Argelander-Institut für Astronomie

Corfu TR33 meeting Sep 17-21, 2012

universitätbonn

The APEX-SZ weak lensing follow-up project

Matthias Klein
AIfA, Bonn University

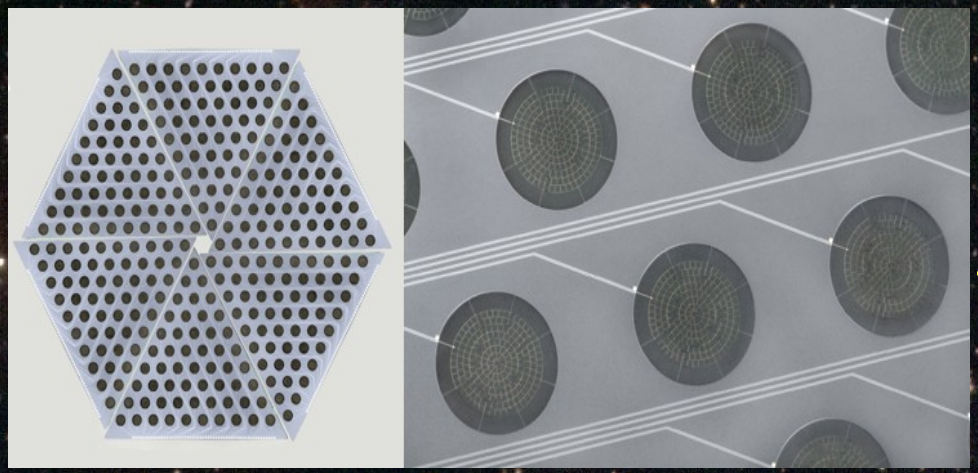
APEX-SZ Group (Bonn):
Frank Bertoldi
Kaustuv Basu
Sandra Burkutean
Matthias Klein
Aarti Nagarajan
Martin Nord
Florian Pacaud

19/09/2012

What is APEX-SZ ?

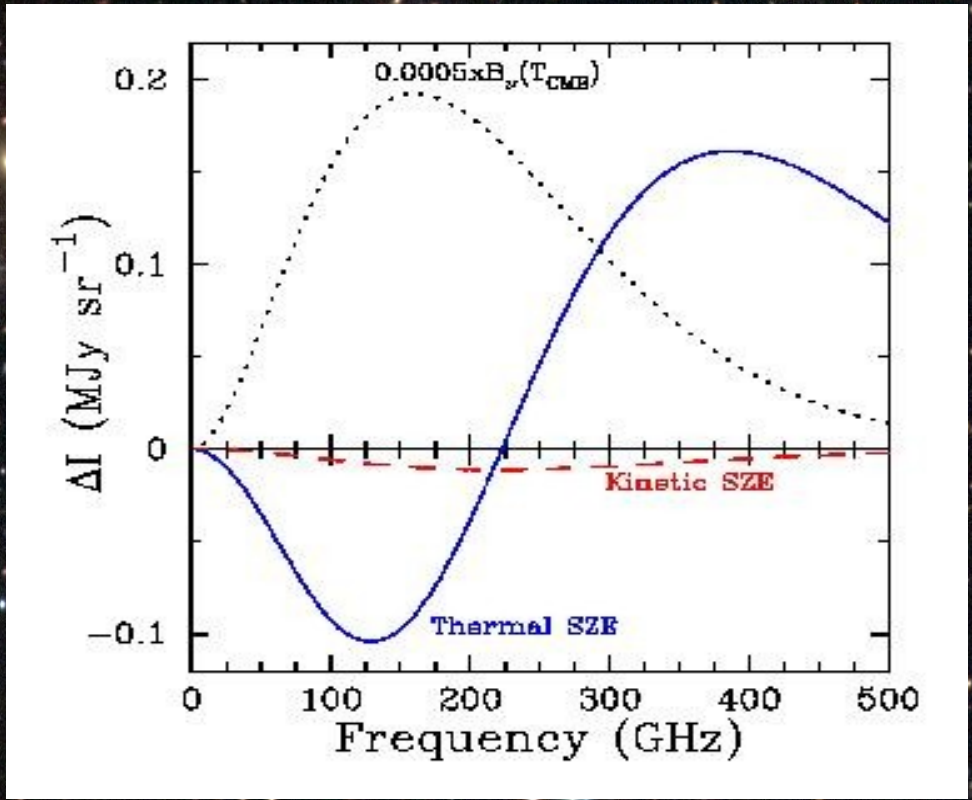
- Bolometer camera mounted on the APEX telescope
- Camera consisting of 330 bolometers
- Sensitive in the SZ regime (at 150 GHz)

What is APEX-SZ ?



- Bolometer camera mounted on the APEX telescope
- Camera consisting of 330 bolometers
- Sensitive in the SZ regime (at 150 GHz)

What is APEX-SZ ?



- Bolometer camera mounted on the APEX telescope
- Camera consisting of 330 bolometers
- Sensitive in the SZ regime (at 150 GHz)

The APEX-SZ project:

- Targeted observations of known clusters
- About 42 detections in SZ
- Redshift range from 0.1 to 1.4
- X-ray coverage of 38 clusters
- Optical coverage for all detections

The weak lensing project (goals):

Complete lensing follow up of all SZ detections with $z<1.0$ for ...

- Scaling between SZ, WL and X-ray observables
- Detailed analysis of individual cluster mergers
- Multi-wavelength studies combining WL, SZ and X-Ray measurements (3D structure)

The weak lensing project (data):

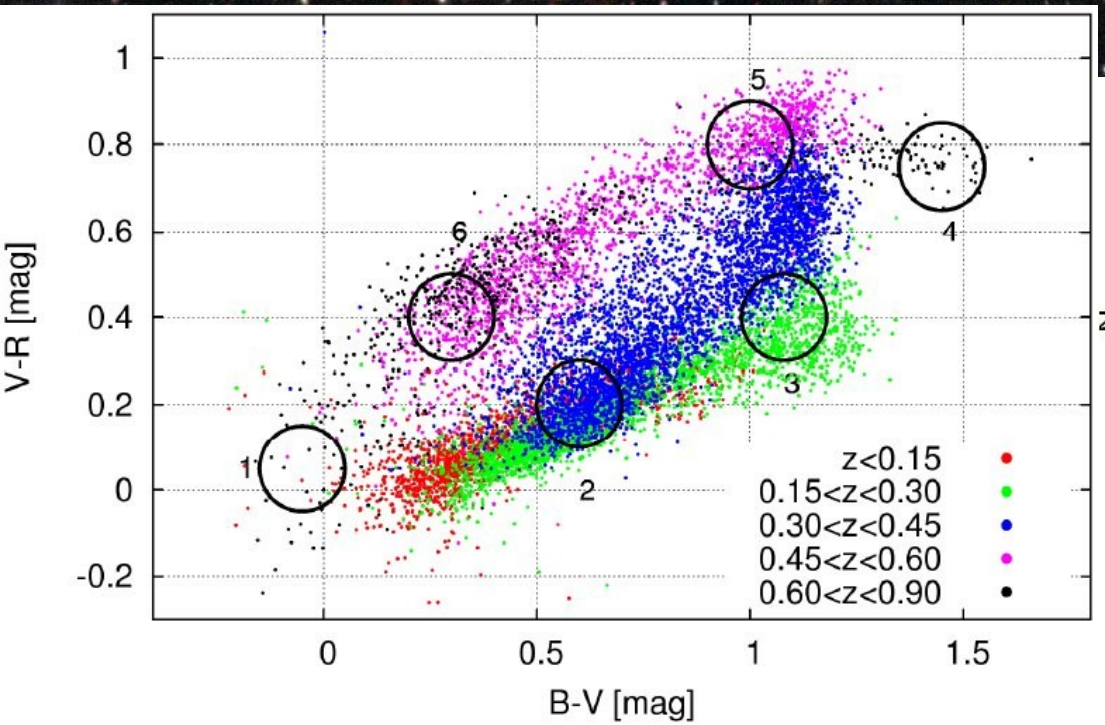
- Own observations with WFI at 2.2 m MPG/ESO telescope (La Silla, Chile)
- Archival data from WFI and Suprime-Cam at Subaru telescope (Manua Kea, USA)
- Homogeneous data reduction & analysis of all clusters

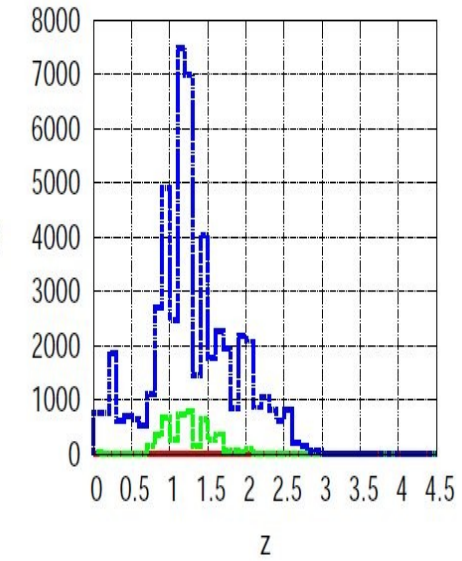
Challenges for the weak lensing project

1. observing strategy:
   - Number of filter band vs. Depth ➡ min. 3 Filters
   - Usage of archival data ➡ max. 2 Instruments
2. measurements:
   - Quality requirements ➡ seeing < 1“
   - Shear measurement code ➡ KSB+
3. analysis methods:
   - Homogeneous methods ➡ background selection & data analysis
   - Minimizing biases ➡ individual redshift estimates

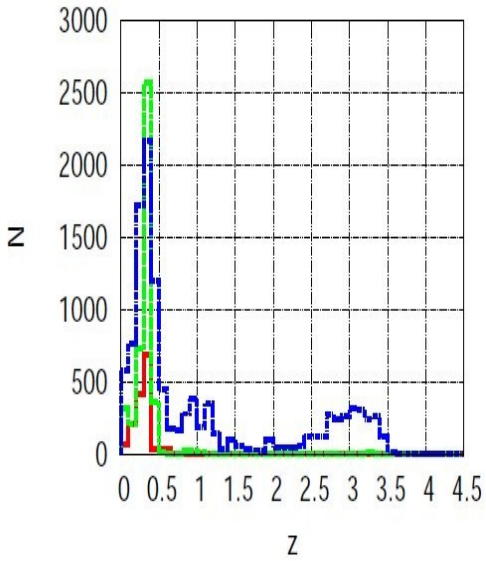
Redshift distribution in the cc-plane

COSMOS-30 photo-z catalog (Ilbert et al. 2009)

