Search for Unexpected New Phenomena at the ATLAS/LHC experiment

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As ATLAS data grows in volume and complexity, **machine learning** offers powerful tools to learn what normal **operation** and normal **physics** look like and to flag what doesn't fit. This idea is applied to **automated detector monitoring** and **model-independent physics searches**

AUTOMATED DATA QUALITY TILECAL

Goal

Automate data quality tasks

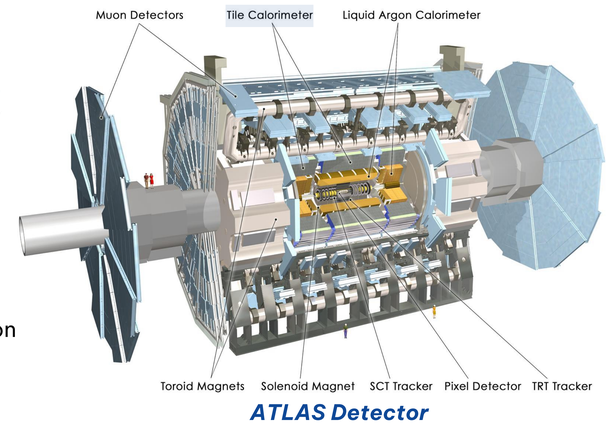
ML-based score as additional tool for DQ shifters

Information used

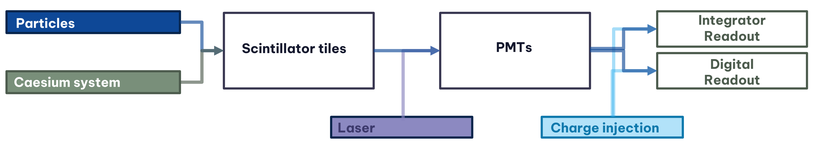
Physics runs information

Laser standalone calibration runs

Pulse shape information



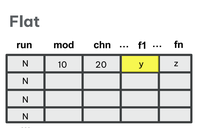
ATLAS Detector

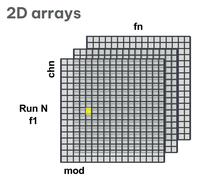


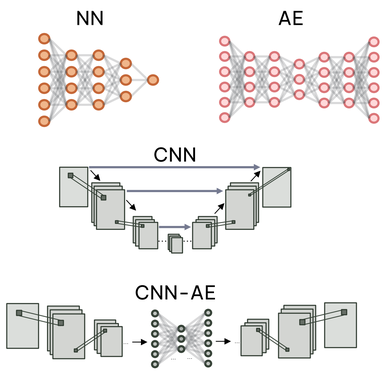
Models Developed

Supervised (NN, CNN) and semi-supervised models (AE, CNN-AE)

Based on flat and 2D arrays inputs







ANOMALY DETECTION IN ATLAS ANALYSIS

Exploring Anomaly Detection across different angles

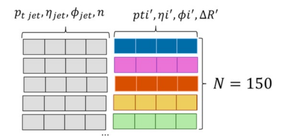
? **Can signal-agnostic AD compete with signal-specific supervision?**

? **How does input representations shape performance?**

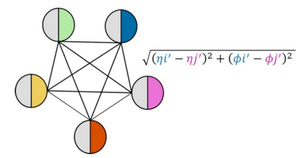
? **How do blind model choices affect sensitivity – and the test statistics**

Goal: Turn this into the methodology of an **ATLAS analysis**

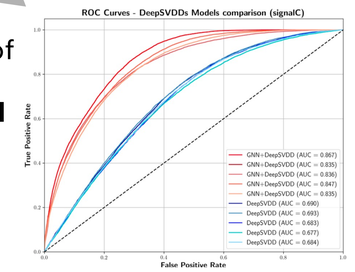
Jet as a graph: constituents are nodes, connected by pairwise ΔR distance (edges)

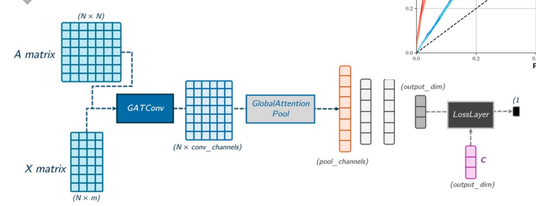


GNN-based embedding consistently beats the flat Deep SVDD baseline



GAT layer learns relevance of constituent information **Pooled** into a single **jet-level embedding**





Monojet Run 3 analysis

Signature:
1 Large energetic jet + **Missing Transverse Energy, fully hadronic decay** – Searches for New Physics using AD methods

Benchmark signals : Model-independent analysis: set of signals from different theoretical models:
Heavy Vector Triplet (**HVT**), 2 Higgs Doublets model (**2HDM**), 2HDM with pseudoscalar singlet a (**2HDM+a**), Supersymmetry Models (SUSY), Dark Matter simplified Model (**Monotop signals**)

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ATLAS EXPERIMENT