Canadian Hydrogen Intensity Mapping Experiment
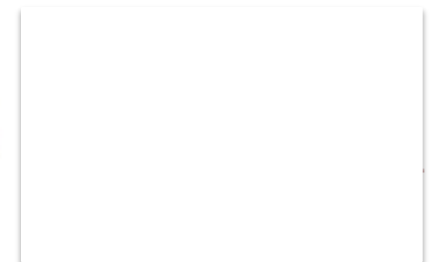
- CHIME will map neutral hydrogen at redshifts z~0.8 - 2.5

- Instrument resolution optimized for BAO measurements

- 5 years of CHIME data will make cosmic variance limited measurement of BAO to explore the nature of dark energy

- CHIME and Pathfinder fully funded, (portion of the) Pathfinder array taking data

CHIME Collaboration

McGill

UBC — THE UNIVERSITY OF BRITISH COLUMBIA

DRAO

NRC·CNRC

UNIVERSITY OF TORONTO

CHIME at a glance

- Full CHIME is an interferometer with
  - 5 cylinders (20m x 100m)
  - 1280 dual-pol feeds total
  - Operates between 400—800 MHz
- Measures the entire available sky in a day (~3/4 of the sky)
- Pathfinder is a shorter 2-cylinder interferometer test-bed
  - 2 cylinders (20m x 40m)
  - 128 dual-pol feeds
  - Fielded!
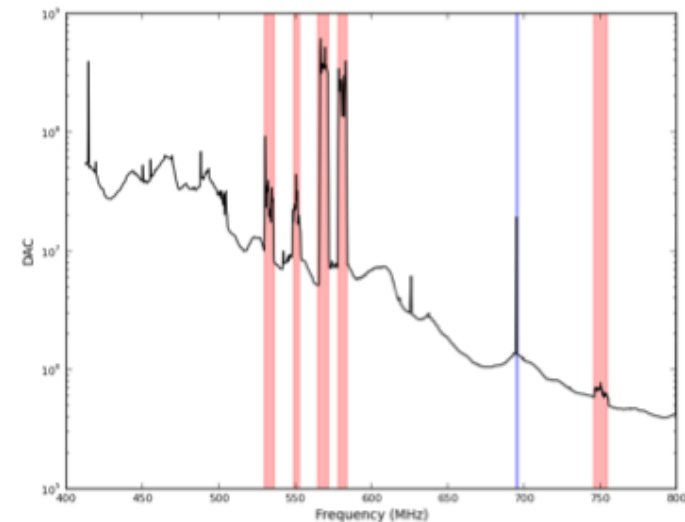 - First light!

Full CHIME

Pathfinder

First Light! (Cas A)
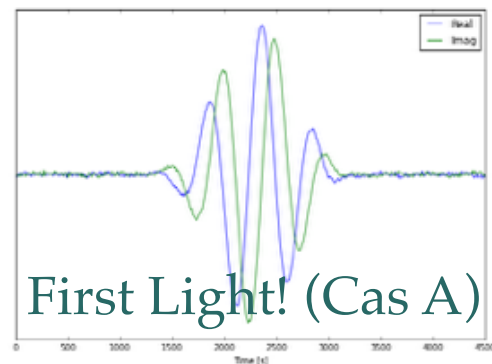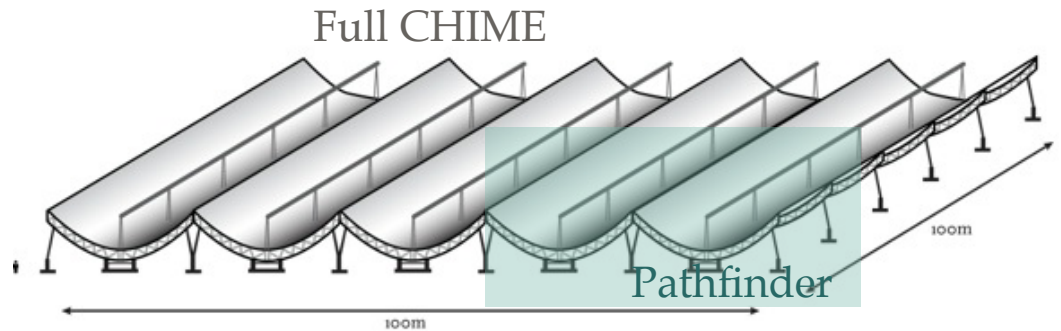
Pathfinder in operation with 8 feeds

Coming soon to arxiv: Bandura etal and Newburgh etal

CHIME Site

full CHIME goes here
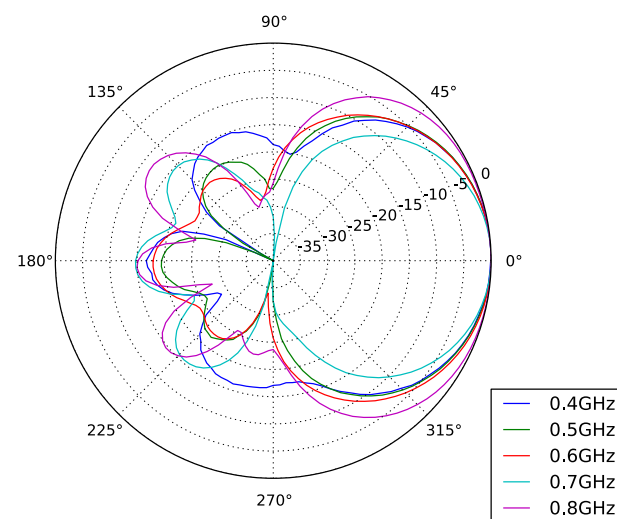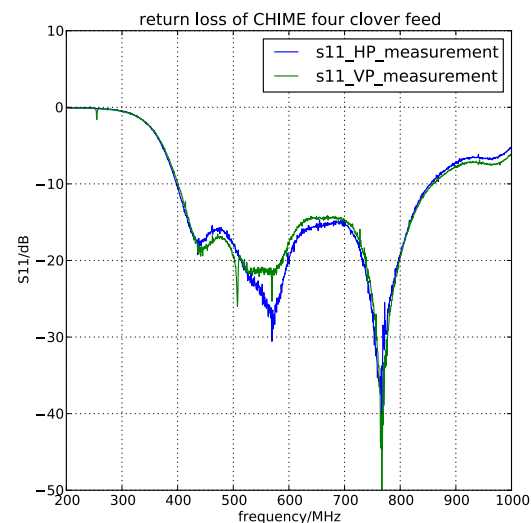
Pathfinder is here

