



DES Large Scale Structure Early Results

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(CIEMAT, Madrid -- UIUC Visiting Scholar)
on behalf of the DES Collaboration

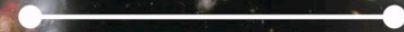
The LSS Working Group:
E.Gaztañaga, A.Ross (leads)



DES Large Scale Structure Early Results

1. LSS in DES
2. Do galaxies cluster in SV data
3. Does clustering correlate with CMB in SV data

Baryon Acoustic Oscillations constituted the early driver for DES LSS observations



Credit: Rostomian, Berkeley Lab

Baryon Acoustic Oscillations constituted the early driver for DES LSS observations

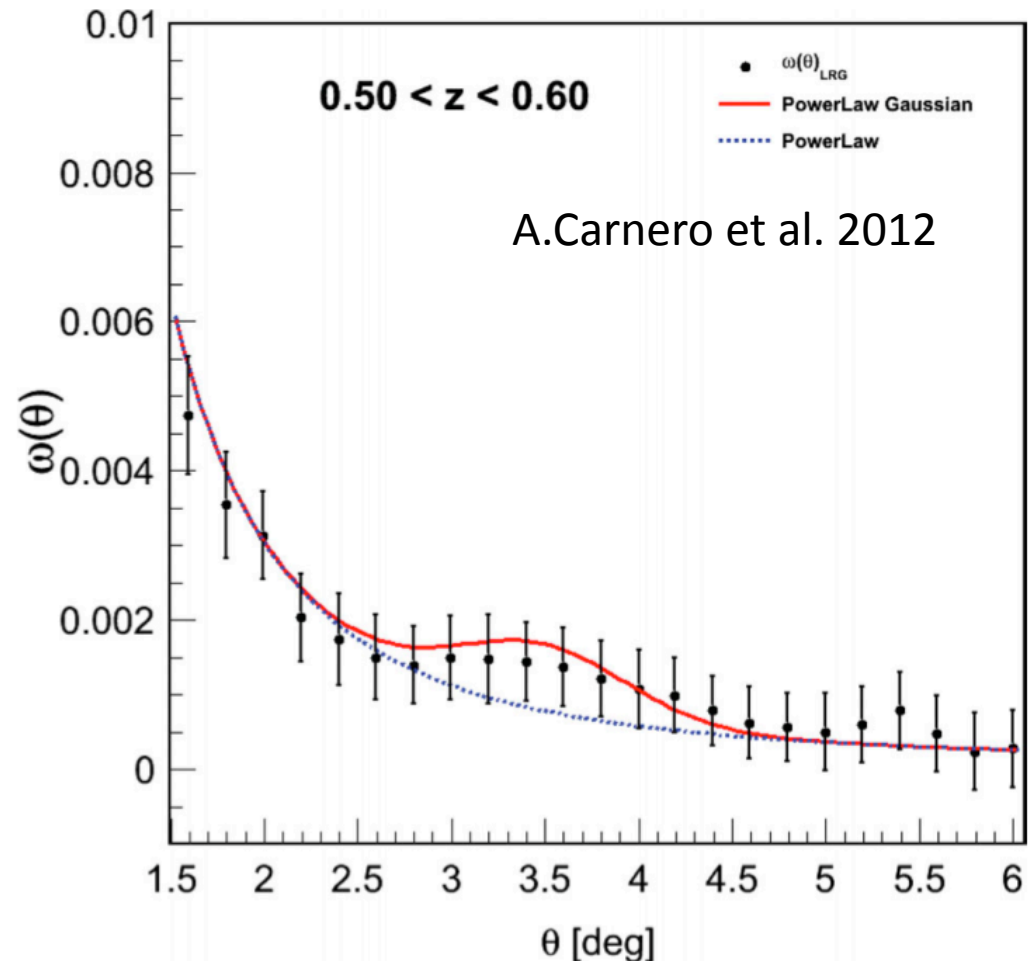
Strategy: distance probe

- BAO provides a 'standard ruler' in comoving coordinates.
- Search for this ruler (a peak) in angular two-point correlation function of galaxies in redshift shells.
- This gives an estimation of the expansion history.

$$\theta_{\text{BAO}} \equiv r_s / \chi(z)$$

- Need to measure a huge amount of galaxies in a large area and volume.

• **Systematics:** photo-z's, projection effects, non-linear evolution, galaxy-mass relationship (bias).



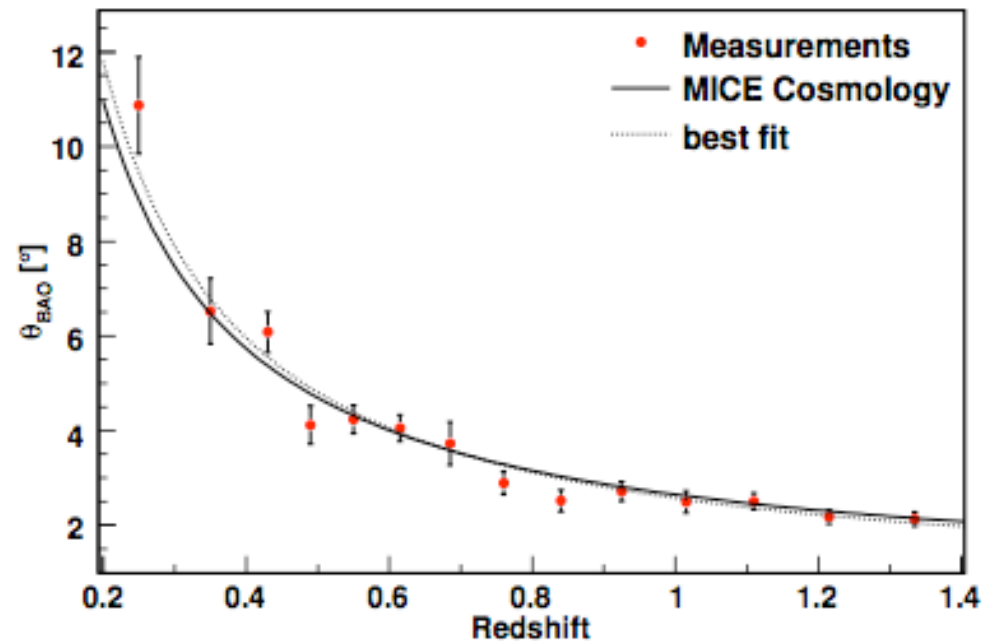
Baryon Acoustic Oscillations constituted the early driver for DES LSS observations

DES numbers:

- Correlation function of $\sim 3e8$ galaxies up to $z \sim 1.5$

What can it provide versus spectroscopic surveys?

