MiniBooNE

Booster Neutrino Experiment

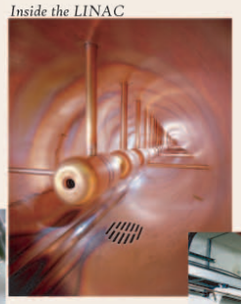
The Quest

MiniBooNE will test whether neutrinos have mass by seeing if they oscillate between flavors. We do this by shooting a beam of muon neutrinos at our detector, and then looking for evidence of electron neutrinos. MiniBooNE's main objective is to prove or disprove the findings of a previous experiment performed at the Los Alamos National Laboratory, using the Liquid Scintillator Neutrino Detector (LSND). LSND reported detecting muon neutrinos having oscillated into electron neutrinos.

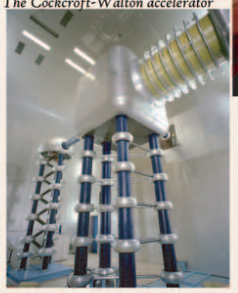
From the Booster...

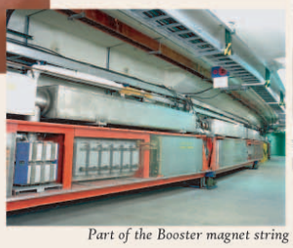
Making neutrinos requires a beam of protons, and MiniBooNE's protons start out as the tiniest puffs of hydrogen gas. The hydrogen atoms are first given an electric charge (turning them into hydrogen ions), and then these particles get an energy kick from huge static electric charges inside Fermilab's Cockcroft-Walton accelerator. Next, the ions move to the linear accelerator (LINAC), where rapidly changing electric fields zip them faster along. Finally, the protons feed into the Booster, a circular accelerator that boosts their energy even higher.

Inside the LINAC



The Cockcroft-Walton accelerator

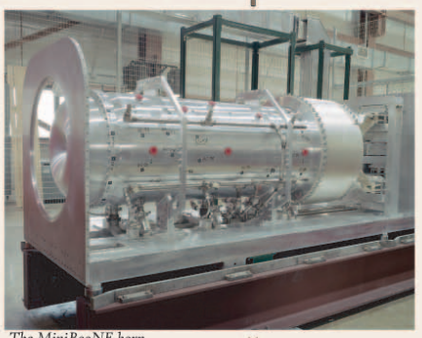




Part of the Booster magnet string

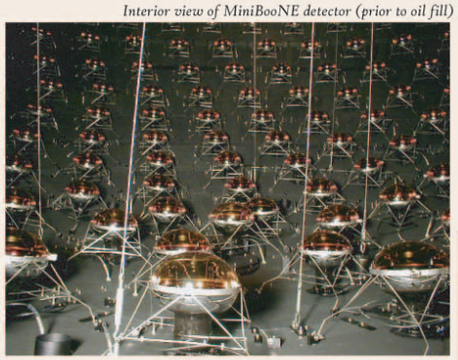
... through the horn ...

The Booster protons are next steered to a magnetic focusing device called the "horn." The beam strikes a metal target inside the horn, producing lots of secondary collision debris, including a bunch of particles called "mesons." Mesons decay into either neutrinos or antineutrinos, depending on the parent meson's electric charge. MiniBooNE wants neutrinos, so the magnetic field generated by the horn selects out the positively charged mesons and heads them downstream to the decay region.

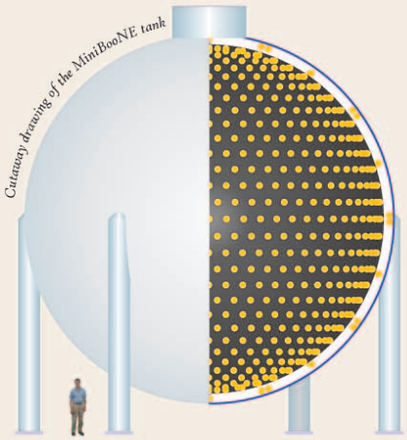


The MiniBooNE horn

Interior view of MiniBooNE detector (prior to oil fill)



Cutaway drawing of the MiniBooNE tank



A MiniBooNE photomultiplier

... into the detector

The MiniBooNE detector is a 12 m diameter spherical tank, filled with approximately 800 tons of exquisitely clear mineral oil. The inside walls of the tank are lined with 1,280 photomultiplier tubes (PMTs), ultra-sensitive light sensors. These tubes detect the very faint light produced from interactions between the beam neutrinos and the nuclei in the oil molecules. If the tubes see interactions indicating electron neutrinos, eureka! neutrino oscillations!

Decay pipe & steel absorber installation

... down the pipe ...

The beam of mesons then enters a 50-meter long decay pipe. The mesons almost always break into two fragments, a muon neutrino and an anti-muon. Neutrinos interact with matter extremely rarely; so piling up about 500 meters of steel and dirt between the end of the decay pipe and the detector filters out the anti-muons and remaining undecayed mesons. The result is an uncontaminated beam of neutrinos passing through to the MiniBooNE detector.