The ACT Sunyaev-Zel'dovich Galaxy Clusters Survey

Matt Hilton, on behalf of ACT collaboration





































2007-10: ACT 'MBAC'

2013-15: ACT 'ACTPol'

2016-19: ACT 'AdvACT'

Full data: about three times lower noise than Planck

Intensity and polarization



























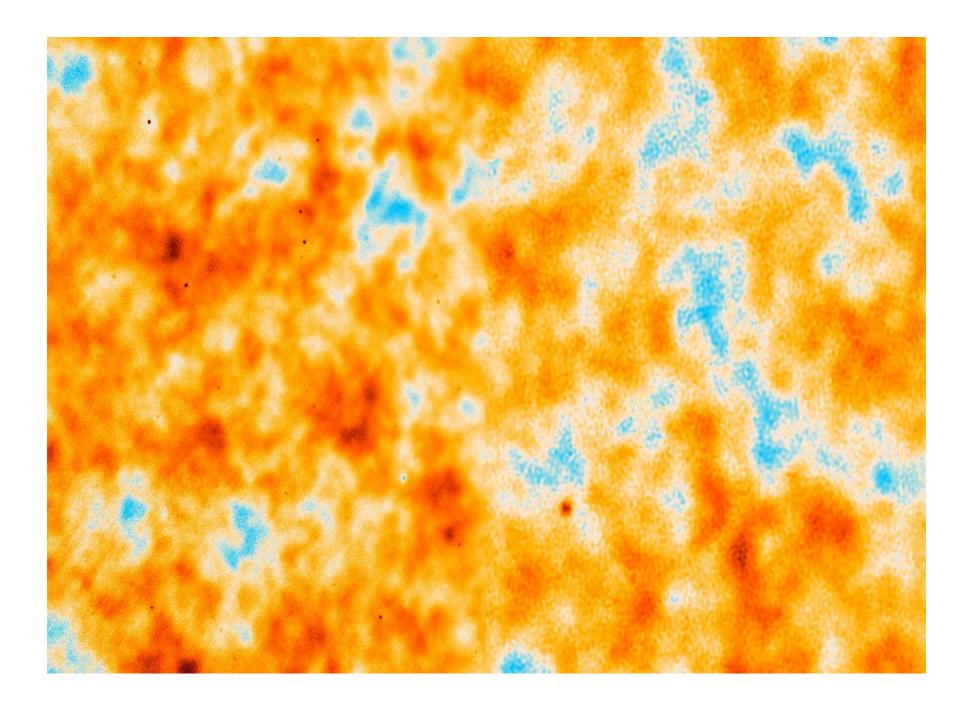








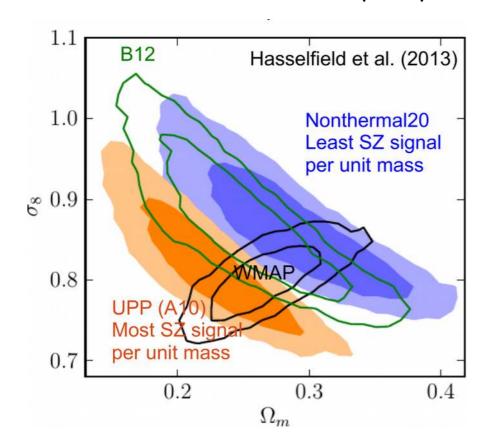
ACT



By Sigurd Næss

ACT (MBAC) cluster work

- Catalogs/cosmology:
 Marriage et al. (2011), Sehgal et al. (2011), Hasselfield et al. (2013)
- Optical/X-ray properties: Menanteau et al. (2010, 2012, 2013)
- Kinematic SZ: Hand et al. (2012)
- Dynamical masses: Sifón et al. (2013, 2016); Kirk et al. (2015)
- Weak-lensing mass calibration: Miyatake et al. (2012), Battaglia et al. (2016)
- Stellar content: Hilton et al. (2013)

