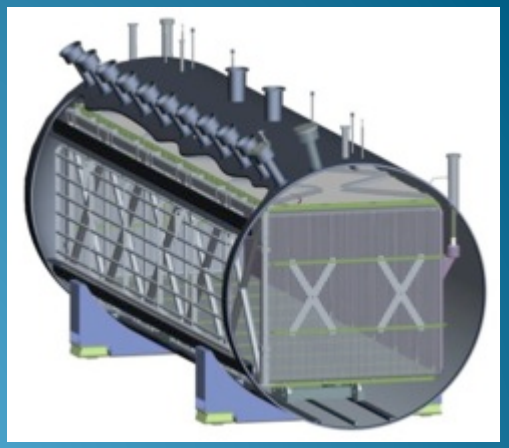
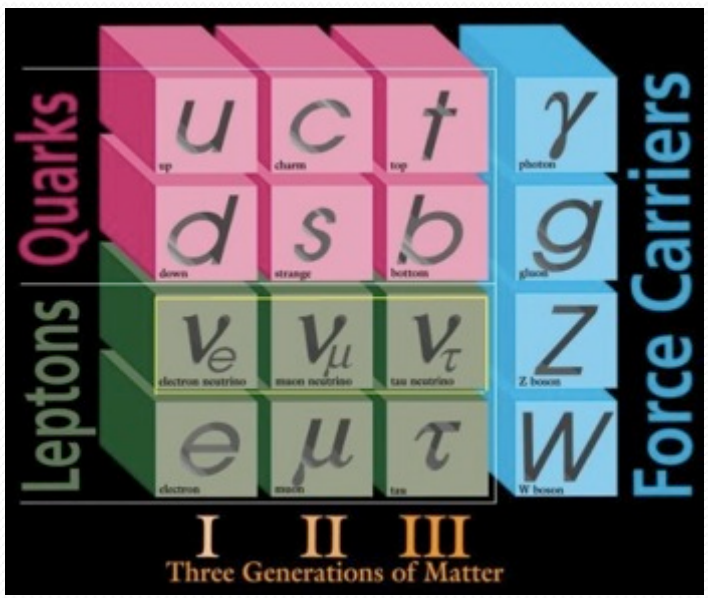
MicroBooNE Assembly: LArTPC Work Experience

Daniel H. Gutiérrez Velázquez
Fermi National Accelerator Laboratory
PPD – Neutrino
MicroBooNE



What is MicroBooNE?

- The name MicroBooNE comes from the past experiment named MiniBooNE. These are Booster Neutrino Experiments.
- Is an experiment that will take really important data from neutrino's oscillations and interactions.
- It is a neutrino detector.



What are Neutrinos?

Least massive particles in the Standard Model which interact with the other particles only through weak force.

There are three types of neutrinos ν_e, ν_μ, ν_τ.

The MicroBooNE's objective and location

- Will be located here, at Fermilab, the experiment will build and operate a large 170 ton Liquid Argon Time Projection Chamber (LArTPC) located along the Fermilab Booster Neutrino Beam line (BNB). The experiment will measure low energy neutrino cross sections and investigate the low energy excess events observed by the MiniBooNE experiment. The detector serves as the necessary next step in a phased program towards the construction of massive kiloton scale LArTPC detectors.

(www-microboone.fnal.gov/)

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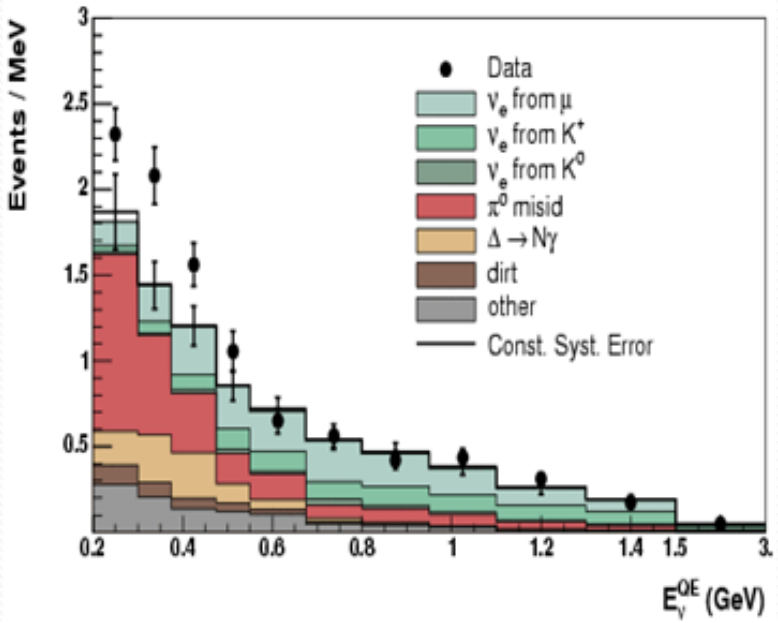
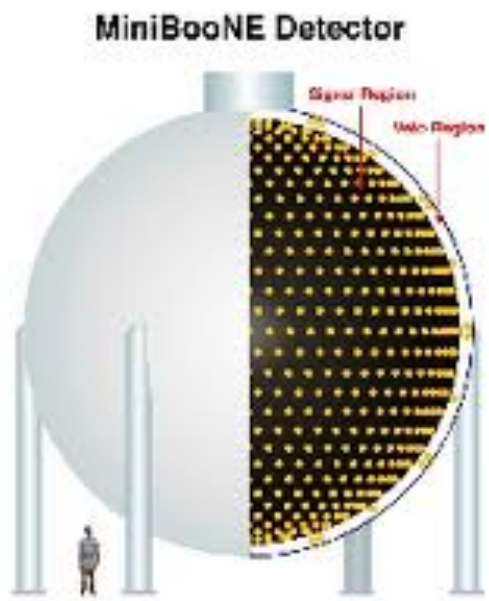
What was the MiniBooNE excess?

