MicroBooNE @ NuSTEC

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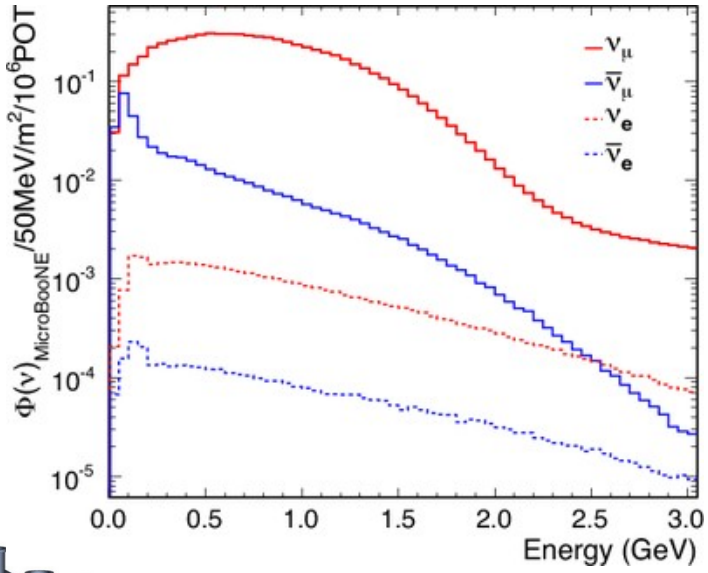
NuSTEC board meeting

