Seeon, June 2007
Obscured AGN Across Cosmic Times

Obscured AGN in the Chandra Deep Field South

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Deep X-ray Surveys: some open issues

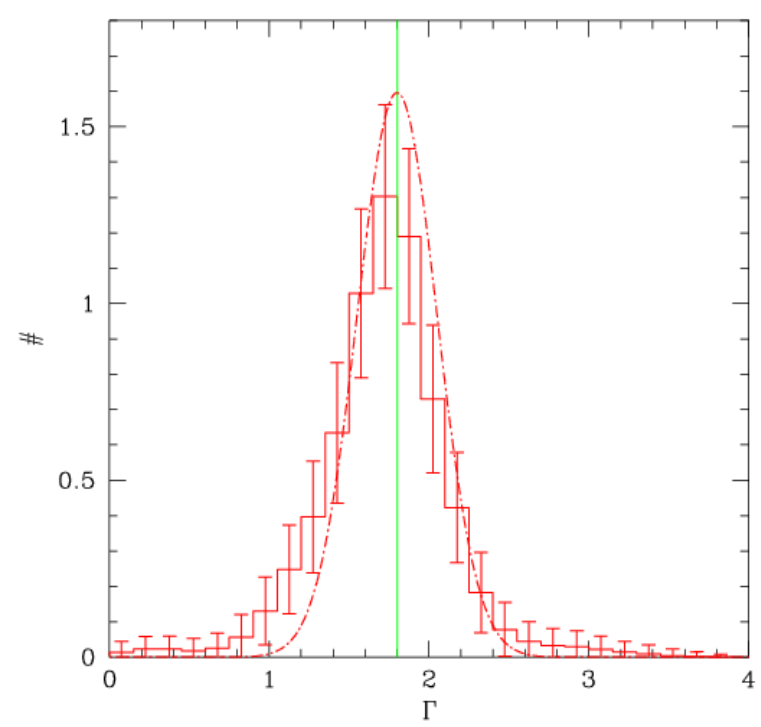
The distribution of intrinsic absorption among AGN
(the nature of absorption and the AGN evolutionary sequence)

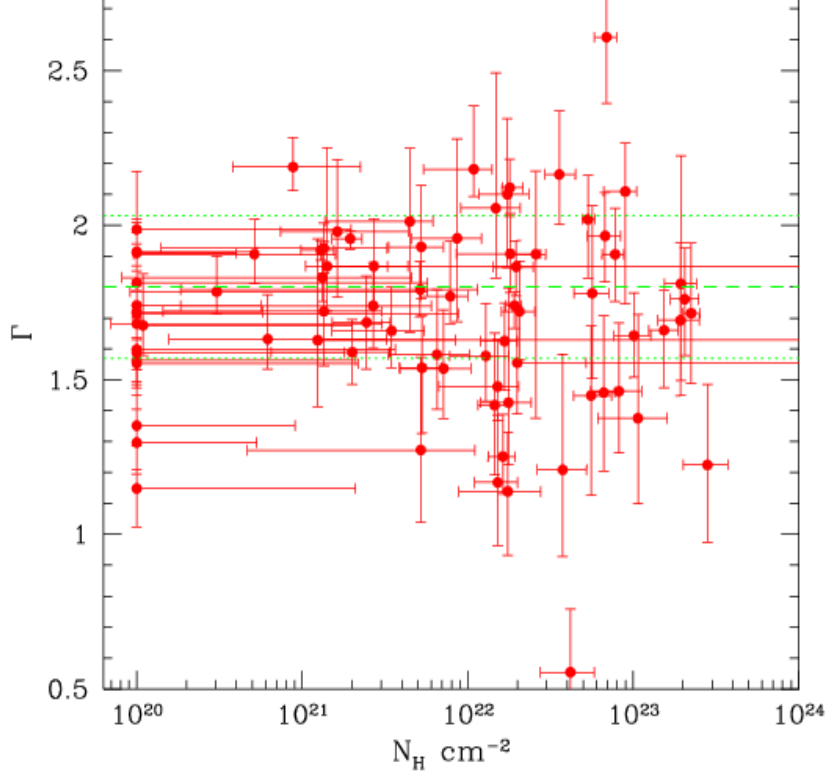
Detection of Compton-Thick AGN
(the complete census of SMBH growth)

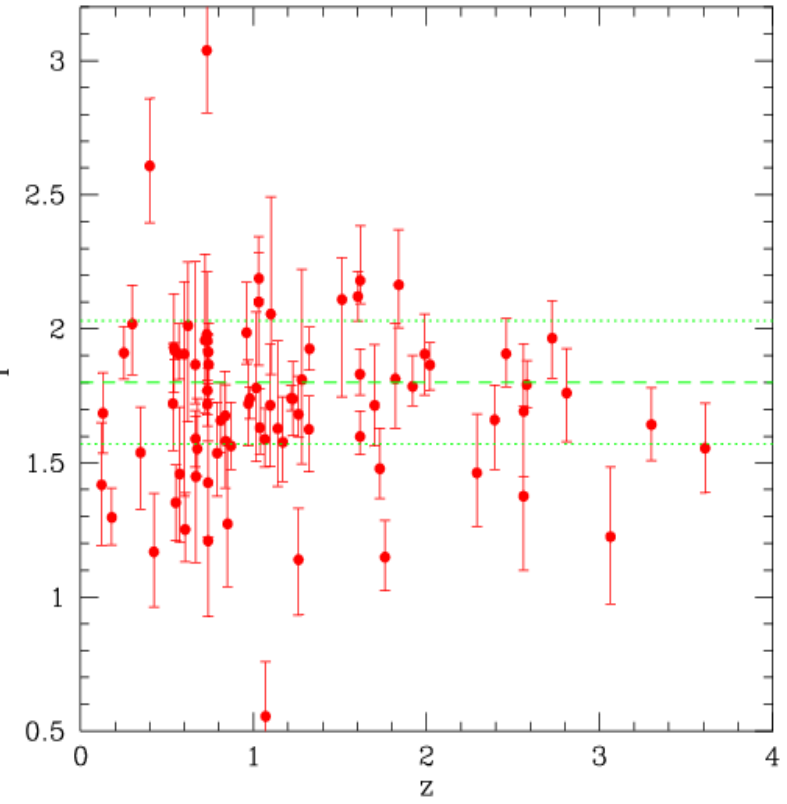
The unresolved fraction of the XRB at high energies

