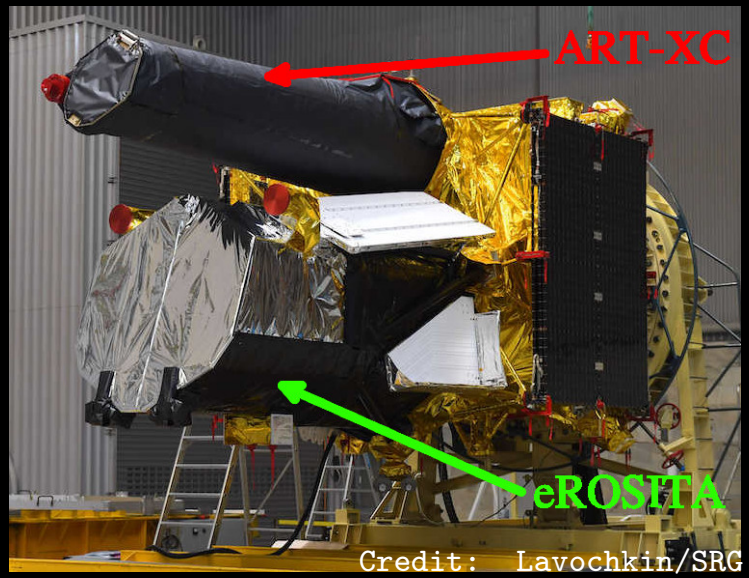
First result from eROSITA and synergies with CMB-S4

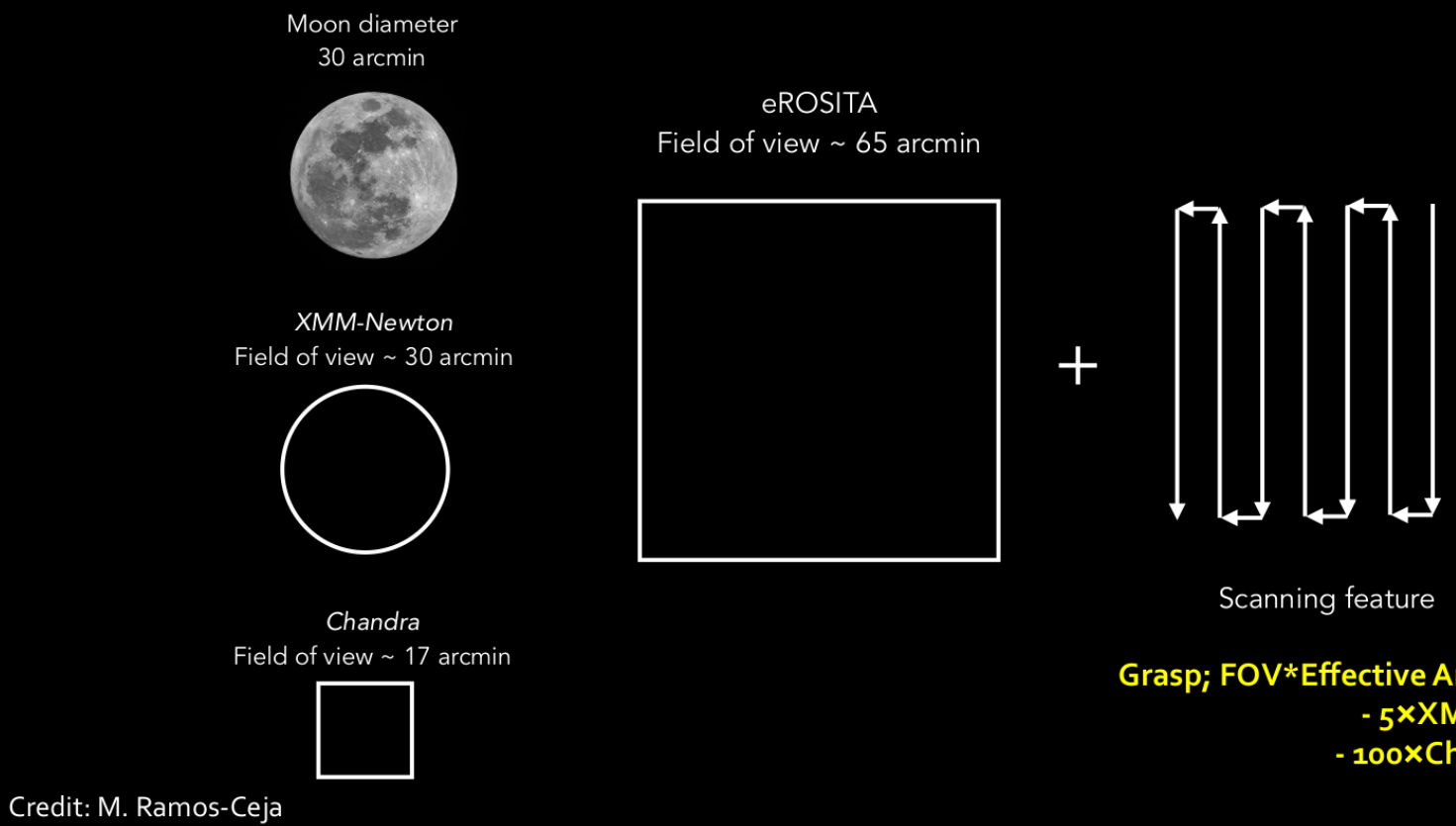
Vittorio Ghirardini

eROSITA on SRG



- 7 mirrors and 7 pnCCD
- Sensitive from 0.2 keV to 10 keV X-ray band
- Spectral resolution: 75-82 eV FWHM at 1.49 keV
- Focal length 1.6m
- FoV 1 deg diameter
- HEW 18″ on-axis, 26″ FoV avg.
- Baffles 92% reduction straight light

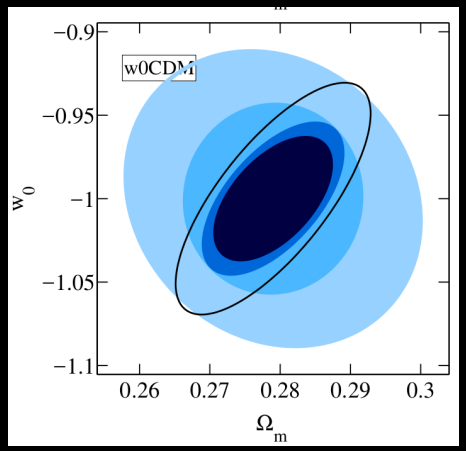
eROSITA advantages for clusters



Grasp; FOV*Effective Area @1keV:
- 5×XMM-Newton
- 100×Chandra ACIS

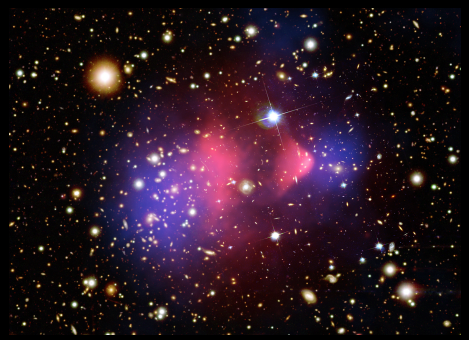
Cluster Astrophysics and Cosmology with eROSITA

Cosmology

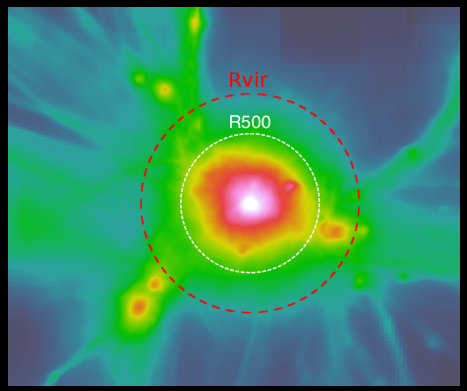


- Map of dark energy (new physics?)
- Nature of dark matter (WIMP, pBH, . . .)
- Inhomogeneity of the Universe
- Baryon evolution