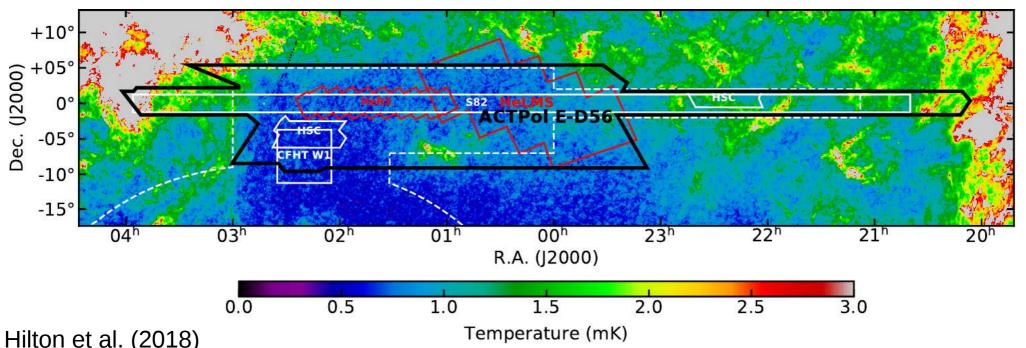




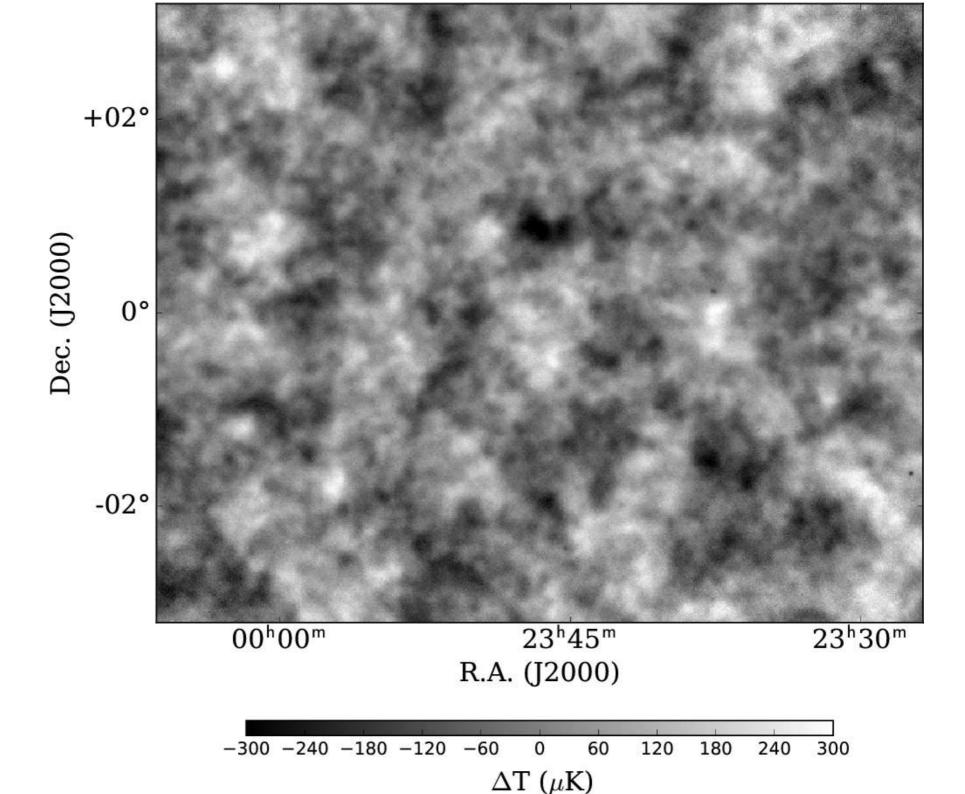
El Gordo: Menanteau et al. (2012)

