Overview, status of *Suzaku* & initial results on X-ray binaries

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ISAS/JAXA

on behalf of the entire *Suzaku* team

on 6 June 2006 at 208th AAS meeting in Calgary

Outline

- Mission overview
- *Suzaku* capabilities and performance
- GO-1 Data processing and distribution
- XIS contamination
- GO-2 program
- Highlights from X-ray binary observations

Suzaku

Investigations of

- structure-formation of the universe
- environment very close to blackholes

Using

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

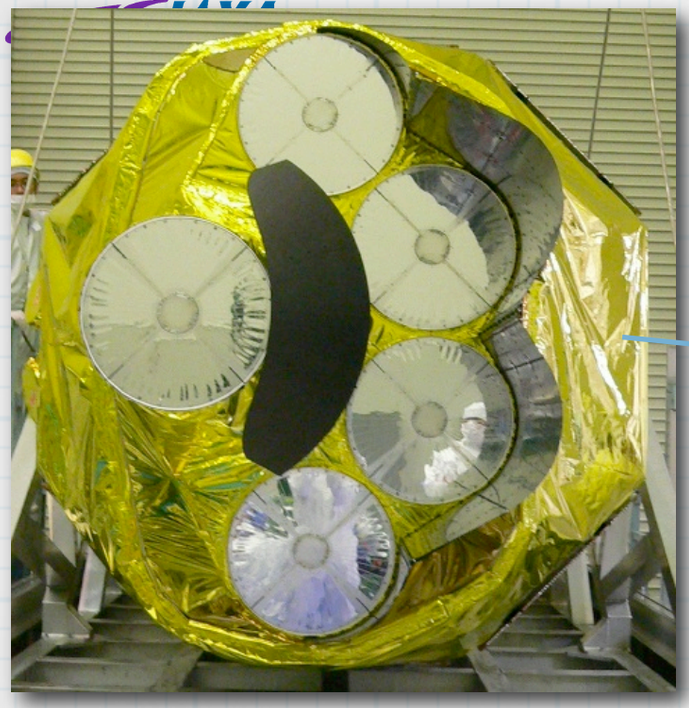
Highly complementary to Chandra (US) and XMM-Newton (ESA)

ISAS/JAXA - NASA International collaborations

- Scientific instruments
  - X-ray optics, X-ray spectrometers
- Analysis software

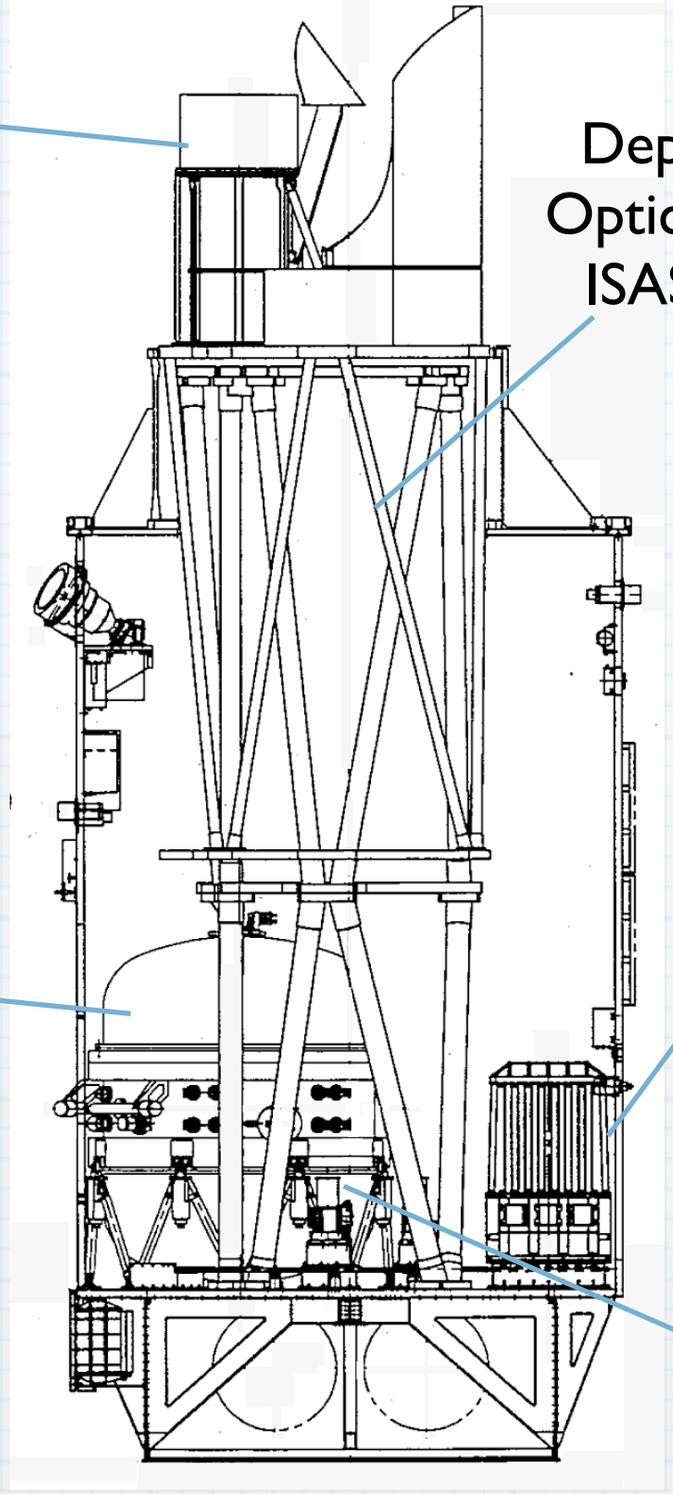
- Launched on July 10, 2005 with M-V launch vehicle

Science Payloads

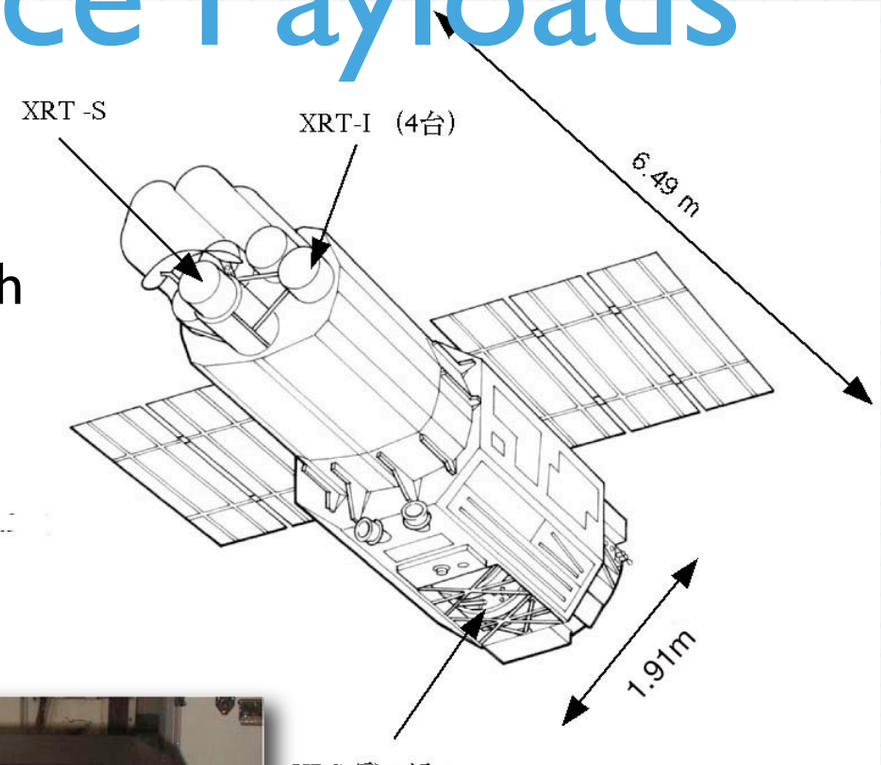


X-ray mirrors

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

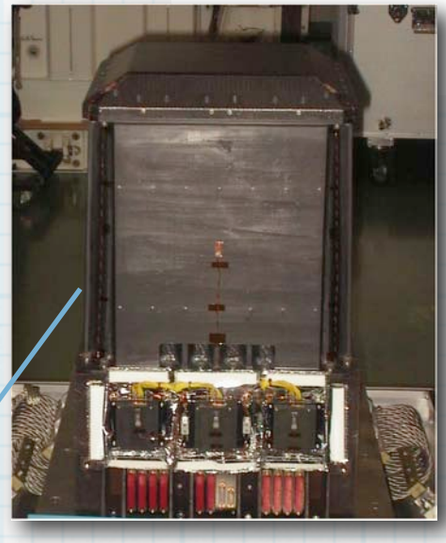


Deployable
Optical Bench
ISAS/JAXA



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

X-ray micro calorimeter



Hard X-ray detector

HXD
Tokyo-ISAS/JAXA-
Riken-Saitama-
HIroshima-Kanazawa-...

X-ray CCD camera

XIS
MIT-Kyoto-Osaka -
ISAS/JAXA-.....

XRS: High resolution spectroscopy

- An energy resolution of 7eV at 5.9 keV was obtained in orbit.

→ next talk by Rich Kelley

- However the functionality was lost due to loss of liquid He after ~ 1 month in orbit.

Independent investigations by the JAXA and NASA investigation boards.

- Root-level causes, recommendations
- JAXA board report issued in January, 2005. A summary (in Japanese) is found in
  http://www.jaxa.jp/press/2006/01/20060125_sac_suzaku_j.html
- NASA board report will be submitted soon.

