Cosmology:
the Cosmic Dawn and Epoch of Reionization

Xiang-Ping Wu

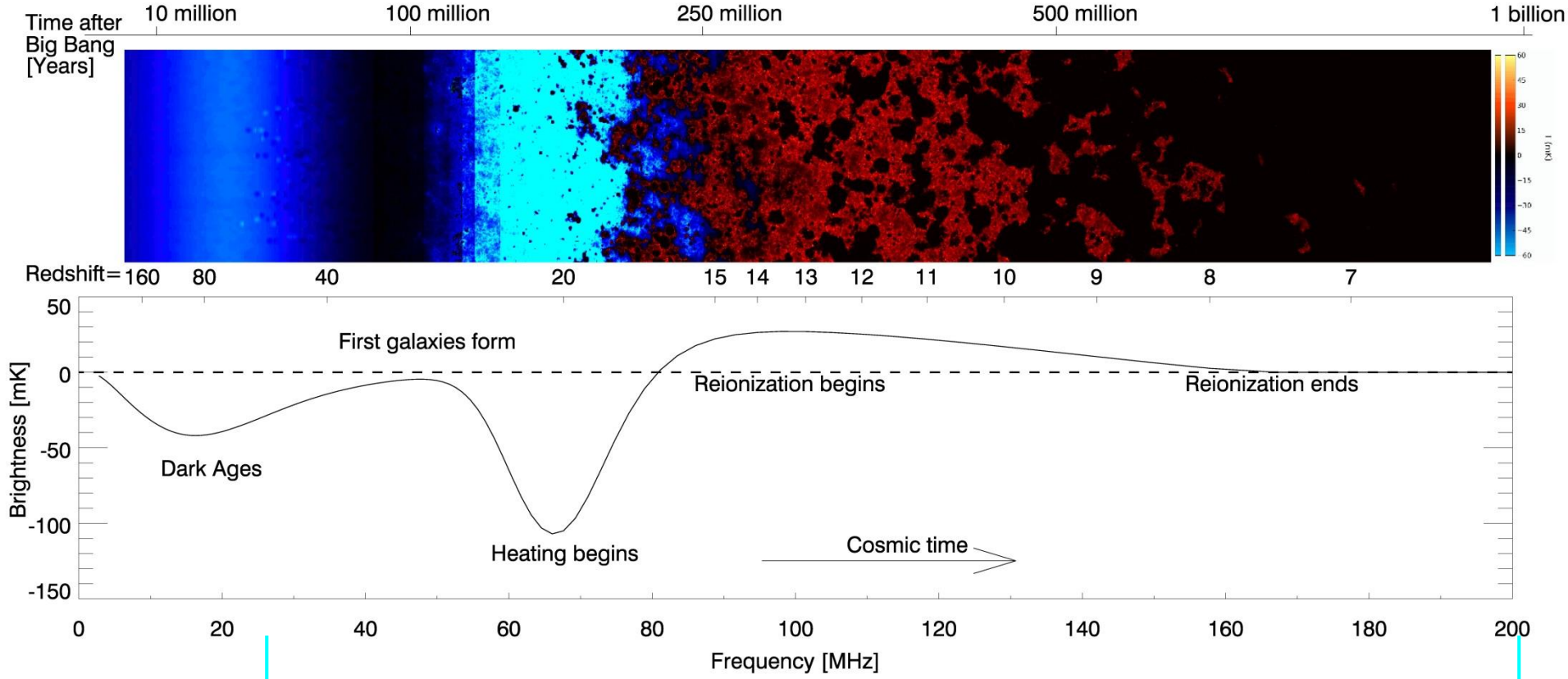
Why is this topic important?

What is currently the biggest challenge in this field? Why?

What do we need to solve it?

