Confirmation and first scientific characterization of new Planck clusters from XMM validation follow-up

Planck Collaboration

Presented by M. Arnaud (CEA-Service d'Astrophysique)

Planck Collaboration, 2011 IX, A&A, 536, A9
Planck Collaboration, 2011 XXVI, A&A, 536, A26
Planck Collaboration, 2012 Intermediate Paper, I, A&A, arXiv:1112.5595

XMM-DDT validation programm

- Agreement between Planck & XMM project scientists
  - snapshot validation observations (10ks)
  - 250 ksec (Val1&2) published in the early paper (2011 IX, A&A, 536, A9)
  - 250 ksec (Val3&4) that explore lower S/N and/or SZ quality signal

Goals of validation follow-up:

- Confirm new clusters
- Better understanding on what cluster Planck (can) detect } spec at high z
- Optimization of candidate internal validation (SZ/anc data) process

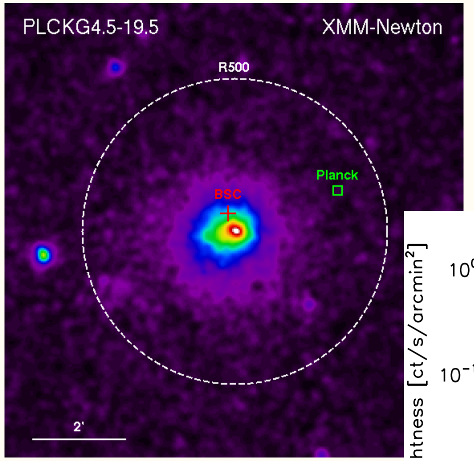
Unique capability of XMM
unambiguously distinguish between false candidate and true clusters
essential here

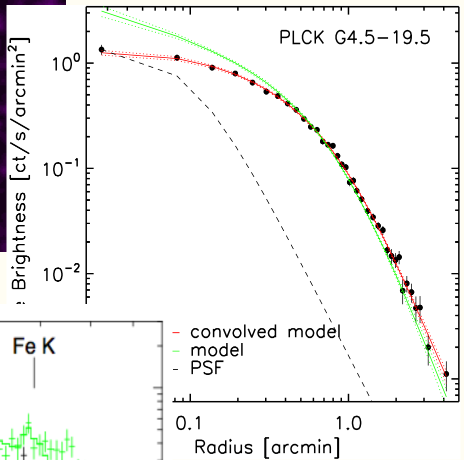
Candidate selection

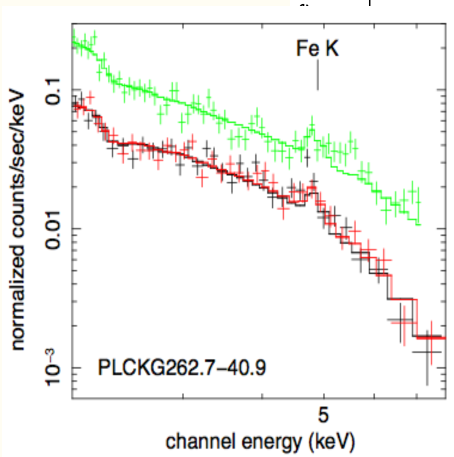
- Candidate blindly detected by 3 methods: MMF & PWS
- Quantitative assessment of the SZ signal: (S/N); N_{det};
- Quality Flag based on visual inspection of raw & SZ maps and spectrum
- External reliability flag based on ancillary survey data: association with FSC/BSC RASS source; excess in the RASS-count rate image (with associated S/N); SDSS or DSS galaxy over-density

