Detection of the 21cm auto power spectrum at $z \sim 1$ with the Canadian Hydrogen Intensity Mapping Experiment

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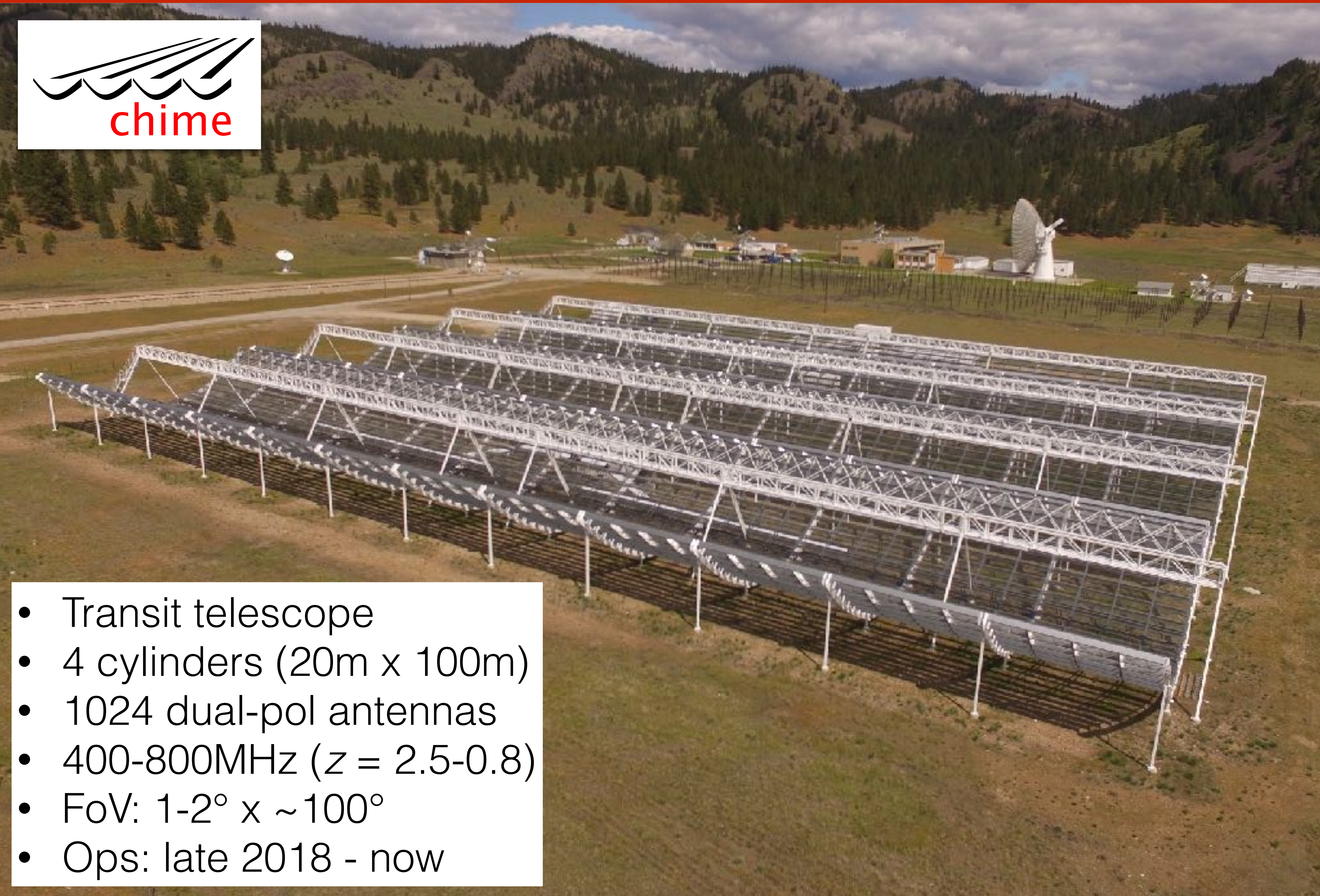
(for the CHIME Collaboration)

Arizona State University

Cosmology in the Alps
March 19, 2026

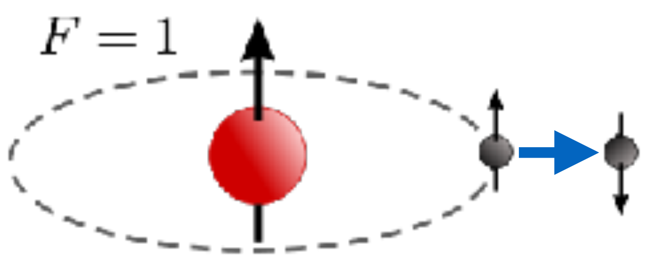
The Canadian Hydrogen Intensity Mapping Experiment

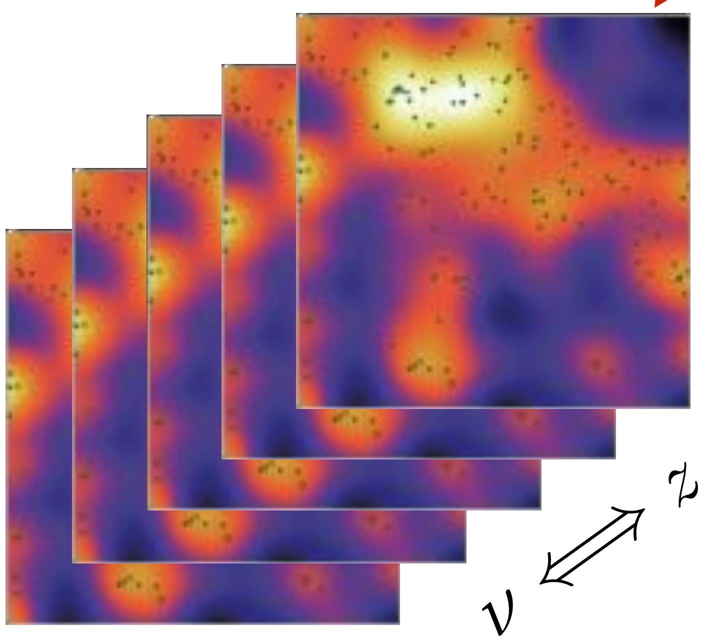
chime

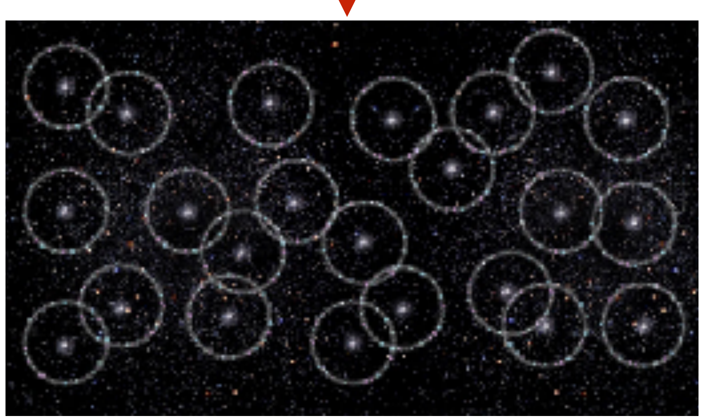


- Transit telescope
- 4 cylinders (20m x 100m)
- 1024 dual-pol antennas
- 400-800MHz (z = 2.5-0.8)
- FoV: 1-2° x ~100°
- Ops: late 2018 - now