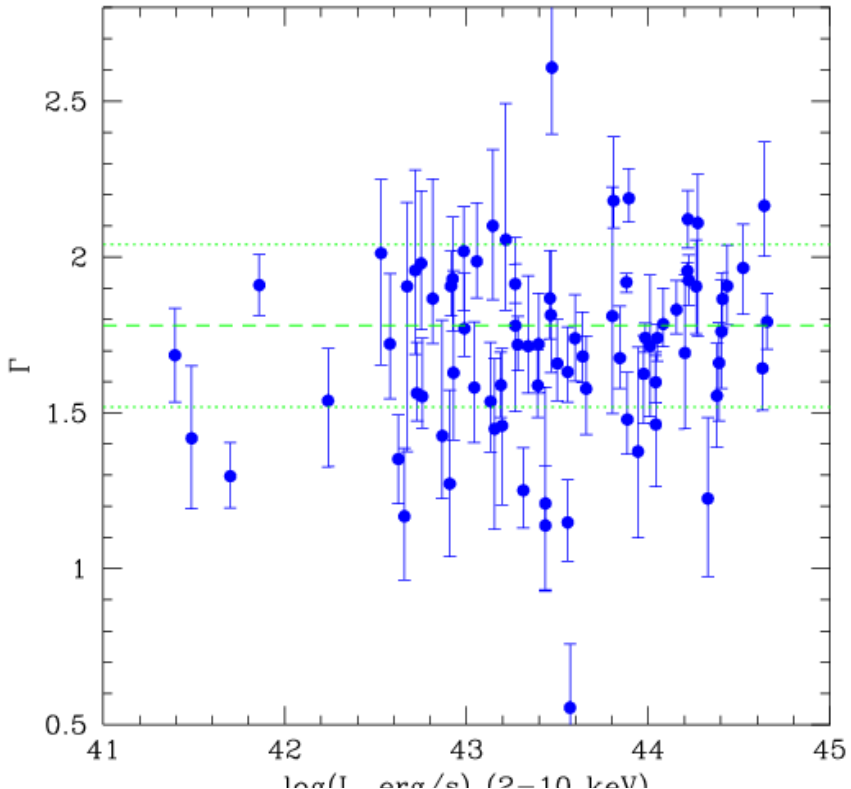
Detailed spectral analysis of X-ray sources in the CDFS
Tozzi, Gilli, Mainieri et al. 2006, A&A, 451, 457

Simple X-ray spectral properties



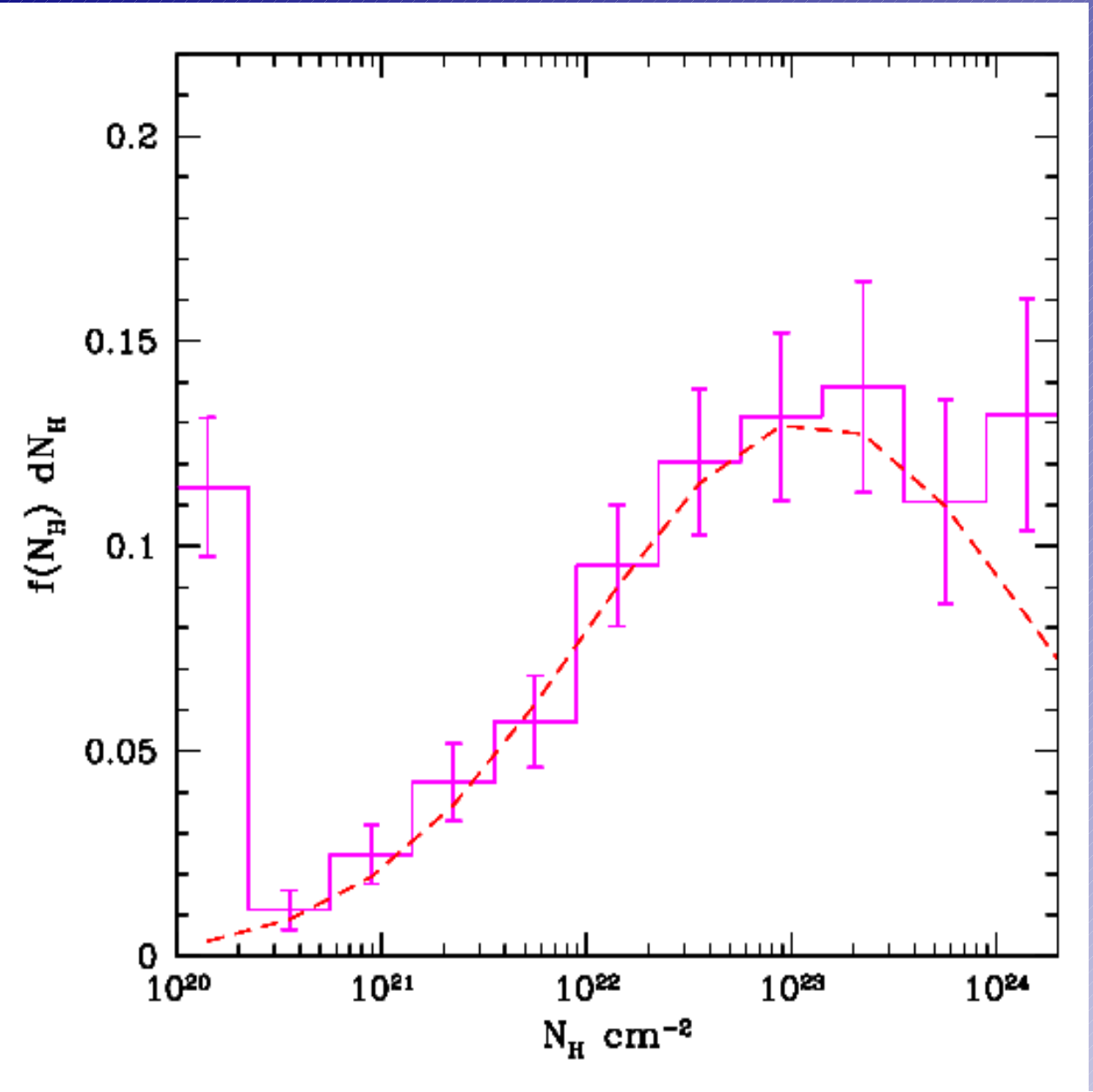






Tozzi et al. (2006) see also Streblyanska et al. (2007) for similar results and Chandra-XMM comparison

N_H histogram corrected for completeness



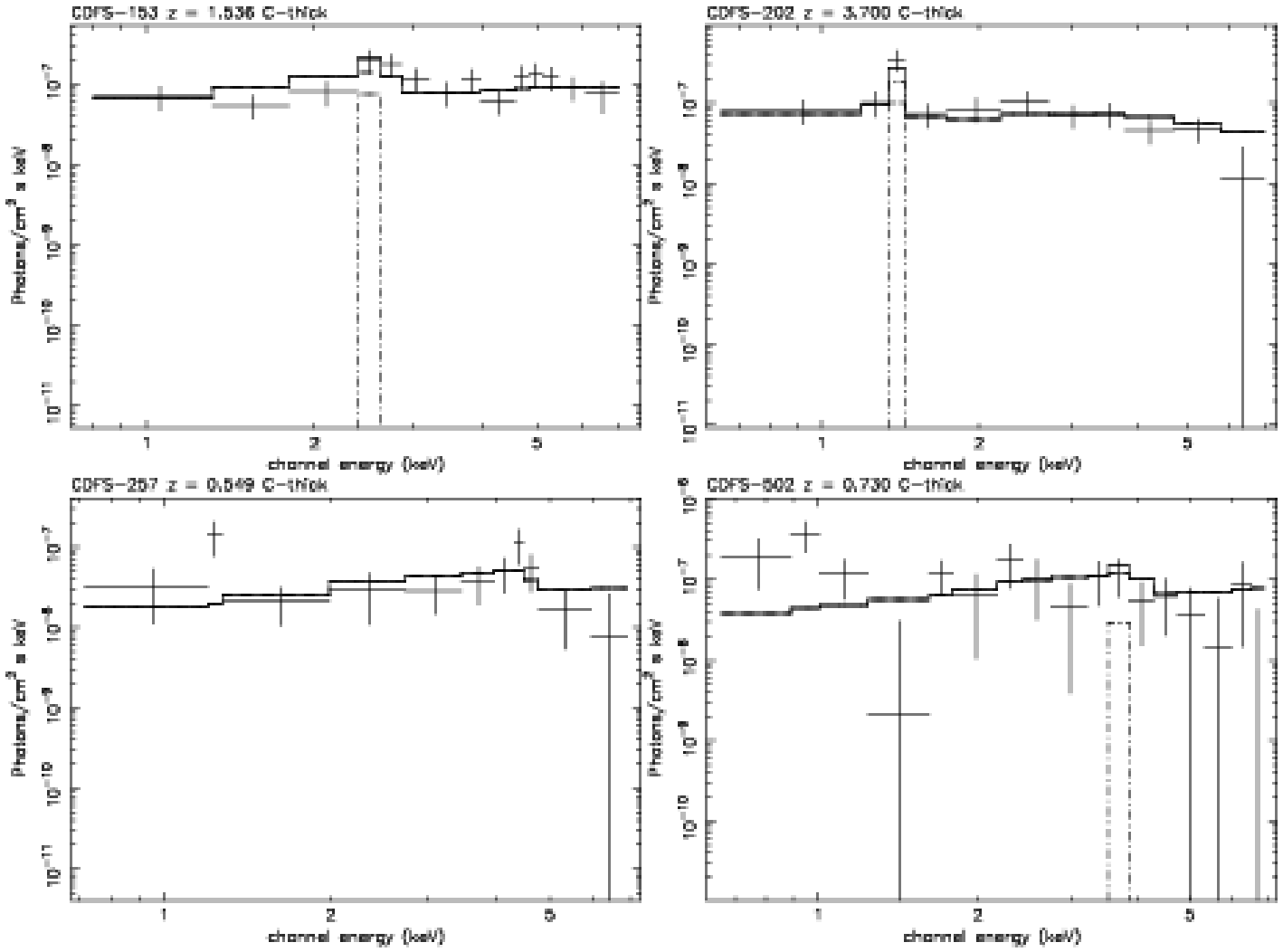
Corrected for completeness and sources outside the detectability region

