

SciBooNE: Motivation, Construction and Preliminary CCQE Analysis

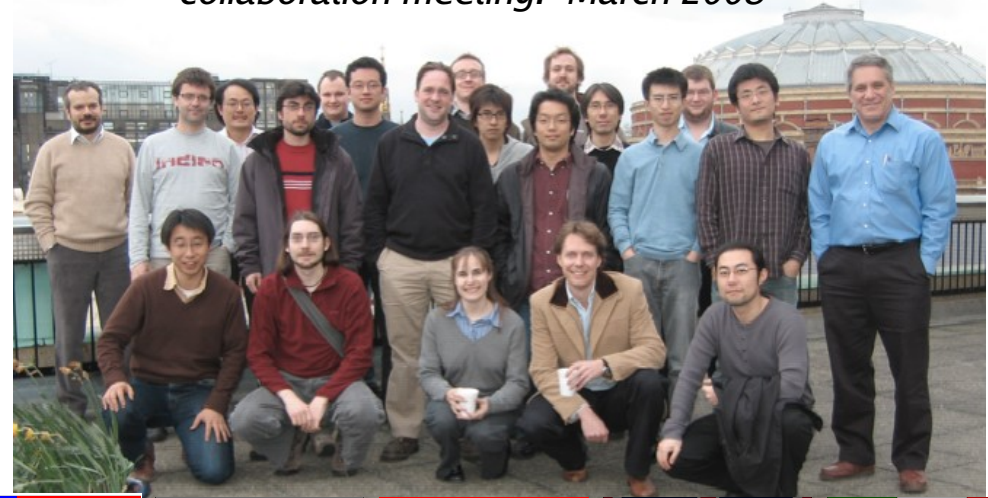
IOP HEPP Conference
March 31st – April 2nd 2008

Joseph Walding
Imperial College London

Outline

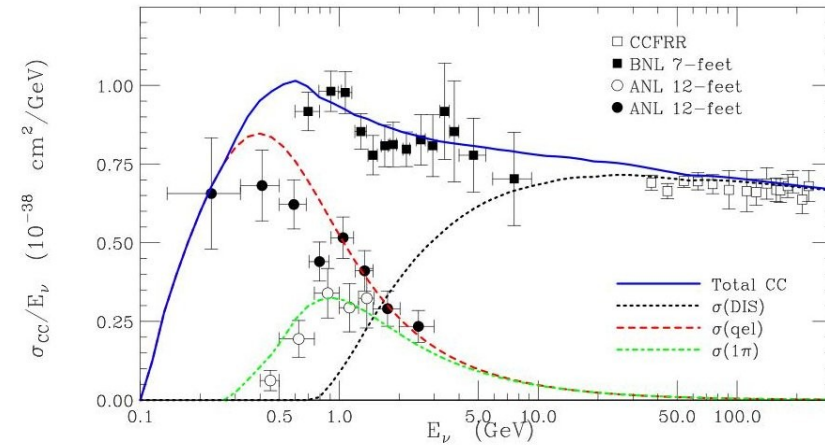
- Motivation for SciBooNE
- SciBooNE: The Detector
 - SciBar
 - Electron Catcher
 - Muon Range Detector
- Construction
- Data Targets
- Preliminary CCQE Analysis

