The Status of the MicroBooNE Experiment

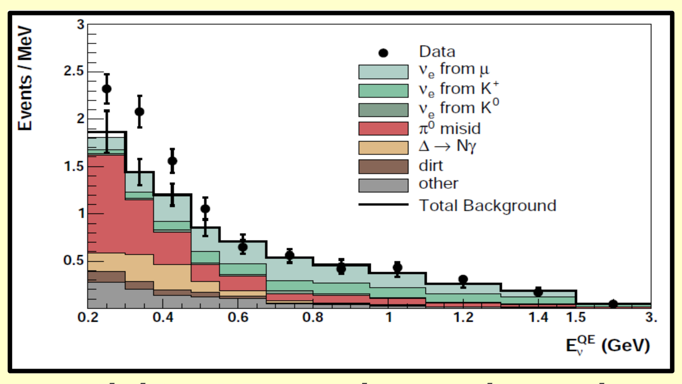
Benjamin J.P. Jones
on behalf of the MicroBooNE Collaboration

Physics Motivation

MicroBooNE is a 170 ton liquid argon TPC detector which will begin taking data in Booster Neutrino Beam at Fermilab in early 2014. MicroBooNE will have excellent particle ID capabilities for low energy tracks produced in neutrino interactions. The goals of the experiment fall broadly into three categories

1. Resolution of the MiniBooNE anomalies

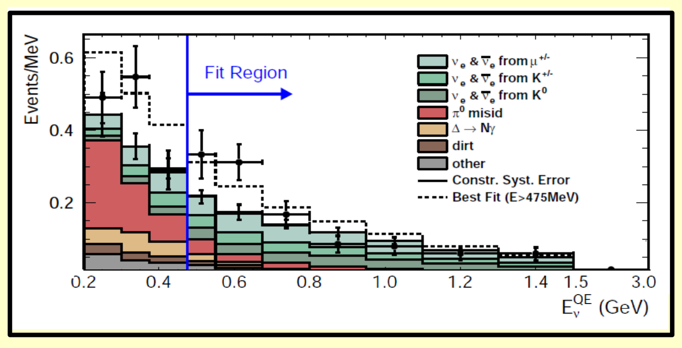
The MiniBooNE experiment observed anomalous electron neutrino appearance signals at low energy in both neutrino and antineutrino modes, and also an intermediate "LSND like" excess in antineutrino mode. MicroBooNE will help to resolve these anomalies by utilizing the same beam but a different detection technology, with excellent PID capabilities at low energy, including clear e / γ separation.



MiniBooNE neutrino mode result

2. Low Energy Cross Sections

MicroBooNE will collect the worlds highest statistics sample of neutrino interactions in argon. The excellent energy resolution and PID capabilities of a LArTPC detector, especially at low energies, means a wide range of low energy cross section measurements are uniquely accessible.



MiniBooNE antineutrino mode result

3. Selected Nonaccelerator Physics

MicroBooNE is capable of observing neutrinos produced from a burst supernova in our galaxy, and will make important measurements of cosmogenic proton decay backgrounds.

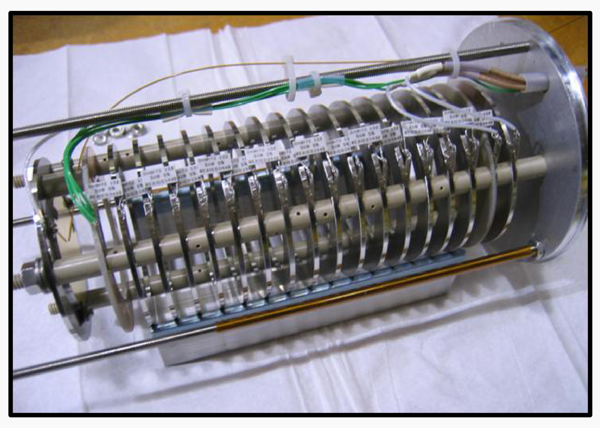
Active Volume & Cryogenics

In order to maintain argon purity, temperature and pressure uniformity, MicroBooNE employs an extensive system of cryogenics. Constant argon purification is employed to combat outgassing from the cryostat, with electron lifetime based purity monitors (shown below) both inside the detector and in the argon circulation system. Temperature is maintained by an LN2 refrigeration system.

