

# **Cluster survey studies with XMM: insights from the XMM-LSS**

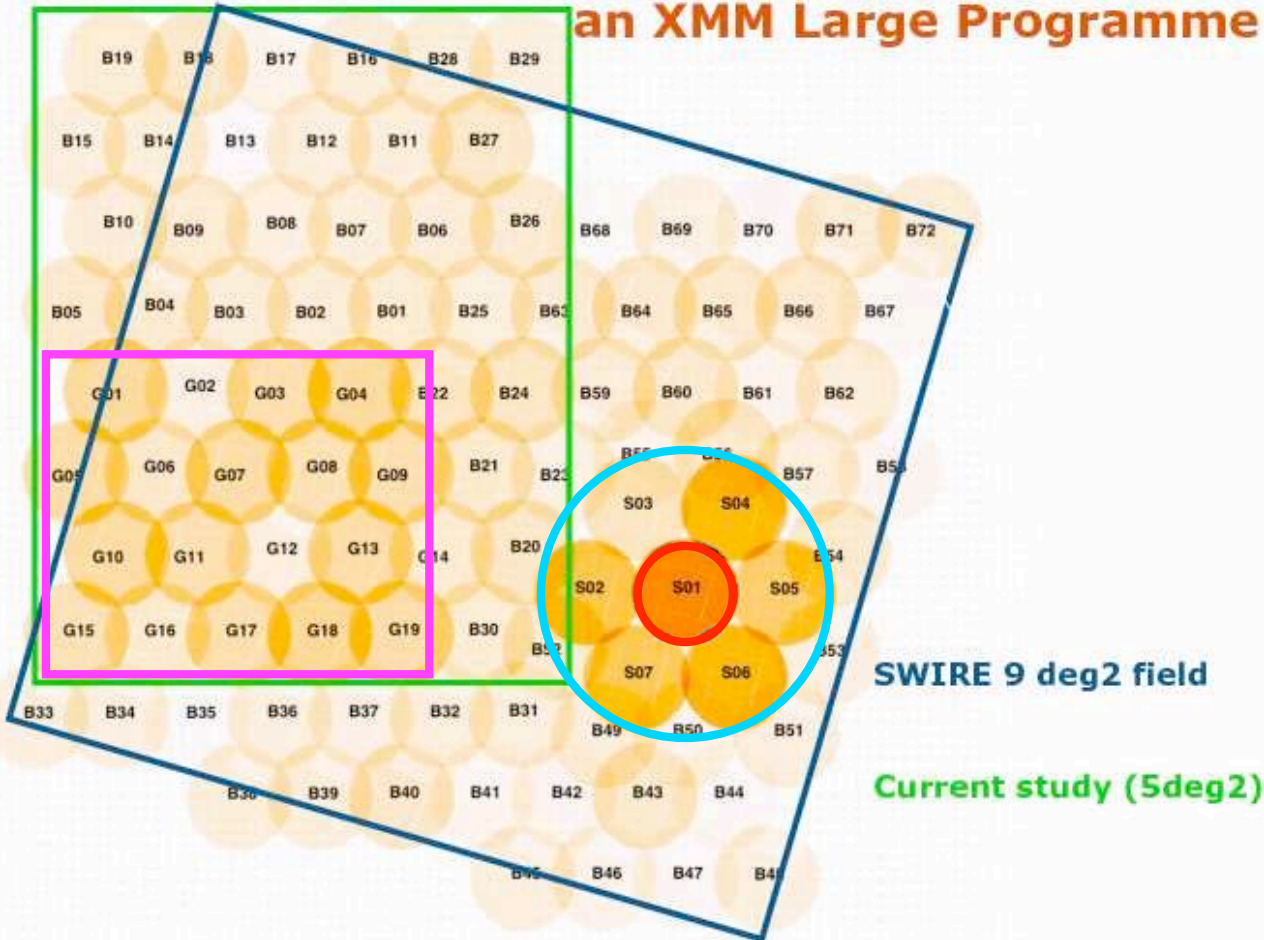
***Florian Pacaud***

for the XMM-LSS collaboration

# XMM-LSS ?

Widest contiguous XMM survey so far

The XMM-LSS/CFHTLS/SWIRE 10 deg<sup>2</sup> field :  
an XMM Large Programme



Nominal 10ks

+ 20 ks

+ 50 ks

+ 100ks

Total of 1.3 Ms

# The XMM-LSS collaboration

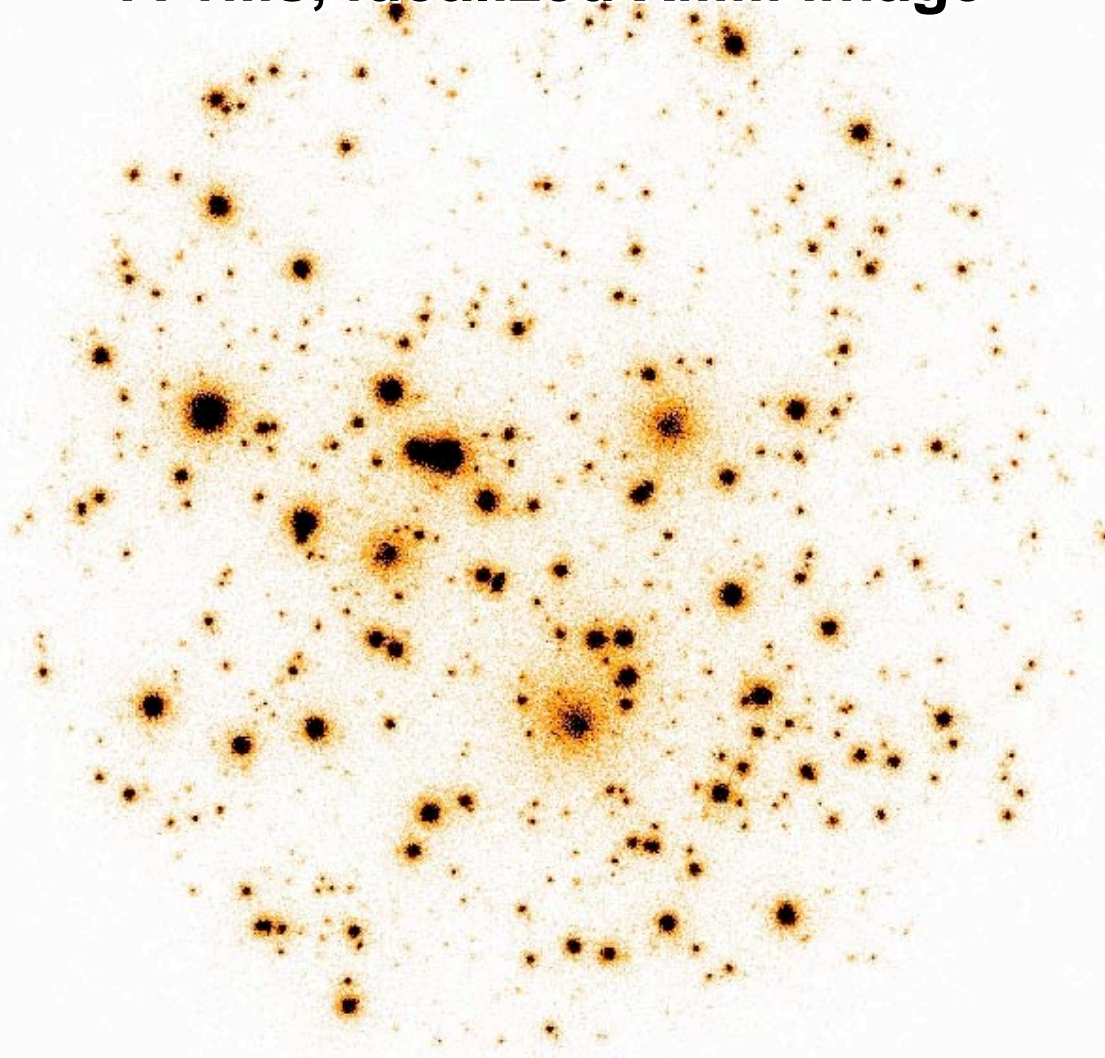
Use the unprecedented sensitivity of XMM to map the LSS through:

- The galaxy cluster distribution up to  $z \sim 1$
- The distribution of AGNs up to  $z \sim 4$

|                 |                        |
|-----------------|------------------------|
| PI:             | M. Pierre (Saclay)     |
| Birmingham:     | Ponman, Raychaudhury   |
| Bristol:        | Birkinshaw, Bremer     |
| Caltech:        | Lonsdale               |
| Cambridge:      | Gandhi                 |
| Leiden:         | Rottgering             |
| Liège:          | Gosset, Surdej         |
| Madrid (ESA):   | Altieri, Valtchanov    |
| Milan (Brera):  | Andreon, Trinchieri    |
| Milan (IASF):   | Chiappetti, Maccagni   |
| Marseille:      | Le Fèvre, Mazure       |
| Saclay:         | Alloin, Duc, Refregier |
| Santiago (PUC): | Galaz, Quintana        |
| Paris (IAP):    | Mellier, Vigroux       |
| U. Victoria:    | Willis                 |

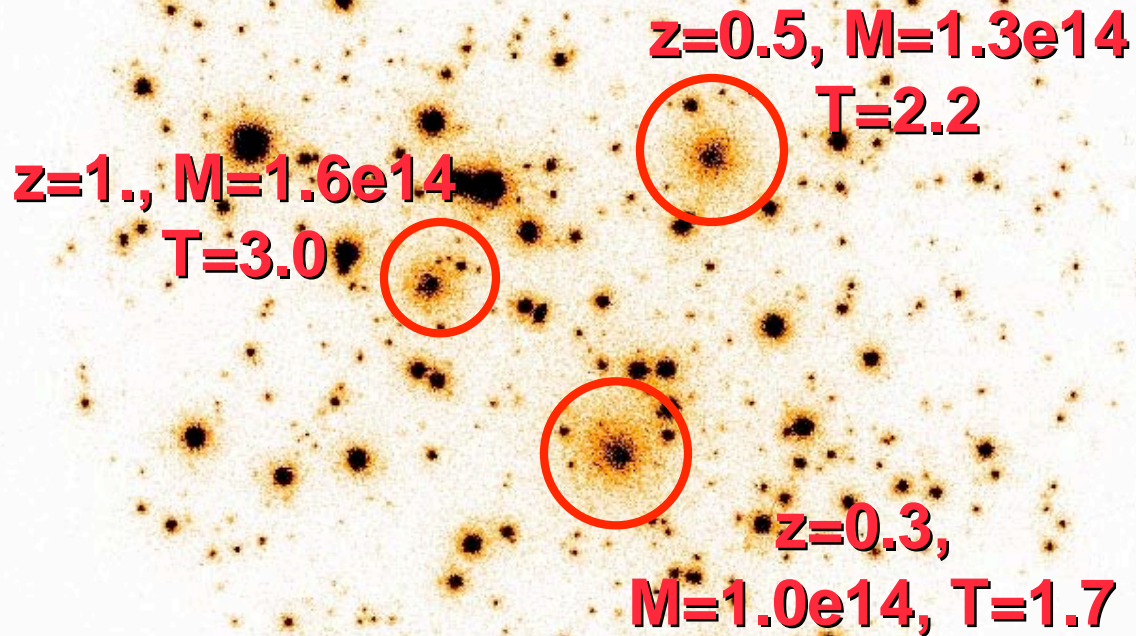
# What does the data look like ?

