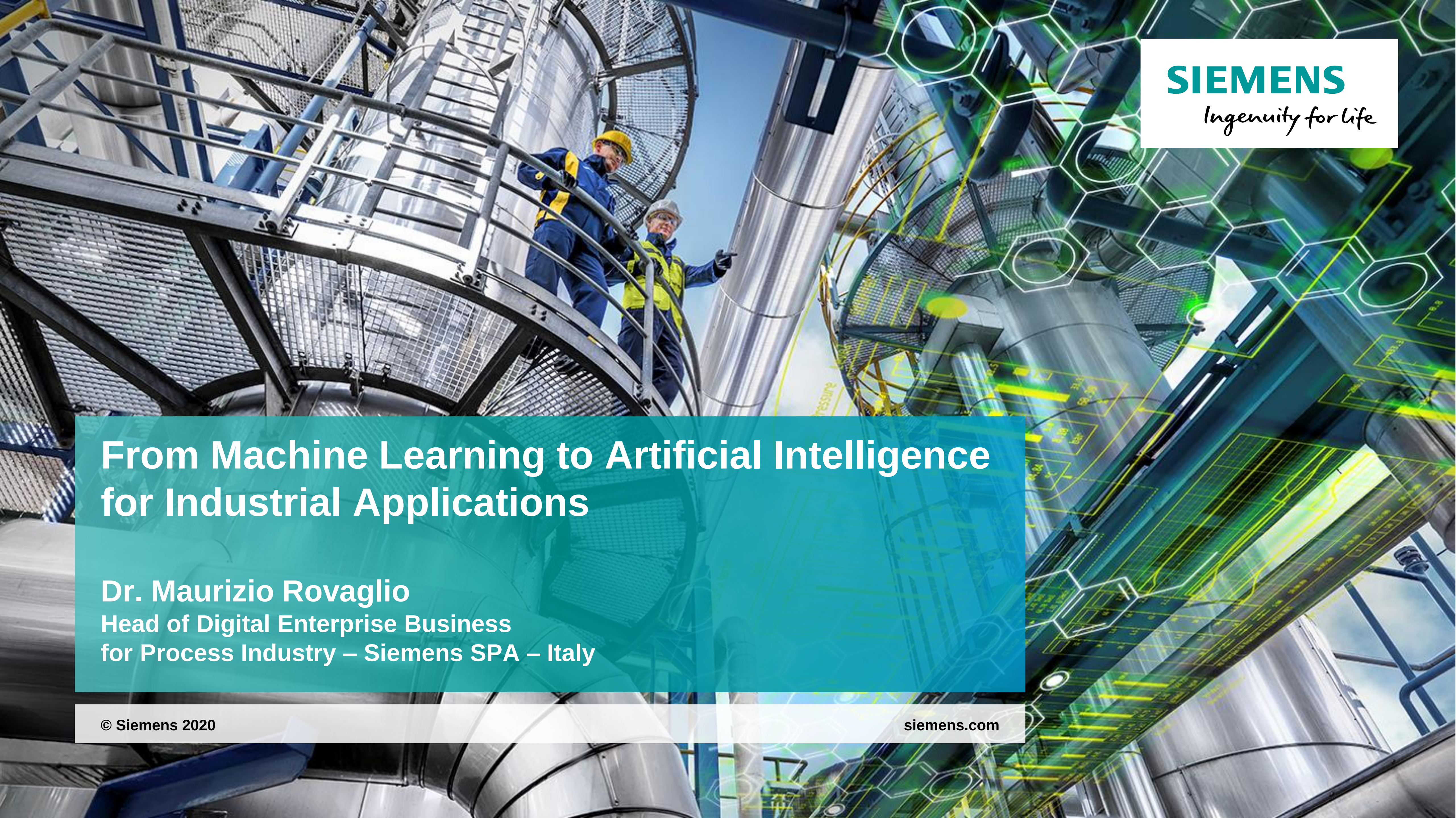

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From Machine Learning to Artificial Intelligence for Industrial Applications

Dr. Maurizio Rovaglio
Head of Digital Enterprise Business
for Process Industry – Siemens SPA – Italy

Agenda

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Value of more production vs. value of maintenance saving

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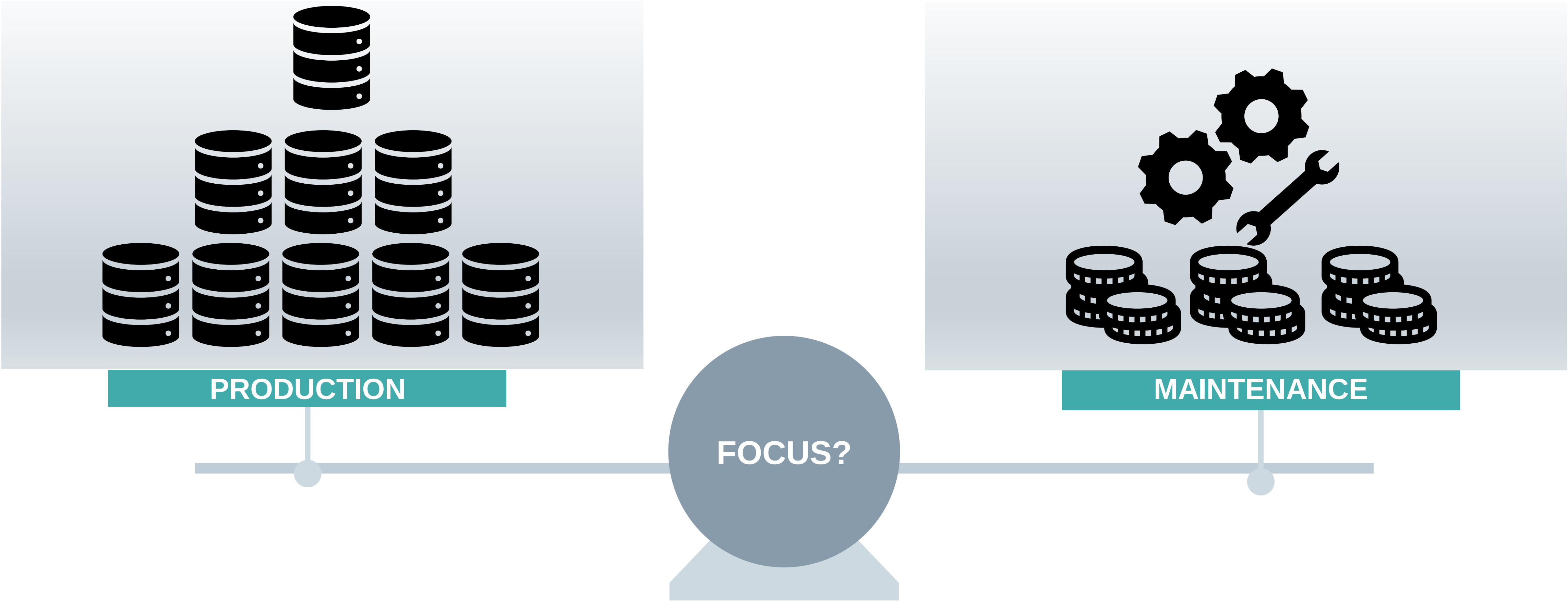

