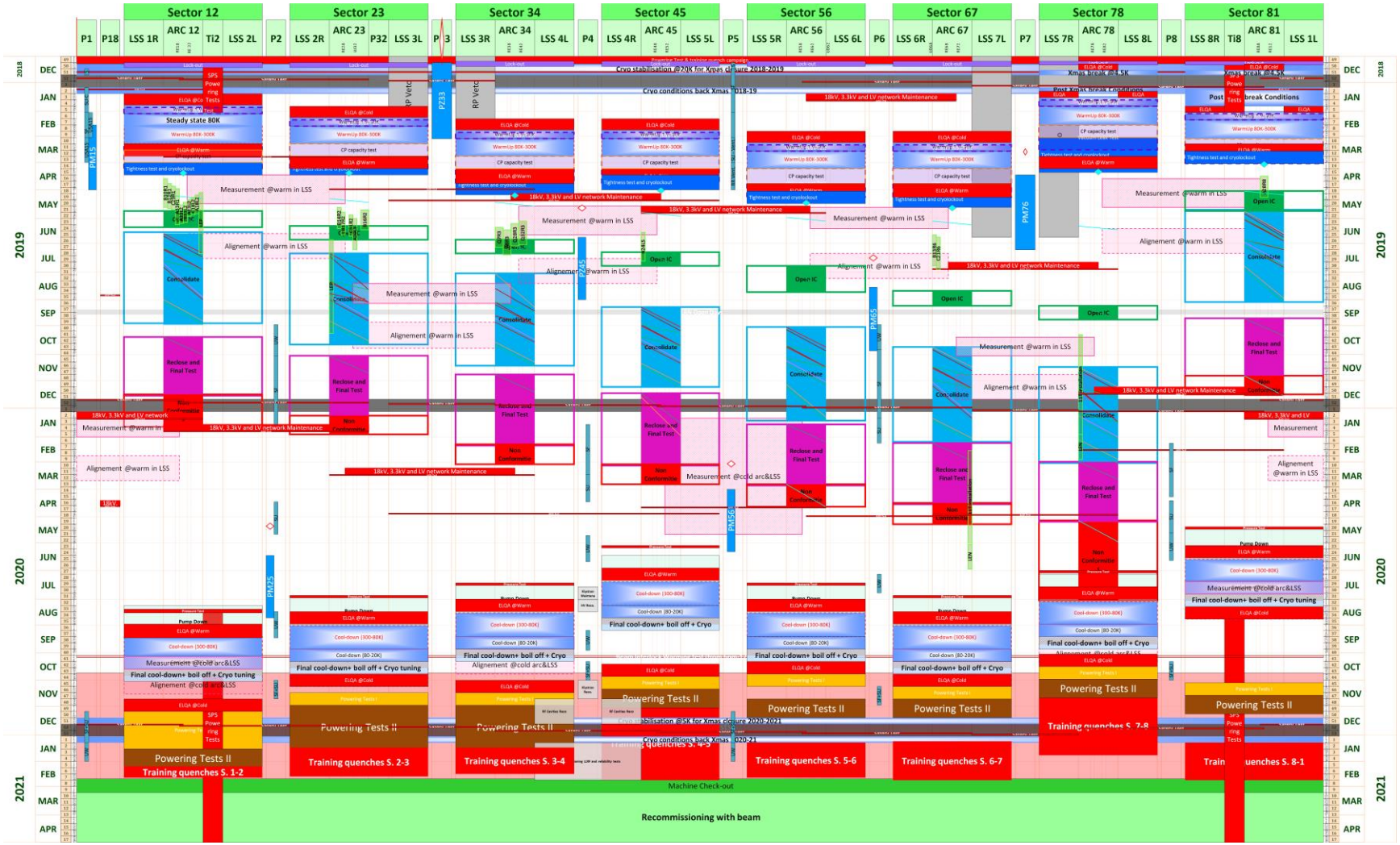
Status, Plans and Concerns for MPE Activities during LS2

Andrzej Siemko on behalf of MPE

LHC-LS2 - the frame planning



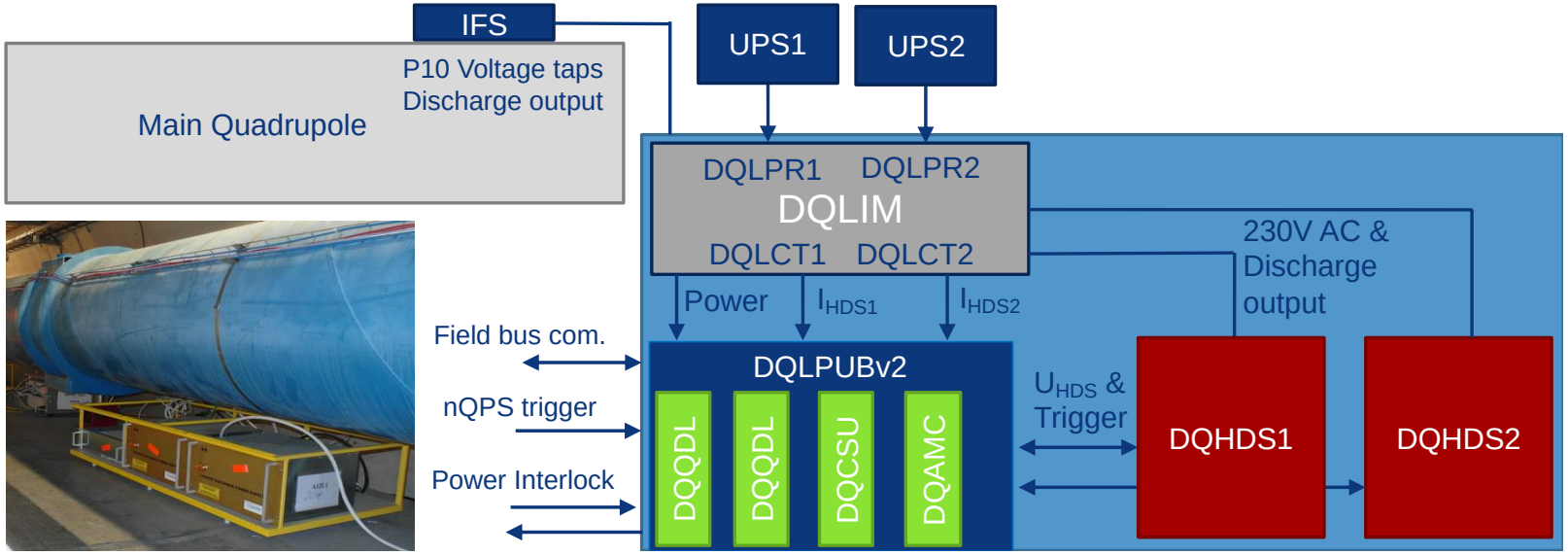
Outline

- Upgrade of DYPQ (yellow racks for main quadrupoles)
- Consolidation and upgrade of other Quench Detection Systems during LS2
- Maintenance of 600 A Energy Extraction Systems
- Maintenance and consolidation of 13 kA Energy Extraction Systems
- Consolidation of Current Leads Regulators
- HL-LHC 11T dipole protection racks
- Deployment of WIC and BIS Interlock Systems
- MPE-EM production of electronics for LS2
- MPE involvement in DISMAC Project

