Data-driven track reconstruction performance studies in MicroBooNE

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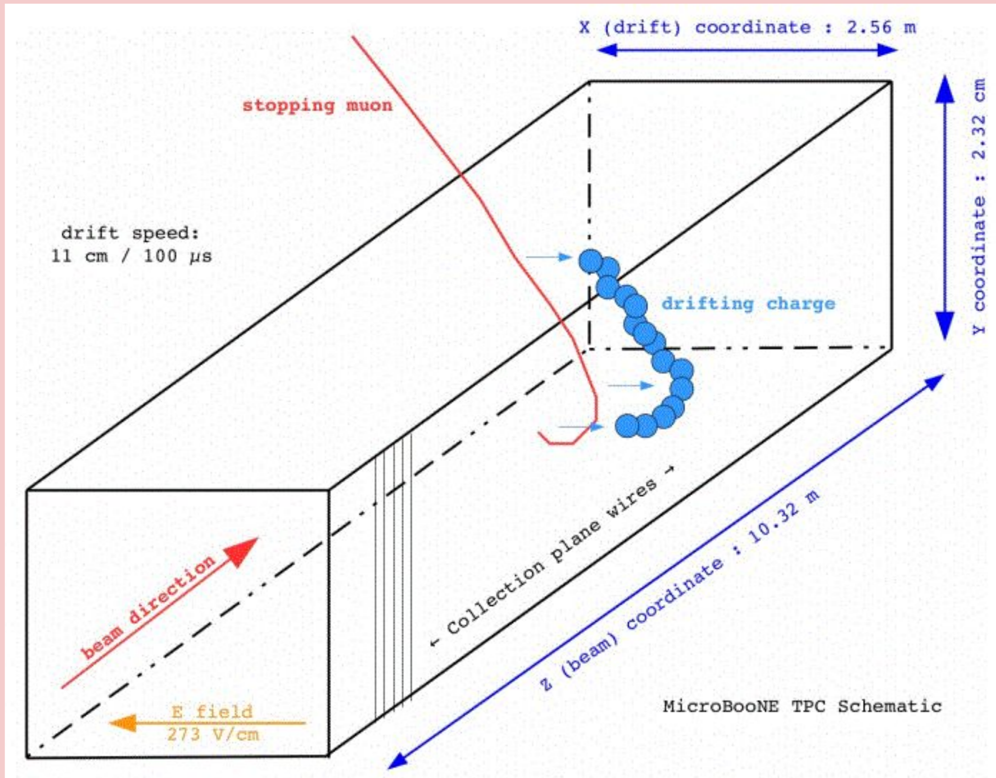
MicroBooNE[1]

CHARACTERISTICS
- Liquid argon time projection chamber (LArTPC) experiment
- Situated on Fermilab Booster Neutrino Beam (BNB) beamline
- 170 tons with 89 tons of active mass

PRIMARY GOALS
- Investigate low energy excess observed by MiniBooNE [2]
- Precision neutrino-argon cross section measurements
- LArTPC technology development



Overview

DATA-DRIVEN RECONSTRUCTION PERFORMANCE
- Evaluate the data-driven **track reconstruction performance** in the Pandora LArTPC framework [4]
- Updating 2018 MicroBooNE reconstruction performance studies [5]
- Three different reconstruction tools were analysed: **Momentum reconstruction** using Multiple Coulomb Scattering (MCS), **vertex resolution**, and **track resolution**

EVENT SELECTION
- Applied a **muon neutrino CC inclusive selection** to produce a sample of **neutrino-induced muon tracks**
- Optimized for **high purity**, requiring high consistency with neutrino-like topology and high-qualty tracks

MCS Momentum Reconstruction

- Muon momentum is reconstructed using two methods: **range** (track length) and **MCS** (based on Multiple Coulomb Scattering [3])
- MCS and range are compared for "**psuedo-exiting**" tracks — a set of fully-contained tracks with 10 cm removed from the end
- **Fractional bias** quantifies the overprediction or underprediction of the MCS momentum reconstruction
- **Fractional resolution** is the spread in MCS momenta relative to the range-based measurement