Value of more production vs. value of maintenance saving

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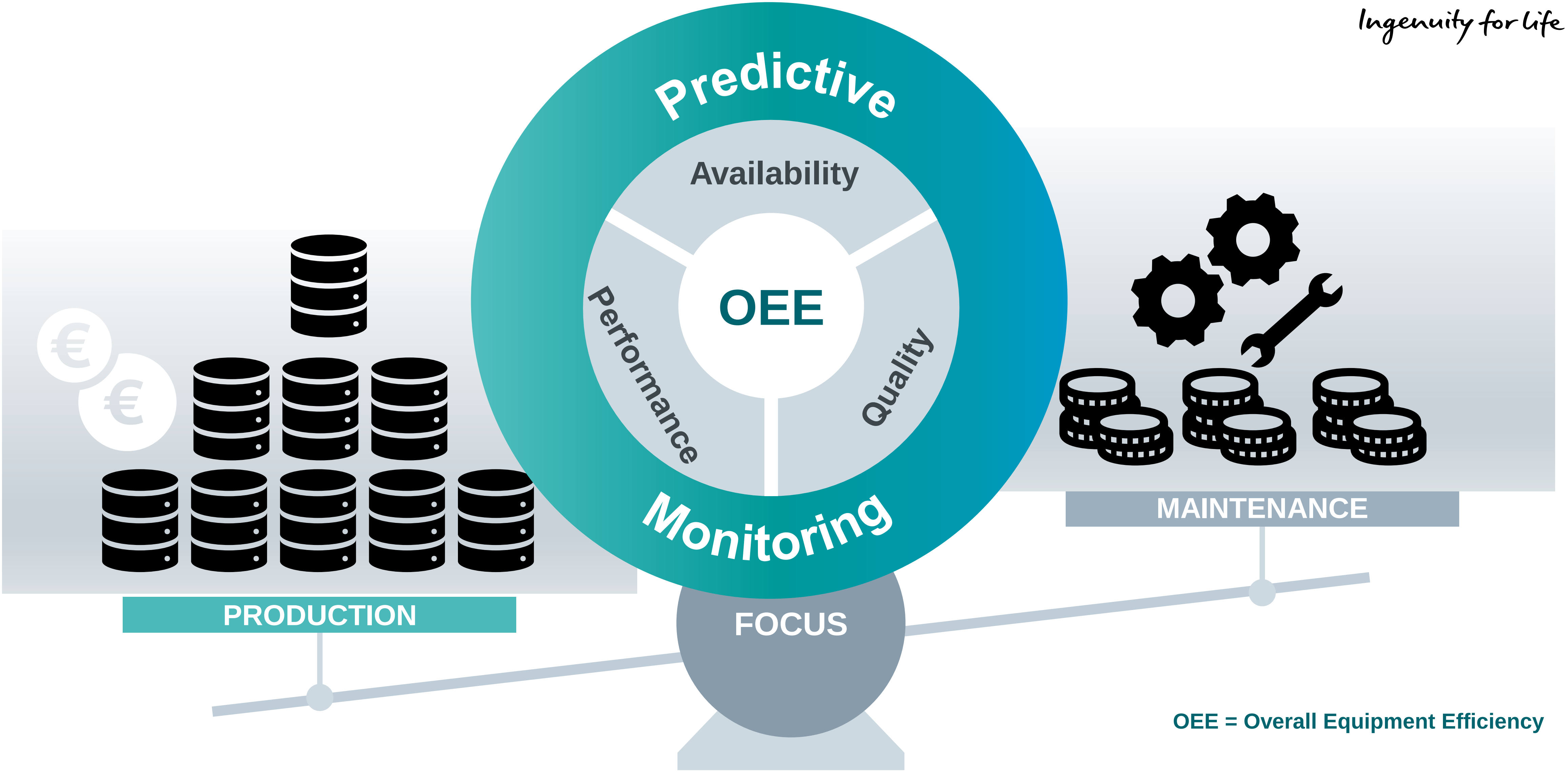

OEE = Overall Equipment Efficiency

What is Predictive Analytics ?

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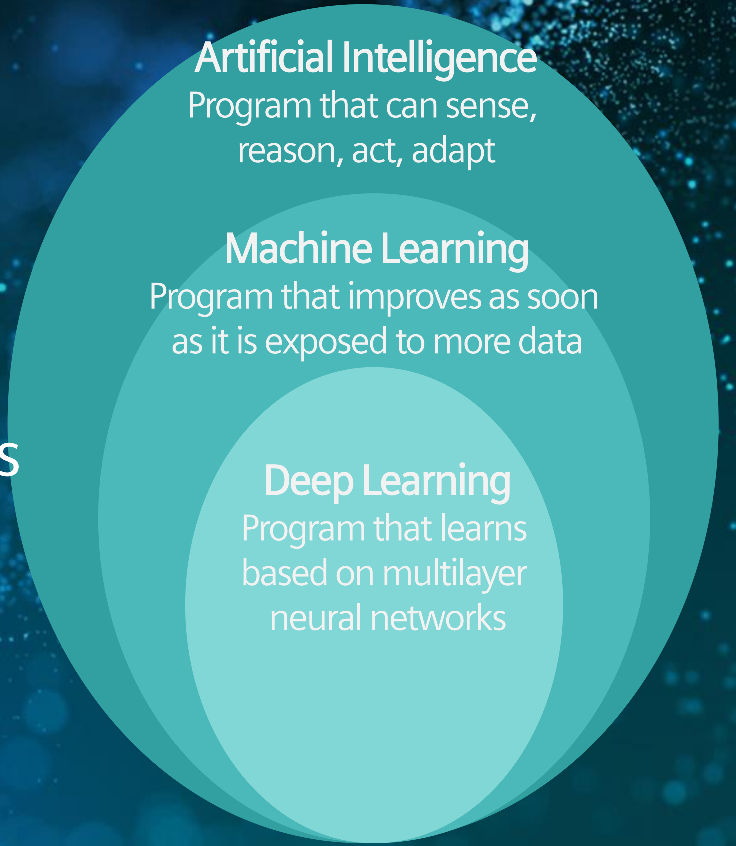
1. Historical behavior → Understand the "pattern"

