



# Industrial Control & Monitoring

*CERN Openlab technical workshop*

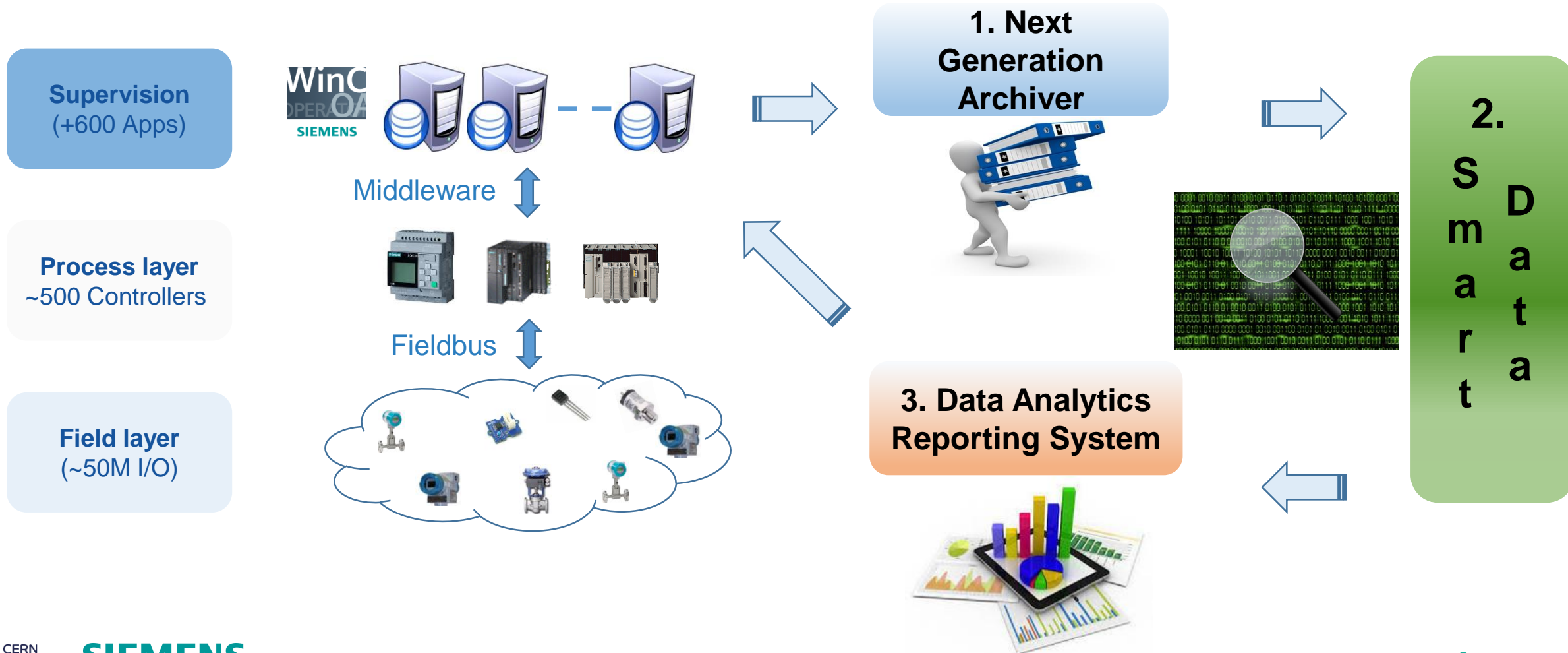
*BE-ICS*

Piotr Golonka, Jakub Guzik, Rafal Kulaga, Brad Schofield, Piotr Seweryn, Filippo Tilaro, Fernando Varela

