K^+ Production from 8 GeV Protons using Neutrino Interactions in SciBooNE

Outline
- •Motivation
- •Experiment overview
- •Signal selection
- •Analysis method
- •Results

Gary Cheng
Columbia University
Rencontres de Moriond
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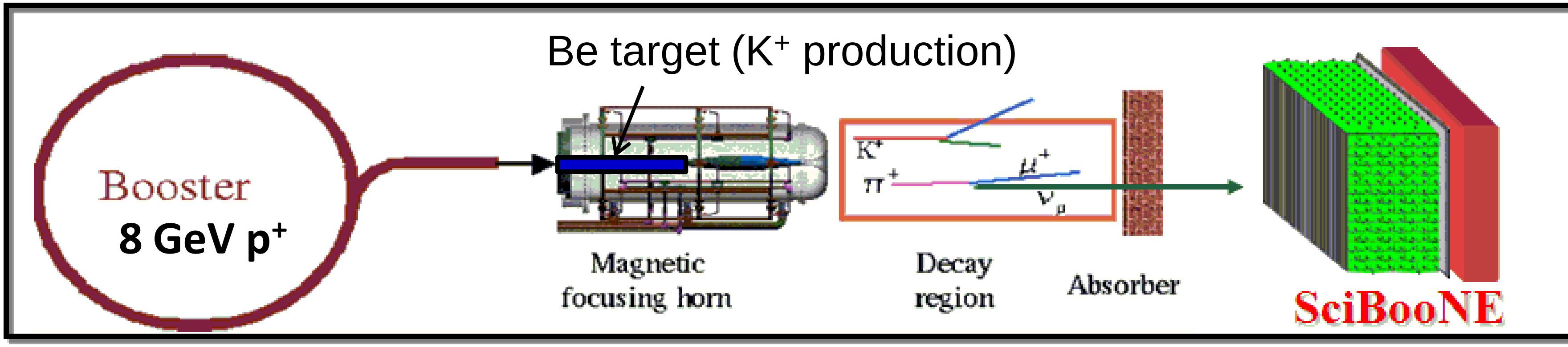
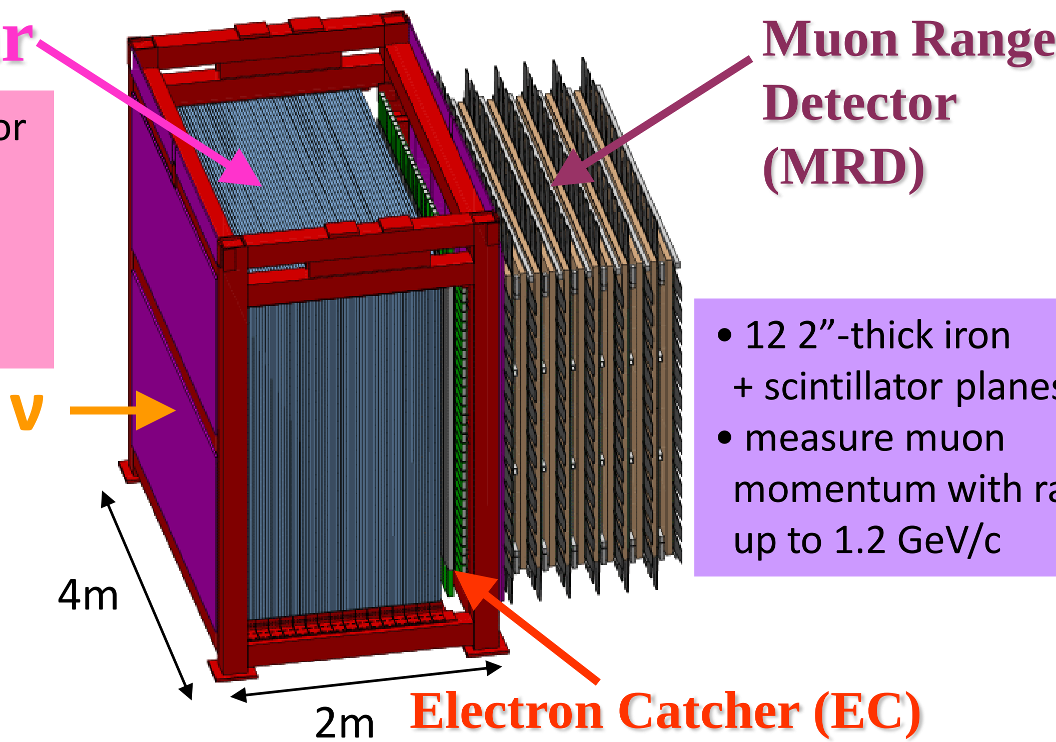
Why Measure K^+ Production from 8 GeV Protons?

