MiniBooNE PAC Presentation
Status of AntiNeutrino Running in 2007

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for the MiniBooNE Collaboration
March 29, 2007

Outline

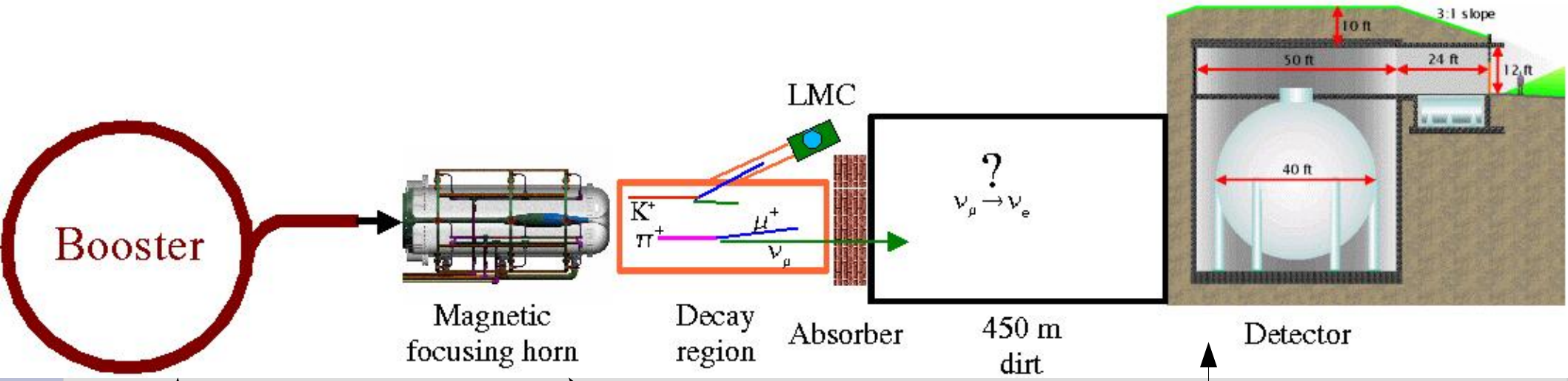
- Motivation for antineutrino running.
- Overview of experiment.
- Status of current antineutrino running.
- Antineutrino data analysis update.
- Conclusions.

Motivation for Antineutrino Running

- No antineutrino cross section measurements at ~1 GeV.
- Next generation long baseline experiments need these for oscillation and CP violation searches.
  - Specific issues related to pion/electron mis-identification rates.
- Extend $\overline{\nu}_{\mu}$ disappearance oscillation measurement by a few orders of magnitude in Δm^2.

Overview of Experiment

- Primary mission to confirm or refute the LSND oscillation measurement.
  - Different systematics, same L/E.



8 GeV protons on Be target
Magnetic focusing horn (polarity reversible)

800 tons CH_2
1280 inner PMTs
240 veto PMTs

Overview of Experiment

- Successfully took 7.0×10^{20} POT in neutrino mode from Aug 2002 to Jan 2006.
  - Have opened the oscillation box, will present April 11th !!
- Jan 2006 switched to antineutrino running.
  - Will update status in this talk.

State of The MiniBooNE Collaboration in FY07

U. Alabama, Bucknell U., U. Cincinnati, U. Colorado,
Columbia U., Embry Riddle Aeronautical U., Fermilab,
Indiana U., Los Alamos, Lousiana State, U. Michigan,
Princeton, St Mary's of Minn., Virginia Polytechnic State,
Western Il., Yale

Currently 65 collaboration members: 25 lab, 20 faculty,
11 postdocs, 9 students

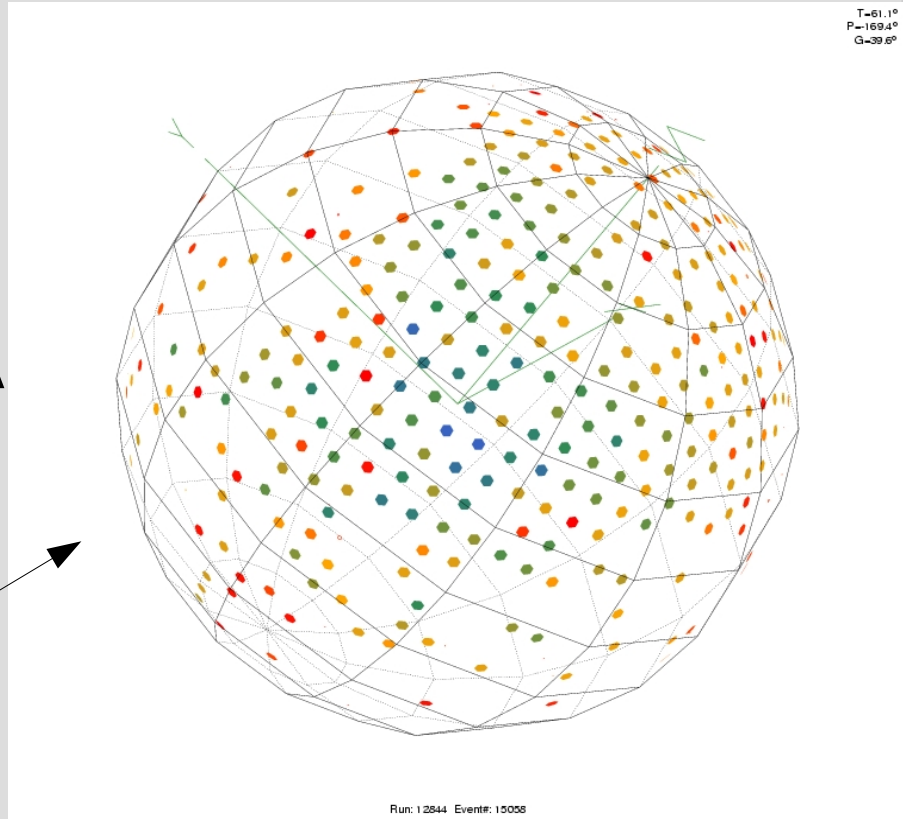
5 new graduate students earmarked for antineutrino analysis

- -1 Columbia student working on π^0 analysis
- -1 Columbia student working on 3+2 osc analysis
- -2 Yale students
- -1 Virgina tech

The collaborators are committed to FY07 running and analysis

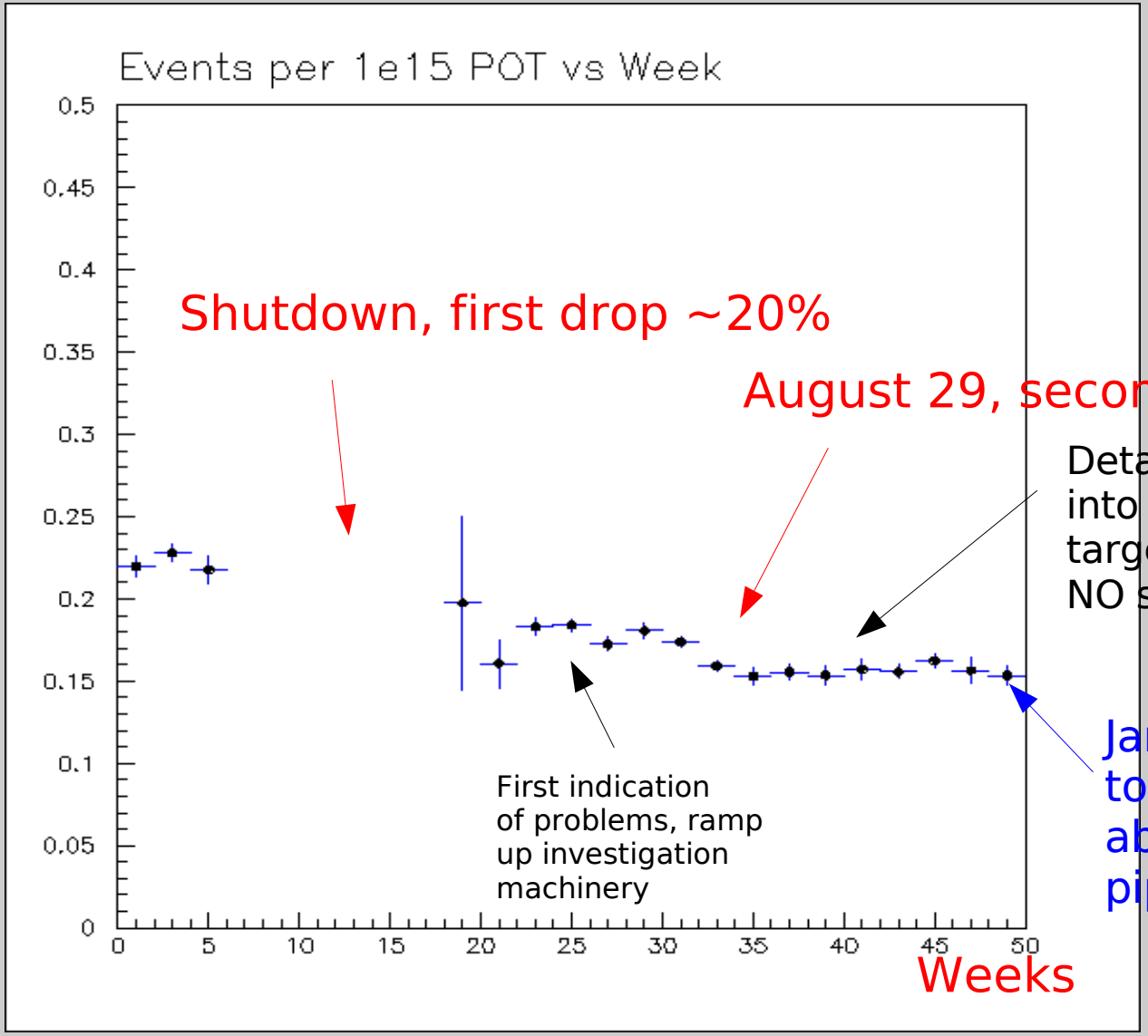
Status of Antineutrino Running

- Early January 2006 switched horn power supply polarity.
  - Two weeks installing new supplies and power bus reconfiguration.
  - Next switch would take only one week.
  - Collected 1.5E20 POT with horn current -174kA
  - During run problems with the beamline uncovered!