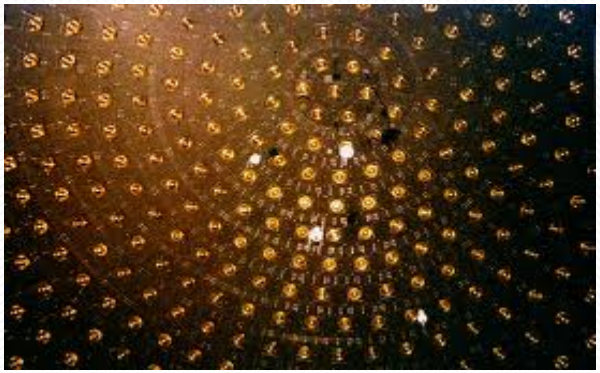
- The MiniBoone excess shows electrons and photons that cannot be differentiate between each other (showering particles). In a non-showering particle they may differentiate in to a muon or a pion with the size of the Cerenkov ring.

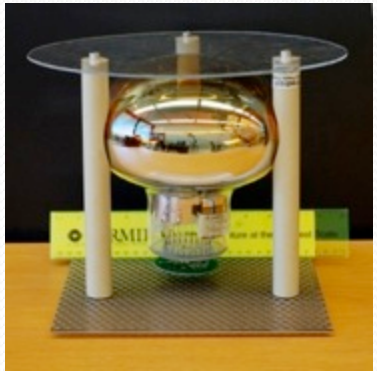




Why MiniBooNE cannot differentiate between electrons and photons?

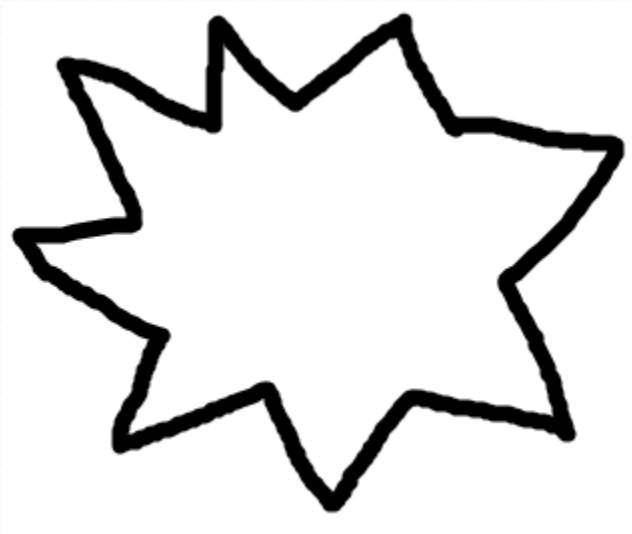
- The MiniBooNE is a spherical vessel filled with mineral oil and the walls are equipped with photomultipliers (PMT). The PMTs detect the light from the particles that result from each event of neutrino's interaction with a nucleus. In a showering particle it get a fuzzy Cerenkov ring (these are e^+, e^-, γ, π^o). In a non-showering particle it get a clean Cerenkov ring (these are μ^+, μ^-, π^+, π^-) that can differentiate between a muon or a pion using the size of the ring.

