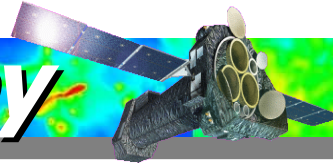


X-ray-SZE cluster survey



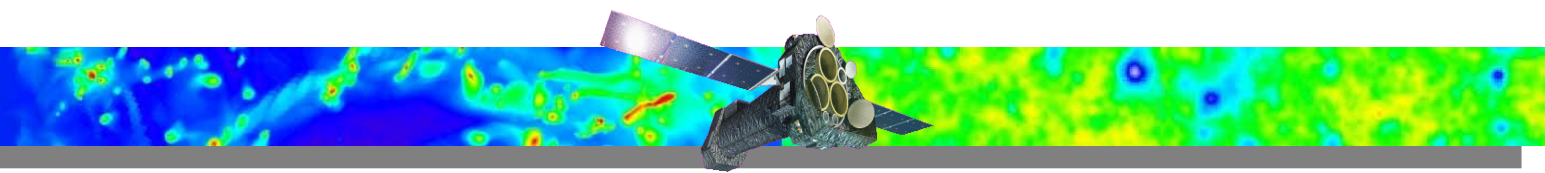
Helping to open the SZE window to the Universe

Róbert Šuhada

XMM-XXL Workshop
Paris, 14. 4. 2008



The Team



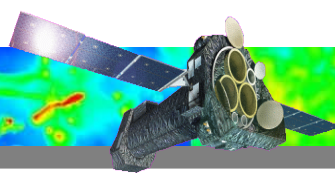
H. Böhringer, J. Mohr, R. Fassbender, G. W. Pratt,
A. Finoguenov, D. Pierini, C. Ngeow, A. Stanford et al.

APEX Team: R. Kneissl, F. Bertoldi et al.

SPT Team: J. Carlstrom et al.

ACT Team: L. Page et al.

Overview



1. X-ray-SZE cluster survey

- Aims
- Collaborators
- Survey characteristic

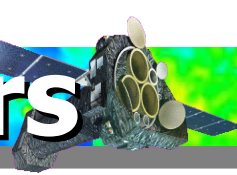
2. Space weather for surveys

- Orb. phase and seasonal dependence
- Residual soft proton contamination

3. Survey status and outlooks

4. Conclusions

Cosmology with Clusters

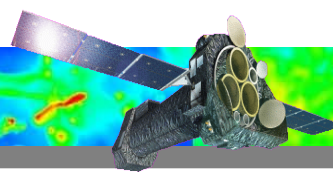


Requirements:

- Way to select large number ($\sim 10^4$) of gal. clusters
- Large redshift range
- Observable which is an unbiased, low-scatter estimator of cluster mass
- Well controlled selection function and calibration



Aims & Motivation



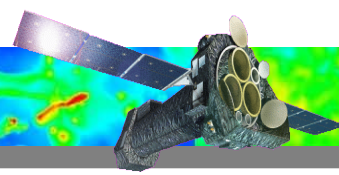
Multi-wavelength survey

- Paving the way to *precision* cosmology with clusters
- The SZ window for cluster astrophysics & cosmology is opening
- Bring together the established and this new technique for cluster selection on a common field
- Unprecedented intercomparison possibilities (SZ, X-ray, optical+NIR, IR and radio data)

X-ray part of the survey

- Detect and study clusters in the test field
- Help calibrating future SZ surveys
- Cluster evolution and cosmological modeling
- Get (modest) constraint on cosmological parameters
- Find and study AGN, AGN clustering properties

Collaboration

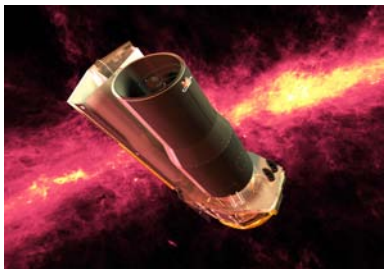


APEX, R. Kneissl et al.
SPT, J. Carlstrom et al.
ACT, L. Page et al.



CTIO Blanco (4m, *griz*), J. Mohr et al.

GROND (2.2m, *BVRIJHK*), MPE Team

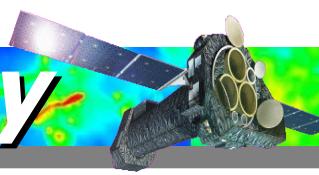


Spitzer Space Telescope (IRAC, 3.6, 4.5, 5.8, and 8 μm)
A. Stanford et al.



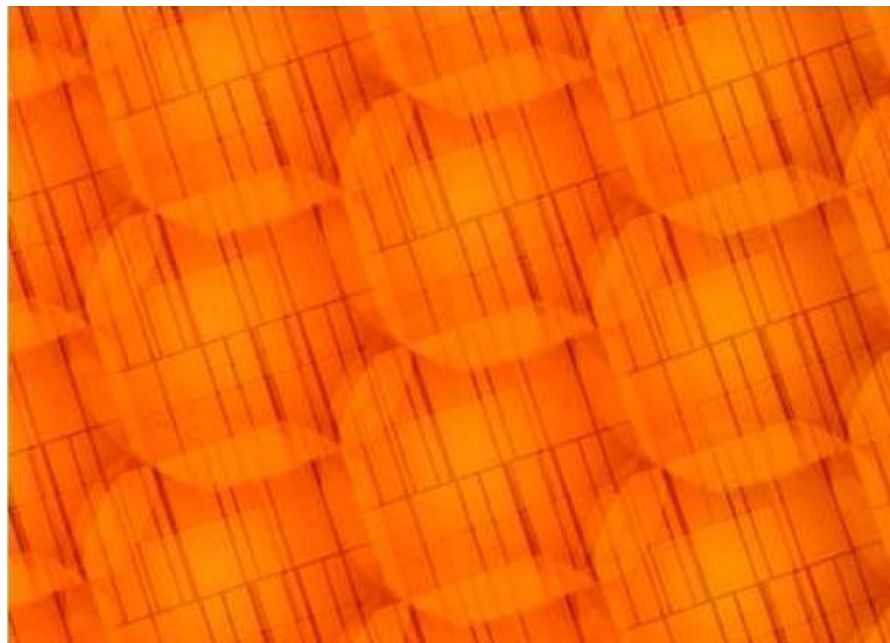
Australia Telescope Compact Array (ATCA)
M. Johnston-Hollit et al.

X-ray-SZE cluster survey



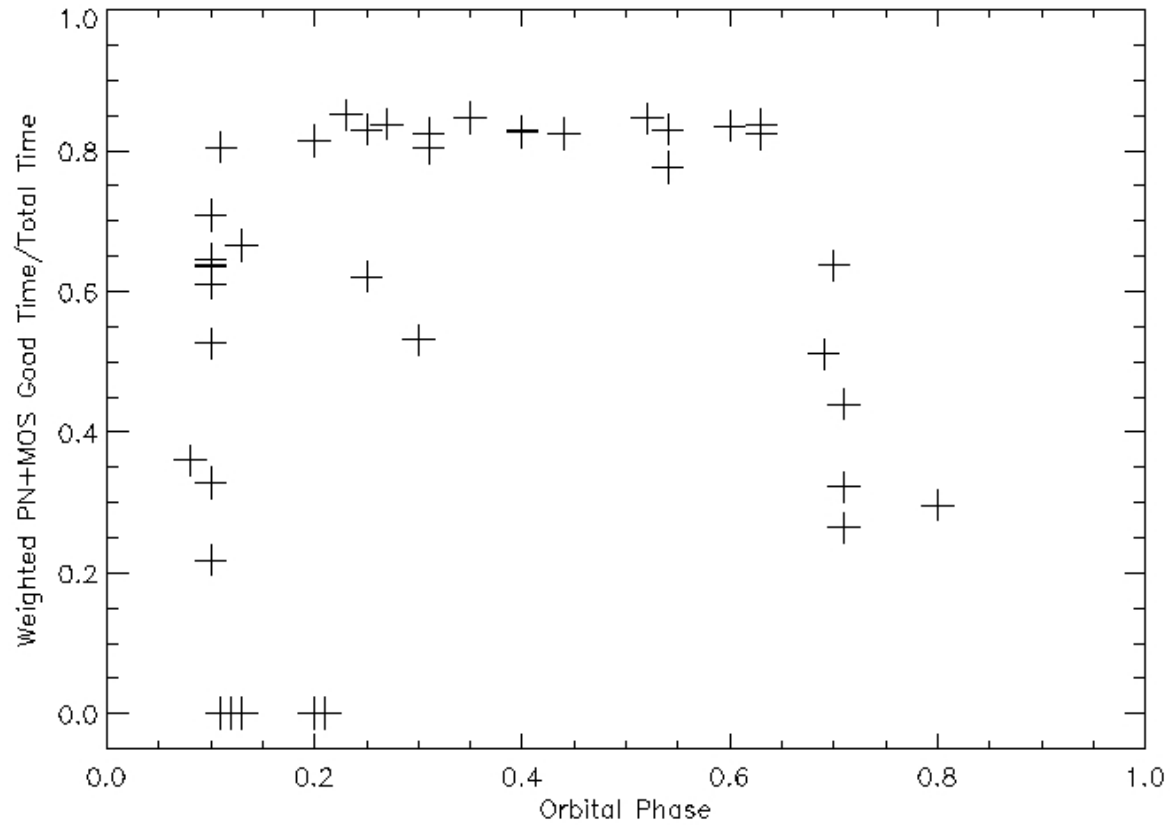
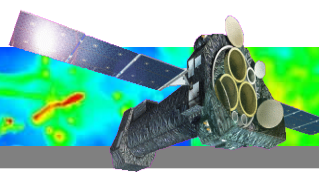
Survey characteristics:

- Survey a 6 deg² region in the common APEX, SPT and ACT test region with XMM-Newton
- „olympic symbol“ survey design with partial overlaps, 42 pointings
- 12 ks exposures (10 ks science time)
- Flux limits (0.5 – 2 keV): $\sim 6.5 \cdot 10^{-15}$ erg cm⁻² s⁻¹ (point sources),
 $\sim 1.0 \cdot 10^{-14}$ erg cm⁻² s⁻¹ (extended sources)



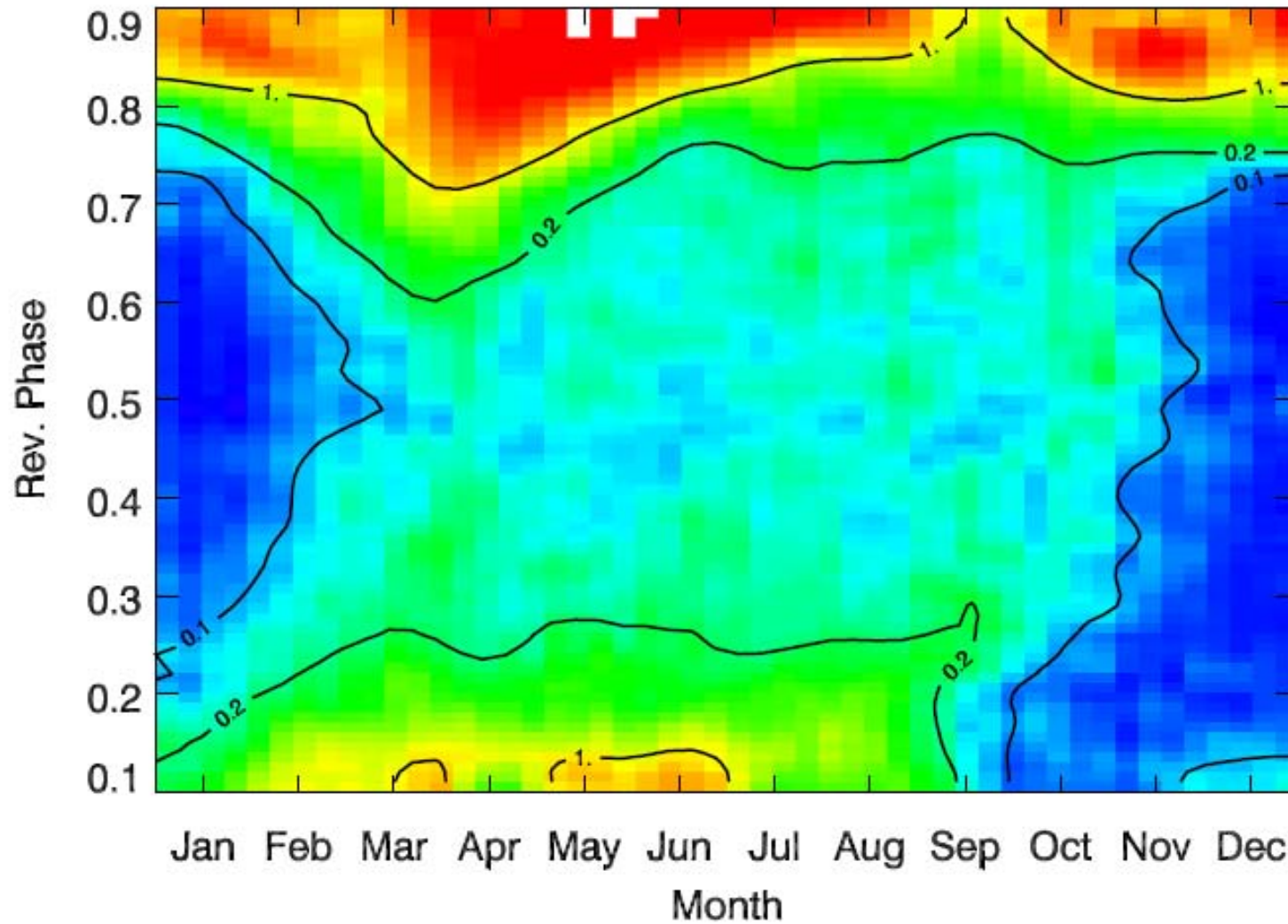
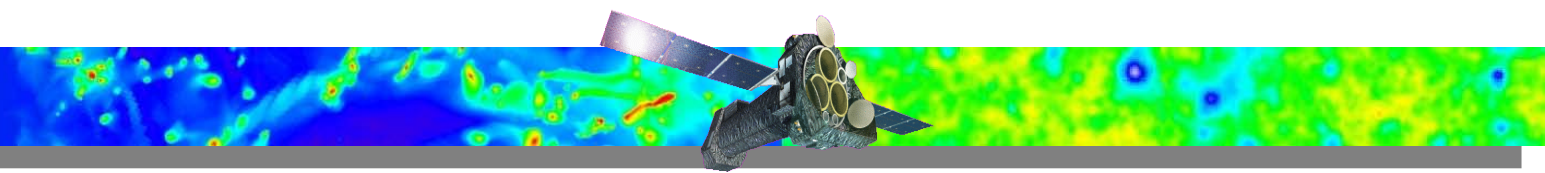
(by A. Finoguenov)

