Current status of the AMI project

Keith Grainge
Astrophysics Group, Cavendish Laboratory, Cambridge

Cosmology with SZ and X-ray Observatories
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OVERVIEW

- Introduction to Arcminute MicroKelvin Imager (AMI)
- The compact and extended arrays
- Backend system and current status
- Predicted performance
- Summary

THE AMI TEAM

Bob Barker	Roger Boysen	Tony Brown	Mike Crofts
Tom Culverhouse	Jerry Czeres	Roger Dace	Rob D'Alessandro
Peter Duffett-Smith	Will Flynn	Keith Grainge (PM)	Mike Hobson
Christian Holler	Mike Jones (Former PM)	Takeshi Kaneko	Rüdiger Kneissl
Anthony Lasenby (PI)	Ian Northrop	Guy Pooley	Vic Quy
Richard Saunders	Jack Schofield	Paul Scott	Clive Shaw
Angela Taylor	David Titterington	Elizabeth Waldram	Simon West
Brian Wood	Jonathan Zwart		

Joanne Baker	James Bartlett	Garret Cotter
Jacques Delabrouille	Jean-Baptiste Melin	Steve Rawlings

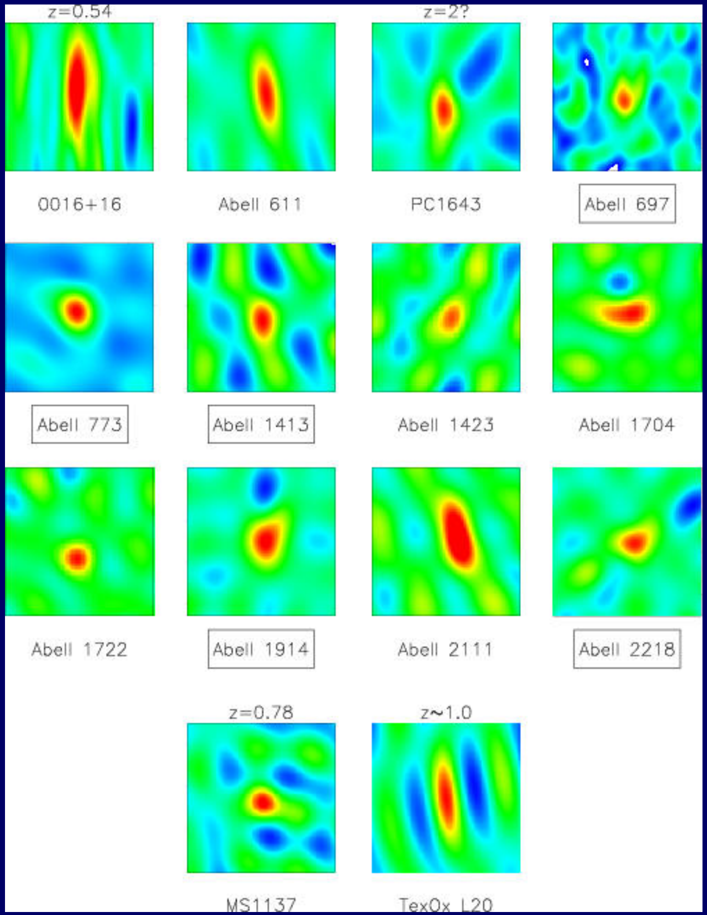
ADVANTAGES OF USING AN INTERFEROMETER

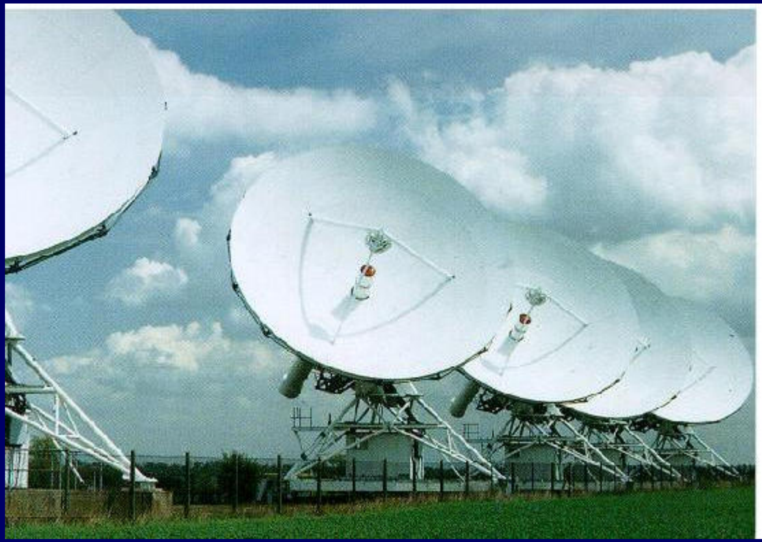
Interferometry is a good way to do SZ measurements:

- not susceptible to scan-synchronous systematics
- rejection of atmospheric signal
- astronomical fringe rate filtering
- high resolution achievable without building a big expensive antenna
- BUT since interferometer of baseline d measures FT of sky on scale λ/d, need short baselines:

Also need high sensitivity to detect faint (low mass) clusters.

