Data Analysis Status & Plans

M. Toups, FNAL

11/23/15

Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

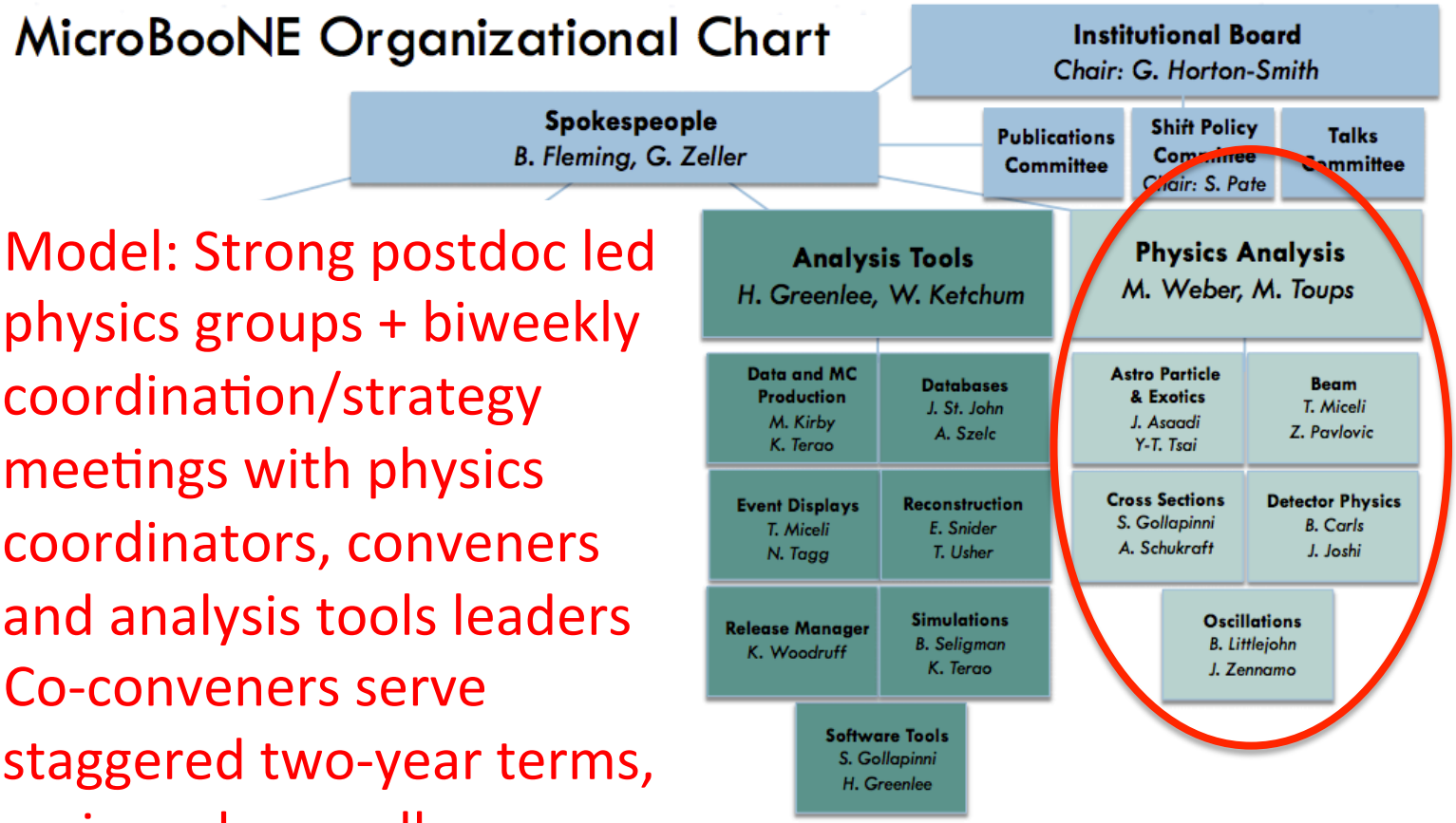
Outline

- Organization

MicroBooNE ORR
Charge Question 4

- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

MicroBooNE Physics Analysis Organization



- Model: Strong postdoc led physics groups + biweekly coordination/strategy meetings with physics coordinators, conveners and analysis tools leaders
- Co-conveners serve staggered two-year terms, reviewed annually

Physics Working Group Organization

- Physics groups have been meeting biweekly for the past 2+ years
- Websites maintained by each physics group outlining analyses, plans, and how collaborators can get plugged in

uBooNE WG

Home | Oscillations | Cross Sections | A.P.E. | Beam | Detector Physics

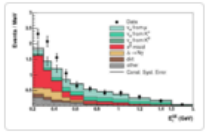
Oscillations Working Group

Conveners: Bryce Littlejohn & Joseph Zennamo

Organizing and carrying out MicroBooNE's flagship low-energy excess analysis, and related physics searches.

Introductions » | Ongoing Analyses » | Documentation » | Useful Links » | Useful Forums »

What does our group do?



Our physics working group aims to investigate the low-energy excess of electromagnetic events observed by the MiniBooNE experiment, and investigate its possible physics interpretations. Examples of such interpretations include an excess of single-electron events due to light sterile neutrino oscillations (which can manifest as electron-neutrino appearance or as muon-neutrino disappearance) or a new single-photon production mechanism from neutrinos interacting with matter.

When and where do we meet?

We meet bi-weekly on Thursday at 11 a.m. (CST) with the meeting room, agenda, and connection details given on the MicroBooNE event calendar.

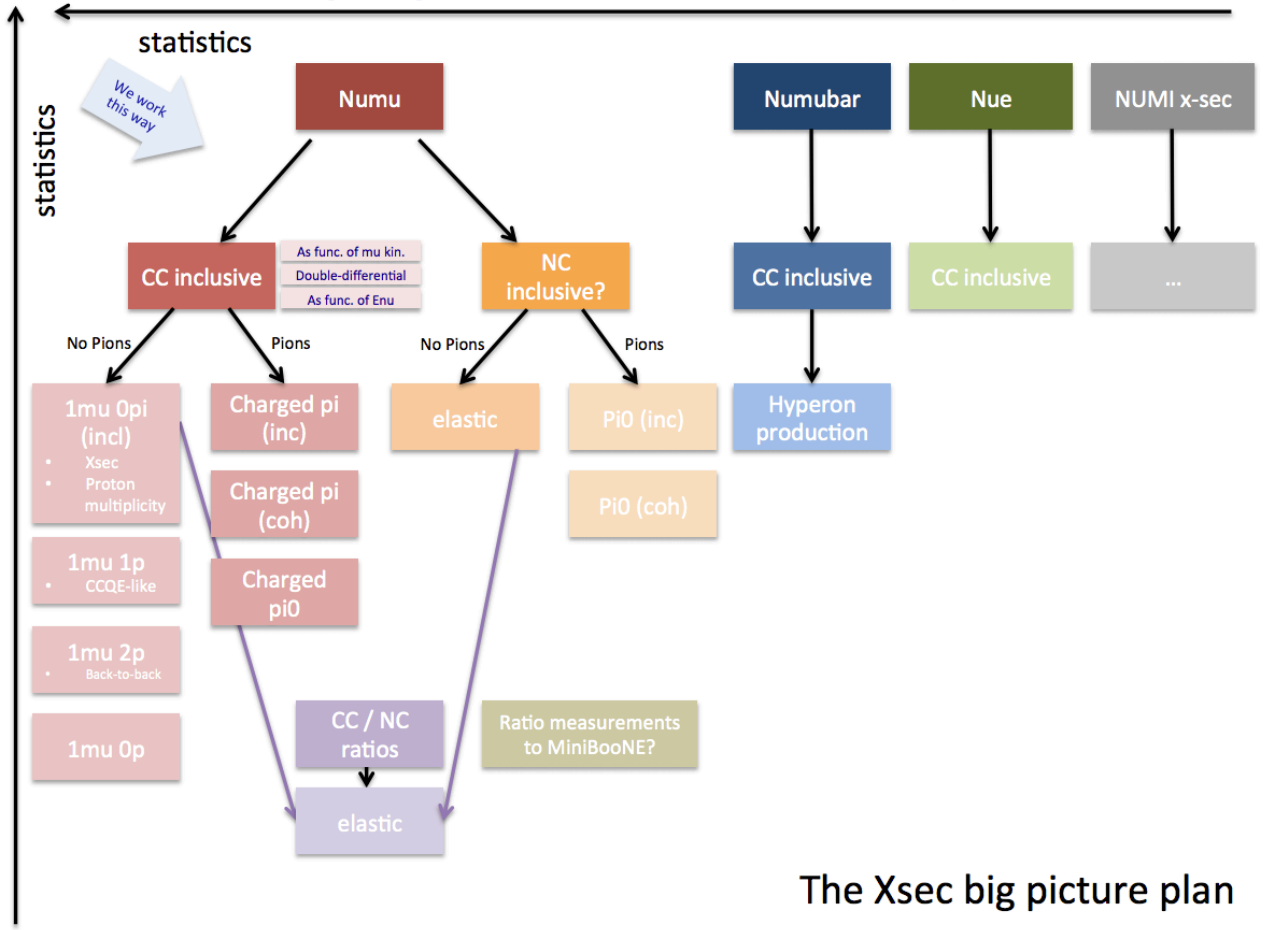
How do I get involved?

Begin by looking at the Ongoing Analyses page and contact Bryce and Joseph.