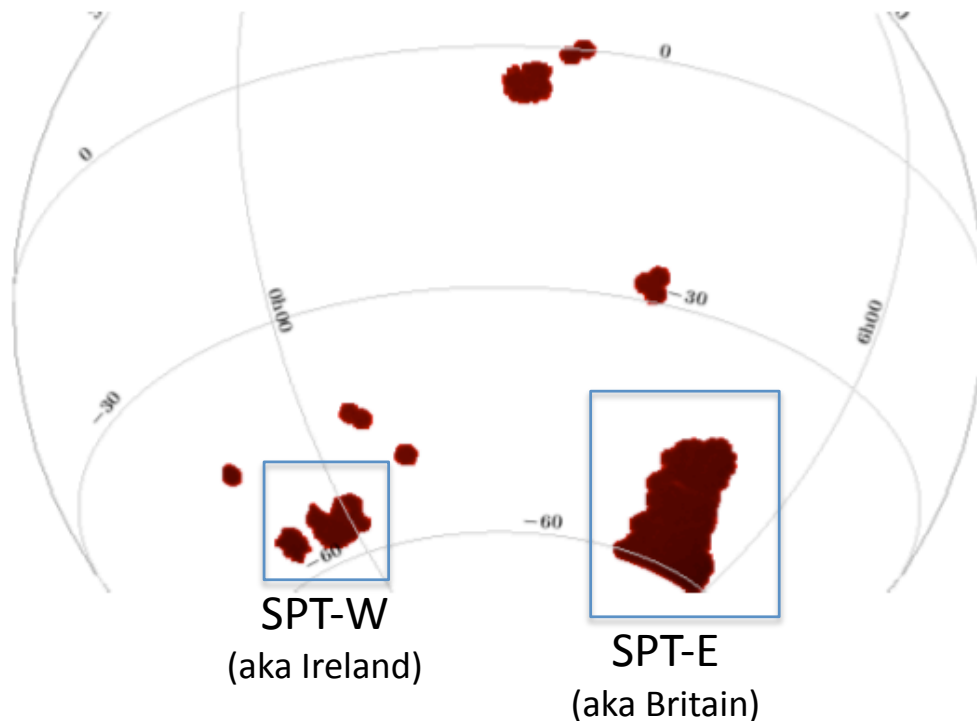
- Probe larger volume and redshift range than current state-of-the-art
- Combine with other probes in same instrument



E. Sánchez et al. 2011

The SPT-E area from Science Verification is being used for early results

200 sq.deg. too small for BAO!



Explore small-scale clustering:

- **HOD models**
- **Galaxy bias**
- **Correlations with CMB**
- **Magnification**
- ...

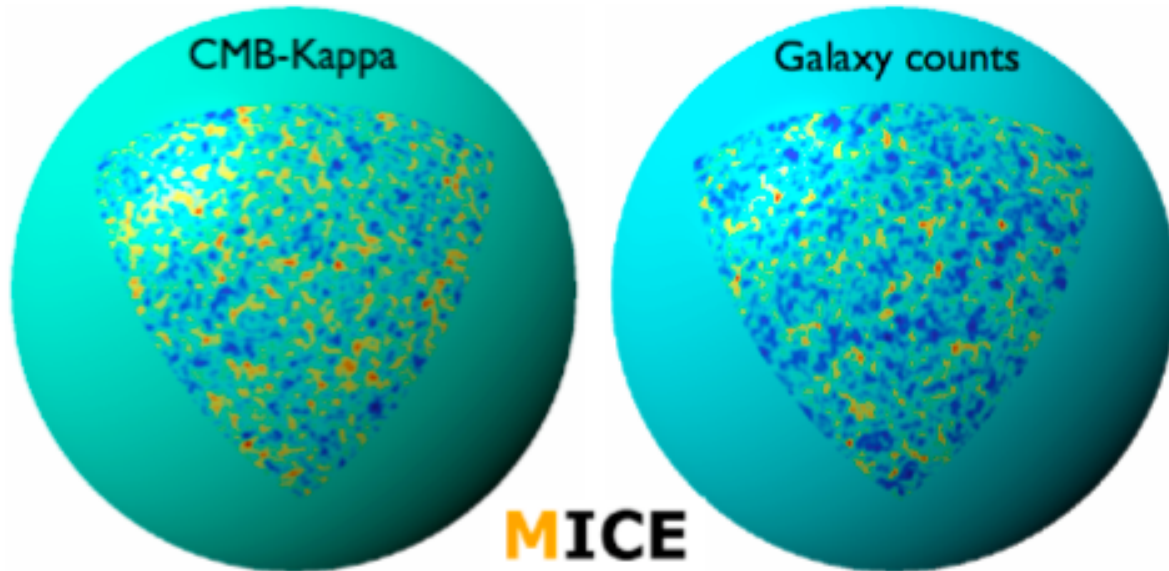
Gold catalog is built, masking worst photometry areas.

For our current studies:

- Cut out 'crazy' colors
- Use shallow cut $18 < i < 22.5$
- Five redshift bins

Around 500k galaxies per bin

Large simulations are used to understand errors



P. Fosalba et al.
MICE sims
IEEC

R. Ponce et al.
Analysis
DES-Spain

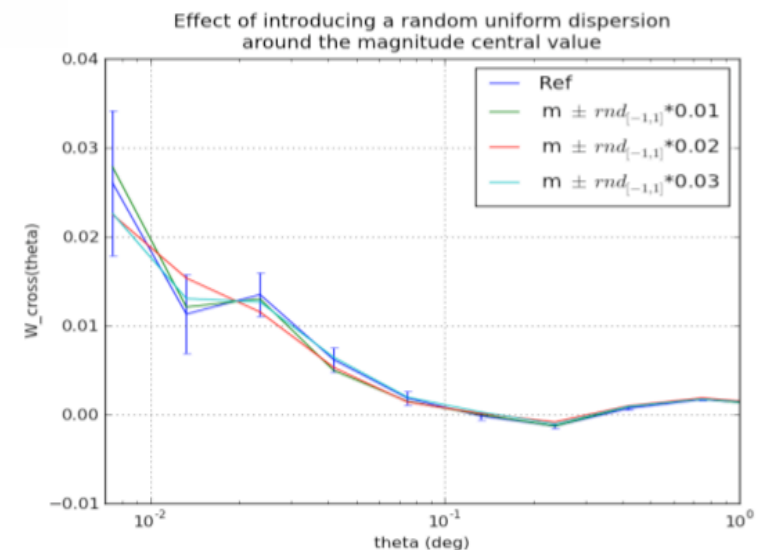
Sims publicly available at

<http://cosmohub.pic.es>

P. Fosalba et al. arXiv:1312.1707

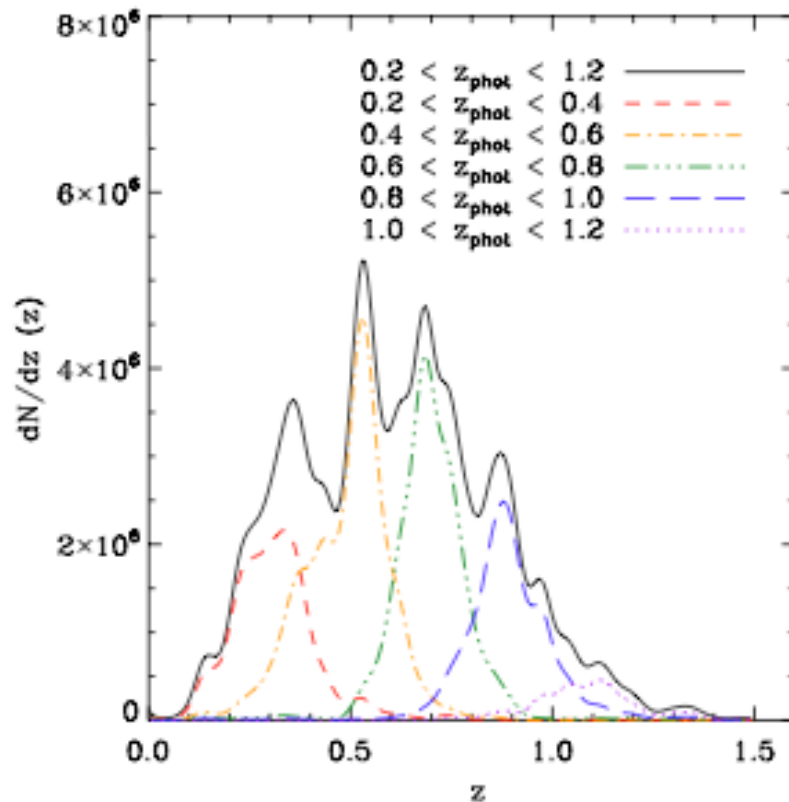
M. Crocce et al. arXiv:1312.2013

P. Fosalba et al. arXiv:1312.2947



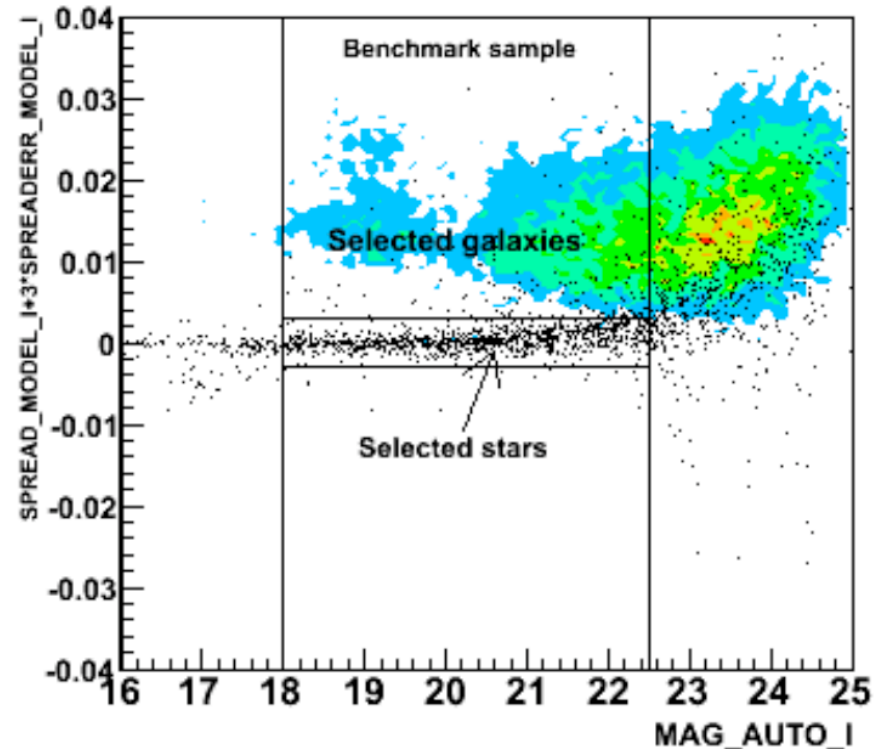
Other regions are used for systematics testing and photo-z calibration

TPZ for redshifts



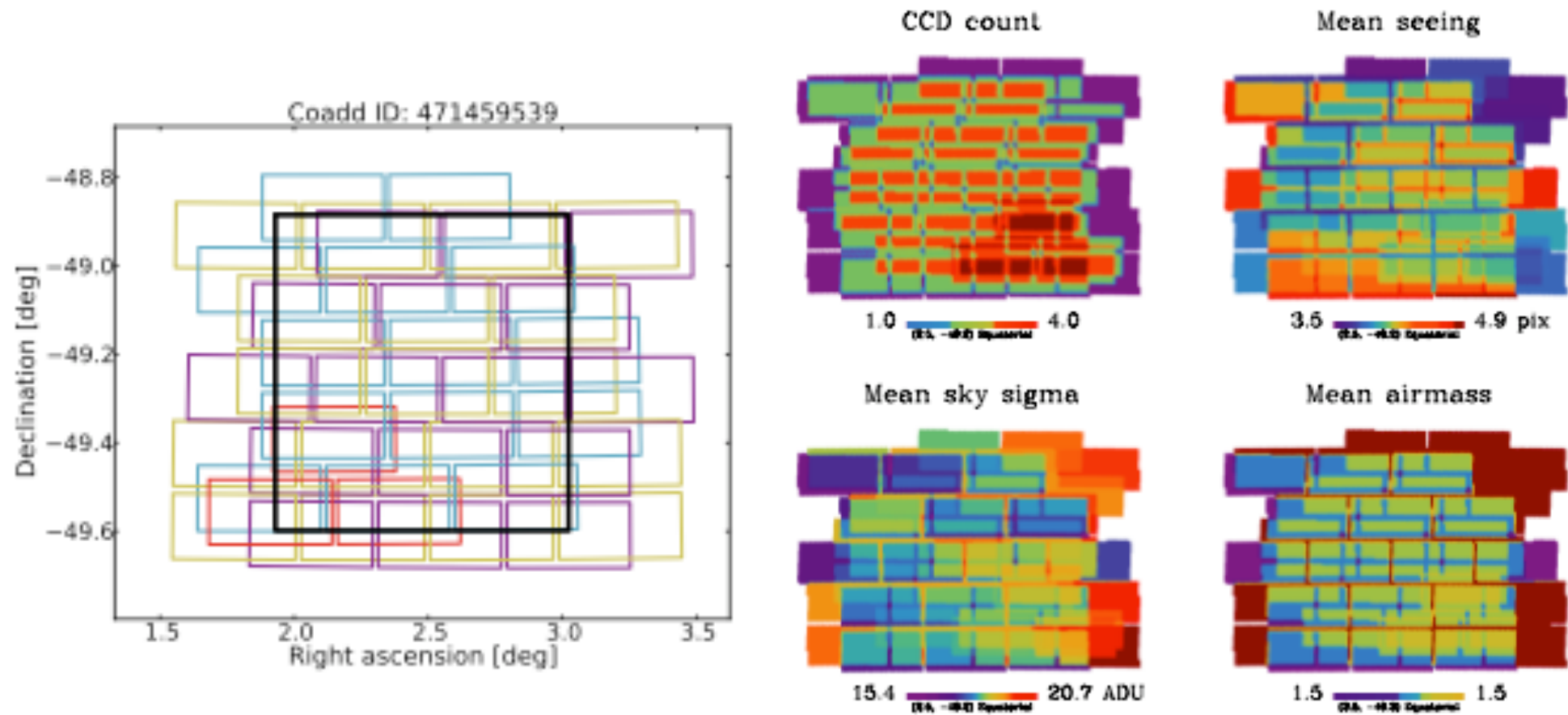
M.Carrasco-Kind et al. (2014)
(tomorrow's talk)

SPREAD_MODEL for SG separation.



