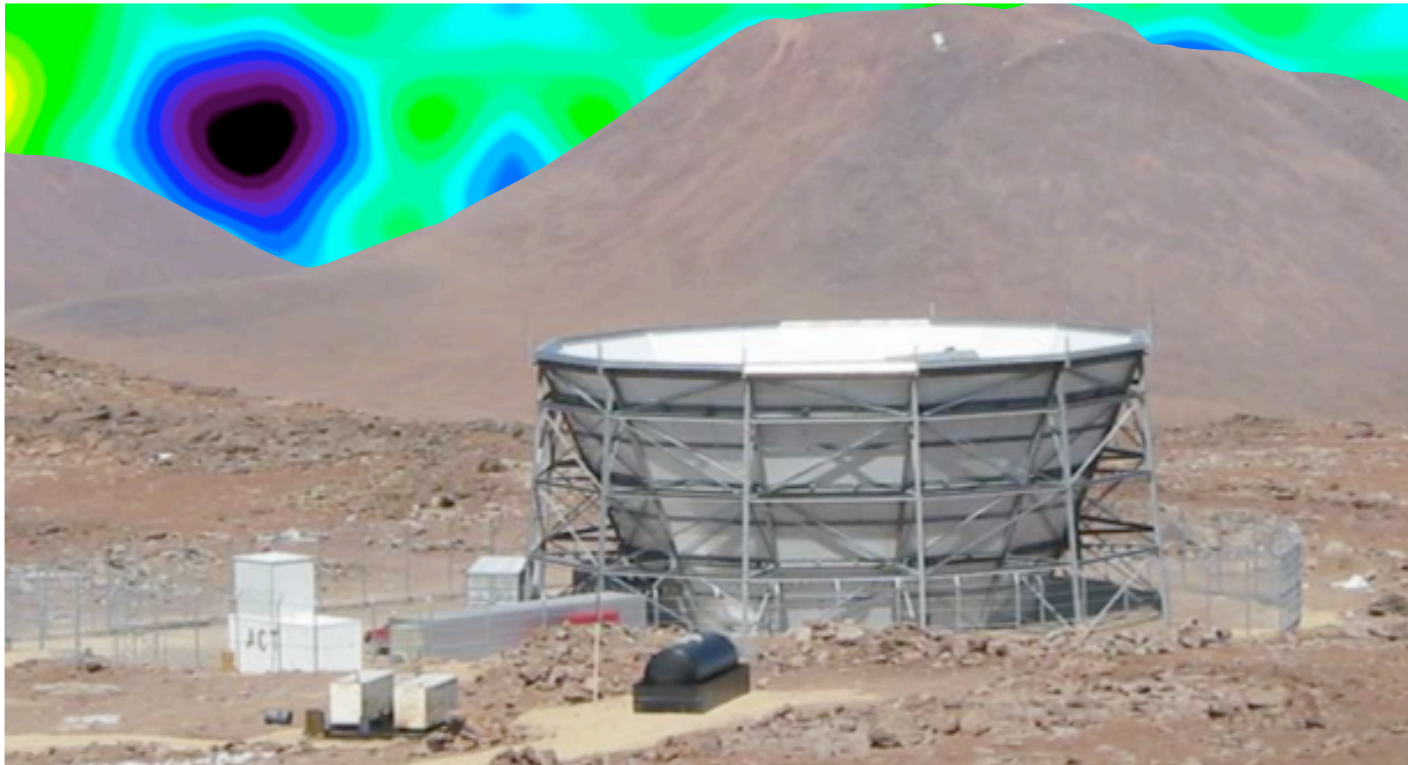


The Atacama Cosmology Telescope: Sunyaev-Zel'dovich Cluster Results



Tobias Marriage (JHU) for the ACT Collaboration
Monsters Inc, UCSB KITP
March 17, 2011



ACT CLUSTERS TEAM (Not exhaustive)



N. Battaglia

J.R. Bond

N. Hand

M. Hilton

J.P. Hughes

L. Infante

Y.T. Lin

T. Marriage *

F. Menanteau *

E. Reese

N. Sehgal *

J. Sievers

H. Trac

...

*ACT
specific
Results
To Be
Discussed
In Detail

ACT CLUSTERS TEAM (Not exhaustive)



N. Battaglia

J.R. Bond

N. Hand

M. Hilton

J.P. Hughes

L. Infante

Y.T. Lin

T. Marriage *

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E. Reese

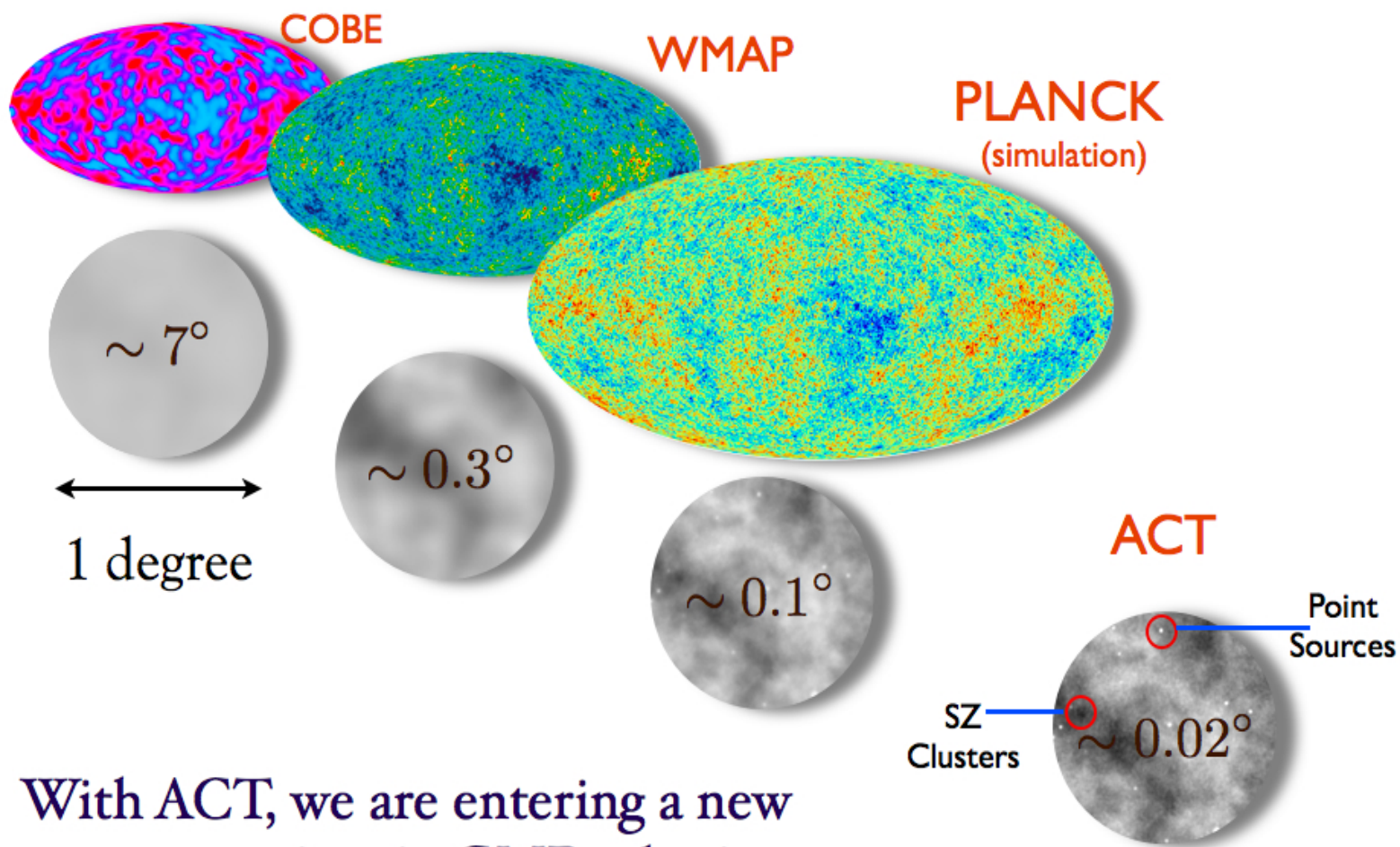
N. Sehgal *

J. Sievers

H. Trac

...

At this
conference
...we are
among
you...



With ACT, we are entering a new regime in CMB physics.

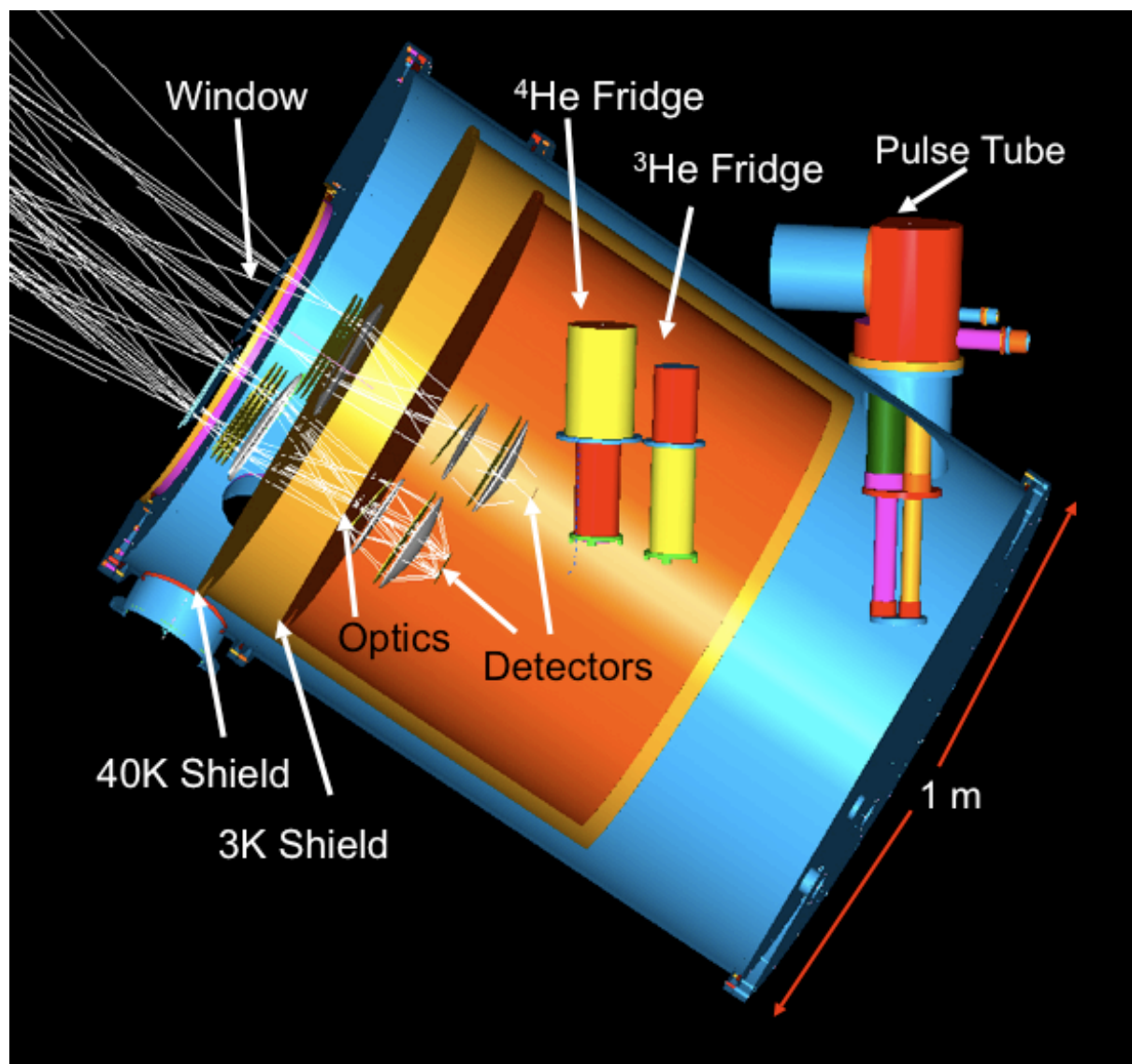
The Site and Telescope

Fowler et al. 2007 (0701020v2)