© 2015 Andrzej Szelc & Jonathan Asaadi
Last modified: 2015-04-23, 20:57
Powered by phpSQLiteCMS

Physics Analysis Organization (I)

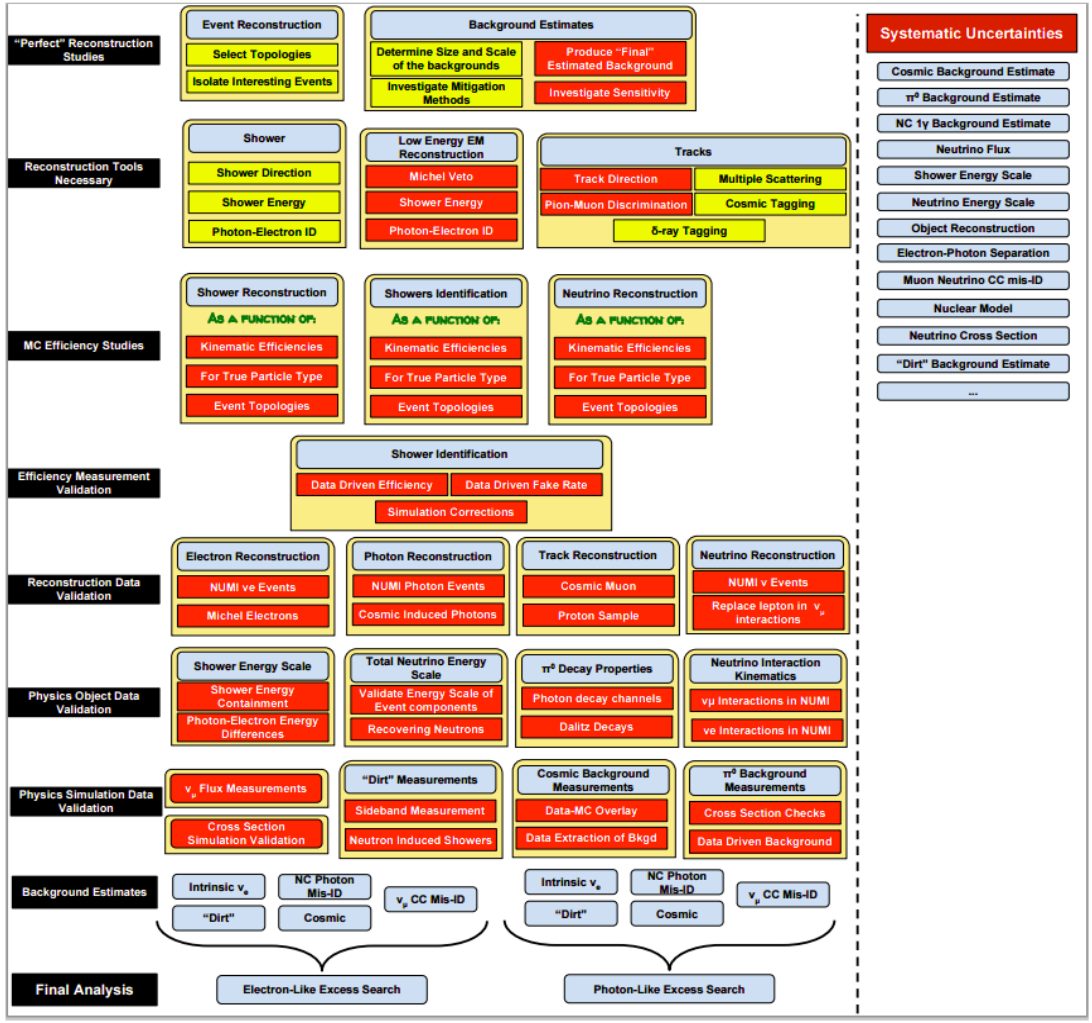
- Physics group plans developed according to the amount of statistics needed and in such a way that analyses build off each other



The Xsec big picture plan

Physics Analysis Organization (II)

- Detailed plans laid out for individual analyses defining major steps and milestones that must be achieved on the path to completing the analysis



ν_e appearance analysis plan

Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

MicroBooNE ORR
Charge Question 4

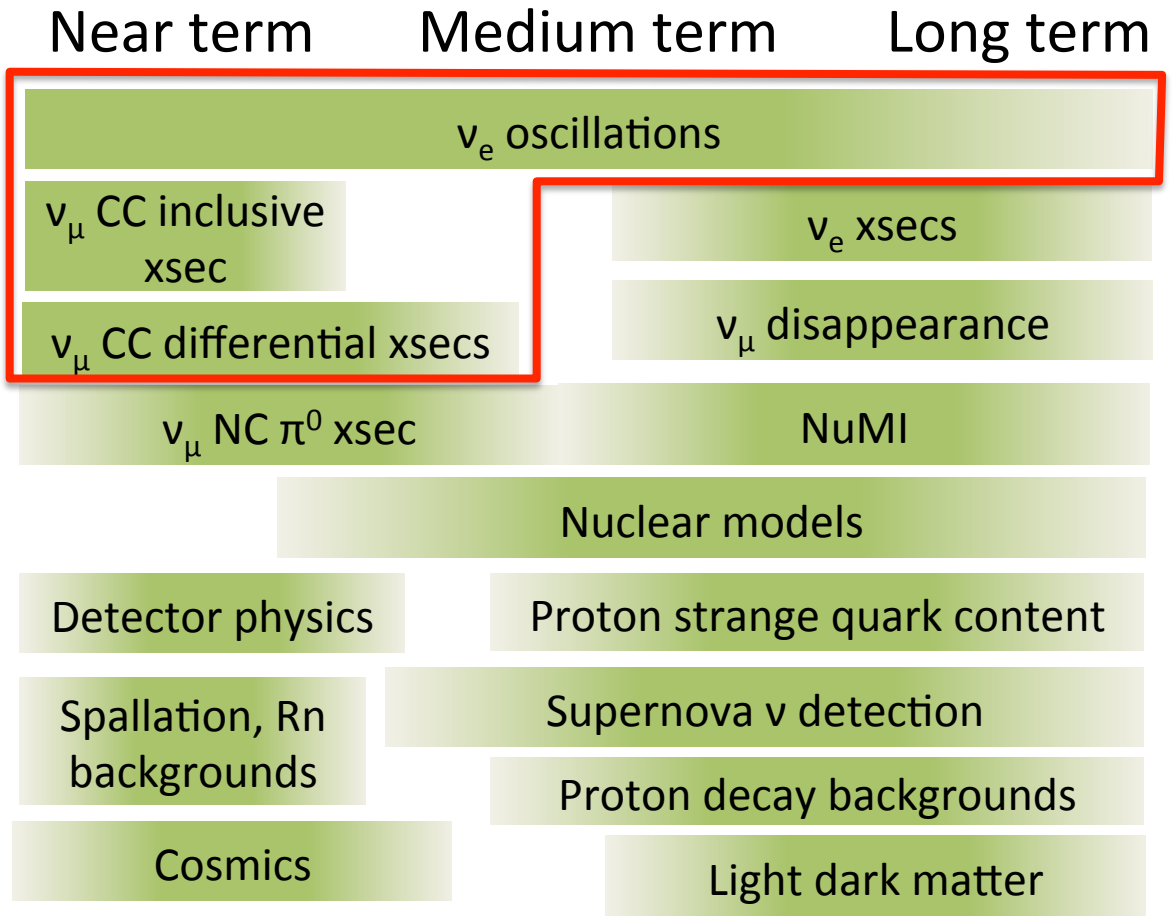
Physics Analysis Topics (I)

- Roughly 50% of the collaboration consists of graduate students and postdocs
- Periodic census of PIs to understand planned analysis and thesis topics

Near term	Medium term	Long term
ν_e oscillations		
ν_μ CC inclusive xsec		ν_e xsecs
ν_μ CC differential xsecs		ν_μ disappearance
ν_μ NC π^0 xsec		NuMI
	Nuclear models	
Detector physics		Proton strange quark content
Spallation, Rn backgrounds		Supernova ν detection
		Proton decay backgrounds
Cosmics		Light dark matter

