TE-EPC Activities during LS2

V. Montabonnet on behalf of TE-EPC group

LS2 DAYS

29-30 SEPTEMBER 2015

http://indico.cern.ch/event/436424/

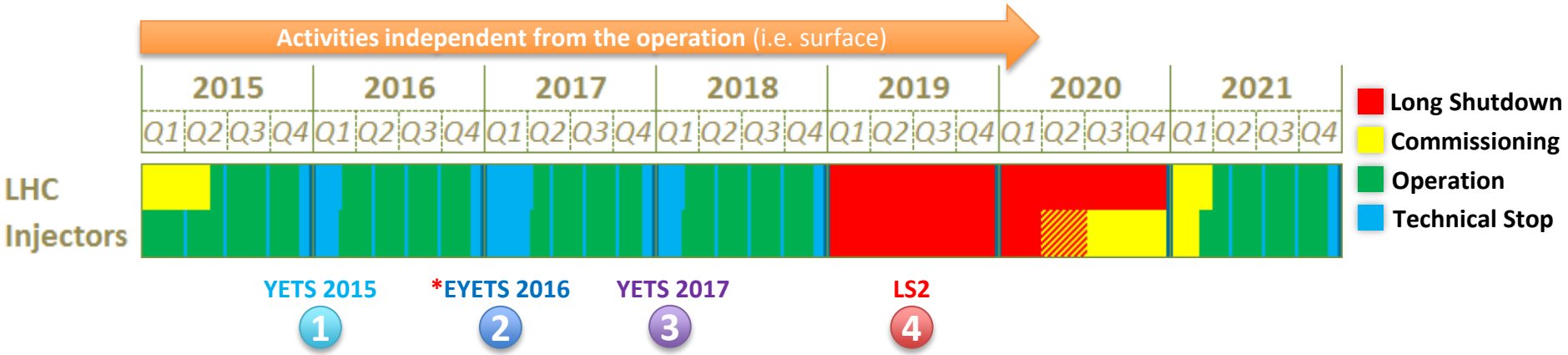
Contents

- Activities
  - Projects
  - Consolidation
  - Under approval
- Resources availability
- Logistics
- Interfaces / interferences
- Conclusions

LS2 Master Schedule

Master schedule up to LS2

Courtesy J. Coupard



3 periods are available for works before the Long Shutdown 2 (LS2)

***: The connection of the Linac4 to the PS Booster is foreseen for the LS2 but all equipment need to be ready by the end of 2016 in case of an early full connection.**

LS2
Project Activities

LIU project

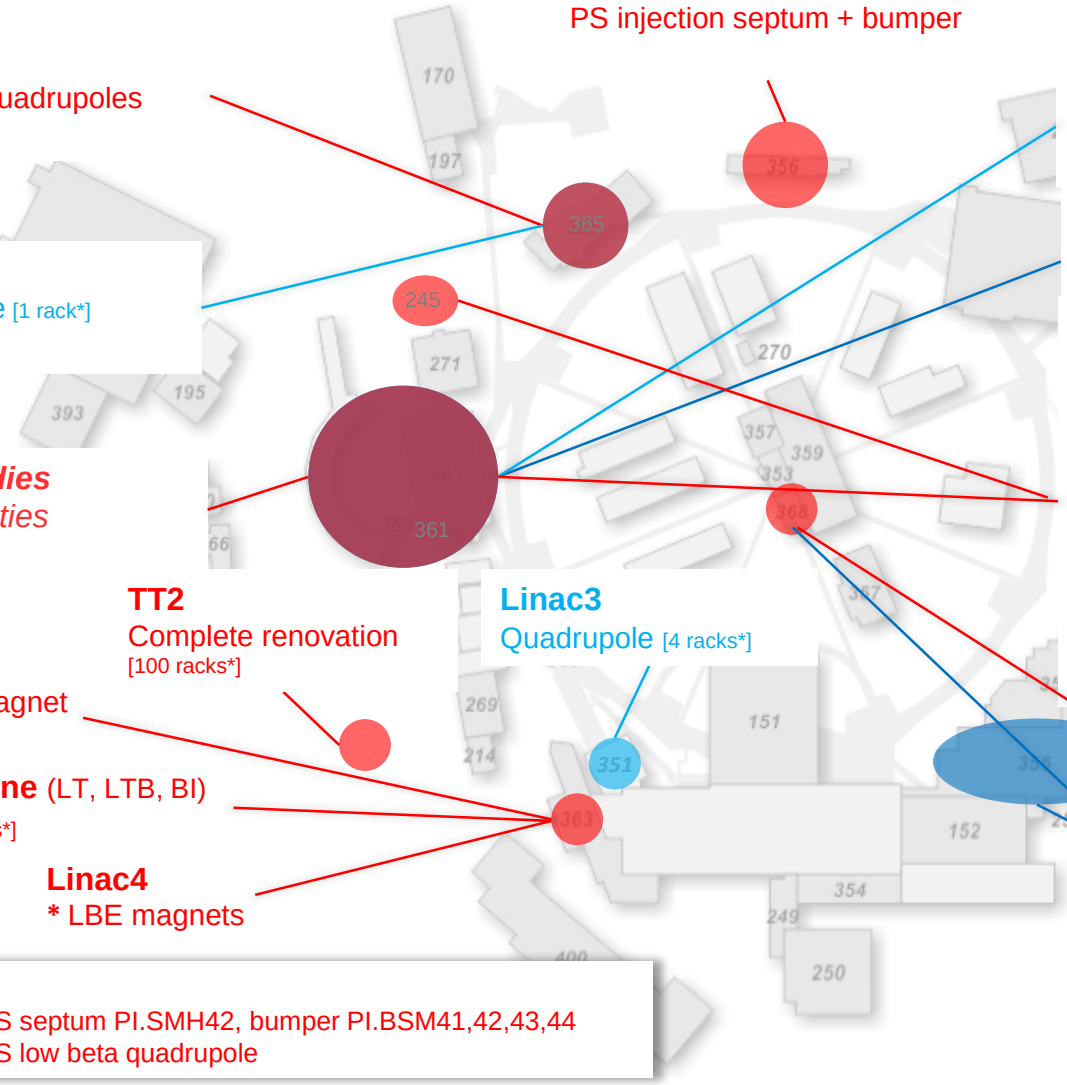
LINAC4, PS Booster, PS machine and TT2

Courtesy J. Coupard

independent
1 YETS 2015
2 EYETS 2016 *
3 YETS 2017
4 LS2

More than 200 Racks*

Rack* = Rack Equivalent (0.6m)



