

# X-ray spectral fitting in X-ray survey fields: CDF-S and COSMOS

## **Chandra Deep Field-South (CDF-S)**

≈7Ms *Chandra* exposure (last obs. at March 2016)

≈3Ms *XMM-Newton* exposure

Deep multi-wavelength coverage

One of the legacy fields (no deeper field for the next 20 yrs)

## **COSMOS**

≈1.8Ms *Chandra* exposure (+2.8Ms extending area and depth)

≈1.55Ms *XMM-Newton* exposure

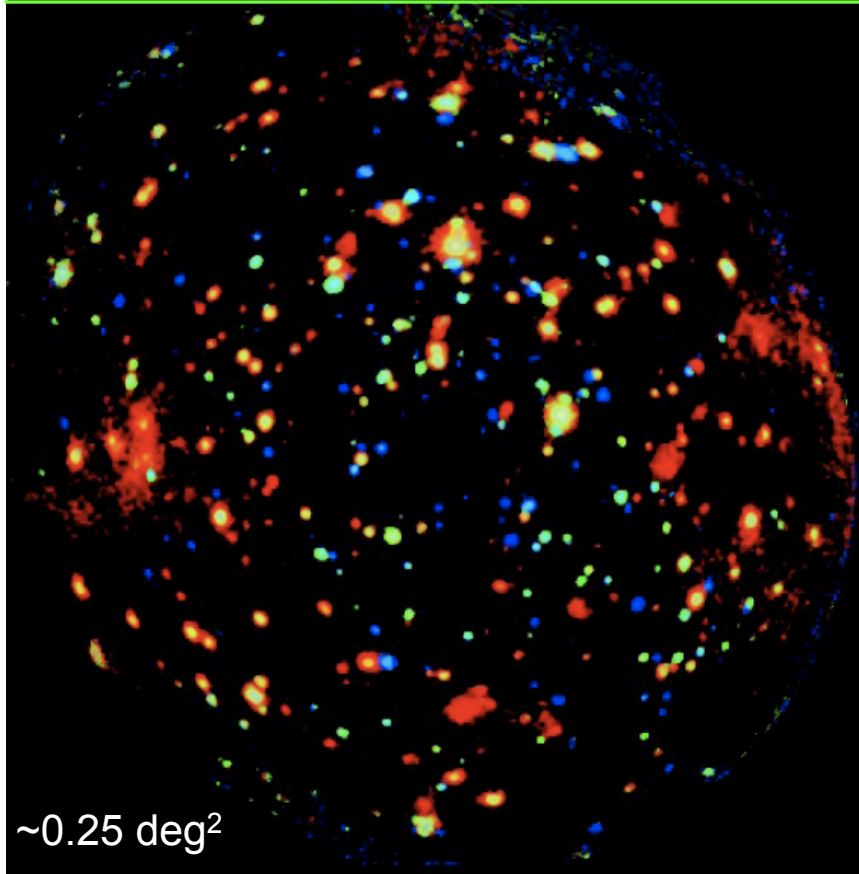
Deep multi-wavelength coverage

Shallower than the CDF-S but on a larger patch of the sky

**Chandra**: good on-axis PSF (i.e., excellent angular resolution) and low background  
→ Sensitive to faint and distant AGN