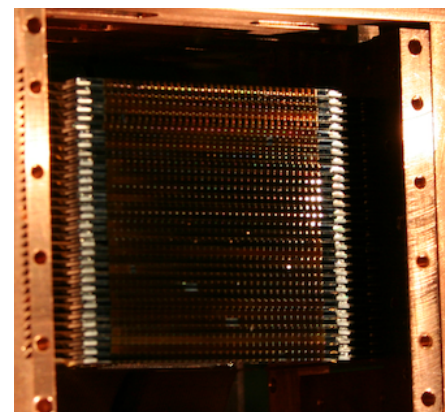


The Receiver

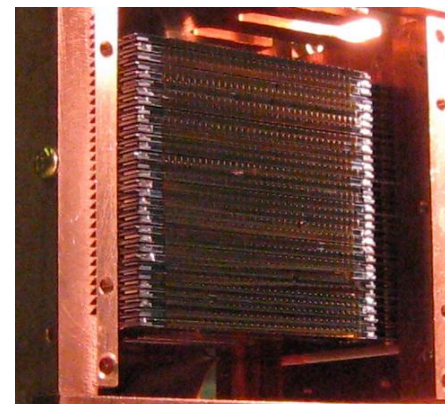
Swetz et al. 2010 (1007.0290)



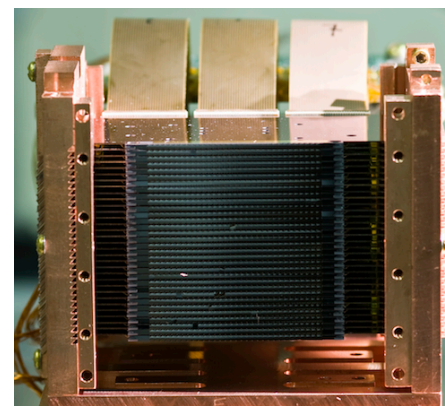
148 GHz



218 GHz

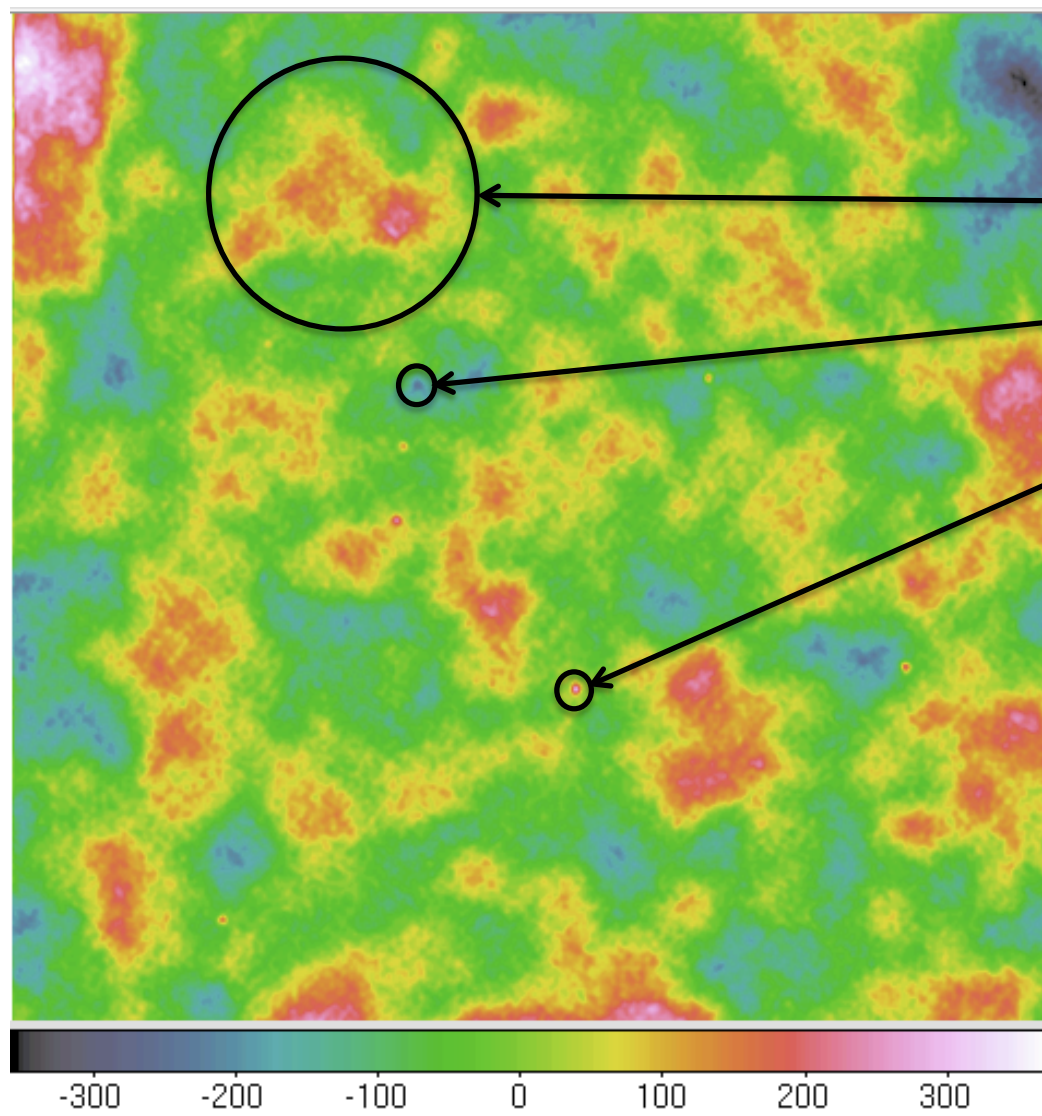


277 GHz



The Reduction Pipeline

Dunner et al. 2010 (in prep)