Electronegative impurities in LAr can absorb free charges during the drift to the wire planes.
- ***Dissolved oxygen and water levels <100ppt***

Impurities quench scintillation light production.
- ***Nitrogen level maintained <2ppm***

Temperature differences lead to non-uniformity of drift velocity and hence image distortion
- ***Temperature uniformity ensured to < 0.1 K***



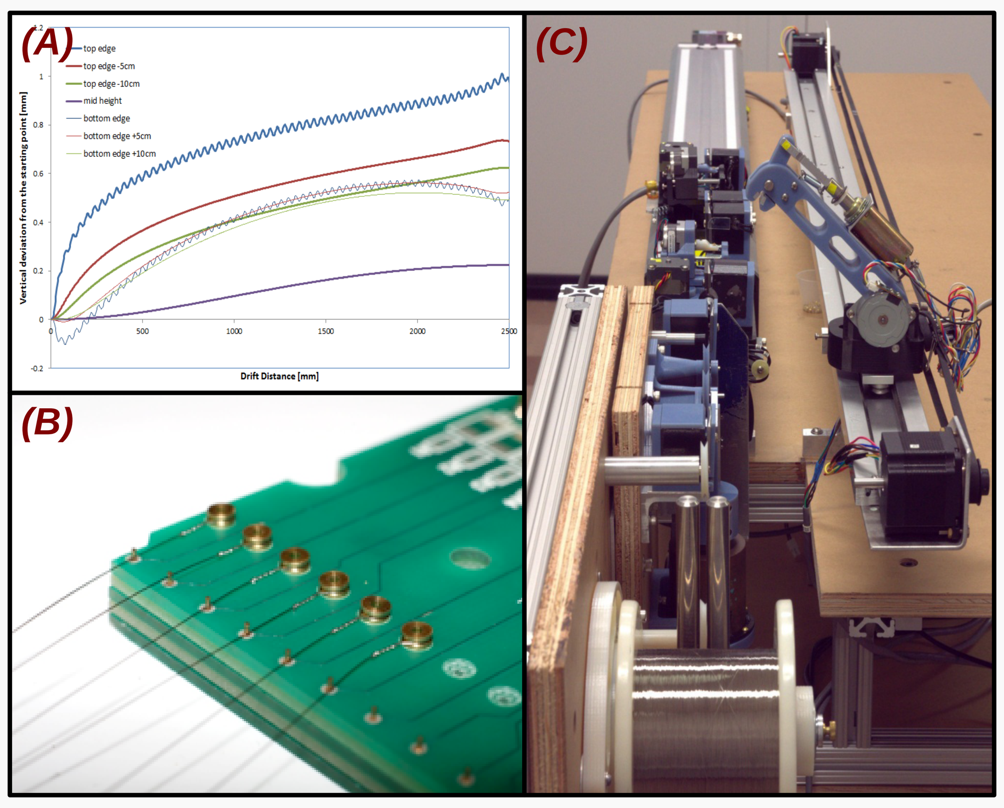
Time Projection Chamber

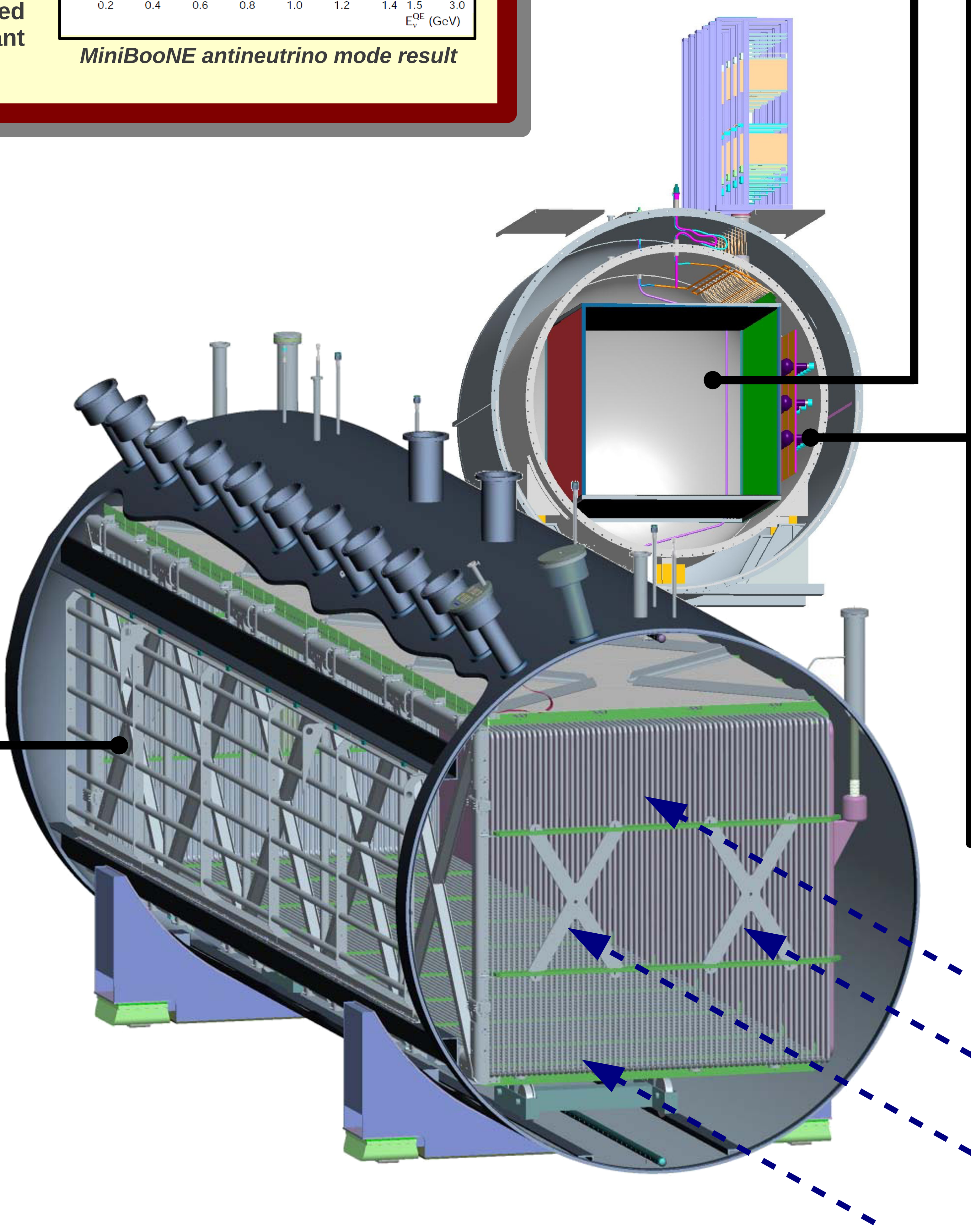
Charge deposited in the MicroBooNE active volume is drifted under the influence of a 500V/cm electric field, towards three crossed wire planes at the edge of the detector. Charges passing each wire induce a voltage, and the amplitude and arrival time of these signals is digitized and used to generate a high resolution 3D image.