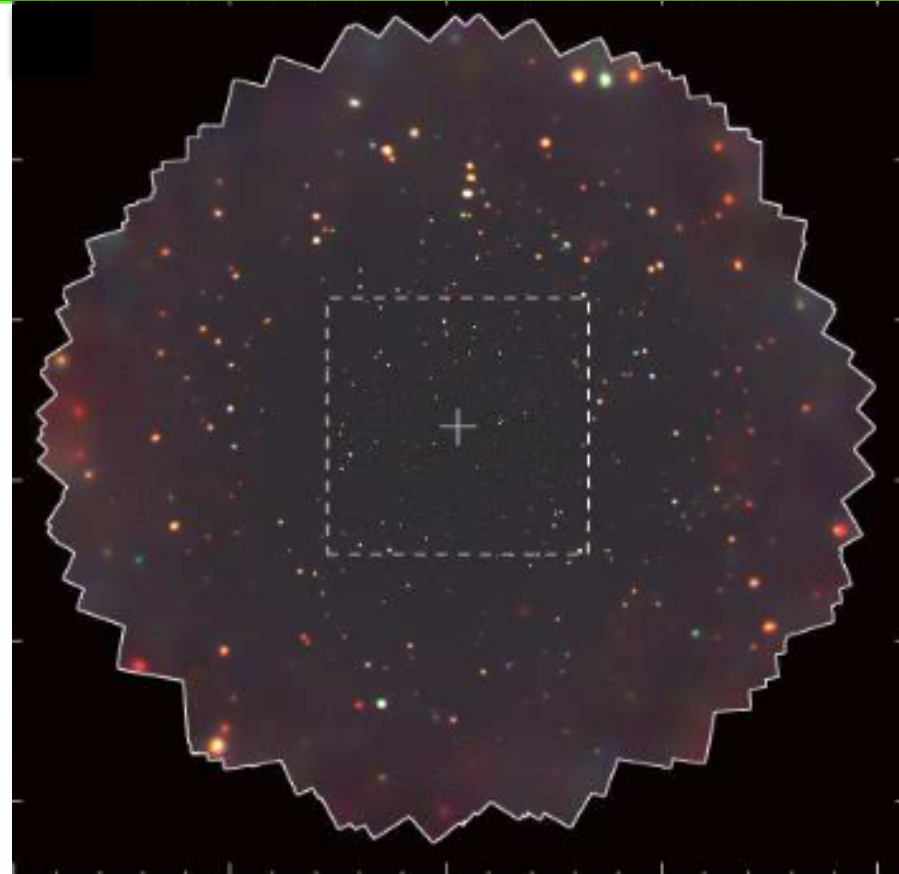
**XMM-Newton**: larger effective area (hence photon statistics), but much worse angular resolution and higher background  
→ Better for X-ray spectroscopy of relatively bright AGN

# The deepest X-ray field: CDF-S



XMM-CDFS 3 Ms survey  
(PI: A. Comastri; Ranalli+13)

$F(2-10\text{keV}) \approx 6.6 \times 10^{-16} \text{ erg/cm}^2/\text{s}$

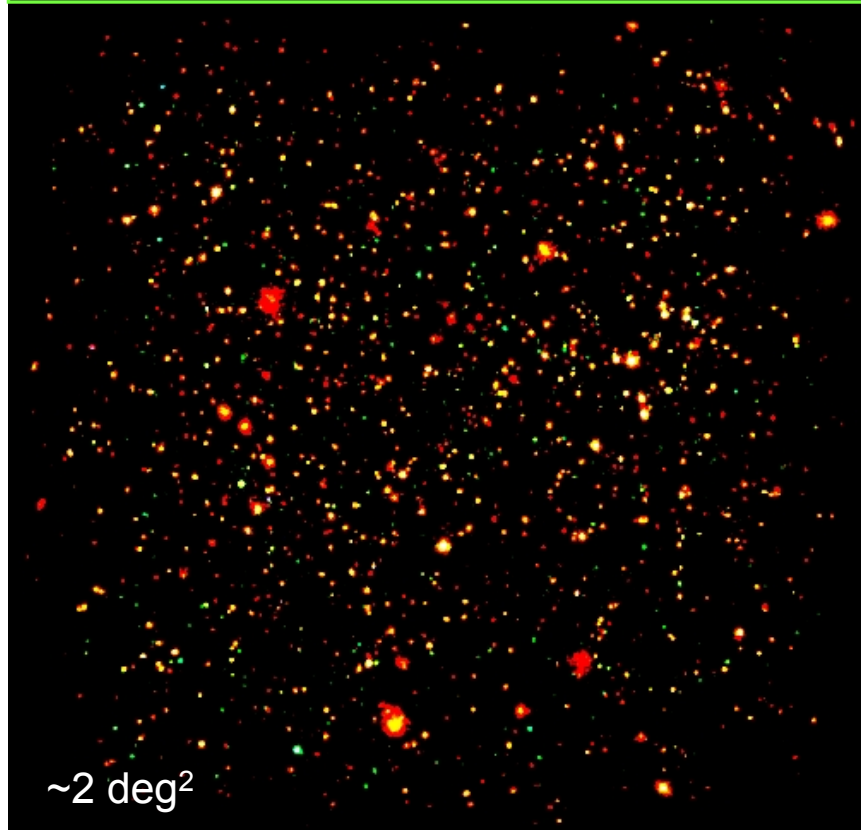


*Chandra-CDFS 7 Ms survey*  
(PI: R. Giacconi, W.N Brandt; Xue+11, Luo+17 )

