Leveraging the PI System® in the Processing of Opportunity Crudes

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Process Information Expert

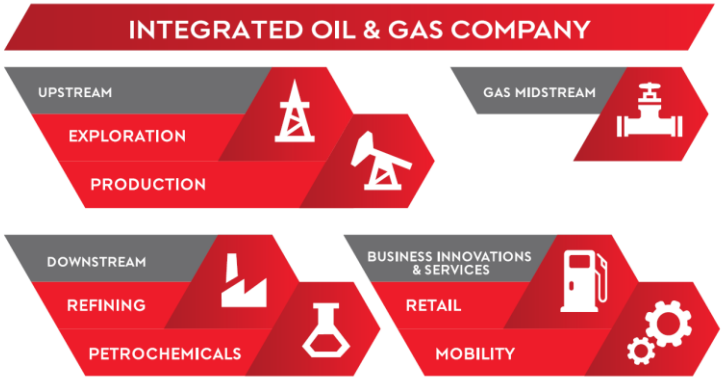
MOLGROUP

Agenda

- Introduction
- Business Opportunity & Challenge
- Solutions:
  - Keeping process in control
  - Early fault detection
- Analytics and Decision Support Strategy

MOL Group

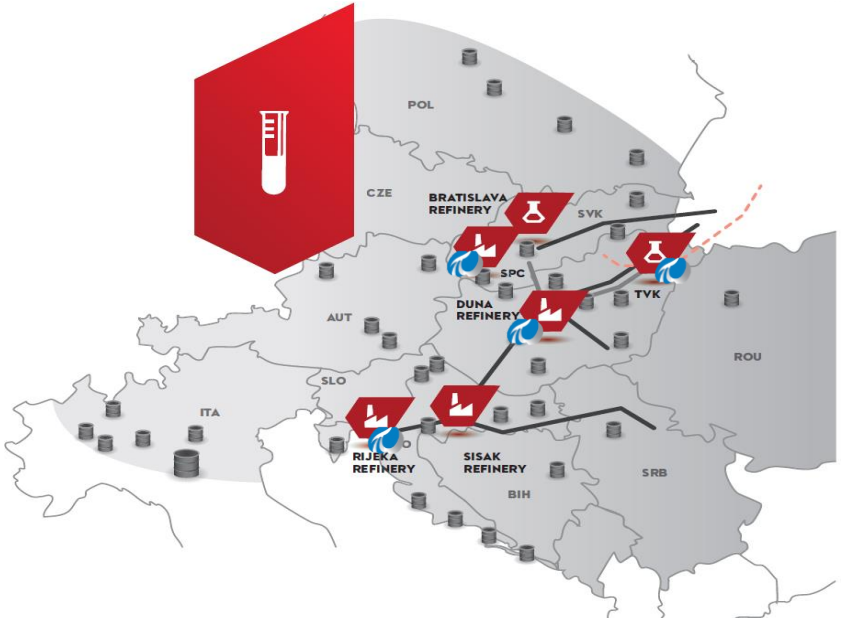
MOL is an integrated, independent, international oil and gas company, headquartered in Budapest, Hungary with a track record of over 100 years in the industry.



An Integrated Downstream Value Chain

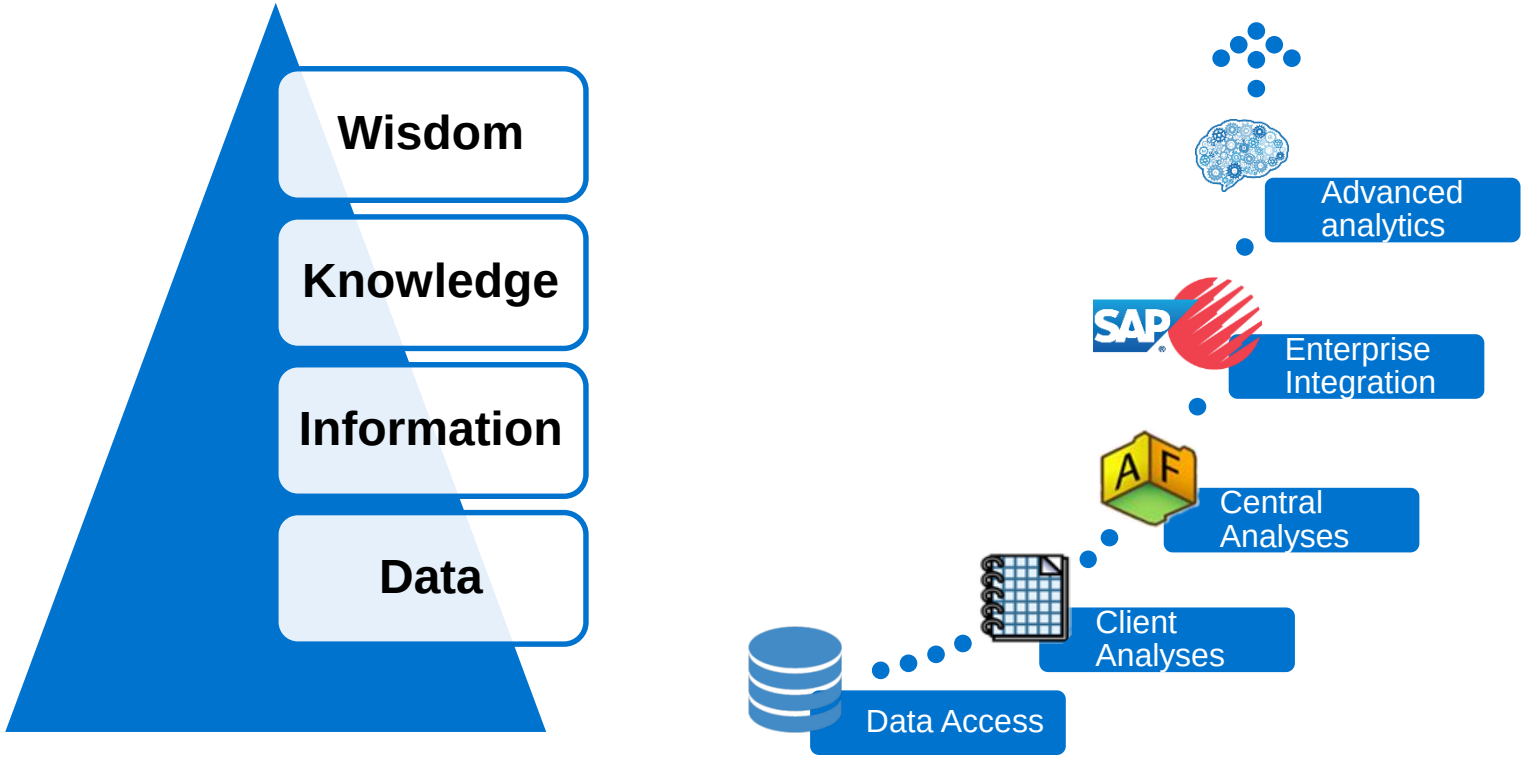
- **Integrated Fuels Value Chain:**
  - 4 refineries, 2 Petrochem plants
  - Logistics including 2 000 retail stations

- **PI System® Overview:**
  - 3 HA collectives, ~400K tags
  - Elements:
    - ~350 element templates
    - ~23K elements & growing
  - Events:
    - ~6K Notifications
    - ~10K Event Frames analyses
    - ~50K Event Frames in 2016