- Operate at the Dominion Radio Astrophysical Observatory (Penticton, BC):

Located in a legally protected radio quiet valley.

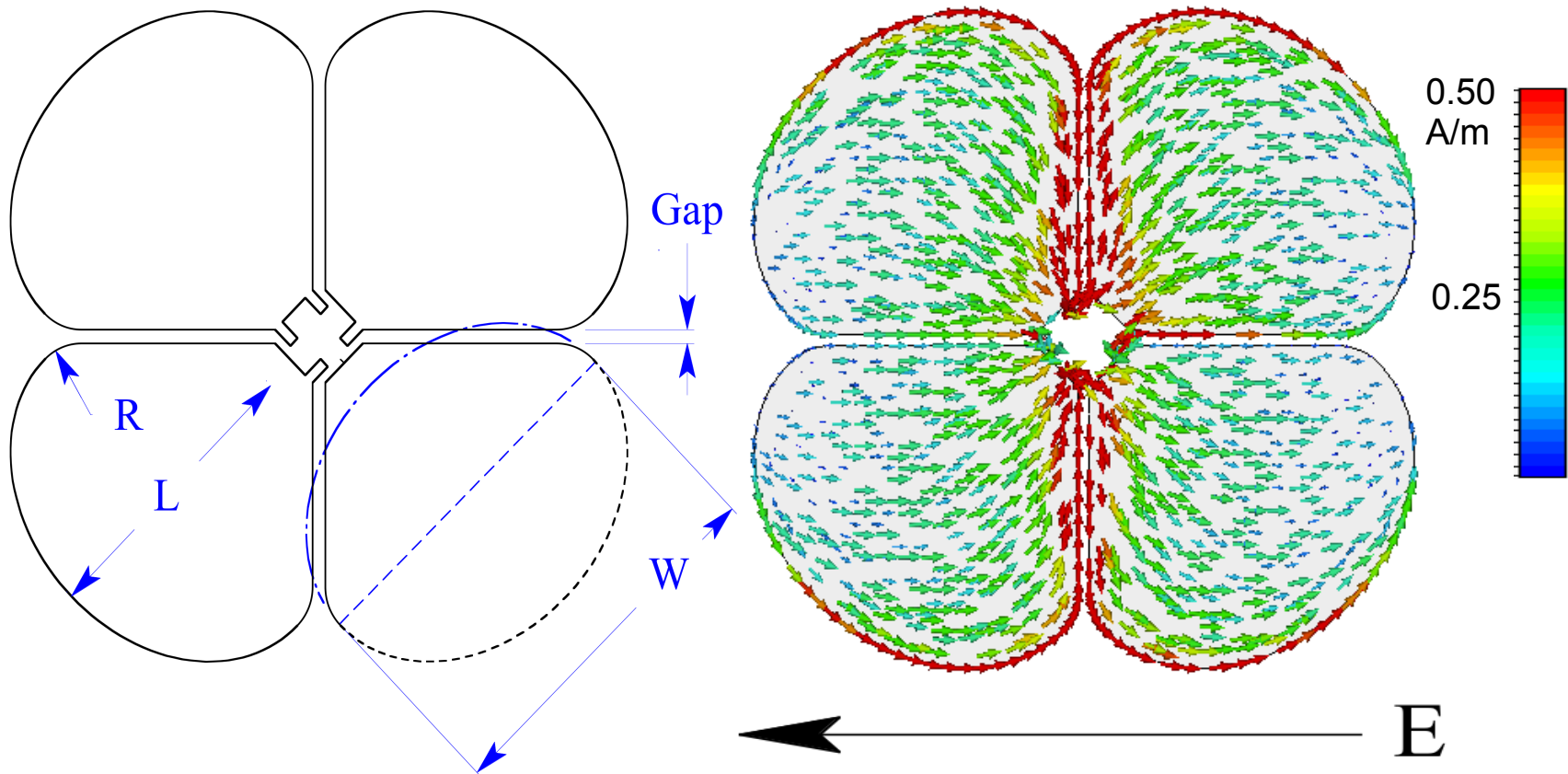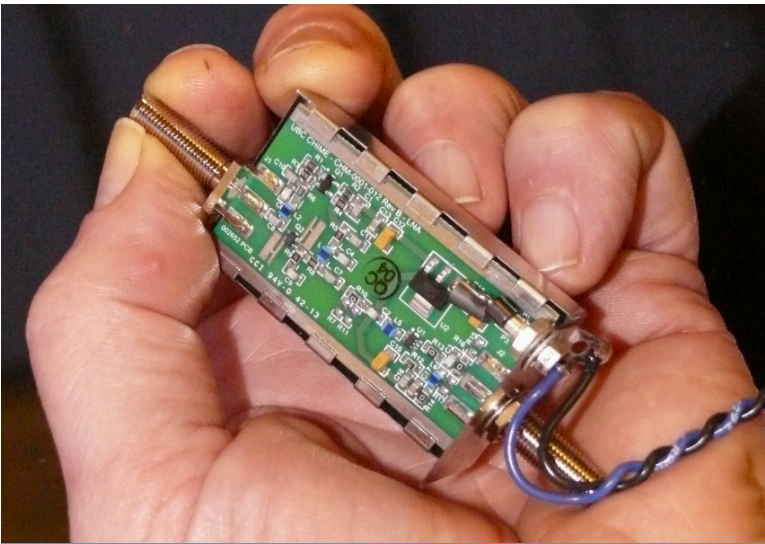# Feed Antenna: Four Leaf Clover