A 1Ms, idealized XMM image



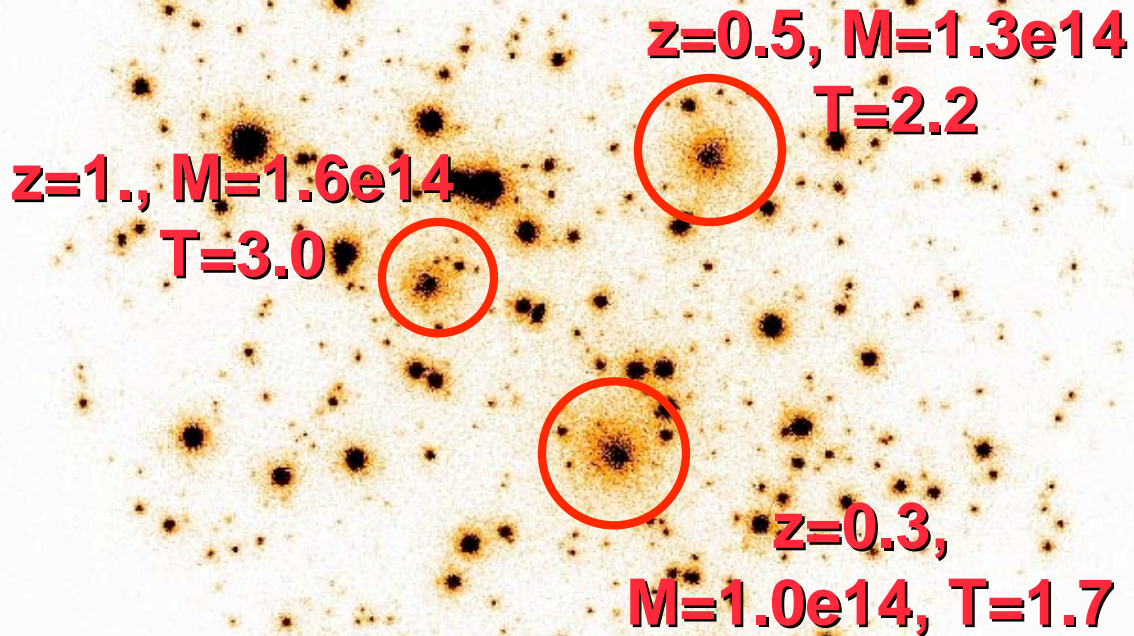
# What does the data look like ?

