LATEST RESULTS FROM PAPER AND HERA

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ARIZONA STATE UNIVERSITY
ON BEHALF OF THE PAPER AND HERA COLLABORATIONS

PAPER Collaborators
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HERA Collaborators
PAPER Collaboration +
Judd Bowman, Andrei Mesinger, Eloy Loi, Steve Furlanetto, Jackie Hewitt, Aaron Ewall Wice, Josh Dillon, Abraham Neben, Miguel Morales, Bryna Hazelton, Nichole Barry, Zak Martinot, Adam Beardsley, Nithyanandan Thyagarajan, Peter Williams

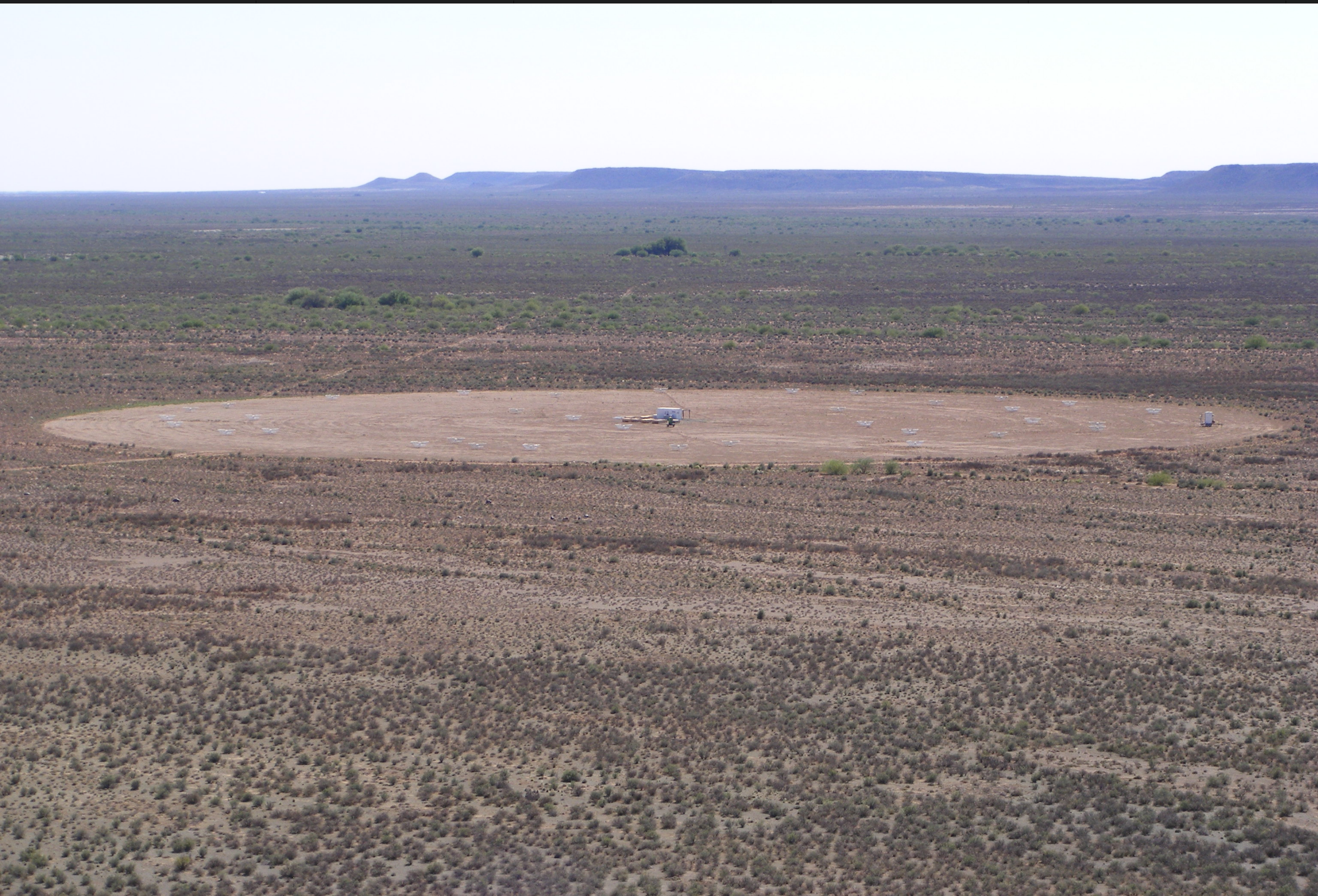


PRECISION ARRAY FOR PROBING THE EPOCH OF REIONIZATION