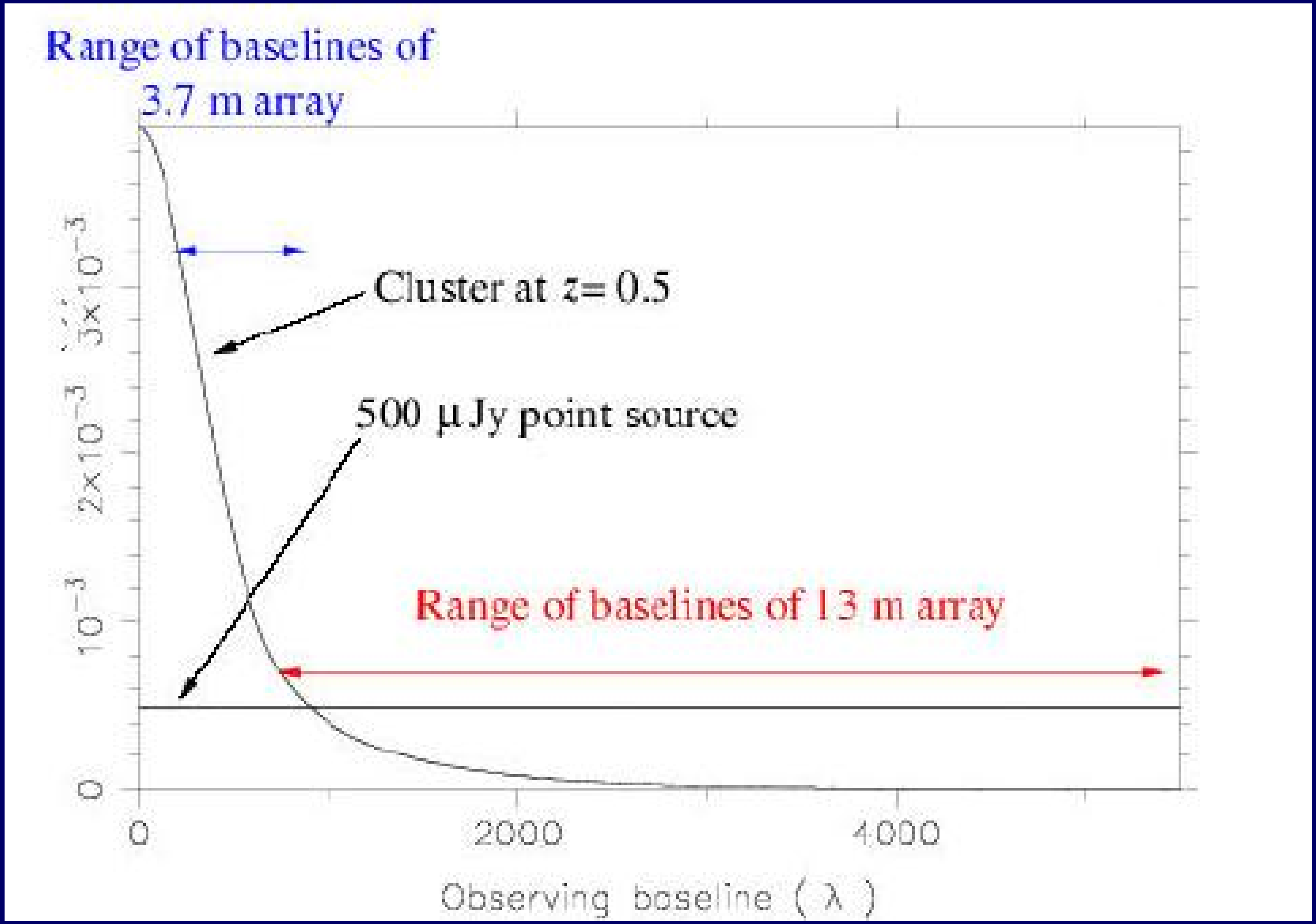
RYLE TELESCOPE IMAGES OF THE SZ EFFECT





- First SZ image (1993)
- Observing at 15 GHz with 350 MHz bandwidth
- East-West array $\longrightarrow$ poor beam at low dec

Flux against baseline

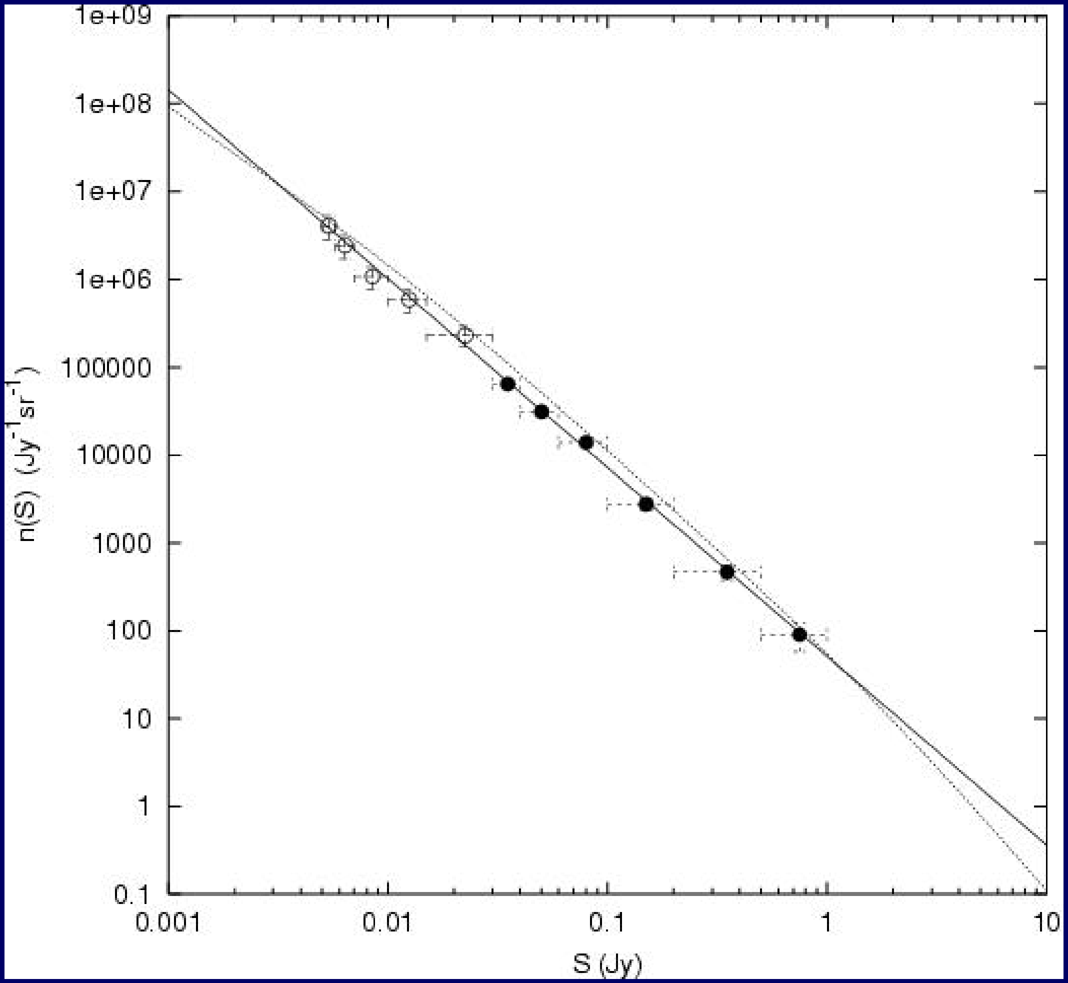


AMI - Compact Array

- **Compact Array**
- 10×3.7m antennas
- 15 GHz
- FOV = 21'
- Baselines 5 – 20m
- Groundscreen enclosure

