

INNOVATIVE SECURE SENSOR NETWORKS AND MODEL-BASED ASSESSMENT TOOLS FOR INCREASED RESILIENCE OF WATER INFRASTRUCTURES



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Enhanced Self-learning Monitoring and Alarm Detection

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French-German project funded by ANR/BMBF

Critical Infrastructure Protection Call

PICS 2014 – Final meeting

Dresden, the 26th June 2018



Enhanced self-learning monitoring

- **Current state**

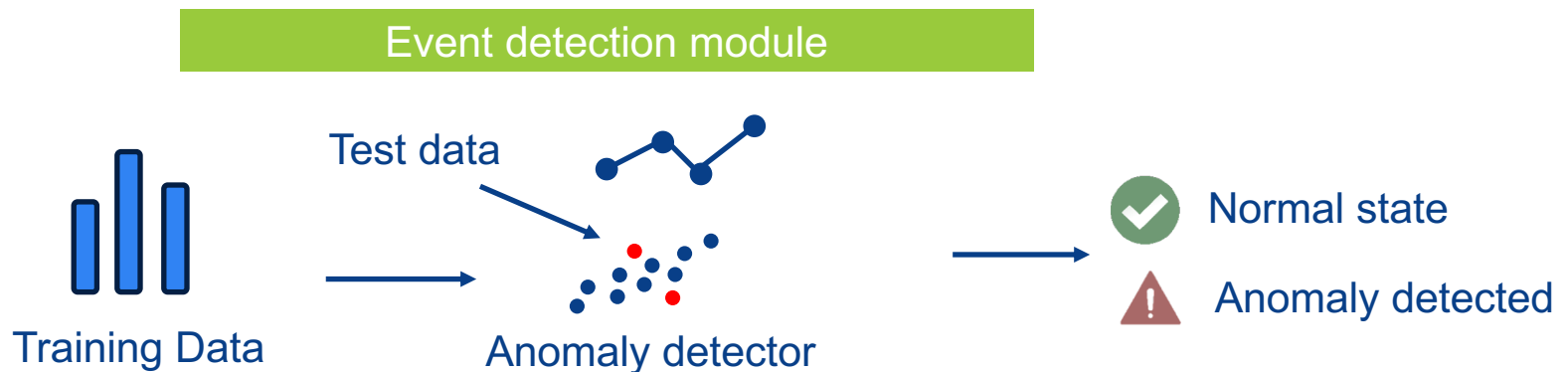
Large amount of quality/hydraulic sensors placed in WDNs

- **Problem**

Lots of parameters need to be set by operators

- **Solution**

Use a data-driven approach to „learn“ the normal state of the sensors and check for anomalies



Enhanced self-learning monitoring

- **Current state**

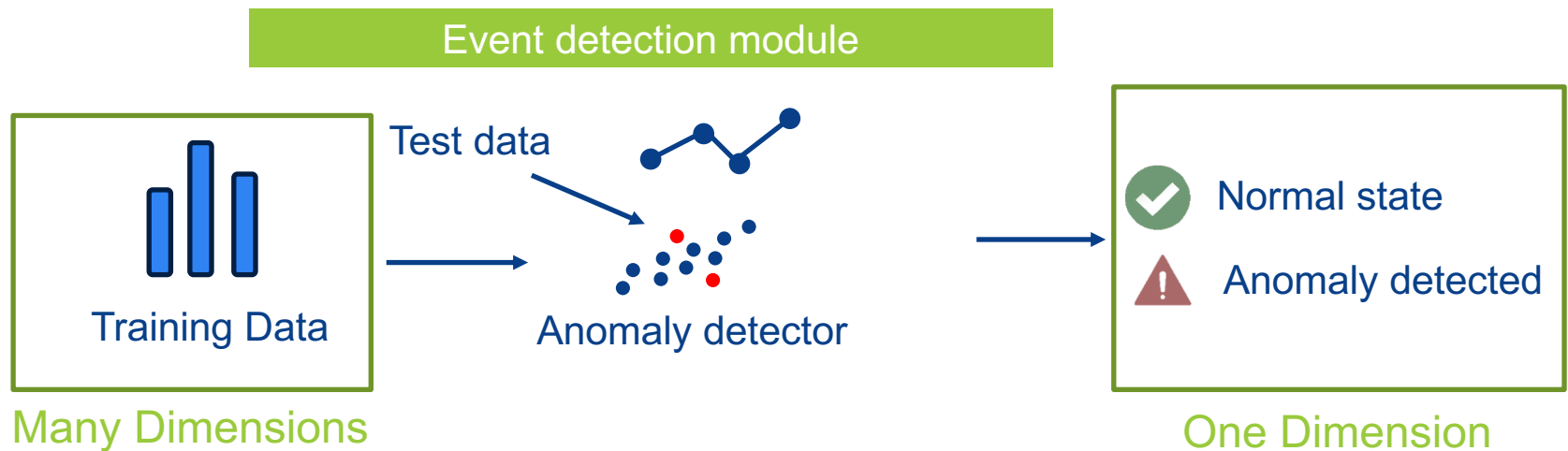
Large amount of quality/hydraulic sensors placed in WDNs

