

# EN-EL and LS2

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Infrastructure for LHCb Upgrade workshop - Session I: Power, electronics, cable

from Thursday, 19 February 2015 at **14:00** to Friday, 20 February 2015 at **18:15**

# Presentation outline

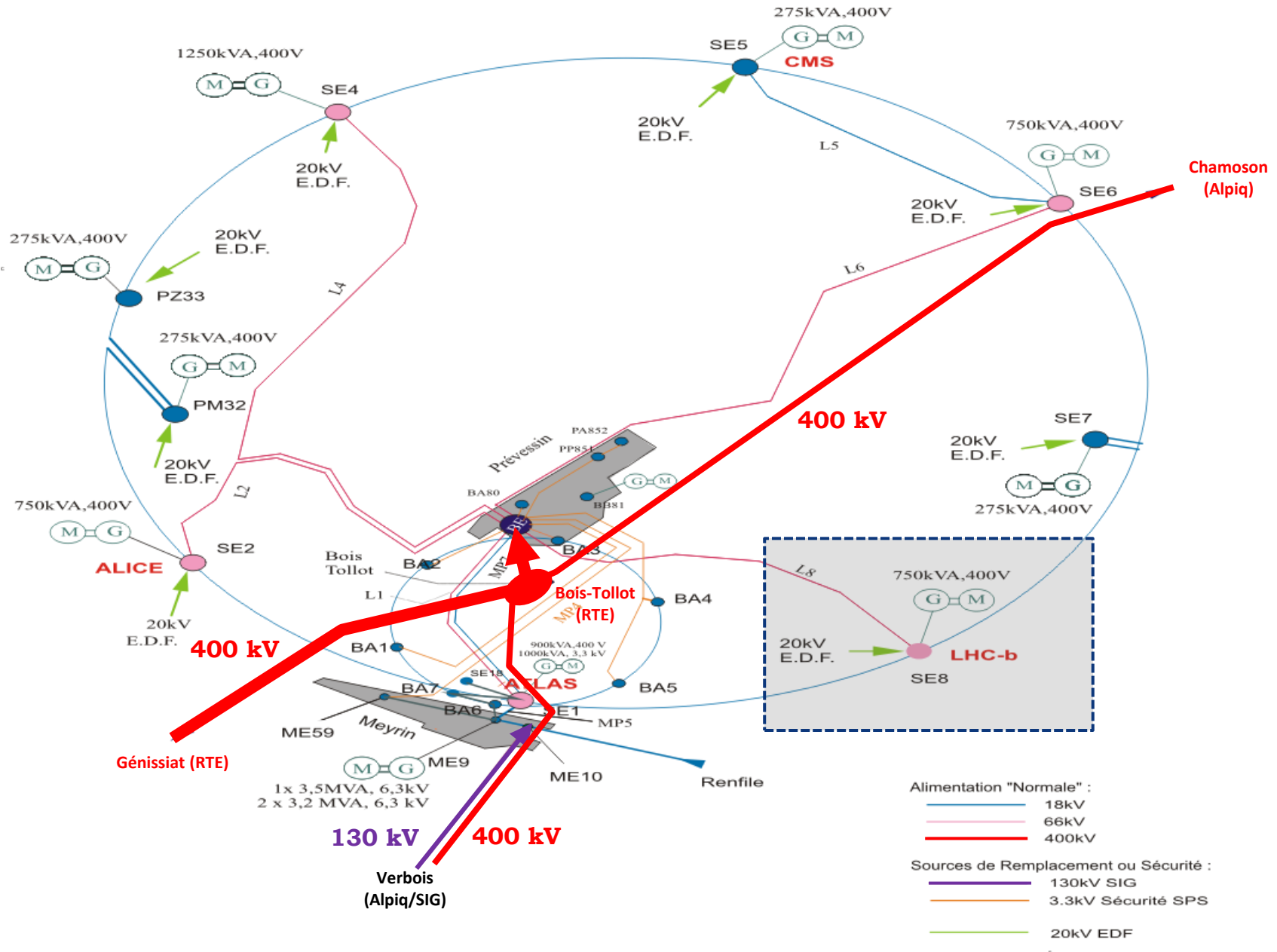
- Part 1 : Overview of CERN's electrical network
- Part 2 : Power Quality \_ Statistics
- Part 3 : Maintenance plan - Availability
- Part 4 : EN-EL LS2 organization – methods - constrains

# Overview of CERN's electrical network

## Part 1



# CERN's Electrical Network (geographical overview)



# Equipment : HTB (400 kV & 66 kV)

- 6 feeders 400 kV
- 3 transformers 400/18 kV      3\*90 MVA
- 2 transformers 400/66 kV      2\*110 MVA
- 15 feeders 66 kV
- 7 underground transmission lines (66 kV)
- 3 transformers 66/18 kV      3\*70 MVA
- 5 transformers 66/18 kV      5\*38 MVA