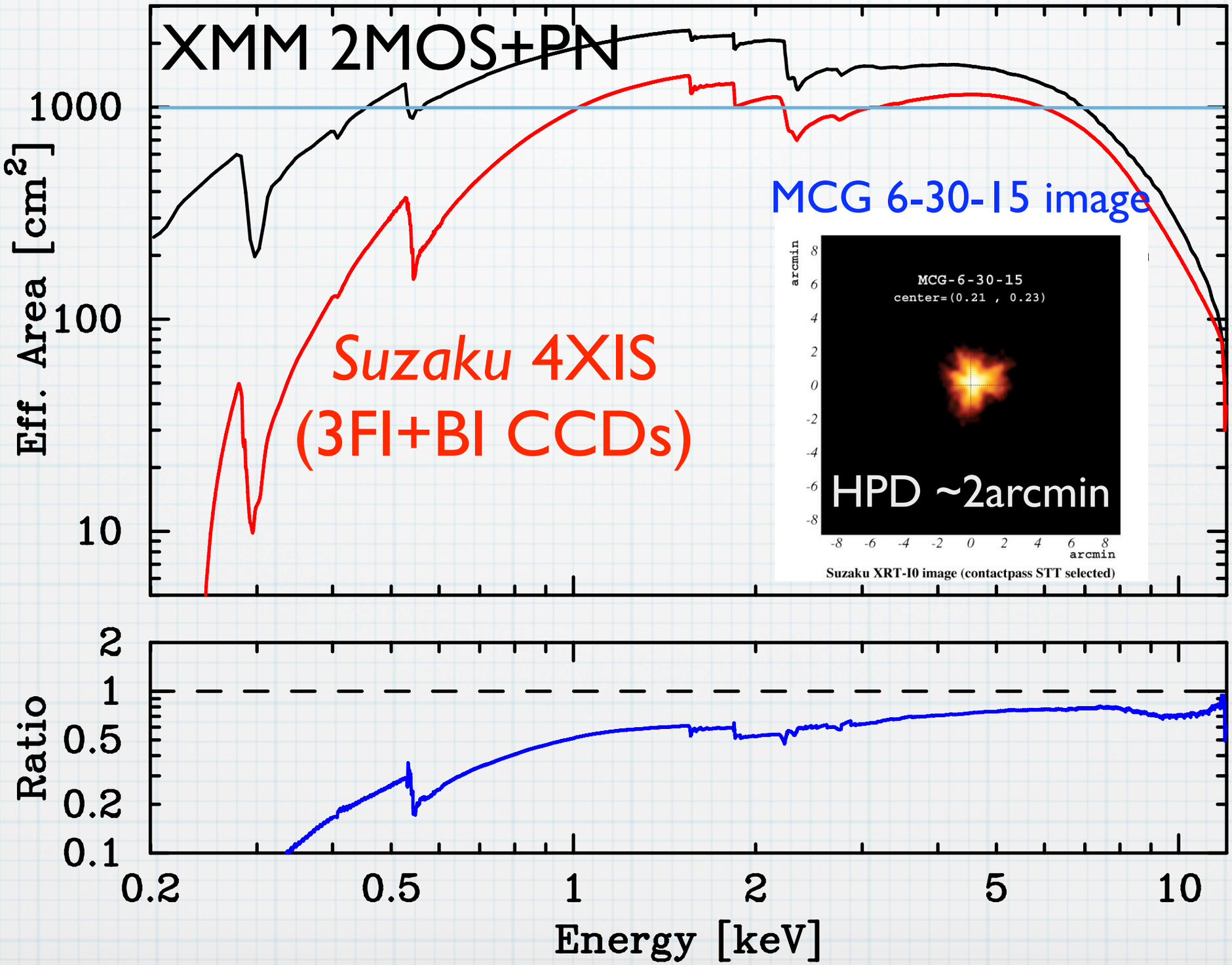
We will do our best to recover as soon as possible the science lost by the failure, implementing the lessons learned and recommendations.

Suzaku now

Wide band X-ray spectroscopy

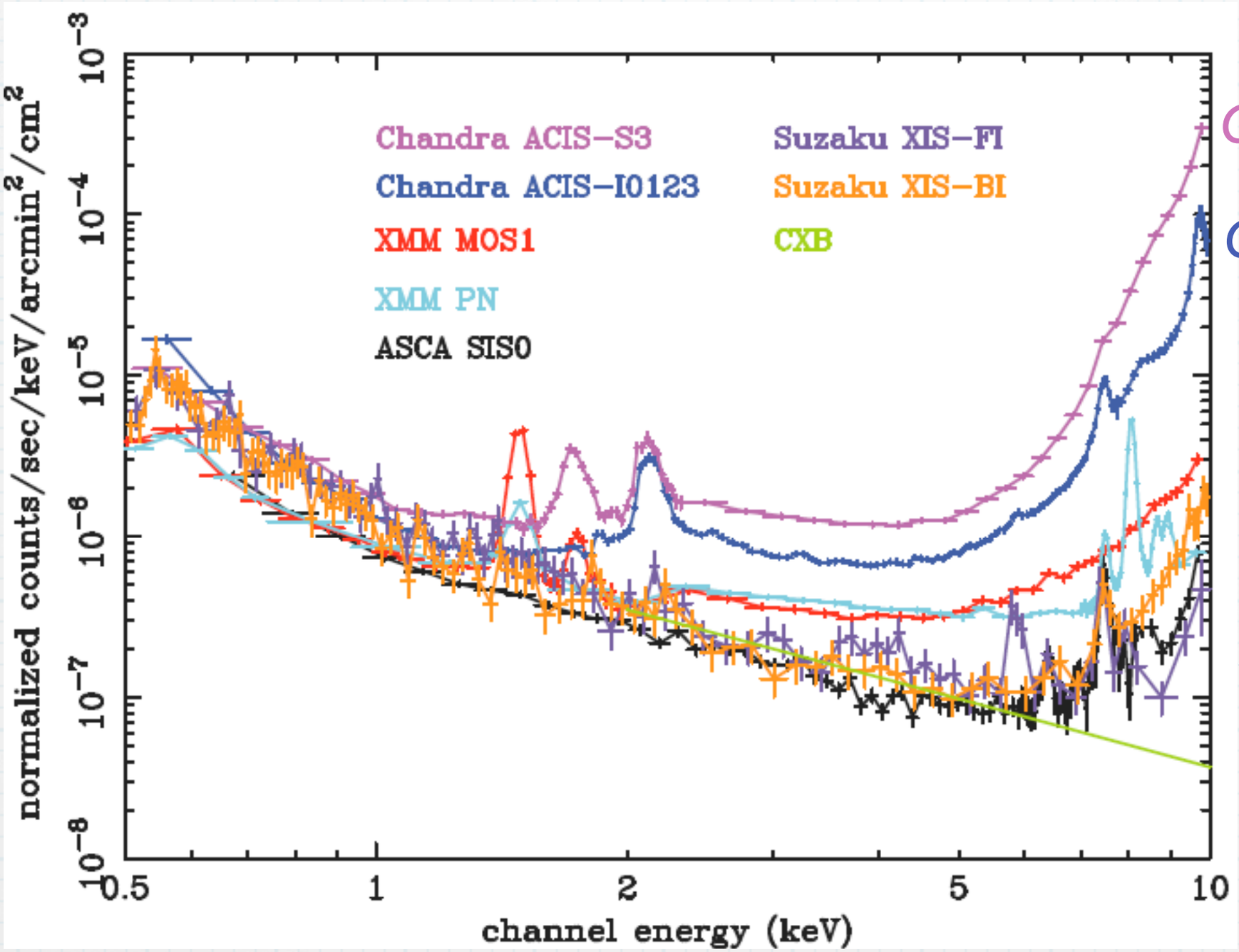
- ~1000 cm^2 effective area 1-6 keV
- Low background
- Good energy resolution
- Improved line spread function on low energy side, particularly important <1 keV

Effective area (XRT+XIS)



