The Chandra COSMOS Survey

C-COSMOS

Simonetta Puccetti

ASI Science Data Center (ASDC)- INAF 0AR

&

T. Aldcroft, M. Brusa, N. Cappelluti, F. Civano, A. Comastri, ***M. Elvis (PI)****, F. Fiore, A. Fruscione, R. Gilli, T. Miyaji, C. Vignali, G. Zamorani et al.*

Summary

- *The Cosmic Evolution Survey : COSMOS.*

- *The Chandra Cosmos survey, C-COSMOS:*
- *science: studying the AGN-host galaxies connection; census of highly obscured AGN*
- *Data analysis*
- *preliminary results:*

  -- catalog: V1 release

  -- chandra versus XMM-Newton, close pairs

  -- multiwavelength identifications of Chandra sources: C-cosmos vs GOODS

  -- stacking analysis: 24μm selected obscured AGNs in the CDFS and the C-Cosmos.

The Cosmic Evolution Survey : COSMOS

- *The primary goal of COSMOS is to study the interplay between the large scale structure (LSS) in the universe and the formation of galaxies, dark matter and active galactic nuclei (AGN). This includes a careful analysis of the dependence of galaxy evolution on the environment.*

NEED

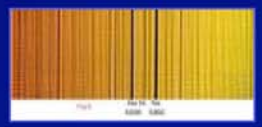
to go to large scales => 2 sq. deg.!

Sensitive Multiwavelength coverage from radio to X-rays

Redshift => optical spectroscopic coverage

COSMOS: a multi-wavelength survey!

HST ACS imaging with resolution 0.05" and sensitivity 27.2 mag (10 σ) provides morphologies of over 2 milions galaxies at < 100 pc resolution!



Optical spectroscopy surveys: zcosmos:540 hours on the ESO VLT using VIMOS. Magellan COSMOS

VLA-Cosmos Large Project plus submm

IR/Optical/UV large surveys to improve photometric redshift

XMM-Newton: 1.4 Msec.

and now Chandra!

PI MARTIN ELVIS

- Cycle 8 proposal
- 1.8 Msec
- 200ksec
- 0.9sq.deg
- f_{lim} ~2x 10^{-16} cgs (0.5-2 keV)

Spitzer: IRAC-deep

MIPS-Shallow

MIPS-Deep

The C-Cosmos Survey Science: AGN-host galaxy link.

- The discovery of SMBH at the center of the most nearby bulge dominated galaxies and, in particular, the “tight” correlation between their masses and galaxy bulge properties, suggest a tight link between AGNs and their host galaxies.

- Theoretical models predict a close connection between the evolution of the AGNs and their host galaxies. The AGN, SN and stellar wind FEEDBACK drives two different AGN populations.

C-Cosmos Science:Three topics to investigate the AGN-Galaxy link.

1. ***The influence of the environment through the ACF & CCF***

   The AGN and galaxy ACF and CCF can give us precious information how the AGNs trace the cosmic web.

2. ***Black Hole Growth and census:***

The combination of Chandra data and Spitzer's 24μm and 3-8 μm data will allow us to unveil highly obscured accretion, thus providing a complete census of accreting SMBH

3. ***Probing galaxy interactions, galaxy activity, clusters, groups.***

XMM has detected ~70 groups/clusters in the central C-COSMOS field (Finoguenov et al. 2006). Chandra will allow us to finely probe their structures and to cleanly separate extended emission from point source emission.

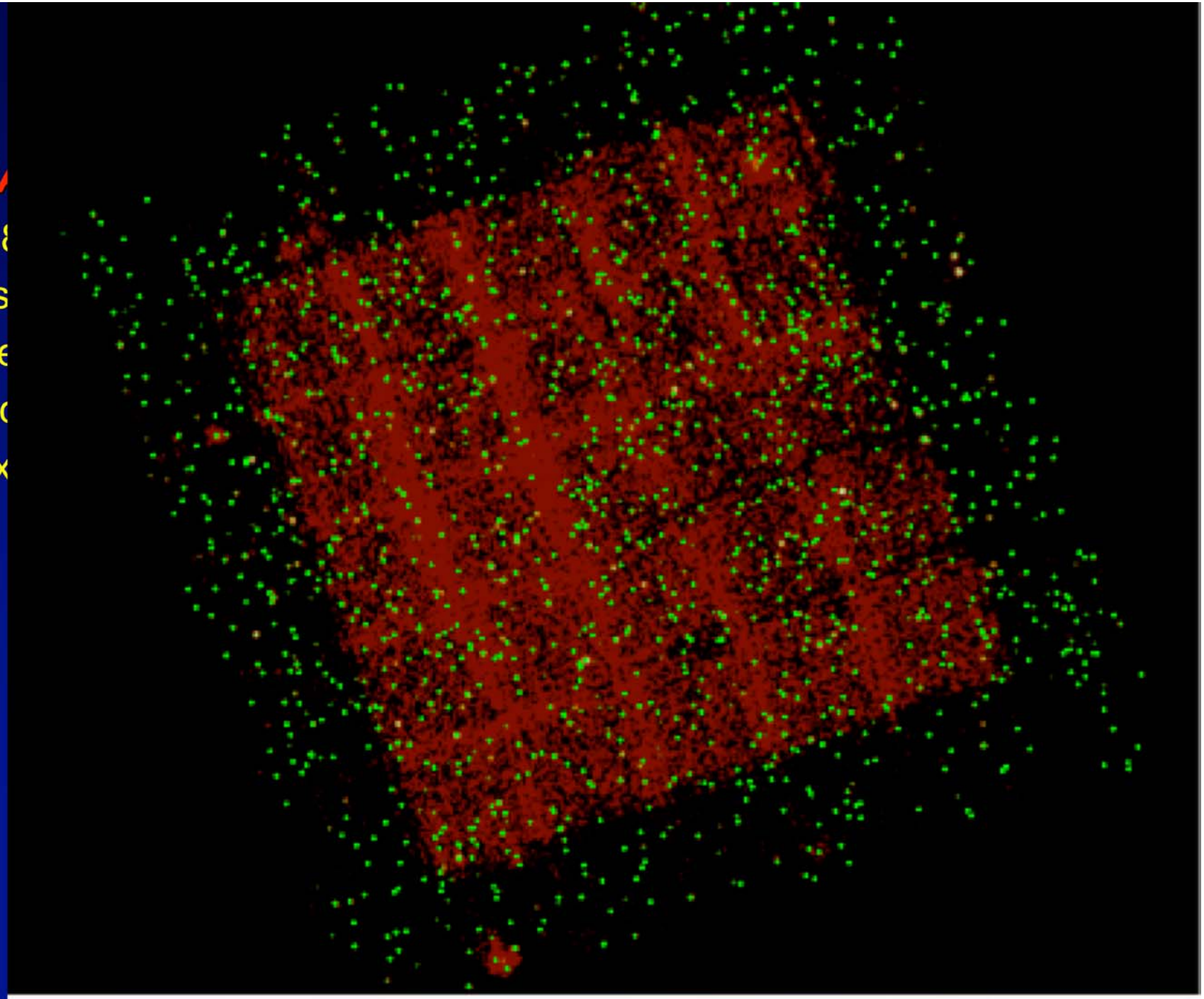
The Chandra 1.8Msec COSMOS survey

- *The Chandra high resolution permits to resolve sources 2" apart over 0.9 sq. deg., corresponding to 8-16 kpc separations for z = 0.3-0.9 and locates point sources to < 4 kpc at any z.*

- *Thanks to the good PFS, ACIS-I is not background limited, then C-COSMOS will reach 2-3 times deeper than XMM-COSMOS in both hard and soft bands.*

- *The low ACIS background enables stacking analysis (see Marcella Brusa's talk).*

- ***PI MA***
- Cycle 8
- 1.8 Ms
- 200kse
- 0.9sq.d
- f_{lim} ~2x keV)



Data cleaning

- *We have verified that the data are strongly affected by Cosmic Ray afterglows.*

Rejection of Cosmic Ray afterglows was done using acis_run_hotpix.

From 47900 to 38500 0.5-7 keV bkg events per ACIS-I field per 50ks expo (24% rejection).

