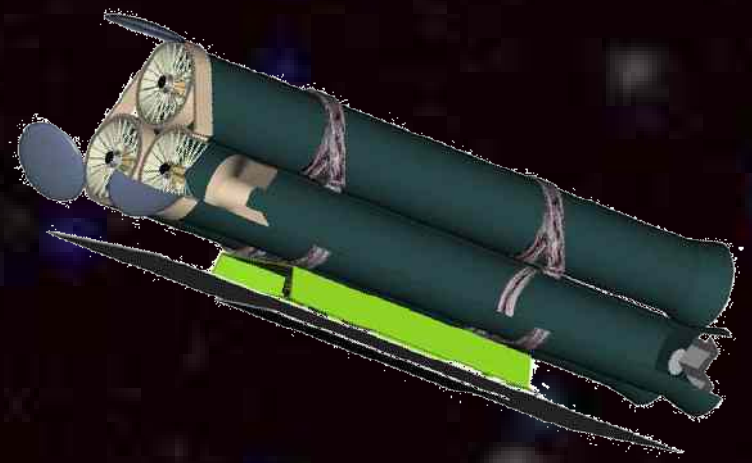
Simulating the X-ray Sky as seen by WFXT

with
Joana Santos
Andrea Bignamini
Heng Yu
Stefano Borgani
Piero Rosati
Roberto Gilli
and the WFXT team



WFXT in few words

The WFXT mission: one high resolution, high collecting area and wide FOV X-ray telescope with low background, to image the 0.5-7 keV X-ray sky down to very low fluxes and characterize the spectra of millions of X-ray sources.

The scientific outcome will be a coverage of at least half of the 0.5-7 keV X-ray sky with a quality and a depth at the level of future multiwavelength wide area surveys, a product which is not delivered by any other existing or planned mission.

WFXT Simulations

Produce images in different energy bands with realistic populations of AGN and Clusters, instrumental and physical backgrounds/foregrounds, to test detection algorithms, check confusion limit, size of the WFXT clusters catalogs, X-ray spectroscopic sample, ICM physics etc, and build accurate science cases, especially those that can be addressed only by WFXT.

Imaging and Spectral simulations are run independently (i.e. we are not creating event files).

The simulations set up will be easily updated as the mission design settles down.

WFXT Key Features

Constant PSF (5" goal HEW) across 1 degree FOV (SiC design)

Effective area ~ 15 X Chandra at 1 keV (goal ~9000 cm^2)

Bandpass: ~ 0.5-7 keV

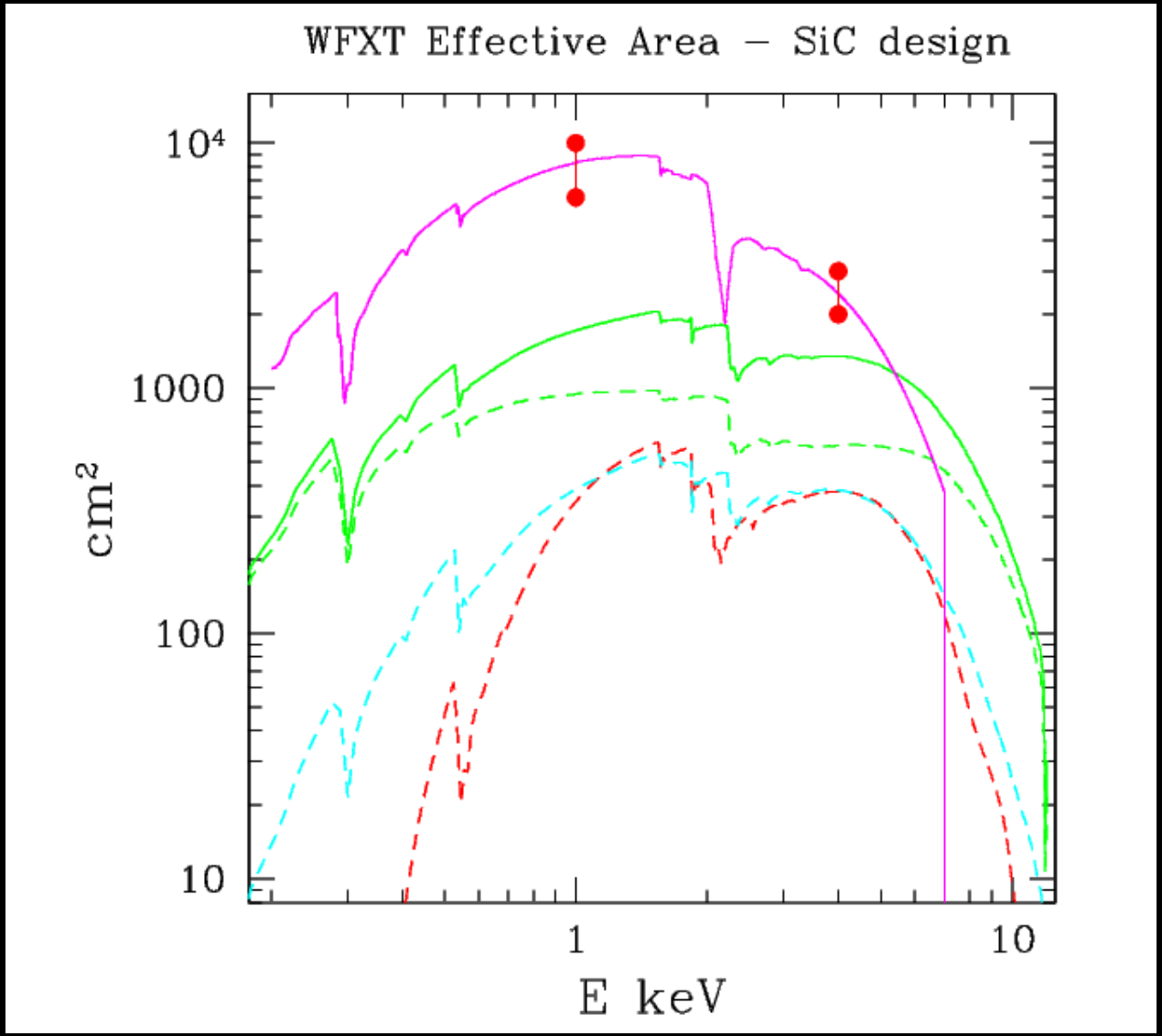
Dedicated survey mission (no GO program), calibrated data products released with no proprietary period

Science goals: discovery and characterization of groups and clusters, evolution of AGN population, star forming galaxies traced up to z>1, halo stars, SNR and compact Galactic objects...

Will serve as a target finder for future X-ray missions

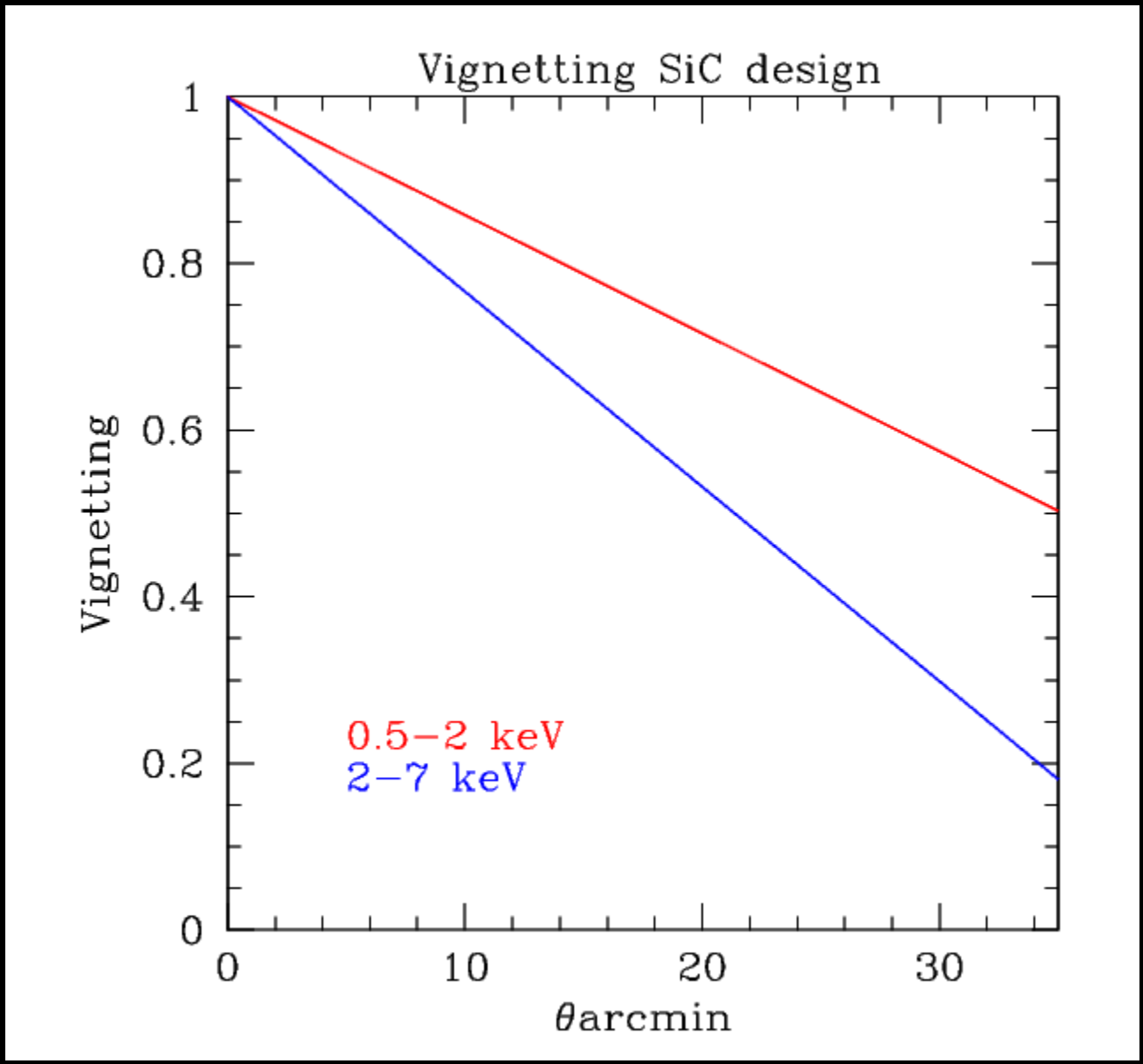
Effective area

Note:
Eff Area
~1/3 of IXO



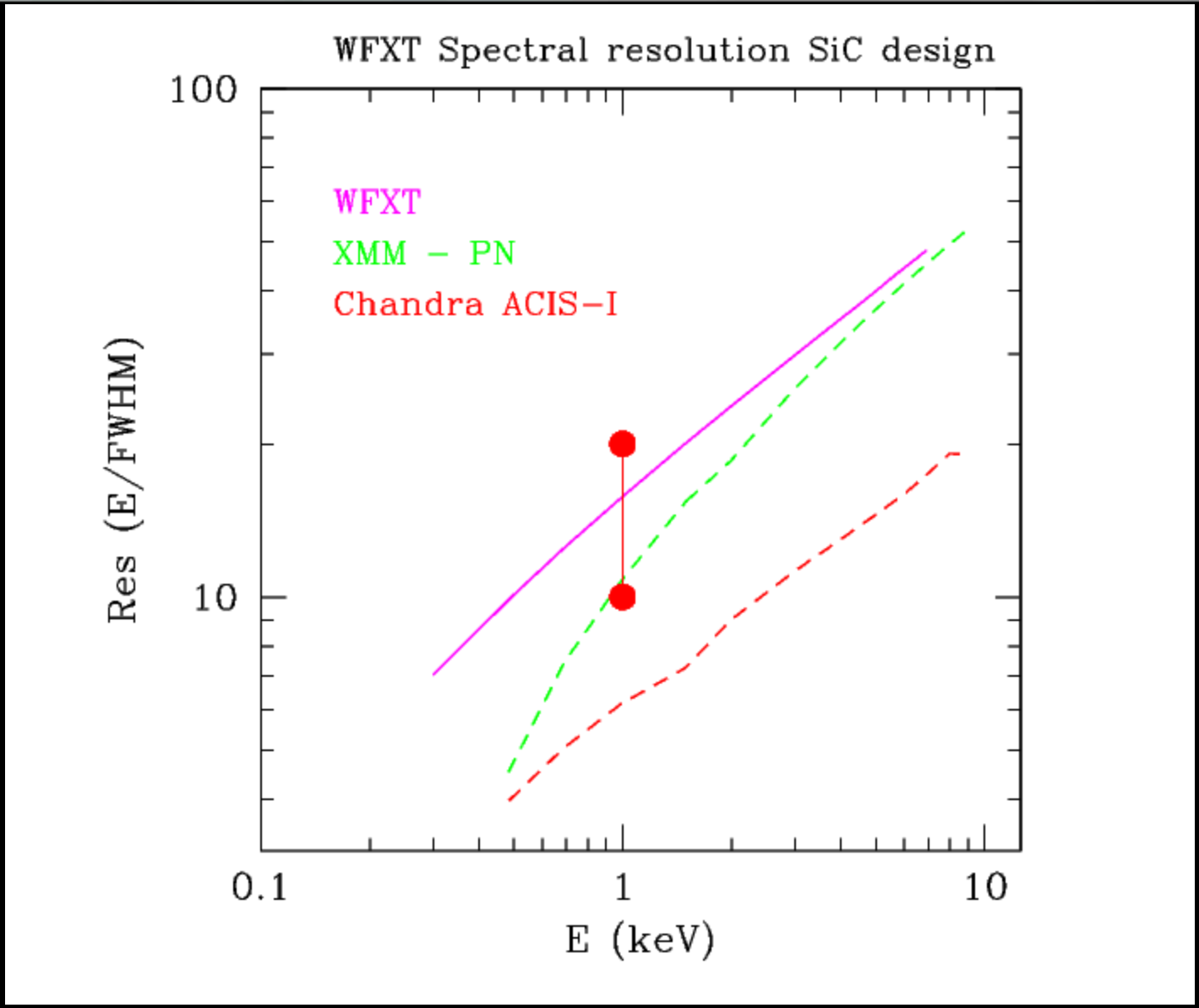
Average Vignetting (SiC design)

Note: Significant vignetting in the hard band.



