

Dynamical mass estimates of Sunyaev-Zel'dovich effect selected galaxy clusters in the Millennium Gas simulations

Nhlakanipho Kwazi Mthembu
kwazinhlaka@gmail.com

School of Mathematics, Statistics and Computer Science

Supervised by Dr Matt Hilton

SAIP 60th Annual Conference

29 June- 3 July 2015



Overview

- Galaxy Clusters
- Sunyaev-Zel'dovich Effect
- Millennium Gas Simulation
- Data Analysis
- Results
- Discussion & Conclusion

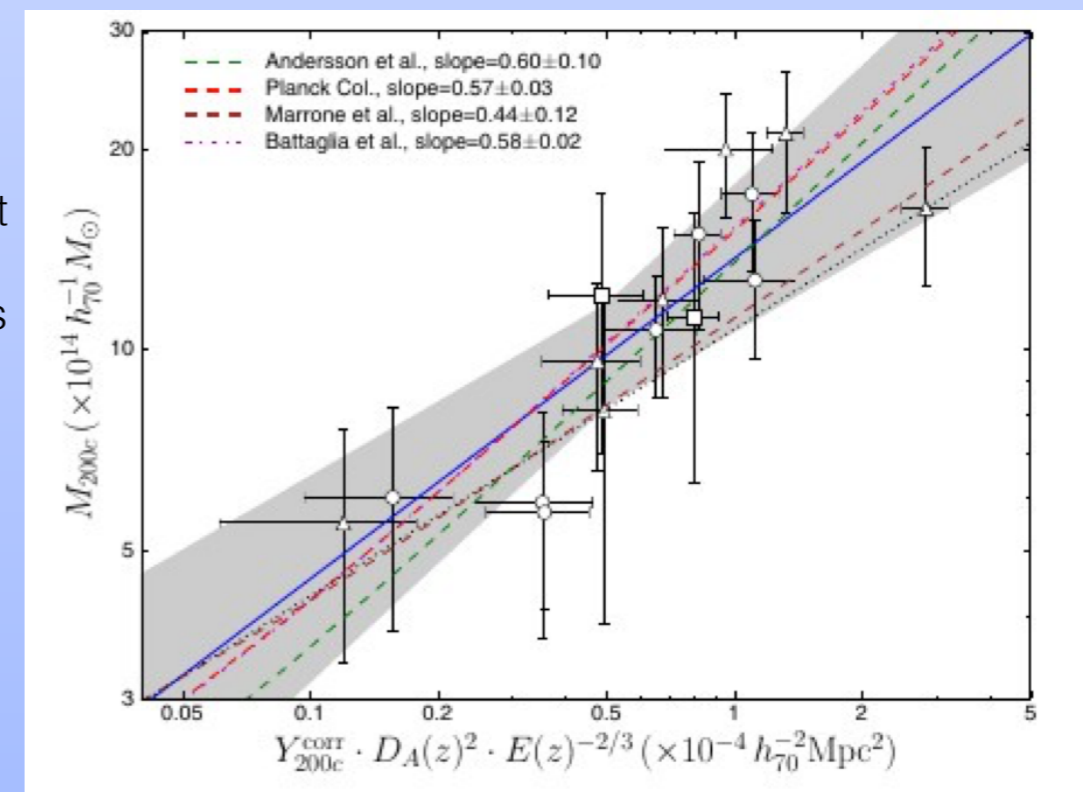
Galaxy Clusters

- We aim to design an optimal observing strategy for calibrating the dynamical mass of the -SZ- signal scaling relation and can be applied for SALT observations in future
- Clusters of galaxies are the most massive, gravitationally bound objects in the universe
- They may give insight into how structure has grown in our universe
- To extract these insight from the structure of the galaxy cluster at a given epoch, it's formation process must be understood well
- Mass is not directly observable quantity but can be determined in several ways
- Use the velocity dispersion as a proxy for cluster mass
- One way to find Clusters is by the Sunyaev-Zel'dovich effect (SZE)

Sunyaev-Zel'dovich Effect

The Sunyaev-Zel'dovich (SZ) effect is a spectral distortion of the CMB caused by inverse Compton scattering of CMB photons by free electrons located in the hot gas within galaxies and clusters

- This effect provides a cosmological tool to probe the properties of the properties of intra-cluster gas
- Experimental surveys from the Atacama Cosmology Telescope (ACT), South Pole Telescope (SPT) and The Planck Collaboration allow one to fully exploit the power of the SZ effect
- Provide large detailed catalogues of SZ effect selected clusters over a wide range of redshift, permitting accurate measurements of cosmological parameters
- Useful for deep surveys since the detection limit of a particular survey is fixed by the mass of the cluster
- Able to detect clusters above a particular mass threshold independent of their redshift, due to the fact that although the CMB suffers redshift dimming, the ratio of the SZE to the CMB does not



