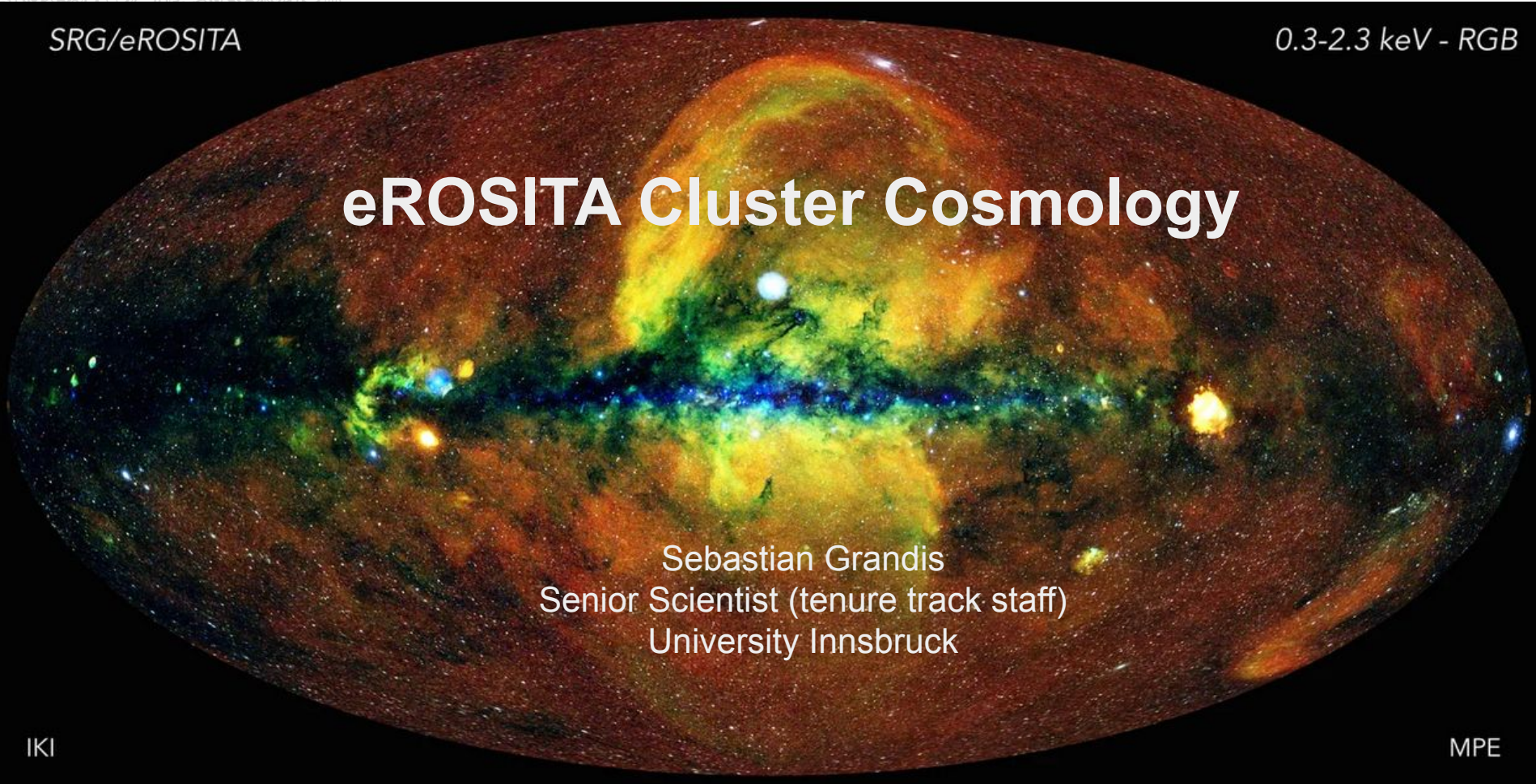
universität innsbruck
Institute for Astro- and Particle Physics Extragalactic Astrophysics

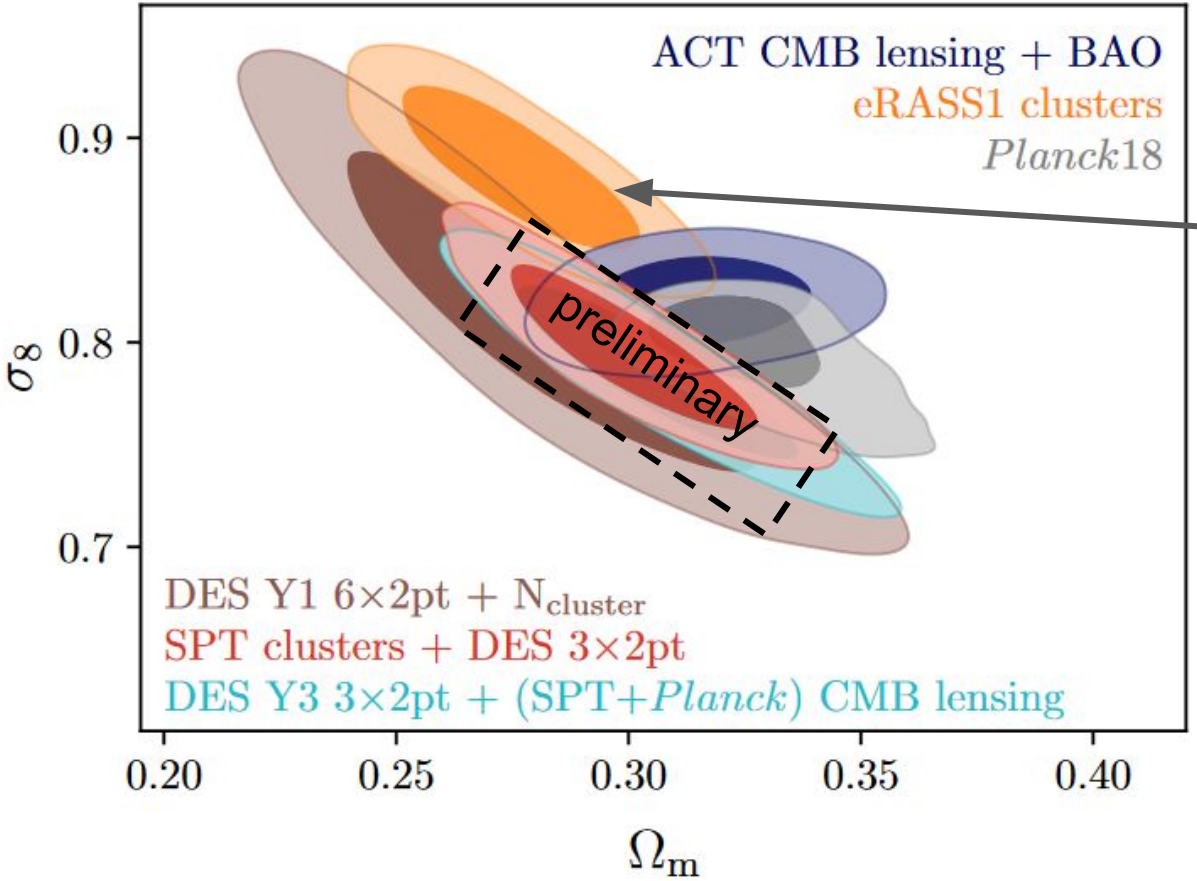
Credit: Jeremy Sanders, Hermann Brunner and the eSASS team (MPE); Eugene Churazov, Marat Gilfanov (on behalf of IKI)