Low XIS background

Background normalized by effective Area and FOV



Chandra ACIS-S3

Chandra ACIS-I0-3

XMM MOS1

XMM PN

Suzaku BI

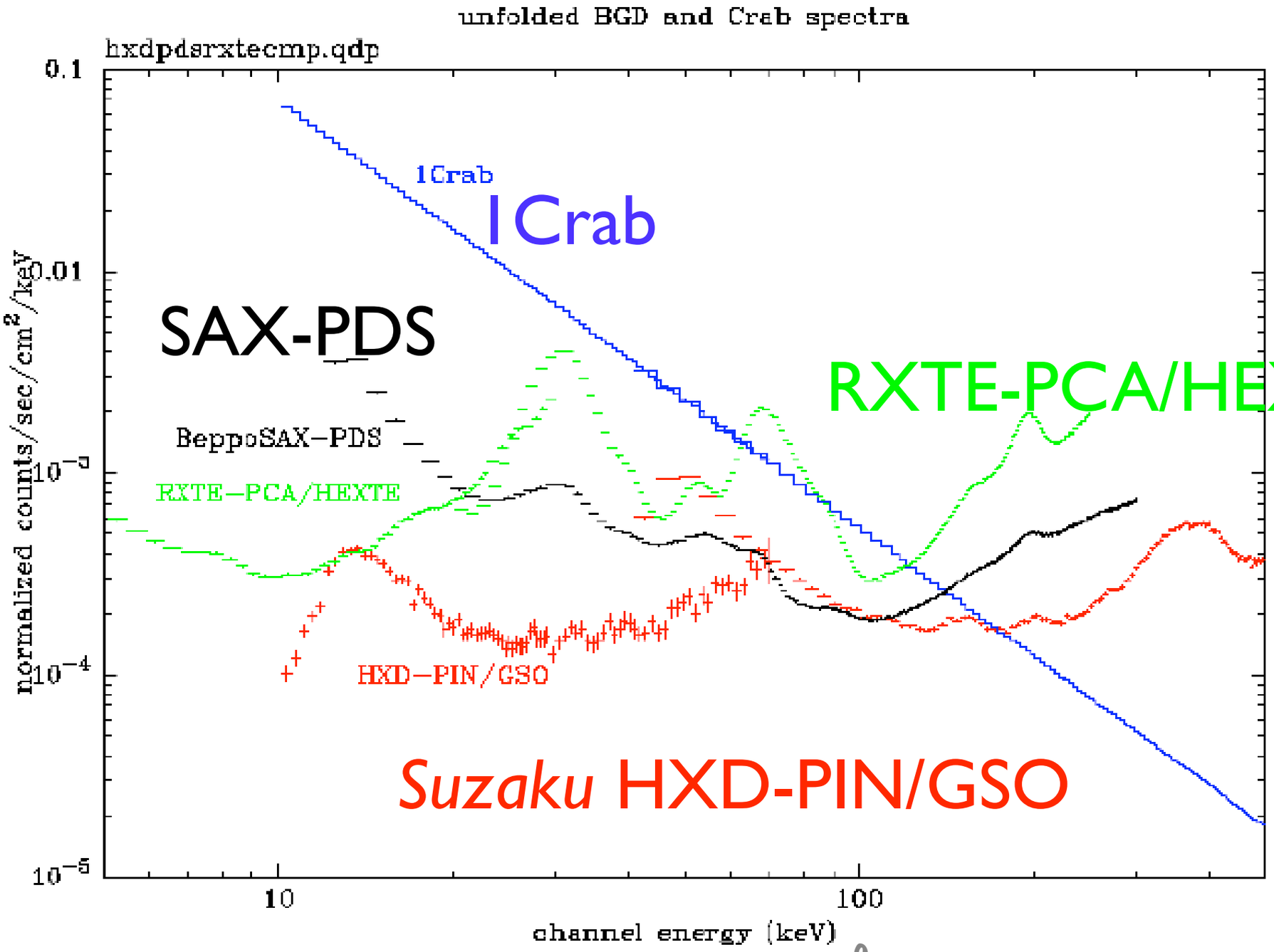
Suzaku FI

ASCA SIS

Suzaku XIS background is comprable to that of ASCA SIS

Low HXD background

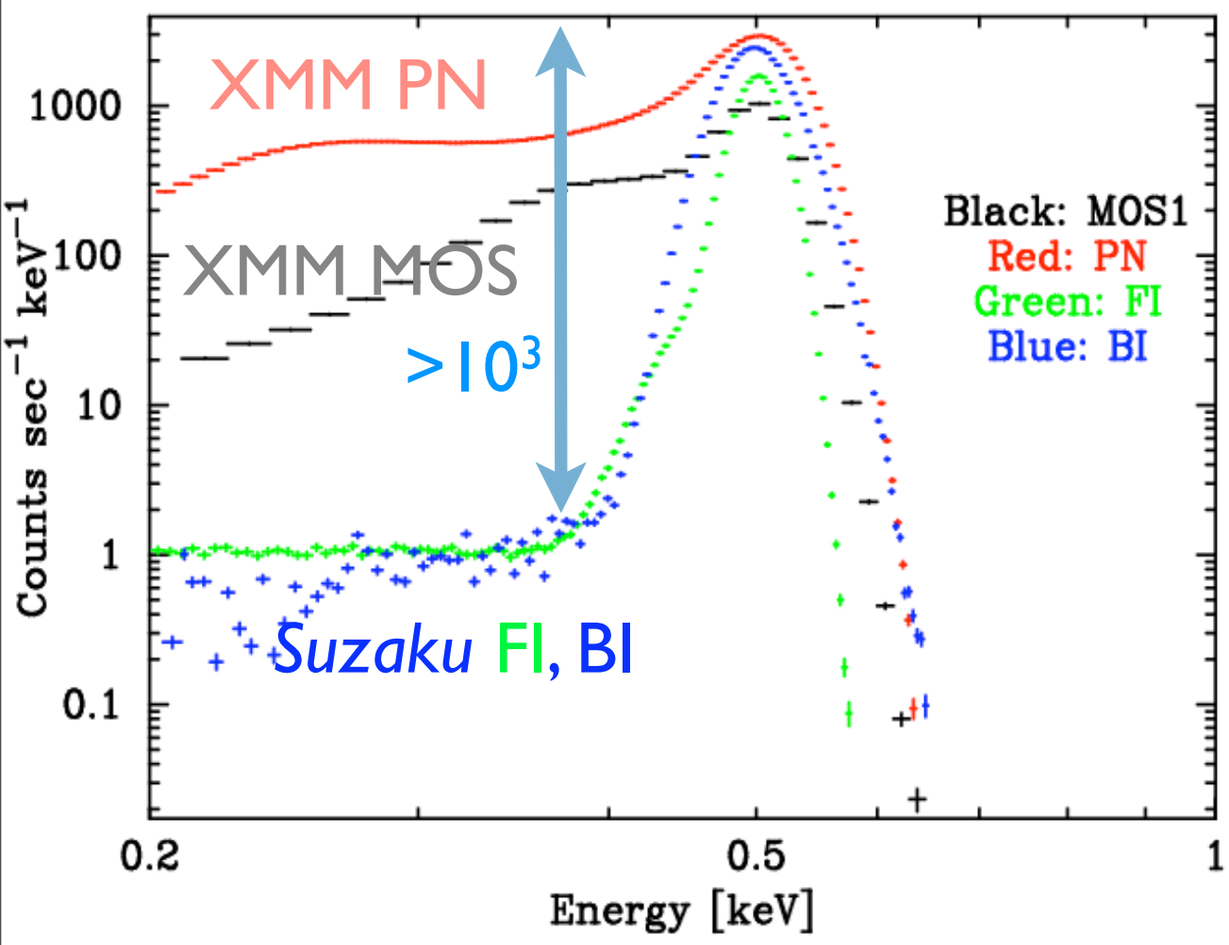
Background normalized by effective area



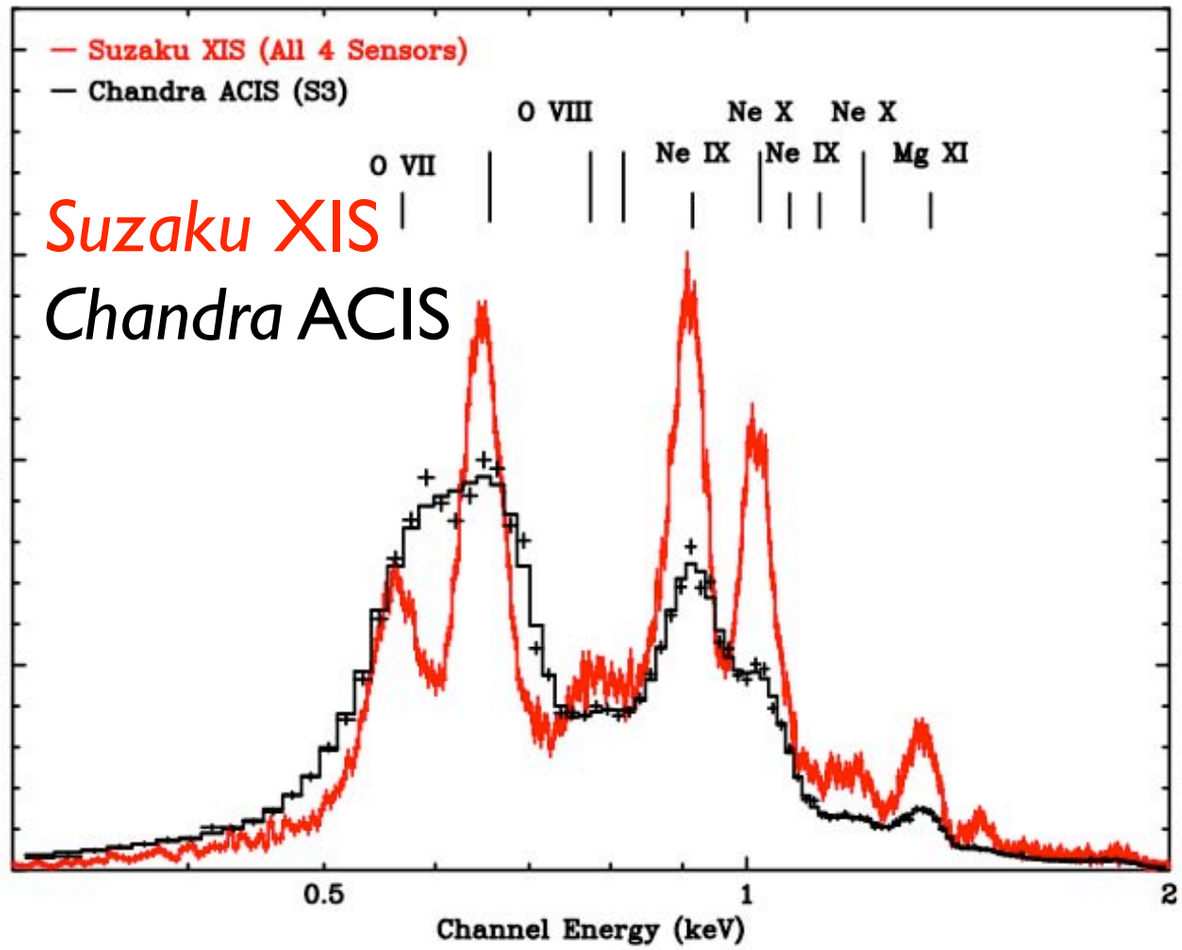
- Presently background can be estimated with an accuracy of 5%.
- Our goal is 1 %.

