

Large-Scale Structure Science

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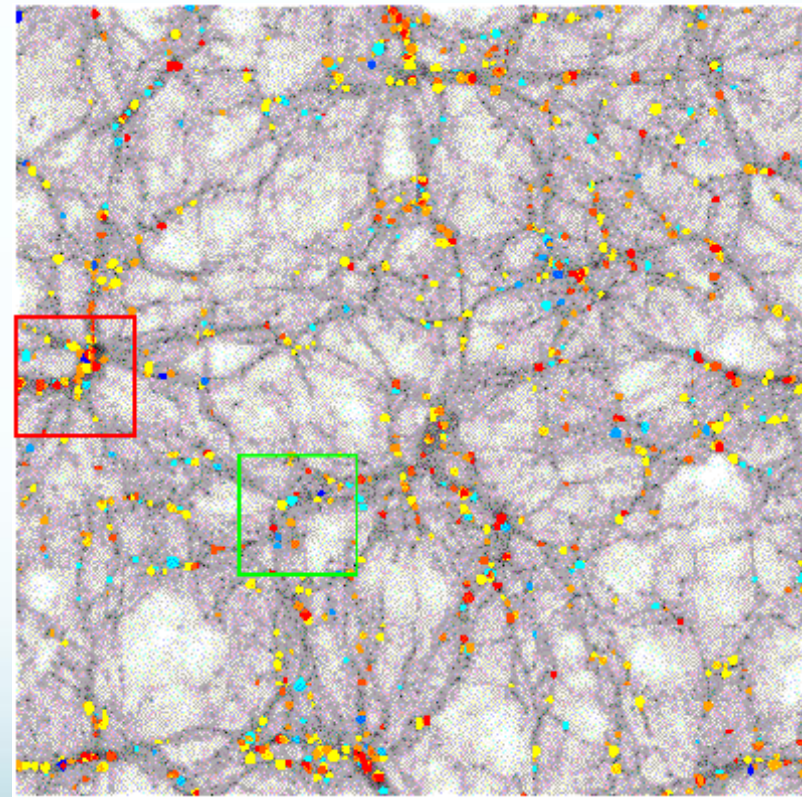


Towards a next space probe for CMB observations and cosmic origins exploration
17-20 May 2016 CERN

Census of the Baryons

- How do baryons flow from gas to stars and back within the cosmic web?
- **Census of the baryons**
 - Where are they: relation to dark matter
 - What are they doing: gas, dust, star formation, etc.
 - *Feedback is key, but not well understood*
- **Missing info on gas, dust, mass at critical epochs**