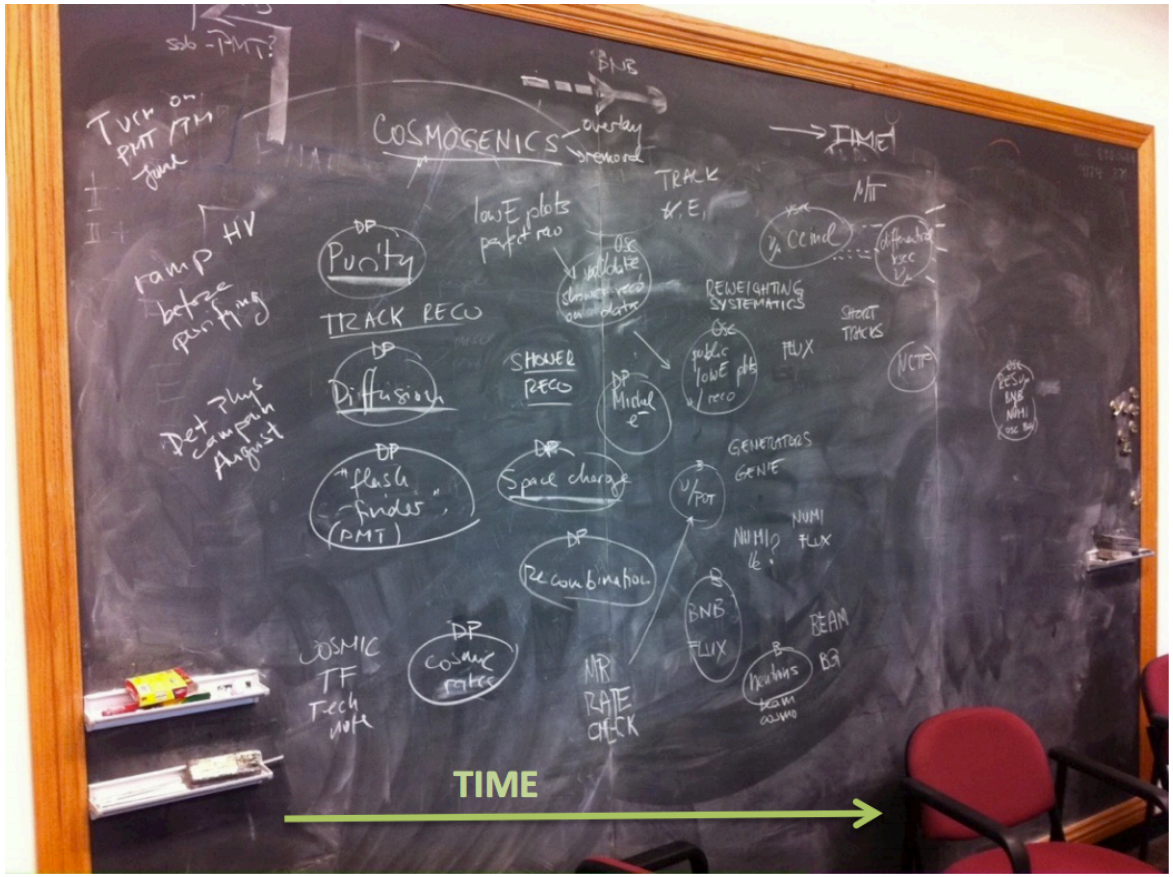
Physics Analysis Topics (II)

- In the near term, are focusing our efforts on highest priority analysis topics, which lie in the oscillations and cross-section groups
- These physics analysis topics will drive detector physics + cosmics investigations and improvements in reconstruction

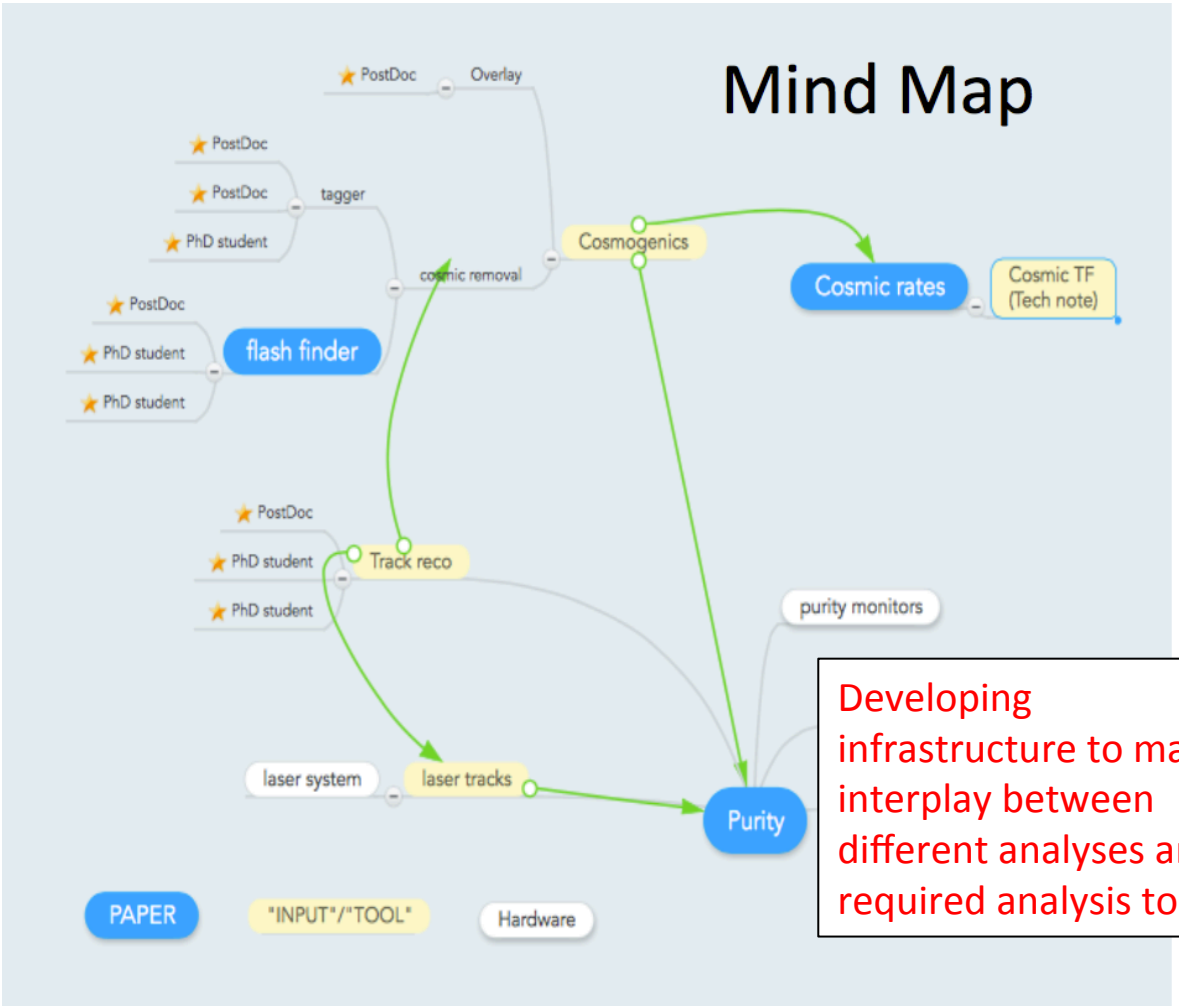


Publications Roadmap (I)

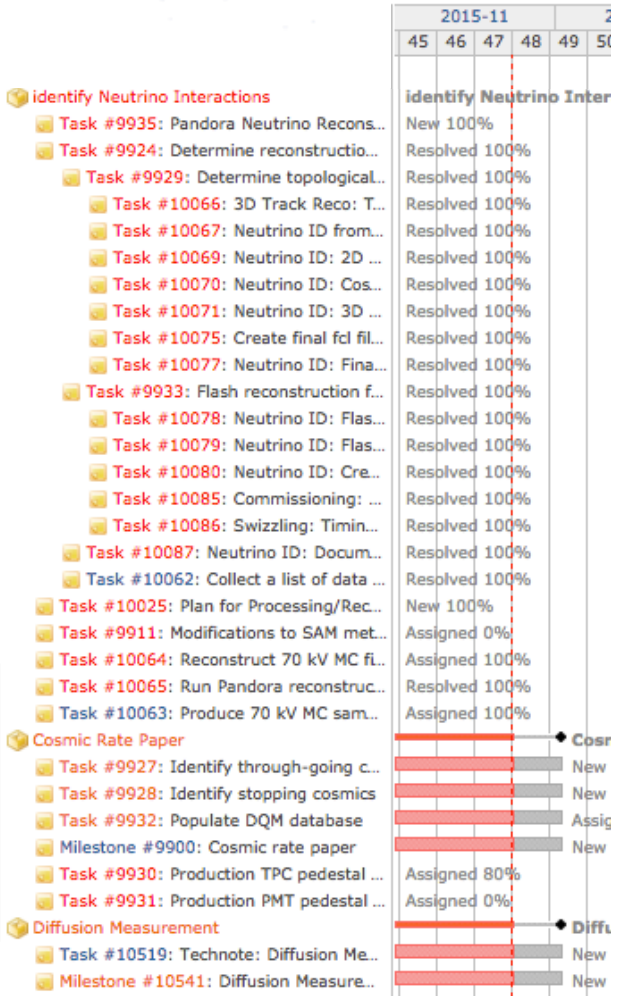
- Physics group conveners' retreat held over the summer
- Agreed that our analysis plans should be developed while having concrete publication goals in mind



Publications Roadmap (II)



Developing infrastructure to manage interplay between different analyses and required analysis tools



