Summary Data Report on GT451A Power Turbine Thrust Bearing

Digital Twin Track

Date: 4th October 2023

Prepared by: Sushovan, Harshavardhan, Shital

BOSCH

Agenda

PHOENIX PARK
GAS PROCESSORS LIMITED

- High level approach
- Some findings
- Summary and next steps

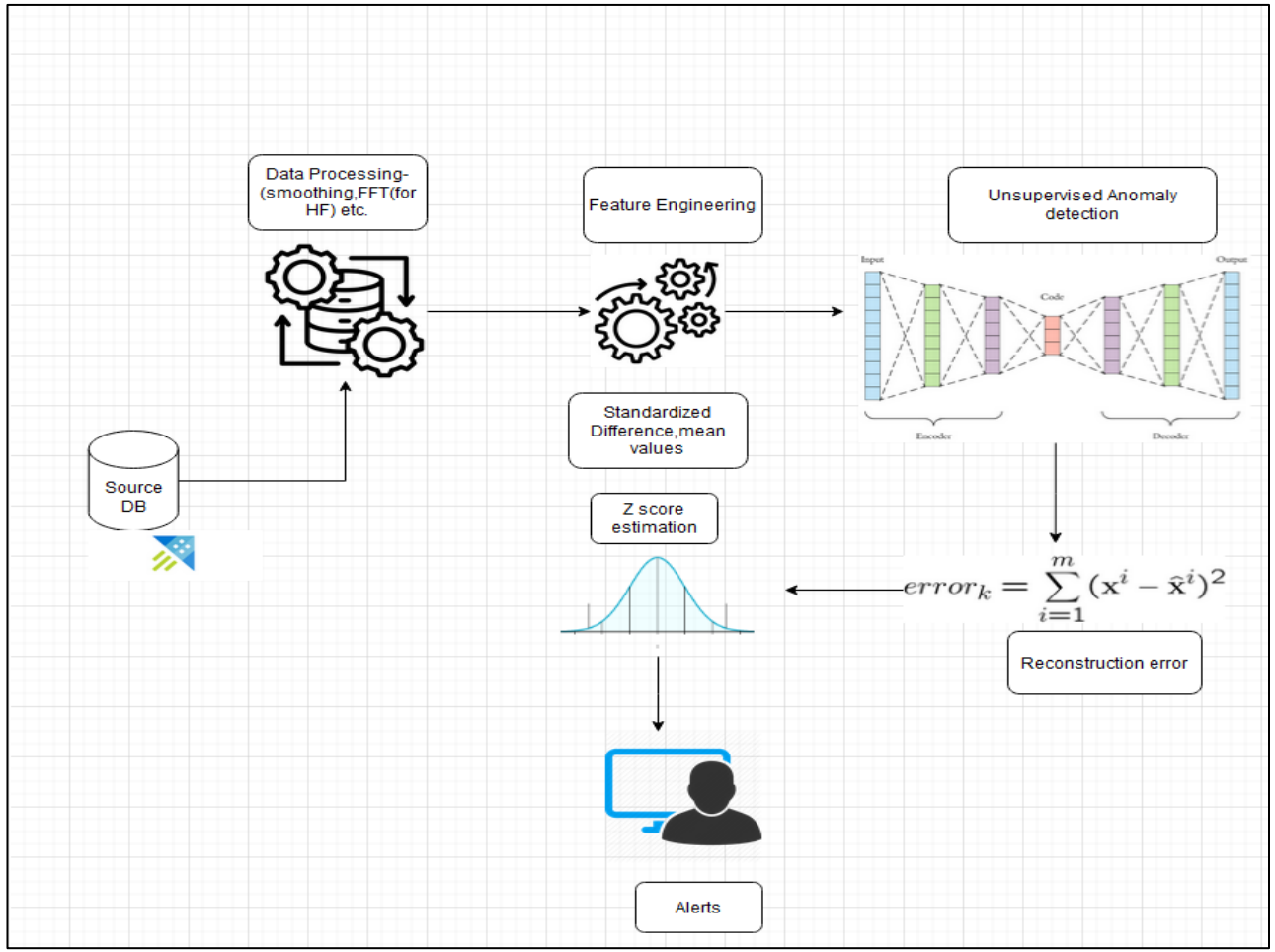
BOSCH

PHOENIX PARK
GAS PROCESSORS LIMITED

High Level Approach

BOSCH

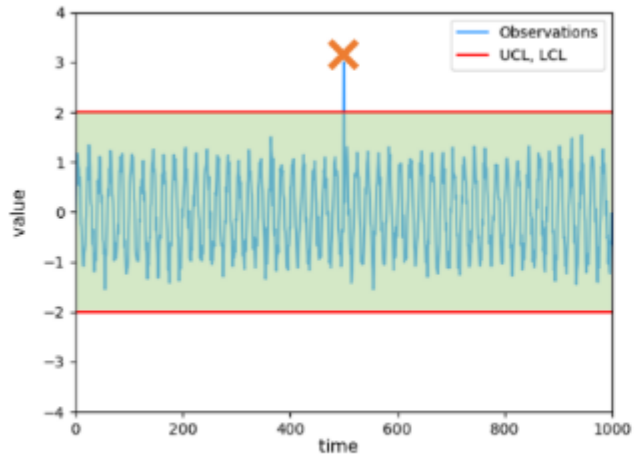
High Level Approach



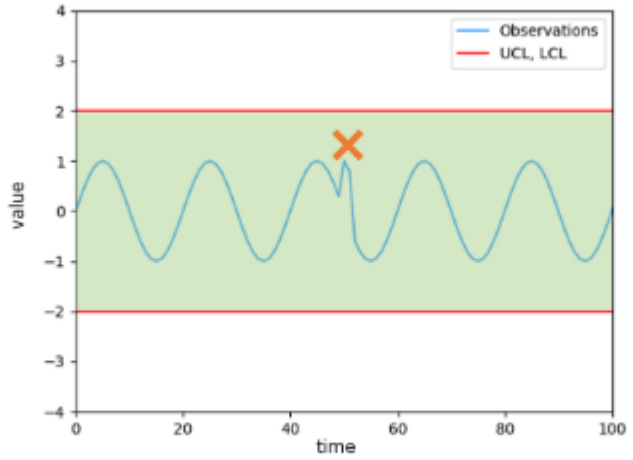
Following steps will be followed

1. **Data Understanding**
   - Understanding Tags
   - Understanding Tag description
2. **Exploratory Data Analysis (EDA)**
   - Understanding correlations
   - Spike significance
   - Feature definitions
3. **Dashboard**
   - Display Trend chart
   - Alert on predefined Threshold Breach
