High track multiplicity events in SciBooNE (towards CC-π^0 x-section)

J. Catala-Perez (IFIC – U. Valencia/CSIC)

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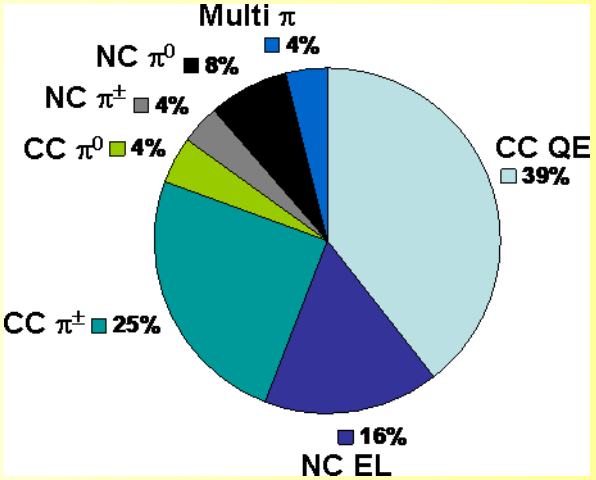
Analysis Motivation

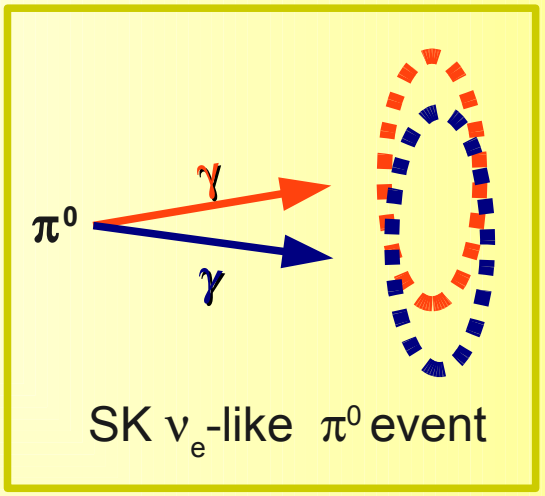
CC-π^0 have an important contribution to inelastic events at low energies. Its limited knowledge affects the spectrum measurement in ν_μ disappearance searches.



Borrowed from MiniBooNE using Nuance and CH_2

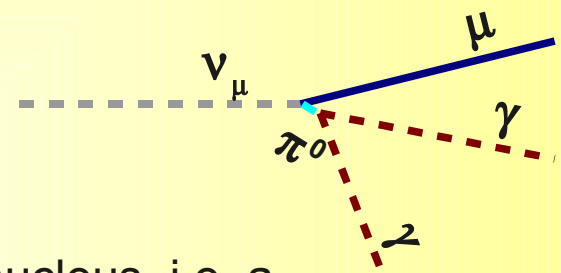
In the low energy range where multipion events have a small contribution, CC-π^0 is bounded to resonant NC-π^0 via isospin and electroweak relations.

π^0 decay may be misidentified as as electron in a cherenkov detector as SuperKamiokande, main detector of T2K experiment. This fact makes NC-π^0 events one of the main backgrounds in ν_e appearance experiments.



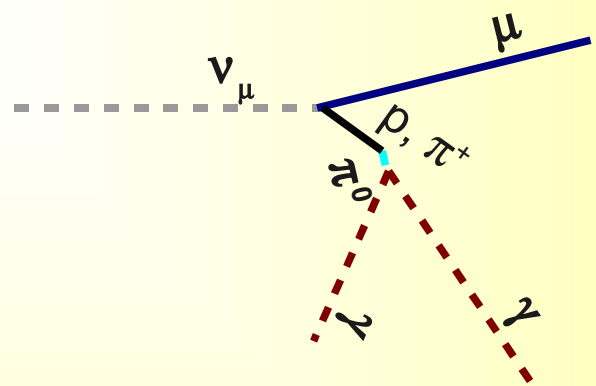
SK ν_e-like π^0 event

CC-1π^0 signal definition



Signal definition:

- Signal is defined as a μ and a π^0 going out of the interacting nucleus, i.e, a primary μ and a primary π^0.
- Background is broken in 3 categories:
  - Primary μ and secondary π^0.
  - Primary μ with no π^0.
  - Other (NC)

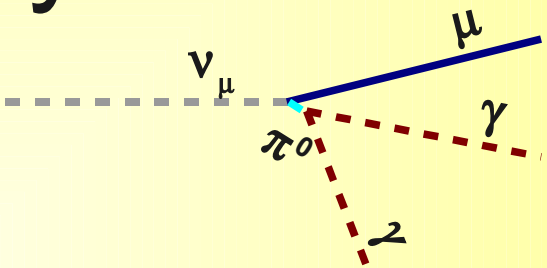


Data used in this analysis:

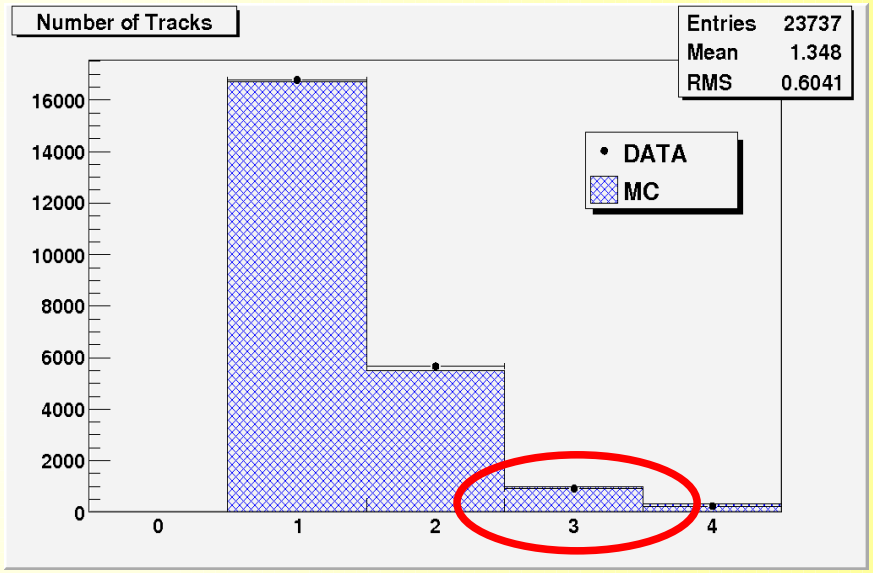
7.67 E19 Protons **O**n **T**arget is used for this analysis.

SciBar-MRD matched events are used for DATA/MC normalization.

CC-π^0 selection: Primary selection



- events with 3-tracks (expected 1 muon and 2 electromagnetic showers).
- 1 SciBar-MRD matched muon (track from SciBar reaching the MRD).
- No tracks escaping through the sides of the detector.

