Contribution ID: **27**   Type: **not specified**

Searching for Long-lived Particles at Future Lepton Colliders Using Deep Learning Techniques

Tuesday, 25 February 2025 15:30 (30 minutes)

This talk presents long-lived particle (LLP) searches in Higgs decays at future lepton colliders (e+e−→ZH) using deep learning techniques. Scanning LLP lifetimes from 0.001 to 100 ns and masses from 1 to 50 GeV, we find that the best sensitivity is achieved at 50 GeV and 1 ns, where deep neural networks, including CNNs and GNNs, reach up to 99% signal efficiency with zero Standard Model background. The Higgs branching ratio into LLPs can be constrained to 1.2×10^{-6} with a dataset of 4×10^6 Higgs bosons, setting a state-of-the-art limit. Additionally, we explore the use of Local Contrastive Learning Machines (LCLMs) to further improve signal purity and reduce training uncertainty. These results demonstrate the power of deep learning in boosting LLP searches at future lepton colliders.

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Session Classification: Afternoon Talks