A 1Ms, idealized XMM image



# What does the data look like ?

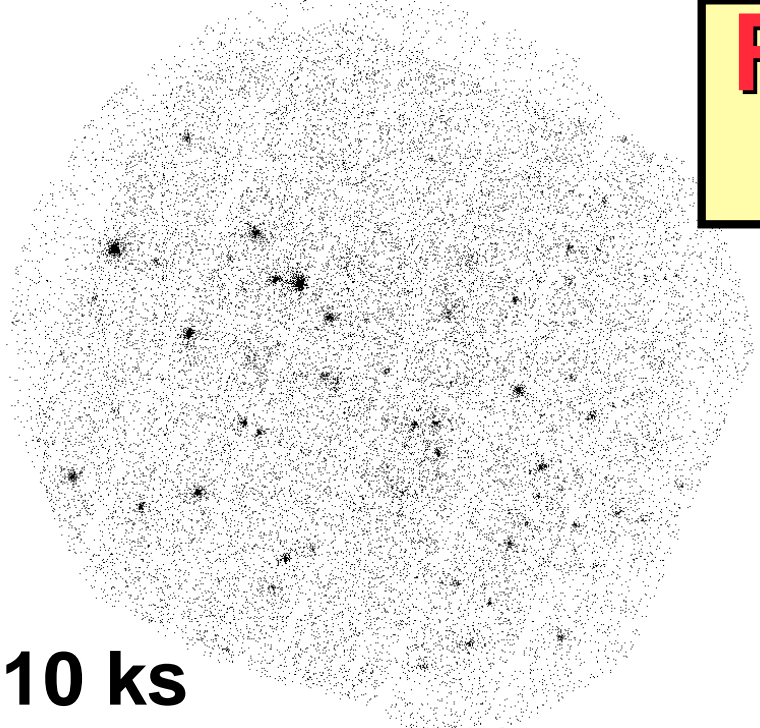
A 1Ms, idealized XMM image



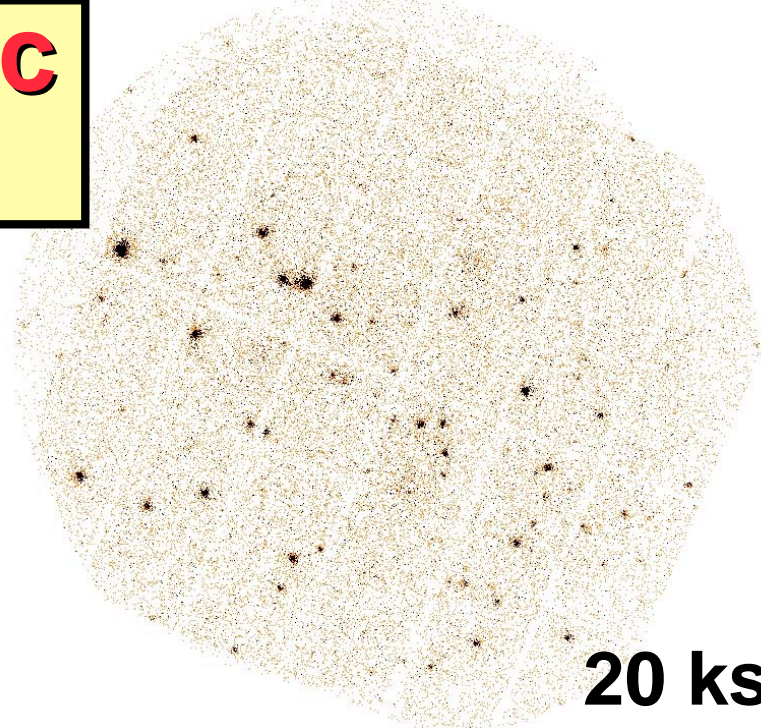
**Not like this !**

**Realistic cases**

**10 ks**

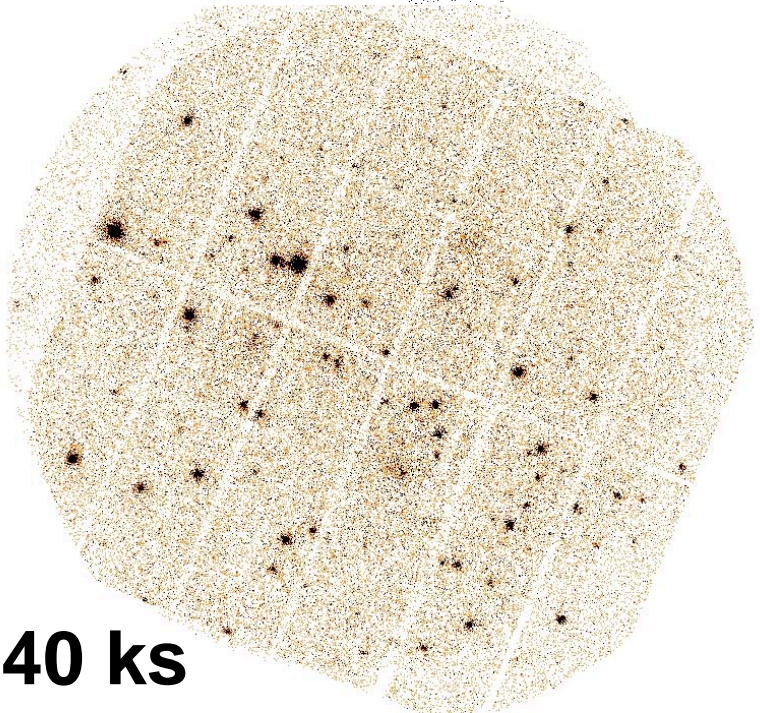


**20 ks**

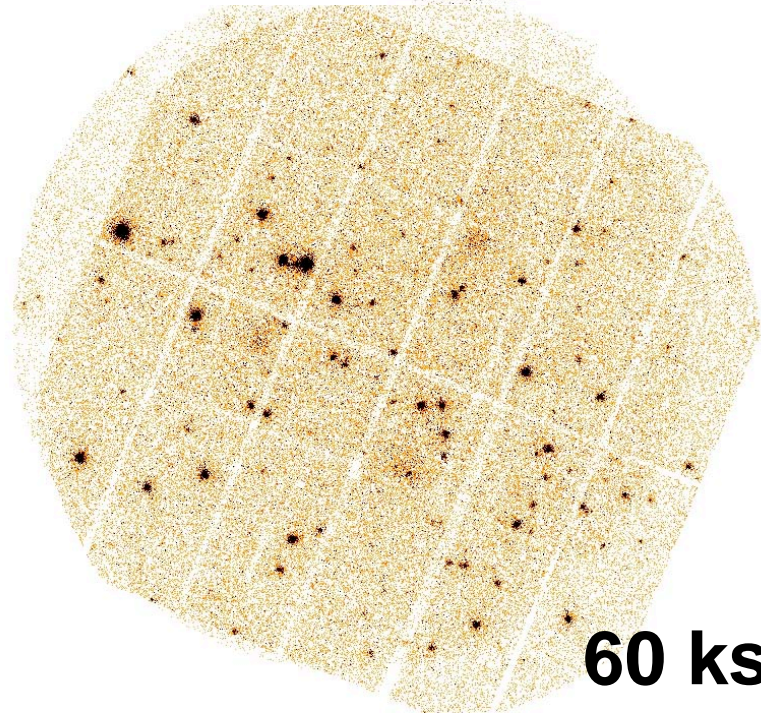


**Not  
as  
easy !**

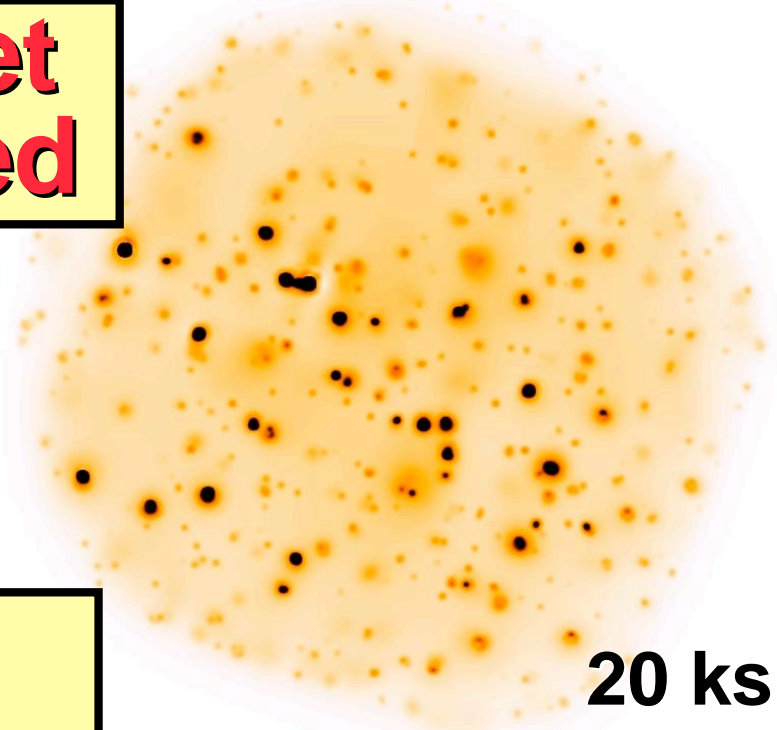
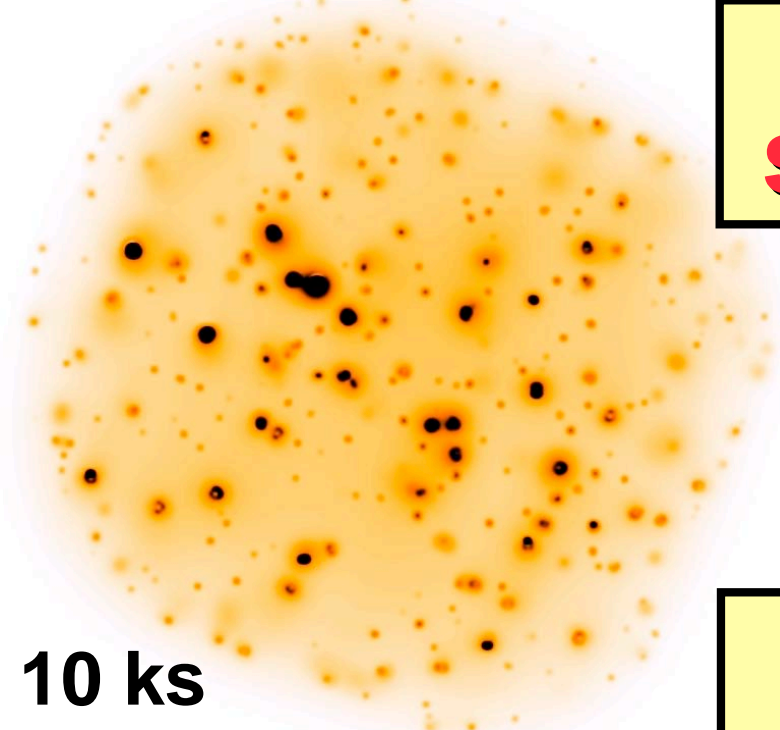
**40 ks**



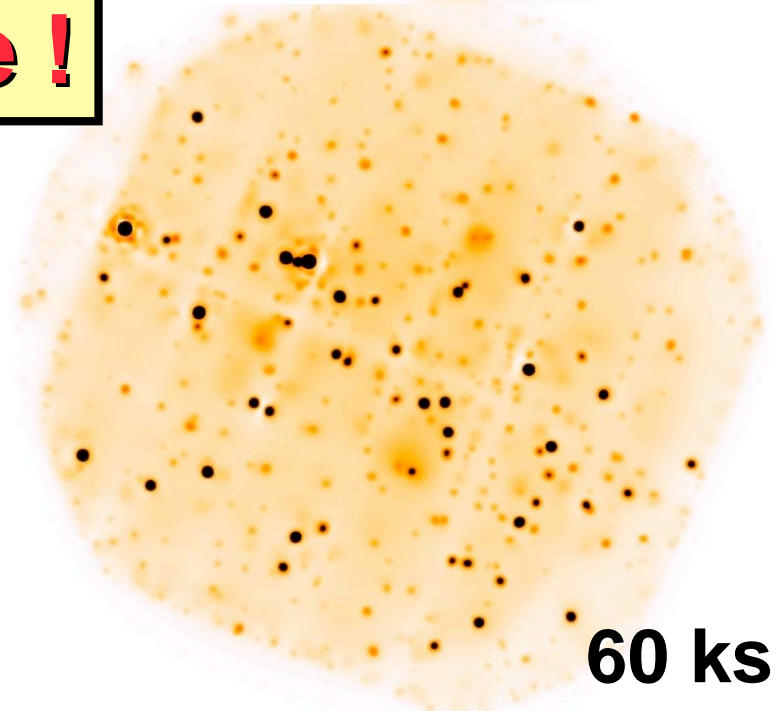
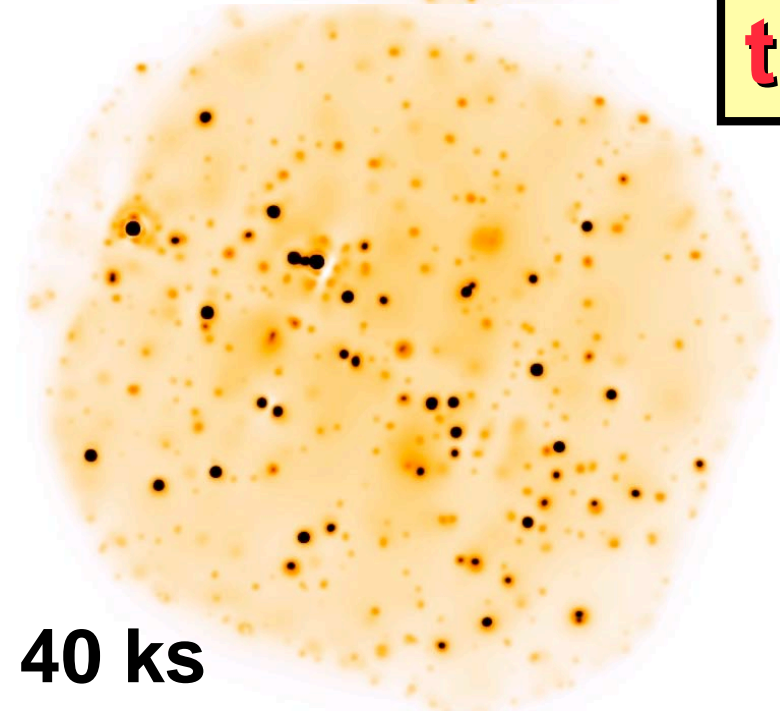
**60 ks**



