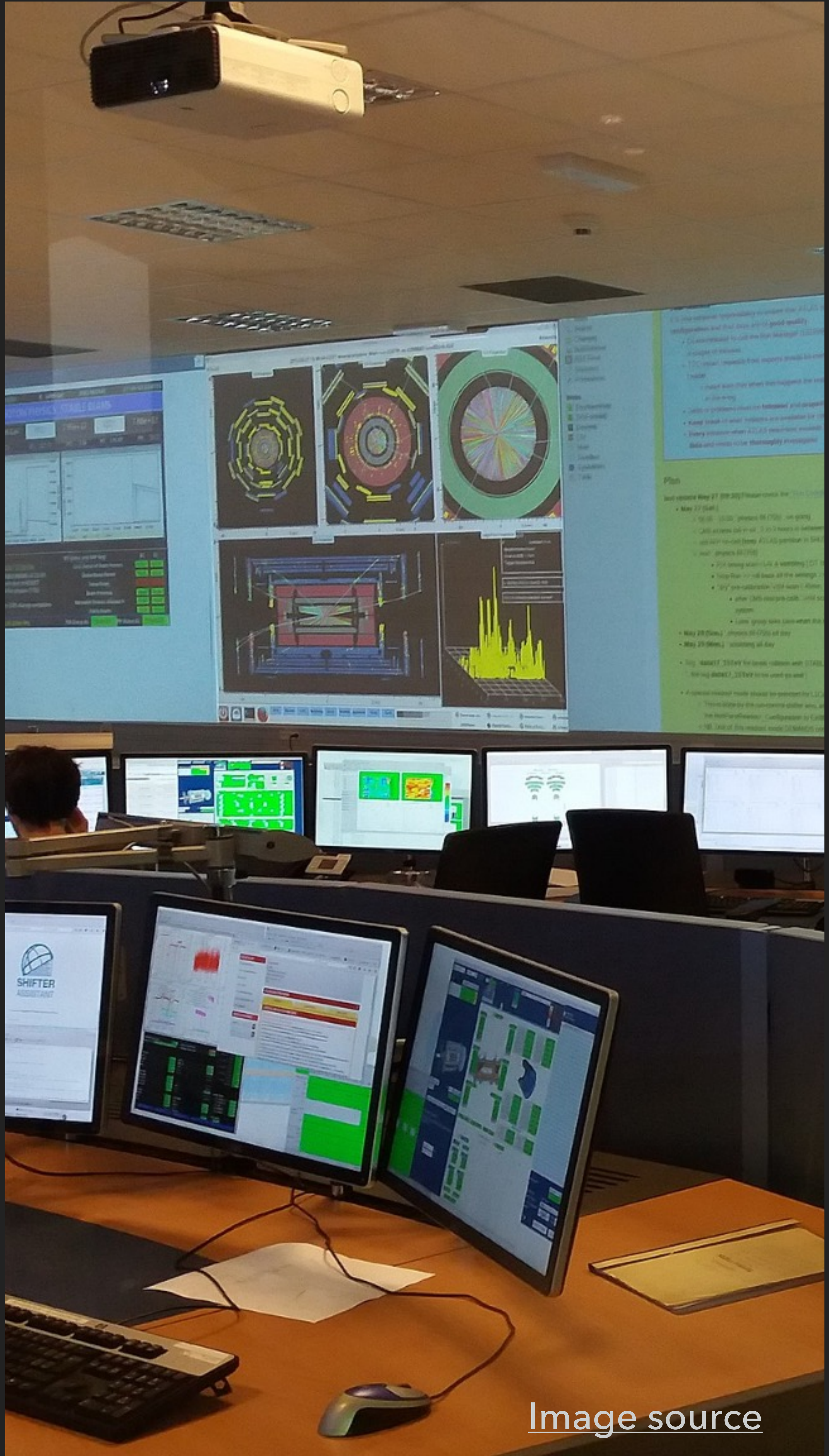
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ATLAS EXPERIMENT

