



Introduction

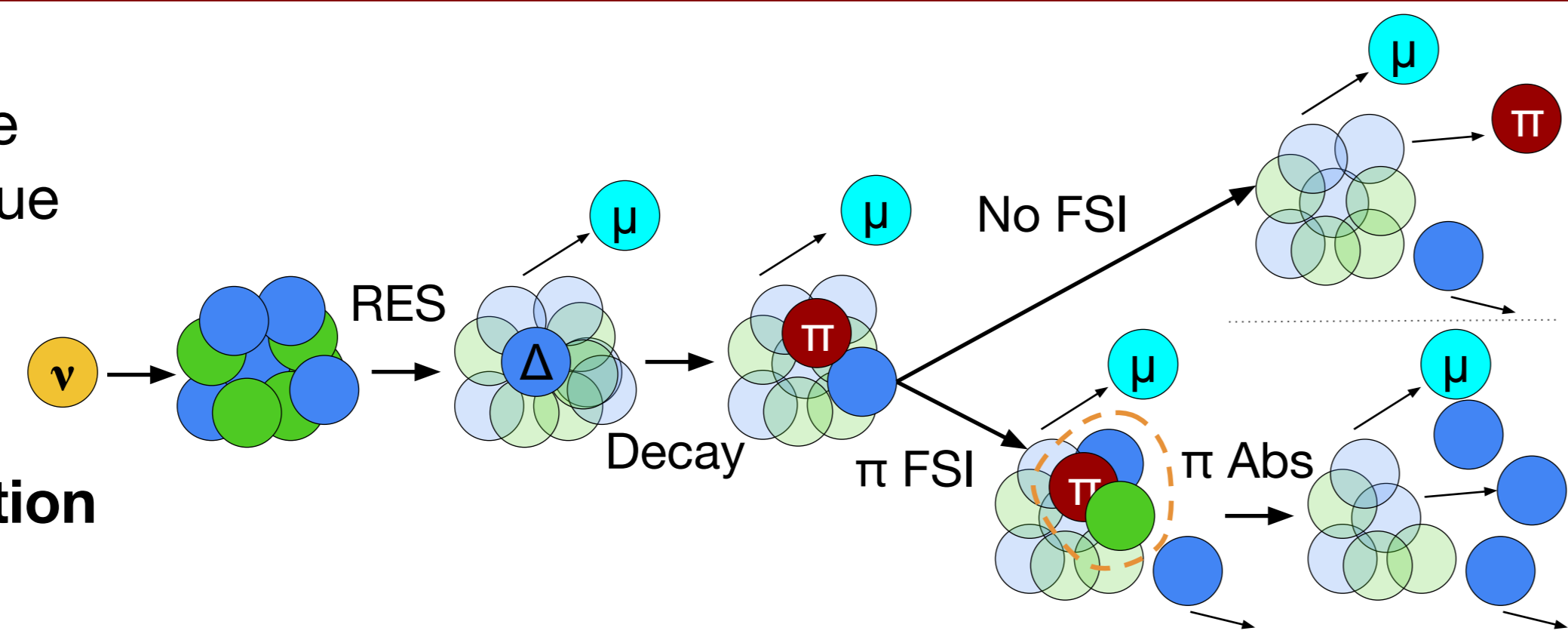
WHAT:

First measurement of negative pion absorption and scattering cross sections on argon

- 0-500 MeV pion kinetic energy
- Uses LArIAT Run II low-energy data.

WHY:

- DUNE's largest uncertainties come from cross section uncertainties due to neutrino-nuclear interactions, including final-state interactions.
- Large modeling uncertainties
- Affects neutrino energy reconstruction and interaction classification



HOW WE ADDRESS THE ISSUE:

Direct hadron-argon measurements improve pion final-state interaction models for liquid argon neutrino experiments and reduce uncertainties.

