

宇宙X線、ガンマ線観測へのGeant4の応用 Application to X/ γ -ray Observations

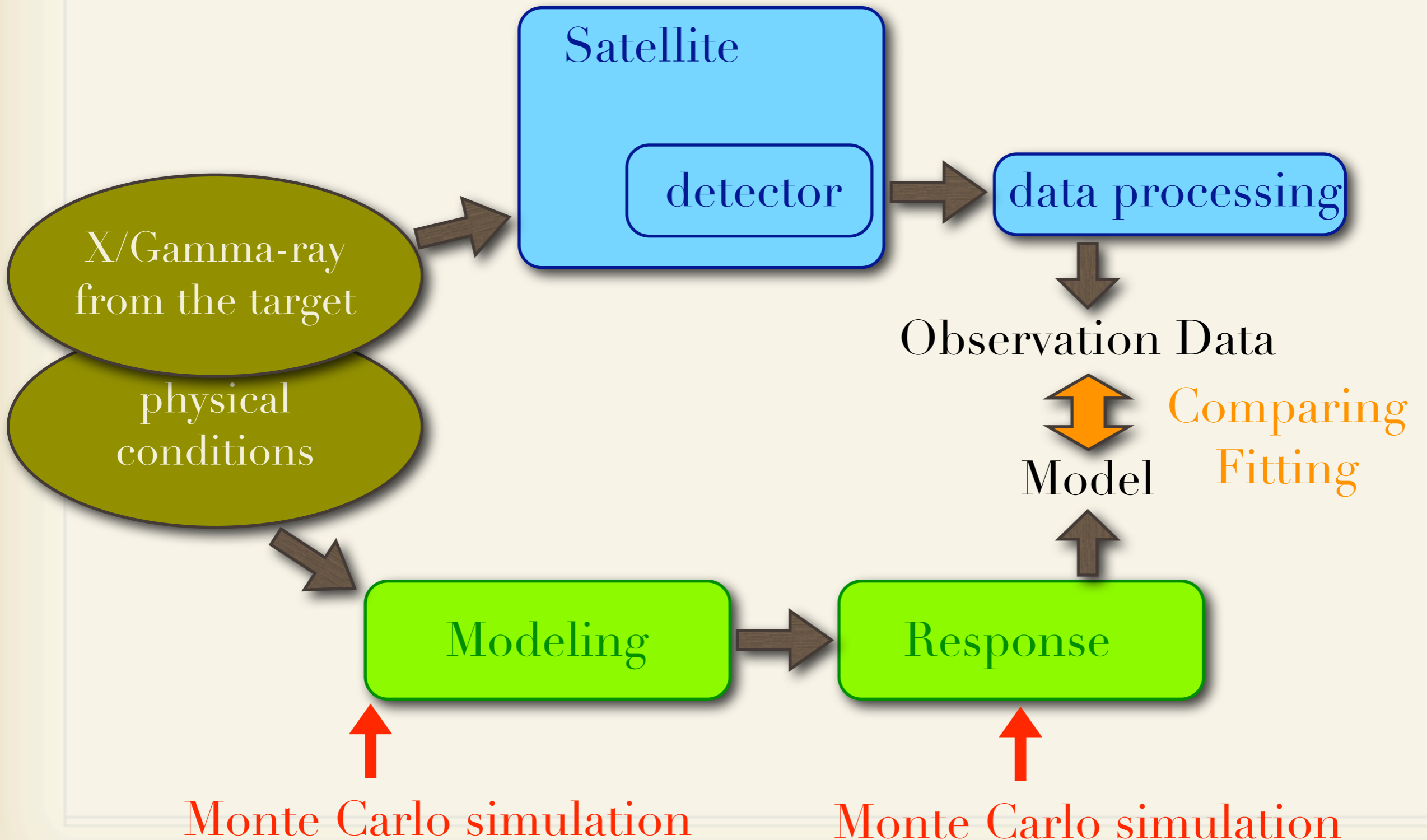
渡辺伸(ISAS/JAXA)

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2006/01/26 Geant4研究会2005

Introduction

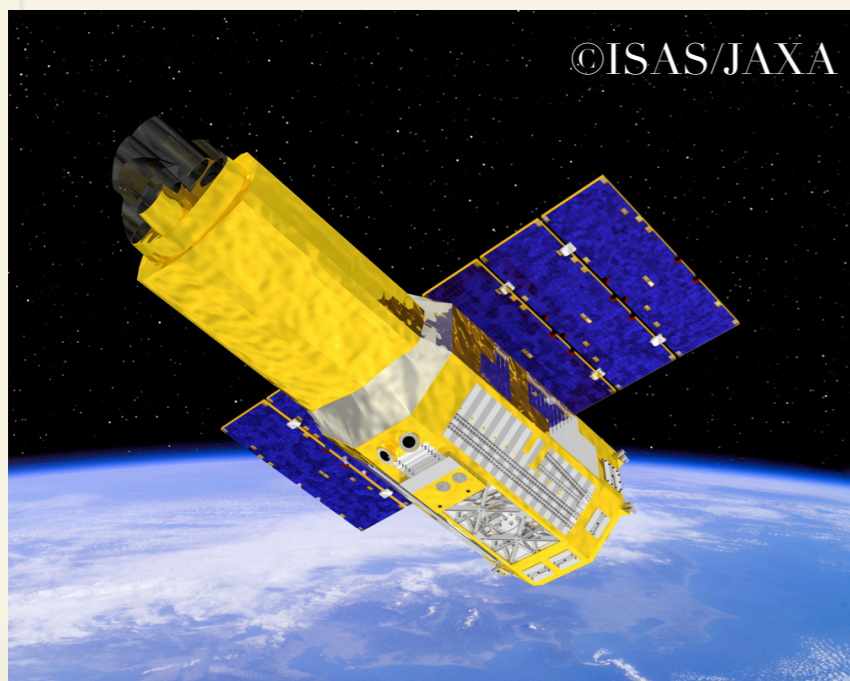
Data Analysis flow in X-ray observations



“Suzaku” Observatory

the 5th Japanese X-ray
astronomy satellite

Launched on July 10, 2005



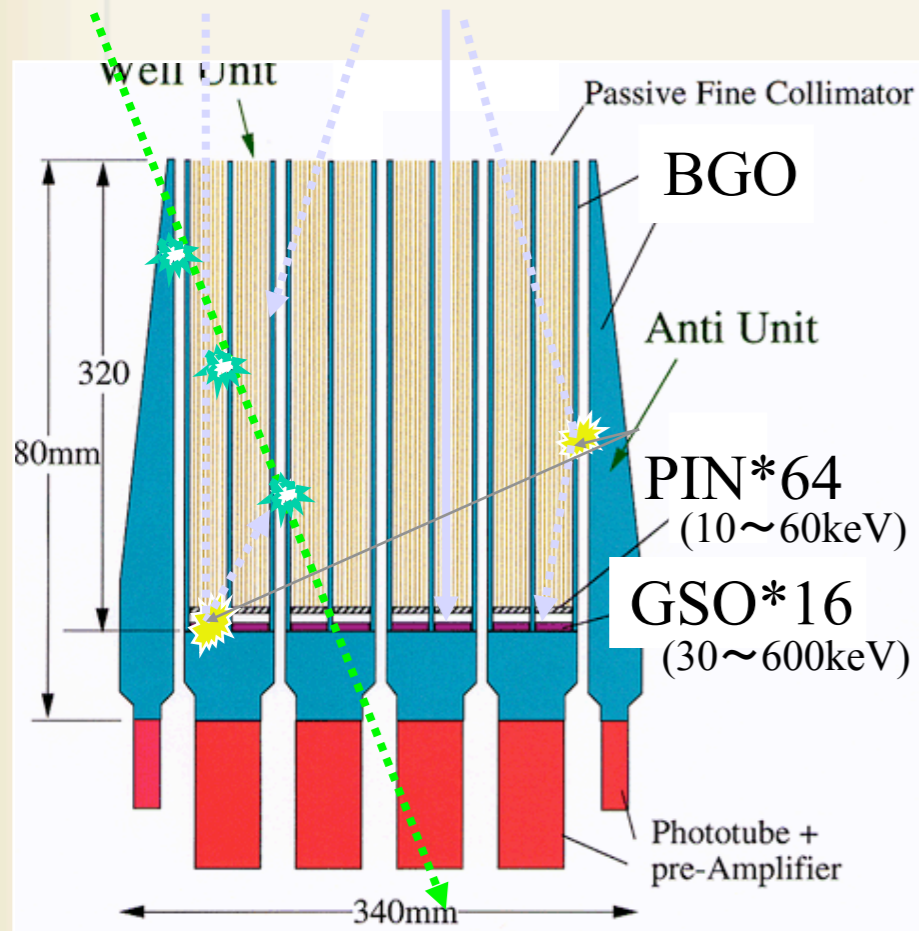
Detector Systems

~~XRS (micro calorimeter)~~

XIS (X-ray CCD) [0.3 — 12 keV]

HXD (Hard X-ray Detector) [10 — 600 keV]

Hard X-ray Detector (HXD)



HXD:

Si-PIN [2mm thick] (10—60 keV)

GSO [5mm thick] (30—600keV)