AUTOMATING ATLAS CONTROL ROOM ANOMALY DETECTION WITH ML

AVERY HANNA

JULY 25, 2024

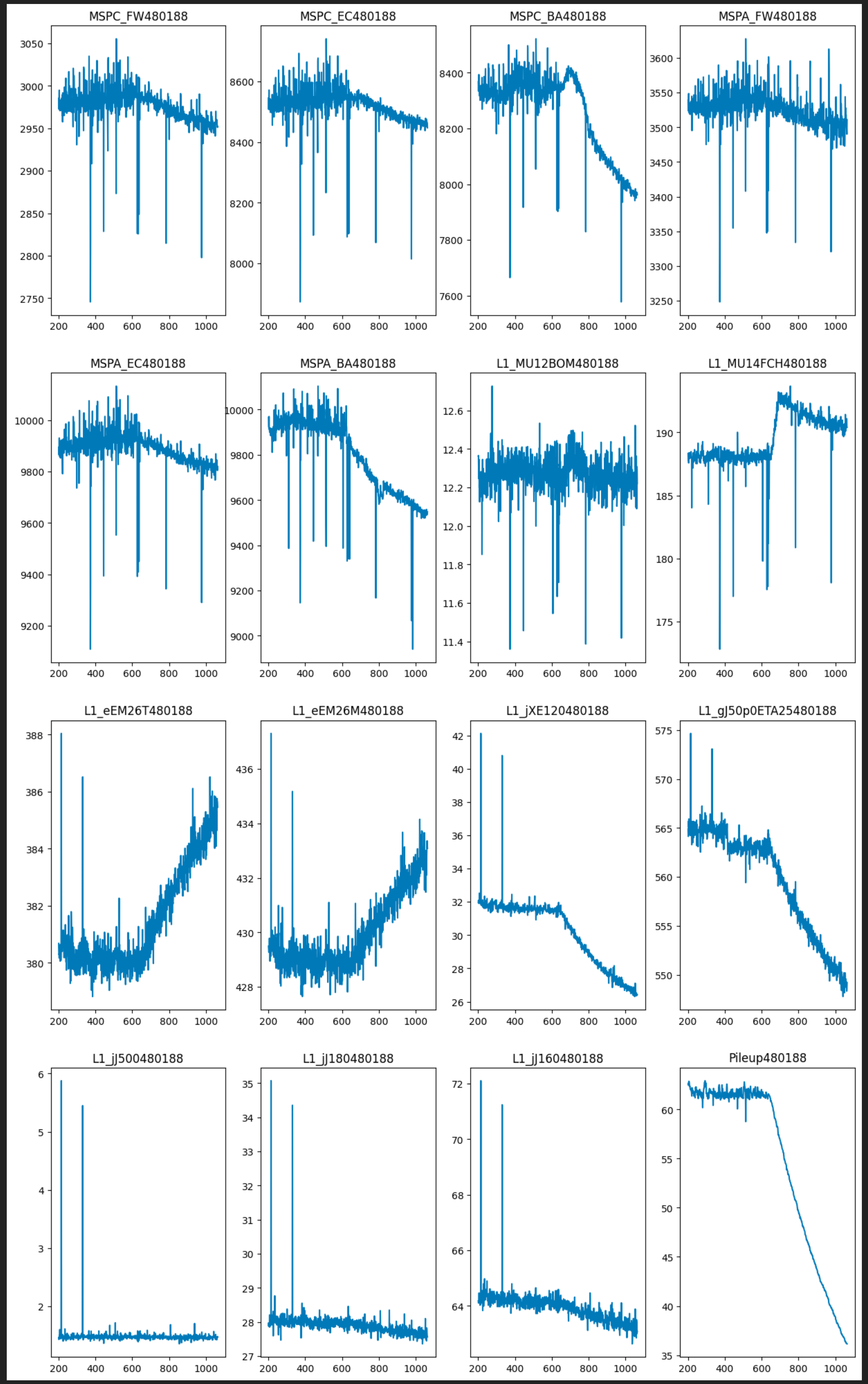
INTRODUCTION

- Goal: More consistently and accurately catch problems in detectors. Decrease workload of ATLAS control room staff
- Approach: Online deep learning anomaly detection algorithm
- Supervisors: Mario Campanelli and Antoine Marzin

ATLAS EXPERIMENT

DATA

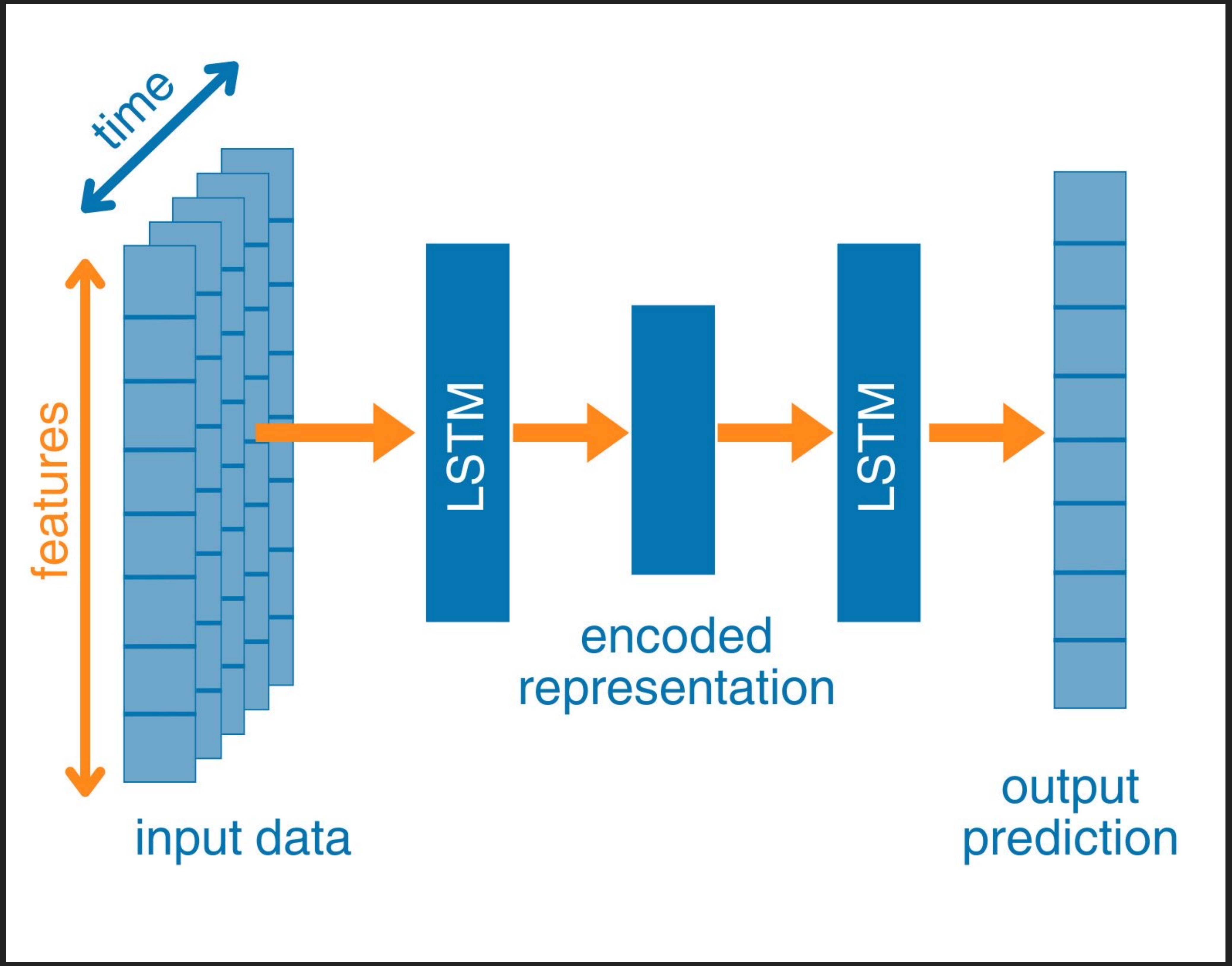
- Input:
  - Time series data of 5 samples
  - Each sample with 16 features: L1 trigger rates, L1 muon sector logic inputs, pileup
- Output:
  - Prediction of 16 features for next sample
    - One luminosity block in future



