

# GMRT-EoR: Lessons learned

30 dishes @45m ea, dual polarization

Operates in 0.2-2m band, similar core sensitivity as LOFAR

Credits: Paciga, Alberts, Chang, Gupta, Hirata, Odegova, Peterson, Roy, Shaw, Sigurdson, Voytek



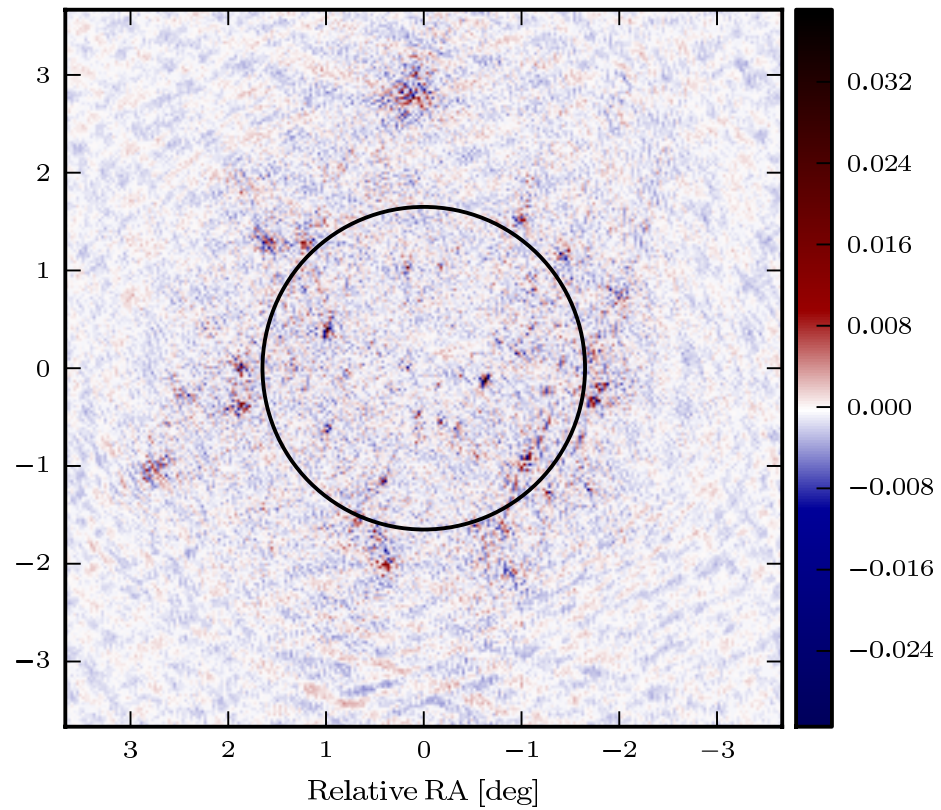
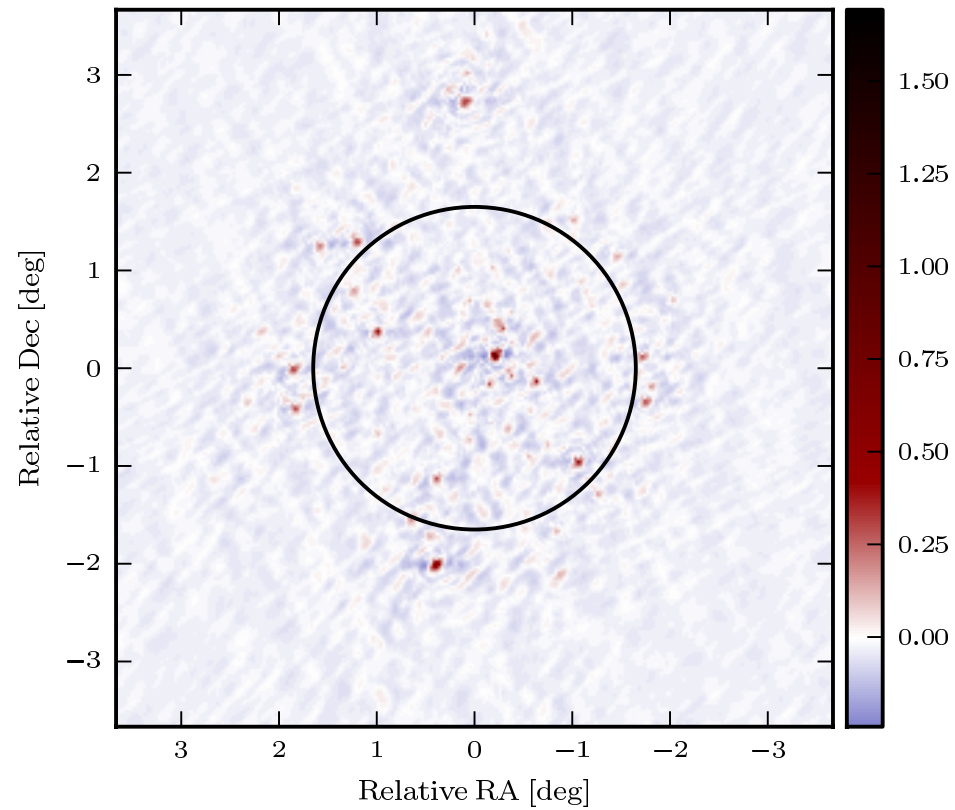
# Optimal Foreground Subtraction