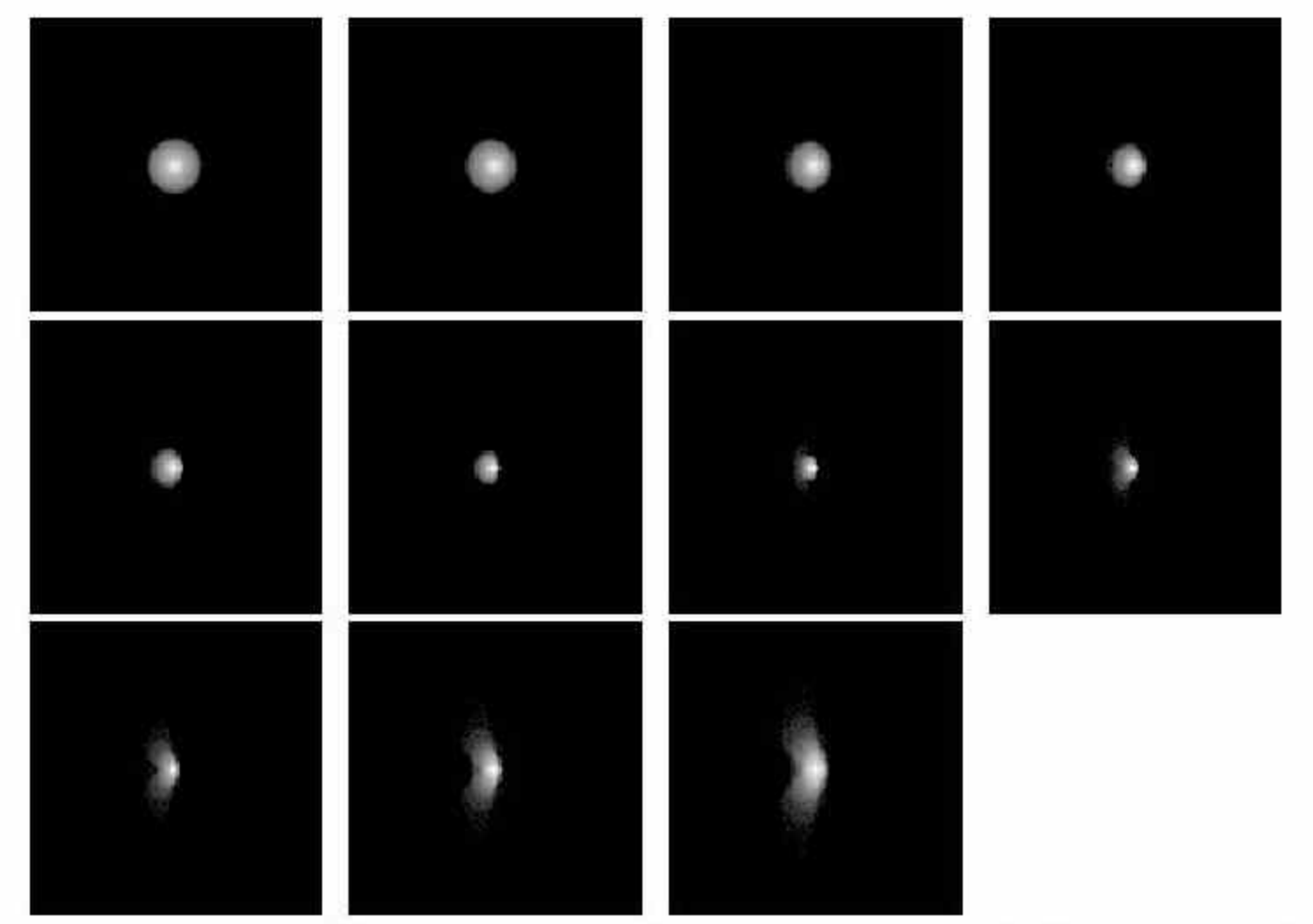
Spectral Resolution (CCD)

Note:
crucial for
line diagnostics



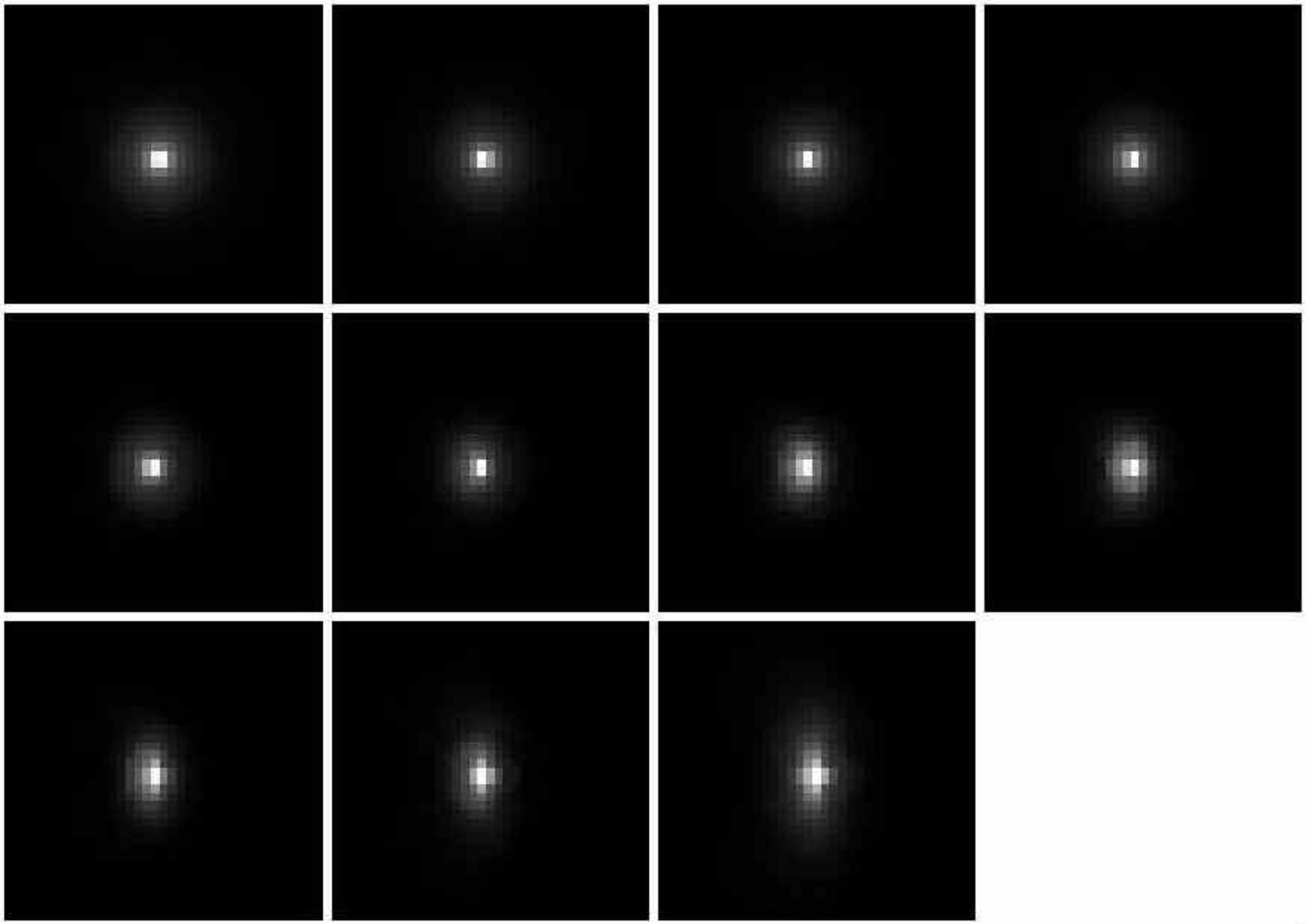
PSF 1keV, SiC design, no manuf. errors

from P. Conconi, August 2009



PSF SiC design, with manuf. errors

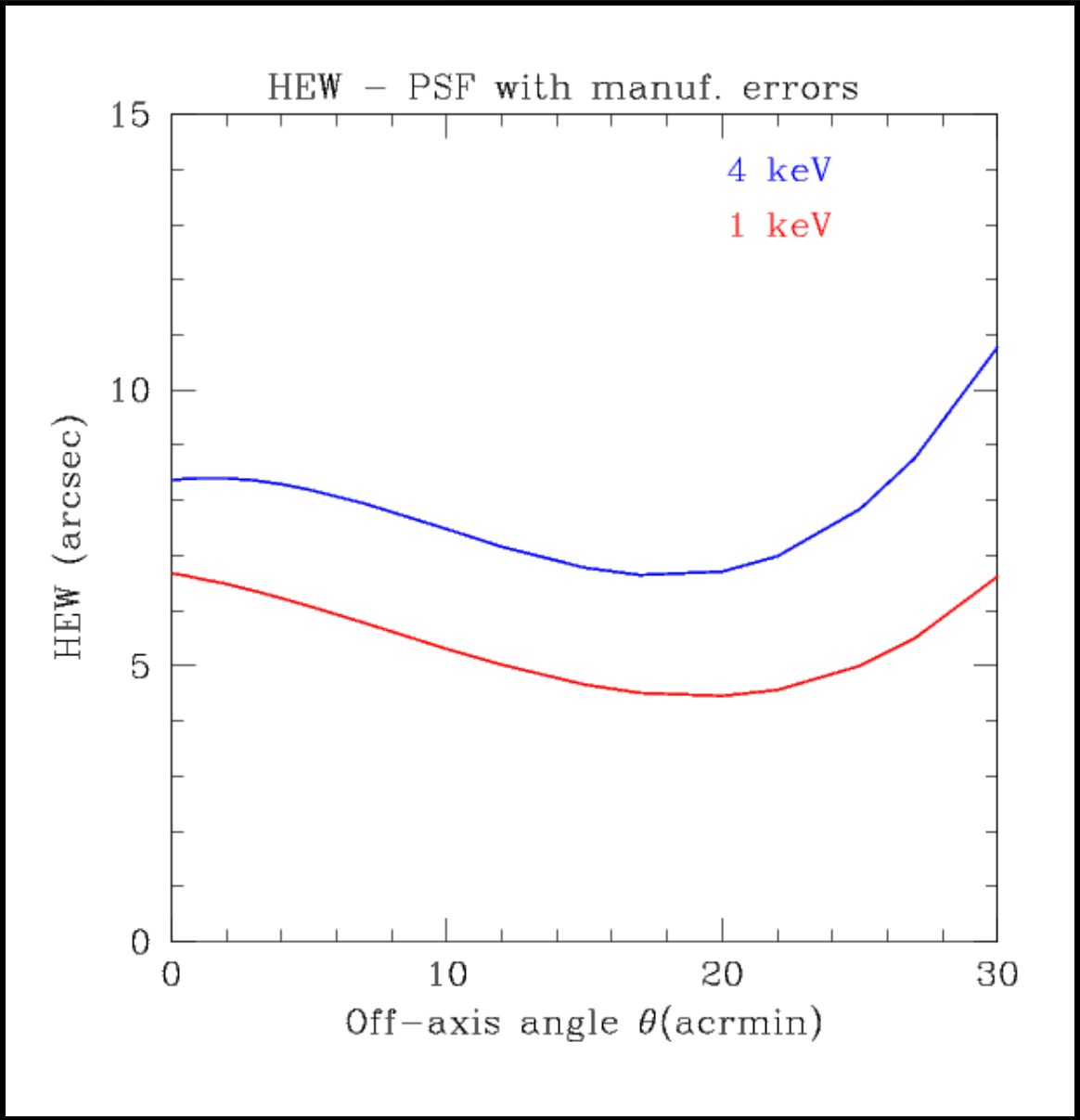
from P. Conconi, August 2009



HEW of the PSF as a function of θ

Note: the inclusion of manufactoring errors makes the PSF flatter as a function of the off-axis angle.

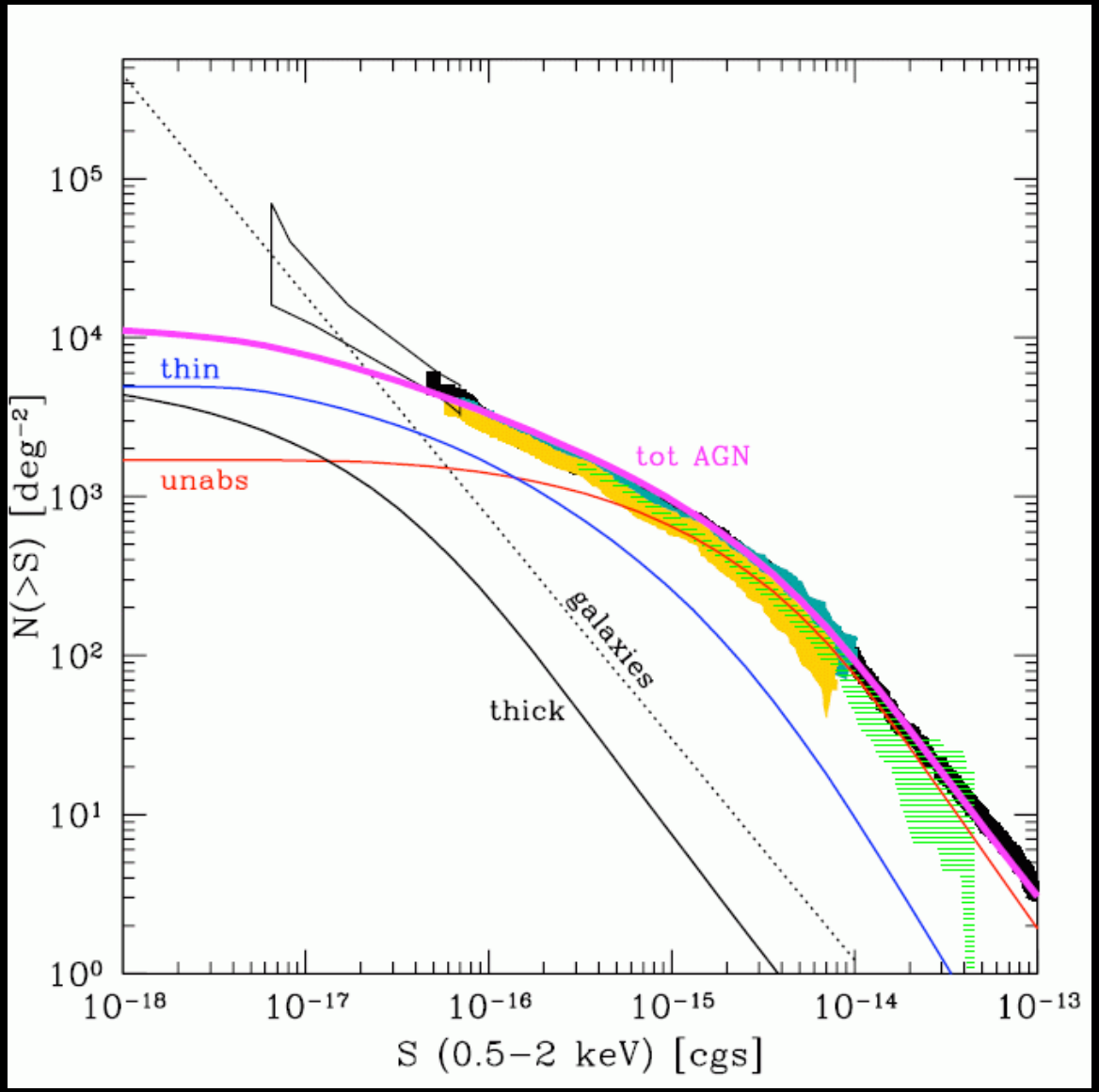
Note: HEW in the hard band is about 2" higher



Planned Surveys

	Wide	Medium	Deep	(Milky Way)
Area (deg^2)	~20,000	~3,000	~100	~1000
$F_{lim,ext}$ (cgs)	$5x10^{-15}$	$1x10^{-15}$	$1x10^{-16}$	$5x10^{-16}$
$F_{lim,pt}$ (cgs)	$3x10^{-15}$	$5x10^{-16}$	$3x10^{-17}$	$1x10^{-16}$
Exposure Time (sec)	$2x10^{3}$	$1.3x10^{4}$	$4x10^{5}$	$\sim 5x10^{4}$
Duration	~2 yr	~2 yr	~1 yr	~1 yr

AGN and Galaxies



Point sources catalogue down to fluxes 10^{-17} cgs with ~30000 sources in one sq deg, of which 1/3 AGN and 2/3 galaxies (following Gilli et al. XRB synthesis model)

