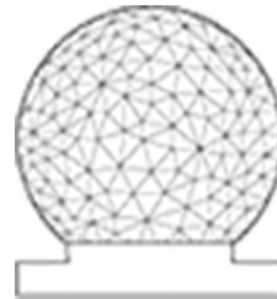


Latest Constraints on the Global Redshifted 21-cm EoR Signal from the EDGES Experiment

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University of Colorado-Boulder

Prof. Judd D. Bowman, Dr. Alan E.E. Rogers, Thomas J. Mozdzen



EDGES

Experiment to Detect the Global EoR Signature



(& Cosmic Dawn)

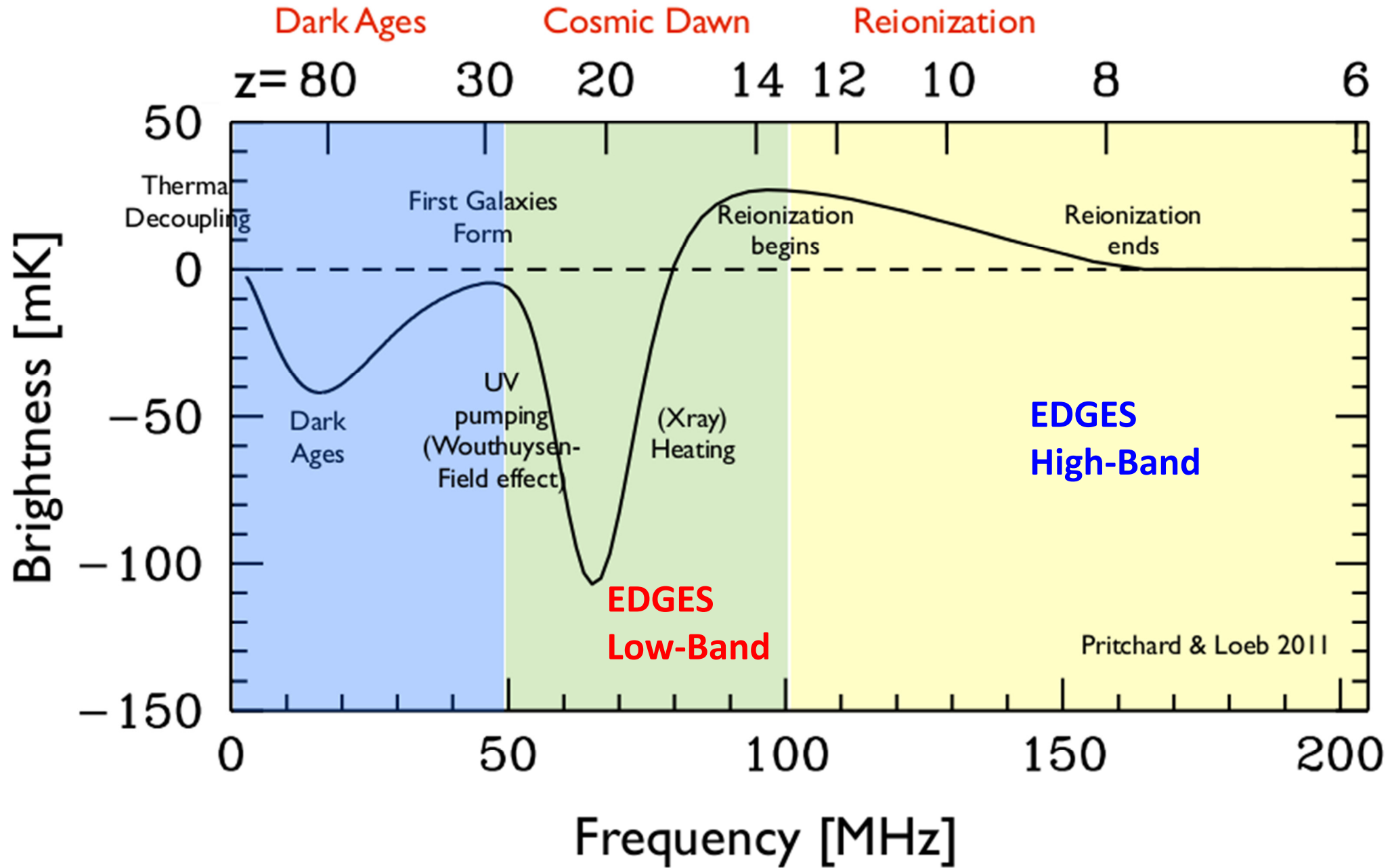
EDGES-I

- Operated Between 2008 and 2012
- Main Results:
 - Rogers & Bowman (2008): Estimate of **spectral index** of diffuse foregrounds
($\beta = 2.5 \pm 0.1$)
 - Bowman & Rogers (2010): Lower limit on the **duration of reionization**
($\Delta z > 0.06$, 95% confidence)
- Other Publications:
 - Bowman, Rogers, & Hewitt (2008): **Instrument** description

