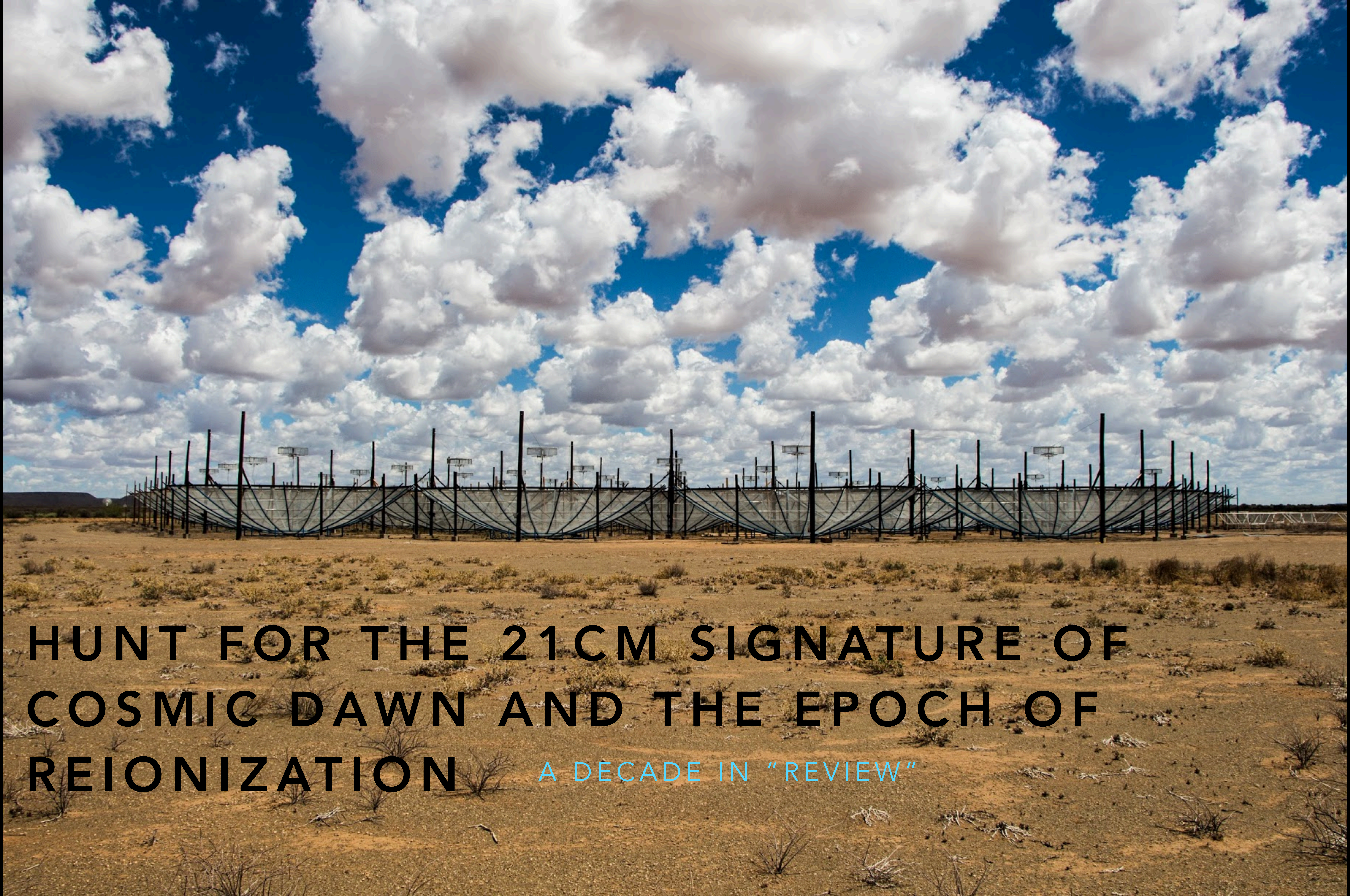


HUNT FOR THE 21CM SIGNATURE OF COSMIC DAWN AND THE EPOCH OF REIONIZATION

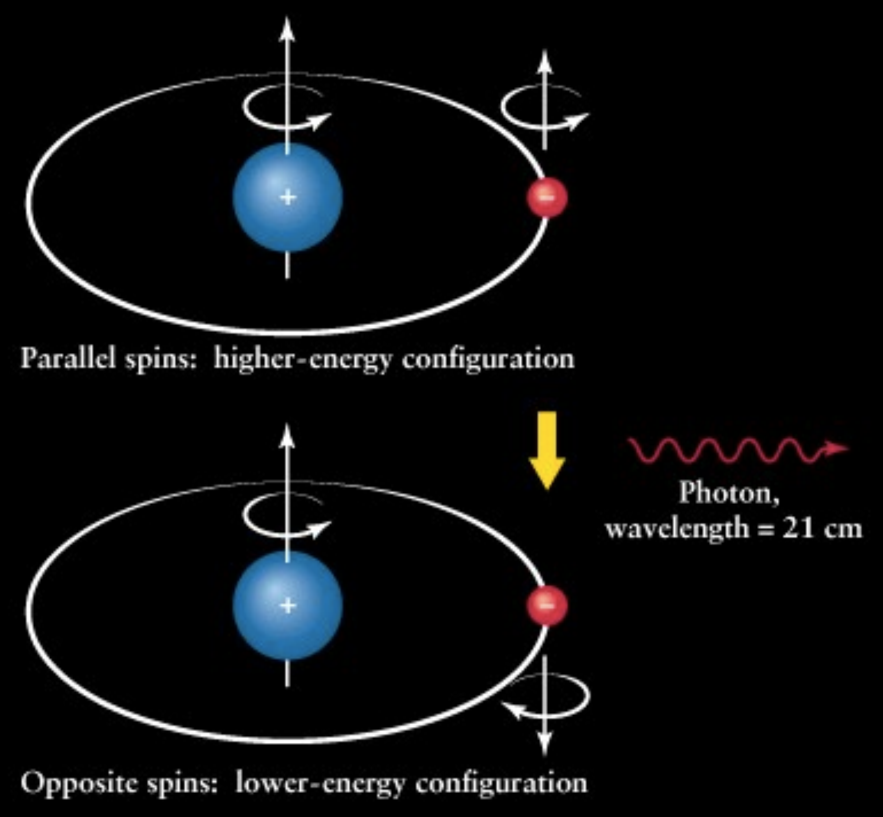
A DECADE IN "REVIEW"

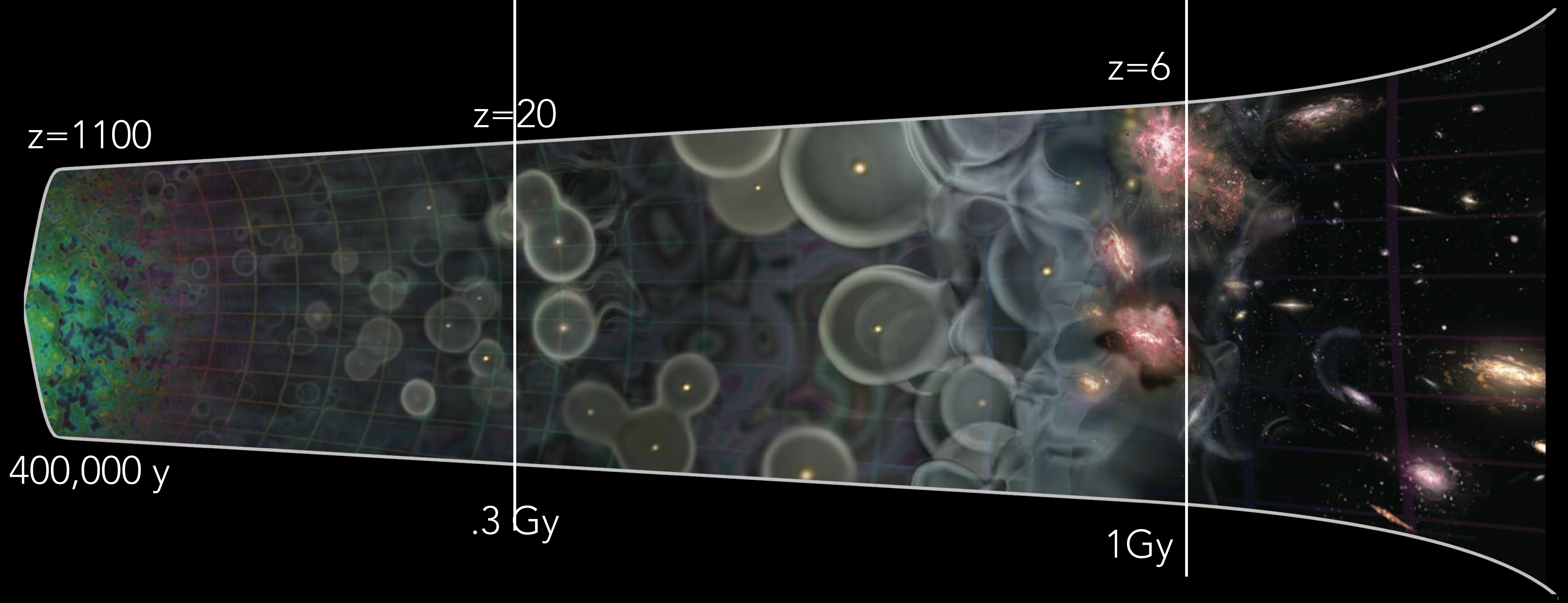
The Many Ages of Neutral Hydrogen

Pre-Reionization
First stars activate 21cm line with Lyalpha
Visible in absorption

