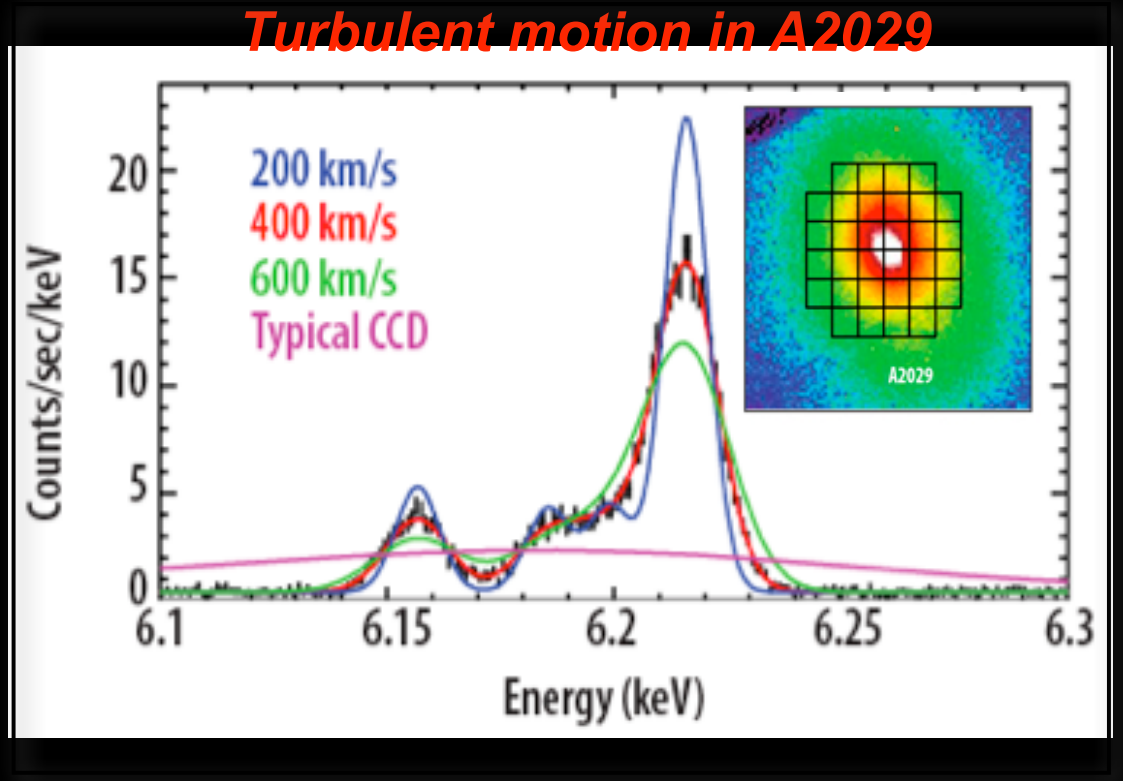


A2256

(z = 0.058)



High Resolution Spectroscopy by ASTRO-H (~2013)



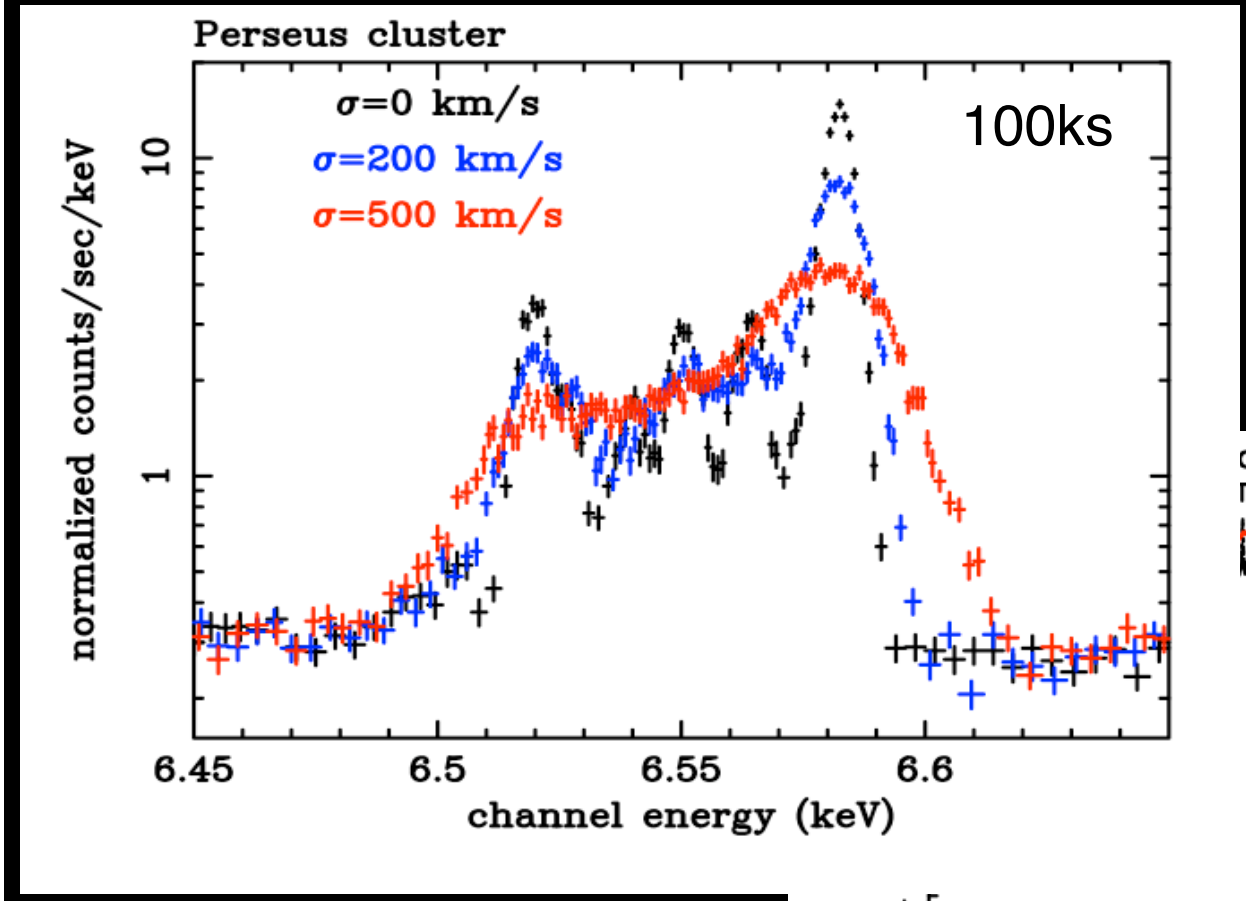
ASTRO-H measures bulk velocity flow as small as 300 km/s in the brightest 30 hot clusters (kt > 5 keV).