In order to prevent image distortion, a very high field uniformity must be maintained. Simulations of charge trajectories inside MicroBooNEs field cage show a maximum deviation of 1mm from the nominal uniform field trajectory for charges deposited in different parts of the fiducial volume *(A).*

The wire chamber is being strung with 8256 wires, fixed to carrier boards by circular ferrules at each end *(B)* beginning this summer, by an automated wire winding machine *(C)* at the Brookhaven National Laboratory.

Y	***Vertical***	***3456 wires***
U	***+60˚***	***2400 wires***
V	***-60˚***	***2400 wires***



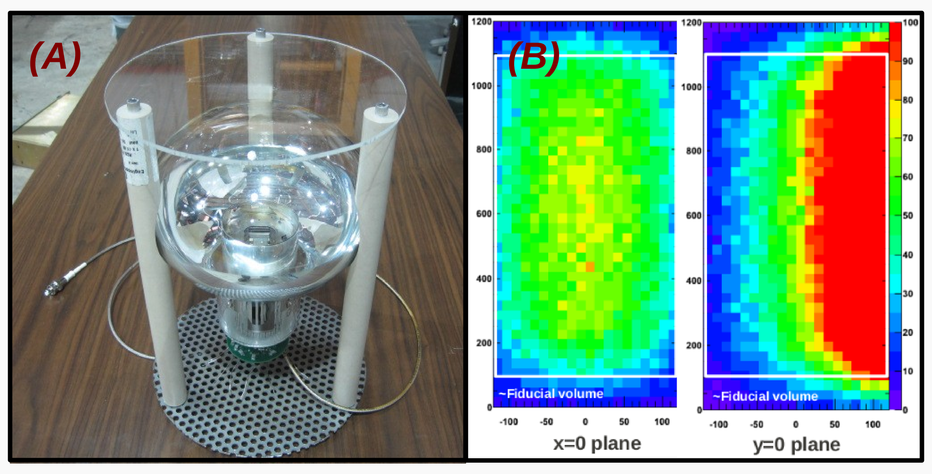


Optical System

The MicroBooNE optical system consists of 30 cryogenic PMTs mounted behind wavelength shifting plates, which record the 128nm scintillation light produced by charged particles traversing the liquid argon active volume.