reionization.org loco.lab.asu.edu/danny_jacobs mwatelescope.org eor.berkeley.edu

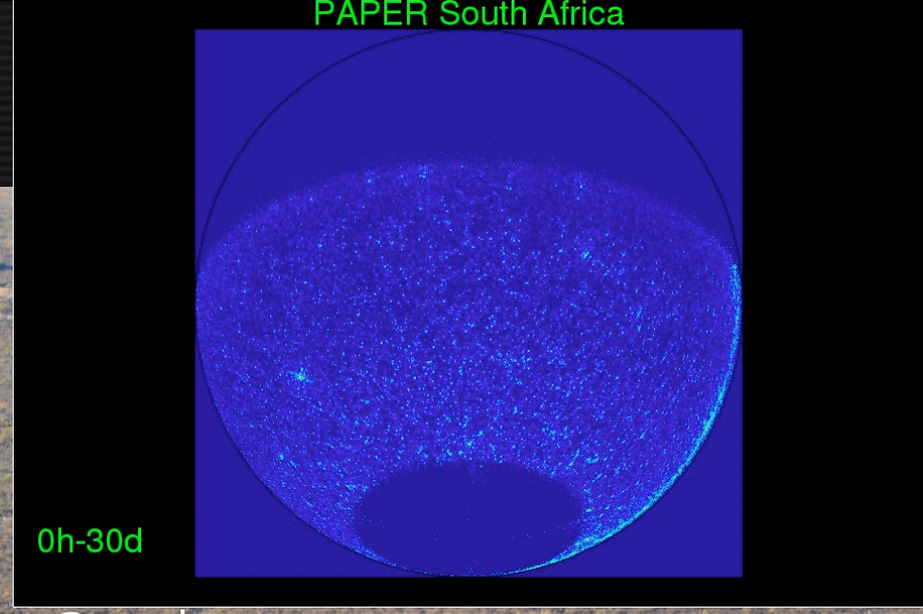
PAPER32 - IMAGINING CONFIGURATION
2009



PAPER32 - IMAGINING CONFIG
2009

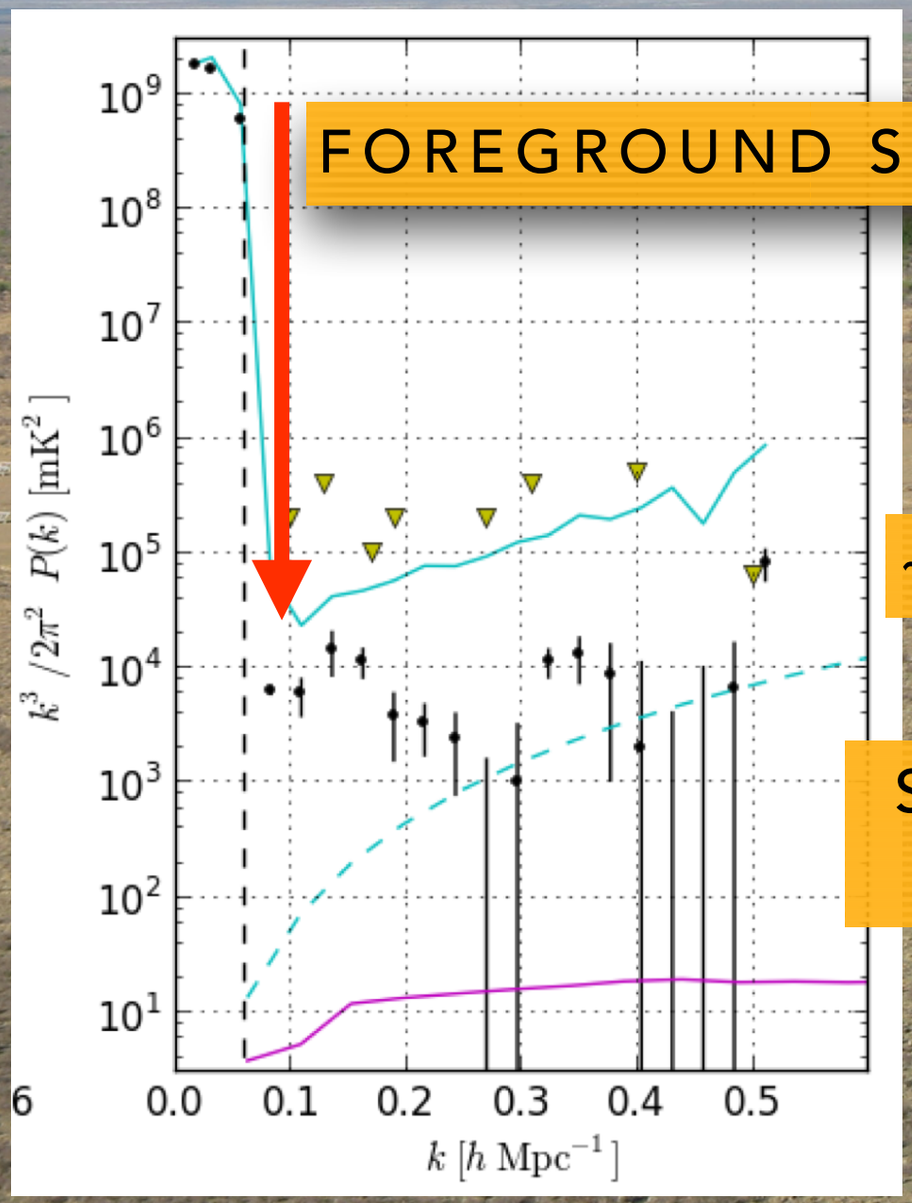


PAPER64 - IMAGINING CONFIG
2010



Catalogs:
Jacobs et al 2012
Jacobs et al 2014

PAPER32 - GRID
2011



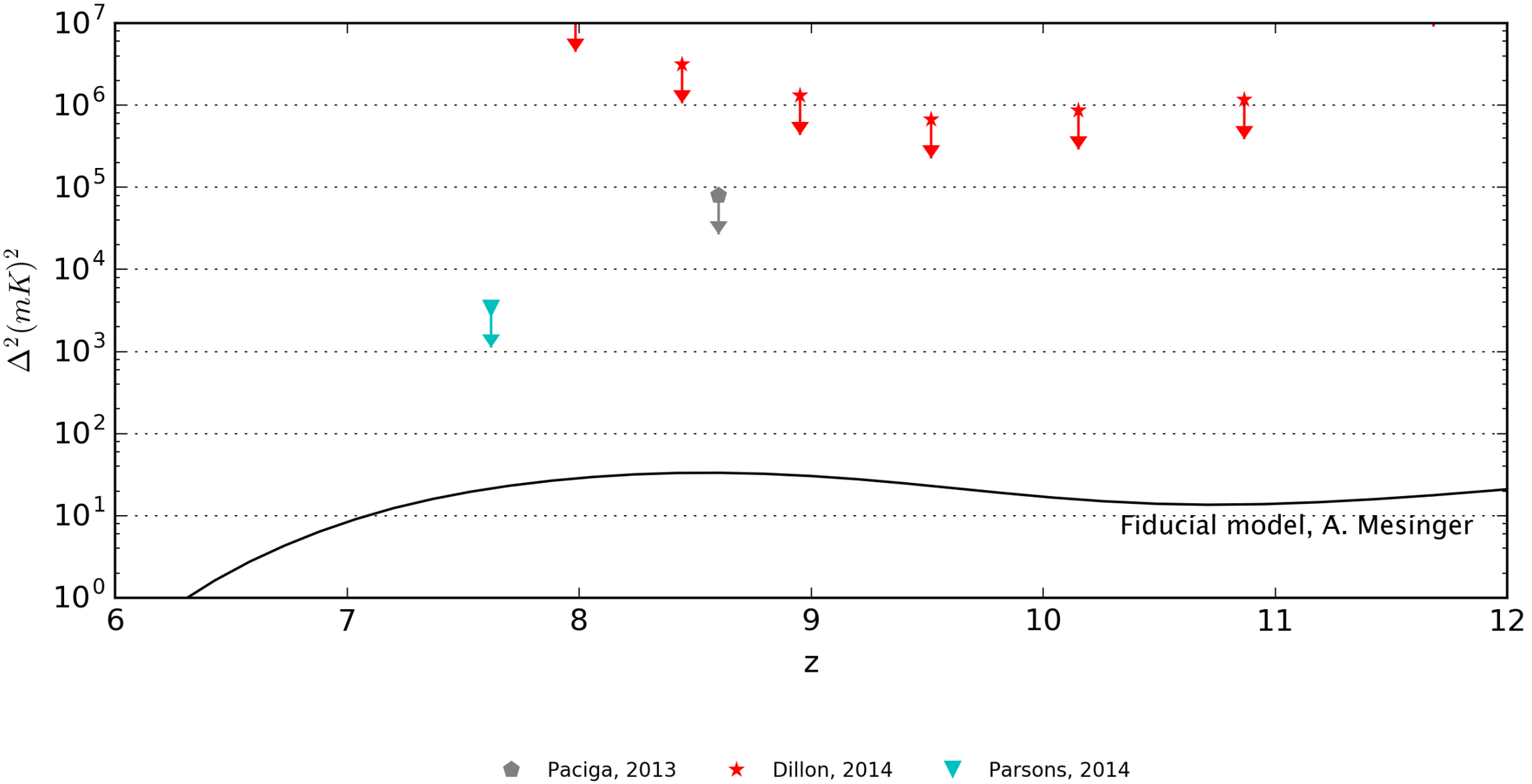
FOREGROUND SUPPRESSION

~FEW SIGMA EXCESSES

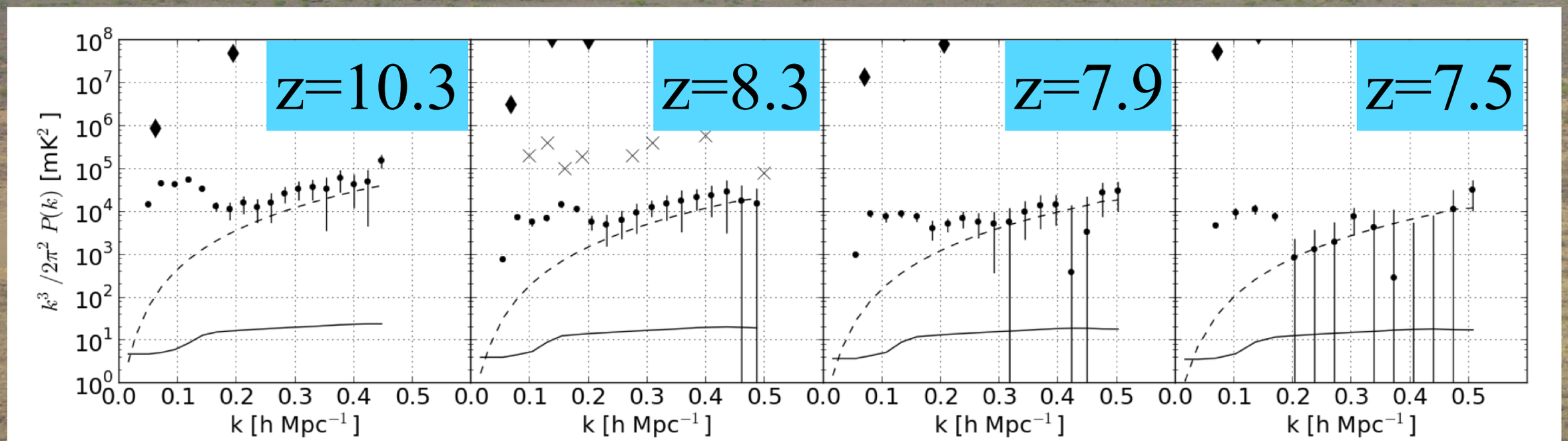
SOME POINTS CONSISTENT WITH NOISE

Parsons et al 2014

PAPER32 - GRID
2011



PAPER32 - GRID
2011

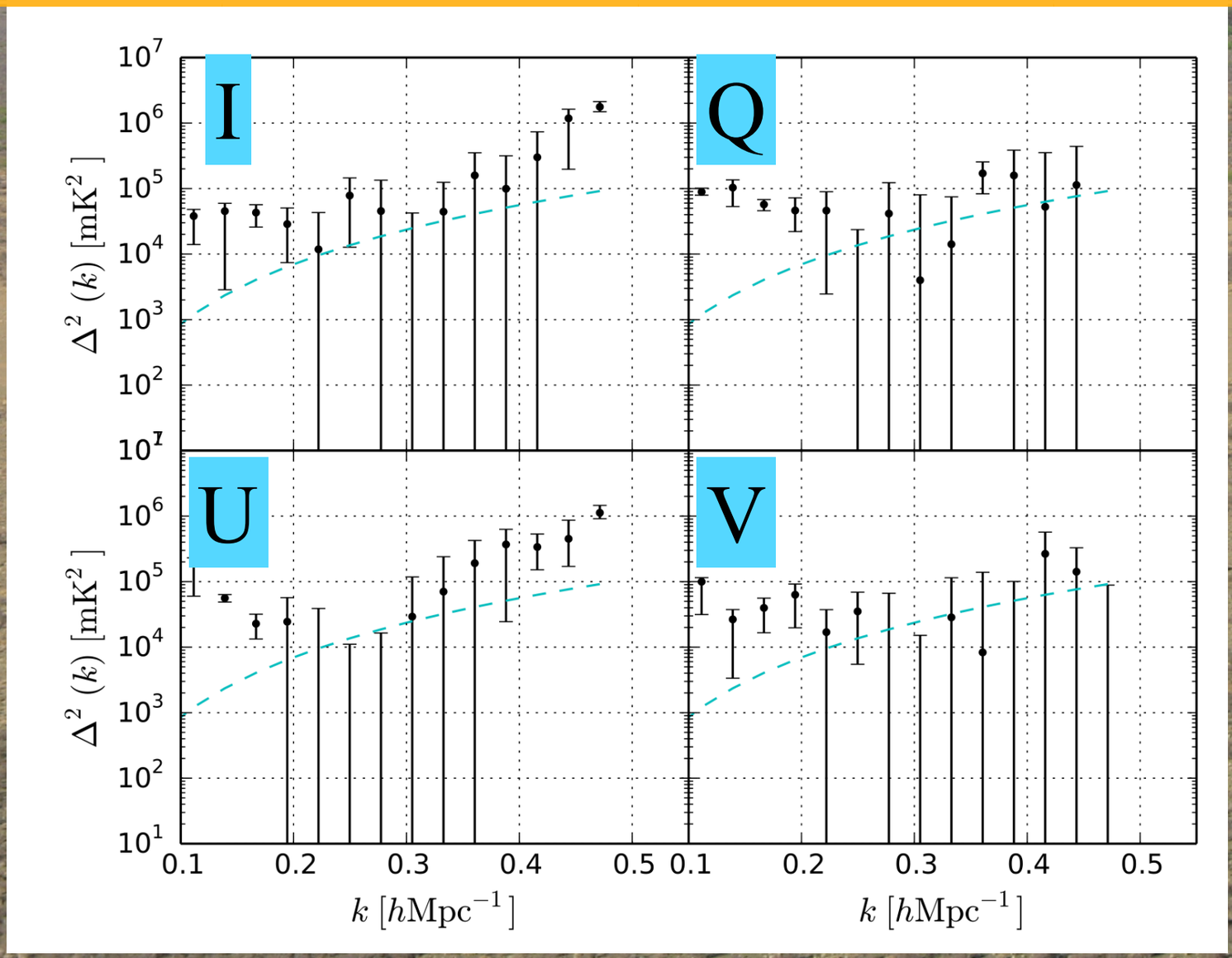