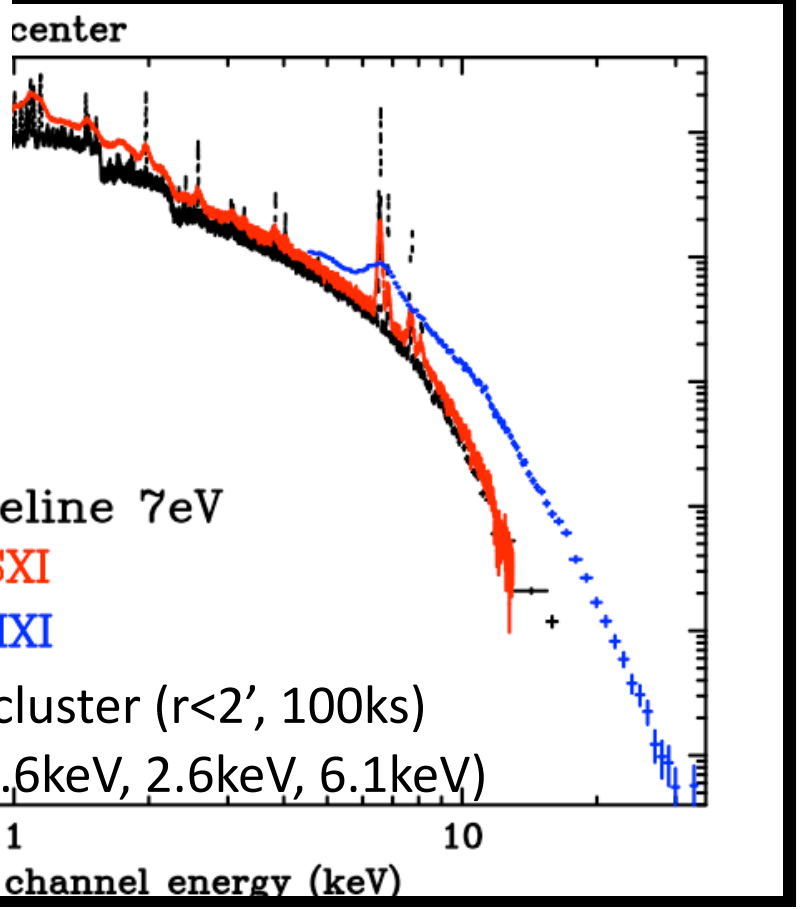
ASTRO-H will push on X-ray astronomy to a new exciting phase by showing dynamical motions in all scales in the universe with a micro-calorimeter.

(cooled at 50 mK)

Line profile from a turbulent gas

Simulation

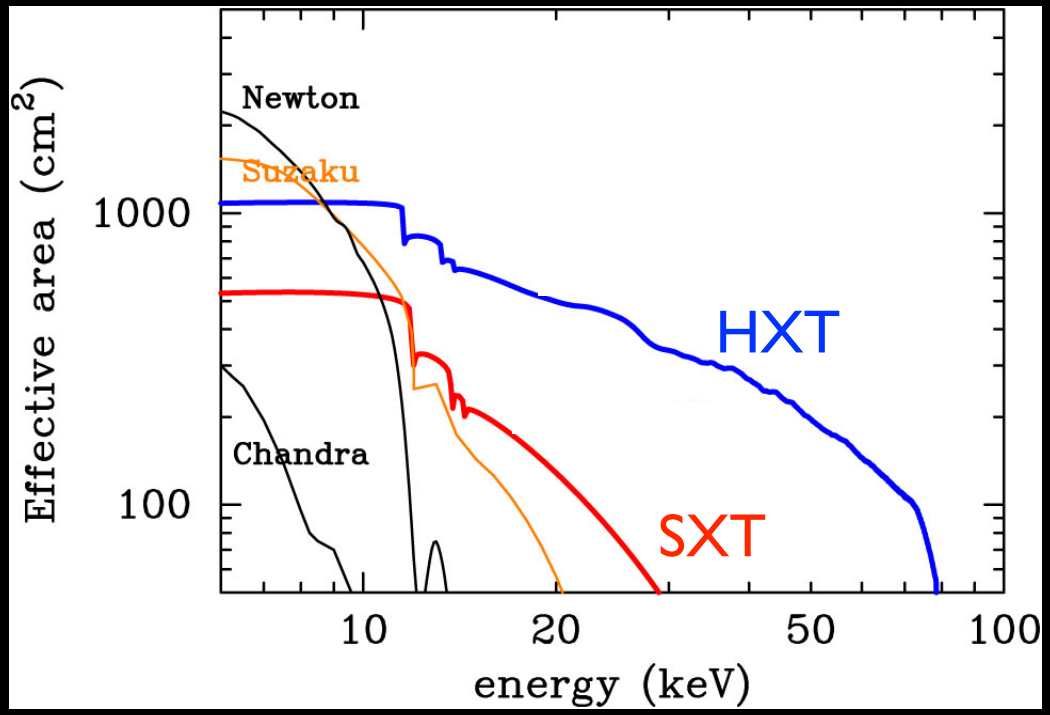




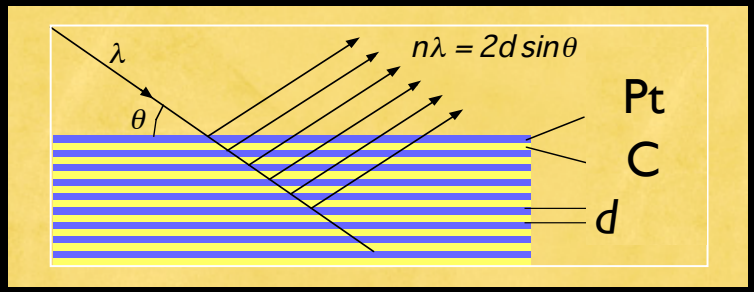
3. Hard X-ray Telescope (HXT)

Imaging at Higher Energies

- New Hard X-ray Telescope with large effective area



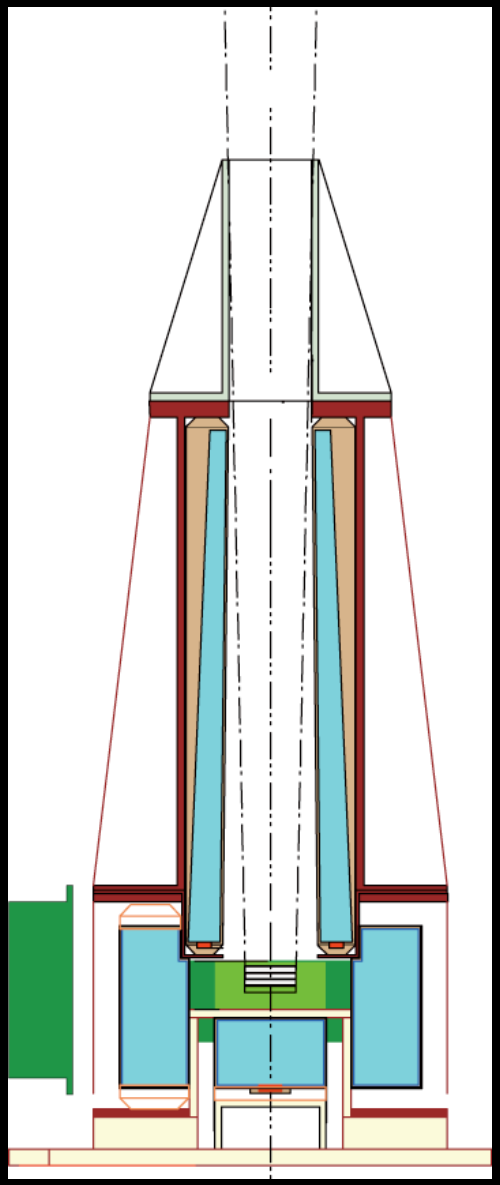
300 cm^2 (@30 keV)