**Wavelet  
smoothed**



**But  
tractable !**





# The XMM-LSS pipeline

**A 2 step process !**

*Pacaud et al 2006*

**(1) Image filtering in the wavelet space**

**Low S/N detection of source**

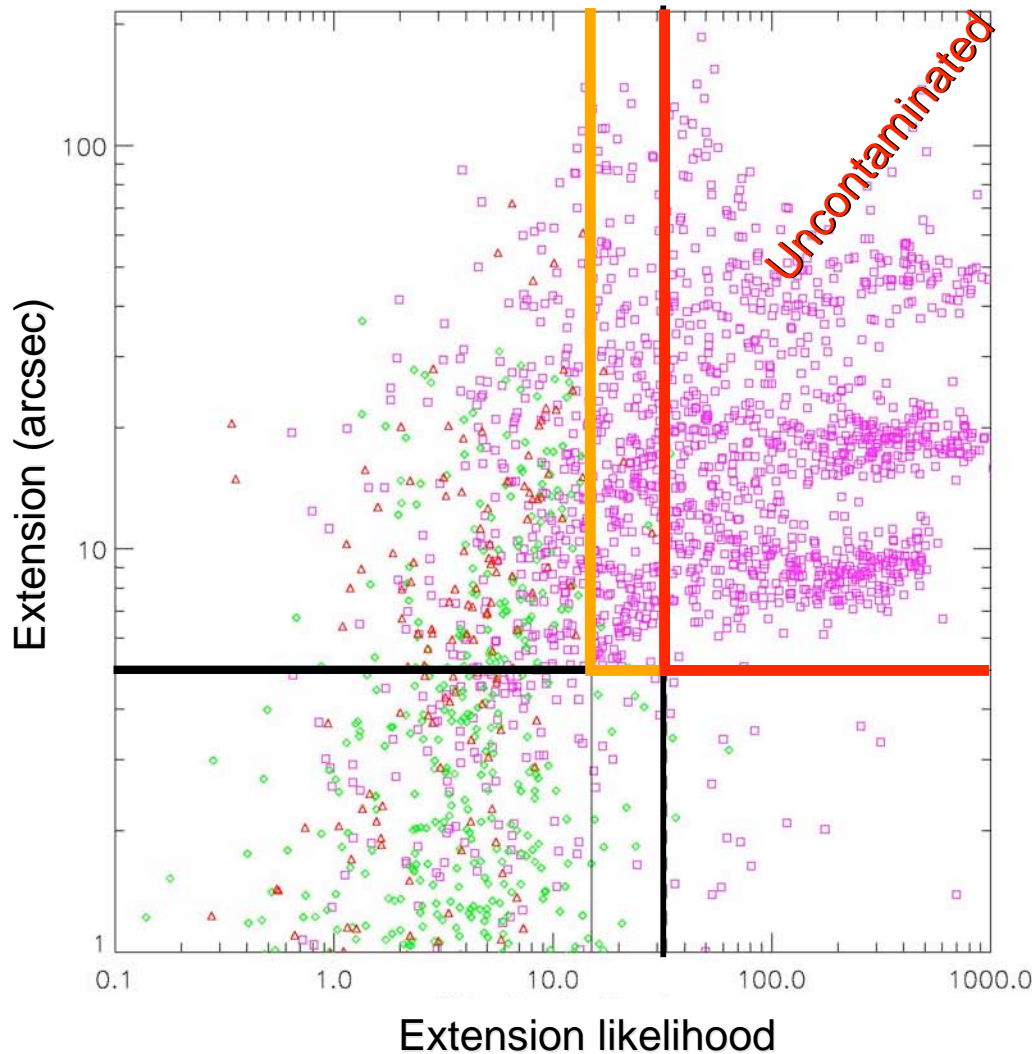
**(2) Maximum likelihood fitting**

- **2 source model: PSF &  $\beta$ -model**
- **Final catalogues including:**
  - **Count-rates**
  - **Detection likelihood**
  - **Extension likelihood**
  - **... etc.**

**Designed and tested over extensive simulations !**

# Selecting a cluster sample

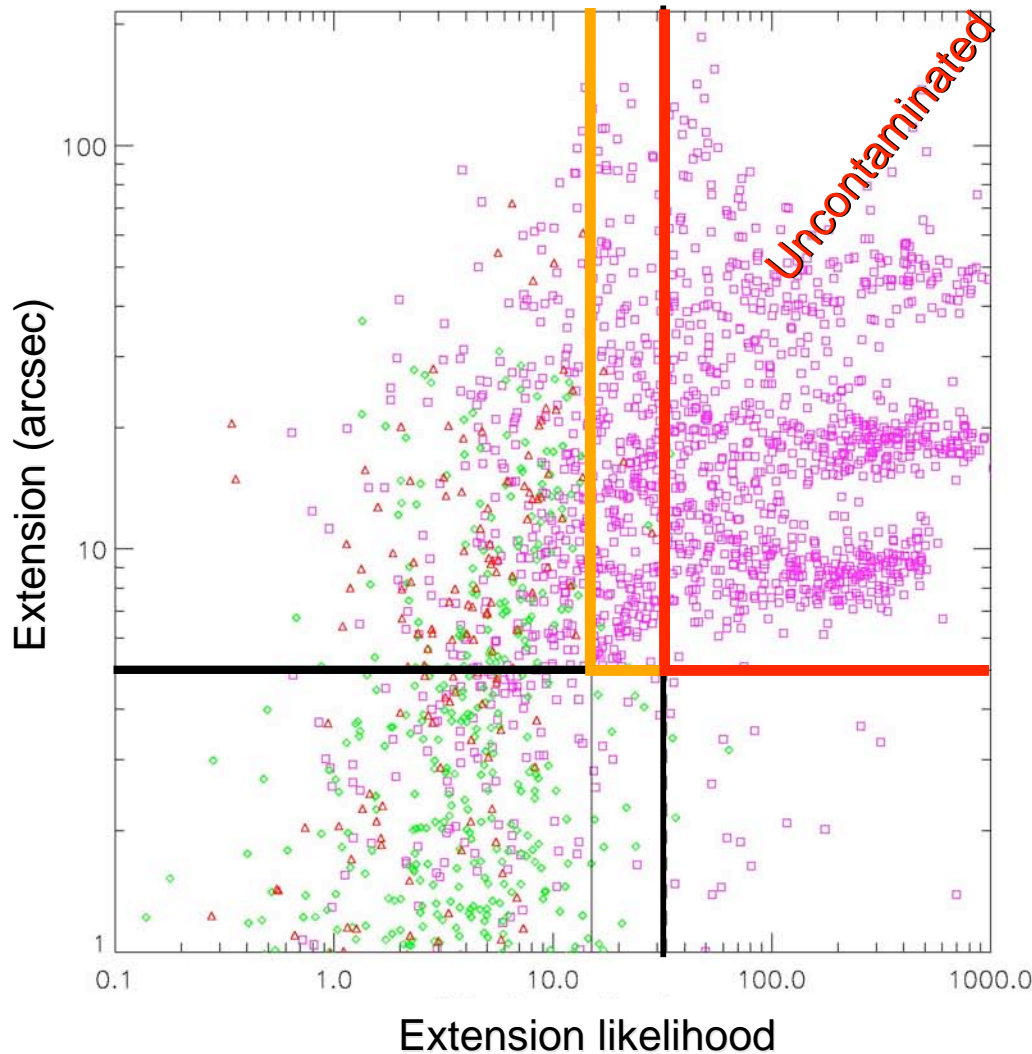
Green = AGNs    Magenta = Clusters    Red = Spurious.



- **C1:**  
Uncontaminated  
5-6 / deg<sup>2</sup>
- **C2:**  
50% contaminated  
but controlled  
another 5 / deg<sup>2</sup>
- **C3:**  
Whatever remains  
?? / deg<sup>2</sup>

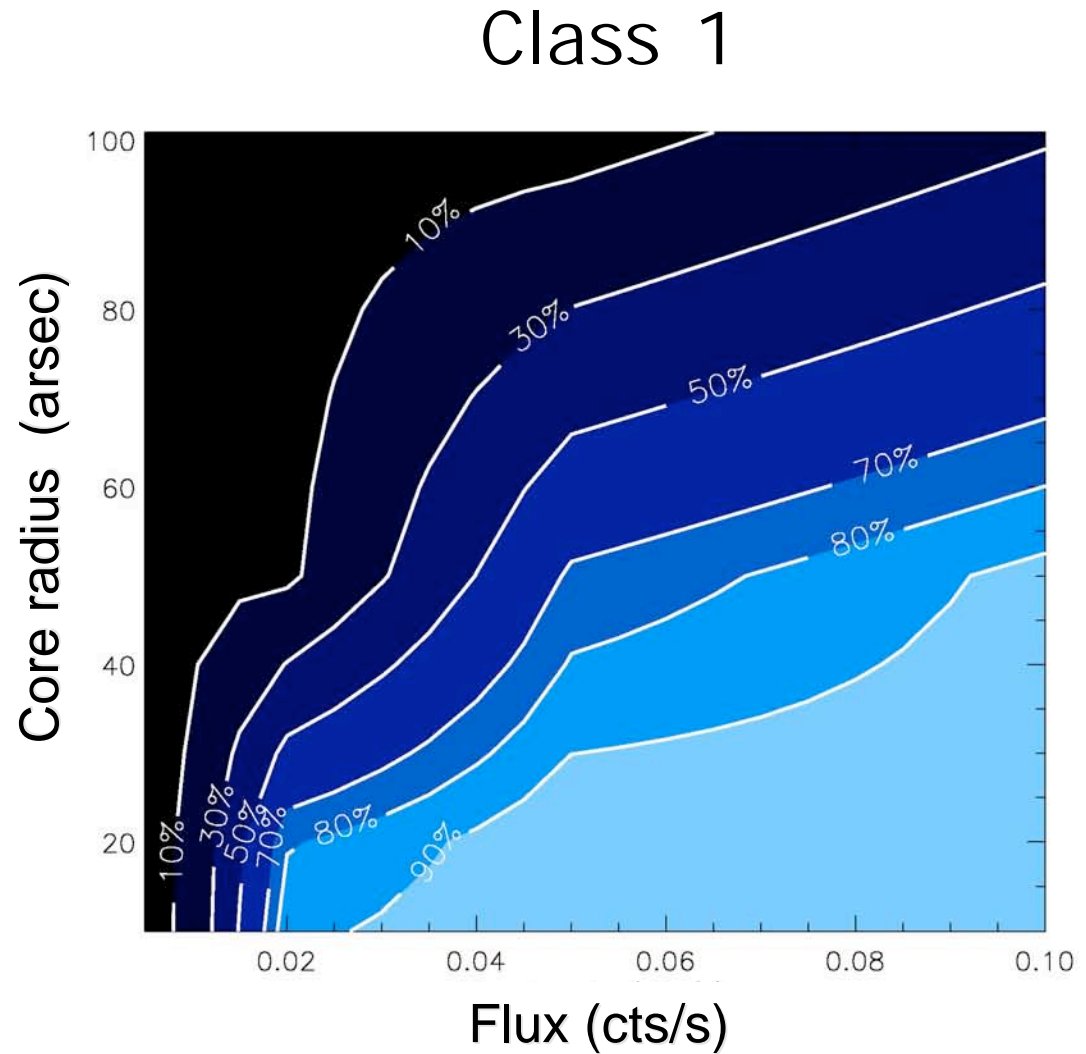
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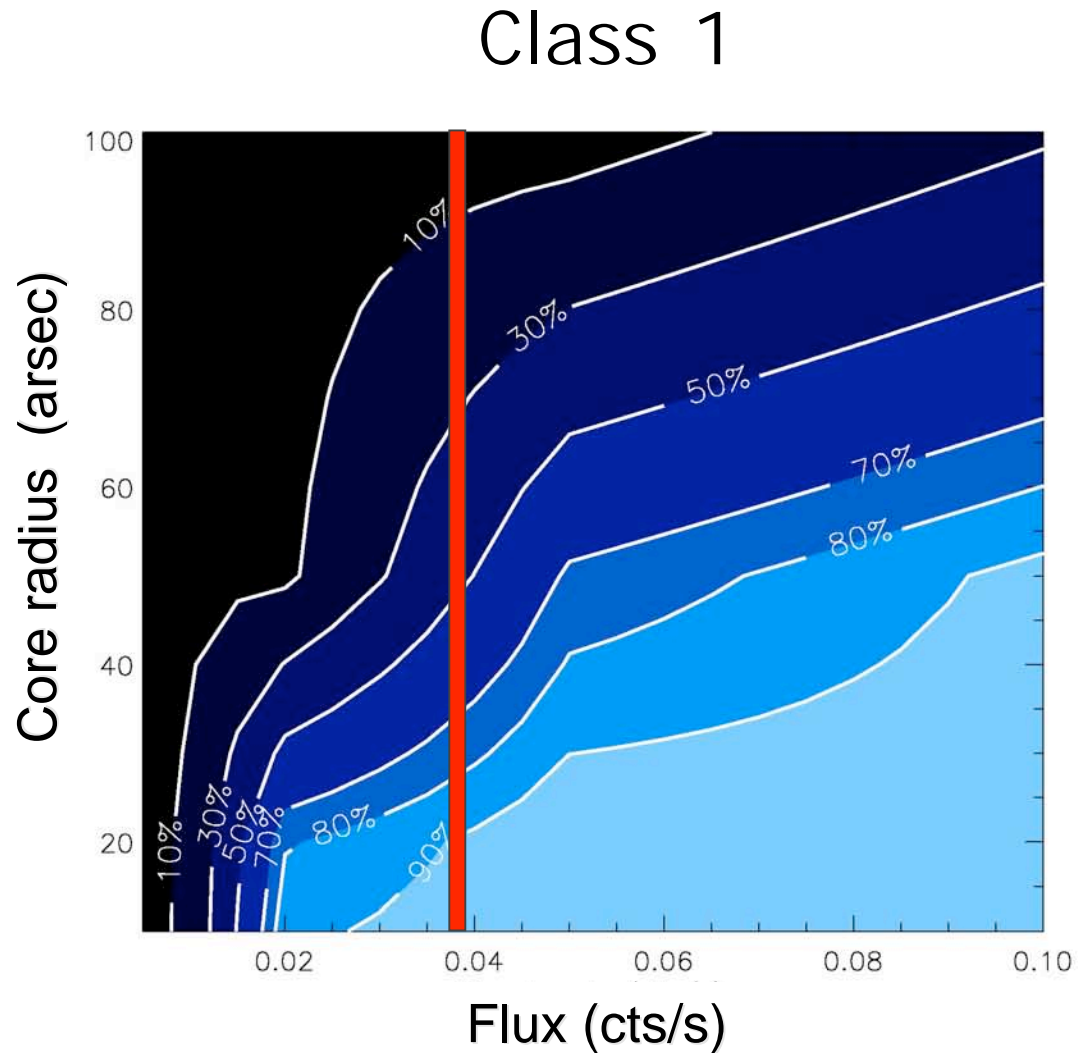
# Detection rates