EDGES-II

- Operating between 2012 and the Present
- Main results to date:
 - Rogers, Bowman, Vierinen, Monsalve, & Mozdzen (2015):
Characterization of **Ionospheric Perturbations**
- Other Publications:
 - Monsalve, Rogers, Bowman, & Mozdzen (2016, Submitted):
Calibration of EDGES-II
 - Mozdzen, Bowman, Monsalve, & Rogers (2016):
Introduction of **Blade Wideband Antenna**
 - Rogers & Bowman (2012):
Description of **Prototype** Experiment

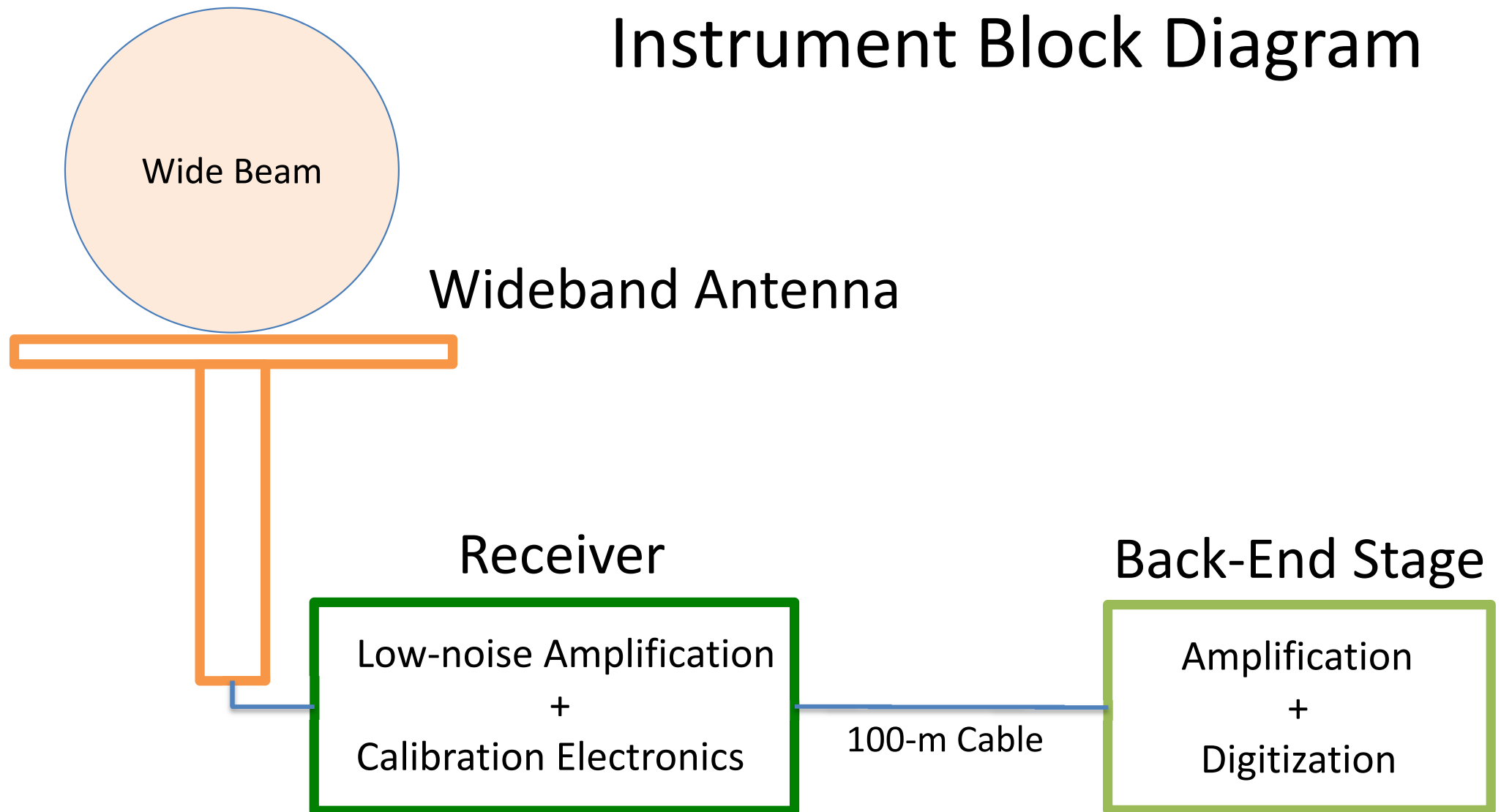
Science



Radio-Quiet Location: **Murchison, WA**



Instrument Block Diagram



Details in

[Monsalve et al. \(2016\)](#)

[arXiv:1602.08065](#)

