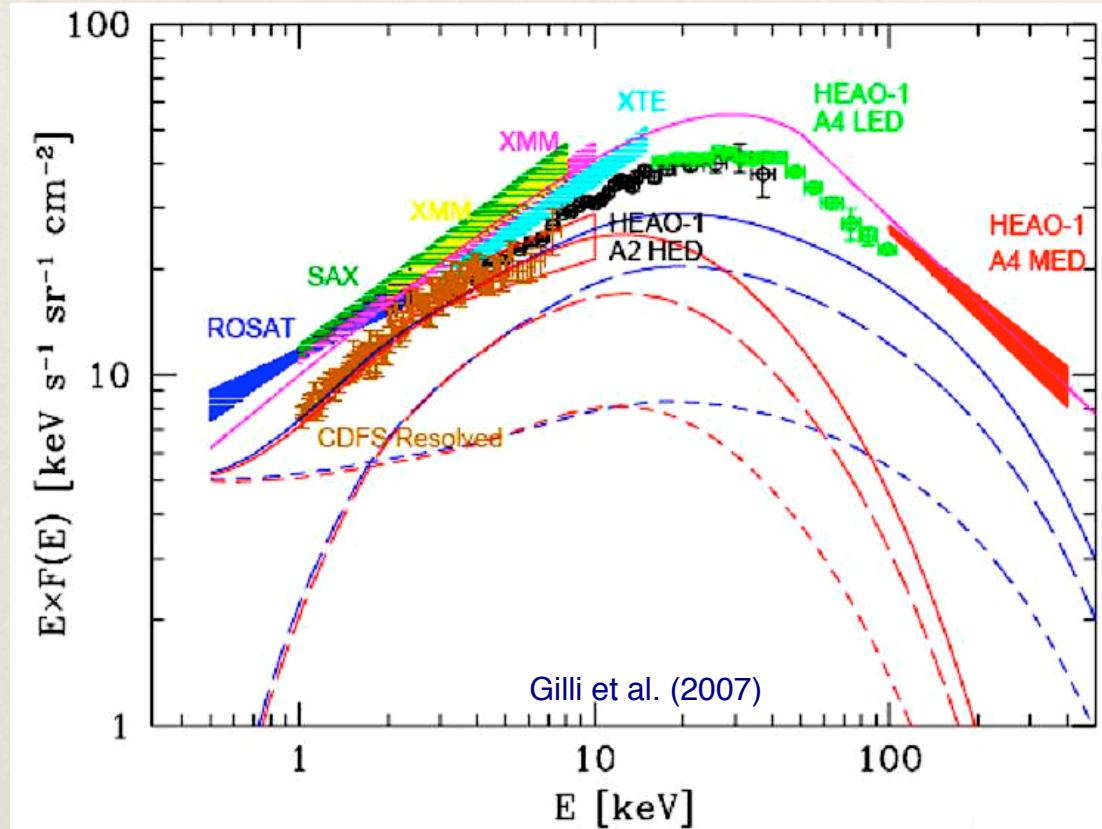


# The NuSTAR hard X-ray view on quasars

Agnese Del Moro

**Survey science team:** D. Alexander, D. Stern, M. Ajello, J. Aird, R. Assef, D. Ballantyne, F. Bauer, N. Brandt, M. Bolokovic, F. Civano, A. Comastri, A. Del Moro, M. Elvis, F. Fiore, F. Harrison, D. Helfand, R. Hickox, S. LaMassa, G. Lansbury, B. Luo, K. Madsen, J. Mullaney, S. Puccetti, C. Saez, G. Tagliaferri, E. Treister, D. Walton, L. Zappacosta, and many others