ATLAS EXPERIMENT

MODEL ARCHITECTURE: PREDICTIVE LSTM AUTOENCODER

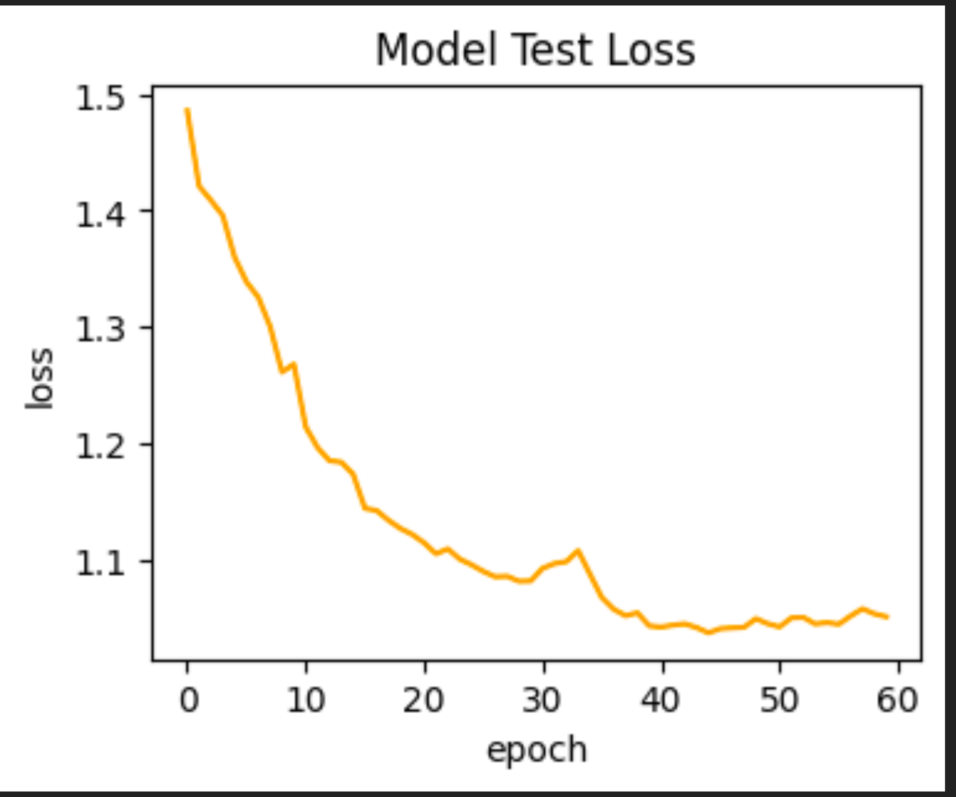
- Long short-term memory (LSTM) layers incorporate time-series element of data
- Autoencoder shape forces model to learn lower dimensional representation of data
- Model trained on clean data so low mean squared error (MSE) with clean values, high MSE with anomalies
- Set threshold MSE between clean and anomalous classifications



