

Uhde innovate 2024

Asset Management & Plant Digitalization

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thyssenkrupp Uhde

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Asset Management & Plant Digitalization

Agenda

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|---|----------------------|
| 1 | Introduction |
| 2 | Asset Management |
| 3 | Plant Digitalization |



1. Introduction

Service solutions along the entire plant life cycle to enhance our customers' competitiveness



Asset Management & Plant Digitalization

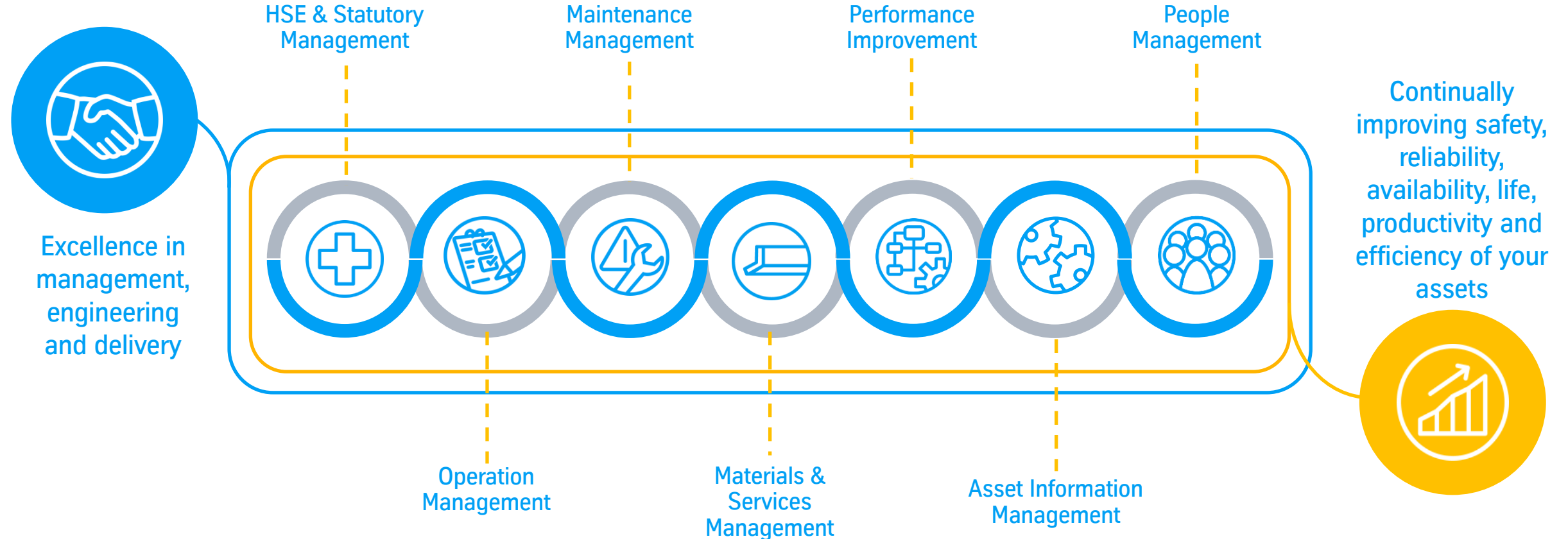
Agenda

- 1 Introduction
- 2 Asset Management
- 3 Plant Digitalization



2. Asset Management

Integrated Asset Management (IAM): Perfectly designed coordinated process for increased performance



2. Asset Management

Phases of O&M

1 Mobilization phase (before MC)

- Definition and development / customization of IAM* methodology
- Preparation of Standard Operating Procedures (SOPs)
- Preparation of Standard Maintenance Procedures (SMPs)
- Training of personnel on IAM procedures, SOPs, SMPs
- Set-up of an OTS**
- Set-up of a CMMS*** and other required systems

2 Execution phase (after MC)

- Rolling out of the customized IAM methodology
- Set-up of Remote Performance Monitoring (RPM) and potential other digital products
- Tracking of KPIs
- Continuous improvement of the plant performance, processes and procedures

Uhde can support customers with different AM packages depending on customer requirements

*Integrated Asset Management; ** Operator Training Simulator; ***Computerized Maintenance Management System