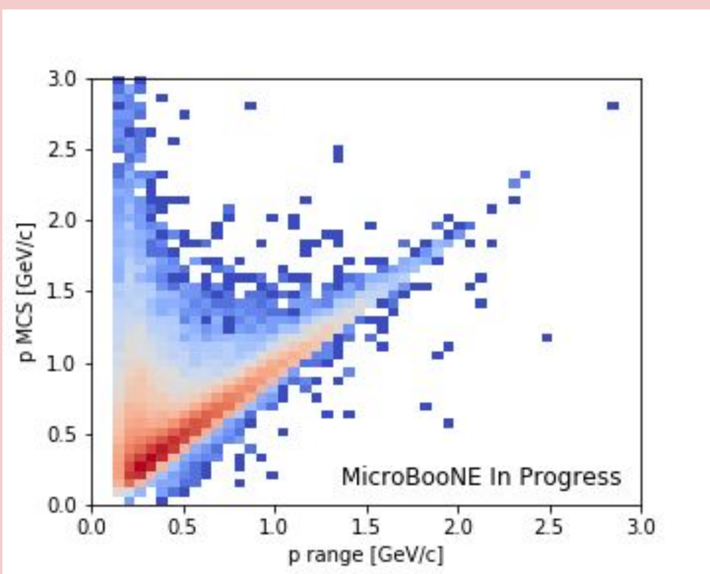


Figure 1: A comparison of the MCS momentum and range-based momentum for contained ν_μ CC muon candidate tracks. (MicroBooNE simulation)

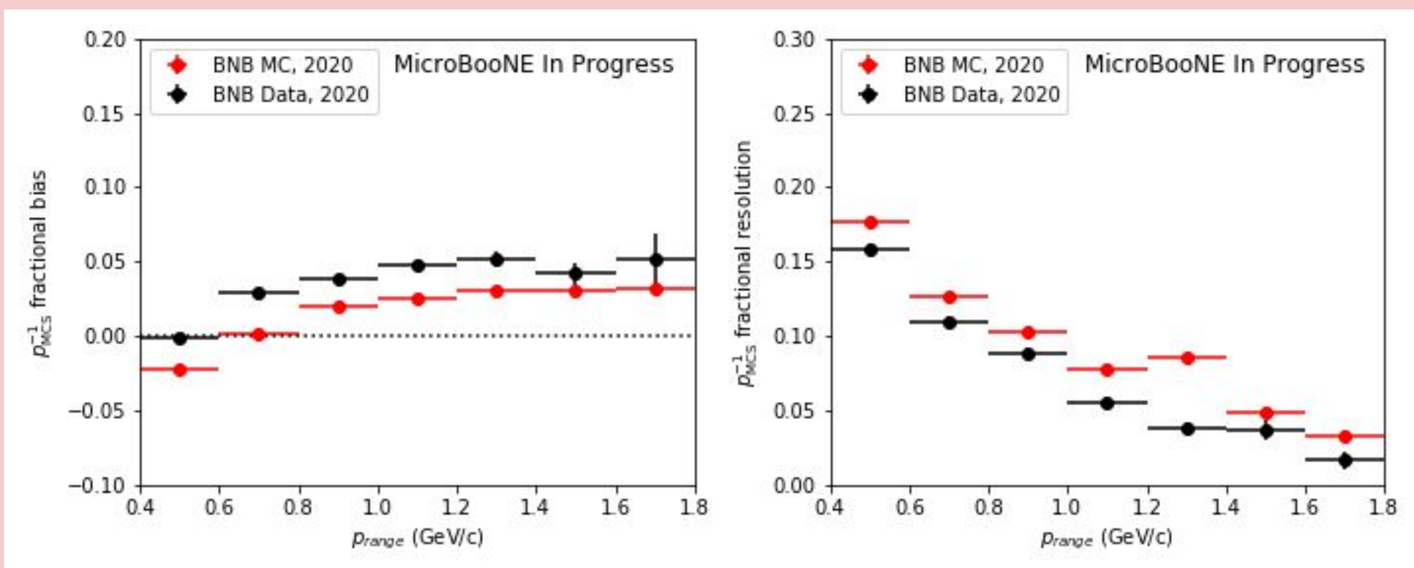
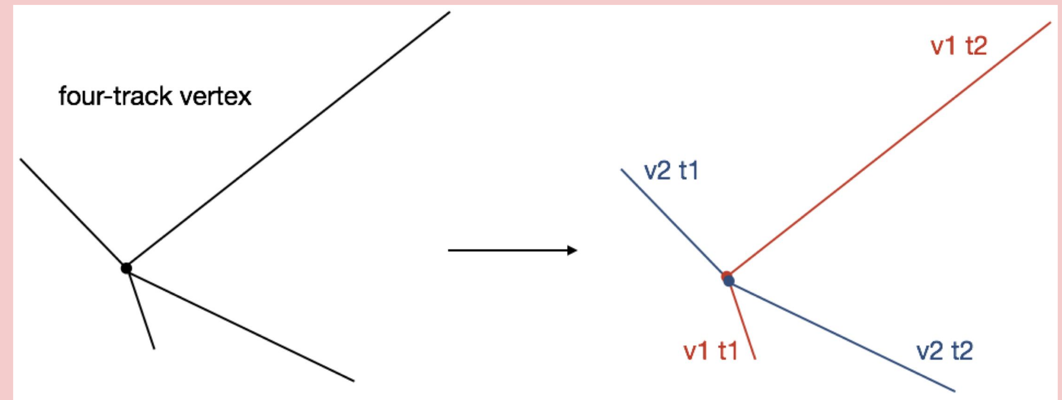


