

# meerkat autocorrelations: 1/f noise

prina patel  
ska ksp meeting, goa, nov 2016



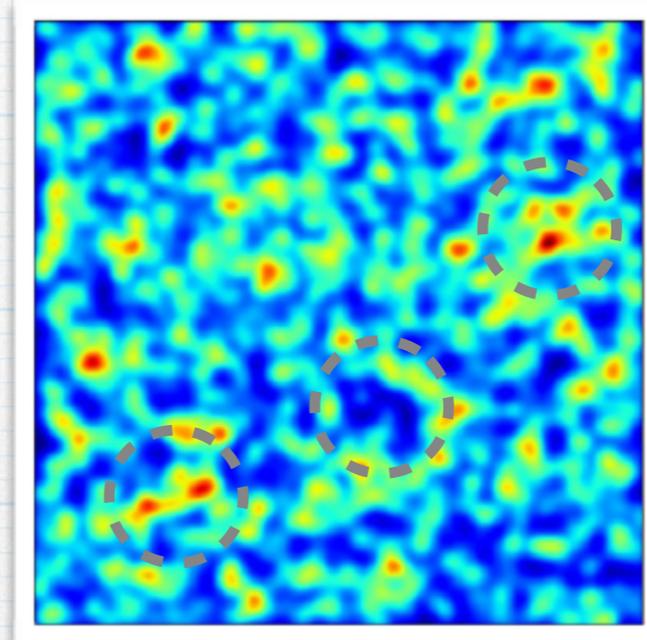
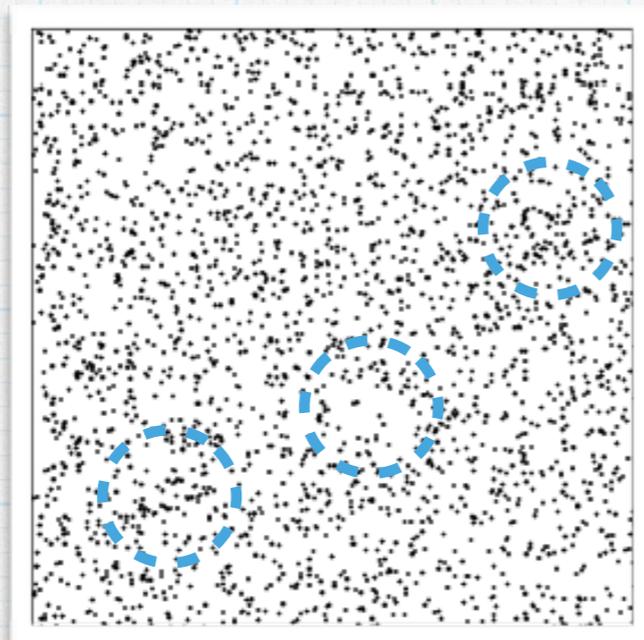
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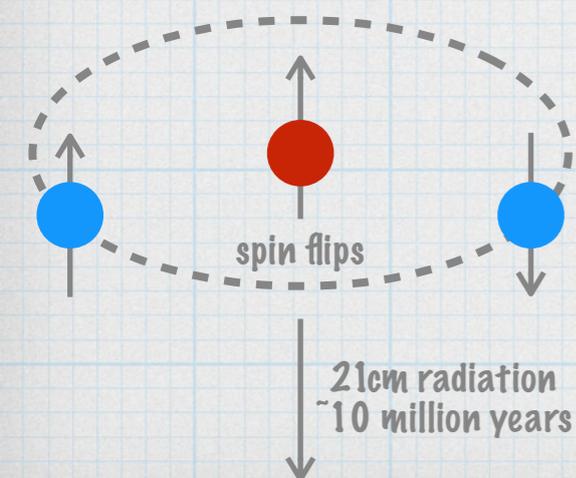


SKA AFRICA  
SQUARE KILOMETRE ARRAY

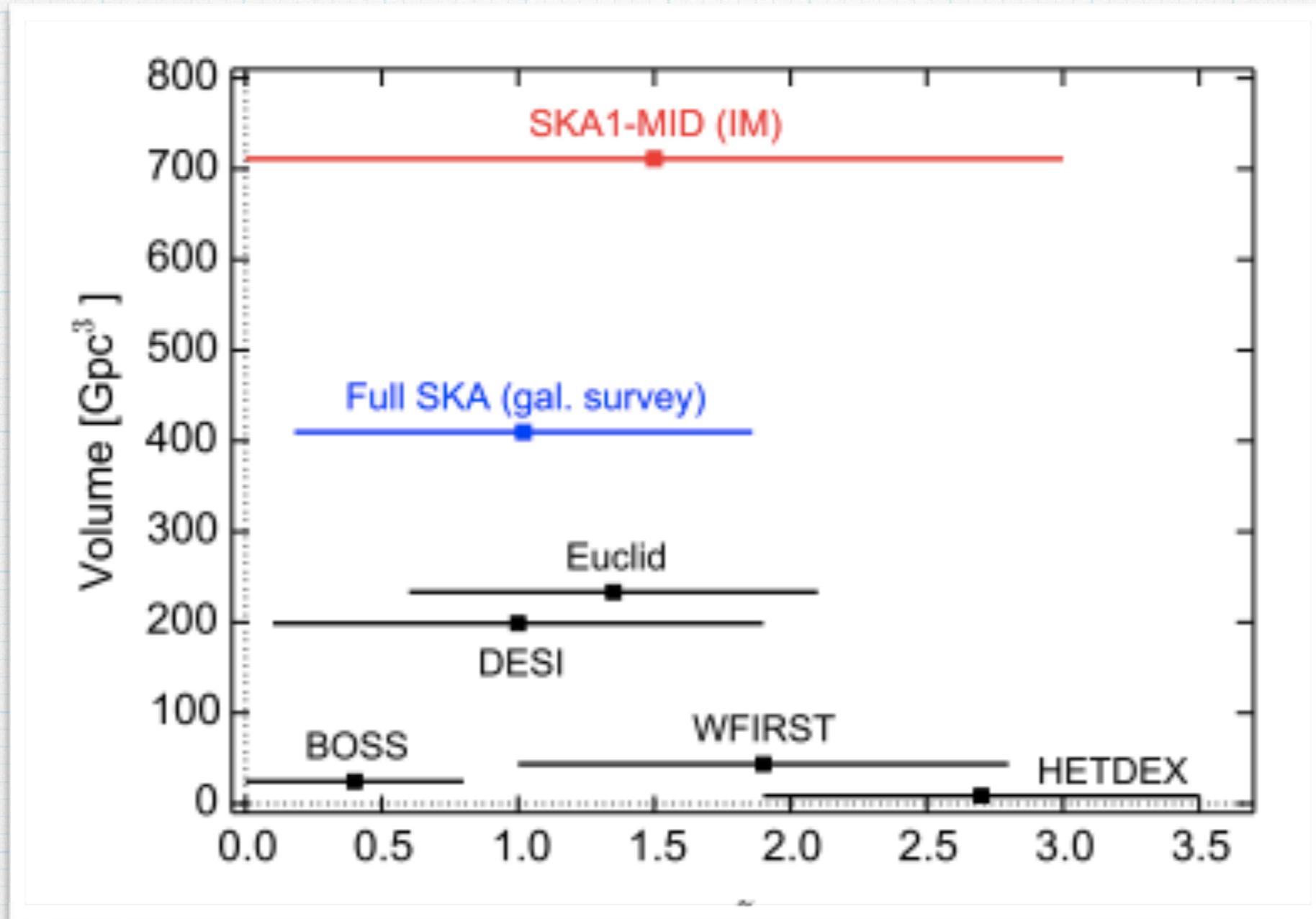
# 21cm intensity mapping



- \* measure the integrated emission of the 21cm line from many galaxies
- \* 3d datasets  $\rightarrow$  map the IGM at different redshift



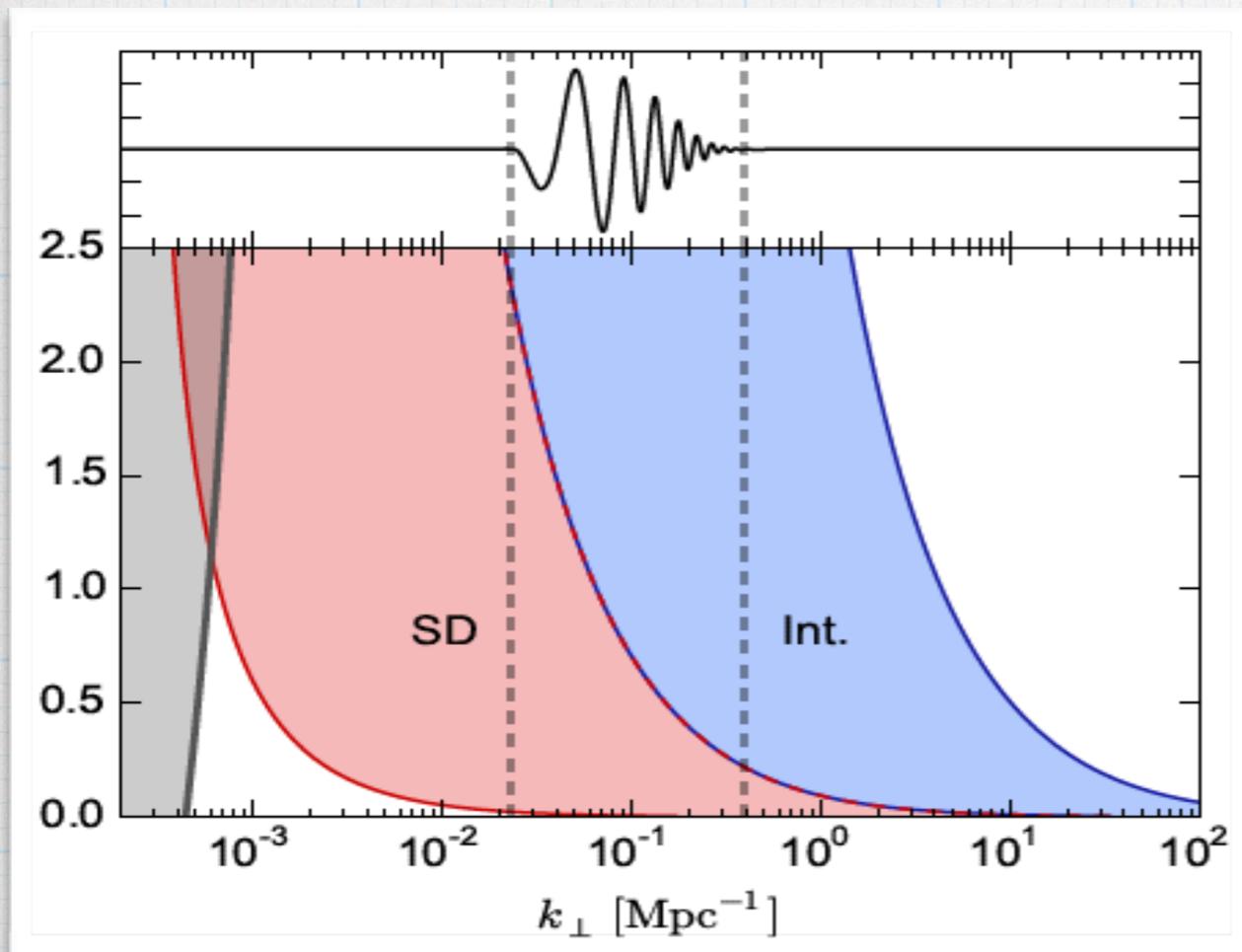
# 21cm intensity mapping



measure large volumes cheaply: ideal for cosmology!