- CMB
- Galaxy Clusters
- Galaxies

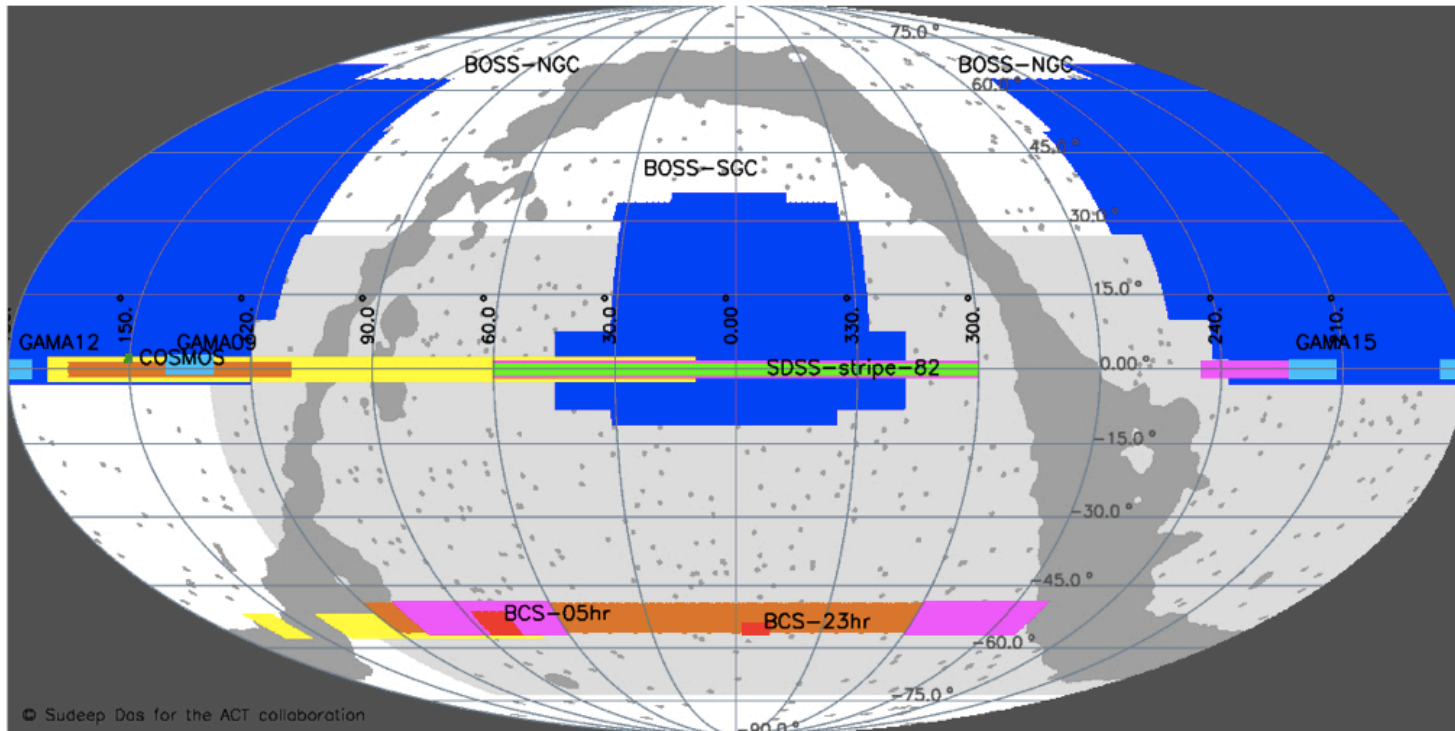


SciNet

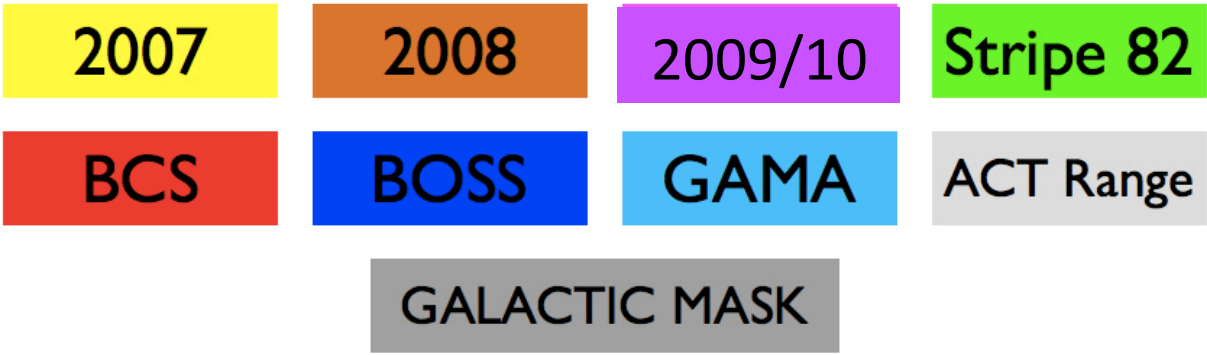
J. Sievers

$\delta T (\mu\text{K})$

ACT Survey



© Sudeep Das for the ACT collaboration

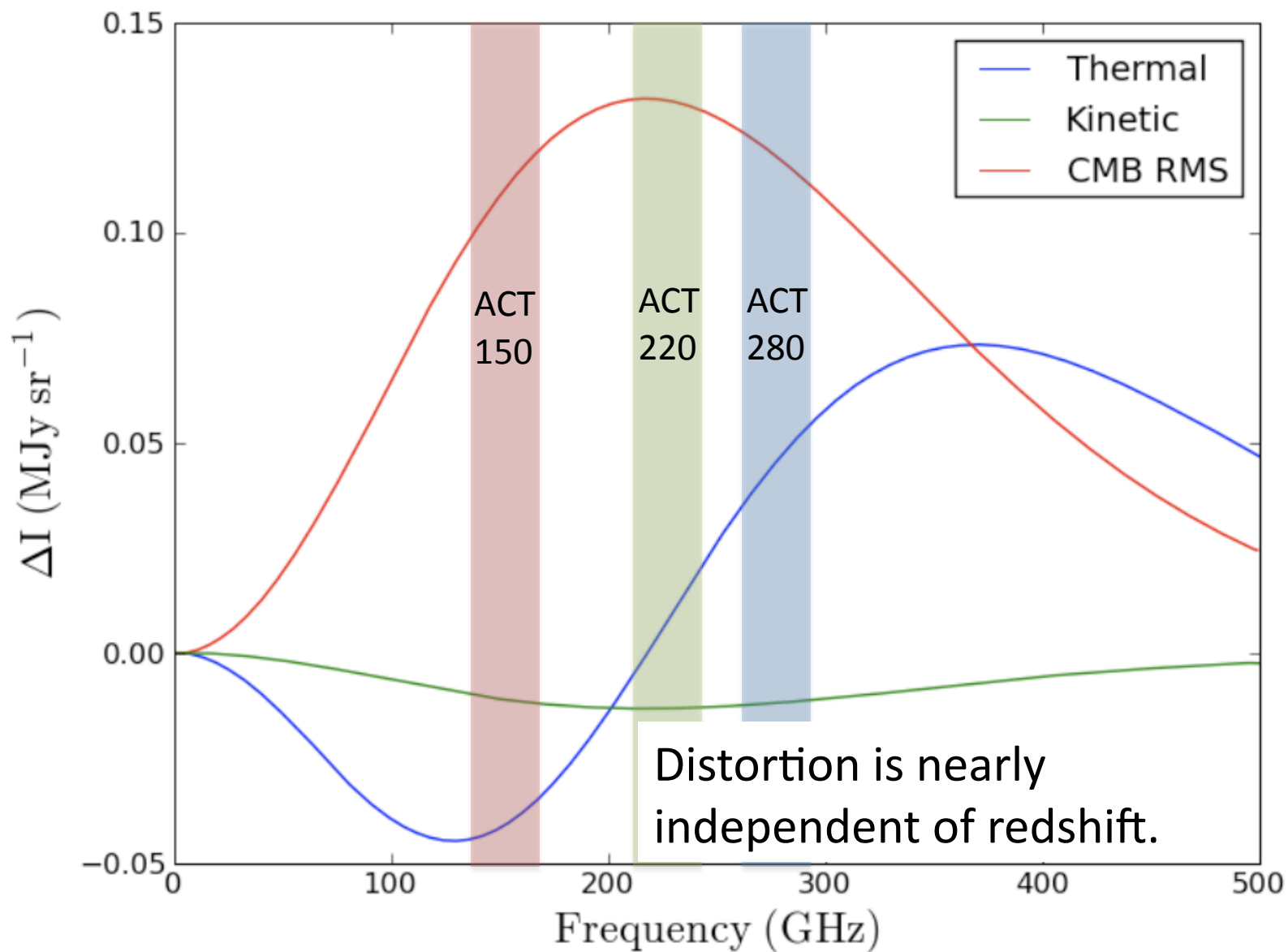


Roughly 1000 Sq Deg at 25 μ K-arcsec (148 GHz) and 40 μ K-arcsec (218 GHz)

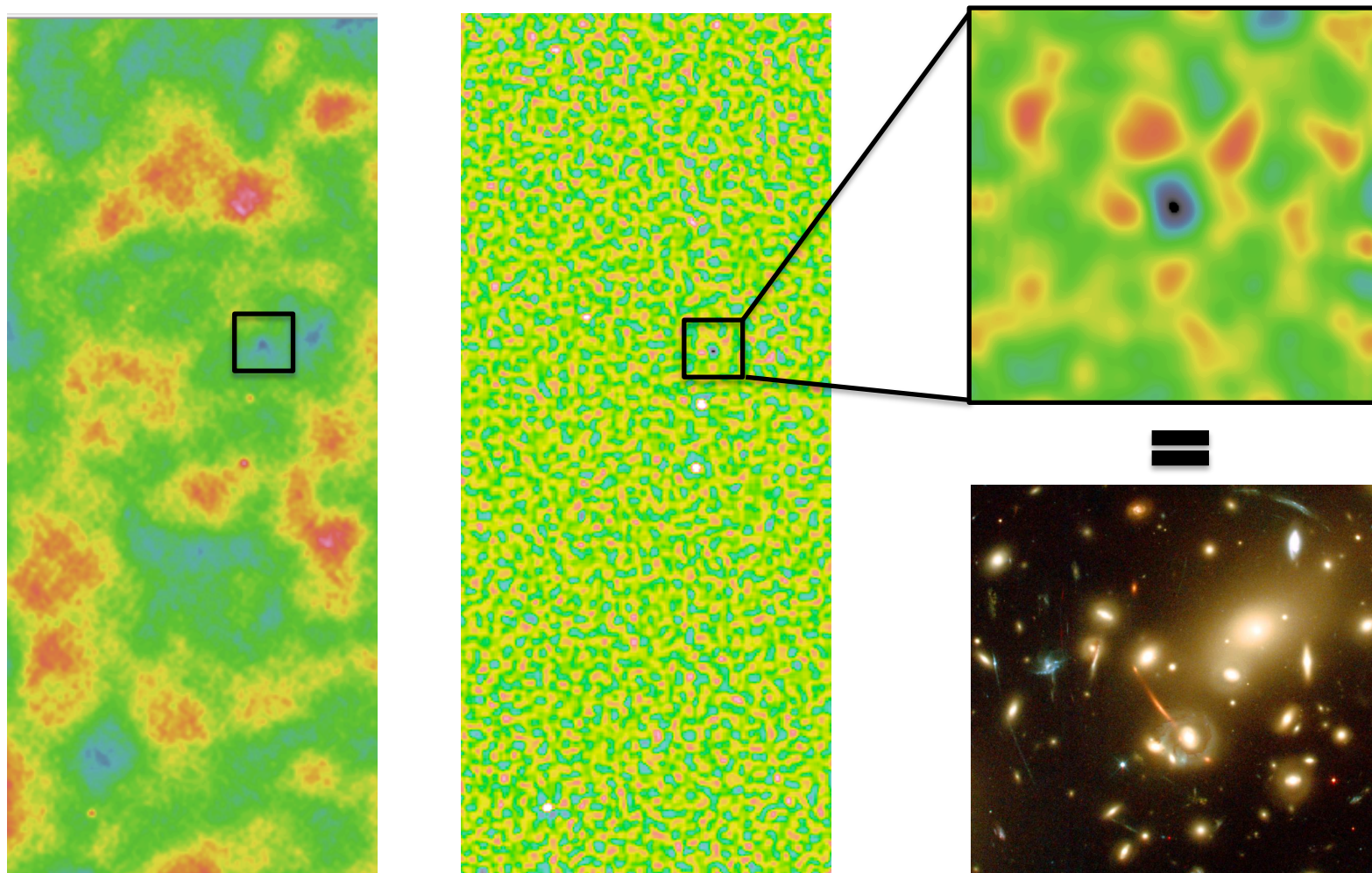
The Results

Marriage et al 2010 (1007.5256)	'Extragalactic Sources at 148 GHz in the 2008 Survey'
Hincks et al 2009 (0907.0461)	'Beam Profiles and First SZ Cluster Maps'
Marriage et al 2010 (1010.1065)	'Sunyaev Zel'dovich Selected Galaxy Clusters at 148 GHz in the 2008 Survey'
Menanteau et al 2010 (1006.5126)	'Physical Properties and Purity of a Galaxy Cluster Sample Selected via the Sunyaev-Zel'dovich Effect'
Sehgal et al 2010 (1010.1025)	'Cosmology from Galaxy Clusters Detected via the Sunyaev-Zel'dovich Effect'
Hand et al 2010 (1101.1951)	'Detection of Sunyaev-Zel'dovich Decrement in Groups and Clusters Associated with Luminous Red Galaxies'
Fowler et al 2010 (1001.2934)	'A Measurement of the $600 < \ell < 8000$ Cosmic Microwave Background Power Spectrum at 148 GHz'
Hajian et al 2010 (1009.0777)	'Calibration with WMAP Using Cross-Correlations'
Das et al 2010 (1009.0847)	'A Measurement of the CMB Power Spectrum at 148 and 218 GHz from the 2008 Southern Survey'
Dunkley et al 2010 (1009.0866)	'Cosmological Parameters from the 2008 Power Spectra'
Hajian, Viero et al. 2010 (1101.1517)	Correlations in the (Sub)millimeter Background from ACTxBLAST
Das, Sherwin et al. 2011 (1103.2124)	'The Atacama Cosmology Telescope: Detection of the Power Spectrum of Gravitational Lensing'

ACT SZ Bands



Match Filter Extraction

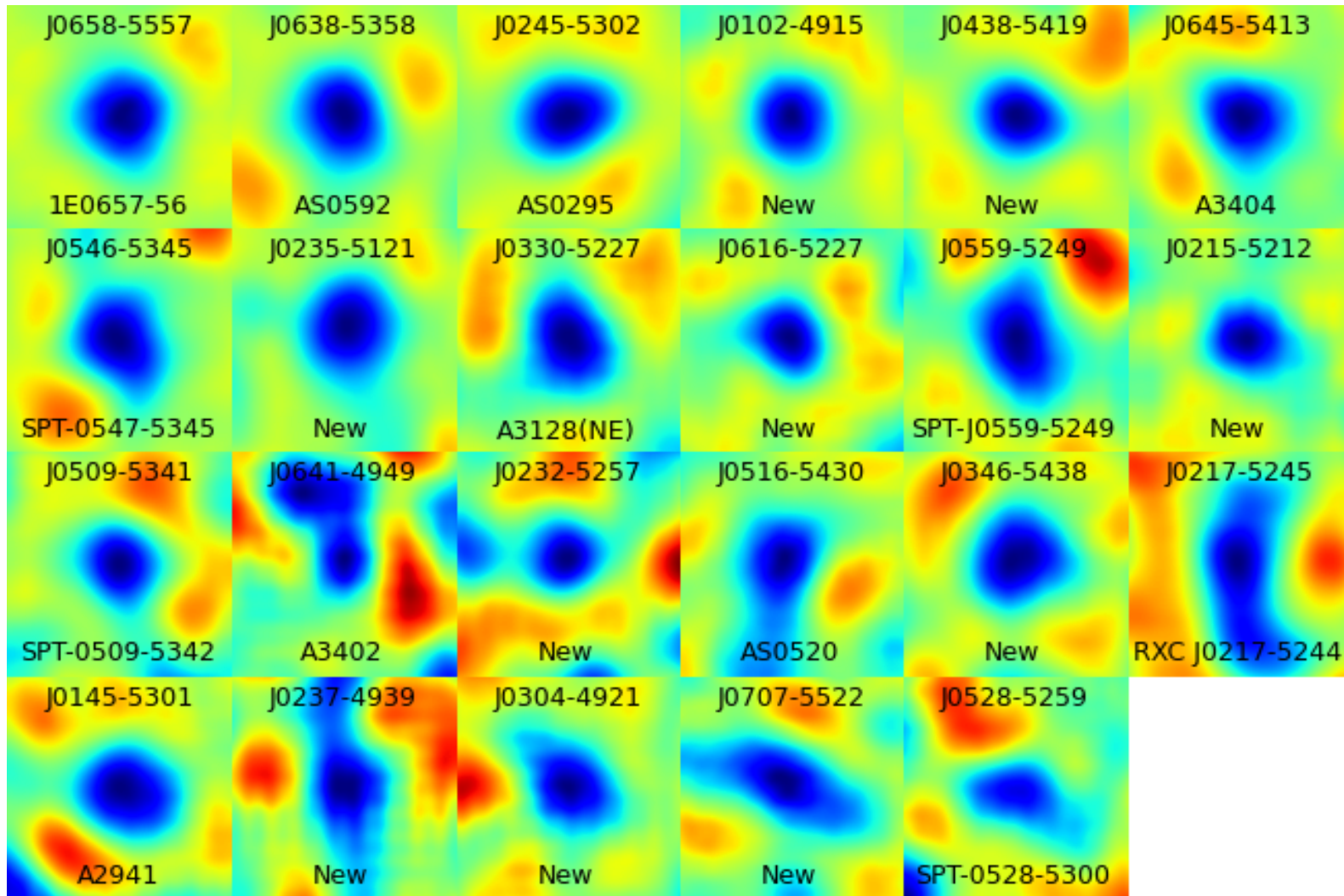


Raw Map \longrightarrow Filtered

(Abell 2218 – Only for illustration;
Different from SZ Detection)

