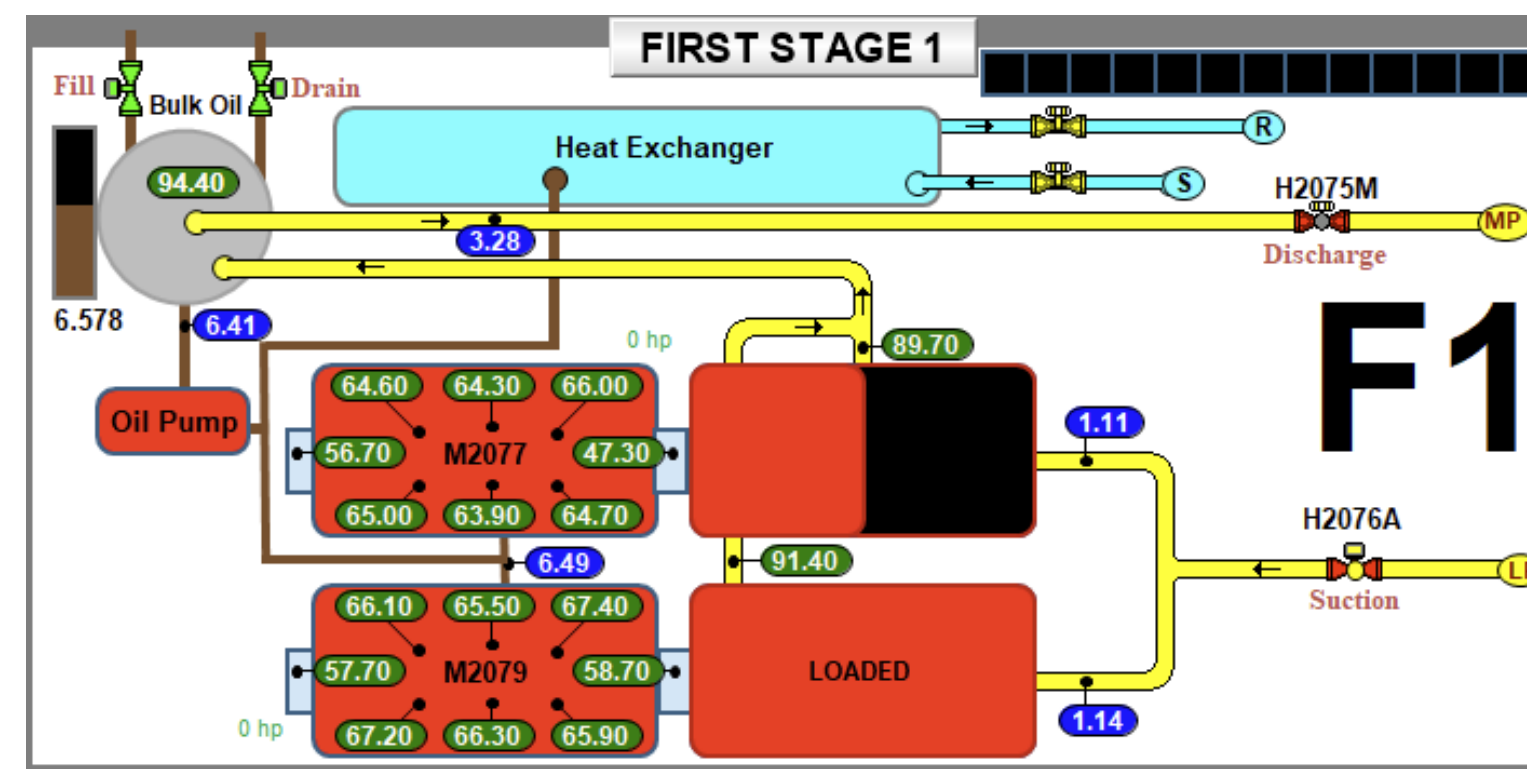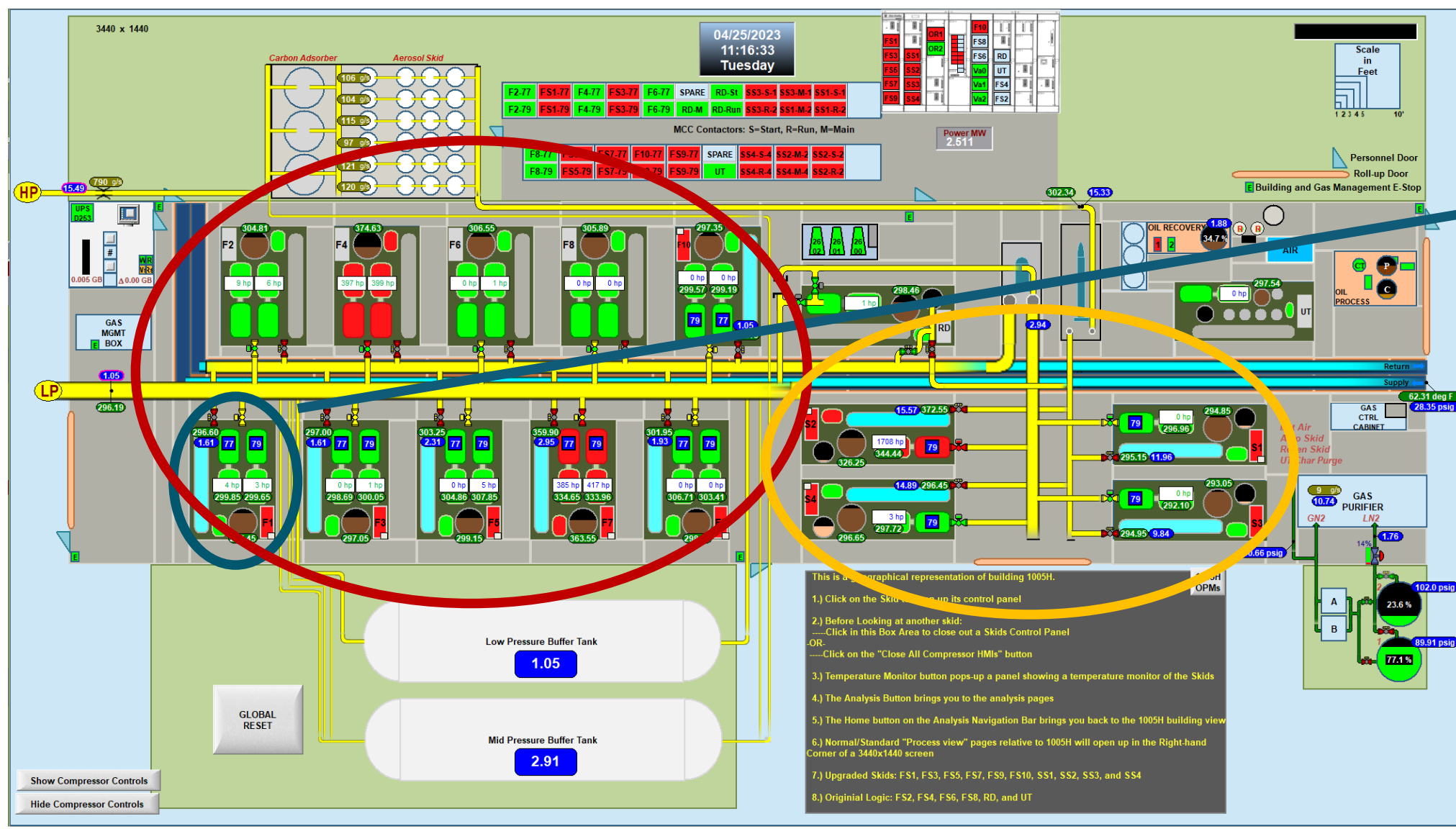# Exploratory Data Analysis on the RHIC Cryogenics System Compressor Dataset*