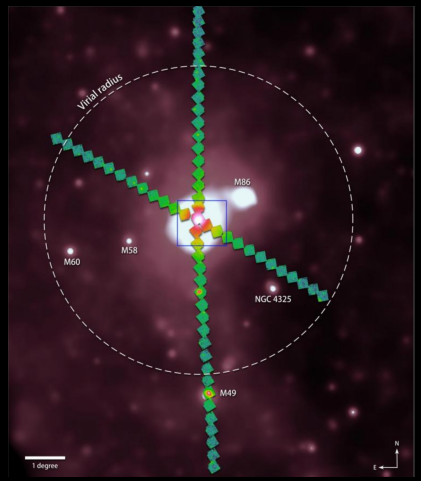
Dark Matter



WHIM



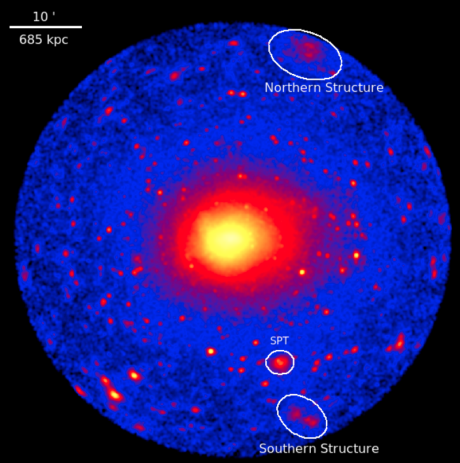
Baryon evolution



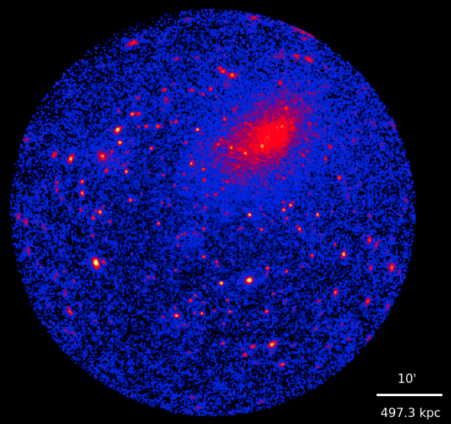
- Chemical enrichment
- Missing baryons
- AGN feedback
- Physics of hot diffuse plasma
- WHIM

Cal-PV program

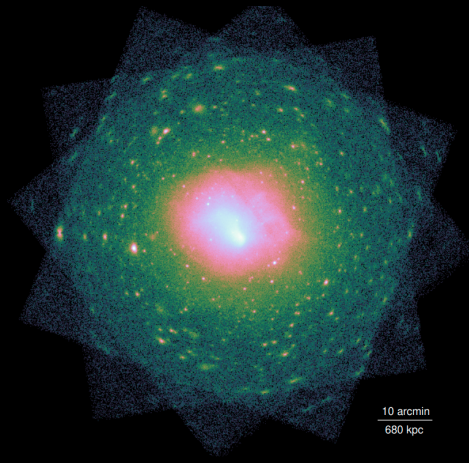
A3158 - Whelan+21

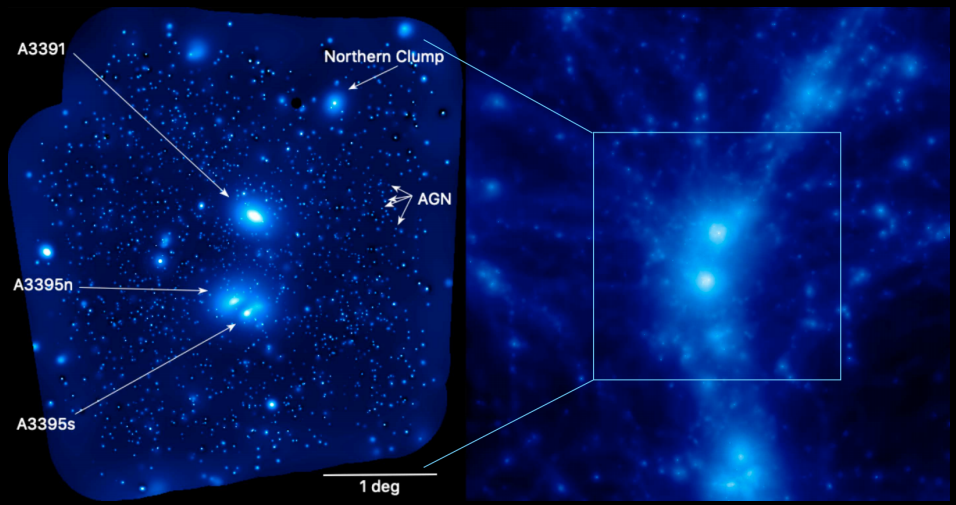


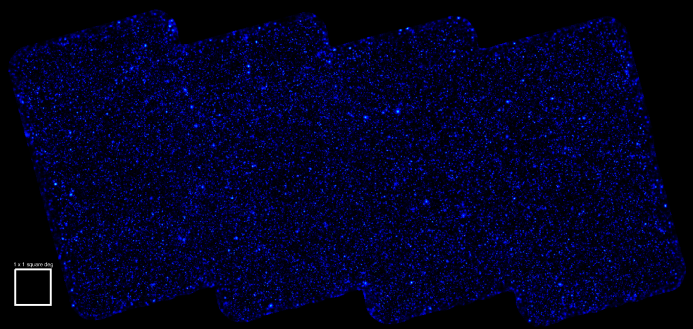
A3408 - Iljenkarevic+21
(AGN 1H0707-495)