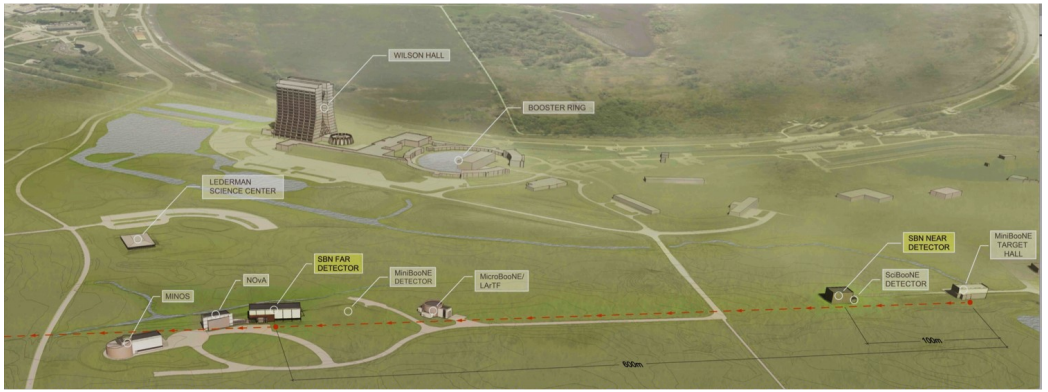
December 2019

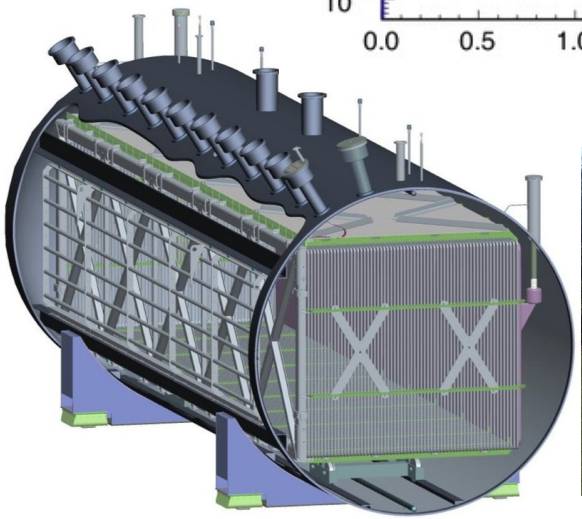
Disclaimer

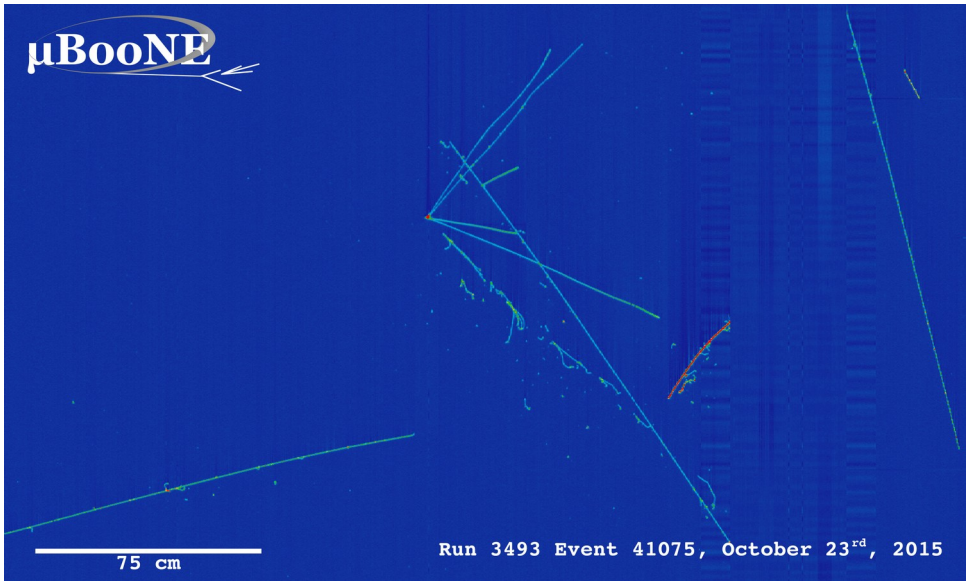
- Similar to other experiments updates…
- This is largely my own thoughts, though I try to stick to official MicroBooNE public statements