Good energy response < 1keV

response for 0.5 keV monochromatic X-ray



Observed energy spectrum of the supernova remnant, E0102.2-729



katsuda 2-Sep-2005 17:27

PV & GO-1 observations

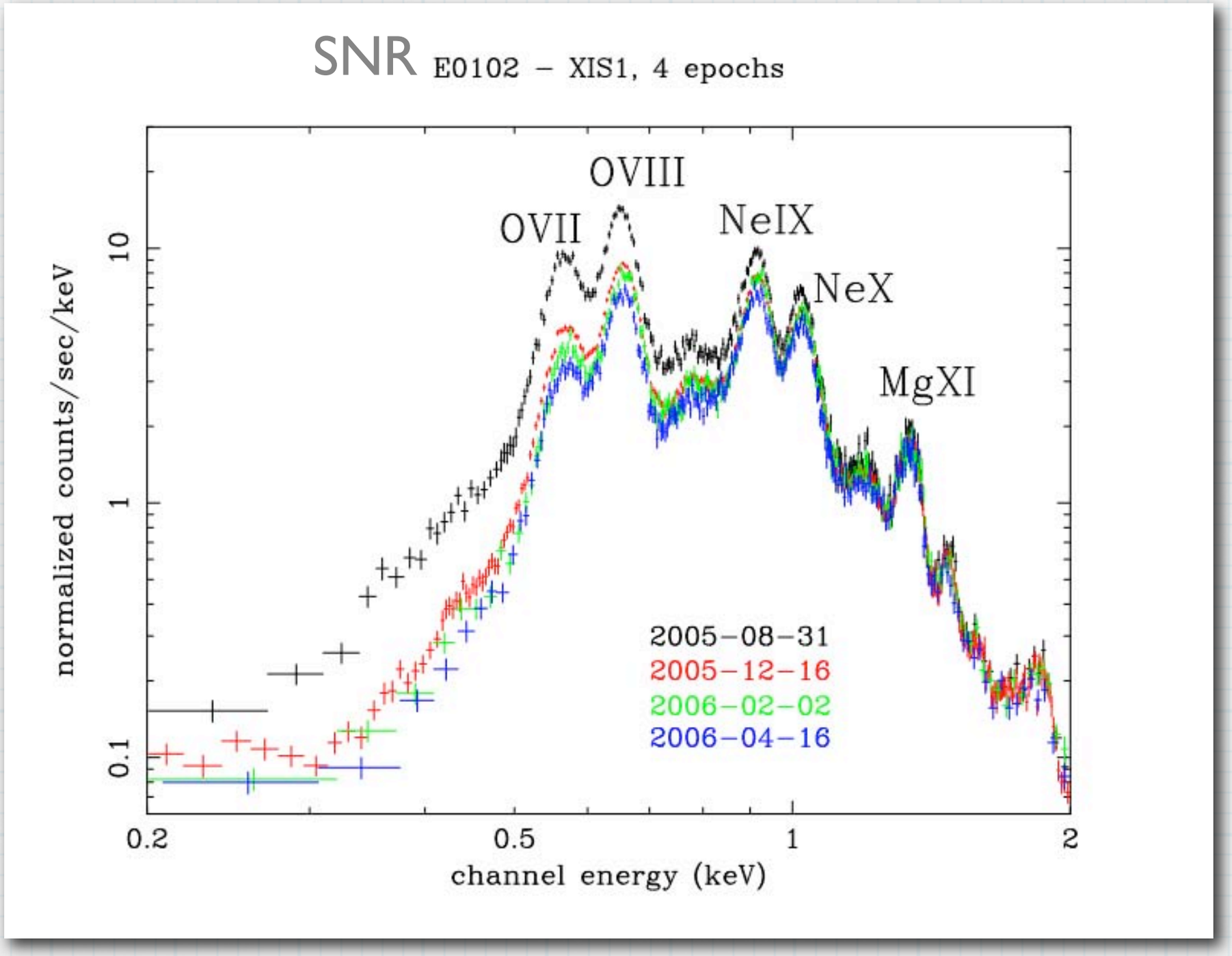
- Performance verification (PV) observations by the science working group (SWG)
  - August 2005 - March 2006
  - ~ 130 pointings
- GO-1 observation started from March 31, 2006 (10h UT)
  - More than 70 targets were observed so far
  - Four pre-selected GO-1 observations in February - March 2006
    - Soft (<1keV) X-ray observations
    - XIS contamination

Data processing and release

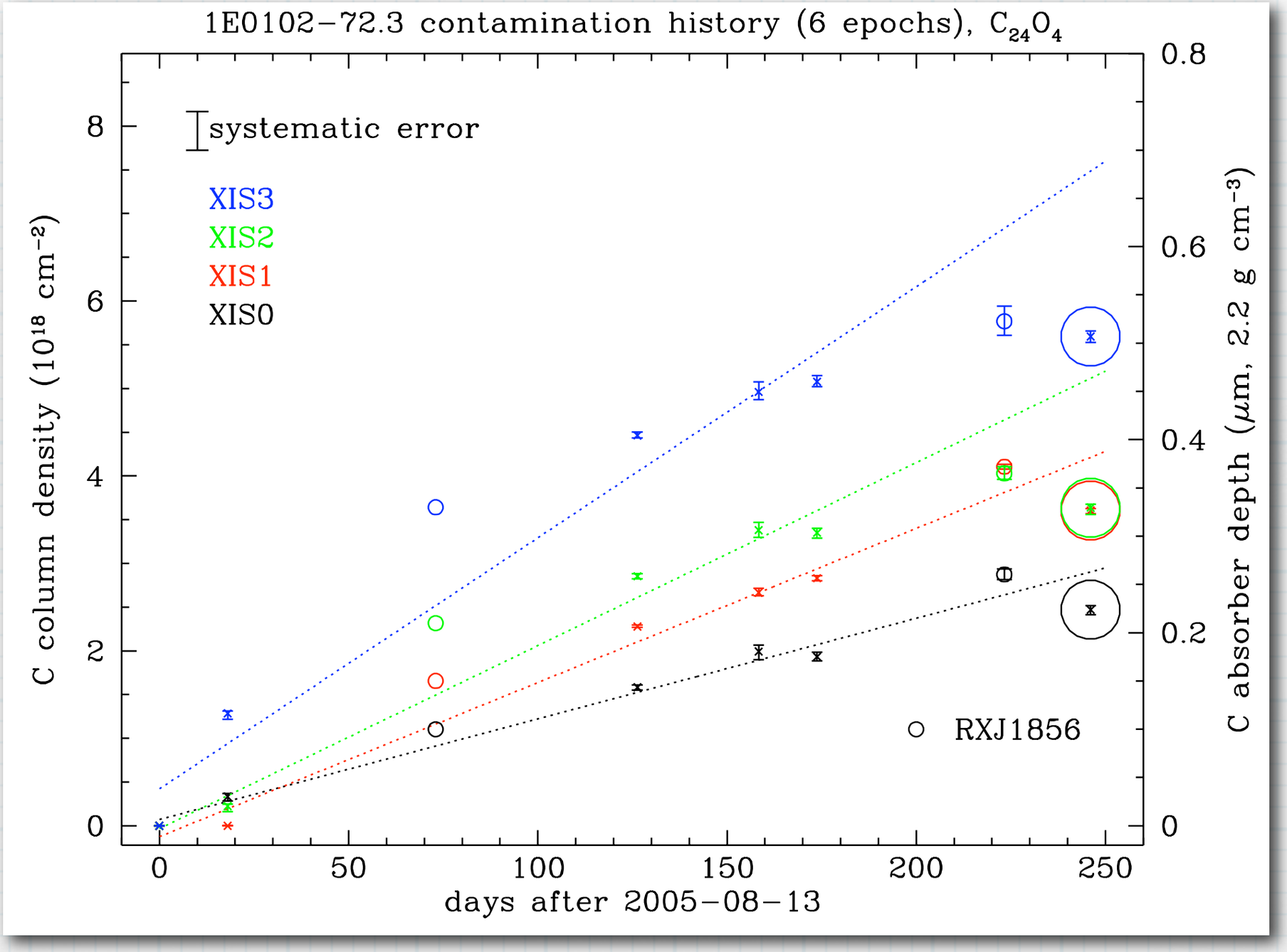
- Pipeline processing for GO-1 data has started on May 30 at ISAS/JAXA and will start soon at NASA/GSFC.
- Data will be distributed to PIs through the internet. Some GO-1 data were already delivered from ISAS to Japanese PIs.
- Analysis software and calibration data are available from NASA/GSFC web pages.
- There are limitations in version 1.0 processing. Please refer to Suzaku web page (http://www.astro.isas.jaxa.jp/suzaku/process/)
  - Spectral analysis tools for extended sources are presently being developed by the *Suzaku* team, including treatment of the XIS contamination.

