LARIAT-II Physics Goals

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Physics goals / Intro

From the draft phase-II proposal

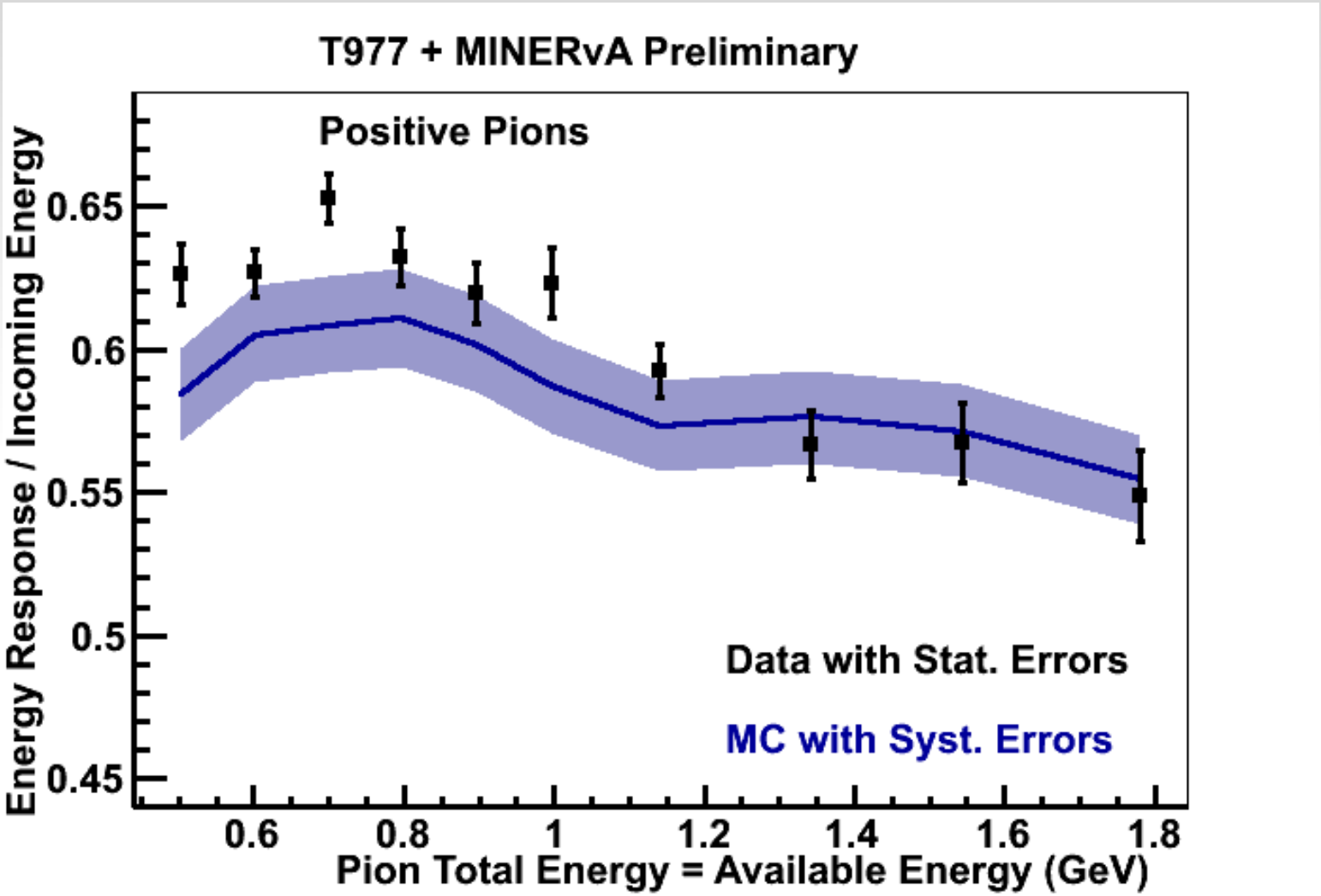
Physics Goals and Requirements

Our primary goal is to conduct a study of particle interactions inside a liquid argon TPC with a large event sample, a well characterized and controlled beam, stable operating conditions, and good external particle identification. Testbeam studies of this sort have commonly been performed as technology R&D ventures (DREAM/CERN-RD52 and CALICE are recent examples) and in support of larger experiments at the energy and intensity frontier. The global HEP community is planning to construct one or more large, multi-kiloton liquid argon TPCs to study neutrino oscillations but, to date, no comprehensive testbeam study of LArTPCs has been carried out. We intend to remedy this situation.