11/01/2018

# Siemens openlab projects

3 openlab projects' related to the CERN Industrial Control System



# Next Generation Archiver for WinCC OA

*Enable data analytics and scale up to the expected data rates beyond 2020*

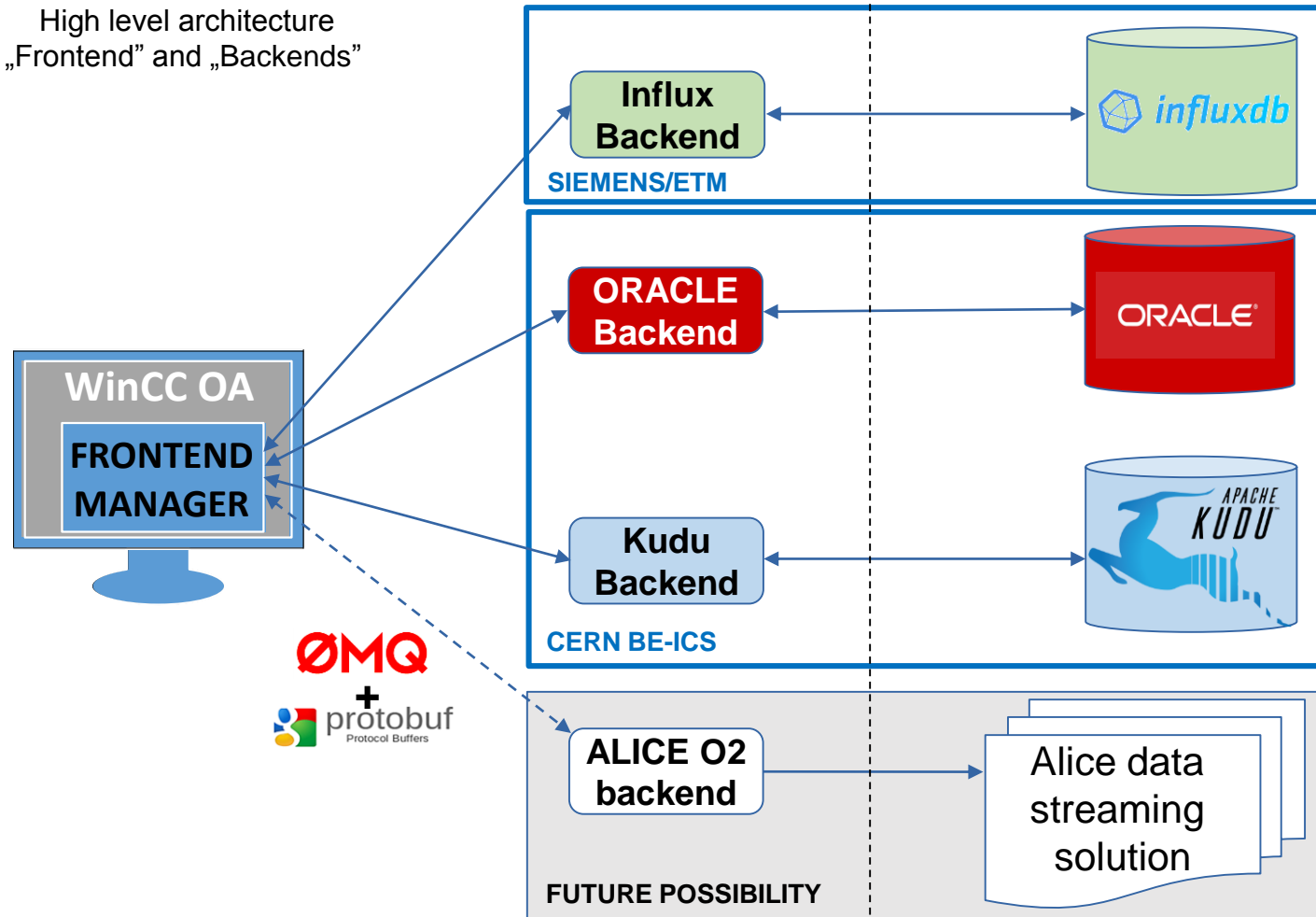
# Next Generation Archiver

- Successor of WinCC OA's Oracle RDB Archiver
  - high-performance
  - cost-effective
  - robustness
- Open architecture and clearly defined layers
  - Frontend with direct WinCC OA connection
  - Language neutral interface
  - WinCC OA-independent backends
- Support for SQL and NOSQL databases
- Internal prototype ready, first version for WinCC OA 3.X in end 2018 / start 2019
- Joint development with Siemens/ETM:
  - One team, good communication, sprint planning, stand-ups, regular follow-up telcos

# NGA architecture and future plans

## Next Generation Archiver

High level architecture  
„Frontend” and „Backends”



