Machine Interlocks Section
TE-MPE-MI

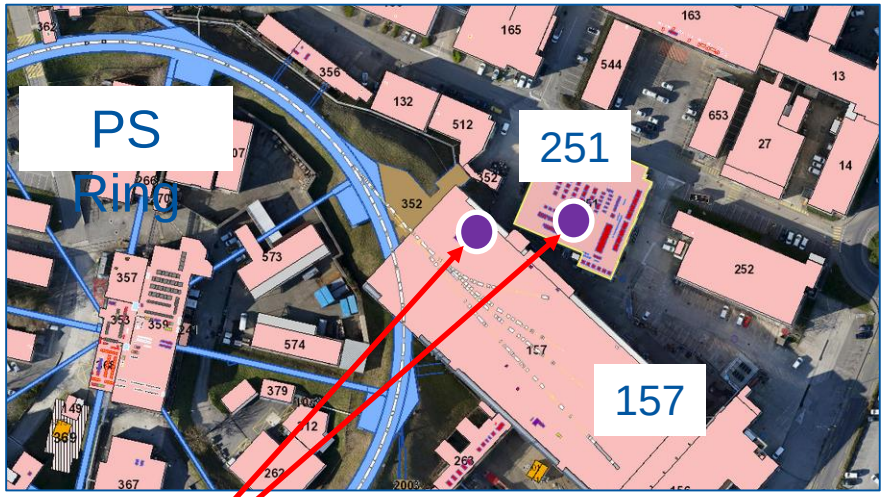
2021bis Plenary Meeting

Jan Uythoven for the MI Section

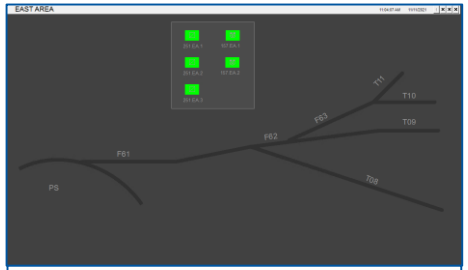
Thanks to the MI members for their input and all the work

WIC activities during 2021: East Area

WIC project completed in July 2021



2 WIC racks



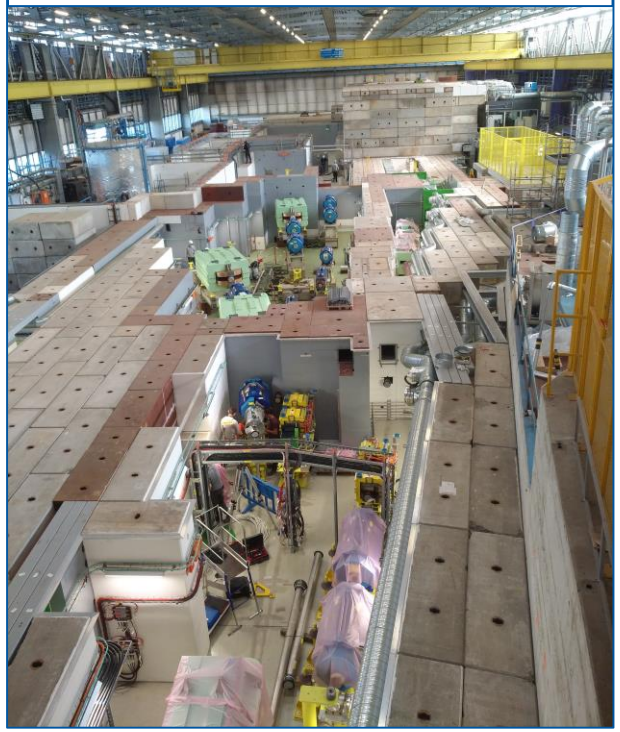
WIC HMI

F61: PS extraction line

Bldg. 251: Power Converters

EAST AREA RENOVATION

Bldg. 157: East Area hall



WIC activities during 2021

- **OPERATION**

Successful restart of the WIC systems in the SPS, SPS-LHC TLs and LHC with BE-ICS

- **CONSOLIDATION LHC-SPS transfer lines (WIC2)**

Upgrade of the WIC systems in LS3 -> WIC2 'Rad-Tol' project

Based on Siemens S7-1500 series

Irradiation test carried out at Co60 -> OK for TID up to 40 Gy

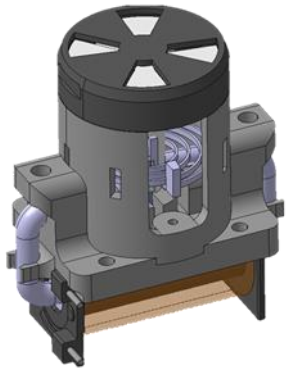
Next test at CHARM in Q2 2022

MCWG

Monitoring and Calculation Working Group

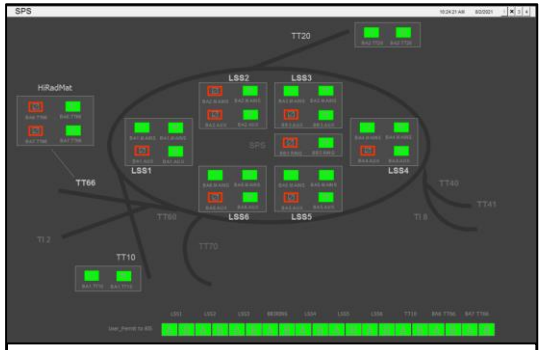
- **CONSOLIDATION SPS**

In house development of a "Trèfle" fault indicator with EN-MME

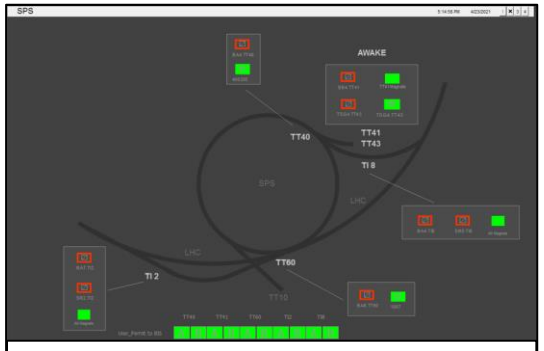


- **CONSOLIDATION PSB Rings & Ejection lines**

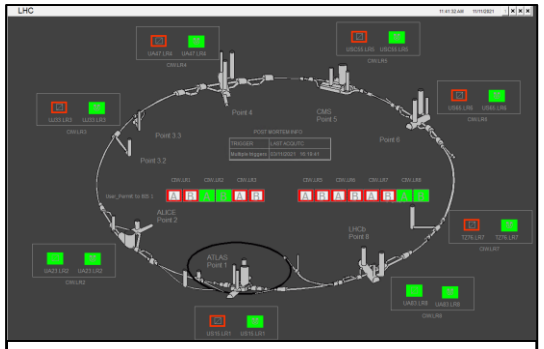
Replacement of power supplies + 2 ECRs impacting 5 systems