A3266 - Sanders+21



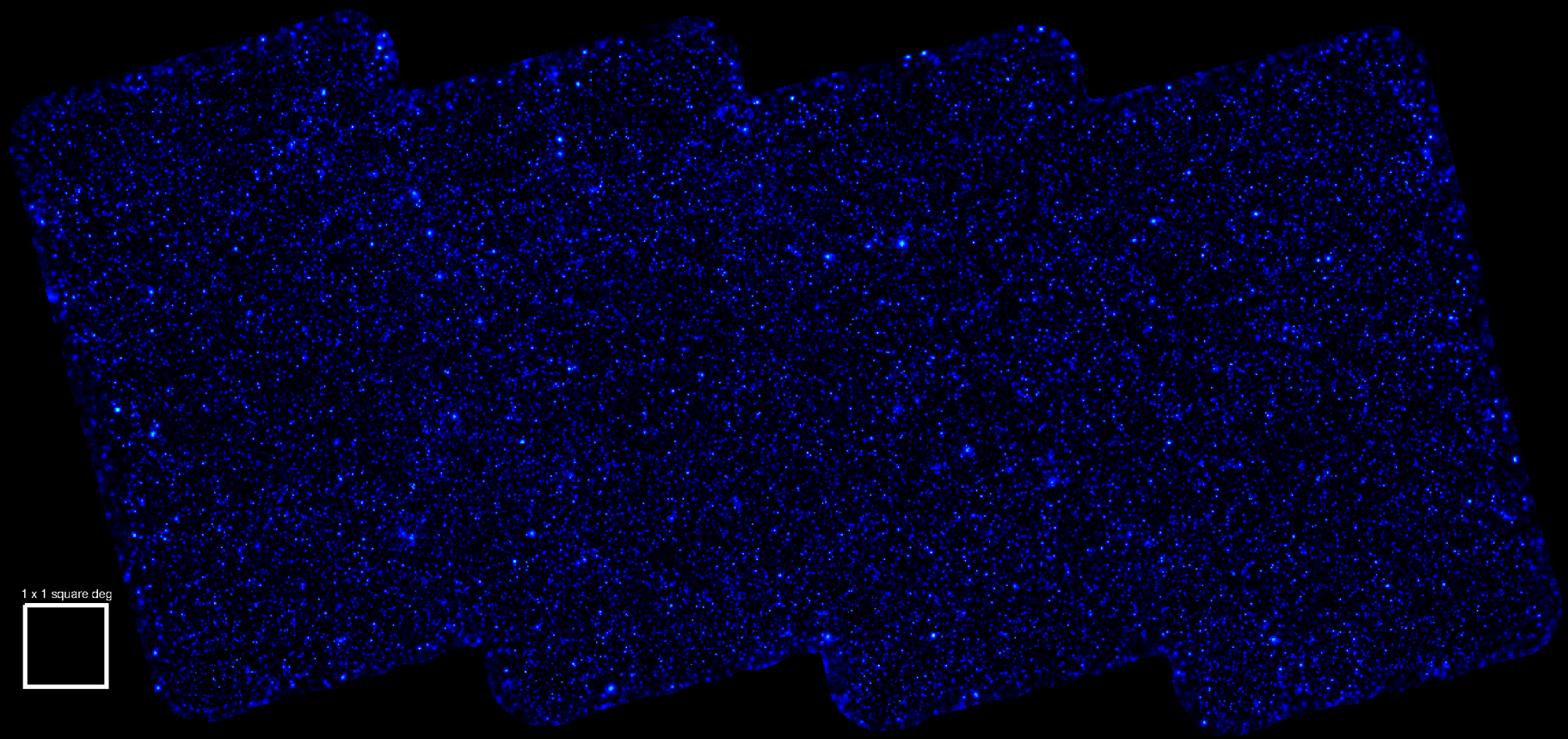




eFEDS

A3391/95 - Reiprich+21 - Biffi+21 - Veronica+21

eROSITA Final Equatorial-Depth Survey

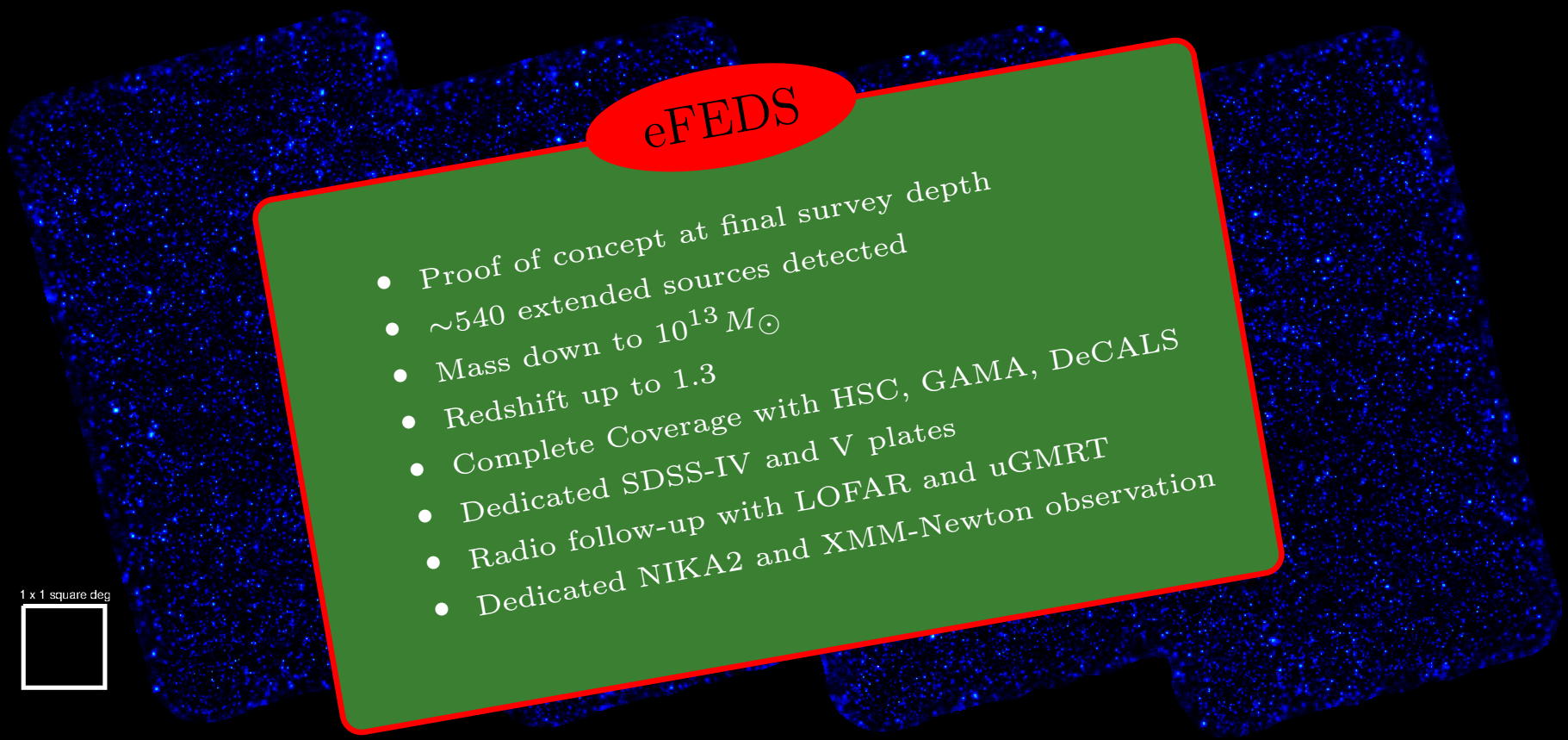


Exposure corrected image in the 0.5–2.0 keV band

MPE/IKI

eROSITA

eROSITA Final Equatorial-Depth Survey

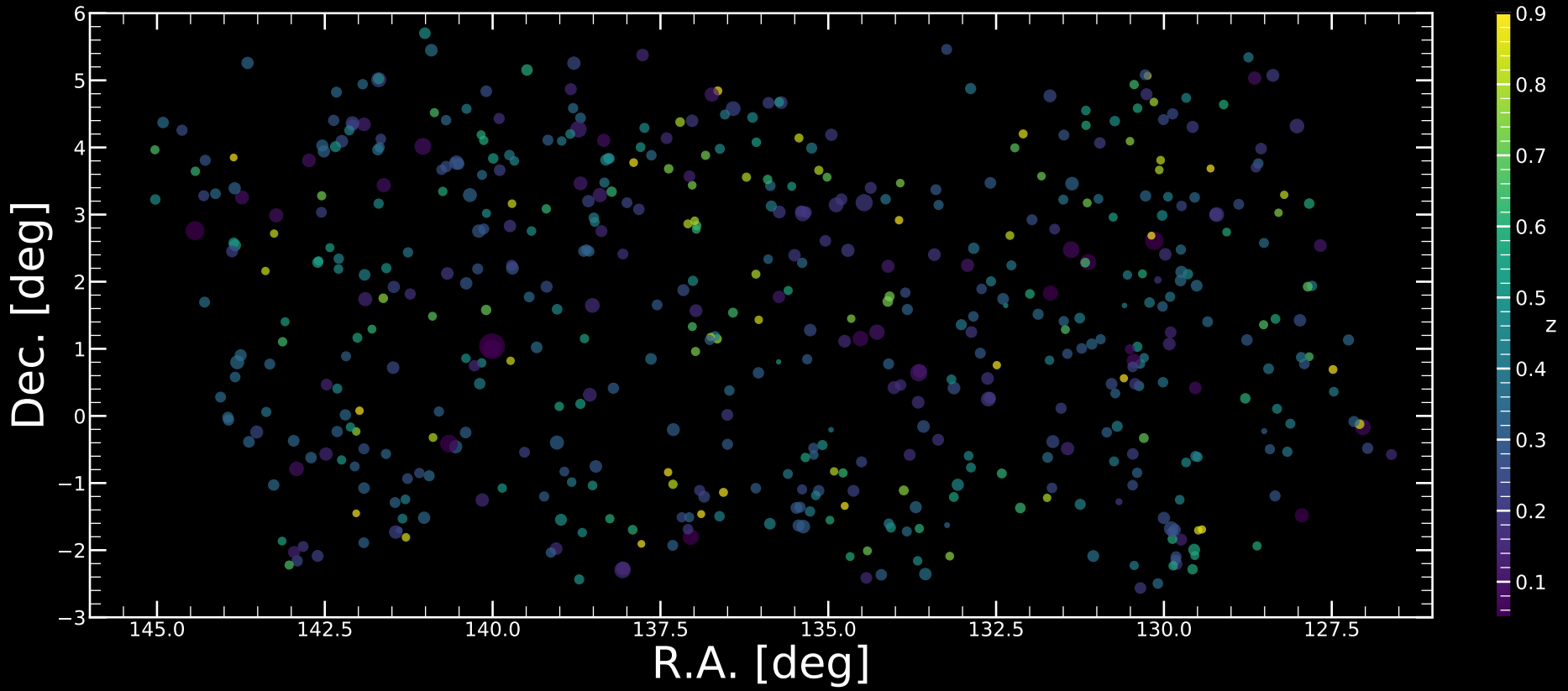


Exposure corrected image in the 0.5–2.0 keV band

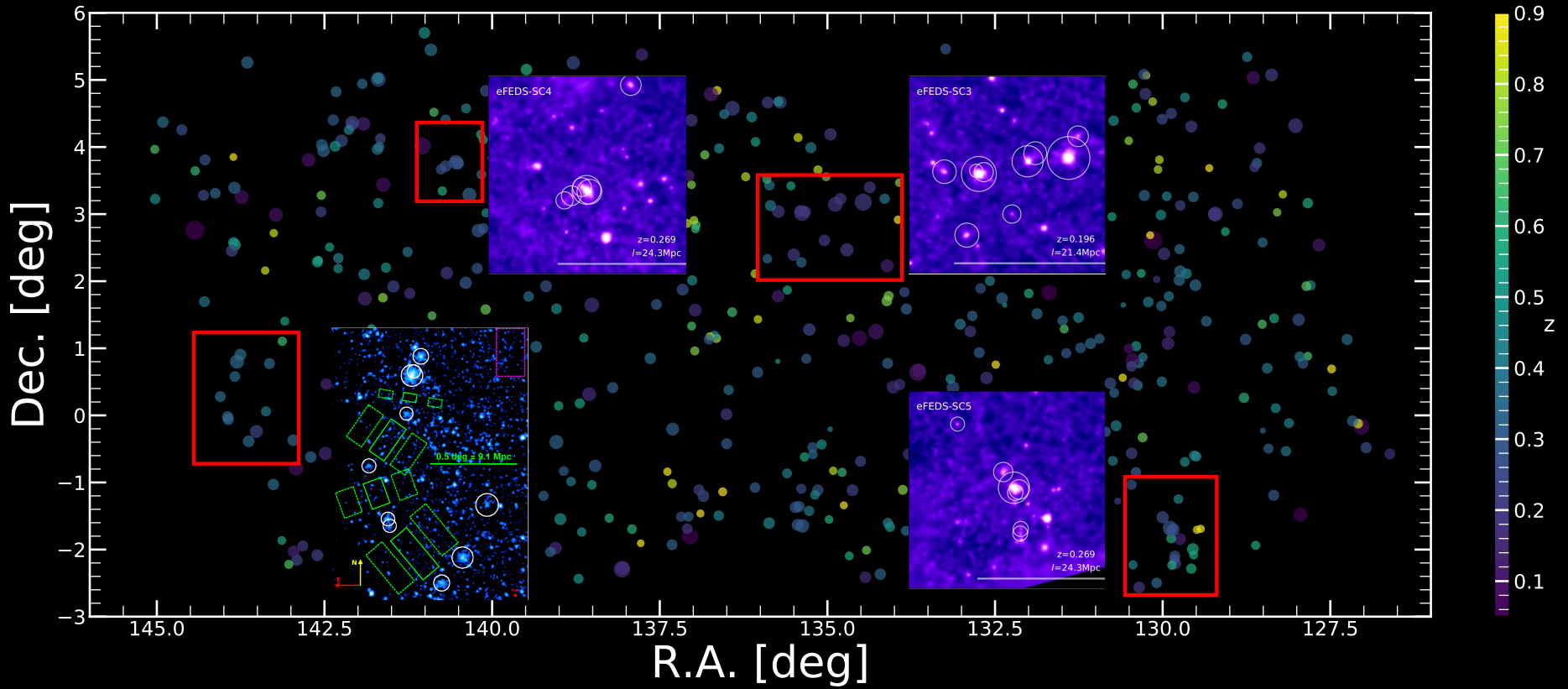
MPE/IKI

eROSITA

eFEDS clusters

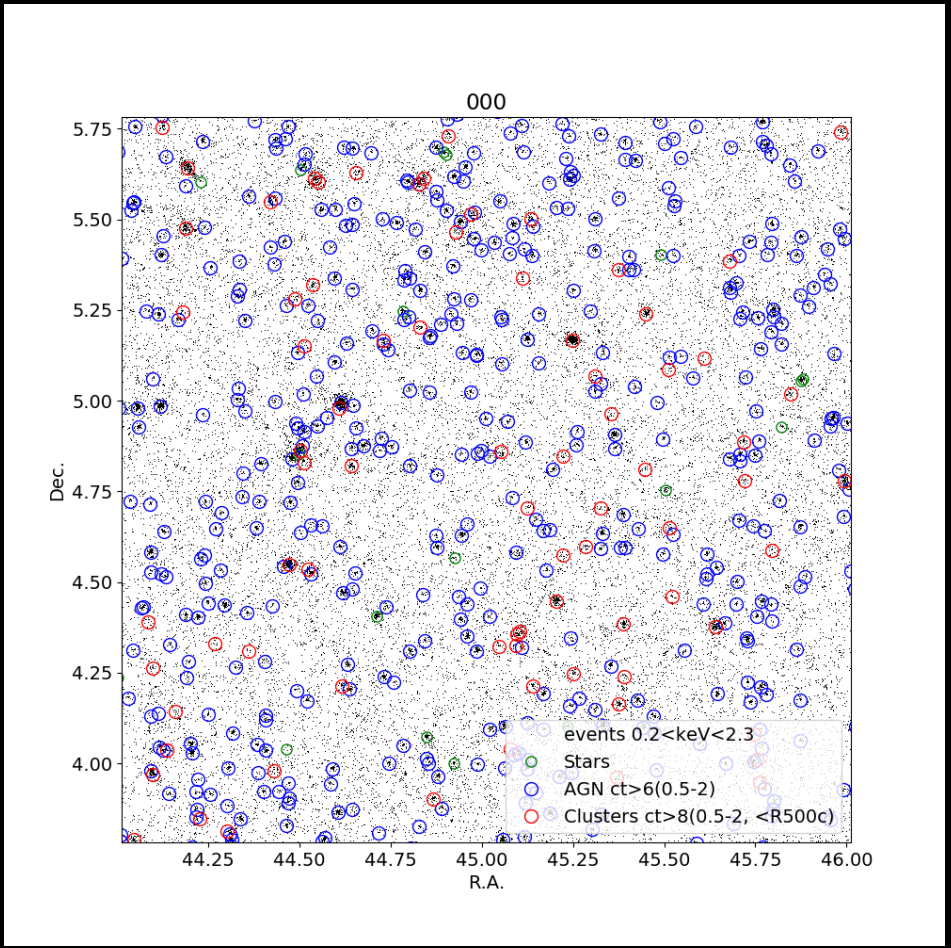