Duncan Campbell-Wilson and Meiling Deng

return loss of CHIME four clover feed
- s11_HP_measurement
- s11_VP_measurement

0.4GHz
0.5GHz
0.6GHz
0.7GHz
0.8GHz

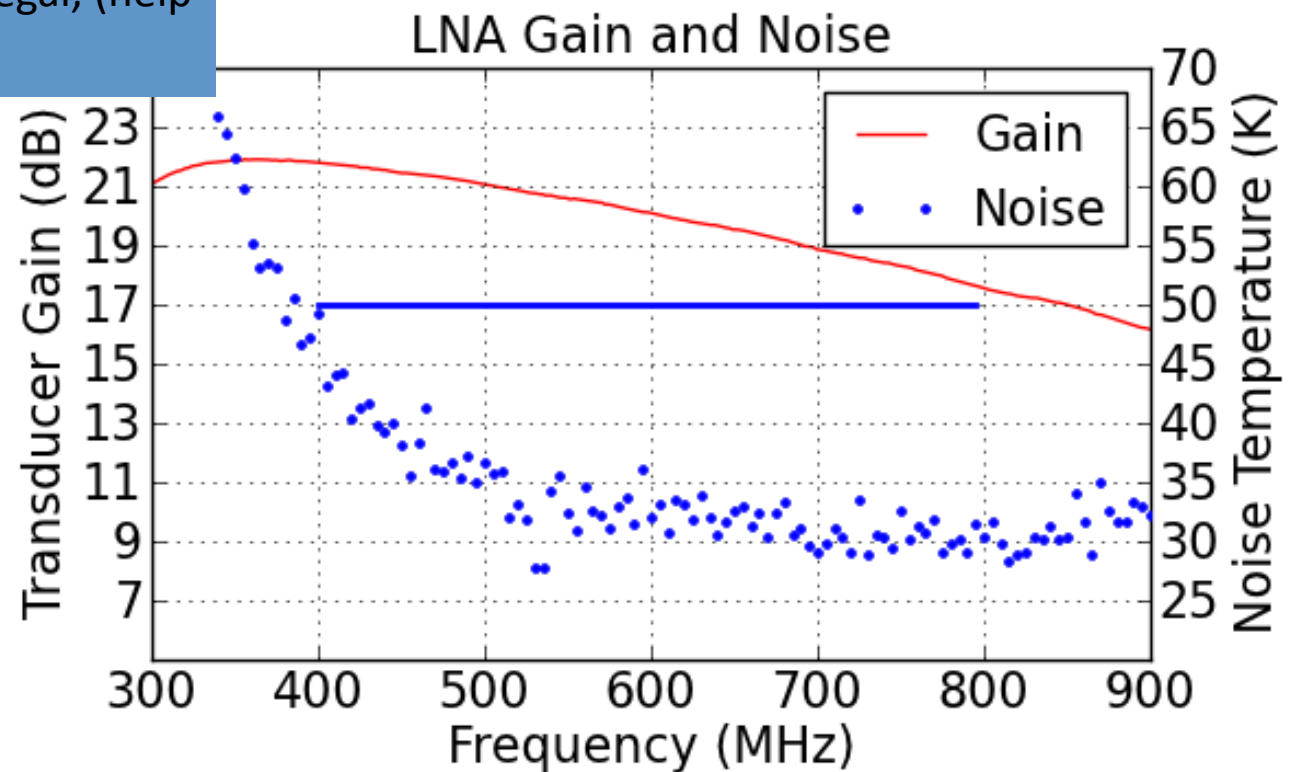# Simulation of Currents in Clover Feed
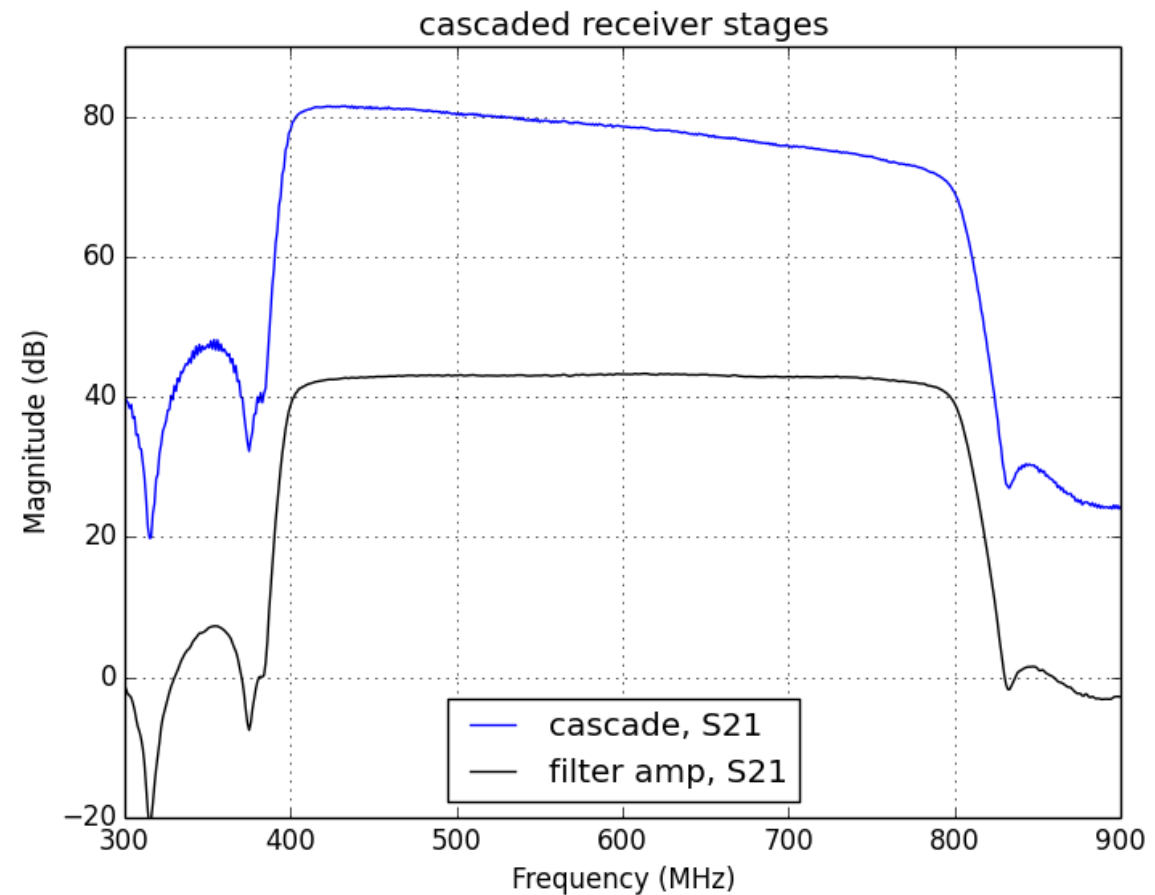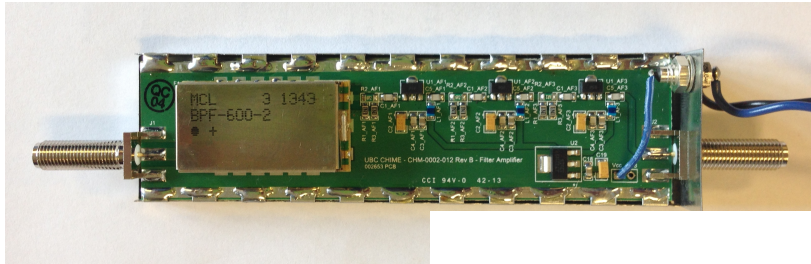
Noise Budget

