MURCHISON WIDEFIELD ARRAY

EPOCH OF REIONIZATION

Danny Jacobs

(c) Pete Wheeler

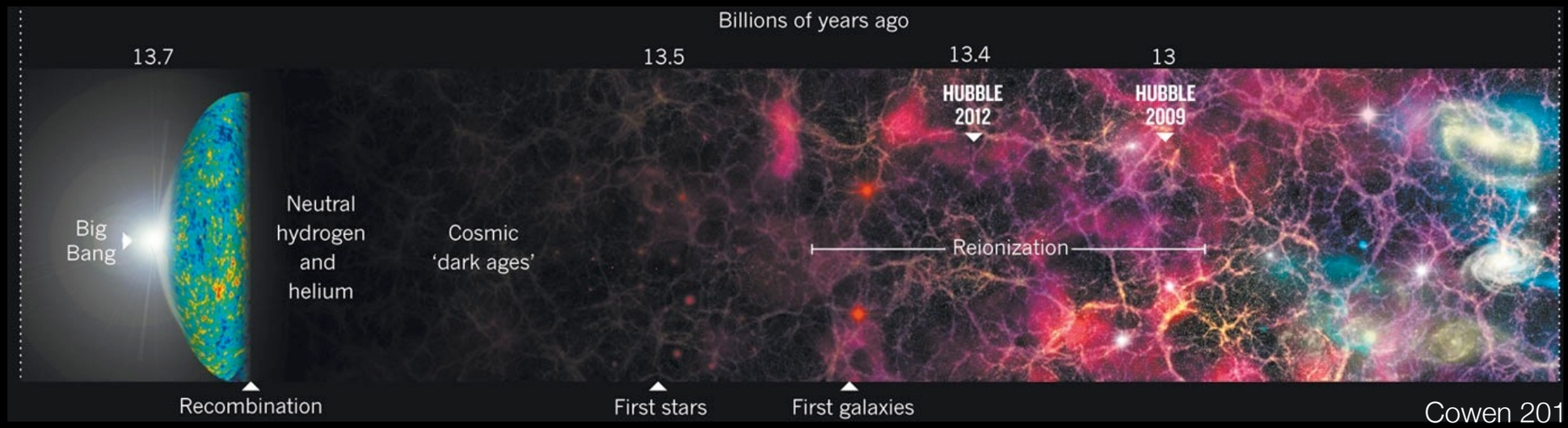
WORK PRESENTED HERE



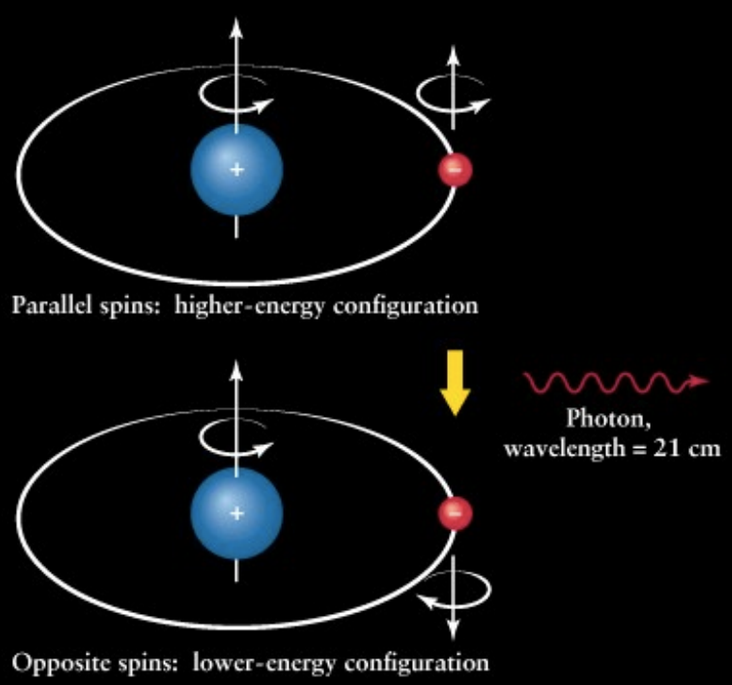
Danny Jacobs, Nithya Thyagarajan, Judd Bowman,
Ian Sullivan, Bryna Hazelton, Adam Beardsley, Patti Caroll,
Nichole Barry, Miguel Morales, Cath Trott, Jonathan Pober
Pietro Procopio, Bart Pindor, Rachel Webster,
Ben McKinley, Josh Dillon, Aaron Ewall-Wice,
Abraham Neben, Jackie Hewitt, Emil Lenc, Jack Line,
André Offringa, and others benignly neglected Danny

21cm line

1100 20? 8? 6

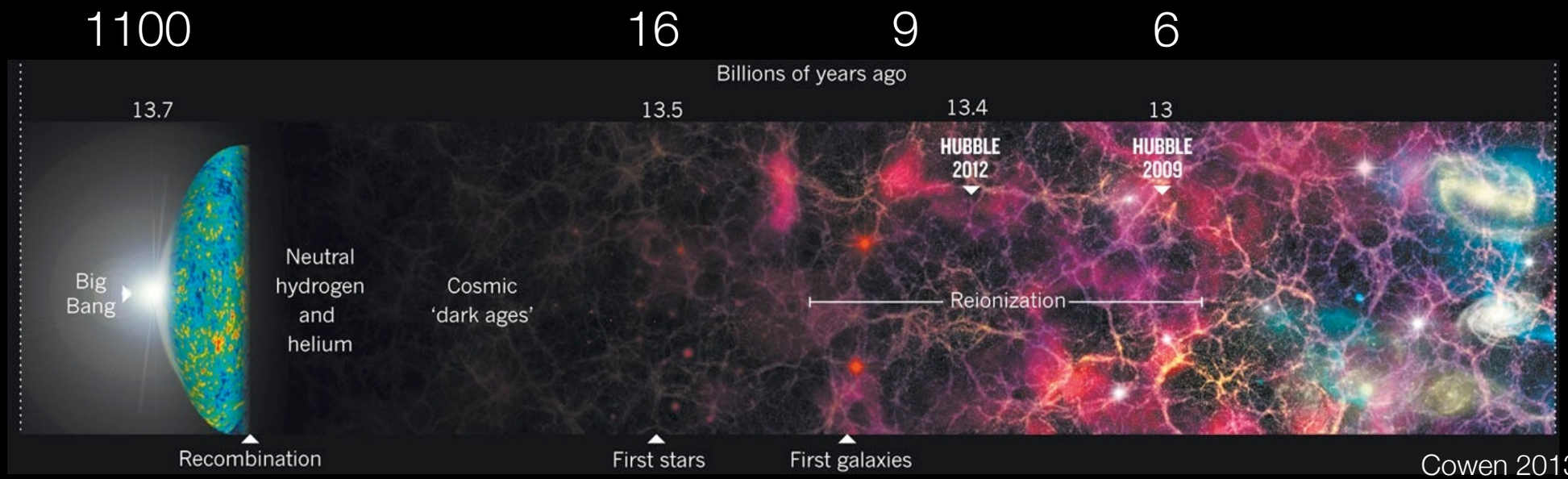


Cowen 2013

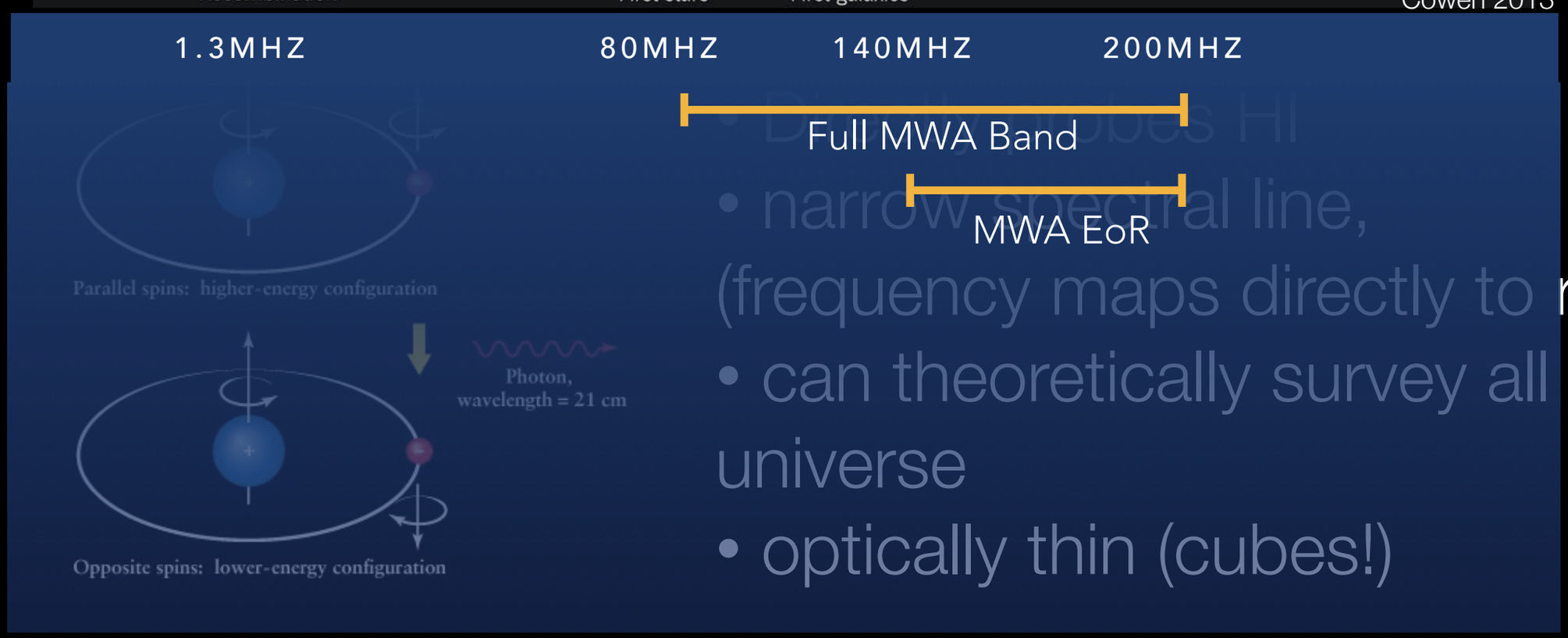


- Directly probes HI
- narrow spectral line, (frequency maps directly to redshift)
- can theoretically survey all visible universe
- optically thin (cubes!)

21cm line



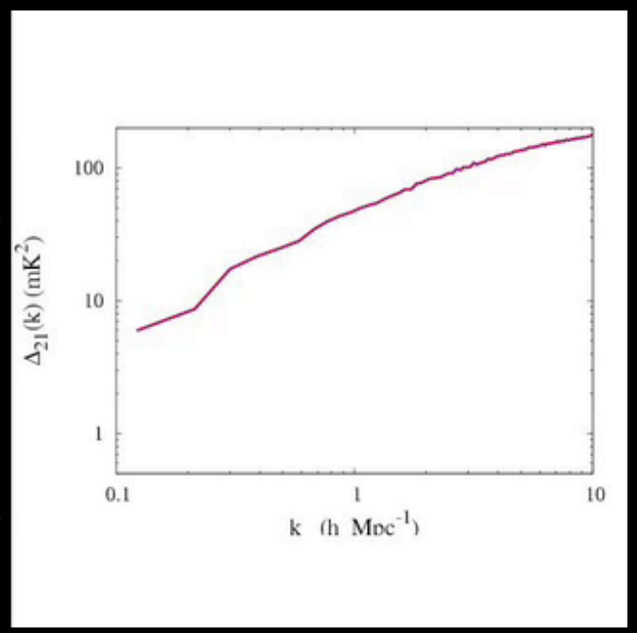
Cowen 2013





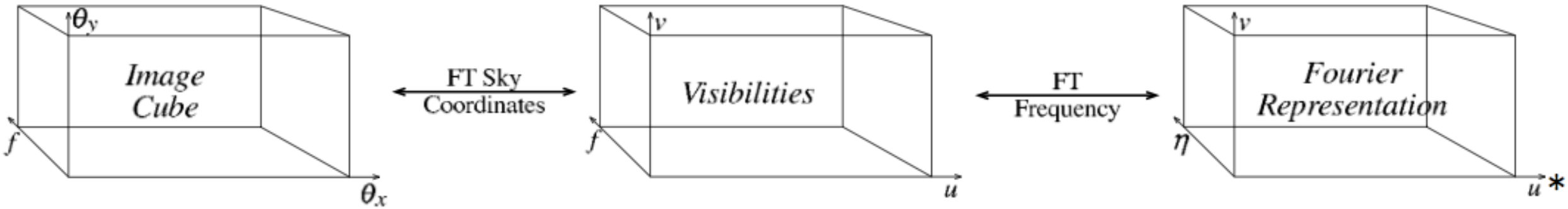
M. Alvarez (CITA)
& R. Kaehler (Stanford)