Reionization
Tau, As, $\sum m_\nu$,
first galaxies, supermassive blackholes

Post-Reionization
dark energy equation of state



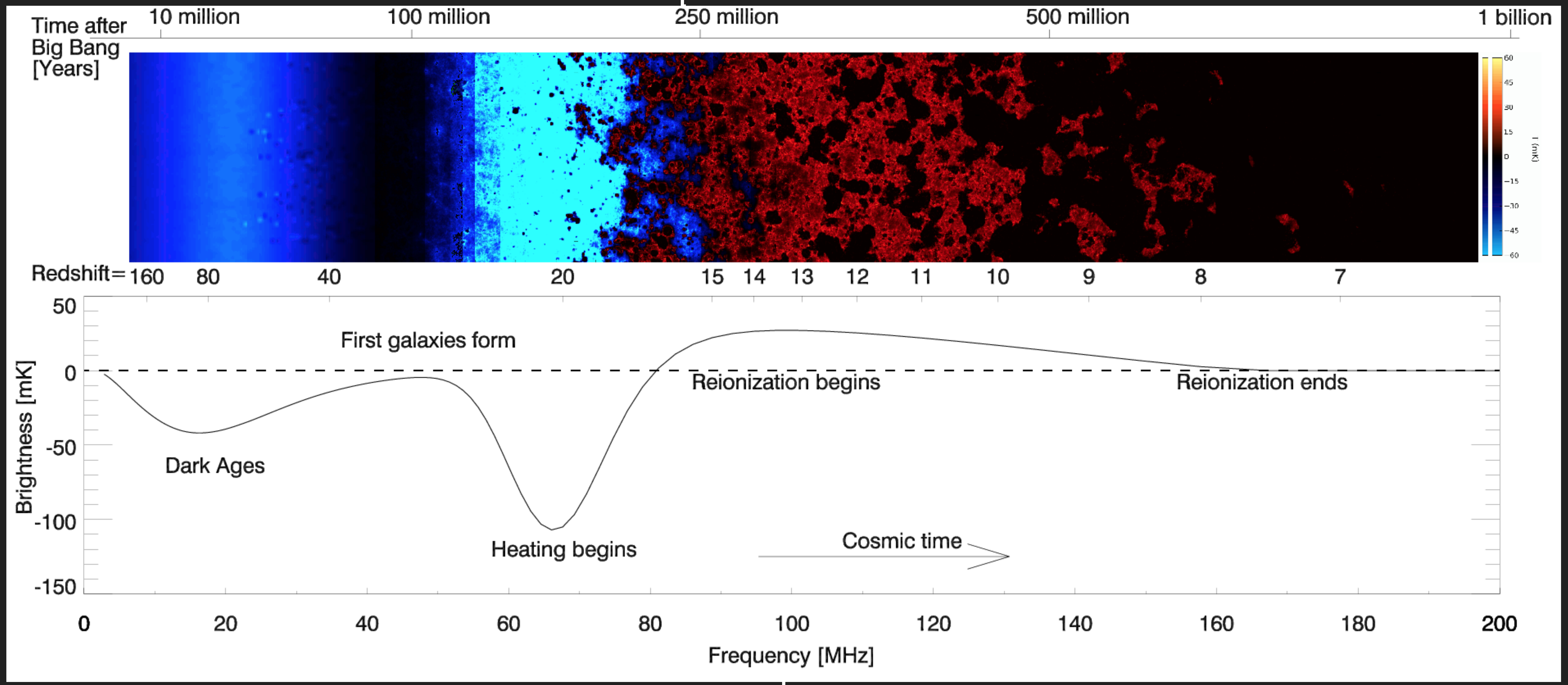


reionization.org

danielcjacobs.com

Observables

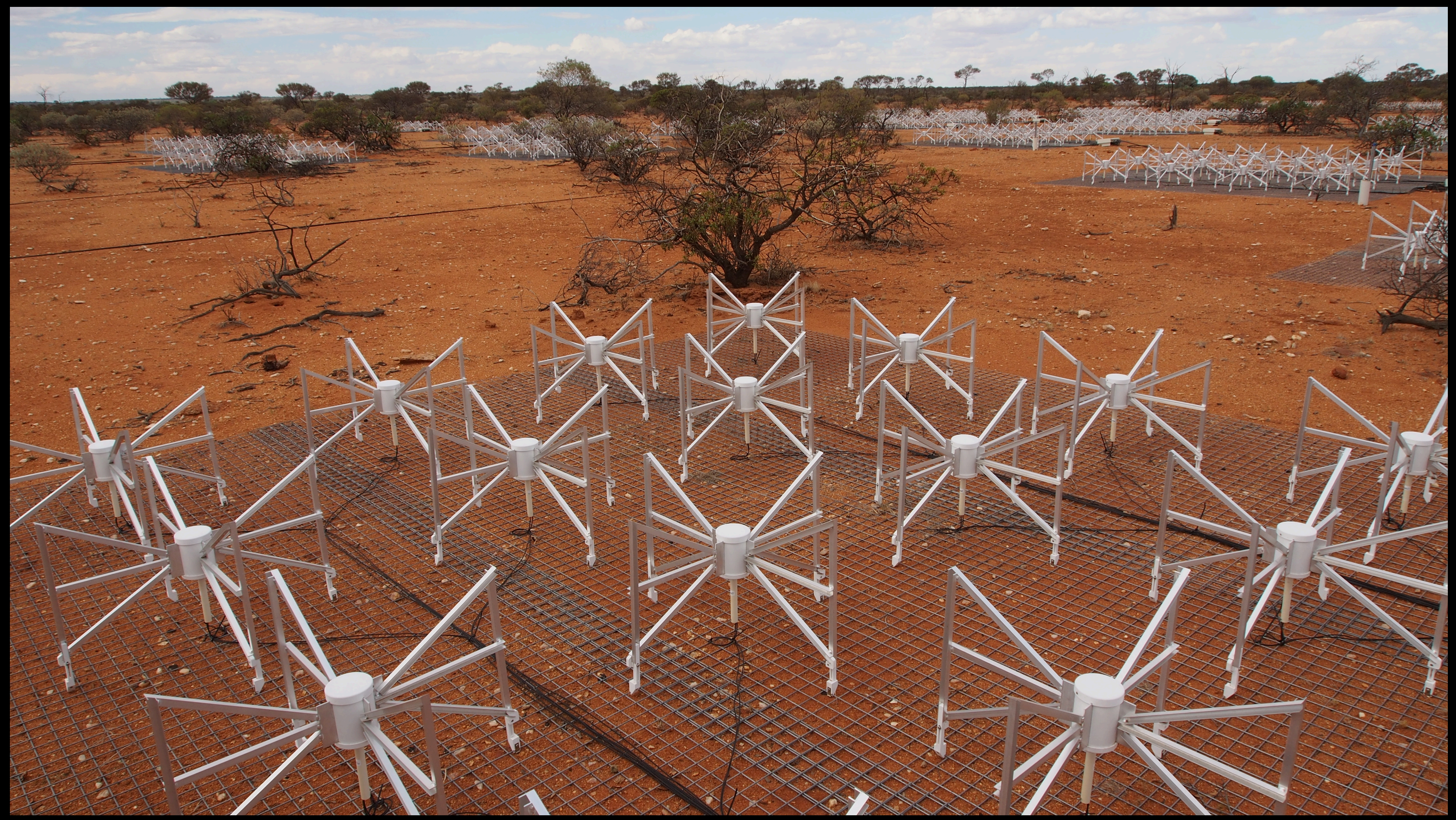
Fluctuations



Total Power

2010-2020 Completed instruments with 21cm results

PAPER 2007-2015



MWA 2012-2016 (Phase I)
2016-2020 (Phase II)

GMRT 2010-2020
2018 (upgrade)