Galaxy Clusters

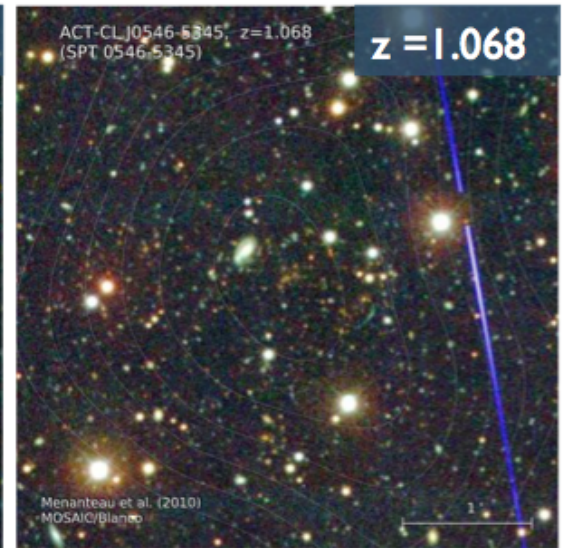
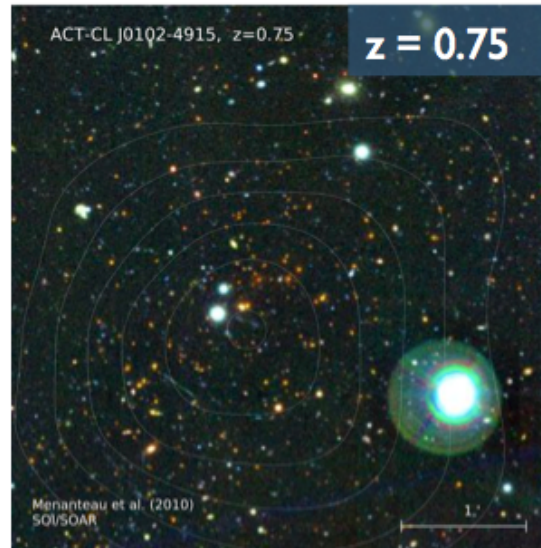
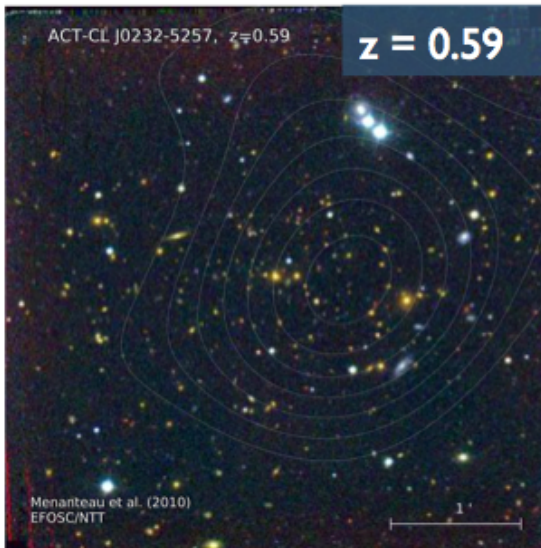
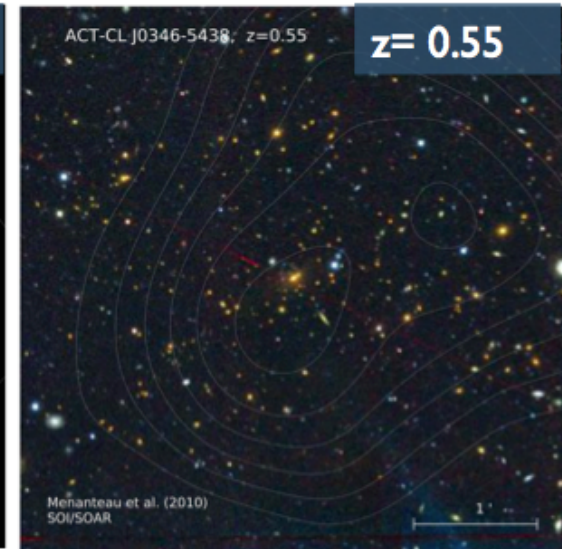
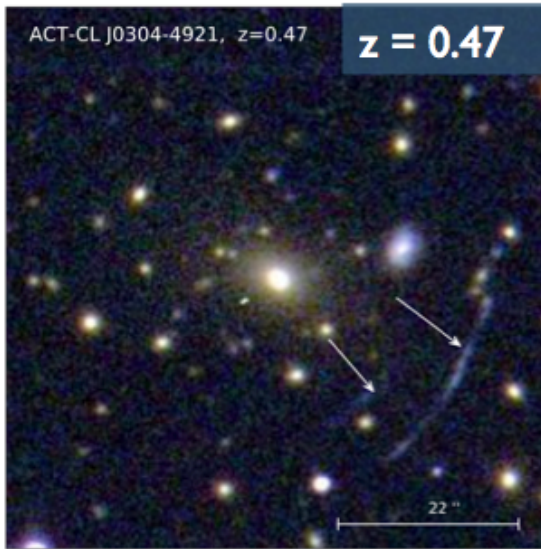
Marriage et al 2010 (1010.1065)

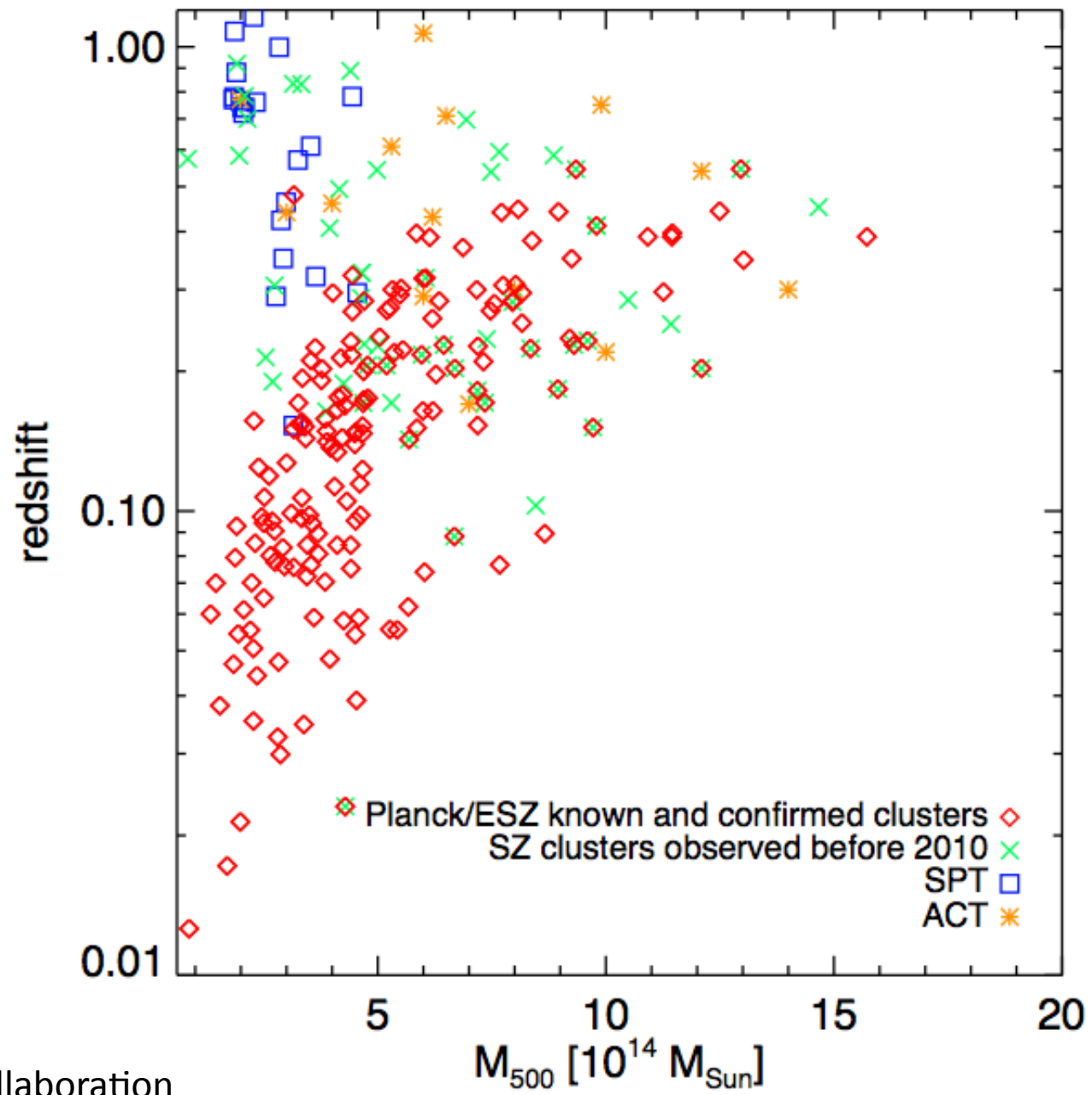


Galaxy Clusters

Optical Observations with Blanco, NTT and SOAR

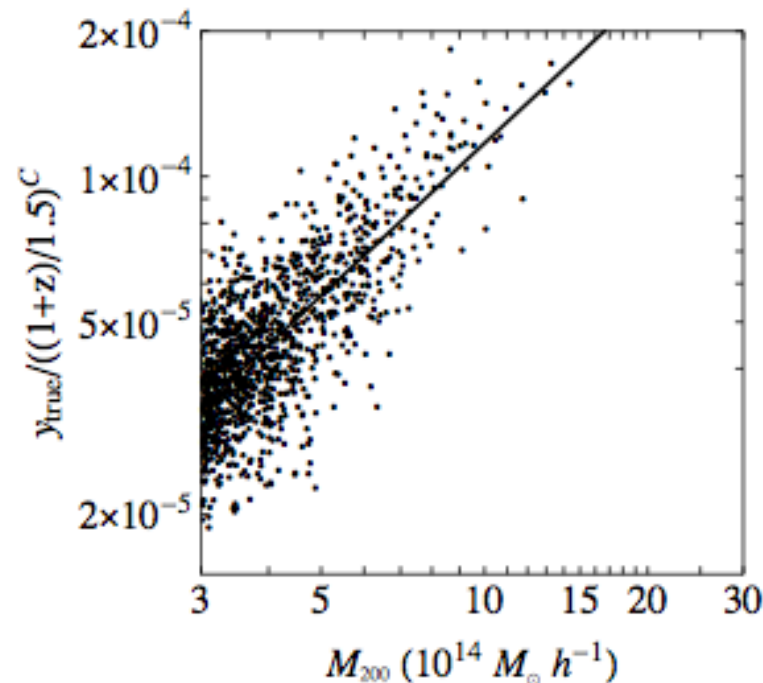
Menanteau et al 2010 (1006.5126)





