

Cluster Cosmology, and redMaPPer and redMaGiC in the DES

Eduardo Rozo
University of Arizona

Eli S. Rykoff (SLAC)

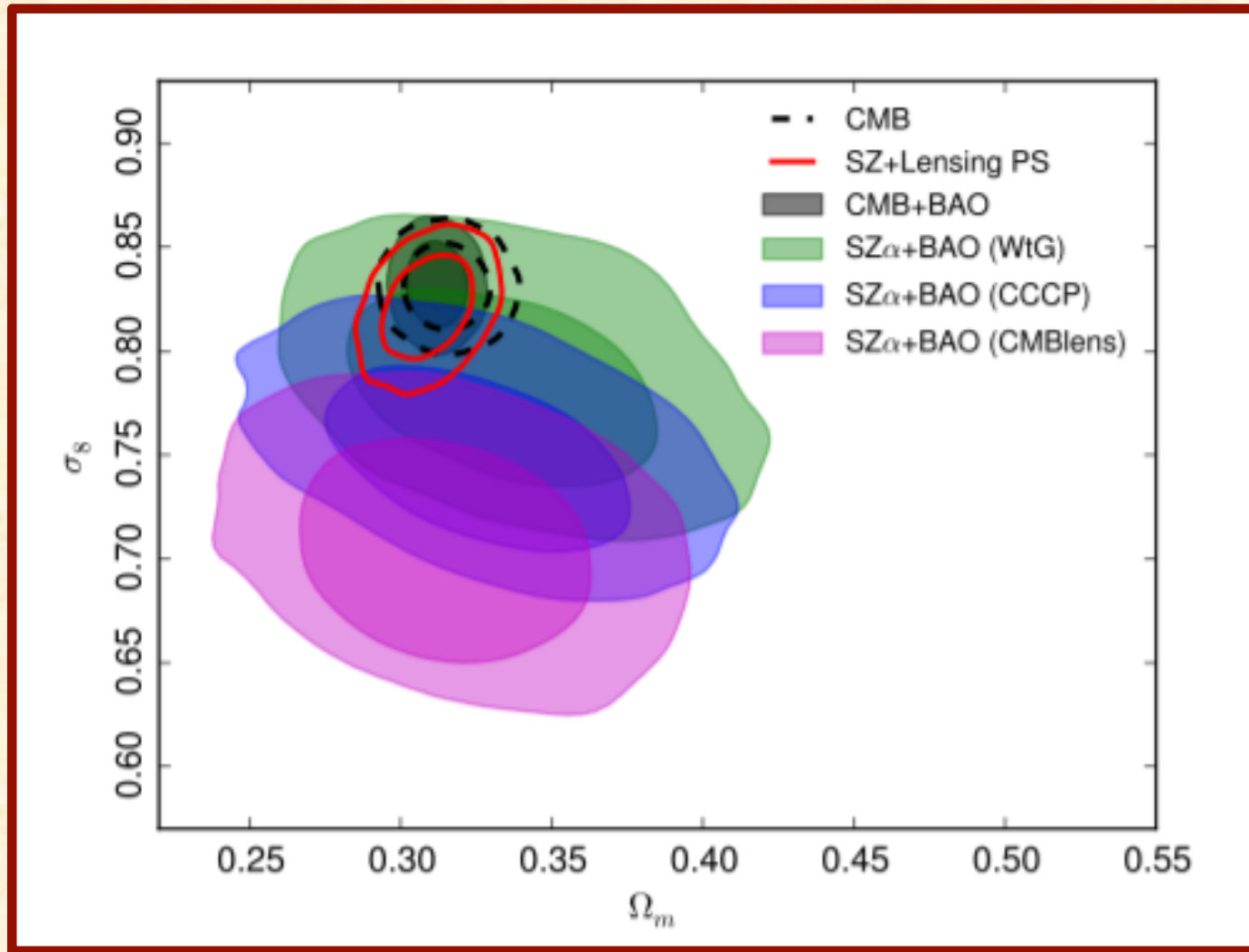
Munich
July 24, 2015

Summary

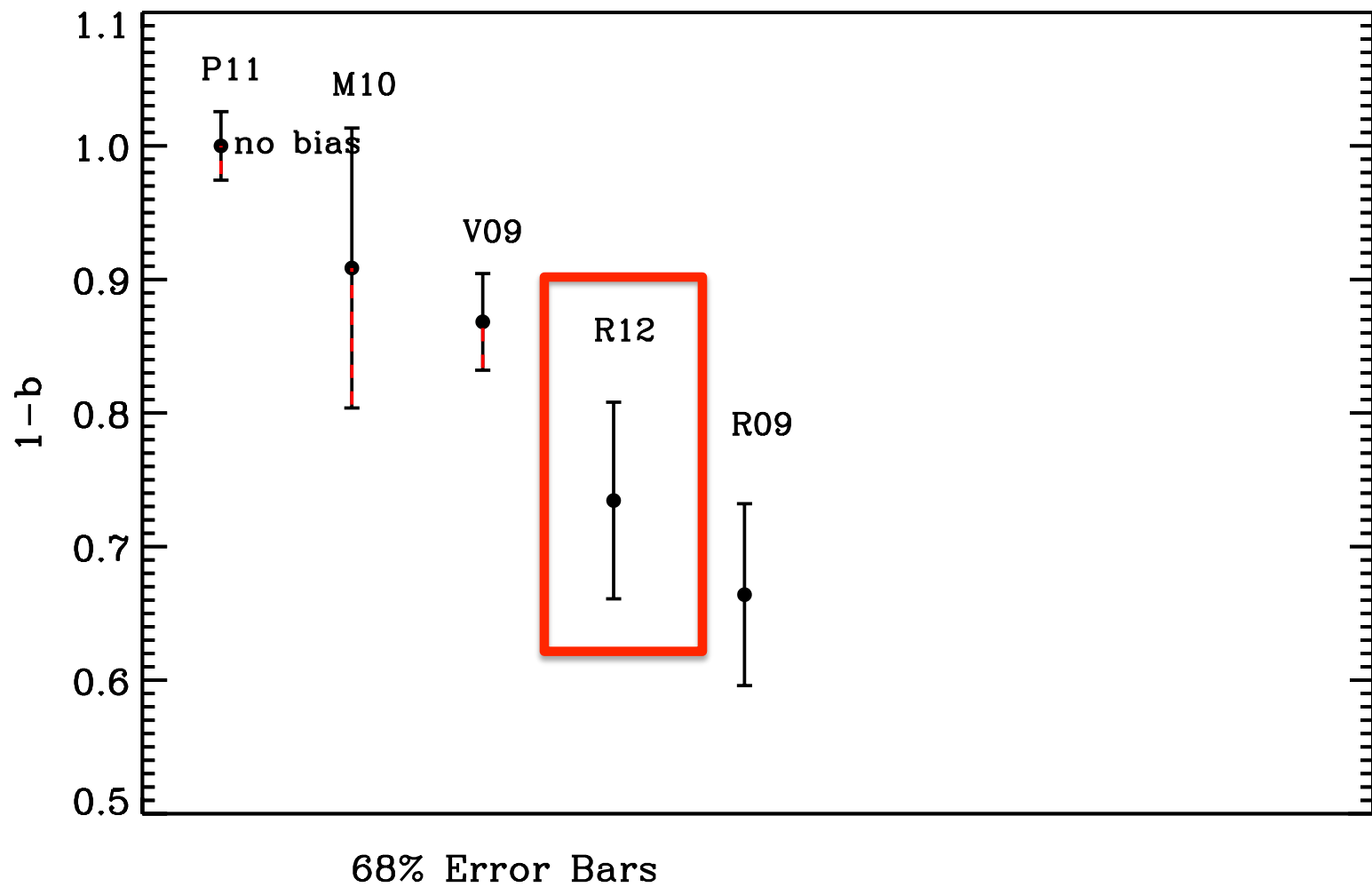
- No compelling evidence of tension between cluster abundances and Planck CMB constraints
- Main systematic is mass calibration.
- DES/HSC/KIDS should be able to significantly clarify the current picture.
- Cosmology requires good photometric cluster finding algorithms. Things look pretty good!
- Cluster finding techniques can be used produce “gold” samples for photometric LSS studies.

Are Clusters in Tension with
Planck?

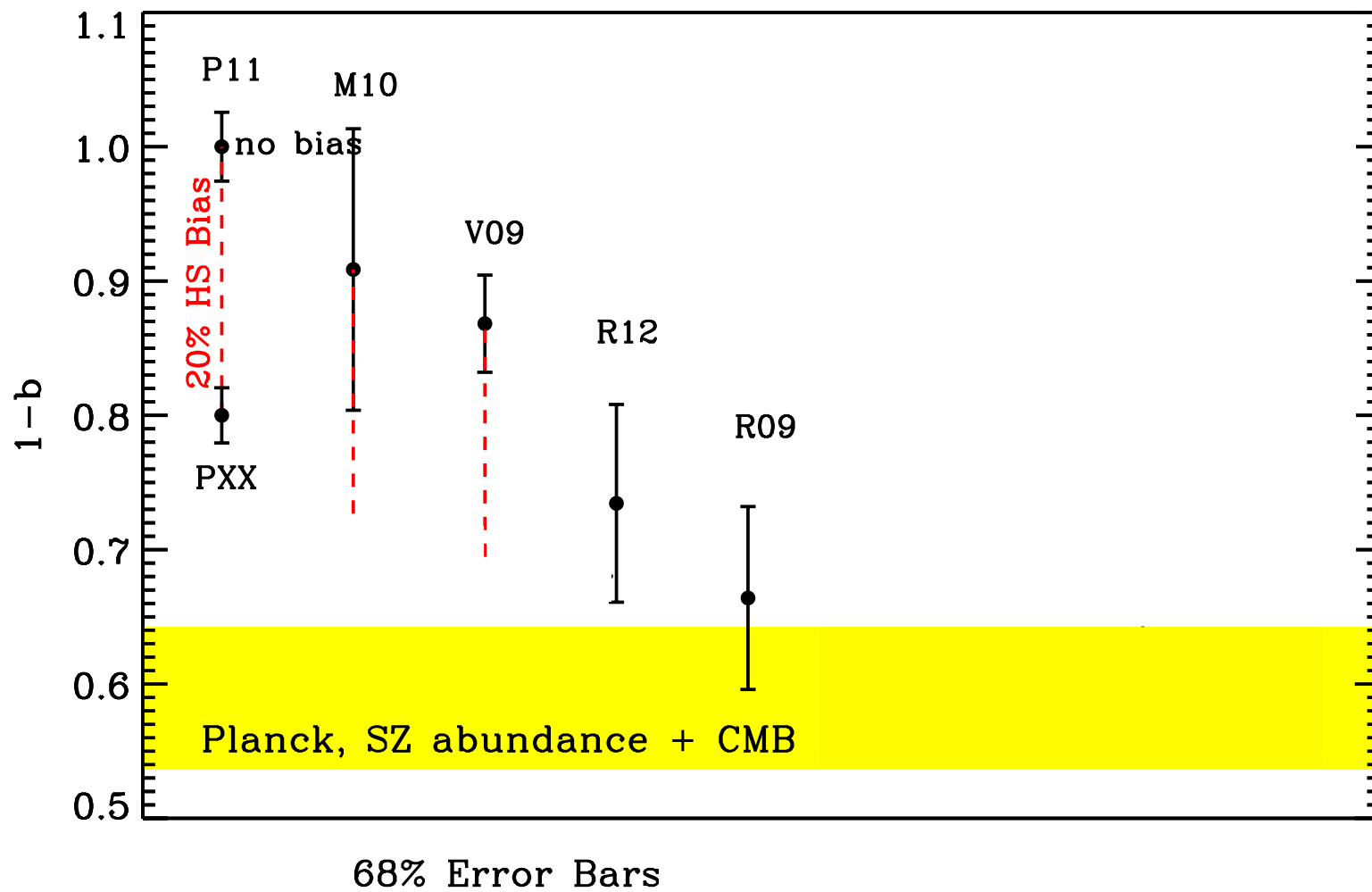
Planck Results



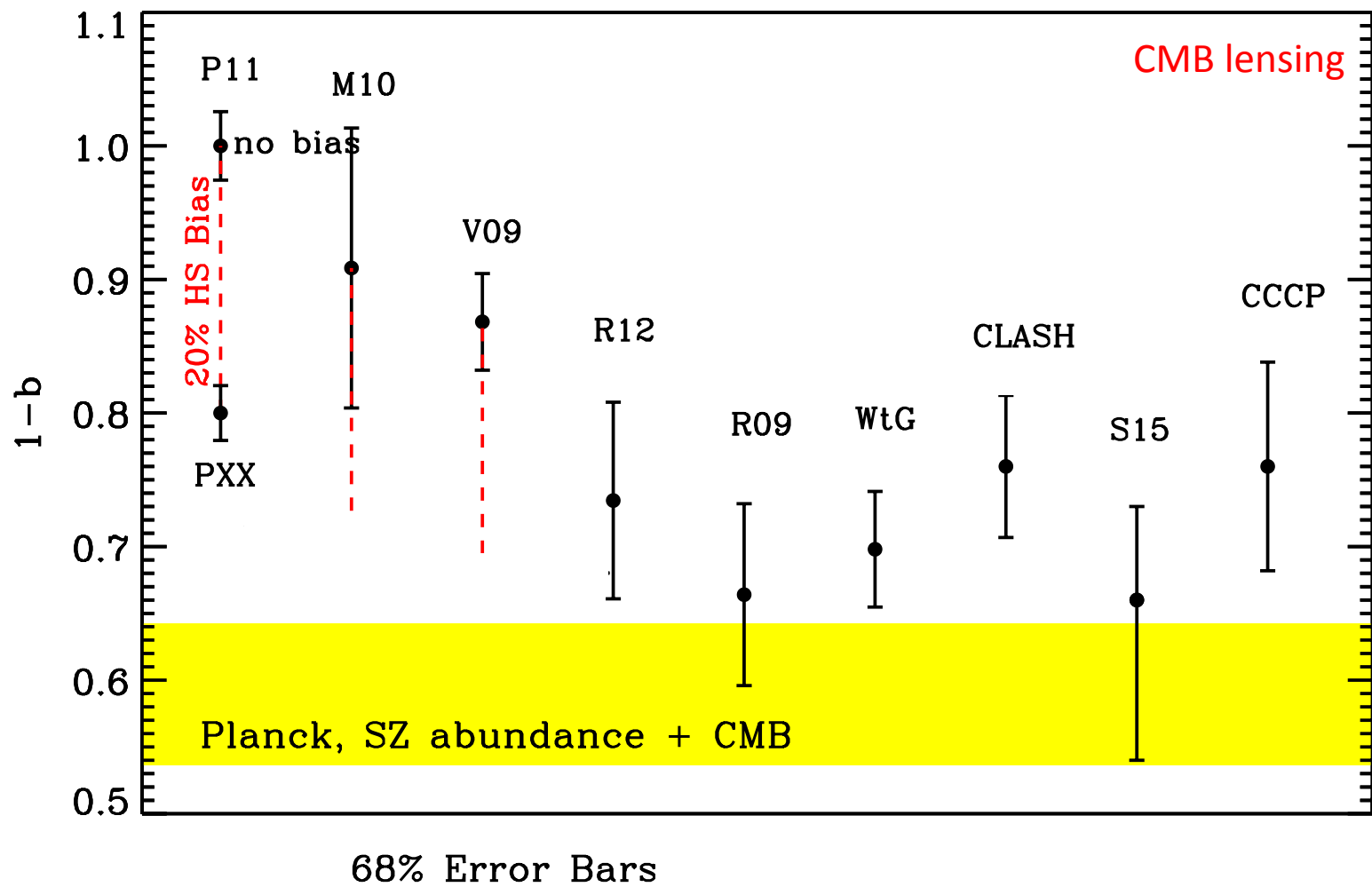
How Secure is the Mass Calibration?



How Secure is the Mass Calibration?



How Secure is the Mass Calibration?



See also talk by Graham Smith.

How Secure is Mass Calibration?

