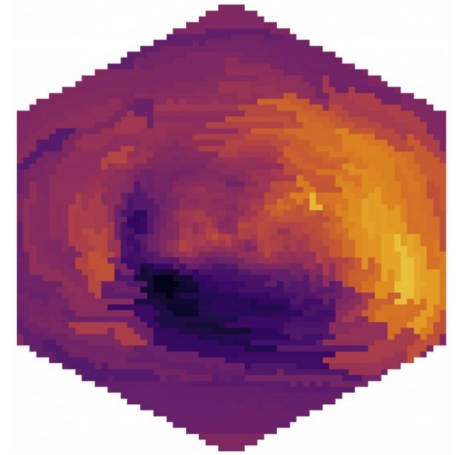
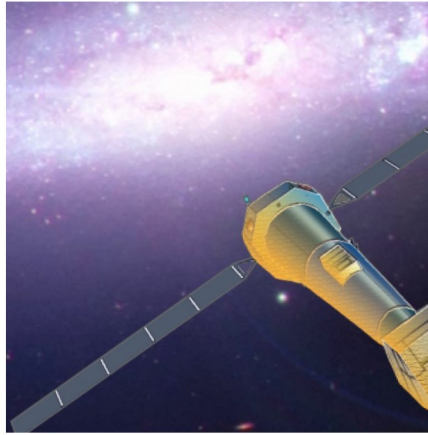
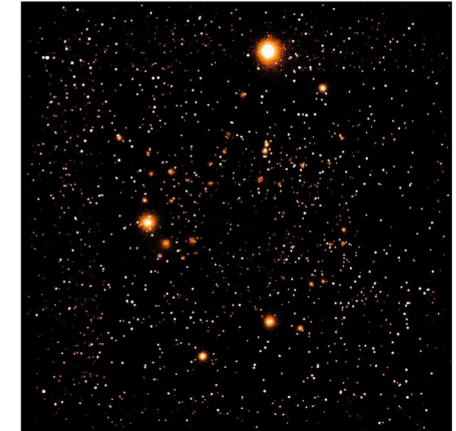


# ATHENA



## Simulating AGN deep fields



G. Lanzuisi  
INAF-OAS Bologna IT



# Athena-WFI survey goals

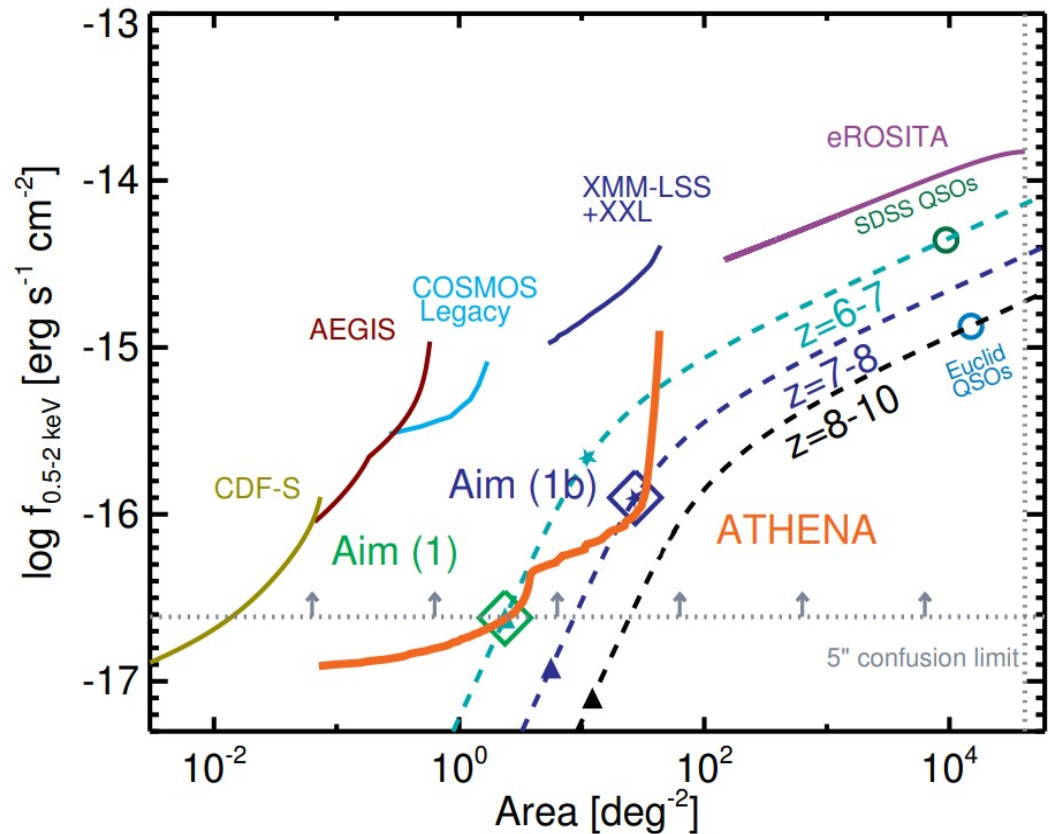
Detect at least:

Aim1: 10 AGN  $z=6-7$  @  $L_x=43-43.5$  erg/s  $\rightarrow F_{\text{lim}} 2.4 \times 10^{-17}$  over 2.4 deg<sup>2</sup>

Aim1b: 10 AGN  $z=7-8$  @  $L_x=43.5-44$  erg/s  $\rightarrow F_{\text{lim}} 1.3 \times 10^{-16}$  over 27.4 deg<sup>2</sup>

Deep Layer  
10x~1Ms+4x1.4Ms

Shallow Layer  
103x84ks



# Athena-WFI survey goals

Detect at least:

Aim1: 10 AGN  $z=6-7$  @  $L_x=43-43.5$  erg/s  $\rightarrow F_{lim} 2.4 \times 10^{-17}$  over 2.4 deg<sup>2</sup>

