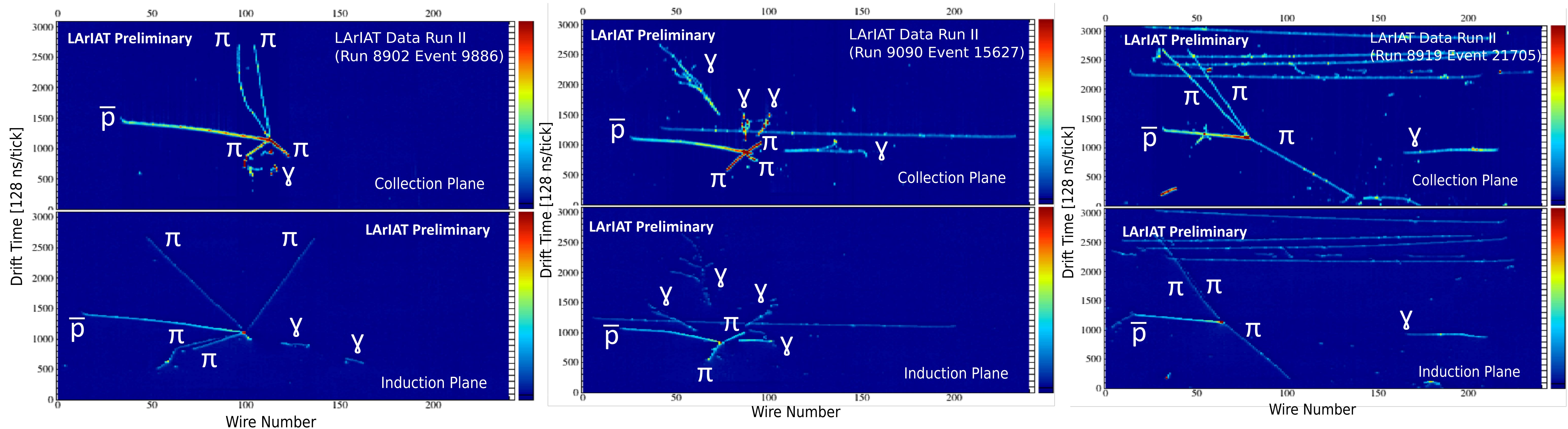


# Observation of Antiproton Annihilation at Rest in LArIAT

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## Antiproton Annihilation at Rest Candidates in LArIAT



## Motivation

- Searches for theoretical  $n - \bar{n}$  oscillation require excellent simulation & reconstruction due to complicated topology.
- Antiproton annihilation at rest on argon is an excellent proxy.

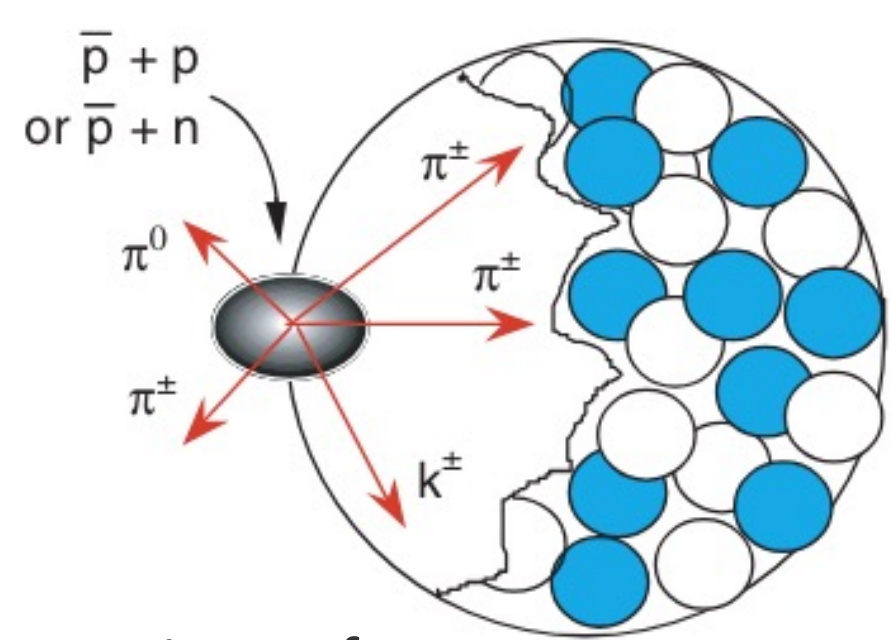
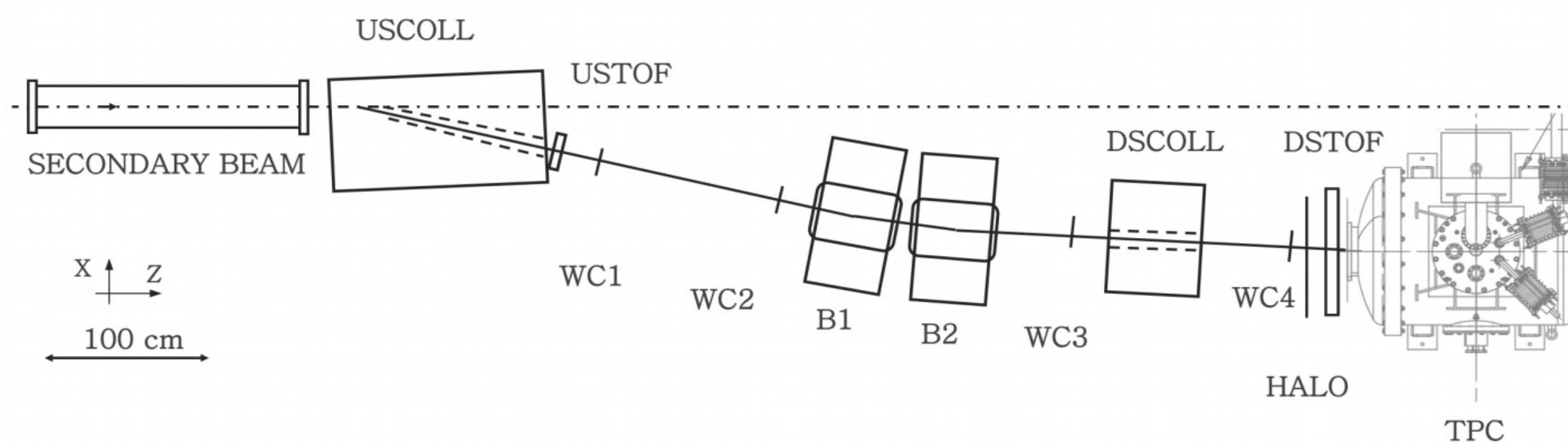