1. Are observing systematics under control?

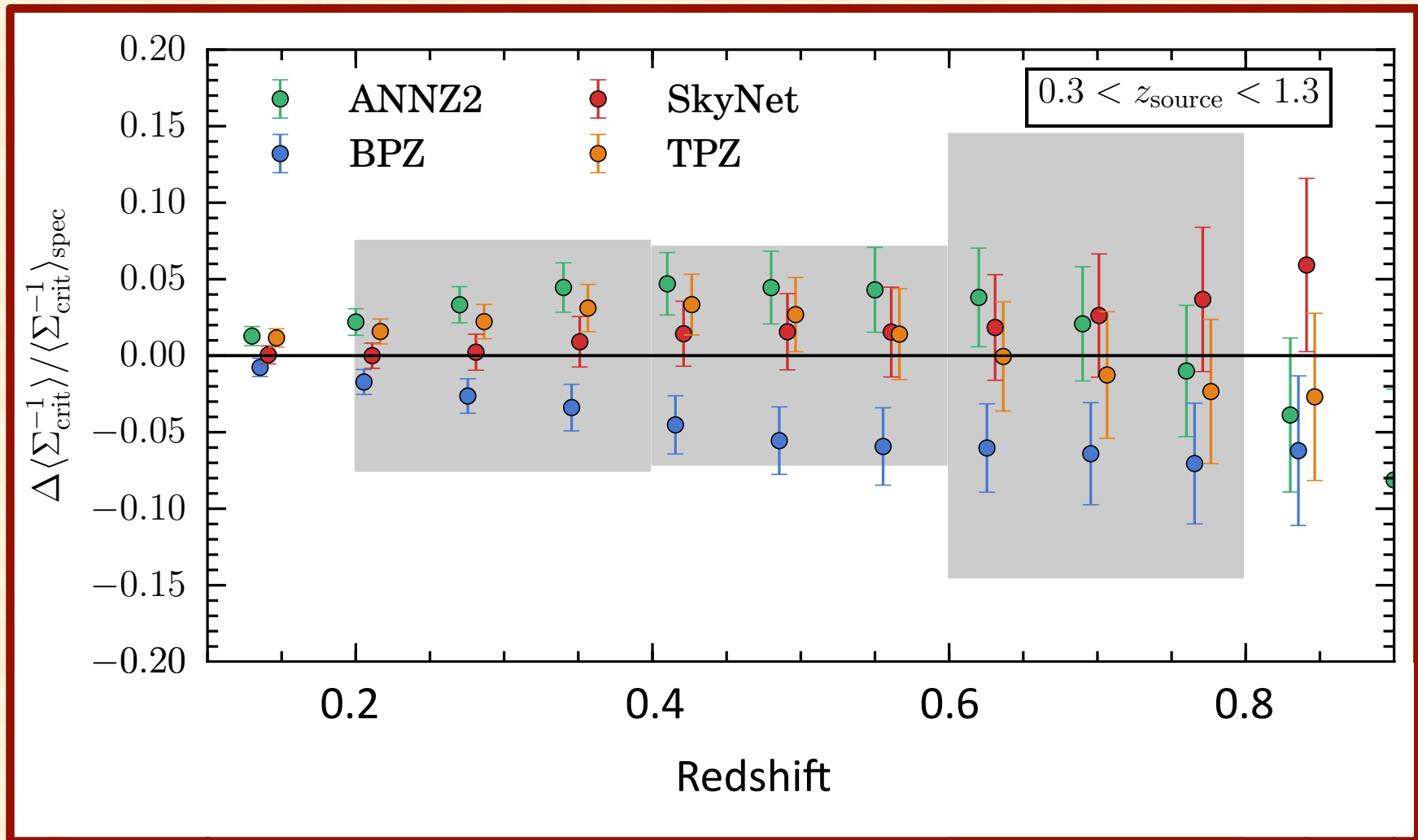
Shear estimates are probably under control.
Photozs, less so.

2. Modeling systematics?

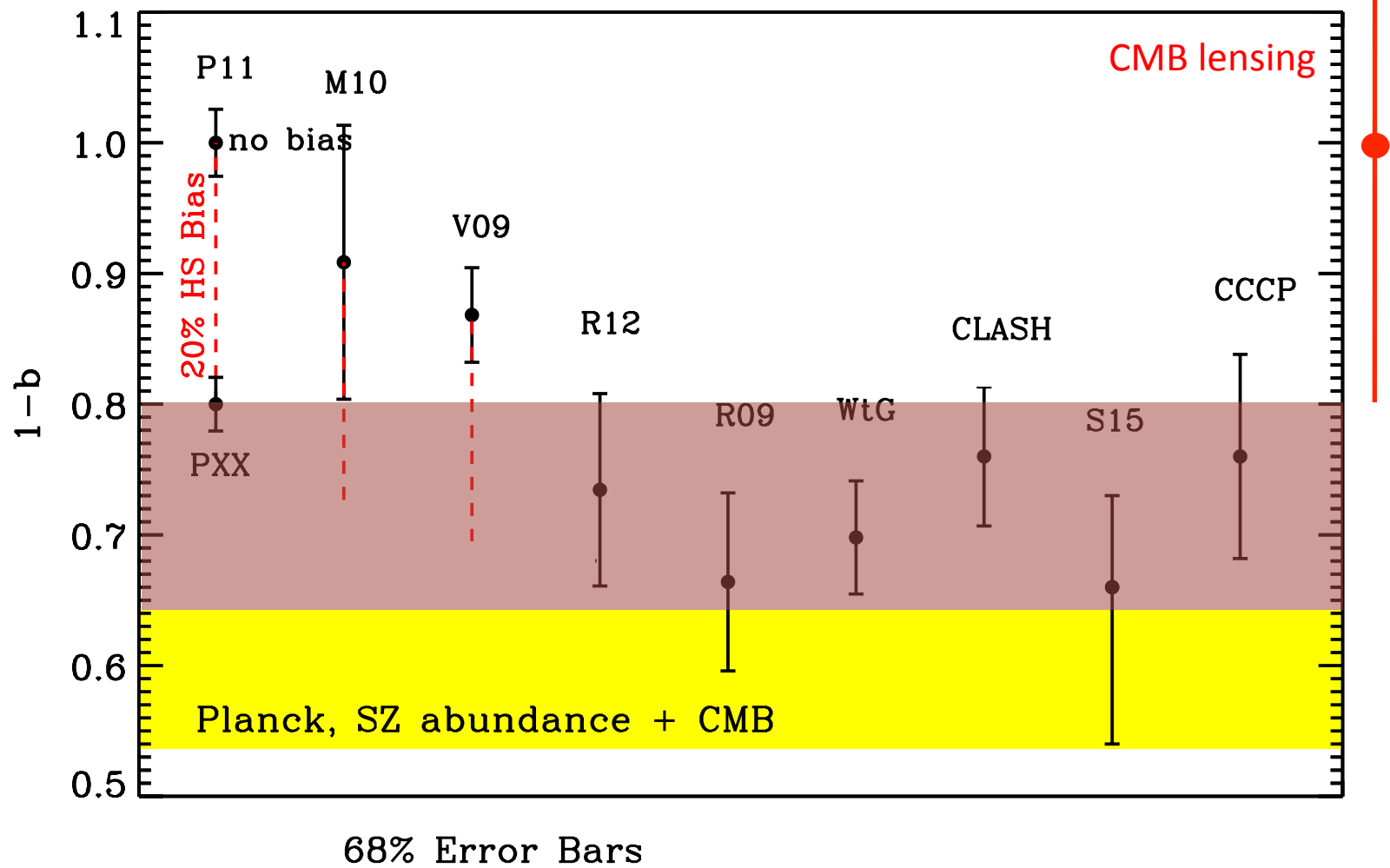
e.g. Joop Schaye's talk, Nick Battaglia's talk.

“Soft” statistics can add $\sim 5\%$ uncertainty.

Photoz Systematics in DES



How Secure is the Mass Calibration?



How Secure is Mass Calibration?

1. Are observing systematics under control?

Shear estimates are probably under control.
Photozs, less so.

2. Modeling systematics?

e.g. Joop Schaye's talk, Nick Battaglia's talk.

“Soft” statistics can add $\sim 5\%$ uncertainty.

Modeling Systematics

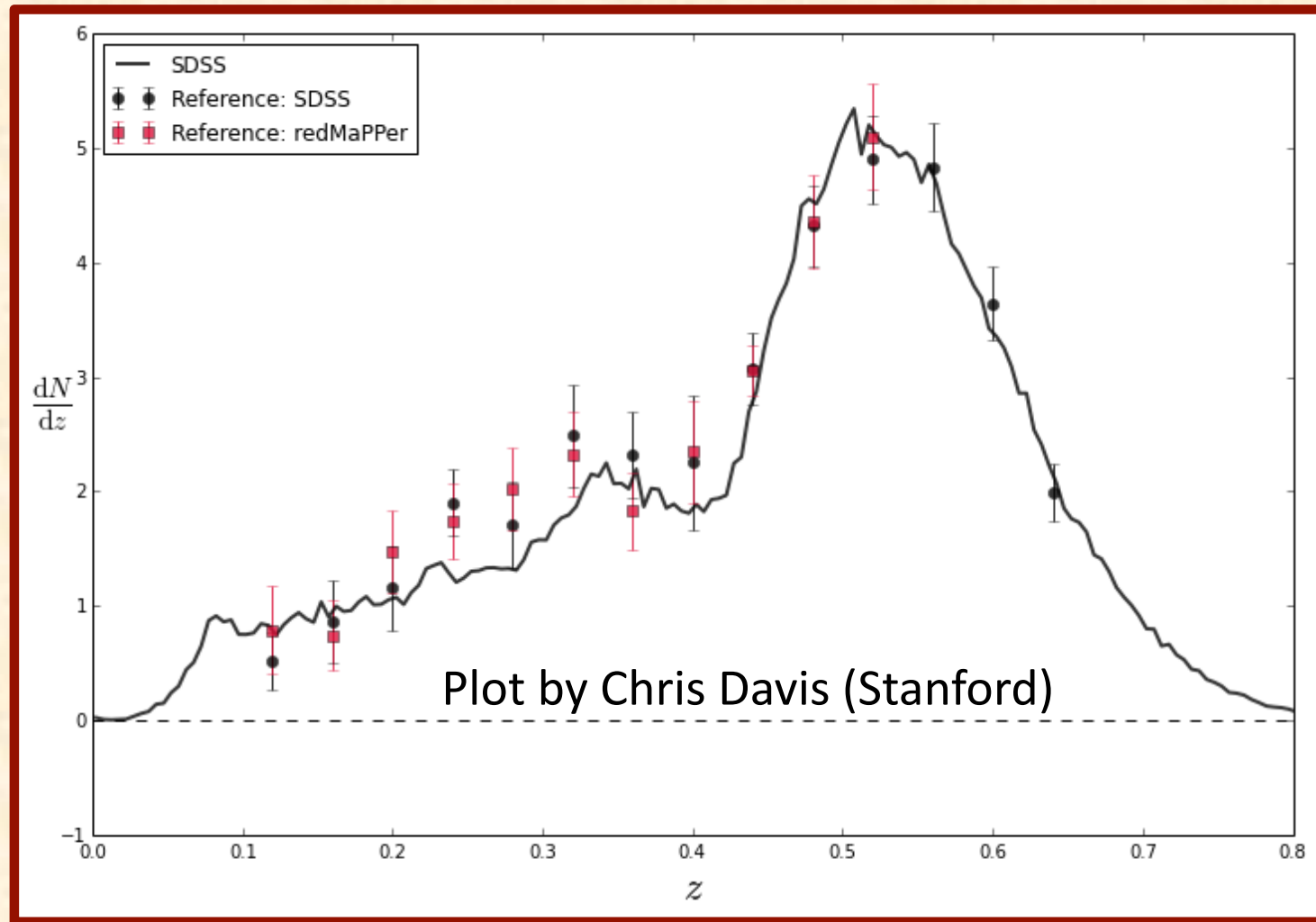
Suppose you want to measure $M_{\text{SZ}}/M_{\text{true}}$.

If you believe $M_{\text{WL}} = M_{\text{true}} + \text{noise}$, then

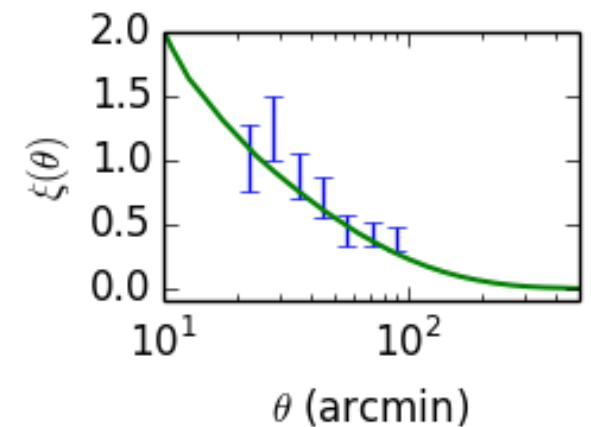
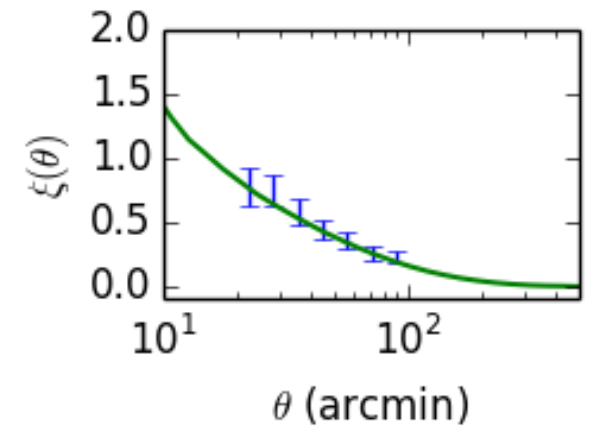
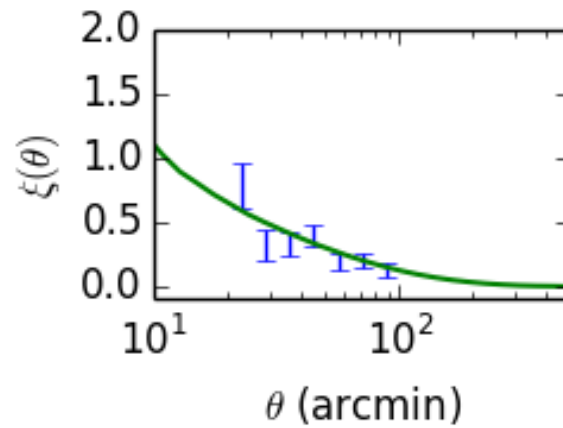
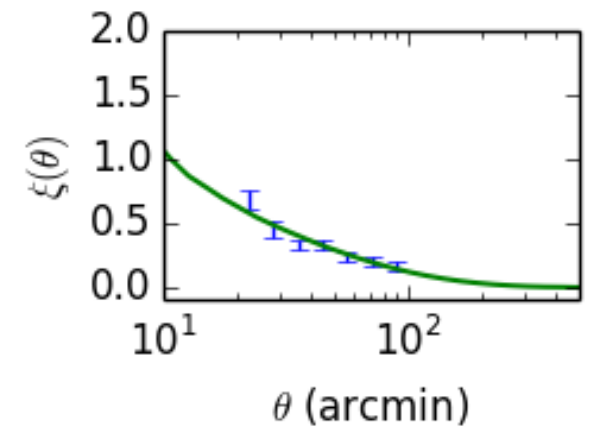
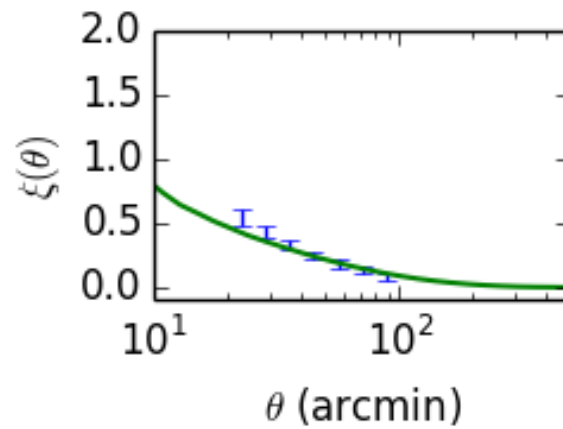
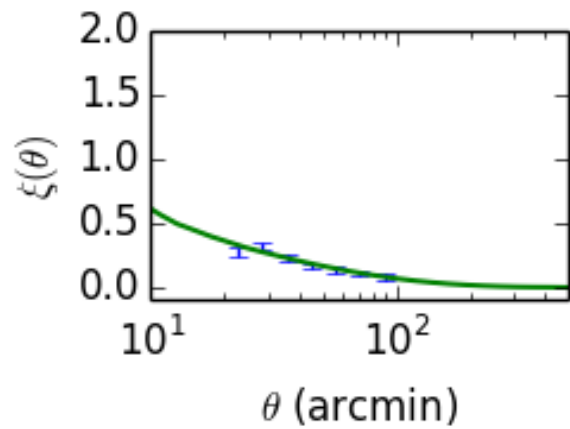
$$\langle M_{\text{SZ}}/M_{\text{WL}} \rangle \neq \langle M_{\text{SZ}}/M_{\text{true}} \rangle = 1-b.$$

WL masses have an intrinsic scatter of $\approx 30\%$,
which corresponds to a $\approx 5\%$ uncertainty in mass.