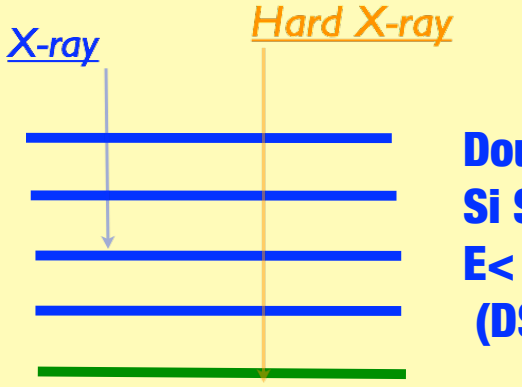
Two Telescopes/ F. L. 12 m
Mounted on the Fixed Optical Bench

4. Hard X-ray Imager (HXI)

Cutting Edge Technology



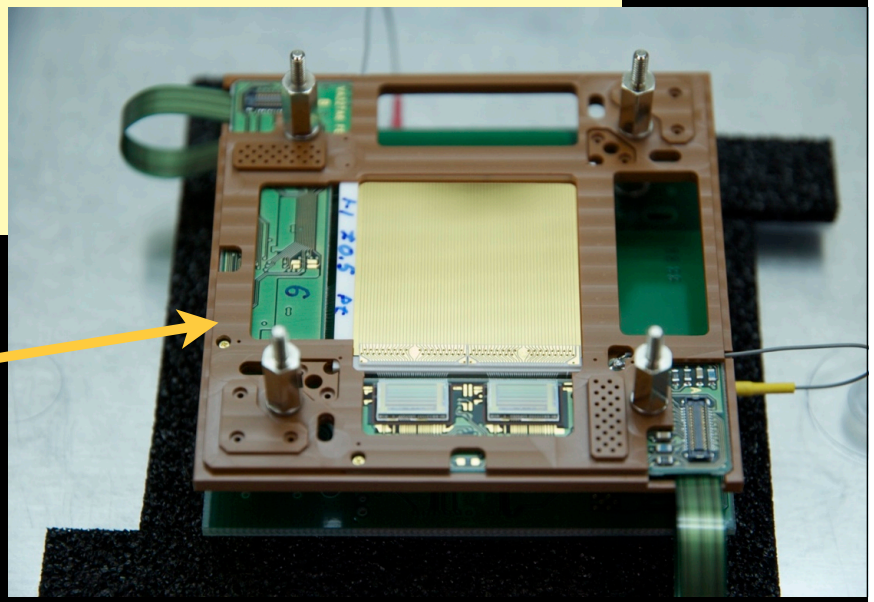
1. Well-type BGO Active Shield (APD Readout)
2. Si/CdTe Hybrid Detector (Double Sided)
   - VERY Careful Design to achieve "Low Background"



9x9 arcmin^2

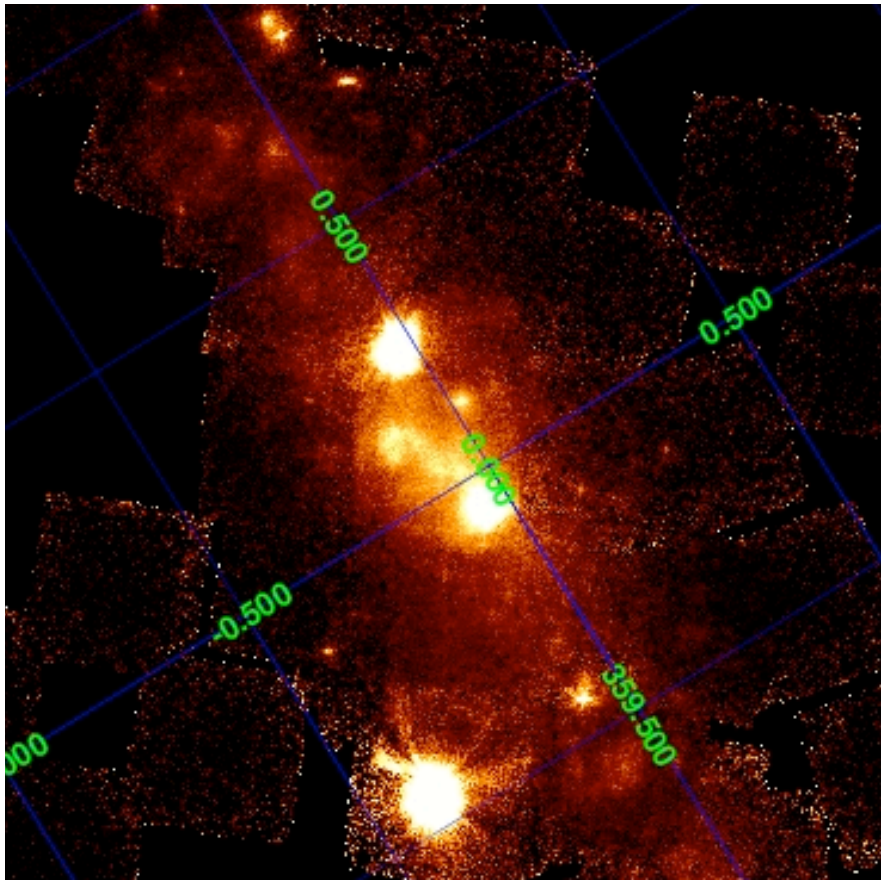
Double Side
Si Strip (Low Activation
E< 25 keV)
(DSSD: 4Layer)