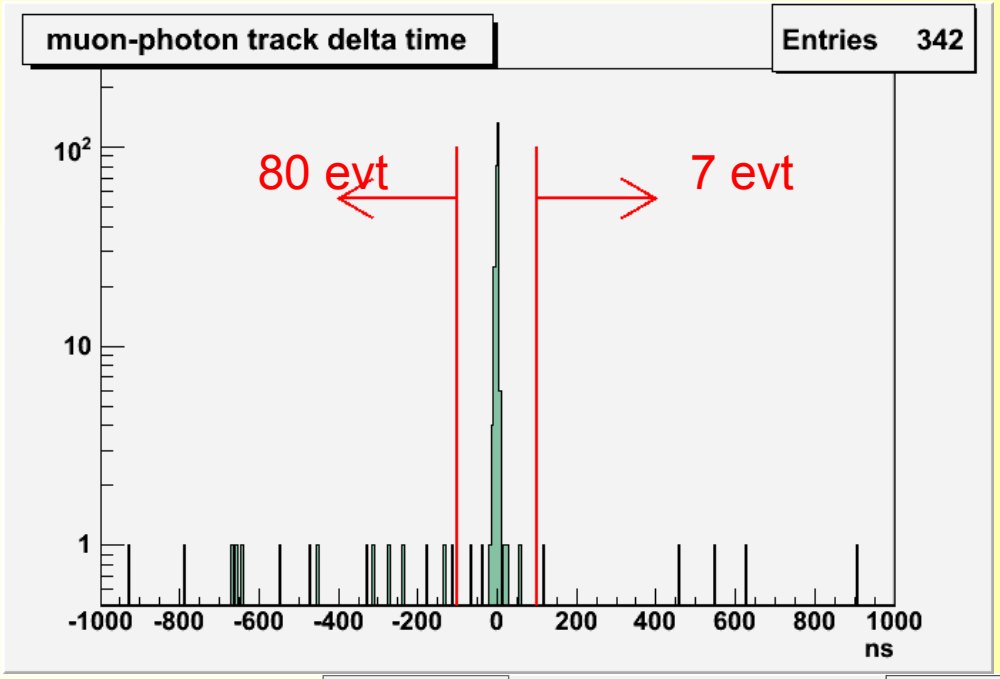


This primary selection give us a 33% purity in the sample.

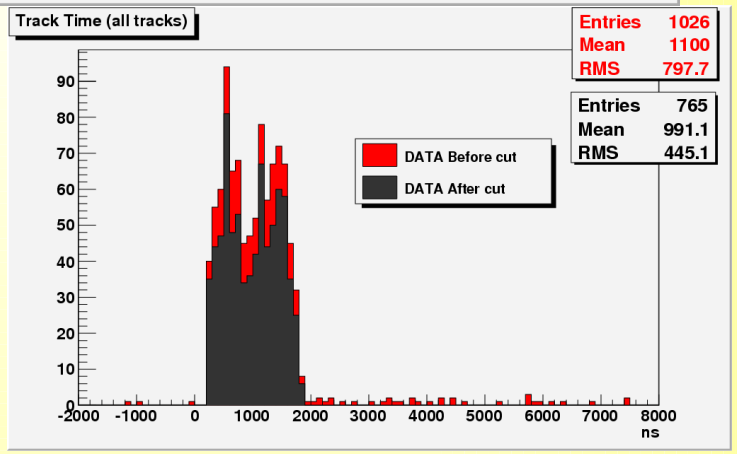
CC-π^0 selection: Time cut

Motivation:
π^0 decays immediately to 2 γ, so EM showers are expected to appear "on time" with the muon.

A Δt variable is defined as time difference between muon and non-muon tracks, and events with tracks outside ±100 ns window are removed from sample.



This plot shows the effect of applying this requirement to the non-muon tracks.

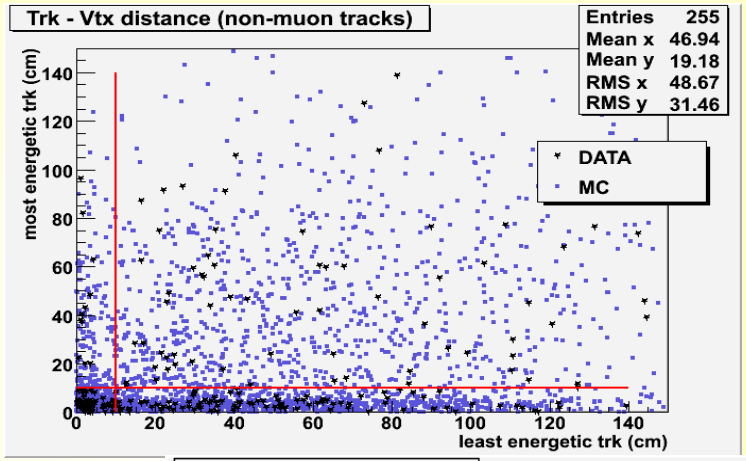


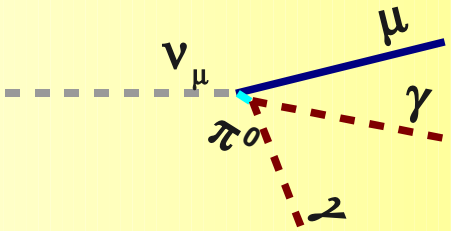
Removing from sample events with tracks out of muon track time increases purity up to **36%**