Weather



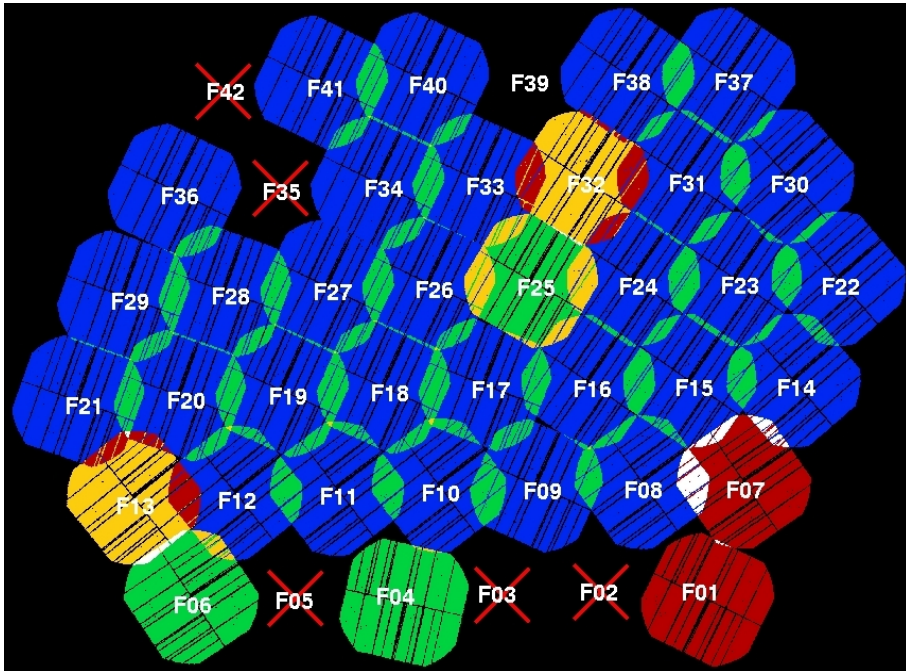
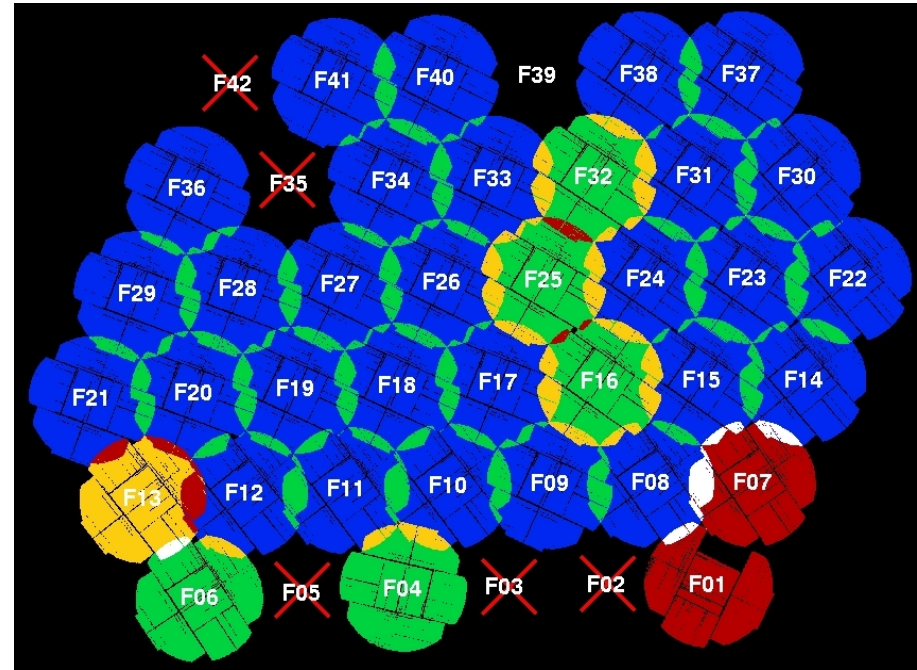
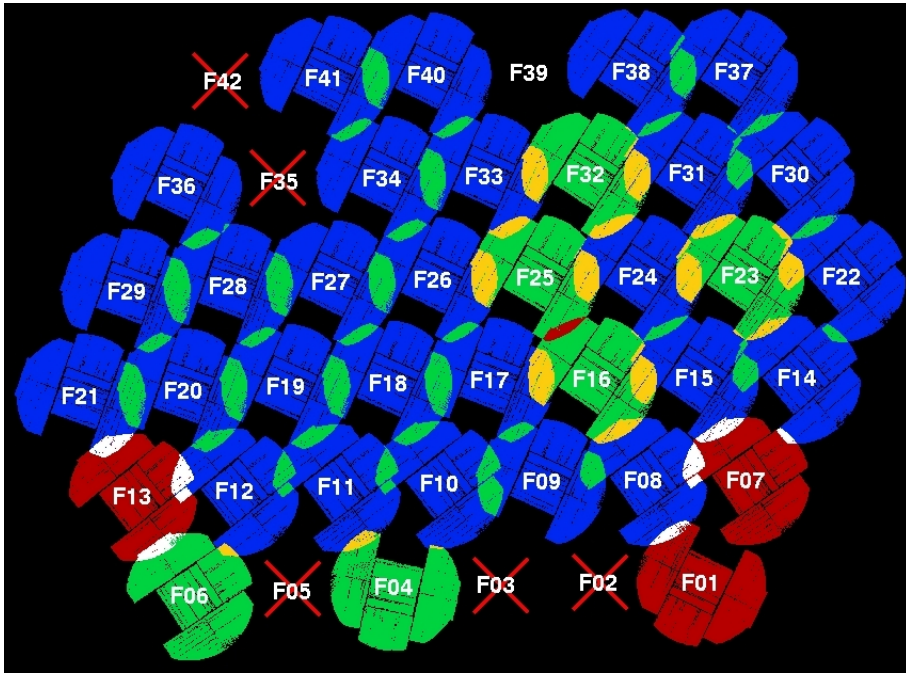
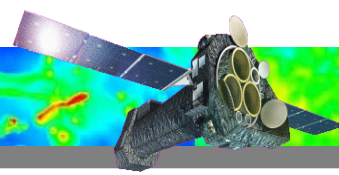
	R	# of Fields
All fields	0.58	41
No zeroes	0.66	36
Months 1-6	0.12	7
Months 7-12	0.68	34
Phase < 0.3	0.48	21
Phase > 0.7	0.39	5

Weather



(P.M. Rodriguez Pascual and R. Gonzalez-Riestra, 2007)

Weather

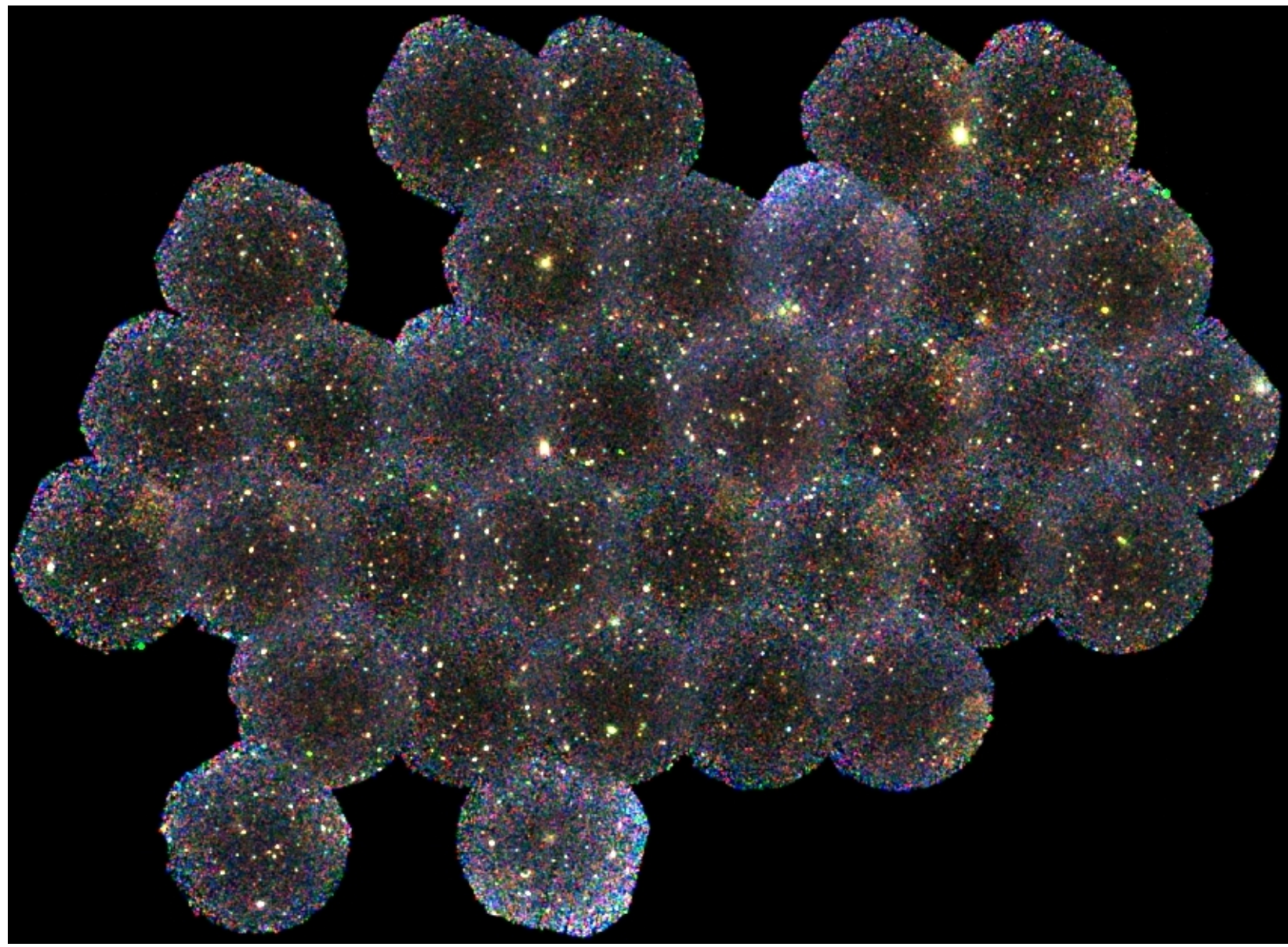
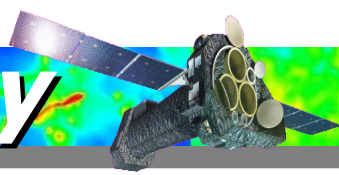


Residual soft proton contamination:



(method by de Luca & Molendi, 2004)