Sifón et al. 2013

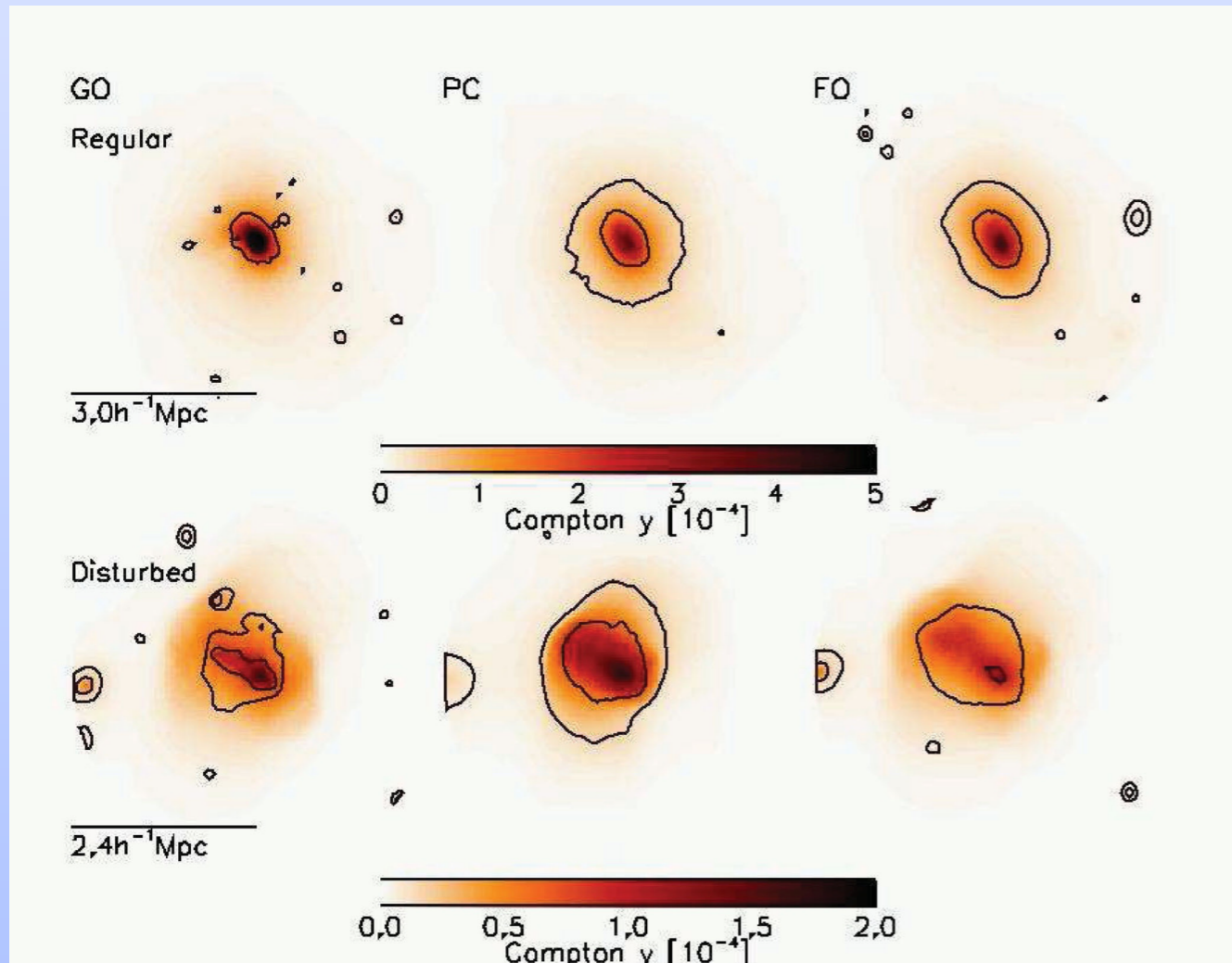
Millennium Gas Simulations (MGSSs)

The Millennium Simulation (MS) is a computer N-body simulation used to investigate how the distribution of matter in the Universe has evolved over time

- Simulations enable us to build a virtual model of the Universe
- This allows us to do virtual experiments to understand how galaxy clusters react to a range of conditions

The aim of MGSSs (Kay et al. 2012) was to study in more detail the SZ effect from simulated galaxy clusters

Millennium Gas Simulations (MGSs)