WAM -> Ohno's Talk

BGO: Shield + Phoswitch

BGO well + Fine Collimator:

narrow FOV

-> Low Background

-> High Sensitivity

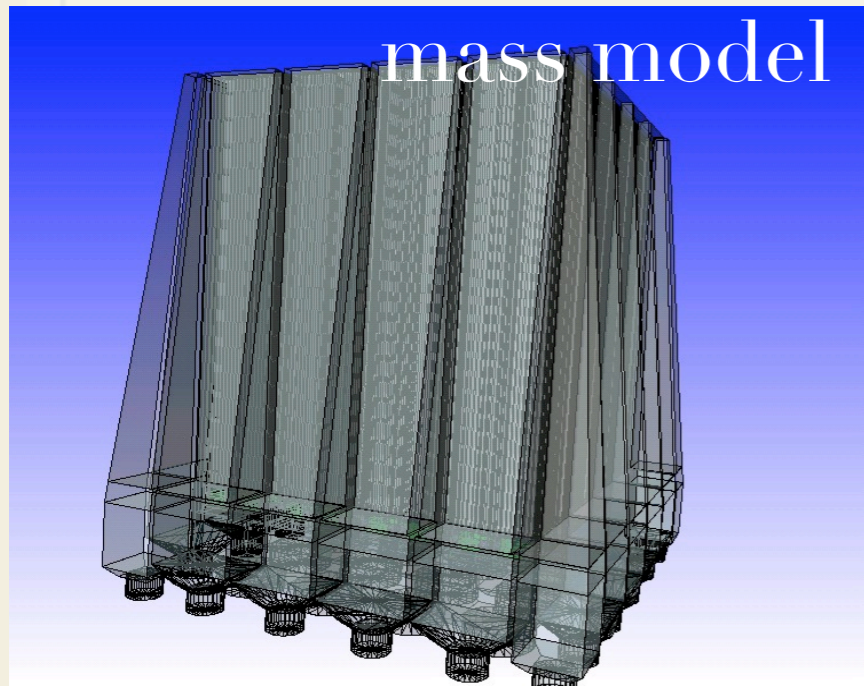


Complex Response

Key: Monte Carlo simulator

simHXD

simHXD-> Full Simulator of HXD



Mass Model

γ , energy, direction

MC simulation
based on Geant4

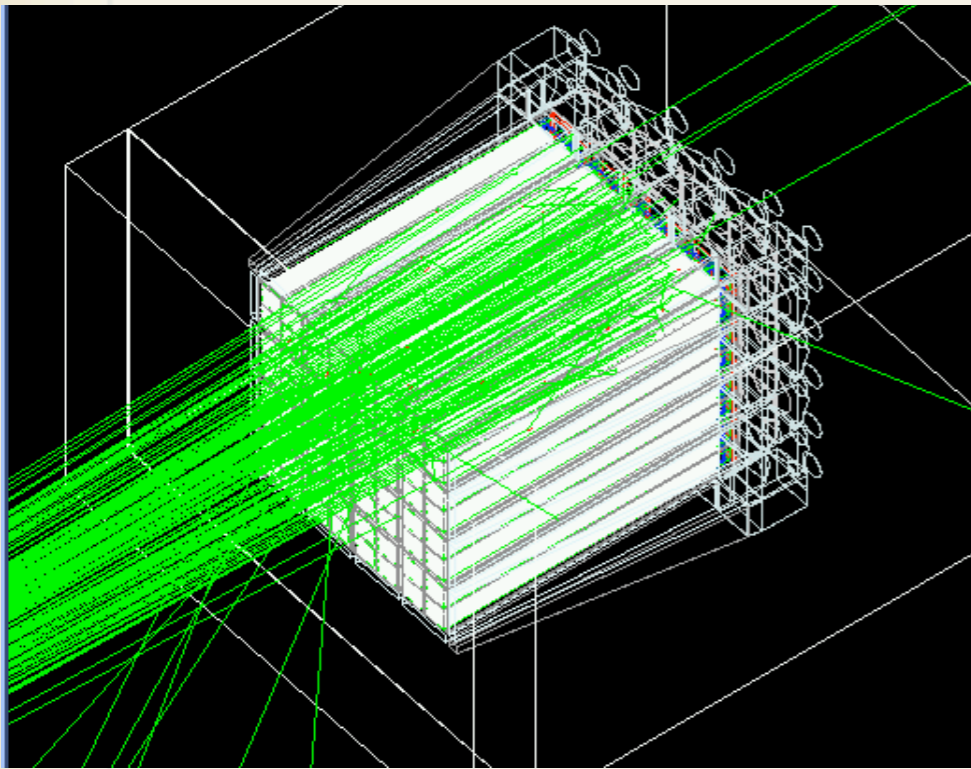
energy deposit-> signal

simAE

simDE

pipeline processing

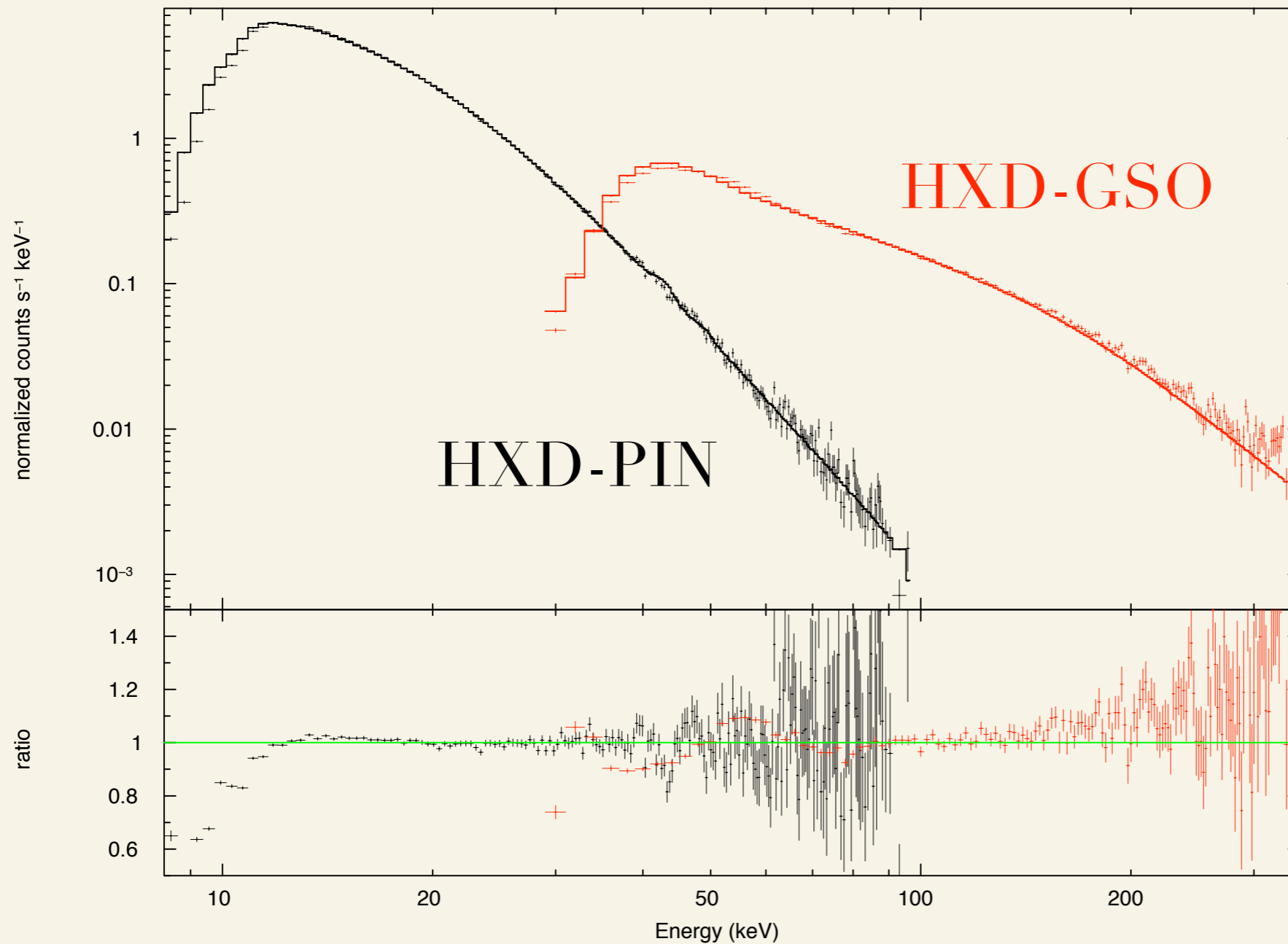
simulation
data



HXD Response

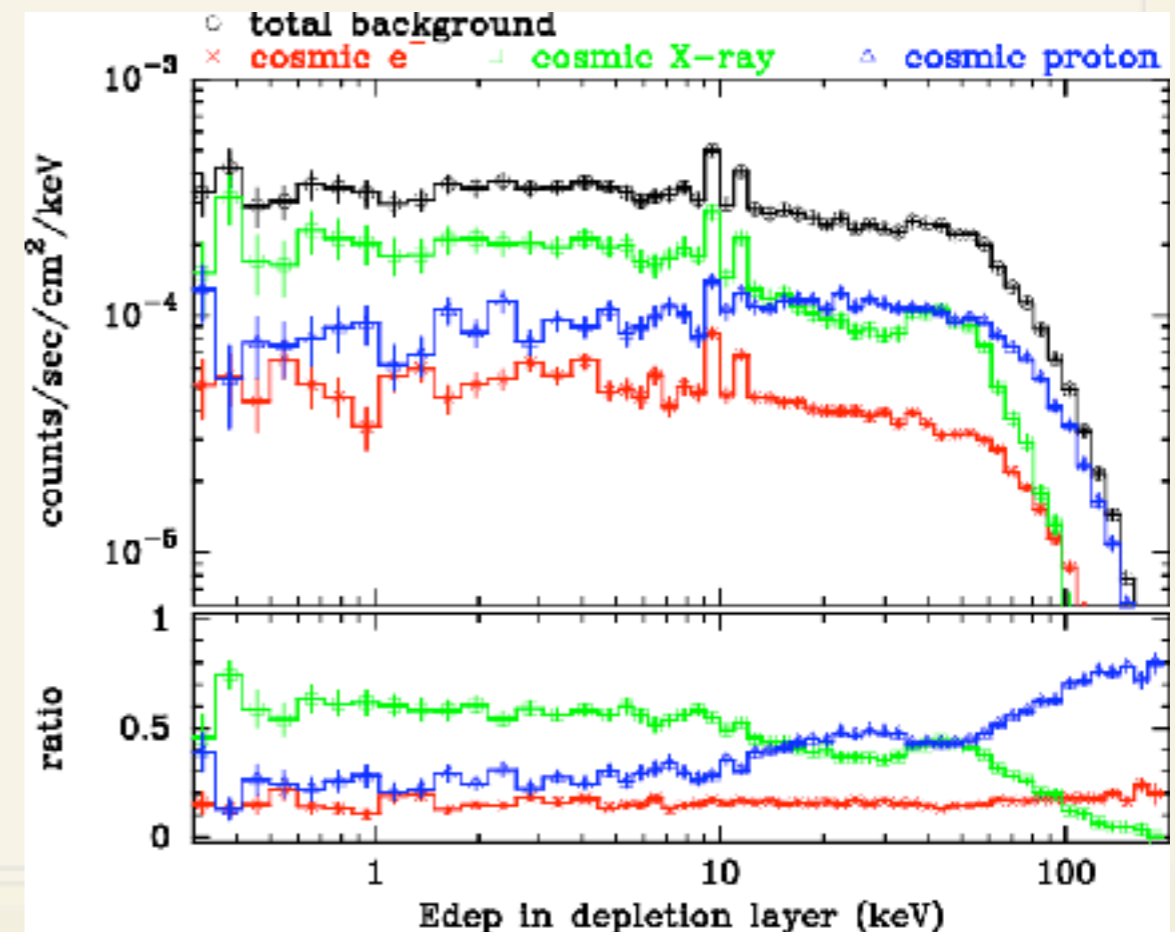
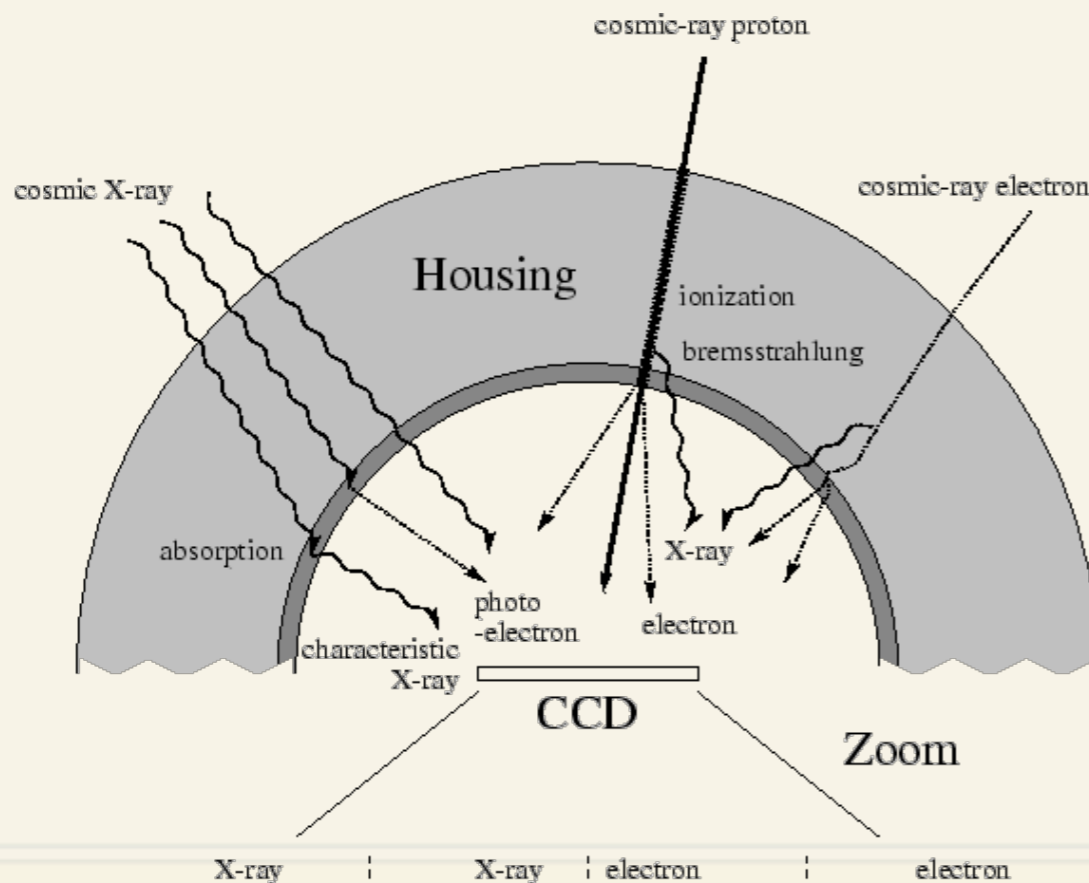
