Current Status of Suzaku

(AstroE-2)

Tadayuki Takahashi
ISAS/JAXA

on behalf of the entire Suzaku team

Outline of the talk

- Mission Concept
- Report on the X-ray Calorimeter (XRS)
- New Power of Suzaku
- Observation Schedule (AO)
- Summary

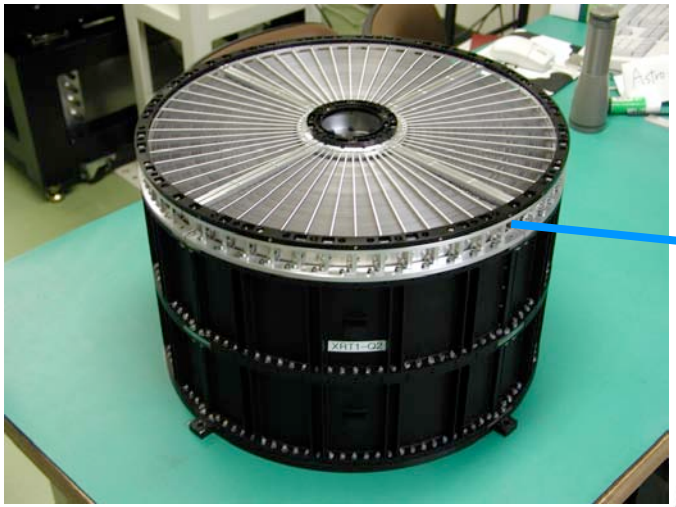
Suzaku

Investigations of
- Structure-formation of the universe
- Environment very close to blackholes

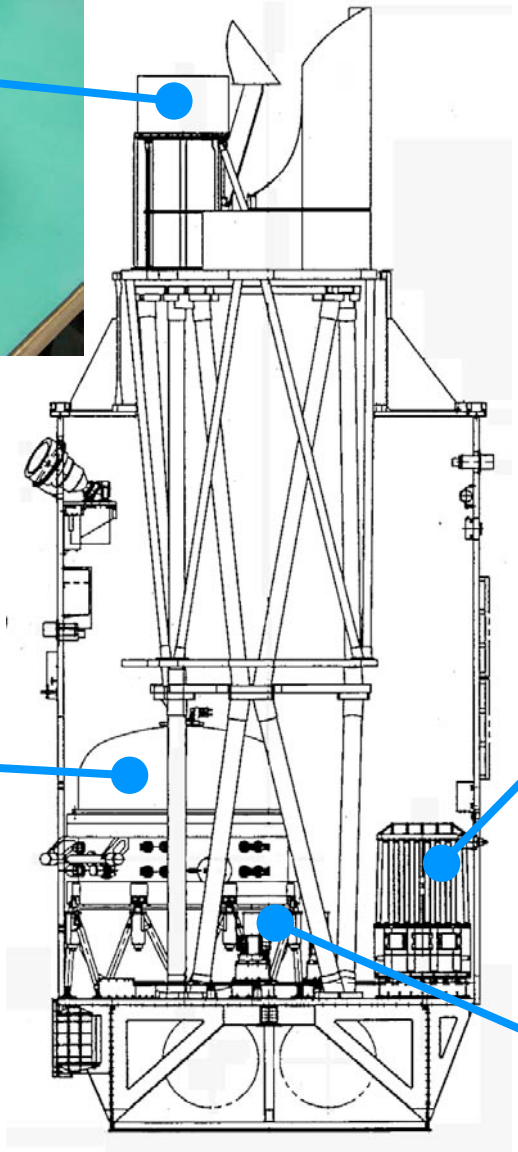
using
- High-resolution X-ray spectroscopy
- Wide-band X-ray spectroscopy

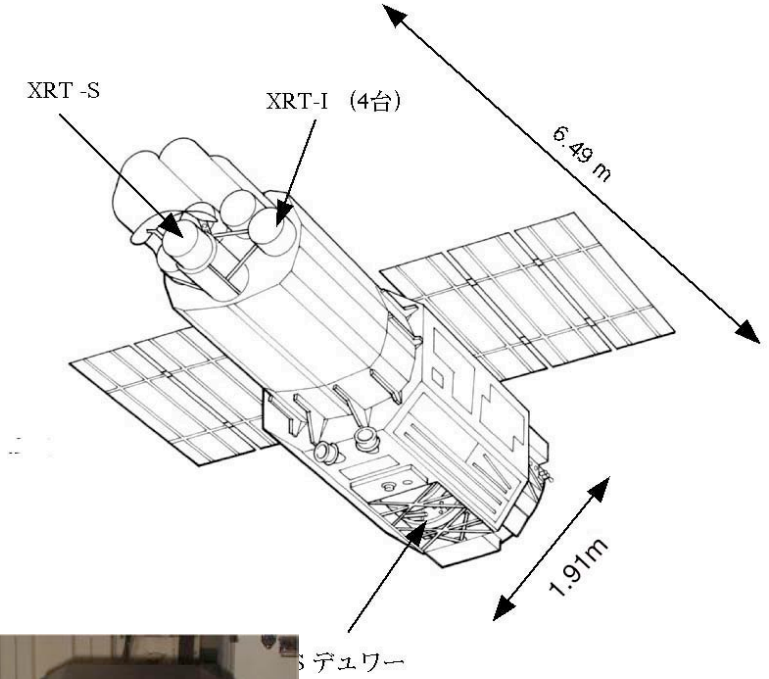
→ Highly complementary to Chandra (US) and XMM-Newton (ESA)

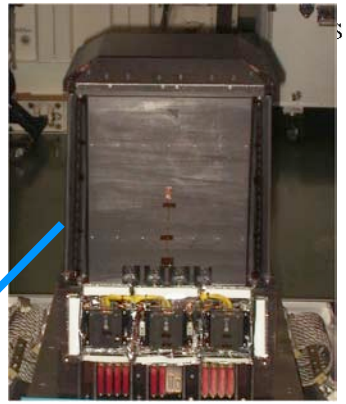
ISAS/JAXA & NASA international collaborations
- Scientific instruments:
  - X-ray optics, X-ray spectrometers (e.g., CCDs, microcalorimeters)
- Analysis software



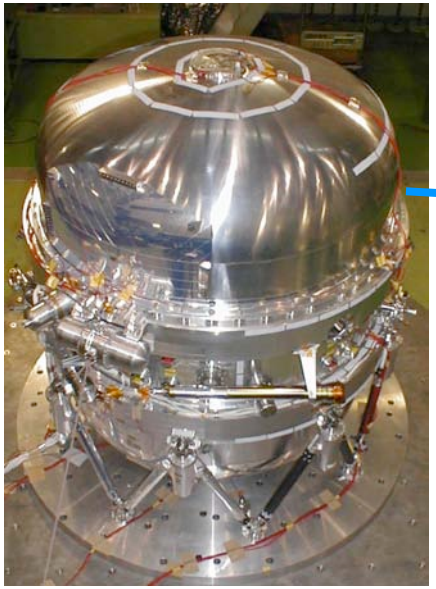
XRT (5 units)
NASA/GSFC-Nagoya-
ISAS/JAXA







HXD
Tokyo-ISAS/JAXA-
Riken-Saitama-
Hiroshima-Kanazawa-
Aoyama



XRS
NASA/GSFC-Wisconsin
-ISAS/JAXA-TMU

XIS (4 units)
MIT-Kyoto-Osaka -
ISAS/JAXA

1700kg

Note: Chandra 4800 kg/Newton 3800 kg)

Lowest temperature and Highest Resolution

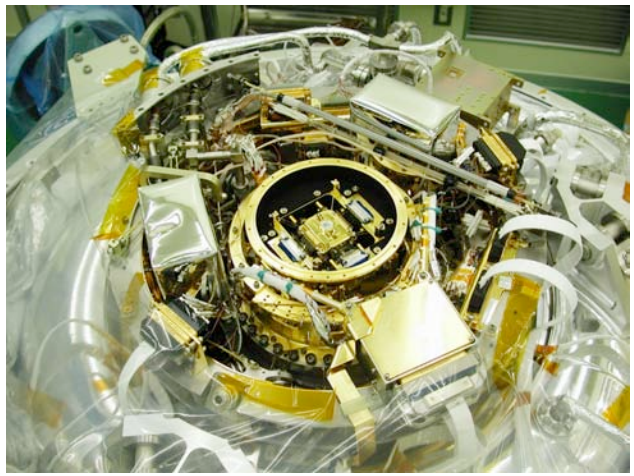
July 26: 60 mK was achieved. (lowest temperature achieved in space

7eV energy resolution was obtained for the calibration pixel.

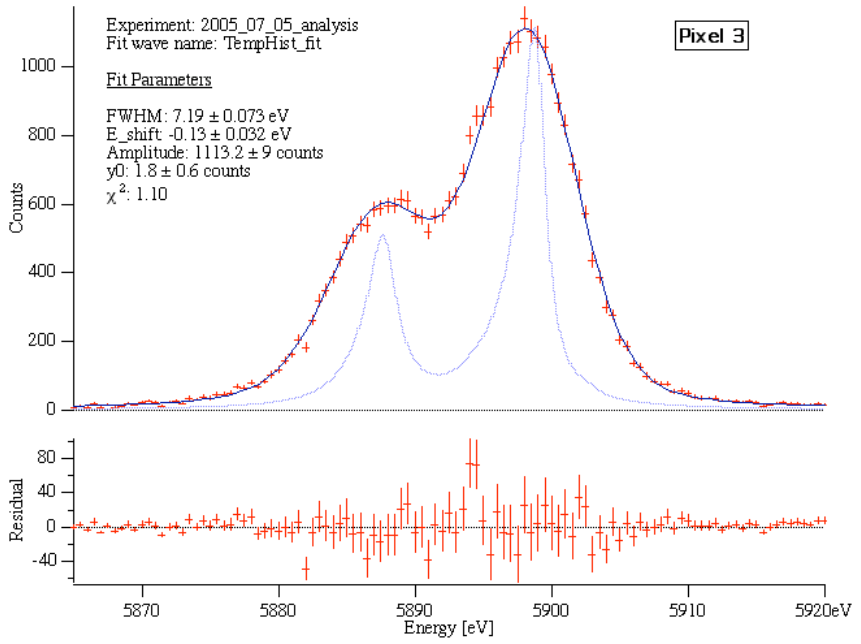
Detector was working as expected. We expected great scientific return for

years of hard work, over the next 3 years or so.