Why would GRAND help solve it?

$$\nu = 1420\ \text{MHz} \ / (1+z) \qquad \lambda = 21\,(1+z)\ \text{cm}$$

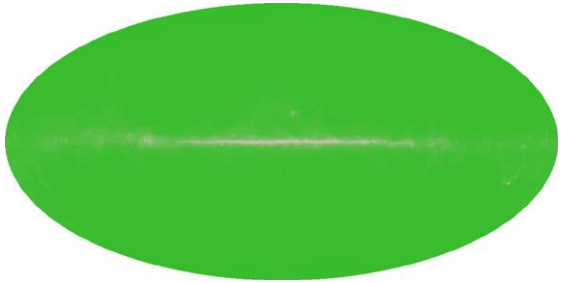


The best window

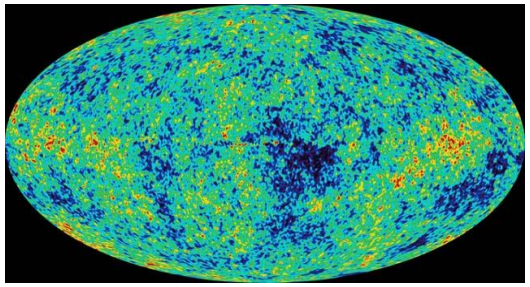
Pritchard & Loeb (2011)

Measurements of the CD/EOR

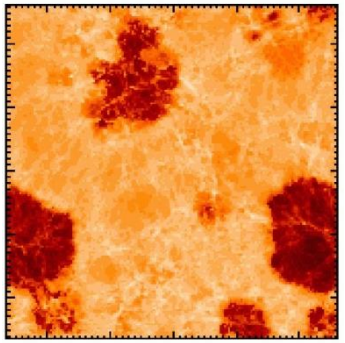
1. Global Signatures (total power)



