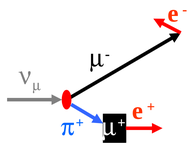
Current Generation Low Energy Cross Section Measurements: SciBar and MiniBooNE

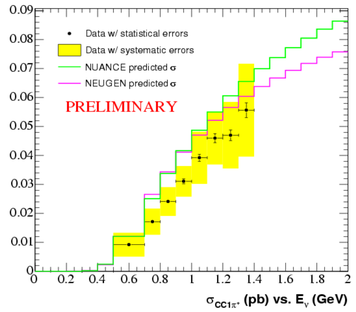
CC π^+

M. Wascko

Motivation
- Understand delta production in detector ($\Delta \rightarrow N\gamma$ background)
- Largest background to CCQE (large σ, ½ rate of QE)
- 25% of total event rate



Event Selection
- 3 subevents
- μ- & π^+, μ- → e- , π^+ → μ+ → e+
- 1st subevent in time with beam, tank hits > 175, veto hits < 6
- 2nd , 3rd subevents electron like 20< tank hits < 200, veto hits < 6
- 84% pure (Nπ, QE background)
- ~ 36,000 CCπ^+ events (5x more)



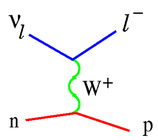
$\sigma_{CC\pi+}$ (pb) vs E_ν (GeV)

First CCπ^+ σ measurement at low E on a nuclear target!
Coherent and resonant, separate results

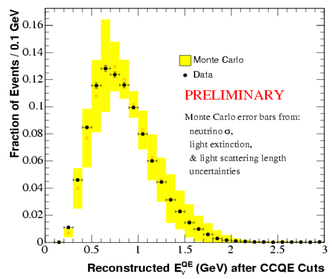
CCQE

J. Monroe

Motivation
- Oscillation signal channel with ~ 10% neutrino energy reconstruction at 1 GeV
- 40% of total event rate



Event Selection
- 2 subevents (μ, decay e)
- 1st event in time with beam (tank hits > 200, veto hits < 6)
- 10 variable Fisher discriminant includes:
  - Fraction of light on vs off ring
  - Fraction of prompt vs late light
  - μ-like (track and energy consistent)
- 86% pure (CC π^+ background)
- ~ 60,000 CCQE events



E_ν QE (GeV) in events/ 0.1 GeV

Search for $\nu_\mu \rightarrow \nu_x$ oscillations
Normalization sample for cross sections
constrain ν_e background from beam muon decay

MiniBooNE

Beam
- 8 GeV protons on Be target
- $<E_\nu> = 0.7$ GeV
- Change horn polarity for ν, $\bar{\nu}$ modes

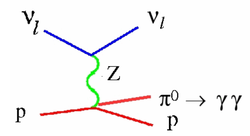
Detector
- 12 m diameter, 800 ton mineral oil (CH_2) tank
- 1280 inner PMTs, 240 veto PMTs
- Events produce prompt Cherenkov light and delayed, isotropic scintillation light
- A "subevent" is cluster of tank activity in time

650,000 ν events and counting!

NC π^0

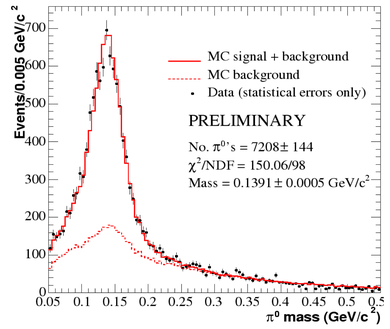
J. Raaf, J. Link

Motivation
- Important background to oscillation analysis (γ from π^0 mimics ν_e)
- 7% total event rate



Event selection
- 1st subevent in time with beam, tank hits > 200, veto hits < 6
- 2 rings (not decay e) w/ E > 40MeV
- Opening angle cut
- 55% pure
- signal extraction using the π^0 mass peak gives 100% pure π^0 data set

Largest sample to date (~ 7000)
Coherent/ resonant NC π^0 ratio



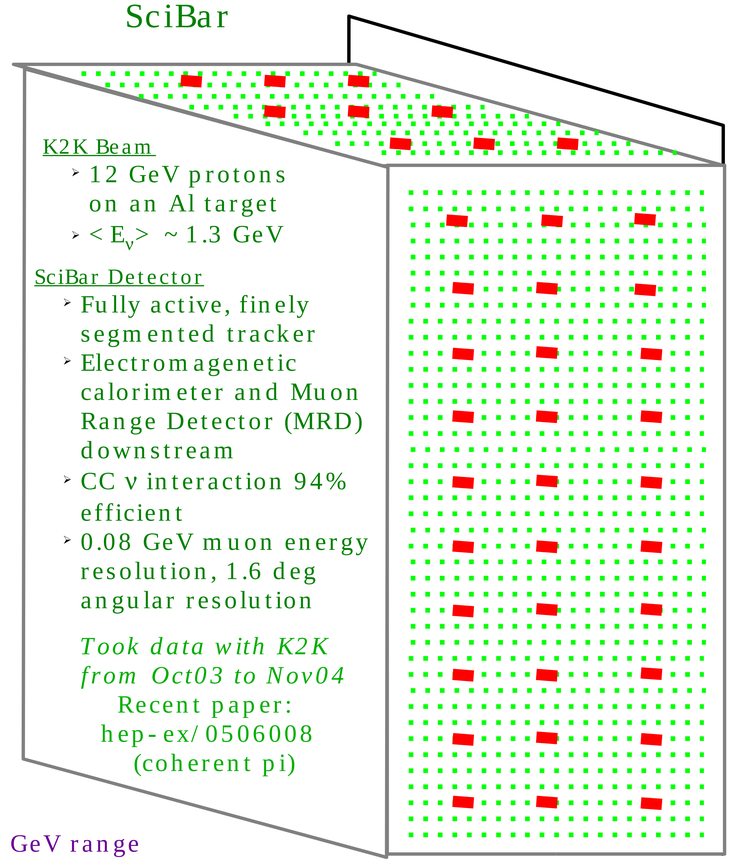
π^0 mass (GeV/ c^2) in events/.005 GeV/c^2

SciBar + MiniBooNE

K. Hiraide, M. Wascko

Put SciBar on-axis in front of MiniBooNE!
- "best of both worlds":
- Fine grained detector
- Unique energy range
- Ideal for T2K

SciBar



K2K Beam
- 12 GeV protons on an Al target
- $< E_\nu >$ ~ 1.3 GeV

SciBar Detector
- Fully active, finely segmented tracker
- Electromagenetic calorimeter and Muon Range Detector (MRD) downstream
- CC ν interaction 94% efficient
- 0.08 GeV muon energy resolution, 1.6 deg angular resolution

Took data with K2K from Oct03 to Nov04
Recent paper:
hep-ex/0506008
(coherent pi)

Improved measurements

CCQE
- Overconstrain E_νQE
  - predict p's location, and check for it
- Reduces flux errors for MiniBooNE

NC π^0
- measure in two beamlines at two different energies
  - can trace out energy dependance for first time

CC π^+
- See whole interaction
  - reconstruct invariant Δ mass

Antineutrino measurements

Few $\bar{\nu}$ σ measurements in few GeV range (and low statistics)
- high statistics
- SciBar can see contamination ν's in $\bar{\nu}$ beam (n vs p)

Potential measurements of:
- $\bar{\nu}$: CCQE, CC π^+, NC π^0
- *Exclusive* $\bar{\nu}$ p → $\bar{\nu}$ p π

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