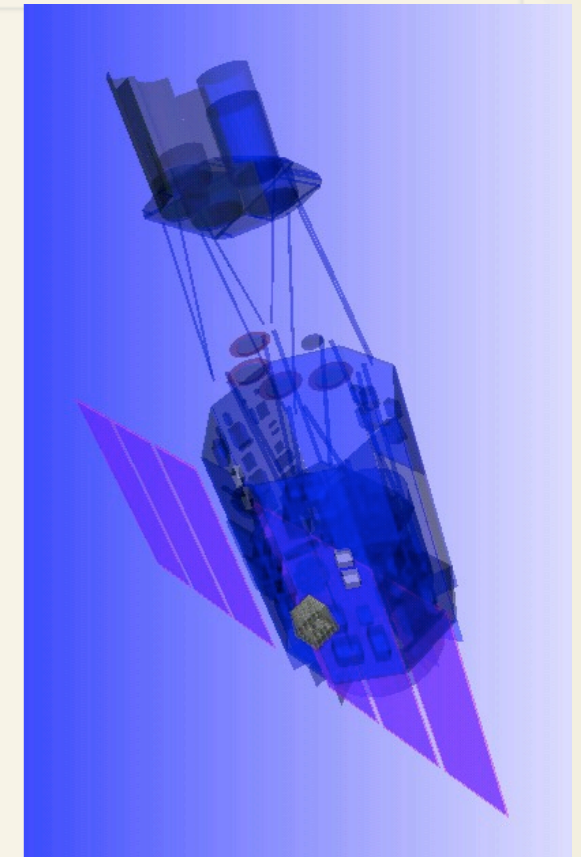
Crab Nebula (a standard candle) \rightarrow synchrotron radiation

data and folded model



Further Prospects

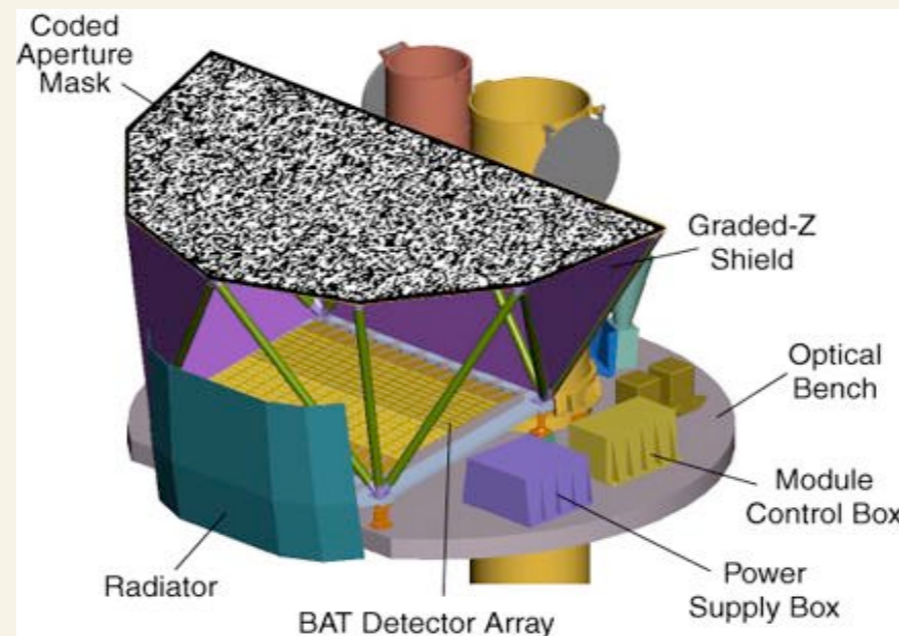
- ~ Background Estimation
 - ~ HXD: activation by protons (SAA, Cosmic Ray)
 - ~ XIS (X-ray CCD): Interactions between low-energy particles and the satellite



The Gamma-ray Burst Mission "Swift"



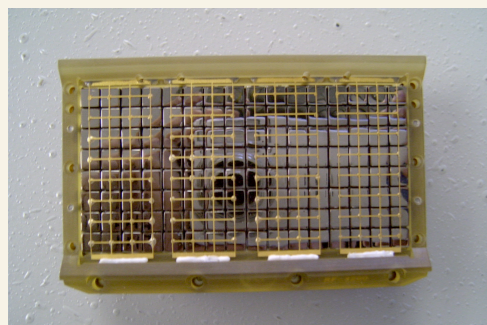
ISAS/JAXA, Saitama Univ. and Tokyo Univ. have been participating in Swift, Burst Alert Telescope(BAT).



