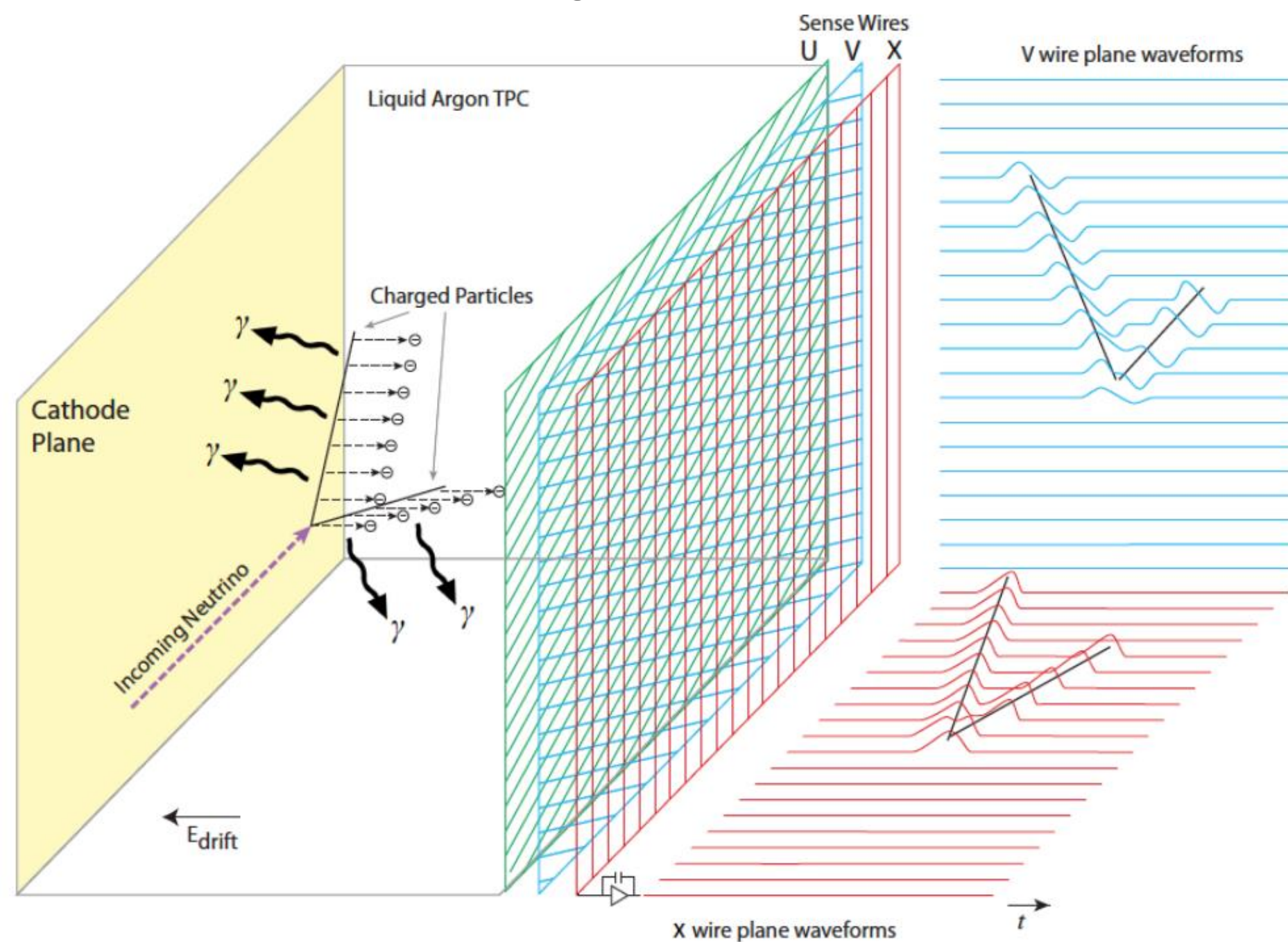


# Measurements of a Total Inelastic K+-Argon Cross Section at ProtoDUNE-SP

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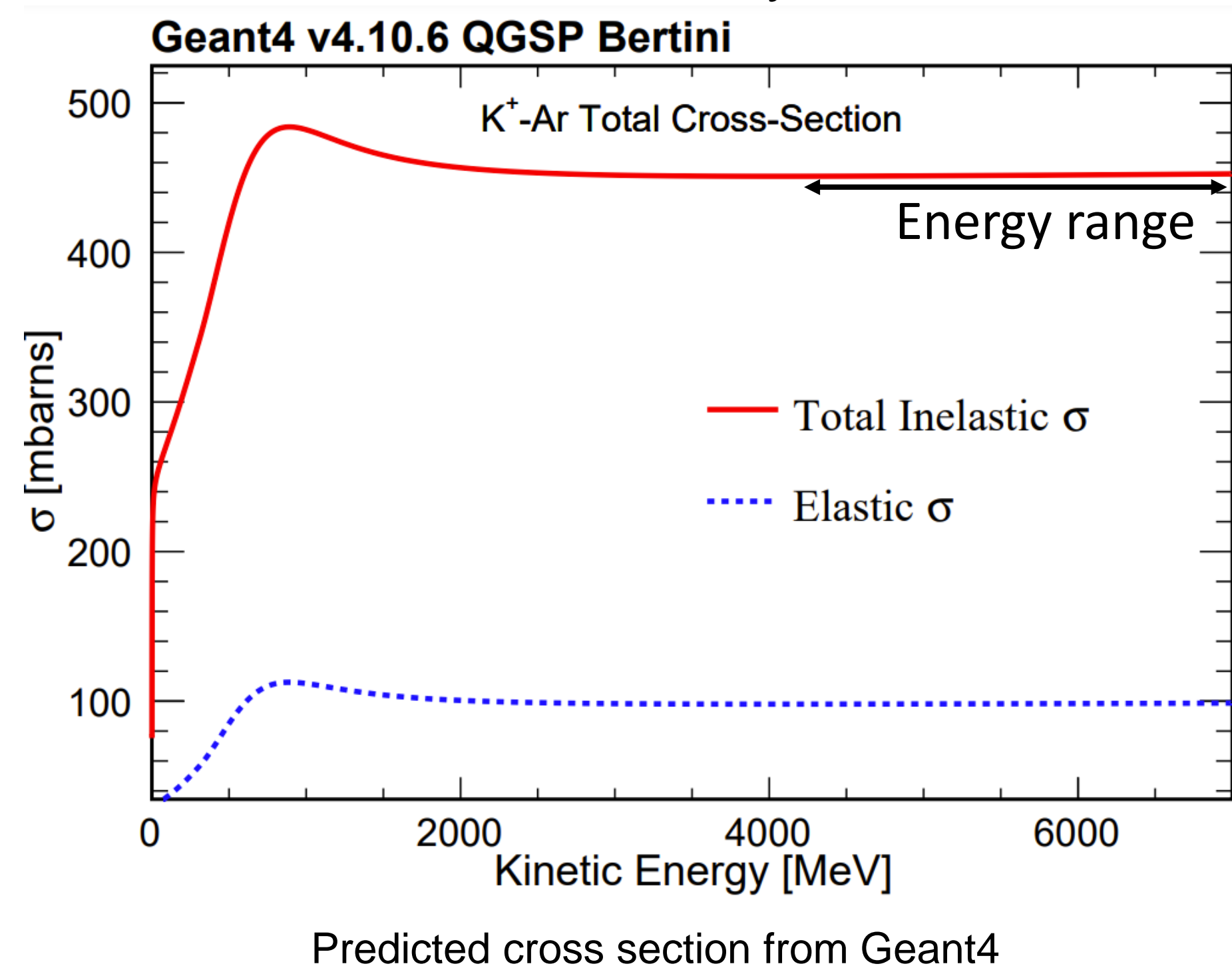
## Introduction

- ProtoDUNE Single-Phase (ProtoDUNE-SP) is full-scale prototype of a Deep Underground Neutrino Experiment (DUNE) Far Detector module.
- Operates as a liquid argon time projection chamber.



Cartoon of a liquid argon time projection chamber. [JINST 15 T08008](#)

- Exposed to the CERN SPS H4-VLE beam ([PRAC 22 061003](#)).
- Produces 6 and 7 GeV/c kaons used to study interactions in the argon.