2. Current behavior → Apply the "pattern" and raise conclusions

Create new "pattern" based on current behavior



Philosophy of Equipment Predictive Analytics

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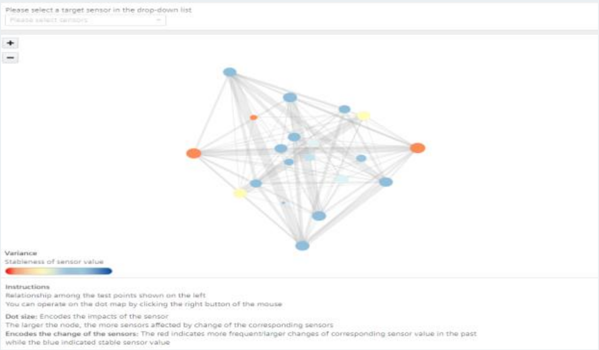
Identify target sensors (most important sensors) and their correlated sensors.

Identify **correlations between the sensors** by correlations coefficients based on historical data and domain knowhow.

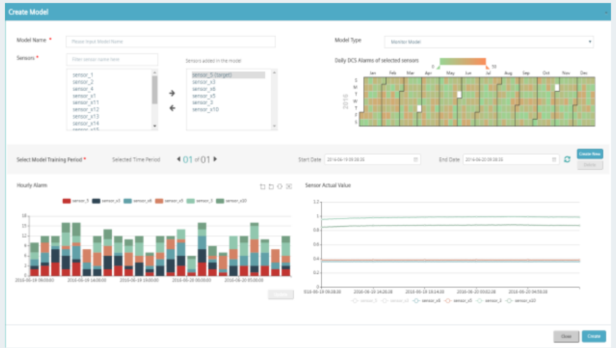
EPA first step should provides a matrix/plot of correlation coefficients.



Model training of target sensors

Training based on **normal behavior data**.

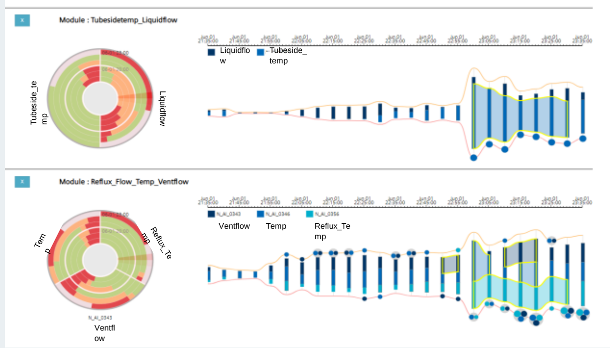
EPA should provides easy tools to retrieve plant data, select ranges and train/update the model as required.



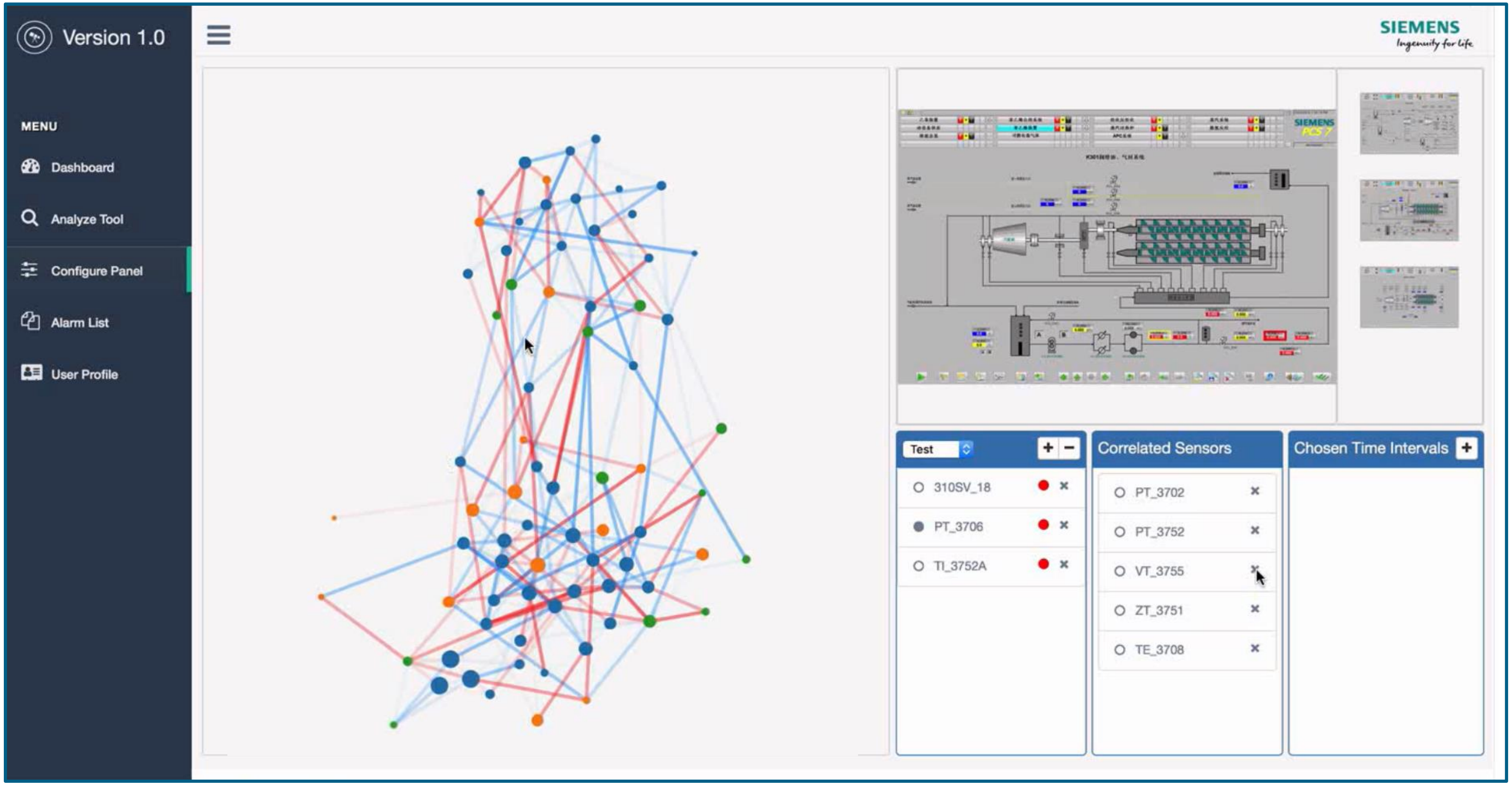
Monitoring target sensors on dashboard

Alerts arising as soon as the **actual behaviour differs from the normal behaviour.**

Therefore EPA provides the daily and hourly alerts.