- **Problem**

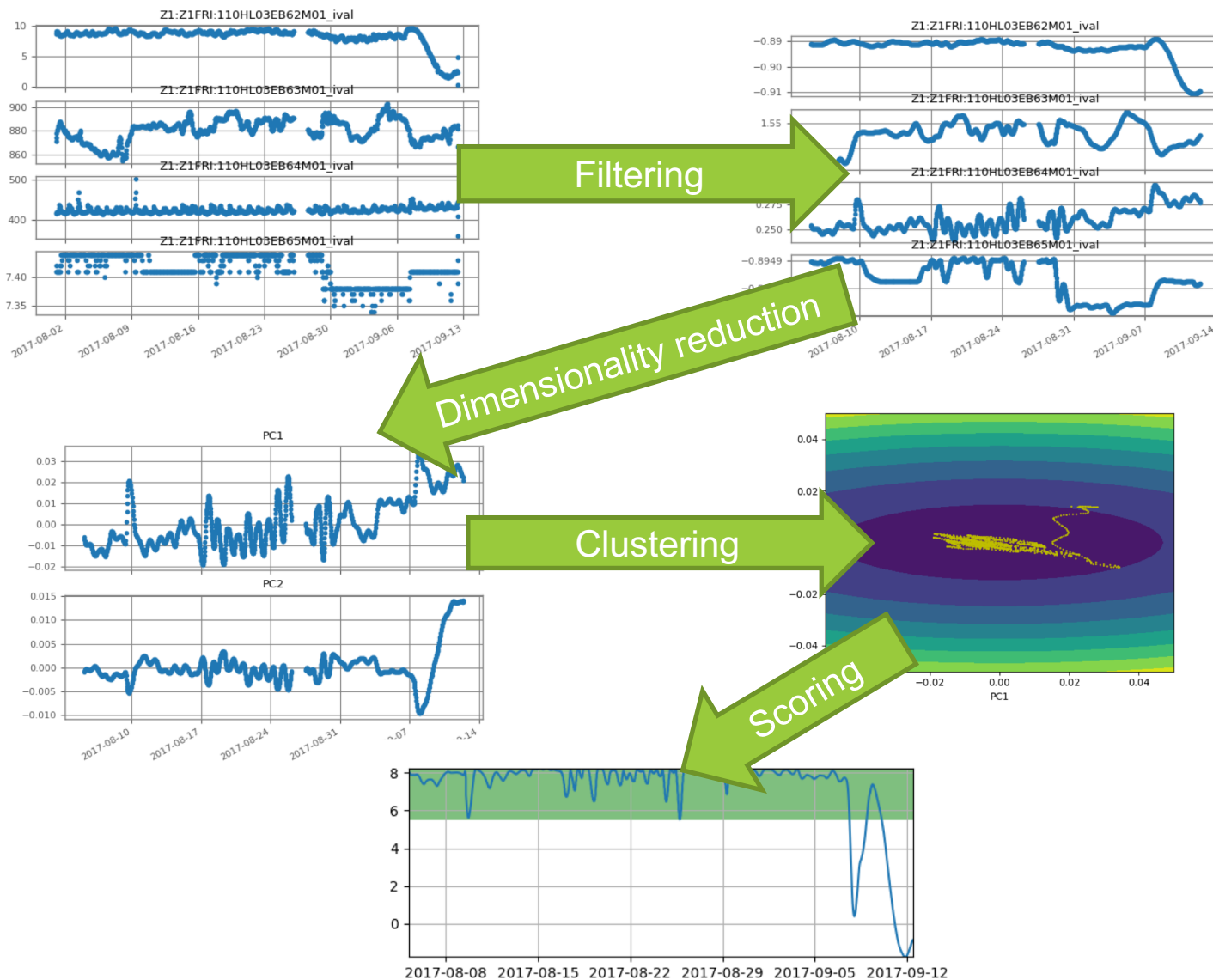
Lots of parameters need to be supervised by operators