XRS



Fine structure of Mn Kα line resolved by XRS in orbit



Tragedy

Dewer

July 10: Valve 6 (He gas bent) was opened

July 25: Valve 12 (main shell evacuation valve) was opened

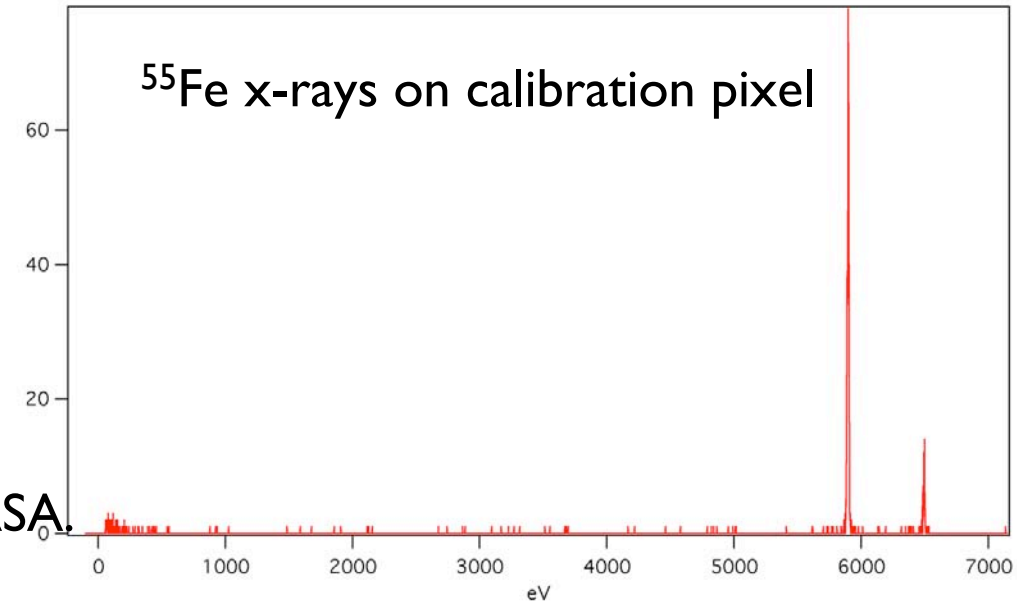
July 29: First temperature spikes were seen, indicating helium gas (almost certainly vented from the tank) got to parts of the XRS that it shouldn't have gotten into.

Aug 5: 7 eV resolution confirmed for most of pixels.

Aug. 8: All Liquid He was lost (during several hours)

Cause of the failure is under investigation by JAXA and NASA.

Real-time data obtained during 10 min contact pass



http://suzaku.gsfc.nasa.gov/docs/astroe_lc/news/xrsend.html

Even without the XRS

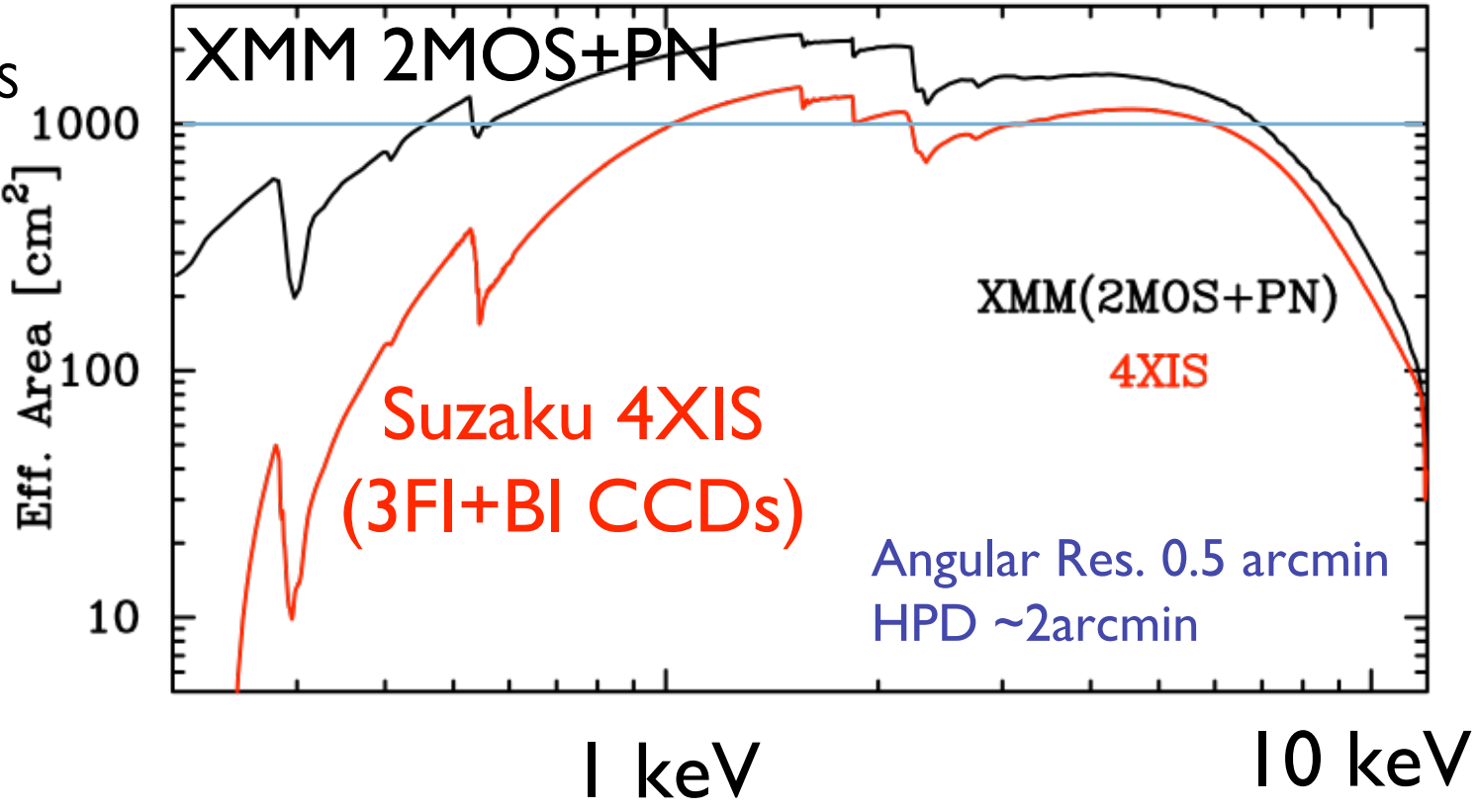
Suzaku *will provide exciting results with*

- Low earth orbit (570 km): Low background
- Large area XRT with pre-collimeter
- Improved X-ray CCD --- XIS
- Low Background Hard X-ray Detector --- HXD