$F(0.5-2\text{keV}) \approx 6.4 \times 10^{-18} \text{ erg/cm}^2/\text{s}$

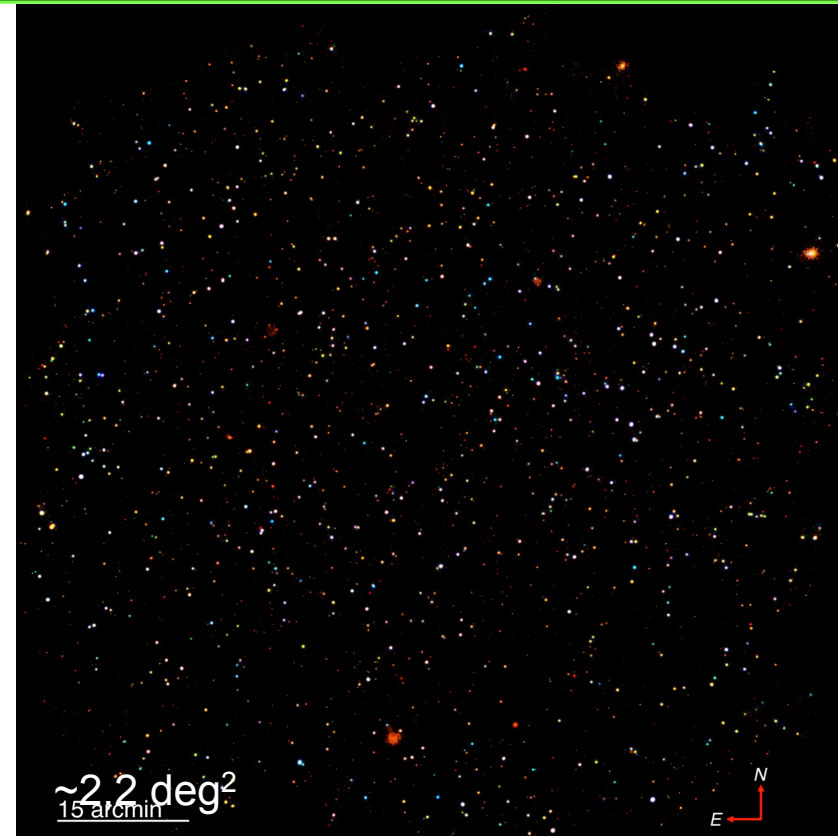
Capable of probing the high-z Universe with some photon statistics

# Relatively large-area X-ray field: COSMOS



**XMM-COSMOS 1.5 Ms survey**  
(PI: G. Hasinger; Cappelluti+09)

**$F(2-10\text{keV}) \approx 9.3 \times 10^{-15} \text{ erg/cm}^2/\text{s}$**



**Chandra-COSMOS 1.8 Ms survey**  
(PI: M. Elvis, F. Civano; Elvis+09, Civano+16)

**$F(0.5-2\text{keV}) \approx 1.9 \times 10^{-16} \text{ erg/cm}^2/\text{s}$**

Capable of probing rare (e.g., luminous) objects

# PLAN (I)

## MAIN

- CDF-S:** Fit *Chandra* spectra for 2/4 sources (excluding XID\_Xue11=198) and the XMM spectra (all EPIC cameras) for these two sources; compare the spectral results
- COSMOS:** Fit simultaneously *Chandra/XMM/NuSTAR* data for 1 out of 2 AGN