- ELQA campaigns during LS2
- LHC magnet circuit re-commissioning

Upgrade of DYPQ yellow racks

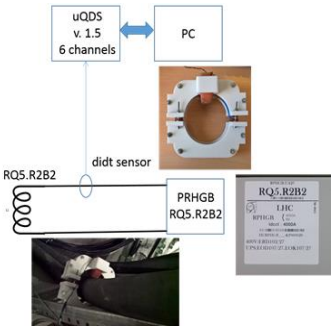
- Production readiness review of the new QDS electronics (DQLPUBv2 chassis) on 09/08/2018 released the series production
- Series production of DQLPUBv2, interface modules DQLIM, power supplies DQLPR and harnesses is handled by TE-MPE-EM section
  - Concern about the delivery time of some components though generally on time
- Current transformers DQLCT being manufactured. Quality control issues at the supplier are delaying the production but on time
- Series production of all power components and QDS for one LHC sector (52 crates) is expected to be completed in **February 2019**. Remaining QDS electronics will be produced by end of May 2019



Consolidation and upgrade of other quench detection and associated systems

- Upgrade of quench detection systems for ITs
  - Replacement of obsolete detection boards by new generation QDS
  - Intermediate solution in point 1 & 5 until HL-LHC, long term for point 2 & 8

- New dIdt sensors for 600 A and IPQ/IPD circuits
  - Type testing ongoing; next test in LHC during the powering tests in December
  - Design of compatible 3 channel quench detection boards started
  - Pilot installation of dIdt sensors during LS2 for potentially critical circuits. Remaining circuits will be equipped with dIdt sensors during LS3



- Radiation tolerant field-bus controller
  - Design started – deployment during LS2 feasible for "hot" zones in dispersion suppressor areas around IP1 & 5
    - Required for HL-LHC operation after LS3

Maintenance of 600A EE systems (1)

- Inspection and standard maintenance are planned to be carried out on all 202 EE systems for 600A
  - More than 10 check points per system will be executed → (Sep - Nov) 2019
    - Maintenance of the circuit breakers (606 pcs)
    - Inspection of all power connection (circuit breakers, bus bars, equalising resistors, dump resistors)
- Individual System Tests (IST)
  - Required services
    - 230V mains and UPS powering to the racks
    - Access
  - Functional tests & Interlock tests
- HWC performance validation

600A EE system racks

Activities on 600A EE systems (2)

- Preparation prior to LS2
  - Instrumentation, tools, other auxiliary equipment – ready
  - Manpower – ensured
    - A team of three persons from BINP (Russia) will be at CERN for 9 months
- Concern
  - Proper protection of the EE system racks must be ensured during water-cooled cable replacement by EN-EL/CV
  - During LS1 in UA67, 8 racks with 16 EE systems were literally flooded by the maintenance of CV!

Water leak during LS1

Maintenance and consolidation of 13kA Energy Extraction systems (1/2)

- More than ten important activities are planned to be carried out. Here are the main ones:
  - All 256 circuit breakers will be taken out from the LHC tunnel for detailed revision and consolidation after 12 years of operation → (Jan – Sep) 2019
    - Resolving the arcing contact issue, replacing micro-switches, etc.
  - Dump resistors
    - Inspection and consolidation of the critical power connections (silver coating, multi-lamella contact replacement), new temperature sensors
  - General maintenance of the 13 kA EE systems → (Jan-Mar) 2020
    - Set up the EE systems back in operational state – tuning, adjustment, check up the control and the auxiliary hardware

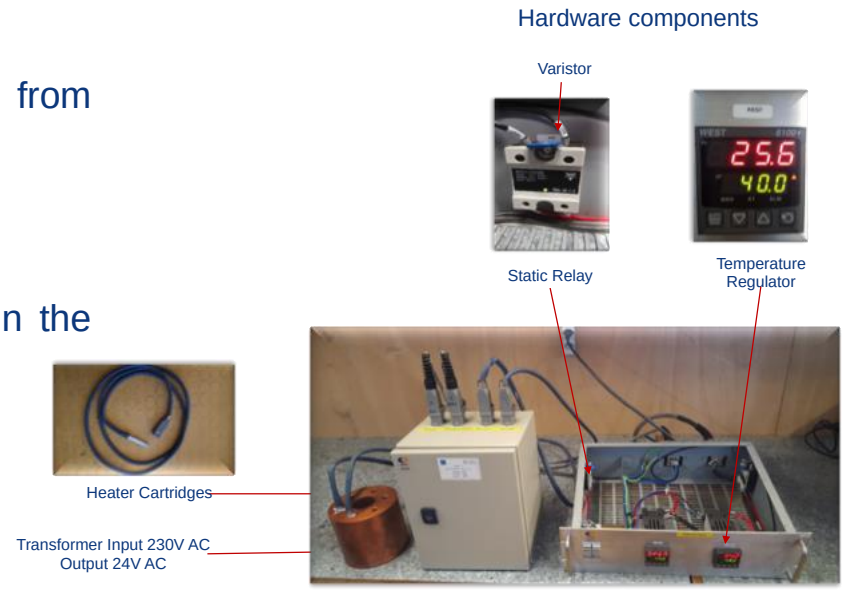
Circuit breakers and busbars

Arcing contact failure

Consolidation of CL's regulators

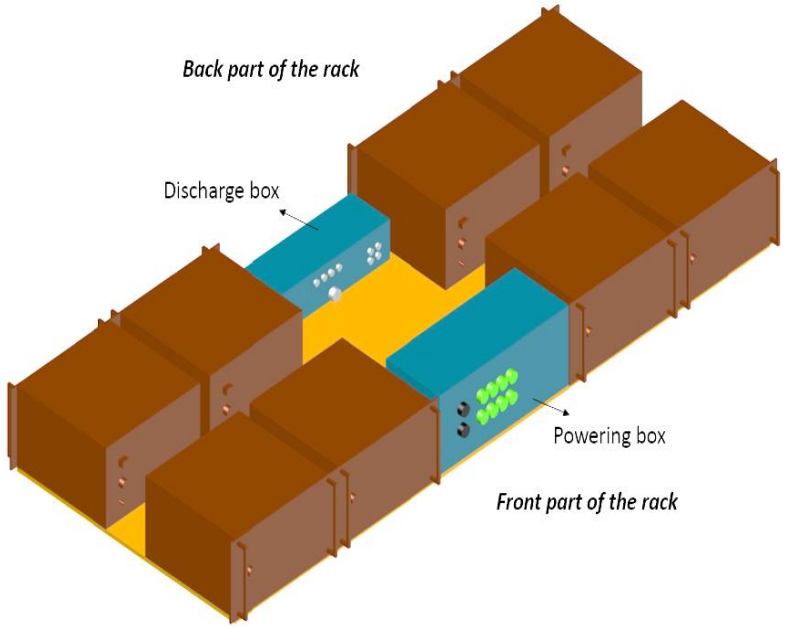
- Activities during LS2:
  - Remove and transport control units (~390 crates) from the tunnel to the lab
  - Replacing the old components by new ones
  - Functional verification of the system in the lab
  - Transport and re-installation of the control units in the LHC tunnel
  - Final verification of the entire system in the tunnel

- Activities **before** LS2:
  - Purchasing of spare components (order for 50% of regulators has been placed)
  - Type test of new components in the tunnel during Technical Stop – done
  - Validation of the new components in CHARM facilities (radiation effect in RR73 and RR77) – ongoing
  - Programming and testing all regulators (about 1500 including spares) on surface before their installation
  - Space area for the consolidation of CL's regulators is identified but still not provided and not equipped – critical now!!