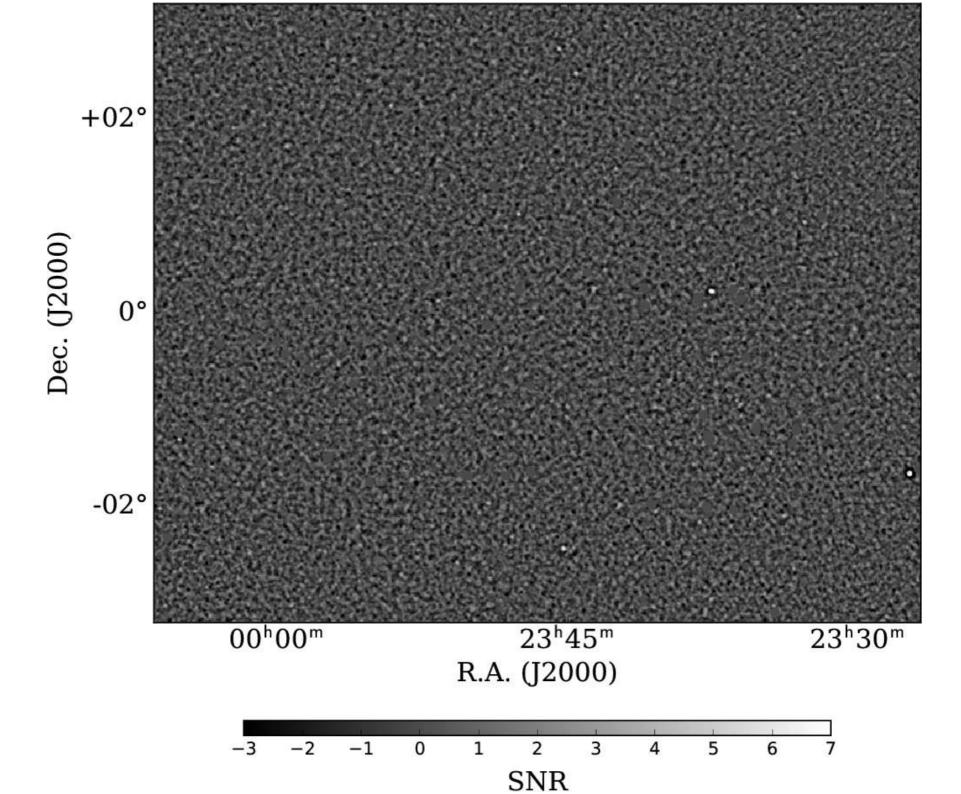
ACTPol: the E-D56 field

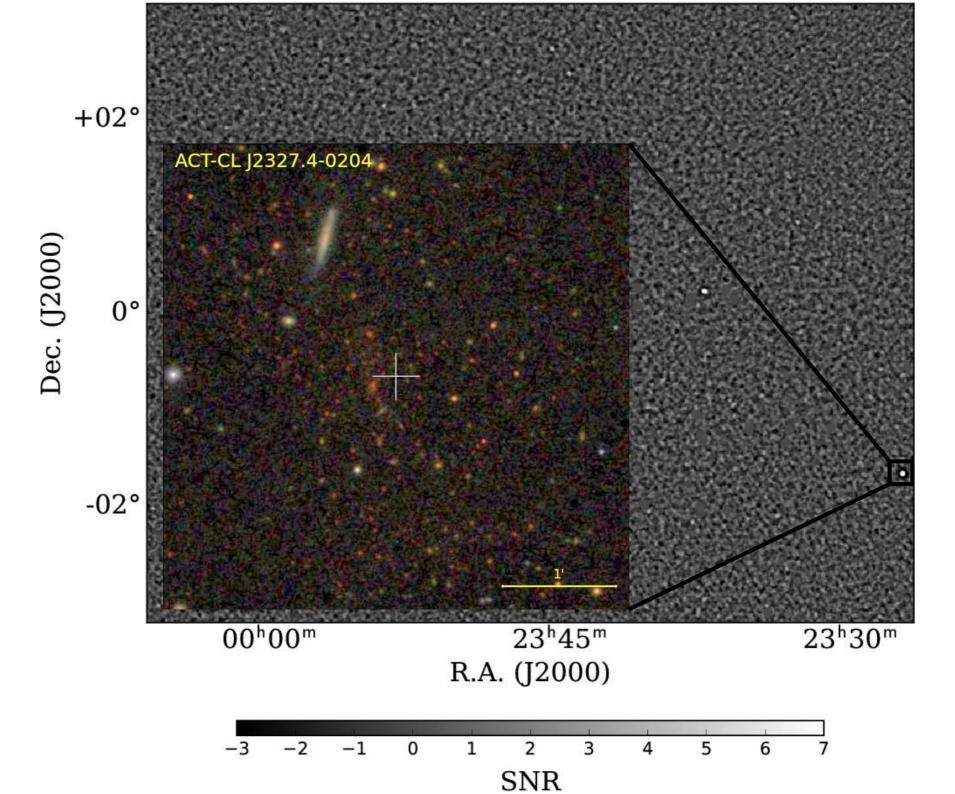
- ACTPol is an upgraded receiver for ACT and two seasons of observations have been analysed so far (2013, 2014 – see Naess et al. 2014, Louis et al. 2016 for CMB power spectrum results; de Bernardis et al. 2017 for kSZ results)
- We extended the cluster search area by combining with ACT equatorial survey data (e.g., Hasselfield et al. 2013)
- Total ACTPol E-D56 field survey area = 987.5 deg²
- Overlap with: SDSS, S82, CFHT W1, Hyper Suprime-Cam Survey (HSC), Dark Energy Survey (DES), Herschel surveys



Hilton et al. (2018)