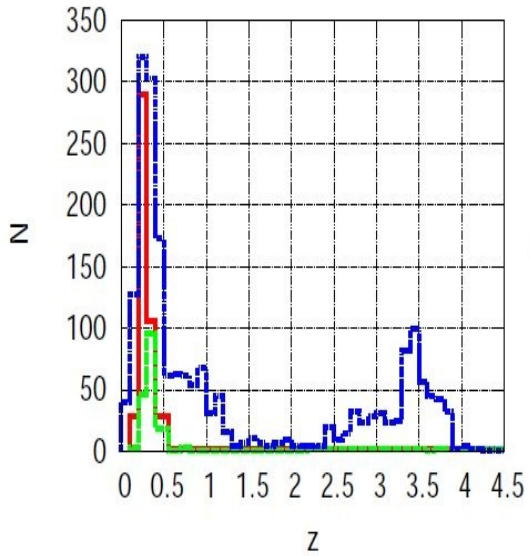




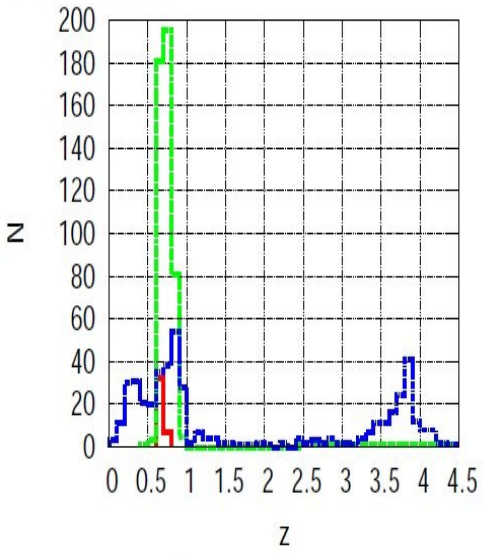
Region 1



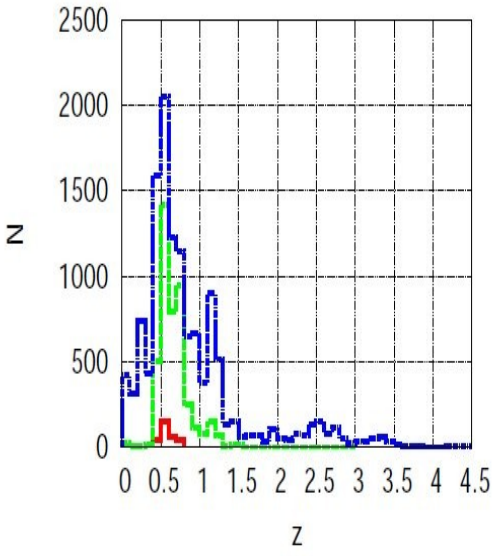
Region 2



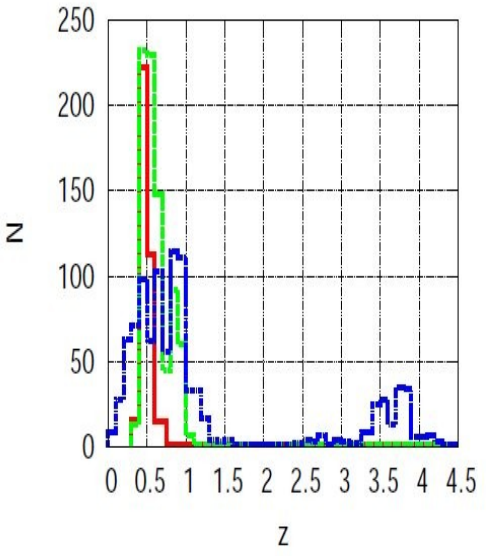
Region 3



Region 4



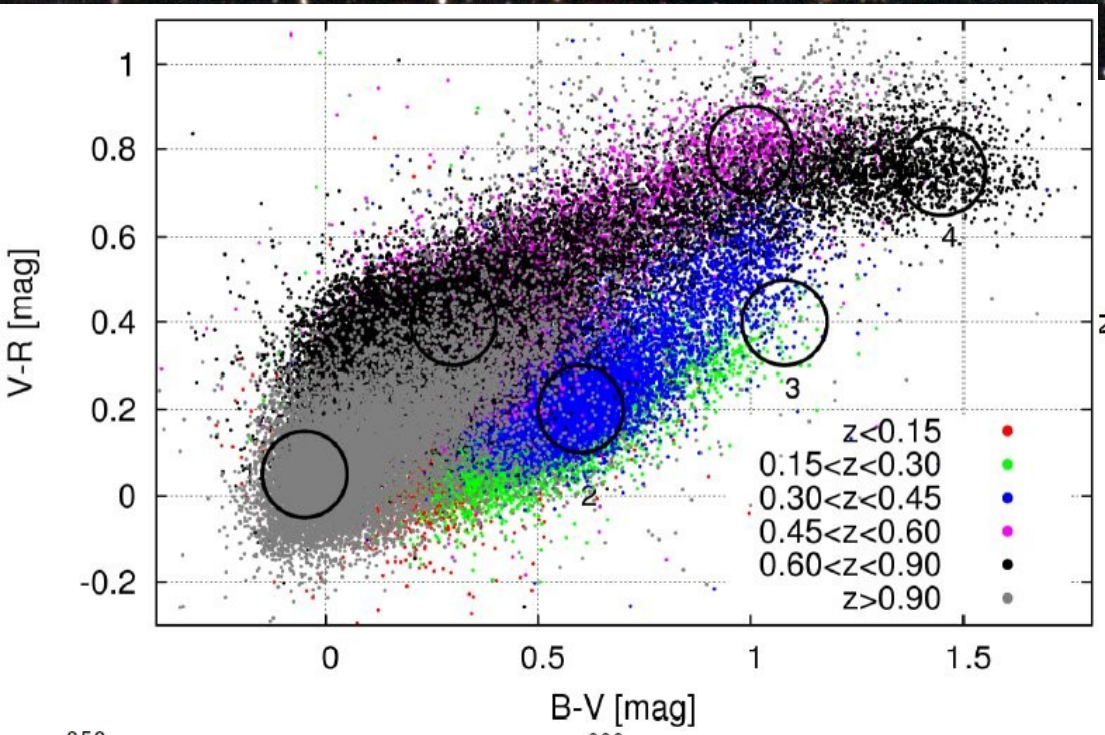
Region 5

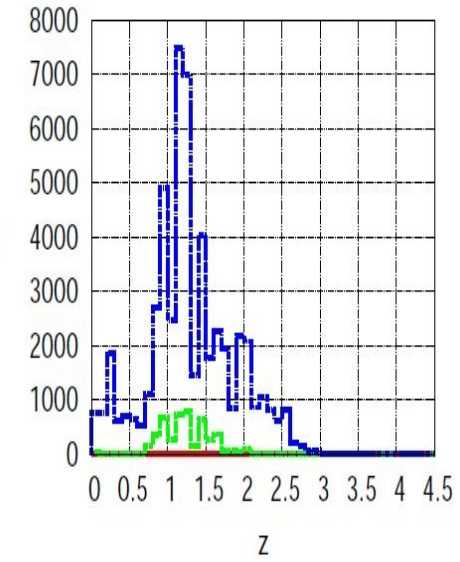


Region 6

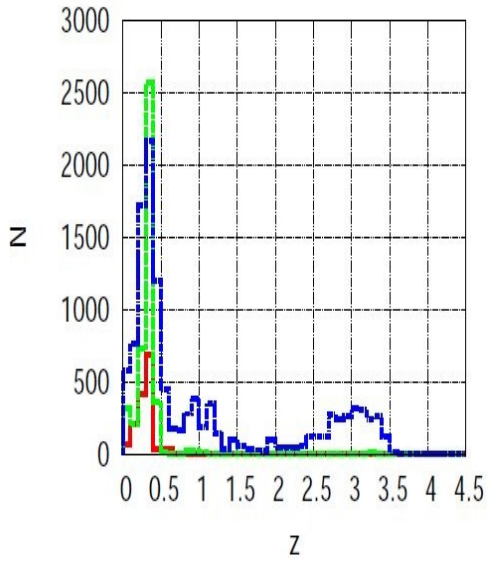
Redshift distribution in the cc-plane

COSMOS-30 photo-z catalog (Ilbert et al. 2009)