EDGES OF BANDS ARE FOREGROUND LIMITED

Jacobs et al 2014

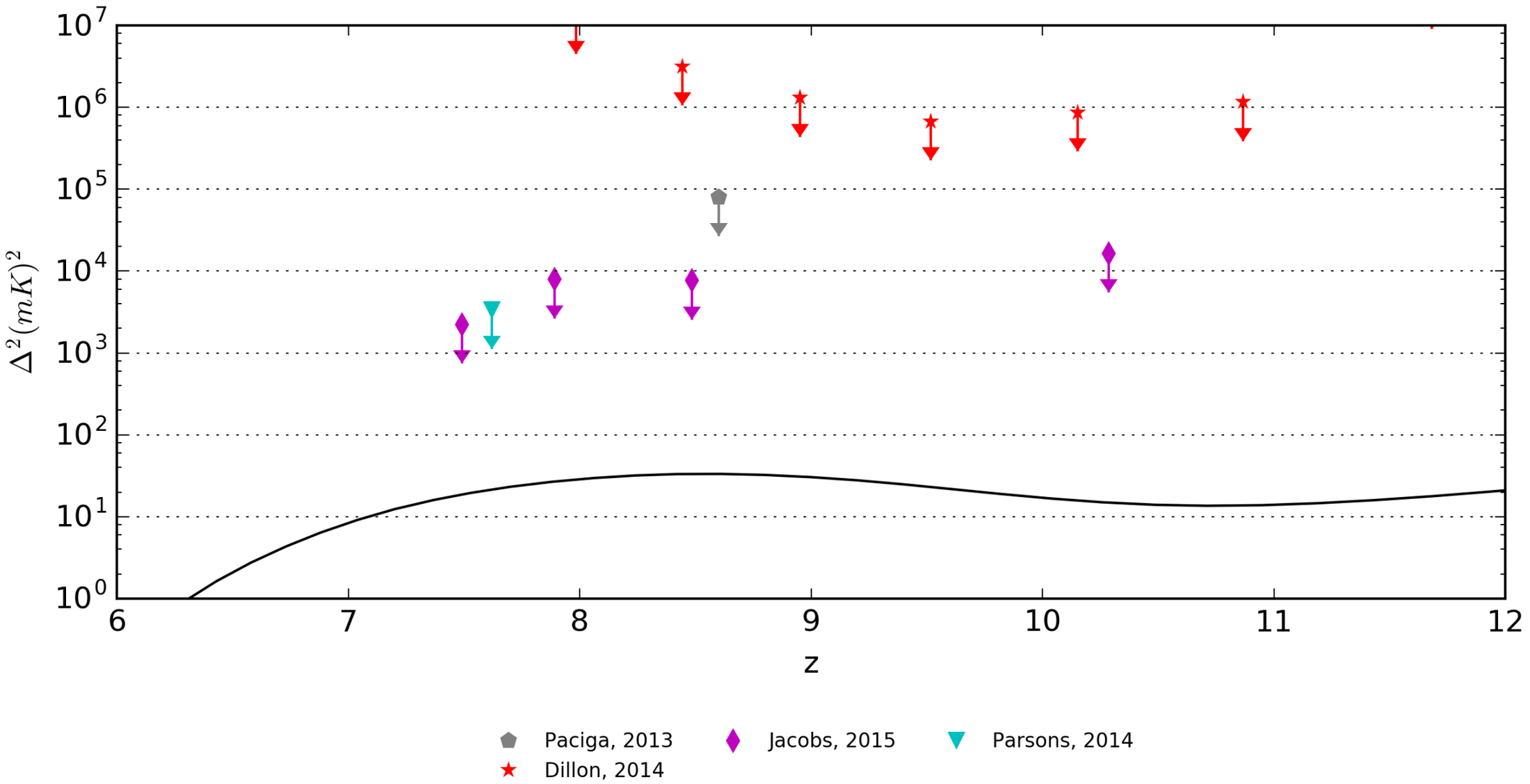
PAPER32 - GRID
2011

I FOREGROUNDS **NOT** COMING FROM POL LEAKAGE



Moore et al 2016 (1502.05072)

SUMMARY


10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
$\Delta^2(mK)^2$
6
7
8
9
10
11
12
z
Paciga, 2013
Jacobs, 2015
Parsons, 2014
Dillon, 2014

PAPER32 - GRID
2011

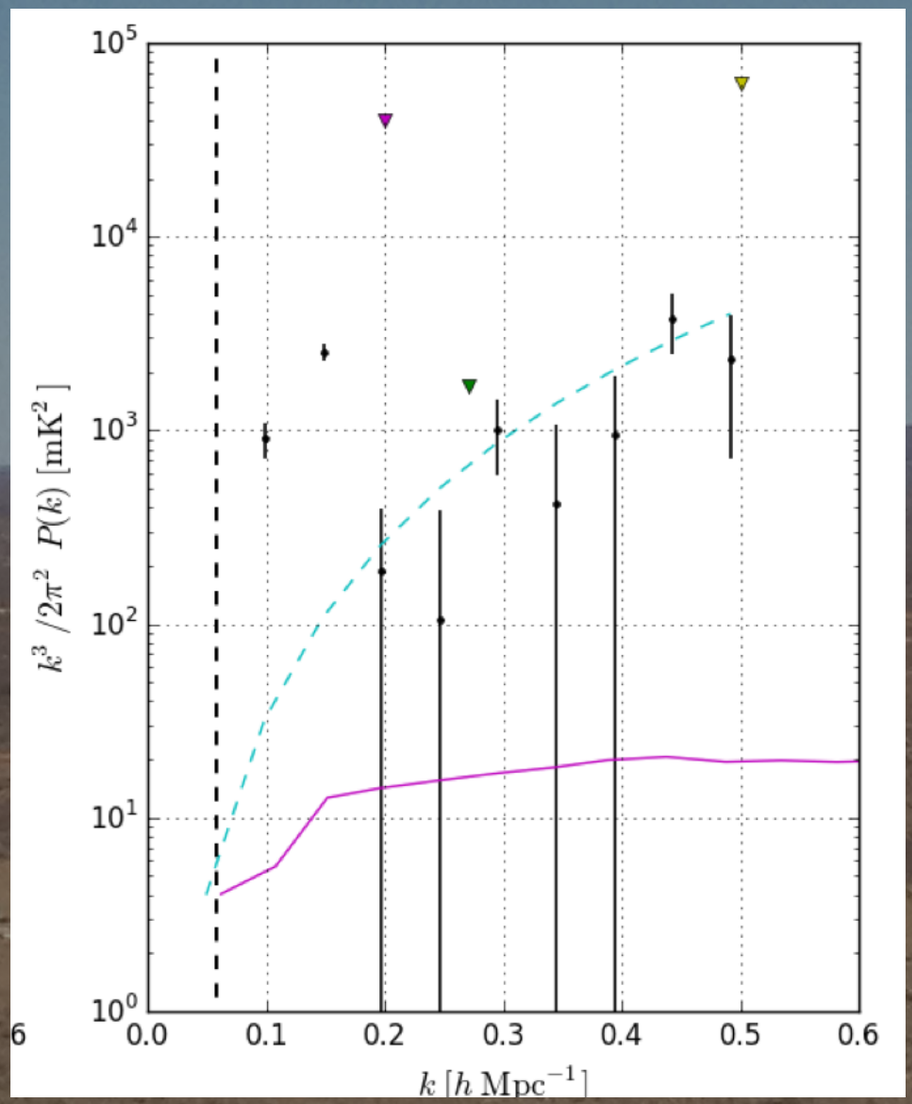


PAPER64
2012



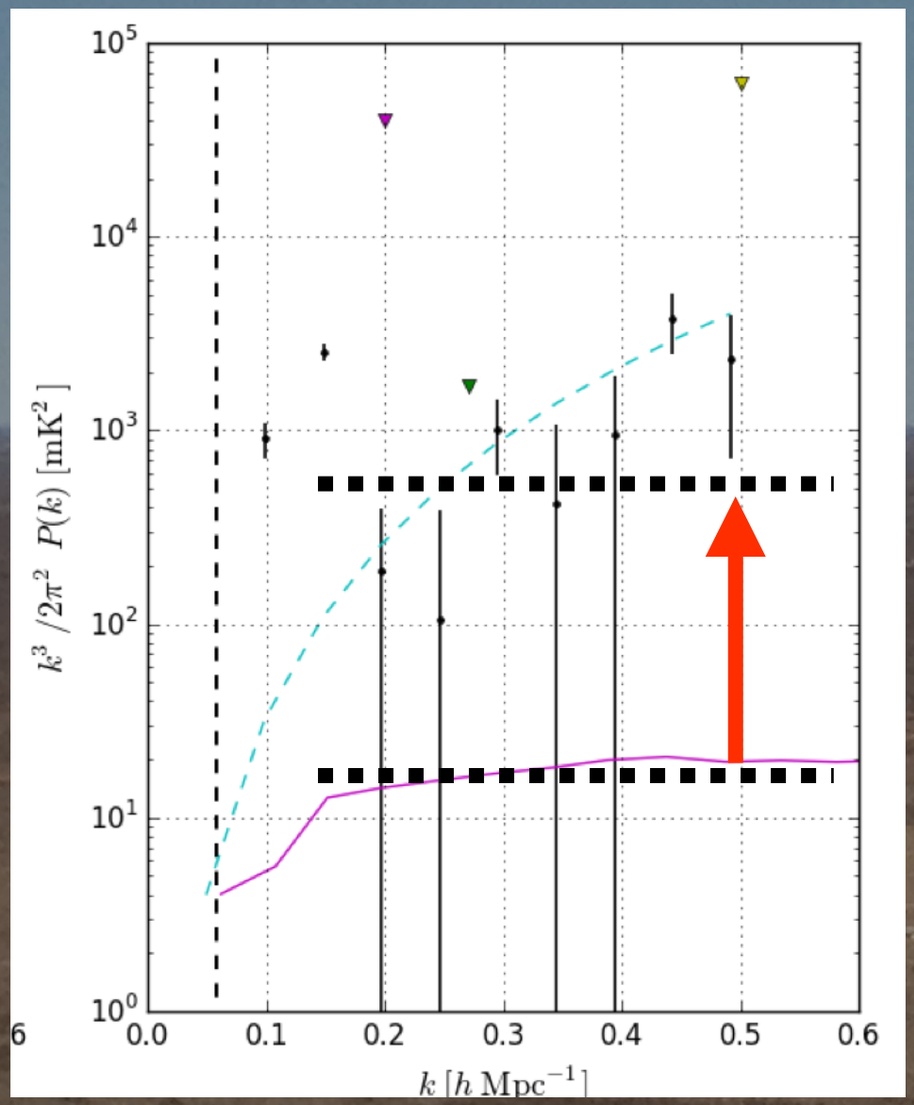
PAPER64
2012

- Doubled antenna count
  32 to 64
- Redundant Calibration
  (Zheng et al, 2014)
- Optimal Quadratic
  Estimator
  (Dillon et al 2015)