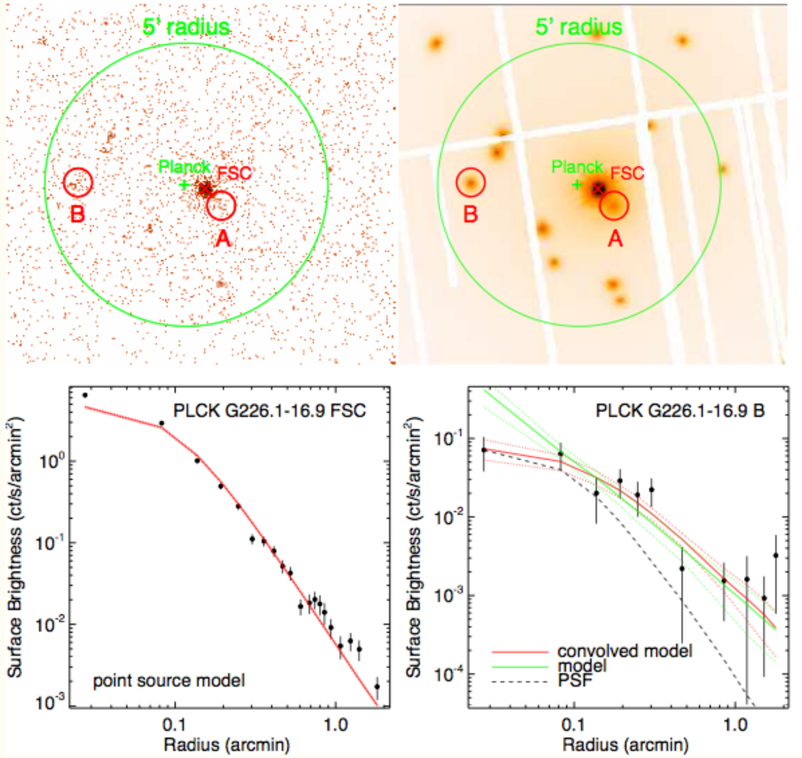
Validation method

A cluster





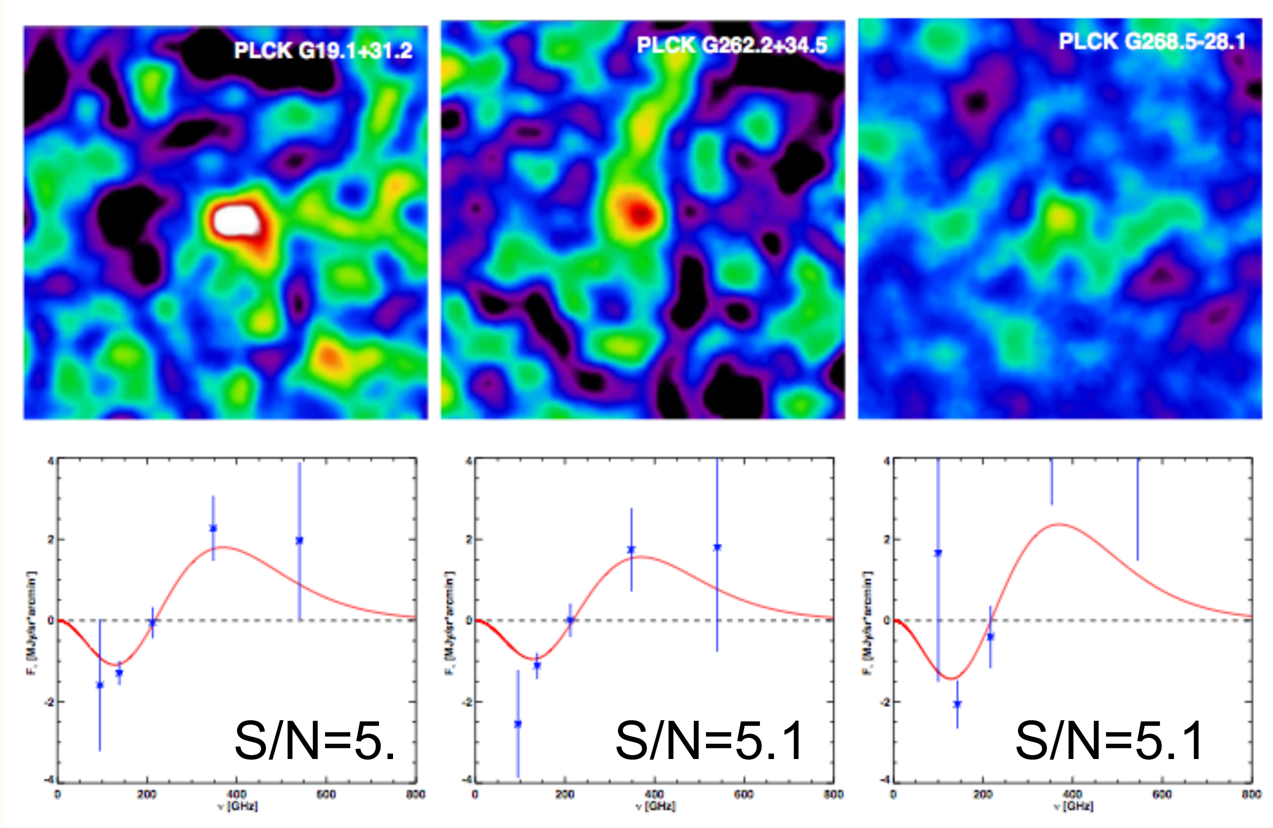




A false candidate

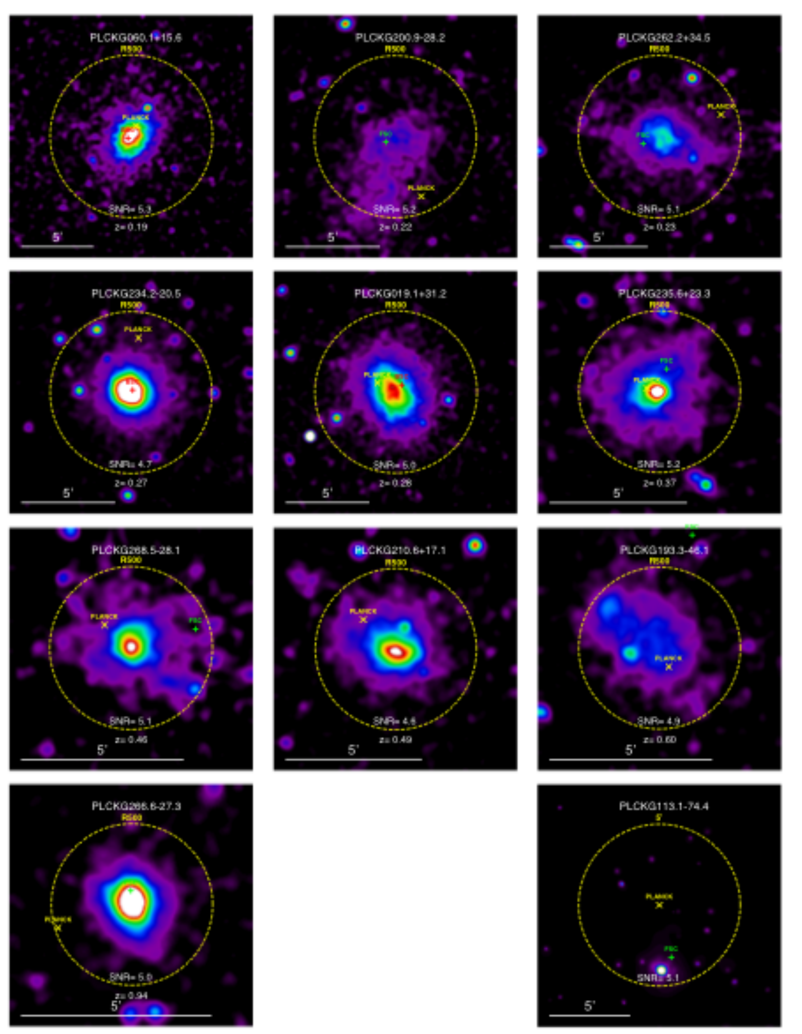
Based on source extent and consistency X/SZ