First neutrino candidate in antineutrino mode

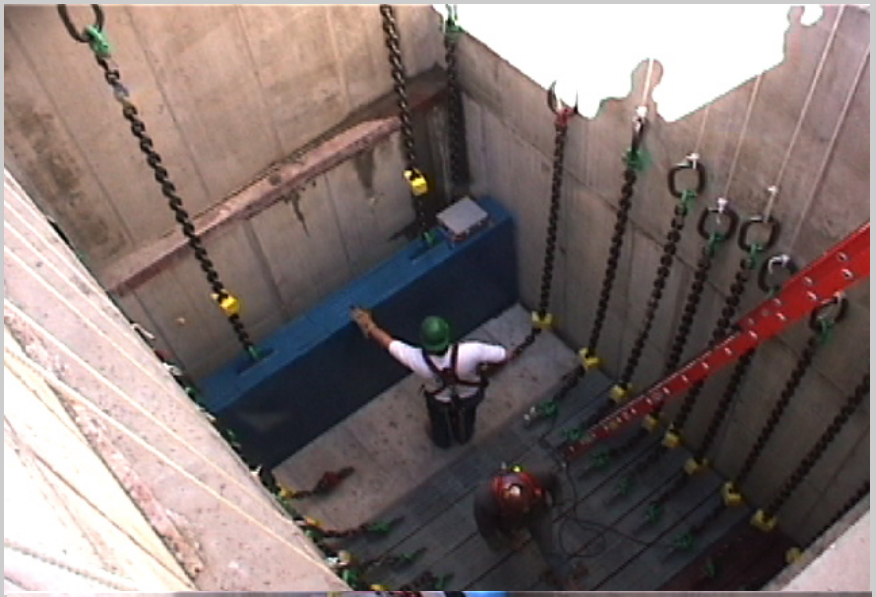
Data Quality Corrected Neutrinos/POT from Jan 18/06 to Jan 1/07



Decreasing Nu/POT Problem what is the source?

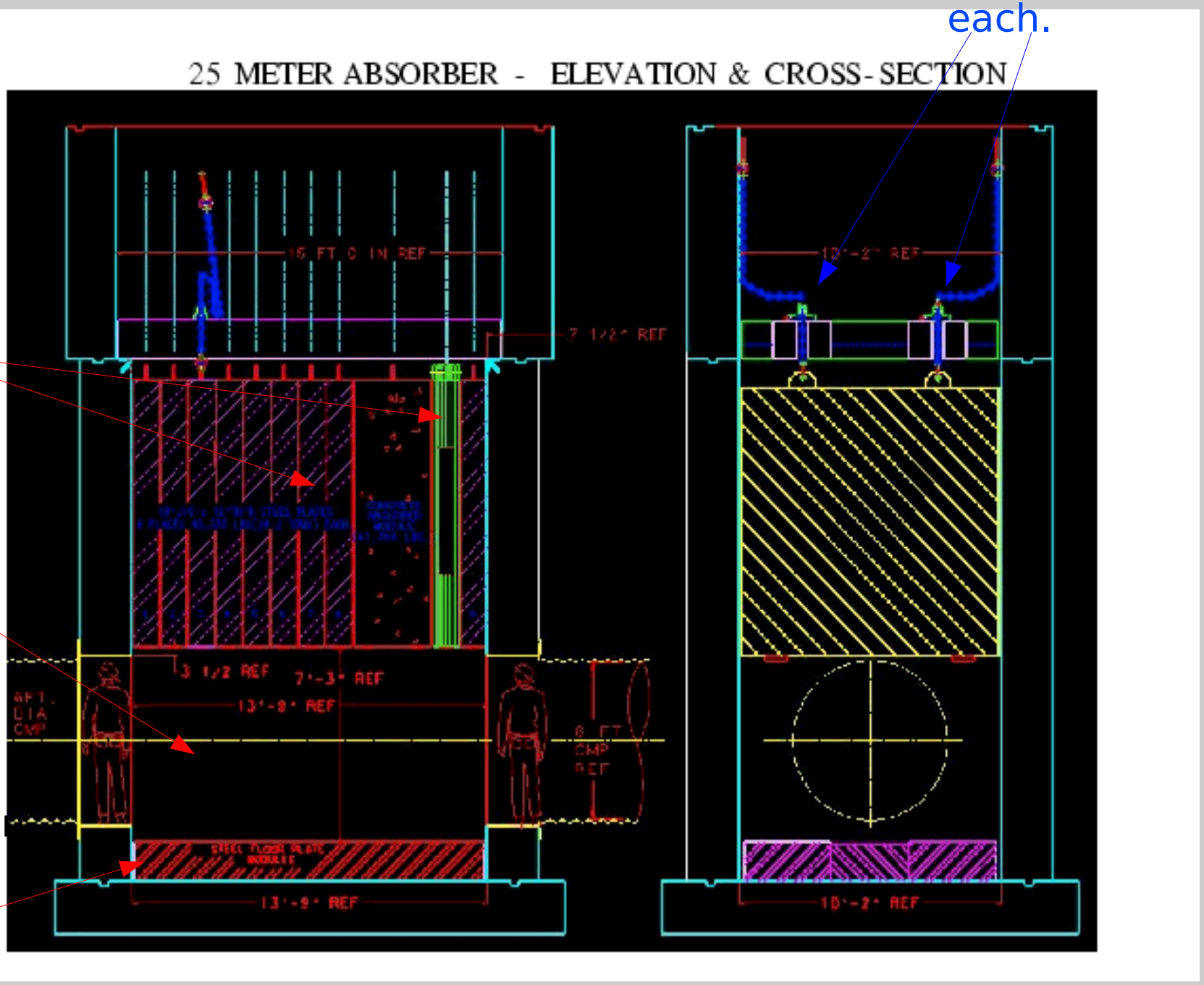
- Beam line
  - Booster and MB toroids consistent with each other ~3% level.
- Horn
  - Horn current and timing nominal. Horn off running rules out horn.
- Target
  - Analysis of target temperature and air flow shows no significant changes correlated with time.
- Detector
  - Low level quantities, energy scale, etc, constant.
  - NuMI nu/POT constant.
- Decay Region
  - Little Muon Counter (LMC), MI13 chipmunk, and 50m dump muon monitors show rate changes correlated in time with nu/POT changes.

25m Absorber Region:



25m Absorber Region

Chains rated for 17 tons each.



Two 25 ton plates fell into down position (a 7' drop).

Beam direction

Steel floor

Broken Chain From Plate #10

Break point very clean. Crack found on surface

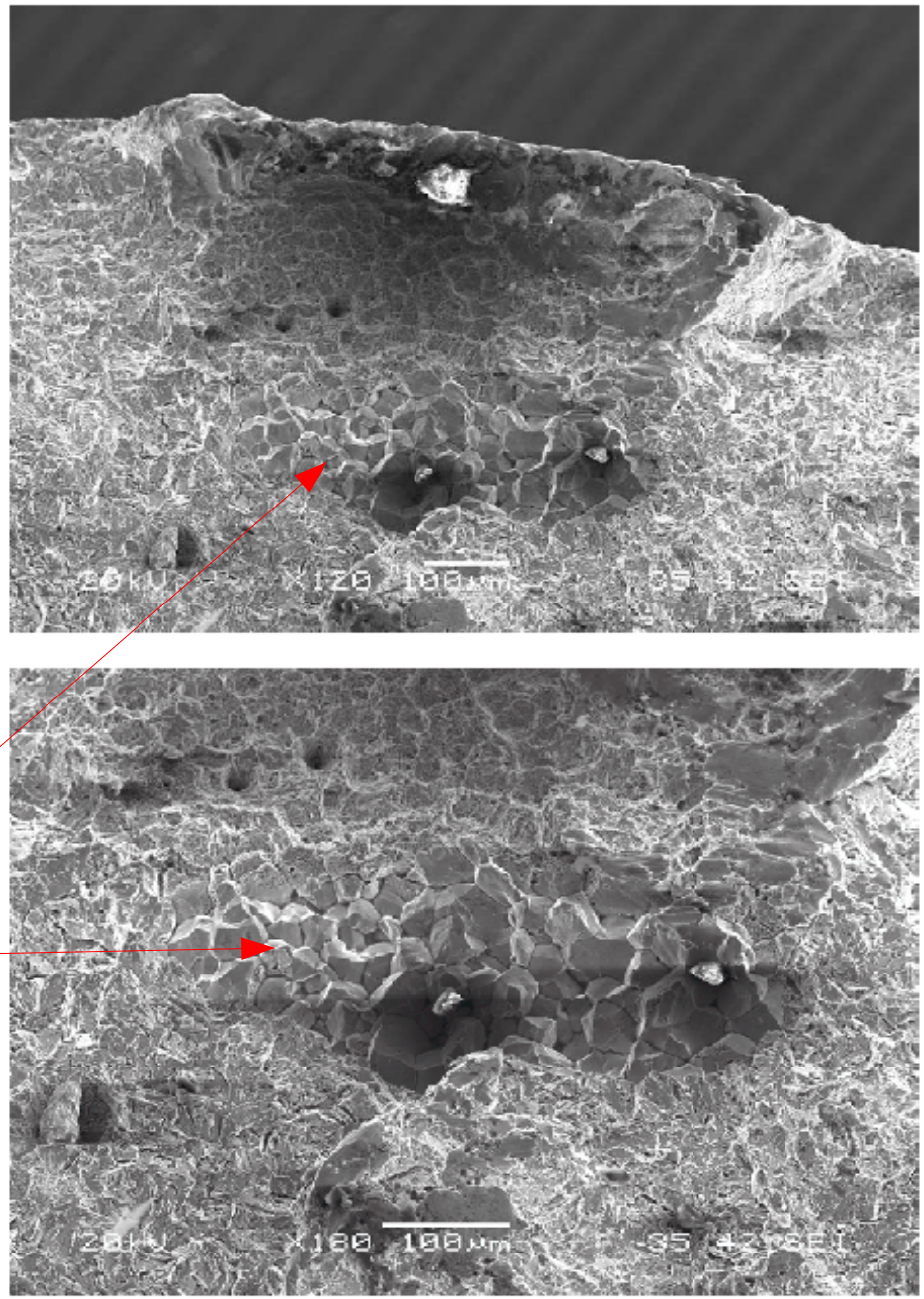
Corrosion is surface only, consistent with wet environment

Welds intact

Chain working load 17T (25T blocks), tested to x2, break point at x4 working load

MEI/FNAL Chain Failure Evaluation

- Conclusive evidence of Hydrogen embrittlement which only affects harden high strength steel.
- LANL MST-6 analysis came to same conclusion.
- Thus stainless steel (T304) is a good choice for new lifting rods.



Inter-granular morphology on crack surface due to H+ re-combining in the metal matrix, reducing local strength.