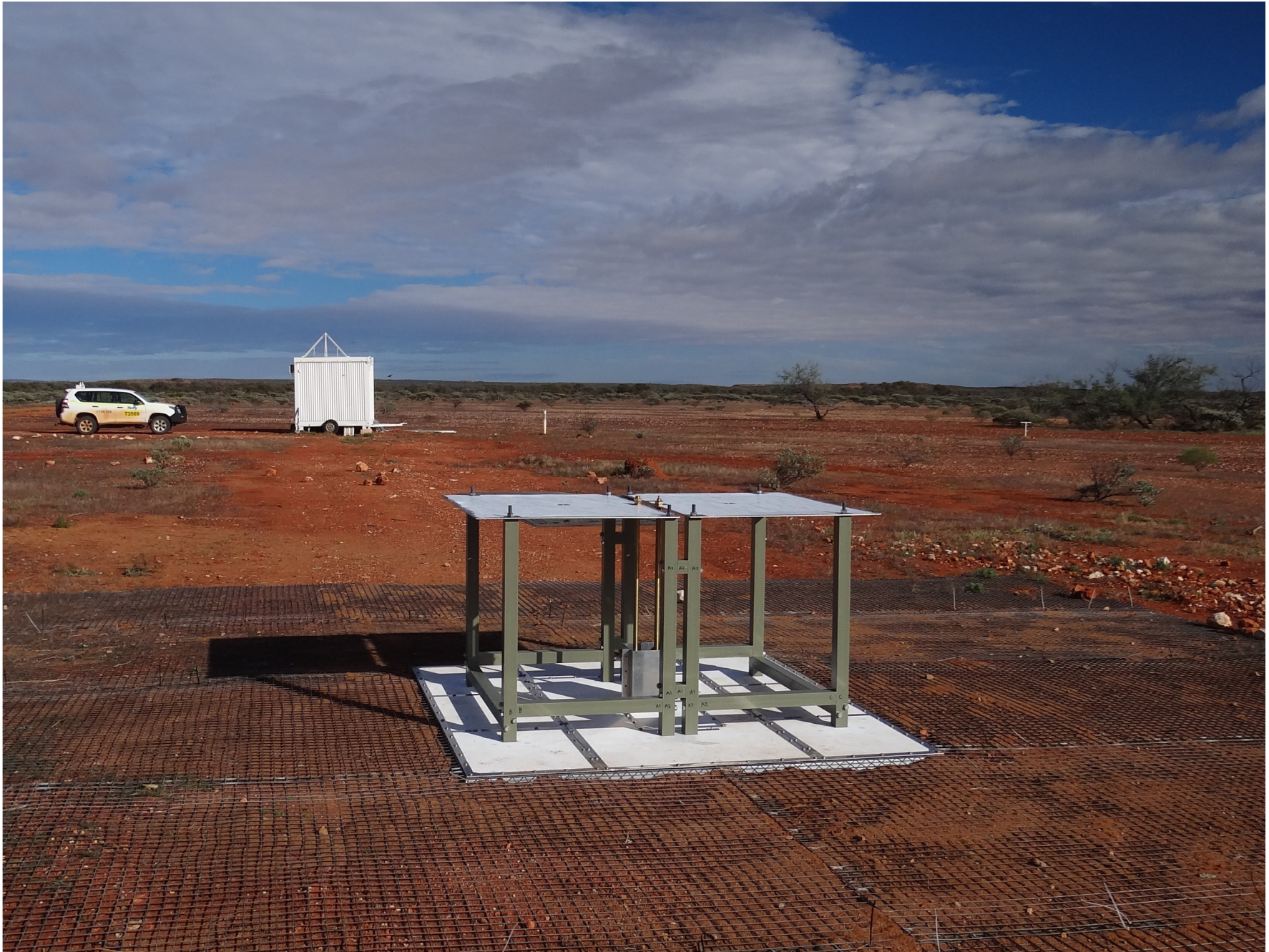
EDGES **High-Band** 2016



EDGES **High-Band** 2016



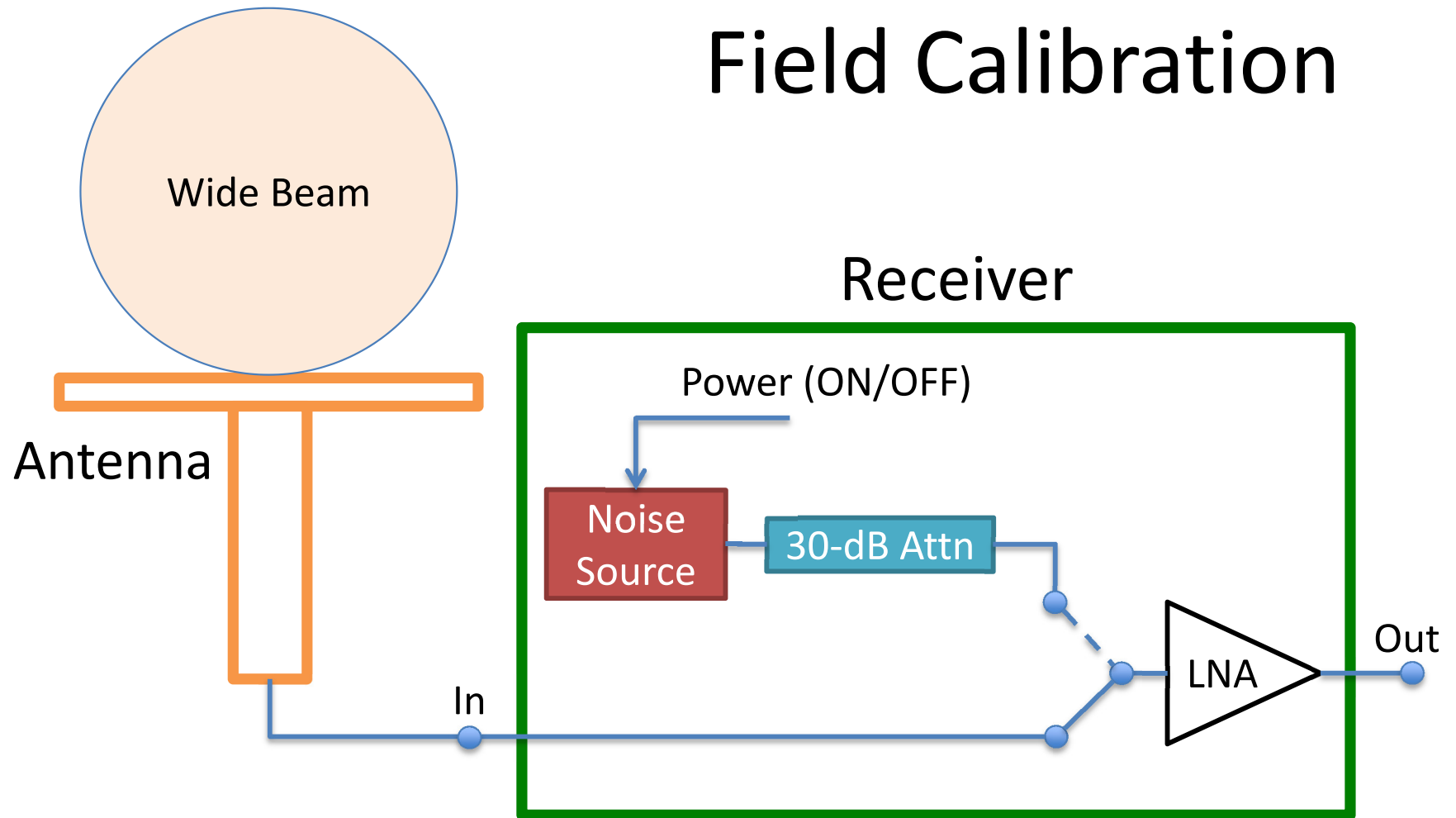
EDGES **Low-Band** 2016



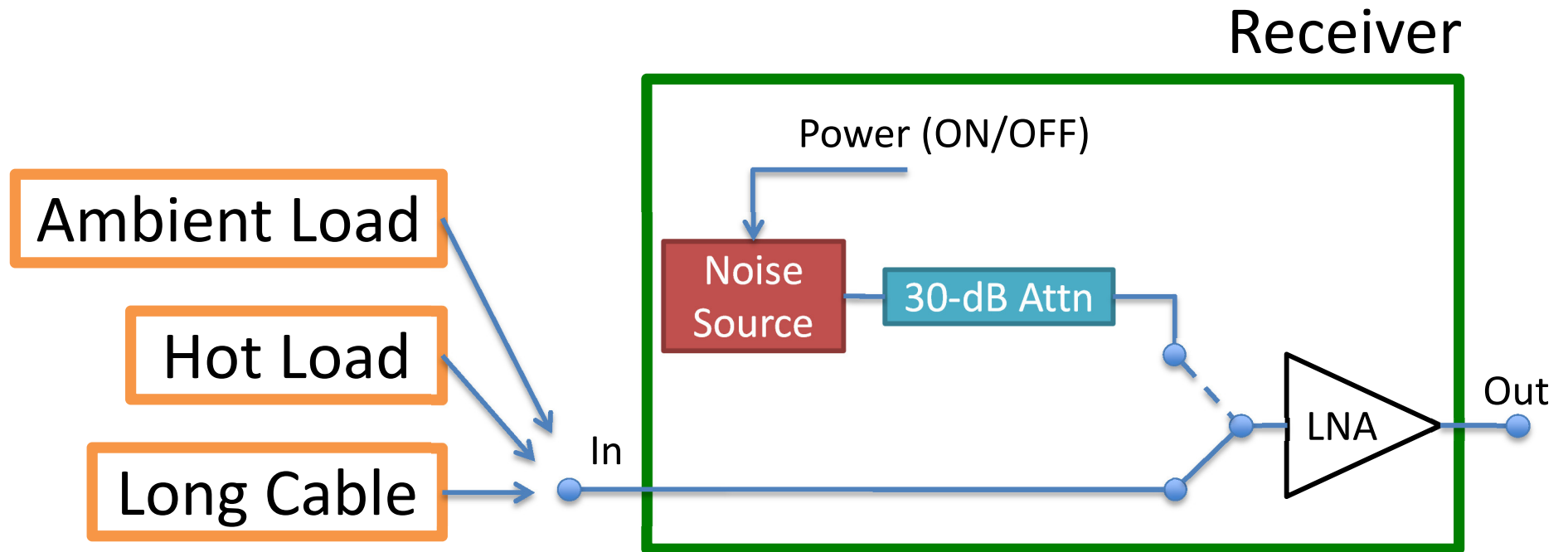
Representative of Local Fauna



Field Calibration