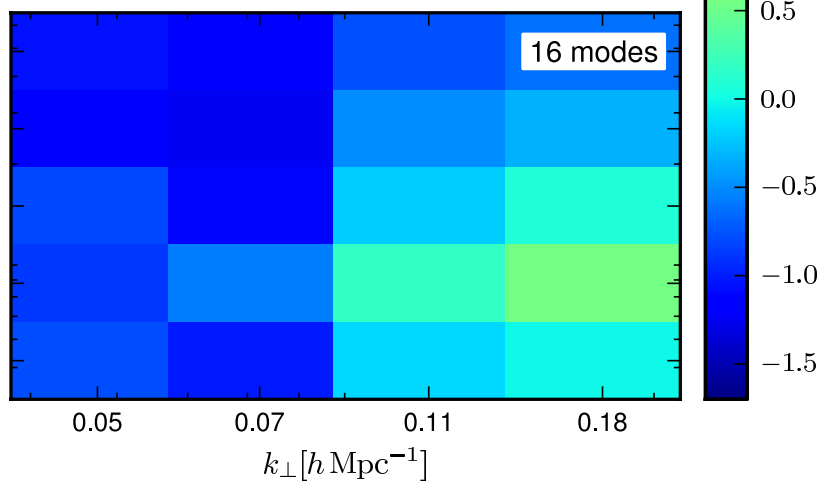
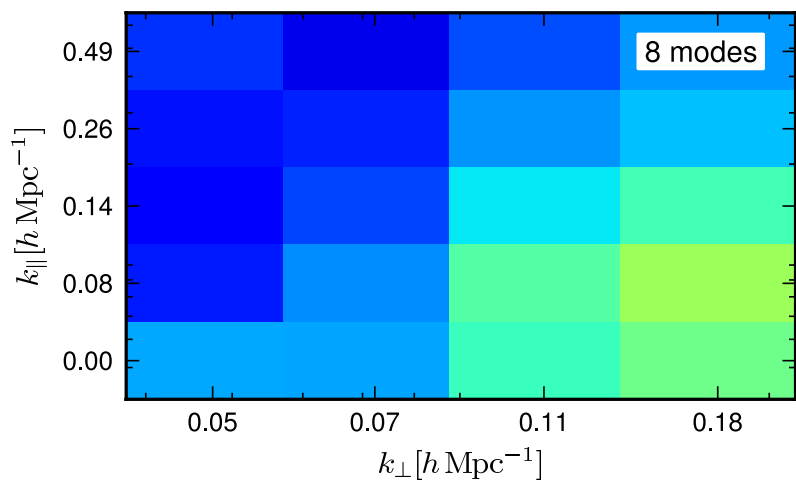
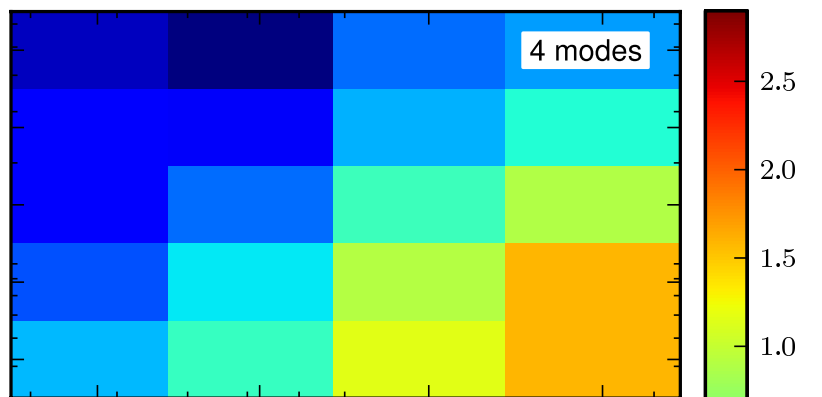
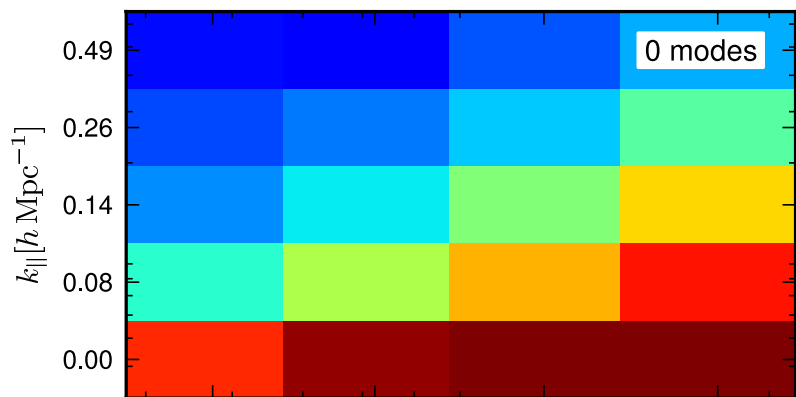
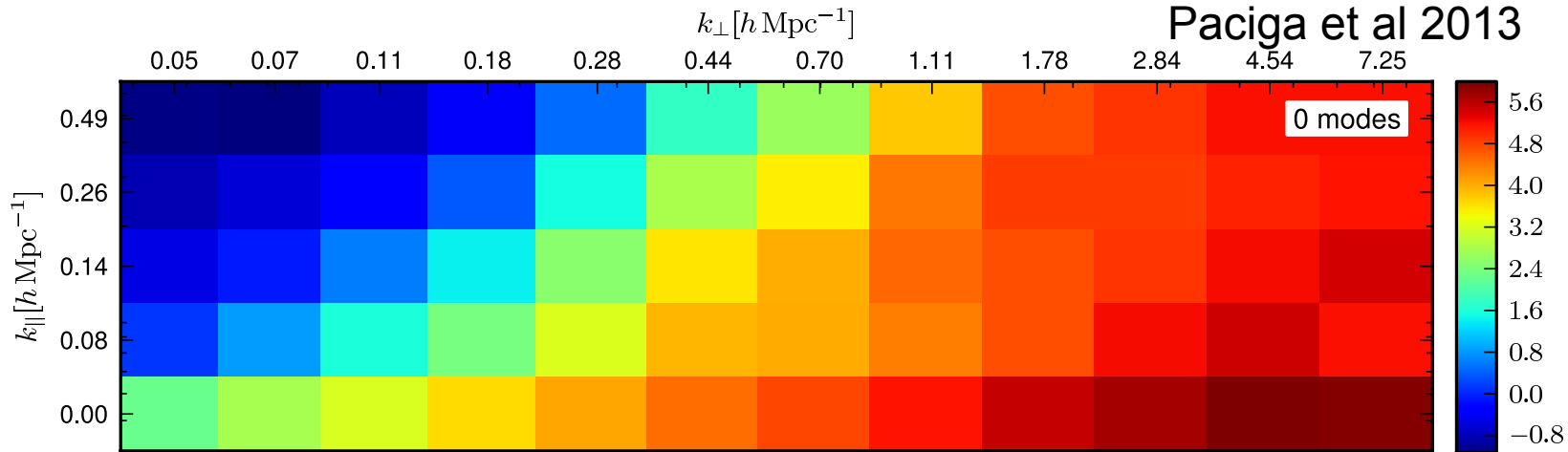
Premise: foregrounds are 1000x brighter, but smooth in frequency

Challenge: instrument is always mixes spatial structure with frequency structure: Diffraction limit. More challenging for sparse interferometers.