$\langle \log(N_H) \rangle \sim 23.1$
dispersion = 1.1

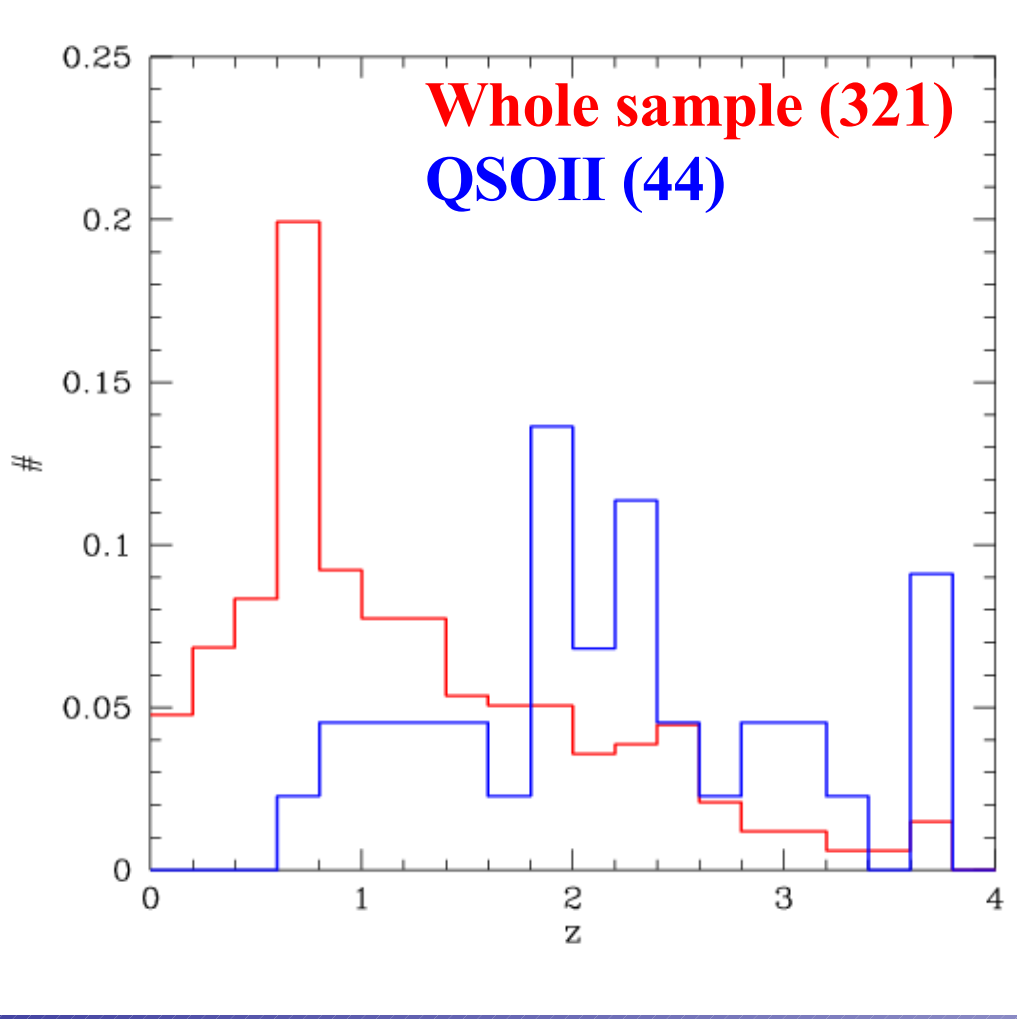
5% C-thick (14 reflection +4 sources $N_H > 1.5\ 10^{24}\ cm^{-2}$)

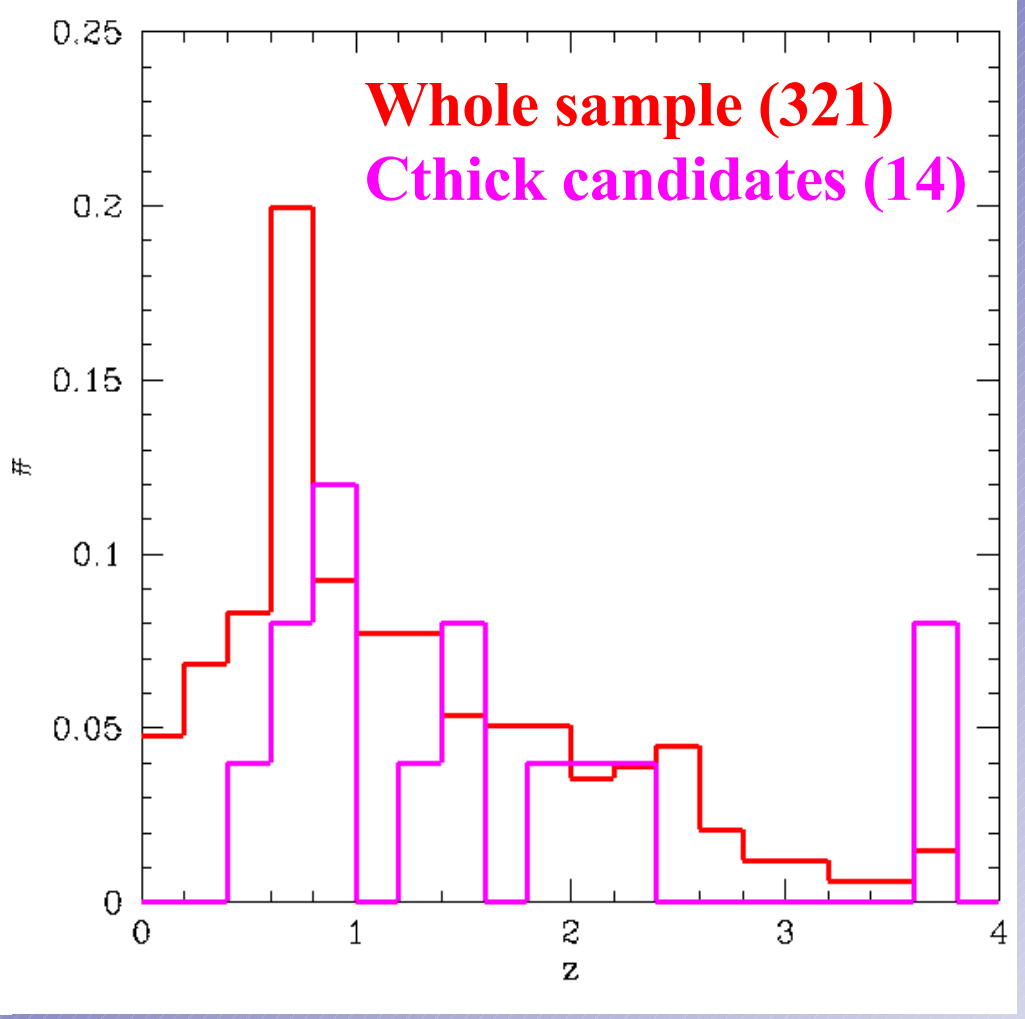
density ~ 200 +- 50 deg^{-2} in agr w XRB model by Gilli, Comastri, Hasinger (2006)