XRT for the XIS

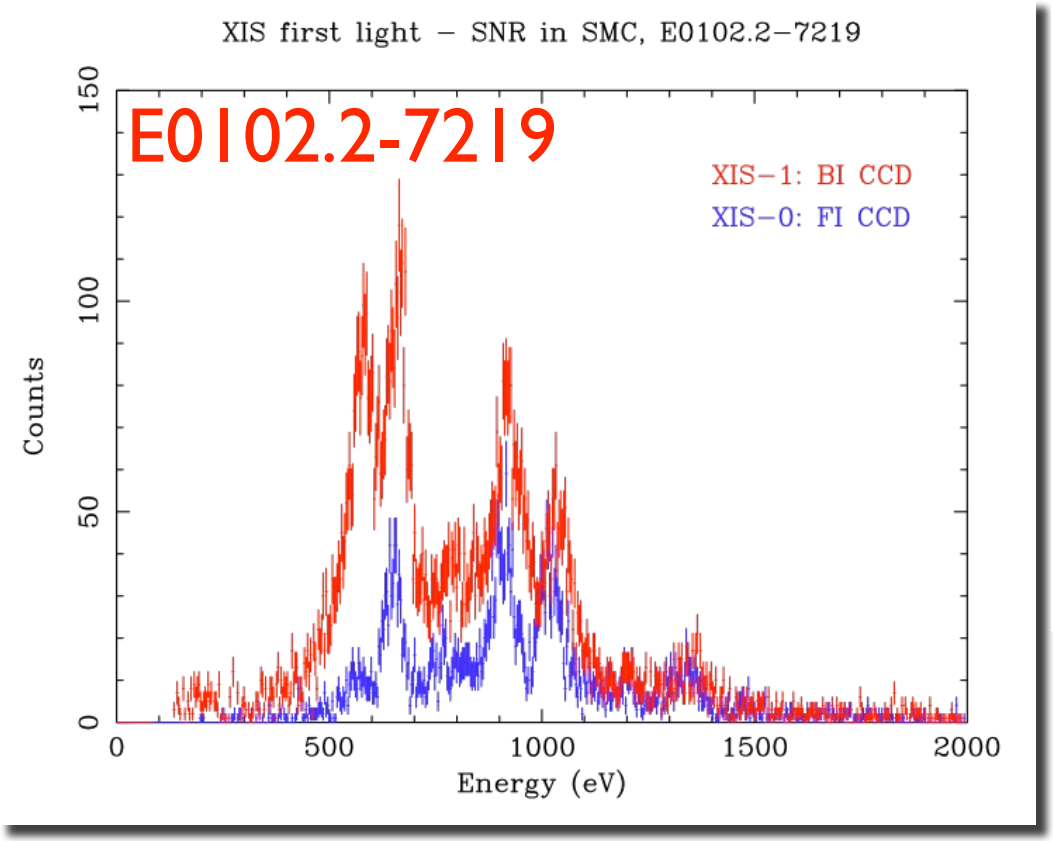
4XRT for XIS
1XRT for XRS

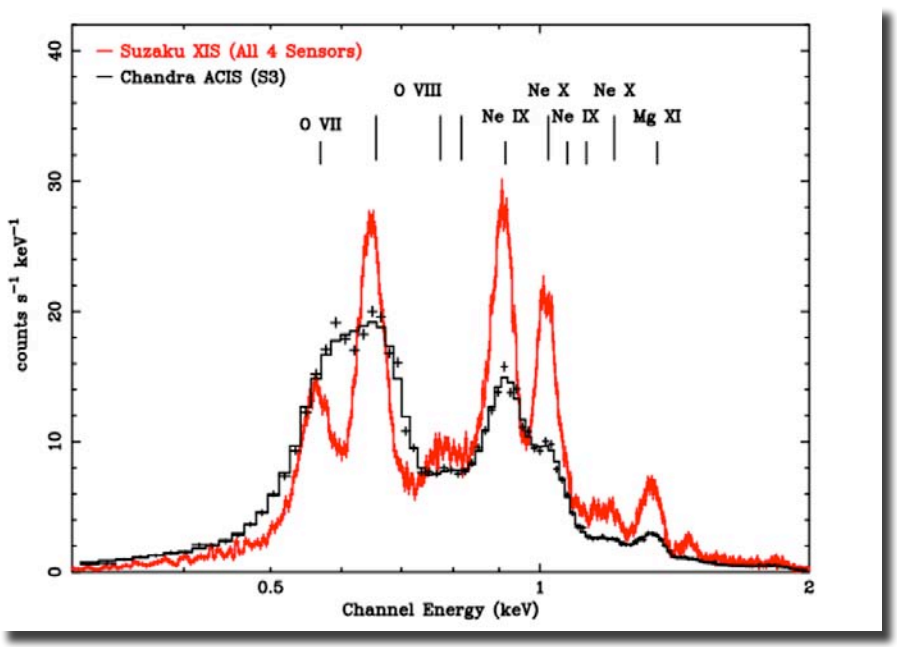
- 20 kg : 175 layers /XRT : thin foil
- ~1000 cm^2 effective area 1-6 keV



New Capabilities Offered by

Suzaku/XIS





Front(3) and BacK(1)-illuminated CCD's

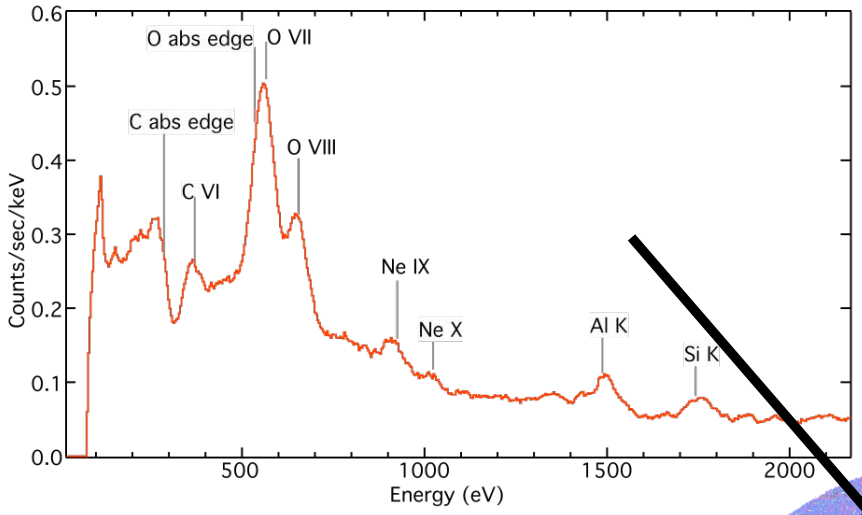
Comparison of *Suzaku* (all 4 sensors) with Chandra/ACIS (S3)

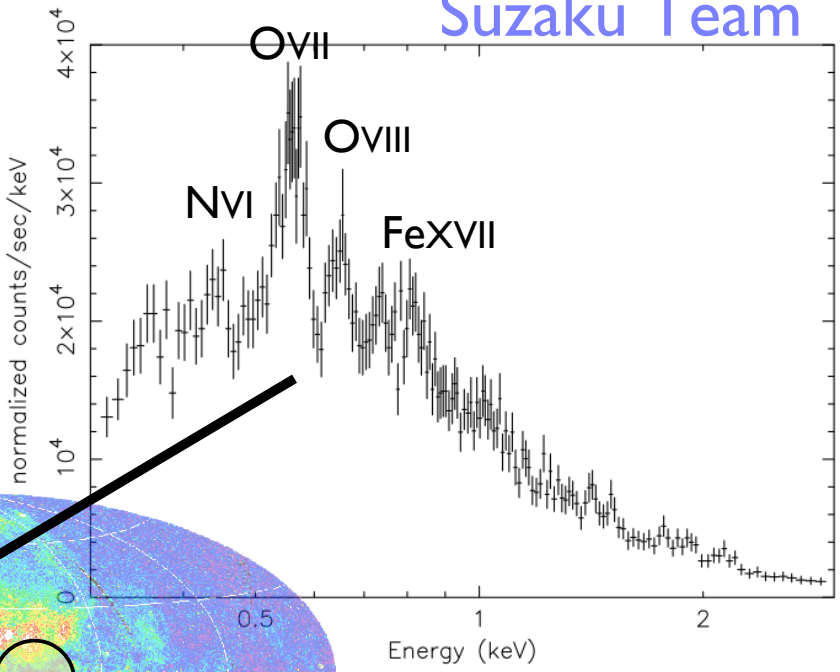
Suzaku Team, preliminary

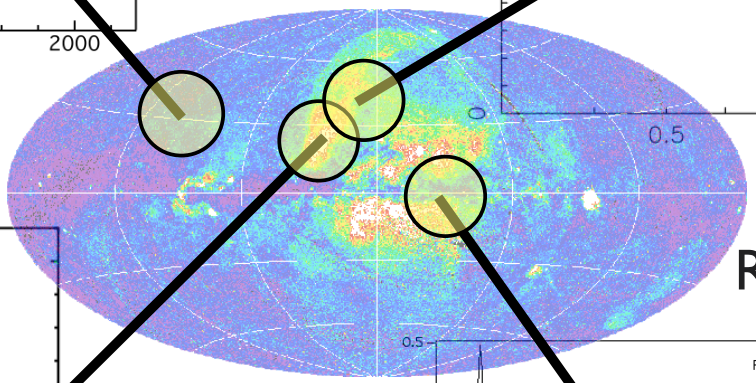
Power of Suzaku

preliminary

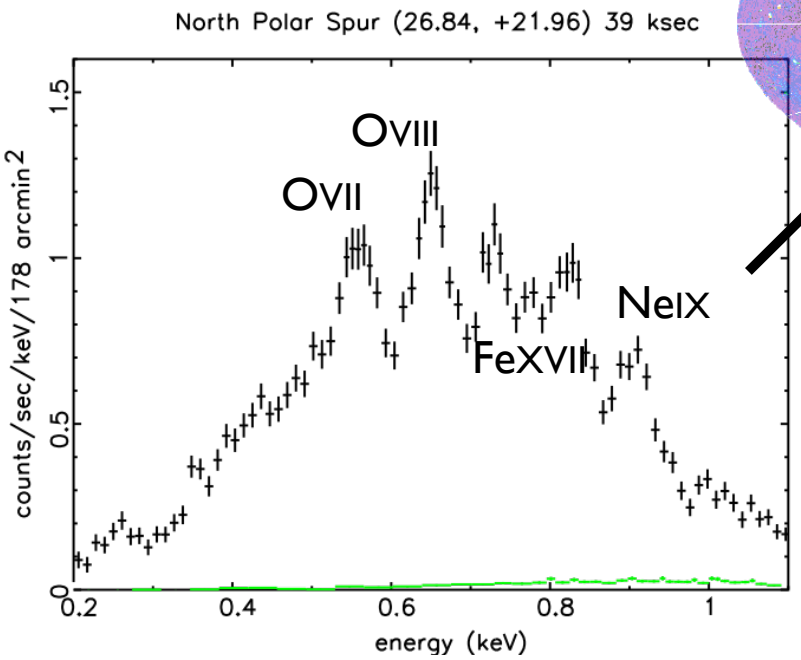
Suzaku Team

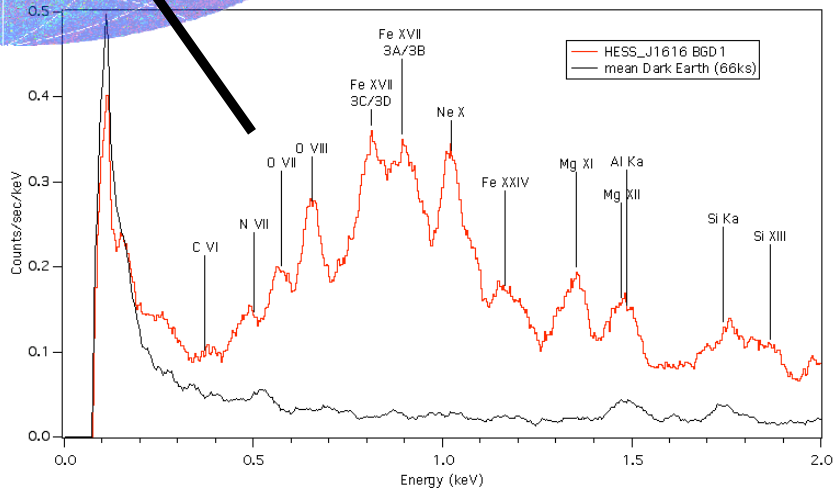






ROSAT 3/4keV band





Hard X-ray Detector

Japan's answer for
the "high sensitivity
Gamma-ray" detector.