Asset Management & Plant Digitalization

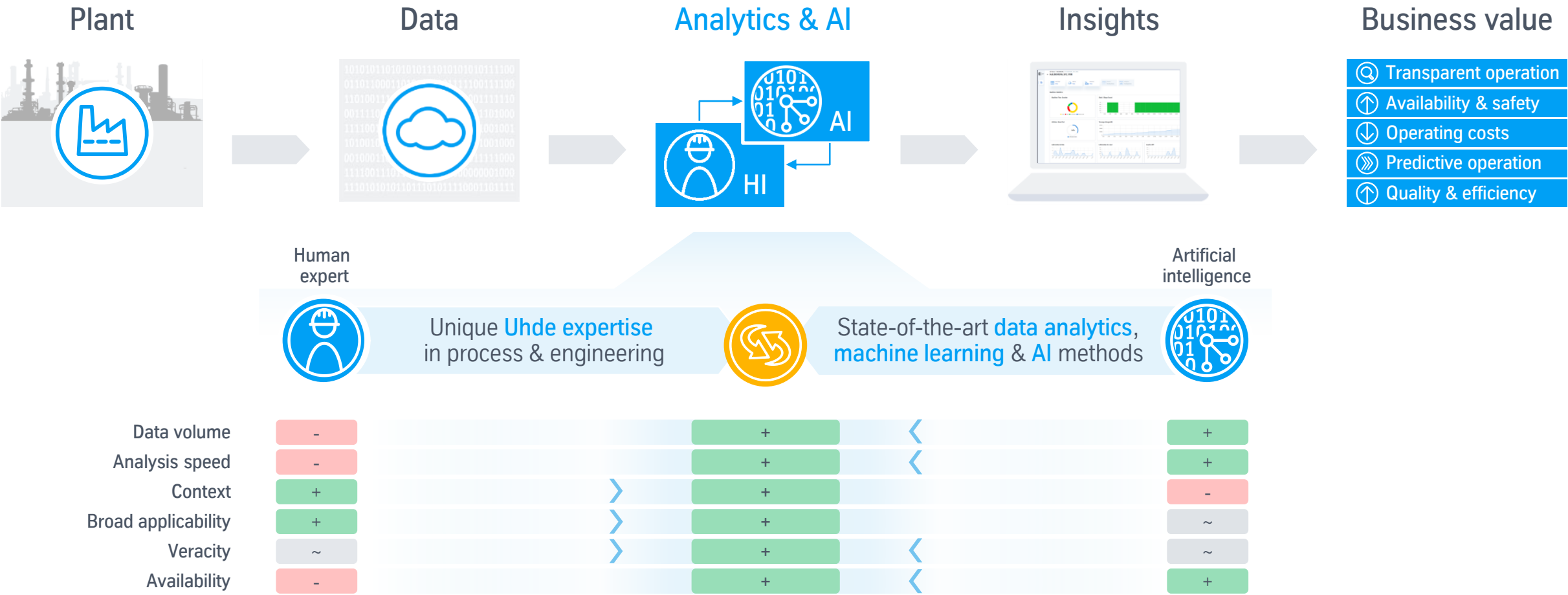
Agenda

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3. Plant Digitalization

The combination of human & artificial intelligence is driving new opportunities



3. Plant Digitalization

Remote Performance Monitoring (RPM) - Online access to plant data and advice by process experts

Scope

- This service is based on operating and analytical data transferred to thyssenkrupp Uhde.
- Online dashboards (incl. mobile access) help management to keep track of KPIs. In addition, regular reports including recommendations for operation and maintenance can be provided, including machine monitoring.

Benefits

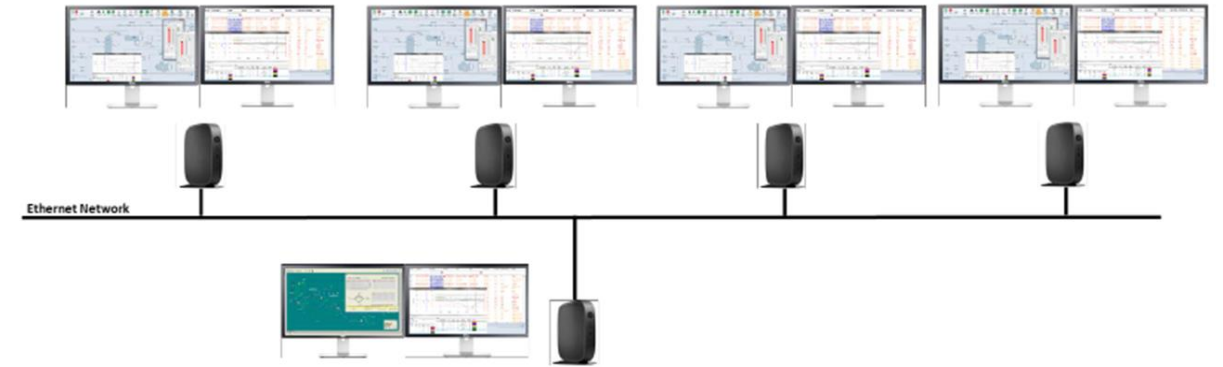
- Full process transparency based on plant data via tk Uhde's proprietary cloud solution
- Deep process insights will be provided by analysing plant performance and advice will be given by process experts.
- Benchmarking: How does your plant compare with others?



