Single Pion Measurement Capabilities at SciBooNE

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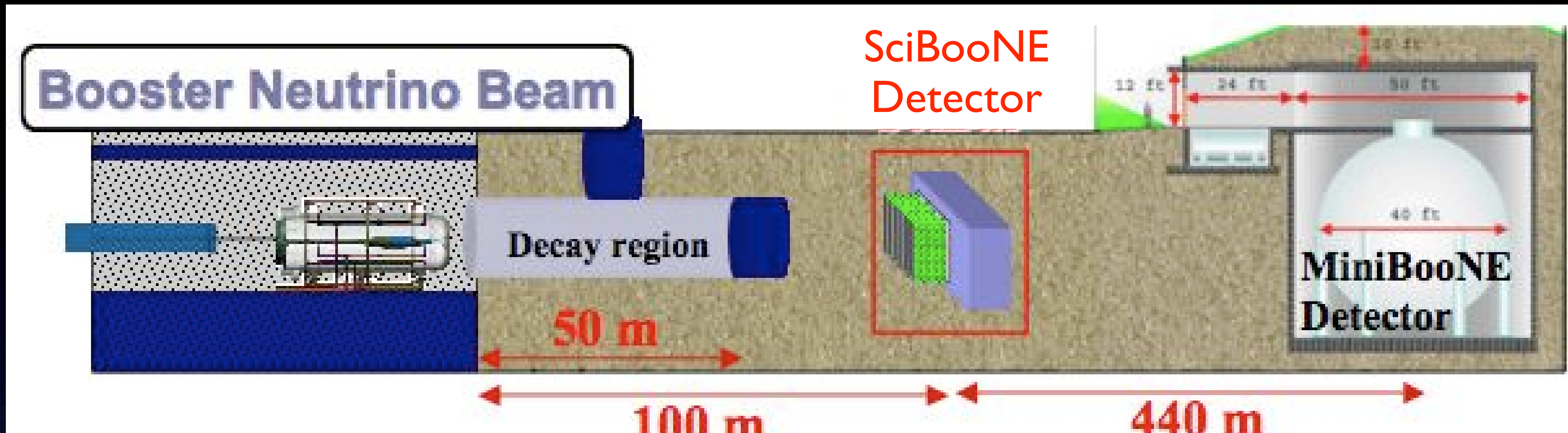
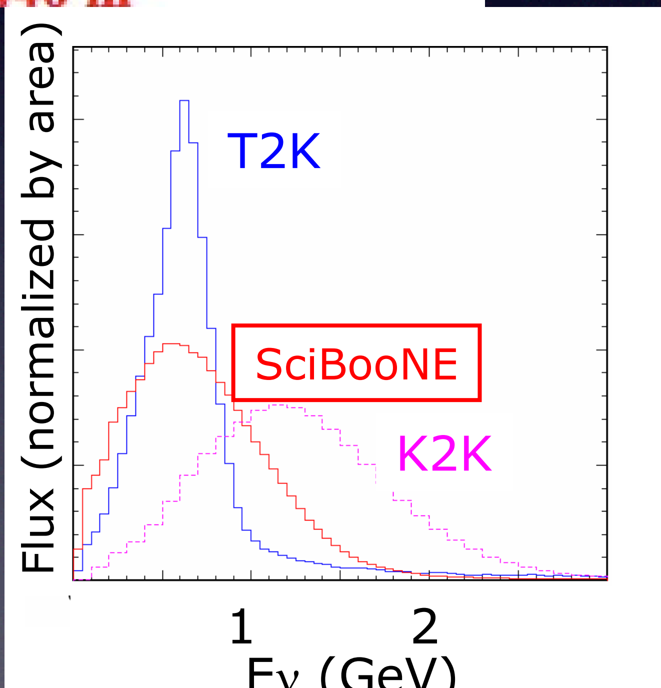
Outline

- SciBooNE experiment
- Motivations to CC1π^+ measurement
- CC1π^+ measurement capability at SciBooNE
- Summary