Photoz Calibration via Cross-Correlation



Expected precision appears to be close to DES requirement (3%).

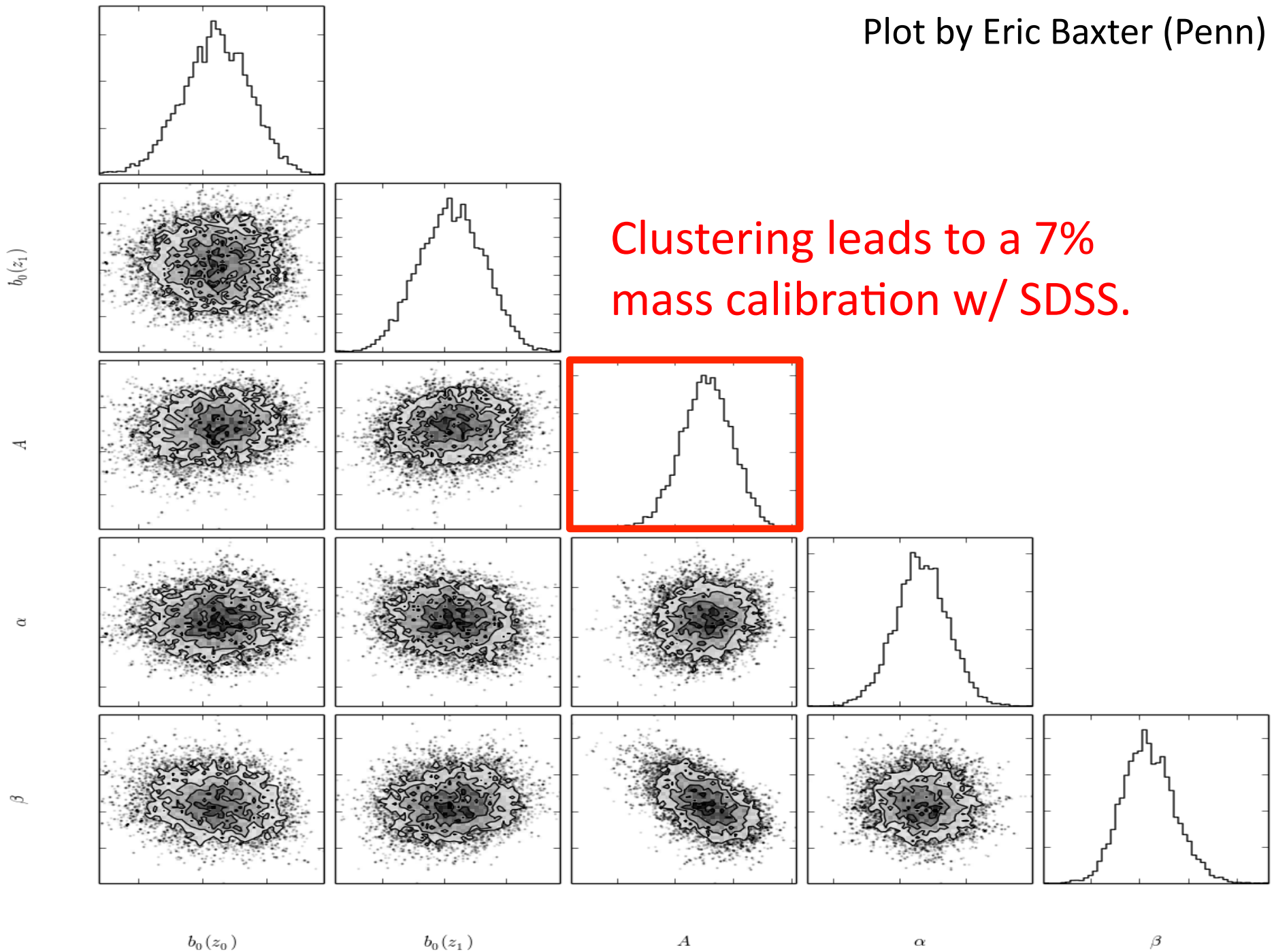


Mass Calibration via Cluster Clustering

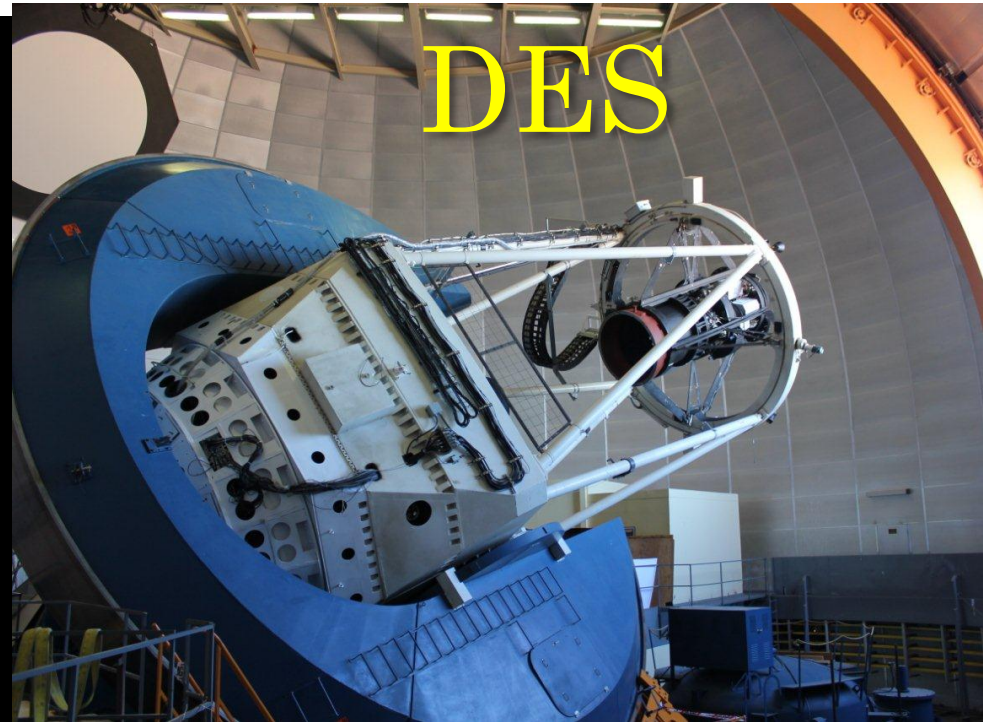
Plot by Eric Baxter (Penn)

Plot by Eric Baxter (Penn)

Clustering leads to a 7%
mass calibration w/ SDSS.



Prospects for Improvement

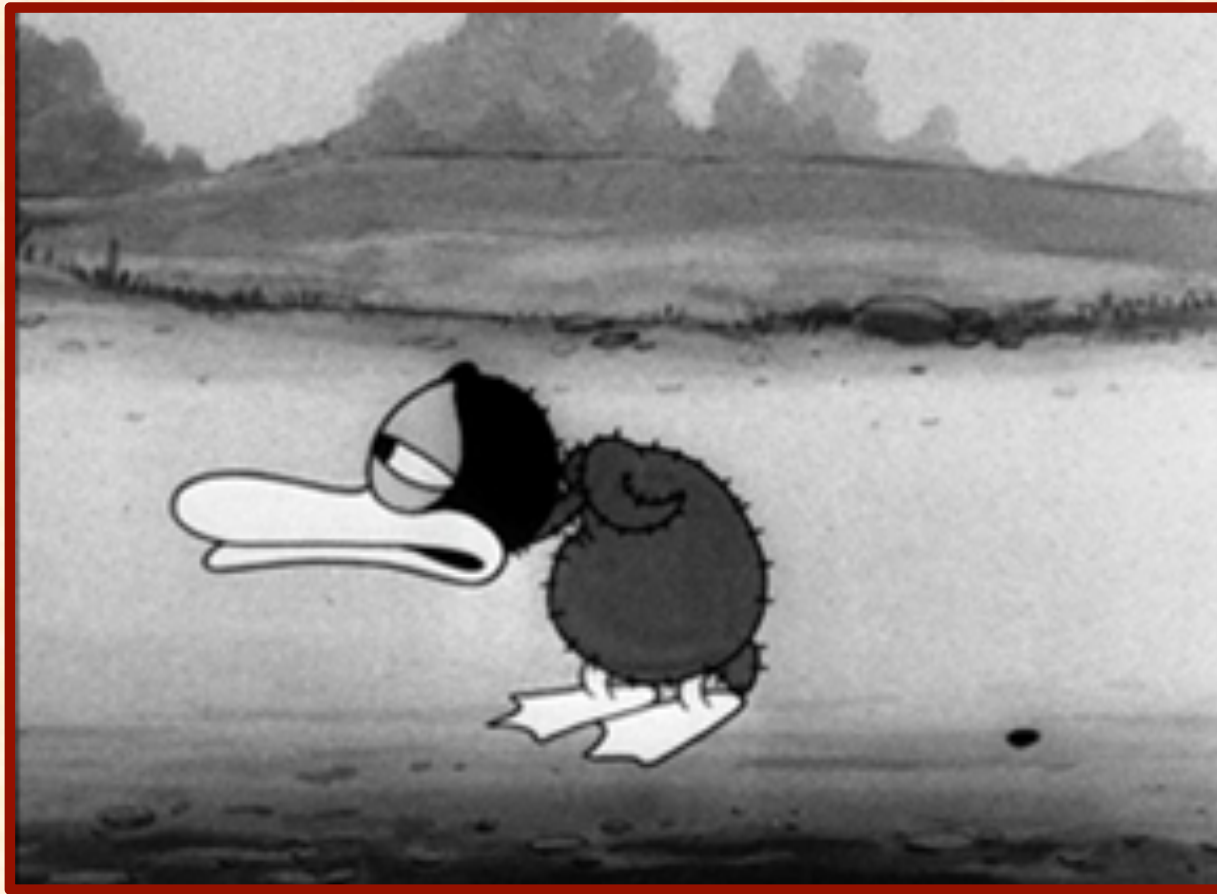


KIDS

(see Konrad's talk)



Need Reliable Cluster Finders!



redMaPPer



What is redMaPPer?

redMaPPer is a red-sequence cluster finding algorithm.

<http://risa.stanford.edu/redmapper/> Rykoff et al. 2014, Rozo & Rykoff 2014

Catalog is publicly available, and continuously updated.

Most recent version: Rozo et al. 2014 (1410.1193).

Judging redMaPPer

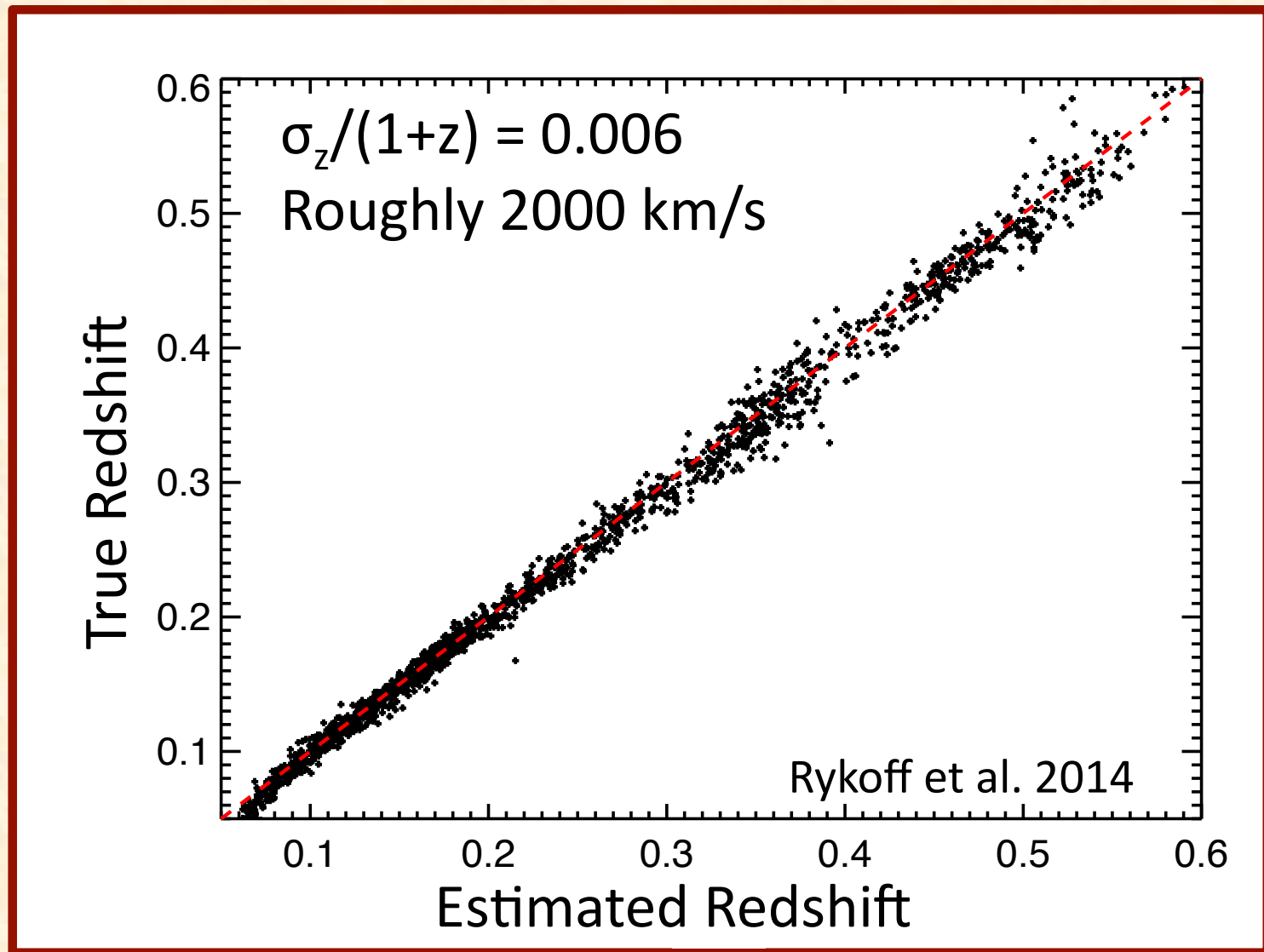
The key outputs of a cluster finder:

- Location of the cluster: redshift
- Some estimate of size: richness = # of galaxies.