Aim1b: 10 AGN  $z=7-8$  @  $L_x=43.5-44$  erg/s  $\rightarrow F_{lim} 1.3 \times 10^{-16}$  over 27.4 deg<sup>2</sup>

Deep Layer

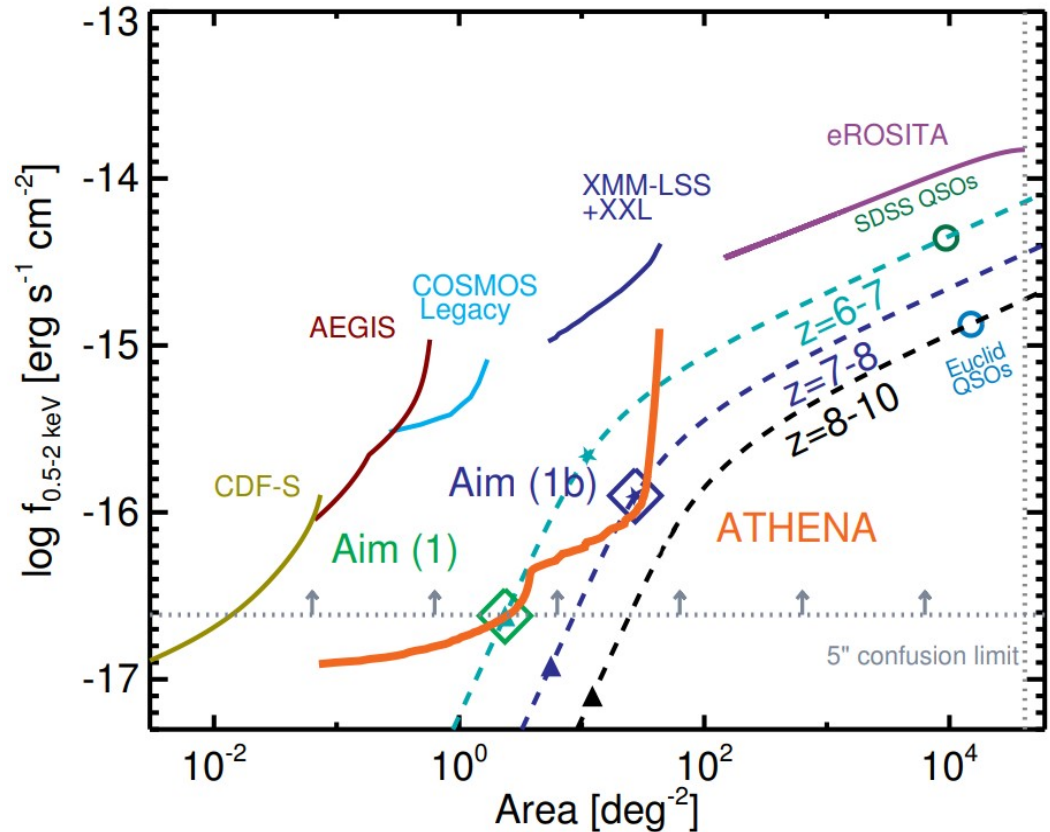
10x~1Ms+4x1.4Ms

Shallow Layer

103x84ks

- End-to-end simulations vs. analytic estimates?

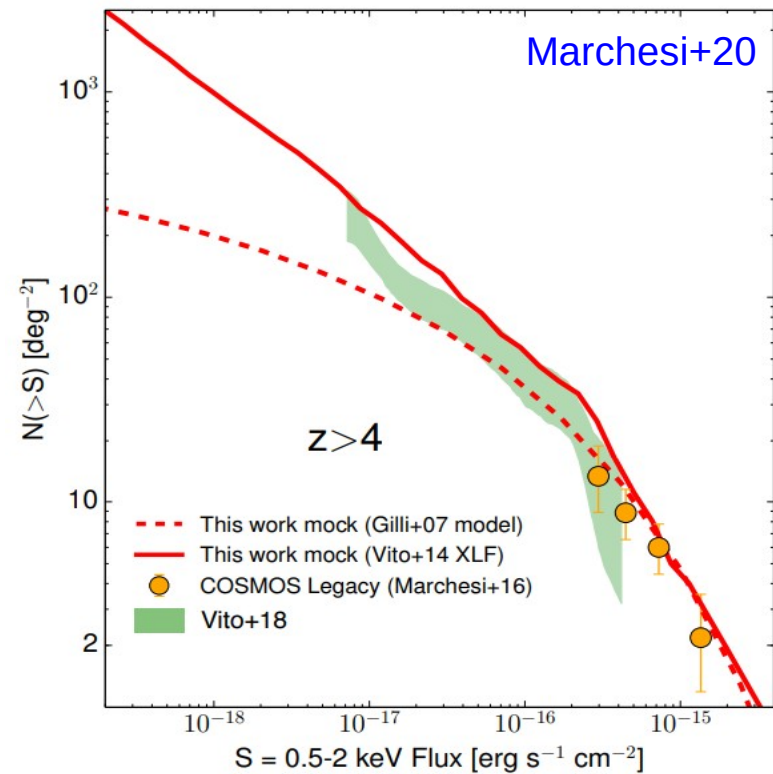
- Impact of different telescope characteristics?