X-ray-SZE cluster survey



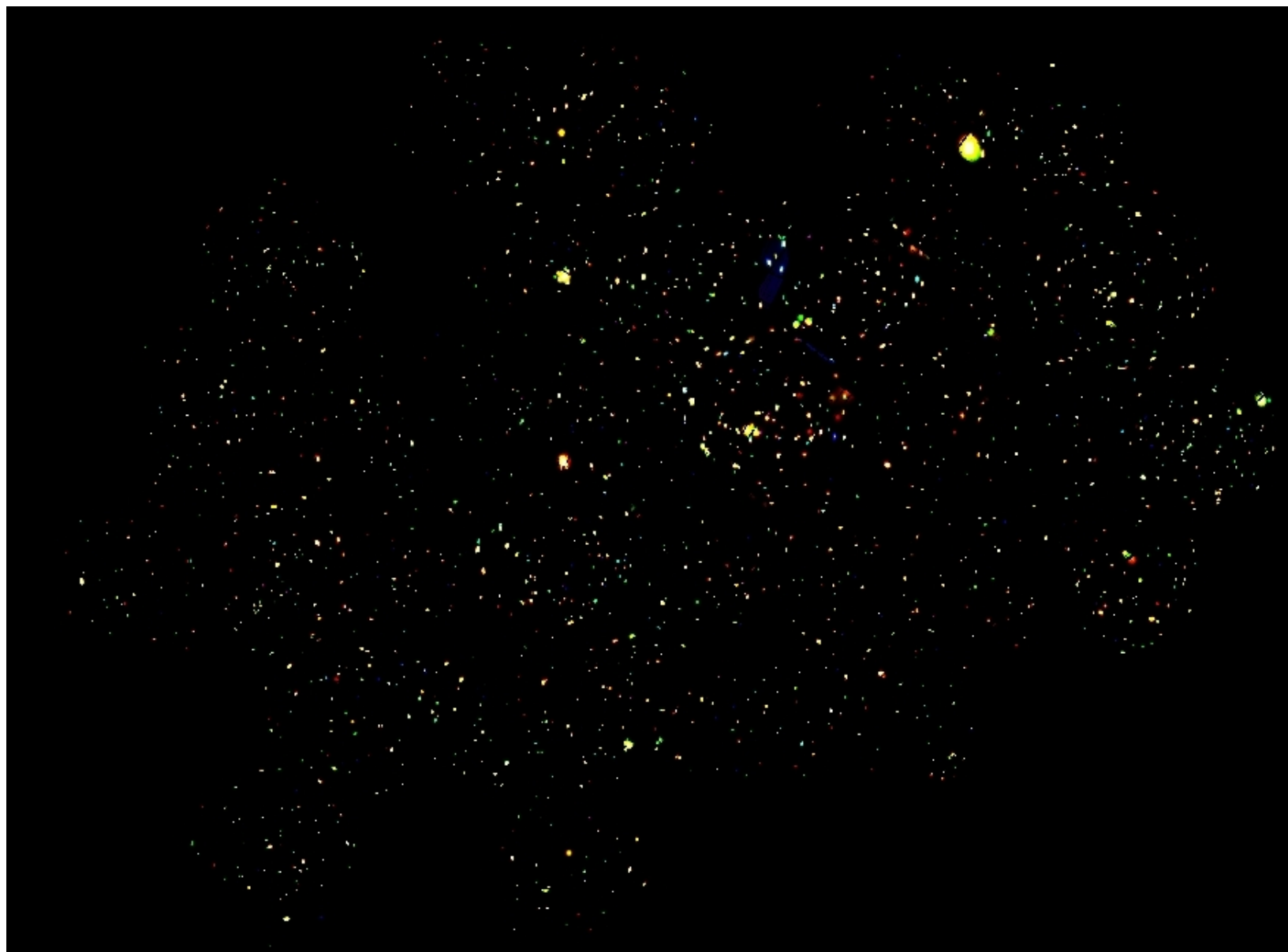
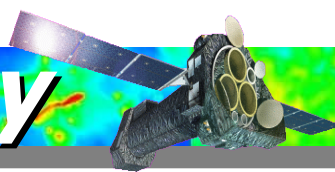
0.3 – 0.5 keV

0.5 – 2.0 keV

2.0 – 4.5 keV

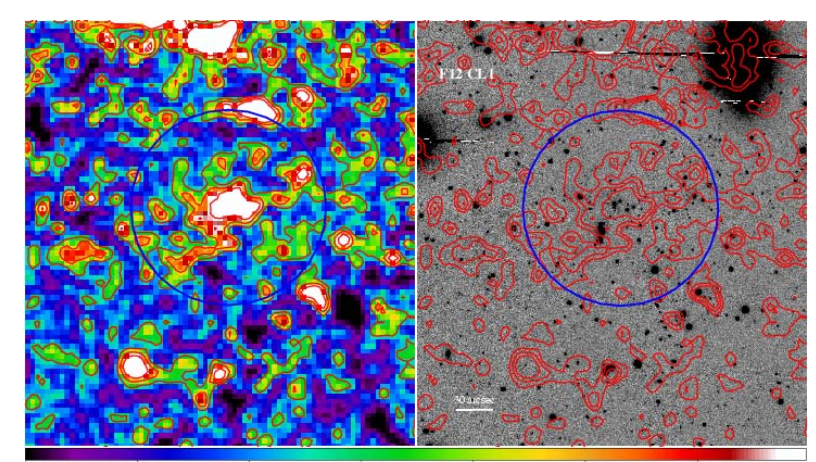
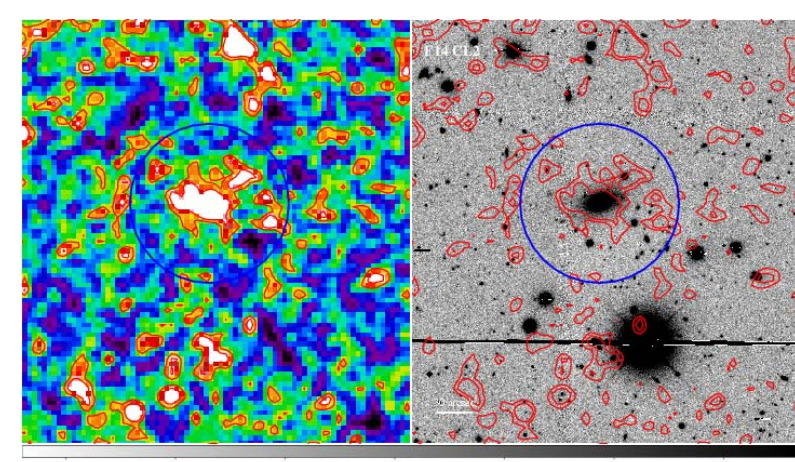
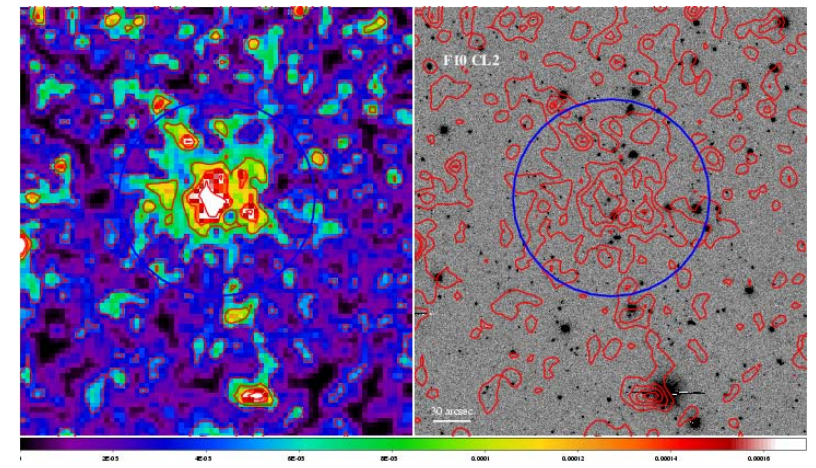
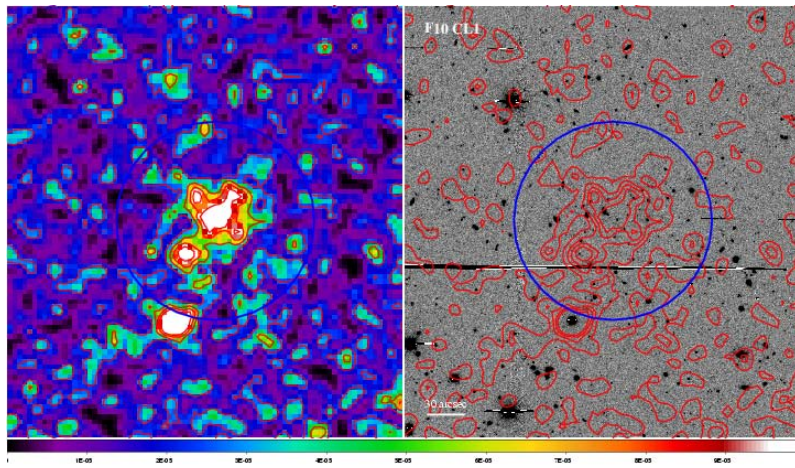
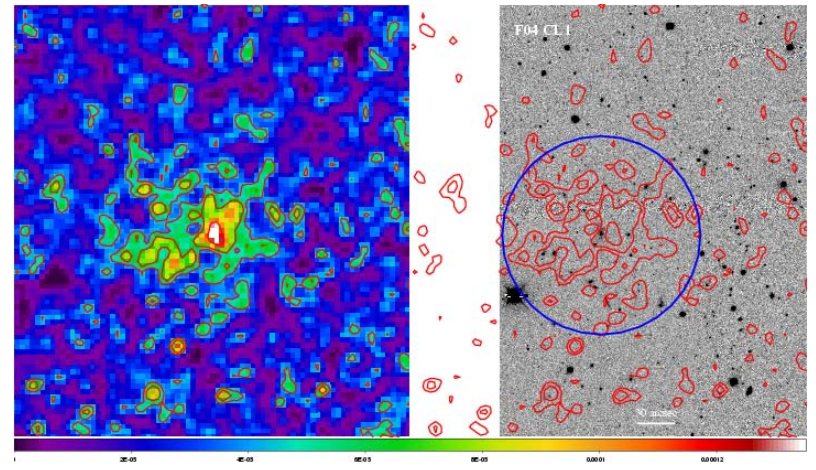
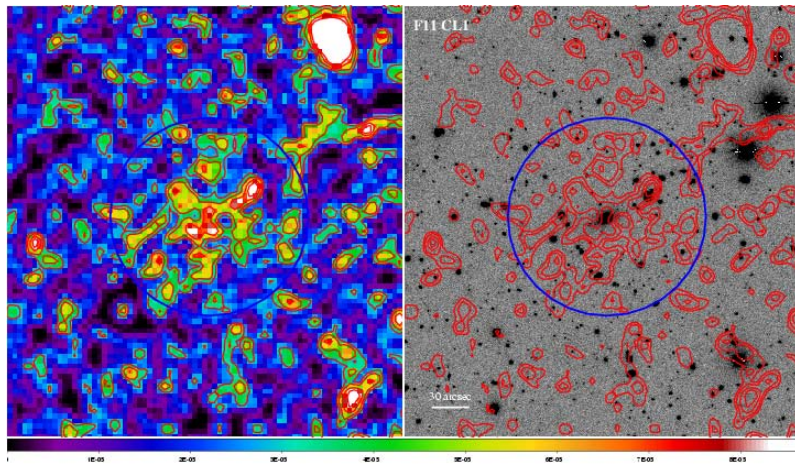
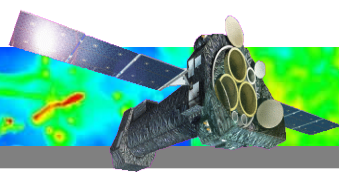
8" gaussian smoothed