EDGES EDGES1 2007-2012
EDGES2 2012-2018
EDGES3 2018-2022

LOFAR 2011- 2020

reionization.org

LEDA / OV-LWA 2015-2017
Upgraded 2020

SARAS2 2018

LWA NM #1 2011-2020
SV 2017-2020

PRIZM 2018

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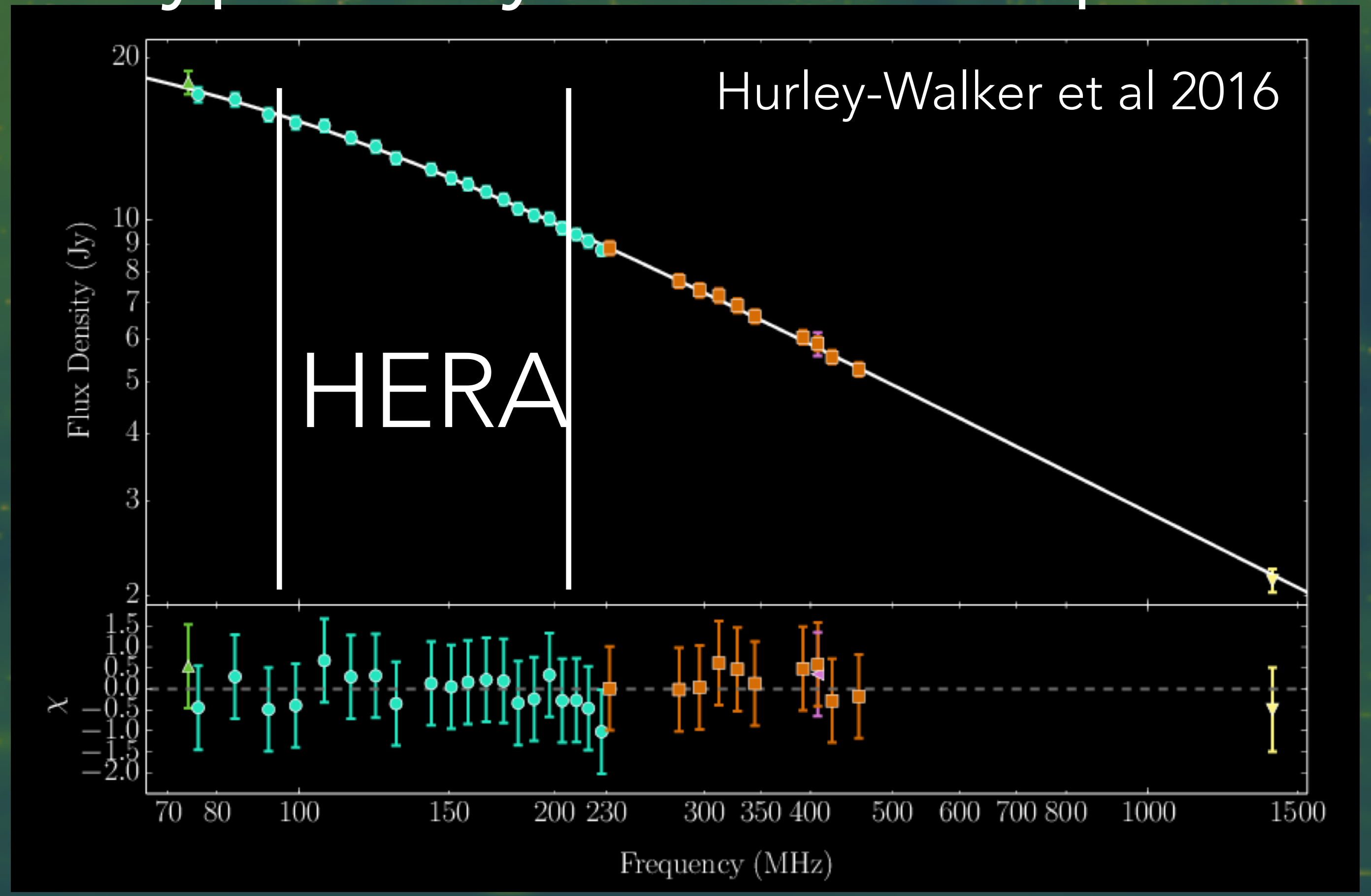
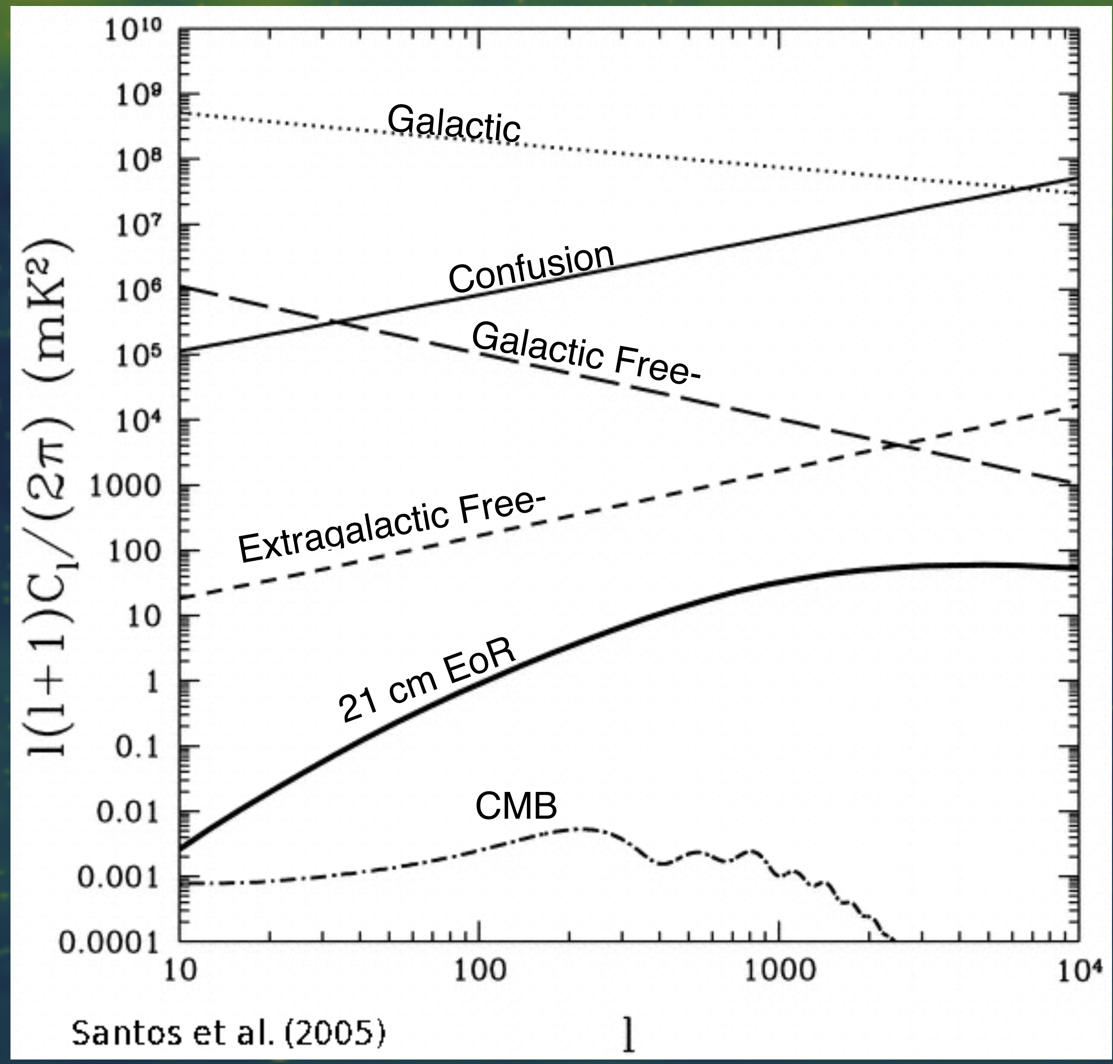
Foregrounds