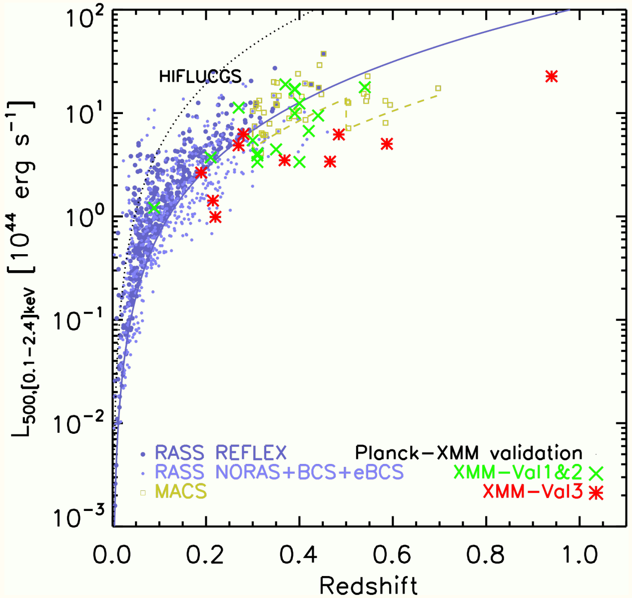
Sample definition (Val 3)



- Maps v4.1 (as for ESZ construction)
- 11 candidates 4.5 < S/N < 5.3 (compared to 5.1<S/N<10.2 for Val2)
- SZ Quality Flag=A,B,C
- Includes two SDSS candidates

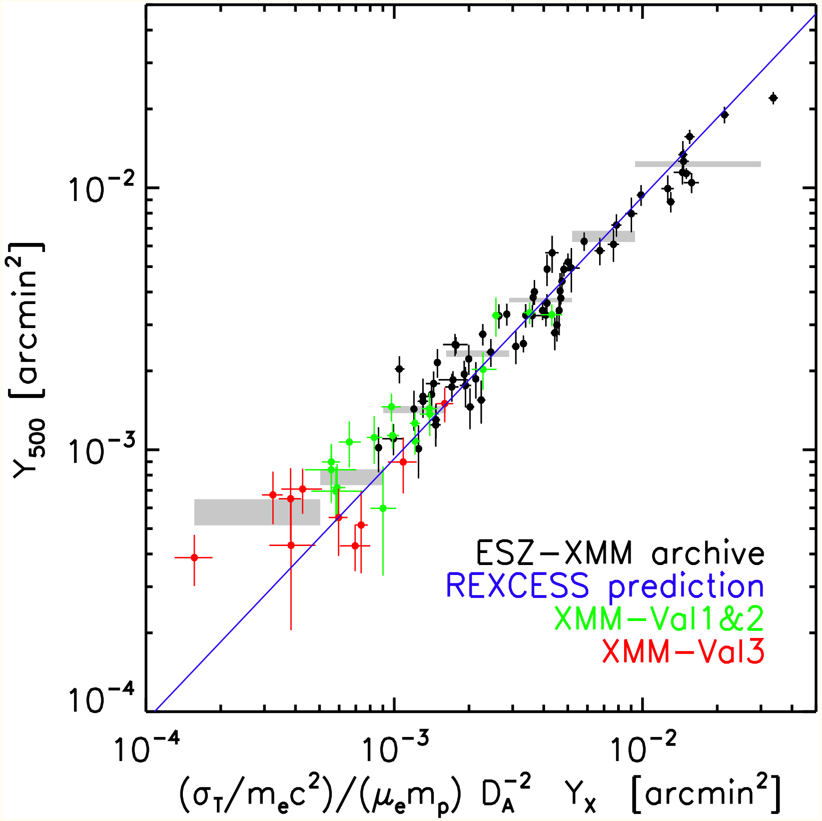
Validation output





- Planck sensitivity: large range of redshift 0.2<z<1 and mass
  (with 2 clusters z≥0.5 and first at z~1)
- Relevance of internal quality flags
  1/11 false (S/N=5 but at lowest Q_{SZ})
- Improved robustness of SDSS analysis
  z~0.6 candidate confirmed