Low noise amplifiers designed and tested by Greg Davis, Rick Smegal, (help from K Bandura and JBP)

Telescope Noise
Budget at
600 MHz:
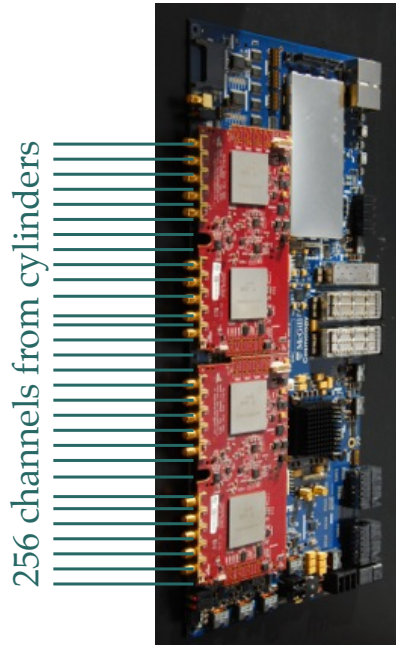 LNA: 35K
   Feed Loss   7K
   Reflector   5K
Total   47K

Filter Amplifier

Pathfinder Correlator

256 channels from cylinders

Pathfinder:
16 FPGA channelizer
cards
16 channels per card

Pathfinder:
16 GPU hosts

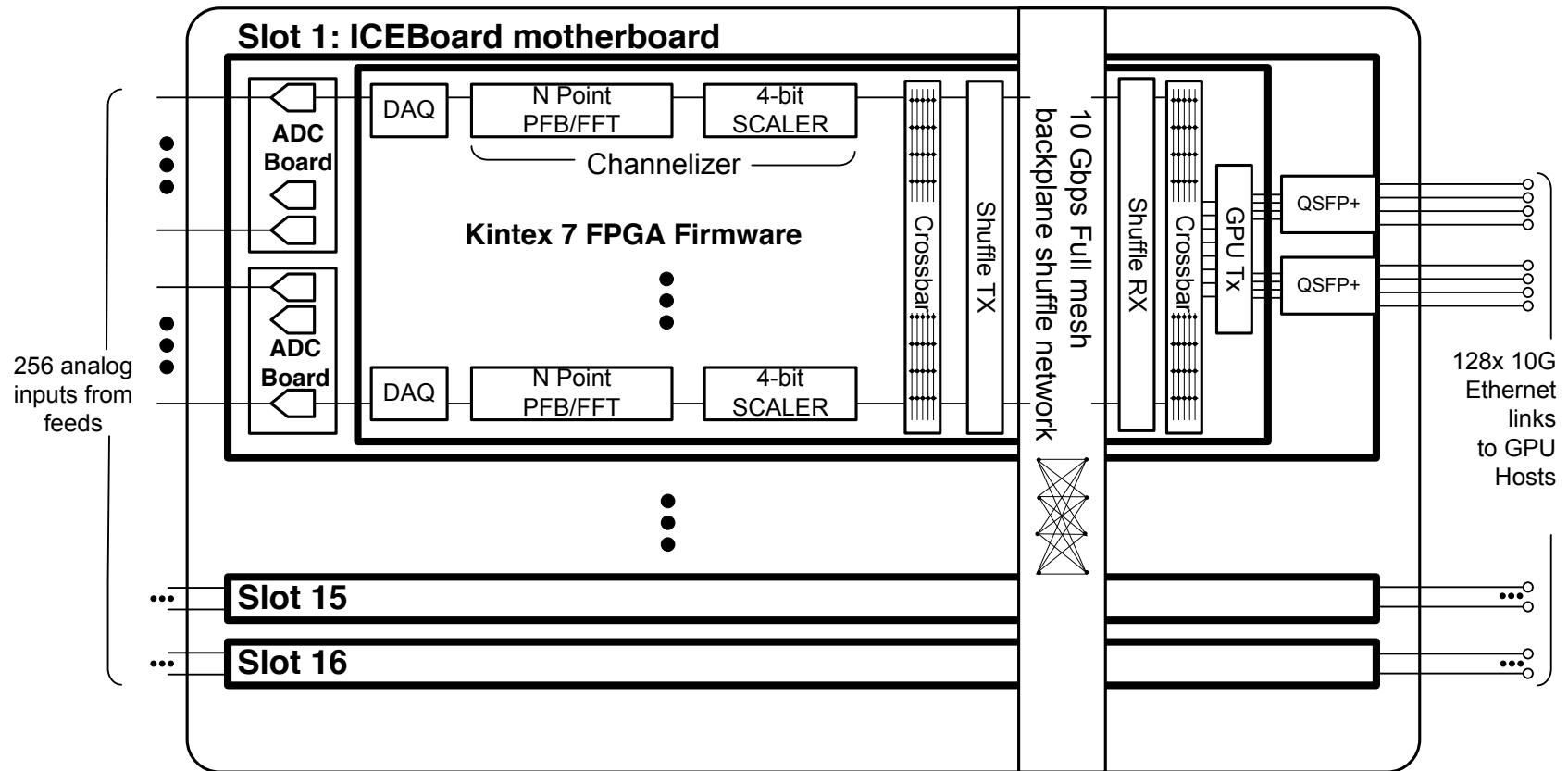-400-800 MHz band sampled at 800 Ms/s in 4k blocks.
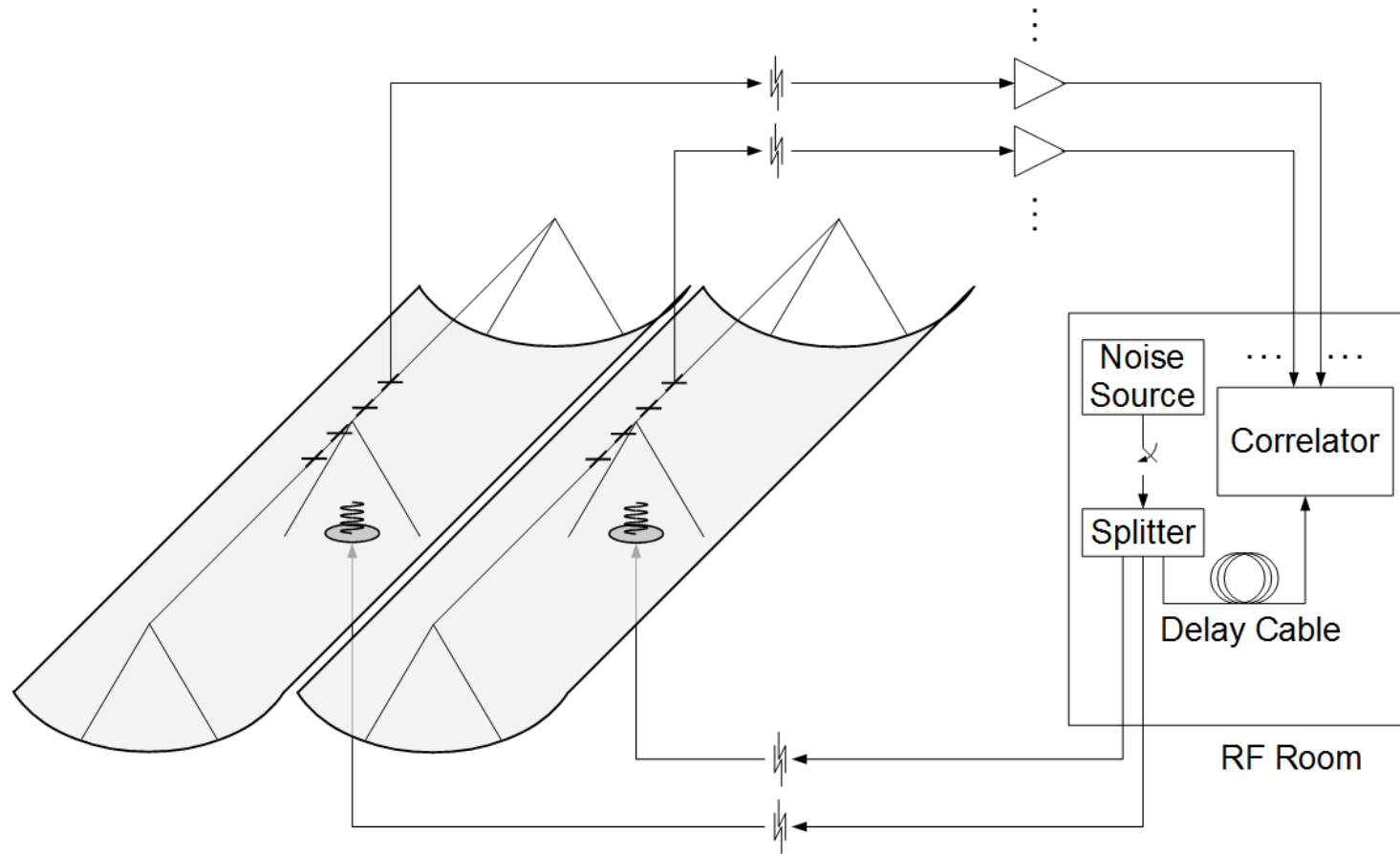
-Xilinx FPGA executes polyphase filter bank (PFB) + FFT