Low Background
Well-type Shield

Si-PIN (8-50 keV)
160 cm2 @ 10 keV

GSO Scintillator (50 - 600 keV)
330 cm2 @ 100 keV

Thick BGO Shield
(av. 4 cm thick)

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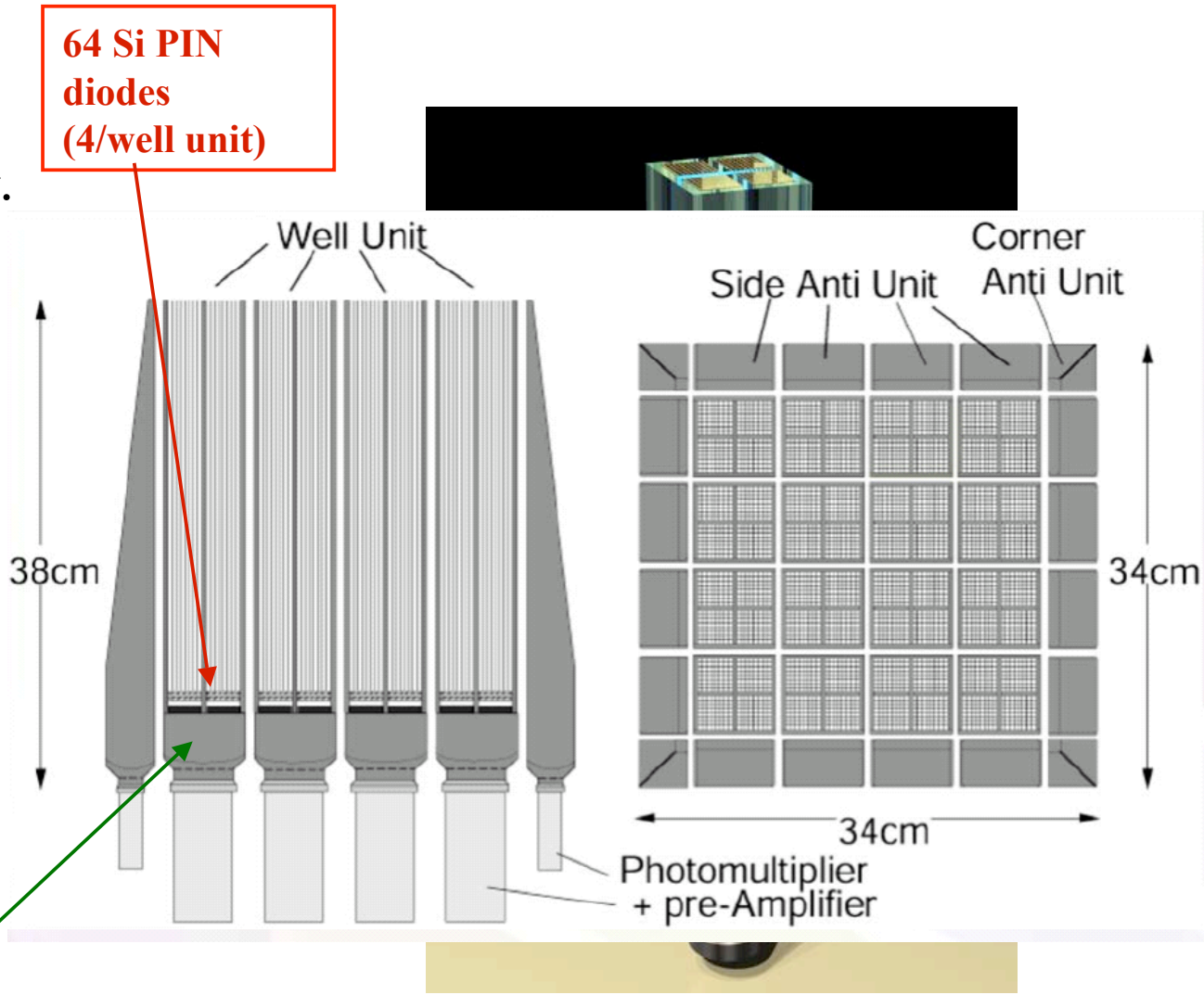
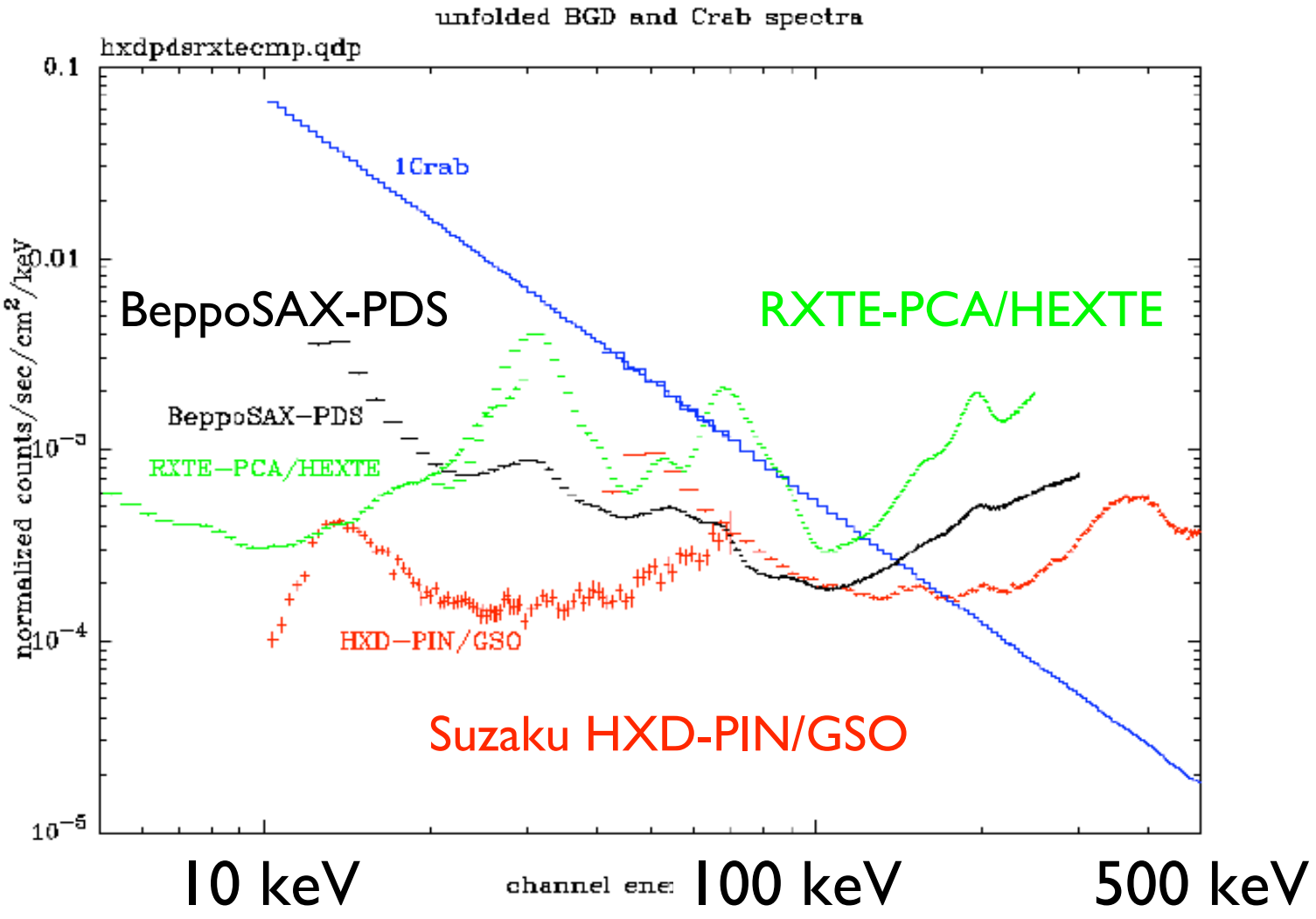