# Input Mocks for a Deep Field

- AGN mocks from Gilli+07 CXB model
- AGN mocks from Vito+14  $z > 3$  LF

both with  $z=0-10$ ,  $L_x=40-48$ ,  $F_x > 10^{-20}$



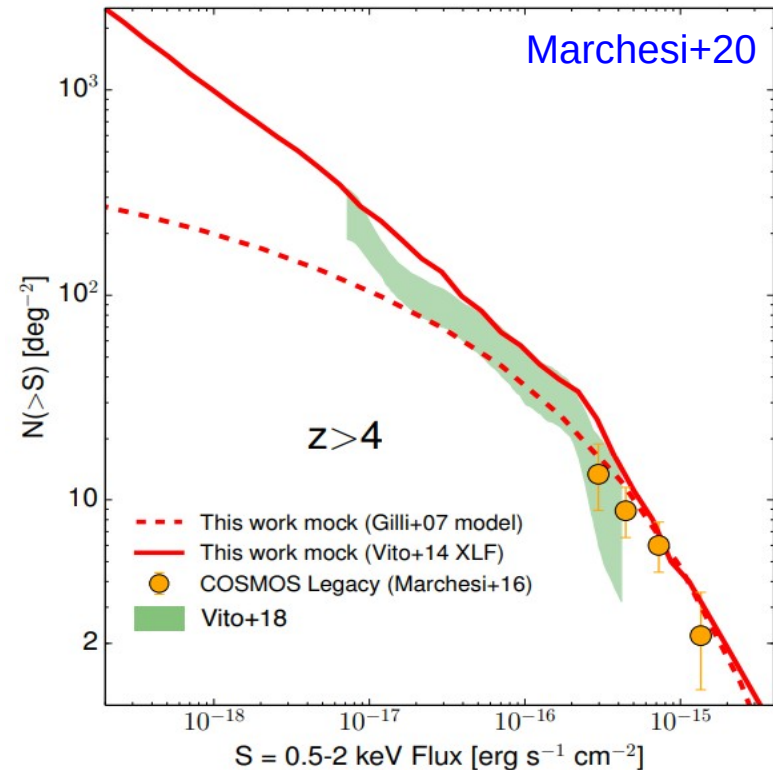
# Input Mocks for a Deep Field

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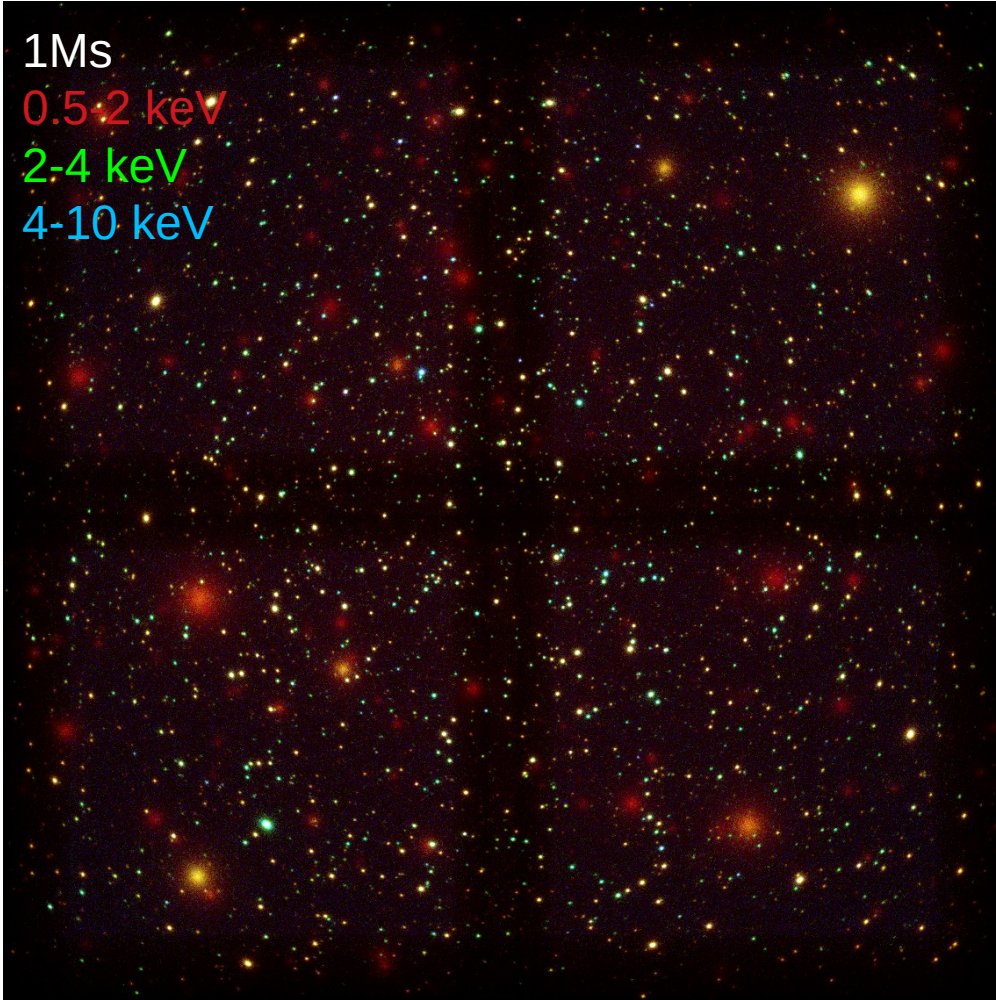
- Galaxy mocks from Ranalli+05 (just fluxes) now updated to **SPRITZ** galaxy mocks from Bisigello+21
- Cluster mocks