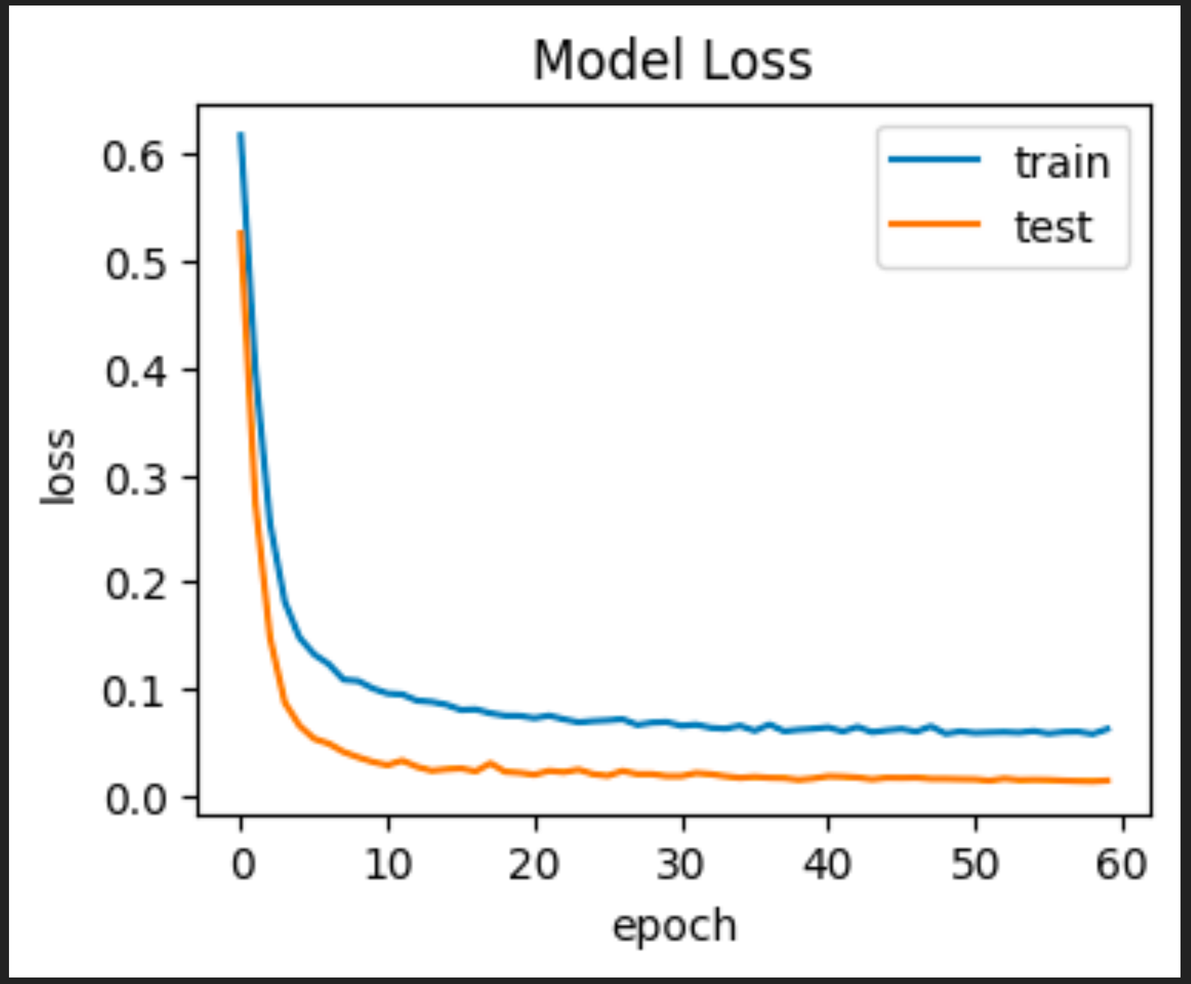
ATLAS EXPERIMENT

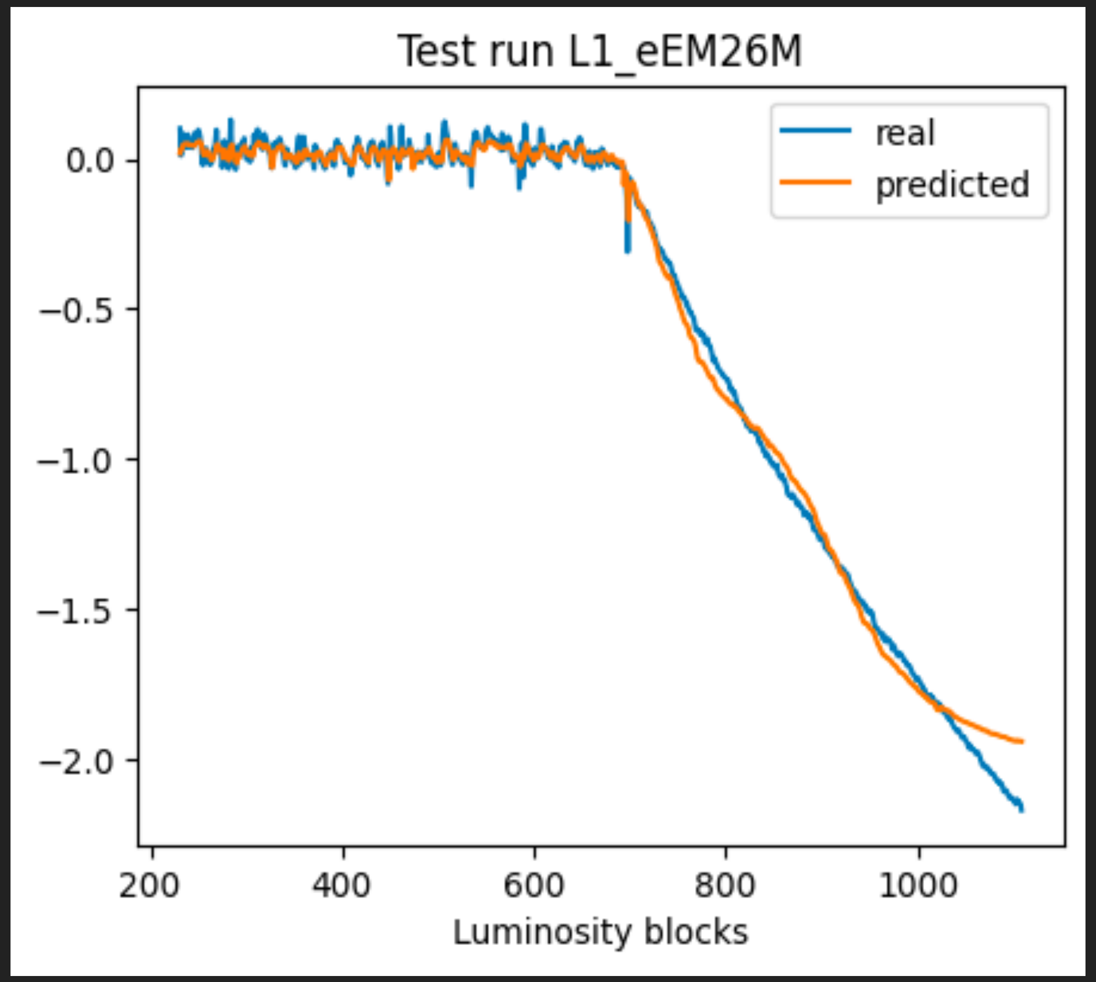
MODEL PERFORMANCE

- Gap in train and test from changing run conditions
  - Train data = 3 full runs
  - Test data = 1 full run
- Robust scaling lets us lower impact of outliers
- Poor predictive power at end of run