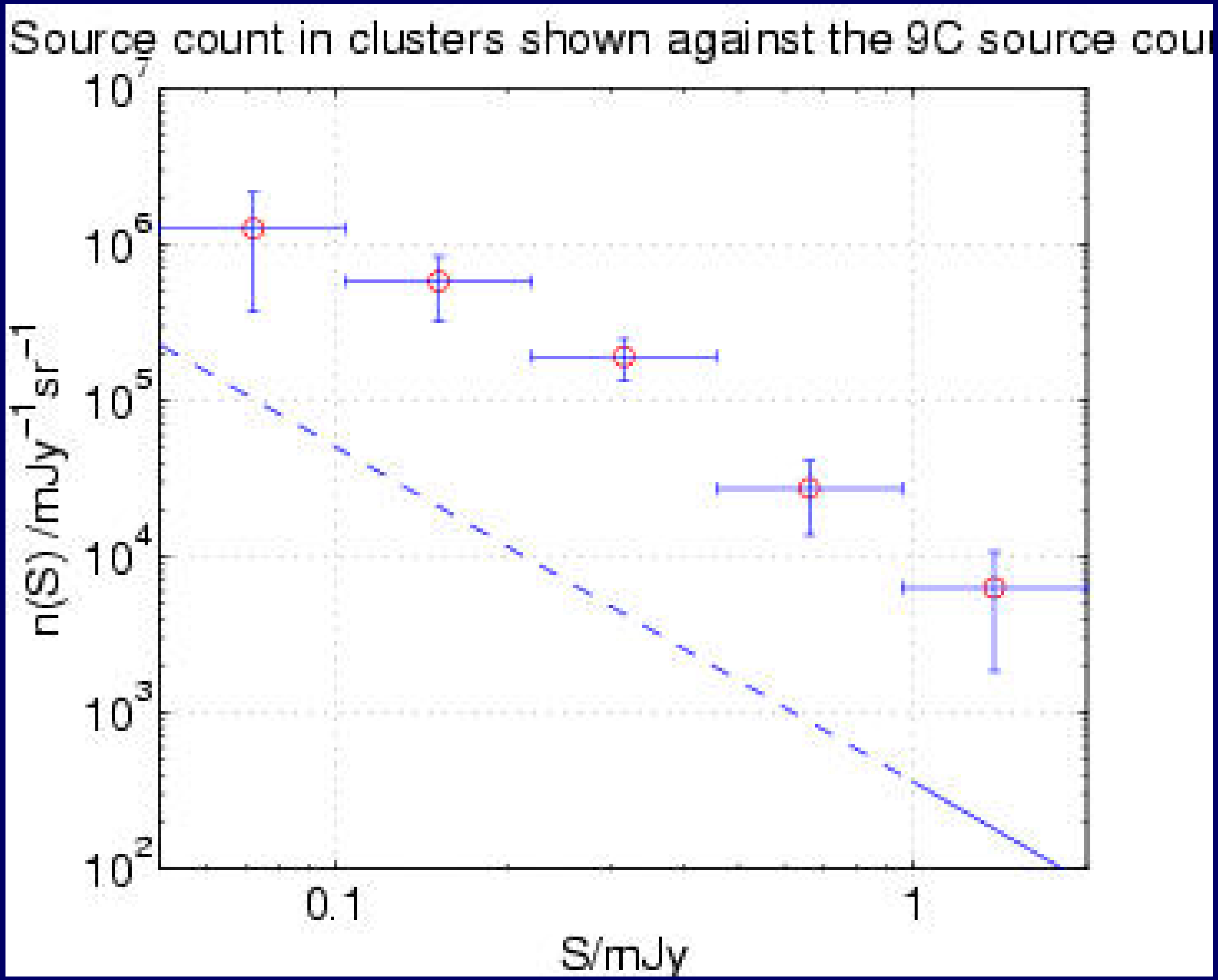
9C SURVEY - SOURCE POPULATION AT 15 GHz

- At 15 GHz background radio sources are dominant confusing background.



Waldram et al. (2003)

SOURCES ASSOCIATED WITH CLUSTERS



Kaneko et al (in prep)

Source Subtraction

- Sources are also variable
  $\Rightarrow$ Need simultaneous observations.

- Can remove their effects through high angular resolution imaging
  $\Rightarrow$ Need long baselines – upgraded Ryle Telescope (baselines 20 – 120m).

  – Fit new NRAO HEMTs

  – Broadband correlator $\Delta\nu = 0.35 \rightarrow 6$ GHz

  – Move antennas 6, 7 and 8 to form compact array (filling factor) and give north-south baselines.

- Spectral discrimination across 6 GHz band can also help
  $\hat{\alpha}_{\text{Source}} \approx 0.7 \qquad \alpha_{\text{CMB}} = -2.0 \qquad (F_\nu \propto \nu^{-\alpha})$

Ryle Telescope Antenna Move

Ryle Telescope Antenna Move

Ryle Telescope Antenna Move

Ryle Telescope Antenna Move

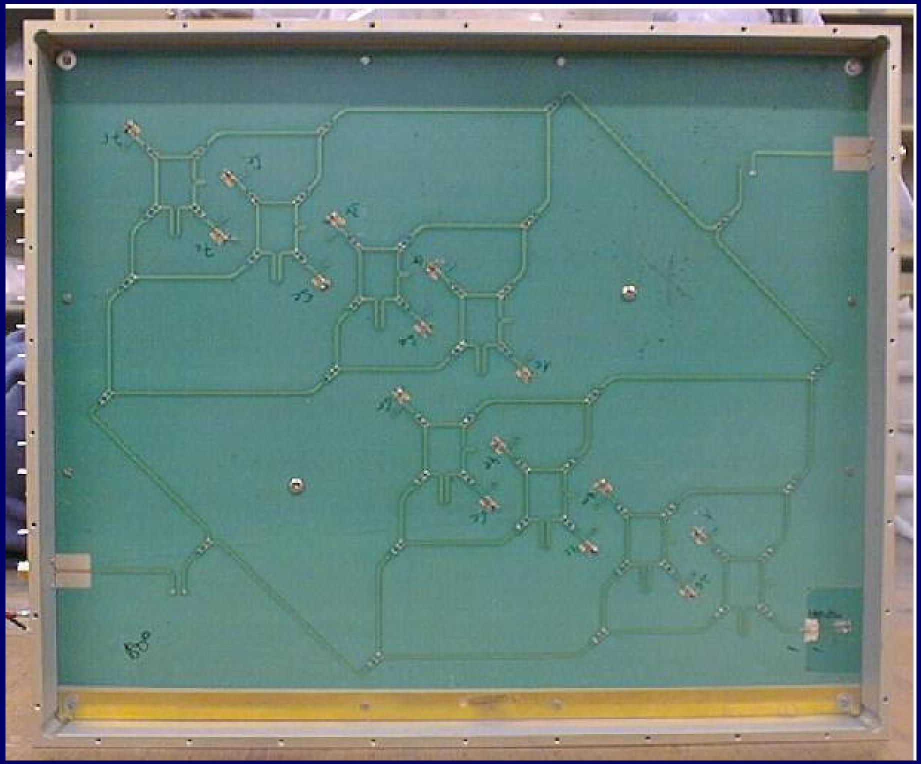
Ryle Telescope Antenna Move

- Antenna move now complete and back-end upgrade underway.