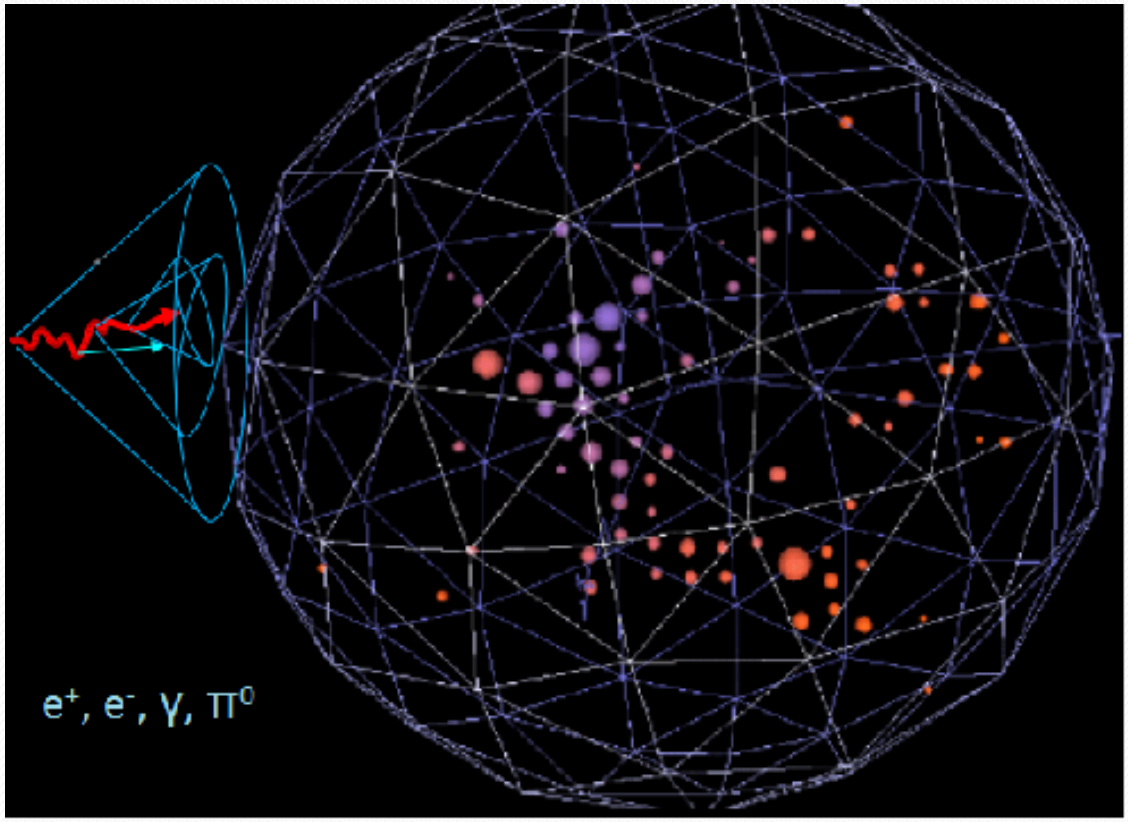




MiniBooNE showering particle

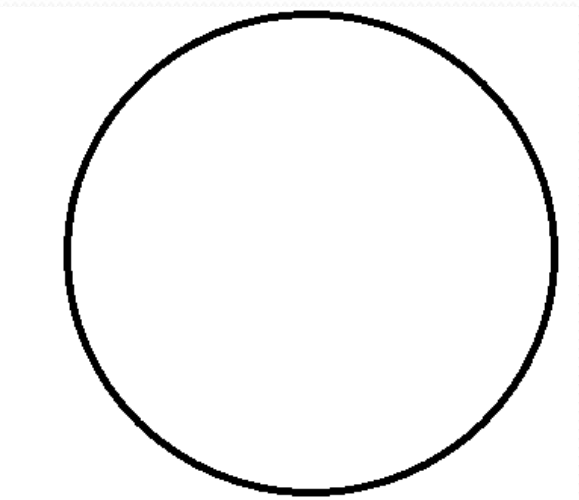
- Fuzzy Cerenkov ring

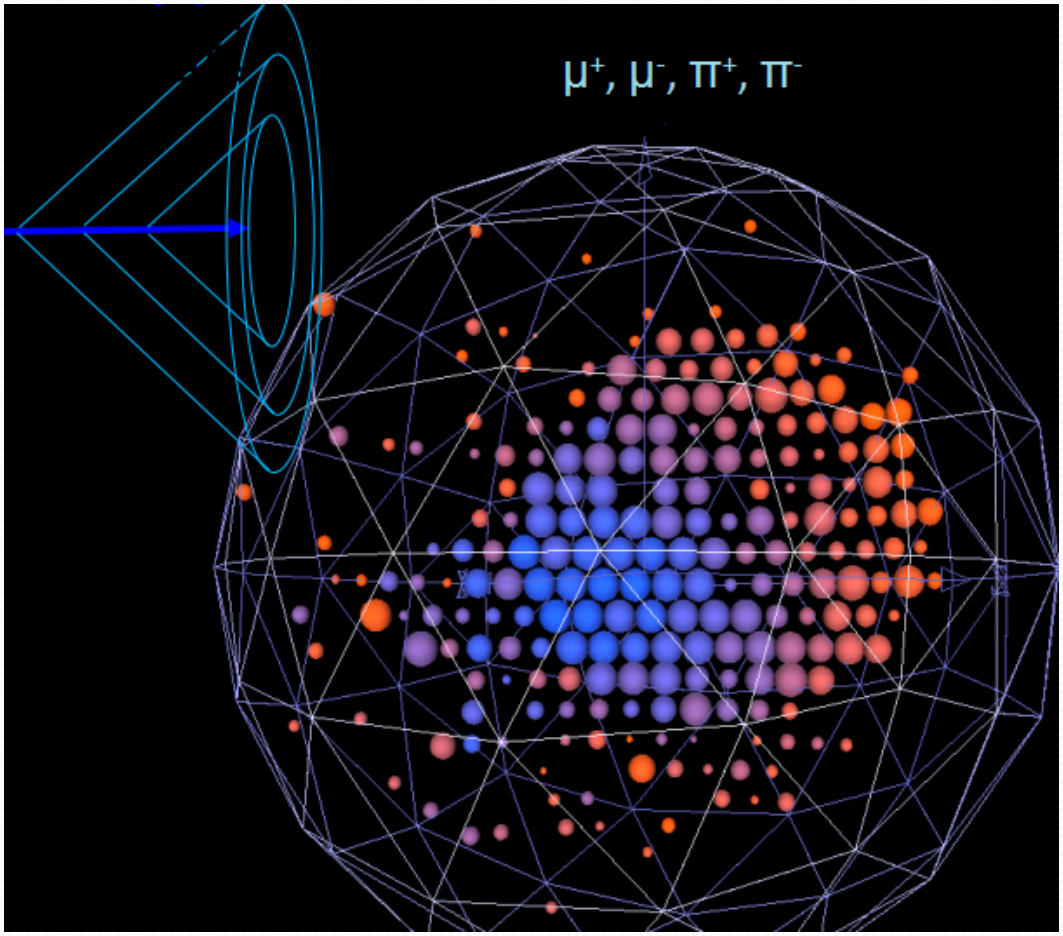




MiniBooNE non-showering particle

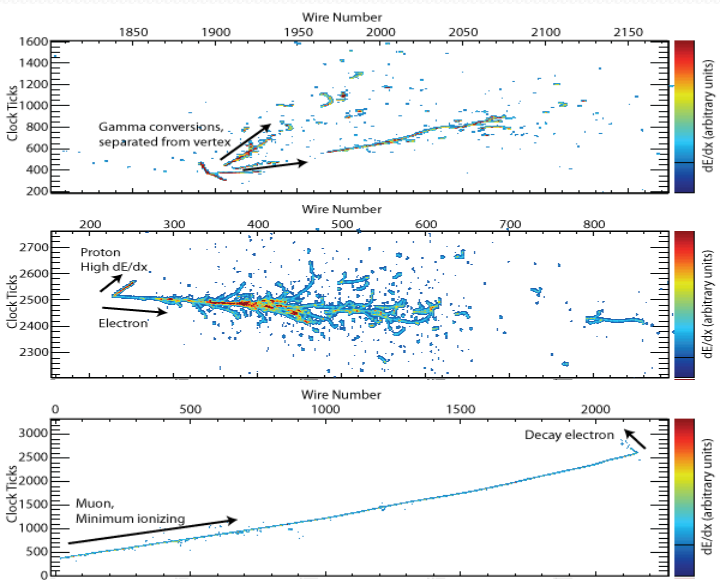
- Clean Cerenkov ring

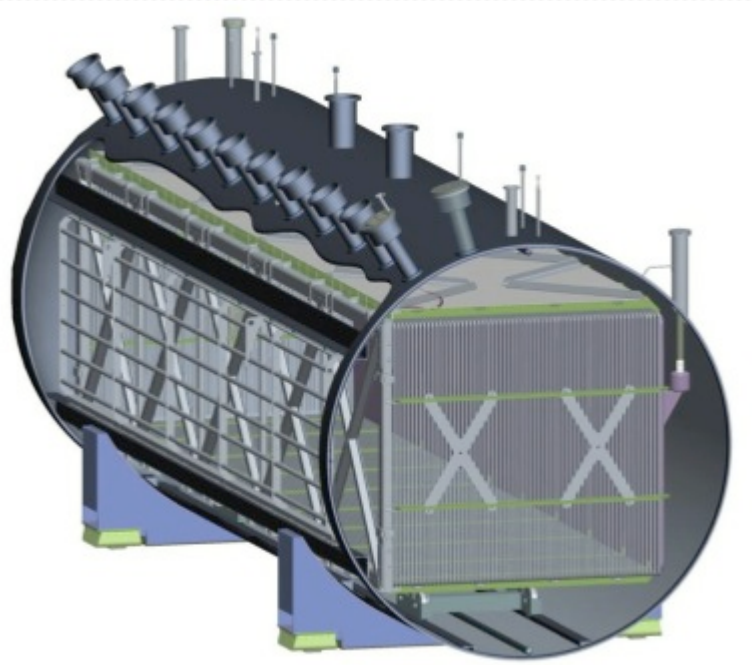




MicroBooNE LArTPC

- A liquid argon time projection chamber (LArTPC) exploits features of pure liquid argon that allow ionization electrons to be transported along uniform electric field lines over several meters to wire chamber planes. A LArTPC delivers excellent neutrino interaction characterization.



