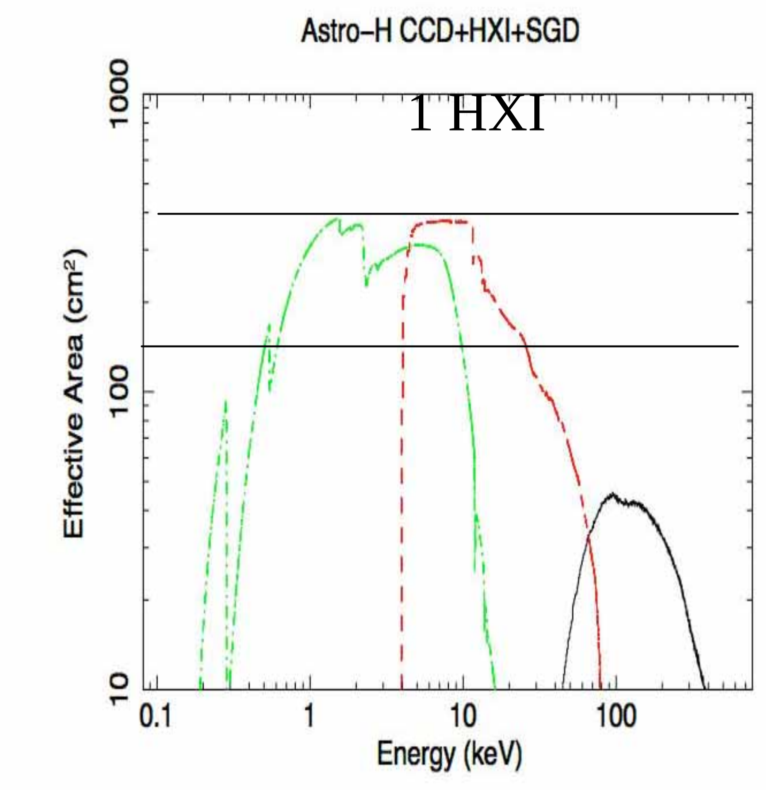
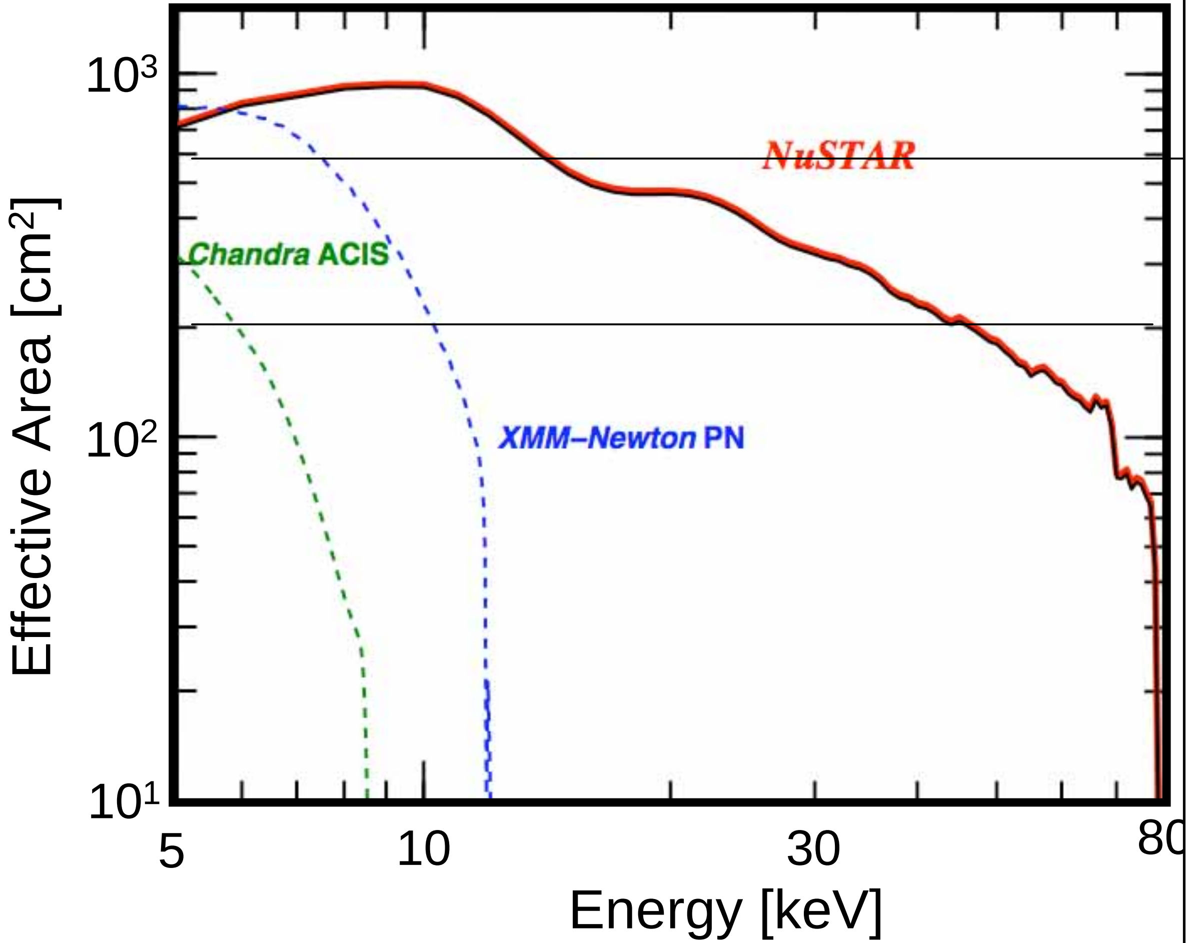
NuStar has similar area 20-80 keV, Astro-H better at E> 80 Kev





