SBND Experiment

- Uses LArTPC technology to visualize particle interactions.
- Main objectives include confirming or ruling out the existence of eV-mass scale sterile neutrinos over $5\sigma$ confidence level, performing $\nu$-Ar cross section measurements, BSM searches and R&D for upcoming LArTPC experiments.
- Equipped with advanced light detection system consisting of PMTs, Xarapucas and light reflecting foils, capable of reconstructing particle interactions at a few nano seconds precision.
- CRT system provides full ~$4\pi$ coverage in identifying cosmics, consists of 7 planes each made up of scintillating modules.

Use of ToF in Separating Intime Cosmics Vs Neutrino Tracks

- $T_{CRT} - T_{PMT} > 0$ ($\nu$-tracks)
- $T_{CRT} - T_{PMT} < 0$ (Cosmics)
- Looked for CRT hits, which are inside BNB beam window (1.6 $\mu$s) and coupled with the largest optical flash (optical hit) with in a 100 ns coincidence time window w.r.t CRT hit time to calculate ToF value.

Tuning CRT and Optical Flash PE Thresholds

- Identified threshold values on CRT PE and optical flash (hit) PE which maximize performance of ToF metric (100 PE on CRT hit PE, 100 PE on optical hit, 1000 PE on optical flashes).

Tunning Width of Coincidence Time Window

- Optimized the width of the coincidence time window to gain higher efficiency for ToF metric (50 ns).

Impact of PMT and CRT Timing uncertainties on ToF

- Smearred the ToF distributions to evaluate the impact of timing uncertainties.

Results

- After optimizing parameters, ToF metric reached 50% (65%) efficiency and 93% (57%) purity in tagging $\nu$-tracks (cosmics).

Chris Hilgenberg first performed these ToF studies in ICARUS. 
Ref: https://mountainscholar.org/handle/10217/219579