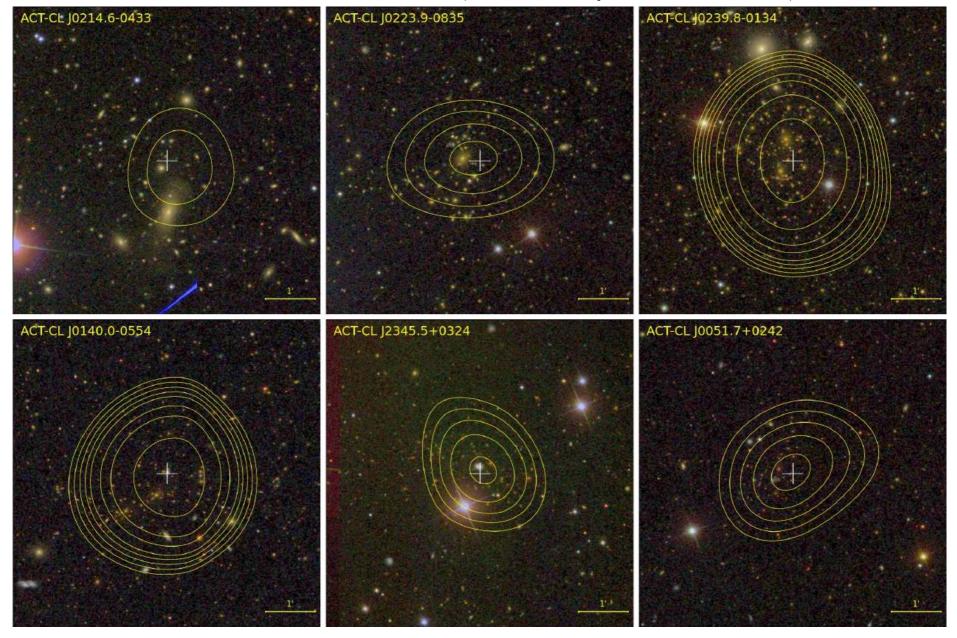






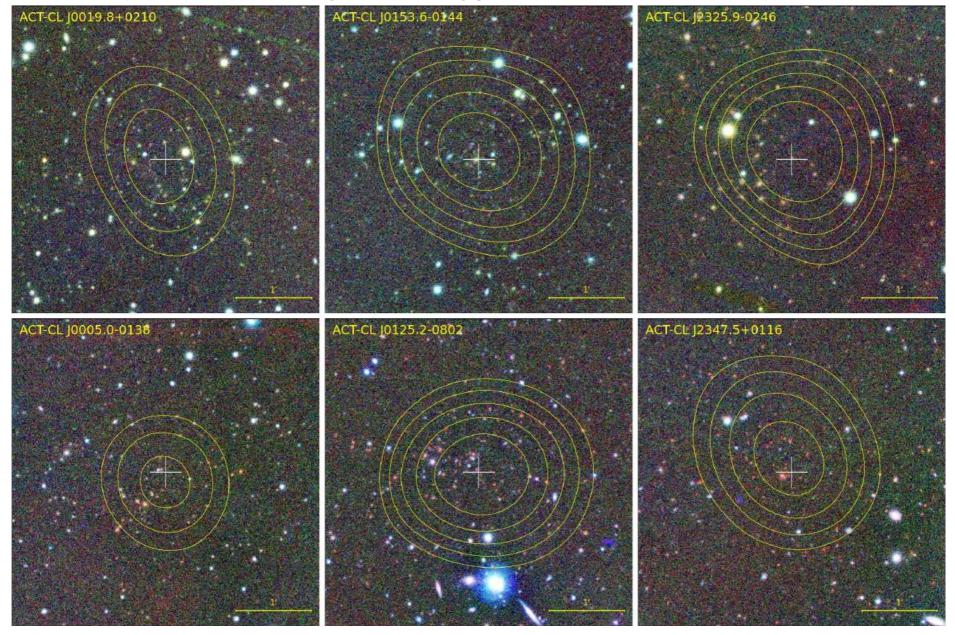
Optical follow-up

• Almost the entire field is covered by SDSS – this allows us to get redshifts for clusters to $z \approx 0.5$ (we have spec-zs for 80%)



