Angle Dependent Electron Lifetime Measurement and Millicharged Particle Detection in SBND

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Electron Lifetime Measurement: Background

- Short Baseline Near Detector (SBND) is filled with liquid argon
- Neutrinos (or other particles) interact, releasing electrons
- Electronegative contaminants absorb electrons from interactions
- Electron Lifetime: τ
- Measure with cosmic muons (MIP)

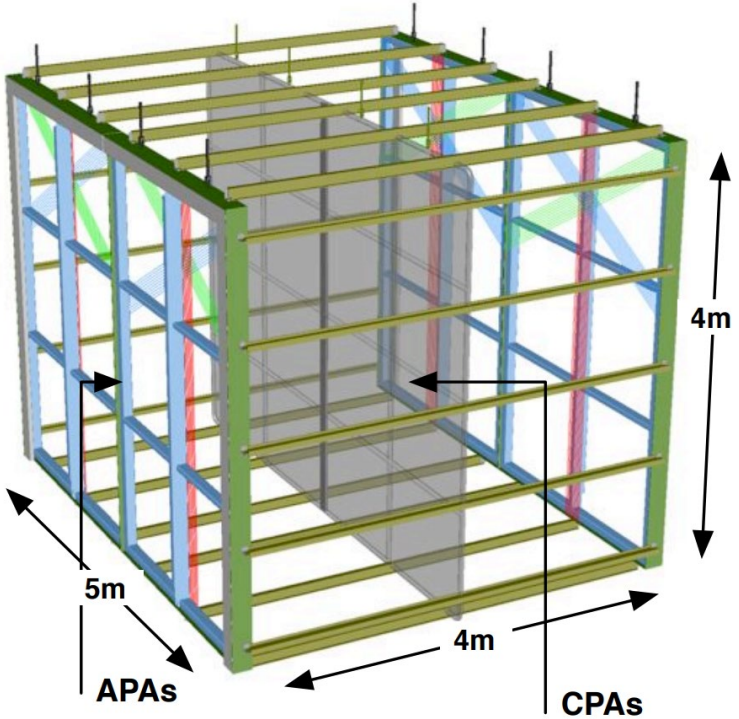

Fig 1. SBND Diagram

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Electron Lifetime Measurement: Prior Work

- Technique to calculate τ from simulation developed in other LArTPCs
- Built upon work done by Lan Nguyen

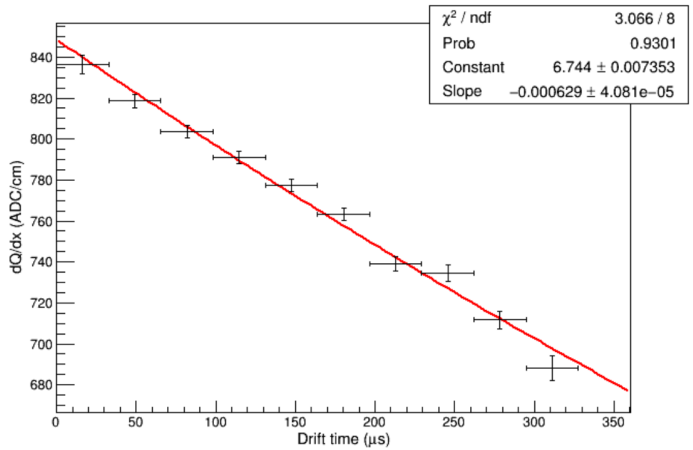

Fig 2. Exponential decay fit: $e^{-t/\tau}$

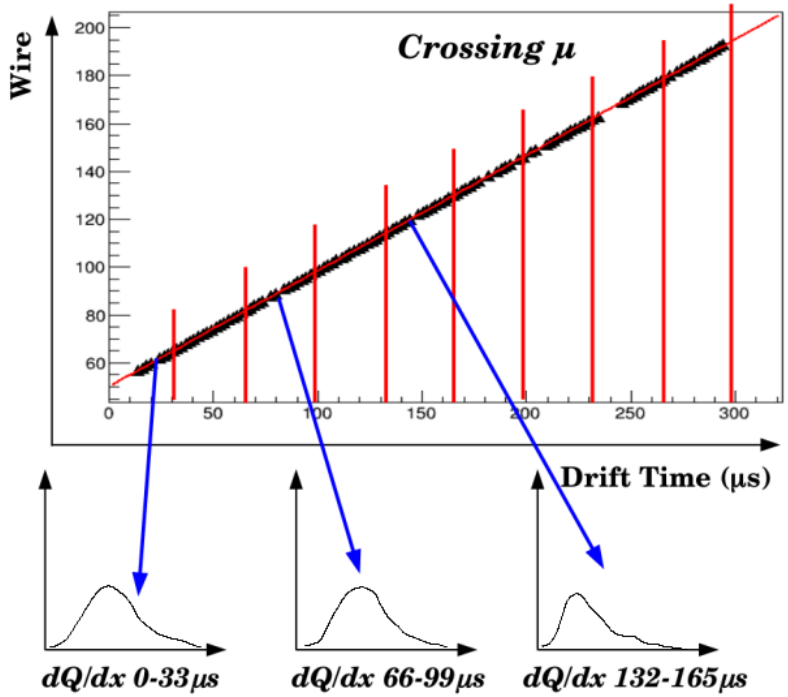

Fig 1. Binned Landau⊗Gaussian fits

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Electron Lifetime Measurement: My Progress

- Angle dependencies
  - Demonstrates edge effects (fig 1)
  - Suggests a cut of angles from 30 to 70 degrees (fig 2)

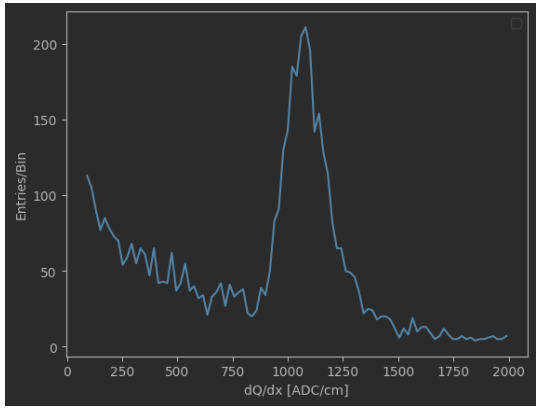

Fig 1. dQ/dx at high angles from perpendicular

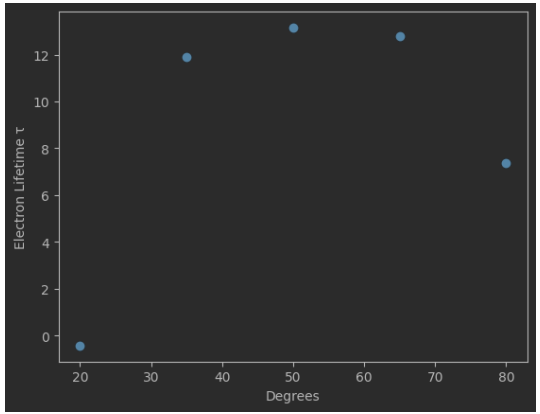

Fig 2. Electron Lifetime by Angle

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Electron Lifetime Measurement: My Progress

- Angle dependencies
- Match muon tracks to CRT position

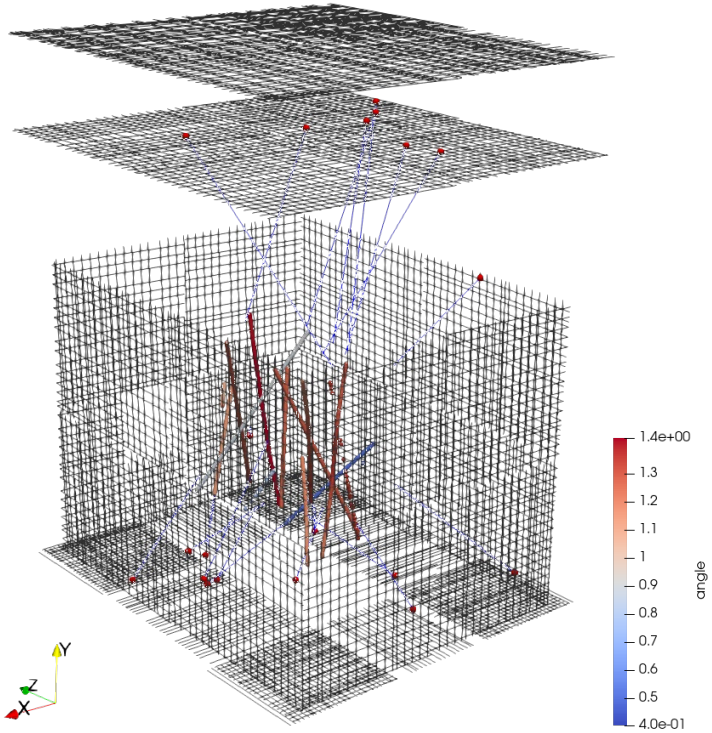

Fig 1. Tracks & Matched CRT Positions

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Electron Lifetime Measurement: Next Steps

- CRT Strip lifetime measurement
  - We are curious if specific CRT strips/groups of strips will provide better accuracy
- Larger sample data
  - Some time & angle bins have too few points to be fit well

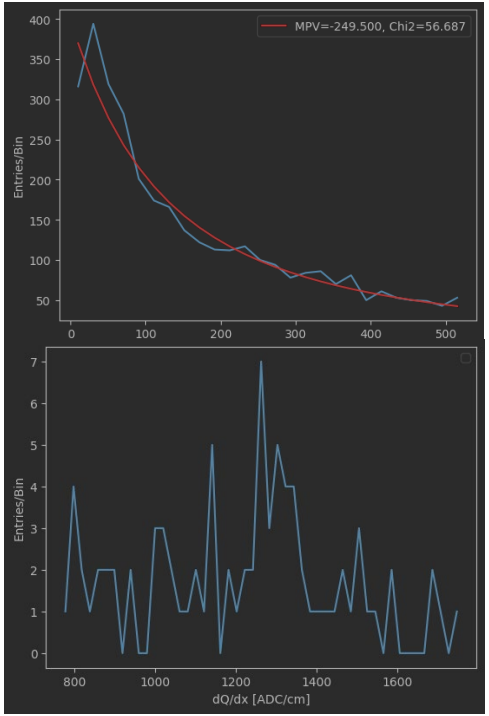

Fig 1. Poor fit due to low statistics

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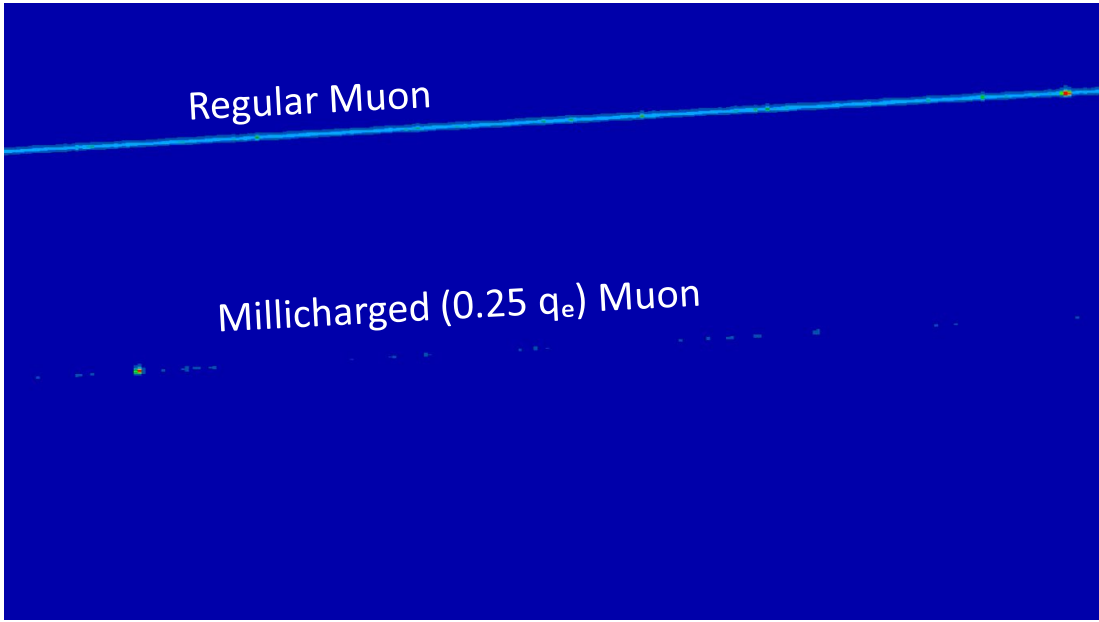
Millicharged Particle Detection: Background

- Theorized particle with fraction of the electron charge
- Much weaker signal than fully charged particle ($^{1}/_{q^2}$)
- EDGES anomaly recently is explainable by these particles

Fig 1: Event Display



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Millicharged Particle Detection: Prior Work

- Simulation in LArSoft
- Detection methods:
  - 2-hit
  - Faint Track

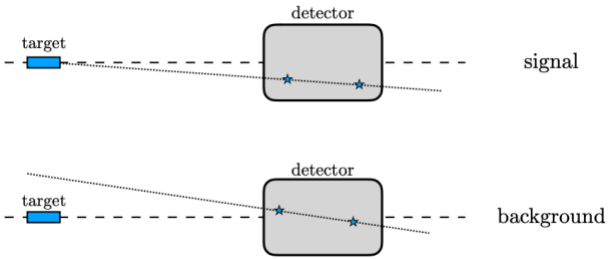

Fig 1: 2-hit Method

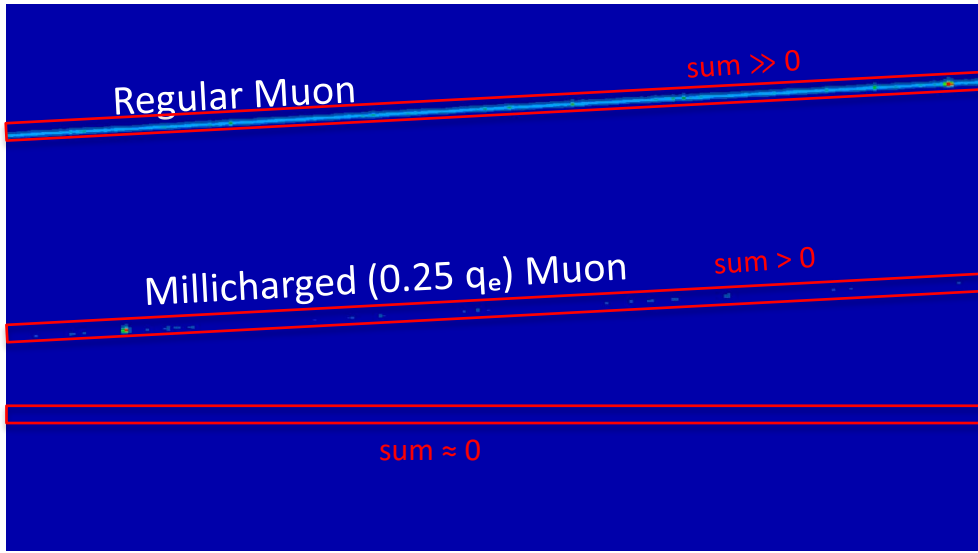

Fig 2: Faint Track method

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Millicharged Particle Detection: My Progress

- GPU track finding

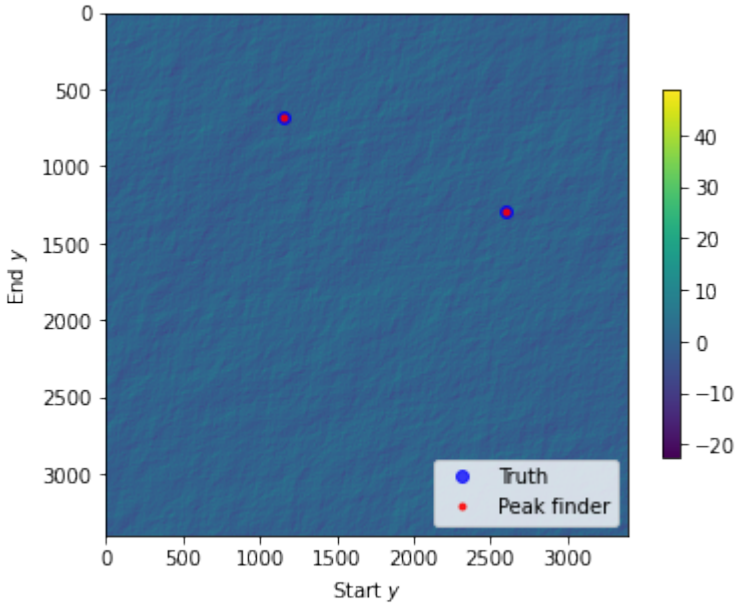

Fig 1: 2D Sum Space

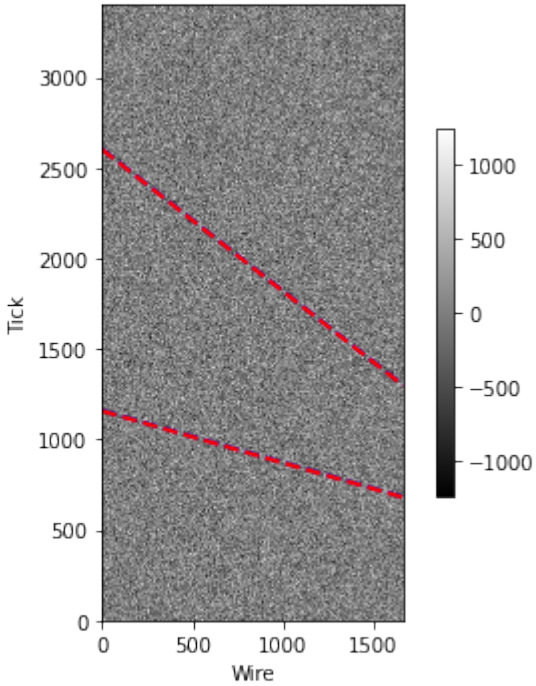

Fig 2: Detected lines in event display

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Millicharged Particle Detection: Next Steps

- GPU signal generation
  - Quadratically more events are needed as charge decreases
- More sophisticated track finding algorithms
  - Statistical analysis
  - Compare to background fluctuation

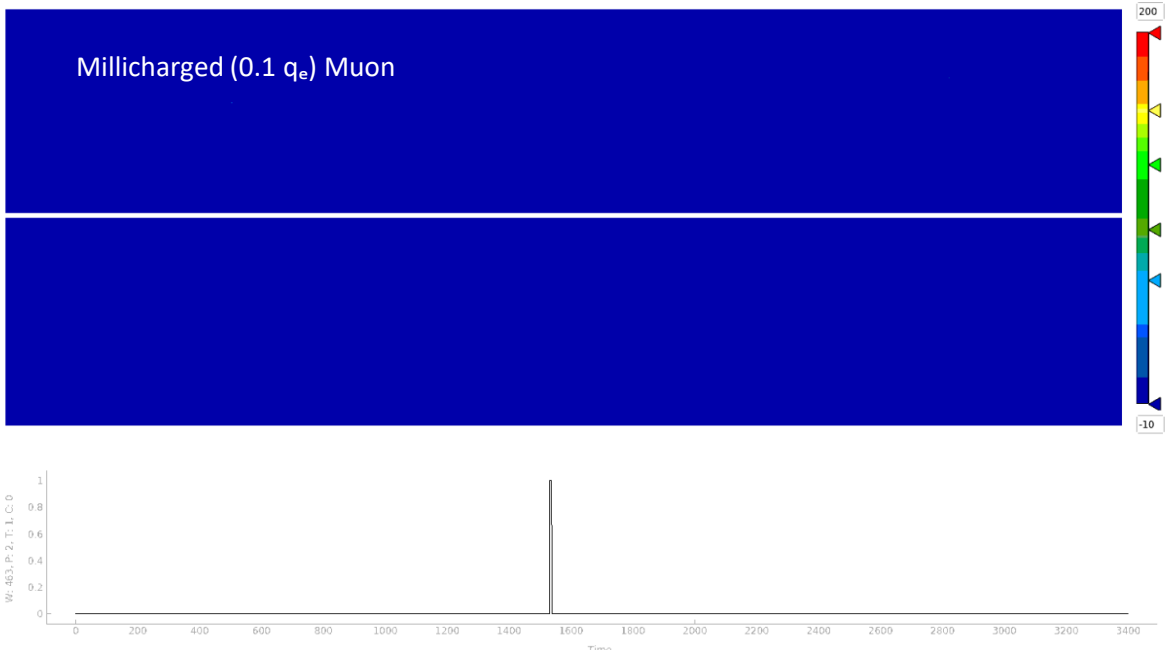

Fig 1: Very Low Charge Particle

Thank you!