see Marchesi+2020 A&A...642A...184 and <http://www.bo.astro.it/~gilli/mock.html>



# Simulated Deep Fields

1Ms  
0.5-2 keV  
2-4 keV  
4-10 keV



Diffuse Galactic Foreground  
+Particle background + dithering

# Simulated Deep Fields

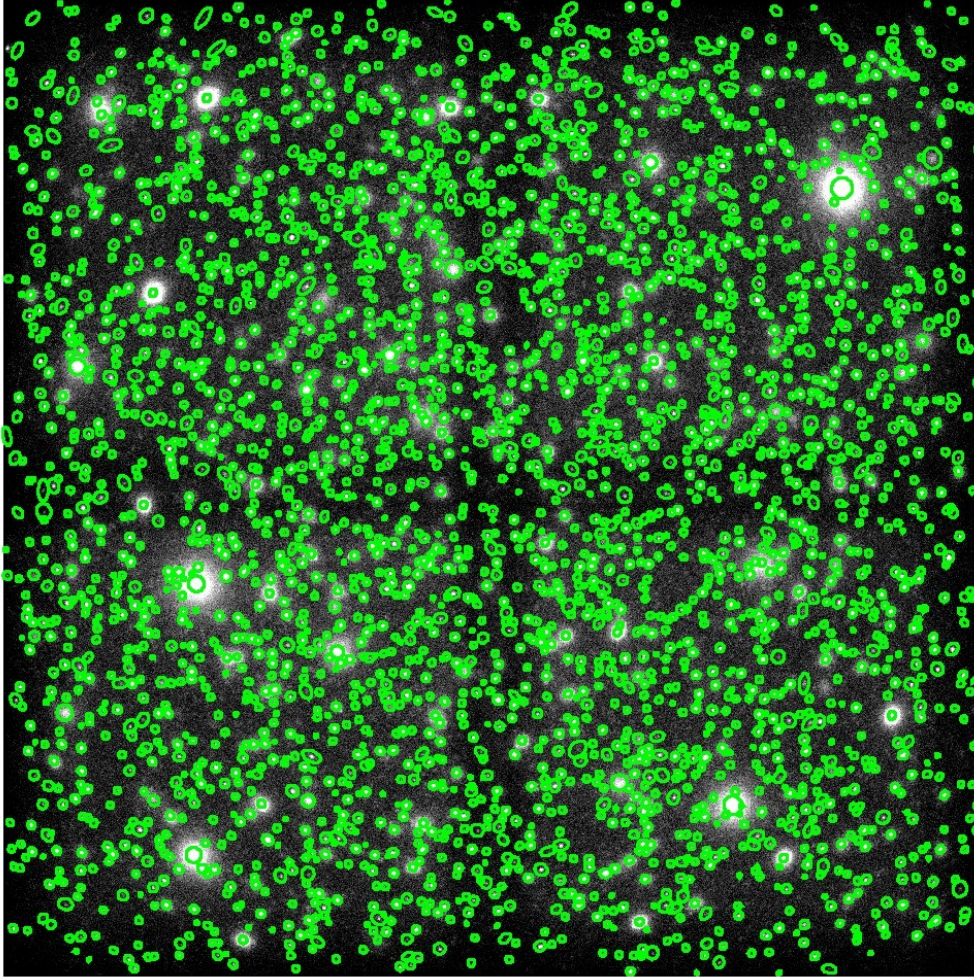


Diffuse Galactic Foreground  
+Particle background + dithering

Merge event files with `ftmerge`, cut  
in energy/time with `ftselect`

Soft band for detection

# Simulated Deep Fields



Diffuse Galactic Foreground  
+Particle background + dithering

Merge event files with `ftmerge`, cut  
in energy/time with `ftselect`

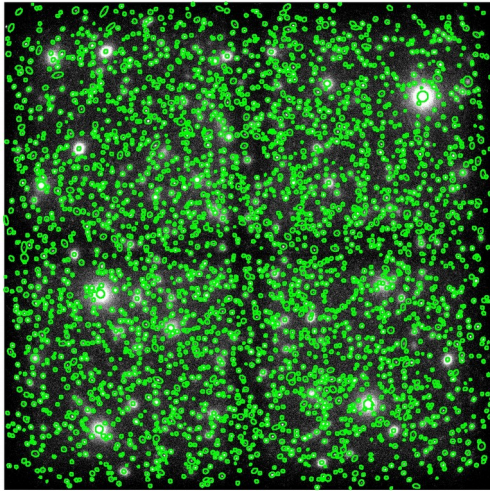
Soft band for detection

Run your detection algorithm...



# Detection algorithms

~3500 src with S/N>3



**wavdetect** from *Chandra*-CIAO... works out of the box

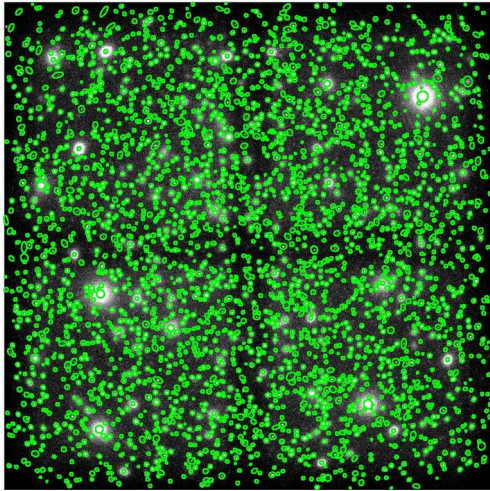
Need input expo\_map and psf\_map (0.39EE in pixels)

BUT:

- no likelihood parameter for a given source
- and not so reliable C-rates/positions

# Detection algorithms

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BUT:

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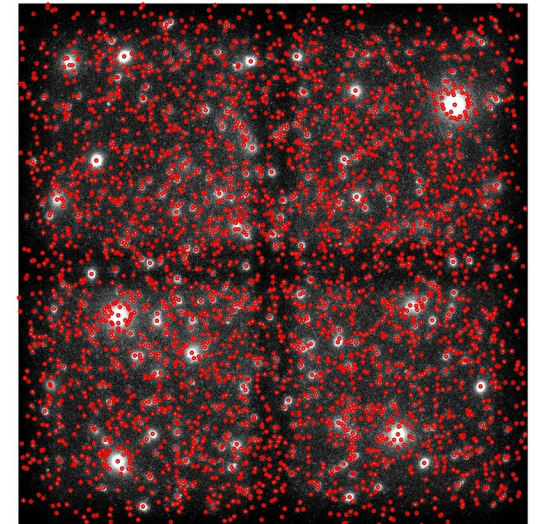
**edetect\_chain** from *XMM*-SAS (eboxdetect+emldetect) adapted with some extra work (credit A. Ibarra @ESAC, **not public**)