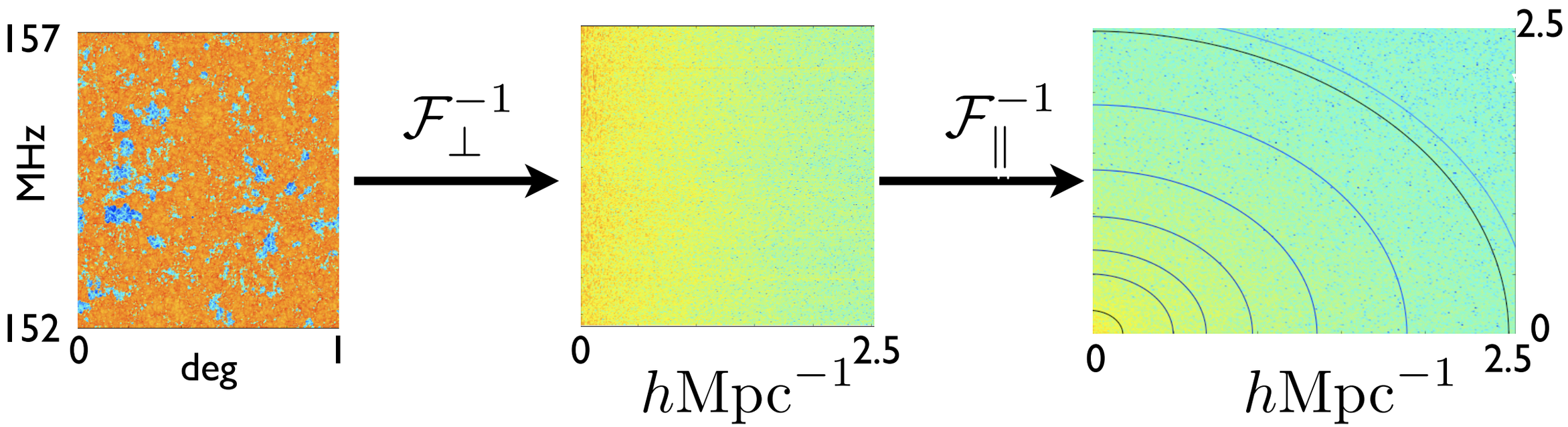


M. Mcquinn (Berkeley)

HI 21cm

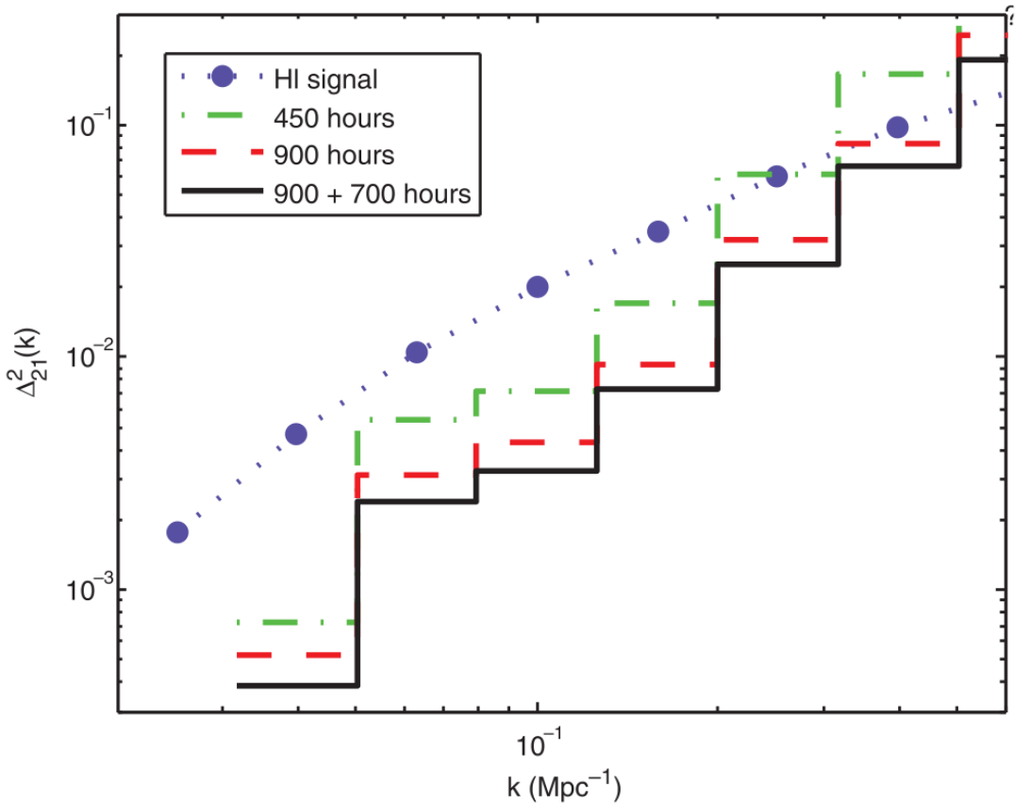


Morales, 2006 AJ 619

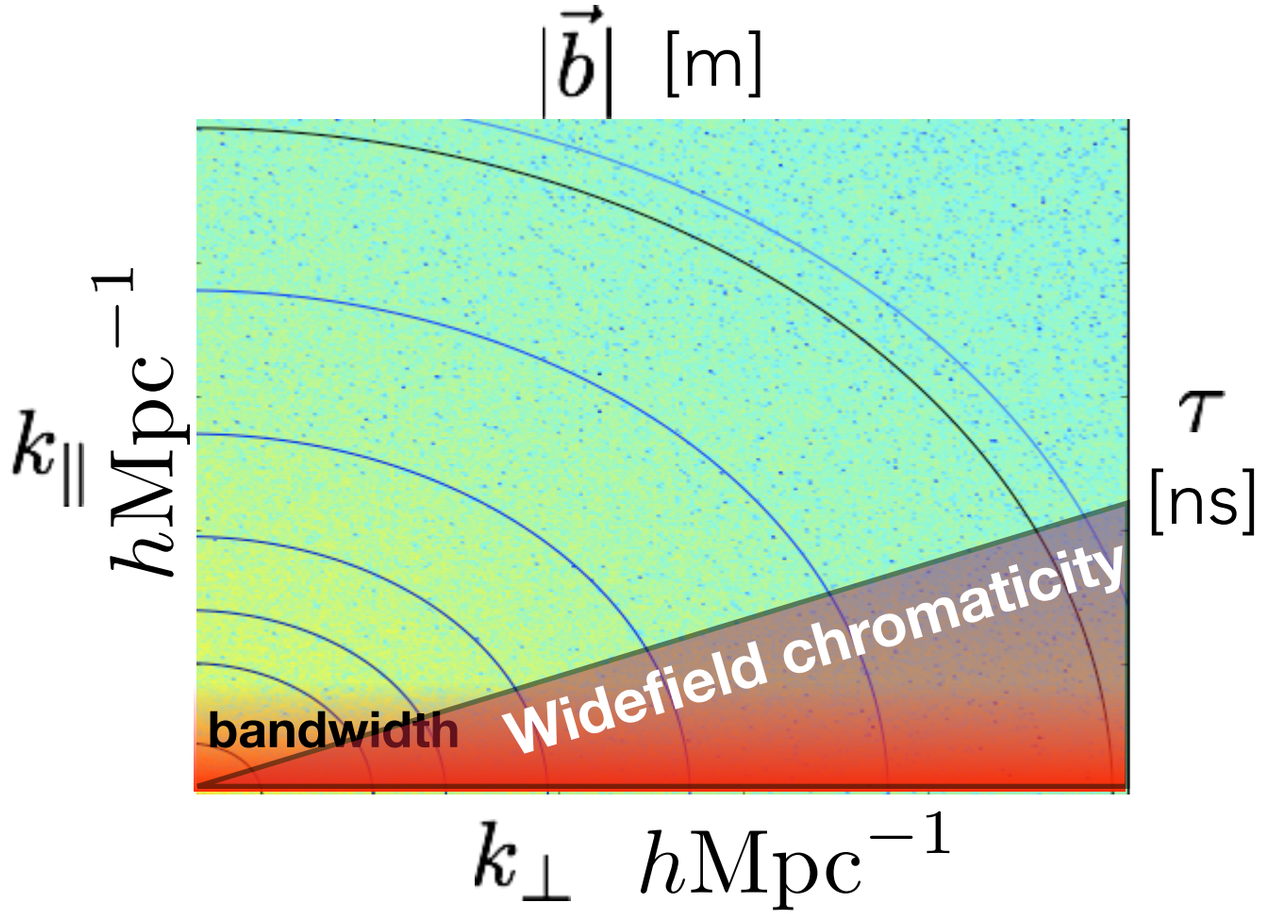


http://loco.lab.asu.edu/danny_jacobs

Foreground Geography in k space

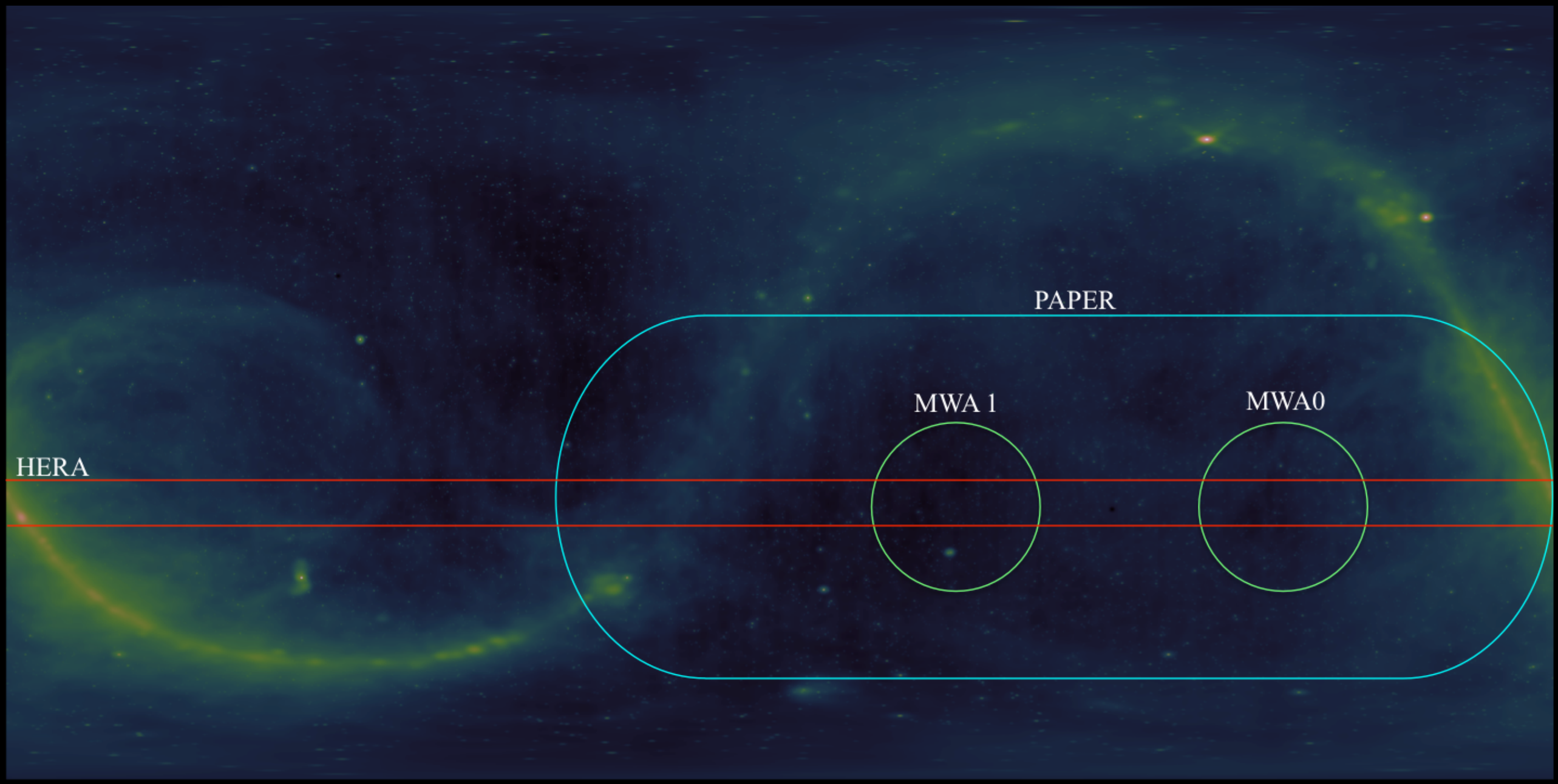


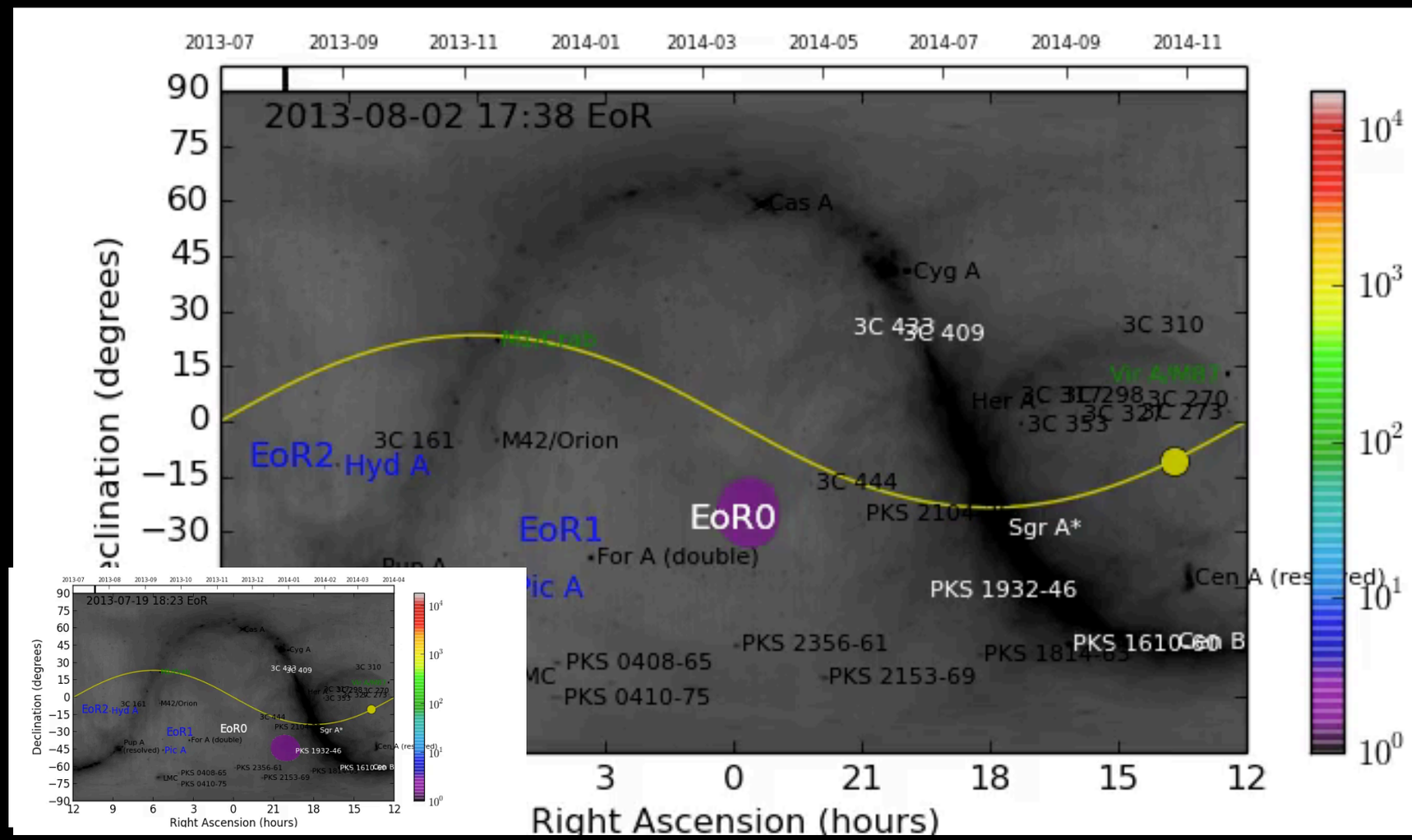
BEARDSLEY 2013



BOWMAN 2009, DATTA 2010, MORALES 2012, PARSONS 2012, VEDANTHAM 2012, TROTT 2012

MWA OBSERVING





	EOR0	EOR1	TOTAL
LOW (9>Z>7.3)	253	322	575
HIGH (7.4>Z>6.1)	345	168	513
TOTAL	598	490	1088 HOURS

GENERIC EOR ANALYSIS STEPS

1. Flag RFI (Cotter/AOFlagger)
2. Average (Cotter/AOFlagger)
3. Calibrate using known foregrounds (RTS or FHD)
4. Subtract known foregrounds (RTS or FHD)
5. Simulate Instrument response, form images (RTS or FHD)
6. Integrate nights
7. Compute Power spectrum (CHIPS or εppsilon)
8. Down-weight residual foregrounds (Dillon et al, Trott et al)

