Measuring the obscured black hole growth phase of z=1-3 galaxies

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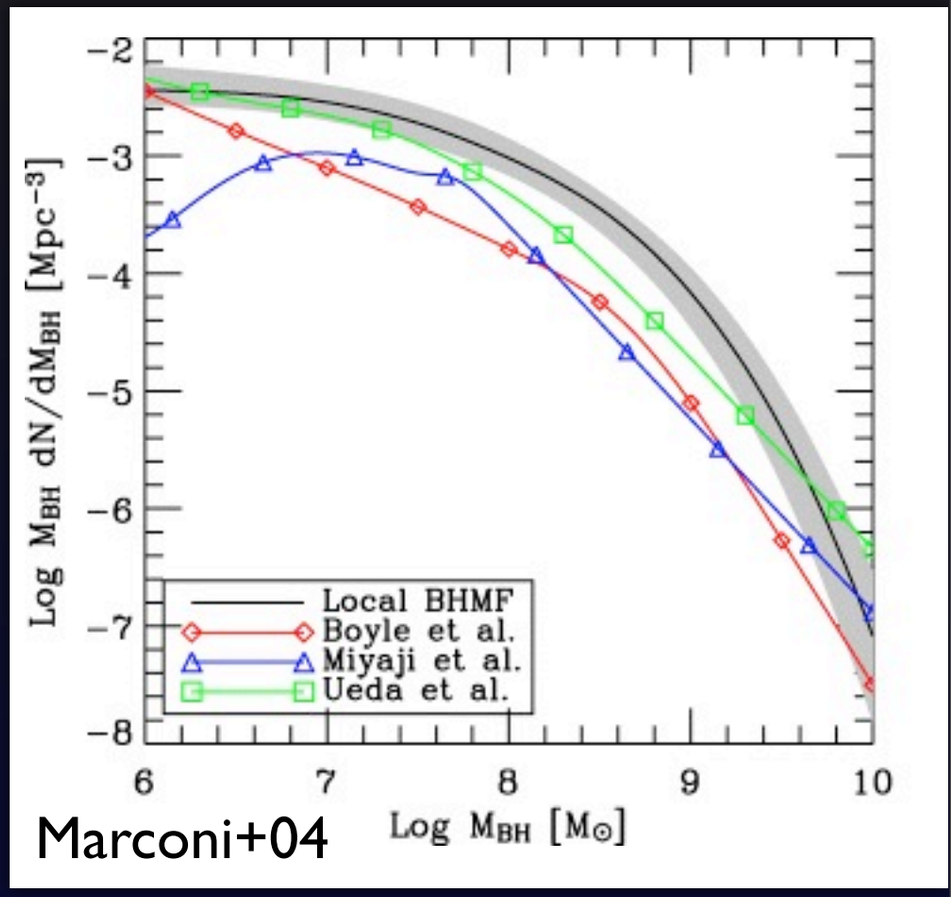
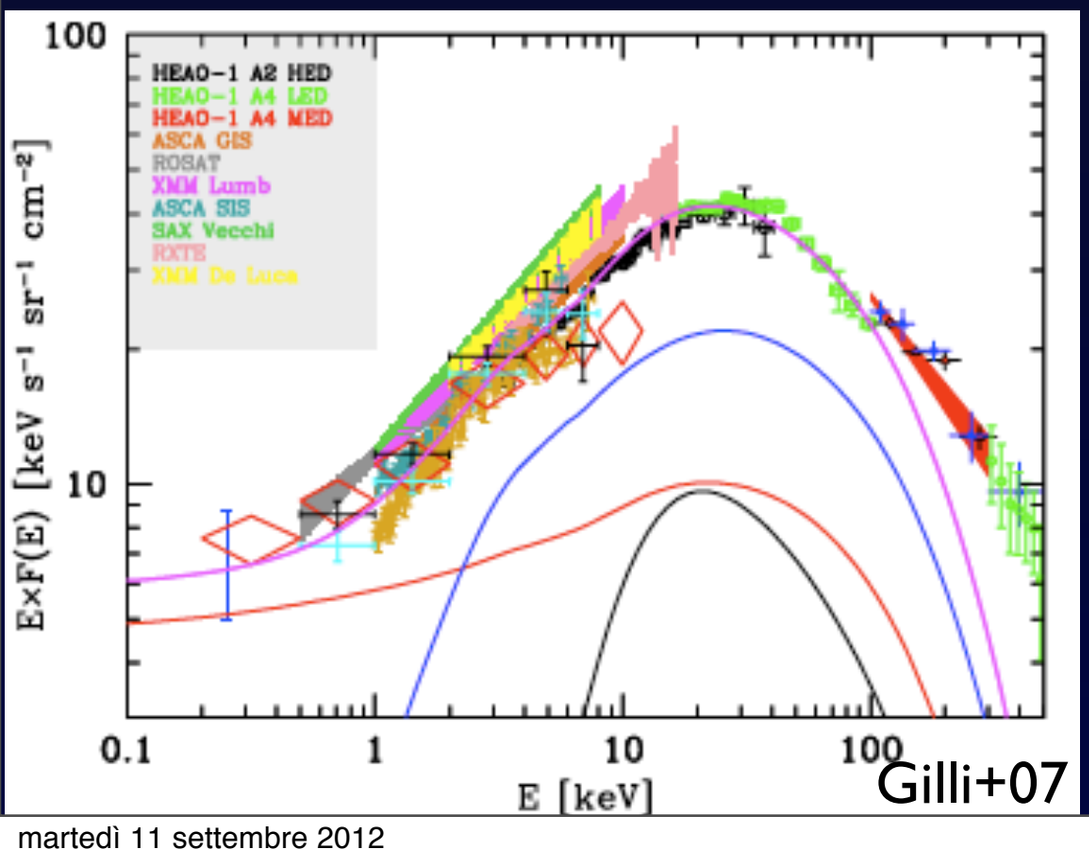
Missing BH?

Many evidences show that X-ray surveys are missing the most obscured BH (Compton-thick): BH mass function, X-ray background models.