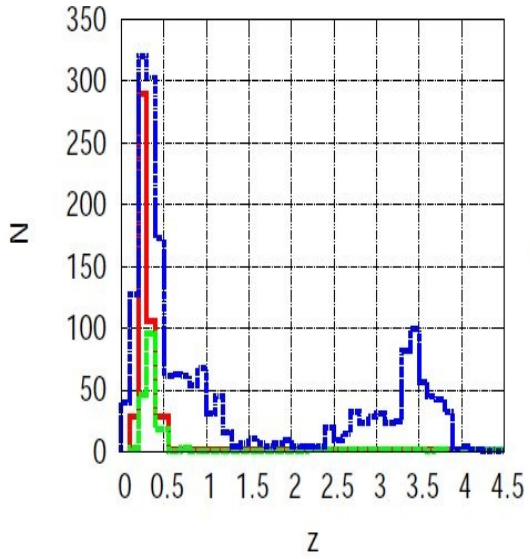




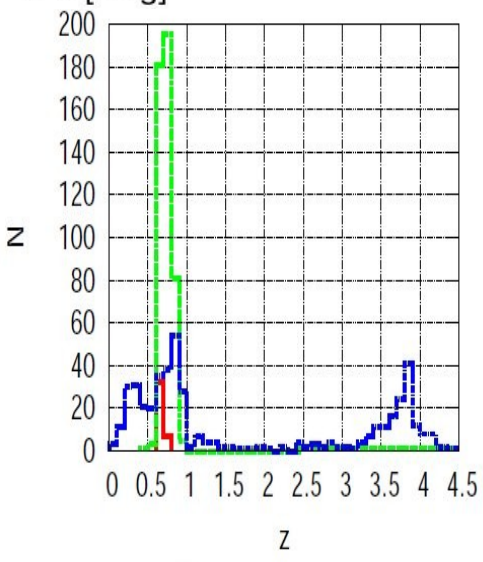
Region 1



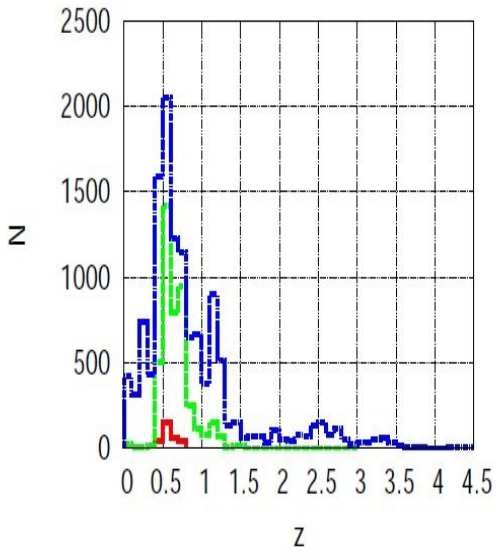
Region 2



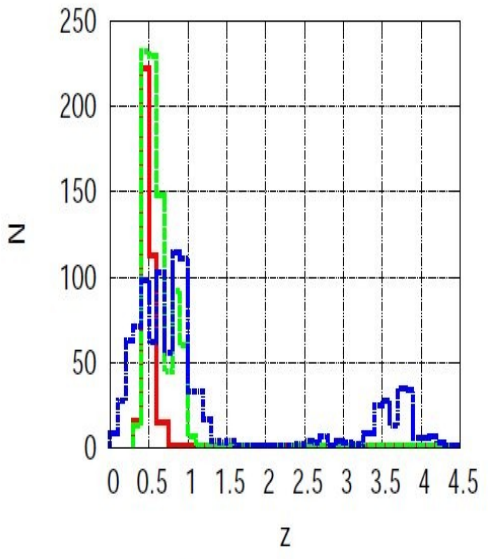
Region 3



Region 4

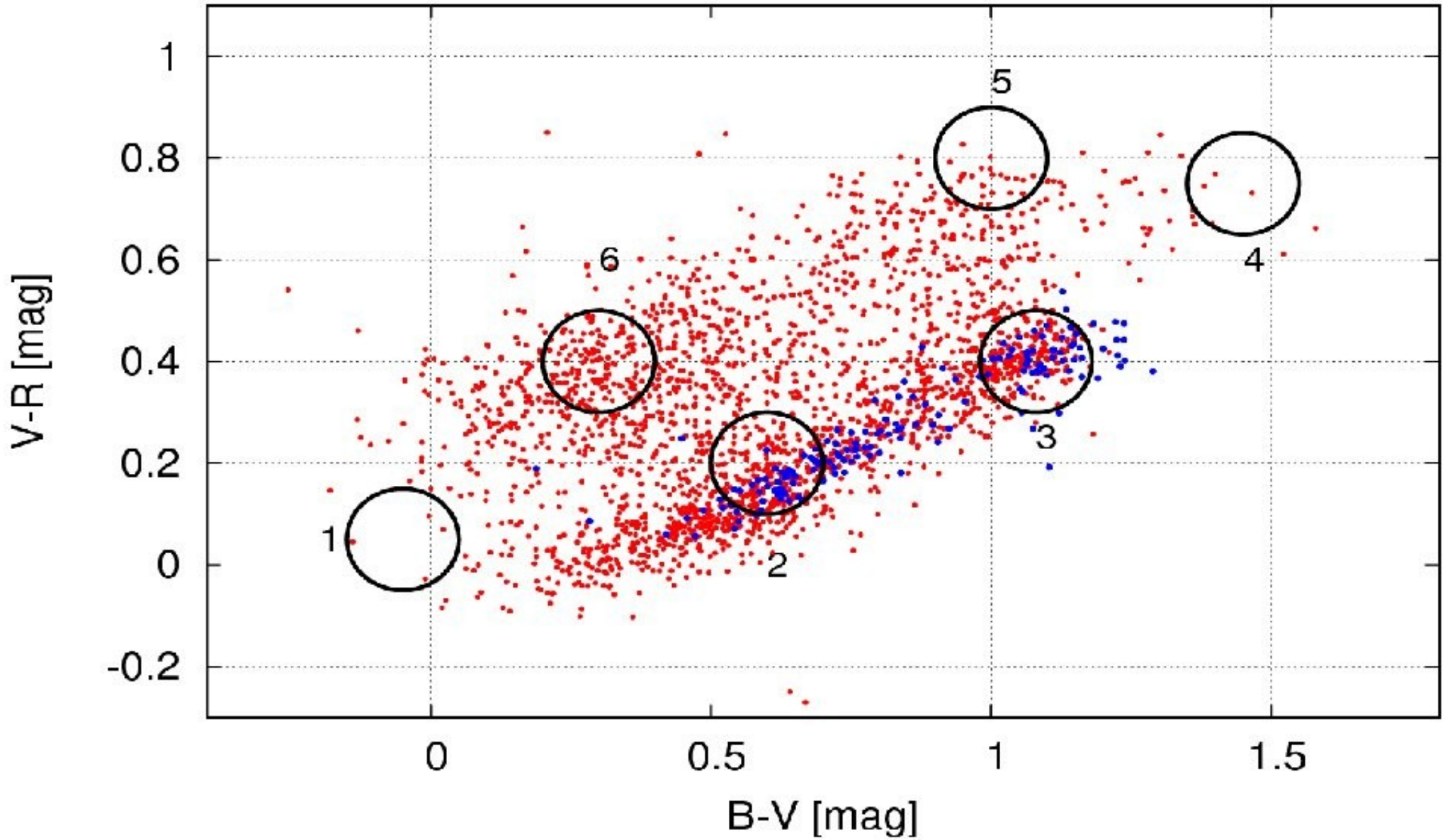


Region 5



Region 6

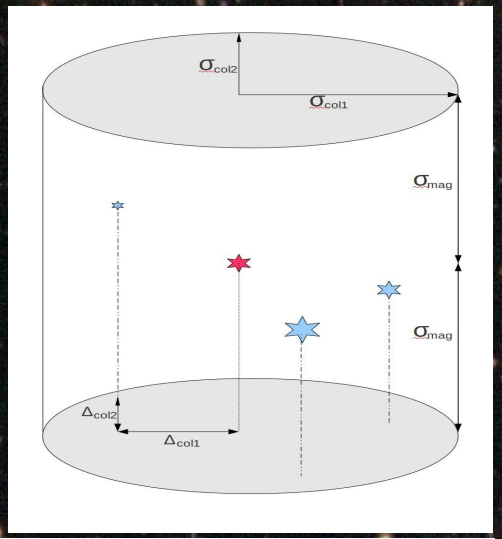
Bright galaxies around RXCJ0532



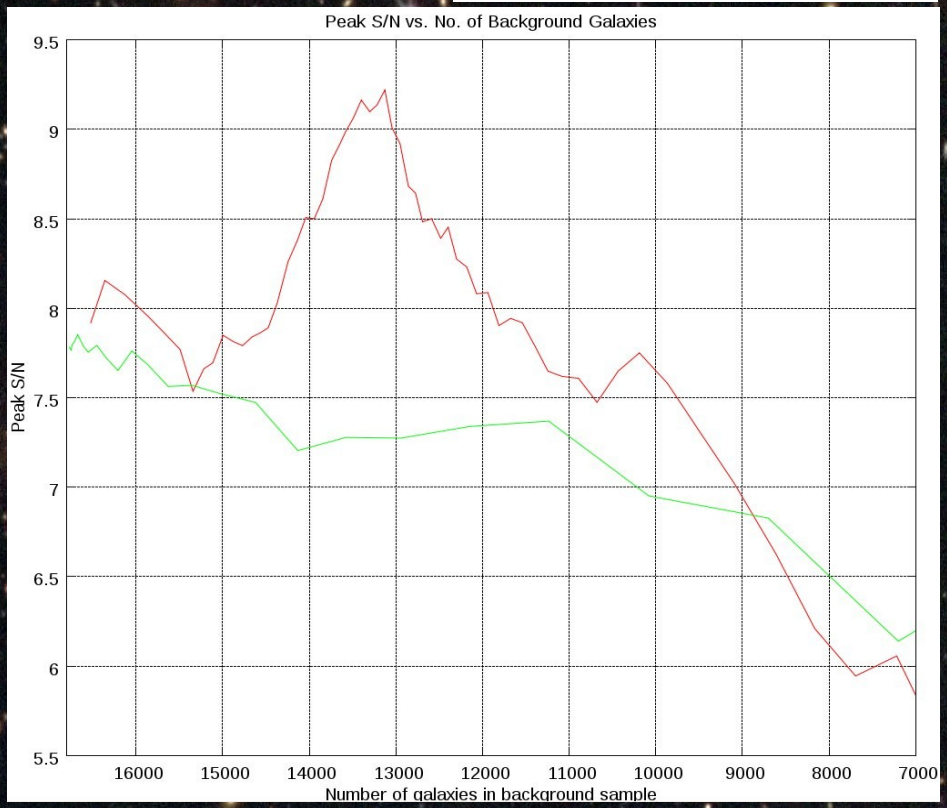
Background selection

- Deriving the angular diameter distance ratio $\beta = D_{ds}/D_s$ for each galaxy:

$$\beta_g = \frac{\sum_{i=1}^{N} w(\Delta_{col1,i}, \Delta_{col2,i})\beta(z_i)}{w(\Delta_{col1,i}, \Delta_{col2,i})}$$