- Frontend Manager is developed together by CERN and ETM (with majority contribution from ETM)
- CERN is working on two backends:
  - Oracle backend with support from ETM
  - Apache Kudu backend for internal usage
- ETM is working on InfluxDB backend
- Oracle backend will be re-integrated in standard WinCC OA later on
- With plugin based architecture there is possibility to create user defined backends to satisfy specific needs (eg. ALICE O2 or feeding data analytics)
- Scalability tests are already scheduled with IT-DB group and ETM

# Smart Data for Industrial Control Systems

*A single analytical framework which combines cloud services with IoT devices*

# Smart Data for Industrial Control Systems

*2 Different groups of data analytics activities*

## Use-Cases and algorithms

*Design and development of data analytics algorithms to match use-case requirements*

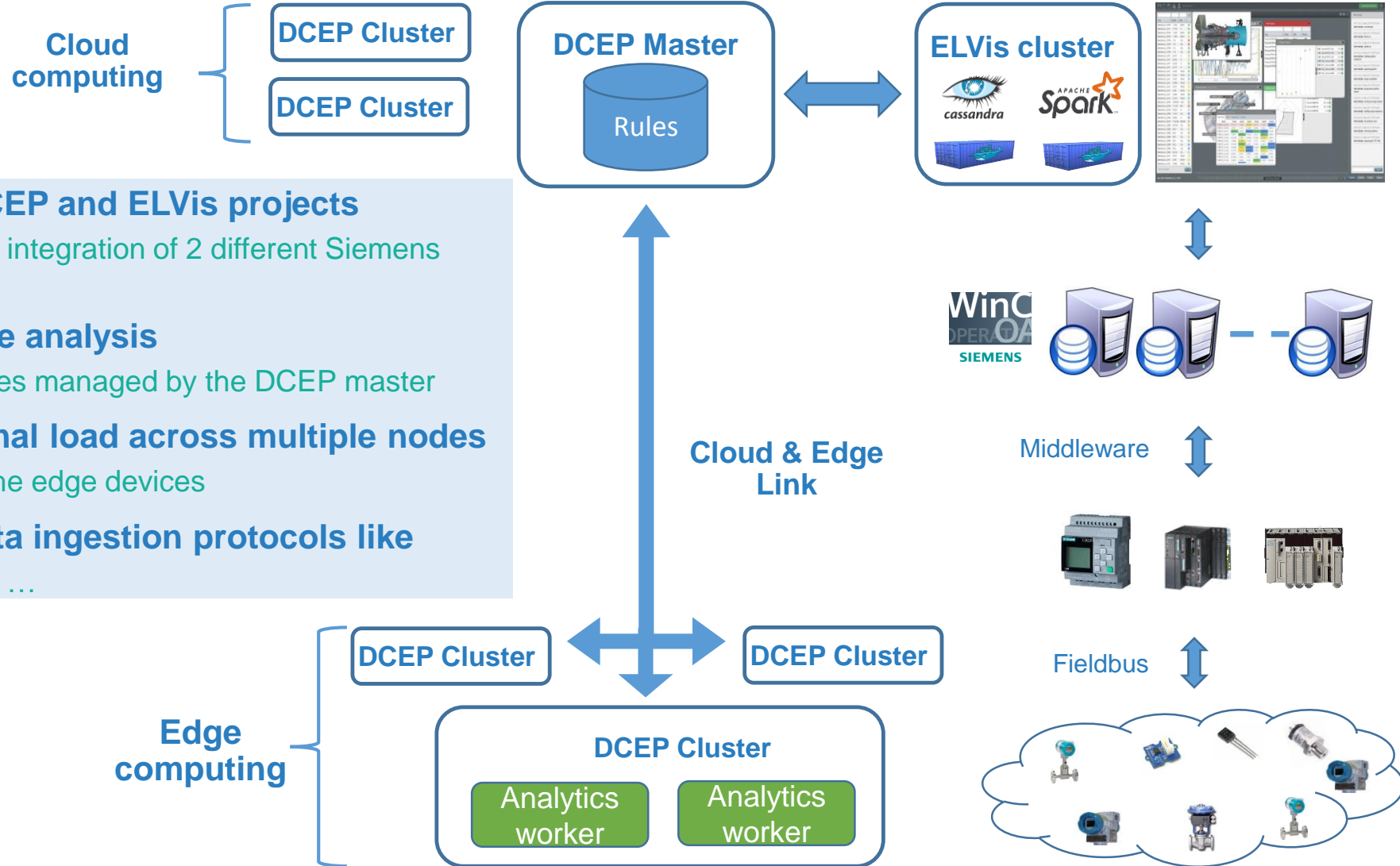
- LHC Circuit Monitoring:
  - Online analyse the power converter circuits signals and the system status in order to assess their health and detect anomalies
  - Anomaly detection based on experts' knowledge
  - Components monitoring (circuits resistance)
- Cooling and ventilation:
  - Tanks leaks detection and alarms tuning
  - Outliers analysis of historical valve opening