X-ray-SZE cluster survey

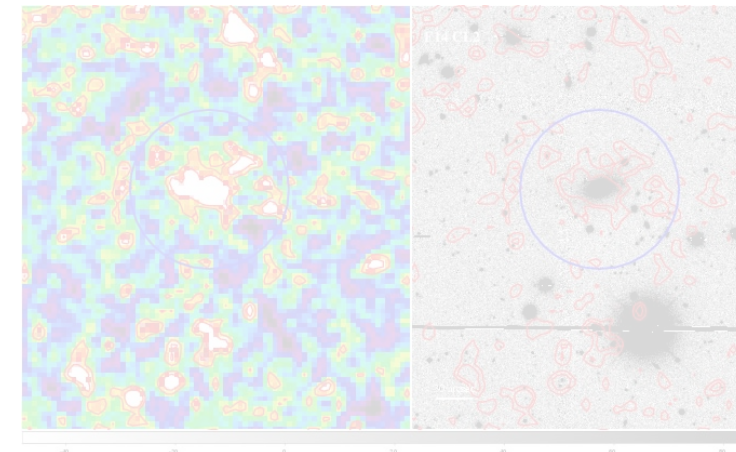
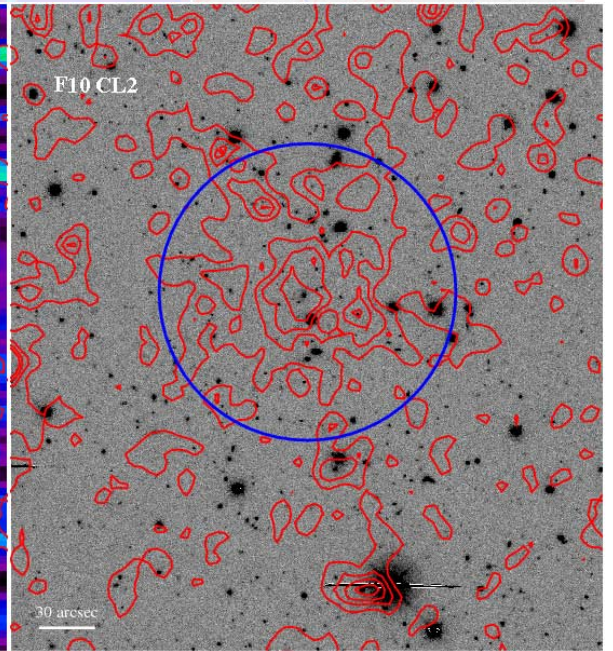
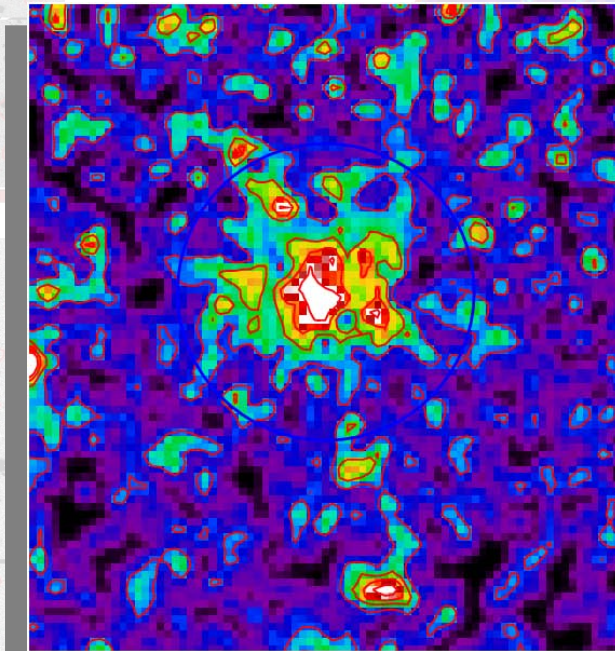
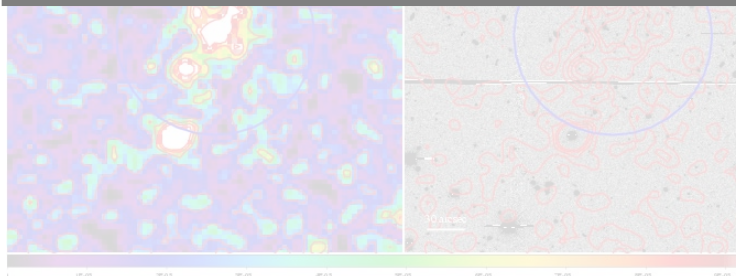
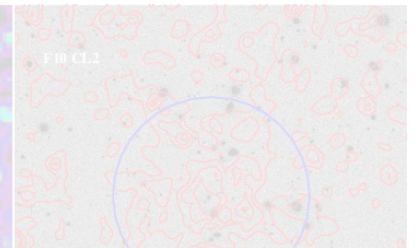
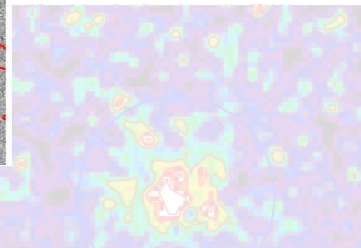
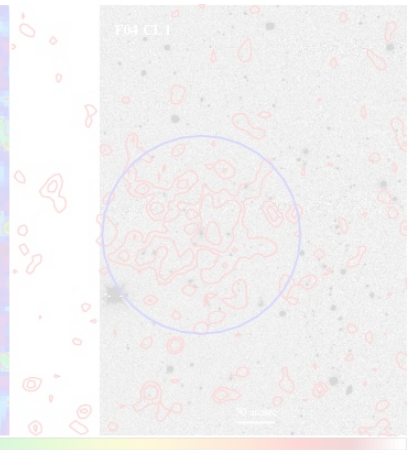
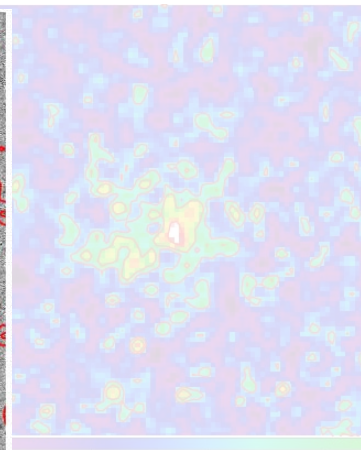
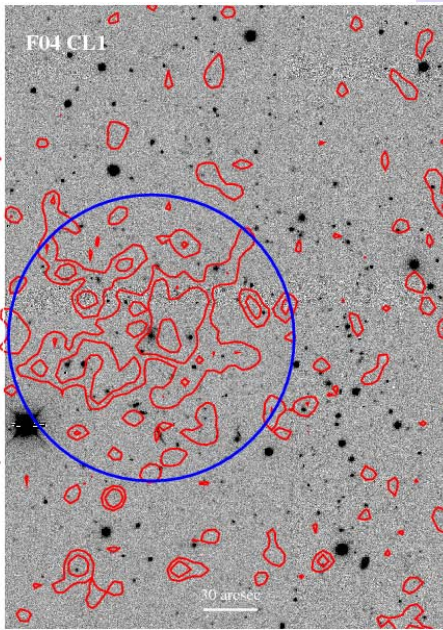
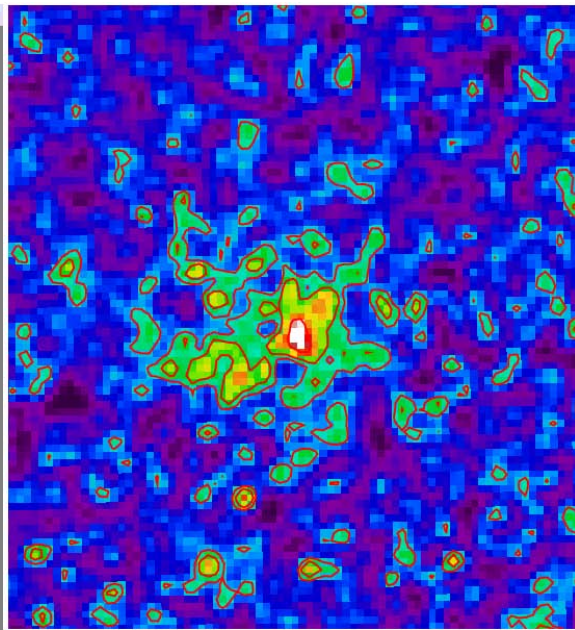
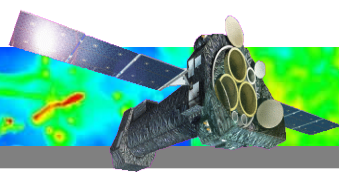