Key parameter is the 2D PSF model for psf-fitting

Full off-axis and energy dependence for PSF,  
multi-PSF fitting

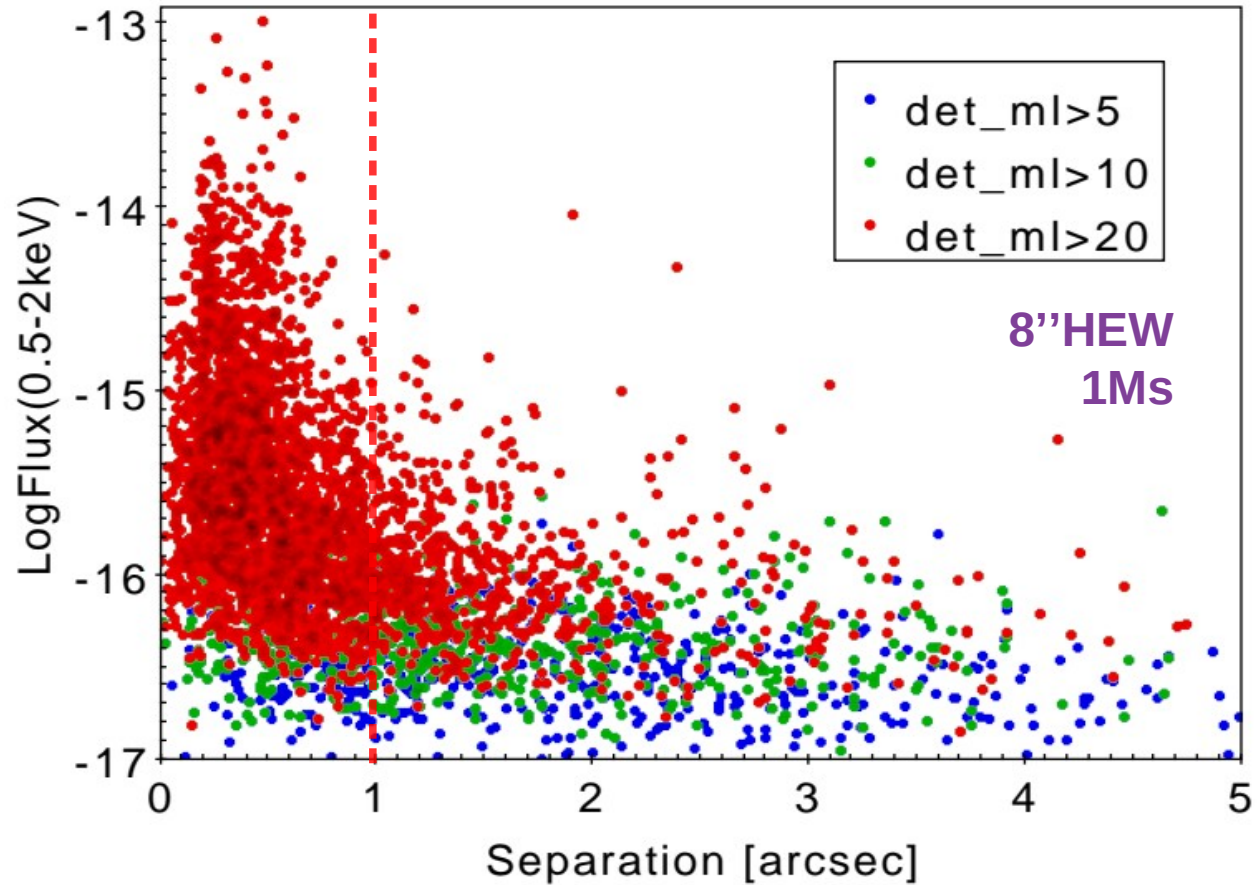
Output catalog include detection Likelihood (**det\_ml**)  
from psf fitting, reliable c-rates, positions etc...

~3000 src with det\_ml>10



# Positional accuracy

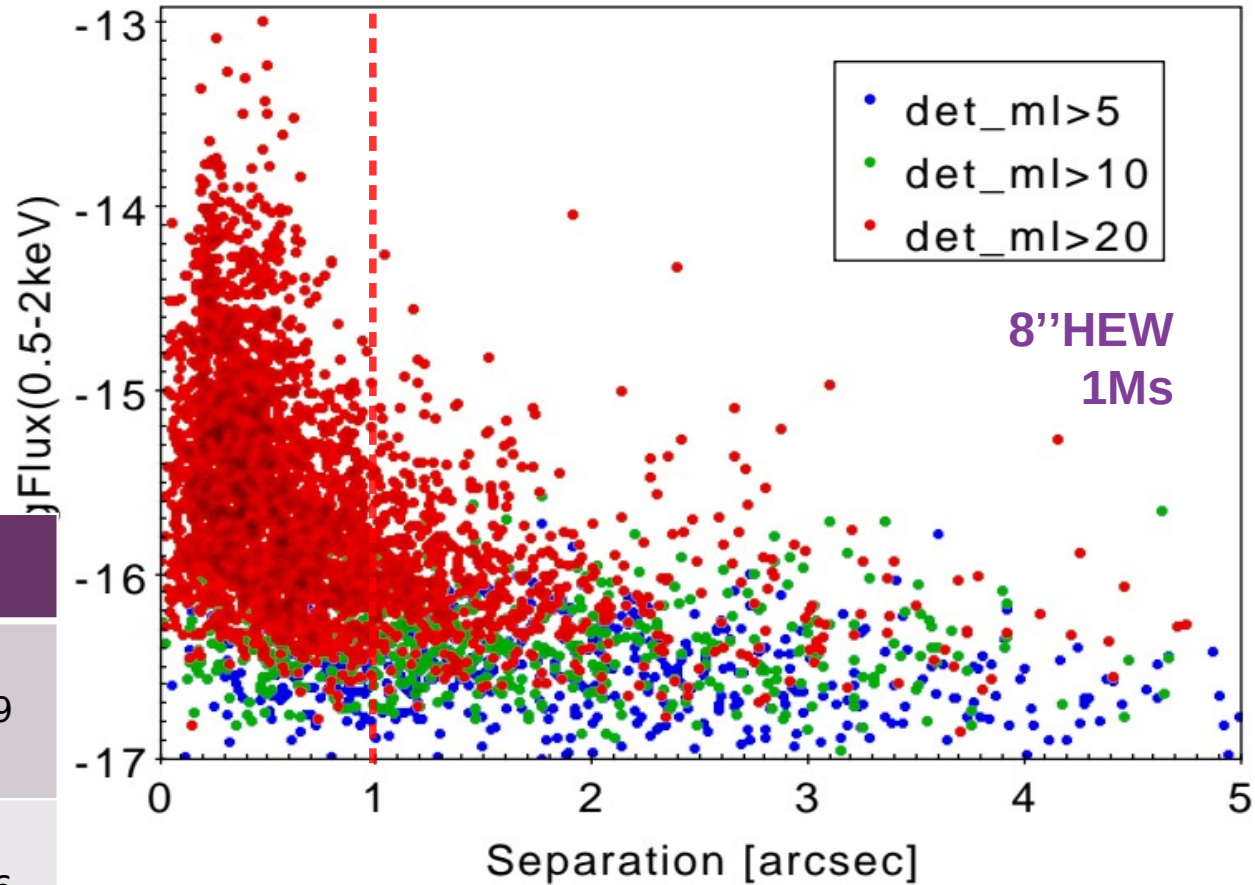
Fraction of sources identified within 1''