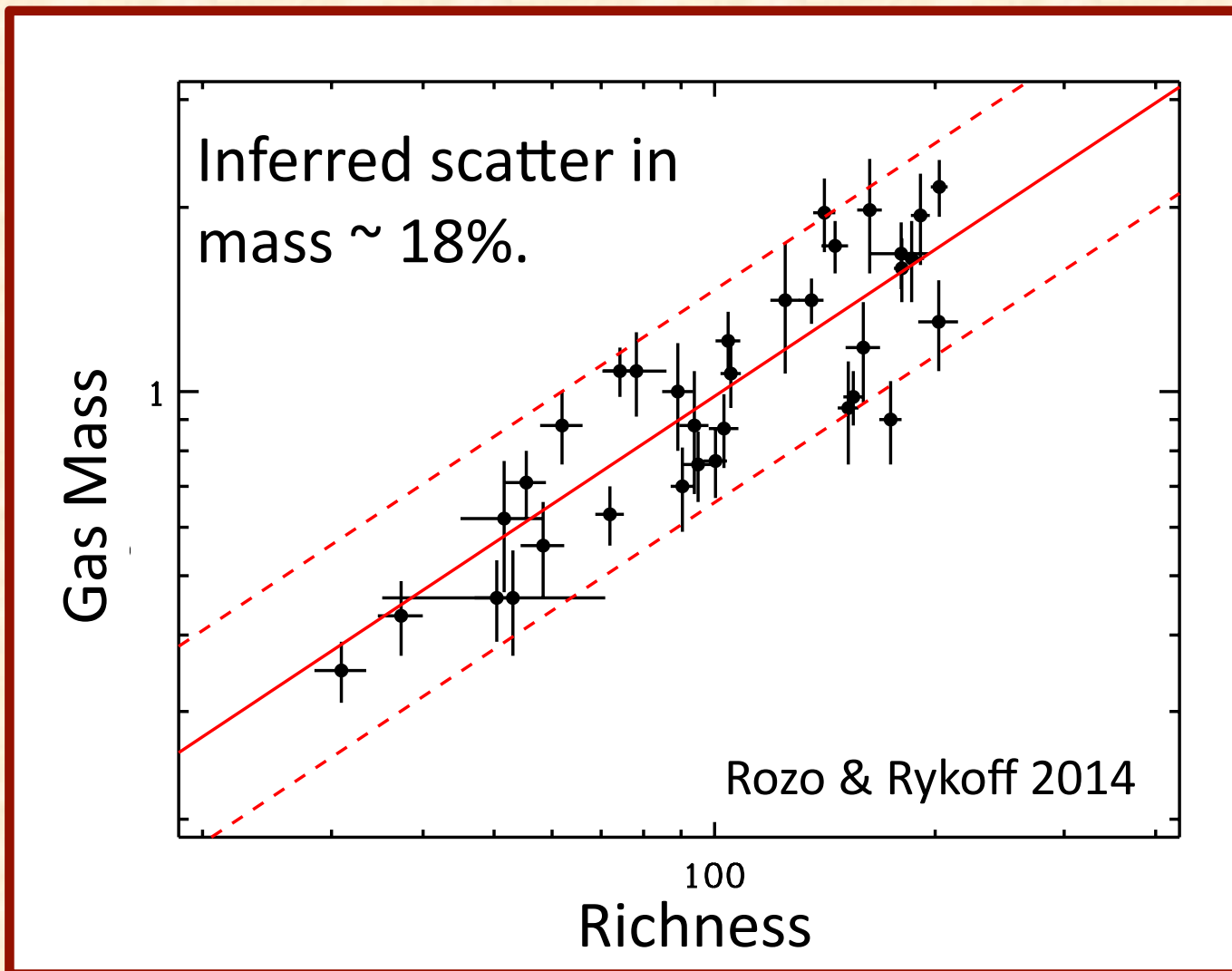
(Relation between size and mass is calibrated with WL)

So how does redMaPPer do at these things?

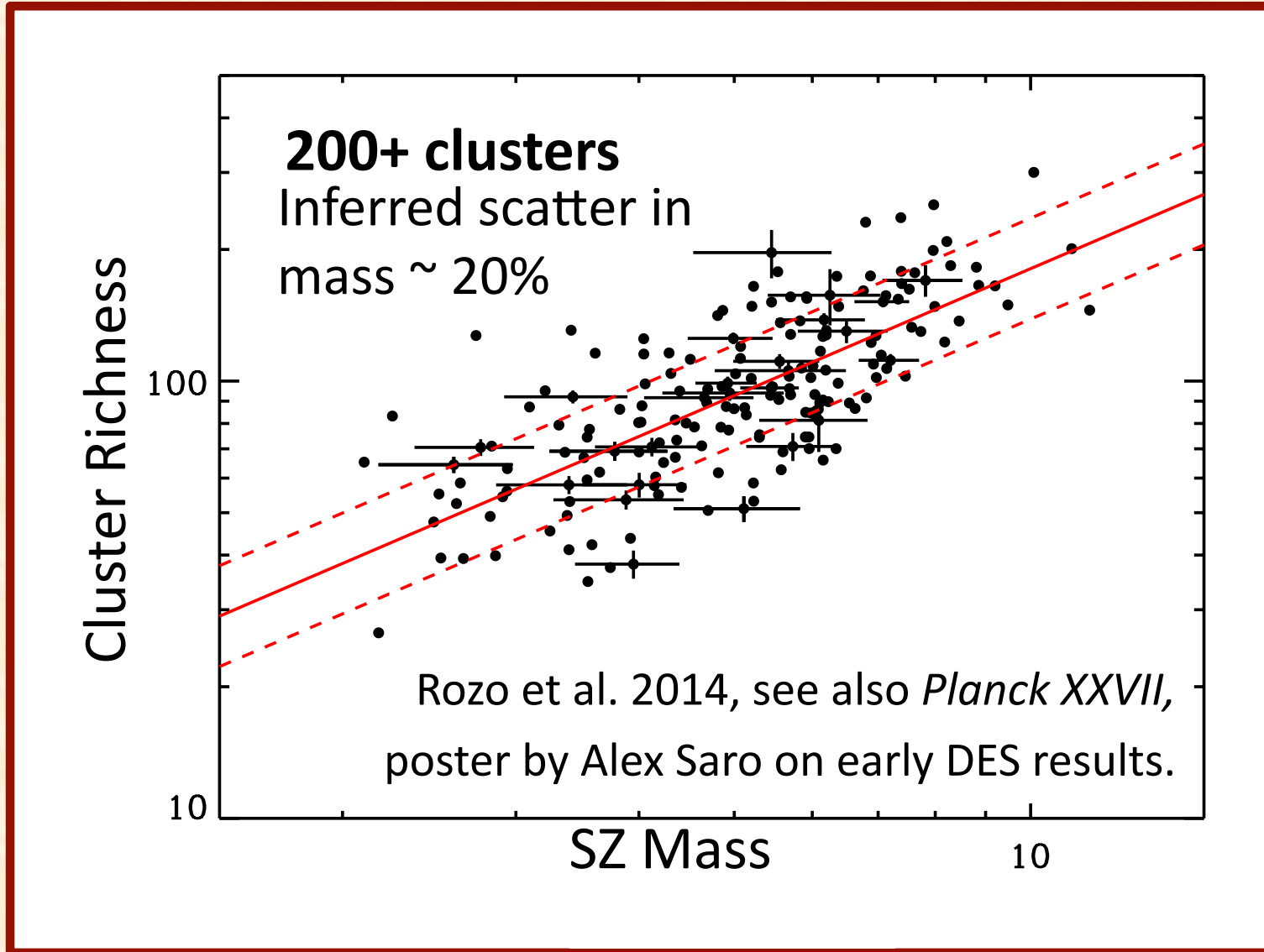
Photometric Redshifts



Mass Proxy



Mass Proxy

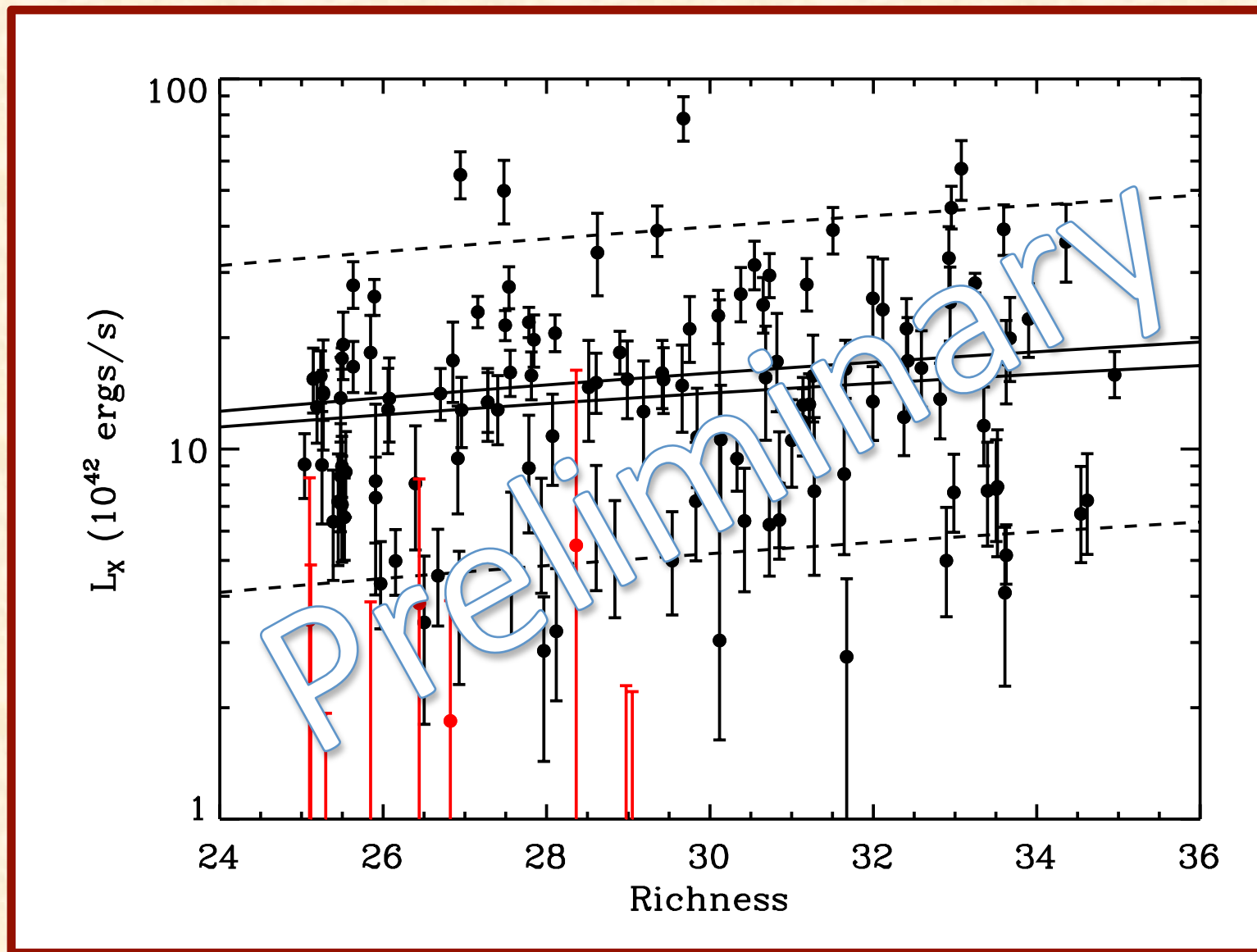


Important Caveat

These test only look at clusters that were already selected in X-rays/SZ.

Need follow-up of a complete representative sample!

The Swift-redMaPPer Sample



The Swift-redMaPPer Sample

134/154 clusters imaged so far.

9 candidate non-detections.

5 firm non-detections.

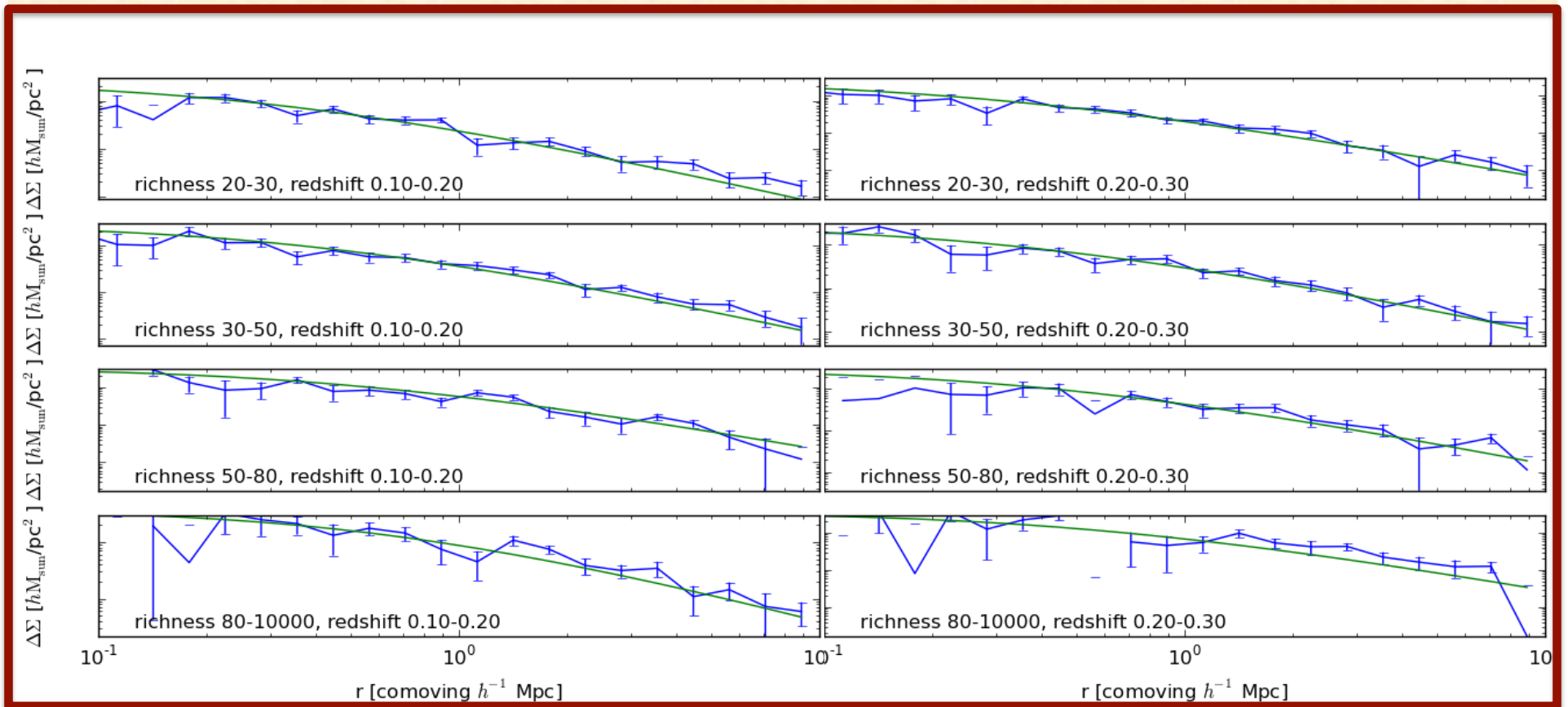
Incidence of projection effects at low richness: 3%-7%.