Background normalized by effective Area Comparison with SAX/RXTE



AGN Spectra

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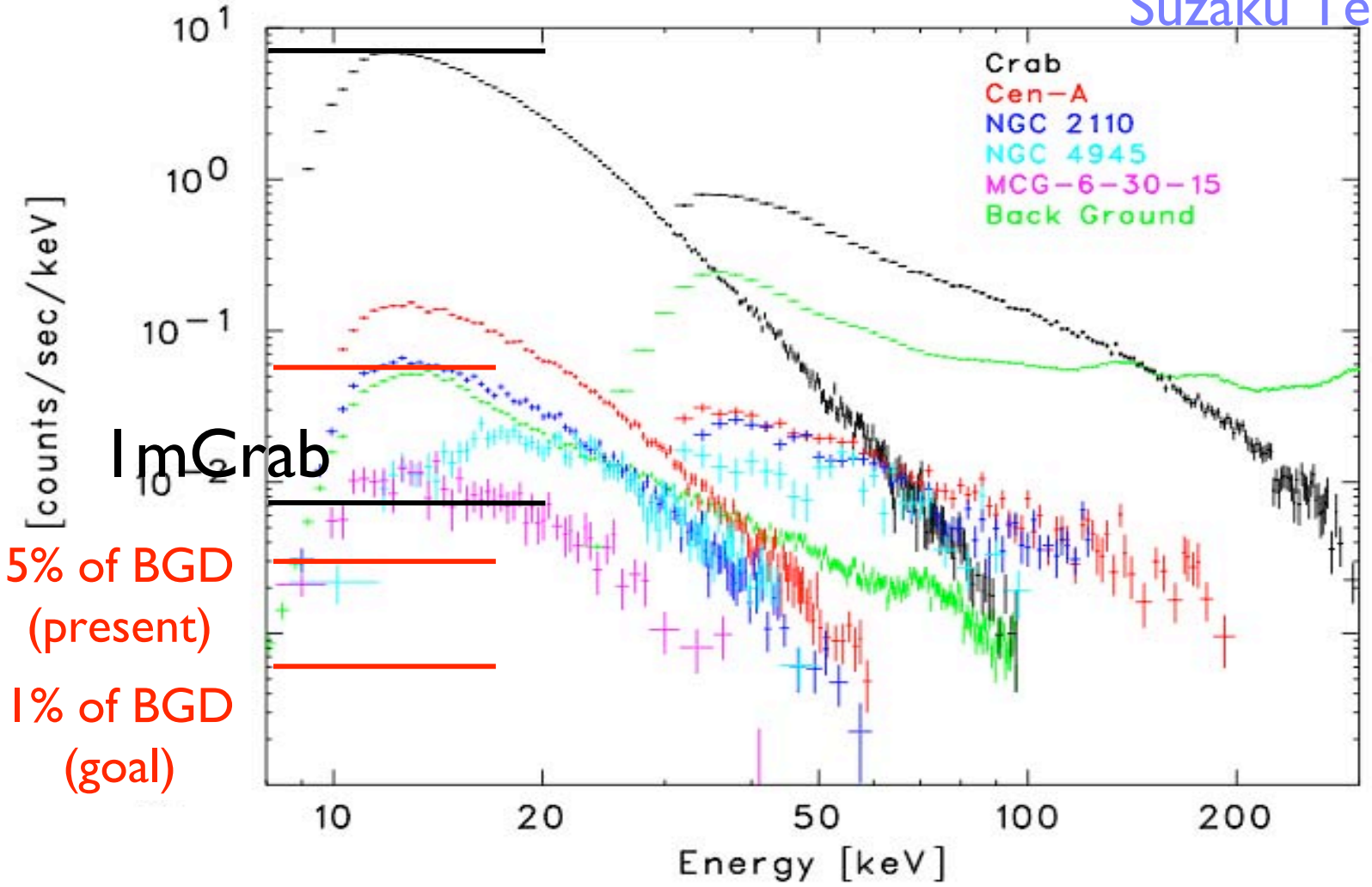
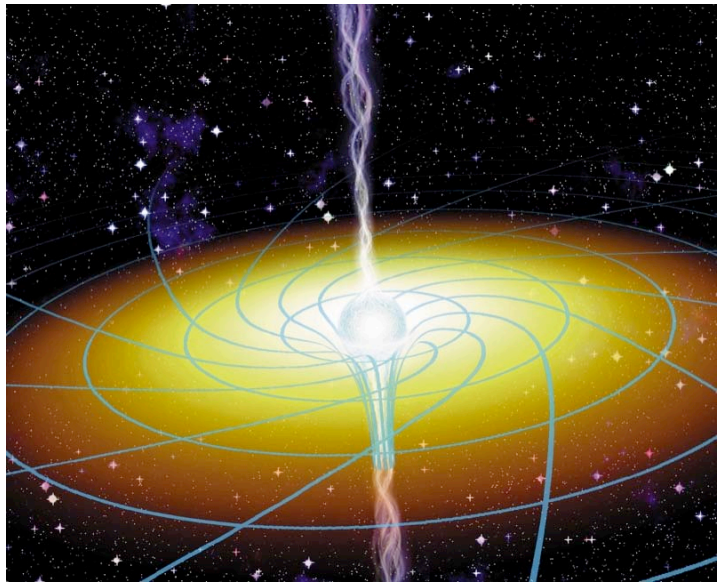


Observable signatures of strong gravity

- Gravitational redshifts:
- Fundamental GR predictions:
  - Innermost stable circular orbit
  - Event horizon



X-ray/Gamma-ray
observations can help for probing GR in the strong field limit

Suzaku's
Broad band pass allows true measure of continuum
High energy response allows measurement of continuum shape (Ecut)

Broad Iron Line!

- All the history start from
  the ASCA observation of Broad Iron Line
  from MCG 6-30-15 (Tanaka et al. 1995)