*Pacaud et al 2006*

# Detection rates

**Not a flux  
limit !**



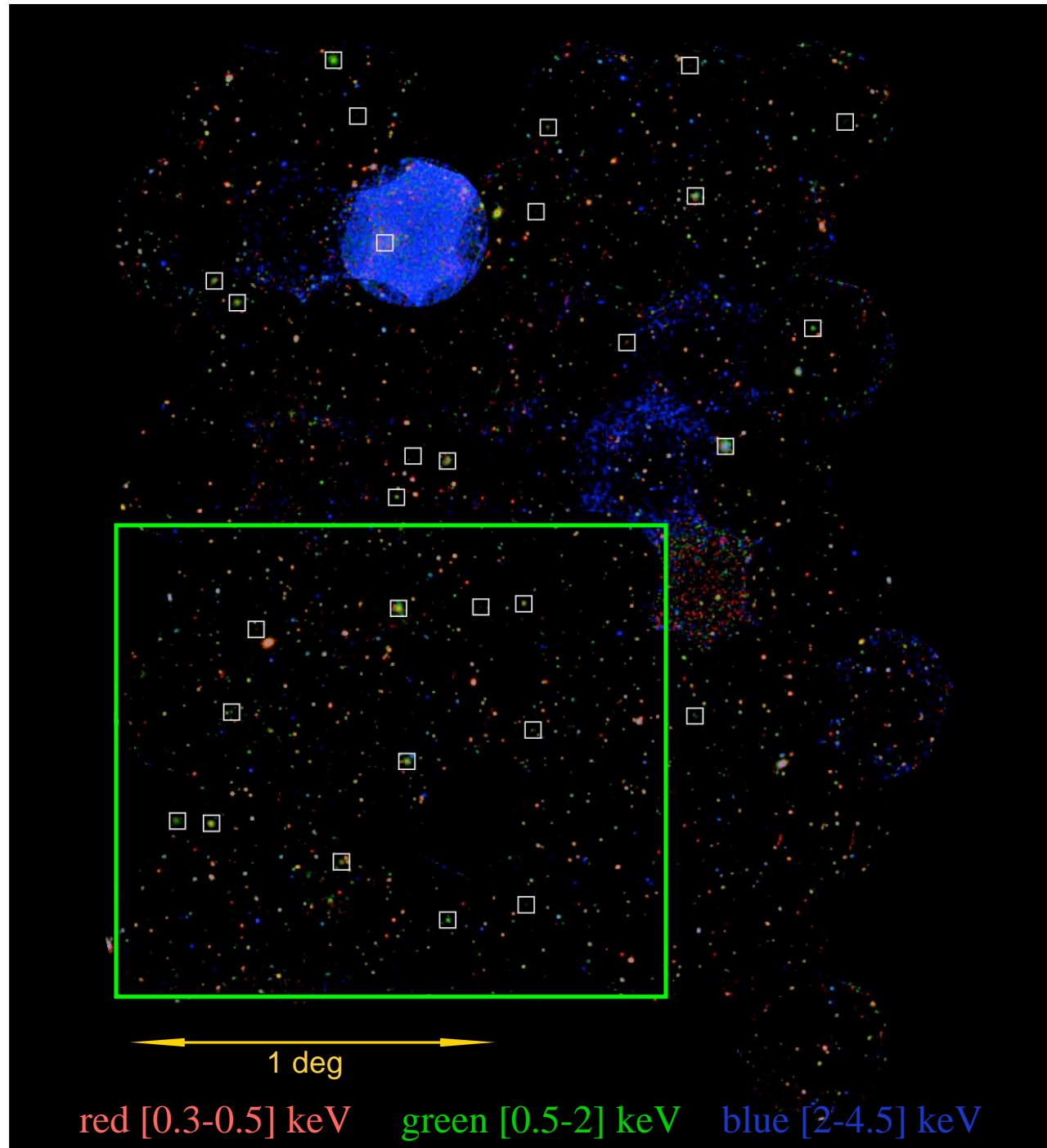
*Pacaud et al 2006*

# The C1 clusters

29 clusters  
over 5.2 deg<sup>2</sup>

 = XMDS (20 ks)