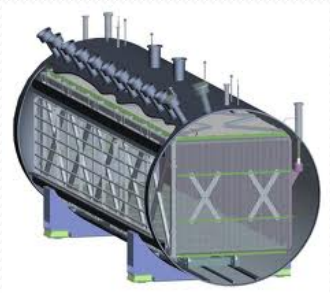


MicroBooNE vs. MiniBooNE

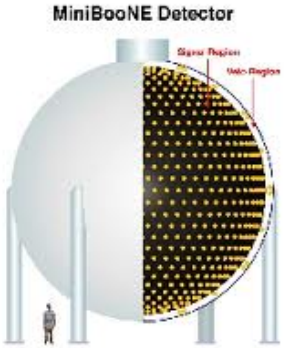
- The MicroBooNE can differentiate between a photon and an electron in a showering particle event, through the wire planes of the TPC which catch the charge of the particle. If is an electron it will get some charge and if is a photon it will get double the charge because of pair production.

$$\gamma \rightarrow e^{+}e^{-} \quad \text{(pair production)}$$

- MicroBooNE will solve the mystery of the MiniBooNE excess and improve cross sections measurements.

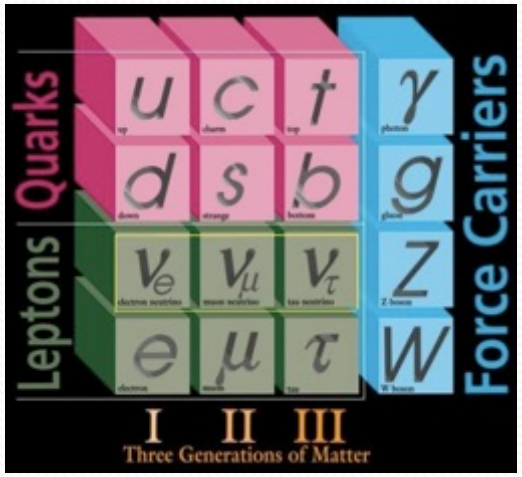


vs.



Possible excess explanations

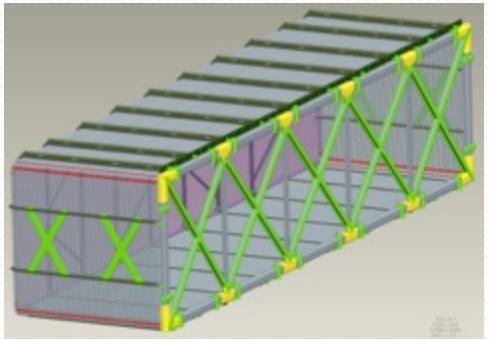
- The MicroBooNE analysis is performed under two assumptions: that the low energy excess is due to an electron-like event and that the low energy excess is due to a photon-like event. If the excess is due to a photon-like event, a possible explanation may be new unknown cross sections. If the excess is due to a electron-like event, a possible explanation may be the existence of a sterile neutrino (3+1, 3+2… theories) that known neutrinos can oscillate to it. Something like this indicate more physics beyond what the Standard Model describes.



LArTPC assembly area

D-Zero Assembly Building

TPC assembly clean room entrance



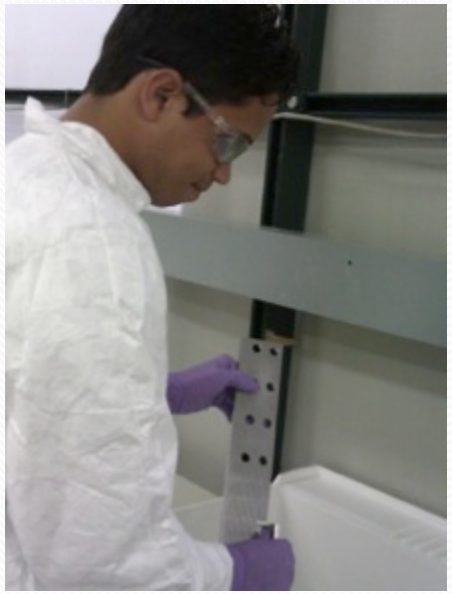
TPC

TPC assembly clean room

Cleaning the room

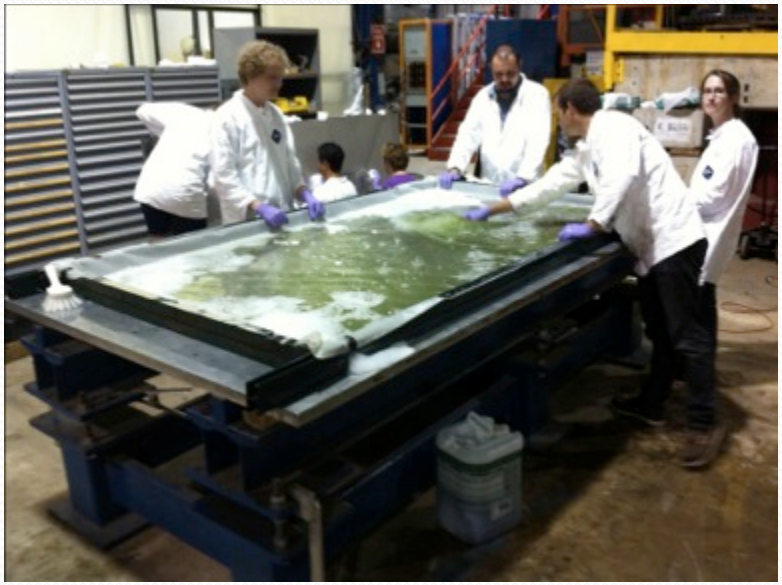
Cleaning the TPC

- Before the assembly, the TPC parts most be really clean. We are cleaning the TPC parts in the Lab F. Most of the TPC parts are stainless steel. We used several tool for the cleaning including brushes, sponges, isopropyl alcohol, distilled water, etc.