BAT:

Coded Mask

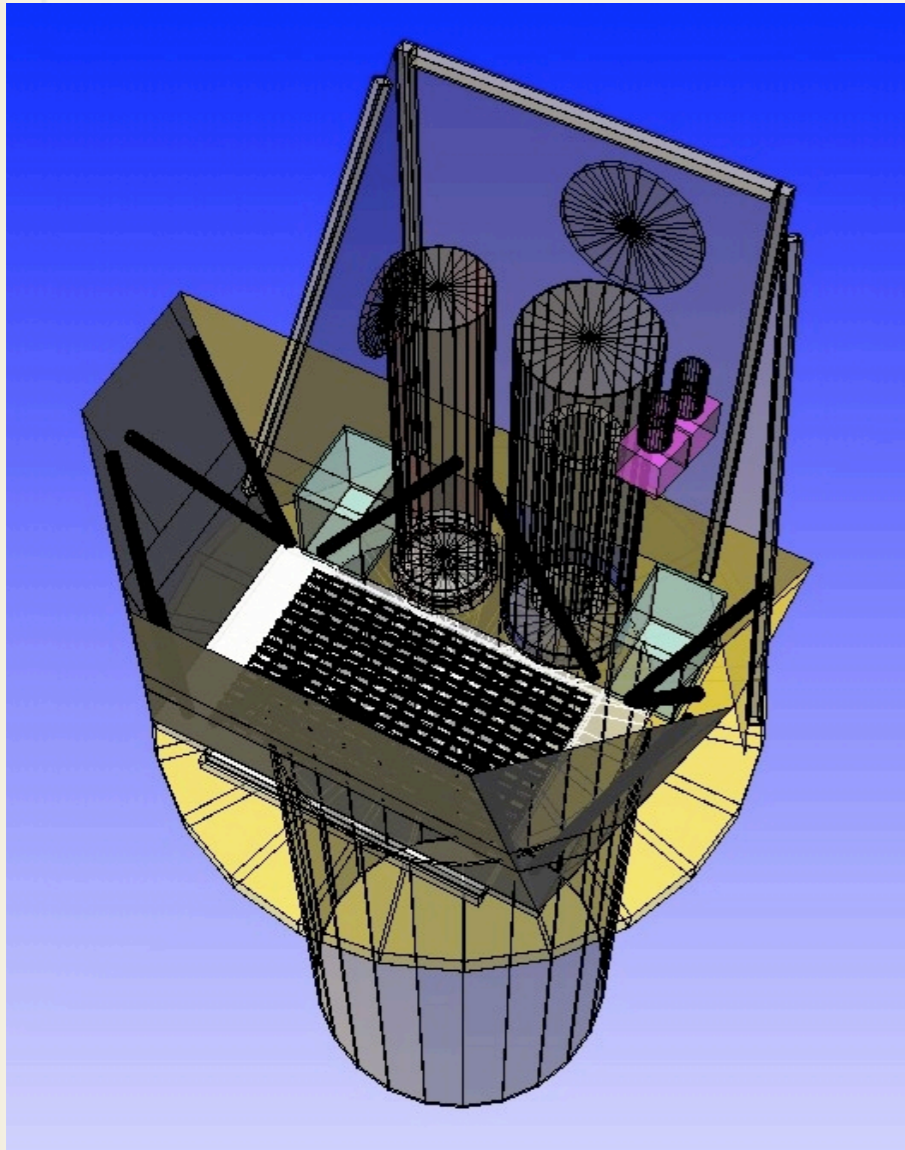
32K CZT Imager



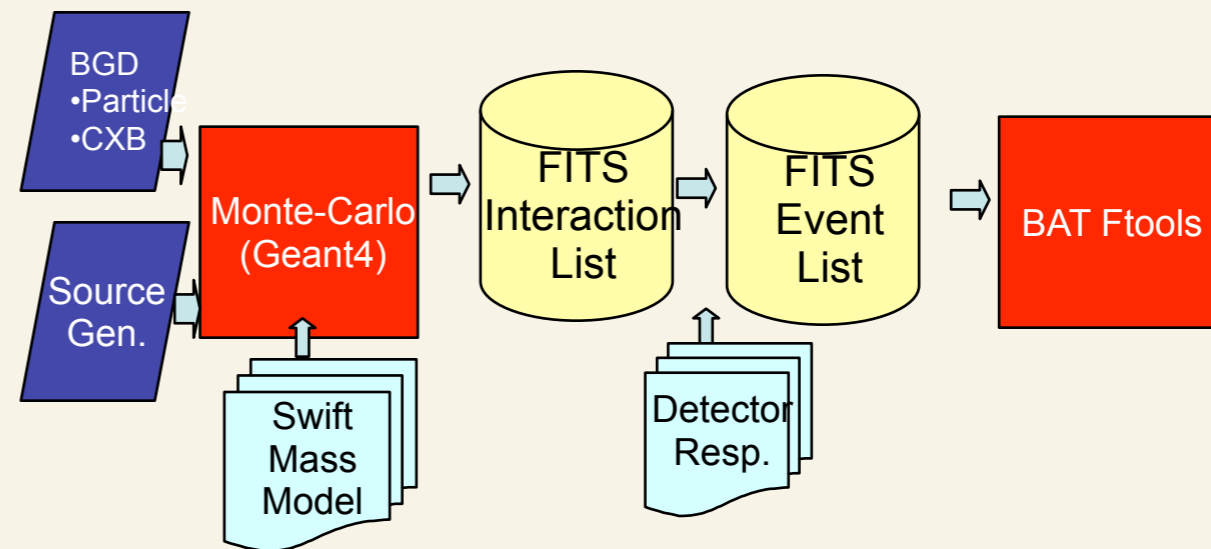
Detector Module

Ground Calibration / Analysis
Construction of Response
Monte Carlo Simulator (SwiMM)

SwiMM(Swift Mass Model)



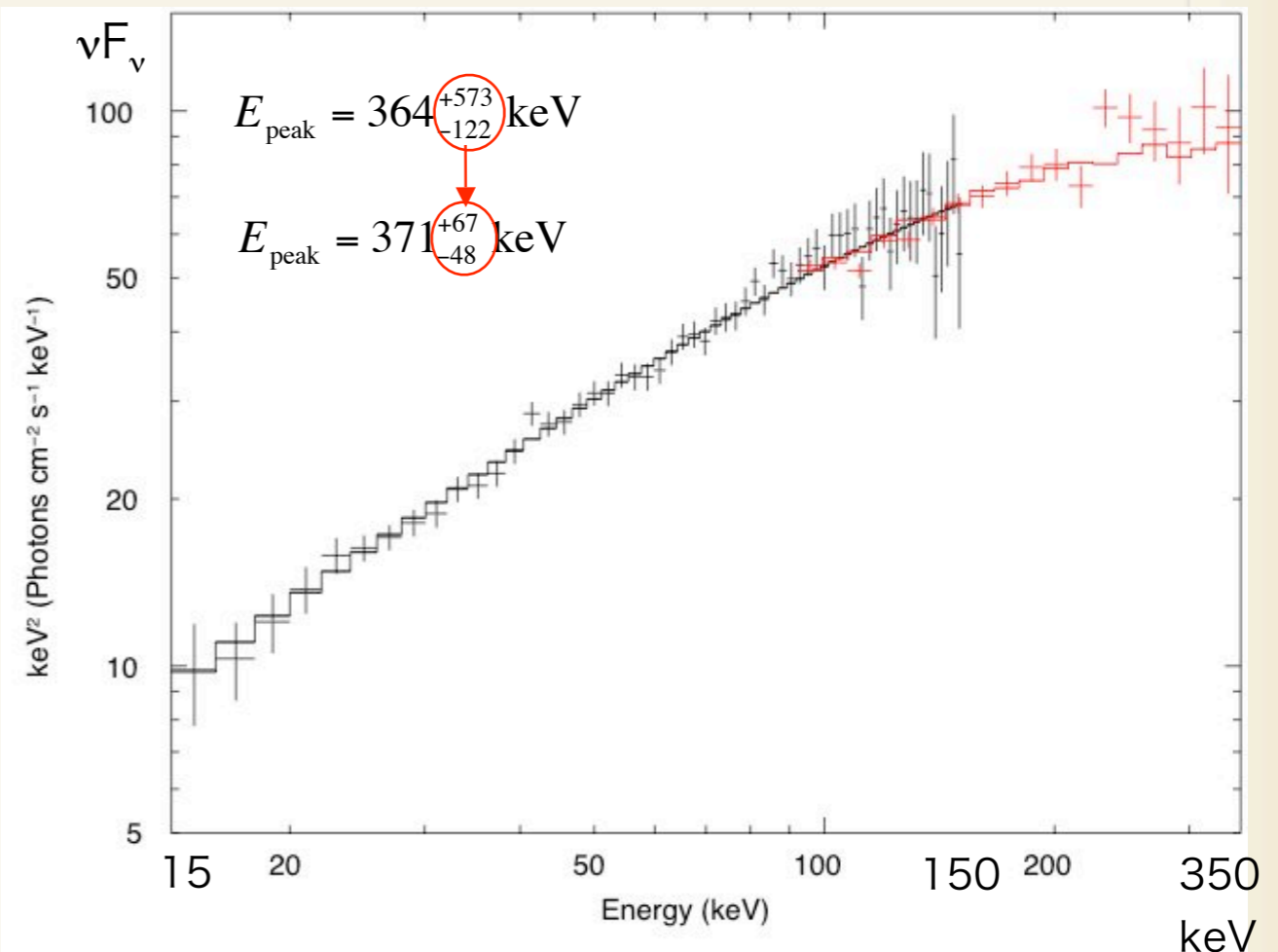
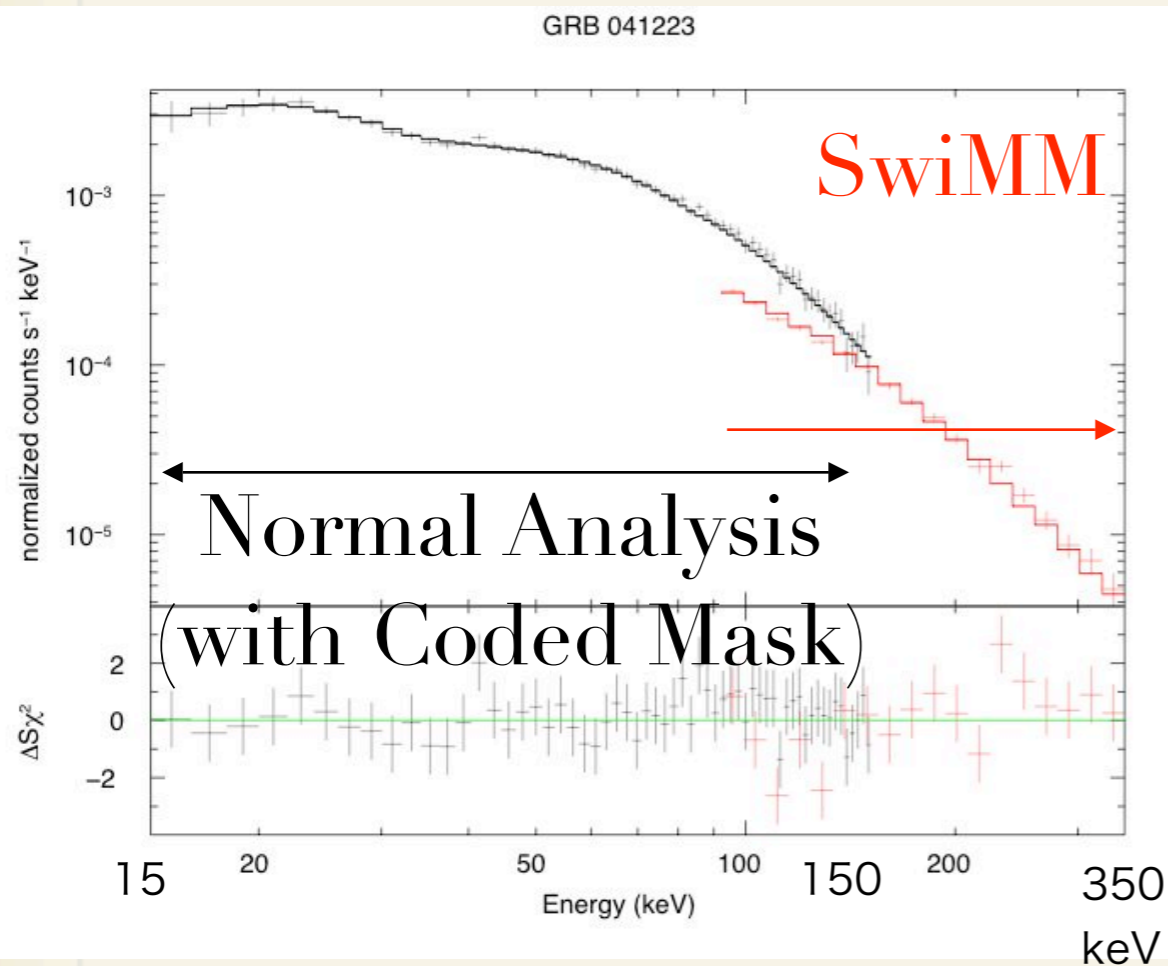
Mass Model