XIS contamination

- Effective area < 1 keV is decreasing

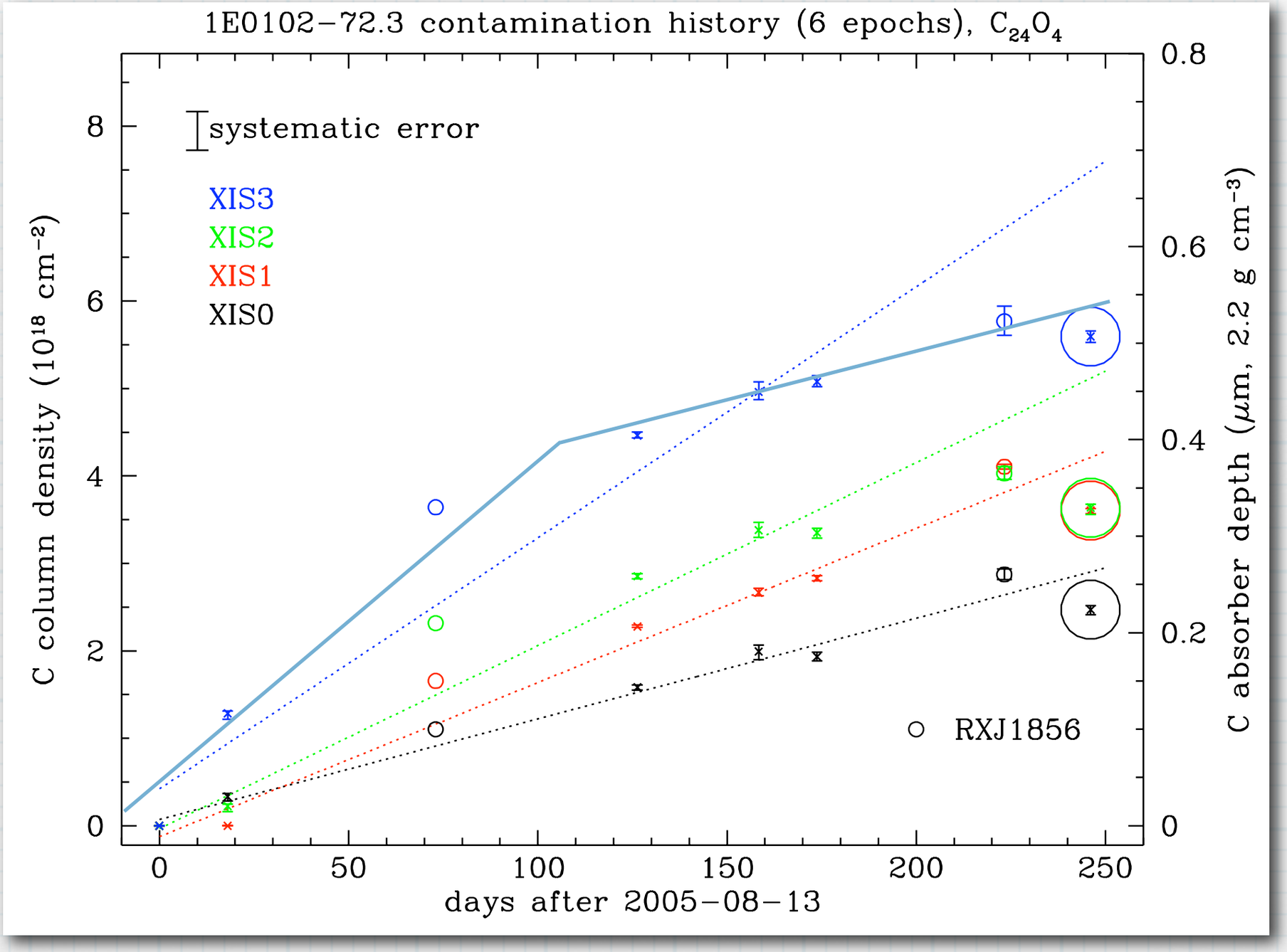


Growth of contamination



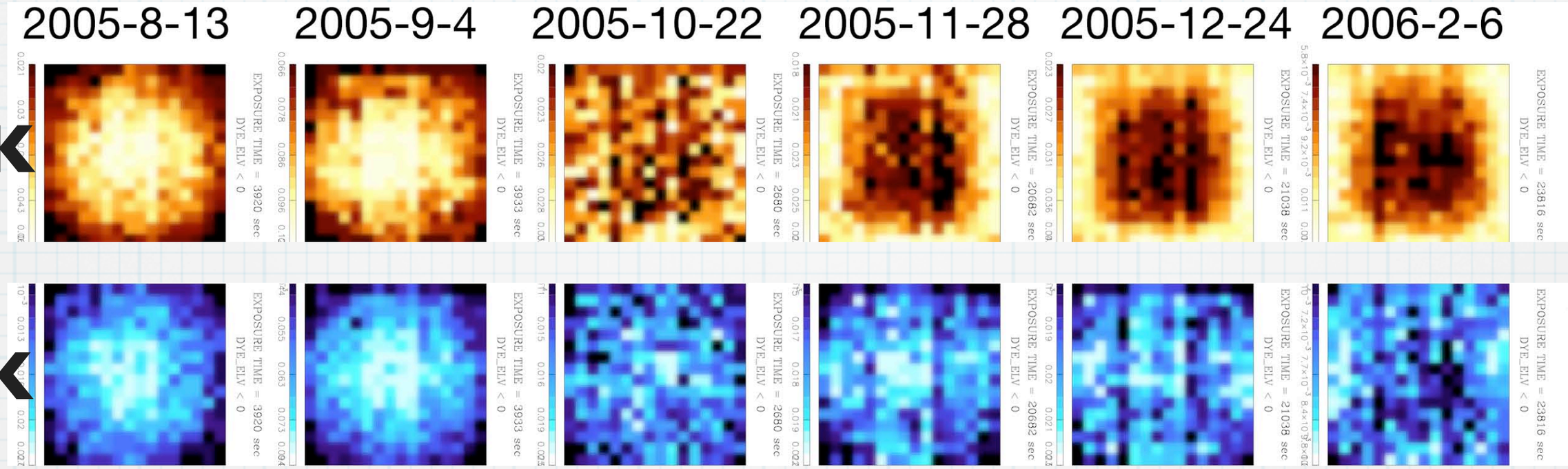
Growth of contamination

significant flattening after day ~ 150



Spatial gradient

- Atmospheric N-K and O-K emissions
  - uniform with the XIS field of view



We have developed software which generates XRT+XIS response in which both the time growth and spatial gradient are took into account.
The software is presently tested by the *Suzaku* team.

GO-2 program

- 2nd Guest Observer (GO) observation will start April 1, 2007
- AO will be released around the end of August, and the proposal due date is December 1, 2006.
- International time allocation is the same as that of GO-1:
  - 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.)
- proposals should be submitted to NASA (US), ESA (ESA countries), or JAXA (Japan and all non-US and no-ESA countries)

X-ray binaries

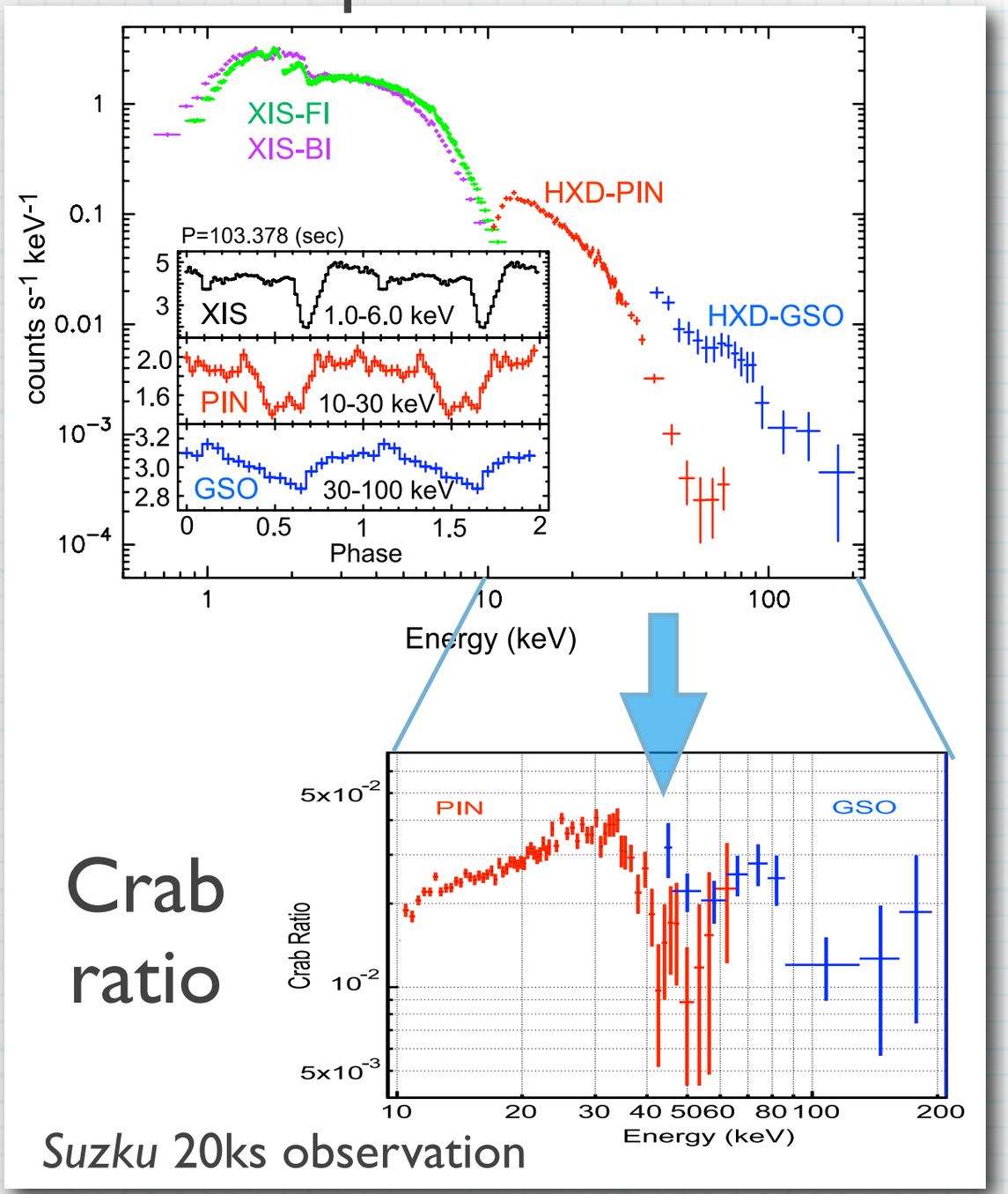
- Soft to hard X-ray emissions
- Highly time variable
- Complex spectral features on steep continuum spectrum

→ The unique feature of *Suzaku*,
"Wide-band spectroscopy all in one observatory"
is very useful for studies of X-ray binaries.

- Small pile up and telemetry saturation of the XIS also ensure observations of bright sources.
  - ~ 60 mCrab (window mode)
  - ~ 0.5 Crab (burst mode)