Under studies:

- Position for the PS septum PI.SMH42, bumper PI.BSM41,42,43,44
- Position for the PS low beta quadrupole

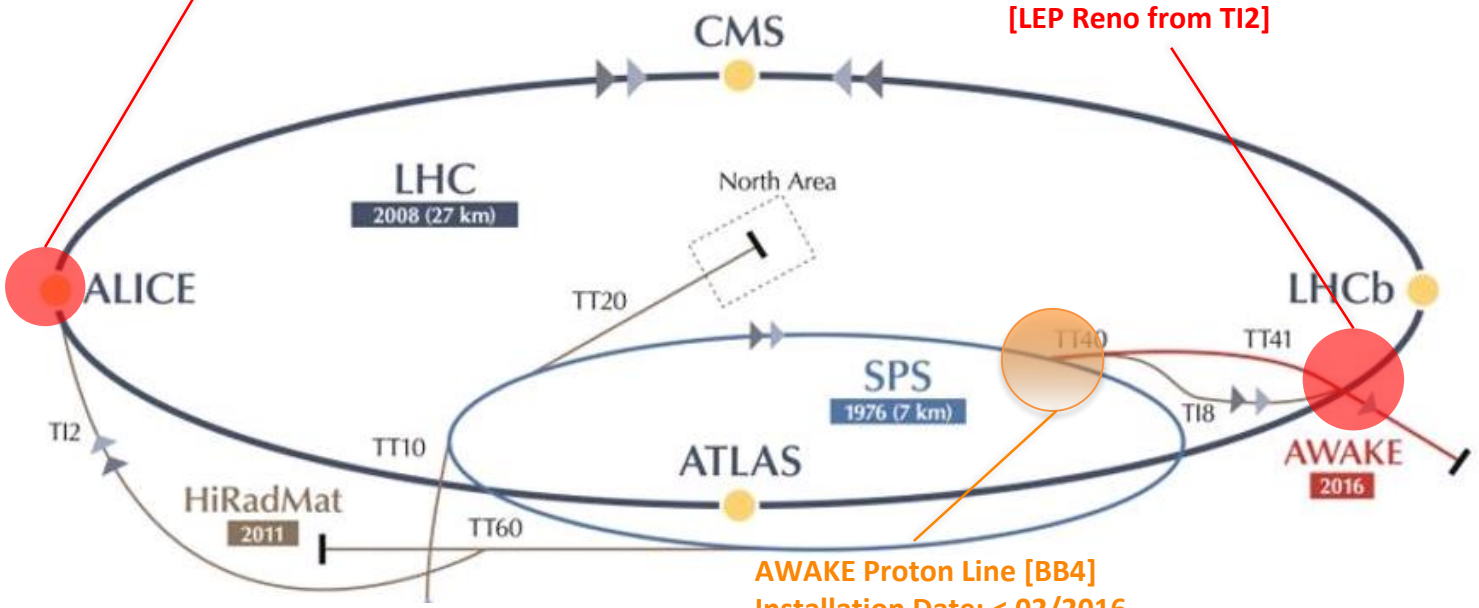
LIU SPS project / AWAKE project activities

SPS machine

independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

LIU SPS TCDI [SR2]
- 1x New RQIF.28800 Power Converter [COMET-2p]
- 1x New MQIF.29000 Power Converter [COMET-2p]

LIU SPS TCDI [SR8]
- 1x new MQIF.87000 Power Converter [LEP Reno from TI2]
- 1x new MQID.87100 Power Converter [LEP Reno from TI2]

