# Context Enriched Prong CNN performance studies in NOvA

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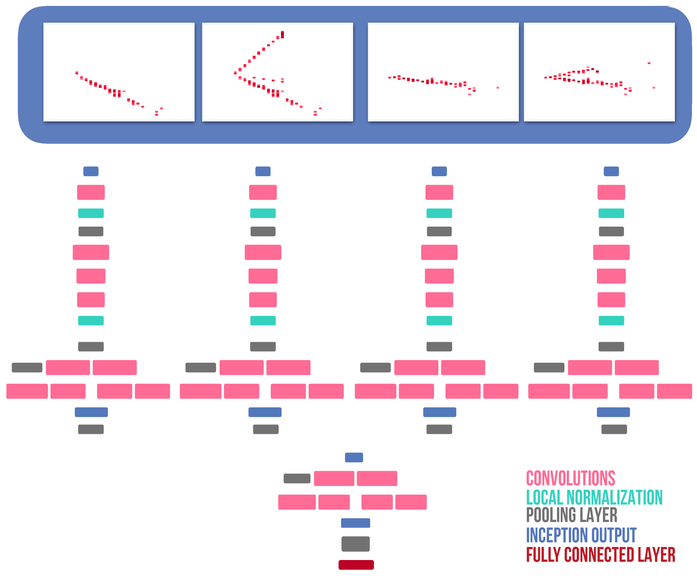
## Introduction

- NOvA is a long baseline neutrino oscillation experiment with a near detector at 1 km and a far detector at 810 km.
- The oscillation measurements depend on neutrino flavour identification and neutrino energy measurement.
- NOvA uses Convolutional Neural Network (CNN) for event classification.

## Prong CNN

- While NOvA uses Event CNN which can classify events, identification of final state particles of the event is needed to better our energy reconstruction and enable cross-section measurements of final states.
- Prong CNN goal is to identify all the final-state particles of a given neutrino event.
- Prong CNN uses a four-tower siamese-type architecture[1] for including context information i.e it takes both event (Context) views and prong (Independent) views.



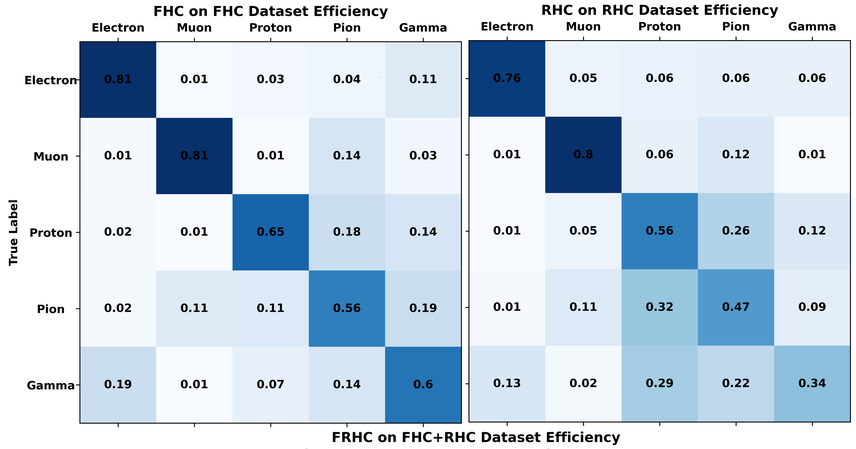

[1] F. Psihas, E. Niner, M. Groh, R. Murphy, A. Aurisano, A. Himmel, K. Lang, M. D. Messier, A. Radovic and A. Sousa, Phys. Rev. D **100**, no.7, 073005 (2019) doi:10.1103/PhysRevD.100.073005 [arXiv:1906.00713 [physics.ins-det]].