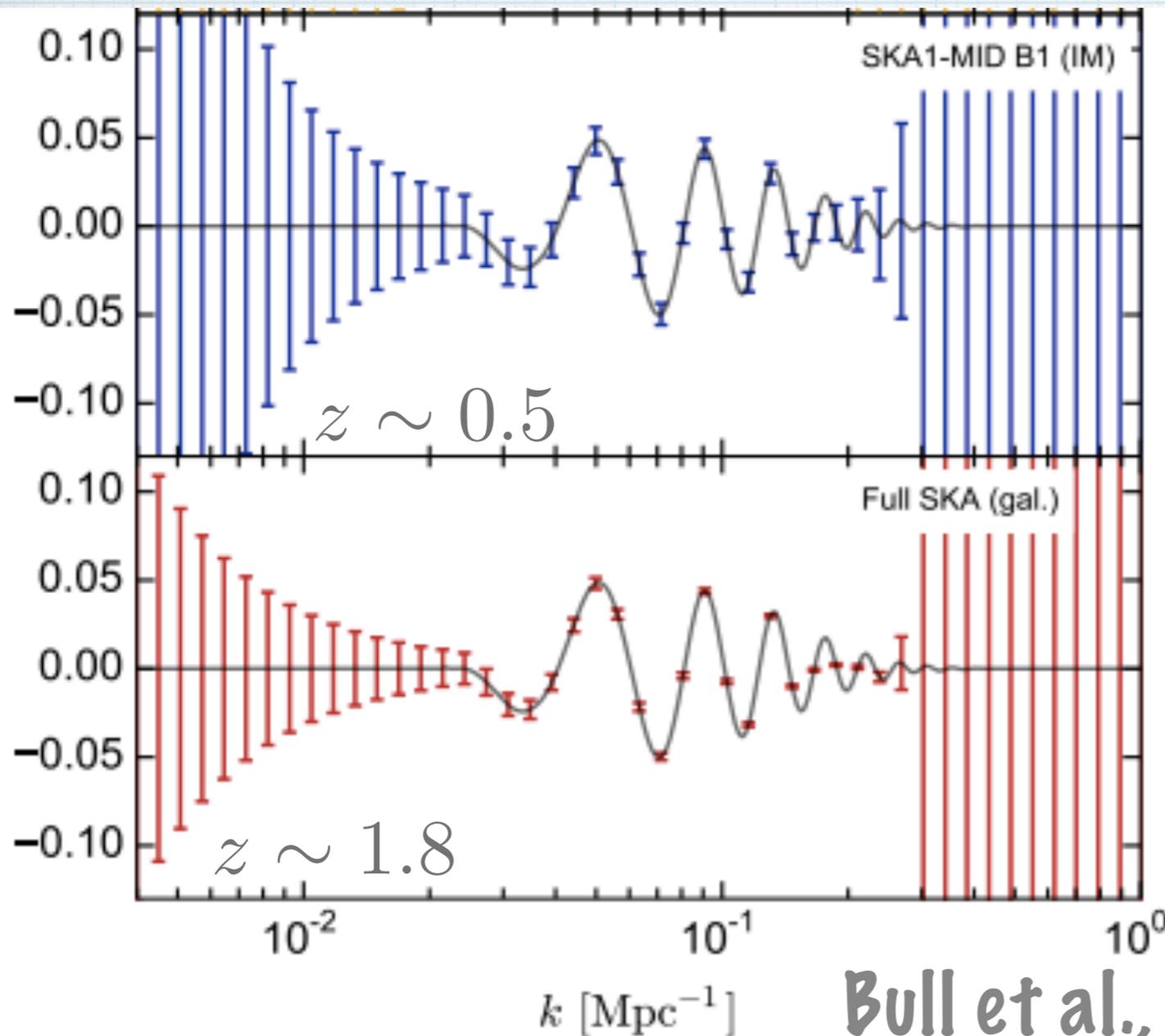
# interferometer or single dish?

interferometer baselines not small enough to probe bAO scales  
SKA in single dish mode!

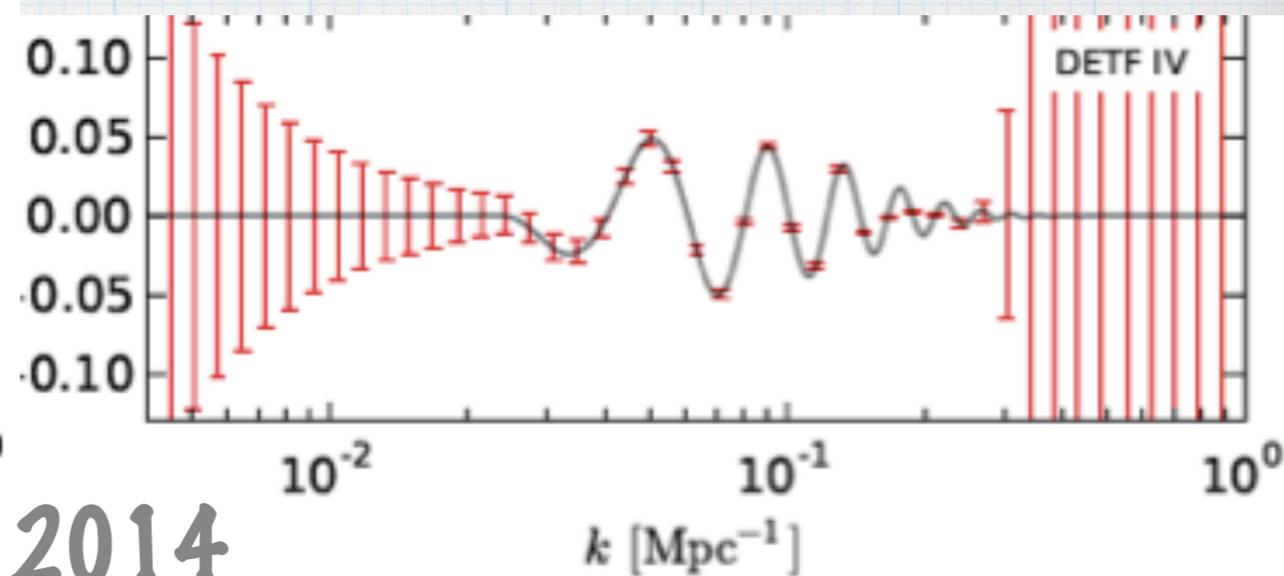


- \* need a combination of interferometer and single dish mode for bAO scales with  $z < 2$
- \* largest scales only accessible to single dishes

# bao with ska

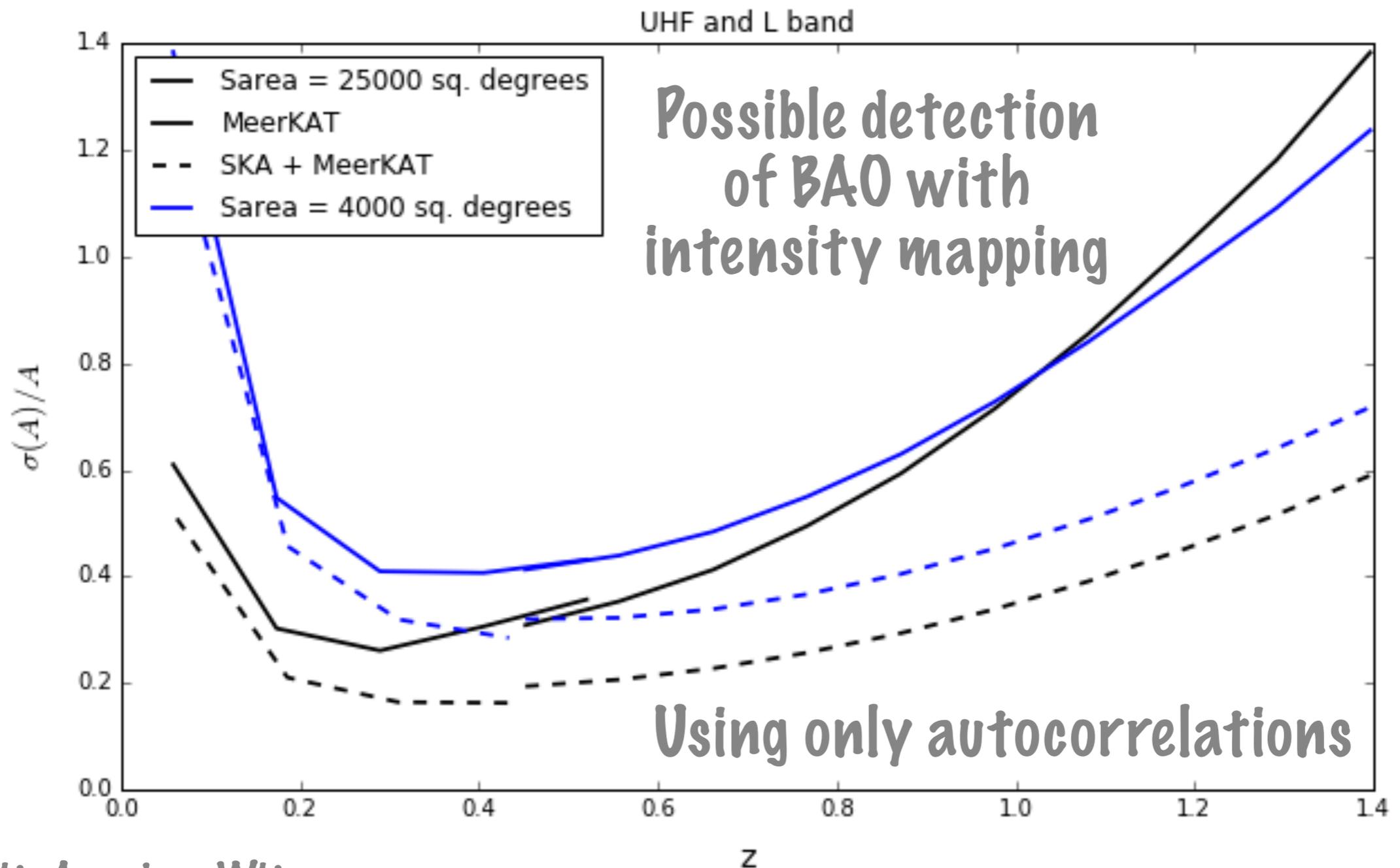


SKA1 Intensity mapping  
comparable to EUCLID  
galaxy survey for  
measuring the BAO