Detected: ~2000 sources total, ~100 extended source candidates, ~ 20 cluster candidates with optical counterparts (screening not finished yet!)

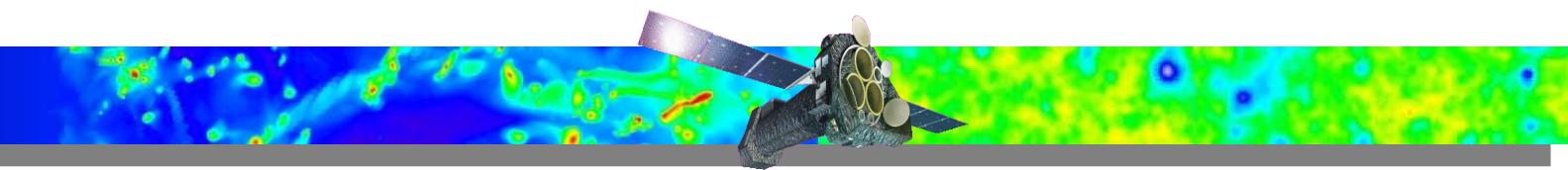
Optical overlays



Optical overlays

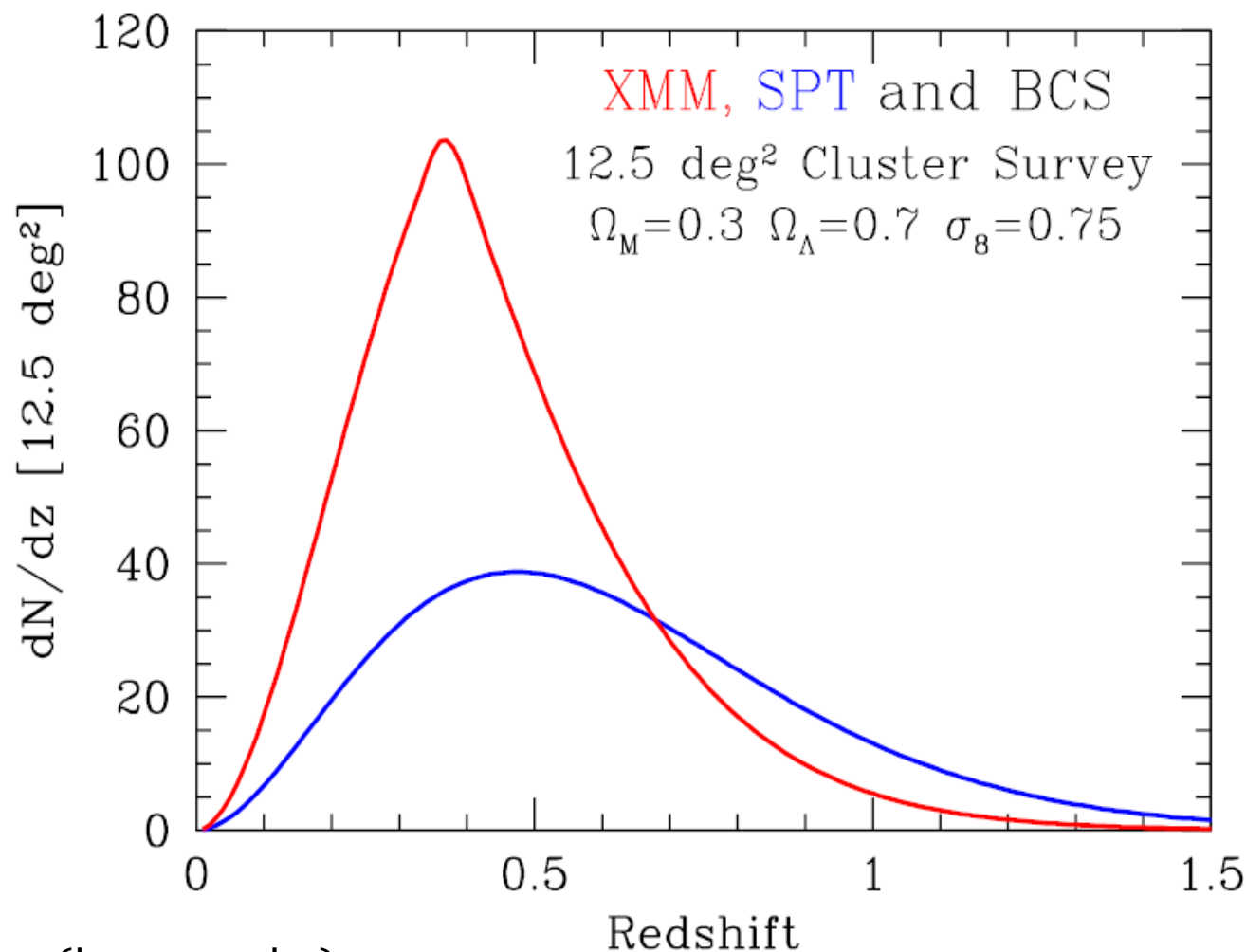


Outlook



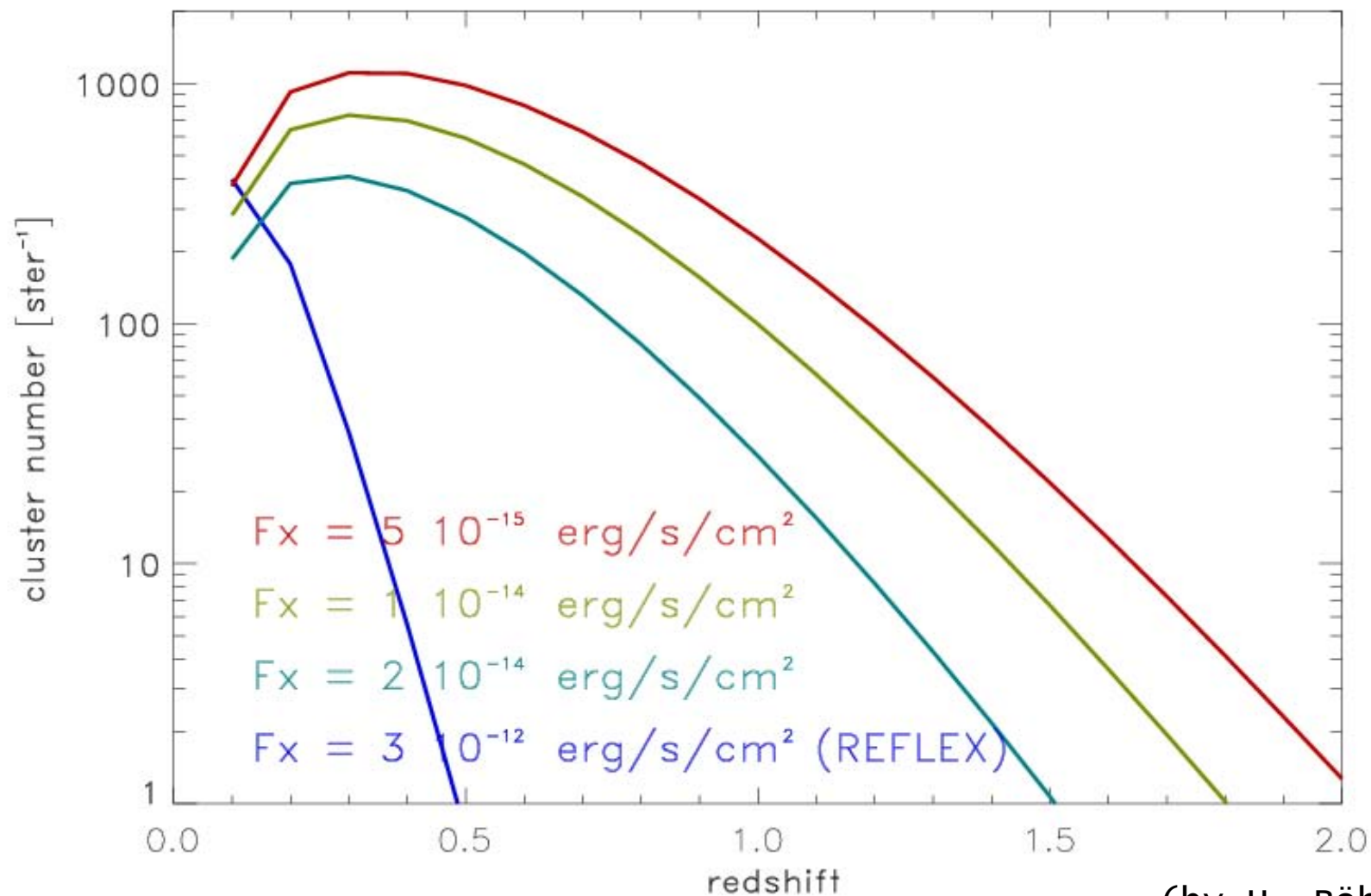
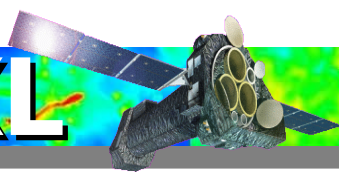
- Detection of $\sim 40 - 50$ clusters with good selection control
- Provide X-ray counterparts of 100% of SZ selected clusters with $z < 1$ and $> 50\%$ for $z > 1$
- $\sim 10\%$ clusters with > 500 photons \rightarrow direct T_x

Extension to the originally proposed 12.5 deg^2 would allow to fully exploit the potential of the survey



(by J. Mohr)

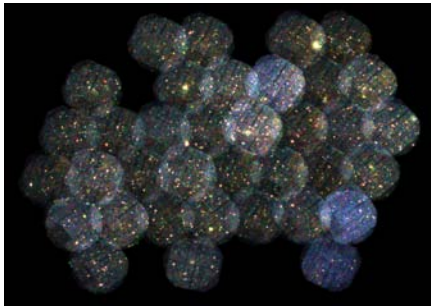
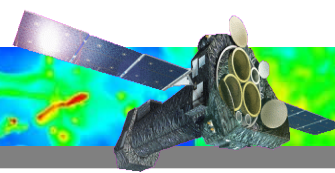
Outlooks for XMM-XXL



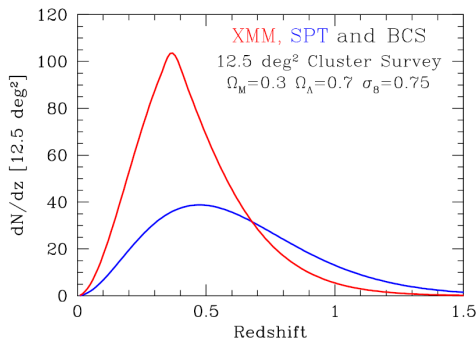
