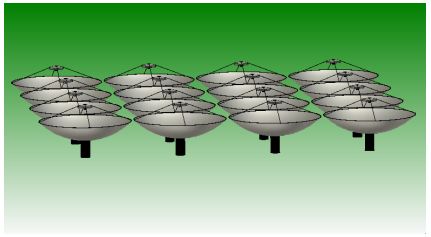
NSF Advanced Technologies and Instrumentation Proposal 2012



Goal: Allow CMU and UW to contribute to the BAORadio/Tianlai effort. Test advantages of compact, high-redundancy arrays with medium-gain antennas. (Funds can't be used to directly support foreign collaborators.)

Motivation:

- Major challenges face all HI measurements: calibration vs frequency (mode-mixing); foreground removal; RFI
- The first generation of interferometers have several drawbacks:
    1. Most are diffuse arrays (PAPER, MWA, LEDA,GMRT). Beam patterns and u-v coverage change with redshift. A packed array can reduce this problem.
    2. Wide beams/small collecting (dipole antennas) area makes calibration difficult. Higher gain antennas facilitate beam mapping, calibration on one or a few sources at once.
    3. Wide beams => broad sky coverage, not optimal for making an HI detection. 1st-generation experiments should increase integration time on smaller sky coverage. (Later, cosmic variance-limited measurements of power spectra will require full-sky.) EoR measurements do not require full sky.
    4. Minimum baseline redundancy – makes calibration difficult.
       (see Parsons et al: arXiv:1103.2135v2 "A Sensitivity and Array Conguration Study for Measuring the Power Spectrum of 21cm from EoR")

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Plan:

- Build and test a 4x4, dual-polarization, close-packed array of dish antennas to measure HI LSS and foregrounds at z ~ 0.3.
- Prototype is (almost) unique:
  1) compact (like CHIME and FFTT);
  2) modest-gain antennas;
  3) low redshift (not EoR)
- Concentrate on foreground removal, calibration, not on hardware development.
- Easy to build, cheap.
  - Operate at Green Bank.
  - Buy off-the-shelf dishes.
  - Use CMU feed/LNA.
  - Use CASPER ADC's/ correlator/ software.
  - Drift scan.

Long-term benefits:

- Prototype for Tianlai dark energy telescope at better site in China.
- Results will be applicable to design of all post-LOFAR HI arrays (SKA, HERA...)
- Part of in international collaboration with a long track record.

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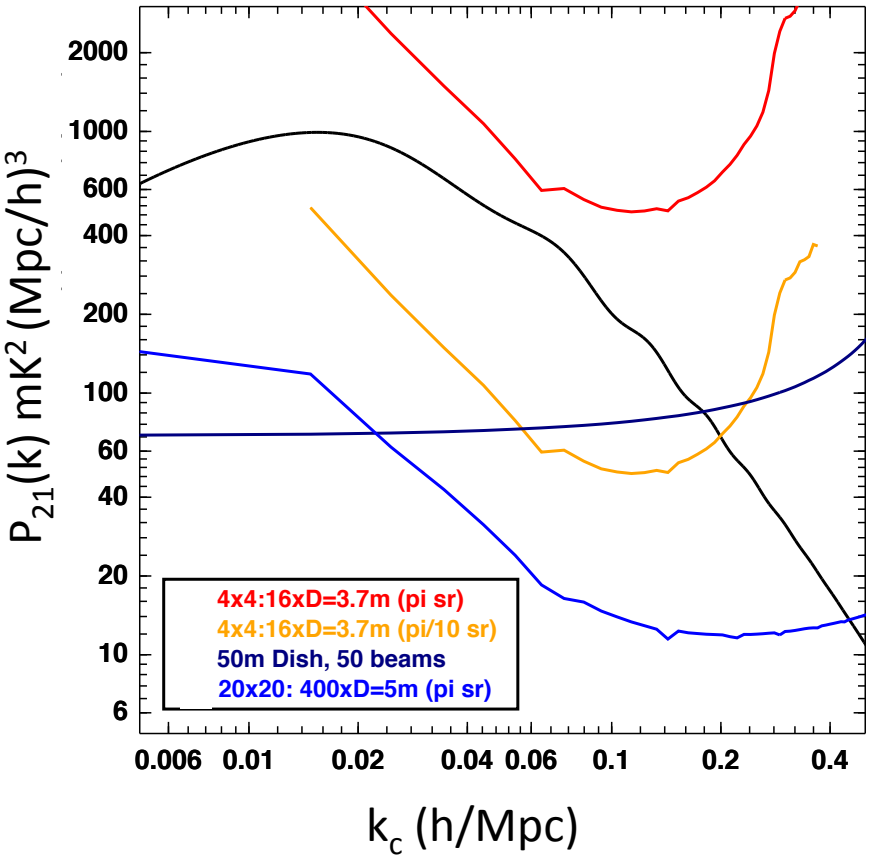
We need:

- simulations of performance of 4x4 dish array (Ansari et al 2011).
- simulations of performance of Tianlai
- discussion of advantages of dense, medium-gain array

z = 0.5



z = 1.5