## Analytical Platform

Design, development and evaluation of the data analytics platform for control systems

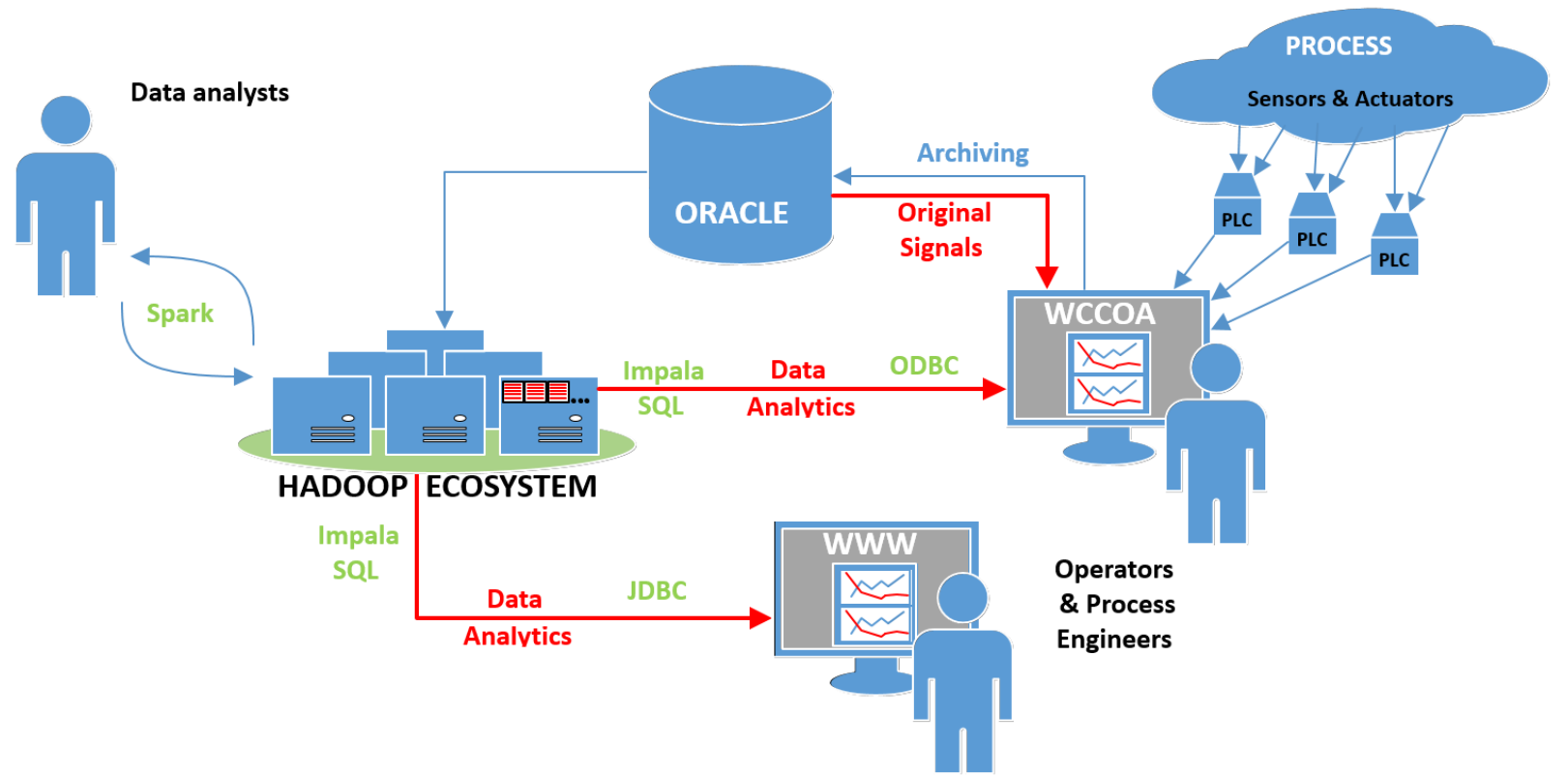
- Expert system with:
  - Event based stream analysis
  - Central rules deployment
- Edge and cloud computing capabilities
  - Data sources identification and localization
- IoT support:
  - Multiple data ingestion protocols
  - Multi-platforms analytics workers
  - Discovery service

