A Machine Learning Approach to Study ν_e ^{127}I (p, n) ^{127}Xe

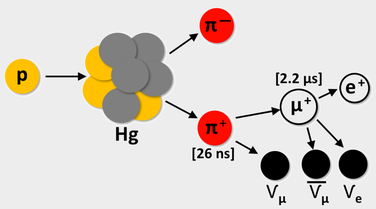
Peibo. An *for the COHERENT Collaboration*
Duke University

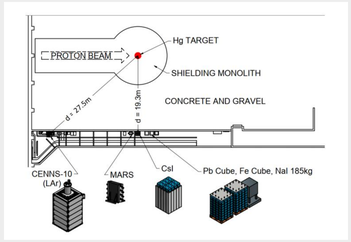
ID:13

Motivation

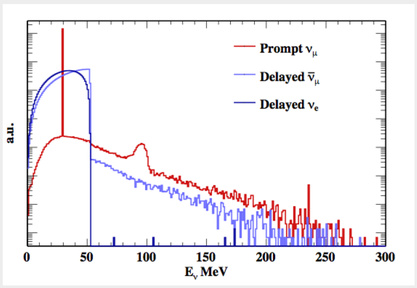
An inclusive measurement of the cross section of the electron neutrino charged-current (cc) interactions on ^{127}I will help study the quenching of g_A, the axial-vector coupling constant, which determines the rate of neutrinoless double beta decays. At the Los Alamos Meson Production Facility (LAMPF), an exclusive measurement was made but with a large statistical error. To make an inclusive and more accurate measurement, a 185 kg NaI[Tl] prototype was deployed by the COHERENT collaboration. To reduce the major background, cosmic rays, a machine learning model based on a convolutional neural network (CNN) is being developed.

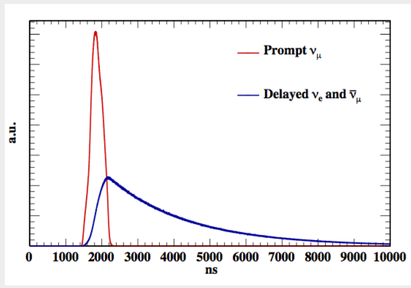
Neutrinos at the SNS





- COHERENT's detectors (right figure above) are deployed at the Spallation Neutron Source (SNS) to utilize the intense pulsed source of neutrinos it produces.
- The pulsed nature of the beam allows for improved background rejection.





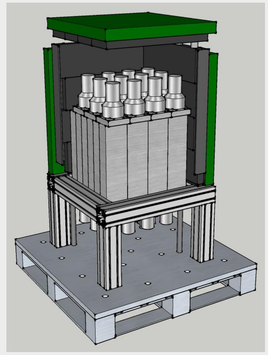
LEFT: Simulated energy spectra of neutrino produced by the SNS. RIGHT: Simulated timing of neutrinos produced by the SNS [1].

NaIνE-185

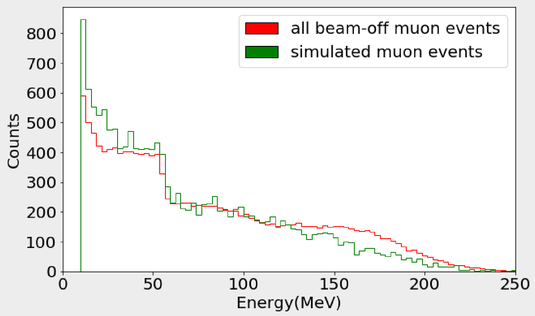
- NaIνE is a 185 kg NaI[Tl].
- One of its purposes is to measure the charged-current neutrino cross section on ^{127}I (* indicates possible excited states).

$$^{127}\mathrm{I} + \nu_e \rightarrow {}^{127}\mathrm{Xe}^{*} + e^{-}$$

- Equipped with Steel shielding and cosmic ray vetoes to further reduce the overall backgrounds and increase the fiducial volume of the detector.

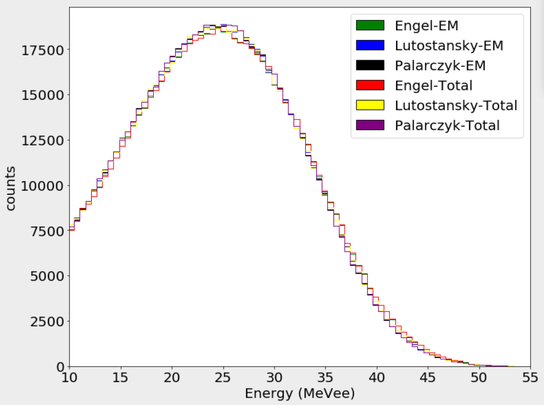


Simulations



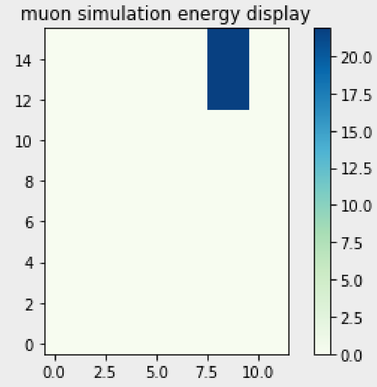
- CRY[2], G4 muon simulations.
- Beam-off muons.
- Discrepancy under investigation.

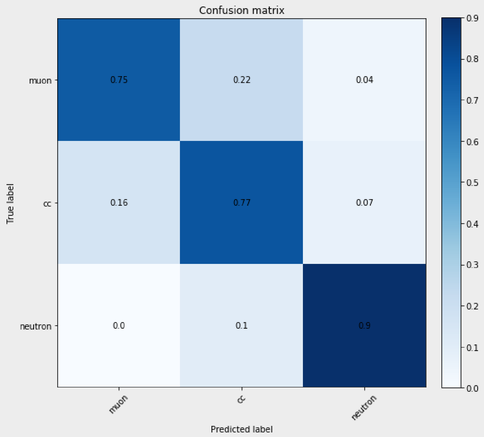
- ν_e ^{127}I (p, n) ^{127}Xe
- MARLEY [3] and G4 simulations.
- EM (lepton+γ).
- Total (quenched NR+ EM).
- 3 B(GT) sources.



Convolutional Neural Network

- Convolutional neural network (CNN).
- Event energy displays shown on the right as visualization of particles with topological patterns and input of CNN.
- Trained, validated and tested with simulations.





- The confusion matrix of the net is shown on the left.
- **77%** of the cc signals are tagged correctly.
- **22%** of muons are also tagged as cc.

References and Acknowledgement

[1] D. Akimov,., et al. (COHERENT Collaboration), arXiv:1509.0872, 2015

[2] https://nuclear.llnl.gov/simulation/main.html

[3] http://www.marleygen.org/index.html

This work is supported in part by U.S. DOE grant no. DE-FG02-97ER41033.