The SciBooNE collaboration at the last collaboration meeting. March 2008

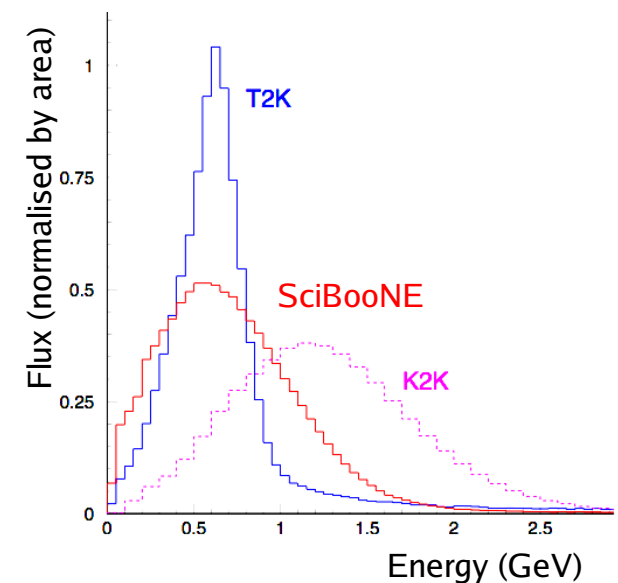


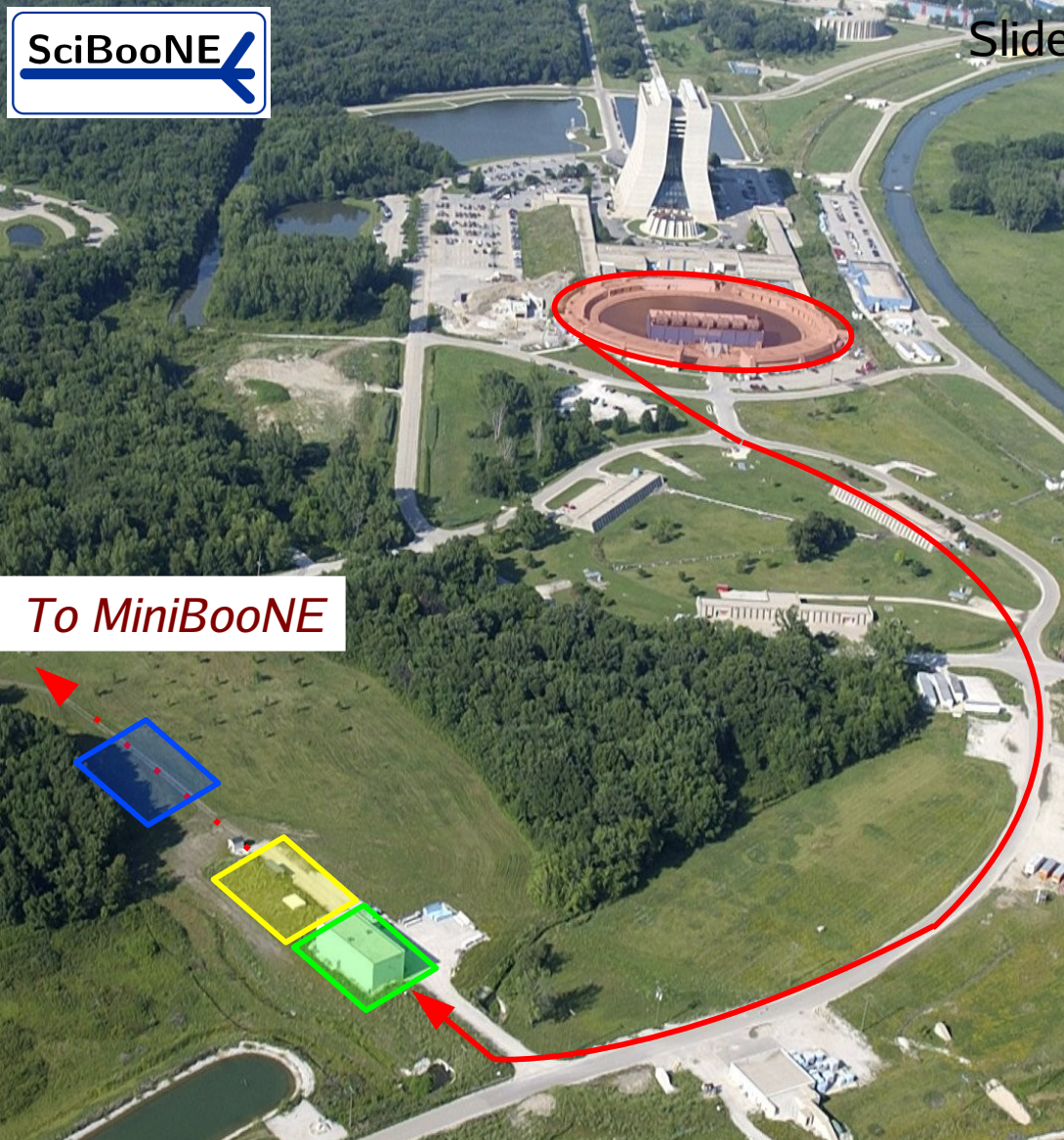
Motivation for SciBooNE

- SciBooNE: A 'ν' experiment at Fermilab
- Aim to measure sub-GeV ν_μ & $\bar{\nu}_\mu$ cross-sections
 - Few measurements in region, all low statistics (below right)
- T2K beam flux peak energy same as Booster neutrino beam (top right)
 - Measurement very useful for T2K
 - Independent data set
- SciBooNE also a MiniBooNE near detector
 - ν_e appearance/backgrounds
 - ν_μ disappearance/normalisation



Lipari et al. *arXiv:hep-ph/0207172*





Booster Proton accelerator

- 8 GeV protons sent to target

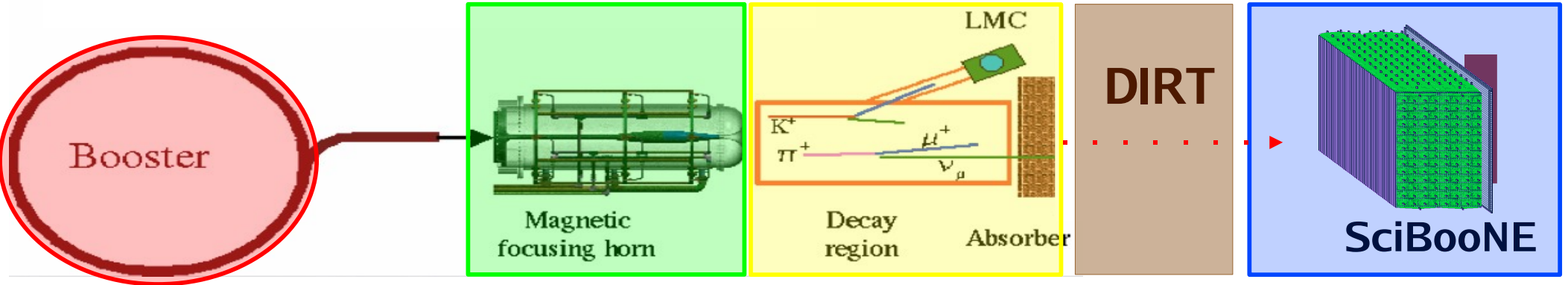
Target Hall

- Beryllium target: 71cm long 1cm diameter
- Resultant mesons focused with magnetic horn
- Reversible horn polarity

50m decay volume

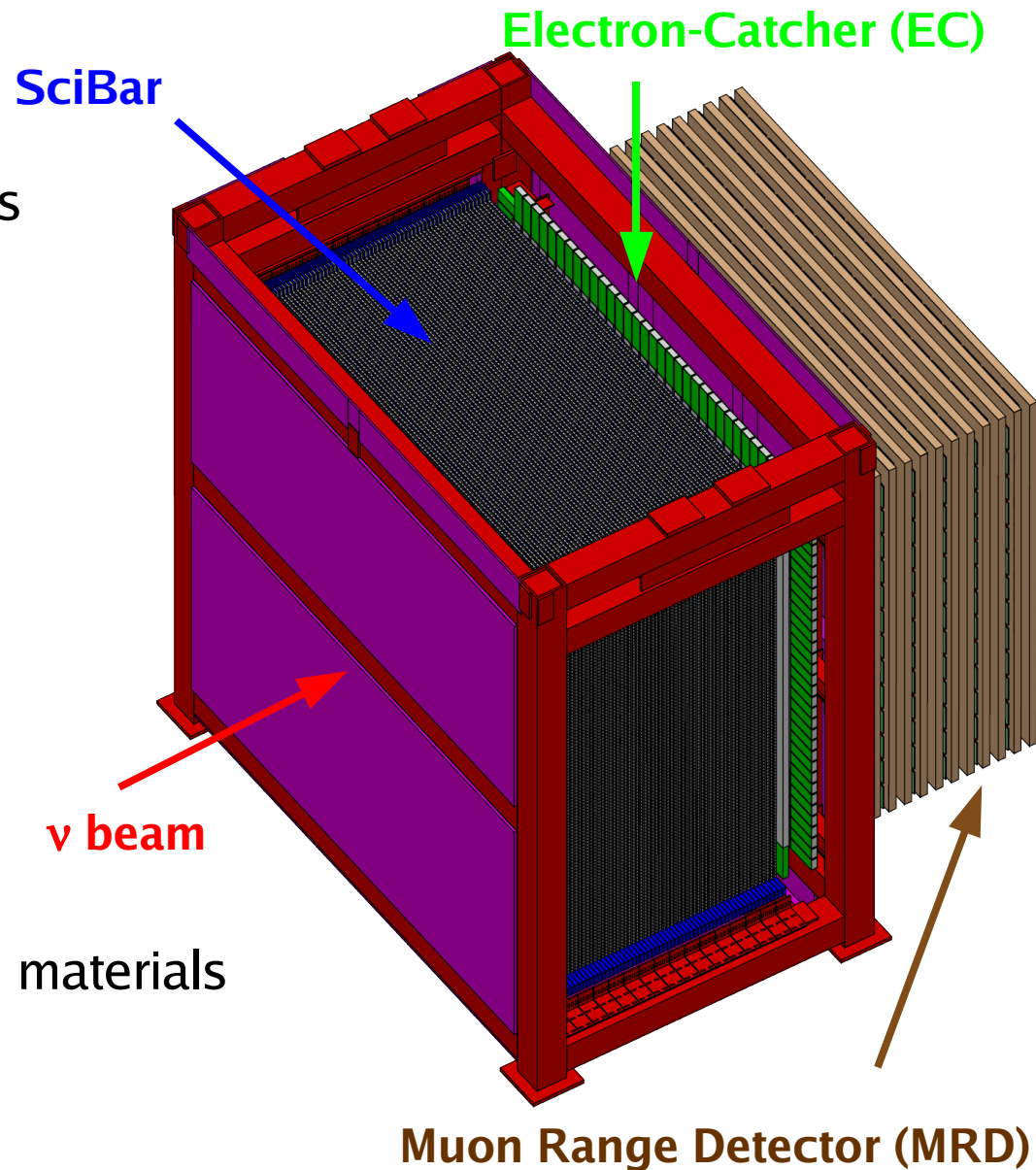
- Mesons decay to μ & ν_{μ}
- Short decay pipe minimises $\mu \rightarrow \nu_e$ decay