Image from: [Nucl. Fusion 44 1097 \(2024\)](https://doi.org/10.1088/1741-4222/44/10/1097)

## LArIAT Beamline Experiment

- LArTPC in a tertiary test beam at Fermilab (2015-2017) [1]. Measured  $\pi^-$ -Ar cross section [2] & charge + light calorimetry [3].



- Wire Chambers (WC) → measure bending angle to get particle's momentum.
- Time of Flight (TOF) → Separate lighter and heavier particles using velocity.

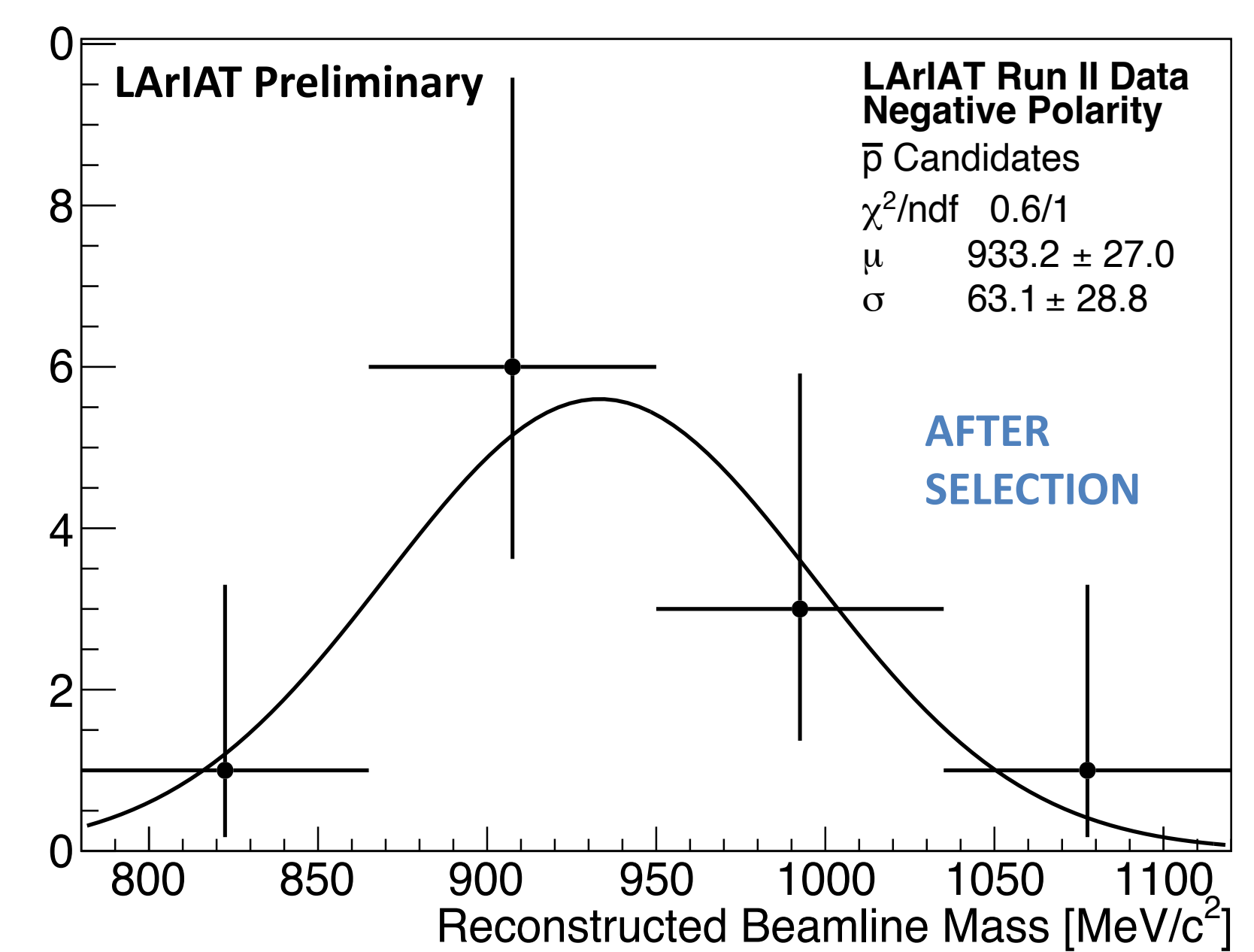
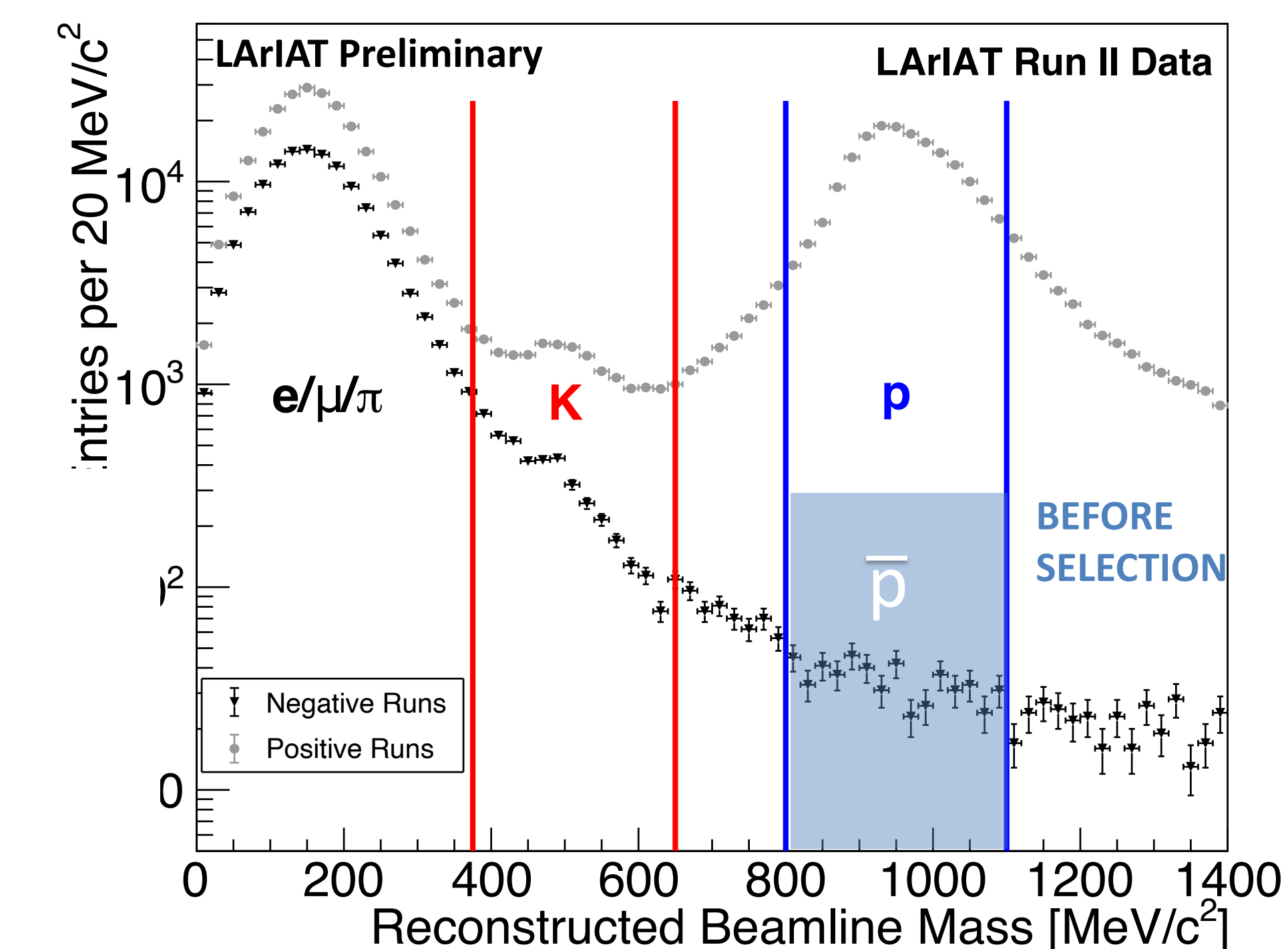
## Antiproton Selection