MWA ANALYSIS STRATEGY

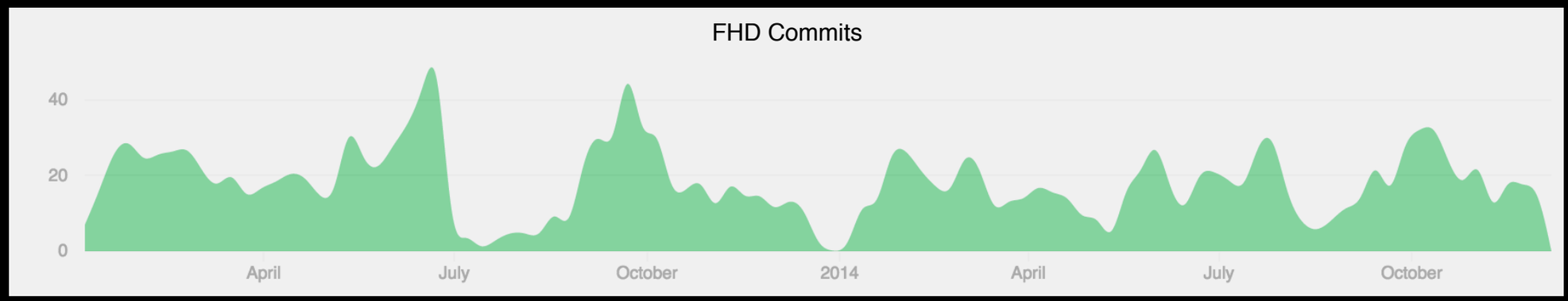
DEEPER INTEGRATION

Precision

FLAGGING AND AVERAGING

DEEP POWER SPECTRUM
(11 NIGHTS, FHD+CHIPS)

FIDUCIAL NIGHT (FHD-εppsilon)

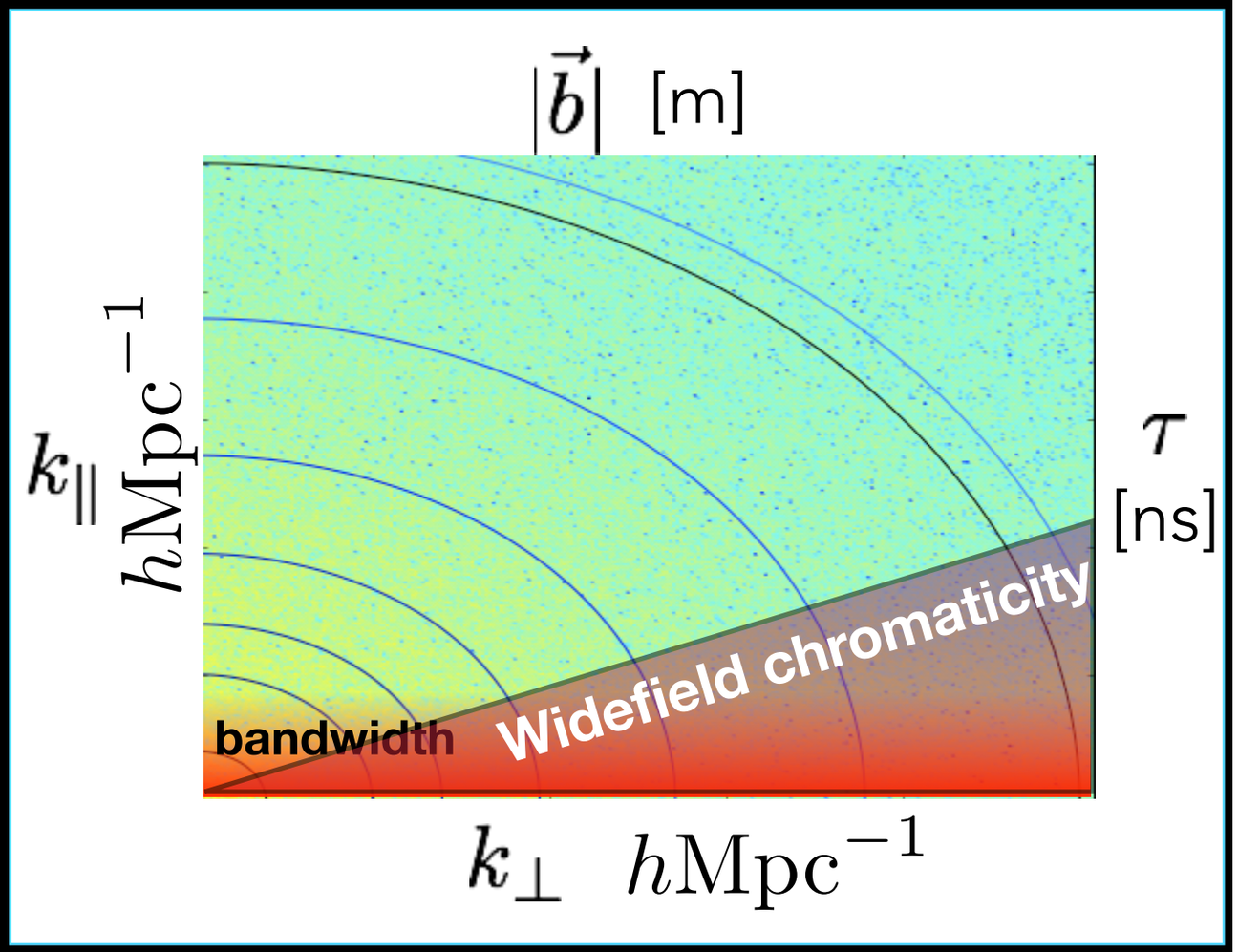


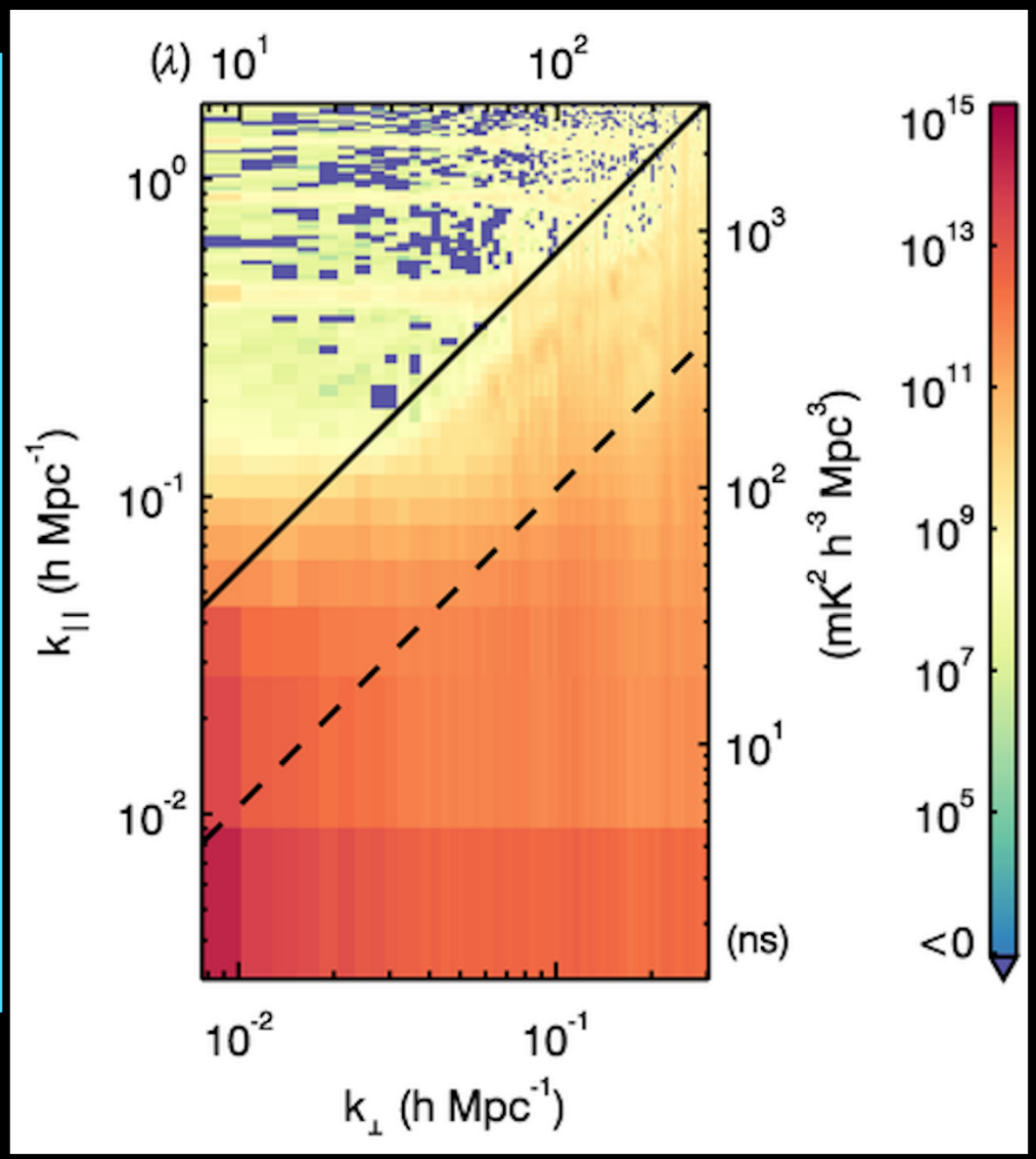
Accuracy

BETTER
POWER SPECTRA

FIDUCIAL DAY POWER SPECTRUM

High band (z=6.8)



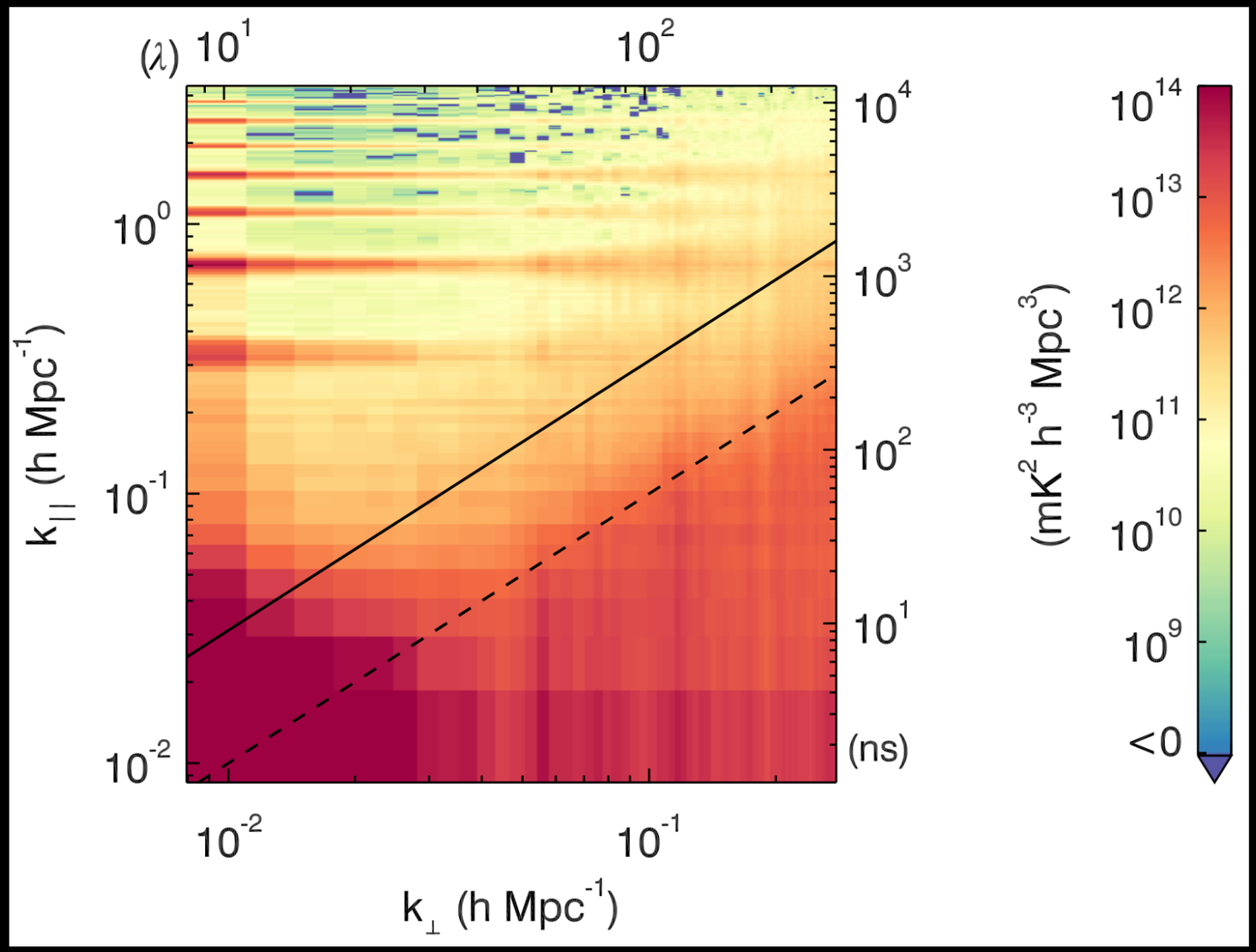


Sullivan, Hazelton, Beardsley, Morales and et al

FIDUCIAL DAY

Low band (z=8)