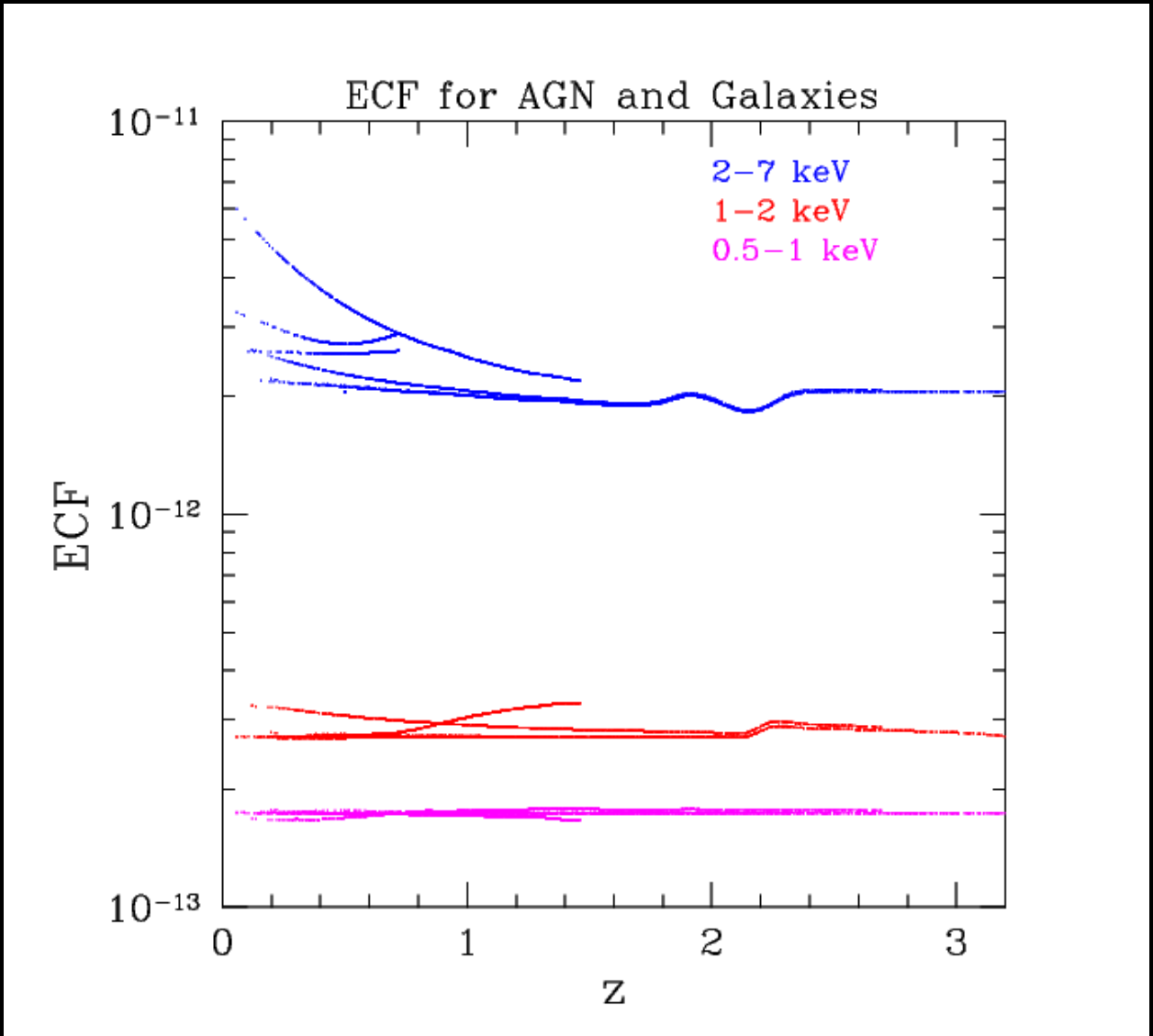
Typical Conversion factors

at the aimpoint

	$0.5-2$ keV	$2-7$ keV
AGN Thin, z=1, $N_H = 10^{21}$	2.2×10^{-13}	2.05×10^{-12}
AGN Thick, z=1, $N_H = 1.5\,10^{23}$	3.45×10^{-13}	2.4×10^{-12}
Galaxies, $\Gamma = 1.9$	2.16×10^{-13}	2.05×10^{-12}
Cluster $kT = 5$, $Z_\odot = 0.3$, $z = 0.5$	2.22×10^{-13}	1.85×10^{-12}

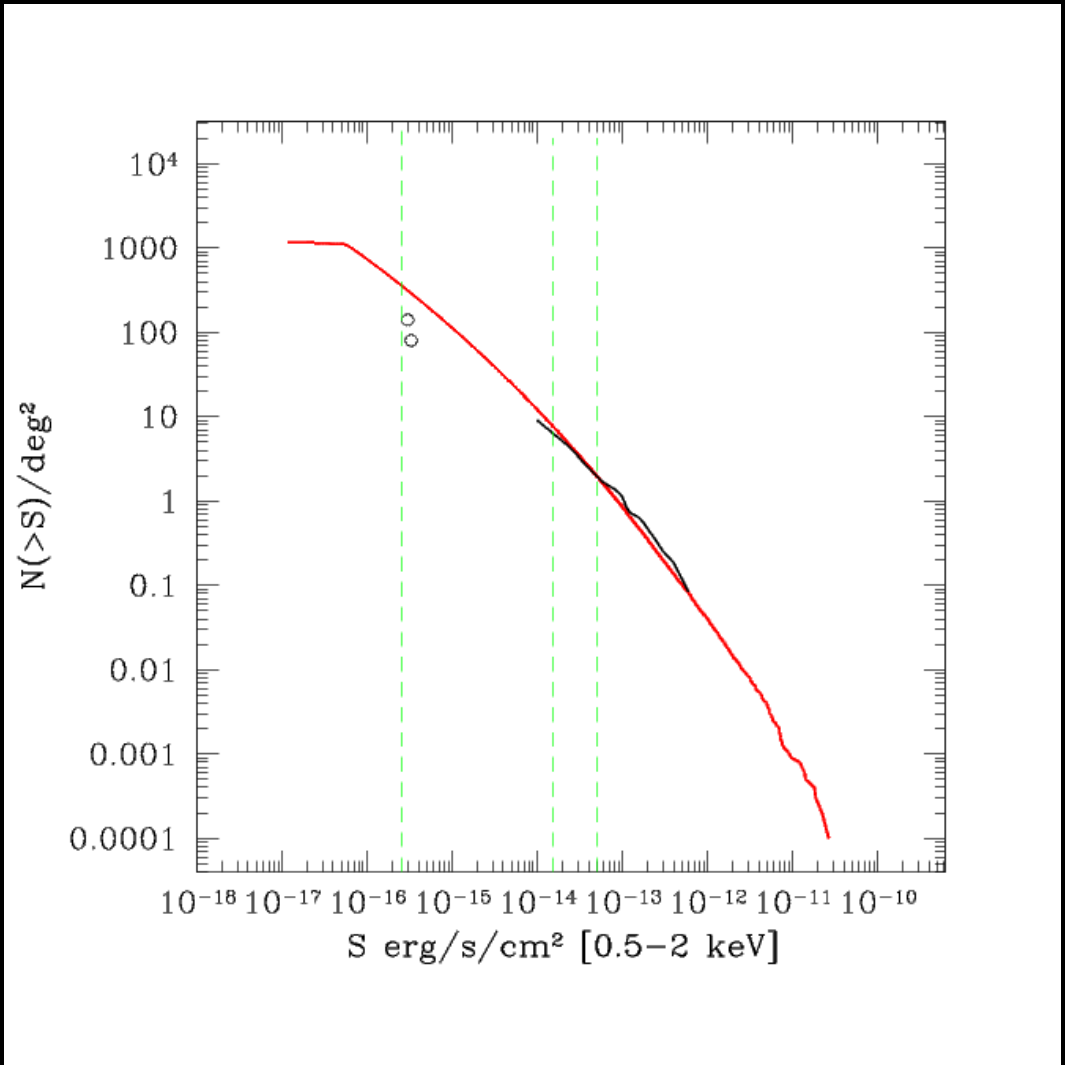
ECF for AGN and Galaxies

Note: we have one NH value for each type (unabsorbed & Galaxies, Thin AGN, Thick AGN)



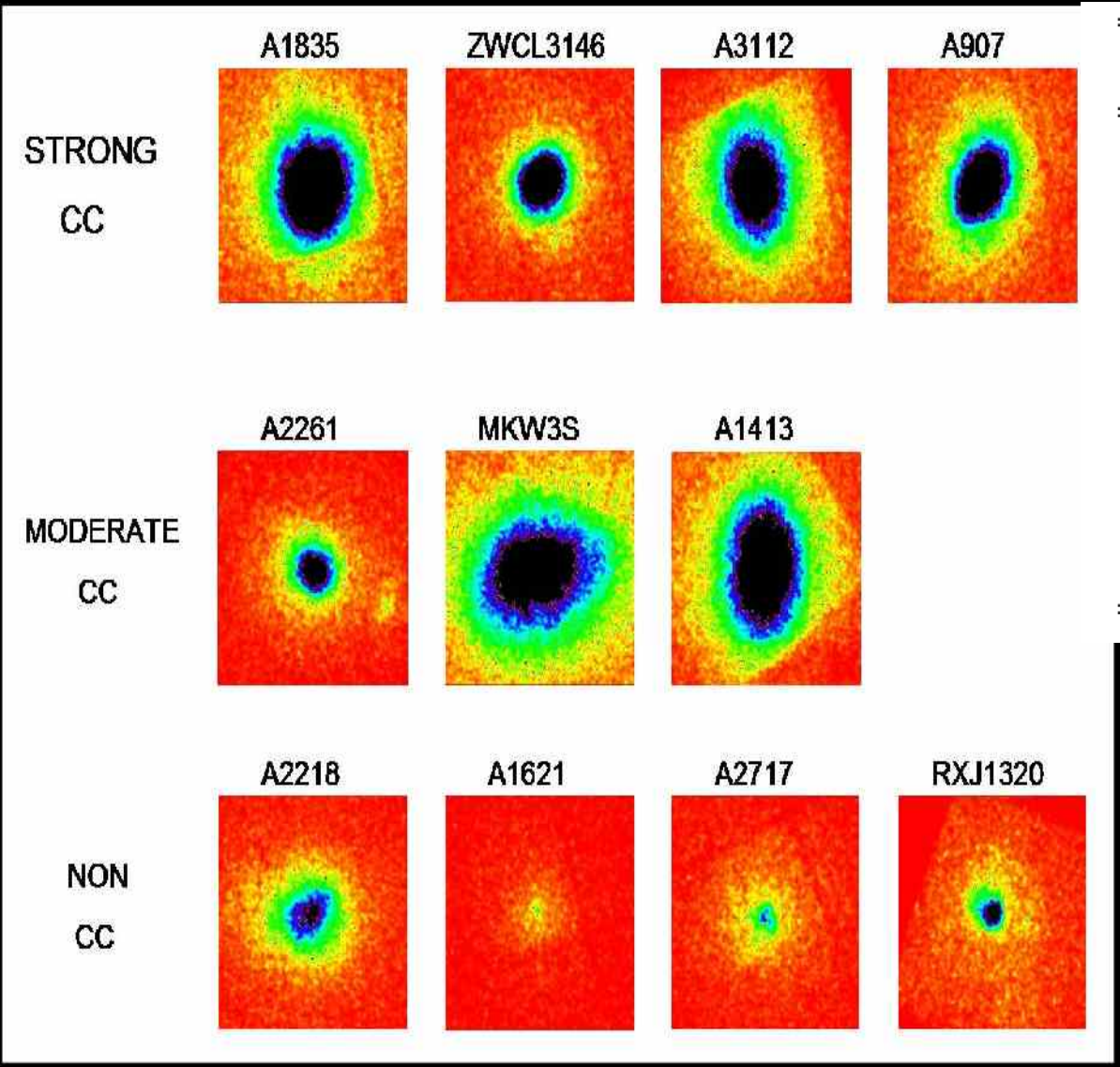
Groups and Cluster LogN-LogS

Note: from 10000 sq deg



Groups/Clusters population
Yu Heng

Groups and Clusters of Galaxies



Cluster	kT (keV)	z	class
RXJ1320	1.00	0.036	0
A2717	2.4	0.0475	0
MKW3S	3.66	0.043	0.5
A1621	3.6	0.085	0
A3112	4.1	0.075	1
A907	5.82	0.153	1
A2218	6.25	0.177	0
A1835	8.1	0.253	1
A2261	7.3	0.224	0.5
A1413	7.5	0.143	0.5
ZWCL3146	8.6	0.291	1.0

Cloning technique, see Santos et al. 2008

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at the aimpoint

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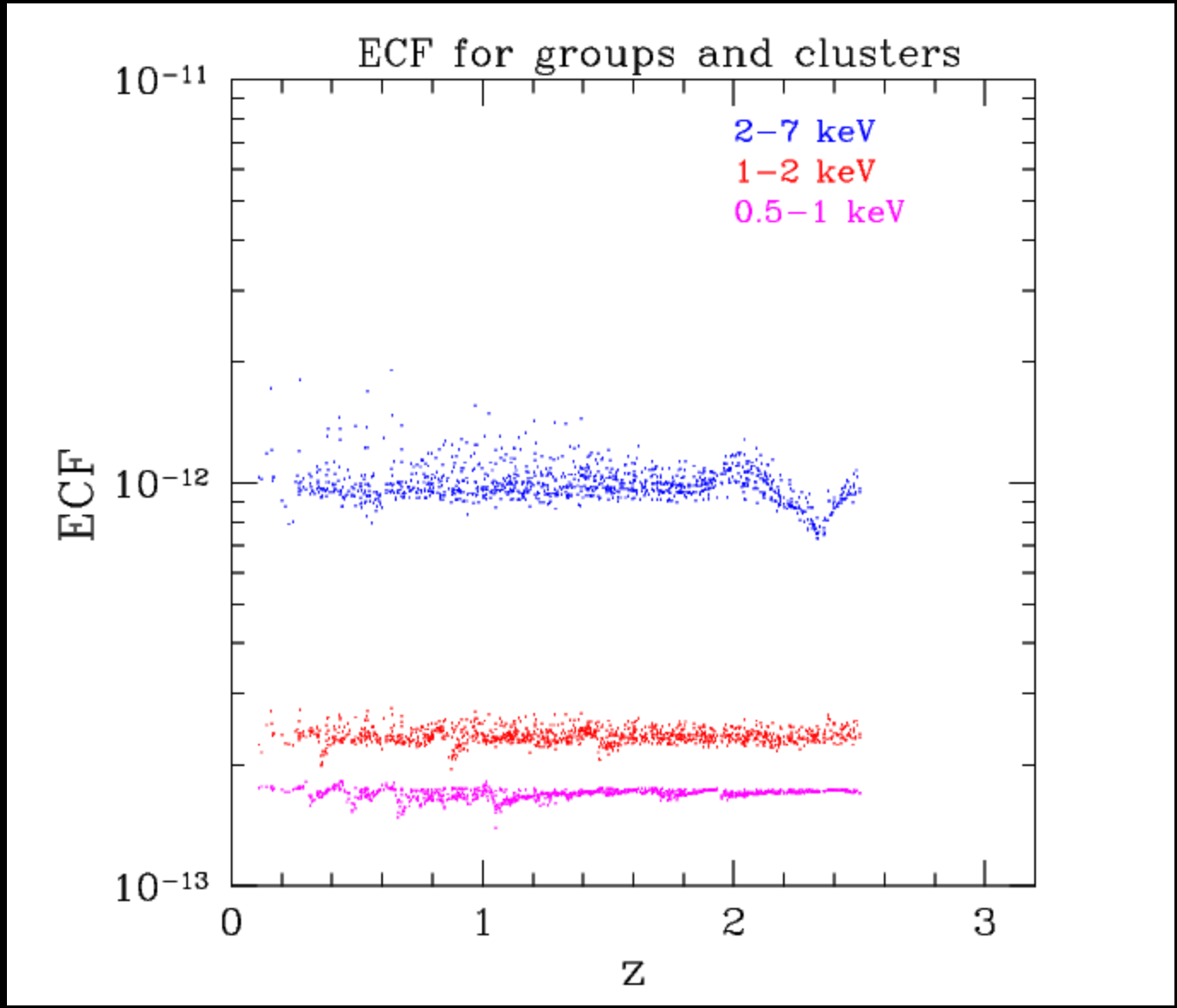
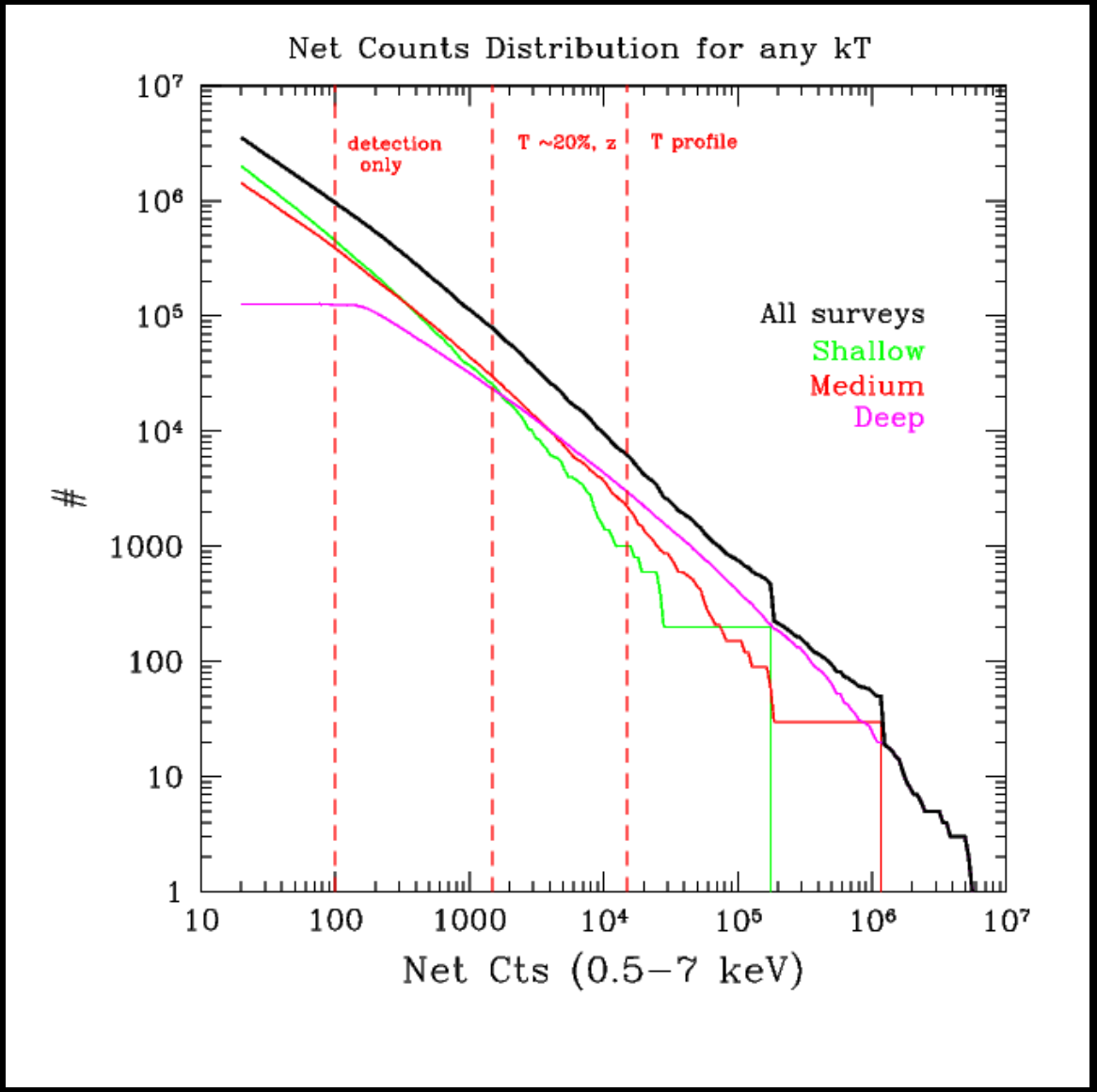
ECF for Groups and Clusters

Note: the dispersion is given by the Temperature distribution at each redshift.
Wiggles correspond to emission lines going through the energy passbands.