# The missing AGN population

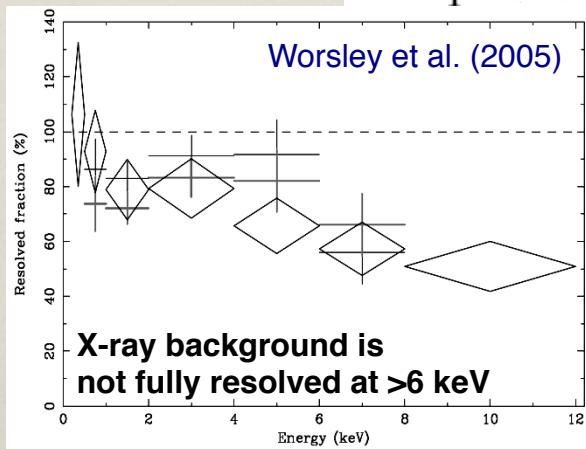
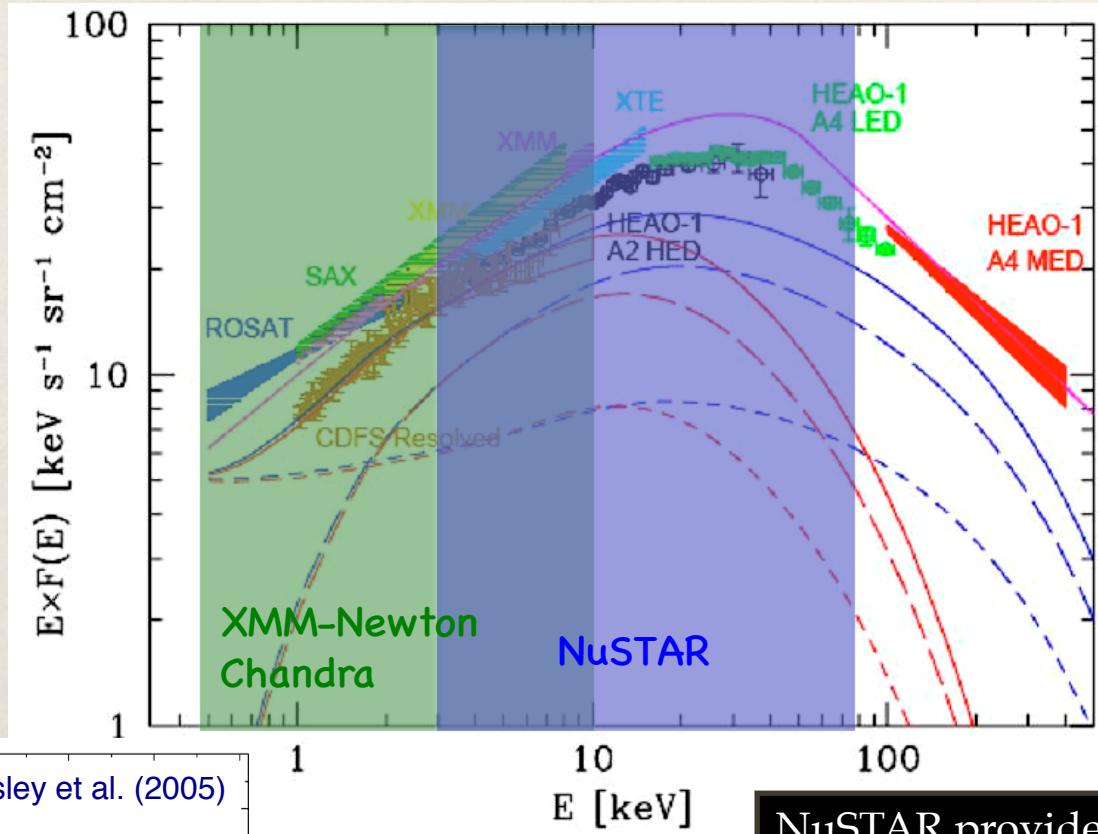


X-ray background spectrum peaks at  $\sim 30$  keV

Large fraction of obscured AGN is required to reproduce the CXB peak

# The missing AGN population

Deep X-ray surveys have resolved ~70-90% of the X-ray background at  $E < 10$  keV  
(Worsley+2005, Xue +2012)