Identify Target Sensors and their Correlations



Model Training of Target Sensors

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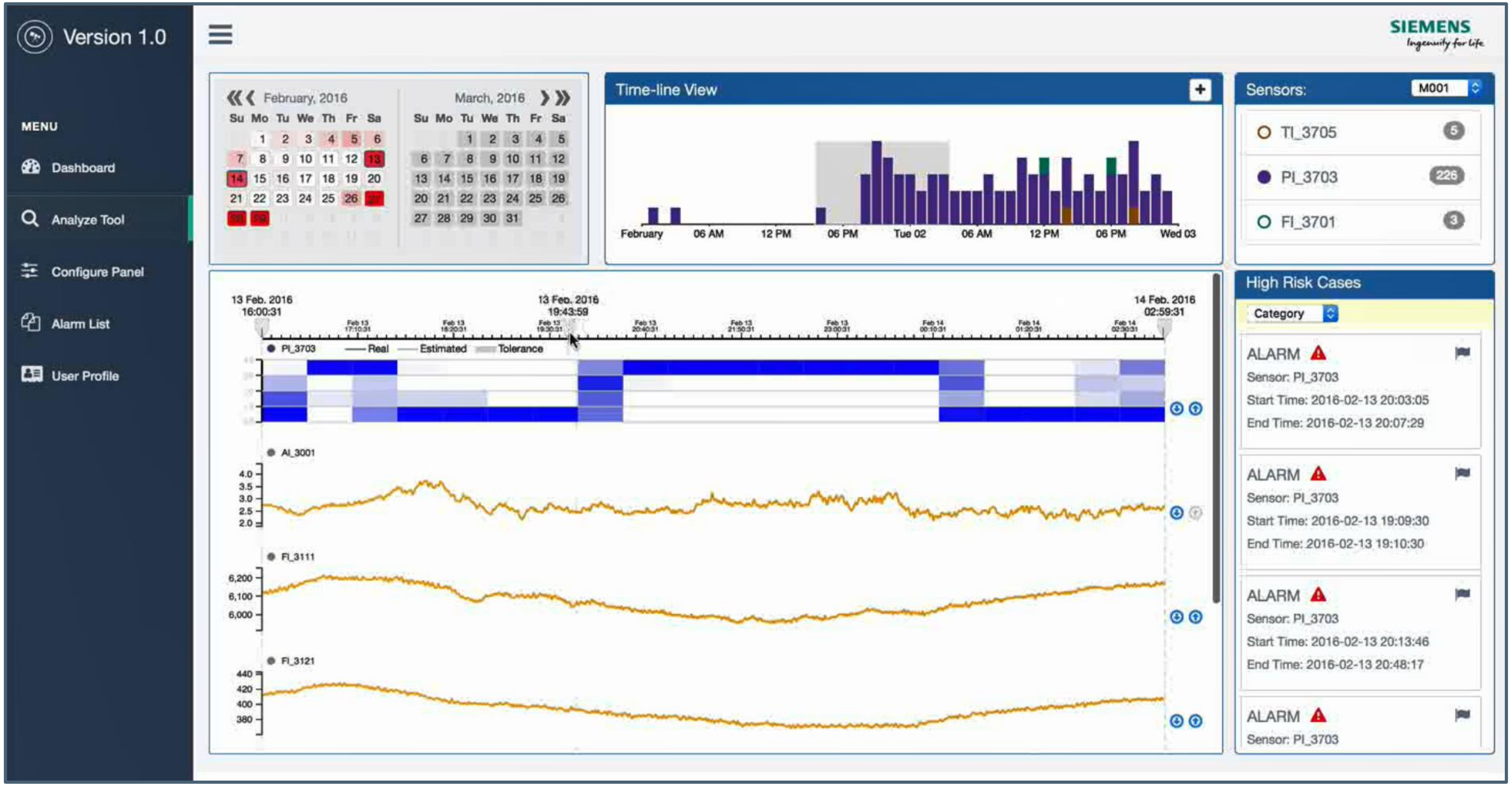
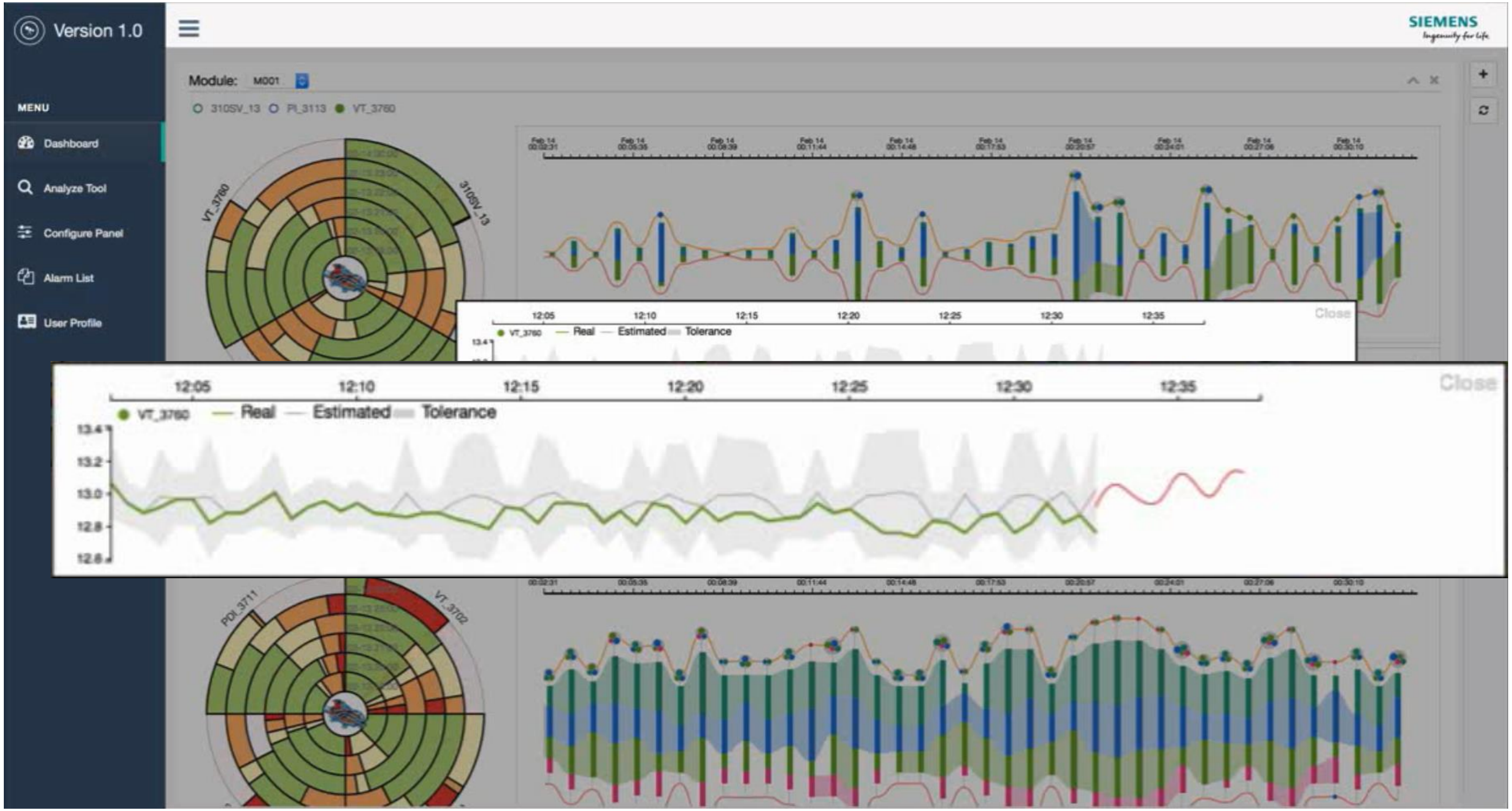