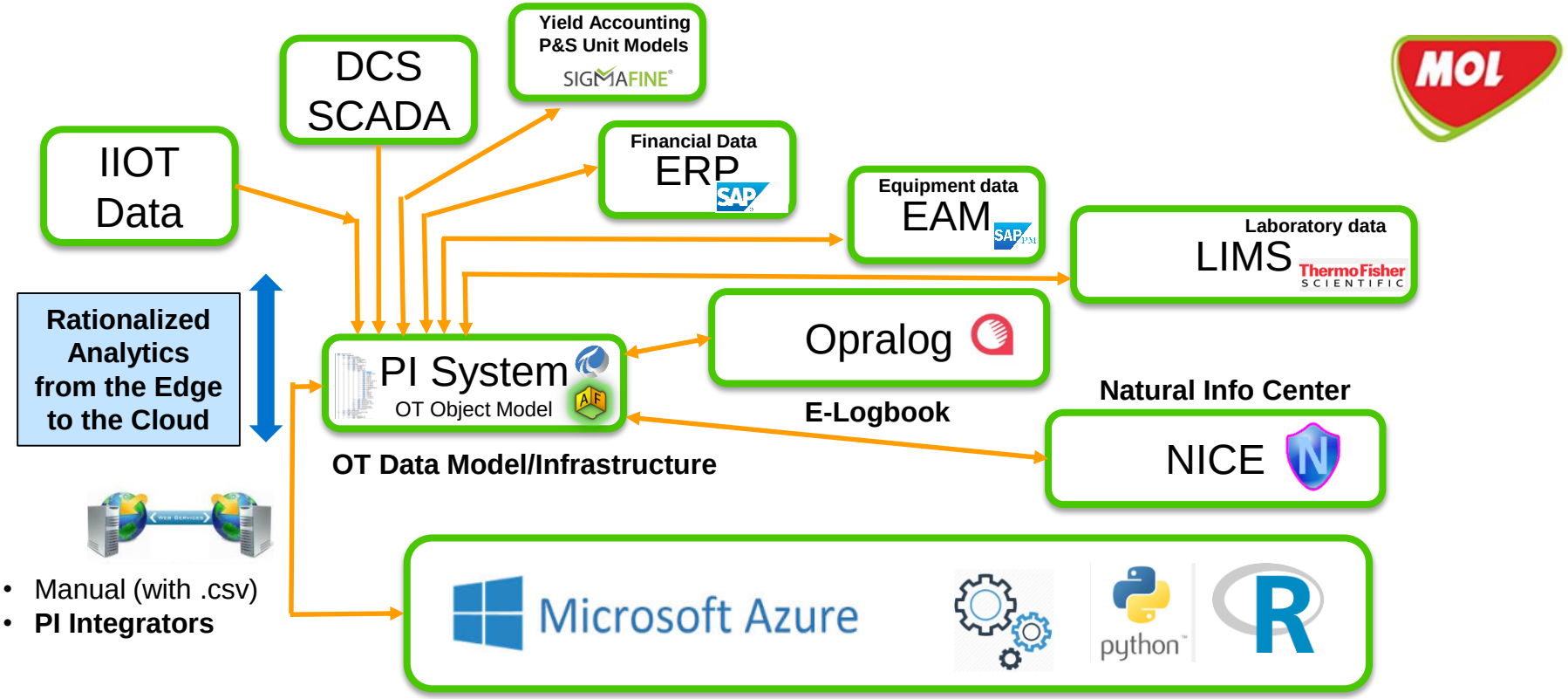


- **PI Coresight™ is the primary process visualization platform**

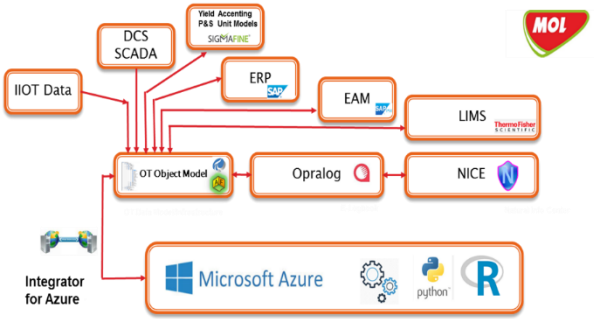
Digitalization Journay of MOL Group

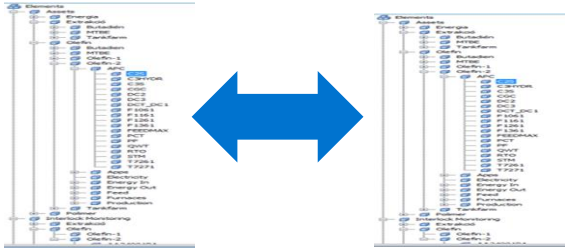


PI AF- the Foundation of MOL's Distributed Analytics



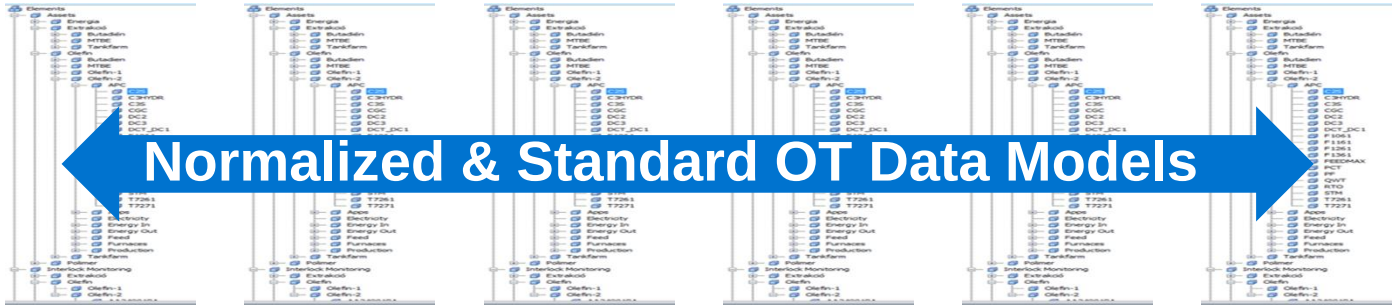
Integrated Smart Fuels Value Chain Vision





Value Chain

Logistics



Normalized & Standard OT Data Models

Danube Refineries — Bratislava, Rijeka, Sisak

Danube Petrochemicals — Slovnaft

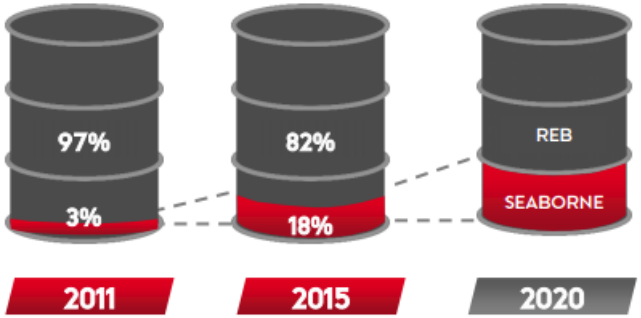
Background – Alternative supply sources

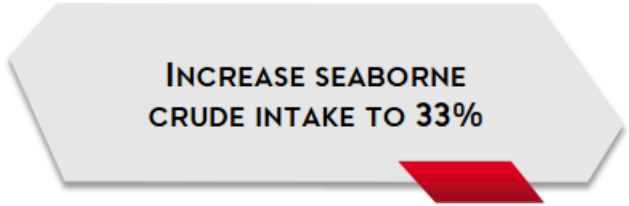
- **Opportunity crudes, Seaborne supply sources:**
  - Discounted price
  - Flexible supply

- **Strategic target:**
  - **Crude basket with 50 + grades**

Opportunities

- **Discounted price**
  - **$2 - $4 / BBl** depending on crude type
  - Can be negative in case of higher grade crude
- **Flexibility**
  - Quickly respond to market changes with crude selection
- **Estimated benefit: $1 - $3 / BBl**
- **10 % alternative crude processing ~ $10M - $11M+ /Year/Refinery**





Strategic goal:

Increase seaborne crude processing to 33% by 2030

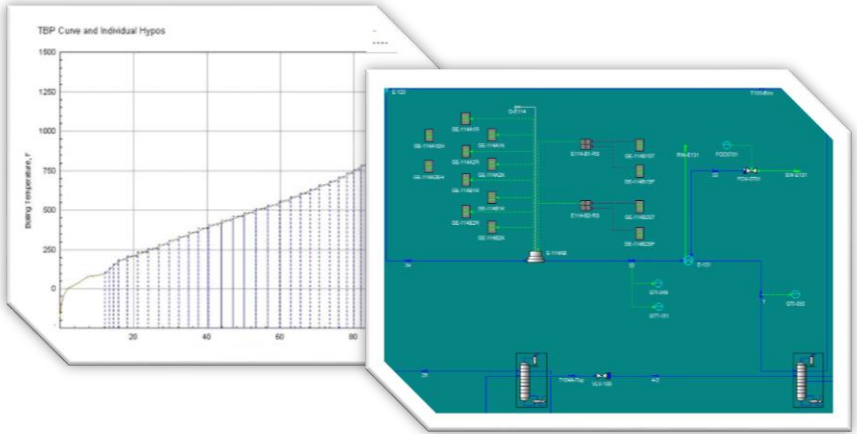
Challenge – Alternative supply sources

- **Refinery was designed for a given type of crude**
- **No crude mixing – fluctuation in process**
- **Operations challenges:**
  - Crude Desalter Performance
  - Corrosion
  - Fluctuation in process
  - Unpredictable issues
  - Equipment Performance & Reliability
  - Fouling

Solution – Crude analysis, Asset upgrade

- Crude Assays
- Process Simulations
- Refinery Modeling

- Crude Blender
- Improvements of desalters and other assets



Solution – Increase Real-Time Situational Awareness

Issues

- Fluctuation in crude quality
- Changes in quality of semi-finished products
- Disturbancies in process

- **Increased number of events to react**

Solution

- Faster, proactive and predictive decision support
- Advanced analytics
- Equipment performance/CBM
- Failure detection, notification

