# Verifying Operational Readiness with the European XFEL's Control System

European XFEL

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#### Summary

- Challenge of Flexible setups
- EuXFEL's Control System
- Data Operation Center
- "Bring Up Days" EuXFEL's verification exercise
- Outlook and Conclusion

#### **Challenge to Operational Readiness**



#### The Karabo Control System

- In-house development of a Supervisory Control and Data Acquisition (SCADA) system
  - Controls the photon systems of the European XFEL
  - Event-driven
  - Message Broker-based with p2p
  - C++, Python
  - Graphical User interface (GUI) with "no code" panels
  - Plugins (devices) implement concrete functionality



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## The Karabo Control System

- In-house development of a Supervisory Control and Data Acquisition (SCADA) system
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  - Event-driven
  - Message Broker-based with p2p
  - C++, Python
  - Graphical User interface (GUI) with "no code" panels
  - Plugins (devices) implement concrete functionality
- Size speaking:
  - 20,000 devices, 2 Million properties 20 GB/s data transfers are routinely transfered

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#### **Karabo Data Collection**

monitoring

- Datalogging is continuous for broker data
   It is done by default, for all devices
   Mainly for maintenance and performance
  - "Never let a disaster go to waste"
    - during the COVID lockdown overhauled the datalogging backend
    - Now using InfluxDB as a data support
  - Run based DAQ for scientific data
    - i.e. EuXFEL's product
      - Also includes Imagers, Large Detector Data







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## **Karabo Operational Historian**

- Can retrieve past device configuration The version of the software stack is recorded
- Can be used to identify changes with the current state
- It is used to recover complete systems in case a system restart is required.

| Re                                                           | rieved Configuration           | Changes                       | Save Configuration (*.xml) |  |  |  |
|--------------------------------------------------------------|--------------------------------|-------------------------------|----------------------------|--|--|--|
|                                                              | All Reconfigurable             |                               |                            |  |  |  |
|                                                              | _deviceId_                     | SPB_XTD9_ATT/MOTOR/ARM4       | -                          |  |  |  |
|                                                              | deviceId                       | SPB_XTD9_ATT/MOTOR/ARM4       |                            |  |  |  |
|                                                              | heartbeatInterval              | 120                           |                            |  |  |  |
|                                                              | _serverId_                     | cppServer/sa1_beckhoff_spare  |                            |  |  |  |
|                                                              | visibility                     | 0                             |                            |  |  |  |
|                                                              | classId                        | BeckhoffMC2Beckhoff           |                            |  |  |  |
|                                                              | classVersion                   | Beckhoff-4.15.11-2.20.8       |                            |  |  |  |
|                                                              | karaboVersion                  | 2.20.8                        |                            |  |  |  |
|                                                              | serverId                       | cppServer/sa1_beckhoff_spare  |                            |  |  |  |
|                                                              | hostName                       | exflcon53n0                   |                            |  |  |  |
|                                                              | pid                            | 3061254                       | -                          |  |  |  |
| es                                                           | Nilhore                        |                               | Cancel OK                  |  |  |  |
|                                                              |                                |                               |                            |  |  |  |
| ing Configura                                                | tion                           | Retrieved Configuration       |                            |  |  |  |
|                                                              | 80.0                           | actualPosition 100.0          |                            |  |  |  |
| tualPosition<br>coderPosition<br><b>c2</b><br>internalSetpoi | 54.4649999999999996<br>nt 80.0 | mc2<br>internalSetpoint 100.0 |                            |  |  |  |

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#### **Grafana Web Backend**







#### **DOC - Data Operation Center**

- For Instrument issues, a single phone number is reacheable 24/7
  - All internal Data Dep. issues are solved internally
- During User Operation Days in presence
  Two persons team 8 Hours Shifts
  Covering from 7:00 to 23:00
- One Data Run Coordinator per week
   Provides operational awareness
   Briefs the shift team
  - Is responsible for decisions to be taken