# eROSITA Cluster Cosmology

Sebastian Grandis
Senior Scientist (tenure track staff)
University Innsbruck

# Do you trust these results?

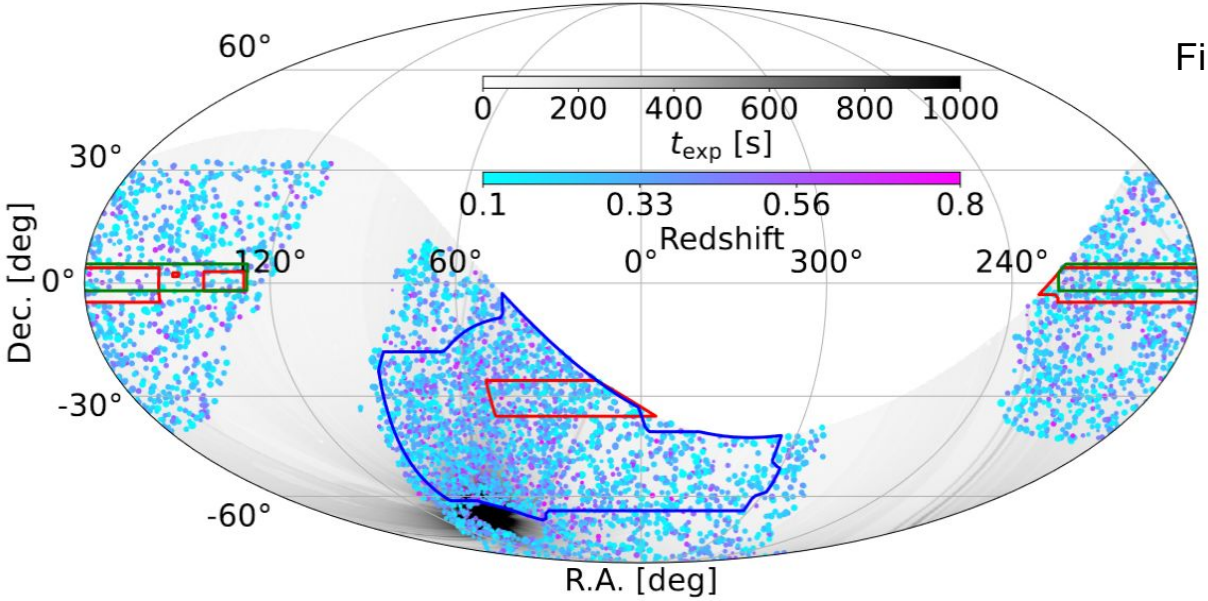



eROSITA constraints are 2+ sigma away from DES 3x2pt + (SPT cl + DES,HST WL)

→ lowish OmegaM
→ high sigma8
→ highish S8

What are the difference with SPT Cl+DES,HST WL?

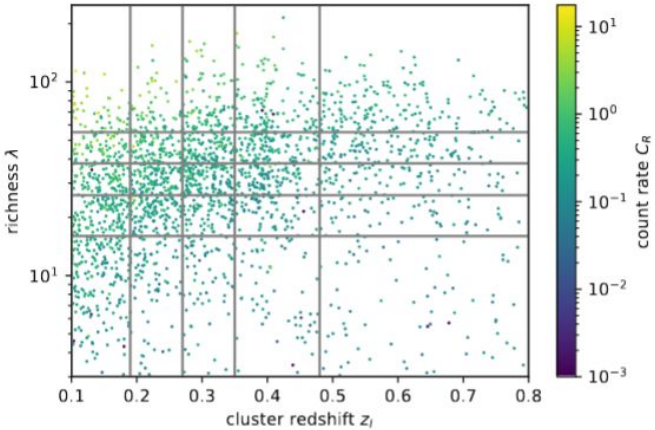
# eRASS1 clusters (cosmology sample)




First eROSITA All Sky Survey (eRASS1)

Selection of clusters & groups as extended X-ray sources
→ 5.5k clusters (Bulbul,...,SG+24)