Goal 1: Energy Reconstruction

- $E_\nu = E_{e,\mu} + E_{HAD}$
- Hadronic interactions → "missing" energy
  - binding, neutrons, neutrinos
  - MC must be benchmarked
- Study
  - calorimetry via ionization collected by wires
  - calorimetry via scintillation + combo
  - augment with event topology → ID secondaries

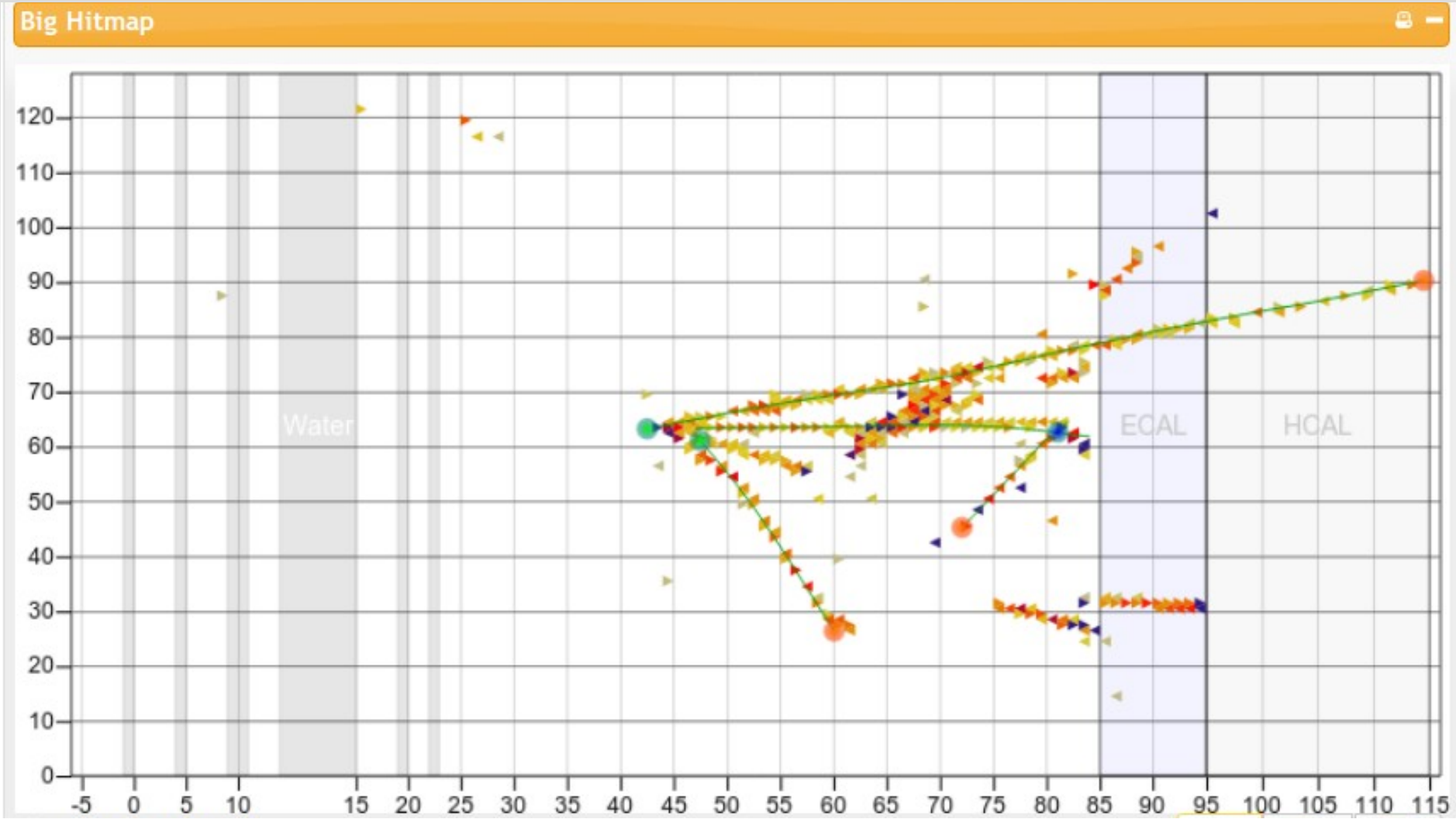
Example


T977 + MINERvA Preliminary
Positive Pions
Energy Response / Incoming Energy
0.65
0.6
0.55
0.5
0.45
0.6
0.8
1
1.2
1.4
1.6
1.8
Pion Total Energy = Available Energy (GeV)
Data with Stat. Errors
MC with Syst. Errors