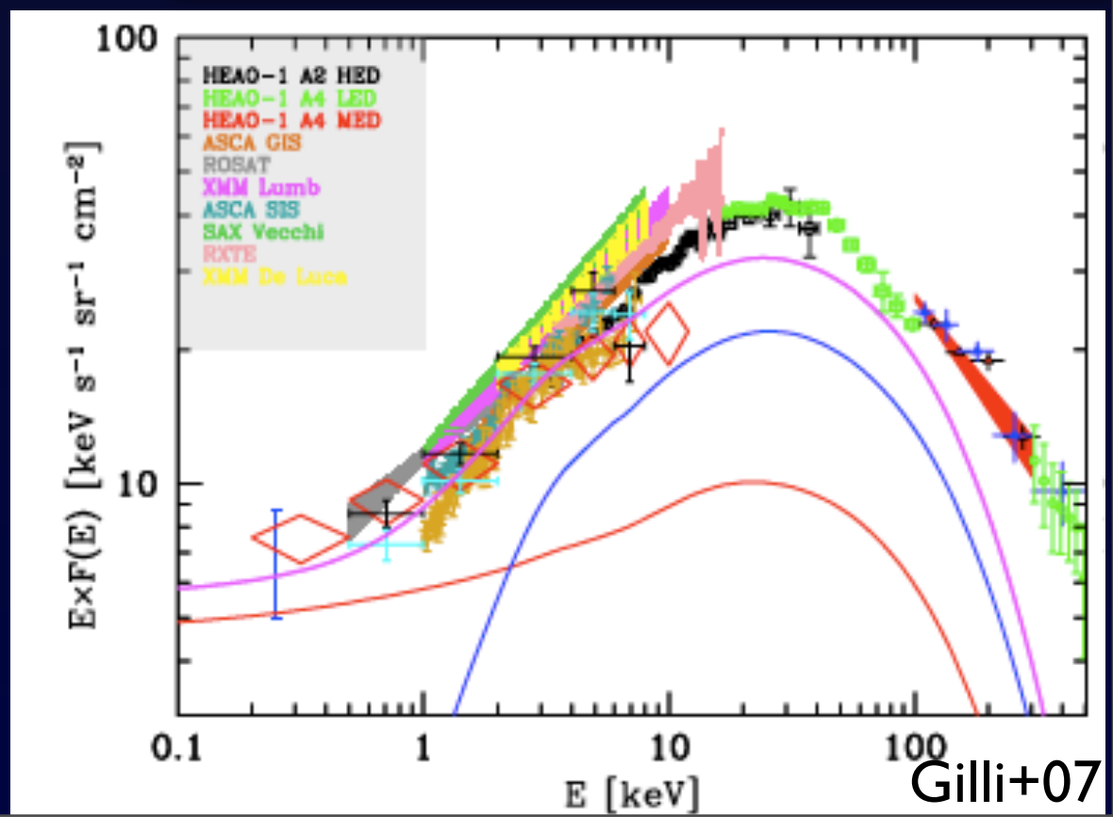
A complete BH census is a key issue to fully understand galaxy evolution.



Marconi+04



Gilli+07



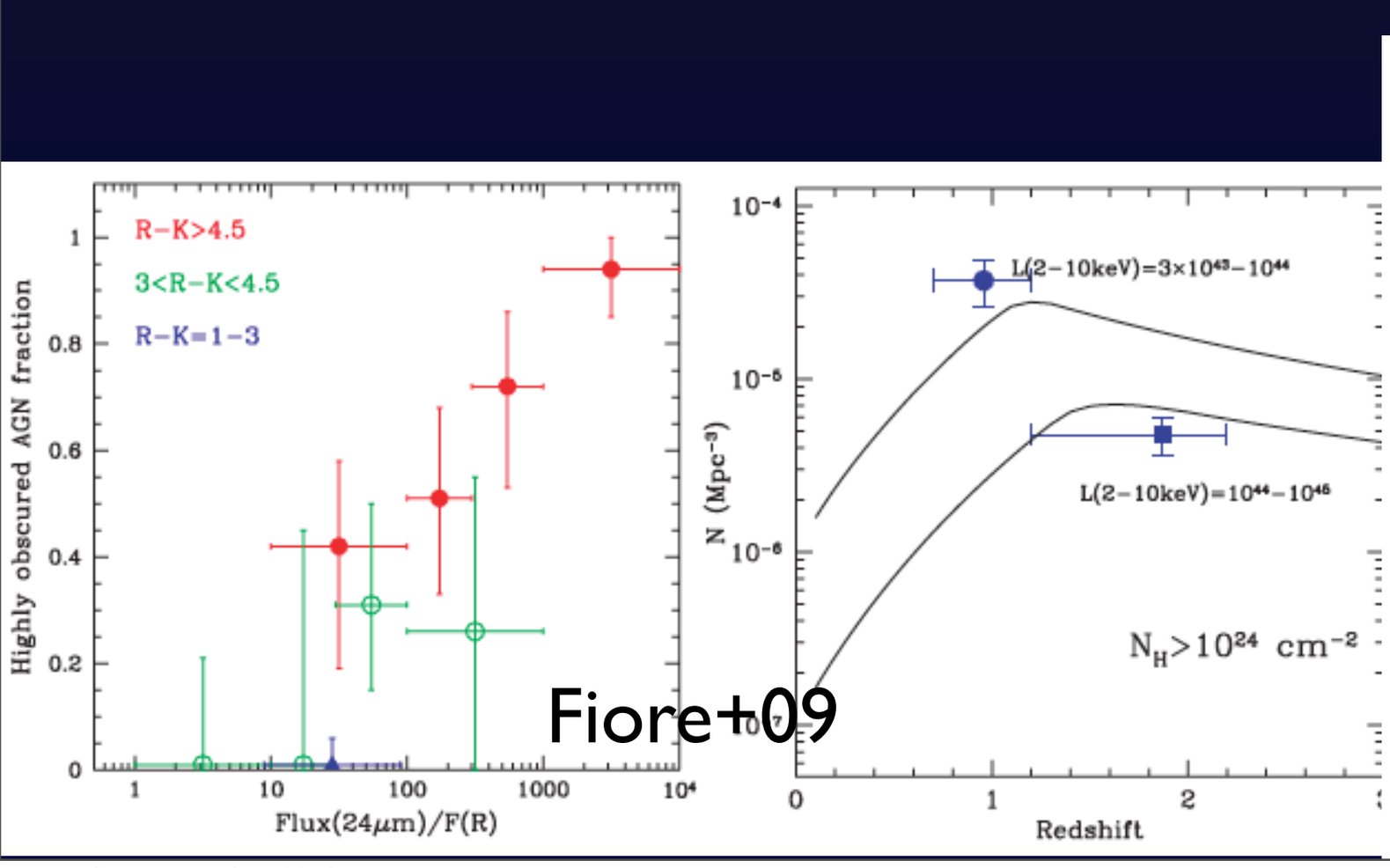
Gilli+07

C-thick AGN in MIR surveys

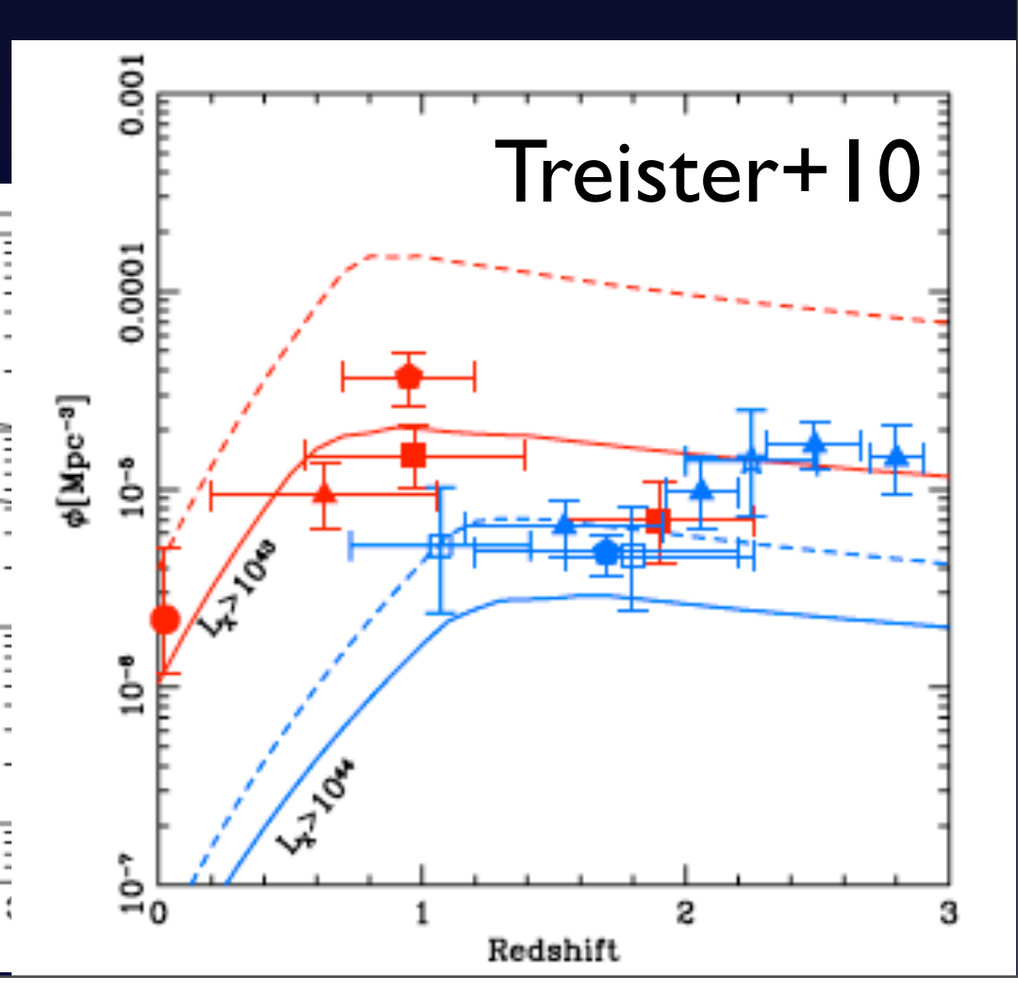
Blocked radiation is reprocessed by dust at MIR wavelengths.