Distant cluster follow-up

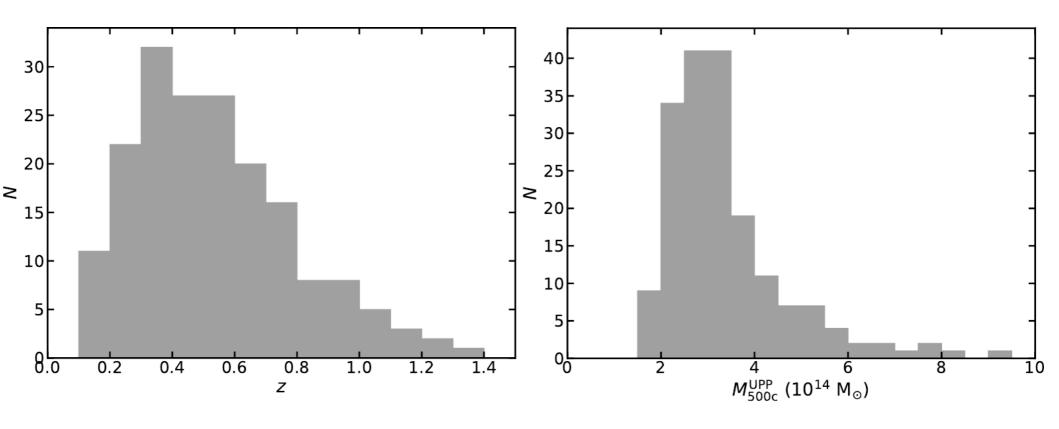
Difficult to see z > 0.5 clusters in SDSS – used SOAR (optical), ARC
 3.5m (IR), and SALT (spectroscopy) to confirm new, distant clusters



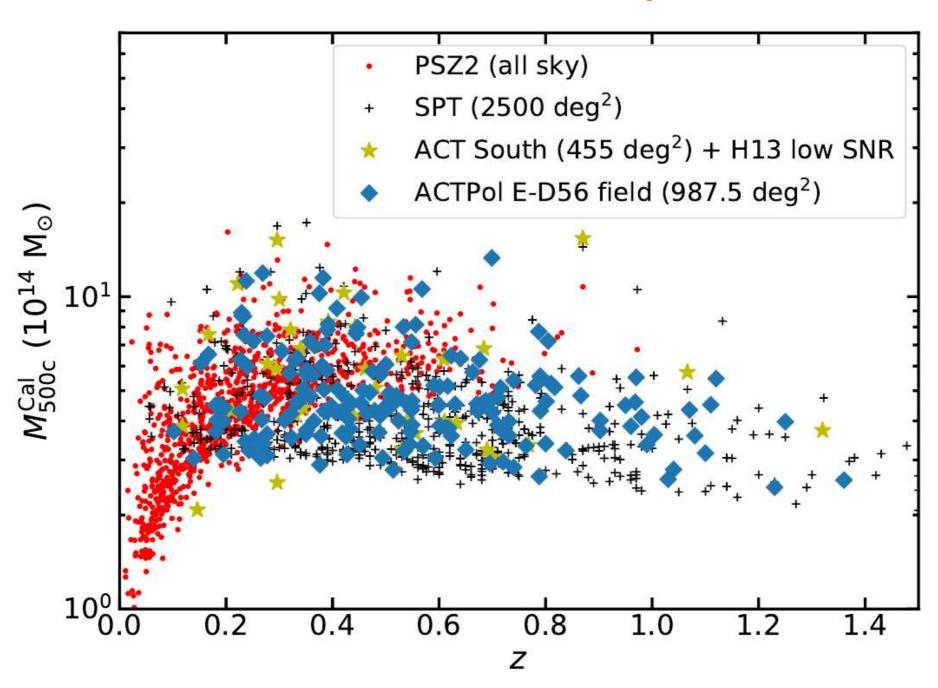
Properties of the sample

- 0.1 < z < 1.4 (80% spec-zs)
- Median z = 0.49
- 182 clusters (28 new)

- $1.6 < M_{500c} / 10^{14} M_{\odot} < 9.1$
- Median M_{500c} = 3.1 x 10¹⁴ M_{\odot}