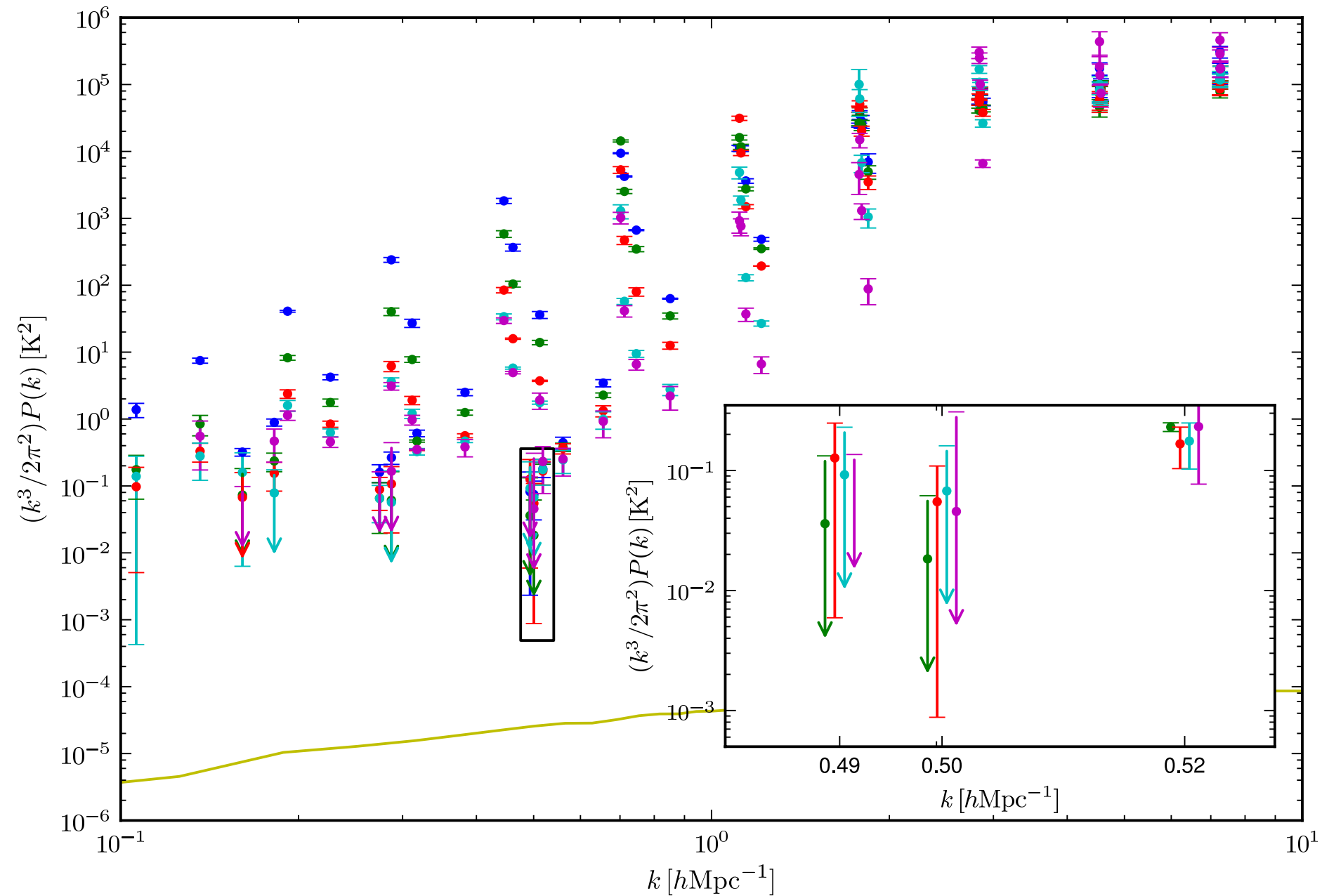
Approach: SVD, S/N eigenmode analysis. Paciga et al 2013, Masui et al 2013a,b, Shaw et al 2013

# Paciga et al 2013





# Paciga et al 2013



# GBT 21 cm intensity mapping collaboration

**Academia Sinica** (Tzu-Ching Chang, **Victor Yu-wei Liao**)

**Beijing** (Xuelei Chen, **Yi-Chao Li**)

**Carnegie Mellon University** (**Aravind Natarajan**, Jeff Peterson, **Tabitha Voytek**)

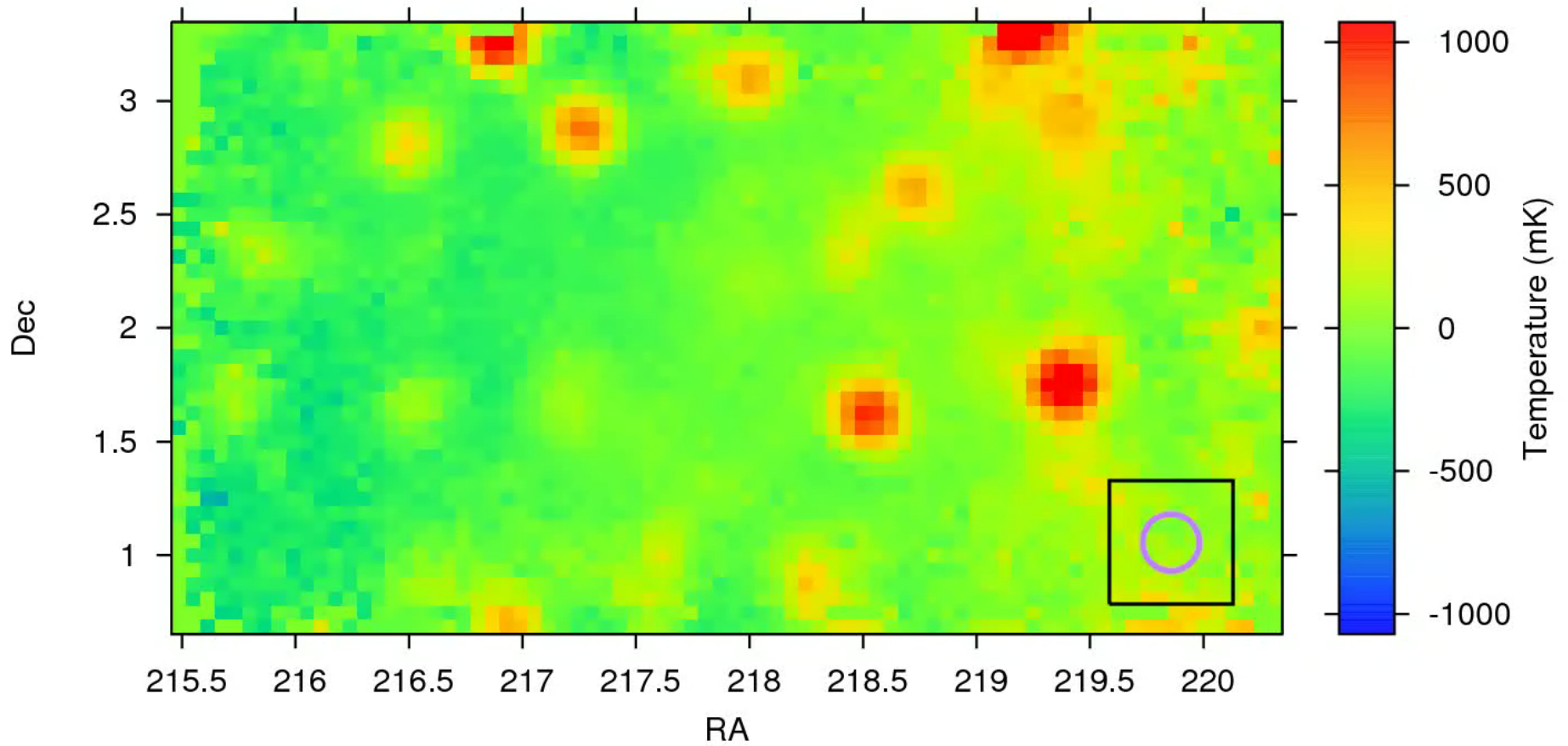
**CITA/UToronto** (Nidhi Banavar, **Liviu Calin**, Adam Lewis, **Kiyo Masui**, Ue-Li Pen, **Richard Shaw**, **Eric Switzer**)