HMI SPS



HMI LHC-SPS TLs

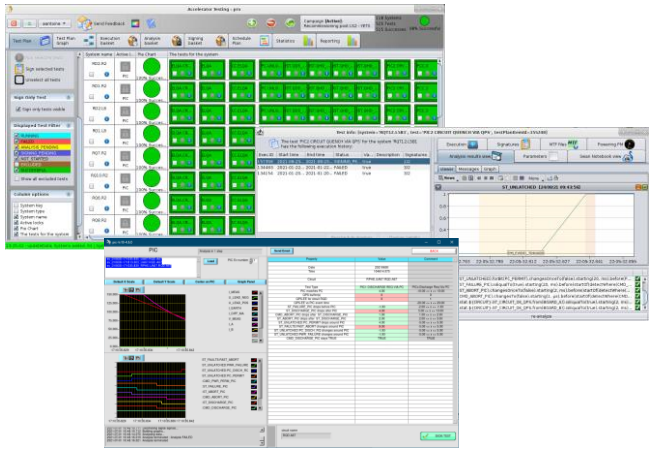


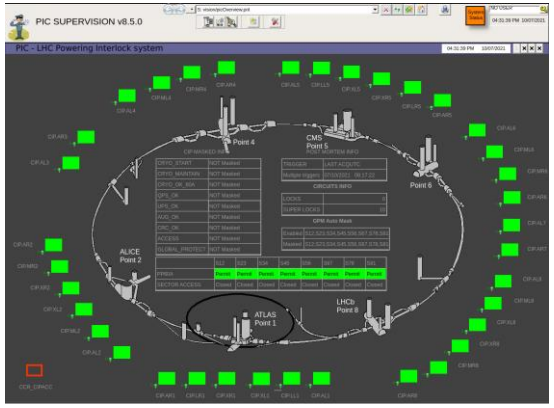
HMI LHC

PIC & FMCM OPERATION

PIC

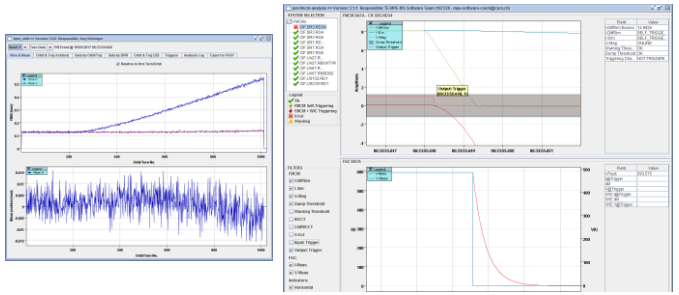
- All PICs have been successfully commissioned smoothly using Acctesting and Post Mortem Event Analyzer (PMEA) tools.
- New Automated Global Protection Mechanism (AGPM) function is now operational.

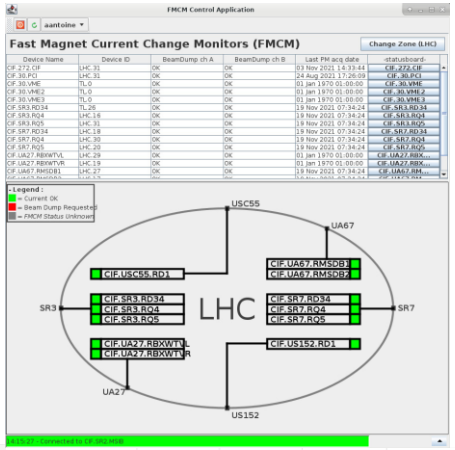


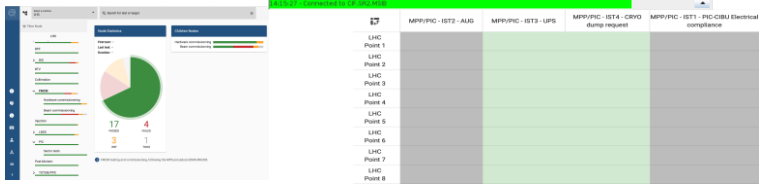


FMCM

- The ISTs of all FMCMs have been performed successfully (SPS & LHC).
- A problem appeared during the beam commissioning for circuits with RPADO converters. Finding a solution – on the PC side – in progress.







All commissioning tests are recorded in the "Checklist" tool

Second Generation of PIC (PICv2)

- Global Strategy defined and presented at the Steering Board taking into account the STRING project (Roadmap).
- Relocation of PICs out of radiation environment in the scope of the HL-LHC project under study (in progress).
- The design of a first prototype has started.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PROJECT MANAGEMENT DOCUMENT

SECOND GENERATION POWERING INTERLOCK SYSTEM
PROJECT ROADMAP & MANAGEMENT PLAN

ABSTRACT:

In order to meet the dependability objectives of the HL-LHC era, TE-MPE-MI needs to develop a second generation Powering Interlock Controller (PIC), which will both address architectural improvements and modifications of the LHC and HL-LHC magnet protection systems as well as guarantee the current dependability and maintainability of the magnet interlock system for the lifetime of the HL-LHC project.
The present document summarizes the status and operational experience of the PIC and serves as a roadmap and management plan for the second generation of Powering Interlock Controller.