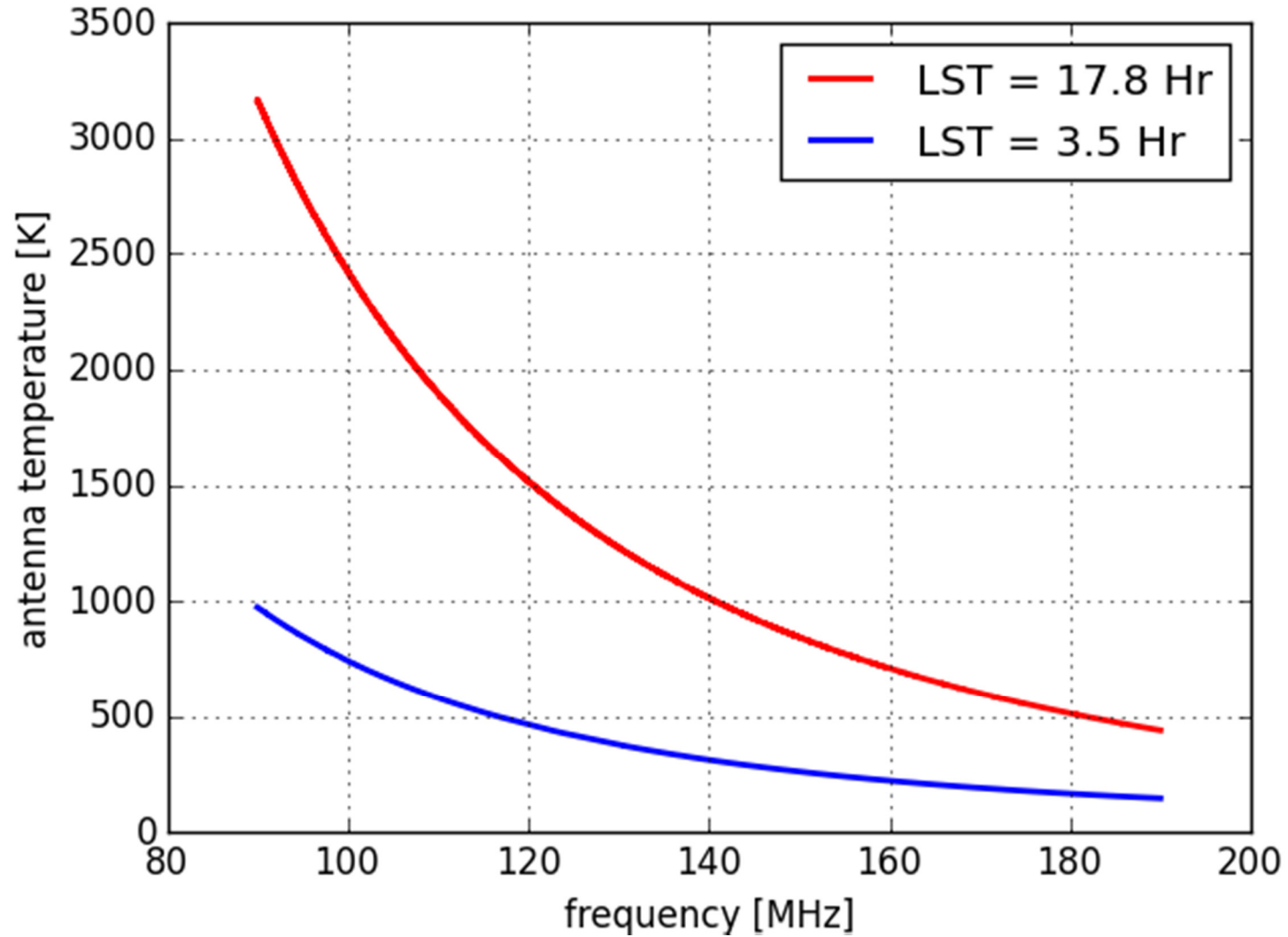
Absolute Lab Calibration



Preliminary Results

EDGES High-Band

Foreground Spectral Index



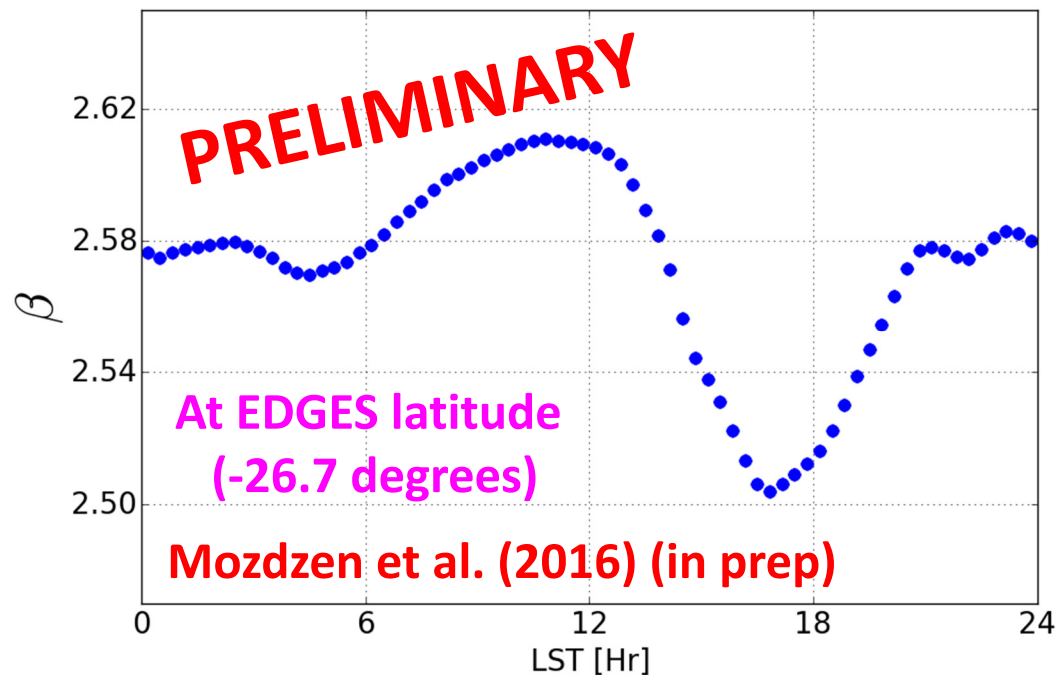
Foreground Spectral Index

Beam from simulations

$$T_{\text{ant}}(\nu) = \int T_{\text{sky}}(\nu, \theta) \cdot \text{Beam}(\nu, \theta) \cdot d\Omega$$

Spatial template from
Haslam et al. (1982)

$$\log(T_{\text{sky}}(\nu)) = \log T_o - \beta \cdot \log \nu - \gamma \cdot (\log \nu)^2$$



Previous Result from EDGES:

$$\beta = 2.5 \pm 0.1$$

(Rogers & Bowman, 2008, AJ)