SciBooNE located 50m from Absorber



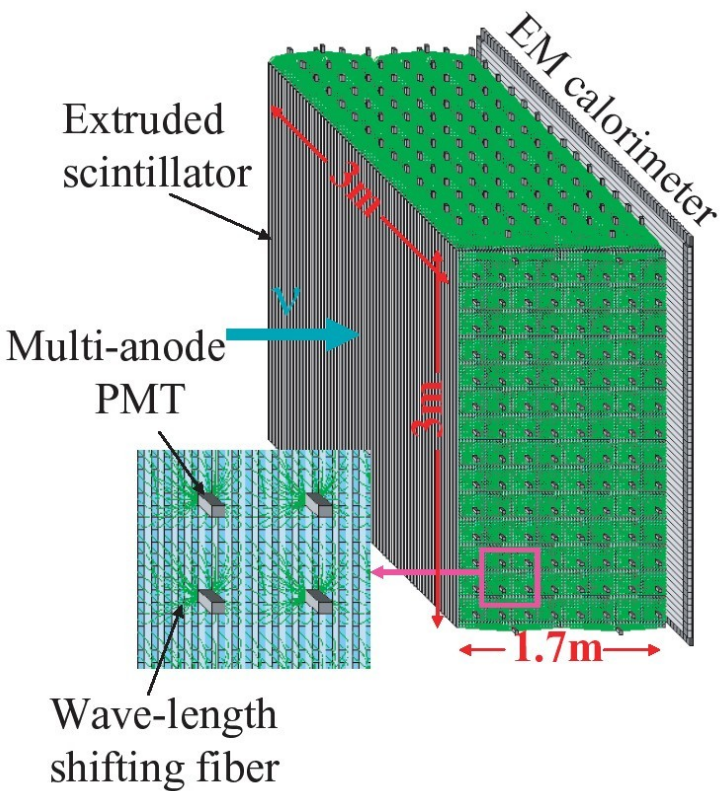
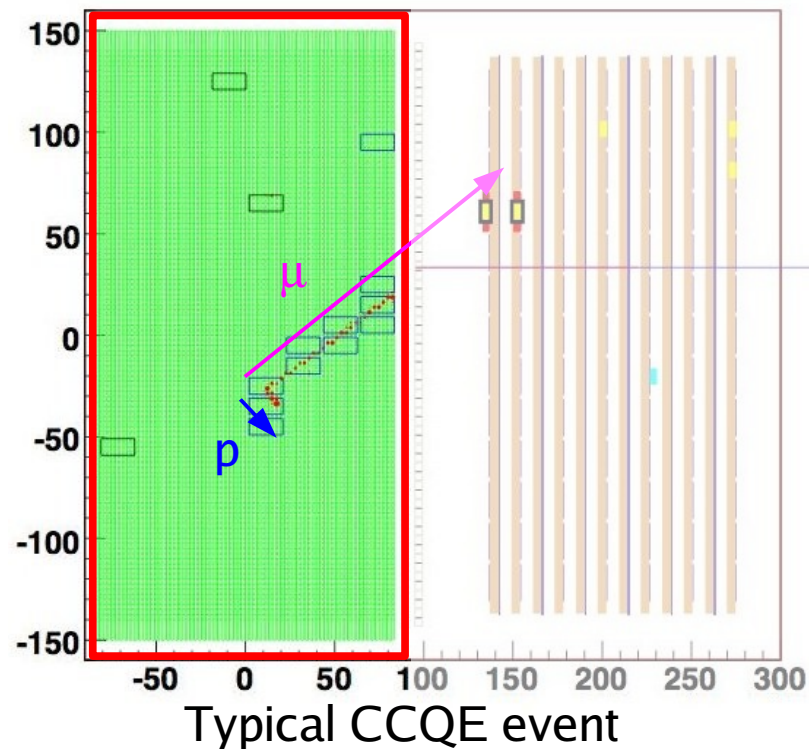
SciBooNE: The Detector

- SciBooNE consists of 3 sub-detectors
- **SciBar**
 - Used in K2K
 - Shipped from Japan to Fermilab
- **Electron-Catcher (EC)**
 - Used in CHORUS & K2K
 - Shipped from Japan to Fermilab
- **Muon Range Detector (MRD)**
 - 'New' detector built from recycled materials



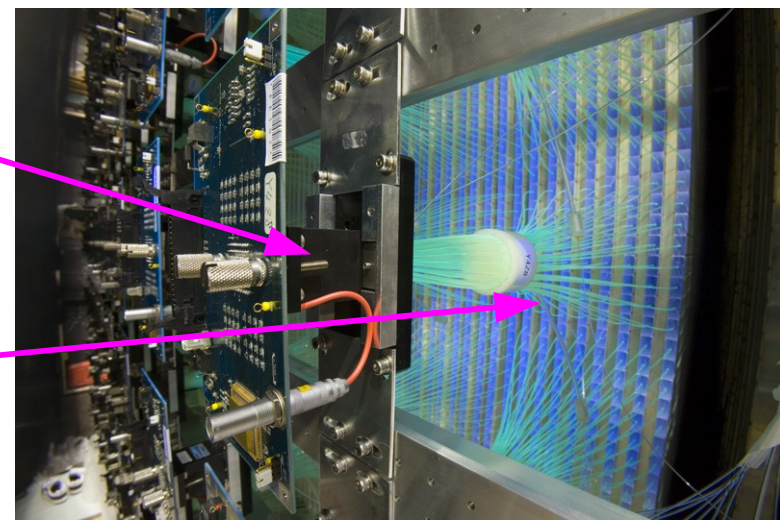
SciBar

- Extruded scintillators
 - Wavelength-shifting (WLS) fibre readout
- Fully active detector
 - Scintillator is the neutrino target
- Total mass: 15 tons
 - Fiducial volume: ~10 tons
- Identify short tracks (>8cm)
- Distinguish a proton from a pion by dE/dx



