n-Ar Cross Section Analysis: Light Validations

Angela White on behalf of the 2x2 neutron analysis team,
08.18.2023

Motivation: n-Ar Inelastic Cross Section

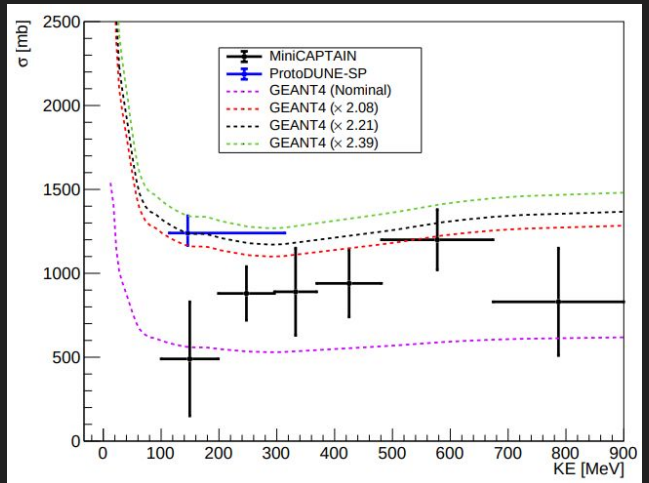
Both MiniCaptain and ProtoDUNE-SP n-Ar cross section measurements suggest Geant4 cross section mis-modeling