- **Support Operational Awareness**

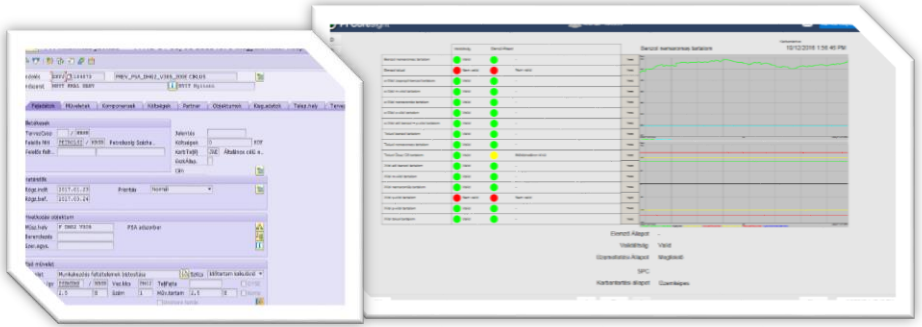
Examples – Keeping process in control

Operation - Avoid harmful process conditions

- Integrity operating window (IOWs)
- Corrosion control & monitoring
- Feed composition tracking

Maintenance - Early failure detection

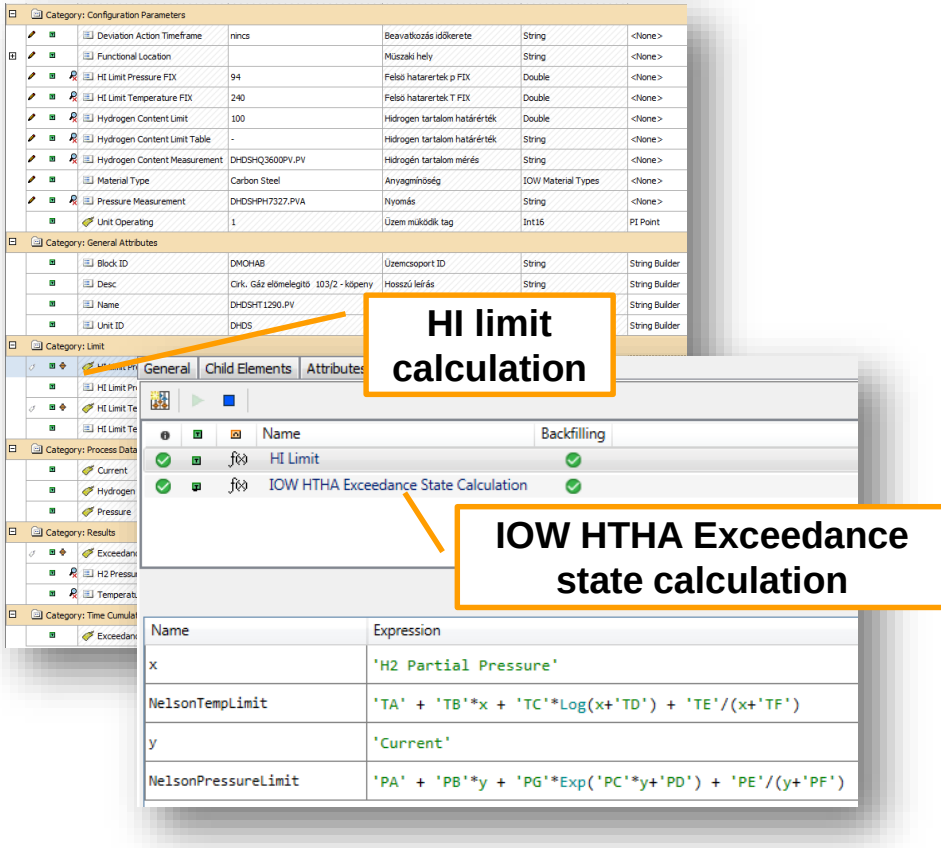
- Preventive & condition based maintenance
- Online statistical validation of controllers, sensors



Integrity Operating Window – Objective

- **Objective:** Keep process safety parameters in control

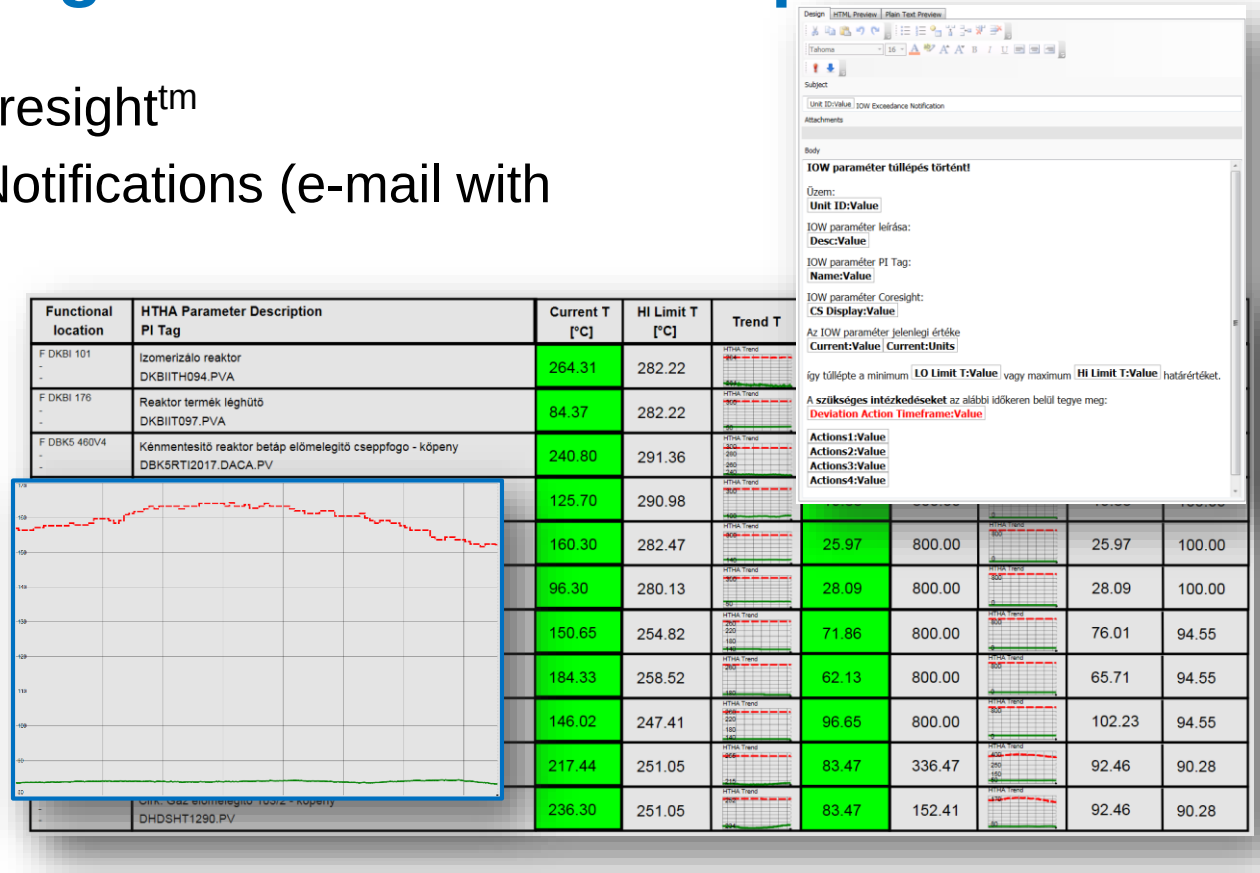
- **Solution:**
  - Structure in PI Asset Framework (PI AF)
  - Calculation, limit evaluation
  - Advanced PI Analytics and PI Event Frames



Integrity Operating Window – User Experience

- **Visualization:** PI Coresight[tm]
- **Work initiation:** PI Notifications (e-mail with suggested actions)