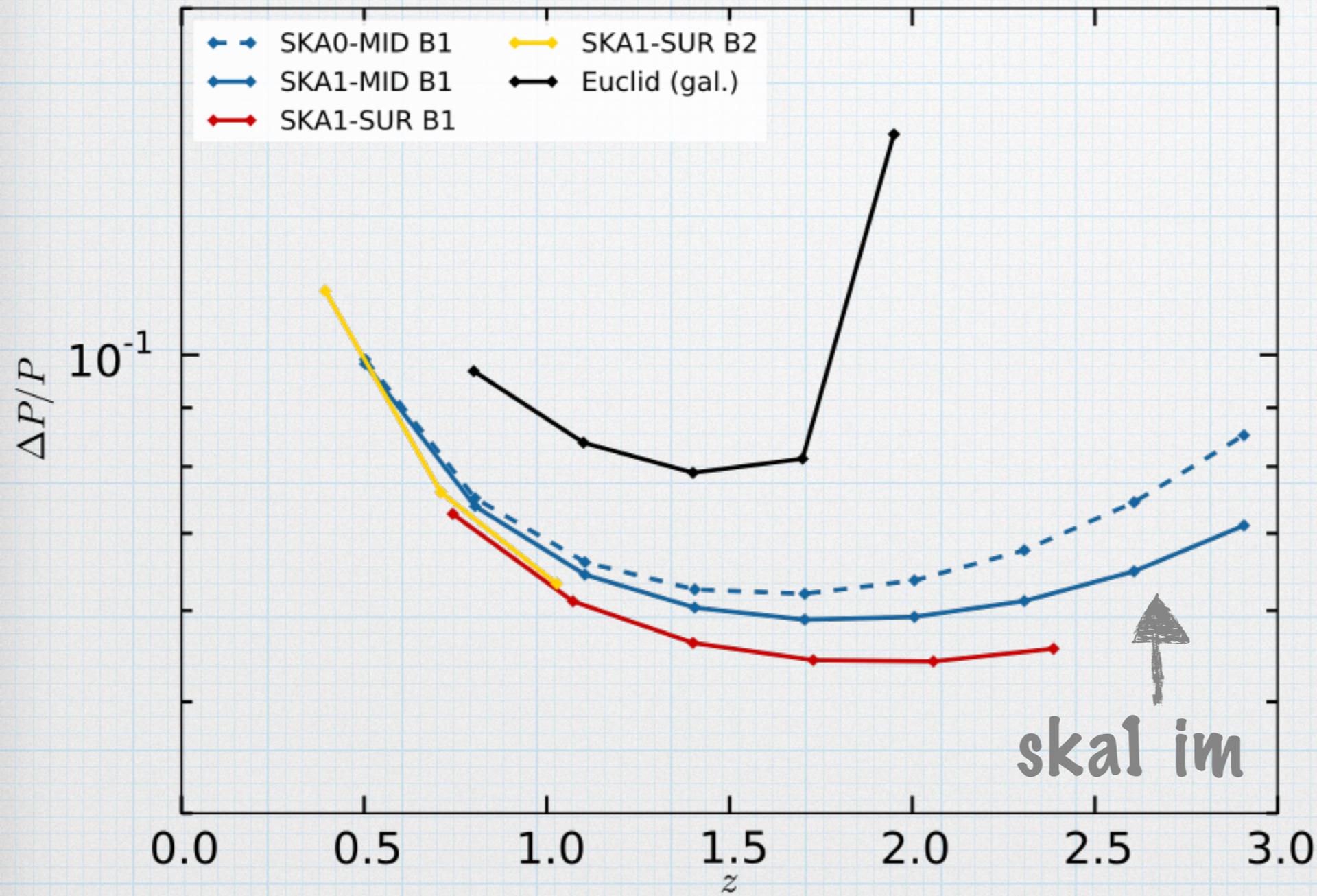


Bull et al., 2014

# bao with meerkat



# ultra large scales



probe the hi signal  
across a large  
redshift range:  
probes primordial  
fluctuations and  
non-gaussianity

↑  
ska1 im

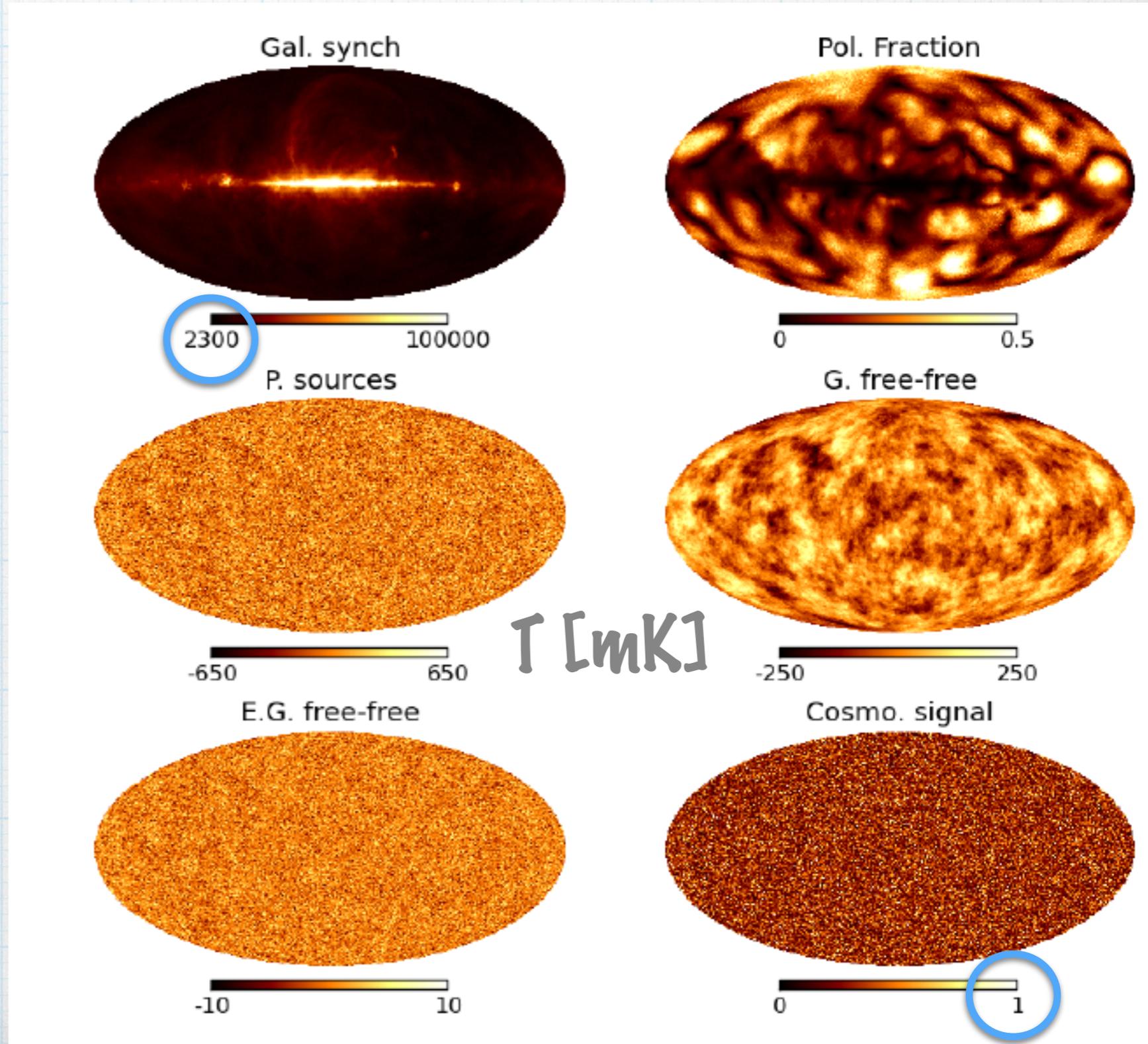
# foregrounds

foregrounds

orders of magnitude  
larger than signal

several contributors

**BUT** spectrally  
smooth



# noise

practical radiometer  
equation:

$$\left( \frac{\Delta T}{T_{sys}} \right) = \sqrt{\frac{1}{\Delta t \Delta \nu} + \left( \frac{\Delta G}{G} \right)^2}$$