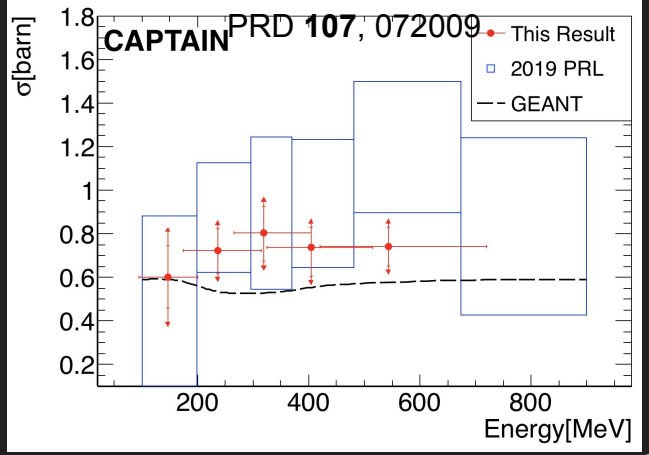
⇒ *Neither using n from ν*

Inform DUNE OA hadronic energy uncertainty

⇒ 20% energy response uncertainty ascribed to neutrons in FD TDR

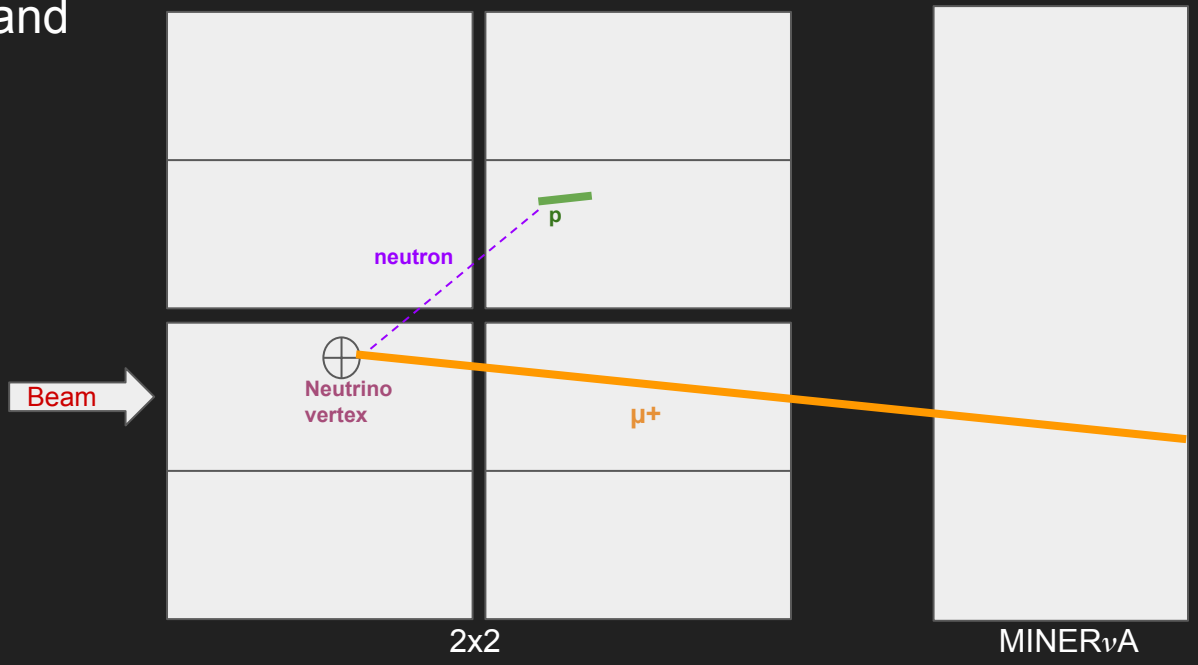
David Rivera, UPenn Dissertation 2021





Light Requirements:

- Q+L matching efficiency and timing resolution must be optimized for this measurement
- Both involve the LRS
- Focus is on:
  - ν vertex identification
  - Matching p blip/track with associated μ track across modules
- This study involves Q+L matching



Study Goals:

First Step:

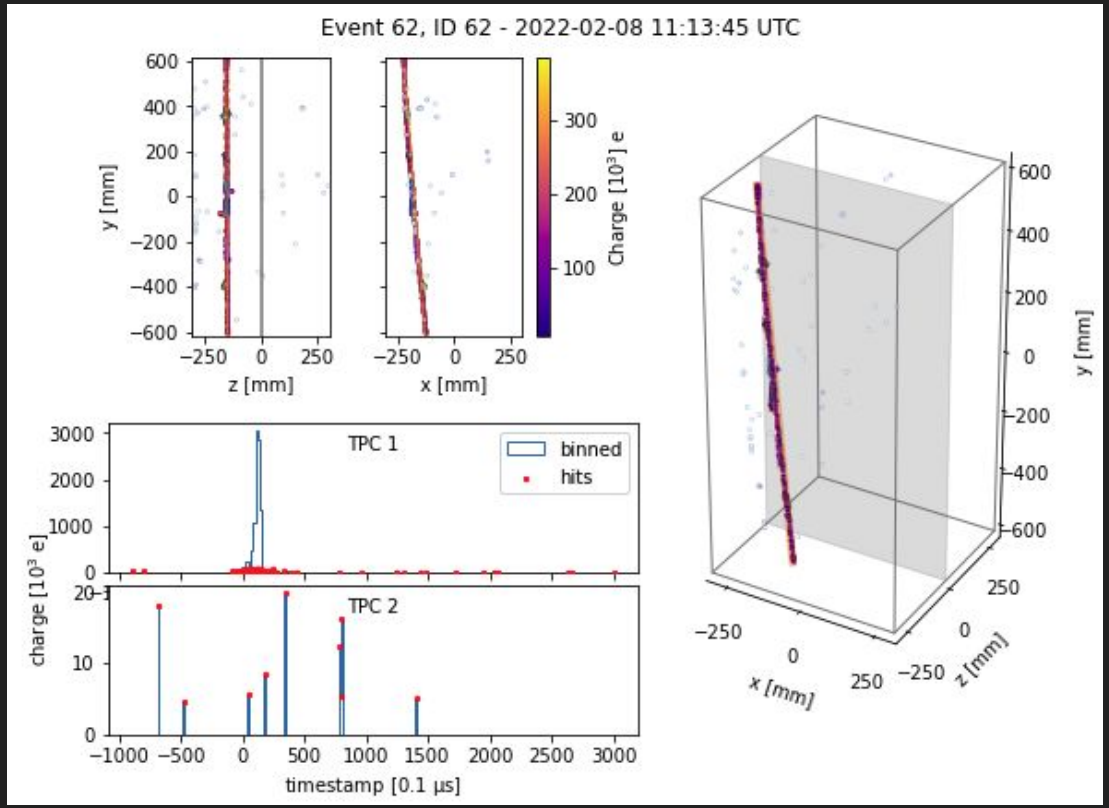
- validate light signal amplitudes produced by larnd-sim using direct data comparisons