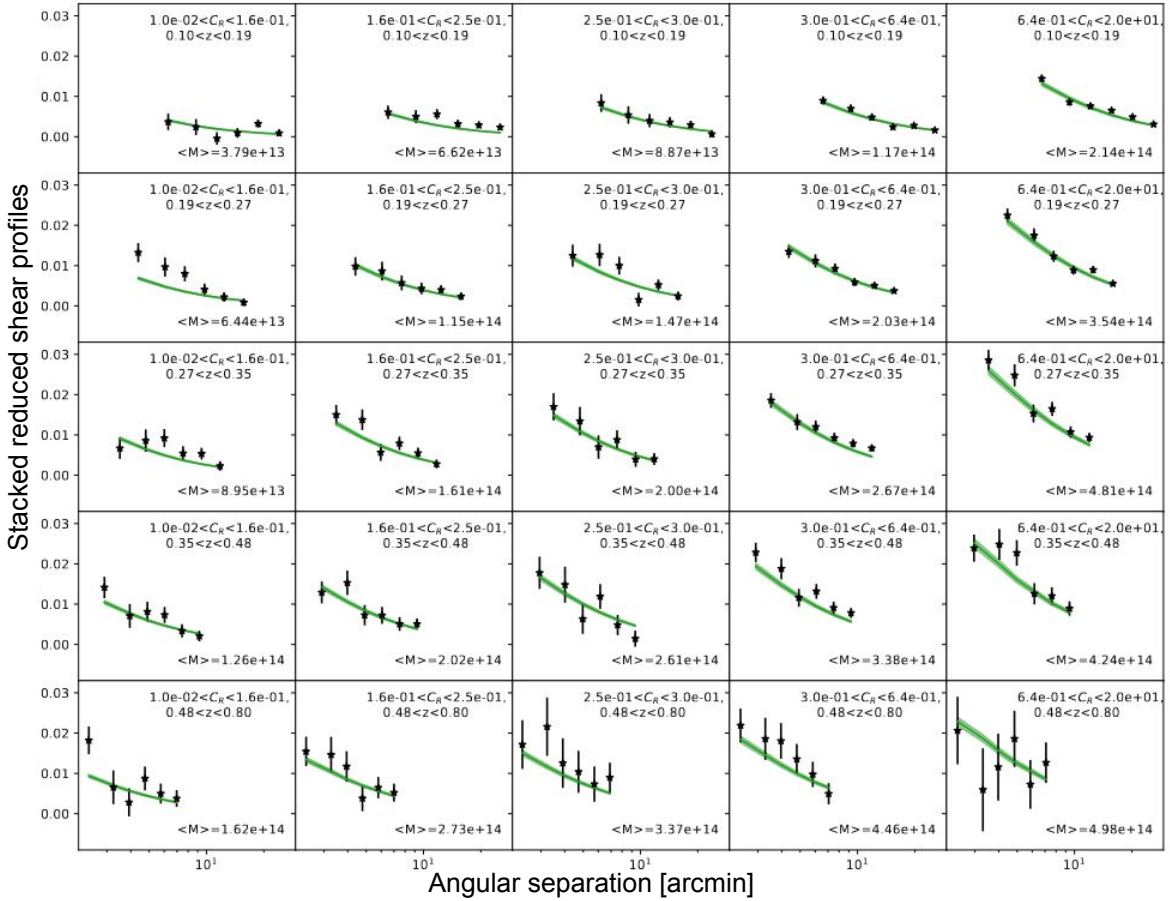
Targeted redmapper in DECaLs DR 10 data for redshifts and confirmation (Kluge,...,SG+24)




Overlap with all 3 stage III WL surveys DES Y3, KiDS, HSC S19A

2201 clusters in DES Y3, with z_med ~ 0.3
(ideal for WL with higher z DES tomo bins)

# WL mass calibration




Mass calibration performed on individual cluster WL profiles (simplifies selection effects modelling)

Goodness of fit validation on stacks in X-ray count rate – redshift bins

Total signal to noise after scale cuts: 62

Is 32 for DES WL of SPT

Goodness of fit

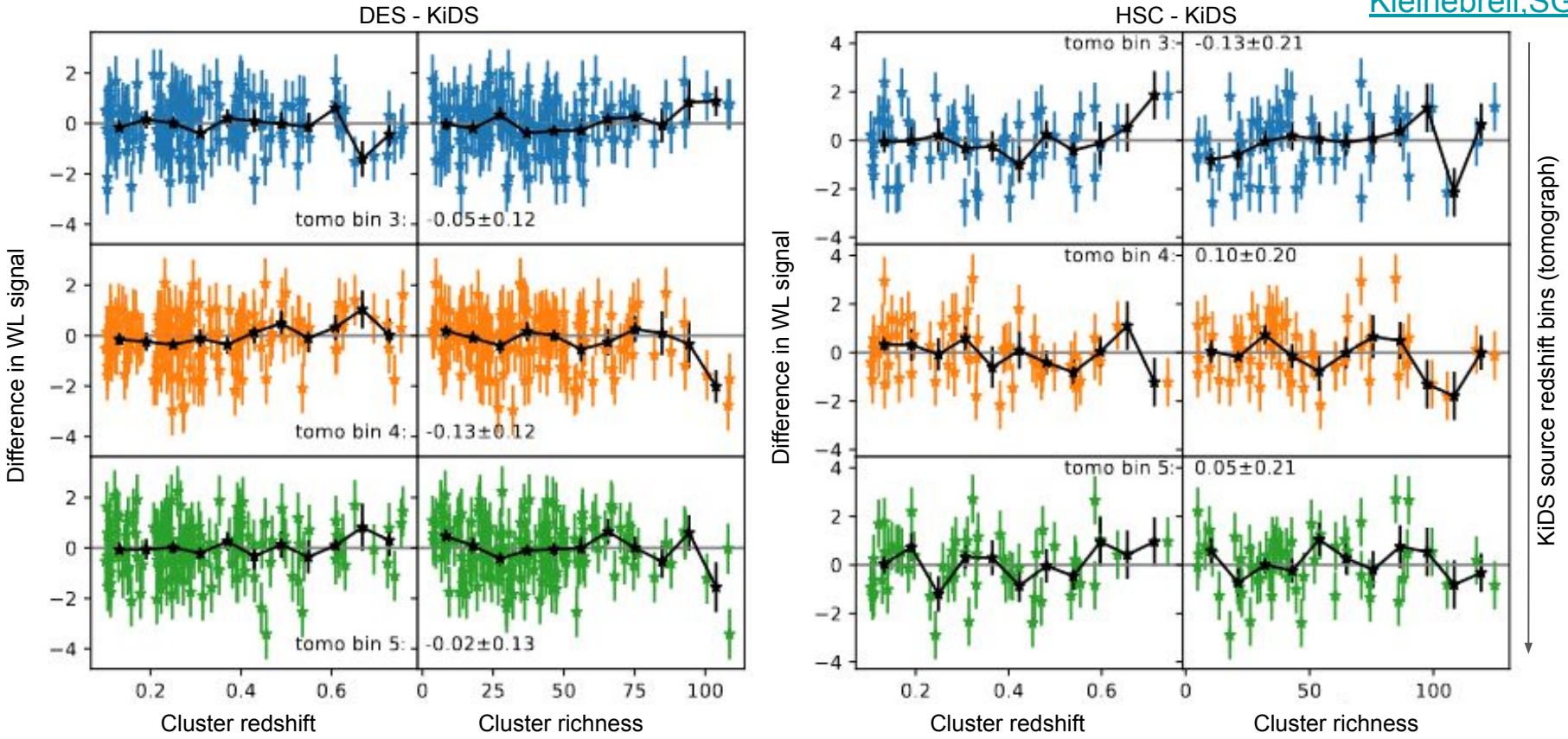
$$\chi^2 = 180.0^{+45.8}_{-30.4} \text{ for } 150 \text{ data points}$$

DES: Grandis+24b
Same technique as SPT work

# Cross survey comparison

Some eRASS1 clusters fall in the footprints of DES&KiDS or KiDS&HSC → compare WL signals