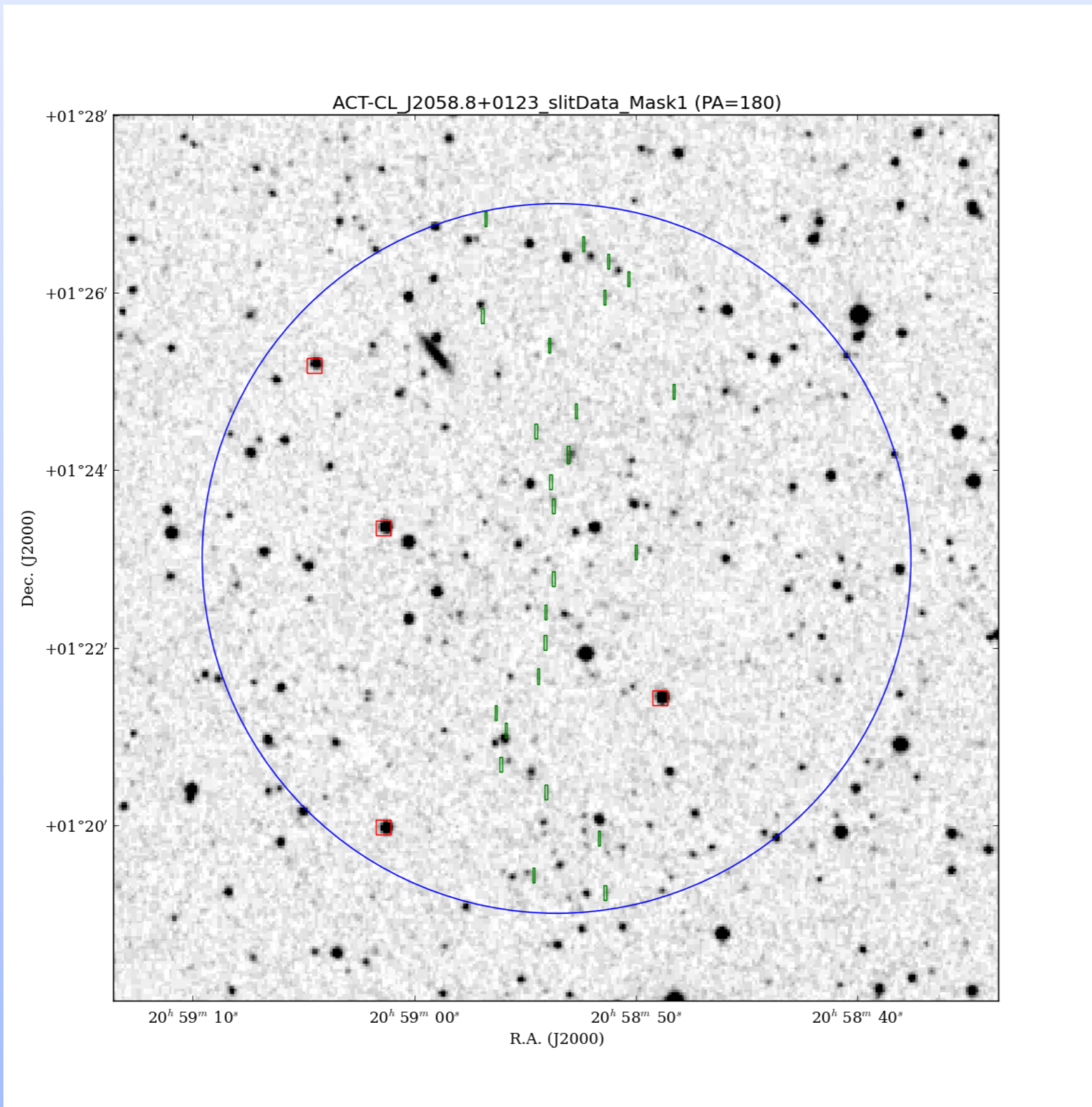
Kay et al. 2012

The feedback(FO) model successfully generated the required excess entropy of the low-redshift population & provided a good match to the structural properties of non-cool-core clusters

- We use a simulated galaxy & cluster from the MGSs
- The simulation adopts a flat Λ CDM
- FO model was applied to our simulation
- It was developed by Short & Thomas which was then applied to MGSs clusters by Short et. (2010)
- The FO model uses semi-analytic galaxy formation model of De Lucia & Blaizot (2007)

Data Analysis

- We use simulated galaxy clusters from MGSs
- Select Clusters $> 10e14$ and do a random selection of 100
- Match them with simulated galaxies
- Convert the position from Mpc into angular coordinates projected onto the sky
- We then feed our new data into a software that is used to generate SALT slits masks
- The slit masks software was used in real SALT observations, in which case the catalogues were taken from SDSS (See Kirk et al. 2015)