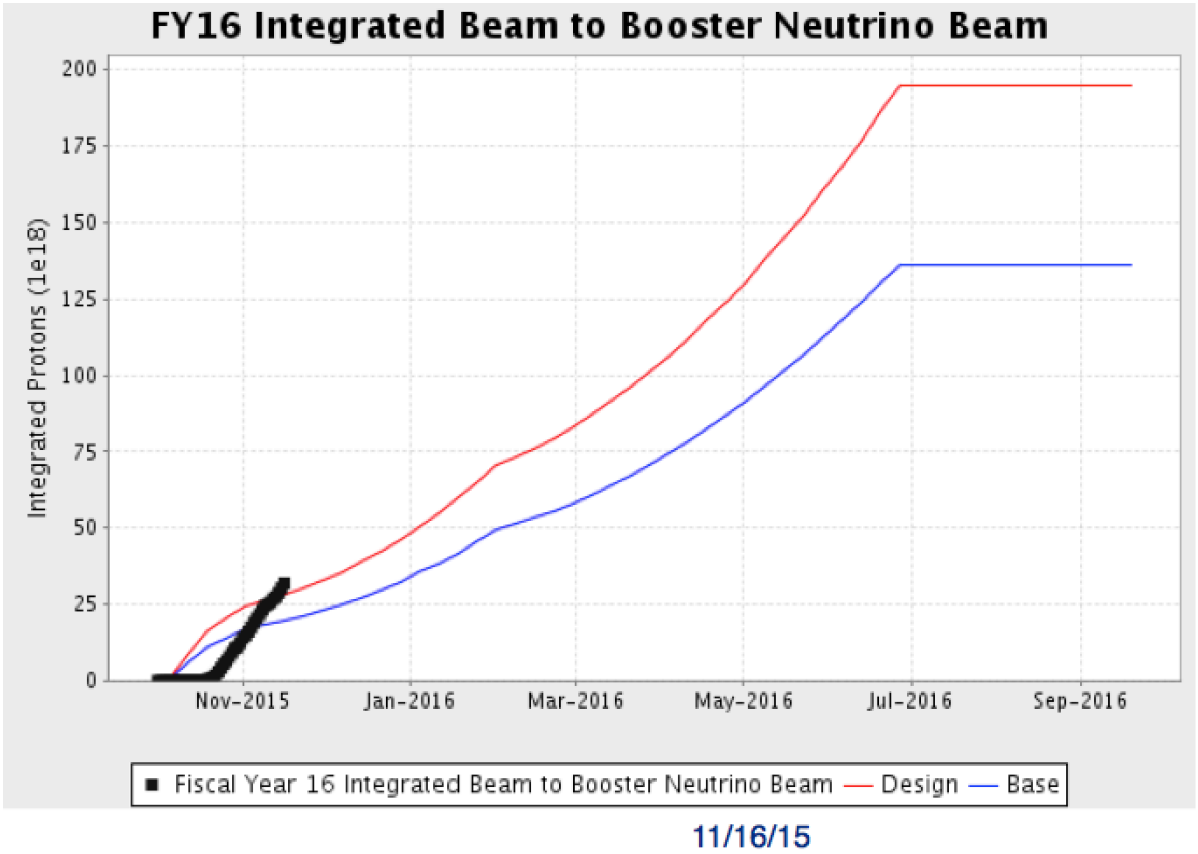
Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

MicroBooNE ORR
Charge Question 5

Expected Data Statistics by Neutrino 2016

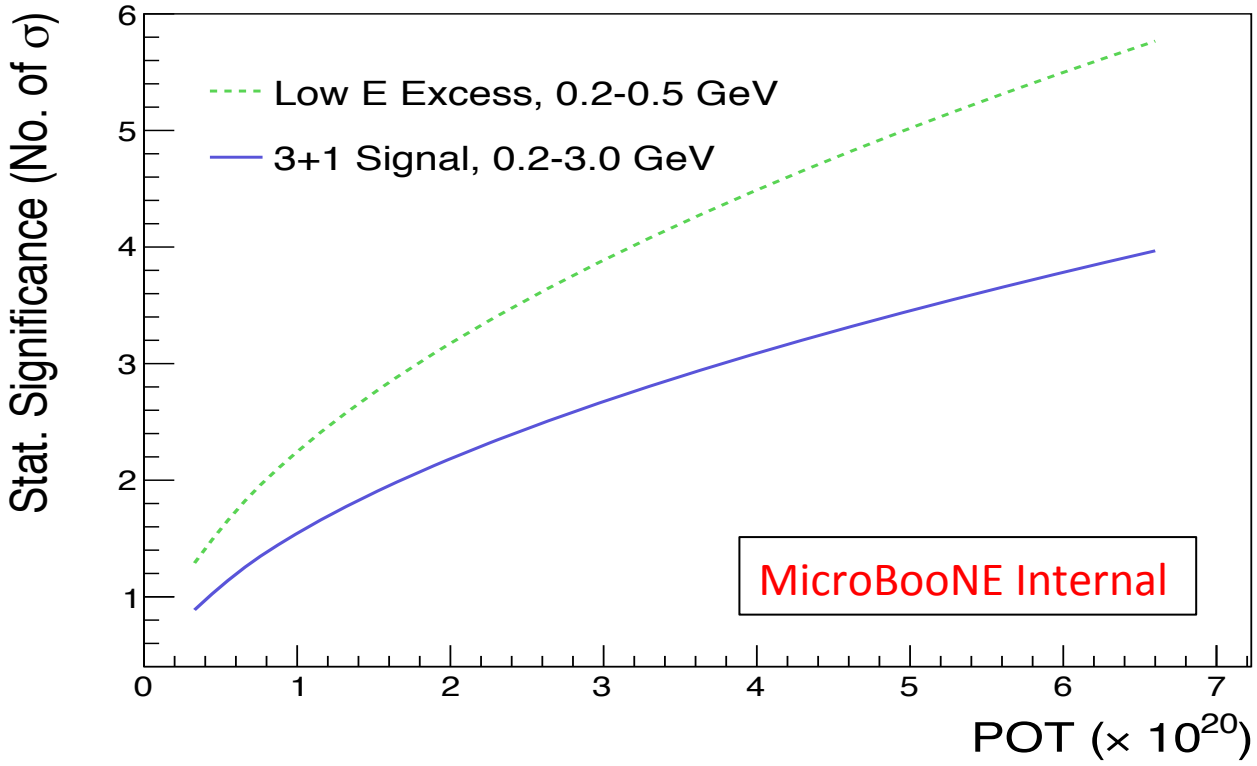
- 1-2 x 10^{20} p.o.t. by next summer shutdown



Low Energy Excess Overview

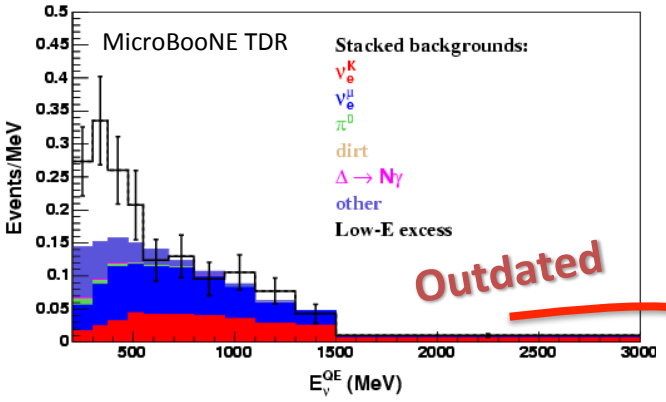
- The primary goal of the MicroBooNE experiment is to address the anomalous excess of events at low energy observed by MiniBooNE

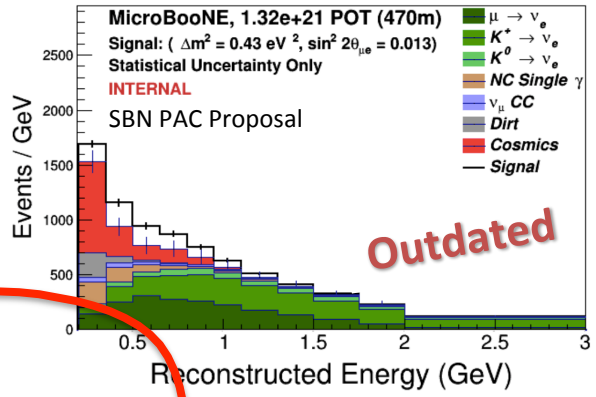
- Statistics from the entire MicroBooNE run are needed to reach full sensitivity to a MiniBooNE-like excess

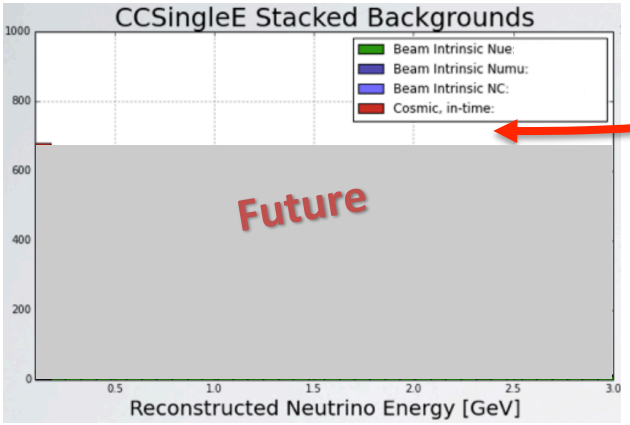


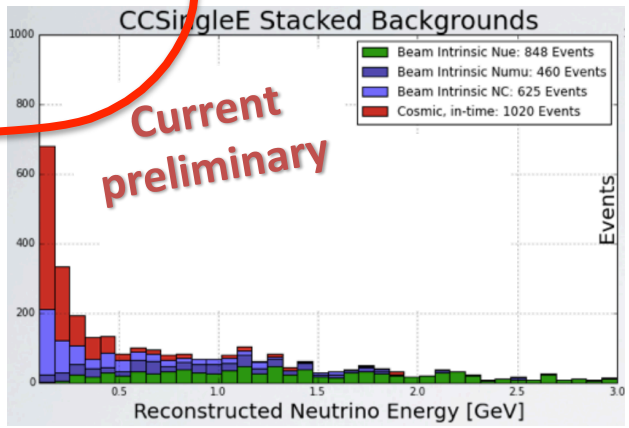
Low Energy Excess: Analysis Status

- Huge recent advancements in low-energy excess analysis framework
- Way beyond simple MiniBooNE scalings or MC-truth-based counting exercises using assumed efficiencies