   - Asset health summary
4. **Feature engineering**
5. **Model development**
6. **Inference pipeline development**
   - Prediction frequency
   - Input payload definition
   - Alert frequency

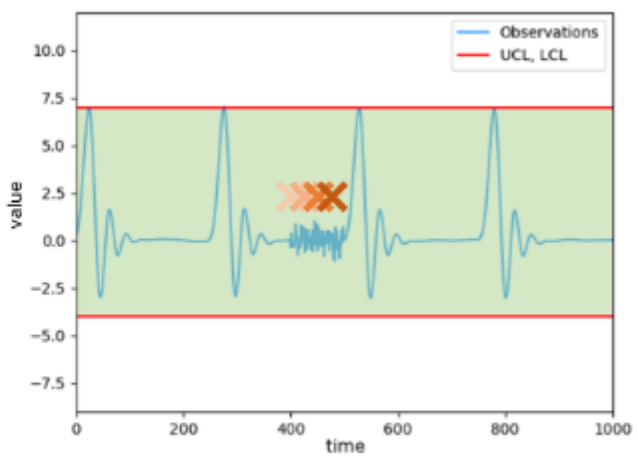
Anomaly categories (Univariate Time Series Anomaly detection)



(a) point anomaly



(b) contextual anomaly



(c) collective anomaly

Source- [Deep Learning for anomaly detection]

Type	Input Data Type	Output
High-dimensional Anomaly Detection	Historian	Anomaly score
Distance-based Anomaly Detection	Historian	Anomaly score
Time-based Anomaly Detection	Historian	Anomaly score
Parameter-free univariate time series anomaly detection	Historian	Anomaly Score
Automated multivariate time series anomaly detection	Historian	Anomaly Score

