AI based services HAZOP+, OPEX4.0, AMAIS

ACHEMA

25.08.2022

Dr. Hans V. Schwarz

Add value.
Inspire trust.

A family of AI applications by atlan-tec systems and TÜV SÜD

- **OPEX4.0**
  - **Data based, automated, continuous optimization** of a plant's operating/process parameters (from DCS) by means of **AI/Machine Learning** towards an economical optimum *(e.g. 'minimized costs/ton')*
  - OPEX4.0 projects follow the recommendations of VDI/VDE-GMA guideline 3714 (execution of big data projects in production), ensuring a **systematic, transparent and structured** project workflow
  - Projects can be **certified by TÜV SÜD experts**

- **HAZOP +**
  - **Synergistic combination of HAZOP and OPEX4.0**
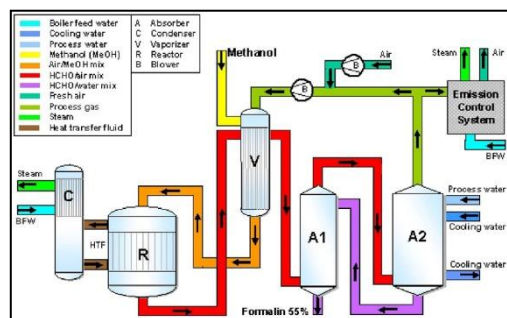
- **AMAIS**
  - **Asset Monitoring** based on **permanently** installed condition **sensors** (e.g. for corrosion, erosion, vibrations, fouling,..)
  - **Evaluation of sensor data by AI**, visualization on a dashboard
  - **Connecting asset integrity data** with **process data** for identification of correlations and better decision making
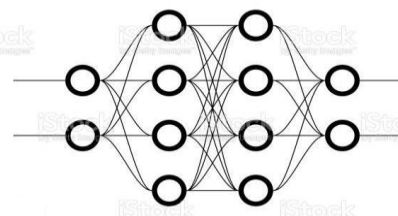
The basic principle of OPEX 4.0

Your PROCESS

Historical Process Parameter DATA
(from DCS: P, T, F, L, Q,..; from Lab)

FIC3221
LIC245
TIC1207
FIC1284
AI2234
AI2945
PC285
PC248
TIC1356

PROCESS MODELS = DIGITAL TWIN
→ OPTIMIZER (e.g. towards minimal cost)
Neural network technology

ADVANCED BIG DATA ANALYTICS
with our smart, data-driven solutions

Optimization of operating parameters using Machine Learning

From traditional process control with fluctuations / suboptimal performance…

higher variability of important process parameters requires wider safety margins relative to optimal conditions
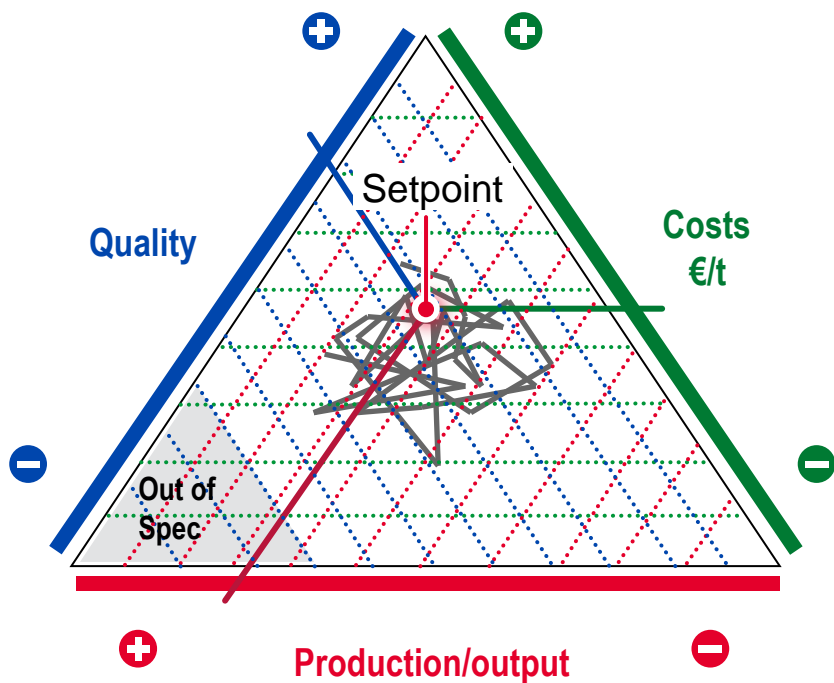
to