XID_Xue11	XID_XMM	Source coordinates	z	Opt. Class + Info
412	144	03:32:29.86 -27:51:06.1	3.700	NL (Comastri+11)
546	180	03:32:39.68 -27:48:51.1	3.064	NL (Vito+13)
533	48	03:32:38.93 -27:57:00.9	0.298	NL
193	289	03:32:13.25 -27:42:41.3	0.605	NL
198	-	03:32:13.86 -27:42:49.3	0.735	NL (close to Xue=193)

1  
CDF-S

2  
COSMOS

<i>Chandra</i> -ID	XMM-ID	Source coordinates	z	Opt. Class
358	1	150.10517 +1.98123	0.372	BL
482	2608	150.42484 +2.066277	0.125	NL

All spectra and response matrices are provided

# PLAN (II)

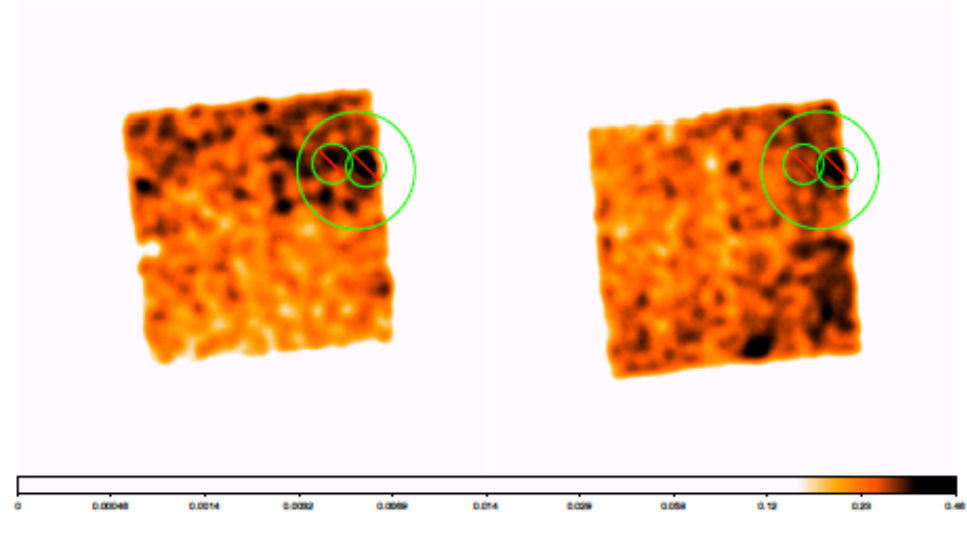
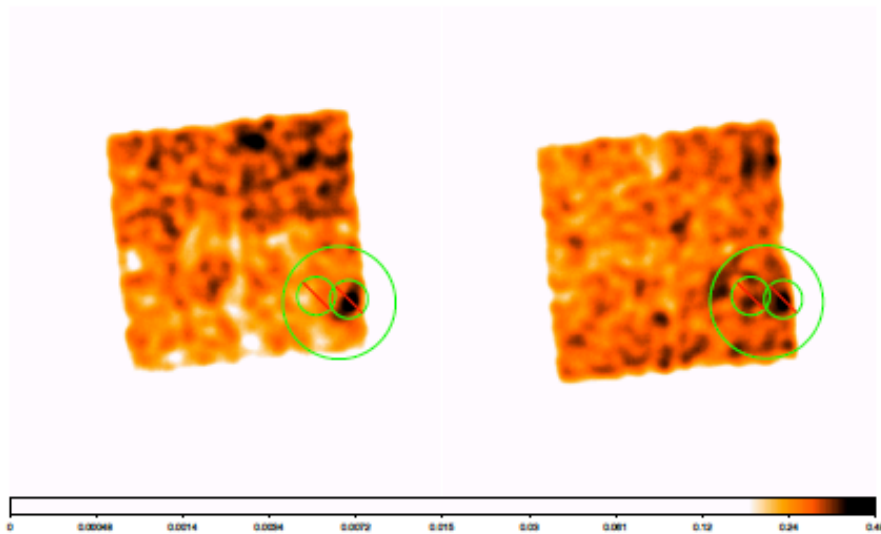
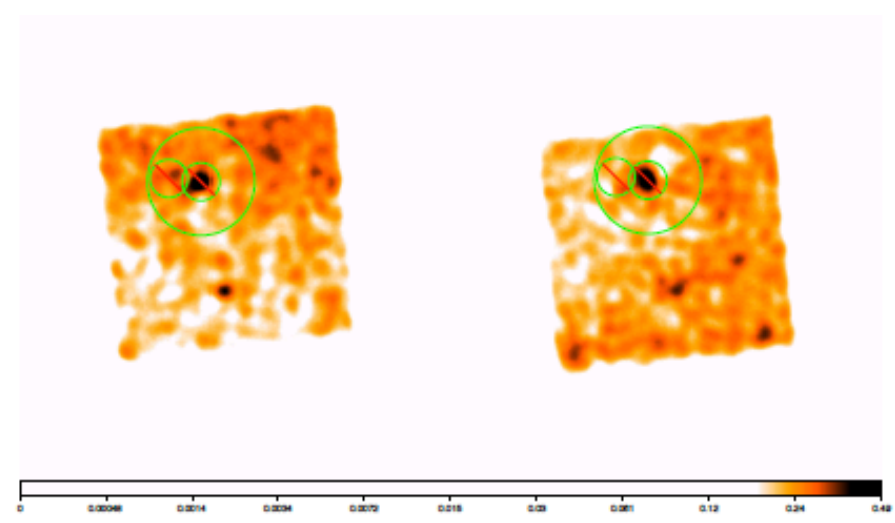
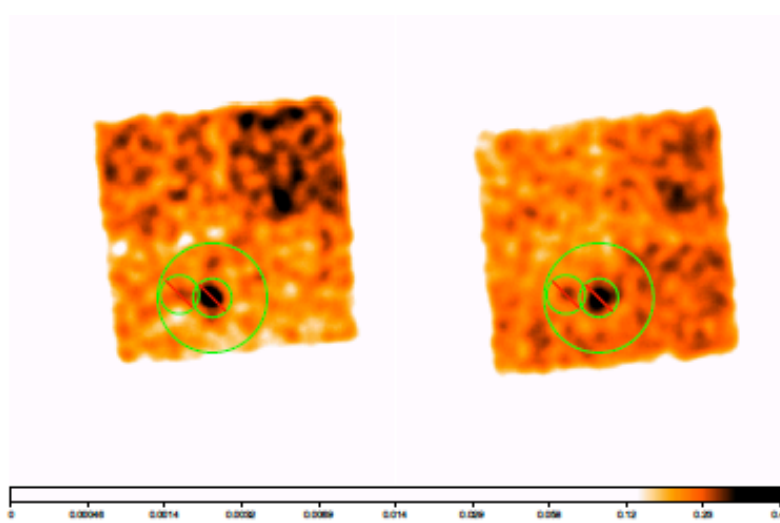
## MAIN – CDFS