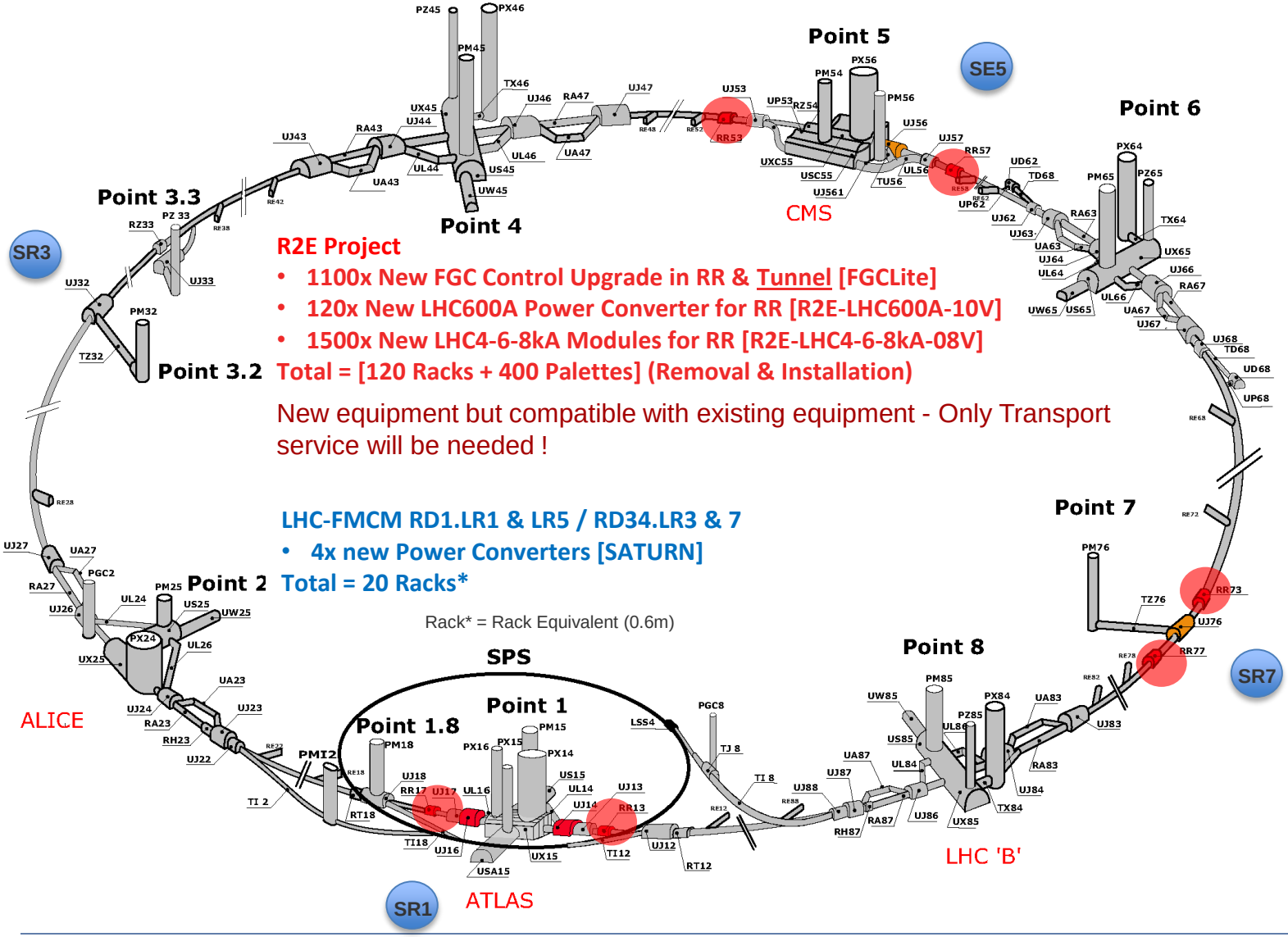


AWAKE Proton Line [BB4]
Installation Date: < 02/2016
- 2x New Power Converters [SPS Reno]
- 1x New Power Converter [COMET]

AWAKE Electron Line
Installation Date: 12/2016 – 03/2017
35 Circuits – Still under discussion

LHC project

independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2



R2E Project

- **1100x New FGC Control Upgrade in RR & Tunnel [FGCLite]**
- **120x New LHC600A Power Converter for RR [R2E-LHC600A-10V]**
- **1500x New LHC4-6-8kA Modules for RR [R2E-LHC4-6-8kA-08V]**

Total = [120 Racks + 400 Palettes] (Removal & Installation)

New equipment but compatible with existing equipment - Only Transport service will be needed !

LHC-FMCM RD1.LR1 & LR5 / RD34.LR3 & 7

- **4x new Power Converters [SATURN]**

Total = 20 Racks*

Rack* = Rack Equivalent (0.6m)

HL-LHC project

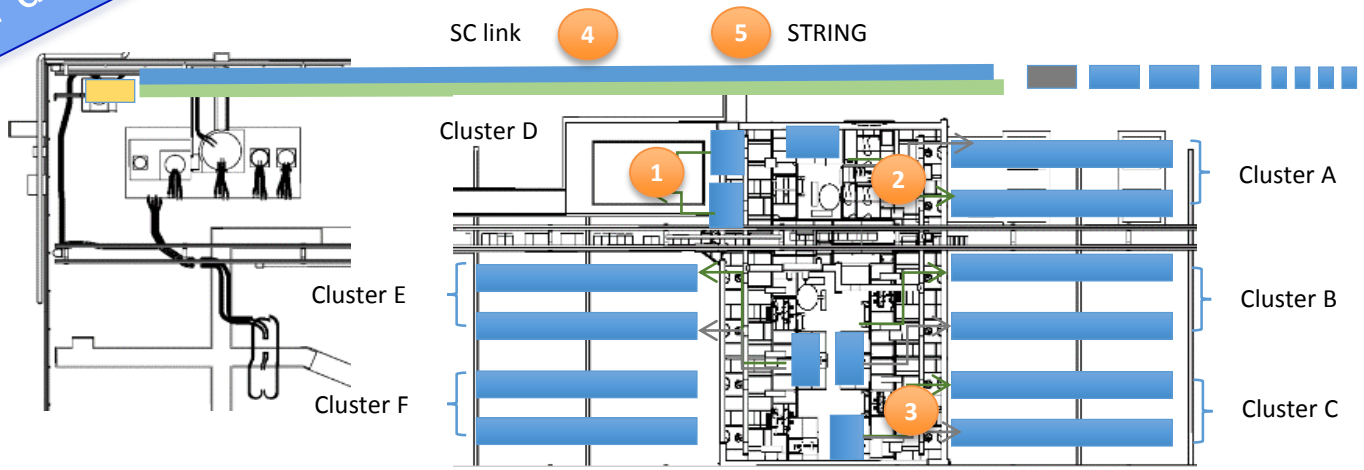
SM18 Test Bench Upgrade

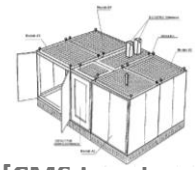
independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

Under discussions

HL-LHC String

- 2x New Power Converter 16.5kA (Q1-Q3 and Q2a-Q2b circuits)
- 1x New Power Converter 13kA(D1 circuit)
- 3x New Power Converter 2kA(Q3-Trim and corrector circuits)
- 1x New Power Converter 0.3kA(Q2-Trim circuit)
- 7x New Power Converter 0.2kA (corrector circuits)
- 2x New Power Converter 0.12kA (corrector circuits)