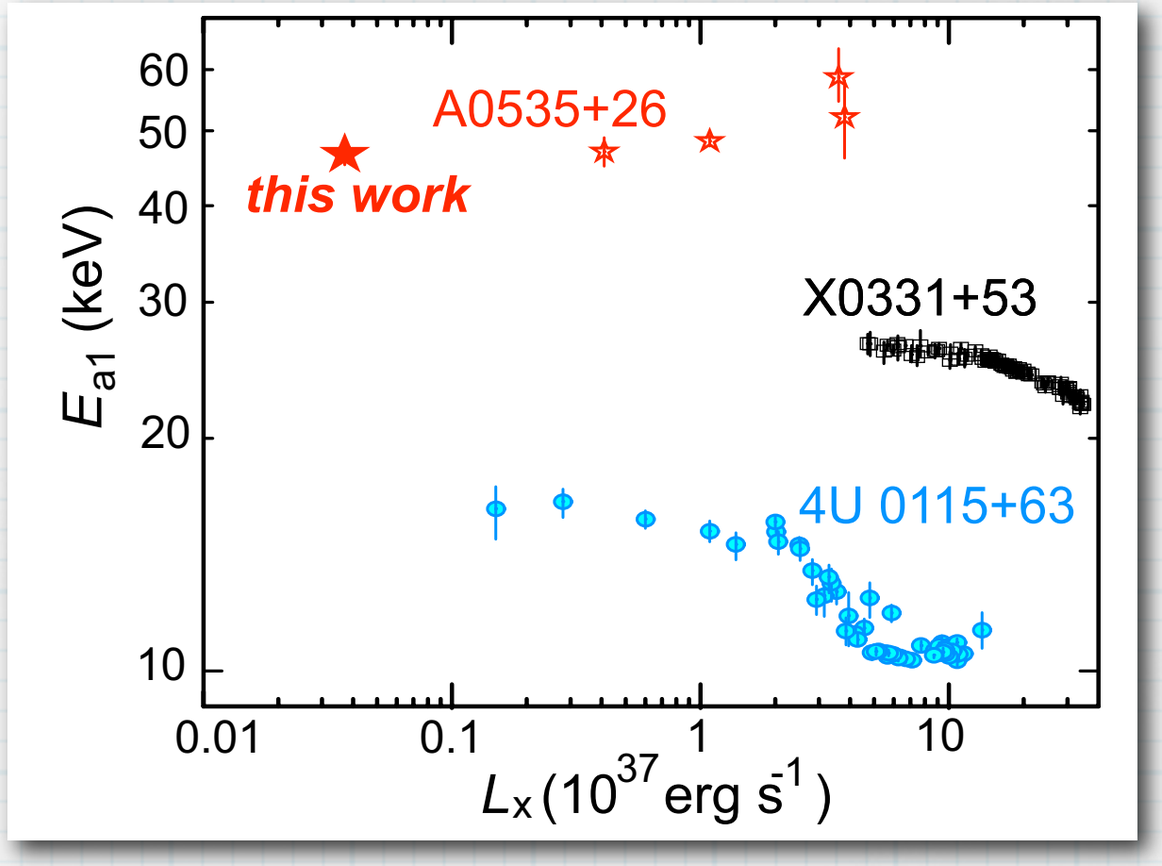
A0535+26

- Observed on September 14, 2005, during the decay phase of a flare



Suzku 20ks observation

- Detection of Cyclotoron resonance line at lowest X-ray luminosity (4×10^{36} erg s^{-1}).
- Constant energy over 2 orders of magnitude luminosity variation.

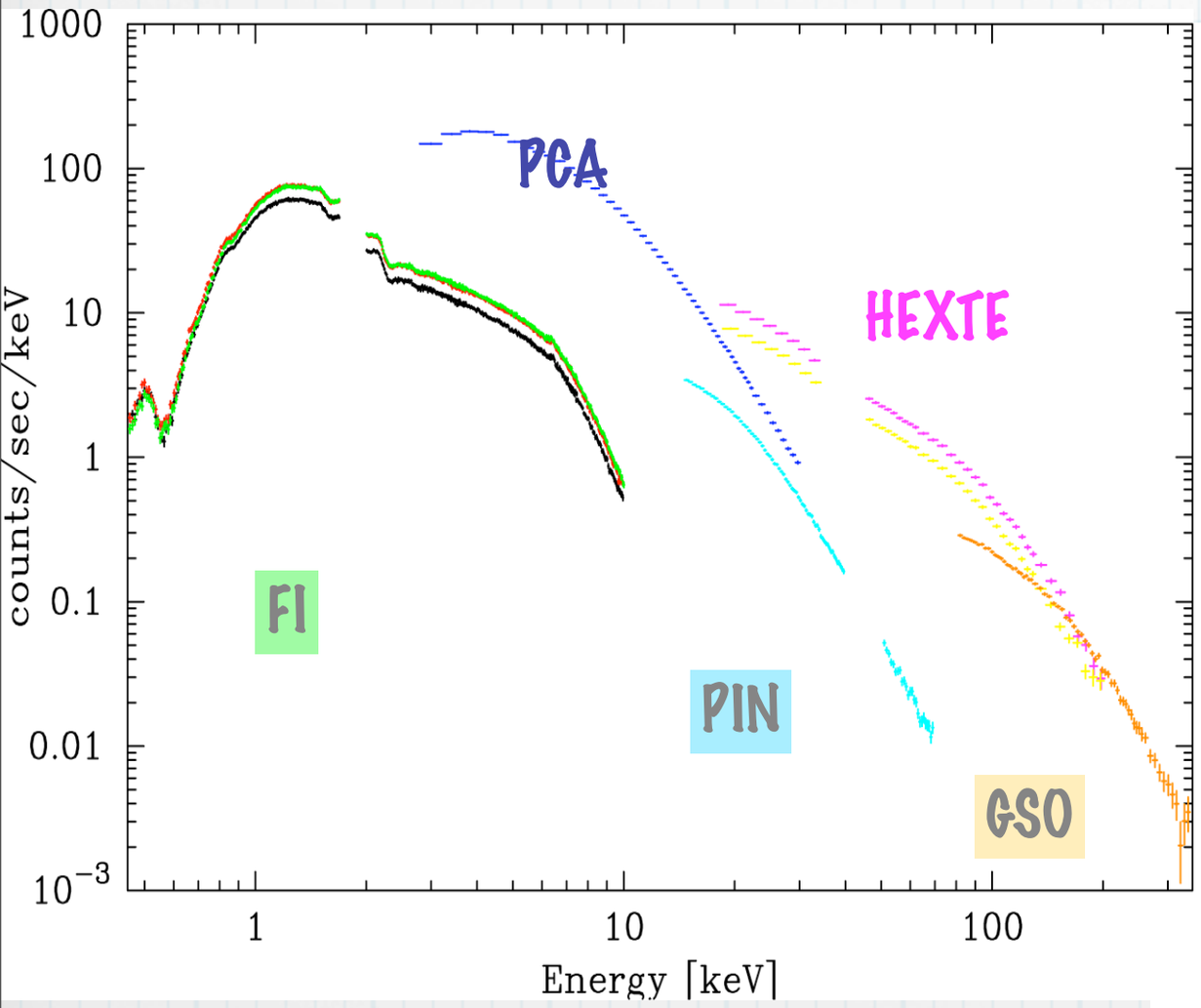


Terada et al. submitted to ApJL

Cyg X-1

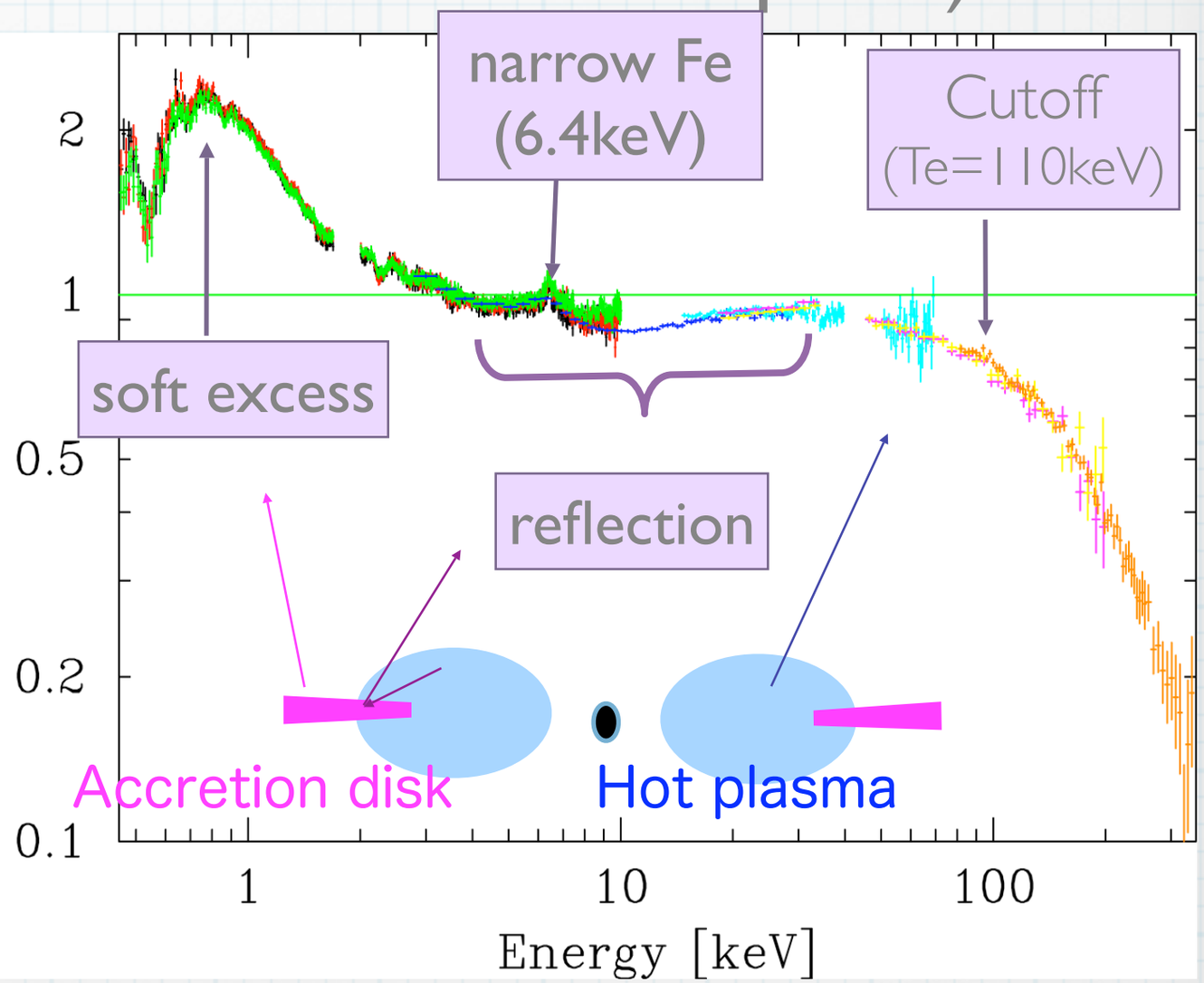
Geometry of the low state black hole

Wide band spectra



Suzaku 17 ks observation

Ratio to power-law model with absorption)