1. Group the spectra (*grppha*) accordingly to the quality of the data
2. Load spectra in XSPEC
3. Define a spectral model and fit it to the data
4. Once a physically justified model is obtained, save the X-ray spectral parameters (including errors) and produce confidence contours
5. Check for further components (to lower the data/model residuals) – Return to point 3
6. For each spectrum, compare *Chandra* and *XMM-Newton* spectral results

## MAIN – COSMOS

1. The same as above; here all of the spectra (*Chandra*, *XMM-Newton* and *NuSTAR*) are fitted *simultaneously*. What about relative normalizations?

**NuSTAR:** two detectors, large PSF FWHM, strong gradients in the background (dark regions in the figure below) across the field of view



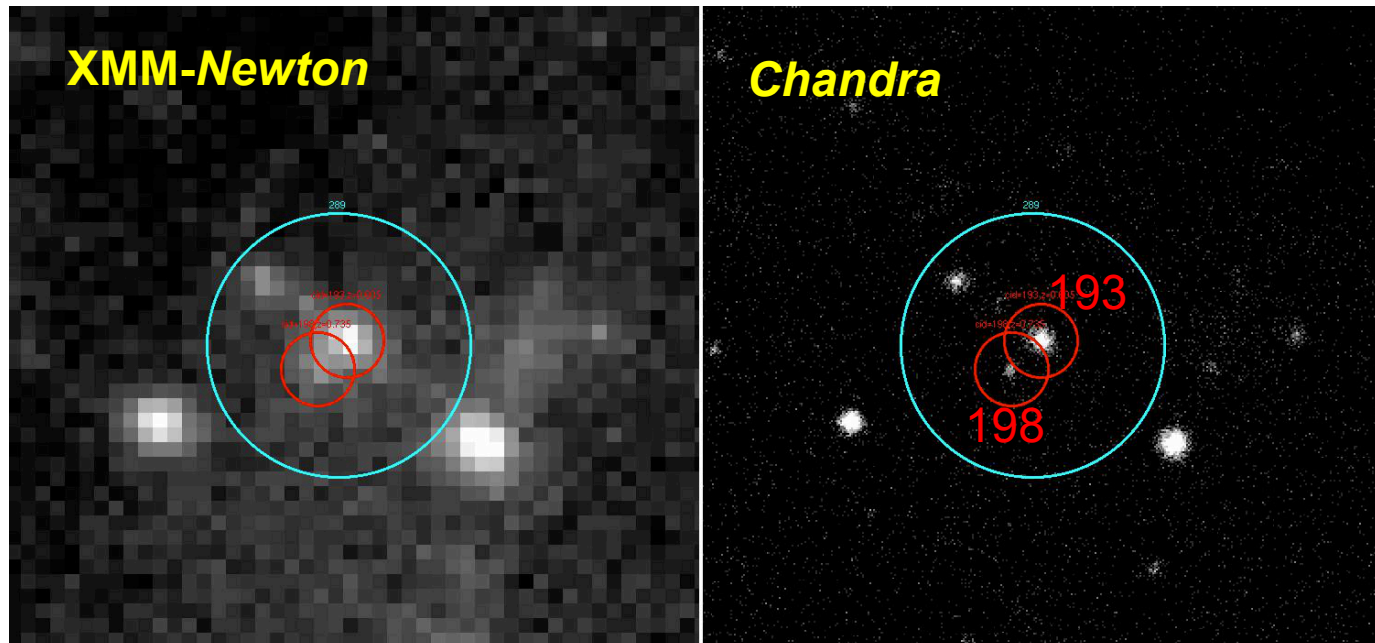


# PLAN (III)

## OPTIONAL (not necessarily in this order)

- Fit some of the remaining CDF-S *Chandra*/*XMM-Newton* spectra
- Verify the X-ray spectral differences between XMM\_ID=289 and the two *Chandra* sources XID\_Xue11=193 and 198
- Fit the COSMOS spectra of the remaining source

Effects of  
blending in  
XMM  
exposures



b.

All spectra and response matrices are provided

# Main publications

## CDF-S

- Comastri A. et al. 2011, A&A, 526, L9  
*Introduction to heavily obscured AGN in XMM-CDFS and focus on the AGN at  $z=3.700$ .*
- Xue Y.Q. et al. 2011, ApJS, 195, 10  
*4Ms Chandra source catalog.*
- Vito F. et al. 2013, MNRAS, 428, 354  
*High-redshift AGN population in the CDF-S: X-ray spectra and LogN-LogS.*
- Ranalli P. et al. 2013, A&A, 555, A42  
*The XMM deep survey in the CDF-S III. Point source catalogue and number counts in the hard X-rays.*
- Luo B. et al. 2016, ApJ Suppl., 228, 2  
*The Chandra Deep Field-South Survey: 7 Ms Source Catalogs.*

## XMM/C-COSMOS

- Brusa M. et al. 2010, ApJ, 716, 348  
*The XMM-Newton wide-field survey in the COSMOS field (XMM-COSMOS).*
- Civano F. et al. 2012, ApJ Suppl., 201, 30  
*The Chandra COSMOS Survey. III. Optical and infrared identification of X-ray point sources.*

## COSMOS-Legacy

- Civano F. et al. 2016, ApJ, 819, 62  
*The Chandra-COSMOS Legacy Survey: overview and point-source catalog.*