Two Clusters

Same Richness and Redshift



WL Mass Calibration Underway

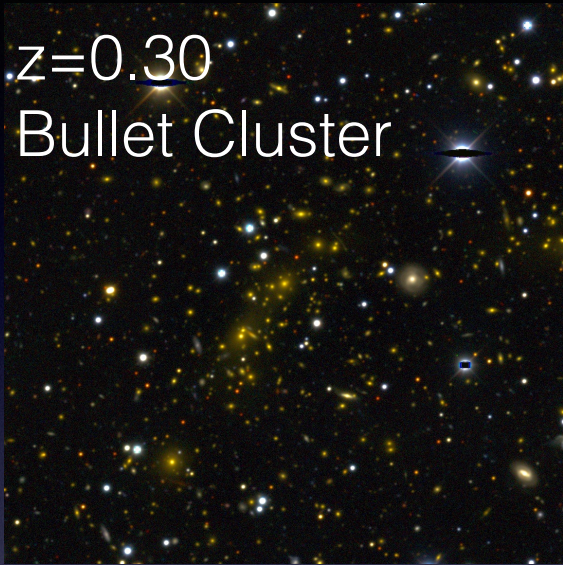


Plot by Melanie Simet (CMU)

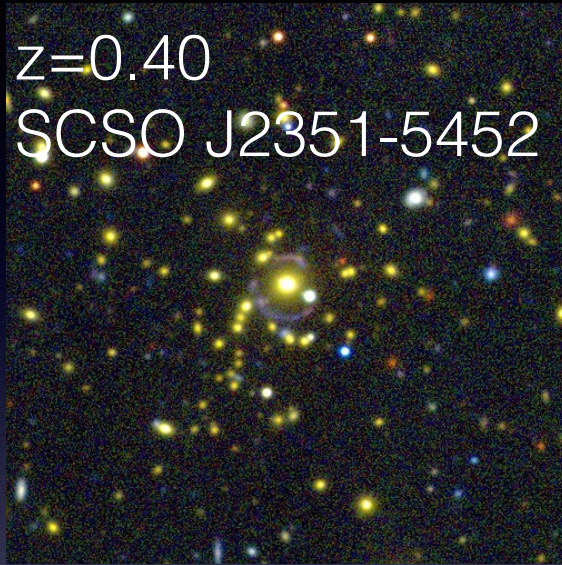
redMaPPer in DES

Rogue's Gallery

$z=0.30$
Bullet Cluster



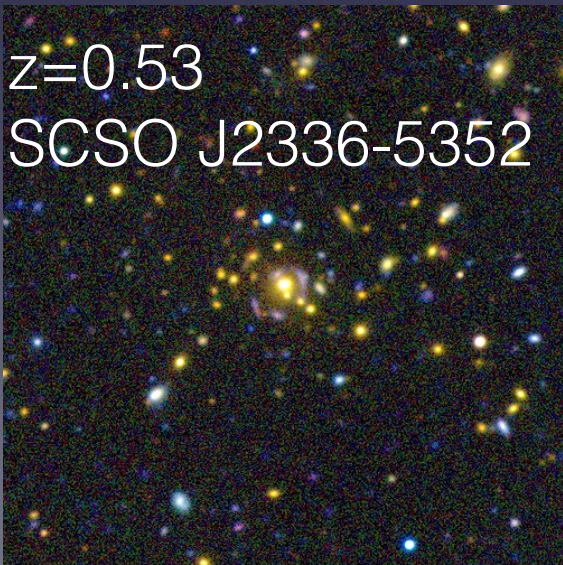
$z=0.40$
SCSO J2351-5452



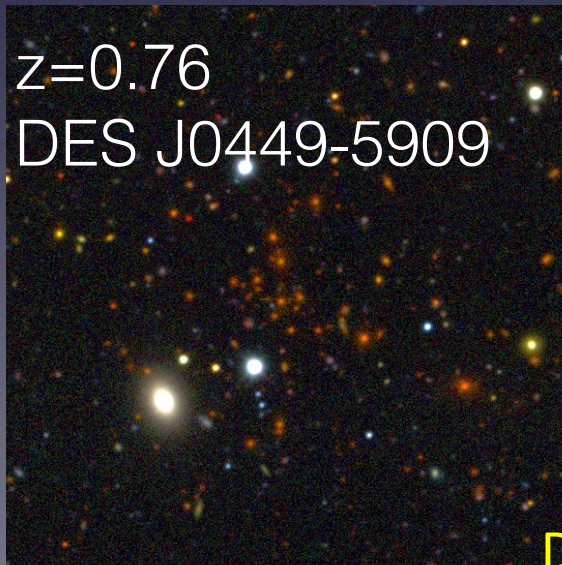
$z=0.87$
"El Gordo"



$z=0.53$
SCSO J2336-5352



$z=0.76$
DES J0449-5909



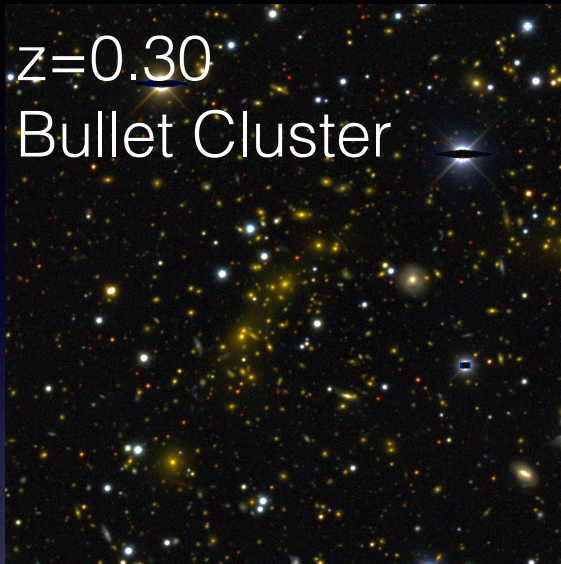
$z=0.83$
DES J0250+0008



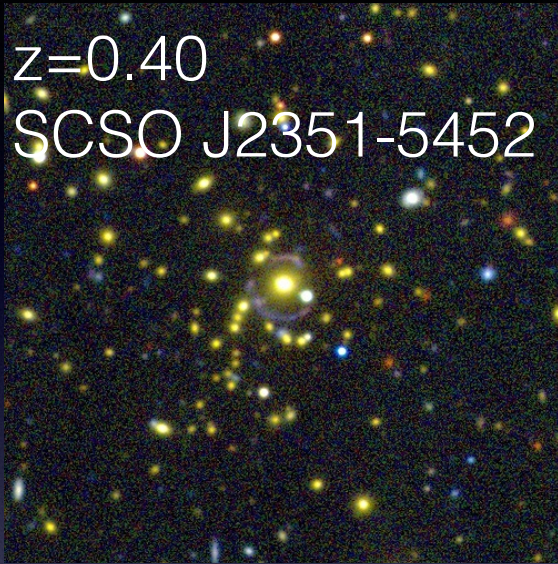
DES Collaboration, Eli Rykoff

Rogue's Gallery

$z=0.30$
Bullet Cluster



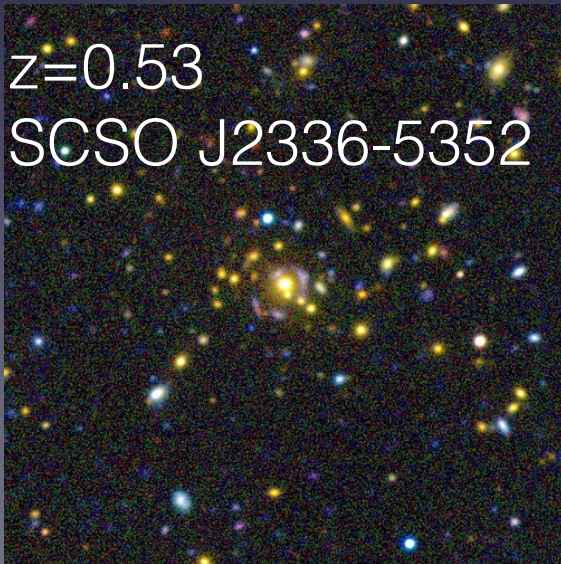
$z=0.40$
SCSO J2351-5452



$z=0.87$
"El Gordo"