MicroBooNE

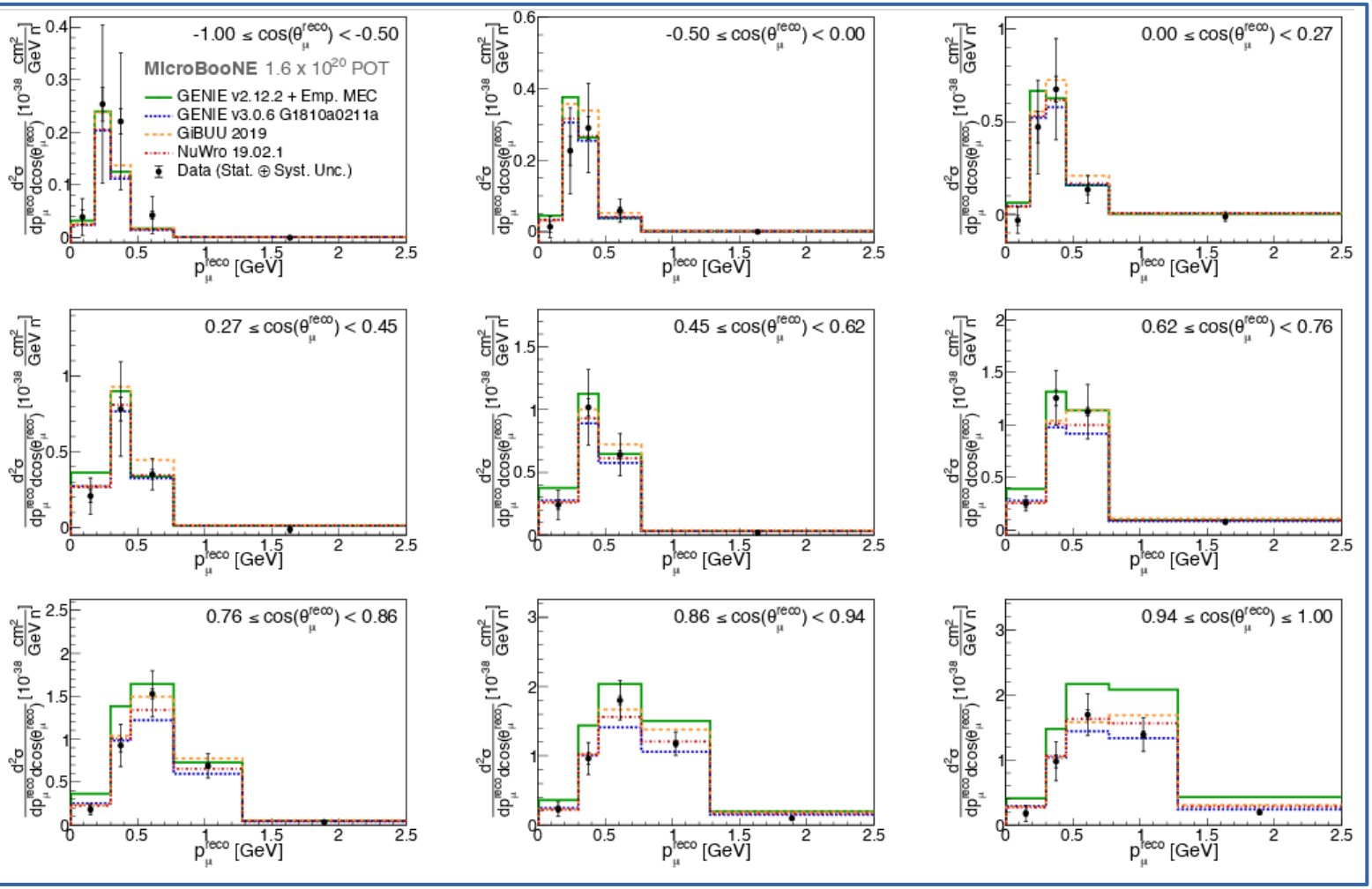

$\Phi(\nu)_{\text{MicroBooNE}}$/50MeV/m^2/10^{6}POT
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Energy (GeV)
ν_μ
$\bar{\nu}_\mu$
ν_e
$\bar{\nu}_e$

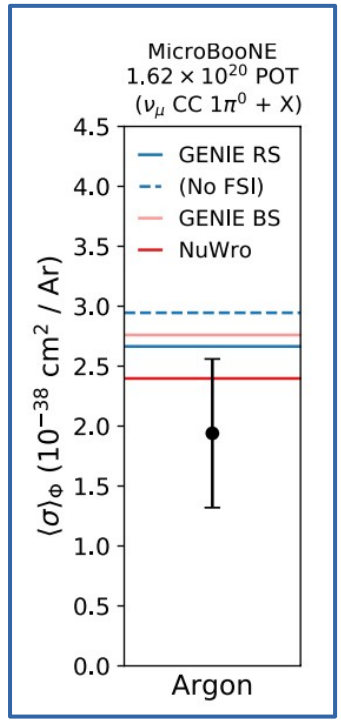

WILSON HALL
BOOSTER RING
LEDERMAN SCIENCE CENTER
SBN FAR DETECTOR
NOvA
MINOS
MiniBooNE DETECTOR
MicroBooNE/ LArTF
SBN NEAR DETECTOR
SciBooNE DETECTOR
MiniBooNE TARGET HALL