Ali et al 2015

PAPER64
2012



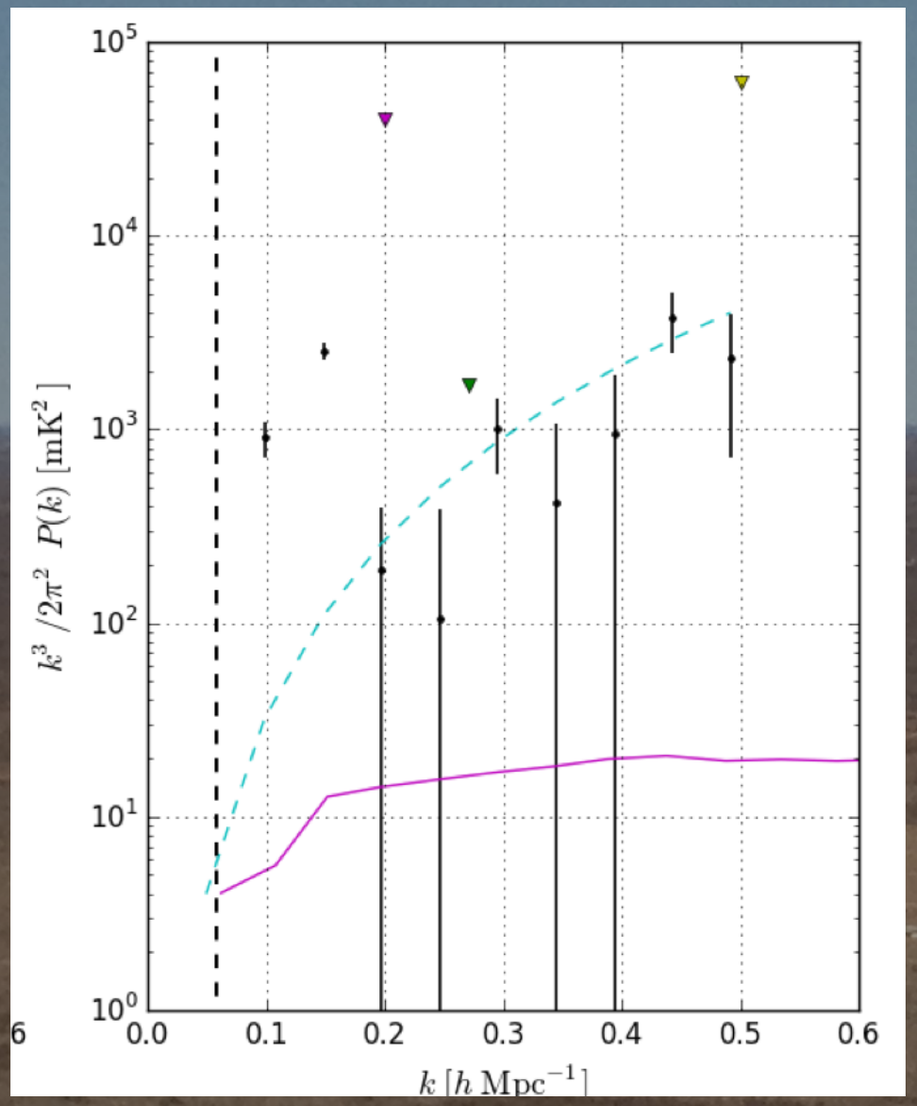
Ali et al 2015

Excluding Ts<T_CMB

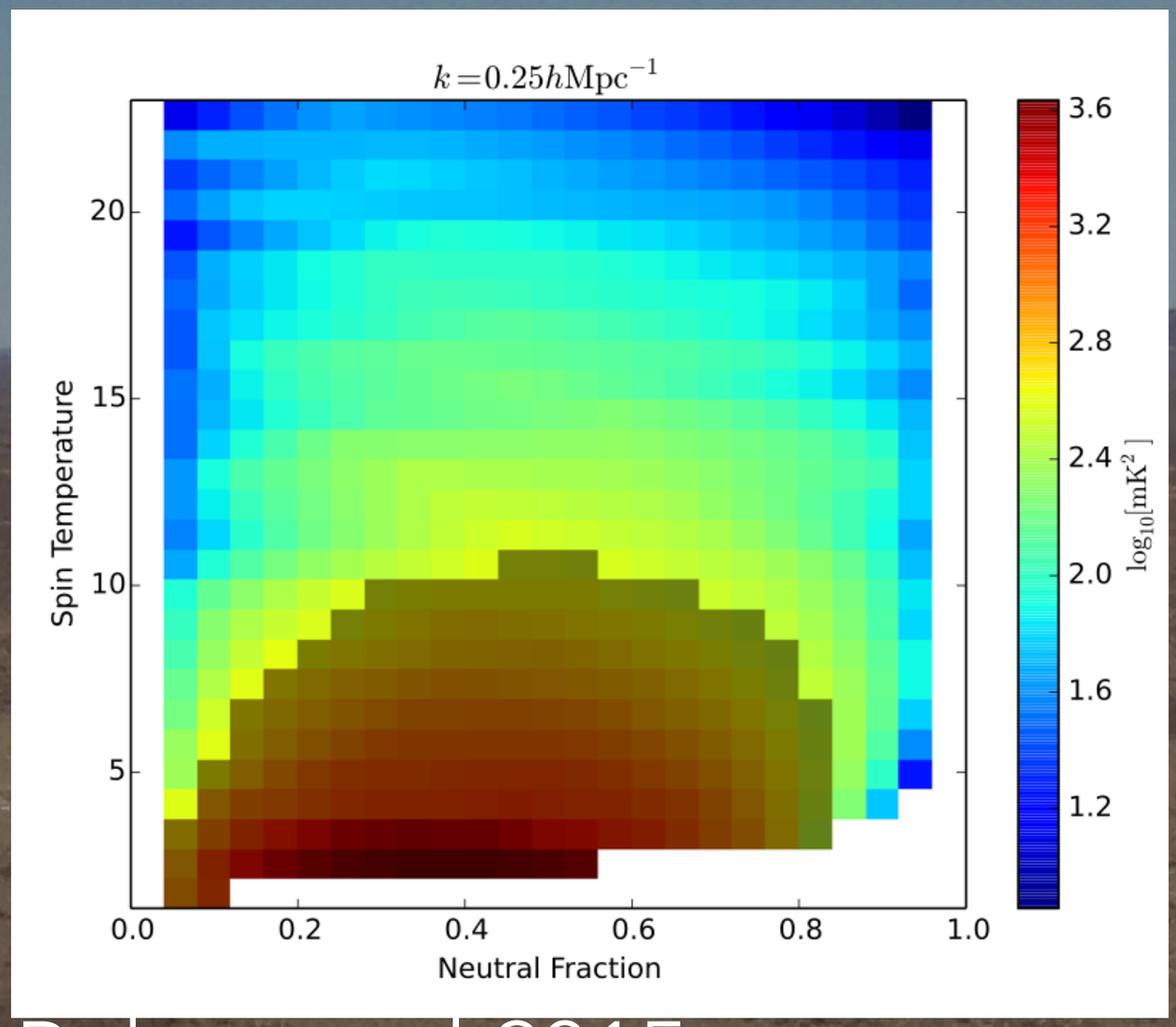
$$\delta T_b(\nu) \approx 9 x_{\mathrm{HI}} (1+\delta)(1+z)^{\frac{1}{2}} \times \left[1 - \frac{T_{\mathrm{CMB}}(z)}{T_S}\right] \left[\frac{H(z)/(1+z)}{\mathrm{d}v_\parallel/\mathrm{d}r_\parallel}\right] \mathrm{mK}$$

PAPER64
2012

$$\delta T_b(\nu) \approx 9 x_{\rm HI}(1+\delta)(1+z)^{\frac{1}{2}} \times \left[1 - \frac{T_{\rm CMB}(z)}{T_S}\right]\left[\frac{H(z)/(1+z)}{{\rm d}v_\parallel/{\rm d}r_\parallel}\right] {\rm mK}$$