PHOENIX PARK
GAS PROCESSORS LIMITED

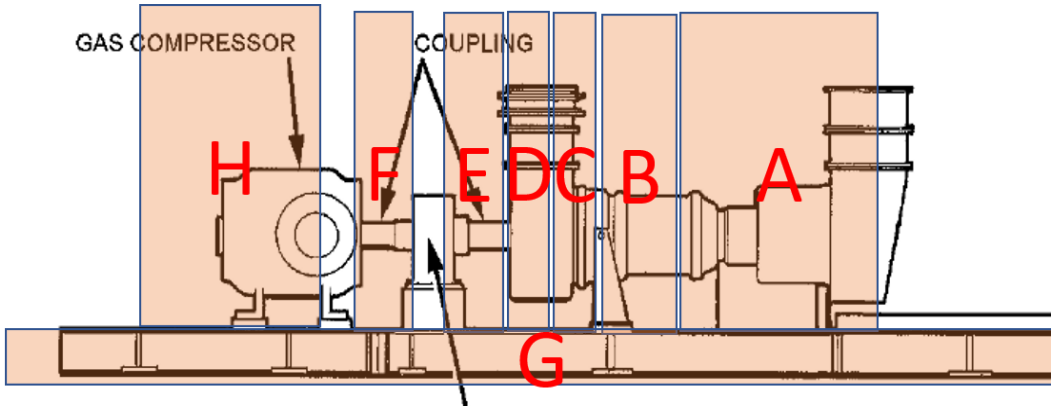
Some Findings

BOSCH

GT451A Asset

Power Turbine Thrust Bearing

Data report for GT451A Power Turbine Thrust Bearing is presented (Region D in the figure).