Example 1: Higher Energy GRB

Constructed a response for each GRB with SwiMM
-> higher energy data become available

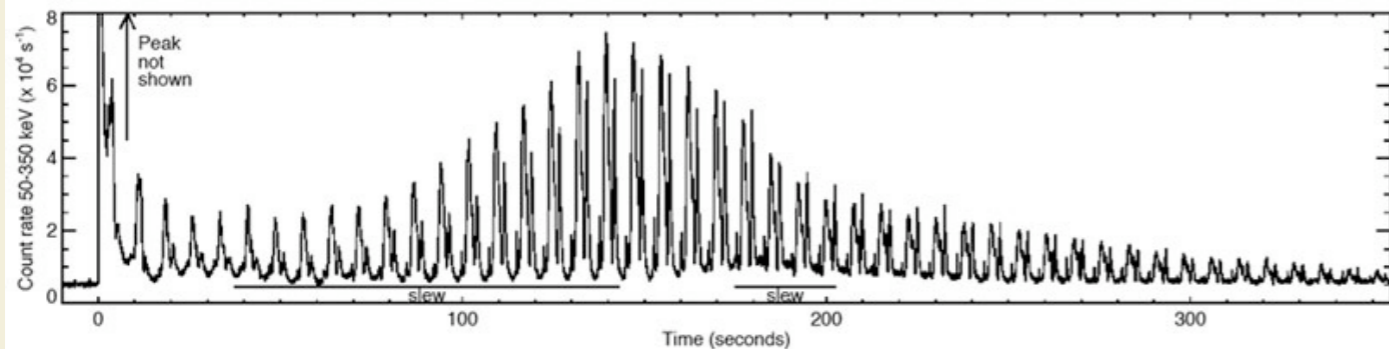
GRB041223



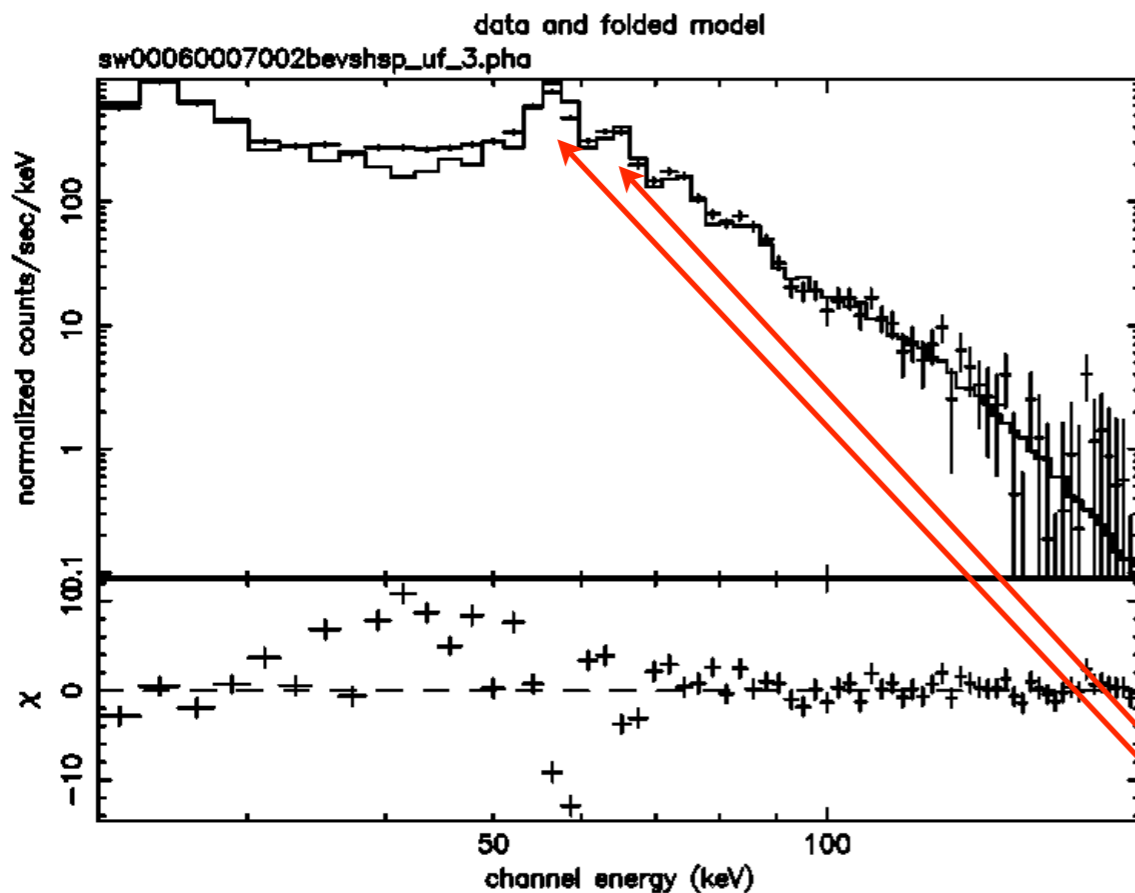
Wide-band spectra -> determinations of E_{peak}