NuSTAR provides direct measurement of the CXB at  $E > 10$  keV

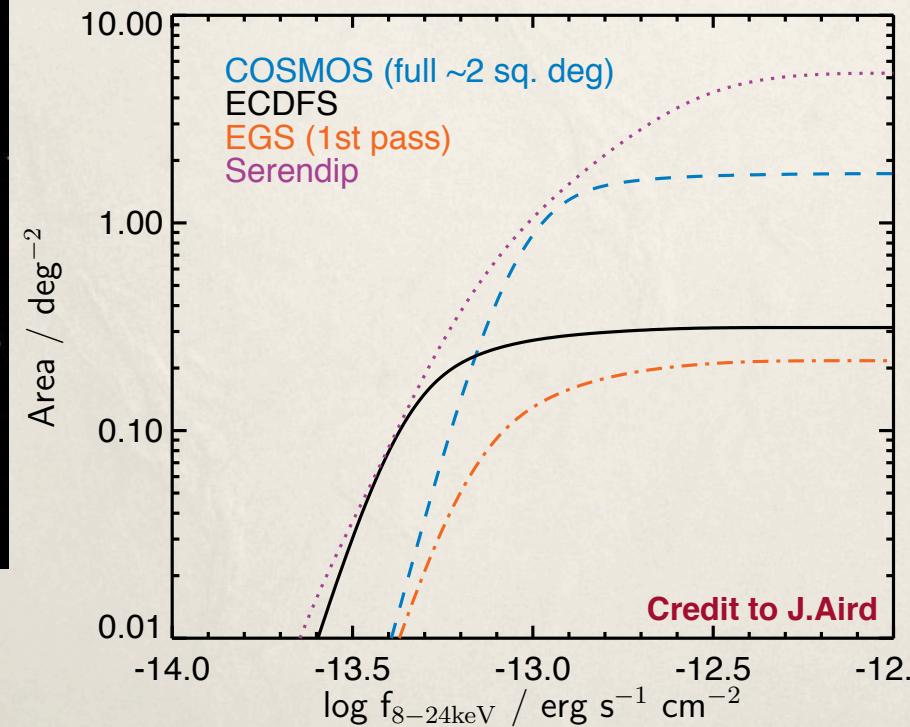


# NuSTAR Extragalactic survey

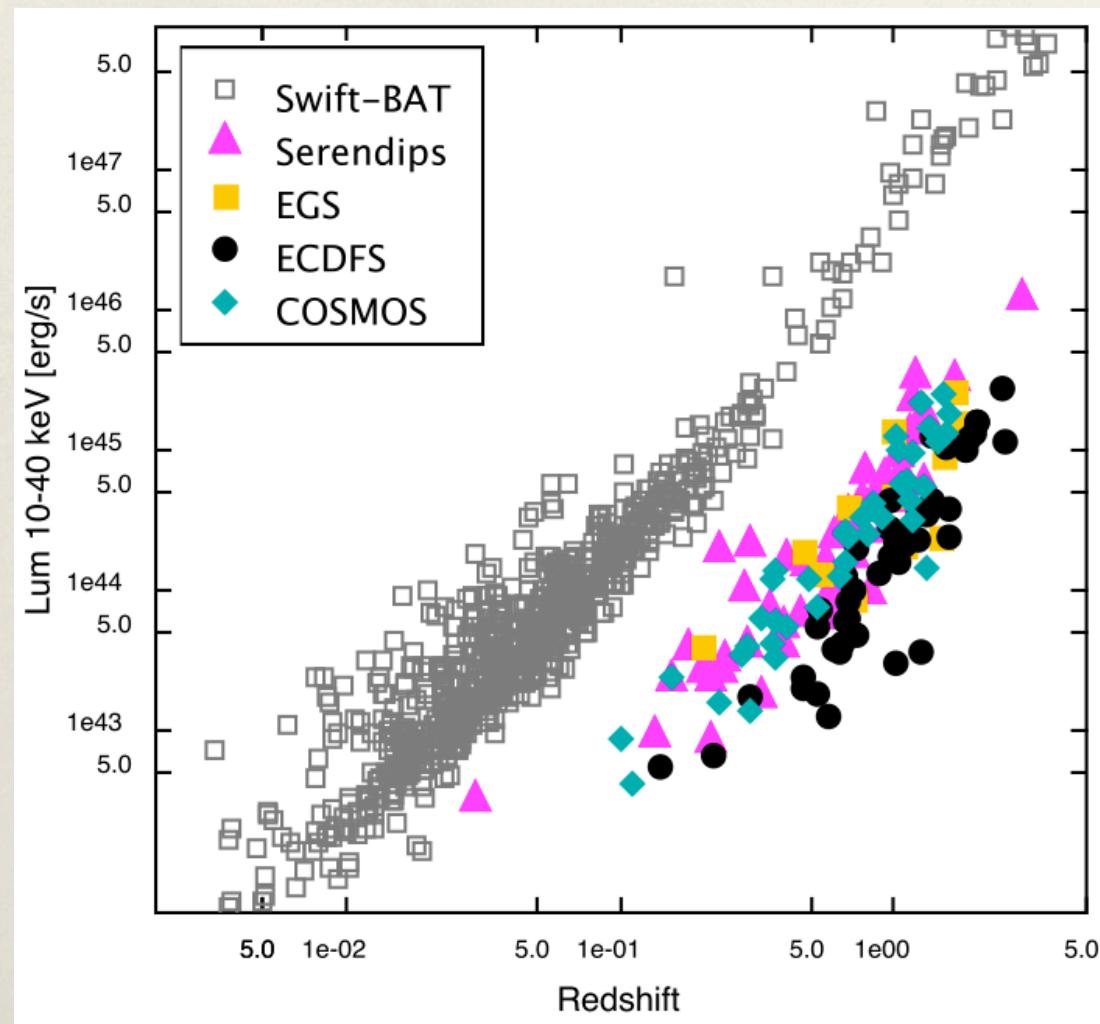