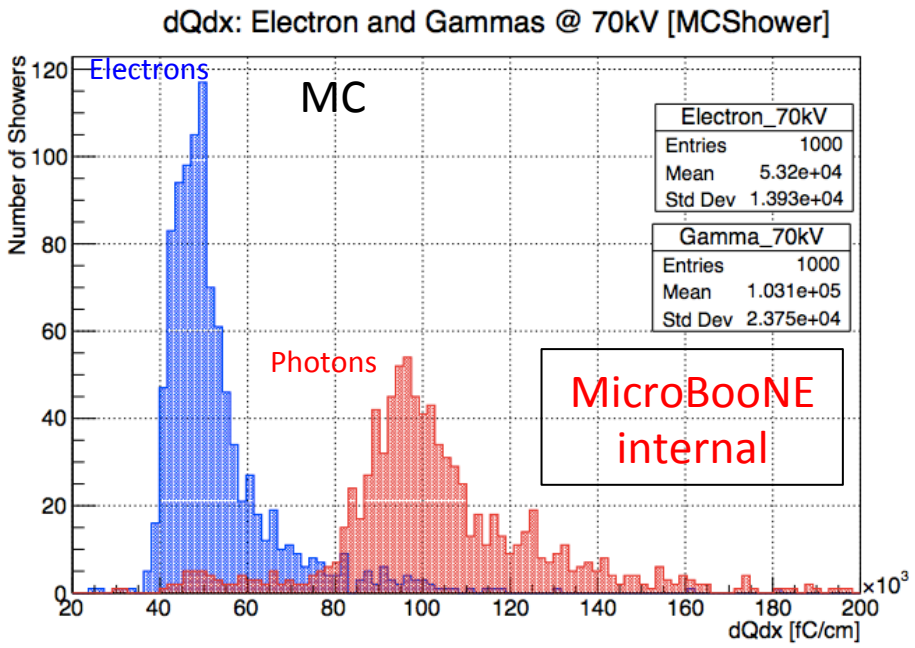


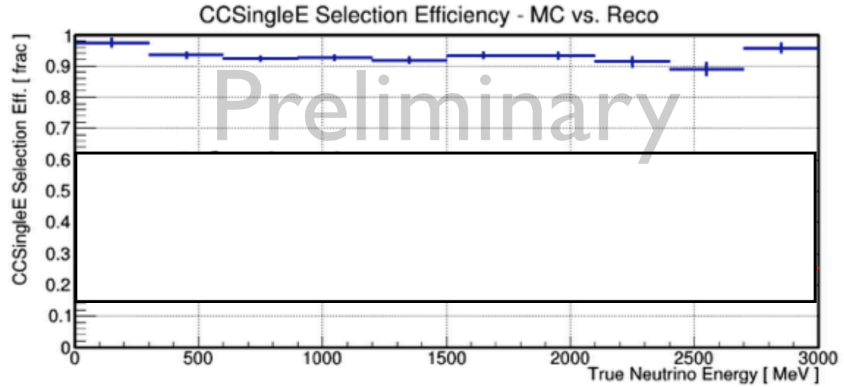




Low Energy Excess: Next 6 Months

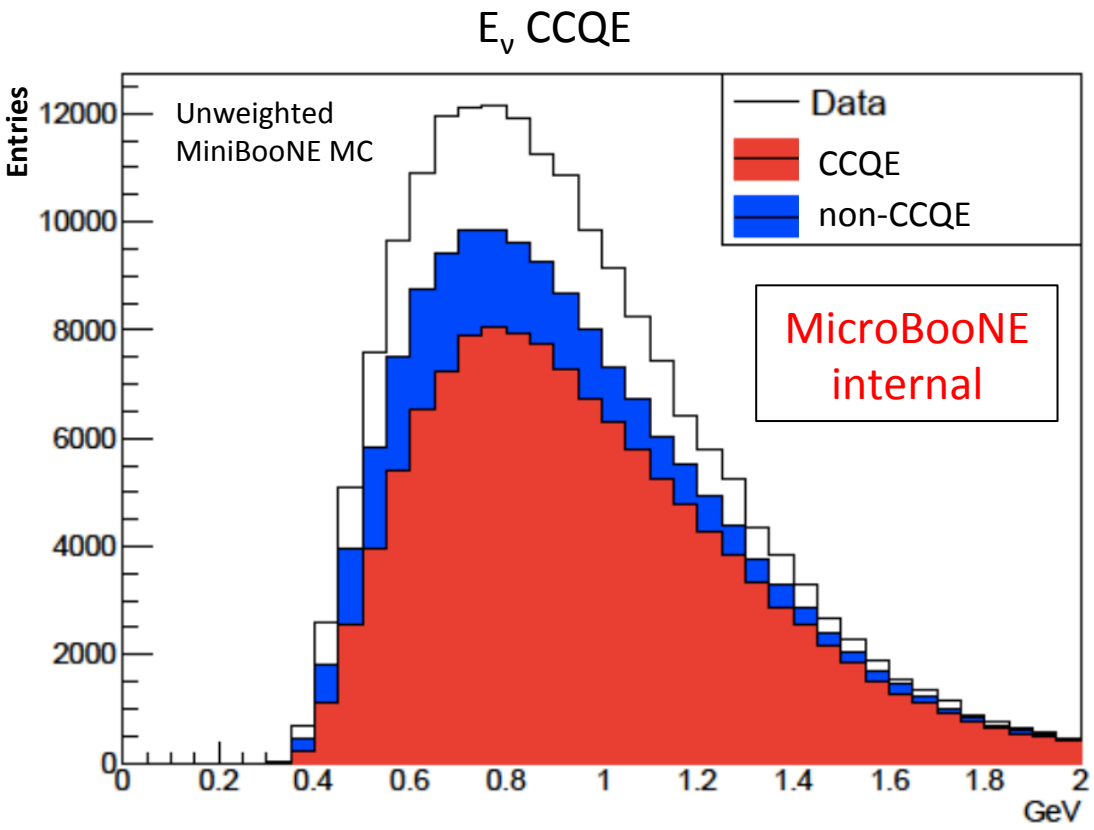
- Aiming for oscillations-relevant analysis results on short timescales
- Identification of the first NC π^0 event in BNB data
  - Demonstrates ability to automatically identify showers in a neutrino event
  - Reconstruction algorithms need not be highly efficient to achieve this goal
- Data-based demonstration of e/γ separation
  - Using, for example, bremsstrahlung photons versus delta rays from cosmic muons
  - Requires good dE/dx algorithms and reliable (but not necessarily efficient) shower reconstruction





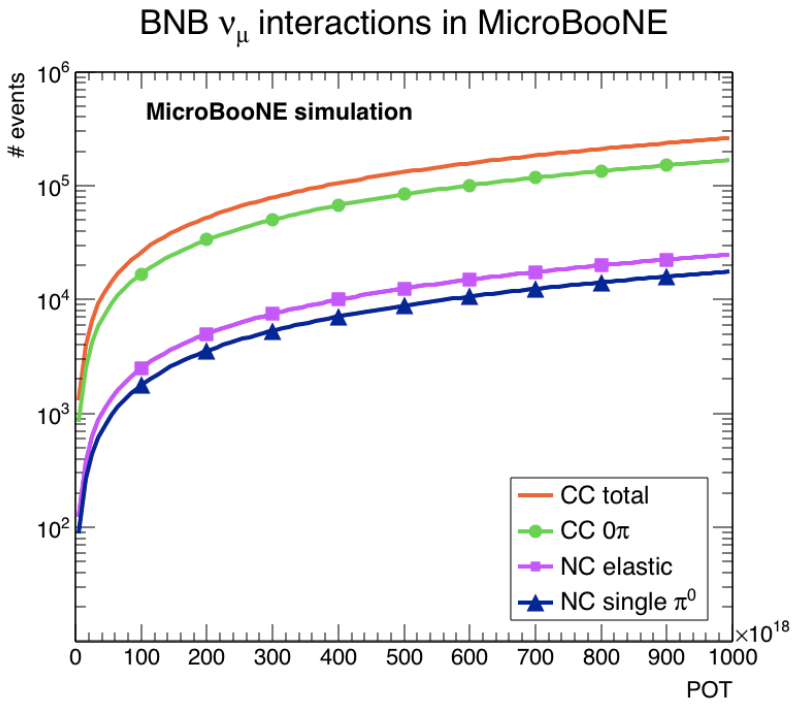
Beam Physics

- Building off MiniBooNE BNB flux determination
- Near term goals
  - MiniBooNE flux check
  - BNB simulation upgrade and validation
- Medium term goals
  - Kaons in the BNB
  - Updated BNB flux paper



Cross Sections Overview

- MicroBooNE will also make ν-Ar cross section measurements in the 100 MeV – few GeV range



	6.6e20 POT (~3 years)			
	numu	numubar	nue	nuebar
CC Total	173302	1407	1469	36
CC - QE	95296	773	729	17
CC – RES	75657	604	702	18
CC – DIS	1607	1.3	29	0.5
CC - COH	740	29	8.5	0.7
NC Total	64661	1002	502	17
NC - QE	35951	633	254	7.0
NC - RES	27665	358	236	9.4
NC - DIS	519	1.3	8.8	0.2
NC - COH	525	10	3.2	0.6