# Positional accuracy

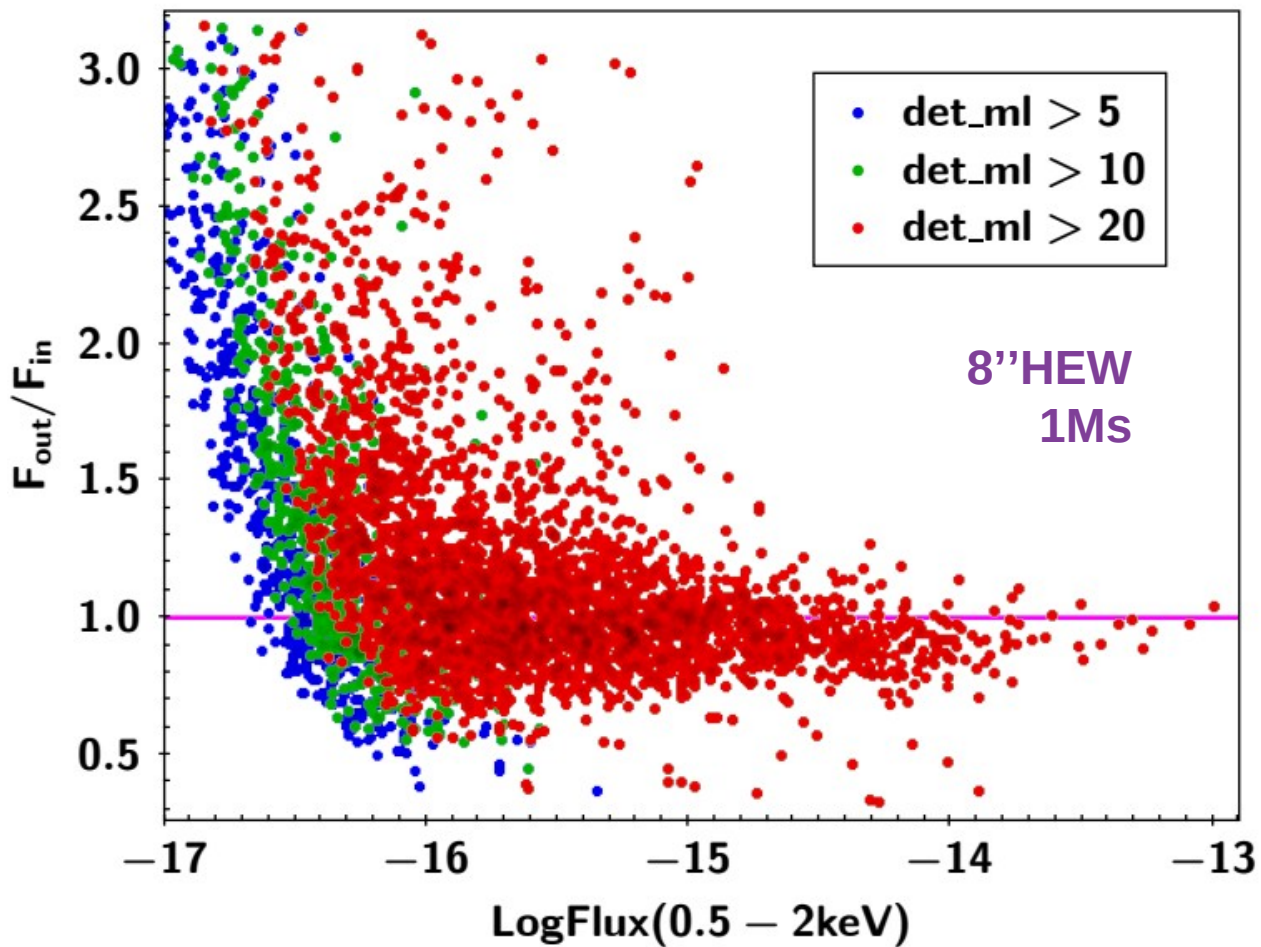
Fraction of sources identified within 1''

1Ms HEW:	5''	8''
Sep <1'' det_ml>5	0,79	0,69
Sep <1'' det_ml>10	0,85	0,76
Sep <1'' det_ml>20	0,93	0,85



