Accelerator Status during LS2RRB
Frédérick Bordry
15th April 2019
# Injectors and LHC: Q4-2018 schedules

## Accelerator Status during LS2

**RRB**

Frédérick Bordry

15th April 2019

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### Injectors and LHC: Q4-2018 schedules

<table>
<thead>
<tr>
<th>Week</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wk</strong></td>
<td>40</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td><strong>Mo</strong></td>
<td></td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td><strong>Tu</strong></td>
<td>Ded. Inj. MD 13 hrs, 7 to 20</td>
<td>Ded. Inj. MD 10 hrs, 8 to 18</td>
<td>Ded. Inj. MD 10 hrs, 8 to 18</td>
</tr>
<tr>
<td><strong>We</strong></td>
<td>Par. SPS MD 10 hrs, 8 to 18</td>
<td>Par. SPS MD 10 hrs, 8 to 18</td>
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<td><strong>Fr</strong></td>
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<tr>
<td><strong>Sa</strong></td>
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<tr>
<td><strong>Su</strong></td>
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</tr>
</tbody>
</table>

**Injectors and LHC: Q4-2018 schedules**

- **Injectors**
  - Ded. Inj. MD 13 hrs, 7 to 20
  - Ded. Inj. MD 10 hrs, 8 to 18
  - Med. Inj. MD 10 hrs, 8 to 18
- **LHC**
  - Par. SPS MD 10 hrs, 8 to 18
- **CERN**
  - Med. Inj. MD 10 hrs, 8 to 18

**Magnet training tests to aiming for 7 TeV after LS2**

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**CERN**

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Initial 10 year Pb-Pb luminosity goal of \(1\text{nb}^{-1}\) reached in 2 runs.

<table>
<thead>
<tr>
<th></th>
<th>Delivered (by 03.12.2018)</th>
<th>2015 Pb-Pb</th>
<th>2015 Pb-Pb x</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATLAS/CMS [(\mu\text{b}^{-1})]</td>
<td>1800</td>
<td>584</td>
<td>3</td>
</tr>
<tr>
<td>ALICE [(\mu\text{b}^{-1})]</td>
<td>905</td>
<td>433</td>
<td>2</td>
</tr>
<tr>
<td>LHCb [(\mu\text{b}^{-1})]</td>
<td>235</td>
<td>6</td>
<td>39</td>
</tr>
</tbody>
</table>

LHCb int. luminosity ~two orders of magnitude above 2015 performance.
Powering Test before LS2 (1 week)

15 quenches done
6.76 TeV equivalent reached

- 8 sectors reached 6.5 TeV with about 170 quenches
- 3 sectors reached about 6.75 TeV with 50 more quenches
- Large difference in behaviour between different sectors
- S12: slower training than predicted
LS2 (2019-2020 period): coordination of multi projects

Maintenance & Consolidation

The main projects during LS2

LS2 is dominated by LIU
### Master Schedule of the Long Shutdown 2

#### 2018
- **OCT**: Linac3, LEIR
- **NOV**: Linac3, LEIR
- **DEC**: Linac3, LEIR

#### 2019
- **JAN**: Linac3, LEIR
- **FEB**: Linac3, LEIR
- **MAR**: Linac3, LEIR
- **APR**: Linac3, LEIR
- **MAY**: Linac3, LEIR
- **JUNE**: Linac3, LEIR
- **JUL**: Linac3, LEIR
- **AUG**: Linac3, LEIR
- **SEP**: Linac3, LEIR
- **OCT**: Linac3, LEIR
- **NOV**: Linac3, LEIR
- **DEC**: Linac3, LEIR

#### 2020
- **JAN**: Linac3, LEIR
- **FEB**: Linac3, LEIR
- **MAR**: Linac3, LEIR
- **APR**: Linac3, LEIR
- **MAY**: Linac3, LEIR
- **JUNE**: Linac3, LEIR
- **JUL**: Linac3, LEIR
- **AUG**: Linac3, LEIR
- **SEP**: Linac3, LEIR
- **OCT**: Linac3, LEIR
- **NOV**: Linac3, LEIR
- **DEC**: Linac3, LEIR