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
A. Antoine I.Romera Ramirez	TBD MPE Steering Board members	F. Rodrigues Mateos on the behalf of the TE-MPE Steering Board

DOCUMENT SENT FOR INFORMATION TO:
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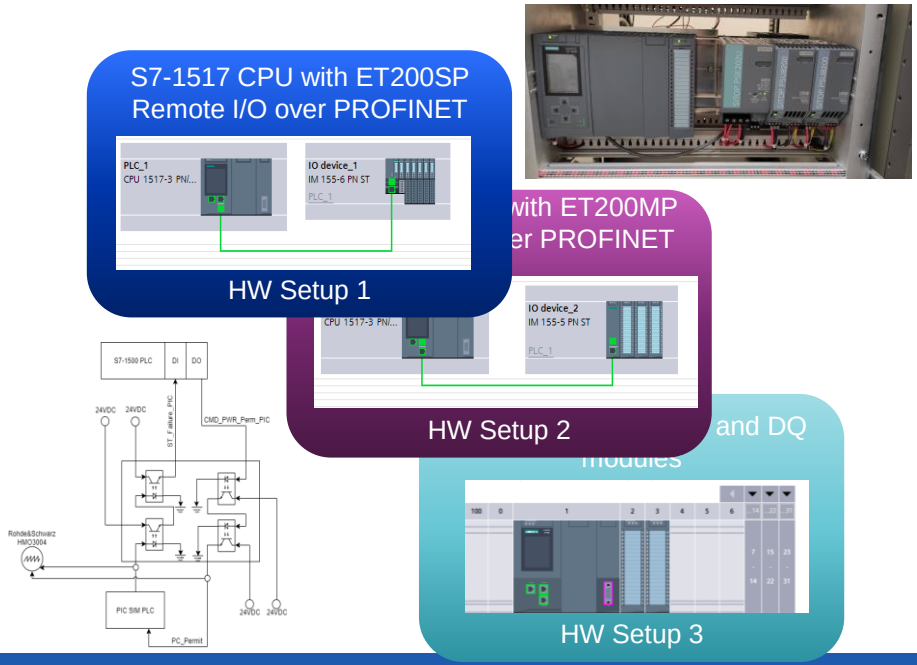
Test bench of a Full Industrial Solution

Reaction Time Tests

- To verify the **feasibility** of such a technical solution from a **reaction time** point of view (≤ 4ms).
- Different hardware and software configurations tested.
- Beam Dump function solution using B&R PLC Re-Action modules is still to be evaluated (≤ 10us).

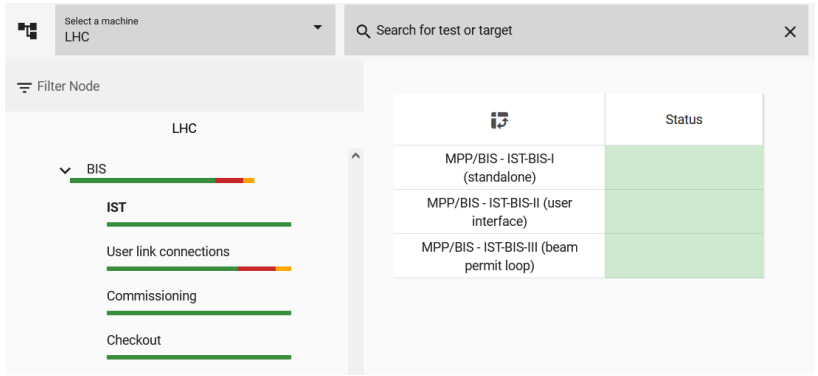
<u>Preliminary</u> result:

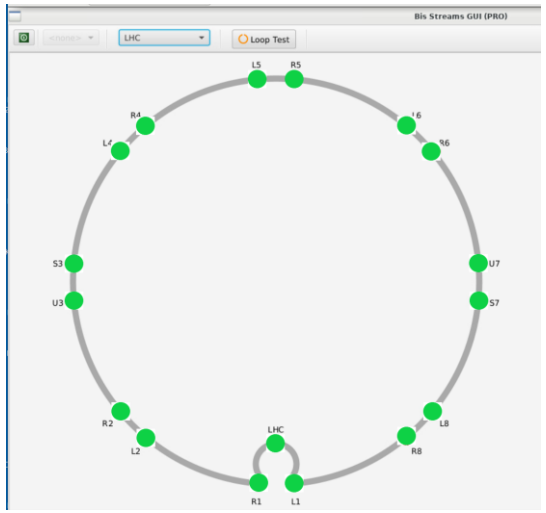
a full industrial solution fulfils the reaction time requirements

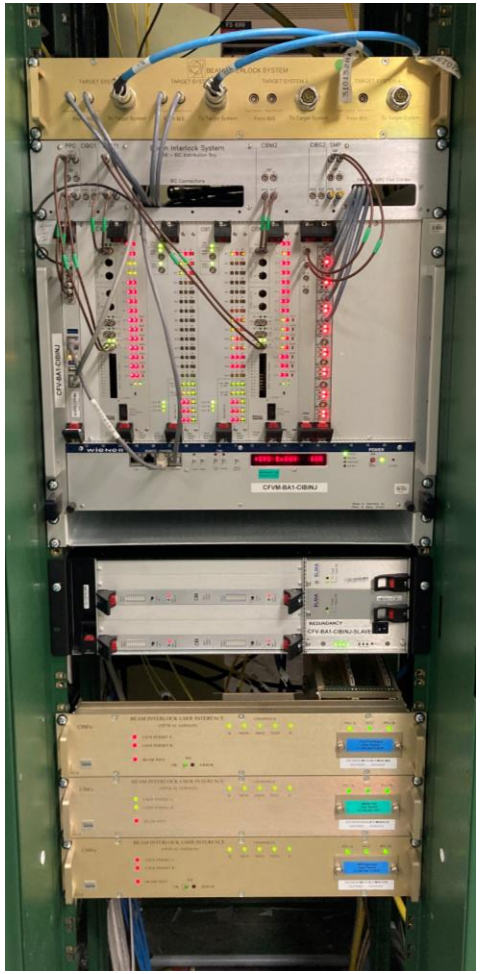


BIS Operation

- New BIS deployed during LS2 in the **SPS injection to provide a highly dependable interlocking solution** following the LIU consolidation
  - **Excellent performance** with protons and ions in 2021 with no major problems observed so far
- LHC BIS back in operation again !
  - BIS loop closed on Saturday 16 October
  - The required BIS IST and MPS tests passed successfully