RF/IF System description

- NRAO HEMT amplifiers (13K)
- RF = 12 - 18 GHz downconverted to IF = 6 - 12 GHz
- 10 bit path compensation
- Automatic Gain Control loop
- System temperature monitoring
- Total system temperature ≈ 25 K
- System is stable to $\approx 10^\circ$ over 24 hours

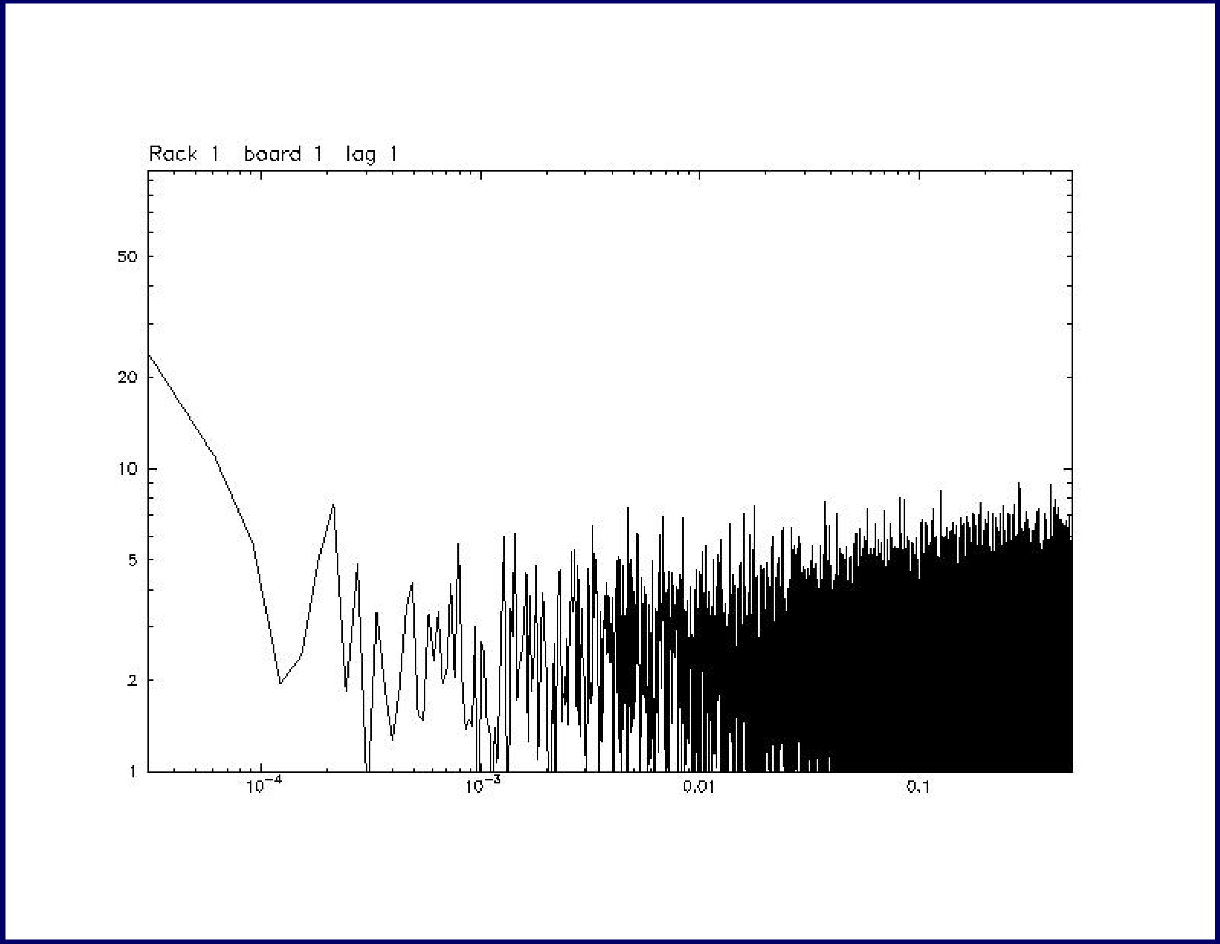
Analogue lag correlator



- 6 – 12 GHz stripline implementation
- 16 correlations per baseline with different path delays

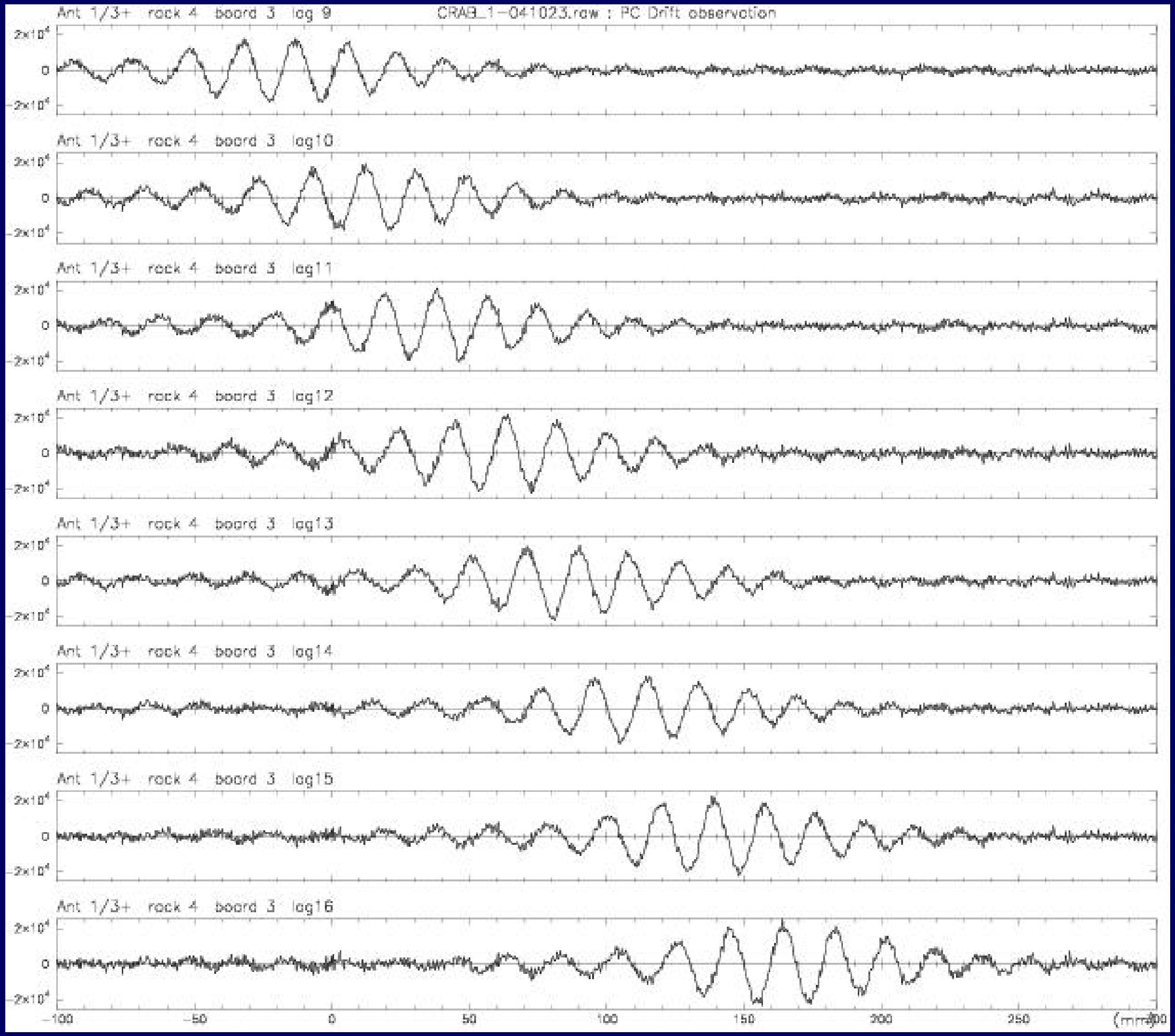
$\Rightarrow$ 8 complex frequency channels of width 0.75 GHz.