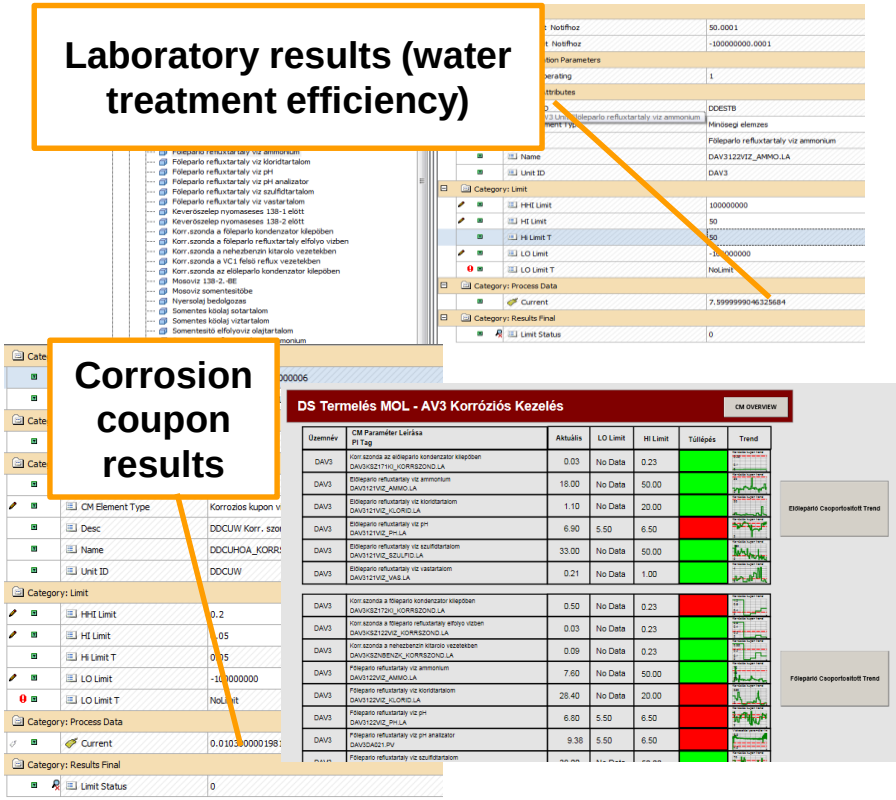
- **Results:**
  - Increased process safety
  - Faster reaction
  - Longer asset lifecycle



Functional location	HTHA Parameter Description PI Tag	Current T [°C]	HI Limit T [°C]	Trend T				
F DKBI 101 - -	Izomerizáló reaktor DKBIITH094.PVA	264.31	282.22					
F DKBI 176 -	Reaktor termék léghütő DKBIIT097.PVA	84.37	282.22					
F DBK5 460V4 - -	Kénmentesitő reaktor betáp elömelegitő cseppfogo - köpeny DBK5RTI2017.DACA.PV	240.80	291.36					
		125.70	290.98					
		160.30	282.47		25.97	800.00	25.97	100.00
		96.30	280.13		28.09	800.00	28.09	100.00
		150.65	254.82		71.86	800.00	76.01	94.55
		184.33	258.52		62.13	800.00	65.71	94.55
		146.02	247.41		96.65	800.00	102.23	94.55
		217.44	251.05		83.47	336.47	92.46	90.28
- -	DHDSHT1290.PV	236.30	251.05		83.47	152.41	92.46	90.28

Corrosion Control & Monitoring

- **Objective:** Support corrosion monitoring and water treatment
- **Solution:**
  - Comprehensive and logical structures in Asset Framework (AF)
  - Visualization in PI Coresight, alerts in Notifications
- **Results:**
  - Reduced corrosion → Cost savings



Corrosion Control & Monitoring–Chemical Treatment

Monitoring

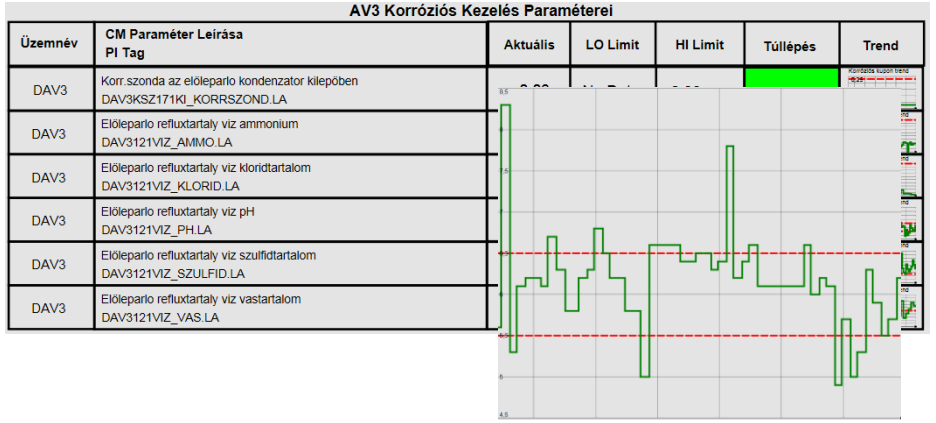
- Online Coresight Display
- Monthly Corrosion Report

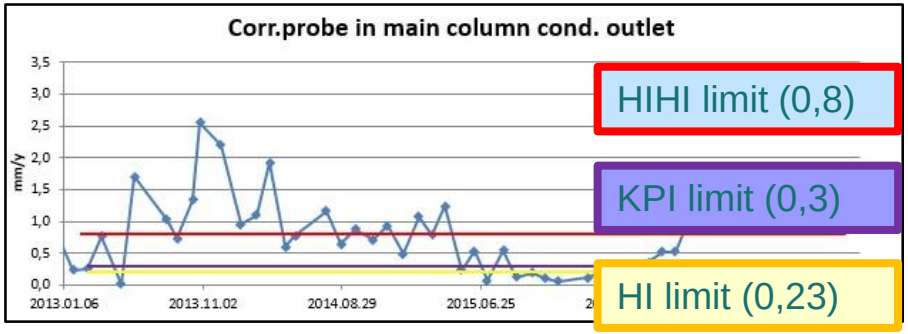
Actions

- Chemical Treatment program
  - Process Treatment
  - Water Treatment
  - Amine System Treatment
- Increased sampling frequency in case of alternative crude

AV3 Korróziós Kezelés Paraméterei

Üzemnév	CM Paraméter Leírása PI Tag	Aktuális	LO Limit	HI Limit	Túllépés	Trend
DAV3	Korr.szonda az elöleparlo kondenzator kilepöben DAV3KSZ171KI_KORRSZOND.LA					
DAV3	Elöleparlo refluxtartaly viz ammonium DAV3121VIZ_AMMO.LA					
DAV3	Elöleparlo refluxtartaly viz kloridtartalom DAV3121VIZ_KLORID.LA					
DAV3	Elöleparlo refluxtartaly viz pH DAV3121VIZ_PH.LA					
DAV3	Elöleparlo refluxtartaly viz szulfidtartalom DAV3121VIZ_SZULFID.LA					
DAV3	Elöleparlo refluxtartaly viz vastartalom DAV3121VIZ_VAS.LA					





Feed Composition Tracking – Background

- **Delayed Coker Unit (DCU)**:
  - Semi-continuous, thermal cracking process
  - Produces white components & coke

- **Wide variety of feedstock:**
  - Residuals from different crudes
  - Heaviest oil from other conversion processes, other refineries

- **Issue:**
  - Increased number of steam eruptions during coke cutting
  - Increased drum vibration during coking and cutting

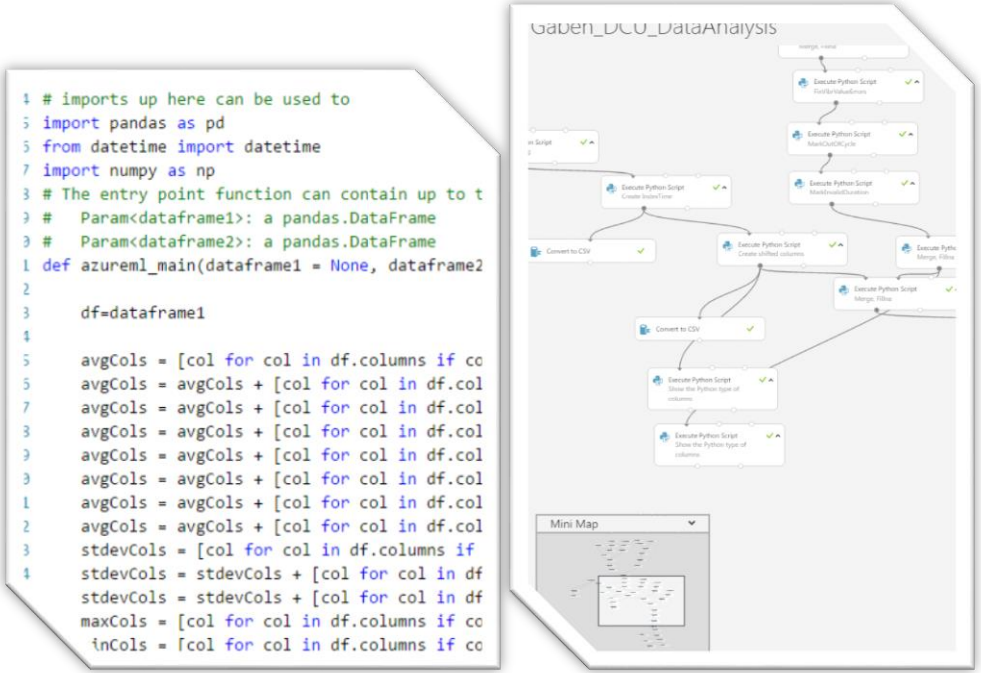
  - **Safety risk**

Feed Composition Tracking – Investigation

- **Datasources:**
  - Process data – Event Frames
  - Movement data – Oracle database
  - Laboratory data – Oracle database
  - Manual data – Excel files