**McGill** (Kevin Bandura)



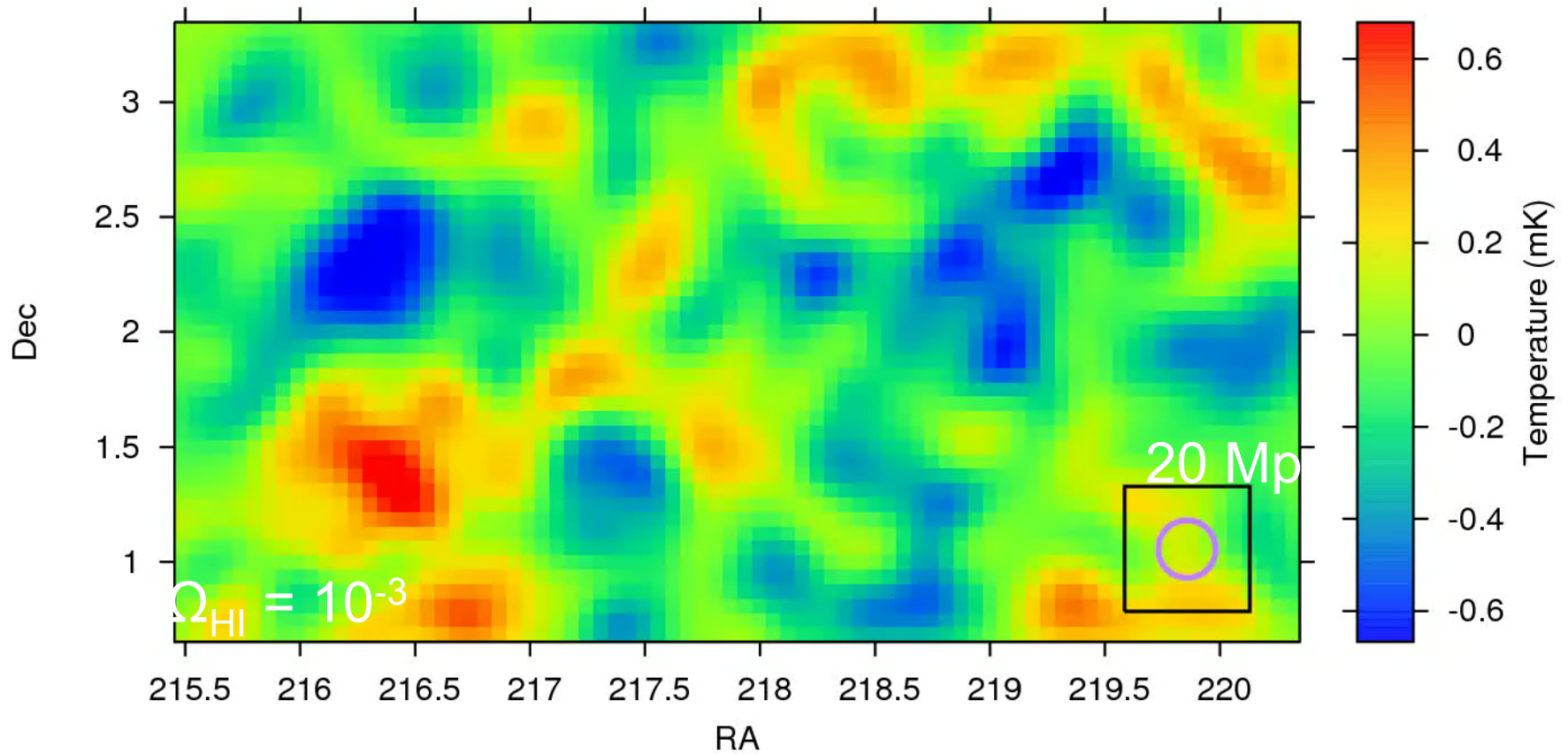
# GBT-IM

Sec. A, GBT\_15hr\_map ( $i = 0$ , freq = 899.6 MHz,  $z = 0.579$ ,  $D_c = 2107$  cMpc)