ECDFS/EGS: ~400 ks at its deepest

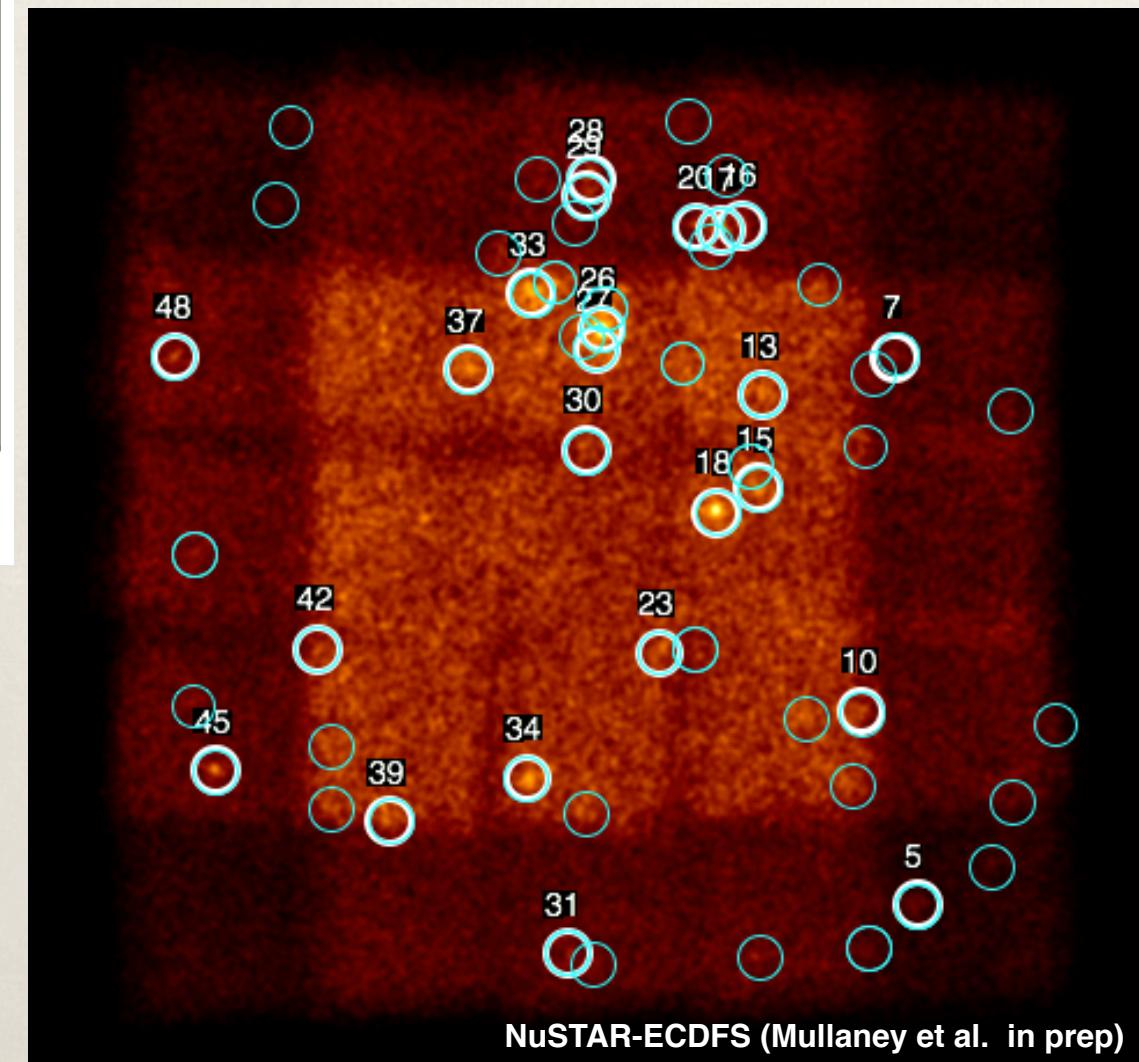
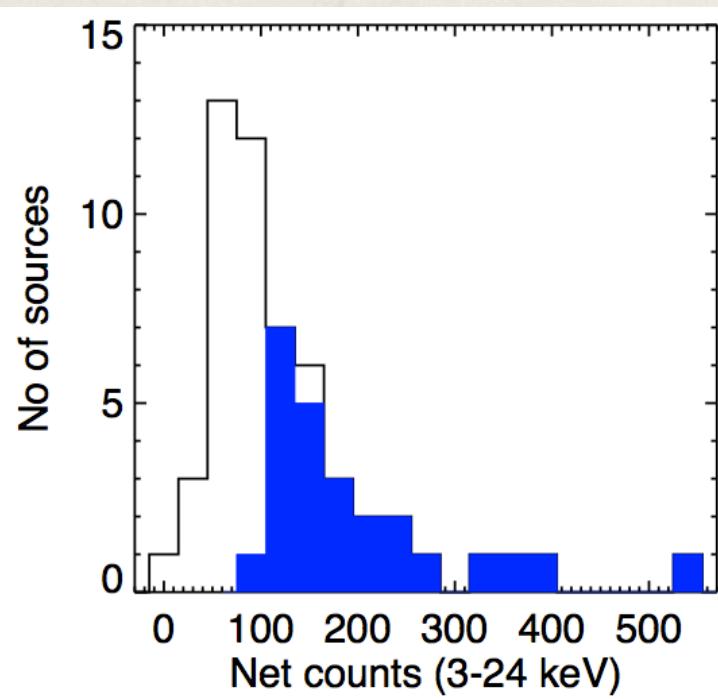
COSMOS: ~90 ks at its deepest