… optimized operation according APC 4.0 with minimized costs / higher efficiency

optimization **reduces variability** by factor 10 → Setpoints can be moved closer to limits **higher production rate, more stable process, lower costs**
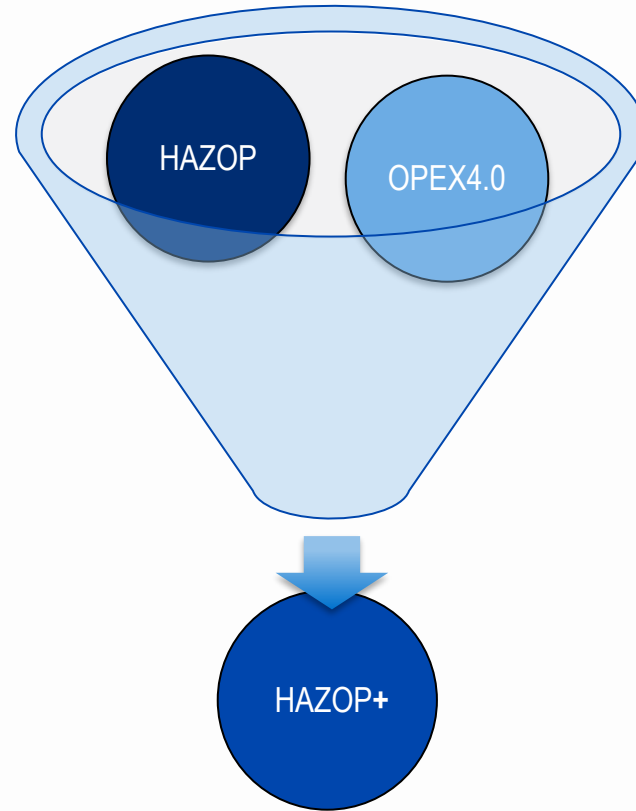

ML based Optimization + HAZOP
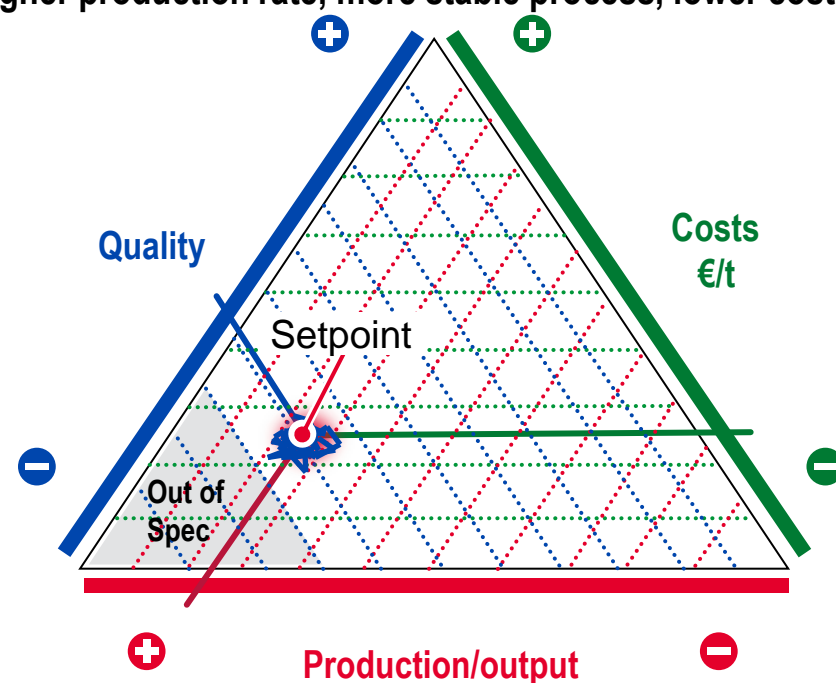
HAZOP + OPEX4.0 = HAZOP+

- **HAZOP**
  - A deep Process Analysis method used for Process Safety
  - Results in recognition of safety gaps and determination of corresponding risk reducing measures
  - deepest and most resource intensive analysis of a plant after its original design process, during its utilization life

- **OPEX4.0**
  - Many companies have a systematic OPEX (Operational Excellence) process, which is used to optimize yields, utility usage, minimize unplanned downtime, and other parameters with cost impact
  - In OPEX4.0 the optimization of operating parameters is based on data centered methods and AI for the Interpretation of the operating data.