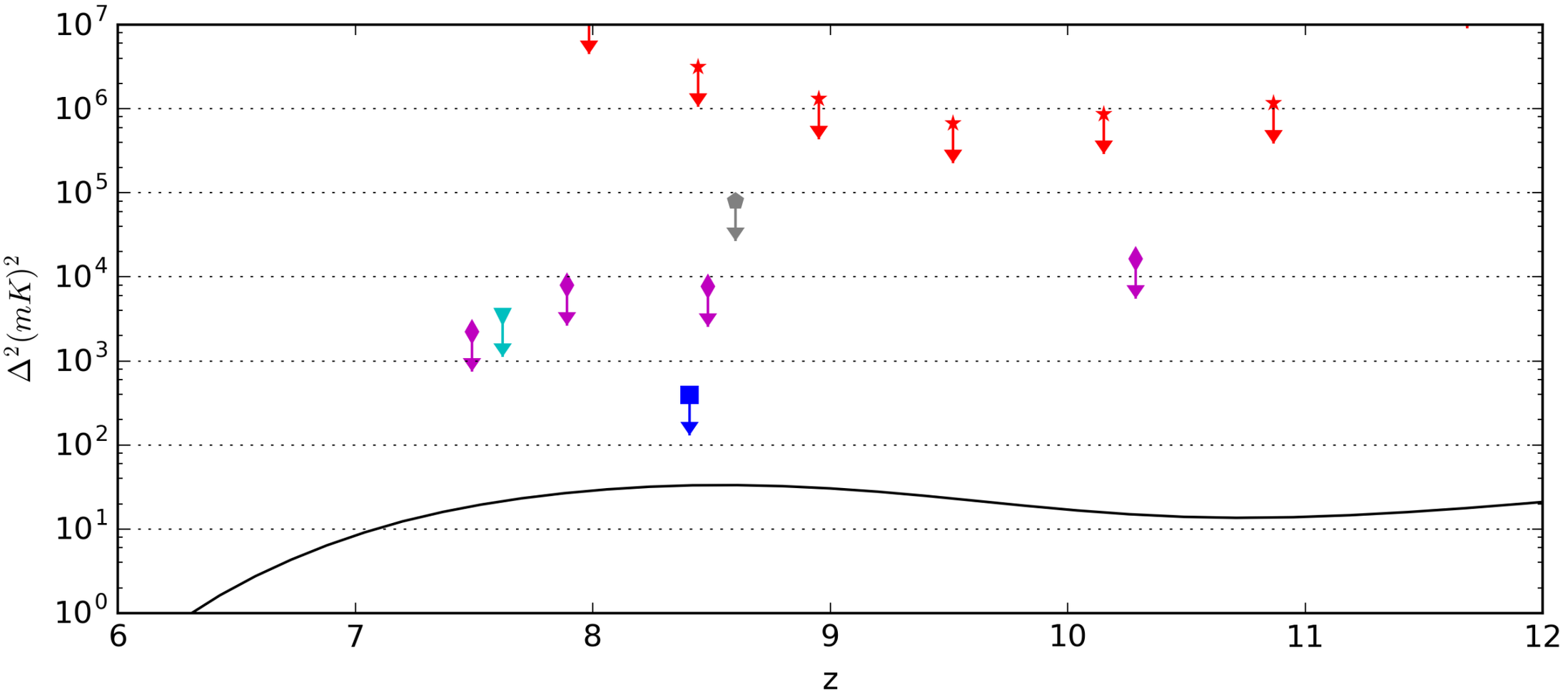


Ali et al 2015

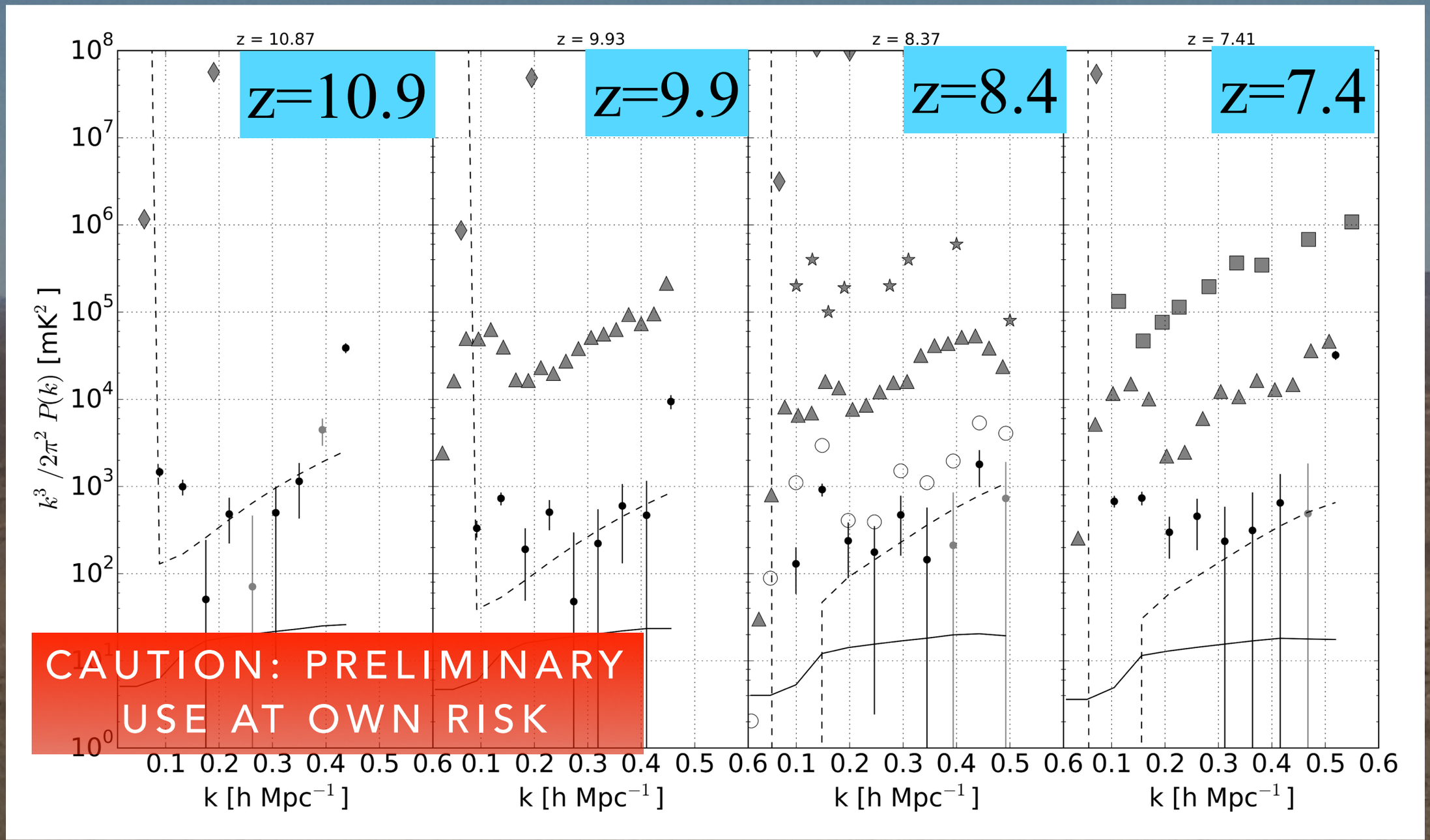


Pober et al 2015

PAPER64

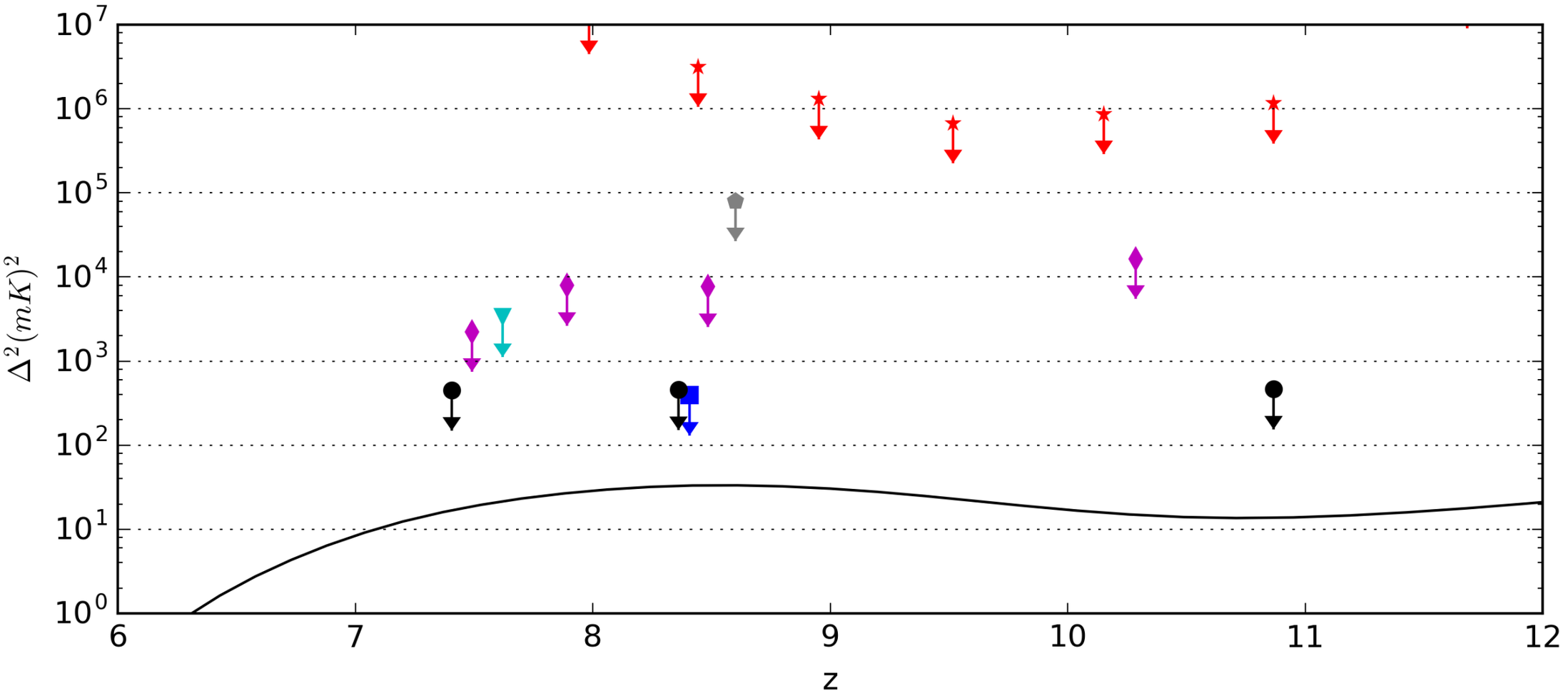

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Paciga, 2013
Dillon, 2014
Jacobs, 2015
Parsons, 2014
Ali, 2015

PAPER64 - MORE REDSHIFTS



Kolopanis et al (in prep)

