Contribution ID: **150** Type: **Parallel Talk**

Lund Jet Plane tagger for boosted particles in the ATLAS experiment

Tuesday, 1 December 2026 15:20 (20 minutes)

This work presents the development, optimization, and deployment of a machine-learning-based jet tagger built upon the Lund Jet Plane representation within the ATLAS experiment at the Large Hadron Collider.

The central objective of this work is to investigate the viability of a Lund-plane-based framework for boosted-object tagging, with particular emphasis on its sensitivity to Monte Carlo modeling effects and jet mass correlations. The study includes a systematic characterization of generator-dependent variations using multiple parton shower and hadronization models, as well as the exploration of mitigation strategies such as mixed-generator training and phase-space restrictions in the declustering sequence.

The performance of the tagger is evaluated for boosted top-quark and W-boson identification and compared to established ATLAS constituent-based architectures, including graph neural networks and transformer-based models. While the Lund Plane tagger does not reach the highest background rejection achieved by state-of-the-art global-attention architectures, it demonstrates competitive performance across a broad transverse-momentum range, particularly at high pT, while relying on a physically structured and compact representation of the jet radiation pattern.

The implementation of the model within the ATLAS software framework (Athena) is also addressed. The tagger is adapted for ONNX-based inference and integrated into the Athena reconstruction chain, enabling its use within standard ATLAS analysis workflows.

An exploratory extension of the method to Higgs boson tagging is presented, establishing a consistent framework for evaluating Lund-plane-based approaches across multiple boosted-object topologies. Overall, this work provides a detailed study of the interplay between physics-motivated jet representations, machine learning architectures, and Monte Carlo modeling uncertainties in the context of modern ATLAS jet tagging.

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Session Classification: Parallel Talks-SD:704

Track Classification: Detector Applications and Computational Methods