Example 2: SGR1806-20

Giant Flare in 27 Dec. 2004



SGR1806-20
からのガンマ線
の到来方向



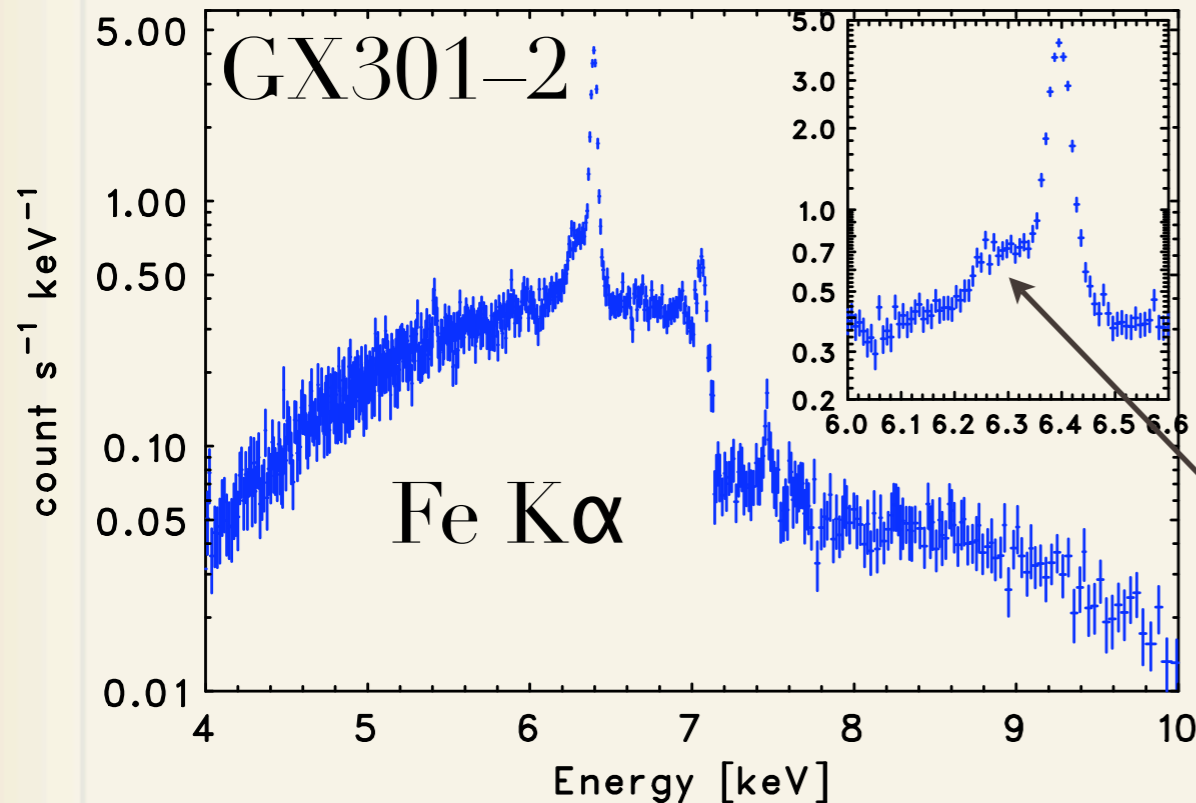
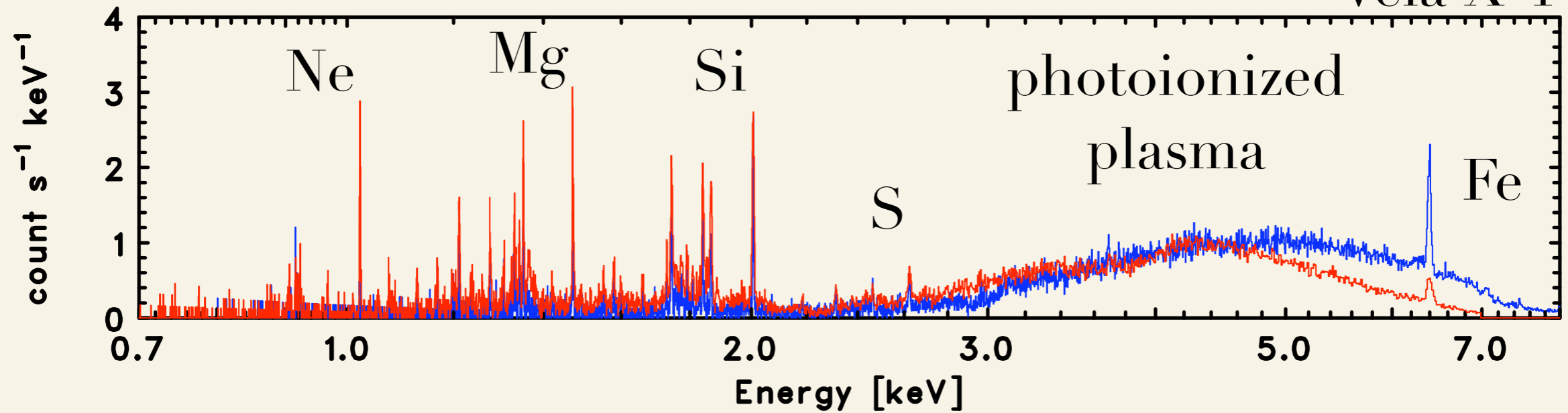
Constructed the response for
gamma-rays from out of the FOV
Calculated the energy flux

Fluorescent lines from
detectors and the satellite.

Astro Monte Carlo

Precise Measurements in X-ray Observations

Vela X-1

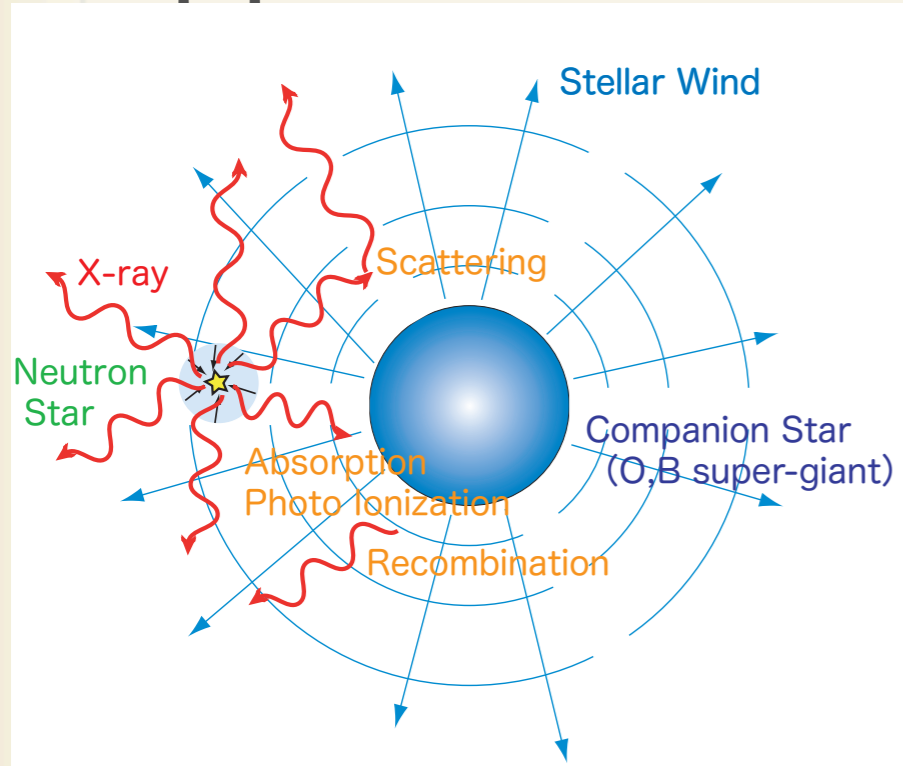


Chandra HETGS Data

simple models are not enough.
ex. uniform density, symmetrical geometry

Modeling with Monte Carlo Simulations

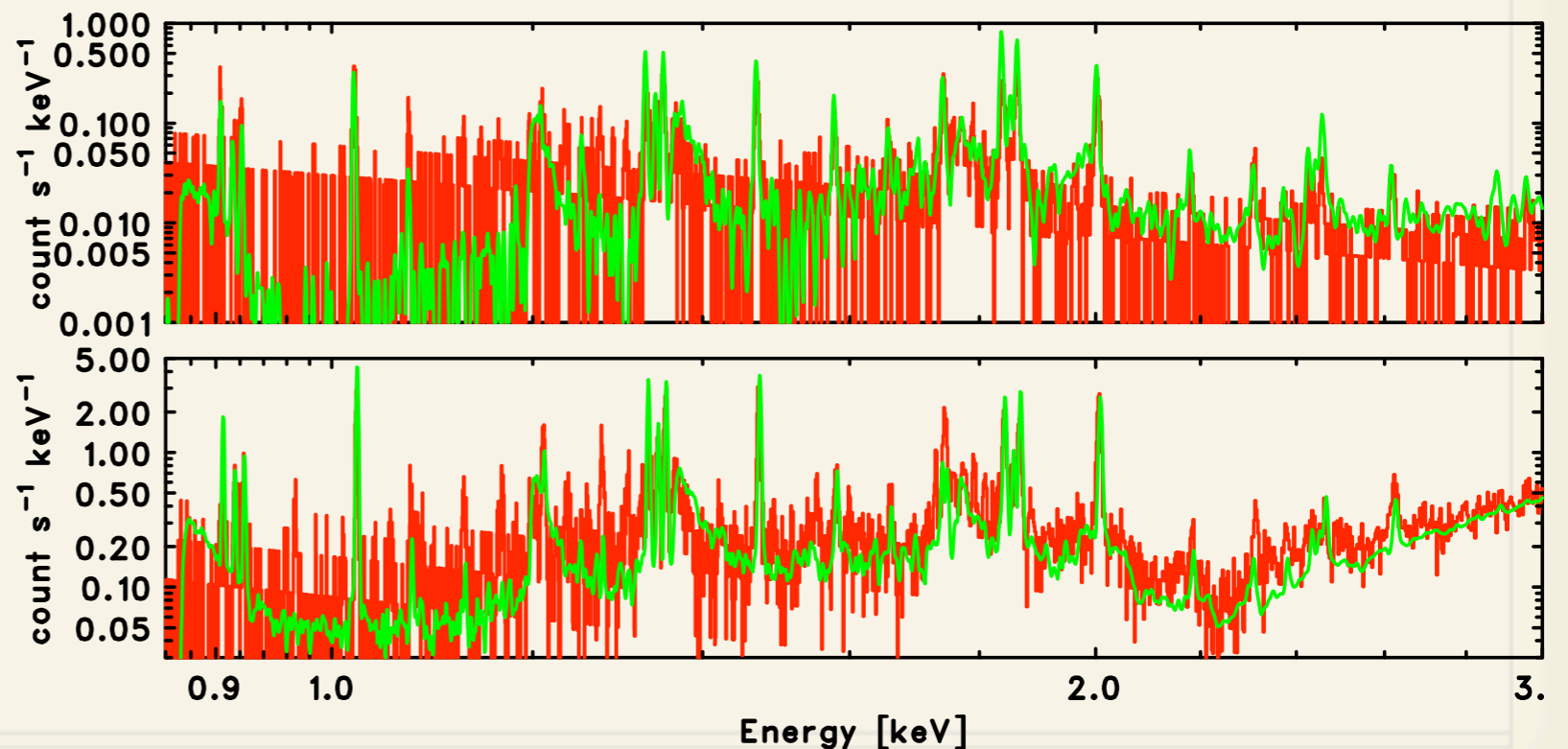
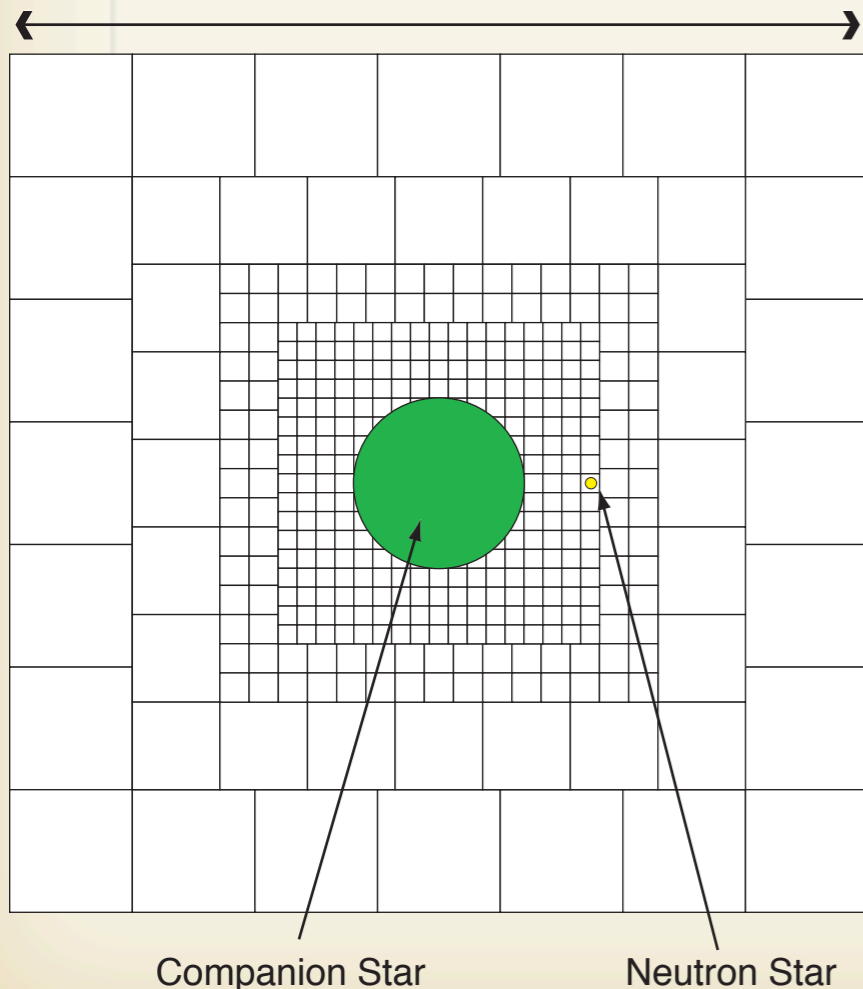
Application to HMXB (Photoionized Plasma)



