# Mesonless $\overline{\nu}_{\mu}$CC Cross Section @ ProtoDUNE-ND

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# Outline

1. Preliminary Selection using ML Reco Information from CAFs
2. Data/MC Comparison Preparation

# Preliminary Selection using ML Reco Information from CAFs

*Main contributor: Andrew Cudd*

# Selection and CAF work update

Many thanks to the team of people updating and producing CAFs for analysis (especially since we keep sending you new bugs)

Most of the recent work regarding CAFs was exercising the reco to truth matching to benchmark the reconstruction and analysis

Primarily limited by available time (it is job application season) and low statistics (only 10 files in PicoRun4.1)

# Selection details

Attempted a rudimentary selection for mesonless (technically CC0pi) events using the CAFs (plots are from structured CAFs) using PicoRun4.1

Selection steps – loop over each interaction in each spill:

- Require 1 muon (either +/-), 0 pions, and 1+ protons as primary particles (no cuts on photons or electrons tagged as primaries)
- No requirement on the muon entering/exiting MINERvA
- No fiducial volume cuts
- No containment cuts

Basically selecting for particle content to obtain the most events

# Selection performance

Still see a vanishingly small fraction of reco interactions that contain 1 muon, 0 pions, 1+ protons as the reconstructed particles

Out of 1738 spills, find 4 / 3130 ~ 0.13% reco interactions that satisfy the selection criteria

Using the truth information the purity for those 4 reco interactions events is 50%

If we accept interactions with no reco proton (but still zero pions), then we select ~47% of reco interactions → proton requirement is a severe cut

Majority of these interactions are from rock interactions rather than events generated in the 2x2 detector

# Future work for the CAF selection

A short task list:

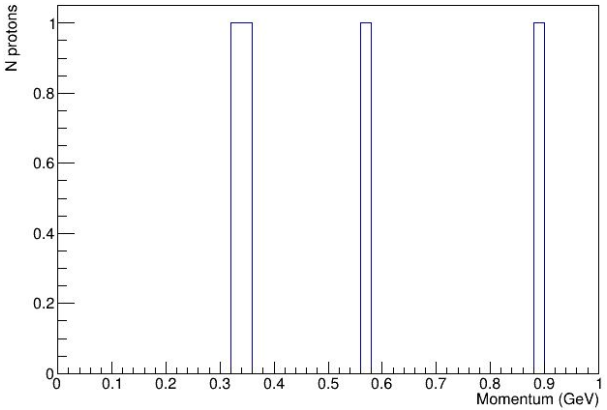
- Calculate more performance metrics using the truth information (e.g. efficiency)
- Plots of reco versus true kinematics
- Start adding more selection cuts (maybe this waits until unified 2x2 and MINERvA information)

Need to reorganize the code a little to better accommodate the truth information before it spirals out of control

Selected event with eight post-FSI protons (reconstructed as one)

```
Reco particles: [2212, 13, ]
True idx 0--> VtxID : 99000010 w/ overlap 0.970075
React : true|4
N prtn: 8
N neut: 4
N pip : 0
N pim : 0
N pi0 : 0
Nprim : 13
Nsec  : 2
Reco 2212
-> -13 w/ overlap 0.0447471
-> 2212 w/ overlap 0.0377358
-> 2212 w/ overlap 0.0555556
-> 2212 w/ overlap 0.0294118
-> 2212 w/ overlap 0.396226
Reco 13
-> -13 w/ overlap 0.898374
```

All 4 reconstructed protons



# Data/MC Comparison Preparation

*Main contributor: Elise Hinkle*

# Data/MC Comparison Preparation Summary

- **Working towards isolated proton selection with Bern single module data for data/MC comparison**
- Selection is not currently possible
  - Need Bern single module data to be **reflowed**
  - **Updates to geometry resource** in flow files are necessary to allow for fiducial volume cuts
- Contributions to **Bern module data reflow effort**:
  - Accounting of differences between *module0_flow* and *proto_nd_flow*
  - Gathering Module 1 files needed for reflow
- Contributions to **geometry resource update**:
  - Changing method names to update x/z coordinate switch + updating drift_regions
  - Changes currently in a feature branch and in the validation stage