# Equipment : HTA (20 kV to 3.3 kV)

- 8 stations 20 kV
- 100 stations 18 kV
- 22 stations 3.3 kV
  
- 1000 protection relays
- 900 feeders 18 kV
- 220 feeders 3.3 kV



*LHC8\_18 KV substation*

- |  |          |
|--|----------|
| • 600 Transformers 18/0.4 kV & 18/3.3 kV | 900 MVA  |
| • 7 Thyr. controlled Compensators 18 kV  | 458 MVar |
| • 1 Saturated Reactor Compensator 18 kV  | 120 MVar |
| • 12 Harmonic filters 18 kV              | 357 MVar |
| • 6 diesel generators 6.3 kV & 3.3 kV    | 13 MVA   |



# Equipment : LV

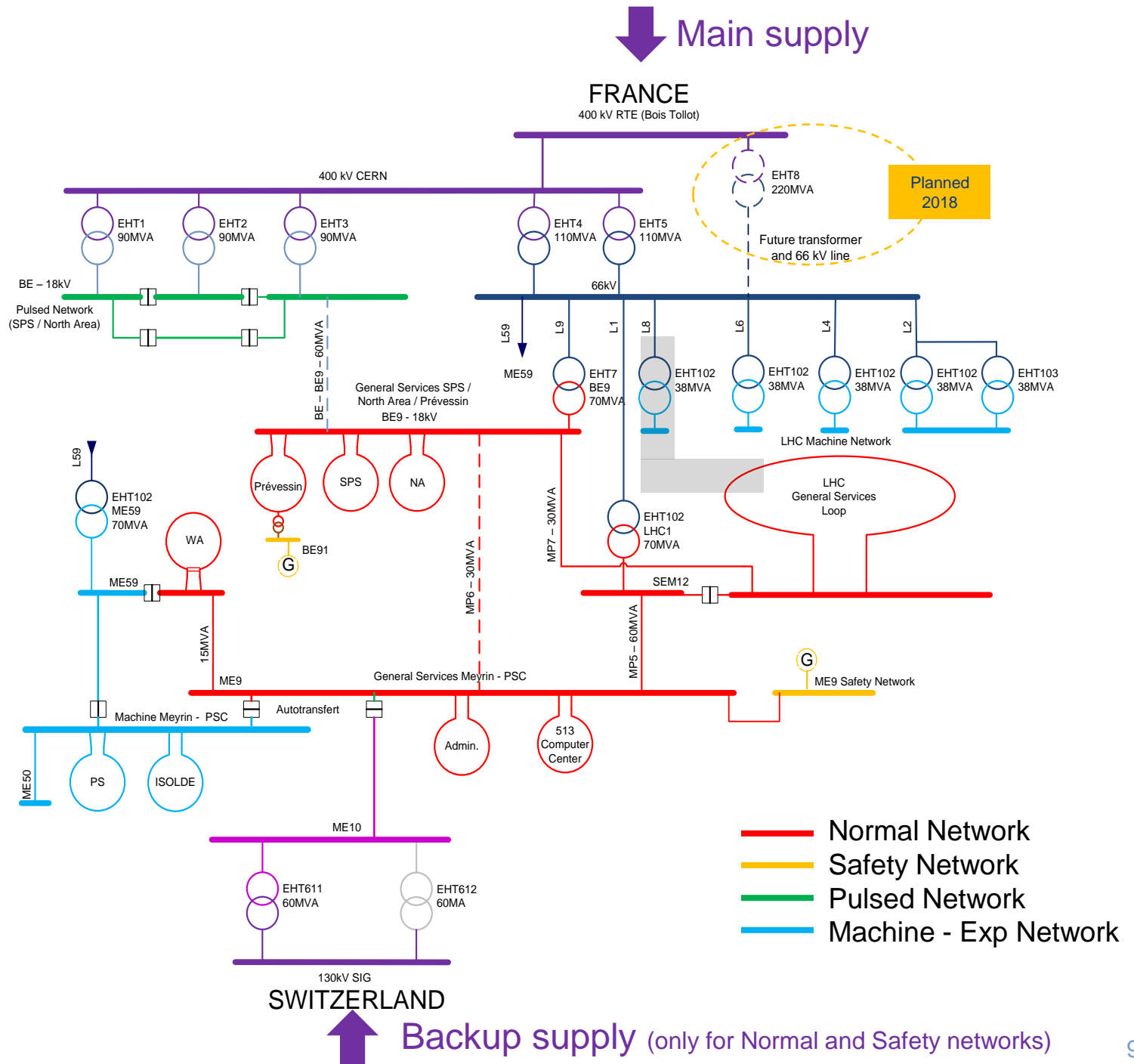
- 400V distribution
  - 26000 feeders regular power distribution
  - 4300 feeders diesel generators distribution (safety)
  - 2200 feeders UPS distribution (uninterruptible)
  - 3200 feeders machine distribution
  - 10 diesel generators totalling 5.5 MVA
  - 250 UPS
- Control
  - 430 battery chargers 48 VDC
  - 13 battery chargers 110 VDC
  - 300 Ni/Cd batteries
  - 100 open & sealed lead acid batteries
  - 1700 feeders 110/48 VDC distribution



*LHC8\_LV substation*



# CERN's Electrical Network SINGLE LINE DIAGRAM





# Type of loads

- General services (infrastructure)

- Fire/Smoke/Gas detection and extraction...
- Alarms transmission and communications systems...
- Ventilation/pressurization systems, lifts, safety lightings...