Comprehensive Modeling

$$T_{\text{ant}}(\nu) = \text{“Baseline” Model} + \text{EoR Model}$$

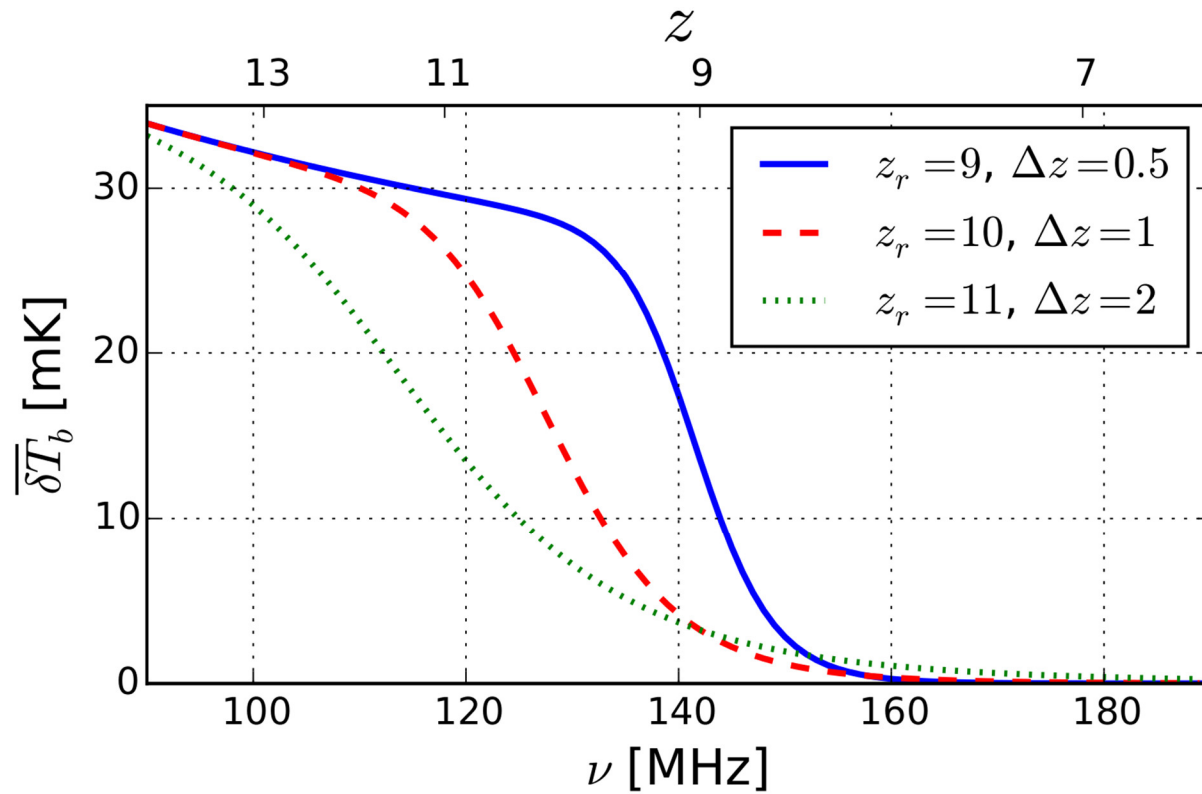


(Beam) + Foregrounds + Ionosphere + Calibration Residuals

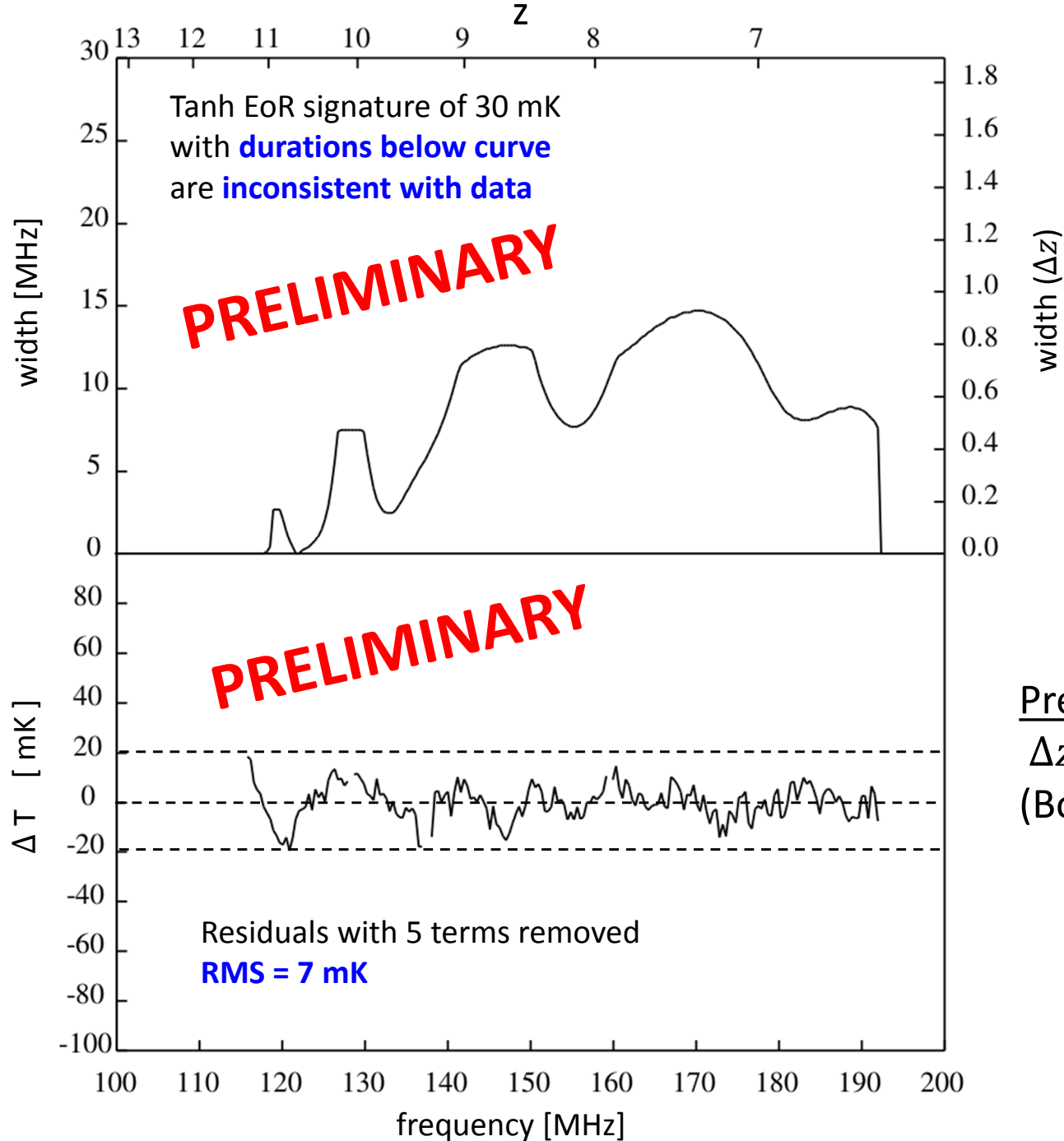
$$\text{Baseline Model} = \nu^{-2.5} [a_0 + a_1(\log \nu) + a_2(\log \nu)^2 + a_3\nu^{-2.0} + a_4\nu^{0.5}]$$

EoR Model

$$\overline{\delta T_b}(z) = \frac{T_{21}}{2} \cdot \sqrt{\frac{z+1}{10}} \cdot \left[\tanh\left(\frac{z-z_r}{\Delta z}\right) + 1 \right]$$