The Cosmic Web

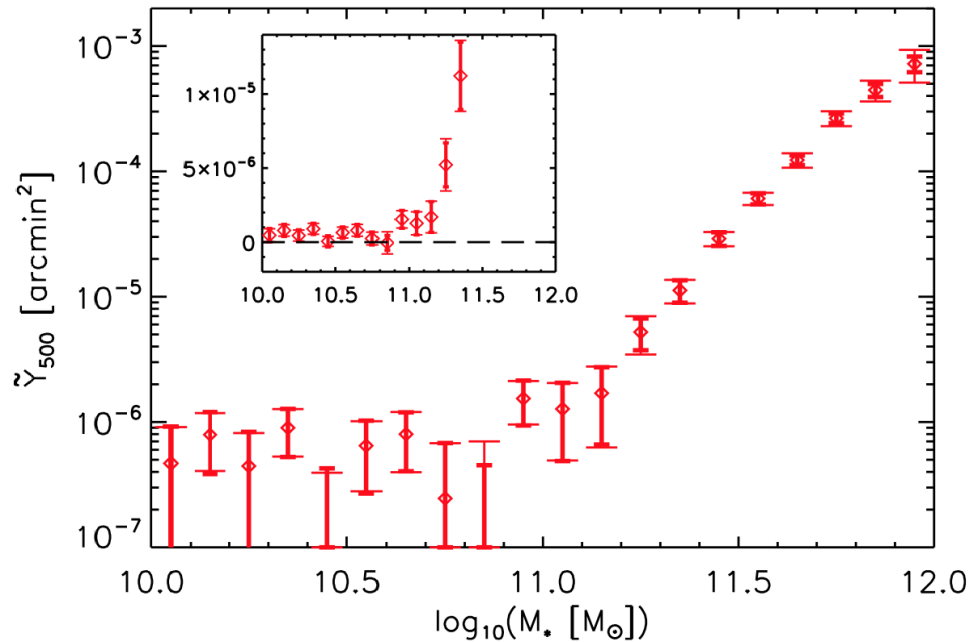


LSS Science Case

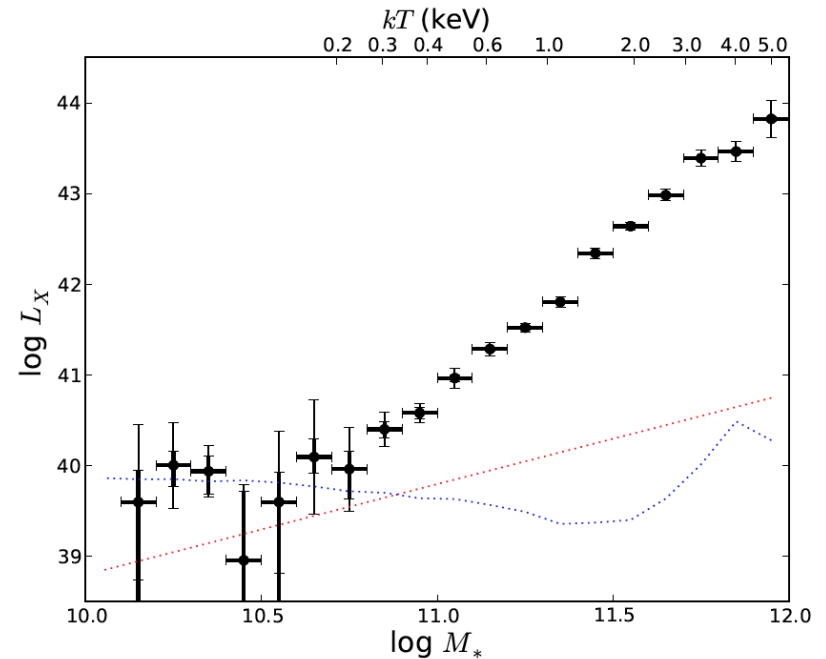
- Sub/millimeter well suited to answer this question:
 - tSZ traces gas
 - CMB lensing traces mass
 - Far-IR traces dust and star formation rate
 - Millimeter traces AGN
- Halo properties (1-halo term)
 - Binning on objects by type and redshift
 - Halo masses via CMB lensing
- Larger-scale distribution (2-halo term, filaments)
 - Cross-correlations

Population Studies

Planck Collaboration Int. XI (2013)



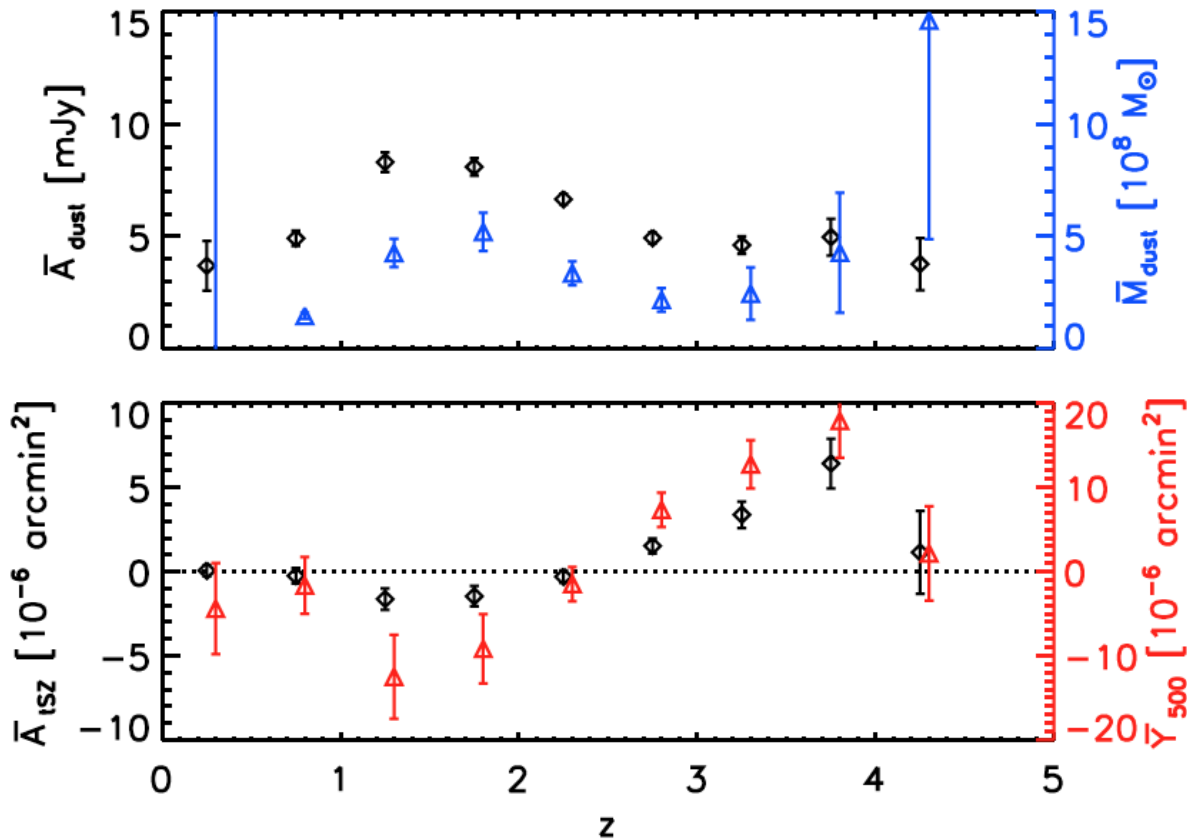
Anderson et al. (2015)