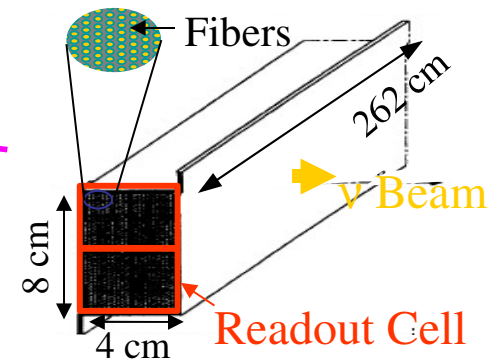
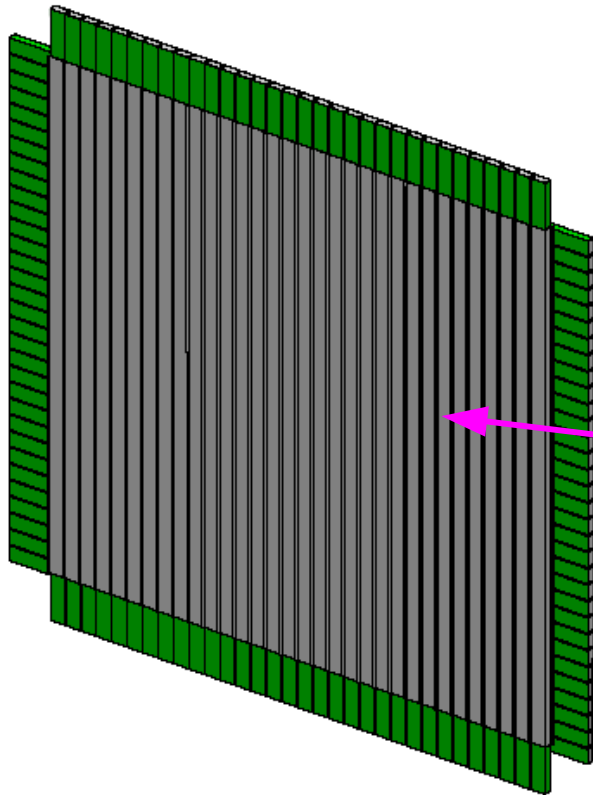
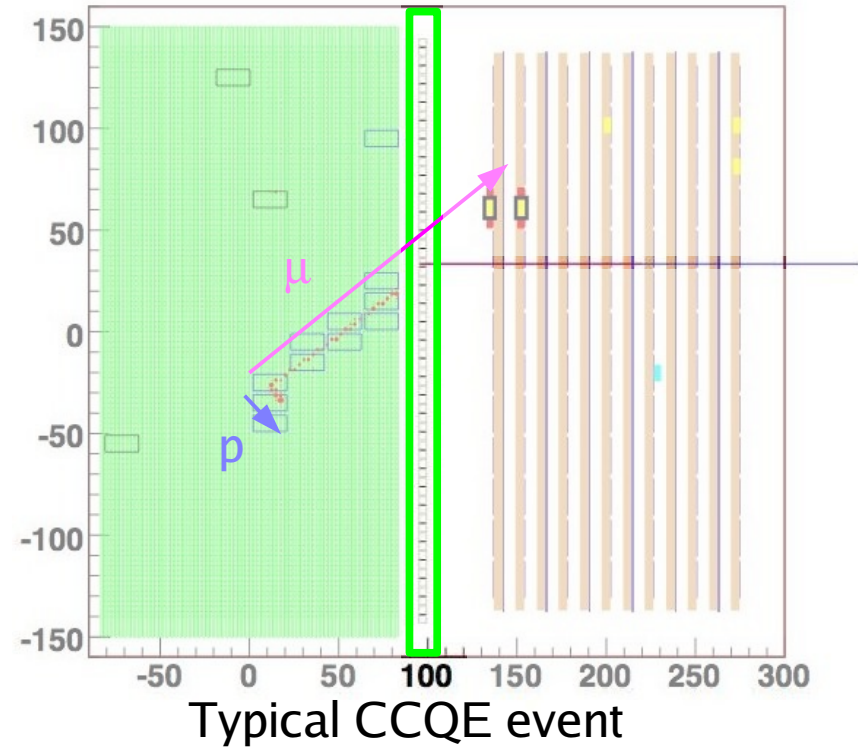
64 channel multi-anode PMT

WLS fibres



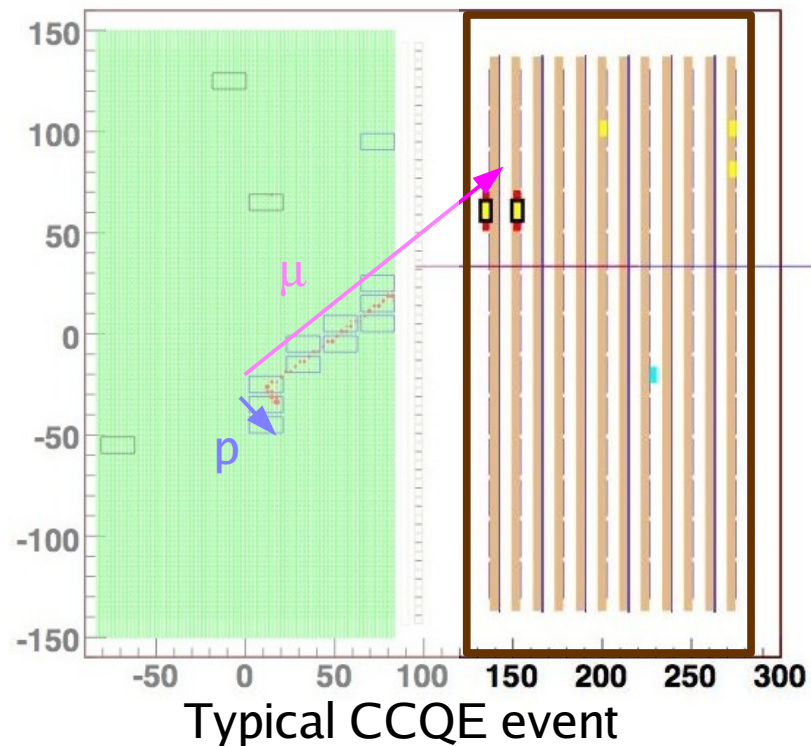
Electron-Catcher (EC)

- Gamma and electron identification (ν_e & π^0)
- “Spaghetti” calorimeter
- 2 planes (X & Y) \equiv $11X_0$

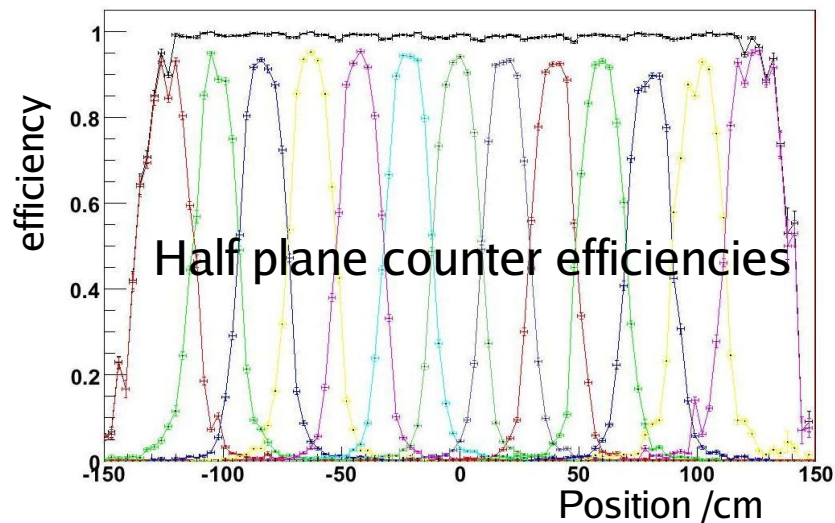


Muon Range Detector (MRD)