µBooNE
75 cm
Run 3493 Event 41075, October 23rd, 2015

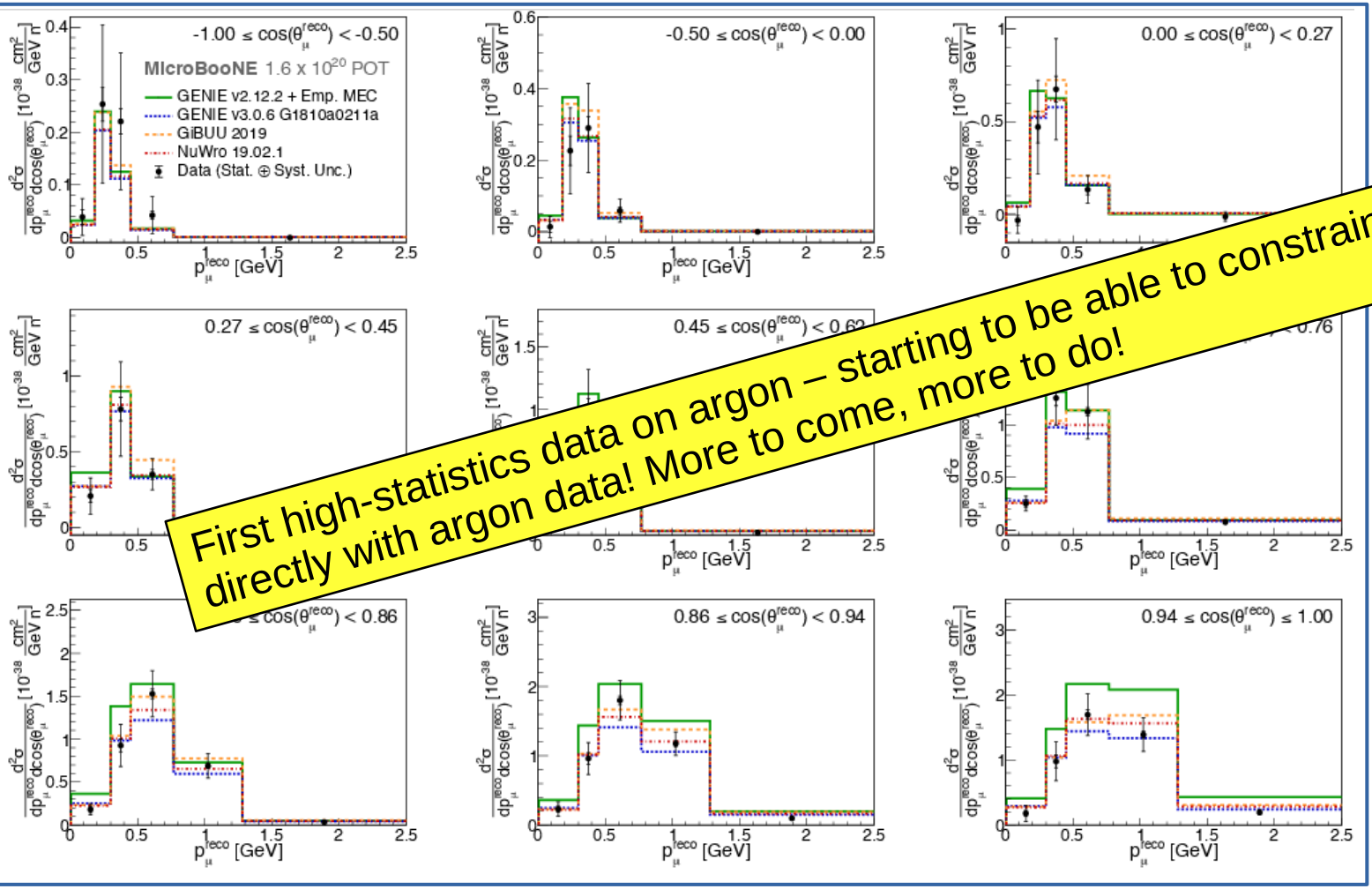
Since the last update



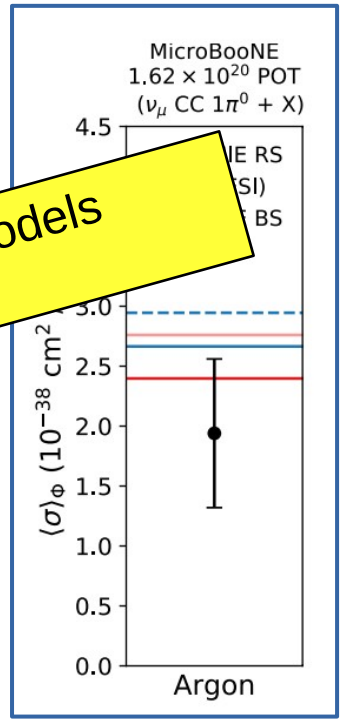


First xsec measurements!
1. CC-inclusive (diff)
2. CC-pi0 (integrated)

Since the last update



First high-statistics data on argon – starting to be able to constrain models directly with argon data! More to come, more to do!