PAPER64 - MORE REDSHIFTS



CAUTION: PRELIMINARY
USE AT OWN RISK

PAPER64 - COMPARISON WITH XRAY MODELS

$$M_{\min} = 4 \cdot 10^9 M_\odot$$

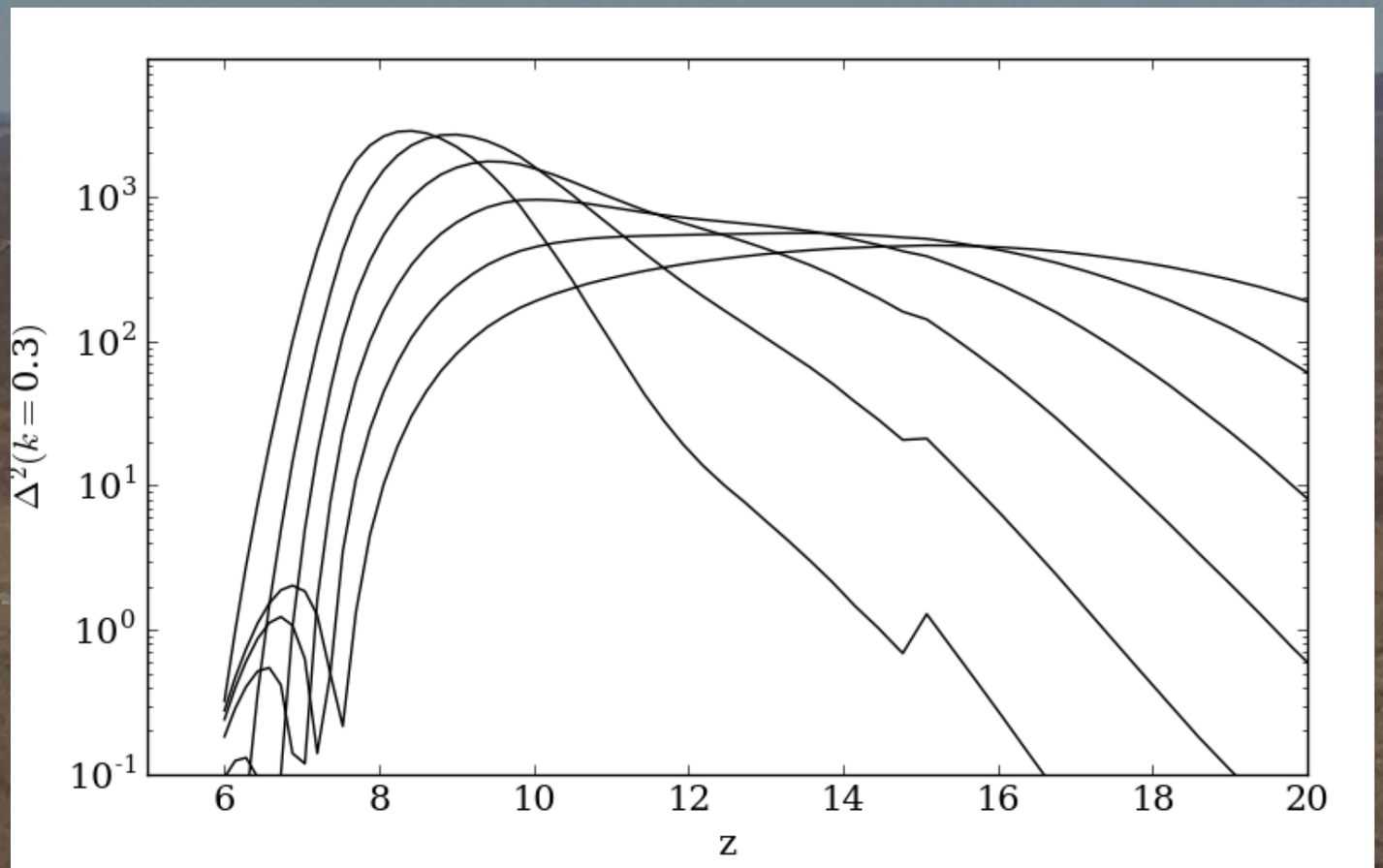
$$\zeta = 70$$

$$R_{\mathrm{mfp}} = 15\mathrm{cMpc}$$

$$N_X = 0.01$$

$$\alpha_X = 1$$

$$M_{\mathrm{minX}} = \{10^8..10^{10}\}$$



21cmfast - Mesinger

PAPER64 - COMPARISON WITH XRAY MODELS

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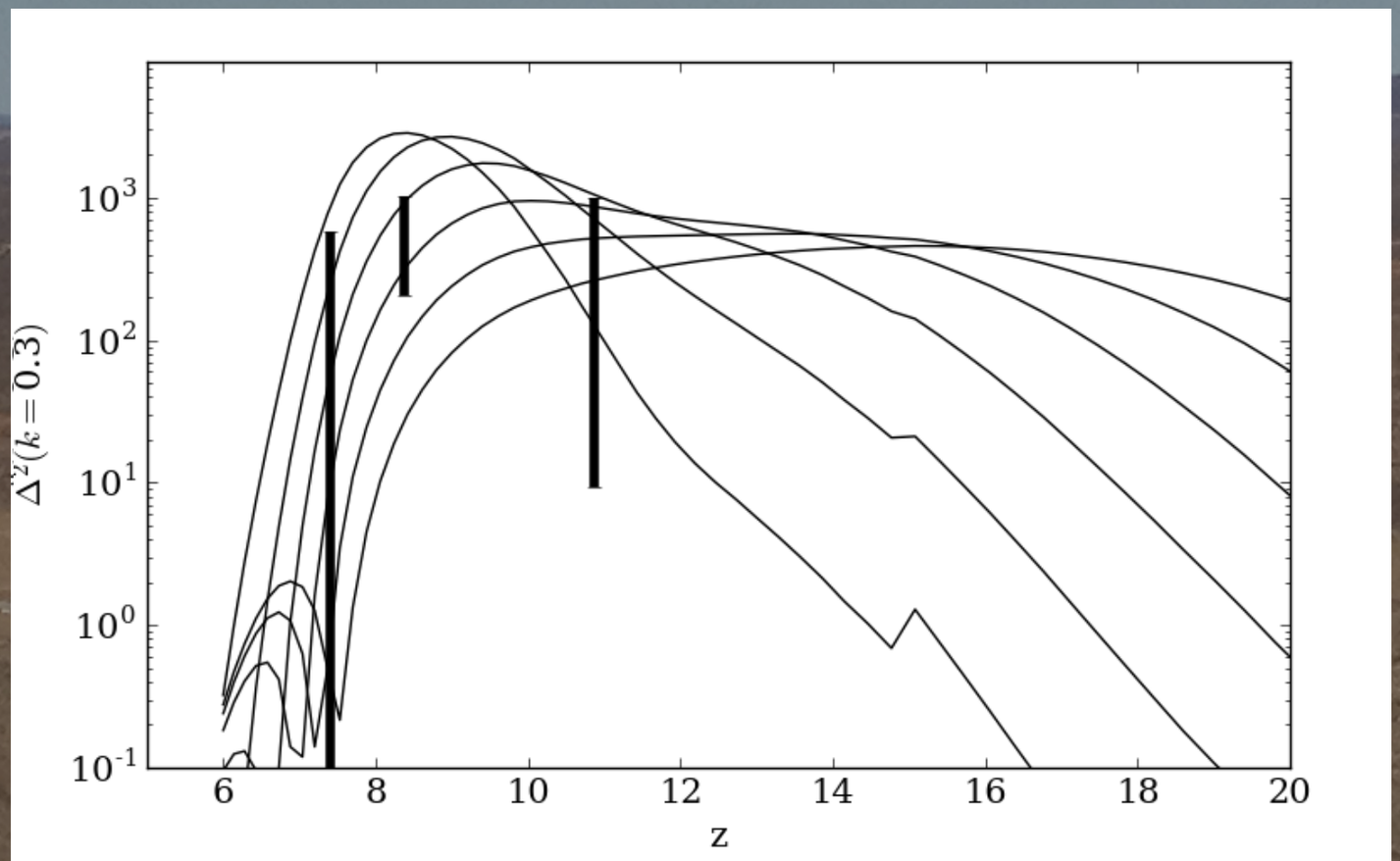
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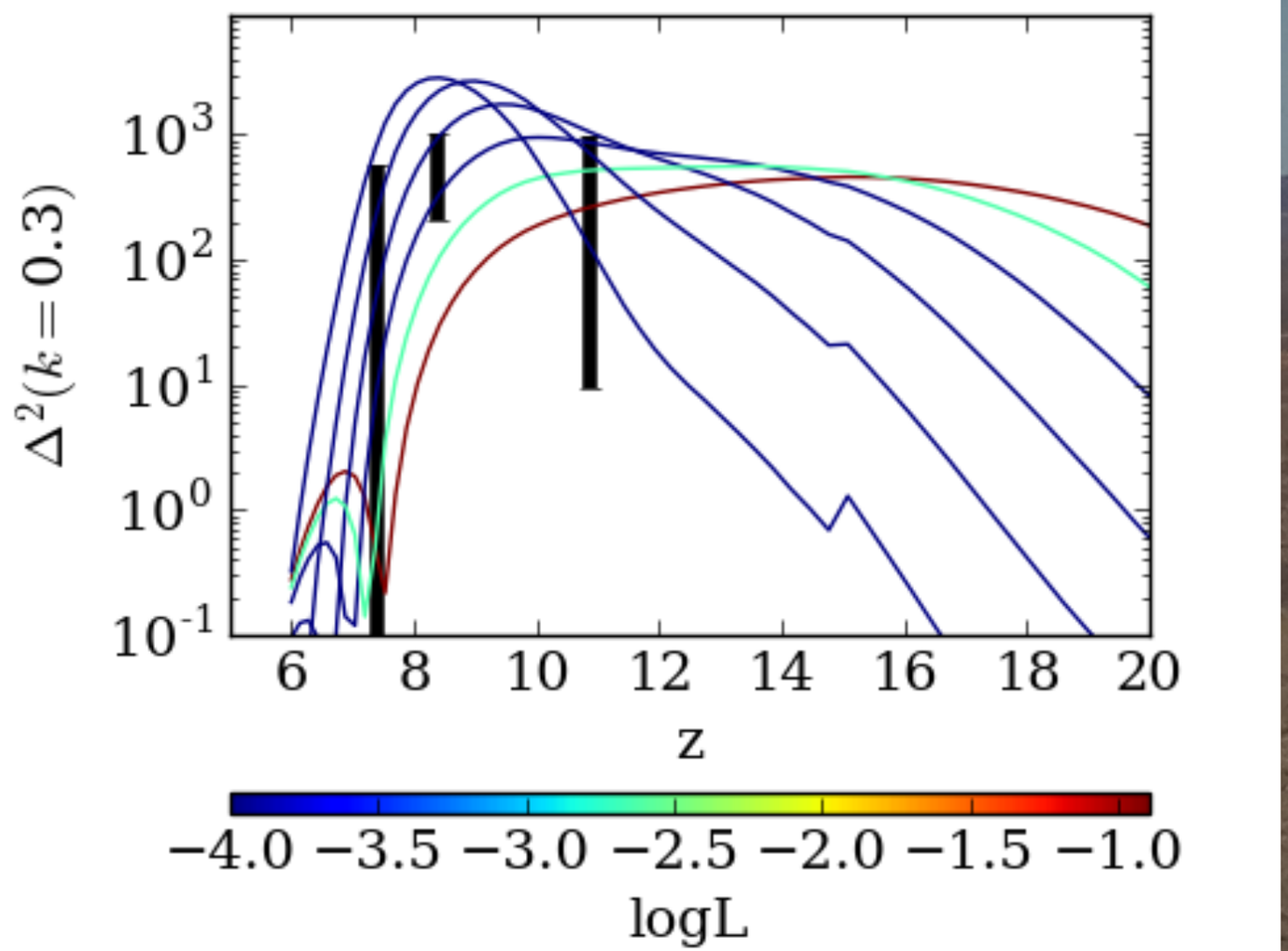