# NuSTAR Extragalactic survey population

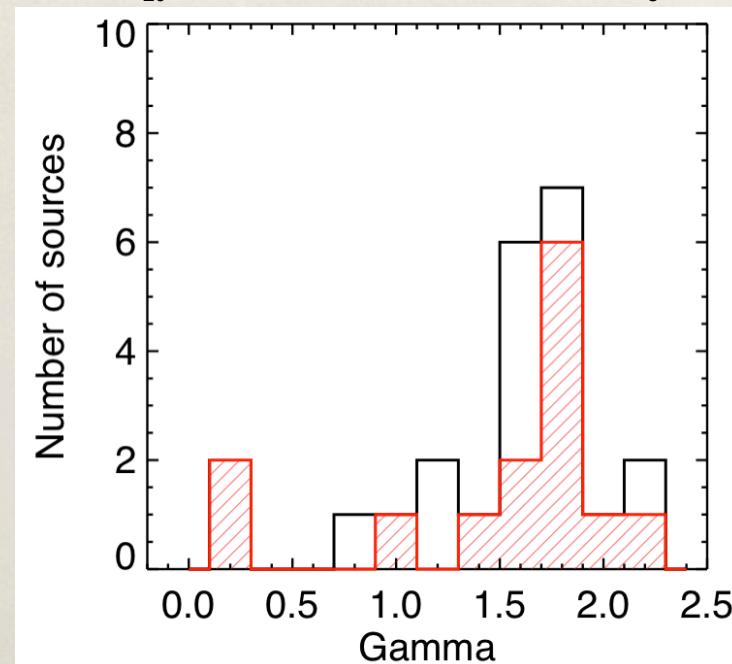
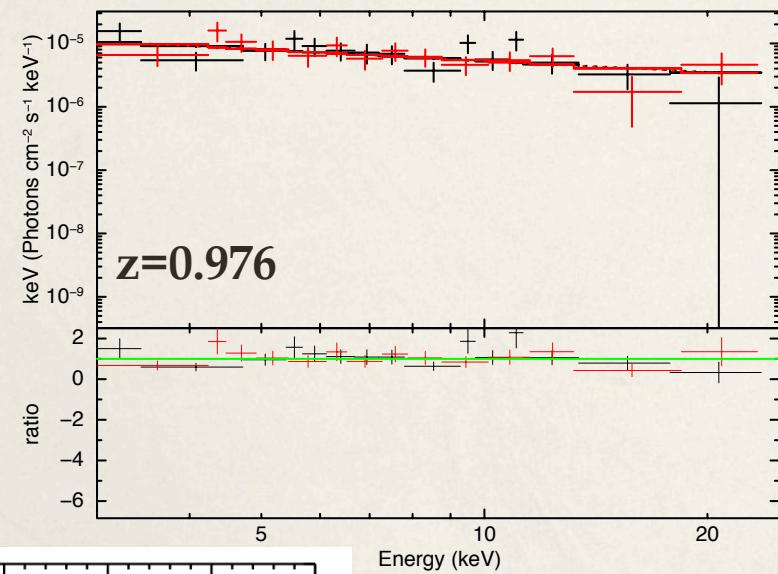
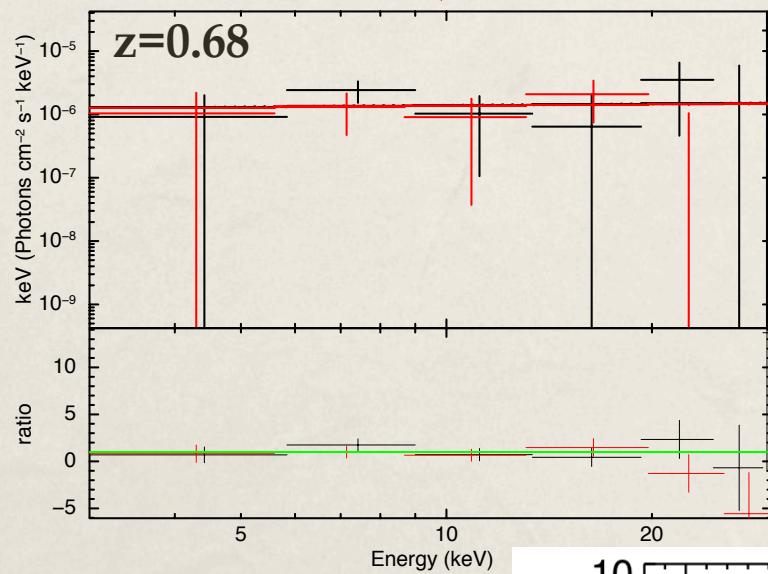