Planck Collaboration

Scaling Relation Between SZ Signal and Mass



Sehgal et al 2010 (1010.1025)

Gas model based on
Bode, Ostriker, and
Vikhlinin, ApJ 2009

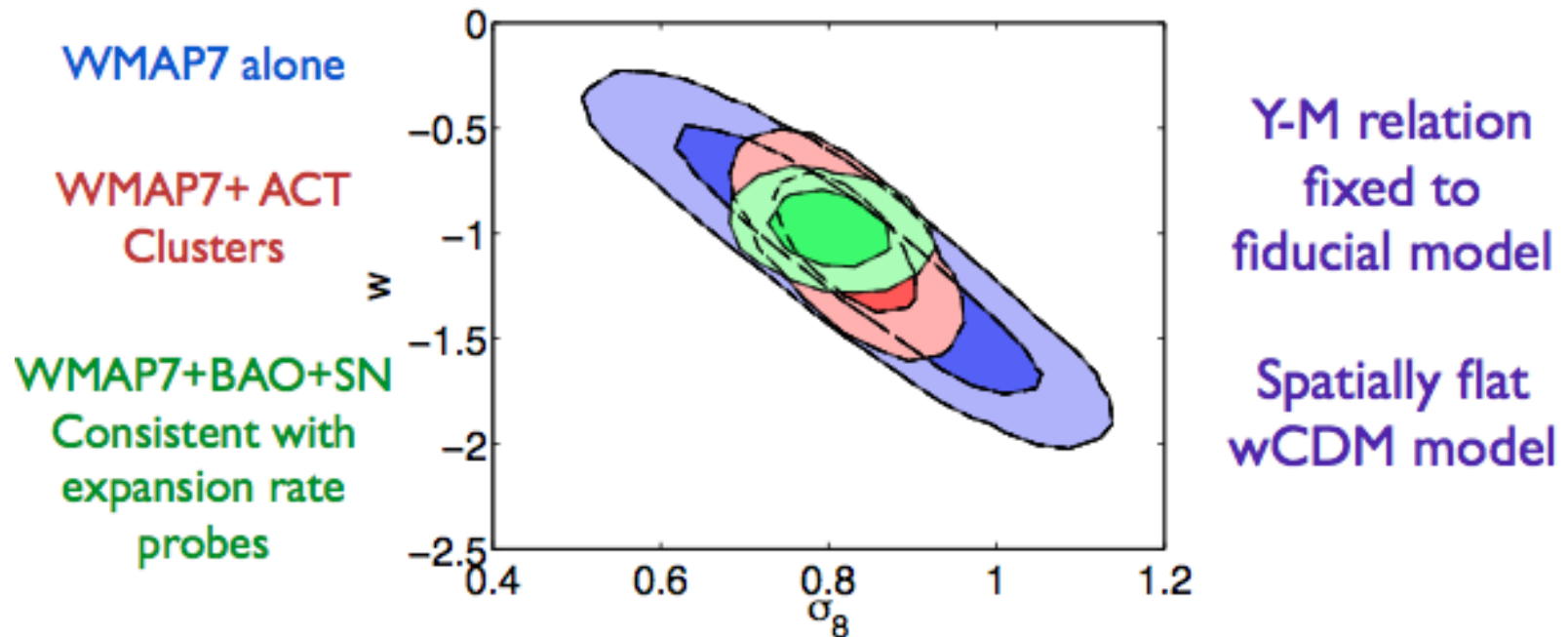
This will be the
fiducial relation

Are these sims
reliable?

Y-M relation from simulations
Sims are from Sehgal et al. 2010

Cosmology Constraints Fixing the SZ Signal Mass Relation

Sehgal et al 2010 (1010.1025)



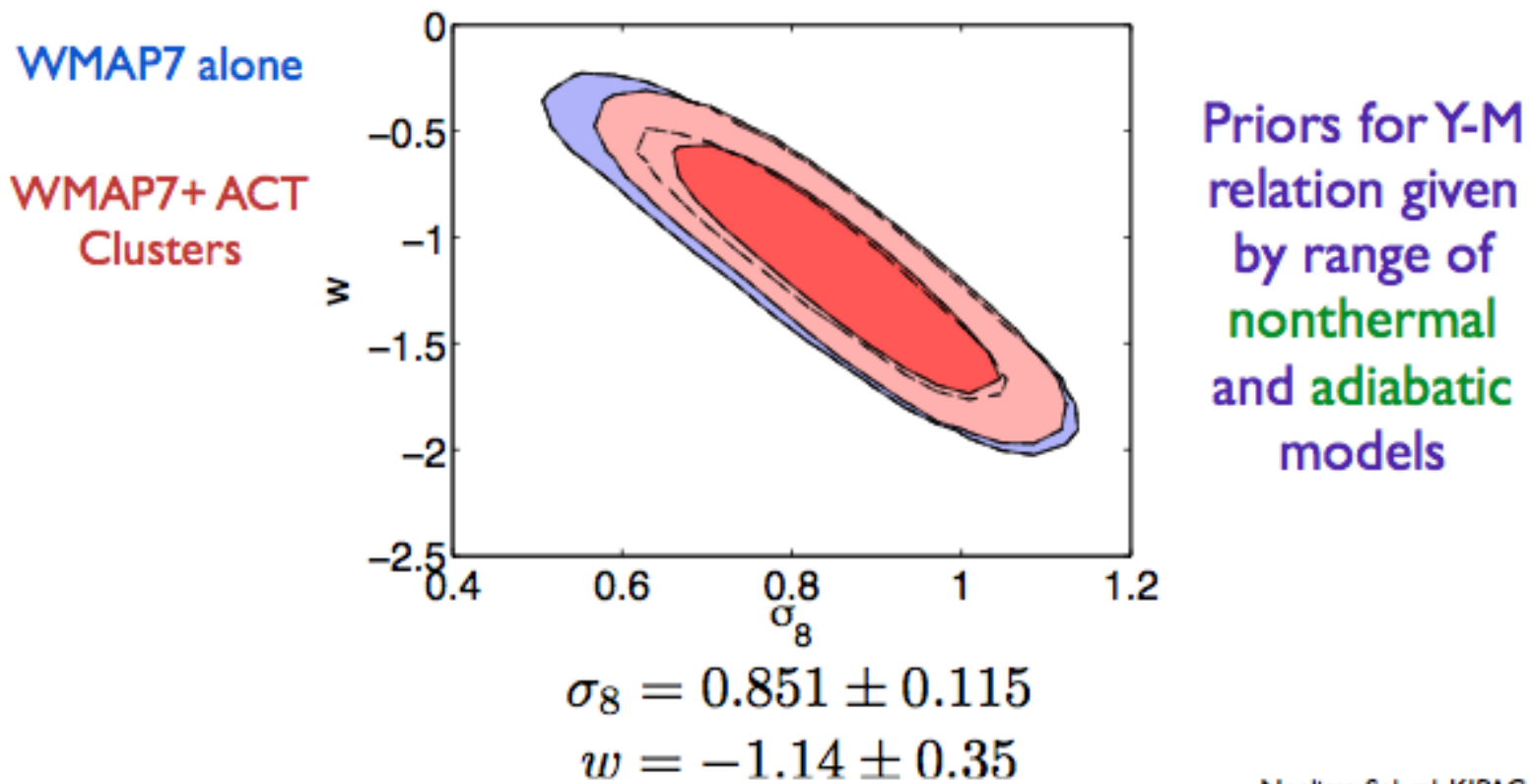
$$\sigma_8 = 0.821 \pm 0.044$$

$$w = -1.05 \pm 0.20$$

Neelima Sehgal, KIPAC

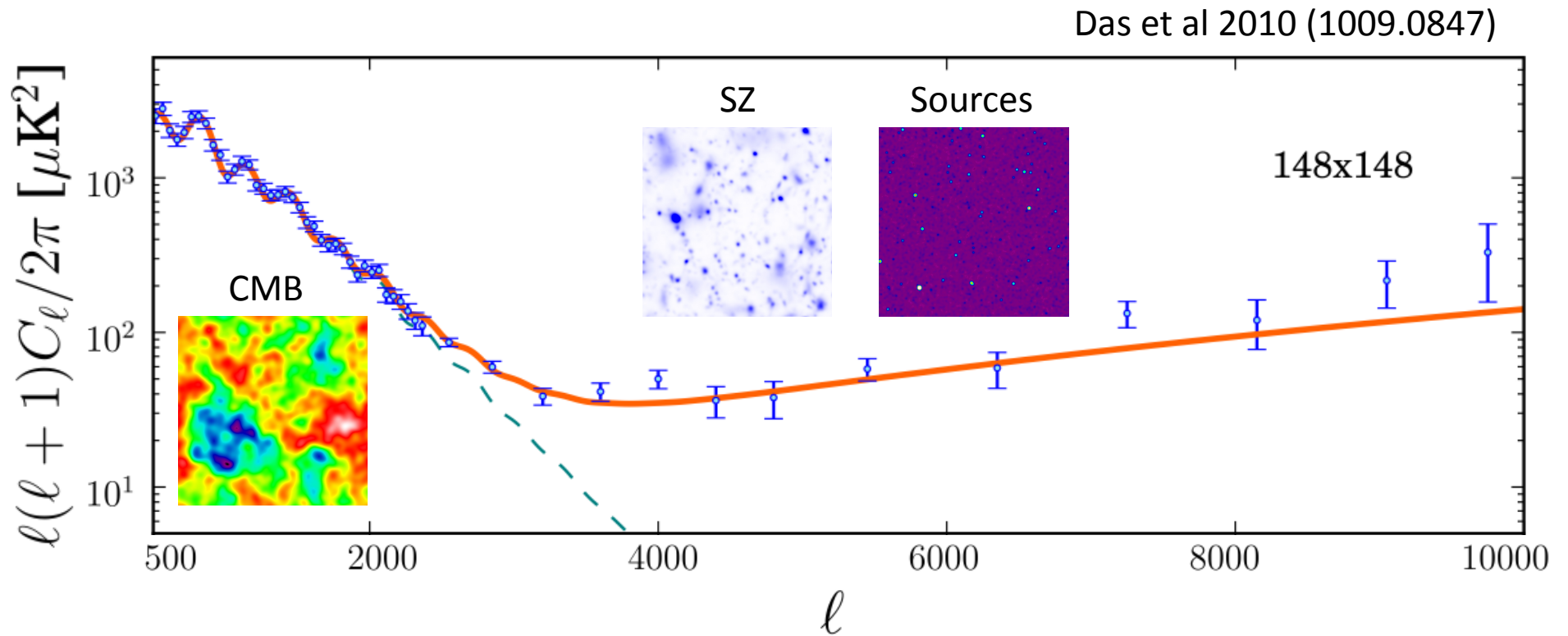
Cosmology Constraints Marginalizing over the SZ Signal Mass Relation

Sehgal et al 2010 (1010.1025)