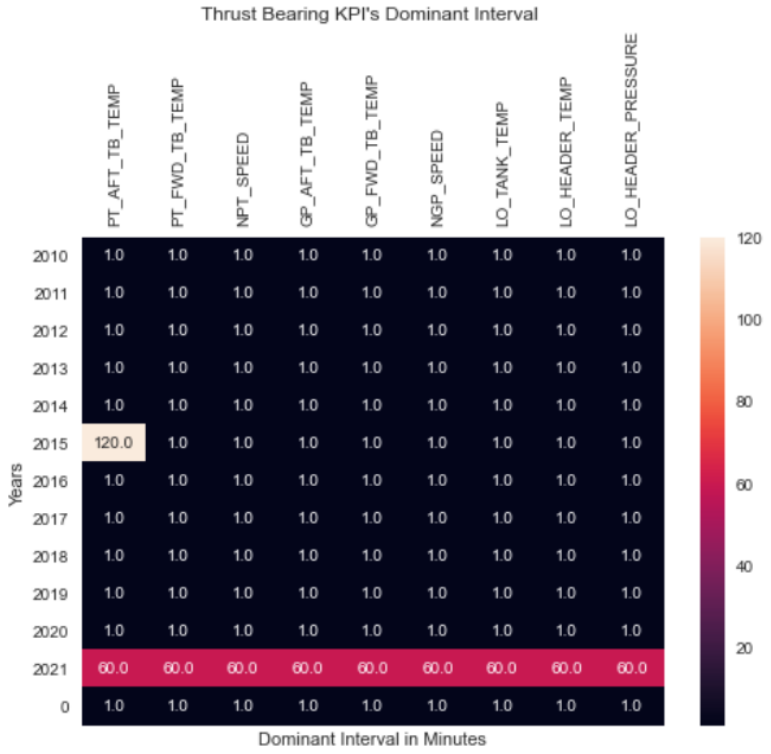


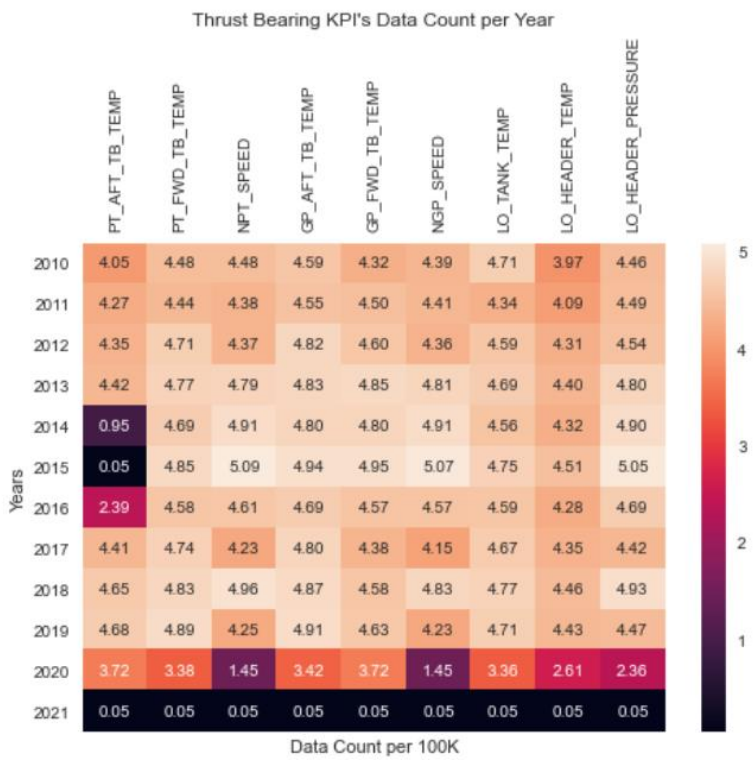
Sensor Tag Name Dictionary

Tag Name	Description
NPT_SPEED	Power Turbine Speed
LO_TANK_T_VALUE	Lube Oil Tank Temperature Value
LO_HEADER_T_VALUE	Lube Oil Header Temperature Value
LO_HEADER_P_VALUE	Lube Oil Header Pressure Value
PT_AFT_TB_TEMP	Power Turbine AFT Thrust Bearing Temp
PT_FWD_TB_TEMP	Power Turbine FWD Thrust Bearing Temp