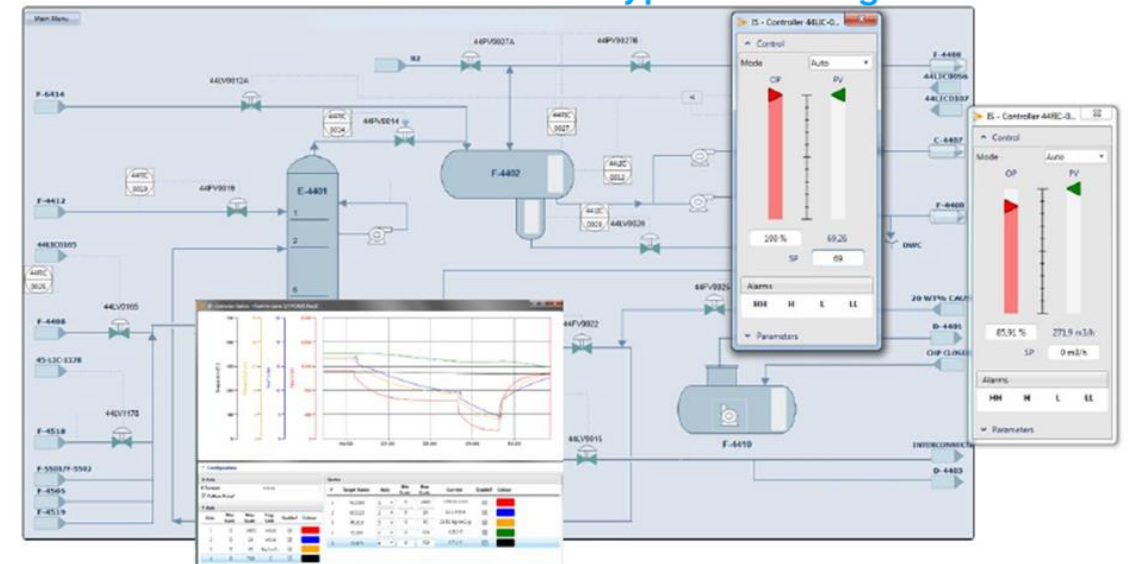
3. Plant Digitalization

Operator Training Simulator (OTS) – Familiarization and continuous training

- An Operator Training Simulator is a learning- and simulation platform for operating personnel to familiarize with the plant elements and their behavior.
- It provides a software simulation of a plant. The technical and graphical appearance and behavior is very similar to the real plant.
- Additionally, an OTS provides a learning section for plant operators to conduct practical learning lessons assisted by an instructor to guide and evaluate the operator learning progress.
- Trainees are trained on DCS as in the real control room, including ability to generate trends, fine tune control parameters, etc.
- Different scenarios may be trained (normal operation, start-up, shut-down, etc.)
- Malfunctions can be simulated, and operators learn to react on abnormal plant behavior (advanced training)



Typical training environment



3. Plant Digitalization

Digital twins of your plant to achieve operational excellence

- Plant structure (plants, units, equipment items)
- Plant documentation
- Planning of maintenance tasks
- Work order management
- Spare parts management
- (Link to) warehouse management
- Analyses

Process Model

- Link to live plant data
- What-if analyses
- Optimization of production
- Predictive maintenance
- Training of personnel (OTS)

Digital Twin

Computerized Maintenance Management System (CMMS)

3D Model

- Visualization
- Support in planning of maintenance and revamp activities
- Training of personnel (OTS - field operator module)



3. Plant Digitalization

Digital twins - What kind of process models are applied?



First principles (White-box)

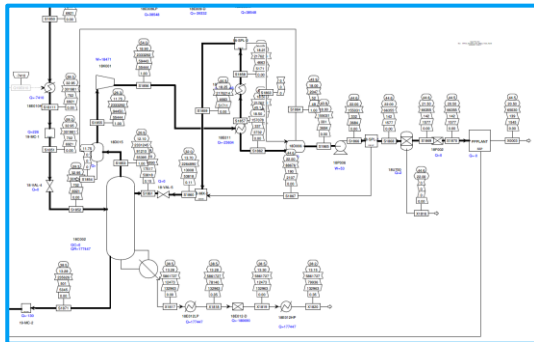
Based on process simulation

Advantage:

- Users can understand the relationship between input and output data

Disadvantage:

- Can only be applied for process technologies with known equipment and thermodynamic properties



Statistics & AI (Black-box)

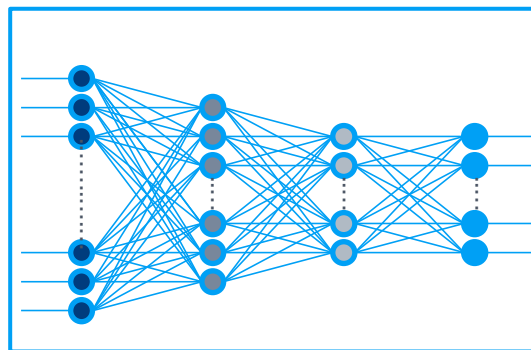
Based on AI (e.g. expert systems, artificial neural networks incl. machine learning)

Advantage:

- Can be applied for all kind of systems, even when system behavior is unknown

Disadvantage:

- Relationship between input and output parameters cannot always be understood by users



Hybrid (Grey-box)

- Combination of white and black box models



3. Plant Digitalization

Digital twins - benefits

1

Optimization

Find better set-points respecting constraints, identify heat loss, etc.