- **HAZOP+**
  - Combines a HAZOP study with an OPEX4.0 project, realizing synergies between the two

HAZOP+ : identifies new correlations & synergies ...

HAZOP

includes the discussion of **process limits** and actual plant operation.

⬇

In **HAZOP+**

more systematic review of plant operation based on **operating data**

OPEX 4.0

projects use **operating data**, which are also relevant for **safety**

In **HAZOP+**

systematic review of optimisation's **safety limits**
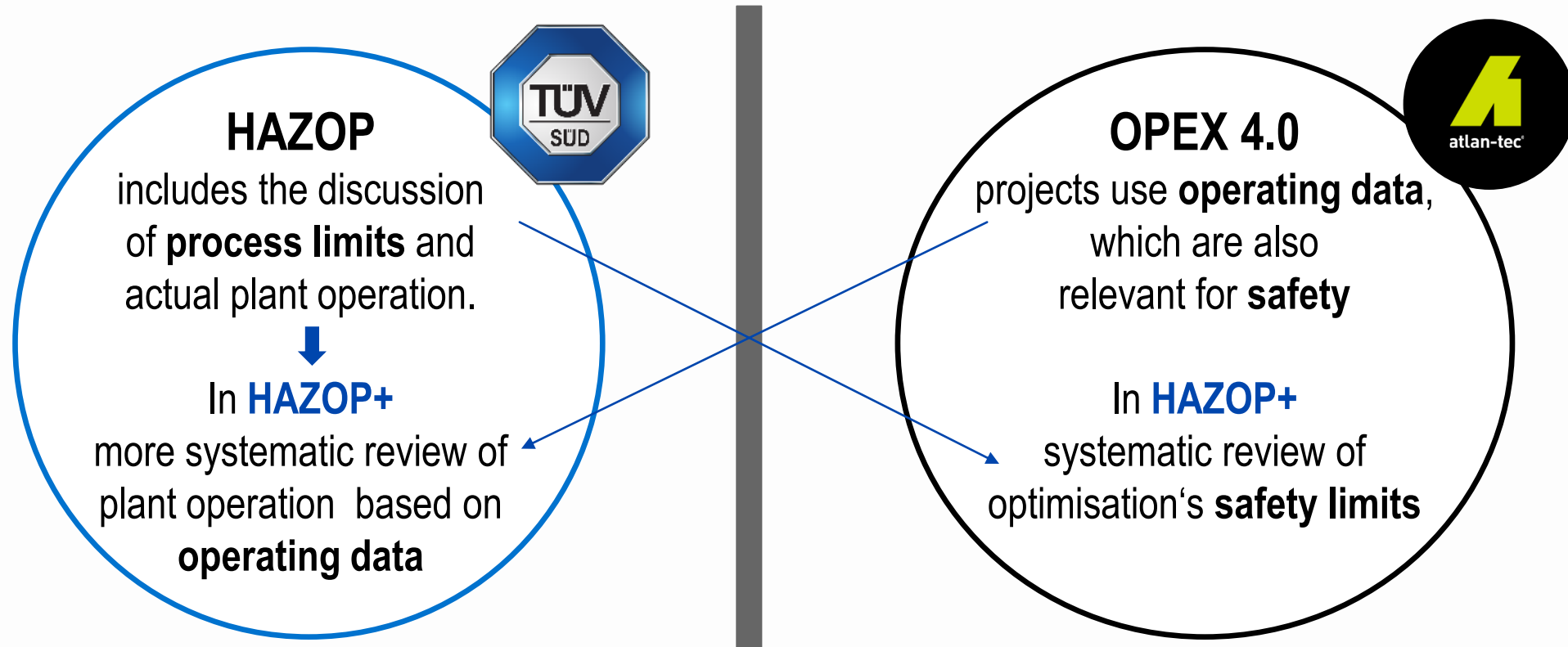
Safety Reviews (HAZOP) and data driven **Process Parameter Optimization (OPEX4.0)** are coordinated for the use of synergies, but nevertheless always performed seperately.