NuStar and Astro-H HXI should have similar FOV

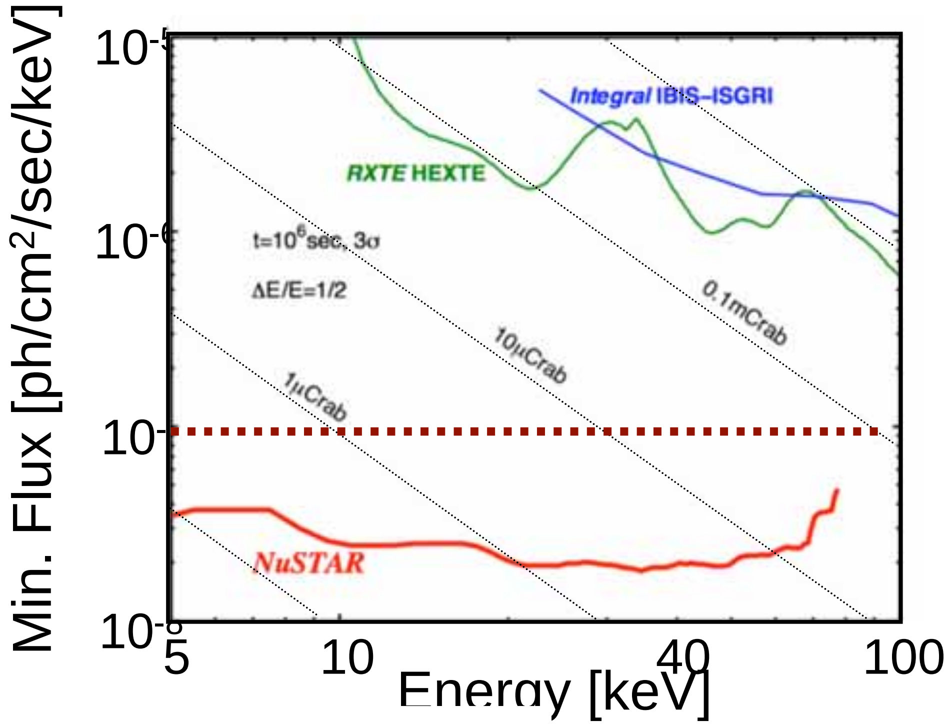
HXI becomes background limited at $3x10^{-14}$ (source 5% of bgd)

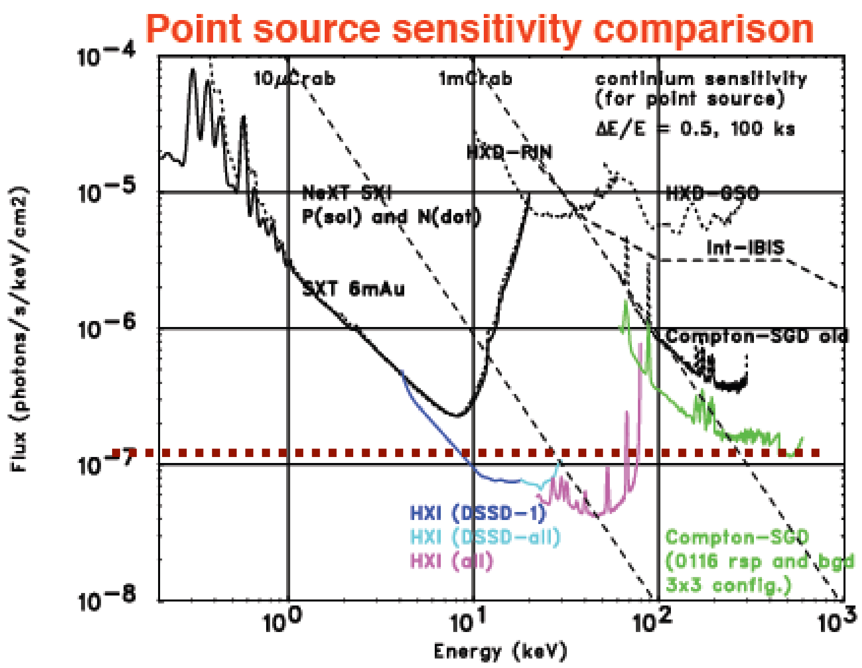
Nustar similar sensitivity(5 uCrab-$3x10^{-8}$ ph/cm^2/sec at 40 keV))

As of last week NuStar in equatorial orbit- will have lower background

Astro-H/Nustar Sensitivity

- Aug 2011 launch will be significantly ahead of Astro-H
- Much of Nustar science will be surveys- no conflict with Astro-H
- We should learn whether extended hard sources exist and their properties to design better observing plans.