Y. Gao†, K. A. Brown, R. Michnoff, L. Nguyen, B. van Kuik, A. Zarcone, Brookhaven National Laboratory, Upton, NY, USA
A. Tran, Facility for Rare Isotope Beams, East Lansing, MI, USA

10 first stage compressors   4 second stage compressors

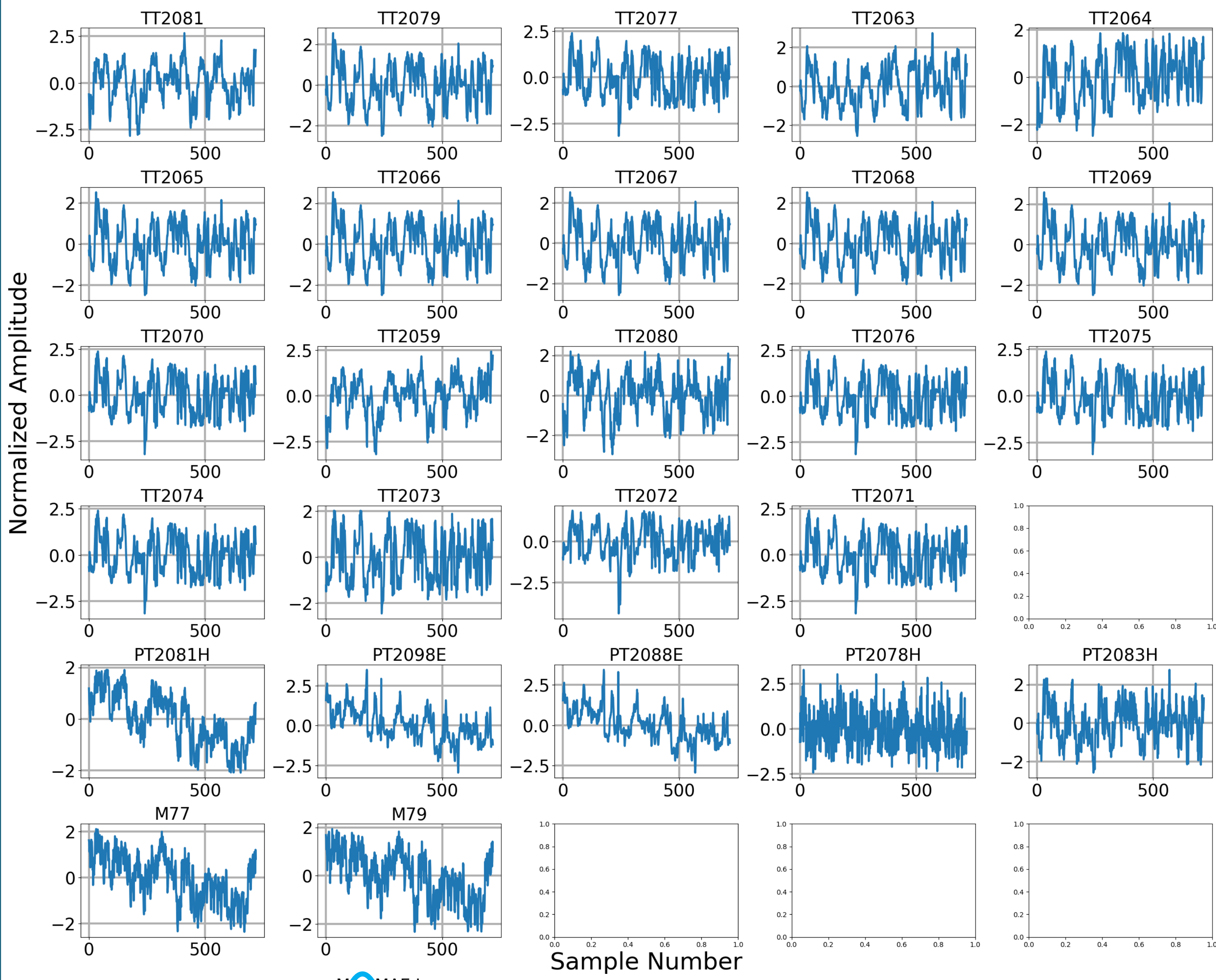Our focus is one set/pair of the First Stage Compressors: FS1