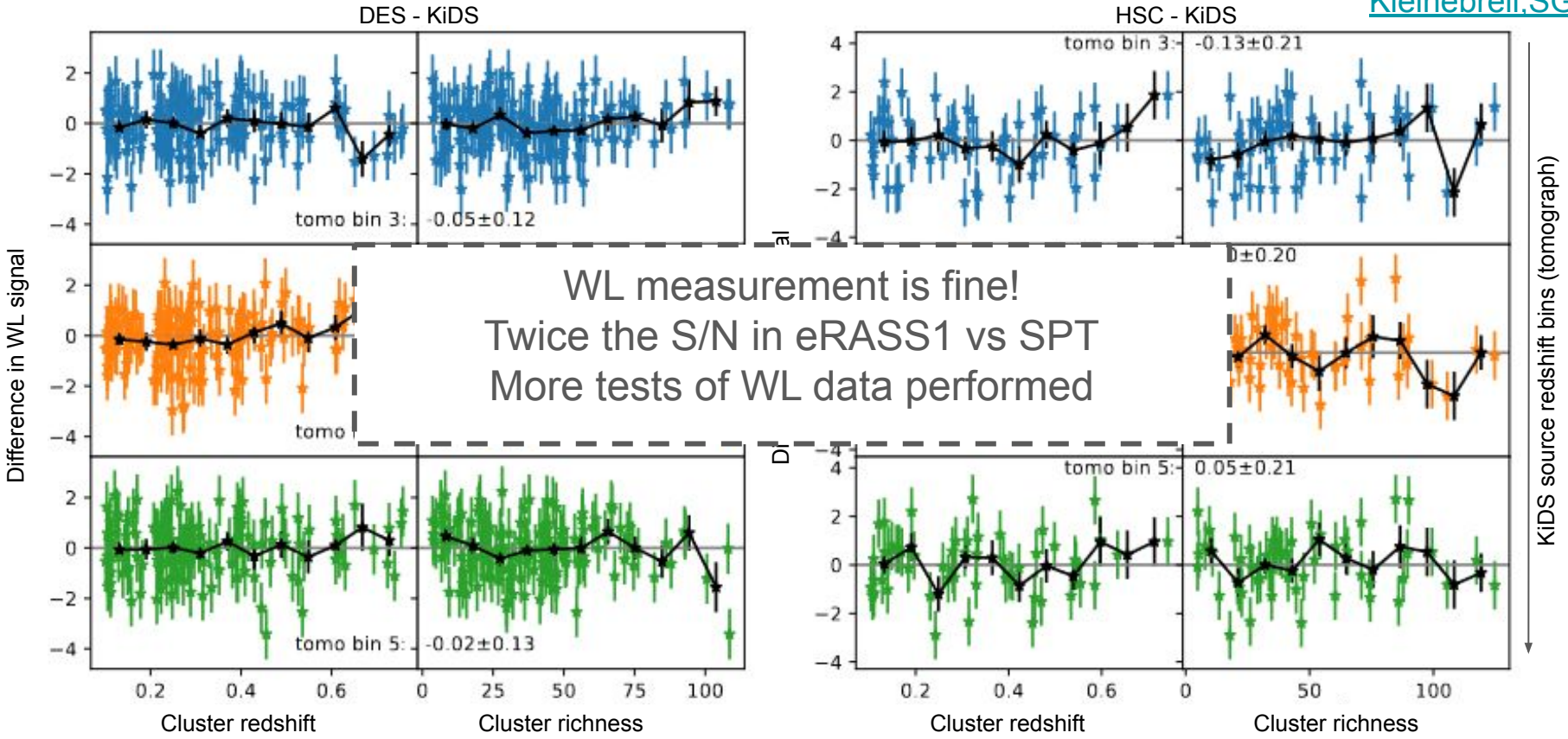
Kleinebreil,SG+24



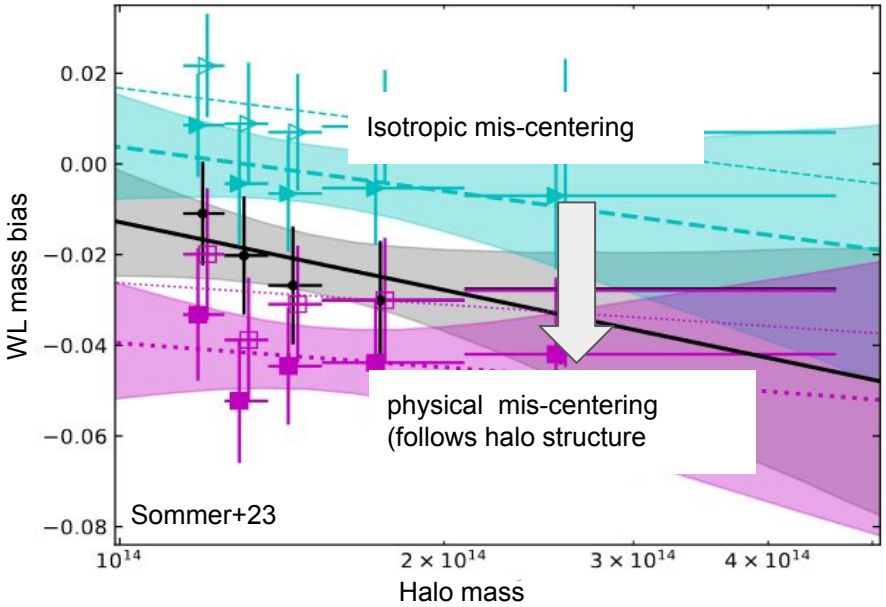
# Cross survey comparison

Some eRASS1 clusters fall in the footprints of DES&KiDS or KiDS&HSC → compare WL signals

Kleinebreil,SG+24



# Mass modelling, center choice

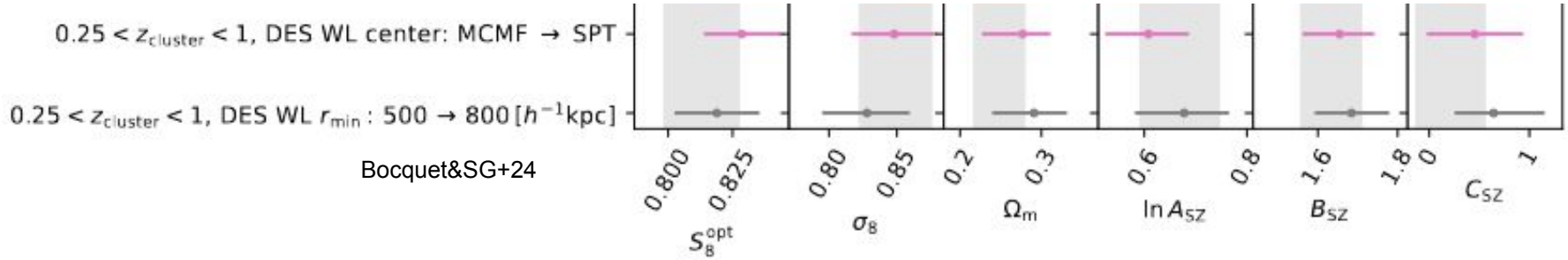



To measure a WL profile, one needs to choose a center

→ observed centers are offset from the true halo center → wash out signal and lead to mass bias