- Power converters
- Magnets

- Klystrons for Radio Frequency
- Cryogenic compressors
- Cooling tower pumps
- Chilled water pumps
- Vacuum pumps
- Electronic racks
- Heating
- Power converters

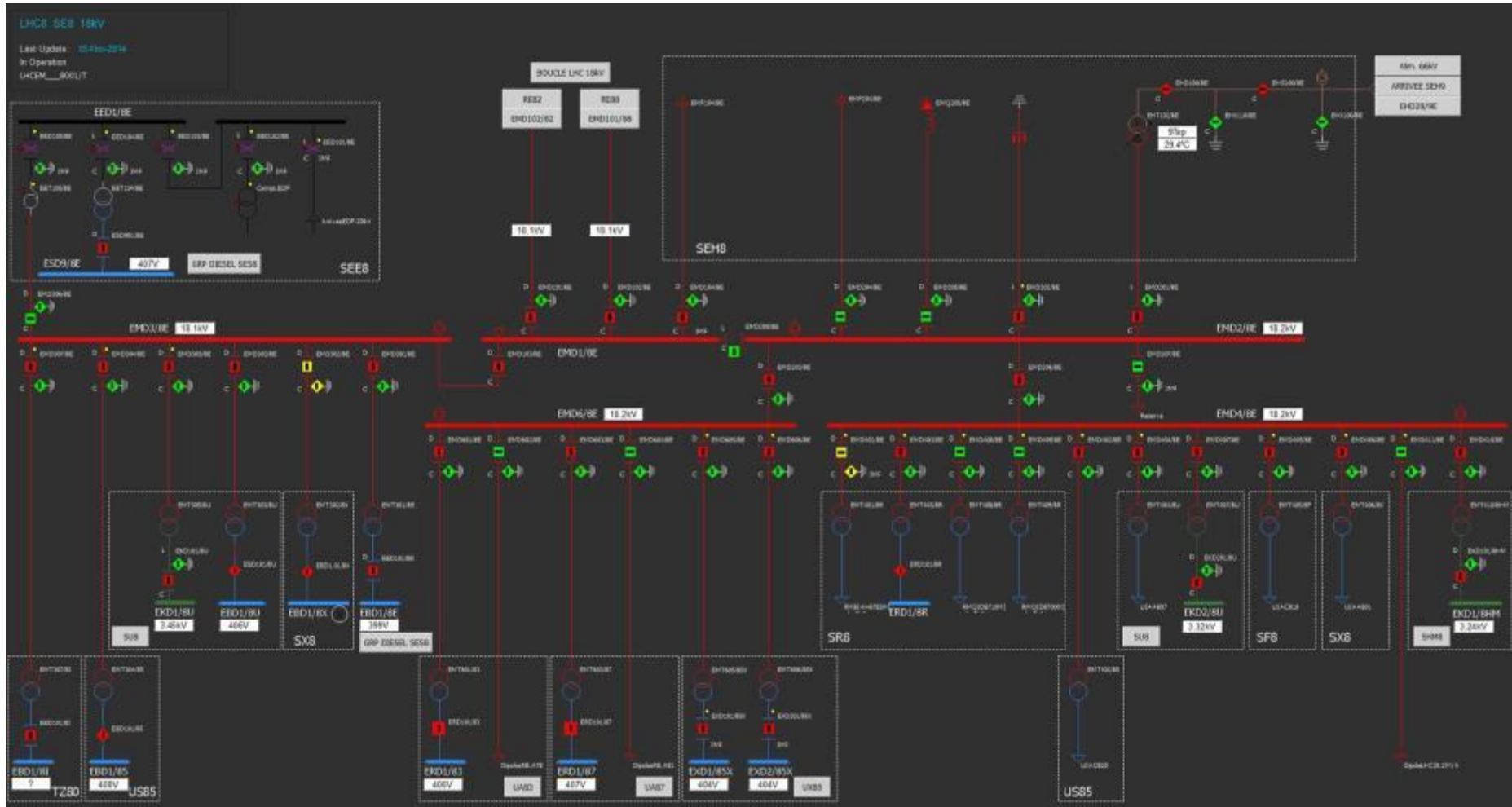
- Normal Network
- Safety Network
- Pulsed Network
- Machine - Exp Network