Total residual bkg = 0.0092 cts/pix/50ks = 0.037 cts/pix/200ks

(~2 cts/200ks/circle rad=2")

- *Only two observations in all data sets needed to be cleaned for background flares (lost 8500 sec and 3500 sec, respectively).*

Data cleaning & Astrometry

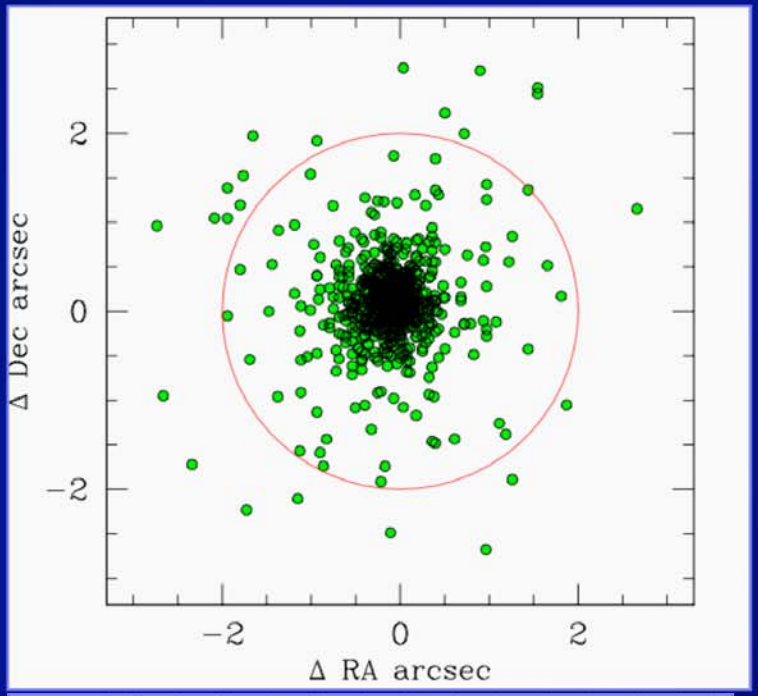
- *Rejection of Cosmic Ray afterglows was done using acis_run_hotpix.*

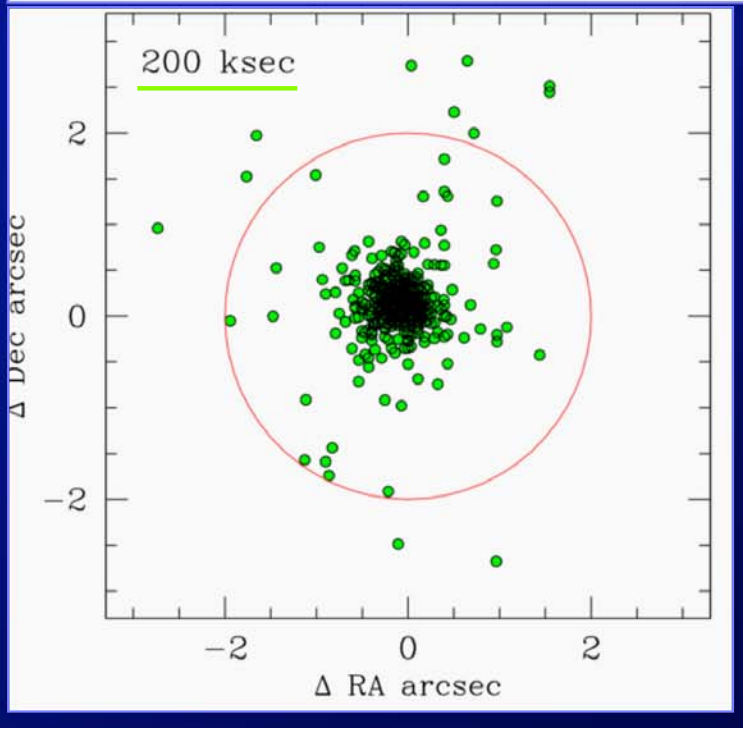
From 47900 to 38500 0.5-7 keV bkg events per ACIS-I field per 50ks expo (24% rejection).

- *Total residual bkg = 0.0092 cts/pix/50ks = 0.037 cts/pix/200ks*

(~2 cts/200ks/circle rad=2")

- *Each pointing was brought to a common astrometric solution by correlating the positions of all X-ray sources detected in a ACIS-I frame with the positions of optical sources*
- *Typical corrections are ≤1", typical dispersions are ~0.3-0.4"*

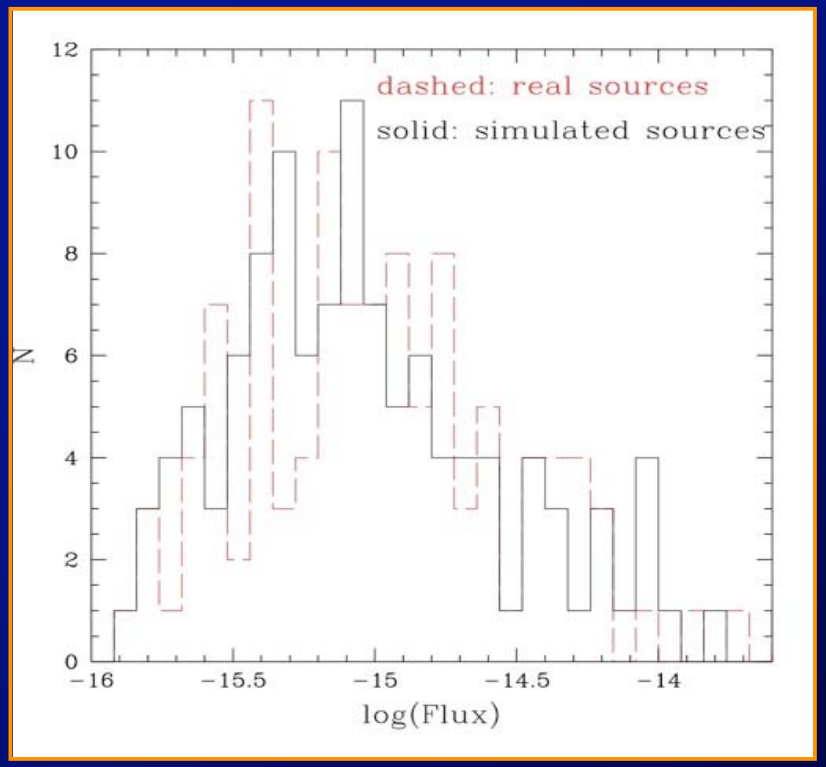




Detections

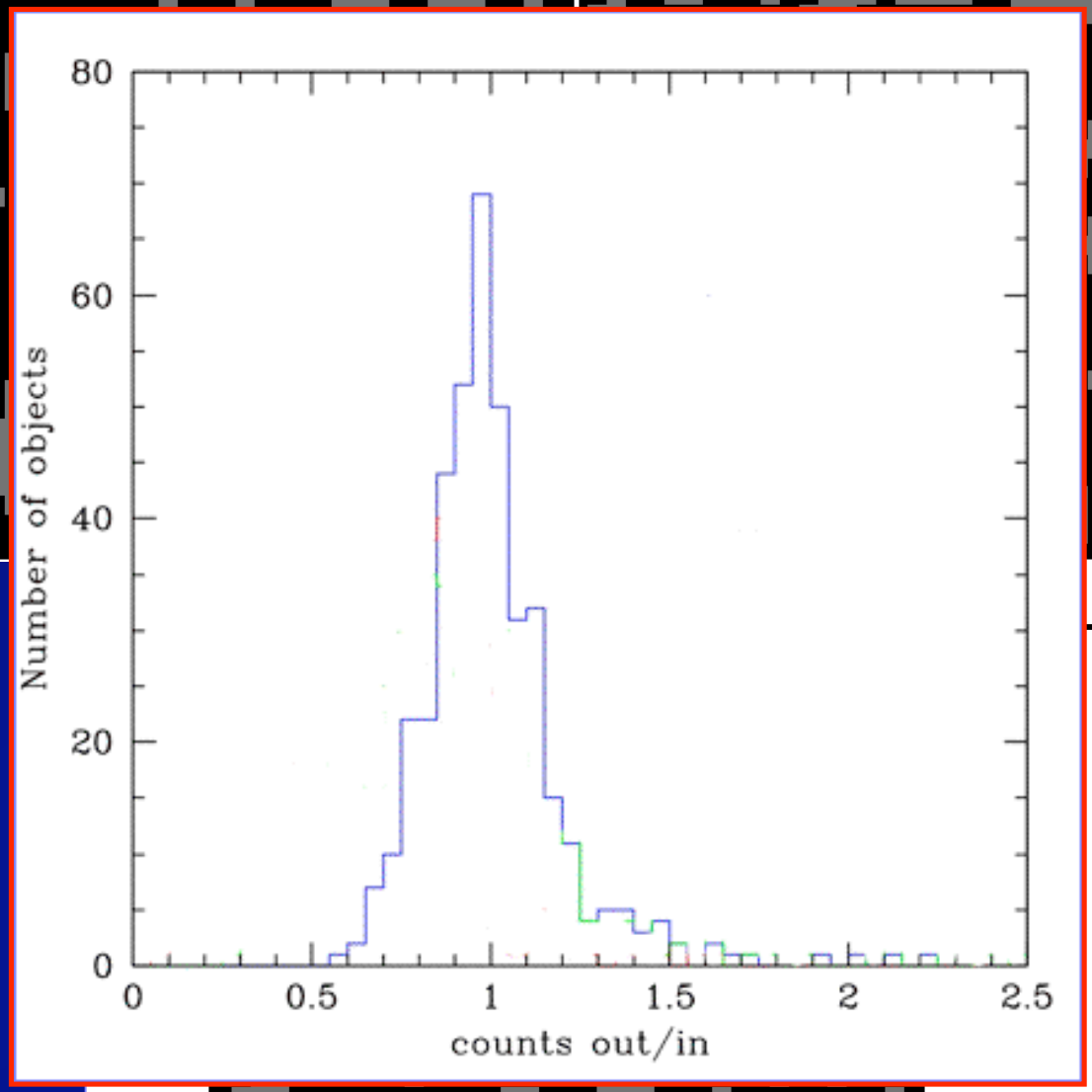
- *We use the Palermo wavelet (i.e. pwdetect, F. Damiani et al. 1997) detection algorithm to get the source positions. The Palermo wavelet works very well to resolve sources in crowded fields like C-Cosmos.*
- *The pwdetect source list is used as input for the MPE (sliding cell + ML fitting) detection algorithm to obtain source counts, expotime, rate, threshold etc etc..*

- *To test the detection algorithm, we have used simulations of eight Chandra pointings using the Gilli et al. 2007 number counts and source positions from the Millennium simulations (thus including source clustering).*



Simulations

Fra *ounts.*
eV)



C-COSMOS Schedule: CATALOGS and DATA

- *First (V1) complete catalog of X-ray sources by 8/31/2007.*

The V1 catalog do not include the faintest sources and has been cut at about twice the ultimate flux limit.