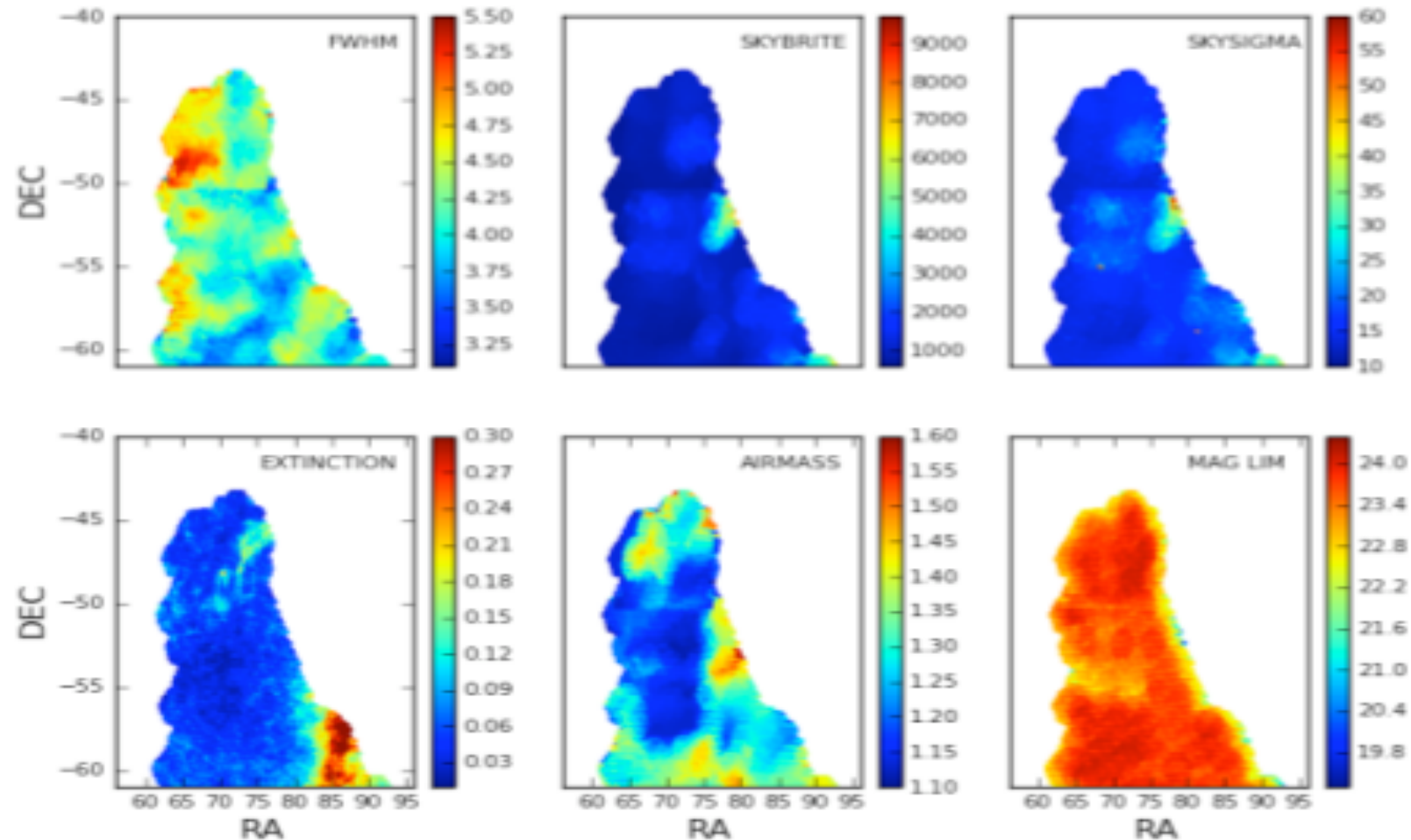
IS et al.

Observational effects were averaged across the single-epoch exposures



B. Leistedt et al. (in prep.)

Systematic effects maps were built in Healpix to determine correlations with clustering