Net counts distribution for groups and cluster

Extracted from PS-like Mass Function



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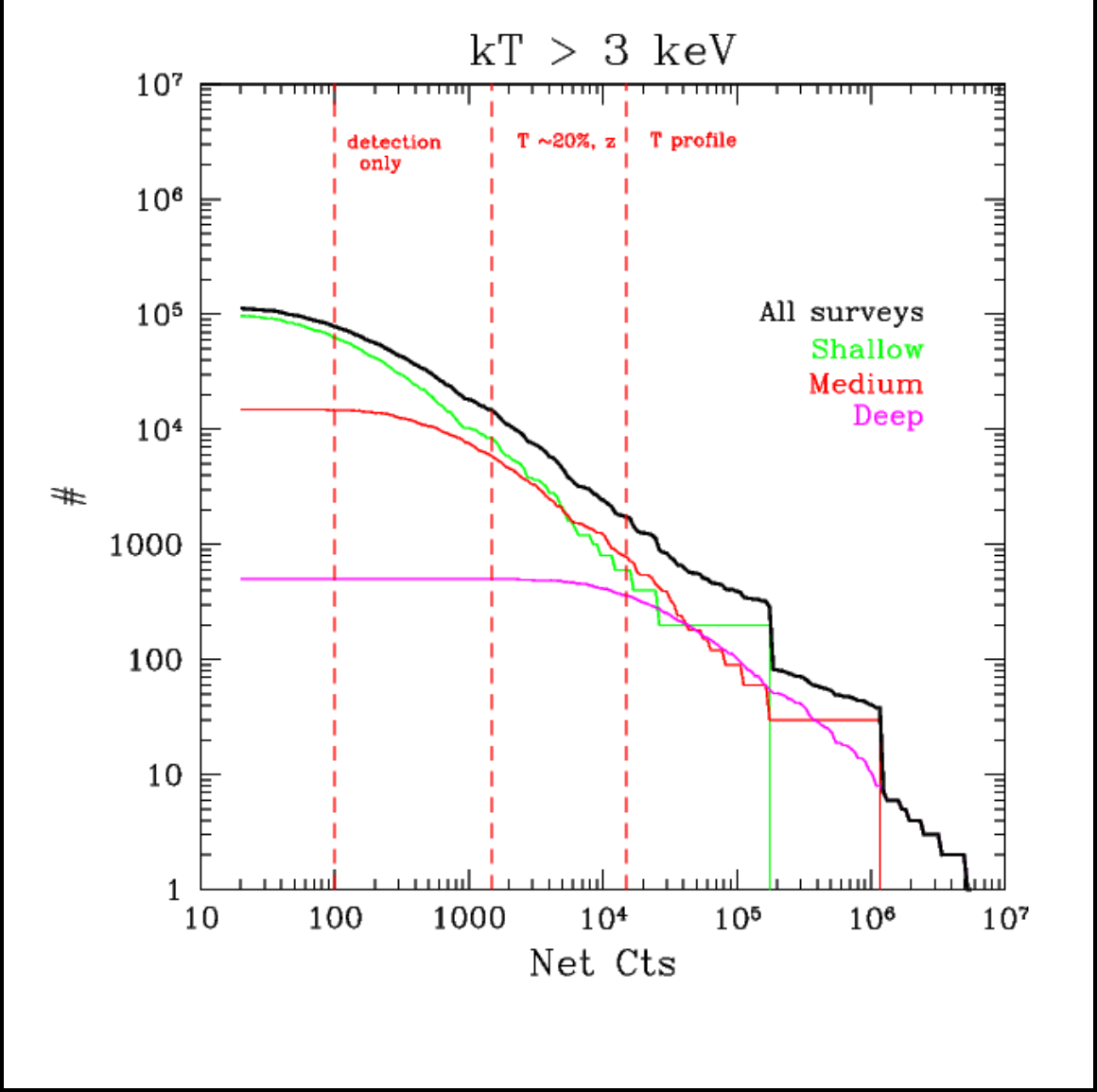
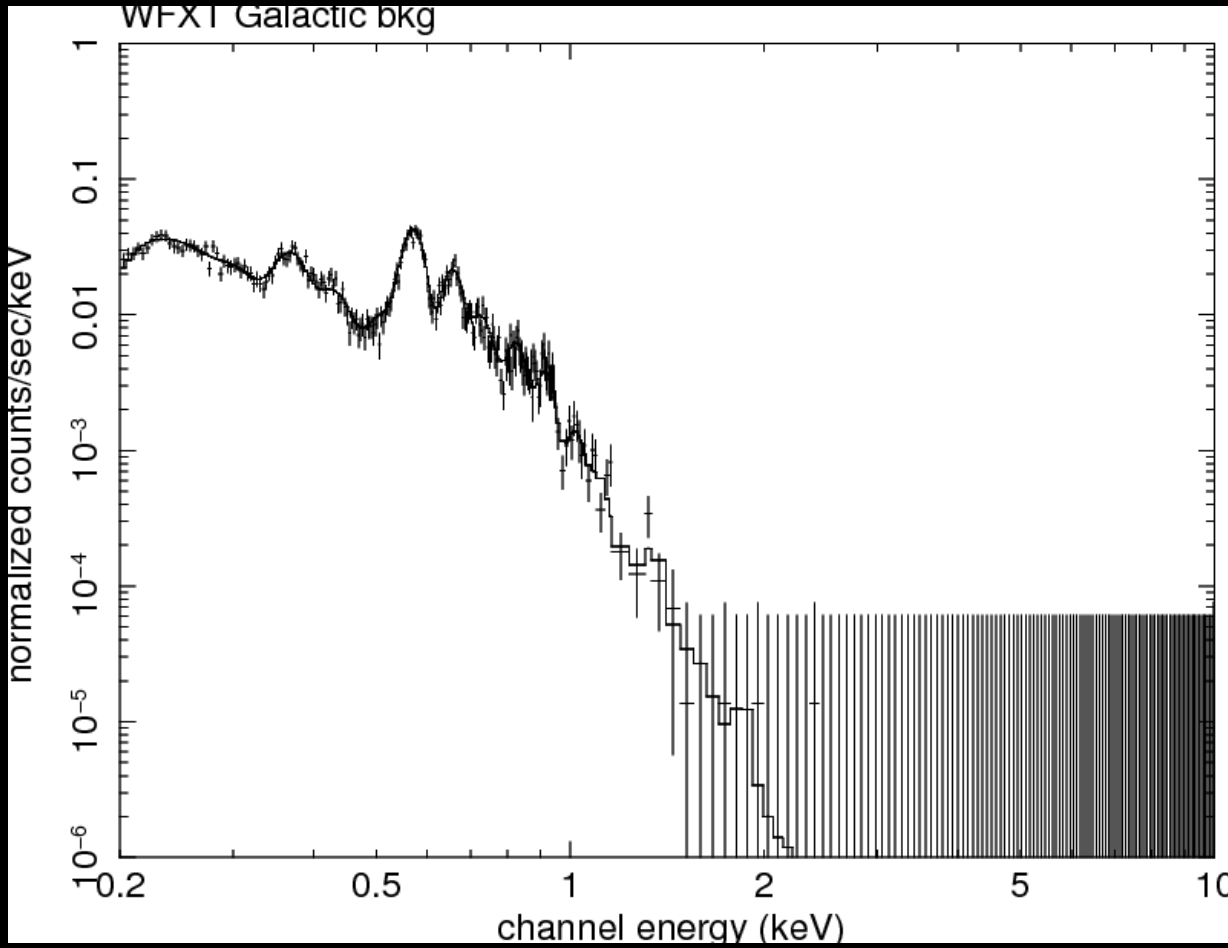


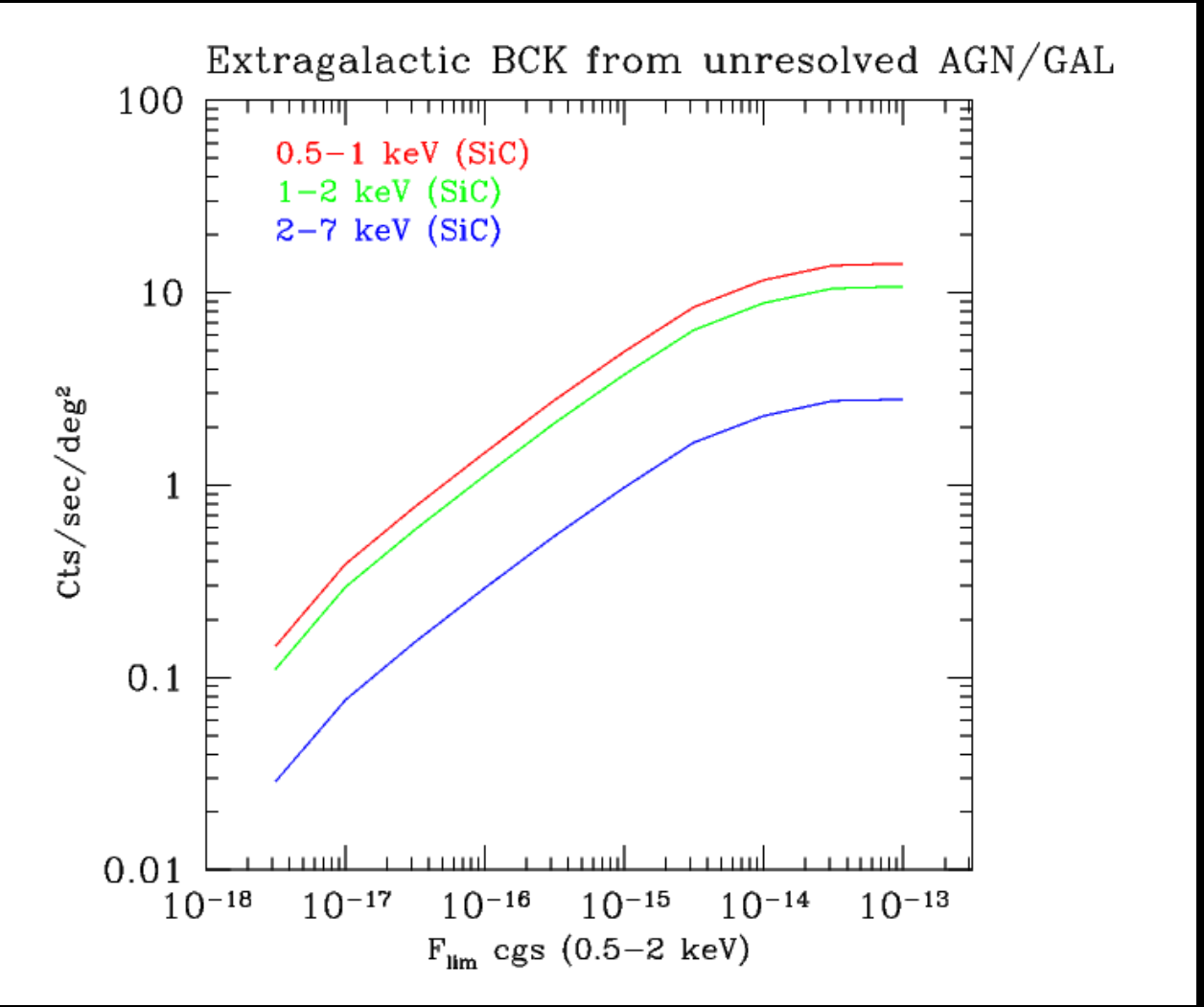
Galactic foreground

Model for Galactic halo and Local halo (Mc Cammon et al. 2003):

$kT = 9.9\ 10^{-2}$ keV
norm = $1.4\ \ 10^{-6}$
$N_H = 1.8\ 10^{-2}$
$kT = 0.225$ keV
norm = $6.05\ 10^{-7}$



Unresolved Extragalactic background



WFXT Backgrounds

cts/sec per FOV (1 sq deg)

	$0.5-2$ keV	$2-7$ keV
particles	0.188	0.397
instrumental	-	-
Galactic	21.4	0.0
AGN shallow	9.5	3.13
AGN medium	3.9	1.65
AGN deep	0.8	0.17
Cluster shallow	1.46	0.3
Cluster medium	0.79	0.14
Cluster deep	0.2	0.03

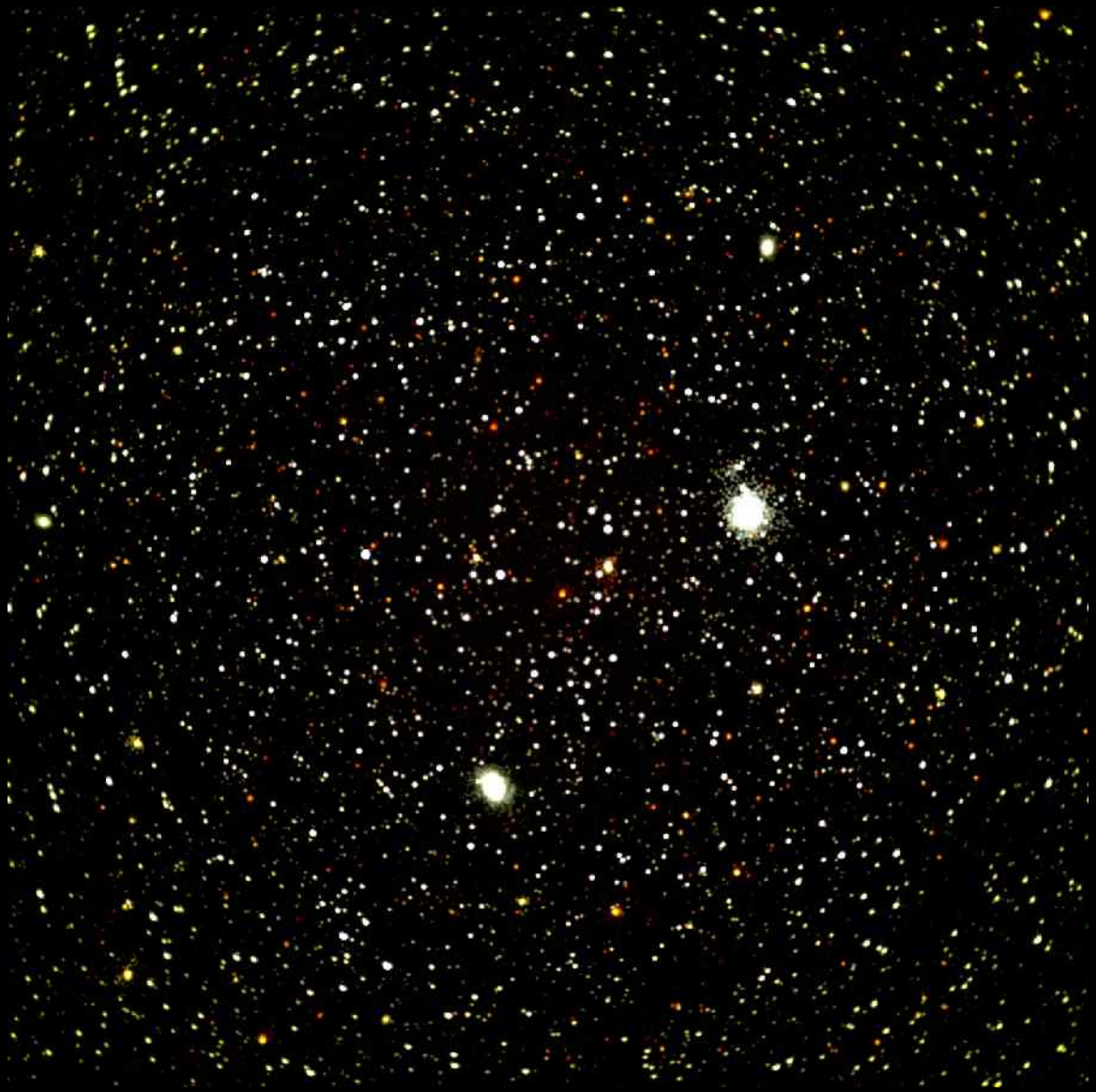
WFXT field (sim01) Wide Survey (2000 ks)