# LHC8 – LHCb : HV Electrical Network Single Line Diagram

20 kV

Loop 18 KV

66 kV Machine network



18 kV Normal Infrastructure

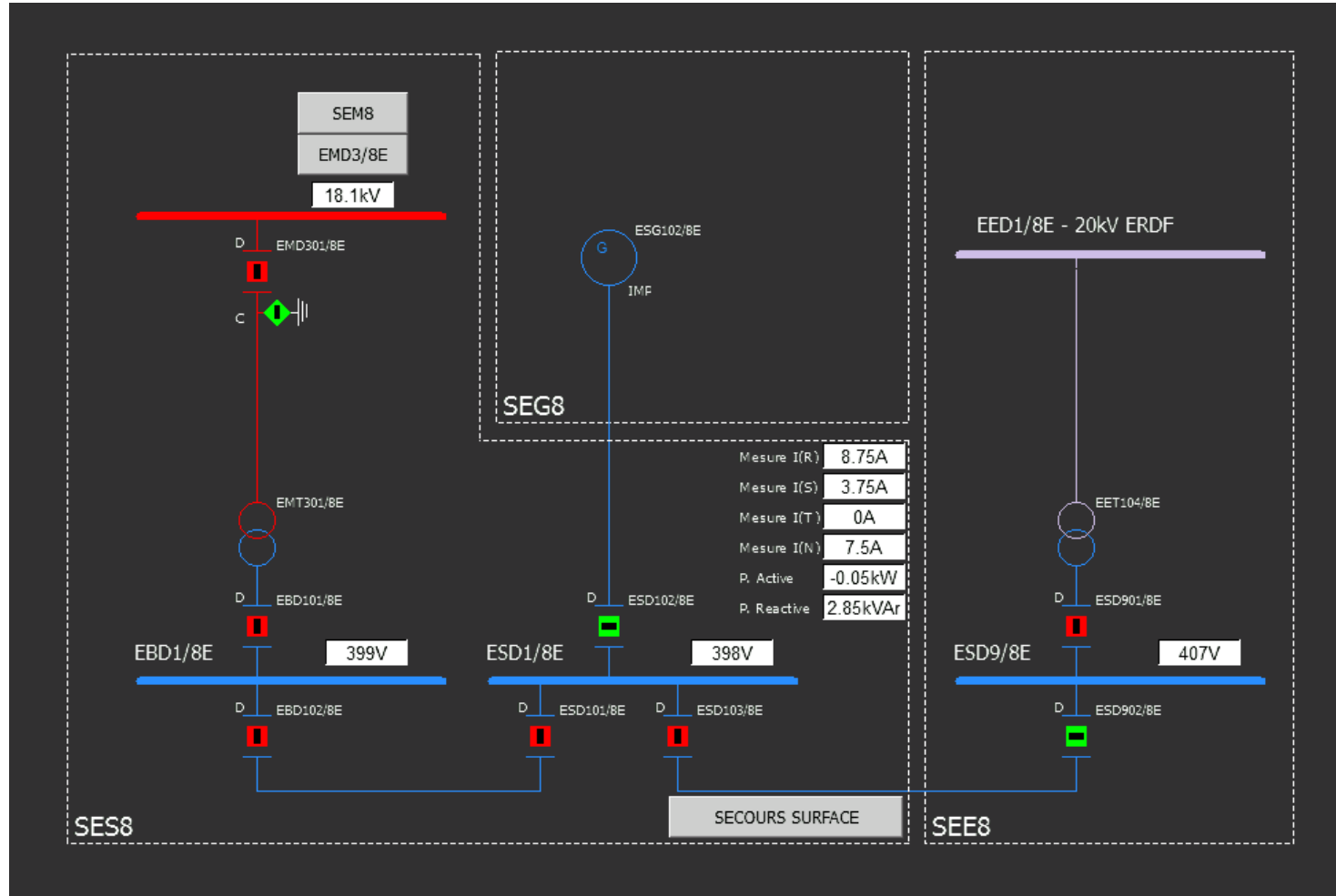
18 kV Machine and Experiment Network

# LHC8 – LHCb : LV Electrical Network Single Line Diagram

18 kV Normal Infrastructure