- **Solution**

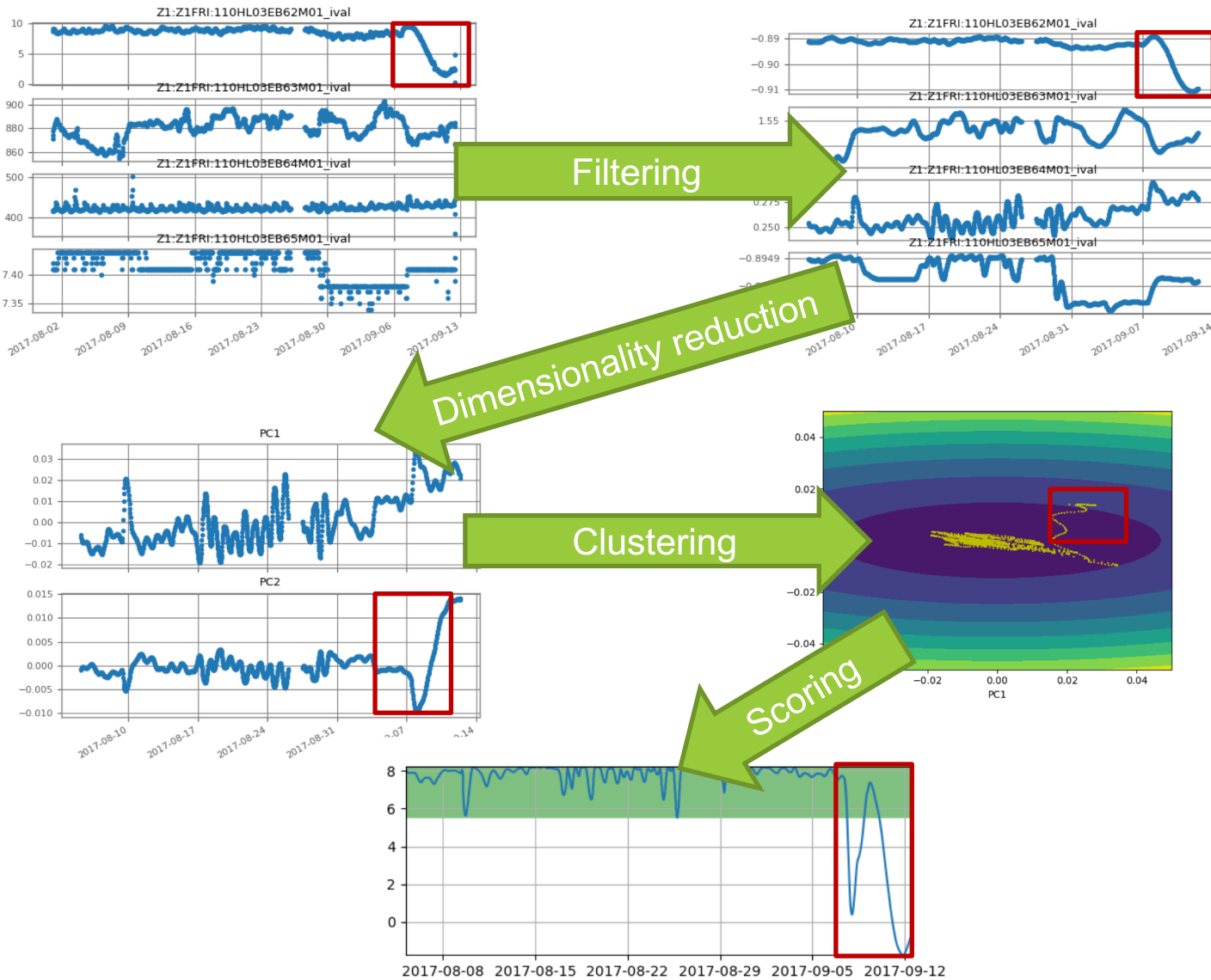
Use a data-driven approach to „learn“ the normal state of the sensors
Check for anomalies



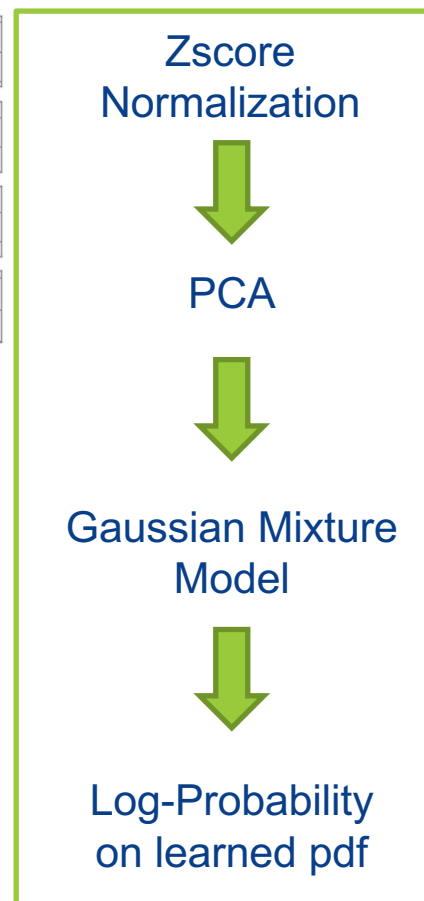
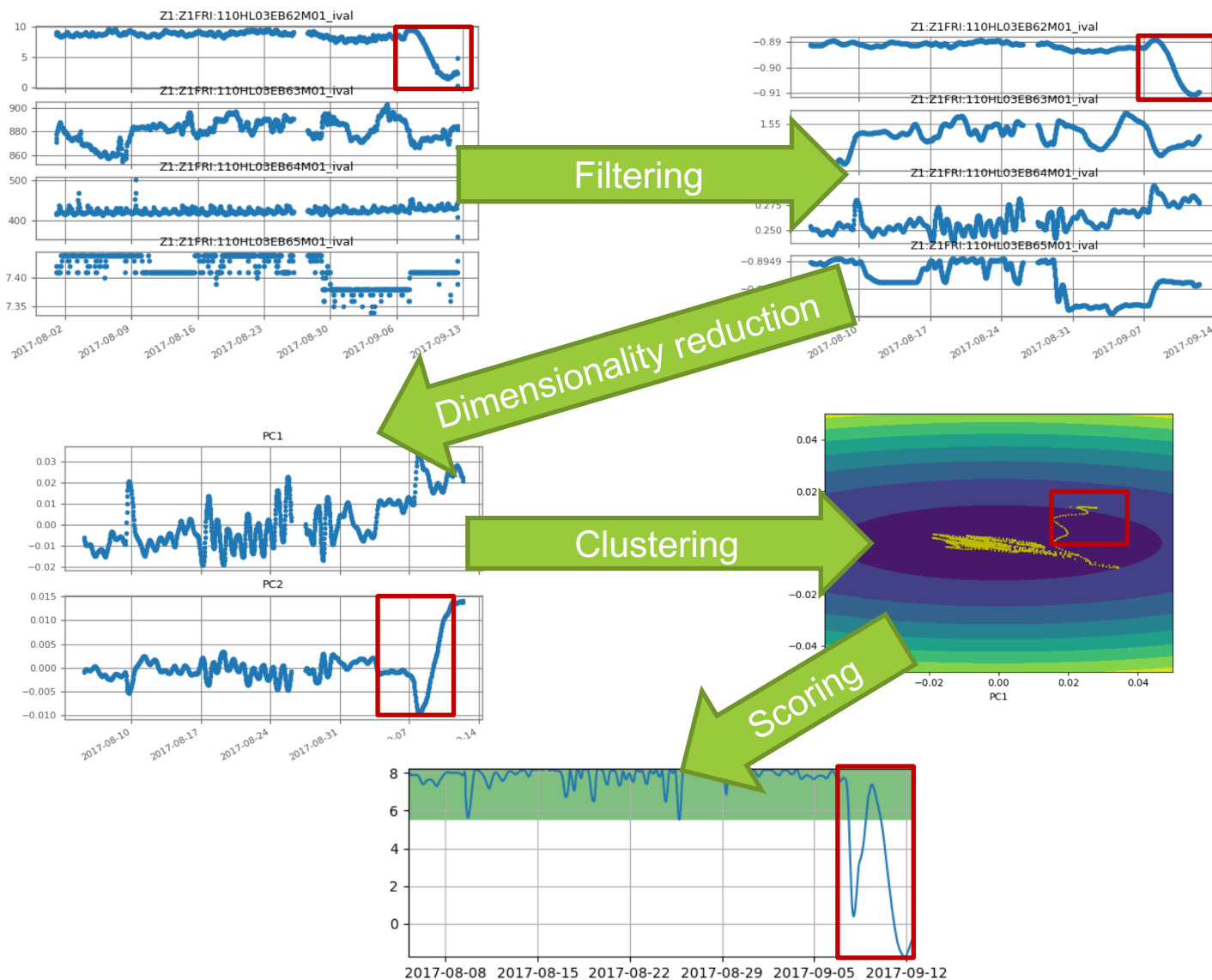
Enhanced self-learning monitoring