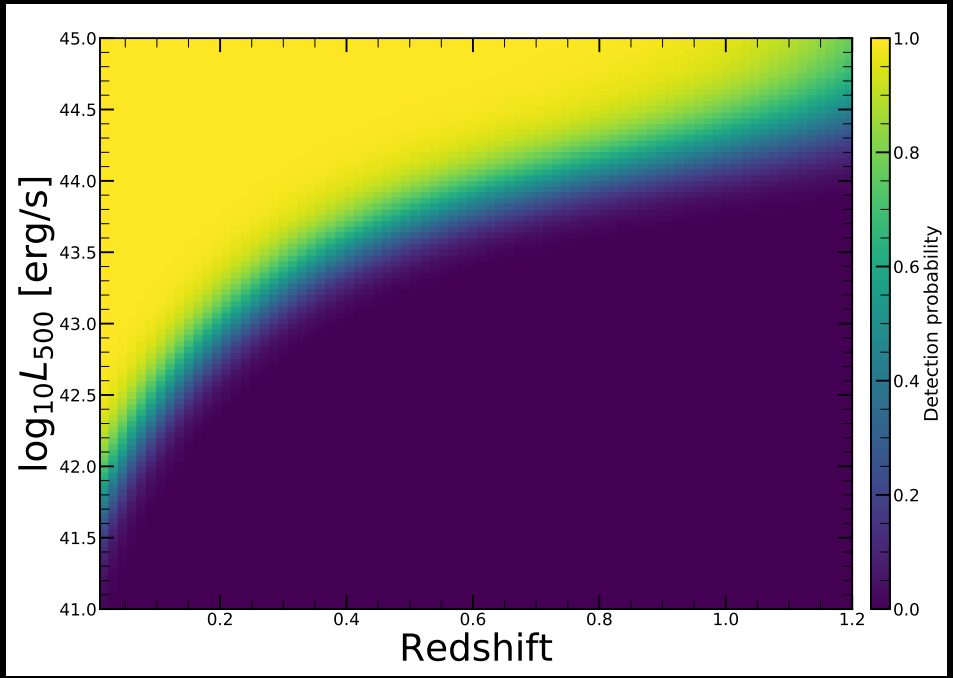
eFEDS superclusters



- 19 superclusters Y. Özsoy

Selection Function using dedicated simulations

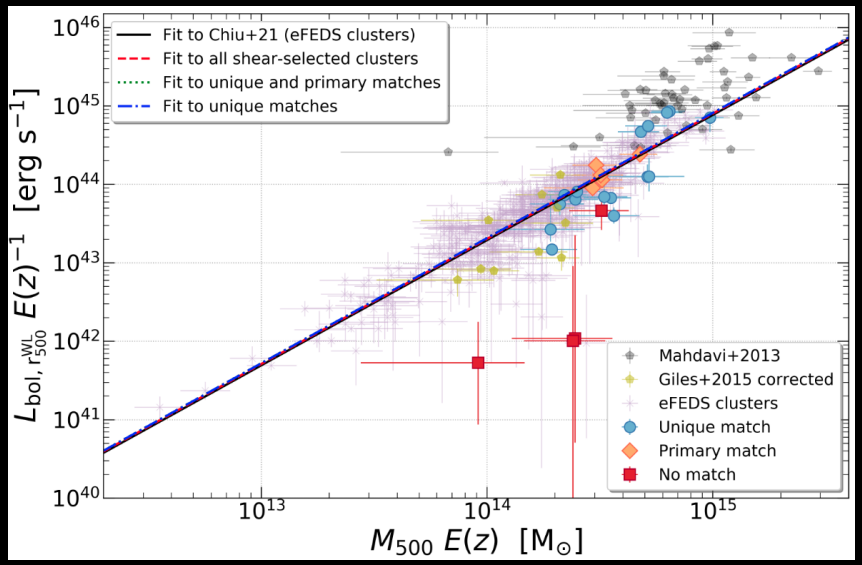


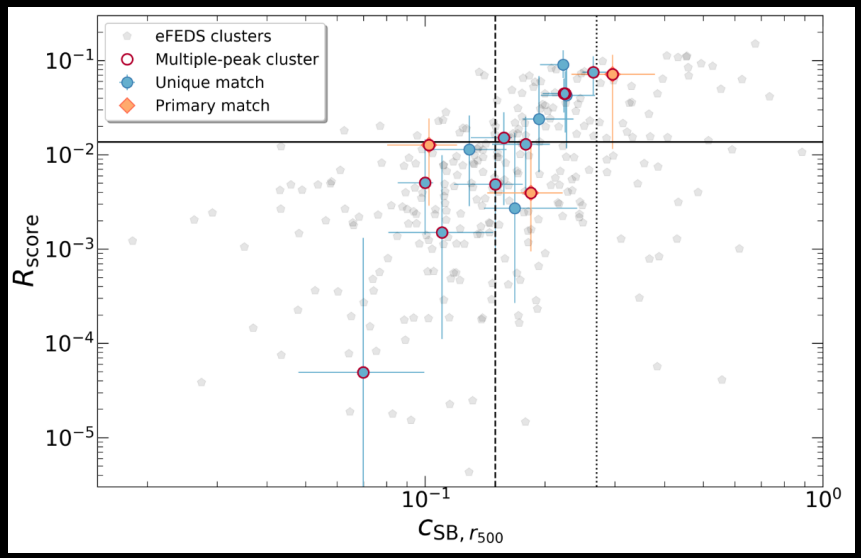


Credit: N. Clerc

Comparat+21

Scaling relation and selection effects

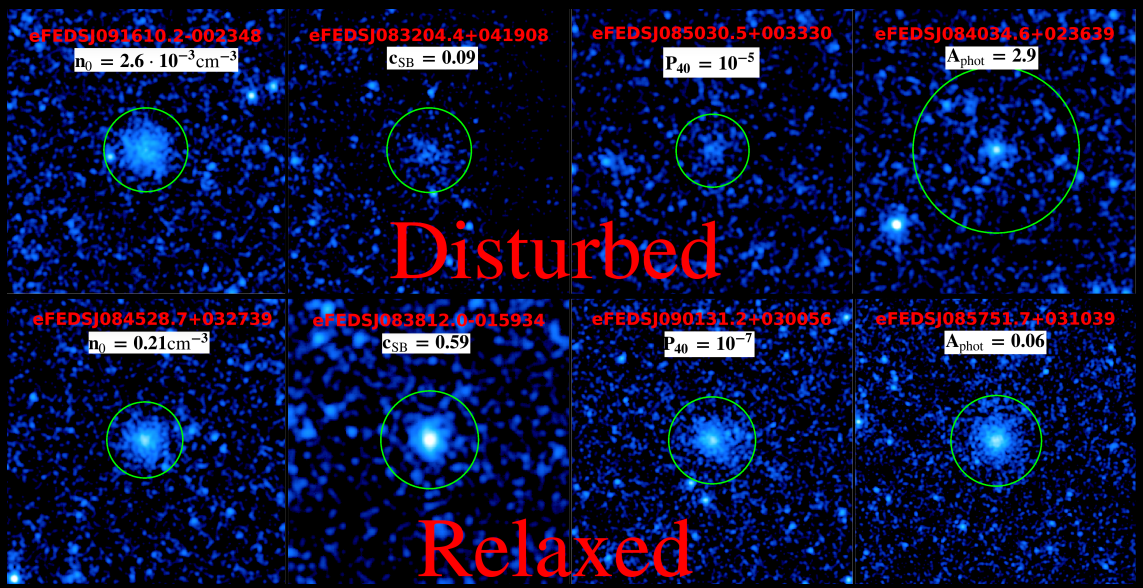


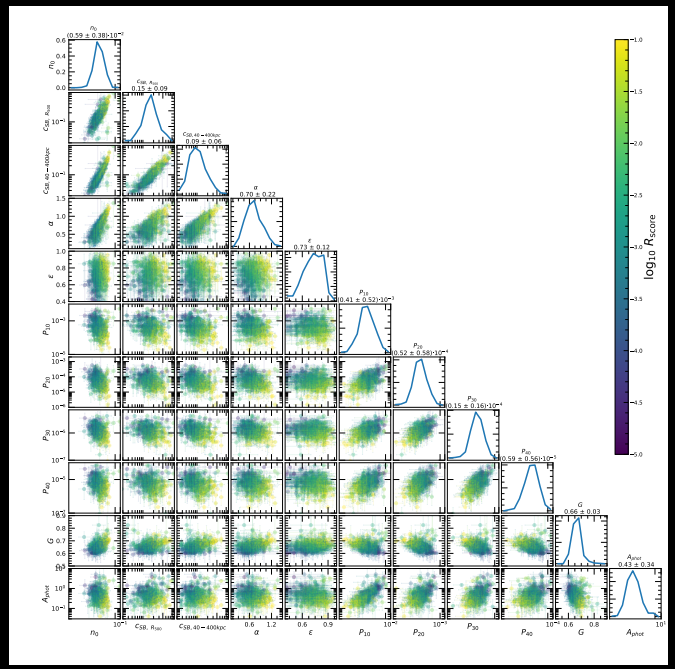


- Comparison of WL Selection with X-rays

Ramos+21

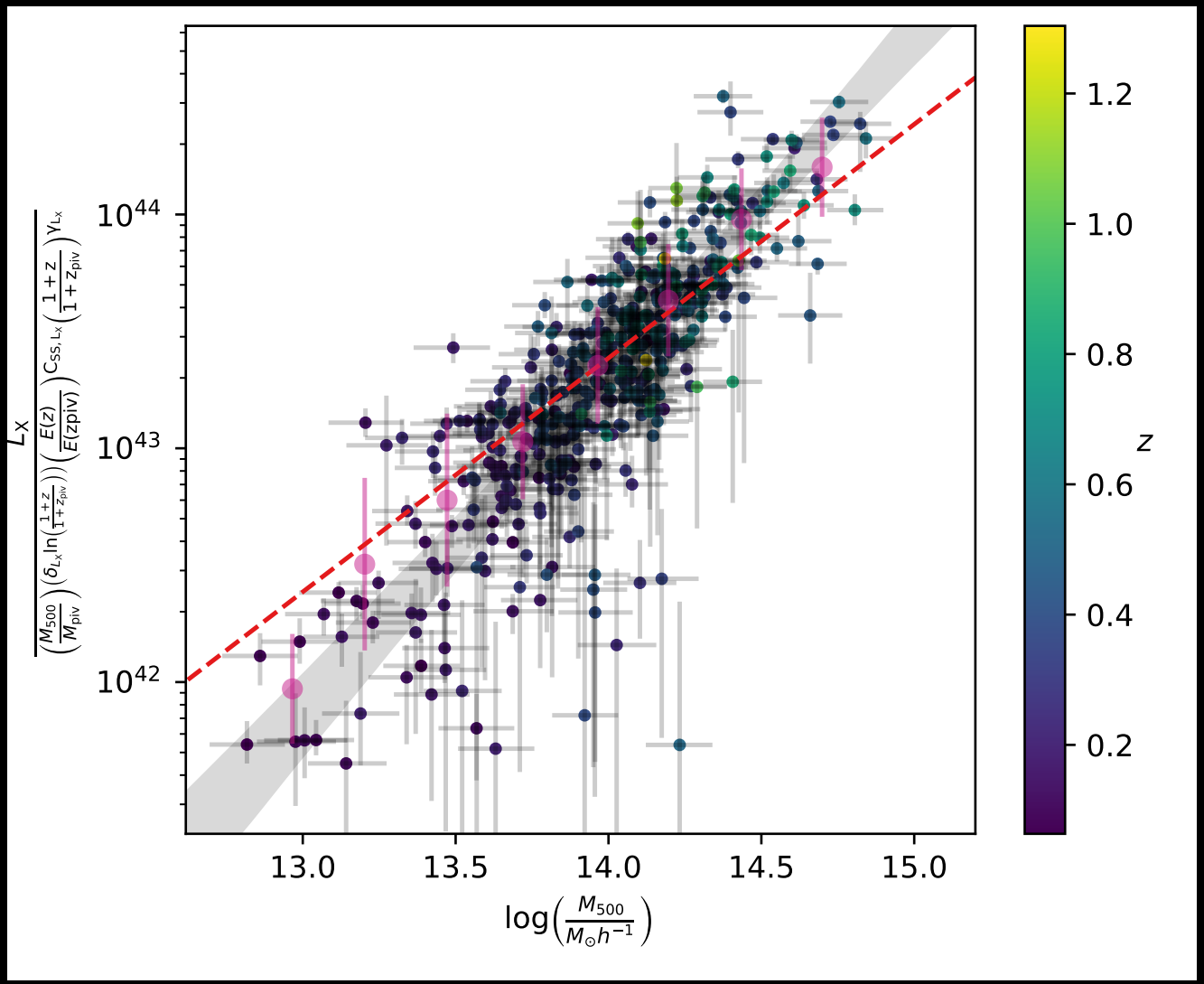
Morphological parameters