Observed: Sept 2014

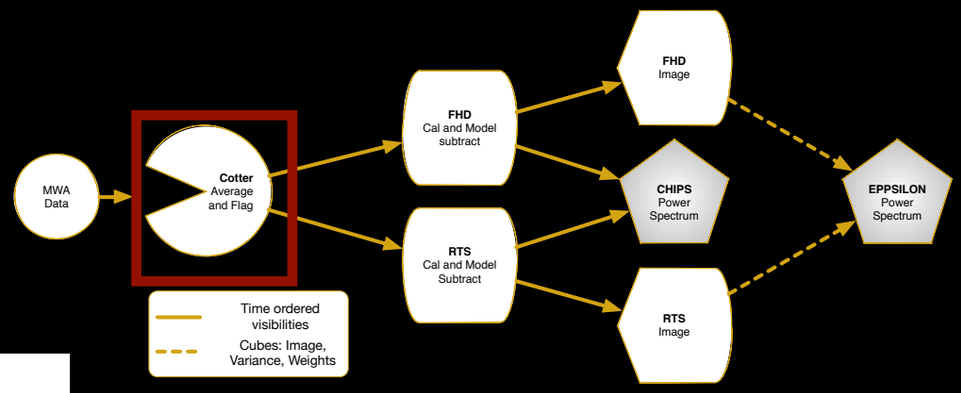


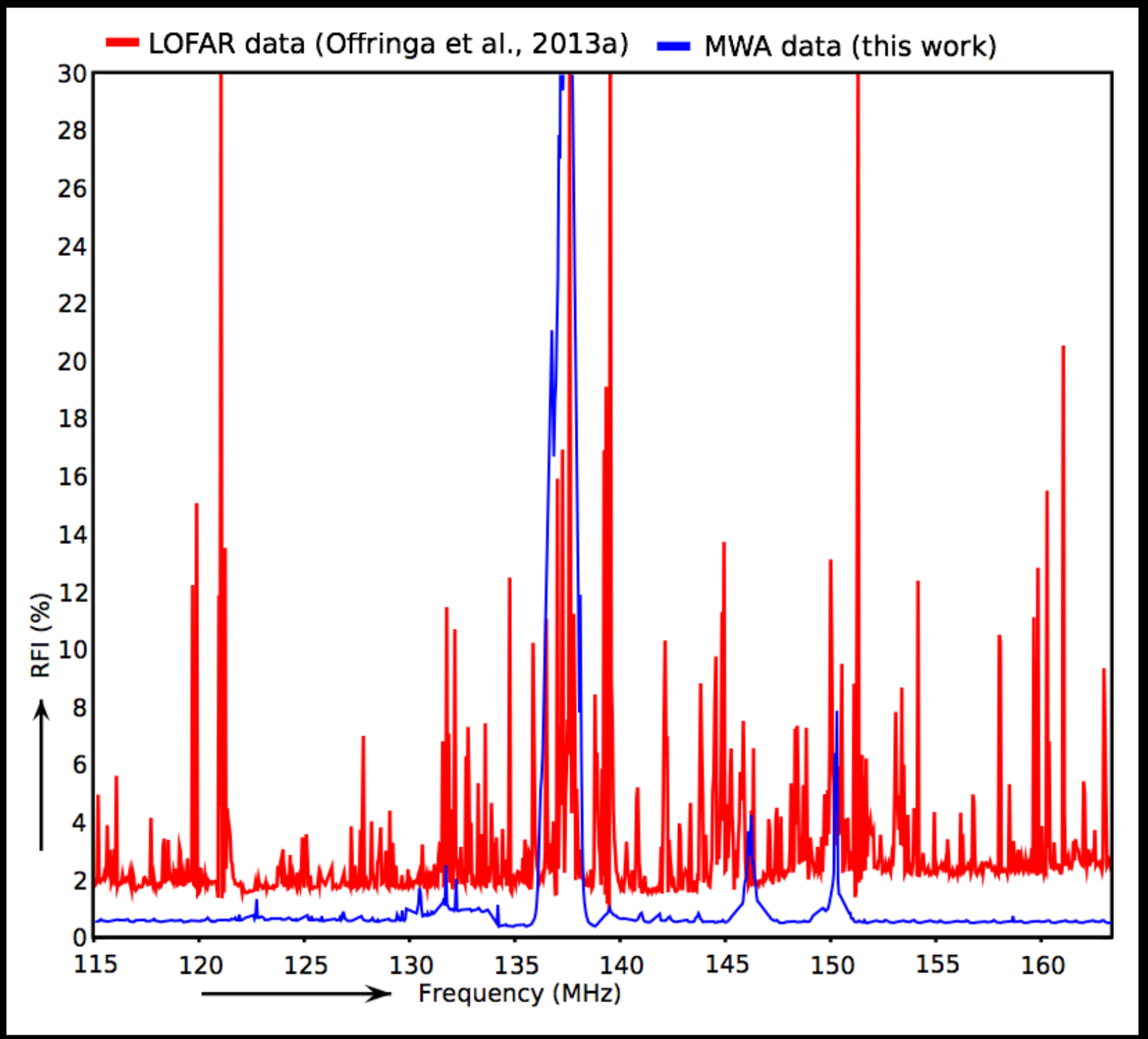
POWER SPECTRUM PIPELINES

How do we tell its working?

MWA
Data

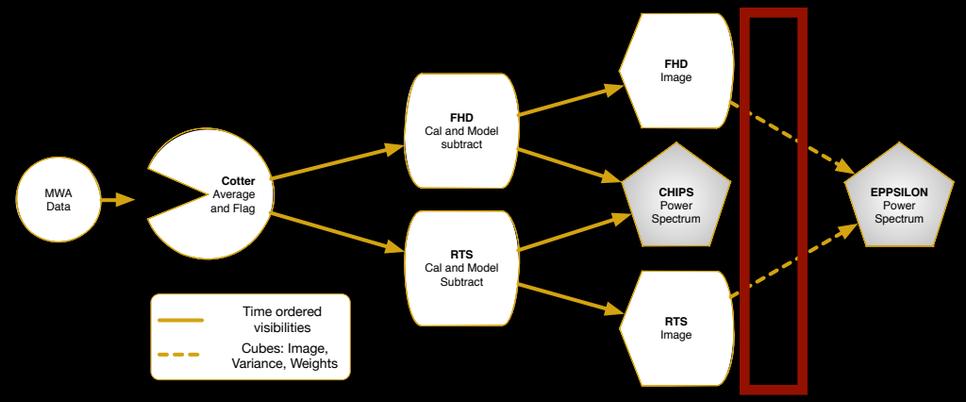
RFI

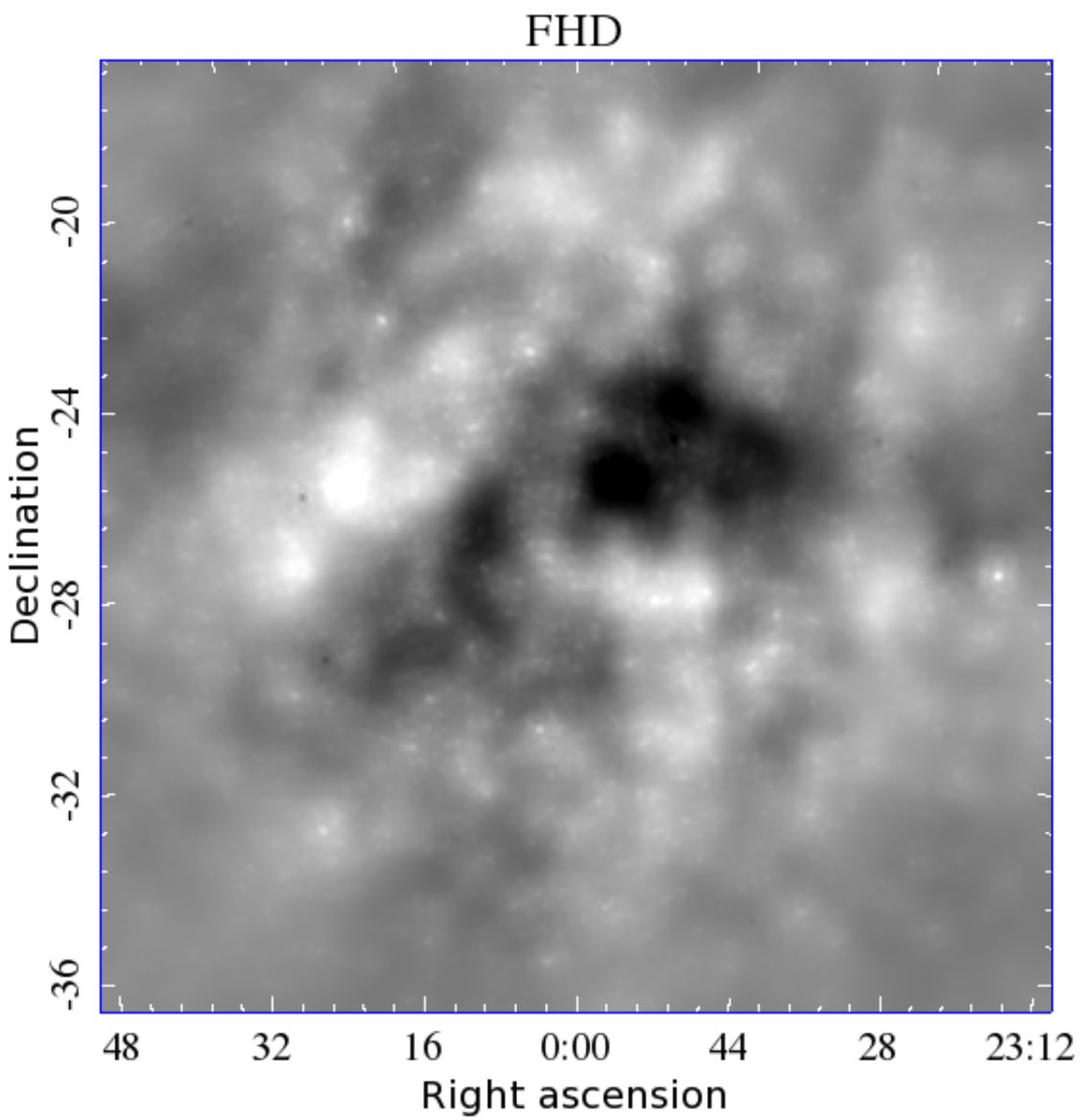


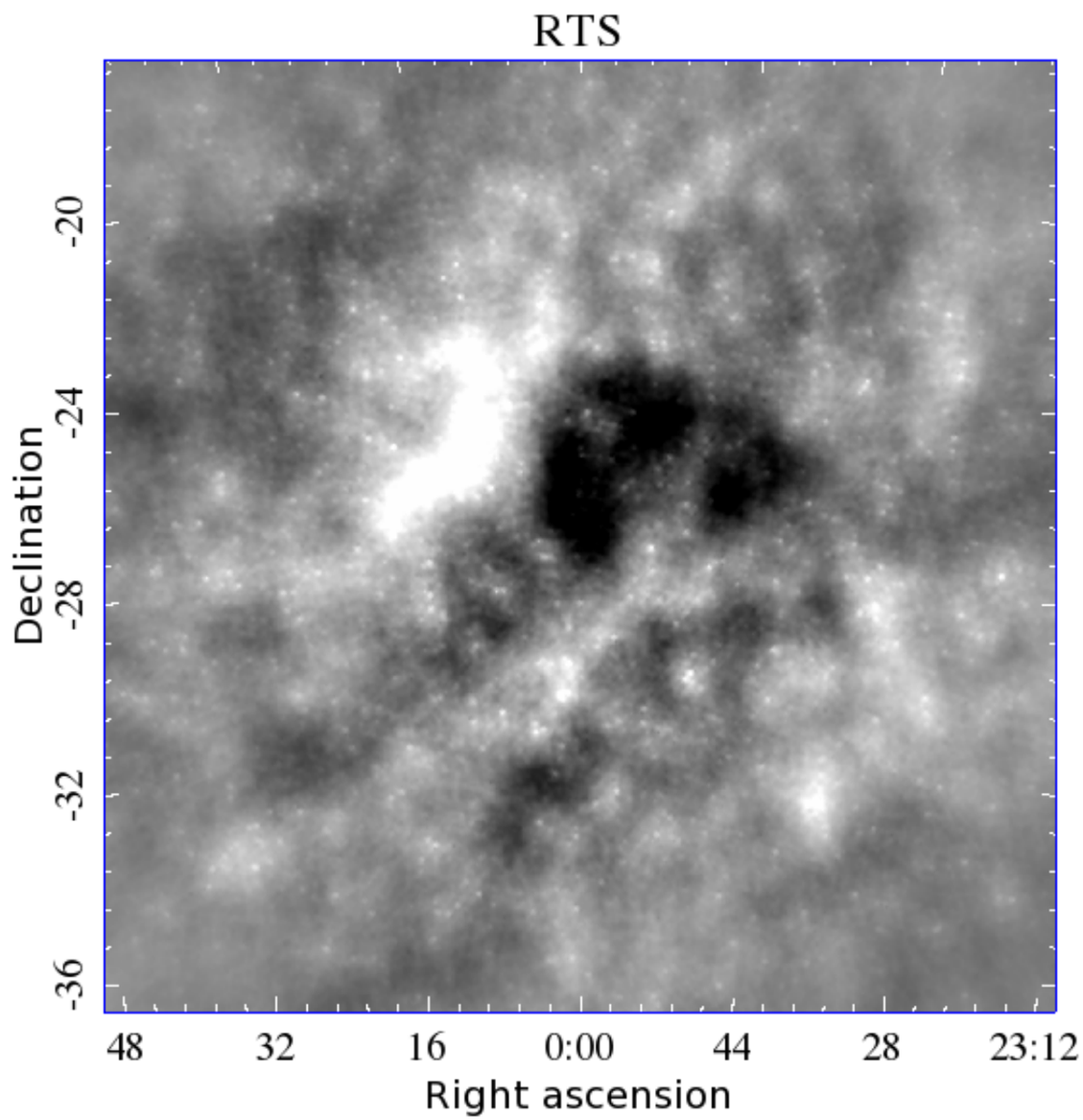


Offringa et al (in review)