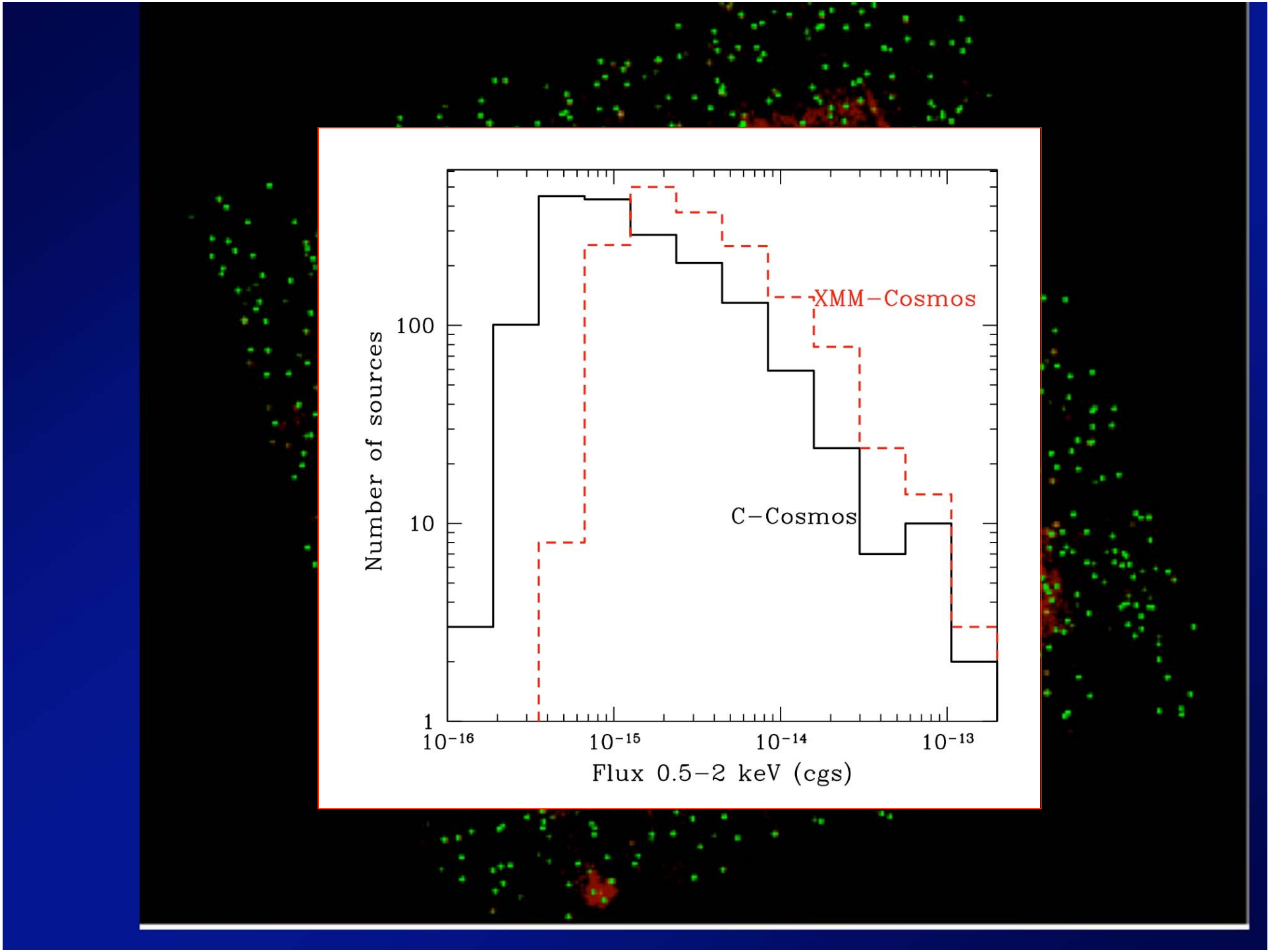
- *Distribution to the public can be foreseen on 01/31/2008.*

- *Since 8/31/2007 we are working at a final (V2) catalog, which will reach the flux limits advertised in the Chandra AO8 proposal.*

- *Distribution of the V2 catalog to the full Cosmos team is foreseen on 2/28/2008.*

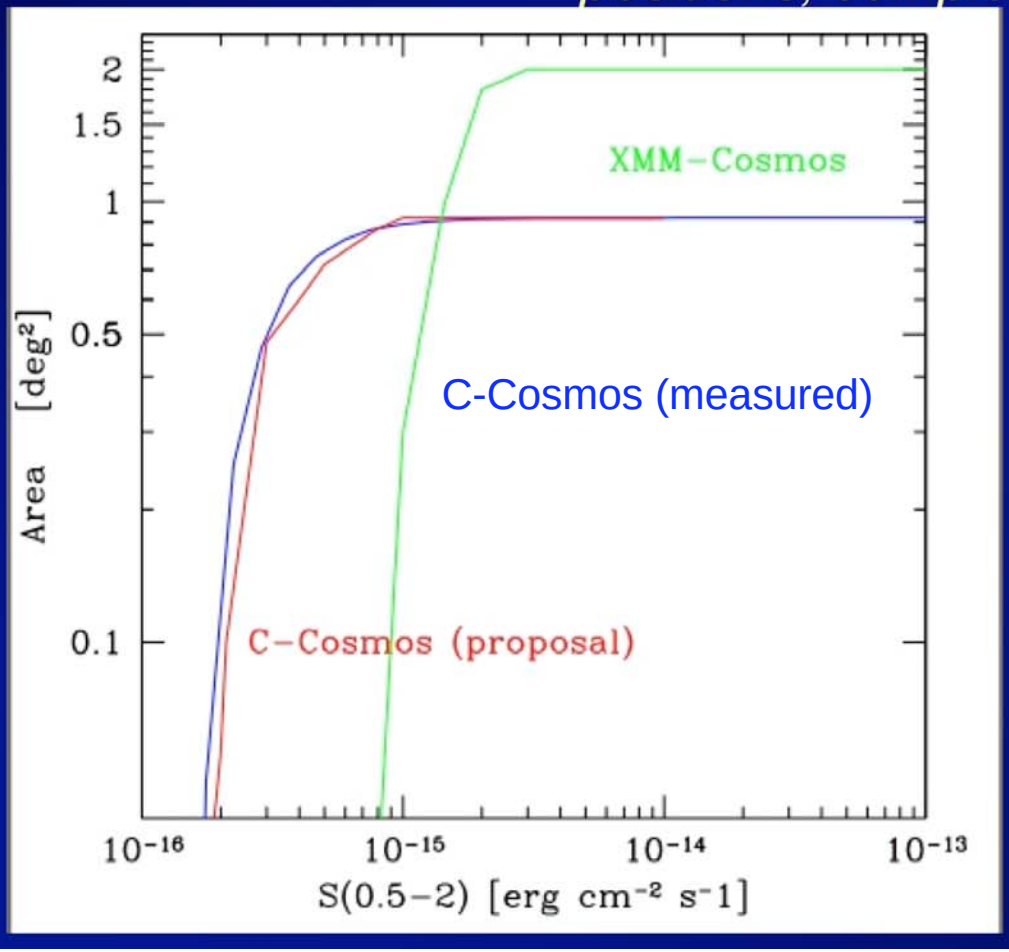
- *Distribution of the V2 catalog to the public is foreseen on 5/31/2008.*

- *Cleaned and astrometrically corrected event files will be made available to the full Cosmos team by 8/31/2007.*
- *Cleaned and astrometrically corrected event files will be made publicly available by 1/31/2008.*


XMM−Cosmos
C−Cosmos
Number of sources
100
10
1
10^{-16}
10^{-15}
10^{-14}
10^{-13}
Flux 0.5−2 keV (cgs)