2

What-if analysis

See how a part of your plant will behave for e.g. different feed conditions, changing pressure or temperature

3

Monitor equipment

Reactor efficiencies, turbo-machinery performance, fouling factors

4

Virtual sensors

Verify existing sensors, estimate fluid & equipment properties where no sensor is installed (i.e. inside equipment), interpolate offline analysis

5

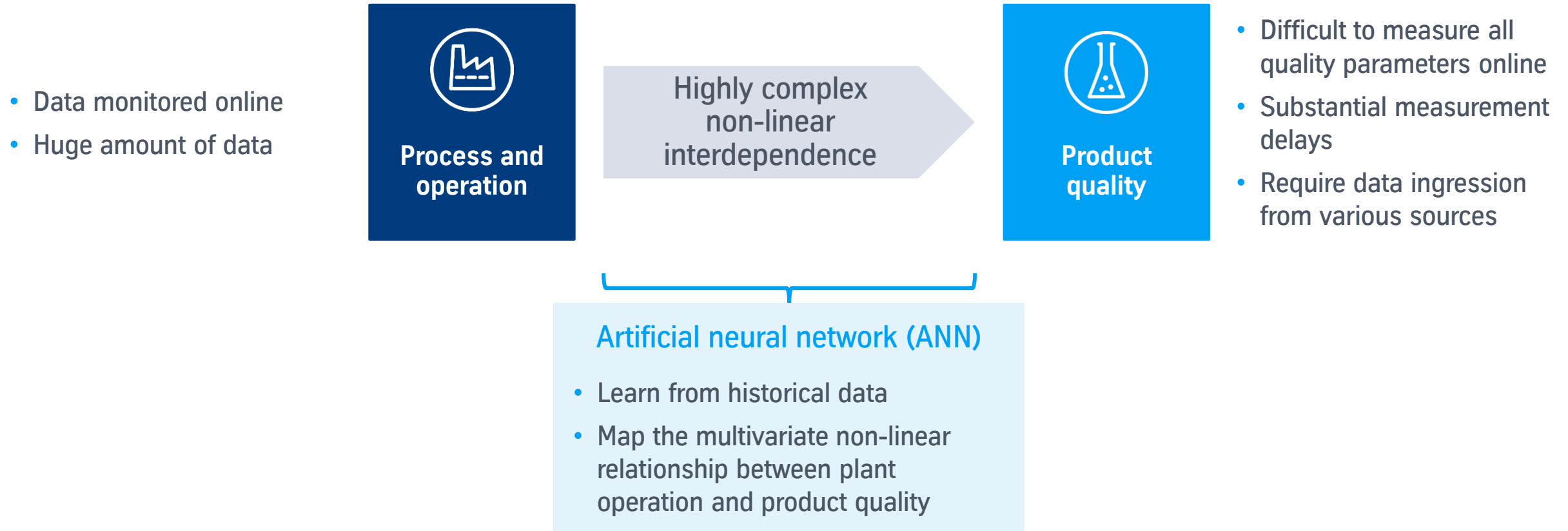
Extended digital twin

Provide training data



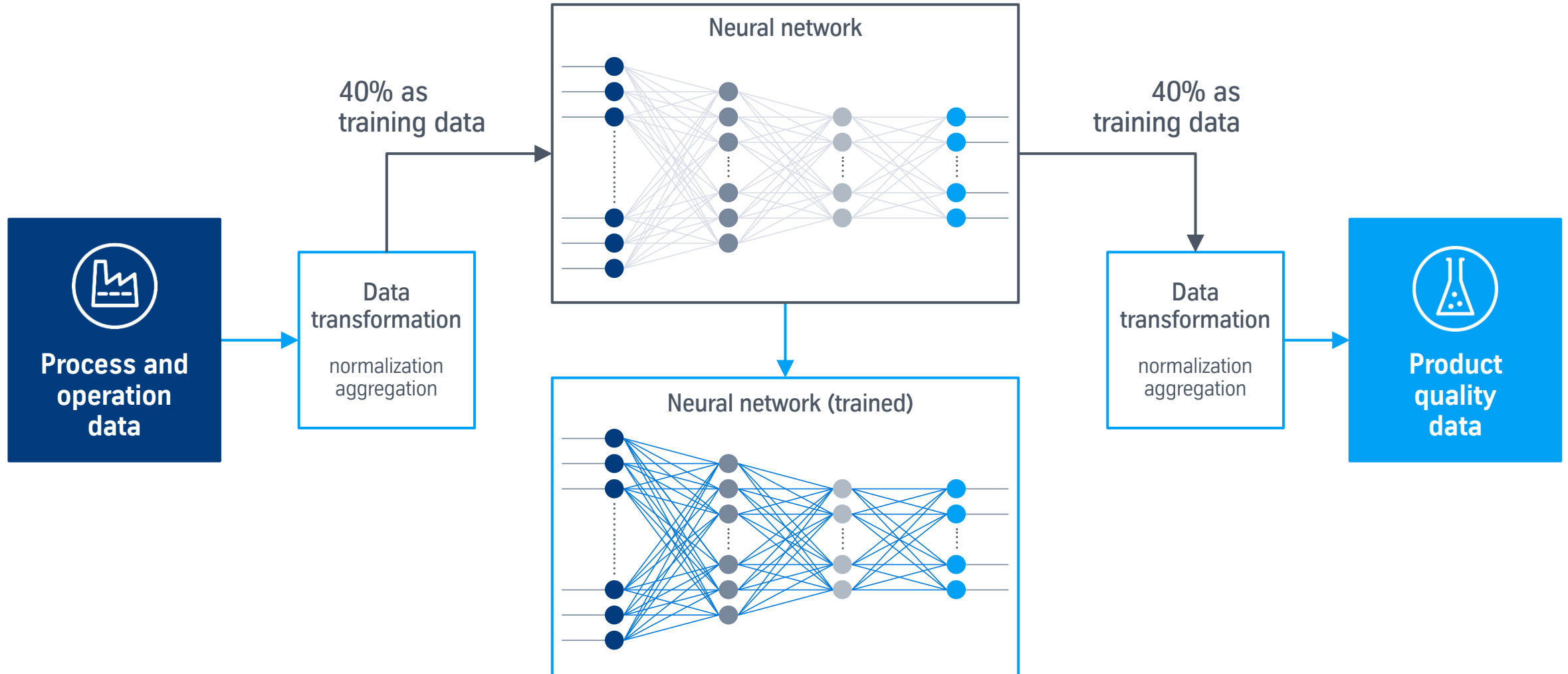
3. Plant Digitalization

Digital twins - Example for a black-box digital twin: Prediction of product quality in a polymer plant based on process data