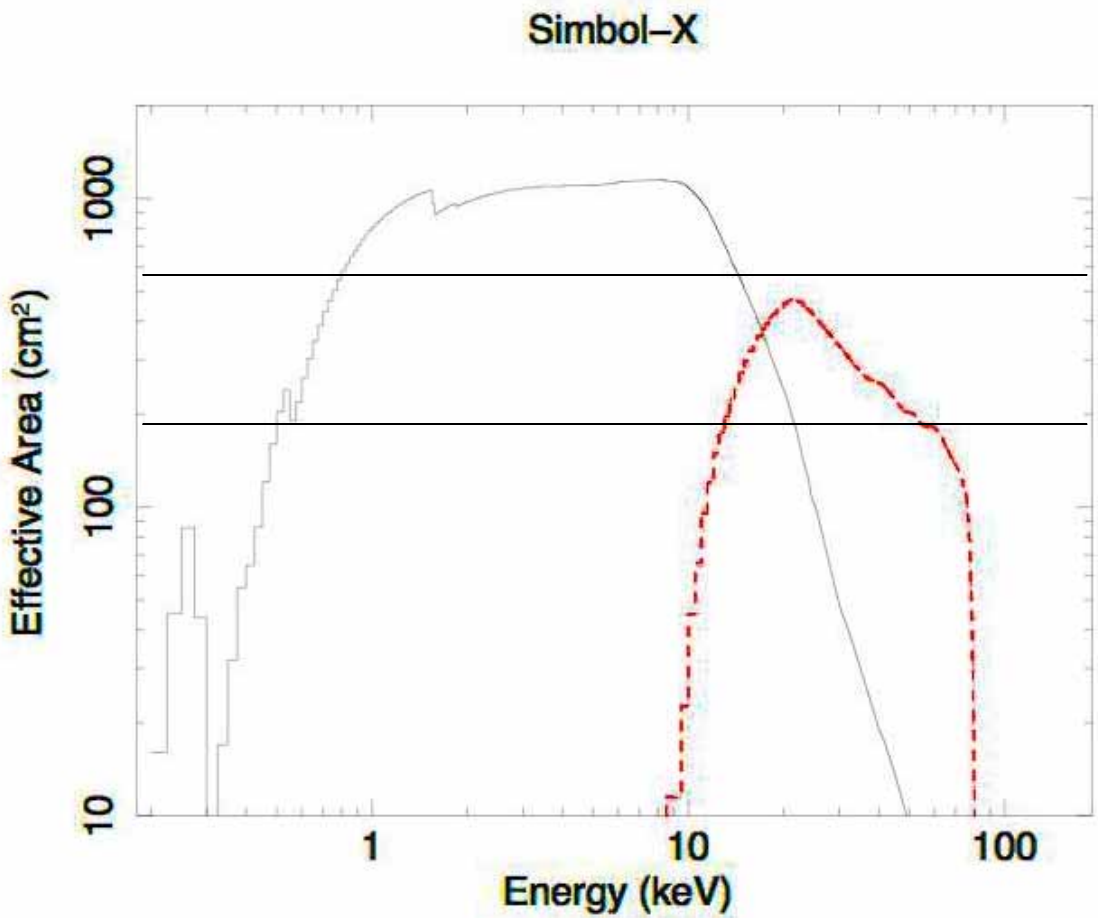




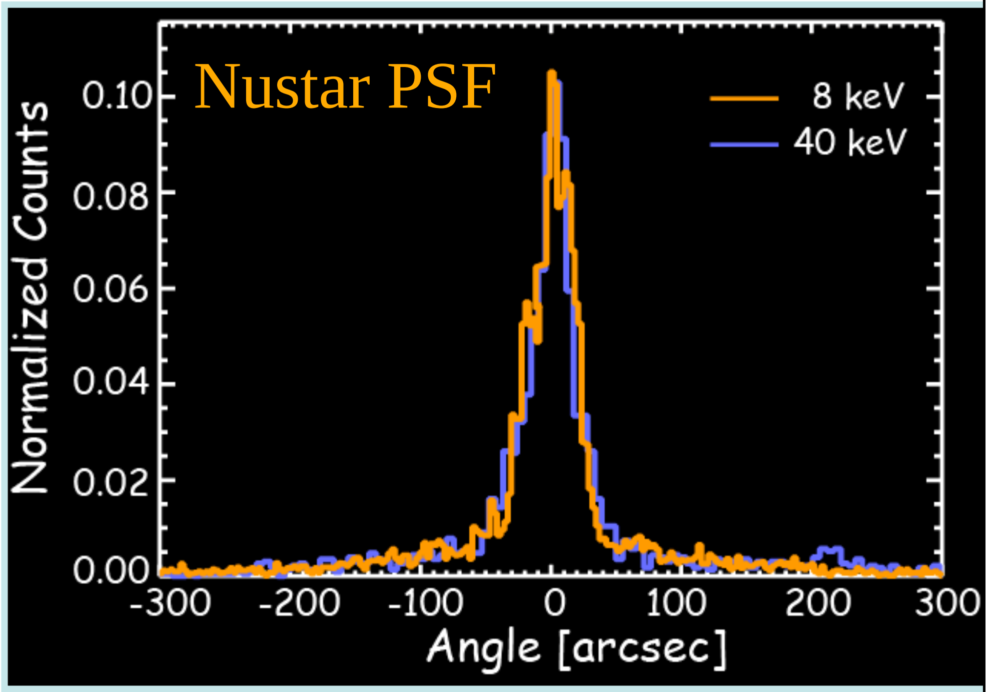
H. Tajima, NeXT SGD SDR, March 19, 2008

Simbol-X

- Has similar collecting area in hard band as Astro-H and Nustar- much more ‘CCD’ area 1-10 kev.
- Does not have soft response of Astro-H.
- Mission operations may be difficult due to ‘station’ keeping mode- long exposures (time variability)



- NuStar will have ~40” FWHM (or better optics; 80% of energy enclosed within 2’).
- Need to compare Astro-H HXI with NuStar angular resolution (e.g. use same metric)
- So if Nustar has similar or larger collecting area and similar or better angular resolution- phase space for Astro-H has to be
  - SGD to go to higher energies
  - Calorimeter and CCD to go to lower energies.
- simulations with just the HXI show that reflection models can be constrained with exposures of 100ks at f(x)~10^{-11} - adding in the CCDs reduces the errors- SGD adds a lot to measurement of high E cutoff
- critical issues like the Fe abundance and relationship of the Fe K line to reflection will not be answered by NuStar
- Nustar may focus on survey science



Phase space for AGN science with hard rays on Astro-H

- time variability (also Simbol-X)
- connection of continuum and spectral features (calorimeter)
- Measurement of high E cutoff (SGD)

Angular resolution vs CCD collecting area

- Given the vast amount of 0.5” Chandra Imaging and 15” XMM imaging is ~1” imaging with Astro-H CCD interesting
- Yes:

Lower background than XMM or Chandra and better energy resolution have shown on Suzaku that good science is there to be done.

Will Astro-H do better than Suzaku?

Yes at E< 1 kev and E> 8 kev **if** mirror has sufficient collecting area.

