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**SULZER**

# Industrial Pump Monitoring – an OEM Perspective

Dr. Arrigo Beretta | Head TC Winterthur | September 3, 2019

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## **THE SAFE HARBOR STATEMENT UNDER THE US PRIVATE SECURITIES LITIGATION REFORM ACT 1995**

**This presentation may contain forward-looking statements, including but not limited to, projections of financial developments, market activities or future performance of products and solutions, containing risks and uncertainties. These forward-looking statements are subject to change based on known or unknown risks and various other factors, which could cause the actual results or performance to differ materially from the statements made herein.**

# Agenda

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- **Sulzer company profile**
- **Pump monitoring challenges**
- **Pump monitoring approach**

# Sulzer

Sulzer offers products, services and know-how for a wide range of **fluid processing** applications in many different markets. **Flow control and applicators** are at the core of Sulzer.



## Pumps Equipment

From standard pumps to highly engineered pumps, covering oil and gas, power, water, mining, pulp and paper, etc.



## Rotating Equipment Services

Parts, service and refurbishment for pumps, turbines, compressors, motors and drives, etc.



## Chemtech

Separation technology and associated services for the chemical processing and refining industries



## Applicator Systems

Specialized fluid applicators for dental, healthcare, beauty, construction, adhesives, etc.

# Pump applications and portfolio

## Energy Business Unit



**Oil & Gas**



**Power**

## Water Business Unit



**Water**



**Wastewater**

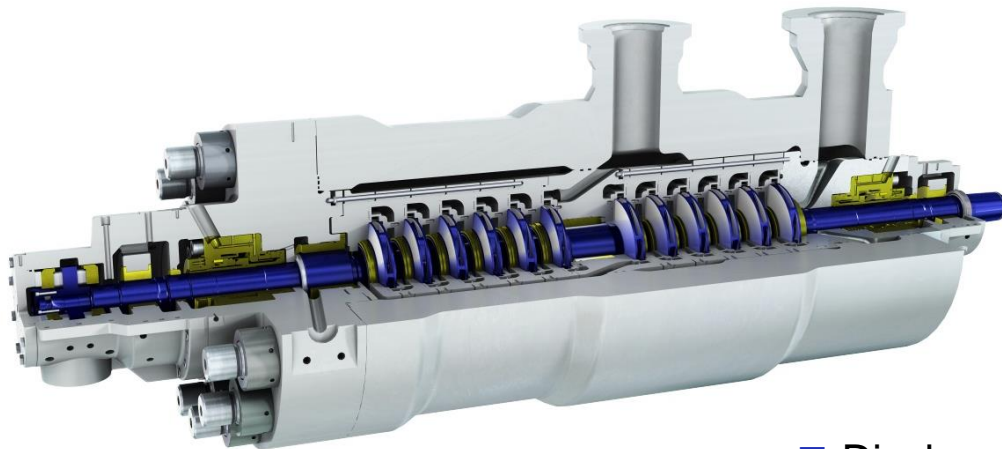
## Industry Business Unit



**General Industry**



**Chemical Processing**



- Discharge sizes: up to 500mm
- Flow: up to 4000m<sup>3</sup>/h
- Head: up to 10'200m
- Pressure: up to 1100bar
- Rotational speed: up to 8850rpm

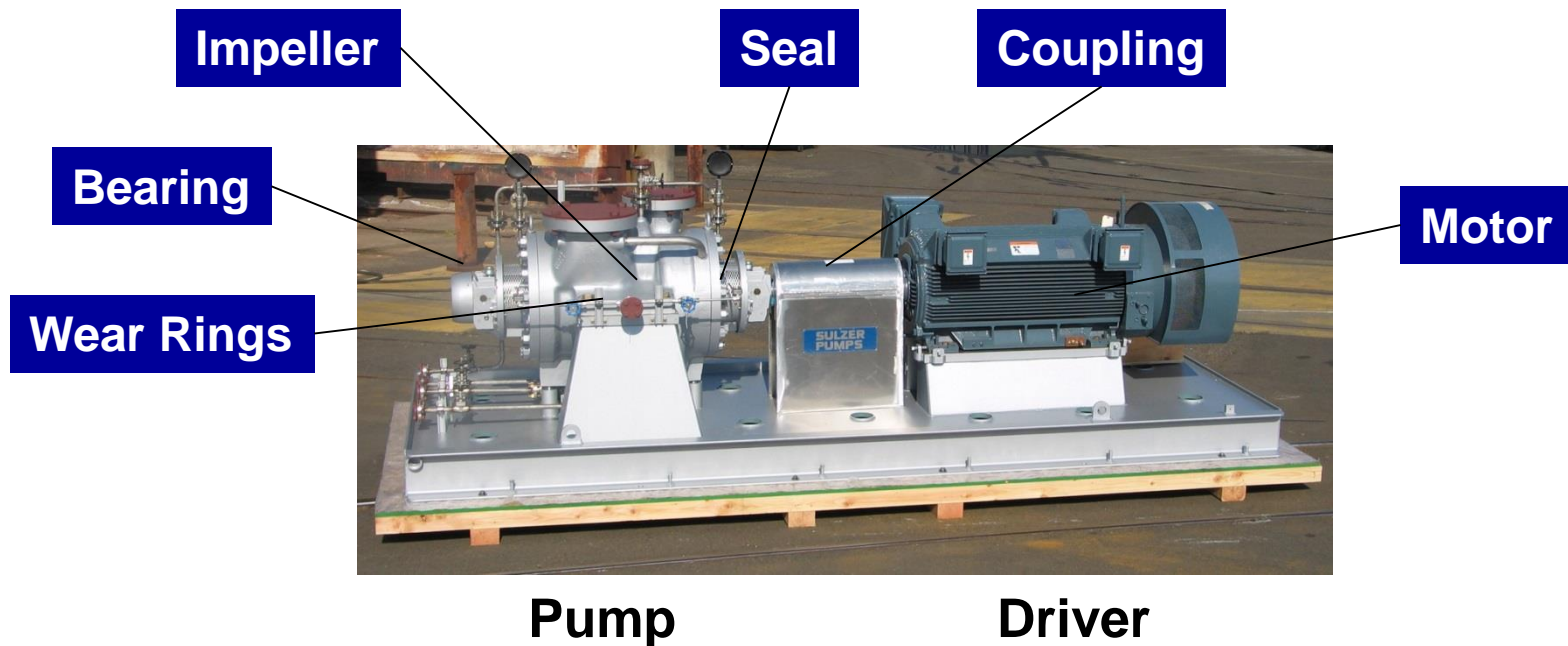
- Discharge size: 32mm
- Overall length: 790mm
- Head: from 4m
- Pressure: up to 16bar