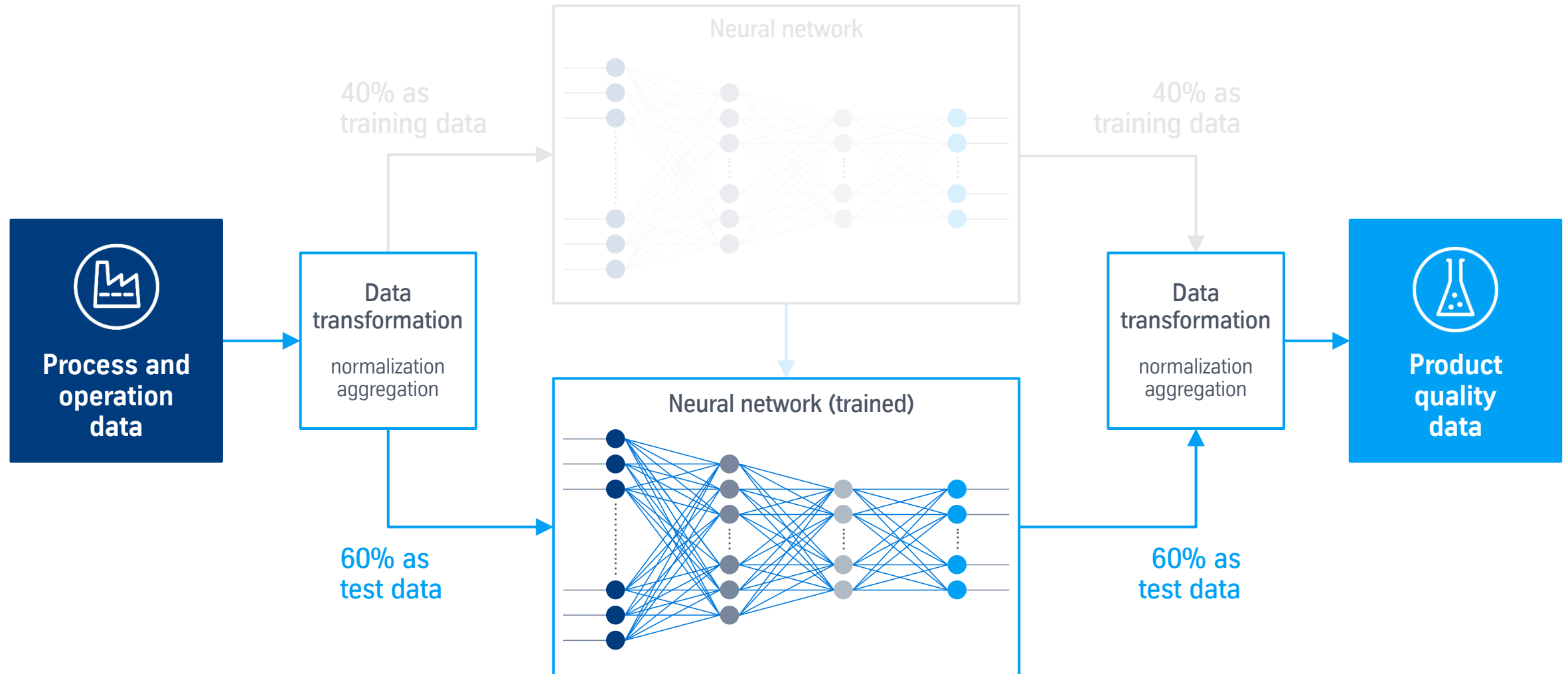
3. Plant Digitalization

Digital twins - Model learns from training data



3. Plant Digitalization

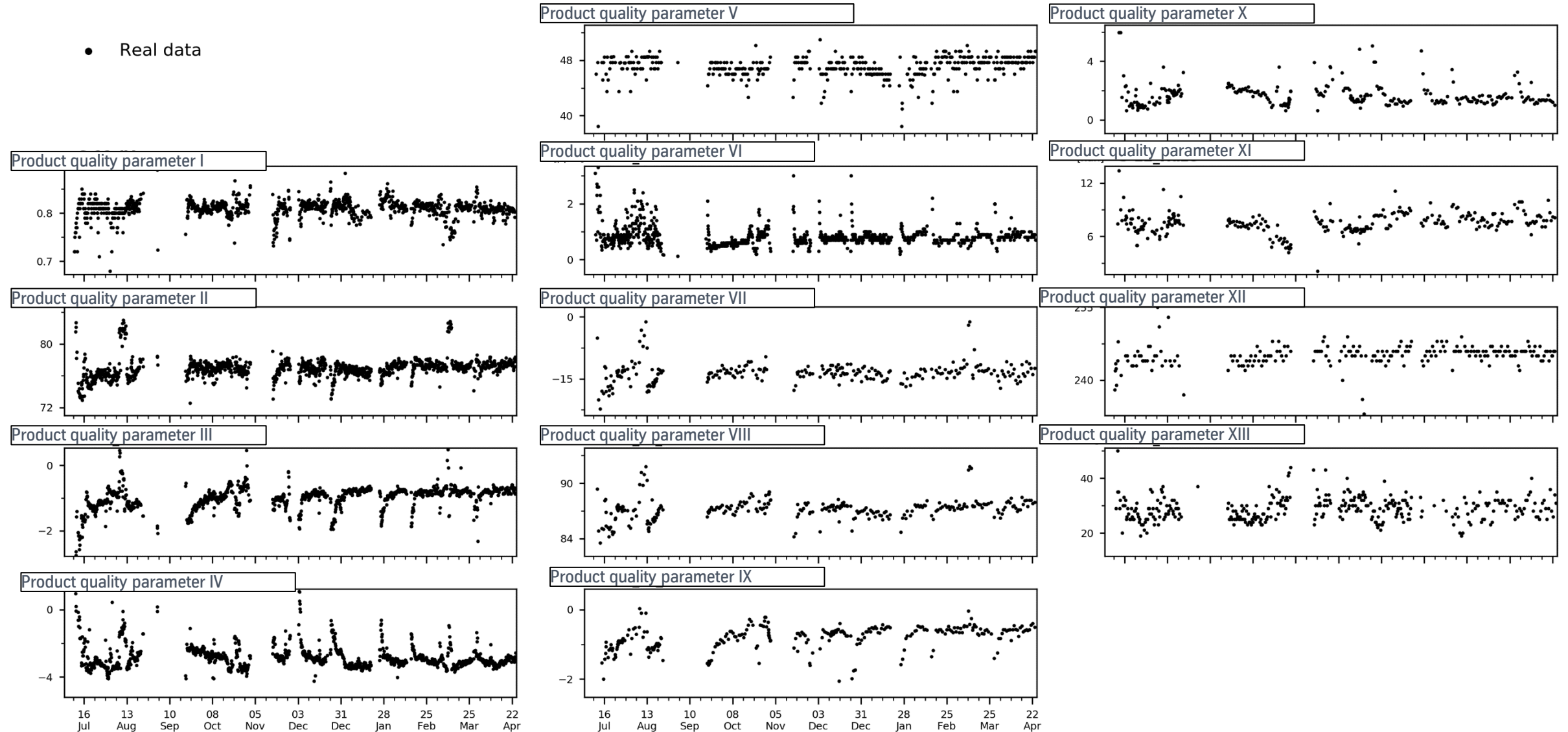
Digital twins - Trained model can be applied to new data