# Smart Data for Industrial Control Systems



- **Combining Siemens DCEP and ELVis projects**
  - CERN deployment and integration of 2 different Siemens frameworks
- **Expert system for online analysis**
  - Central database of rules managed by the DCEP master
- **Distributed computational load across multiple nodes**
  - Both in the cloud and the edge devices
- **Support for multiple data ingestion protocols like**
  - CMW, OPC UA, MQTT ...



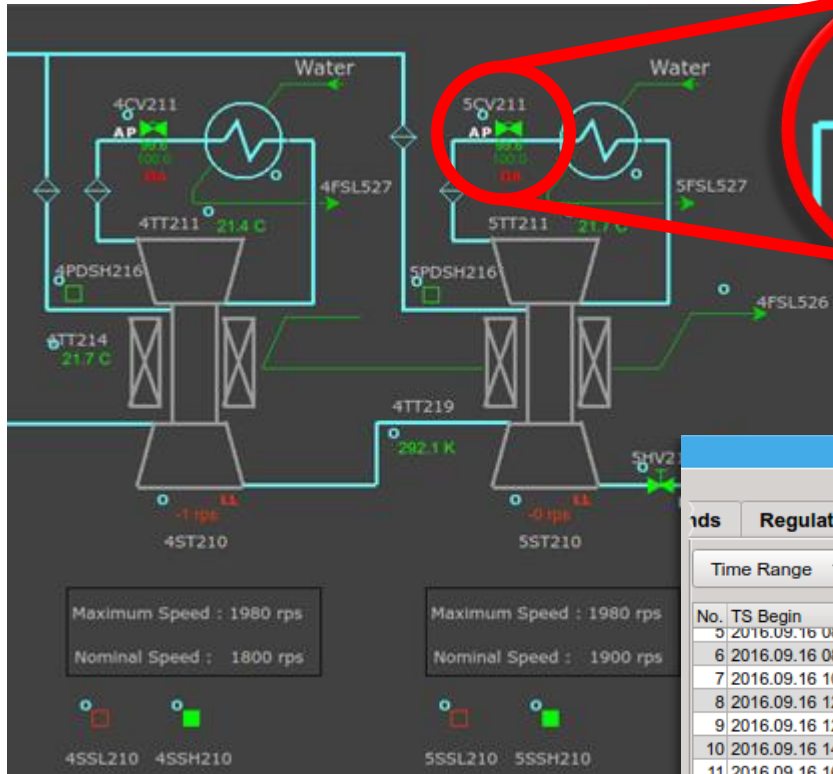


# Data Analytics Reporting for Industrial Control Systems

*Display analytics results on the operator's screen and web-frontend.*

# Data Analytics Reporting System for WinCC OA

Attract operators attention



5CV211  
AP 99.6  
100.0  
DA

Easy and direct access to the analytics results

1 - QSRB\_6\_4CV211 Brake valve 4TU210

QSRB\_6\_4CV211

Time Range From: 2016-09-11 00:00:00.000 Until: 2016-09-18 00:00:00.000

No.	TS Begin	TS End	Type	Comment
5	2016.09.16 08:00:00.000	2016.09.16 10:00:00.000	Correlation Analysis	KNN-graph and correlati
6	2016.09.16 08:00:00.000	2016.09.16 10:00:00.000	Correlation Analysis	KNN-graph and correlati
7	2016.09.16 10:00:00.000	2016.09.16 12:00:00.000	Correlation Analysis	KNN-graph and correlati
8	2016.09.16 12:00:00.000	2016.09.16 14:00:00.000	Correlation Analysis	KNN-graph and correlati
9	2016.09.16 12:00:00.000	2016.09.16 14:00:00.000	Correlation Analysis	KNN-graph and correlati
10	2016.09.16 14:00:00.000	2016.09.16 16:00:00.000	Correlation Analysis	KNN-graph and correlati
11	2016.09.16 16:00:00.000	2016.09.16 18:00:00.000	Correlation Analysis	KNN-graph and correlati
12	2016.09.16 18:00:00.000	2016.09.16 20:00:00.000	Correlation Analysis	KNN-graph and correlati
13	2016.09.16 20:00:00.000	2016.09.16 22:00:00.000	Correlation Analysis	KNN-graph and correlati

Present Selected Present All Present Last...

On Off Set Value... Inc. Dec. Allow-Restart Limits  
Auto Mode Manual Mode Forced Mode Ack. Alarm Select

AnalysisModule: AnalysisResults

English, US [en\_US.iso88591]

**DATA ANALYTICS - INDIVIDUAL ANALYSES VIEW**

Options

Type	Alias	Begin
2	CA QSRB 6 4CV211AO	2016-09-16 00:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 02:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 04:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 06:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 08:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 10:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 12:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 14:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 16:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 18:00:00