Complex data preparation and cleaning was needed

Azure Machine Learning with Python scripts




```
# imports up here can be used to
import pandas as pd
from datetime import datetime
import numpy as np
# The entry point function can contain up to t
#   Param<dataframe1>: a pandas.DataFrame
#   Param<dataframe2>: a pandas.DataFrame
def azureml_main(dataframe1 = None, dataframe2

    df=dataframe1

    avgCols = [col for col in df.columns if co
    avgCols = avgCols + [col for col in df.col
    avgCols = avgCols + [col for col in df.col
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    avgCols = avgCols + [col for col in df.col
    avgCols = avgCols + [col for col in df.col
    stdevCols = [col for col in df.columns if
    stdevCols = stdevCols + [col for col in df
    stdevCols = stdevCols + [col for col in df
    maxCols = [col for col in df.columns if co
    inCols = [col for col in df.columns if co
```
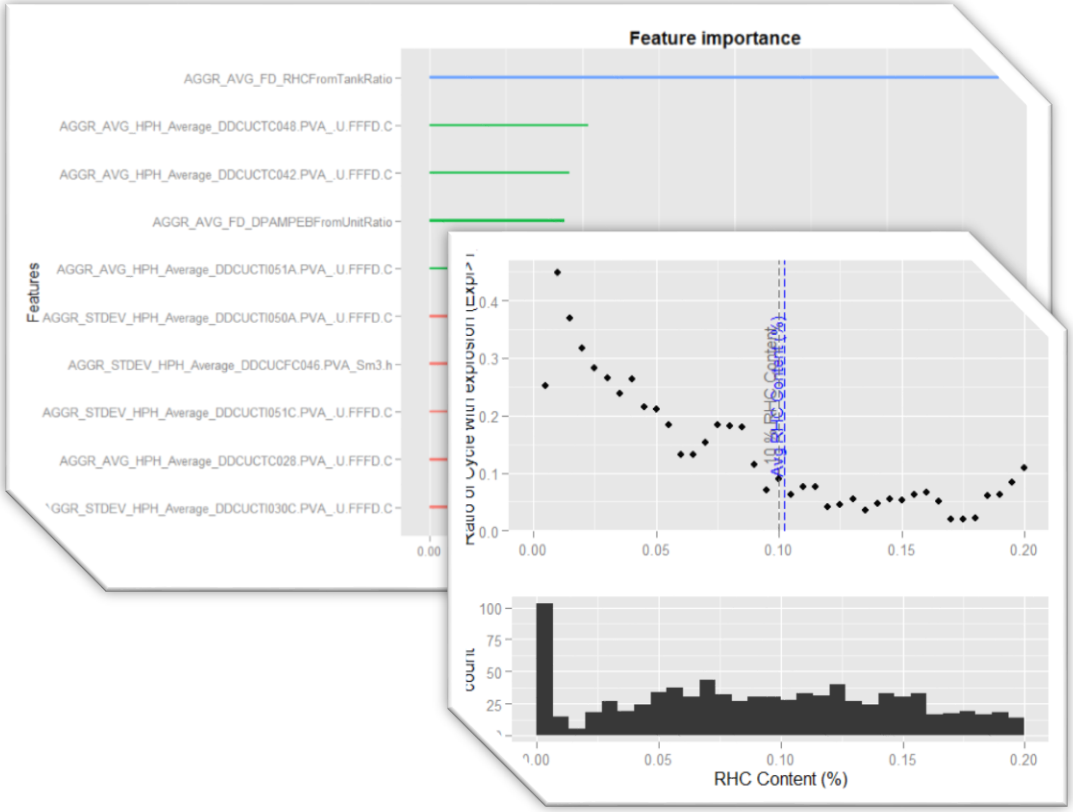

Feed Composition Tracking – Investigation

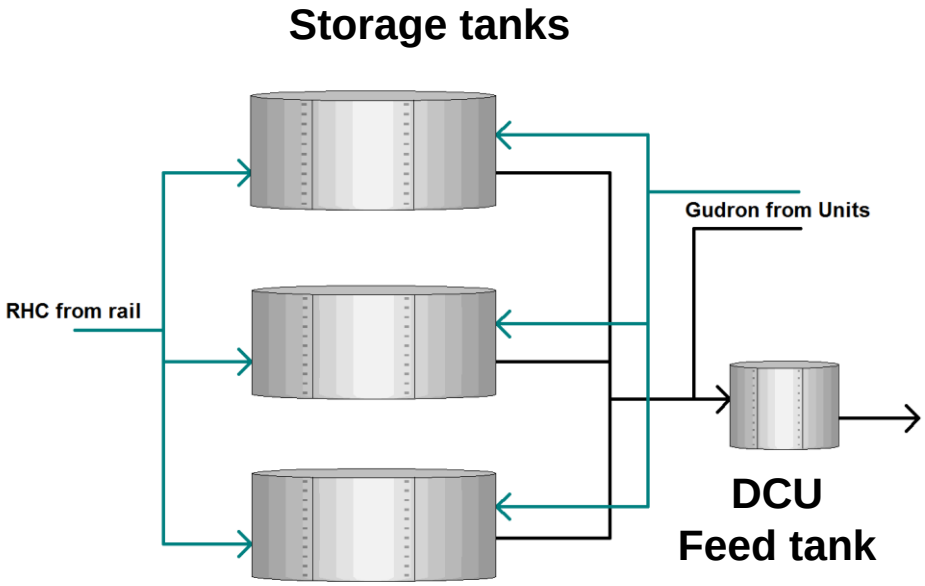
- Model building, analysis in Rstudio:
  - Gradient boosting model
  - Feature importance and visual analysis
- Most important factor:
  - RHC content of feed (RHC: heaviest product of Residual Hydrocracker)
  - It has to be kept above 10 %
  - Difficult to calculate online



Feed Composition Tracking – Online Calculation

- **RHC content of storage tank:**
  - Data: movement information in a Oracle database
  - Frequency: daily

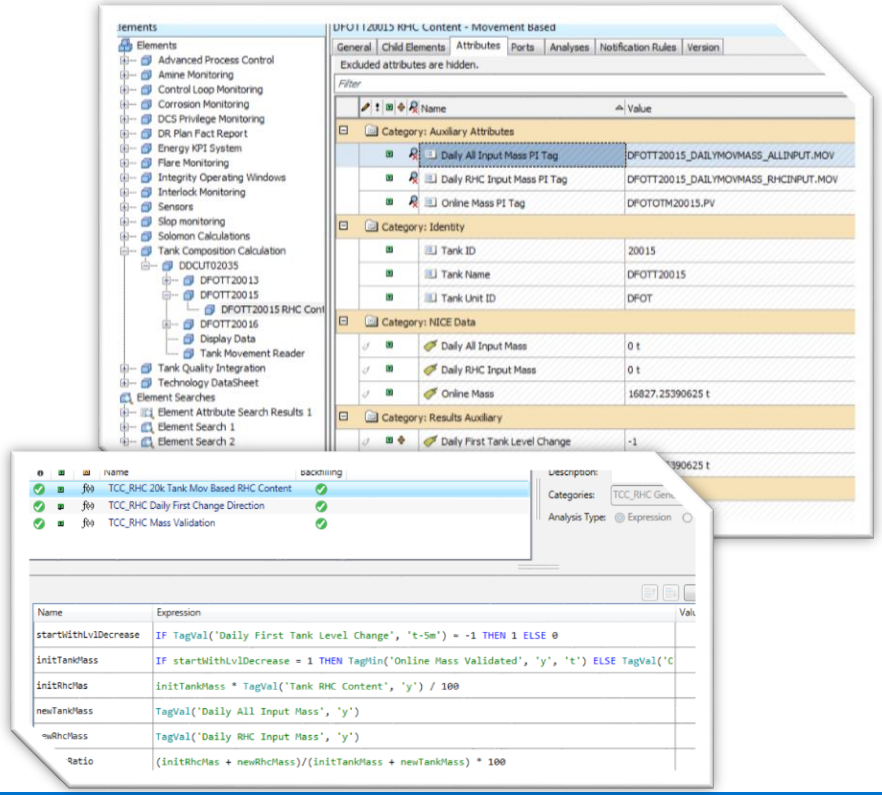
- **RHC content of feed tank:**
  - Data:
    - Valve positions
    - Tank volume change
    - Storage tank RHC Content
  - Frequency: online



Feed Composition Tracking – Online Calculation

- **First step: Storage tanks:**
  - Base data: material movement into storage tanks
  - Data import with PI RDBMS Interface
  - Daily calculation
  - Calculate the RHC content of storage tanks with a simple mixture calculation