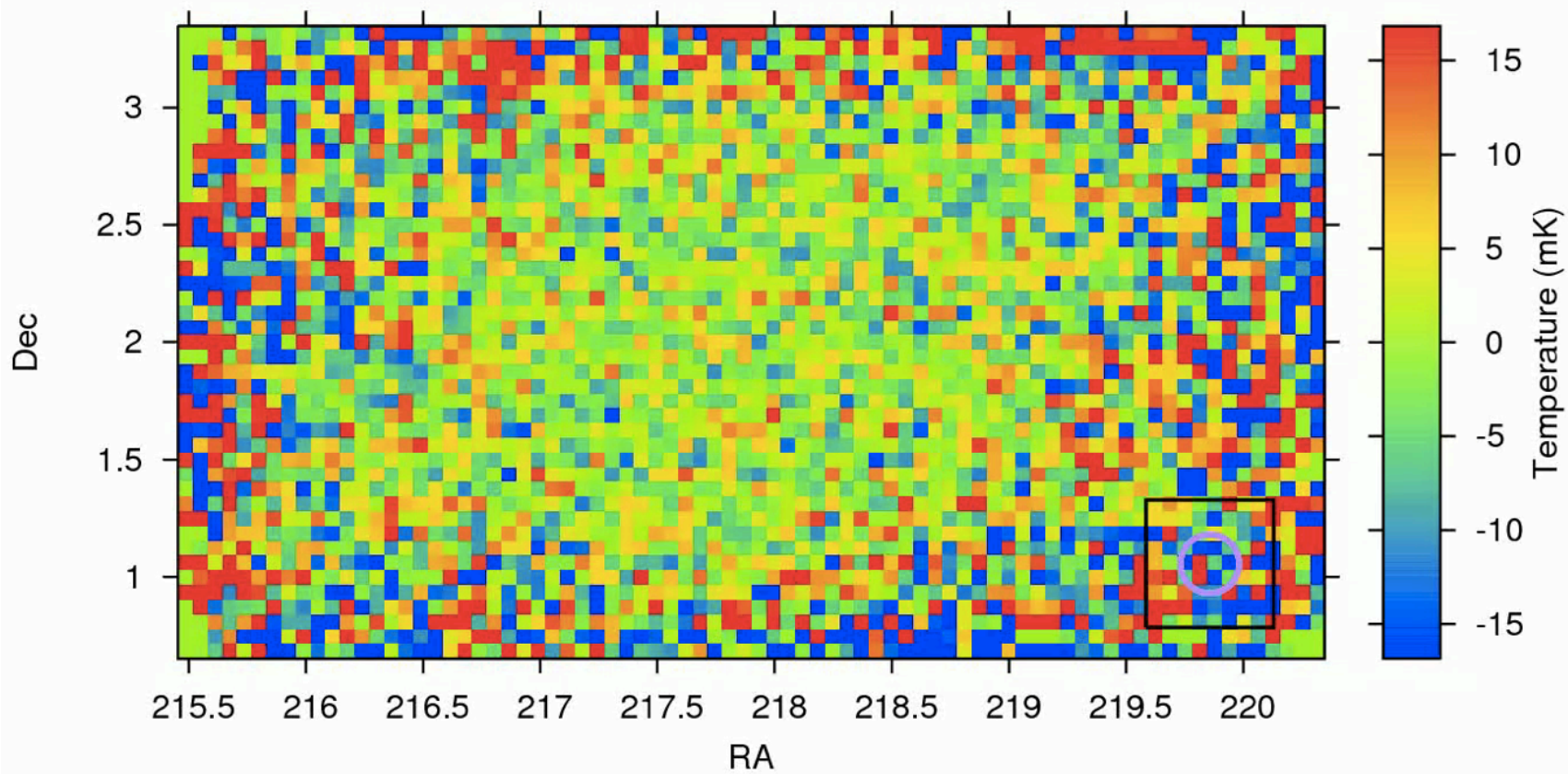
# Signal-only simulations

simvel\_beam\_000 (i = 0, freq = 899.6 MHz, z = 0.579, Dc=2107 cMpc)

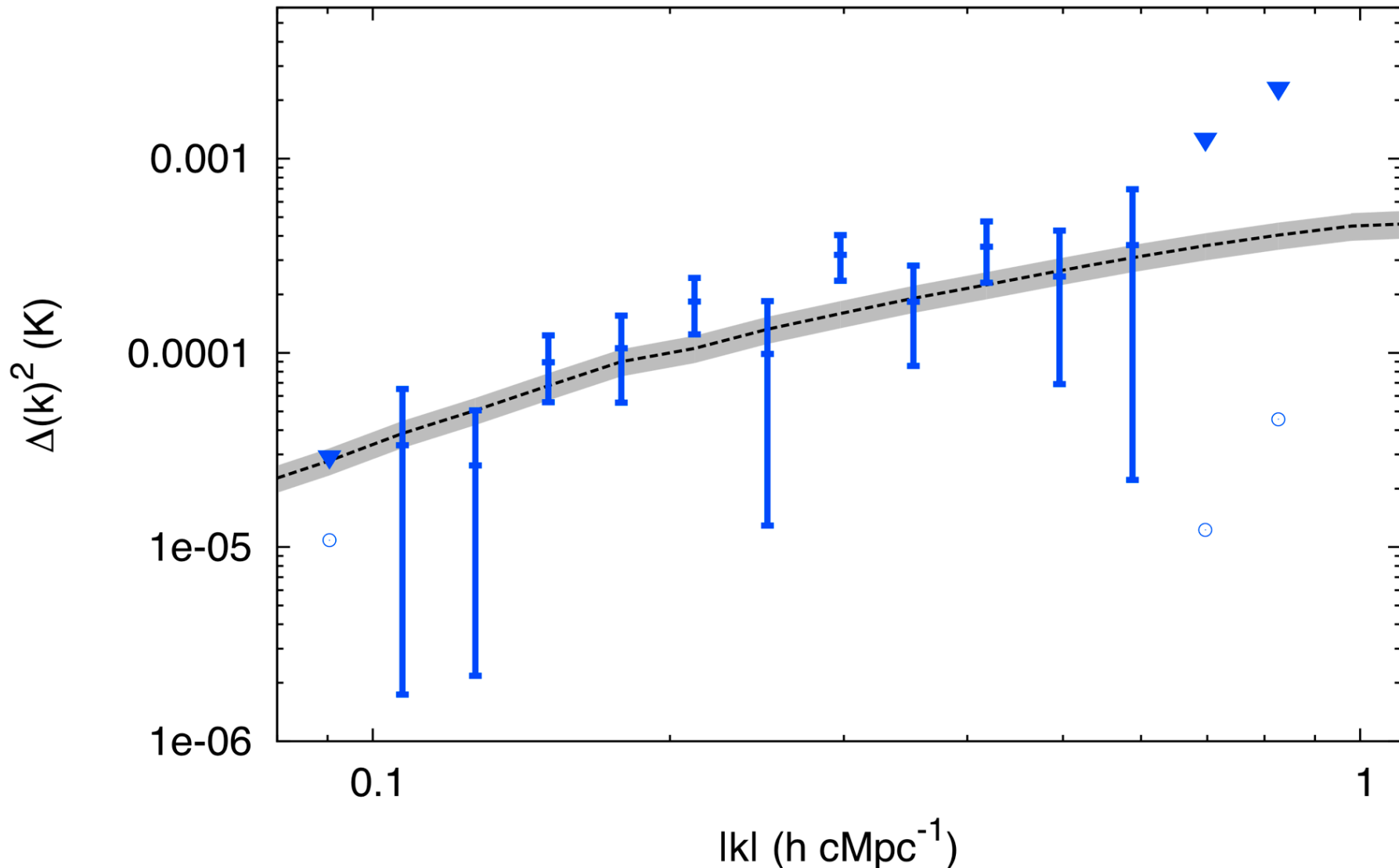




5hr\_map\_fdgcal\_cleaned\_noconv\_combined-map\_20modes (i = 0, freq = 899.6 MHz, z = 0.579, Dc=2107 cMpc)