3. Plant Digitalization

Digital twins - Final product quality

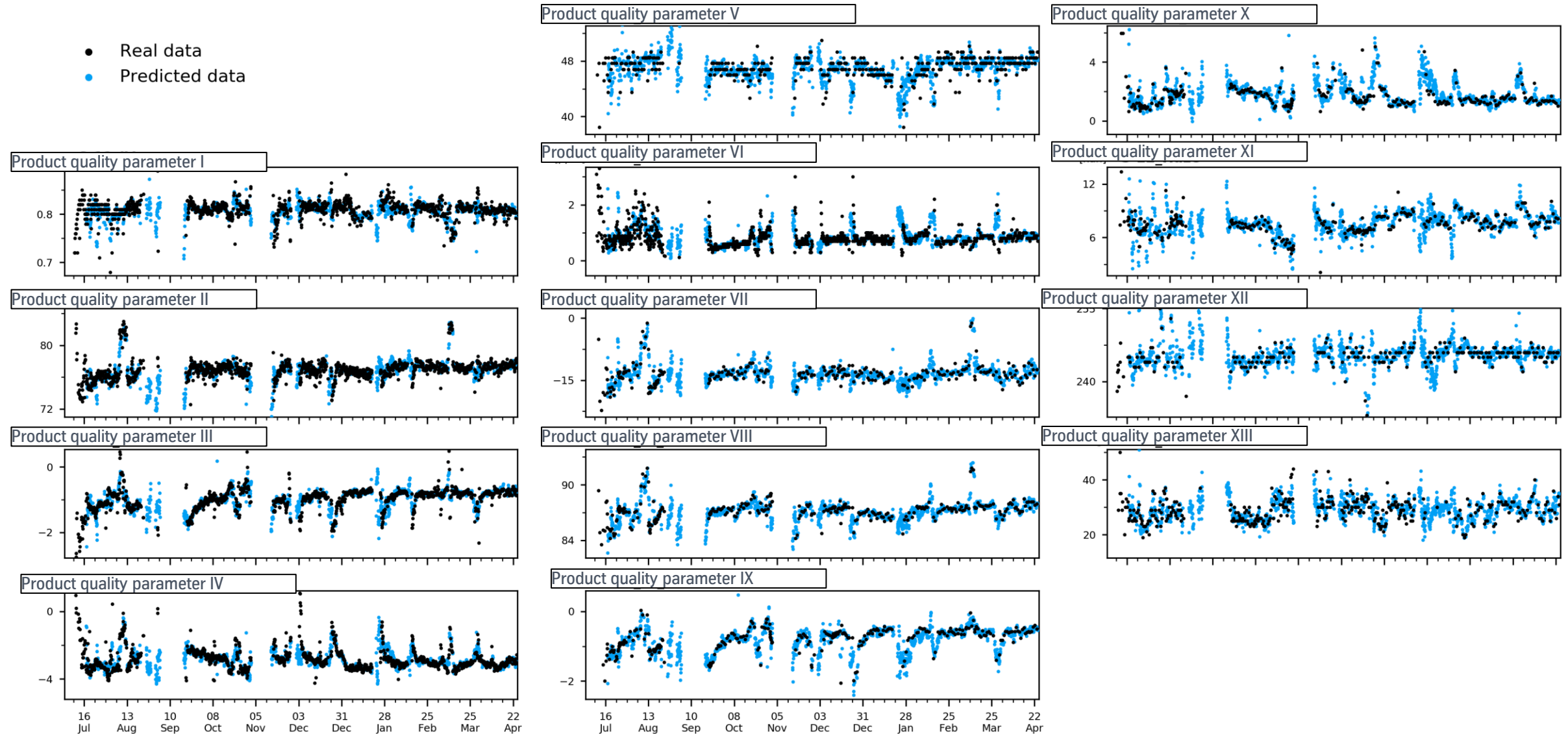
- Real data



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Digital twins - Predictions from neural network model