21cmfast - Mesinger

PAPER64 - COMPARISON WITH XRAY MODELS

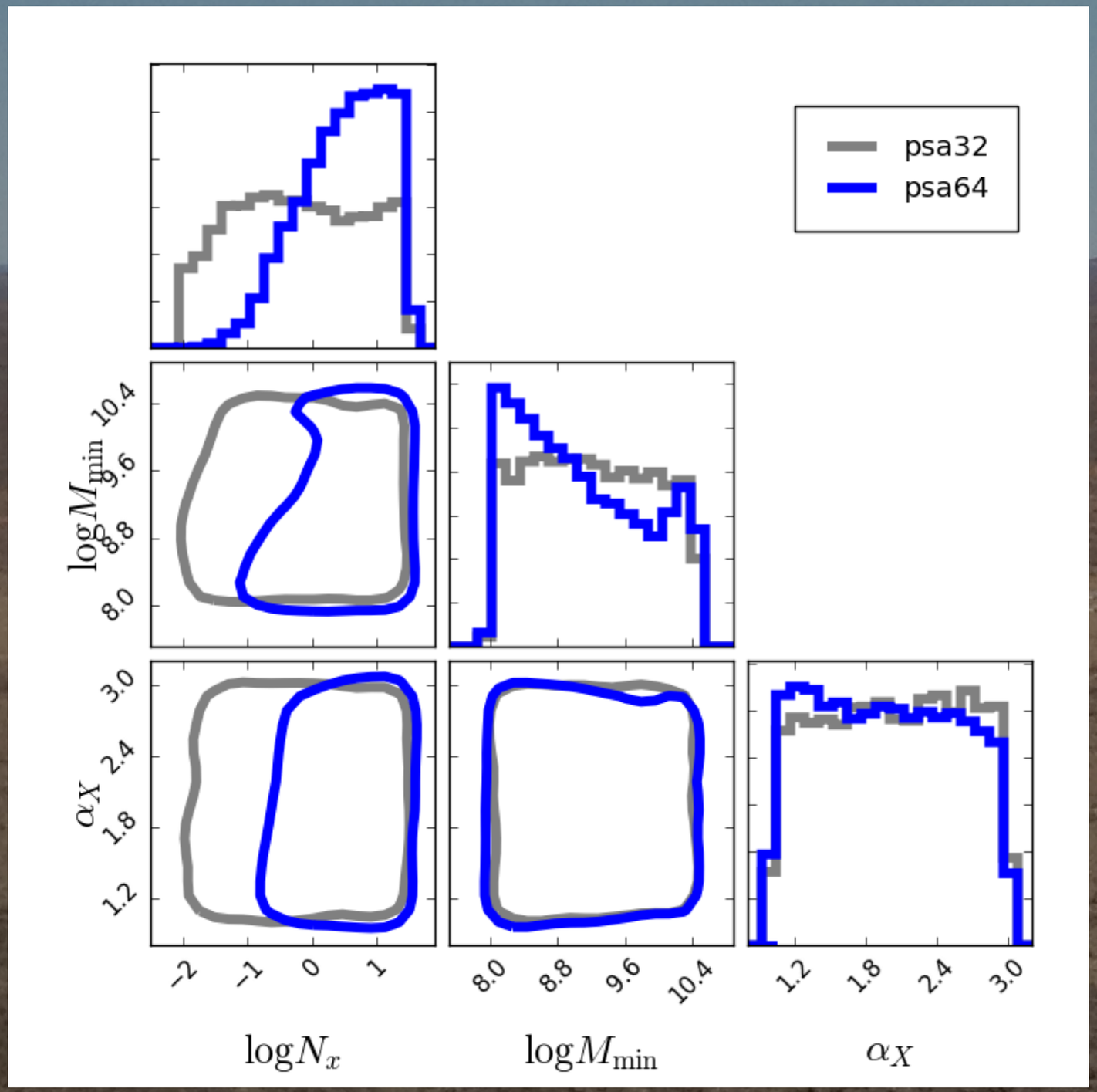
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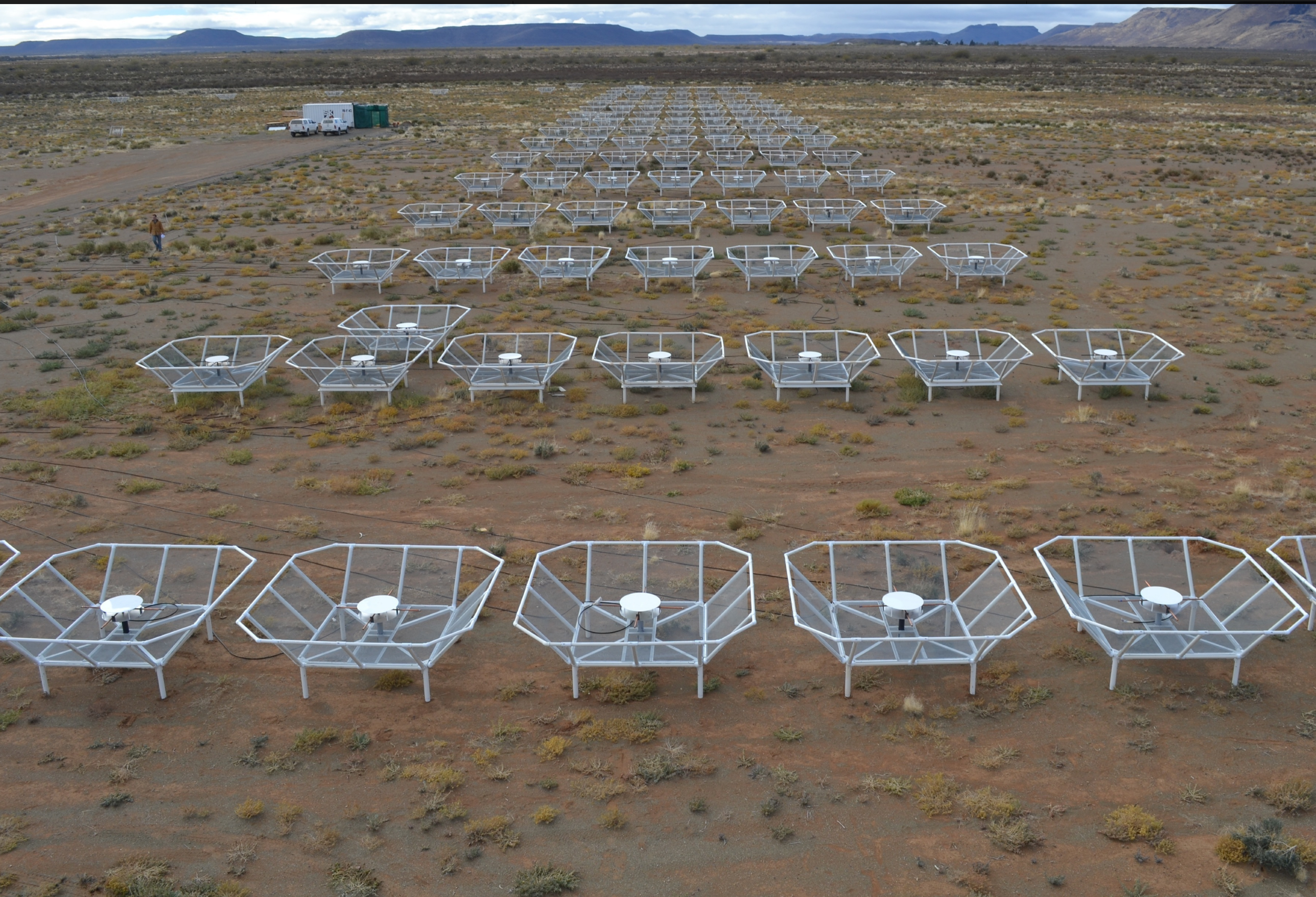