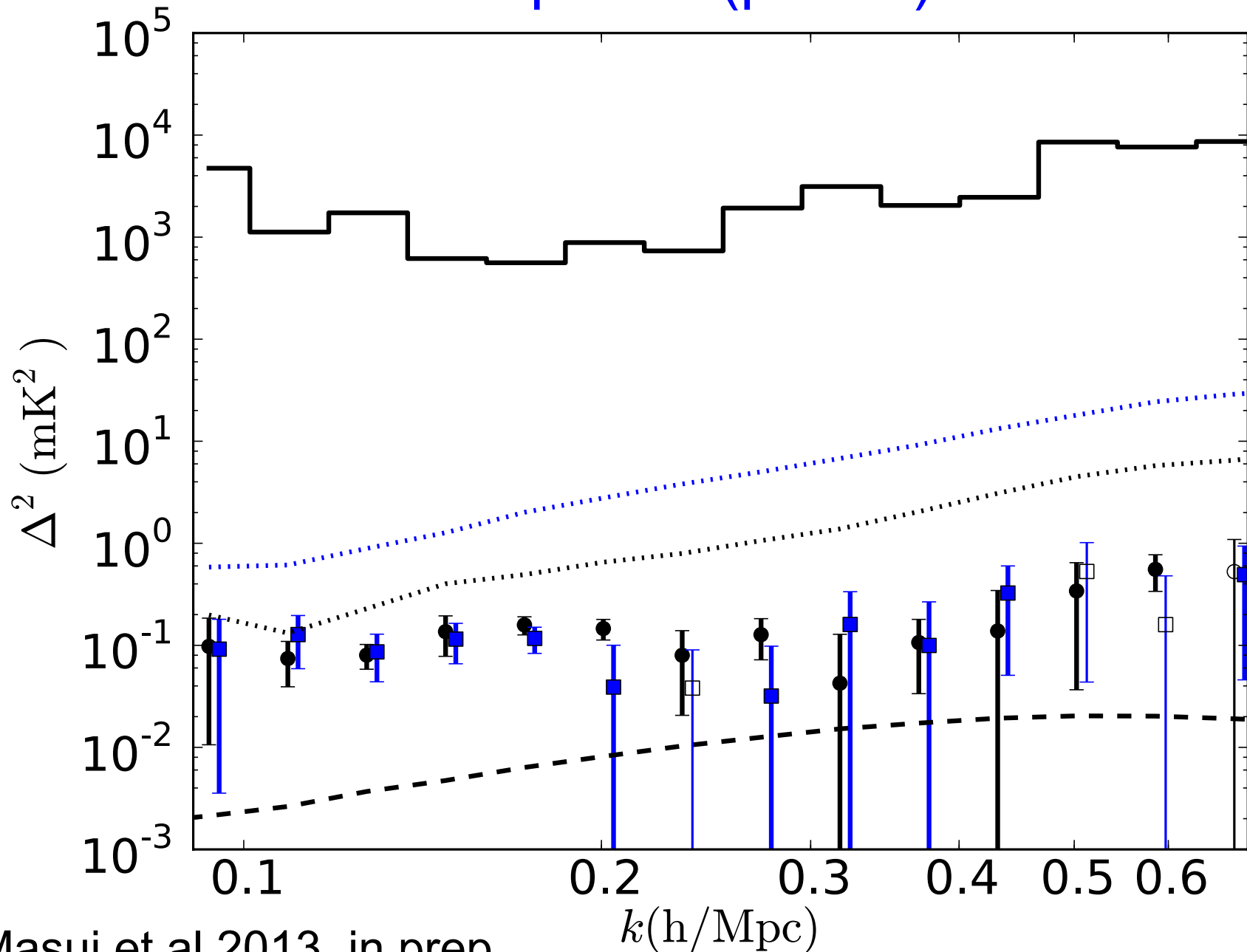
# GBT x WiggleZ, 15 hr field



$0.6 < z < 1$ , Masui et al 2013, GBT-IM collaboration.