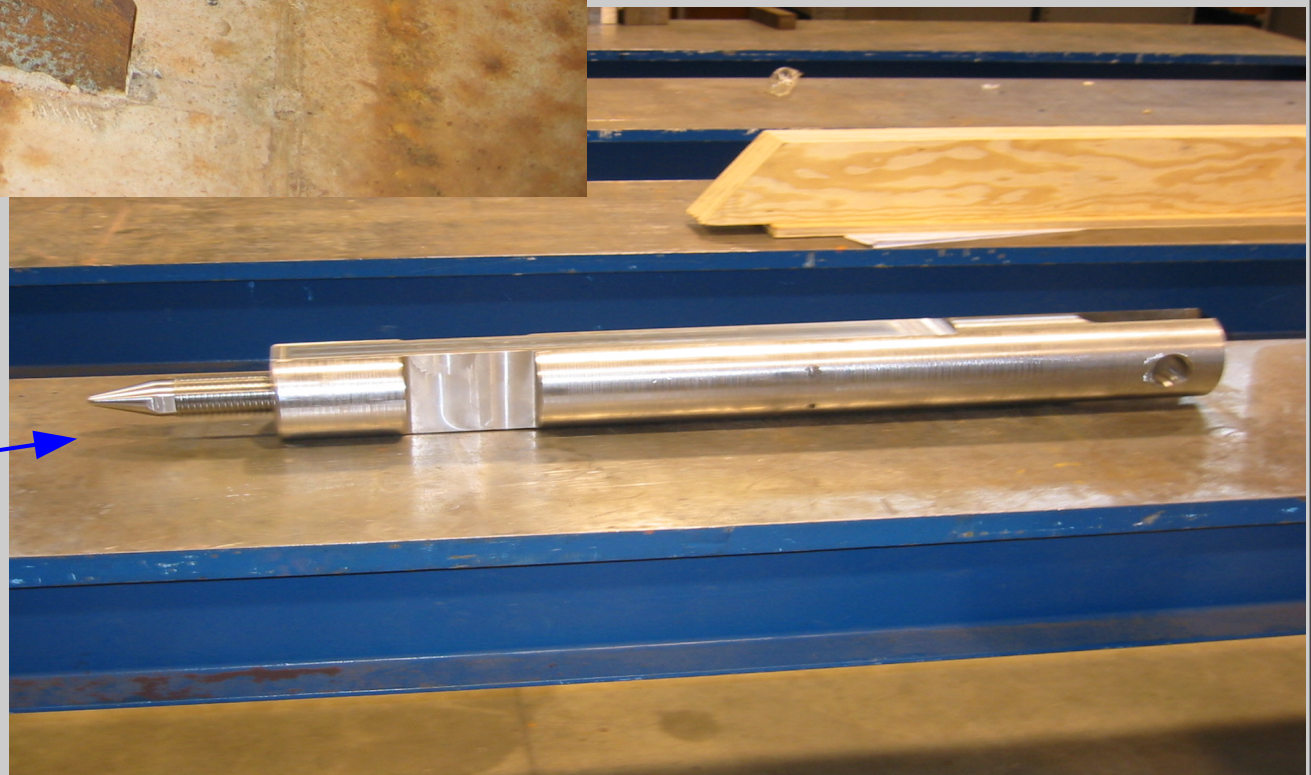
The Repair Plan

- AD repair team formed, headed by Mike Andrews.
- Two phases; Phase I,
  - Lower plates, and understand source of problem.
  - Design twin screw jacks (cost effective, safe).
- Phase II,
  - Raise absorber plates using stainless steel rods.
- Back up running April 12th !!

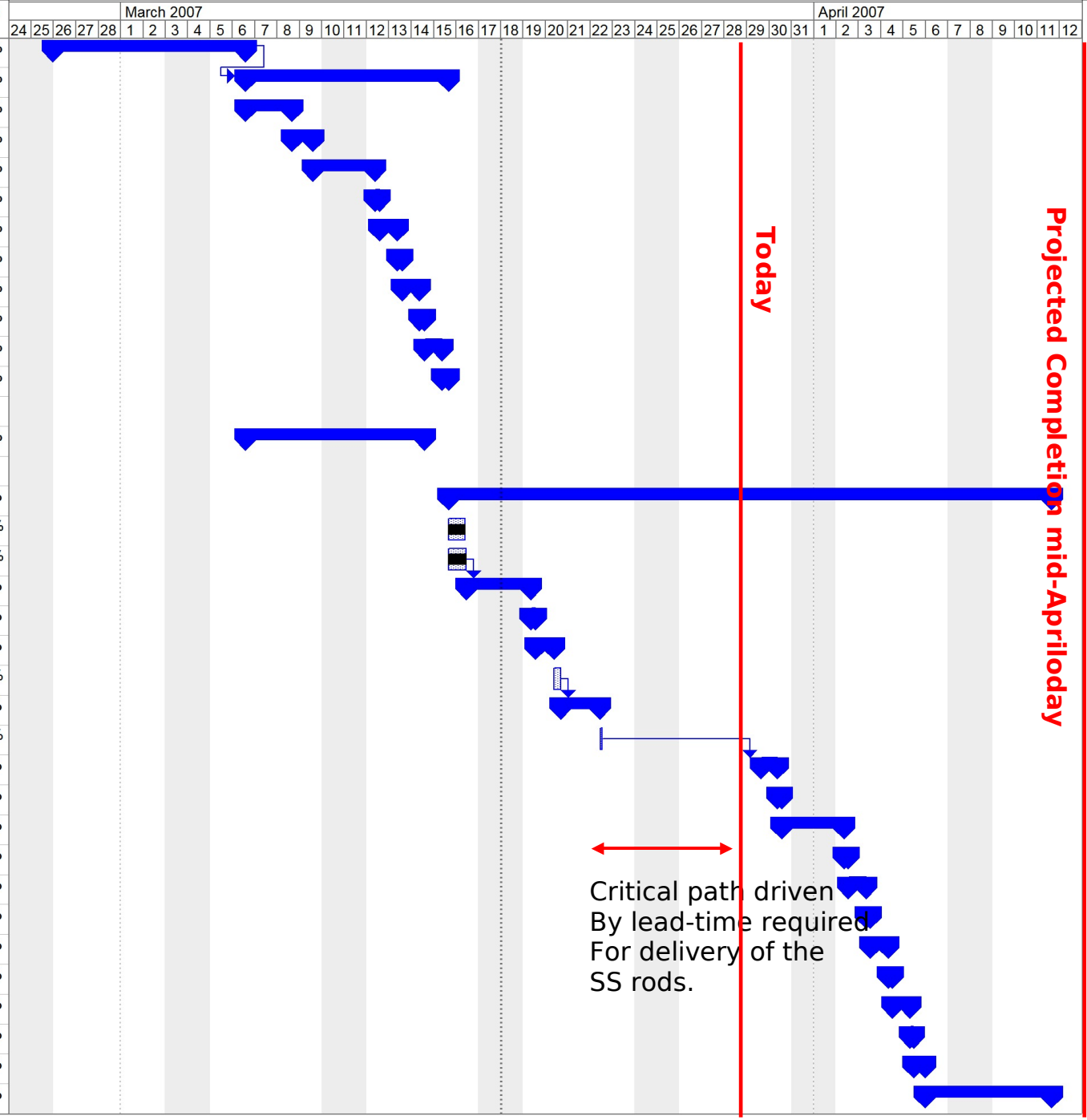
Screw Jack lifting device in action
-all 9 absorber plates were
successfully/safely lowered.

Clean, inspected, tested, and prepared lifting lugs. All okay, ready for lifting!

New Stainless steel rods to hang absorber plates (just arrived).



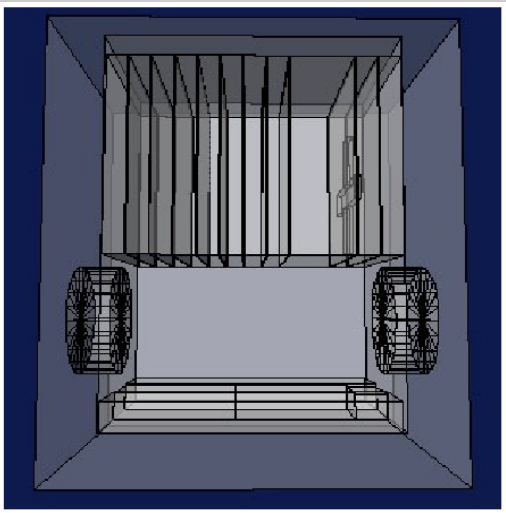
ID	Task Name	% Complete
1	**Lower Absorbers Design and purchase phase**	**100%**
20	**Lower Absorbers**	**100%**
21	**Prep for lowering absorbers**	**100%**
30	**Lower absorber 1**	**100%**
39	**Lower absorber 2**	**100%**
48	**Lower absorber 3**	**100%**
57	**Lower absorber 4**	**100%**
66	**Lower absorber 5**	**100%**
75	**Lower absorber 6**	**100%**
84	**Lower absorber 8**	**100%**
93	**Lower absorber 9**	**100%**
102	**Lower absorber 11**	**100%**
112		
113	**Repair Phase EDIA**	**100%**
120		
121	**Testing and Repair phase**	**6%**
122	move tent	100%
123	Set up 150 ton crane remove 20,000 lb steel	100%
124	**Remove chains from absorbers**	**0%**
136	**Pull test lugs from absorbers**	**0%**
148	**Welding**	**0%**
162	paint prep and Paint module tops	0%
163	**Install Holding Links**	**0%**
175	Rig in screw jack assembly position over absorber 1	0%
176	**Absorber 1**	**0%**
182	**Absorber 2**	**0%**
190	**Absorber 3**	**0%**
198	**Absorber 4**	**0%**
206	**Absorber 5**	**0%**
214	**Absorber 6**	**0%**
222	**Absorber 7**	**0%**
230	**Absorber 8**	**0%**
238	**Absorber 9**	**0%**
246	**Absorber 10**	**0%**
254	**Absorber 11**	**0%**
263	**Finish**	**0%**