# Spectral properties of the NuSTAR sources



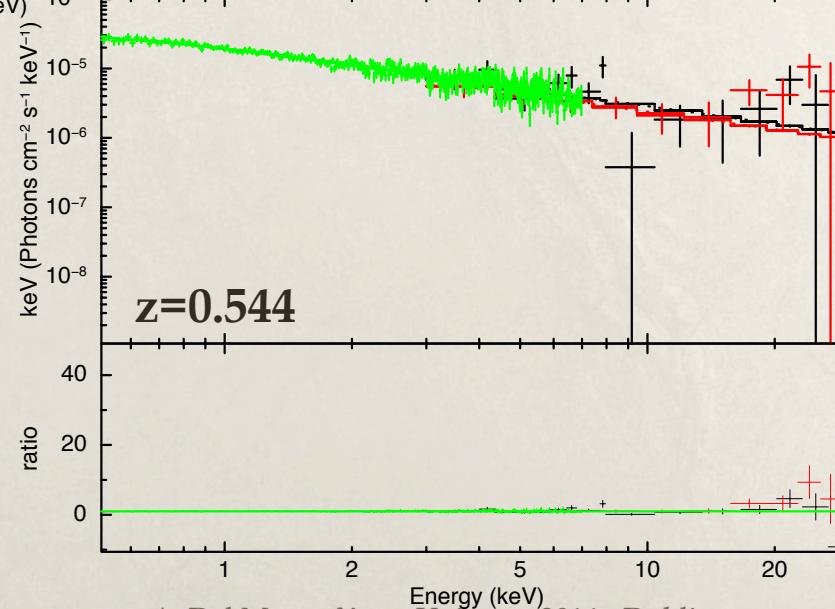
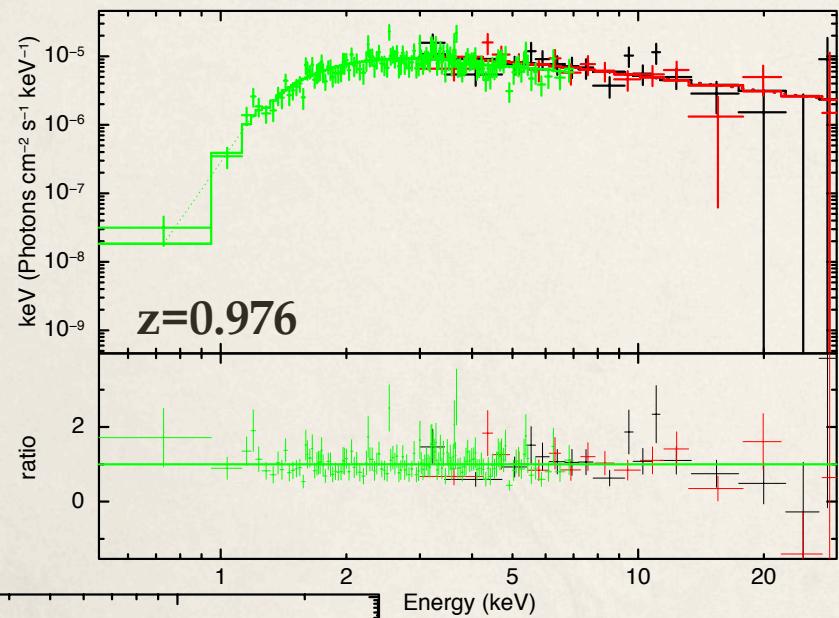
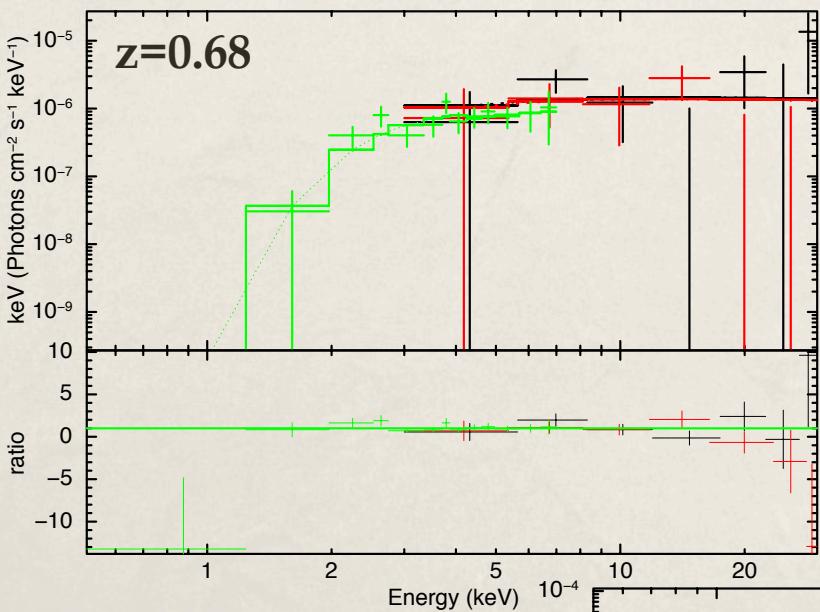
- Net counts CTS>100 (FPMA&FPMB)
- Redshift identification