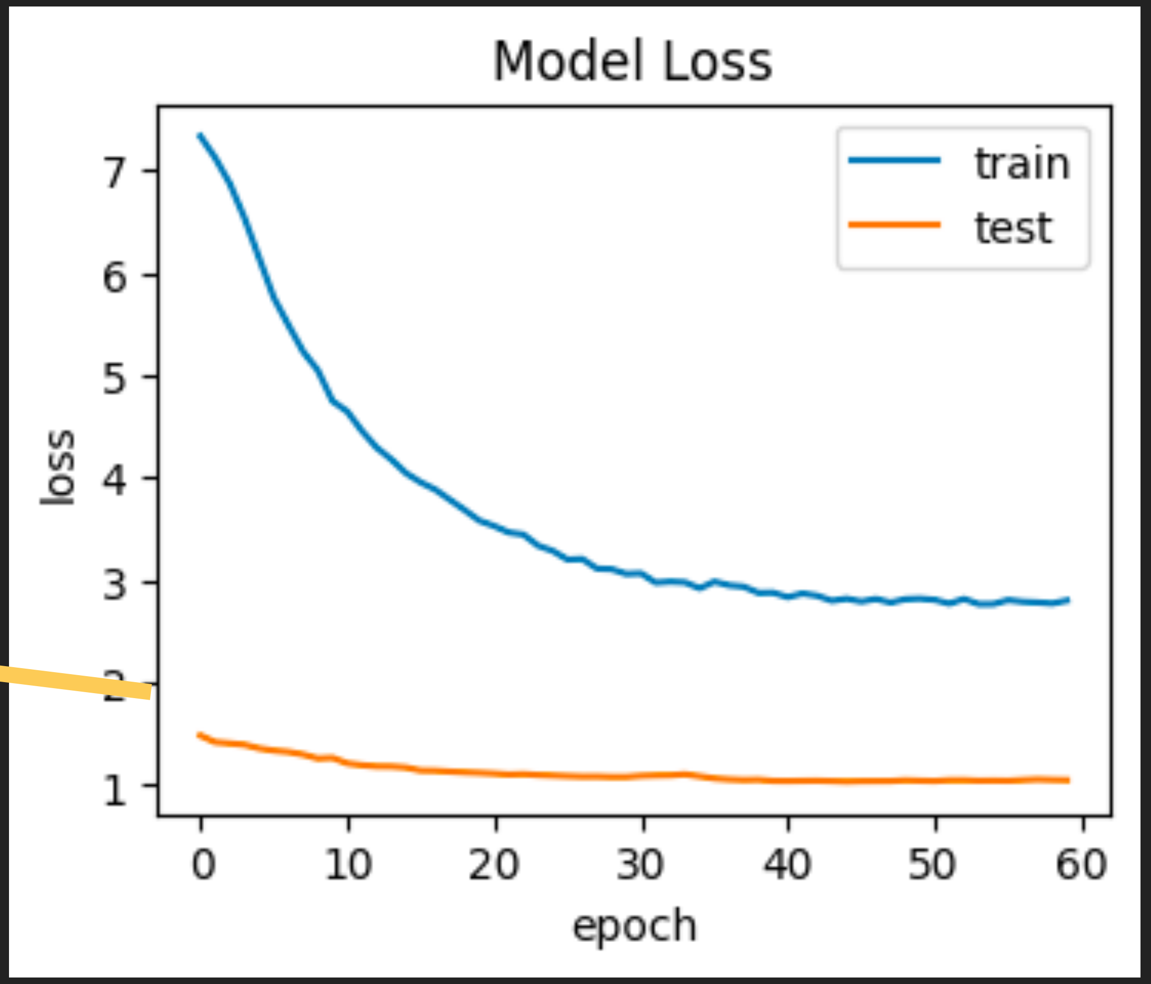


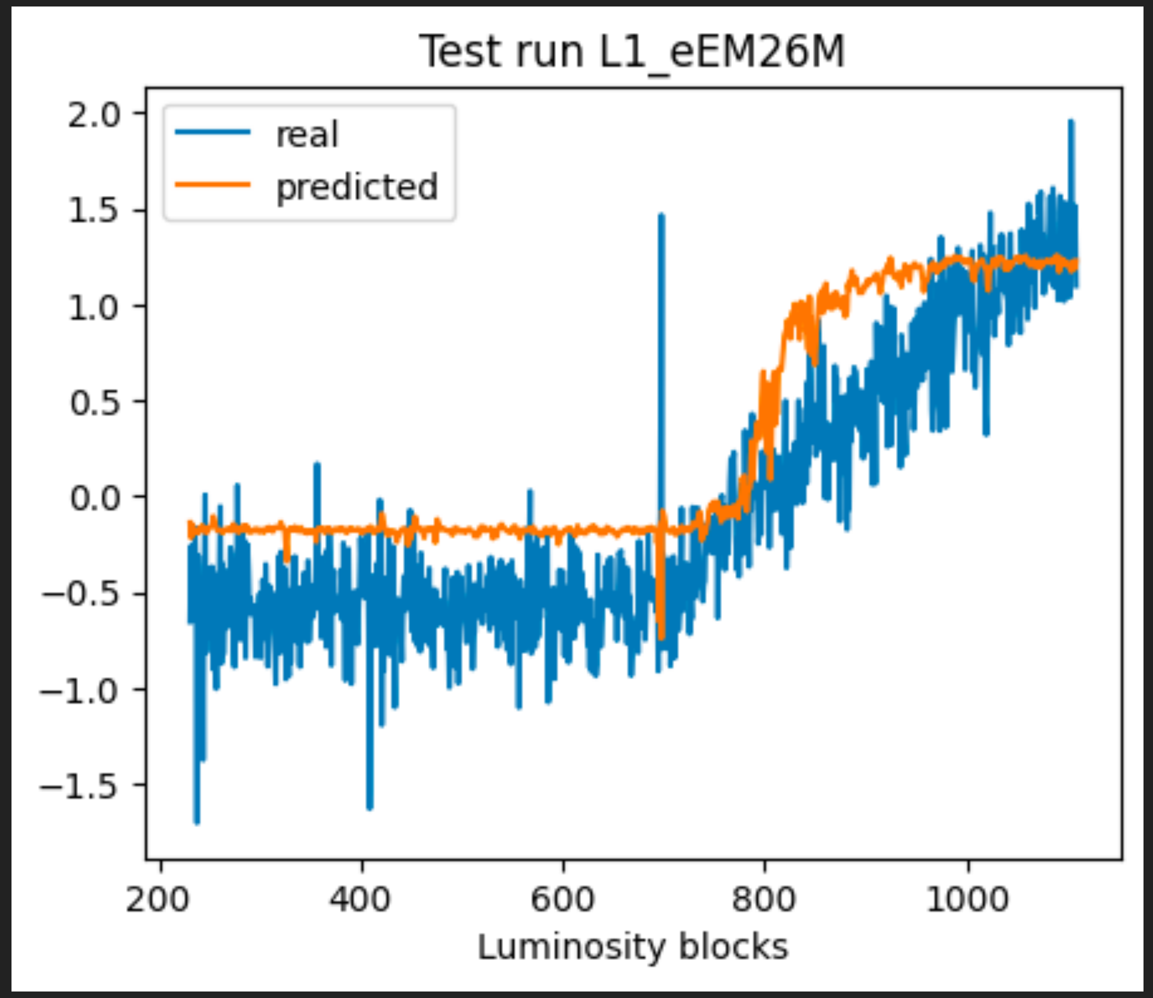
No pre-processing





Normalizing with pileup



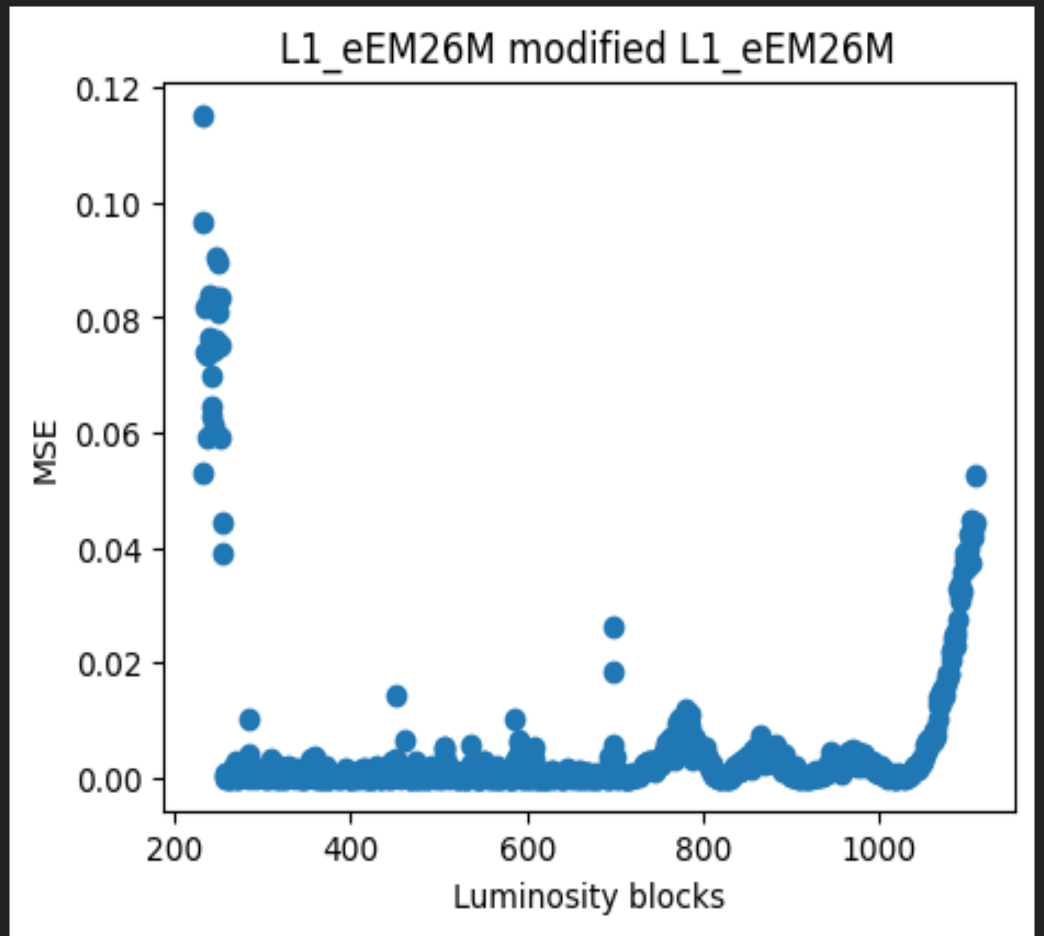