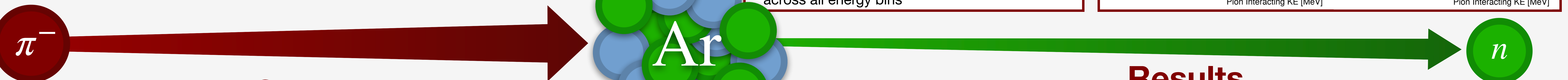
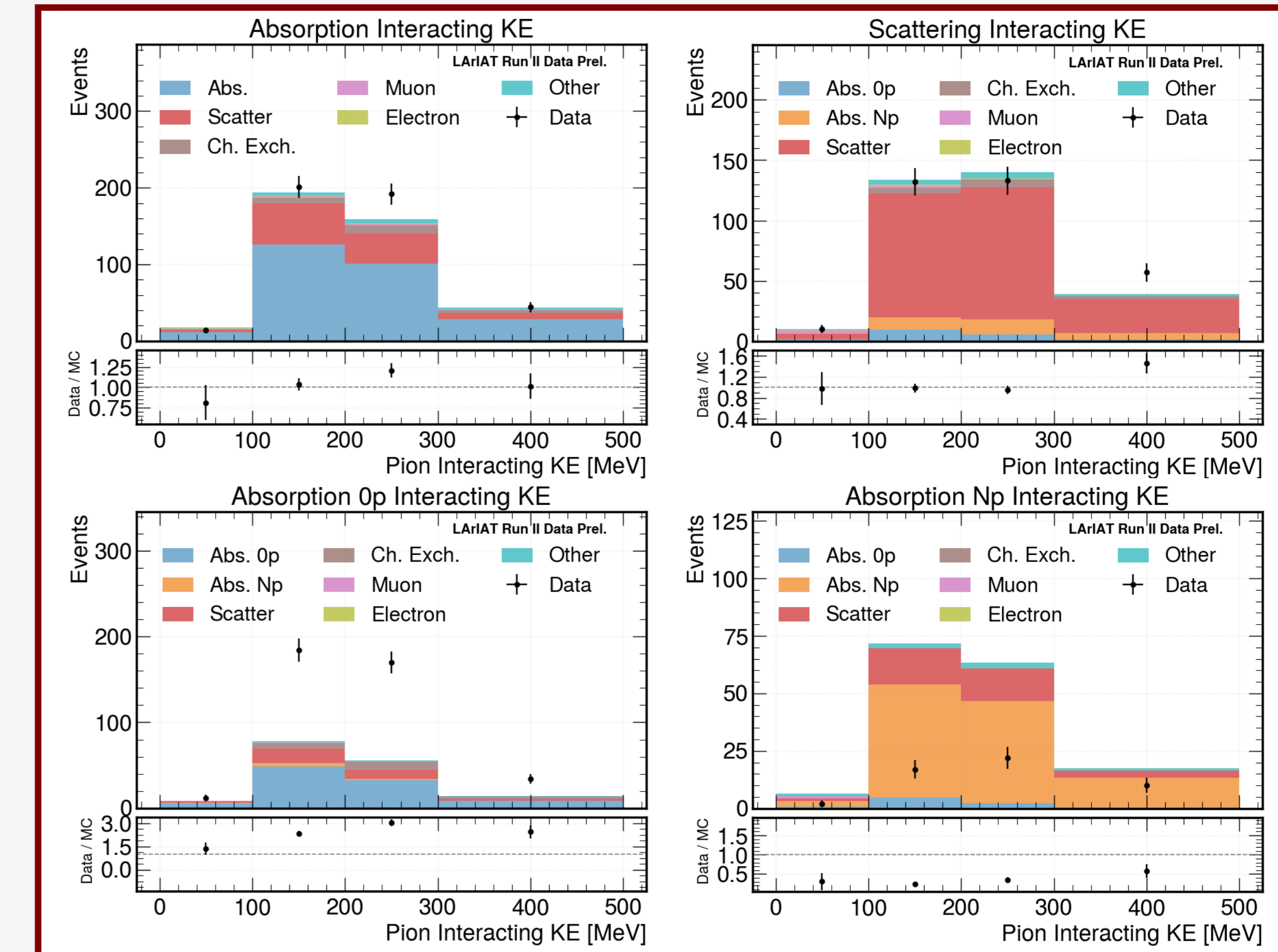
Selection statistics:

- 400 absorption 0p, 51 absorption Np, and 332 scattering events selected in data
- Scattering achieves the highest purity at 76%; absorption channels reach 60% (0p) and 68% (Np) purity and 69% combined
- Efficiency is 12% for scattering, better secondary track containment would help increase this
- Absorption has 31% efficiency (inclusive) and high cross-contamination between 0p and Np

Selection results:

- Inclusive absorption ($\chi^2 = 1.9$) and scattering ($\chi^2 = 2.2$) counts are in broad agreement with Geant4 10.3.p3.
- 0p events are underpredicted ($\chi^2 = 101.4$) while Np events are overpredicted ($\chi^2 = 18.7$) across all energy bins