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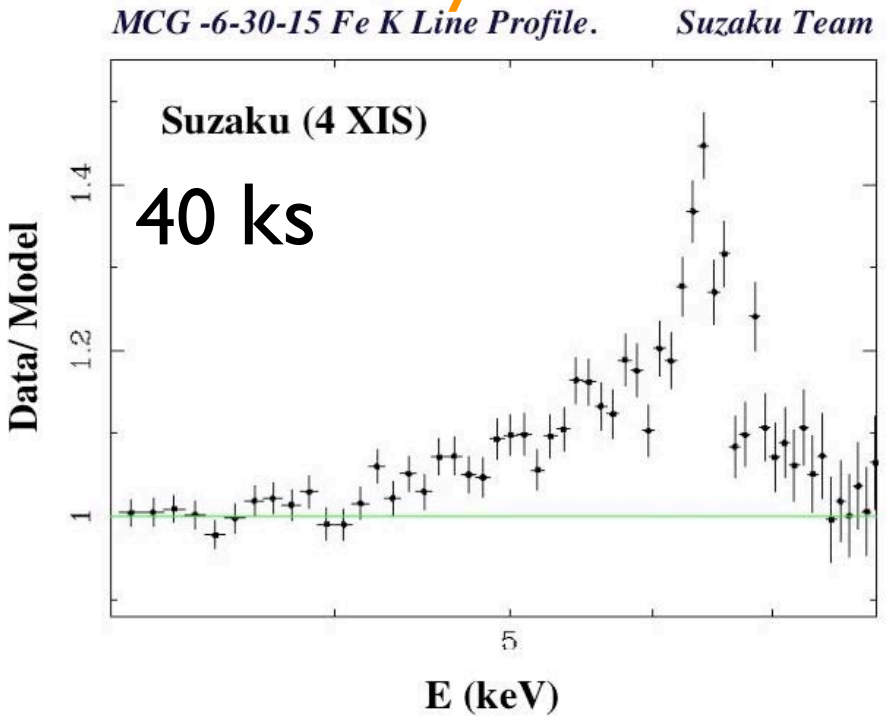
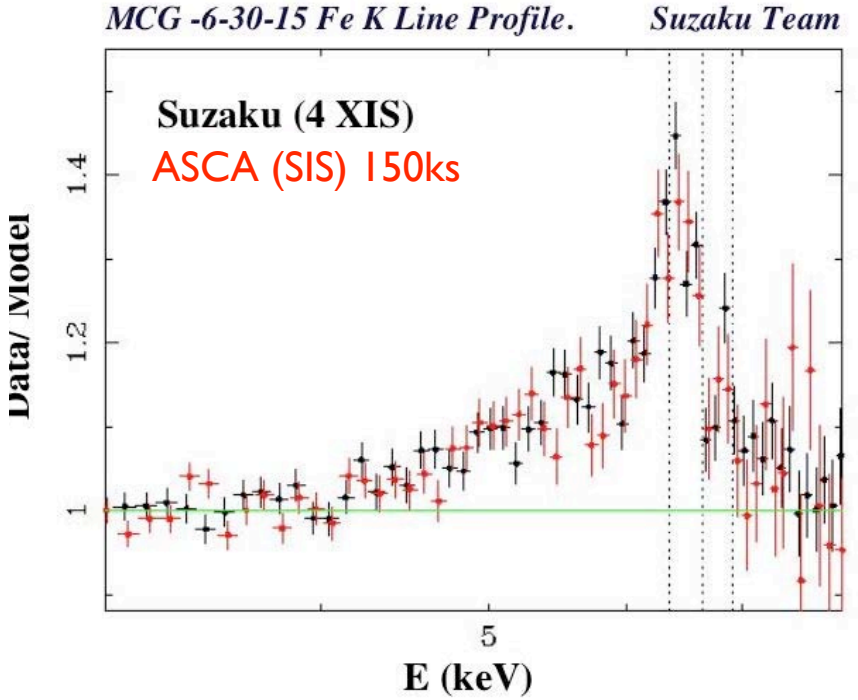
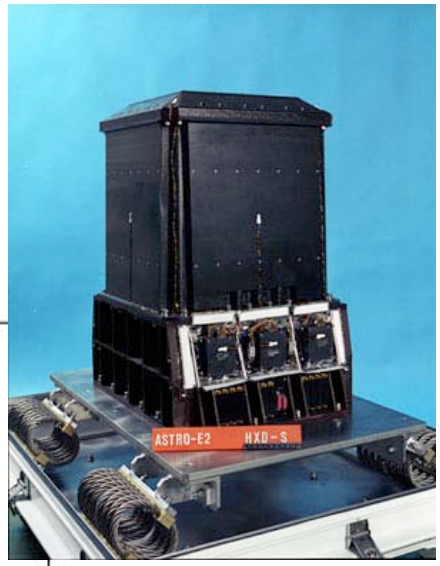
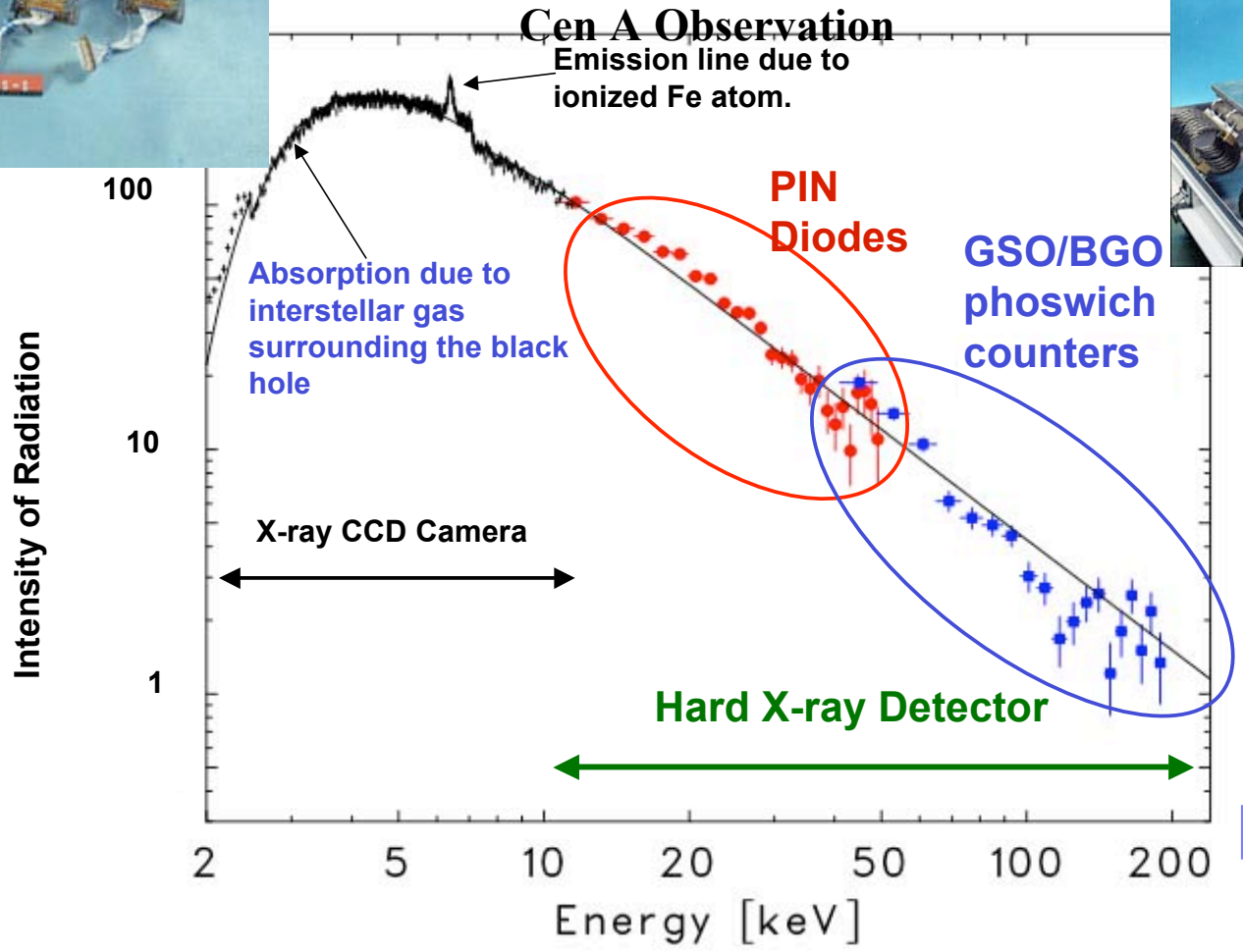
Suzaku nicely confirms





Power of Suzaku





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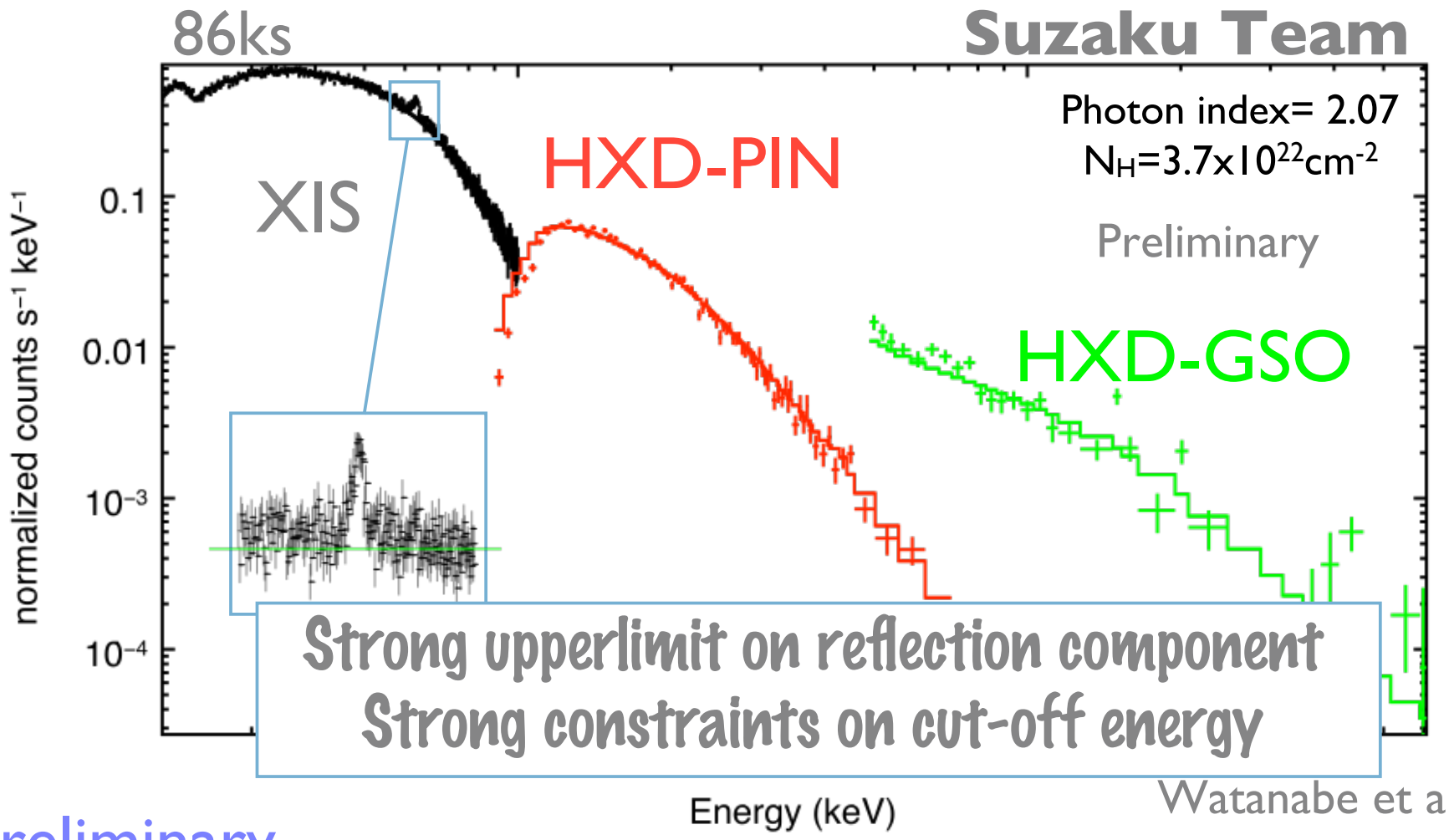
Sy Galaxy (NGC2110)



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GSO is detecting at least up to 200 keV

Study of Accelerator in the Universe

Site of acceleration

Maximum Energy

But, note that 90% of CR density is contributed by particles with energy <100 GeV:

Acceleration mechanism?

Hadronic versus leptonic (proton?, electron?)