Physical properties preview

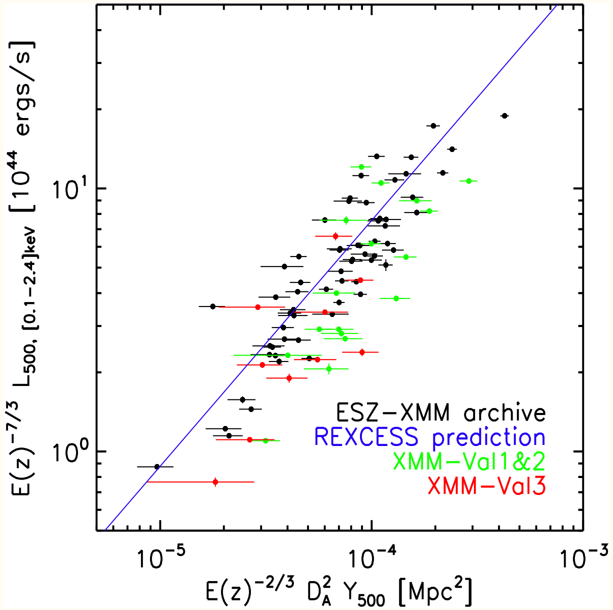


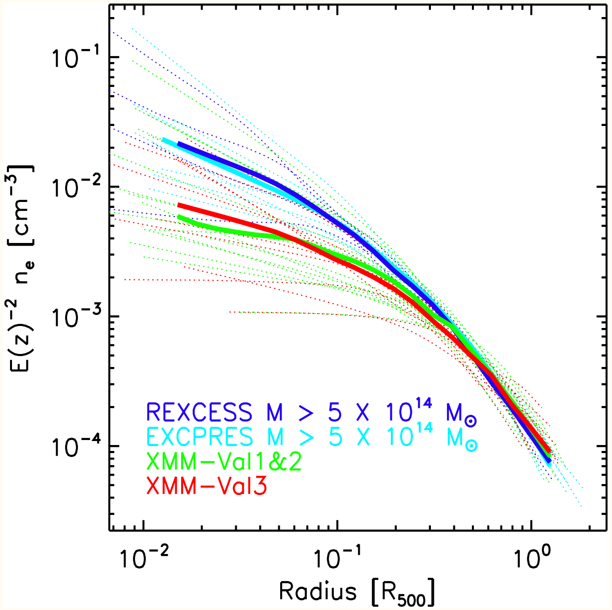
Confirm at lower Y and/or higher z:

good agreement between Y_X and Y_{SZ}

First clear evidence of Malmquist bias turn-over @ Y_{SZ}~410^{-4} arcmin^2

Physical properties preview

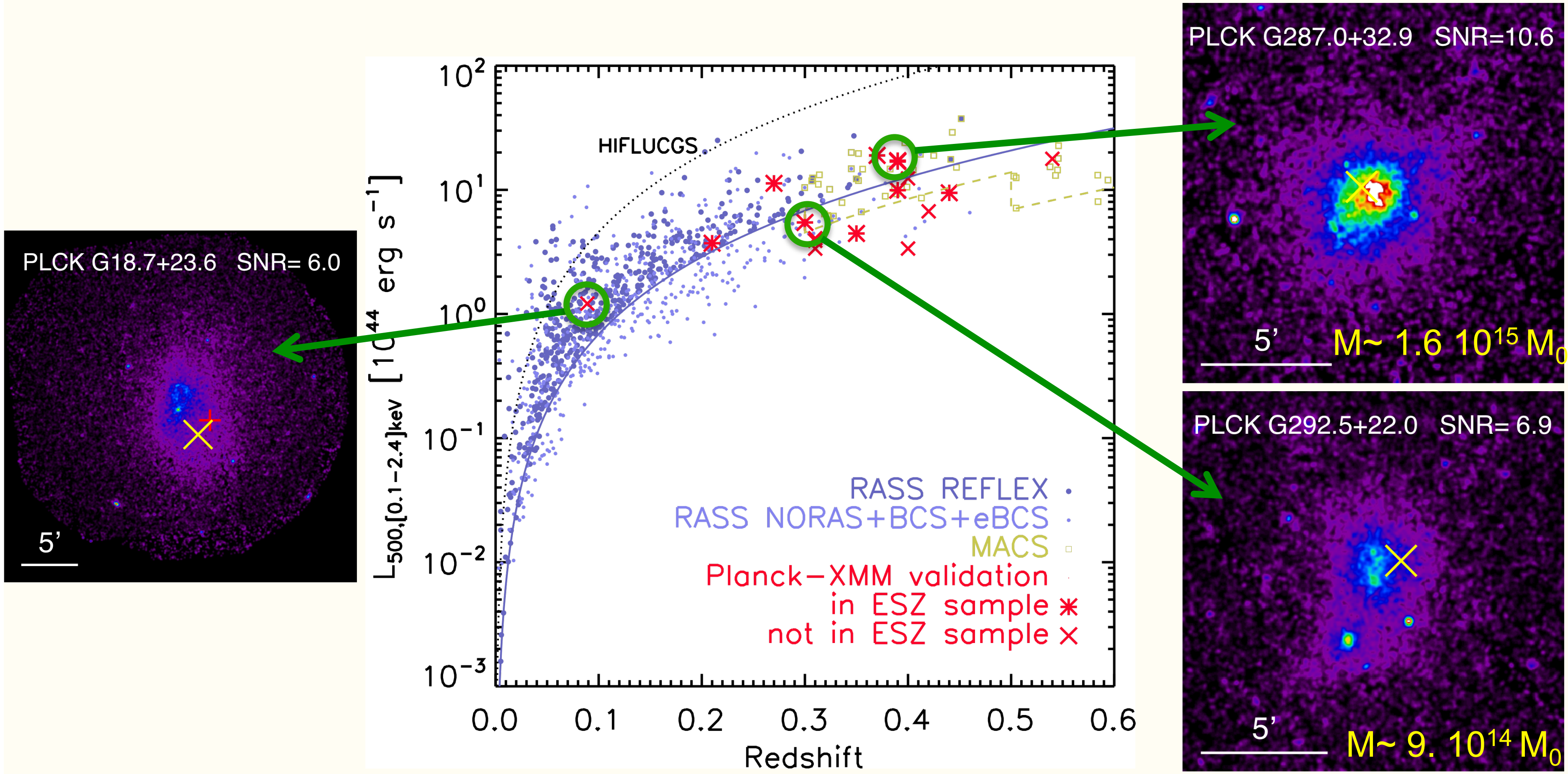




Confirm at lower Y and/or higher z:

large variety of dynamical state with new clusters more disturbed and undermuminous