Note: we choose a field with an excess of hot bright clusters

WFXT field (sim01) Medium Survey (13200 ks)

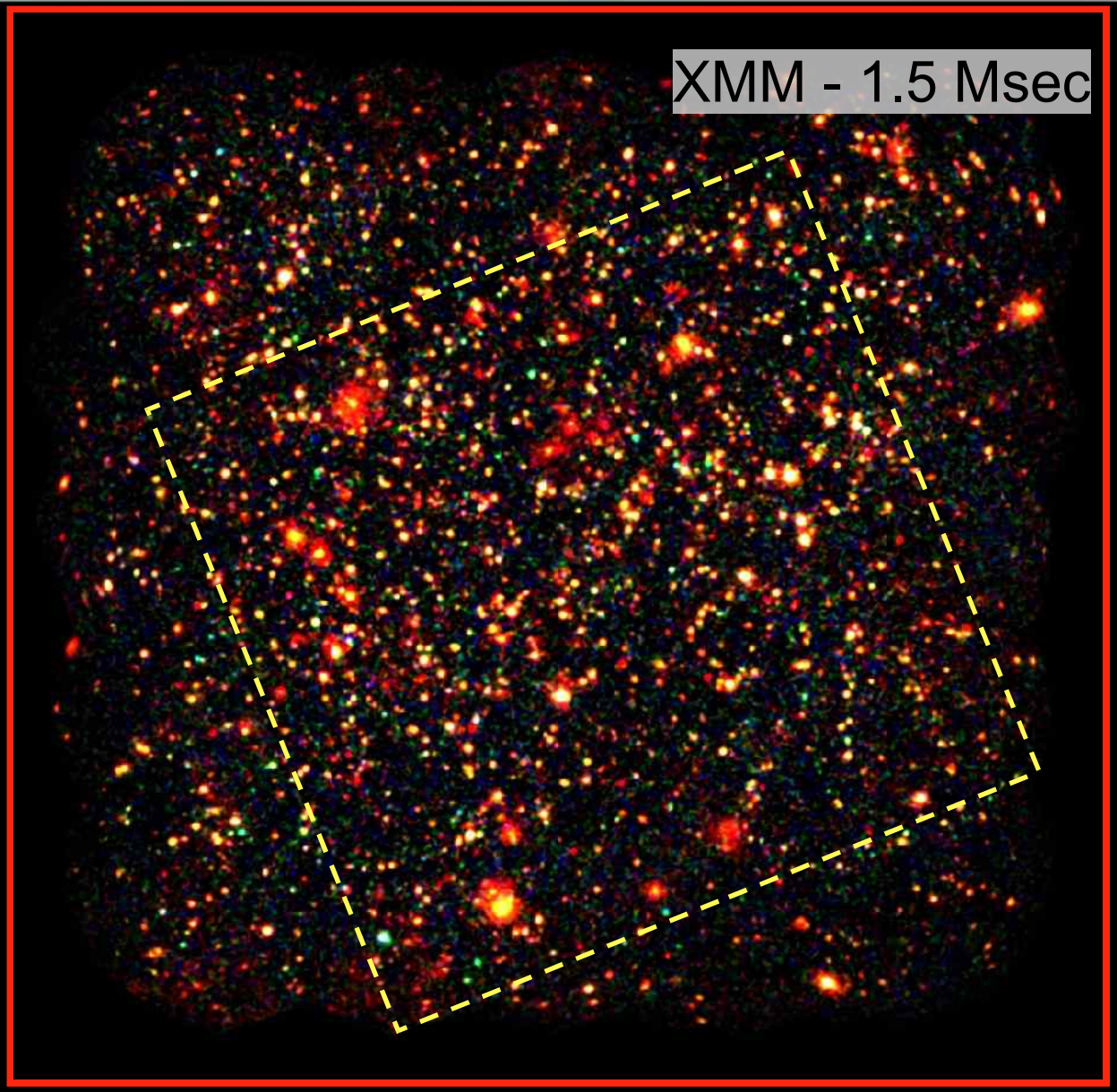
Note: we choose a field with an excess of hot bright clusters

WFXT field (sim01) Deep Survey (400000 ks)

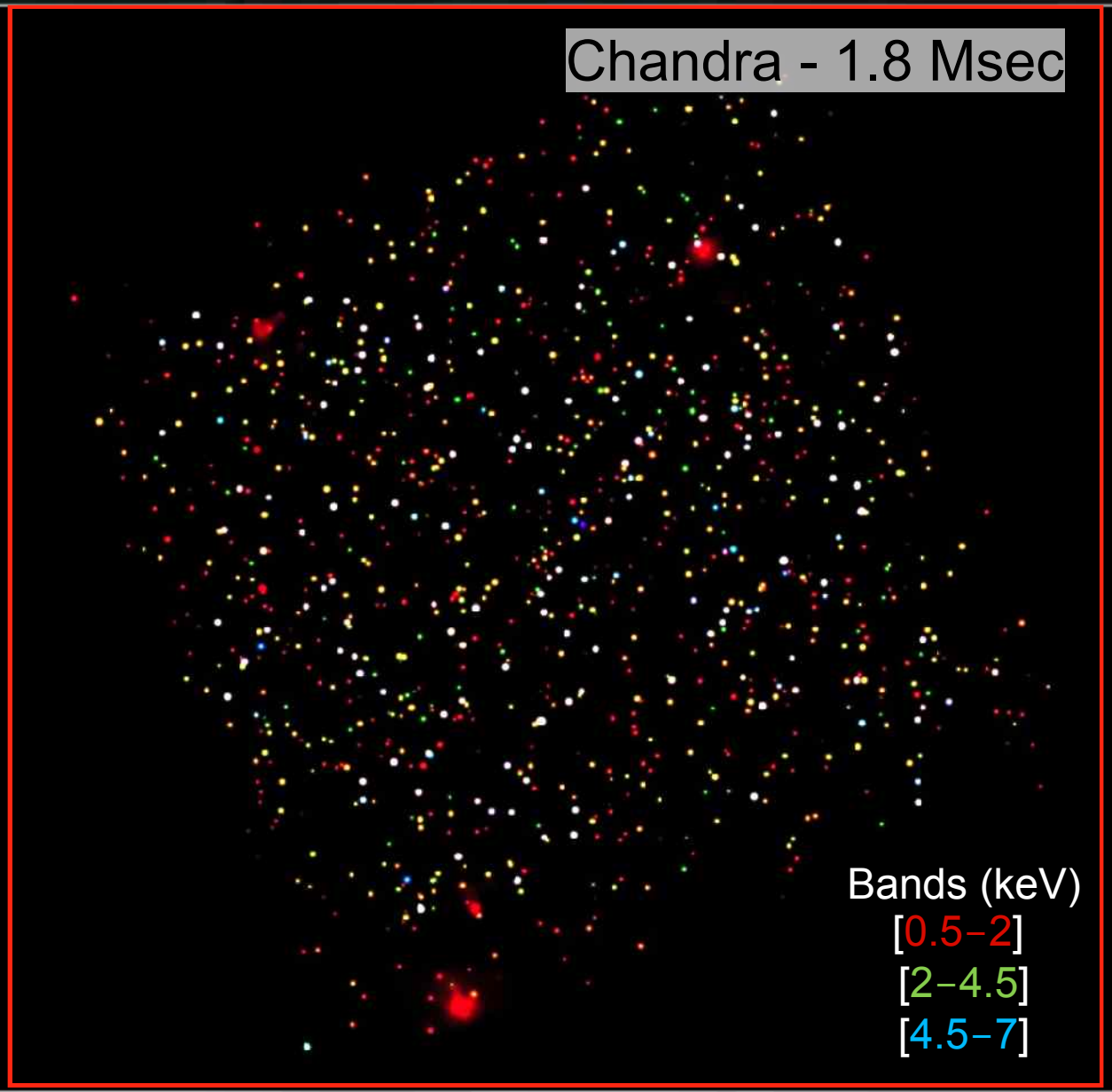


Note: we choose a field with an excess of hot bright clusters

XMM COSMOS survey (2 deg^2) (Cappelluti et al. 2009)

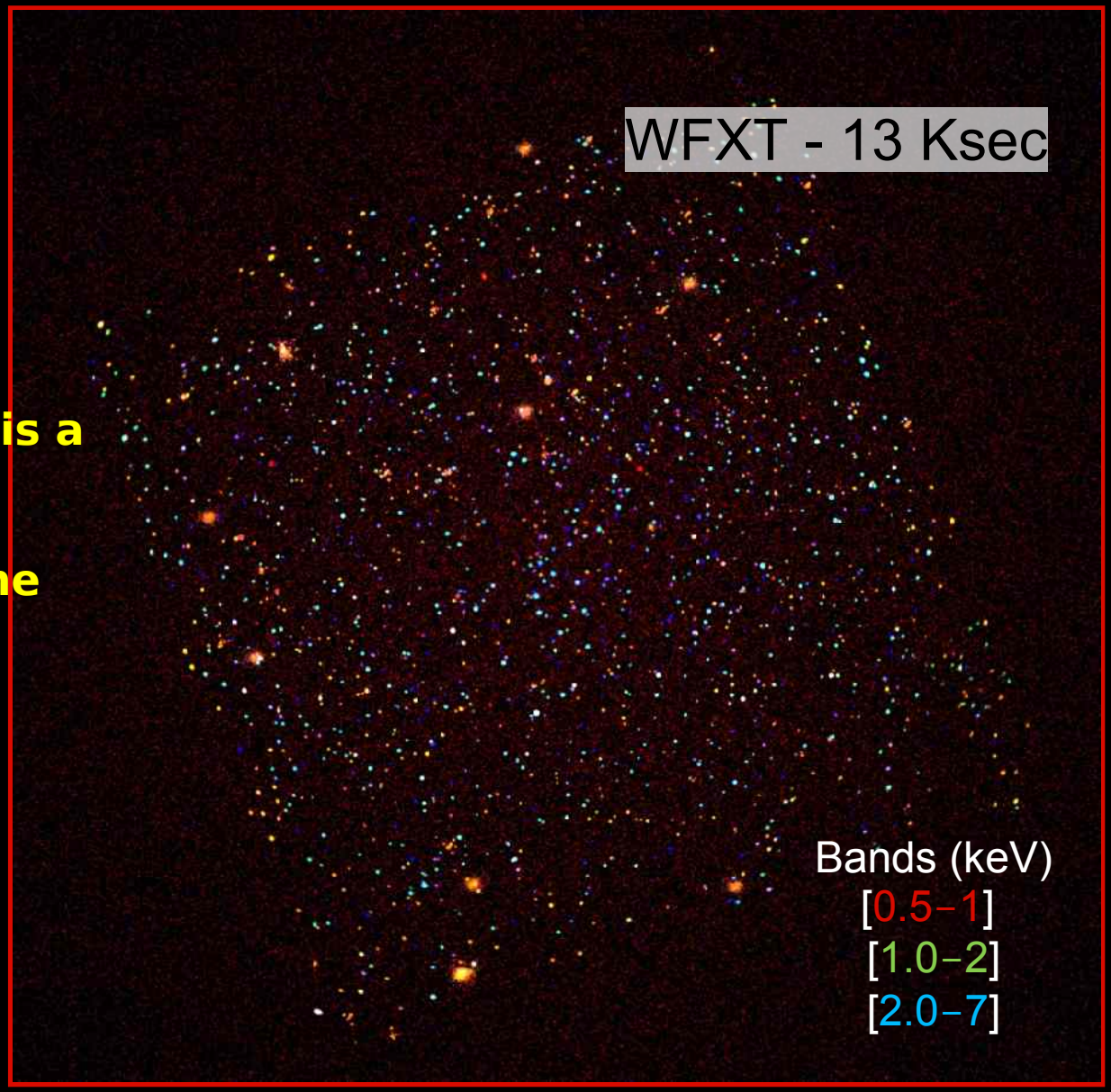


Chandra COSMOS survey (1 deg^2) (Elvis et al. 2009)



WFXT simulation (one tile from the medium survey)

Note: the average PSF is comparable to that of Chandra-Cosmos! Spectral res is a factor of 2 higher. Exposure time is 150 times lower.



