ν_μ CC-0π Interactions on Lead in the Near Detector of the T2K Experiment

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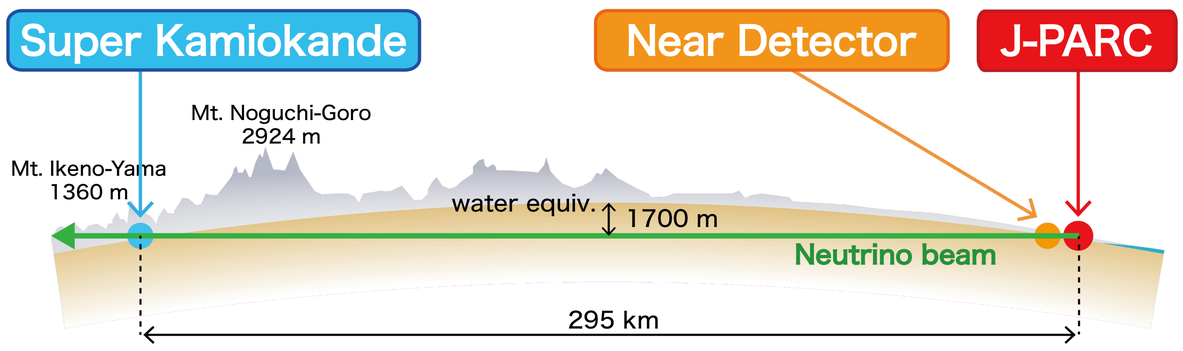
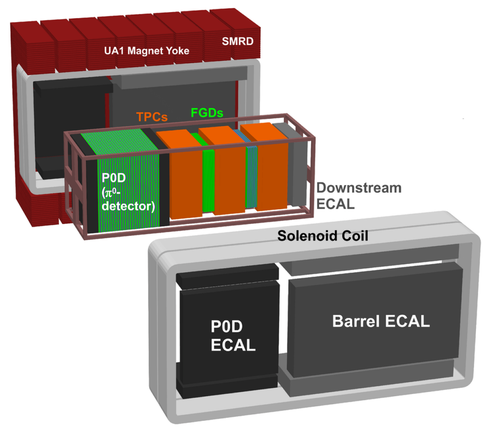


❖**Long-baseline** neutrino experiment located in Japan.
❖**Accelerator-made neutrino beam** with energy peak at 0.6 GeV.
❖Two main detector stations: **near detectors (ND280 and INGRID)** located at 280 m and **Super-Kamiokande** at 295 km from the beam target.
❖Goals: Measure the parameters of the model of neutrino oscillations and understand neutrino interactions with nuclei

❖Former **UA1** magnet: magnetic field of 0.2T to measure particle momenta and charges. Partially instrumented with scintillators (**SMRD**) for the measurement of the muon momenta from their ranges in iron.

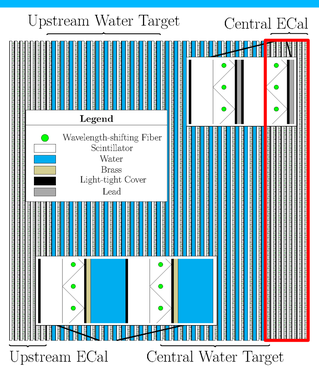
❖π^0 detector (**P0D**): water/brass or lead layers interleaved with scintillator layers.



❖Tracker: 2 **FGDs** of plastic scintillator layers (FGD2: scintillator/water layers), 3 **TPCs** particle tracking, momentum and charge measurement and particle ID

❖**ECAL**: scintillator/lead layers to improve track/shower separation

P0D Central ECAL

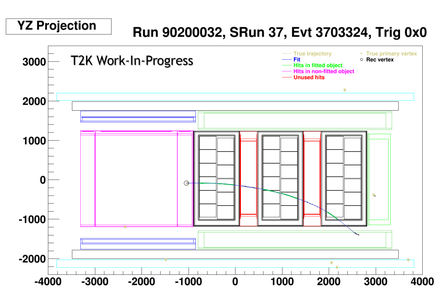


❖The most downstream part of the P0D detector.

❖Followed by a Tracker where muon momentum can be measured.

❖Central ECAL constists of **lead radiators** interleaved with two layers of **horizontal (X)** and **vertical (Y) scintillator bars**.

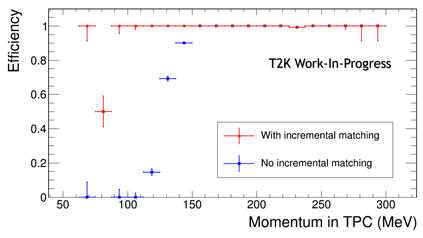
Reconstruction of tracks in Central ECAL

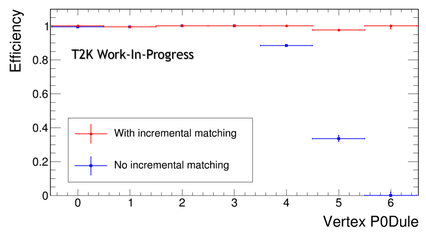


❖New reconstruction algorithm (incremental matching) which combines information from P0D and Tracker.