Hamamatsu CCD seems to be very good at E< 1 kev - main science was what we did in early Suzaku observations ISM in MW and other nearby galaxies and other soft targets (black holes in high state)- is there enough of this to be interesting?

At E> 8 kev is CCD interesting given the existence of the HXI?

CCD has larger Ω than XMM 37’ (1,370 sq arc min) vs 15’ radius (circular) 700 sq arc min

Better Angular Resolution Science

- High z cluster temperature profiles- at z>0.2 clusters too small for Suzaku- need high E response since these objects are hot
- Supernova shocks- sharper imaging required - need High E response
- Soft SNR (e.g.Cygnus loop) need soft response
- Fe K knots changing near GC
- Binaries in nearby galaxies- soft +hard response needed * (to do better than XMM)
- Is source 'contamination' an issue? (e.g. calorimeter is looking at weak diffuse emission near a bright source or regions with multiple sources inside PSF of calorimeter mirror)- if separation less than 2' yes

Cluster and SNR science benefit from the lower background of Astro-H compared to XMM

IF better angular resolution mirror has ~1/2 collecting area of foil optic what do we lose

•timing (but have XRS+HXI, is this important; (bright sources)

•Connection of spectra to HXI ?- is resolution of CCD at E>8 kev needed?

•Fewer soft photons for large extended objects (e.g. GC, plane)

Examples Of CCD Science with Astro-H

- As shown by Suzaku wide field, low background, good energy resolution with CCD can do
  1) soft x-ray background 2) charge exchange in solar wind
  3) comets 4) soft excess in clusters- need CCD to define ISM for calorimeter (Tamura et al A2052)
  5) galactic ridge, 6) soft SNR (Puppis, Cyg loop etc)
  – etc