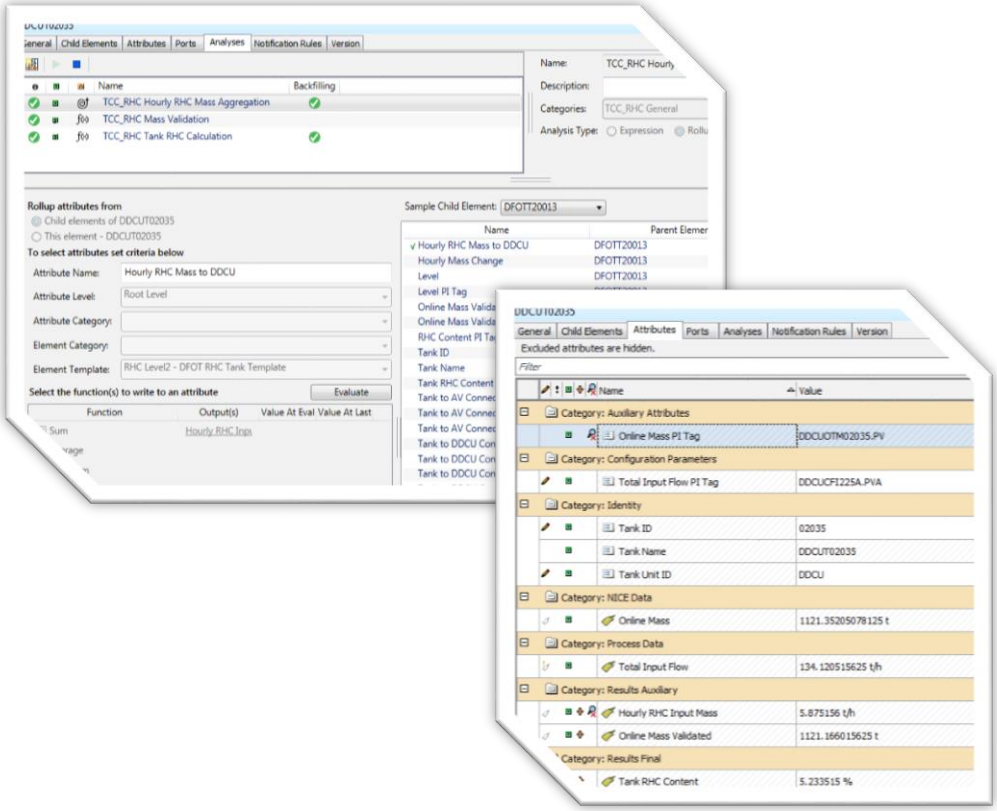
- **Result**: RHC content of storage tanks (daily resolution)



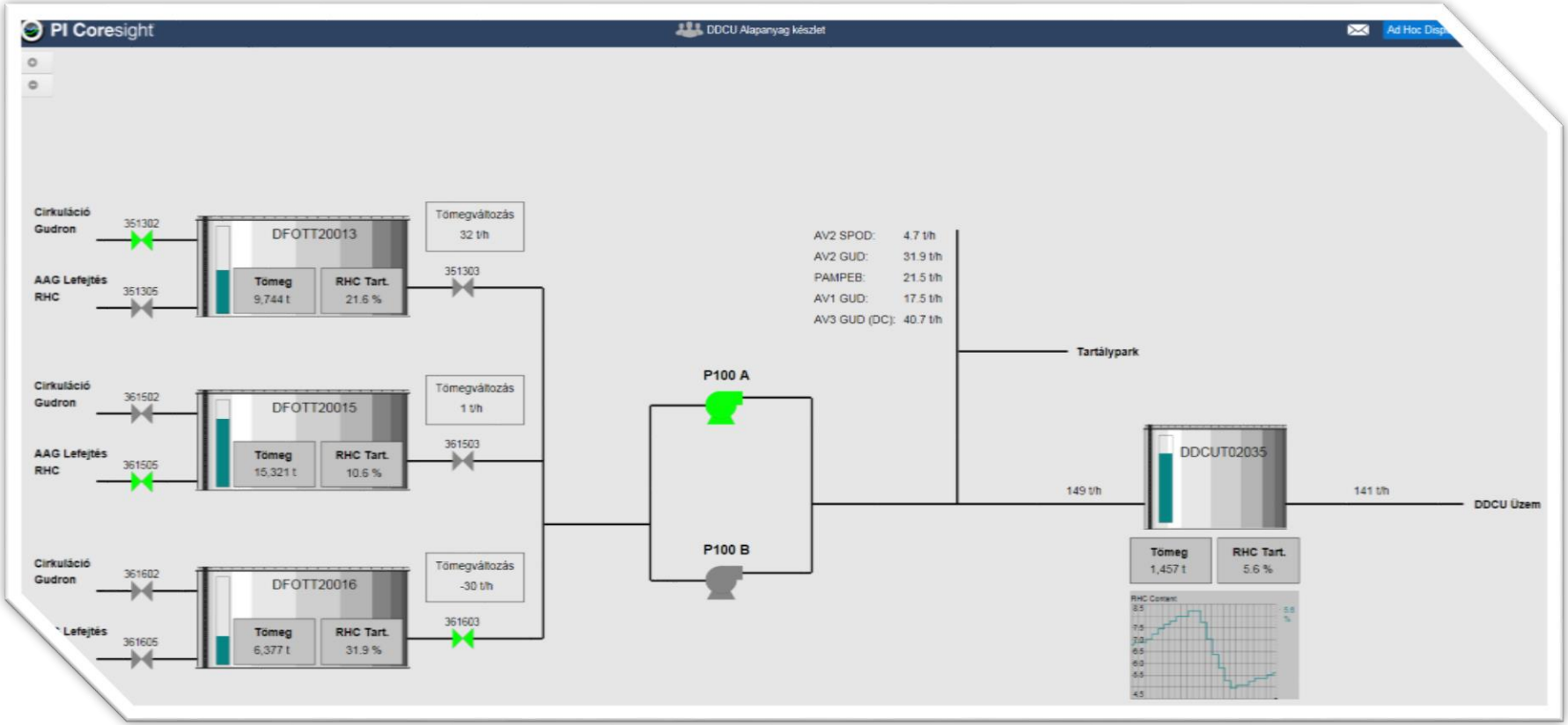
Feed Composition Tracking – Online Calculation

- **Second step:** Feed tanks:
  - Base data: RHC content of storage tank, valve positions, online tank mass
  - Online data from DCS system
  - Hourly mixture calculation

- **Result**: RHC content of feed tank (hourly resolution)



Feed Composition Tracking – User Interface



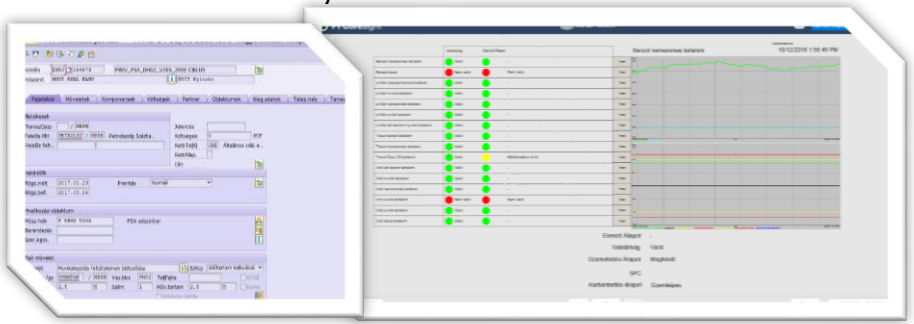
Examples – Keeping process in control

Operation - Avoid harmful process conditions

- Integrity operating window
- Corrosion control & monitoring
- Feed composition tracking

Maintenance - Early failure detection

- Preventive and condition based maintenance
- Online statistical validation of controllers, sensors



Preventive and Condition Based Maintenance

- **Objective**: a robust OT/IT system to support preventive maintenance strategies

- **Criteria:**
  - **Flexibility and scalability** (further strategies expected)
  - **Integrated solution** (utilization of existing softwares)

- **Tools**:
  - PI System® → Main process database + Real time analysis
  - SAP PM → Equipment database + Maintenance management tool

- **Solution**: Connection between systems

Preventive and Condition Based Maintenance

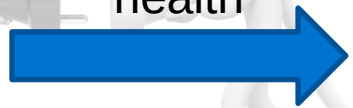
PI System®

- Process database
- Online analysis of process information
- **Calculation of asset health**
  - Asset condition
  - Running hours
  - Performance
  - Risk
- User Interface
  - PI Coresight™
  - PI DataLink™

Connection

(WebLogic)