400 V DIESEL Generator

Back-up network 20 kV



400 V Normal Network

400 V safety Network

400 V safety backup

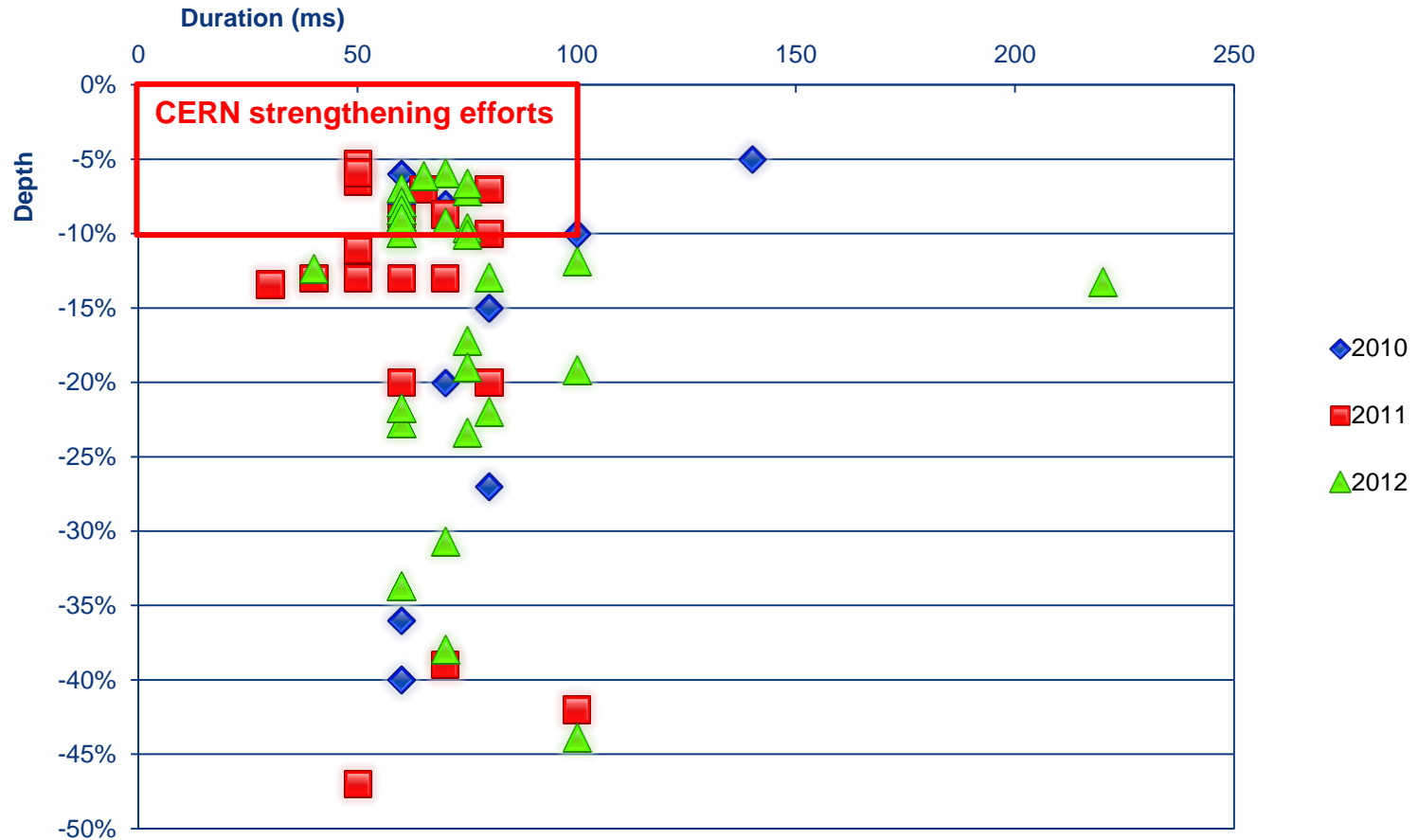
# Power Quality

## Part 2



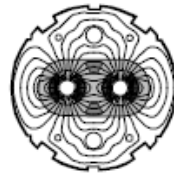
# Transient disturbances (< 1s) : LHC response