NOISE SPECTRUM



- White noise spectrum for frequencies above 10^{-4} Hz (c.f. typical fringe rate 10^{-2} Hz).
- Further rejection provided by differencing correlations made with and without 180 deg hybrid.

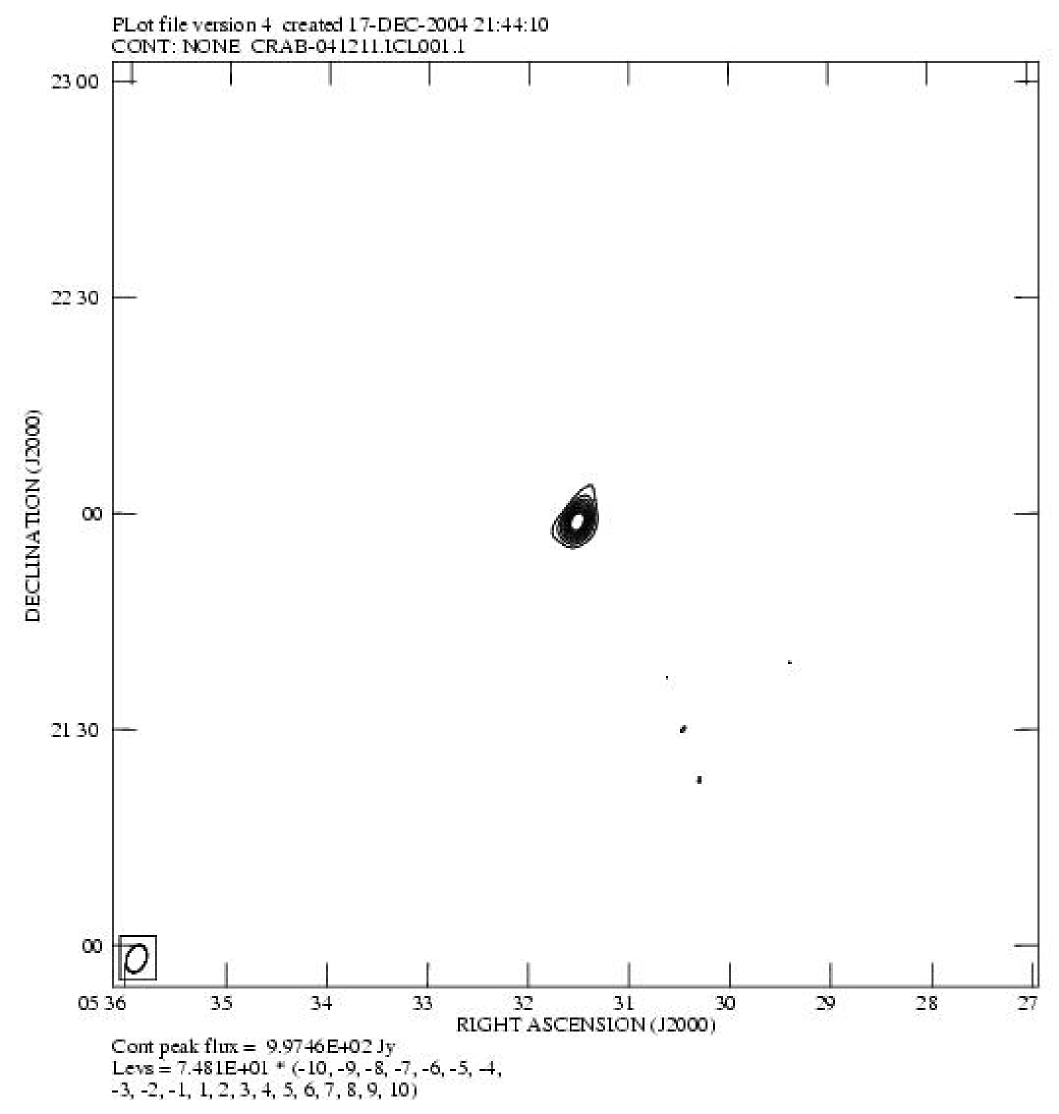
FRINGES



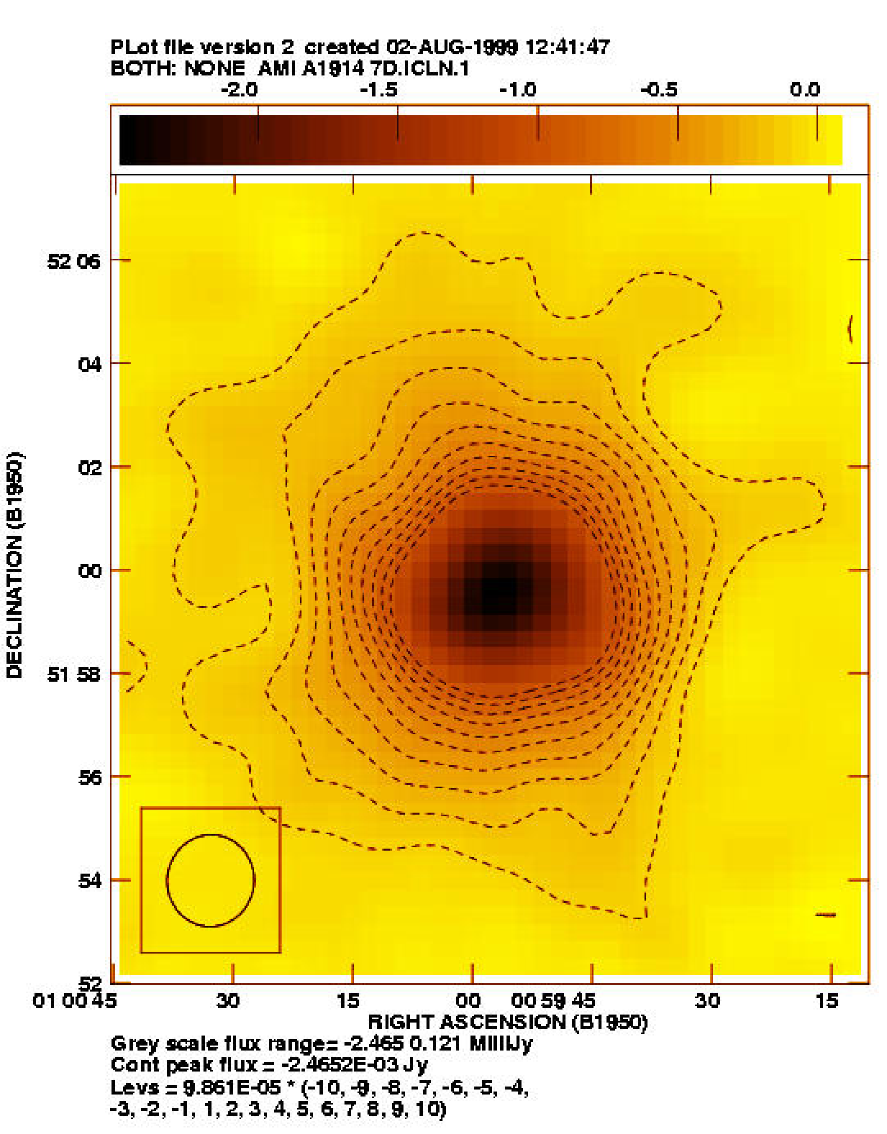