Enhanced self-learning monitoring



Enhanced self-learning monitoring



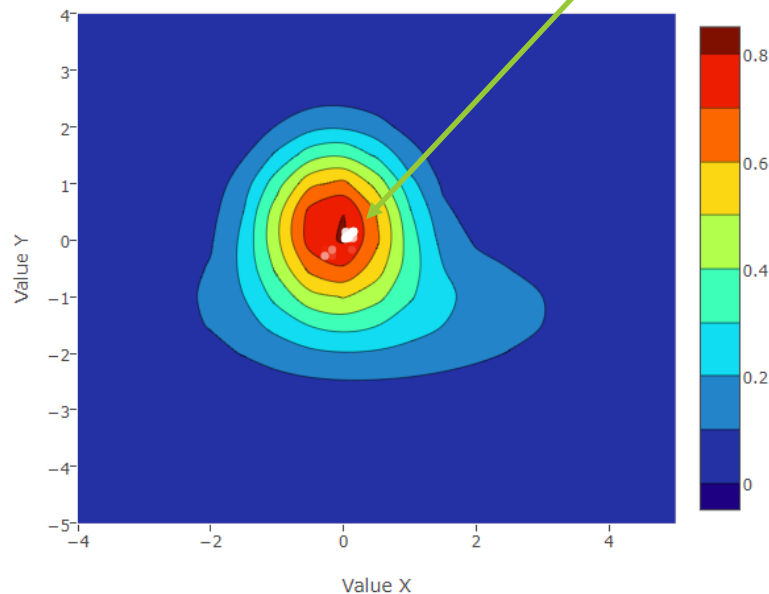
Enhanced self-learning monitoring

STATE TRAJECTORY

Normal state

Tegel180

State trajectory



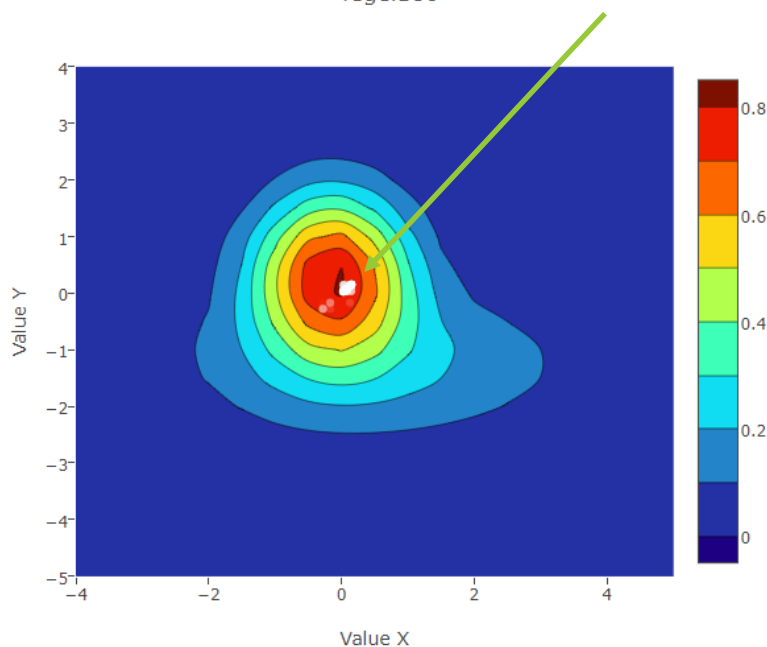
- Generation of a two dimensional map of the measurement station
- Dimension x and y are the first two principal components
- Iso-bar represents the detected cluster(s) from the Gaussian mixture model
- New measurements are transferred into the map