Compton thick candidates



Several C-Thick AGN expected to be missed at high z (they are ~40% in the local Universe)





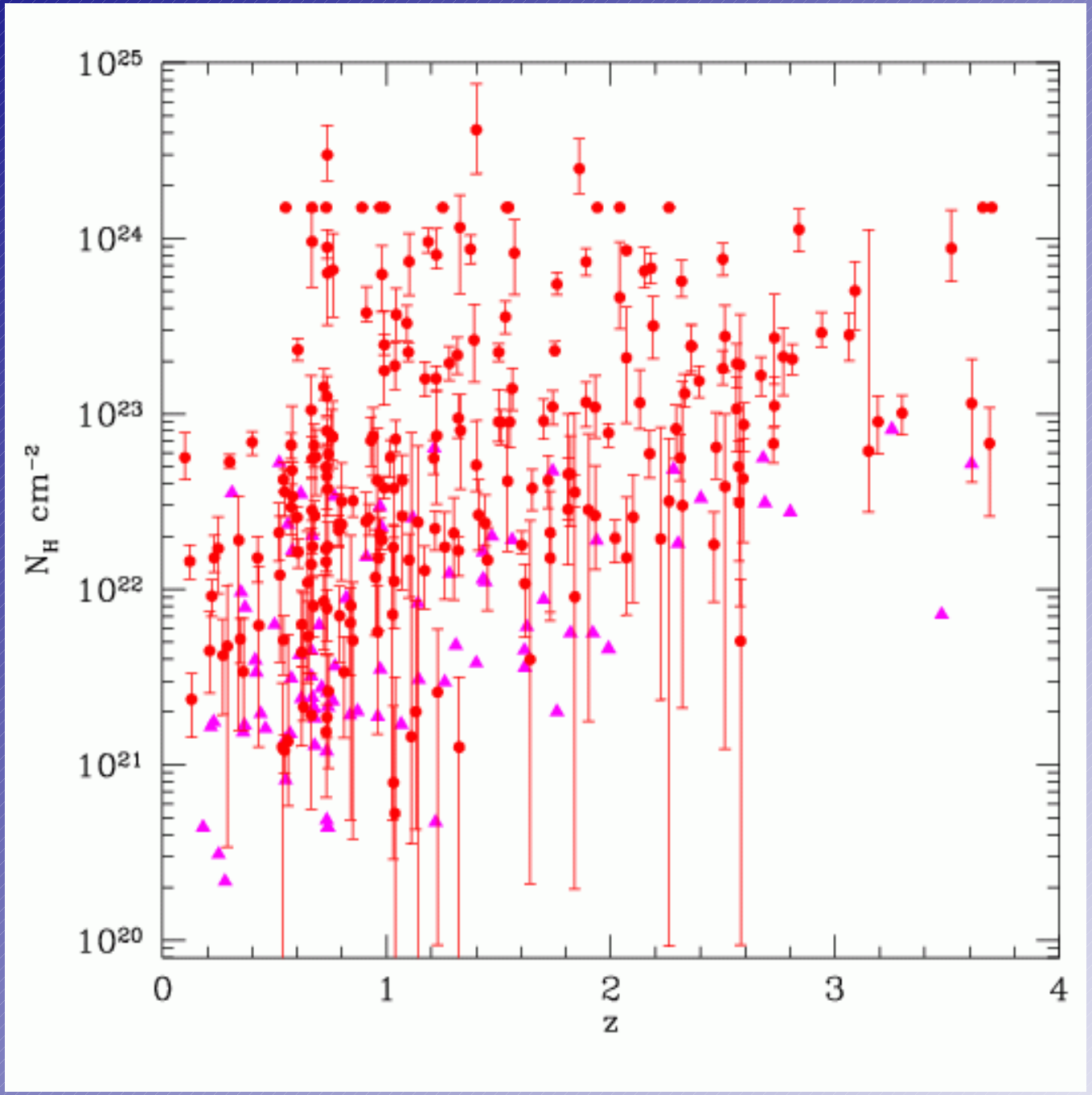
Consistent with evolutionary sequence:
pre-QSO phase
C-thin absorbed QSO (QSOII @ high z)
unobscured QSO activity
quiescent spheroidal galaxy