A typical synchrotron spectrum

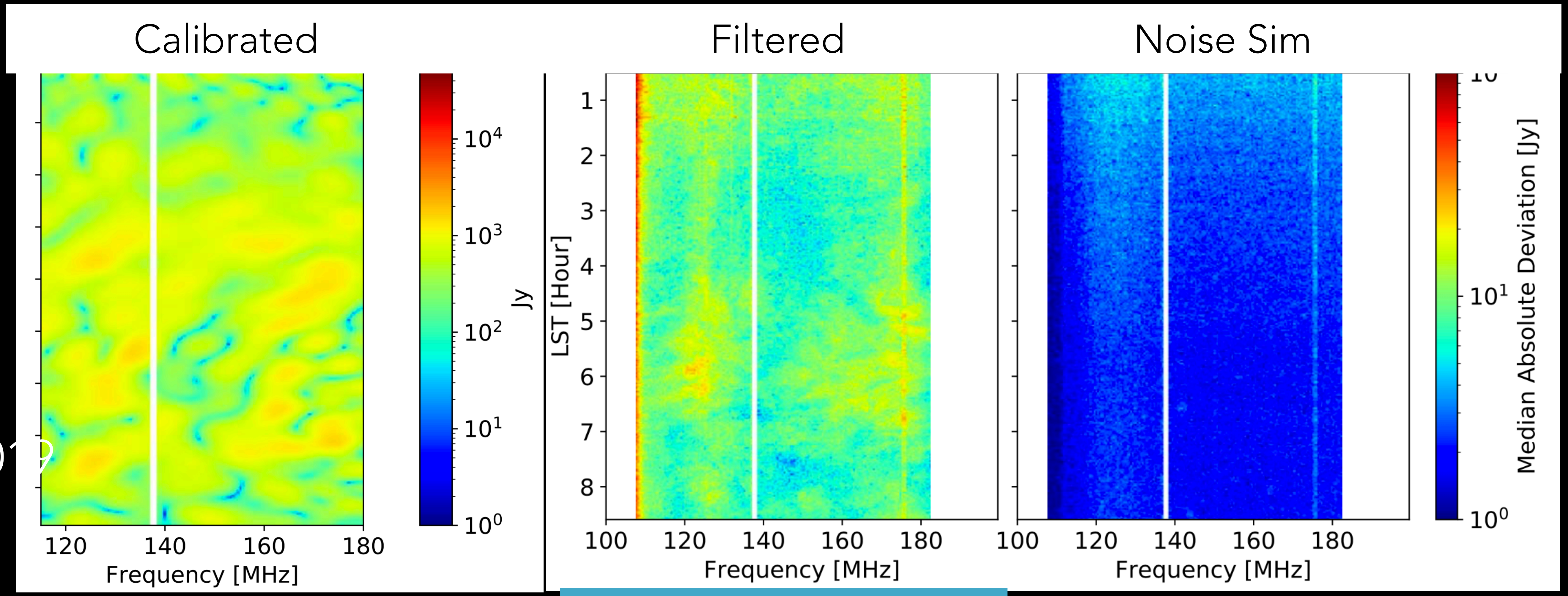




Bright, but smooth spectrum

NAME OF THE GAME: SPECTRAL DYNAMIC RANGE

PAPER
SDR - 100-1000
Kolopanis et al 2019



SINGLE BASELINE

LOFAR
SDR ~ 25
Mertens et al 2020

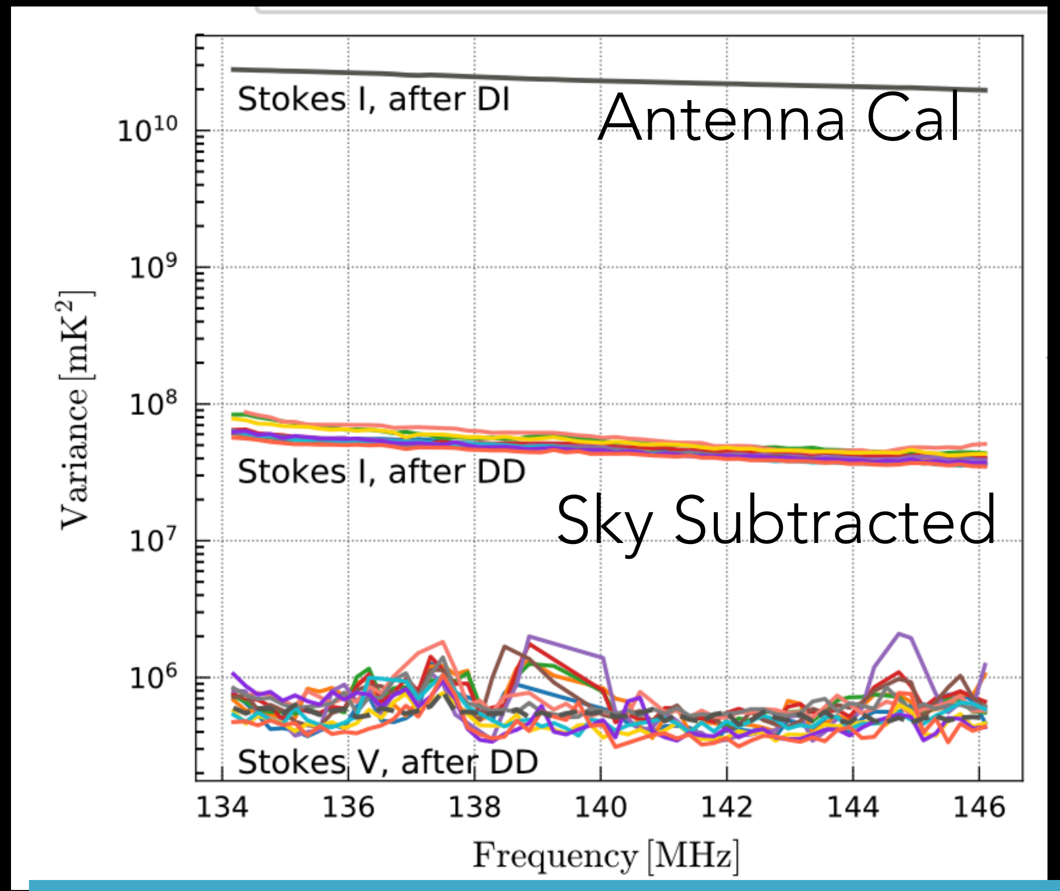
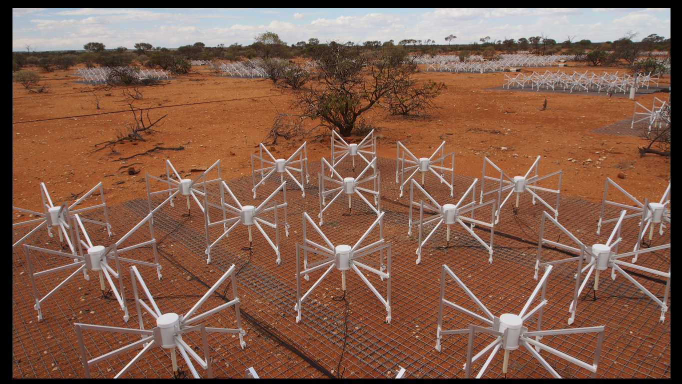


IMAGE PLANE VARIANCE

MWA
SDR - 8-16
Beardsley et al 2016
Barry et al 2019



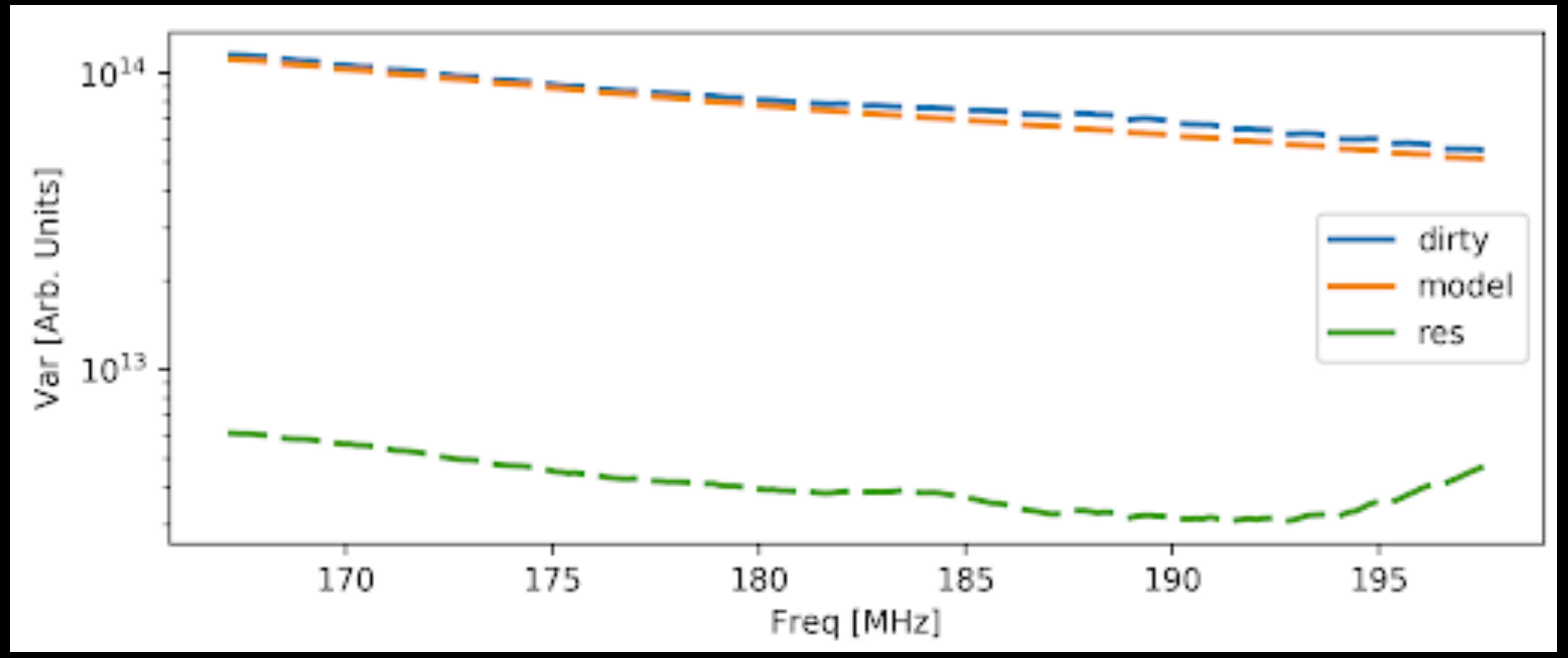
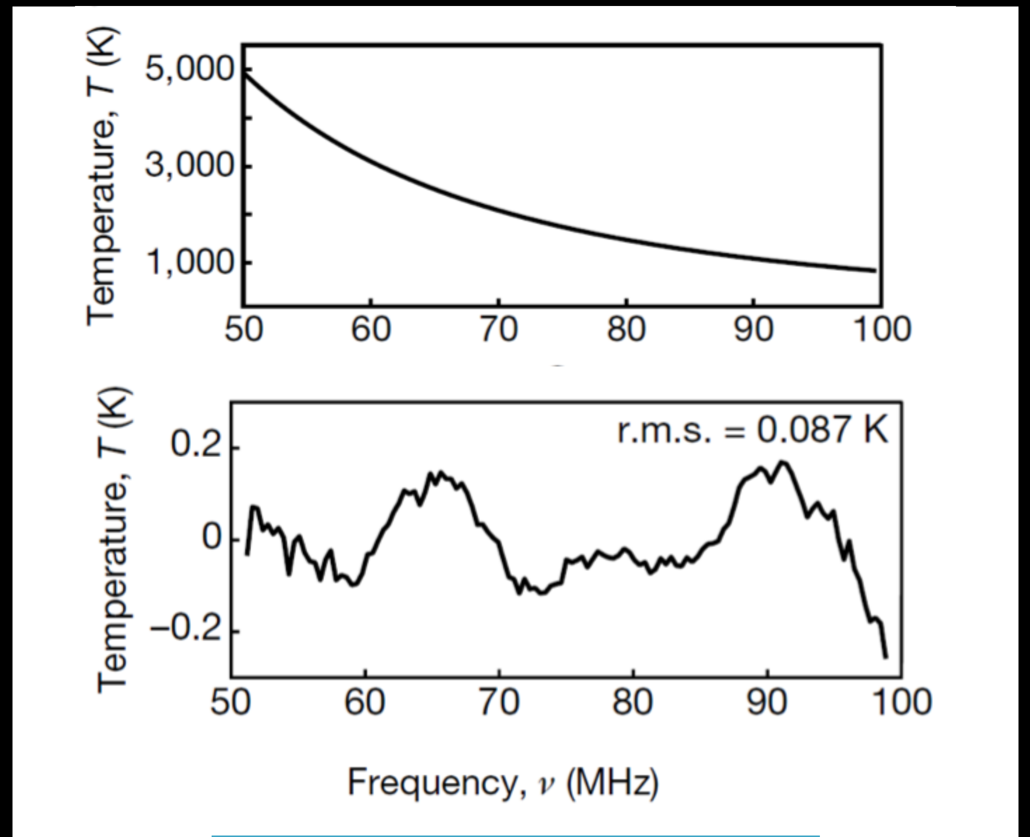