2. Fluctuations (power spectrum)

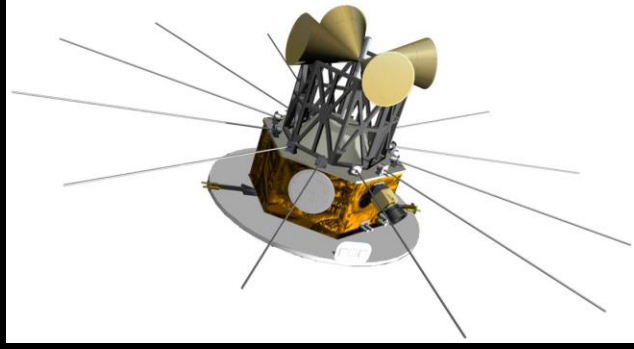


3. Imaging (structures)



EDGES

Global Signature



DARE

LOFAR

21CMA

LWA

Power Spectrum

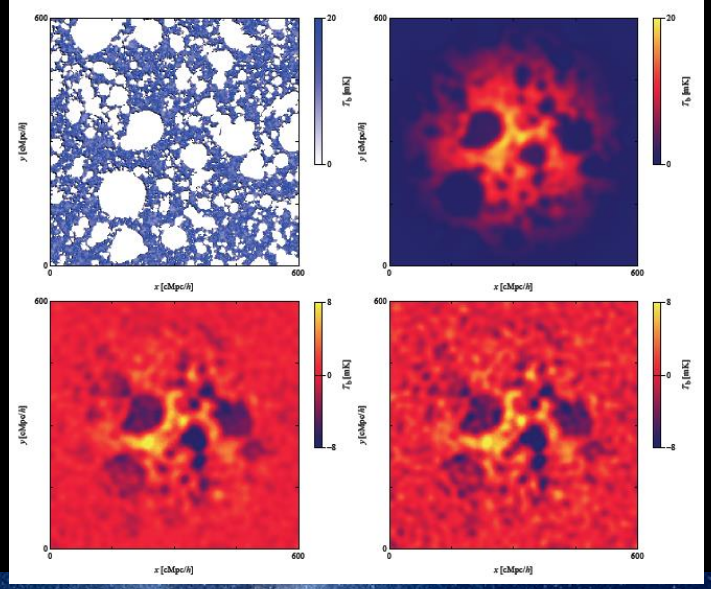
MITEoR

PAPER

HERA

MWA

Deep imaging of EoR



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Following Mauricio's Order

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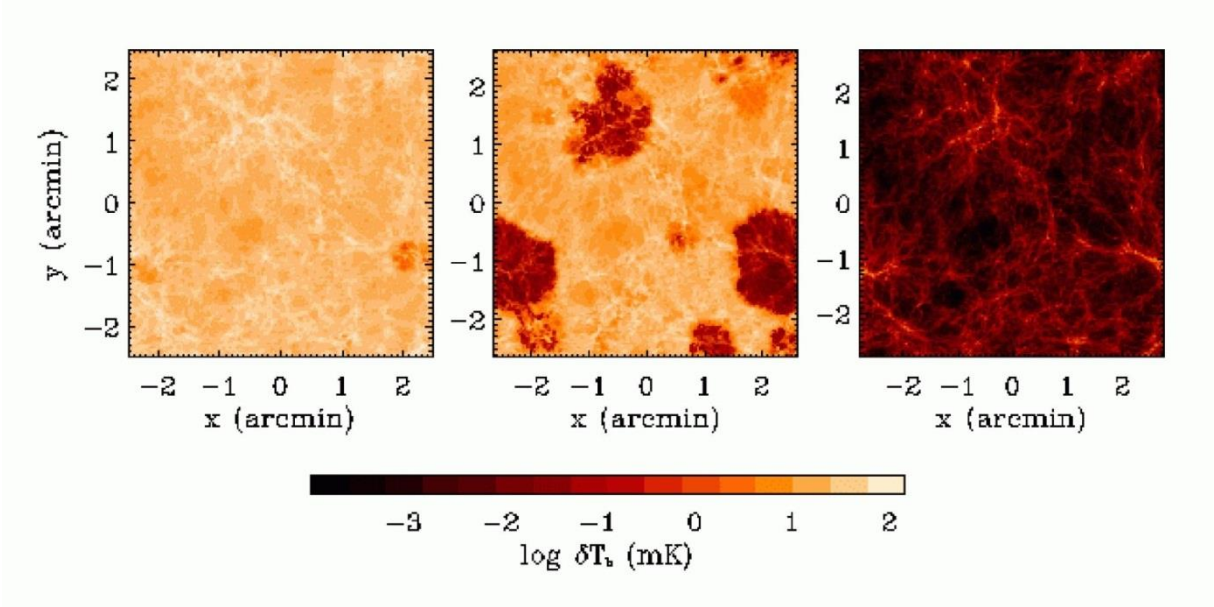
Signal of EoR