System Overview

We focus on 26 analog sensors for a first-stage compressor :
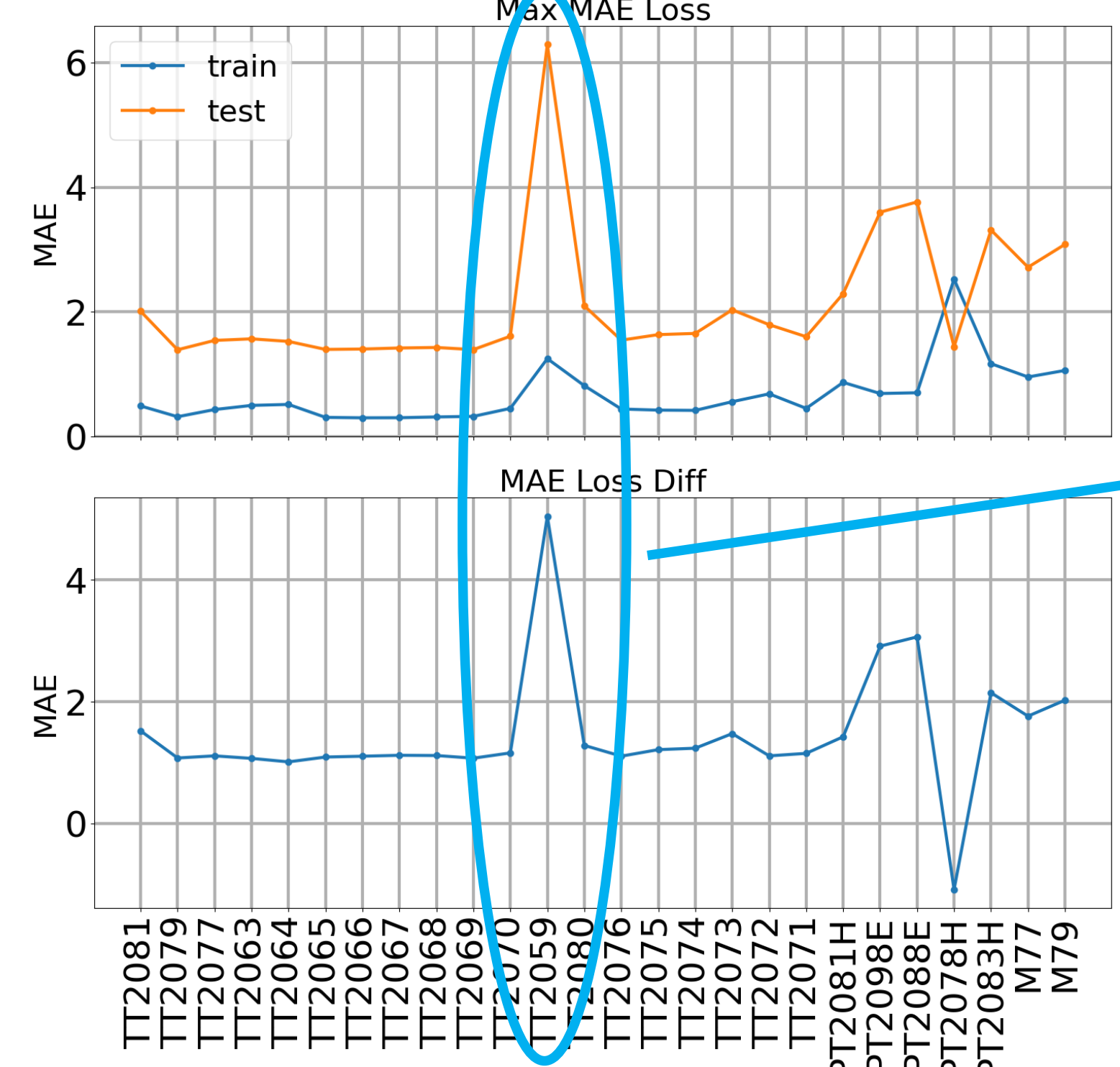