Monitoring Target Sensors



Integration of Data Driven and Knowledge Driven Approach

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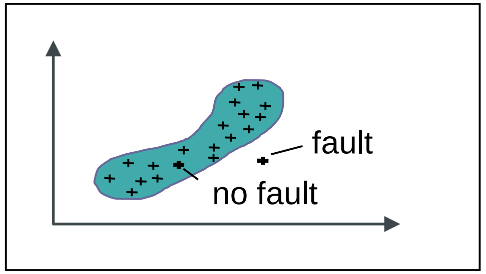
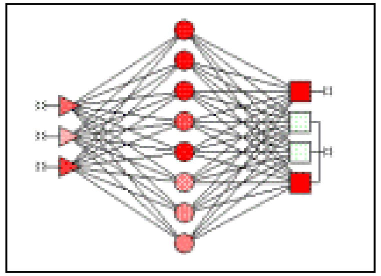
Data Driven Analytics





Knowledge Based Analytics

Effects	Insufficient Discharge Pressure	Intermittent Operation	Insufficient Capacity	No Liquid Delivery	High Bearing Temperatures	Short Bearing Life	Short Mechanical Seal Life	High Vibration	High Noise Levels	Power Demand Excessive	Motor Trips	Elevated Motor Temperature	Elevated Liquid Temperature
	Anomalies												
Bent Shaft					●	●	●	●		●			
Casing Distorted from Excessive Pipe Strain					●	●	●	●		●		●	
Cavitation	●	●	●	●	●		●	●	●				●
Clogged Impeller	●		●	●				●		●			
Driver Imbalance						●	●	●					
Electrical Problems (Driver)						●	●	●		●	●	●	
Entrained Air (Suction or Seal Leaks)	●	●	●					●	●			●	
Hydraulic Instability					●	●	●	●	●				
Impeller Installed Backward (Double-Suction Only)	●		●							●			
Improper Mechanical Seal							●						
Inlet Strainer Partially Clogged	●		●					●	●				●
Insufficient Flow through Pump													●
Insufficient Suction Pressure (NPSH)	●	●	●	●				●	●				
Insufficient Suction Volume	●	●	●	●	●			●	●				●
Internal Wear	●		●					●		●			

Natural Language Processing

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Industry challenges

- High efficiency and “squeezing iron” by more than 100% capacity

EPA solution

- Interactive machine learning tool
- Correlation calculation and EPA models for Rotating machines
- Risk pre-alert via historical-data-based model training and real-time data analysis
- NLP-based smart diagnosis for know-how/experience consolidation

Benefits

- Increased plant uptime through avoidance of shut-downs by pre-alerting on failures.
- Higher operation efficiency through predictive monitoring.

EPA Use Case in Petrochemicals
Advanced compressor monitoring

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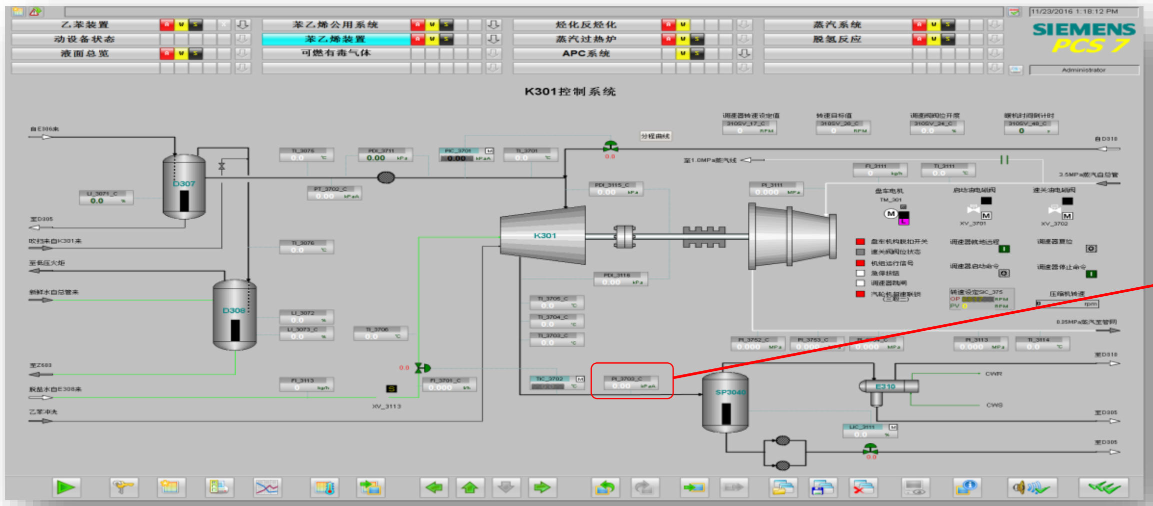
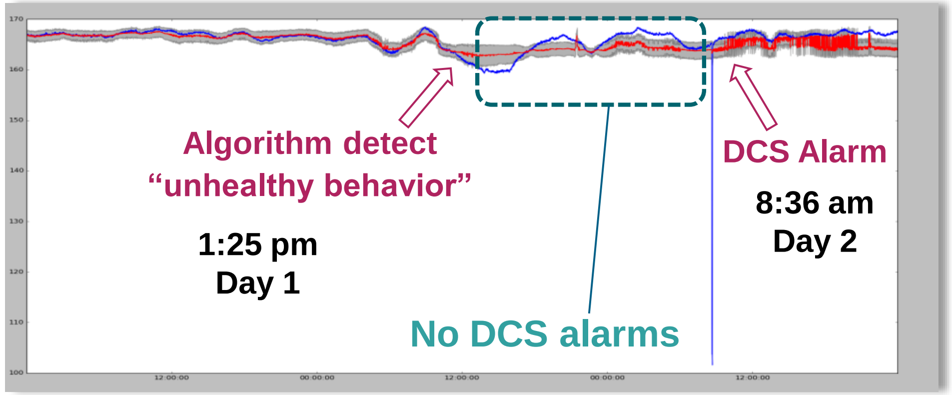