## Methodology and Event Selection

- Uses the *thin slice* method ([PRD 106 052009](#)) to measure cross section.
  - Based on the survival probability of particles in a medium:

$$N_{\text{surv}}(d) = N_{\text{inc}} \exp(-d/l) = N_{\text{inc}} \exp(-\sigma dn)$$

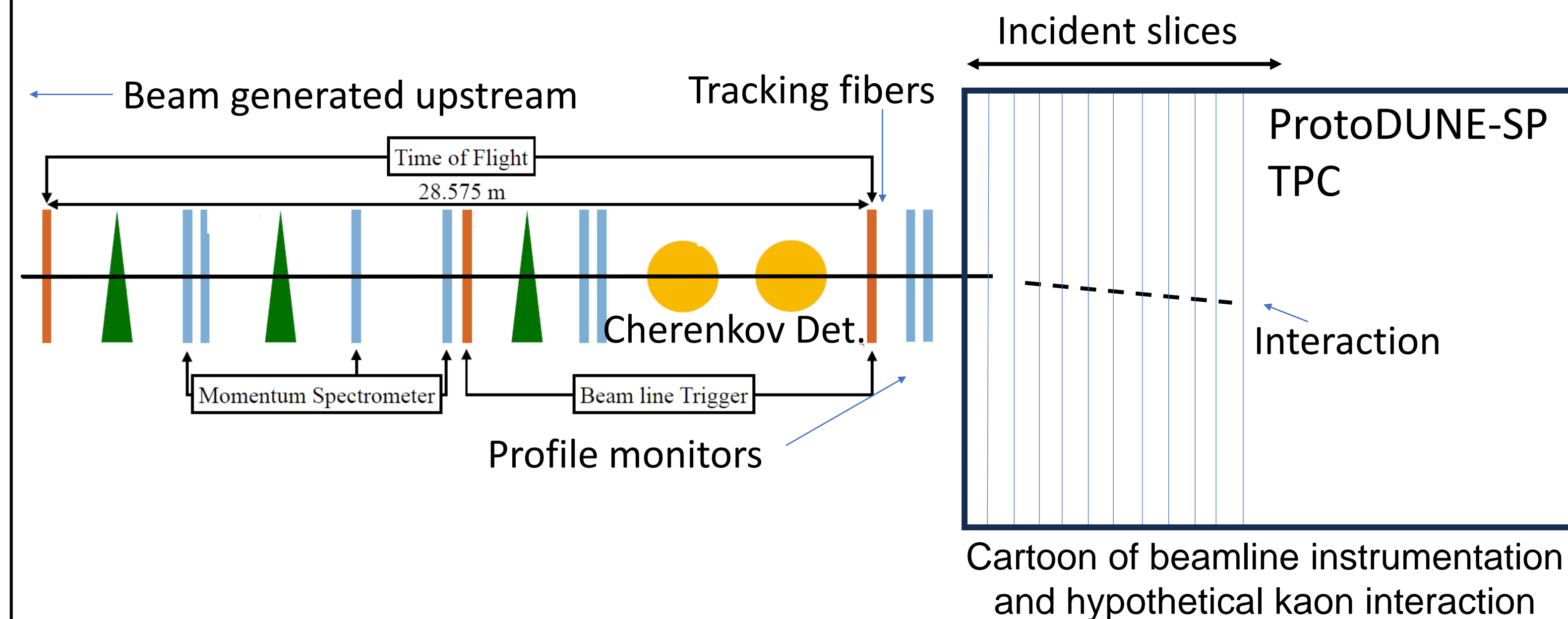
- Altering the equation into *thin slices* of the detector:

$$\sigma(E_{\text{kin}}) = \frac{M_{\text{Ar}}}{N_{\text{Ar}} r \rho} \ln \left[ \frac{N_{\text{inc}}(E_{\text{kin}})}{N_{\text{inc}}(E_{\text{kin}}) - N_{\text{int}}(E_{\text{kin}})} \right]$$

Labels: Avogadro's number, Mass of argon, Incident and interacting slices, Pitch between slices, Liquid argon density