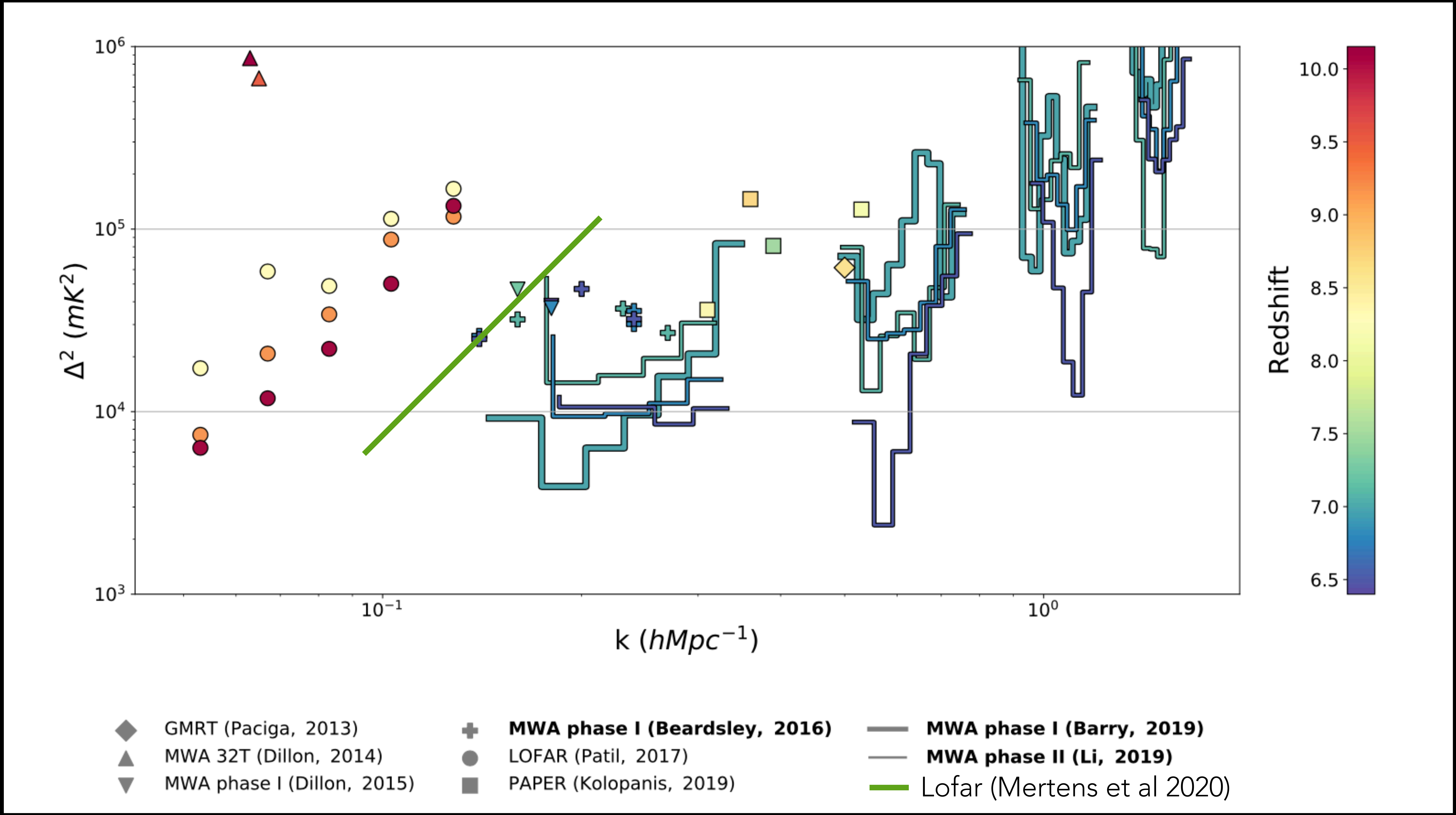
IMAGE PLANE VARIANCE



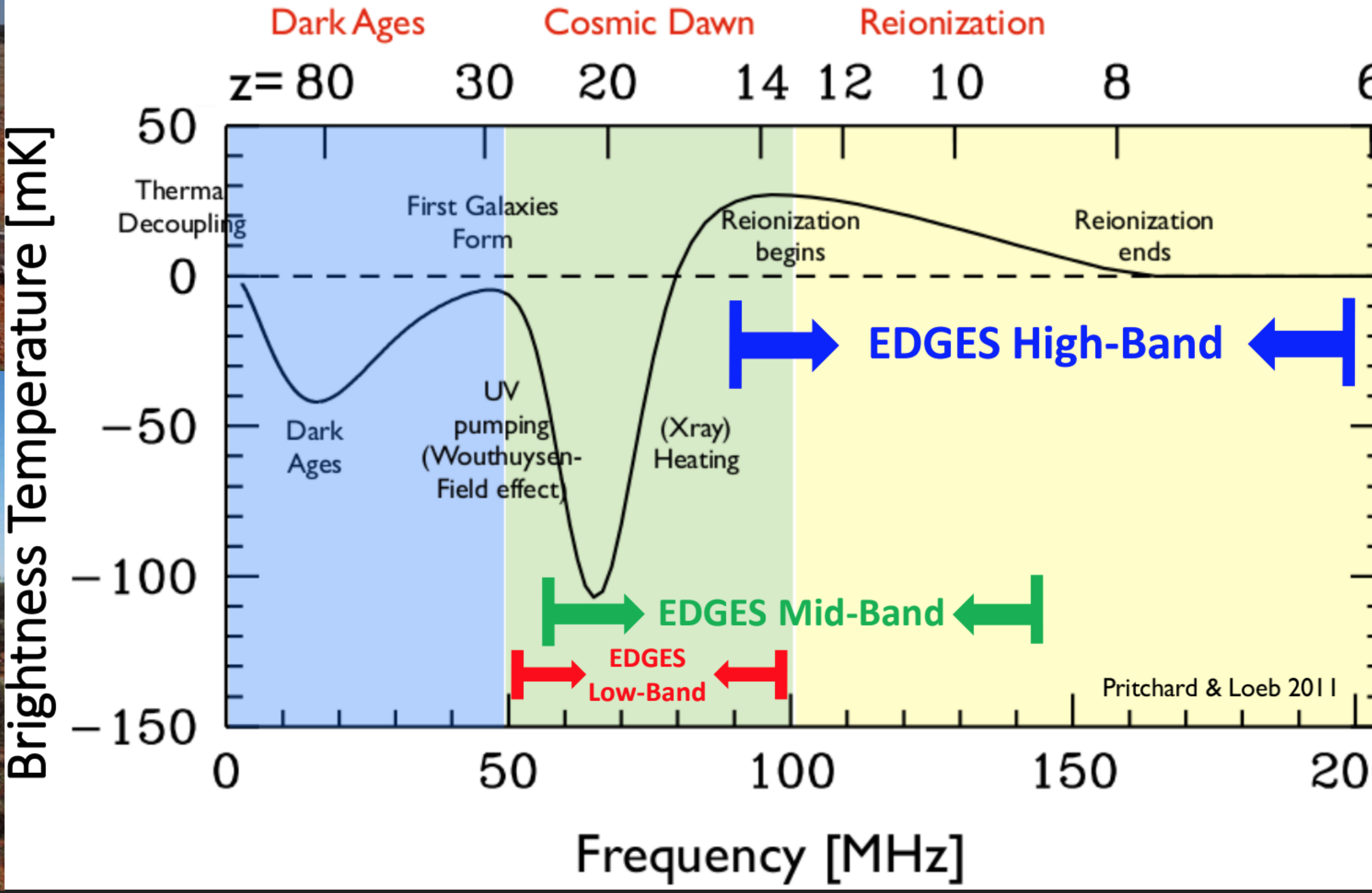
TOTAL POWER

EDGES
SDR - 15000!
Bowman et al 2018

TARGET DYNAMIC RANGE TO SPECIFIC MODES



EDGES Instruments

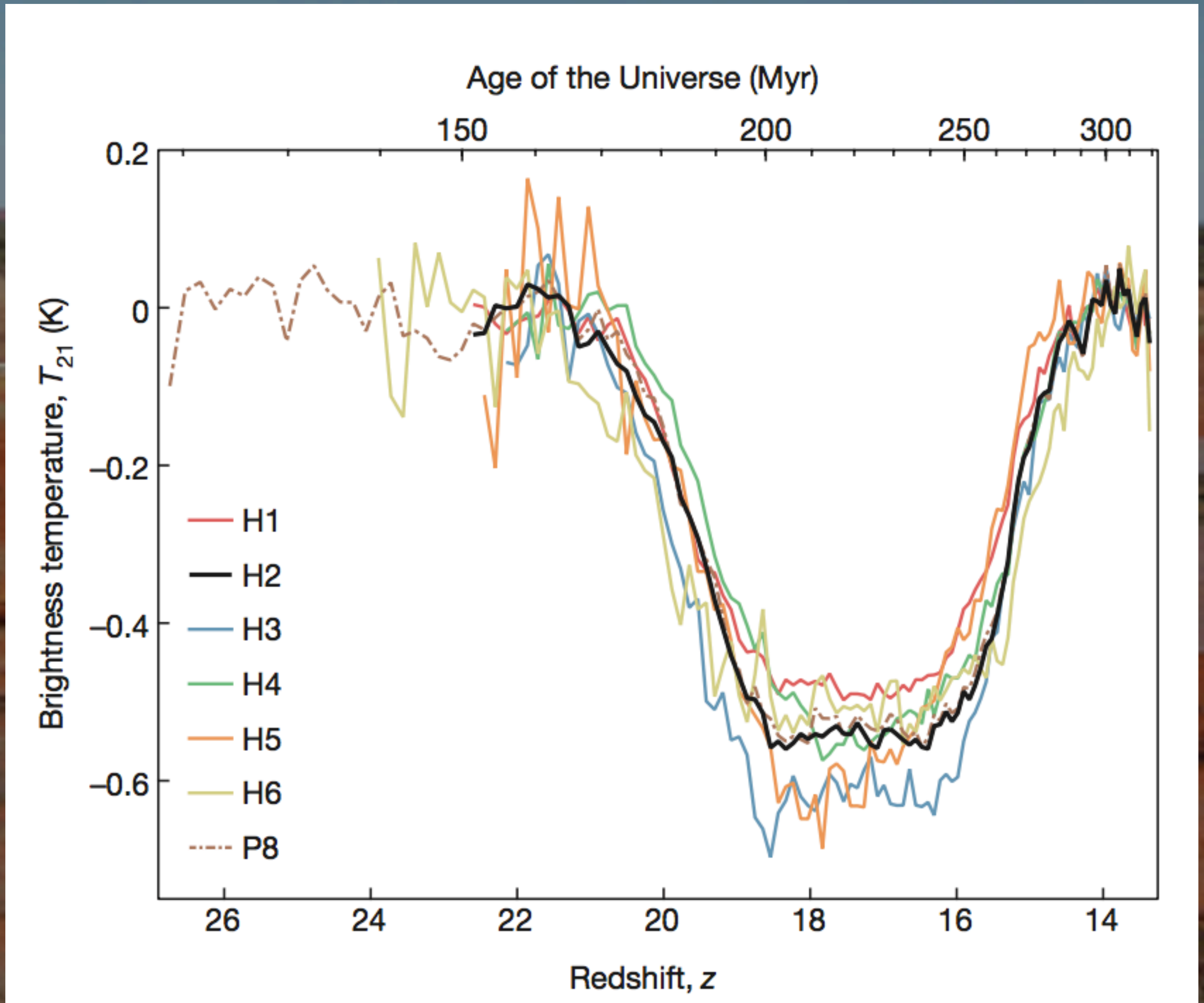


Memo Series and Data Releases @ loco.lab.asu.edu/edges