## Voltage transients affecting the LHC



# Main parameters of the LHC LV distribution system

**CERN**  
CH-1211 Geneva 23  
Switzerland



the  
**Large  
Hadron  
Collider**  
project

*LHC Project Document No.*

**LHC-EM-ES-0001 rev 2.0**

*CERN Div./Group or Supplier/Contractor Document No.*

**ST/EL**

*EDMS Document No.*

**113154**

Date: 2000-09-29

## Engineering Specification

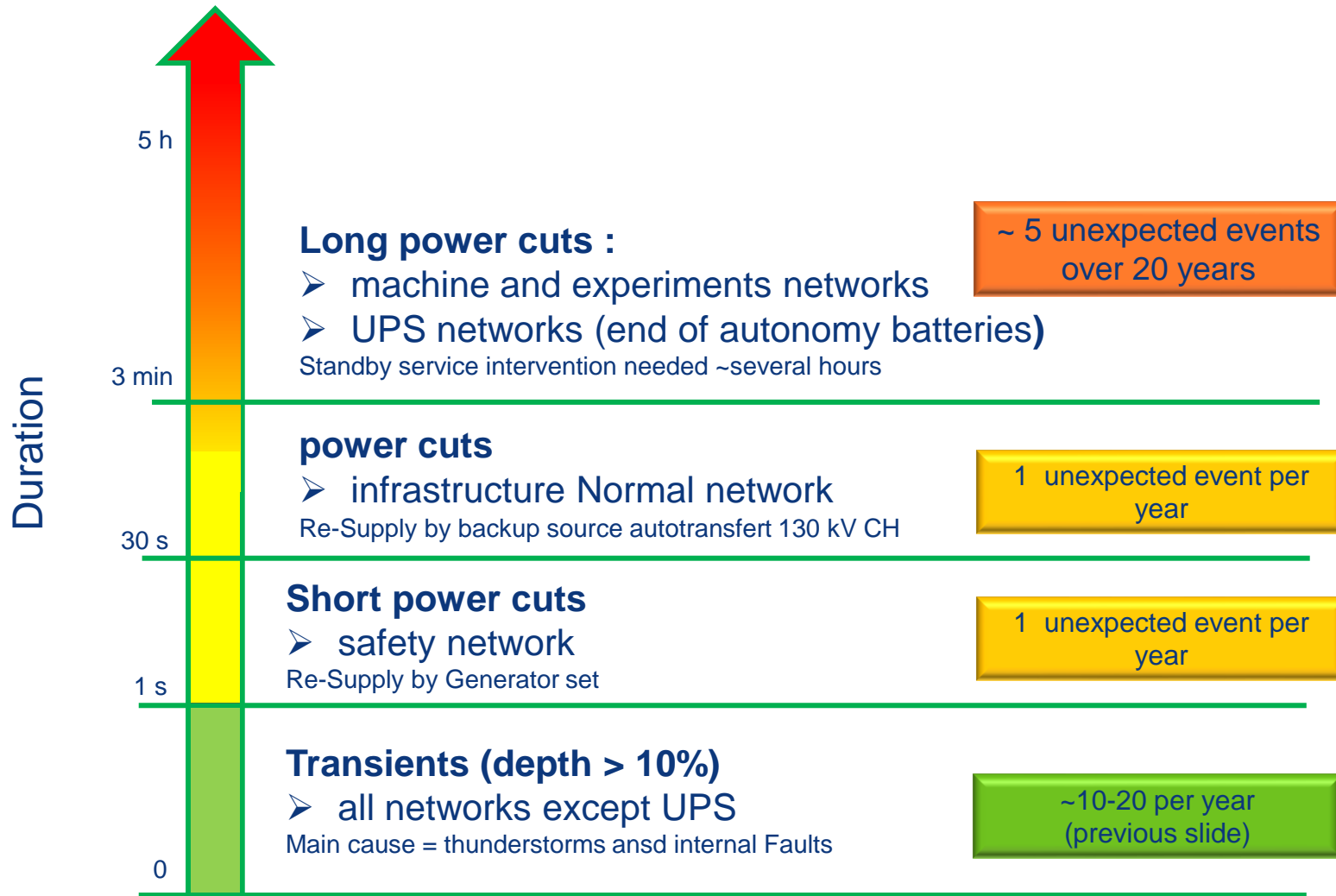
# MAIN PARAMETERS OF THE LHC 400/230 V DISTRIBUTION SYSTEM

### *Abstract*

This document gives the data of the CERN 400/230 V power distribution system, susceptible to be of interest for a large number of users installing their equipment at CERN. The parameters of the network are given, together with explanatory notes whenever necessary. The document also presents requirements, that the user's equipment must fulfil. Finally recommendations with respect to performance are given.

**This document provides information about CERN 400/230V power distribution system. It allows user to design their equipment with proper margins. It contains requirements and recommendations.**

# Transients & Power cuts : stats and duration





# Maintenance \_ availability

## Part 3



# Powercuts for safety tests and maintenance

- Safety tests :

system	Maintenance plan	powercut
CERN safety networks	every year	10 mn (except UPS)
Emergency Stops tests	every year	1 day

- Maintenance

Equipement	Maintenance plan	powercut
Transformers	every 3 years	1 day
HV switchboards	every 6 years	1 day
LV switchboards	every 9 years	1 day
UPS	every year	1 day _ no powercut, charge not protected
Generator set Diesel	every year	1 day _ no powercut, charge not protected
48V batteries	every year	1 day _ no powercut



# Type of LV networks and their availability

**AUG**



Types	See mains perturbations ?	Switched off by AUG ?	Back up by Diesel set ?	Downtime ?
Normal <b>EBD</b>	Yes	<b>Yes</b>	No	Yes Mains downtime
Machine <b>ERD - EZD</b>	Yes	<b>Yes</b>	No	Yes Mains downtime
Experience racks <b>EXD</b>	Yes	<b>Yes</b>	No	Yes Mains downtime
Assured <b>EAD</b>	Yes	<b>Yes</b>	Yes	Yes ~ 15s
Safety <b>ESD</b>	Yes	<b>No</b>	Yes	Yes ~ 15s
UPS <b>EOD</b>	No	<b>Yes or No</b>	Yes or No	No Battery autonomy
48 VDC <b>ECD</b>	No	<b>No</b>	Yes	No Battery autonomy