C-COSMOS V1 CATALOG

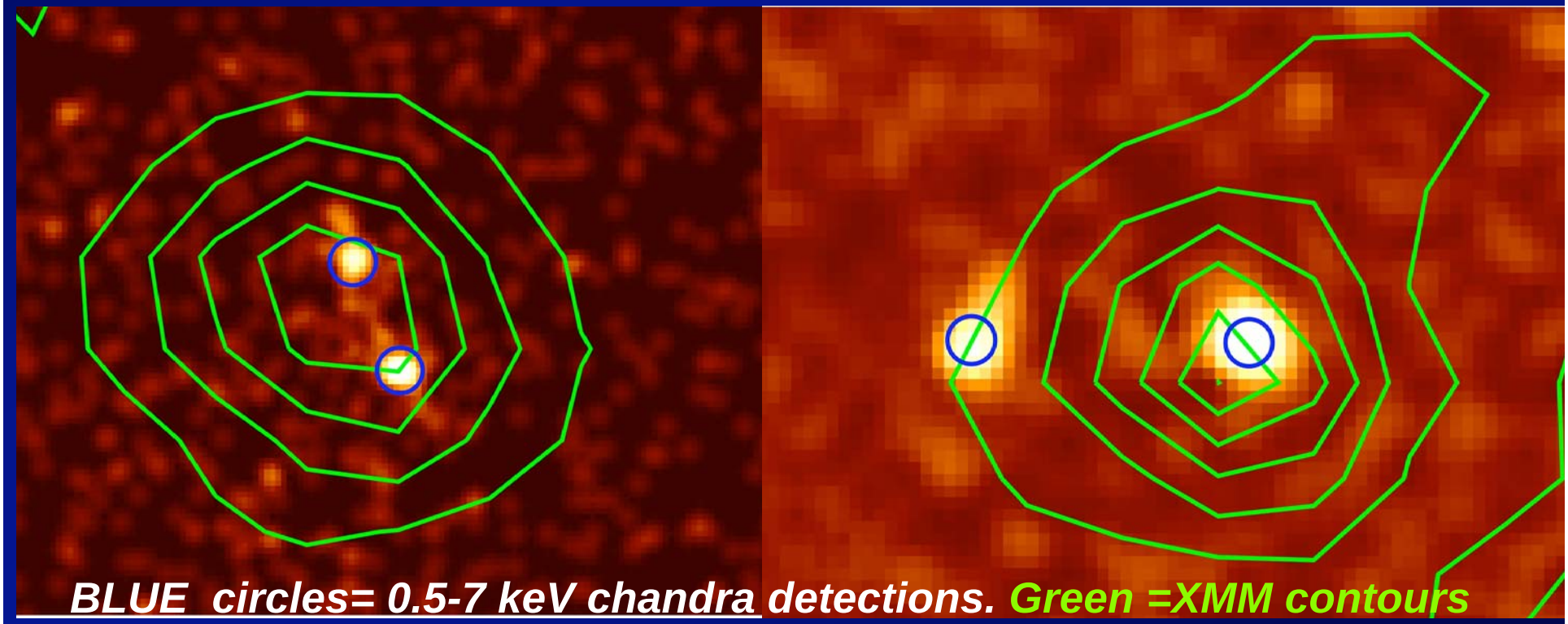
About 1678 sources are detected in the Chandra 0.5-7 keV images at a threshold probability of 2E-5 . This list of sources is still being extensively checked in order to quantify its reliability in terms of fluxes, positions, completeness etc.



The Sky coverage: *is fully consistent with the sky coverage advertised in the Chandra AO8 proposal.*

C-COSMOS/XMM-COSMOS comparison

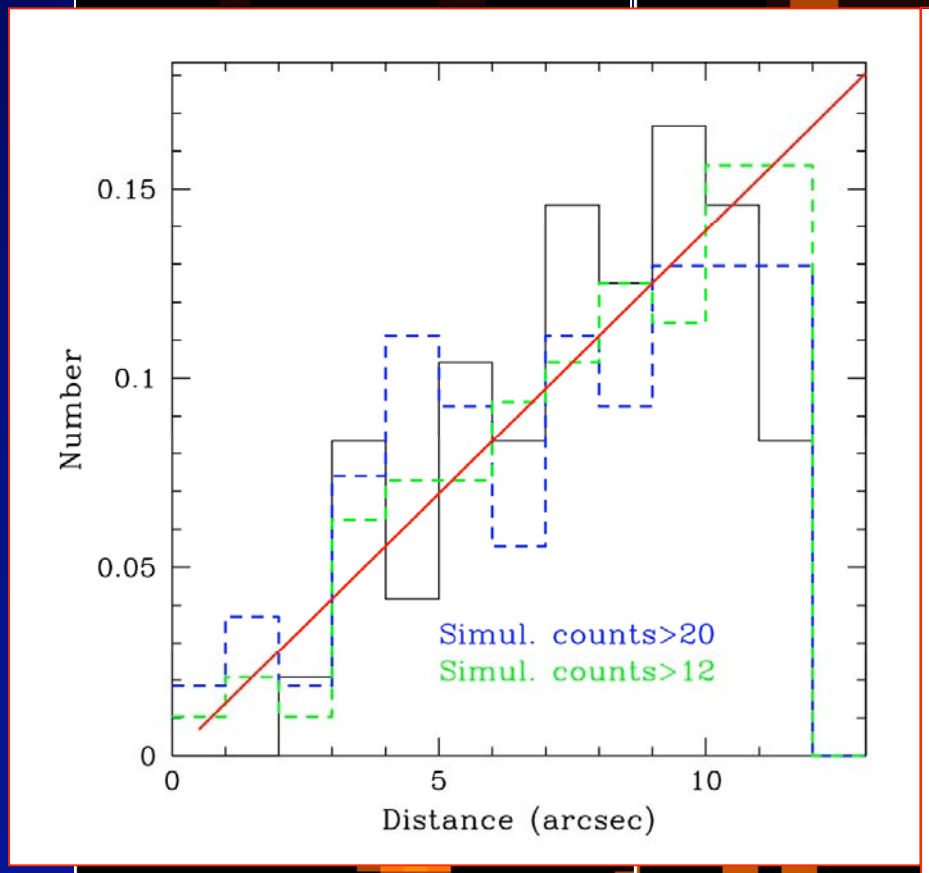
About 30 XMM sources have associated two chandra detections. In several cases the brightness of the sources of the pair is similar => XMM is overstimating the source flux