High Res.
CdTe Diode
(Cross Strips)
250 micron pitch



Simulation
Comparison with INTEGRAL/IBIS image

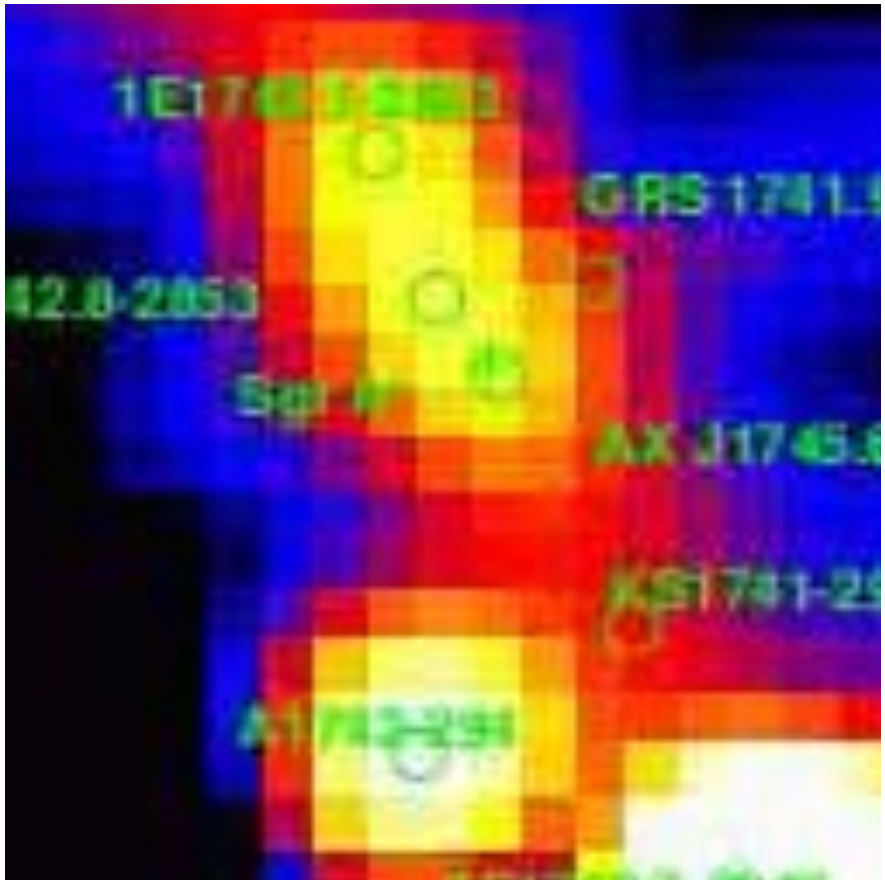
ASTRO-H HXI



100-150 ks/pointing

by A.Bamba

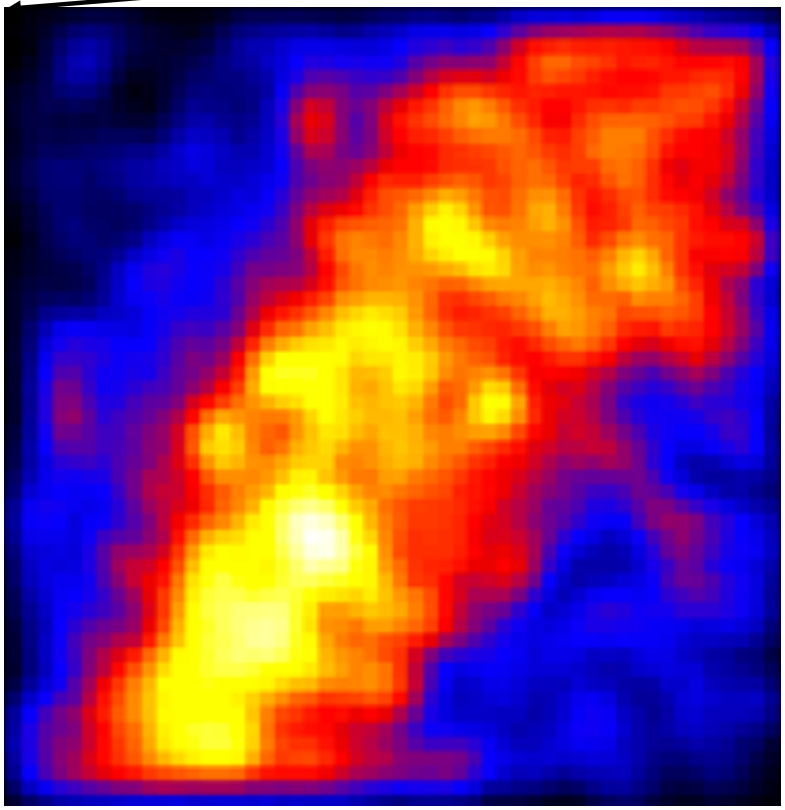
INTEGRAL IBIS

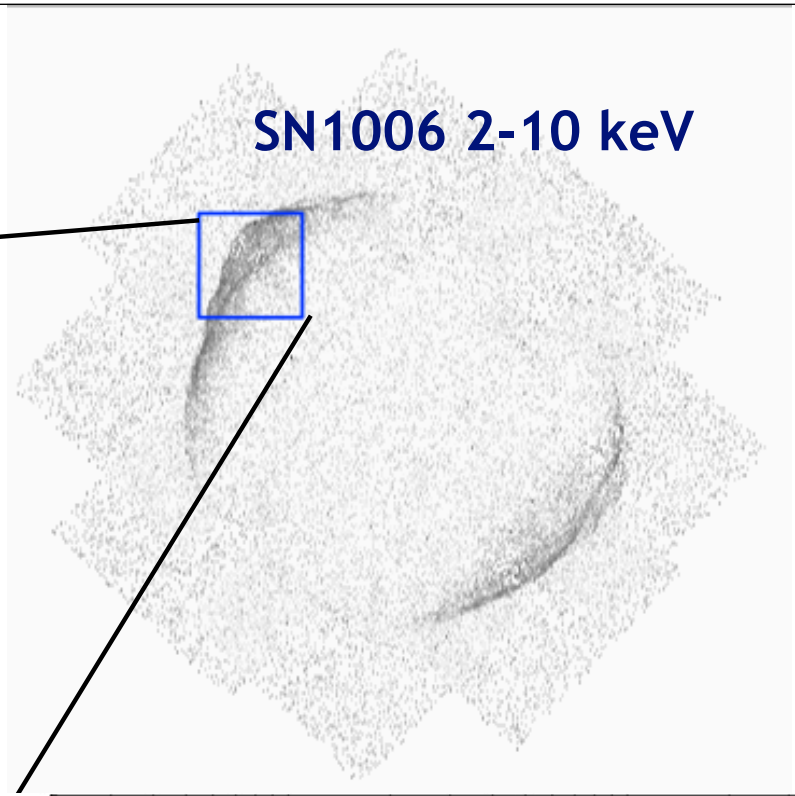


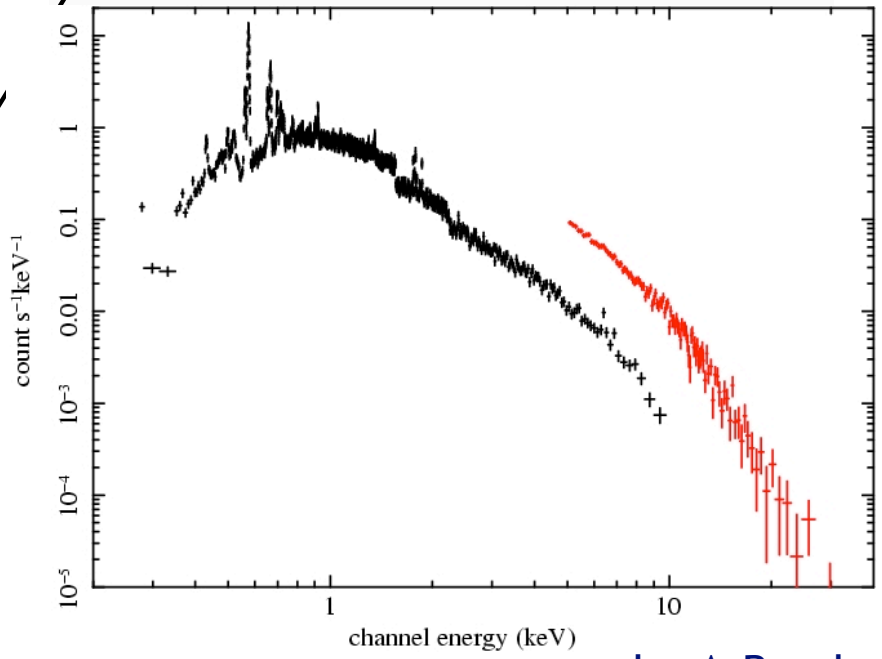
(Revnivtsev+04)

SN1006 with HXI

HXI 10-40 keV (100ks)