## Components to be monitored

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**Pumping solution condition and live time depends on condition of critical components**



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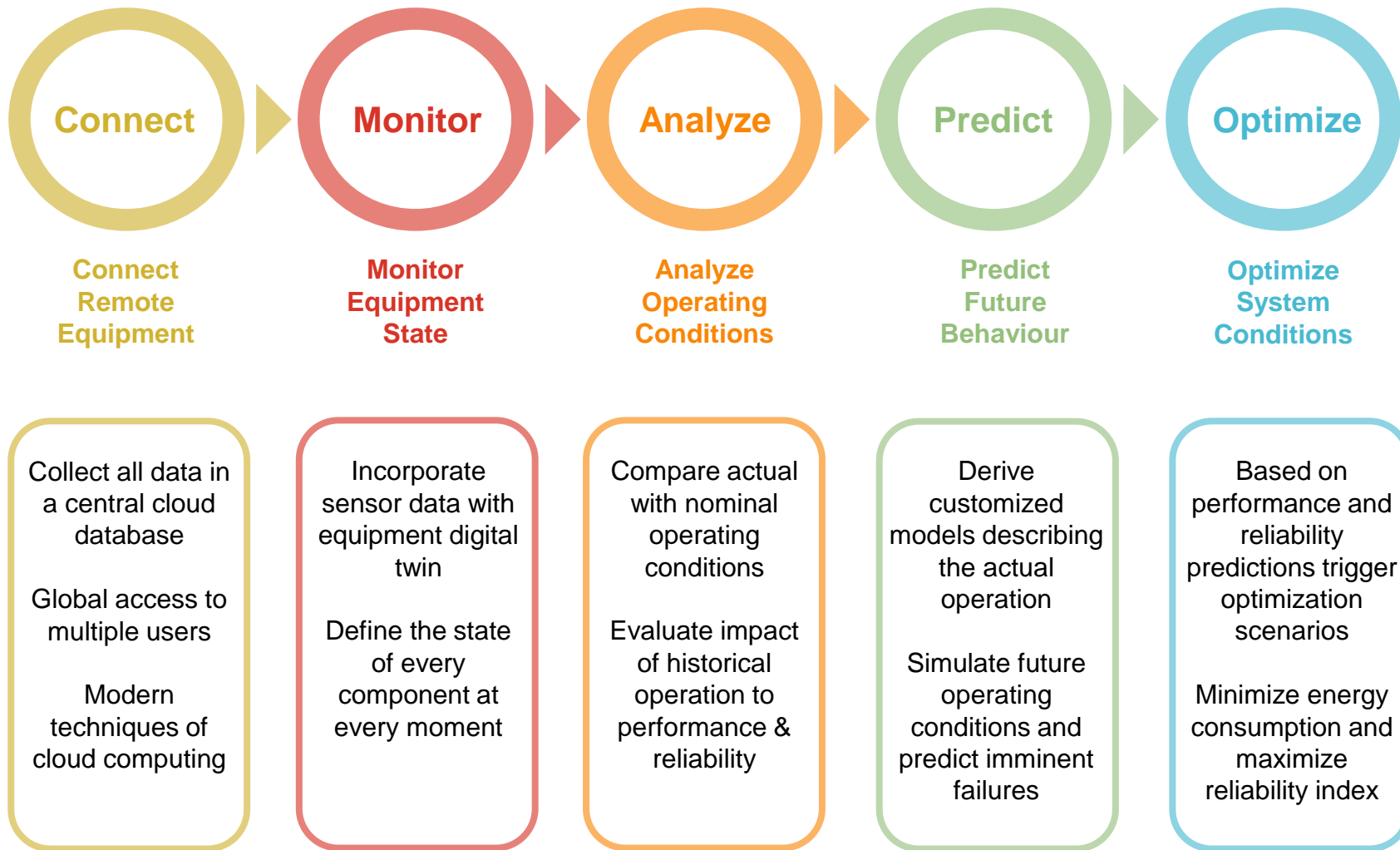
**Operating point has a major influence on condition of components**