Implications for feedback: gas pushed out to
 $R_{500} < R < 5R_{500}$

Population Studies: QSOs

Verdier et al. (2016): Planck



Tracer of SF

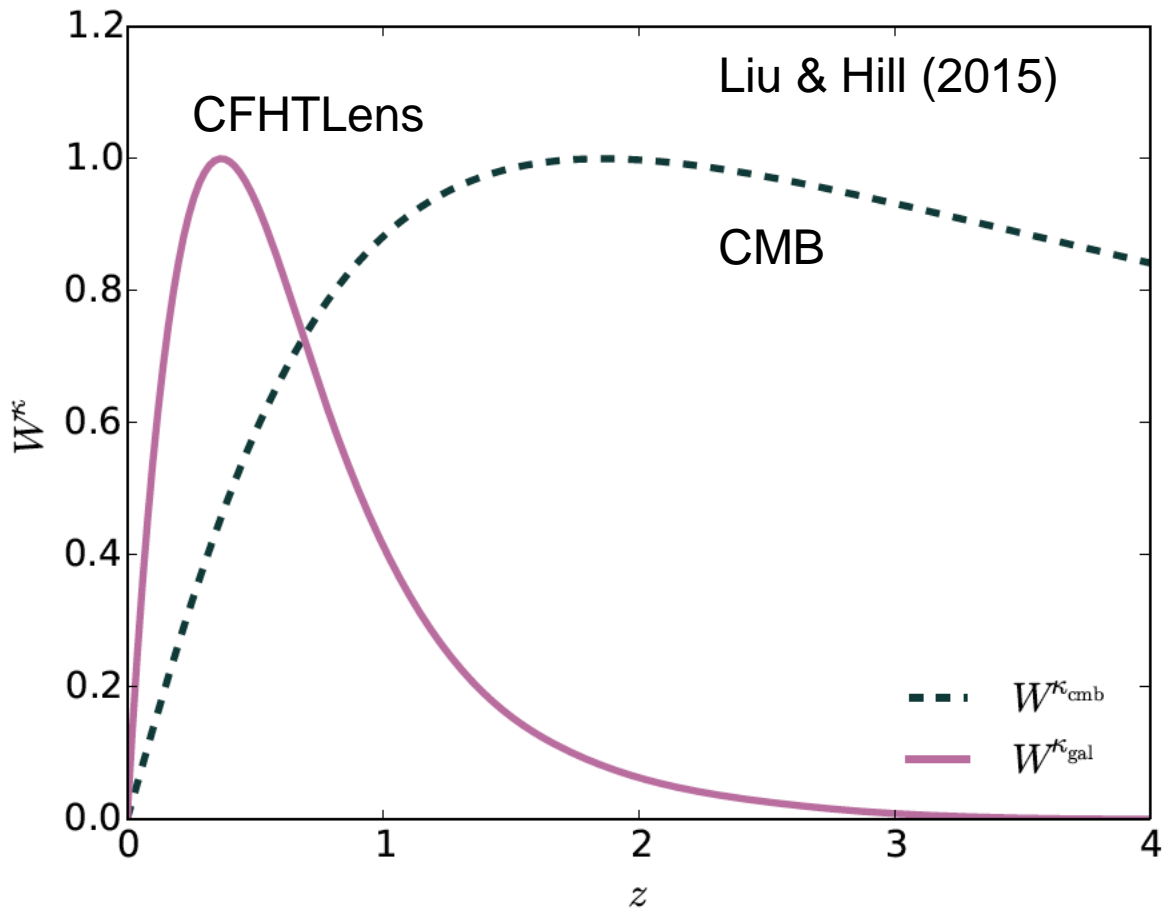
tSZ at $z > 3$!

