

A preliminary investigation into determining $CC0\pi$ cross-section sensitivities in SBND

Rhiannon Jones
University of Liverpool
School of Physical Sciences
rjones@hep.ph.liv.ac.uk
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Abstract

Random stuff

1. Introduction

Neutrino physics is at the core of current high energy research. The standard model of particle physics explains many elements of the physical nature of our universe, though we now know that it does not cover everything. If neutrinos were to be described by the standard model they would be massless, but this was proved not to be the case when the Super-Kamiokande experiment observed neutrino flavour oscillations [find reference](#). Neutrino research provided the first confirmation of the existence of physics beyond the standard model.

To date, neutrino experiments have

- Amazing things to date
- Amazing things in the future

1.1. Neutrino interactions

Due to the elusive nature of the neutrino, directly observing them in a detector isn't possible. It is therefore necessary to infer their existence from particles produced when they interact. Since this process relies upon the reconstruction capabilities of the experiment, purpose-built detectors have been constructed to maximise the efficiency of neutrino reconstruction.

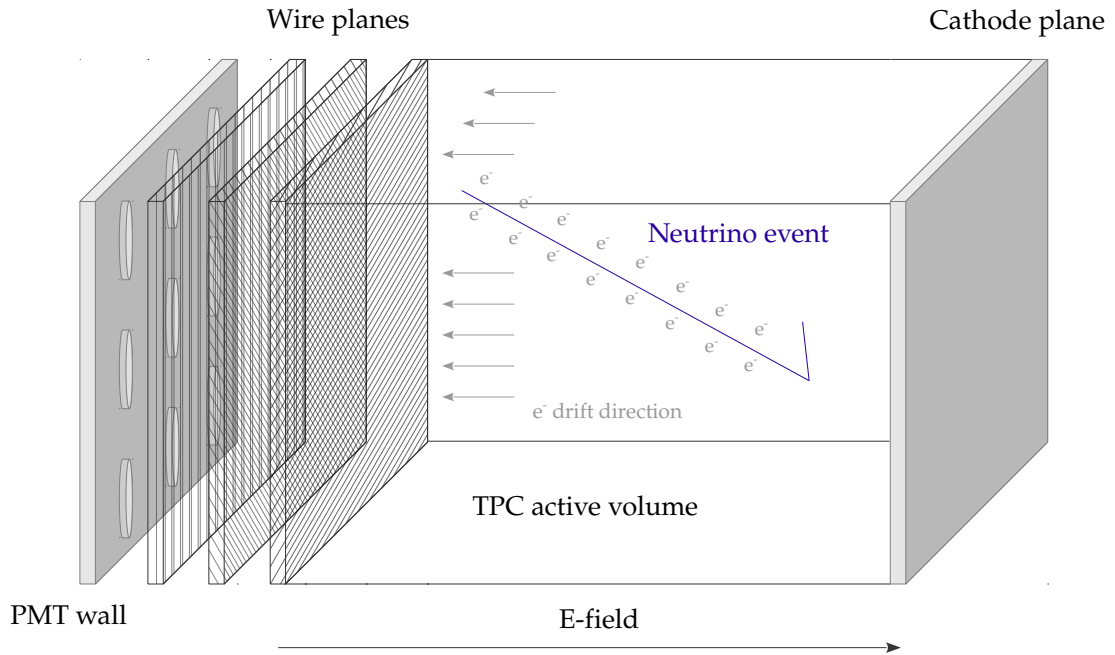
1.2. GENIE

GENIE is the world leading neutrino interaction generator.

1.3. Cross-sections

- Why?
 - Simulation
 - GENIE
- Historical
- Current knowledge
- Needs for future
 - LArTPCs
 - Statistics

Process		No. Events
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ν_μ Events		
CC 0 π	$\nu_\mu N \rightarrow \mu + Np$	3,551,830
CC 1 π^\pm	$\nu_\mu N \rightarrow \mu + nucleons + 1\pi^\pm$	1,161,610
CC $\geq 2\pi^\pm$	$\nu_\mu N \rightarrow \mu + nucleons + \geq 2\pi^\pm$	97,929
CC $\geq 1\pi^0$	$\nu_\mu N \rightarrow \mu + nucleons + \geq 1\pi^0$	497,963
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NC 0 π	$\nu_\mu N \rightarrow nucleons$	1,371,070
NC 1 π^\pm	$\nu_\mu N \rightarrow nucleons + 1\pi^\pm$	260,924
NC $\geq 2\pi^\pm$	$\nu_\mu N \rightarrow nucleons + \geq 2\pi^\pm$	31,940
NC $\geq 1\pi^0$	$\nu_\mu N \rightarrow nucleons + \geq 1\pi^0$	358,443
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Total ν_μ & ν_e events		7,251,948



1.4. SBND

- LArTPC general functionality
- LArTPC resolution benefits
- Comparison with other detector materials
 - Example event display?
- SBND specifics

- Dimensions
 - Beamline
 - Flux
 - Statistics
- Cross-section precision capabilities

1.5. GENIE-Professor global fits

2. Neutrino Interaction Phenomenology in the few-GeV Energy Range

2.1. Dominant topologies

2.2. Golden channel

2.3. Signal

2.4. Potential backgrounds

2.5. Maybe some results here?

3. Theory and Recent Measurements of $CC0\pi$ Cross-Section

3.1. Cross-sections

Inc. equations

3.2. Method

3.3. Unfolding

3.4. Results

Plots and cross-section values

4. A Global Fit of $CC0\pi$ Data

4.1. Experiments involved

4.2. Process

4.3. Results

5. Prospects for a $\text{CC}0\pi$ Measurement at SBND and Sensitivity Estimates

5.1. SBND sensitivity

5.2. Future

6. Discussion

References