# Pump monitoring challenges

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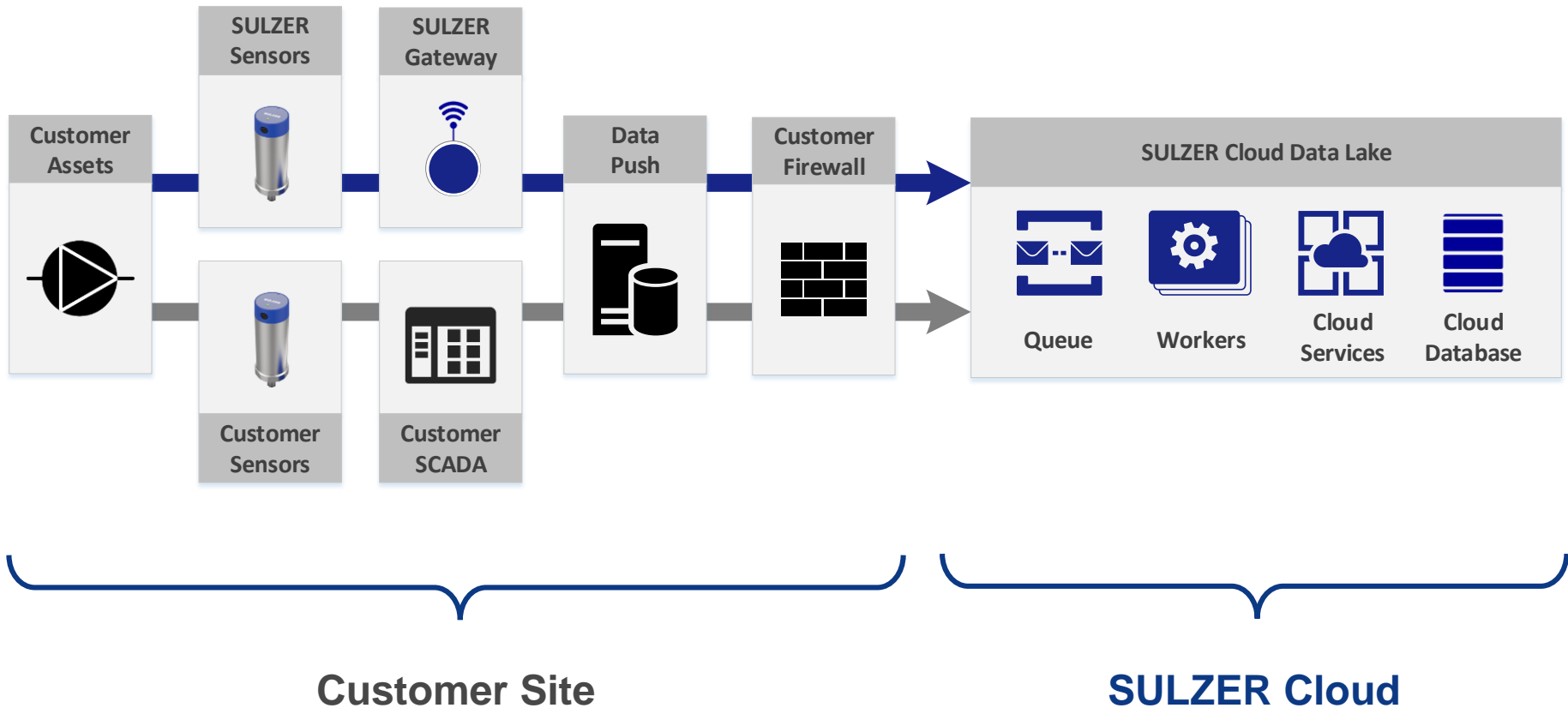
- **Diverse market segments**
- **Criticality of pumps**
- **Ratio “cost of monitoring solution” / “cost of equipment”**
- **Most critical events are rare:**
  - Data availability and quality
  - Model performance
- **Instrumentation availability for specific failure mode**
- **Availability of maintenance logs and historical events**

