



Contribution ID: 60

Type: **Parallel session talk**

Embedded ML Solutions for Real-time Processing in Future Drift Chamber Detectors

Wednesday 8 October 2025 12:00 (20 minutes)

Cluster counting (dN/dx) offers significant promise for enhanced particle identification (PID) resolution compared to traditional dE/dx methods by measuring the number of primary ionization acts per unit length. However, future detectors such as IDEA operating under high-speed digitization face unprecedented data transfer rate challenges. We are developing advanced ML algorithms that demonstrate superior performance over conventional derivative-based methods for cluster counting tasks. We further investigate optimizing these models to fit within estimated front-end resource constraints while achieving competitive latency performance. This ML-based front-end electronics approach enables real-time data reduction with substantial compression ratios. These capabilities address immediate bandwidth limitations and simultaneously open new possibilities for implementing intelligent real-time data acquisition in future collider experiments. In this presentation, I will discuss our progress in developing these ML-assisted data processing solutions, demonstrate performance comparisons with traditional methods, and discuss the implications of this data reduction capability for drift chamber applications at FCCee.

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Session Classification: RDC 6 Gaseous Detectors

Track Classification: RDC 6 Gaseous Detectors