Cluster A

- 1x [20kA/±61V] (upgrade of RM.A)
- 2x New Power Converter 2kA/10V [COMBO]

SC Link

- 3x New Power Converter [20kA/8V]
- 4x [±600A/±12V] (old cluster F and A)

Cluster C

- 1x New Power Converter [20kA/±26V] [CMS type]
- 2x New Power Converter [2kA/10V] [COMBO]

Cluster D

- 1 x [30kA/±16V] (RM.D + RM.F in parallel)

Cluster D (1)		Cluster A (2)		SC link (4)				Cluster C (3)		HL-String (5)	
S1-2016	S2-2016	S1-2017	S2-2017	S1-2018	S2-2018	S1-2019	S2-2019	S1-2020	S2-2020	S1-2021	S2-2021

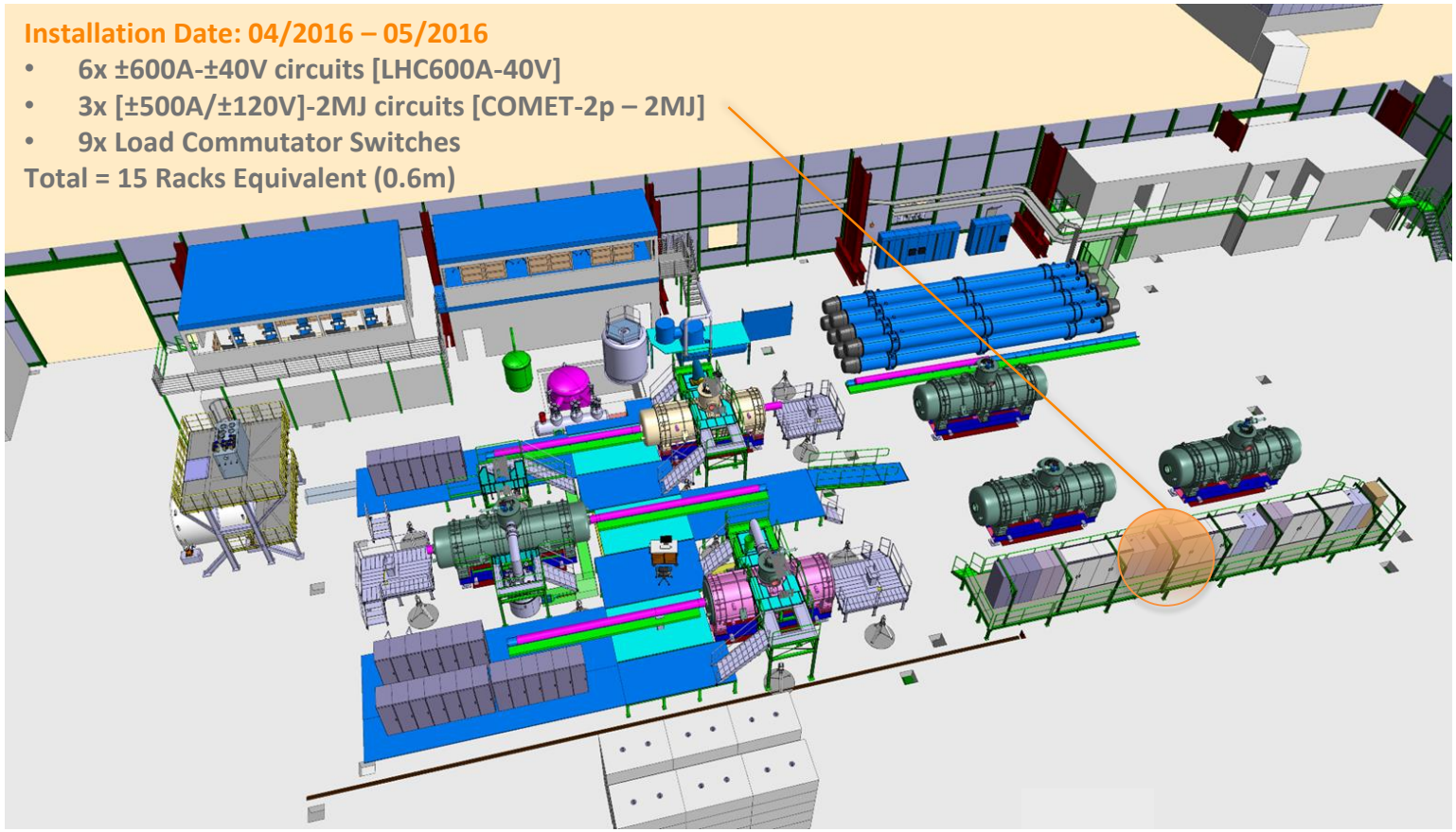
independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

S-FRS Project

Installation Date: 04/2016 – 05/2016

- 6x ±600A-±40V circuits [LHC600A-40V]
- 3x [±500A/±120V]-2MJ circuits [COMET-2p – 2MJ]
- 9x Load Commutator Switches

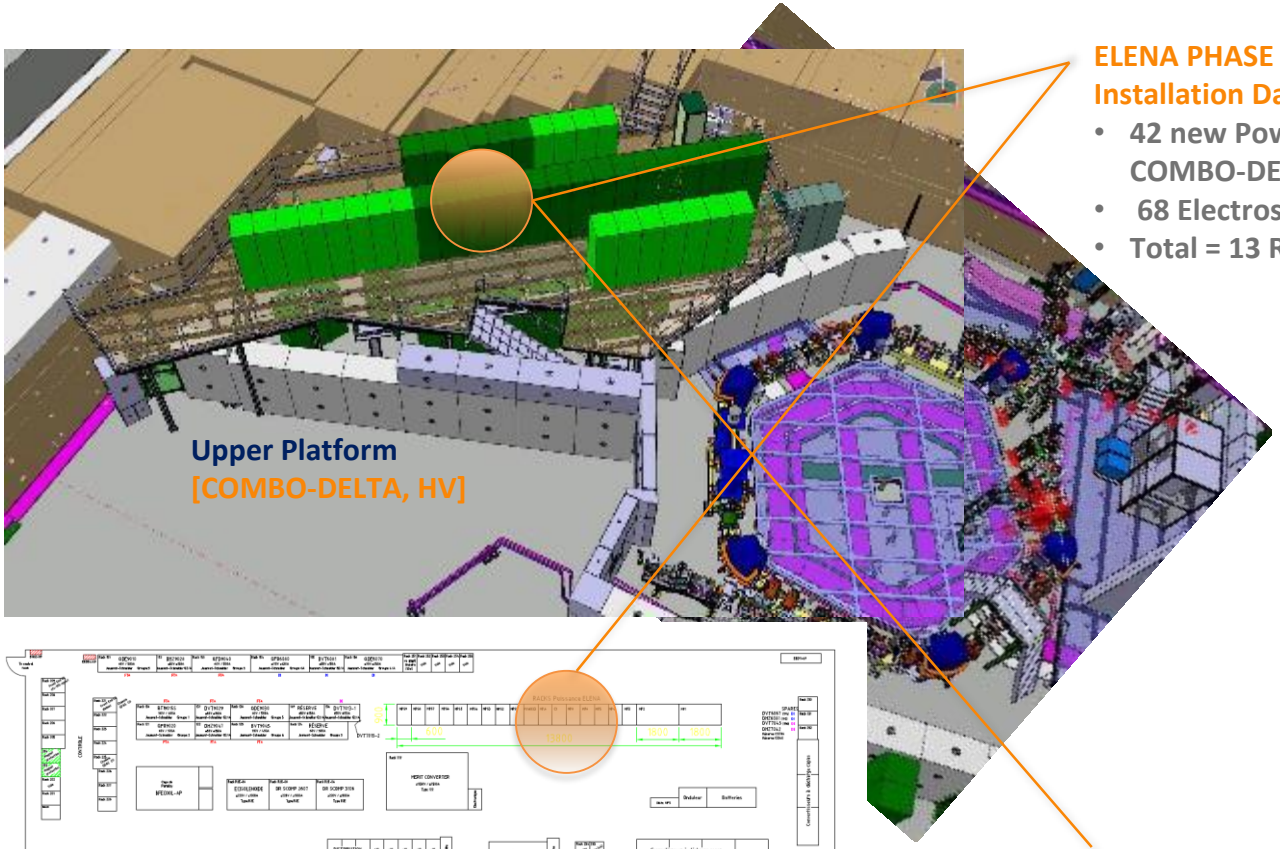
Total = 15 Racks Equivalent (0.6m)



independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

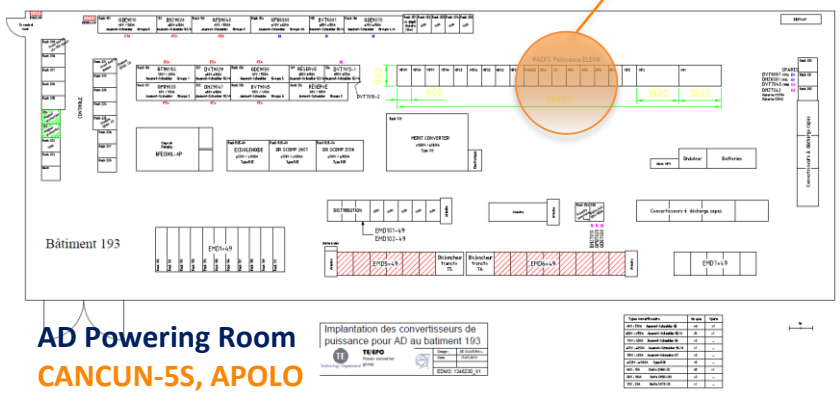
ELENA

Without Electron Cooler



ELENA PHASE 1 w/o electron cooler
Installation Date: 02/2016

- 42 new Power Converters [CANCUN-50S, COMBO-DELTA, APOLO-2P with spares]
- 68 Electrostatic Circuits
- Total = 13 Racks Equivalent (0.6m)



AD Powering Room
CANCUN-5S, APOLO

ELENA PHASE 2
Installation Date: 01/12/2016 – 01/08/2017
302 Electrostatic Circuits [High Voltage Power Converters]
Total = 03 Racks Equivalent (0.6m)

LS2
Consolidation Activities

Consolidation project

RF

independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

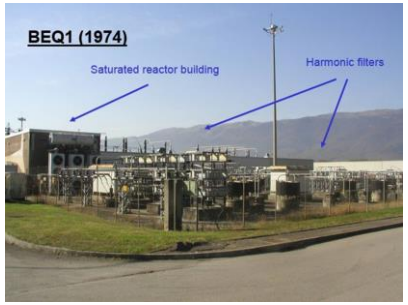
- PSB RF Cavities Power Converters
  - included in LIU Project ; see Slide 7

- HighVoltage PS RF Cavities Power Converter — 2 EYETS 2016 — 4 LS2
  - 5 new Power Converters in Bld. 355/R-021
  - Total : 5x [2700 mm x 800mm]

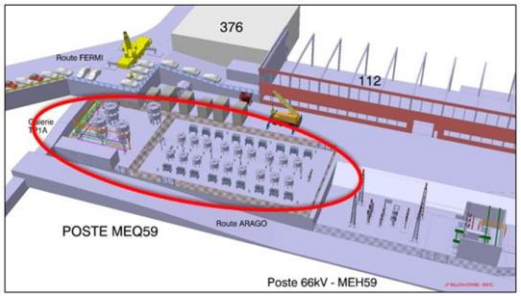
- HighVoltage SPS RF Cavities Power Converter [SPS-200] — 4 LS2
  - 13 new Power Converters in Bld. BA3

Consolidation project
Electrical Power Quality

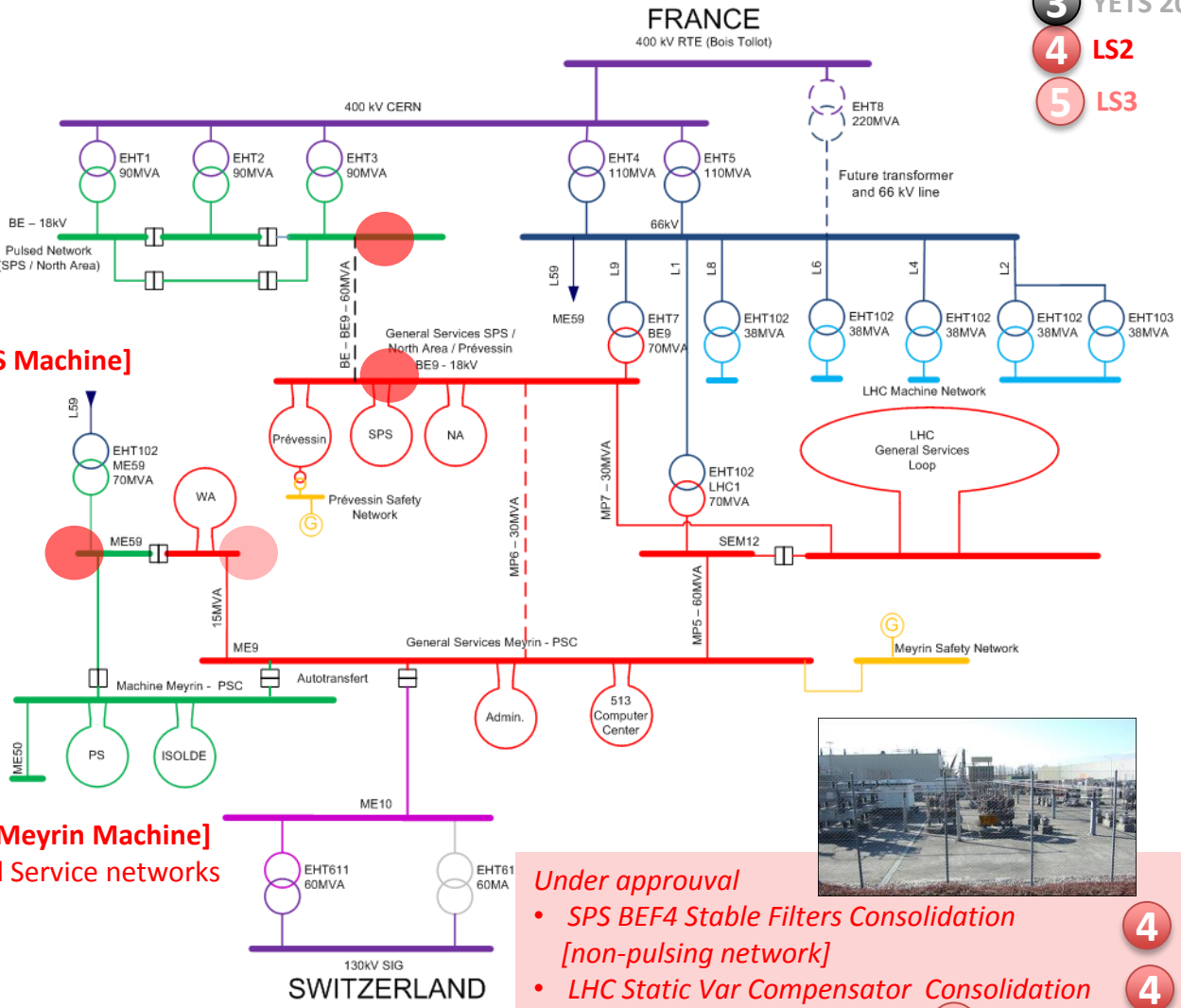
independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2
5 LS3



New BEQ1 Static Var Compensator [SPS Machine]



New MEQ59 Static Var Compensator [Meyrin Machine]
needed when the Machine and General Service networks will be divided into separate networks



Under approuval
- *SPS BEF4 Stable Filters Consolidation [non-pulsing network]* 4
- *LHC Static Var Compensator Consolidation* 4 5
- *Meyrin Filters consolidation* 5

Consolidation project

Under approval

- **LINAC2** part (LINAC4 to PS Booster) - 48x New Power Converters
- **PS** - 13x New Capacitor Discharge Power Converters
- **PS Injector** Converter **Control** – New Electronics for 100 Power Converters to standardize one control over the Injector Chain

  Quantity = converters not covered by LIU / Consolidation projects
- **SPS COD** - 300x New Power Converters (Electronics & Power included)
- **SPS** Aux Power Converter **Control** - New Electronics for 200 Power Converters to standardize one control over all the Injector Chain
- **AD** - 25x New Capacitor Discharge Power Converters
- **East Experimental Area** - 59x New Power Converters
- **nTOF** - 7x New Power Converters
- North Experimental Area – 1x New Power Converter for **COMPASS** Spectrometer

Consolidation project

Under approval

independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2
5 LS3

- **Oil transformer consolidation** [Total Quantity : 202]
  - **Over a period of about 10 years**
  - Replacement of oil transformers by cast resin transformers when possible
  - Consolidation of LHC RF oil transformers and transformers with high power ratings and their oil retention system

Cast Resin Transformer Type

Oil Transformer Type

LS2
Preventive Maintenance Activities

Maintenance Activities

Preventive Maintenance

- **Recurrent Preventive Maintenance Activities during LS**
  - Few impact on other activities / groups
  - Shall be integrated in the Coordination Schedule for access and service readiness