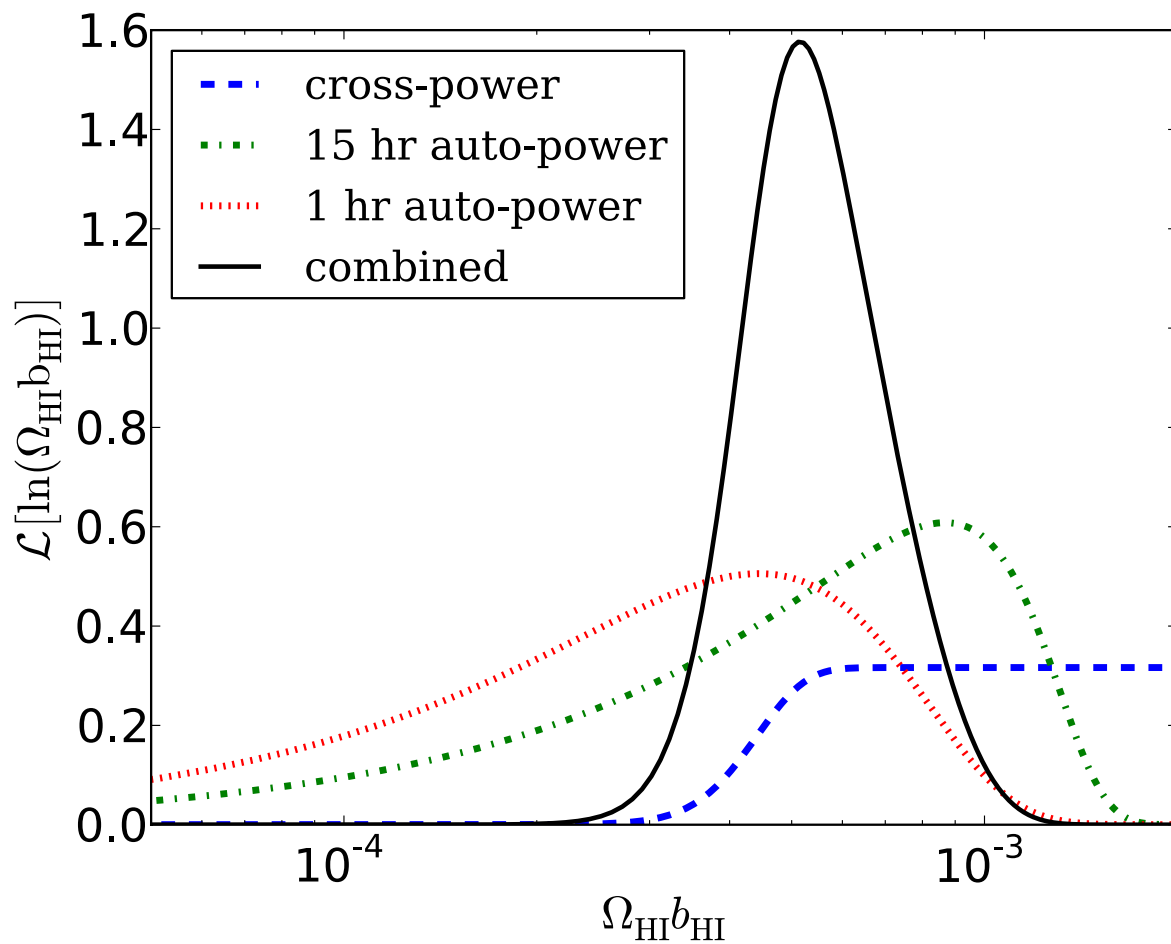
$$\Omega_{\text{HI}} b_{\text{HI}} r = [0.43 \pm 0.07(\text{stat.}) \pm 0.04(\text{sys.})] \times 10^{-3}$$

# 21cm self power (prelim)

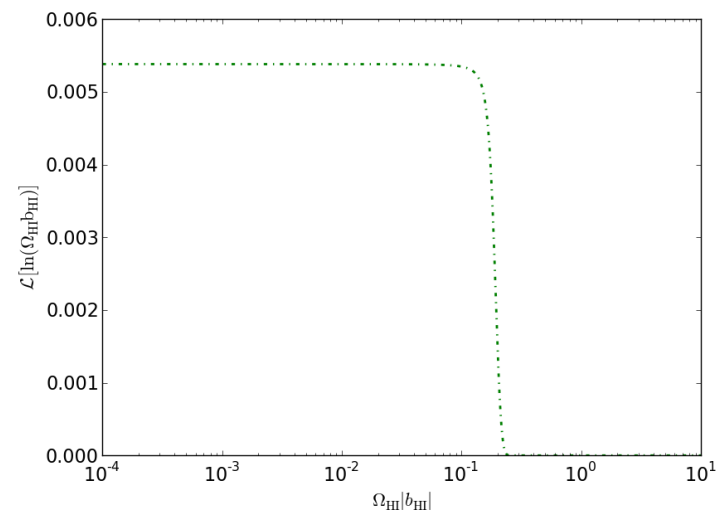


# Current measurement of $z \sim 1$ cosmic 21cm

$\Omega_{\text{HI}} b = 0.6 \pm 0.16 \pm 0.05 \times 10^{-3}$



Masui et al 2013,  
preliminary



# Canadian Hydrogen Intensity Mapping Experiment

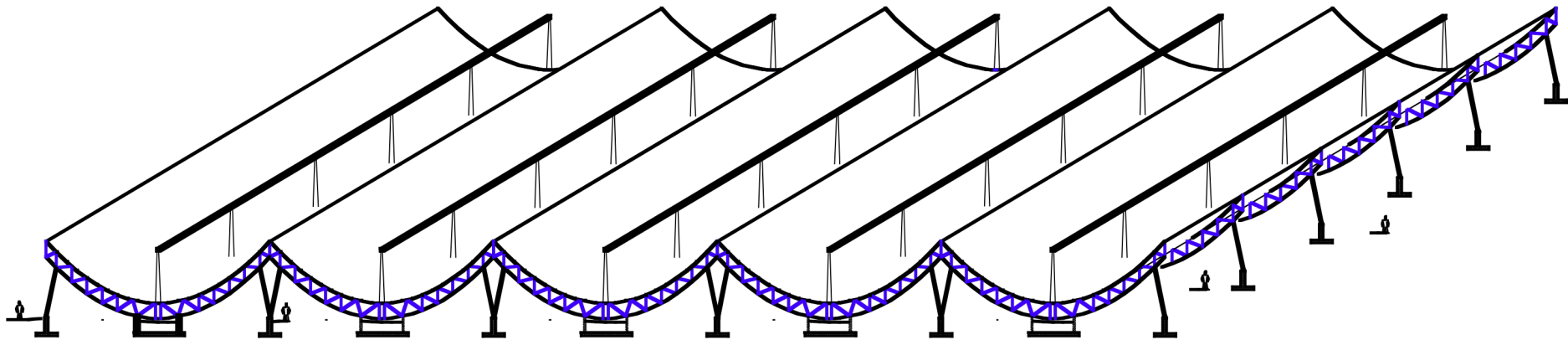
Fast Fourier Transform Telescope:  
CMU, CHIME, Tianlai, CRT, etc