EDGES

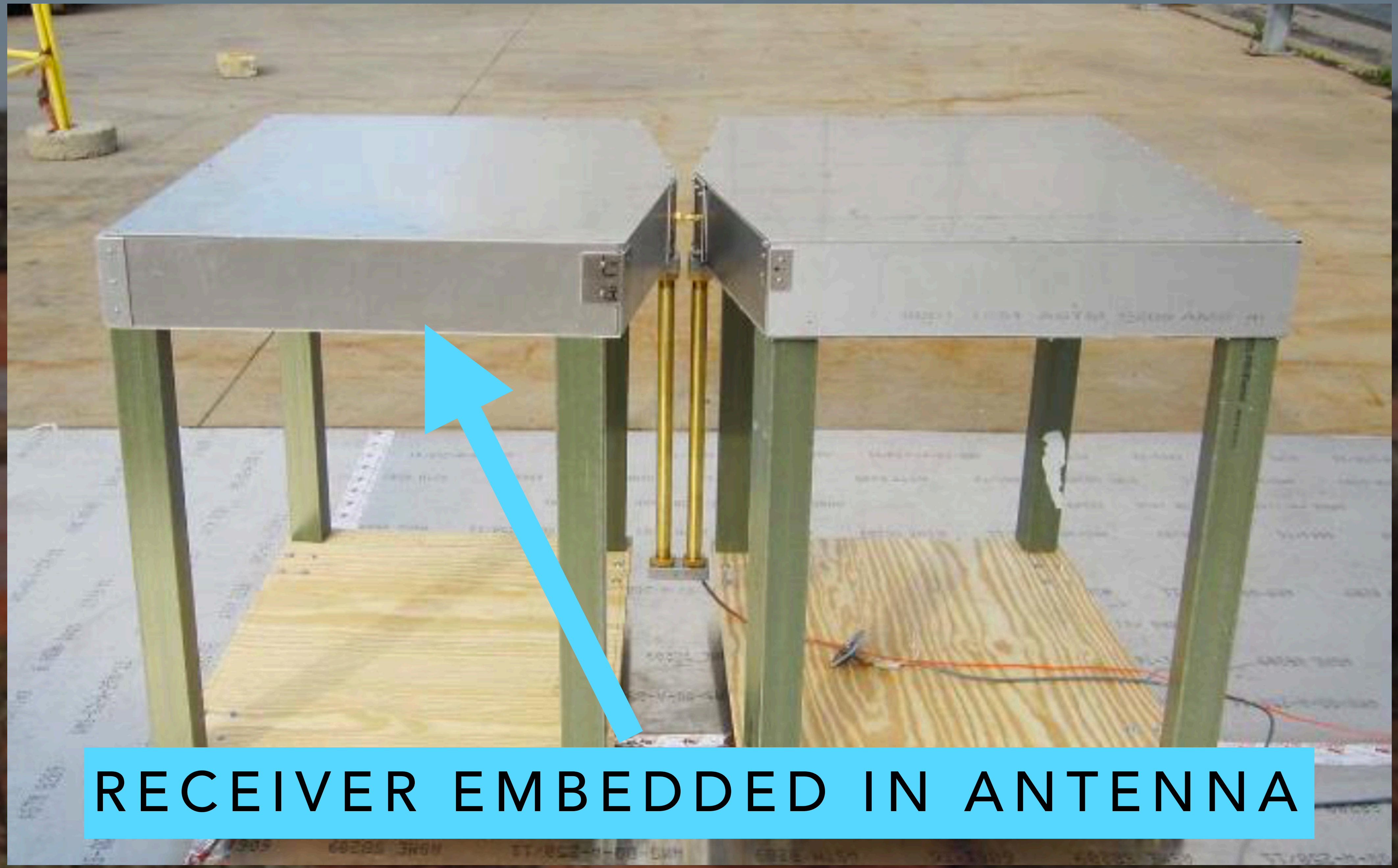
March 2018, Nature 555, 67

Bowman, Rogers, Monsalve, Mozdzen, Mahesh

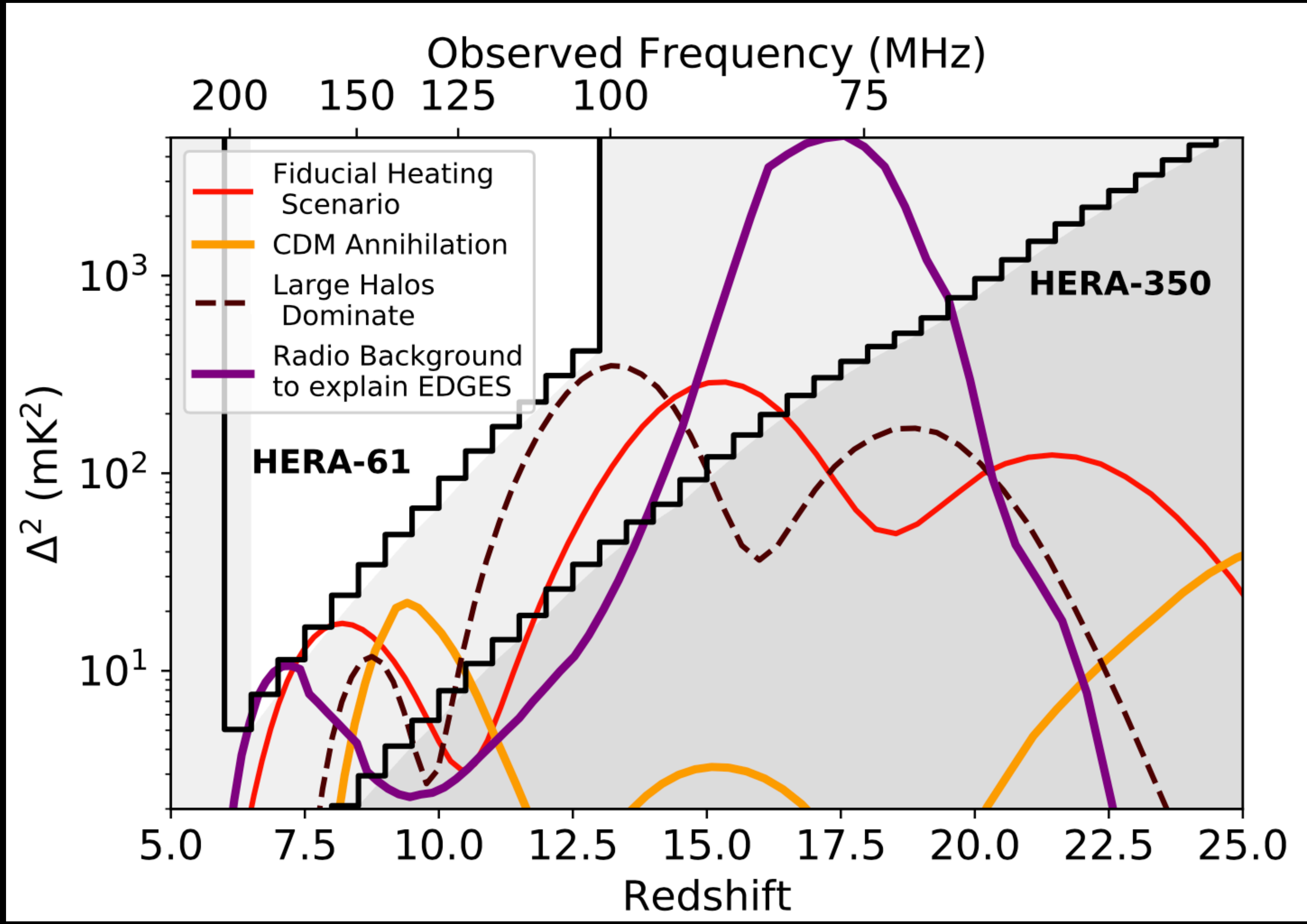


Current work

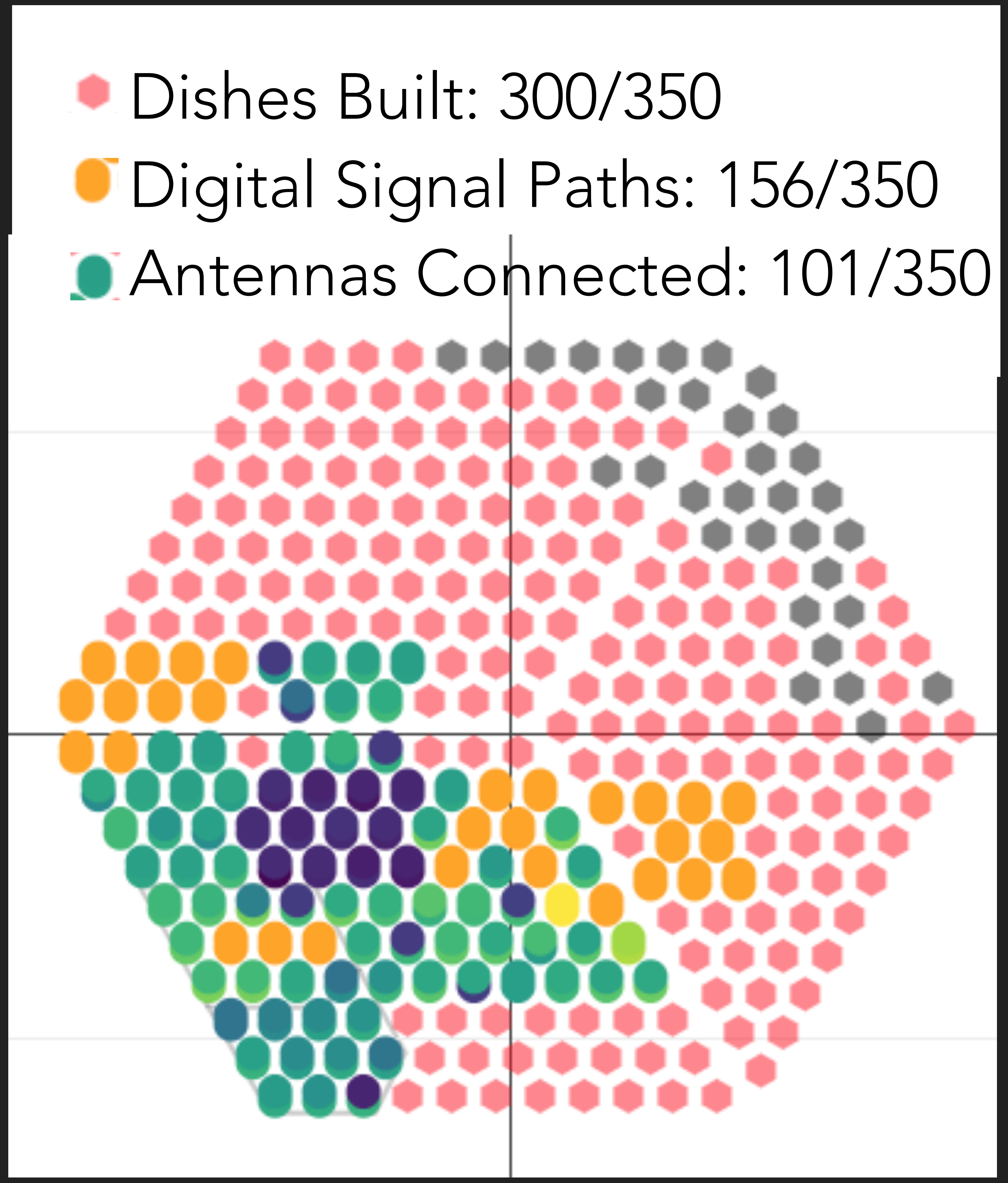
- Automating lab calibration
- Mid-band verification
- EDGES3