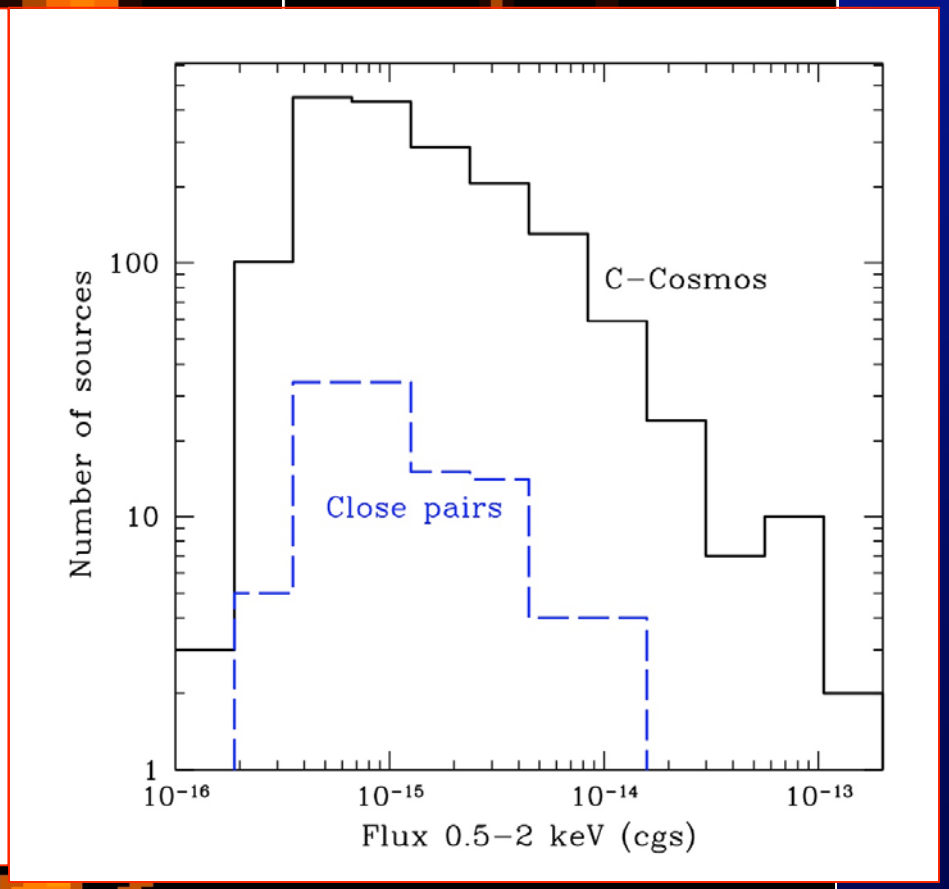


BLUE circles= 0.5-7 keV chandra detections. Green =XMM contours

Close Pairs

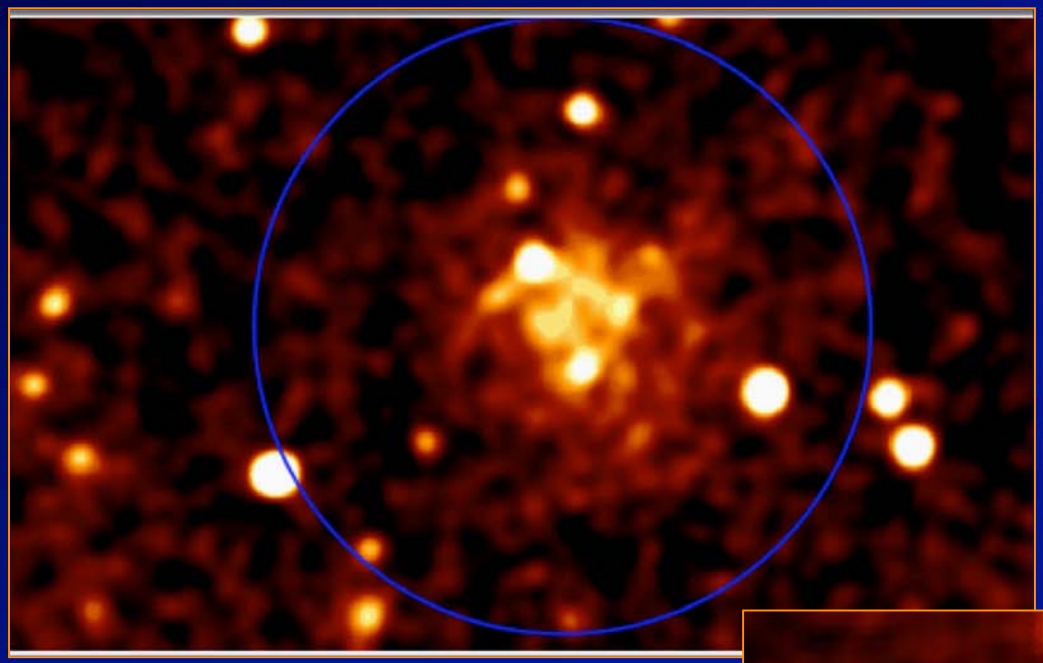
- *96 source in pairs or triplets within 12 arcsec in 0.5-7 keV energy band.*
- *50% of the chandra pairs and triplets have associated only one XMM source.*





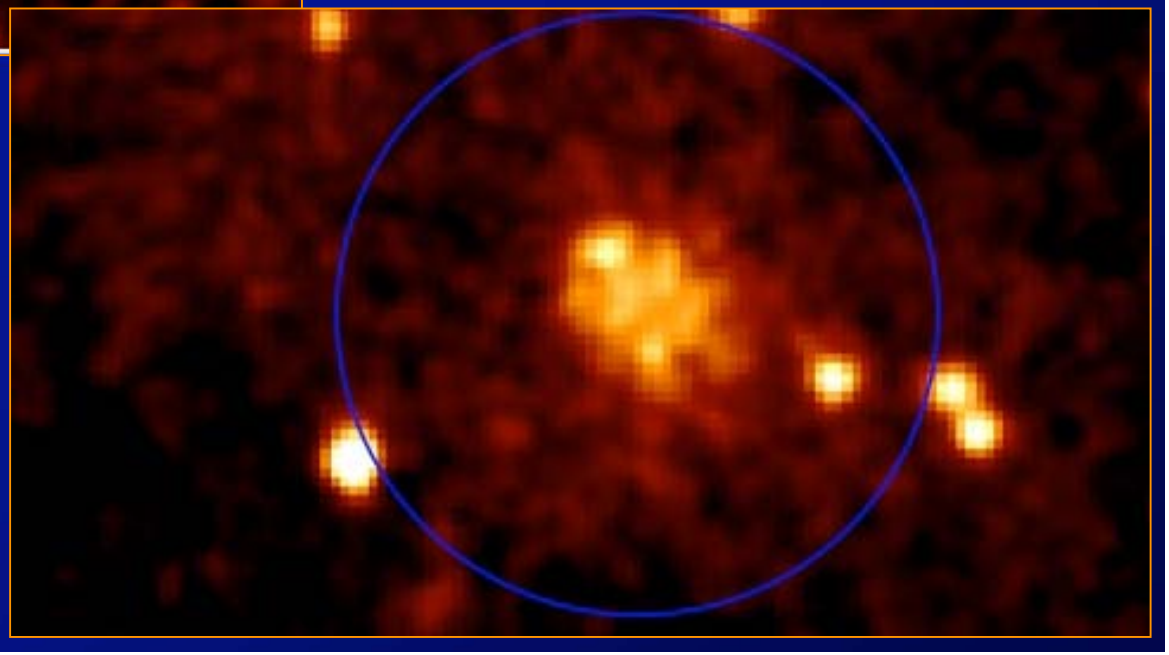
Green: chandra 0.5-7 keV detection. Blue:XMM detected sources.

The z = 0.73 structure



C-COSMOS

XMM-COSMOS



Multiwavelength indentifications of C-Cosmos sources

The identifications of the counterparts of the Chandra sources in the HST-ACS, near infrared, IRAC and Mid infrared COSMOS catalogs is a working in progress led by F. Civano et al.

We present here preliminary results based on the correlation of the Chandra data with a MIPS catalog (provided by A. Steffen, Liam Yan, M. Salvato, M. Brusa, F. Fiore, C. Feruglio and A. Aussel.)

MIPS catalog cuts to S/N>4:

938 sources in the C-Cosmos

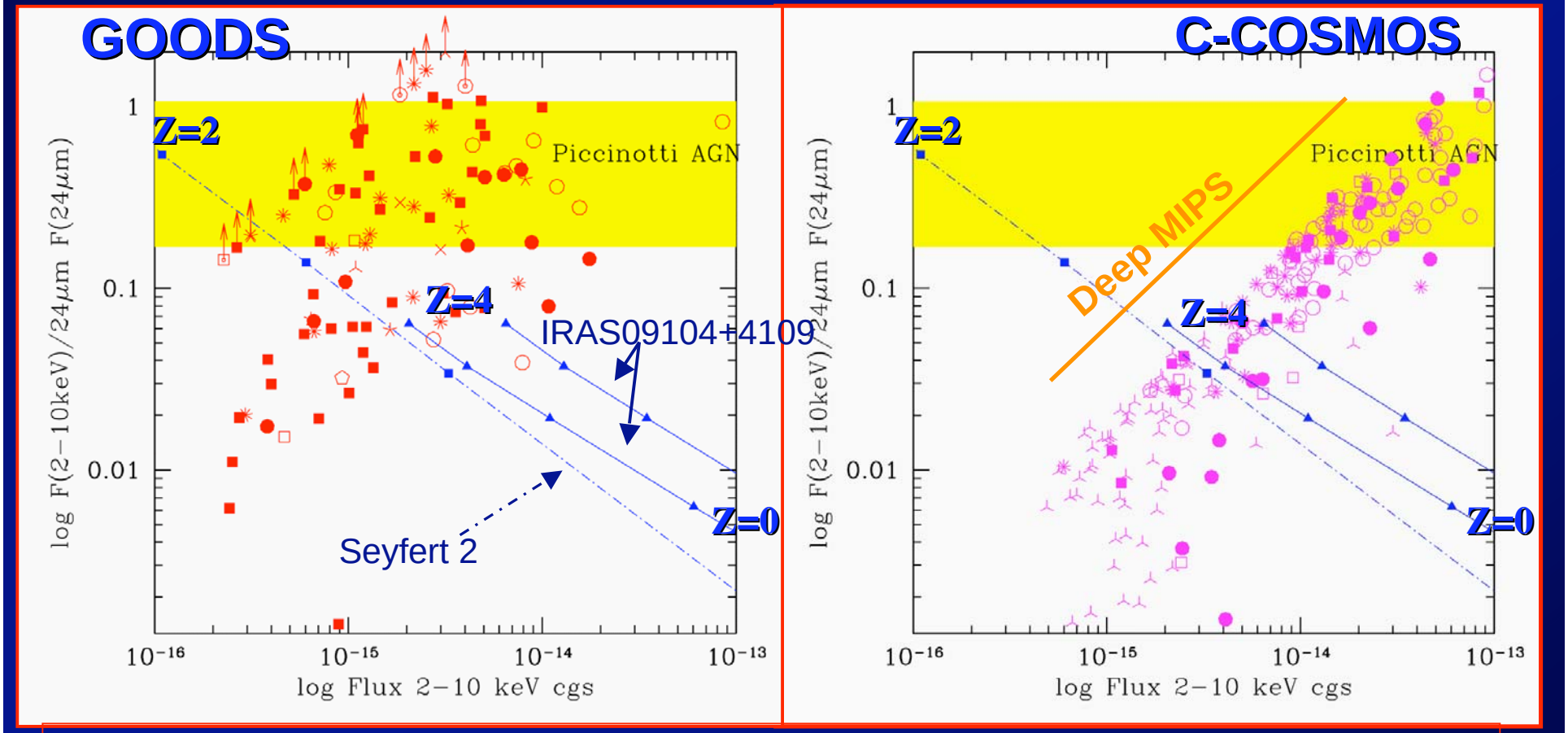
924 with optical counterparts.