SciBooNE overview



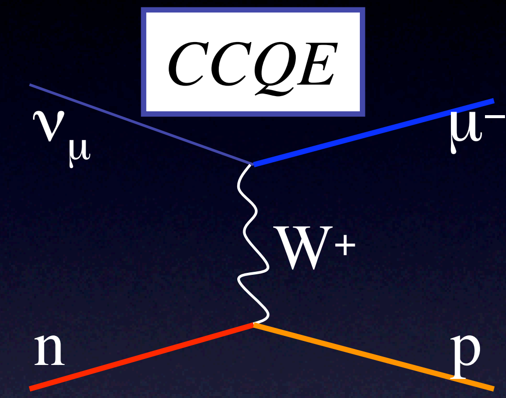
- Well developed fine-grained fully active detector: SciBar, used in K2K
- On the well-understood neutrino beam-line: Fermilab Booster Neutrino Beamline
- Aiming for precise cross-section measurements below ~1 GeV region.
  - Helps MiniBooNE (near detector) and T2K (same energy region).
- Single pion production is one of very important topics.

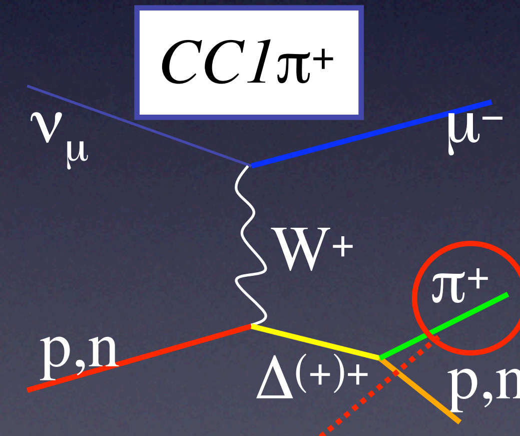


SciBooNE

Motivations for single pion measurement (1)

- ν_μ disappearance ($\nu_\mu \rightarrow \nu_x$) experiment: T2K, MiniBooNE (Cherenkov detectors)
  - Signal: CCQE (~40% of total int.). Neutrino energy can be reconstructed by muon kinematics.
  - Background: CC-1π^+ (~20% of total int.). Since pions and protons are low momentum, <u>they are below Cherenkov threshold.</u>





a few 100 MeV/c,
can be absorbed in nuclei.

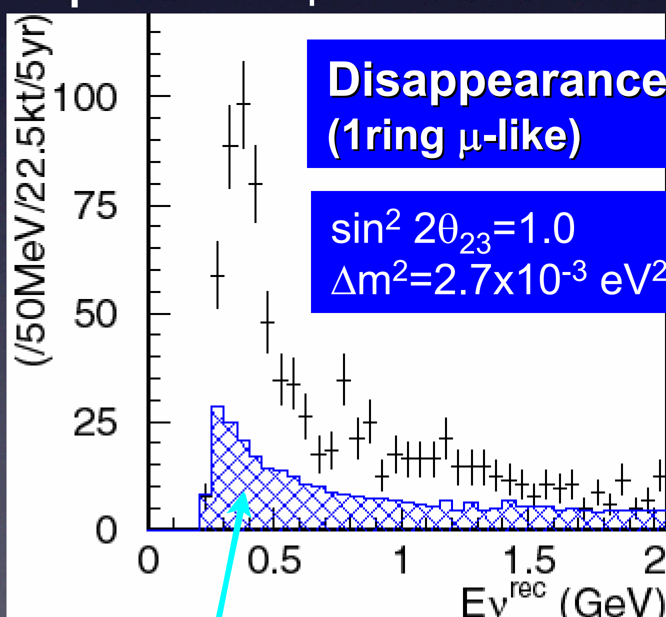
Precise knowledge of cross-section is required to understand the backgrounds.