Constraints on QSO feedback

See also Crichton et al. (2016): ACT

CMB Halo Lensing

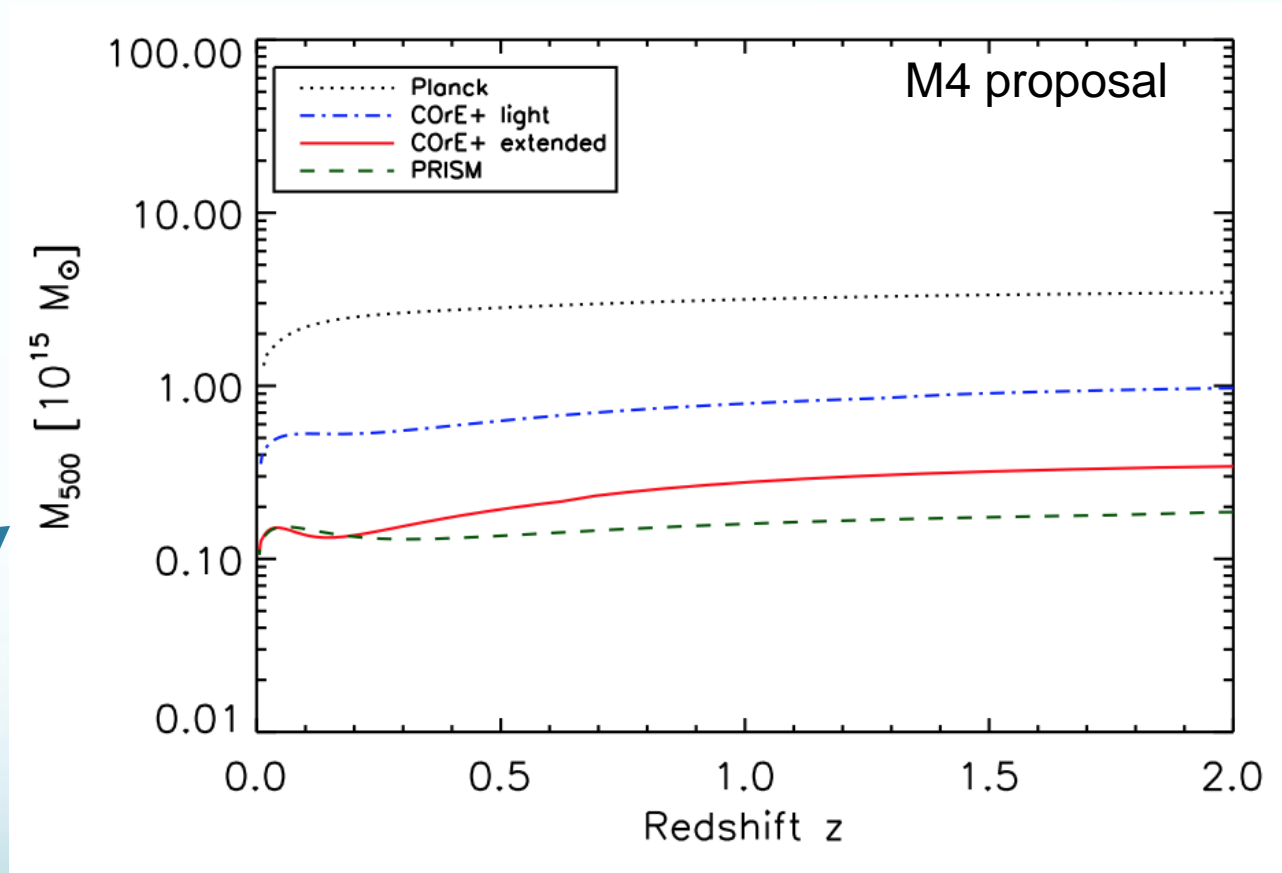
- CMB: Much broader lensing kernel
- Reach critical high-z epochs