Neelima Sehgal, KIPAC

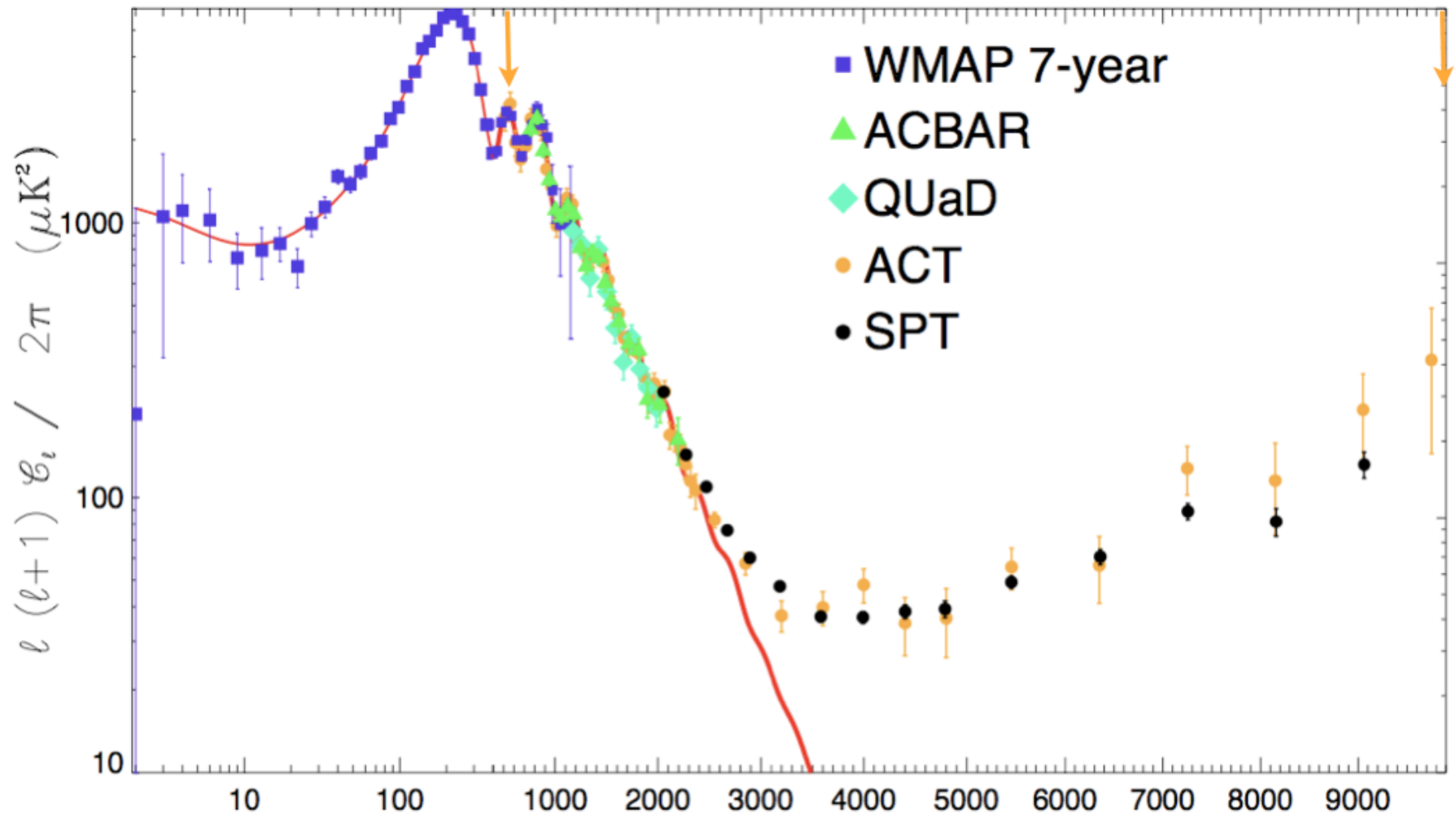
The Power Spectrum



Power Spectrum with largest multipole range (500-10,000) published to date.

Power Spectrum All-Stars

ACT spectrum from $\ell = 500$ to 10,000!



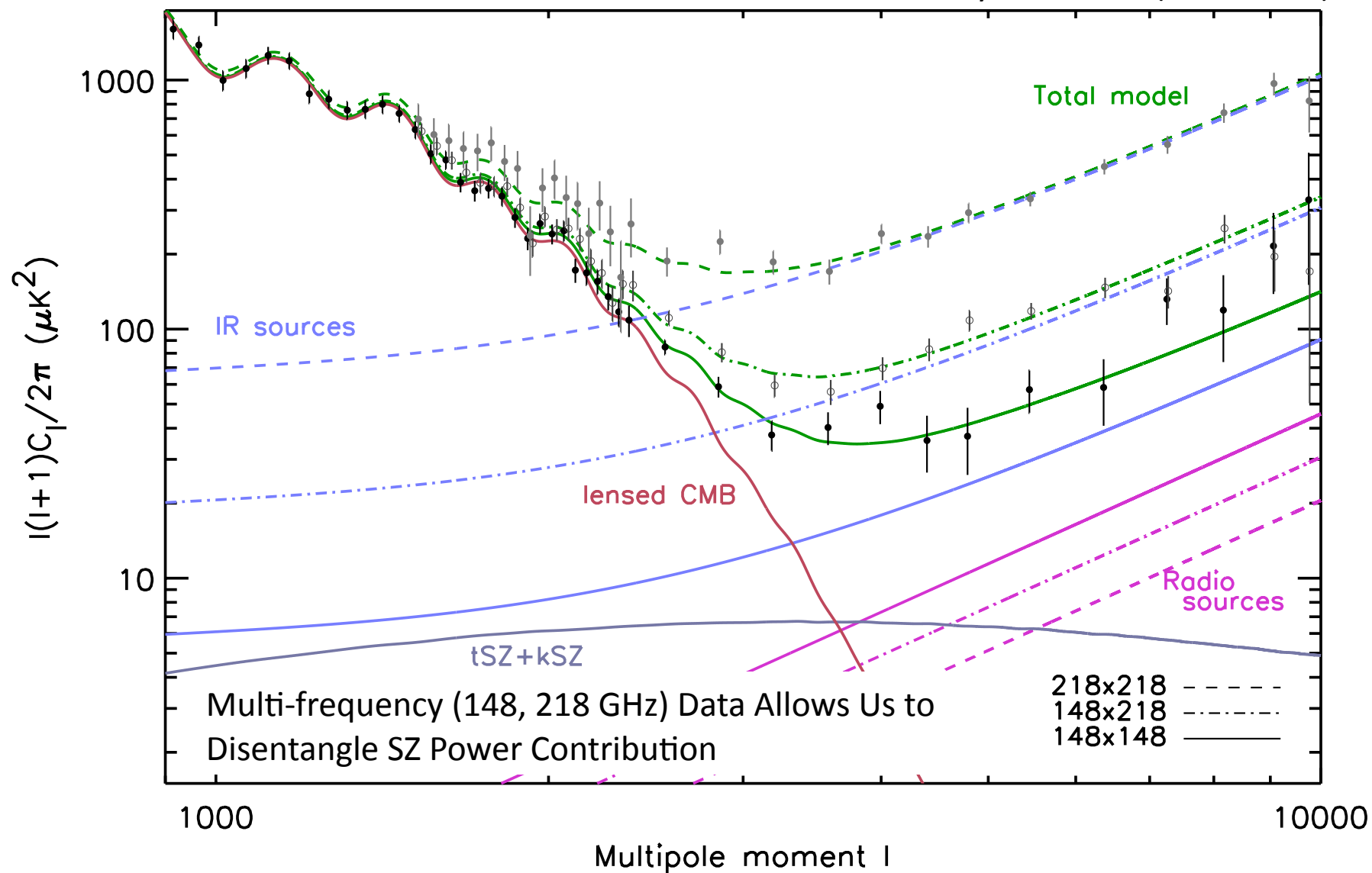
Shirokoff et al. 2010

l

Neelima Sehgal, KIPAC

The High- l Power Spectrum

Dunkley et al 2010 (1009.0866)

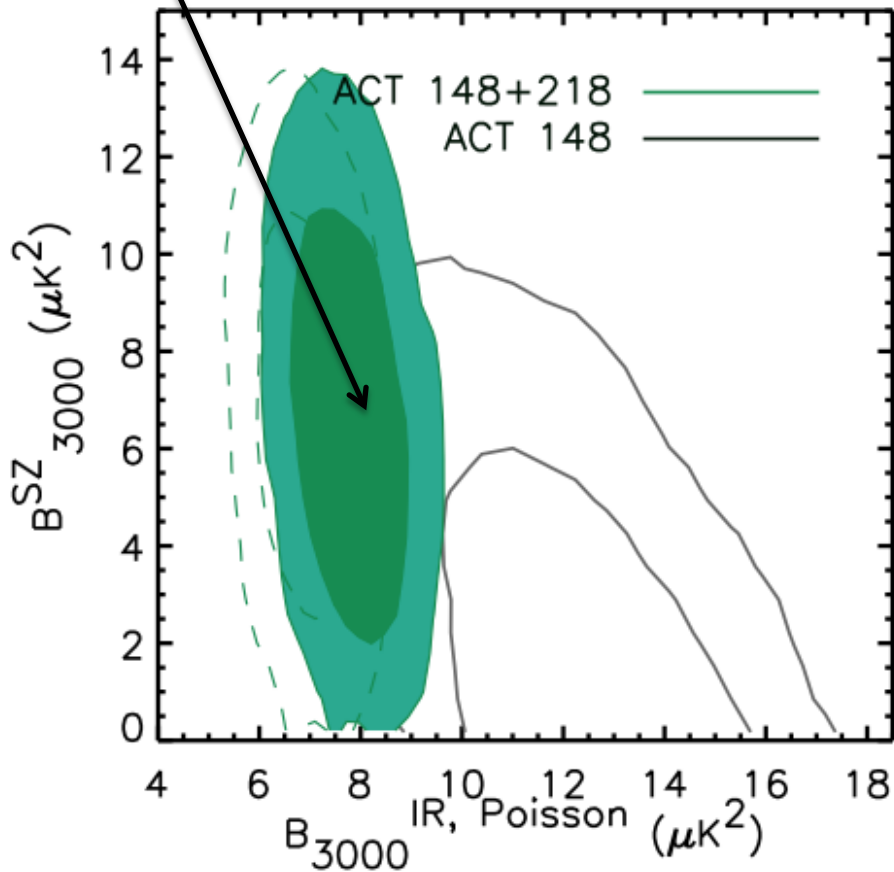


Best-fit SZ Power Spectrum
 Level Insensitive to
 Assumed SZ Template:
 differences in
 interpretation of level.

Galaxy Clusters

Probing the Entire Cluster Population
 Astrophysical/Cosmological Implications

Dunkley et al 2010 (1009.0866)



Sehgal 2010
 Trac 2010
 Battaglia 2010
 Shaw 2010

	$\sigma_8^{SZ,7}$	$\sigma_8^{SZ,9}$
	$0.8 \times (A_{tSZ}^{1/7})$	$0.8 \times (A_{tSZ}^{1/9})$
Sehgal 2010	0.74 ± 0.05	0.75 ± 0.04
Trac 2010	0.78 ± 0.05	0.79 ± 0.04
Battaglia 2010	0.77 ± 0.05	0.78 ± 0.04
Shaw 2010	0.77 ± 0.05	0.78 ± 0.04

First such constraints from SPT:
 Leuker et al. 2010
 Recent: Shirokoff, Reichardt et al. 2010

³² During the analysis for this work we discovered that the joint primary CMB-tSZ constraint on σ_8 in Lueker et al. (2010) erroneously assumed the S10 model was created using $\sigma_8 = 0.77$ instead of the correct value of $\sigma_8 = 0.8$. The constraints on σ_8 should therefore have been 0.767 ± 0.018 (assuming no theory uncertainty, see Section 6.4 in Lueker et al. 2010) and 0.778 ± 0.022 (assuming a 50% theory uncertainty). Shirokoff et al 2010