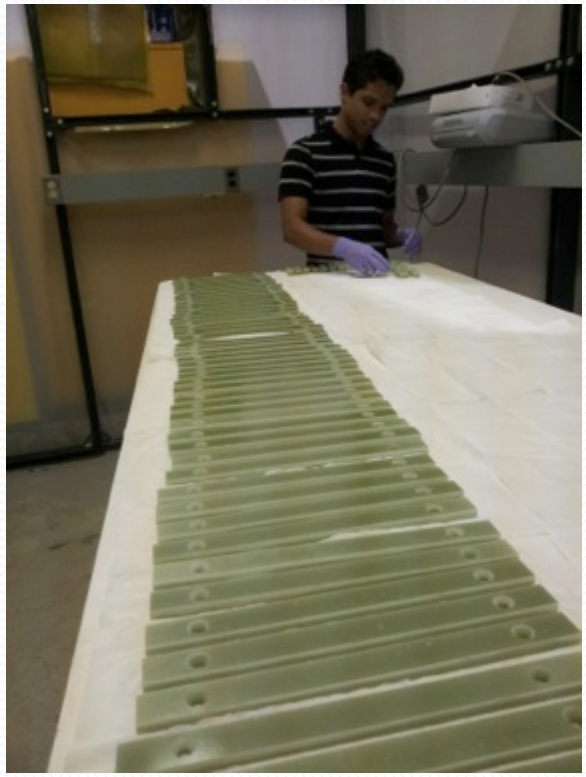
Set up baths

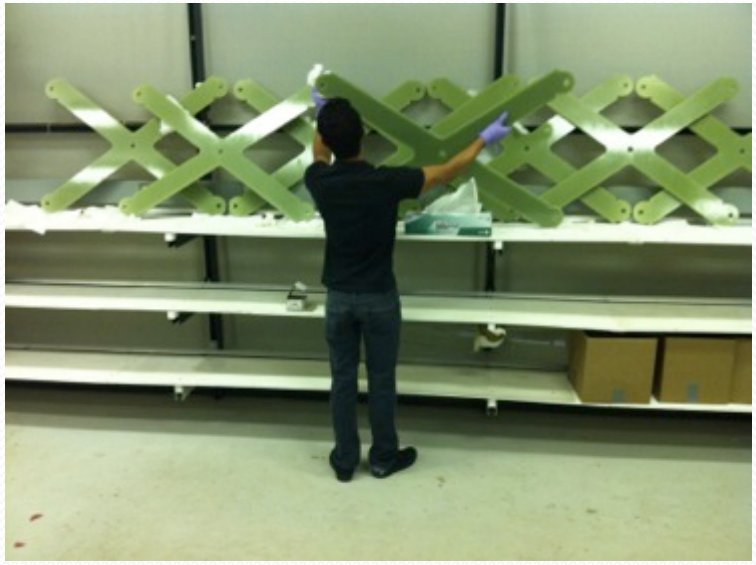
- For huge parts like the cathode planes, we had to set up baths with the available equipment.



More cleaning

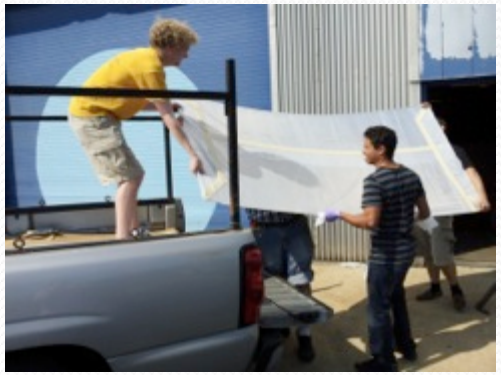
- The G-10 parts of the TPC (same material of circuit panels) are more difficult to clean because they absorb water.