CMB Halo Lensing

- Stack on selected objects

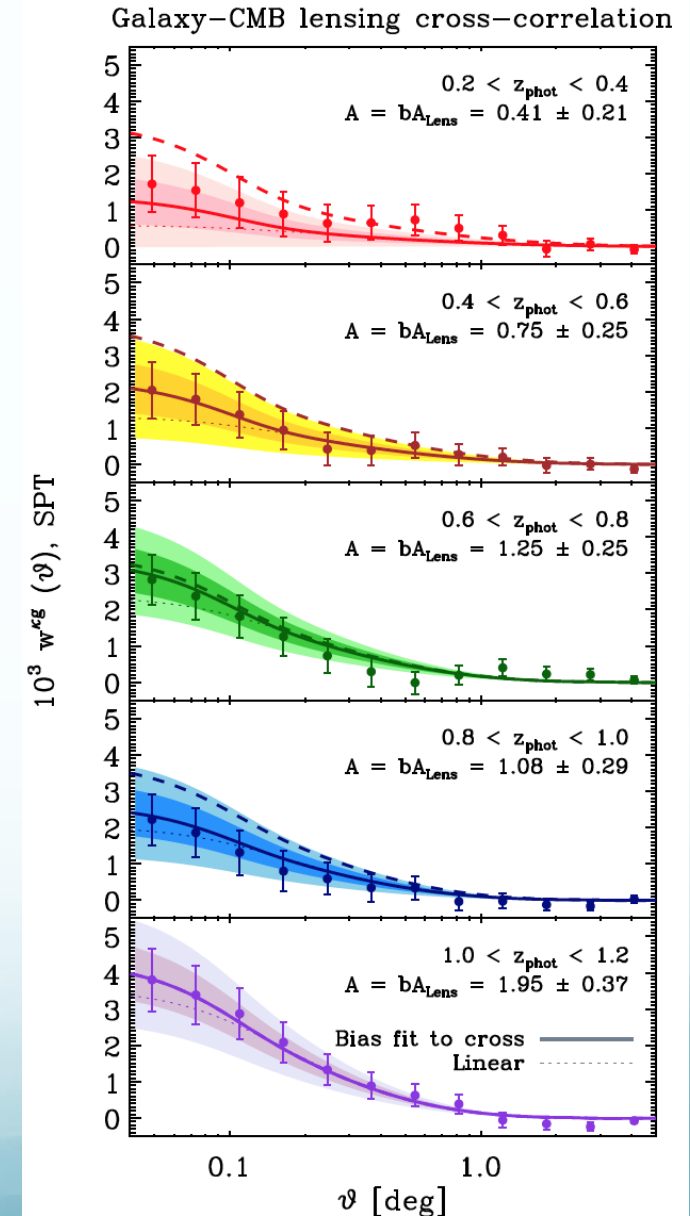
1-sigma filter noise
(Melin & Bartlett 2015)