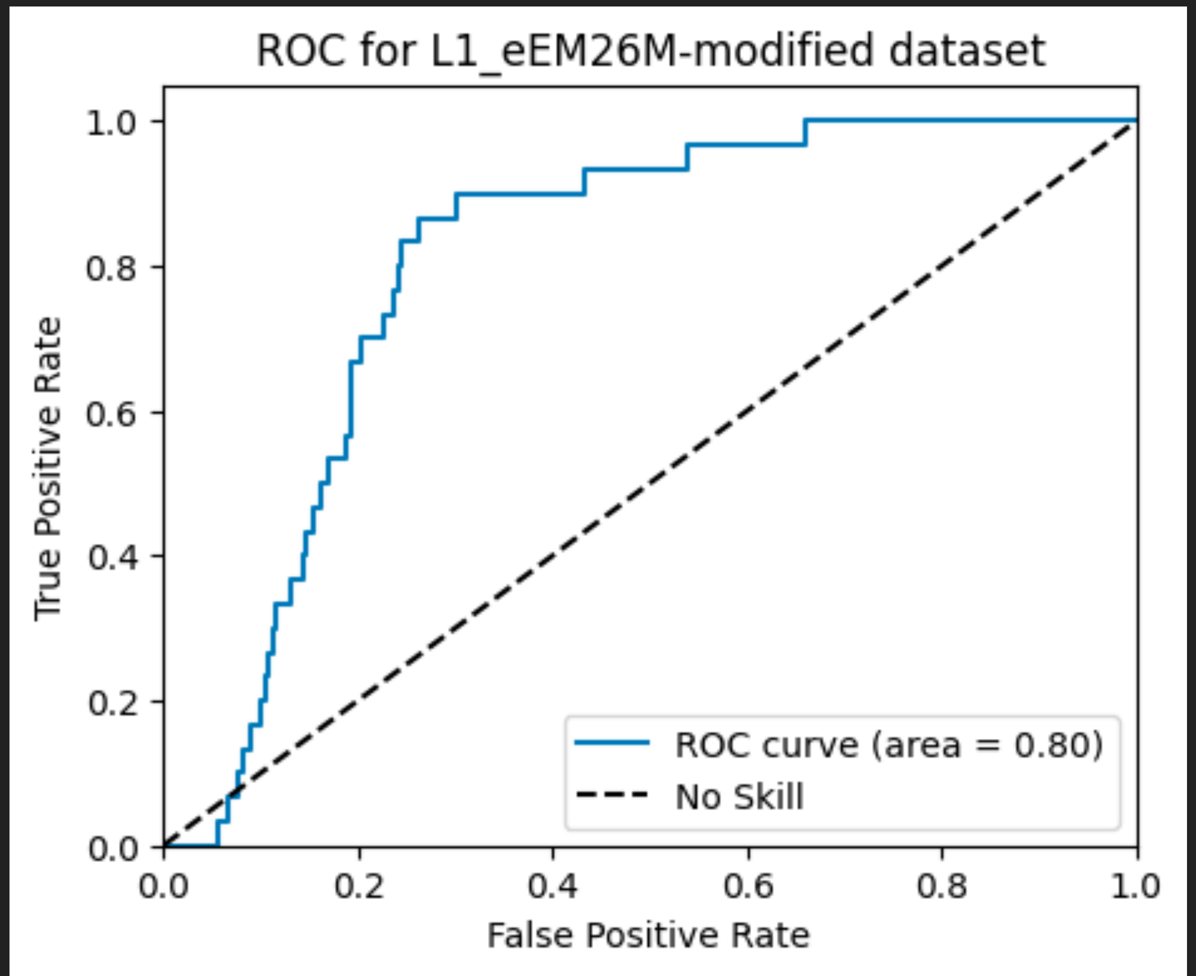
ATLAS EXPERIMENT

DETECTING 5% ANOMALY

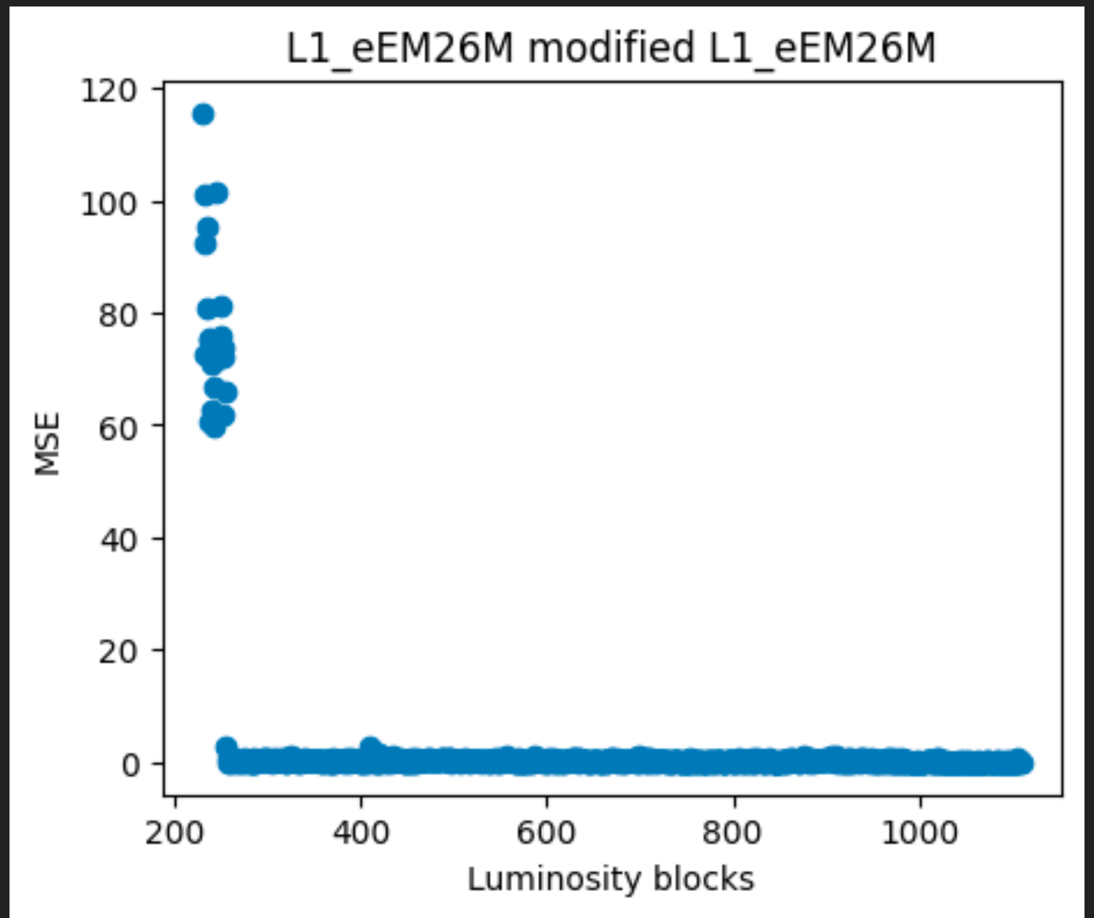
- Produce artificial anomalous data sets by taking test set and increase single feature of first 30 LBs by 5%
- Normalizing with respect to pileup gives us more consistent MSE across luminosity blocks so easier to detect anomalies