21cm Intensity Mapping with CHIME

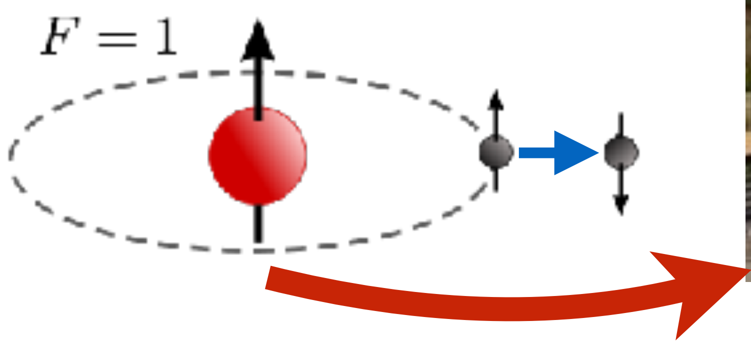


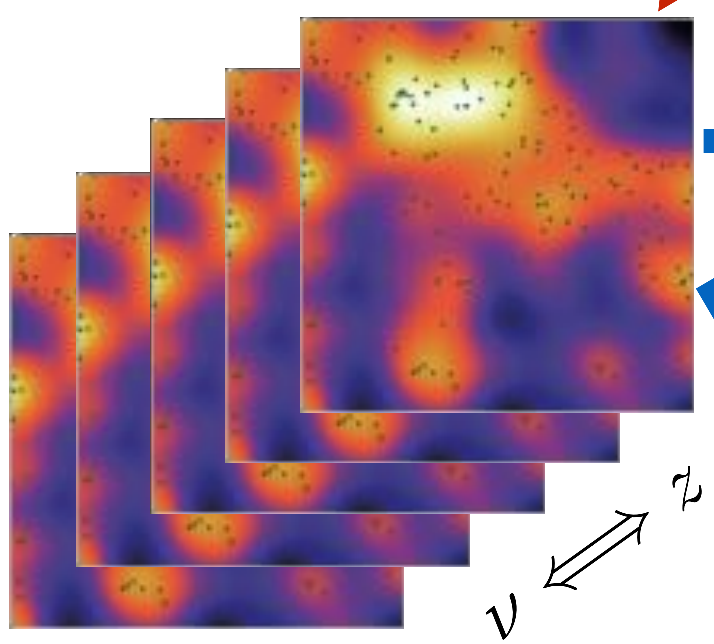


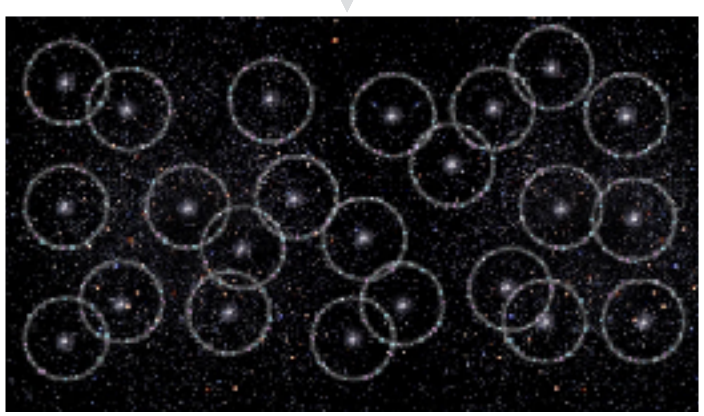


Dark Energy (via BAO)

21cm Intensity Mapping with CHIME

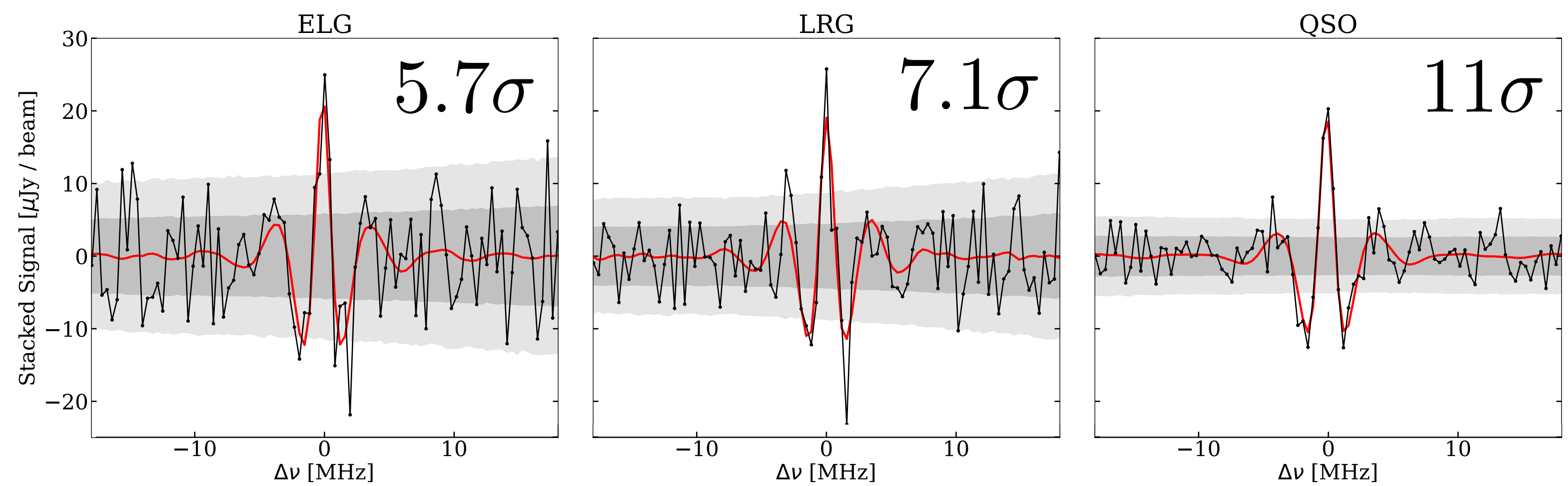




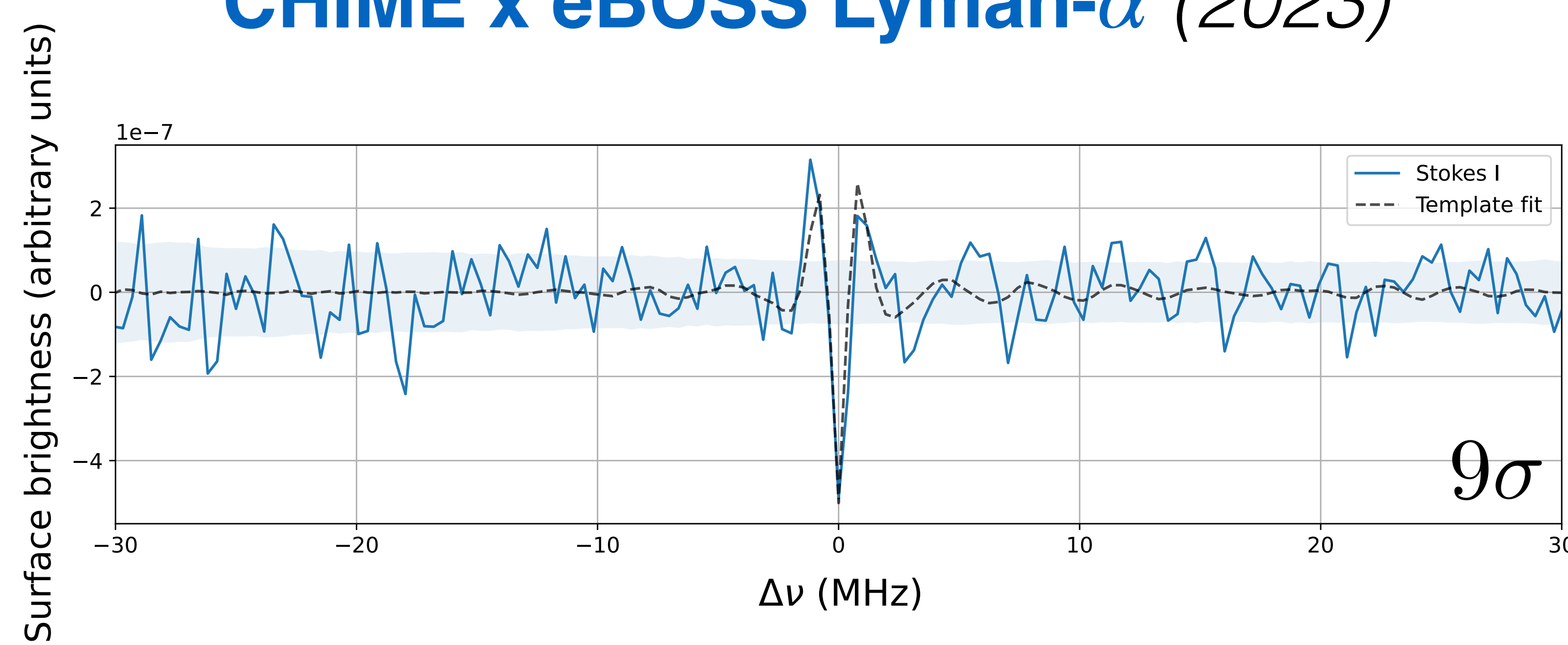


Dark Energy (via BAO)

