

# Expanding the ATLAS Physics reach with Anomaly Detection at Trigger Level

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## INTRODUCTION

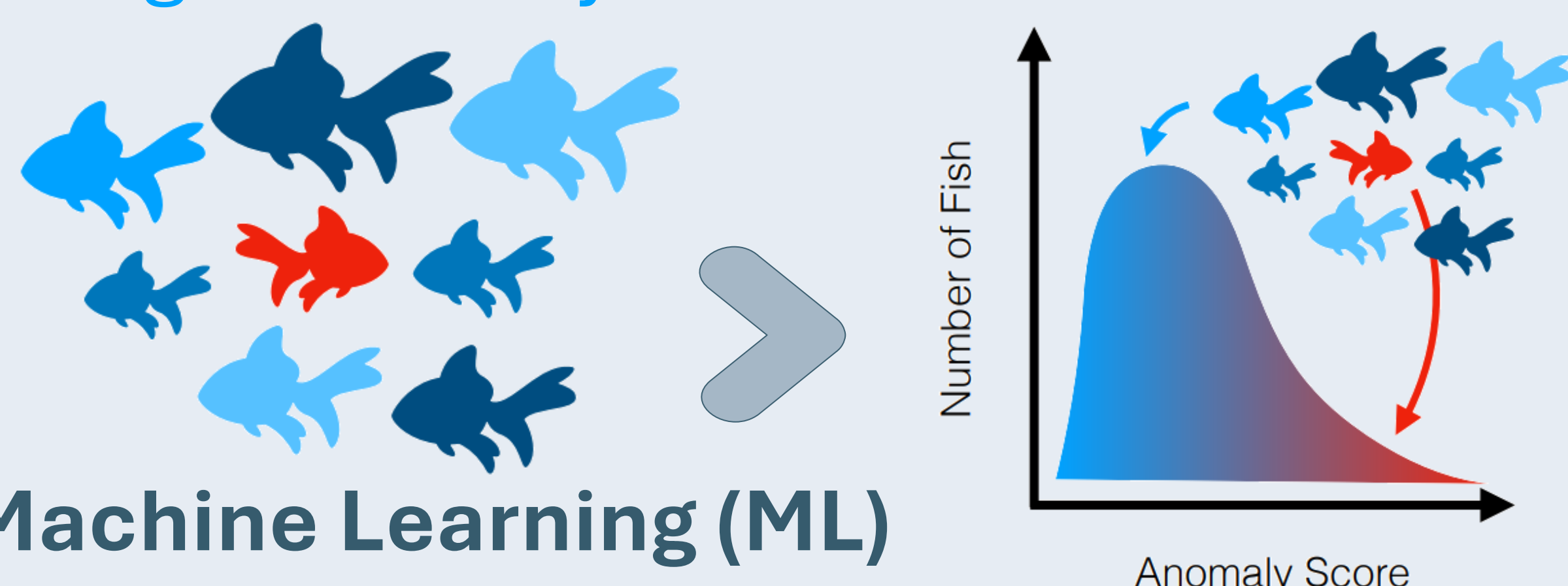
The **ATLAS Trigger System** is responsible for the **online event selection**, according to the physics goals of the experiment (e.g. selecting objects with high transverse energy or exploiting specific event topologies).

Crucial to offline analysis since the data from the rejected events cannot be recovered.

The **Standard Model** is a remarkably successful, yet incomplete theory.

**Is ATLAS missing rare or unexpected physics?**

**Anomaly Detection (AD)** is a model agnostic approach that aims to identify collisions that are **inconsistent** with the **background-only model**.



**Machine Learning (ML)**

can be used extract relevant features from data.