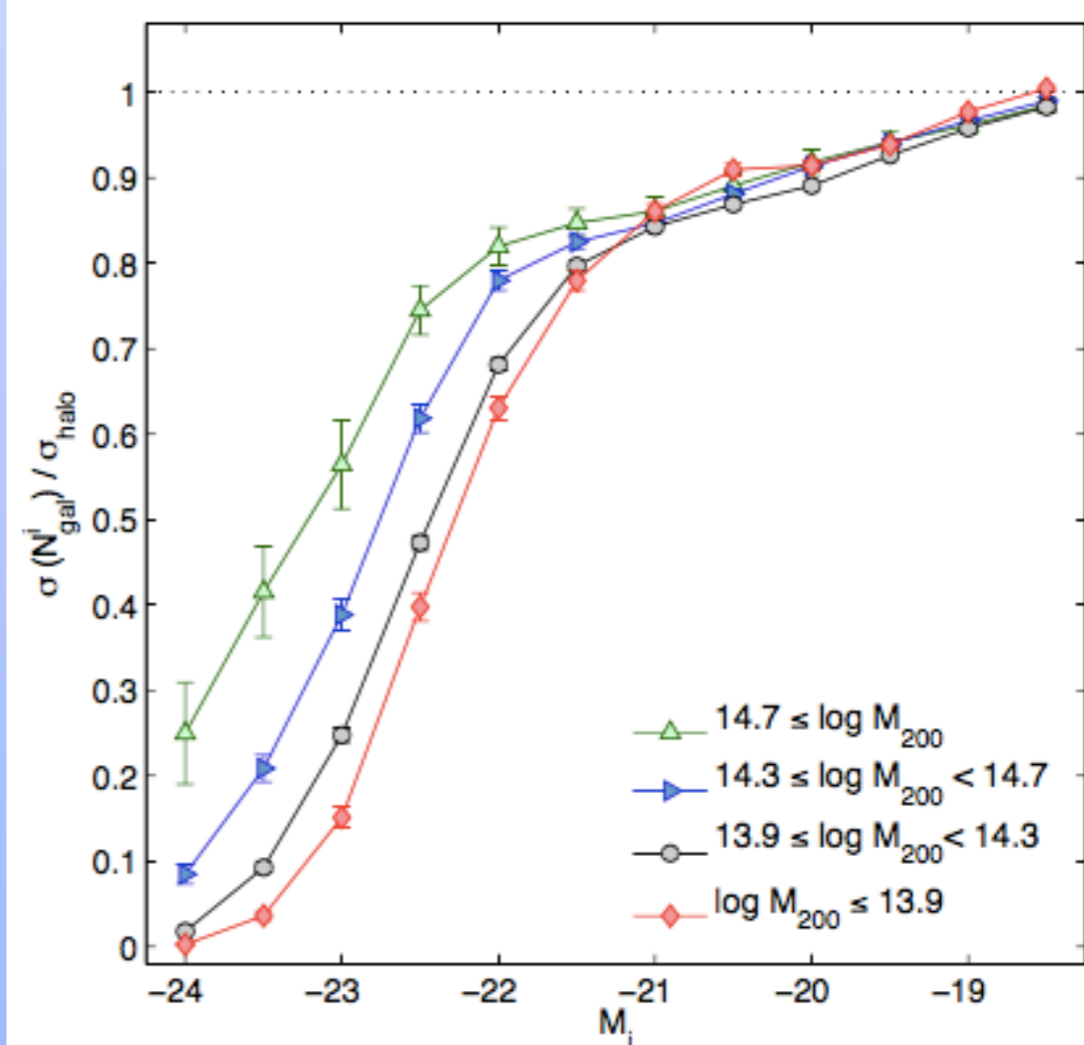
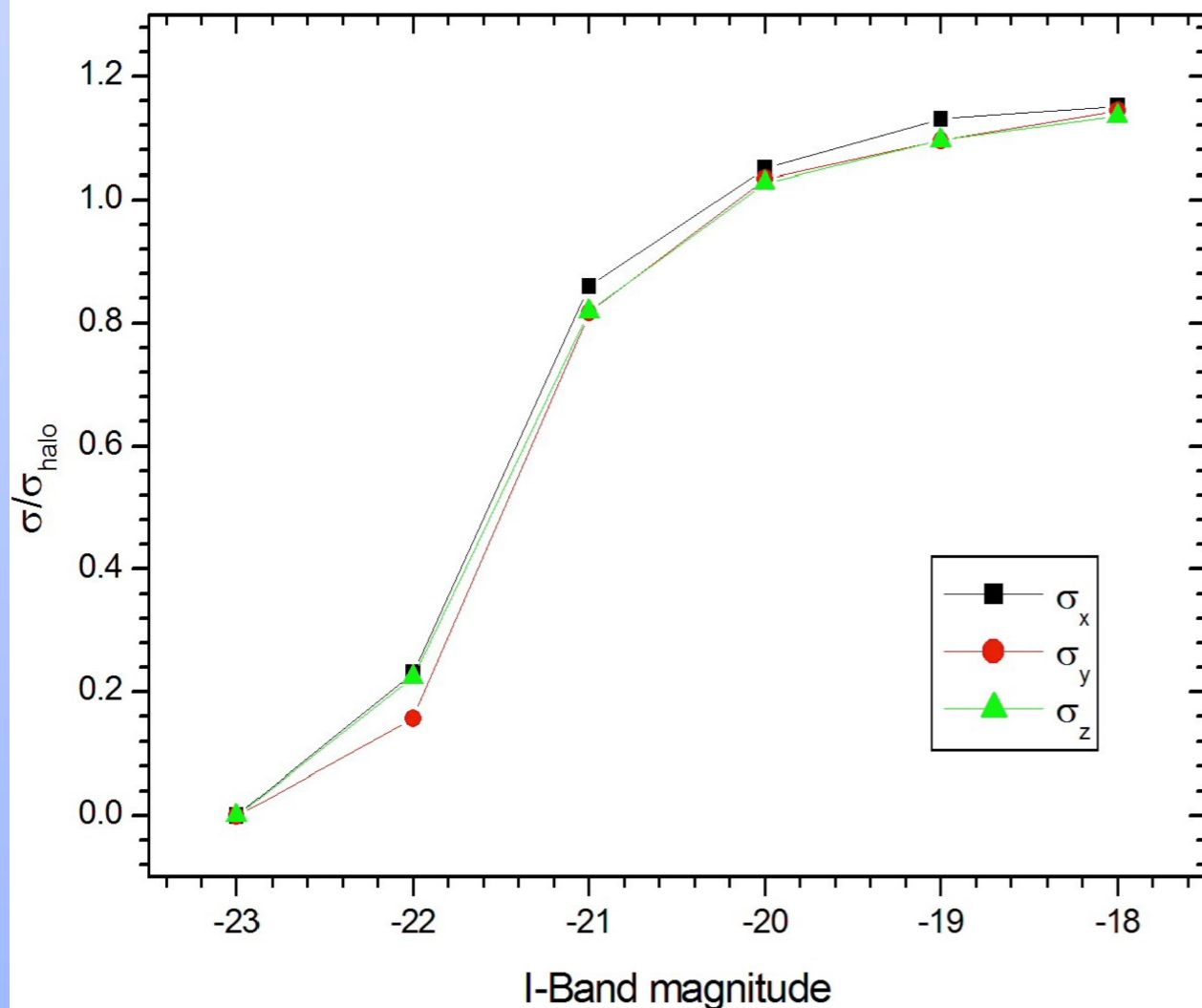
Slit mask design finder chart

