

21^{cm} Experiment for the 21st Century

Where Do We Stand?

1. Science

A. Motivation

- The primary science goal for a Radio BAO experiment is measuring the Dark Energy equation of state.
- Secondary science includes searches for pulsars, GRBs, HI cosmology, astrophysics of foregrounds.

B. Observables

- The redshifted emission in 21cm of neutral hydrogen on large scales (a-ka Intensity Mapping).
- Signal comes from individual galaxies (a-ka DLAs), we will measure the large-scale fluctuations in the signal, not resolve individual galaxies on the sky.
- Detecting the BAO peak in the power spectrum of the signal will provide constraints on the DE.

1. Science

C. Signal

- We need to measure a $<1\mu\text{K}$ signal against a $\sim\text{few K}$ foreground (similar to CMB polarization experiment).
- Foreground contamination appears to be less severe than is often thought. Proof-of-concept demonstration has already been done (HIPASS, GBT).
- A quiet (low RFI) site is crucial.

D. Context

- The BAO measurement constrains the DE by itself.
- Eventually all Stage IV DE experiments will be combined together to obtain the most stringent constraint.
- There may never be a Stage V.

1. Science

E. Landscape

- The most important complimentary probe is a large-scale weak lensing experiment (a-ka LSST).
- Two competing/complementary probes:
 - **BigBOSS** (\$100M, done by 2020+)
 - Based on [OII] emission line
 - **JDEM** (\$650M, done by 2021+)
 - Based on H α emission line
- Radio is very complimentary to other probes: in the radio we detect mostly dwarf, HI rich, slow star-forming galaxies, all optical-IR surveys rely on emission line (i.e. actively star-forming) galaxies.

2. Technical Approach

A. Strawman Design

- We have two strawman designs, and the machinery to make more.
- To a large extent, the design choice is driven by the cost considerations.

B. Instrument Optimization

- We do have software developed for the complete design of the telescope and antennas.
- Electronics development is well under way.

C. Path to validate requirements

- Two prototype cylinders exist at Pittsburgh.
- A 10% prototype is the next step.

2. Technical Approach

D. Experiment simulation and development

- The telescope simulation software is fairly complete.
- State-of-the-art foreground model (a-ka Angelica's Sky), realistic cosmological signal, Dave's telescope simulator & foreground removal pipeline.

E. Site selection

- Multiple sites have been tested. No site selection has been made.
- Eventual site selection will largely depend on the primary source of funding.

3. Schedule, Collaboration, and Funding

A. Collaboration - personnel commitments

- Fermilab personnel commitment is ~3 scientists, but we can contribute more.
- Total collaboration effort is ~10 scientists and ~4 engineers.

B. Collaboration organization

- Most of organization is in place.

C. Role of FNAL - institutional commitment

- FNAL is a major player in the collaboration (McGinnis is the Instrument Scientist).
- The future of FNAL involvement will largely depend on this review and on the DOE review in September.

3. Schedule, Collaboration, and Funding

D. Other needed areas of expertise

- It is desirable to have more local radio astronomy expertise - a consultant/joint appointment (a-la Rich Kron or Rai Weiss). Such a position is on the strategic plan for the Astronomy Department at U. of Chicago.

E. Plan for Schedule development

- Conceptual design: end of 2010.
- 10% prototype: end of 2012.
- Start of construction: mid 2013.
- Science operations: mid 2015.
- Trip to Stockholm: end of 2018.

3. Schedule, Collaboration, and Funding

F. Plan for Budget development

- The first step is to complete the Conceptual Design Report.
- In order to follow it up with the budget plan, we need engineering resources and other R&D support.

What We Ask For

- Endorsement of the Fermilab participation in the collaboration and completion of the Conceptual Design Report.
- Support for increased scientific involvement.
- Acknowledgement of our need for the engineering resources for developing a realistic budget and schedule.