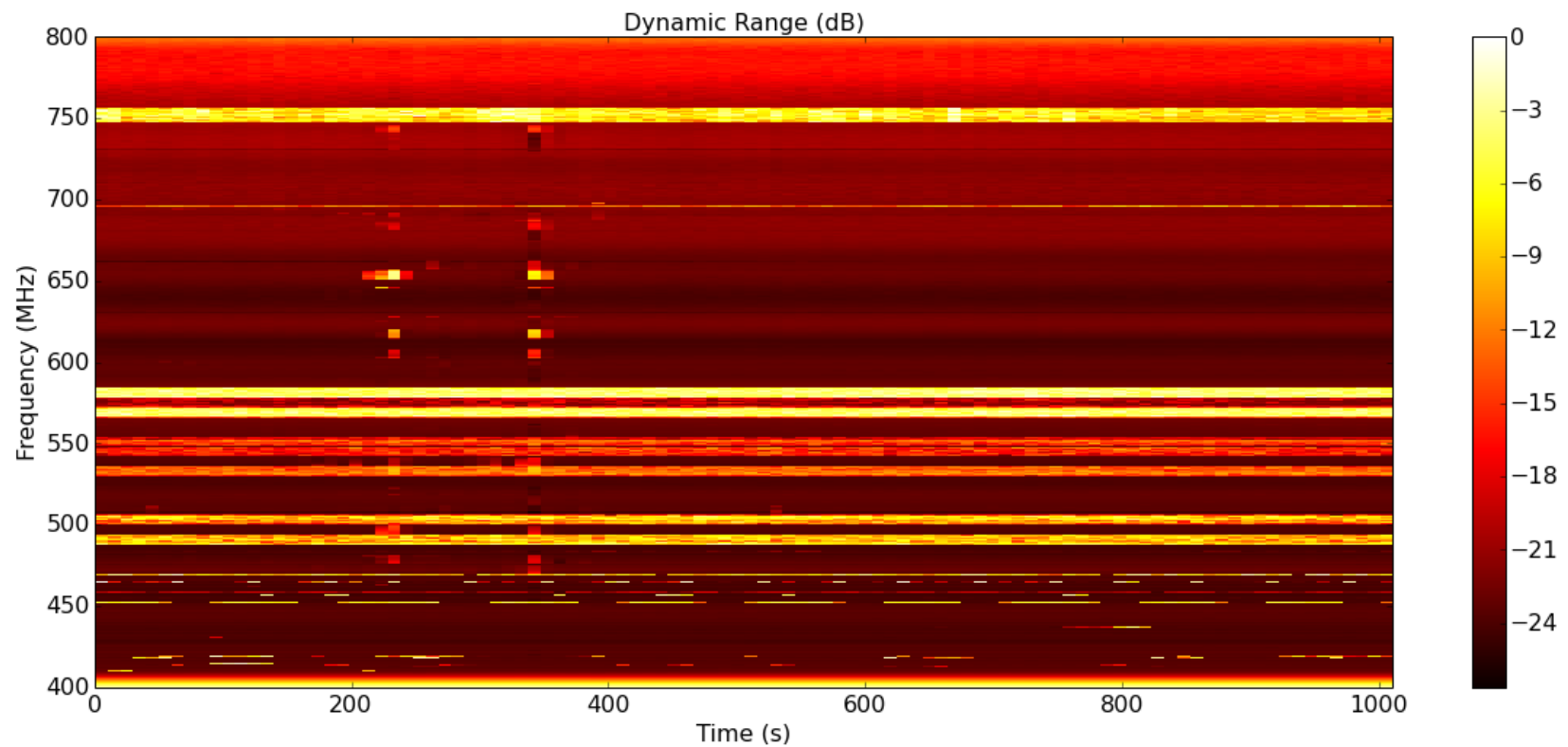-10 GbE to GPU array

-All N(N-1)/2 cross products accumulated.