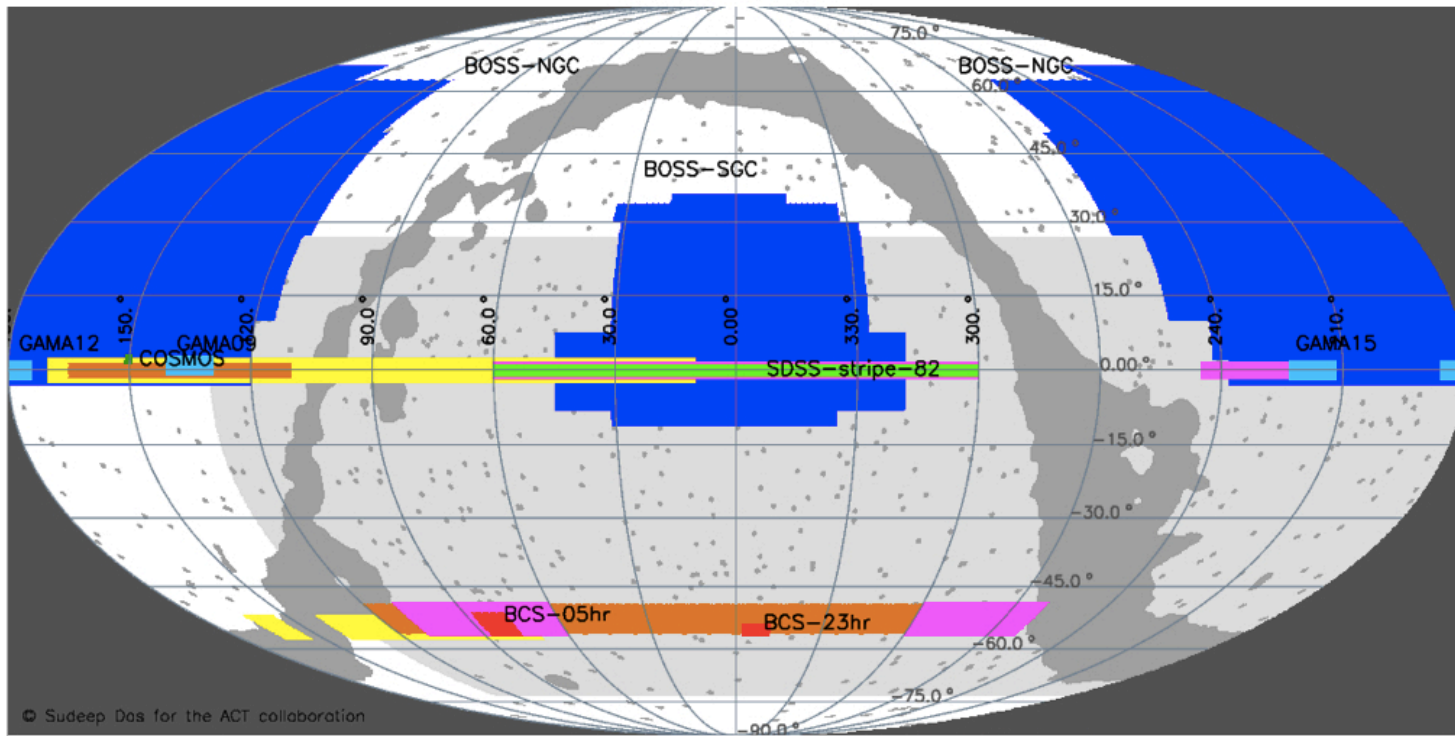
Less tension than originally reported: a couple sigma tension in sigma8.

Completely dominated in by systematics, dominated by cluster astrophysics in systems (low mass, high redshift) that need more study.

To repeat what has been said throughout the conference about apparent problems. This data represents an additional opportunity to better understand cluster physics in systems without well constrained models.

For well measured massive systems used in cluster count cosmology, things are better in hand.

STRIPE 82



2007

2008

2009/10

Stripe 82

BCS

BOSS

GAMA

ACT Range

GALACTIC MASK

Clusters in SDSS Stripe 82

27 Confirmed SZ Detections

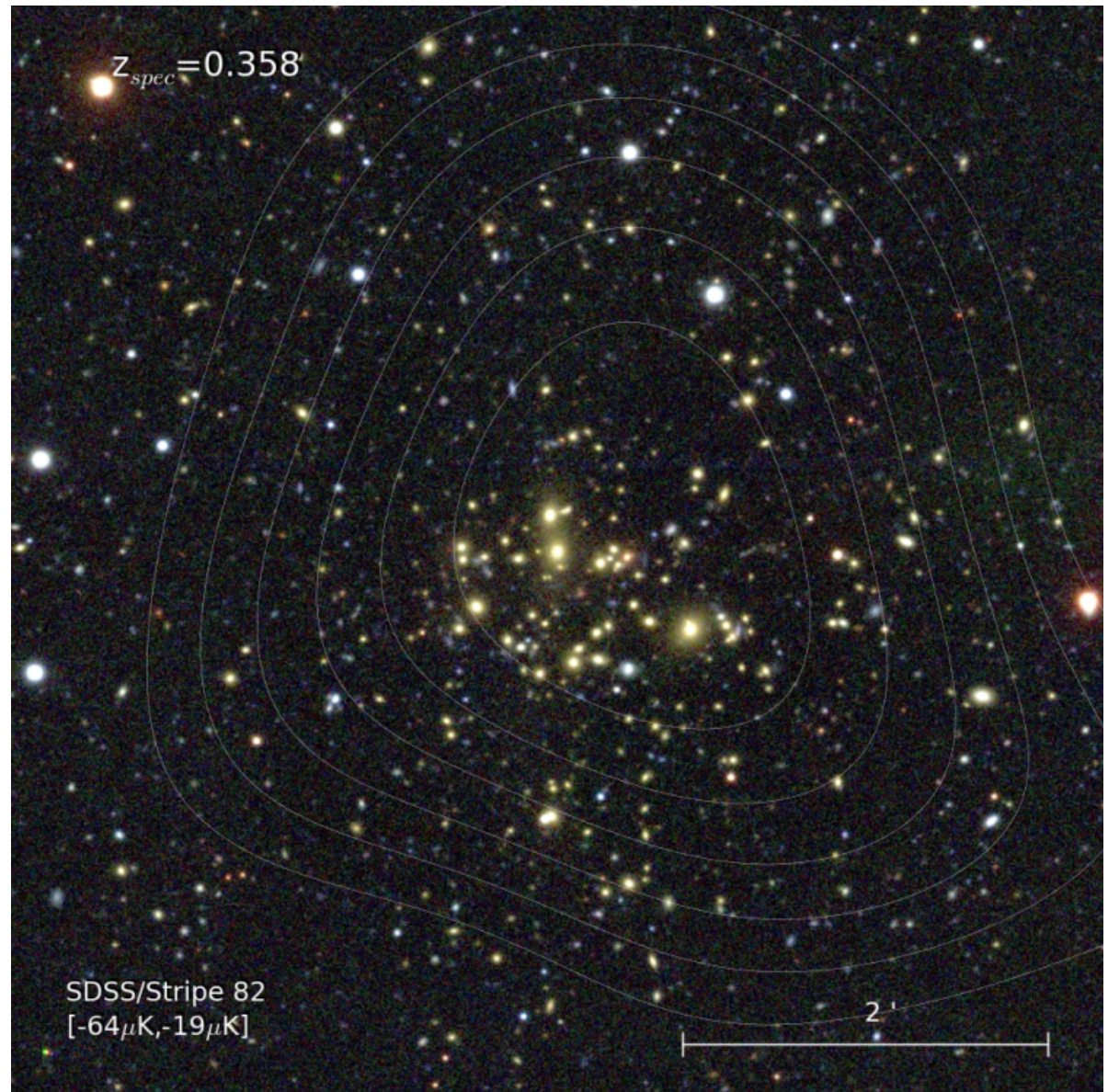
“Automatic” Confirmation
From Sloan

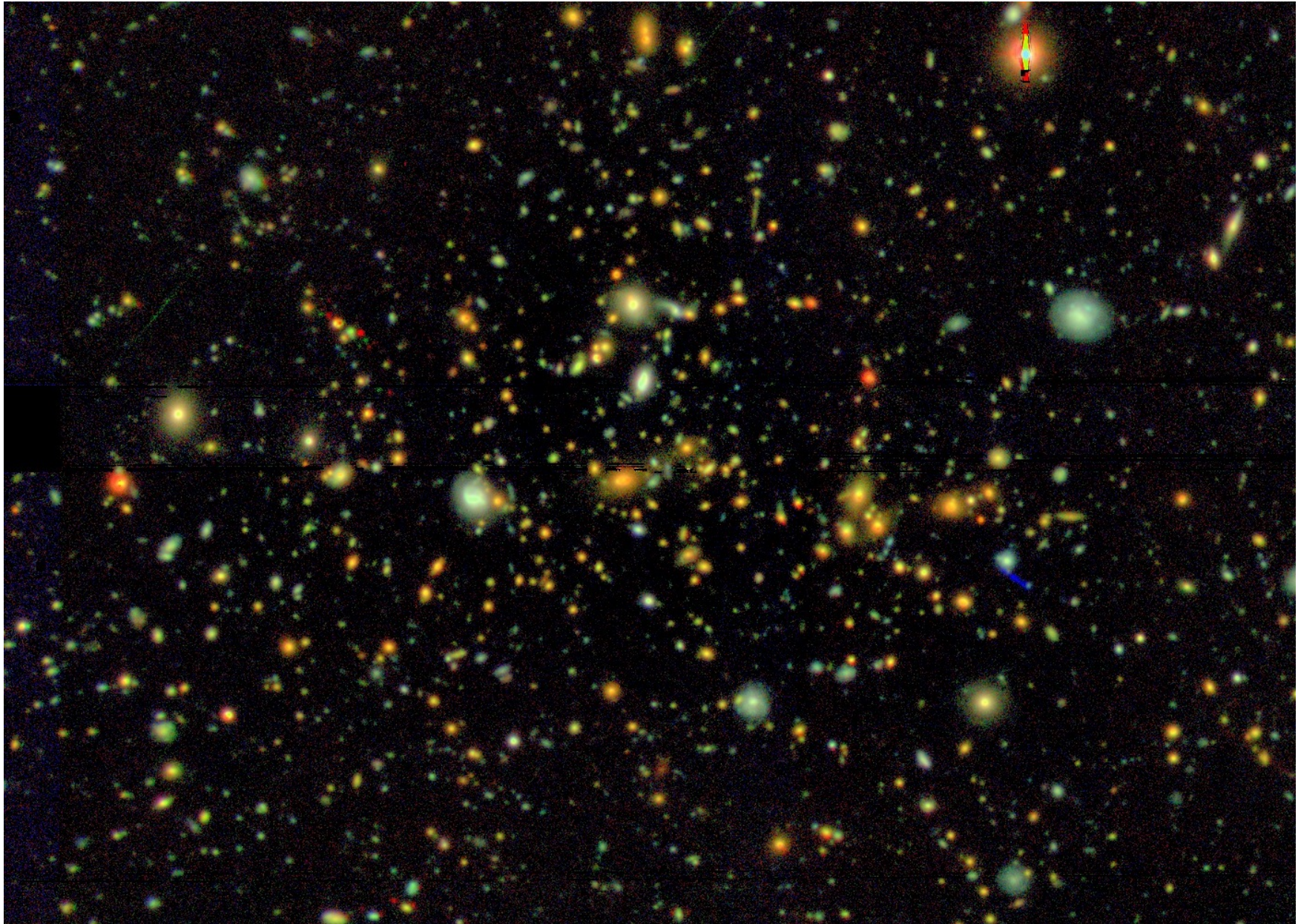
24 New Detections (well
maybe not after today!)

Spec-z for BCGs from Sloan

Complementary Sky Coverage
to SPT

Observable from both
Hemispheres.





Subaru Lensing Study of ACT Equatorial Cluster @ $z=0.8$

PI: M. Takada
Larger proposal in this year!