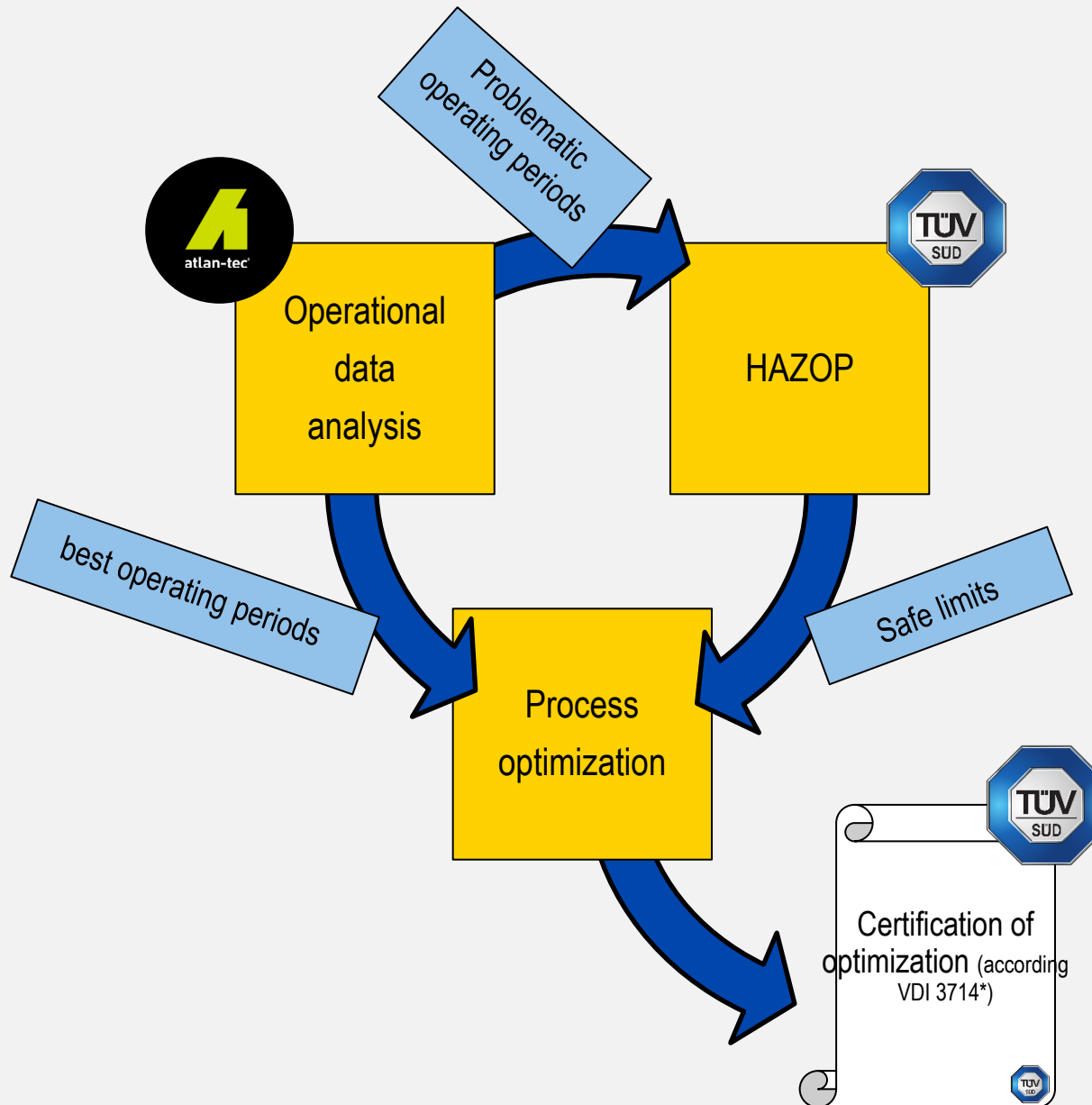
HAZOP+ workflow

- HAZOP study performed by experienced **TÜV SÜD** experts
  - Using the unfavorable run periods identified in the data analys for systematic discussion of plant operation
- OPEX4.0 performed by partner **atlan-tec Systems**
  - Using the favorable run periods identified in the data analysis
  - Optimization of operating parameters using Machine Learning
- Certification of optimization according VDI 3714* by **TÜV SÜD** experts

*VDI3714: German engineering guideline for the optimal execution of big data projects

Execution of HAZOP+ Projects

Preparation
- Required documents
- Necessary updates
- Data (from DCS, LIMS..)