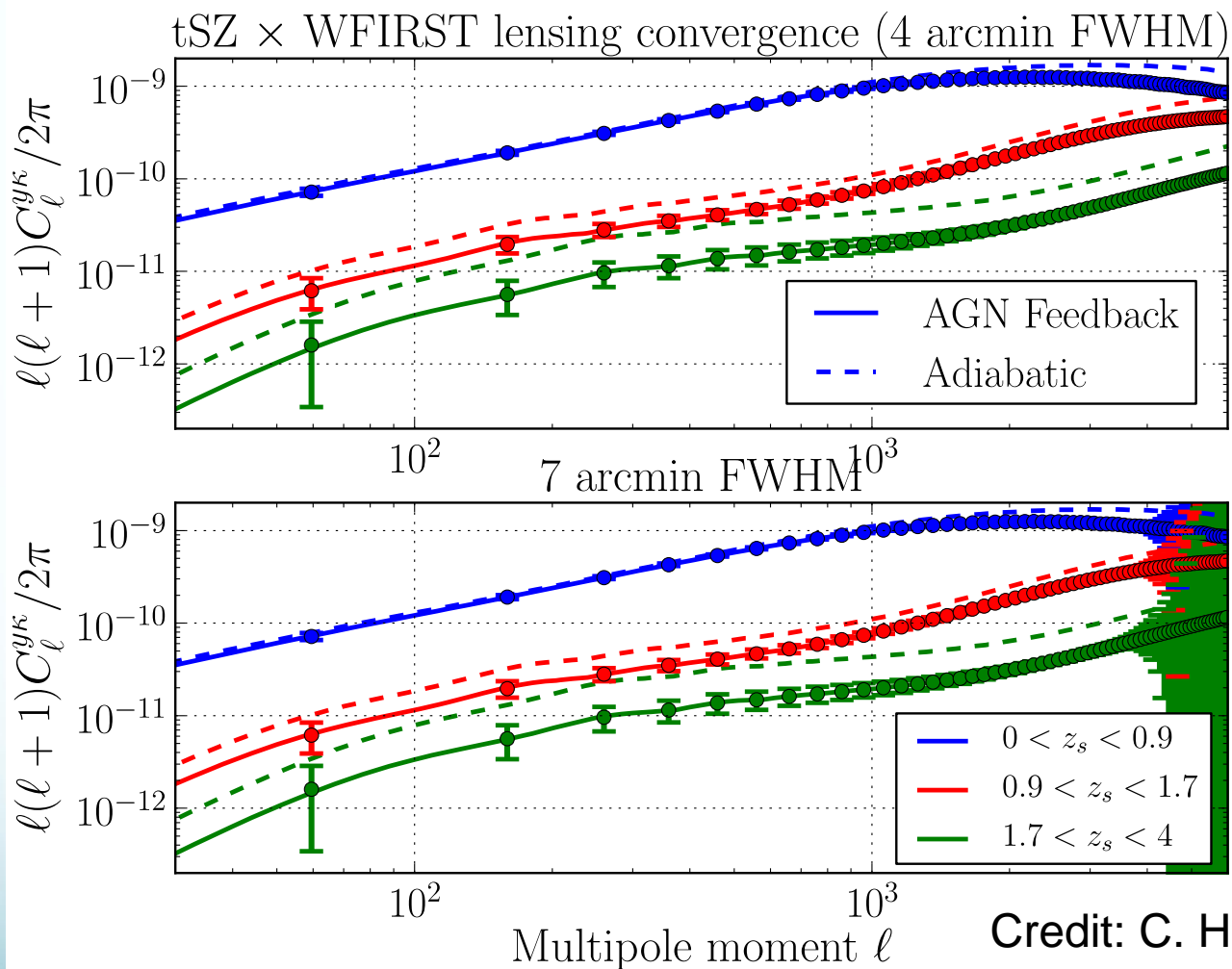
Cross Correlations

- SPT CMB lensing
- Dark Energy Survey SV galaxies
- Tomography
 - Galaxy bias
 - Structure growth rate (neutrino mass, dark energy, modified gravity)

Giannantonio et al. (2016)