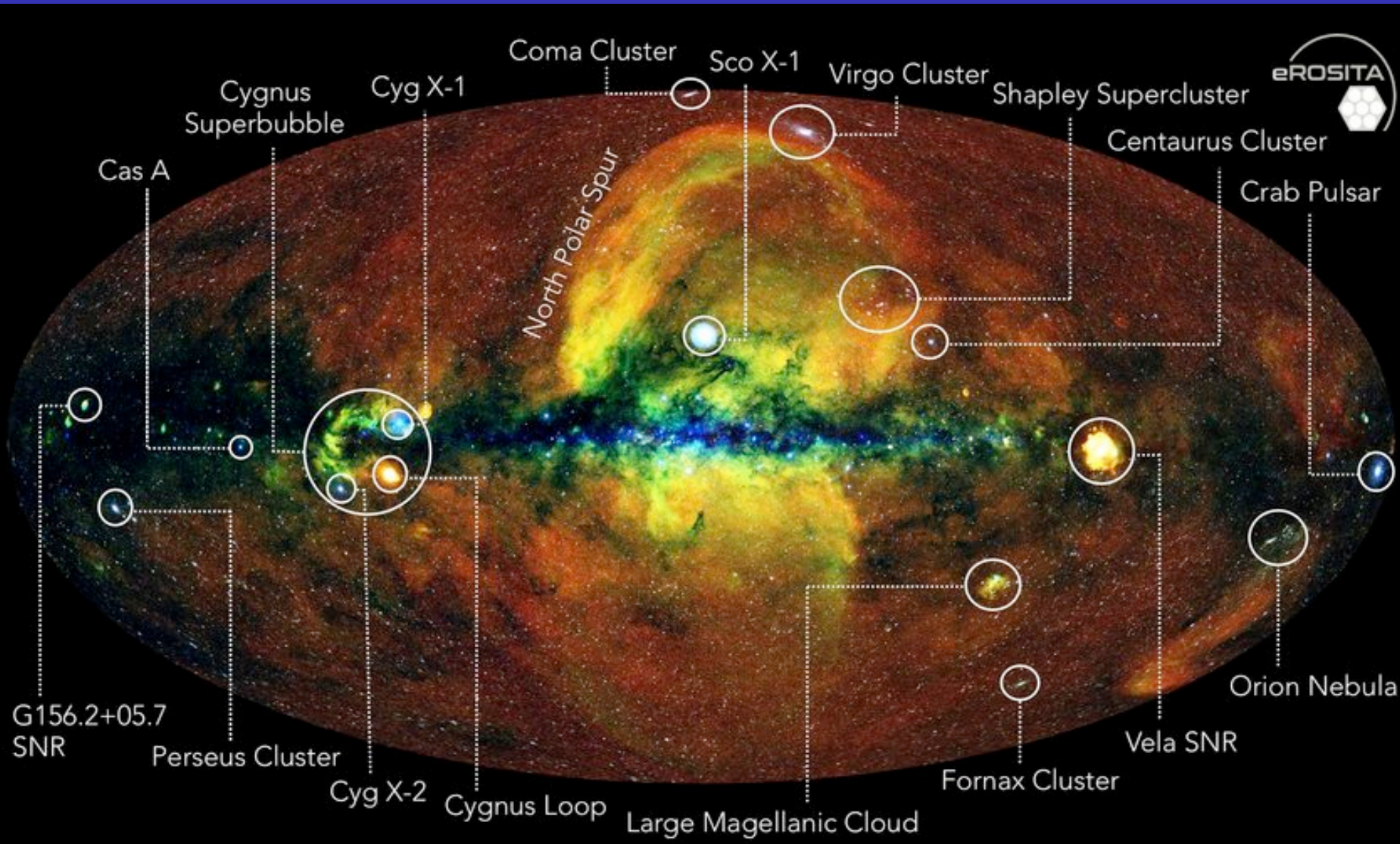
Ghirardini+21

Cluster Mass Calibration

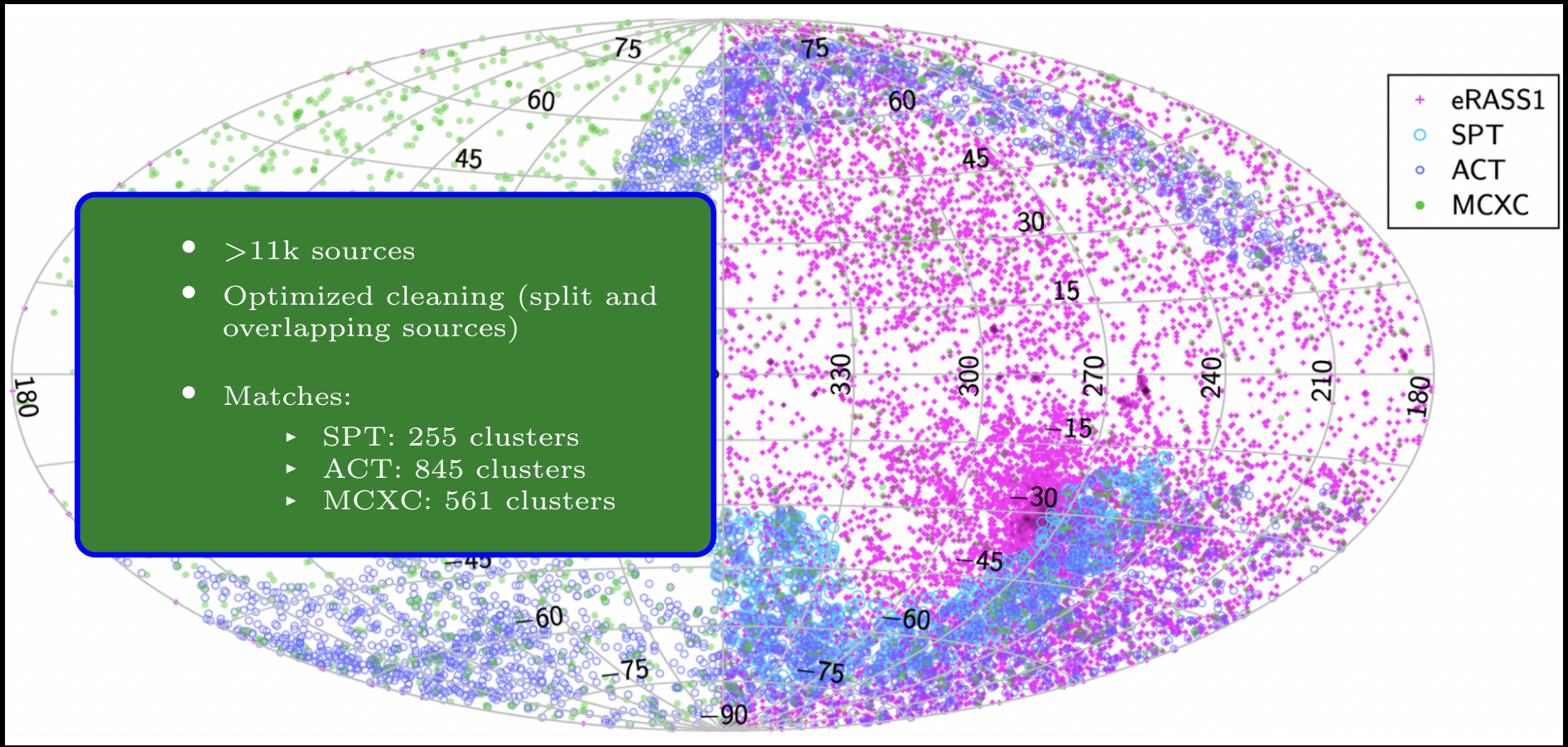


Chiu+21

eROSITA First All-Sky Survey (eRASS1)



eRASS1 groups and clusters



- >11k sources
- Optimized cleaning (split and overlapping sources)
- Matches:
  - SPT: 255 clusters
  - ACT: 845 clusters
  - MCXC: 561 clusters

Credit: E. Bulbul

Synergies with CMB-S4

- Thermodynamical Properties of the ICM out to R_{200}
  `Eckert+13, Ghirardini+19`