# A step-wise pump analytics approach

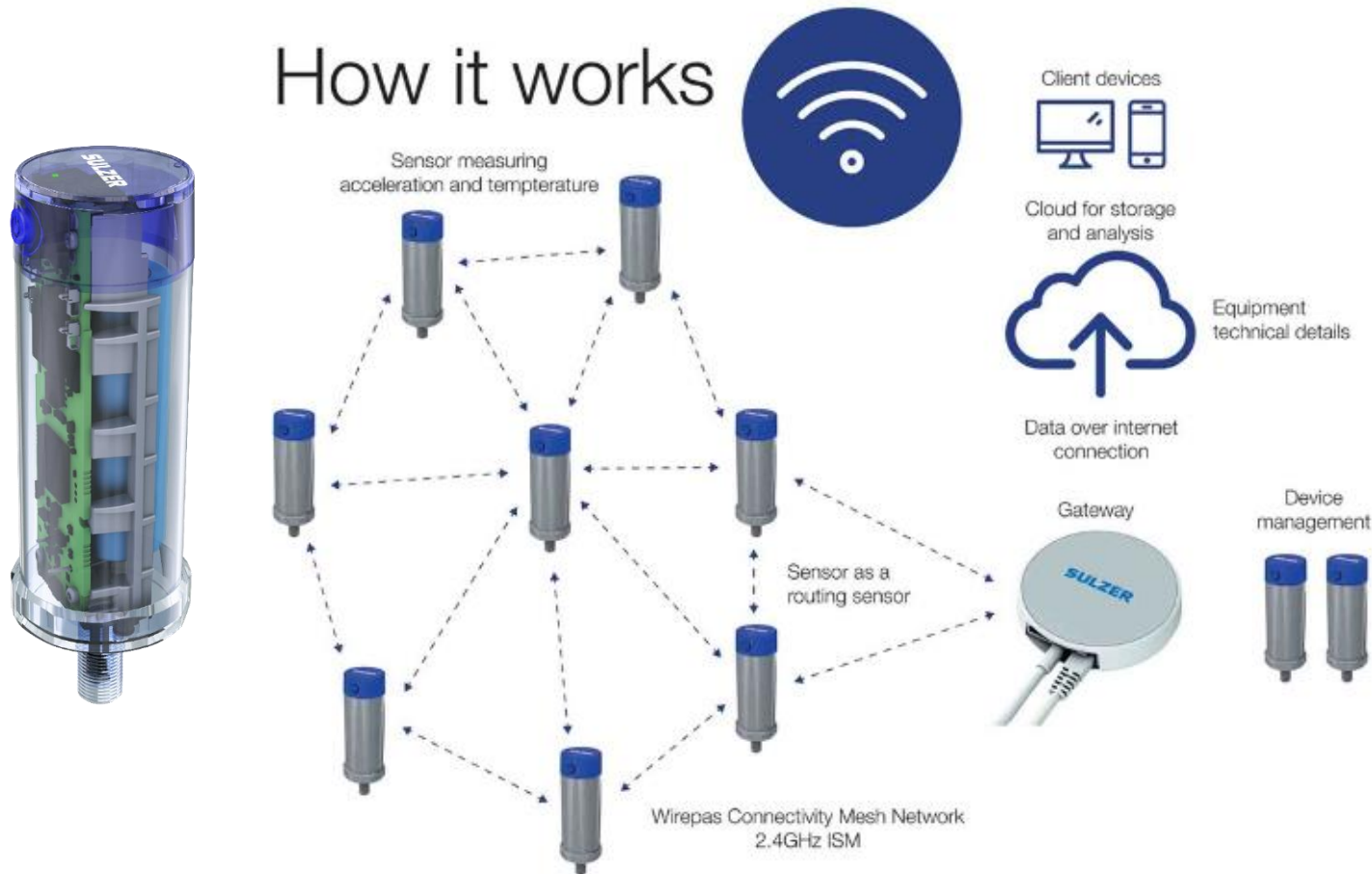


# Connectivity

- Leverage existing infrastructure, does not disrupt existing processes
- Deliver securely all required data to a central cloud environment



# Connectivity: Sulzer Sense bearing monitoring service



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Bulk Orders 2 Your Cart \$1,097.89

General Monitoring

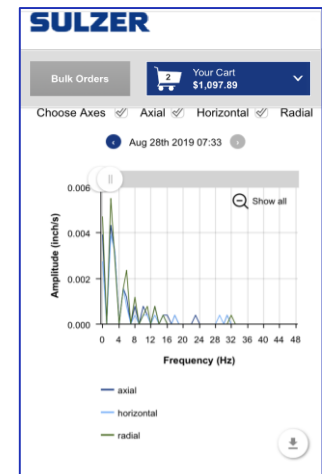
**Equipment and sensor**

Serial number  
Z94116764

Sensor ID  
e1287644a AHLSTAR-001

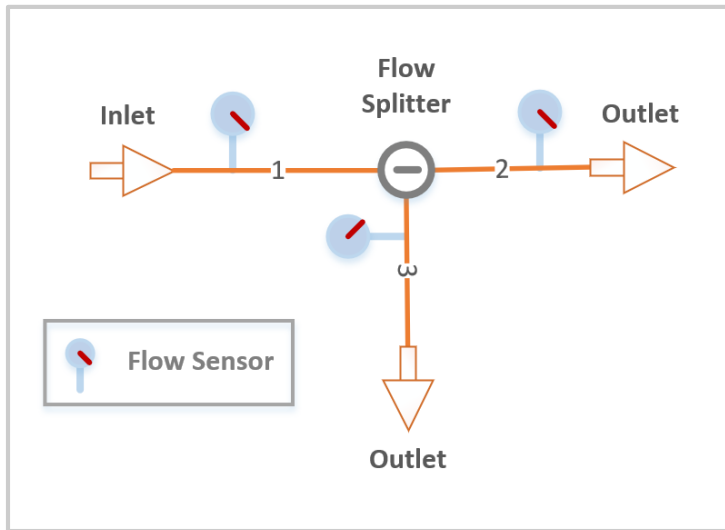
**Last updates** 26.2.2019 12:34

Temperature		56,5 C
Vibration axial		11.0
Vibration horizontal		12.3
Vibration radial		9.8
Battery		Low