CHIME x eBOSS (LRG, ELG, QSO) *(2022)*

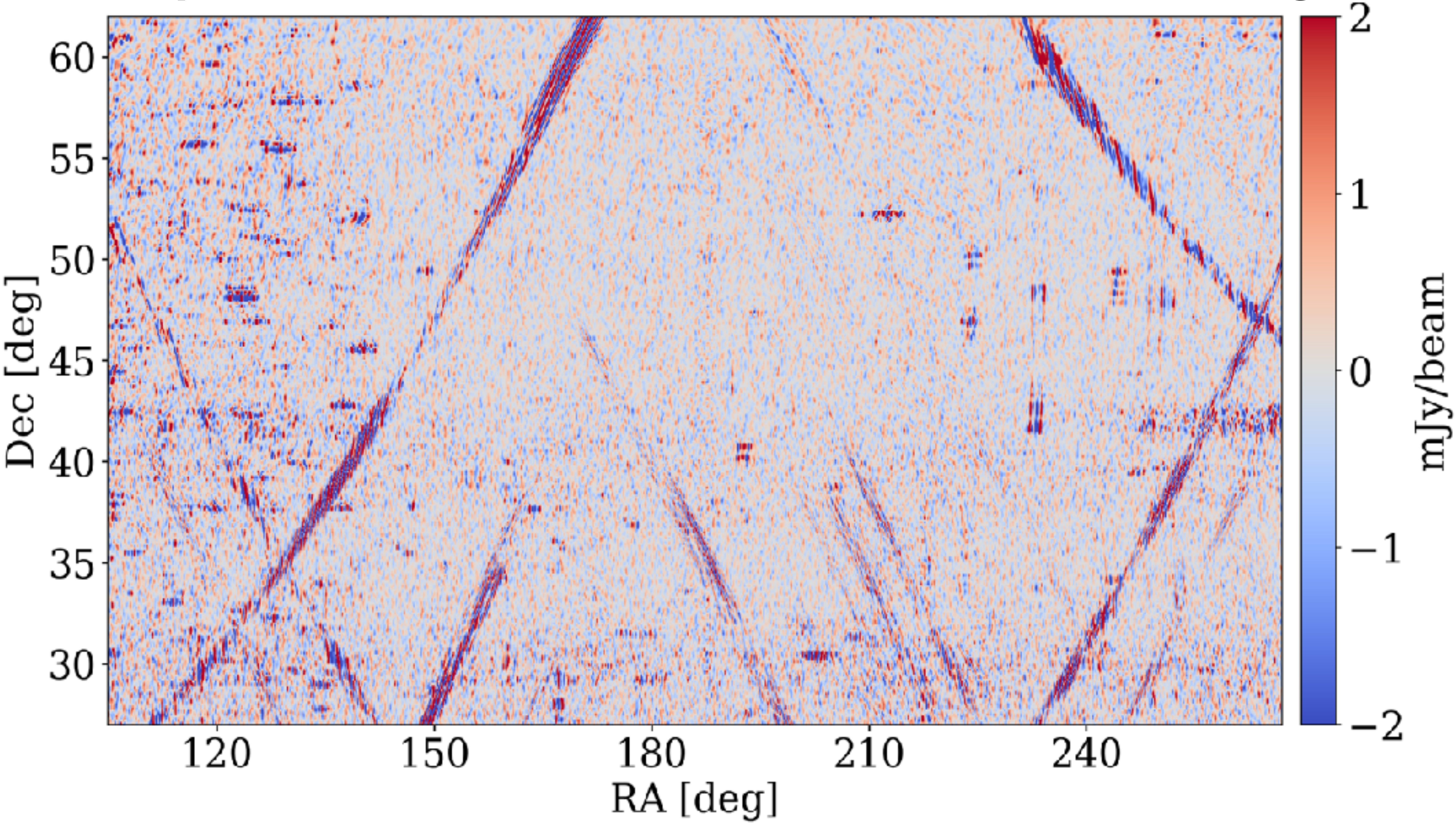


CHIME x eBOSS Lyman-α *(2023)*



Improved data processing and foreground filtering

YY pol, 700.78125 MHz - used for eBOSS stacking



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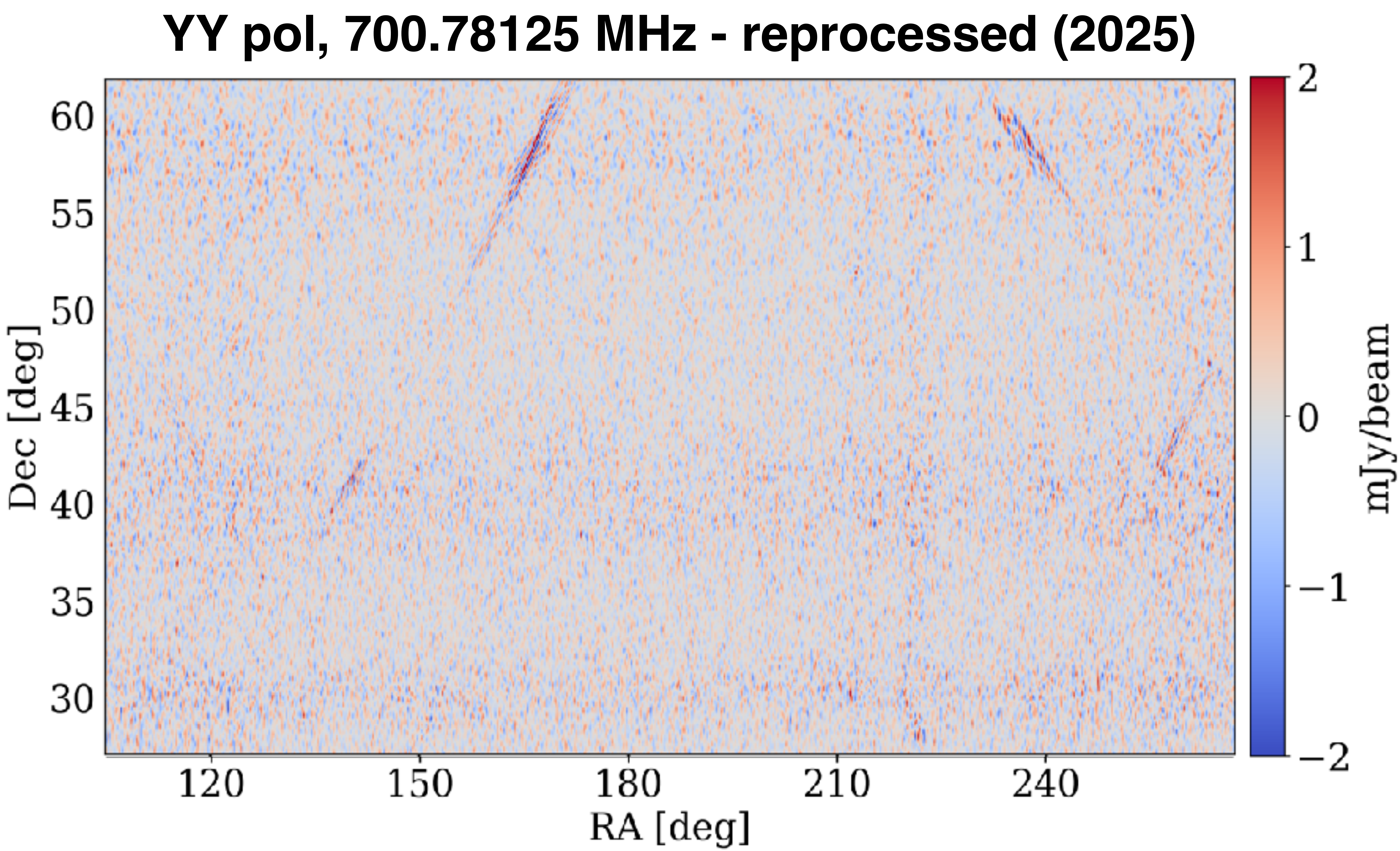
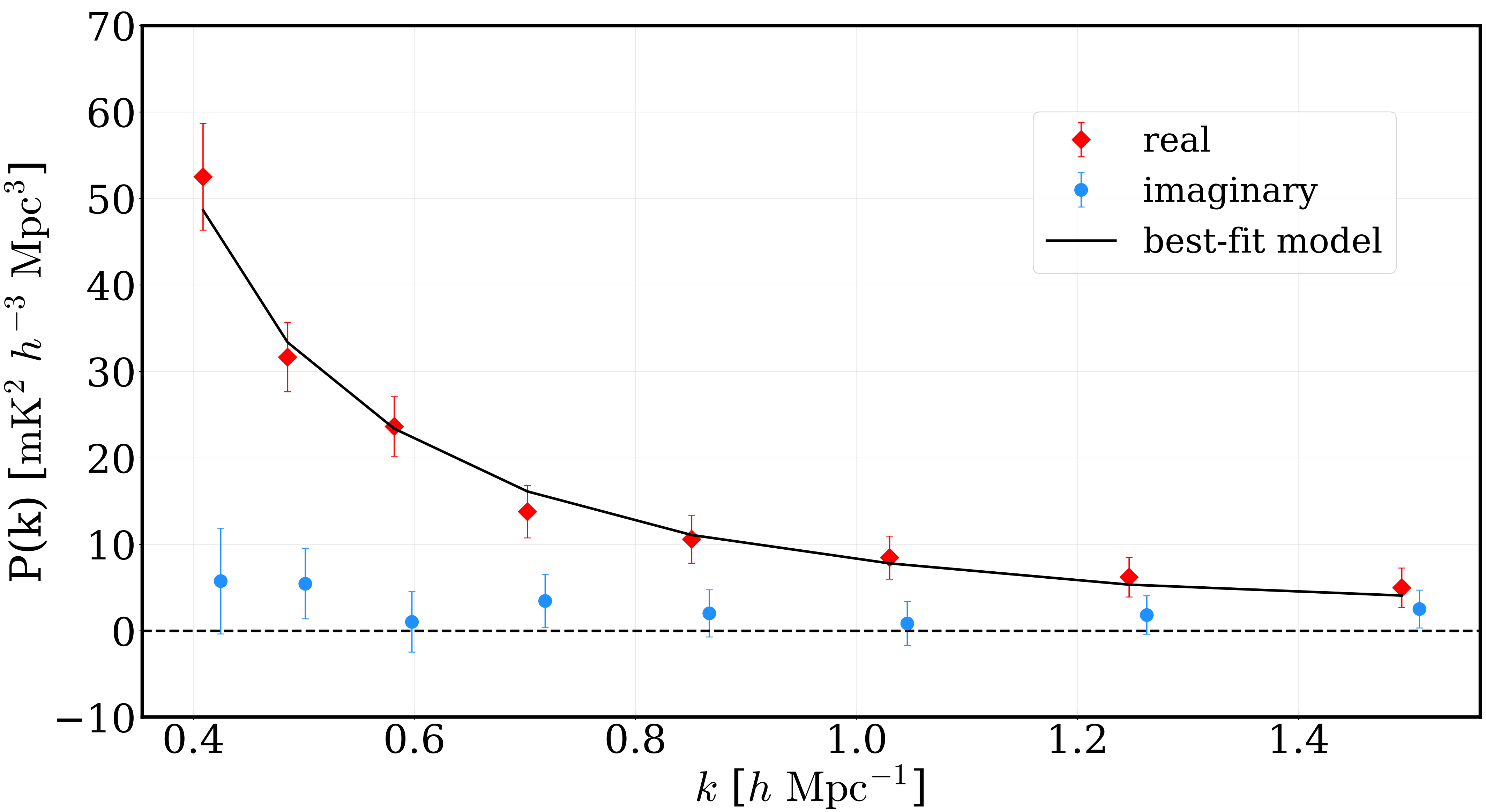


