

# Update and Requests of the Track Multiplicity Group

# Plan Moving Forward

Reminder: We are a tool-based analysis group.

- Track multiplicity, as a measurement, is merely a light post to move towards.

Summer Goals (in ascending order of progress since last meeting):

- Develop rudimentary event selection with available reco output
- Understand the four FSI models in GENIE
- Develop systematics using the existing GENIEReweight tools in nusystematics
  - Sidebar: Geant4 modeling systematic uncertainties using Geant4Reweight.
- Brainstorm relevant detector systematics

# Reco-related Developments

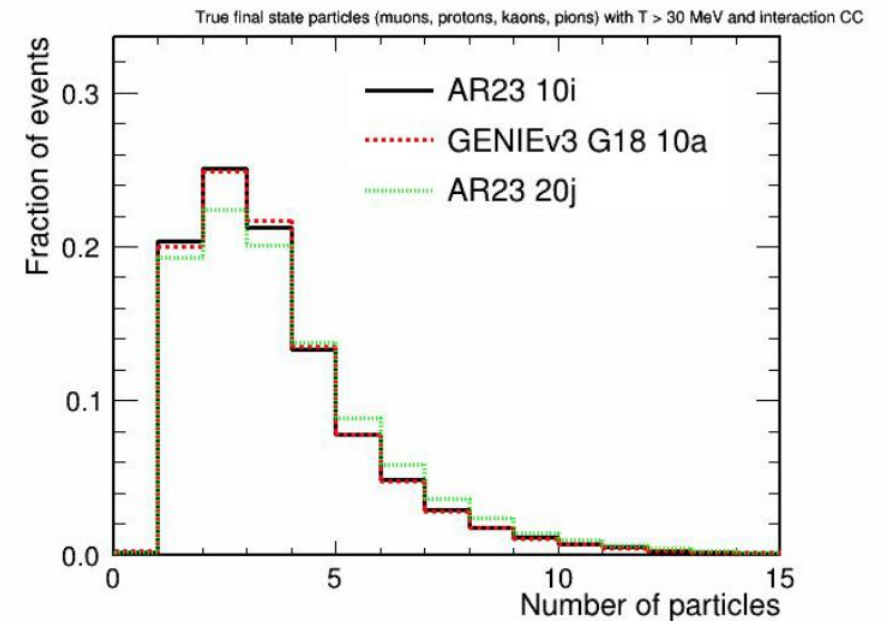
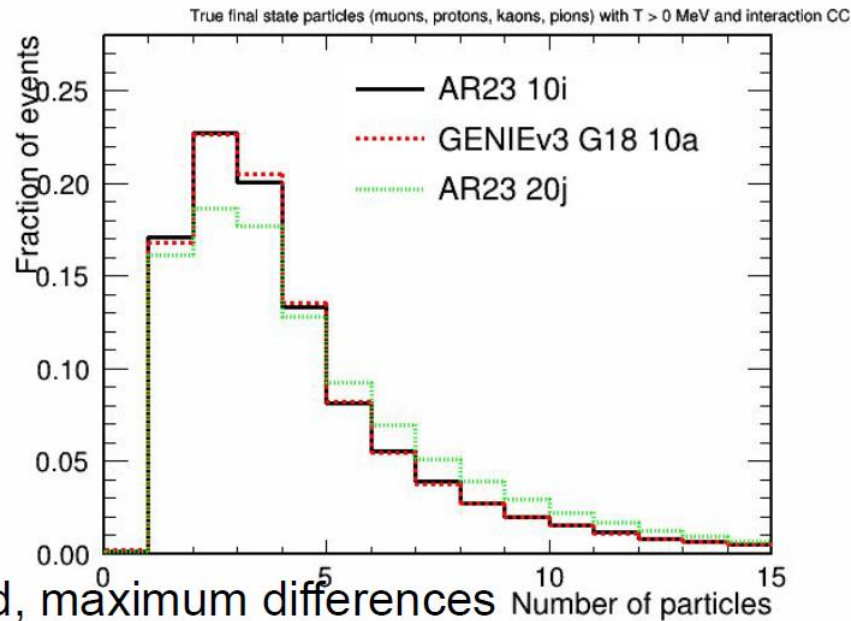
- Adapted a [python script](#) for Pandora to get full hits and backtracked information with help from LBNL.
- Pandora has a working validation code for experts.
- Pandora output suitable for users is planned for next Thursday's meeting.