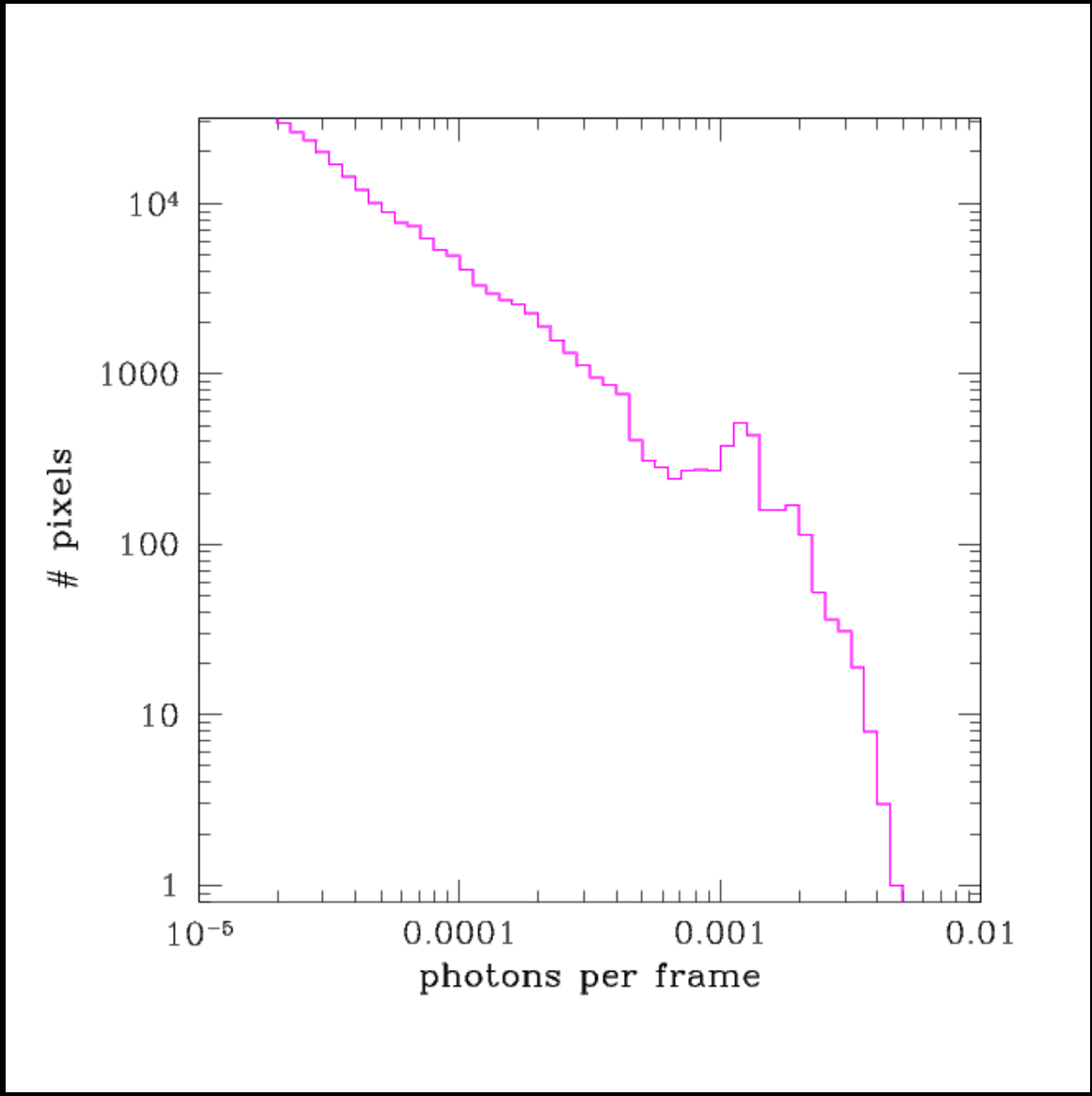
Dithering

400 ks image in chip coordinates (0.5-7 keV) assuming Chandra-like dithering

Pile Up

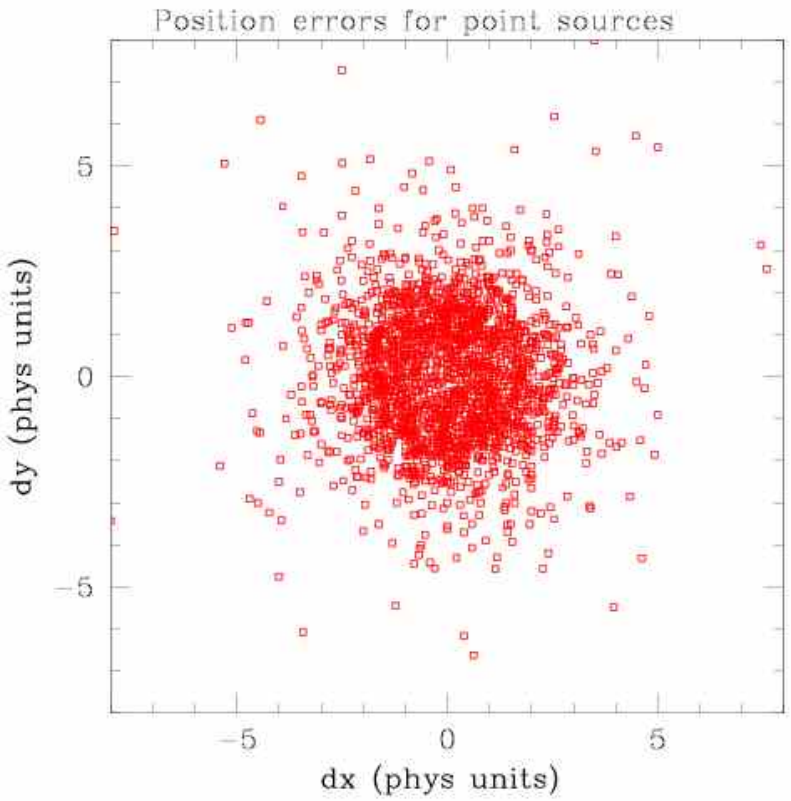
Time frame 3.2 sec
Fmax 2 10^{-13} cgs

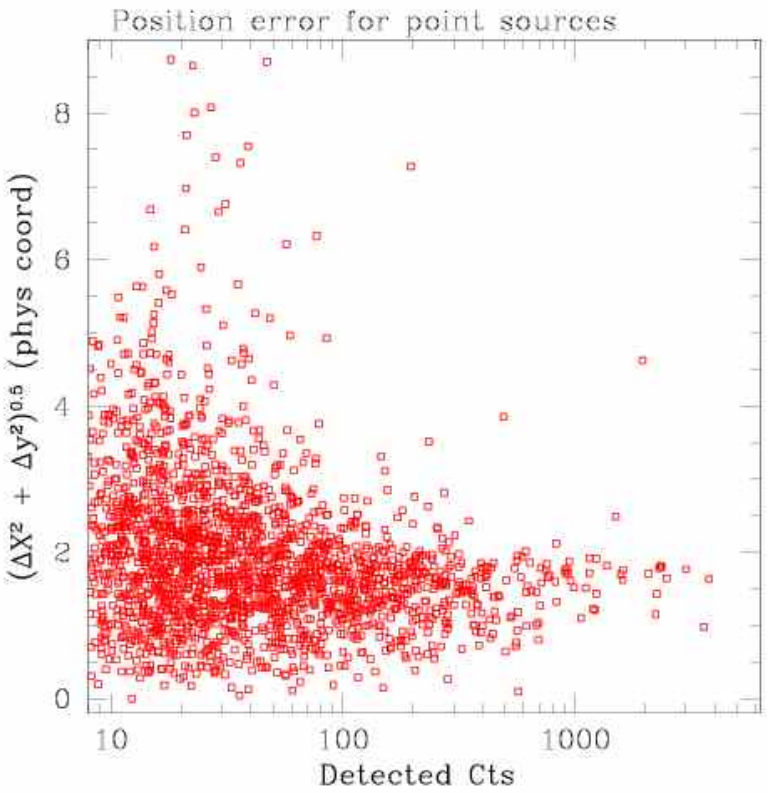
Pile up is expected to be the same as in Chandra



Source detection (point sources)

Quick analysis of one field of the Medium survey (w. wavdetect)





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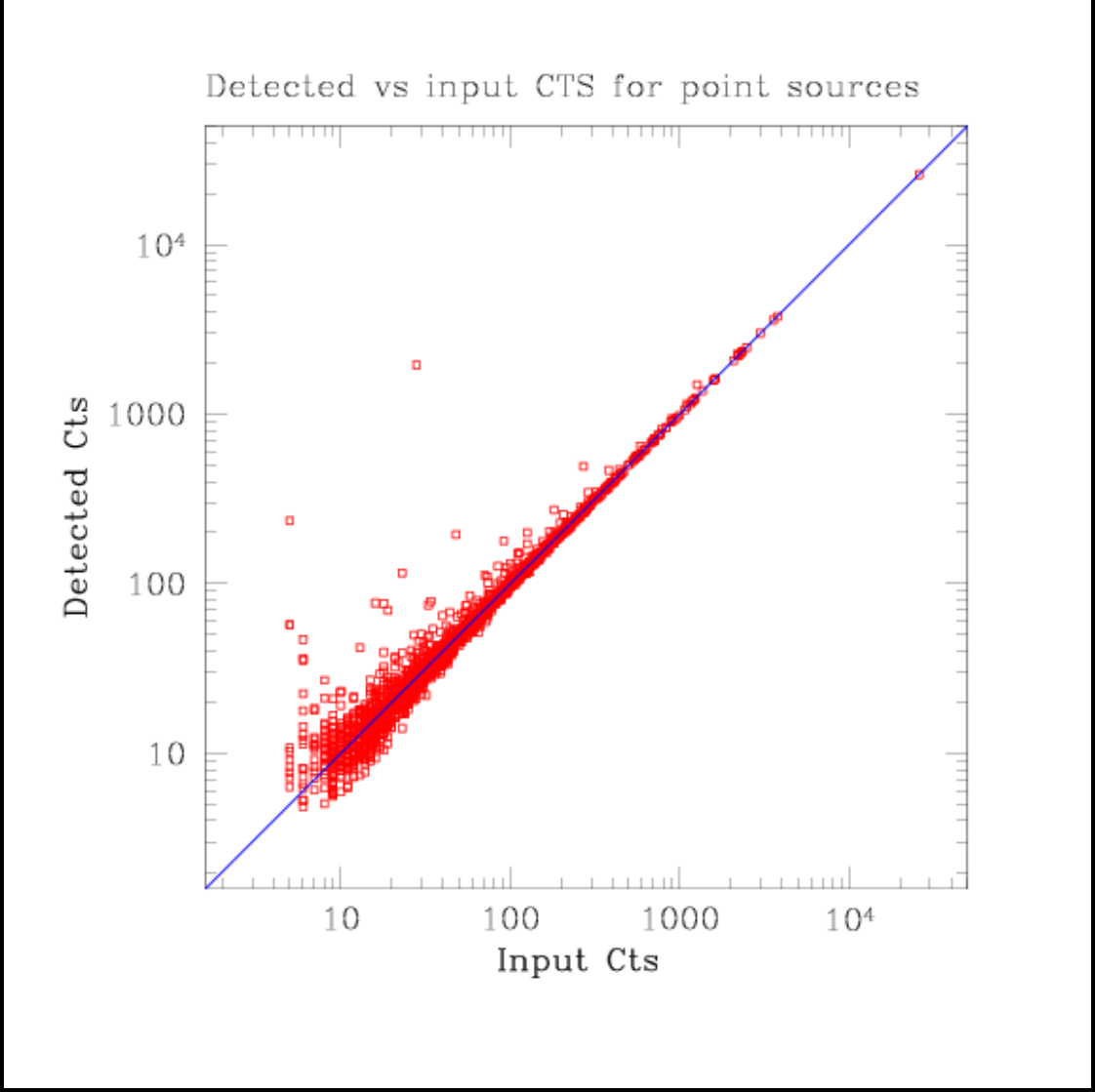

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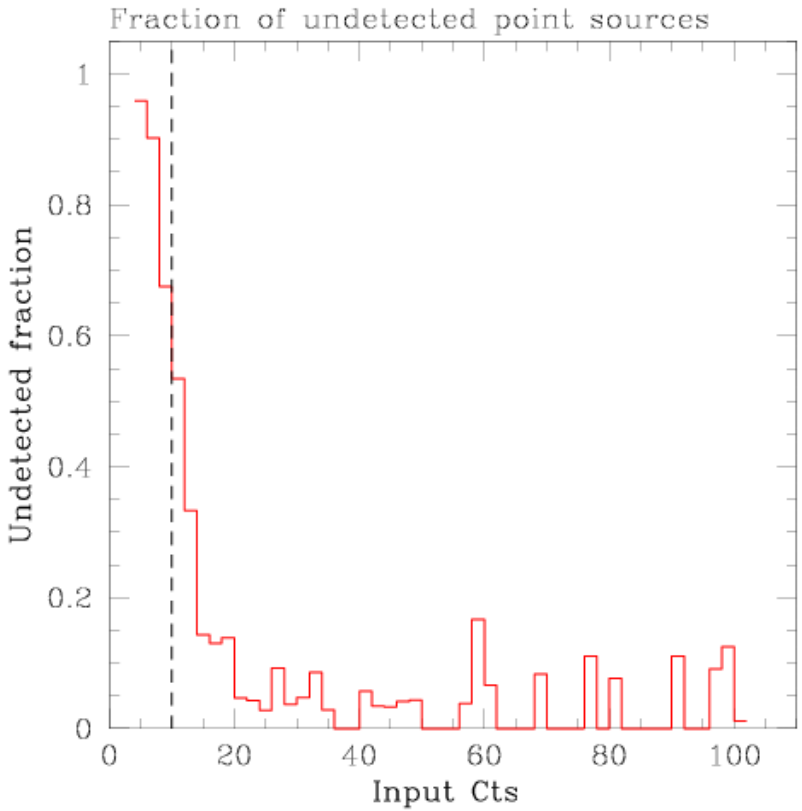