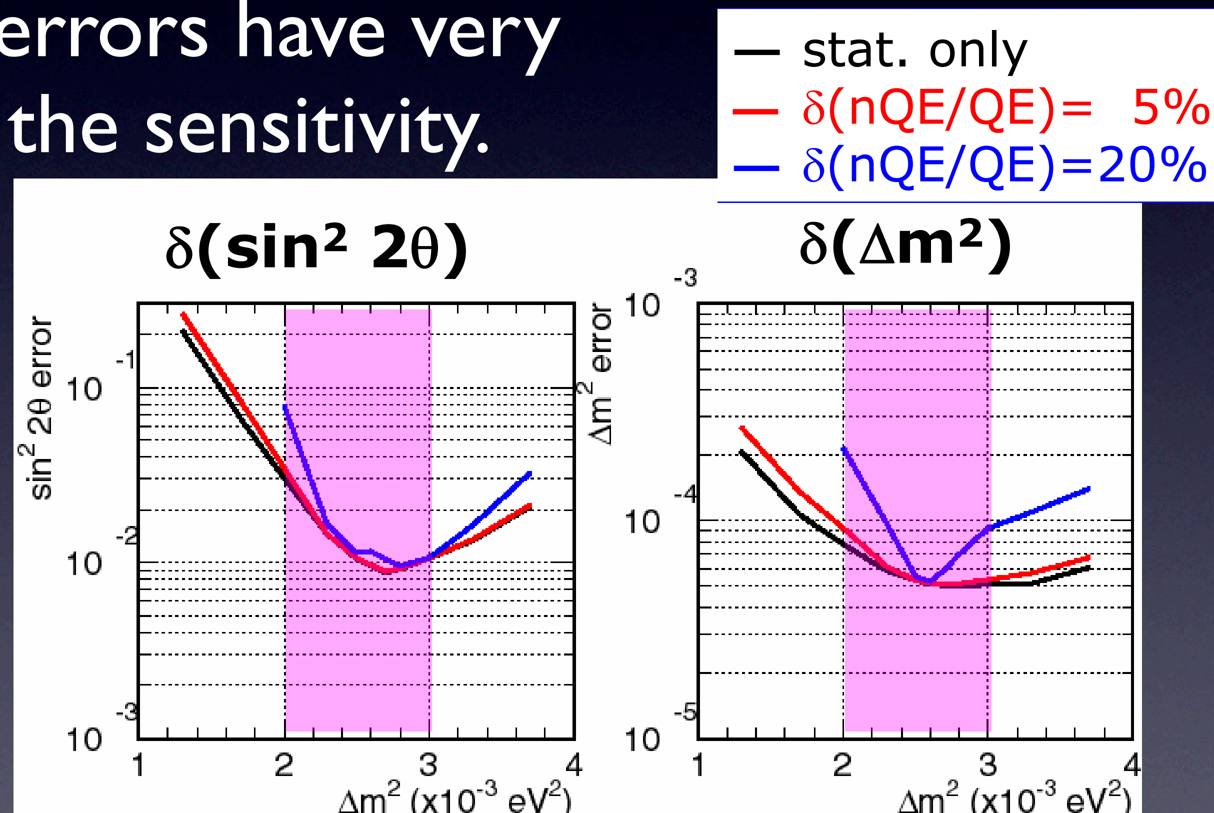
Motivations for single pion measurement (2)

T2K case:

- Cross section errors have very large effect on the sensitivity.