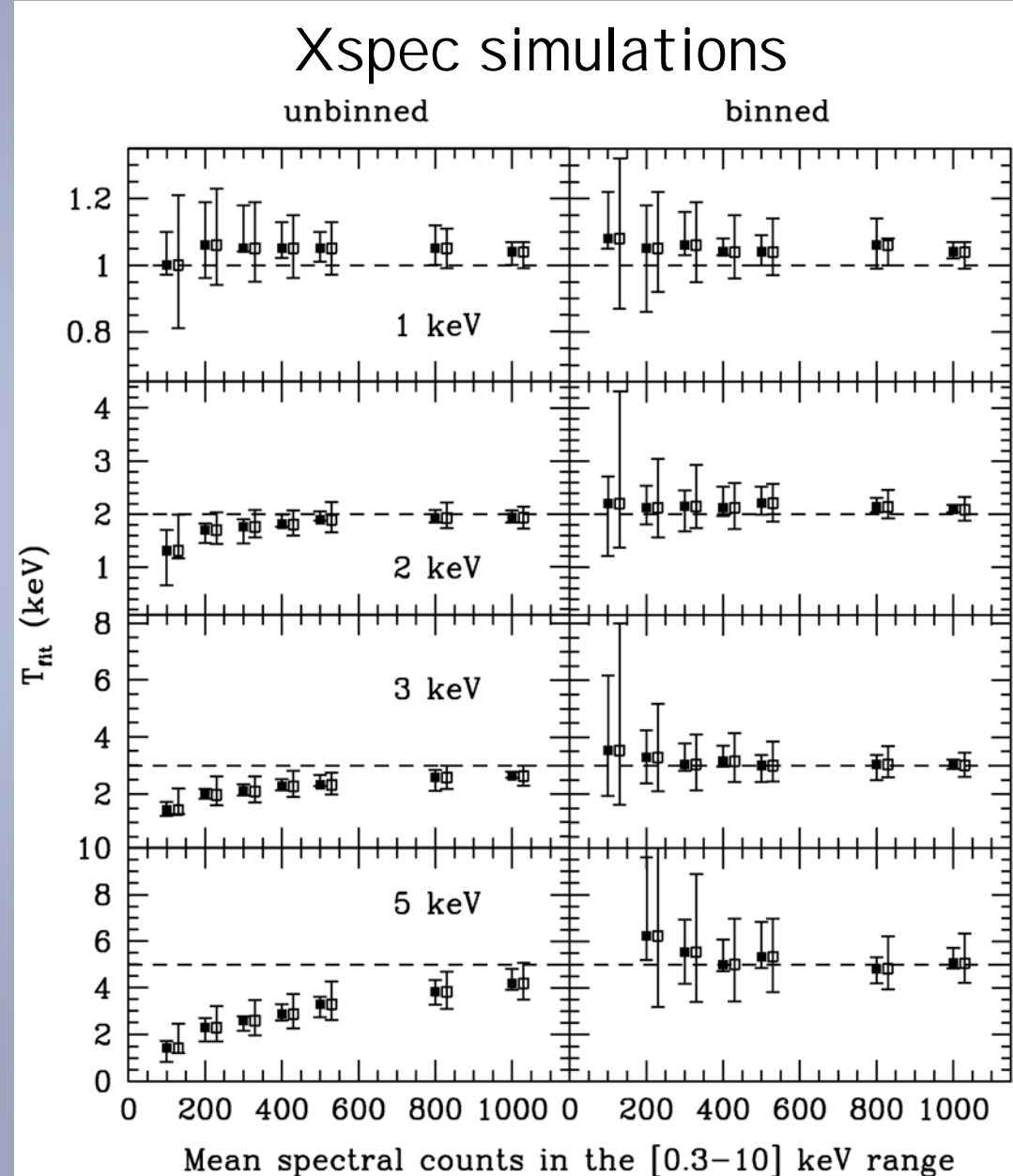
*Pacaud et al, 2007*



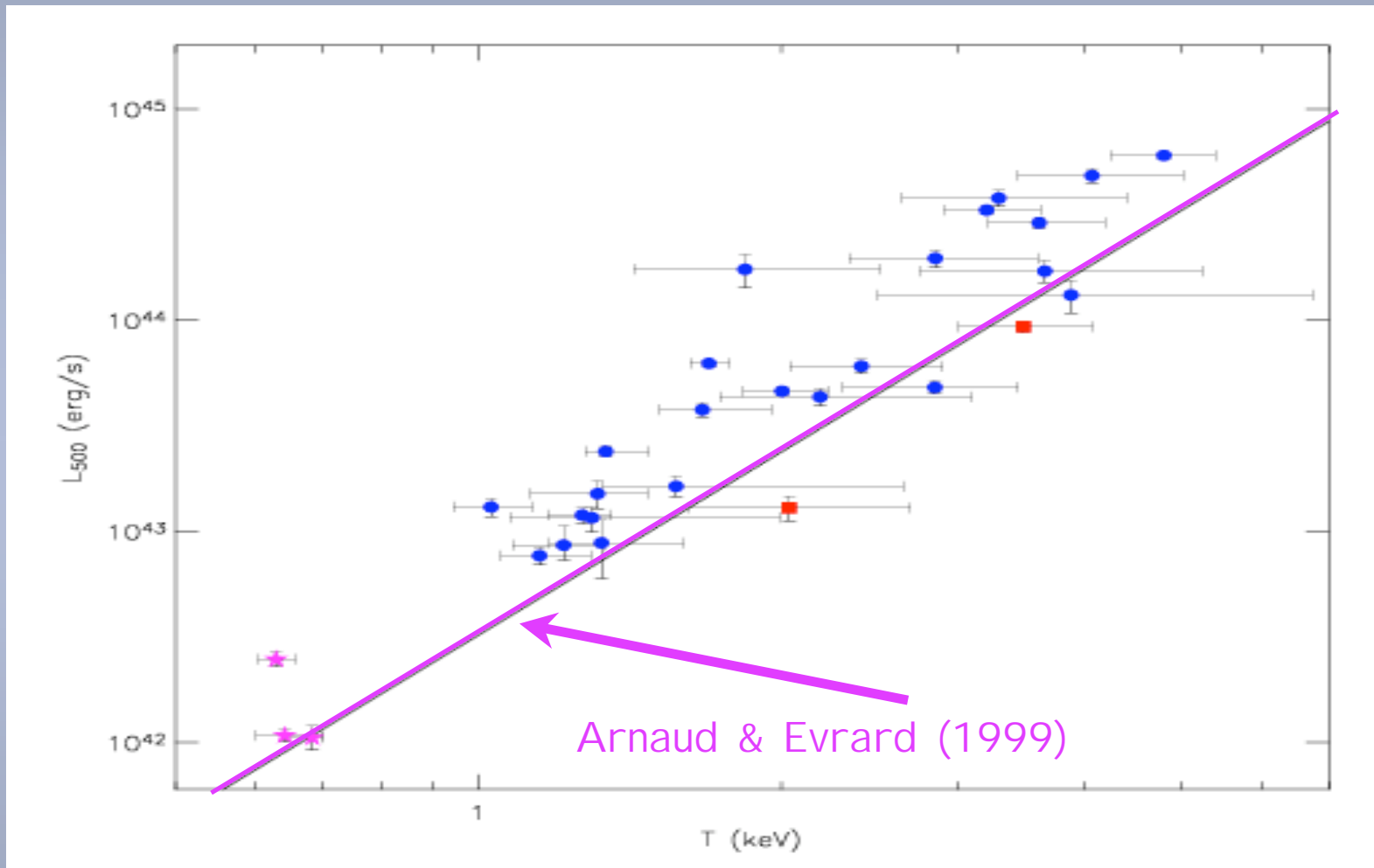
# Measuring temperatures

- Proper statistical treatment needed
- Possible **statistically** for low T clusters with just ~150 cts
- Empirically: works for all Class 1 clusters

*Willis, Pacaud, Valtchanov et al. (2005)*



# $L_x$ -T relation over 5.2 deg<sup>2</sup>



Self-similar:

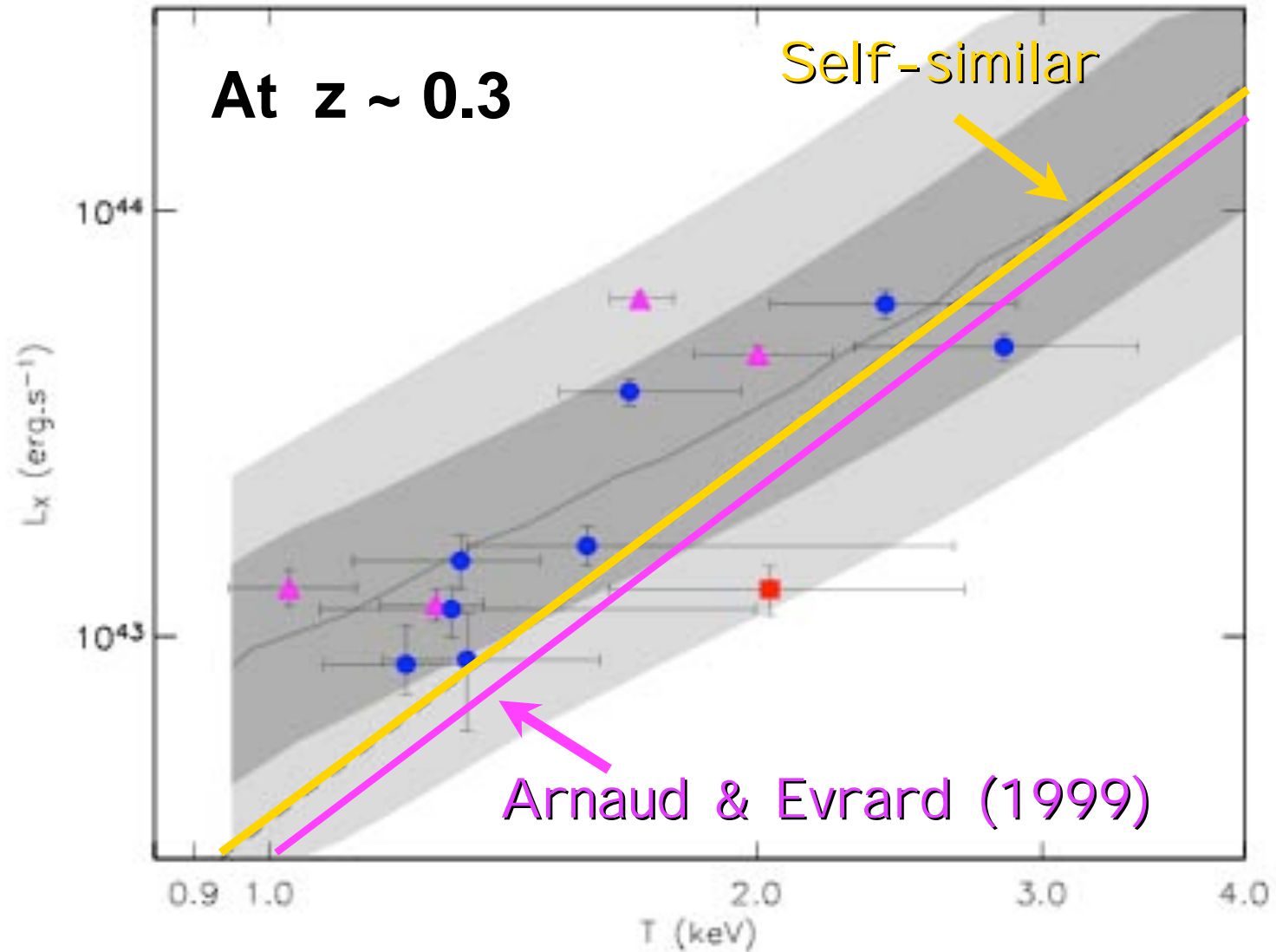
$$L(T, z) = L(T, 0) \cdot E(z)$$

$$E(z) = H(z)/H_0 \Rightarrow 1.5 \text{ at } z=1$$

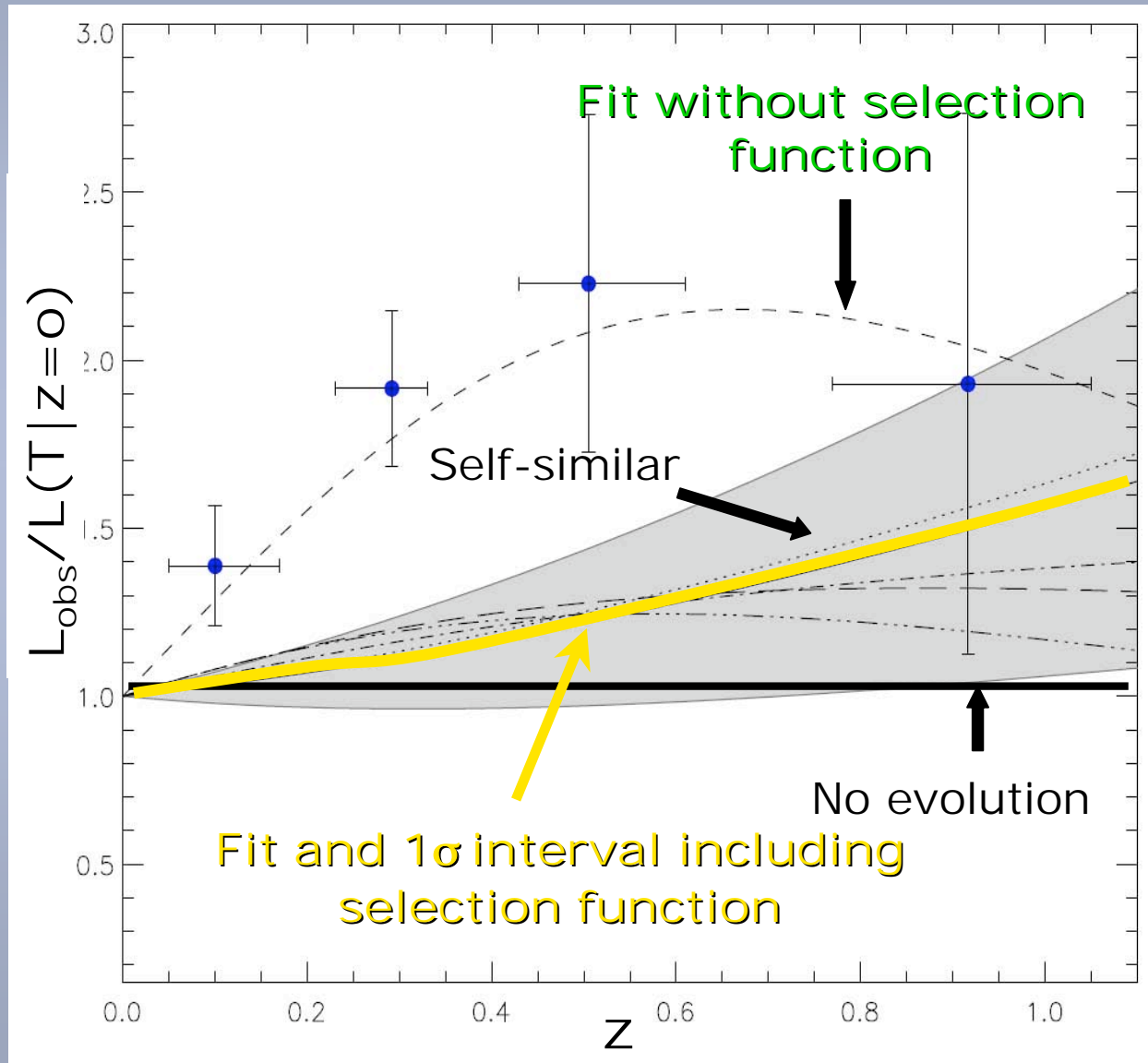


# $L_x$ - $T$ evolution

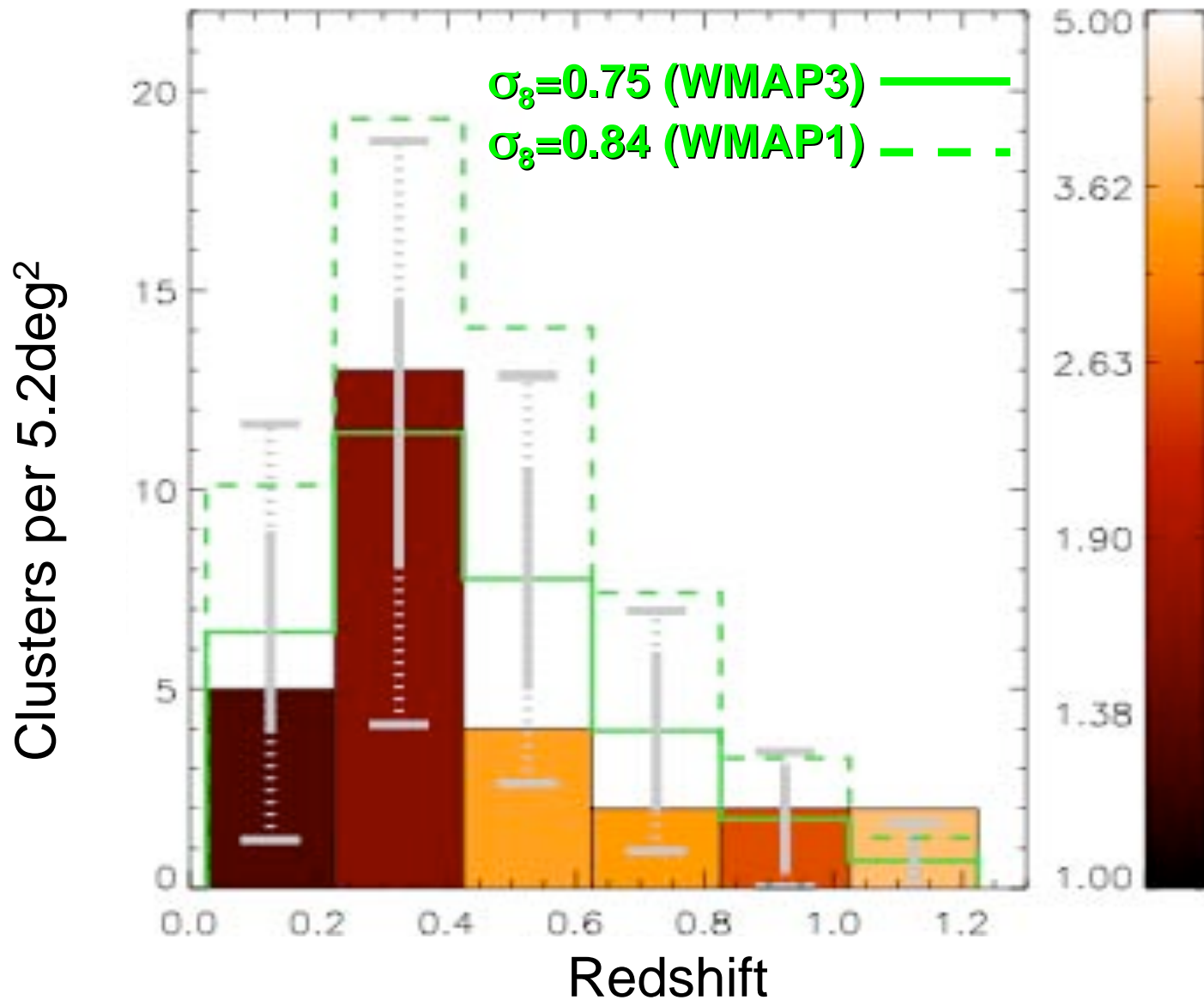
For  $\sigma_{\ln(L|T)}=0.6$  !!!