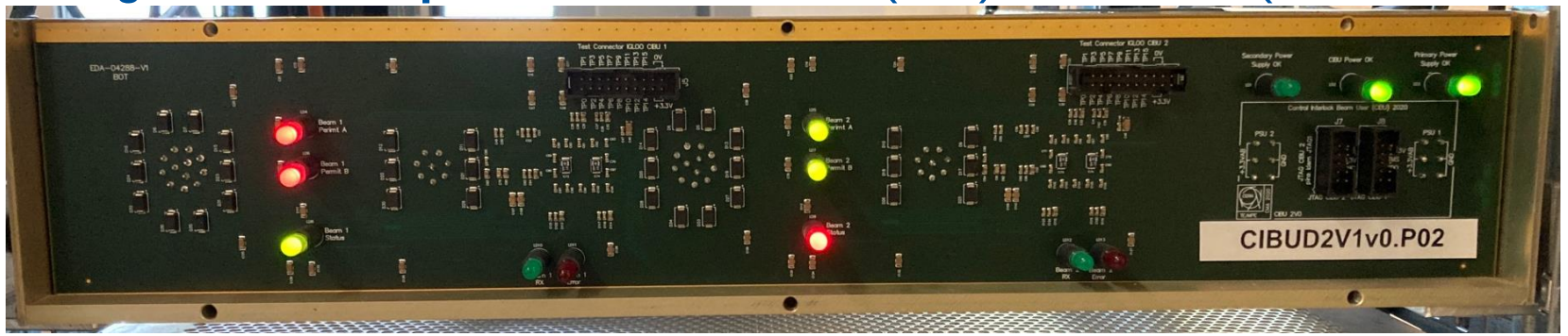




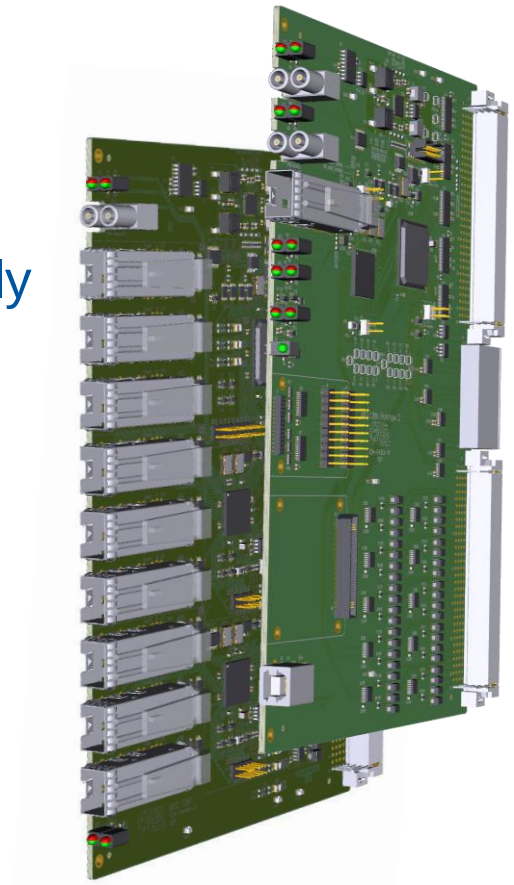
SPS Injection BIS crates in buildings 868 and 269

BIS consolidation project – BIS v2 (1/2)

- Very **good progress with different prototype designs:**
- **CIBM - Manager**: 2nd prototype built, firmware written and validated
- **CIBU - User interface**: Prototype fully functional, firmware written and validated. Hardware compatible with BIS v1 !
- **CIBFi – Optical user interface receiver**: Prototype designed and currently being tested
- **CIBG – Generator**: Schematics ready, soon in prototype form
- **CIBX – Master**: Same hardware as CIBM, firmware written and validated
- Working on **testbed platforms for CIBU** (PXI) **and CIBM** (PXI and JTAG)



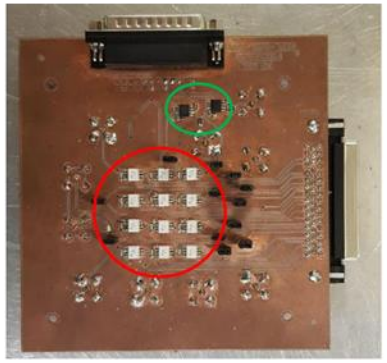
CIBU 2v0 – Electronics hardware



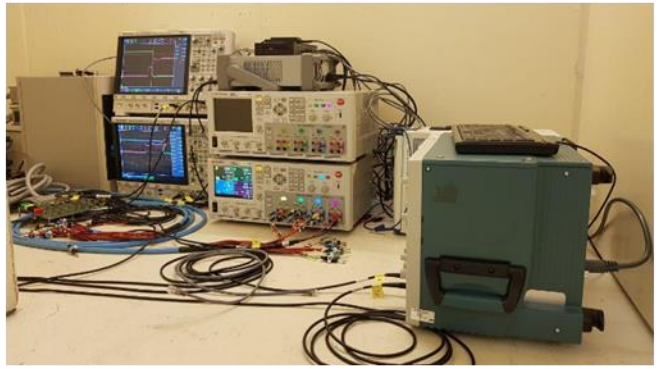
CIBFi and CIBM boards

BIS consolidation project – BIS v2 (2/2)

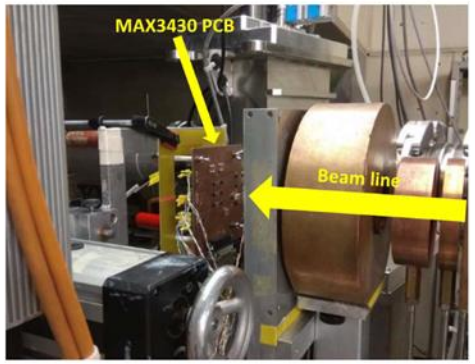
- **Radiation tolerant design** – All CIBU electronic parts already tested at PSI and soon at CHARM