Highly obscured AGN can be recovered by selecting sources with intense MIR emission (and faint optical/UV).

However, C-thick AGN are still present at smaller MIR/O ratios.



Fiore+09



The sample

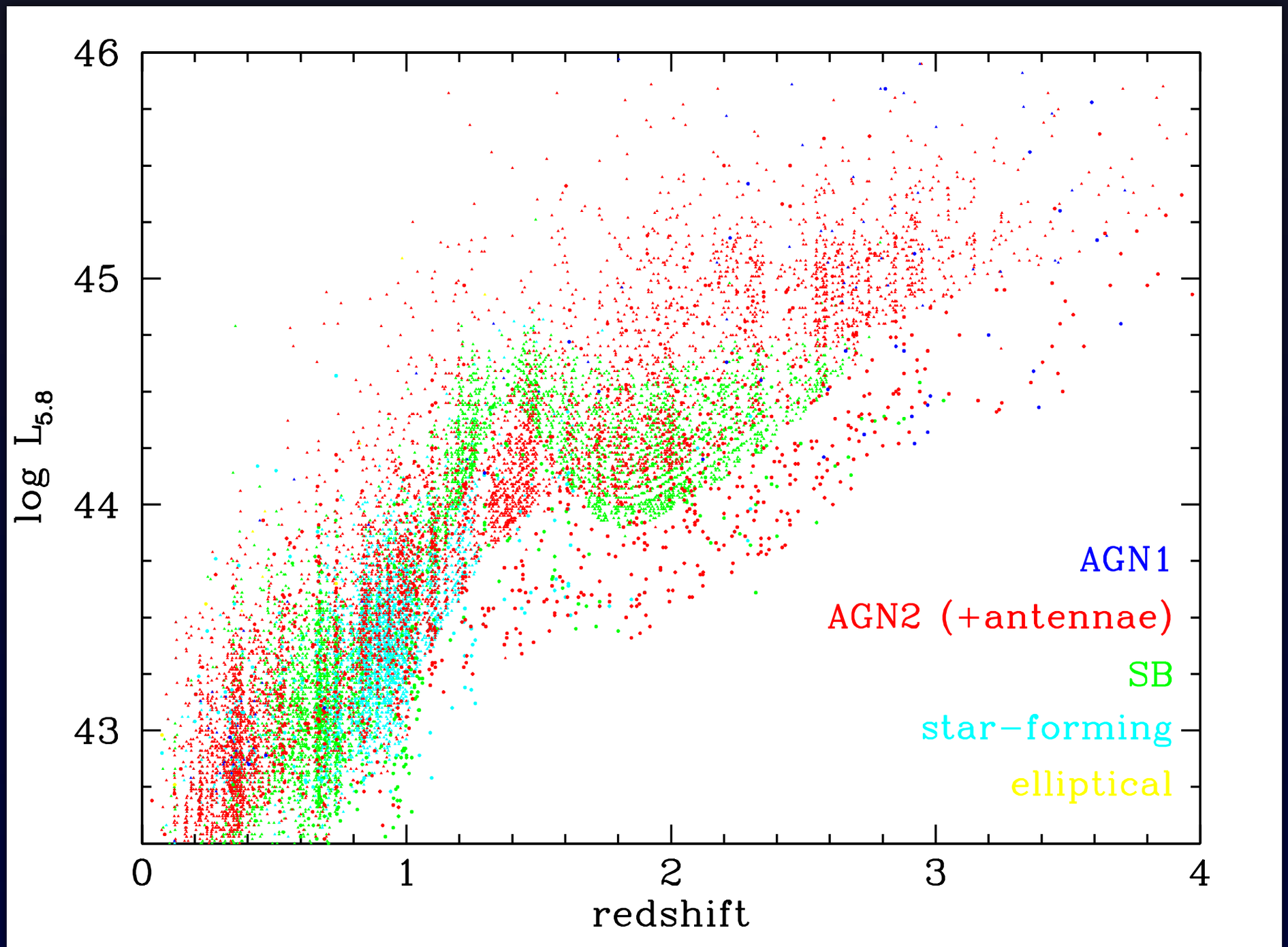
Data sets:

- COSMOS (MIPS GO3, F24>80uJy), central 0.9 deg^2 area fully covered by Chandra (~200 ks effective exposure, Elvis+09) ~15000 galaxies.

- GOODS-MUSIC (F24>20uJy, 0.143 deg^2; Grazian+06, Santini +09) + 4 Ms CDFS data (Xue+11), ~2000 galaxies.