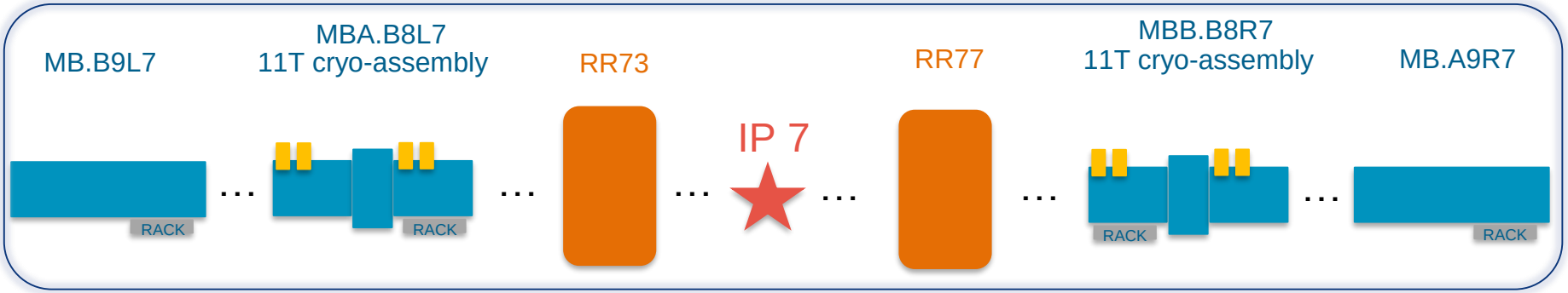
HL-LHC 11T Dipole Protection Racks

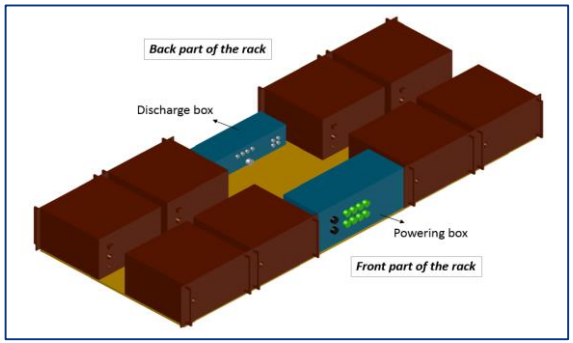
- Conceptual design of the new rack for the 11T dipole protection finished (new heater power supplies, interface modules and powering boxes)
- DQHDS Prototype Zero being irradiated in CHARM
- Prototype design & manufacturing completed by the end of 2018 (TE-MPE-EM)
- Final specifications and green light for series production by April 2019
- Acceptance tests of series production in October 2019
- Installation of 11T dipole protection racks foreseen in July 2020

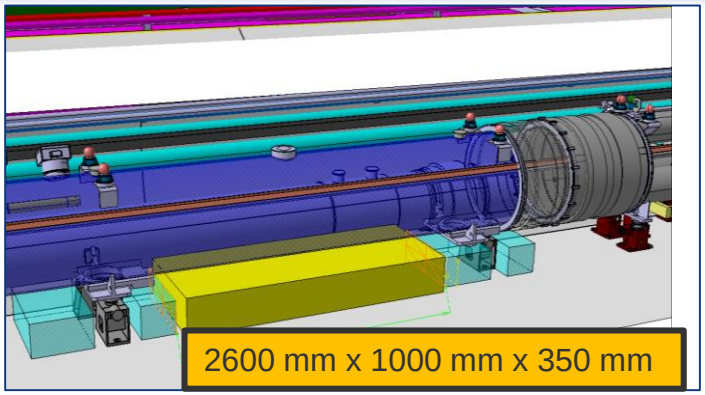


11T protection racks integration and related ECR

- MPE prepared and approved internally a document containing all the changes required for the installation, commissioning and operation of the 11T magnet assemblies around P7
- This document was afterwards inserted into the general ECR handled by TE/MSC, which received no comments on the MPE chapters
- MPE considers closed all integration aspects for the related protection equipment



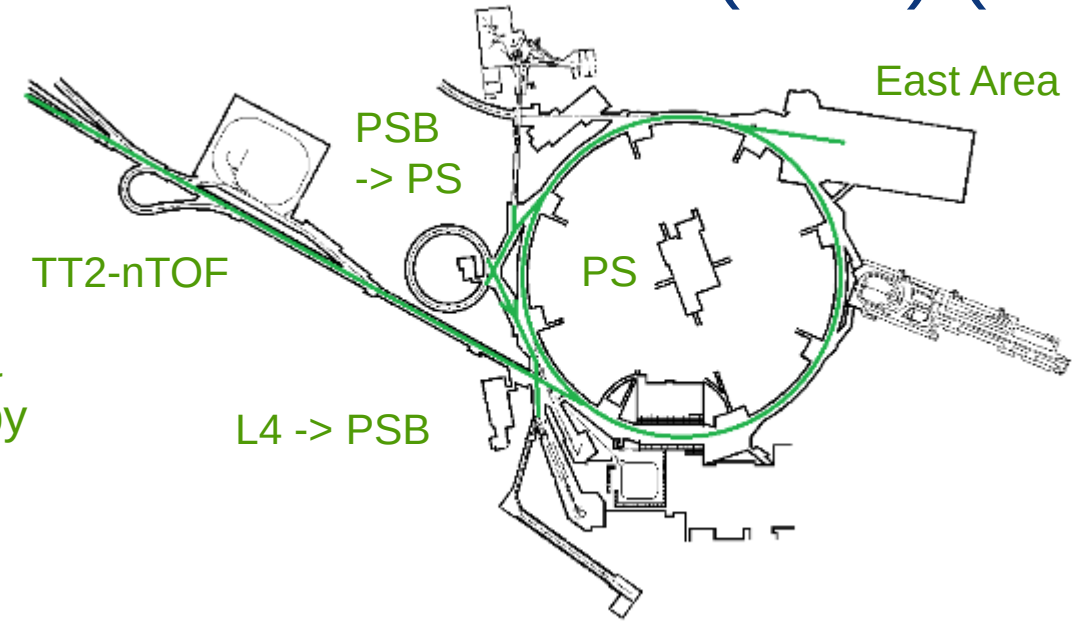




Warm Magnet Interlock Controller (WIC) (1/2)

5 new WIC systems to install during LS2

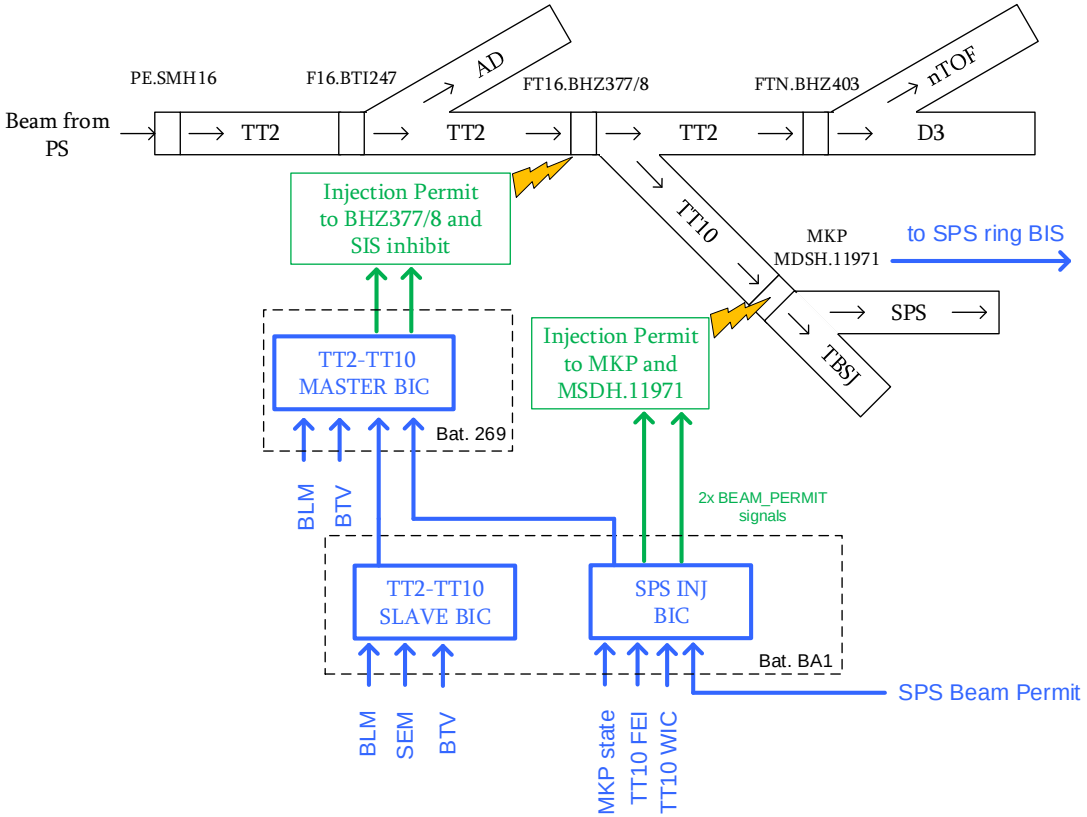
After LS2, the full proton & ion chain will be covered by WIC systems