→ up to 4% effect on recovered mass

→ 5% mass bias leads to 1 sigma shift in S8



# Selection function

Personal opinion: SPT has the best selection function modelling
(cut in significance, model significance mass relation and scatter)

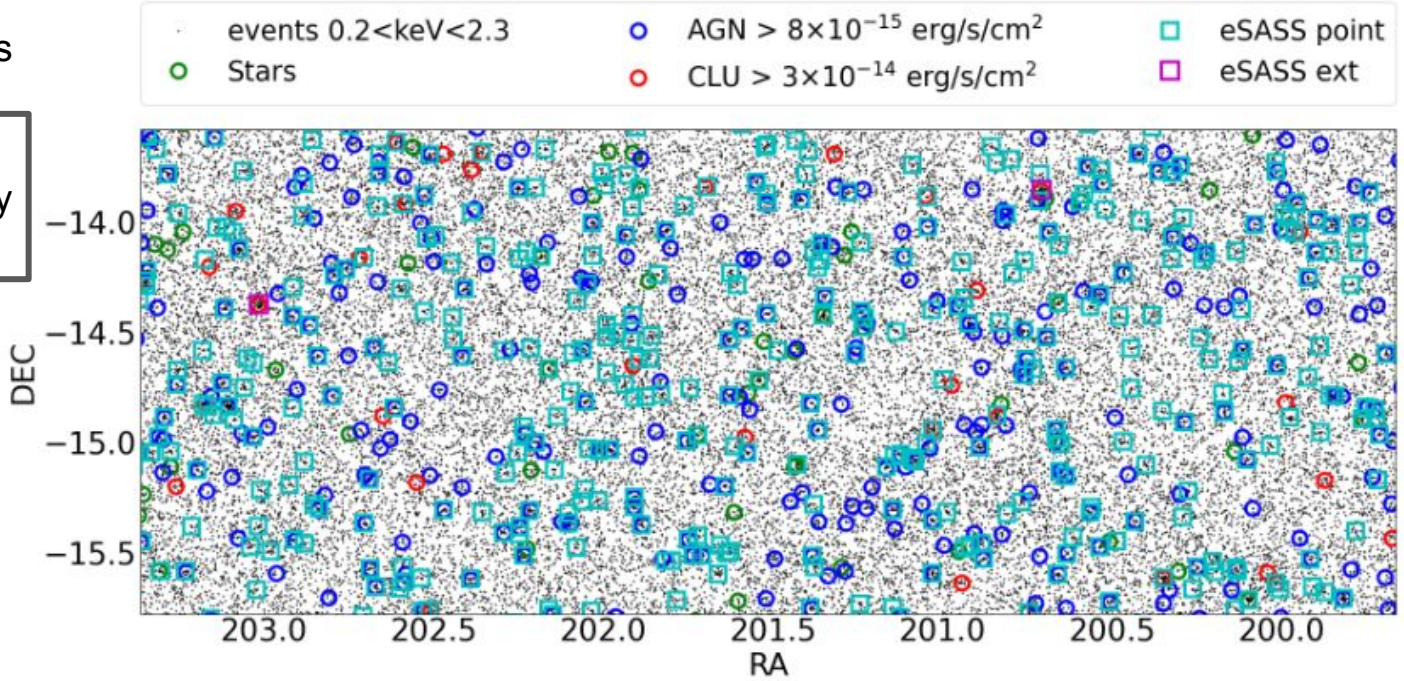
Hard to do with strong variation in exposure time (like Planck or eROSITA)

Seppi+22, Clerc,...,SG+24

Extensive image simulations

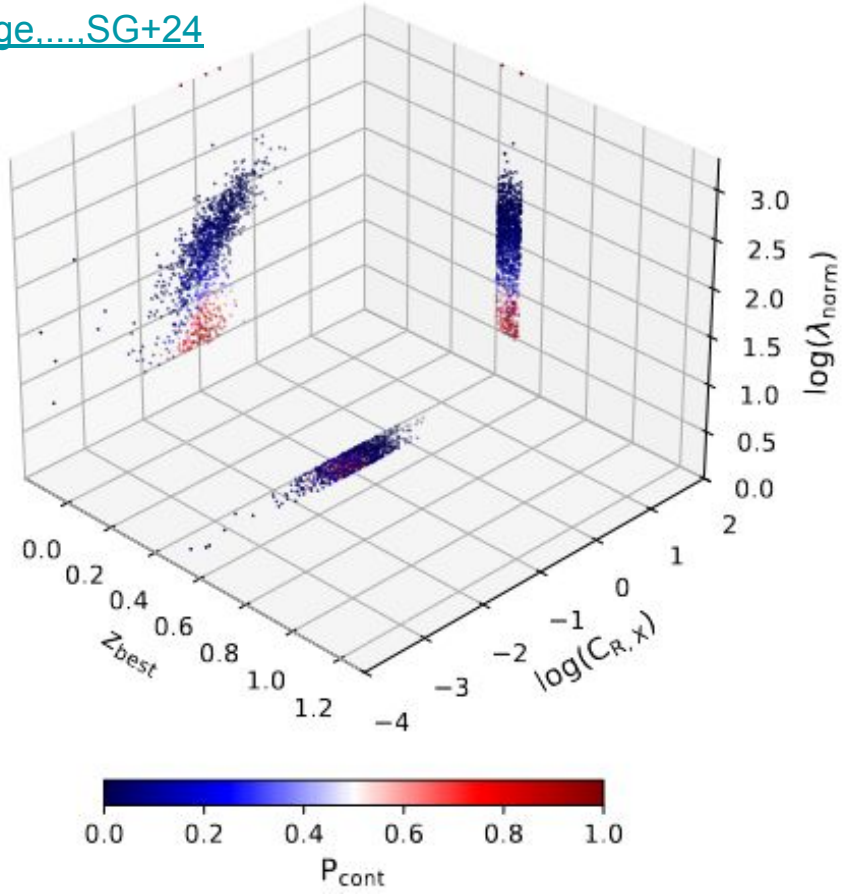
Does not marginalize of residual inaccuracy of X-ray image simulations

eRASS1: blind tests with different selected function showed that cosmology in invariant