- cut out galaxies with low β
- find cut (β_{max}) with maximum S/N
- starting at β_{max} searching for a cut which suggest the optimal clean cut (β_{opt})
- in most cases $\beta_{opt} \approx \beta_{max}$



Background selection

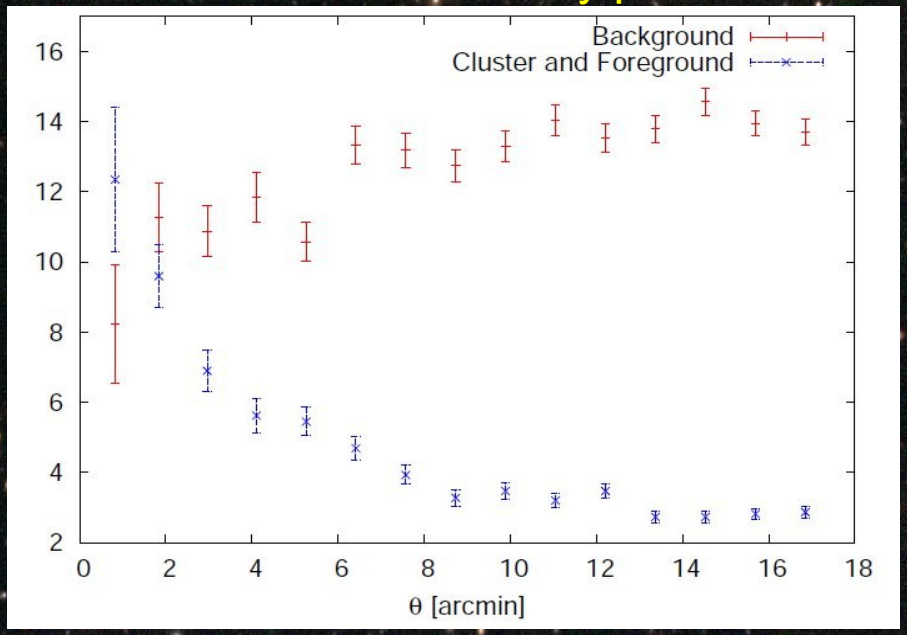
Check plots:

- number density profile
- shear profile for low & high redshift sub-samples

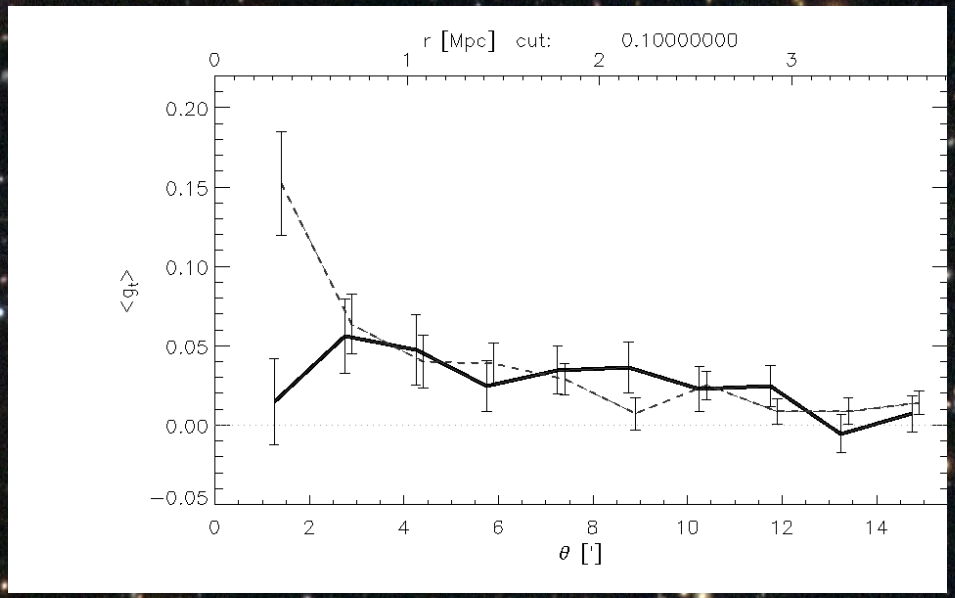
➡ using individual β_G can correct for …

- remaining contamination
- local variation

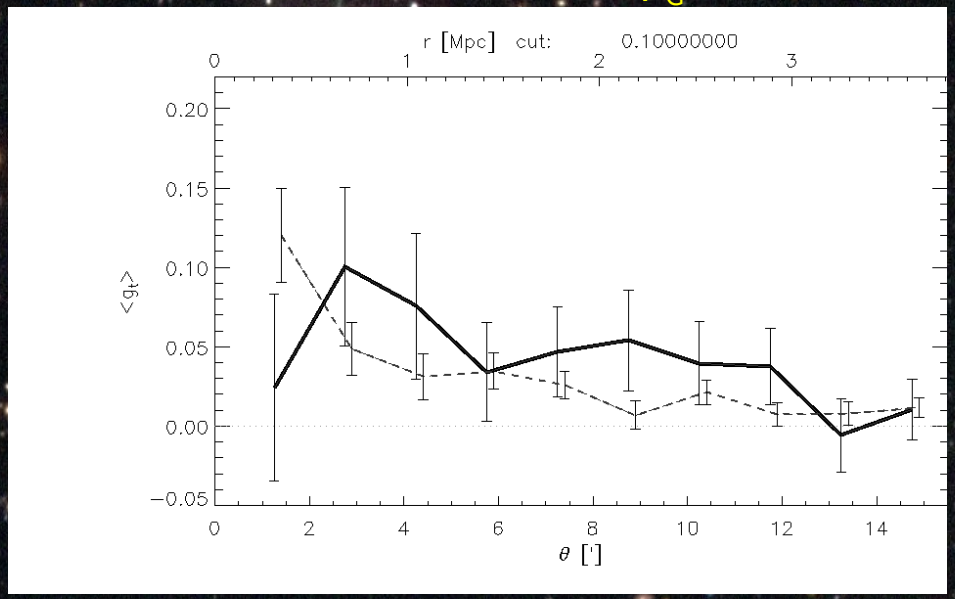
Number density profile:



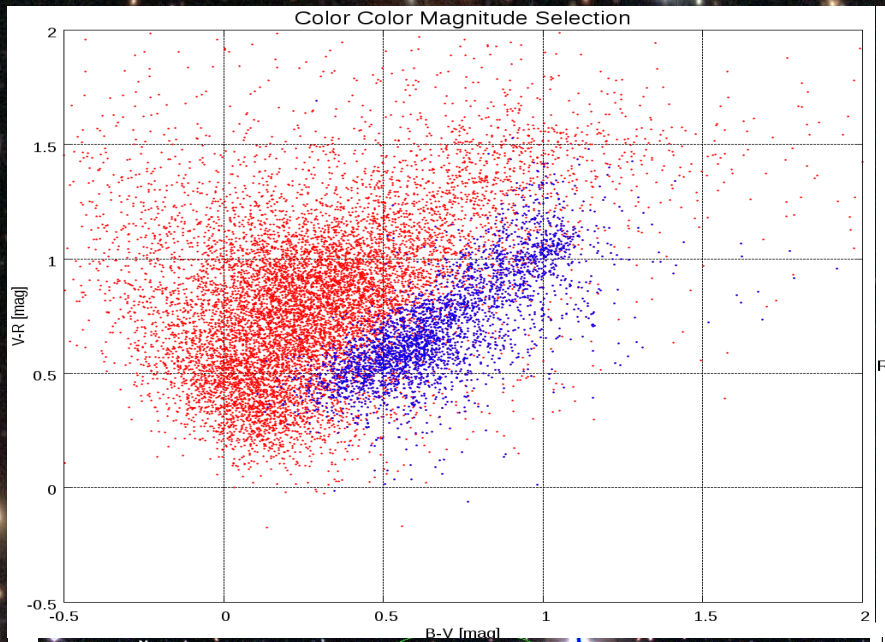
Single source sheet:

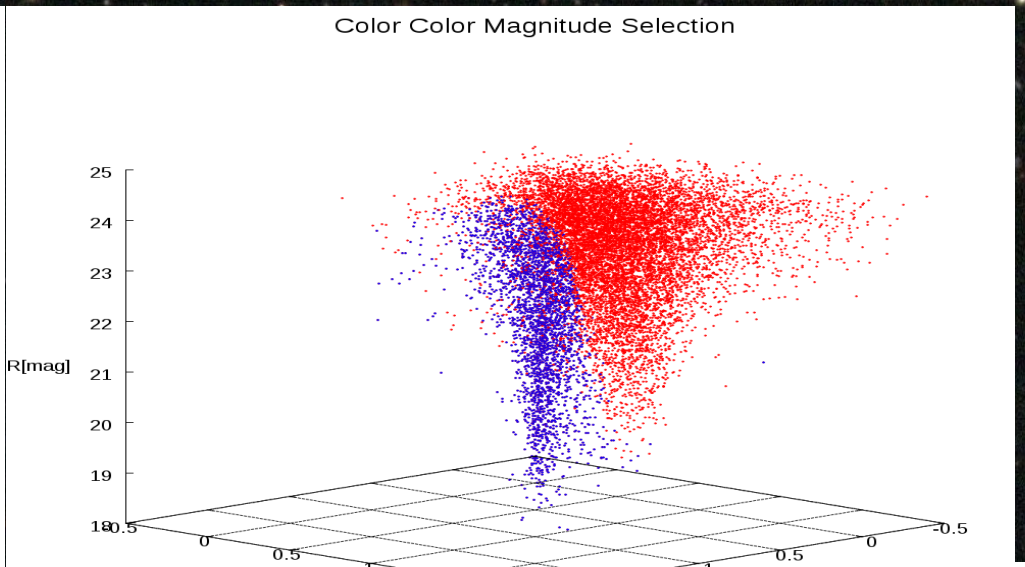


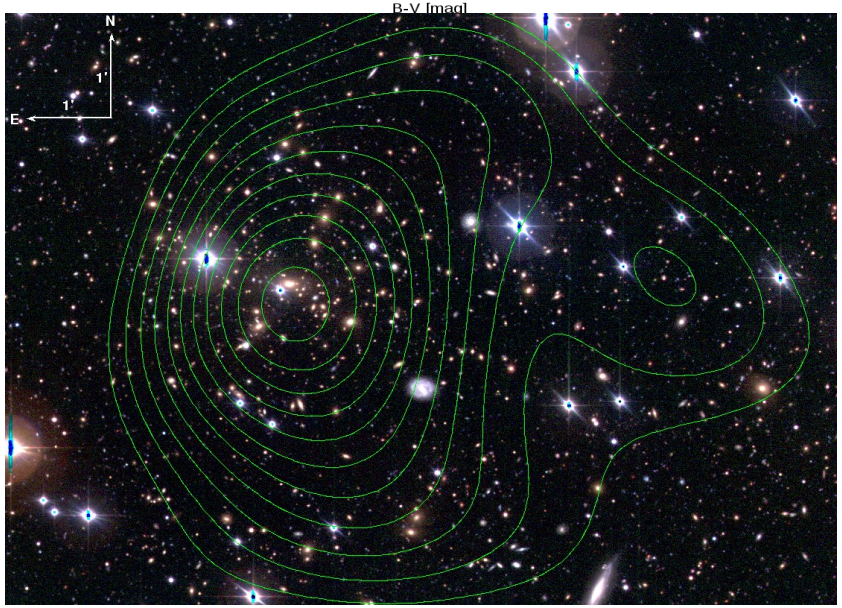
using individual β_G

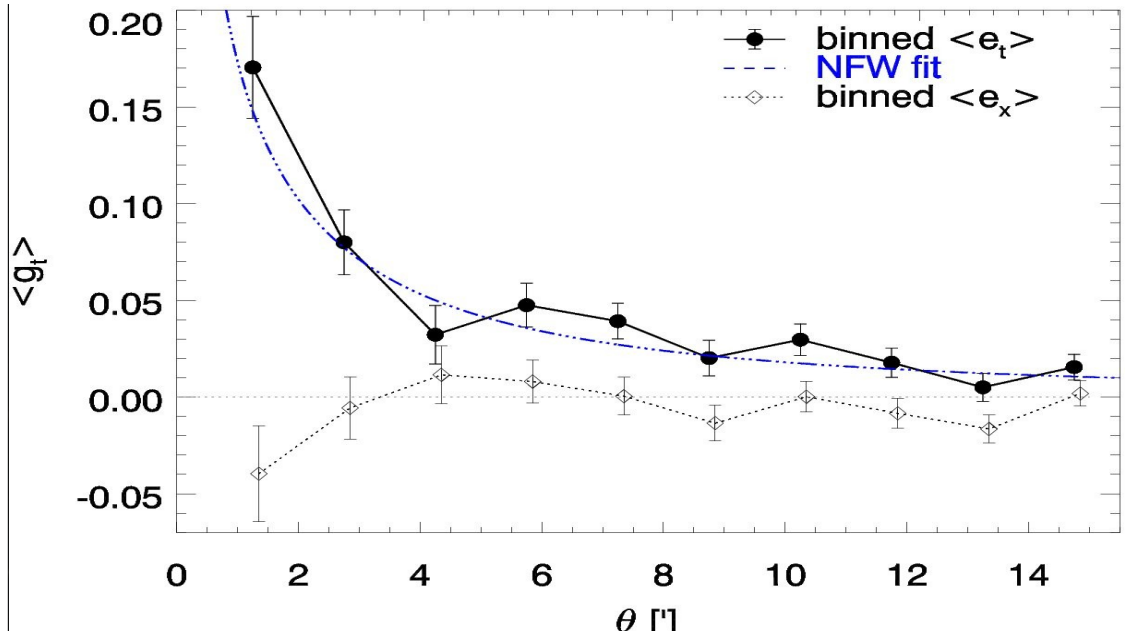


Applying color color magnitude selection on a galaxy cluster





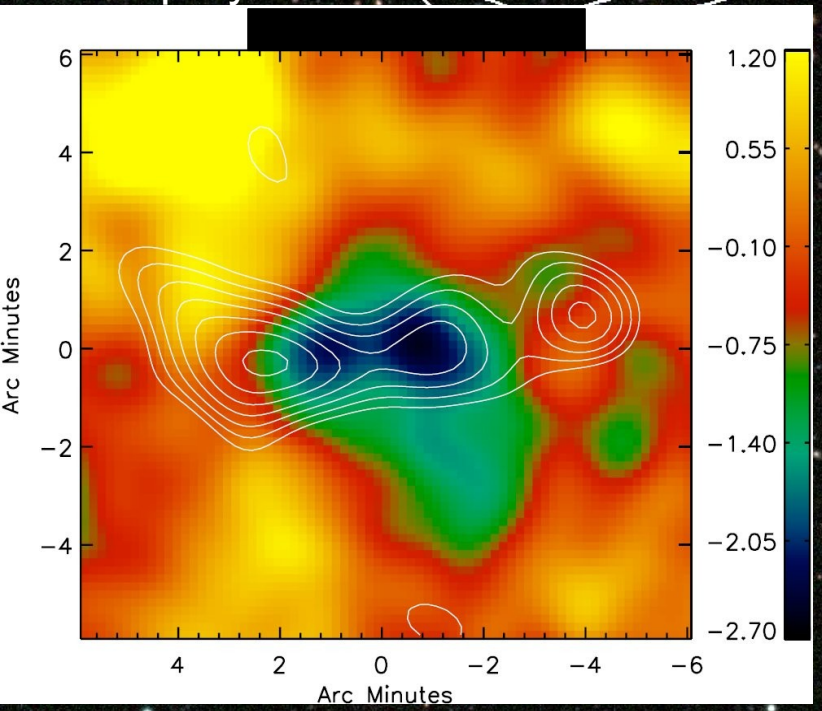


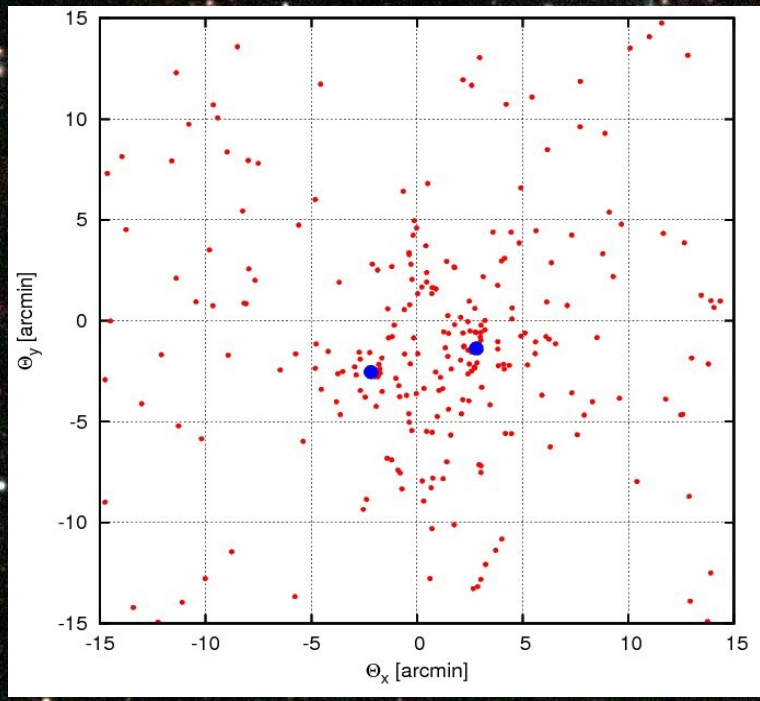


Interesting clusters:

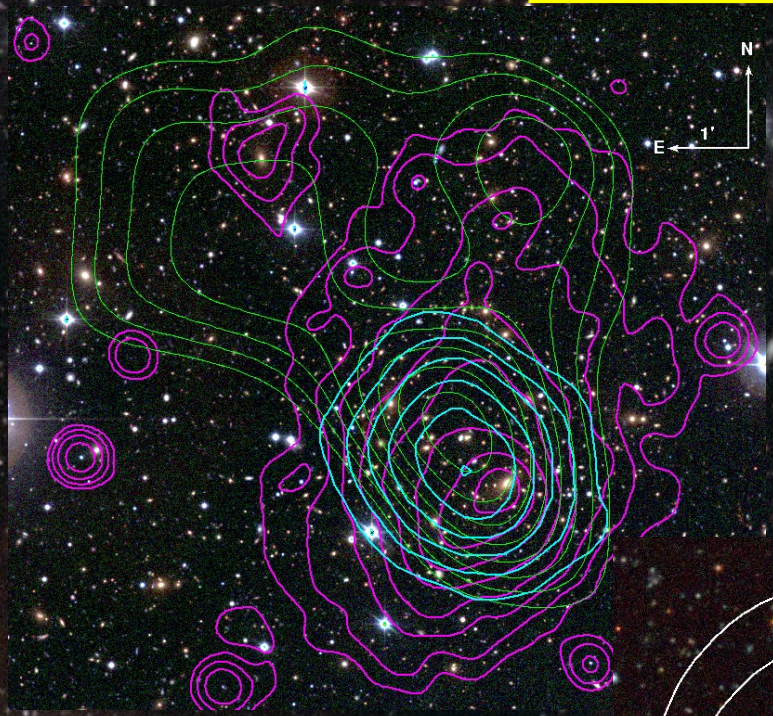
1.4 Mpc = 5.2 arcmin

SZ map by M. Nord





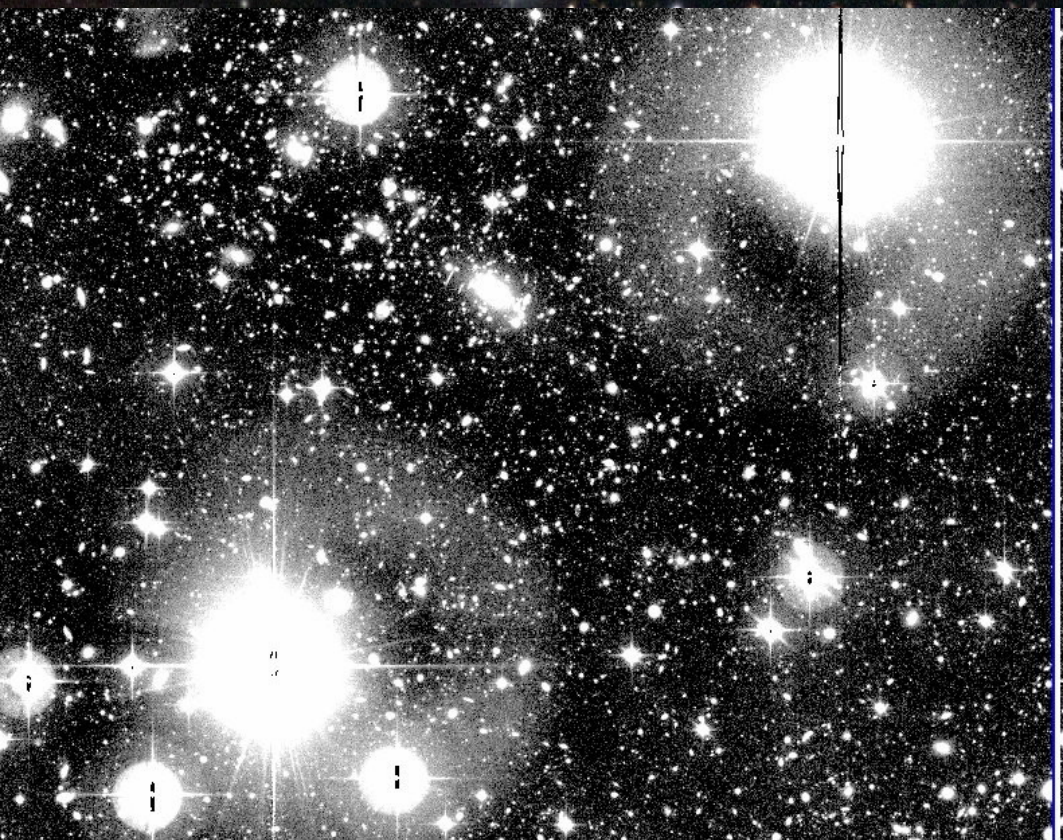
Interesting clusters:

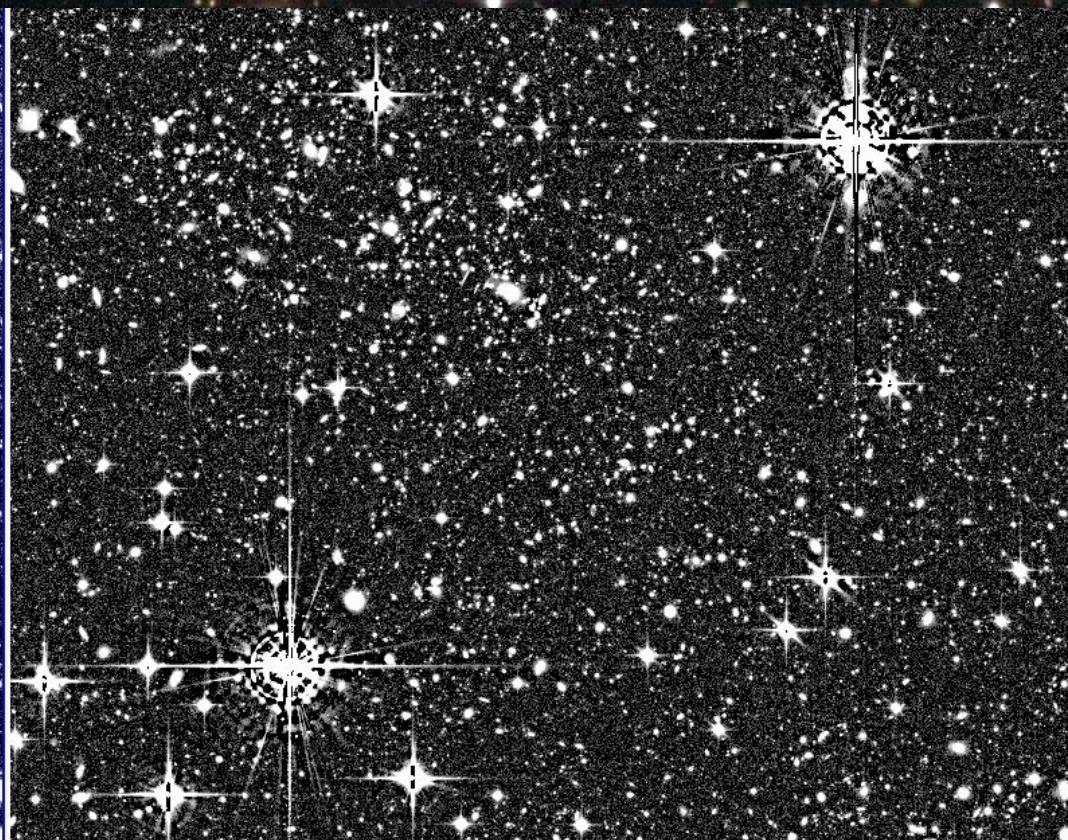


Reflections around bright stars:

critical assumptions:

- flux changes on larger scales than typical source size
- Reflections are faint enough that sources are not saturated





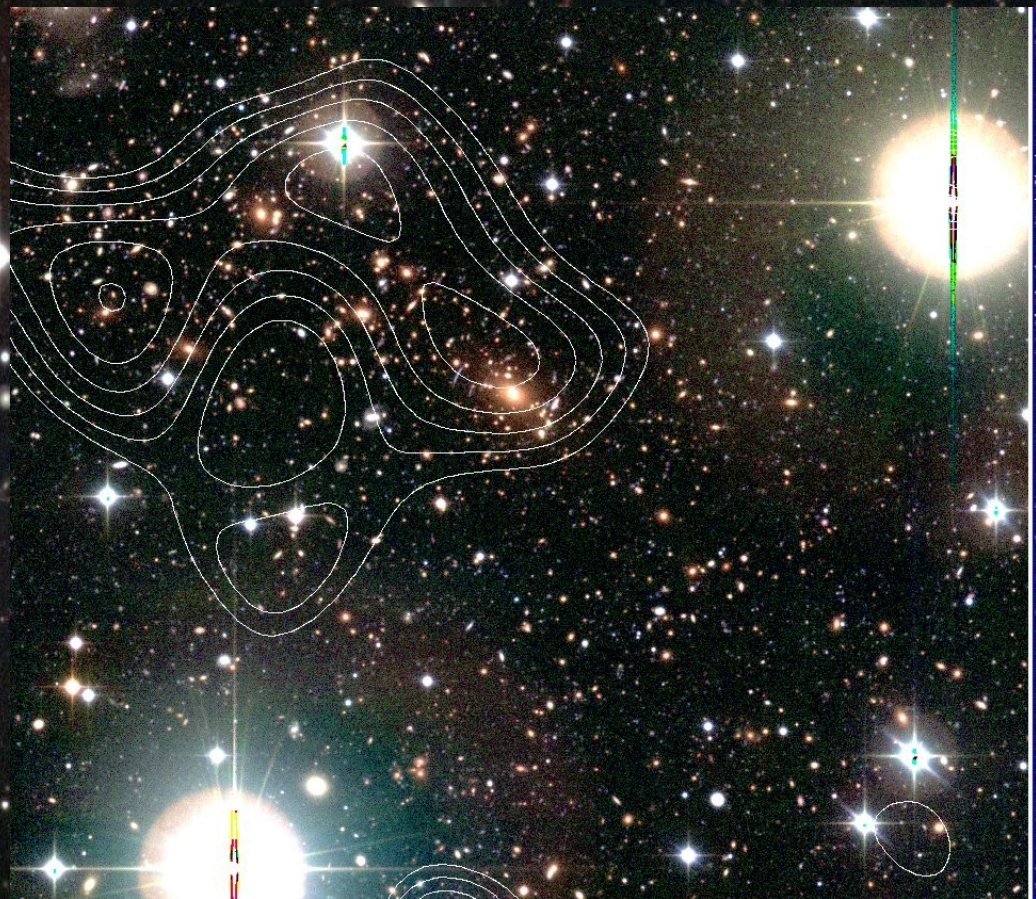
Reflections around bright stars:

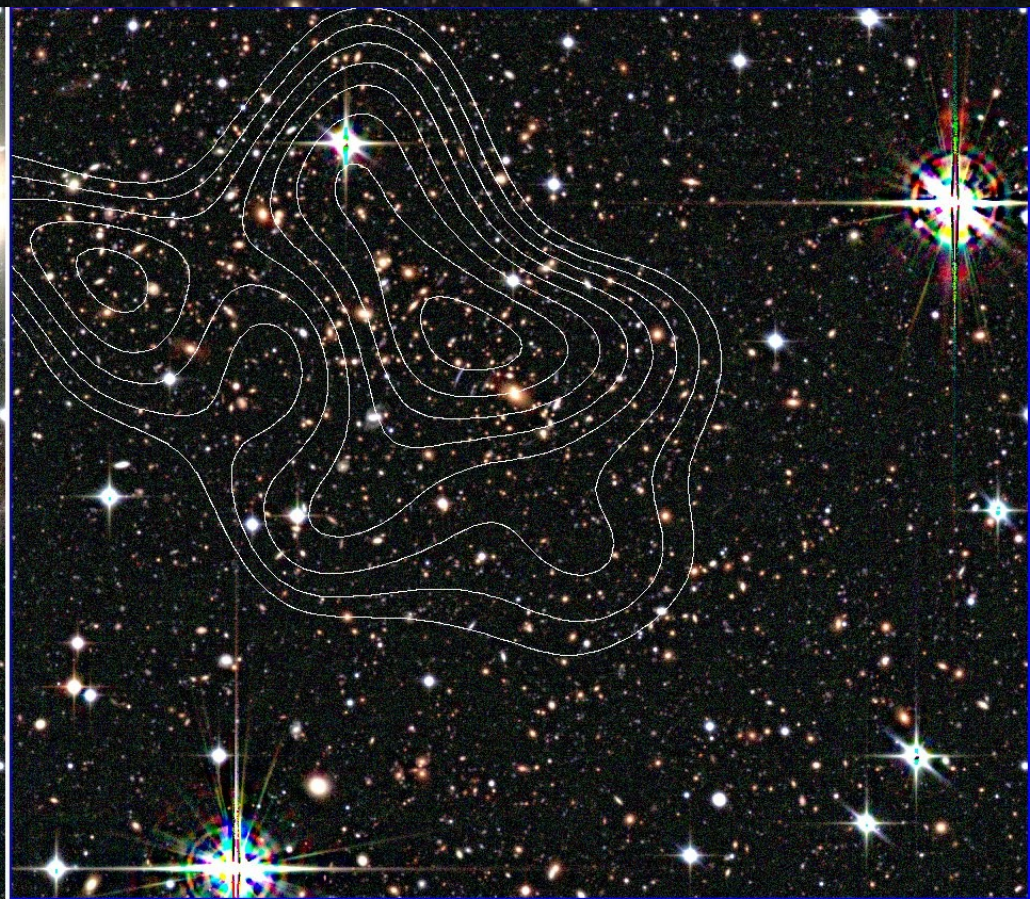
1st Attempt using sextractor background images:

- Increase of the total number of galaxies by ~15% !
- Increase of peak S/N from 8.4 to 10.1

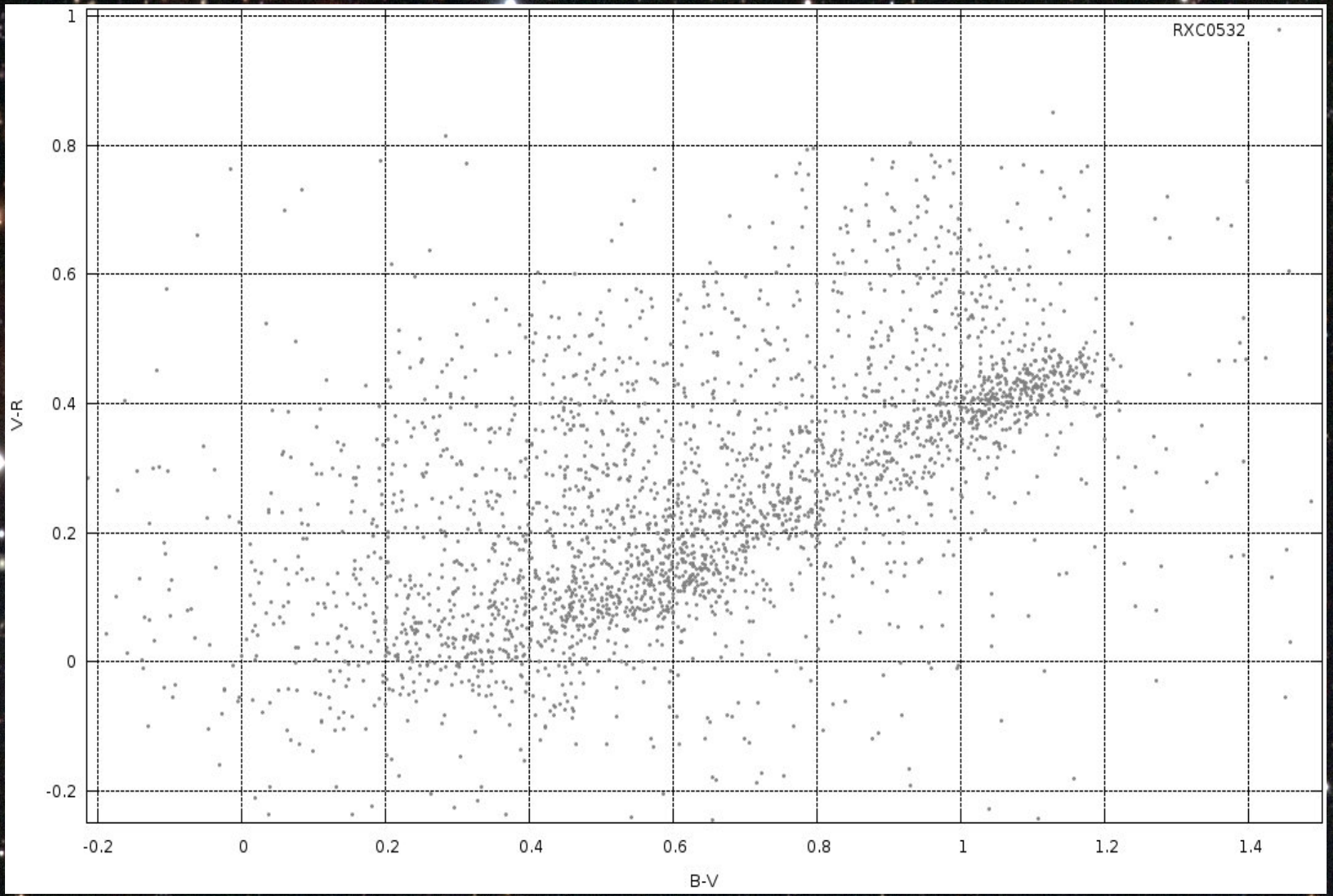
To do:

- Check for flux loss for extended sources
- Verify effect on shear measurements



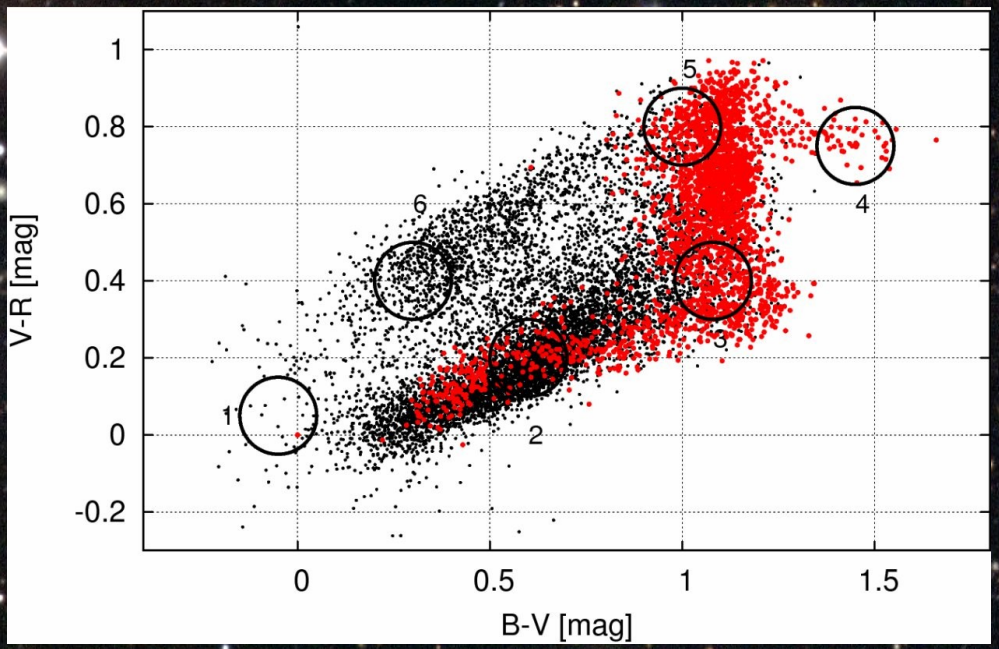


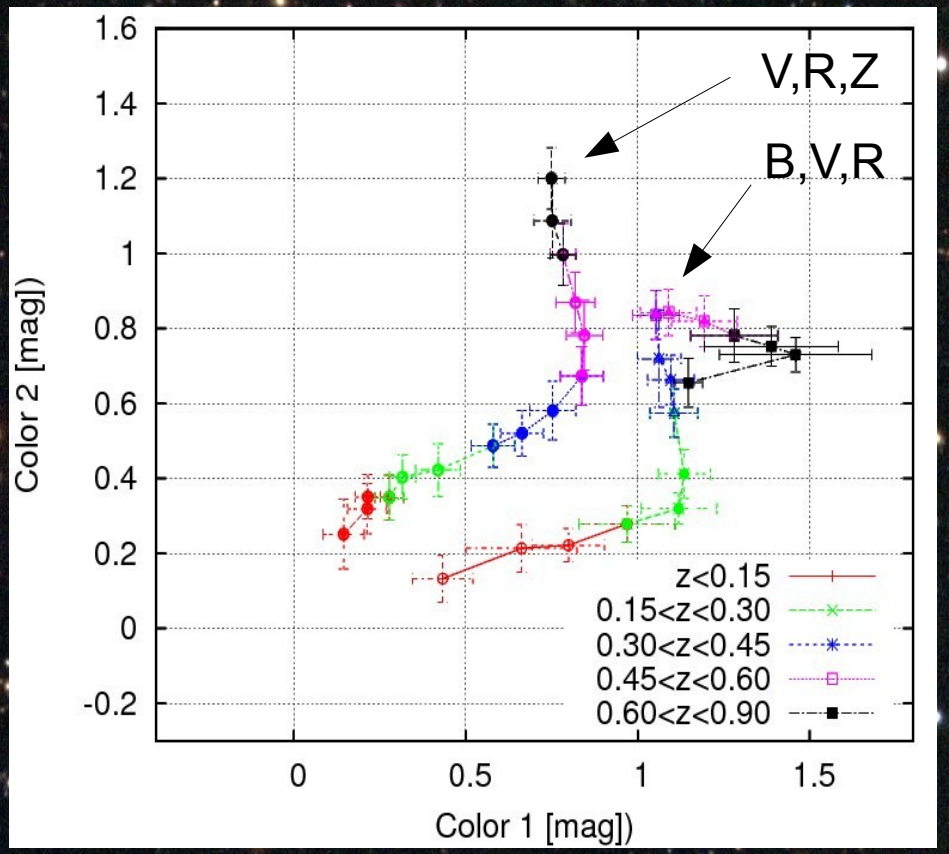
Cluster redshifts using color color magnitude space:



Cluster redshifts using color color magnitude space:

- Position of red cluster galaxies in cc-space are strongly redshift dependent
- Use over density of red ellipticals in cc-space to trace cluster redshift
- Different optimal filter combinations for different redshifts





