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The CMS W Mass Analysis as a Blueprint for Efficient HL-LHC Data Handling

Thursday 10 July 2025 09:30 (20 minutes)

The unprecedented volume of data and Monte Carlo simulations at the HL-LHC poses increasing challenges for particle physics analyses, demanding computation-efficient analysis workflows and reduced time to insight. The recent W mass measurement by CMS exemplifies these challenges and demonstrates the application of cutting-edge techniques essential for future analyses. We present a comprehensive analysis framework that leverages RDataFrame, Eigen, Boost Histograms, and the Python scientific ecosystem, with particular emphasis on the interoperability between ROOT and Python tools and output formats (ROOT and HDF5). Our implementation spans from initial event processing to final statistical interpretation, featuring optimizations in C++ and RDataFrame that achieve favorable performance scaling for billions of events. The framework incorporates interfaces to TensorFlow for fast and accurate complex multi-dimensional binned maximum likelihood calculations and robust minimization. We will discuss the validation and reproducibility of the complete analysis pipeline, ensuring reliable results from event processing through statistical interpretation —critical components for precision measurements in the HL-LHC era.

Secondary track

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