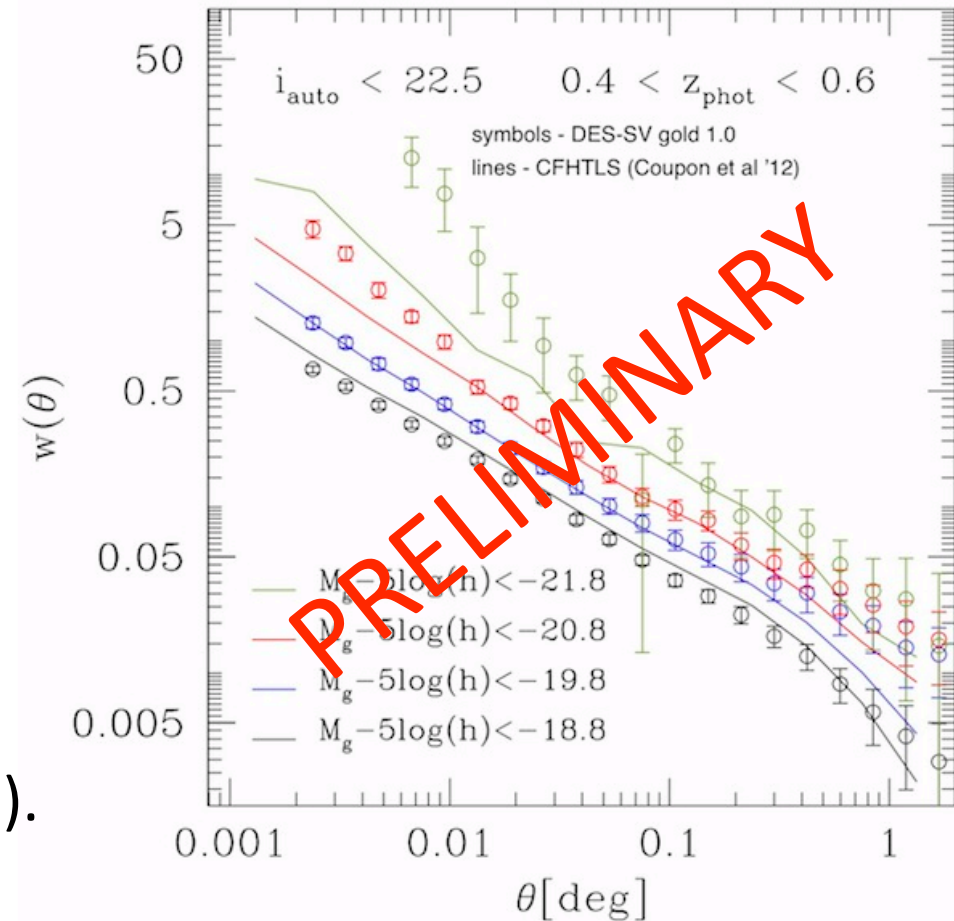


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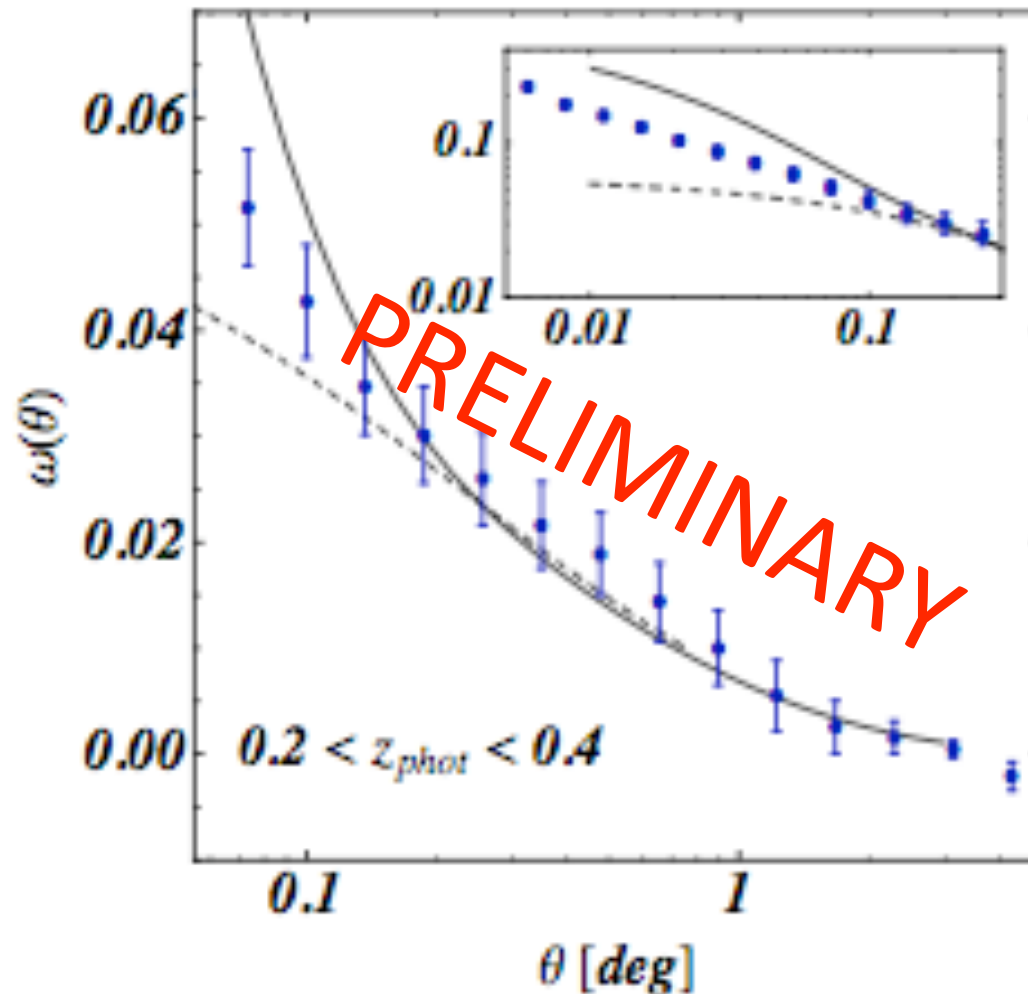
I. Sevilla DECam workshop

An early 2-point statistical measurement of galaxy distribution with a few goals

- Make an early clustering measurement with Science Verification area to show the quality of the dataset.
- Compare against theory and previous measurements.
- Measure the galaxy bias evolution.
- Led by Martín Crocce (IEEC, Barcelona), Ashley Ross (OSU).



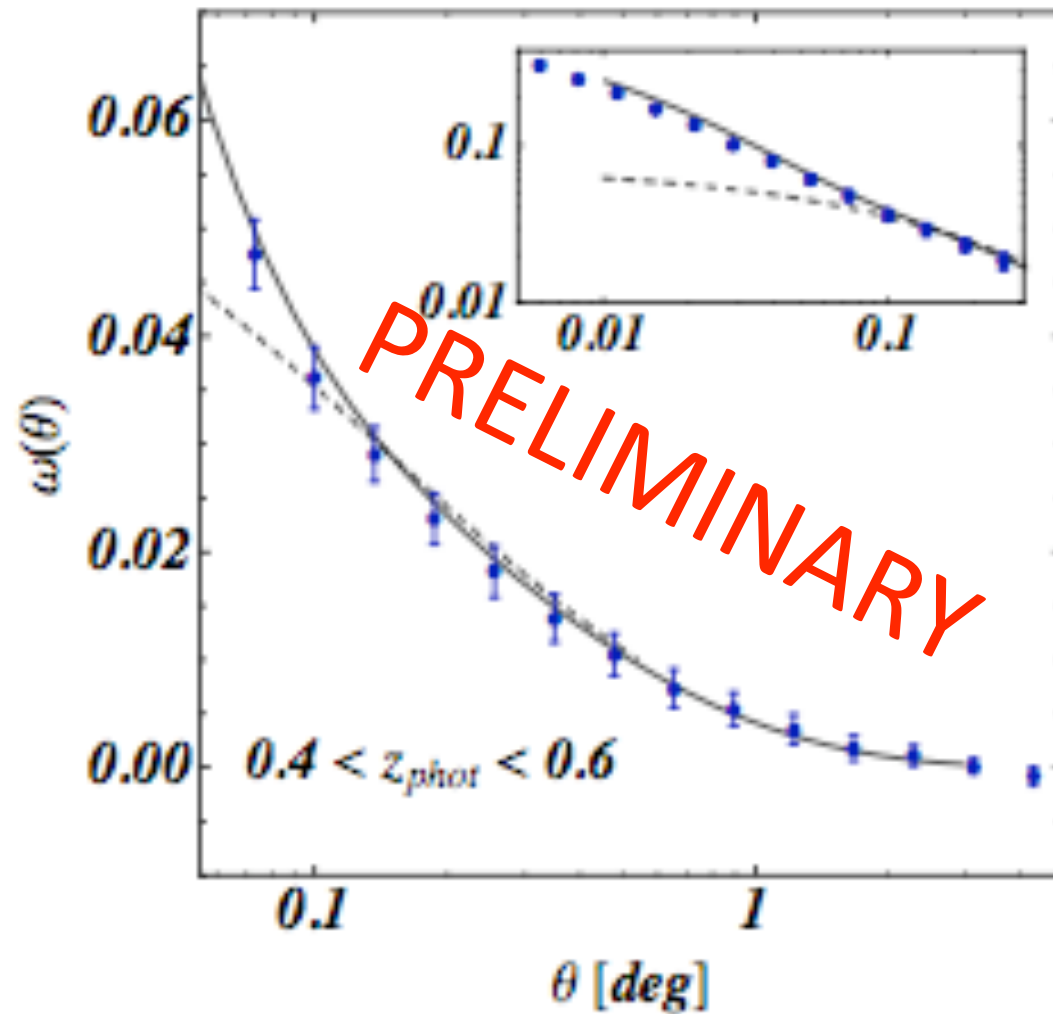
There is a fairly good agreement with theoretical predictions



Dashed and continuous lines are linear and non-linear theory predictions (CAMB, Planck 2013) with bias as free parameter.