e.g. RFI flagging, daily foreground filtering, achromatic beamforming

arXiv:2511.19620: **21cm auto power spectrum at $z \sim 1.16$**



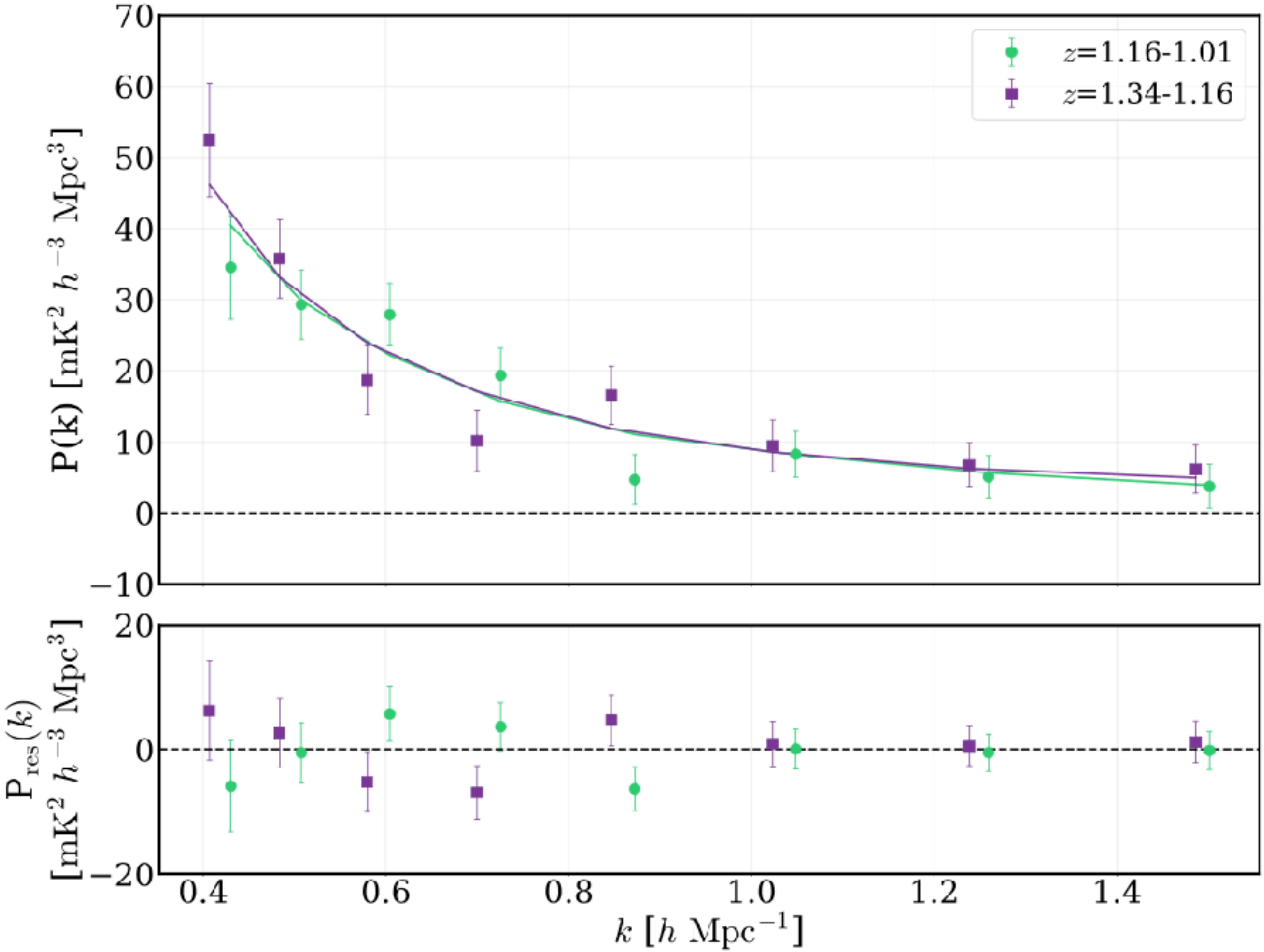
Arnab Chakraborty
(McGill postdoc)

Seth Siegel
(SKAO operations scientist)

- S/N =12.4
- Second reported measurement of 21cm auto power at any redshift*
- First auto measurement at $z > 0.5$