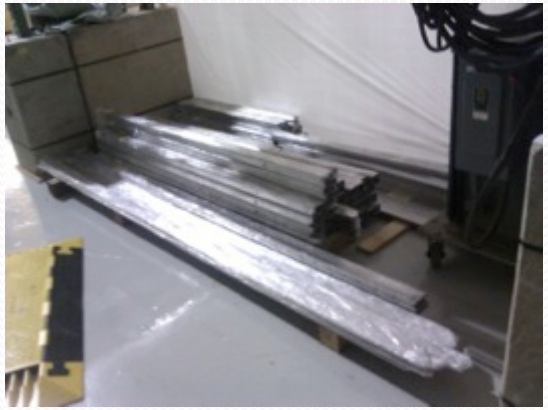




After cleaning

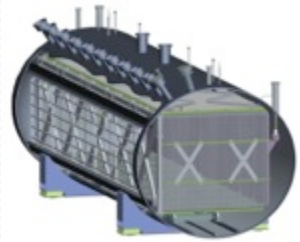
- After cleaning the parts, we double wrapped, transport and store them at D-Zero Assembly Building until the start of the assembly





Importance of the cleaning

- The TPC will be submerged in Liquid Argon inside a cryostat. The main importance of cleaning the TPC parts is to maintain the purity of the Liquid Argon. If there are other substances beside the Liquid Argon, the particles that come from the interaction events may be absorbs by the substances and affect the data. Most of the TPC pieces are made of stainless steel, without the proper cleaning, metal pieces from the cut of the parts will stay stick. If there are metal pieces floating in the LAr, it may distort the electric field that is supposed to be uniform and mess up the particles track reconstruction and time of flight calculation.



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MicroBooNE news

Fermilab *Today* Monday, July 16, 2012

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Calendar

Have a safe day!

Monday, July 16
2 p.m.
LHC Physics Center Topic of the Week Seminar - Sunrise, WH11NE
Speaker: Daniel Elvira
Title: SUSY Searches II: Elements of a Data Analysis and Their Integration in a Search Result

PARTICLE ASTROPHYSICS SEMINARS WILL RESUME IN THE FALL

3:30 p.m.
DIRECTOR'S COFFEE BREAK - 2nd Flr X-Over

THERE WILL BE NO ALL EXPERIMENTERS' MEETING THIS WEEK

Tuesday, July 17
10:30
Research Techniques

Feature

Students help MicroBooNE clean up for its big debut

High school physics teacher Daniel Gutierrez and Fermilab physicist Jennifer Raaf inspect a beam composed of G10 polymer, which will provide part of the structural support for the future MicroBooNE time projection chamber. *Photo: Reidar Hahn*

The interior of Fermilab's Lab F, located near the geodesic dome, looks like a massive construction site. Strewn

ES&H Tip of the Week: Safety

Construction season safety - drive carefully and watch out for those yellowjackets

Driving while using your cell phone on Fermilab grounds is a traffic violation. Be safe - don't let yourself be distracted while driving.

Building construction is prevalent at the laboratory this summer, and it can pose a danger for those on the road.

It is particularly important to slow down and pay close attention while driving. Motorists, bikers and pedestrians must pay attention to warning signs, detour signs and flaggers. Dangers still exist in work zones even if workers are not present.

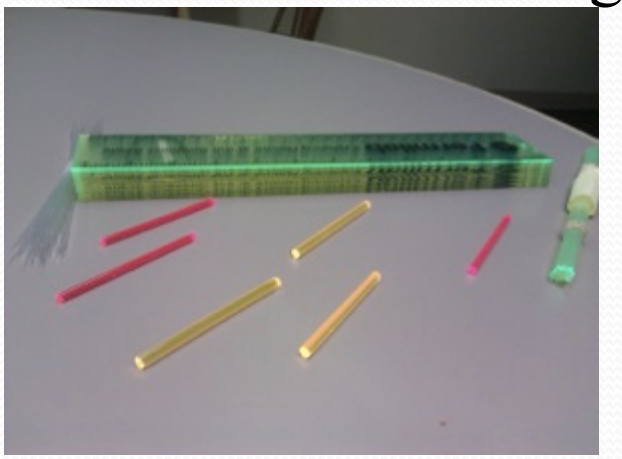
Personnel may not drive any motor

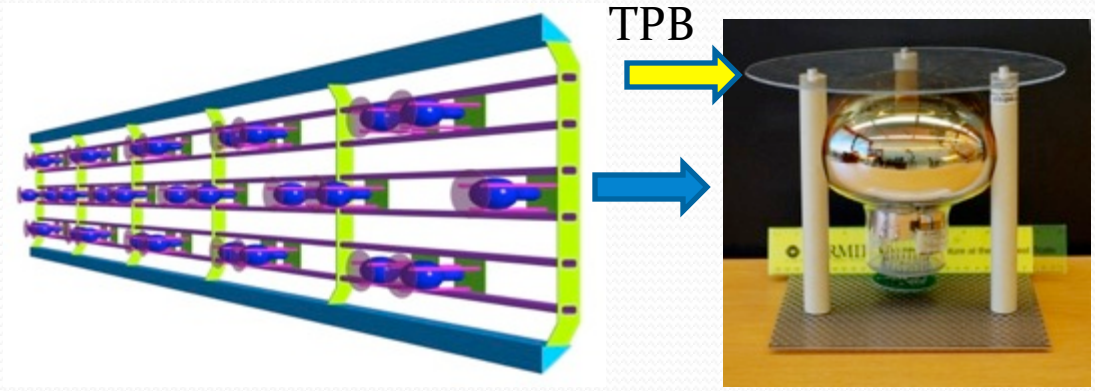
Sanding and painting electronic racks

- In the Grid Computing Center we are sanding and painting the MicroBooNE electronics racks. These are electronics racks from old experiments that are being recycled for use in MicroBooNE.