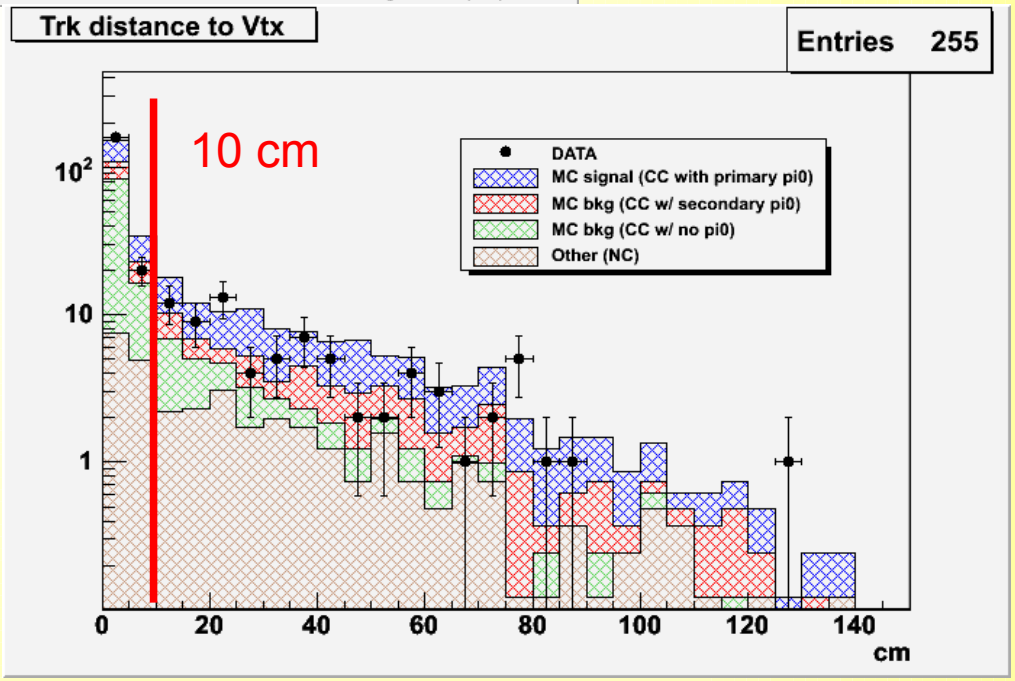
CC-π^0 selection: Distance cut

Motivation:
As photons are not detected in SciBar but only the electrons from the EM shower, a "track disconnection" from the event vertex is expected. Event vertex is defined as the initial edge of the μ track.

This fact allows us to remove events where reconstructed tracks come from protons or $\pi^{\pm}$ starting in the vertex.