**First: MeerKAT, z ~ 0.32 and 0.44, k ~ 0.4 to 8 h Mpc^{-1} (Paul+ 2023)*

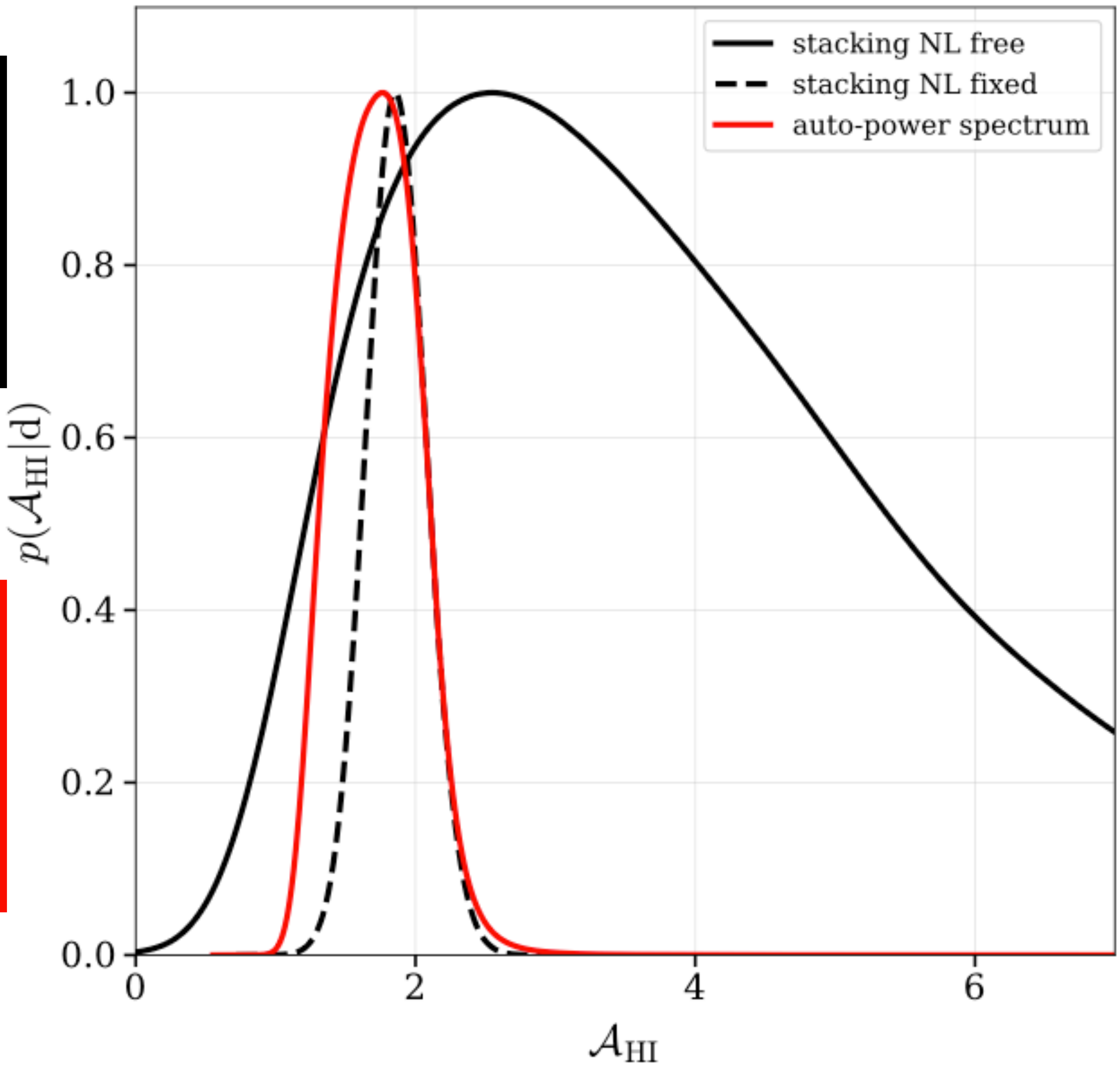
1d power spectrum in sub-bands



Amplitude comparison: eBOSS stacking vs. auto spectrum

$$P_{21}(k) \sim \langle T_{21} T_{21} \rangle \propto \mathcal{A}_{\rm HI}^2$$

$$\text{Stack} \sim \langle T_{21} \delta_{\rm g} \rangle \propto \mathcal{A}_{\rm HI}$$

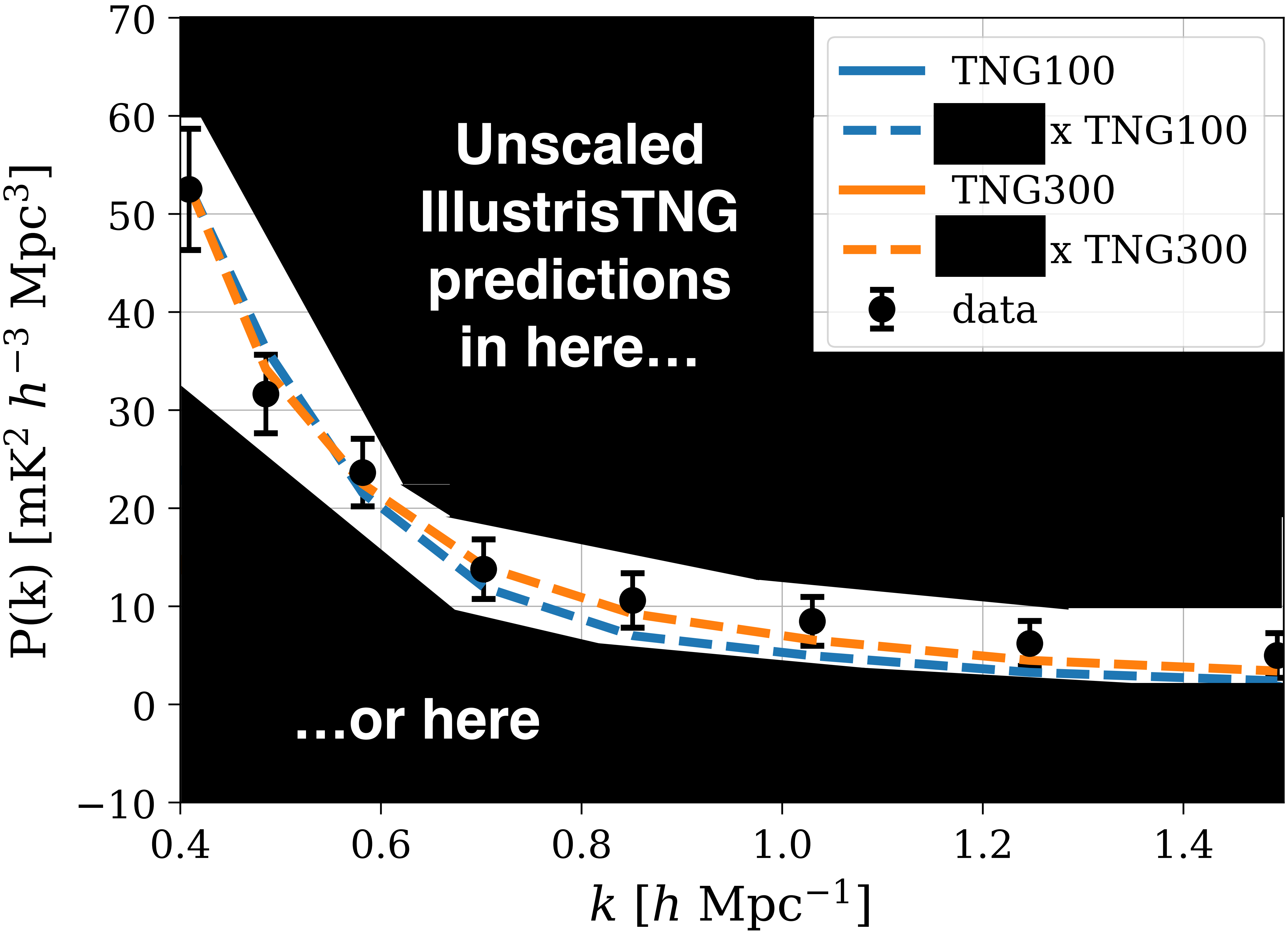


Validation tests

Data Selection	**Selection Criteria**	**p-value**
Imaginary component	$\mathrm{Im}[P(k)]$	0.58
(Even–Odd) nights	$\mathrm{Re}[P(k)]$	0.90
	$\mathrm{Im}[P(k)]$	0.55
Stokes-Q	$\mathrm{Re}[P(k)]$	0.21
	$\mathrm{Im}[P(k)]$	0.33
RA bins	(RA2 − RA1)	0.54
Dec bins	(Dec2 − Dec1)	0.44
Baseline Selections	[(1+2+3)-cylinder] − [1-cylinder]	0.76