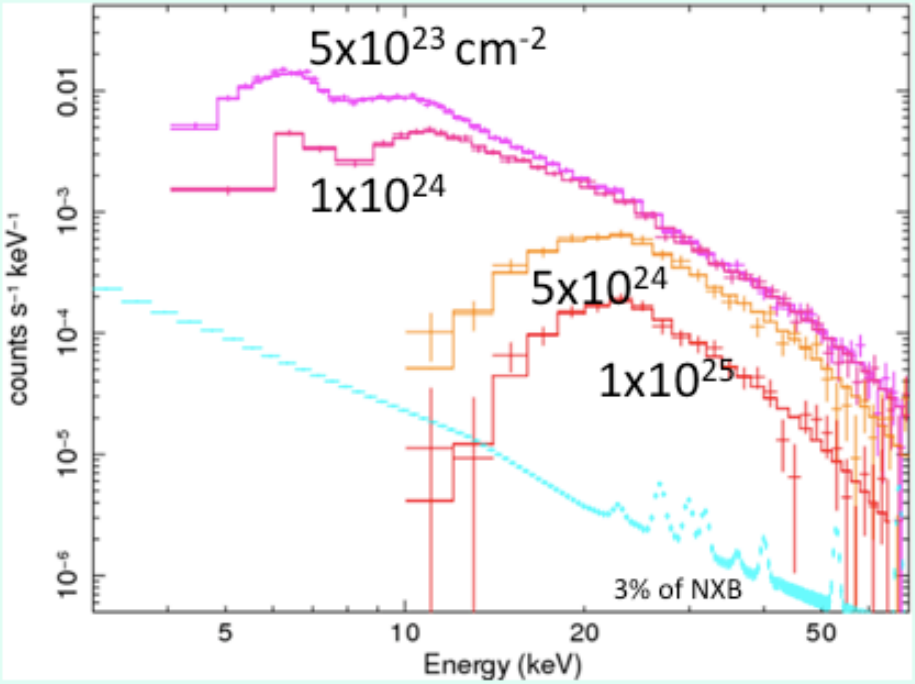
pos. difference of cutoff ?
thermal parameters w. SXS
-> acc. efficiency

by A.Bamba

Obscured blackholes

ASTRO-H Observation of VERY Compton-thick AGN

NEW type AGN: Swift J0601: NH~1x10^{24} cm^{-2}; F2-10(intrinsic) = 1x10^{-11} cgs
Assumption: log NH = 25 if viewed from edge-on
photon index 1.9; No reflection component.



Astro-H HXT+HXI

100 ksec

(300 ksec for 1x10^{25})

Scattered emission and Fe line not included.

Buried very Compton thick AGN detectable at >10 keV.

Terashima

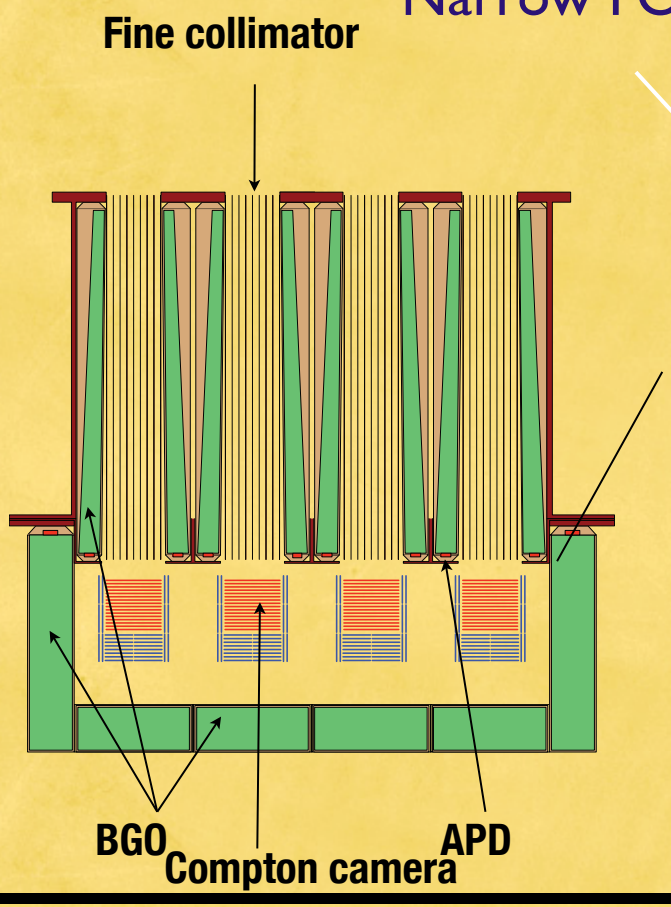
The origin of the CXB? ASTRO-H should directlyresolve out >30% at peak.

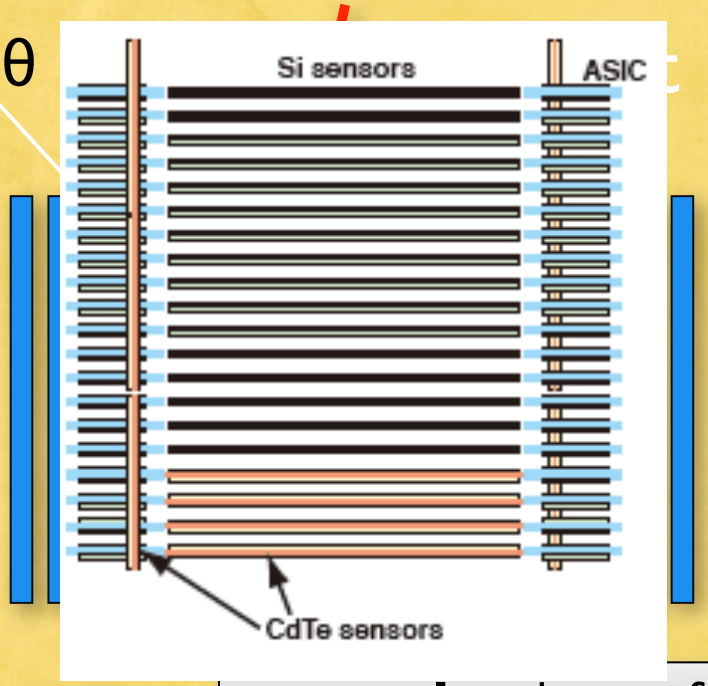
5. Soft Gamma-ray Detector (SGD)

Higher Senstivity above 80 keV

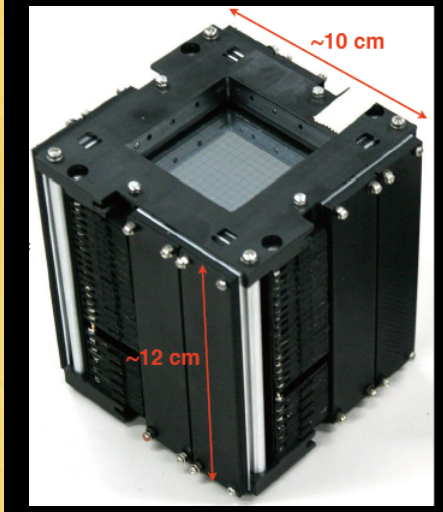
- Completely New Approach to achieve "Low Background"