RESIDUAL IMAGES







Jacobs et al 2015

Power Spectrum Method

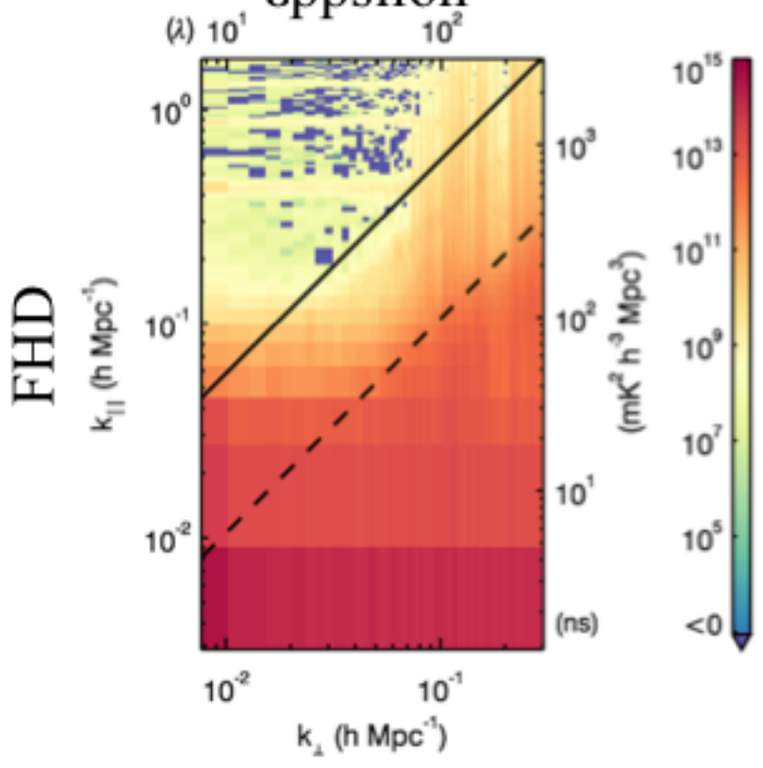
Foreground Removal

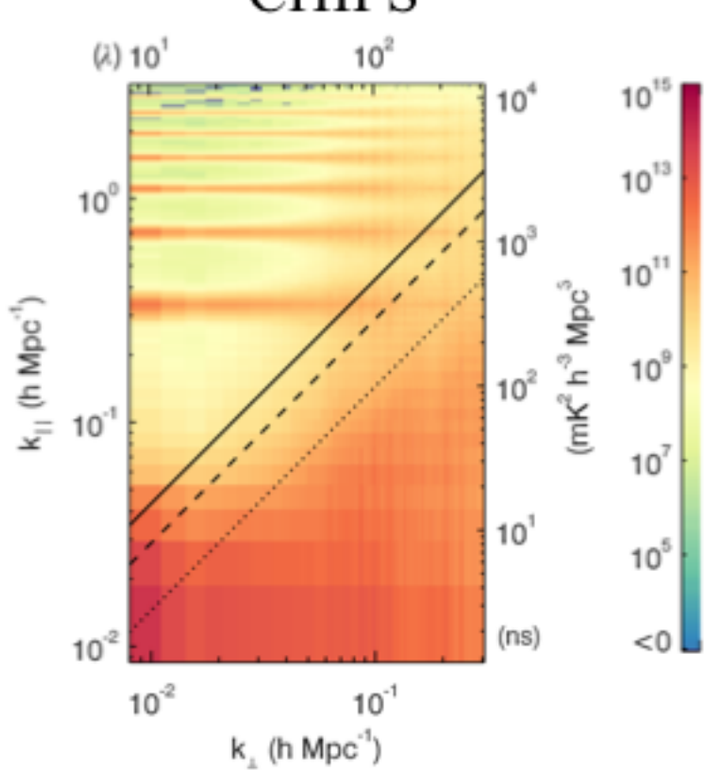
FHD

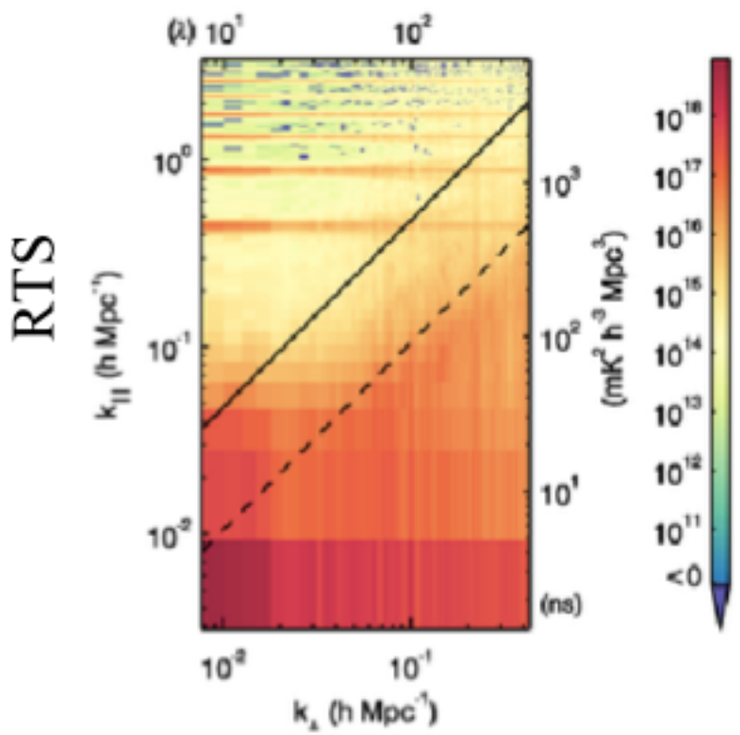
RTS

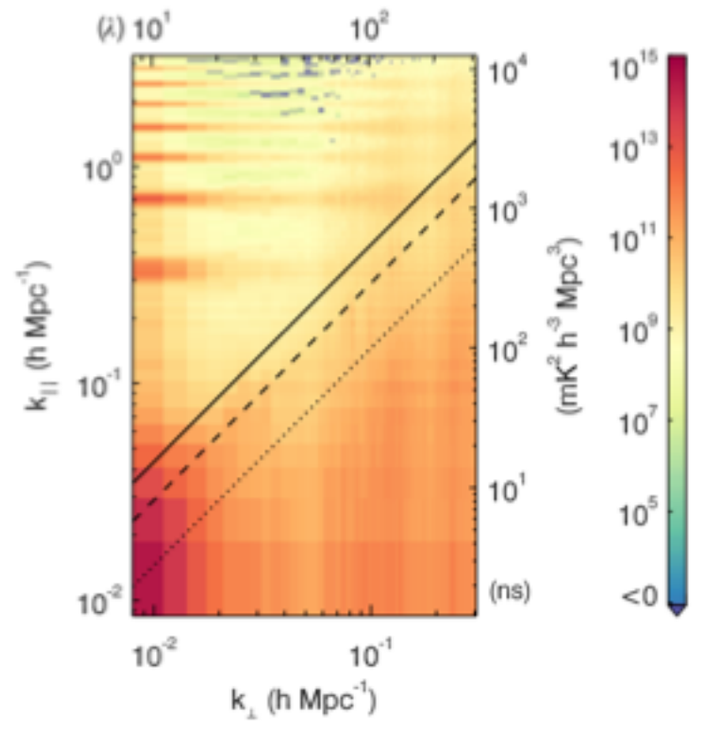
εppsilon

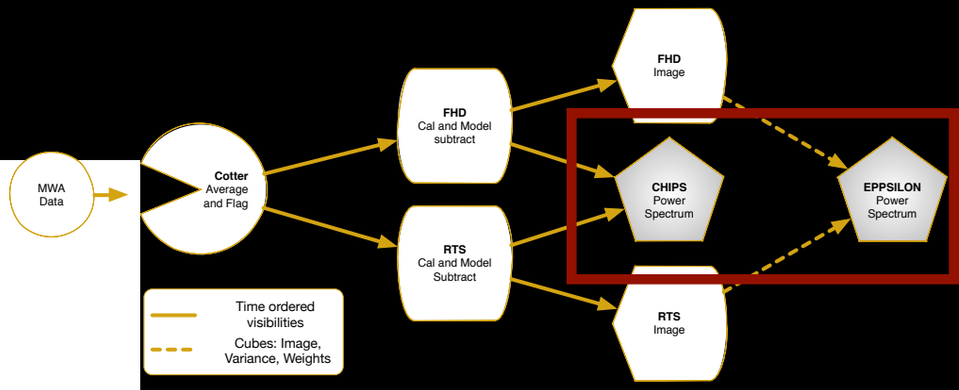
CHIPS











Fiducial Night

3 hours

z=7

Jacobs et al 2015

MWA ANALYSIS STRATEGY

DEEP INTEGRATION

Precision

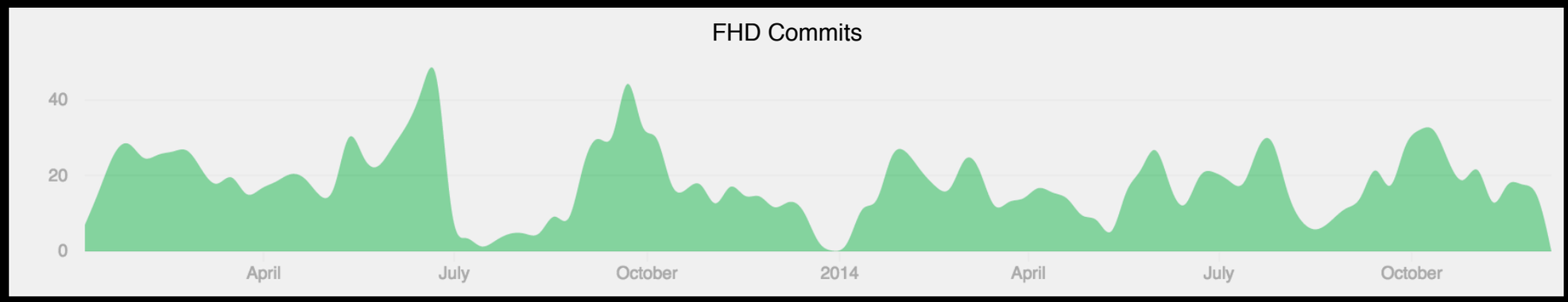
FLAGGING AND AVERAGING

"WEEK1" POWER SPECTRUM
(11 NIGHTS, FHD+εppsilon)

CROSS-OVERS

FIDUCIAL NIGHT (RTS-CHIPS)

FIDUCIAL NIGHT (FHD-εppsilon)