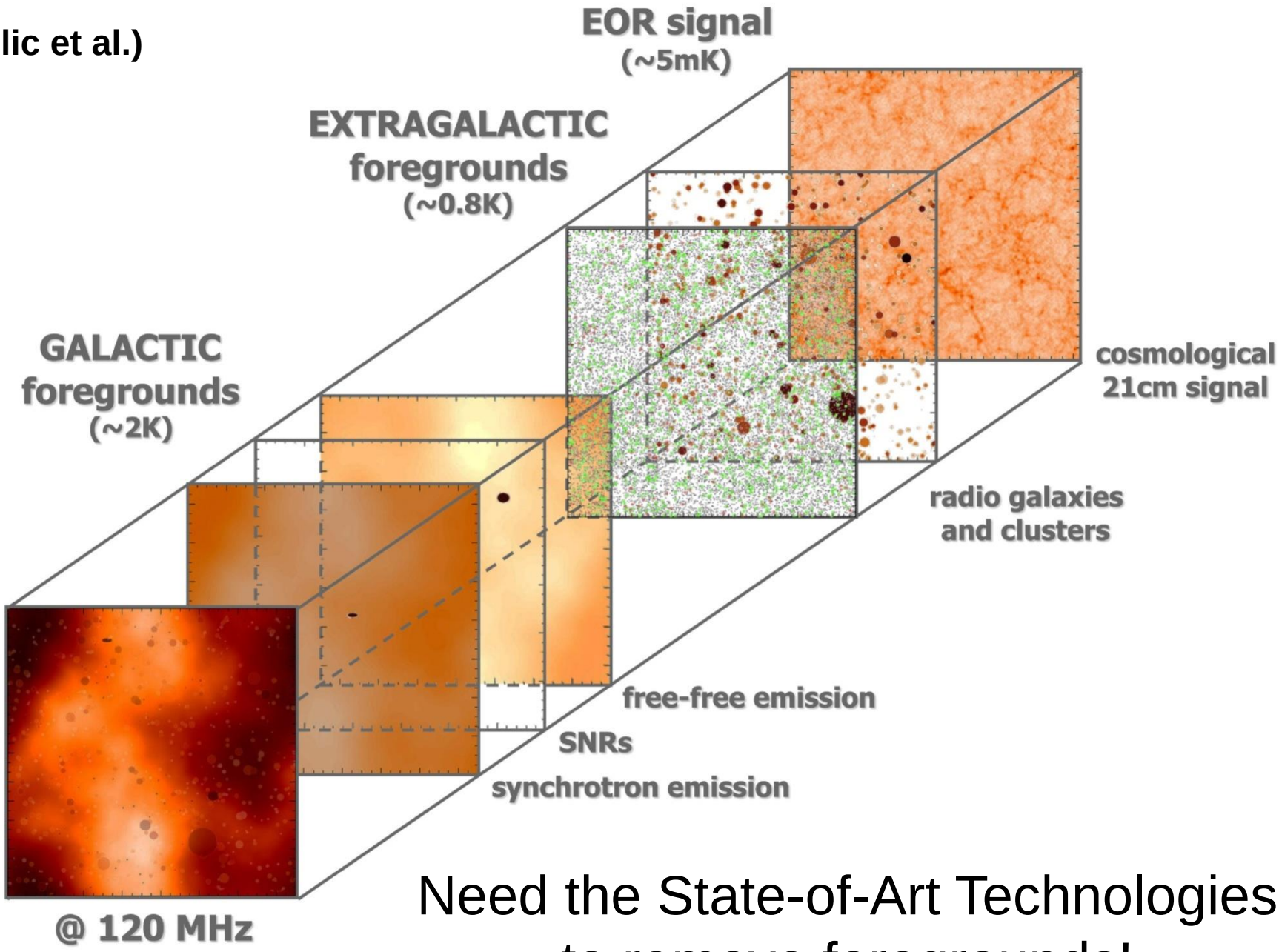


Furlanetto et al. (2003)

$$\delta T \approx 23.5(1+\delta)\, x_{\mathrm{H}} \left(\frac{T_S - T_{\mathrm{CMB}}}{T_S}\right)\left(\frac{\Omega_b h^2}{0.02}\right)\left(\frac{0.15}{\Omega_M h^2}\right)^{1/2}\left(\frac{1+z}{10}\right)^{1/2} \mathrm{mK}$$

Need High Sensitivity
to see images and structures!

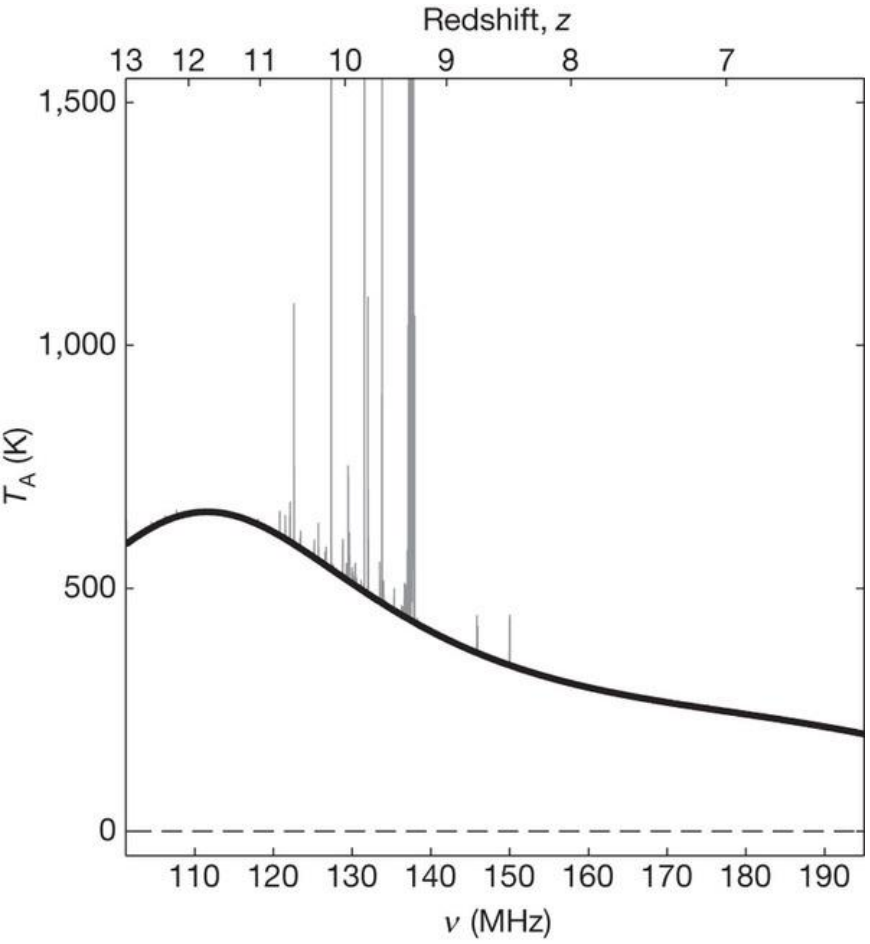
(Jelic et al.)