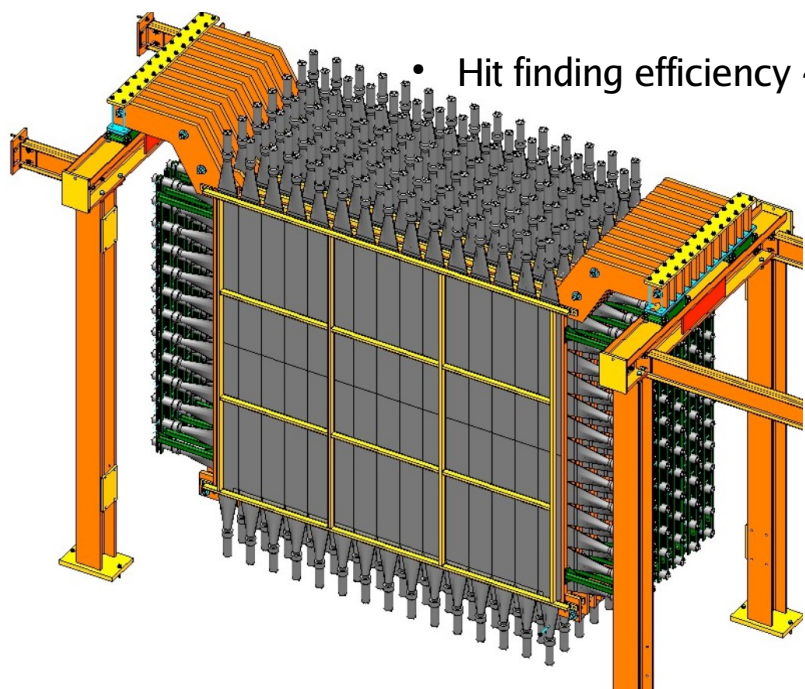
- The MRD reuses Fermilab materials
- Second-hand: Iron, scintillator, PMTs, electronics, signal cables and high voltage cables
- Ranging used to reconstruct muon energy
 - 13 alternating X & Y planes
 - 60cm iron total depth
 - MRD stops muons with momentum $< 1.2 \text{ GeV}/c$
- Total ~ 55 tons
 - Large sample of CC events on iron



View:0, Layer:1, Side:0



• Hit finding efficiency ~99% (see below right)



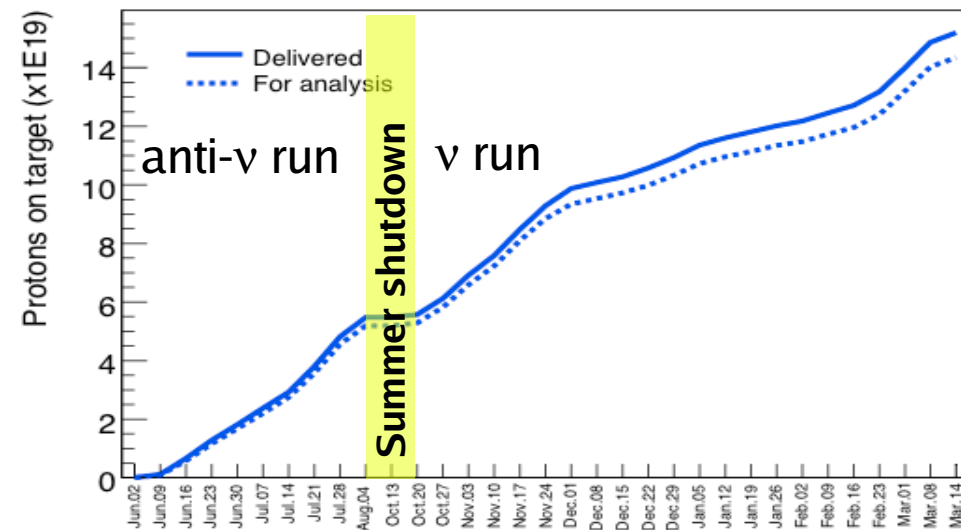
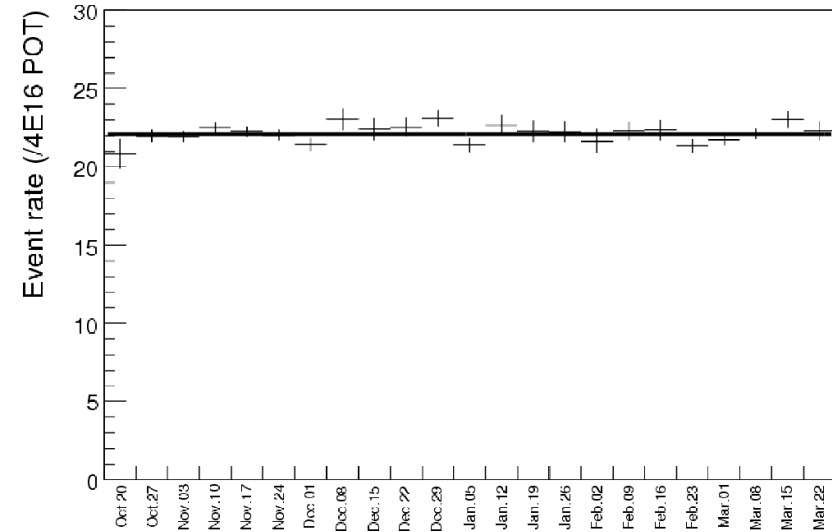
Construction

- SciBooNE Timeline
 - SciBooNE proposal Dec '05
 - MRD counter construction began June '06
 - SciBar & EC arrived at Fermilab July '06
 - Detector Assemblies completed March '07
 - Detectors moved to experiment hall April '07
 - anti-v run began June '07
 - v run began October '07
 - Completion of run by ~August '08