+ Varying masking threshold

Paper in preparation: comparison with IllustrisTNG

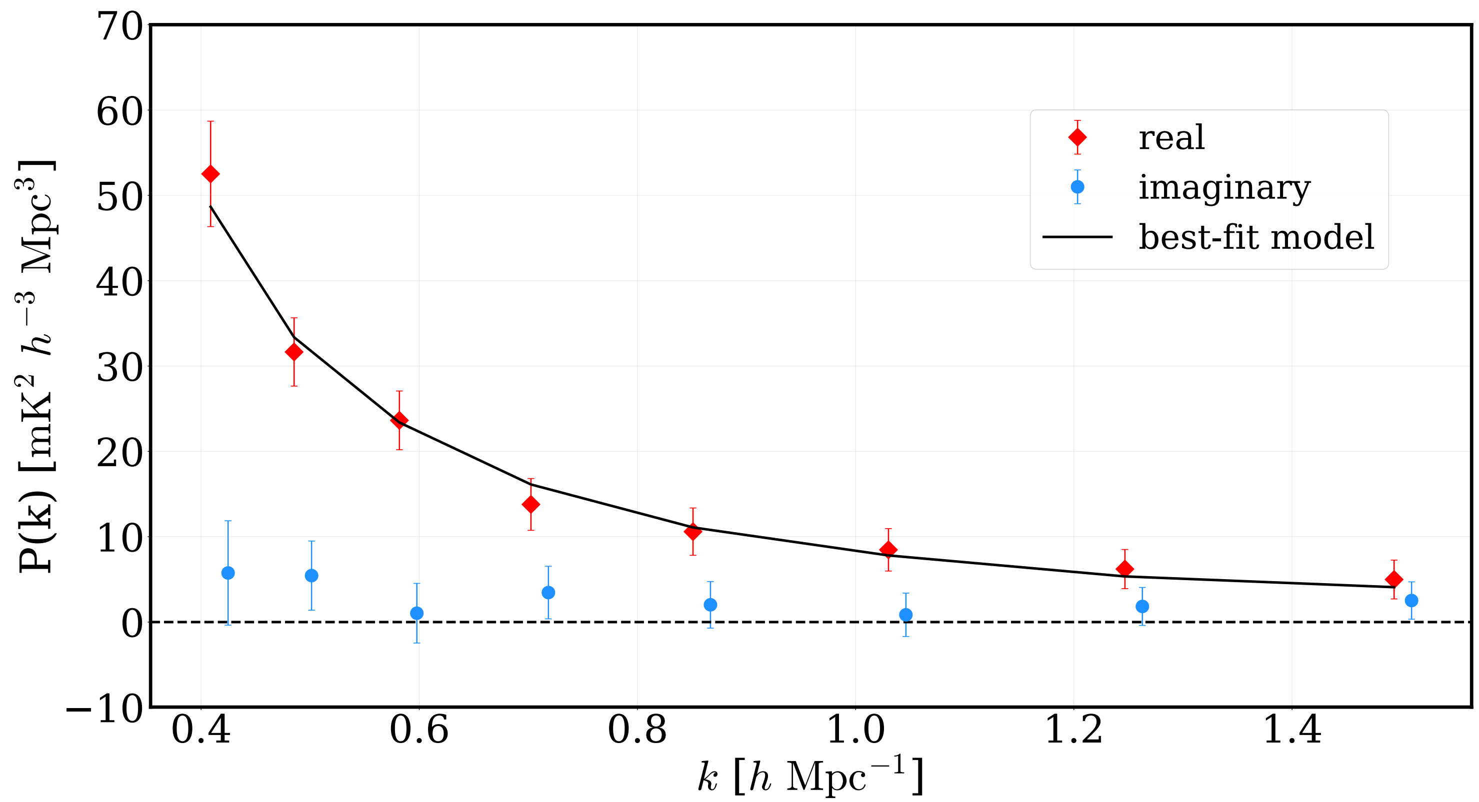


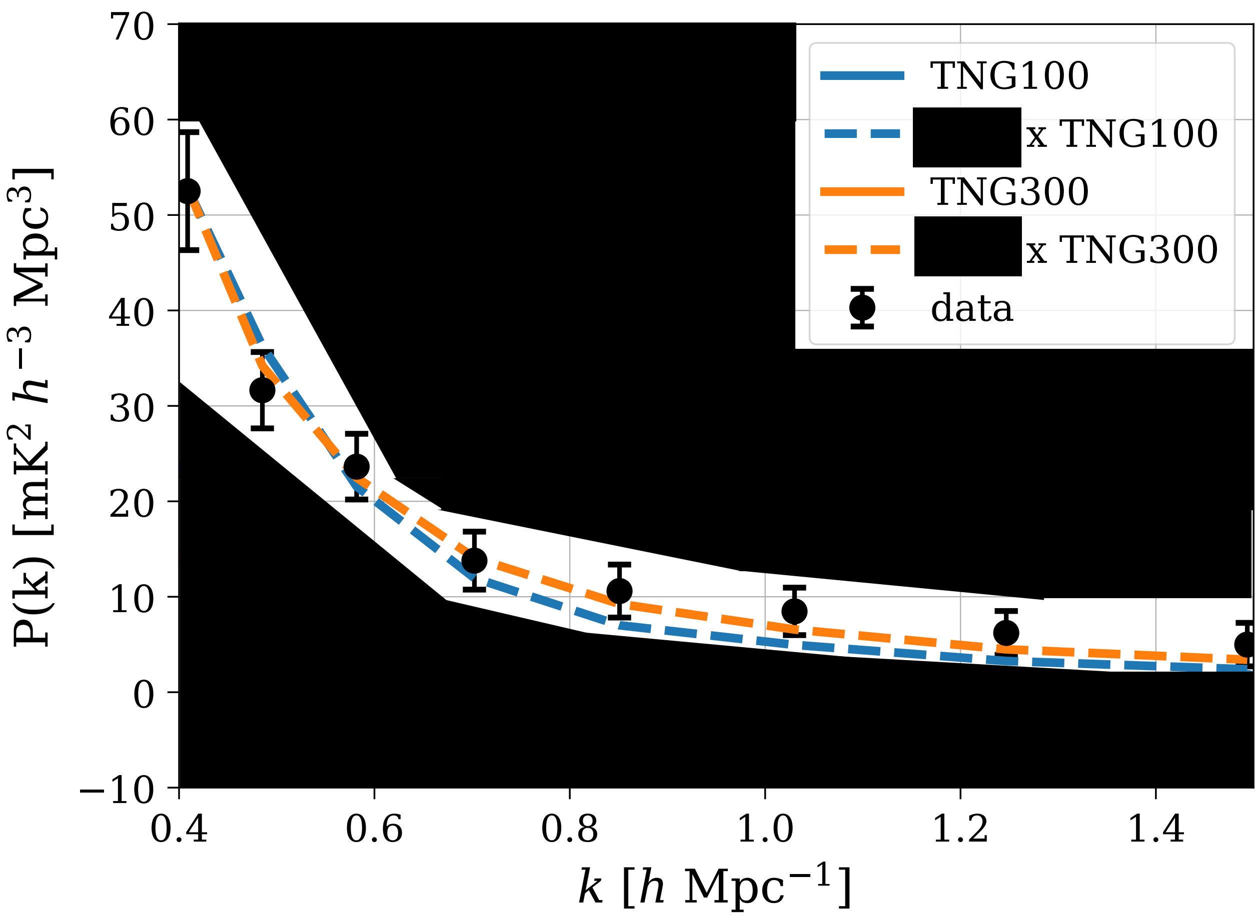
Albin Joseph
(ASU postdoc)

Shabbir Shaikh
(ASU postdoc)