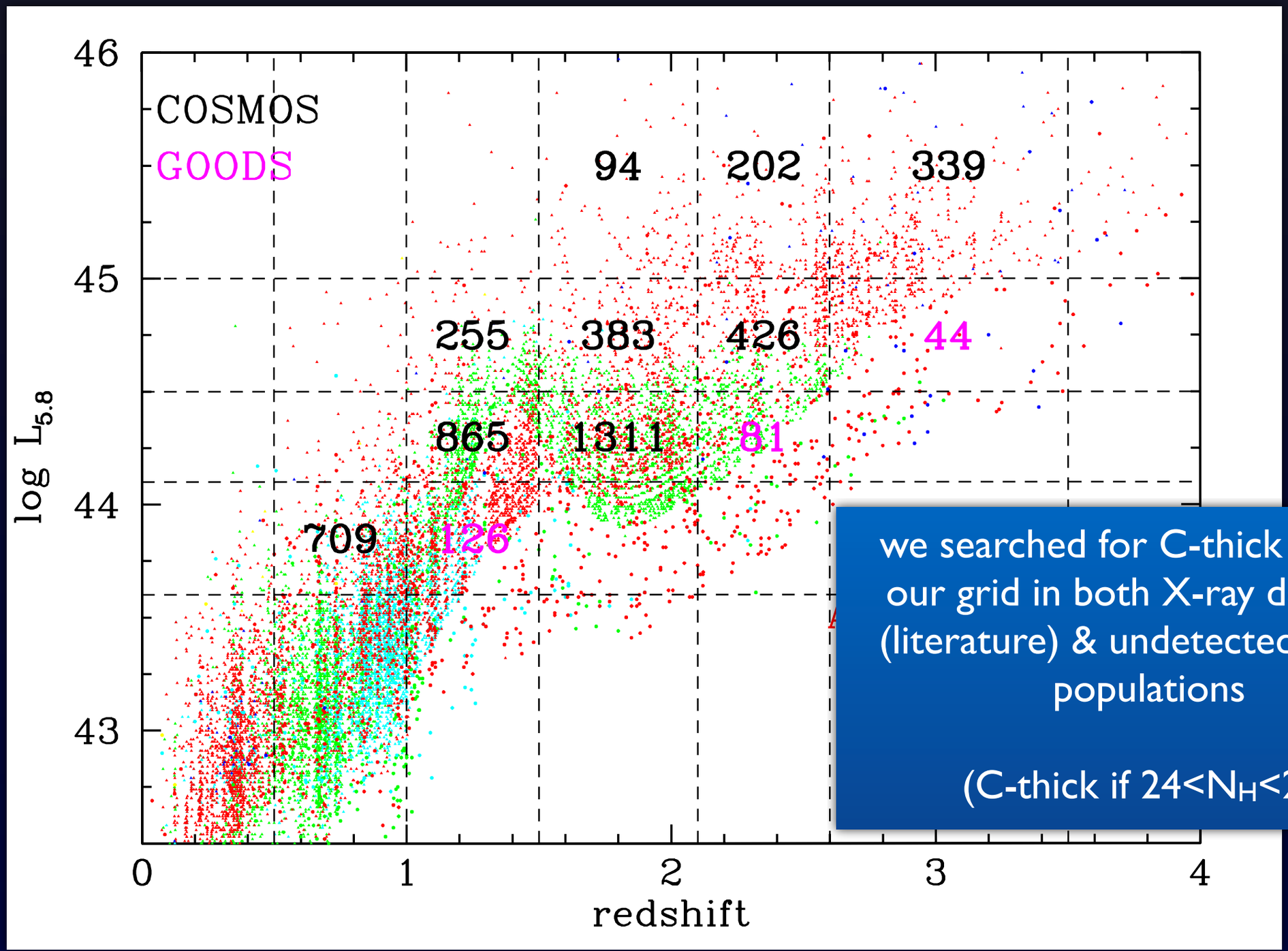
accurate 5.8 um luminosities from SED fitting (24 um+IRAC bands).

The sample


46
45
44
43
log $L_{5.8}$
0
1
2
3
4
redshift
AGN1
AGN2 (+antennae)
SB
star−forming
elliptical

The sample

12 $L_{5.8}$-z bin (9 with COSMOS sources, 3 with GOODS sources)



we searched for C-thick AGN in our grid in both X-ray detected (literature) & undetected source populations

(C-thick if $24<N_H<25$)

X-ray detected C-thick AGN?

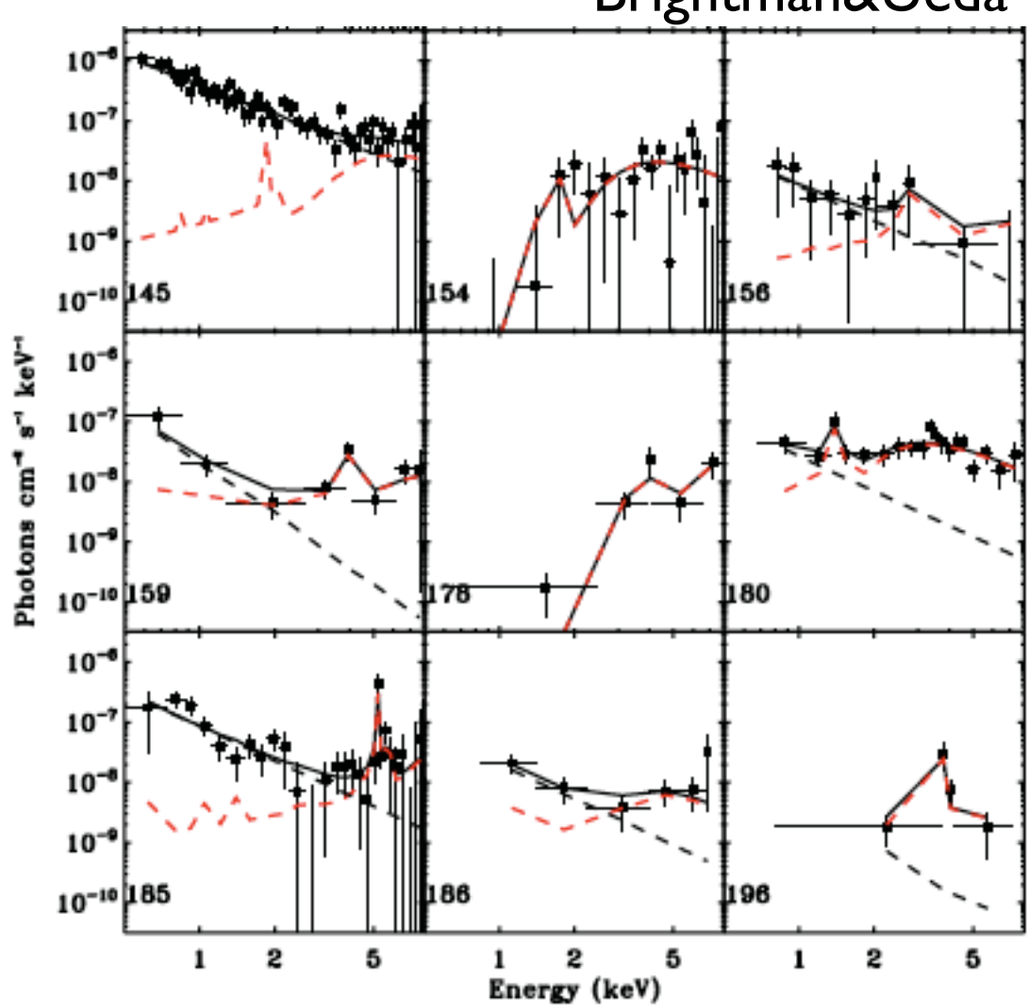
COSMOS: no C-thick among sources with a spectral fit.

We analyzed the average spectrum of the <70 cts and N_H>23.8 (from HR) subsample with no spectral fit but did not found any significant contribution.

GOODS: 41 C-thick AGN from Brightman&Ueda 2012 ($24<N_H<26$) from CDFS 4 Ms, 20 secure (cl>90%).

Included in our analysis.