Purity of the cut: 47%
Efficiency (relative): 49.1%

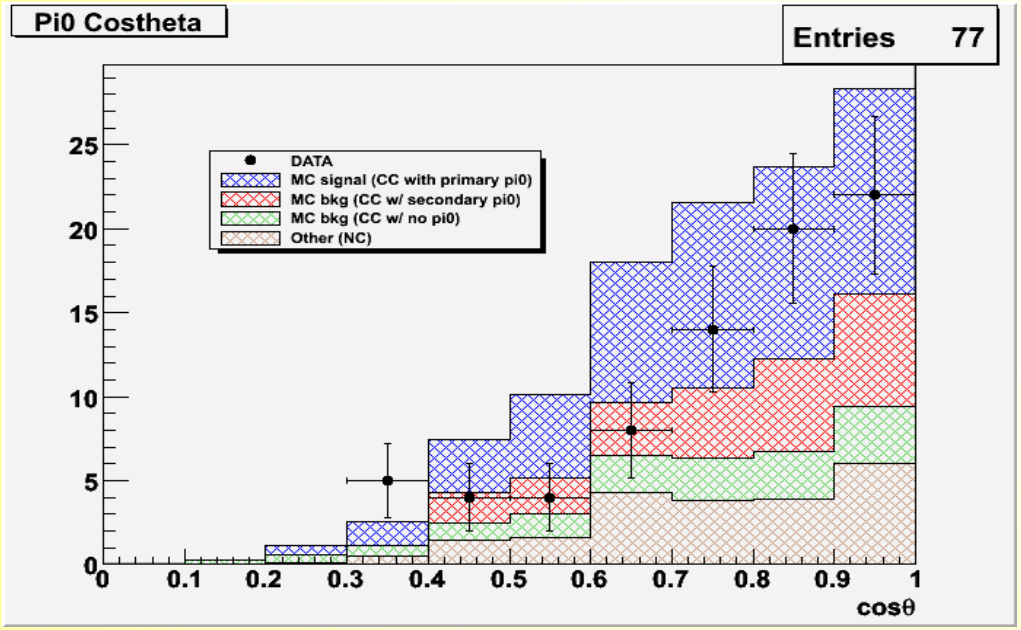
Event reduction summary

	# Events	Purity	Efficiency
MRDMatch sample	23737	8%	19%
3 tracks + veto	342	33%	1.7%
Time cut	255	36%	1.1%
Distance cut	77	47%	0.5%

Detector performance 1 π^0 in final state: 85% Purity

Results

At this stage of the analysis we are able to show π^0 physical quantities as the angle between the beam axis and the reconstructed π^0.



Reconstructed photon momentum is used to calculate π^0 direction.

DATA and MC shape in reasonable agreement within small statistics.

Conclusions

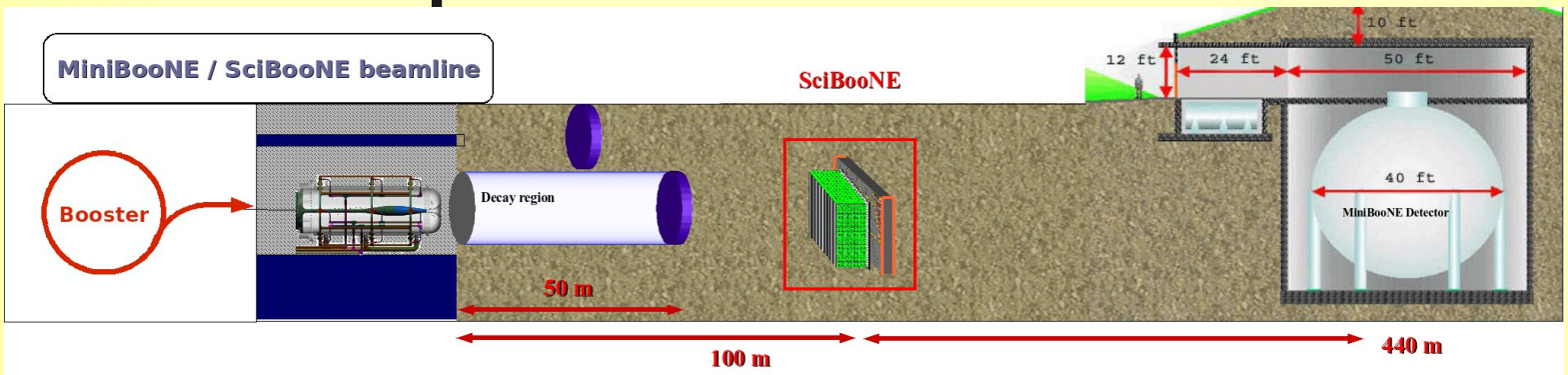
- SciBooNE is able to reconstruct π^0.
- DATA and MC shape in reasonable agreement within small statistics.
- Purity has been improved around 40%.
- Further studies will be focused to increase purity and efficiency:
  - 2 non-muon tracks pointing to vertex.
  - Looking to increase the sample using 4 track events in which one of the tracks is off-time (cosmics).

That's all Folks!

SciBooNE

Backup

Experiment Overview



Beamline:

8 GeV Protons come from Booster

Beryllium target produces an amount of π and K and the switchable Magnetic Horn allow us to focus positive or negative charged particles.

Decay Region: $\pi^+ \rightarrow \mu^- + \bar{\nu}$

$\pi^- \rightarrow \mu^+ + \nu$

An absorber at the end of the decay region stops muons and protons coming from the beam.