Summary

- CHIME has measured the 21cm auto power spectrum at $z \sim 1.16$ (arXiv:2511.19620)
- Paper coming soon:
  - Comparison with HI power spectra from IllustrisTNG
  - Constraints on Ω_{HI} and b_{HI} using power spectrum model (Albin Joseph's talk)





Extra slides

21cm absorbers

- 40 narrow-band unresolved features discovered in cosmology data (390kHz resolution)

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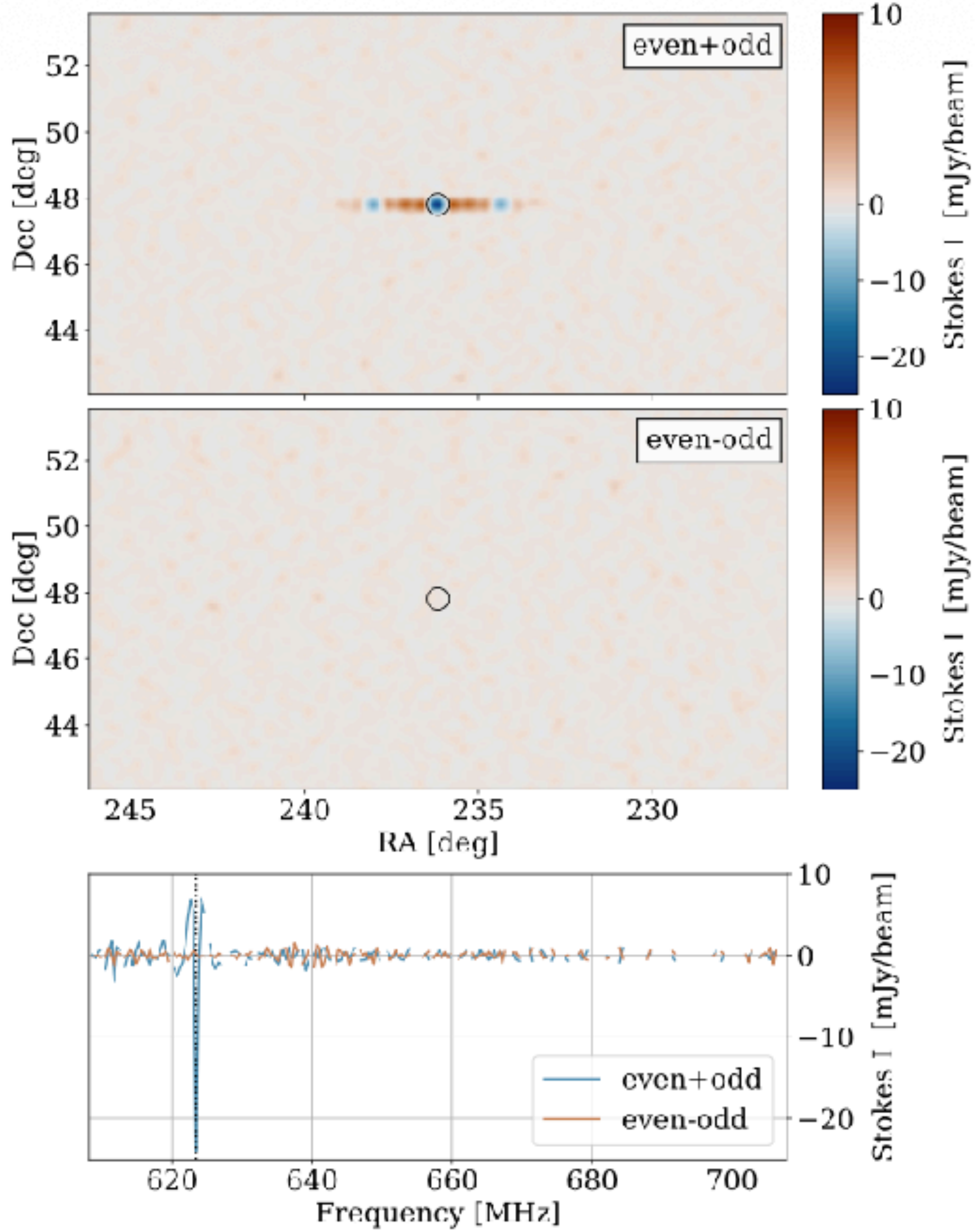
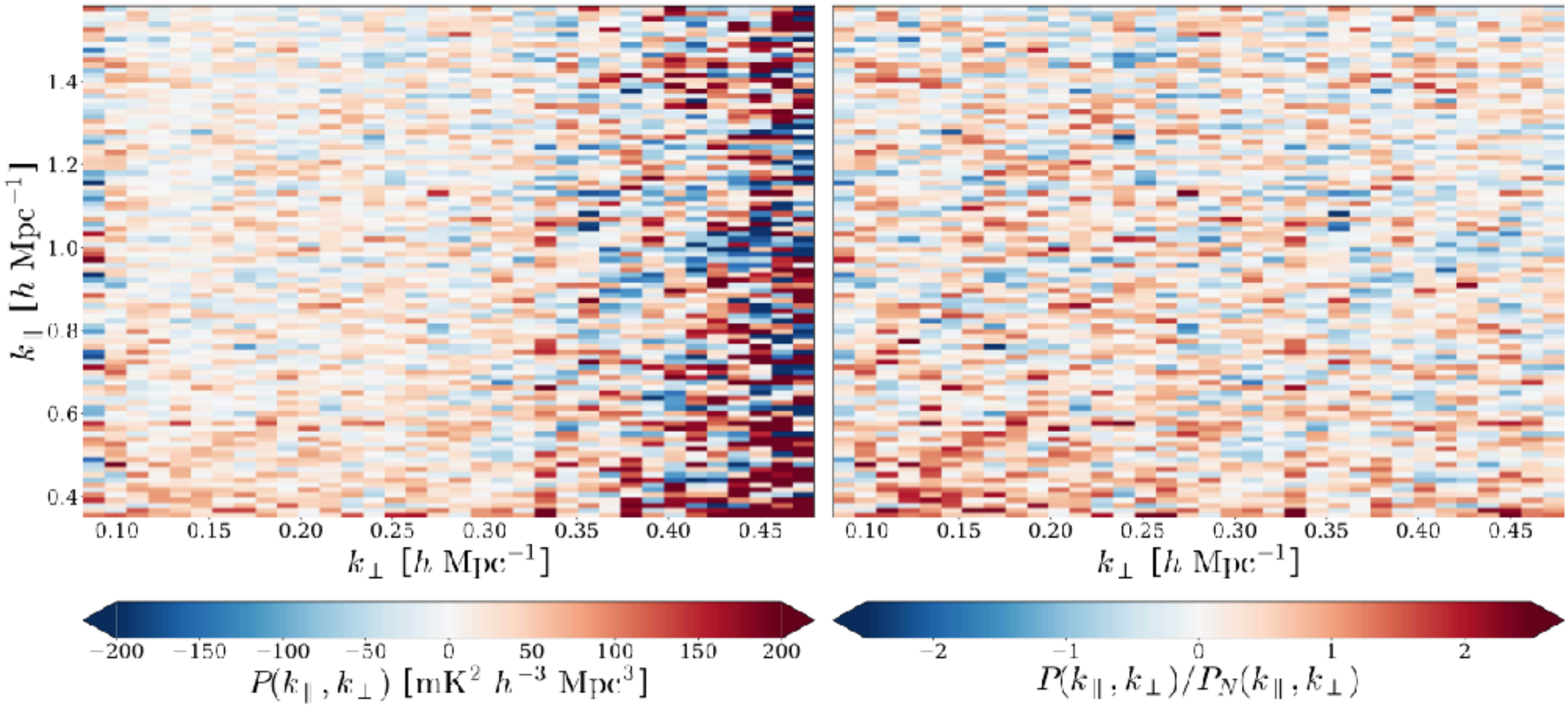
Candidate 21cm absorption systems
(characterization underway)