Thrust Bearing Data Frequency Analysis

PHOENIX PARK
GAS PROCESSORS LIMITED

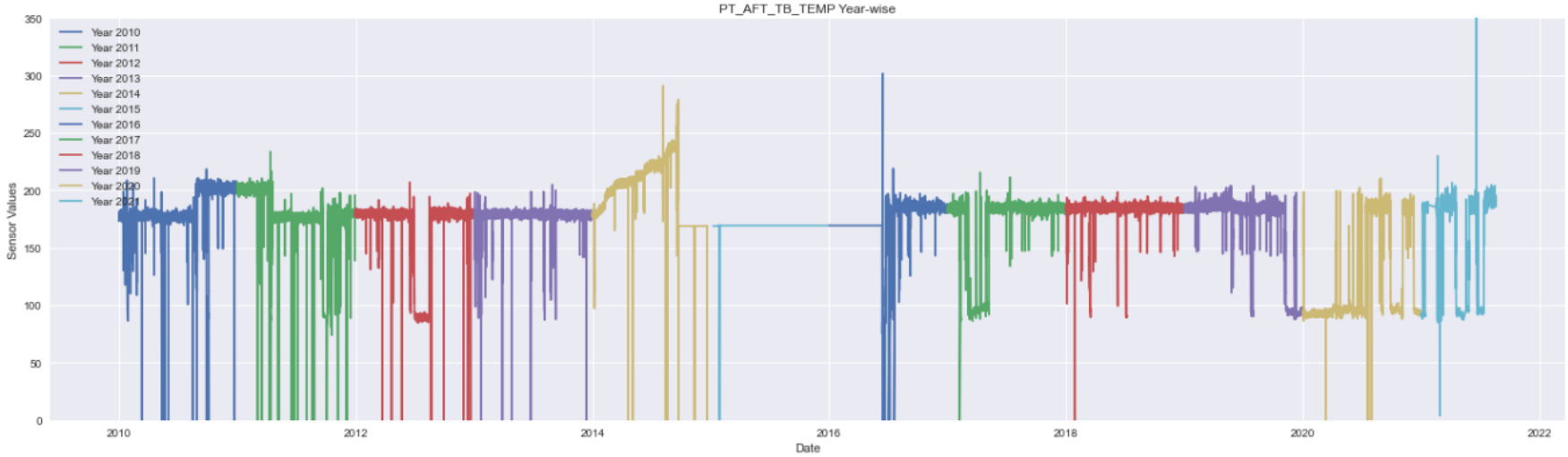


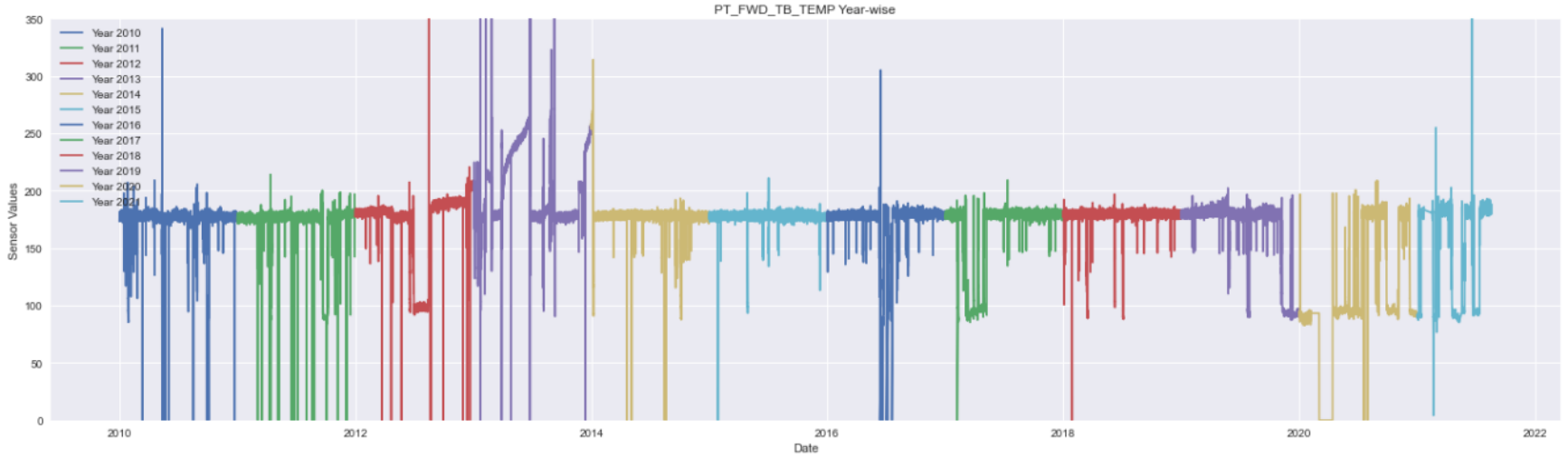


- Data Frequency is predominantly around 1 minute for year range (2010-2020). For the year 2021 we observe the data is received at 1 hour interval instead of 1 minute
- PT_AFT_TB_TEMP Dominant Data frequency in 2015 is around 120 minutes and the data count for years 2014,2015 are significantly less.

BOSCH

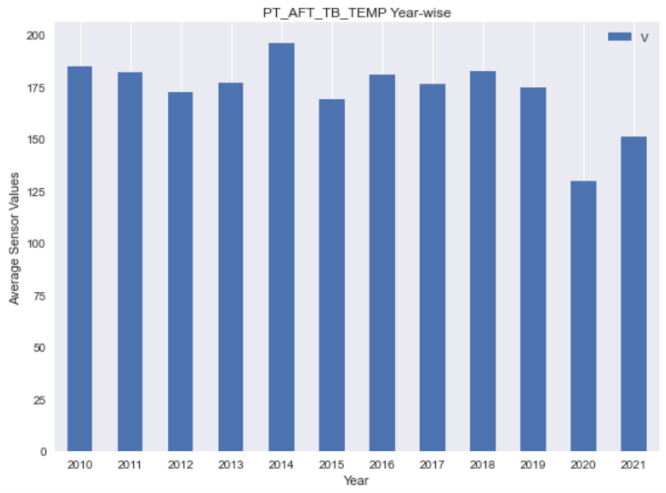
Analysis on Power Turbine Thrust Bearing Temp (2010-2022)