$$\left( \frac{\Delta G}{G} \right)^2 = \gamma_0 + \gamma_1 t$$

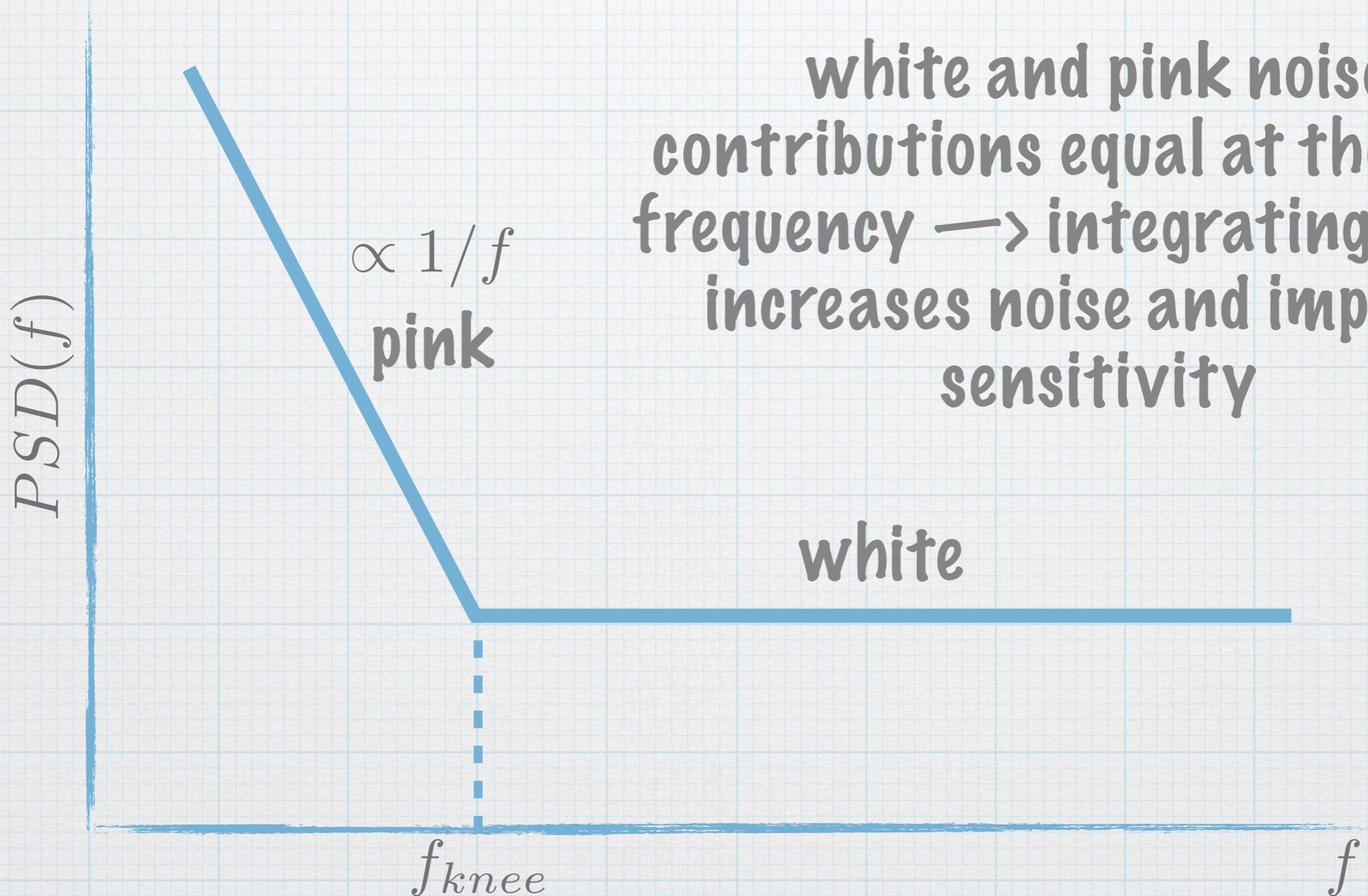
stochastic gain fluctuations

white and pink noise  
contributions are equal

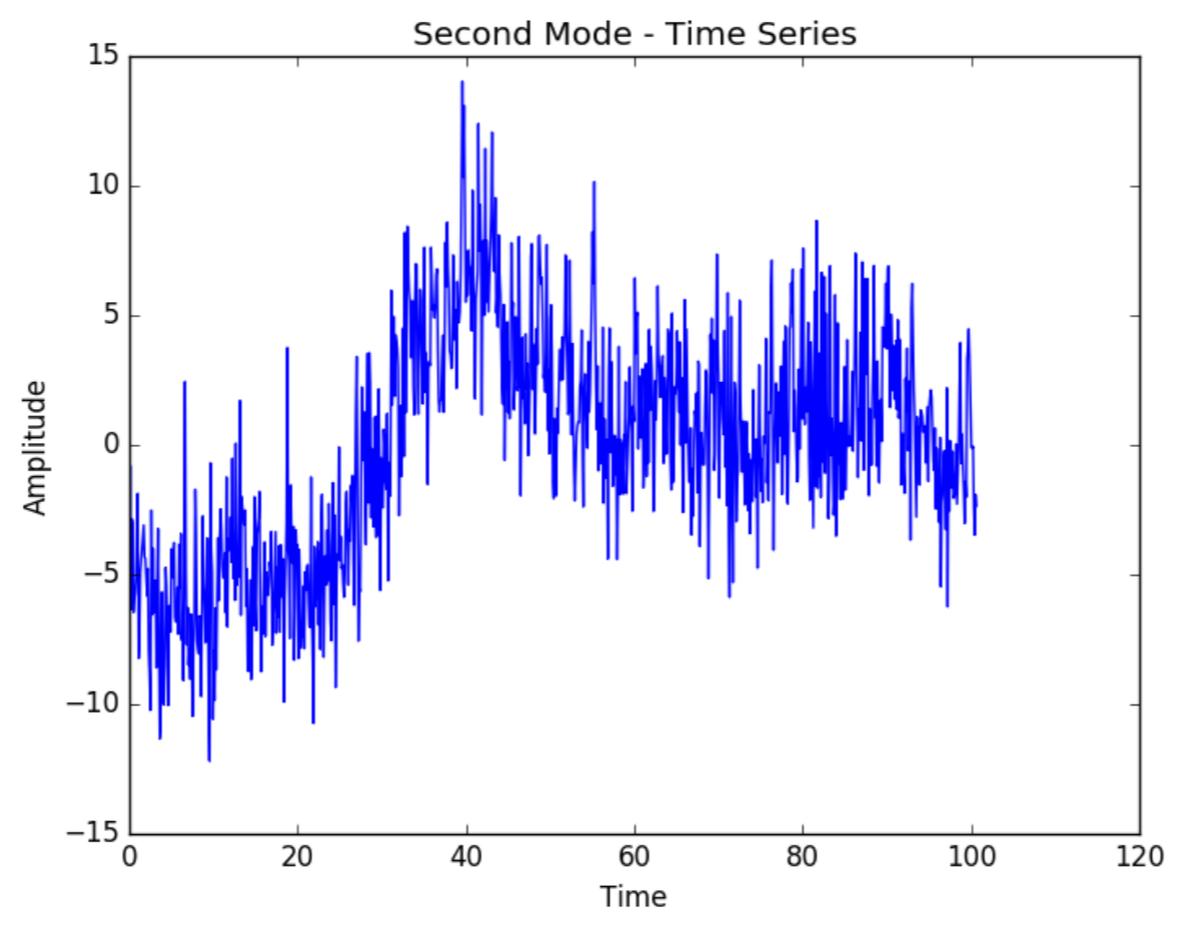
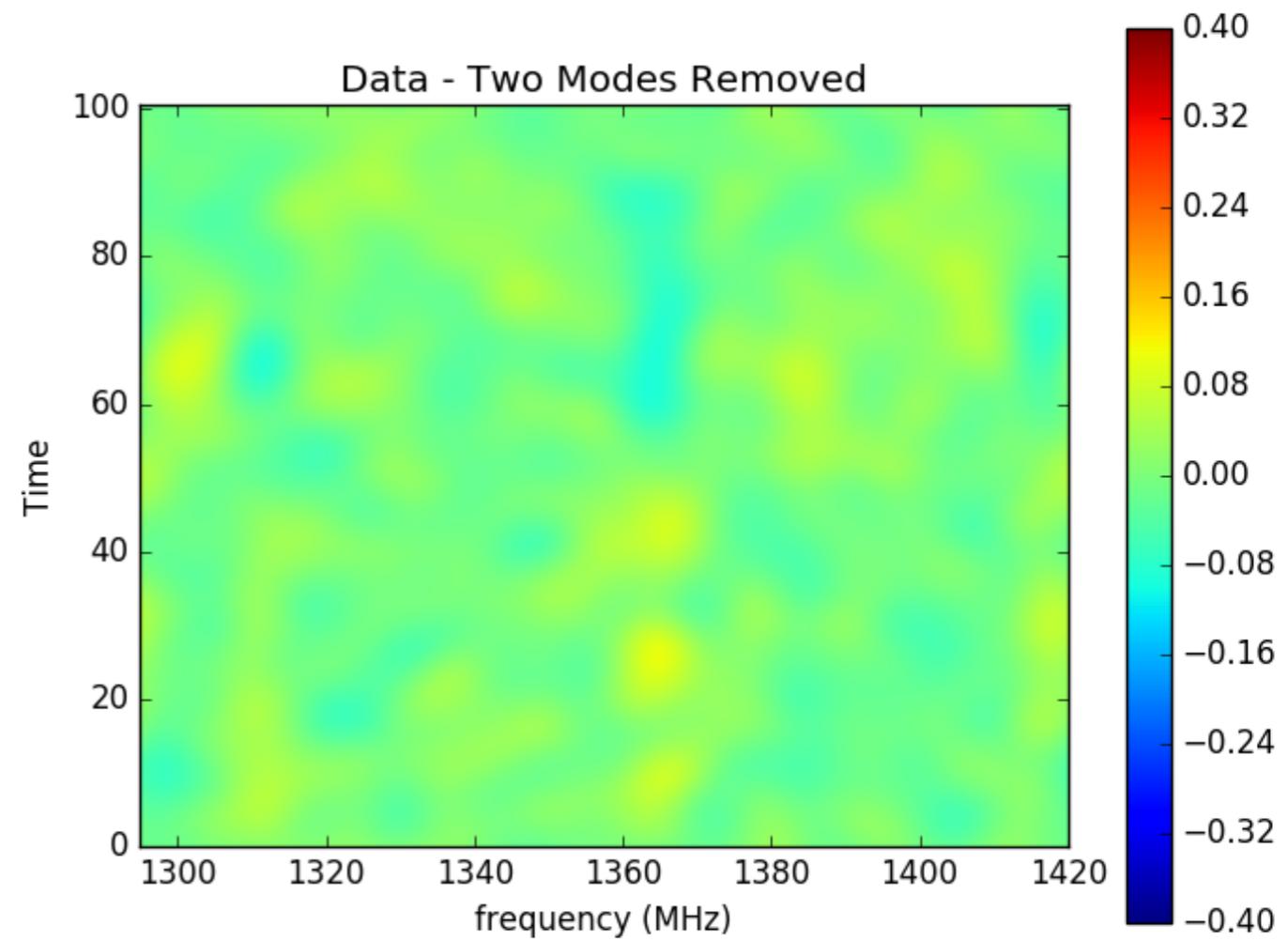
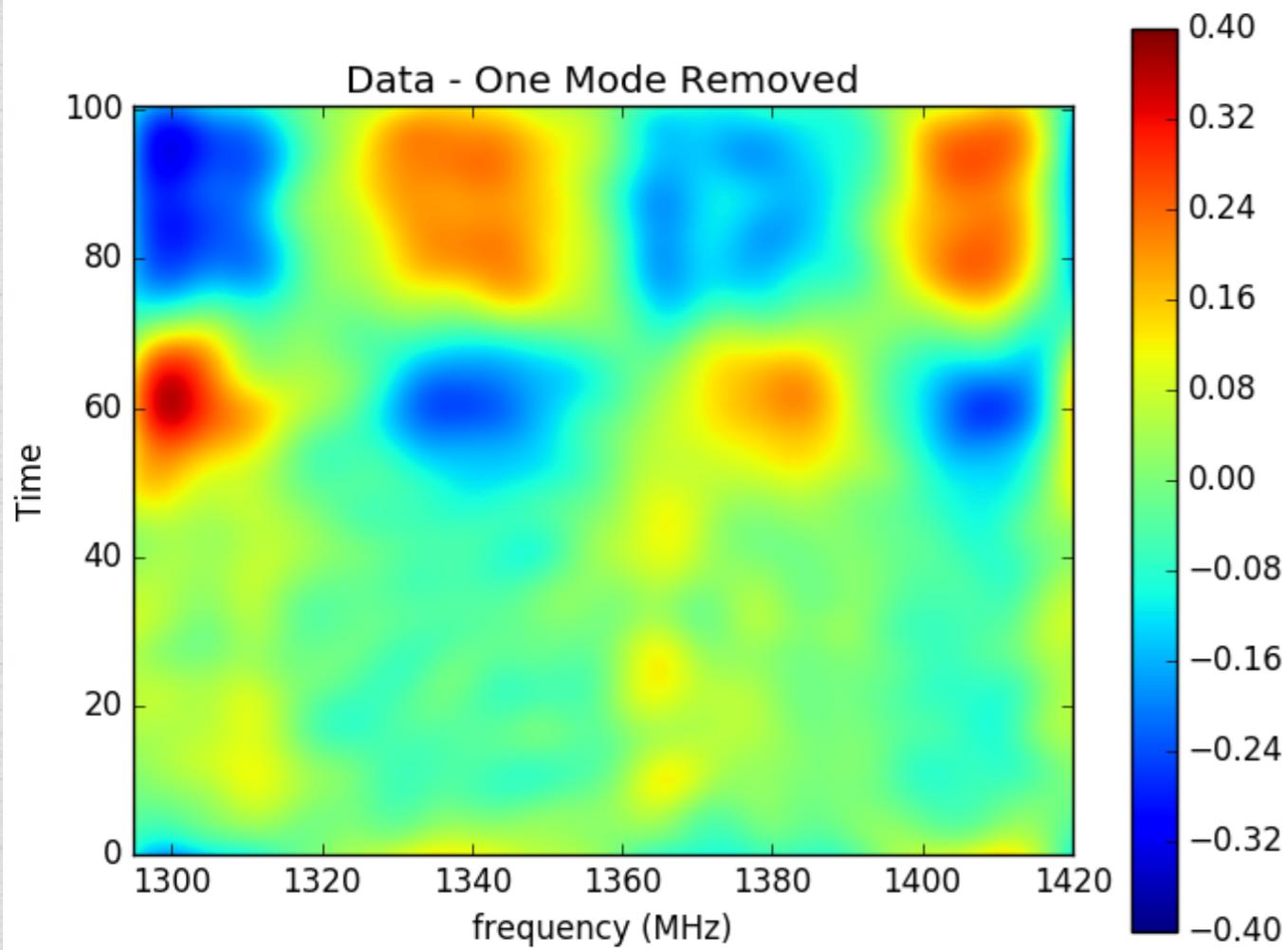
$$t = \frac{1}{\sqrt{\gamma_1 \Delta \nu}}$$