Need the State-of-Art Technologies to remove foregrounds!

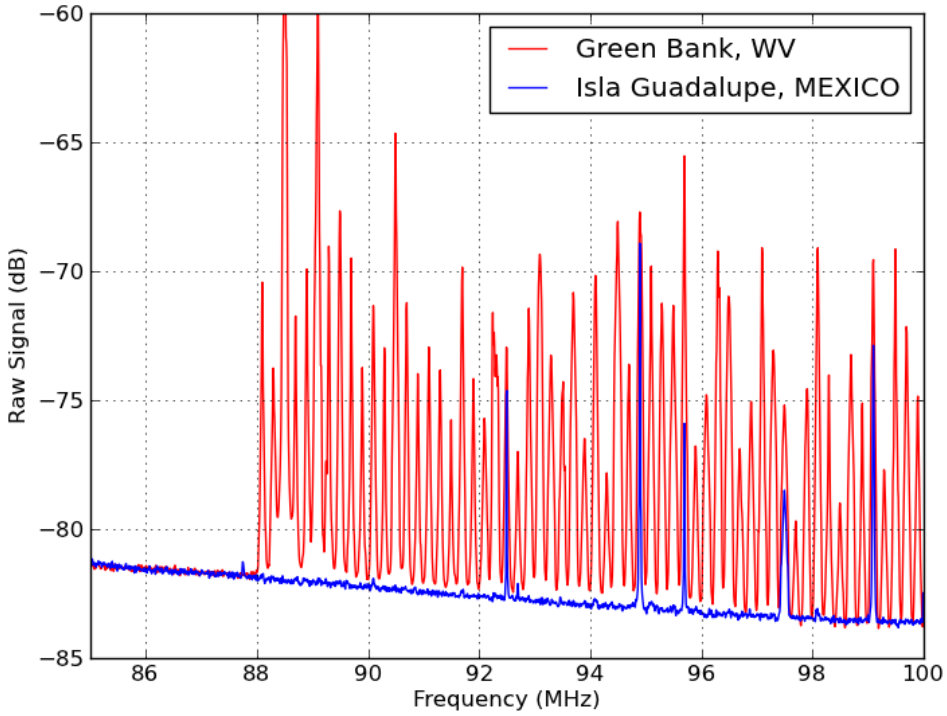
Examples: Measurements of Global Signature of EoR