ISM spectra
Shelton et al

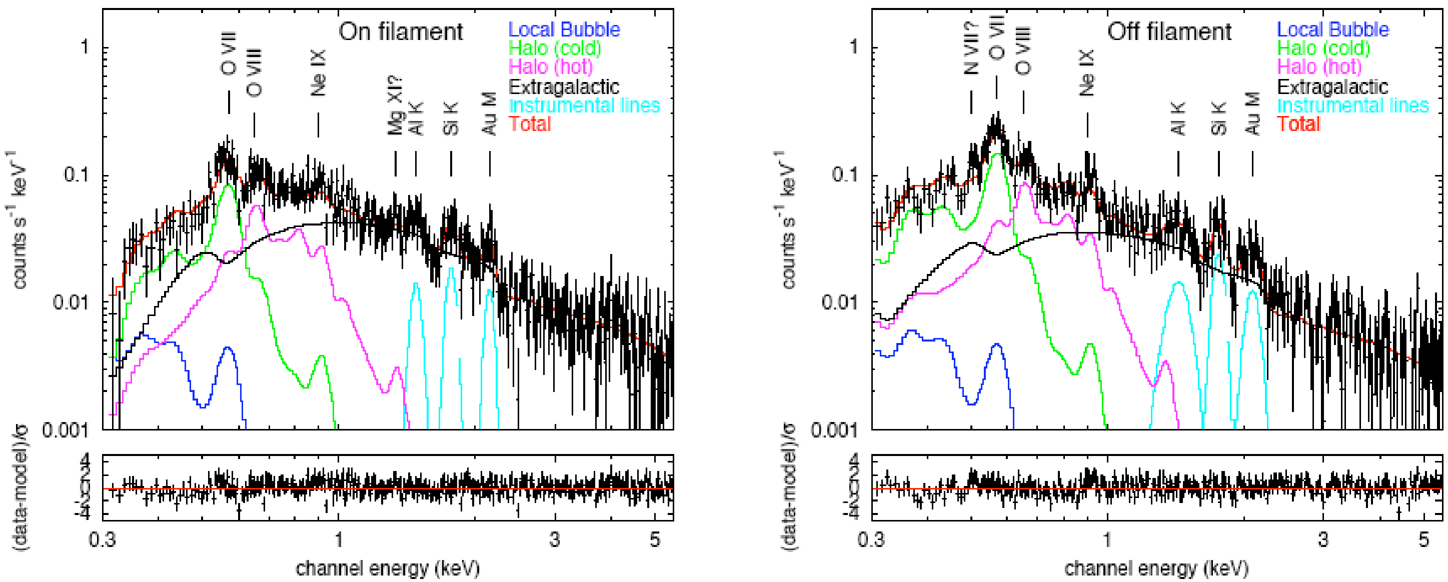
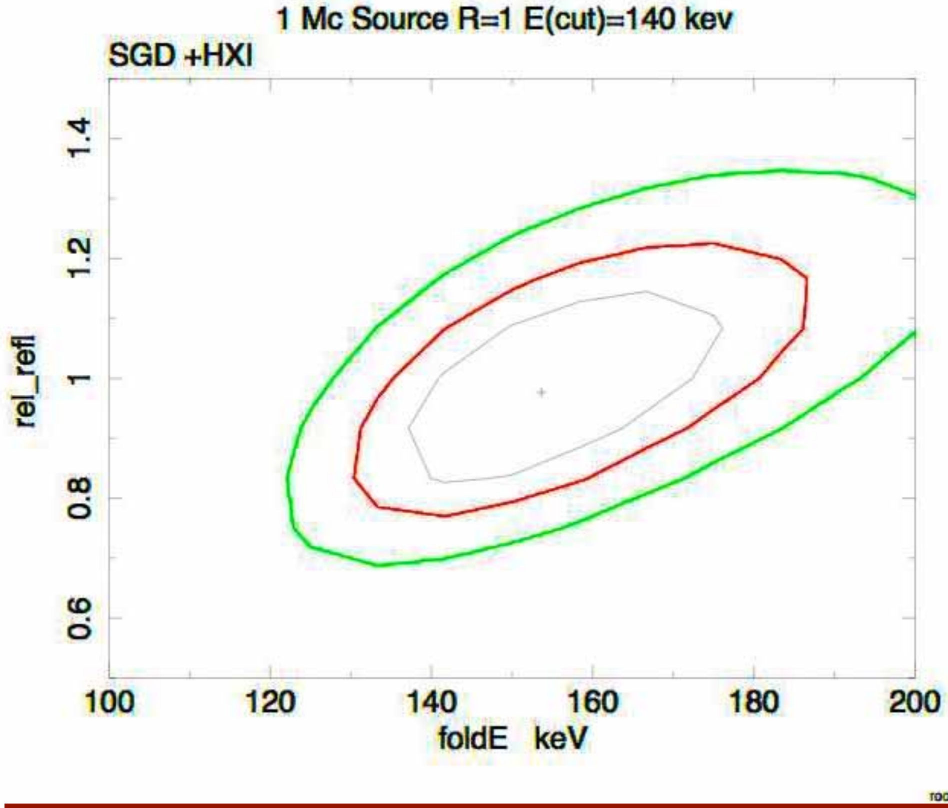


FIG. 3.— Our observed on-filament (*left*) and off-filament (*right*) *Suzaku* spectra, with the best-fitting model obtained by fitting jointly to the *Suzaku* and *ROSAT* data (Model 1 in Table 7). The gap in the Si K instrumental line is where channels 500–504 have been removed from the data (see §2).