Calculated asset health



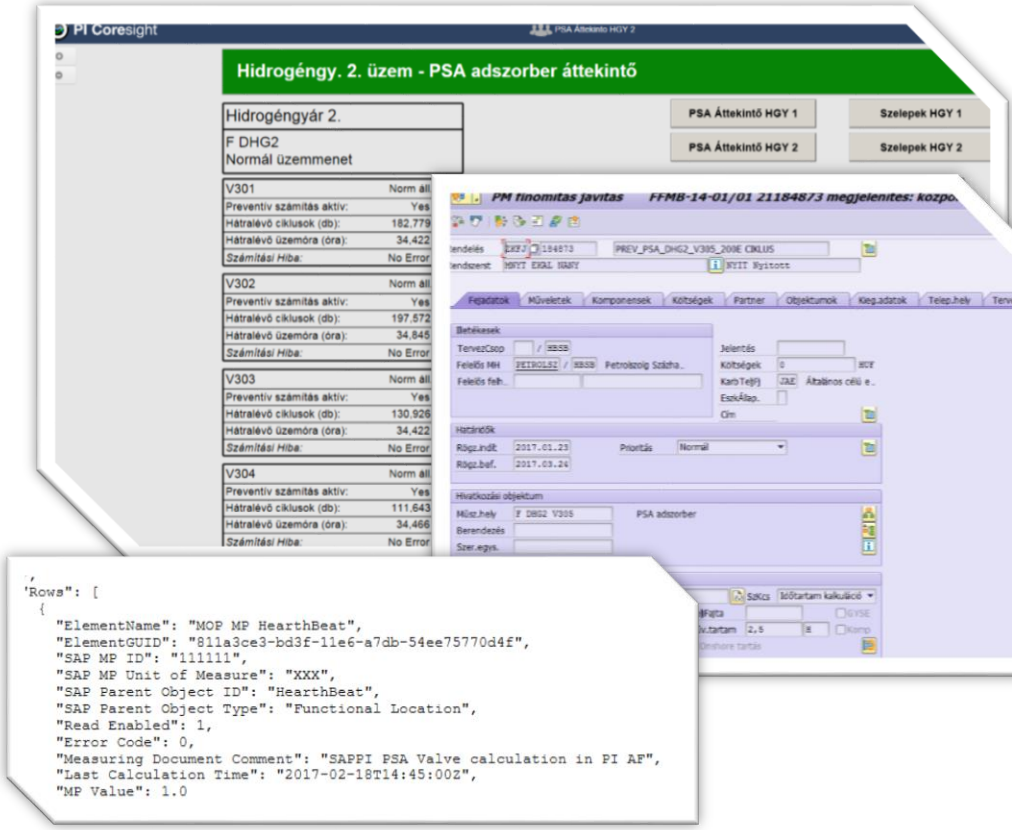
Maintenance related information

SAP PM

- Maintenance database
- Management of maintenance processes
- Creation of work orders or notifications
- Trigger maintenance strategies based on asset health

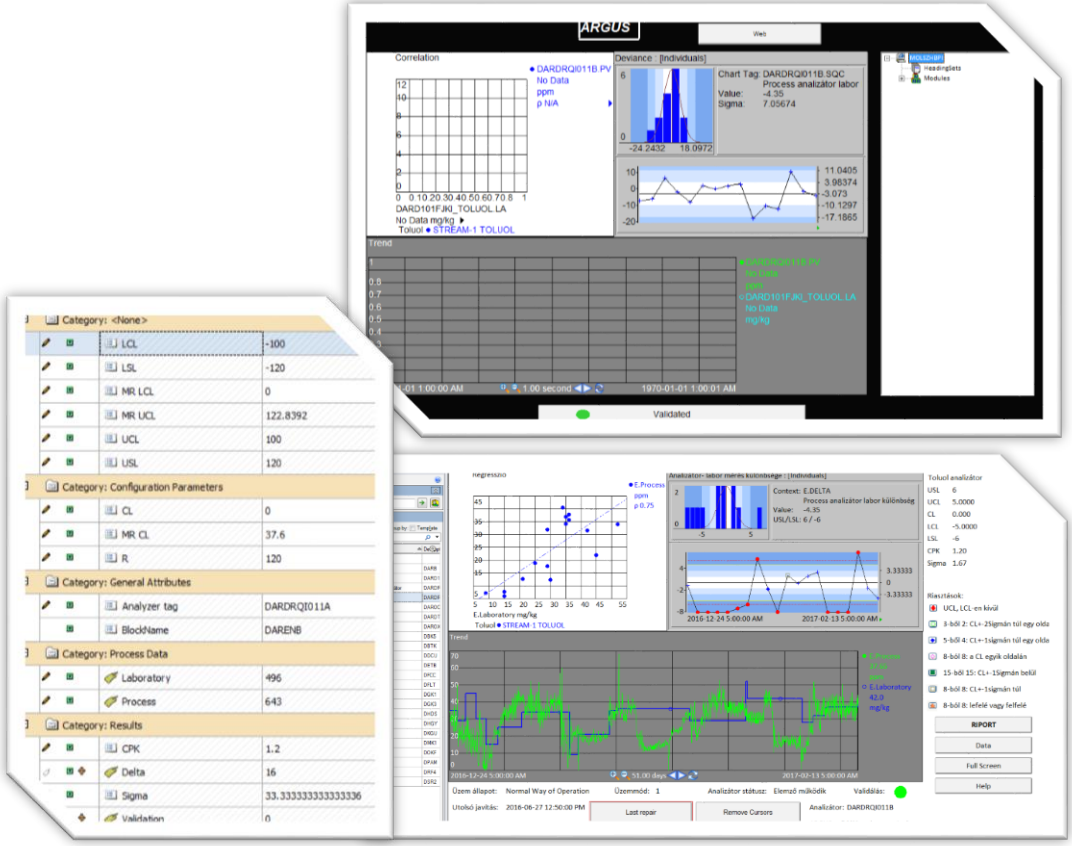
Preventive and Condition Based Maintenance

- **Flexible calculations in PI Asset Framework (PI AF)**
- **Interface with PI Web API**
- **Work Order creation in SAP PM**
- **Estimated benefit**: **$230,000/year**
- **First working solution:**
  - Preventive maintenance of pressure swing adsorber valves in Hydrogen Production Plants



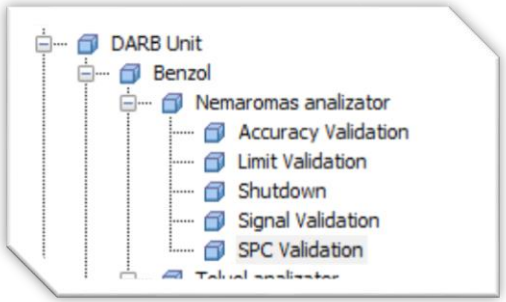
Analyser Validation – ARGUS 3.0

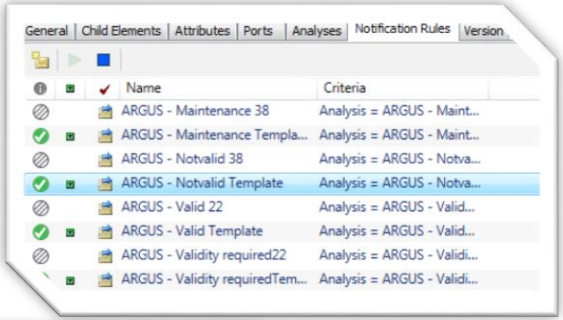
- **ARGUS 1.0:**
  - Analyser validation with statistical methode in PI ProcessBook + VBA
- **ARGUS 2.0**
- **Centralized calculation with PI Asset Framework (PI AF)**
- **Missing components**
  - Further signal evaluation
  - Workflow management

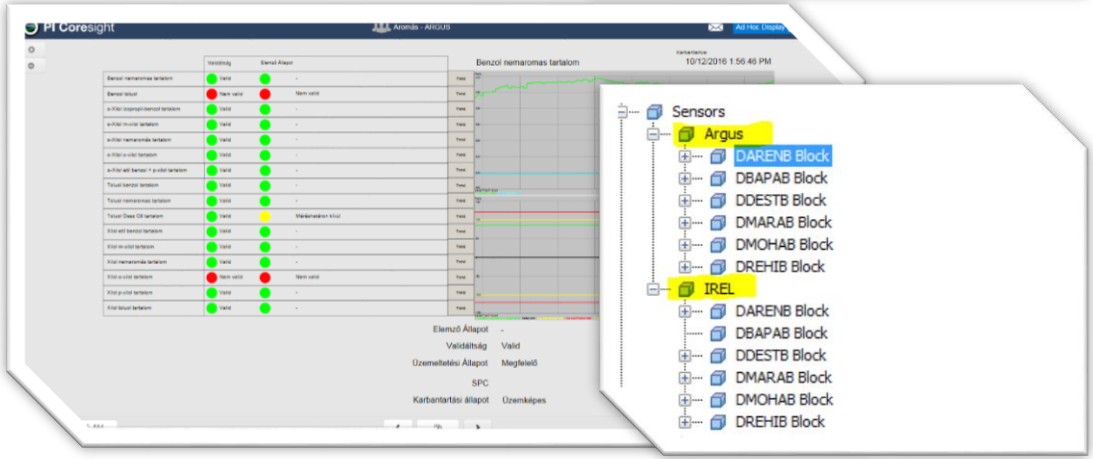


Analyser Validation – ARGUS 3.0

- **New functionalities:**
  - Different validation methodes
  - Wofklow management
    - Failure detection
    - Maintenance request
    - Validation request
    - Validation
- **Common solution for analysers and soft-sensors**
- **PI Coresight[tm] based UI**







Analytics & Decision Support Strategy–Distributed Analytics

- **Analytics with different scope, scale and target:**
  - Online calculations
  - Machine learning
  - Maintenance scheduling
  - Etc ...