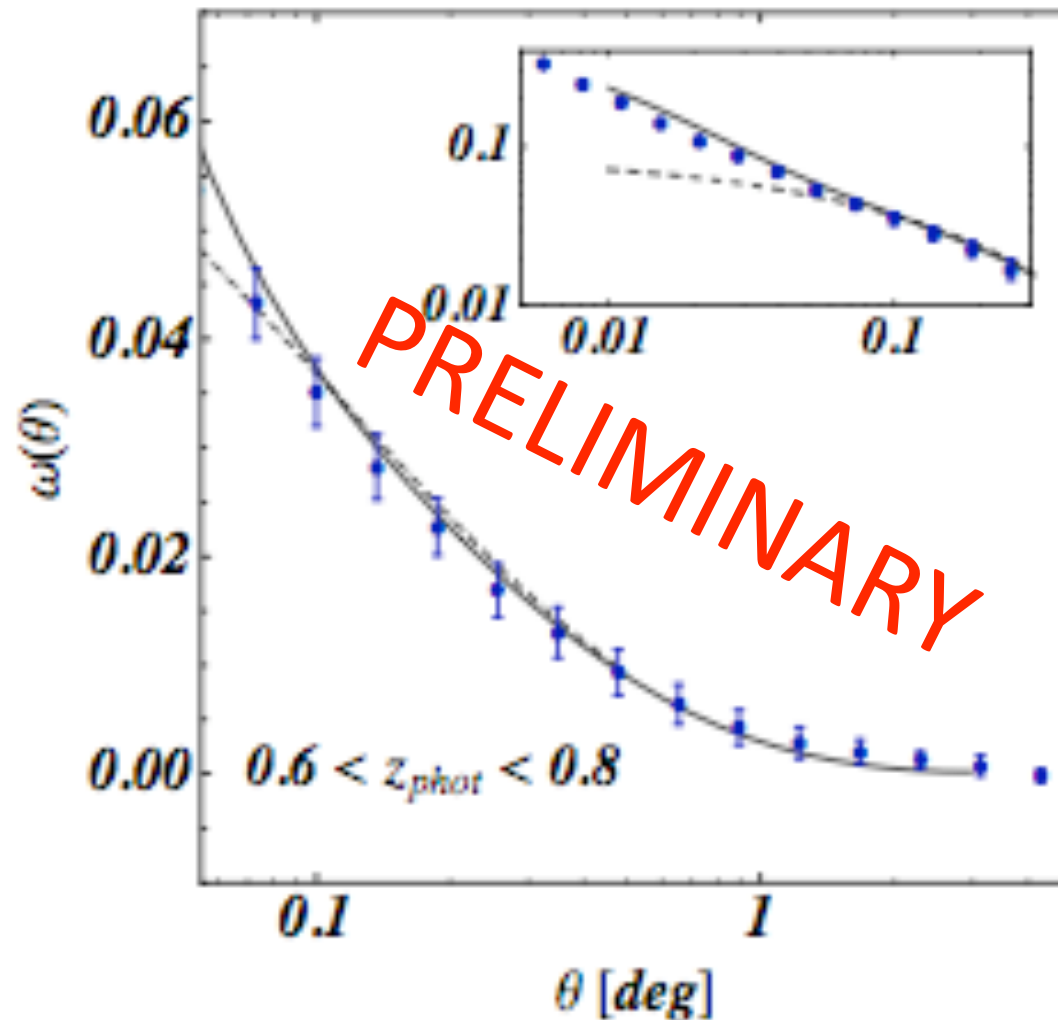
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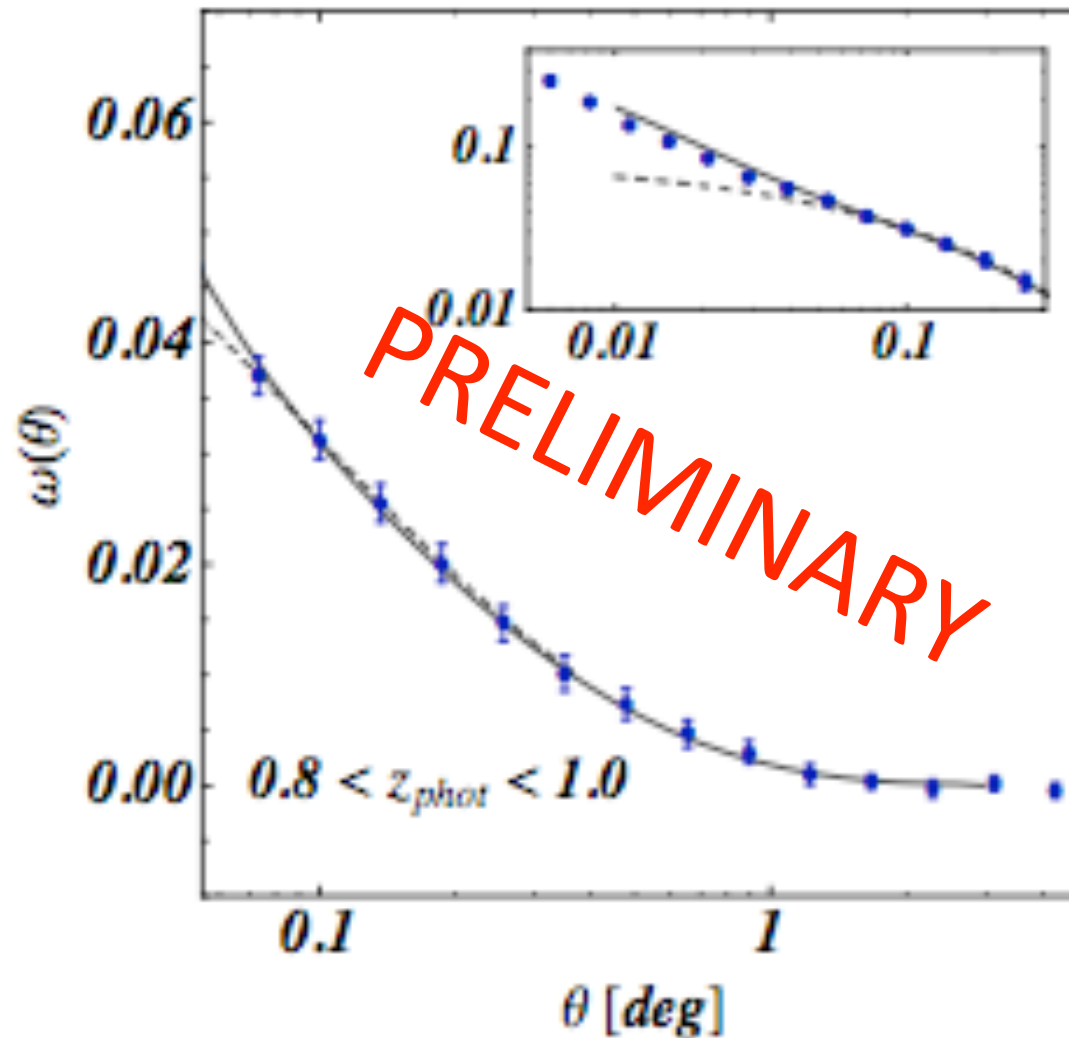
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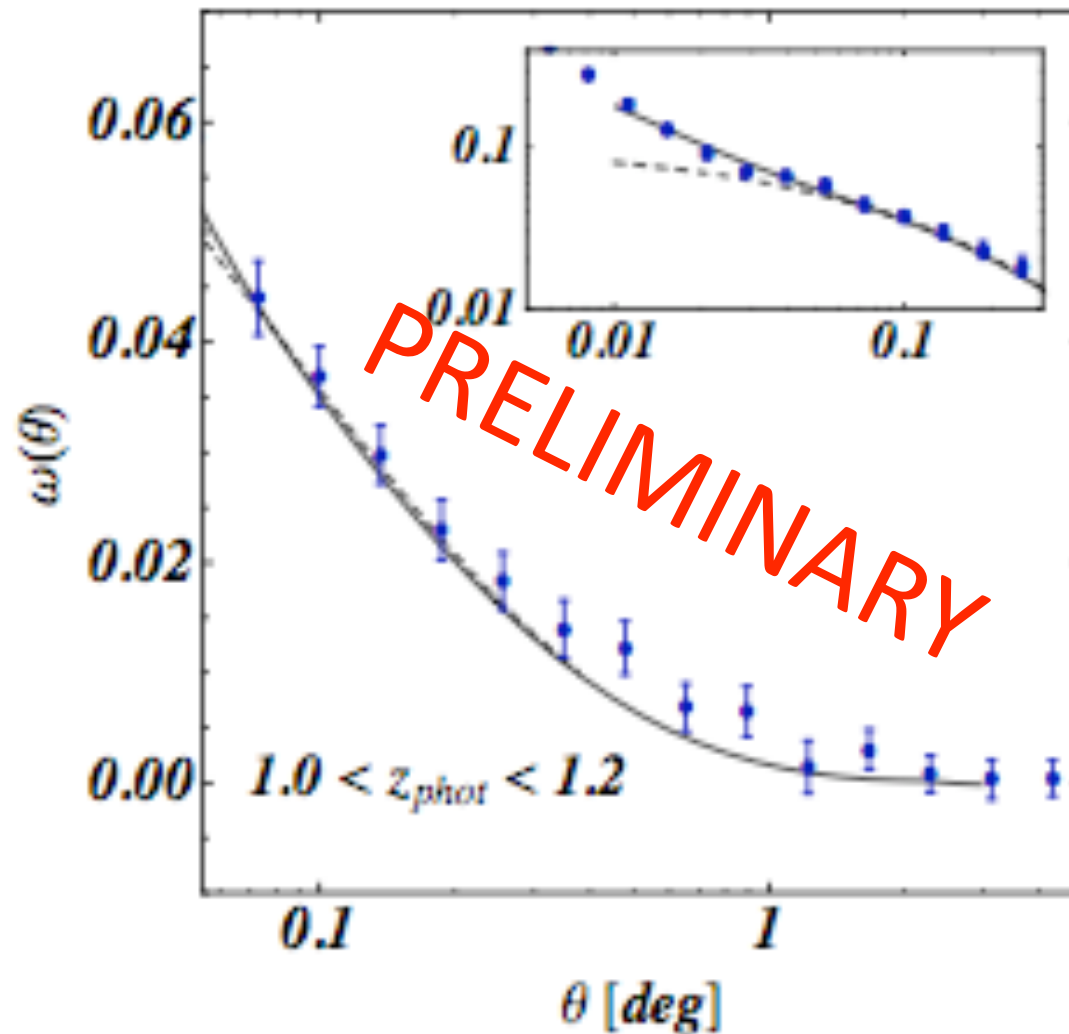
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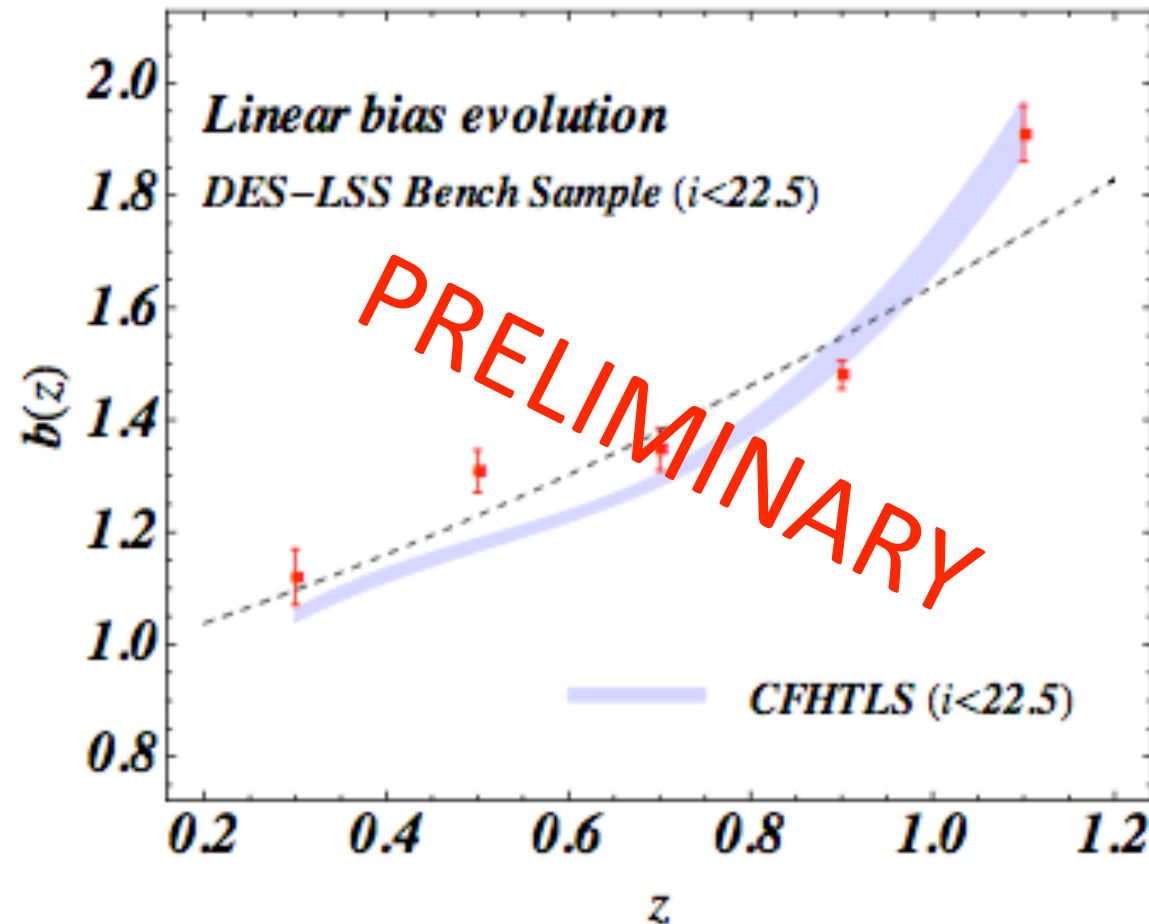
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I. Sevilla DECam workshop