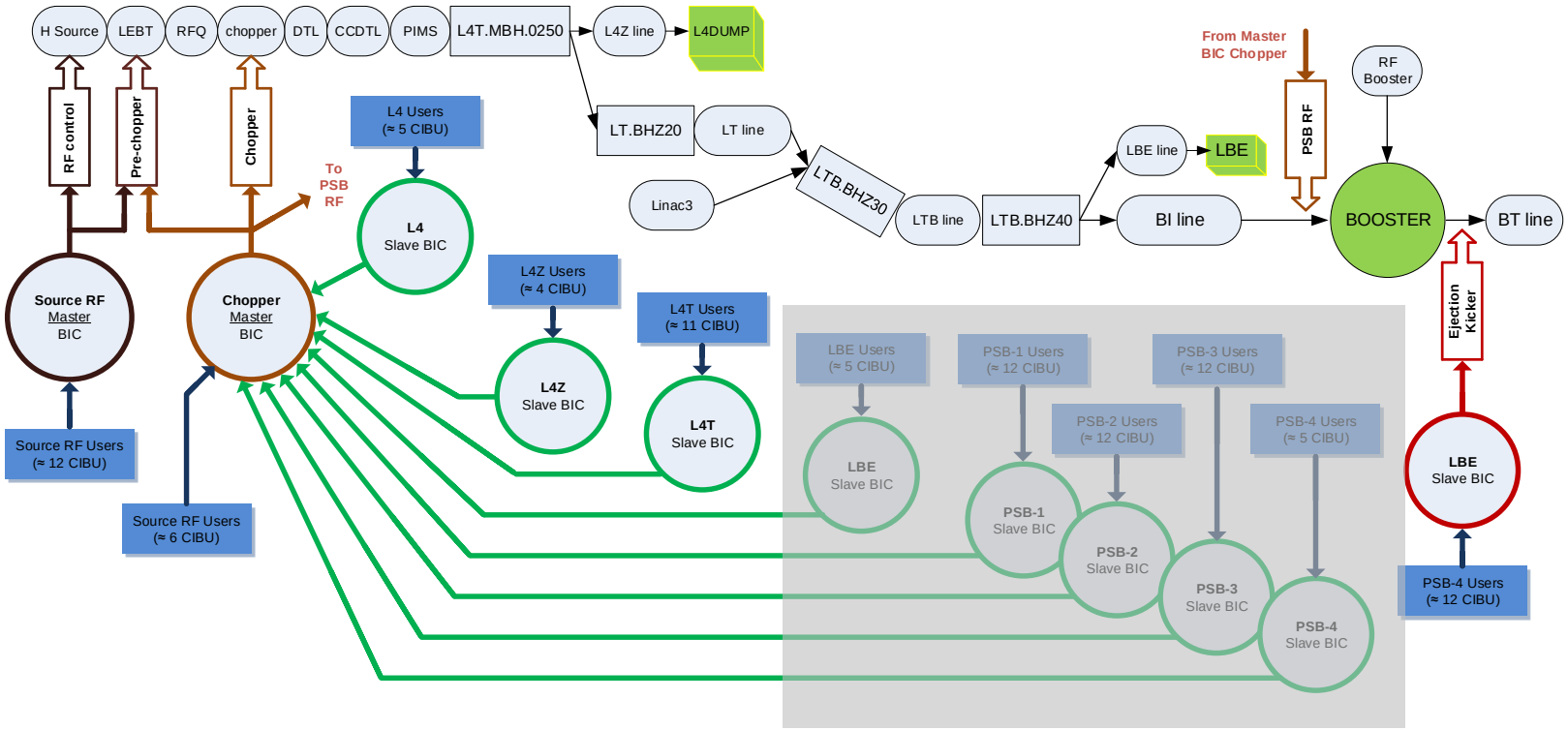
Projects	PLAN	Engineering Specification	ES Status	HW ready	Lab tests completed
L4 to PSB TLs	11109	EDMS 1701479	Released	Yes	Yes
PSB to PS TLs	10819	EDMS 1701480	Released	Yes	Q4 2018
TT2 + nTOF TLs	10811	EDMS 1701477	Released	Yes	Yes
PS Aux	10809	EDMS 1701483	Under Approval	Yes	Q4 2018
East Area	10812	Q4 2018	Draft	Q2 2019	Q4 2019

New Injection Beam Interlock System SPS

- A new Beam Interlock System (BIS) will be deployed for the SPS injection
- It will provide a highly dependable interlocking solution following the LIU consolidation
- In addition, the SPS-ring BIS will be reconfigured following the SBDS relocation



BIS LINAC4 – PSB



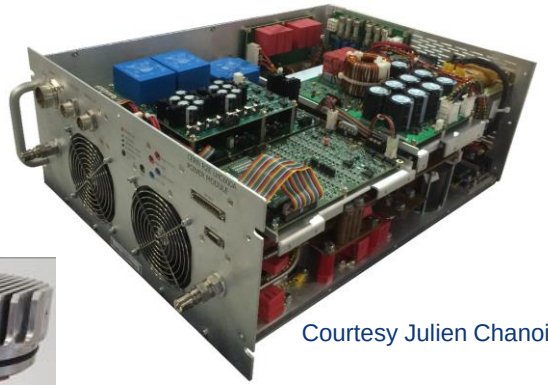
- Deployment of the 4 new Beam Interlock Controllers for the LBE line and PSB-1 to PSB-4 in building 361
- Connect and commission ≈ 50 User Interface (CIBU)

MPE-EM production of electronics for LS2 – examples and concerns

Courtesy Vicente Herrero

TE-EPC R2E-LHC600A-10V project:

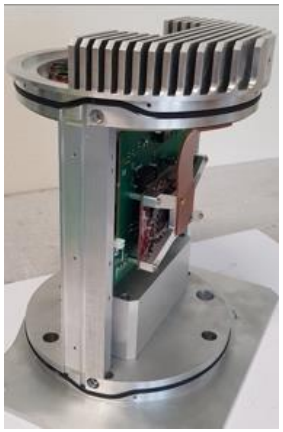
- 23 different types of electronic cards
- **Total amount of 5'402** electronic cards
- 2'004 pcs already delivered



Courtesy Julien Chanois

TE-EPC R2E [4-6-8kA; 8V] project:

- 17 different types of electronic cards
- **Total amount of 5'125** electronic cards
- 2'845 pcs already in production



Courtesy Hamza Boukabache

HSE-RP CROME project:

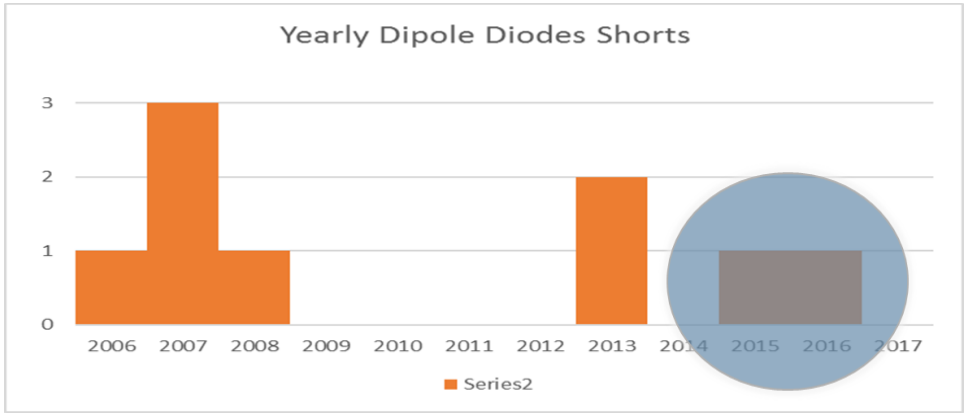
- 22 different types of electronic cards
- **Total amount of 450** electronic cards
- 125 pcs already delivered

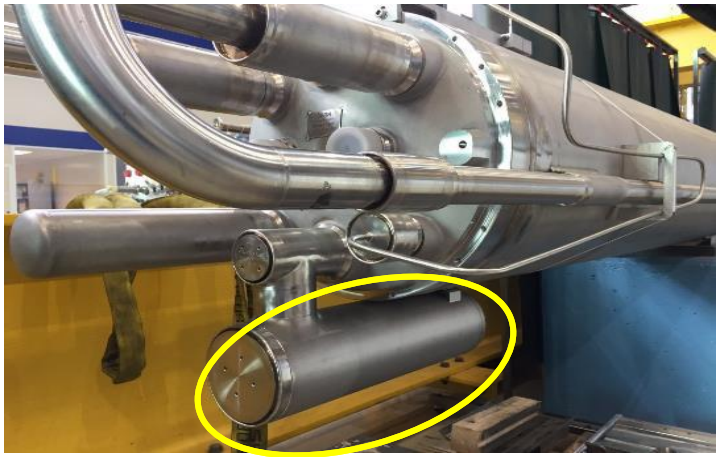
Concerns:

- **Availability and delivery lead time** for a number of standard components
- **Late production requests**, like for example SMB-SC request to produce **a total of 1250** electronic cards of 3 different types for the monitoring system. Request was received on 27/09/2018

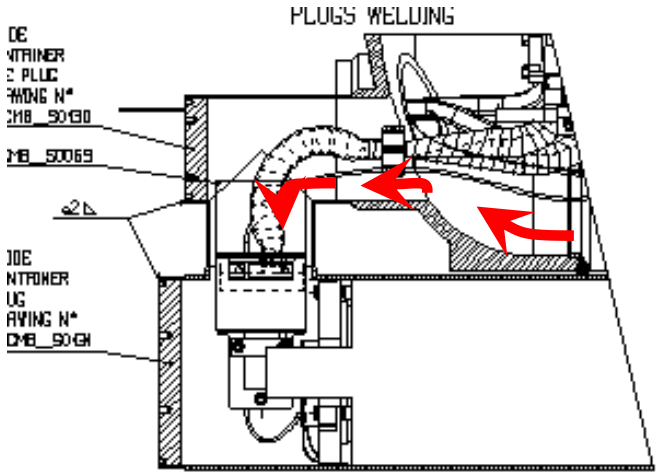
DISMAC Project: The Root Cause

- 9 short circuits to ground localised since 2006 on the main dipole circuits in the dipole diode containers
- 7 first ones fixed by opening and cleaning as LHC was at or close to room temperature
- 2 last ones in 2015 and 2016 during training (quench) campaigns **so at cold**





- Created by metal debris, present in the dipole cold mass, transported by the helium flow (warm-up, cool-down, flushing and quench)

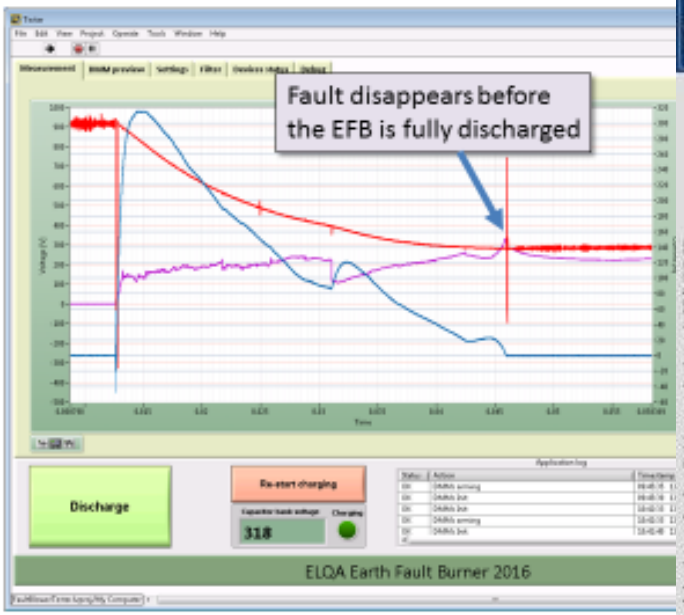


DISMAC Project: The Root Cause

- The 2 short to ground noticed at cold were removed thanks to the Earth Fault Burner (EFB)
  - No warm-up necessary

Earth fault burning

- ✓ The discharge is initiated remotely from the CCC .
- ✓ Dedicated application automatically records and stores the measurement curves from 6 measurement channels.

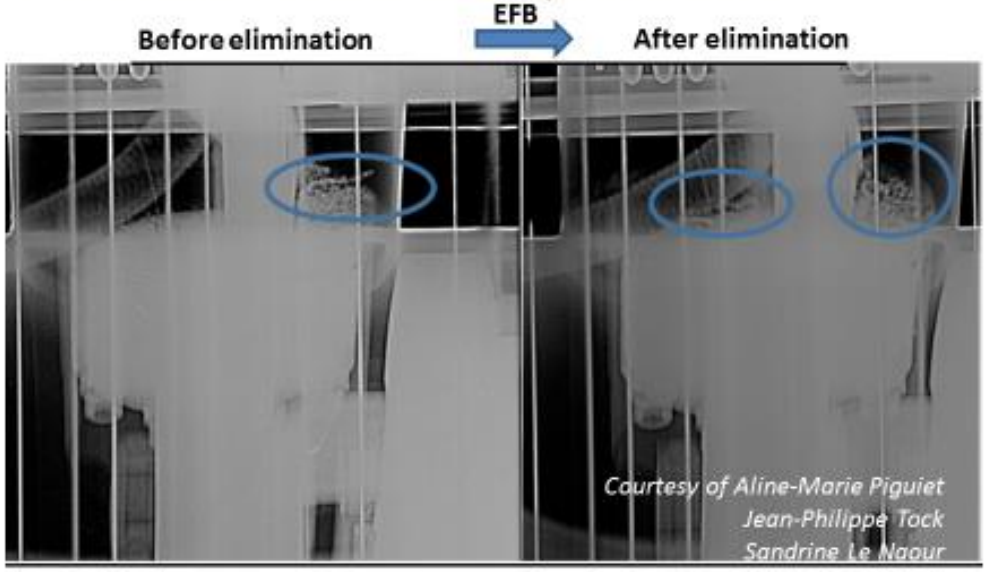


Chamonix, Full energy exploitation 24/01/2017, Mateusz Bednarek, TE/MPE-EE

Final X-ray

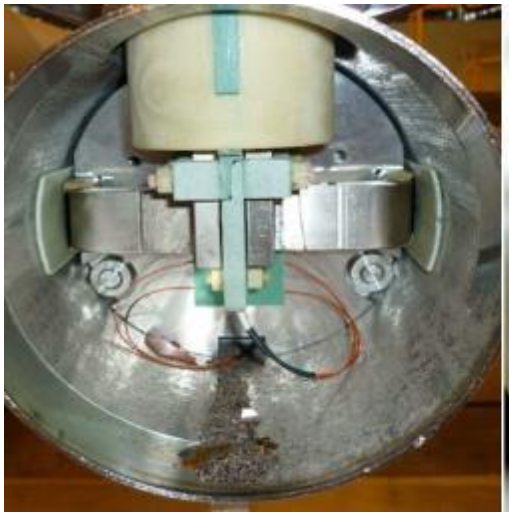
All standard qualification tests passed:

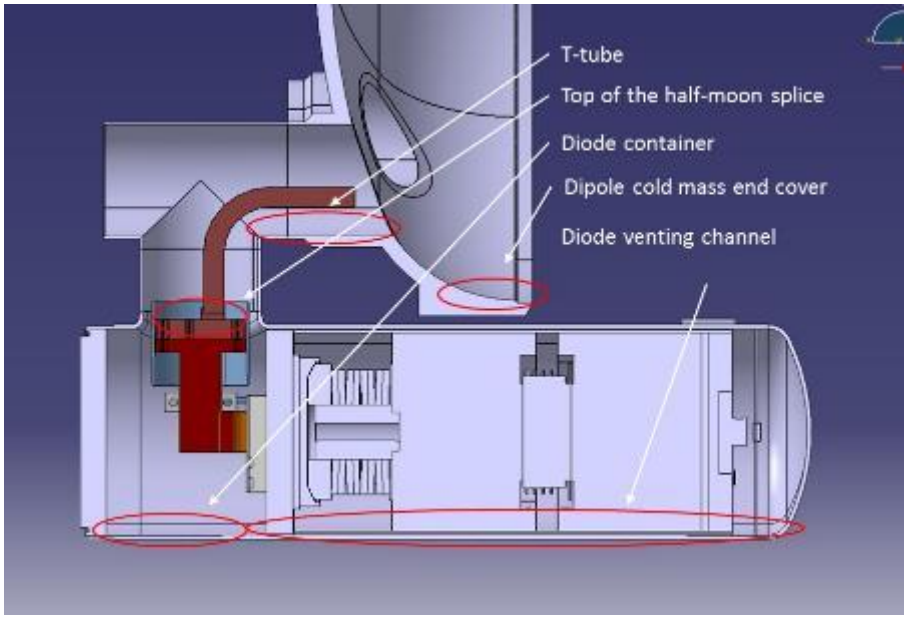
- The fault was successfully eliminated



TECHNICAL SOLUTION : 3 main actions

1 Removal of accessible (metal) debris

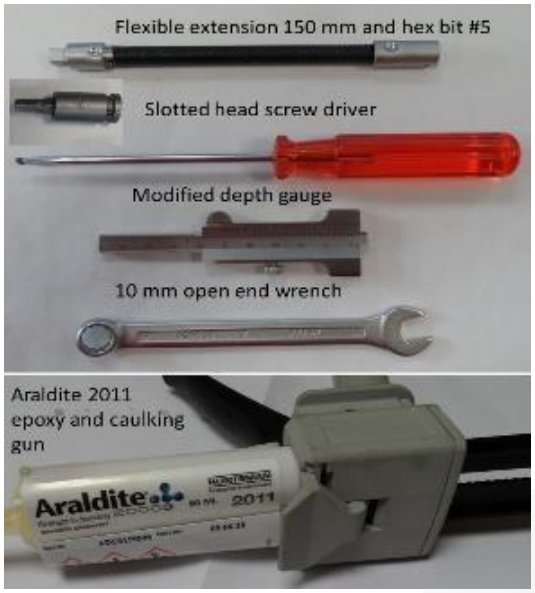


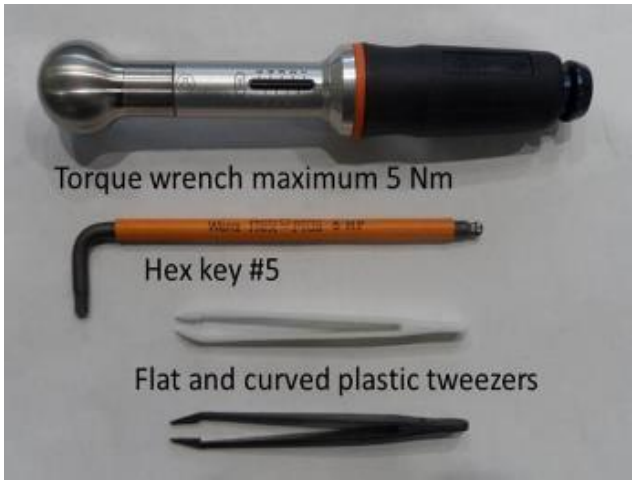


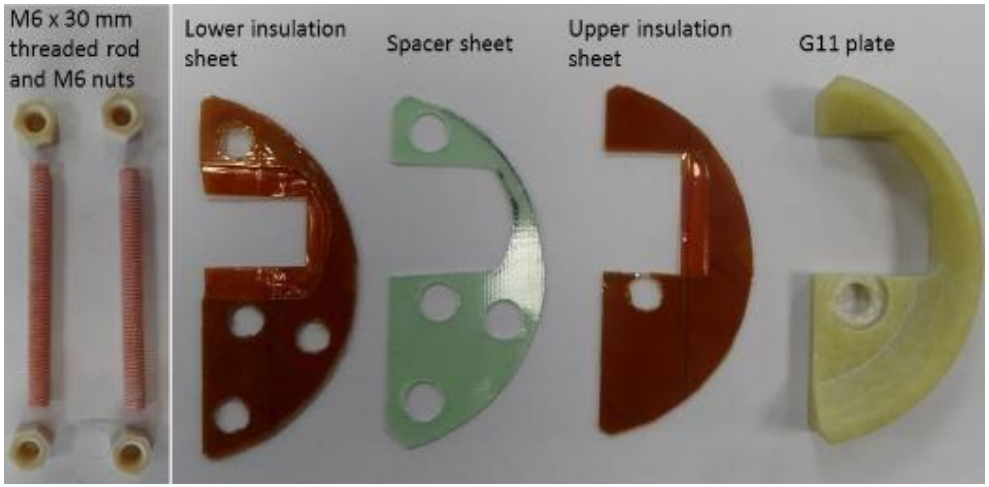
Courtesy J-Ph. Tock

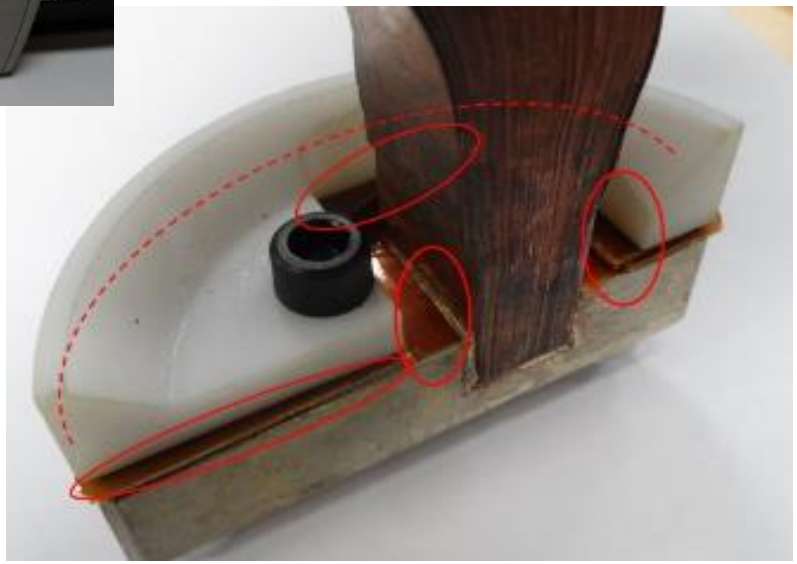