- No path compensation $\longrightarrow$ envelope of the fringes moves through the lags as the antennas track the source across the sky.

Map of Tau-A

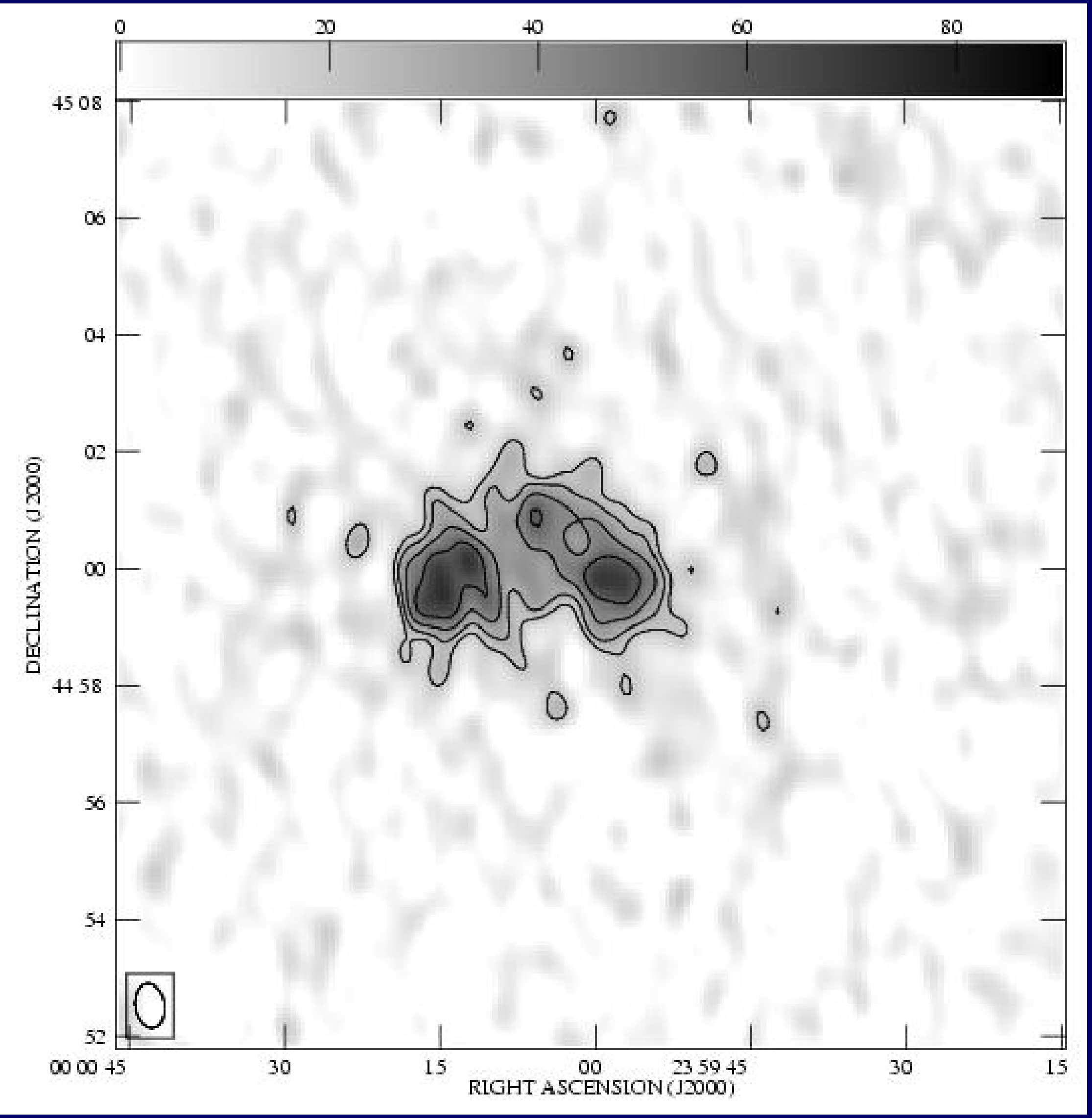
- 10 baseline system now working on compact array
- Commissioning observations underway