SGD

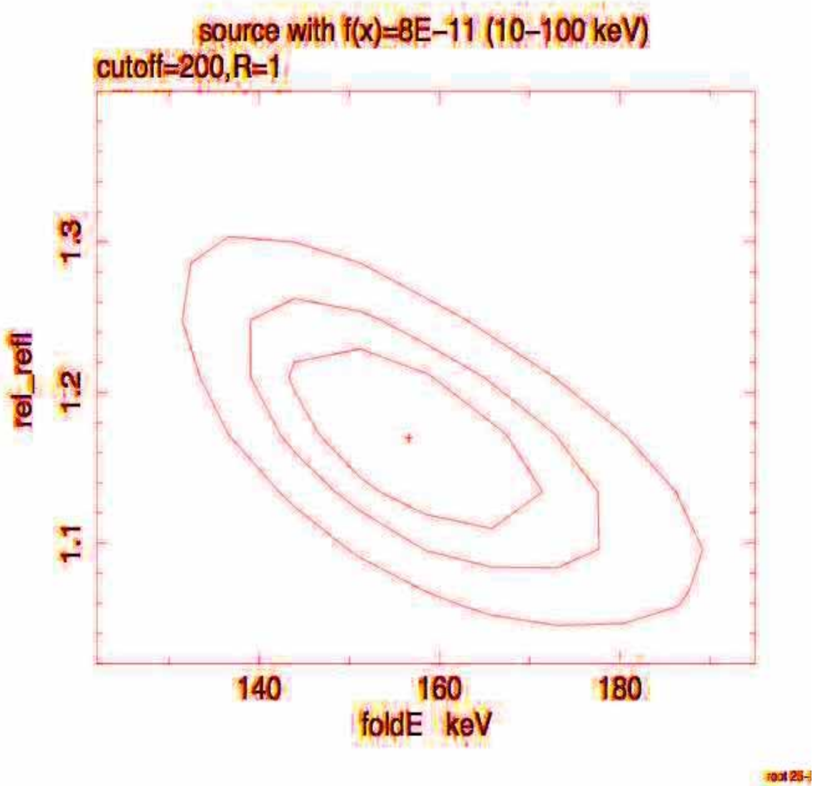
- The SGD matrices sent out last week show a MAJOR improvement in sensitivity compared to the NeXT SGD.
- There are now many 10's of AGN which can have their cutoff energies determined as well as HESS sources and x-ray binaries- e.g. SGD can detect them to >200 kev
- Increased sensitivity may make a major difference in search for Fermi source counterparts (require spectral continuity between SGD and HXI)