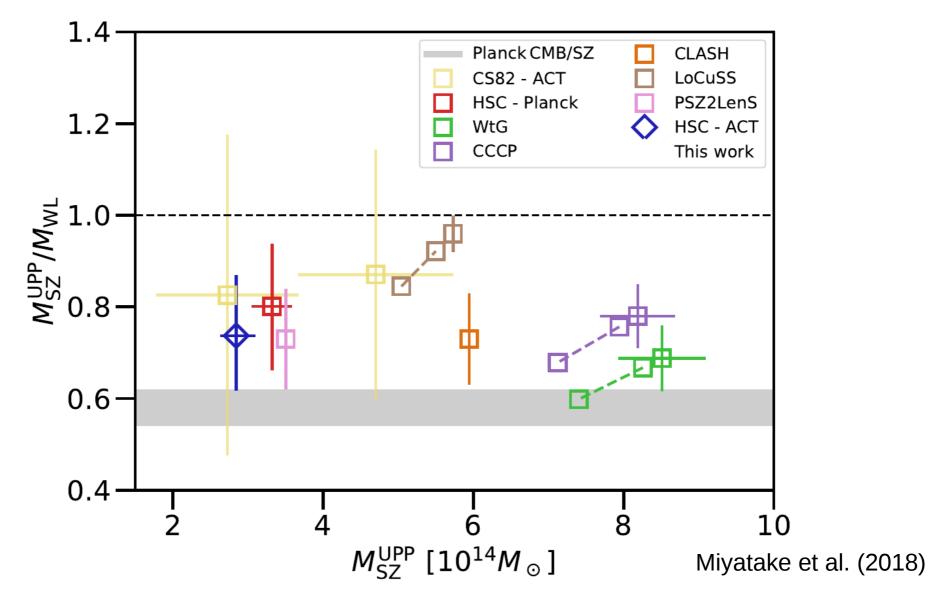
ACTPol cluster sample



Hilton et al. (2018)

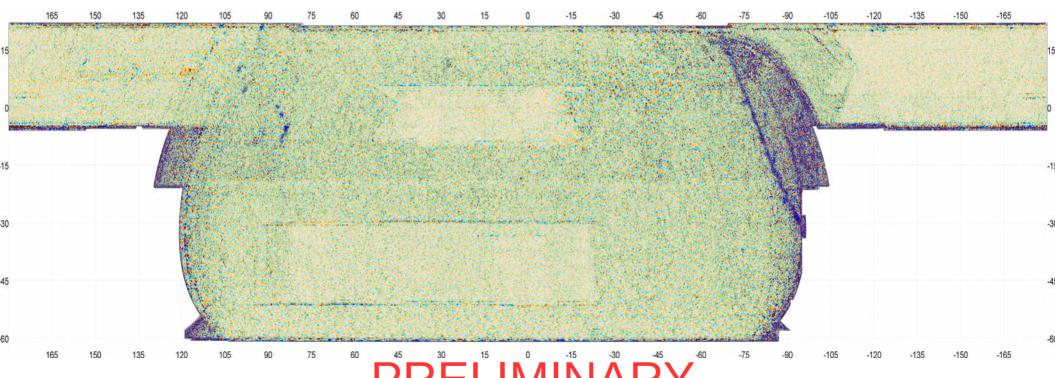
Mass calibration with HSC

 We have made direct weak-lensing mass calibration measurements using ACTPol clusters in the HSC Survey (Miyatake et al. 2018)



150 GHz AdvACT temperature map

Map by Sigurd Næss – 18,000 square degrees, 330 x 10⁶ pixels



PRELIMINARY

<u>S16</u>

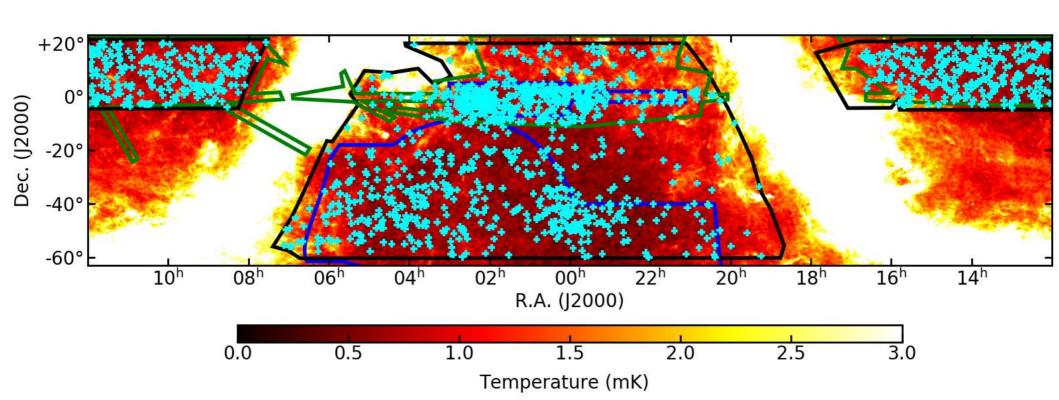
PA2 @ 150 GHz **PA3** @ 90 / 150 GHz HF @ 150 / 220 GHz S17/s18