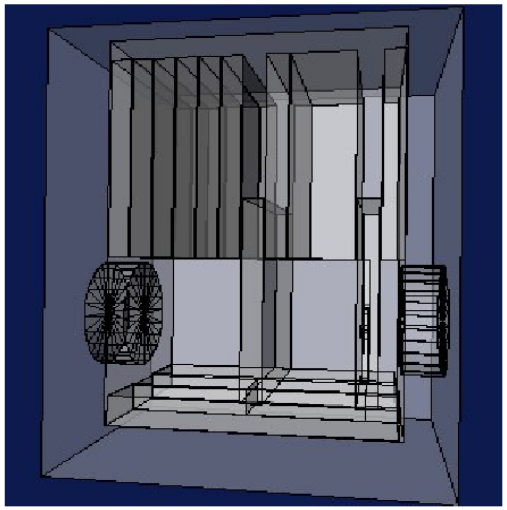
Project: Shutdown 07
Date: Sun 3/18/07

Task		Summary		Rolled Up Progress		Project Summary	
Progress		Rolled Up Task		Split		Group By Summary	
Milestone		Rolled Up Milestone		External Tasks		Deadline	

MC Understanding the Data

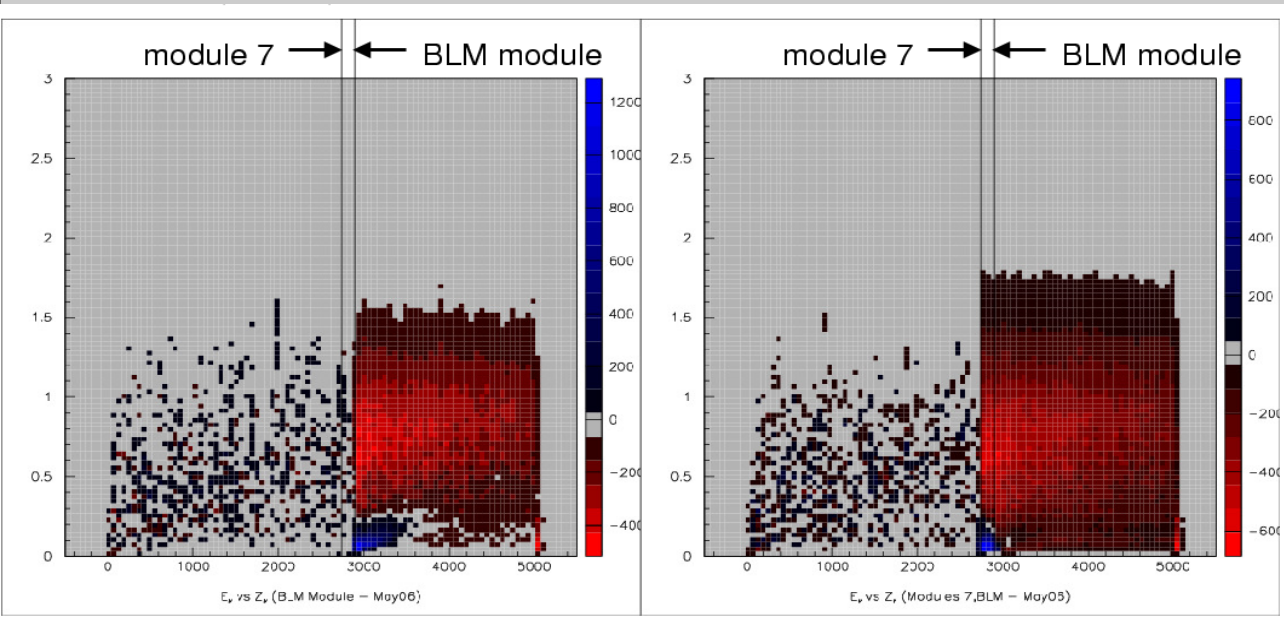


Default Geometry



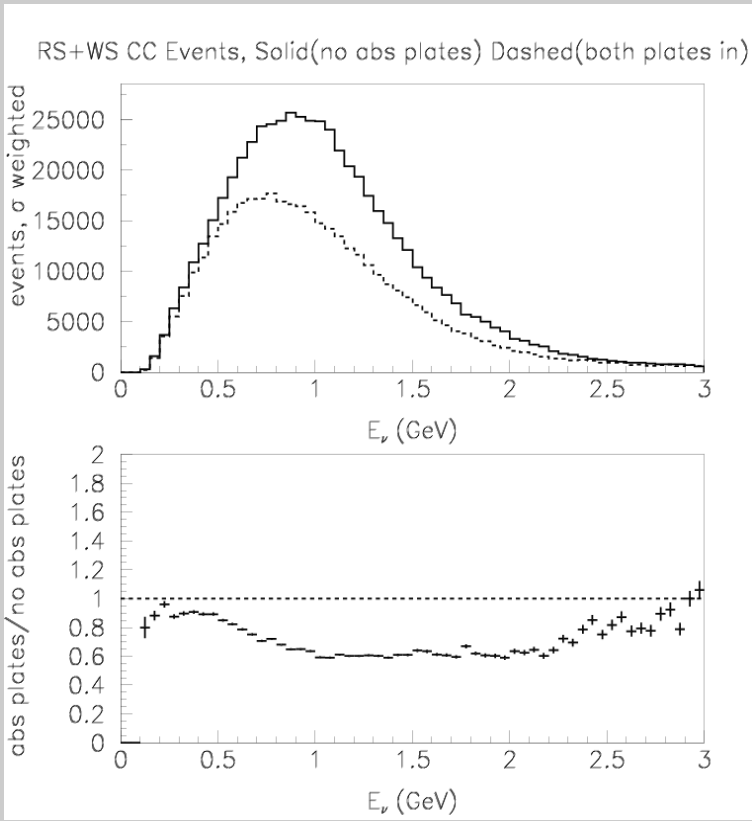
"Both Modules" Geometry

Geant4 simulation of the 25m absorber region, 1030 steel:
-98.86% Iron
-0.75% Manganese
-0.30% Carbon
-0.05% Sulfer
-0.04% Phosphorus