Enhanced self-learning monitoring

STATE TRAJECTORY

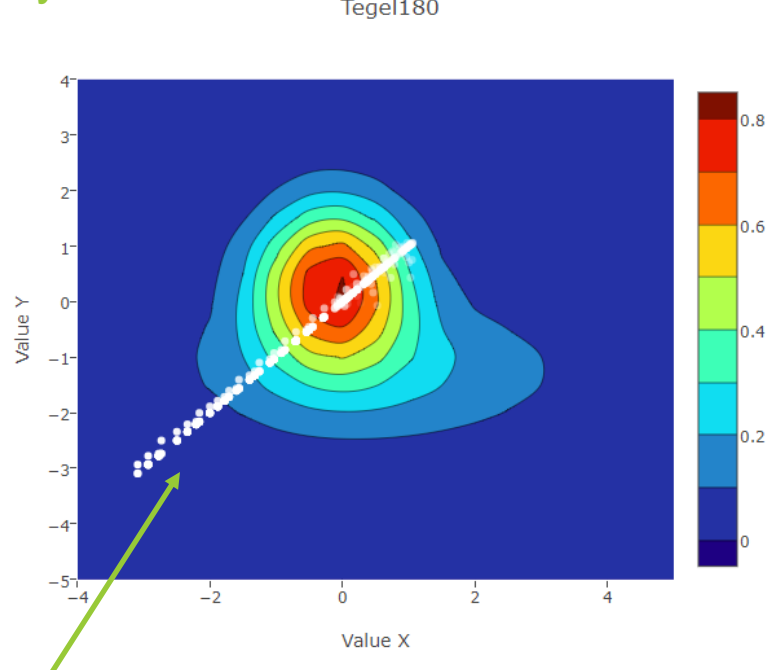
Normal state

Tegel180



Detected event

Tegel180

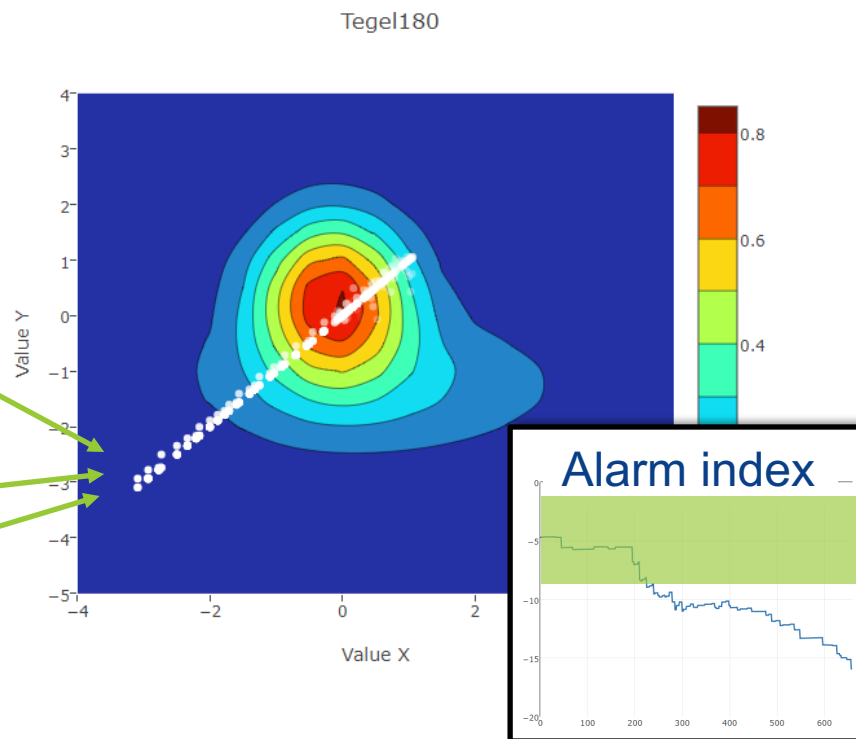
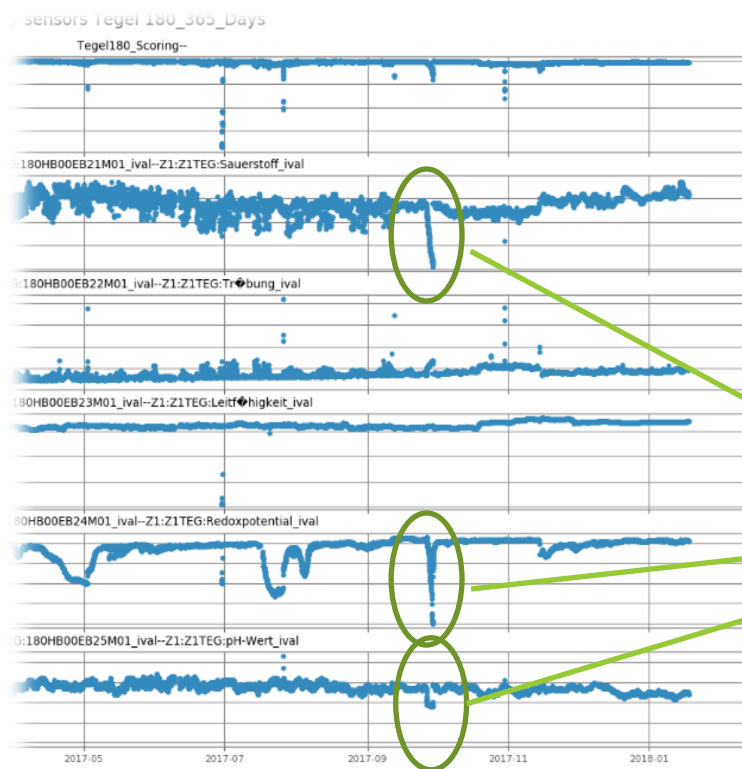