EDGES



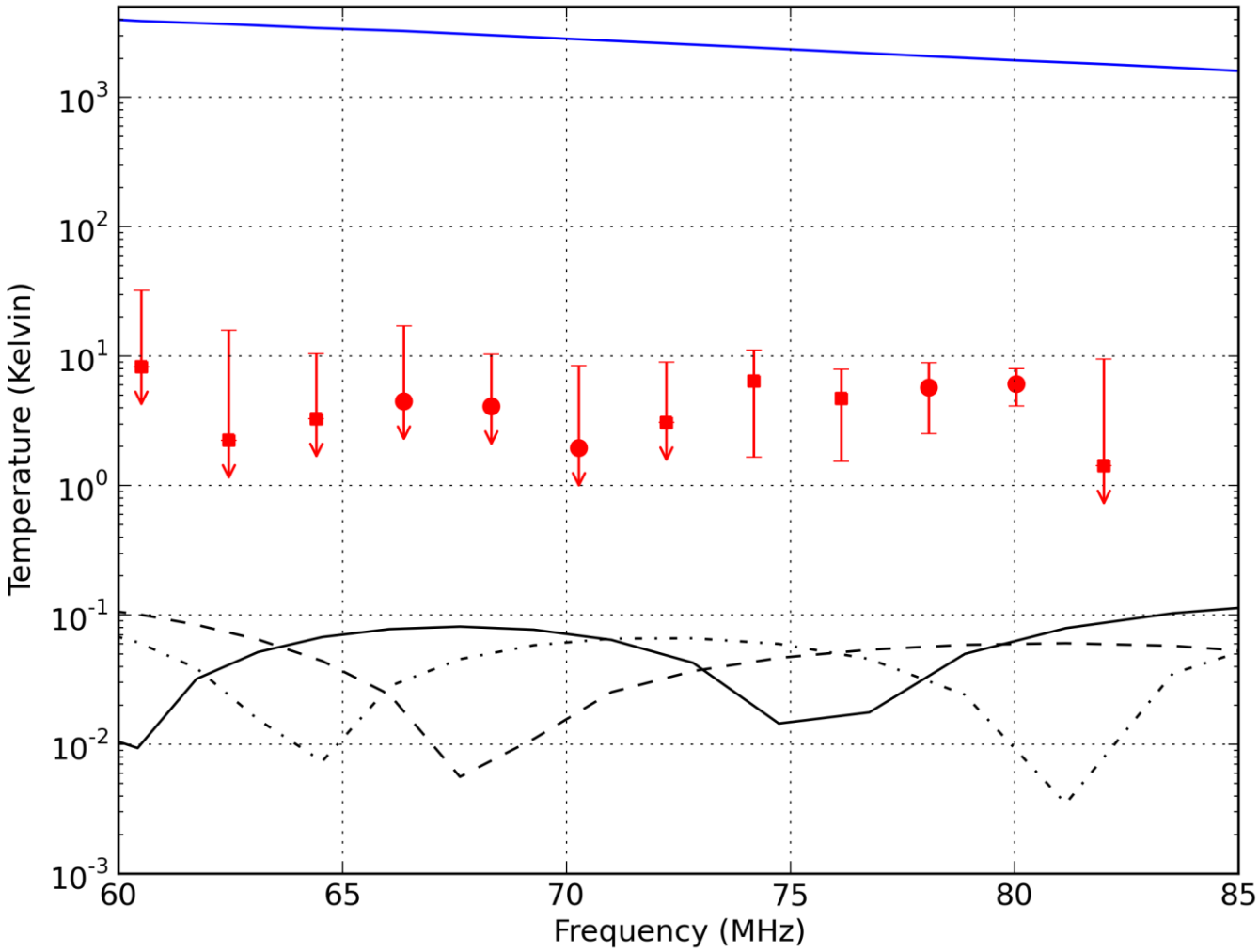
Bowman & Rogers
(2010, Nat 468)

SCI-HI



arXiv.1311.0014

SCI-HI



Magnitude comparison of foregrounds (blue), residuals from 4.4h of integration(red) and predictions (black)

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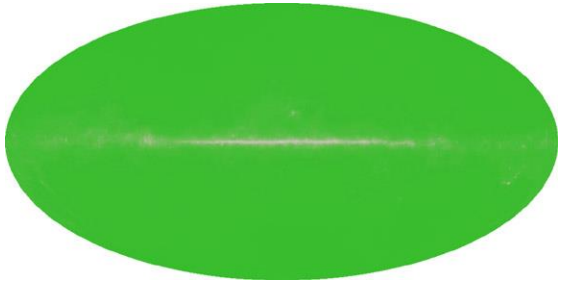
GRAND's Targets

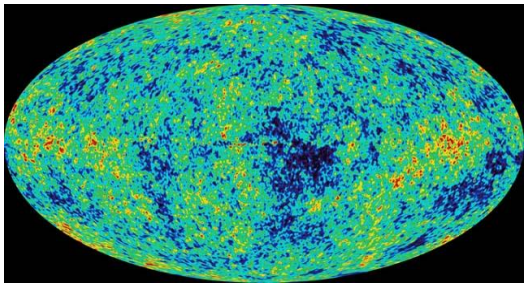
1. Global Signatures (total power)

(next a few years)



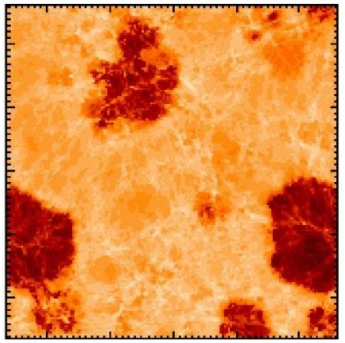
2. Fluctuations (power spectrum)

