Contribution ID: **110** Type: **Oral**

Wire-Cell: A High Quality Automated LArTPC Reconstruction for Neutrino Experiments

Monday 11 March 2024 16:50 (20 minutes)

Liquid Argon Time Projection Chamber, or LArTPC, is a scalable tracking calorimeter featuring rich event topology information. It provides the core detector technology for many current and next-generation large-scale neutrino experiments, such as DUNE and the SBN program. In neutrino experiments, LArTPC faces numerous challenges in both hardware and software to achieve optimum performance. On the software side, the main challenge is two-fold. First, there is a need for further accumulation of deep domain knowledge. Second, the event's degree of freedom is high due to its large scale and the uncertainties in initial neutrino-argon interactions.

To address the reconstruction challenge from LArTPC detectors, we developed a comprehensive software suite and a set of algorithms, collectively termed 'Wire-Cell.' This innovative system is founded on the concept of topographical 3D reconstruction using multiple 2D LArTPC images. Key to enabling this 3D reconstruction was an extensive study of detector signal formation and signal processing, providing crucial insights. Building on the outcomes of the 3D reconstruction, we crafted a high-quality automated neutrino reconstruction chain. This chain integrates both traditional and machine-learning algorithms. The effectiveness of the Wire-Cell reconstruction approach is validated with real experiment data, specifically in the context of MicroBooNE physics analyses.

In this presentation, we delve into the Wire-Cell LArTPC reconstruction paradigm, with a particular emphasis on the underlying algorithms. Our focus is to demonstrate how Wire-Cell not only addresses but also advances the field of LArTPC detector data interpretation.

Significance

The Wire-Cell development is a multi-year project that aims to address fundamental issues in LArTPC reconstruction. Now, the full set of algorithms is ready and has been tested in real data analyses. We think it is time to present the big picture of this project, along with its algorithms and toolkits, to a broader community to exchange ideas.

References

Experiment context, if any

Neutrino Experiments, DUNE, MicroBooNE

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Session Classification: Track 2: Data Analysis - Algorithms and Tools

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