XMM validation 1&2

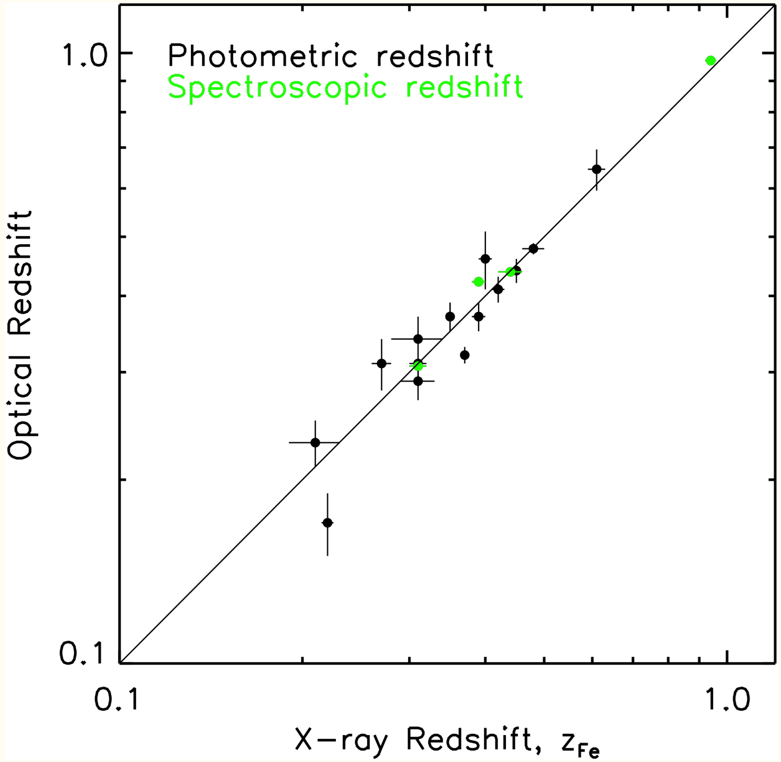


Unveiling a population of dynamically perturbed clusters @ z>0.3, possibly under-represented in X-ray surveys