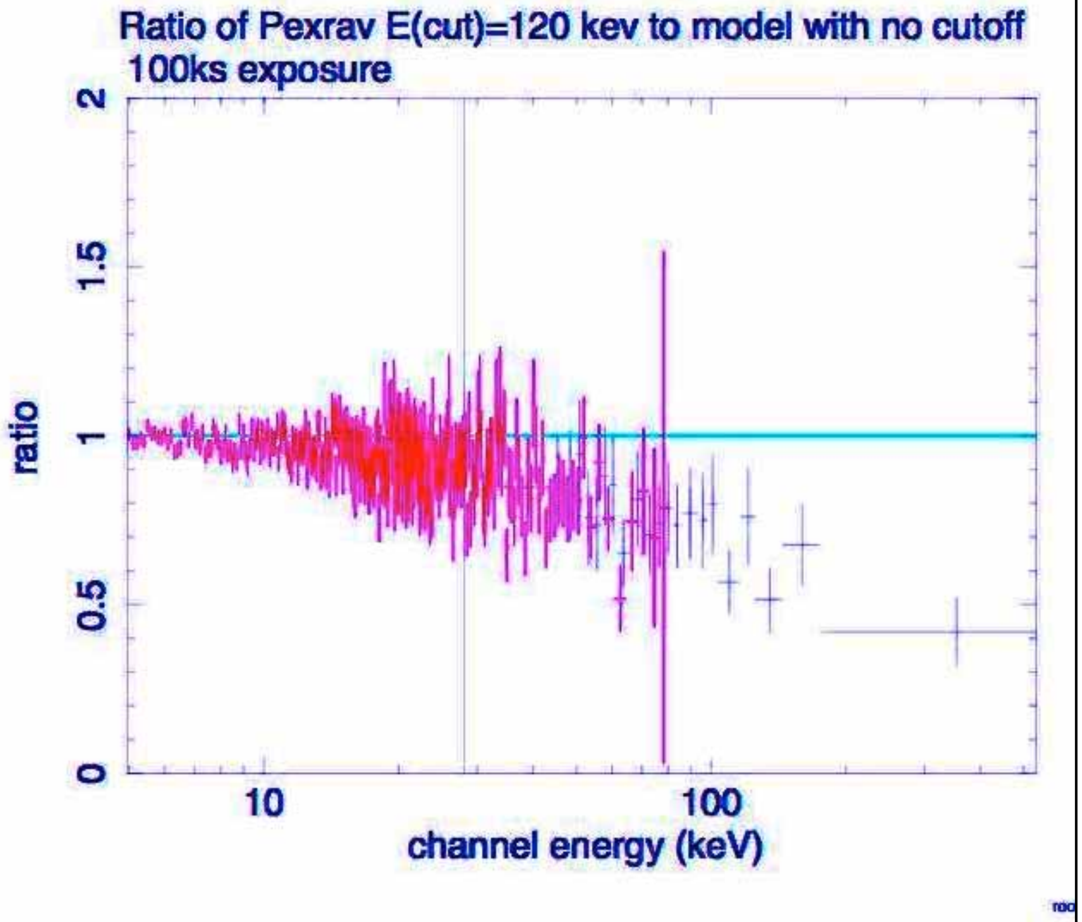


Allow first sensitive search for time variability in E>50 keV band.
2 mC source (10-100 keV) will give 1.2×10^{-2} cts/sec and be at 30% of background. Thus timing at the 5ks level is achievable!

SGD Continued

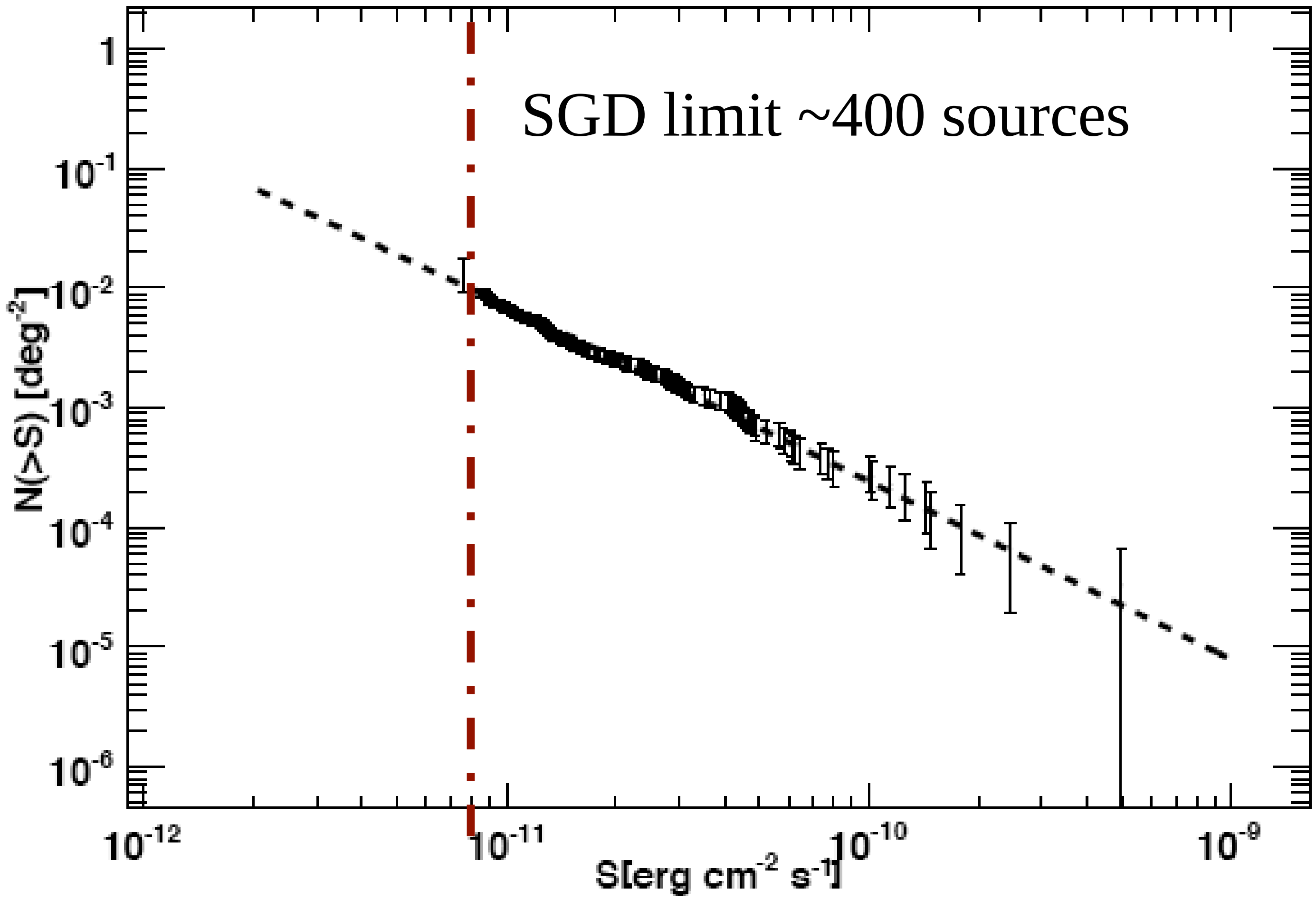
- Good signal to 200 kev for a AGN like spectrum, 2mC with reflection model.