FOD060LR2 PCB tested at PSI



Instrumentation setup to collect data during tests

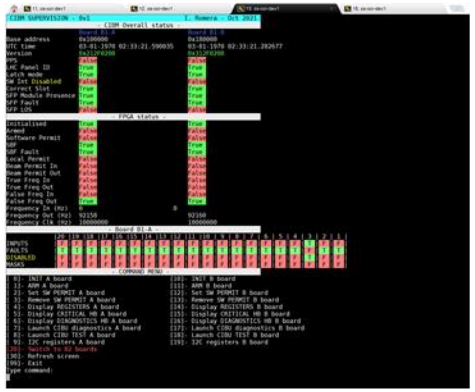


MAX3040ESA tested at PSI

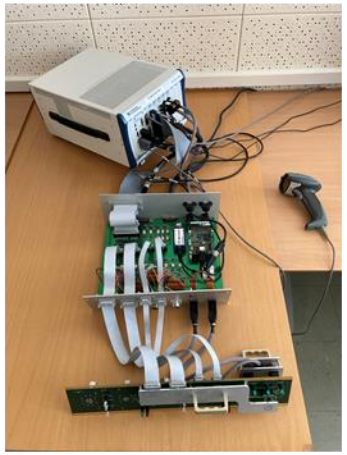
Courtesy: BE-CEM

- **And lots of testing in the lab!**

CIBM 2nd prototype in the lab



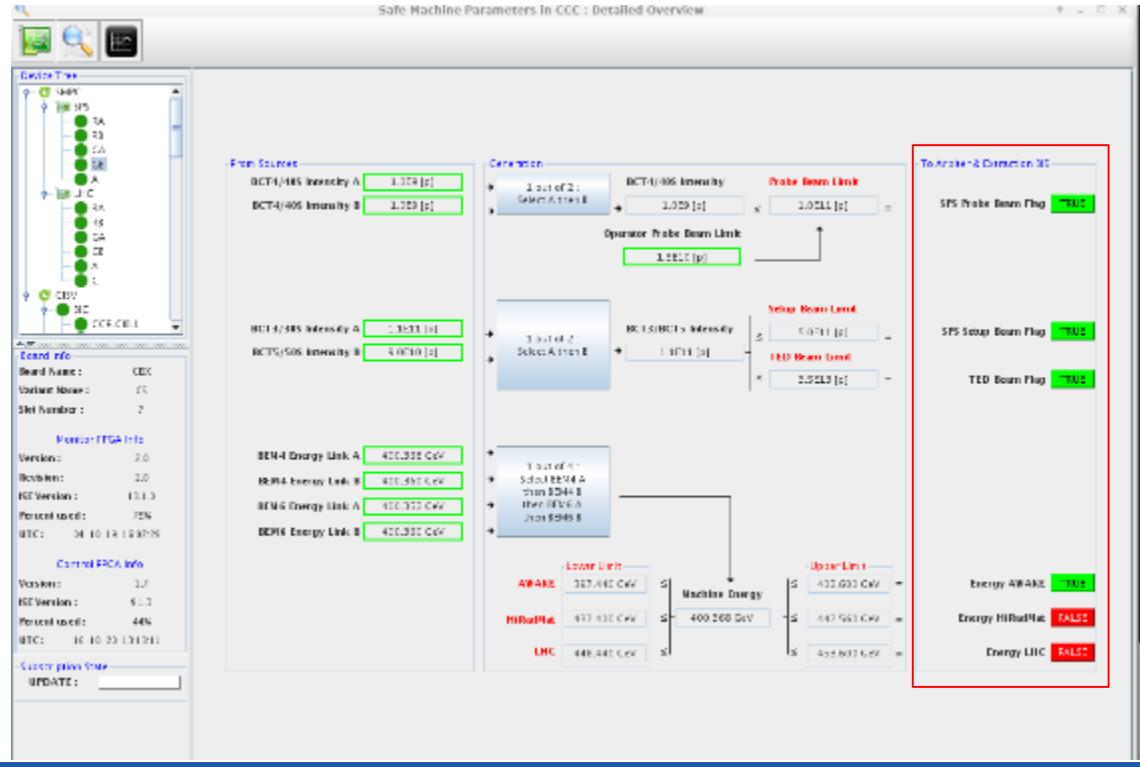
Python GUI for debugging

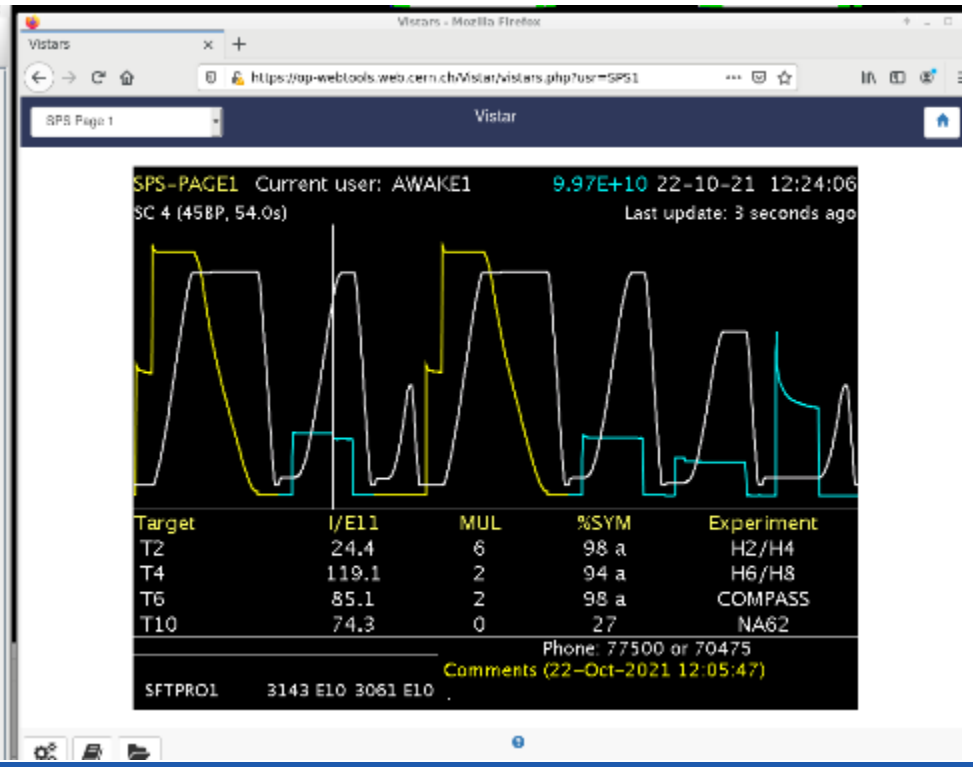


CIBU 2v0 Testbed platform

SMP – In operation - SPS

- Commissioning of **SMP** for both **SPS** and **LHC**.
- SMP-SPS operative since **February 2021**, **no problems encountered** during SPS operation:
  - **New Interlock flags** correctly delivered for protection of **Target Extractions Dumps** (TEDs)
  - Problems with **timing** network fixed during commissioning, mainly due to FESA2 to FESA3 change.





SMP consolidation project – SMP v2

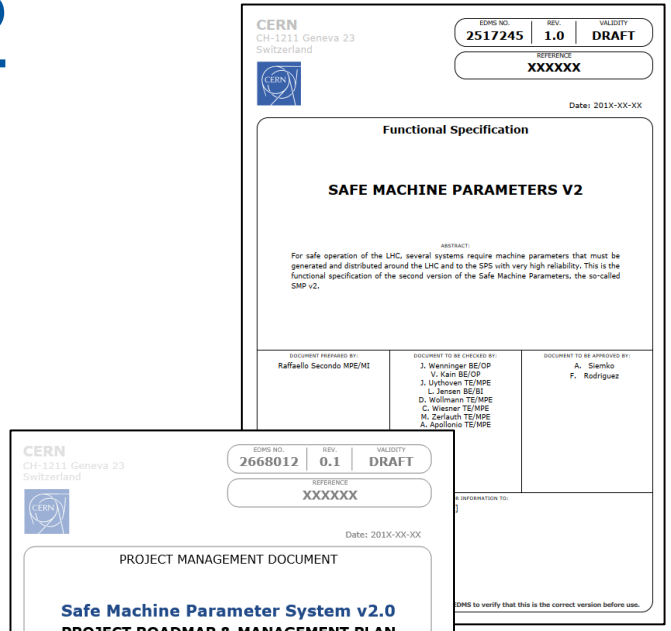
- Series of **SMP v2** technical meetings with all groups interfacing the system in particular: SY-BI, SY-ABT, BE-CEM, BE-CSS, BE-BI and BE-OP

- **Requirements** for **SPS** and **LHC well defined**, together with target Reliability and Availability levels.

- **Functional Specifications** published on EDMS together with **Project Roadmap and Planning** presented at Steering Board.

- **Request from Injectors** to possibly deploy an SMP for **LINAC4-PSB**

- Evaluation of design choices. **Hardware design** scheduled to start in **2022**.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Functional Specification