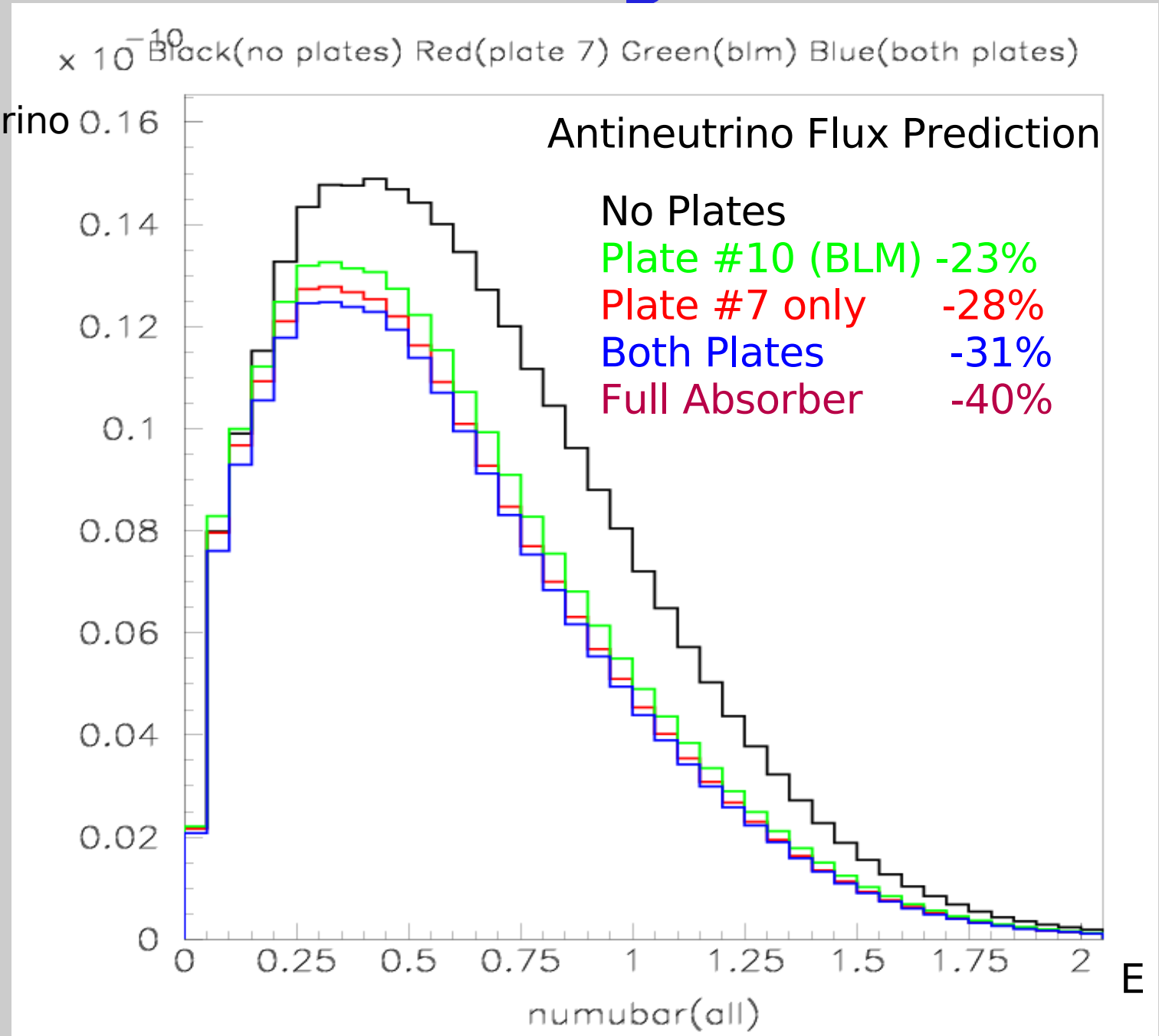


Difference with and without BLM module

Difference with and without modules 7,BLM

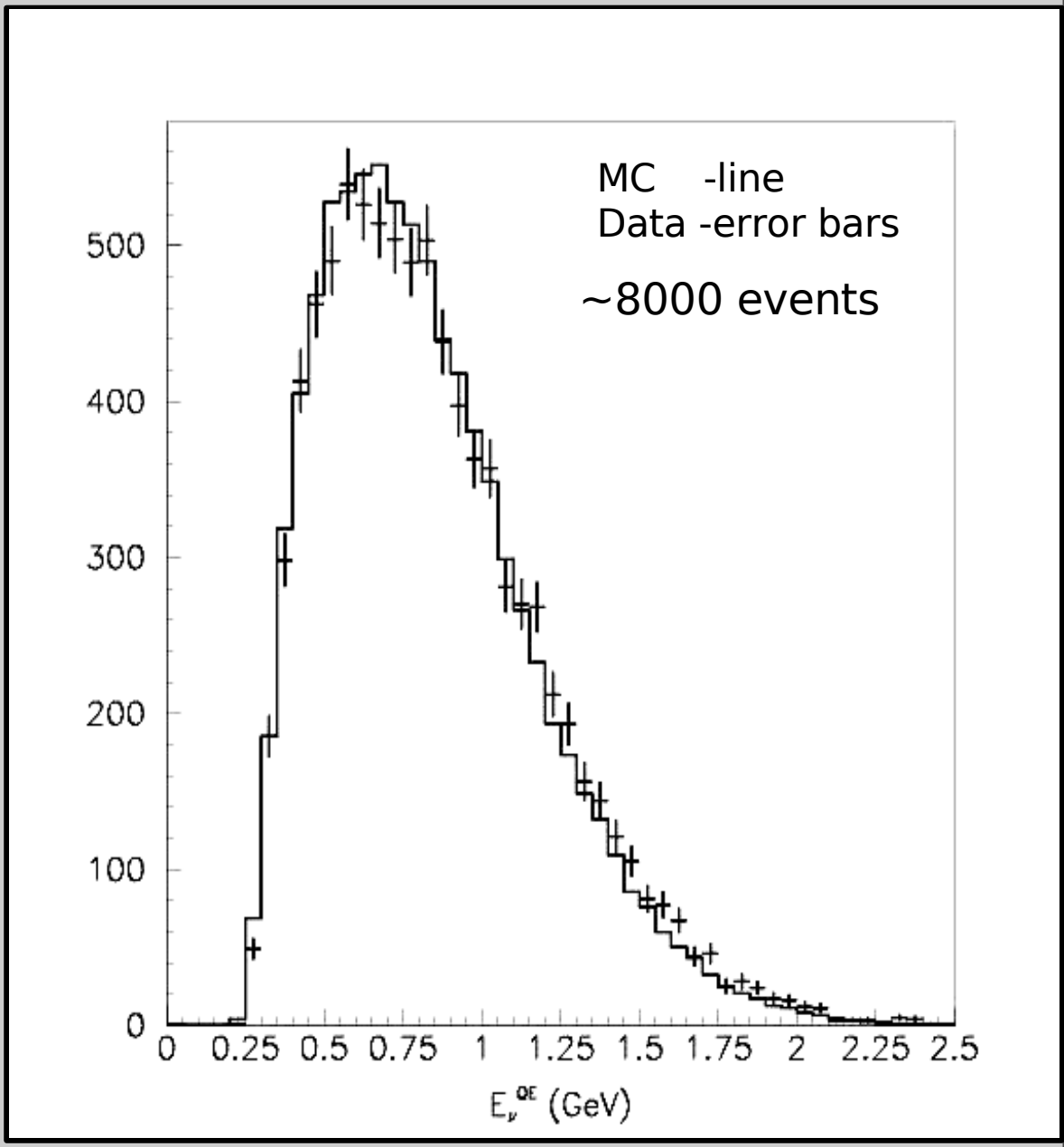


25m Absorber MC Rate/Shape Change



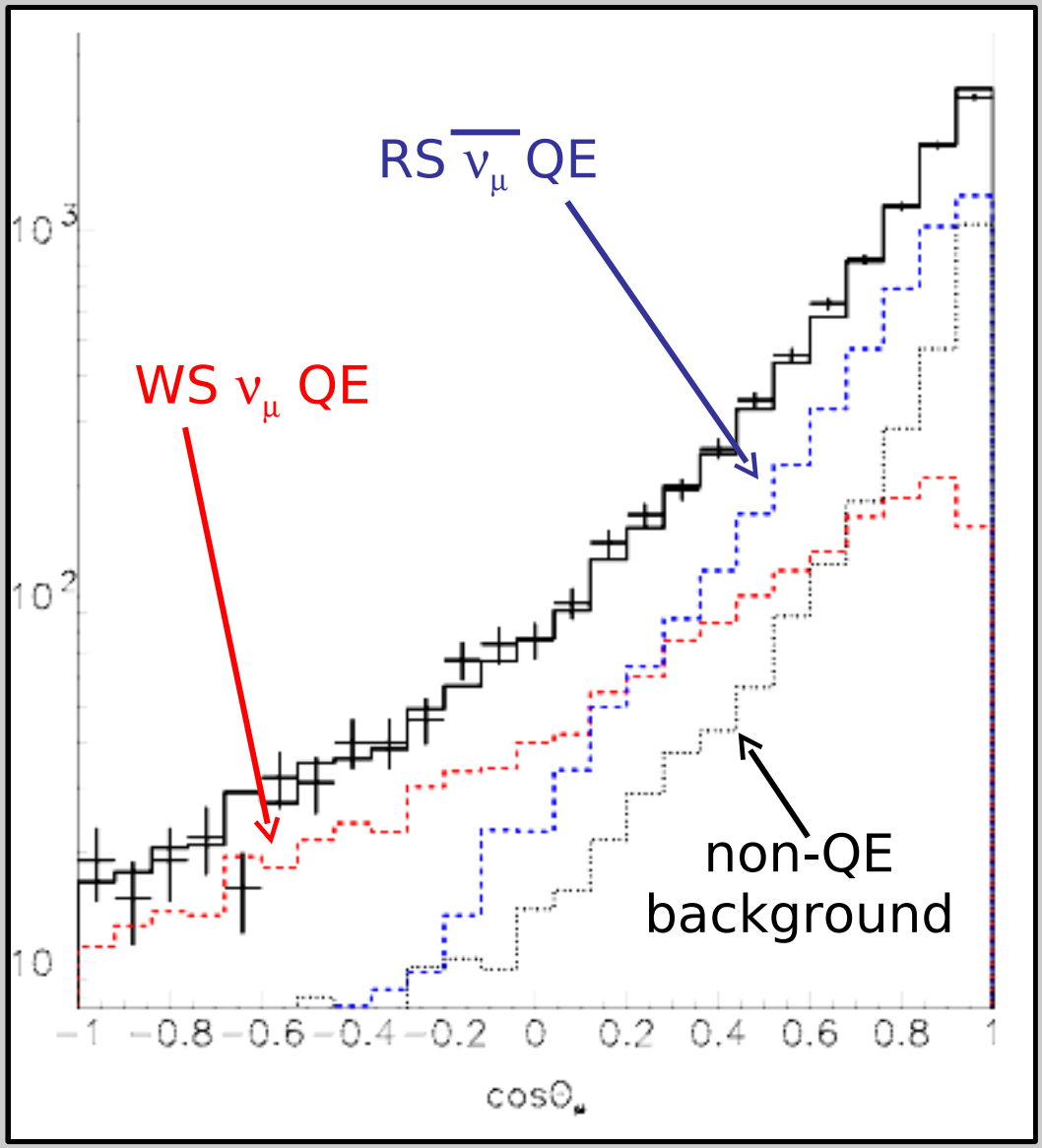
CCQE Neutrino Energy Distribution

- CCQE (single muon) large stats sample and good energy/angle reconstruction.
- MC reweighted according to fraction of events with one and both plates in beam
- Relative normalization