Analysis
- HAZOP study
- Data- & AI- based analysis of operation

Implementation
- HAZOP action items
- Optimisations

Follow up & Finetuning

Preparation

- P&ID, Control scheme, plot plan, equipment data,…
- Plant upsets, repairs, incidents, …
- Operating parameter data from DCS, LIMS, optimally from several years
- Simulation results (if available)

Analysis

- HAZOP:
  Review of all P&IDs, Check of all safety devices (SIL, PSVs,…)
- OPEX4.0:
  - Analysis of process parameters
  - Determining good and bad run periods
  - Formation of models
- Synergies:
  - Safe limits of optimisation
  - Including plant upsets and 'bad' run periods in the HAZOP study

Implementation

- Safety measures, resulting from HAZOP
- Optimized setpoints of relevant control loops
  - Offline, Operator input
  - Closed loop: AI feeds optimized setpoints directly to DCS
- Certification of the Optimization according VDI3714 through TÜV SÜD

Follow up & Finetuning

- Follow up on HAZOP measures/action items
- Further optimisation of operating parameters, based on continuously updated statistical models of the AI

AMAIS combines 4 elements

1 Continuous monitoring through
network of permanent sensors

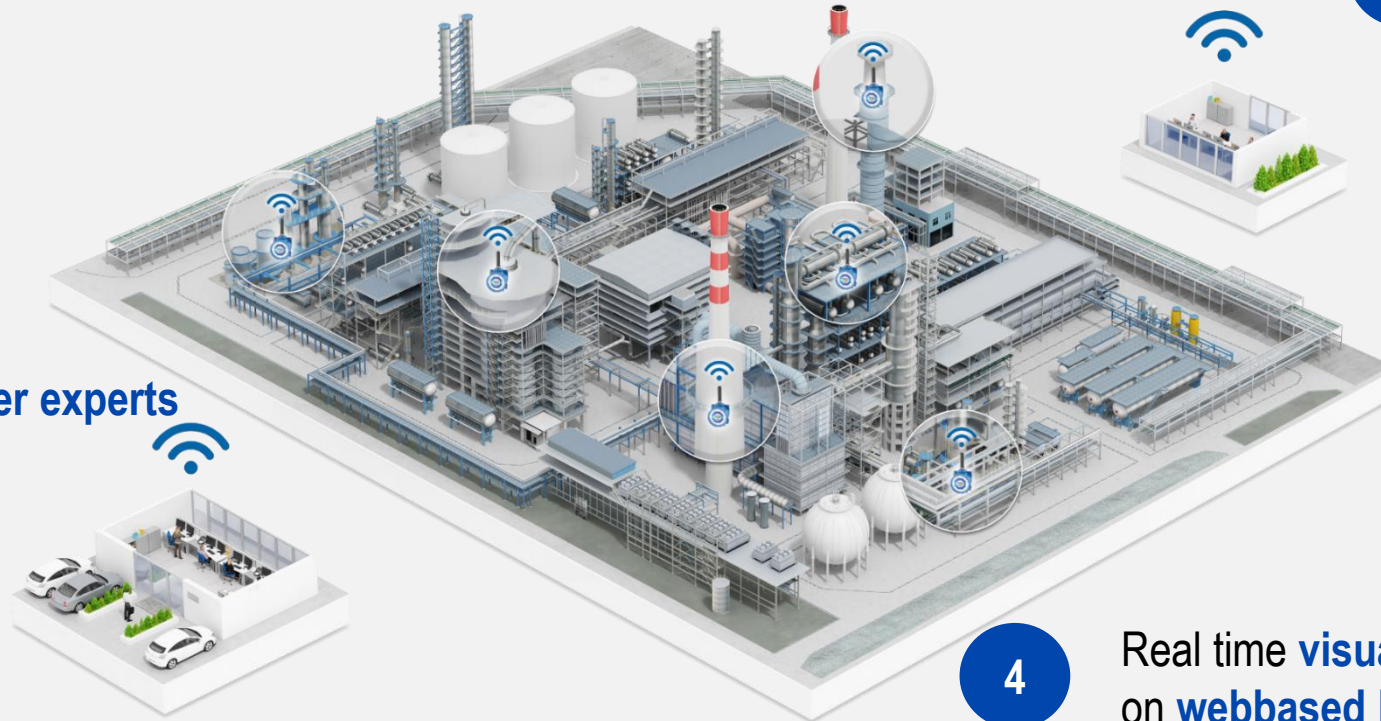**2** **Interpretation**
by **subject matter experts**