  In doing so:

  - Streamline ndlar-flow pipeline for data processing ahead of 2x2 data-taking
  - Improve Q+L matching using data from module 1 (and, eventually, 2 and 3)
    - (currently a main focus, working with Livio Calivers and Karolina Wresilo)

Methodology:

1. From Module 1 L+Q matched data, select tracks that are:
   a. Through-going
   b. Don’t touch the cathode
   c. Don’t touch the LRS
   d. Have no shower-like features
2. Build a mock edep-sim file using events
3. Feed file through larnd-sim, compare sim. waveforms with data waveforms



Data File: /global/cfs/cdirs/dune/www/data/Module1/TPC12/dataRuns/packetData/packet_2022_02_08_12_48_18_CET.h5

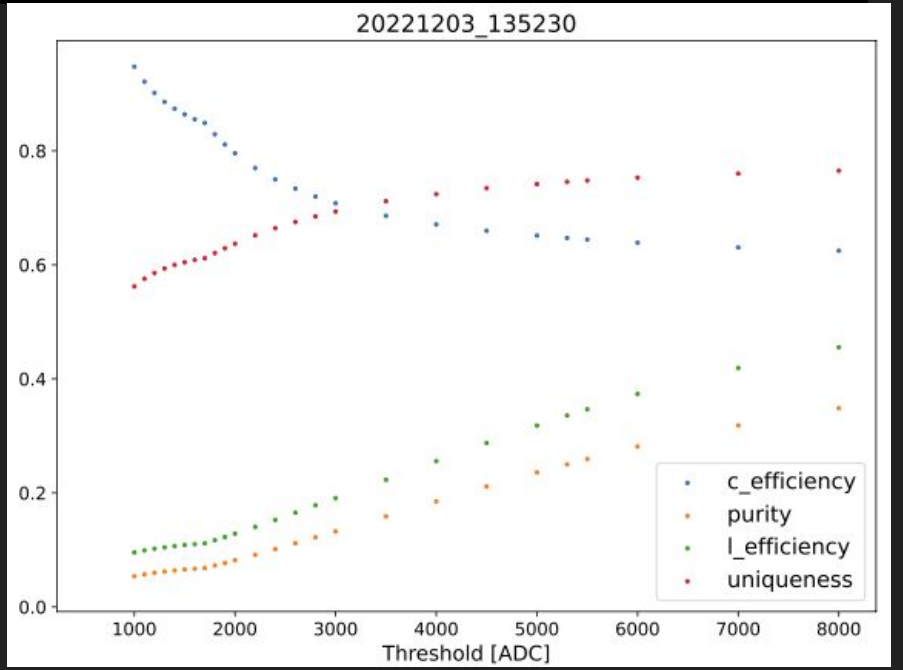
Additional Check to Ensure Validity of Study:

- Test workflow with pure simulation:
  - Take ndlar-flow simulation output file and select events as similar as possible to those in the data selection
    - (cosmic-free NuMI production, for 1st pass)
  - Put simulated charge through workflow to produce mock-edep sim file
  - Run through larnd-sim
  - Compare output
- Pure simulation test should be completed by middle of next week.