Accuracy

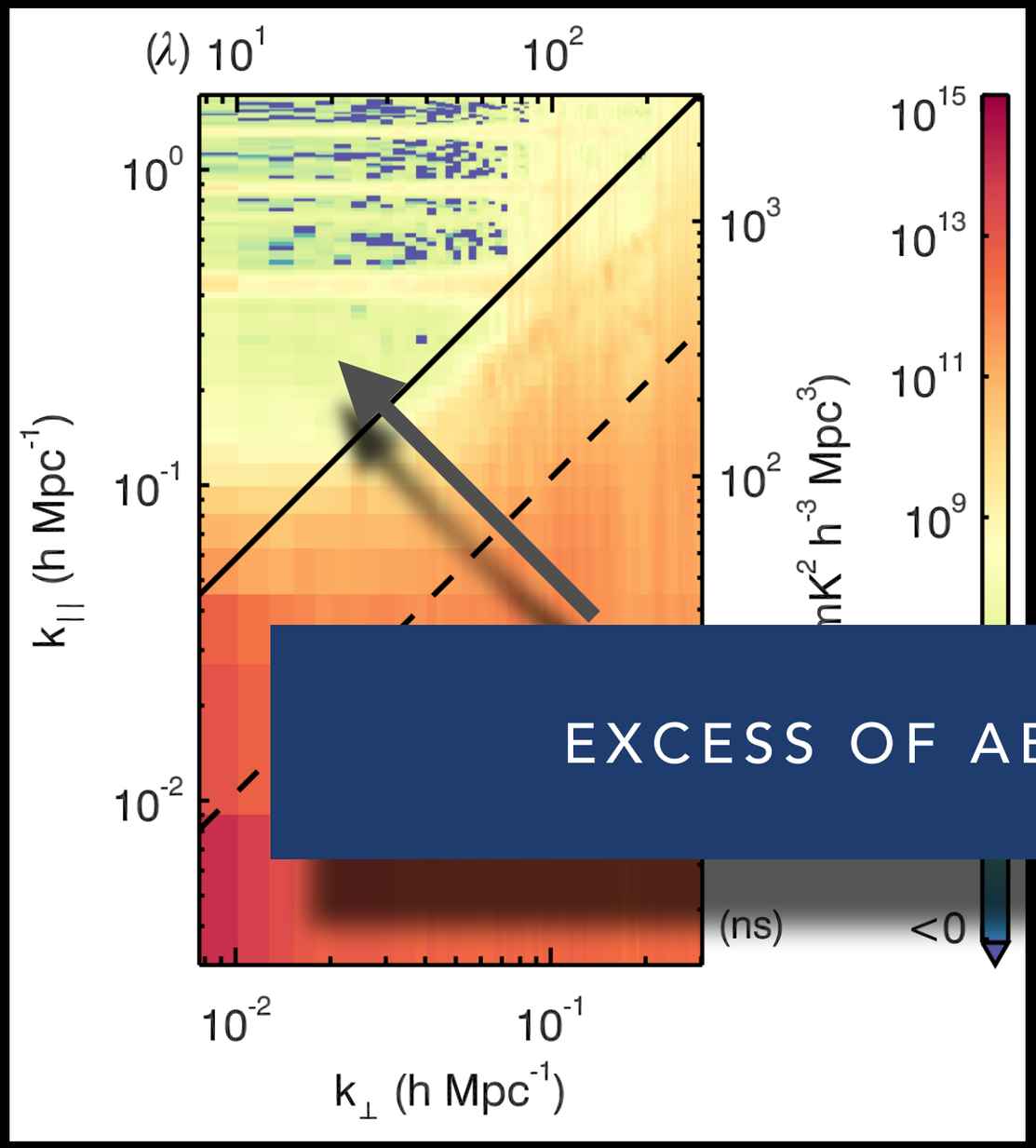
FOREGROUNDS ELIMINATED

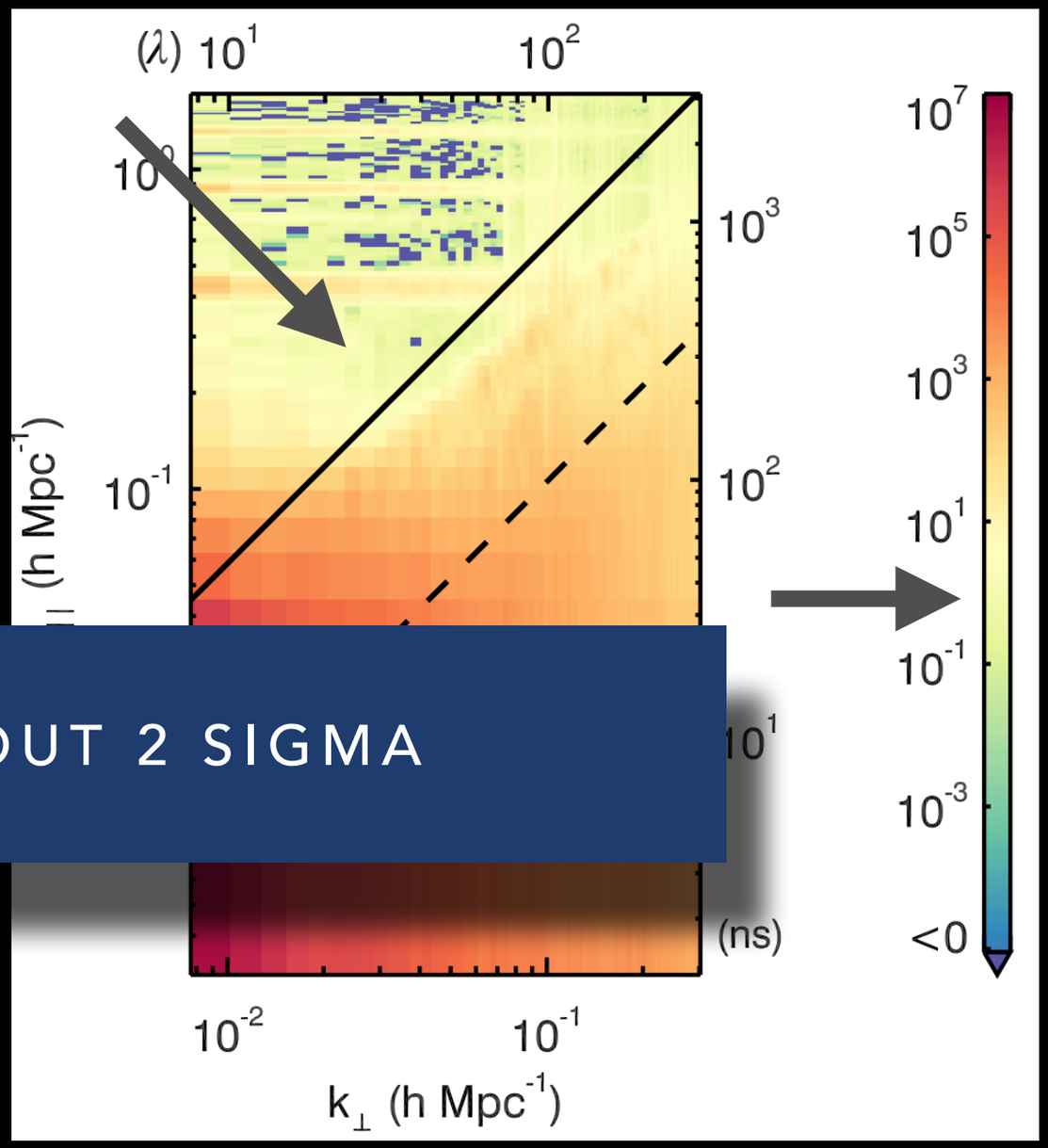
PRELIMINARY!

POWER SPECTRUM - 40 HOURS

power spectrum

power/error



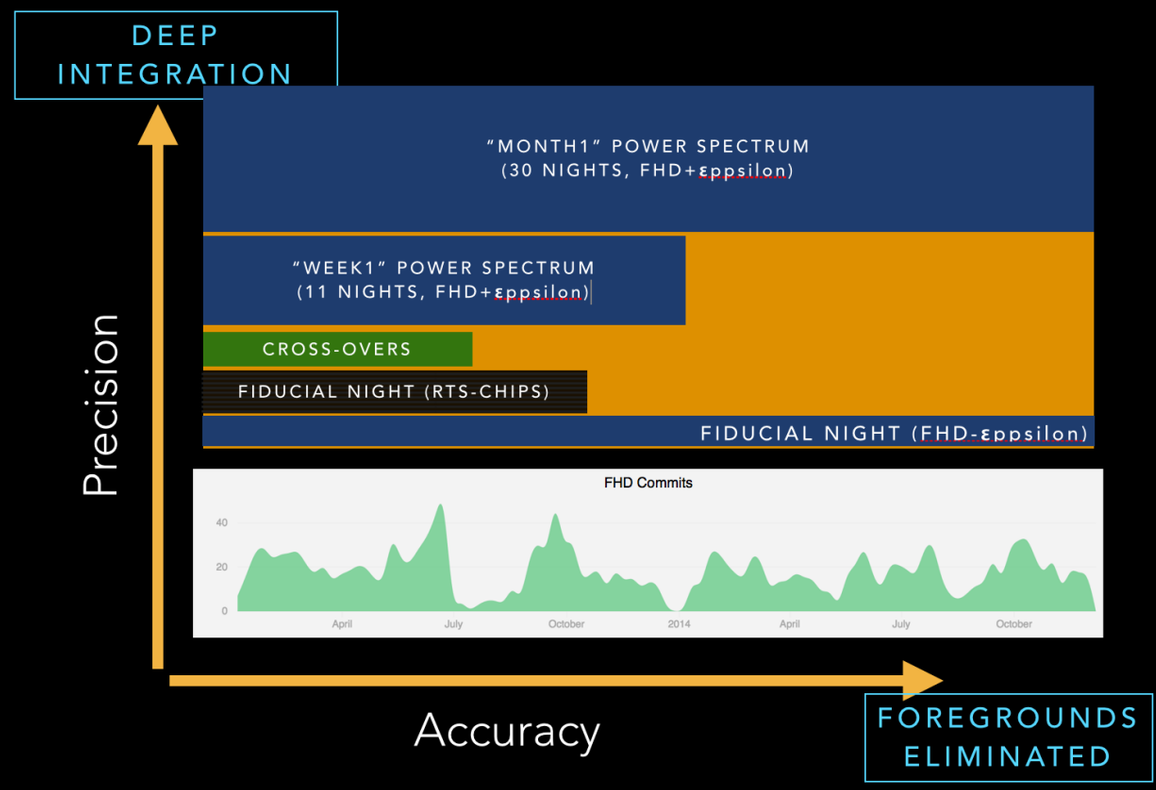


EXCESS OF ABOUT 2 SIGMA

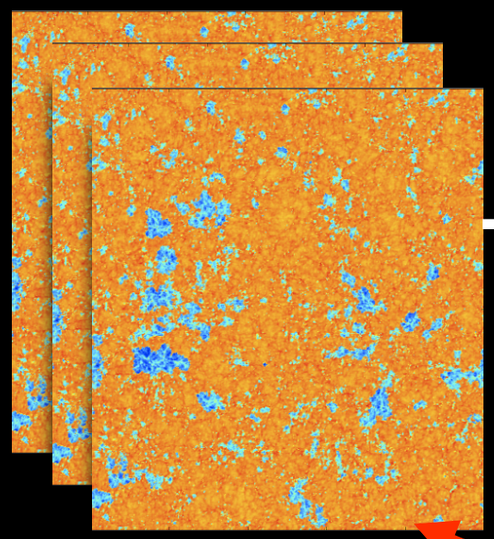
Beardsley, in prep

BETWEEN 3 AND 40 HOURS

- revised beam model (A. Neben, Curtin/MWA Engineering Staff, and many many other et als)
- cable reflections (Beardsley)
- unified catalog (Carroll)
- wide-field self-cal (Sullivan, Procopio)
- refined bandpass (Barry)
- tracking analysis weights (Pindor)
- pipeline calibration (Pober, Hazelton)
- ionosphere, highest redshifts (A. Ewall-Wice)