$$\epsilon_X \propto \int \overbrace{n_e n_{\rm I}}^{\sim n_e^2} \overbrace{\Lambda_c(T_e, Z)}^{\sim\sqrt{T_e}} dl \Rightarrow \boxed{n_e}$$

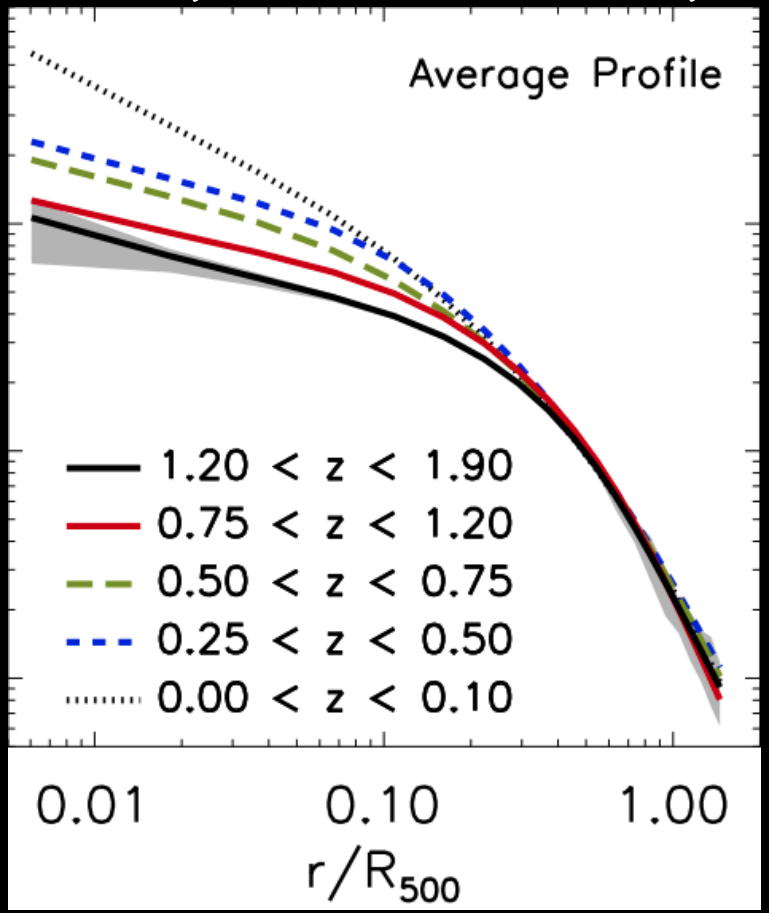
$$\epsilon_{SZ} \propto \int n_e T_e dl \Rightarrow \boxed{P_e}$$

- Temperature P_e/n_e
- Entropy $T_e n_e^{-2/3}$
- Hydrostatic Mass $M(< R) \propto n_e^{-1} dP_e/dR$
- Polytropic Index $P_e \propto n_e^{\Gamma}$

Synergies with CMB-S4

- Evolution of thermodynamic properties

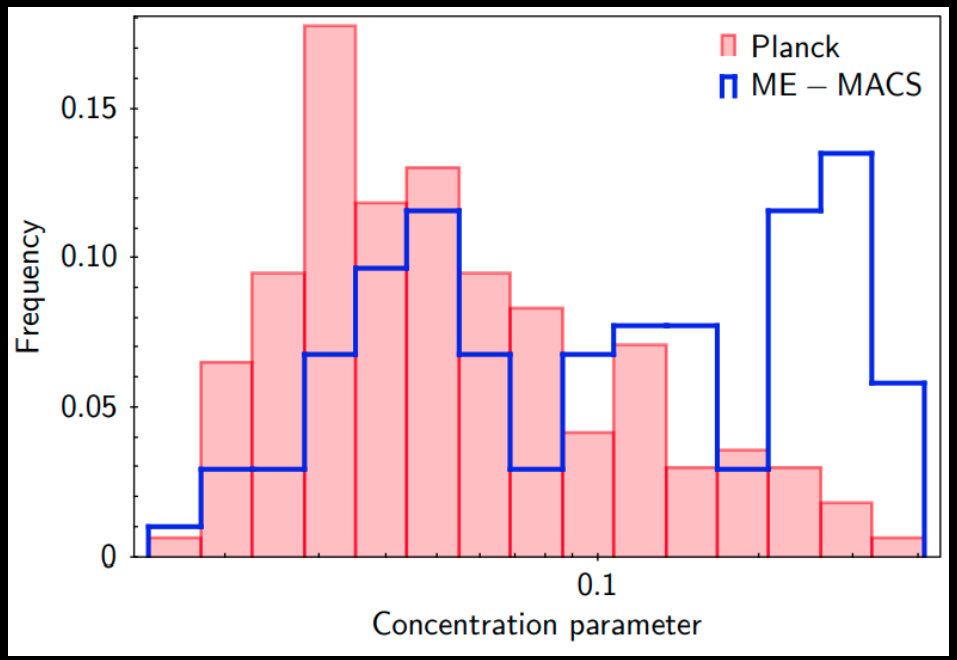
  Ghirardini+20, McDonald+14+17, Sanders+17



Credit: McDonald+17

Synergies with CMB-S4

- Population studies (selection effects)
  `Lovisari+17, Rossetti+17, Nurgaliev+17, Ramos+21`



Credit: Rossetti+17

Synergies with CMB-S4

- H_0 measurement

  Bonamente+06, Kozmanyan+19

$$\epsilon_X \propto \overbrace{n_e n_{\rm I}}^{\sim n_e^2} \overbrace{\Lambda_c(T_e, Z)}^{\sim\sqrt{T_e}} d_A$$

$$\epsilon_{SZ} \propto n_e T_e d_A$$

$$\Rightarrow \frac{\epsilon_{SZ}^2}{\epsilon_X} \propto T_e^{3/2} d_A \propto T_e^{3/2} H_0^{-1}$$