# Flux accuracy

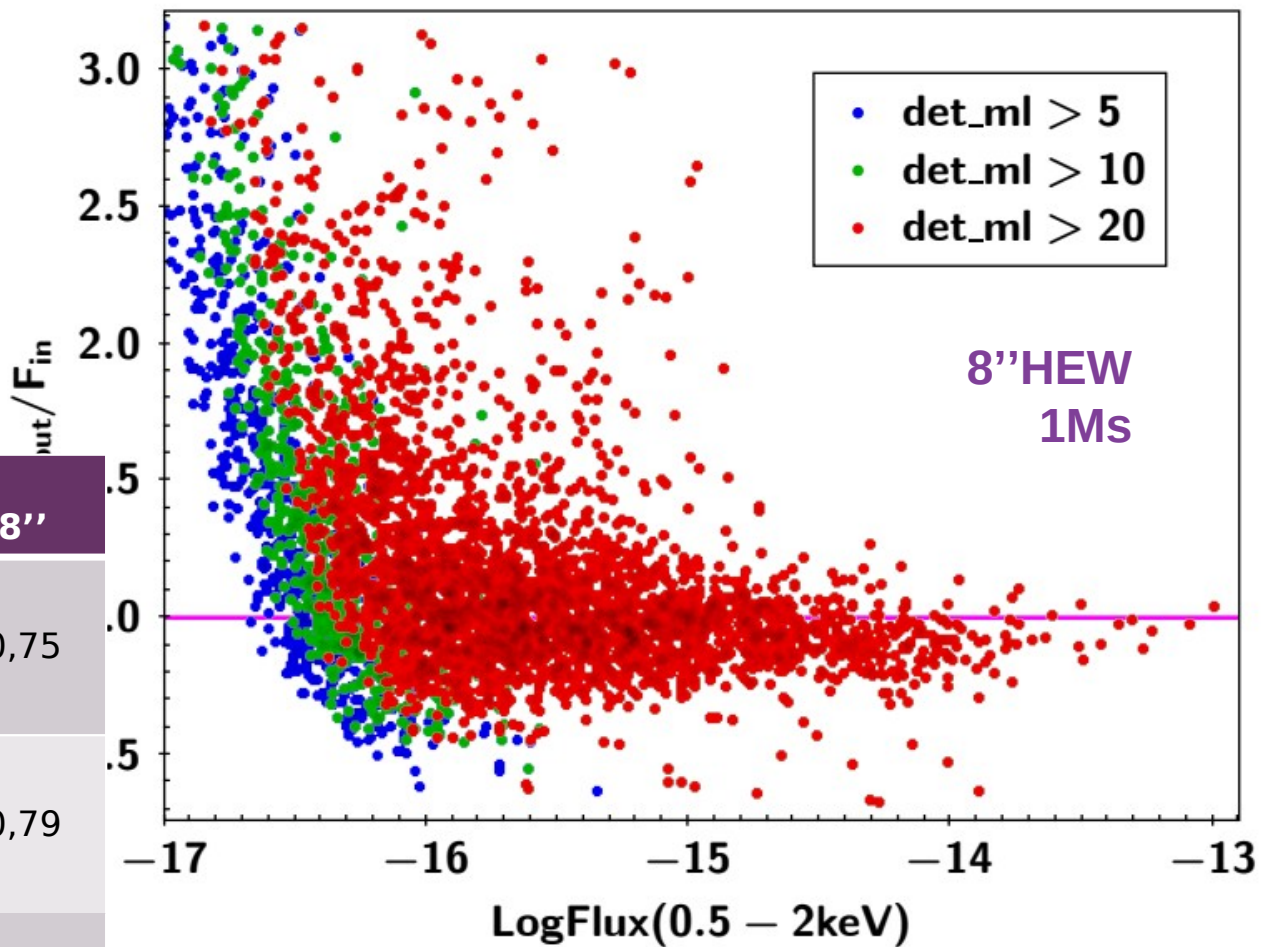
Fraction of sources  
With  $F_{\text{out}}/F_{\text{in}} < 1.5$