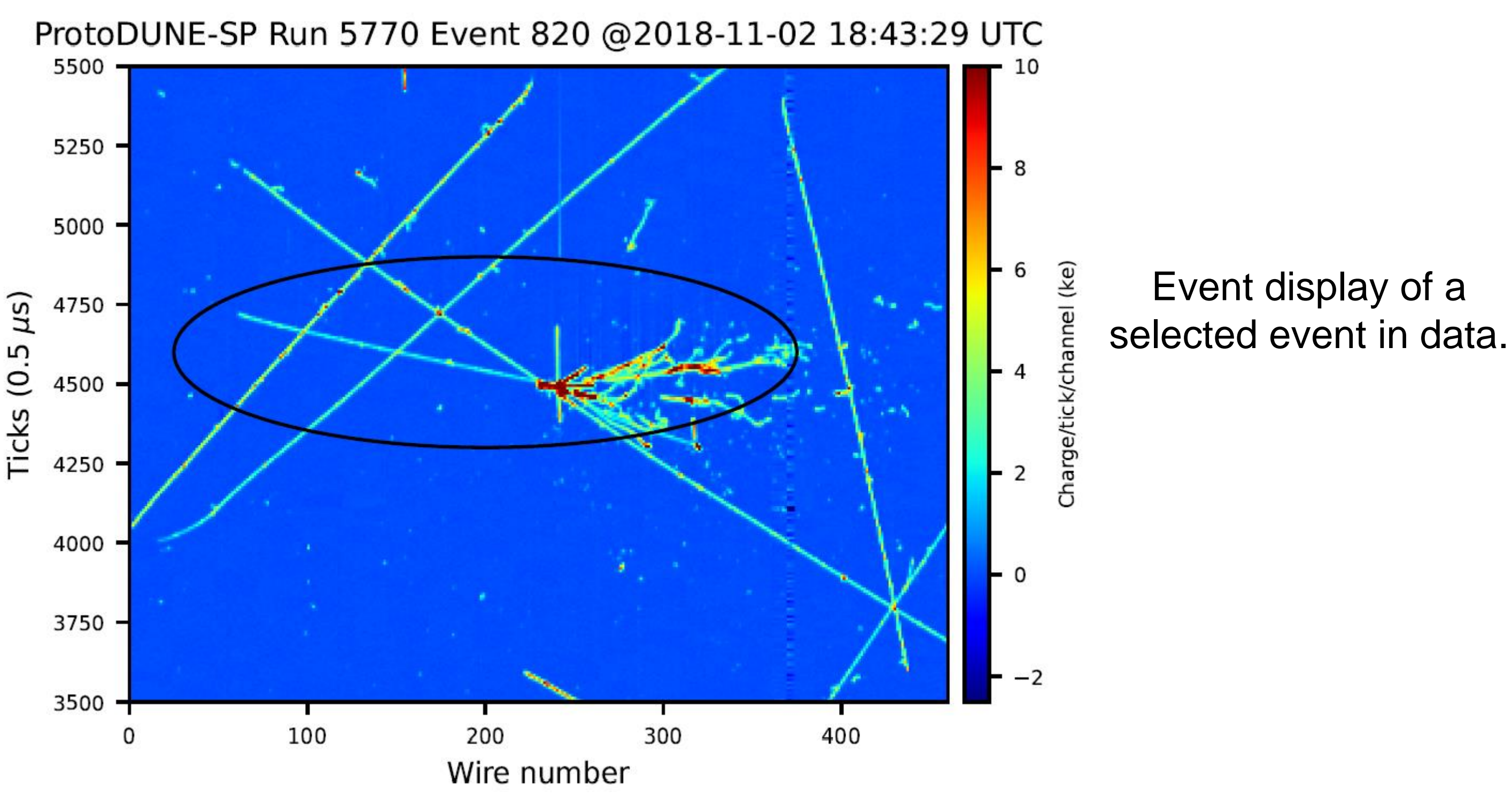
### Event Selection:

- Beamline instrumentation identifies kaon with Cherenkov detectors.
- Reconstruction ([EPJC 83 681](#)) selects a TPC track.
- The TPC track must agree with beamline instrumentation tracking information.