SAFE MACHINE PARAMETERS V2

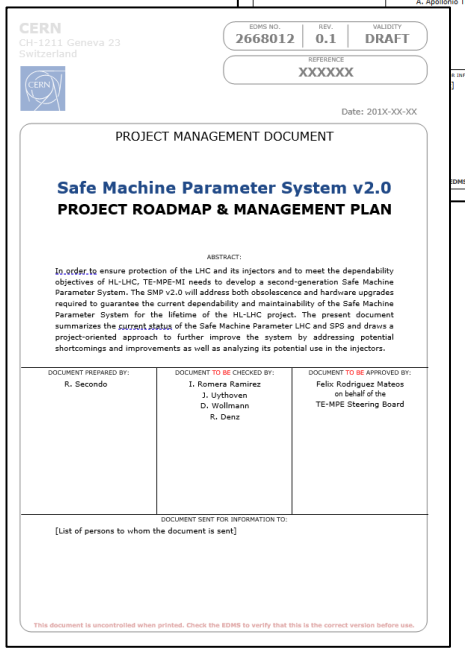
ABSTRACT:

For safe operation of the LHC, several systems require machine parameters that must be generated and distributed around the LHC and to the SPS with very high reliability. This is the functional specification of the second version of the Safe Machine Parameters, the so-called SMP v2.

DOCUMENT PREPARED BY: Raffaello Secondo MPE/MI

DOCUMENT TO BE CHECKED BY: J. Wenninger BE/OP, V. Kain BE/OP, J. Uythoven TE/MPE, L. Jensen BE/BI, D. Wollmann TE/MPE, C. Wiesner TE/MPE, M. Zerlauth TE/MPE, A. Apollonio TE/MPE

DOCUMENT TO BE APPROVED BY: A. Siemko, F. Rodriguez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PROJECT MANAGEMENT DOCUMENT

Safe Machine Parameter System v2.0
PROJECT ROADMAP & MANAGEMENT PLAN

ABSTRACT:

In order to ensure protection of the LHC and its injectors and to meet the dependability objectives of HL-LHC, TE-MPE-MI needs to develop a second-generation Safe Machine Parameter System. The SMP v2.0 will address both obsolescence and hardware upgrades required to guarantee the current dependability and maintainability of the Safe Machine Parameter System for the lifetime of the HL-LHC project. The present document summarizes the current status of the Safe Machine Parameter LHC and SPS and draws a project-oriented approach to further improve the system by addressing potential shortcomings and improvements as well as analyzing its potential use in the injectors.