# noise

power spectrum in time...



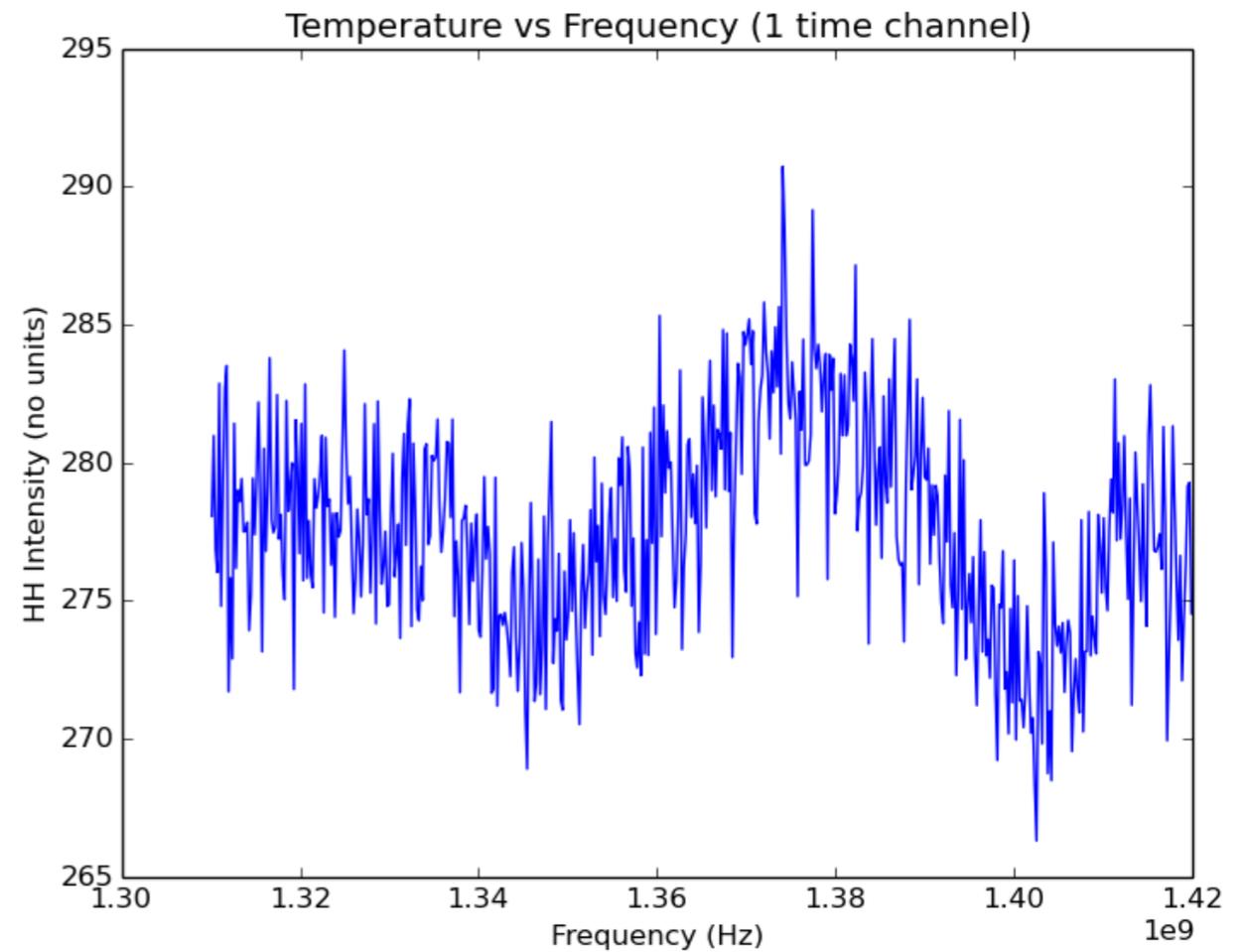
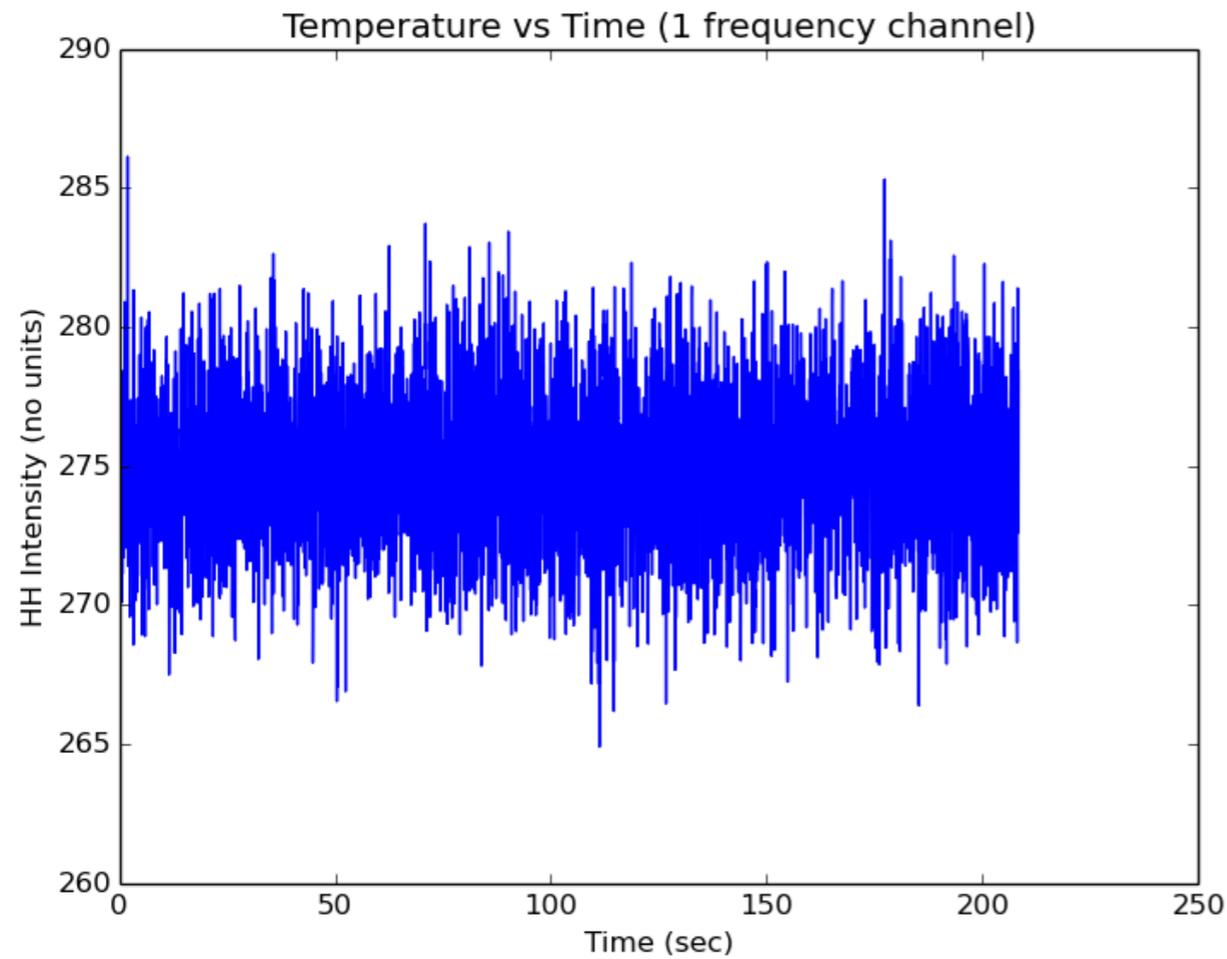
white and pink noise contributions equal at the knee frequency  $\rightarrow$  integrating longer increases noise and impacts sensitivity