Current EoR Rejection Results

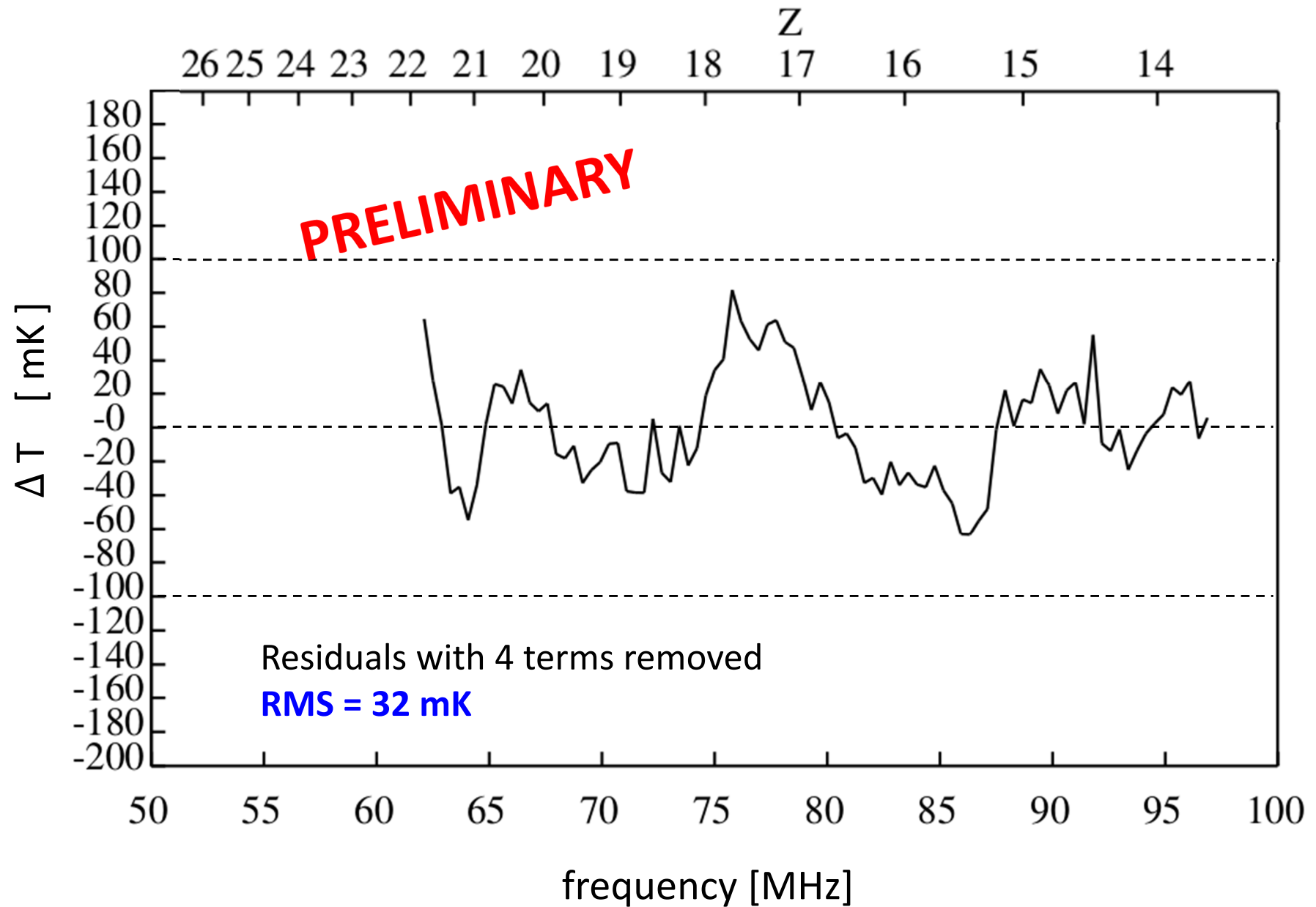


Previous Result from EDGES:
 $\Delta z > 0.06$, 95% confidence
(Bowman & Rogers, 2010, NATURE)

Preliminary Results

EDGES Low-Band

Current Low-Band Residuals



Status and Summary

- **220 days** of observation with the current-generation **High-Band** instrument.
- **140 days** of observation with current-generation **Low-Band** instrument.
- **Continue** taking data.
- **Statistical sensitivity sufficient for detection. Working on understanding systematics.**
- Achieving residuals of **7 mK** for the **High-Band** and **32 mK** for with the **Low-Band** systems, over wide fractions of the bands, **after data selection and baseline removal.**
- Preparing to **rule out EoR durations $\Delta z < 1.0$** for certain ranges of reference redshifts. Factor of **~ 10 improvement** wrt results from 2010.
- Also preparing to **rule out other extreme** cosmological **scenarios** suggested in the literature.
- Despite obvious challenges, **EDGES represents an effective and cost-effective** experiment considering the potential scientific return.
- Joint ASU/Haystack **NSF proposal** has been **submitted** to fund EDGES for another three years.

Thank You

Backup Slides

Calibration Equations

Uncalibrated Antenna Temperature:

T^* : From **Internal Hot/Cold** Calibration

Calibrated Antenna Temperature:

$$T_{ant} = (C_1 T^* + C_2) K_B - T_U K_U - T_C K_C - T_S K_S$$

K_B, K_U, K_C, K_S

Encode **Reflections** between
Antenna and Receiver

C_1, C_2, T_U, T_C, T_S

Calibration quantities obtained from
Lab Measurements