DOCUMENT PREPARED BY: R. Secondo

DOCUMENT TO BE CHECKED BY: I. Romera Ramirez, J. Uythoven, D. Wollmann, R. Denz

DOCUMENT TO BE APPROVED BY: Felix Rodriguez Mateos on behalf of the TE-MPE Steering Board

DOCUMENT SENT FOR INFORMATION TO:

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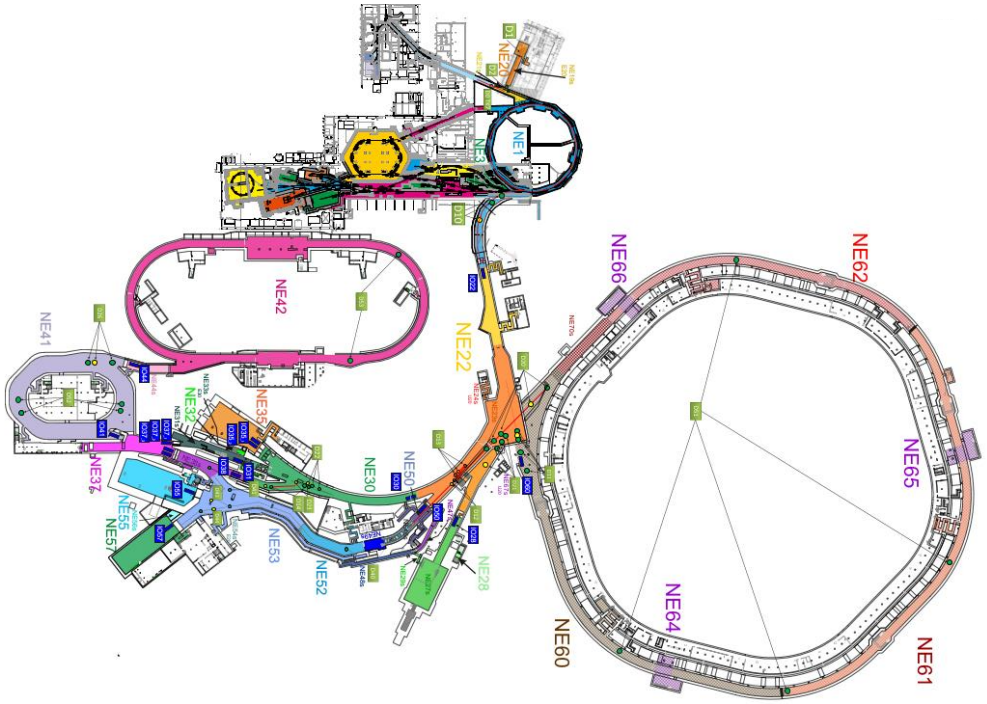
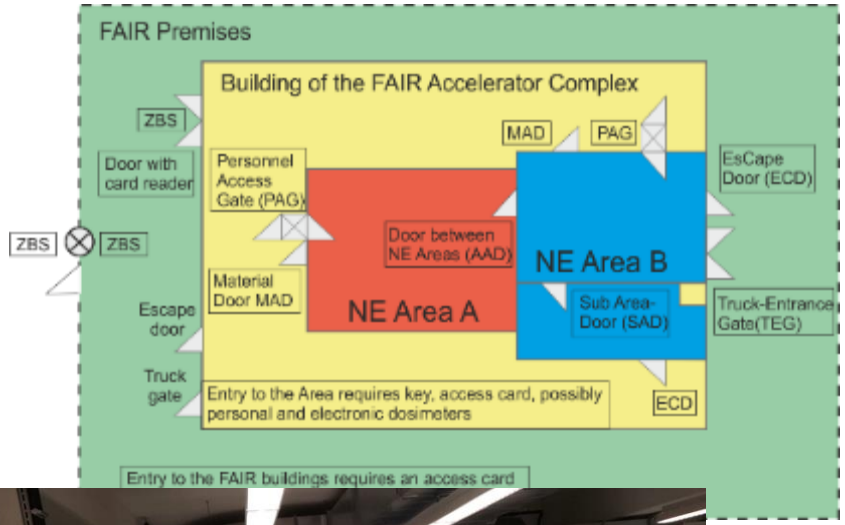
Personnel Access System prototype for GSI

GSI – CERN collaboration because of:

- CERN expertise in programming of safety PLCs
- CERN experience with accelerators and access systems
- CERN and MPE connections with GSI

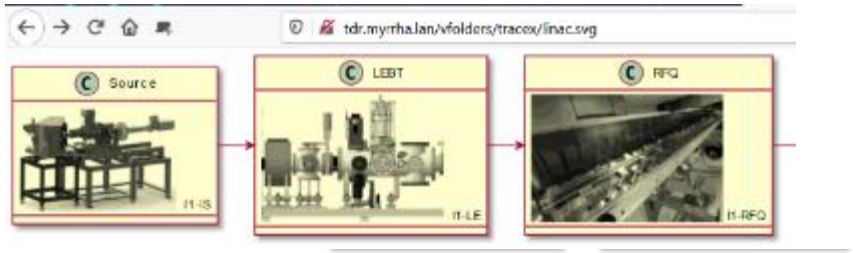


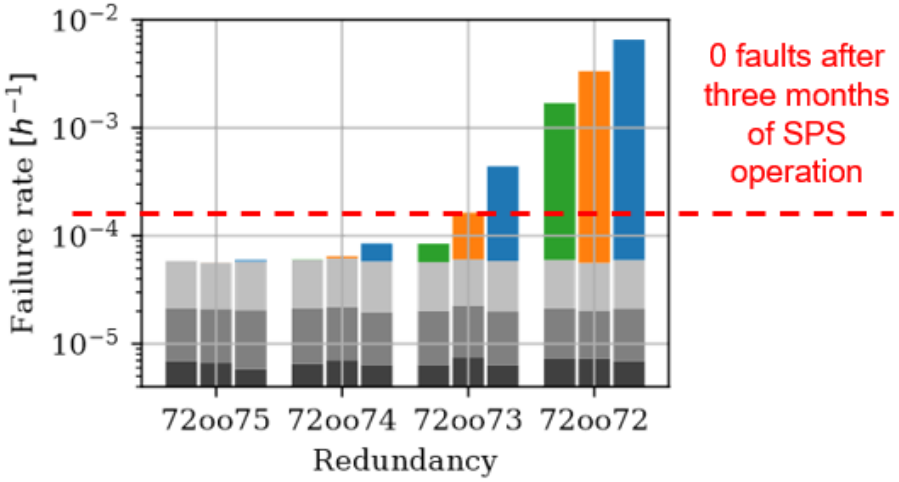


- ✓ First part of the system delivered and tested in the end of 2020
- ✓ Second (and last) part of the system delivered in October 2021
- ✓ Tests of the whole prototype system at GSI hardware test bench in November 2021 – **successful!**