- **Refinery is more than the sum of independent business and technological processes**

„The whole is greater than the sum of its parts."
Aristotle

- **Decision supporting tools have to be organized in an integrated system:**
  - **Analytics are distributed across components**
  - Data and information flow through each element

Machine Learning

⇕

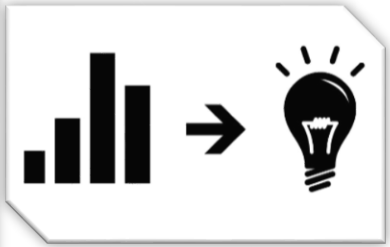
Operational Intelligence

⇕

Business Process

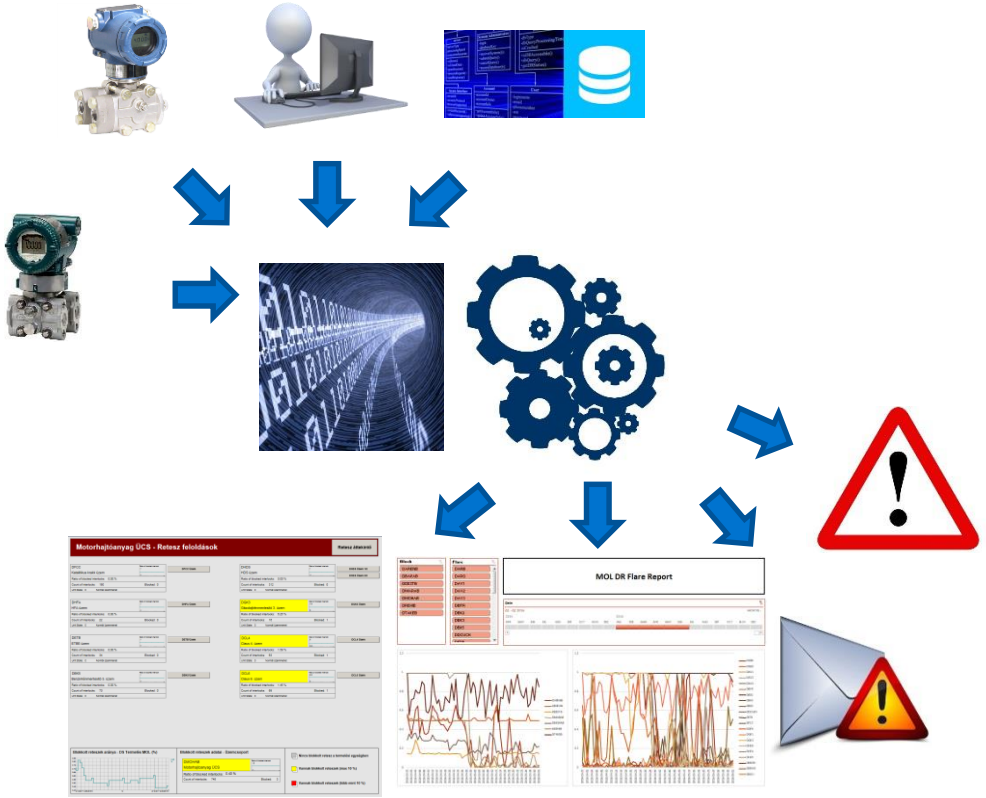
Offline Analysis

- **Visual Analysis or Machine Learning:**
  - Model building
  - Investigation
- **Data sources:**
  - Process database: PI System
  - Relational Databases
  - There are always extra Excel files
- **Tools:** PI Coresight[tm], RStudio, Azure ML
- **Result:**
  - Insight, Knowledge
  - Model



Into Operation

- **Goal:** put knowledge into operation
  - Results from an investigation
  - Model to run continuously
- **Platform:**
  - Asset Framework (AF), the foundation
- **Connection**
  - Maintenance: SAP PM
  - Operation: Shift Logbook + DCS
- **Visuals**
  - PI Coresight[tm] dashboards
  - PI DataLink[tm] reports

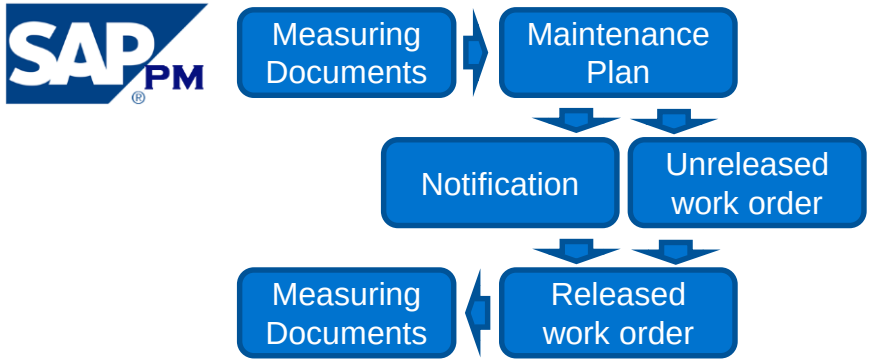


Business Process

- **Online issue and disturbance identification**

  Action

- **Solution**



- **Actions:**
  - Workflow management
  - Feedback collection
  - Support collaboration

opralog

Event based entries to inform operation or collect feedback

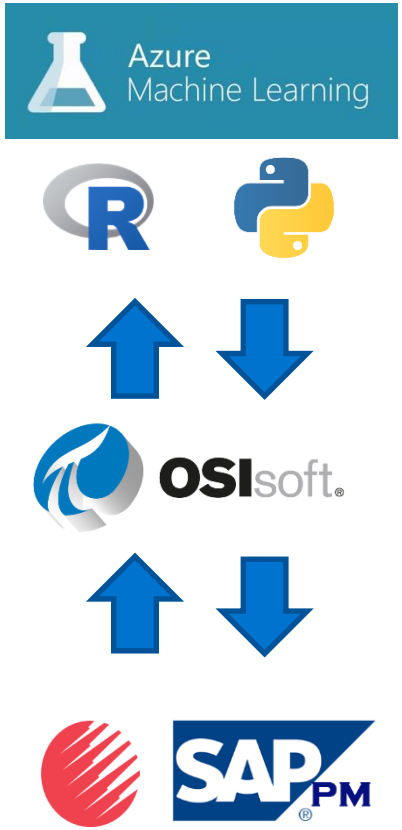
- **Tools:**
  - SAP PM, Shift Logbook
  - PI Coresight^{tm}, PI Notifications

Targeted notifications with suggested actions

Current State - Next Steps

- **Existing architecture:**
  - Offline analysis (RStudio or Azure Machine Learning)
  - Real-time analysis (AF and Asset Analytics)
  - Visualization with PI Clients and trigger in other systems
    - PI Coresight™, PI DataLink™
    - Opralog, SAP PM, DCS

- **Possible developments:**
  - Integrated Advanced Analytics and Operational Intelligence
    - Data transfer from PI System® to analytical tools
    - Machine Learning model implementation with direct output to PI System®



Addressing Operational & Reliability Issue from the Processing of Opportunity Crude

COMPANY and GOAL

In its 2030 strategy, MOL Group is aiming **increased flexibility** and **quicker response** to market changes with a **crude basket of 50+ grades** to improve EBITDA.

MOLGROUP
THE ENERGY OF POSITIVE CHANGE

CHALLENGE

Alternative crude processing brings benefits, but also risks and disturbances in process.

- Benefit with increased flexibility and discounted price
- Changing feed quality can cause disturbances in the process, new corrosion mechanisms, & asset performance/reliability issues

SOLUTION

Operational Intelligence, online analytical solutions, & advanced analytics to support faster decisions.

- PI System® supported workflow initiation and management
- Real time decision support tools
- Integrated system: investigation – online analysis - reaction

RESULTS

Ability to react faster, prevent or eliminate disturbances and keep the process stable with changing feed quality.

- Stable operation with changing crude quality
- Longer asset lifecycle
- **Strategic goal: 33 % seaborne crude by 2030**

Contact Information

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Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

Please remember to…

Complete the Online Survey for this session

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감사합니다

谢谢

Danke

Gracias

Merci

Thank You

Köszönöm

ありがとう

Спасибо

Obrigado

“In God we trust; all others bring data.”

W. E. Deming