Request: Any ntuples (about to be provided according to Pandora)

Question: What is the status of MLReco?

# Understanding the Four GENIE FSI Models

- Jan Kunzmann has done work comparing hA (empirical) and hN (cascade sim.):



- Request: Move from Laura's forked GENIE tune of GENIE v3.2 to AR23\_20i\_00\_000 in GENIE v3.4 (Will be in MiniRun4, so this has been accepted and adopted)
- Request: Add INCL++ and Geant4 to the usable builds on DUNE Fermilab machines (posted to chat, Robert Hatcher has not acknowledged it, but I noticed some non-working preliminary builds are on ups)

# GENIE Systematics and More

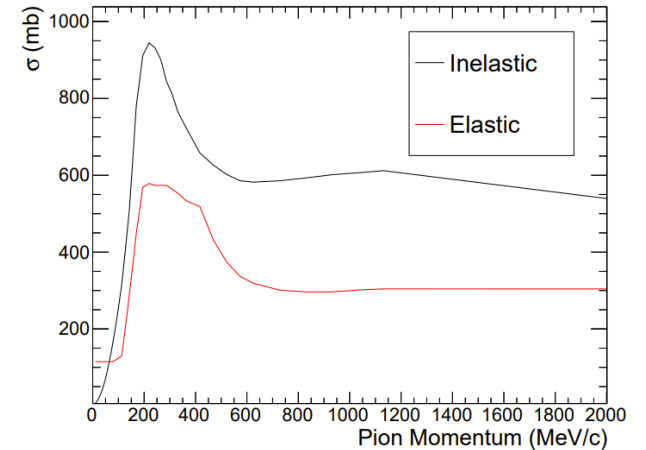
- Rik and Laura will give talks soon over NUIWG2 and 2x2 in July and August.
- Steve Dytman suggested using all hA dials (the only FSI dials to exist):
  - See if it covers the other three models (see [MicroBooNE's method](#))
  - If it does, then great, we can move on to uncertainties with the neutrino scattering model and focus less on the intranuclear cascade.
- Question (for me): Can nusystematics handle the exclusive cross section reweights in GENIEReweight.
  - Can reweight say, pion charge exchange, but need to make sure that a change to pion charge exchange keeps the total inclusive pion cross section the same.
- Request: Generic and new parameters outside GENIEReweight and timelines for these new parameters.

# Geant4Reweight

- Question from DUNE: Could Geant4Reweight be adapted for edepsim and how could we save the information.
- Discussed with Jake Calcutt (the creator) about implementation.

## Suggestions:

1. Need to use small slices to accurately generate weight
  - Should not use the track length since we miss structure of the xsec due to energy loss.
  - Cannot just use CAF info to generate weights then.
2. Edepsim segments can be used if they are sufficiently small and do not interpolate track length.



**Figure 1.** Geant4 cross section predictions for  $\pi^+$ -Ar interactions. Pion cross section from *JINST 16* P08042. Notice the small width of the peak.

$$w_1(l_1, E_1) \quad w_2(l_2, E_2) \quad w_i(l_i, E_i)$$
$$\text{weight} = w_1 * w_2 * \dots * w_i$$
$$\text{weight does not equal } w(l_{\text{tot}}, E_{\text{avg}})$$



Hopefully, it does not do this.

# Detector Systematics

- We need to understand the calibration process first.
- For example:
  - MicroBooNE laser+cosmic [tracking resolution studies](#) (for SCE, which we won't have)
  - MINOS method for calorimetry in LArTPCs from [ProtoDUNE-SP](#) and [MicroBooNE](#).

Request: We need a scheme or organizational chart so we can start planning.  
(Not urgent since we have predecessors)

Request: We should not do the [WireMod method](#). We have too many channels and not enough cosmics.