Expected ν_μ event at SK

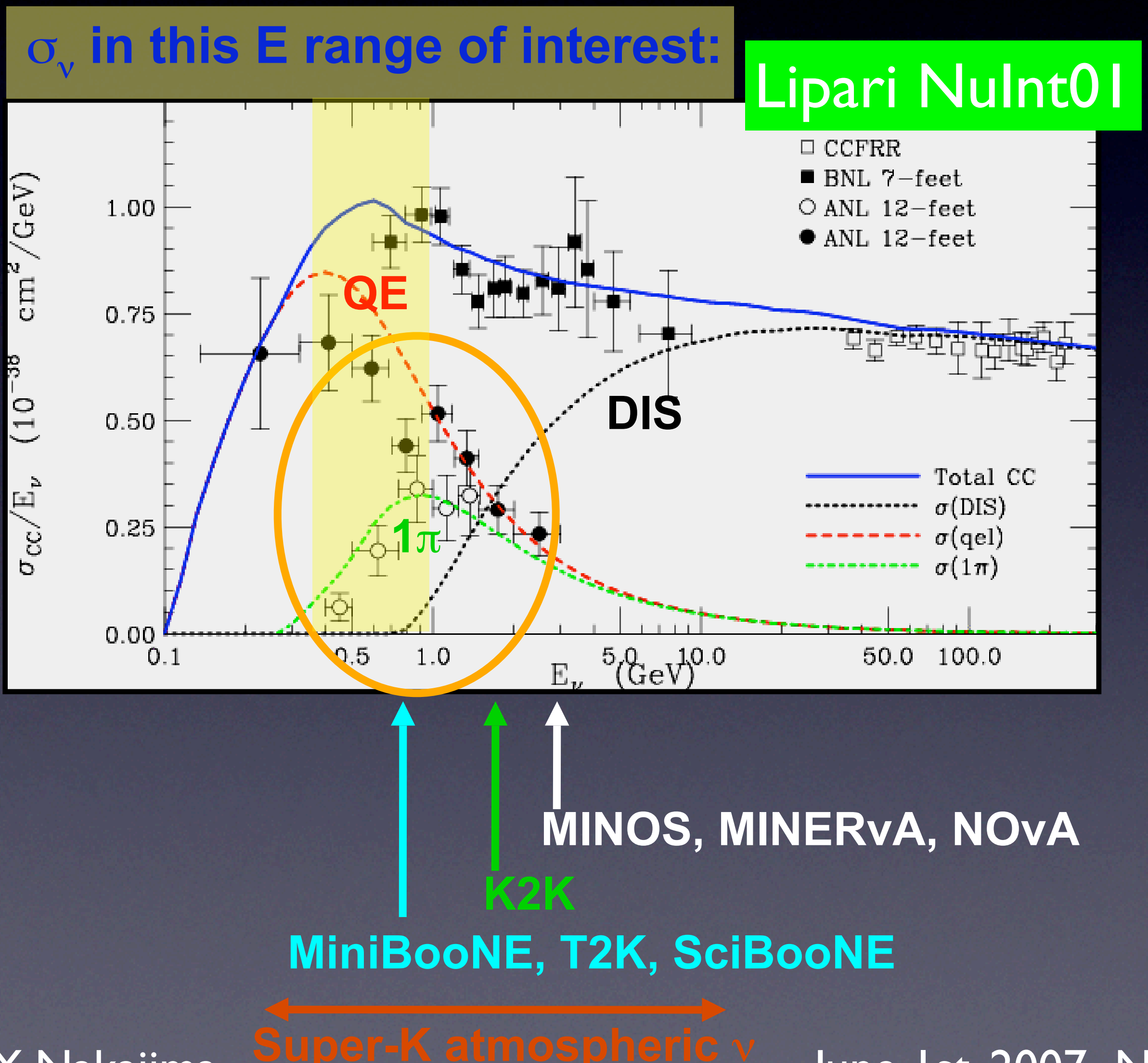




5% measurement is ideal

Non-QE (Mostly CC1π^+) backgrounds

Previous cross-section measurement

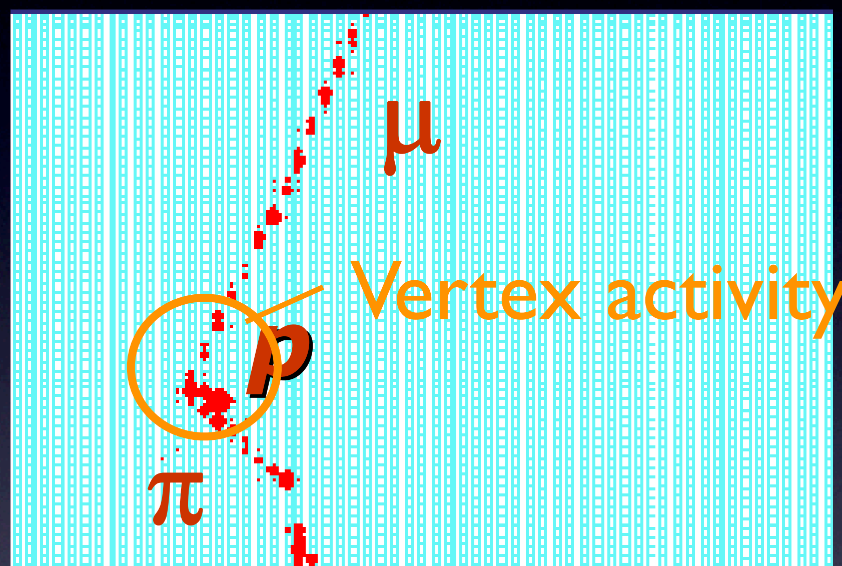


- Most of data comes from old bubble-chamber experiments.
  - poor statistics
- K2K and MiniBooNE are making great measurements.
- SciBooNE will follow with:
  - higher statistics than K2K
  - higher resolution than MiniBooNE.