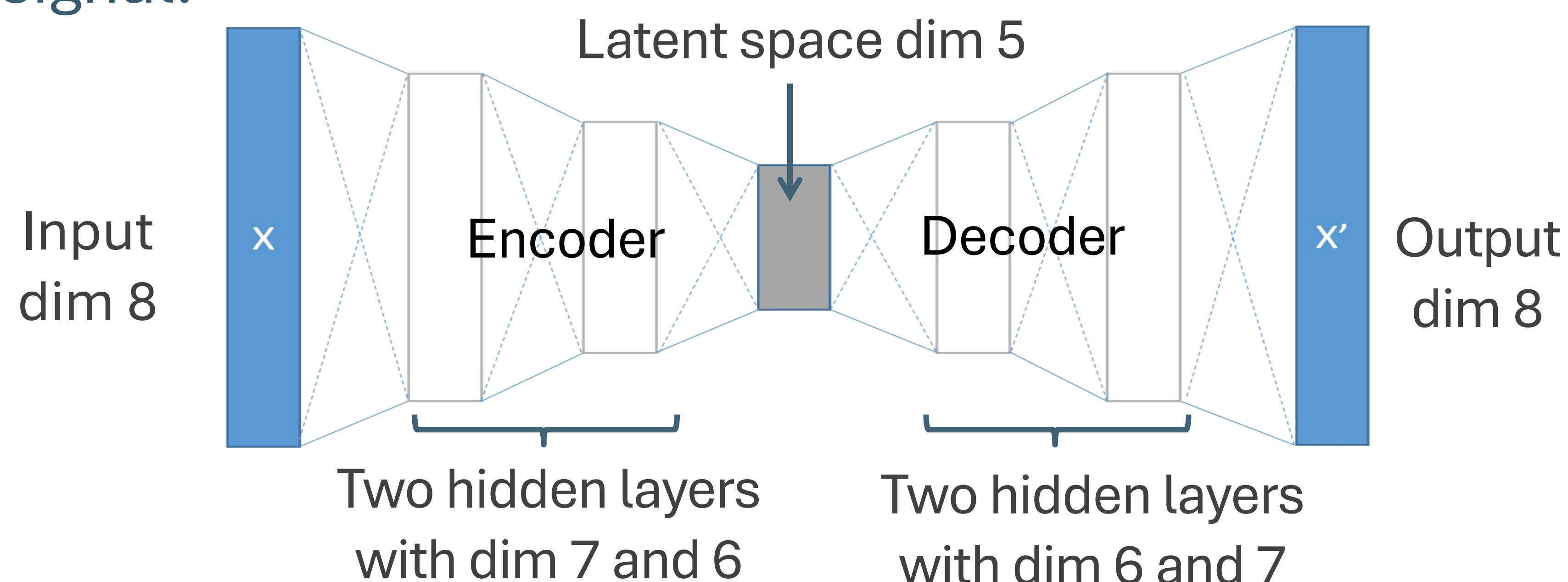
Can we apply AD at trigger level to select “anomalous” or potential signal-like events?