X/Gamma-ray emissions are associated with the most violent phenomena of the Universe

→ Suzaku

Energy Frontier = X/TeV

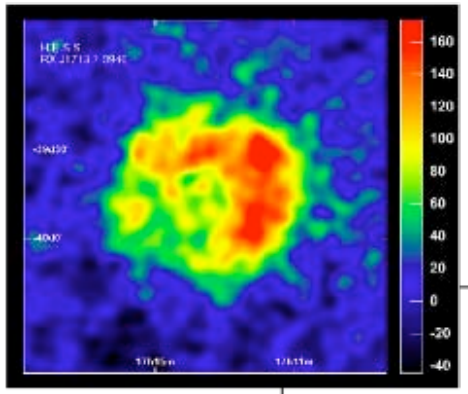
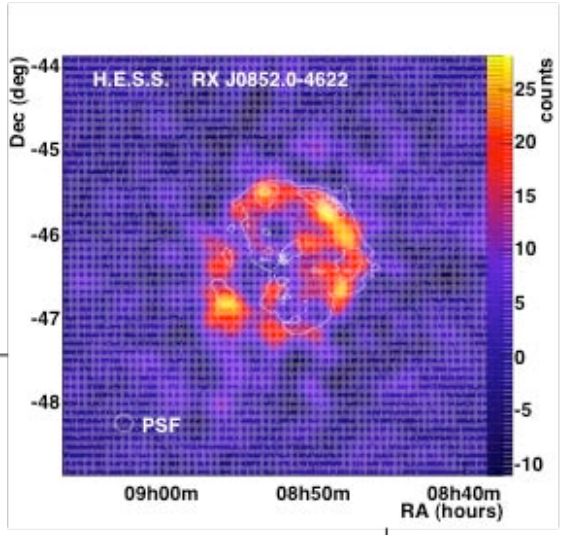
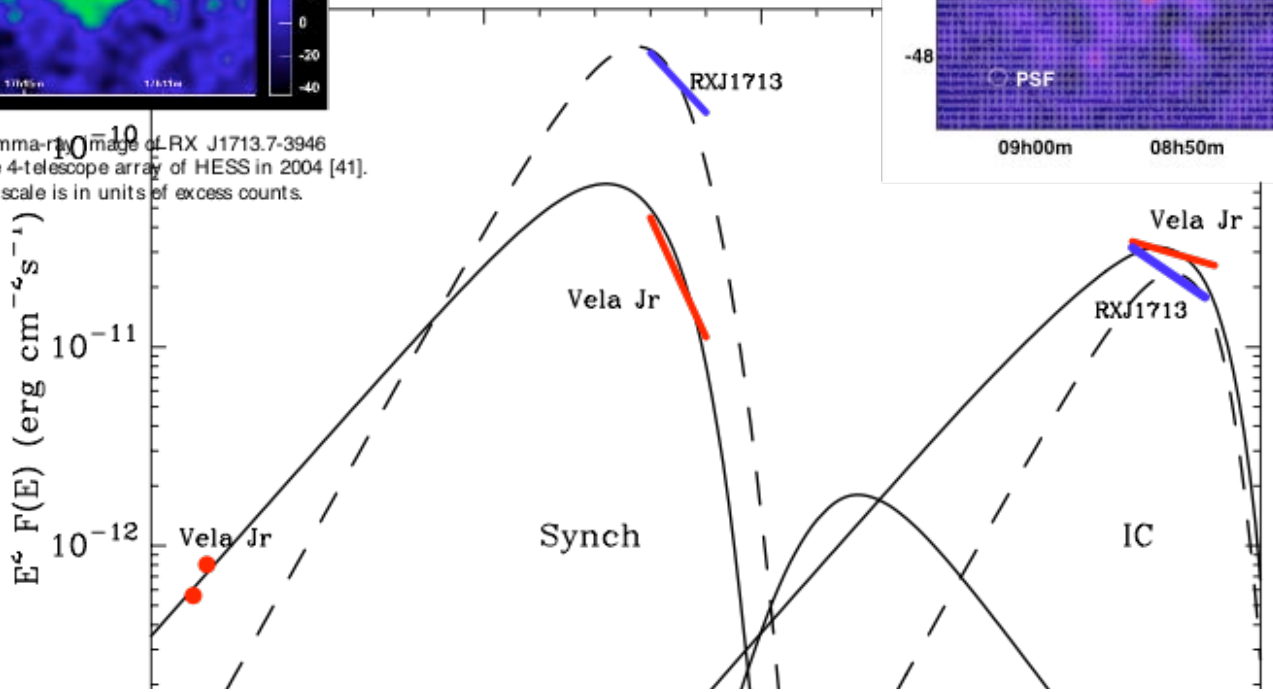


Figure 2: The gamma-ray image of RX J1713.7-3946 obtained with the 4-telescope array of HESS in 2004 [41]. The linear colour scale is in units of excess counts.

TeV Image
RXJ1713



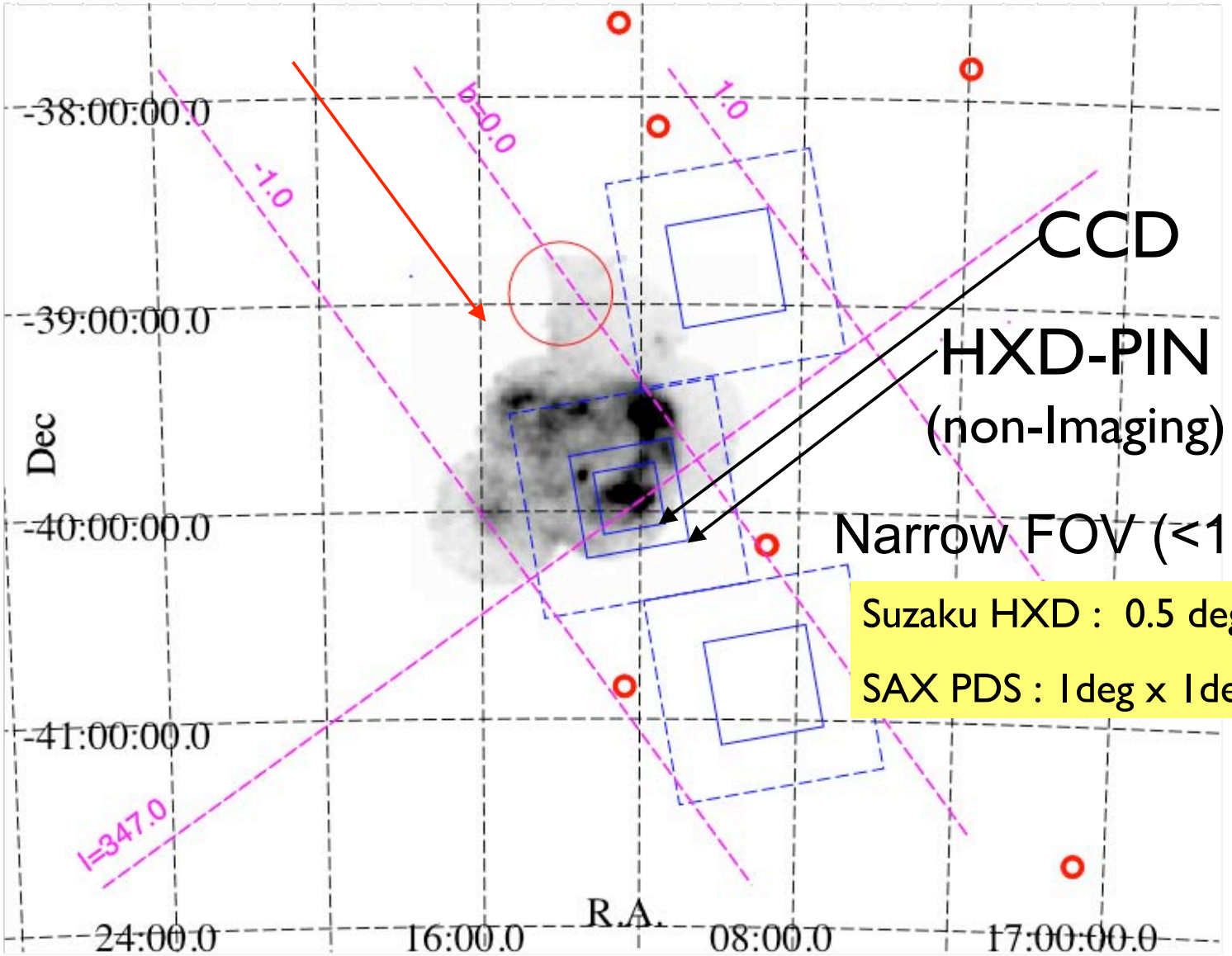
TeV Image
Vela Jr.



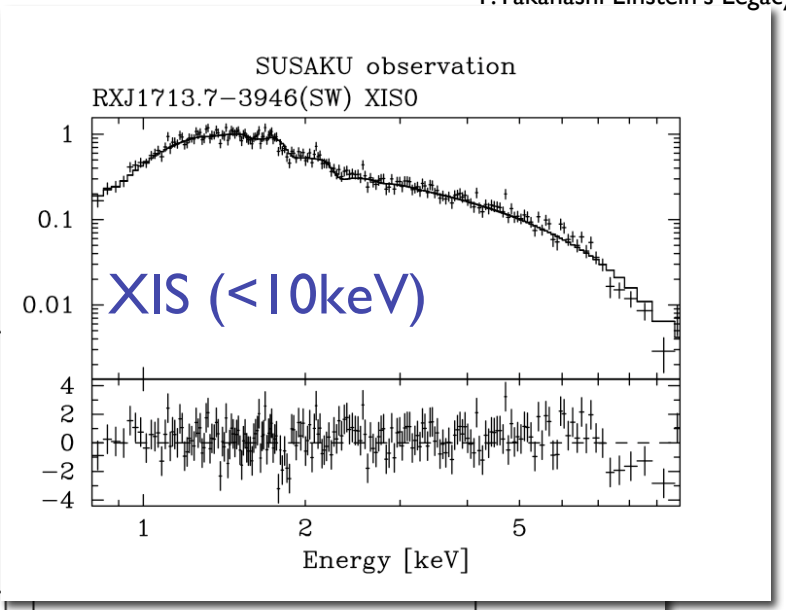
X/TeV, due to high energy end of electron distribution