Interacting Counts



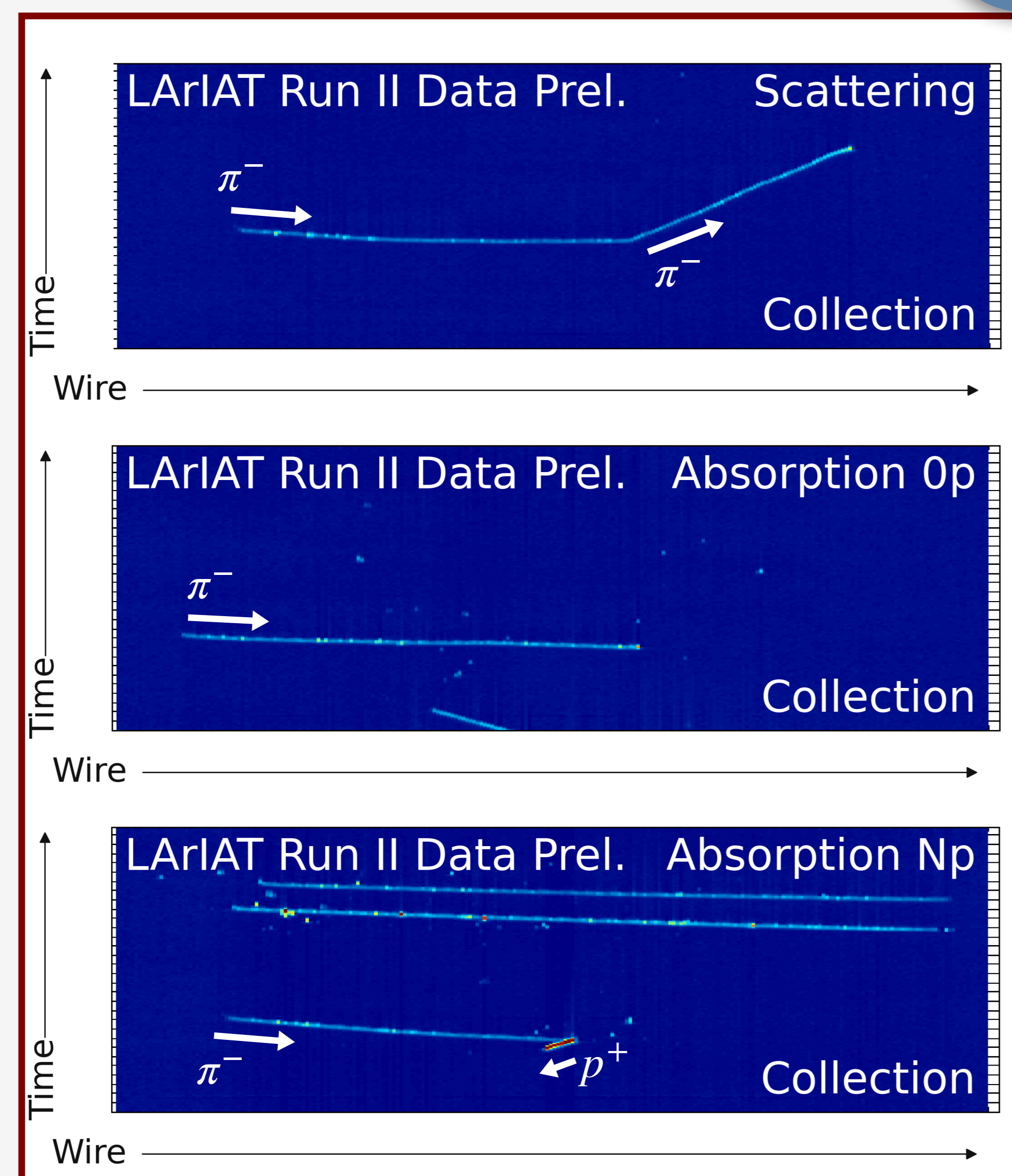
Selection

We select for:

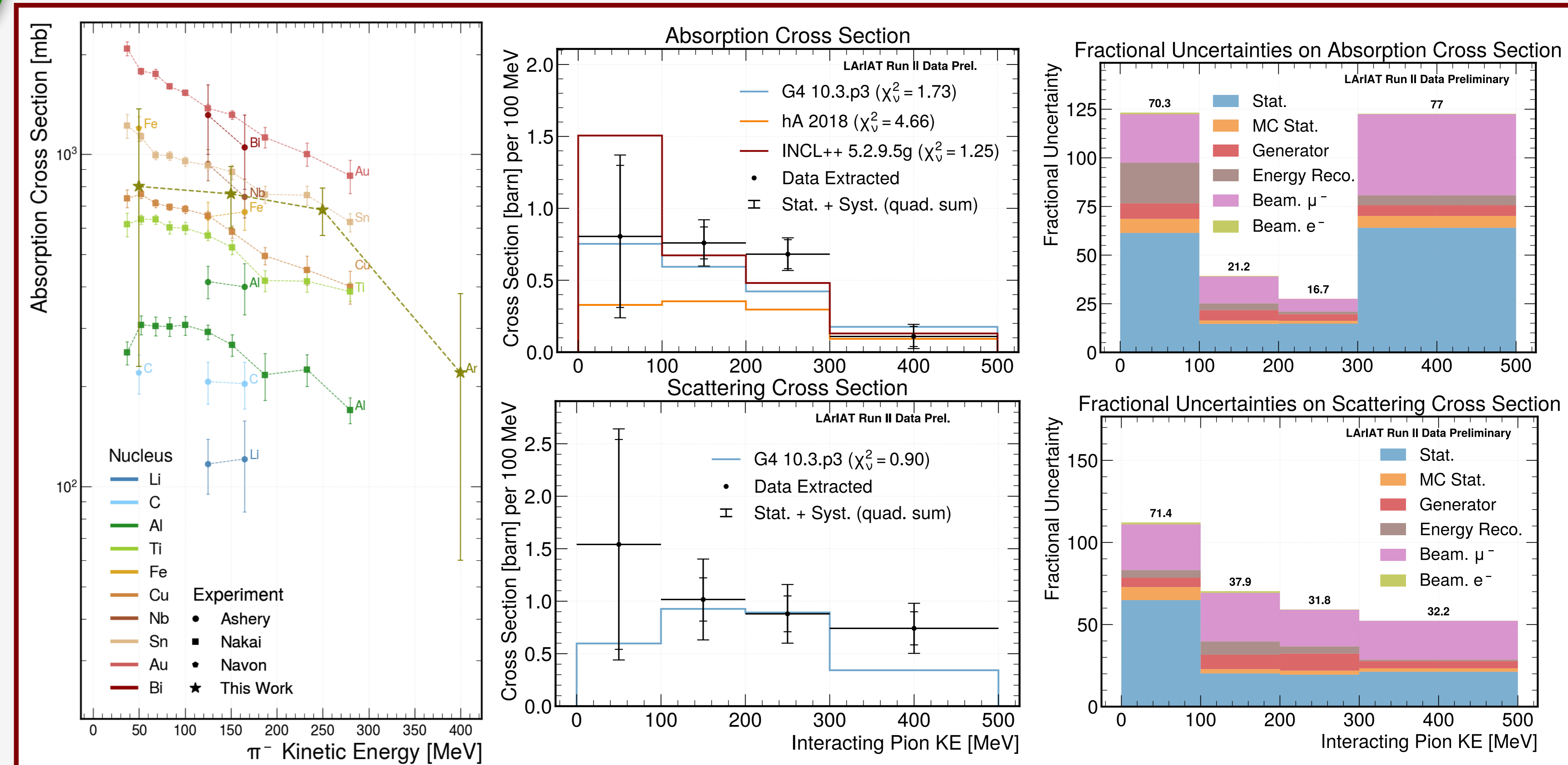
- **Absorption:** only neutrons, protons, or pions with K.E. below 50 MeV
 - 0p: no protons with K.E. above 75 MeV
 - Np: one or more proton with K.E. above 75 MeV
- **Scattering:** exactly one π^- with K.E. ≥ 50 MeV and scattering angle $\geq 5^\circ$

Our selection steps are:

1. Beamline mass $m_{\text{beam}} \leq 350$ MeV
2. Exactly one beamline-to-TPC match and < 3 through-going tracks
3. Reject EM showers and stopping π^- via χ^2 PID templates
4. Interaction vertex within fiducial volume; secondary tracks tagged via χ^2 PID, fallback to mean dE/dx
5. Reject events with unreconstructed induction-plane hits



Results



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