## Run 3 Trigger System



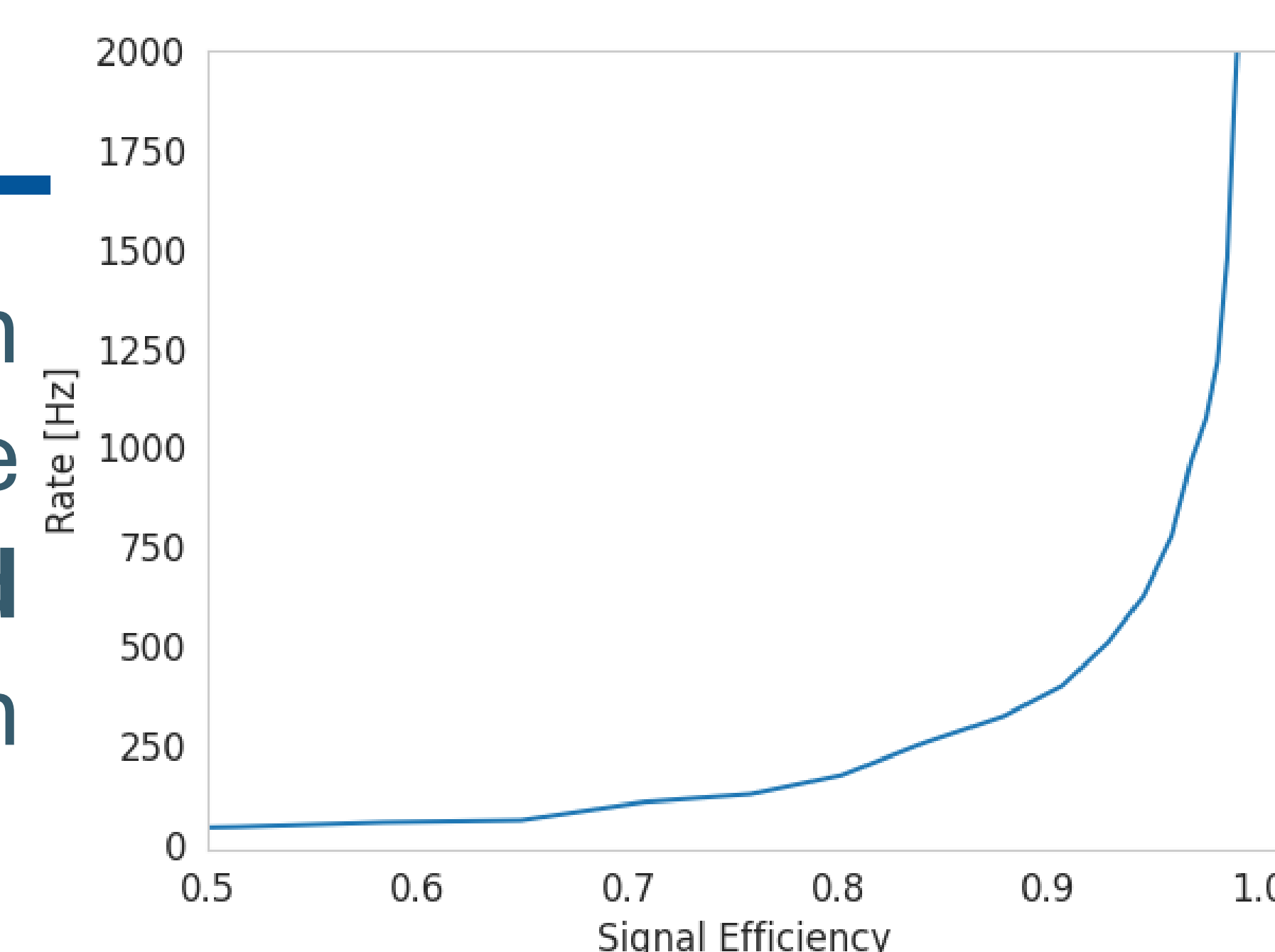
## METHODOLOGY

Simulate software trigger logic that employs an unsupervised ML method (**autoencoder**) as a reconstruction model, trained using real-data background events and tested with a SM simulated signal.