**Safety First**
- Excellent
- Good
- Average
- Poor

**Quality second**

**Schedule third**

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**Safety First**

**Quality second**

**Schedule third**
### LS2 activities

**PS Booster - underground**

- New Booster Scrape
- New Wire Scanner 4
- Refurbishment of the painting
- Water-related control (WRC) and beam line interlock system (BLI) deployment
- Consolidation of the beam lines replacement of lost pumps and pumping groups
- Replace extraction kicker (PSA, PSB, PSX)
- Replace bending magnets (PSA, PSB, PSX)
- Injection line 3:
  - New injection bending (PSA, PSB, PSX)
  - New distributor (PSA, PSB, PSX)
  - New septa (LS2)
- Refit beam instruments (R-APOLLO)
- Change of the magnets parameters
- New DFM
- New beam loss monitors
- New RF bypasses
- Change the bending magnets (PSA, PSB, PSX)
- Change the beam stopper (BT1, BT2, BT3)
- Upgrade magnets (LS2, PSX) and add new corrector magnets

**Extraction line BTP:**
- New prototype cavities (RF, APA, APA)
- New RF cavities with new beam monitors (BT1, BT2, BT3, BT4, BT5, BT6, BT7, BT8)
- New RF cavities with new beam monitors (BT1, BT2, BT3, BT4, BT5, BT6, BT7, BT8)
- New beam loss monitors
- Change the quadrupoles

**Renovation of the PSB cooling system**

- De-cabling, cabling & consolidation
- Maintenance & consolidation of magnets

**LS2: Booster Linac 4 connection**

[Diagram of LS2 activities and Linac 4 connection]

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**De-cabling, Cabling & Consolidation**

- Linac4 Transfer Line
- Beam direction

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**Linac 4 connection**

[Diagram of Linac 4 connection]
Most of the high radioactive elements have been removed from the machine.
De-cabling @ Point 3
 Shift works started between services to keep deadlines!

SPS5 – decabling campaign
Magnet exchange 2+

Pipes consolidation in BA3
Civil engineering starting in BA5
SPS Damaged jacks

LS2: SPS highlights
LS2: LHC warming-up status (on 31st March 2019)
LS2: Superconducting Magnet replacements

Total x26
- 19 Dipoles exchange
- 3 Quadrupoles exchange
- 2 Dipoles removal for 2x11T full assembly installation
- 2 CC removal for 2x CC full assembly installation

S 2-3
- x 5 dipoles exchange
- x 1 LECL.11R2 removal for cryo assembly installation

S 1-2
- x 9 dipoles exchange
- x 1 LEBR.11L2 removal for cryo assembly installation

S 3-4
- x 1 dipole exchange
- x 3 Quadrupoles exchange

S 4-5
- x 1 dipole exchange

S 6-7
- x 1 dipole removal for 11T installation

S 7-8
- x 1 dipole removal for 11T installation

S 8-1
- x 1 dipole exchange

ELQA at warm

IC openings in Sector 8-1

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Aperture restriction:

- Measured at injection and 6.5 TeV
- UFO stopped after 2nd beam screen warm-up
- Reference orbit is bumped by +1mm in V and -3mm in H at 15R8.
- Probably not a limiting aperture for operation
- But stability of the object remains a concern
- How does it behave with higher intensities?

Aperture in 15R8: MUFO => ULO

Still have to face the intensity ramp-up:
- UFOs, etc., cloud, beam induced heating, instabilities, especially 25 ns
- ULO (Unidentified Laying Objects)
Completion of the shaft excavation at Point 1

Start of cavern excavation at Point 1
Completion of the shaft excavation at Point 5

Shaft picture seen from the top

Start of cavern excavation at Point 5
The progress of the LS2 could be followed with dashboards updated every week:

https://lhcdashboard.web.cern.ch/lhcdashboard/ls2
The LS2 is a marathon and will not be all plain sailing but thanks to a solid preparation and to the dedication of numerous persons, a successful start respecting the motto:

1\textsuperscript{st} Safety
2\textsuperscript{nd} Quality
3\textsuperscript{rd} Schedule

6.5 km ..... still 35.7 km

Thanks for your attention