(next a few years)

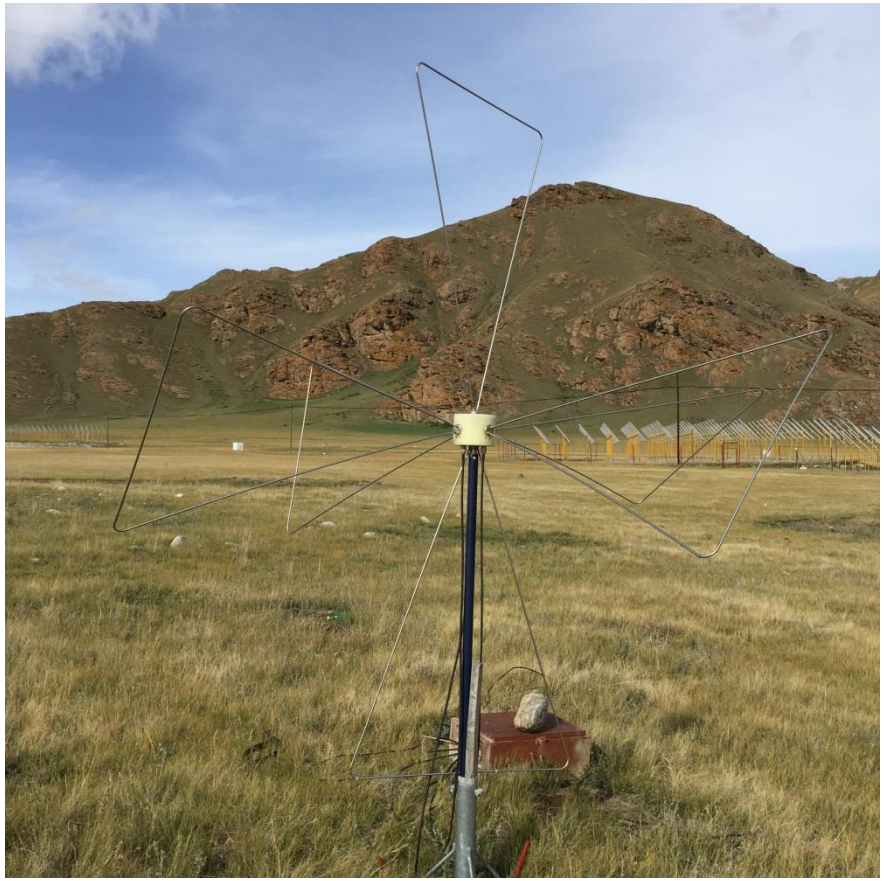


3. Imaging (structures)

(next 10 years @ SKA only



Detection of the Global Signature of CD/EoR @ GRAND



Technical Requirements

Frequencies: 10 - 200MHz

Sensitivity: 1mK

Integration time: 24h for 1 antenna

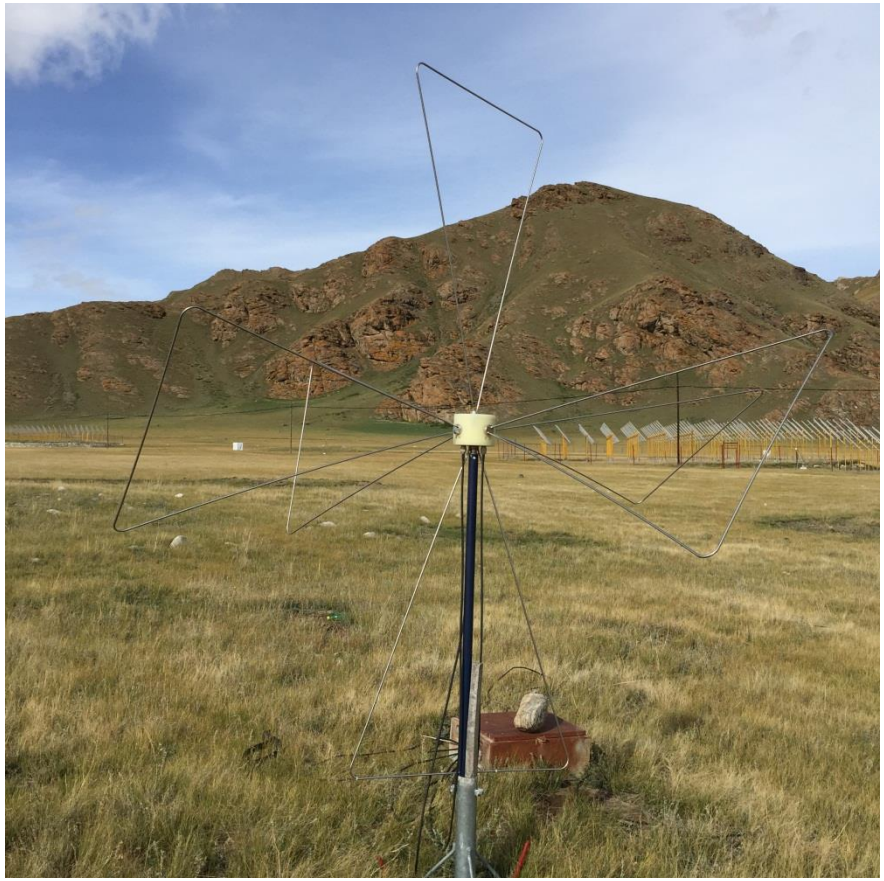
Stability: 1mK over 24 h

Calibration : 1mK

Foregrounds: 1mK

Detection of the Global Signature of CD/EoR