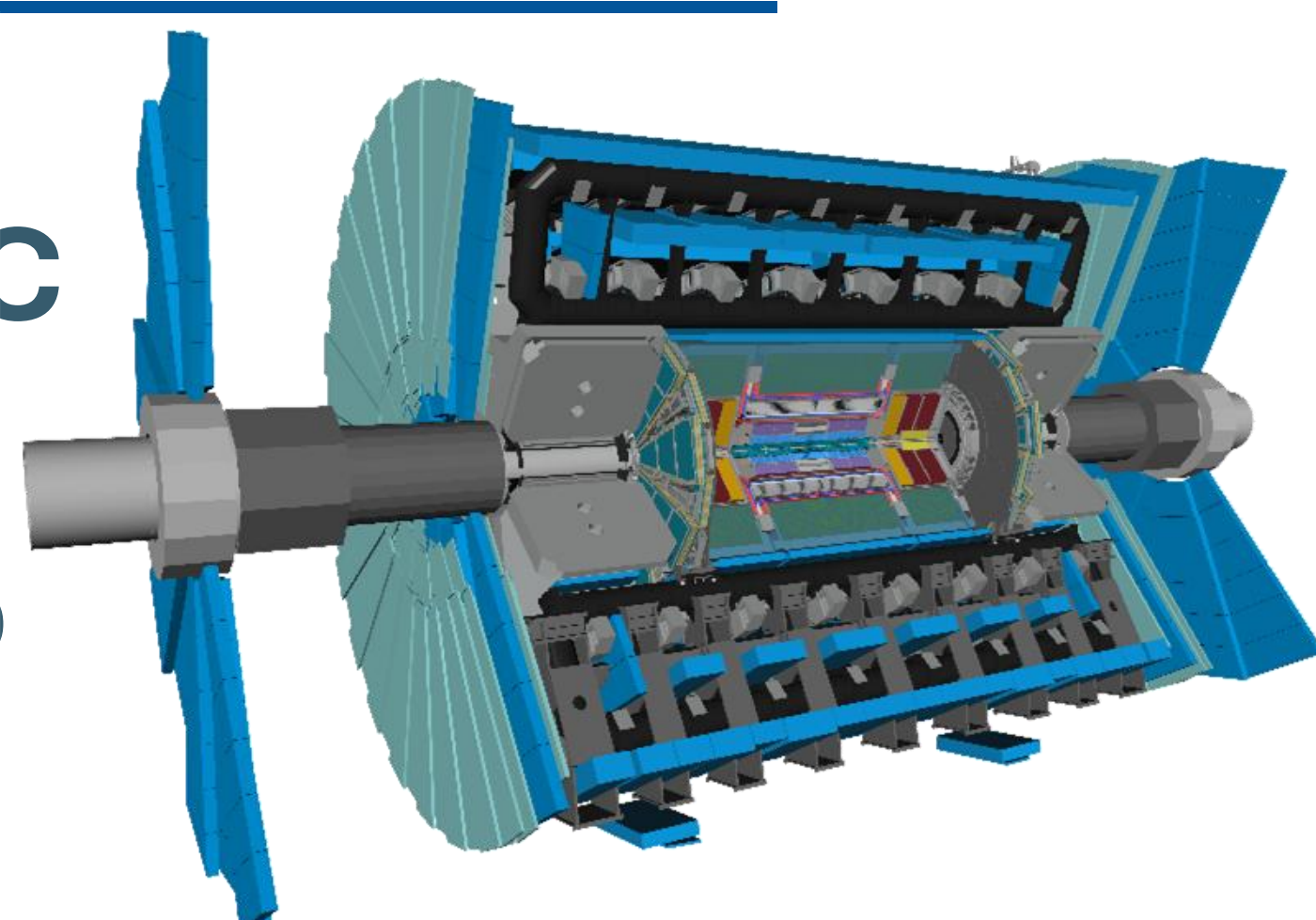
## RESULTS

Use the reconstruction error as an anomaly score to predict **the background rate** for a trigger chain based on this model.

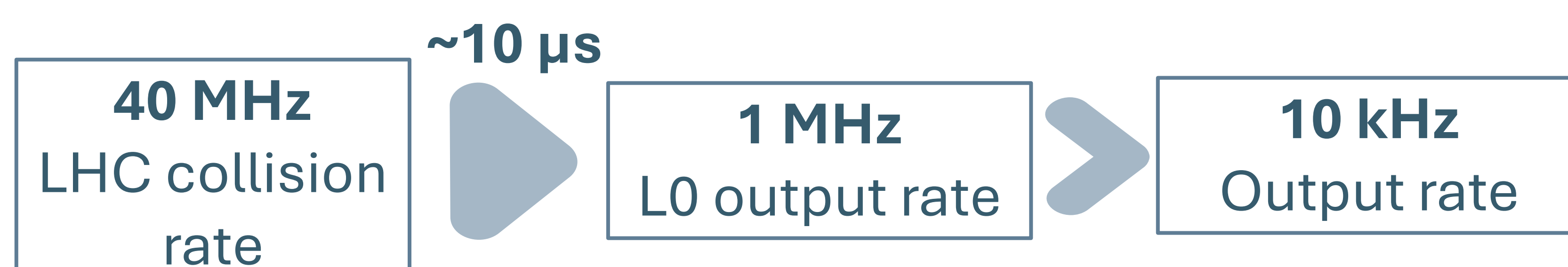


## FUTURE WORK

In preparation for the **High Luminosity LHC (HL-LHC)**, the ATLAS detector will undergo major upgrades.



Namely, the significant increase in the luminosity poses **additional challenges** to the Trigger and Data Acquisition system.



The increase in latency enables the introduction of more advanced **event reconstruction and analysis** capabilities at the **earliest trigger level**.

**ML models can be used to ensure that AD methods in the trigger meet the timing and resource constraints without compromising the physics performance.**