Goal 2: Particle ID & Reconstruction

- Osc. experiments need to ID e vs γ
- Hadron identification via dE/dx
  - Phase 1 goals extended in phase 2
  - Endpoint for stopping hadrons
- ID & reconstruction when the hadron interacts
  - common case, MINERvA grappling w/ this
- .... or decays
  - kaons, neutral pions, Michels, etc

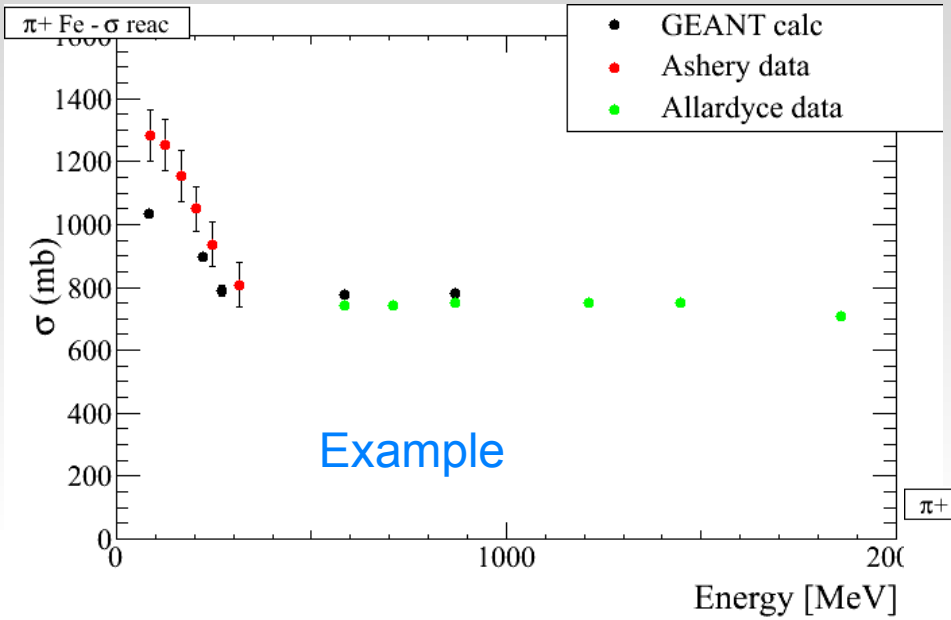
A typical MINERvA event



Goal 3: Hadronic cross-sections

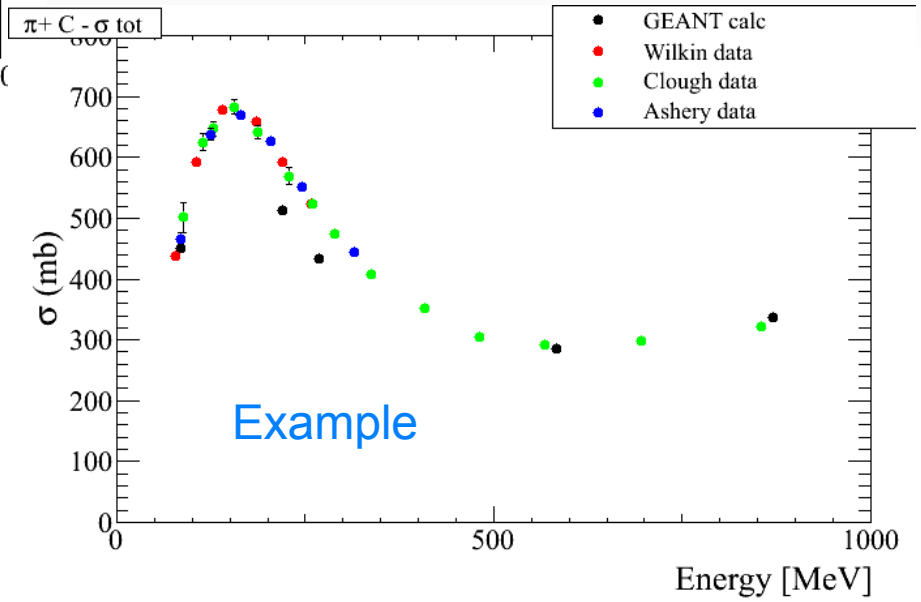
- Suggested by a few people, panned by a few
- Direct way of tuning MC
- hA cross-sections used to validate FSI models
- $\pi A \rightarrow \pi A$ input to νA coherent π production

MINERvA studies



MC cross-section model effects reconstruction efficiency, ID and energy reco.

Very little (any?) data on Ar



Discussion points

- How much detector is needed?
- How many events?
- What beam conditions?