Alexander et al. 2005; Stevens et al. 2005

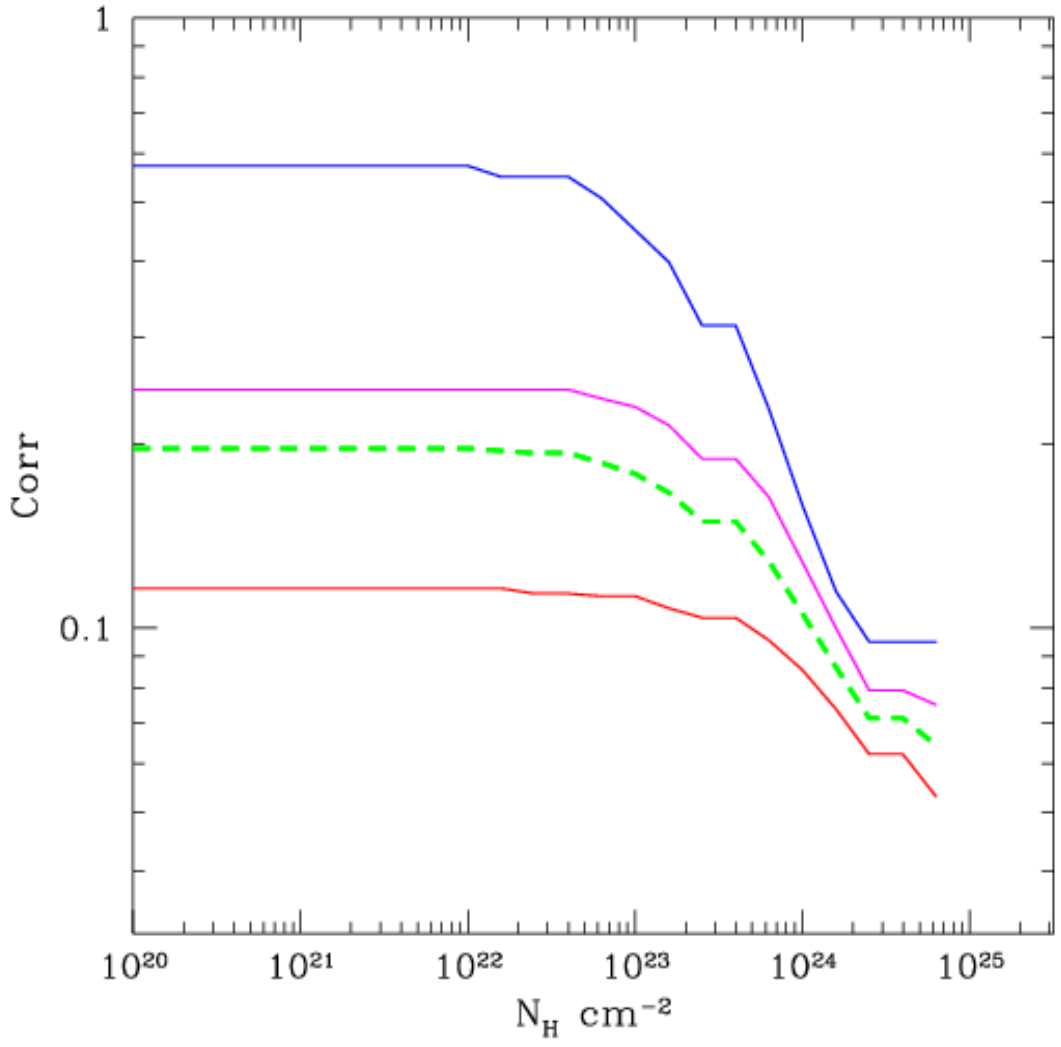
Model: Granato et al. 2005, Dan Stern

Medium z strongly absorbed moderate luminosity, possibly C-thick sources, in a secondary, relatively low phase of accretion (see "downsizing")

N_H vs redshifts for the whole sample



Detected fraction as a function of N_H and z



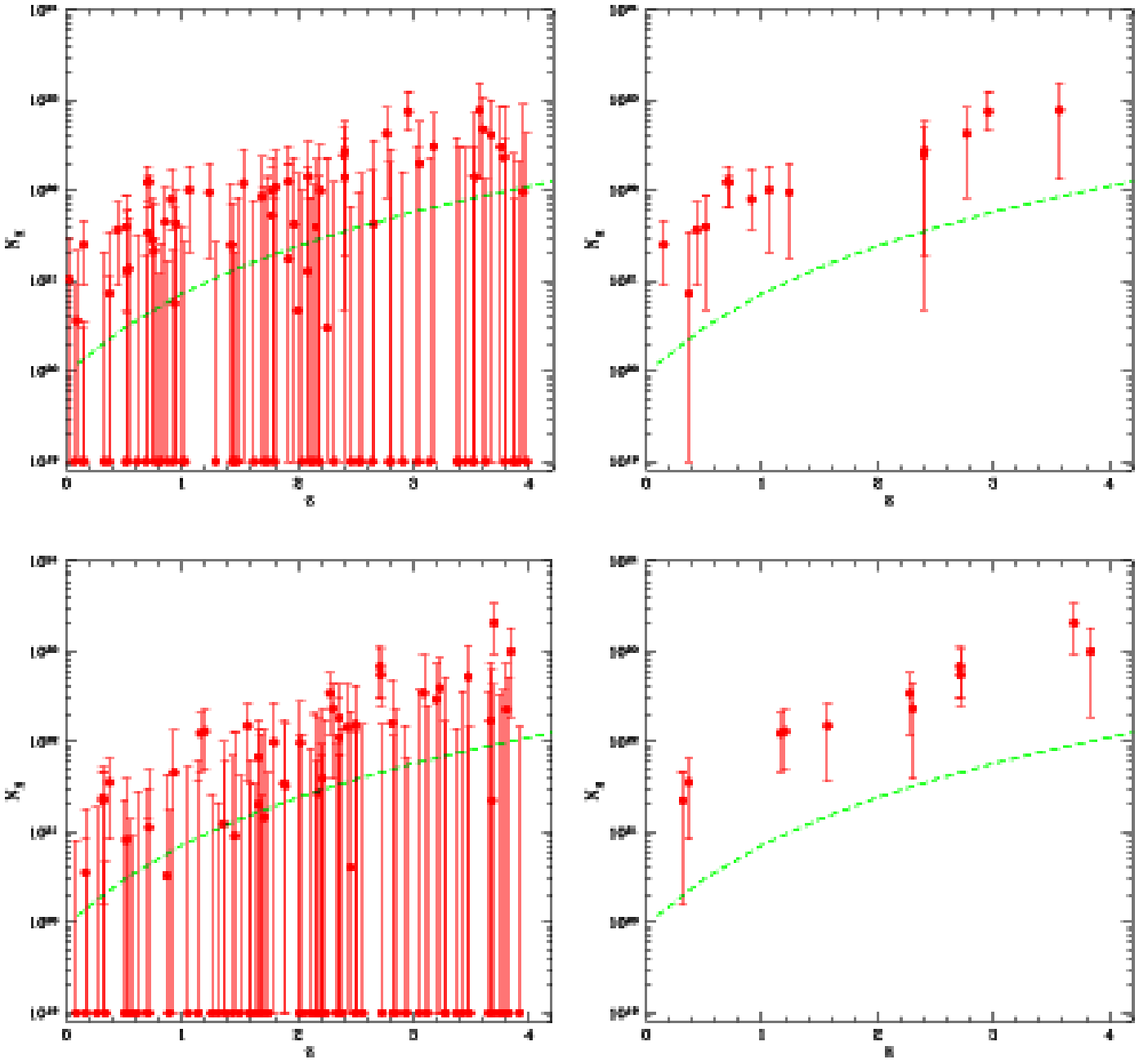
z < 0.7

0.7 < z <1.5

z > 1.5

Sampling different luminosity and spectral population at different z
Selection effects are relatively easy to model in the X-ray band