Brightman&Ueda 12



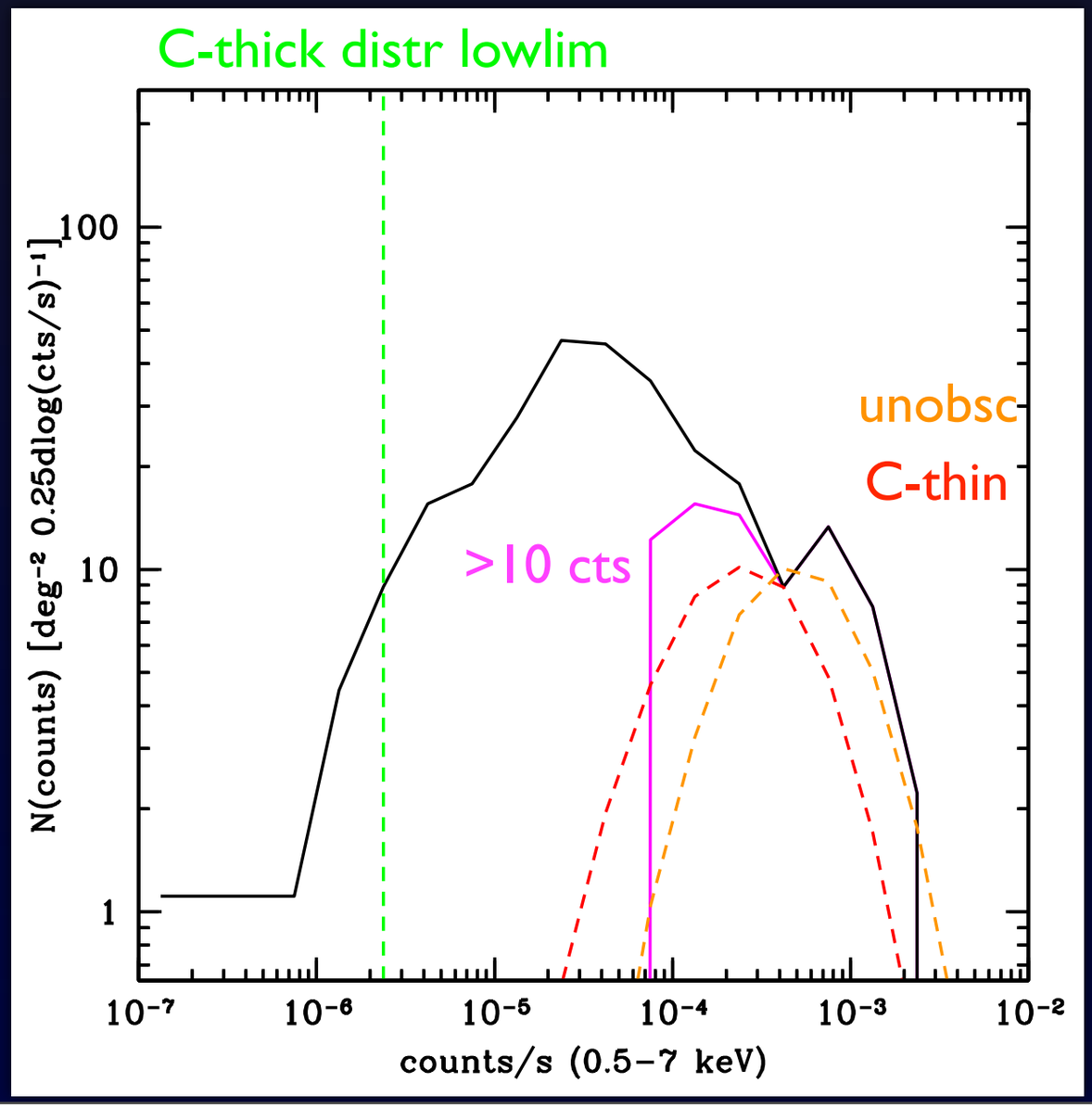
X-ray undetected sources

We constrain the C-thick AGN fraction among MIR sources by comparing the observed average HR (from stacking analysis) with simulated values for different expected fractions (assuming an N_H distribution and an average spectrum).

We studied the 0.5-7 keV count rate distribution of MIPS sources and searched the range in which C-thick AGN are expected to be found.

X-ray count rate distribution

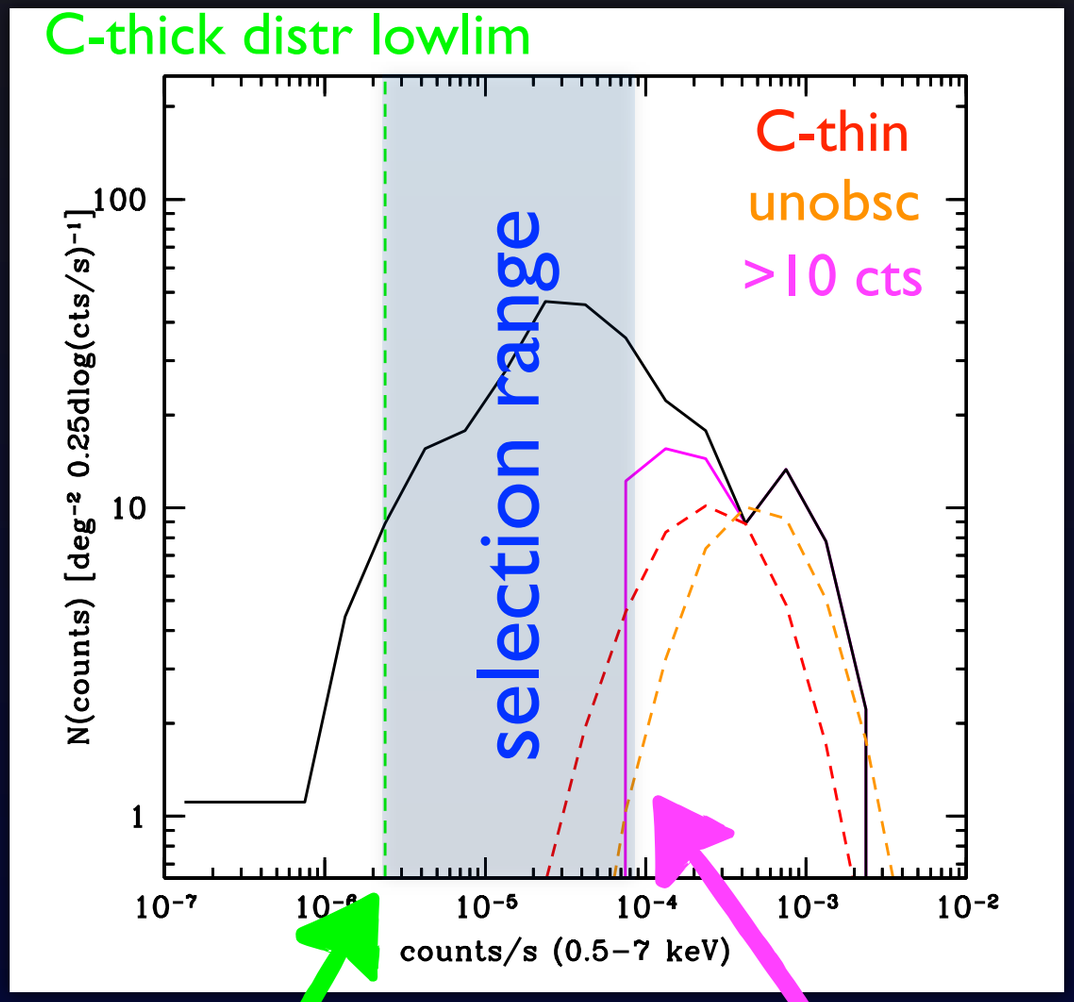
We generated the expected count rate distributions of unabsorbed, C-thin & C-thick AGN as predicted from the La Franca+05 luminosity function, assuming a scaling relation between 5.8 um and X-ray luminosities and an average X-ray spectrum (function of N_H).



We calibrated the $L_{5.8}$-L_X relation using the C-COSMOS data for two classes of absorption.

Comparing the expected and observed count rate distributions we define (for each bin) a count rate range in which we perform the following stacking analysis and simulations.