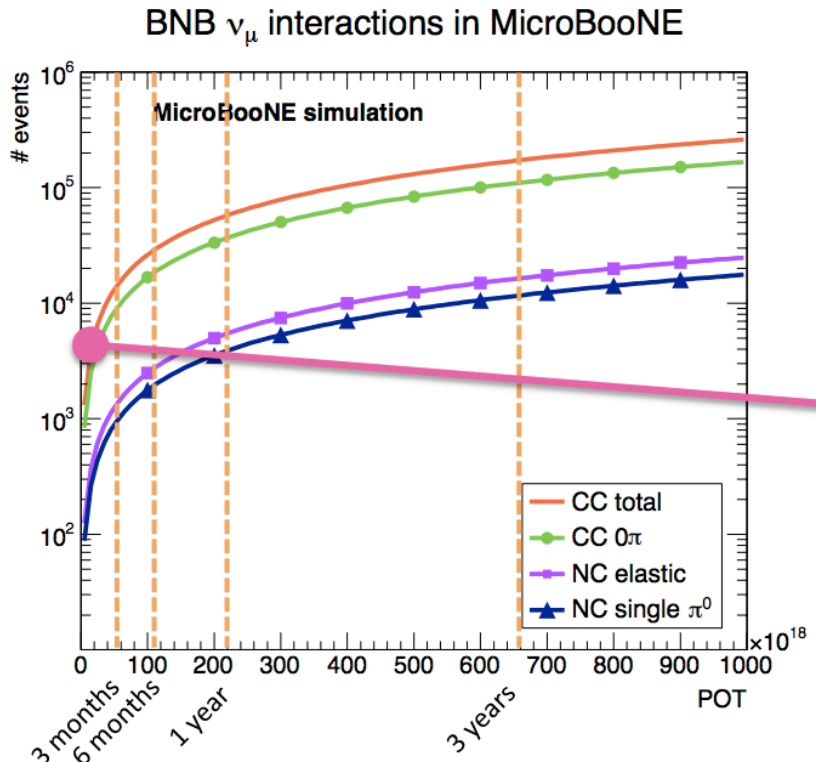
Cross Sections Strategy

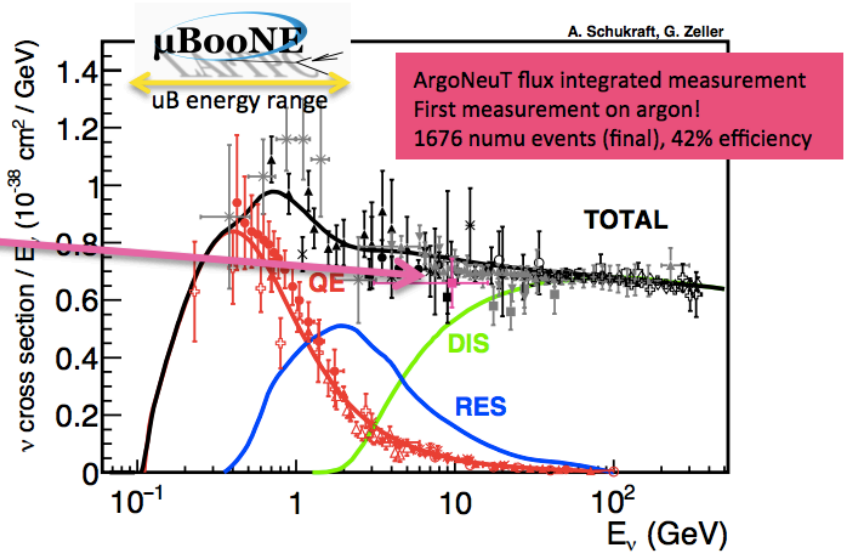
- Focus on ν_μ CC inclusive as first result
  - Will help develop all basic tools needed for other channels
  - Largest statistics

MicroBooNE

	CC incl. events
1.5×10^{19} POT	3990
1×10^{20} POT	26553
2×10^{20} POT	53106

(87 tons, 100% efficiency)

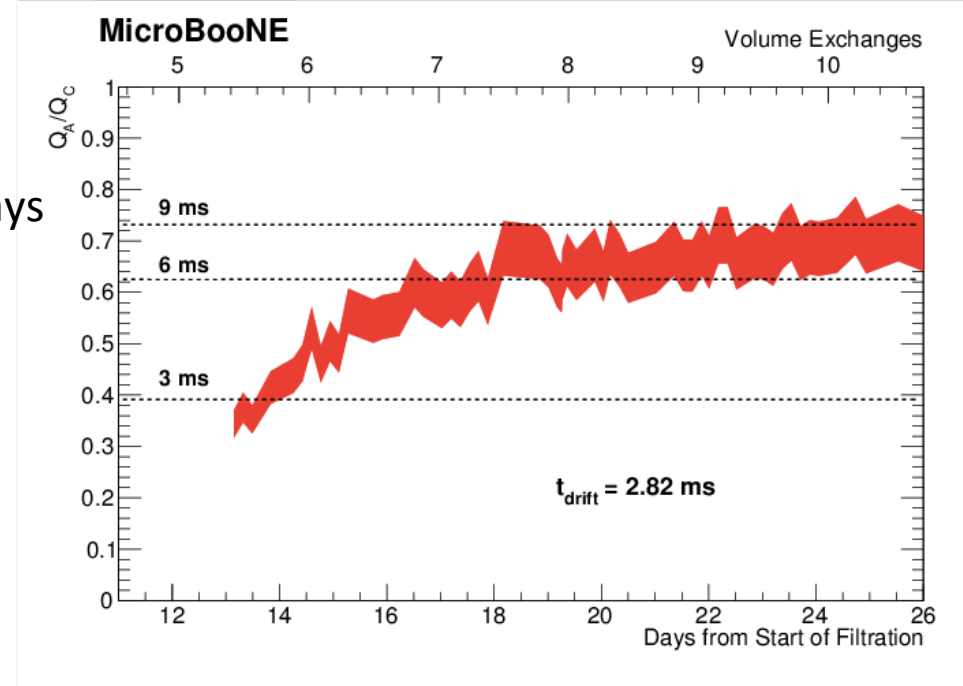




Detector Physics: Next 6 months

- MicroBooNE will also contribute to the development of liquid argon detector technology useful for future neutrino physics experiments

- Purity measurements
  - Analysis from purity monitor and gas analyzers complete
  - Analyses using the TPC from cosmic rays and the laser are ongoing
- Cosmic ray characterization
  - Compare observed to simulated
  - Removal effectiveness
- Diffusion
  - Measurement using cosmic rays
  - Important for future detector optimizations



Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

Collaboration Review of Drift HV Setting

Expectations & Risks

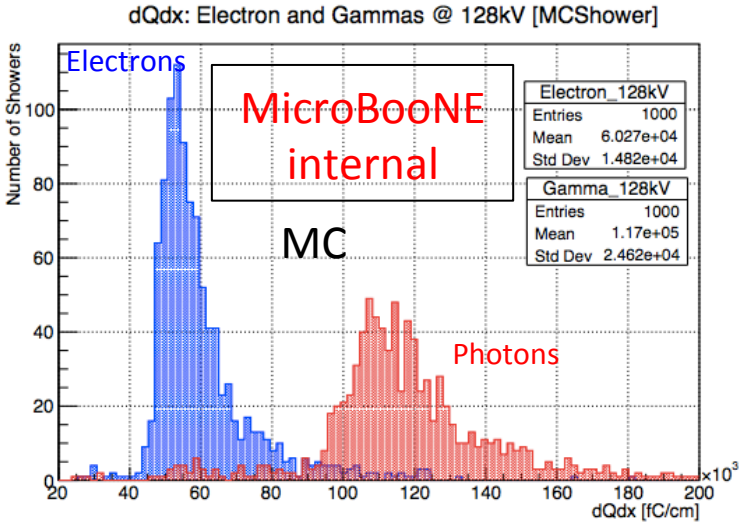
- A third ramp above 70 kV is likely to give the same results as the last two since as far as we understand the relevant experimental conditions, they are the same
- Additional HV power supply trips have serious risks associated with them (e.g. mini-Captain experience)

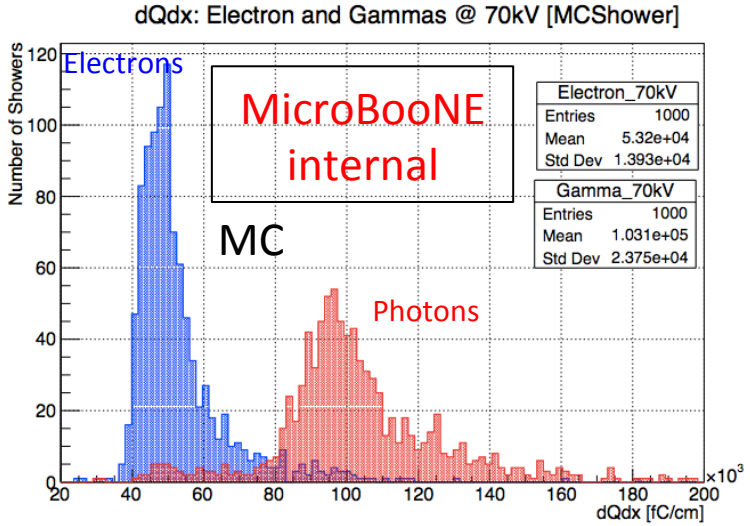
Presentation to collaboration at Sep 4 Status meeting