# EN-EL LS2 Organization & methods

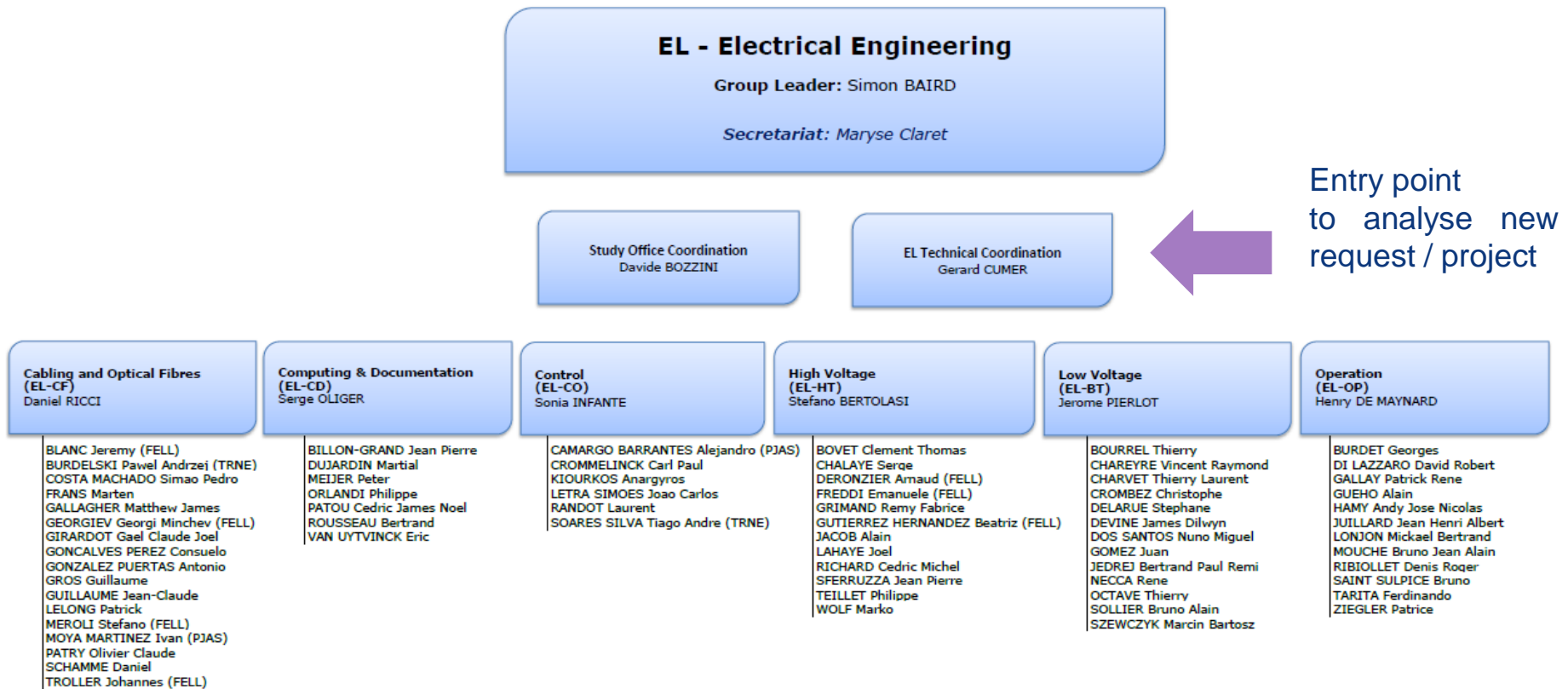
## Part 4



# EN-EL Mandate

- The EL group is responsible for the CERN electrical distribution network from 400kV to 400/230V. Its main missions are to **operate, maintain, extend and renovate the network**, analyse and make projections for CERN electrical energy consumption and manage relations with the energy suppliers.
- The group is also in charge of making **modifications and extensions to the network as required by new projects**, in terms of project studies, equipment procurement, installation, supervision and commissioning.
- A section of the group is responsible for **providing all cable installations for accelerators and experiments**. This includes a great variety of HT and LV cables distributed over the entire CERN site and LHC ring. Optical fibres installation is also provided by this section