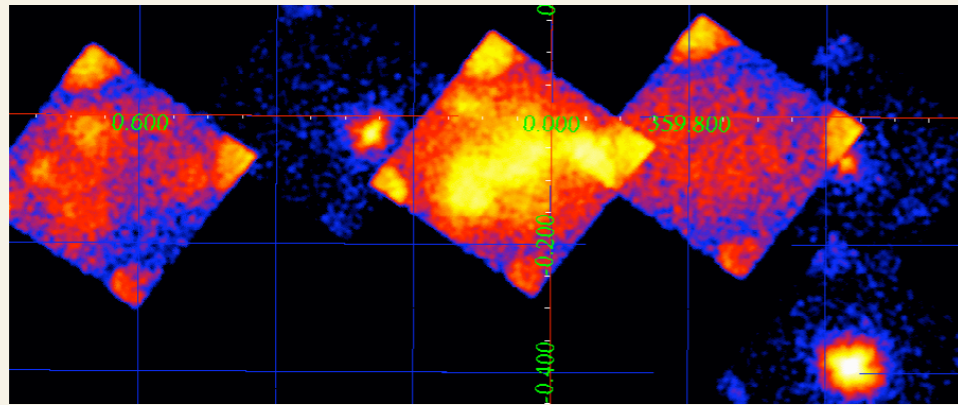
2.1×10^{13} cm

Physical Processes in Photoionized Plasmas
(H/He-like ion processes, Doppler Shift)
Large Size Geometry ($\sim 10^{13}$ cm)

Observed Data, MC Data



"Suzaku" DATA (Galactic Center)



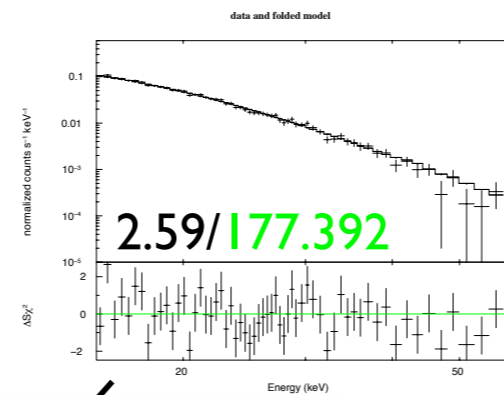
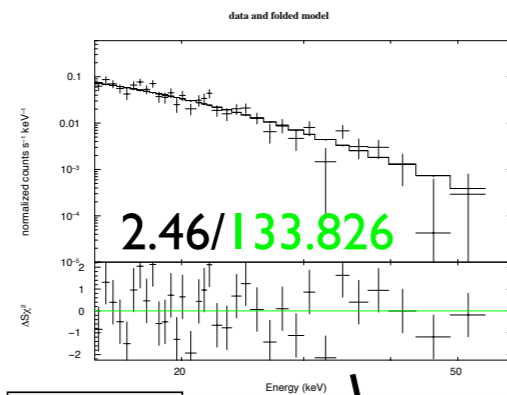
Iron K α line map

GC specs 2

Γ / Flux (10-12erg/cm2/s)

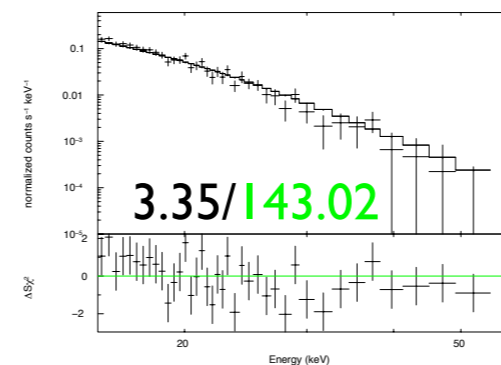
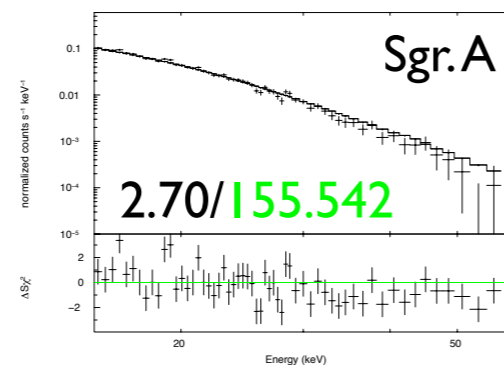
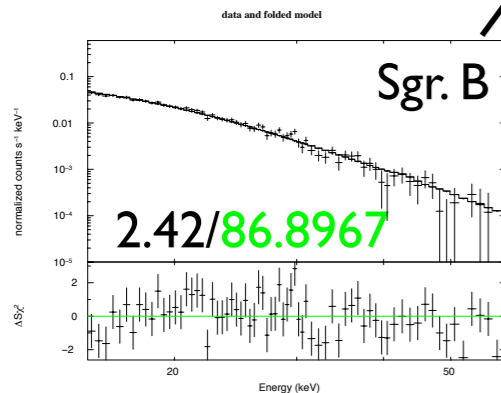
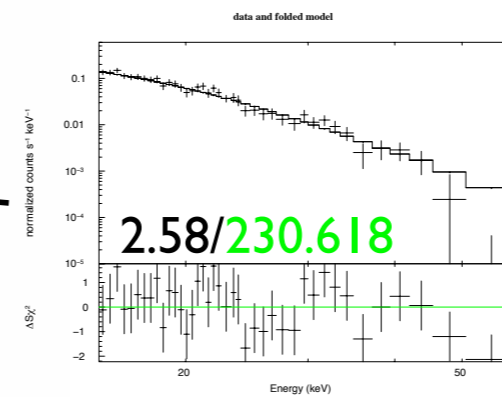
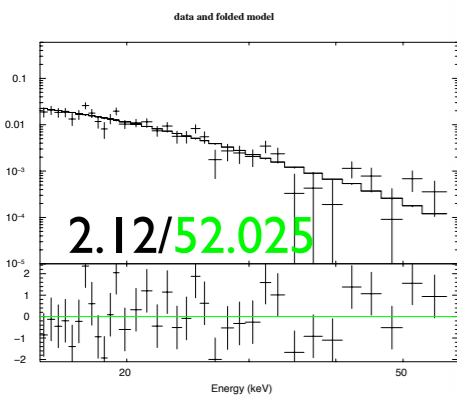
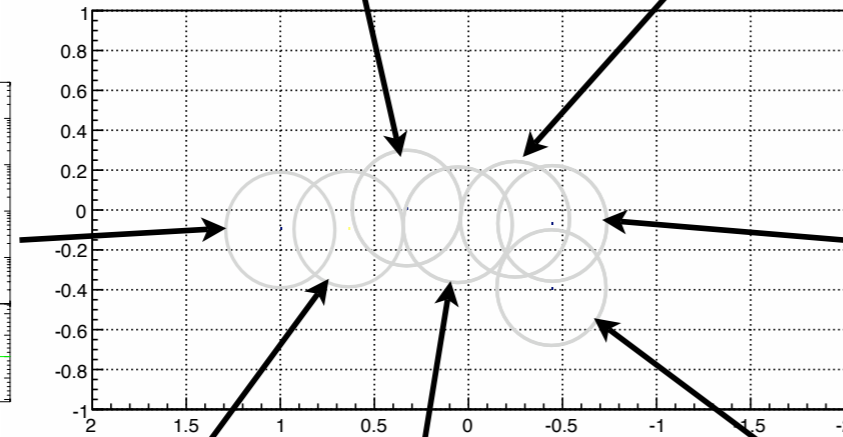
20-50keV