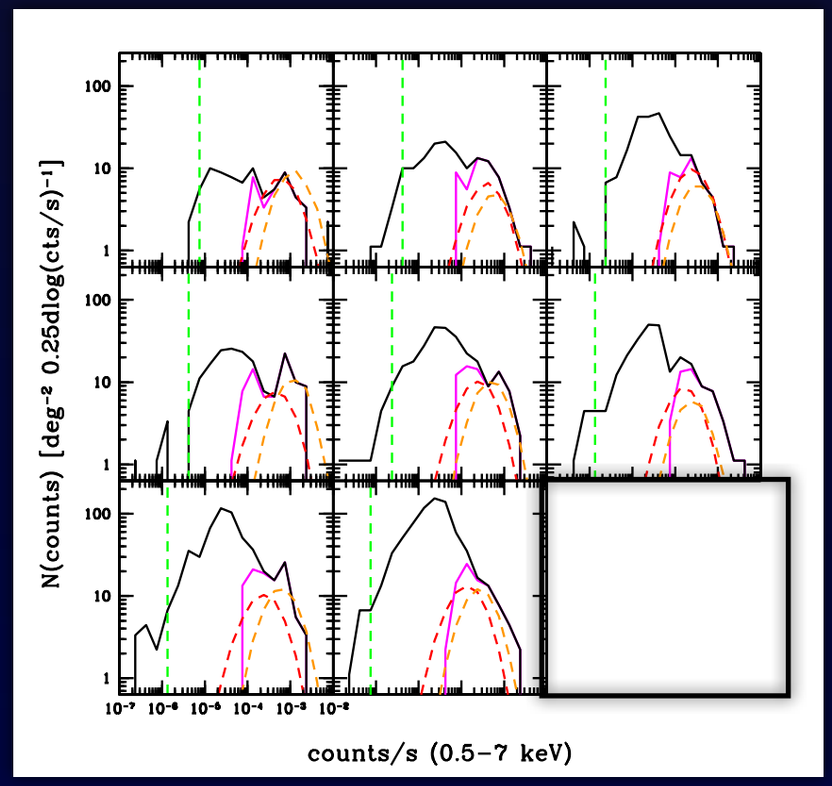
X-ray count rate distribution



good agreement between the expected unobscured & C-thin distributions and secondary peak at high cts/s.

end of expected CTk cts/s distribution; little CTk expected here (mostly SF galaxies)

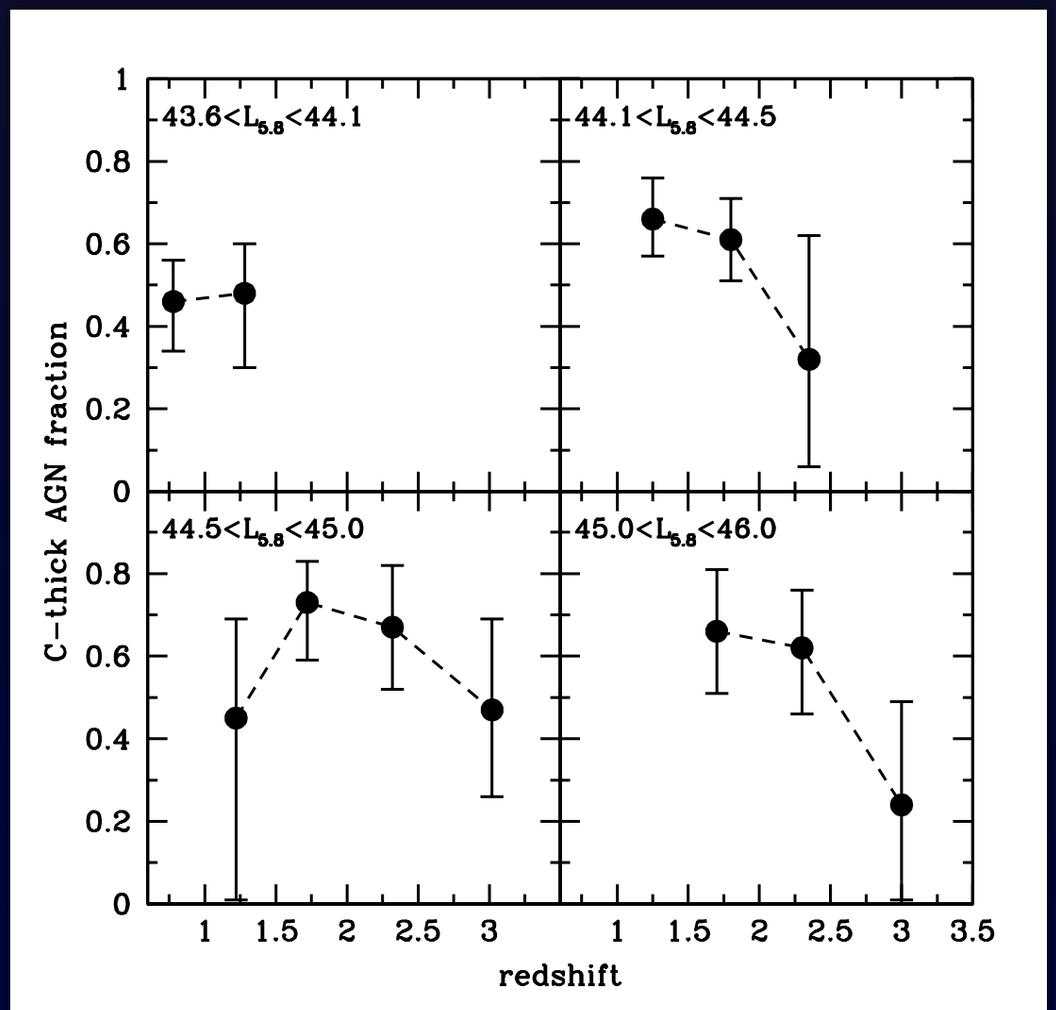
~thin/unobsc distributions; few CTk expected here (will be detected!)