(by H. Böhringer)

Flux [erg s ⁻¹ cm ⁻²]	6 deg ²		50 deg ²	
	all	z > 1	all	z > 1
1×10^{-14}	~ 80	6 – 8	~ 700	50 – 70
2×10^{-14}	~ 40	1 – 2	~ 350	10 – 15

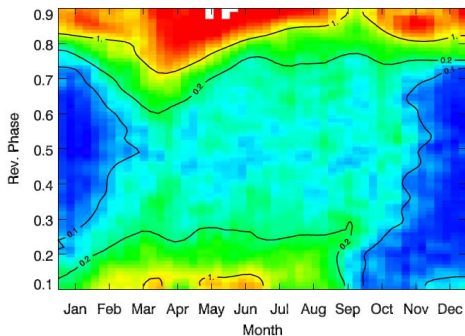
Conclusions



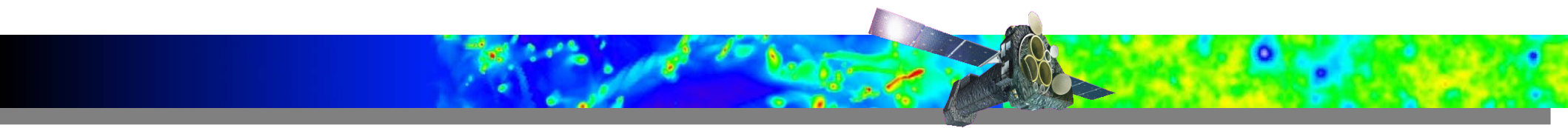
- X-ray-SZE cluster survey will provide a X-ray catalogue of clusters for selection function studies of SZ experiments
- Additional science includes cl. evolution and cosmology modeling, AGN clustering analysis etc.



- Extending to 12.5 deg² allows for stronger constraints especially for higher z
- An substantial overlap with SZ experiments might be an interesting variant for XXL

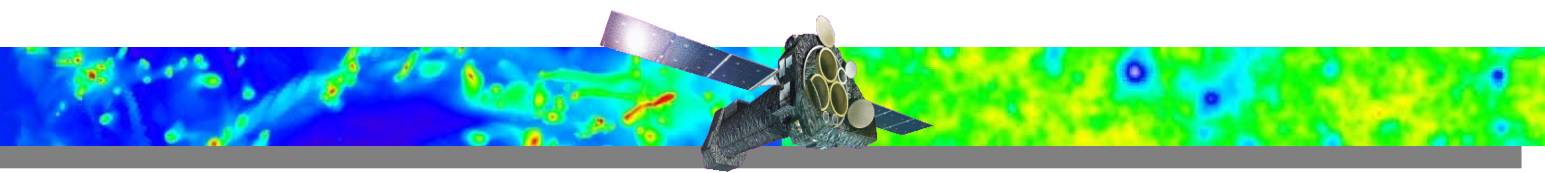


- Intensity of flaring periods depends on orbital phase and time of year
- Might lead to non-negligible losses for short exposure observations