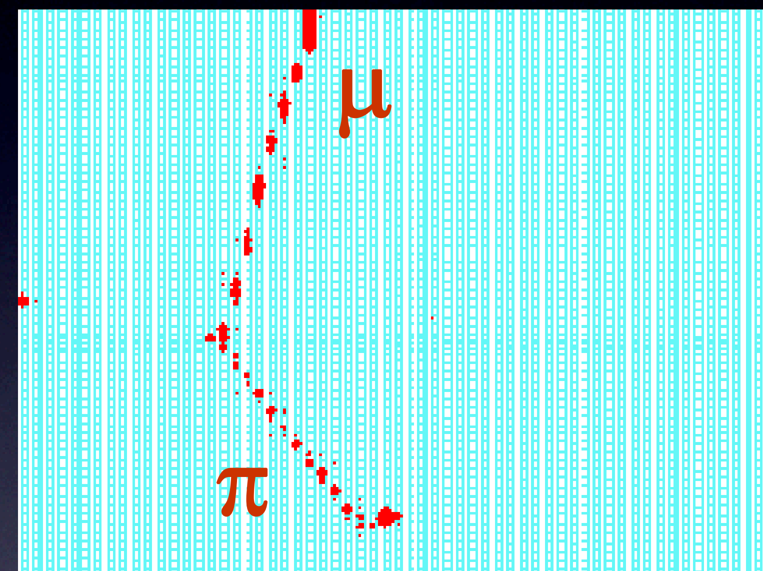
Single Pion Measurement at SciBooNE

CC-1π^+ final state tagging

MC: $\nu_\mu p \rightarrow \mu^- p \pi^+$



MC: $\nu_\mu n \rightarrow \mu^- n \pi^+$



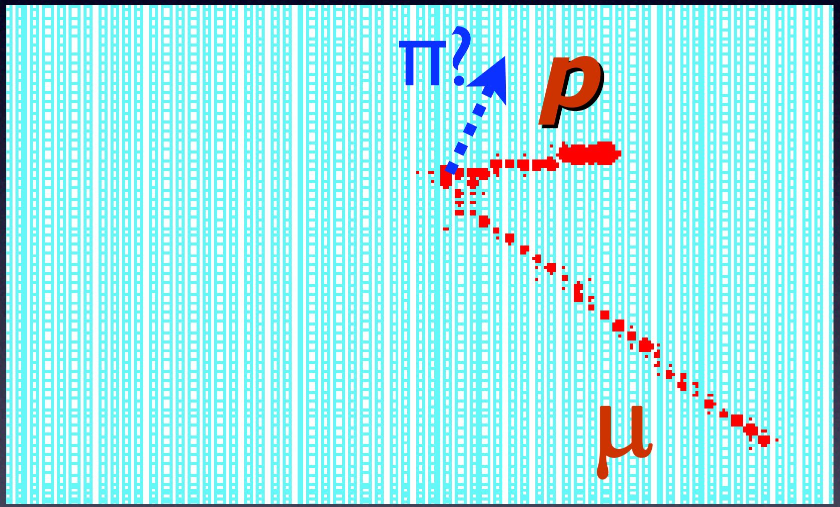
- Clear event-by-event final state tagging!
- Able to separate $\nu_\mu p \rightarrow \mu^- p \pi^+$ from $\nu_\mu n \rightarrow \mu^- n \pi^+$

Sensitivity to Pion absorption in nuclei

MC: $\nu_\mu p \rightarrow \mu^- p \pi^+$

Absorbed in nuclei

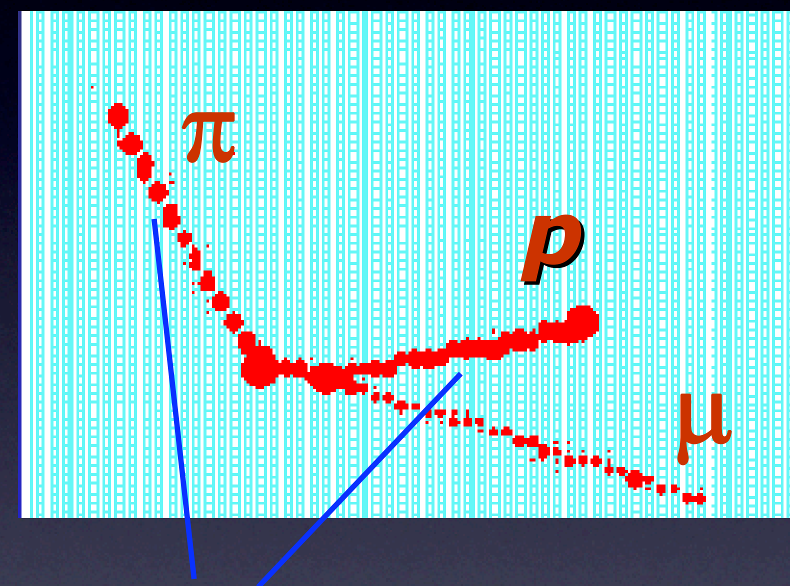
- We can distinguish Pion absorption events from CCQE by checking p-μ kinematics.
- Capability of measuring effect of pion absorption in nuclei.