# EN-EL organization



# EN-EL \_ LS2 ( Marzia Bernardini \_ Chamonix 2014, 25<sup>th</sup> Sept. )

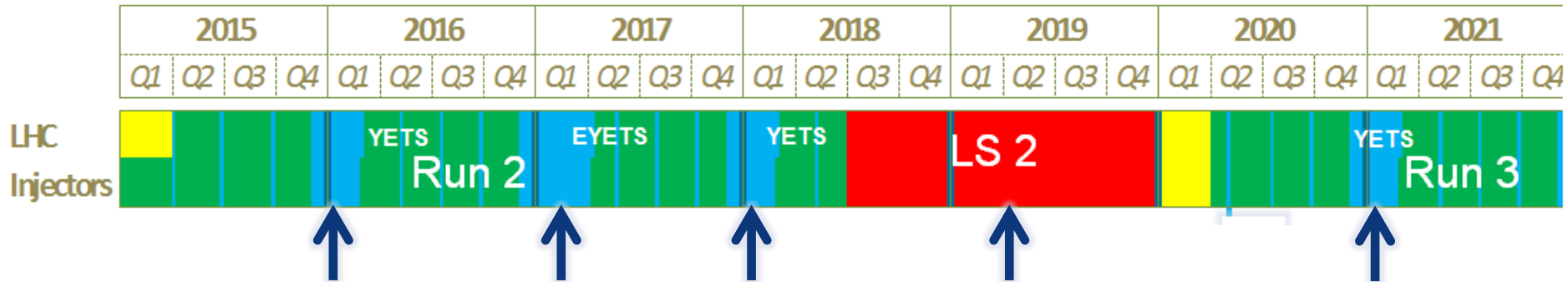
***Electrical group EN-EL has a huge and heavy plan around consolidation. It is a long term plan [2025] , which will be implemented step by step during YETS, EYETS and Run 2. The plan has major activities also in the frame of LS2***

- Jura Station consolidation: ME9,
- SPS, Meyrin Machine network consolidation (HV, LV)
- Additional CERN station 400/66 kV near Bois Tollet [CERN 2 400kV \_220MVA]
- Heavy maintenance plan (400 kV – 66 kV – 18 kV – LV – UPS...)
- Automatism of control and regulation consolidation for Diesel LHC
- Partial replacement of 18 kV protection relays and 48VDC systems on LHC surface
- All users projects (Machine, Experiments, Infrastructure...)

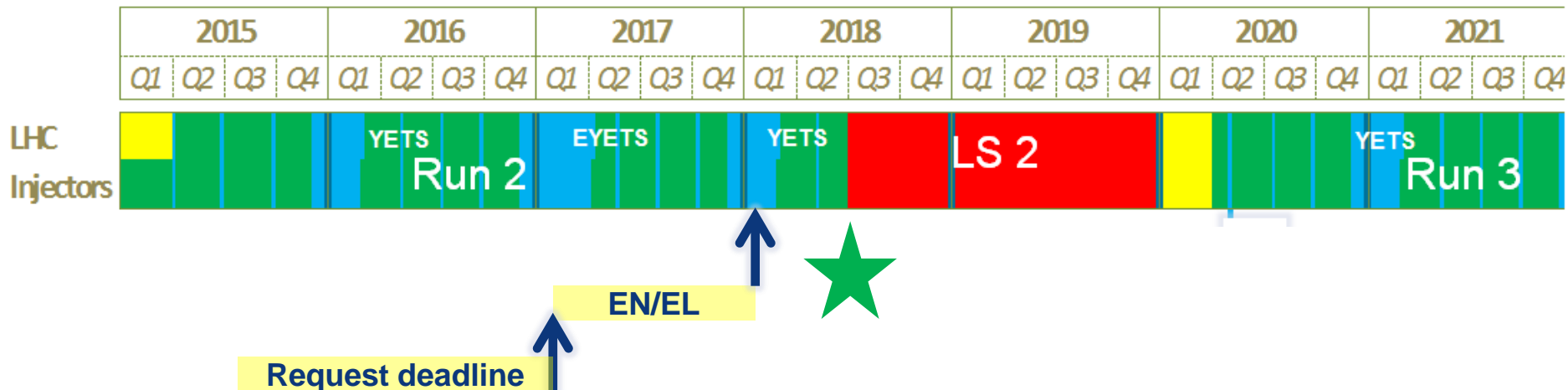
**→ *Very tight and heavy schedule → on the critical path !!!***



# Run 2 and LS2 \_ EN/EL constrains



**Modifications** on the network possible **only during YETS, EYETS and LS2**  
**AND**  
 EN/EL needs at least **ONE YEAR** between user's request and delivery



# Conclusions

- Electrical group has a huge and heavy plan around consolidation, mainly dedicated to injectors.
  - A long term plan, which will be implemented step by step during YETS, EYETS, Run 2 and LS2.
- **EN-EL LS2 : very tight and heavy schedule, on the critical path**
- EN-EL needs at least 1 year between user's request and commissioning, but **more** if modifications of infrastructure are necessary.
- EN-EL-CF outlines the need to receive the requests of copper cabling at least 1 year before LS2
- EN-EL to be contacted - informed of project since the earliest phase !



ENGINEERING  
DEPARTMENT