$z=0.53$
SCSO J2336-5352

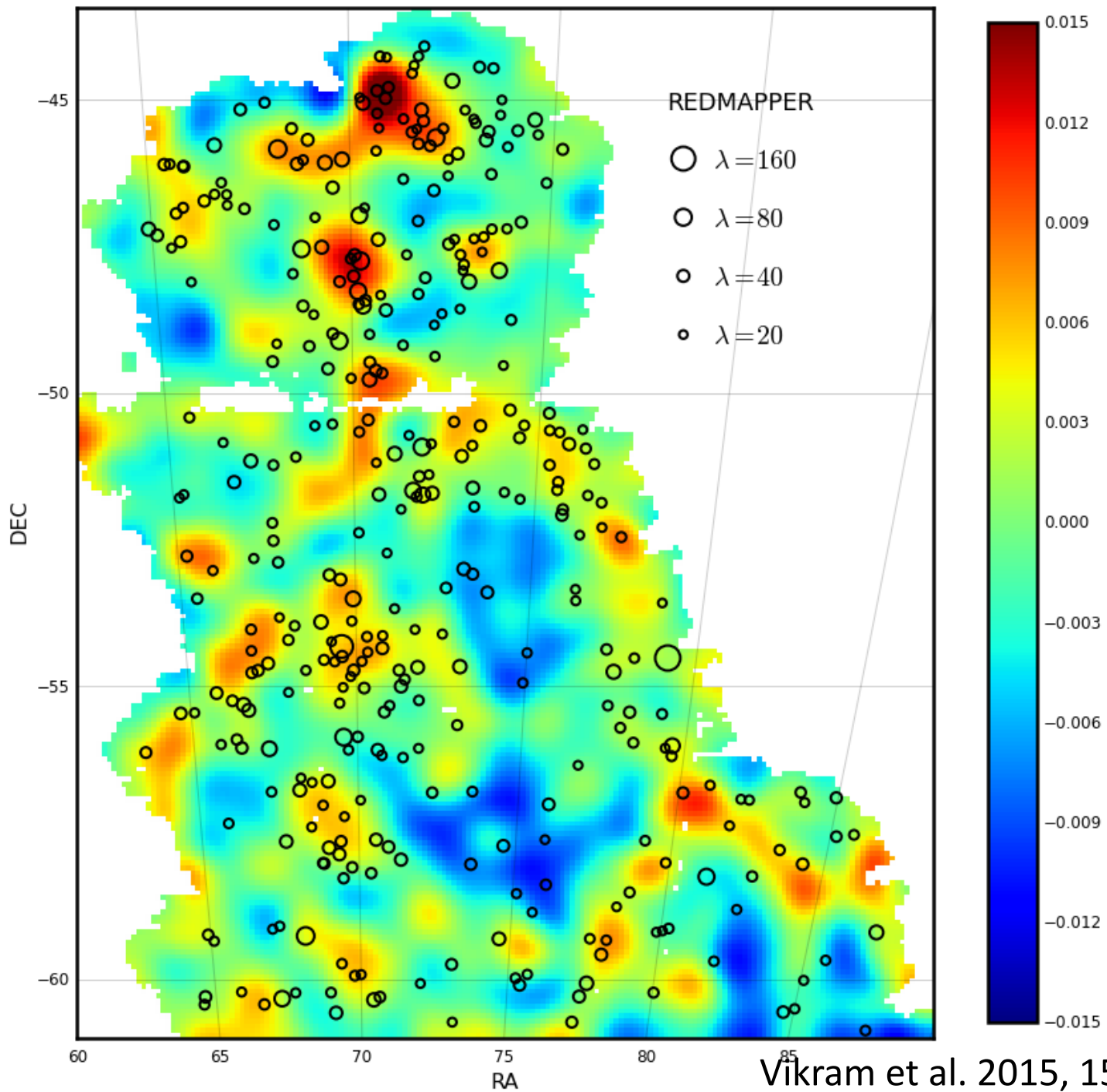


$z=0.76$
DES J0449-5909

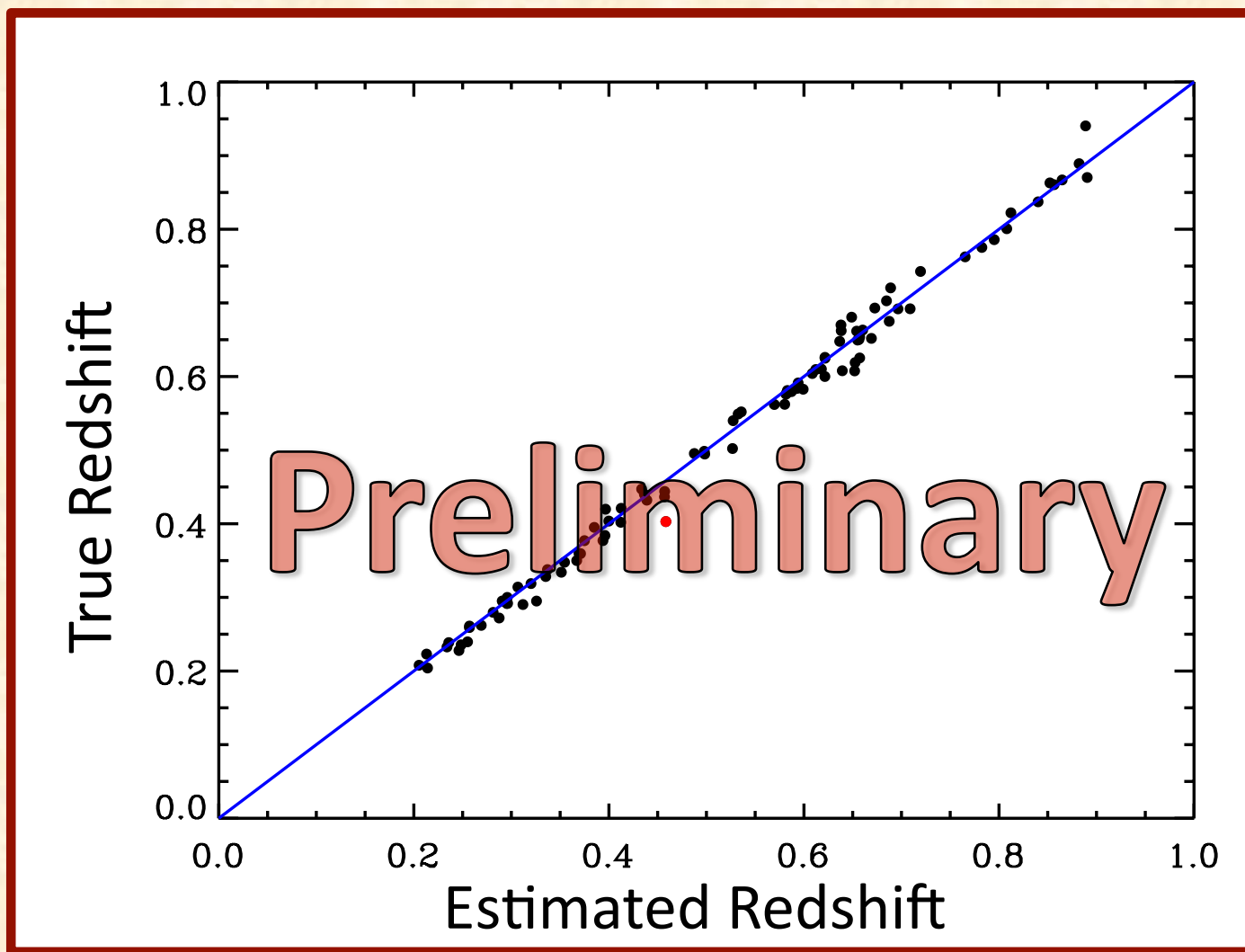


$z=0.83$
DES J0250+0008

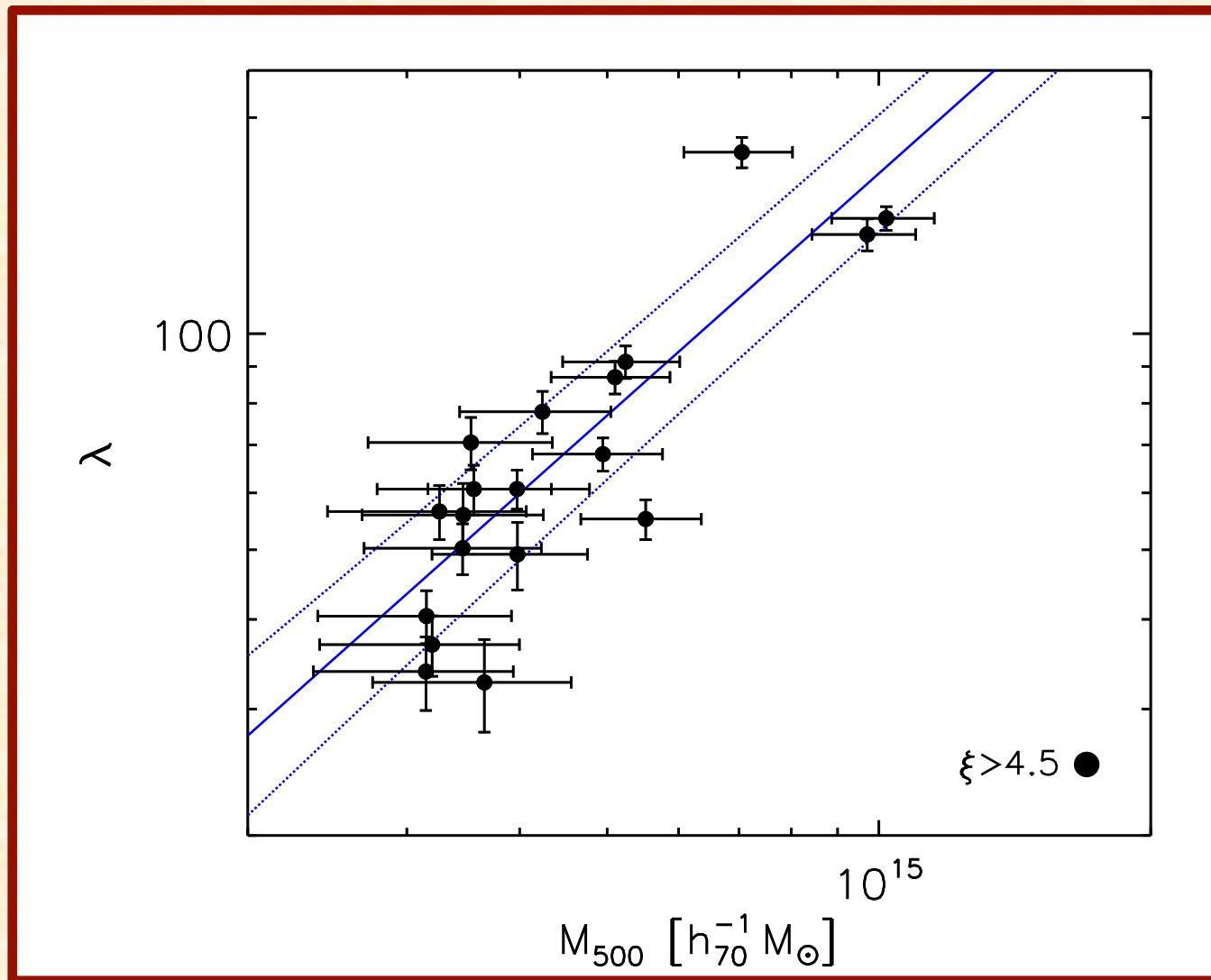




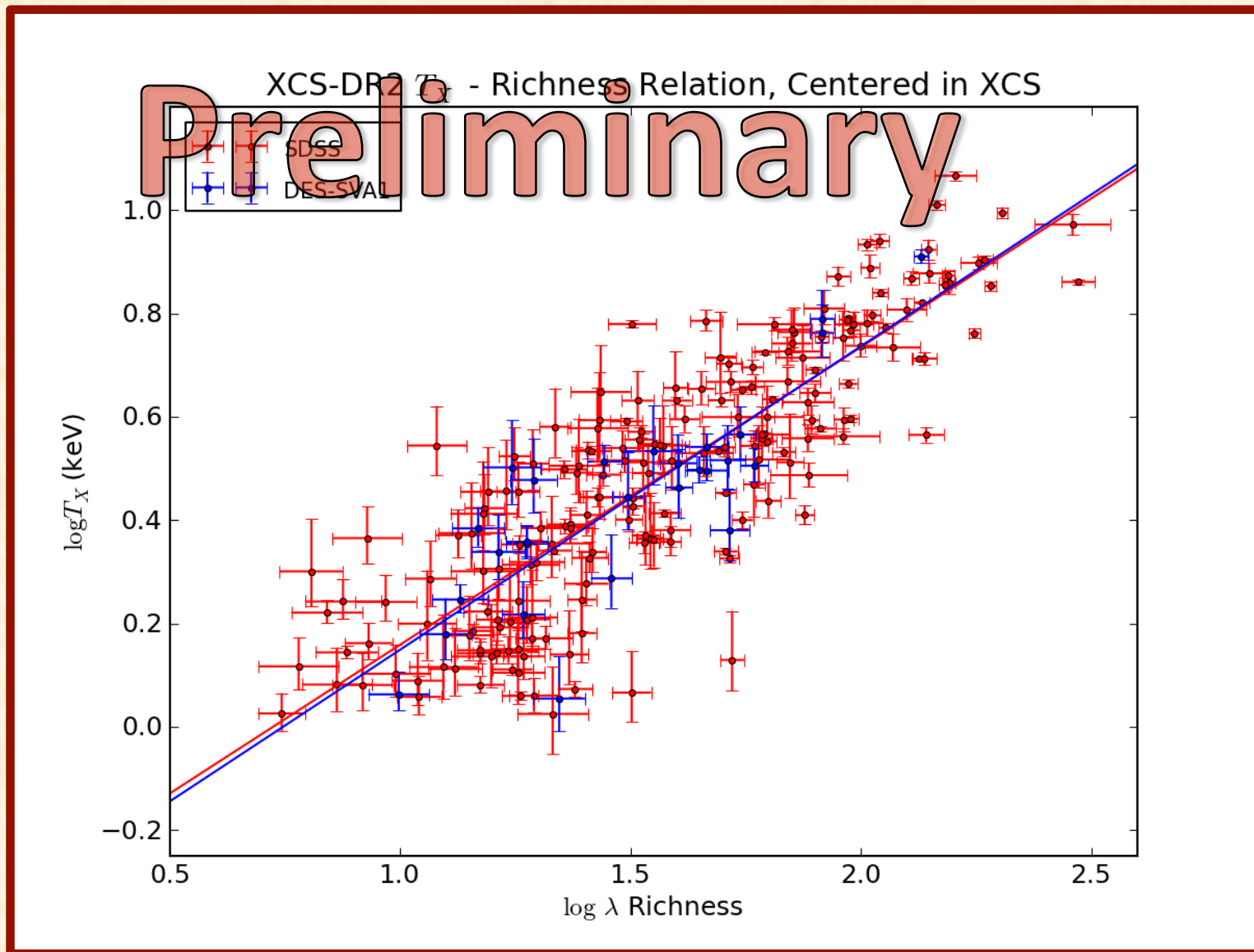
Redshift Accuracy: DES SV



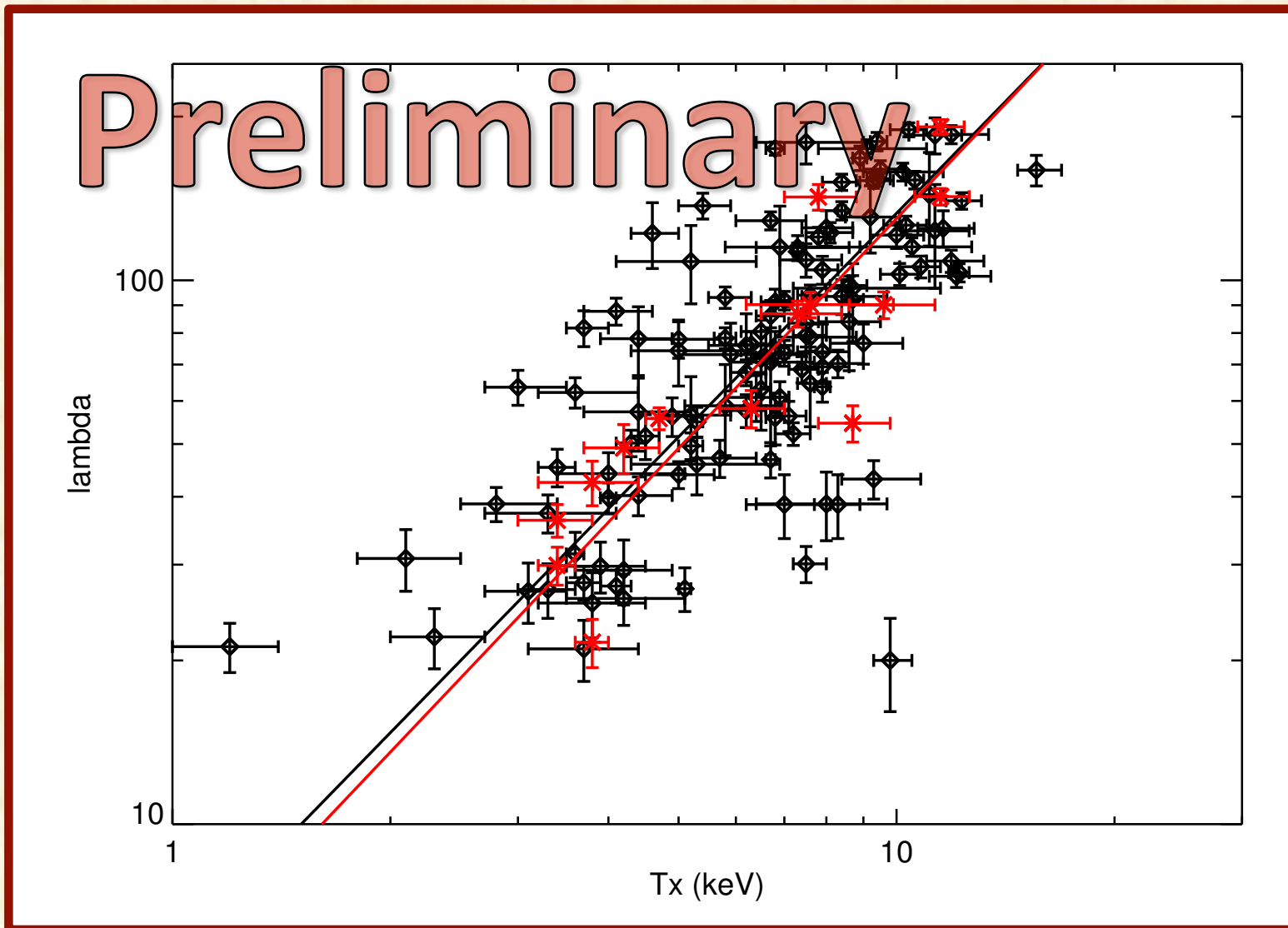
Scaling with SZ



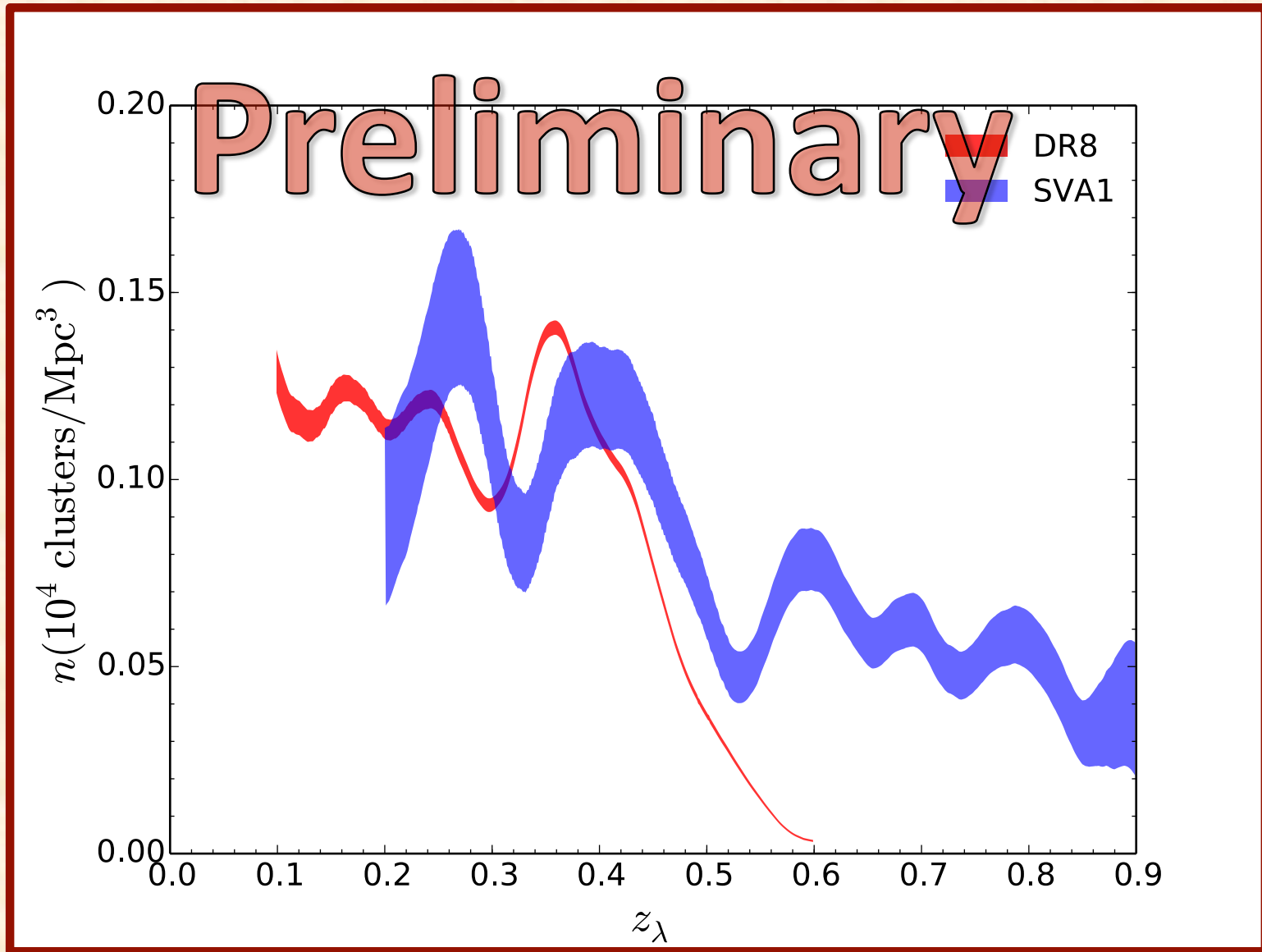
Scaling with T_X (XMM)



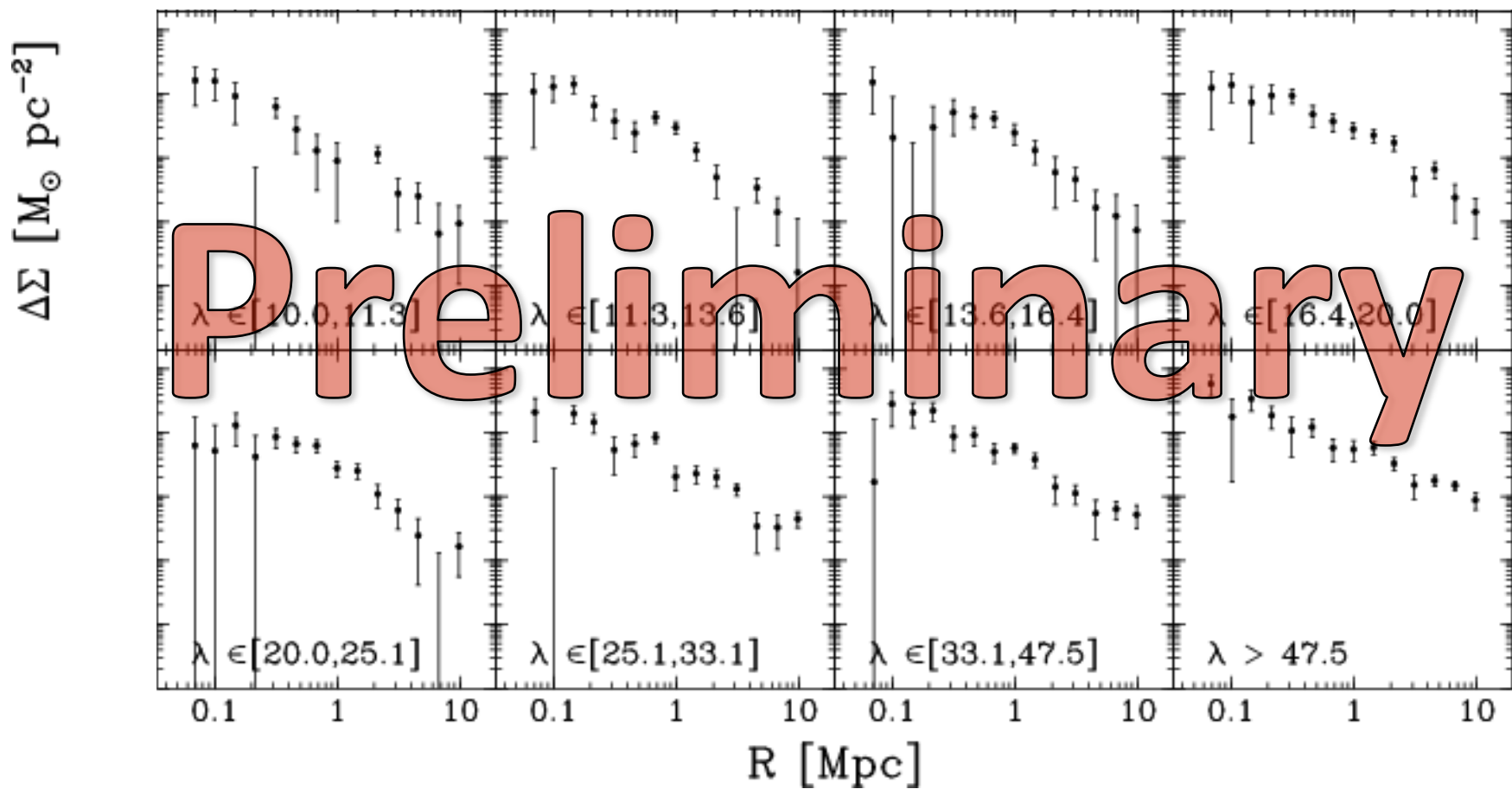
Scaling with T_X (Chandra)



Cluster Abundances



Weak Lensing Analysis Underway



One more thing...