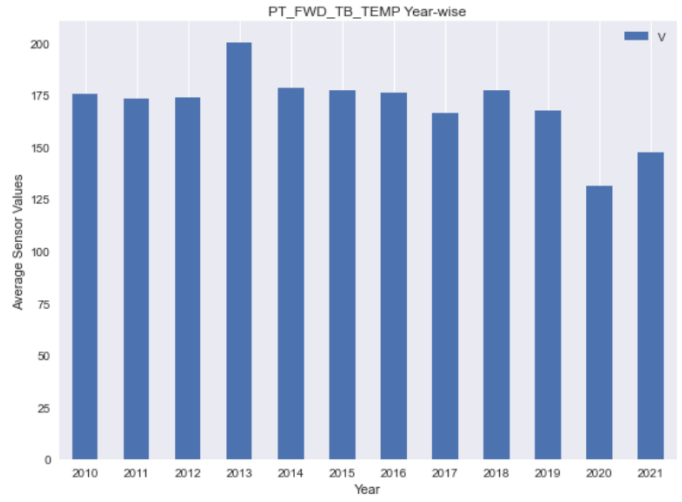


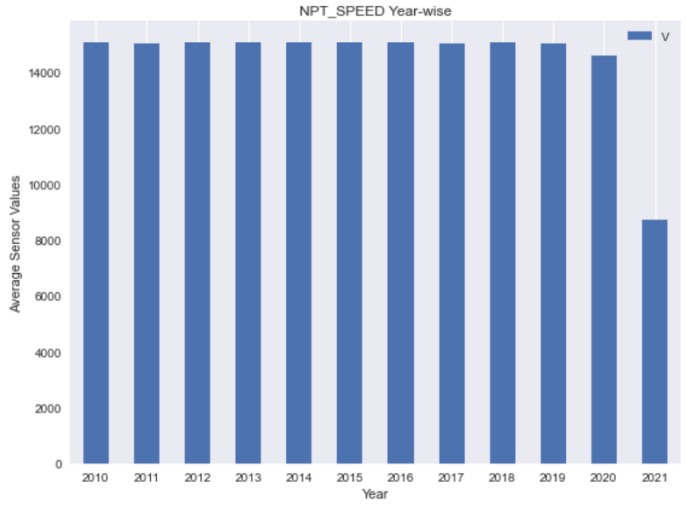


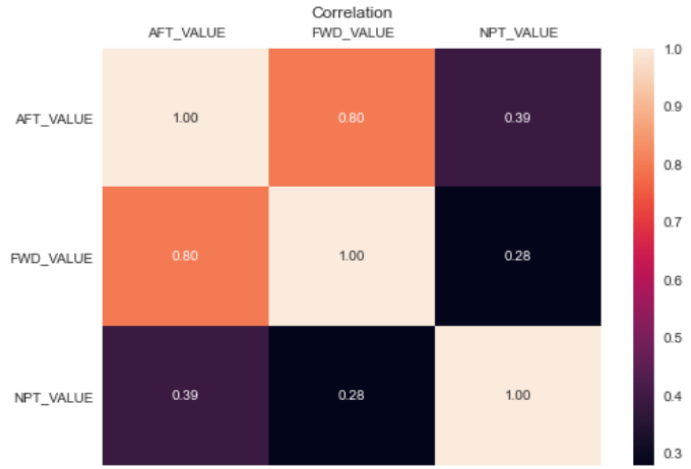
- Data is filtered within the range 0° to 500° Fahrenheit
- Multiple Spikes Ranging Greater than 250° and less than 100° degree are noticed across the years.
- Steady drop in Temperature across Sensor tags are noticed in 2012, 2017 and 2020.
- There is Unsteady variations in 2020 as Temperature drops down under 100° Fahrenheit