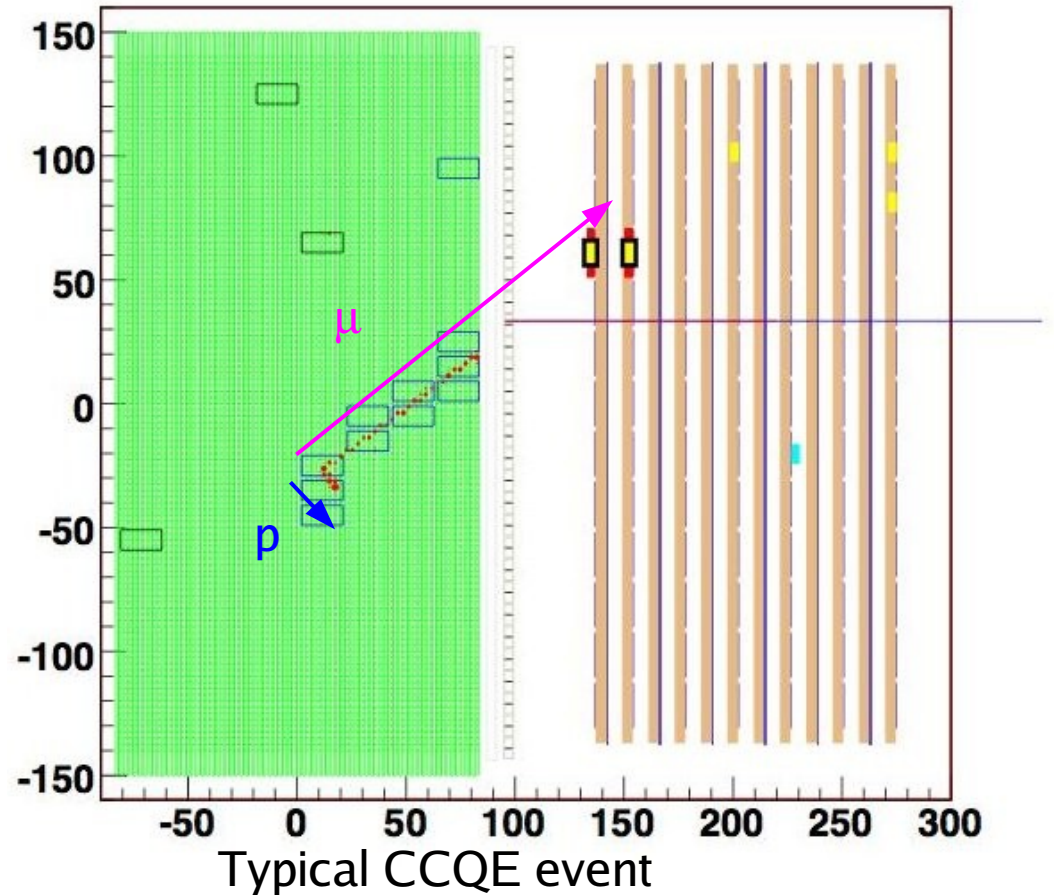
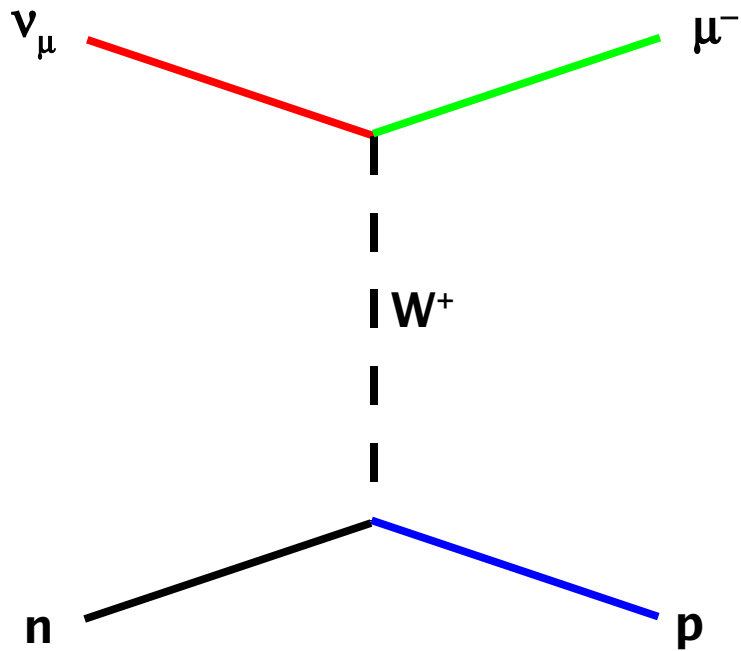


Data Targets

- Projected 2×10^{20} Protons on Target (POT)
- So far received 1.48×10^{20} POT
 - $\bar{\nu}$: 0.54×10^{20} (goal 1×10^{20})
 - ν : 0.94×10^{20} (goal 1×10^{20})
- Event rate/POT very stable
- Switch back to $\bar{\nu}$ mode in next month
- 94% average detector live time



Preliminary Charged Current Quasi-Elastic (CCQE) Analysis

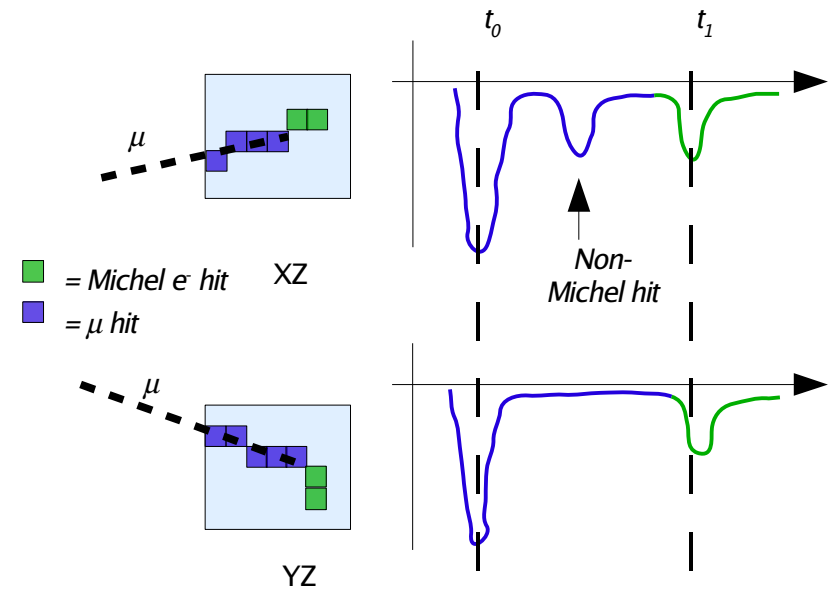
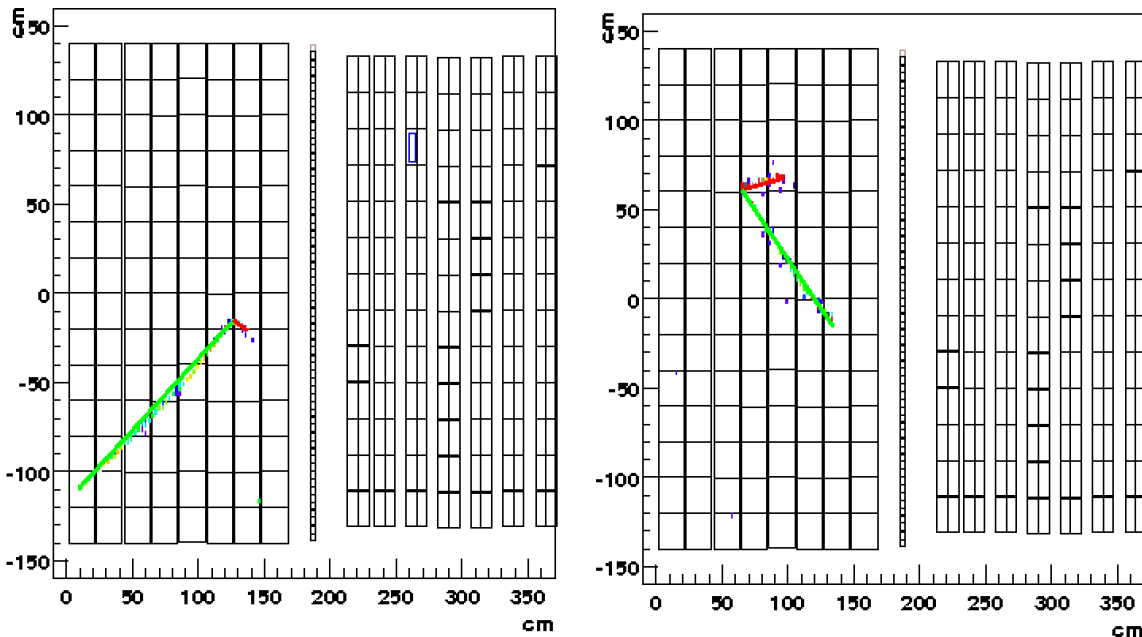