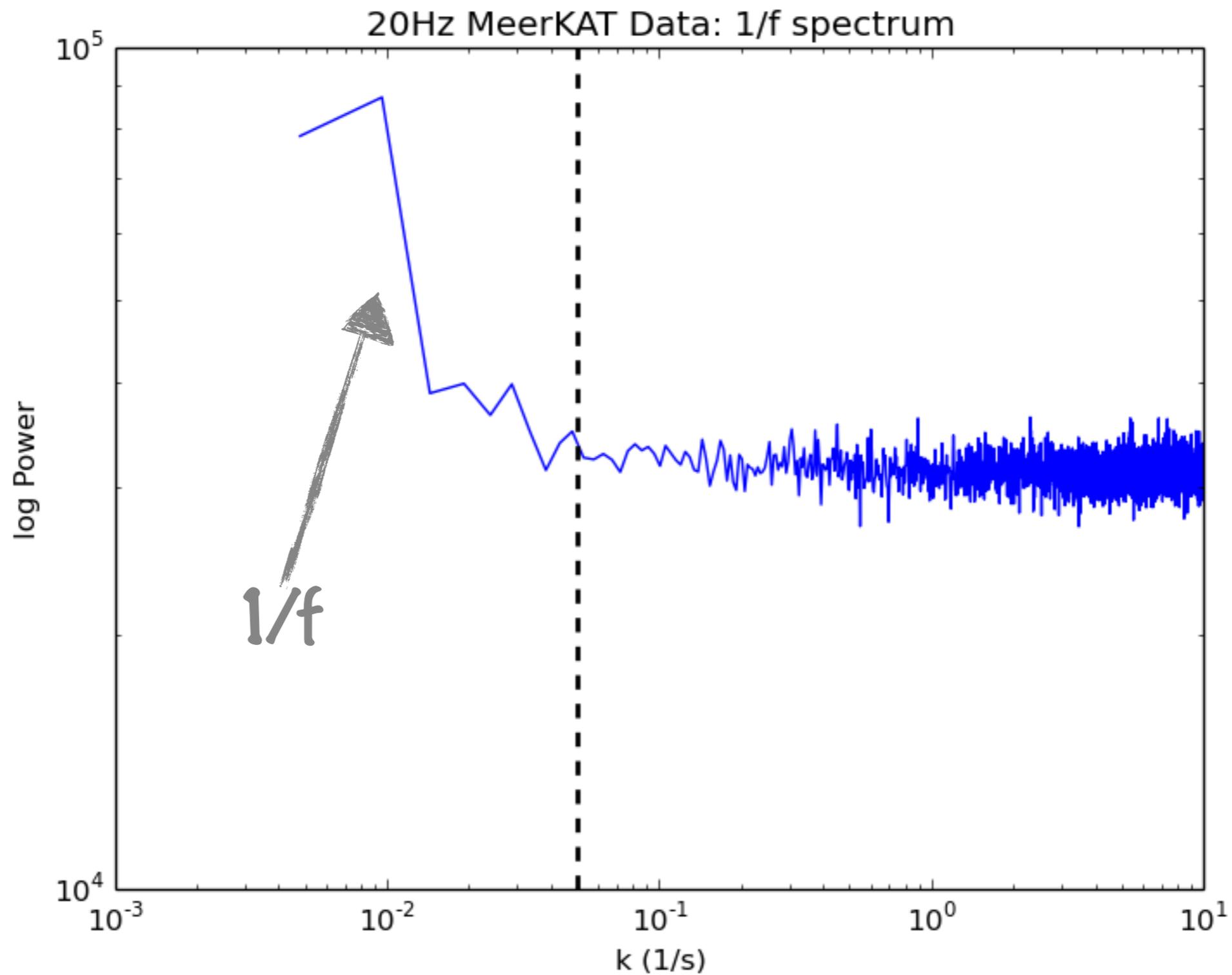
characterising  
meerkat 1/f

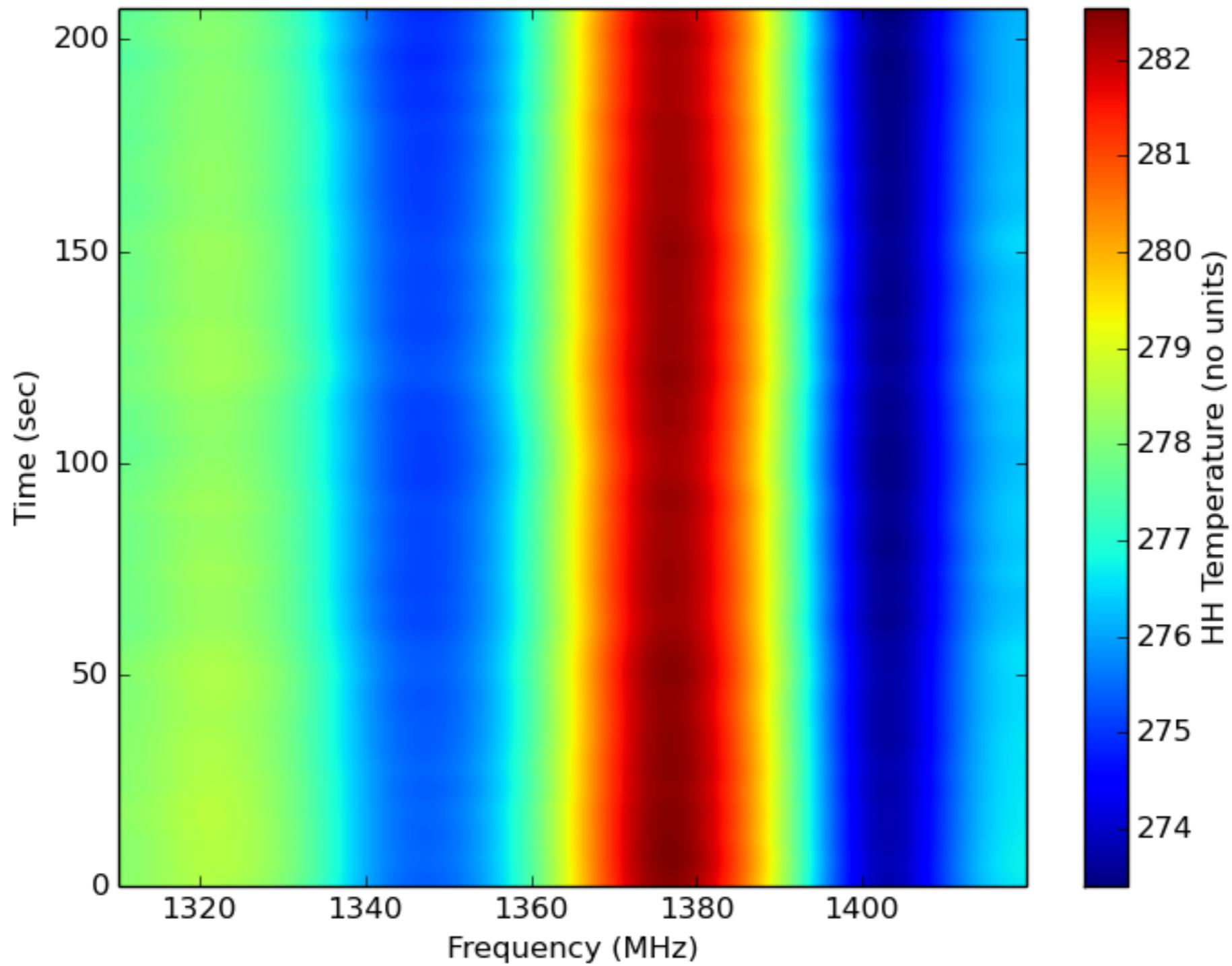
# meerkat autocorrelation data

200 seconds staring at the scp, 20hz dump rate



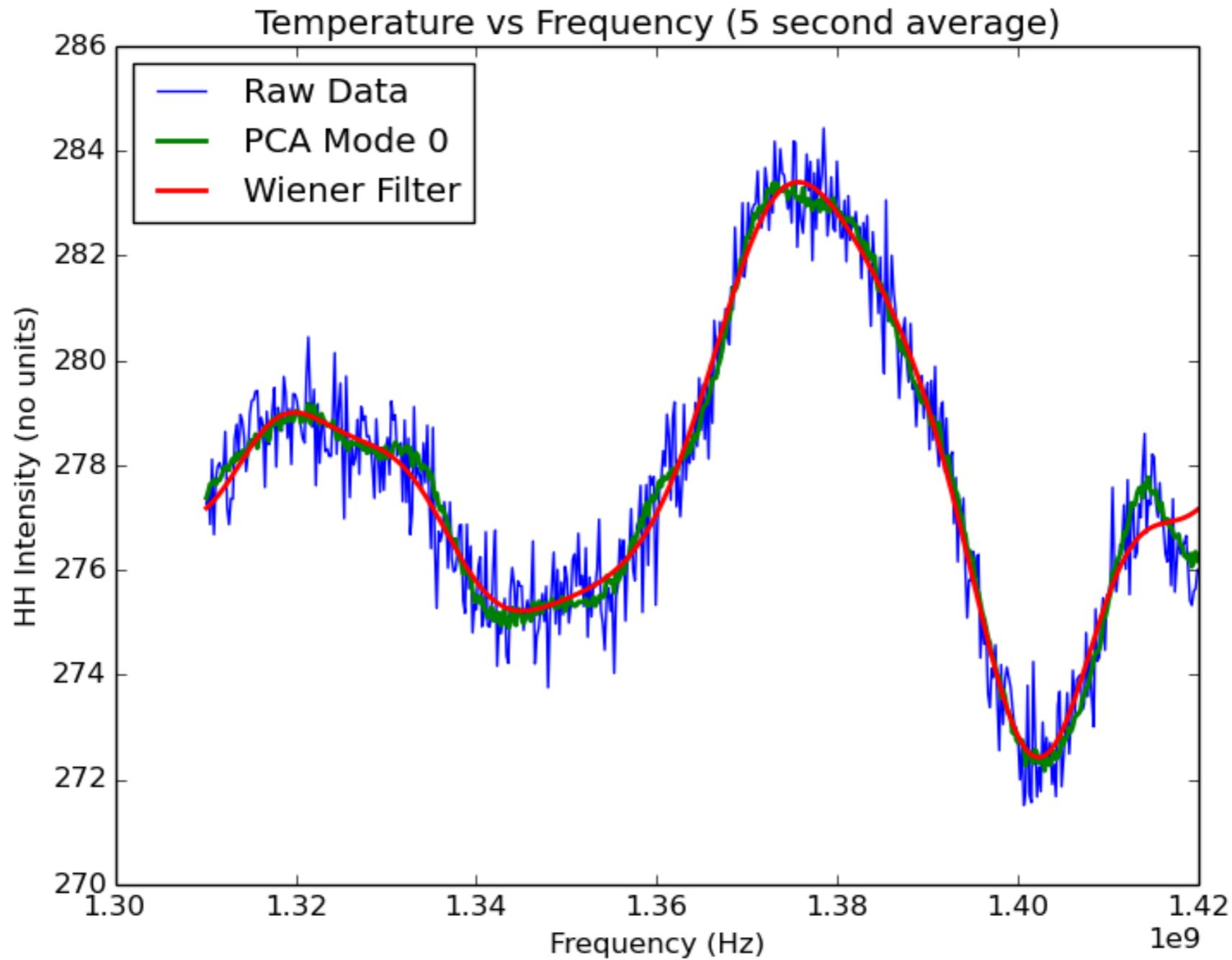
1/f



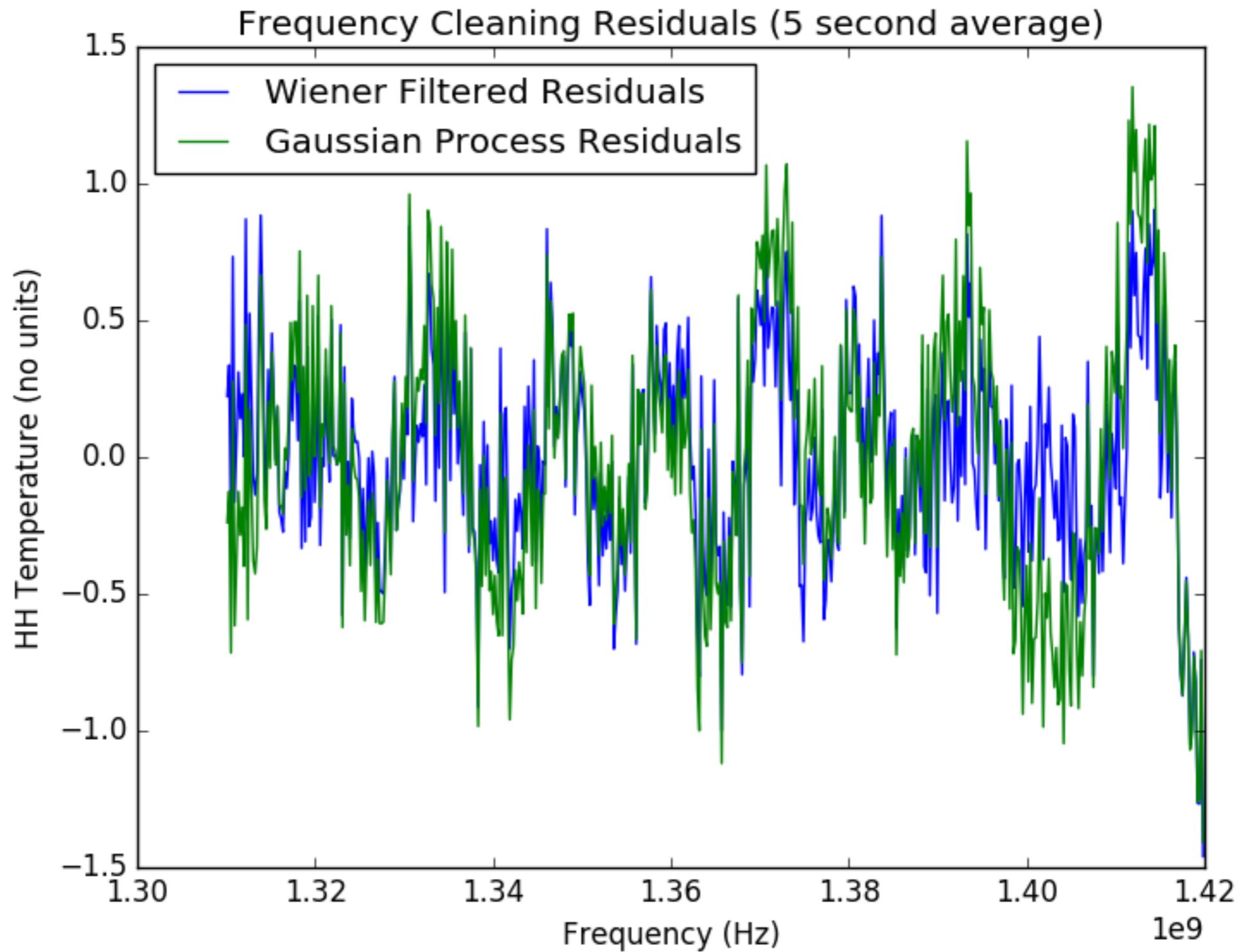


frequency cleaning can improve the  $1/f$