model:pegwrlw



Hard X-ray map 20-50 keV

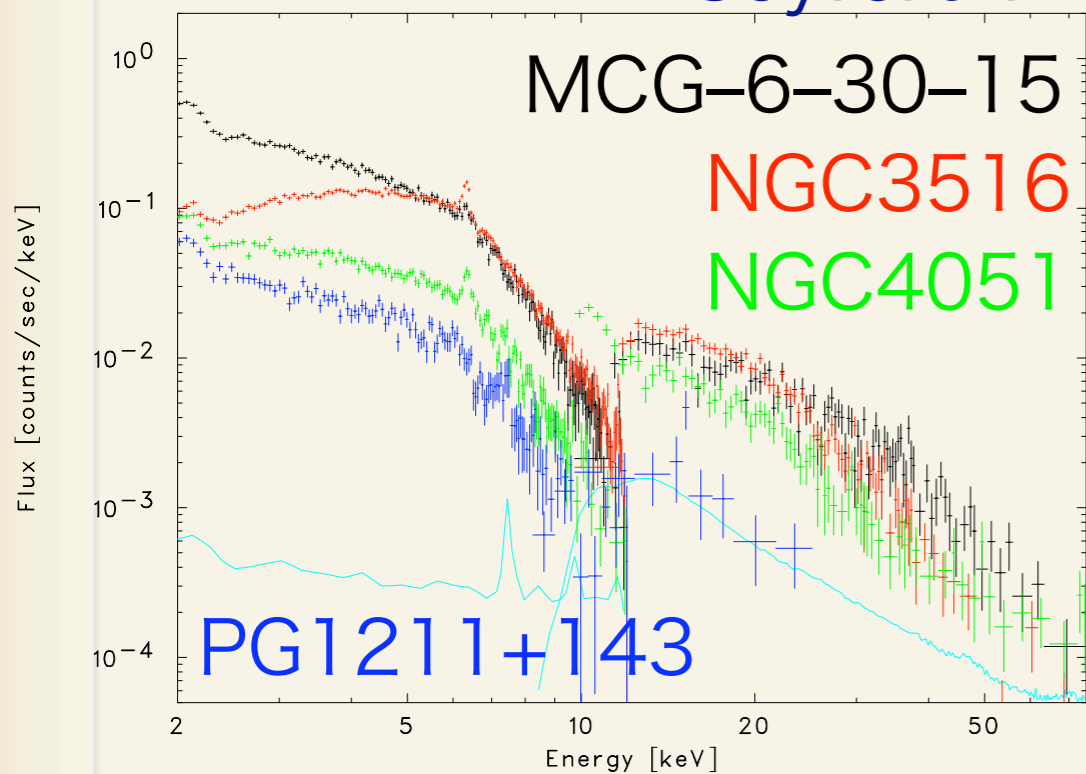
galactic plane



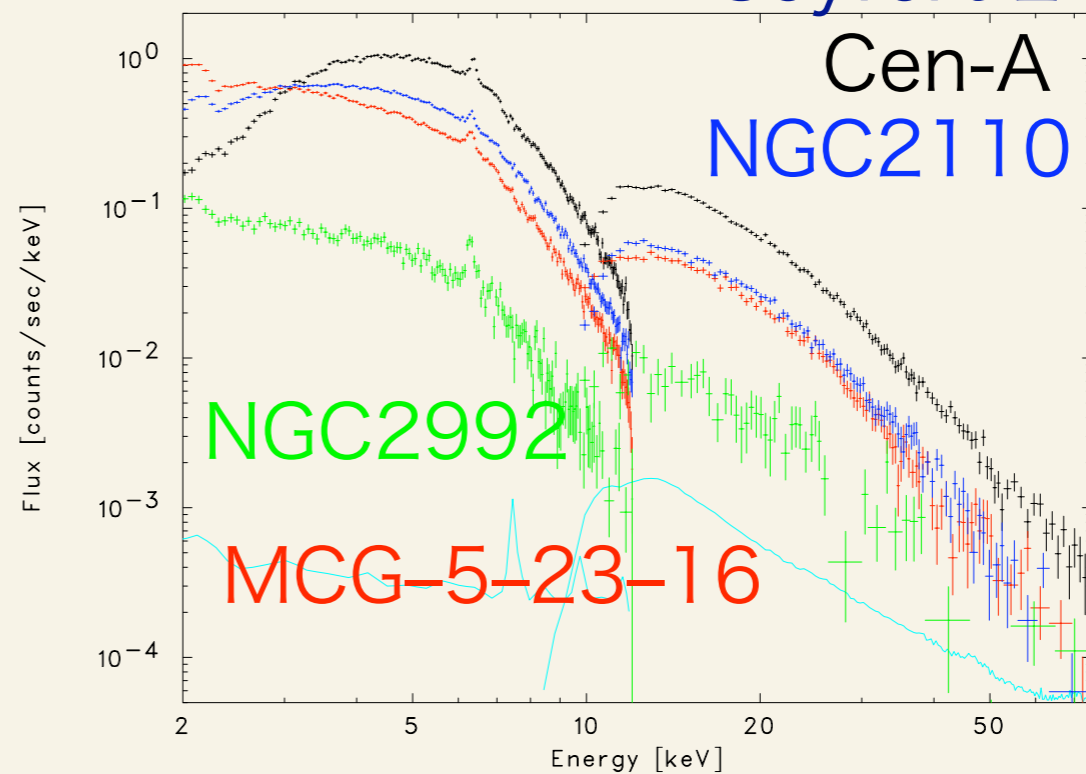
"Suzaku" DATA (Active Galactic Nuclei)

Black Hole?, Accretion Disk?, Torus Cloud?, Jet?

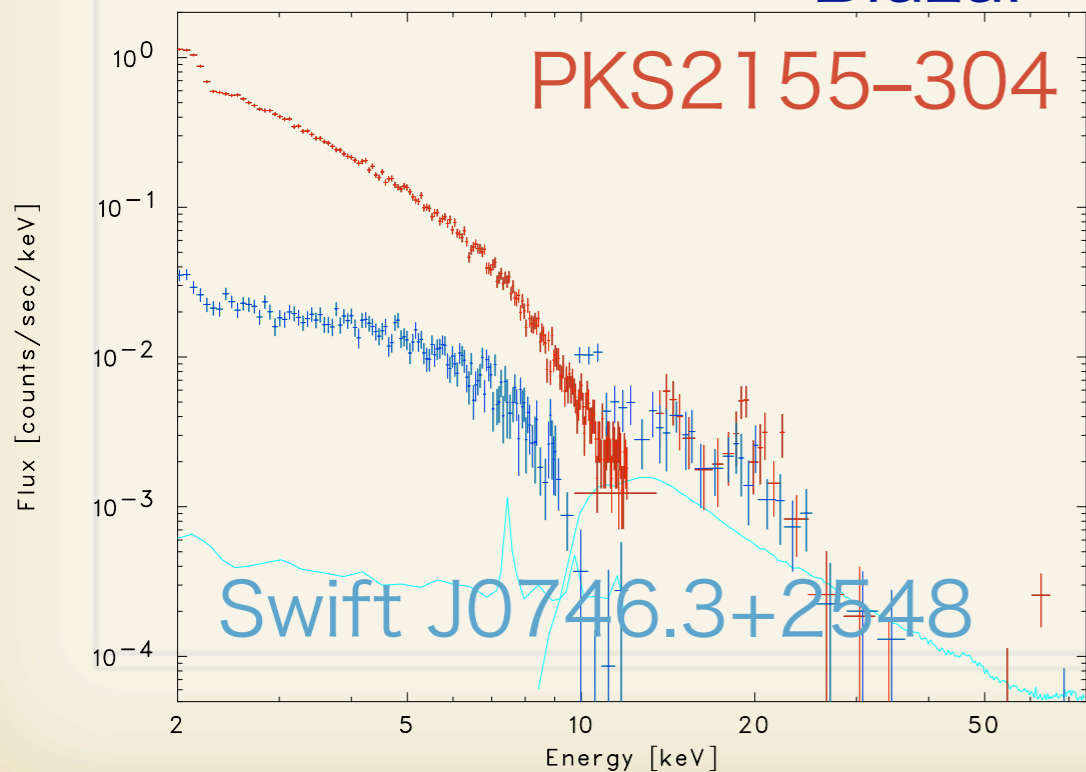
Seyfert 1



Seyfert 2



Blazar



strongly absorbed Seyfert 2



Summary

- ~ Geant4 Application to X/ γ -ray Observations
- ~ Instrument Response
 - ~ Suzaku(HXD)
 - ~ Swift (BAT)
- ~ Modeling X-ray Spectra from Astrophysical Objects
 - ~ HMXB, Photoionized Plasma
 - ~ (Future) Suzaku data

Our Computer