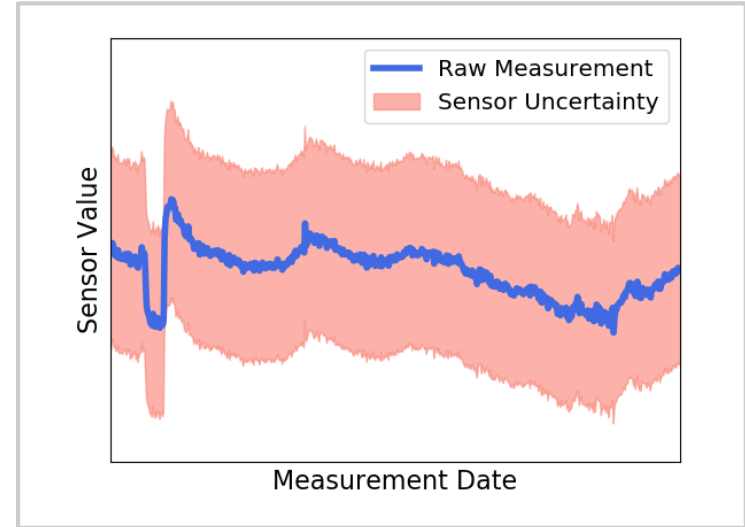


# System advanced monitoring

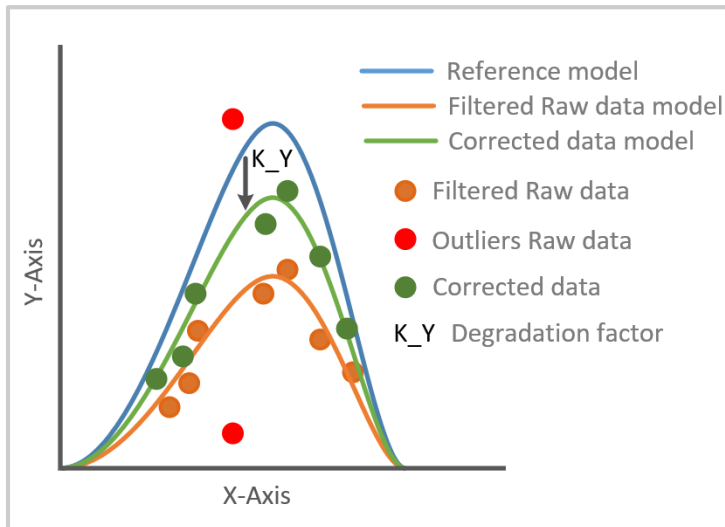
## Sensor Redundancy



## Measurement Uncertainty



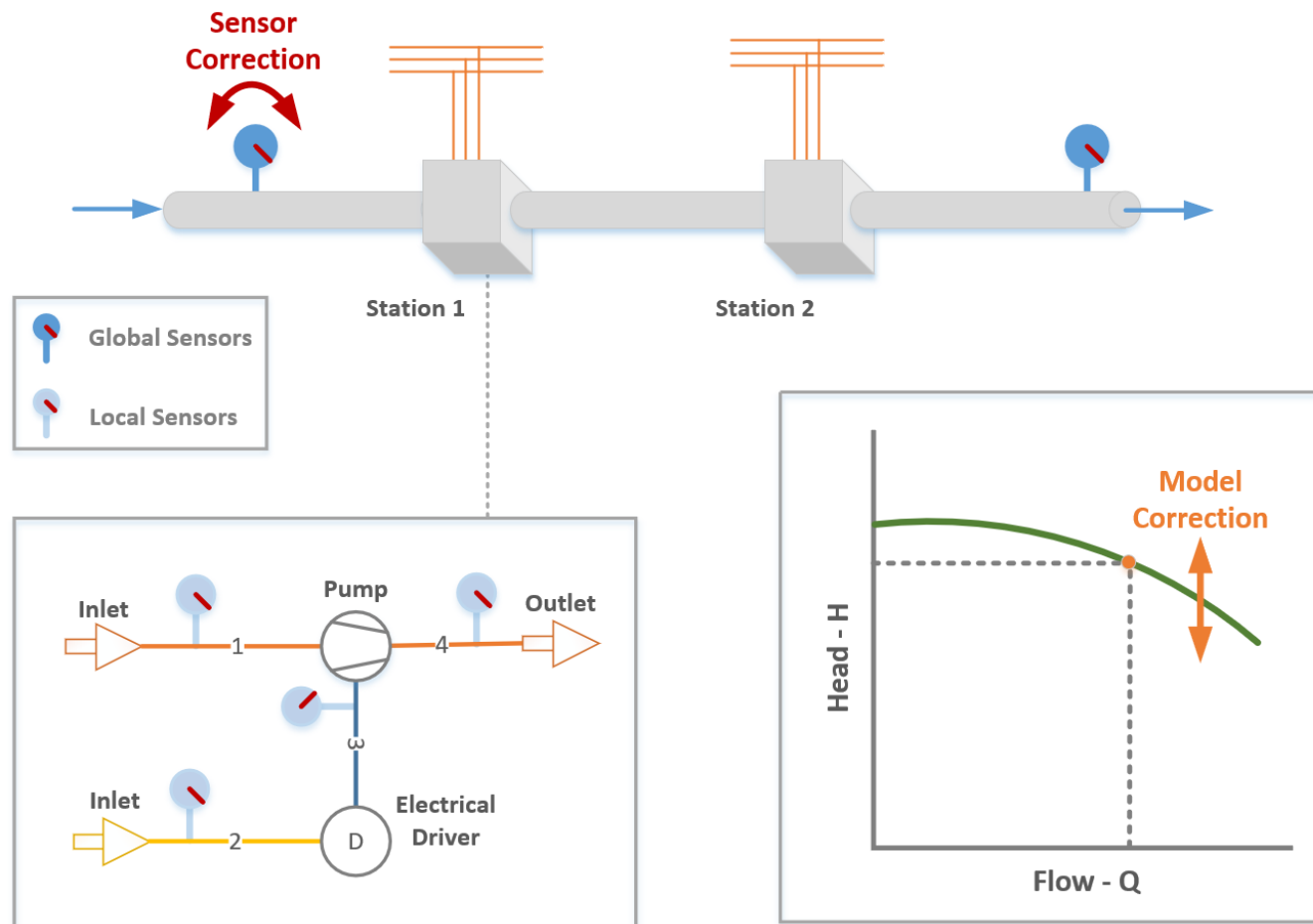
## Model Uncertainty



## Data Reconciliation:

- Leverage unused sensors
- Account for measurements uncertainty
- Account for models uncertainty and components degradation