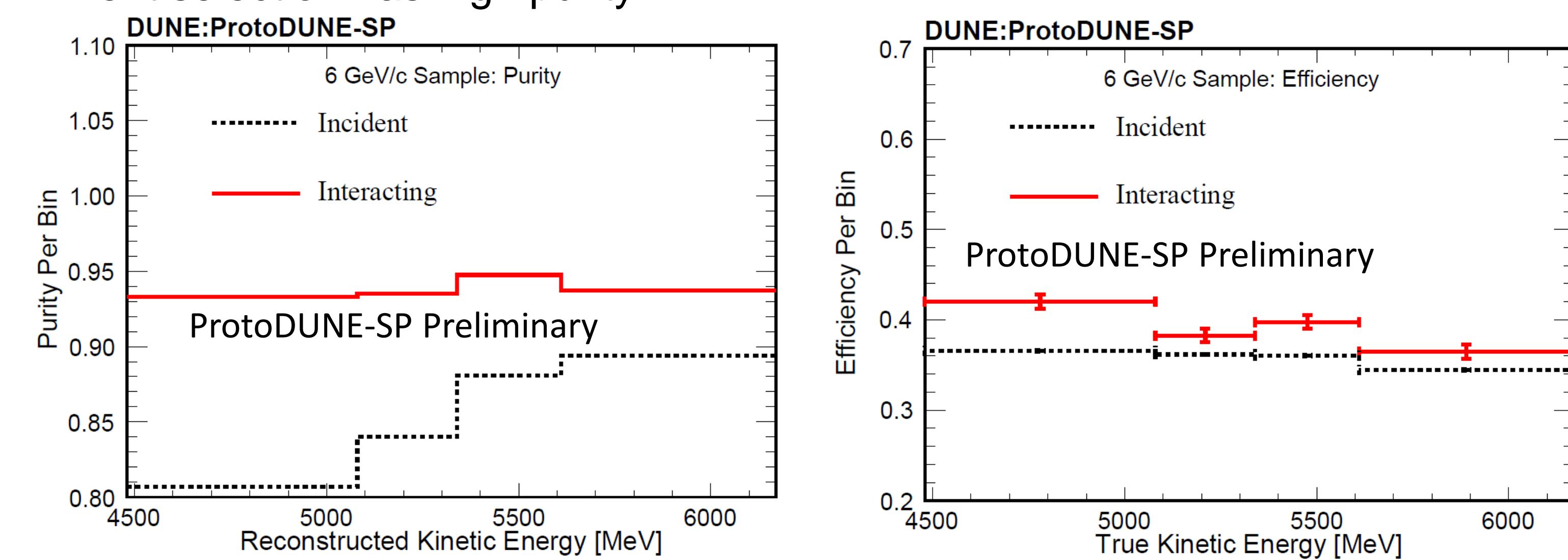


- Interaction point identified where reconstructed track ends.
- Signal def.: Scattering angle >11 degrees and/or more than >1 secondary.