3 **AI-supported Analysis & Prognosis** der gesamten Anlagenintegrität

4 Real time **visualization** of plant condition on **webbased Dashboard**

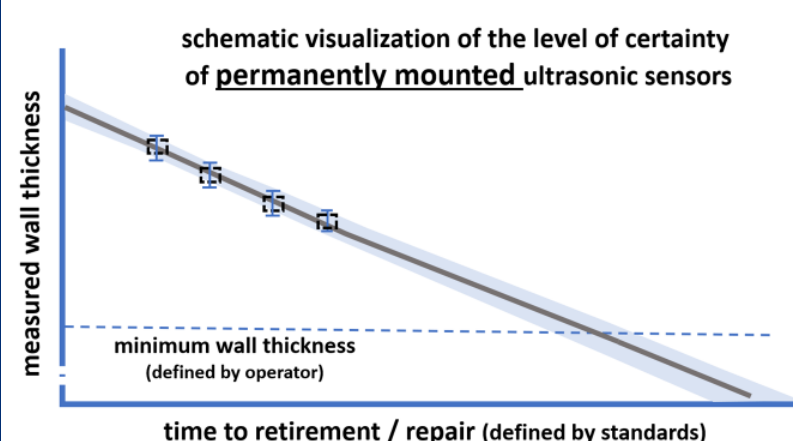# AMAIS Asset Health Monitoring supported by AI

Traditional Asset Integrity Management (AIM)

- **Plant Monitoring through periodic** and **manual Inspections.**
  time consuming and costly, only points in time

- Changes in Corrosion-/Erosion rates or growth of cracks are only detected in the next manual inspection

- **Manual inspetions** vary in location, equipment used, etc.
  resulting in **larger error bars**

- **Reactive** Safety Strategy
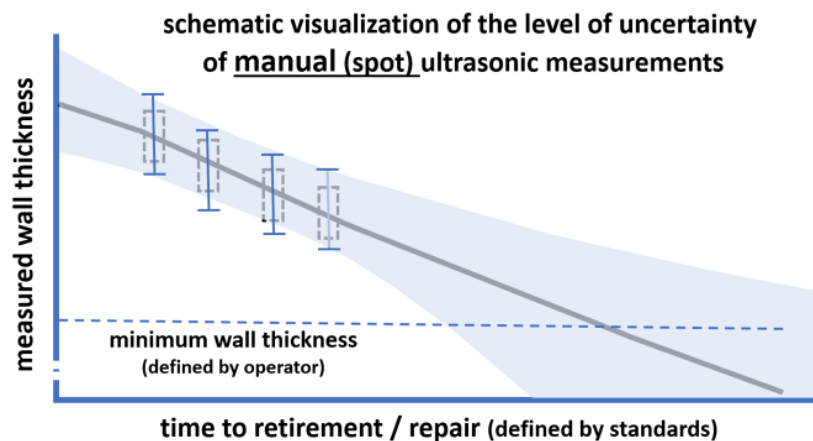
Asset Monitoring AI Supported (AMAIS)

- **Permanent Monitorng** through Sensor Network
  and **AI-supported Analysis/Prognosis of** plant integrity

- **Higher accuracy/smaller error bars** with permanent sensors

- **Alarms** at predefined limits send critical Informations to stakeholders

- Cost savings **through avoiding u**nplanned outages and maintenance

- **Proactive** and **predictive** safety strategy

schematic visualization of the level of uncertainty of **manual (spot)** ultrasonic measurements

measured wall thickness

minimum wall thickness (defined by operator)

time to retirement / repair (defined by standards)

schematic visualization of the level of certainty of **permanently mounted** ultrasonic sensors

measured wall thickness

minimum wall thickness (defined by operator)

time to retirement / repair (defined by standards)