→ Collaboration consensus to operate at -70 kV for the initial physics run

Physics Impact of Running at -70 kV

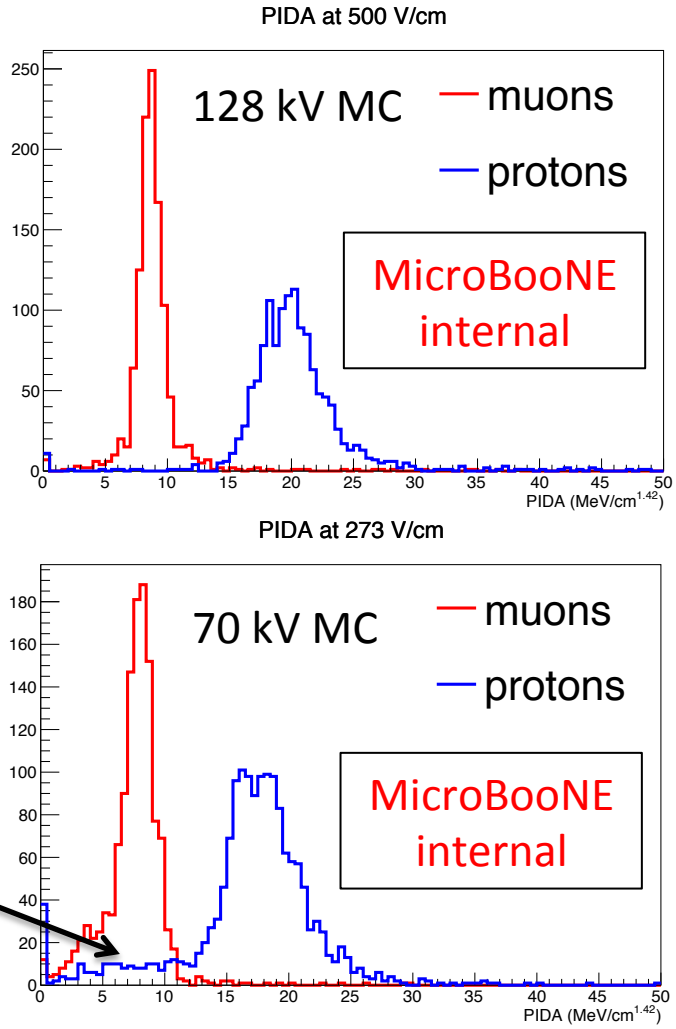
- Purity not an issue for MicroBooNE
- Low energy excess
  - Distinguish electrons from photon conversions
    - Calorimetry: e/γ separation (looks OK)
    - Topology: γ conversion separation from interaction vertex
      - Resolution in X direction is somewhat better, diffusion in X direction is somewhat worse
    - Cosmic ray background up to ~40% higher
      - PMT system important for rejection





Physics Impact of Running at -70 kV

- Purity not an issue for MicroBooNE
- Low energy excess
  - Distinguish electrons from photon conversions
    - Calorimetry: e/γ separation
    - Topology: γ conversion separation from interaction vertex
      - Resolution in X direction is somewhat better, diffusion in X direction is somewhat worse
    - Cosmic ray background up to ~40% higher
      - PMT system important for rejection
- Cross sections
  - Proton/muon separation with no additional cuts has only ~8% mis-ID
- LArTPC detector development

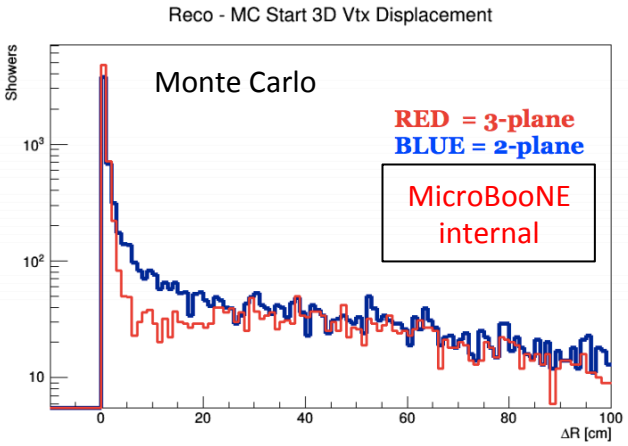


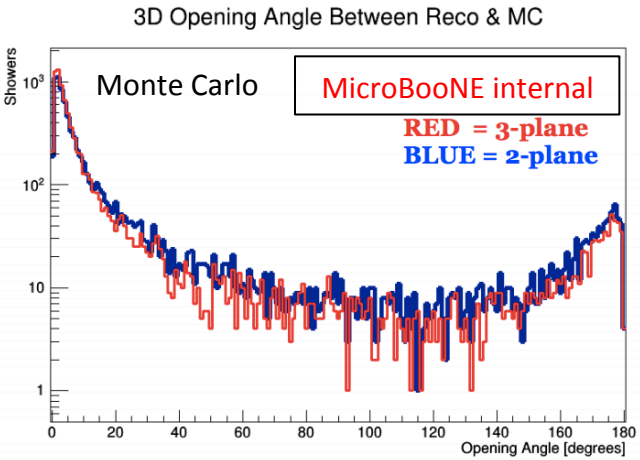
Outline

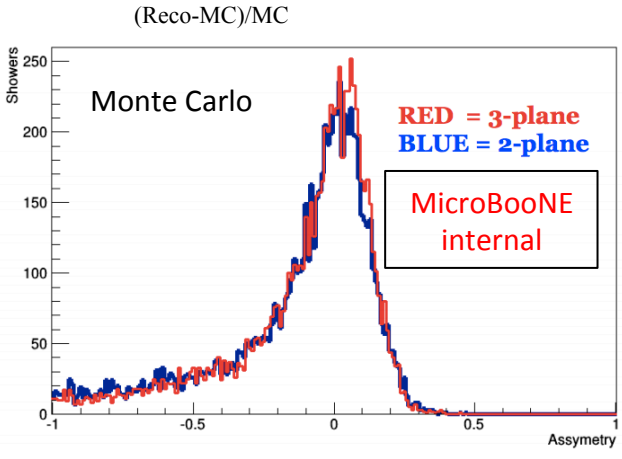
- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

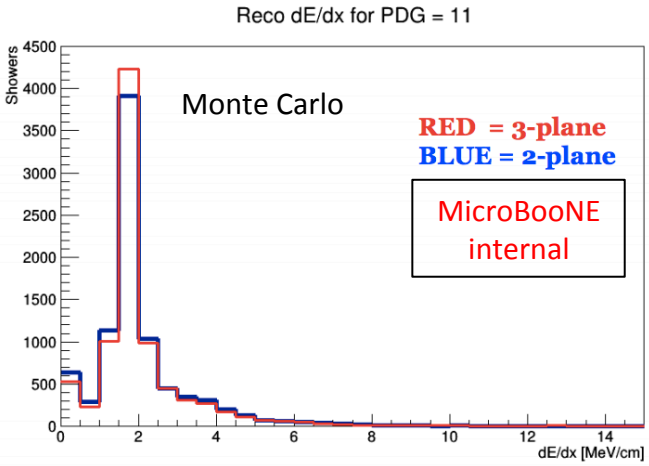
Physics Impact of Noisy/Dead Channels

- Built-in redundancy due to third wire plane
- Wires in at least 2 planes are good for >95% of the TPC
- Shower reconstruction studies ignoring third plane indicate small hit in performance









Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

MicroBooNE ORR Charge Question 5

MicroBooNE Analysis Procedures

- Analysis approval procedures are in place and have already been used for the timely release of several MicroBooNE results

Final Analysis approval stages
(after an analysis has reached maturity within a group)

Group Phase

1. An **internal Analysis Note** is prepared
2. An Editorial Board is formed (PC)
3. Presentation at a group meeting and circulation (after initial review and approval by the EB)
4. **1 week time for comments / questions**
5. Analysis team / EB handle comments with GC
   If necessary, loop over 3, 4, 5
6. Approval by GC (in consultation with EB)

Collab. Phase

1. **2 weeks circulation** of the **internal Analysis Note** (by GC)
2. GC / Analysis team handle comments with EB
   If necessary, recirculate
3. Approval by PC (in consultation with EB and GC)

Circulation times can be shortened in exceptional cases

Analysis and Publication Policy DocDB 3278

GC = Group Convener(s)
PC = Physics Coordinator(s) or Analysis Tools convener(s)
EB = Editorial Board

Making it public

Final results: **Publication** (Publications Committee)

Preliminary results: Circulation of a **Public Note (with preliminary plots)** (Plots Policy, **1 week***)

* May overlap with the Collaboration internal analysis note circulation

Editorial Boards

Active	Analysis	Group	Date created	Public Note / Publication
	NumuCC inclusive cross section study based on simulation	Xsec	Oct 2015	DocDB-4994
	Electronegative concentration and electron lifetime		Sept 2015	DocDB-4928
	First neutrino events	Reco	Sept 2015	DocDB-4903
	Nuceon Decay	APE	Aug 2015	DocDB-4765
	Noise vs. Fill Level	Commissioning	July 2015	DocDB-4717

Shown at:
NuINT 2015
NNN 2015
NuINT 2015
TAUP 2015
TAUP 2015

First Neutrino Events (I)

- More than "just" a few event displays
- "End-to-end" analysis
- Automated reconstruction and selection
  - PMT timing
  - 2D/3D reconstruction
- Public note

First neutrino interactions observed with the MicroBooNE Liquid-Argon TPC detector