PI 3703 – Compressor output pressure



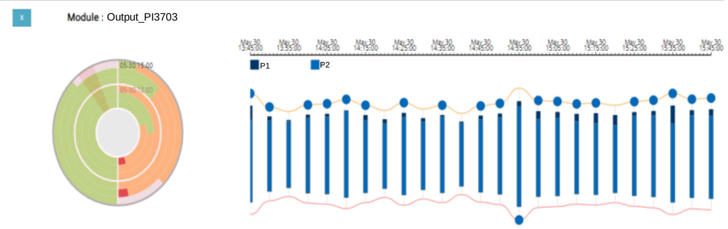
Real-time Observation

Estimate Value

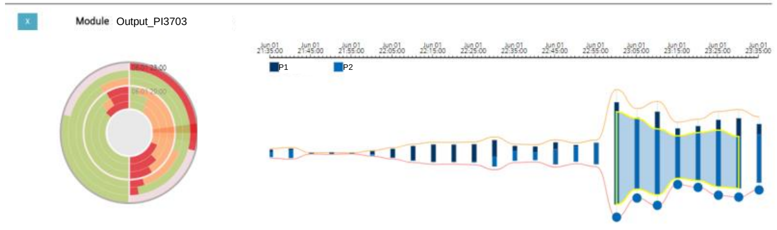
Tolerance band

Risk detected ~18 hours earlier!

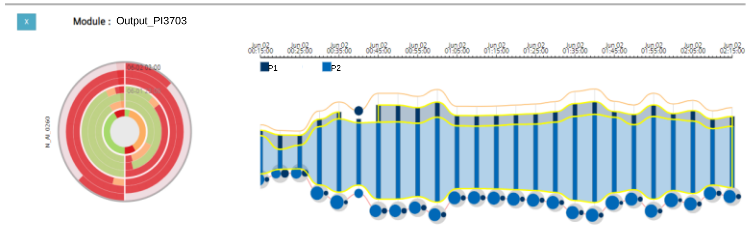
1. Almost no high risk alerts



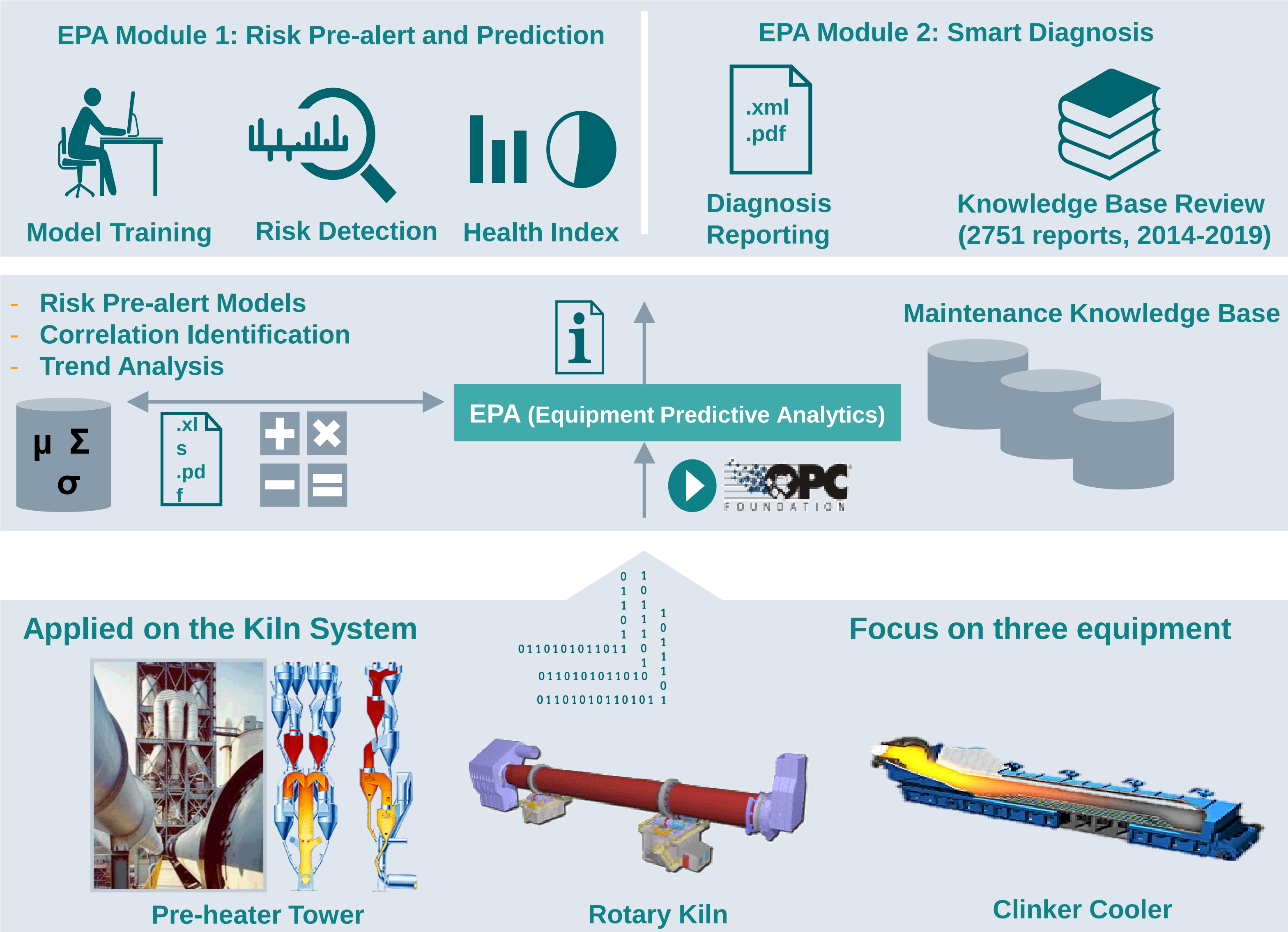
2. Series of high risk alerts



3. Only high risk alerts



EPA reference case in Cement



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Industry Challenge:

- **Crust**
- **Stack of materials**
- **Blockage**

EPA Solution:

- **Risk Pre-alert and Prediction:**
  Apply EPA models trained by industrial big data collected from onsite sensors
- **Smart Diagnosis:**
  Apply NLP (Natural Language Processing) technology to match similar historical cases (failure/maintenance report) to support decision making

Benefits

- **Increased plant uptime** through avoidance of shut-downs by pre-alerting on failures.
- **Higher operation efficiency** through predictive monitoring.