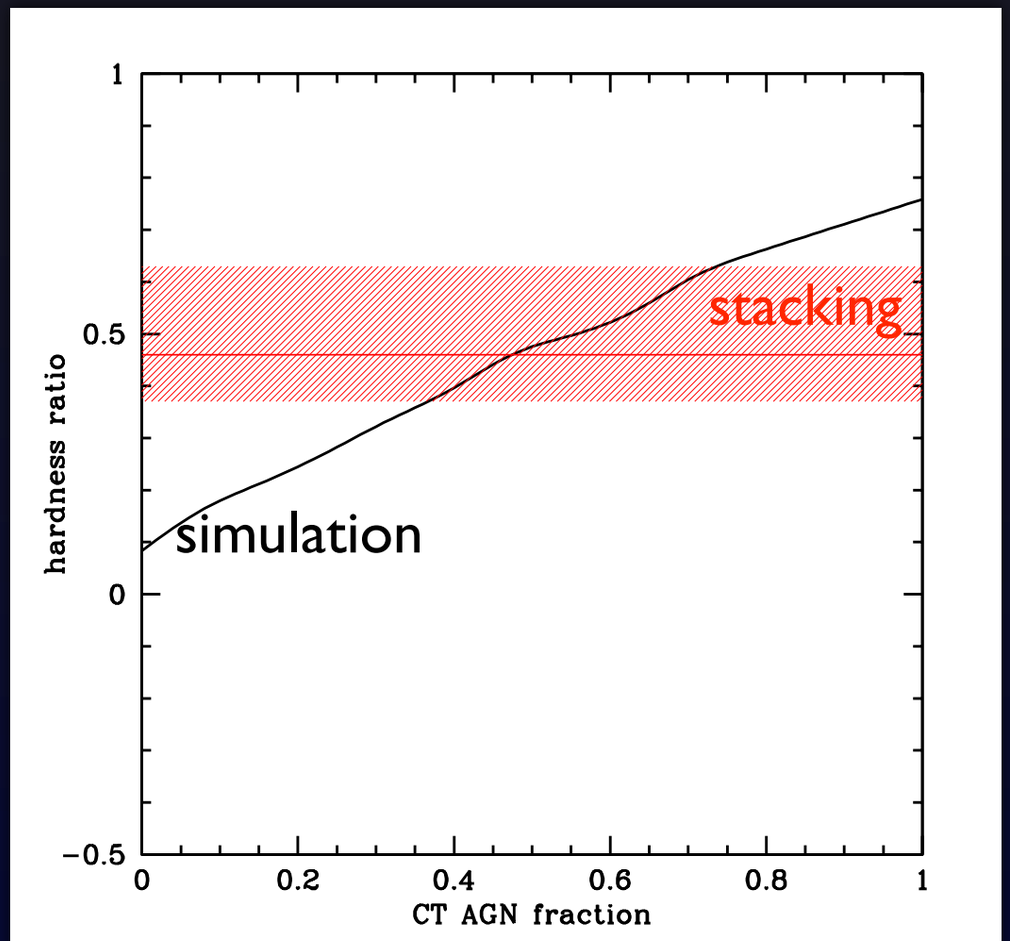


C-thick AGN fraction

X-ray stacking analysis for the sources in the selected cts/s range.

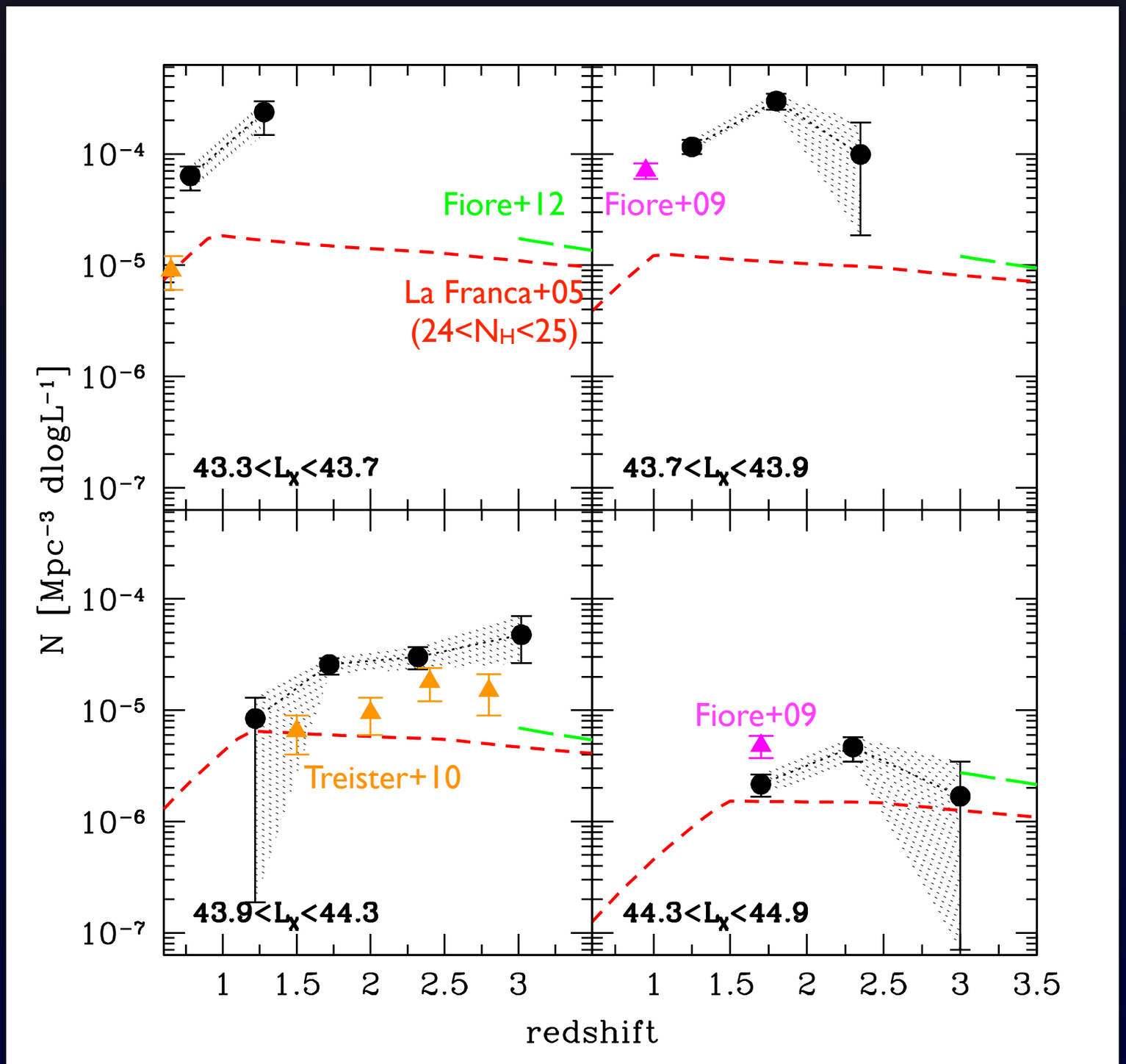
Observed HR are compared with detailed simulations of C-thick+SF galaxies to constrain the C-thick fraction in each bin.





By correcting the volume density of IR sources by the C-thick fraction in each bin we find the C-thick volume densities.