Narrow FOV Si/CdTe Compton Detector

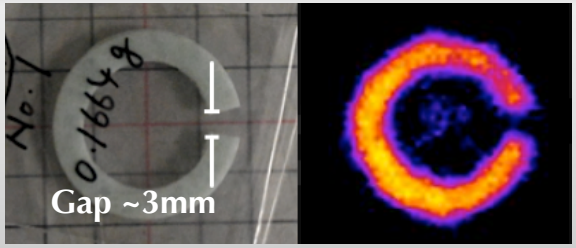




CdTe Pixels



Imaging performance



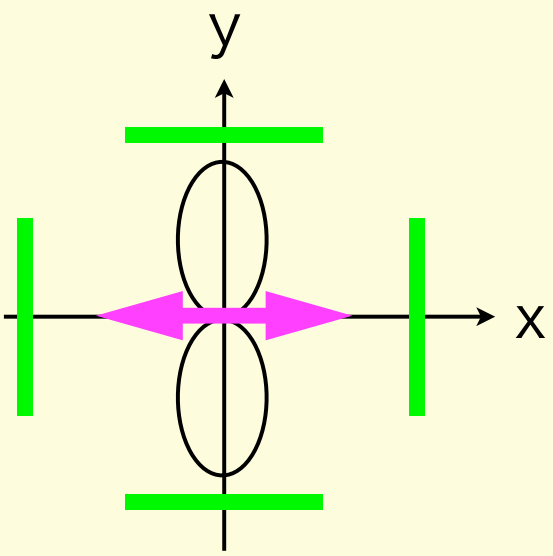
JAXA/Gunma U./JAEA(2008)

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

With Polarization Measurement Capability

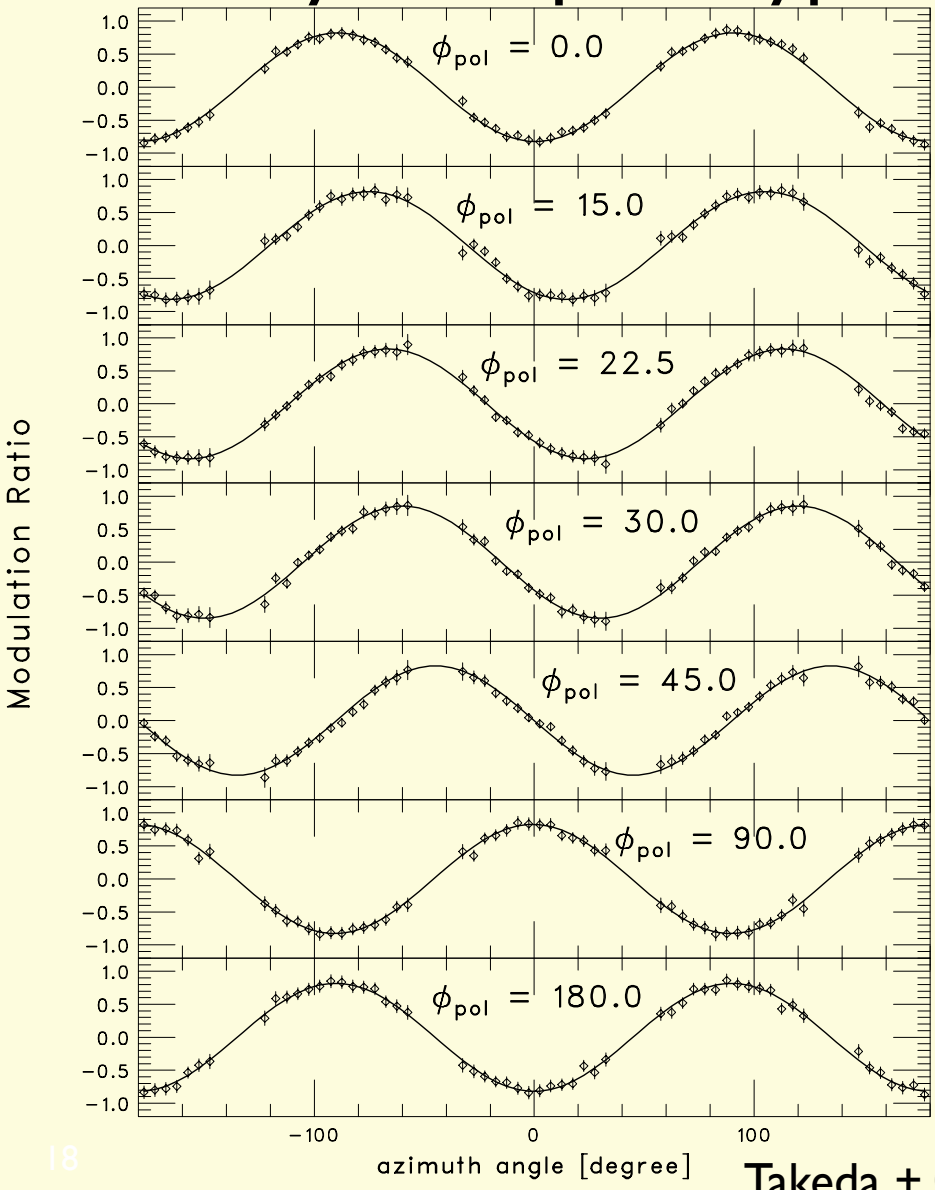
Experimental Results by SGD prototype

100% polarized beam (SPring-8)



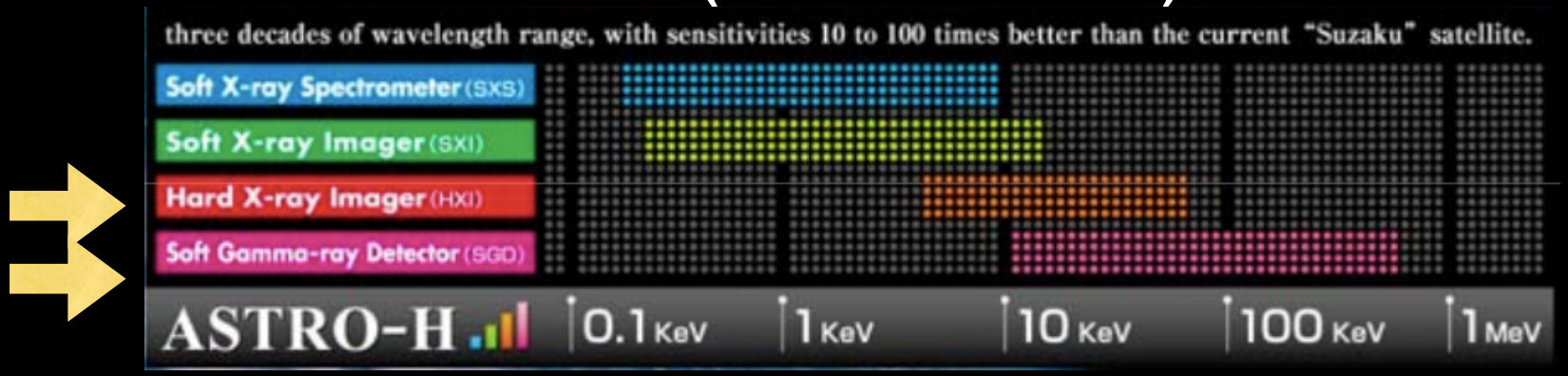
Simulation results (EGS4)