First xsec measurements!
1. CC-inclusive (diff)
2. CC-pi0 (integrated)

Detector unfolding

- First measurements developed a “forward-folding” mechanism
  - Results presented in reconstructed variables
- We are interested to hear feedback from theorists, model builders, tuners, etc
  - Does this work? Can we make it easier?
  - We already know the methods can be made more accurate
- Likely a discussion for the CCWG

Low-energy excess search

- MicroBooNE's primary goal now is to "search for" the low-energy excess observed by MiniBooNE
- Cosmic backgrounds eliminated through requiring a proton
  - We would like to have some confidence in our **prediction of final state protons**
- Use the ν_μ spectrum to constrain the ν_e spectrum
  - **ν_μ/ν_e ratio on argon?**

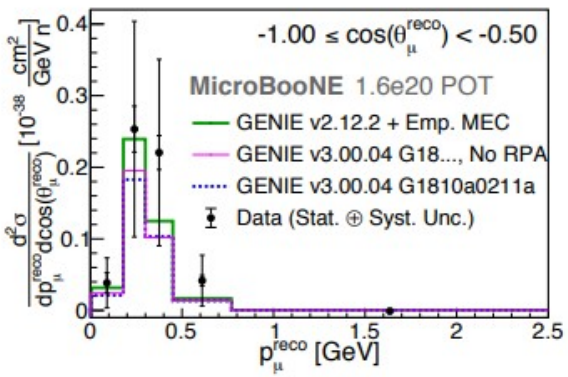
Protons

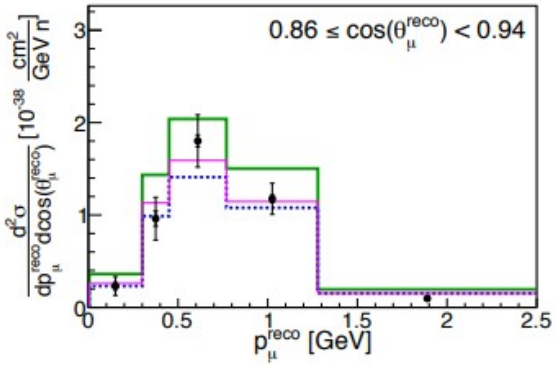
MEC models/uncertainties

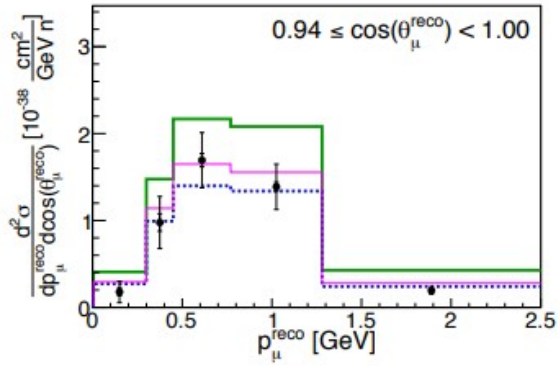
- We have two MEC models
- Neither make hadron kinematic predictions
- Neither really quantify uncertainties
- Total cross sections differ by 100%
  - This is a large systematic uncertainty for us
  - Is it a realistic estimate?