# Contamination

Kluge,...,SG+24




Learn X-ray distribution of contaminants from image sim, measure richness redshift distribution from data

optical follow up of point sources → misclassified AGN
Optical follow up of empty LoS → random lines of sight

We considered a three component model

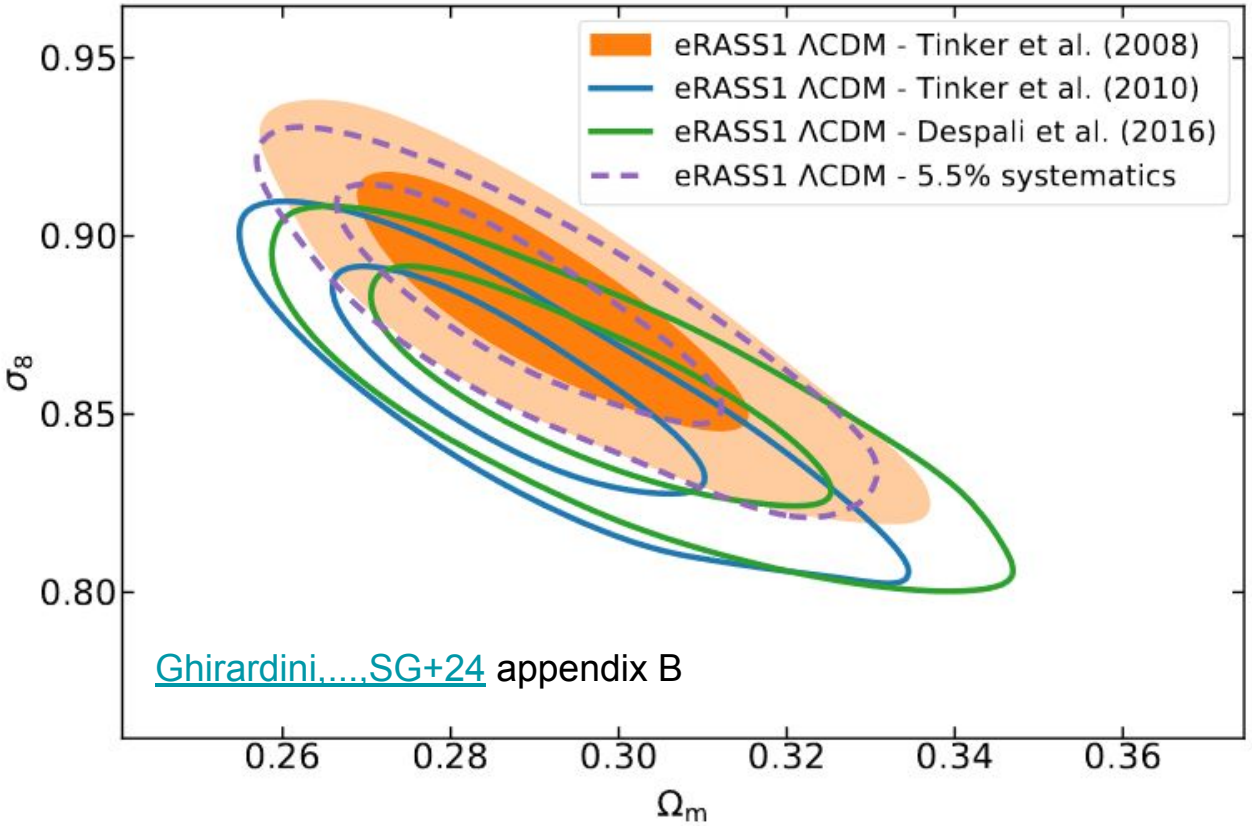
Clusters (follow population model), mis-classified AGN, random fluctuations

Fractions fitted on the fly $f_{\rm RS} = 0.0061 \pm 0.0023$
$f_{\rm AGN} = 0.0462 \pm 0.0038$

Ghirardini+24

Matches expectation from X-ray simulations

# Theoretical uncertainties




Ghirardini,...,SG+24 appendix B

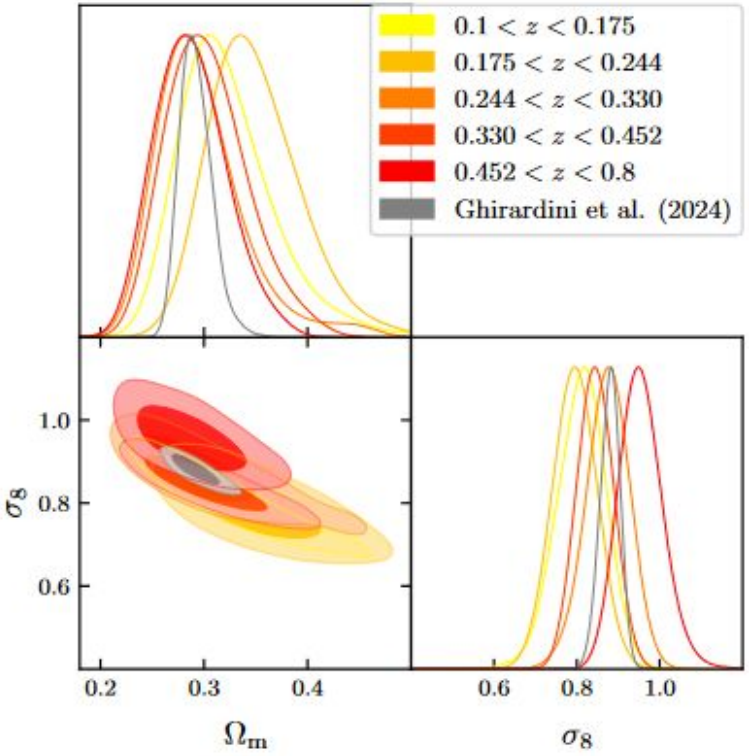
Like SPT, we used Tinker+08

We learned after blending, that at our precision, the choice of the halo mass function does matter to 1 sigma level