When your only tool is a hammer...



When your only tool is a hammer...

If we can select red galaxies in clusters,
why not select red galaxies in the field?

Expect clean photozs: use as “gold
sample” for photometric LSS studies.



redMaGiC

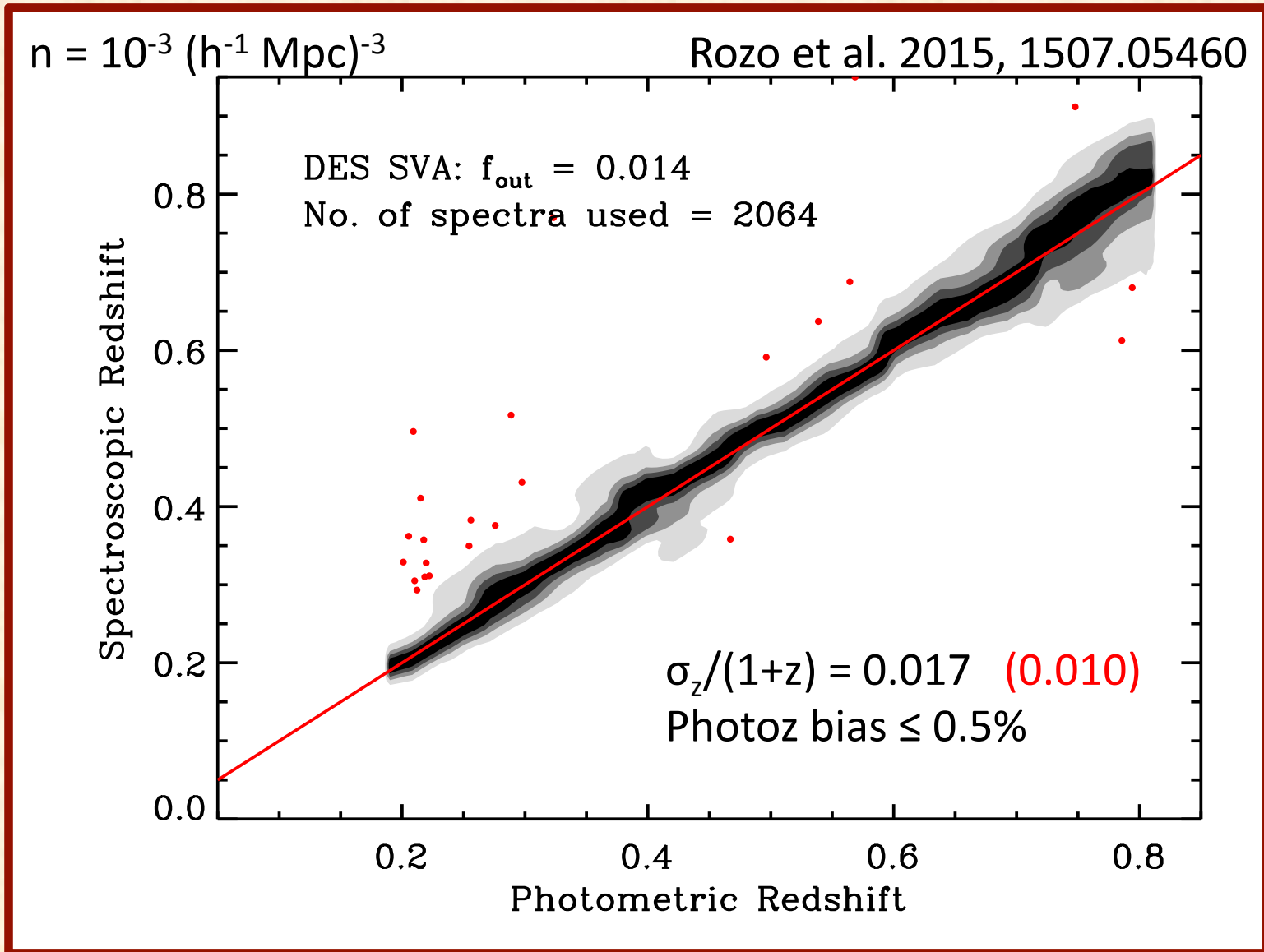
Use calibration of the red-sequence from redmapper to select red galaxies in the field, and assign them photozs.

Selection has only two free parameters:

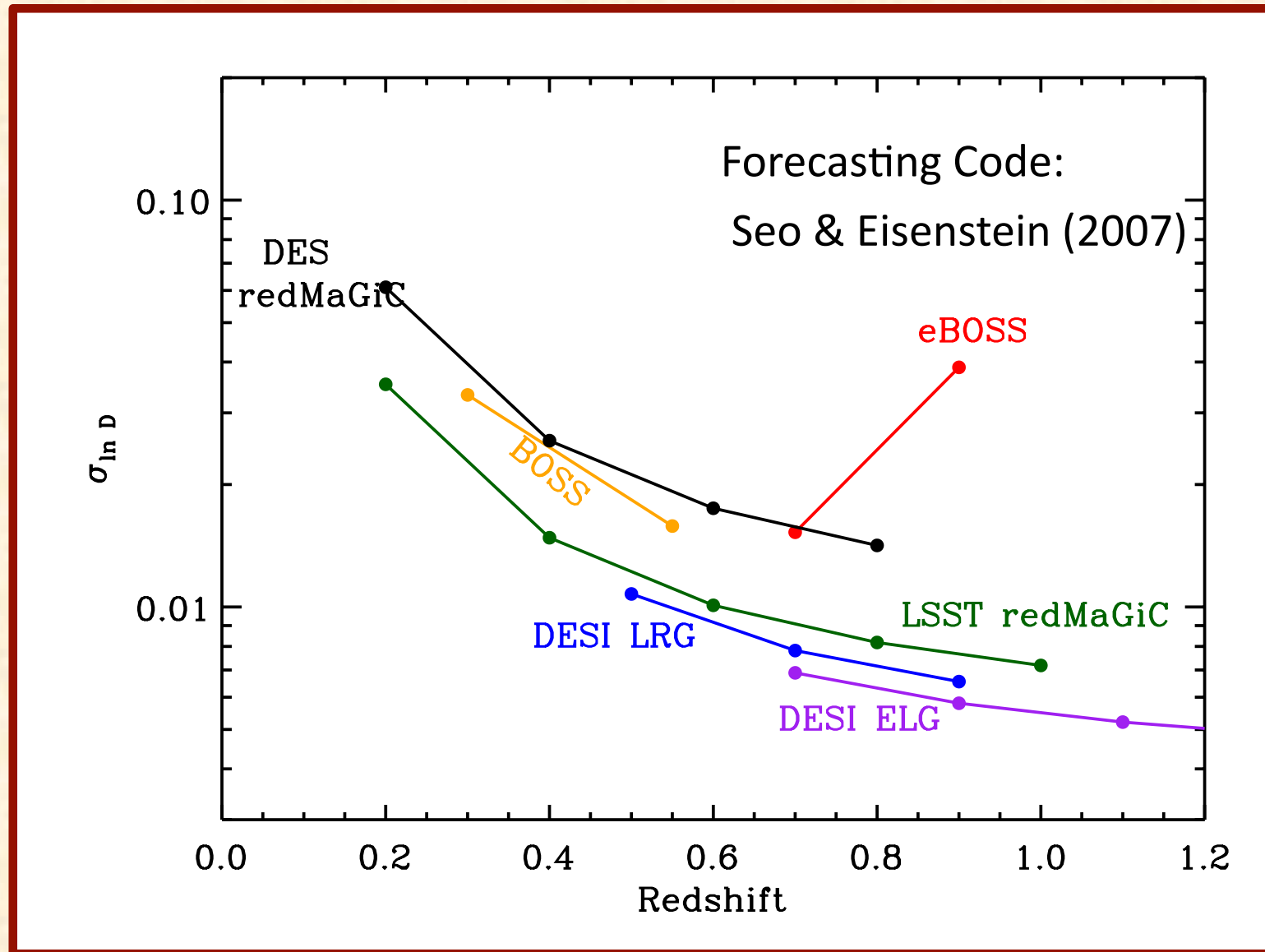
- A desired luminosity threshold, e.g. $L > 0.5L_*$
- A desired comoving space density,
e.g. $10^{-3} (h^{-1} \text{ Mpc})^{-3}$

Algorithm uses the red-sequence calibration from redMaPPer to determine the necessary color cuts.

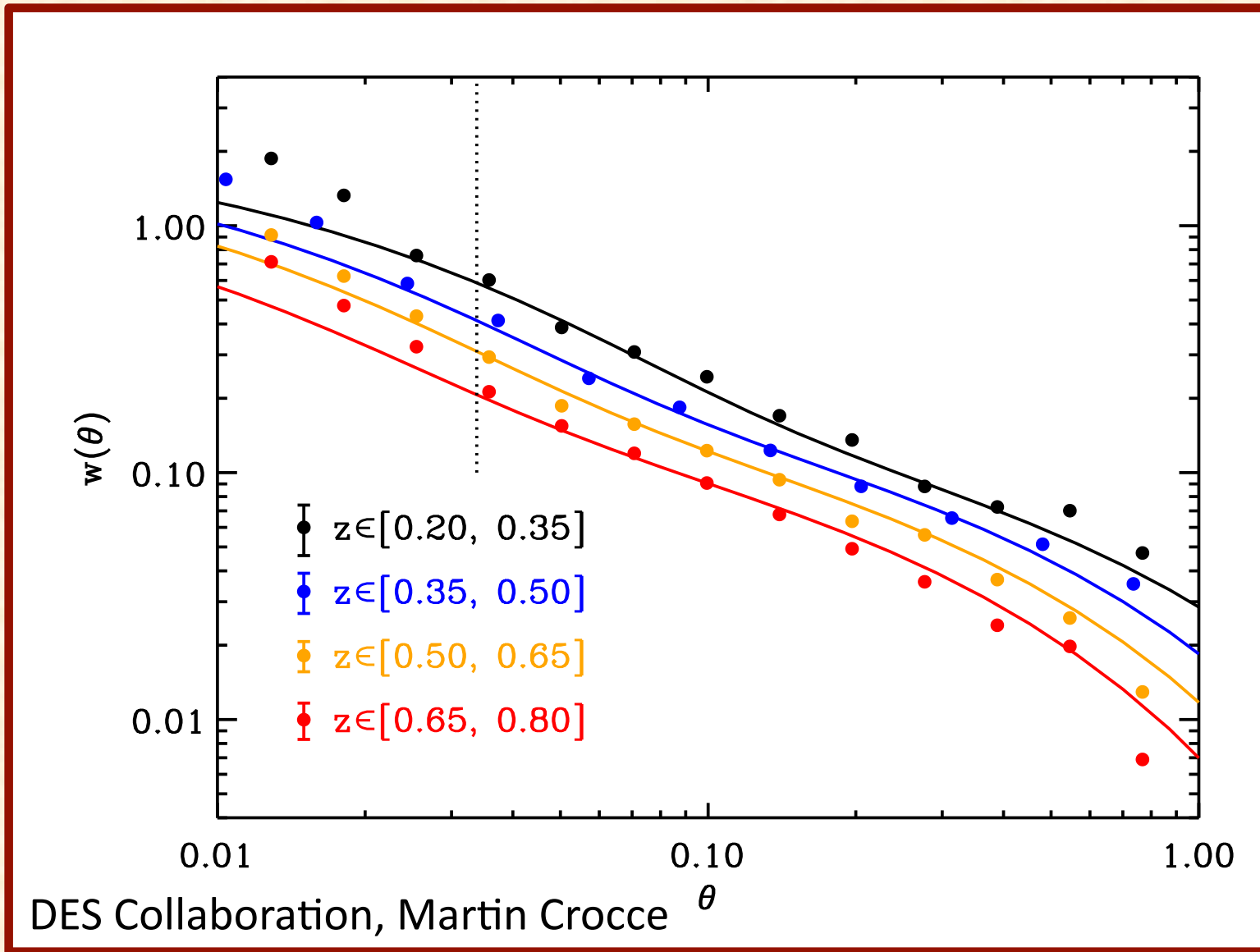
Photoz Performance (DES)