AI supported data analysis and diagnosis

Mechanical Integrity data from sensor network

Relevant Process data

APC Professional

Central, AI-supported

Analysis Software

Holistic analisis of asset integrity

Process data with impact on degradation rates taken in consideration by the AI

E.g. in case degradation rates are accelerated by small temperature or concentration changes

In some cases it is possible to detect and monitor fouling/ formation of deposits in pipes.

APC professional

APC Professional: a grafic configuration software with integrated AI (automated machine learning)

1. **Mechanical Integrity data** and **Process data** are entered through an interface and **analysed by AI**

2. **Complex correlations** and **anomalies** are recognized, **prognosis of effects on plant integrity**

3. **Early warning** to stakeholders, when critical limits are exceeded

Plug, Play and Analyze

- Block oriented Control- and simulation program

- Block library with 800 function blocks
  e.g. Characteristic curves, Calculation, Integration, PT1/2
  or Machine Learning modules

- No individual programming required

- Interface to the DCS
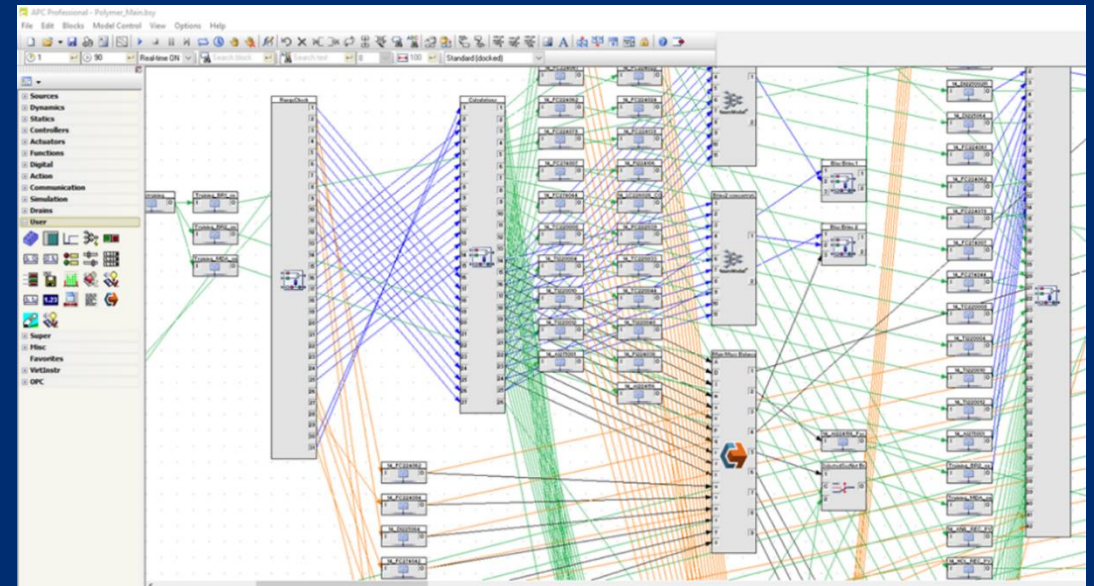
Example applications and benefits

- **Wall thickness** measurement on equipment and pipelines with corrosion hazard

- Wall thickness measurement **under insulations**, with multiple sensors,
  e.g. also withsensors printed on foils, avoiding to take off insulation periodically

- Continuous **vibration monitoring** of rotating equipment for early detection

- Detection of cracks or **growth of cracks**

- Detection and monitoring of **fouling and deposits** in pipes,
  enabling informed decisions on cleaning outages

- Leakage sensors enabling early **detection of leaks**

- APC Professional helps to understand correlations between process
  conditions and corrosion rates, and enables suitable countermeasures

Thanks for listening!

Contact:

Dr. Hans V. Schwarz
Hansvolkmar.Schwarz@tuvsud.com
+49 1520 921 5207

Dipl. Ing.Thomas Froese
T.Froese@atlan-tec.com
+49 2161 277 5253

Add value.
Inspire trust.