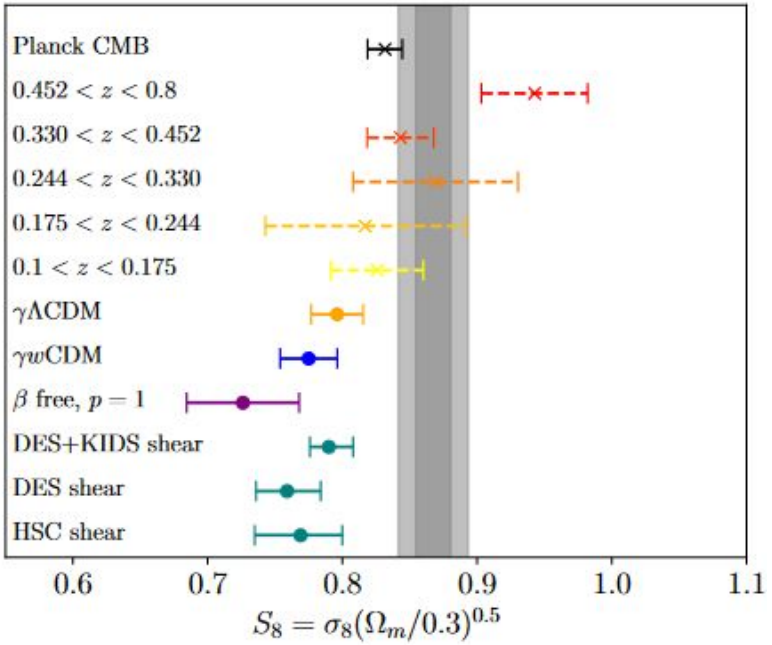
We need to account for this more carefully in Data Release 2

# Redshift trends

Artis,...,SG+24

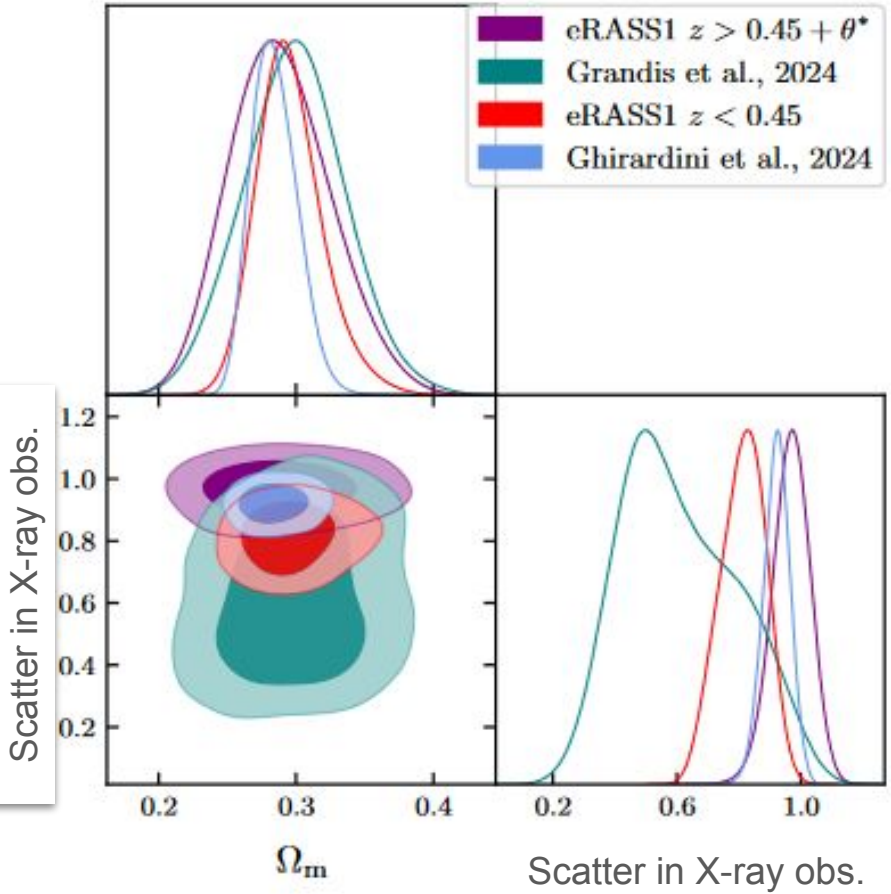



We can split our sample in 5 equally populated redshift bins and redo the analysis in each bin



# Redshift trends

Artis,...,SG+24




The high redshift bin, z>0.45 displays significantly larger scatter among X-ray photon count rate and mass

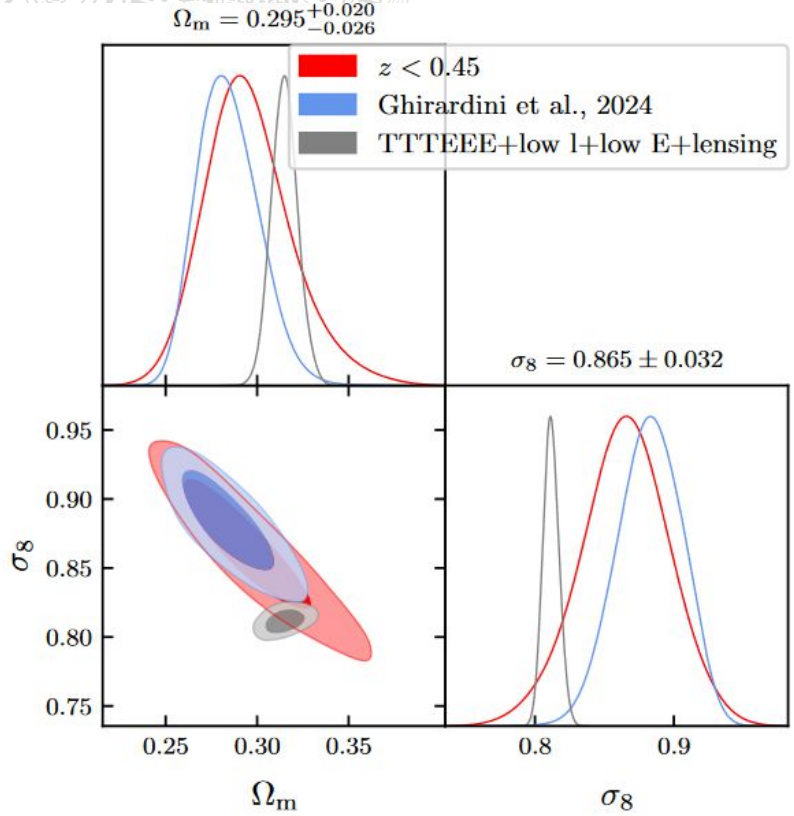
→ this scatter modulates the incompleteness as a function of mass, and is fitted for in the fly