- Important: CCQE is process used for oscillation searches
- Clean process: ν energy easily reconstructed from μ

Preliminary CCQE Analysis

- 2 Charged Current Quasi-Elastic (CCQE) analyses in SciBooNE
 - MRD stopped muon
 - SciBar stopped muon (my analysis)
- Started looking at 2 track contained CCQE sample
 - Two types of 2 track CCQE events
 - Muon and Michel electron (below left)
 - Proton & muon (below right)

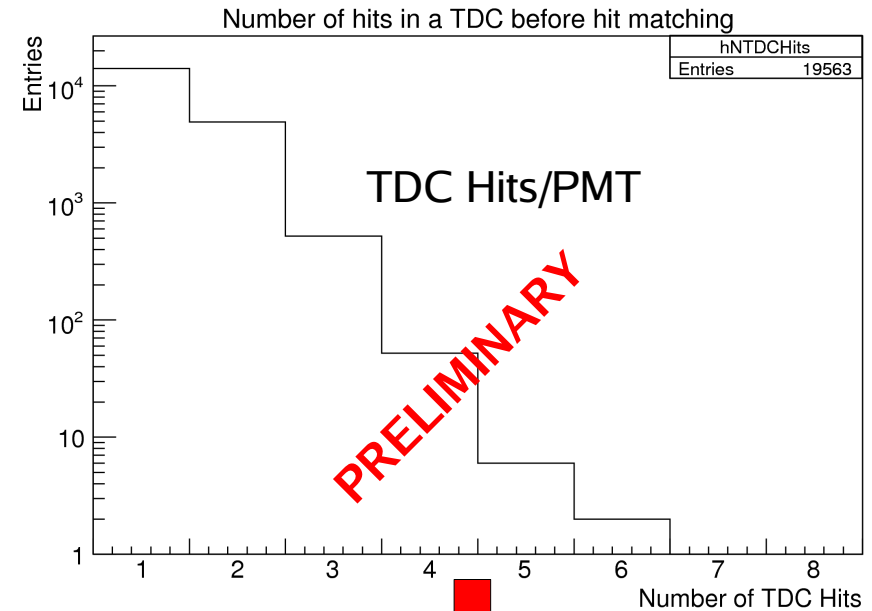
- SciBar stopped muons are tagged using Michel electrons
 - Identify Michel using timing information
 - Match hits using coincidence between top and side views to remove background hits (below)



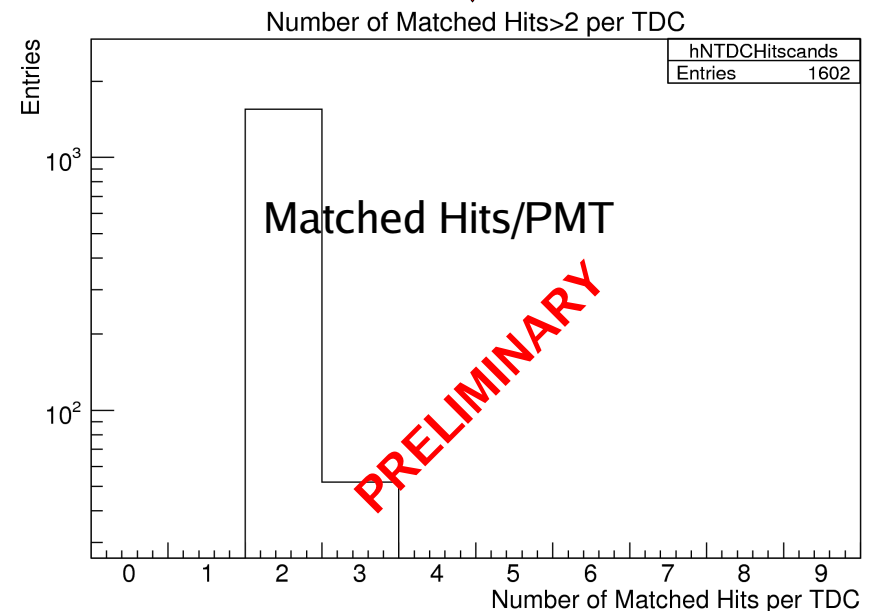
Preliminary CCQE Analysis

Thu Mar 27 08:08:43 2008

- 7.67×10^{19} POT ν data used
- No systematic errors shown
- For hits to be matched the separation time between in both views < 20 ns
- This projection matching removes almost all non-Michel e^- hits
- Remove some of the $CC1\pi$ background by removing double Michel events



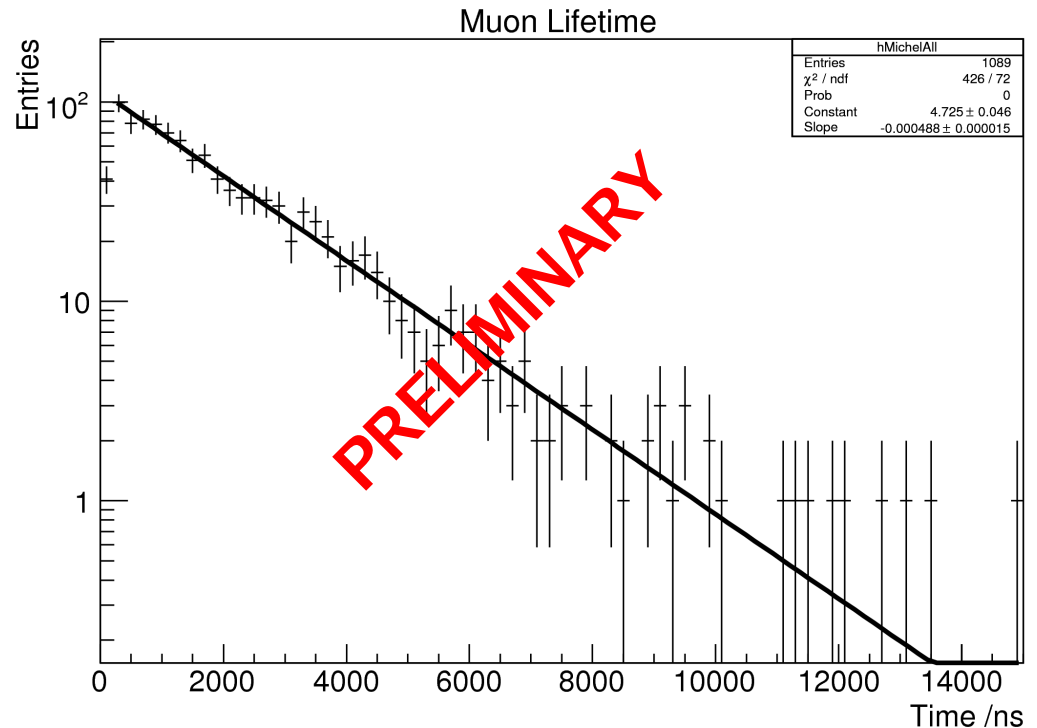
Thu Mar 27 10:40:57 2008



Preliminary CCQE Analysis

Thu Mar 27 07:51:17 2008

- Muon lifetime
 - $\tau_{\mu} = 2.049 \pm 0.060(\text{stat}) \times 10^{-6} \text{s}$
 - c.f. $2.0263 \pm 0.0015 \times 10^{-6} \text{s}^*$
 - Agrees with muon capture value
- *Suzuki et al. Phys. Rev C. 35 (1987) 2212-2224
- TDC deadtime 50-100ns
 - Fit starts from 100-200ns bin