State trajectory moves out of cluster center

Enhanced self-learning monitoring

STATE TRAJECTORY

Detected event

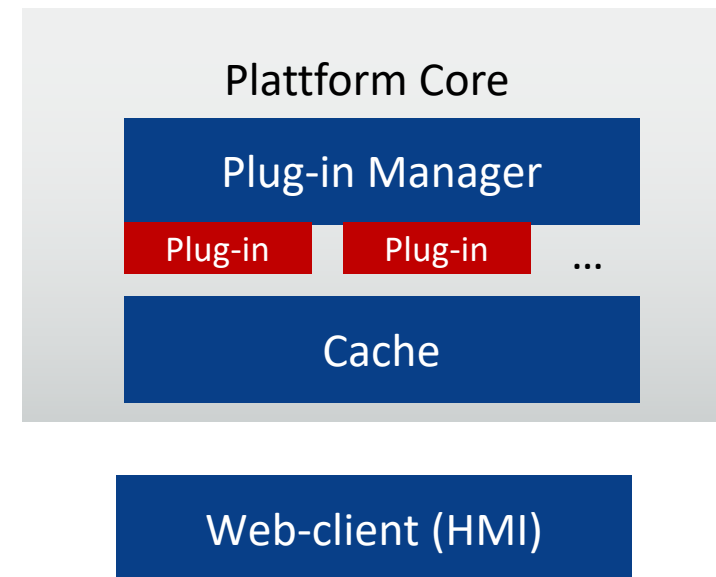


Web-based Event Detection Platform

Aim

- Provides a standardized interface to read and analyze data from the end-users
- Fusion from different data sources
 - Integrate .csv files
 - Connect to opc-ua
 - Get data from databases...
- Write back results
 - As web-based visualization
 - Write back to end-user's scada system
 - Send notification in case of event...
- Several machine learning algorithms should run in parallel

Platform Architecture



Web-based Event Detection Platform

Plug-in: Program the does independent small tasks

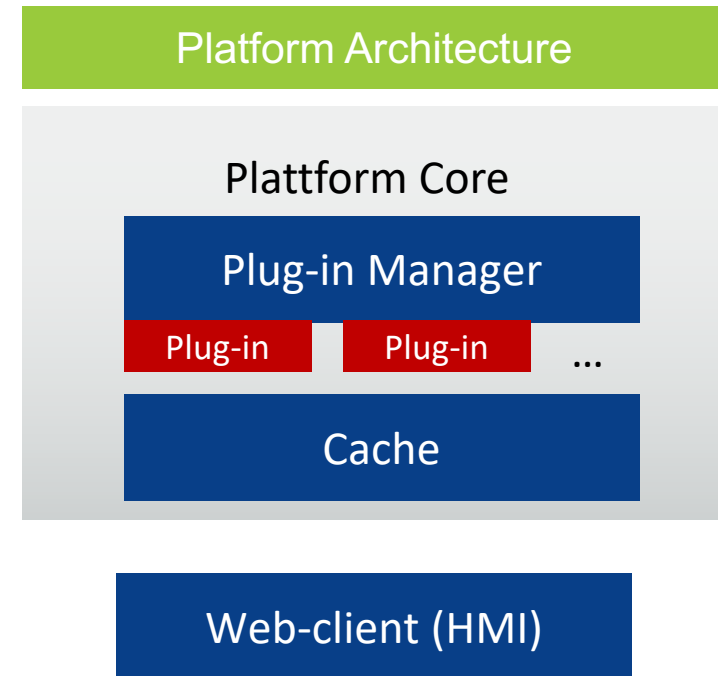
- Integrate measurements in database
- Perform event-detection
- Push data to web-interface ...

Plug-in Manager: Manages the plug-ins

- Configure, start, stop,...
- Thread-management, Exception-handling,...