QE models

- We are at low energy and “large” nuclear size
- Lots of low Q^2 issues…
- Inclusive data sensitive in forward region to nuclear model and RPA corrections
  - No model that we tested achieves “good” agreement, though we are moving in the right direction







FSI

- Sensitive to low-energy hadrons
- Large differences between models
  - Largest differences sit just below our thresholds
- We would appreciate guidance from the generator/theory communities as to how to better assess uncertainties on FSI
  - And how to constrain this better with our own data

Ratio

Known unknowns

- MicroBooNE is (read – I am) very glad to hear about progress on radiative corrections!
- We place a 2% uncertainty on the ν_μ/ν_e ratio to account for these
  - Basically copying T2K
- We also have uncertainties due to second-class currents
  - Again, shamelessly stolen from T2K
- Is this “enough”? Other effects?

Nuclear size

- Strategy involves using external data (as far as possible) to select models and uncertainties
  - Most external data is on carbon
  - We don’t really know how to “add” uncertainty for scaling to argon
  - Any input here is greatly appreciated!
- Some data from MINERvA heavy targets – C/Fe
  - Attempt to “interpolate” to argon?

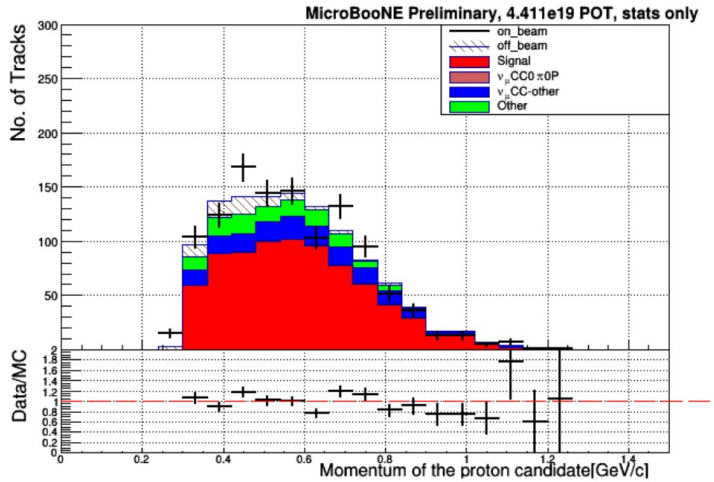
Coming results

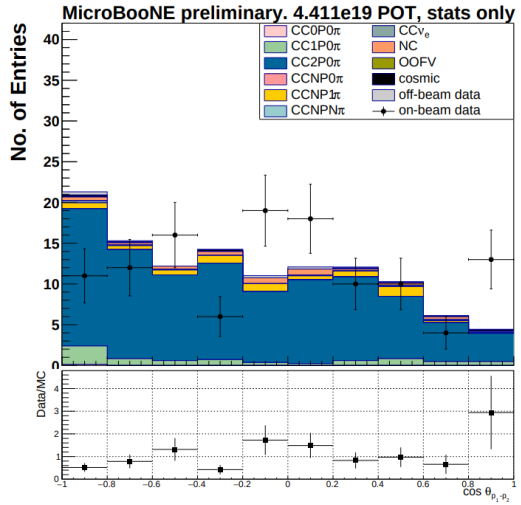
Exclusive channels

- Several exclusive channel analyses will come out soon:
  - CC0πNp
  - CC0π2p
  - “QE-like” CC1p
  - Semi-inclusive mu+p+X generator fitting
- And stepping up the energy:
  - CCπ0 differential measurement
  - CCπ^+

Proton measurements

- Current threshold of 300 MeV/c
- Cross section measurements in final stages
- Better ability to distinguish nuclear effects than inclusive data





Use of GENIE

- We are moving to GENIE v3
- Shows better agreement with most data
- Expecting to be the first neutrino experiment to do a GENIE v3-based analysis
  - Working hard to understand the uncertainties

Interpretations...

- All of these data are final state measurements
  - Mix of interaction channels, muddied by FSI
- We will try to interpret our data in this context (i.e. infer where tensions with models indicate problems with those models)
- But, people who know and understand those models better than us can help here!
  - Serves to benefit those models too, as a rigorous test of their accuracy