Source	Observation time	N_γ	3σ MDP
Crab	5 ks	85,900	6.0%
Cygnus X-1 soft state	25 ks	92,800	6.4%
X0115+63	25 ks	52,400	8.5%
Mk501 flare	100 ks	56,400	8.2%

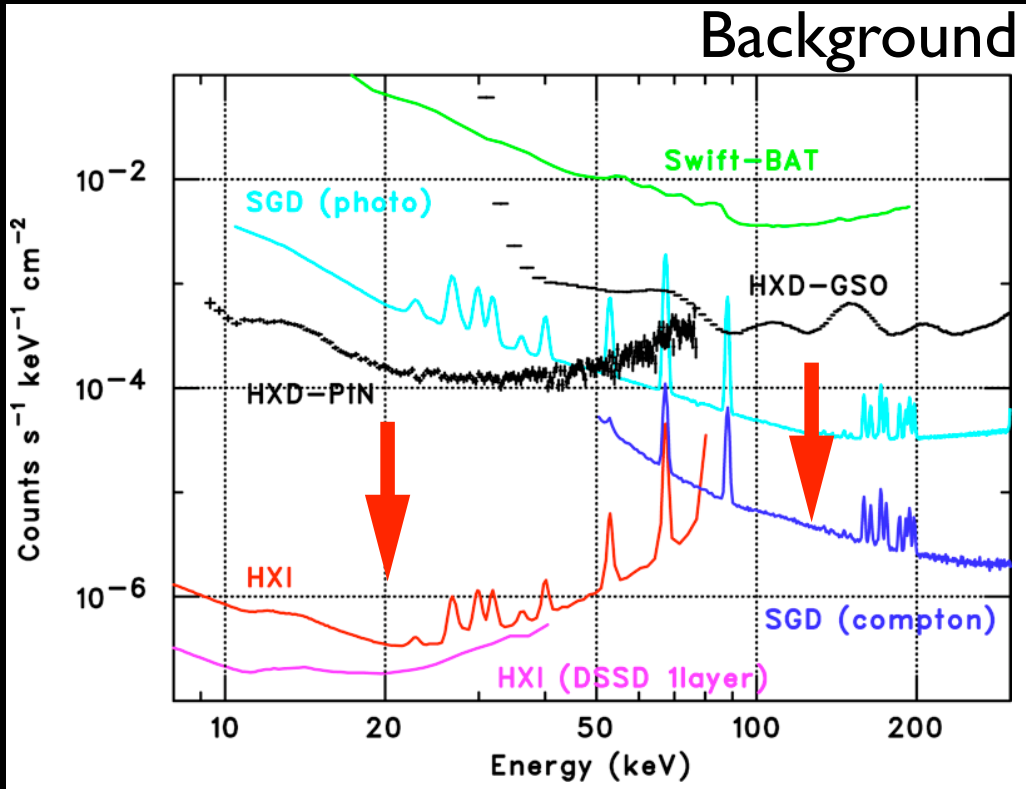


Takeda +,09

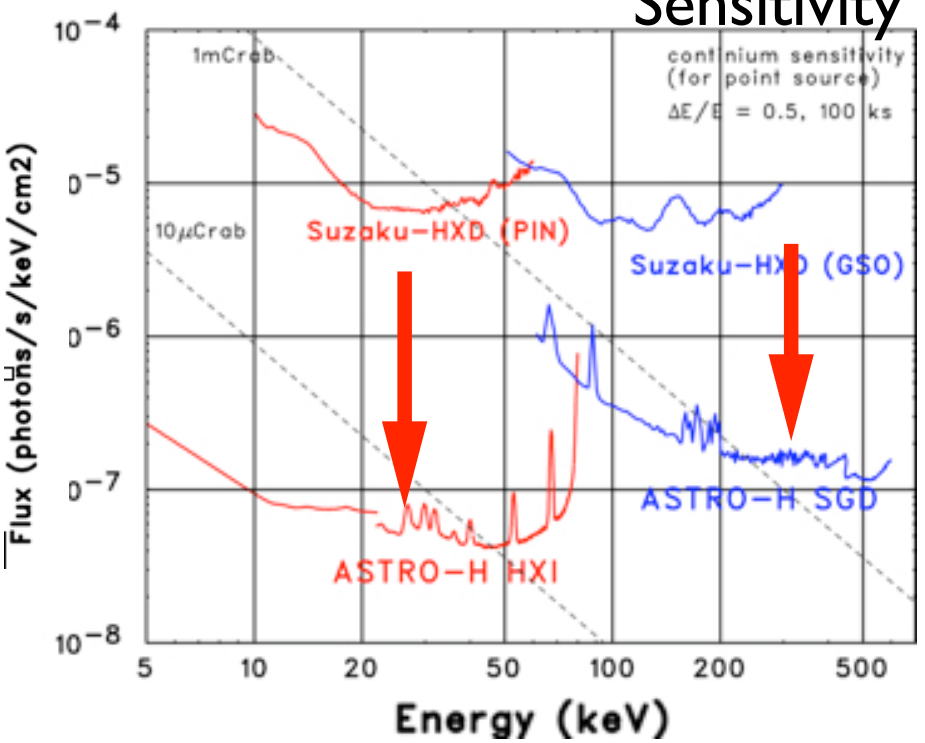
ASTRO-H Sensitivity for Hard Photons (Point Source)