PATRICIA/MYRRHA

- Collaboration with SCK-CEN (Belgium) on proton accelerator reliability
  - Extreme reliability requirement: 0.1 beam trips > 3 sec. per day
    - 2-3 Orders of magnitude above existing accelerators
- Plenary talk given at yearly collaboration meeting
  - Exposed non-accelerator community to reliability findings, challenges ahead and associated need for modelling and testing
- Automated fault tracking prototyped for CERN LINAC4 and MYRRHA accelerator test stand
- AvailSim4 extensively used for availability modelling
  - Preparing use of AvailSim4 software at SCK-CEN
- Availability modelling and assessment on schedule for deliverables in August 2022
- Completed SPS RF amplifier model is being validated

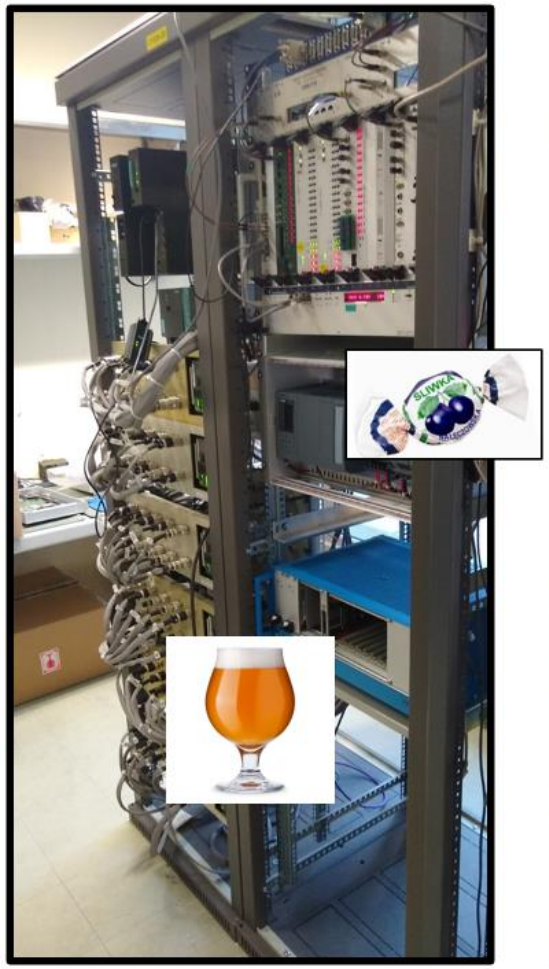


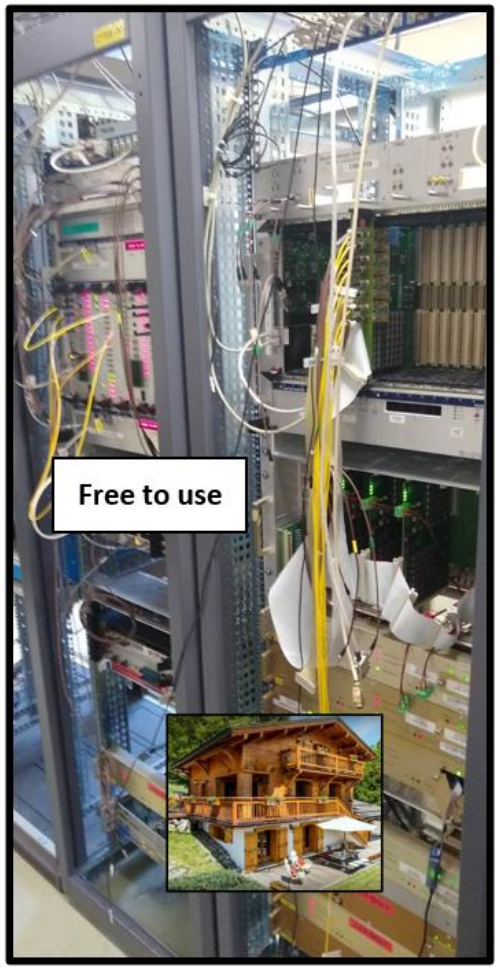


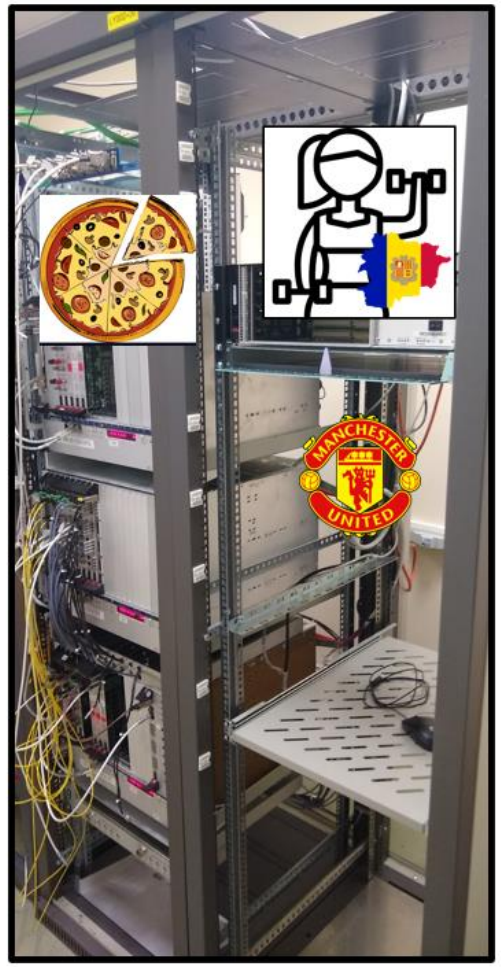
sck cen Belgian Nuclear Research Centre PATRICIA

Re-organization of lab space – below the BIS & PIC lab with rack space assigned to clearly identified individuals

Work started in bldg. 281 (ISR) for reception and testing of BIS2 and PIC2 components







Thanks Raffa