



Contribution ID: 4

Type: **Long talk (25min. + 10min. Q/A)**

LUCiD: a Light-based Unified Calibration and tracking Differentiable simulation

Thursday 30 October 2025 13:55 (25 minutes)

Next-generation monolithic Water Cherenkov detectors aim to probe fundamental questions in neutrino physics. These measurements demand unprecedented precision in detector calibration and event reconstruction, pushing beyond the capabilities of traditional techniques. We present a novel framework for differentiable simulation of Water Cherenkov detectors that enables end-to-end optimization through gradient-based methods. By leveraging JAX's automatic differentiation and implementing a grid-based acceleration system, our framework achieves millisecond-scale simulation times - four orders of magnitude faster than traditional approaches. The framework can incorporate neural network surrogates for unknown physical phenomena while maintaining interpretability throughout the simulation chain. As a demonstration, we employ a neural network to model differentiable photon generation probability distributions. Our modular architecture extends to various Water Cherenkov detectors, representing a significant step toward addressing systematic limitations in future neutrino experiments through differentiable programming techniques.

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Session Classification: AI//ML for Detector Physics Modeling