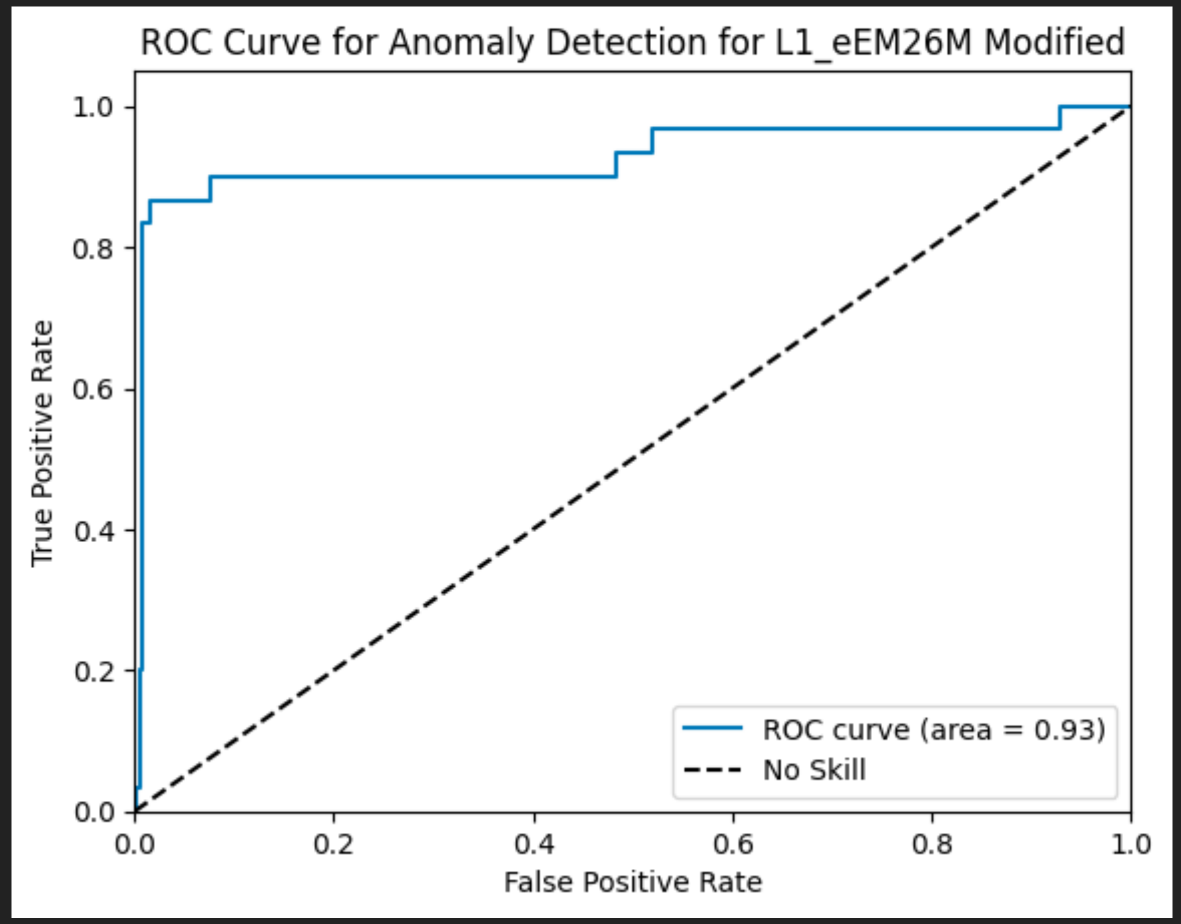
No pre-processing





Normalizing with pileup

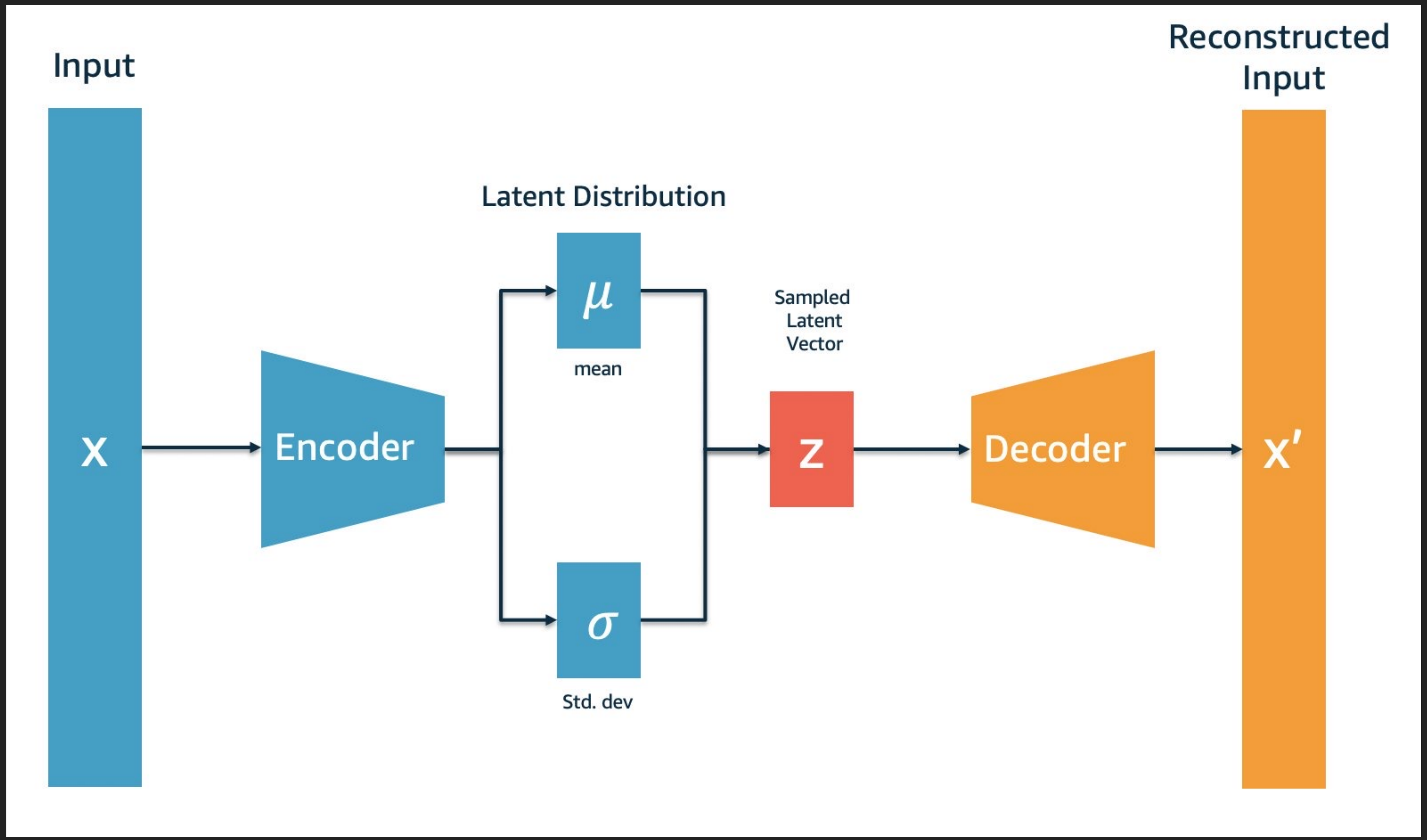




ATLAS EXPERIMENT

NEXT STEPS

- Better cleaning of training data
- Data augmentation of low pileup region
- Extensive hyperparameter sweep
- Variational autoencoder structure



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ATLAS EXPERIMENT

ATLAS EXPERIMENT

WHEN NOT CODING…