2	CA QSRB 6 4CV211AO	2016-09-16 20:00:00
2	OA QSRB 6 5CV211AO	2016-09-15 17:00:00

Analysis ID: 60552446-b650-11e6-a4fc-02163e008c5b

Object: QSRB\_6\_5CV211AO.PosSt

Type: Oscillation Analysis

TS Begin: 2016.09.15 17:00:04.000 Additional Information

TS End: 2016.09.15 21:59:50.000

Signals in time

Trend Options

100  
50  
0

18:00:00 19:00:00 20:00:00 21:00:00

Value over value trend

Trend Options

Amplitude(Frequency) 0.0113389  
0.499923  
Threshold(Frequency) 0.4  
0.499923

4  
2  
0.00 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45

Amplitude-Period juxtaposition

Table Options

No.	Amplitude	Period
1	0.58264794125926	110.89204545455
2	0.64330856478838	118.28484848485
3	0.85347594872231	153.67716535433
4	0.85969552681293	134.6
5	0.9733114467467	152.4765625
6	1.0841298811063	165.39830508475
7	1.3140846365301	157.39516129032
8	1.3954806029795	172.71681415929
9	1.862287386939	171.20175438596

# Summary

- 3 openlab projects running in collaboration with Siemens
- Advancing at good pace
- Integration of Siemens solutions and analytical frameworks into CERN control system
- A big **thanks** to **Siemens** for the fruitful collaboration and continuous support !

## Summer students:

- **Lauri Sainio**: “Web reporting framework for control data analysis”.
- **Urishita Puri**: “Simplified Frontend for data generation and testing purposes”.

## 2017 publications in international conferences:

- *An expert knowledge based methodology for online detection of signal oscillations - CIVEMSA 2017, F. Tilaro, M. Gonzalez, B. Bradu, M. Roshchin*
- *Model Learning Algorithms for Faulty Sensors Detection in CERN Control Systems - ICALEPCS 2017, F. Tilaro, B. Bradu, F. Varela, M. Roshchin*
- *Automatic PID Performance Monitoring Applied to LHC Cryogenics - ICALEPCS 2017, B. Bradu, E. Blanco, F. Tilaro, R. Marti*
- *Data Analytics Reporting Tool for CERN SCADA Systems - ICALEPCS 2017, P. J. Seweryn, M. Gonzalez-Berges, J. B. Schofield, F. M. Tilaro*
- *Future Archiver for CERN SCADA Systems – ICALEPCS 2017, P. Golonka, M. Gonzalez, J. Guzik, R. Kulaga*



# Thank you!

*CERN BE-ICS*

<https://be-dep-ics.web.cern.ch/>