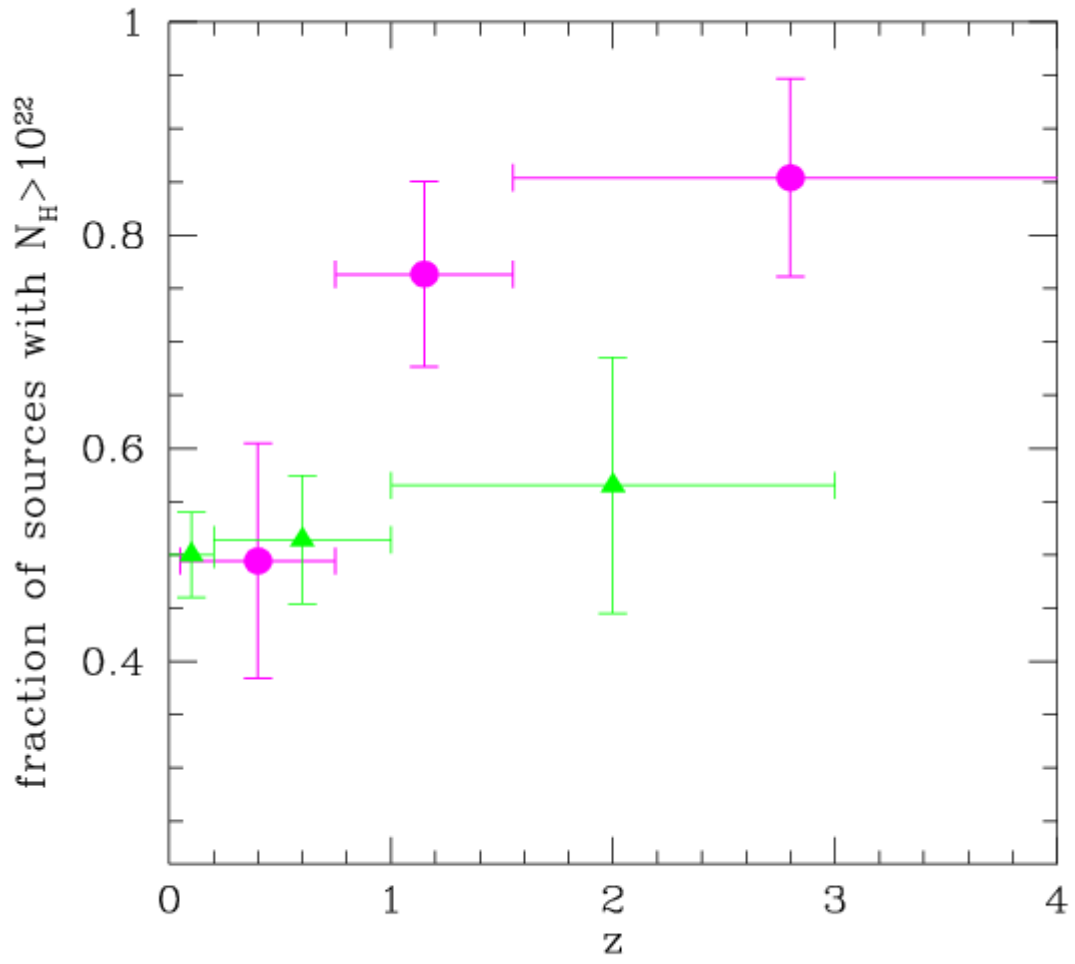
Average N_H artificially increases towards high-z



$N_H \sim 10^{20} cm^{-2}$
150 and 80
net counts

Tozzi, Gili, Mainieri et al. 2006

The evolution of the obscured fraction with redshift



This work
see also La Franca et al. 2005

Ueda et al. 2003

Difficult to measure from X-rays due to positive K-corr, but increasing evidence that many weak, high-z obscured AGN are missed in X-ray.

A missed fraction of obscured AGN selected through 24 micron emission. Relevant for the population of strongly obscured (C-thick) AGN and for the SMBH mass function, but little contribution to the HXRB (Fiore et al. 2007, see also Martinez-Sansigre et al. 2006, Radio+MIR).

Most of these C-Thick AGN reside in massive galaxies at z~2: little contribution to the HXRB, but relevant for SMBH growth and termination of SF activity (downsizing) by feedback (Daddi et al. 2007)

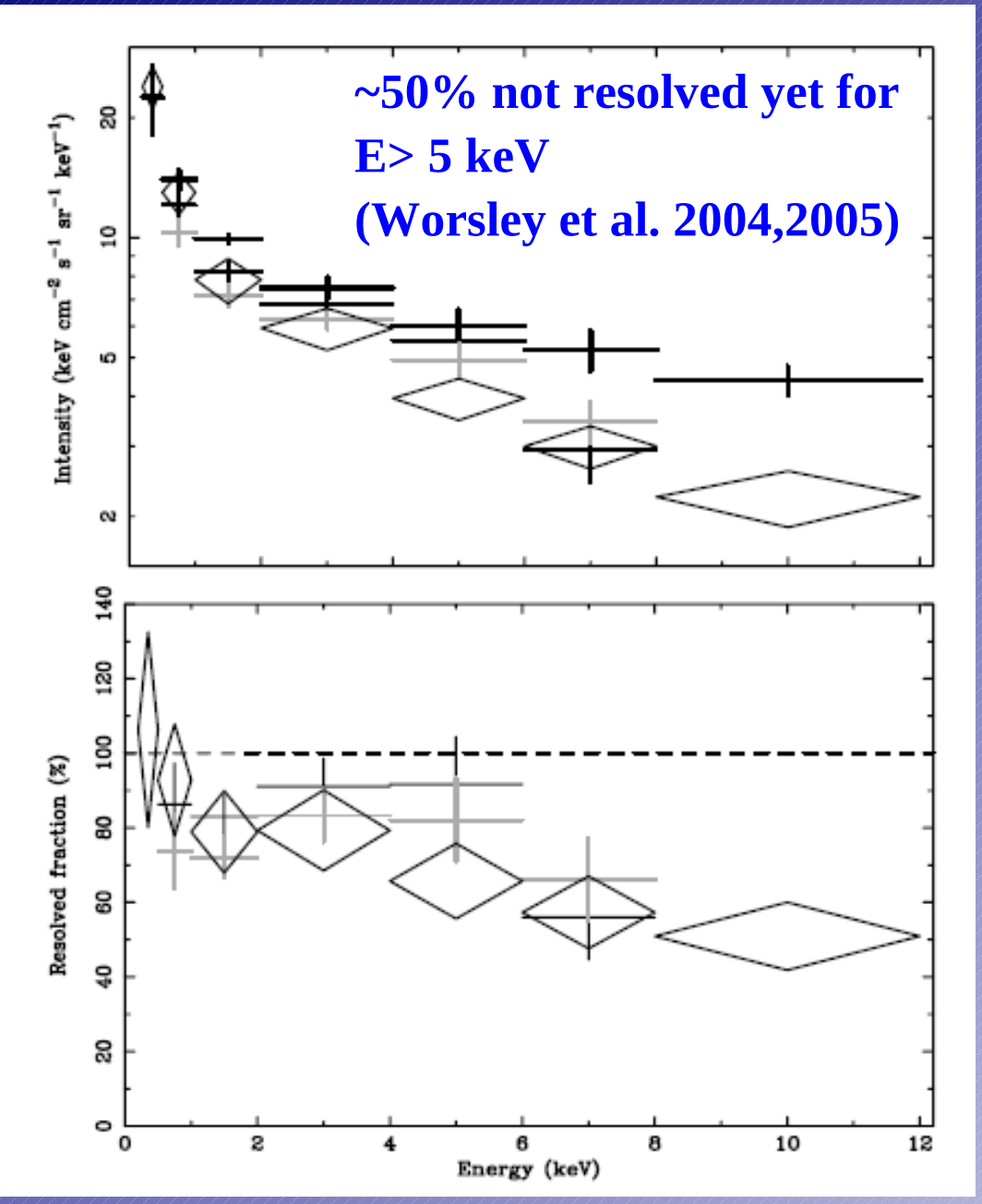
Bright MIPS sources contribute only 6% of the XRB in the 6-8 keV band (Steffen et al. 2007).