Good agreement has been found with CFHTLS bias evolution



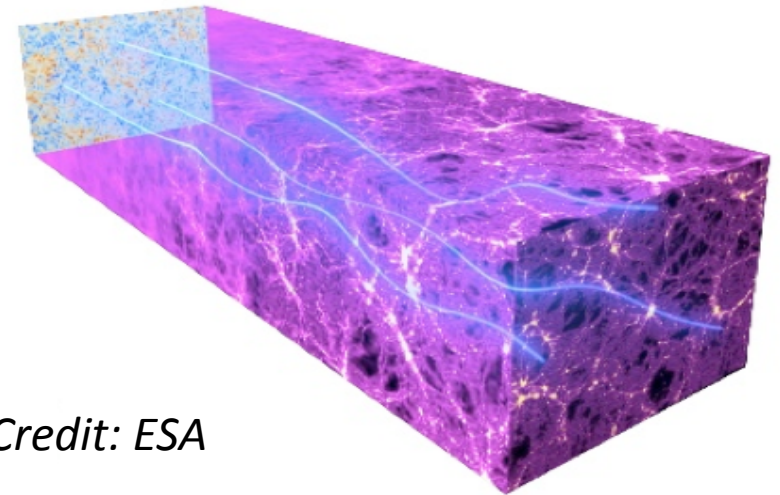
OBSERVED ACF BIAS FIT ESTIMATED PZ THEORY

$$\delta_g(\hat{\mathbf{n}}) = \int_0^\infty b_g(z) \frac{dn}{dz}(z) \delta(\hat{\mathbf{n}}, z) dz$$