- Reduce uncertainty for intrinsic ν_e background from K^+ decay in Fermilab Booster Neutrino Beam, currently at 40%. This background affects current and future oscillation analyses.

- Test Feynman scaling at the 8 GeV proton interaction level.
  - Feynman scaling works well at higher energies.

SciBooNE Experiment at Fermilab





- scintillator tracking detector
- neutrino target

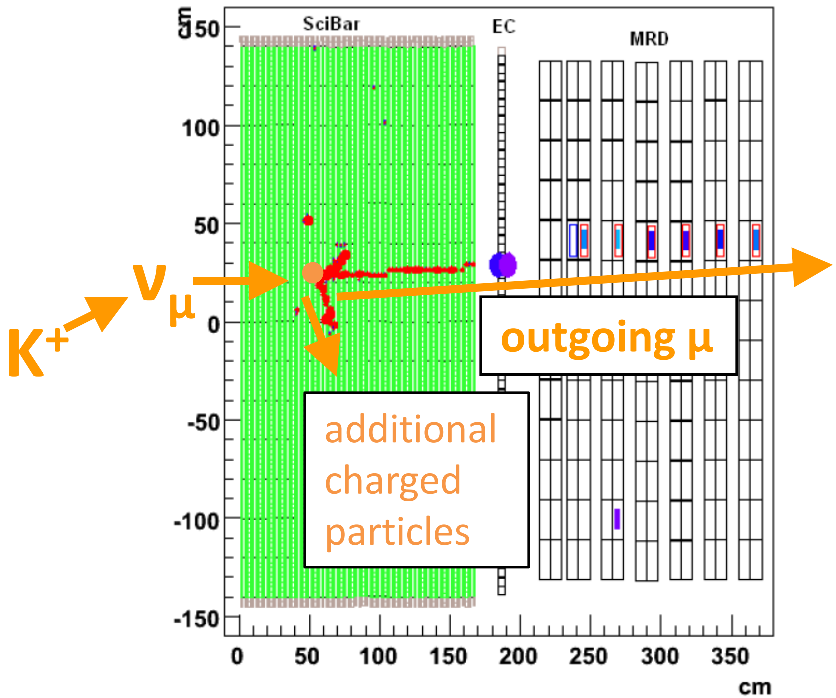
- 12 2”-thick iron + scintillator planes
- measure muon momentum with range up to 1.2 GeV/c

- spaghetti calorimeter

Two running modes:

- Neutrino mode
  - positive horn
  - 9.9×10^{20} POT
- Anti-neutrino mode
  - Negative horn
  - 1.51×10^{20} POT

Selection Cuts



Main K^+ selection criteria:

- ν_μ at high energy (> 2 GeV) are mostly from K^+ decay.
- To select high energy ν_μ , **high energy muons** are selected. Hence, the penetrating muons.

1. Pick events with one MRD penetrating muon.
2. Separate events based on number of SciBar tracks: 1,2,3.

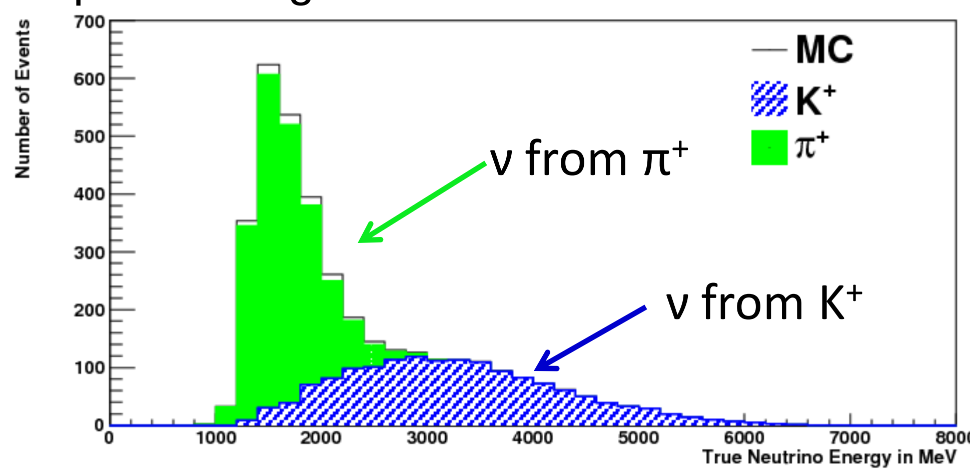
Neutrino Mode:

- Data (MC): 3090 (2921) events
- K^+ MC: 1194 events

Anti-neutrino Mode:

- Data (MC): 1699 (1360) events
- K^+ MC: 257 events

penetrating muon events in neutrino mode



Analysis Method

- The K^+ production normalization is determined by fitting the reconstructed muon angle relative to beam axis for neutrino events.
  - different distribution shapes between K^+ and π^+, π^-
- Minimize standard covariance matrix χ^2.

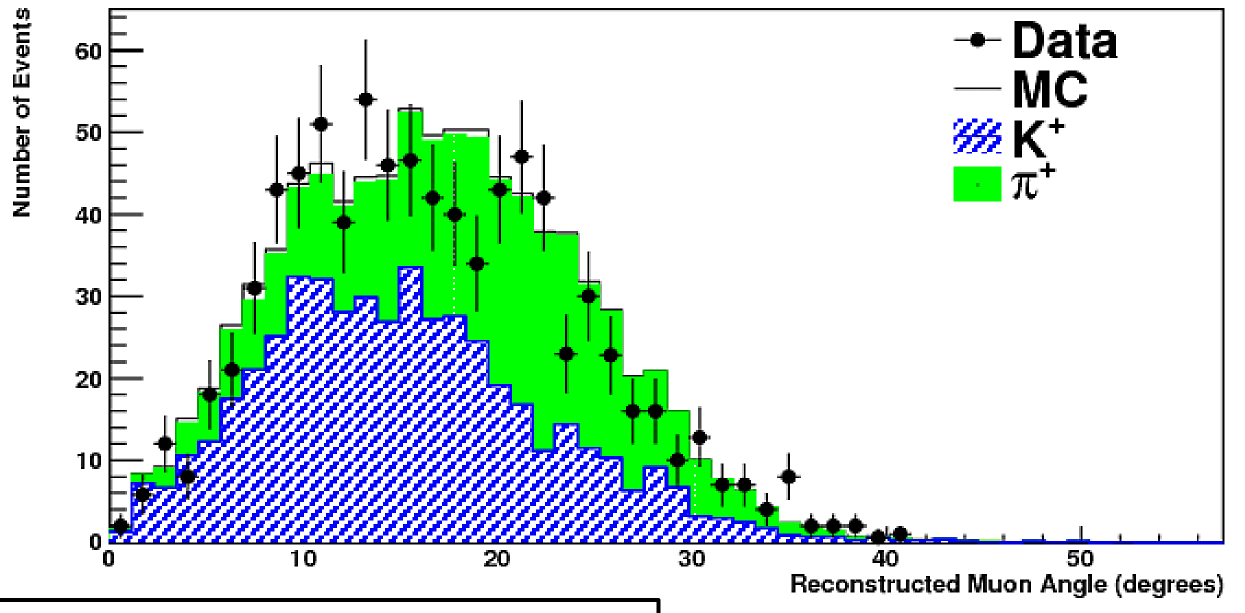
$$\chi^2 = \sum_{j,k}^{Nbins} (N_j^{obs} - N_j^{pred})(V_{sys} + V_{stat})_{jk}^{-1}(N_k^{obs} - N_k^{pred})$$

- Systematic Uncertainties:
  - Beam Errors
  - Cross-section and Nuclear Model Errors
  - Detector Errors

Final Result

- After Applying K^+ Production Normalization

Muon Angle Distribution for the 2 SciBar Track Sample



•Insensitive to neutrino cross-section.
•Analysis is done with both NEUT and NUANCE. Good agreement.
•K^+ production uncertainty reduced from 40% to 14%.

K^+ production normalization:
0.87±0.12 (stat. + sys.)

Backup

Comparisons

Before Any Correction (Default MC)

After Applying K^+ Production Normalization w/ best fit cross-section values