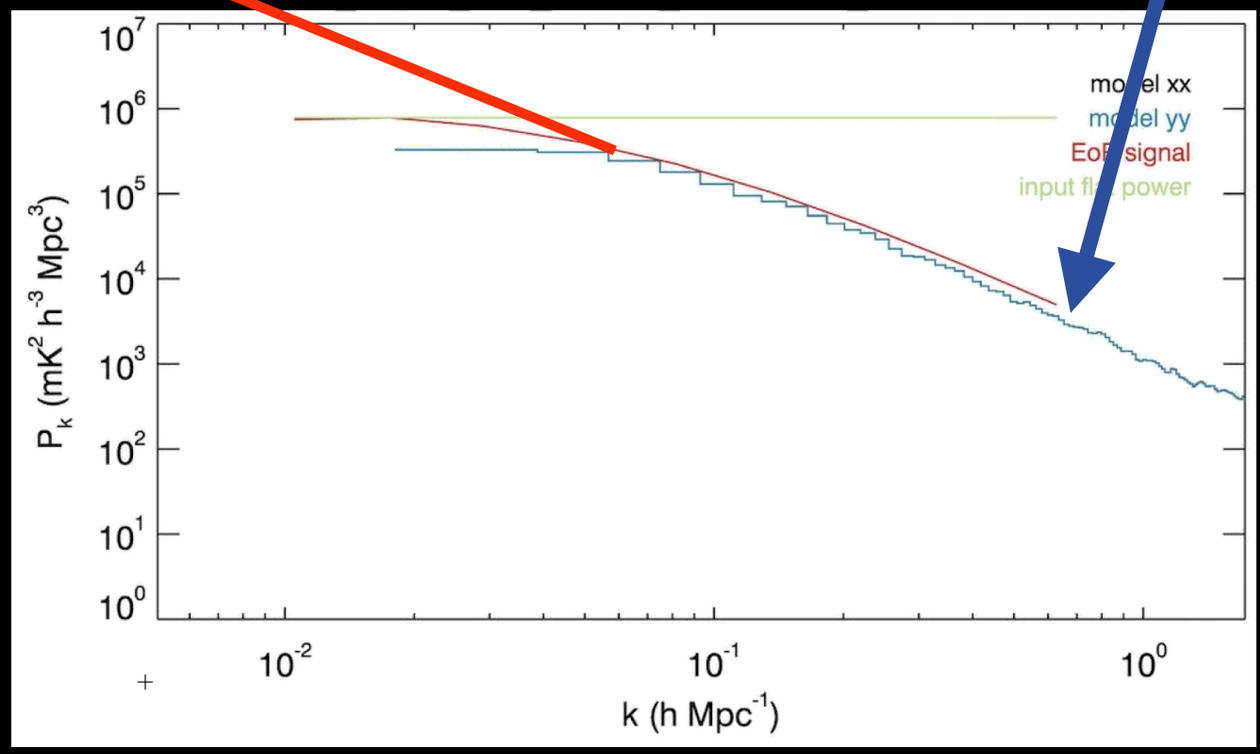


CALIBRATING THE PIPELINE



FHD

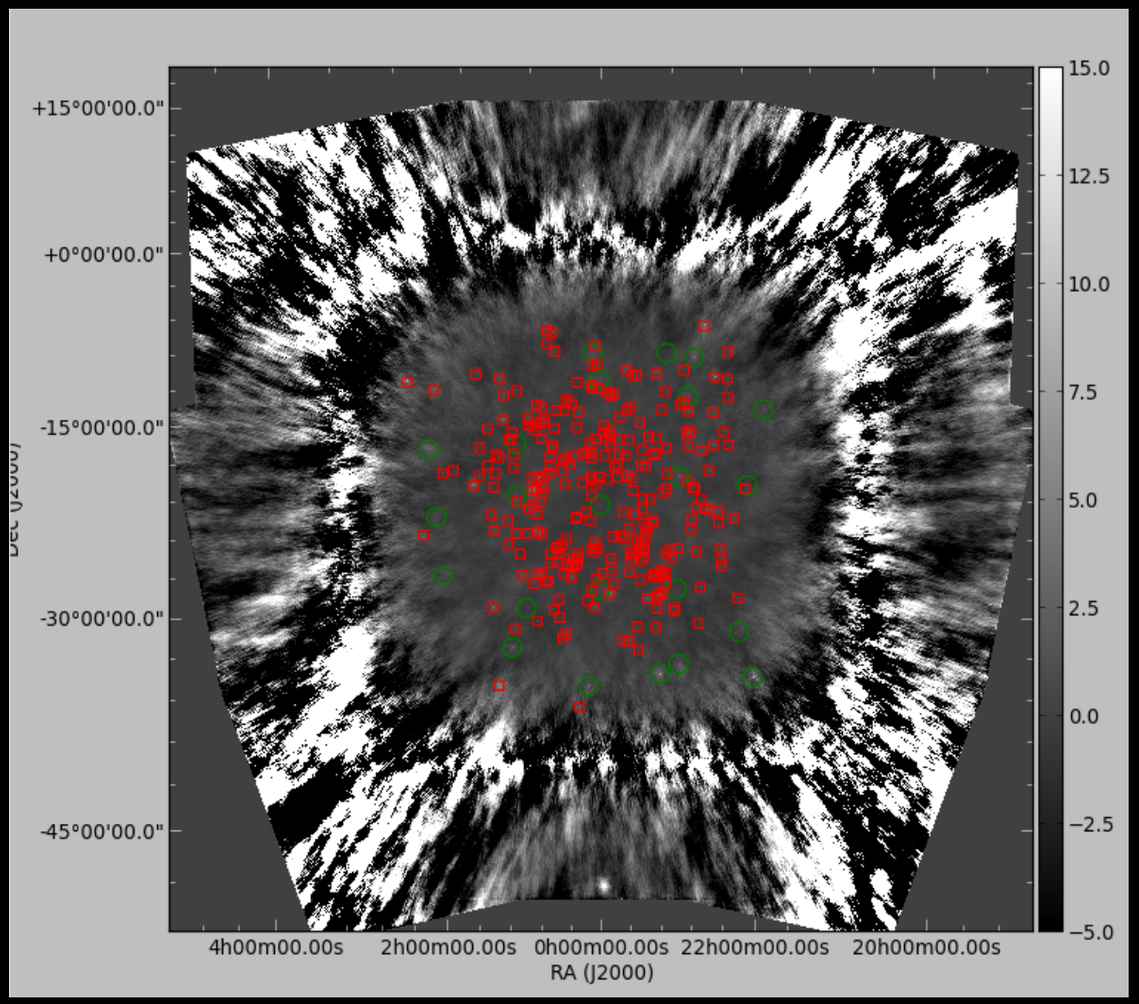
εppsilon



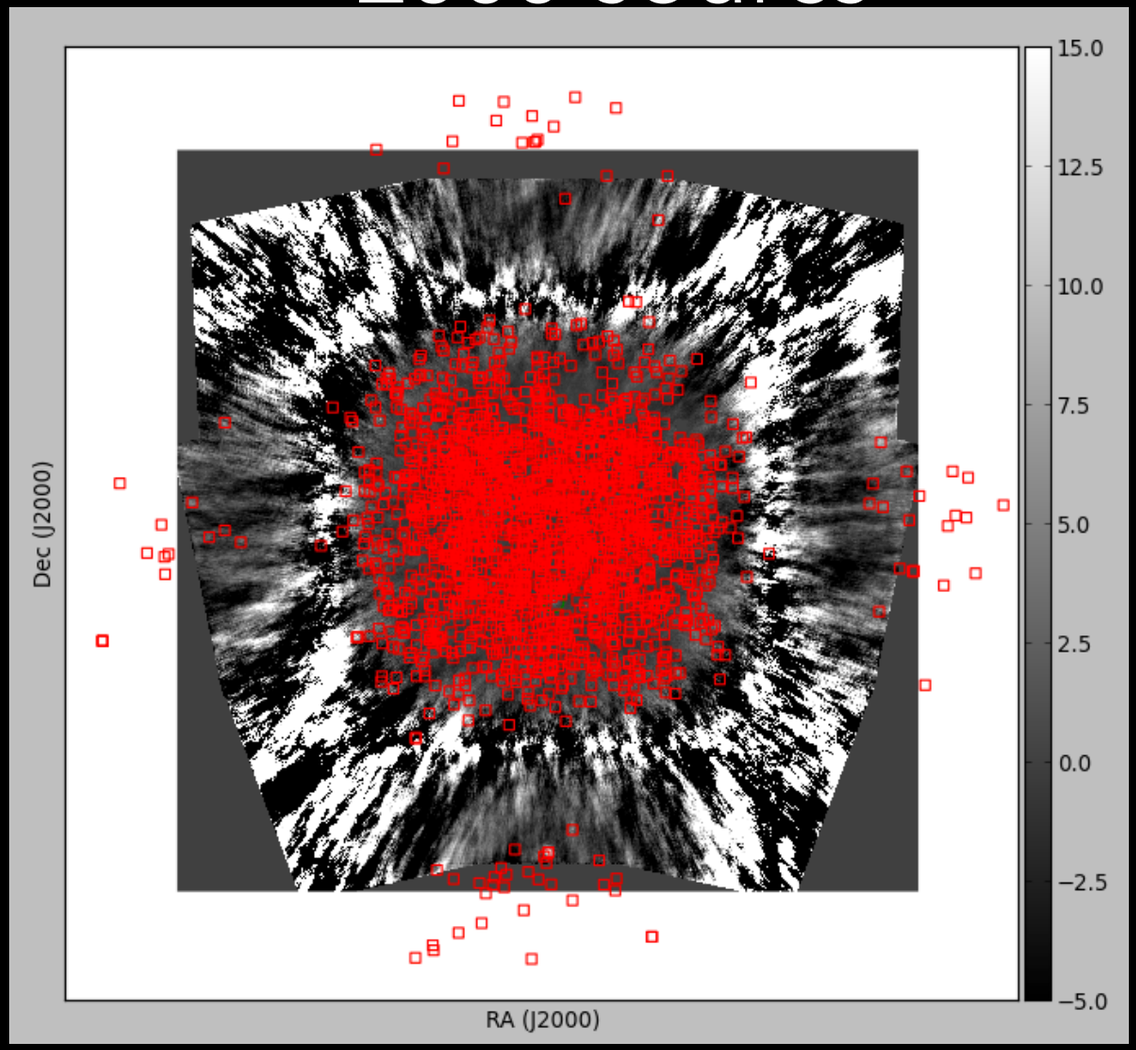
Pober and Hazelton

MODEL CALIBRATION

300 sources



2000 sourcs



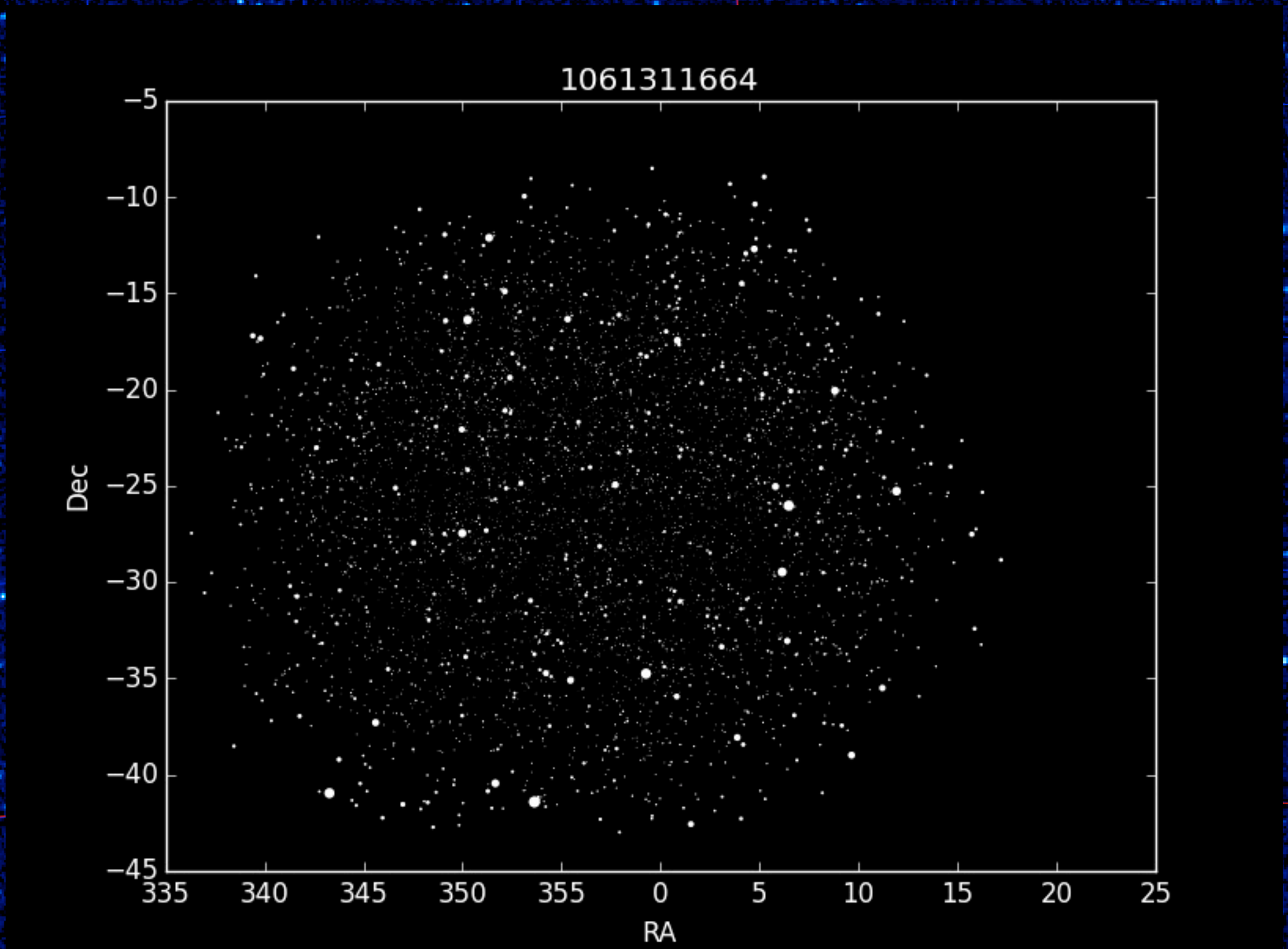
CARROLL 2014

CATALOGING

Talk later today

CARROLL 2014

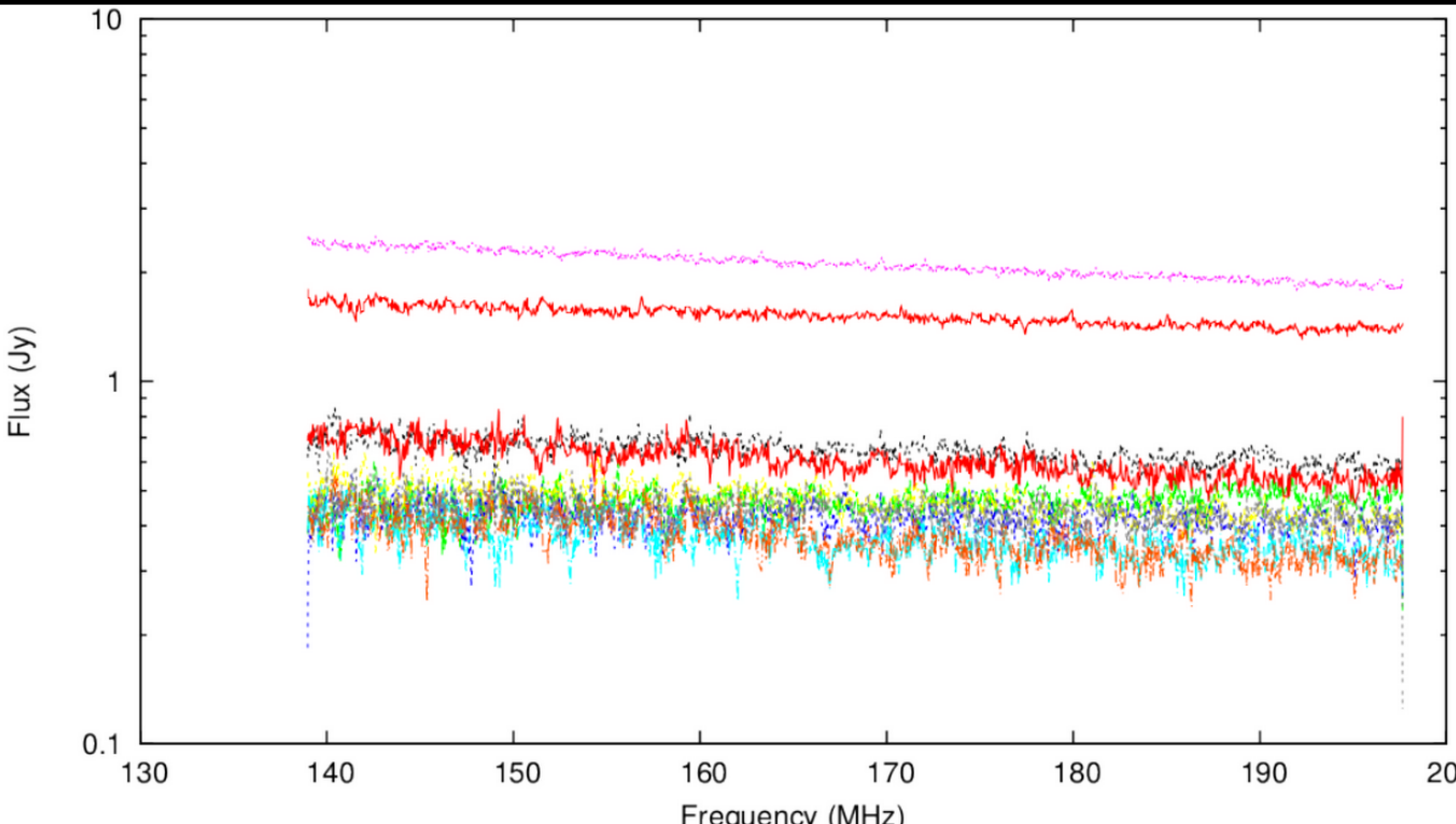
C



Talk later today

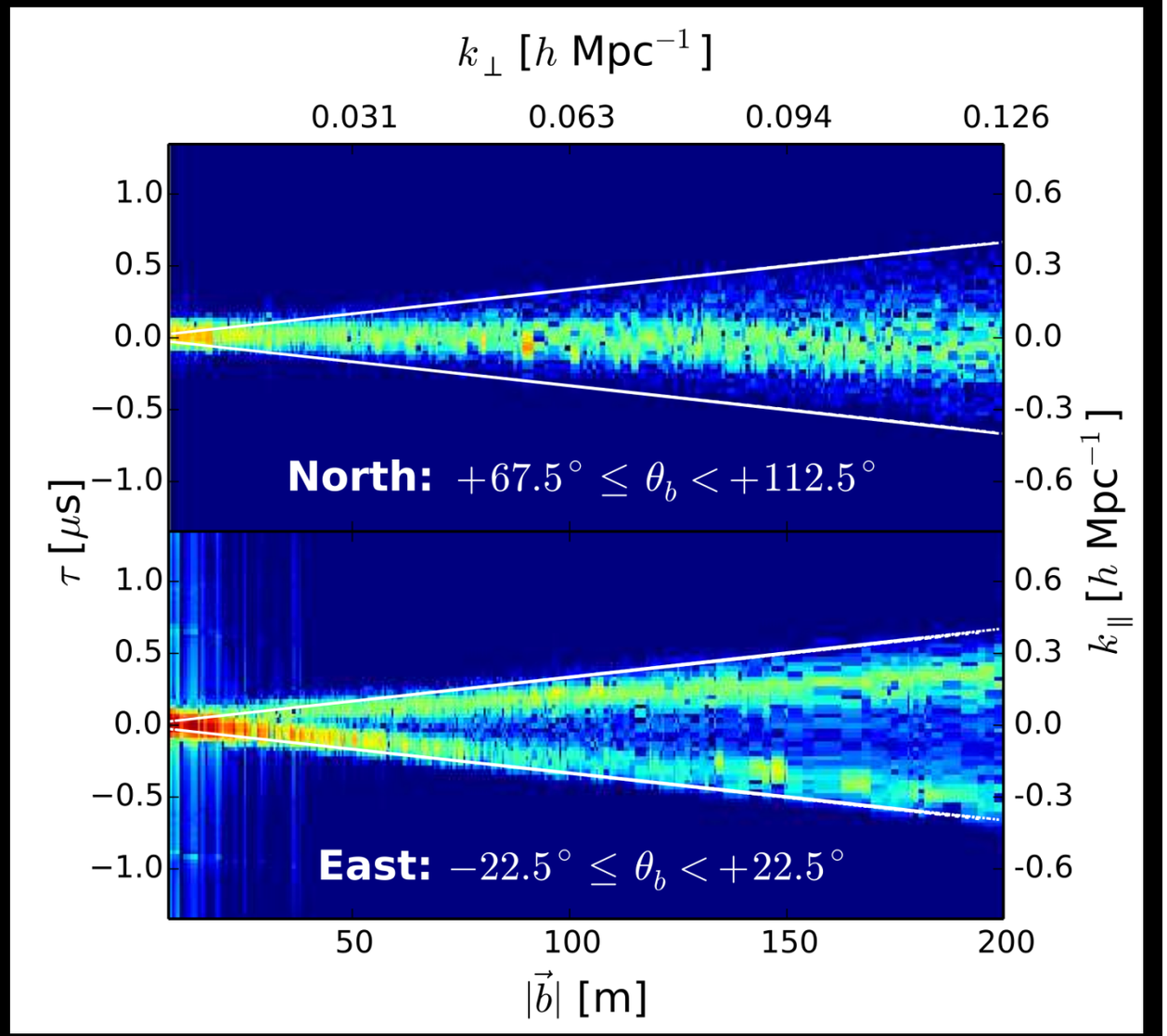
A. OFFRINGA

DEEP SPECTRAL CATALOGING



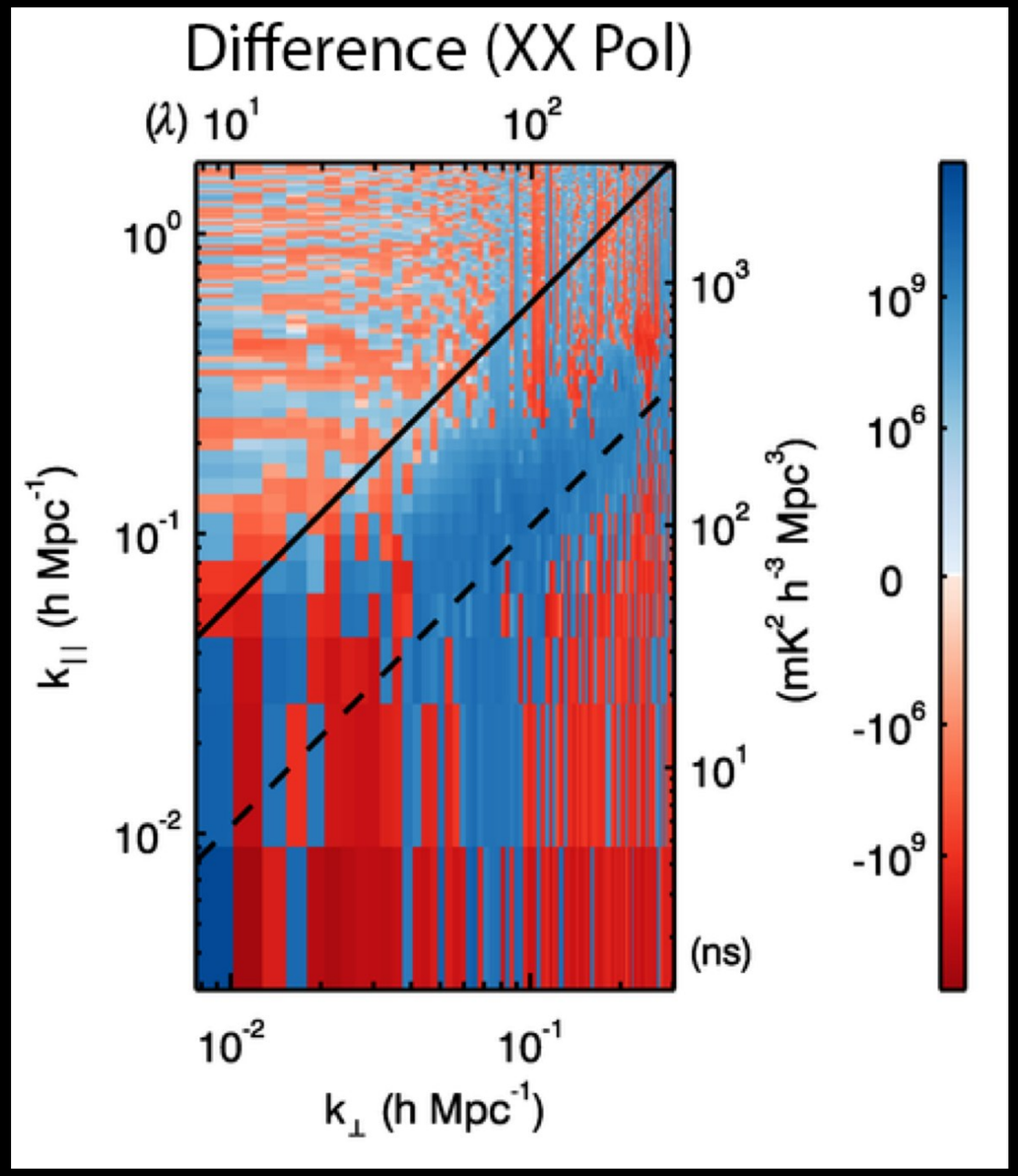
FOREGROUND MITIGATION

Avoidance



Thyaragarajan
(this afternoon)

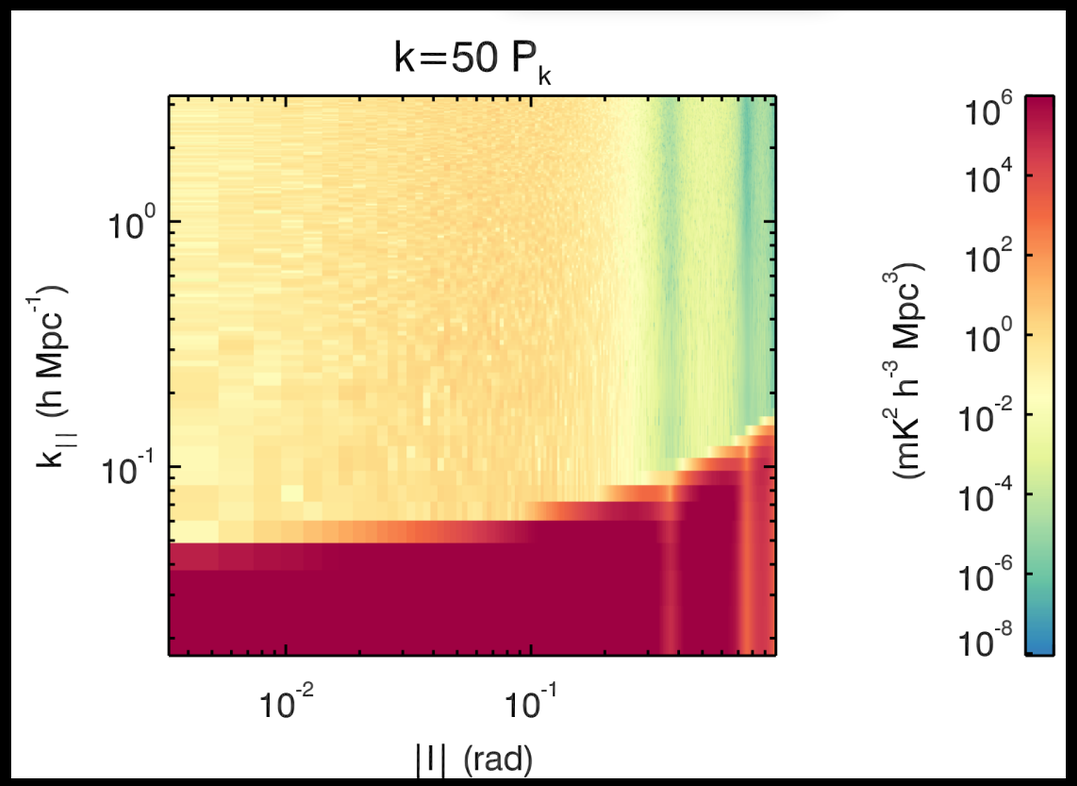
Subtraction



Pober