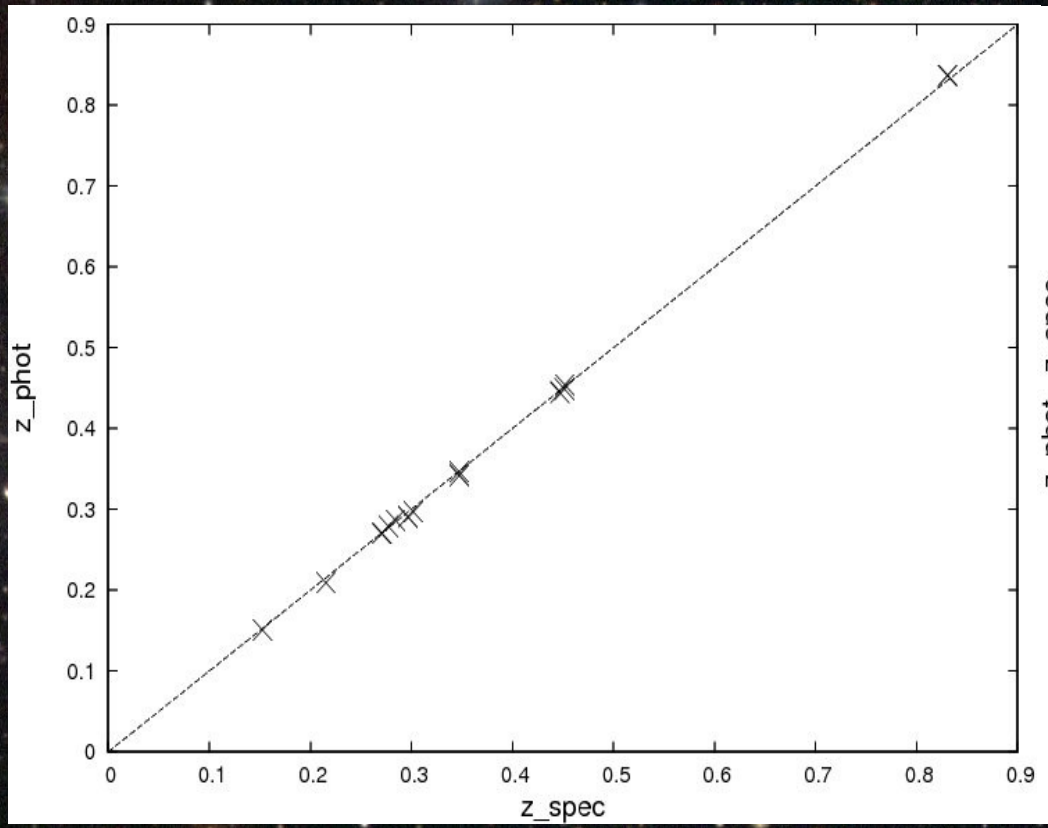
Cluster redshifts using color color magnitude space:

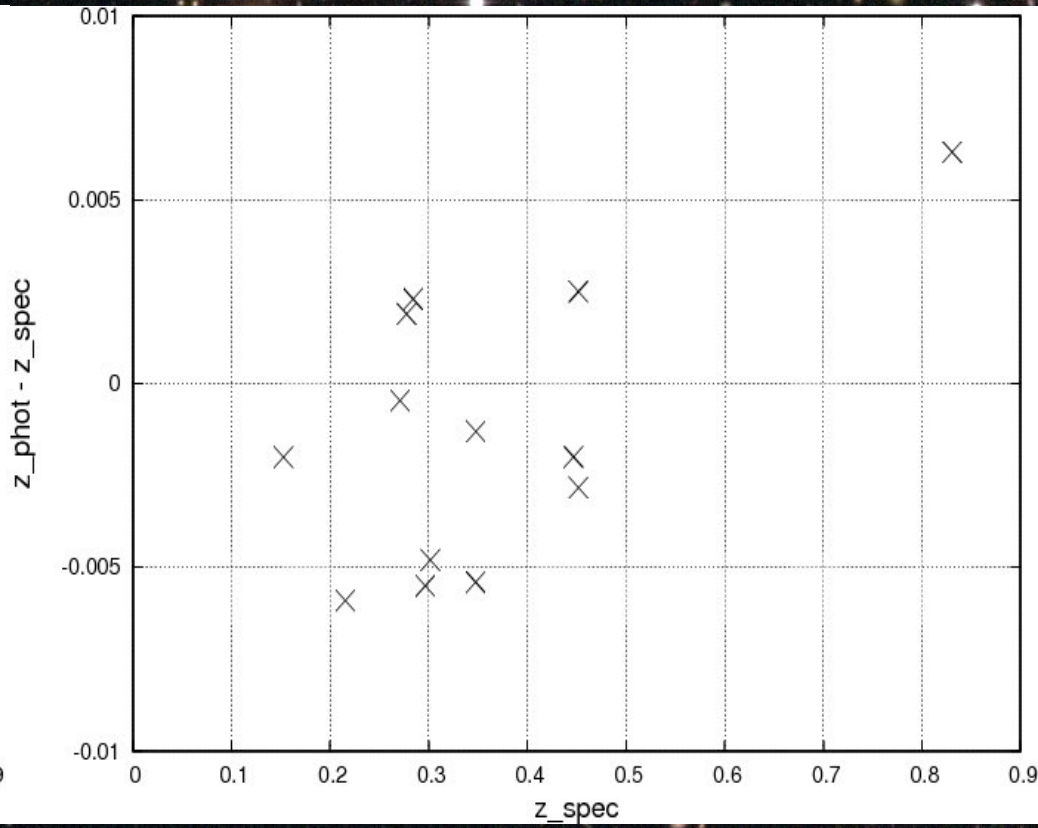
Result for 13 clusters:

$$\rightarrow \overline{\Delta z} = 0.002$$

$$\rightarrow \sigma = 0.004$$

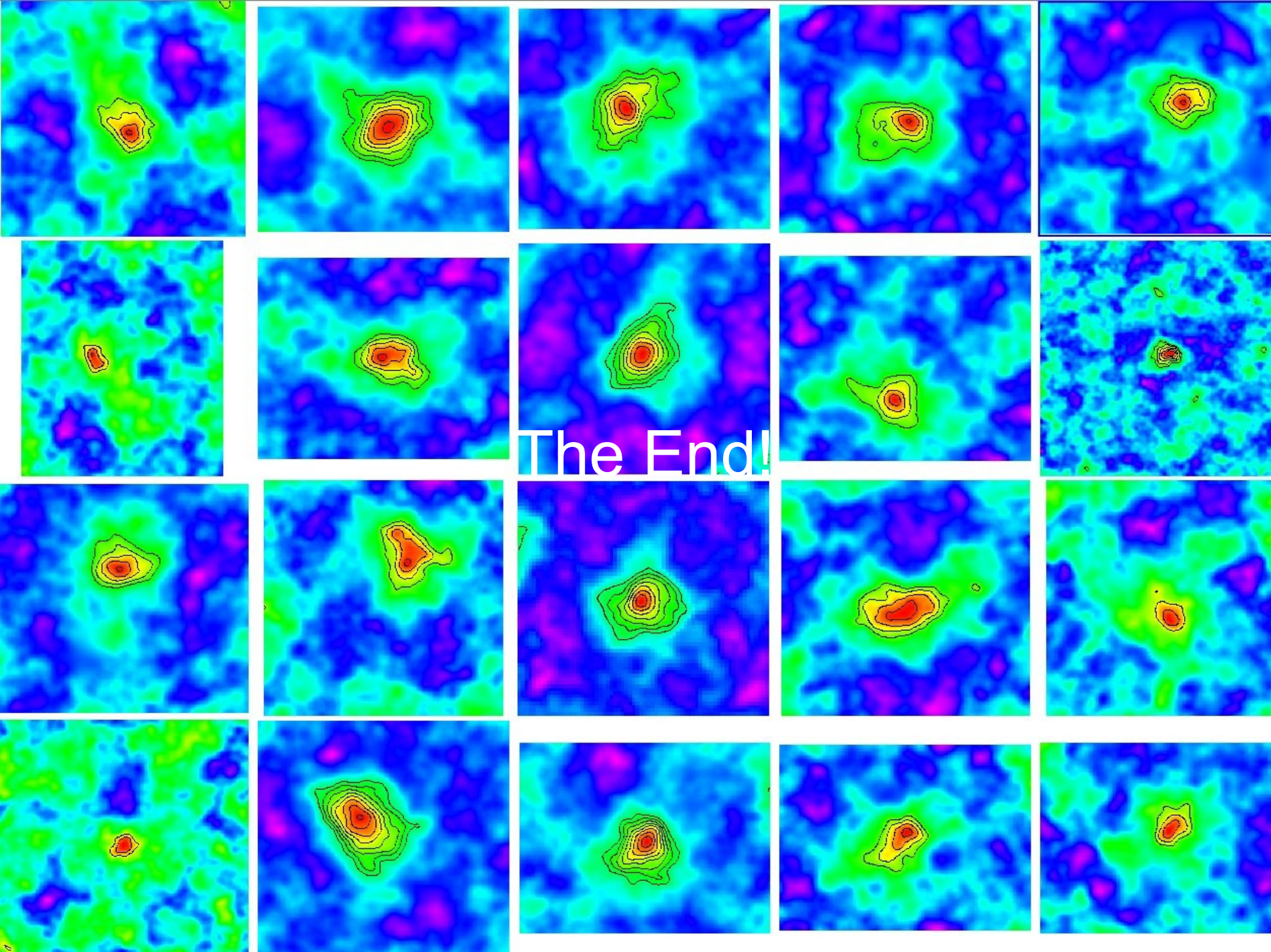
Other photometric methods yield σ=0.007 (for z<0.25) and σ=0.02 (0.15<z<0.99) (High et al. 2009 & 2010)!





Summary

- Complete lensing follow up of all APEX-SZ detections with $z<1$
- Homogeneous treatment of the full data set
- Minimizing biases by using individual redshifts
- Investigation of individual clusters
- New method for photometric redshift estimates of galaxy clusters


The End!