The PMT units for MicroBooNE, each incorporating one PMT, wavelength shifting plate, bespoke cryogenic base, combined signal / HV cable and PEEK plastic frame will be assembled *(A)*, tested and characterized in a cryogenic test stand at Fermilab this autumn.

Simulations have shown the systems ability to act as an effective trigger for the design benchmark of 40MeV proton tracks, and suggest high trigger efficiency for tracks with as little as 5MeV of energy deposition *(B).*

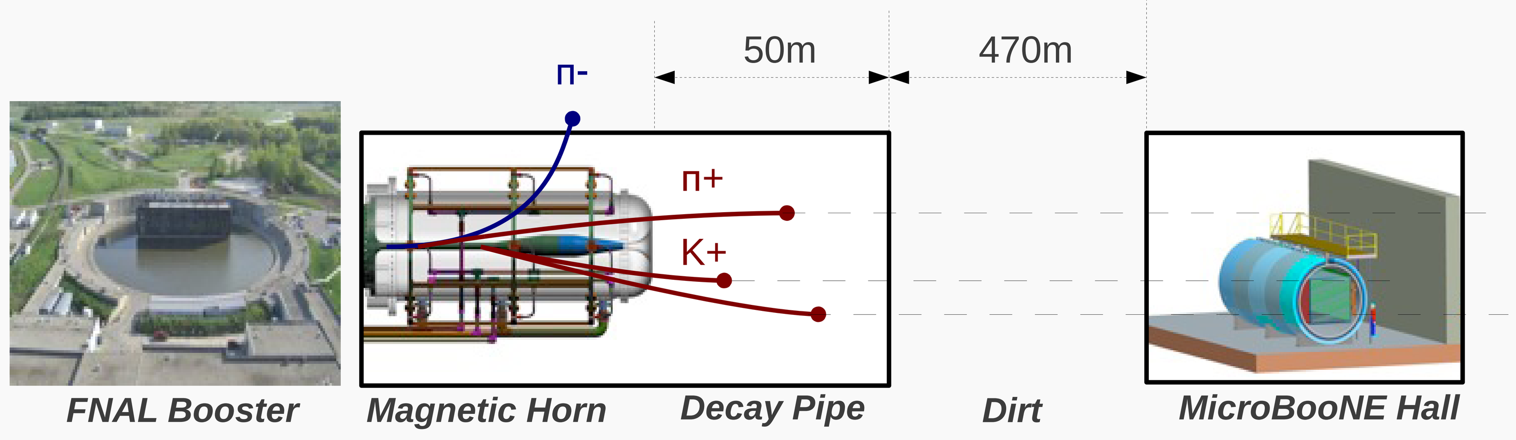


The Booster Neutrino Beam

Neutrinos are supplied to MicroBooNE by the Booster Neutrino Beam (BNB) at Fermilab. To form the BNB, 8GeV protons produced by the Booster accelerator are fired into a beryllium target, producing pions and kaons.

A magnetic horn selects either positively or negatively charged mesons and focusses them in the forward direction whilst defocussing the species of the opposite charge. The sign selected mesons, along with a small wrong sign background, travel along a 50m tunnel and decay in flight, producing a collimated beam of neutrinos with flux peaked at 1GeV. Remaining mesons and charged leptons are absorbed by a beam dump at the end of the tunnel.

The neutrinos travel through 470m of dirt, and a small fraction will interact in the active volume of the MicroBooNE detector, which will be situated ~100m upstream of the existing MiniBooNE experiment.



PID in MicroBooNE

Liquid argon TPCs produce high resolution 3D images of neutrino events. By measuring the dE/dx along a track, very accurate particle identification can be achieved. Resolving the MiniBooNE anomaly relies upon differentiating between electron and photon events. The former produces a single shower, whereas the latter converts to an e+e- pair and produces two overlapping showers. We expect LArTPC technology to give unrivalled e/γ separation.

By a simple dE/dx measurement, a strong e/γ separation is achieved *(see right).*

Full reconstruction of complicated events in LArTPC detectors is a developing field, and MicroBooNE has made major contributions to LArSoft, a general purpose software package for LArTPC reconstruction, which also supports ArgoNeuT, LBNE and various Fermilab based liquid argon test stands.

Additional particle ID information may also be obtainable from the time profile of scintillation signals, this technique is currently in development at Fermilab.