# frequency cleaning

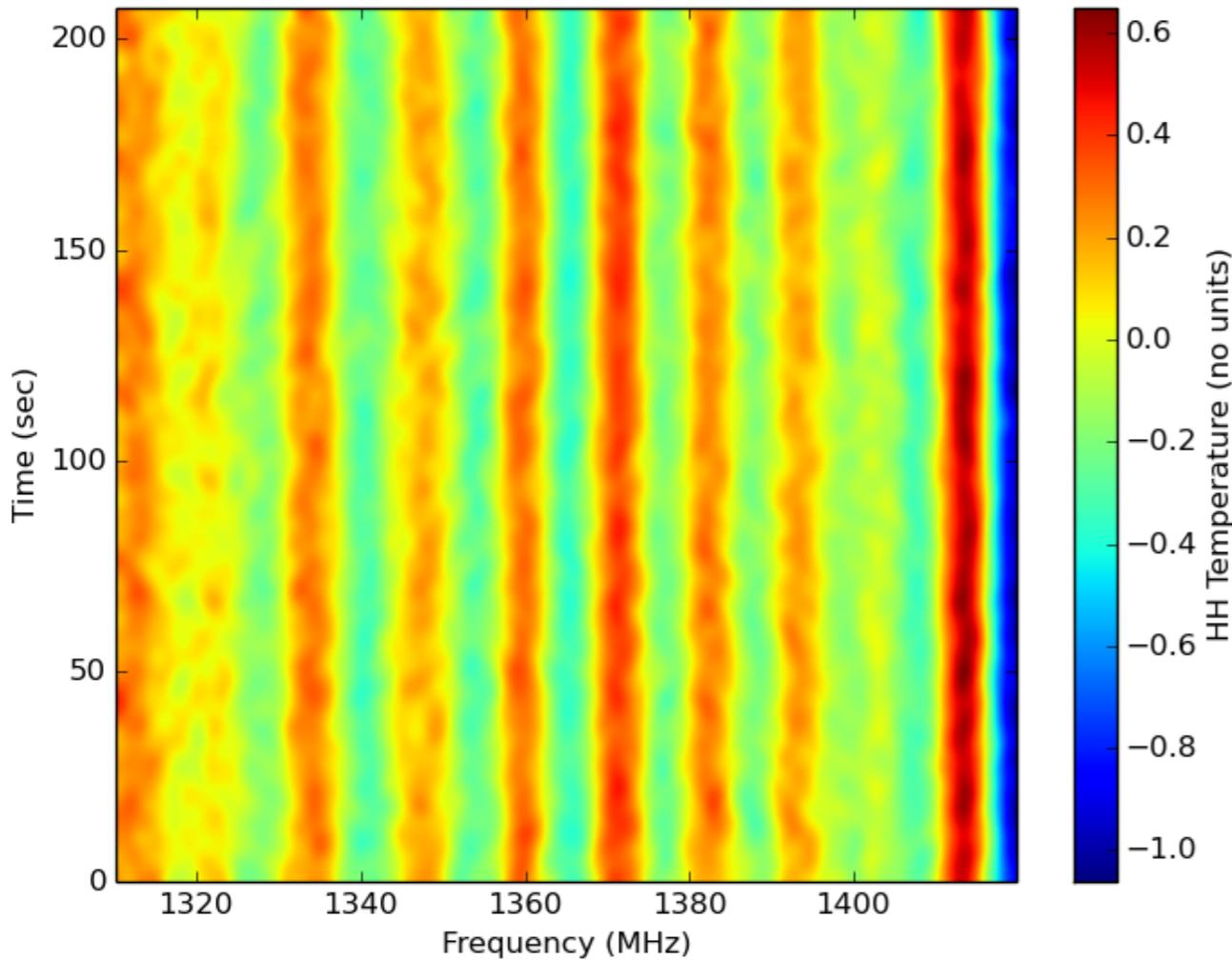


# cable reflections?

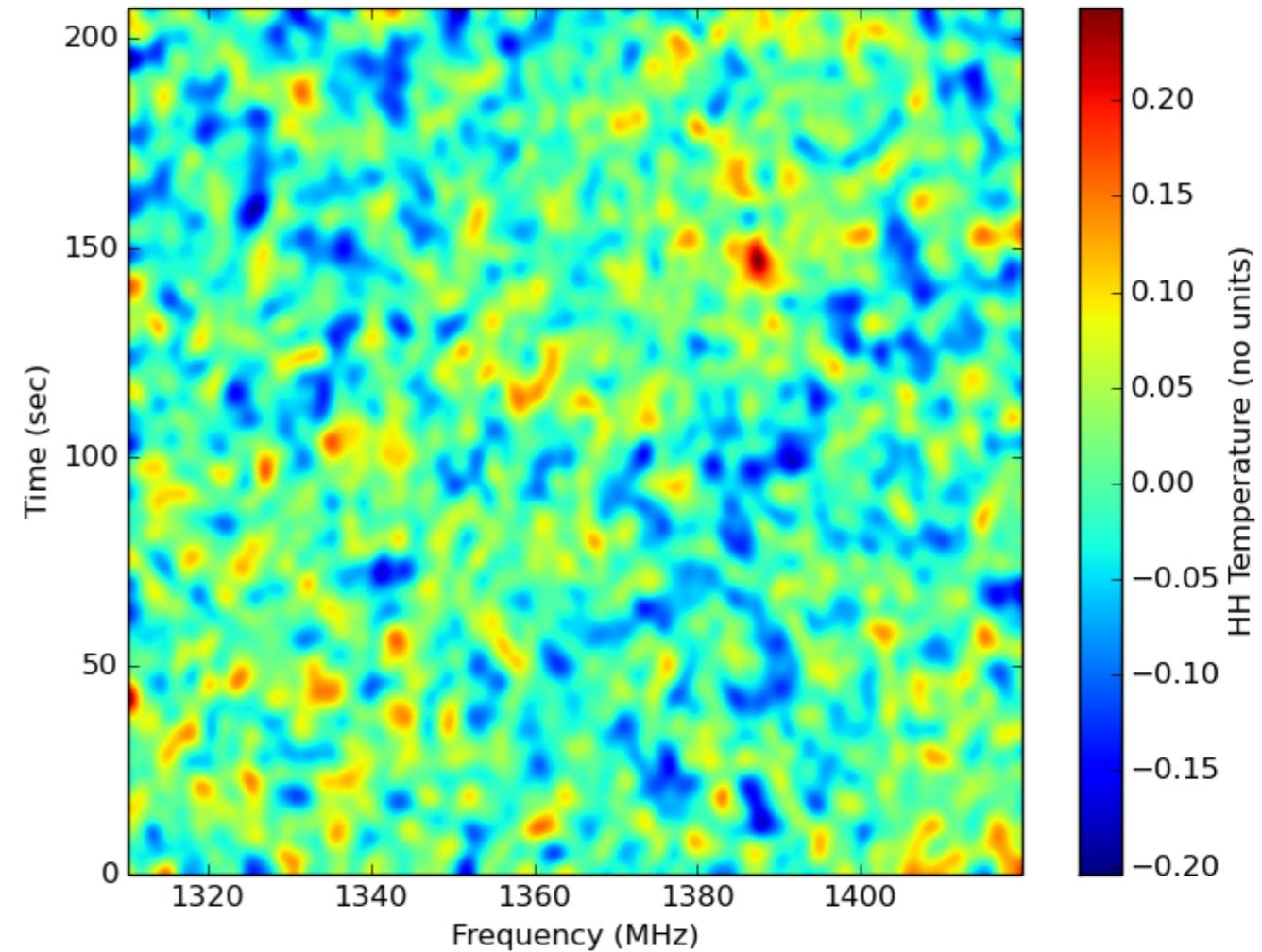


# wiener filter leaves significant structure

20Hz Data: Wiener Filter Residual

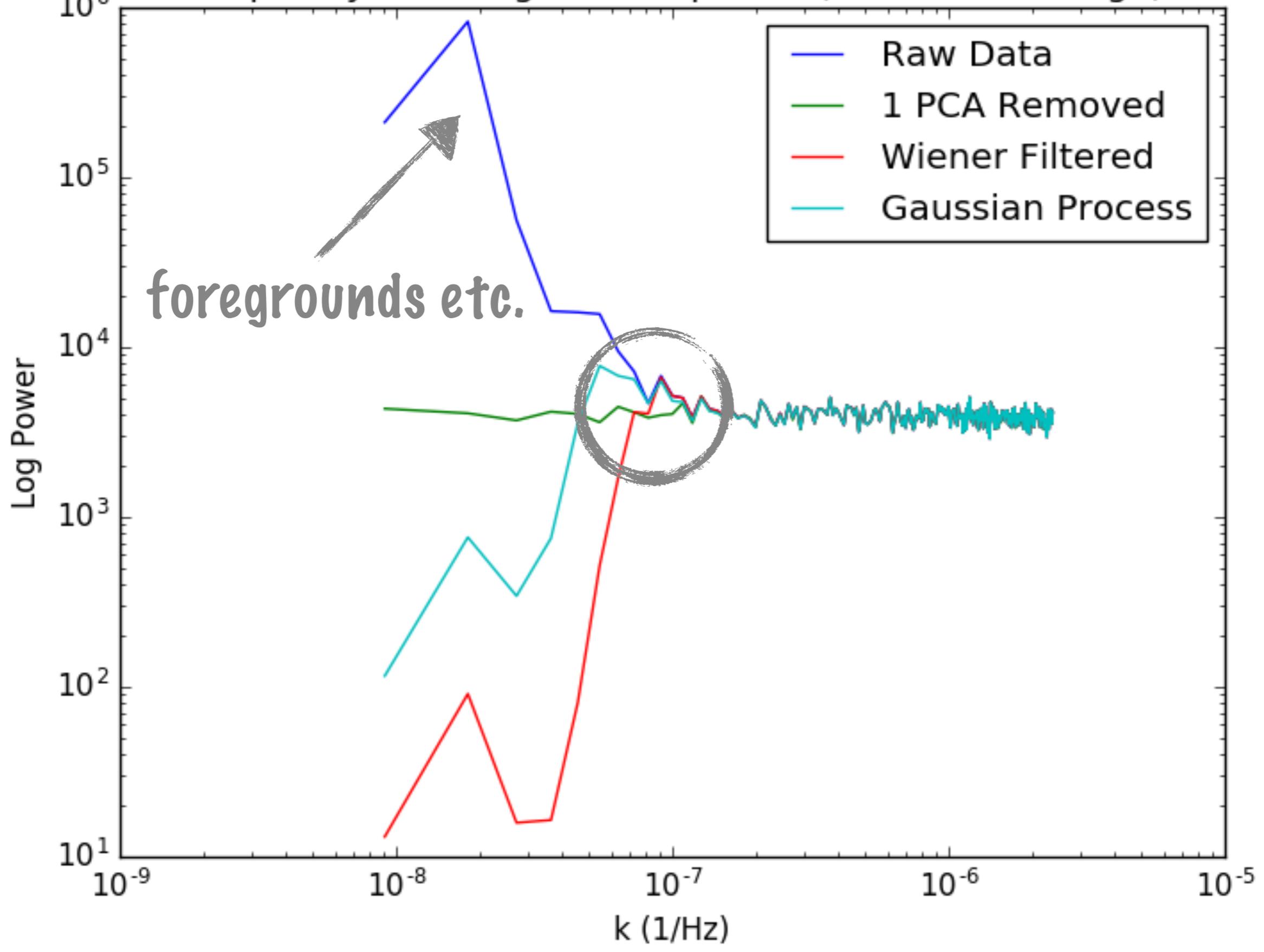


20Hz Data: 1 PCA Removed Residual

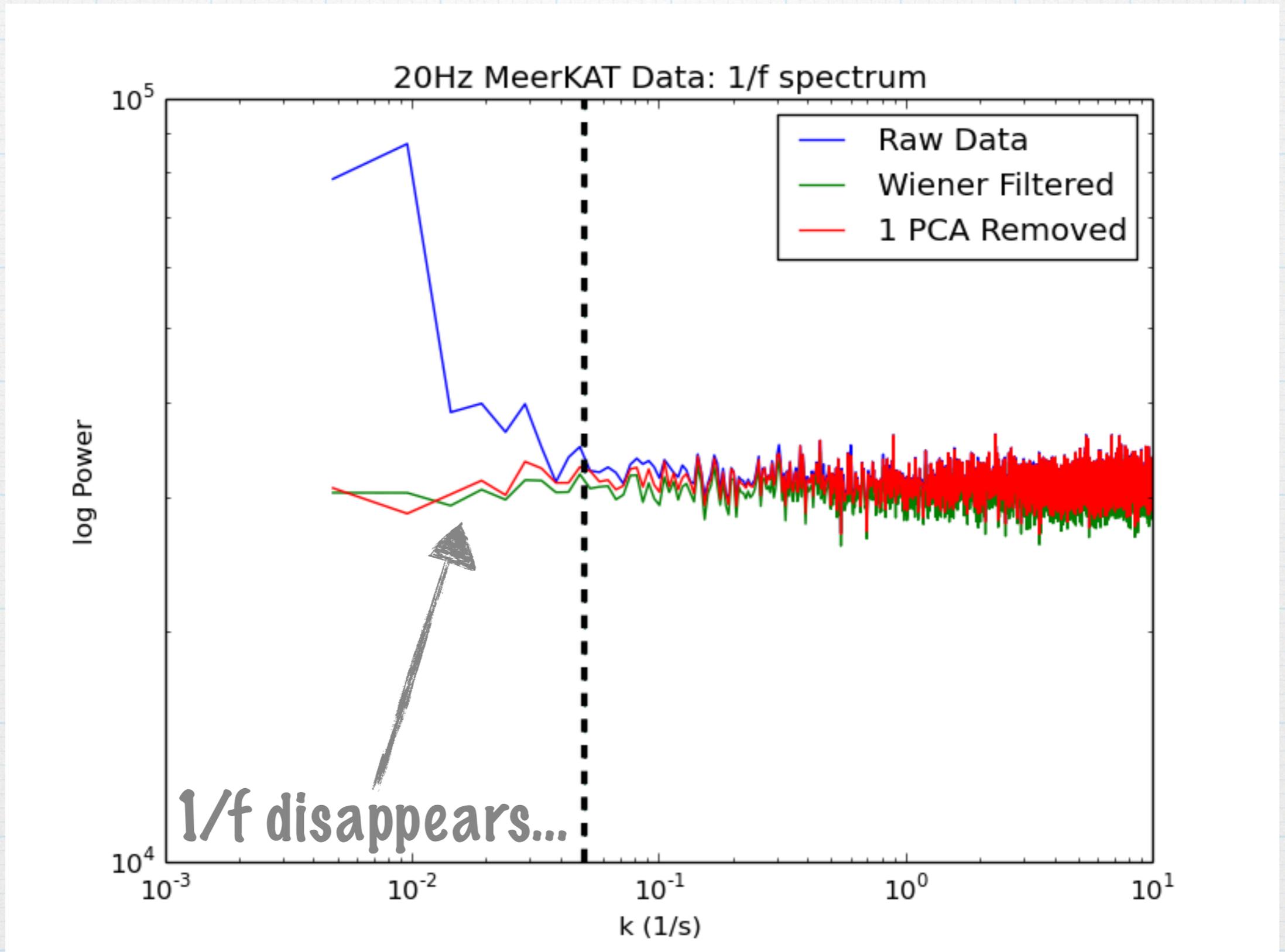


pca residuals look much more noise like!

Frequency Cleaning Power Spectra (5 second average)



1/f



# summary

- \* intensity mapping could be an excellent cosmological probe...
- \* ...if we can calibrate properly
- \* single dish autocorrelations can probe very large scales...
- \* ...which is great for cosmology
- \* meerkat will be a really important testing ground for how to do this with ska