### A. Beamline Selection

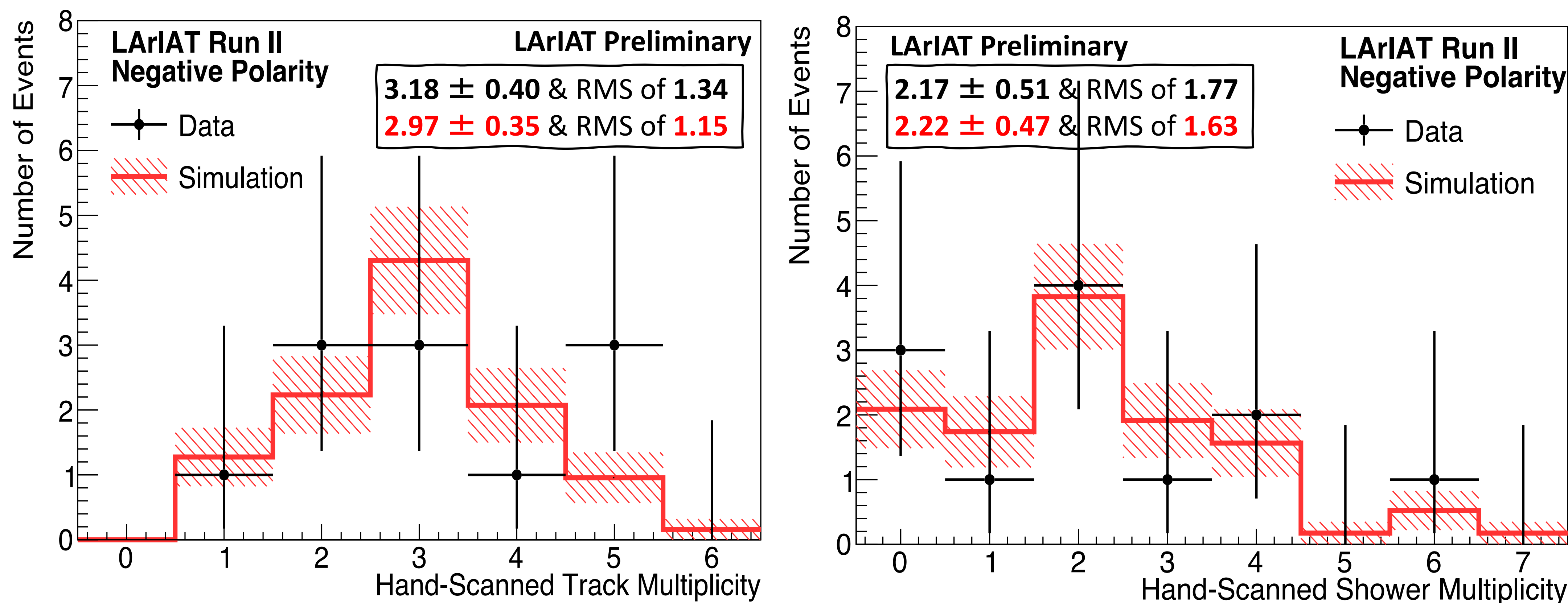
1. Proton-like mass between 800 MeV/c<sup>2</sup> and 1100 MeV/c<sup>2</sup>.

### B. LArTPC Selection

1. Visible Bragg Peak → stopping
2. Proton-like using a  $\chi^2$  with expected dE/dx vs residual range.



## Results – Outgoing Multiplicities



## Conclusions

- Antiproton-argon annihilation at rest observed and measured for the first time in LArIAT with simulation and data agreement.
- Important results for future  $n - \bar{n}$  oscillation searches in LArTPCs.

- [1] [JINST 15, P04026 \(2020\)](https://doi.org/10.1088/1741-4222/15/4/P04026)  
[2] [Phys. Rev. D 106, 052009 \(2022\)](https://doi.org/10.1103/PhysRevD.106.052009)  
[3] [Phys. Rev. D 101, 012010 \(2020\)](https://doi.org/10.1103/PhysRevD.101.012010)

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