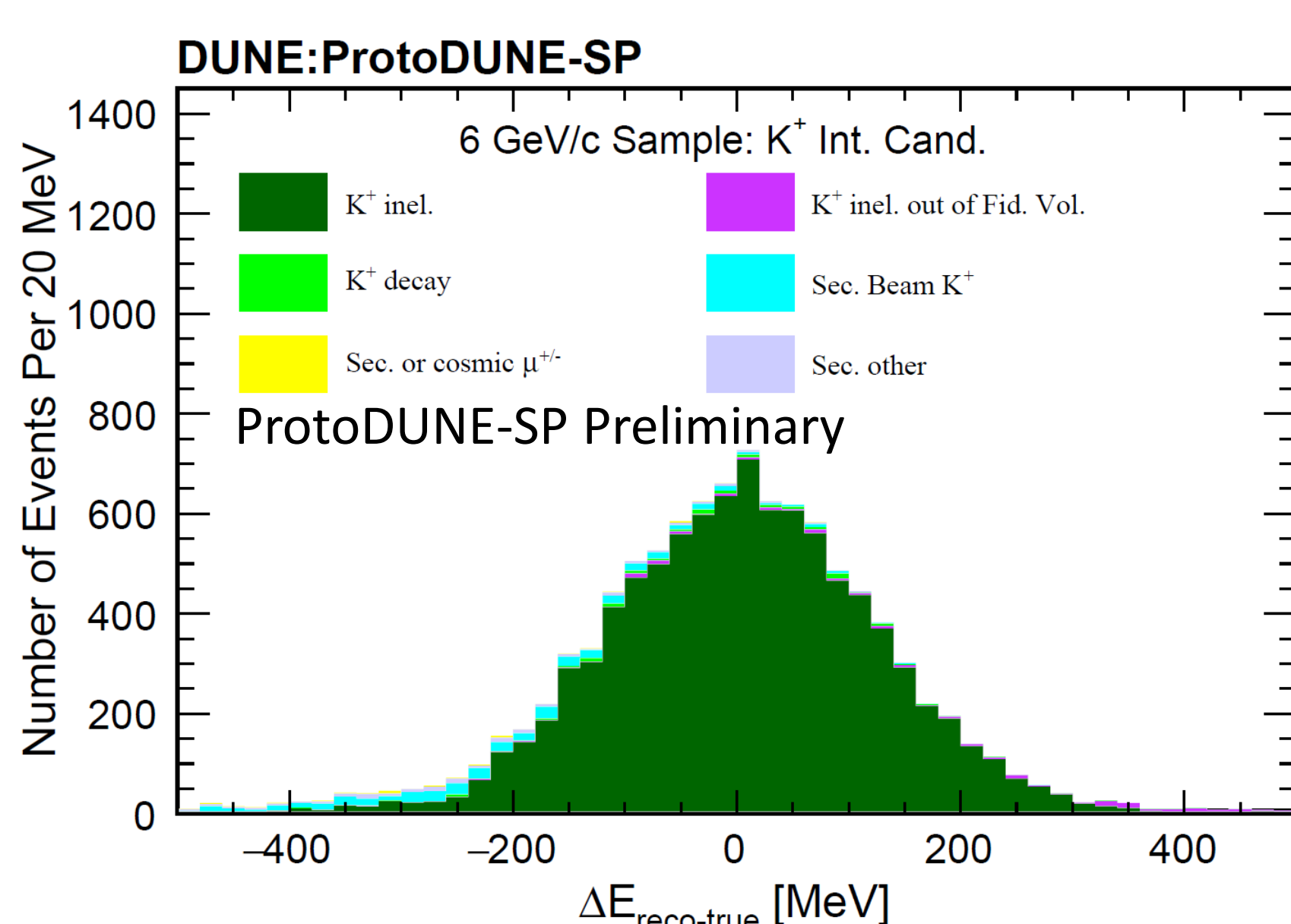
## Results from Event Selection



- Event selection has high purity:

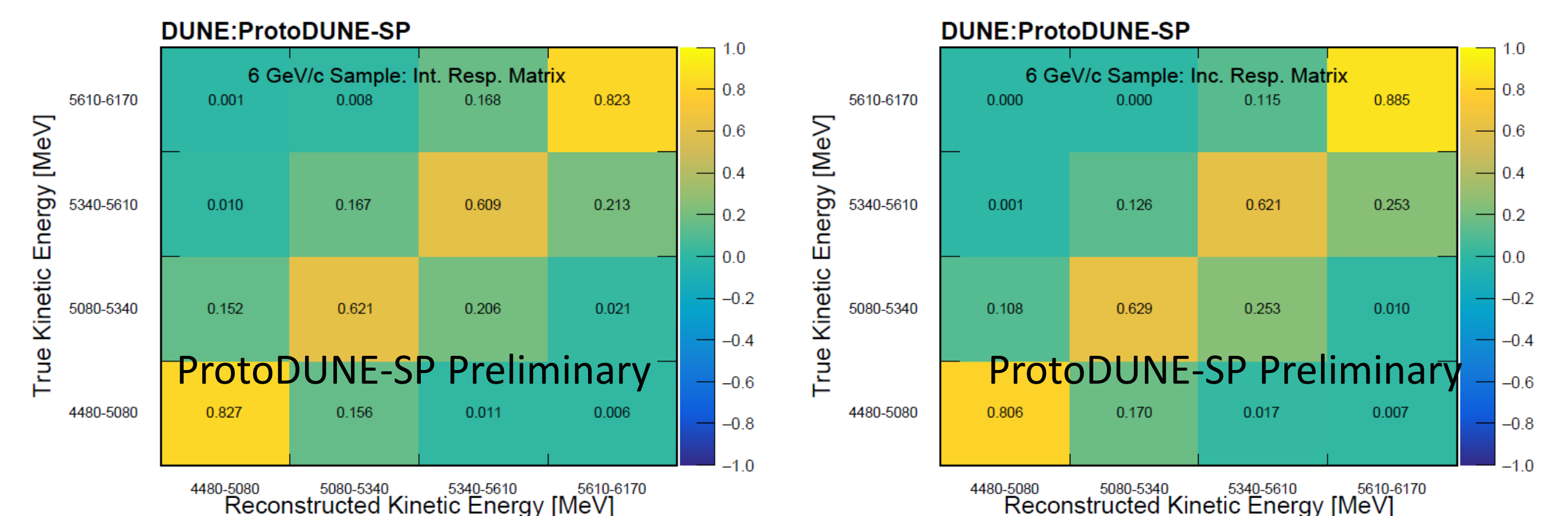


- Low efficiency driven by events without a TPC track.
- Simulation shows method has unbiased interaction point energy reconstruction.

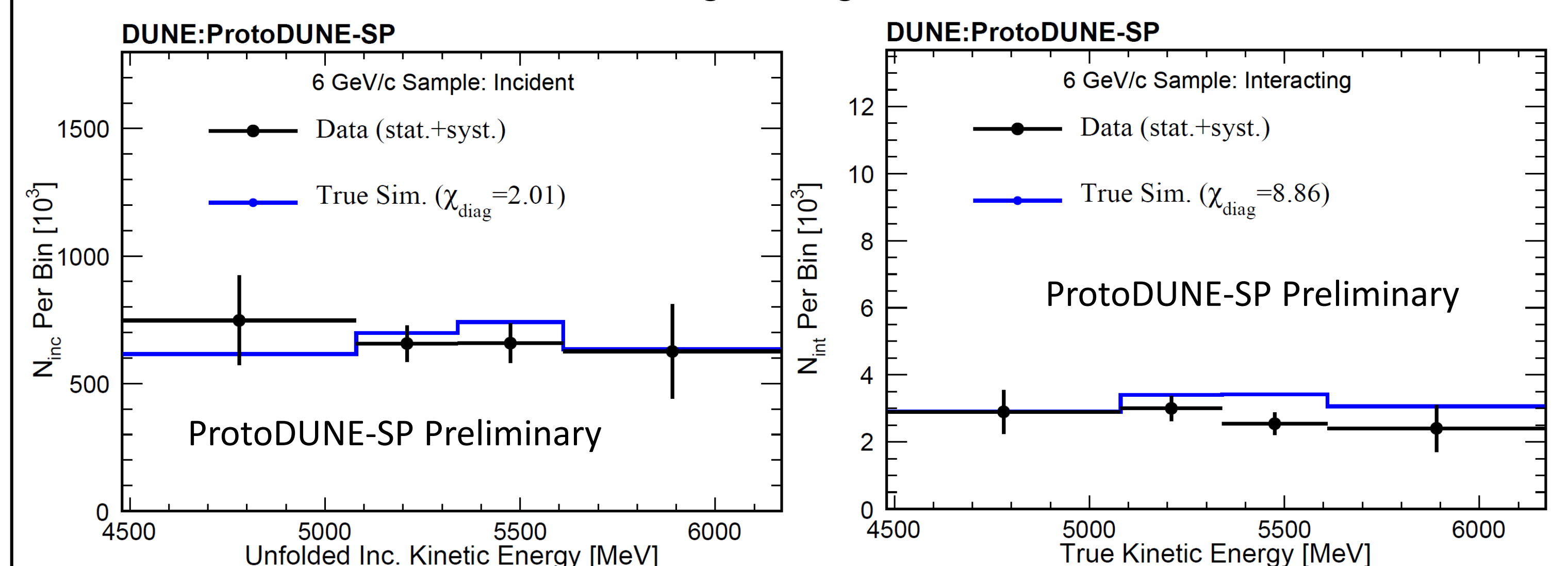


## Cross Section Measurement

- Incident and interacting slices have purity, [unfolding](#), and efficiency corrections applied using a [Bayesian-like algorithm](#) based on [Lucy-Richardson](#) deconvolution
- Response matrices:



- Unfolded data distributions have good agreement with true simulation.



- Unfolded histograms applied to the *thin slice* equation to calculate cross section.
- Both GENIE and Geant4 overestimate the cross section by around 15%.