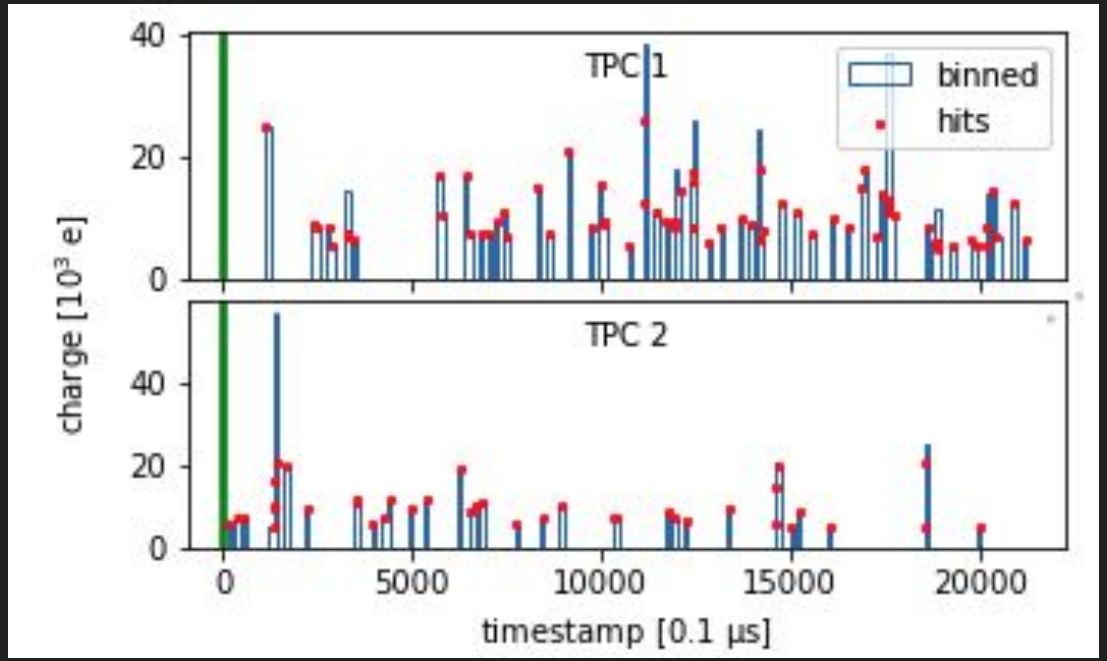
Currently:

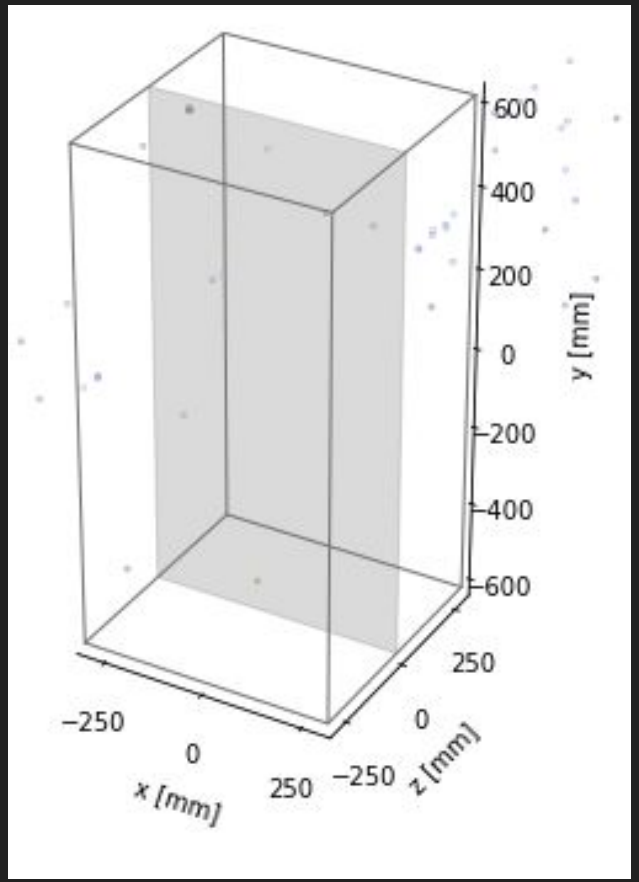
- Charge-Light matching currently not working for Module 1 data
  - Myself and Livio, with help from Karolina, are working on solutions
- Much higher rates of matching are achievable (see Karolina's plot for Module 2 data)
- Goal: have viable, matched events by next Tuesday
-

```
~~~ FINISH ~~~
H5FlowDatasetLoopGenerator.finish()
charge_light_associator.finish(charge/events)
Total charge trigger matching: 5/54045 (0.0001)
Total charge event matching: 4/62377 (0.0001)
Total light event matching: 4/8430 (0.0005)
RunData.finish(charge/events)
~~~~~~~~~~~~~~~
```



Currently, have 4 matched events:





Further Progress:

- By end of today, will have produced 1st mock-edep sim file
  - Currently using ‘tracklets’ field to mimic ‘segments’
  - Goal: build hit-to-hit groupings for ‘segments’, instead
- Livio has preliminary validation plots ready to use
- Try running light-charge matching on Module-0 data to make sure matching issues are specific to Module-1 setup

For anybody interested in getting involved:

- Before anything else, we need to get light-charge matching working in ndlar-flow for a generalized data input