869 with near infrared counterparts.

232 with a Chandra detection, of these166 redshifts from XMM catalog (Brusa et al. in prep., 44 photometric redshifts sources, Salvato et al. in prep.)

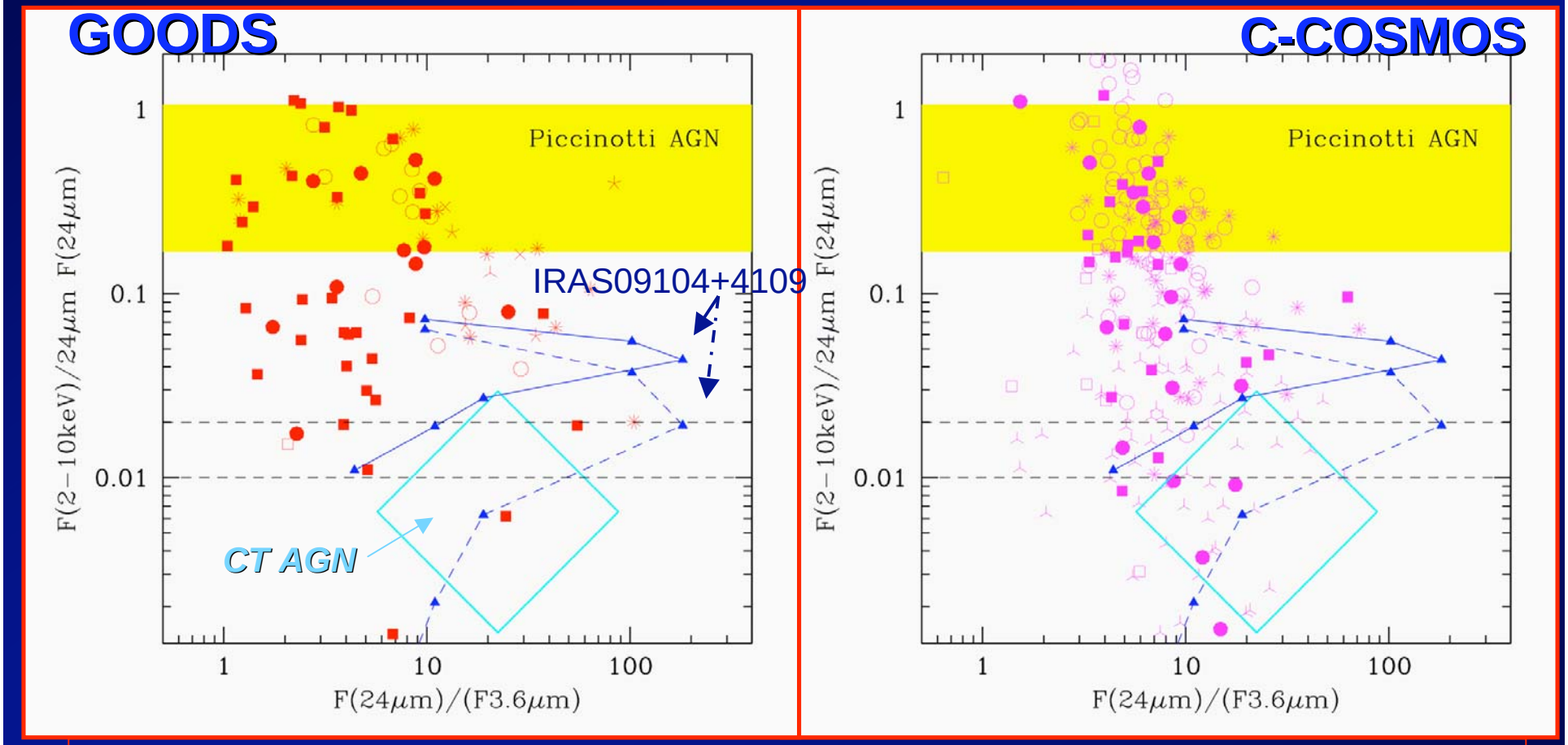
Multiwavelength properties: GOODS vs. C-COSMOS

***MIPS flux** : GOODS 40 μJy, C-COSMOS 400μJy. **2-10 keV flux**: GOODS ~3E-16 c.g.s, C-COSMOS ~9E-16 c.g.s. **R** : GOODS 27.5 mag , C-COSMOS R~26.5 mag*



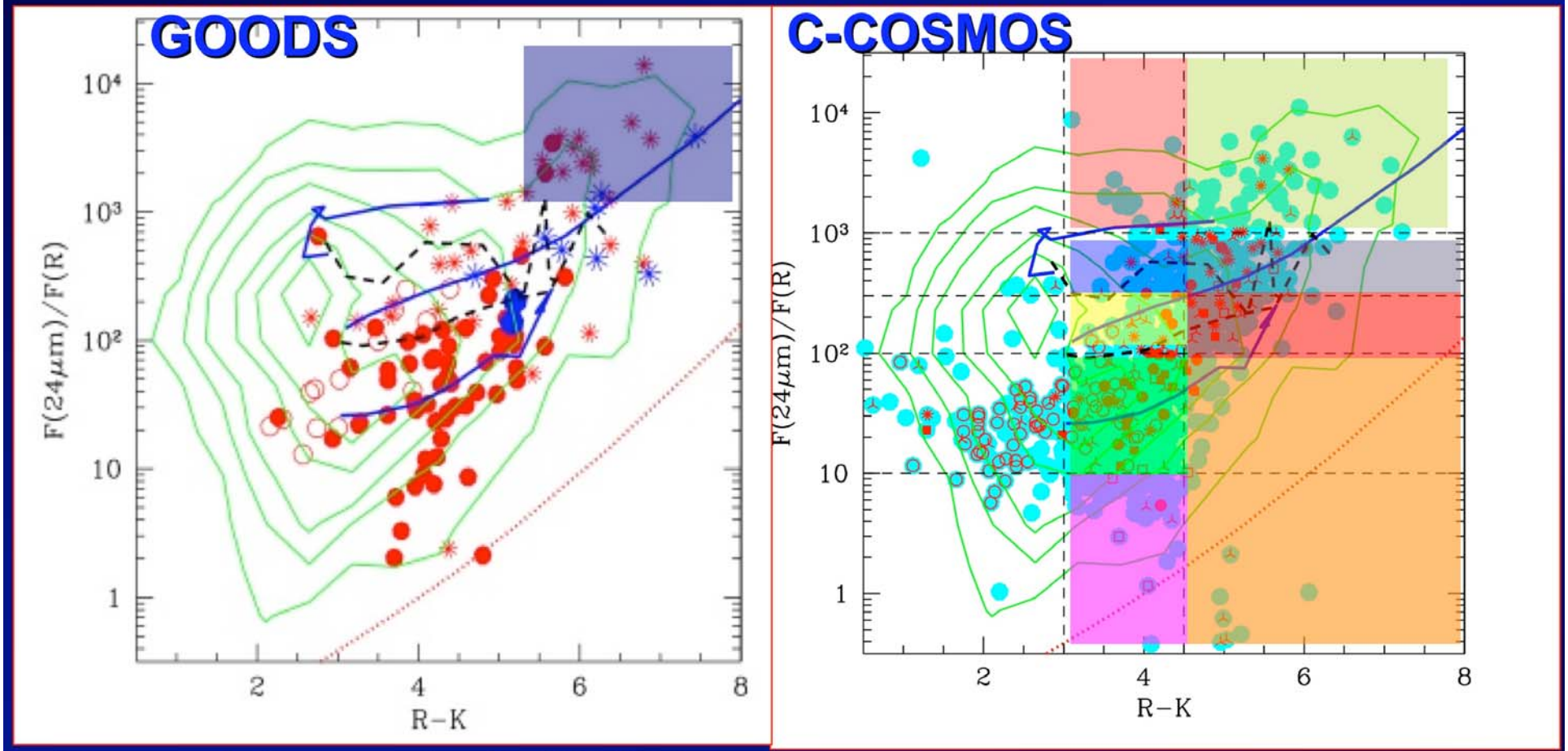
Open symbol: AGN type 1. Filled symbols: AGN non type 1. Stars: photometric redshift. Triangles: only identification