Cache: Contains the real-time data

- Every plug-in has access to the cache
- Plug-in communication runs over cache

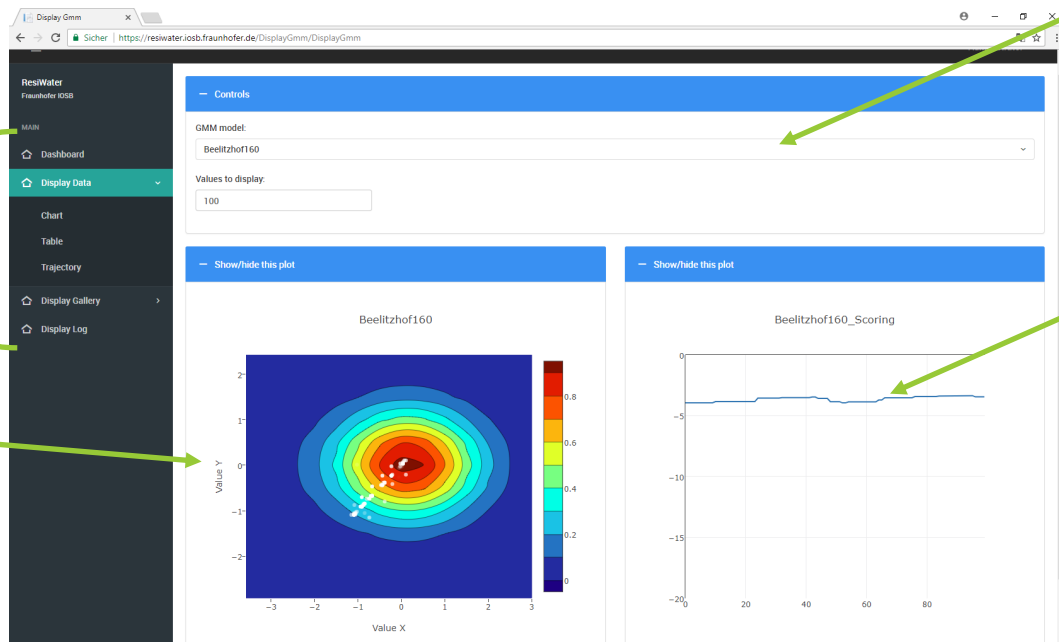


Tools for the Launch of the EVD Module

Web-client

- Dashboard
- Charts
- Graphics

State trajectory



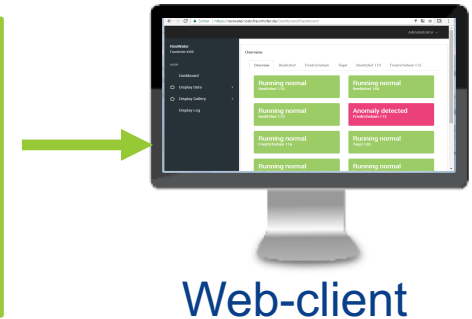
Selection of trained model

Alarm index

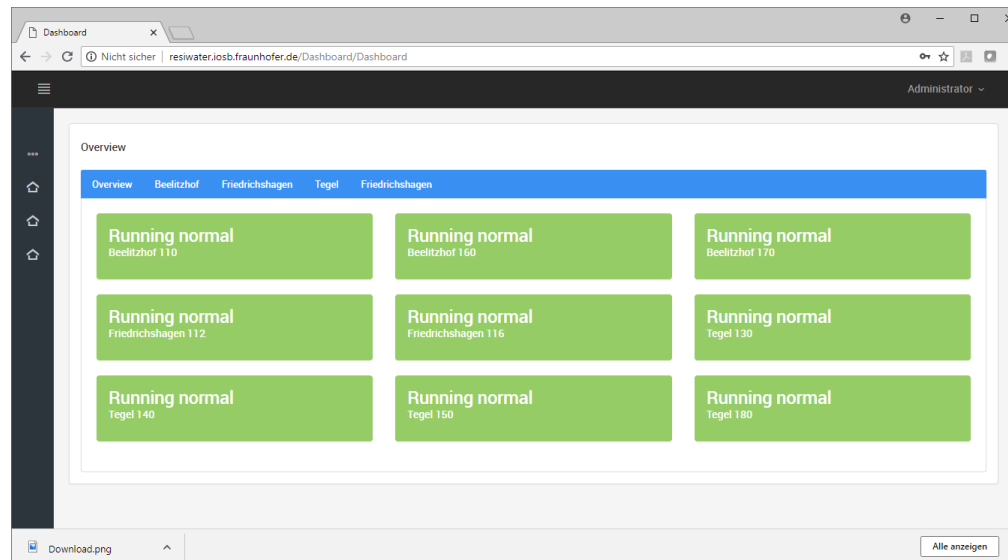
USE-CASE Berliner Wasserbetriebe



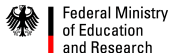
- Data provided every hour as .csv file
- 9 anomaly detectors run in parallel
- Access via Web-Client
- Possibility to send notification e-mails



Results from 22.6.
No Events



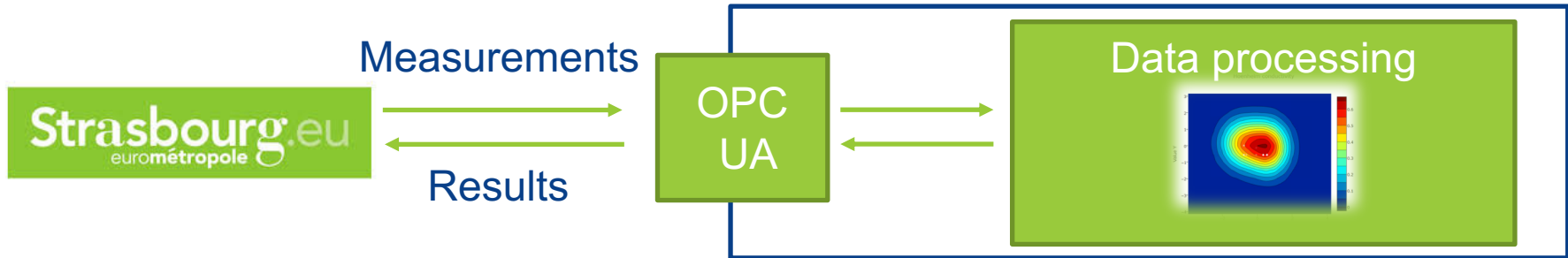
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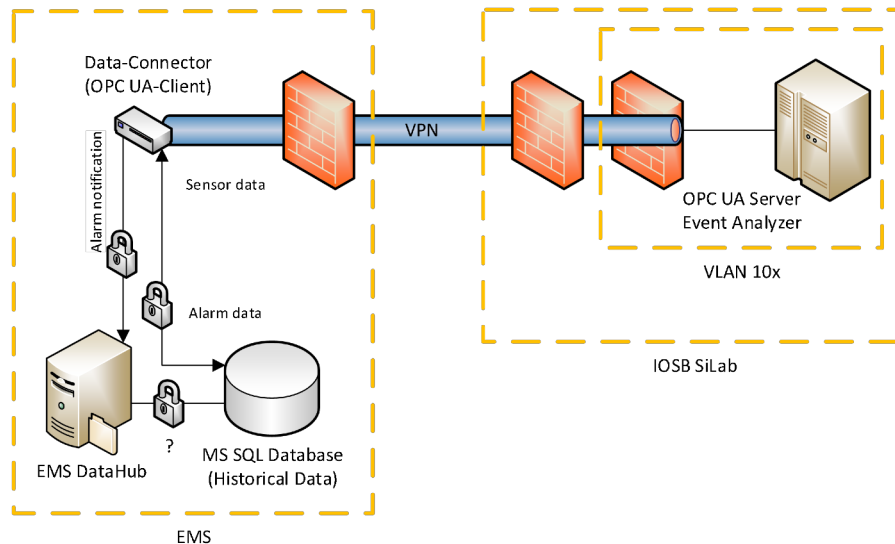
Federal Ministry
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and Research