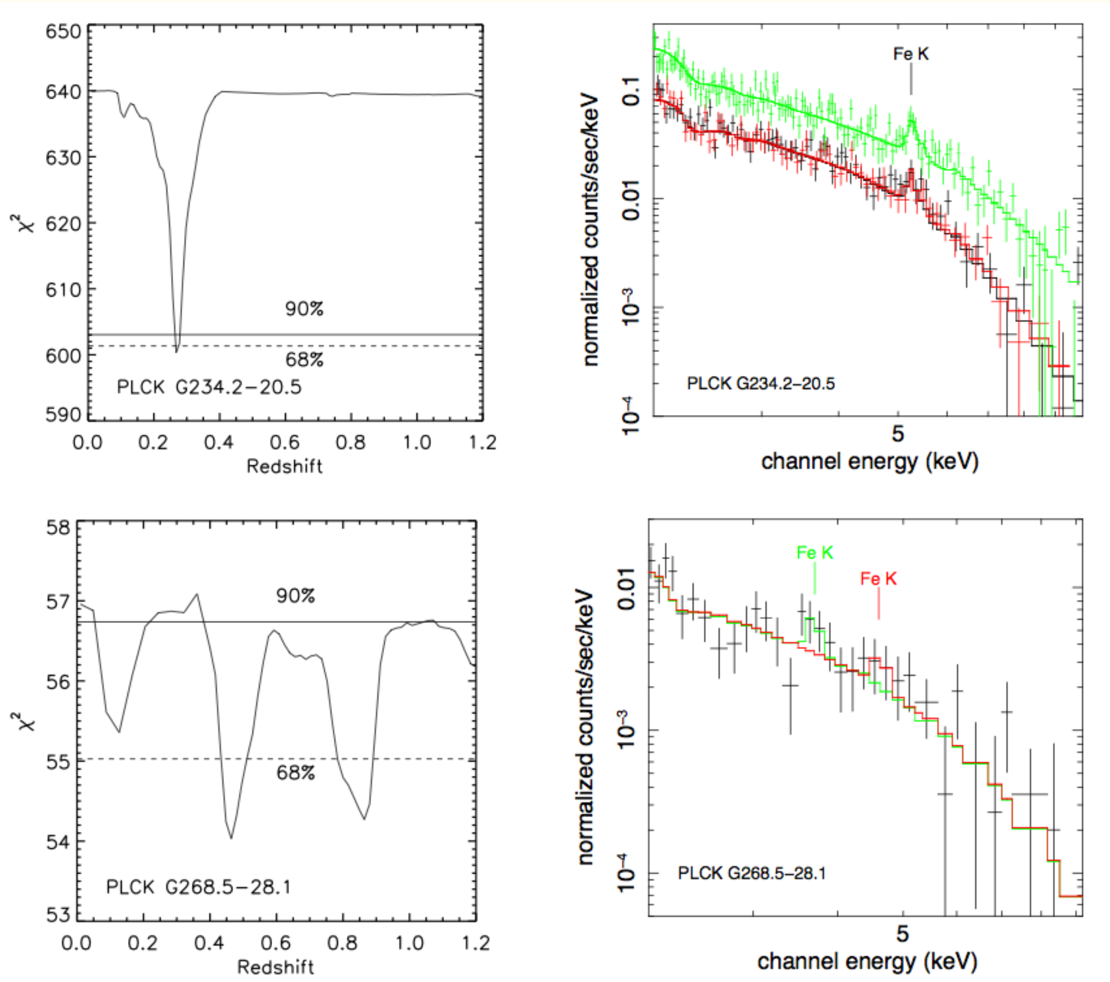
Redshift estimate: z_{opt} verus z_X

Name	z_{Fe}	z_{opt}	Ref.
PLCK G100.2−30.4	0.31 ± 0.03	0.34 ± 0.03	1 (p)
PLCK G171.9−40.7	0.27 ± 0.01	0.31 ± 0.03	1 (p)
PLCK G193.3−46.1	0.59 ± 0.02	0.65 ± 0.05	2 (p)
PLCK G205.0−63.0	0.31 ± 0.01	0.31 ± 0.02	3 (p)
PLCK G210.6+17.1	0.48 ± 0.02	0.478 ± 0.01	2 (p)
PLCK G214.6+37.0	0.45 ± 0.02	0.44 ± 0.02	3 (p)
PLCK G241.2−28.7	0.42 ± 0.01	0.41 ± 0.02	3 (p)
PLCK G262.2+34.5	0.21 ± 0.02	0.23 ± 0.02	3 (p)
PLCK G262.7−40.9	0.39 ± 0.01	0.422	4 (s)
PLCK G266.6−27.3	0.94 ± 0.02	0.972	5 (s)
PLCK G271.2−31.0	0.37 ± 0.005	0.32 ± 0.01	5 (p)
PLCK G272.9+48.8	0.40 ± 0.01	0.46 ± 0.05	3 (p)
PLCK G277.8−51.7	0.44 ± 0.02	0.438	5 (s)
PLCK G285.0−23.7	0.39 ± 0.005	0.37 ± 0.00	6 (p)
PLCK G285.6−17.2	0.35 ± 0.01	0.37 ± 0.02	3 (p)
PLCK G286.3−38.4	0.31 ± 0.01	0.307 ± 0.003	6 (s)
PLCK G286.6−31.3	0.22 ± 0.005	0.17 ± 0.02	3 (p)
PLCK G287.0+32.9	0.39 ± 0.01	0.37 ± 0.02	3 (p)
PLCK G292.5+22.0	0.31 ± 0.02	0.29 ± 0.02	3 (p)
PLCK G334.8−38.0	0.35 ± 0.03	0.37 ± 0.02	3 (p)

References: (1) Present work from ENO/IAC80 observations; (2) SDSS-DR7 data base http://www.sdss.org/dr7/; (3) Present work from ESO/MPG2.2m observations; (4) Sifon et al. (2012) ACT J0438−5419 (5) Williamson et al. (2011); SPT-CLJ0615-5746, SPT-CLJ0549-6204, SPT-CLJ0254-5856, respectively. (6) Planck Collaboration et al. (2011c)