Figure 2: Fractional bias and resolution for the track momentum measured via Multiple Coulomb Scattering relative to the range-based momentum, for truncated ("psuedo-exiting") contained ν_μ CC muon candidate tracks selected in on-beam data and cosmic-overlaid Monte Carlo.

Track Vertex Resolution

- Vertex resolution measurement method: **four-track events** are taken and **split into two sets**
- Each set is independently fit and the resolution of a two-track vertex is extracted by comparing the positions from these two split vertices



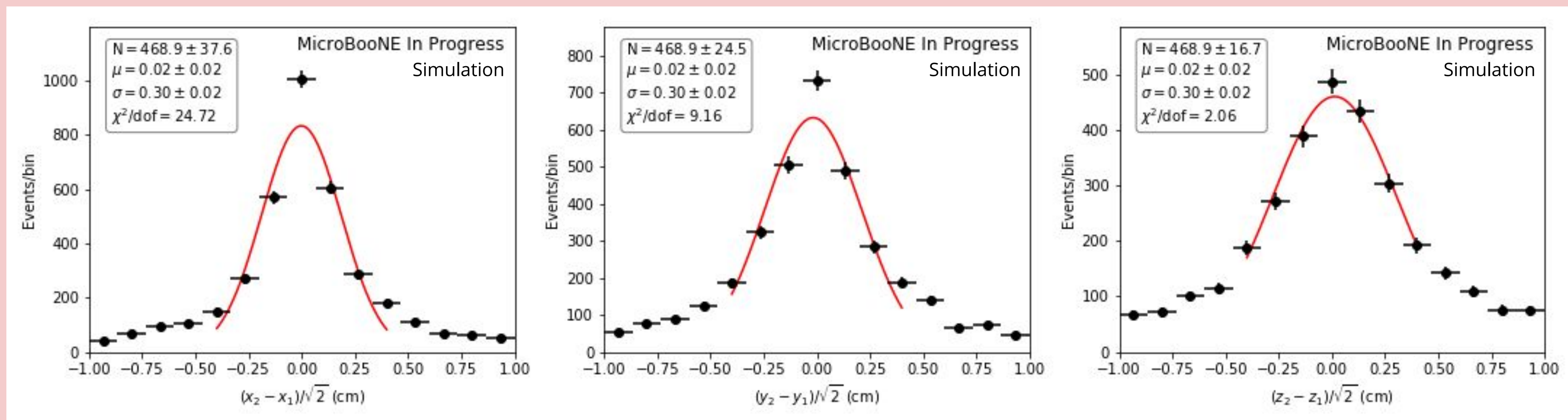


Figure 3: Split vertex resolution plots for Monte Carlo neutrino events with data cosmic activity overlaid

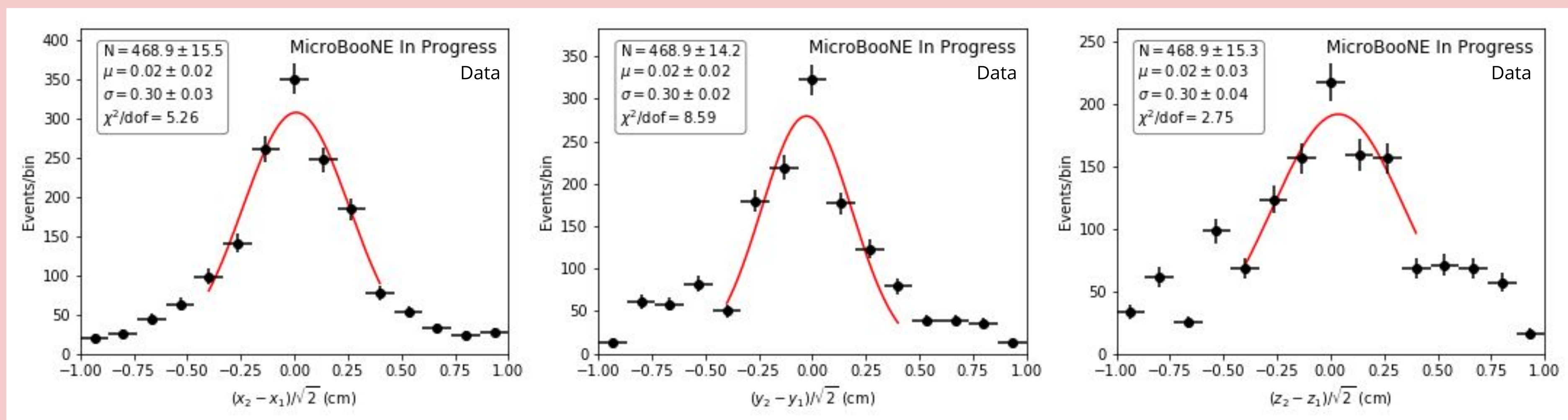


Figure 4: Split vertex resolution for on-beam data events

Split Track

- **Track resolution** validation: A candidate track is split in half and the two split tracks are fitted
- The resolution is determined by comparing a special parameter k between two sets
- Analysis in progress now

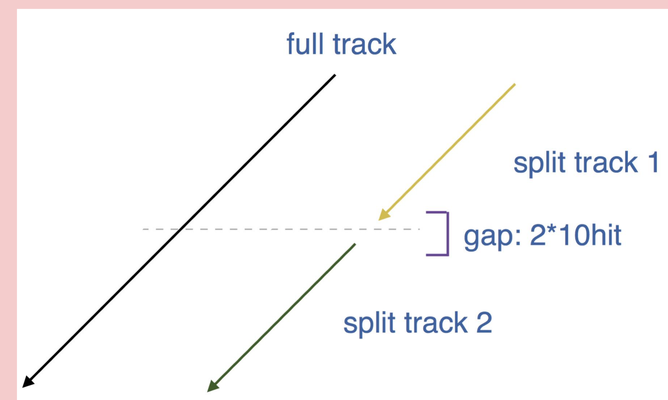


Figure 5: Sketch of the method to split tracks at the middle point.

References

[1] https://microboone.fnal.gov/microboone-physics/
[2] MiniBooNE Collaboration, Phys. Rev. Lett **121**, 221801 (2018).
[3] MicroBooNE Collaboration, JINST **12**, P10010 (2017).
[4] MICROBOONE-NOTE-1049-PUB (https://microboone.fnal.gov/public-notes/)
[5] MicroBooNE Collaboration, Eur. Phys. J. C **78**, No. 82 (2018).

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