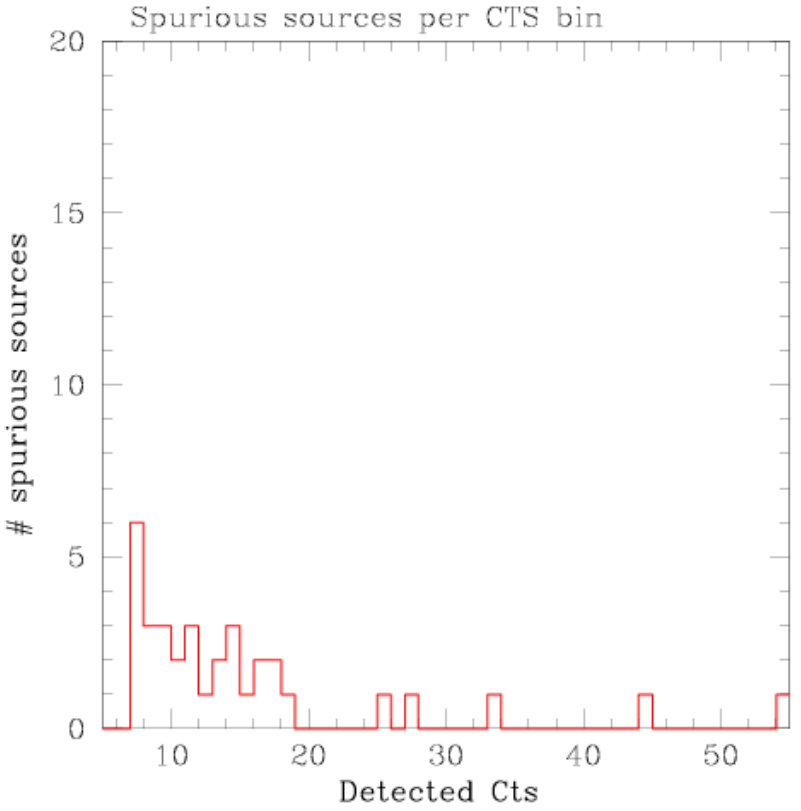

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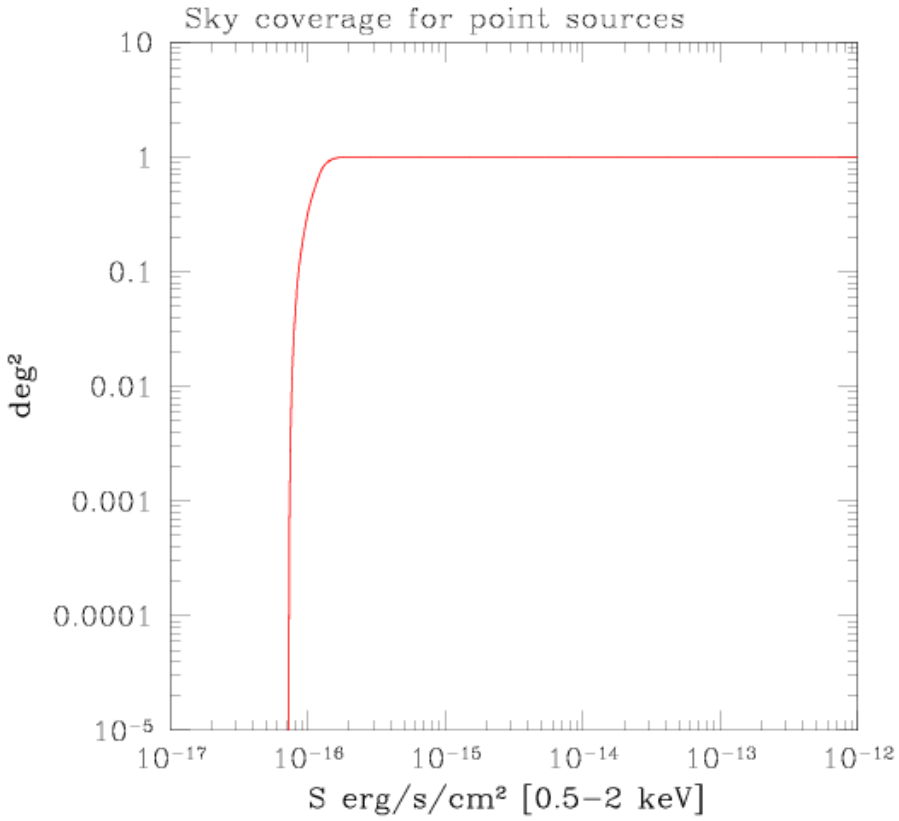
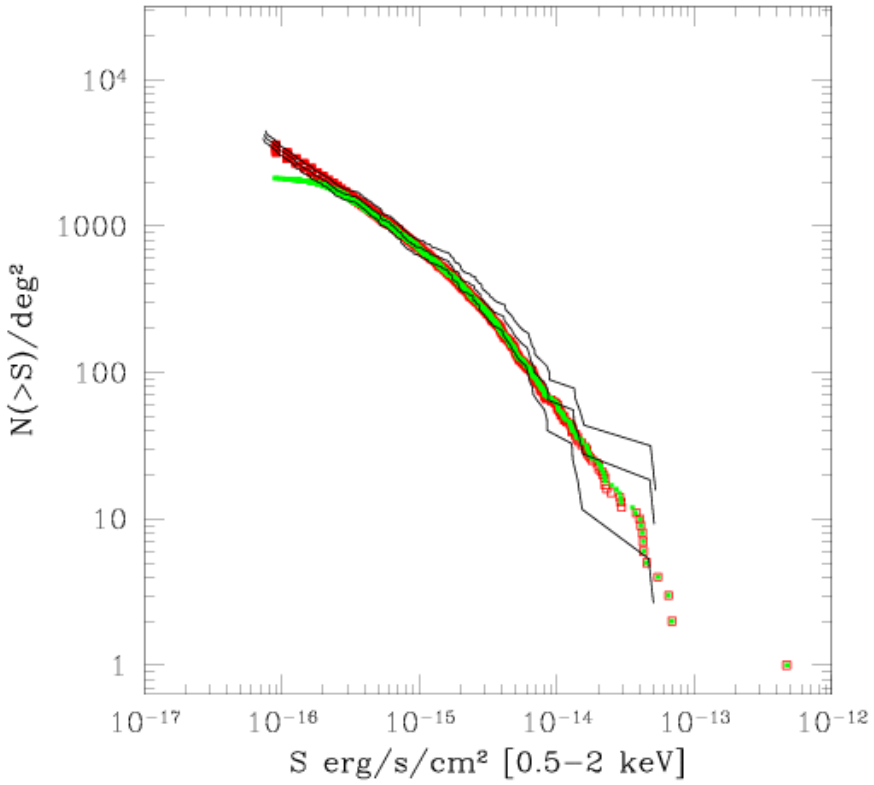
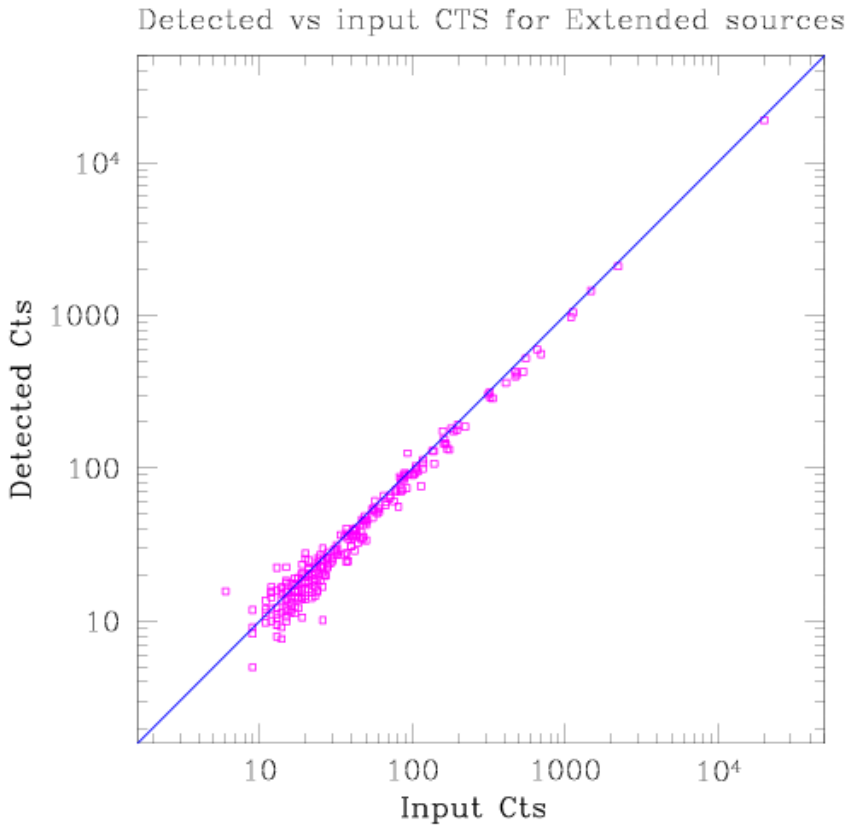
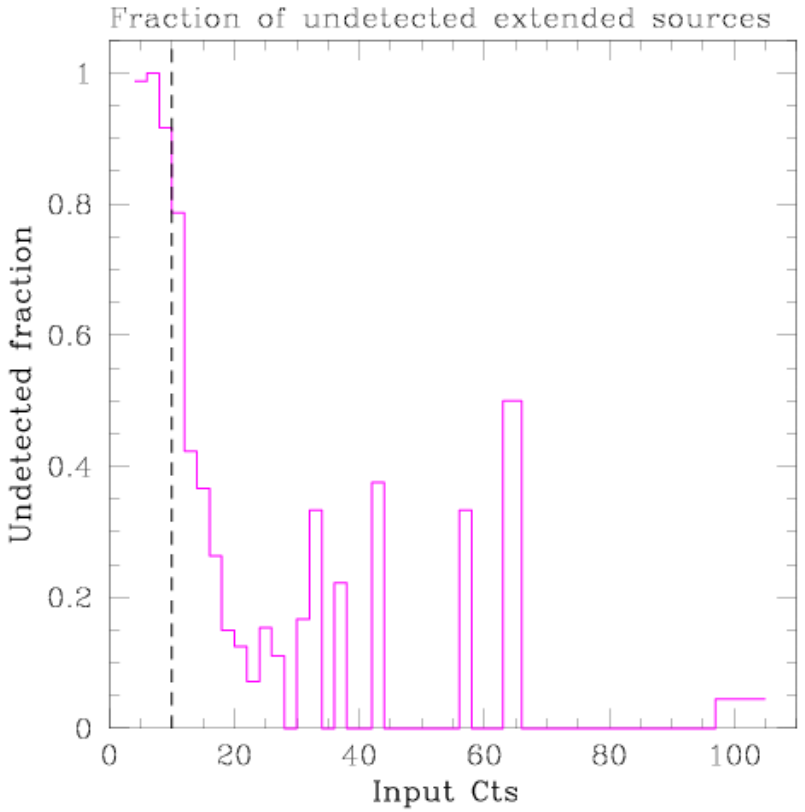




Source detection (extended sources)

Quick analysis of one field of the Medium survey (w. wavdetect)





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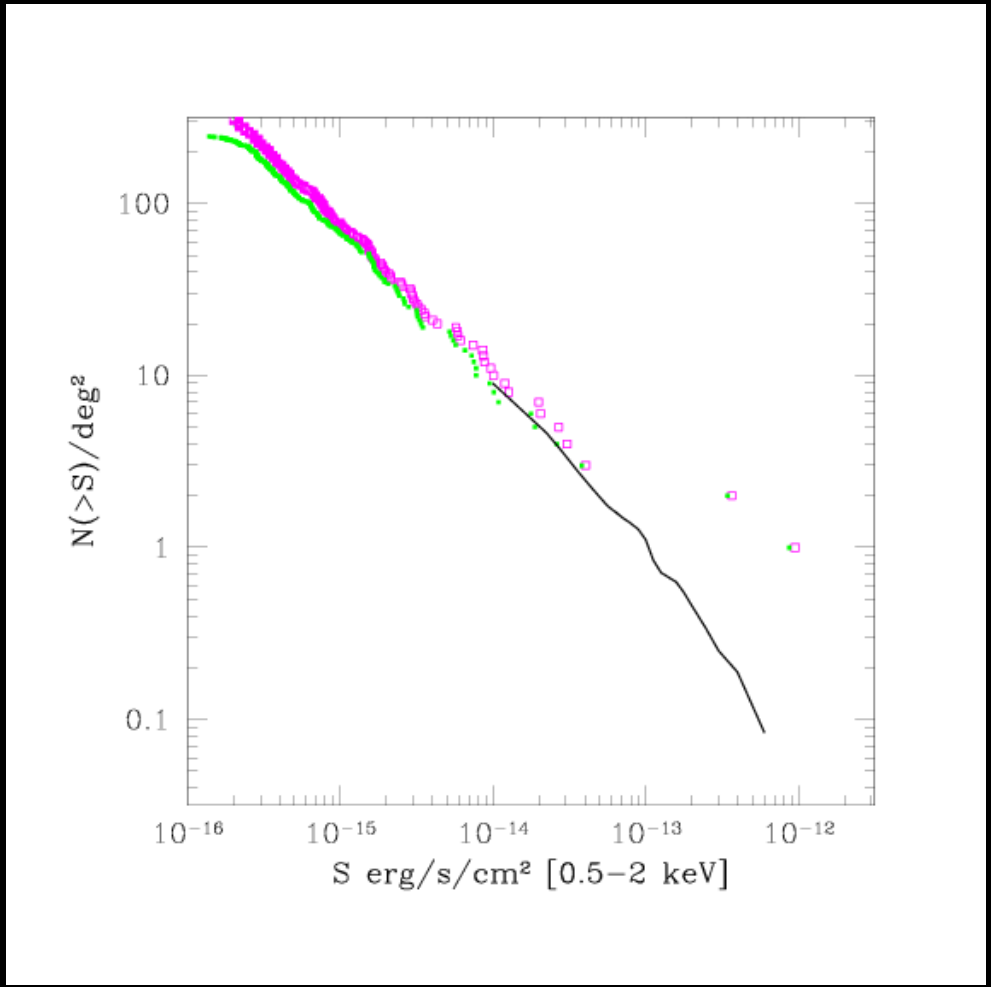
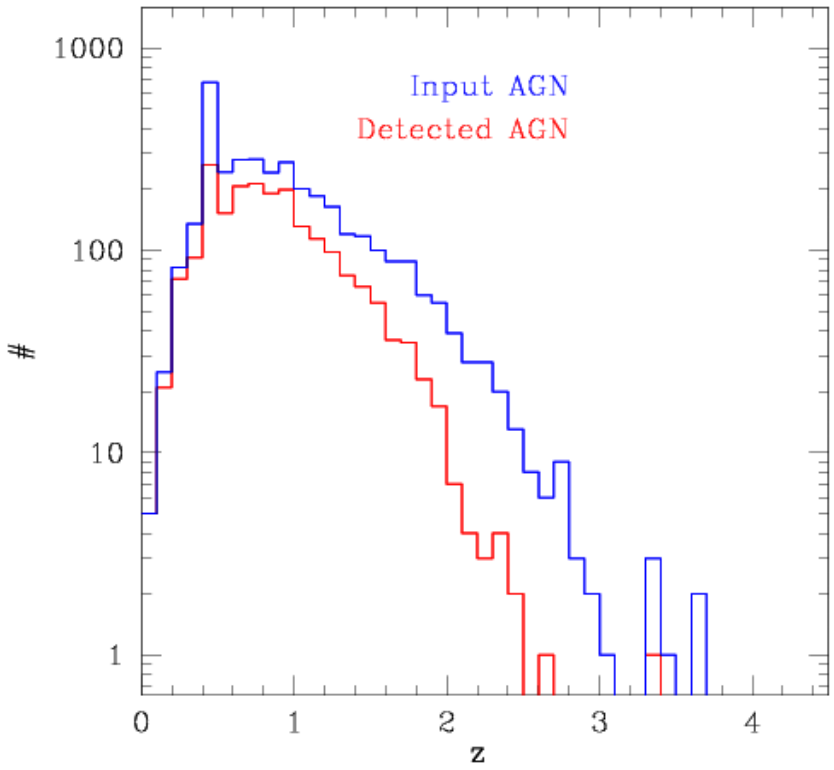
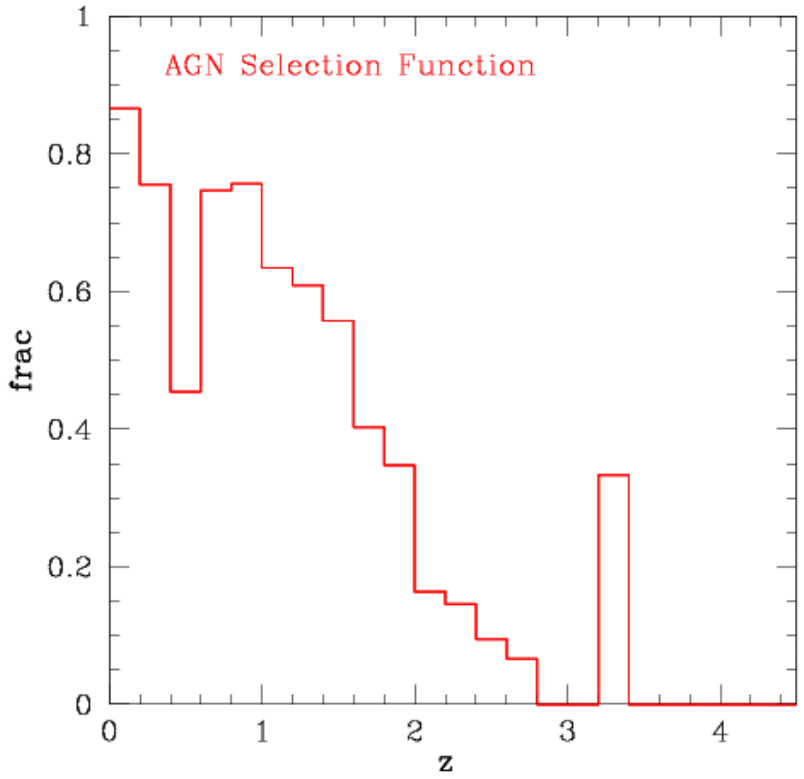
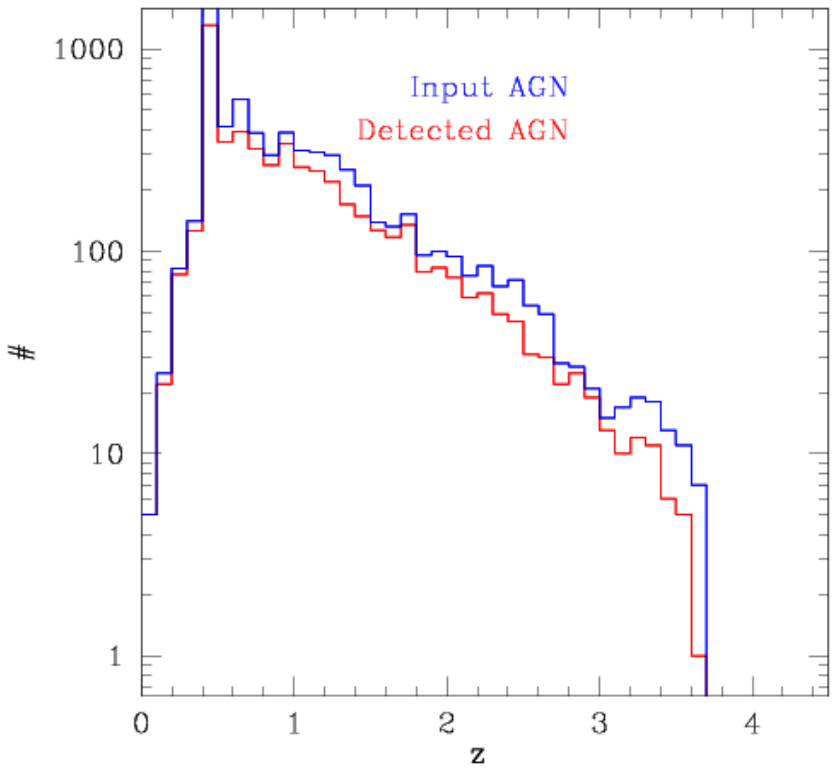