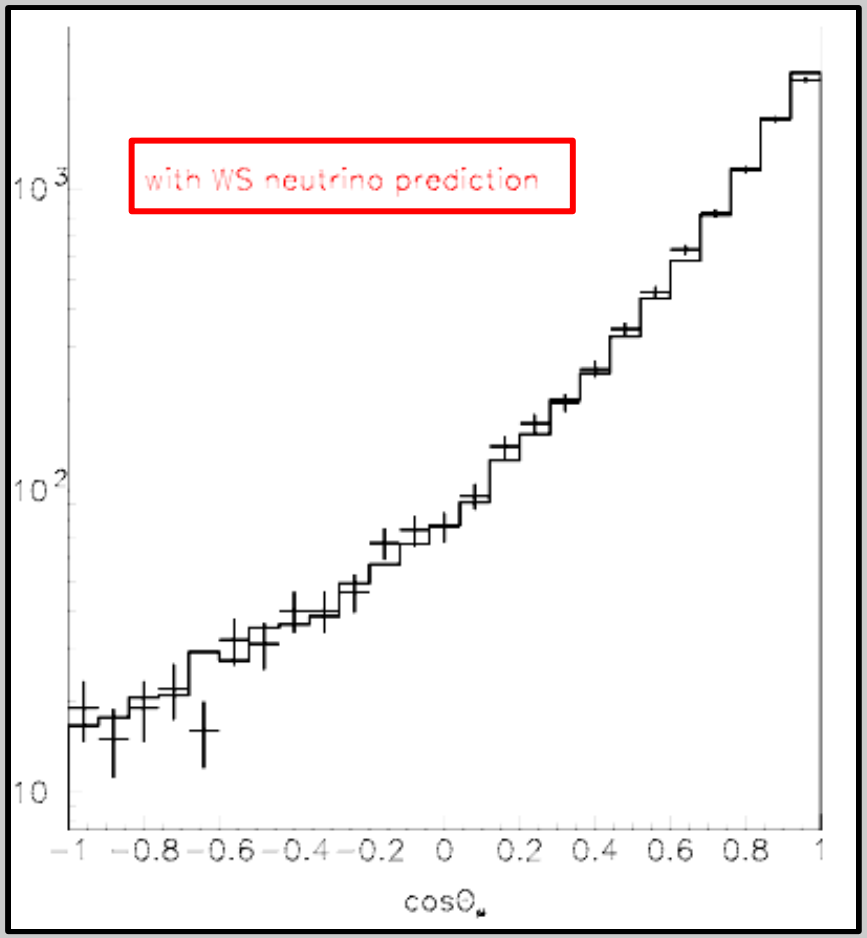
CCQE Muon Angular Distribution

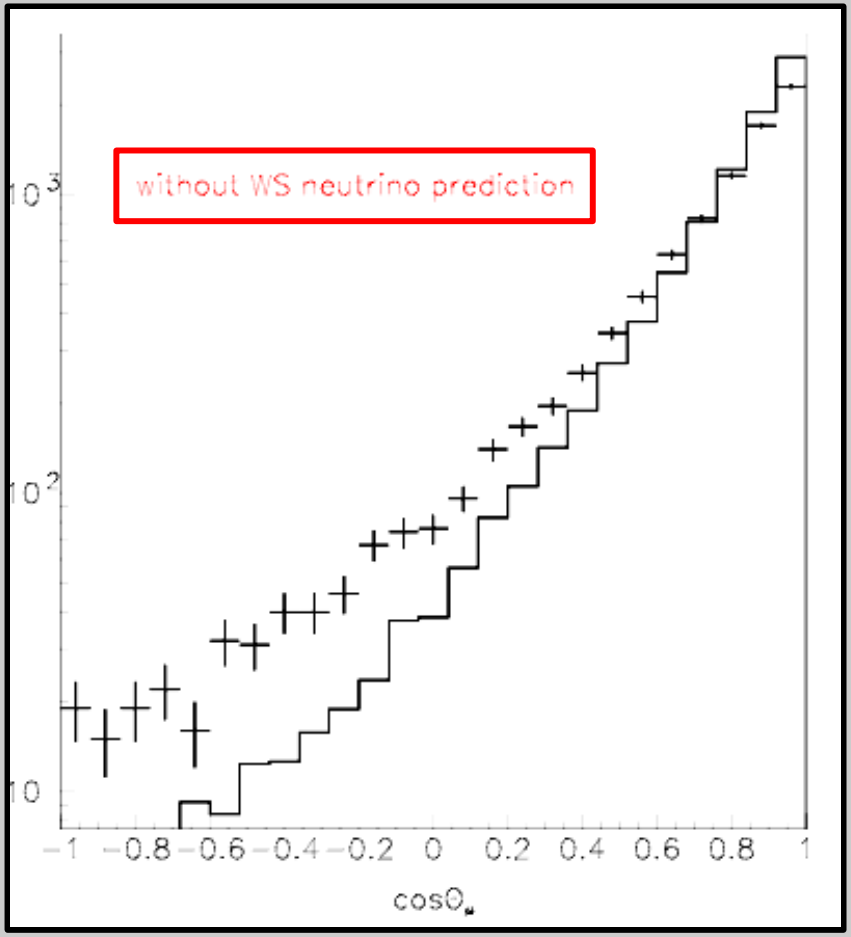
- this is the distribution that can tell us about WS (neutrino) content in the beam
- plot shows our default MC predictions (27% WS)
- current WS prediction does not seem far off



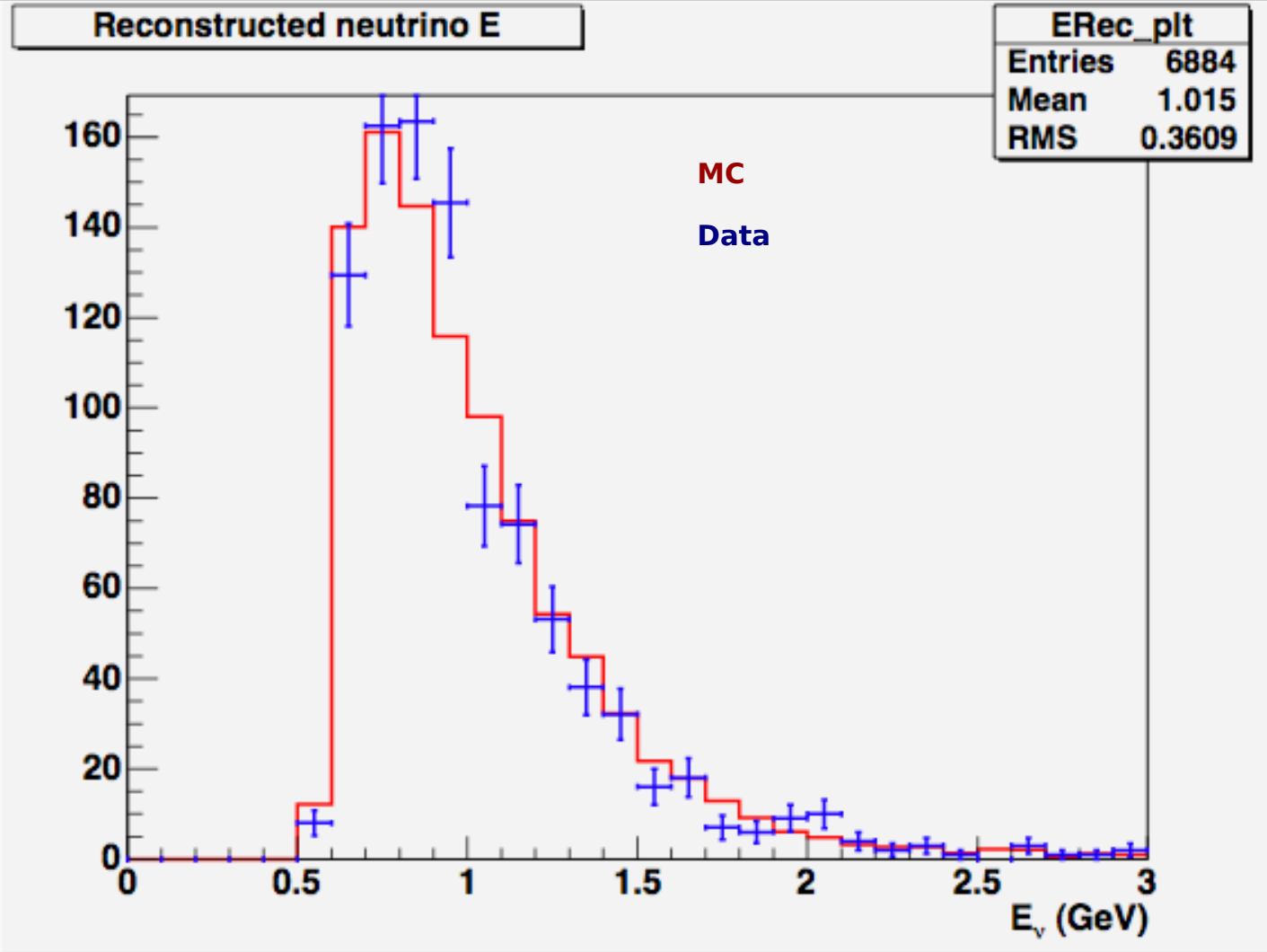
CCQE Muon Angular Distribution

- can get some sense of our sensitivity to WS content
- both relatively normalized to the data (1.5 x 10^{20} POT)