# System advanced monitoring



- Use all available sensors and derive most probable operating conditions
- Reduce sensor and model uncertainties, improve monitoring results accuracy

# Analyze operating conditions

## SULZER BLUE BOX™ Pump Analytics

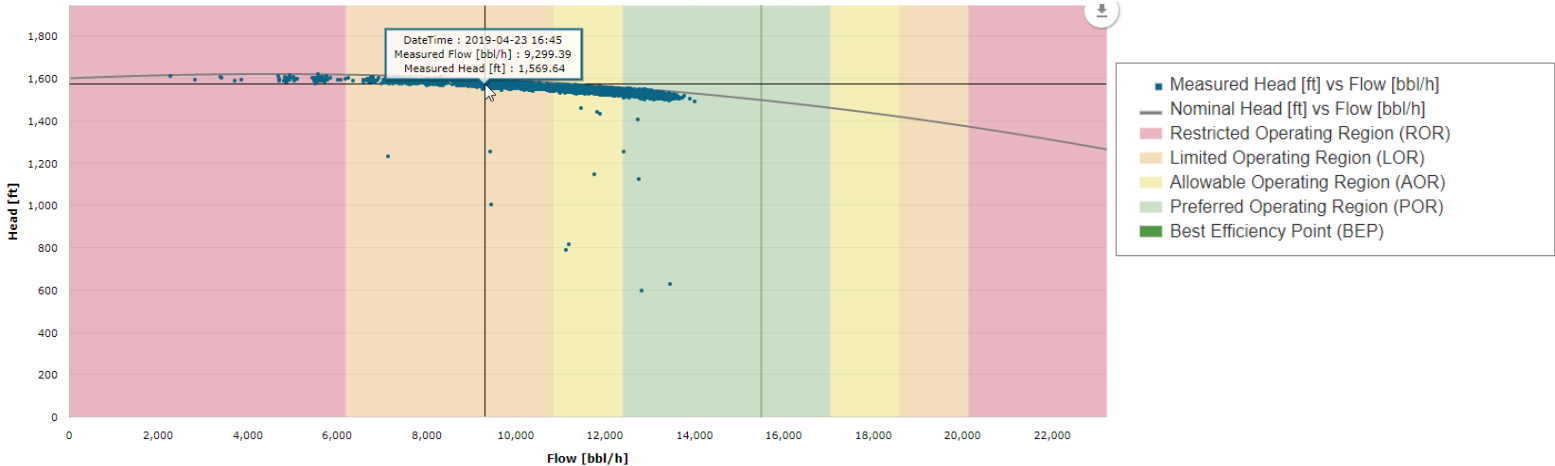


SULZER BLUE BOX™

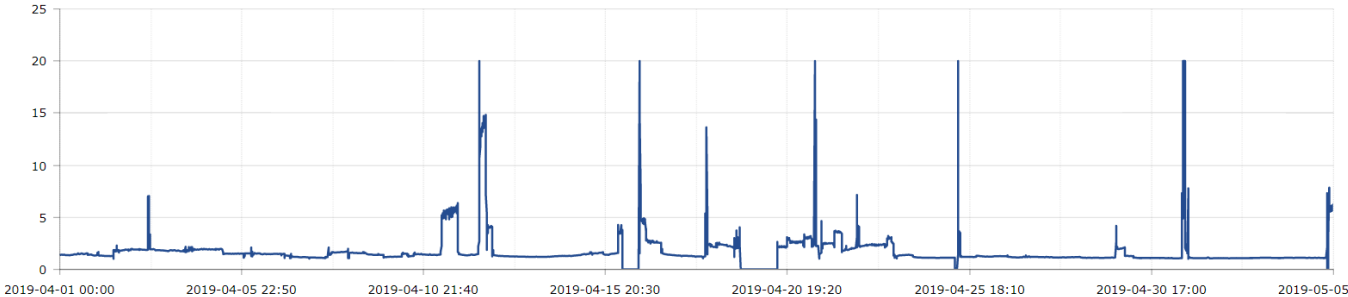
SUMMARY PRODUCTIVITY RELIABILITY **HEAD VS. FLOW** EFFICIENCY VS. FLOW PUMP REPORT ANOMALY DETECTION

- Line\_Demo
  - Station\_1
    - Pump\_1
    - Station\_2
      - Pump\_2\_1
      - Pump\_2\_2
    - Station\_3
    - Station\_4
      - Pump\_4\_1
      - Pump\_4\_2

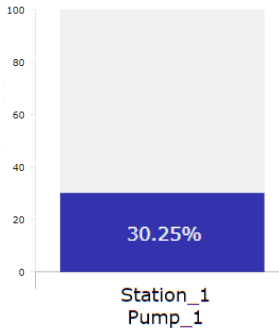
From: 2019-04-01 00:00 To: 2019-05-05 16:00 Show Default Data Aggregation: None ☐ Auto-Aggregation ☐ Hide Operating Regions