PREDICTED PERFORMANCE – POINTED OBSERVATIONS



Simulation of A1914

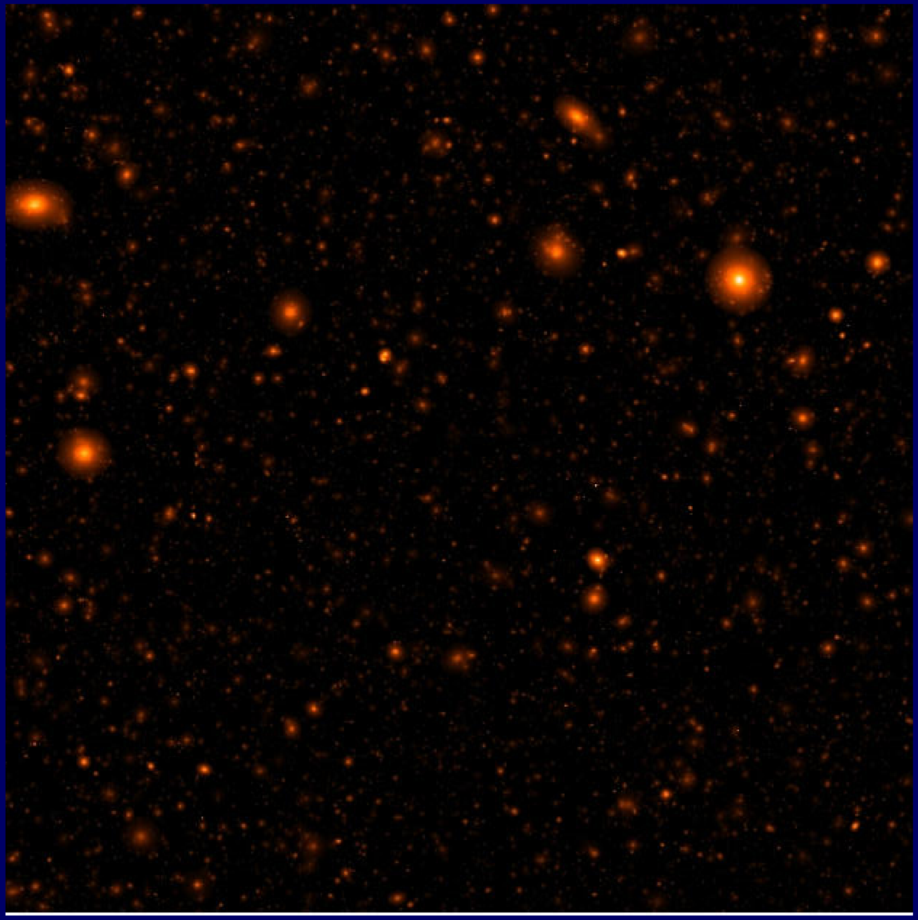


Simulation of z=1.5, M = $2 \times 10^{14} M_\odot$ cluster

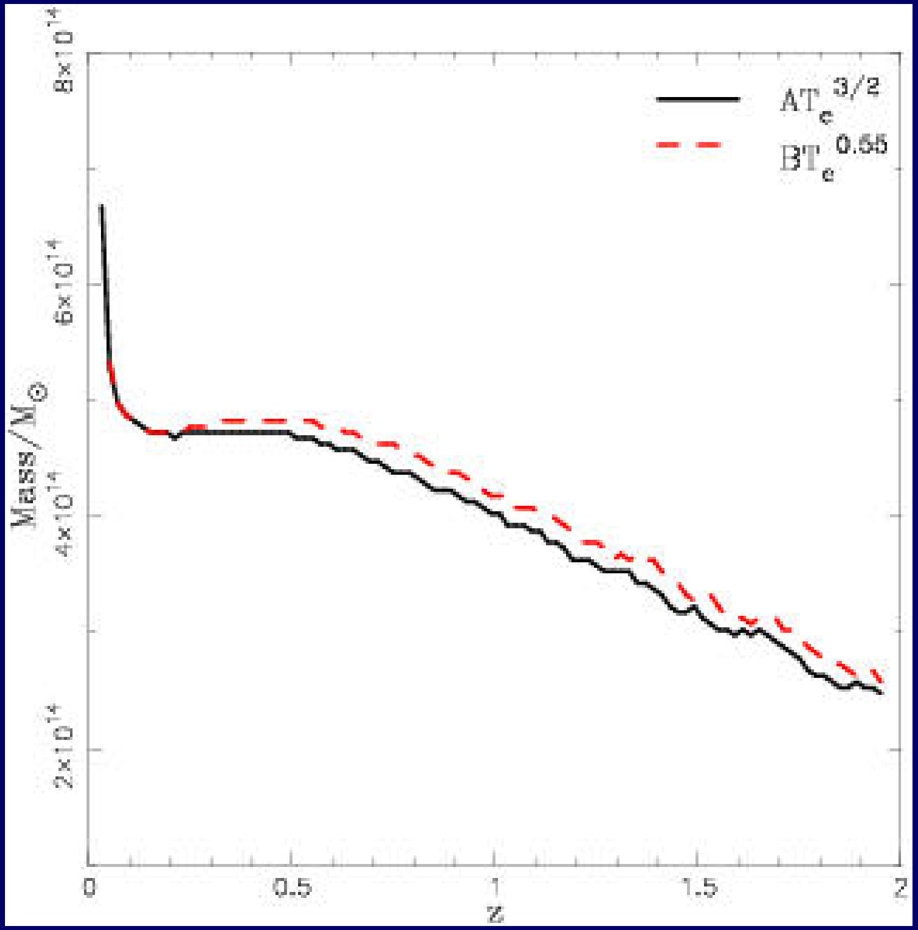
SZ Survey - Cluster identification

- In order to interpret cluster survey must know the selection function for the survey.
- In particular must assess the survey completeness (false negatives) and contamination (false positives).
- Estimate these through simulations; issues include:
  - Primordial anisotropies
  - Field radio sources (can be clustered)
  - Cluster radio sources (population will evolve)
  - Cluster-cluster correlation $\longrightarrow$ cluster confusion
  - Cluster ellipticity
  - Cluster scaling relations and how these evolve
- Investigating both simple linear filters and full Bayesian approach to cluster finding.