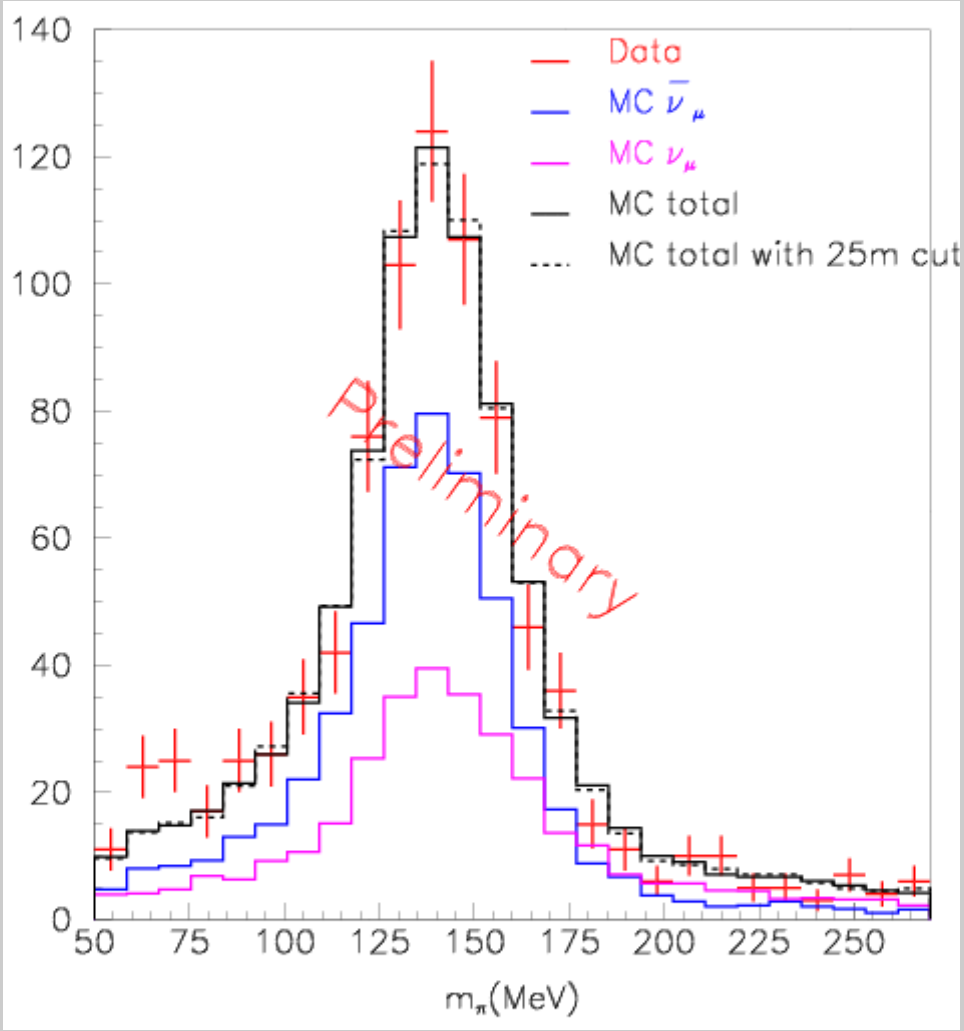




CCPi+ Reconstructed neutrino energy

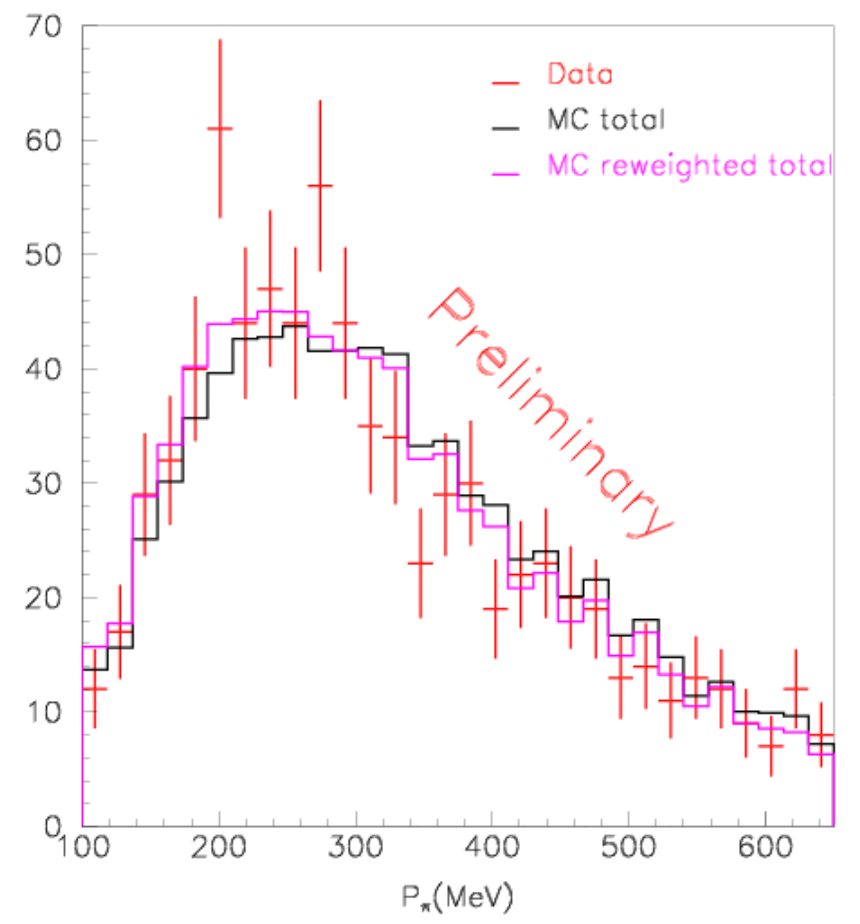


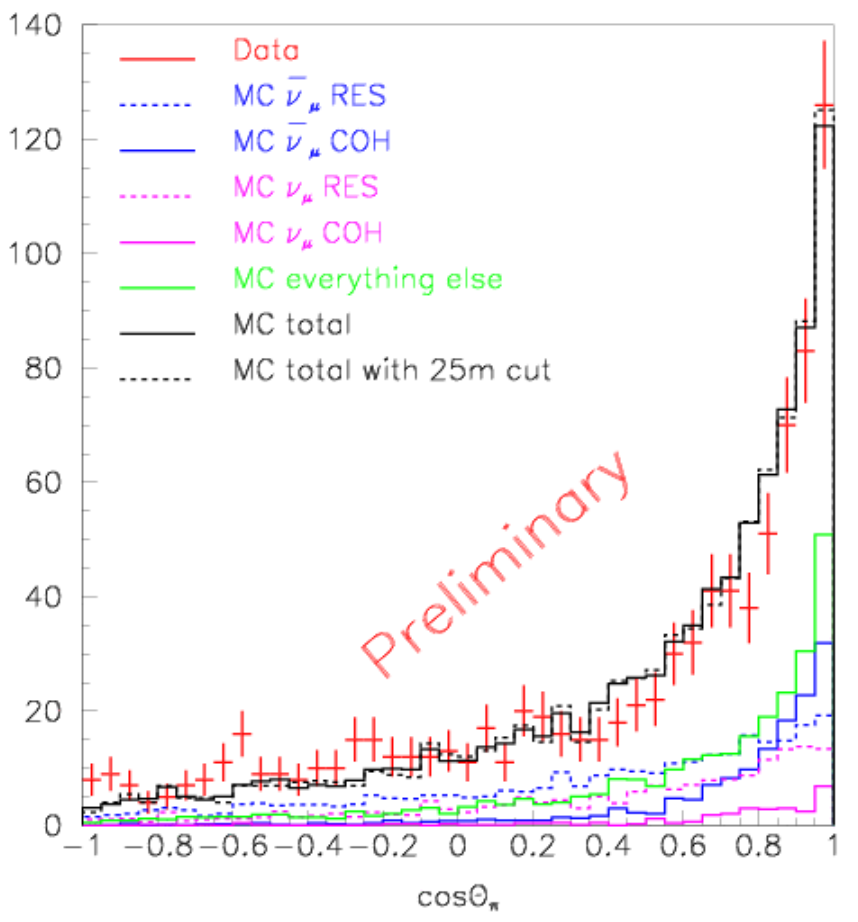
π^0 Reconstruction



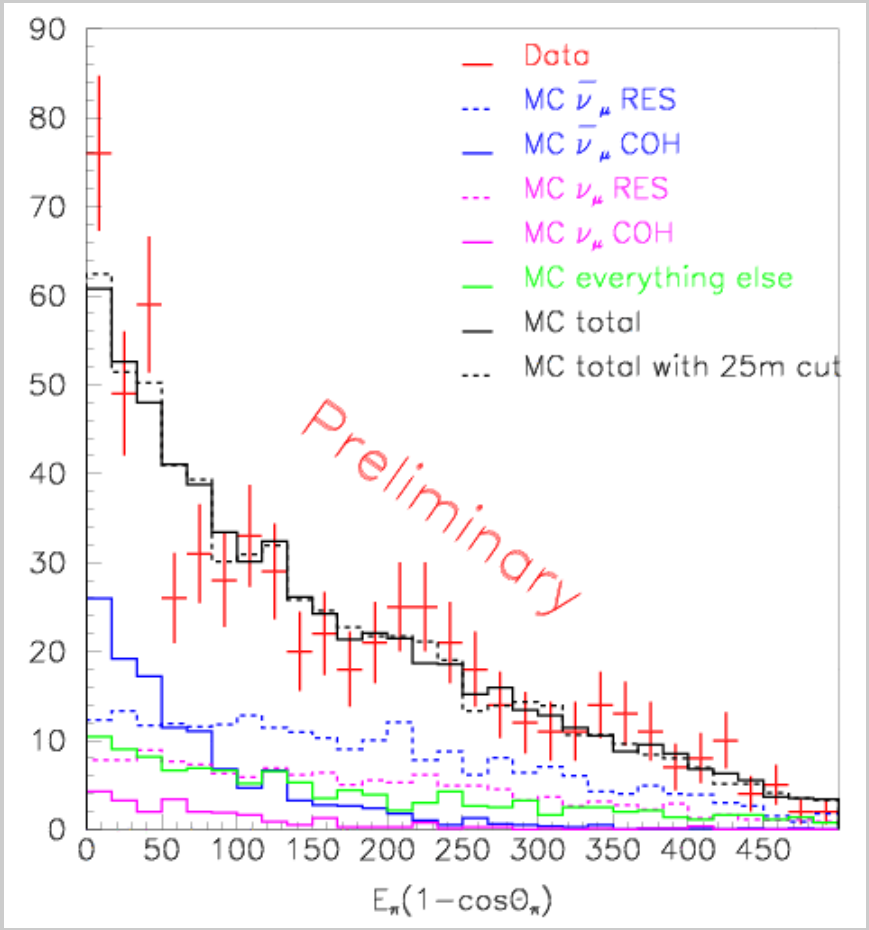
Reconstruct ~900 events, which is consistent with expectation.

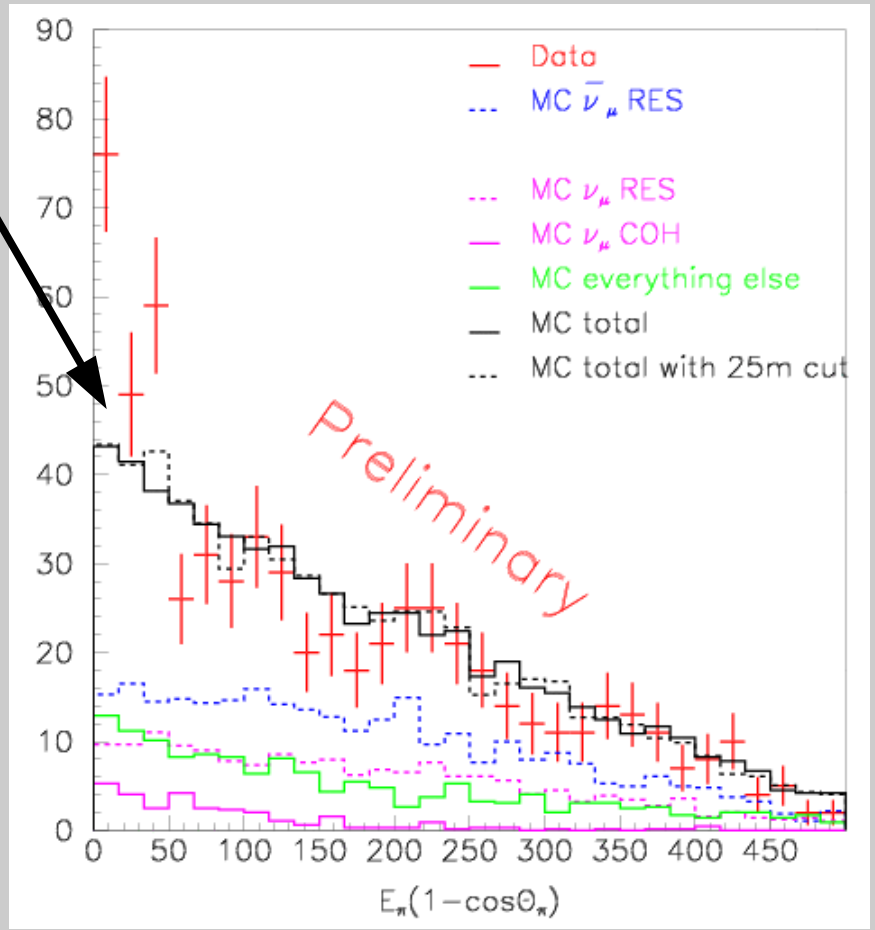
π^0 Kinematics





Suggestive of antineutrino
NC coherent π^0 production





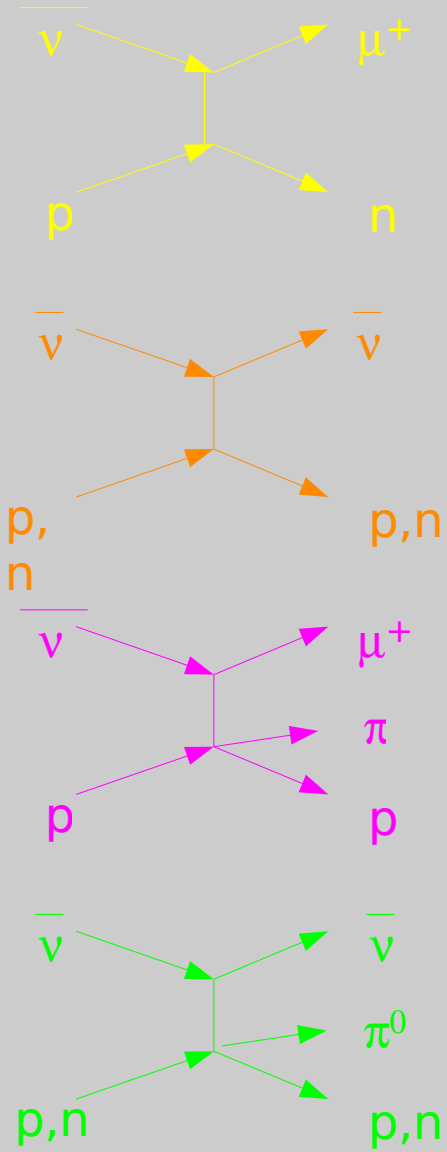
No $\bar{\nu}_\mu$ COH contribution

Summary of MiniBooNE Antineutrino Running

- Projected to be back online mid April (12th) in 50m configuration.
  - Much thanks/appreciation to Accelerator Division for professional and speedy repair!
- Antineutrino mode POT totals to date:
  - 0.2E20 POT no absorber.
  - 0.7E20 POT absorber #10 down.
  - 0.6E20 POT absorber #10 and #7 down.
- Plan is to collect 0.6-0.9E20 POT in antineutrino mode (no absorber), to give a total ~2E20POT.
- Continue work on understanding antineutrino data, which looks promising.
- Stay tuned for April 11th osc analysis presentation.