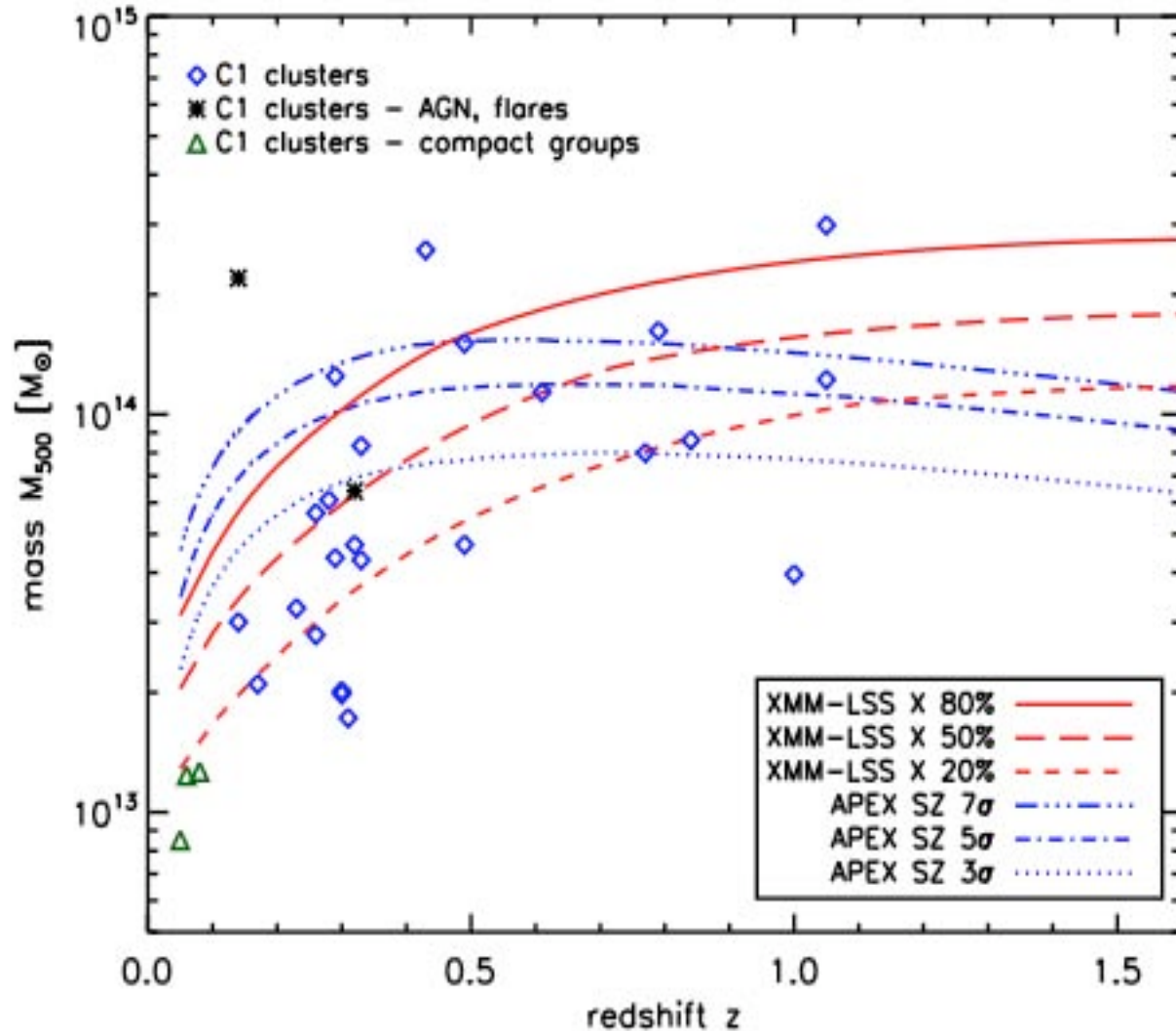
# Constraining L-T evolution



# Predicted dn/dz (WMAP 3rd yr.)



# Comparison with SZ



**X-rays:**

**C1 for 10ks**

=

**5-6/deg<sup>2</sup>**

**SZ:**

**10 $\mu$ K @150GHz**

+

**10 $\mu$ K @220GHz**

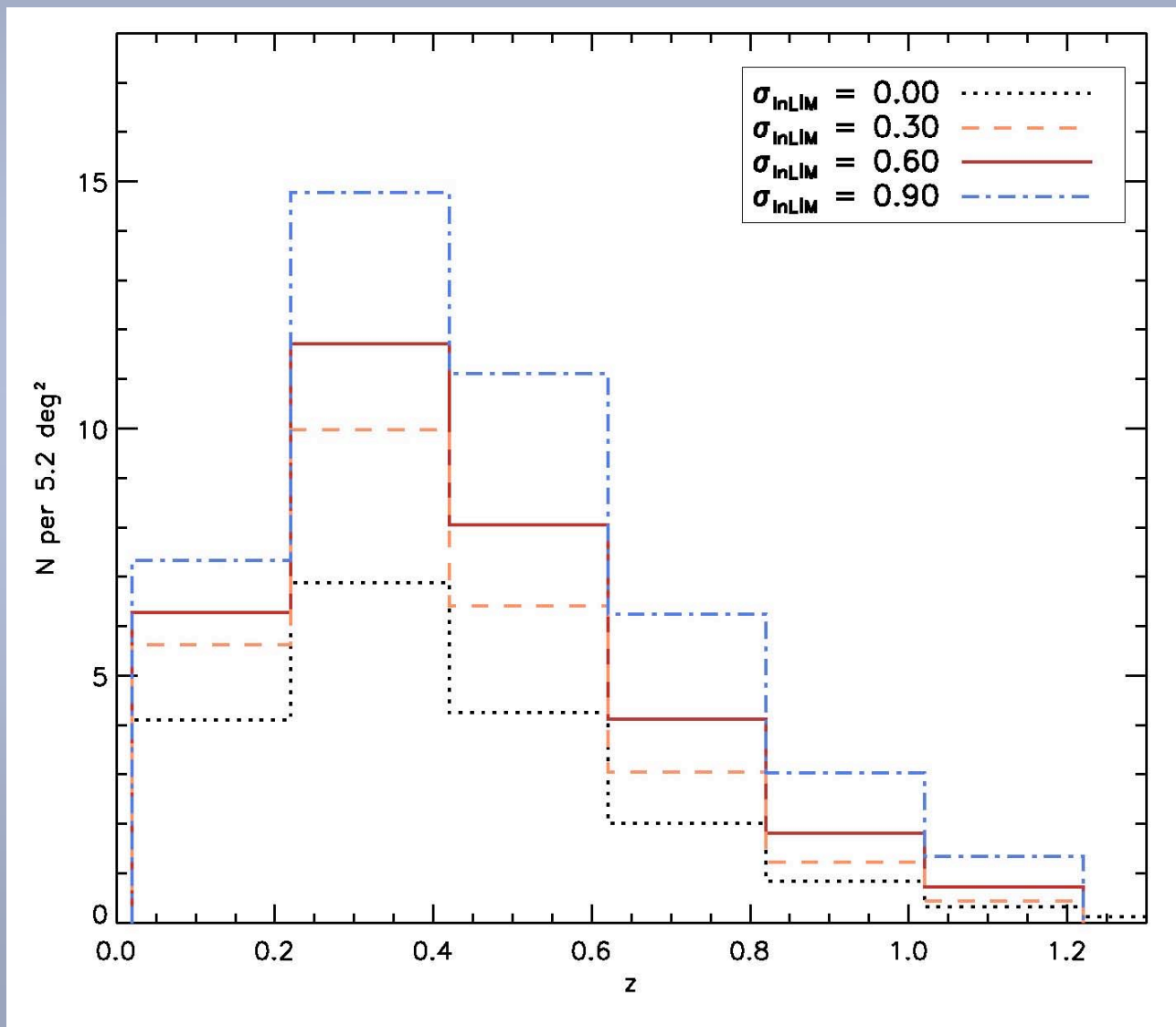
=

**3-4/deg<sup>2</sup>**

**OK**

**but ...**

# Impact of the dispersion in $M-L_x$

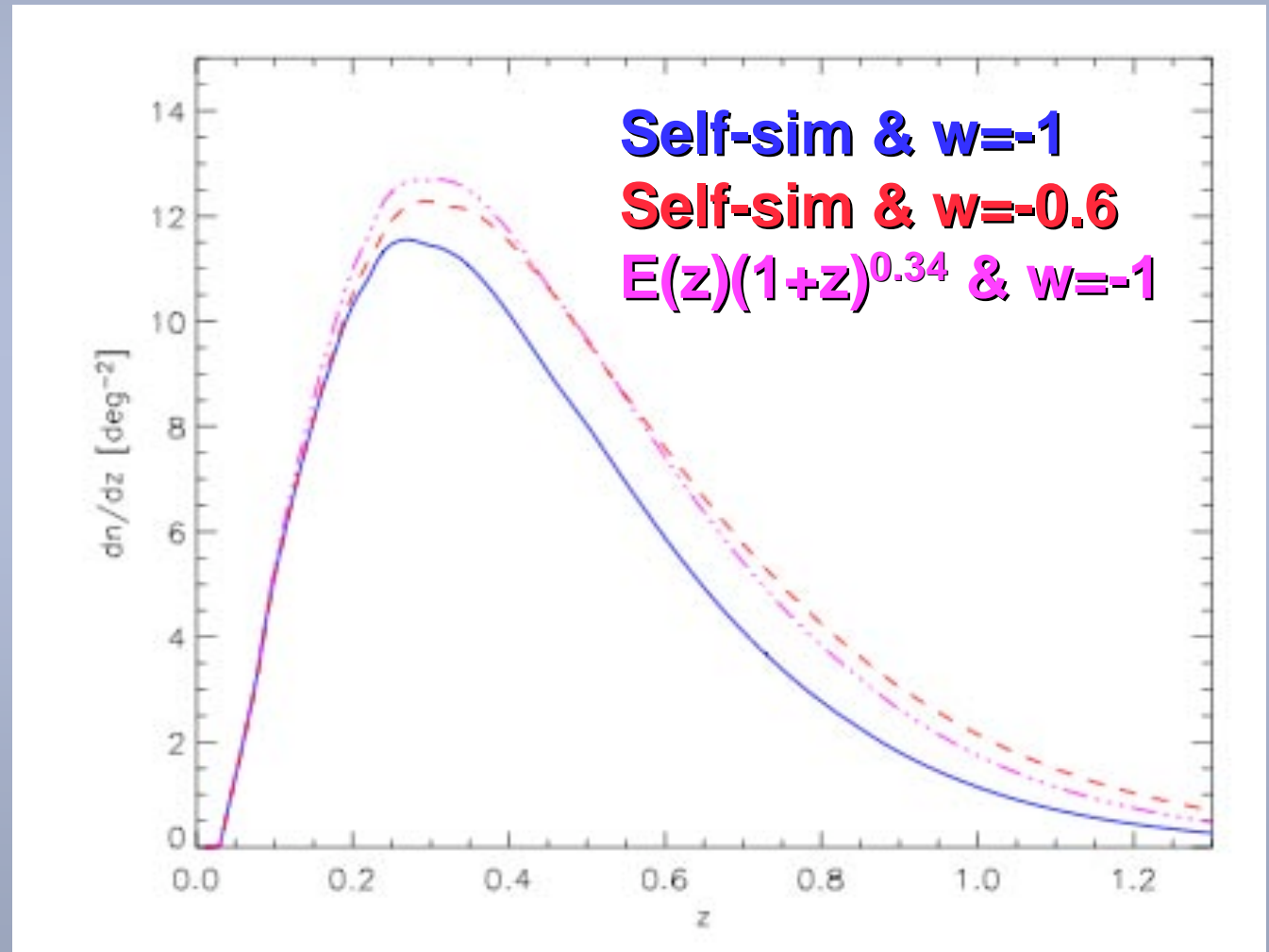


# Dark energy ?

Not without a better Mass-obs calibration !

**example :**

different  $L_X$ -T  
evolutions mimic  
variations in the  
equation of state  
of Dark Energy



# Conclusion

- Shallow exposures already enable the detection of 6 (~12) clus. per deg<sup>2</sup>.  
=> **We have the tools to extract them and the first sample is consistent with our expectations.**
- We can derive temperatures for the C1 sub-sample and constrain the M-Obs relations  
=> **Crucial to determine the required depth of an XXL survey**



# Conclusion !

A very accurate knowledge of M-Obs is necessary to constrain cosmology

=> **Topic of several talks tomorrow**

...

**Including mine**