MF @ 90 / 150 GHz MF @ 90 / 150 GHz HF @ 150 / 220 GHz S19

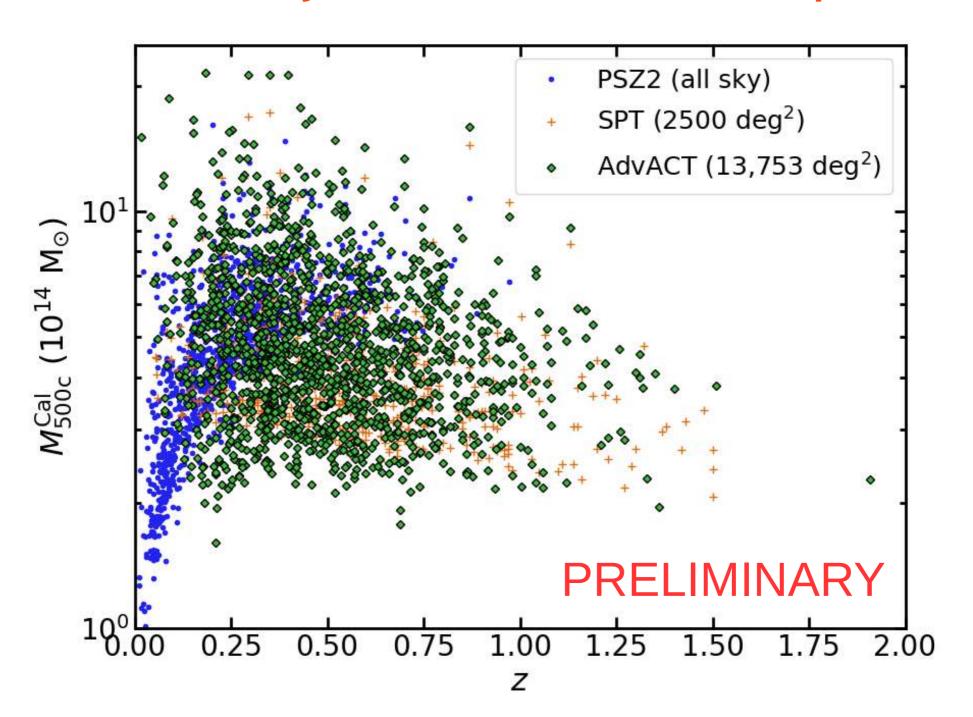
LF @ 28 / 41 GHz MF @ 90 / 150 GHz HF @ 150 / 220 GHz

Advanced ACT cluster search

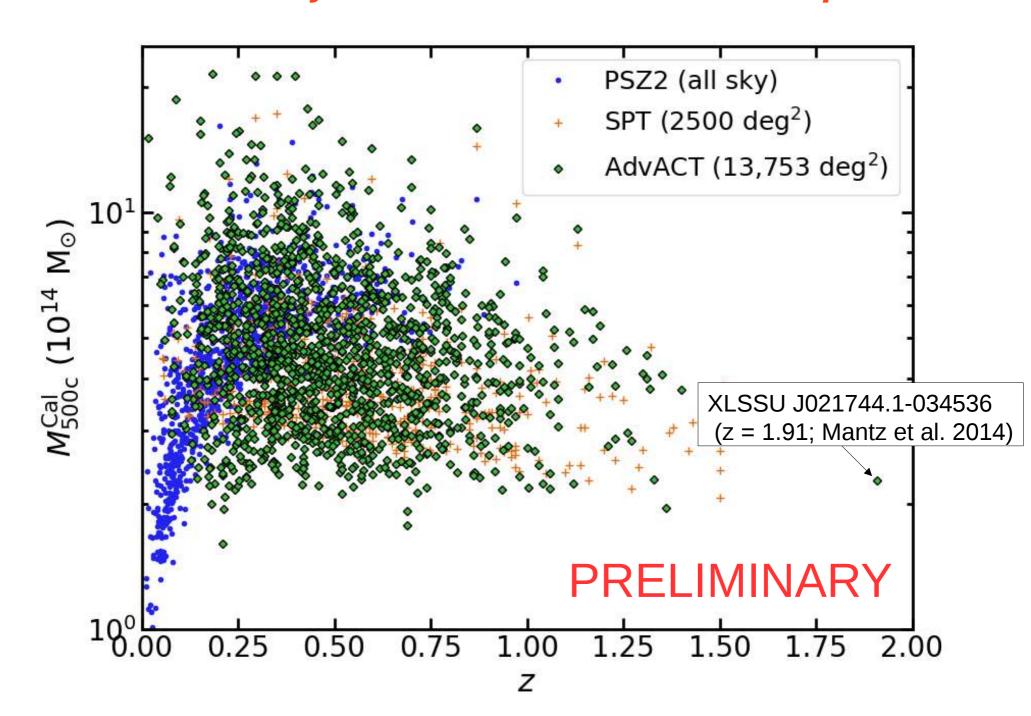
- Advanced ACT is underway surveying southern sky in 5 bands (30 → 220 GHz) with complete LSST overlap
- Preliminary cluster search: 90 + 150 GHz multi-frequency matched filter, one season of AdvACT data + all other available ACT/ACTPol data
- Black = area used for a preliminary cluster search, overlaid on Planck 353 GHz map; Blue = DES; Green = SDSS – we have not done optical follow-up outside of SDSS + DES (public DR1) regions yet



Preliminary Advanced ACT cluster sample

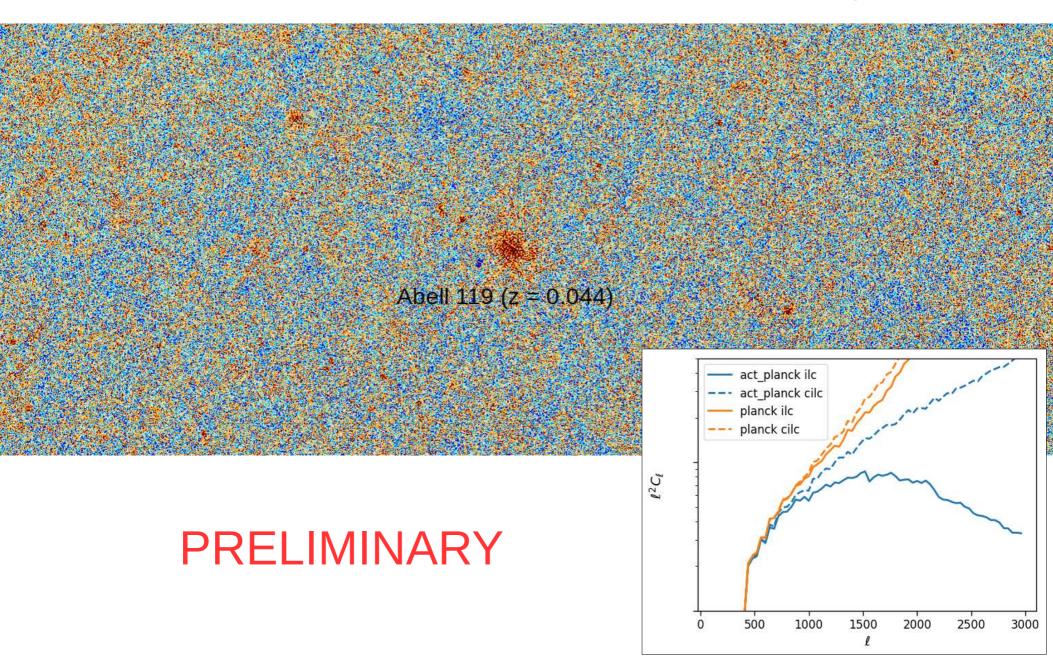


Preliminary Advanced ACT cluster sample



Preliminary ACT + Planck y-map

ILC map (D56 field) from Colin Hill, Mat Madhavacheril, Sigurd Næss



Future MeerKAT studies



- Science topics for cluster studies with MeerKAT radio observations:
 - Diffuse radio emission (radio halos and relics; see Knowles et al. 2016 + 2018; arXiv:1806.09579; for GMRT studies of ACT clusters)
 - Radio AGN and star formation in cluster galaxies using radio continuum measurements
 - Magnetic fields (Faraday rotation of emission from background sources)

Summary

- The Sunyaev-Zel'dovich effect provides a way to find massive clusters up to very high redshift, and to date published blind SZ surveys have detected ~2000 clusters
- With ACTPol, we have produced a catalog of 182 SZ clusters detected in a 987.5 square deg field (median z = 0.49) – cosmological analysis in progress...
- The main uncertainty for cluster cosmological analyses is mass calibration – we are addressing this through weak-lensing measurements in collaboration with HSC (Miyatake et al. 2018), KiDS (Robertson et al., in prep.) and in the future with DES (and then LSST)
- Advanced ACTPol is underway and at the time of writing we have a preliminary sample of 1500+ clusters with redshift measurements, detected in a ~14,000 deg² survey area