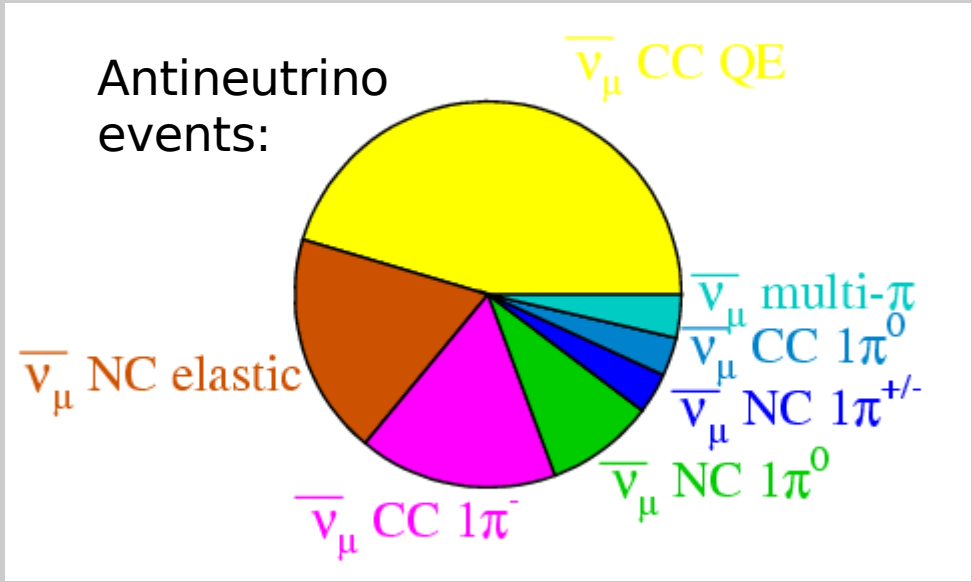
Backup Slides

Event Rates for 2×10^{20} POT:



CCQE	32,500
NC elastic	13,300
CC π^-	11,900
NC π^0	6,500

Reconstruction with R<550cm



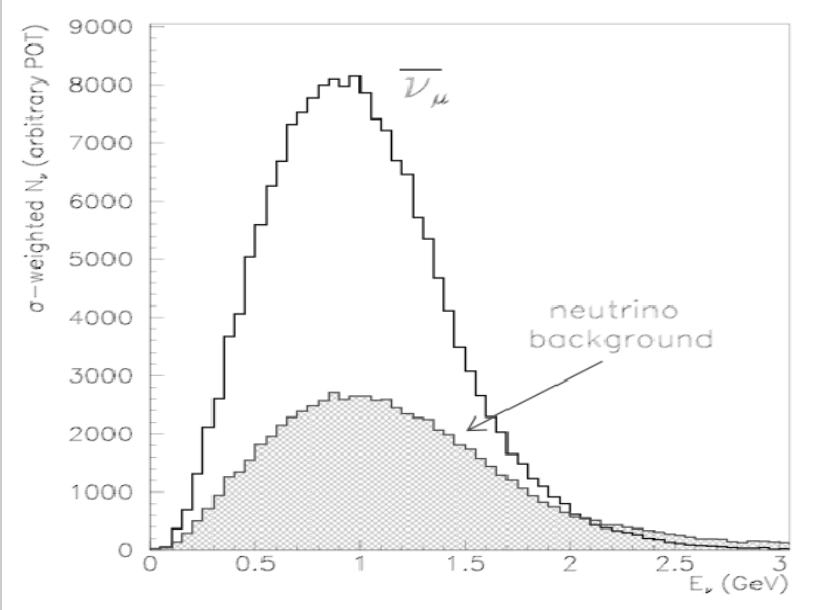
To date all anti-neutrino beams suffer from neutrino (aka ''wrong-sign'') background

Why?
Because the leading + charged particle is hard to defocus

At MiniBooNE:

	$\bar{\nu}$	ν
CCQE	32,500	11,200
NC elastic	13,300	4,700
CC π^-	11,900	0
CC π^+	0	7700
NC π^0	6,500	2,200

(Reconstruction with R<550cm)

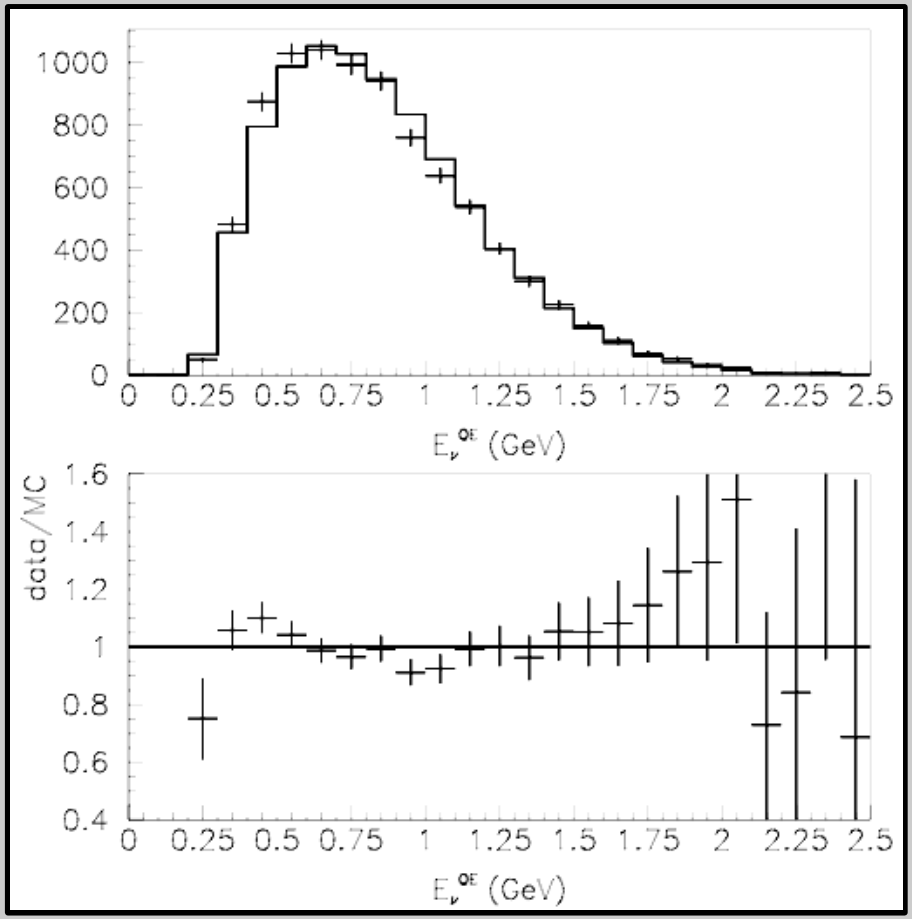
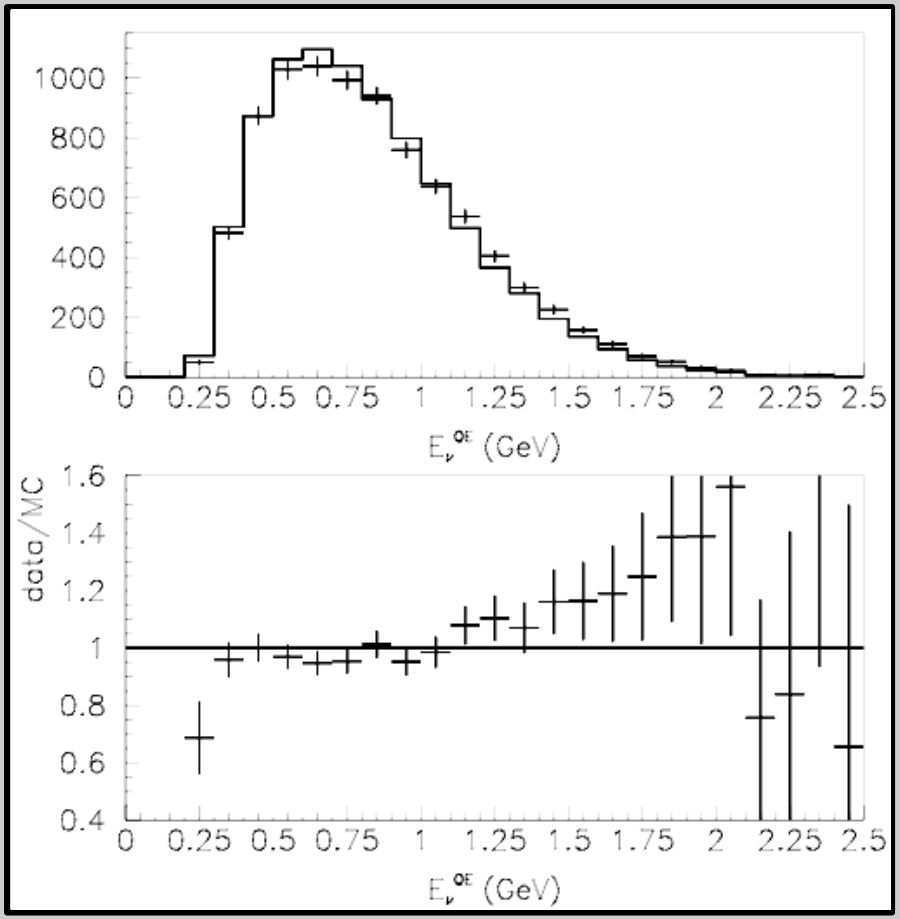


Compare to ~2% WS contamination in neutrino mode

- Have developed a method to reduce WS error on xsec to 2%
  - THIS IS CRUCIAL TO OUR PHYSICS GOALS

Estimating Effect of Absorber Plates

MC with no absorber plates:



MC reweighted according to fraction of events with one & both plates in beam: