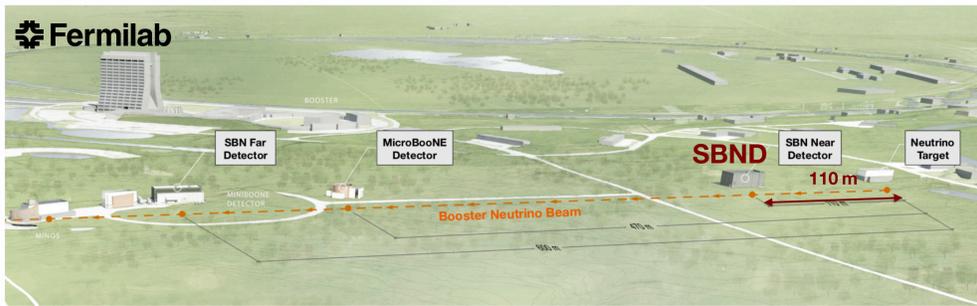# Studying Neutrino-Nucleus Interactions at SBND with ν_μ CC 0π Events
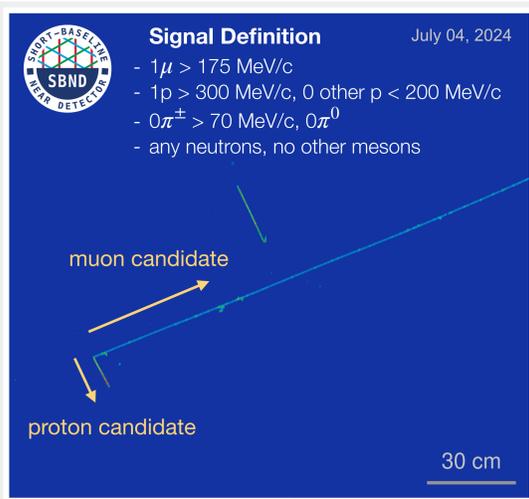
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Short-Baseline Near Detector at Fermilab

- Liquid argon time projection chamber (LArTPC) experiment and the near detector of the Short-Baseline Neutrino program [1,2]

- Will collect the world's largest $\nu - Ar$ scattering dataset, at a rate of over 7000 neutrino events per day

- Taking data at full voltage as of July 2024

ν_μ CC 0π

Signal Definition — July 04, 2024
- $1\mu > 175$ MeV/c
- $1p > 300$ MeV/c, 0 other p < 200 MeV/c
- $0\pi^\pm > 70$ MeV/c, $0\pi^0$
- any neutrons, no other mesons

- LArTPCs enable excellent reconstruction of complicated neutrino interaction final states using both topological and calorimetric information

- Final state topologies are representative of interaction modes: QE is enhanced in $1p0\pi$, MEC is enhanced in $2p0\pi$
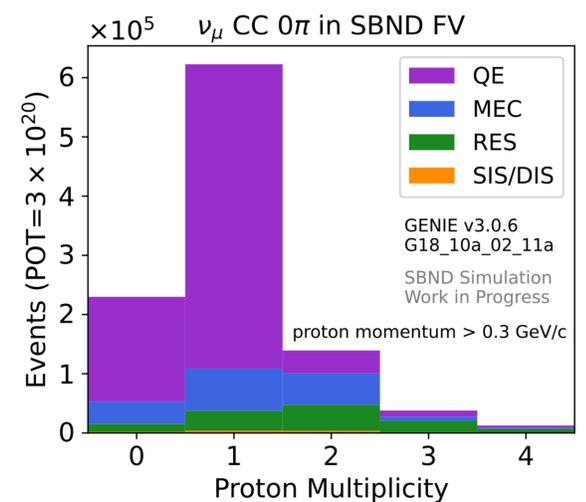
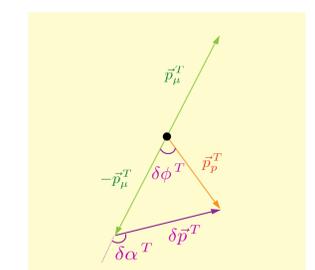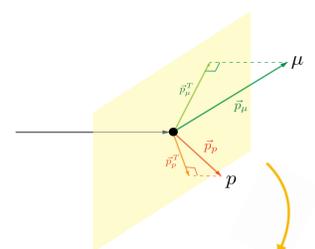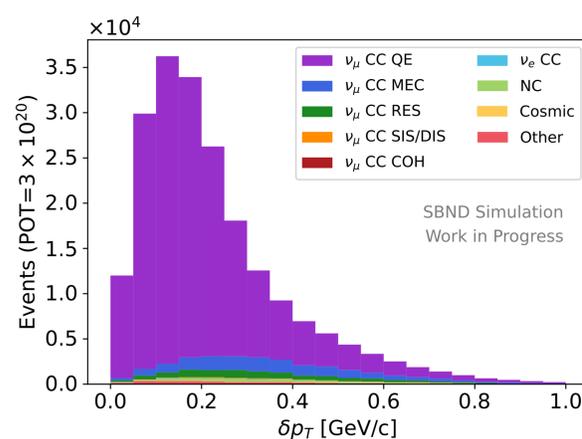## $1p0\pi$ Event Selection

- Selection achieves signal purity ~84%, efficiency ~39%
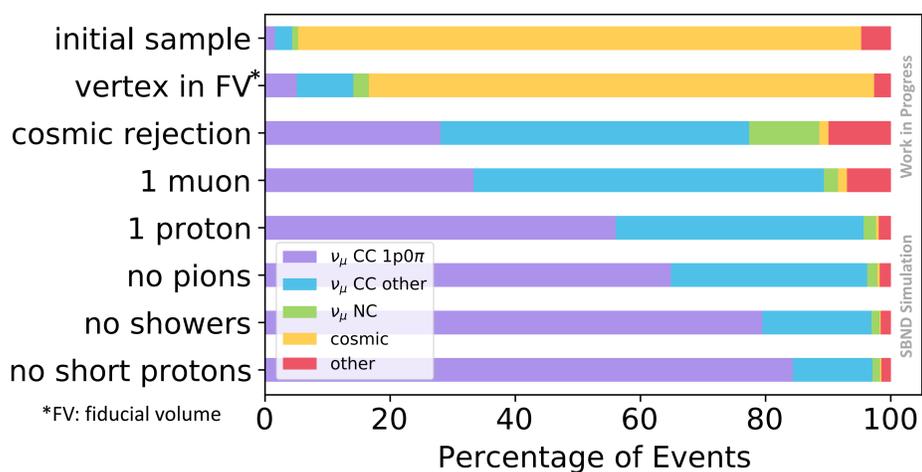
Kinematic Imbalance

- Imbalance in muon-proton kinematics on the transverse plane implies background interaction modes and existence of nuclear effects
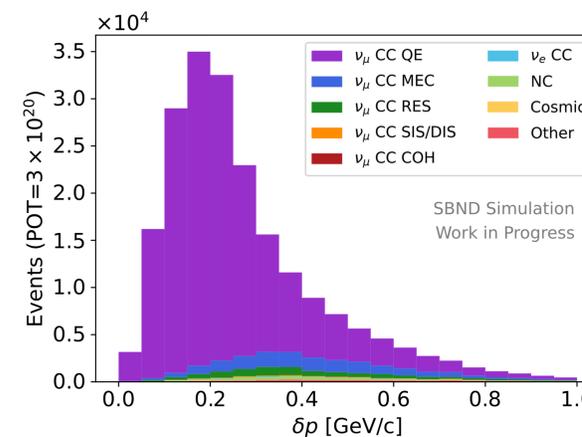

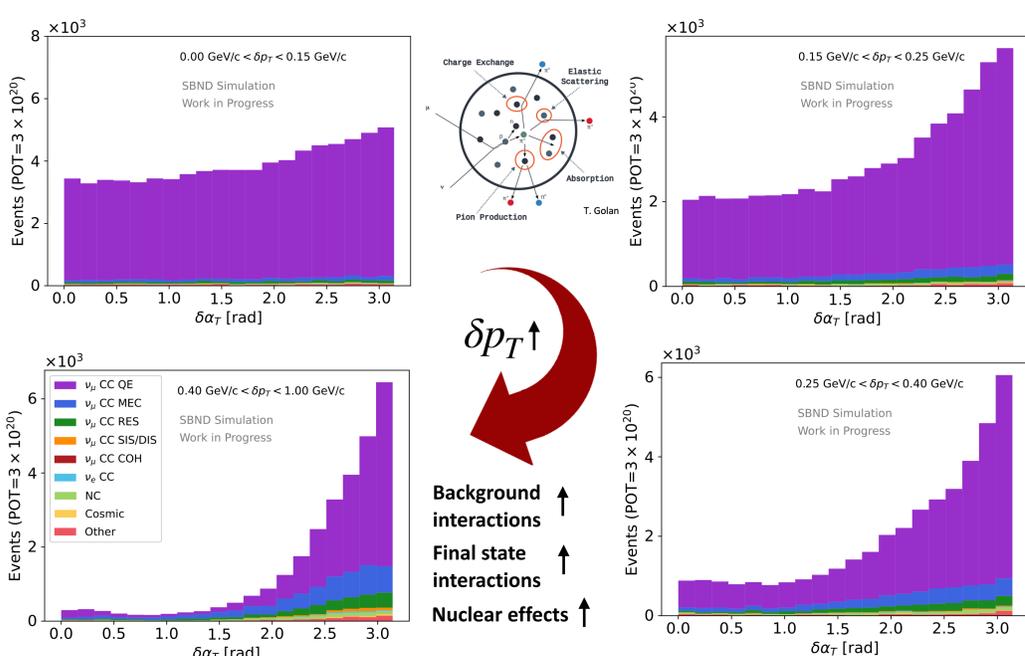$$\delta p_T = |\vec{p}_T^\mu + \vec{p}_T^p|$$

$$\delta p_L = \frac{1}{2}R - \frac{m_{A'}^2 + \delta p_T^2}{2R}$$

$$(R = m_A + p_L^\mu + p_L^p - E^\mu - E^p)$$

$$\delta p = \sqrt{(\delta p_T)^2 + (\delta p_L)^2}$$

- N-dimensional phase space measurements of imbalance variables allow detailed investigation of the complex $\nu - Ar$ interactions at the few-GeV energy range

$\delta p_T \uparrow$

Background interactions ↑
Final state interactions ↑
Nuclear effects ↑

References
[1] P. A. Machado, O. Palamara, and D. W. Schmitz, Ann. Rev. Nucl. Part. Sci 69 (2019).
[2] R. Acciarri et al., The SBND Collaboration, JINST 15 P06033 (2020).

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