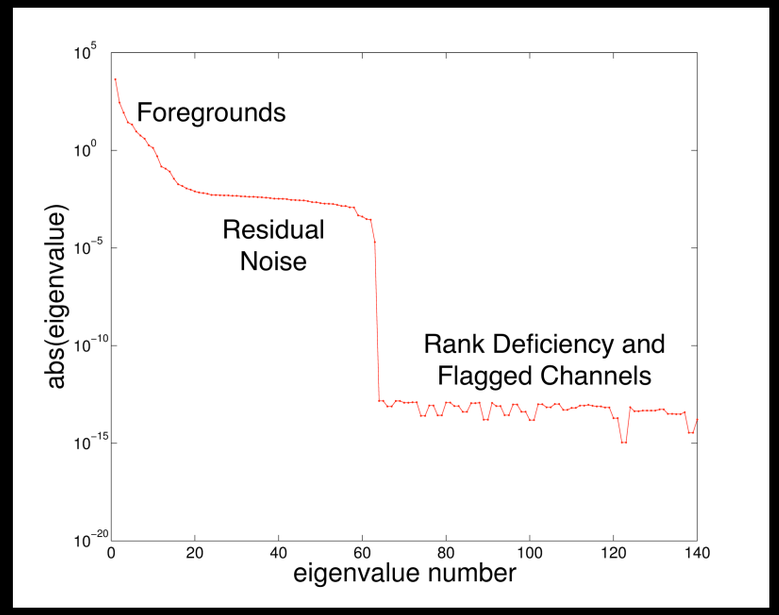
MINIMIZING FOREGROUNDS IN THE POWER SPECTRUM

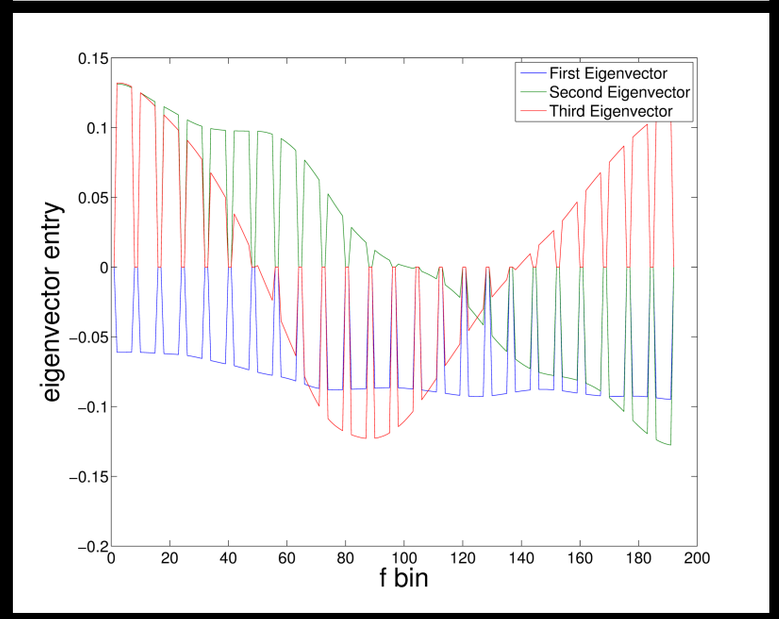
Forward modeling residuals



C. Trott

empirically measuring residuals





J. Dillon

See talks tomorrow afternoon

SUMMARY

- Tiered Analysis efforts:

  - Accuracy Efforts (understanding what we are doing):
    3 hours (300 runs and counting!)
    precision sky modeling and cataloging
    modeling the residual
    empirically down-weighting the residual

  - Depth efforts (doing what we are understanding):
    This time last year: ~2 sigma excess at 3 hours
    Today: ~2 sigma excess at 40 hours
    Starting this week: 113 hours (all of season1, z=7)

MCDXX