→ weakly constrained from WL mass calibration

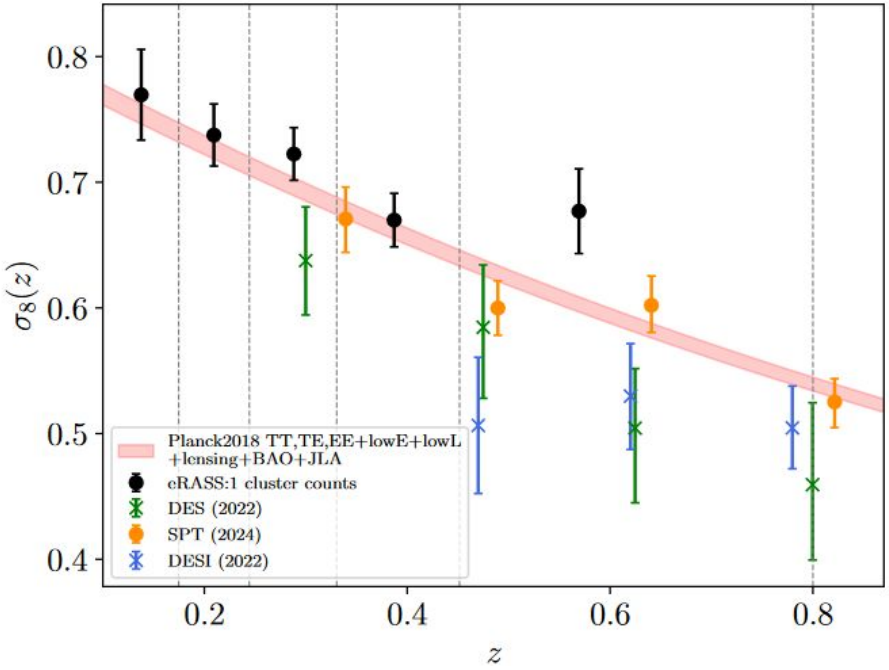
Possible reasons
→ more contamination at high redshift
→ more disturbed and heterogeneous dynamical states
→ more contamination of the X-ray flux by AGN in clusters

# Redshift trends

Artis,...,SG+24

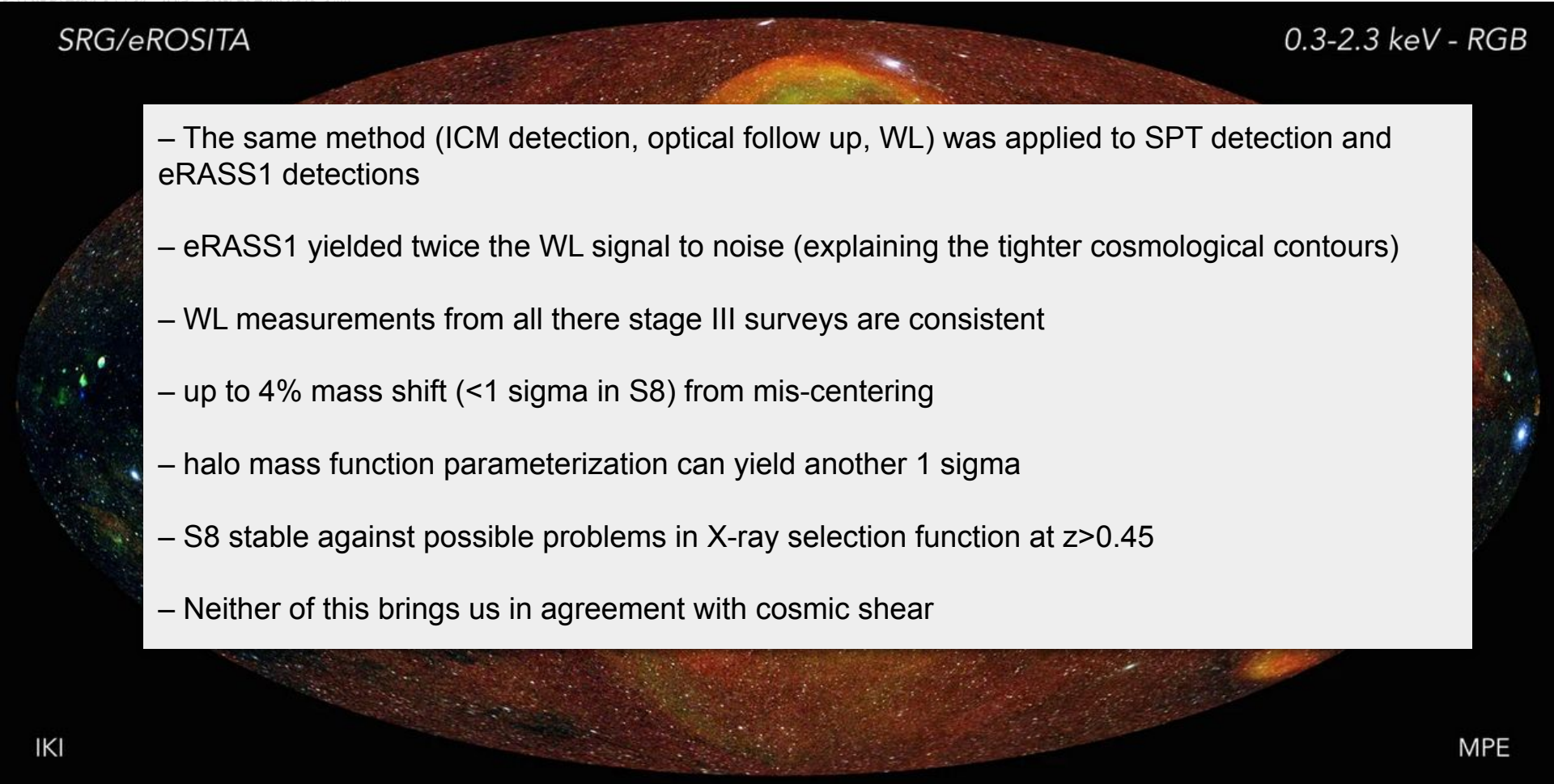



Excluding the problematic high redshift clusters do not change S8



universität innsbruck

# Summary




– The same method (ICM detection, optical follow up, WL) was applied to SPT detection and eRASS1 detections

– eRASS1 yielded twice the WL signal to noise (explaining the tighter cosmological contours)

– WL measurements from all there stage III surveys are consistent

– up to 4% mass shift (<1 sigma in S8) from mis-centering

– halo mass function parameterization can yield another 1 sigma

– S8 stable against possible problems in X-ray selection function at z>0.45

– Neither of this brings us in agreement with cosmic shear

universität innsbruck

# Summary