>20% of CC-1π^+

Sensitivity

- Expect ~28000 resonant CC-1π^+ interactions in SciBar fiducial volume (10t) (for 1.0 x 10^{20} P.O.T.)
- We will have sufficient statistics/systematics to measure CC-1π^+/CCQE cross-section ratio with 5 % precision



pπ separation with dE/dx

SciBooNE

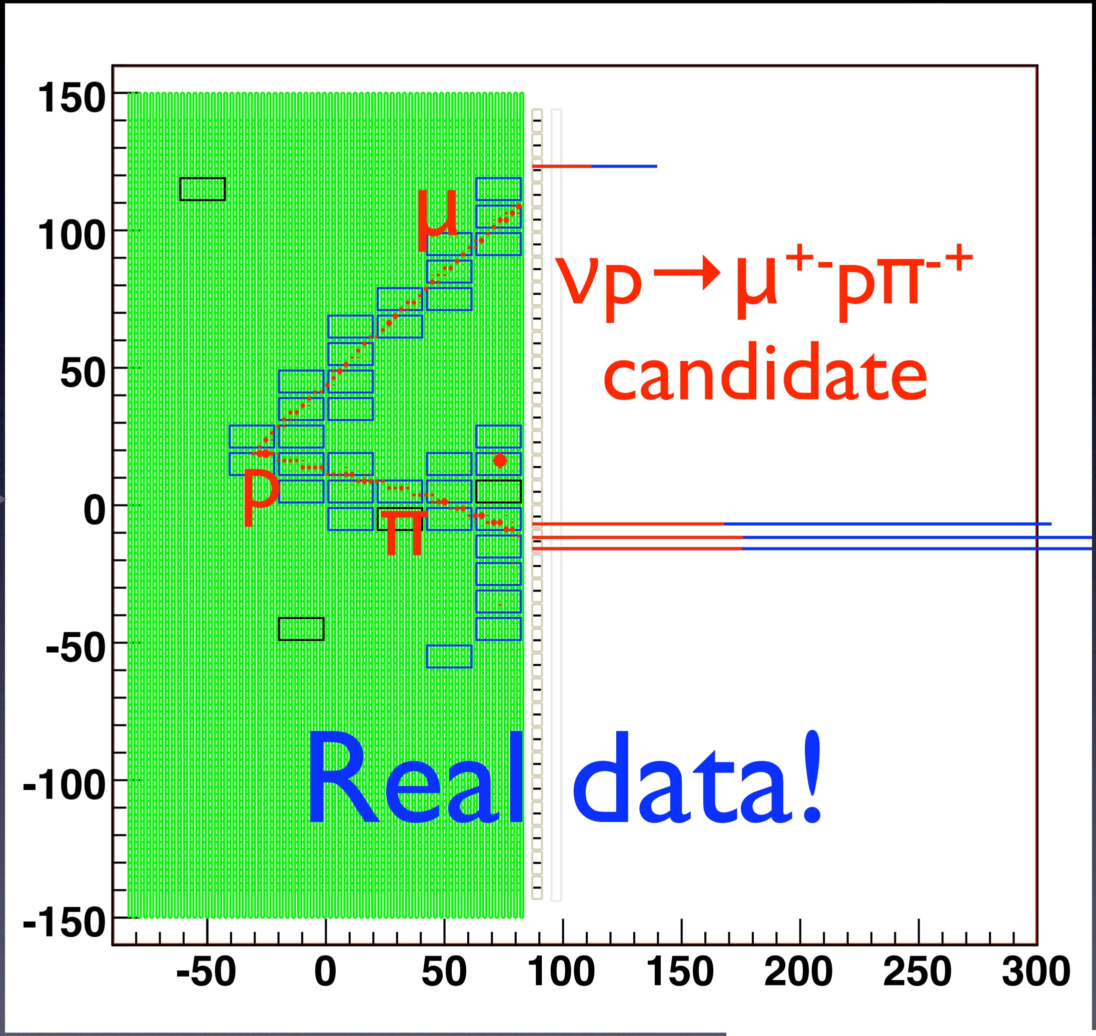
Summary

- SciBooNE is aiming to make precision cross-section measurements below ~1 GeV region.
  - Helps MiniBooNE, T2K
- For CC1π^+ measurement, all muons, pions, and protons can be reconstructed as tracks.
  - Clear separation of interaction type.
  - Sensitivity to pion absorption in nuclei.

We've just started!

- We've just finished detector installation, and started commissioning!