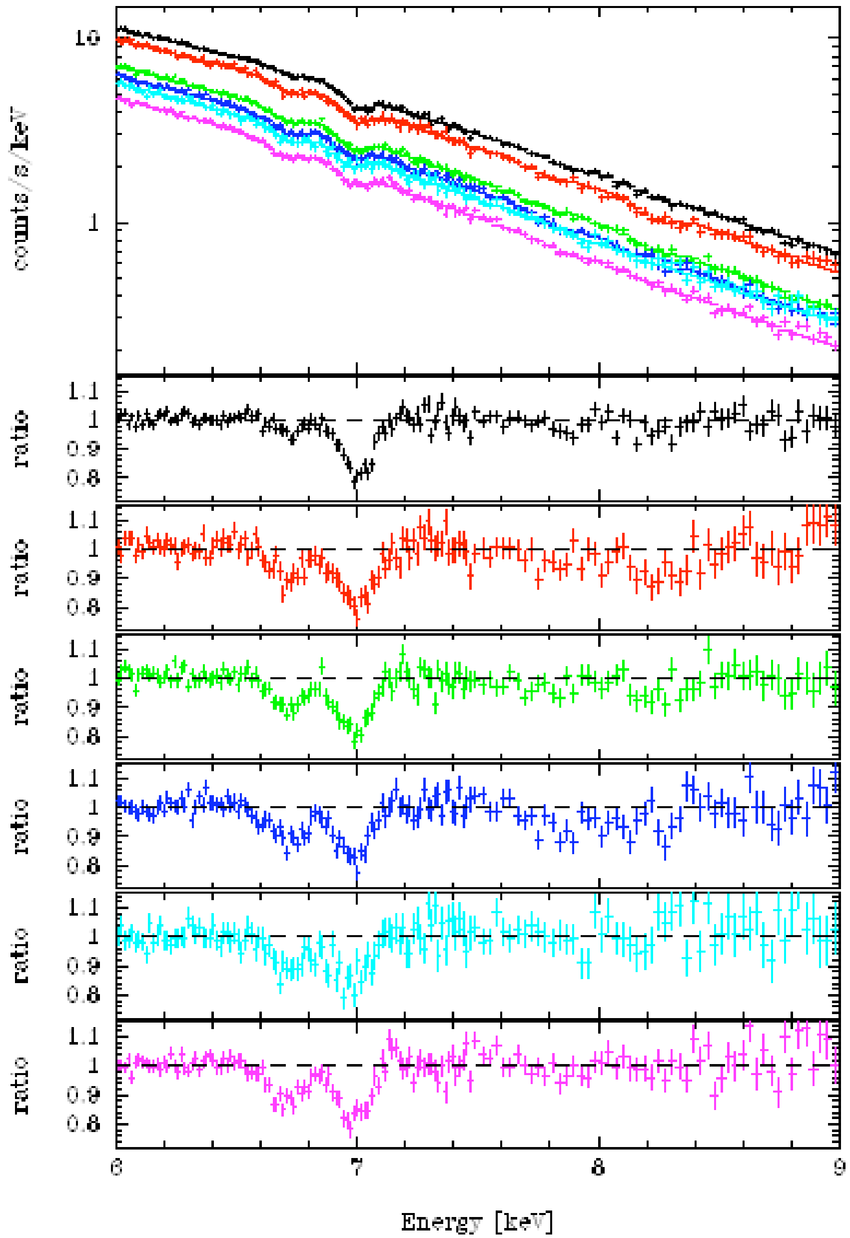
Source confusion issues for hard x-rays.

- Based on BAT log N-log S M. Ajello, et al 2009
- There will be 40 srcs/deg^2 at background limit of Astro-H- to avoid confusion one needs an angular resolution of <1' - Astro-H will be confusion limited.



Pile Up

- As Kaastra showed yesterday- this is important for Galactic BHs and bursters (NS eq of state)
- In CCD 100mC ~450 cts/sec, in XRS ~350 cts/sec
- Is high resolution of XRS required or can 10 ev suffice ??- e.g. does rotation or Compton scattering intrinsically broaden lines?)
- Do we need the filter wheel or is offset pointing, analysis of events in wings of PSF enough??
- Do we need CCD as well as XRS for these bright sources (more counts for analysis of spectral/timing signatures)
- Remember HXI goes to 5 keV what are its count rate limits.



Kubota 4U1630 Suzaku data