❖Implemented and validated using MC particle guns, data sand muons and cosmic muons.

❖Allows to recover particles produced at the downstream edge of Central ECAL and improve P0D-Tracker matching efficiency in the downstream modules (P0Dules).





Selection strategy

Select events with at least 1 P0D-TPC track
Find highest momentum negative track with TPC segment
Track quality + fiducial volume cut
P0D veto cut
Muon likelihood cut

1 TPC MIP
No Michel electrons
No P0D-contained pions

First hit in Y layer → **CC-0π on Carbon (sideband1)**

First hit in X layer → **CC-0π on Pb (signal)**

>1 TPC MIP → **CC-Non0π (sideband2)**

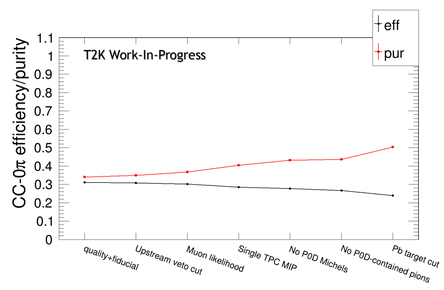
Motivation

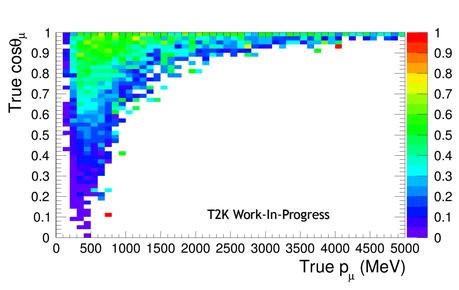
❖Investigate the influence of the nuclear environment on CC-0π interactions in the low energy region (not probed by MINERvA [1,2]). Look at the A-dependence of the cross section.

❖The measurement can help discriminate between different models of both initial state nucleons and final state interactions.

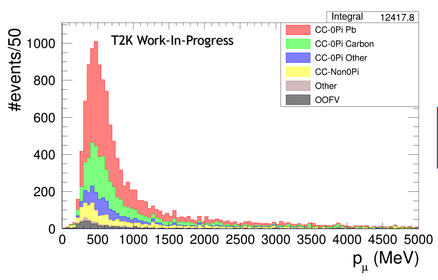
Selection results

❖Signal selection efficiency/purity, efficiency vs true muon momentum (p_μ) and cosine of the angle wrt. ND280 long axis ($\cos\theta_\mu$)

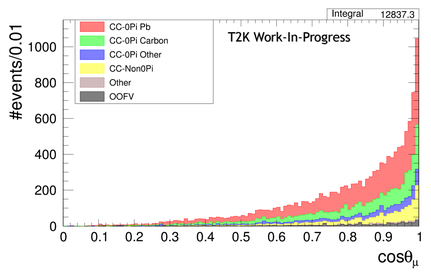


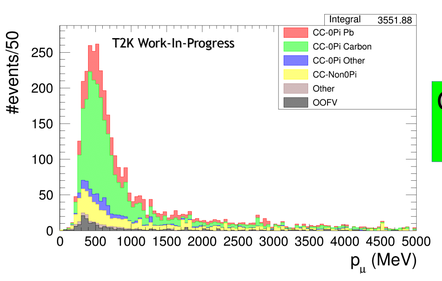


❖Reconstructed muon momenta (p_μ) and cosine of the angle ($\cos\theta_\mu$)

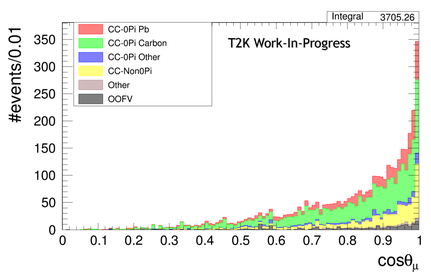


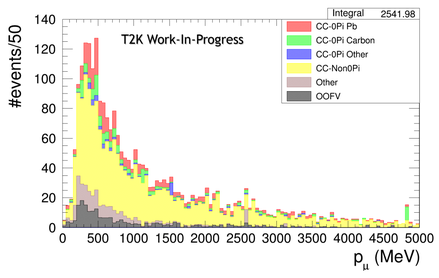
Signal sample



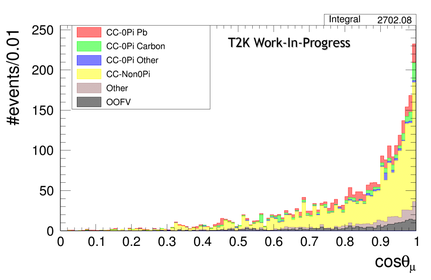


CC-0π on Carbon purity 50%





CC-Non0π purity 63%



Future cross section measurement

❖Goal: measure double-differential cross section on Pb in muon momentum and angle space
❖Possible measurement of Pb/Carbon cross section ratio

References

[1] B. G. Tice et al. (MINERvA collaboration), Phys. Rev. Lett. 112, 231801 (2014)
[2] M. Betancourt et al. (MINERvA collaboration), arXiv:1705.03791v1

Acknowledgements

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