Multiwavelength properties: GOODS vs. C-COSMOS

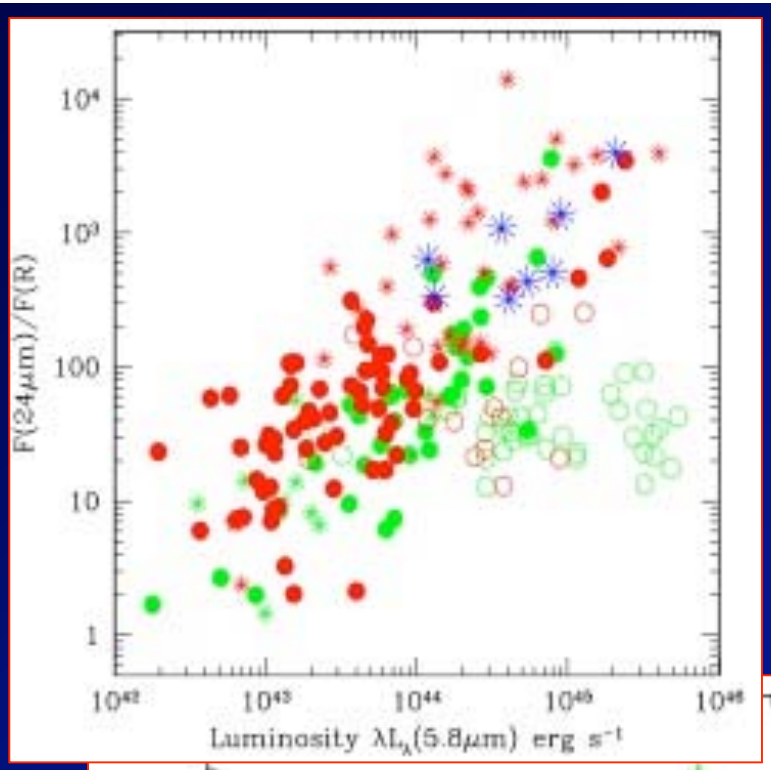


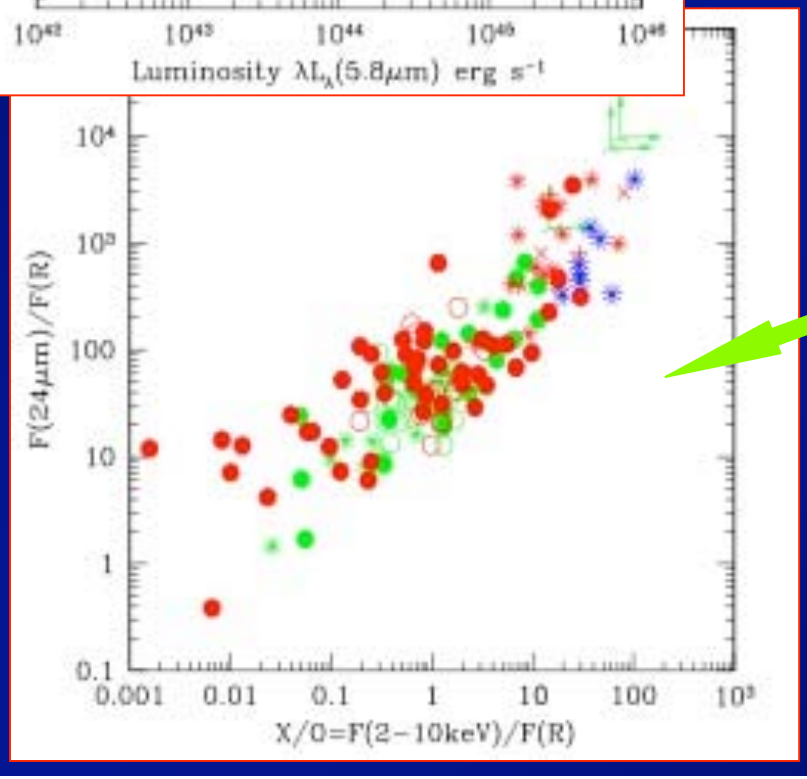
Open symbol: AGN type 1. Filled symbols: AGN non type 1. Stars: photometric redshift. Triangles: only identification

24μm selected obscured AGNs in the CDFS and the C-Cosmos.



From Fiore et al. 2007. Open symbol: AGN type 1. Filled symbols: AGN non type 1. Stars: photometric redshift. Triangles: only identification