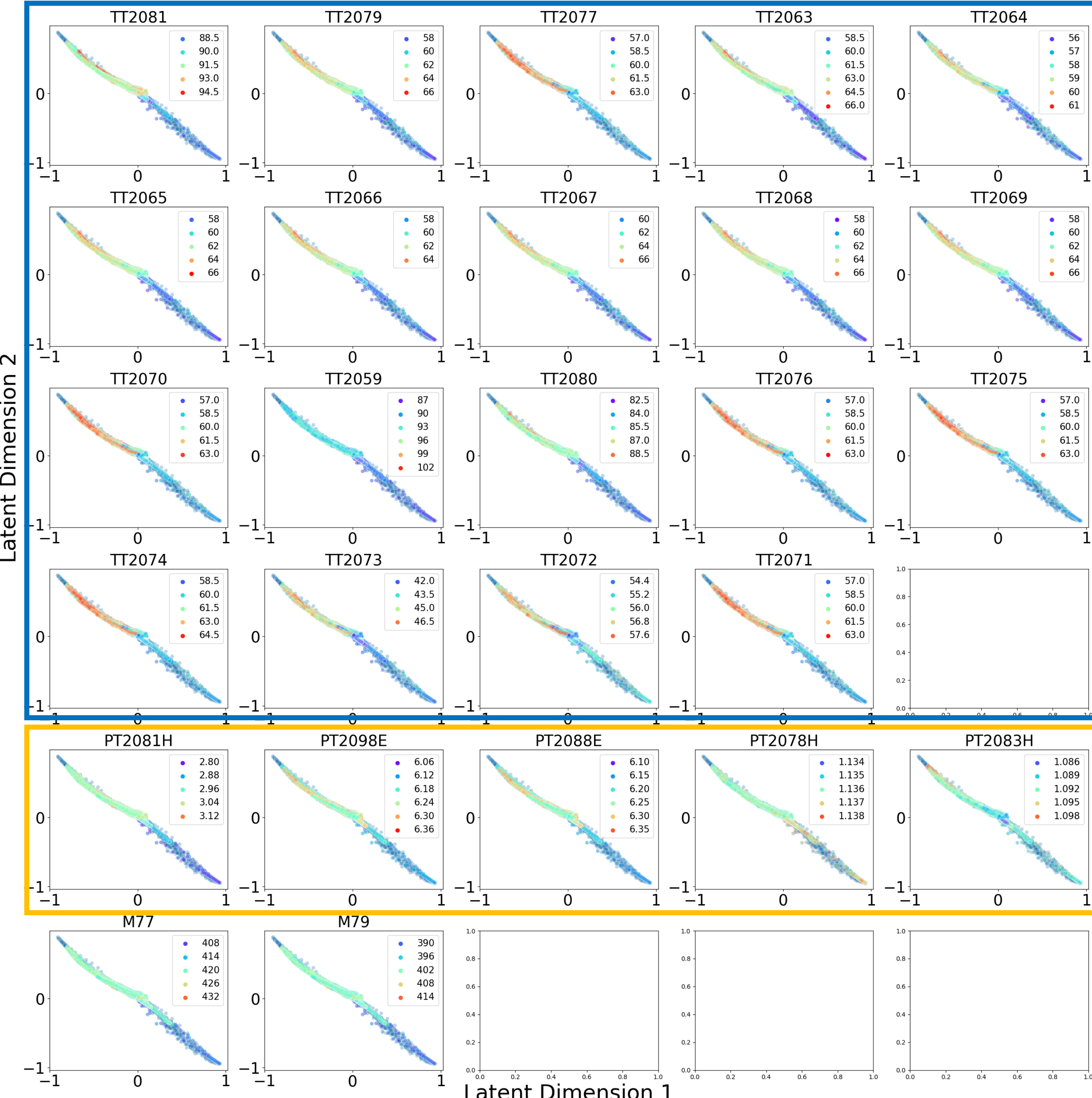19 Temperature (TT), 5 Pressure (PT), 2 horsepower (M77, M79) sensors.