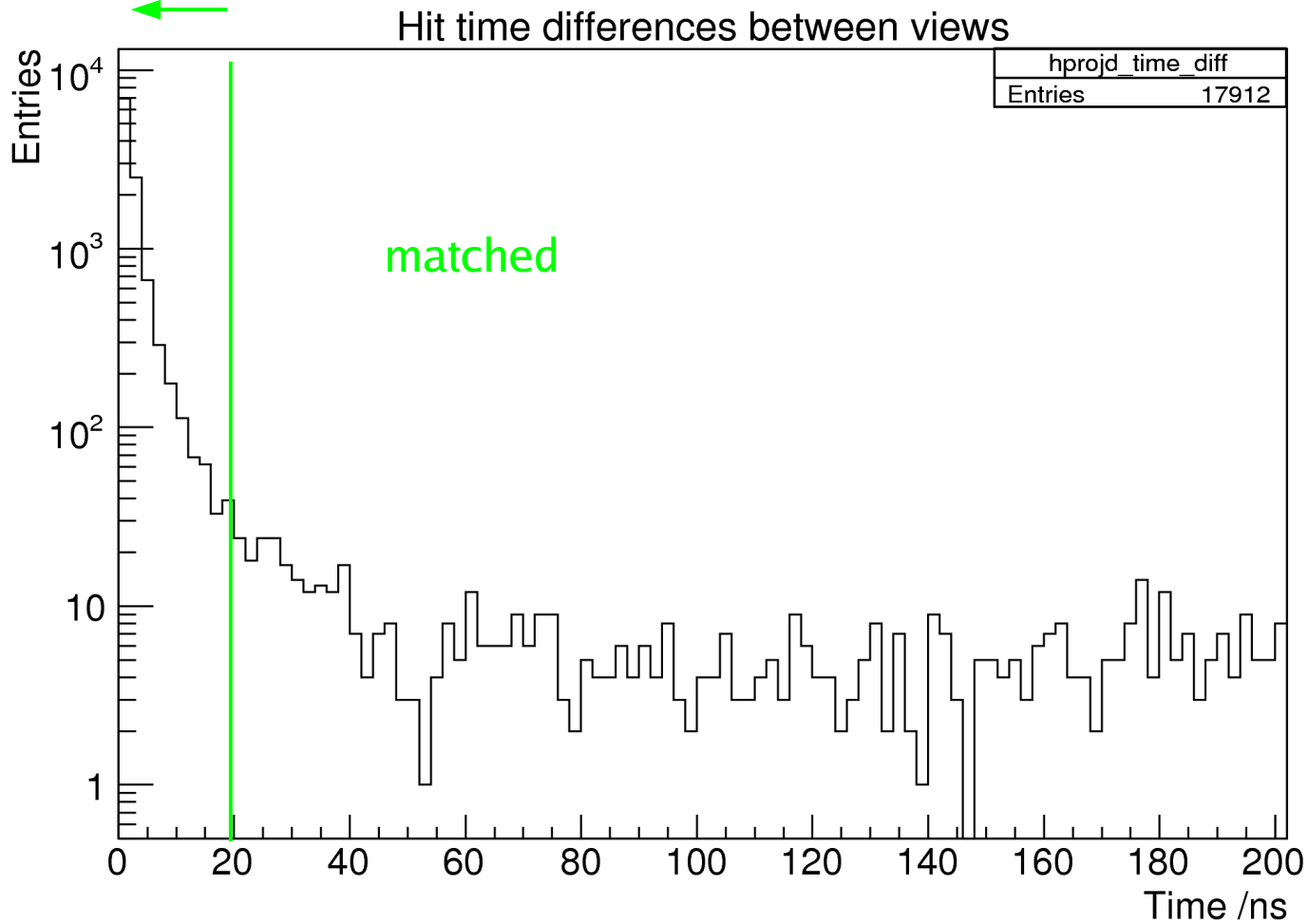
Summary

- SciBooNE is the new neutrino experiment at Fermilab
- Goal: To measure sub-GeV ν_{μ} & $\bar{\nu}_{\mu}$ cross-sections
- $\frac{3}{4}$ of all data already taken
- Contained muon CCQE analysis has been started
 - CCQE important for oscillation searches
- Goal: Measure CCQE cross-section to $\sim 10\%$

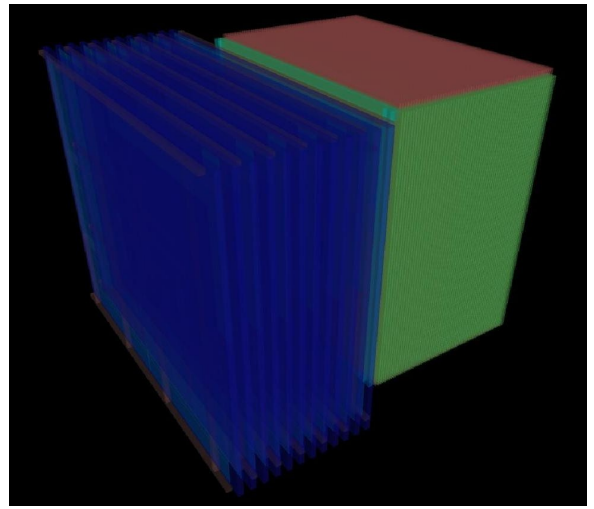
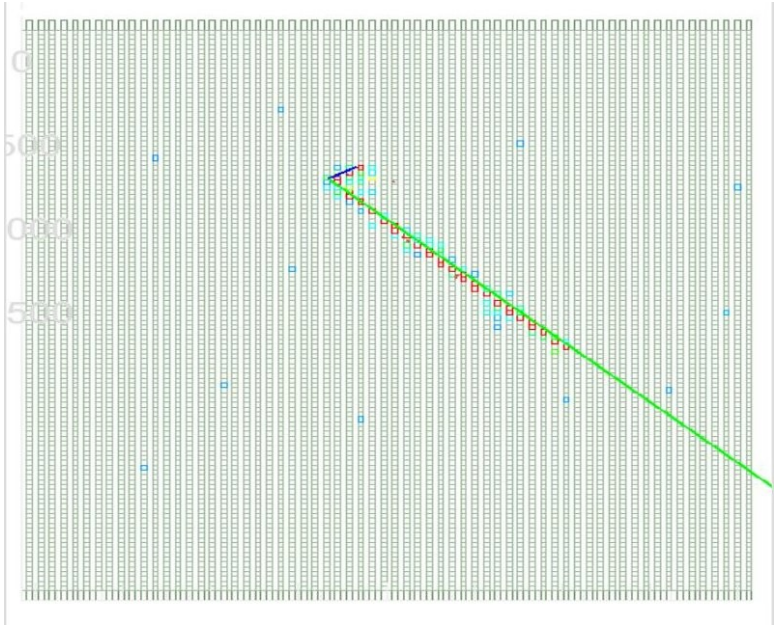
Backup Slides

View Matching

Thu Mar 27 07:55:29 2008



SciBooNE in T2K



31st March 2008

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