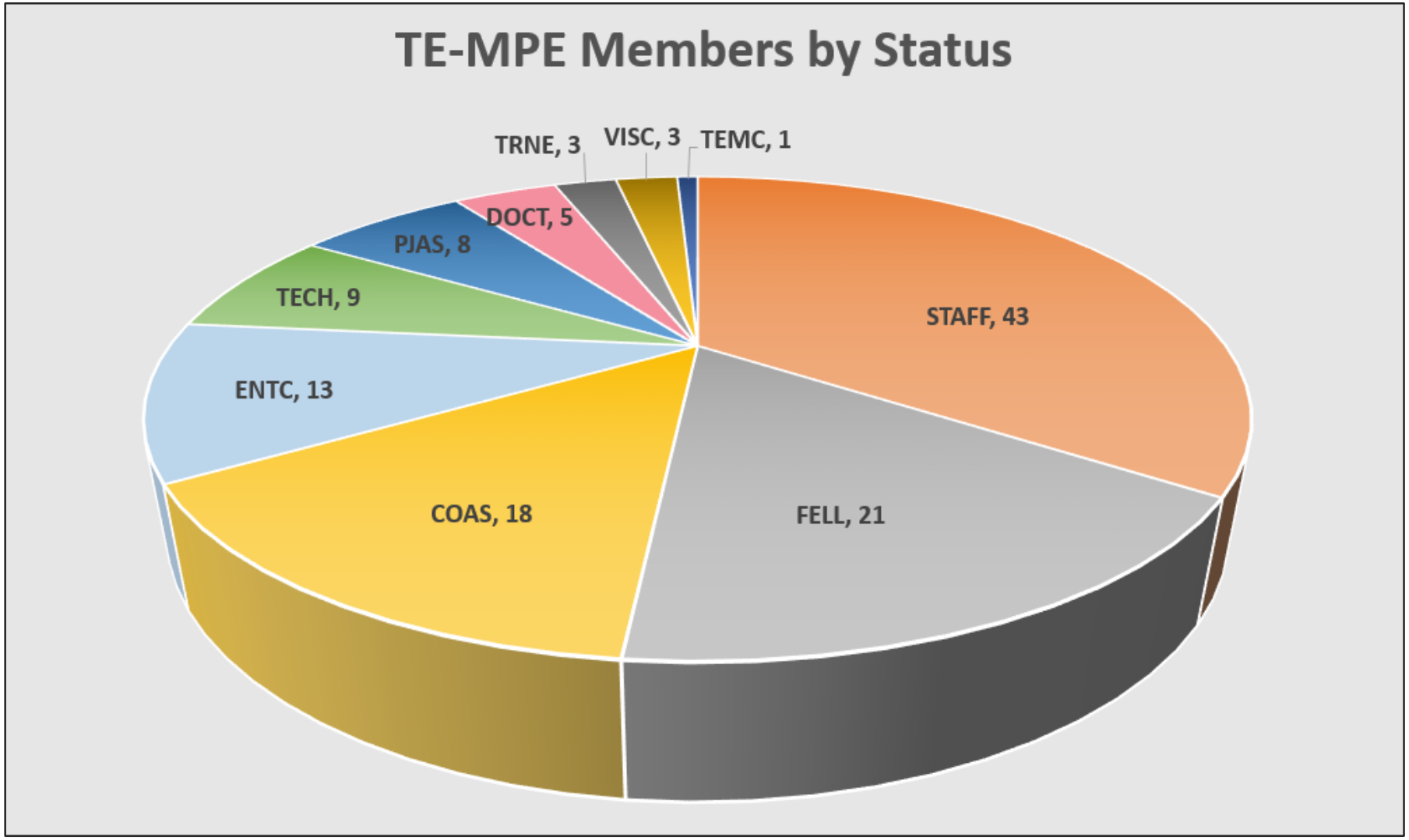

CERN

TE-MPE Group Meeting

07 December 2017

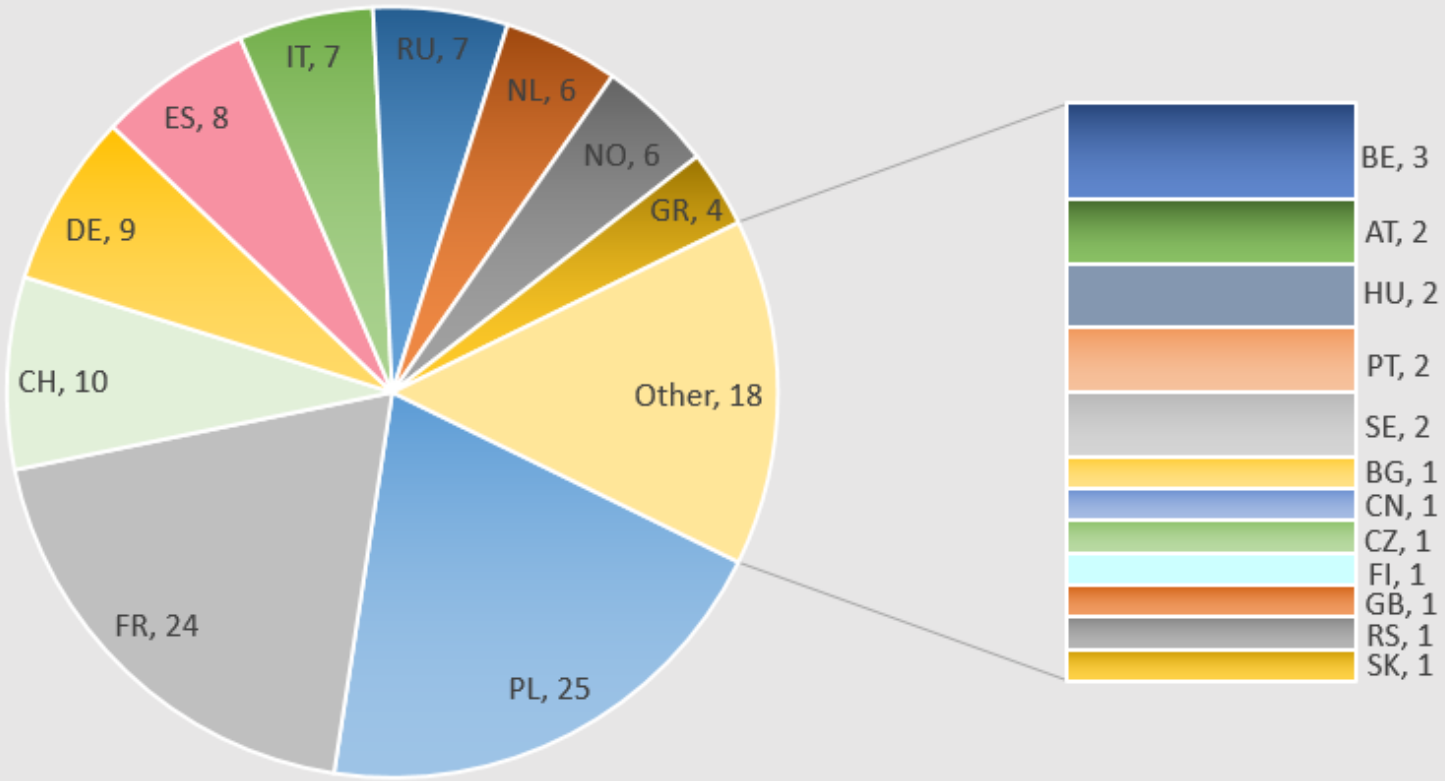
Outline

- MPE group in numbers
- MPE car pool
- LHC operation in 2017
- Highlights of the MPE Sections in 2017
- Projects, priorities and main objectives for 2018

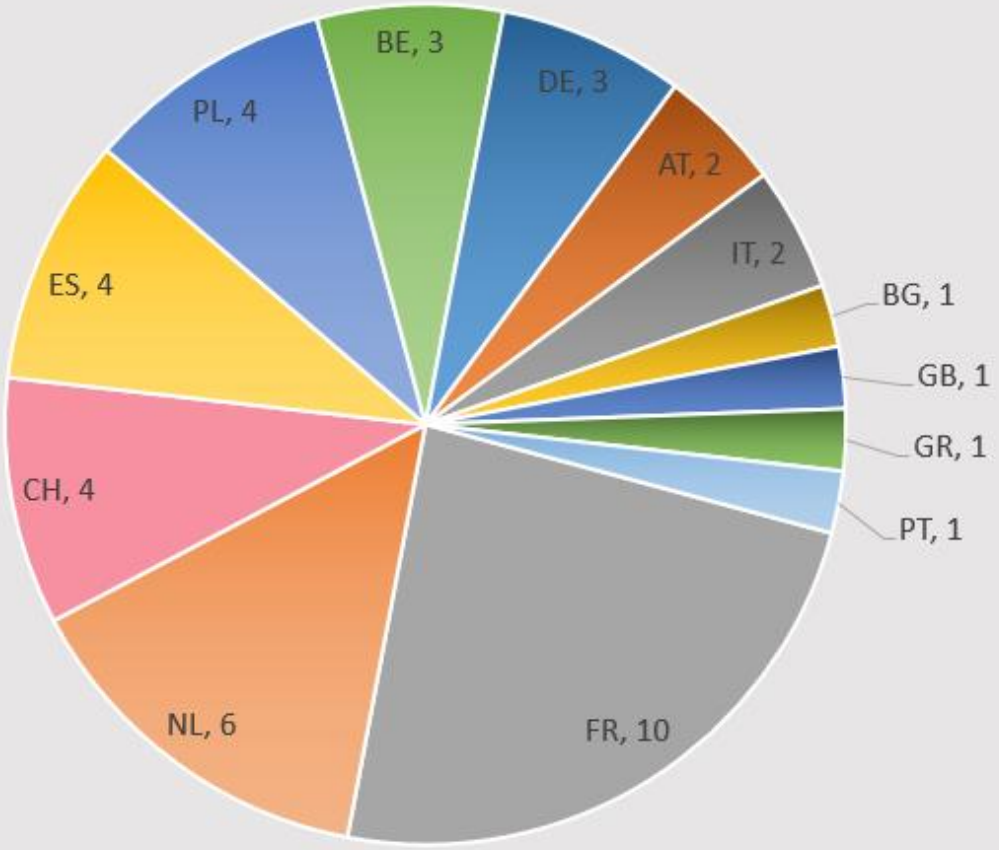


Total 125 members (01.12.2017)

All MPE Members by Nationality



Staff Members by Nationality



Machine Protection & Electrical Integrity Staff Members

A. SIEMKO	Group Leader	
M. ZERLAUTH	Deputy	
B. PUCCIO	Technical Coordinator & Group Leader Support	

Secretariat : S. SAPOUNTZI

Electrical Engineering EE

F. RODRIGUEZ MATEOS

M. BEDNAREK
D.M. CARRILLO BARRERA
G.-J. COELINGH
G. D'ANGELO
A. DINIUS
M. FAVRE
J. MOURAO
B.I. PANEV
S. PEMBERTON
G.J. SEWERYN

Electronics Modules EM

M.-E. MAGNIN

R. BERBERAT
S. EXCOFFIER
S. KAUFMANN
N. WAUQUIER

Electronics for Protection EP

R. DENZ

F. BOISIER
D. CALCOEN
V. FROIDBISE
S. GEORGAKAKIS
T. PODZORNY
J. SPASIC
J. STECKERT

Machine Interlocks MI

J. UYTHOVEN

A. ANTOINE
Y. BASTIAN
C. MARTIN
A. MIRANDA FONTAN
R. MOMPO
B. PUCCIO
R. SECONDO
I. ROMERA RAMIREZ

Machine Protection Software MS

M. ZERLAUTH

Z. CHARIFOULLINE
M.A. GALILEE
J.-C. GARNIER

Performance Evaluation PE

A. VERWEIJ

B. AUCHMANN
M. JONKER
M. MENTINK
D. WOLLMANN

DECEMBER 2017

New roles

MPE Safety Link Person

Bruno Puccio →

Daniel Calcoen

MPE-TM Organisation

Michael Jonker →

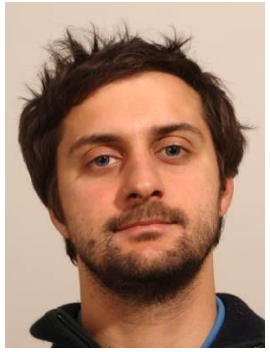
Jean-Christophe Garnier &

Jens Steckert

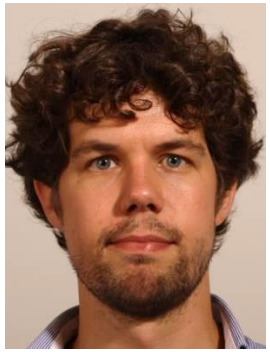
Arrivals 2017 - Staff

David Carrillo
EE Section

Adrian Miranda Fontan
MI Section



Raffaello Secondo
MI Section



Matthias Mentink
PE Section

Welcome!

Arrivals 2017 – Fellows & Trainees

Balatsoukas Stimming Alexios	Fellow, MI Section
Bjerkeseth Morten	Fellow, EP Section
Bjorkhaug Erik Hildre	Fellow, EE Section
Blasco Serrano Daniel	Trainee, EP Section
Bogyai Filip	Fellow, MS Section
Buffet Thibaud	Trainee, MS Section
Daidone Luca	Fellow, EE Section
Fodi Gyorgy	Fellow, EP Section
Majewski Marcin	Trainee, MS Section
Martins Ribeiro Tiago	Fellow, MS Section
Rog Jorgen Wago	Fellow, MI Section

Welcome!

Arrivals 2017 - Students

Faraasen Hans Anders	TECH, EE Section
Freischlag Christian	TECH, MS Section
Iliopoulou Adamantia	TECH, EE Section
Motyka Mikael	TECH, PE Section
Pocwierz Maciej	TECH, MS Section
Pridii Tetiana	TECH, EP Section
Stubberud Edvard	TECH, PE Section
Will Andreas	DOCT, PE Section

Welcome!

Arrivals 2017 – Project Associates

Fernandez Campos Gonzalo	PJAS, EE Section
Nowak Edward	PJAS, EE Section

Welcome!

Departures 2017

Geza Csendes	Alejandro Fernandez Navarro	Alexander Kiefer
Nicolas Bellego	Christophe von Siebenthal	Chloe Cardin
Pierre Dahlen	Ergys Dona	Piotr Zdunek
Stephane Gabourin	Vivien Raginel	Janet Do
Jozsef Makai	Sara Ambjorndalen	Serhiy Boychenko
Carlos Garcia Argos	Philippe Belanger	Kamil Krol
Mikael Storkersen	Pal Forr Austnes	Denis Hugle
Stavroula Balampekou	Arend Dinius	Rins Rutgers

Thank you for your valuable contribution!

And a very special
THANKS to…

Rüdiger Schmidt

Bruno Puccio

Betty Magnin

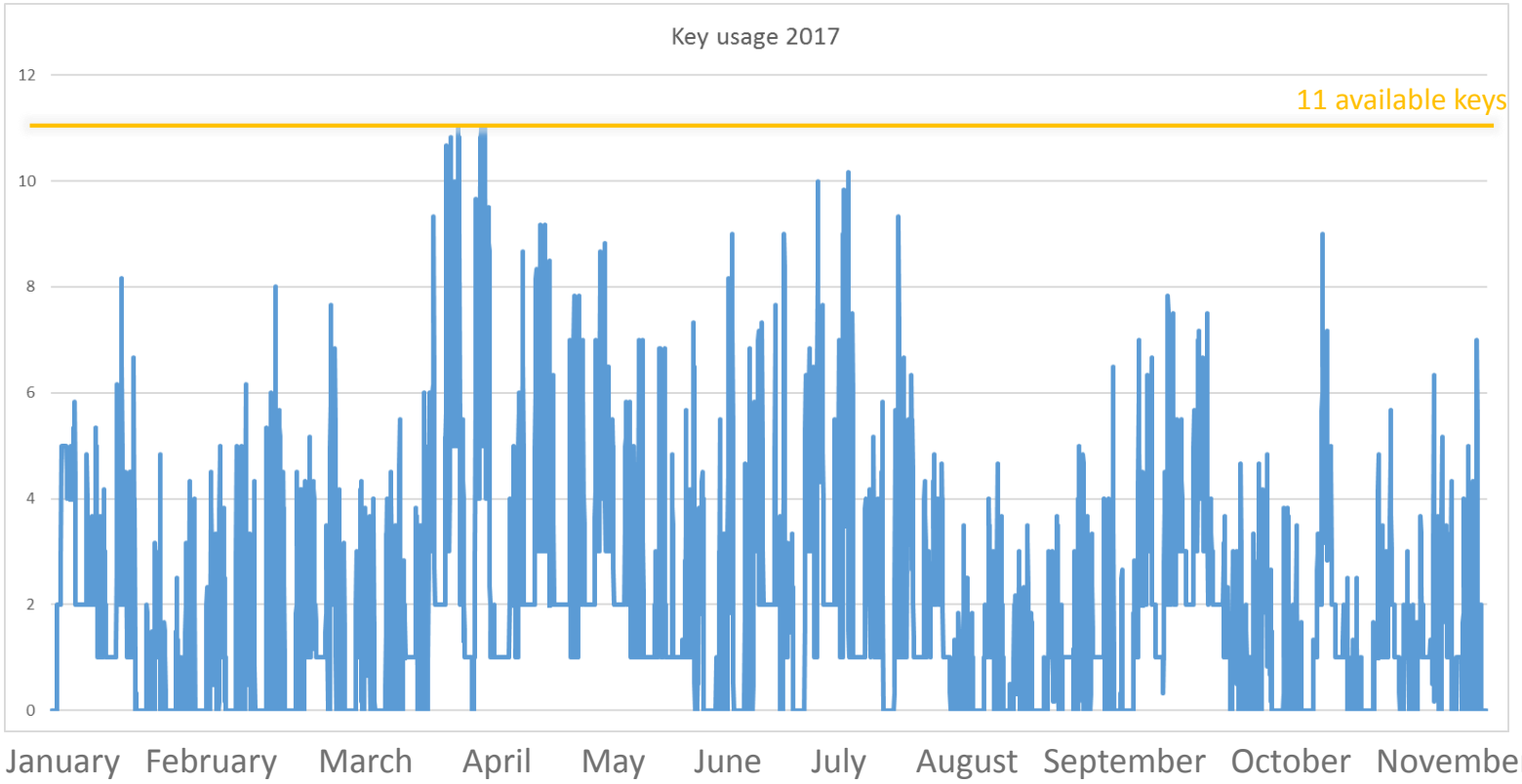
Stefanie Sapountzi

MPE car pool

MPE car pool

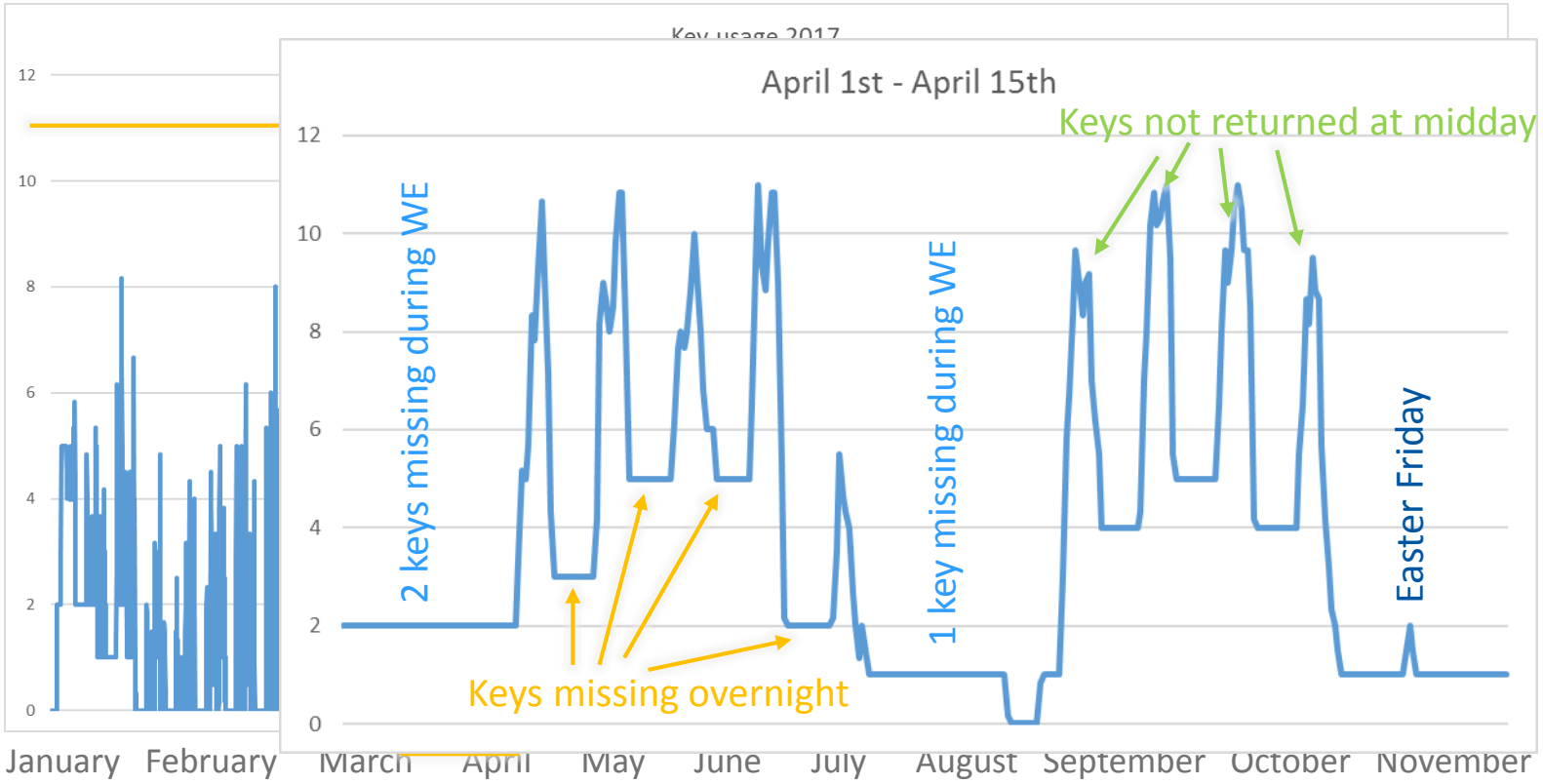
- Since it's introduction end 2015, the MPE car pool has very efficiently contributed to a more efficient and economic use of cars
- YETS and Technical stops known periods of more intense use
  - Car pool is monitored to assure fair usage amongst the teams and avoid shortages in periods of higher demand
- Today 11 cars are shared within TRAKA system (without any restrictions between sections)
  - 2 additional cars are reserved in system for the MPE standby service and 1 car for MPE-EM section

MPE car pool usage in 2017



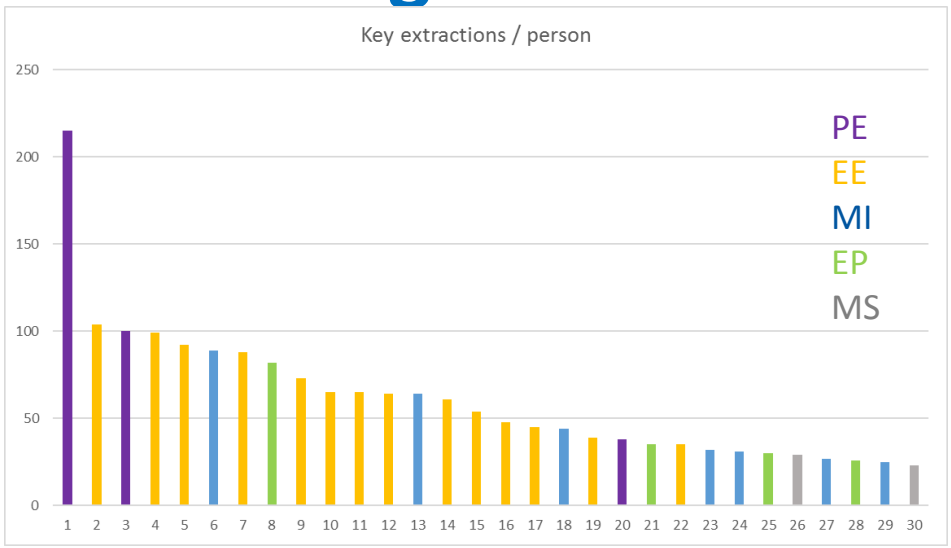
- In 2017, 11 cars in the pool used for a total of ~ 13207 hours in 2017
- Average occupation of ~ 30% of cars throughout the year -> Only 2 occasions of 1 hour each where all keys were extracted

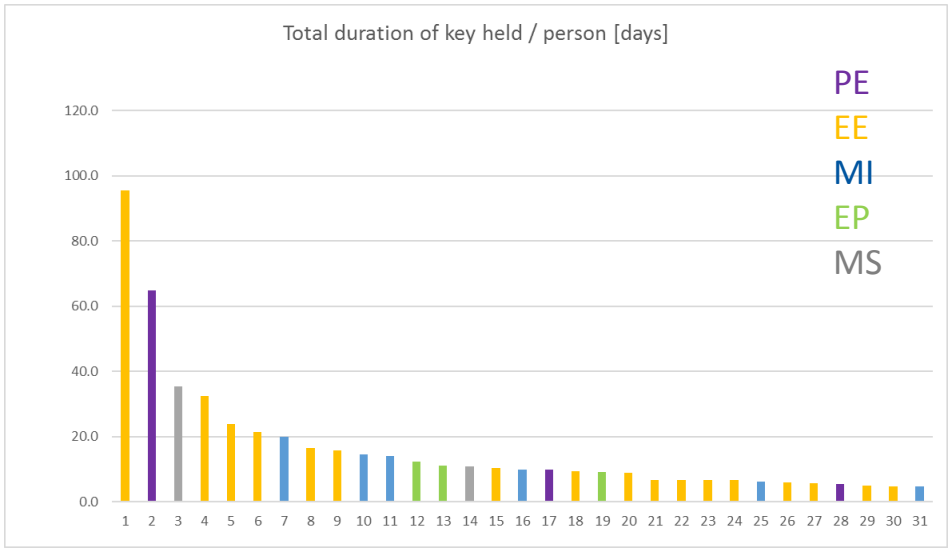
MPE car pool usage in 2017



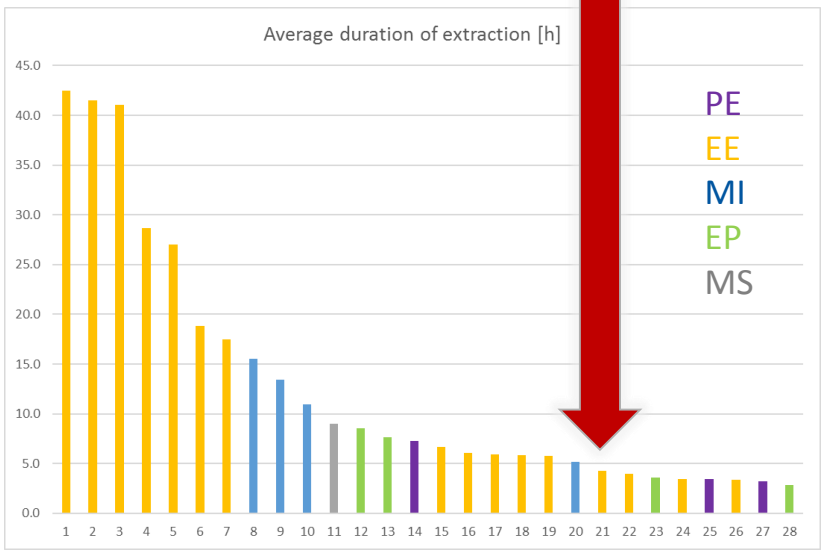
- Forgetting to return keys led on very rare occasions to ‘avalanche’ effects and key shortages (afraid of not getting a key when I need it during the day….)

Some usage statistics…





- Please note that:
  - The use of MPE cars is basically limited to 4h before lunch and 4h after lunch !!!



MPE car pool

- Following recent reports on the unauthorised use of CERN vehicles, we would like to remind you of the rules and regulations.

- Please note that:
- The use of CERN cars is limited to professional purposes only. It is **strictly forbidden to use CERN vehicles for personal reasons** (i.e. driving home, shopping, etc).
- Travelling outside the CERN perimeter is only permitted if a mission order/job order for the specific event has been issued.
- The transport of passengers, i.e. family members, using an official vehicle is not permitted.

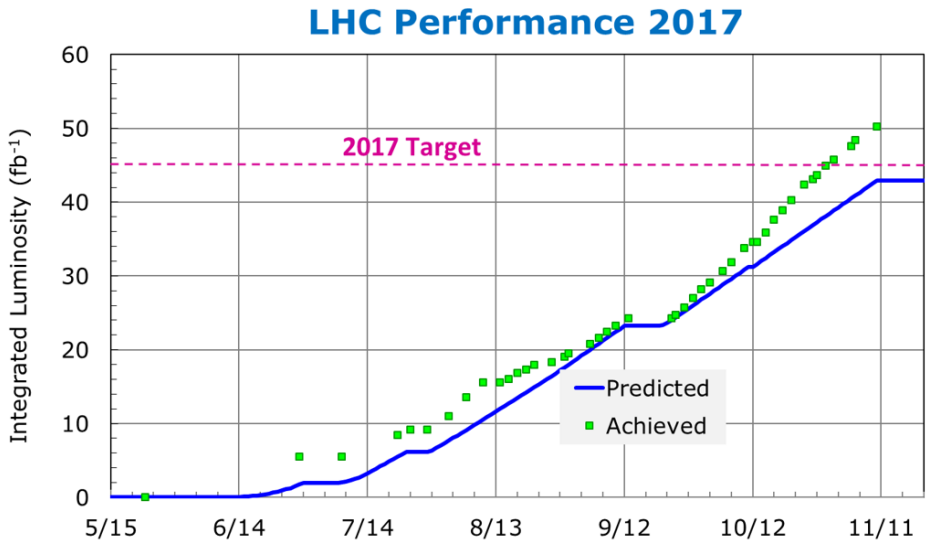
- All CERN vehicles have recently been equipped with a **GPS tracking device** and any unusual or unauthorised use – in particular outside the CERN perimeter, i.e. Thoiry, Sergy, Geneva, as well as outside working hours – is being monitored and followed up on a Departmental Level.

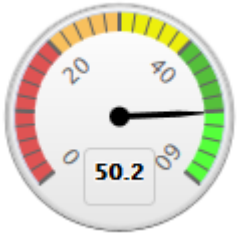
- Please be aware that, due to **insurance restrictions**, any incident involving a CERN car during a trip not related to the professional activities might result in severe legal and financial consequences for the driver.

LHC operation in 2017

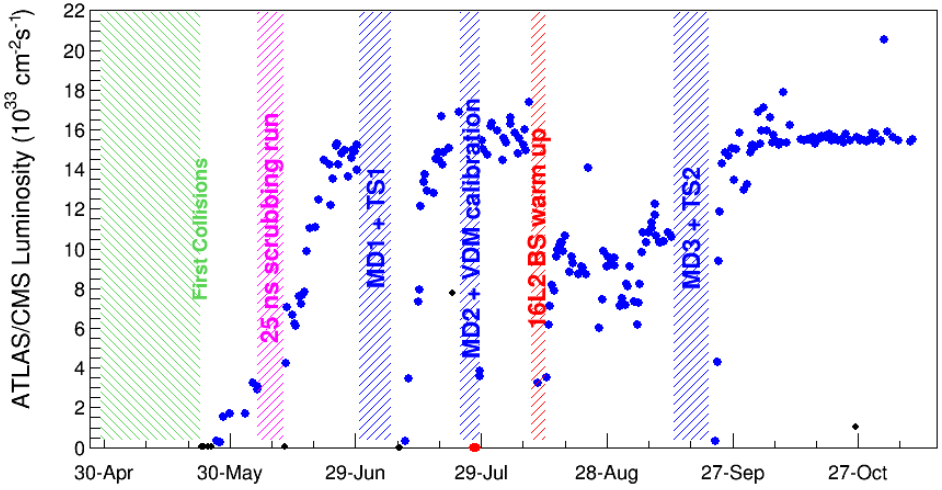
LHC operation in 2017

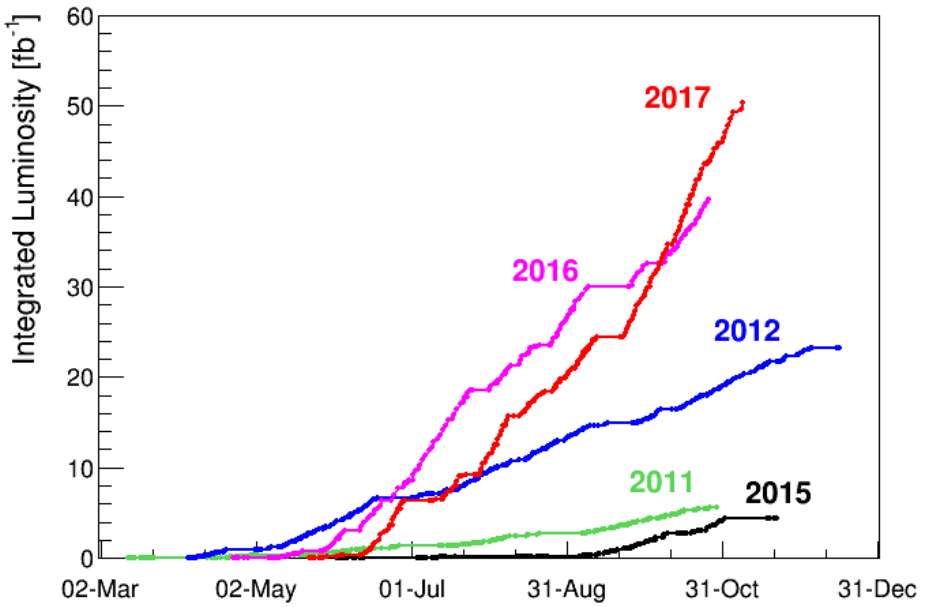
- ATLAS > 50 fb^{-1}, CMS a few pb-1 below 50 fb^{-1}, **LHCb 1.76 fb^{-1}**, **ALICE 16.6 pb^{-1}**.



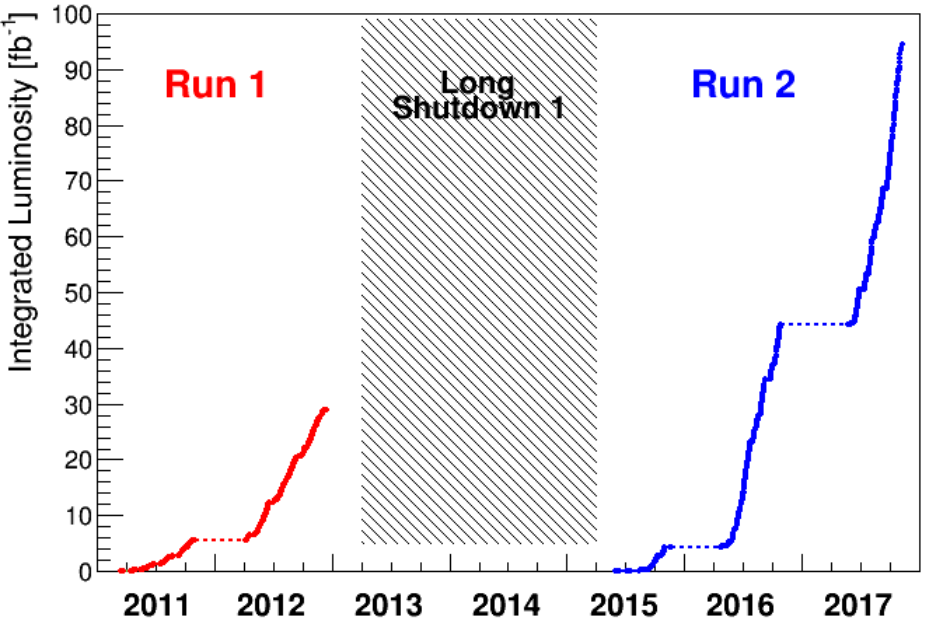


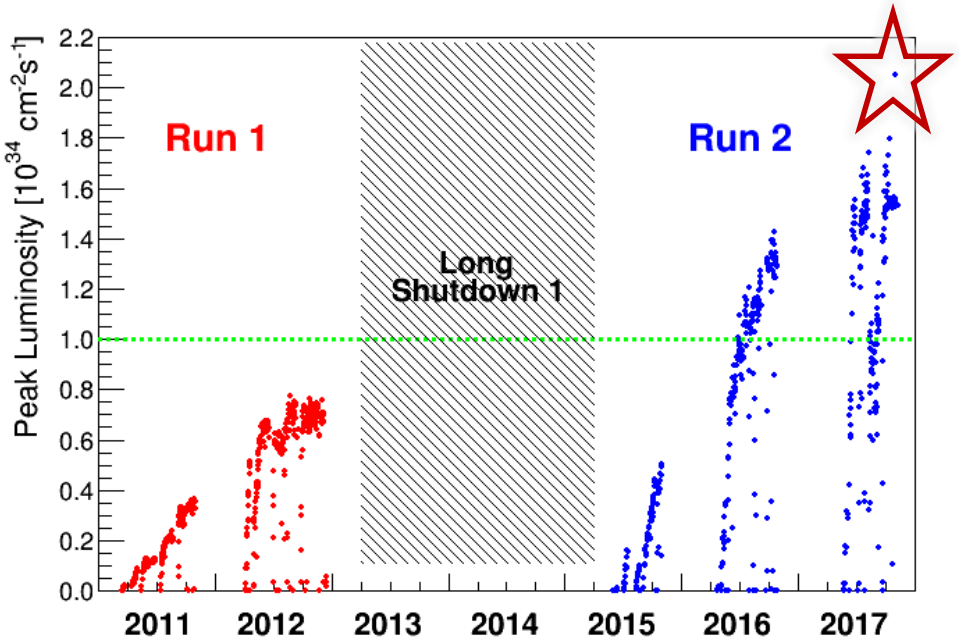
0.5 fb-1/day on average since TS2

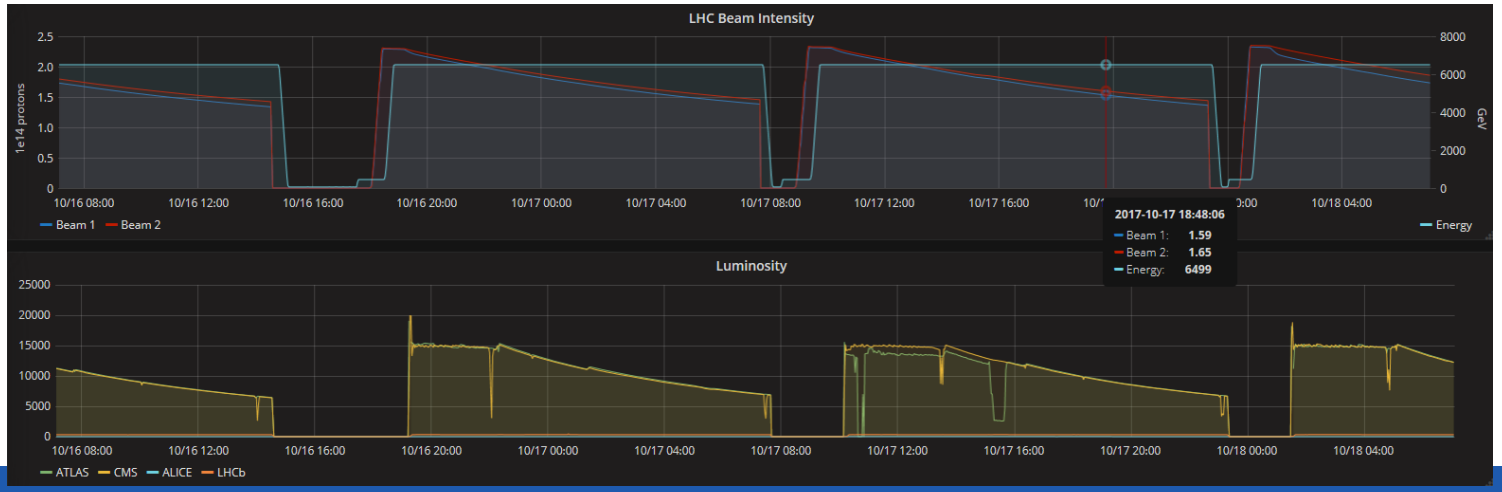




LHC operation in 2017



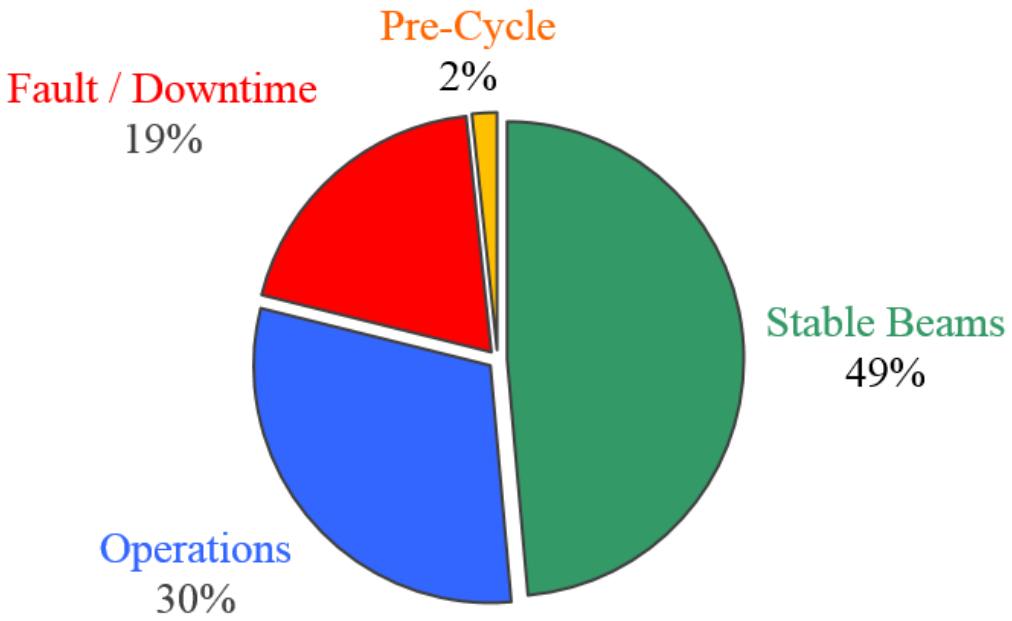




LHC operation in 2017

140 ½ days physics ≈ 3362.1 hours

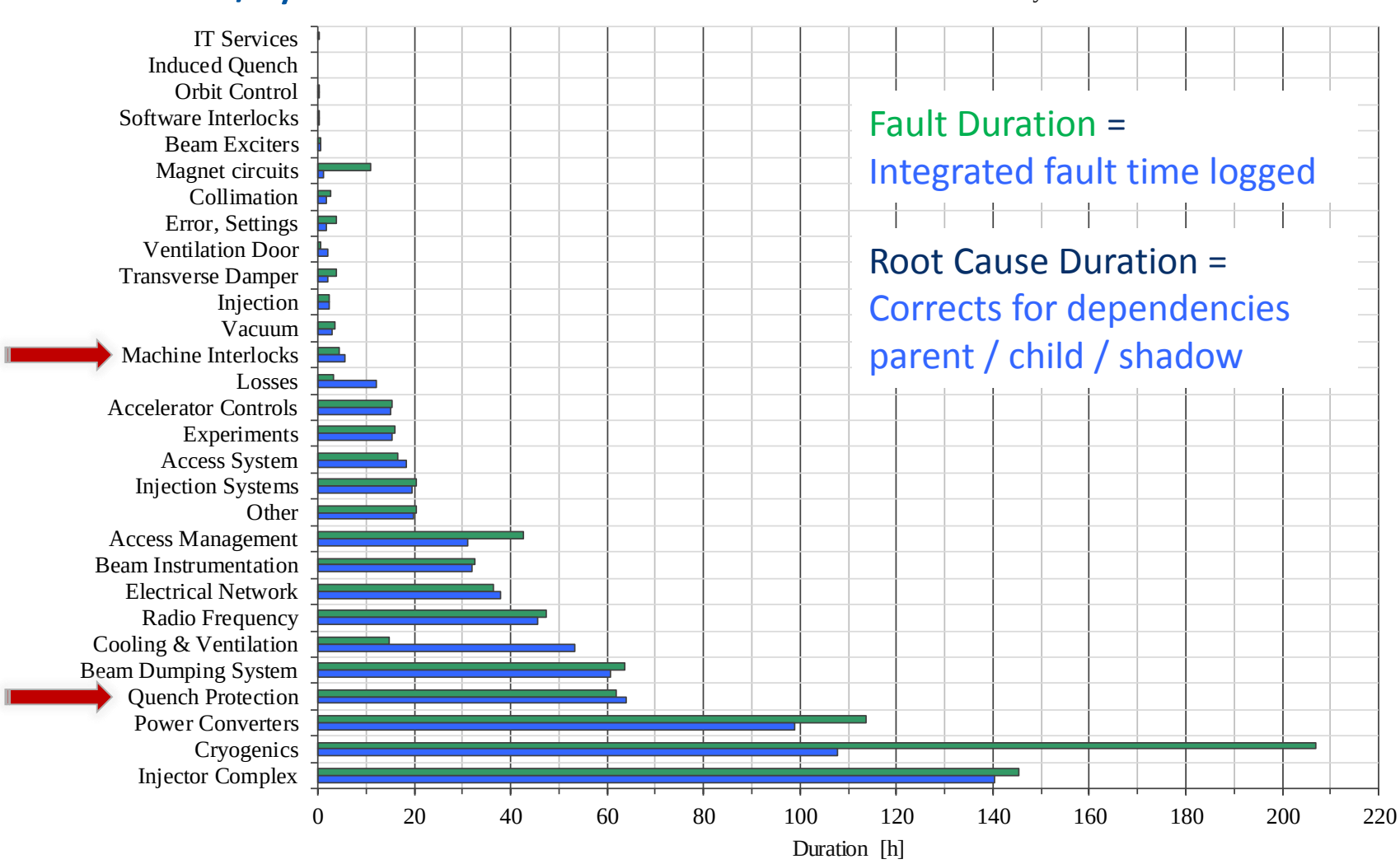
	Duration [h]
Stable Beams	1633.9
Operations	1018.1
Fault/Downtime	652.9
Pre-Cycle	57.2
	= 3362.1



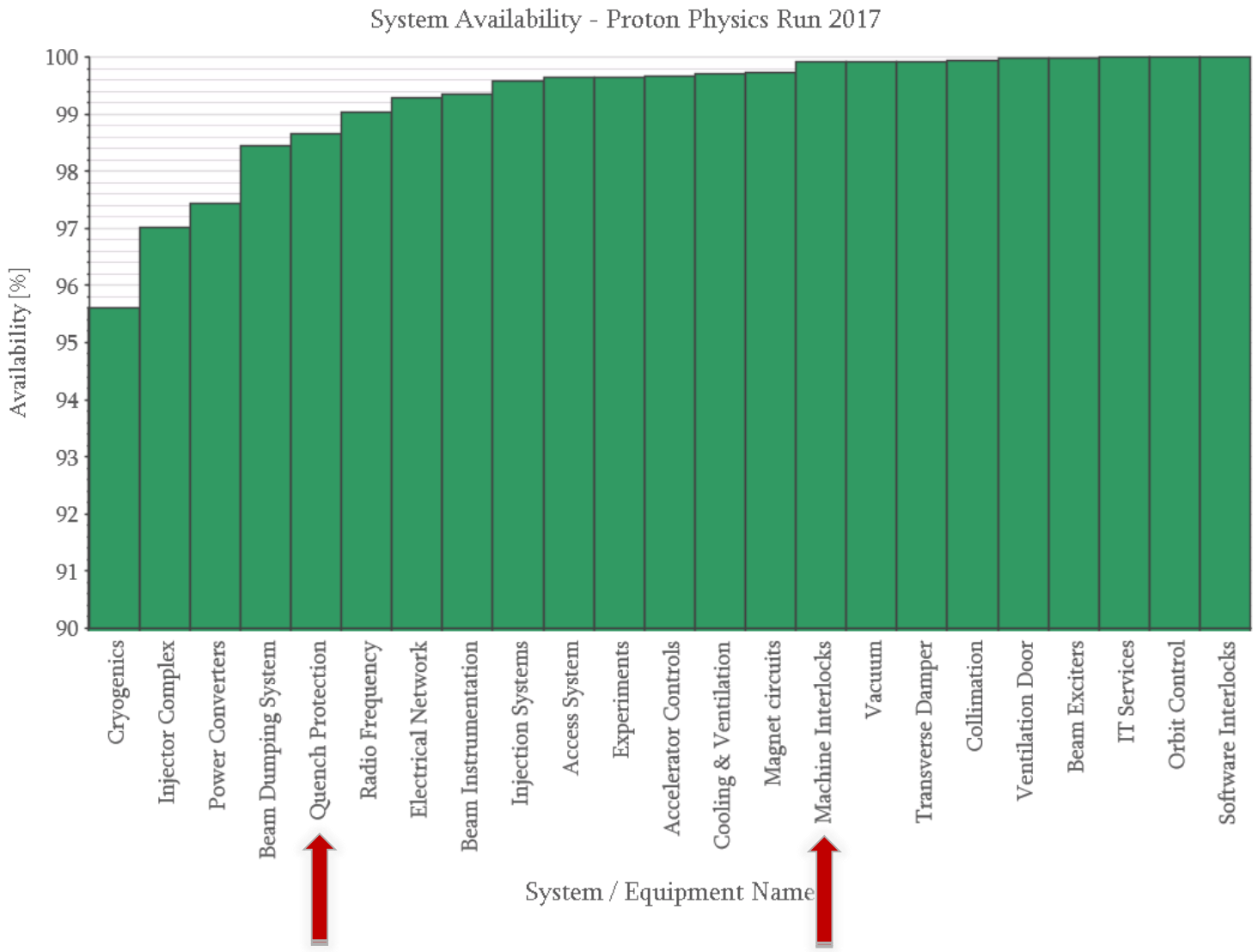
Courtesy B. Todd

LHC operation in 2017

Downtime/system



LHC operation in 2017



TE-MPE 2017 Highlights

EM Section

B. Magnin

Key figures

- 620 new demands since 01.01.17, similar to 2016, of which
  - 395 new designs or design changes
  - 470 Manufacturing of PCB (190 at PH-DT-DD)
  - 470 assembly of prototypes in the assembly workshop
  - 40 assembly of MPGD for PH-DT-DD
  - 70 repair or modification in the assembly workshop
  - 190 outsourcing of PCB or crate assembly
- Current workload
  - 200 jobs on-going
  - 50 jobs in the waiting list

Collaboration with main users

TE-EPC:

- Manufacturing of FGC3, RegFGC modules for the 3rd year
- Manufacturing of R2E-LHC600A-10V electronic boards for 4Q converters
  Procurement of components with long leadtimes for R2E4-6-8kA modules.
- Manufacturing of 200 FGC3 crates

Collaboration with main users

EP-DT:

Setup of a dedicaded working place for the assembly of large detectors, to be installed in B107.

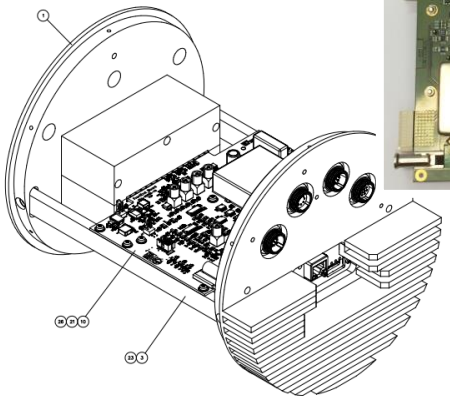
EP-ESE:

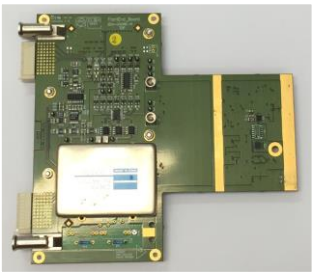
Assembly of 25 GTK Silicon detectors

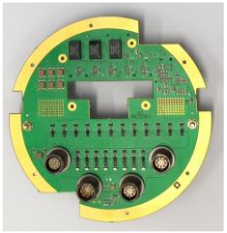
Collaboration with main users

HSE-RP

Design and manufacturing of the first CERN Radiation MOnitoring Electronics (CROME) units, the new generation of CERN radiation monitors







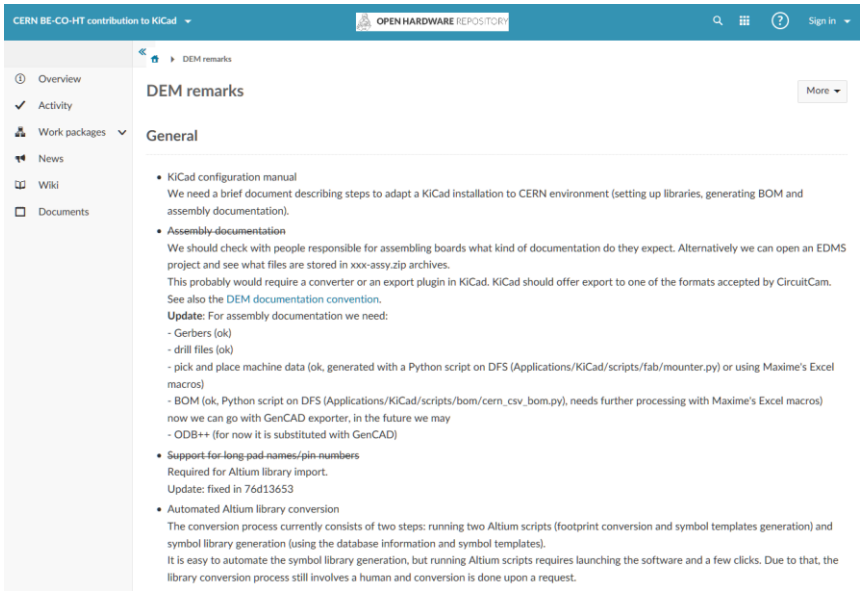
BE-BI

Design and assembly of the first LCP (Liquid Cristal Polymer) circuits for ultra-vacuum applications

BE-CO

Contribution to the development of Kicad, the most advanced open-software for PCB design, strongly supported by CERN.

Since April, as an advanced user, EM plays an active role in the development of Kicad, the open hardware design of PCB supported by CERN

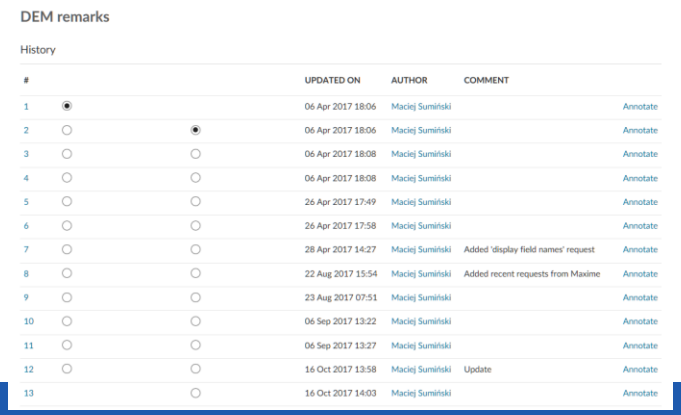


Eeschema

- ~~Good quality BOM generator~~
  The current user interface is terrible. It requires to choose a file that provides an xsltproc plugin (if you know where to look for one). As far as I know, it can generate only .csv files.
  A good candidate to fix the problem is Oliver Walters component table viewer.
  Drop XSLT, switch to Python plugins? **Be sure they are automatically detected, so all the user has to do is to pick the output format and settings.**
  Update: Eeschema is able to take advantage of Python scripts when generating BOM. There is a Python script that is good enough for CERN needs, could be upgraded if needed.
  Automatic detection of plugins is still needed to improve the user experience.
- Default fields for new components
  Currently there are a few default fields (name, value, footprint), so for each new component others have to be added manually (e.g. datasheet link, mounted, tolerance).
  These fields should be used by the BOM generator. A possible solution is to import .csv files with a list of pins and their properties.
  There are external tools that already exploit this approach.
- Editable pin table
  Schematic library editor currently lists pins in read-only mode. It should be modified to enable changing the properties values.
- Copy/paste (between sheets, possibly via system clipboard)
  Especially for drawings. One can export a drawing and import it to a schematic sheet, but is very cumbersome.
- Display field names
  Now only the values are displayed, so for boolean type fields it is not clear what does it mean (e.g. "No" vs "Mounted: No").
- ~~Update component field values~~
  There are cases when symbol libraries fields change (e.g. Obsolete field), but there is no way to reflect the change in already placed component.
  Update: fixed in e29d77c8
- Custom fields for worksheet templates
  Now there the fields might store only very basic and predefined information. Ideally should be able to add own fields that could be displayed in a worksheet template (page layout).

Bugs (to be confirmed and posted on the bug tracker)

- Create array does not work correctly when lowercase letters are used for requested range
- 'Invisible' texts should disappear not only after unchecking 'Hidden text' checkbox in the Render tab, but also after disabling the original layer visibility.
- When saving a footprint with a different name, the 'Value' field is not updated.
- 3D models might not be displayed until one opens the path configuration dialog and closes it.
- Opening the path configuration dialog causes round pads to be displayed as squares in the 3D viewer.



EM collaboration with other services

- Renewal of the PCB purchasing contrats. IT to be sent this month.
  Increased to 3Mio over 3 years to cover increasing requirements.
- Contribution to the e-procurement project. As a frequent user, EM is involved as beta-tester.
- Contribution to the replacement of JMT J3. EM applications will be part of the requirements for this replacement
- Preparation of the move to B107.

EM collaboration with member states

- ILO meeting in October: presentation of EM services, contacts with ILO's from Turkey, Pakistan, UK, Switzerland
- Attended to Sweden@CERN and UK@CERN
- Several orders placed to 4 new firms: 1 in Portugal, 3 in Norway

MS Section

M. Zerlauth

2017 – starting preparation of major LS2 upgrades

BIS

QPS

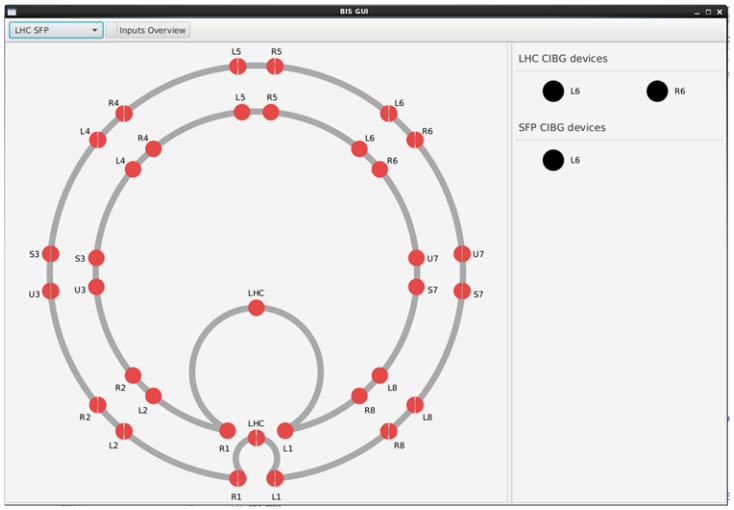
PM

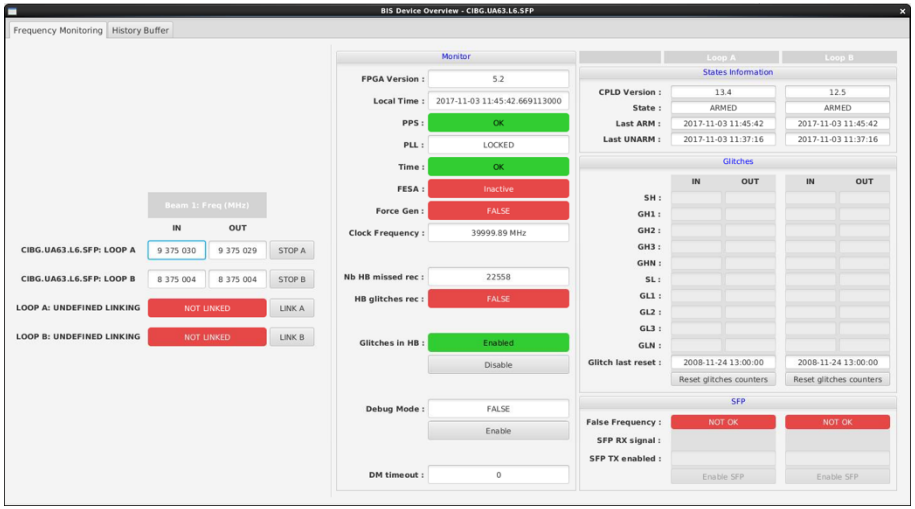
AccTesting

Online Monitoring

SFP Validation

- Preparing the FEC and GUI software for BIS v1.23/v2 (and end-of life of FESA2/32bit)
- New BIS GUI in JavaFX
  - Operational and SFP devices
  - Detailed SFP panels
- Migration to FESA3: CIBM, CIBX, CIBG
  - Lightweight
  - Well tested
  - Continous Integration
- New CIBSM FESA3 class
  - SFP monitoring





Powering and Protection Testbed

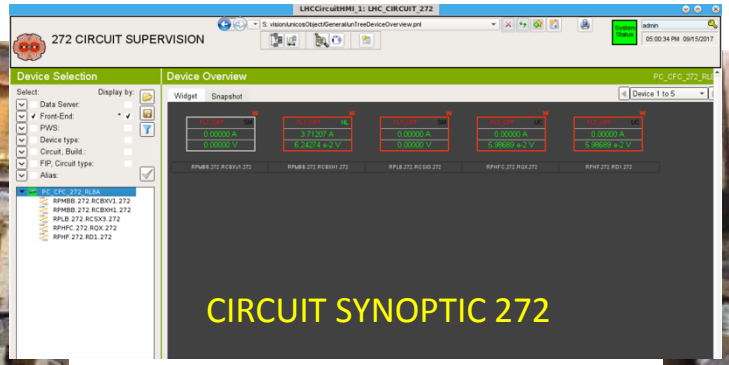
- Collaborative effort between MPE, BE/CO, BE/ICS, BE/OP, TE/EPC and EN/STI to construct a representative and safe test environment for new hardware and software developments for magnet and beam protection system
- First 120A and 600A circuits installed an operational!

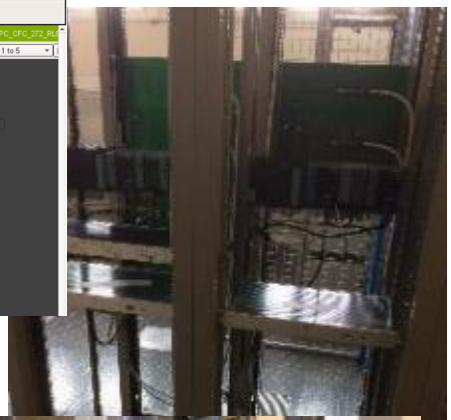
Deployment of high-level supervisory and controls stack in progress – Collaboration with CO for testing in GPN

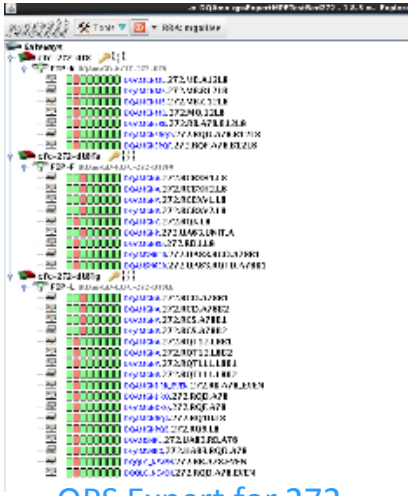
Vital tool for QDS consolidation

Acknowledgments: EP, EE, MI, BE/CO, BE/ICS, TE/EPC

Powering and Protection Testbed deployments…

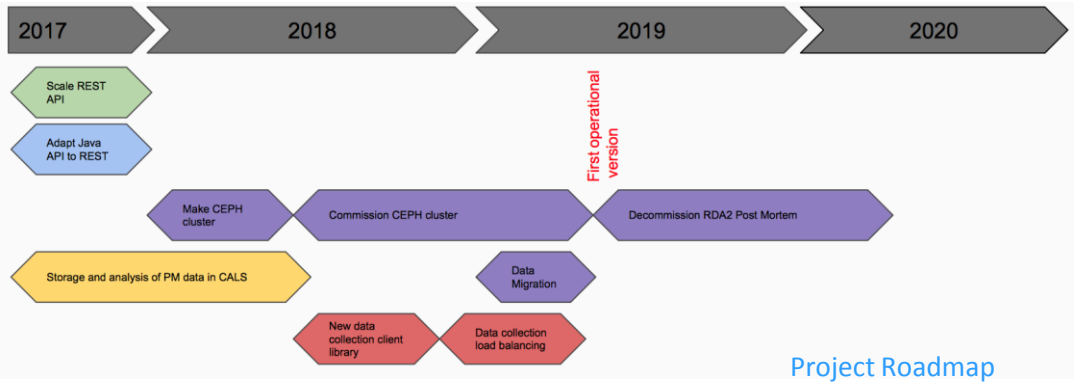




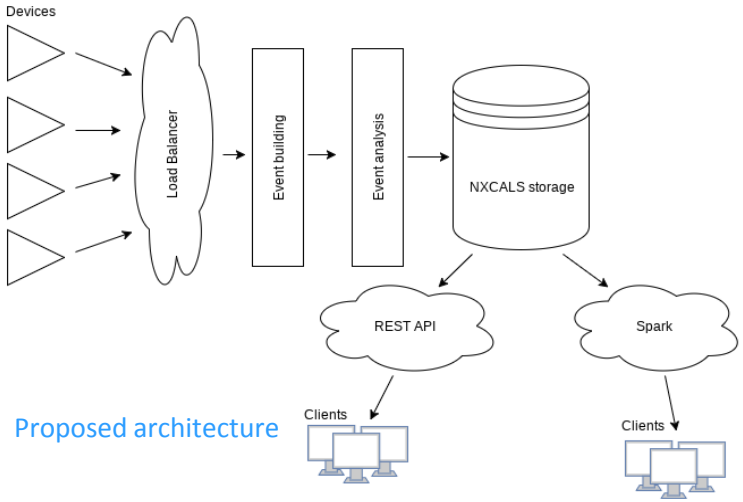


Post Mortem Consolidation

- Post Mortem consolidation during LS2 is being prepared, providing full integration with NXCALS infrastructure for data storage
  - Single data storage solution for both systems, with dynamic load balancing
  - Ability to perform complex analysis on both PM and Logging data using Spark
  - Common extraction API with distributed caching and auto-scaling for better performance
  - Close collaboration with NXCALS team, developing solution in a joint effort

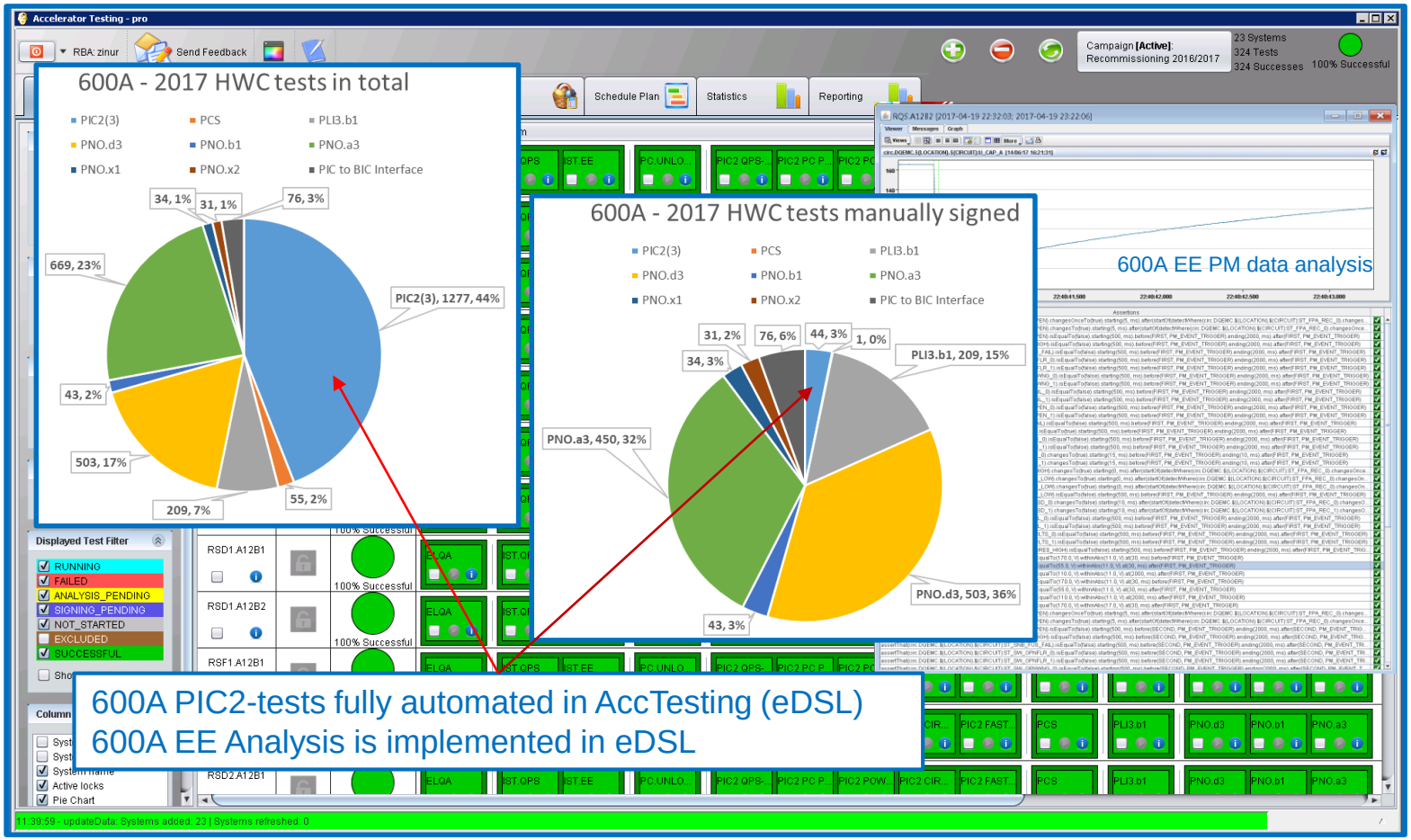


Project Roadmap

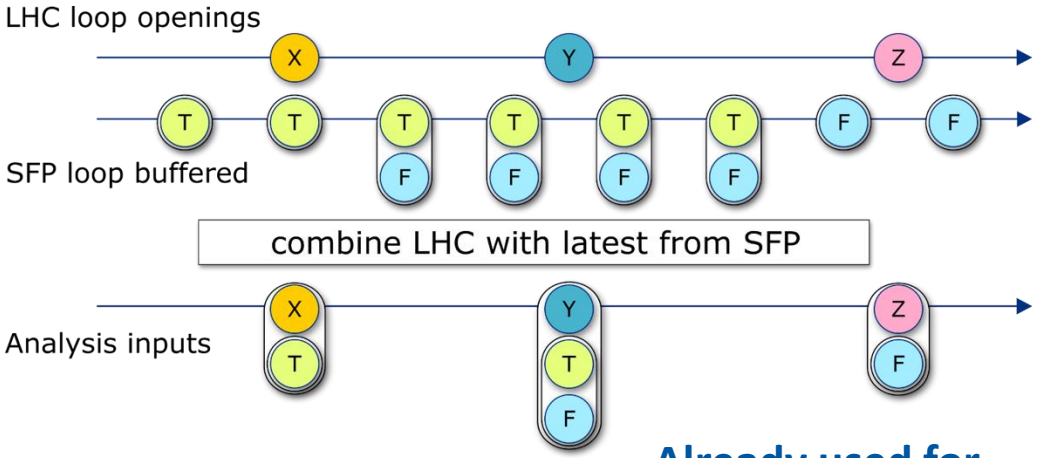


Proposed architecture

AccTesting and Automated analysis



Data Streams and Online Monitoring



Leveraging **reactive streams**, complex use cases can be:

- **described**
- **analyzed**
- **implemented**
- **reused**

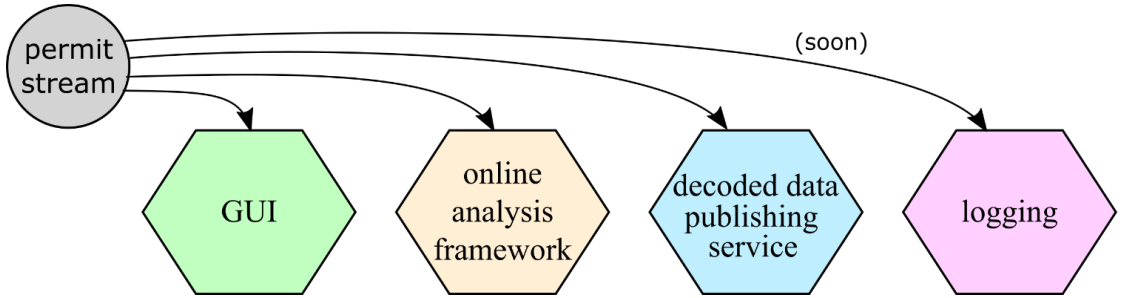
Already used for

SFP loop openings vs LHC loop openings for the BIS

Direct logging of decoded data from FECs

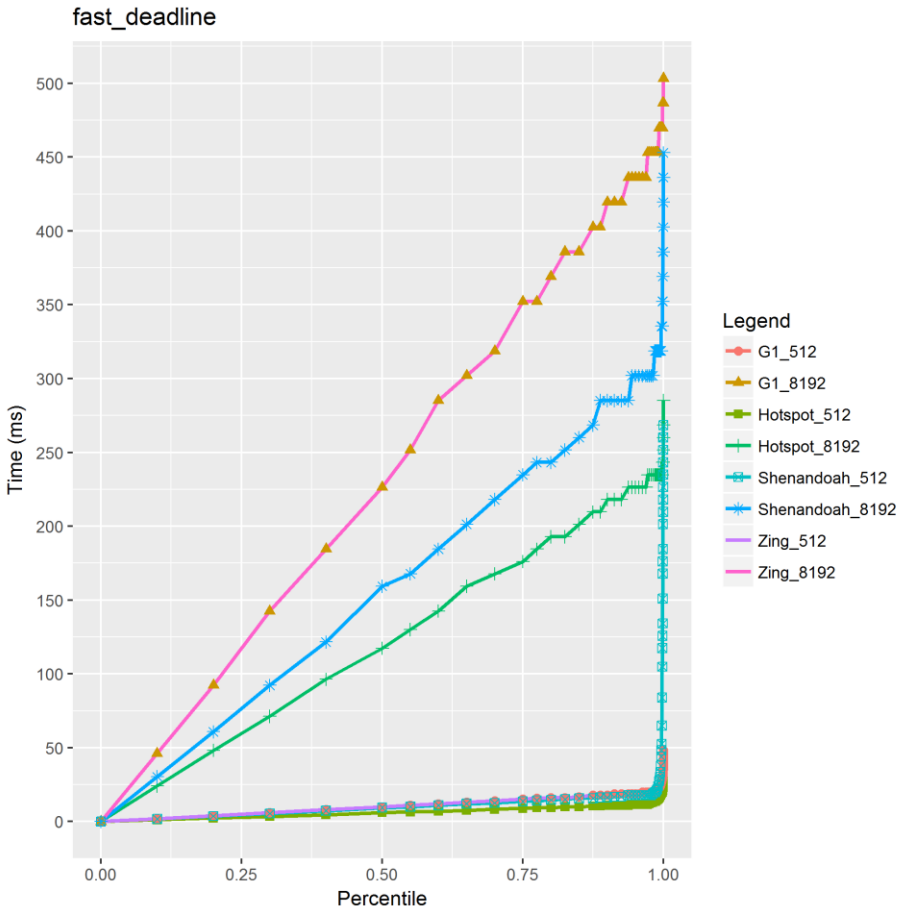
Fixed Display for LHC injections (BE/OP)

same definition
same code
→ reused across multiple applications, providing to multiple services



Java Lightweight Front-End Control Software ?

- R&D with CO into more lightweight applications and controls solutions
- Yes we can!
  - Soft and firm real-time can be achieved directly executing Java on a FEC
  - Java is a performant solution for simple hardware access layers
- More studies to be performed but promising solution!



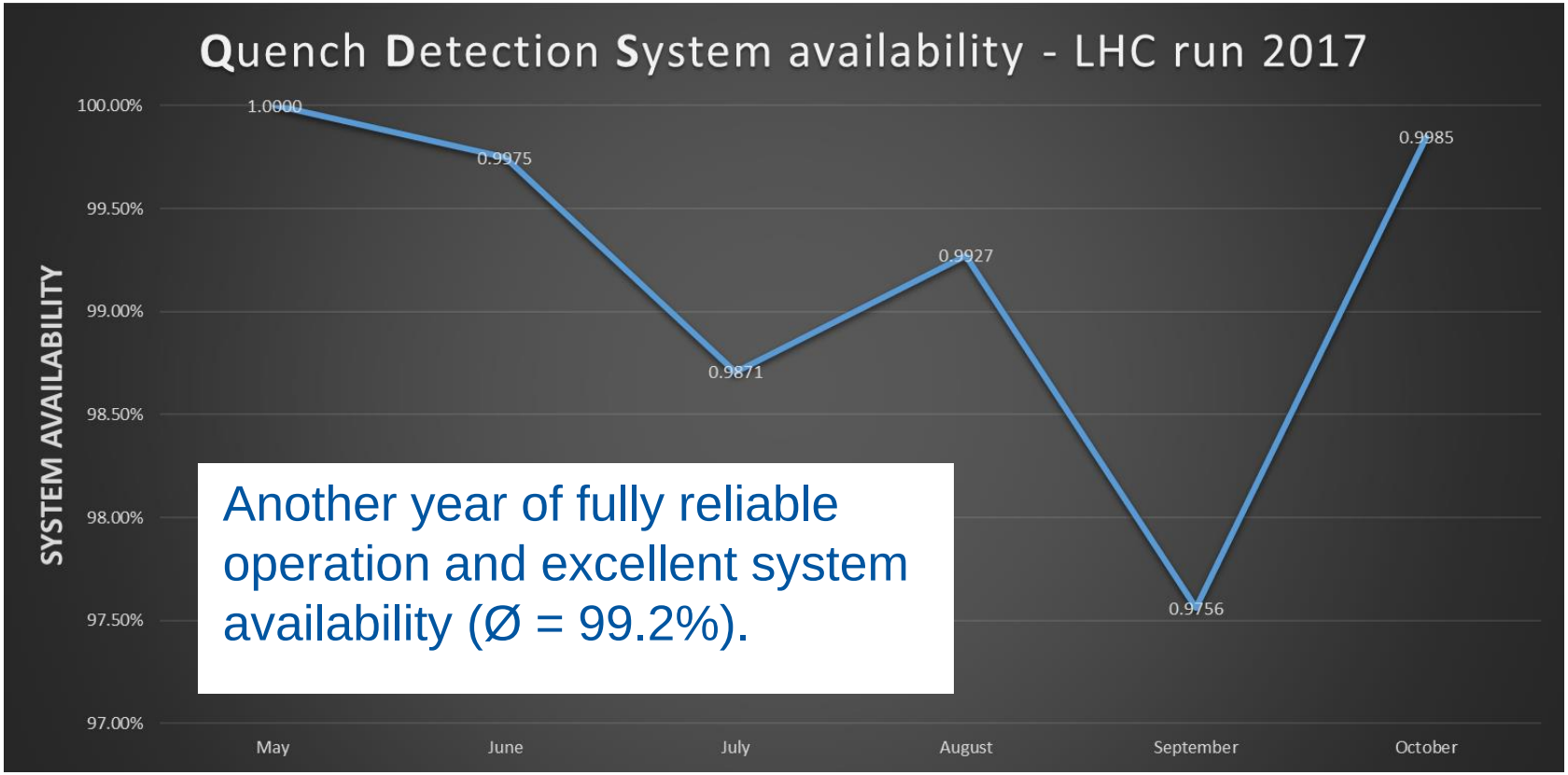
Confidence indices of JVM Garbage Collectors performing before the deadline

And we also do…

EP Section

R. Denz

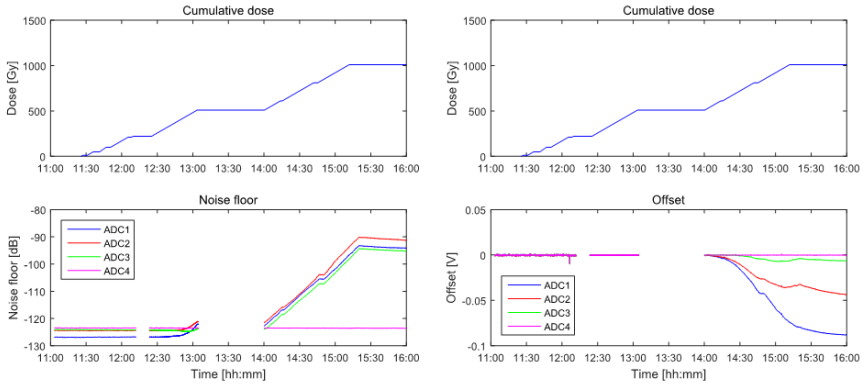
QDS system operation in 2017

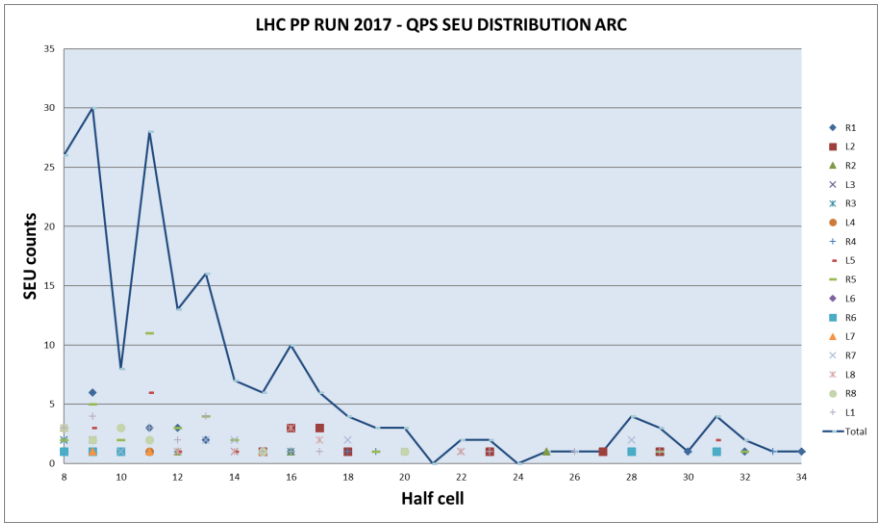


Another year of fully reliable operation and excellent system availability (Ø = 99.2%).

QDS & R2E in 2017

- DAQ SEU rate significantly reduced compared to 2016 7.4/fb^{-1} → 4.0/fb^{-1}
- New hotspot in half cell 11R5
- No R2E related system trigger in 2017 (~10000 radiation exposed interlocking QDS boards in LHC)

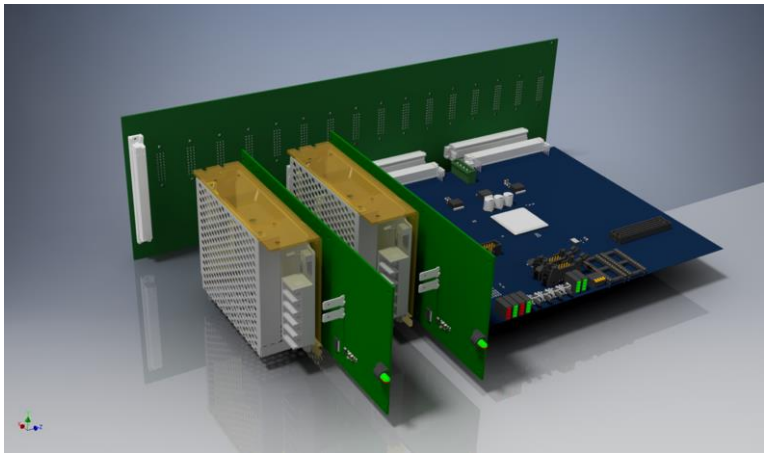


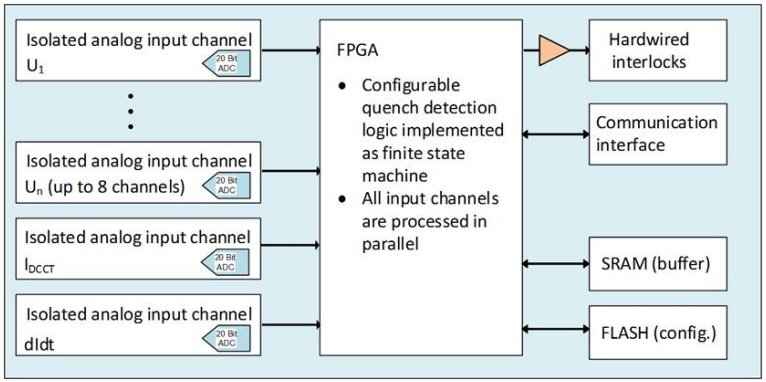


- Successful radiation test campaign focussing on high resolution fast SAR ADC (1 MSps 20 Bit)
- ADCs tested for noise and offset performance and single event errors → within specifications up to 500 Gy

Quench **D**etection **S**ystems for HL-LHC

- Next generation of QDS for Nb_3Sn based magnets and MgB_2 superconducting links
- Versatile base system, which can be easily adapted to various tasks reaching from sophisticated quench detection systems to high performance DAQ systems



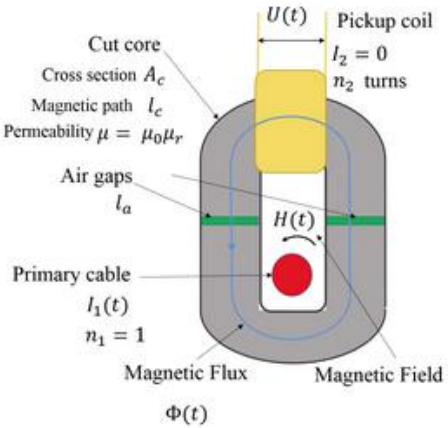


MQ detection systems upgrade during LS2

- 392 QDS units to be integrated into refurbished protection racks (short “yellow racks”)
- Development of new radiation tolerant quench detection and DAQ systems
- Upgrade of QPS supervision layer
  - Enhanced options for remote maintenance, DAQ and configuration managment

QDS consolidation

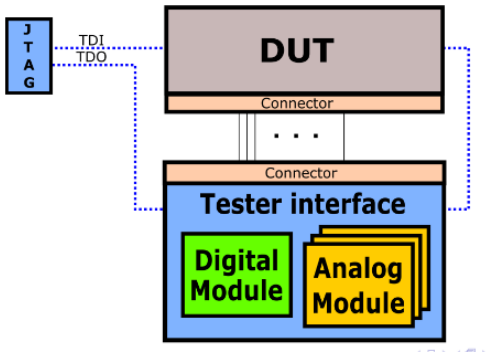
- Next generation of remote power cycle units
- Fast quench loop controllers for HL-LHC
- Usage of didt sensors as alternative quench detection method
- …



Advanced functional test systems

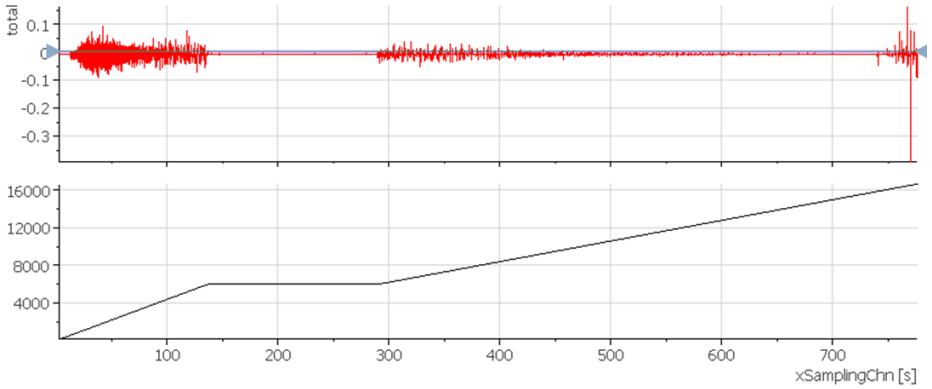
- Custom made JTAG test module with digital & analog I/O channels

- Functional tester for MQ detection system upgrade



QDS for test benches

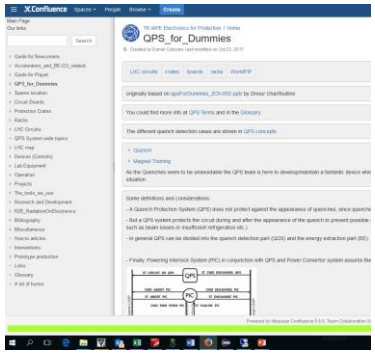
- HL-LHC QDS type testing in SM18 during MQXF tests
  - 20 Bit, 0.9 MSps/channel
  - Excellent data quality; flux-jumps, vibrations and “quench precursors” recorded

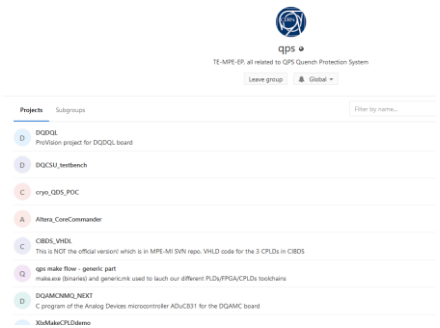


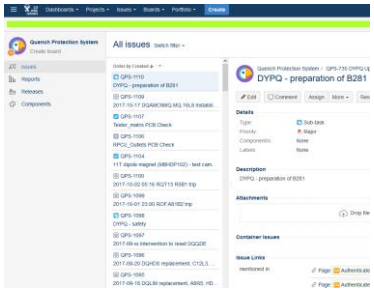
- QDS equipment for MPE test bed in B272

TE-MPE-EP publications & documentation

- Exhaustive system documentation using state of the art software tools (Confluence, GIT, JIRA…)
- Conference contributions
  - IPAC'17 Tomasz
  - MT25 Ernesto
  - EUCAS'17 Josef
  - RADECS'17 Jelena
- + presentations at various workshops and reviews







EE Section

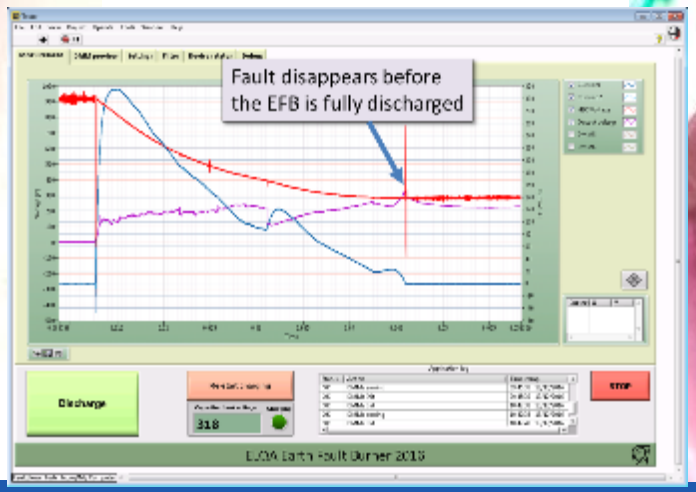
F. Rodriguez Mateos

Contents

- LHC
  - Earth Fault Burner
  - Consolidation projects: DYPQ, 13-kA EE Switches and Controls
  - EE contribution to bdg. 272 test bed
  - ElQA Hard- and Software Upgrades
- HL-LHC
  - Energy Extraction Systems
  - CLIQ
  - 11-T Dipole Heater Discharge Supplies Racks
  - ElQA High Voltage Withstand Levels definition

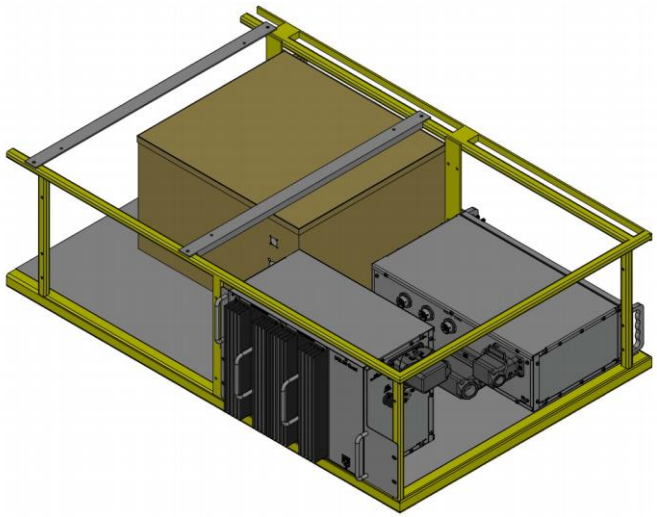
EFB

- December 2016 – successful fault elimination in S3-4
- Experiments on the energy deposition limits are on-going
- Various configurations are studied
- Optimised Earth Fault Burner will be manufactured



DYPQ-EE

- TE-MPE-EE contribution to the replacement of the yellow racks of the quadrupoles during LS2
  - Contract for the manufacturing of 900 current transformers already signed
  - Prototypes of power supplies, interface modules and cabling ready to be sent to TE-MPE-EM for series production



DYPQ upgrade – new DQLCT

New procurement contract for a production of additional 900 precision measurement current transformers

Re-activation of testers

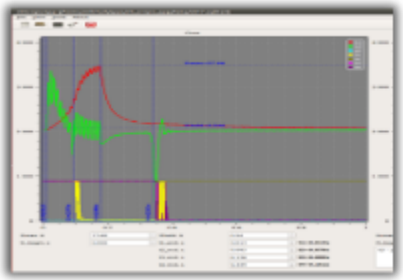
13kA EE Switches

- Long term strategy → to continue using the high speed VAB49 circuit breakers
  - 35 new switches were ordered
- Arcing contacts issue – 18 cases found during EYETS-2017
  - New contacts produced by another method were ordered to fix the problem. Replacement → LS2.

Arcing contact failure mode

- New equipment providing more diagnostic feature was introduced from 2017 in the maintenance campaign

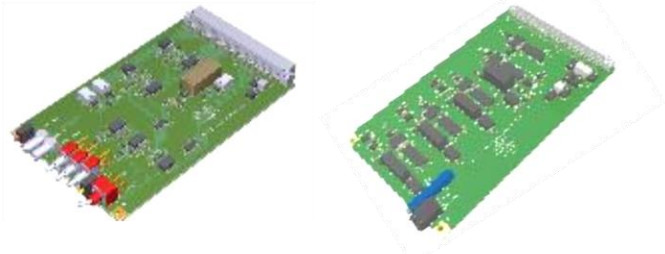
Holding coil inter-turns short checker



DAQ module to check the performance of the micro-switches, the holding coils and fast opening coils.

13kA EE Control Systems

- Control electronics consolidation – started Sep 2016
  - The first stage: currently ongoing
    - Will provide the urgently needed deliverables (see pic.)
    - Will fix some modifications and obsolete design
    - Will guaranty in a large extend the stable operation until LS3



New FPA and Measurement boards are production

Design is ongoing

Relay no.1
Ready
for installation

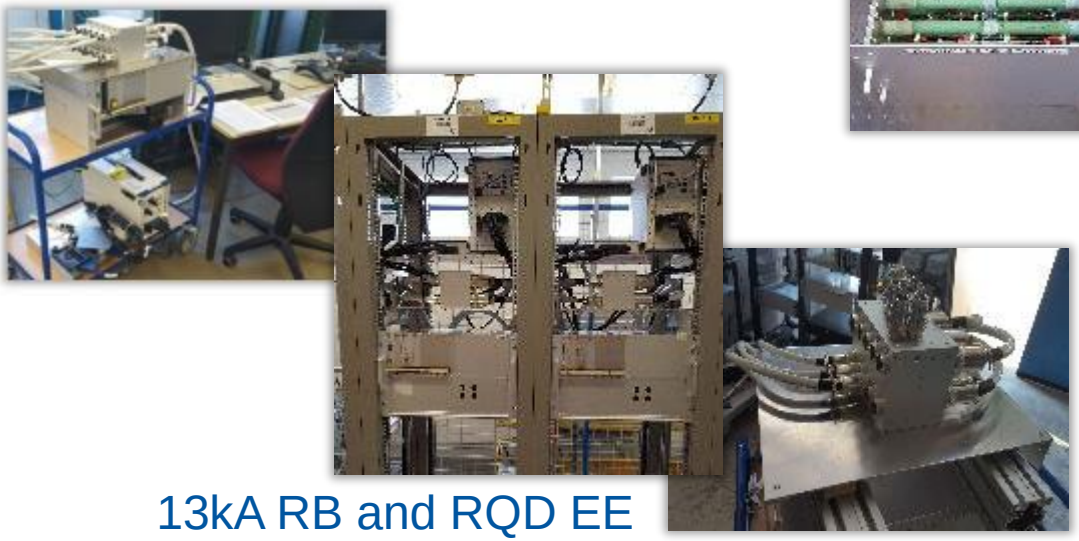
  - Second stage: starts in 2019
    - Will consolidate the systems for the next 15÷20 years operational perspective
    - Re-design and simplification of all auxiliary circuits
    - Renewal of the breaker control modules (BCMs)
    - Modern control electronics

EE contribution for the test bet in bld.272

- Four original 600A EE systems
- 13kA EE system simulators – RB and RQD
  - PXI to generate the switch signals and interlocks
  - New hardware to interface the DQPIRB/Q
- Dummy loads for 60 DQHDSs
- DQLIMs and DQHDSs for yellow racks

Dummy loads

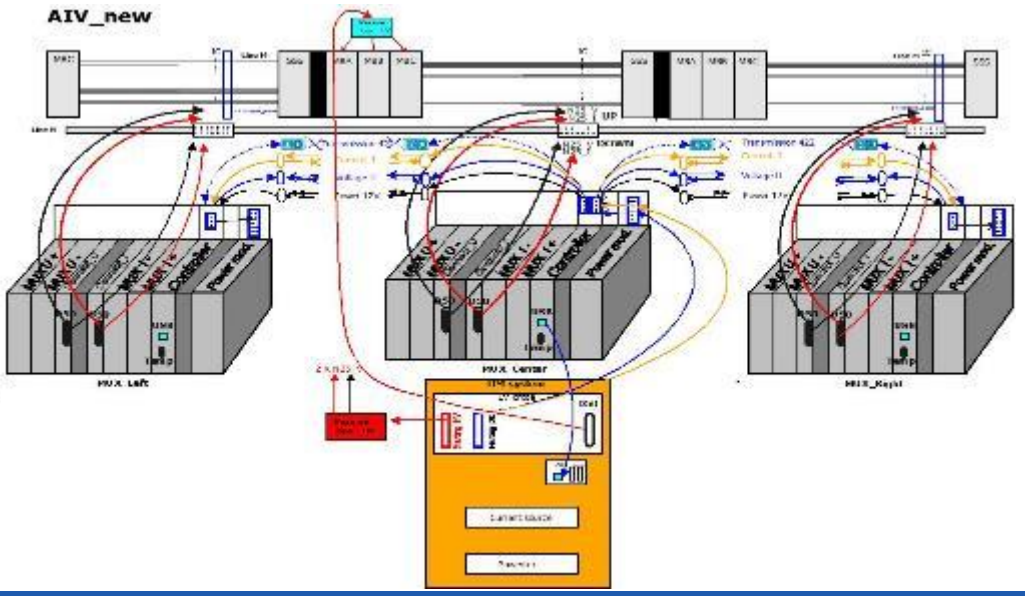
600A EE systems



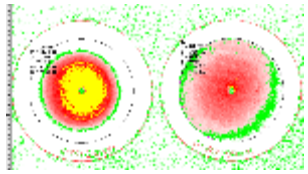
13kA RB and RQD EE systems

ELQA: Hard- and Software upgrades

- Fruitful collaboration with HNINP
- Full commissioning of S1-2 starting from 2 Jan 2017
- Upgrades of core ELQA systems on-going
- Preparing YETS 2017/2018 activities
- Getting ready for LS2!



Cold Diodes activities

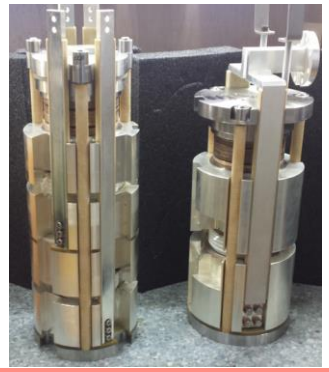


Diode press-packs:

- 207 units electrically tested at 300K and 77K (LN2)
- All press-packs geometrically measured: Fuji Film

Diode stacks:

- All new components received and verified for 30 Dipole and 10 Quadrupole stacks
- Assembly and Testing at 300K and 77K of 8 MBs and 8 MQs stacks
- Cold testing (4K) in SM18 of 4 MBs and 4 MQs stacks
  - 3 MQ and 2 MB stacks accepted



New diode lab installation in building 272: under preparation, well advanced…

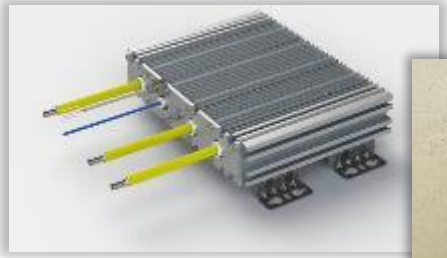
Bdg. 272 – a new home for MPE activities

- LHC
  - Earth Fault Burner
  - Consolidation projects: DYPQ, 13-kA EE Switches and Controls
  - EE contribution to bdg 272 test bed
  - ElQA Hard- and Software Upgrades
- HL-LHC
  - Energy Extraction Systems
  - CLIQ
  - 11-T Dipole Heater Discharge Supplies Racks
  - ElQA High Voltage Withstand Levels definition

EE systems using vacuum switches

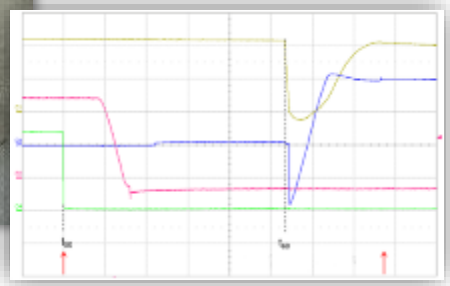
- 2kA EE system – A candidate for HI-LUMI magnets QPS
  - Prototype will be completed at the end of 2017
  - Two vacuum breakers connected in series rupture the main current
  - Very promising preliminary results
  - Evaluation and qualification tests - 2018

Vacuum Interrupter



Dump Resistor

Two vacuum breaker sliding cassettes

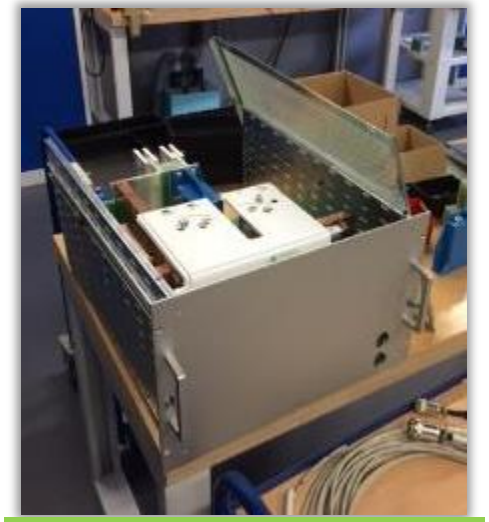


Commutation < 1.8ms

- 600A EE system
  - Production of two systems is ongoing
  - Compatible with LHC
  - Expected delivery end of 2018

EE systems using IGBT switches

- The concept has been finalised
- The assembly of the prototype has started



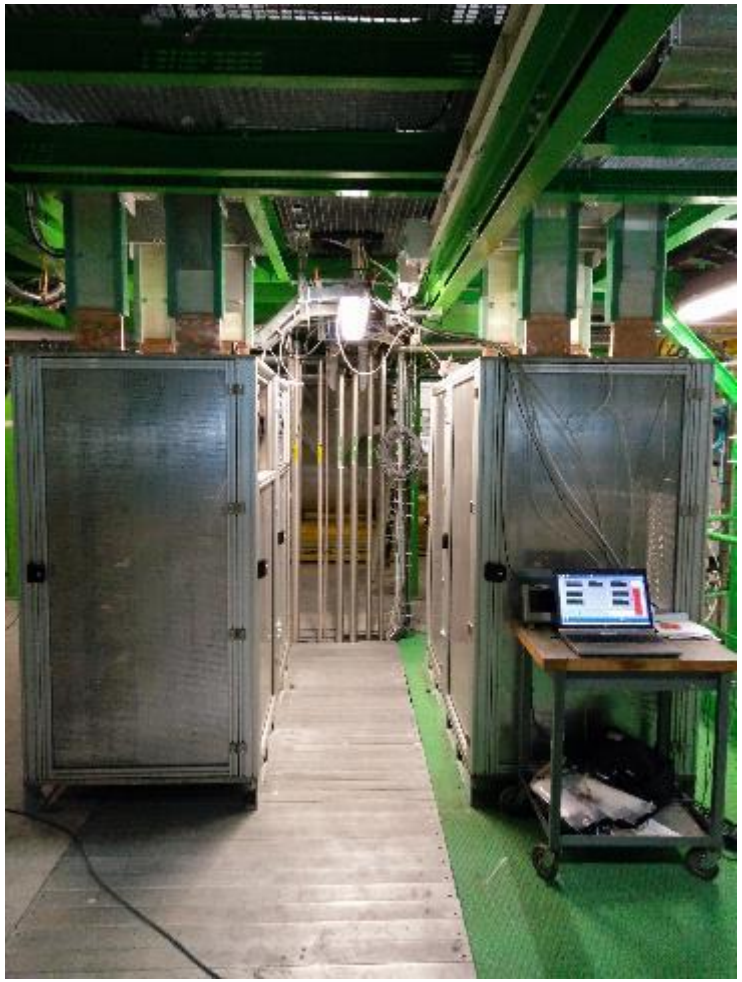
The first 1kA module is ready

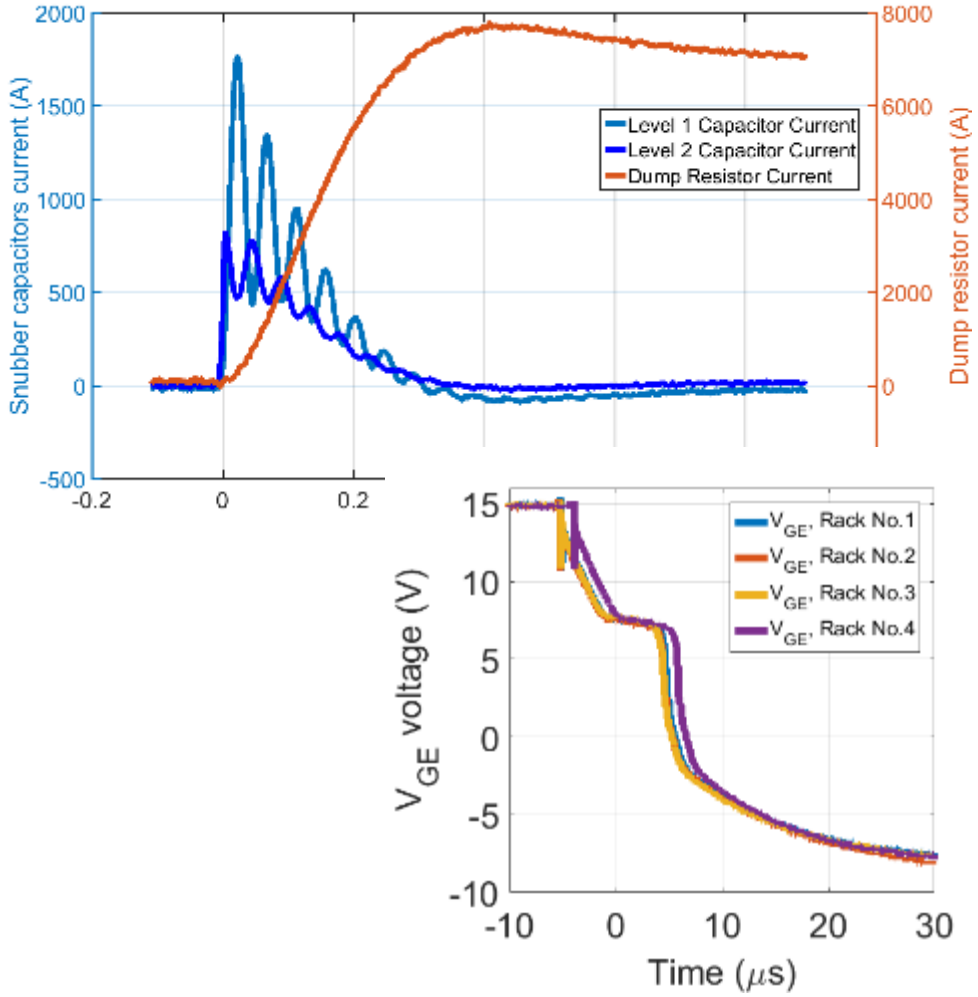
The second 1kA module will be ready end of Nov

The rack with the busbars and the cooling water pipes

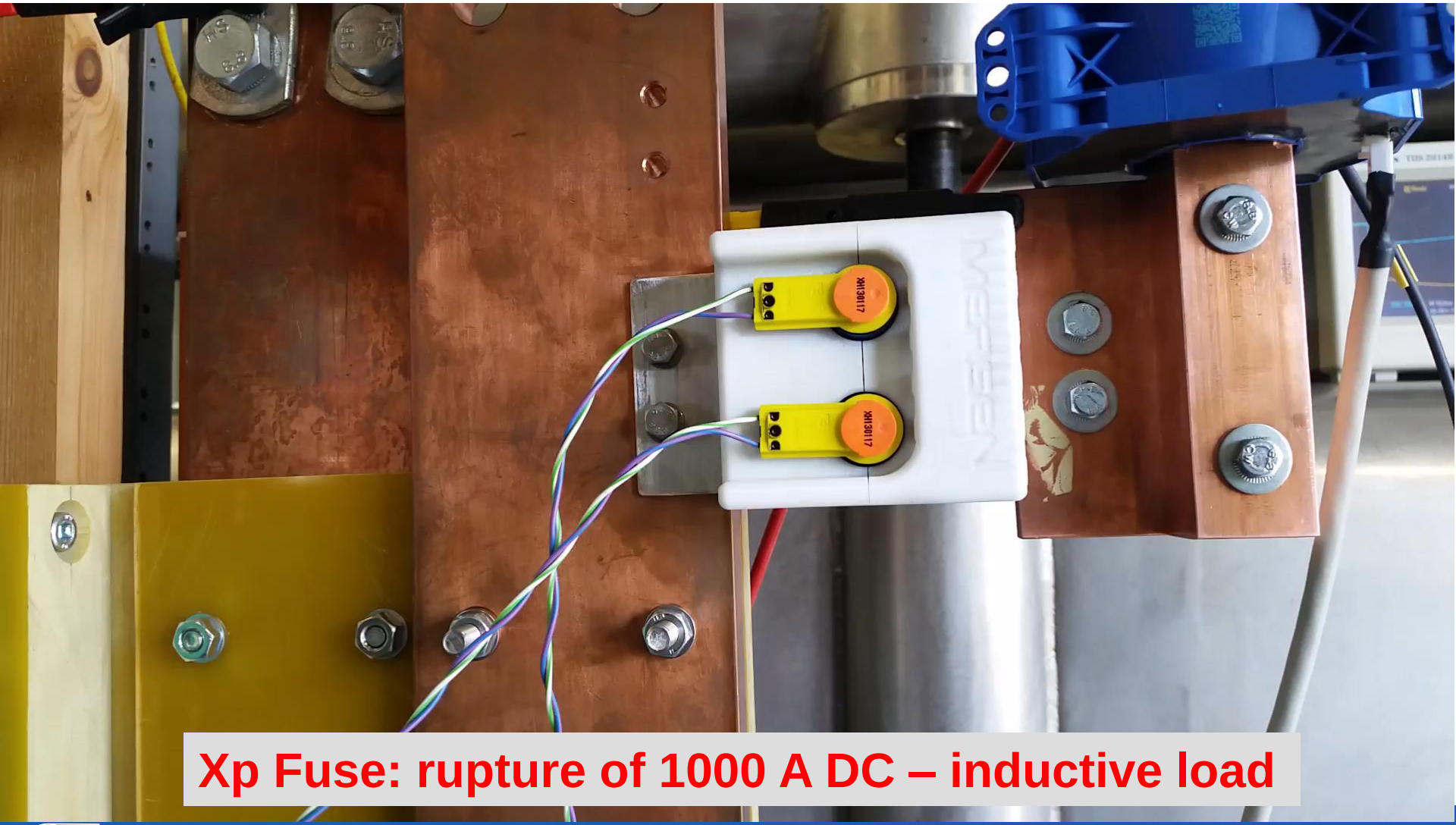
- The first tests with 1kA bipolar and 2kA uni-polar are expected soon

30kA Energy Extraction System for SM18 fully commissioned and operational





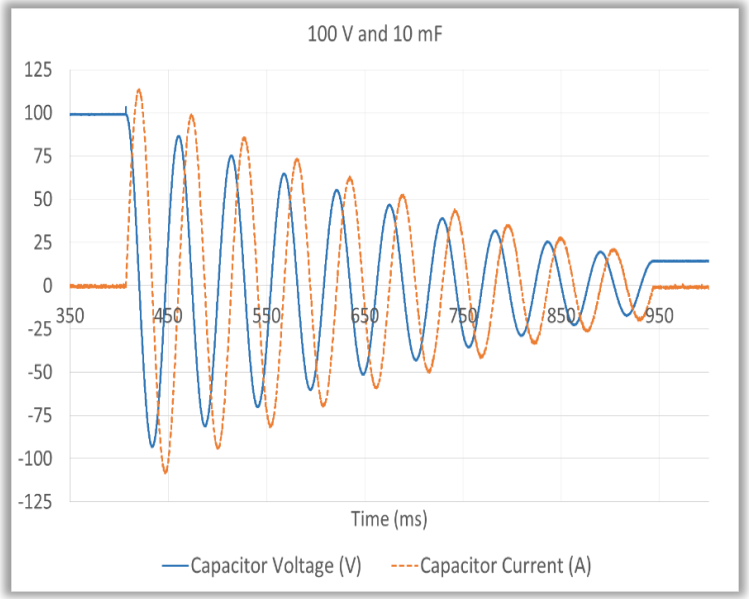
Back-up of protection switches: validation of industrial fuses



Xp Fuse: rupture of 1000 A DC – inductive load

CLIQ

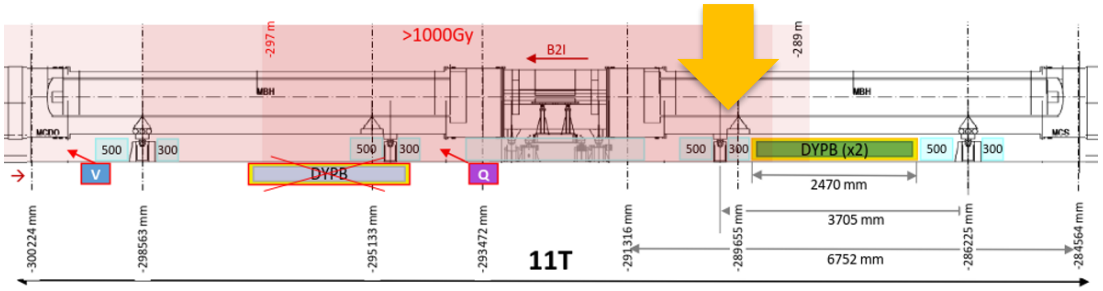
- Three CLIQ v2 units successfully qualified are on the starting block to be used in an extensive R&D program at the SM18 test facilities for the HL-LHC program
- Contract for the industrial manufacturing of five CLIQ v2 units to be signed in November 2017
- CLIQ design and manufacturing presented at MT25 conference

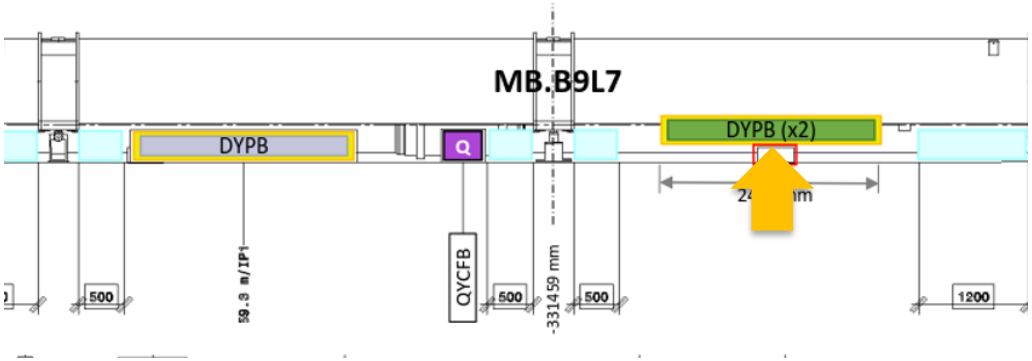


11T dipole – New rack DQHDS status

Location of the DQHDS

- Point 7 – left side: 11T dipole before the collimator and MB.B9L7 right
- Point 7 – right side: 11T dipole before the collimator and MB.A9R7 right





New rack for the DQHDS

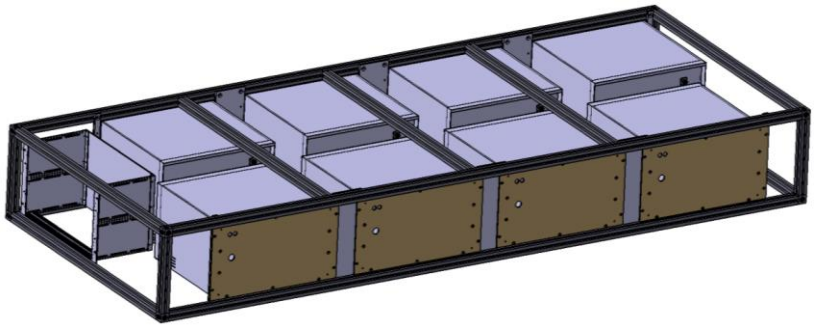
Under design – first approach

Per IP side

- 1 DQlim → 8 CT
- 8 QHPS
- QDS and AMC in the RR

Total numbers

- 6 racks to be built
  - 4 machine
  - 2 spares



Definition of electrical test voltages for HL-LHC

Acceptance and reception

Manufacturer & 1st test at arrival to test bench

300 K, 1 bar , AIR

1st test at cold in the test bench

Nominal operating conditions

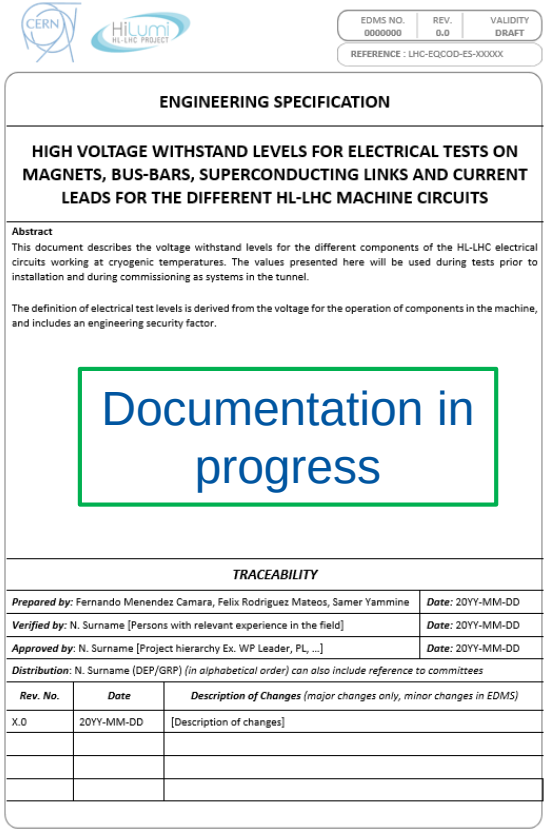
Installation

1st test after cold test in air but possibly with He gas

300 K, 1 bar , He (gas)

Test at cold after acceptance or reception test

Nominal operating conditions



EDMS NO. 0000000 | REV. 0.0 | VALIDITY DRAFT

REFERENCE : LHC-EQCOD-ES-XXXXX

ENGINEERING SPECIFICATION

HIGH VOLTAGE WITHSTAND LEVELS FOR ELECTRICAL TESTS ON MAGNETS, BUS-BARS, SUPERCONDUCTING LINKS AND CURRENT LEADS FOR THE DIFFERENT HL-LHC MACHINE CIRCUITS

Abstract

This document describes the voltage withstand levels for the different components of the HL-LHC electrical circuits working at cryogenic temperatures. The values presented here will be used during tests prior to installation and during commissioning as systems in the tunnel.

The definition of electrical test levels is derived from the voltage for the operation of components in the machine, and includes an engineering security factor.

Documentation in progress

TRACEABILITY

Prepared by: Fernando Menendez Camara, Felix Rodriguez Mateos, Samer Yammine	***Date:*** 20YY-MM-DD
Verified by: N. Surname [Persons with relevant experience in the field]	***Date:*** 20YY-MM-DD
Approved by: N. Surname [Project hierarchy Ex. WP Leader, PL, ...]	***Date:*** 20YY-MM-DD
Distribution: N. Surname (DEP/GRP) *(in alphabetical order) can also include reference to committees*	

Rev. No.	*Date*	*Description of Changes (major changes only, minor changes in EDMS)*
X.0	20YY-MM-DD	[Description of changes]

	Max discharge V to GND	Max V coil to GND	Max V coil to heater	Minimum design withstand voltage {Acceptance/ Reception}				Test Voltage to GND {Installation}		V Inter-turn
				Gnd	QH	Gnd	QH	Ground		
MQXF	-	670	900	1800	2300	3700	3000	810	360	70

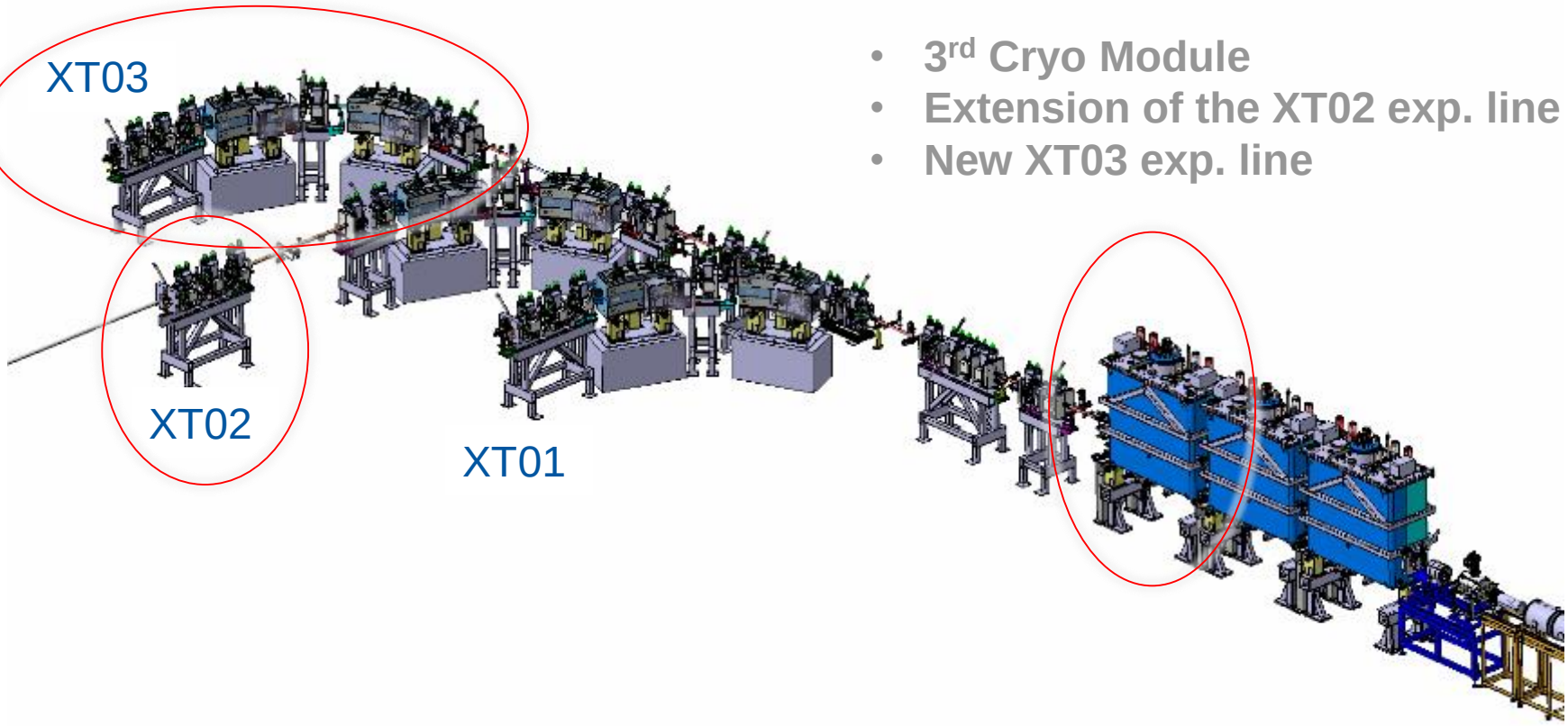
MI Section

J. Uythoven

WIC for Hie-Isolde Ph. 2a (2017)

Reconfiguration of the WIC to accommodate:

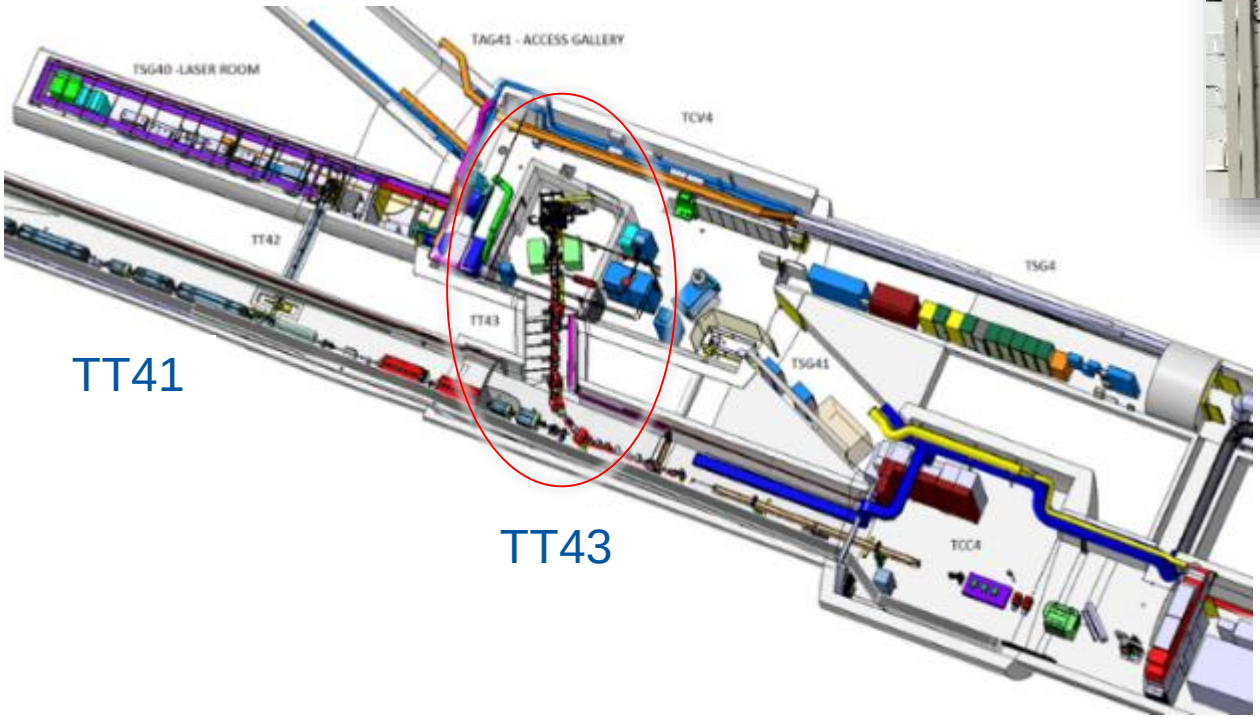
- 3rd Cryo Module
- Extension of the XT02 exp. line
- New XT03 exp. line



WIC for Awake Ph. II (2017)

Extension of the WIC for the **TT41 p+ line**

- To include **TT43 e- line**



TT41

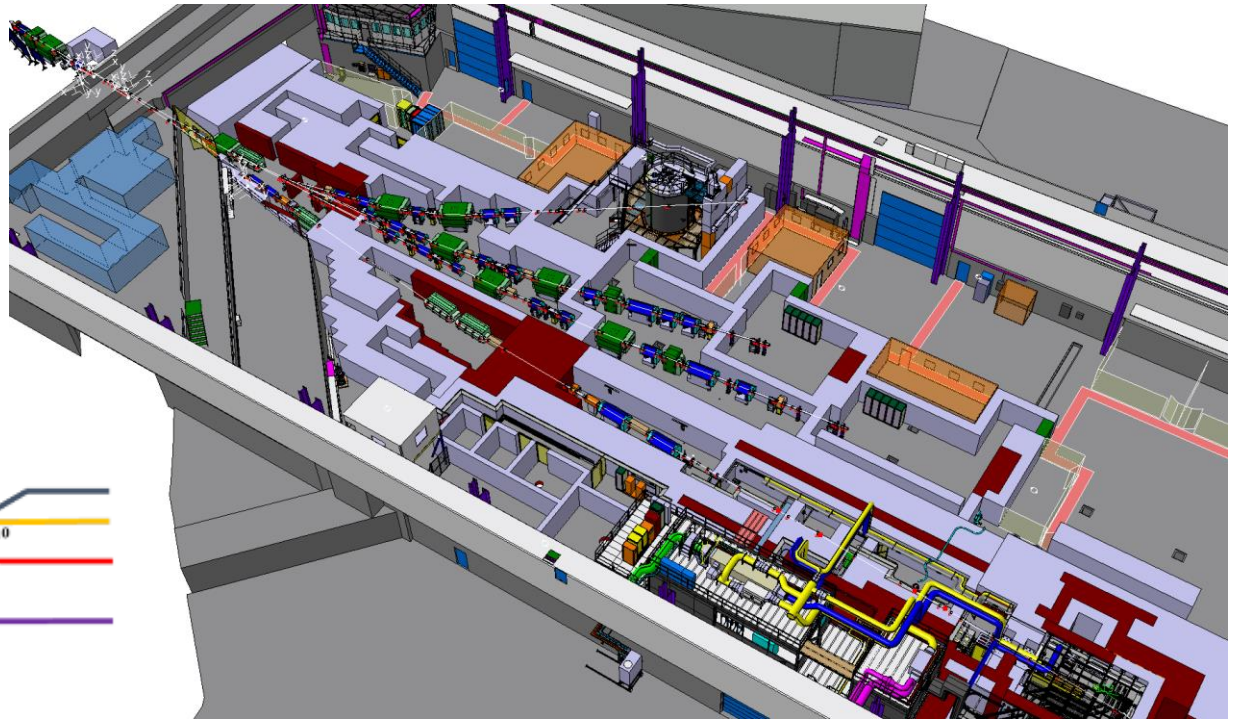
TT43

WIC team

Future project (LS2)

A new WIC for the East Area

- Full renovation of hall 157 + bld. 251 and bld. 352
- 60 new magnets
- 60 new PCs

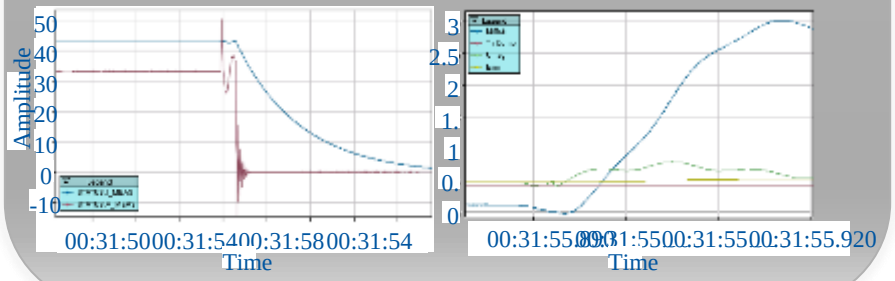


FMCM with Saturn Converters

- In **2016**, FMCM units provoked **22 beam dumps** caused by electrical disturbances.
- During YETS 2016, installation of New Saturn power converters for RD1.LR1/5, RD34.LR3/7 circuits by TE-EPC.
- In **2017**, **no dump** recorded for RD1.LR1/5, RD34.LR3/7 because of electrical disturbances.

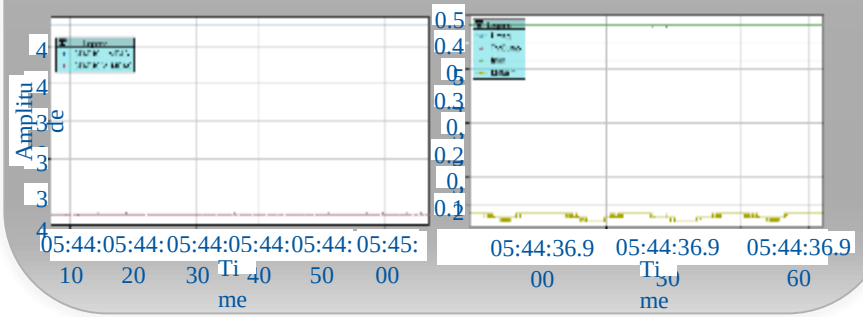
On 12th October **2016**, RD1.LR5 triggered a beam dump because of an electrical perturbation of ~8.5 % with a duration of 100 ms.

Power Converter **FMCM**



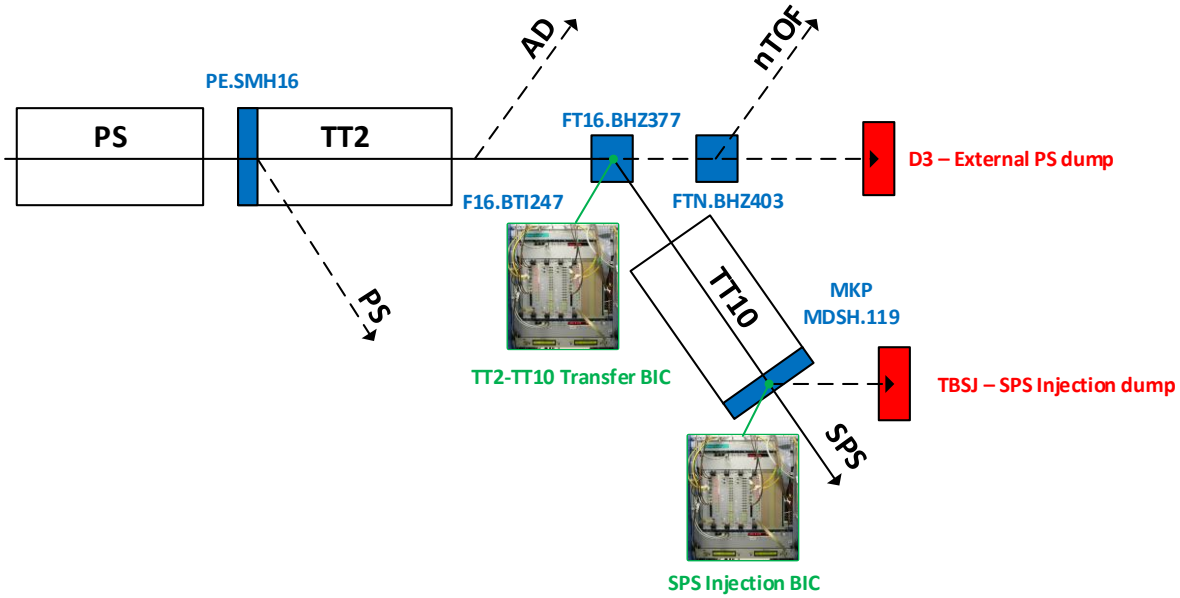
On 31th May **2017**, RD1.LR5 converter rejected successfully a comparable electrical perturbation.

Power Converter **FMCM**

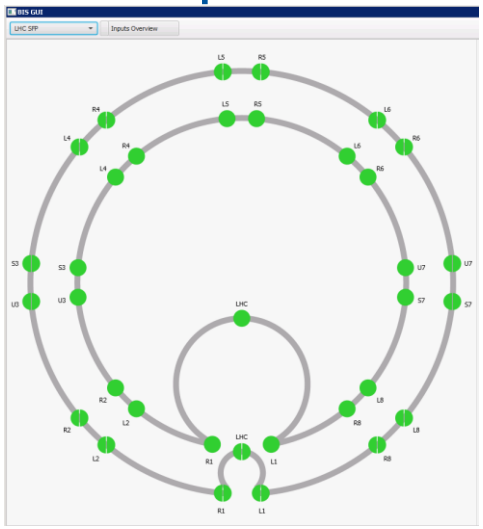


BIS – SPS injection

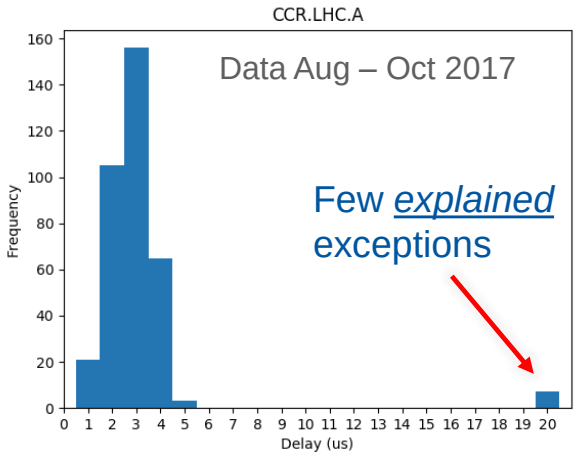
- In the framework of the LIU project and following the SPS Beam Dumping System relocation during LS2, **a standard BIS solution will be deployed in the SPS injection area** to take care of the injection inhibit mechanism
- **Technical specification** under preparation and ready by end 2017



Improvement of the BIS optical permit loops
Part of the BIS 1.23 Project

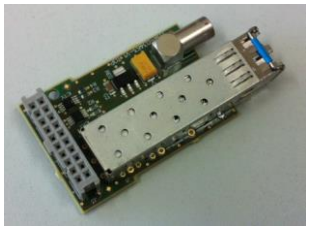


Two new BIS loops have been installed in parallel of the operation LHC BIS loops

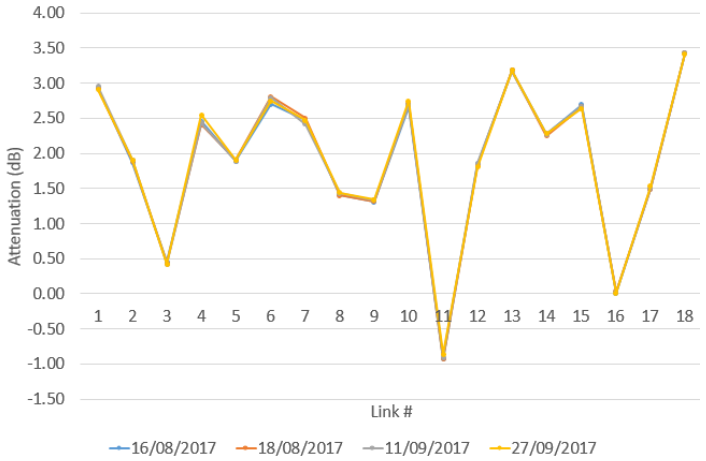


Delay in µs between operational and test loop local permit when beams are dumped

Current CIBO module
- Home made
- Low power margin
- High temp drift
- No monitoring

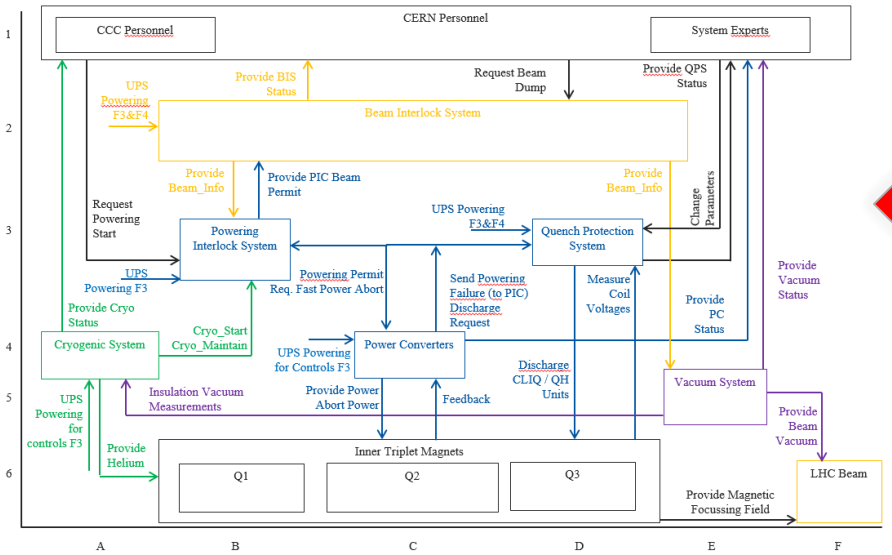


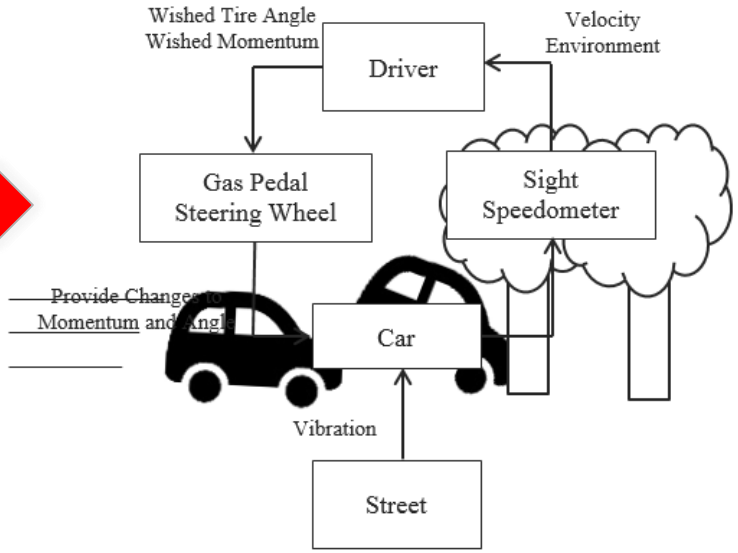
New SFP module
- Industrial standard
- High output power
- Low temp drift
- Monitoring function



Measured attenuation of new LHC optical fibre links installed in the LHC: Very Stable !

Failure Analysis HL Inner Triplet Protection using System Theoretic Process Analysis (STPA)





FMEA and Fault Tree of SPS Beam Dumping System (finished) and LHC Main Quadrupole QPS (started)

Consequences / Frequency	Downtime	Catastrophic 3 month	Major 3 weeks	Moderate 3 days	Low 3 hours	Negligible 3 mins
Very frequent	1/hour					
Frequent	1/day					C4
Probable	1/week					
Occasional	1/month				C3	
Remote	1/year			C1		
Improbable	1/10years		C2			
Not credible	1/100years					

PE Section

A. Verweij

The PE section in brief

Magnet circuits

Development of STEAM.
Protection studies LHC.
Protection studies Hi-Lumi.
Protection studies FCC.

Strong involvement in MP3, HL-MCF, EuroCirCol.

Machine protection

Studies on damage limits of SC's, hydrodynamic tunnelling, dBLM's, injection losses, UFO's.
Machine protection studies (LHC, Hi-Lumi, FCC, CLIC).

Strong involvement in MPP, BLMTWG, LHC operation and MD's.

Reliability & Availability

Fault tracking in the LHC.
Fault tracking in the injector complex.
Follow-up of Linac 4 reliability run.
Development of availability modelling tools.

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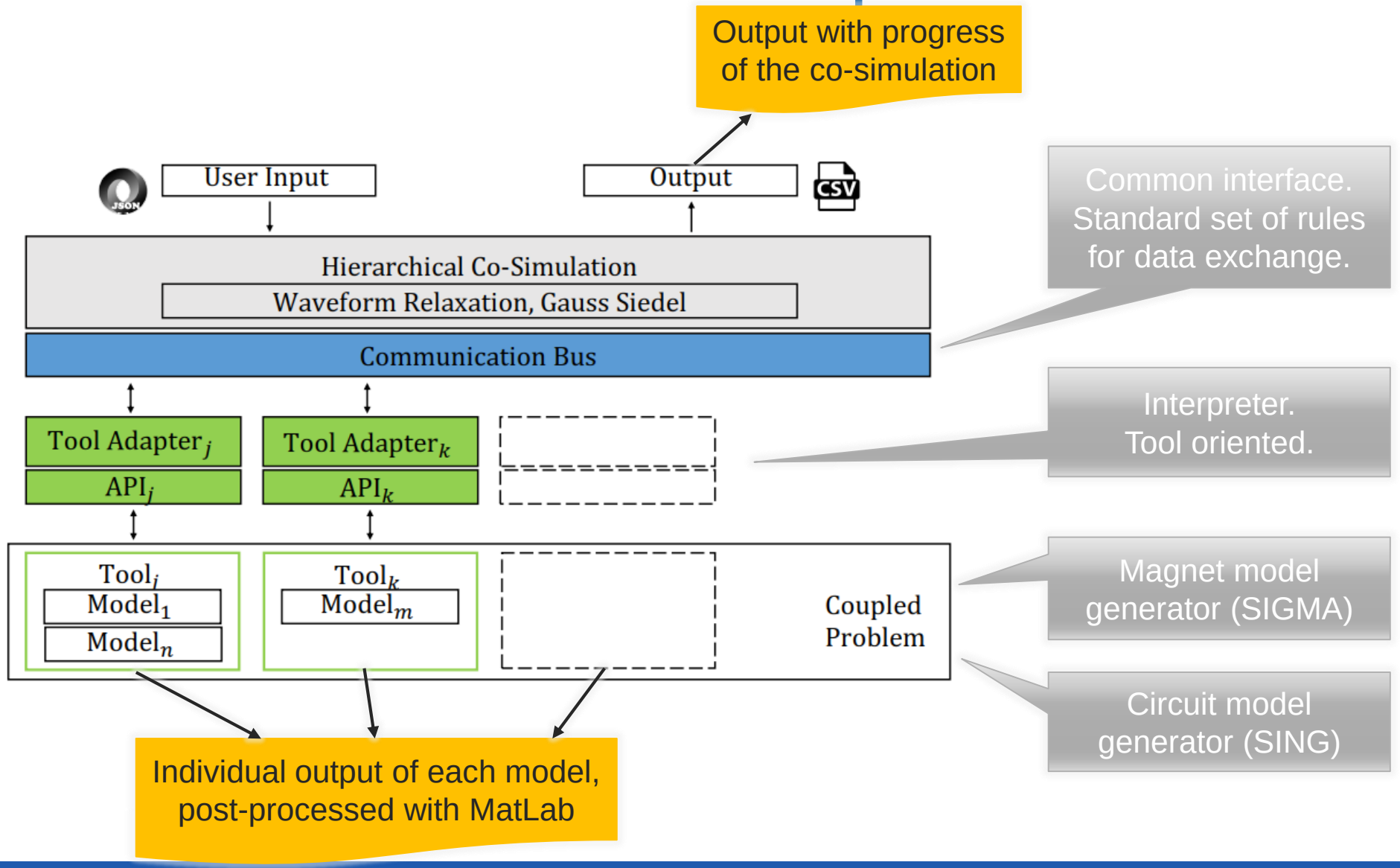
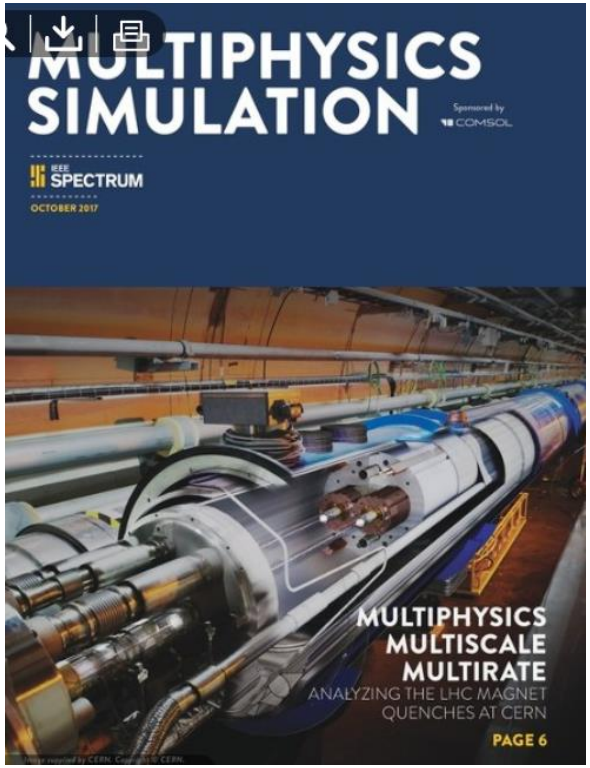
STEAM development



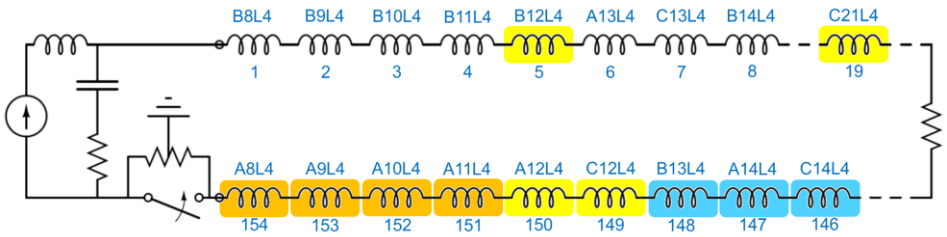
STEAM development

- Great collaboration workshop in Darmstadt.
- First version released.
- Co-simulation improving further.
- Number of tools, magnet models, and circuit models increasing.
- Number of STEAM users is growing (LBNL, Tampere Univ, MSC group)
- Special applications made for SM18 tests (FRESCA2, 11 T)
- We will now try to add more physics (cooling/cryogenics, radiation losses)

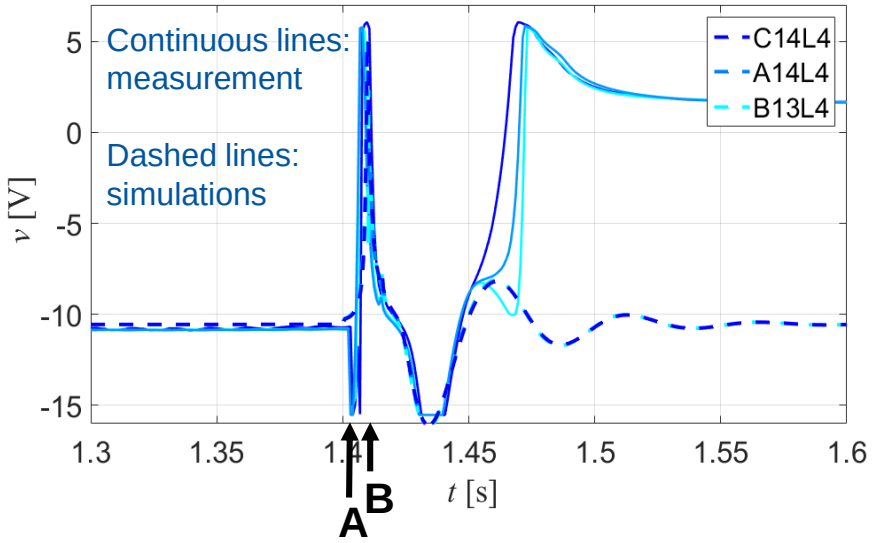


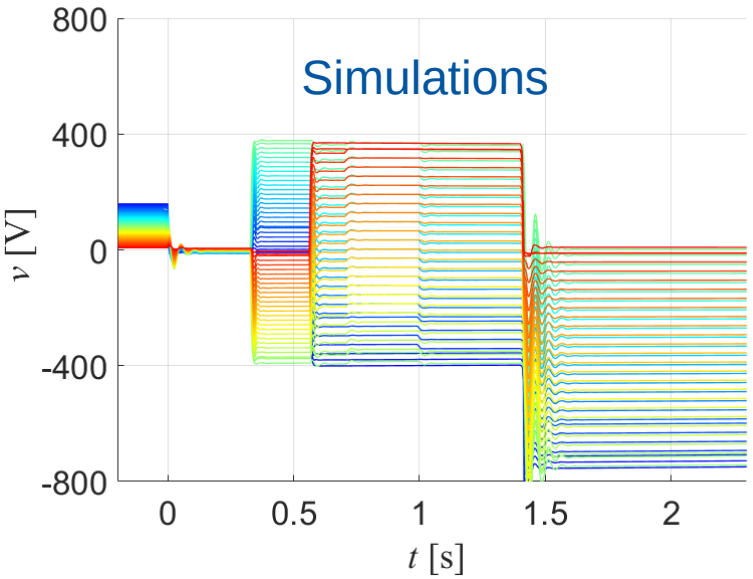
We use STEAM extensively for LHC, Hi-Lumi, and FCC, see next slides.

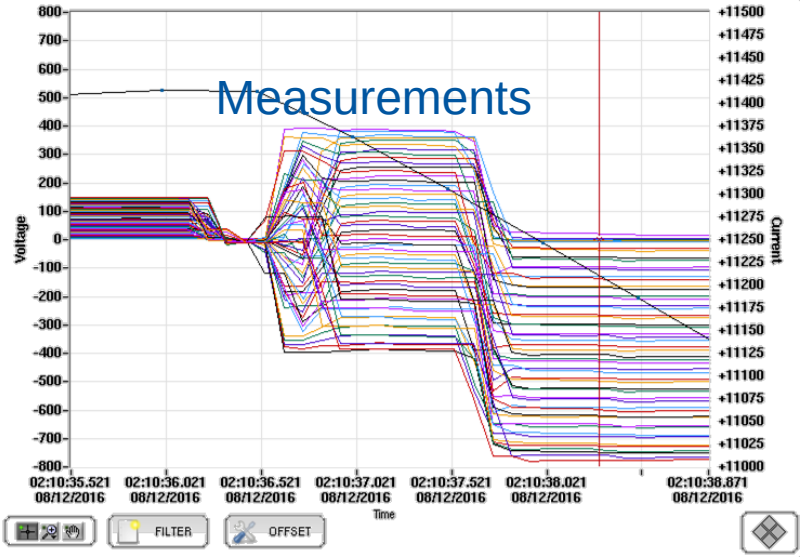
LHC circuit modelling: short-to-ground



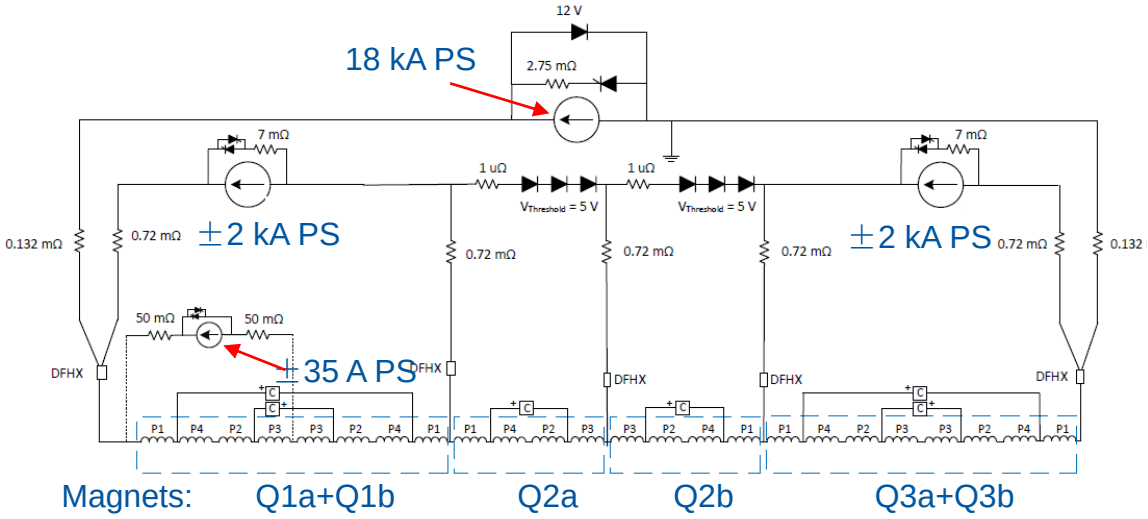
Quenched before the short
Family PN
Family NP



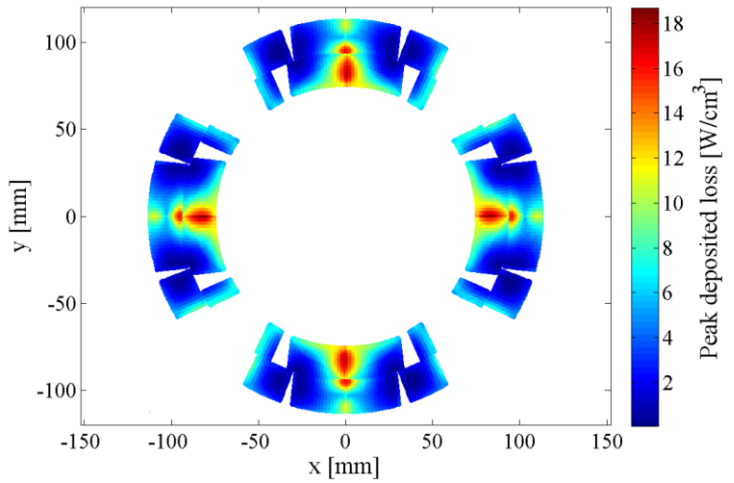




Hi-Lumi circuit modeling

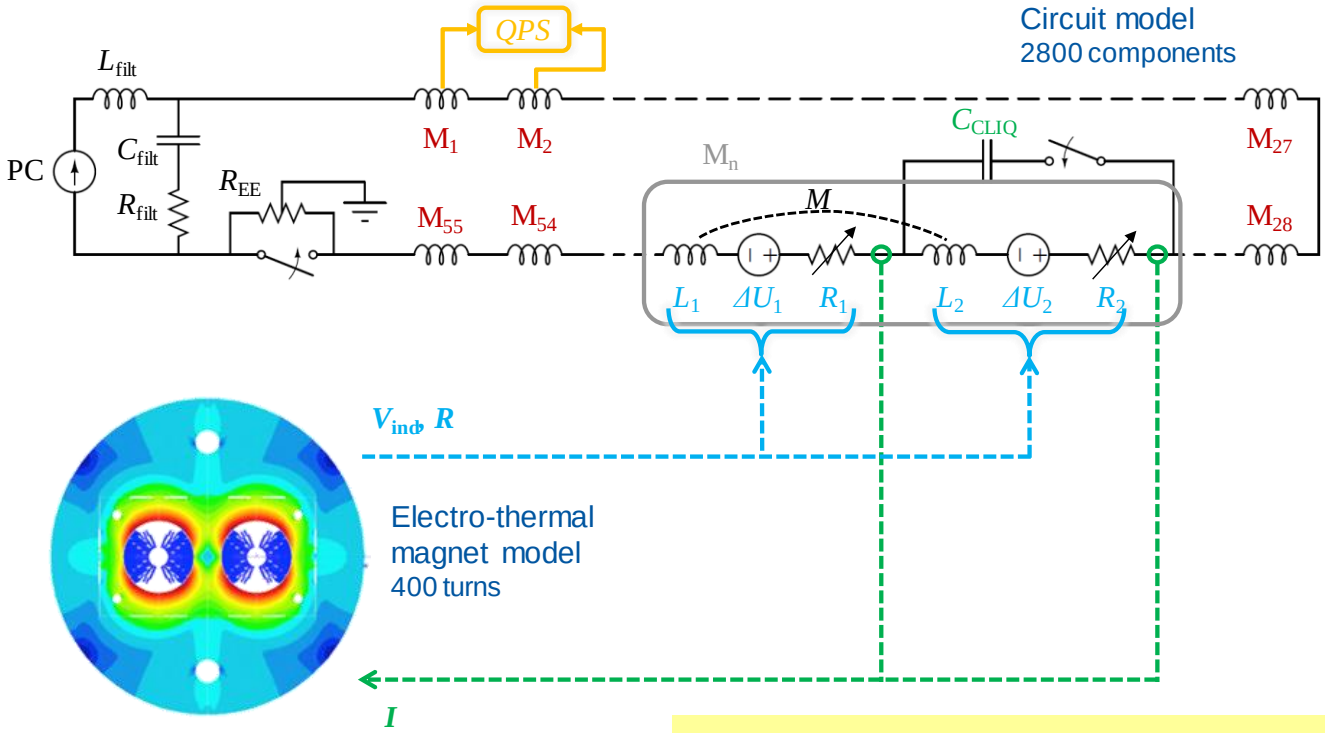


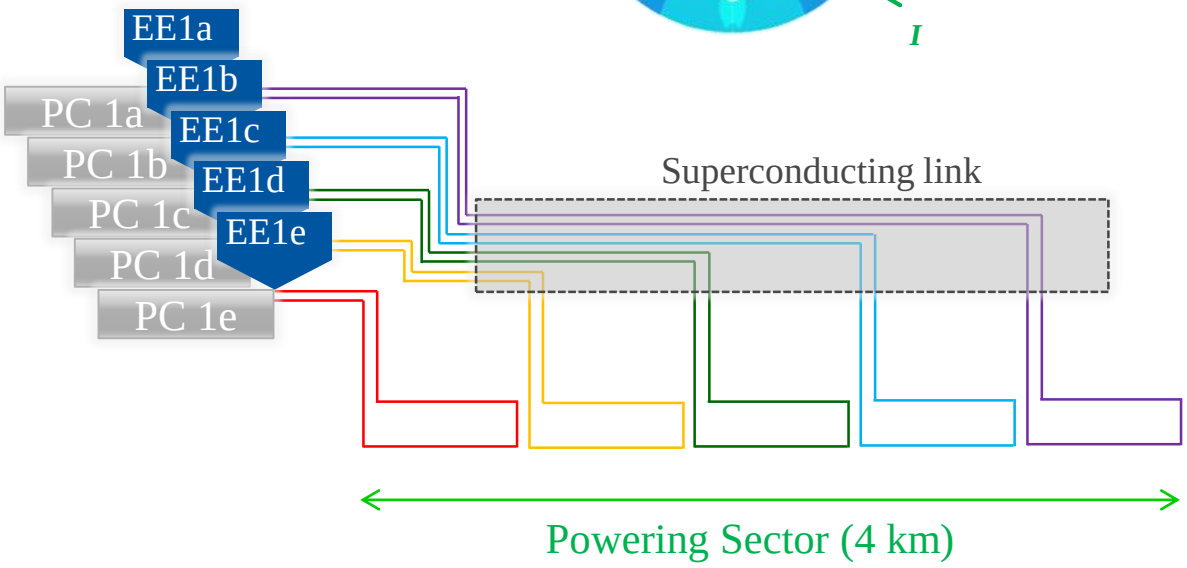
HL-LHC triplet circuit



- Nested circuit with 4 power converters and 6 Nb_3Sn quads.
- Combined quench protection using CLIQ and quench heaters.
- $T_{quench} \rightarrow 350$ K
- Several circuit alternatives.
- Many failure scenario's.
- Huge number of simulations with STEAM were needed!!!

FCC circuit modeling





FCC main dipole circuits optimized for maximum allowed temperature and voltage transients during quench event.

⇒ About 100 (!) main dipole circuits in the FCC with CLIQ protection.

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Fault tracking in the injector complex.
Follow-up of Linac 4 reliability run.
Development of availability modelling tools.

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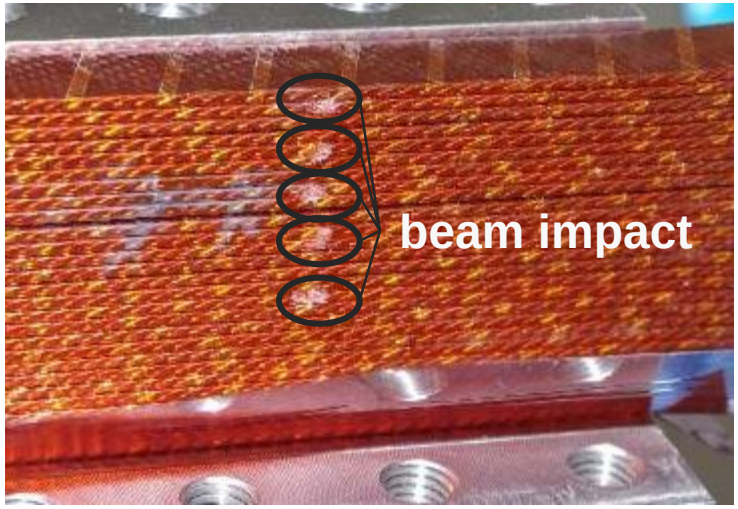
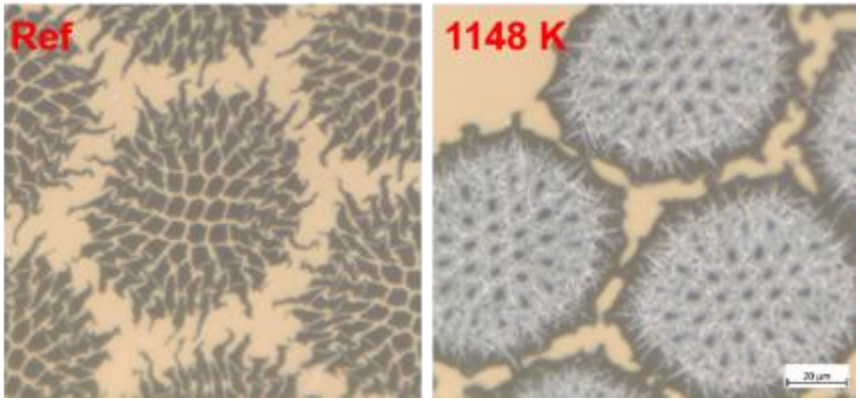
Damage due to impact of 440 GeV protons



Side view of a Nb-Ti cable stack after beam impact



Polyimide insulation

- No degradation up to ~1050 K for few ~ms
- Weakening of the insulation at the point of the beam impact was observed for T > 850 K

NbTi strands

J_c degradation for **T>900 K**

J_c decreases with increasing exposure time

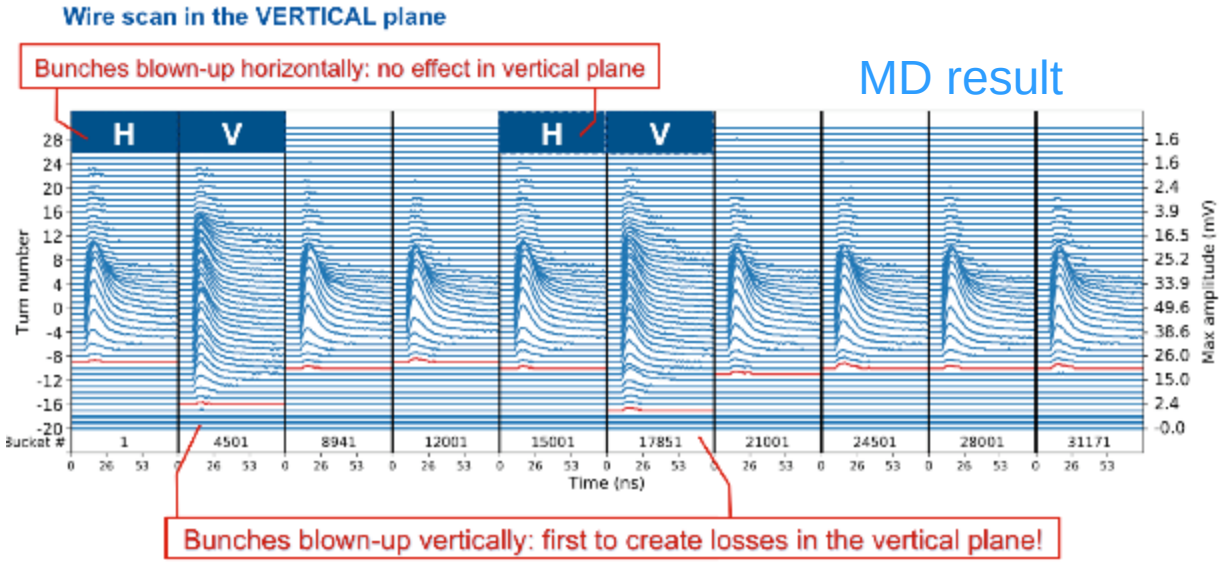
Cause: variations of α-Ti precipitates size and spacing

Nb_3Sn strands

J_c decreases with decreasing exposure time

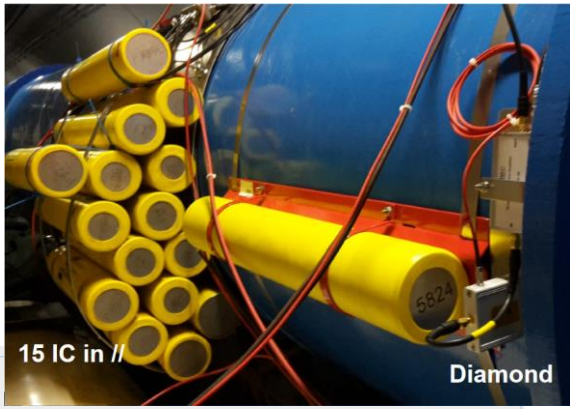
Cause?: stresses and cracks caused by fast heating and high thermal gradients

UFO & 16L2 studies

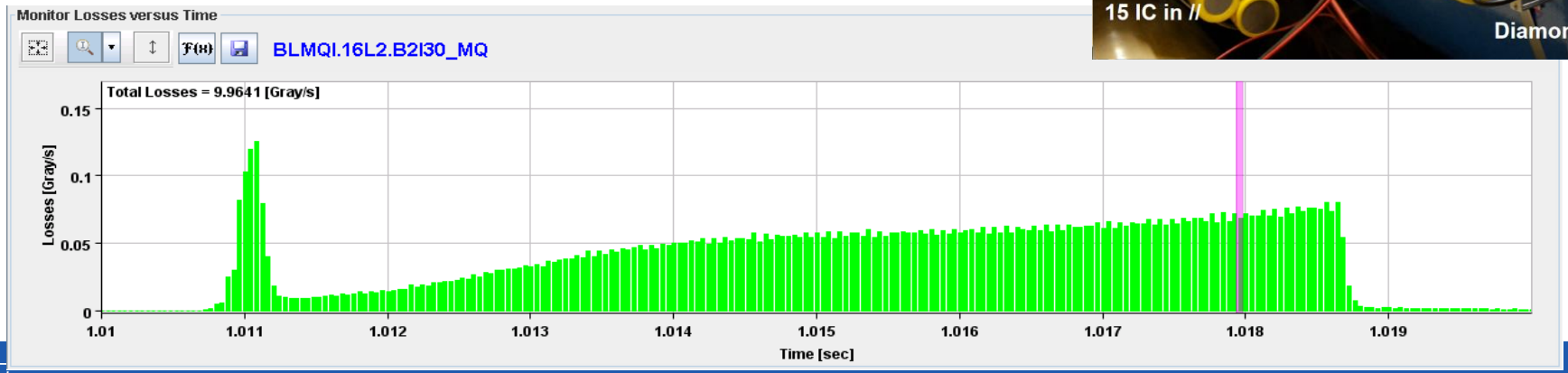


Bunch-by-bunch loss response using diamond BLM allows:

- Identification of wire-scanner-UFO movement plane
- Comparison to model of UFO movement dynamics

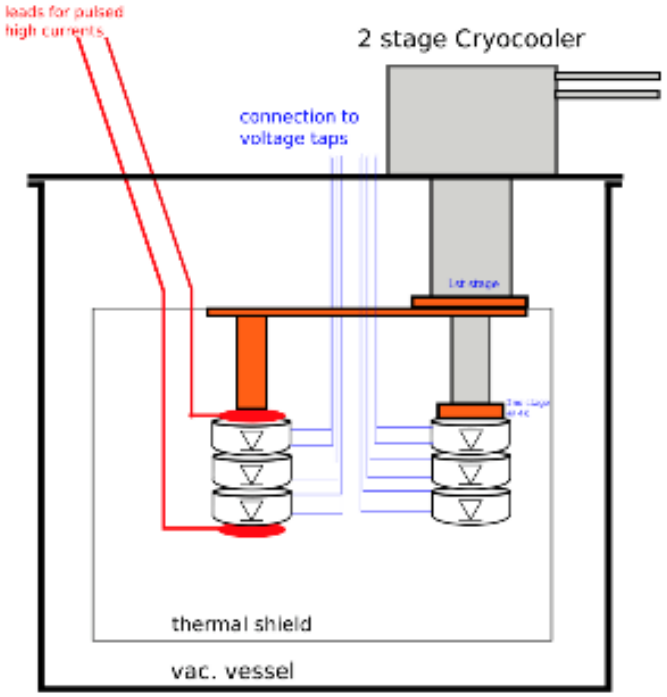


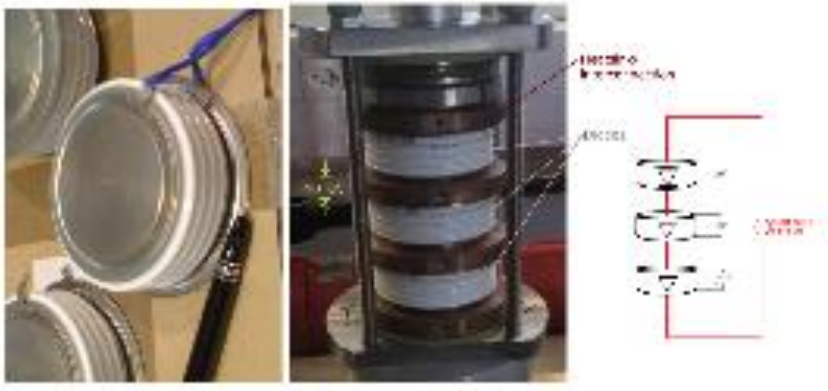
Spatial and time distribution of losses in 16L2 following UFO likevent in 16L2 and IP7.



Design of a test-stand for cold diode radiation testing

- **Adaptation** of LHC type diffusion diodes for triplet currents and time constants (18 kA, ~100 s / 7 kA, ~ 100 ms).
- → Qualification for HL-LHC radiation levels required.
- **Irradiation and in-situ testing** in CHARM in 2018
- Depending on results further testing in CHARM or other facility OR modification of diodes and re-testing.
- **Turn-key cryo-cooler based** cryostat → expected cost ~ 90 kCHF (HL-LHC)



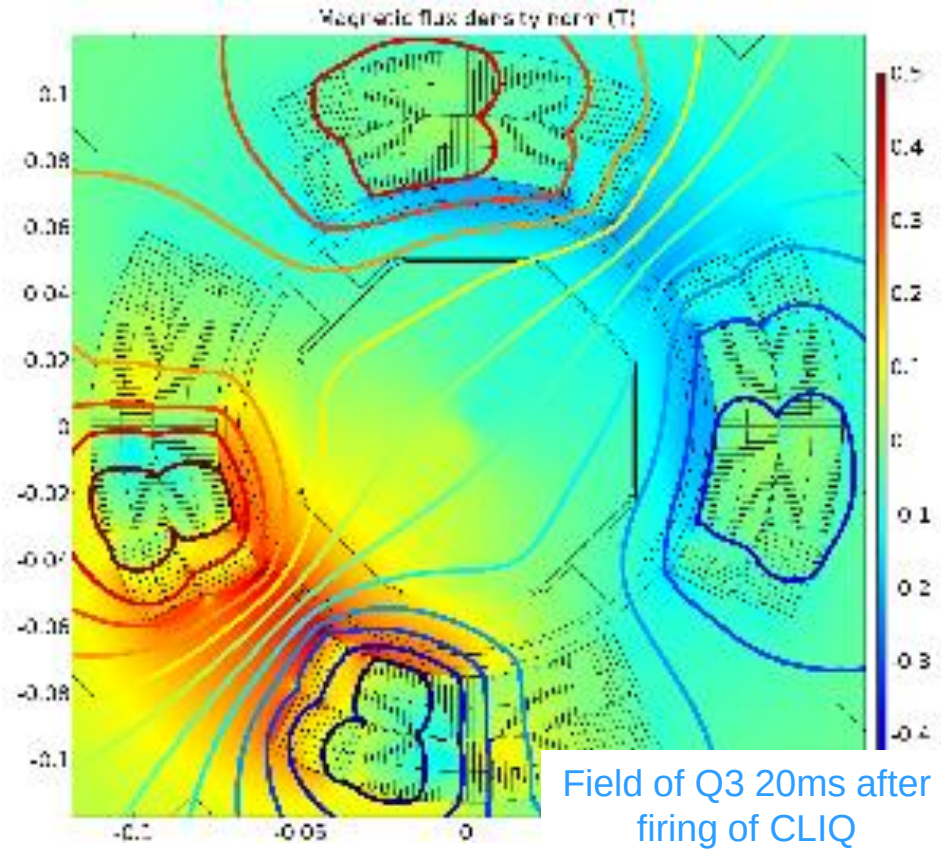


Fast Failures HL-LHC

Firing quench heaters and CLIQ with circulating beam will give strong kicks onto the beam – (HL-triplet 52 sigma)

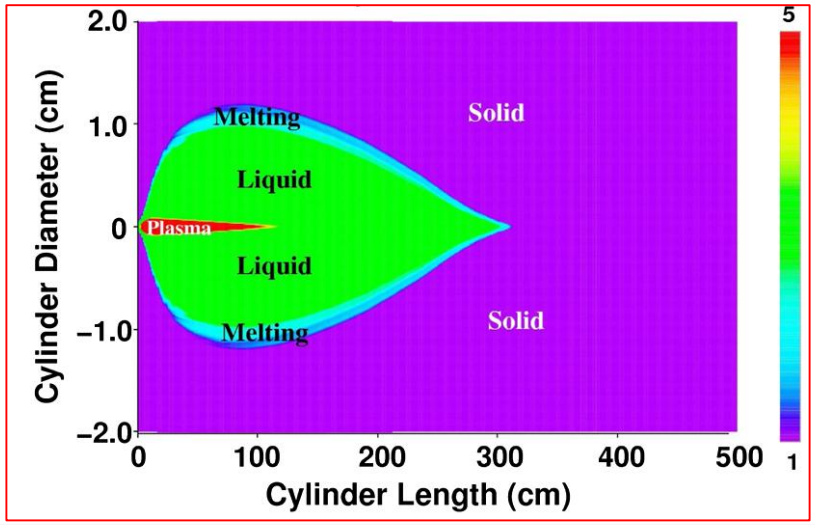
Required:

- Beams should be **dumped before firing** protection equipment
- **Interlock discharge** in case of spurious firing.

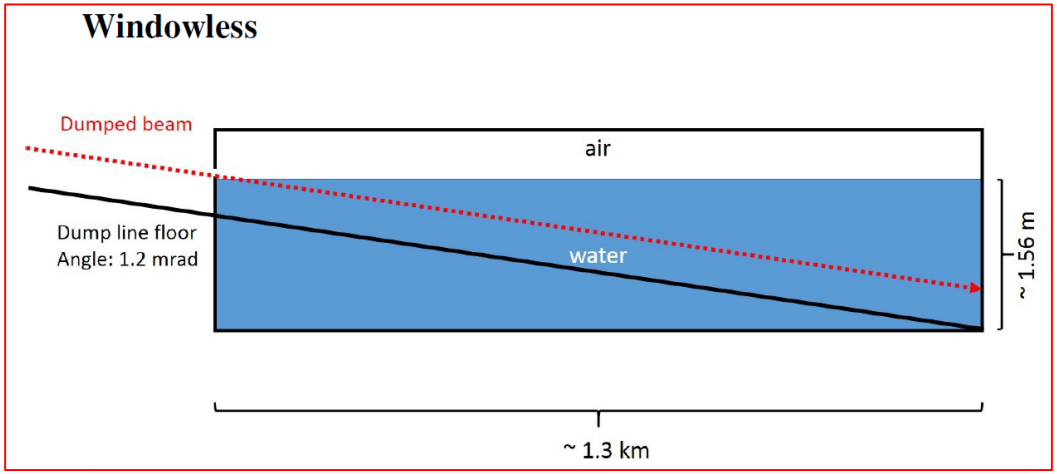


Field of Q3 20ms after firing of CLIQ

FCC beam impact on material

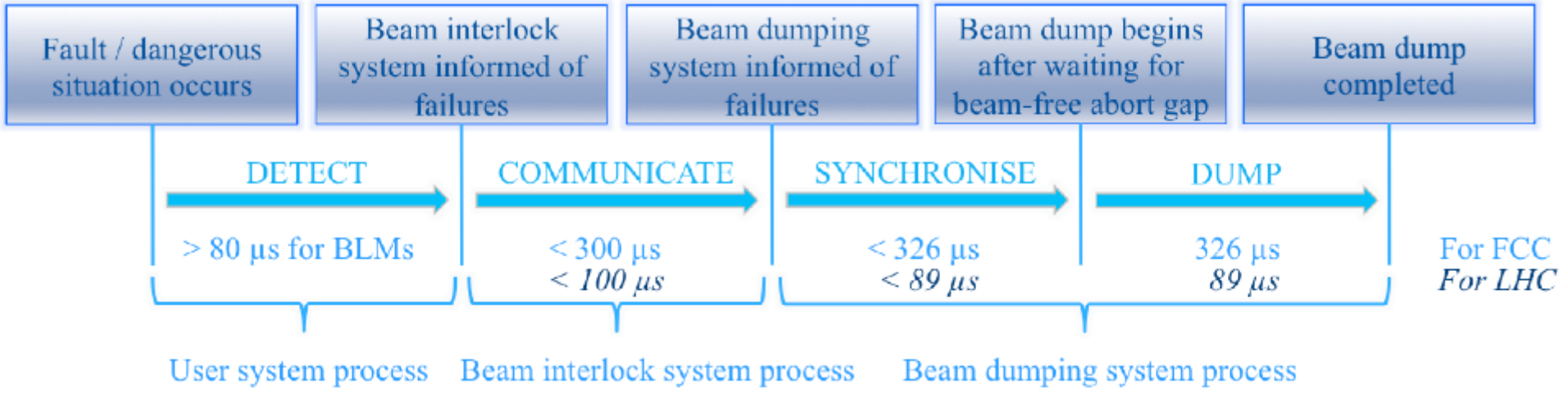


Hydrodynamic tunneling in a copper target, 10600 bunches: 290 m @ 40 TeV; 350 m @ 50 TeV! (compared to 35 m in the LHC)



Water dump
50TeV, 10600 bunches, $\sigma_{x,y}$= 0.4 mm → 1.3km

MPS reaction time FCC versus LHC



Machine Protection Panel (MPP & rMPP)

- Follow-up re-commissioning of MP systems with the different HW teams
- Definition and follow-up of intensity ramp-ups after EYETS, TS, configuration changes (beta*) etc.
- Verification of critical Machine Development requests
- Definition of machine protection requirements for beta*=30 cm

MP System	Responsible	MPP presentation	Commissioning procedure
Collimation System	B. Salvachua (Stefano Redaelli / Roderik Bruce) ✔	17.04.	Released
Injection Protection System	C. Bracco / W. Bartmann ✔	31.03.	Released
Beam Interlock System	C. Martin / I. Romera ✔	17.03. JJ	Released
Powering Interlock System	A. Antoine / I. Romera ✔	17.03. - JJ	Released
Vacuum System	G. Pigny ✔	17.07.	Released
Beam Dump System	C. Bracco / W.Bartmann ✔	31.03.	Released
FMCM	A. Antoine / I. Romera ✔	17.03. - JJ	Released
BLM System	C. Zamantzas / B. Holzer ✔	17.04. tbc	Engineering check
Warm Magnet Interlock System	R. Mompo / P. Dahlen ✔	17.03. - JJ	Released
Safe Machine Parameter System	I. Romera / C. Martin ✔	17.03. JJ	Released
Software Interlock System	J. Wenninger / L. Ponce ✔	17. (or 31.03.)	Released
Beam Current Change Monitor	D. Belohrad ✔	17.04.	Draft procedure

Without massive HW + SW interventions	With massive HW + SW interventions
• One fill with either **pilot bunches or max 2-3 nominal** bunches into SB (cycle revalidation etc.). • One fill with **600 bunches** and 2 - 5 hours of stable beams (known intensity step to disentangle wrong settings, de-conditioning, etc. from intensity dominated effects at full intensity). • **Back to pre-stop** intensities. Total 2 fills for ramp-up	• One fill with either **pilot bunches or max 2-3 nominal** bunches into SB (cycle revalidation etc). • One fill with **~50 bunches** and about 1 - 2 hours of stable beams. • One fill with **600 bunches** and 2 - 5 hours of stable beams (known intensity step to disentangle wrong settings, de-conditioning, etc. from intensity dominated effects at full intensity). • If > 2000 bunches reached, one fill with about **half max number of bunches** and about 5 hours of stable beams. • **Back to pre-stop** intensities. Total 3-4 fills for ramp-up

Verification of failure cases and required interlocking of new elements:

- beam-beam wire compensators
- new TED interlock for LIU-beams in SPS
- ADT-AC dipole mode
- Crab cavities for the SPS

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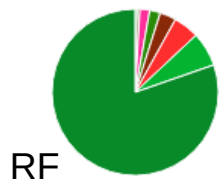
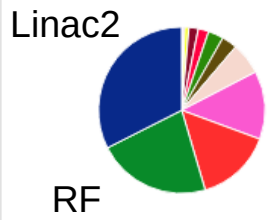
Fault Tracking

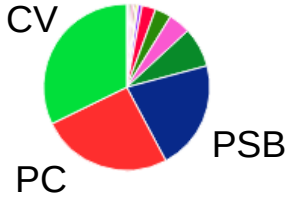
Collaboration with EPC, injector supervisors & OP

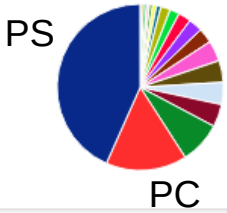
+ Accelerator Fault Tracker in use in all injectors from the beginning of 2017

Linac2	PSB	PS	SPS	LHC
Machine availability	Machine availability	Machine availability	Machine availability	Machine availability
98.9%	97.0%	92.6%	89.5%	80.8%
Weekly Availability	Weekly Availability	Weekly Availability	Weekly Availability	Weekly Availability
Linac2 Root Cause Downtime	PSB Root Cause Downtime	PS Root Cause Downtime	SPS Root Cause Downtime	LHC Root Cause Downtime





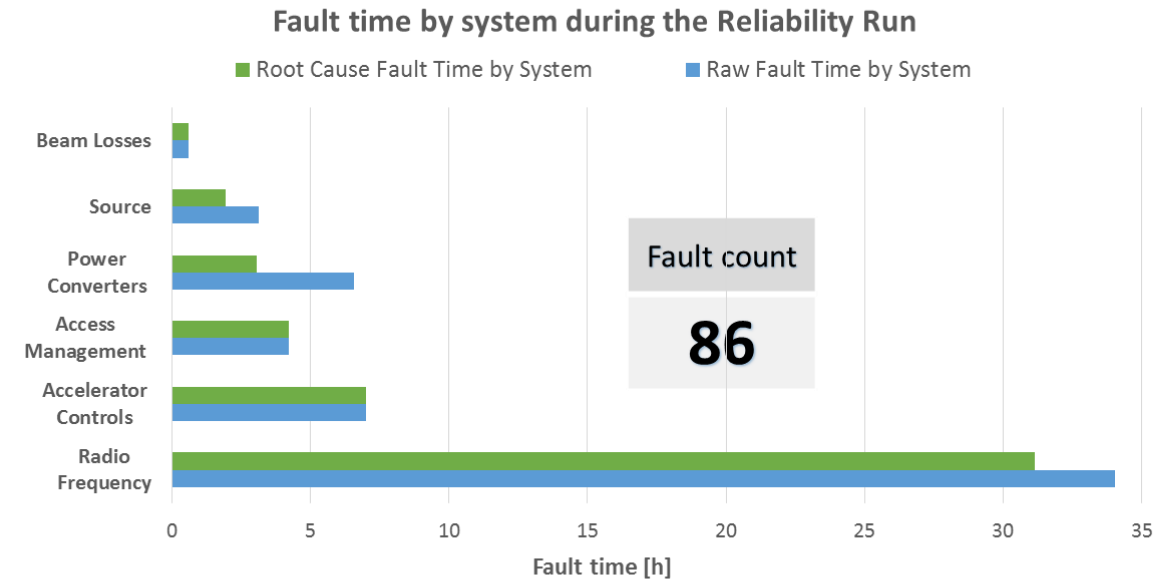




May-September

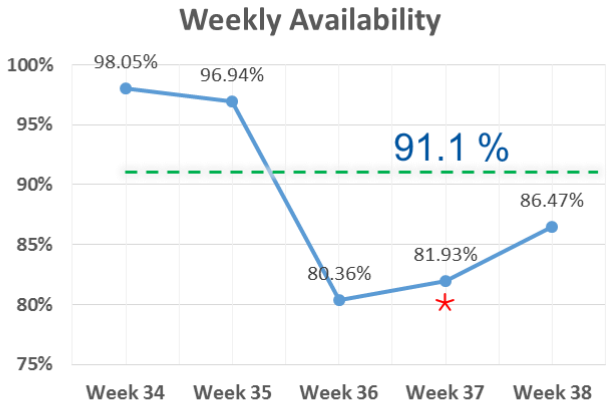
Follow-up of Linac4 Reliability Run

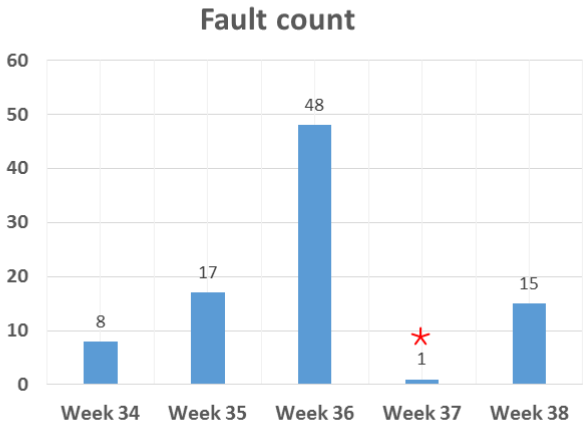
Collaboration with ABP, Linac4 team, and OP-PSB



+ 91.1 % average availability

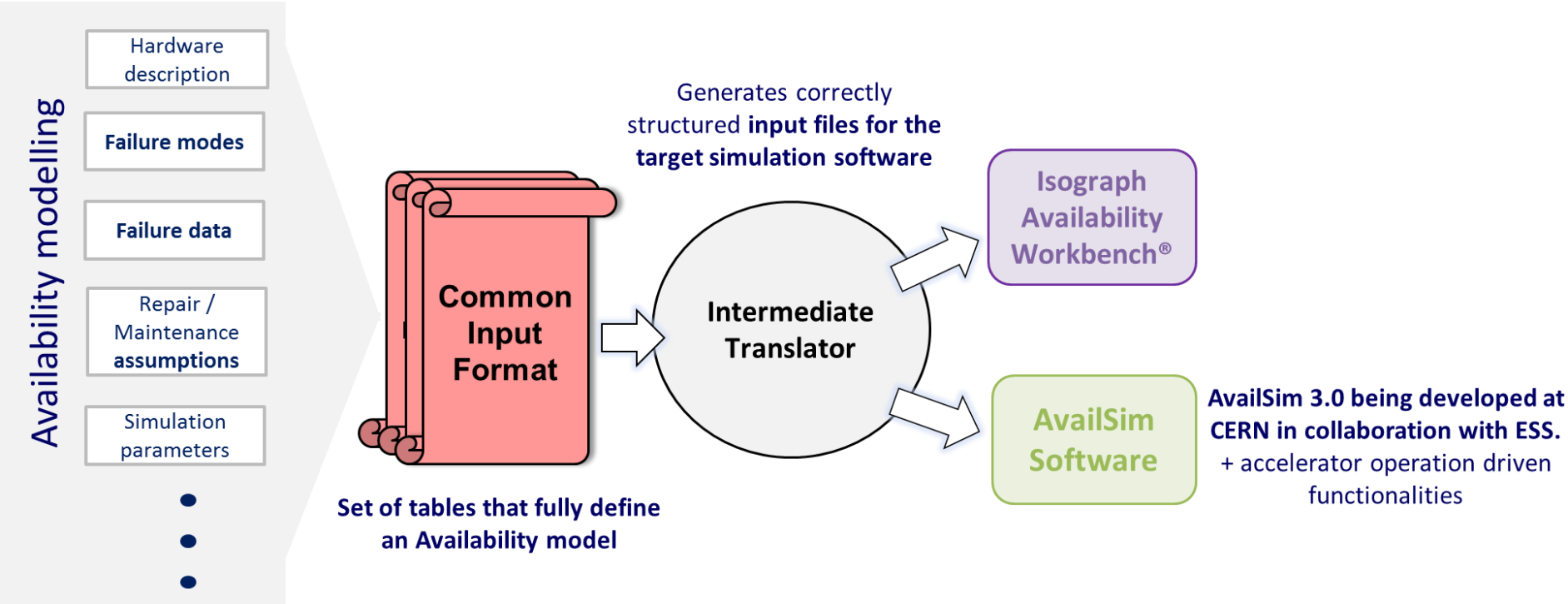
+ 67 % of the systems operated without faults





*Planned Source replacement –
Just one day of operation in Week 37

Availability Modelling Tools

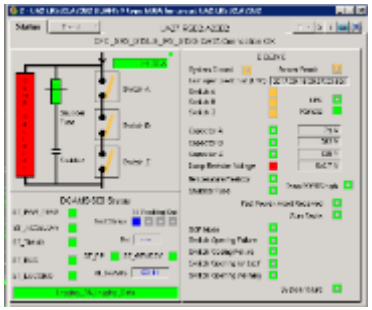


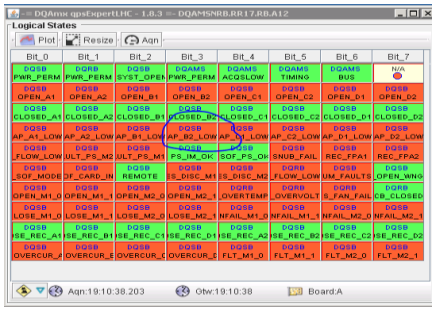
+ Modelling and simulations in various software packages
+ Single model definition, input to several packages
+ Benchmarking of results from different packages

MPE Piquet service

8 members: Giorgio, Grzegorz, Joaquim, Mathieu, Spyros, Steven, Vincent , Yan

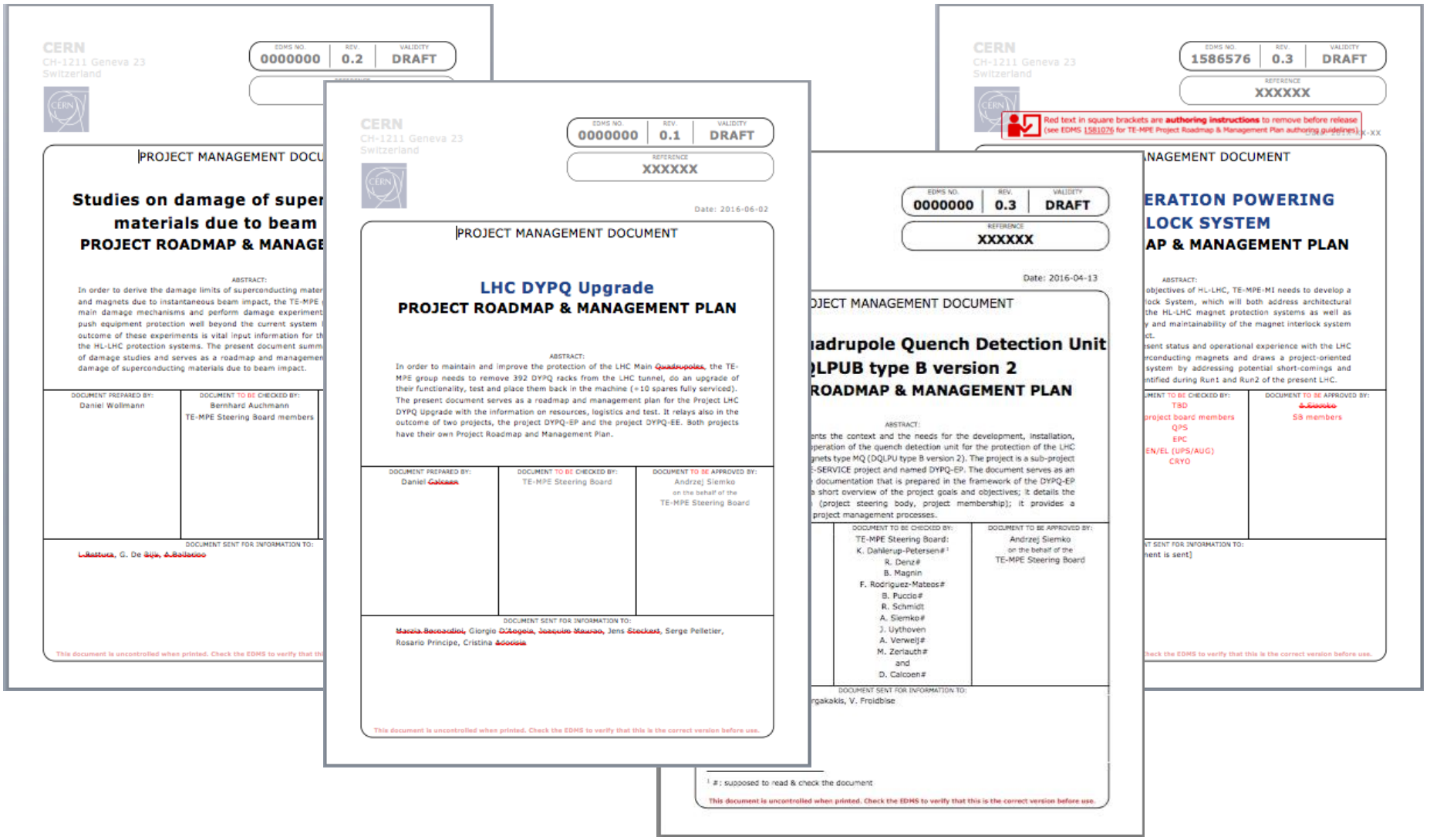
29 Interventions, 21 requiring tunnel access ! (03.11.2017)





Projects, priorities and main objectives for 2017

TE-MPE Projects Towards LS2



Main objectives and priorities for 2018

- For MPE there are 5 top priority objectives for 2018
  - **YETS** (2017-2018 Year End Technical Stop)
    - Advanced ELQA diagnostics in several LHC sectors
    - A lot of maintenance work
    - ELQA campaigns, in particular for complete warmup of sector 1-2
    - LHC re-commissioning and restart of operations
  - **Operation** of our systems during the last year of Run 2, with the objective to maintain the MPE systems availability
  - **MPE-EM** – to retain the present level of services for the layout design, prototype board assembly, industrialization and production of electronic circuit boards and modules
  - **LS2 preparation** – completion of all MPE projects critical for our commitments towards the LS2, including the first HL-LHC deliverables
  - **FCC study** – completion of the machine, magnet circuits and individual magnet protection studies for the FCC conceptual design report

Special objective for 2018

- An important objective for MPE is to maintain in 2018 and to increase after the LS2 the **MPE systems availability**
  - The present availability level of the MPE systems was improved over past years mainly through the elimination of week components and implementation of radiation tolerant QDS electronics, reducing significantly the single event effects
  - Efforts to **further increase the MPE systems availabilities** requires an important change of working methods and habits like:
    - Respect of ESD protection for all electronic equipment
    - Cleanliness of assembly process for sensitive elements
    - More strict management of spares and storage conditions
  - Change of our working methods and habits is progressing, in particular in our new labs, but this **process should be accelerated and completed in 2018**

Final remarks

- Remarkable performance of LHC in 2017 would not be possible without a team of dedicated MPE experts

- Big thank you to all of you for a job well done !!
  - All section crews
  - Stefanie
  - Lisette and her colleagues Lisa, Mariane, Georgina, and Brigitte

Merry Christmas & Happy New Year! 2018