SciBooNE goal is to precisely measure neutrino cross section on carbon in the 1 GeV energy region.

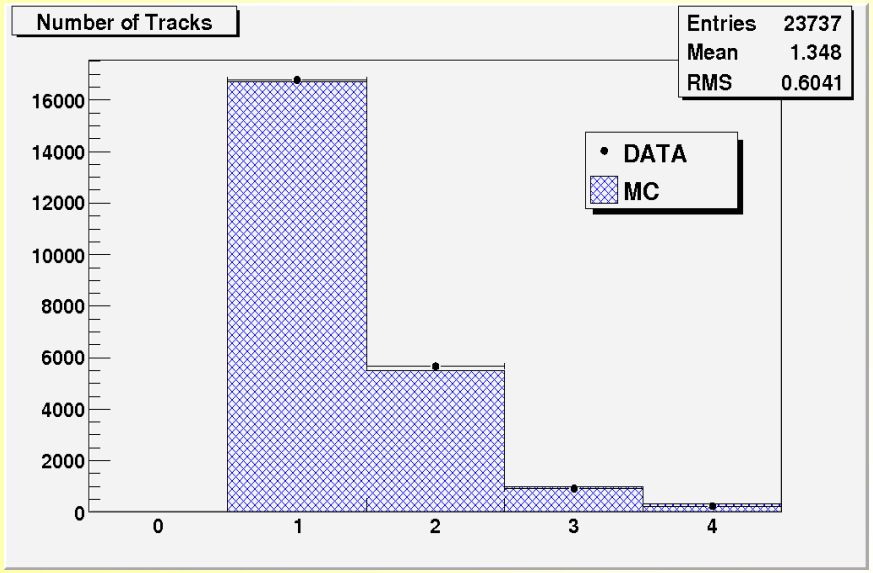
The detectors:

SciBar: Fully active, finely segmented tracking detector acting also as a ν target. 15 tons of 2.5 x 1.3 x 300 cm^3 scintillator strips (14336 total) and ~8 cm track length resolution.

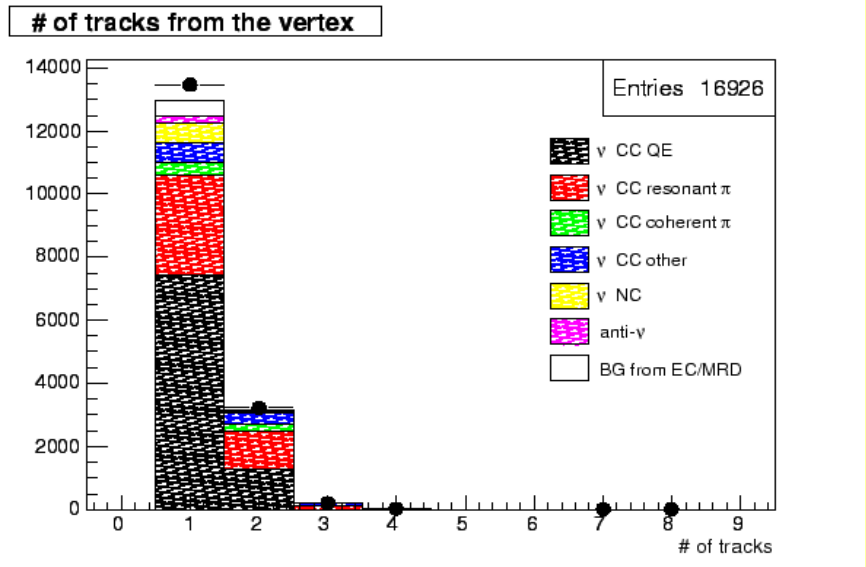
EC: Electromagnetic calorimeter consisting in two planes whit 32 lead & scintillator-fiber modules each plane.

MRD: Muon Range Detector consisting in 12 iron plates sandwiched between vertical and horizontal scintillator layers. Up to 1 GeV μ stopping power.

of track plot



SciBar-MRD matched events



- SciBar-MED matched events.
- Muon stopped in the MRD.
- Tracks going out from the vertex.