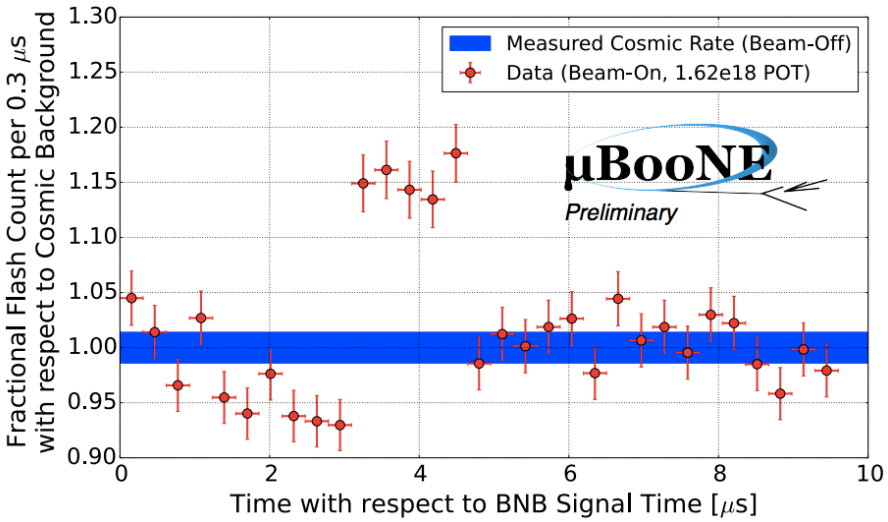
The MicroBooNE Collaboration

November 2, 2015

Abstract

The MicroBooNE liquid-argon TPC detector started to take its first neutrino data from the Booster Neutrino Beam at the Fermi National Accelerator Laboratory on October 17, 2015. We have performed fully-automated 3D reconstruction on these first data events using algorithms we have developed for the LArSoft software package, and we have developed a filter to distinguish neutrino interaction candidate events from the large number of events that contain activity originating mostly from cosmic rays. This is the first-time events from a large liquid argon TPC operating on/near the surface have been automatically reconstructed and selected for analysis. We describe the reconstruction and automated filtering procedure, and show displays of some of the first neutrino interactions observed with the detector using 1.86×10^{18} protons on target.

First Neutrino Events (II)



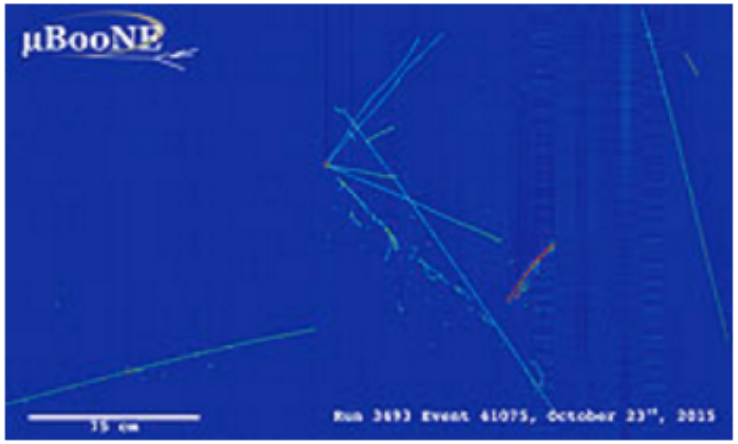
MicroBooNE Preliminary
1.86E18 POT, BNB

First ν identification

Number of events	Automated event selection Optical + 3D-based	Automated event selection Optical + 2D-based
Non-beam background (expected)	4.6 ± 2.6	385 ± 24
Total observed	18	463

Feature

MicroBooNE sees first accelerator-born neutrinos



This display shows a neutrino event candidate in the MicroBooNE detector. *Image: MicroBooNE*

Today the MicroBooNE collaboration announced that it has seen its first neutrinos in the experiment's newly built detector.

ν_μ CC Inclusive MC Performance Study (I)

- Simulated signal and background
- Includes all the basic ingredients for a cross section
  - Reconstruction
  - Cosmic removal and background estimation
  - Signal selection and efficiencies
- Differential distribution vs. muon momentum
- Public note

MC performance study for an early ν_μ charged-current inclusive analysis with MicroBooNE

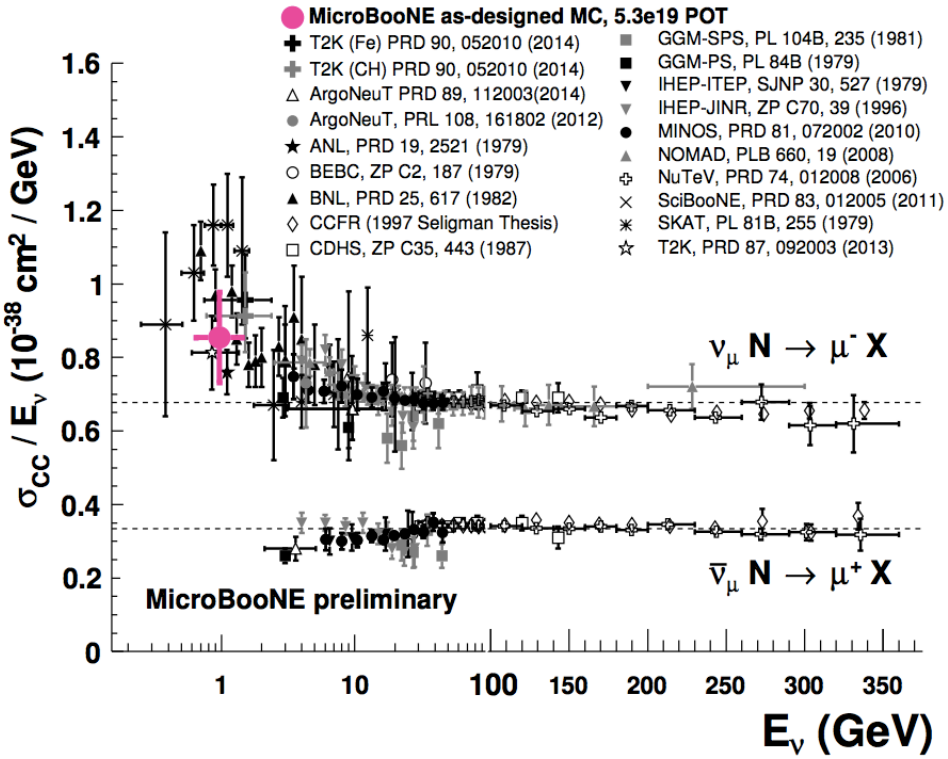
The MicroBooNE Collaboration

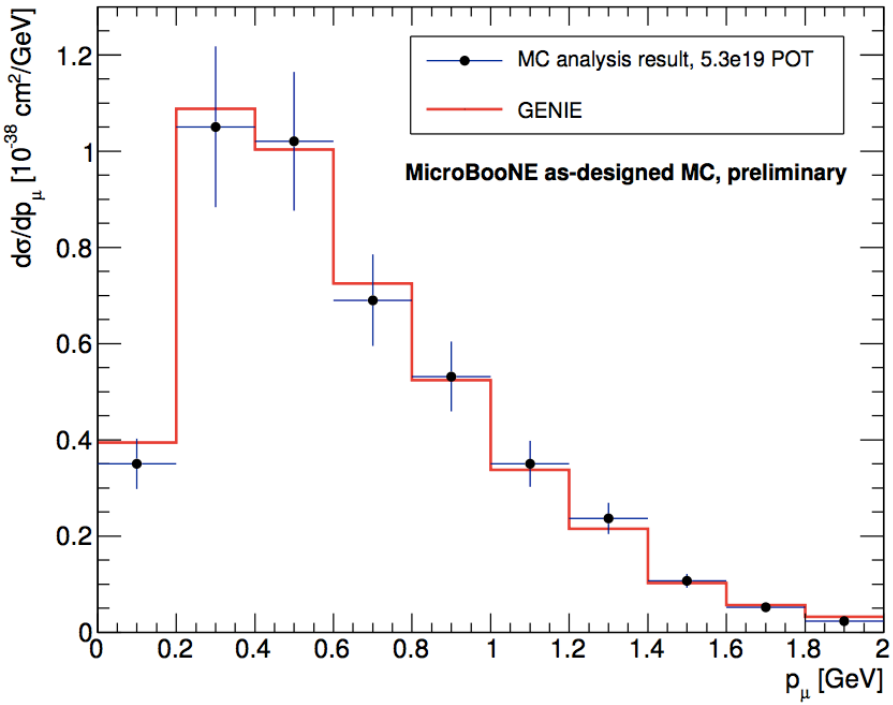
November 6, 2015

Abstract

This note describes an analysis performed on Monte Carlo data to evaluate the sensitivity of MicroBooNE for an early ν_μ charged-current inclusive cross section measurement. Such an analysis is intended to be done using the first three months of Booster Neutrino Beam data. The event selection is entirely based on an automated event reconstruction. The Monte Carlo prediction for a flux-integrated and single differential cross section measurement with an approximate estimation of statistical and systematic uncertainties for the MicroBooNE detector as designed is presented. This allows the comparison of the sensitivity of MicroBooNE to theory and other experiments.

ν_μ CC Inclusive MC Performance Study (II)





Outline

- Organization
- Plans & Priorities
- Goals
  - Physics Impact of Running at -70 kV
  - Physics Impact of Noisy/Dead Channels
- Infrastructure for Publishing Results
- Conclusion

Conclusion

- We have an active and established infrastructure for data analysis
- We have a demonstrated ability to complete analyses and make our results public in a timely fashion
- We have data analysis plans and goals in place looking towards Neutrino 2016 and beyond

Back-ups

Detector Physics: 1-2 Years Out

- Field distortion corrections
  - Field non-uniformities due to space charge and other effects
  - Corrections using the laser system
- Recombination
  - Analysis with cosmic rays
  - Measurements at different drift HV values