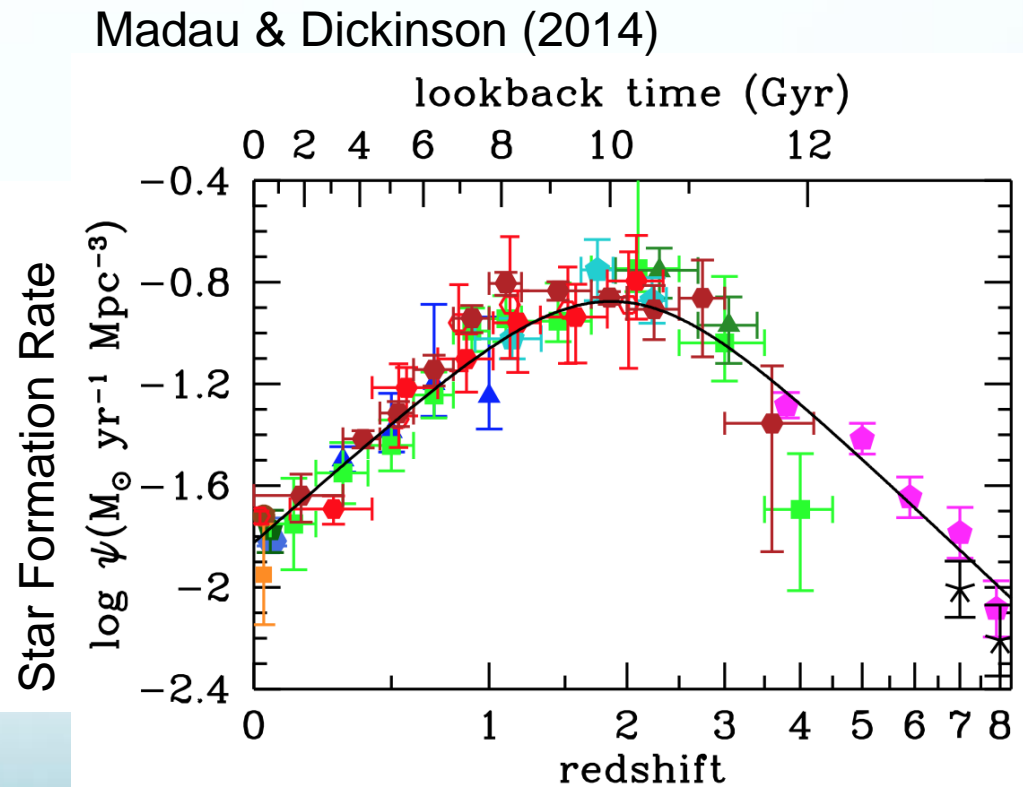


Cross-Correlations



Unique Science

- Probe critical epochs of galaxy formation: $z \sim (1-8)$



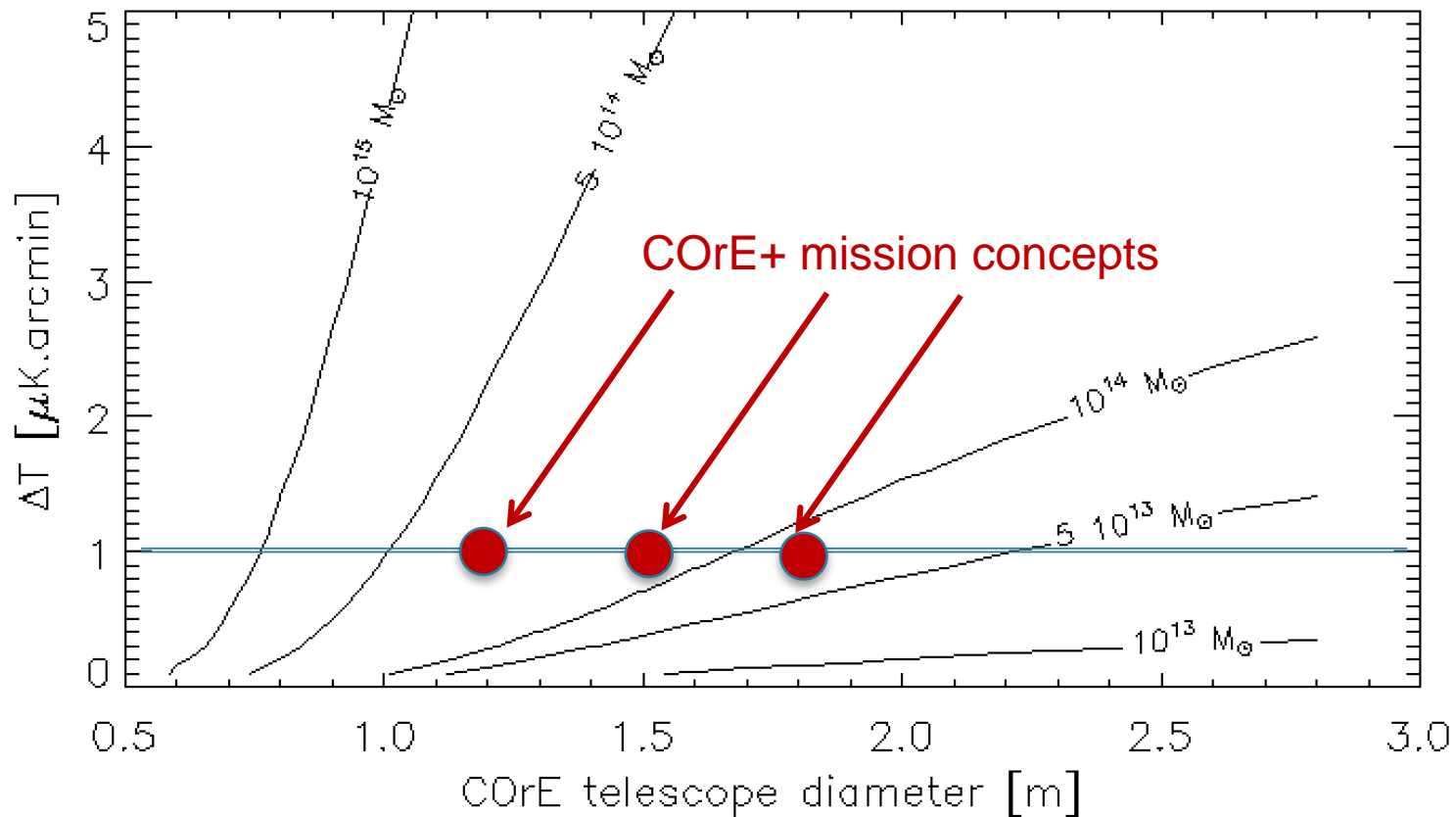
Unique Science

- Probe critical epochs of galaxy formation: $z \sim (1-5)$
- Trace hot gas phase over critical epochs
 - Feedback mechanism running thermal cycle
 - **Recall: galaxy formation is inefficient: Why?**
- Trace dust during critical epochs
 - Metal production
 - Star formation activity
- Trace dark matter
 - Host halos
 - Larger-scale distribution