CHIME: construction at Penticton, BC

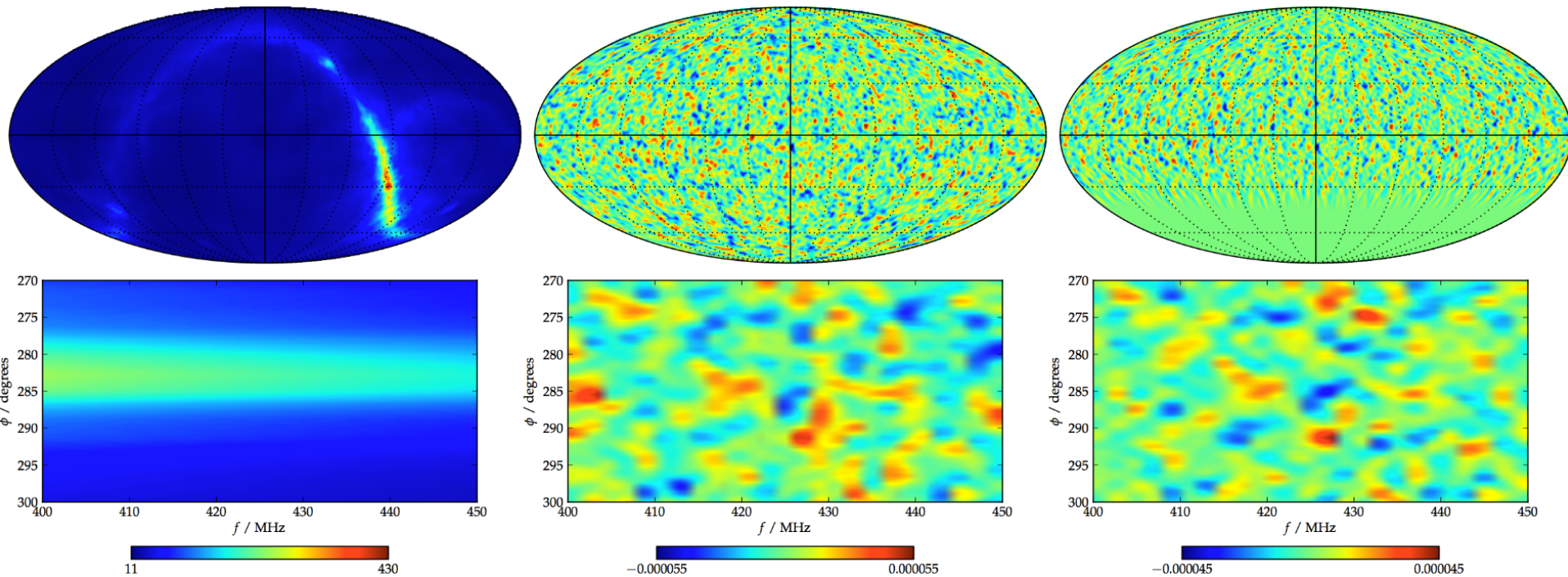
CFI-funded collaboration: McGill, Toronto, UBC

Pathfinder (20%): Late 2013

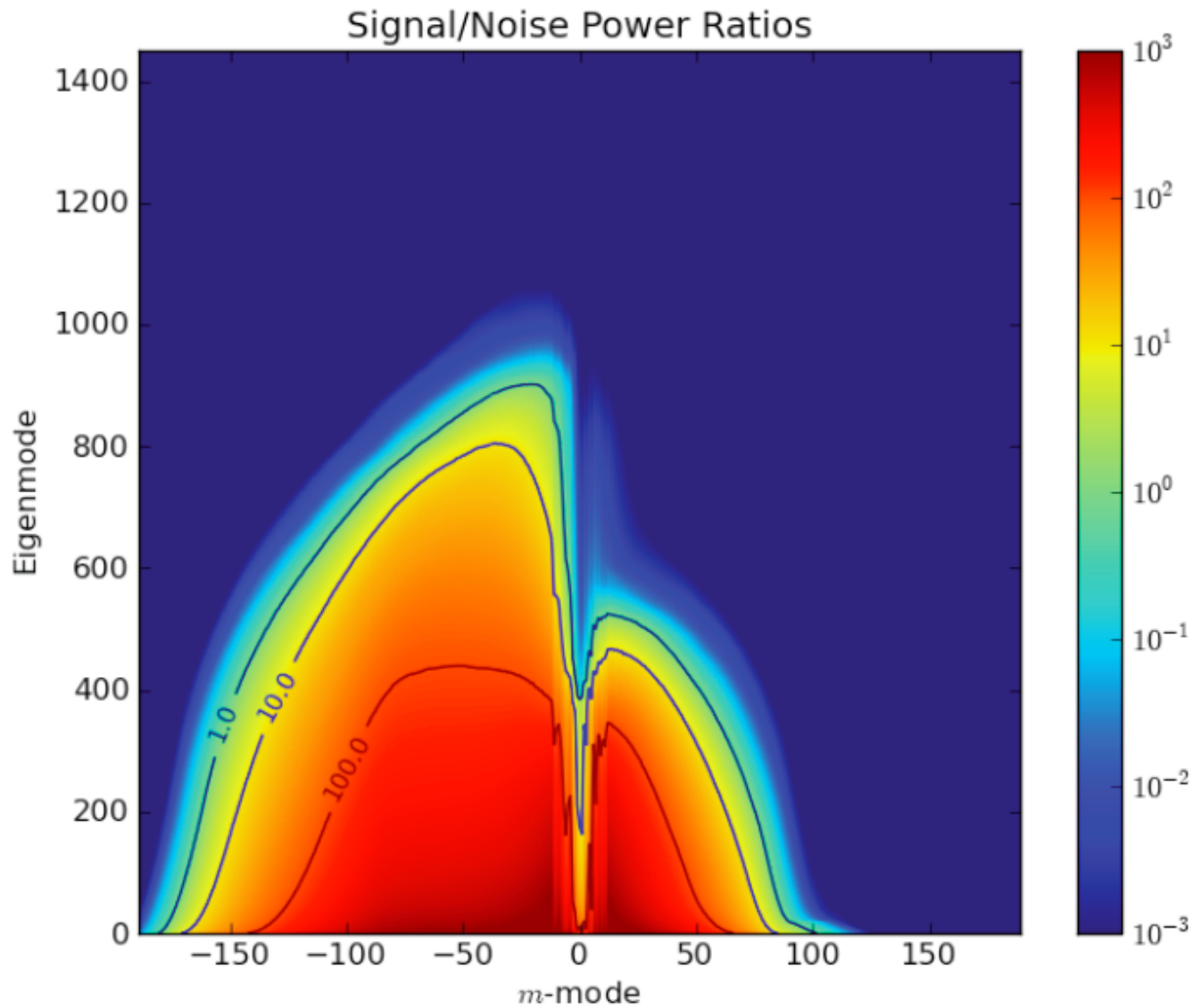
Full operation: 2015



# CHIME imaging and foregrounds: all sky m-mode



Shaw et al, 2013



Shaw et al 2013b: also exact m based polarizarion de leaking.

# Lessons learned

EoR and IM are similar challenges.

Long baselines not essential. Pulsar calibration.

Stability: filled aperture, reflectors, rigid response -> drift scan (in progress @GMRT)

Polarization: same strategy

Computation: FFT-beam forming, FFT m-mode...

Layout: maximize collecting area. N-S cylinders.

CHIME: funded, under construction. Scalable to lower frequencies.

GBT-multibeam: faster mapping w/7 beams