FLUCTUATIONS CAN HELP DISCRIMINATE MODELS

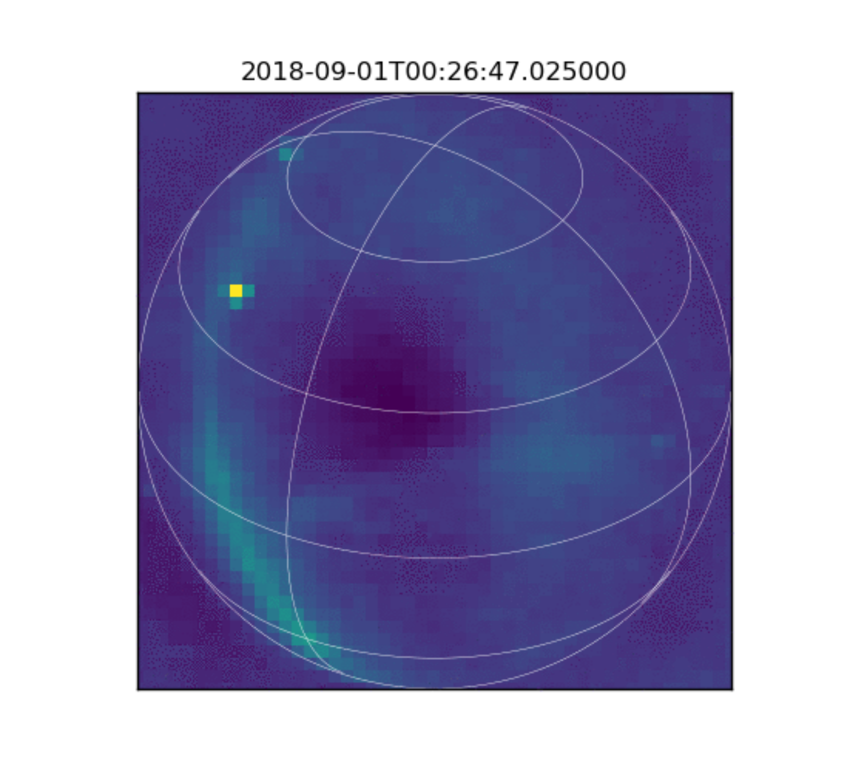


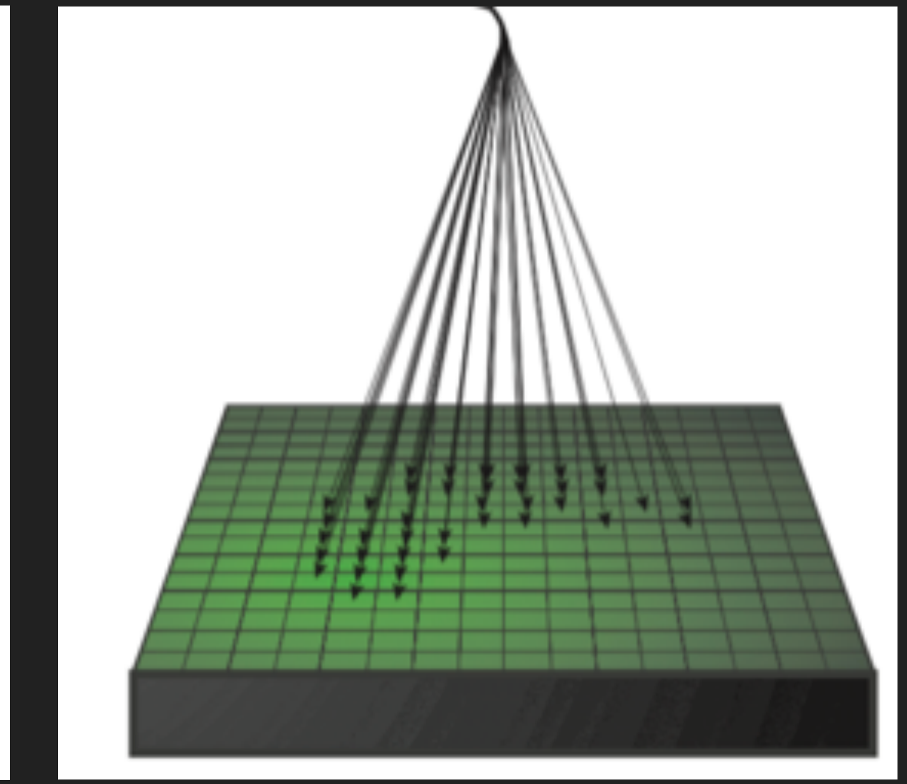
HERA Status Feb 2020



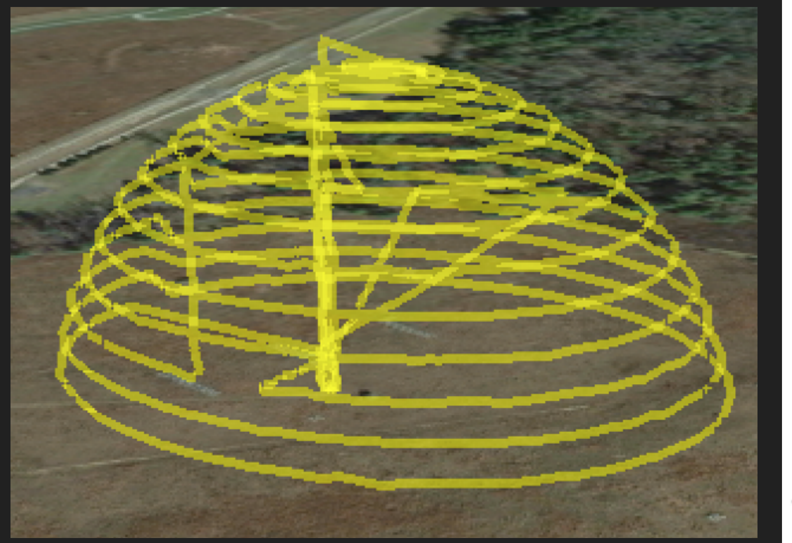
The Future

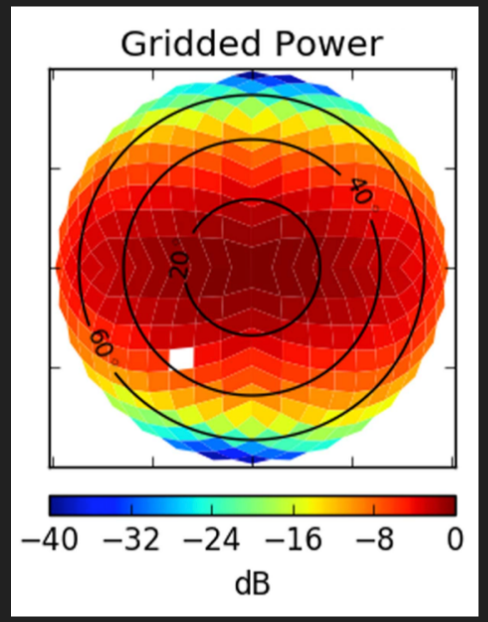
EPIC: correlate 10k antennas to get ultradense UV sampling