CHIME PATHFINDER CRATE

Slot 1: ICEBoard motherboard

ADC Board

ADC Board

DAQ

N Point PFB/FFT

4-bit SCALER

Channelizer

Kintex 7 FPGA Firmware

DAQ

N Point PFB/FFT

4-bit SCALER

Crossbar

Shuffle TX

10 Gbps Full mesh backplane shuffle network

Shuffle RX

Crossbar

GPU Tx

QSFP+

QSFP+

256 analog inputs from feeds

Slot 15

Slot 16

128x 10G Ethernet links to GPU Hosts

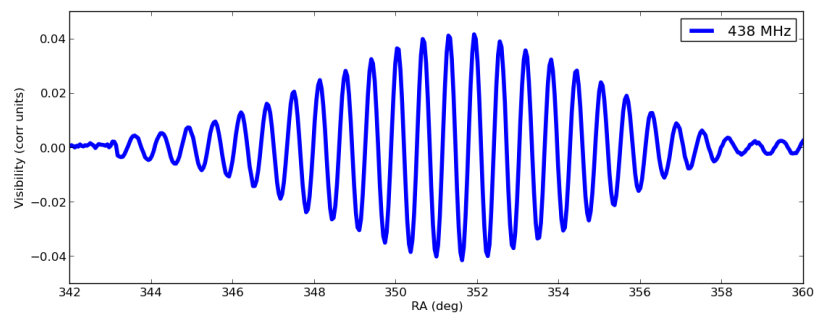# Complex Gain Rigidization via Broadband Random Signal Injection
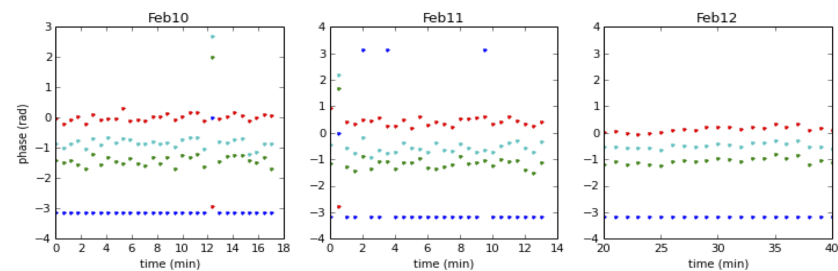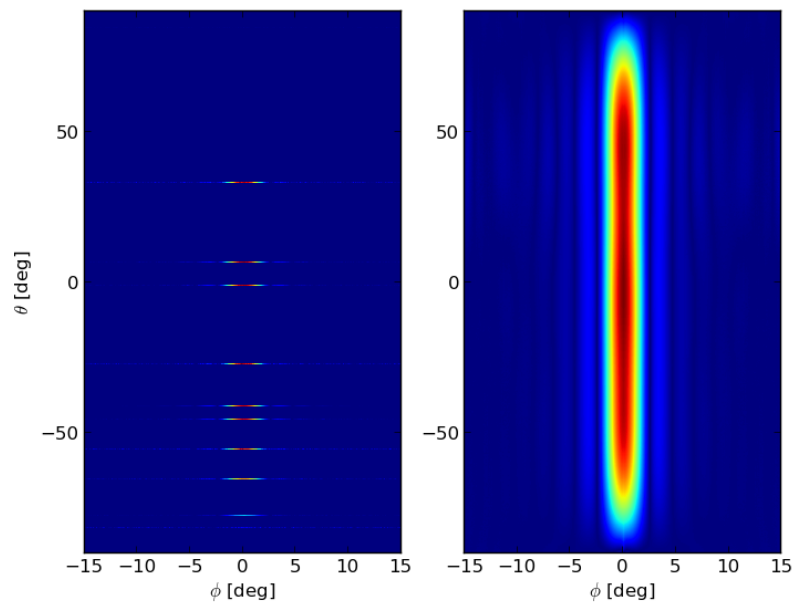
2nd/1st Eigenvalue ratio

Achieving gain stabilization to 1% over most of the band...0.1% needed.