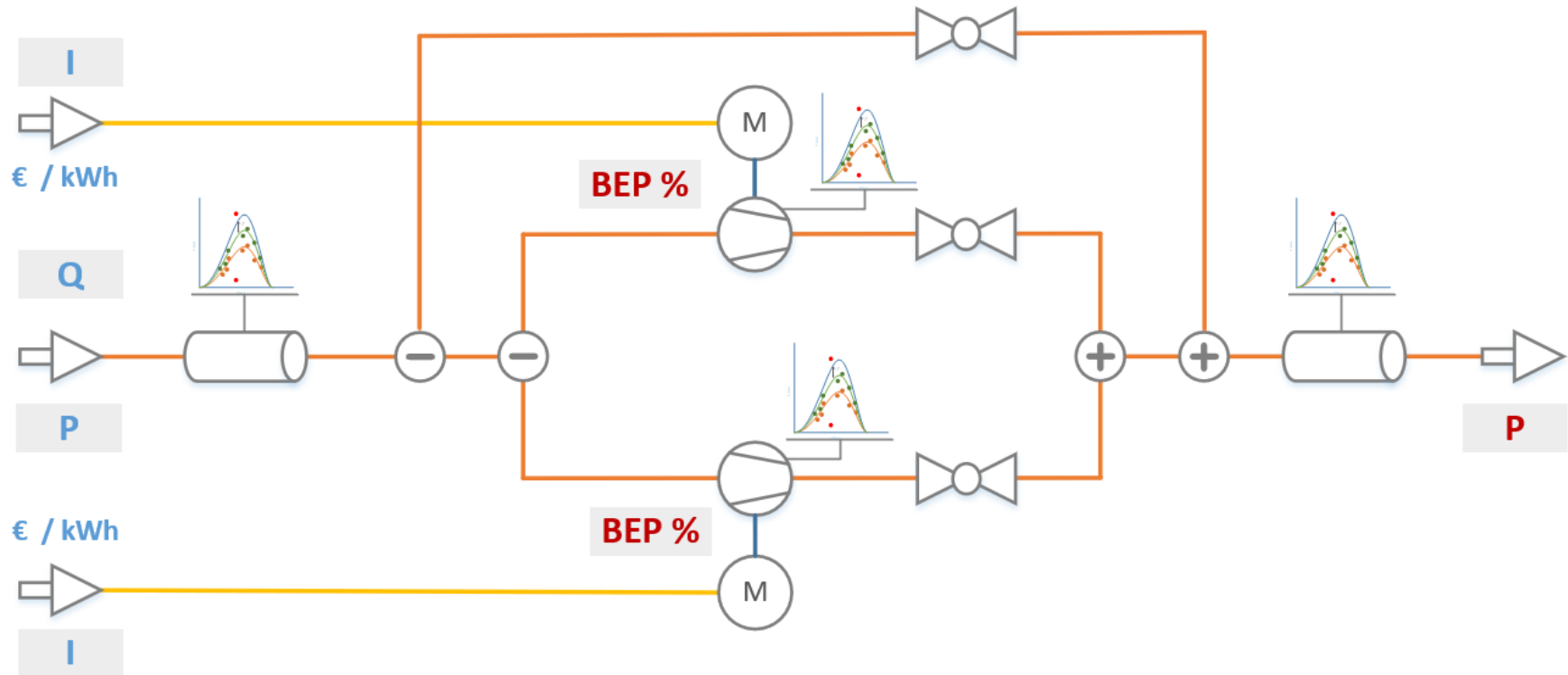
Rate Of Lifetime Consumption [-]



Current Estimated Remaining Lifetime [%]

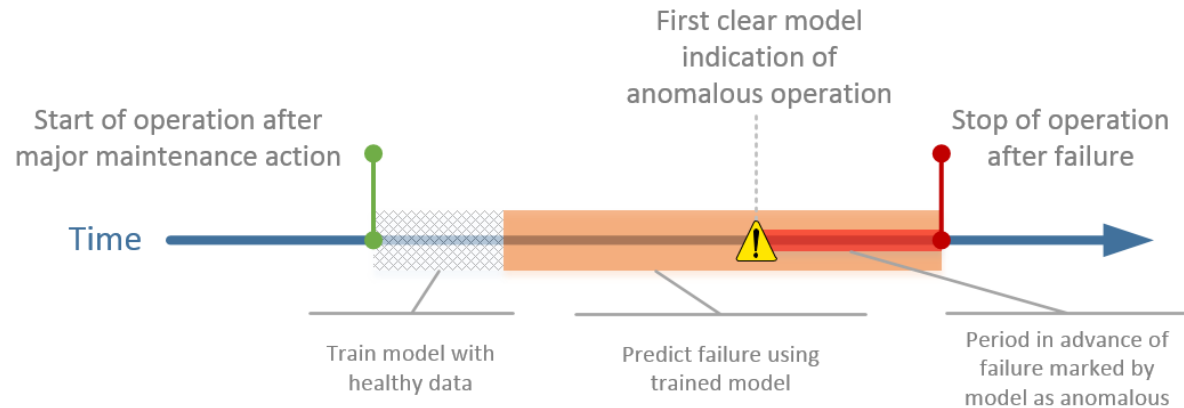


# Performance predictions and optimization

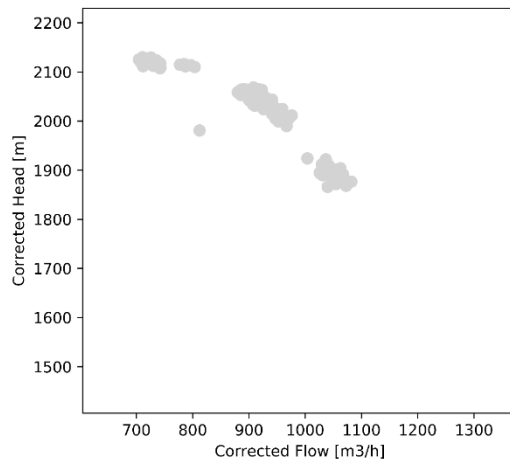


- Components' modelling is regularly updated by recent operation, representing a realistic and current behaviour of their operation
- Triggering what-if simulation scenarios and assessing future system operation:
  - Are pumps operating close to BEP? Are the system operational requirements met?