Background

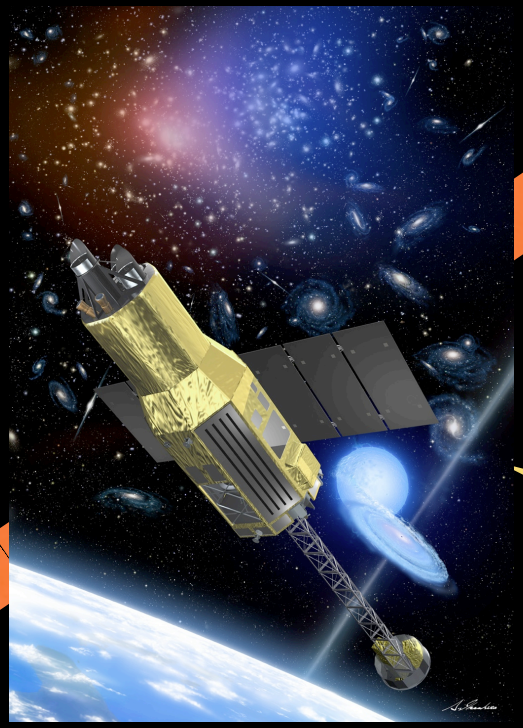


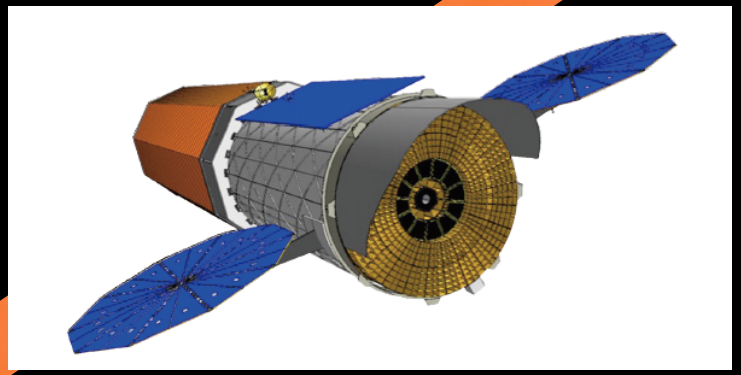
Sensitivity



ASTRO-H is the next generation of X-ray observatories

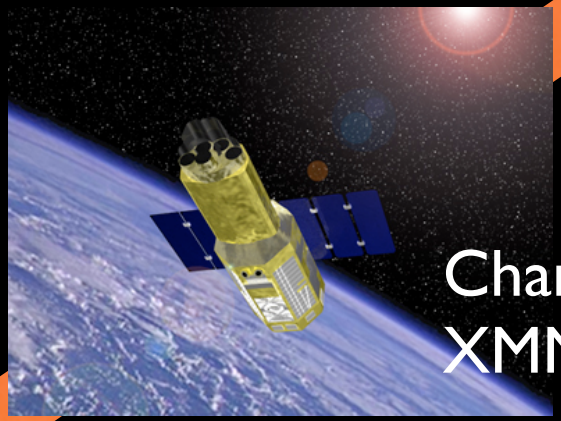
ASTRO-H





IXO

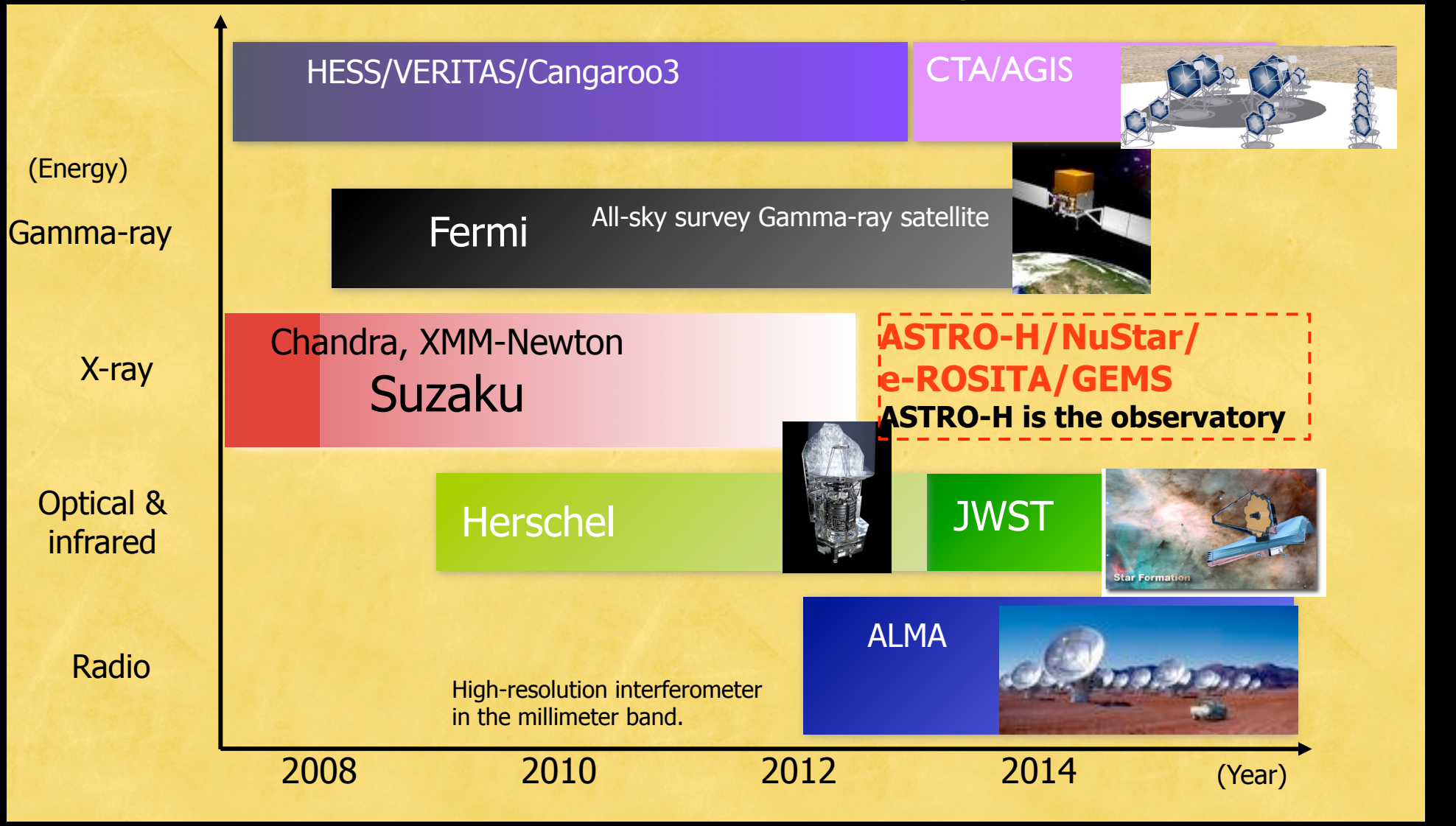
Suzaku



Chandra
XMM/Neton

ASTRO-H is a jumping board to IXO

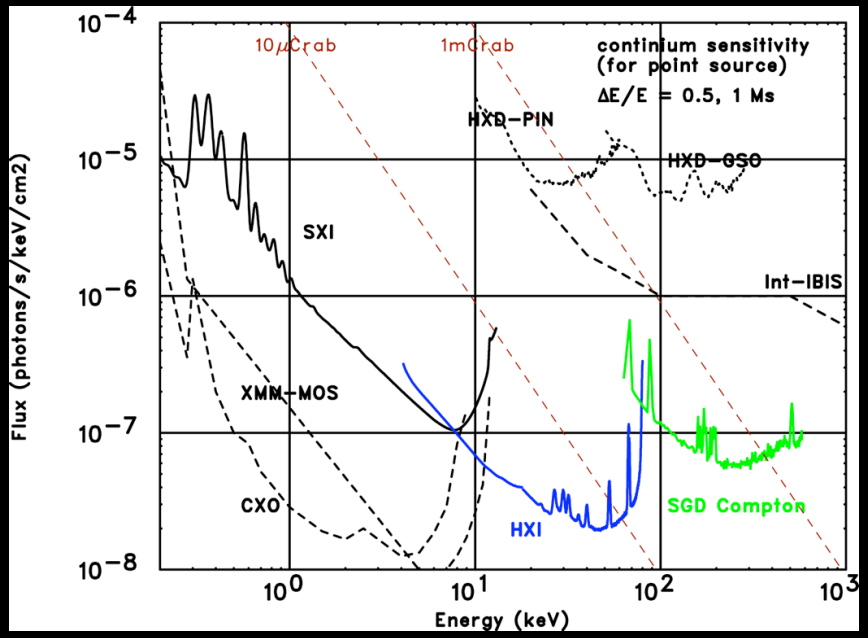
Then, we will have a complete set of X-ray missions to work with BIG representatives from other wave length



Summary

1. ASTRO-H is a real mission. It's in Phase B both in Japan&US.
2. Wide-band/Low-background & Micro-Calorimeter Resolution.
3. Large International Collaboration
   (NASA/SRON/ESA/CSA/DAI/Geneva U. and more)
4. Many reasons to have ASTRO-H (This Conf.).
5. Best Match with BIG observatories in other wavelength

Sensitivity (Point Source)



Sensitivity (Diffuse Source)