Impact on Mission

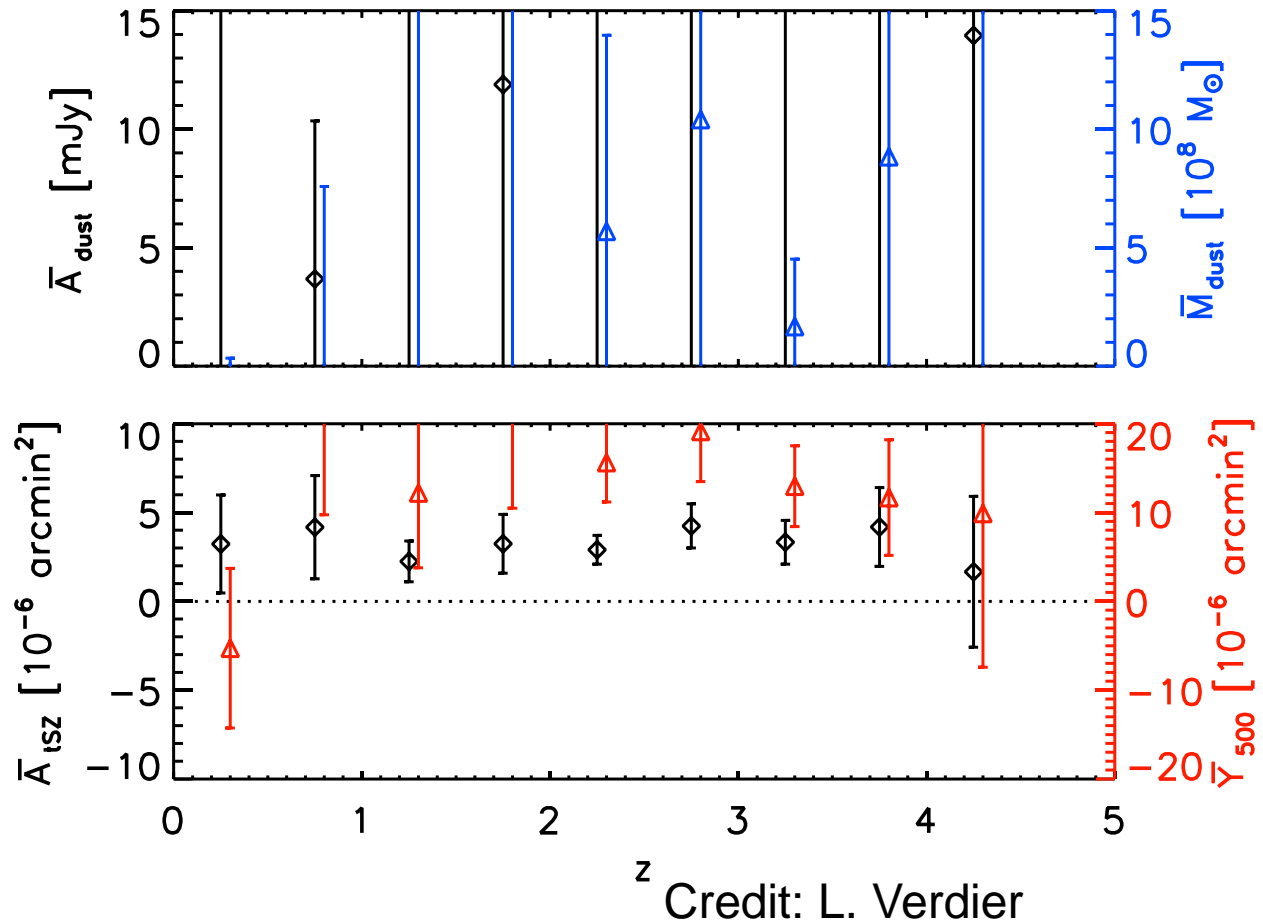
- Frequency coverage for tSZ and Dust
 - Population studies: +resolution
 - Large-scale distribution: e.g., CIB/SZ separation
- Resolution for CMB halo lensing

CMB Halo Lensing



Frequency Coverage

- QSO study with: 70, 100, 143 & 217 GHz
- Loose dust information
- Bias SZ signal
- **Need high frequencies**



Work

- Sell science case
 - Outside our community
- CMB halo lensing
 - Minimum variance estimator
- Sensitivities for SZ, dust & mass stacks
- Cross-correlation predictions
- Studies for different mission profiles

Work

Astronomy & Astrophysics manuscript no. corelss
May 19, 2016

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***COrE+*: Large-Scale Structure Science**

The *COrE+* Collaboration
James G. Bartlett, Jean-Baptiste Melin et al.

Received ; accepted

ABSTRACT

This is the abstract.

Key words. Large-Scale Structure

- 1. Introduction**
- 2. Census of the Baryons**
- 3. Halo Lensing**
- 4. Cross-Correlations**
- 5. Conclusion**

Acknowledgements. Here are the acknowledgements...