Data Analysis

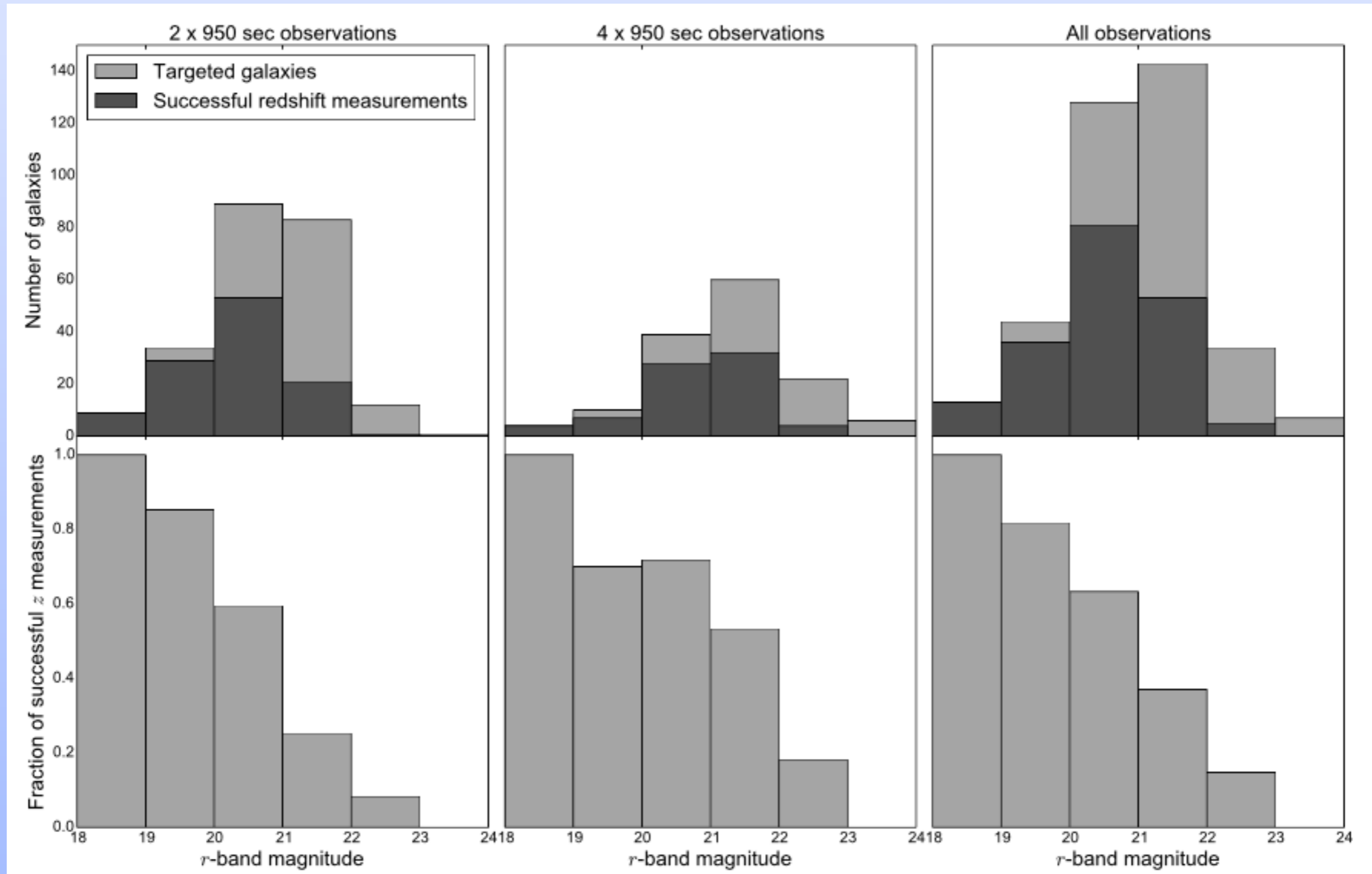
- We used the biweight location method (Beers et al. 1990) to determine cluster redshift
- Remove foreground, background galaxies & interlopers using the fixed-gap method to identify cluster members similar to Crawford et al. 2014
- The biweight scale estimator (Beers et al. 1990) was used to calculate the velocity dispersion from the galaxies selected as members