C-thick volume density

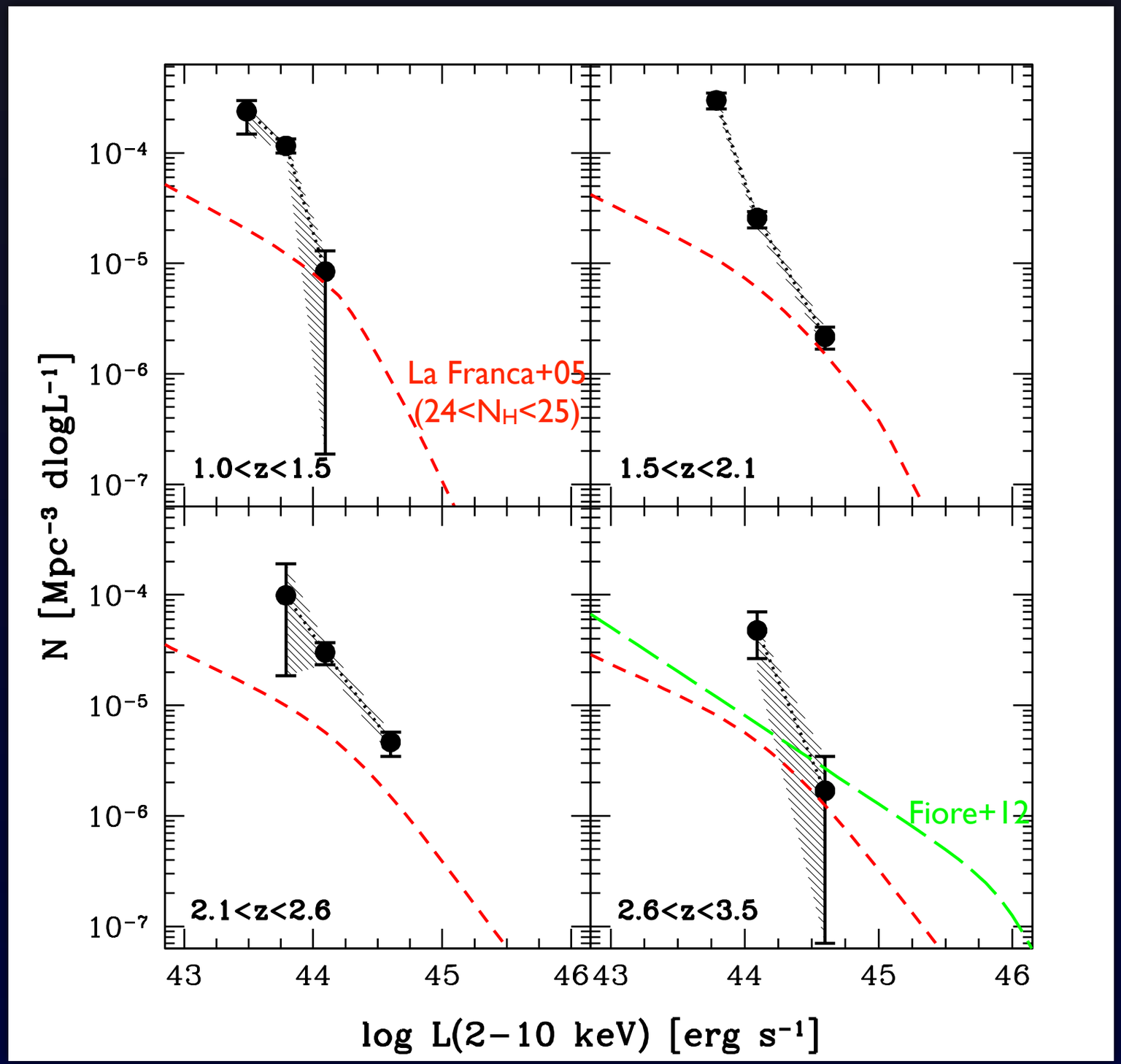


Density of IR sources in each bin are computed with $1/V_{max}$ method.

Correcting by the C-thick fraction in each bin gives the C-thick volume densities.

CDFS X-ray detected C-thick densities (Brightman&Ueda 2012) are also computed & included.

C-thick volume density



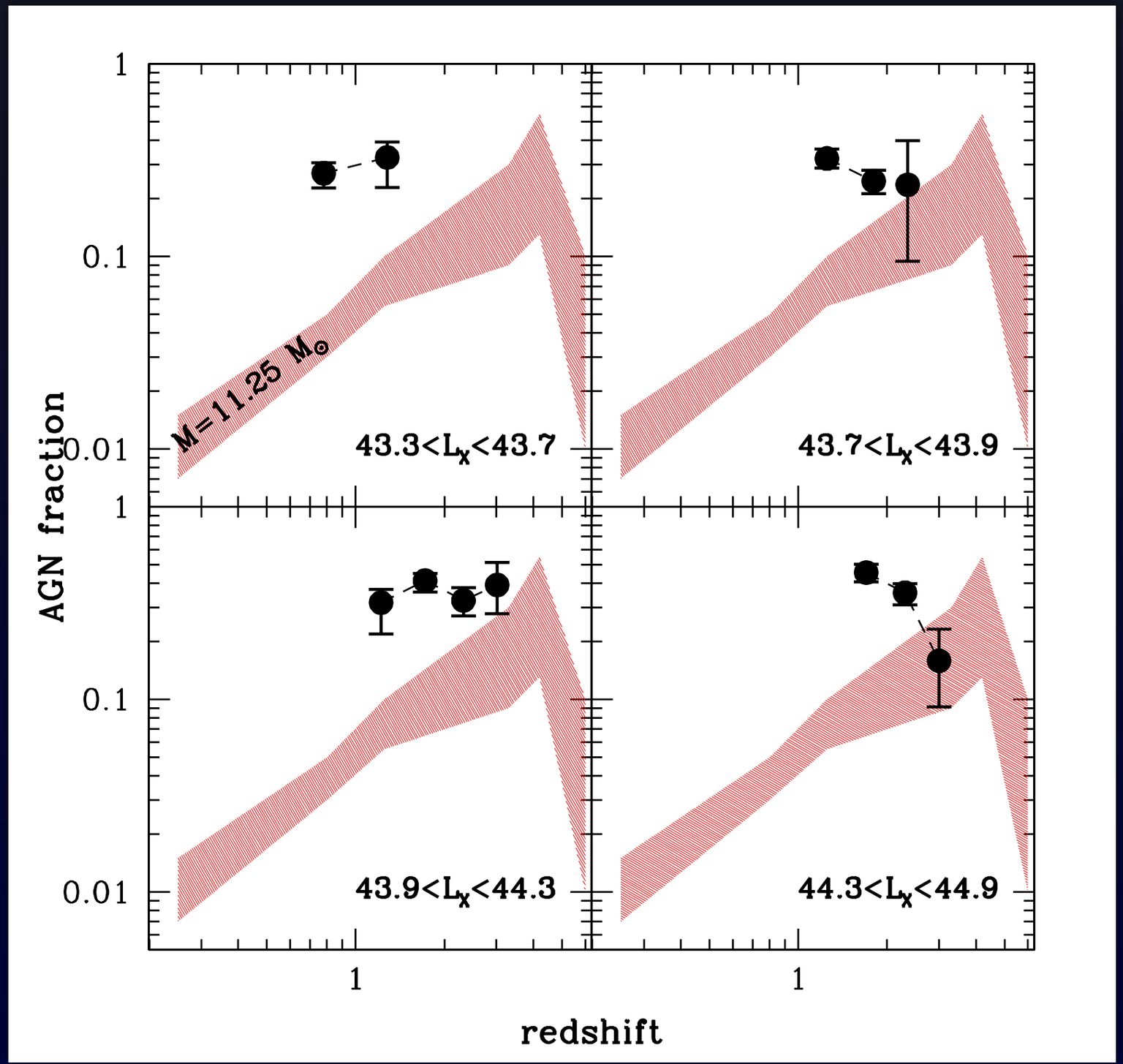
Density increasing at low luminosities.

Total accreted BH mass in agreement with local BH density estimates:

$$\rho_{BH} = 3.55 \times 10^5 \; M_\odot \; \mathrm{Mpc}^{-3}$$

(unobscured + C-thin + C-thick)

AGN duty cycle



PRELIMINARY

n of AGN with N_H<24 has been computed assuming La Franca+05 LF.

Shaded areas: expectations from Fiore+12 (active +normal galaxies).

duty cycle ~30% at z=1-3

Summary

- we computed the volume density of IR sources in 12 $L_{5.8}$-z bins and used the fraction of C-thick AGN found in these bins to find the volume density of C-thick AGN;

- we adopted a new selection criterion based on the count rate distribution of C-thick AGN to define the count rate range in which perform our study;

- we found higher densities for C-thick AGN than expected from X-ray luminosity functions predictions (increasing at low luminosities);

- our estimation imply a total accreted black hole mass that is still compatible with the local black hole mass density estimations;

- we found a value of ~30% at z=1-3 for the AGN duty cycle.