Use DRAO 26-meter to make holographic surface maps of CHIME and to calibrate using pulsars
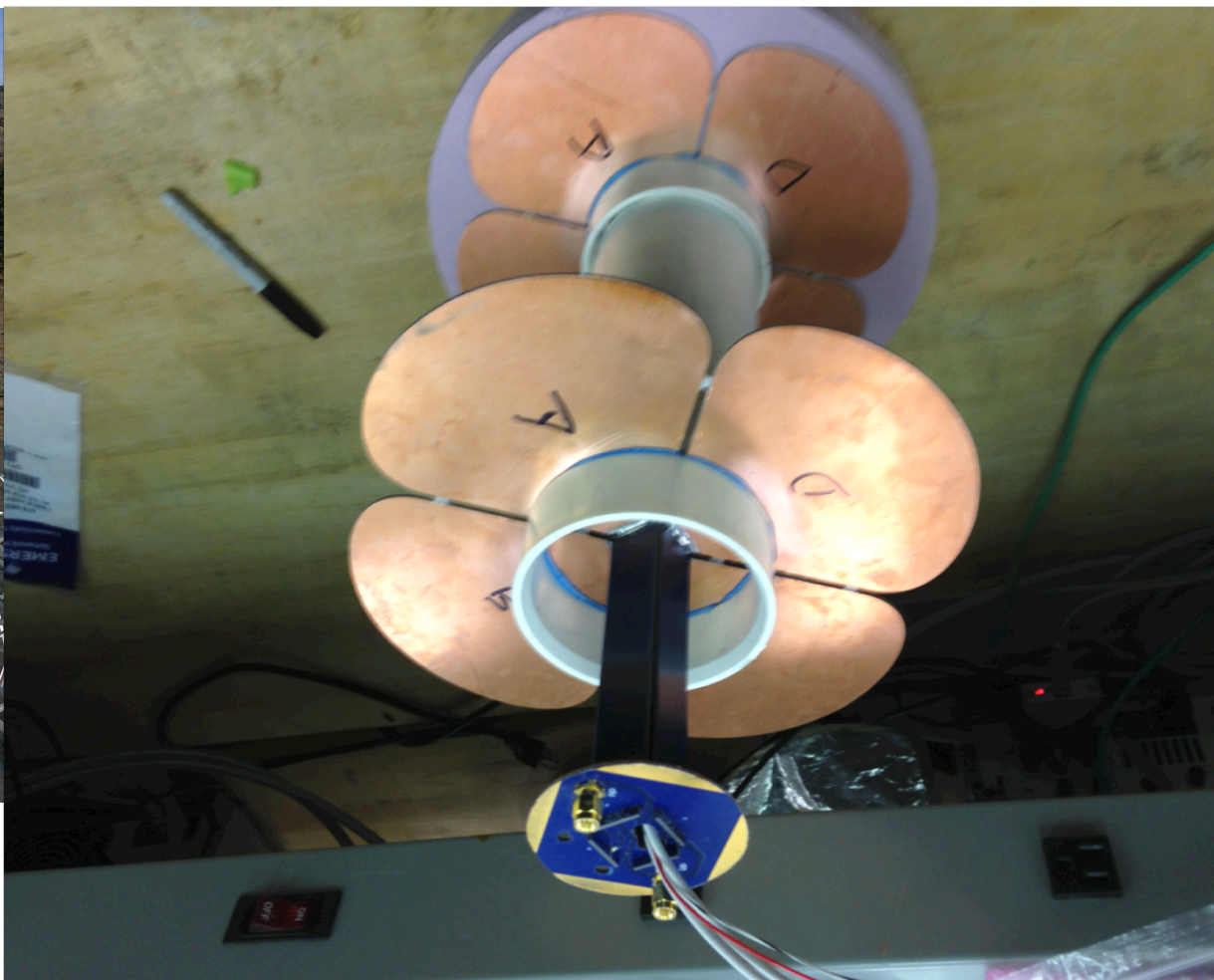
Fringes for Cas A between the 26m (tracking)
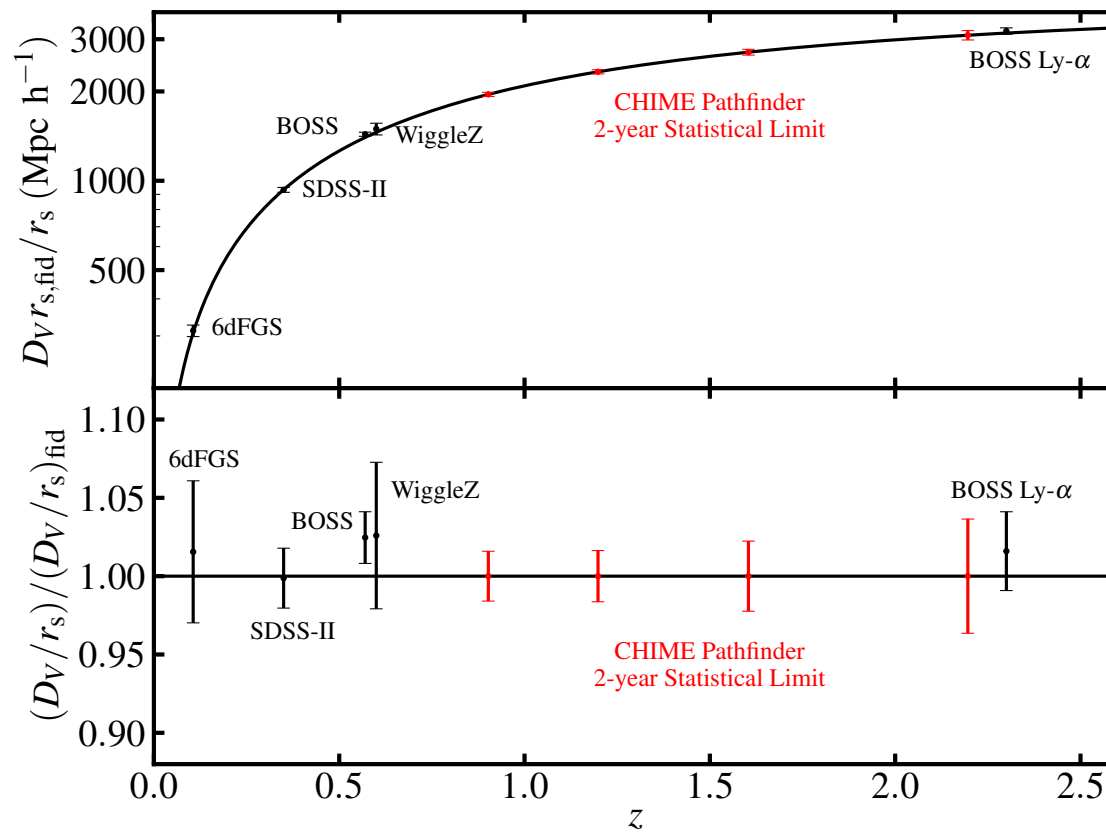And a single Chime Feed.

Relative phase of pulsar signal
among four feeds,
over three days

Pulsar paths across the single-feed beam pattern
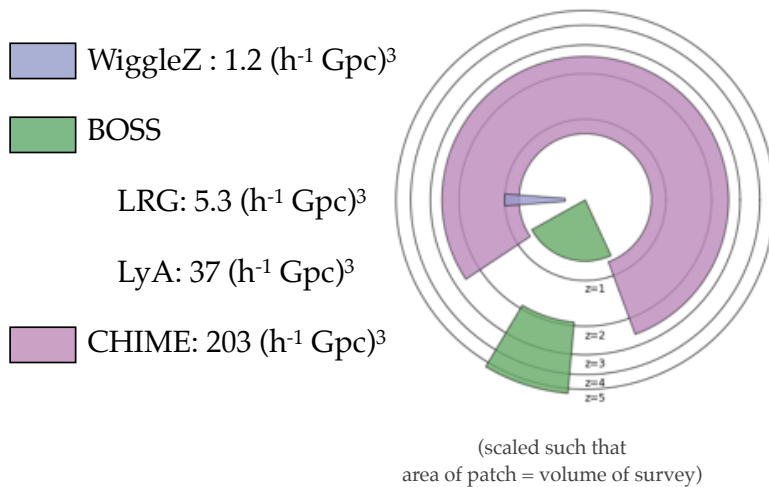
Real time RFI subtraction

Pathfinder Sensitivity to BAO Spatial Scale

CHIME Forecasts

more volume = less sample variance

WiggleZ : 1.2 $(h^{-1}$ Gpc$)^3$

BOSS

LRG: 5.3 $(h^{-1}$ Gpc$)^3$

LyA: 37 $(h^{-1}$ Gpc$)^3$

CHIME: 203 $(h^{-1}$ Gpc$)^3$

(scaled such that
area of patch = volume of survey)

- Anticipated sensitivity for two years of data (projected to a single redshift z=1.5)