COUPLING BETWEEN AN INTEGRATED CALIBRATOR SYSTEM AND THE CERN ASSET MANAGEMENT TOOL

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EUROPEAN SPALLATION SOURCE

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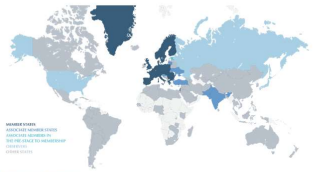
Cryogenics systems are critical within the framework of the LHC accelerator and its detectors. Interruption of refrigeration capacity has direct impact on accelerator availability and the acquisition of physics data. During the second Long Shut down 2, spanning from 2019 to 2020, one key element for reliability enhancement was the application of a robust preventive maintenance and calibration policy. Lessons learned after the first previous Long Shut down has allowed to develop, optimize, and implement the tools and methods, in particular concerning the criticality analysis and the methodology for calibration of high precision instruments. In an effort to improve the quality and the traceability for the maintenance instrumentation teams, a new integrated calibration tool application has been developed and implemented with a software bridge to communicate with the existing CMMS Database. This implementation of the new calibration tool and associated database, as well as feedback for several months preventive maintenance, will be explained in the poster.

CERN, European Organization for Nuclear Research

An Intergovernmental Organisation for the High Energy Physics Research



Today CERN has 23 Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and United Kingdom

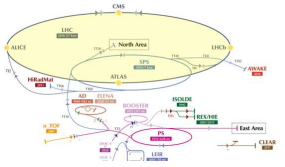
Cyprus, Estonia and Slovenia are Associate Member States in the pre-stage to Membership

Croatia, India, Latvia, Lithuania, Pakistan, Turkey and Ukraine are Associate Member States.

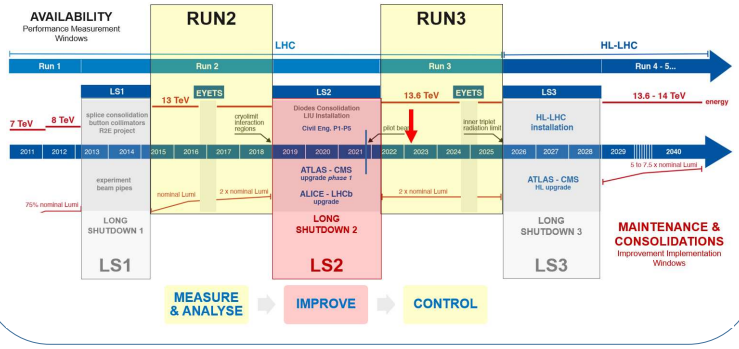
Japan and the United States of America hold Observer status with respect to the LHC, while the United States of America also holds Observer status with respect to the HL-LHC. The international organisations European Union and UNESCO currently have Observer status at CERN. The Observer status of the Russian Federation is suspended in accordance with the CERN Council Resolution of 8 March 2022. The Observer status of JINR is suspended in accordance with the CERN Council Resolution of 25 March 2022.Observer status has in the past been granted to States and international organisations.

The accelerator complex at CERN is a succession of machines that accelerate particles to increasingly higher energies. Each machine boosts the energy of a beam of particles, before injecting the beam into the next machine in the sequence. In the Large Hadron Collider (LHC) – the last element in this chain – particle beams are accelerated up to the record energy of 6.8 TeV per beam. Most of the other accelerators in the chain have their own experimental halls where beams are used for experiments at lower energies.

The LHC cryogenic system, among the most complex and powerful in the world, allows the cooling of the superconducting magnets distributed over the 26.7 km of the accelerator's underground ring down to super fluid helium temperature at 1.9 K. In the physics detectors, it will also cool down the large spectrometer magnets at their operating temperature of 4.5 K.



LHC cryogenics timeline and requirements



beamex

A BETTER WAY TO CALIBRATE

- A Finnish company specializing in equipment for instrument calibration
- Offer both workshop and field equipment for performing calibrations.
- Have a calibration management software to go with their calibrators.

Beamex MC6

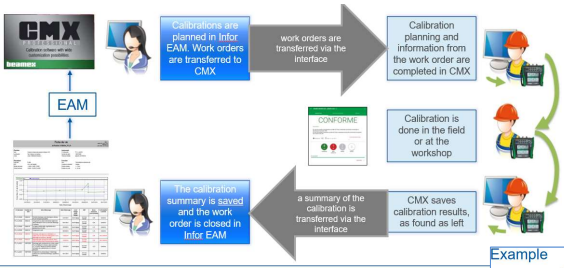
- The Beamex MC6 is an advanced, high-accuracy field calibrator and communicator
- It offers calibration capabilities for pressure, temperature and various electrical signals.
- The MC6 also contains a fieldbus communicator for HART, FOUNDATION Fieldbus and Profibus PA instruments.