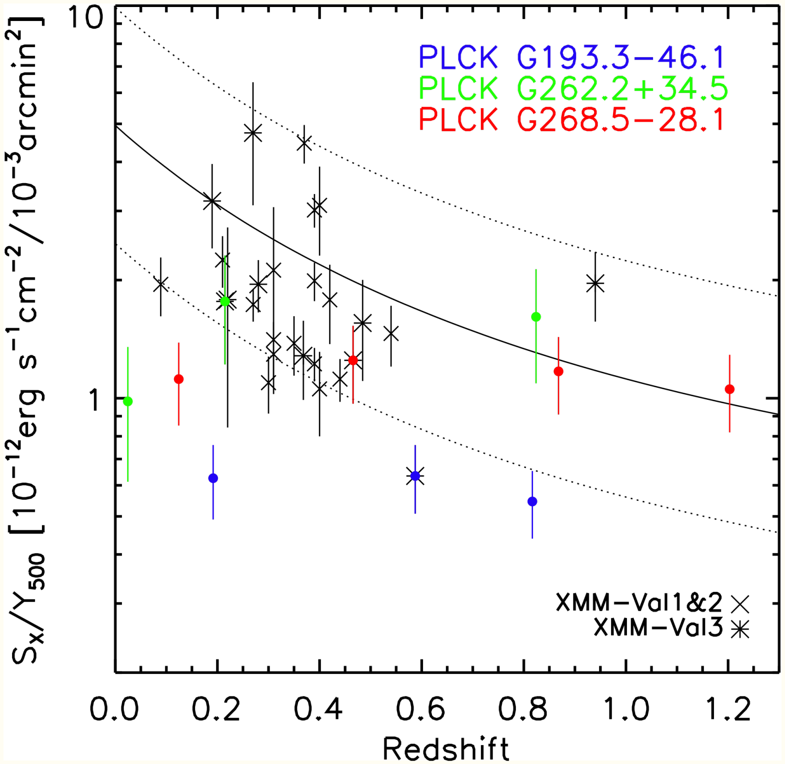


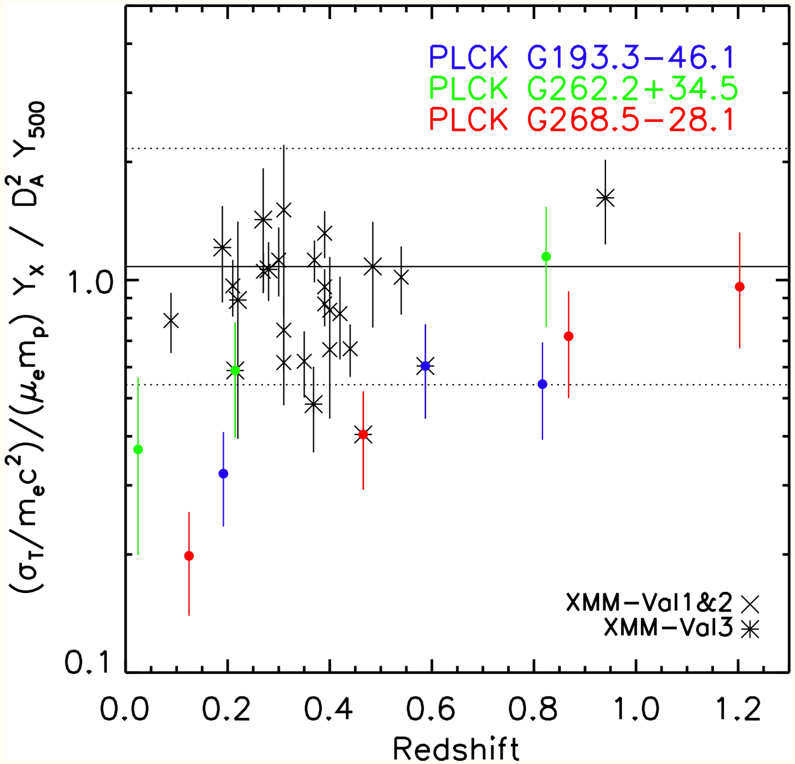
Redshift estimate z_X



Various quality

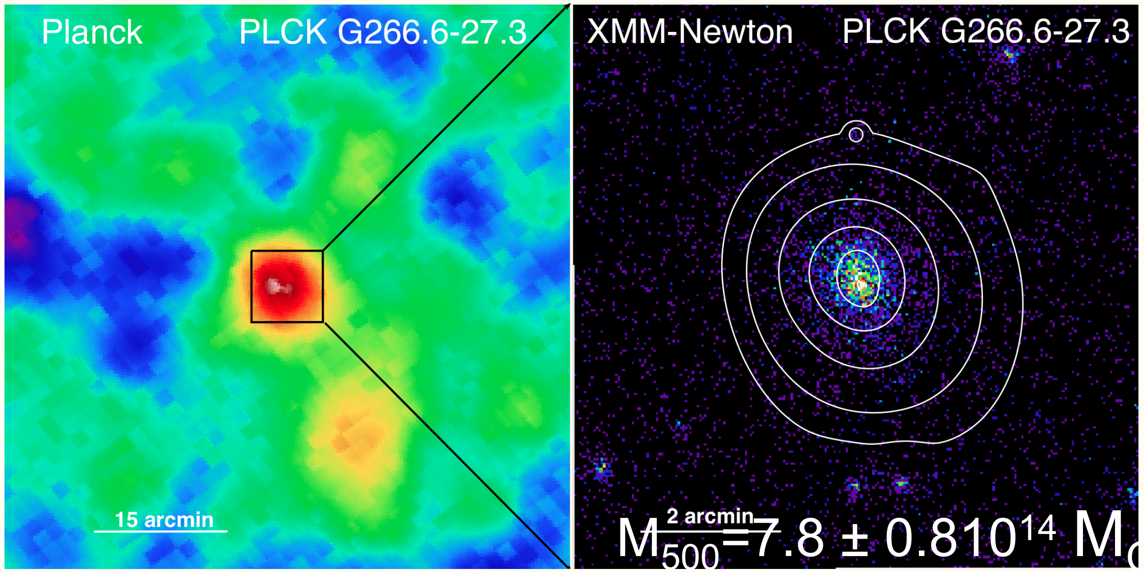
Redshift estimate: from Z/SZ

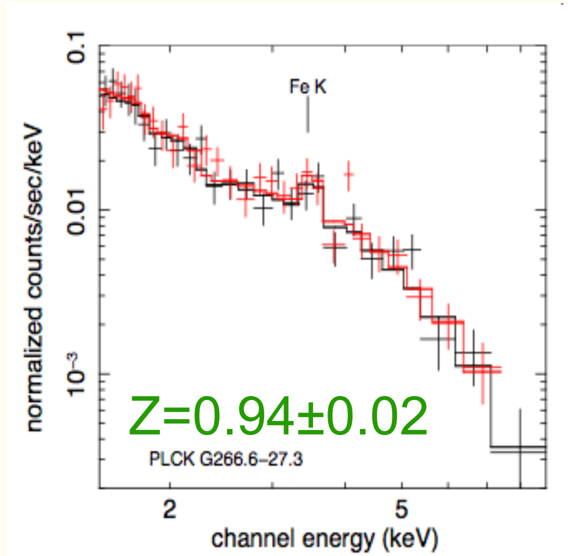




Provide lower limit on redshift

A high z high mass cluster

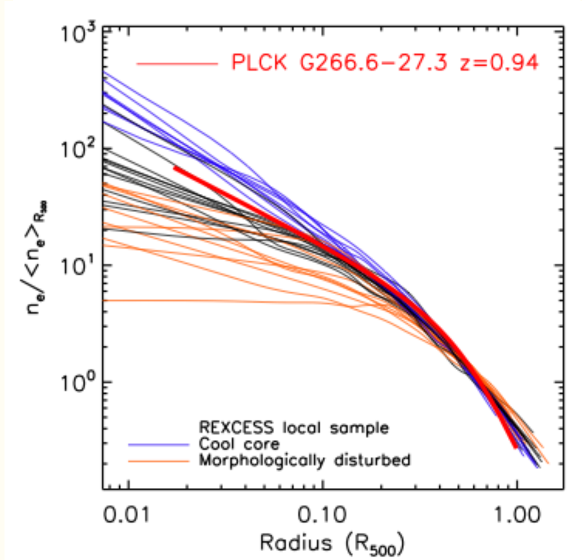


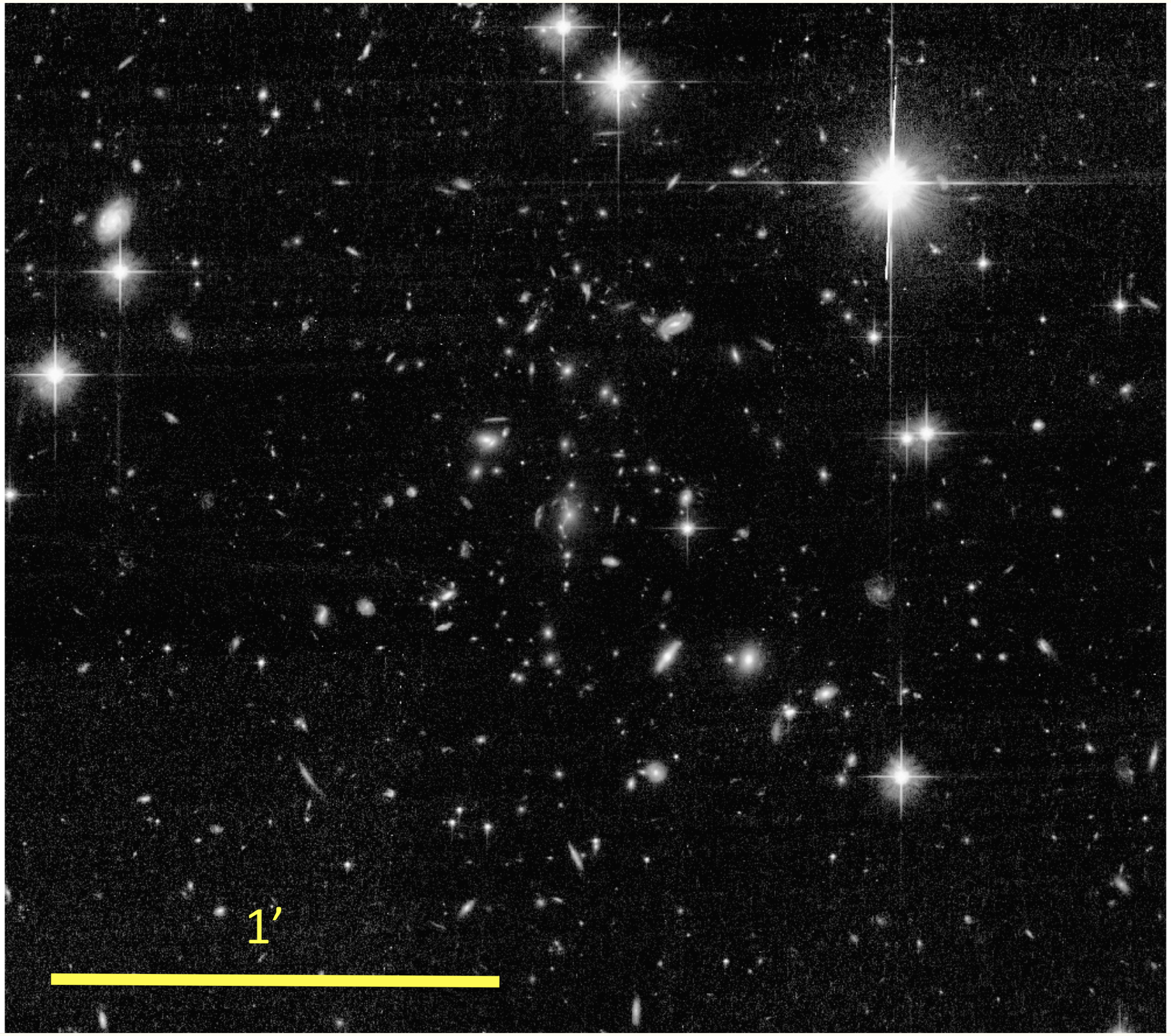


The Planck Collaboration, 2011 XXVI
(independent discovery by SPT, Williamson etal , 11)

a relaxed cool core (?) at high z

Chandra/HST deep pointing
(PI P. Mazzotta)





HST preview

Conclusion

- 25 (Val1&2)+ 11 (Val3) candidates observed
  21 + 10 confirmed including 2 doubles + 2 triples (SC)
  ➔ 37 new clusters most with z estimates

- Optimise the quality assessment & validation process

- Sensitivity of Planck up to high z , beyond RASS

- New population of disturbed objects missed by X-ray surveys

More with XMM-Val4 (15 candidates) in prep.
high z
discuss use of ancillary data

The scientific results that we present today are the product of the Planck Collaboration, including individuals from more than 50 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA) and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.