Transfer of knowledge to the classroom

- After developed a class of the Standard Model (SM), the teacher will show images of different tools that scientist use to study the SM and will do a demonstration using wavelength shifters.
- The MicroBooNE will have wavelength shifters (TPB) because the PMTs cannot detect UV light, the wavelength shifter turn UV light in to visible light.





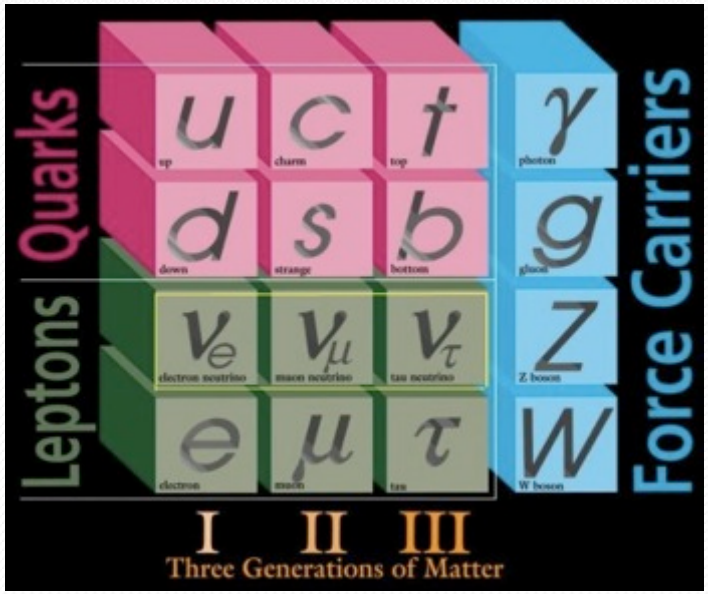
Acknowledgment

- Harry Cheung
- Bjoern Penning
- Jennifer Raaf
- Hector Méndez
- Tom Jordan

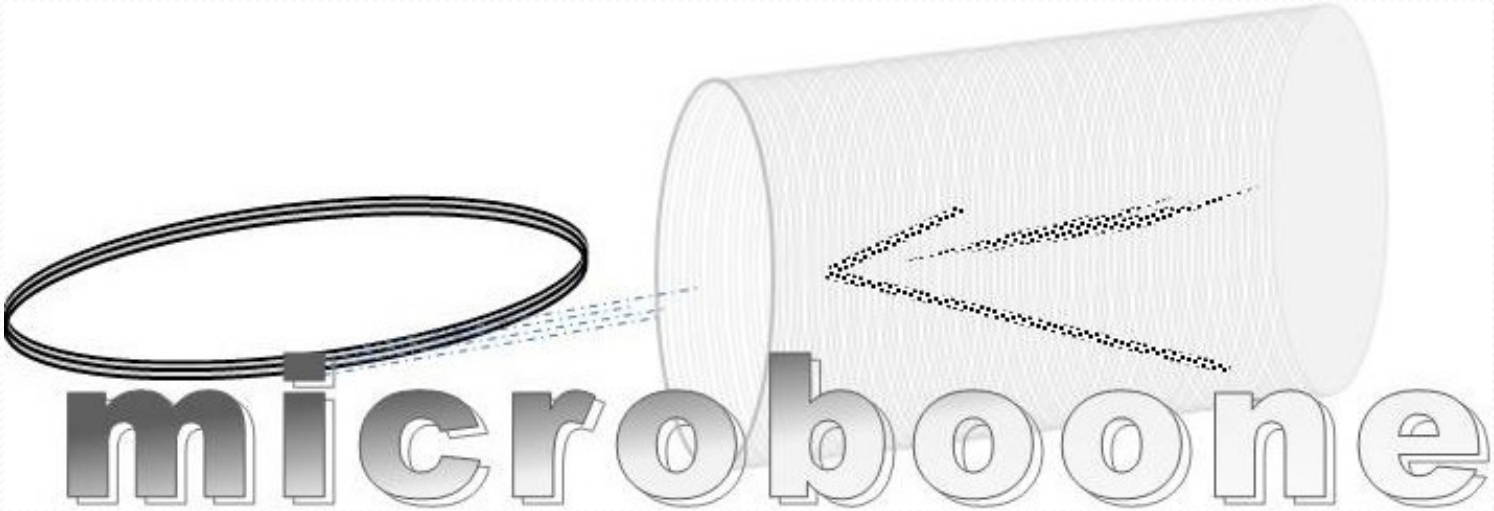
Reference

- http://www-microboone.fnal.gov

- The MicroBooNE TDR (2/24/2012-DocDB 1821-v12): The MicroBooNE Collaboration



Fermilab



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