Aharonian 2005

Suzaku observation of TeV SNR RXJ1713-3946



Hard X-ray Spectrum of RXJ1713-3946



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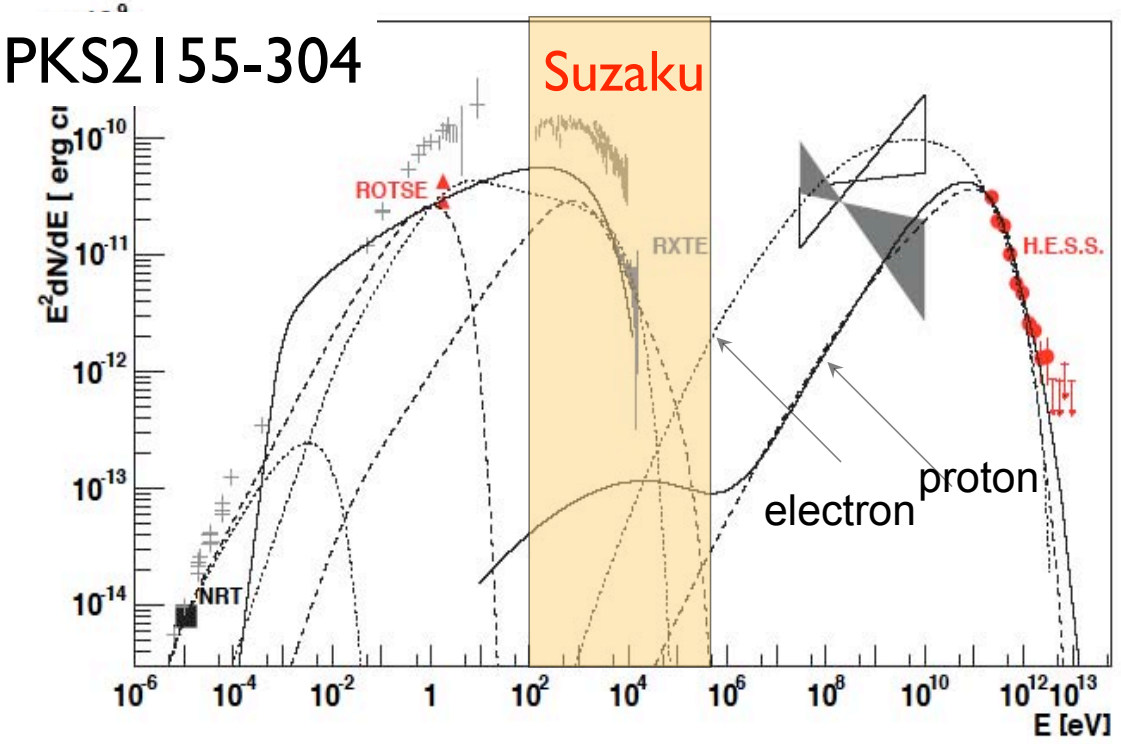
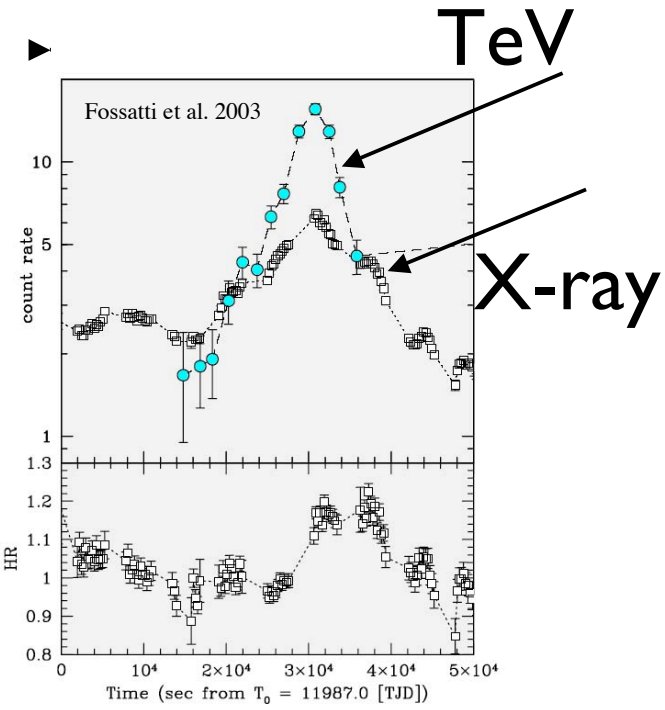
Blazar Observation

Particle Accelerator in Jet
- Maximum Energy
- Non-thermal Efficiency
- Lepton Jets vs Hadron Jets
- Cosmic Gamma-ray Background

Suzaku's Wide Band Coverage
1. Soft X-ray
2. Soft Gamma-ray

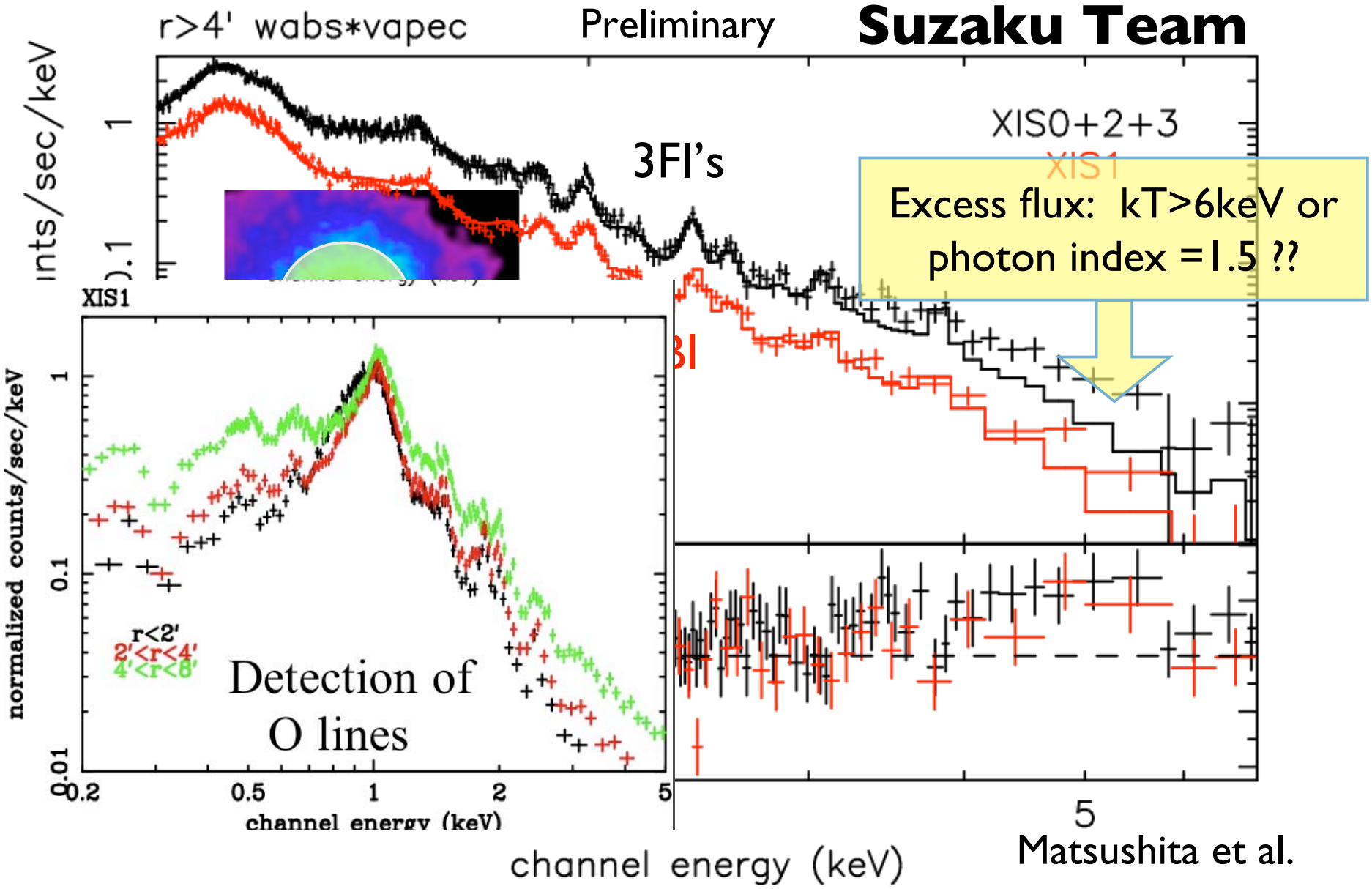
New line-up of multi-band observatories
HESS (TeV)/Swift (Opt-Gamma)/Spitzer (IR)





Cluster of Galaxy

Fornax cluster r>4'



Schedule

Science Working Group (SWG) observations until March 2006

SWG target list to be released this a week.

International time allocation:

Japan - 50%, US - 37.5% and Japan/US - 12.5%

Japan allocation includes all non-US proposals

(8% of total, will be used for ESA/Europe.)

Guest Observer (GO) observations will start April 1, 2006

New AO was released October 15

Due date is January 6, 2006

Planning to release data from ~ 8 representative targets by end of November.

Summary

Successful Launch of Suzaku
after the failure of the launch of AstroE1.

Loss of the XRS is sad. However, we at least have a strong engineering success, vital for future microcalorimeter missions..

I believe a mission with a calorimeter is now regarded as the highest priority in the X-ray community

We have started observations with
the XIS and the HXD
-- New Power of Suzaku --
Wide-band spectroscopy all in one observatory
High energy response & Low background

We will do our best to realize a micro-calorimeter in VERY-NEAR FUTURE mission.