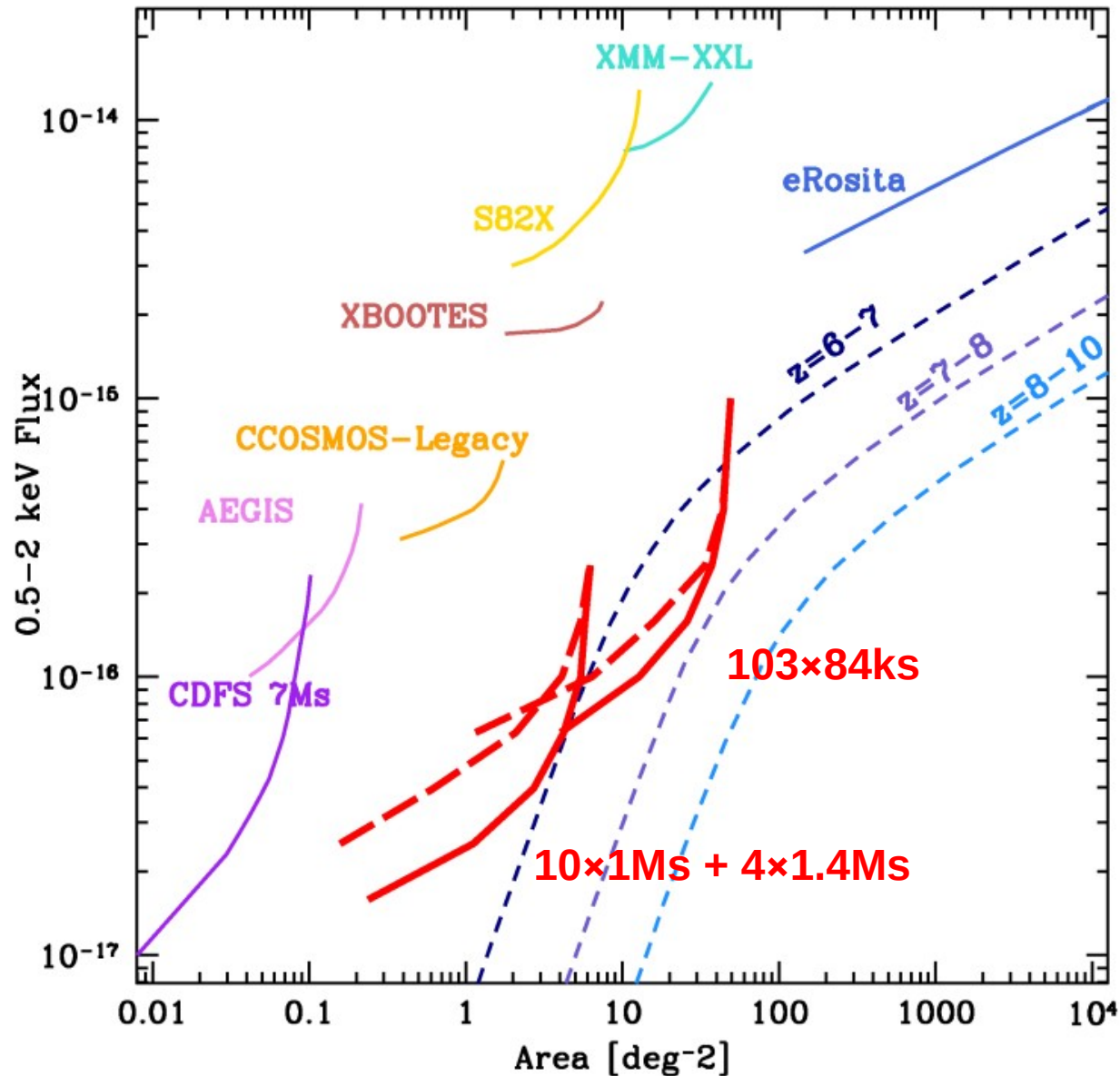
# Flux accuracy

Fraction of sources  
With  $F_{\text{out}}/F_{\text{in}} < 1.5$

1Ms	HEW:	5''	8''
$F_{\text{out}}/F_{\text{in}} < 1.5$ $\text{det\_ml} > 5$		0,76	0,75
$F_{\text{out}}/F_{\text{in}} < 1.5$ $\text{det\_ml} > 10$		0,80	0,79
$F_{\text{out}}/F_{\text{in}} < 1.5$ $\text{det\_ml} > 20$		0,84	0,84

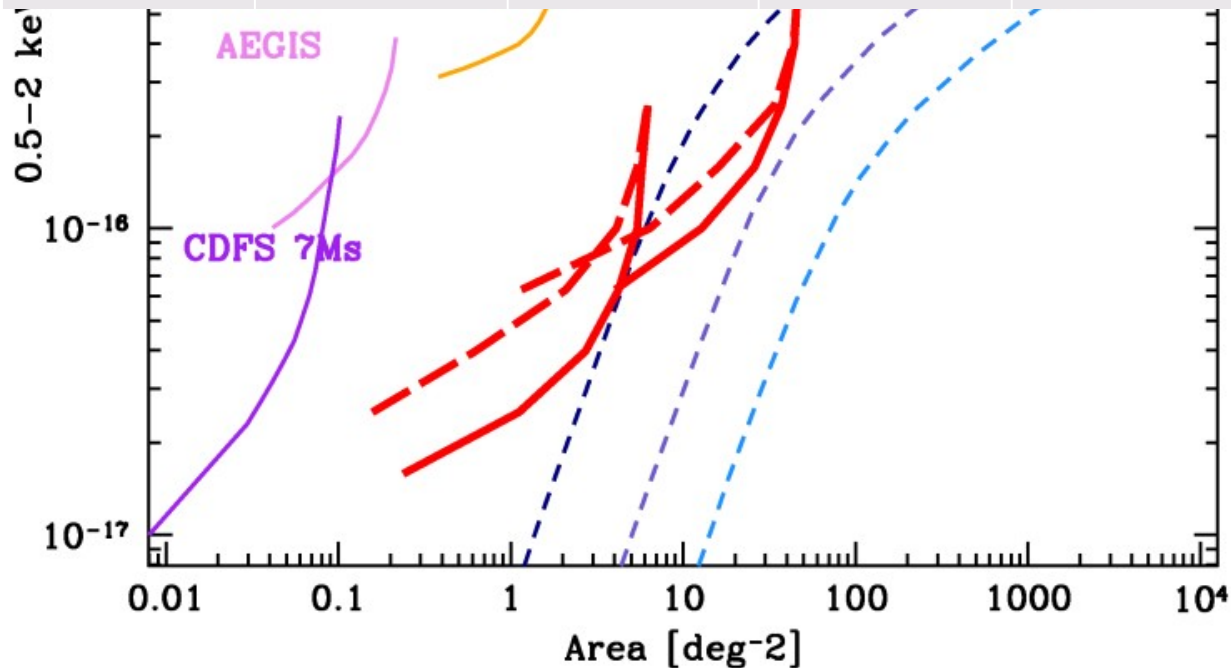


# Updated sensitivity curves



# Expected numbers for high-z AGN

	HEW LF	5'' G07	8'' G07	5'' V14	8'' V14
All $L_x$ $z=6-7$		44-58	40-49	115-156	100-132
All $L_x$ $z=7-8$		10-13	8.9-11	40-58	34-46.5





# Summary

- Mock catalogs for AGN, Galaxies and Clusters available at:  
<http://www.bo.astro.it/~gilli/mock.html>  
down to  $F_{\text{lim}}=10^{-20}$  erg/s/cm<sup>2</sup> and up to 100 deg<sup>2</sup>
- Don't forget Galactic foreground and particle background
- Use CIAO **wavdetect** for detection, keep in mind limitations
- Stay tuned for public release of WFI-adapted SAS **edetect\_chain**