Year wise Sensor Value Analysis



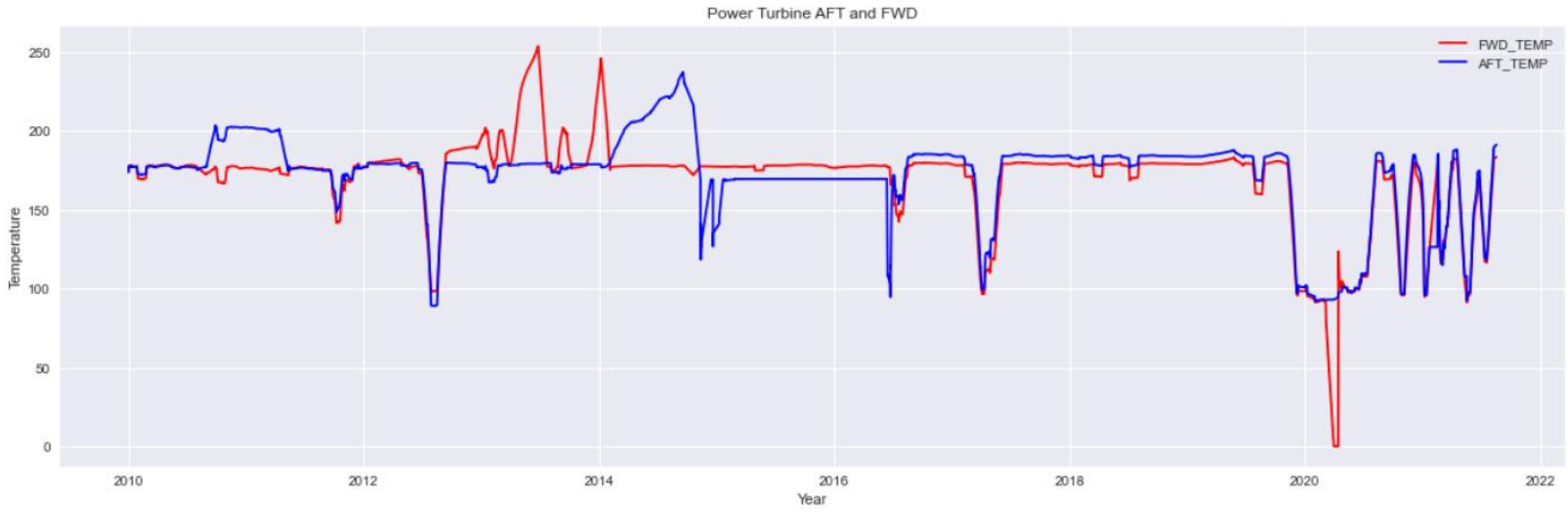


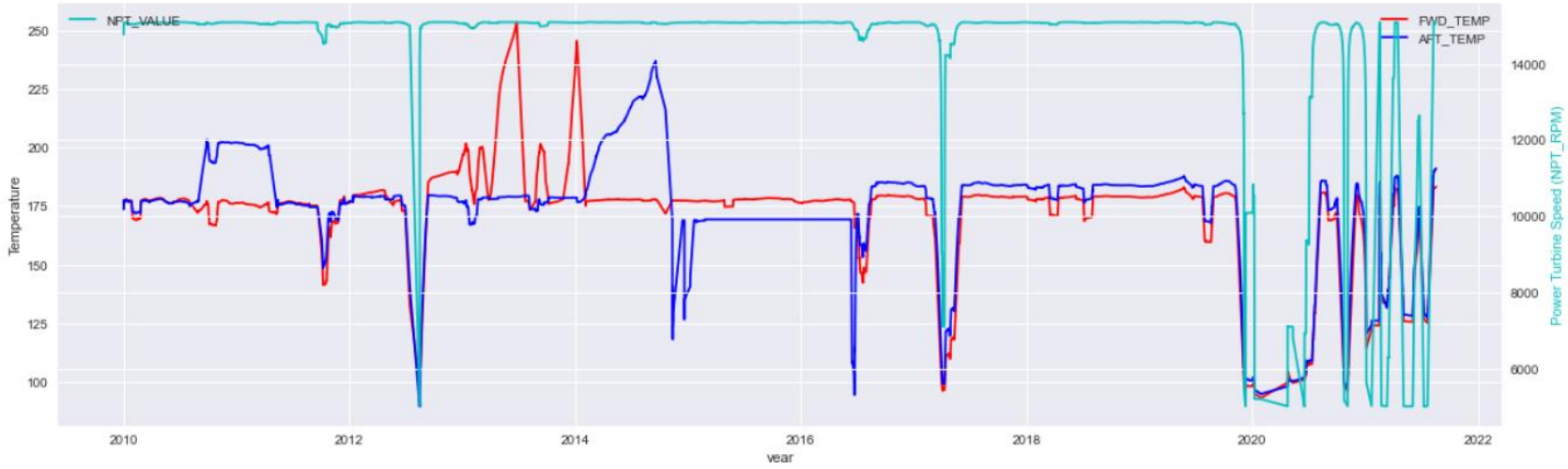




- Average Temperature was significantly lower in 2020 for AFT and FWD Temperature compared to other years.
- We observe a positive correlation wrt. NPT speed and temperature values