- Exciting new data is coming soon!

beam

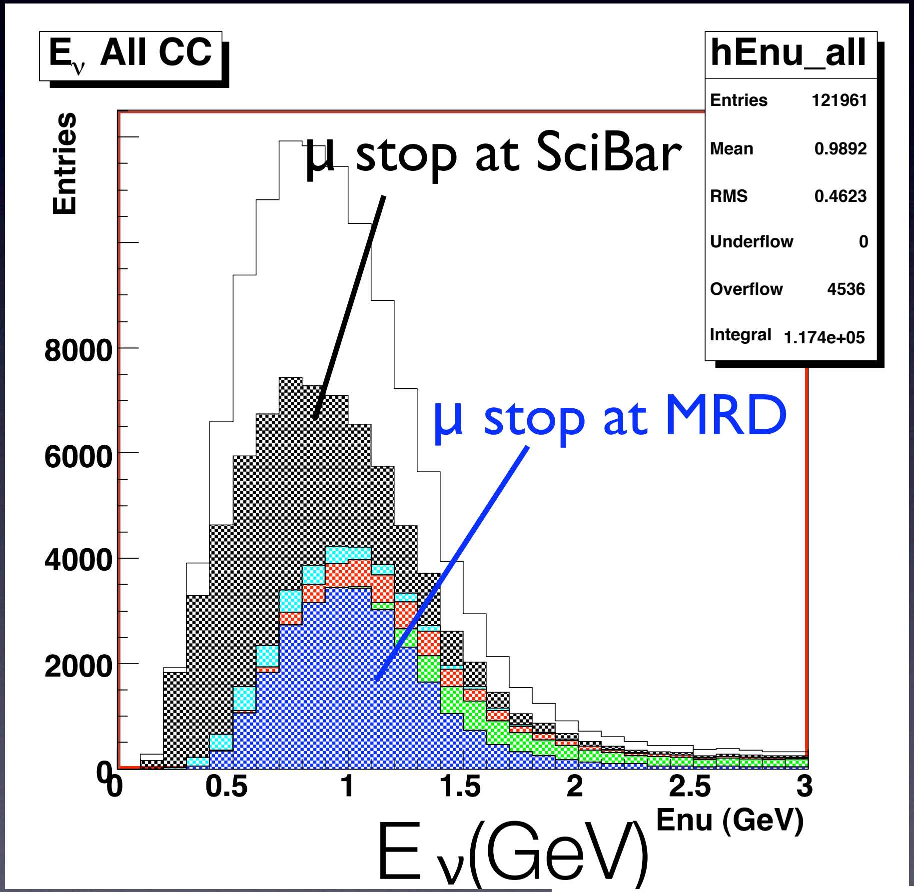


SciBooNE

Backup slides

Geometrical acceptance for CC events

- Require μ stopped inside the detectors.
- ~60 % total geometrical acceptance for CC interaction.



Event selection criteria for CC-1π^+ (ν+N→μ^-+N+π^+)

- 2 tracks from the common vertex
- Both tracks are MIP-like (μ & π)

Neutrino run (0.5x10^{20} POT)

Selection criteria	# of events	# of CC-1π^+ events	Purity	Efficiency
Generated in FV	73,219	13,892	-------	100%
CC inclusive sample (SciBar+EC+MRD)	37,174	8,977	24.1%	64.6%
# of tracks =2	8,291	2,705	32.6%	19.5%
1st track PID =μ-like	7,845	2,580	32.9%	18.6%
2nd track PID =μ-like	2,898	1,355	46.8%	9.8%

SciBooNE