# NuSTAR only: 3-30 keV spectral fits

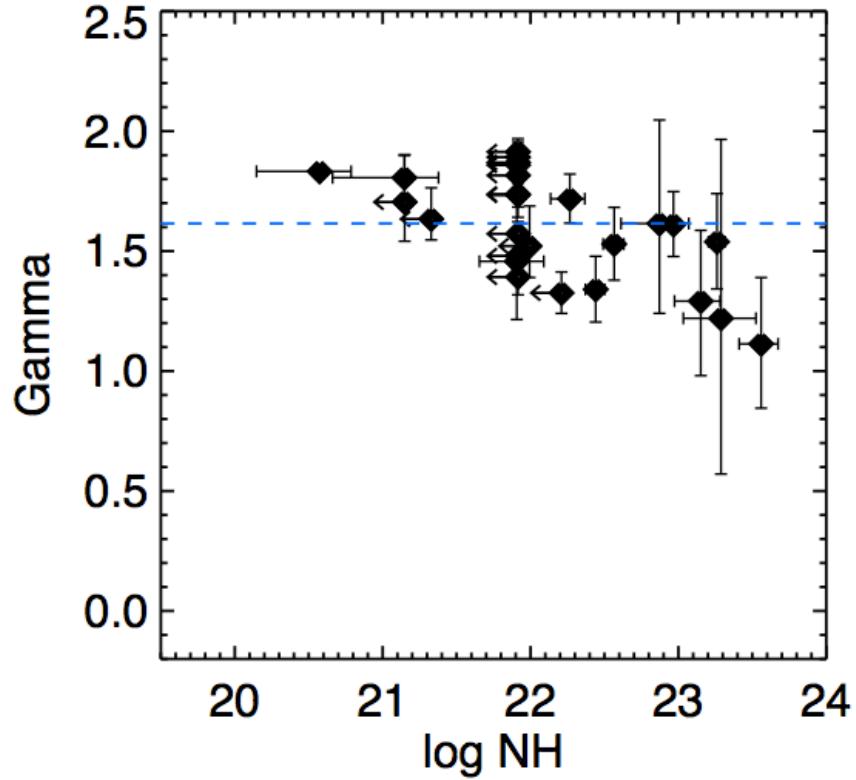
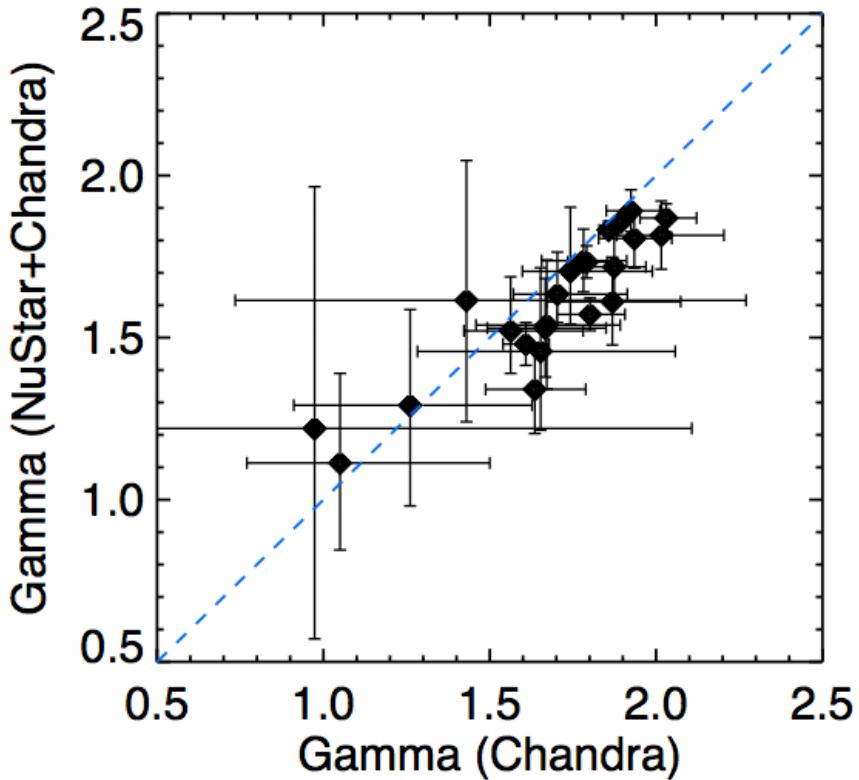


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# NuSTAR + Chandra: broad-band (0.5-30 keV) fits