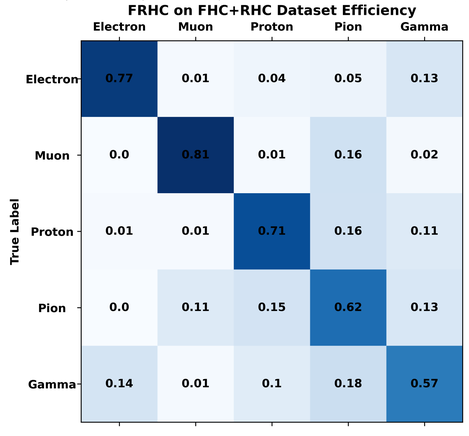
- The previous iteration of Prong CNN used by NOvA trained on neutrino (FHC) and anti-neutrino(RHC) dataset separately. In this work, the network is trained on a combined (FRHC) neutrino and anti-neutrino dataset and compared with the separately trained networks.
- Following selection cuts are used on the training sample:

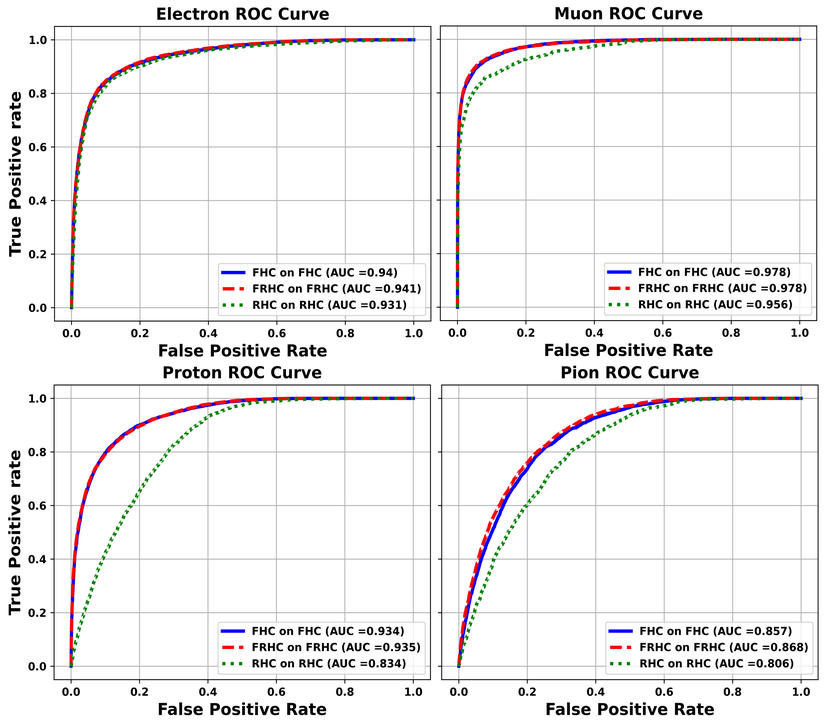
| Selection cuts | Description |
|---|---|
| Containment Cut | Selects the prong and the event contained within the detector boundaries |
| Cosmic Veto | Removes cosmic events |
| Purity Cut | Realistic looking cluster with prongs $\mu^{\pm}, \gamma$ : 50 %, $e^{-}$ : 40 %, $\pi^{\pm}, p^{+}$ : 35 % |
| Prong length | Cut prongs with prong length more than 5 m |

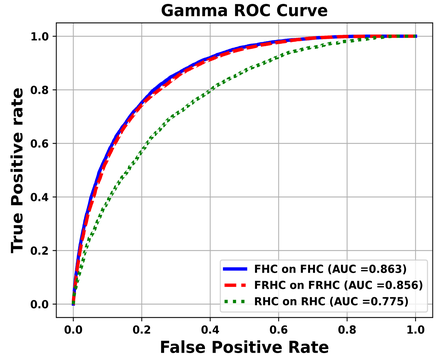
- The resulting dataset is then balanced to contain an approximately equal number of each type of particle.

## Results




## Conclusion and Future Work

- Preliminary training networks show that FRHC network is on par with RHC and FHC networks trained separately even though FRHC has double the dataset.
- **Future:** Will try to find if the network performance can be improved by tuning the network parameters.
- **Future:** Train with complete dataset and compare the three networks.
- **Future:** Check the effect of purity cuts on network performance.