#### Started in March 2021

| ALL OK                           |                                         |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
|----------------------------------|-----------------------------------------|---------------------------------------------------|----------------|-----------------------------------|-----------------|-----------------------|--------------------|----------------------------|----------------------------------|-------------------------|-------------------------------------------------------|---------------------|----------------------|-------------------|----------------|-------------------------|
| C RabbitMQ Me                    | ି SA1                                   | SA1 Rabbit Di     SA2 Rabbit Di     SA3 Rabbit Di |                |                                   |                 |                       | oit Di             | i SA1 Rabbit MQ Broker     |                                  |                         | <sup>i</sup> SA2 Rabbit MQ Broker <sup>i</sup> SA3 Ra |                     |                      | bbit MQ Broker    |                |                         |
| RABBIT MEMORY<br>OK              | RAE                                     | RABBIT DISK RABBIT DISK RABBIT<br>OK OK OK        |                |                                   |                 |                       | DISK<br>(          | RAI                        | BBI                              | гок                     | R/                                                    | ABBIT               | ОК                   | RAE               | BIT            | OK                      |
| C                                | Bunch Decoder Status                    |                                                   |                |                                   |                 |                       |                    |                            | i XGM DOOCS-karabo bridge Status |                         |                                                       |                     |                      |                   |                |                         |
| ALL OK                           |                                         |                                                   |                |                                   |                 |                       |                    |                            | ALL XGM OK                       |                         |                                                       |                     |                      |                   |                |                         |
| Time Server Health (Instruments) |                                         |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
| status FXE                       | ОК                                      | OK status HED C                                   |                |                                   | status I        | status MID <b>OK</b>  |                    | status SCS <b>OK</b> statu |                                  | tatus SPB <b>OK</b> sta |                                                       | status S            | status SQS <b>OK</b> |                   |                |                         |
| Time Server Health (Aux)         |                                         |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
| status LA1                       | ОК                                      | OK status LA2 OK                                  |                |                                   | status I        | atus LA3 <b>OK</b> st |                    | status                     | SA1                              | ОК                      | OK status SA2                                         |                     | ОК                   | OK status SA      |                | ОК                      |
| RunMonitor - Alarm               |                                         |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
| <b>OK</b>                        | OK                                      |                                                   | )K             | SA1                               | <sup>сомм</sup> | SA1 P                 | ™<br>K             |                            | K                                | sa2 pbm                 | <                                                     | SA3 COMM            | SA3                  | рвм<br><b>) К</b> |                | ser<br>K                |
|                                  | DAQ Health Global State (Instruments) ~ |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
| FXE<br>MONITORING                |                                         |                                                   | MID<br>MONITOR | ID MID Monit.<br>ORING MONITORING |                 | so<br>MONIT           | SPB SPB MONITORING |                            | SPB Monit.<br>MONITORING         |                         | sc<br>ERF                                             | as<br>ROR           | SXP<br>MONITORING    |                   |                |                         |
| DAQ Health Global State (Aux)    |                                         |                                                   |                |                                   |                 |                       |                    |                            |                                  |                         |                                                       |                     |                      |                   |                |                         |
| PASSIVE                          | PASSIV                                  | E P                                               | ASSIVE         | MON                               | A1 COMM         | sa<br>PAS             | 1 PBM<br>SSIVE     | SA2 CO                     | ORING                            | SA2 PBM<br>MONITOR      | RING                                                  | SA3 COMM<br>PASSIVE | P/                   | SA3 PBM<br>ASSIVE | SQS LL<br>PASS | <sup>ASER</sup><br>SIVE |

# **Bring Up Days**

- The Operation Schedule usually has two maintenance periods when large hardware and software changes can be deployed
- After each maintenance period, new issues (re)appear.
- Bring Up Days" used to be two full days sessions with the instruments partly seen as a "site acceptance test"
  - Started in Summer 2022



# January 2025 Bring Up Days

- Two 3 hours Session per Instrument:
  - Session A: "System" components (Motors, Vacuum, Cameras, Orchestration)
  - Session B: "Data Collection" (Detectors, DAQ, Calibration, Data Analysis)
- Each Session:
  - DATA is present with experts and collects the reports
     Supports in case of issues and mostly observes
     The Instrument Scientists/Experts are crucial to
     identify the components that are needed in the upcoming run (operational awareness)
    - verify the components with their expected behaviour



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BS 6.1.0





SPB Jungfrau4M ExtraFOAM

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NBS 🕥

## January 2025 Bring Up Days Results

- Issues And Requests are Highlighted
  - Often the issues can be solved directly during the bring up days What could not be addressed immediately, is followed up
  - Some Feature Requests are collected and new or existing features can be demonstrated and/or explained
    - Experts/Devs and the main users of their work are in the same room.
- This year we had very fast focussed sessions
  - Although the maintenance period was short, we had large tasks to handle (e.g. DSSC @ SCS)
  - Great support for this procedure from the instrument scientists
  - Extended to Tunnels Installations
  - Initiated a process to feedback issues from the "Data Operation Center" into the "Bring Up Days" programs



SASE1 Overview



#### Outlook

The next Goal is to slim down further the Bring up days
 However Increase the frequency
 Simplify the scheduling

- Embrace the Instrument fortnightly changes
  - Modularises the verifications
  - Close further the distance between Data Support groups and instrument scientists
- Once the definitions are codified, automate where possible
- Encourage each new "automation" project to include a "baseline" verification step or feature

#### Conclusion

- Changing setups and flexibility at the European XFEL
- We have tools to manage the change
  - Karabo Devices, Karabo Infrastructure, GUI
  - InfluxDB, Grafana
  - Data Operation Center
- The Bring Up Days offer the ability to verify Operational Readiness
   Delivering positive "culture" benefits
- Continue the "clandestine effort" to introduce system verification

# Thank you for your attention