Thank you

Workflow



Initial data reduction and soft proton cleaning



Background modeling & source detection



Final source detection, source parameter estimation

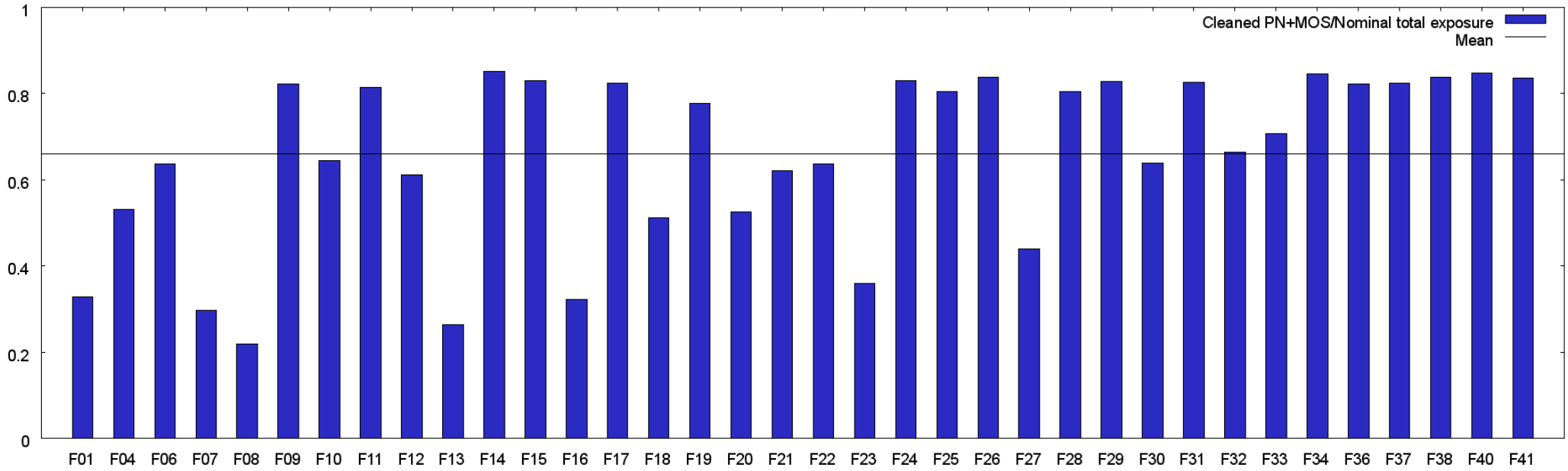
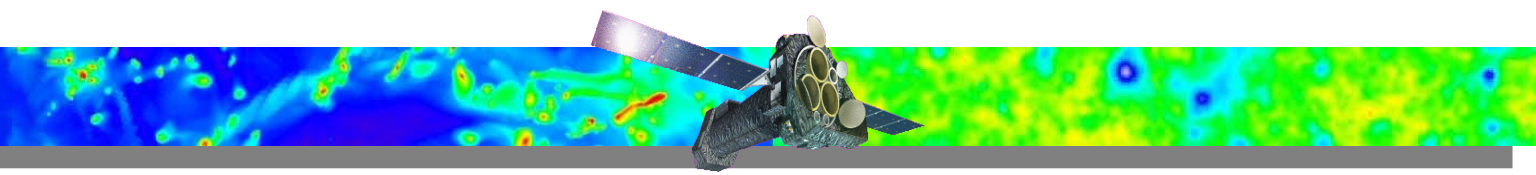


Cross-correlation with optical data, photo-z

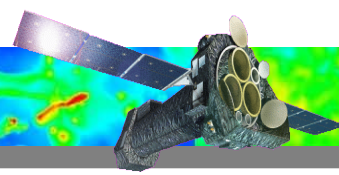


Final cluster catalogue

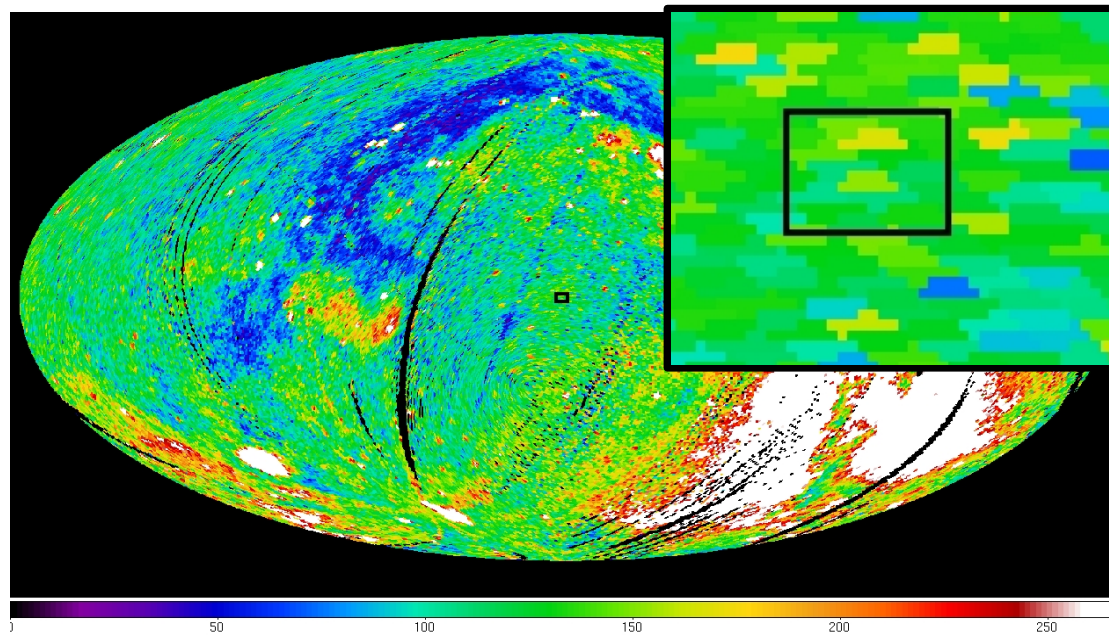
Weather



Lay of the Land

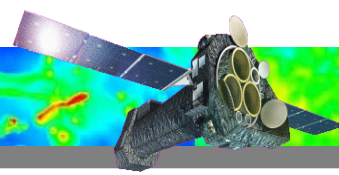


- Survey in the common APEX, SPT and ACT test region with XMM-Newton
- Low N_{H}
- No unusual X-ray background features

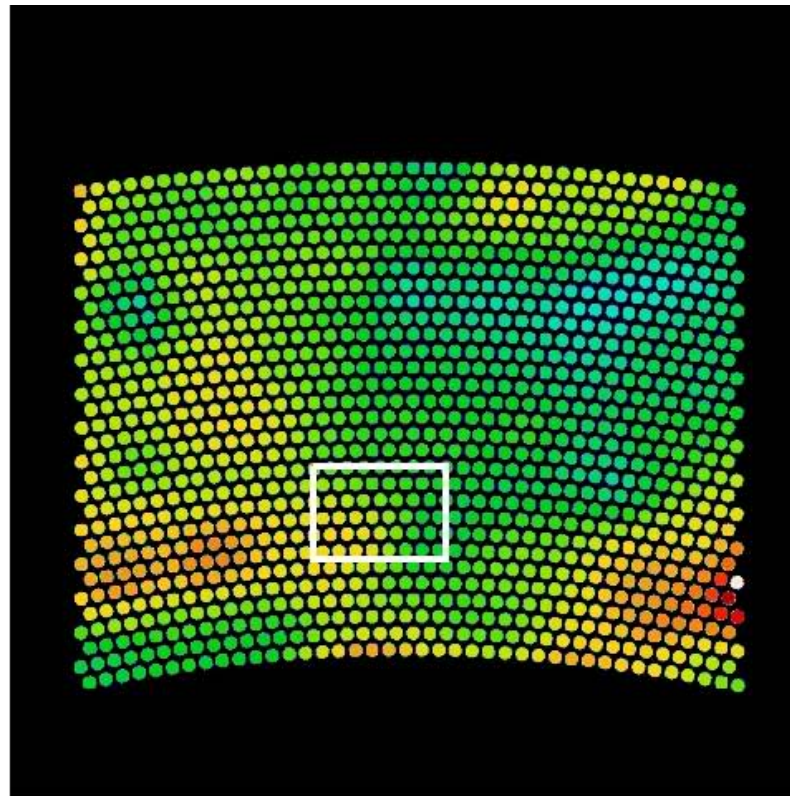


RASS, 0.75 keV

Lay of the Land



- Survey in the common APEX, SPT and ACT test region with XMM-Newton
- Low N_{H}
- No unusual X-ray background features



0.5

1

1.5

2

2.5

3