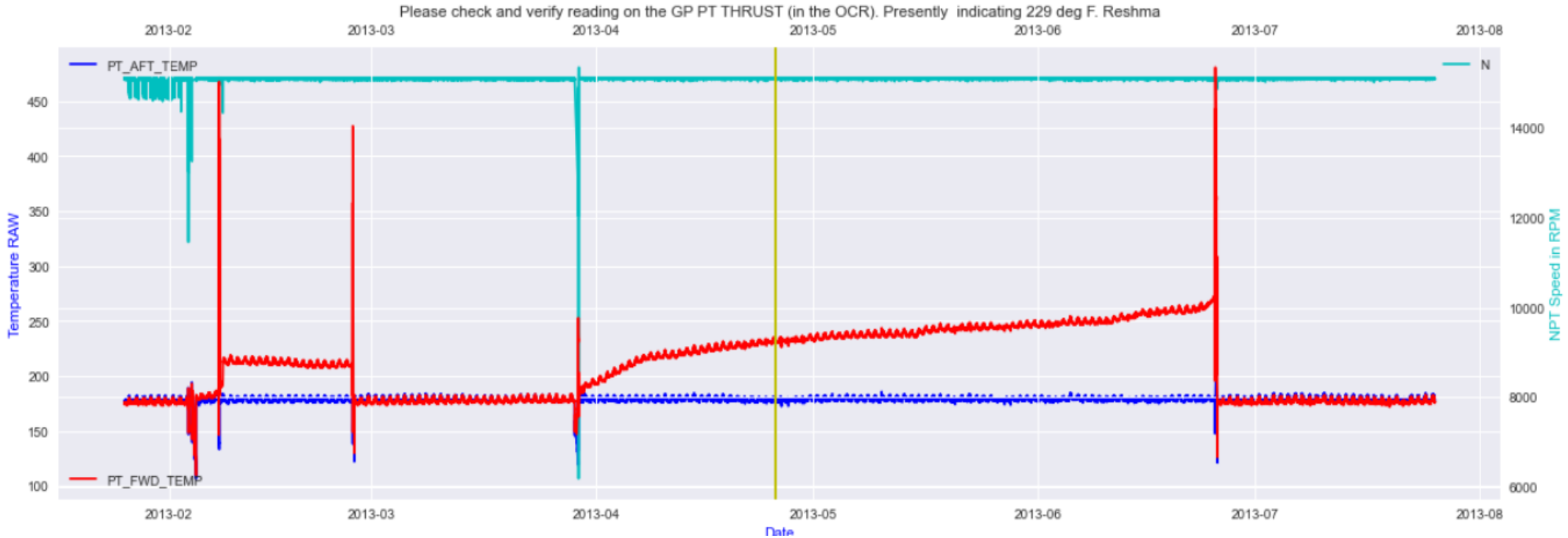
Power Turbine AFT, FWD Temperature and NPT Speed (RPM)





- Steep Increase in Temperature is noticed around 2013 in FWD Temperature.
- Steep Increase in Temperature is noticed around 2014 in FWD Temperature.
- There is a positive correlation between FWD, AFT Temperature with Power Turbine Speed value as seen in the visualization.
- At 2010-2011, 2013, 2014 the abnormal Increase in AFT and FWD Temperature is not in Sync with Power Turbine Speed which can be an Anomaly

Observation from maintenance records



Summary and Next steps

Summary and next steps

PHOENIX PARK
GAS PROCESSORS LIMITED

Summary of observations

- It is observed that AFT and FWD temperature have a good correlation. Difference between the two parameters along with NPT speed can be a good candidate feature for anomaly detection model
- 2021 data has a dominant frequency of 1 hour and the quantum of data is less compared to all years. Need to check the usability of such data
- It is observed that there are significant drops in 2014 and 2015 for AFT temperature. Need to asses the usability
- Significant downtime observed for 2020 resulting contextual and collective anomaly in temperature parameter

Next Steps

- Correlate work order maintenance sheet values with actual Sensor values and visualize anomalous behavior.
- Analyze Gas Producer Thrust Bearing and Journal Bearings in similar manner and procure further insights.
- Define Fault Model and develop the same.

Recommendations

- As per observed data frequency and data quantum, for the current parameters it seems data from 2016 to 2019 seems most usable for further analysis and model development.

BOSCH

Thank you