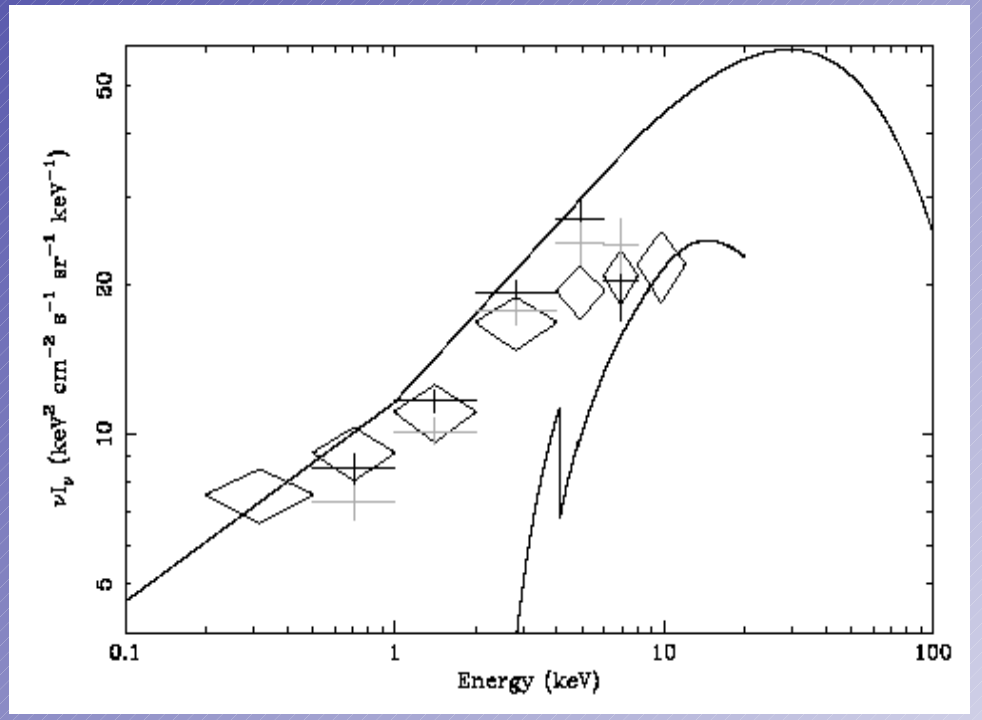
MIR selection misses strongly obscured AGN (Dan Stern this morning)

The level of the total XRB is confirmed to be that measured by HEAO-1 if not lower (Frontera et al. 2007).

To summarize: high redshift (z>1) strongly absorbed AGN relevant for SMBH growth and galaxy formation and evolution, little contribution to XRB. On the other hand, medium-z, medium luminosity strongly absorbed AGN already "complete" the XRB.

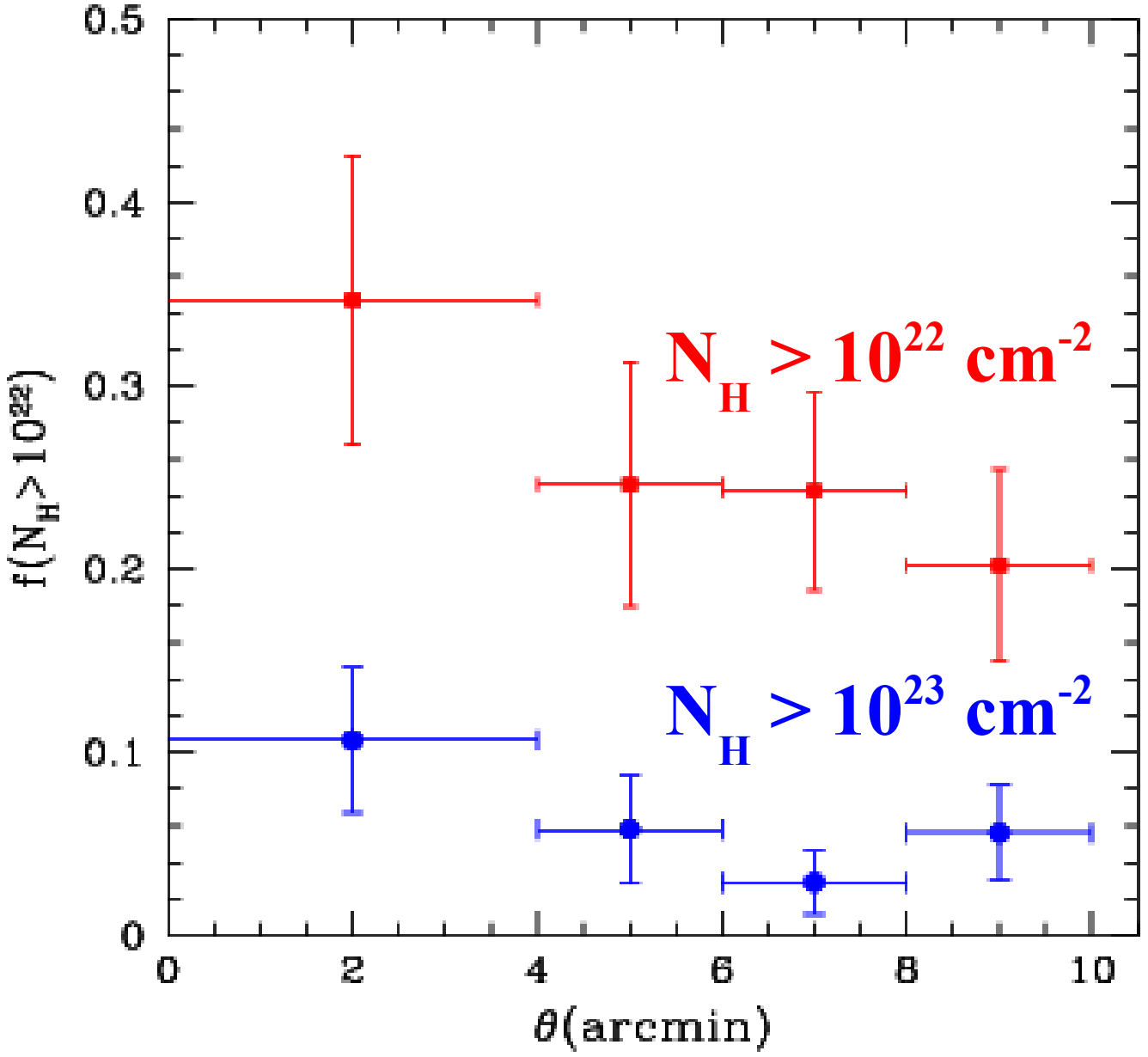
The unresolved fraction increases with the energy band