  - **List**
    - Current Calibration Measurement Campaign for all accelerator complex
    - Equipment's fans replacement
    - Transformer maintenance
    - Visual inspection
    - ……

LS2
Resources / Organization

Resources availability

Versus Activities

- **Project & Approved Consolidation Activities**
  - Manpower available
- **Consolidation Activities under approval**
  - Synergy could be found during the procurement of equipment with approved activities
  - Nevertheless, additional manpower will be needed
- **Unforeseen Activities or New Projects**
  - No doubt that the activity list will increase depending on operational issues found during Run 2. Depending of the volume and priority, additional manpower will be needed.
  - New Project will not be possible to manage up to LS2

Resources availability
Versus Planning

- **Manpower during INSTALLATION and COMMISSIONING**

Machines	Opening of the machine (weeks) not including the xmas break of 2 weeks		
	YETS 2015	EYETS 2016	YETS 2017
PSB	10	13	8
PS	8	13	8
SPS	8	11 (BA1) - 13	7 (BA1) – 8
LHC	10	16	10

EDMS 1470895: Length of the YETS 2015-2016 / EYETS 2016-2017 / YETS 2017-2018

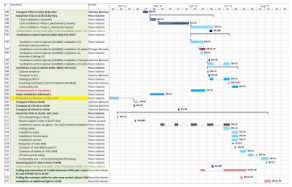
- Lot of activities concentrated in short periods
- Need flexibility for increasing manpower during these periods, mainly through Field Support Unit (FSU)
- Need optimization at the level of the **LS2 coordination** to optimize the group load by resources leveling across ALL facilities (Injector, LHC and Experimental Areas)
- Need to be aware in advance of any change of planning

Resources organization

Versus Planning & Activities

For efficiency and manpower estimation/optimisation, TE-EPC needs :

- **During INSTALLATION phase**, a detailed schedule with the different steps to performed across the different groups (who is doing what when)
- **During (Re)COMMISSIONING phase**,
  - the planning of the Individual System Tests period dedicated to TE-EPC group taken into account the readiness of the services, access, control, EIS …..
  - the clarification of TE-EPC contribution during the Circuit (Re)Commissioning



Step	Description for Reconnection	Responsibility
Step	Description for Disconnection	Responsibility
1	Electrical lock-out ('consignation') of power converters, calibration racks and hot spare racks (AC + UPS)	TE-EPC
2	Purge water pipes (demineralized water cooling circuits for power converters >600 A)	EN-CV
3[1]	Purge water pipes (demineralized water for DC-cooled cables)	EN-CV
4[1]	Purge chilled water pipes for calibration racks	EN-CV
5	Disconnect water cooling pipes (where applicable)	EN-CV
6	Disconnection of cables: DC (including water-cooled DC cables), AC, UPS[1], FIP, controls and Ethernet[1]	TE-EPC
7	Unplug the 600 A and 120 A[1] modules from the power supply racks and fix them on transport pallets	TE-EPC
8	Detach the power supply racks or converters from the support structure	TE-EPC
9[1]	Transport the power converters, racks and the modules (on transport pallets) to building 272 (Meyrin) for storage	EN-HE
10	Remove beam supports for the racks	TE-EPC
11[1]	Remove copper grounding rig	TE-EPC
12	Remove powering and controls cables	EN-EL
13[1]	Remove Ethernet cables	TE-CE

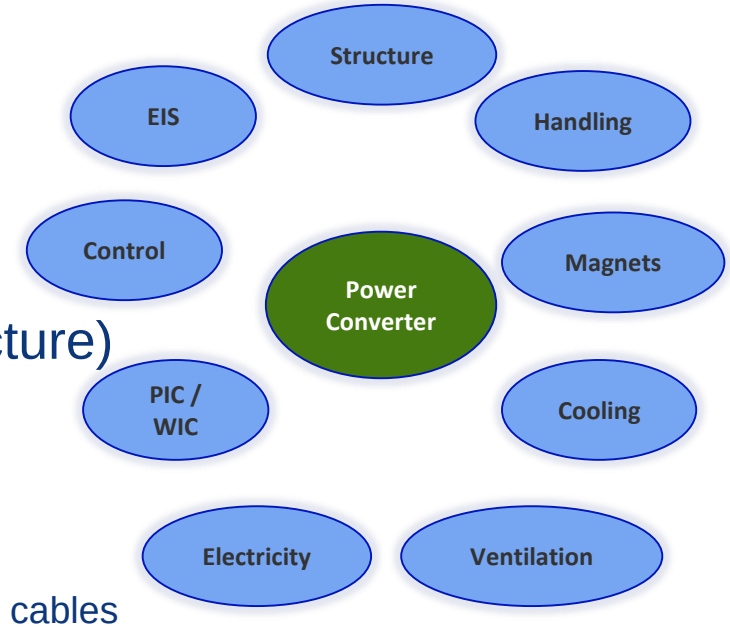
Logistics
Storage

- Irradiated Equipment
  - Some equipment removed from the LHC tunnel for consolidation could be activated after Run2
  - Need dedicated radioactive storage place
  - Need area for repairing / testing irradiated electronics (blg. 867)

- Storage
  - TE-EPC will need buffer area to store
    - converter parts received from industry before their test and integration in the power converters
    - the power converters ‘ready for installation’ before their final installation in the machines
  - Around **1000m^2** needed

Interface / Interference

- **Interference -** Any change of the interfaces with an impact on the power converters should be agreed with TE-EPC group especially for the CONTROL part (BE-CO)



- **Interface**
  - New Power converters imply service support (transport, infrastructure structure) and in most of cases upgrade or consolidation of cooling, electricity distribution and cabling
  - Reminder : TE-EPC contributes to the definition of the cables BUT is neither responsible of the 'Demande de Cables' nor the different cables needed to interconnect the different systems