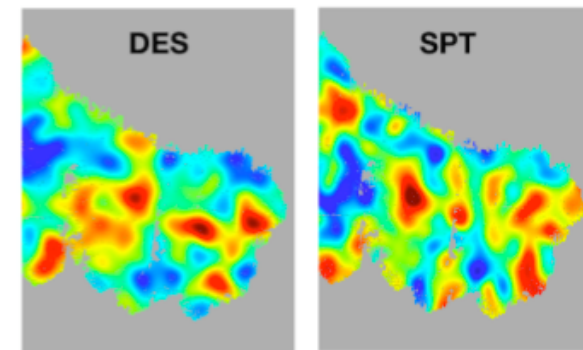
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Light from CMB interacts with large scale structure on its way towards us

- Make an early cross-correlation measurement of CMB lensing (SPT, Planck) with the galaxy distribution in the Science Verification data.
- DES power:
 - Redshift evolution.
 - Depth.
- Compare against theory.
- Measure bias evolution.
- Led by Tommaso Giannantonio (Cambridge, UK), Pablo Fosalba (IEEC, Barcelona).

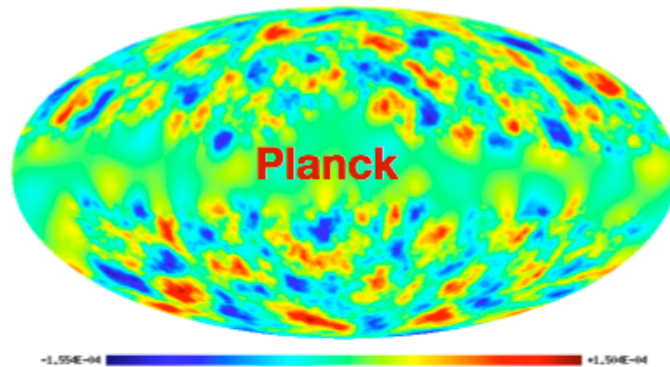


Credit: ESA



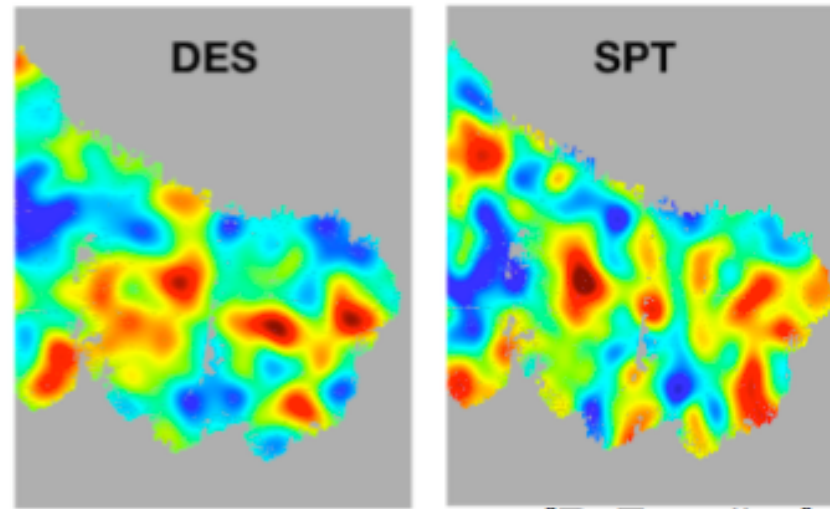
We have Planck (public) and SPT (partnership)
CMB data available

PLANCK



- Lensing potential map
- Full sky
- Noise limited

SOUTH POLE TELESCOPE



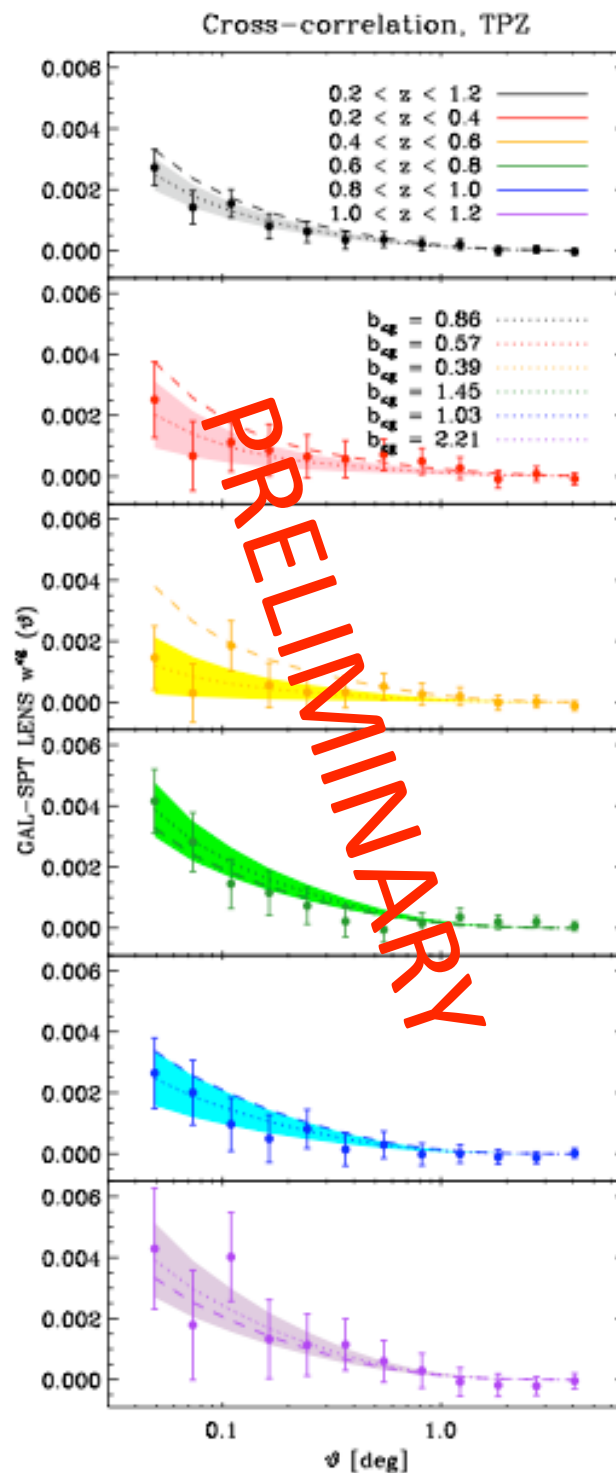
- Convergence map
- Small region
- Higher resolution

A cross-correlation signal is seen with SPT data

- Significant cross-correlation with SPT, not with Planck
- Cross-correlation agrees with theoretical expectation (slightly less significance). First time measurement!
- Opens the possibility of using CMB lensing to probe structure formation.

T.Giannantonio, P.Fosalba, LSS WG

I.Sevilla DECam workshop



Large Scale Structure in DES: much more than BAO!

We expect SV results on small scale clustering and CMB cross-correlations to be released in the coming weeks.

Besides BAO, watch out for:

- Measurement, or limits, to neutrino mass
- Growth of structure at several redshifts
- Halo Occupation Distribution modelling
- Magnification bias, galaxy-galaxy lensing
- Non-Gaussianities, Counts in Cells, Homogeneity scale