@ GRAND



Disadvantages

Cosmic Rays & Neutrinos:

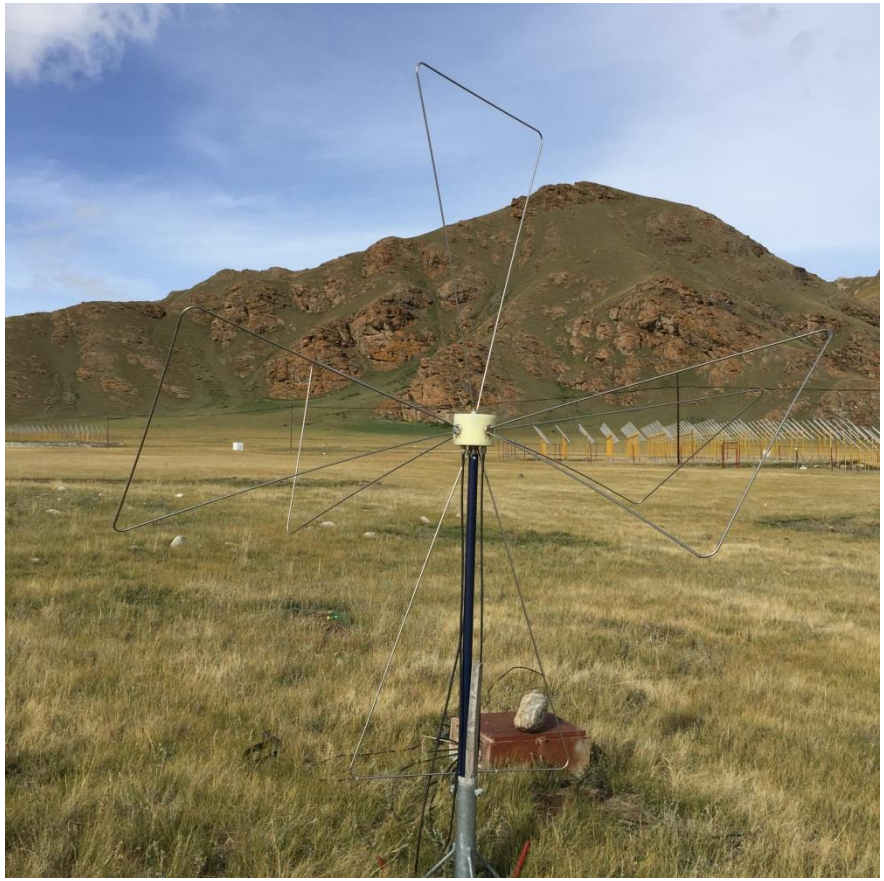
time domain: pulses@triggers

CD/EoR Detection :

frequency domain: noise

Different Working Modes !

Detection of the Global Signature of CD/EoR @ GRAND



Advantages

Many independent Antannas:

1. **Good for Stability Control**
2. **Good for Statistics**
3. **Polarization Information**