EPA Cement Use Case 1:
Crust Risk in Pre-heater

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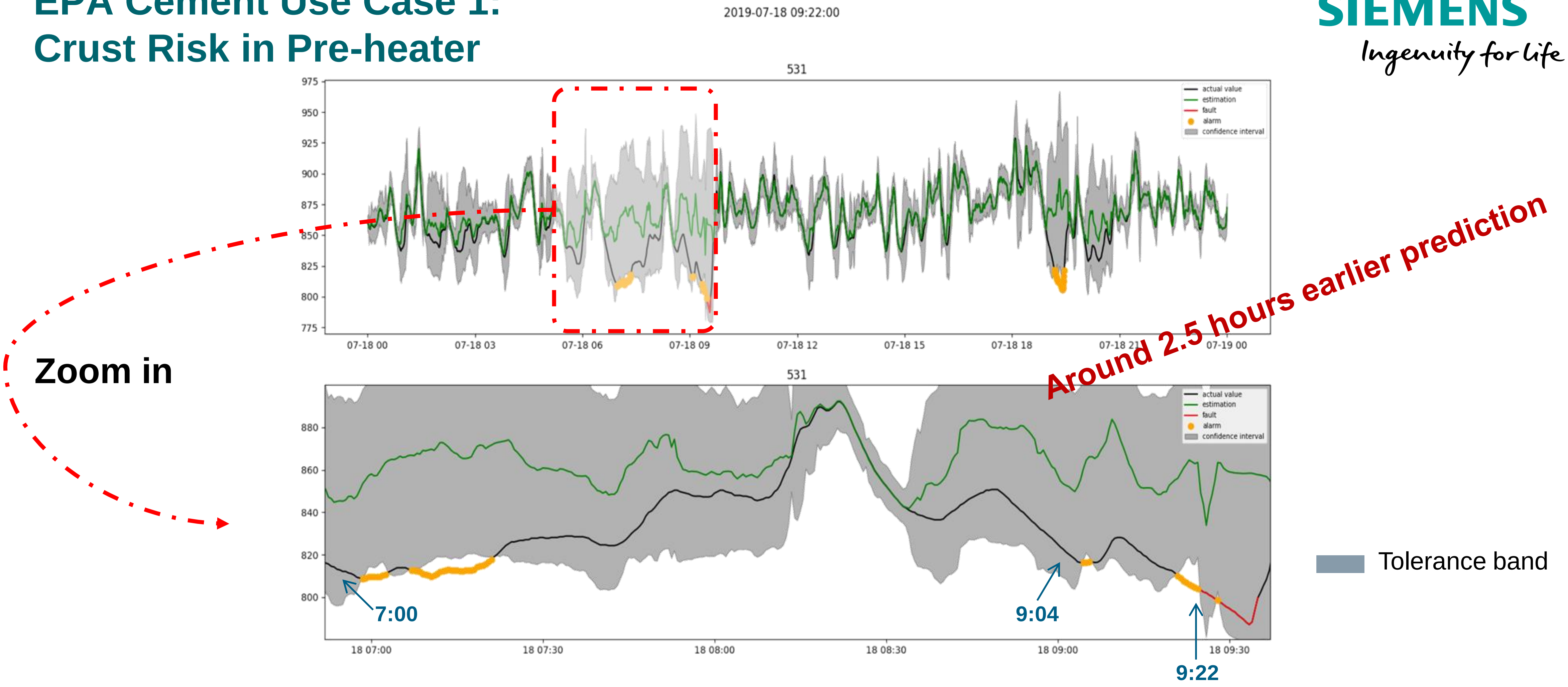
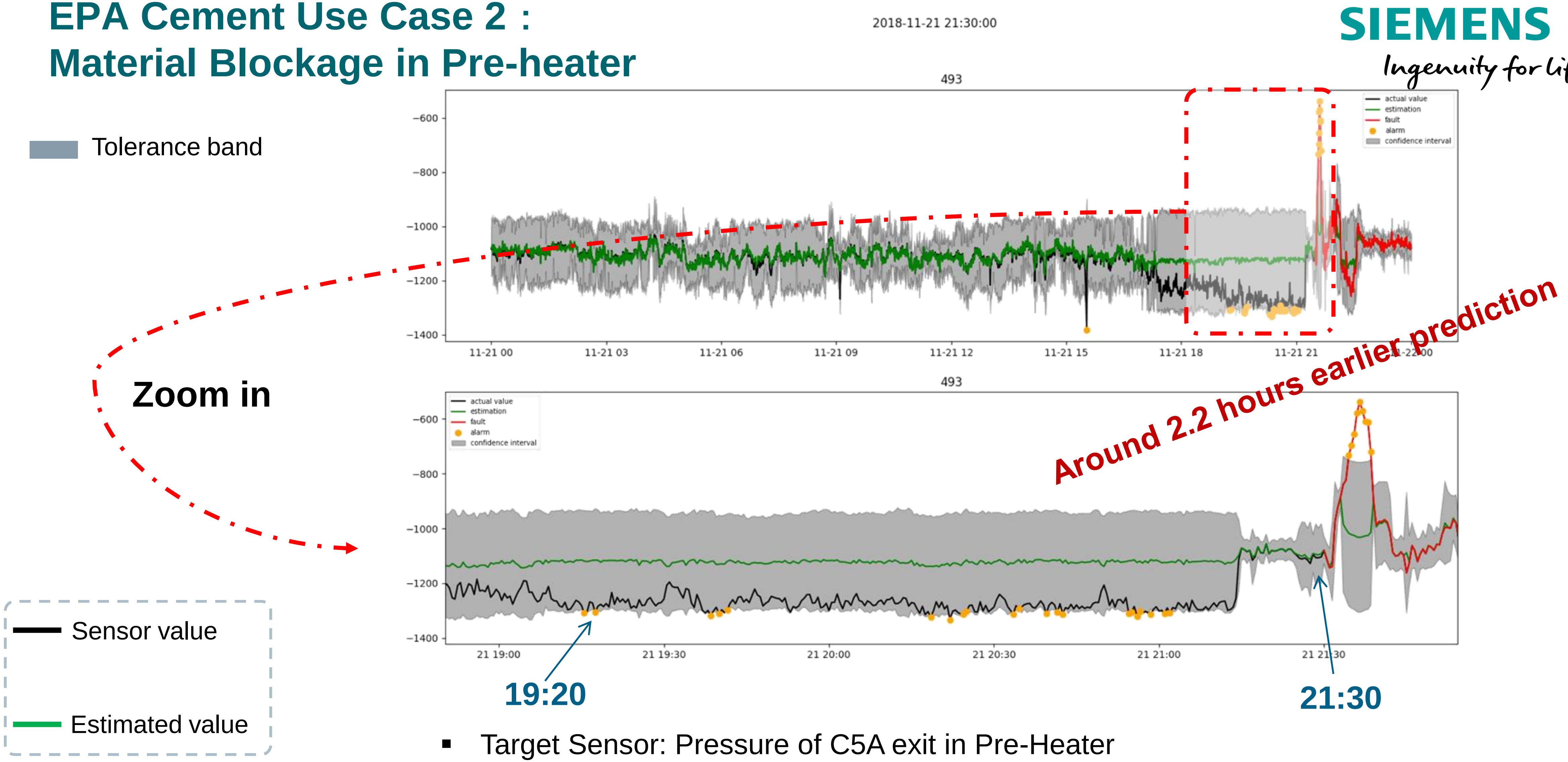