Beamex CMX

- Calibration Management software
- Synchronises and stores detailed calibration results and collected instrument information from the MC6 device
- Can be used for scheduling instrument calibrations

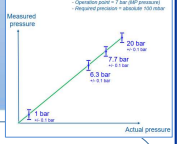
Beamex Business Bridge (B3)

- Made for easy integration with CMMS systems
- Exposes webservices for interacting with Beamex CMX
- General idea:
  - Detailed calibration data and traceable calibration records are stored in CMX
  - Plant hierarchy and instruments are created and maintained in the parent system
  - When calibration work has been performed, work order acknowledgements is sent to the CMMS



Once the solution was identified, we focused on the feasibility on the CERN site. Well helped by the EN-IM-AMM section, which provide a collaborator available to us to develop the product, we managed not without difficulty, to install the CMX database on an Oracle Cloud Server. Then in a second step, the bridge communicator was implemented and made functional by the CERN team in collaboration with experts from the Beamex company. For our part, we started by asking ourselves the question of the number of sensors that would be affected. We have therefore extracted the complete lists of our DI and AI, in order to highlight the most critical sensors, according to their function in terms of machine and human safety as well as the regulation loops.

Example

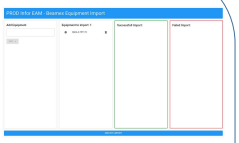


Integration with EAM

Goals:

- Send existing positions from Infor EAM to Beamex CMX
- Handle scheduling of calibrations in Infor EAM using work orders and PM Schedules
- Store a summary of the calibration results in the work orders custom fields
- Generate a calibration certificate in Beamex CMX and store this in EDMS

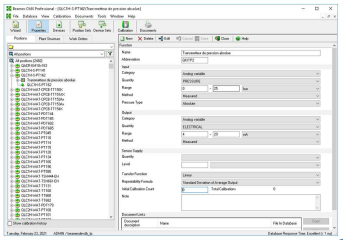
CERN interface for sending equipment



Equipment in Beamex CMX

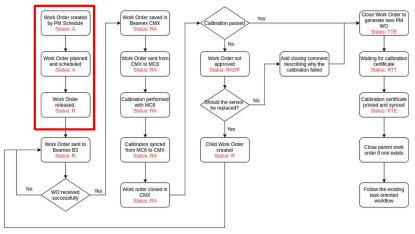
Set up definition

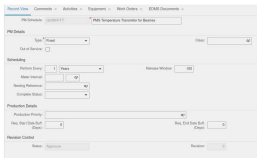
- Classes created for identifying equipment that can be sent to CMX
- Position name, description and parent are sent to CMX
- Additional information to be sent to CMX is stored in custom fields

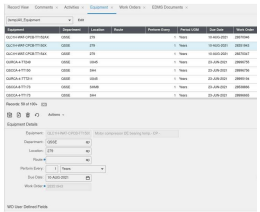


Handling Work Orders and Scheduling in EAM

Workflow

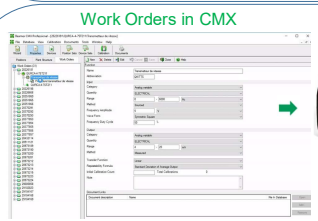






Preventive maintenance Schedule

Work Orders in CMX



Selection of the sensor/WO

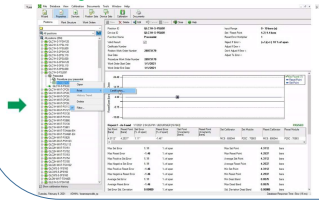
Automatic calibration with result in live

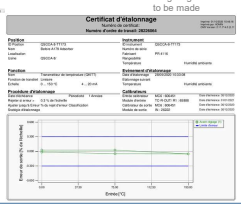
Calibration

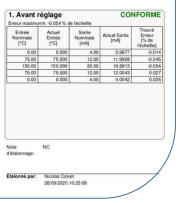
Wiring diagram to be made

Compliance verification

Printing certificate and stored in EDMS







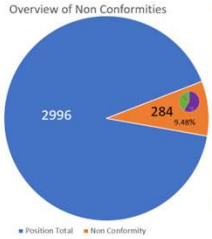
Some figures and KPIs for LS2

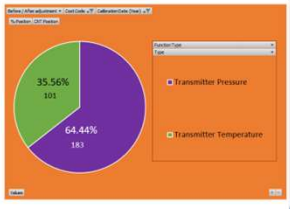
Total sensors for LHC: 17 251 positions, compare with critical equipments downloaded in CMX database: 2996= 17,31%

LHC Details

Function Type	Type	CNT Position	% Position
Pressure	Switch	235	15.16%
	Transmitter	1315	84.84%
Pressure Total		1550	51.74%
Speed	Switch	43	44.79%
	Transmitter	53	55.21%
Speed Total		96	3.20%
Temperature	Switch	437	32.37%
	Transmitter	913	67.63%
Temperature Total		1350	45.06%
Grand Total		2996	100.00%

Overview of Non Conformities





Conclusion: We are now definitively oriented towards an integrated preventive maintenance strategy for monitoring the calibration of our critical sensors. This now works perfectly, but it required a significant investment for implementation and efforts must now be maintained on a permanent basis, in particular through the constant integration of equipment for new projects. We are currently in the database consolidation phase, recovering sensor data where possible (Hart or Profibus). The next step will aim to optimize the KPIs, in order to be able to drive even more efficiently during Long Shut Down 3.