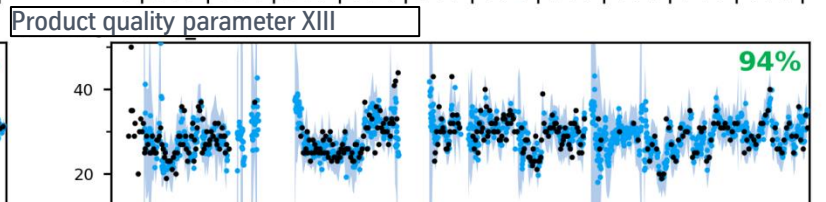
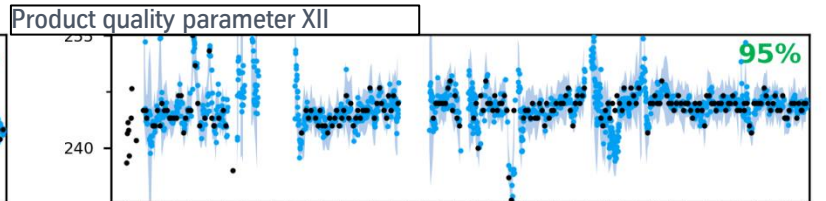
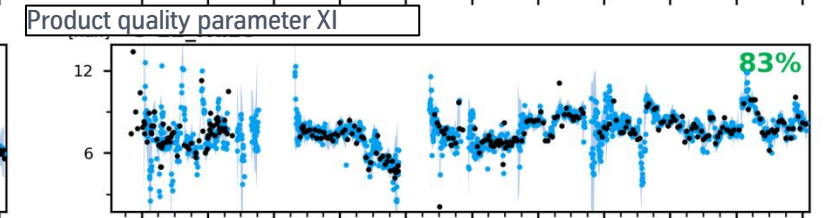
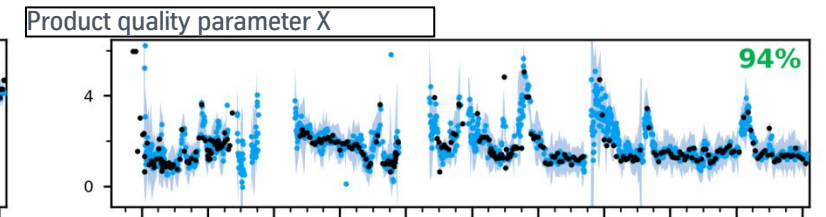
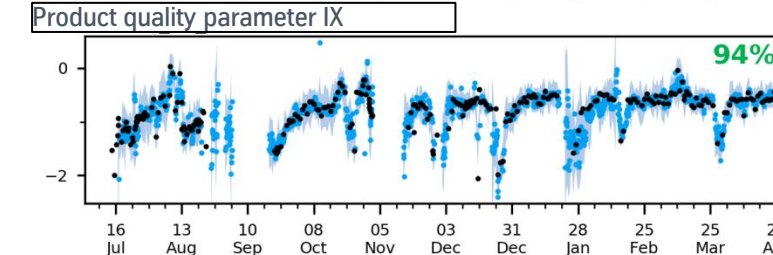
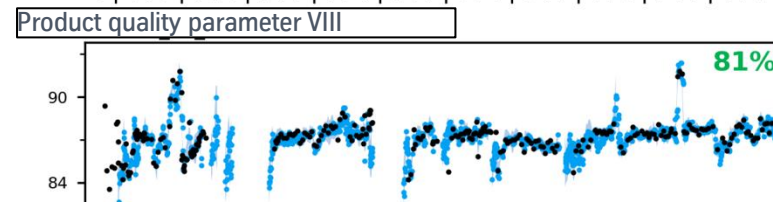
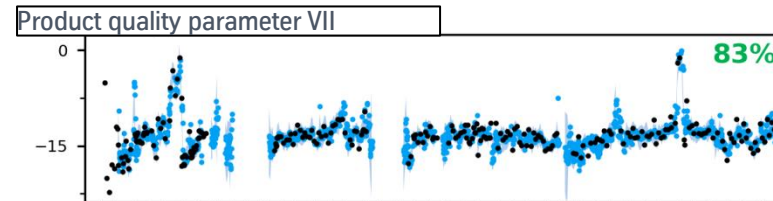
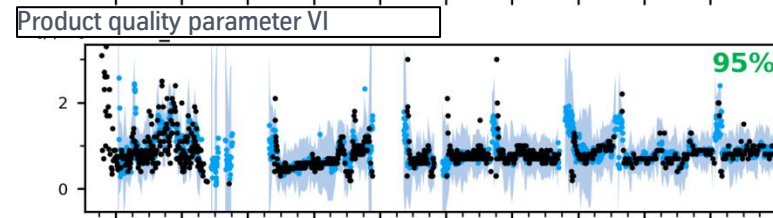
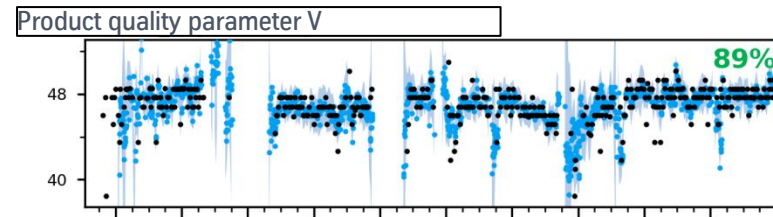
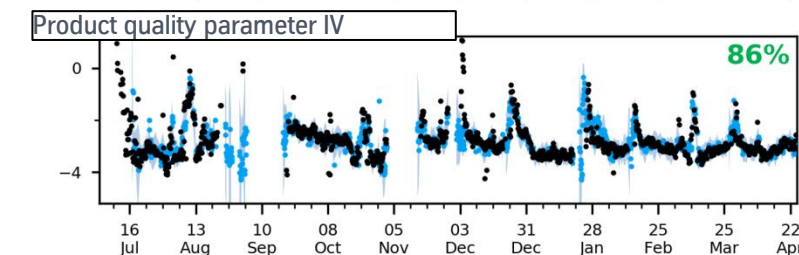
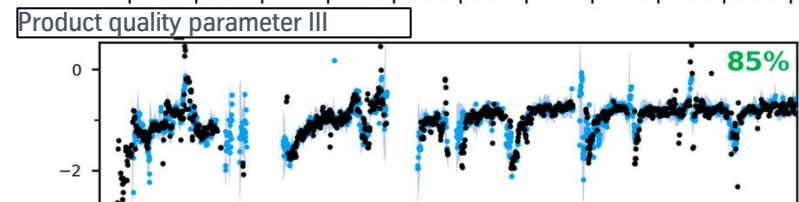
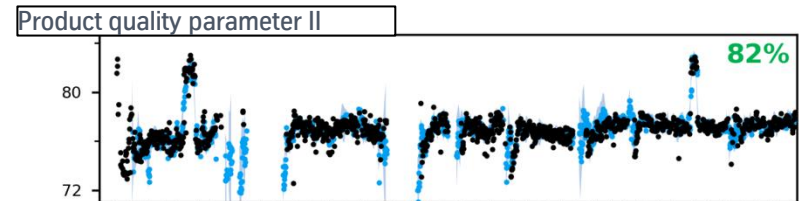
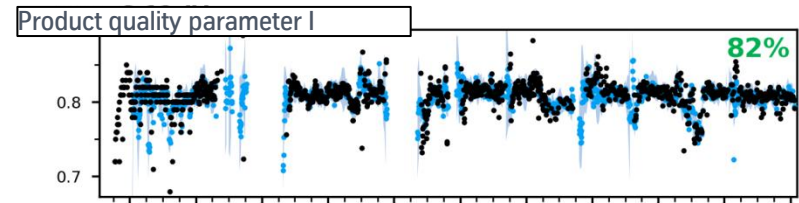
- Real data
- Predicted data



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Digital twins - Predictions from neural network model

- Real data
 - Predicted data
 - Confidence intervall
- Real data within predicted confidence intervall [%]



Overall prediction accuracy for final product quality

88%





Thank you for your attention



Head of Asset Management &
Digital Products



sascha.wenzel@thyssenkrupp.com