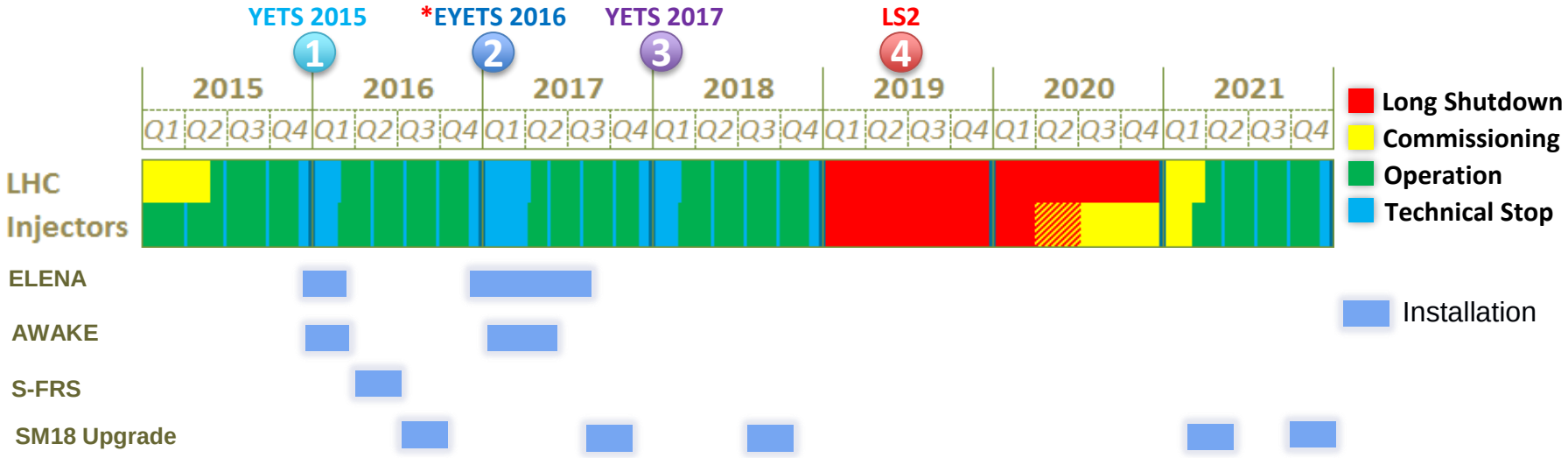
Interface
Definition / Database

- **Interface**
  - Need a clear overview of the different systems per circuit
    - Not clear who is doing this definition / coordination
  - Need a clear definition of the interface between systems per circuit
    - Interconnection as cabling, cooling are discussed during Integration meeting

- **Databases** – Need a good support for
  - the definition of the Functional Positions and the layouts of the new circuits through the Layout Database
  - managing the change especially in Injector Complex
  - the equipment code definition through the Naming Service

Conclusions

- High volume (bigger than LS1) of activities for TE-EPC group with high technical challenge in some case
- Few margins to complete unforeseen activities during LS2
- No margin for new projects
- LS2 can only be successful with a global planification and coordination for the entire facilities




CERN
LS2 DAYS
29-30 SEPTEMBER 2015

Additional Activities mentioned during LS2 Days

HL-LHC project
LS2 Work Packages

independent
1 YETS 2015
2 EYETS 2016
3 YETS 2017
4 LS2

- **WP3 - New Q5 magnets in LSS6 for ATS Optics**
  - 2x New Power Converters (Integration not yet started)

- **11T Dipole uncertainty**
  - *"We ask to keep open the possibility to install 2 units of 11T around P2 or P7 in case of need in the second part of LS2.The issue will be defined at Chamonix 2016 or in Spring 2016 at latest."*

    Lucio's presentation
  - 2x New Power Converters (Integration not yet started)

LHC project
CMS

- 20kA Free-wheel Thyristor

Technical Coordination

Magnet :reliability & minimal on-off cycles

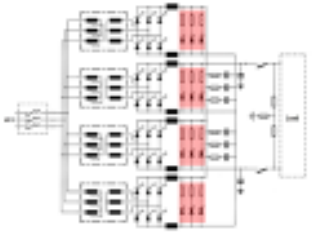
Maintaining magnet performance at 3.8T over the next 2 decades is imperative

On-off cycles are bad for the magnet eg (Target: 5/year, no FD. Will exceed in 2015)

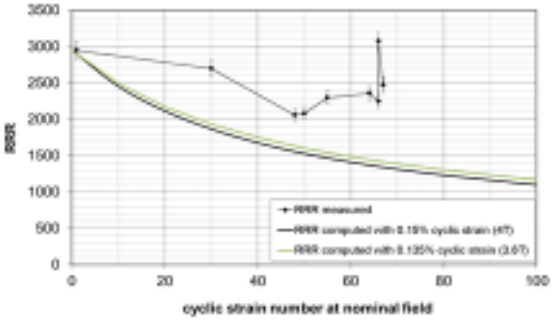
	2006	2008	2009	2010	2011	2012	2013	2015	Total
Number	12	12	10	14	7	9	2	2	68
On request	9	9	5	7	4	2	1	1 (2024)	38
Unexpected	3	3	5	7	3	7	1	1	30
FD at nominal field	5	1	1	0	2	1	0	0	10

Phase 2 upgrade (delayed from Phase 1)
"Cooled Freewheel thyristor"
draft tech spec/costing written with TE

UPS/diesel protection of FWT cooling vital



RRR predicted to reduce with on-off cycles; eventually (250 cycles?) will not sustain 3.8T
Measured RRR evolution not as simulated but recovery due to LS1 warm up reversed.



Immune to power converter faults (power, cooling)
Field decays with time constant ~25 hours.
Prototype on M1 magnet in 2016,
Implement in CMS during LS2

Others

- **Recommissioning** Plans of Machines and Experimental Areas for beam after LS2