Summary

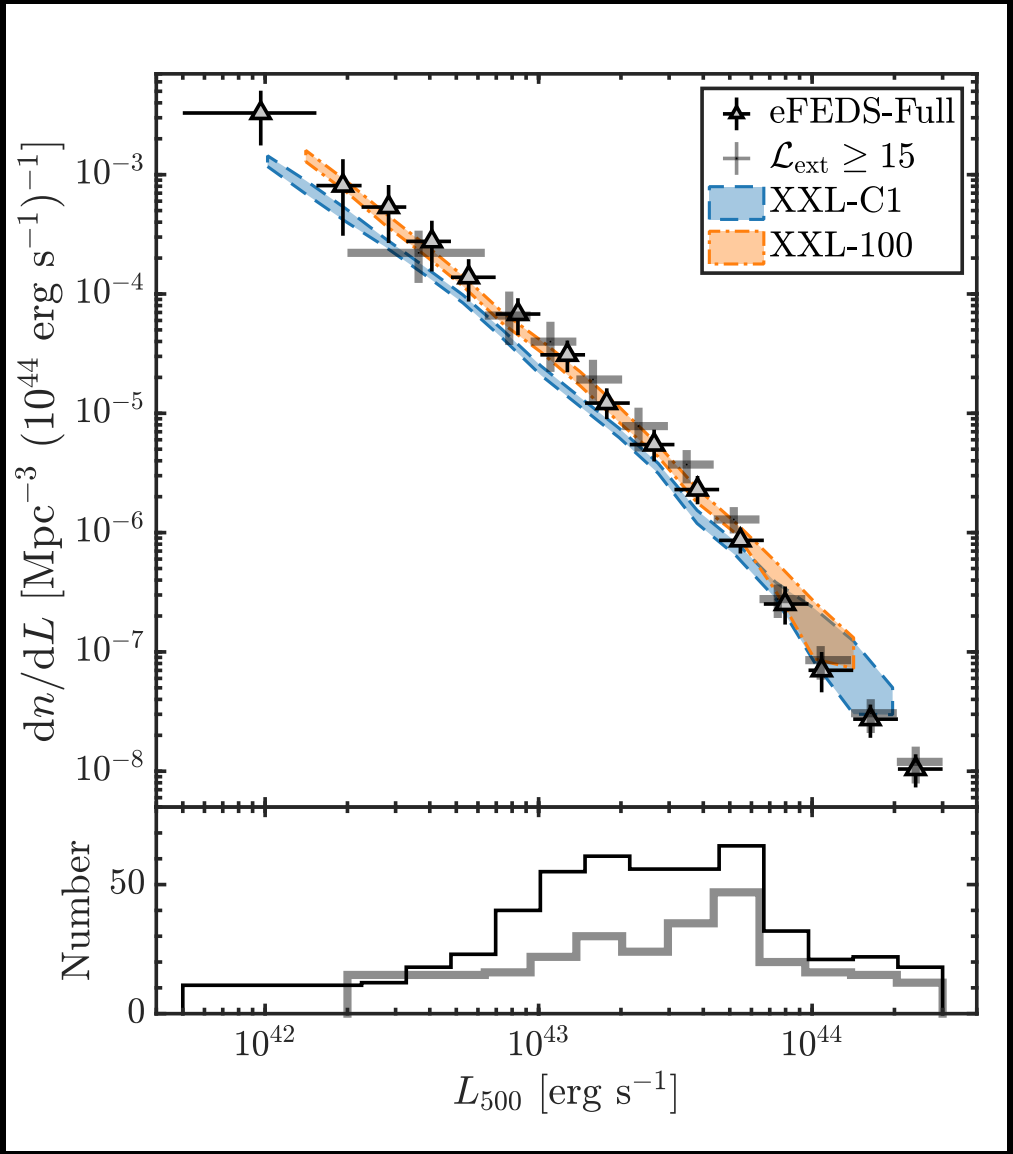
- In eFEDS we detect >4 clusters per deg^2, as expected
- $M > 10^{13} M_\odot$, $z < 1.3$
- Contact our working groups

https://www.mpe.mpg.de/455860/working_groups

- Liu+21 Clusters and group catalog
- Ghirardini+21 Morphological properties
- Klein+21 Optical properties
- Bahar+21 Scaling relations
- Ramos+21 X-ray properties of HSC selected sample
- Chiu+21 Weak lensing mass calibration
- Pasini+21 Radio properties
- and more ...

Backup slides

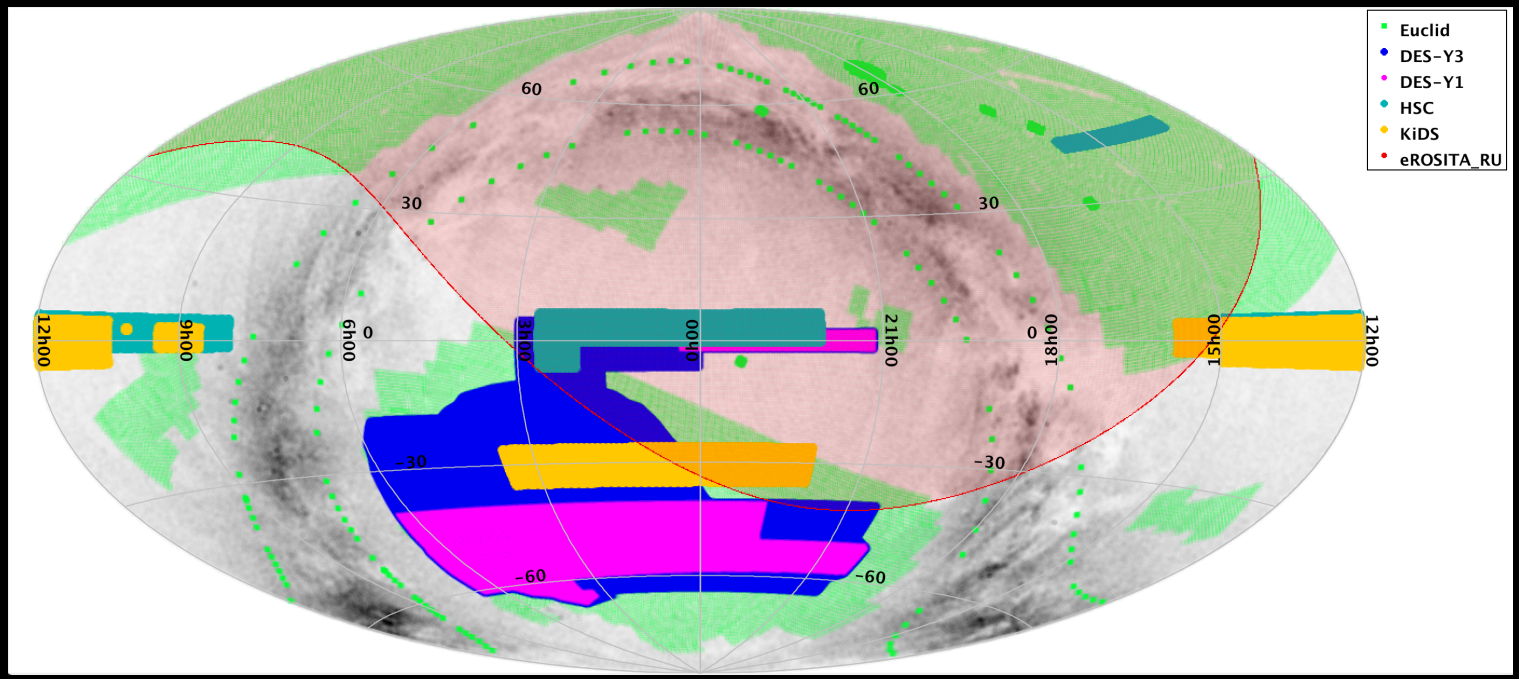
X-ray luminosity function



Liu+21

Cluster Mass Calibration

- Optical Data through richness vs. mass scaling relations
- X-ray observations through hydrostatic eql. assumption
- Weak Lensing (DES, KIDS, and HSC)



Credit: F. Pacaud