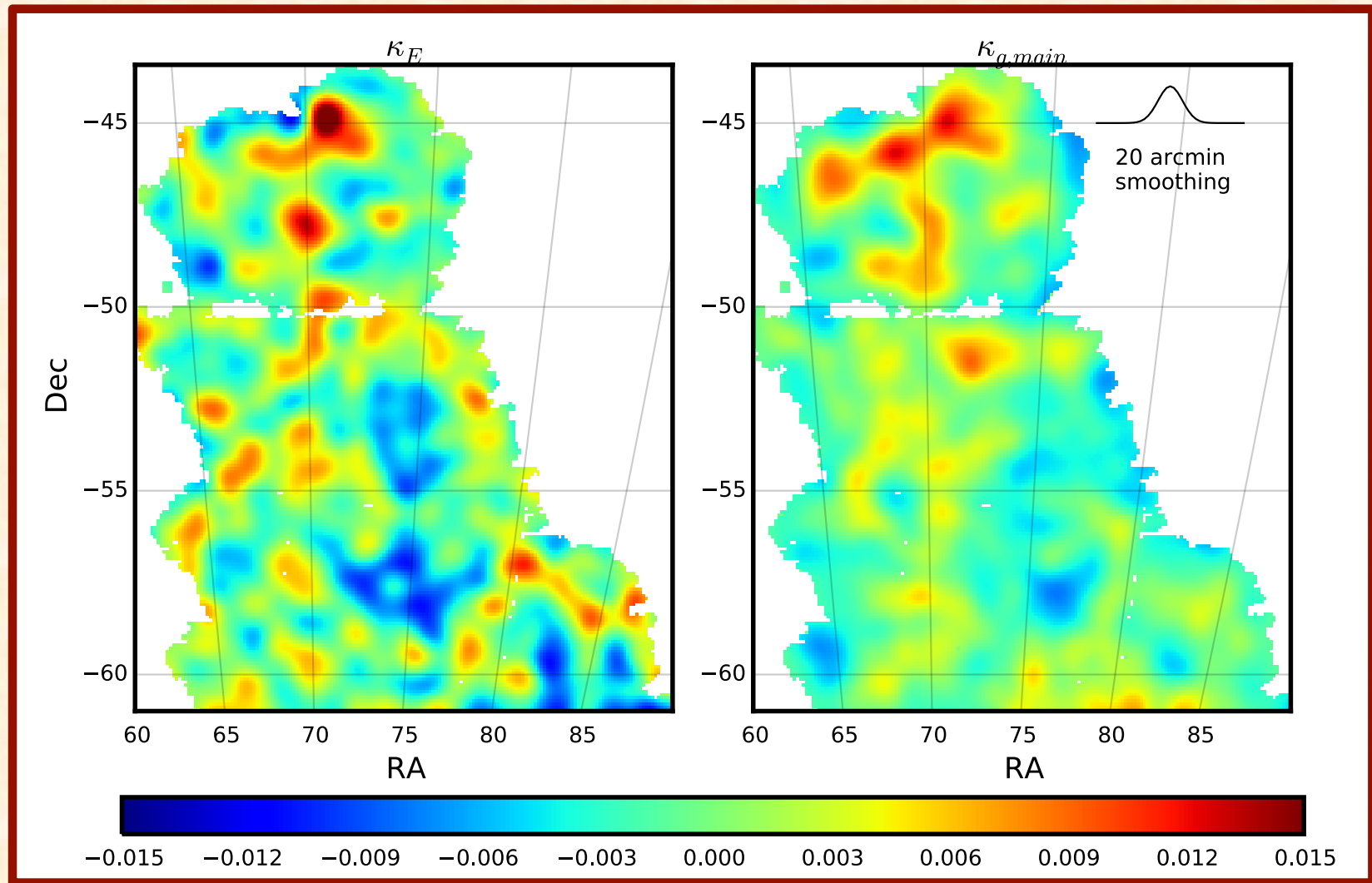
BAO with redmagic



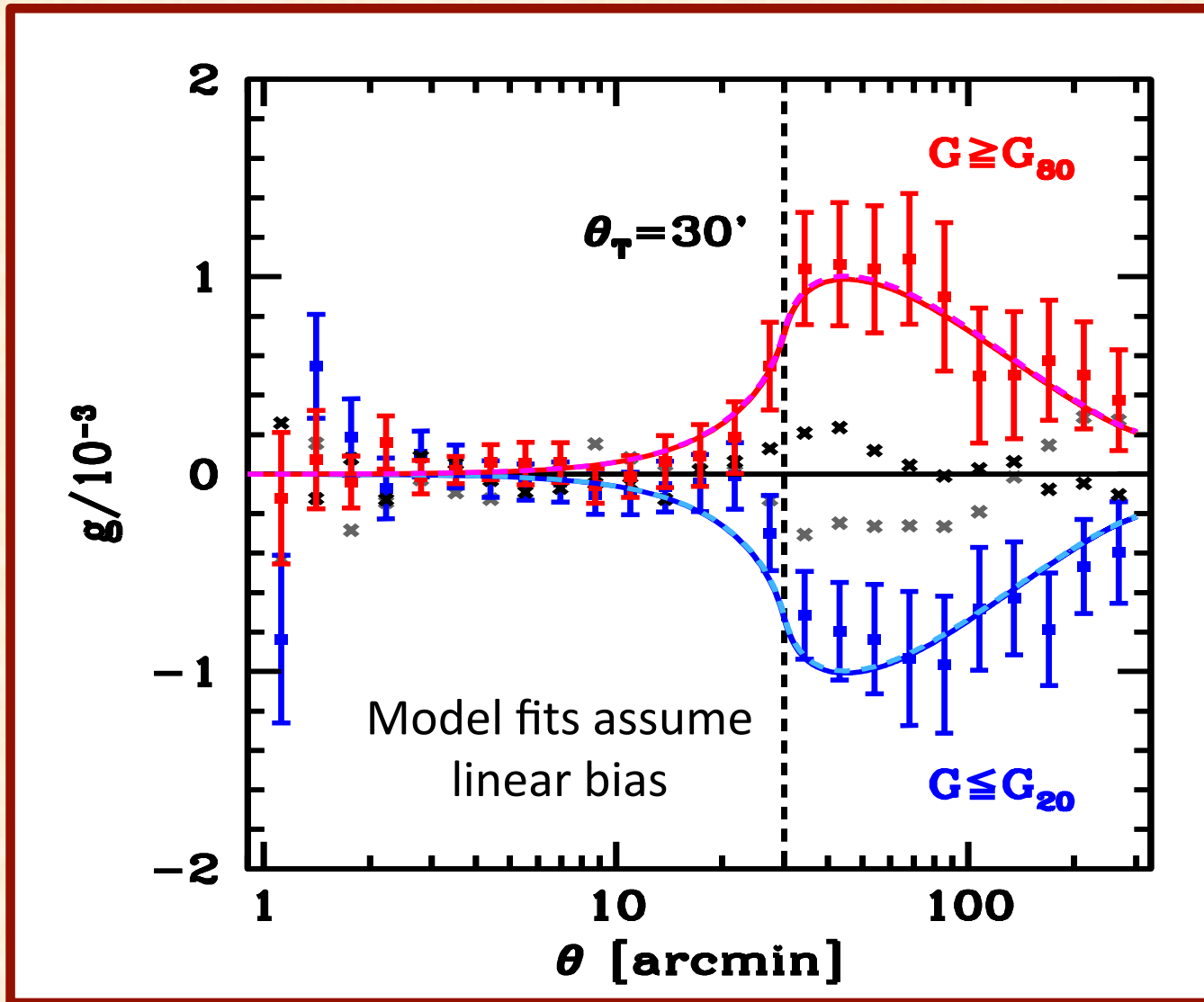
Clustering in DES SV



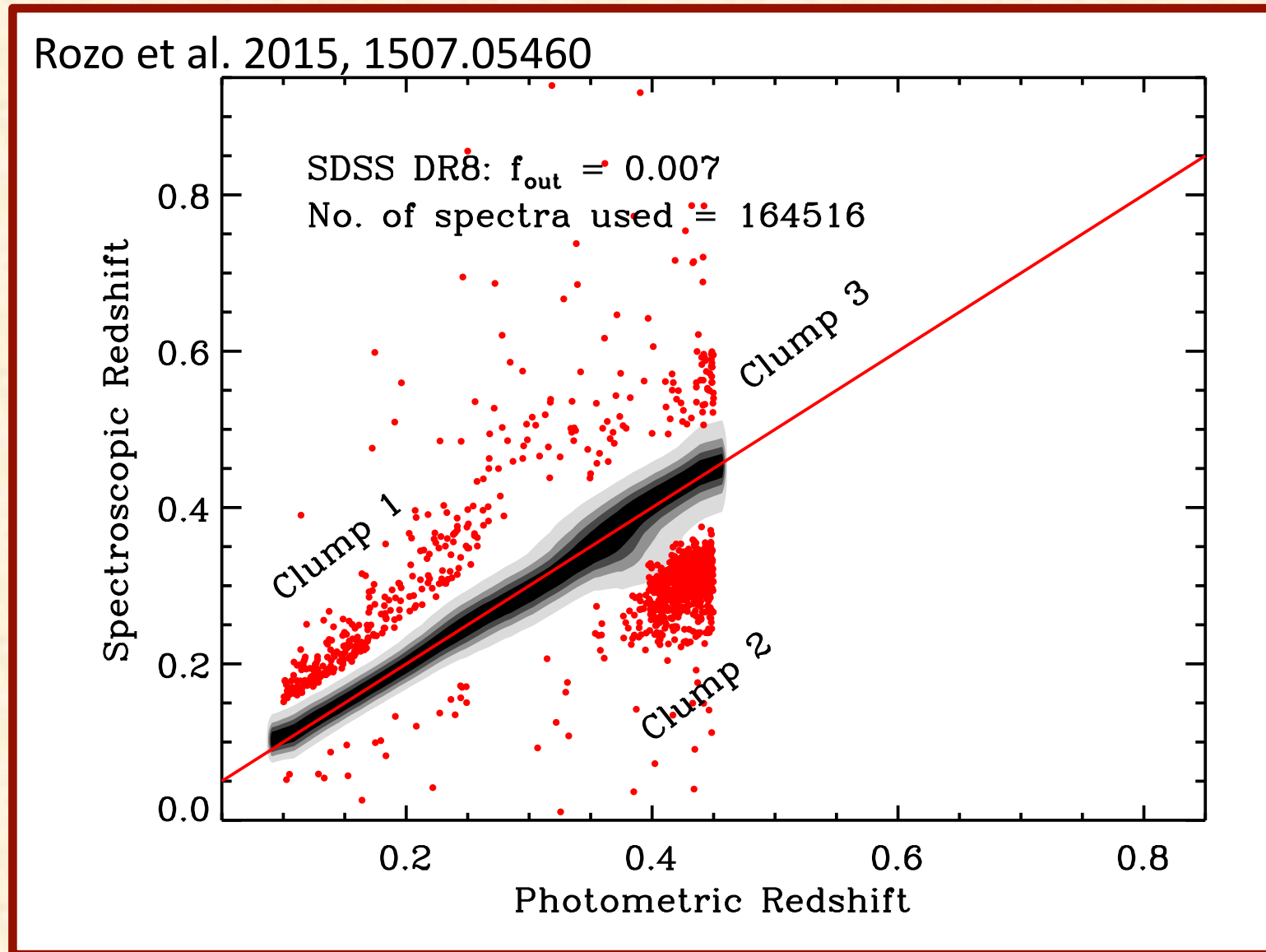
Comparison to WL Mass Maps



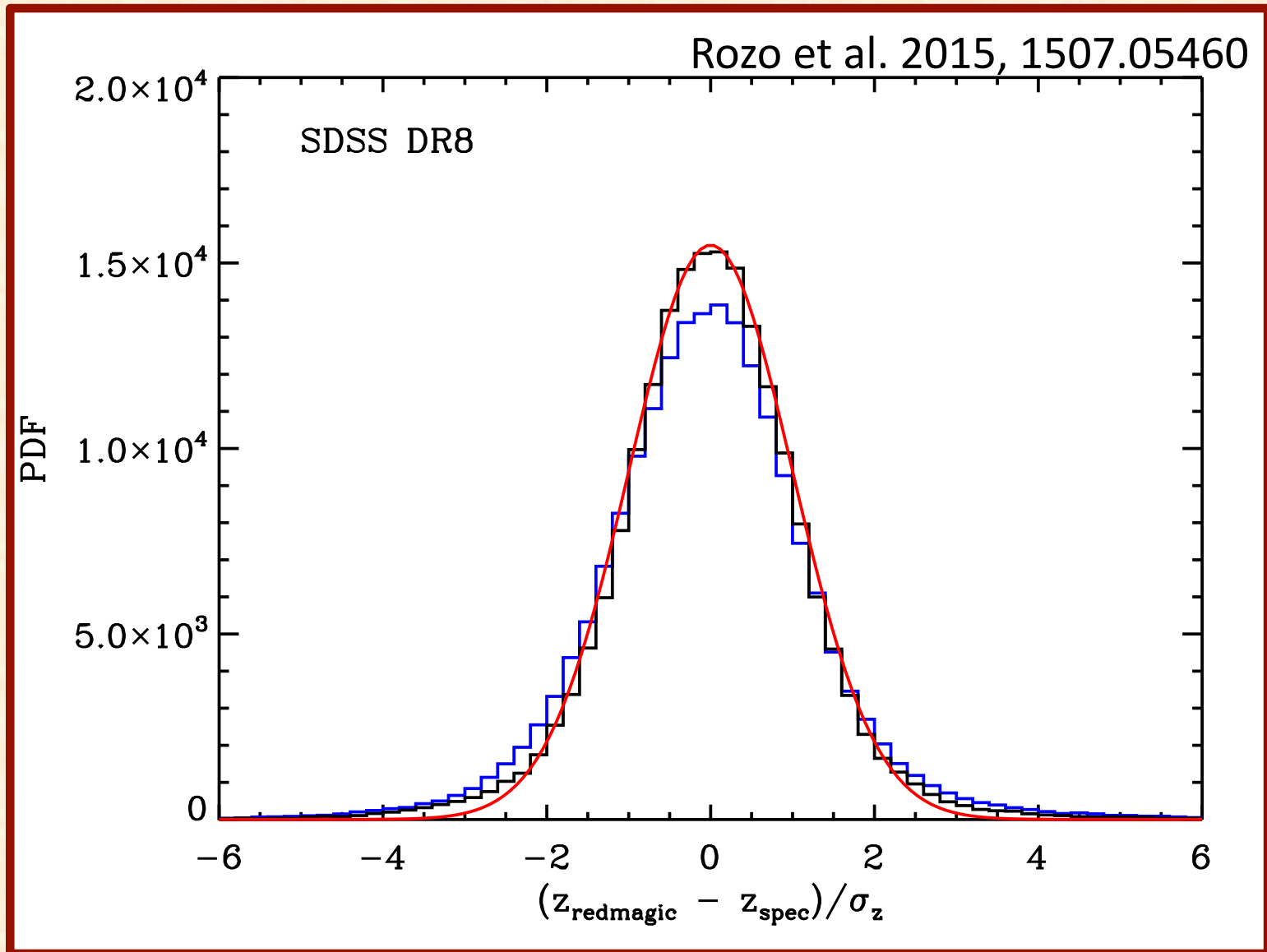
Trough Lensing



Photoz Performance (SDSS)

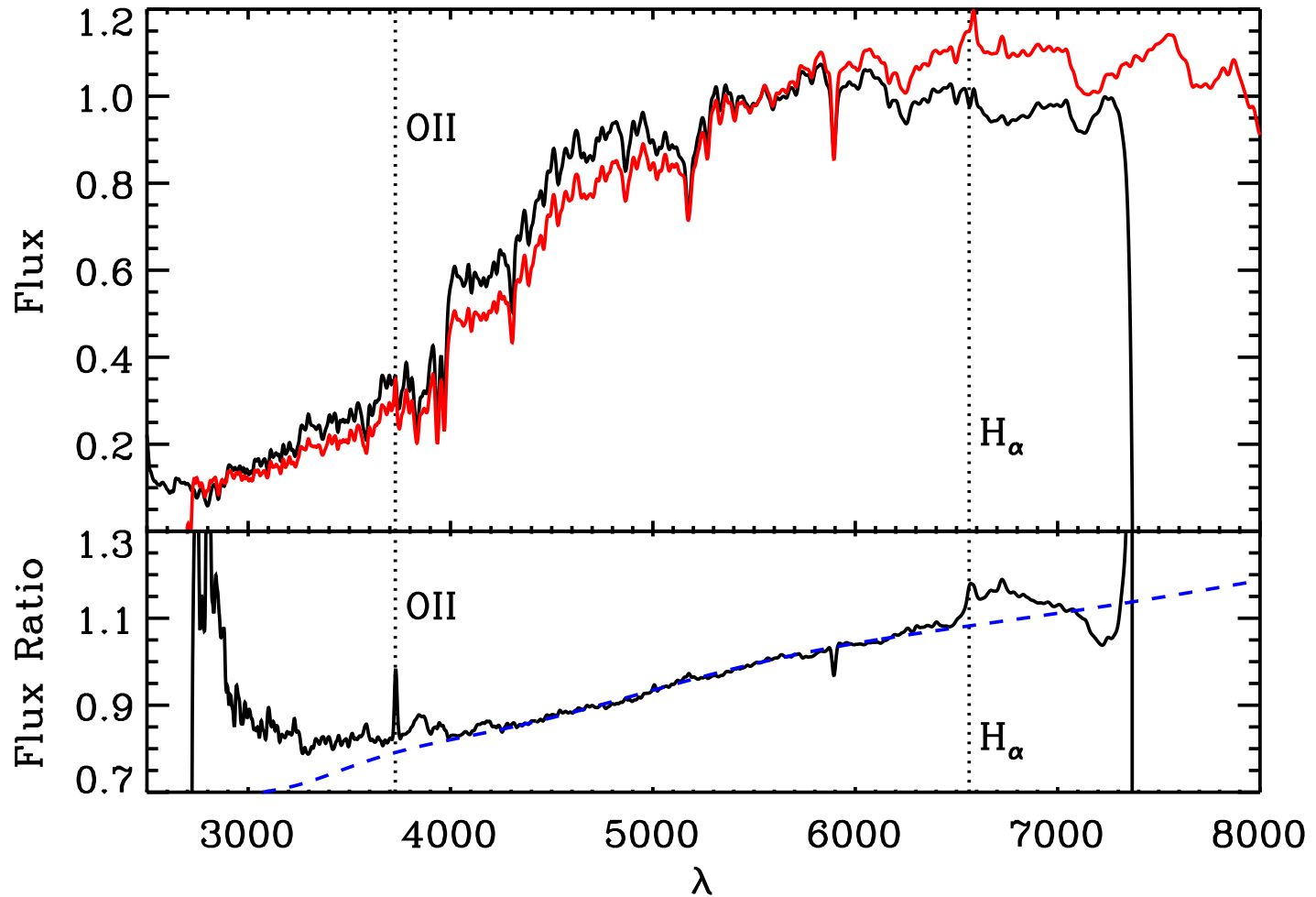


Photoz Performance (SDSS)



Clump 2 Galaxies

Rozo et al. 2015, 1507.05460



Dusty Ellipticals





Summary

- No compelling evidence of tension between cluster abundances and Planck CMB constraints
- Main systematic is mass calibration.
- DES/HSC/KIDS should be able to significantly clarify the current picture.
- Cosmology requires good photometric cluster finding algorithms. Things look pretty good!
- Cluster finding techniques can be used produce “gold” samples for photometric LSS studies.