Previous Results

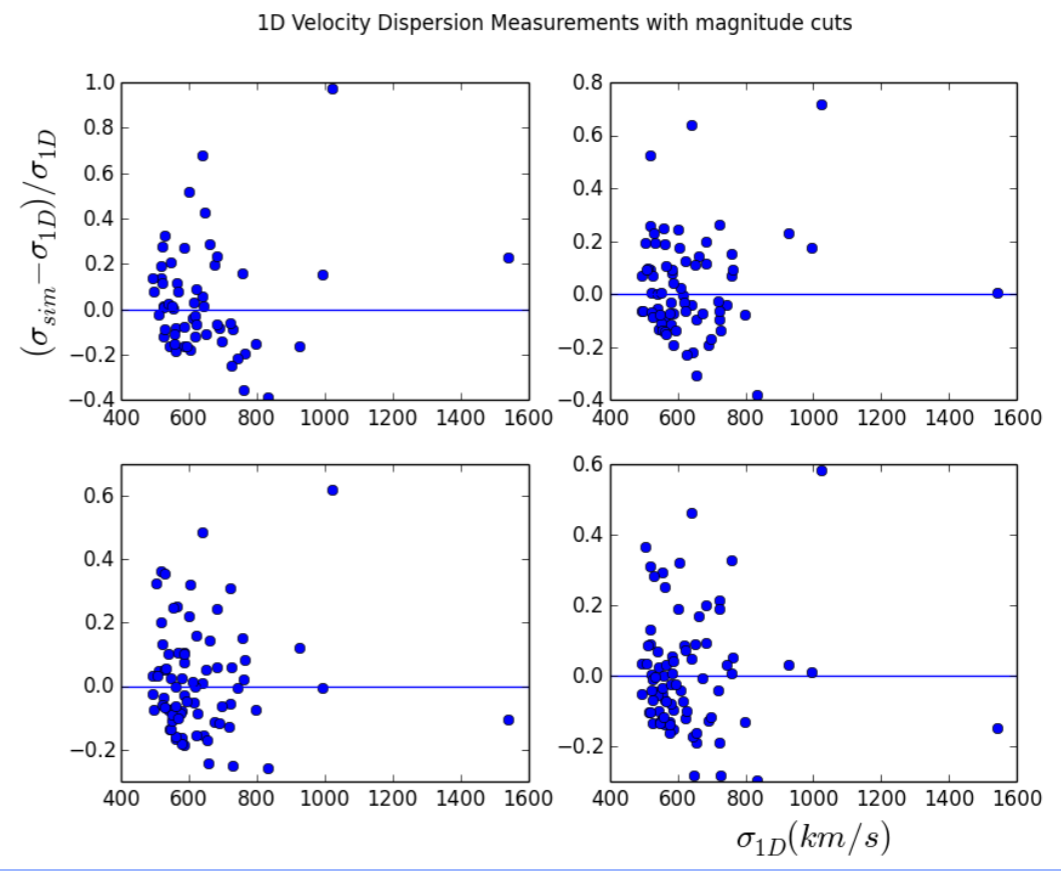
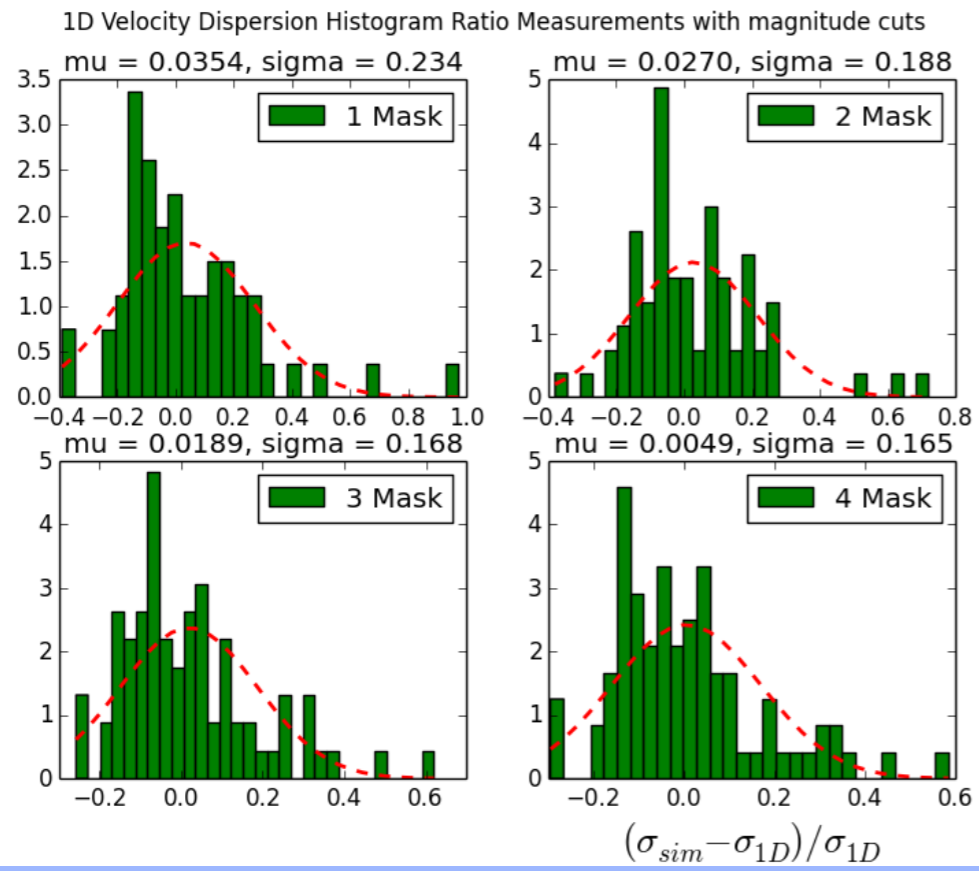
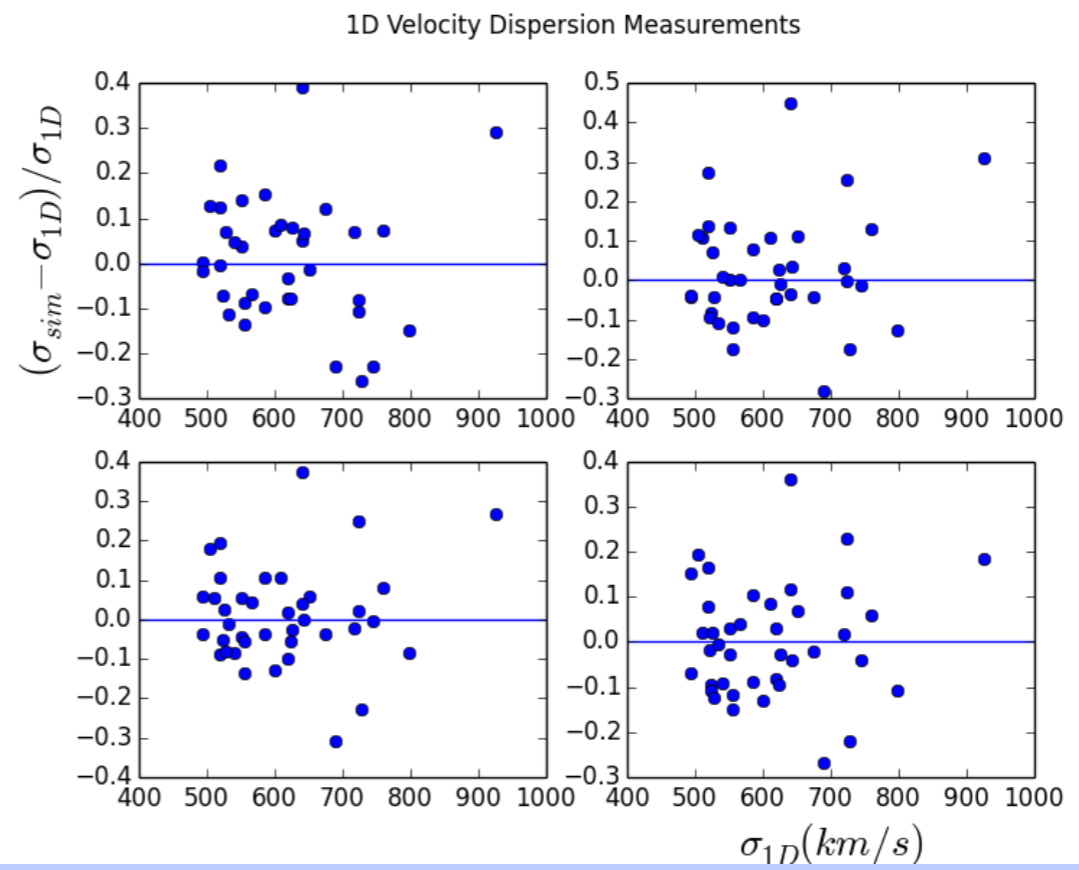
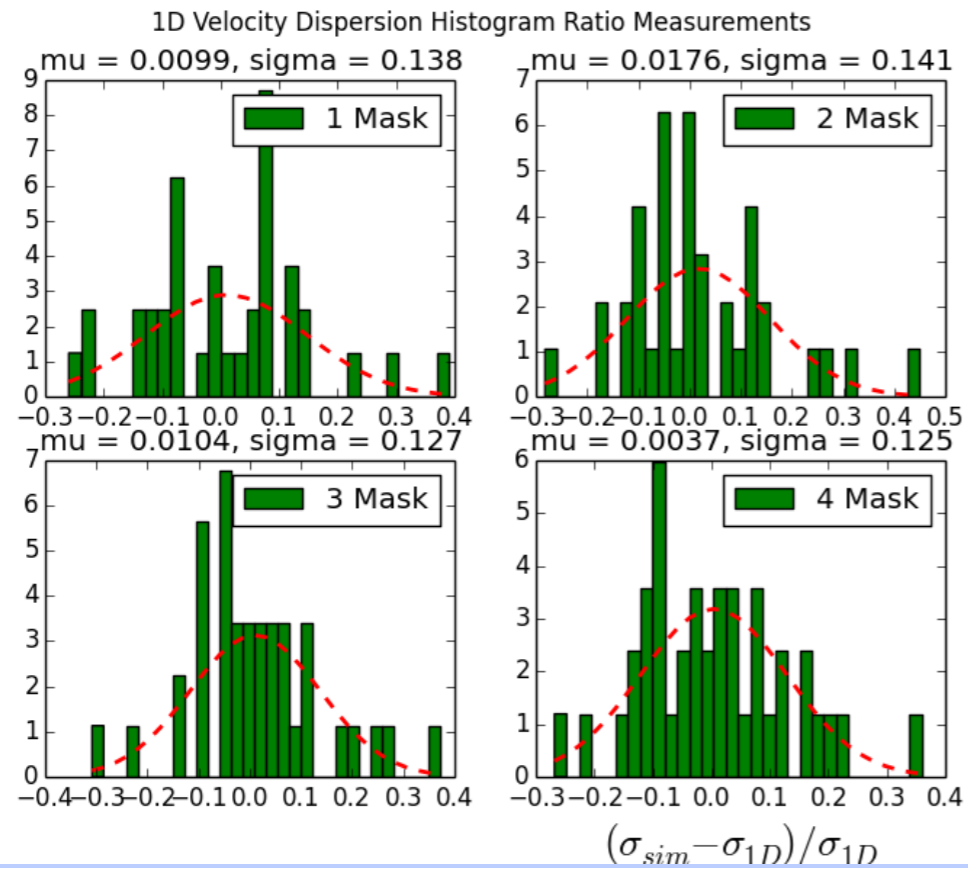
Previous studies have found systematic bias introduced when selecting the spectroscopic redshifts of brighter cluster galaxies to estimate the velocity dispersion of galaxy clusters from simulated galaxy catalogues



Previous Results



Results



Discussion & Conclusion

- Determining the velocity dispersion and mass distribution of galaxy cluster is a challenging exercise
- Next we will use the Munari et al. 2013 relation to get the dynamical mass measurement
- Since we dealing with simulations we know which mass to expect for our results and will also do scaling relations of Y-M and compare our results with similar work
- We want know how the number of mask applied when doing observations affect the measurements of scaling relations e.g Y-M
- Is it better to observe 10 clusters with 1 mask or 4, that is what we would like to find out

The End
Thank You