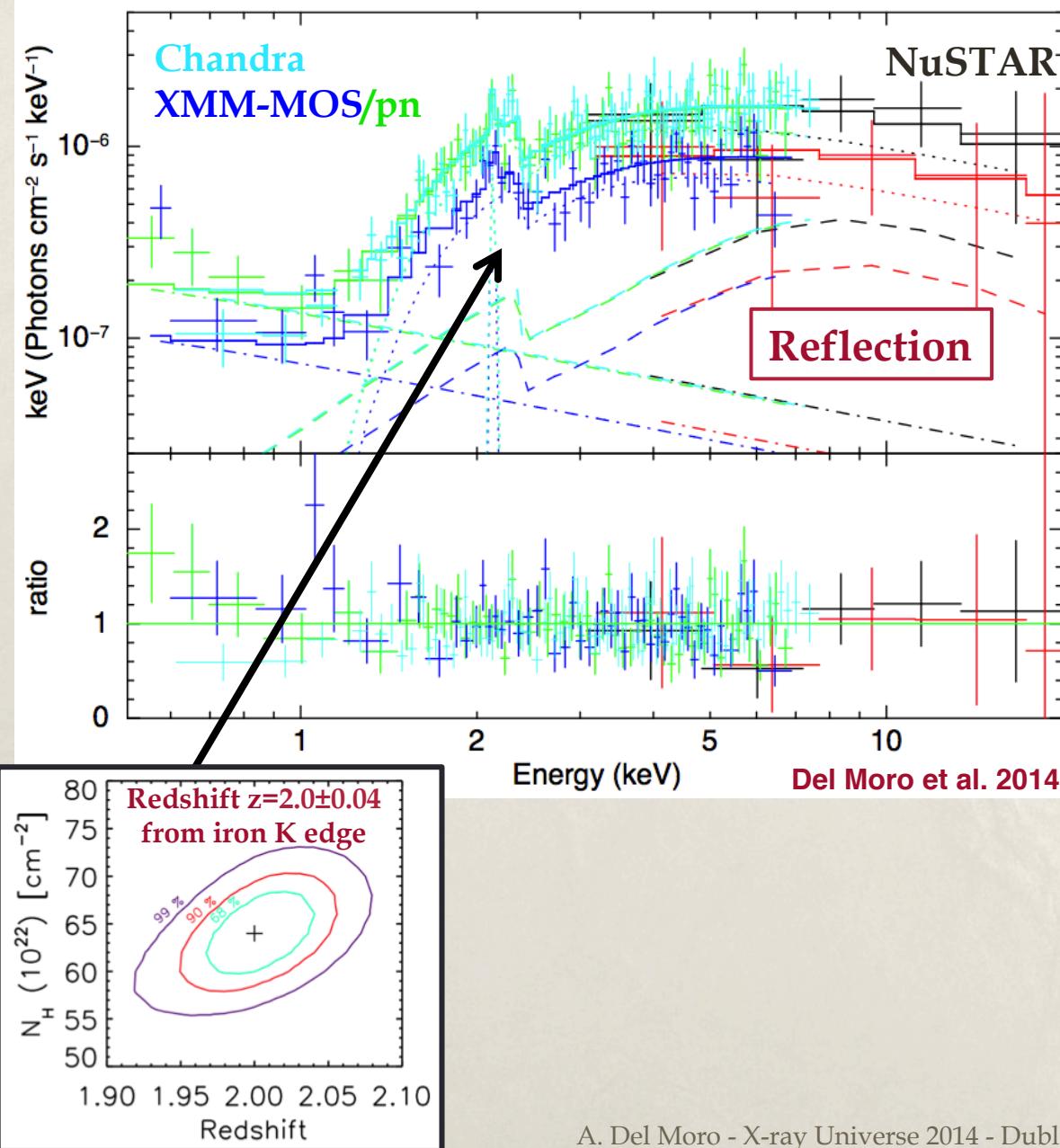


# NuSTAR + Chandra:



- Median  $\Gamma=1.62$
- $\sim 40\%$  obscured AGN with  $\text{NH} > 10^{22} \text{ cm}^{-2}$
- $\sim 60\%$  unobscured AGN ( $\text{NH} < 10^{22} \text{ cm}^{-2}$ )

# NuSTAR J033202-2746.8



$$z = 2.00 \pm 0.04$$

$$\Gamma = 1.6 \pm 0.2$$

$$N_{\mathrm{H}} \approx 6 \times 10^{23} \text{ cm}^{-2}$$

→ 2-3 times higher than that found from XMM/Chandra alone

$$L_{10-40 \text{ keV}} \approx 6 \times 10^{44} \text{ erg/s}$$

(≈ 30% from Compton reflection)

Compton reflection

$$R = 0.6 \pm 0.4$$

→ higher than typical radio-loud sources ( $R \approx 0$ ; Reeves & Turner 2000)

# Summary

The extragalactic survey is designed to:

- (1) Directly resolve ~25-50% of the X-ray background at peak
- (2) Indirectly resolve (via stacking analysis of Chandra/XMM sources) most of the remaining X-ray background
- (3) Better define the high-energy properties of AGN to better model the X-ray background

- NuSTAR observes a population of AGN ~2 orders of magnitude fainter than what was previously possible at hard X-rays ( $E > 10$  keV)
- X-ray spectral analysis of NuSTAR data, combined with lower energy data, provides better constraints on the intrinsic properties of AGN
  - Spectral slope
  - NH distribution
  - Reflection component