USE-CASE Eurométropole de Strasbourg



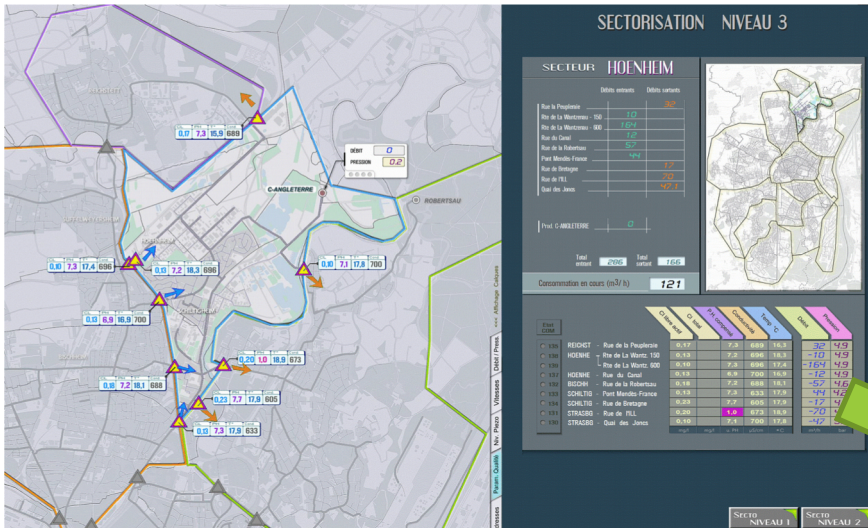
Developed secure IT-Infrastructure



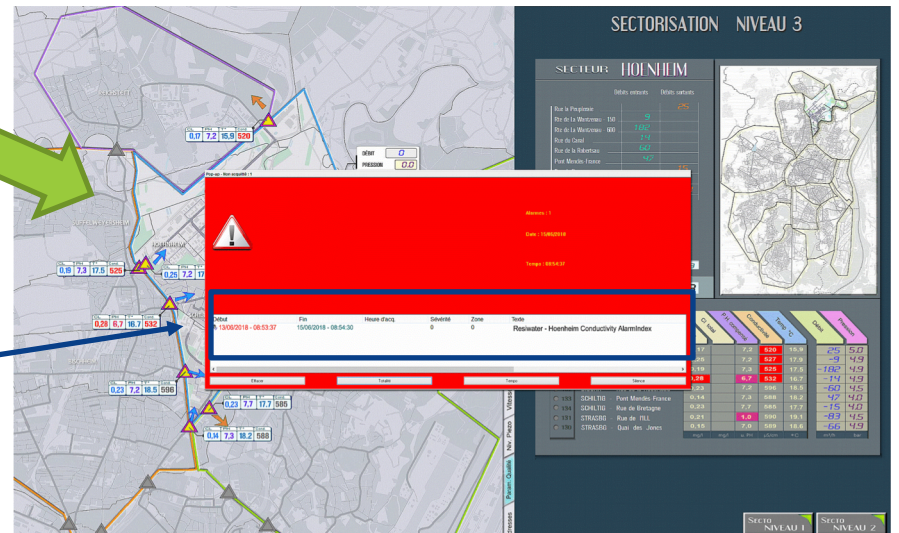
- Real-time data exchange via OPC-UA
- 6 anomaly detectors run in parallel (3 pressure, 3 conductivity)
- Integration of the alarm modules in their SCADA system
- Access via Web-Client

USE-CASE Eurométropole de Strasbourg

View on the Scada System



Pop-up event



Event detected in „Sector Hoenheim Conductivity“

Summary

- **Development of an extensible data fusion and analysis platform**
 - Development of Machine Learning algorithms for the Event Detection in drinking water
 - Possibility to add new data sources, preprocessing and machine learning algorithms through developed plug-in structure
 - Web-based visualization

- **Set-up of of the platform at Berliner Wasserbetriebe and Eurométropole:**

BWB:

- Hourly transfer of .csv files; results shown in web-client and e-mail notification
- Monitoring of multiparameter probes

Eurométropole:

- Real-time data exchange through OPC-UA
- Monitoring of different sectors concerning conductivity and pressure

Thank you for your attention

Any questions?



www.resiwater.eu