LSTM Autoencoder Analysis

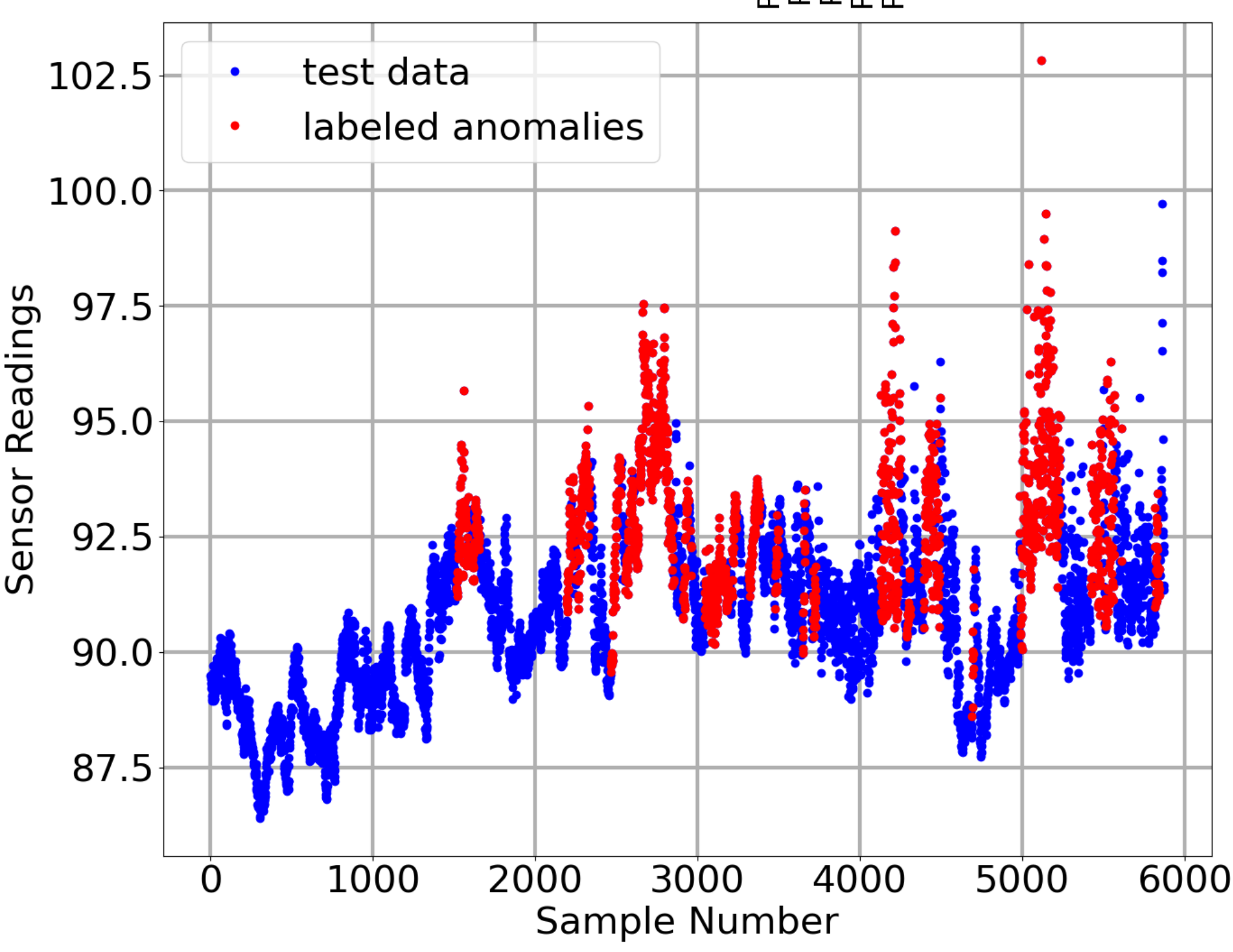Overview of the 26 float type variables.

Latent space visualization for each variable.

Reconstruction Mean Absolute Error (MAE) plot:
The sensor TT2059, which is the actual cause of the machine trip, gets the highest error value.

From the latent space visualization, we can see:
1. TT2059 has a different pattern with other TT temperature sensors;
2. PT2078H and PT2083H don't have obvious data patterns, can be omitted for analysis;

- The compressor has a documented trip which happened on Apr. 7th, 2022, due to the discharge temperature sensor TT2059 interlocking the FS1 compressor after it breached a high limit of 125 degrees C for 3 seconds. Technicians found a loose crimp on the sensor, and the compressor was returned to service after repairs.

- The LSTM autoencoder was trained on data from Jan. 15th to Mar.5th, 2022, and tested on data from Mar. 6th to Apr. 5th, 2022, to see if it is able to detect any anomaly precursors.

Anomaly detection on sensor TT2059 demonstrates the LSTM autoencoder is able to detect early precursors so proactive actions can be taken to prevent machine failure.

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