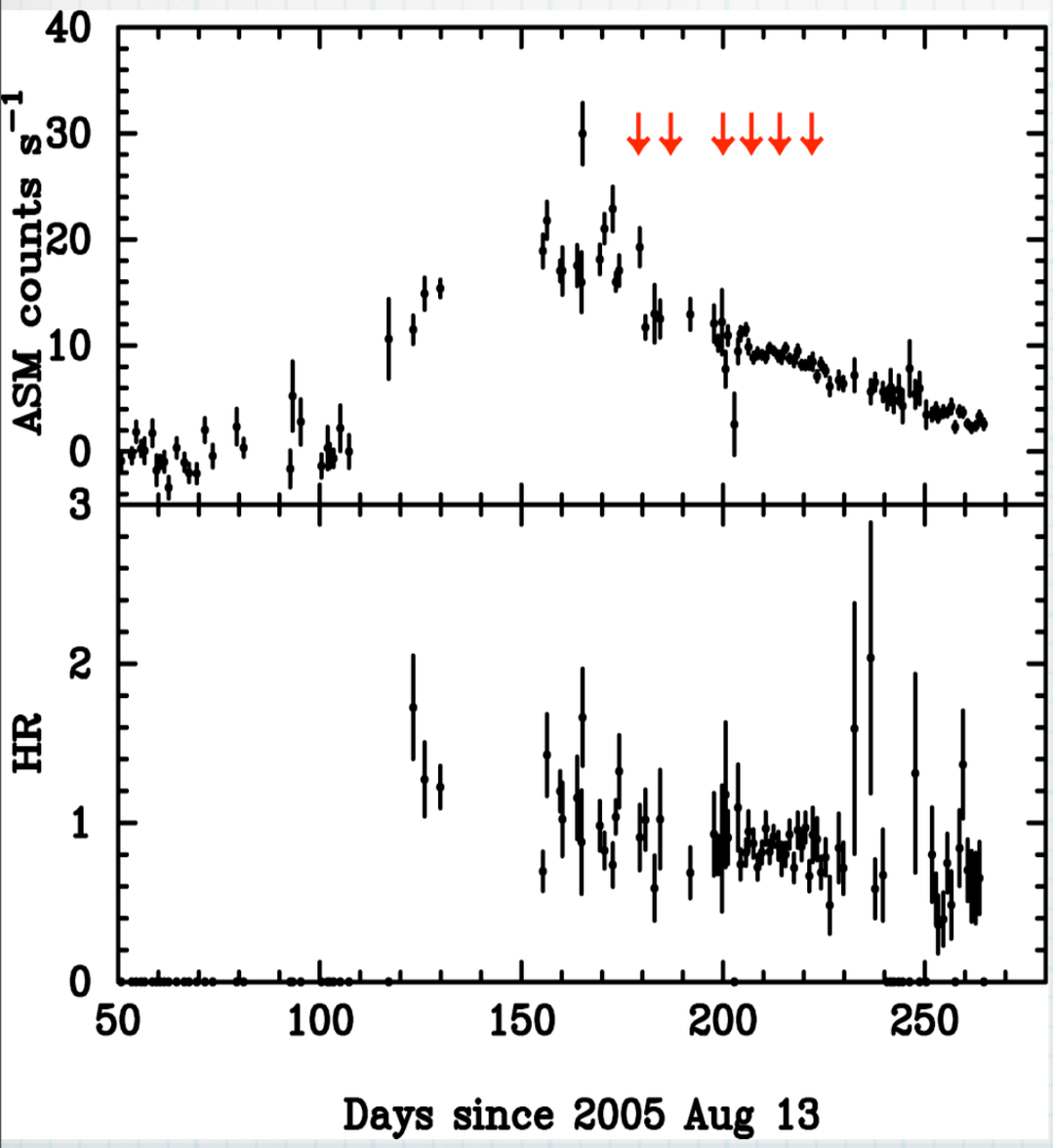


Kubota et al. preliminary

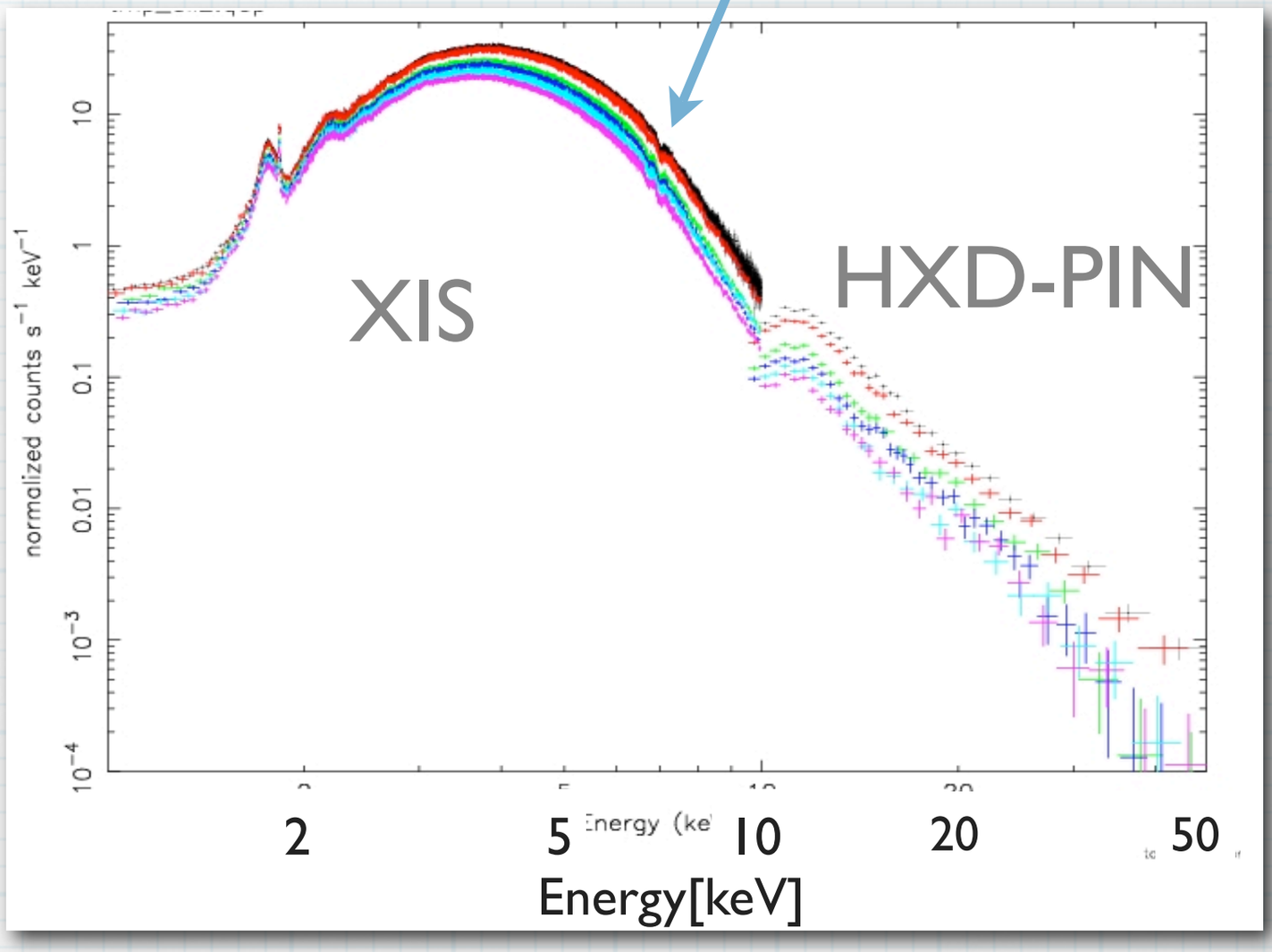
4U1630-472

6 observations in 2 months

RXTE/ASM light curve



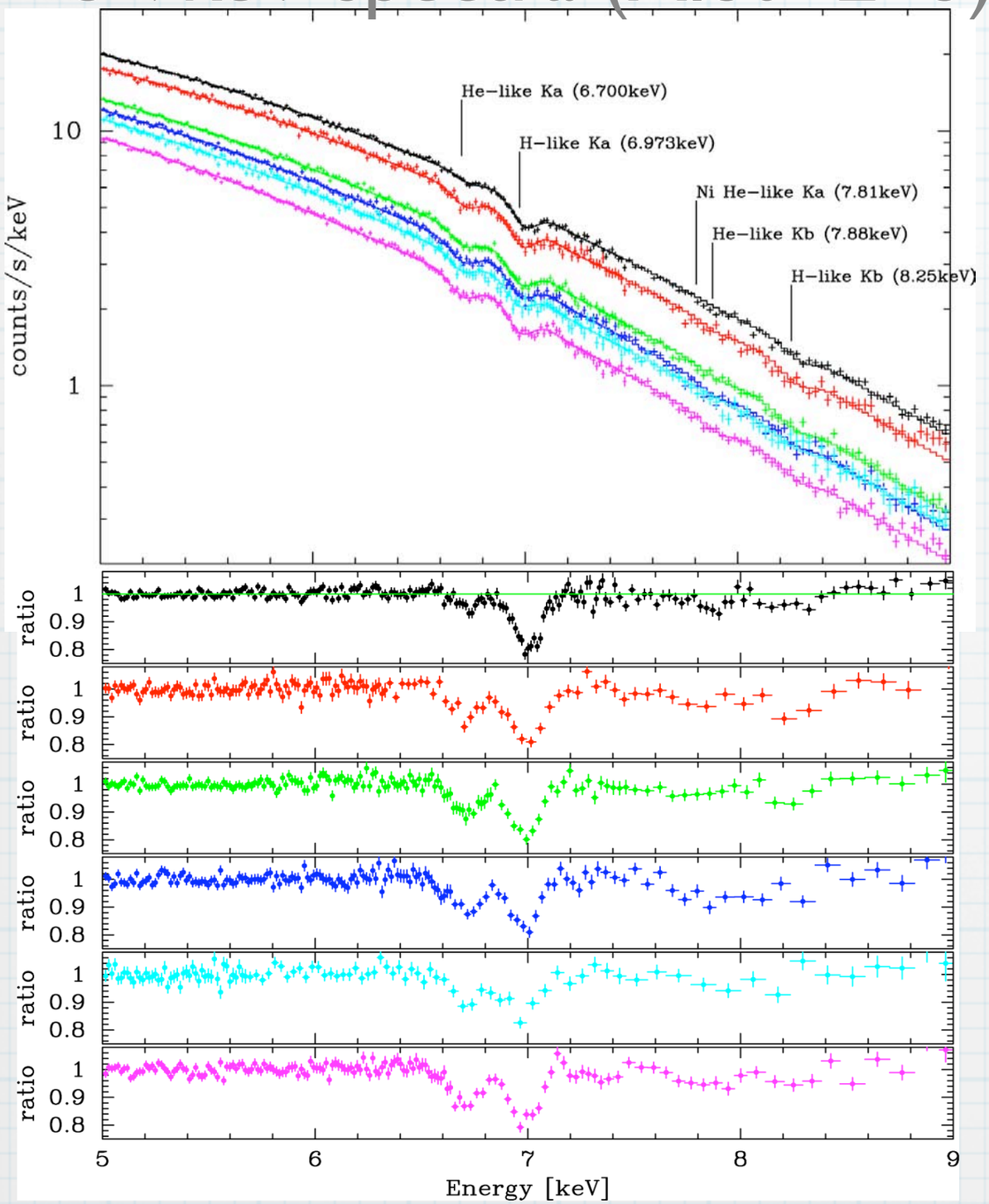
absorption line feature



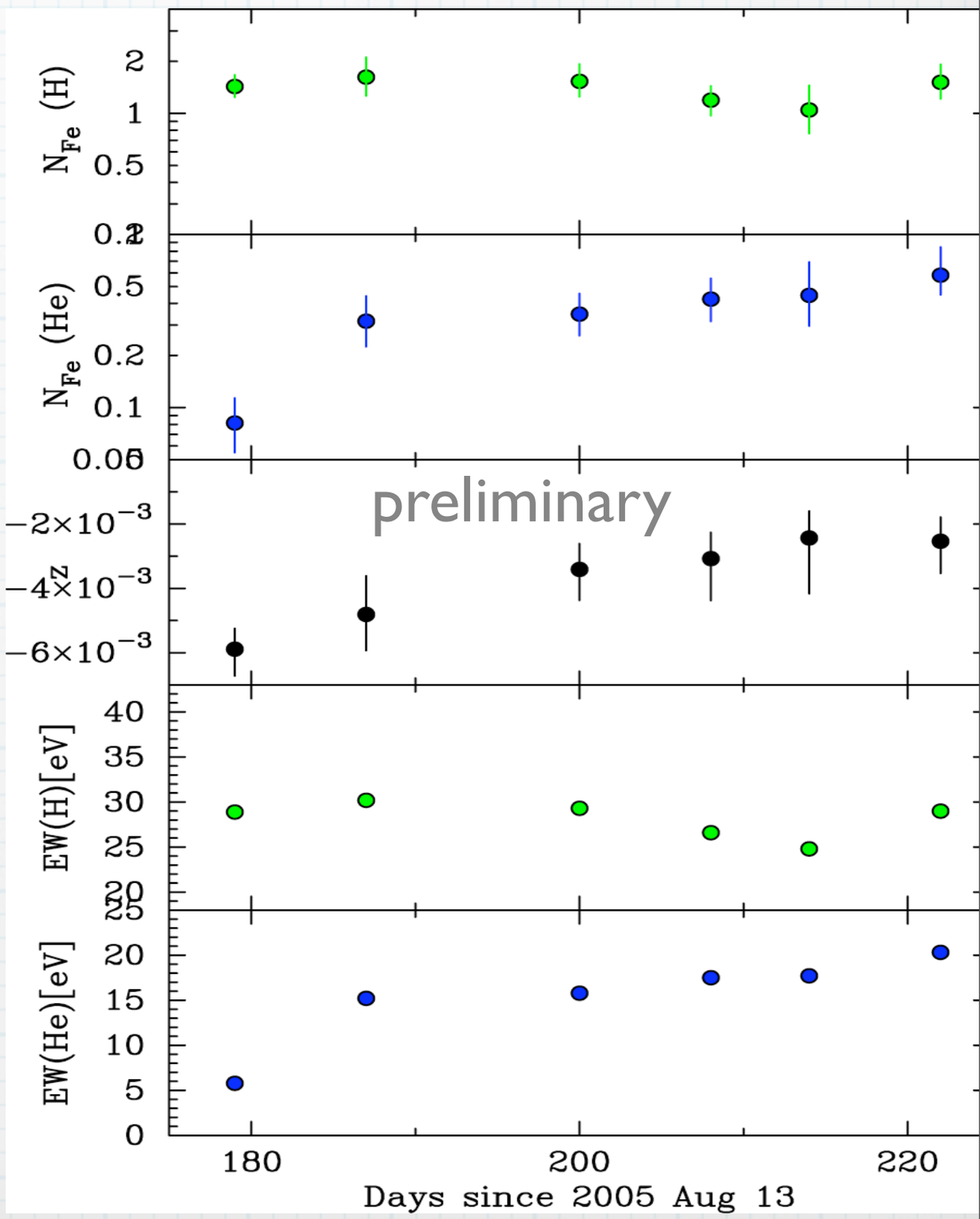
Kubota, Cottam et al. preliminary

He-like & H-like Fe absorption lines

5-9keV spectra (XIS0+2+3)



model: Voigt profile



Suzaku

Wide-band spectroscopy all in one observatory

- Low background over a very wide X-ray band
- Good energy resolution with greatly improved line spread function, in particular, < 1keV compared to Chandra and XMM-newton

Very much a unique and powerful observatory

- Cluster of galaxies, SNRs, Accreting BHs, ISM, IGM, ...

talks in this session and two talks in wam-hot gas session this afternoon

We, the *Suzaku* team, would like to thank all the support from US astronomy community and would like to ask continuous support.

Welcome
What's New
Important Dates
Registration & Abstract Submission
Program
Proceedings
Circular
Venue, Travel & Visa
Accommodation & Tour
Kyoto
Committee

Scopes

The 5th Japanese satellite Suzaku (Astro-EII), in collaboration with NASA, was successfully launched on 10-th July, 2005. The excellent performance of the XIS and HXD combined with a dedicated strategy for Suzaku observations will lead us to much outstanding science even after the loss of XRS. Many of the first exciting results should be ready within one year. Accordingly, an international Suzaku conference should be held to exchange the new results and new ideas, to deepen our understanding, and to demonstrate the promise and capabilities of Suzaku to the entire world.

The conference title is "The Extreme Universe in the Suzaku Era", where "the Extreme Universe" will be deeply probed with Thermal and Non-Thermal X-rays observed with XIS and HXD.