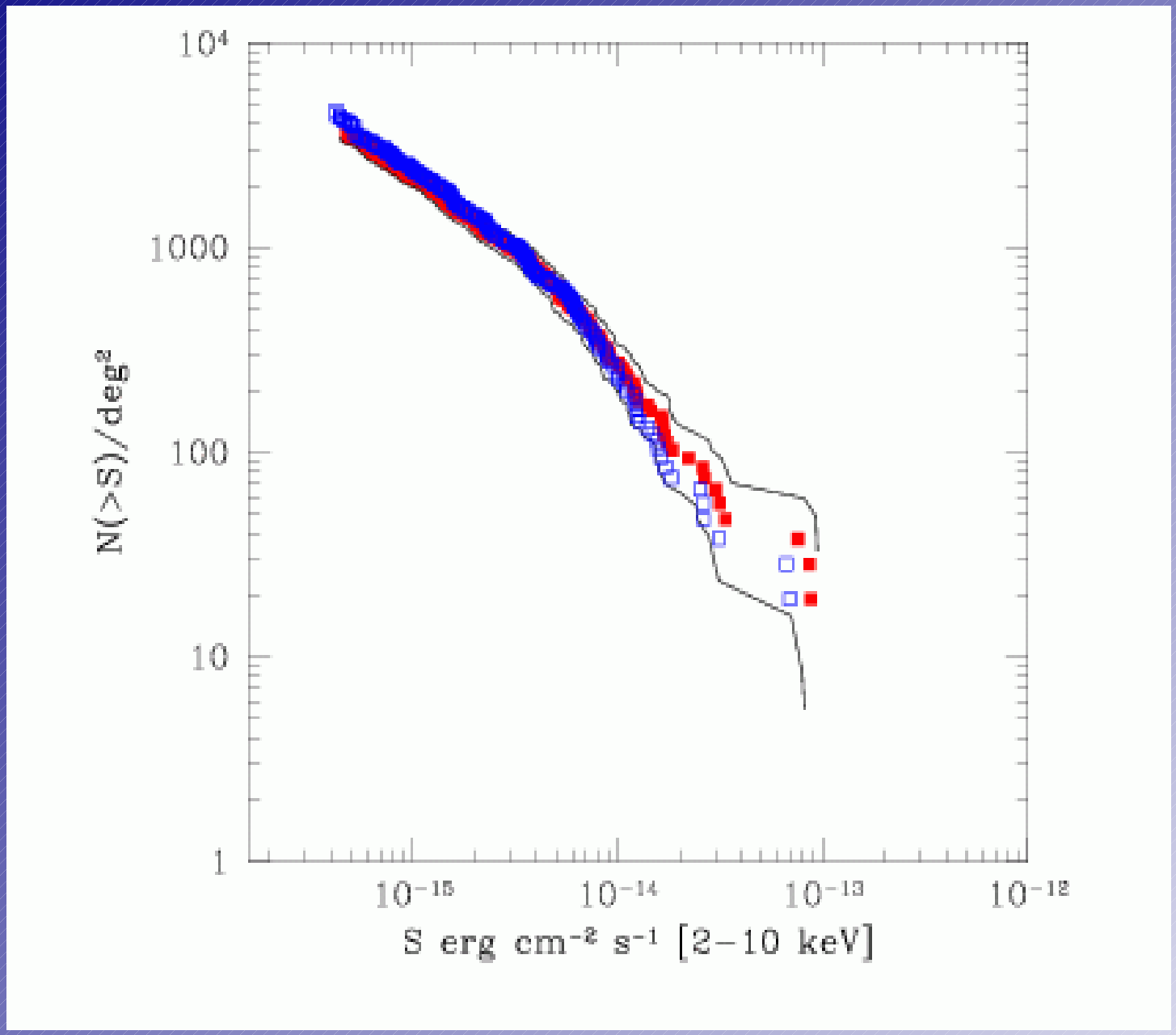




Missing XRB: N_H=4.5 10^{23} cm^{-2} @ z=0.8

Compute the contribution of the absorbed sources to the XRB





Assuming an average spectral shape (Gamma ~ 1.4)

After computing the skycoverage according to the spectral shape of each source

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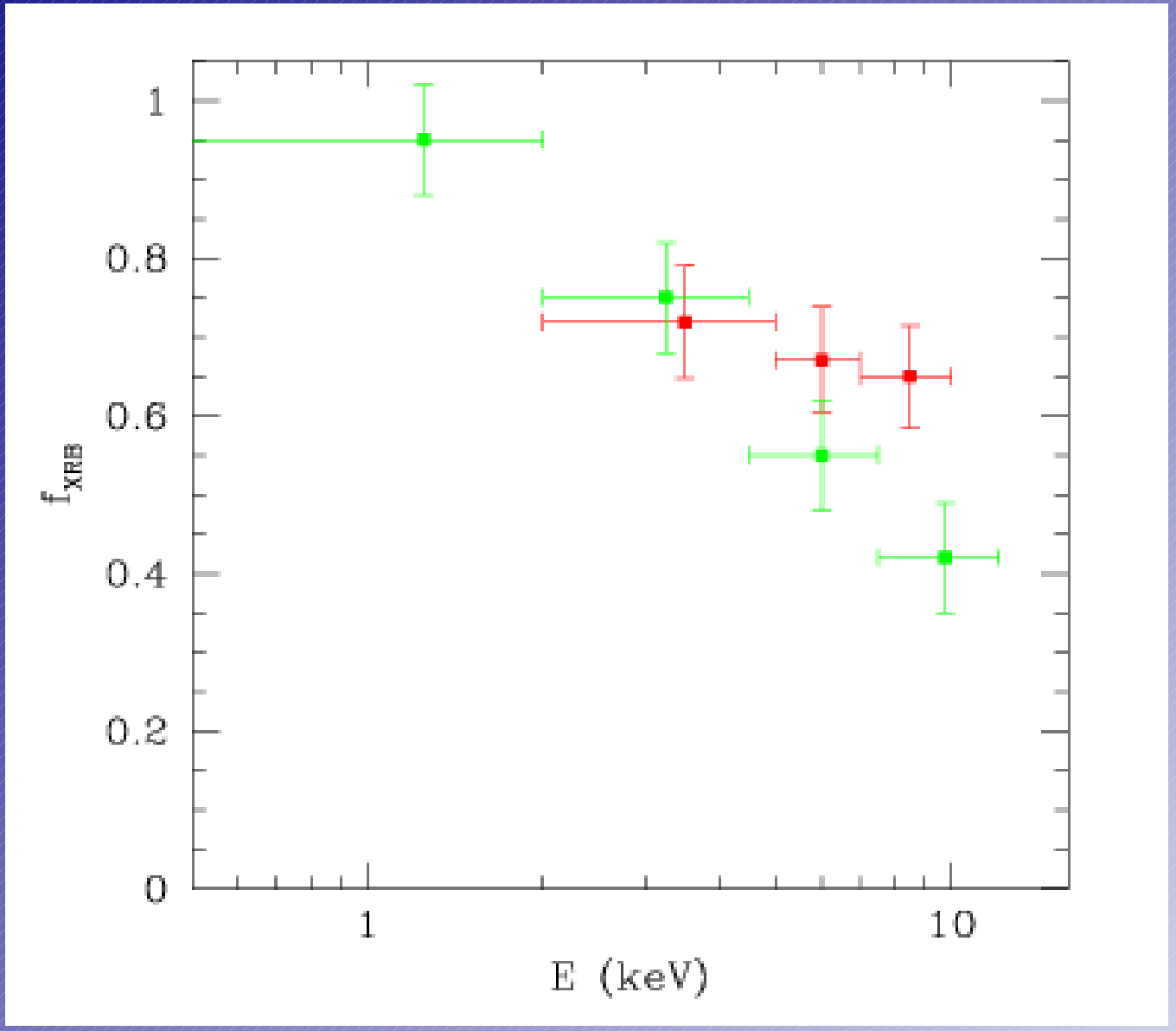

Worsley et al. 2004

This work

CONCLUSIONS

- Towards an universal distribution of intrinsic absorption (selection effects can be easily modelled in X-rays)
- Evidence for strongly absorbed, C-thick sources @ z~1, and a substantial QSOII population at z>~2
- When taking into account spectral shapes, we recover part of the "missing" HXRB
- Now that the HXRB is about to be totally resolved, it is even more important to go deeper with the spatial resolution of Chandra in order to detect faint C-thick sources and stacked emission from faint strongly-absorbed AGN (hard X-ray emission is still the best diagnostic for obscured accretion when coupled with MIR)
- 5 Ms with Chandra is a unique occasion (AO9 proposal, PI N. Brandt)