2d power spectrum



North-South beamforming

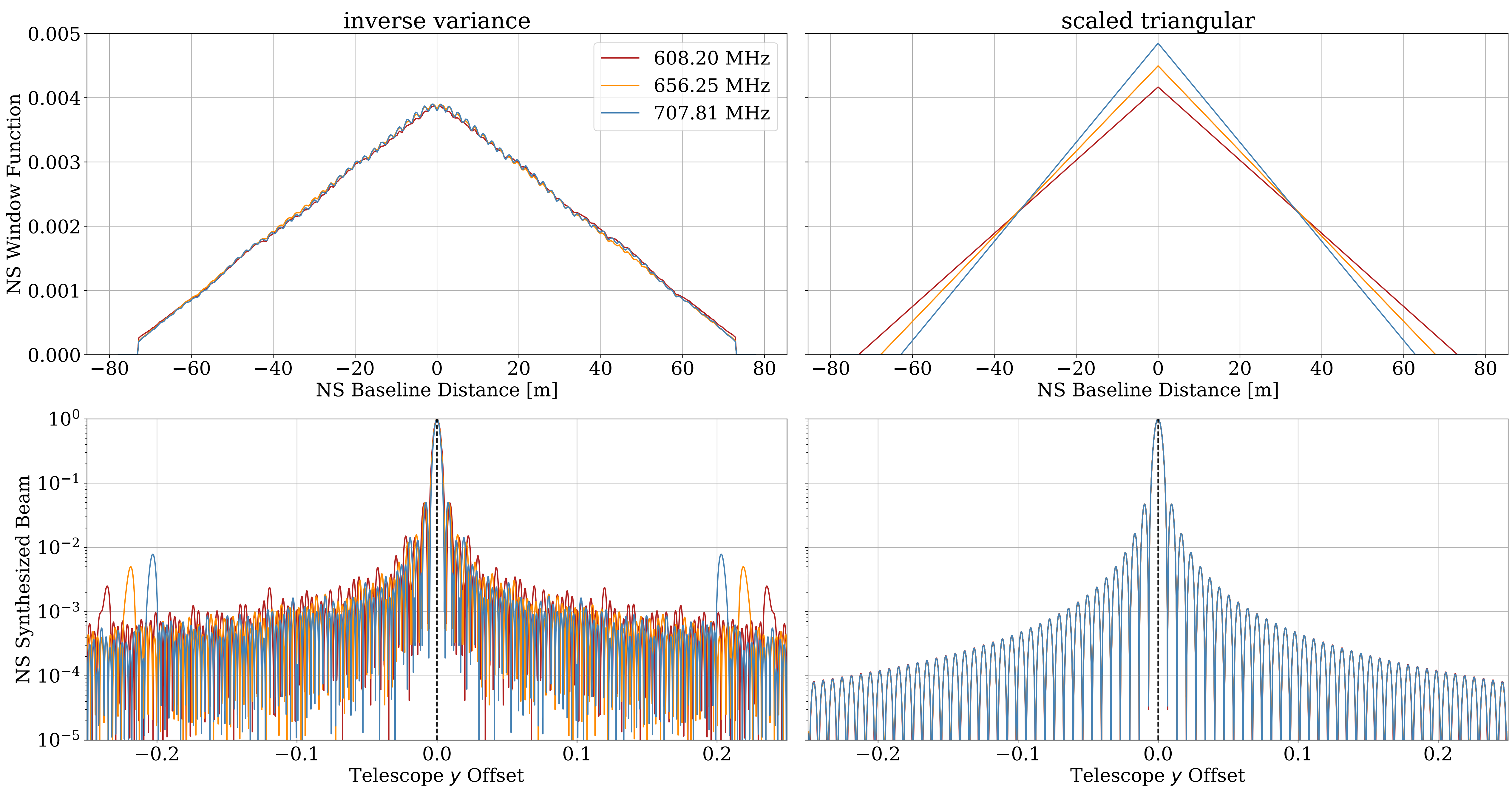
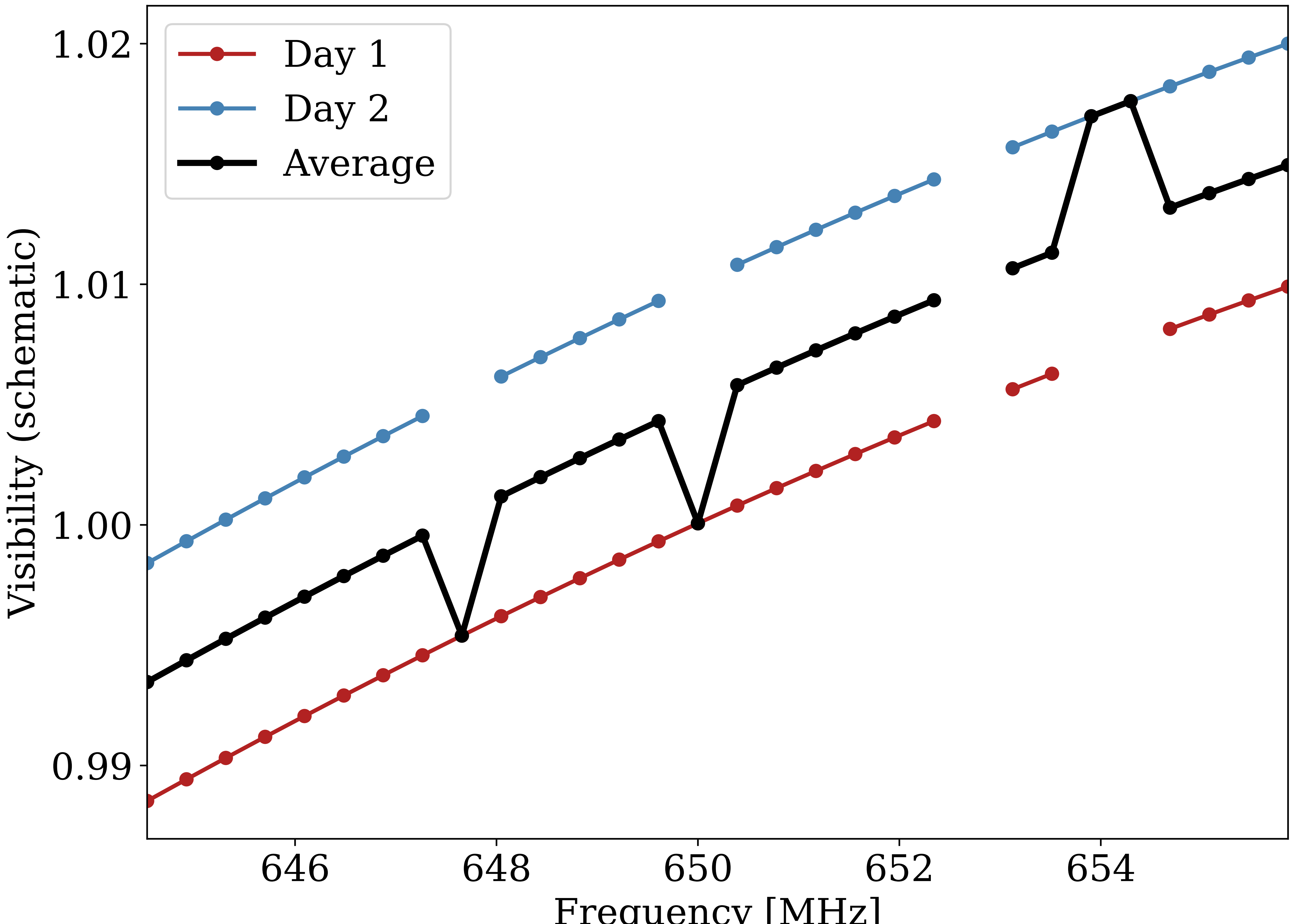


Figure 1. *Top:* Normalized window function, $W^{\rm NS}$, versus NS baseline distance, shown at three representative frequencies near the bottom, middle, and top of the band. The left column shows the window function used in CHIME Collaboration (2023) which is derived from the inverse-variance weights, while the right column shows the scaled triangular window function adopted in this work. *Bottom:* Fourier transforms of the normalized window functions, illustrating the expected synthesized beams as a function of offset in the telescope y coordinate. The inverse-variance weights produce a beam that narrows with increasing frequency and exhibits large frequency-dependent sidelobes, in part due to ripple-like structure from noise cross-talk. By contrast, the triangular window is scaled with frequency to maintain an identical synthesized beam across the band.

Illustration of spectra leakage from time-varying gains



Foreground filtering validation