ACT Cluster Yield to Date

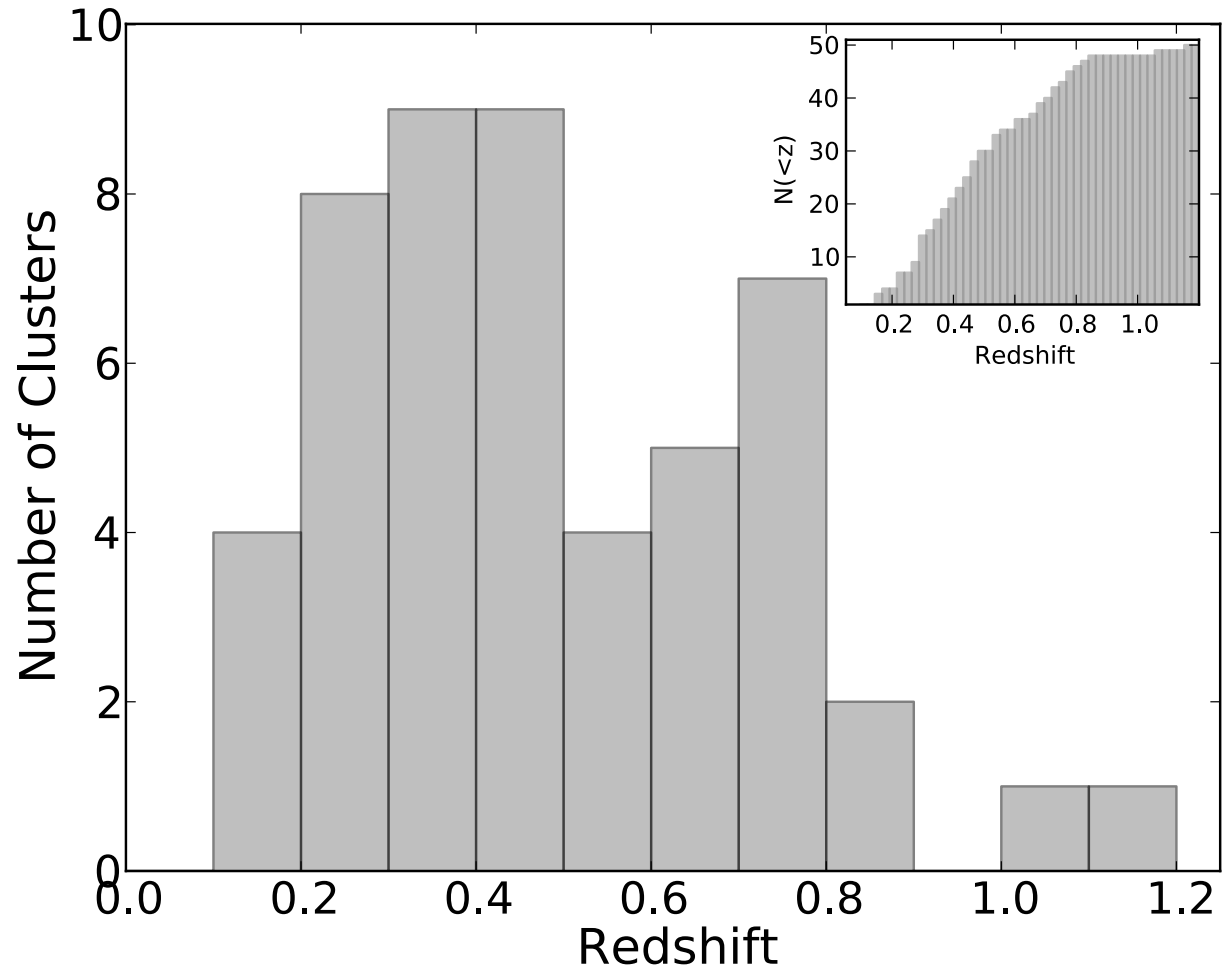
Stripe 82 plus 2008 Southern
Results:

50 Total Clusters

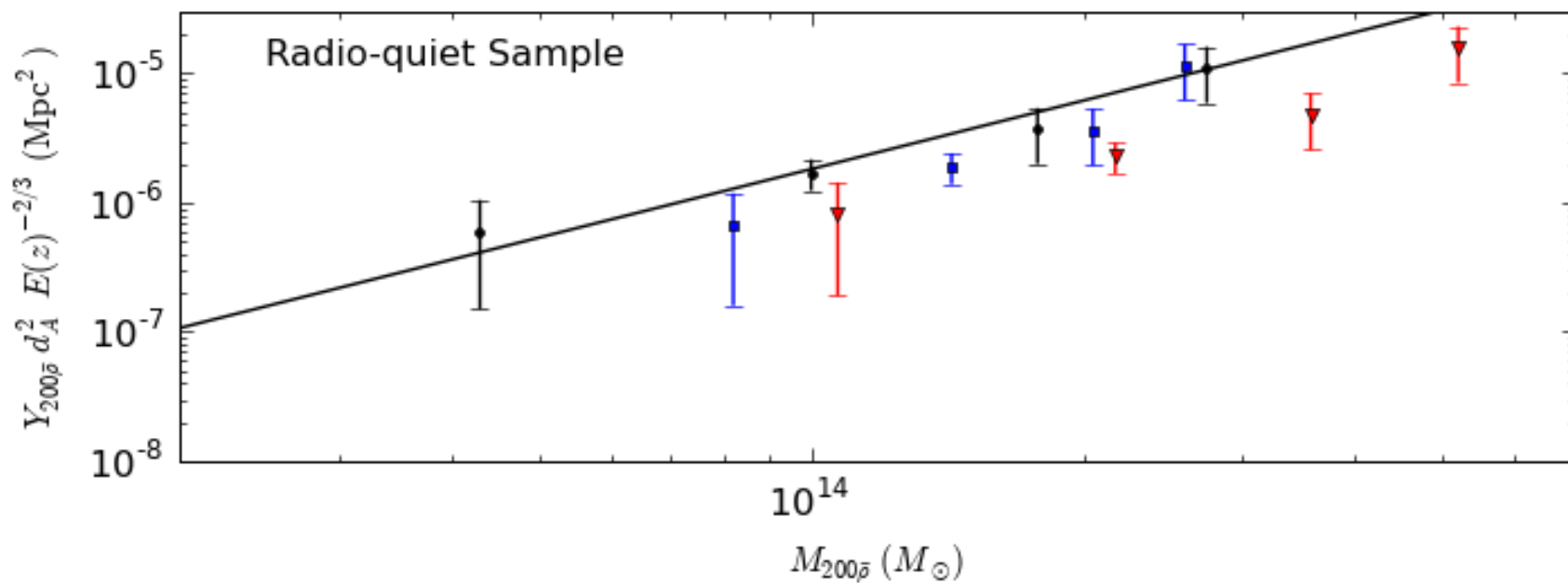
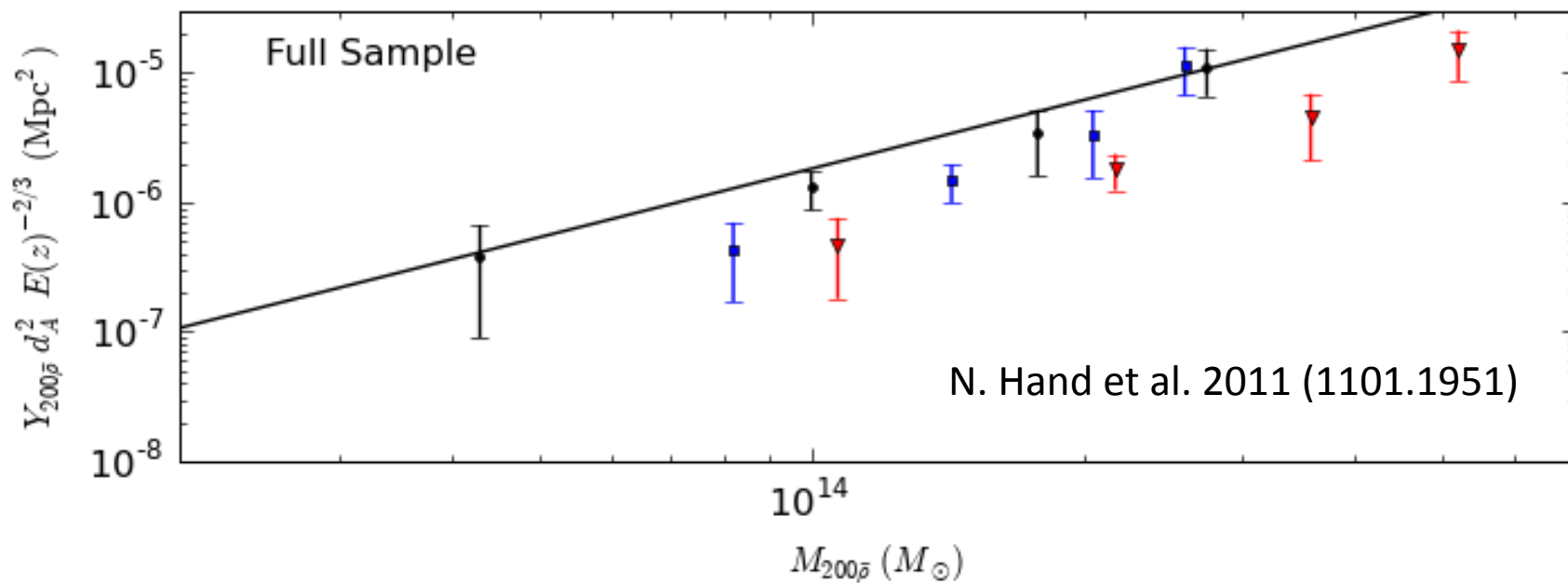
**37 SZ-discovered
(not all from ACT)**

Median Redshift: 0.45

More to come as more data is
analyzed.



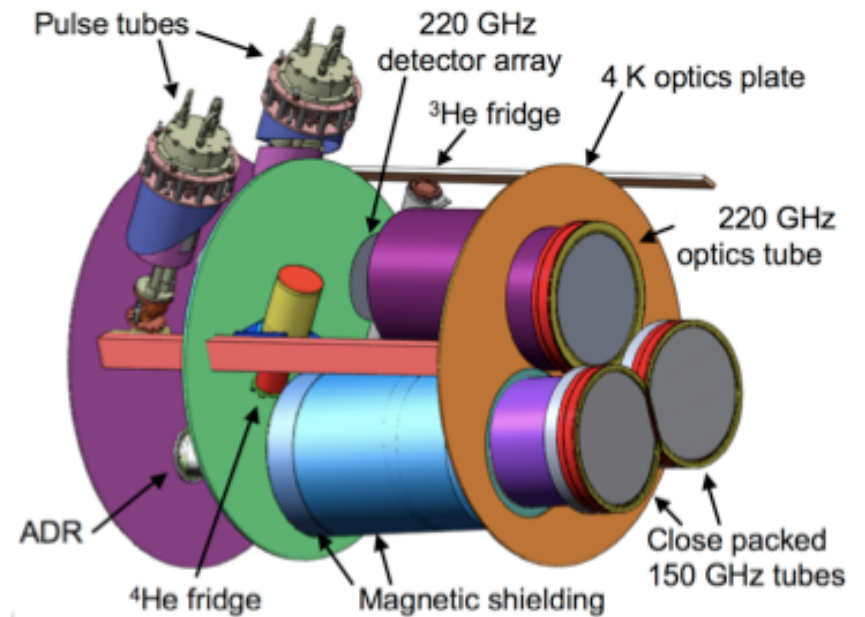
Y-M from Stacking on LRGs



ACTPol

M. Niemack et al. 2010 (1006.5049)

Deploy date: Summer 2012
4x More Sensitive than ACT
4000 sq-deg 25 uK-arcmin survey
300 sq-deg deep (few uK-arcmin) survey
Equatorial Latitudes
~800 Clusters Expected



Overlap with anticipated Subaru Hyper Suprime Cam lensing survey and prime focus spectrograph follow-up. Think Sloan photo/spectro survey repeated at $z=1$ and 2.

Stay Tuned...



Data Used in 2008 South Results Hajian et al (2010)