LIKELIHOOD ASSUMING ALL MEASUREMENTS ARE UPPER LIMITS

PAPER64 - XRAY PARAMETER CONSTRAINTS



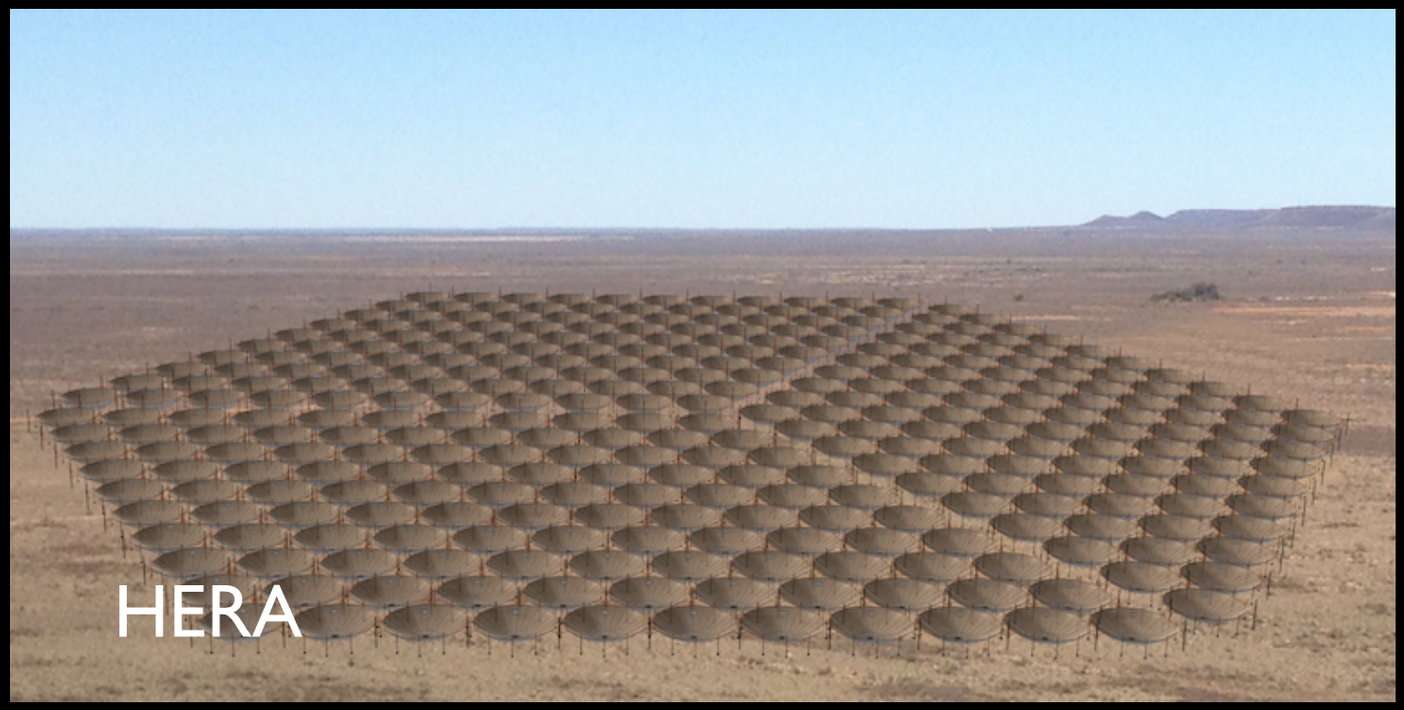
PAPER128
2013 - 2015



HYDROGEN EPOCH OF REIONIZATION ARRAY (HERA)

Location: Karoo Desert, South Africa
High sensitivity on Reionization and late Dark Ages
350 14m dishes

Goal: High SNR Power spectra and first images
Stretch goal:
Expanded redshift range 13<z<20
Supported by the NSF Mid-Scale program, construction under way.



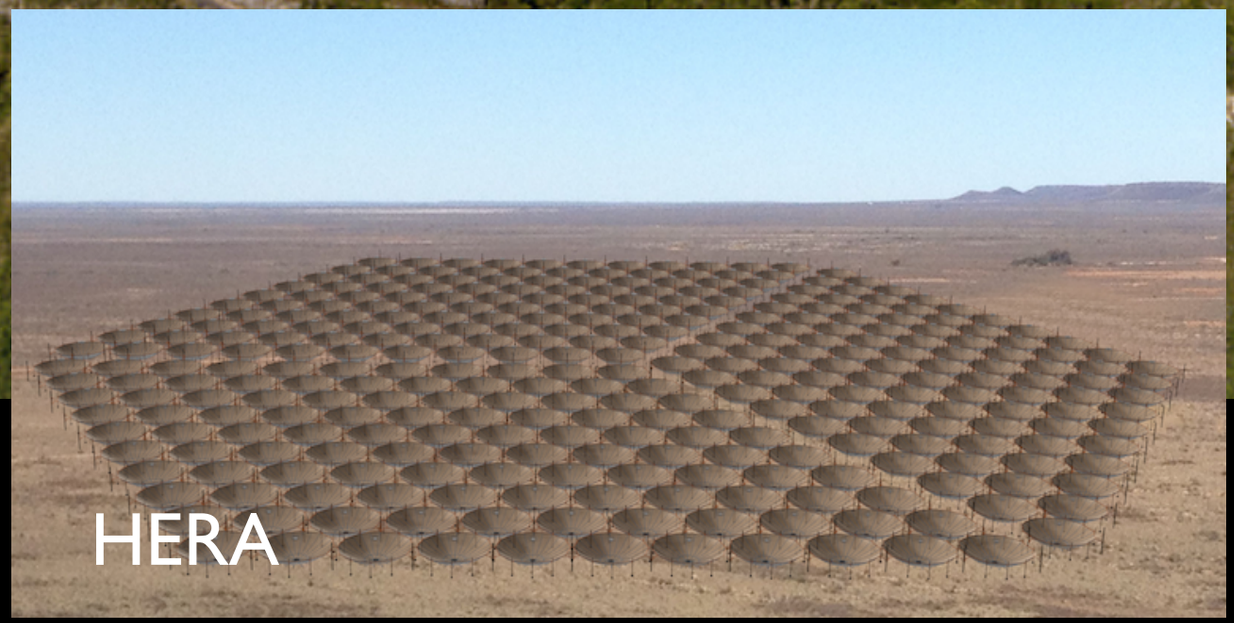
HERA PRIMARY SCIENCE

1. Detect and characterize reionization 21cm emission at high significance

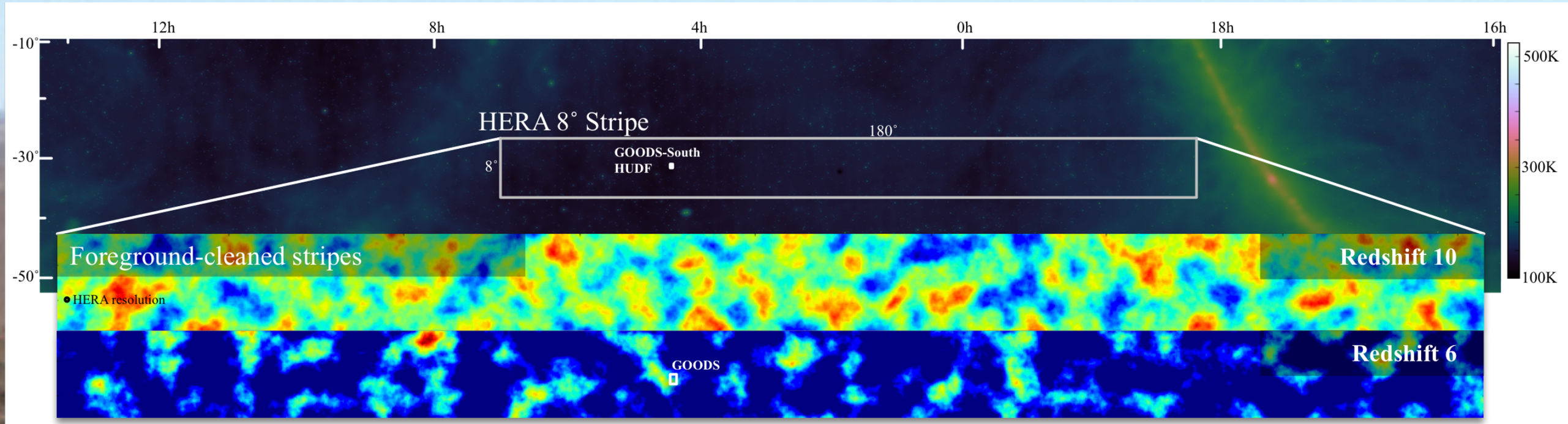
2. Constrain global parameters of First Astrophysics

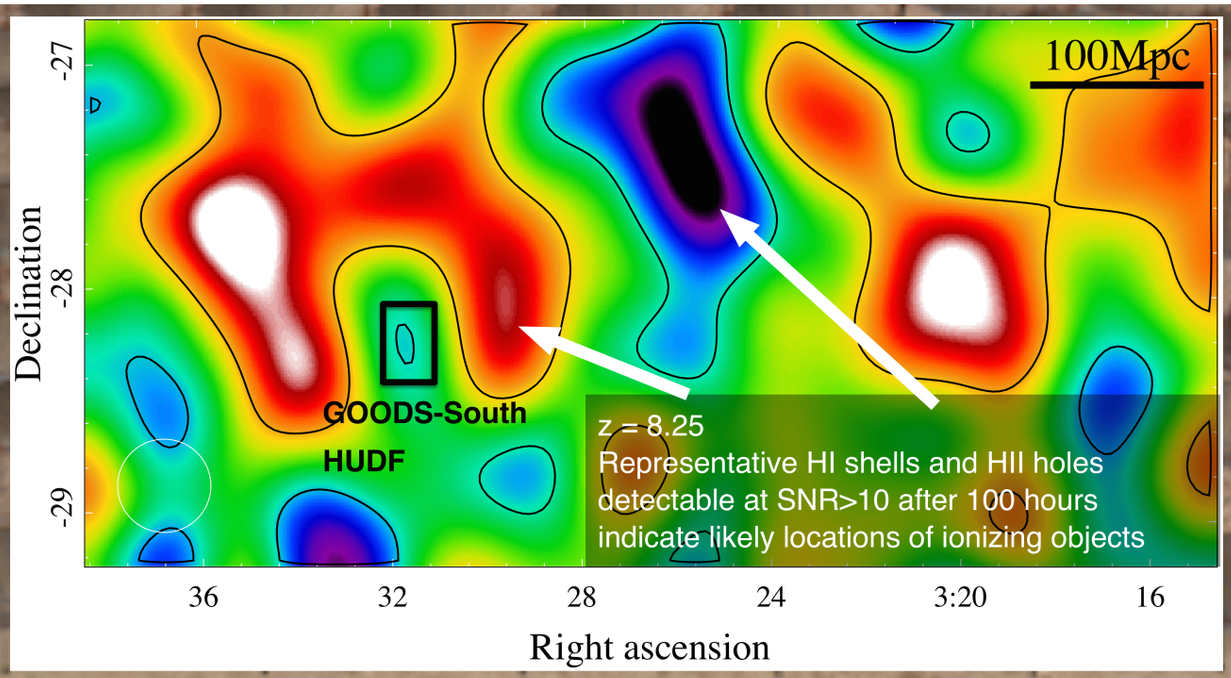
3. Direct measurement of CMB optical depth (tau)

4. First true survey images suitable for cross-comparison


HERA

4. First true survey images suitable for cross-comparison





ERA

HERA STATUS
HERA19 ONLINE - 7 MARCH 2016



HERA STATUS
HERA19 ONLINE - 7 MARCH 2016