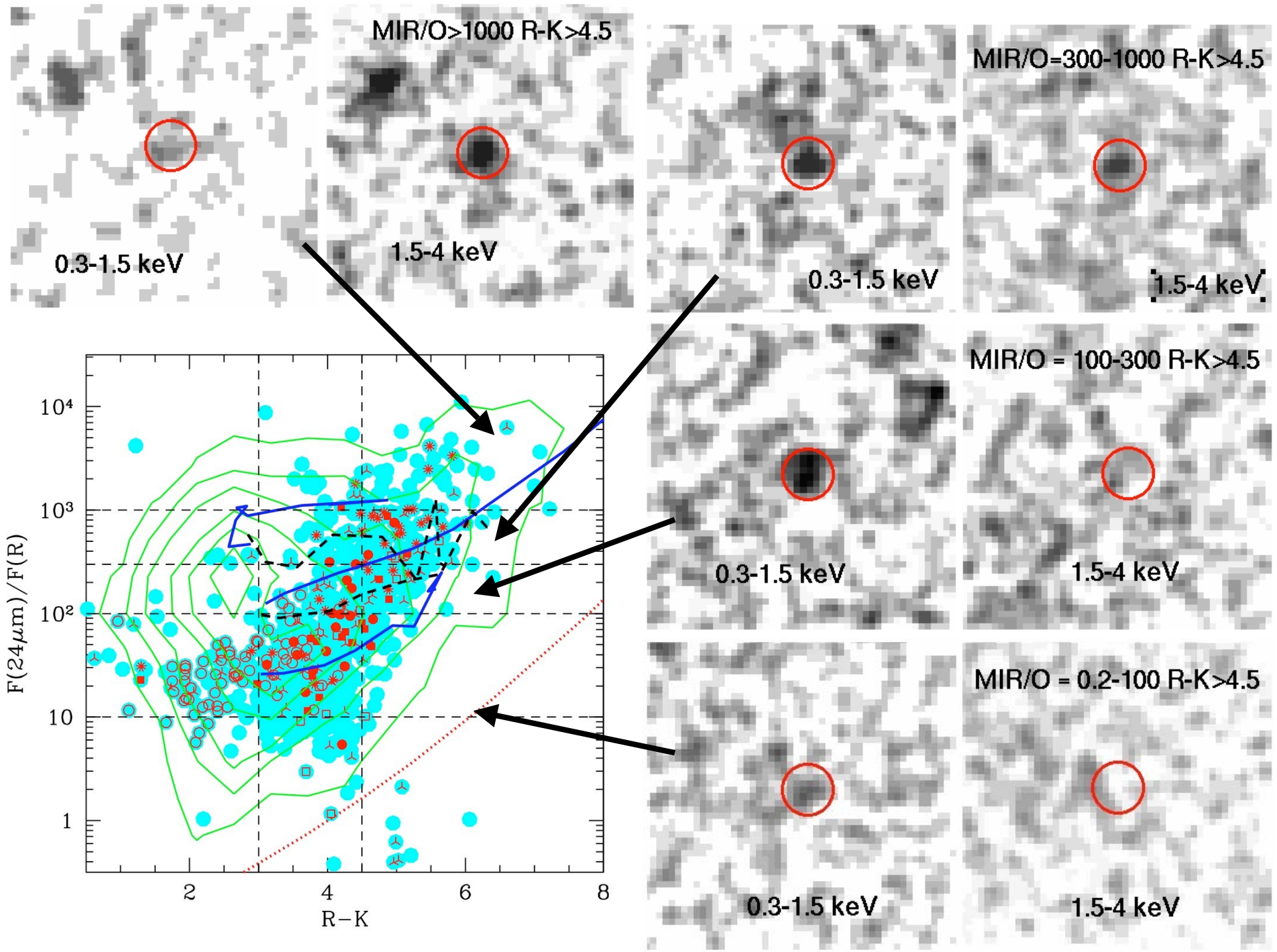


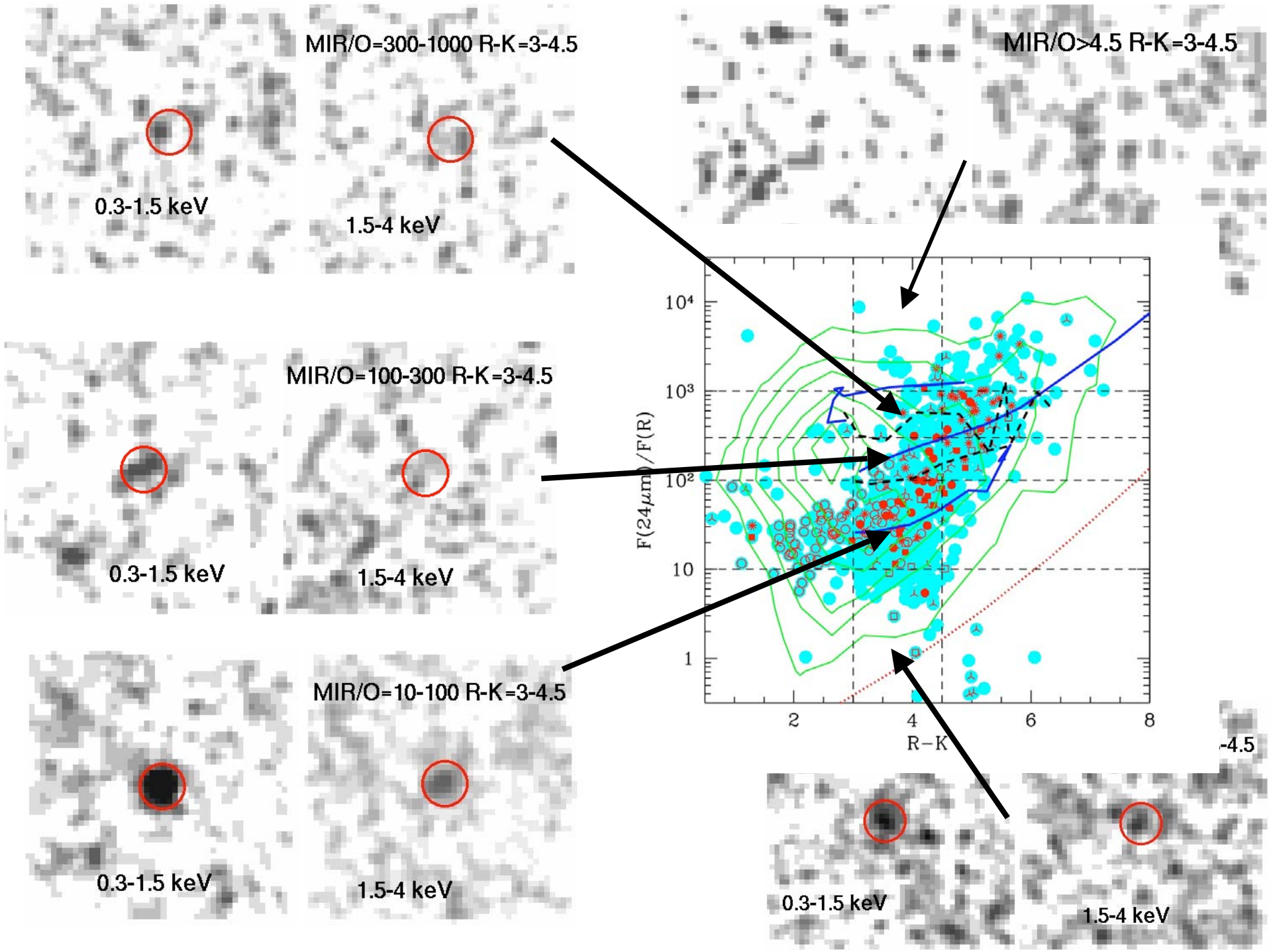


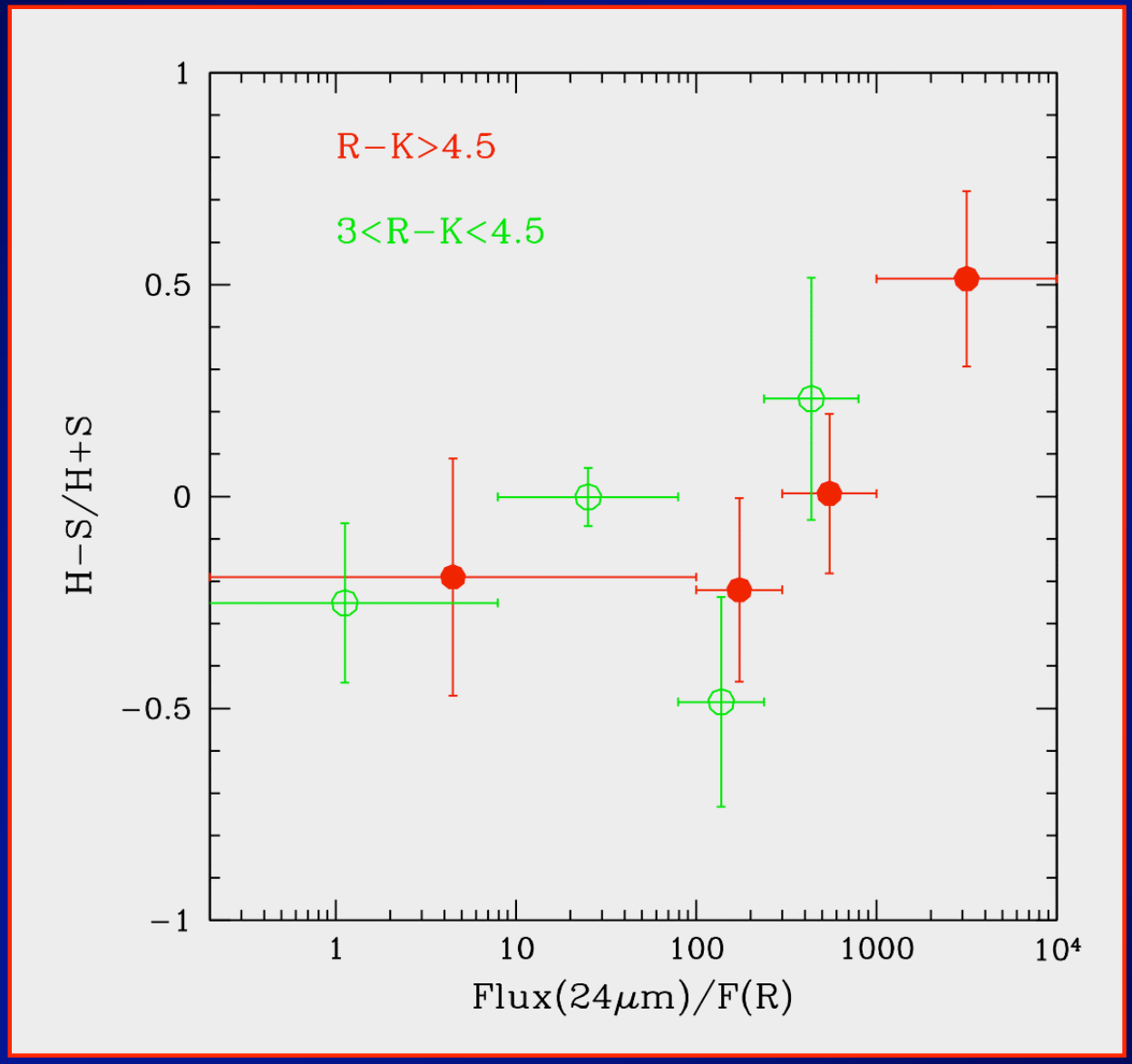
24μm selected obscured AGNs:

- *Non type 1 AGNs show mid-infrared to optical flux ratio (X/O) strongly correlated with λFλ(5.8μm) (from Fiore et al. 2007). This is similar to the tight correlation between the X-ray to optical flux ratio (X/O) and the X-ray luminosity, observed for the Compton thin AGNs detected in X-rays (Fiore et al. 2003, Eckart et al. 2006).*

- *X-ray obscured AGNs tend to have red R-K colors (Brusa et al. 2005 and reference therein). Could the Compton thick AGNs have similarly red colors?*


MIR/O>1000 R-K>4.5
0.3-1.5 keV
1.5-4 keV
MIR/O=300-1000 R-K>4.5
0.3-1.5 keV
1.5-4 keV
MIR/O = 100-300 R-K>4.5
0.3-1.5 keV
1.5-4 keV
MIR/O = 0.2-100 R-K>4.5
0.3-1.5 keV
1.5-4 keV
F(24μm)/F(R)
10⁴
10³
10²
10
1
2
4
6
8
R−K


MIR/O=300-1000 R-K=3-4.5
0.3-1.5 keV
1.5-4 keV
MIR/O>4.5 R-K=3-4.5
MIR/O=100-300 R-K=3-4.5
0.3-1.5 keV
1.5-4 keV
MIR/O=10-100 R-K=3-4.5
0.3-1.5 keV
1.5-4 keV
10^4
10^3
10^2
10
1
F(24μm)/F(R)
2
4
6
8
R−K
-4.5
0.3-1.5 keV
1.5-4 keV


R−K>4.5
3<R−K<4.5
1
0.5
0
−0.5
−1
H−S/H+S
1
10
100
1000
10⁴
Flux(24μm)/F(R)

Conclusions

- C-COSMOS V1 release.
- The close pairs are resolved.
- Multiwavelength analysis is a working in progress.
- The stacking analysis of MIPS selected C-COSMOS sources confirms the results found in CDFs.
- C-COSMOS+GOODS will allow a complete coverage of the L-z plain.
- Direct detection of QSO2 in C-COSMOS.