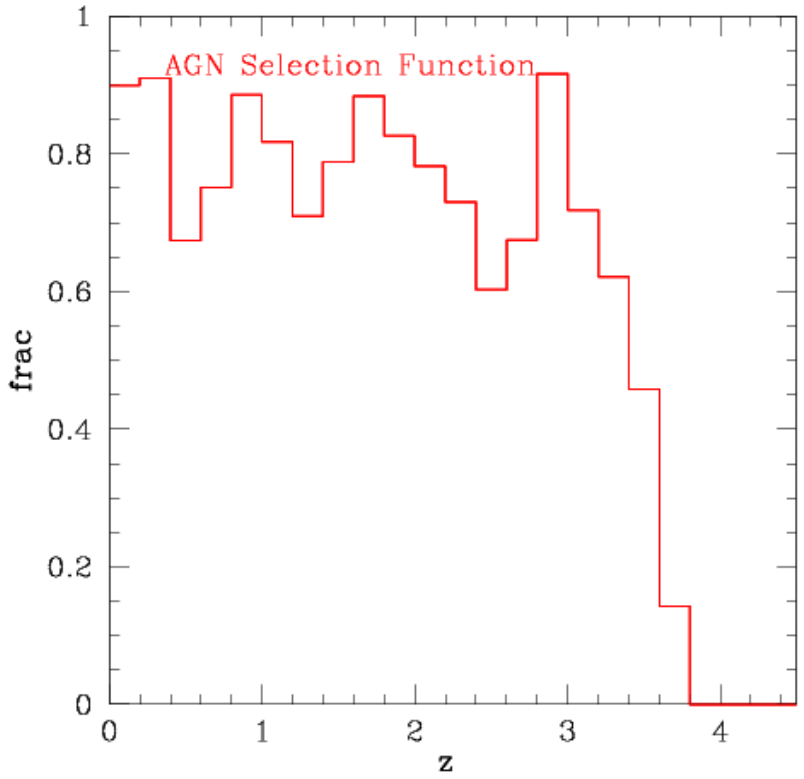
AGN detection vs z (from one tile of the Medium survey)



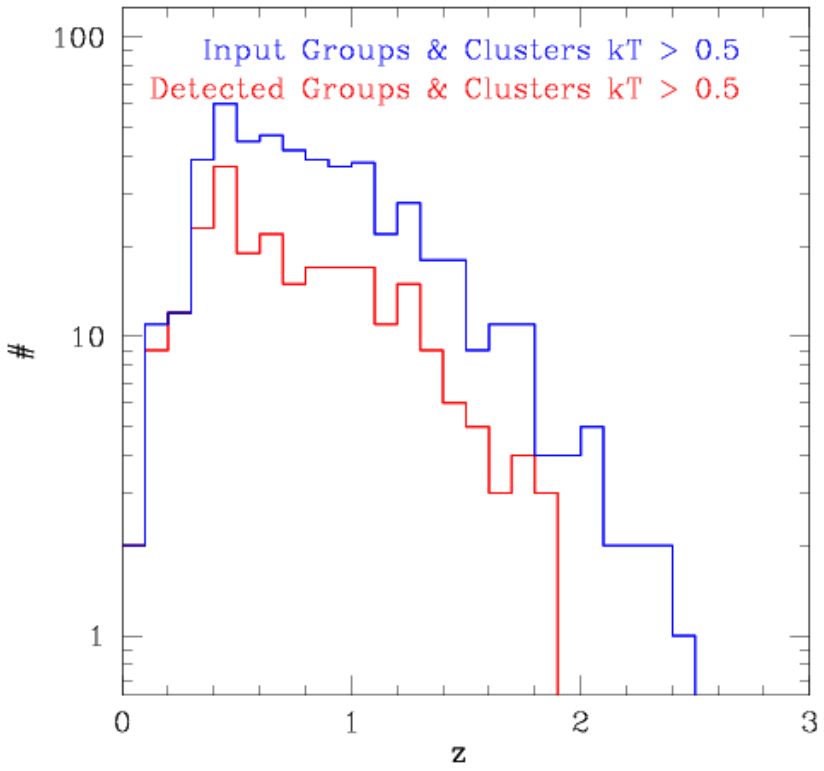


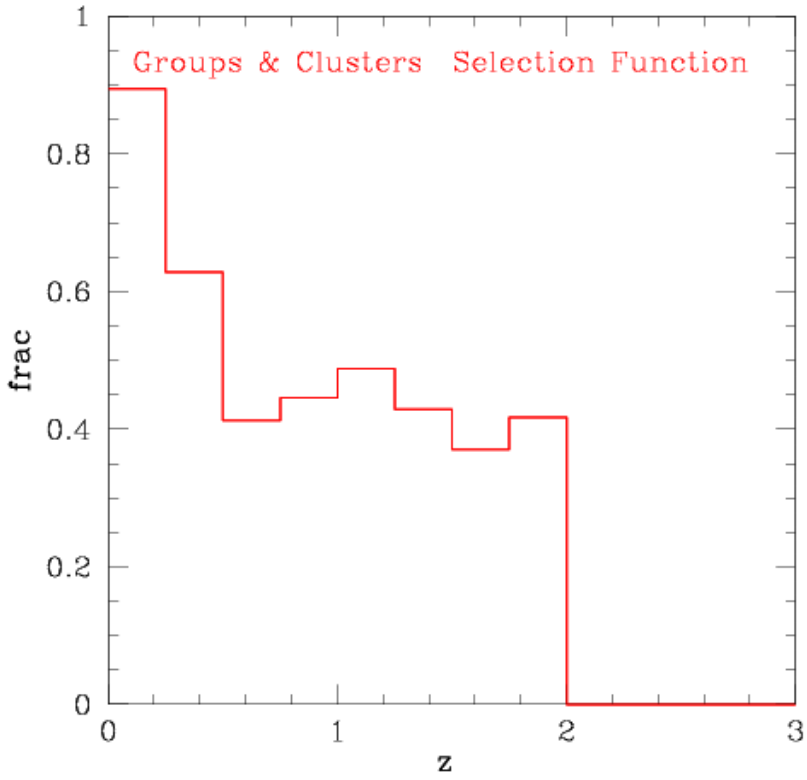
AGN detection vs z (from one tile of the Deep survey)



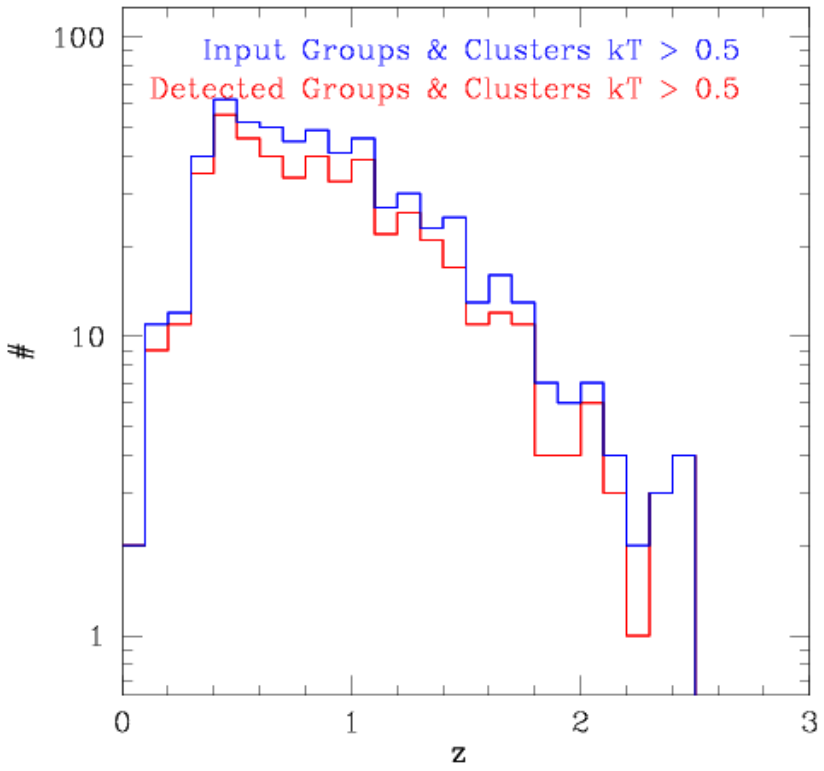


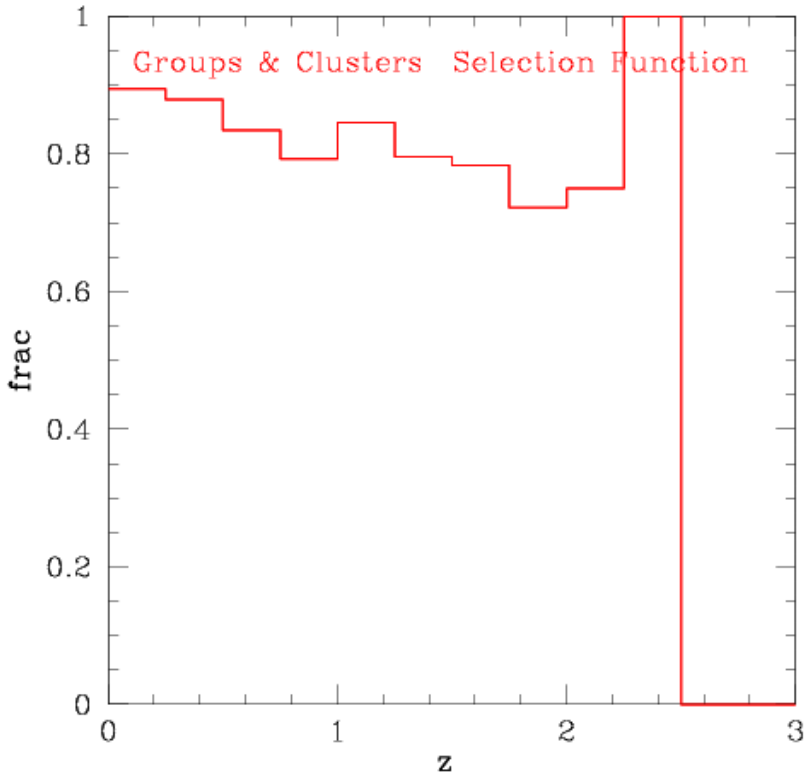
Groups/Cluster detection vs z (from a tile of the Medium Survey)





Groups/Cluster detection vs z (from a tile of the Deep Survey)





Clusters at very high z

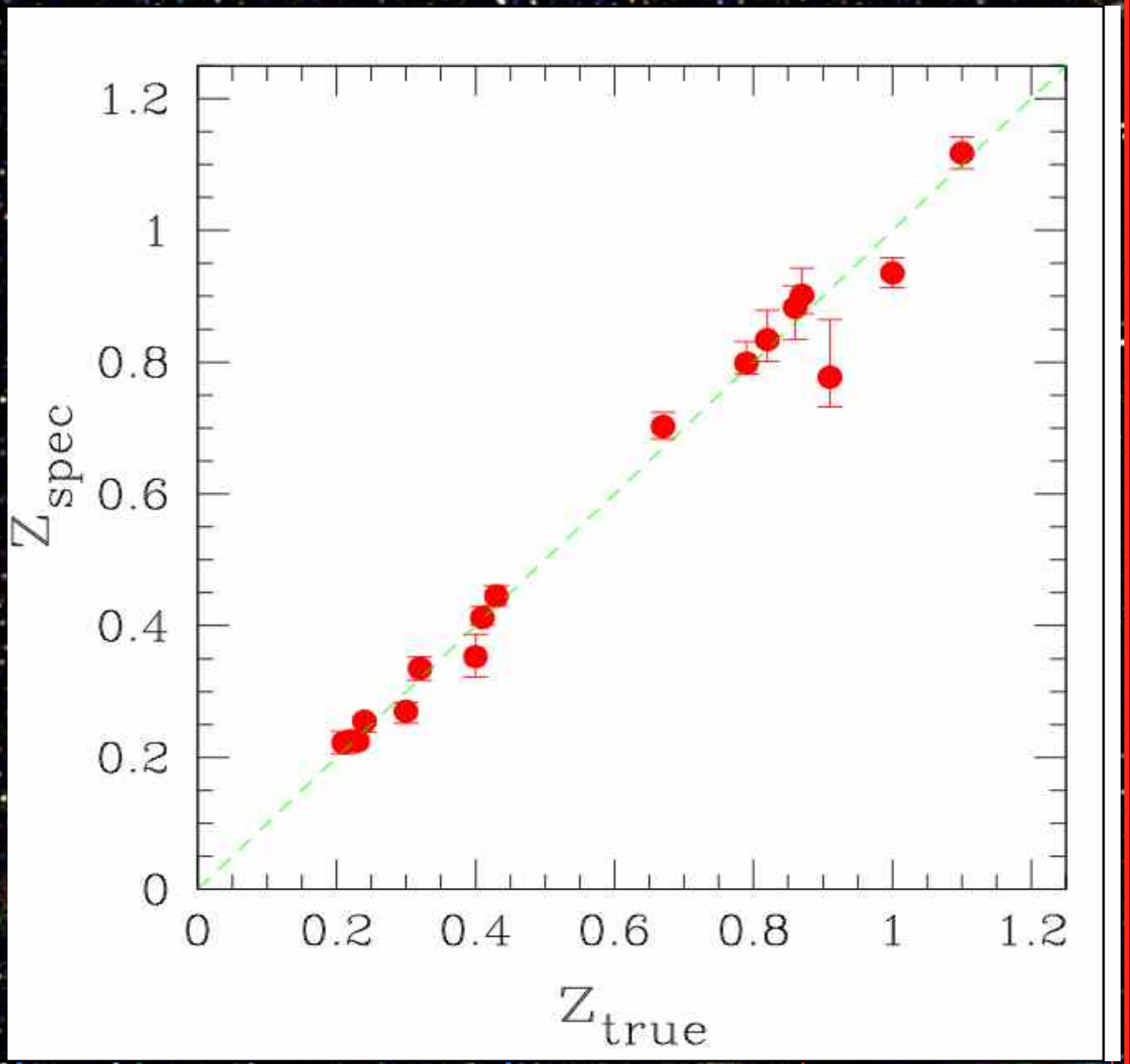
With 13 ks: ~L* clusters at z=1.6 detected with ~ 500 counts.

With 400 ks: the simulated Spiderweb cluster detected with > 10^4 counts.

Redshifts measured with ~500 counts for the 17 brightest clusters in this field

Completely X-ray based cluster redshift survey!

Clusters at very high z



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The Bullet cluster (z=0.3, T=14 keV) with WFXT

Deep survey: 400 ksec

z=0.5 z=1.0 z=1.5

10’

Joana Santos (INAF, Trieste) and the WFXT Team

Wide range of science

With simulations we can assess in detail many science cases for which WFXT is unique:

Halo stars

LMXB and HMXB population

SNR remnants

Obscured accretion at high-z

Distribution of intrinsic absorption at different L

Evolution of Fe abundance in the ICM

Evolution of cool cores in clusters and feedback

Low SB regions in the outskirts of clusters

...

Specific science goal (WFXT only!)

Fraction of CC/NCC clusters as a function of z and flux.
Measured vs true distribution of NH in AGN as a function of z).
Detection and characterization of Compton Thick AGN as a function of the input population.
Selection function of Clusters and constraining power on cosmological parameters.
Fe content evolution of the ICM.

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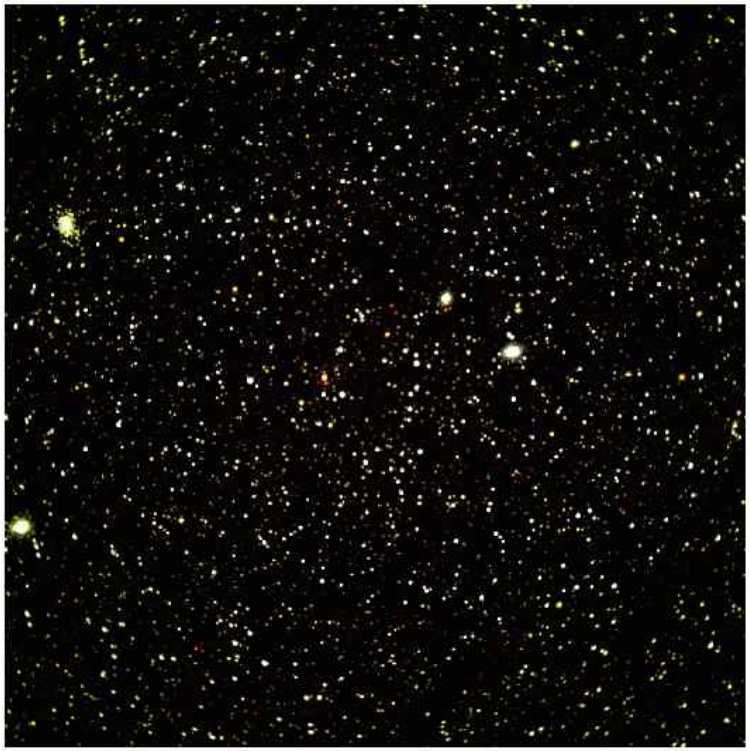
A Document on WFXT simulations



Simulating the WFXT sky

Version 1.0
July 30th, 2009

Prepared by: Andrea Bignamini, Stefano Borgani, Roberto Gilli, Piero Rosati, Joana Santos, Paolo Tozzi, Heng Yu