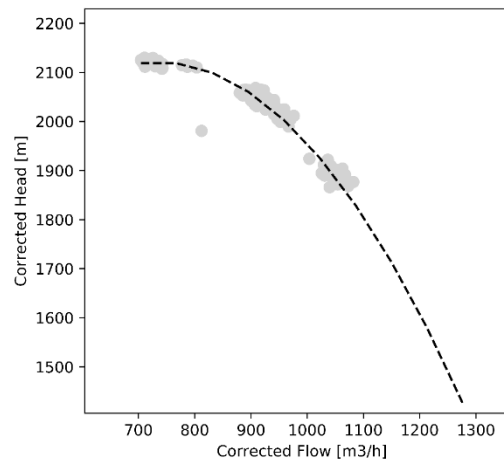
# Reliability predictions



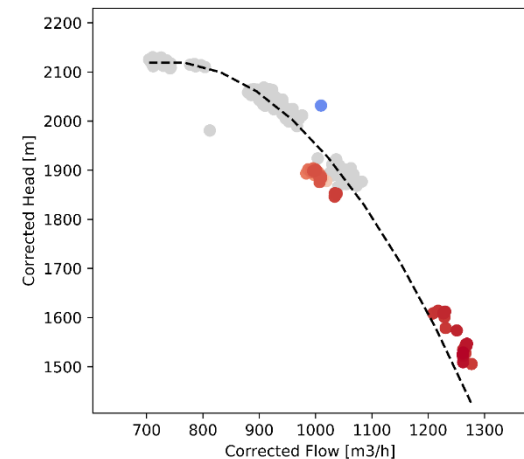
## Machine Learning anomaly detection:



**Healthy data**

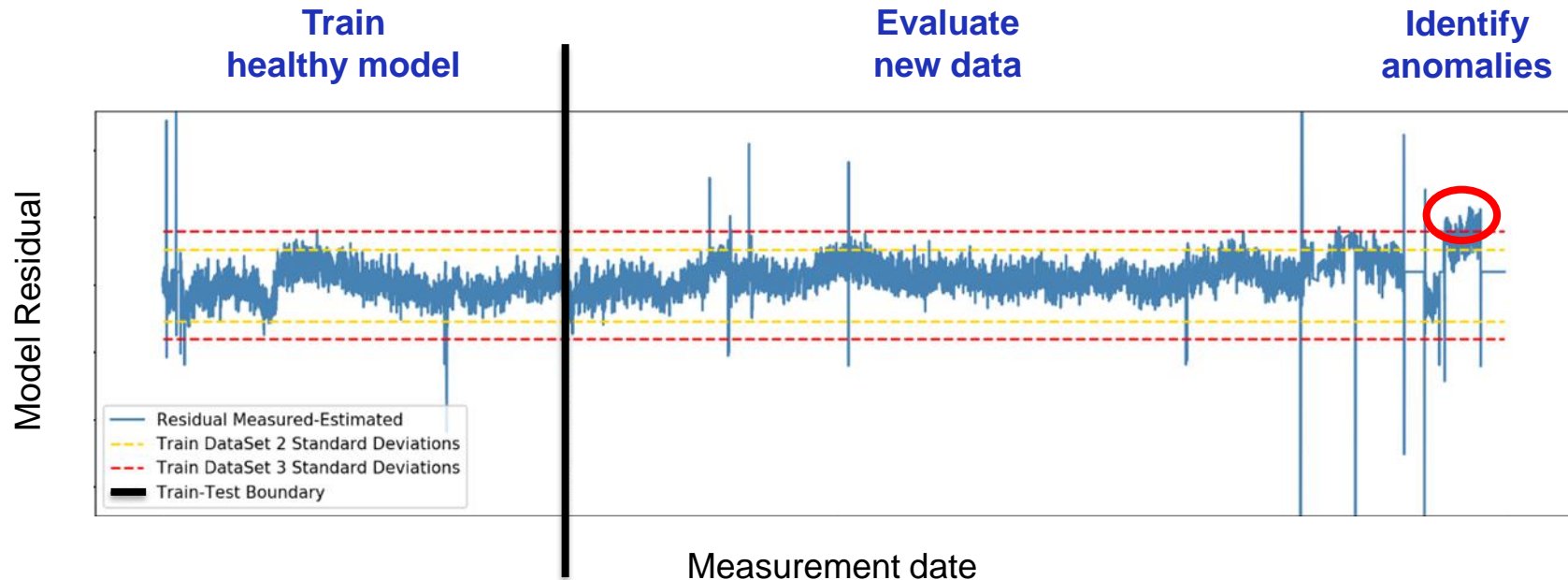


**Train physical model for healthy operation**



**Identify abnormalities**

# Reliability predictions



- Predict pump Anomalous Operation before any catastrophic failure occurs
- Reduce pump maintenance and outage costs

# Summary

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## A comprehensive pump system digital solution was presented

5 distinct building blocks: **Connect**, **Monitor**, **Analyze**, **Predict**, **Optimize**

- Connectivity is leveraging existing customer's infrastructure and modern cloud computing techniques
- Advanced monitoring approach is addressing short-comings of traditional systems, reducing sensor and model uncertainties
- Performing pump focused data analysis and assessing historical operation
- System performance and reliability predictions, enabling simulations and anomaly detection algorithms
- Recommending optimal operating conditions for future operation