TECHNICAL SOLUTION : 3 main actions

2 Installation of *optimised* half-moon insulation pieces (1/2)







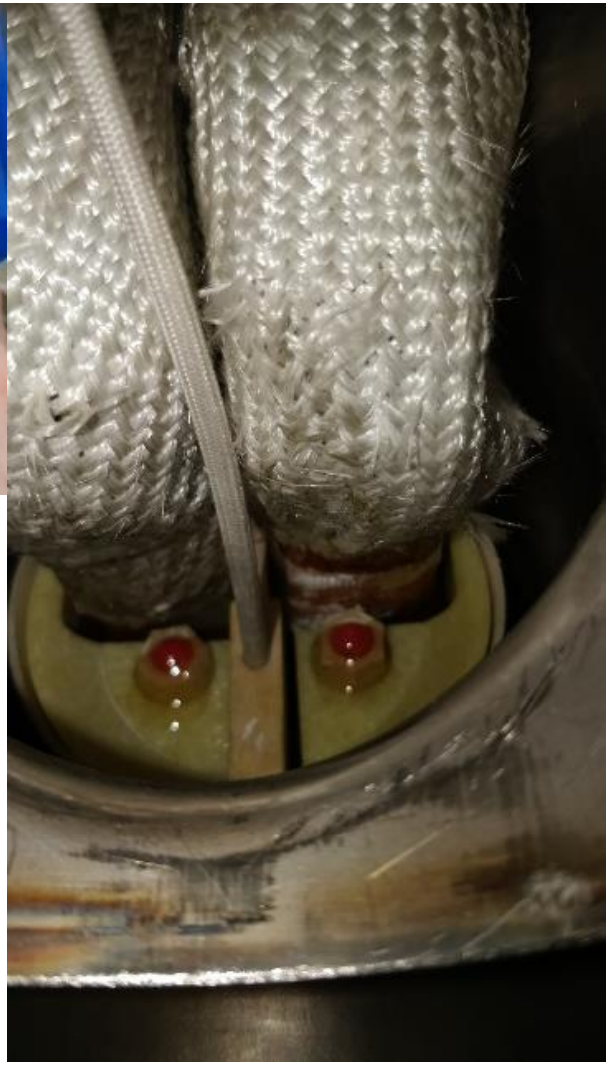


Courtesy J-Ph. Tock

TECHNICAL SOLUTION : 3 main actions

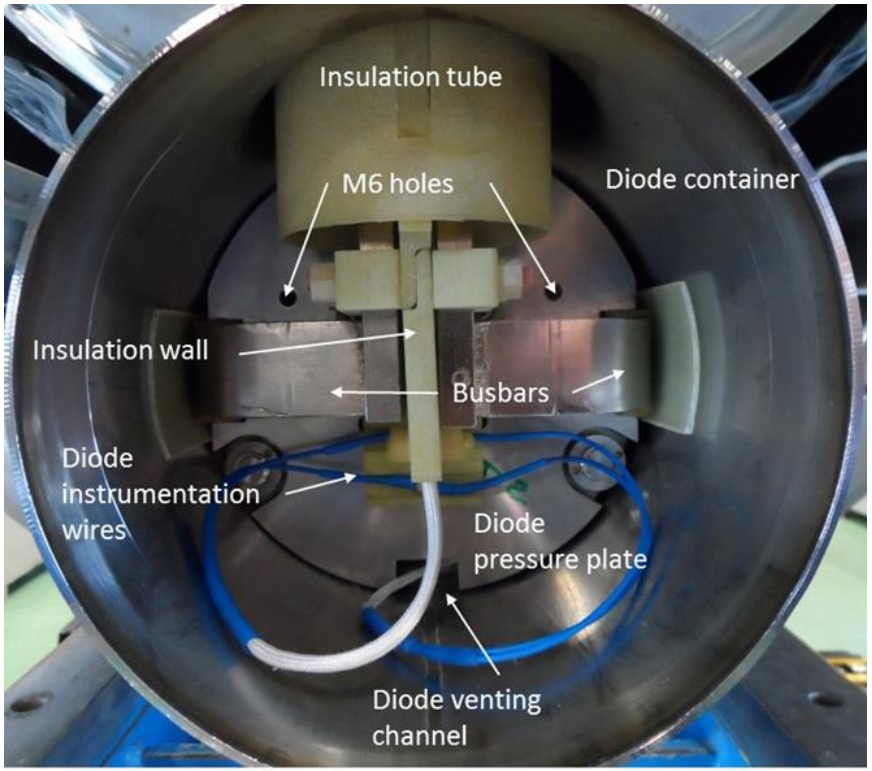
2 Installation of *optimised* half-moon insulation pieces (2/2)