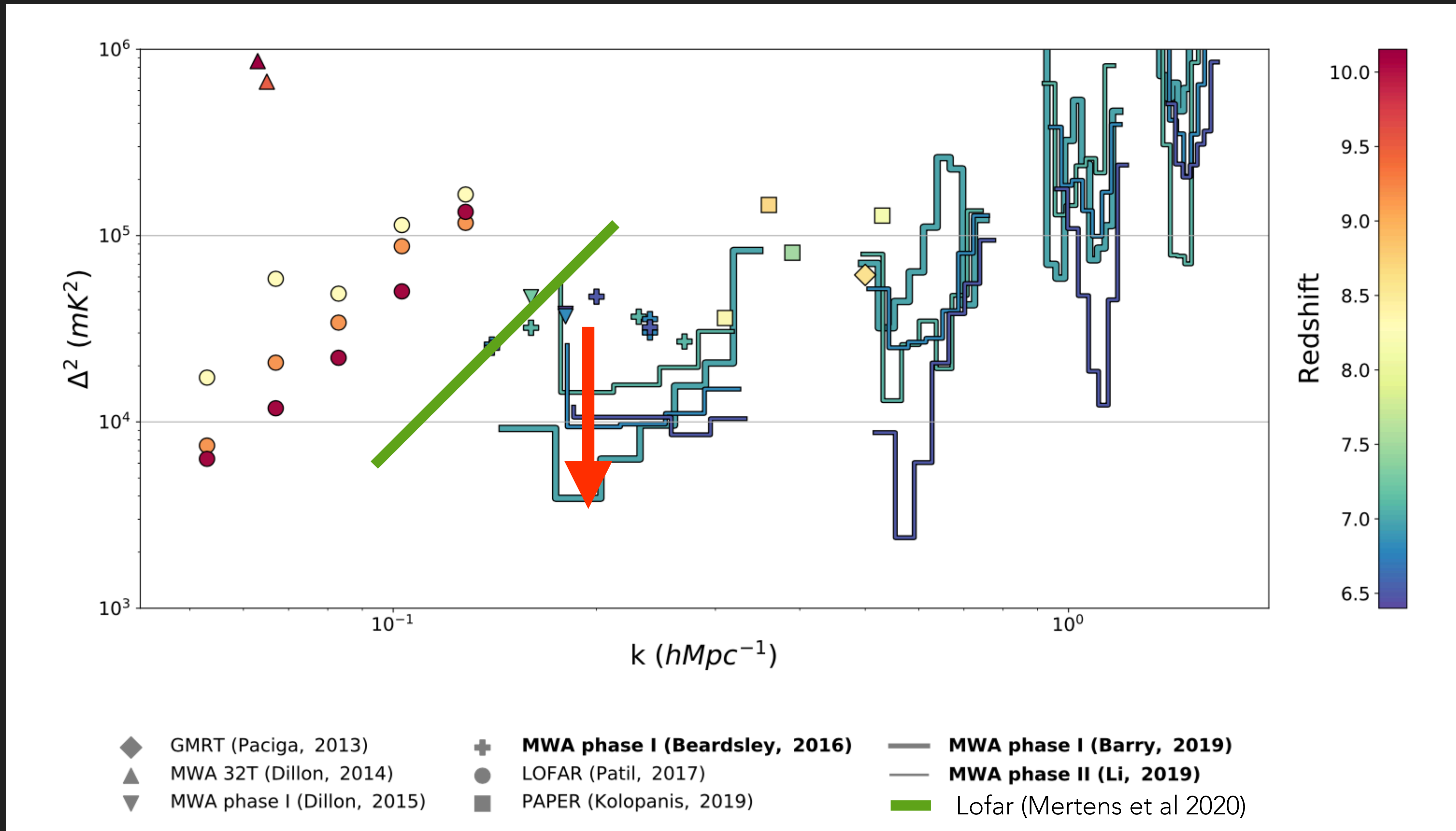


Better measure instrument properties, eg with ECHO drone system





More accurate calibration and imaging, better model subtle instrument effects



Technologies

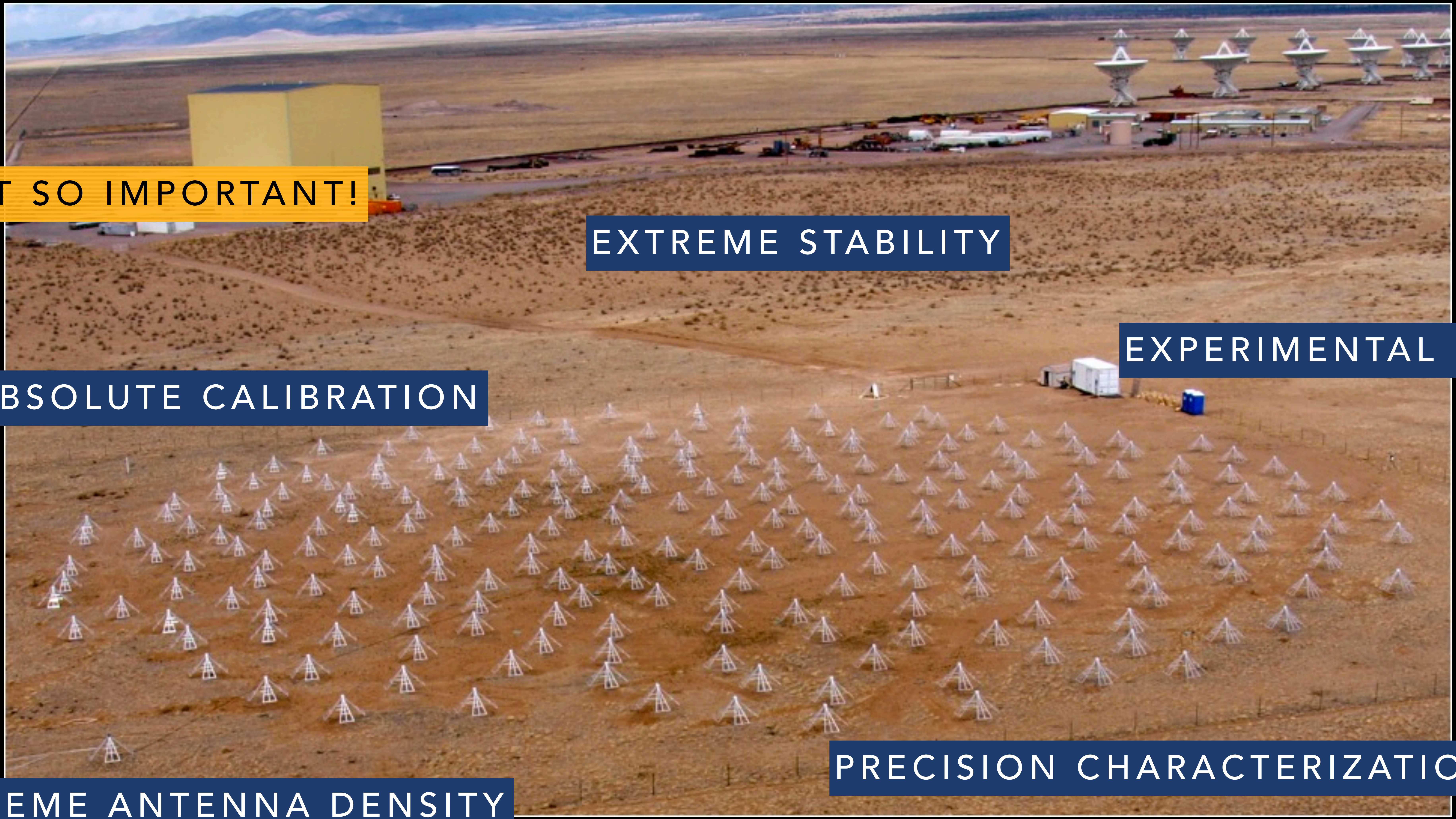
Analysis

THINKING ABOUT THE FUTURE

- reionization imaging (JWST, ALMA,
- intensity mapping cross correlation)
- dark ages power spectrum
- Neutrino mass etc

Science Goal	Requirements
Imaging	No wedge
Cross correlation	Steerable field of view, scale matching
CMB lensing	Visible sky imaging, Full Scale matching
Neutrino Mass	(see CMB)
Reionization	100-200MHz
Dark Ages	50-100MHz

BASIC DESIGN REQUIREMENTS



BASIC DESIGN REQUIREMENTS