Cluster mass function

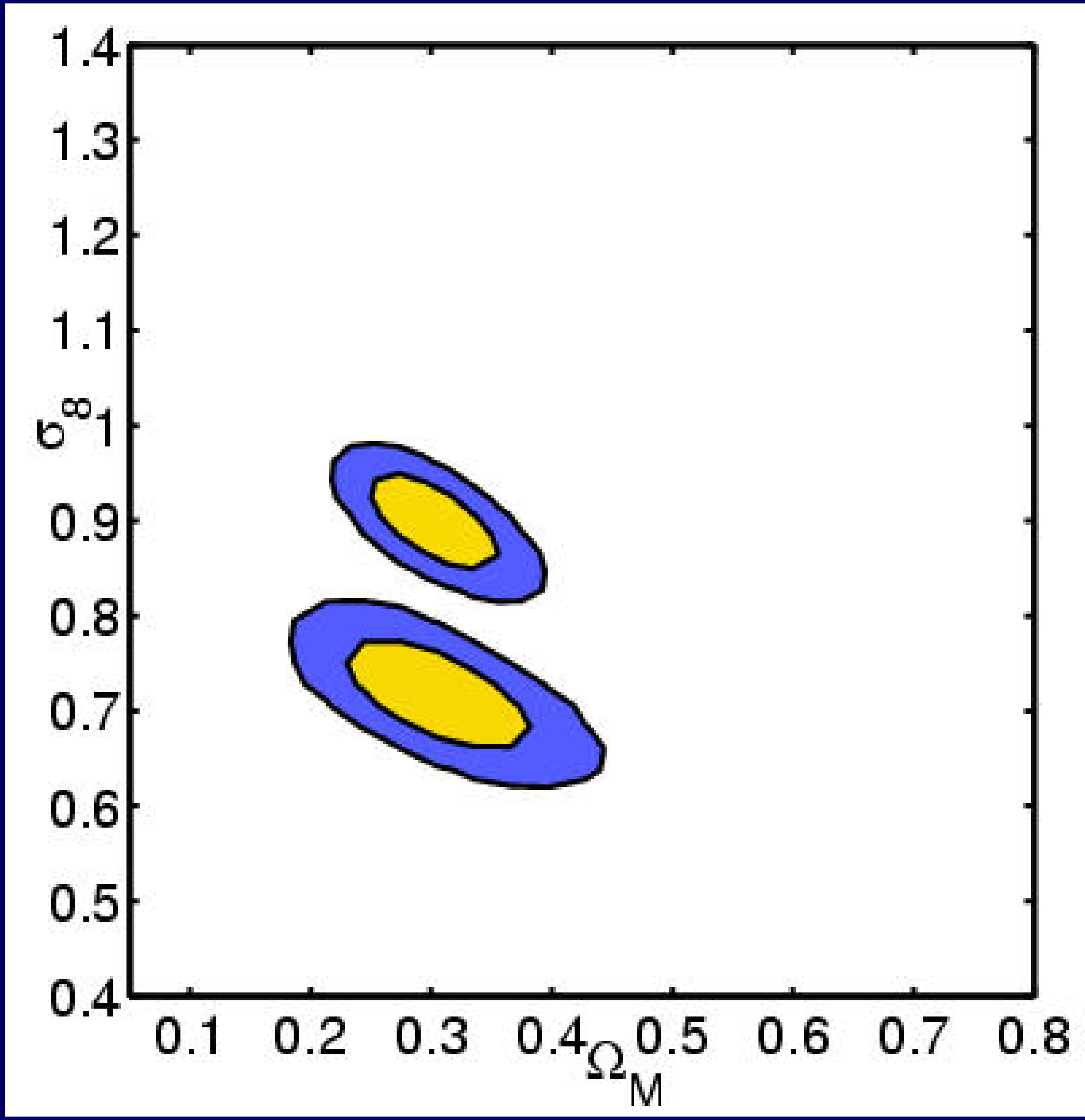


Velic et al. (in prep)



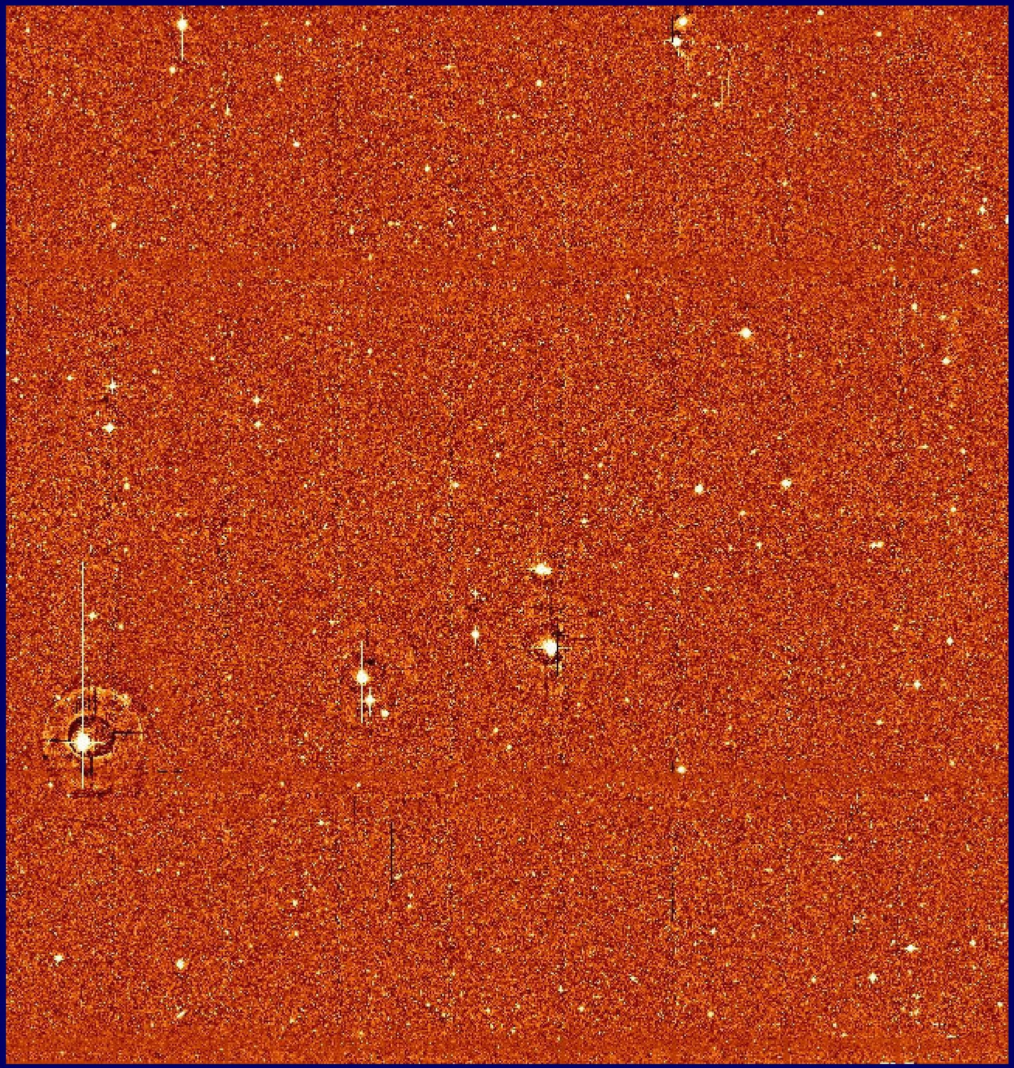
Culverhouse et al. (in prep)

PREDICTED COSMOLOGICAL CONSTRAINTS



- 1 year, 100 square degree AMI survey

Optical pre-follow-up



- CFHT MegaCam and 12k observations (Culverhouse and Zwart)
  - Will allow us to identify low redshift clusters

$\Rightarrow$ SZ clusters without optical IDs are good high-z candidates

SUMMARY AND FUTURE TIMESCALES

- Extended array antennas in place.
- Compact array commissioning underway on 10 baseline system.
- Current Ryle Telescope has surveyed for point sources down to 1 mJy over 40 square degrees.
- Sufficient for a wide shallow survey; start this summer.
- Deeper survey will require fully upgraded Ryle; available at end of year.
- Simulations predict should detect several hundred clusters during a 12 month survey.