This year, 2006 is one millennium after SN1006. Needless to say SN1006 is a symbolic object in which Thermal and Non-Thermal X-rays jointly play key roles on the "Extreme Universe". The famous Japanese poet, Teika Fujiwara wrote a short note of the Supernova event in 1006 on his diary, "Meigetsu-ki" (the bright moon). It is reasonable to have the millennium meeting in Kyoto, the hometown of Teika, with the title of "The Extreme Universe".

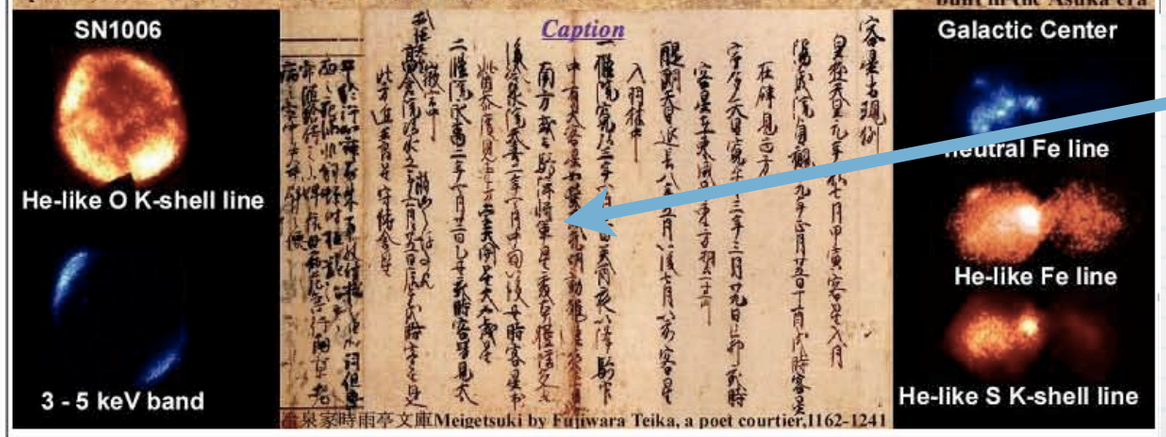
Obviously, the topics is not limited to SN1006 but should be part of the general theme: "The Extreme Universe probed with Thermal and Non-Thermal Radiation". These may be carefully studied with Suzaku, but the topics should all be recent high energy results from currently active satellites, Suzaku, Chandra, XMM, Integral, Swift and Others.

< Topics >

- Diffuse X-ray Sources in Galaxies
  - Extended Thermal X-ray Sources
  - Non-thermal X-ray/GeV/TeV Sources
  - The Galactic Center and its Environments
- X/γ-rays from Stars and Compact Objects in Galaxies
  - White Dwarf and Neutron Star Binaries
  - Isolated Compact Stars
  - Normal Stars, Planets and Nebulae
- Structure and Evolution of Galaxies and Clusters
  - Chemical Compositions and Evolutions
  - Thermal and Non-thermal Structures
- Stellar/Intermediate/Super-Massive Black Holes
  - Accretion Physics on Black Holes
  - Outflow/Jets from AGNs and Micro-Quasars
- Extremely High Energy Objects
  - Gamma Ray Bursts
  - GeV/TeV Emissions
  - Cosmic Rays and Neutrinos
- Special Session: "The millennium of SN 1006: Particle acceleration"

Caption

飛鳥時代のキトラ古墳壁画
（奈良文化財研究所提供）
The wall painting of "Suzaku" in the ancient tomb "Kitora" built in the Asuka era



Organized by:

Conference in Kyoto

- SN1006 millennium
- please visit the conference web site: http://www-cr.scphys.kyoto-u.ac.jp/conference/suzaku2006/

Diary of Fujiwara Teika who lived in Kyoto in 12th century. Here he wrote about the guest star on May 1, 1006 in Lupus.