- Target Sensor: Temperature of C5A Entrance in Pre-Heater
- **First high-risk alert in EPA at 7:00**
- **DCS alarm (lead to unplanned shut-down of kiln product) at 9:22**

EPA Cement Use Case 2 :
Material Blockage in Pre-heater



- Target Sensor: Pressure of C5A exit in Pre-Heater
- **First high-risk alert in EPA at 19:20**
- **DCS alarm (lead to unplanned shut-down of kiln product) at 21:30**

VIDEO (https://www.youtube.com/watch?v=SoXAz47hq8g&t=6s)

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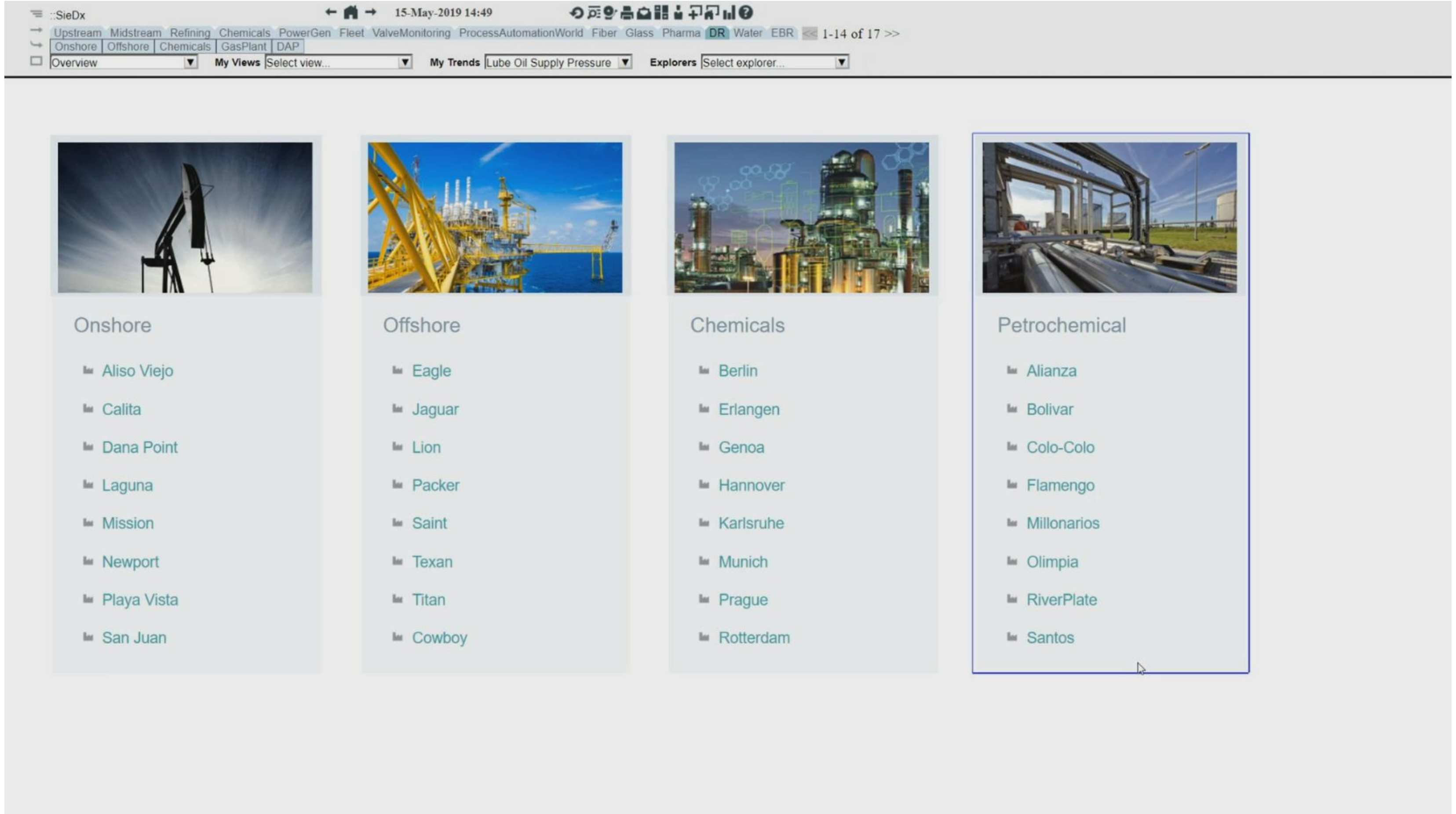

Recap and Key Takeaways

- ✓ EPA approach require efforts
- ✓ EPA provides ALERTS but with no knowledge
- ✓ AI knowledge based algorithms enhance EPA use
- ✓ False positive must be addressed
- ✓ Large Improvement of operation efficiency

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THANK YOU !