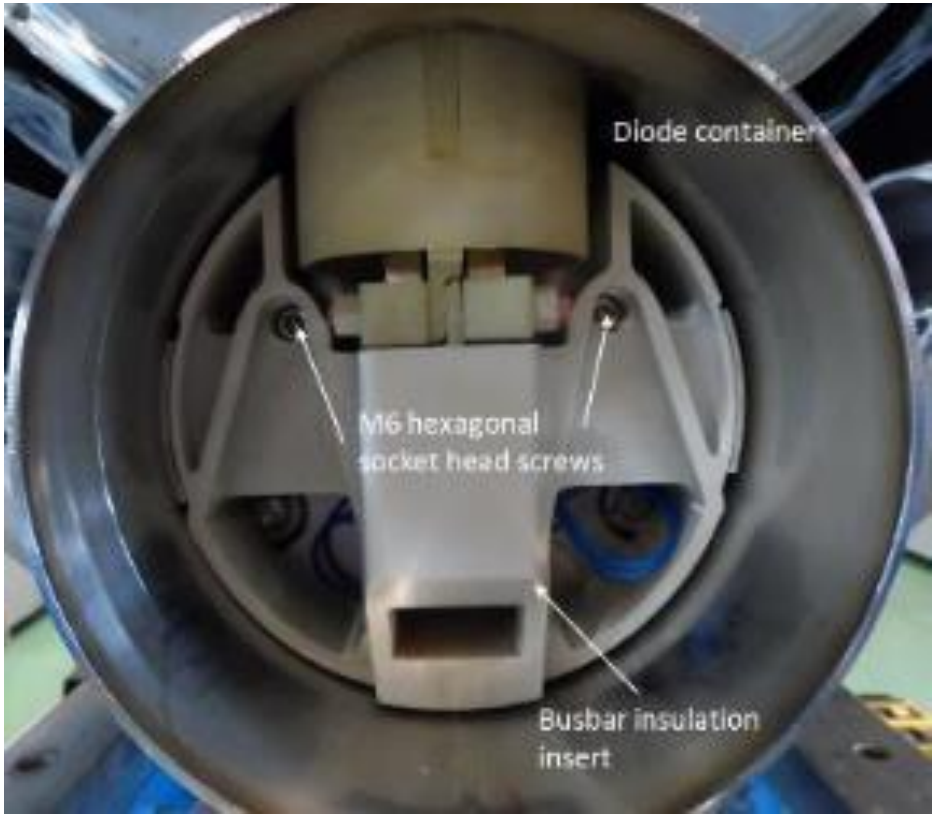
Courtesy J-Ph. Tock



TECHNICAL SOLUTION : 3 main actions

3 Insulation of diodes bare busbars ; insert installation



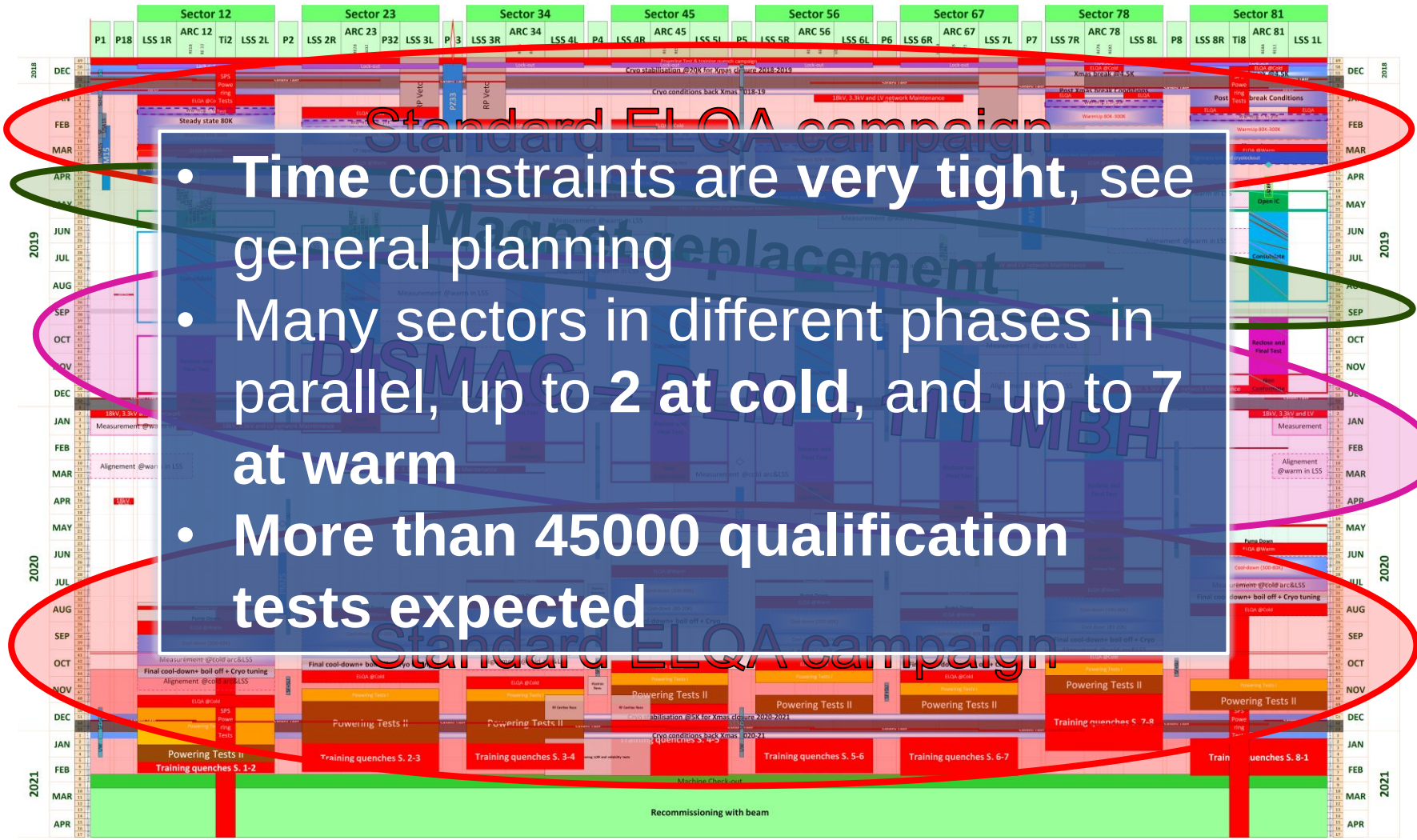


Courtesy J-Ph. Tock

ELQA campaignes during LS2

- ELQA activities are at the core of LS2 project
  - ELQA campaign at cold state of LHC starts the LS2 project in December 2018
  - ELQA will be the last part of the LS2 project giving the green light for the powering tests and restart of the LHC

LHC-LS2 the frame: ELQA activities



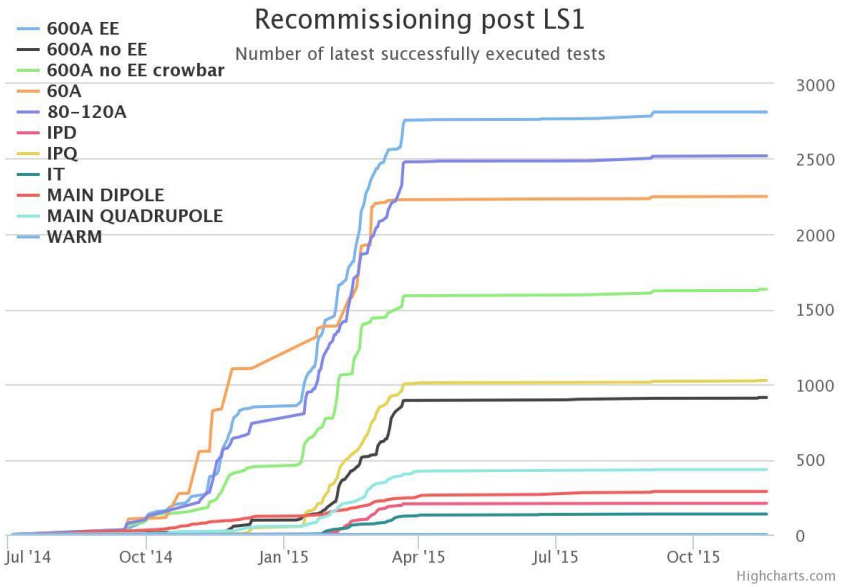
- **Time** constraints are **very tight**, see general planning
- Many sectors in different phases in parallel, up to **2 at cold**, and up to **7 at warm**
- **More than 45000 qualification tests expected**

LHC-LS2: ELQA resources

- Manpower:
  - 5 staff + 22 PJAS + 2 Fellows
- Measuring systems:
  - Upgraded 8 TP4 + 2 AIV measuring systems are ready
  - 4 Diode Lead Measuring (DLM) systems under development
- Concern:
  - Network coverage in the tunnel is mandatory for functioning of ELQA measuring systems
  - Maintenance Lab for ELQA measuring systems still needs to be organized

Powering Tests post LS2

- **Plans:**
  - "Business as usual" for majority of circuits, similar to previous HWC campaigns
  - HWC procedure + test sequences in AccTesting for the RB's (EDMS 874713) will have to be modified to take into account the 2 sectors with the 11T
  - Powering parameters (EDMS 1375861) will be updated for the 7TeV optics
- **Status:**
  - Work in progress for integration of new DYPQ and 11T controls
  - Work in progress for full analysis automation of 600A circuits
- **Concerns:**
  - Timely analysis of about 20 dipole quench events per day (in case we train 8 sectors in parallel to 12 kA) , also taking into account the analysis of other tests



Conclusion

- All TE-MPE LS2 projects are advancing well, according to the schedule
- LS2 project will be a big challenge to all MPE group members
- ELQA activities are at the core of LS2 project
- I have no doubt that HNINP ELQA team will face and challenge all ELQA challenges during the whole LS2 project

Please remember and respect our priorities during LS2

- The third priority: LS2 SCHEDULE
- The second priority: LHC PERFORMANCE
- The first priority: YOUR SAFTY

Thank you for your attention!