• LS2 scope
• Safety Coordination
• Equipment readiness, Schedules & Milestones
• Handover to RUN 3 and beyond
Definition of **main works** over the LS2 for the **whole CERN accelerator facilities** and of **potential arbitrations** based on priorities given to activities.

Definition of a CERN-wide “**resource-loaded planning**”, ensuring compatibility of resources and planning across **Injectors, LHC Machine, LHC and Non-LHC Experiments**.

**Preparation, coordination and follow-up till completion** of all activities.

Flexibility to use the end-of-year technical stops before and after the LS2 to decrease the load of the LS2.
LS2 Scope – Main objectives

Increase **Intensity** & **Brightness** in the injectors to match HL-LHC requirements

- **LIU Project**

Increase injector **Reliability** and **Availability** to cover HL-LHC run

- **Consolidation Project**

Anticipate **Civil Engineering** works and **beam equipment**

- **HL-LHC Project**

Perform major **Maintenance** & **Infrastructure** Consolidations

- **M&O activities**
LS2 Master Schedule (EDMS 1687788 – rev. 2.4)
## Safety – LS2 Accidents

<table>
<thead>
<tr>
<th>Facility</th>
<th>Total</th>
<th>Minor</th>
<th>With days of absence</th>
<th>Total days</th>
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<tr>
<td>PS</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>36</td>
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<tr>
<td>SPS</td>
<td>17</td>
<td>8</td>
<td>9</td>
<td>227</td>
</tr>
<tr>
<td>LHC inc. LEX</td>
<td>22</td>
<td>17</td>
<td>5</td>
<td>56</td>
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<tr>
<td>Surface</td>
<td>21</td>
<td>9</td>
<td>12</td>
<td>153</td>
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<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td><strong>36</strong></td>
<td><strong>29</strong></td>
<td><strong>472</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>Minor</th>
<th>With days of absence</th>
<th>Total days</th>
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<tbody>
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<td>9</td>
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<tr>
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<td>ENTC</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td><strong>36</strong></td>
<td><strong>29</strong></td>
<td><strong>472</strong></td>
</tr>
</tbody>
</table>

### November 2019

- Frequency Rate: 7.6
- Severity Rate: 0.08
- Frequency Rate: 4.0
- Severity Rate: 0.16
- Frequency Rate: 13.3
- Severity Rate: 0.20
- Frequency Rate: 10.0
- Severity Rate: 0.16

**LS1 Accidents**

- 3.7 Million Hours worked
- 64 minor accidents (no absence)
- 31 accidents with total 273 days absence

**Frequency Rate:**
Accidents with absence per million hours worked

**Severity Rate:**
Days of absence per thousand hours worked
Safety – Operational Dosimetry

Personal Dosimetry

1st of January 2019 – 30th of November 2019

Collective personal dose: 251.6 person · mSv
Maximum individual dose: 1.3 mSv (4 pers.)
Safety – Operational Dosimetry

Operational Dosimetry

1st of January 2019 – 31st of January 2020

Collective operational dose: 192.8 person · mSv

Dose by complex in person mSv

- PS: 94.0 mSv
- SPS: 52.8 mSv
- LHC: 25.7 mSv
- Other: 20.3 mSv

PS complex:
- PS: 50 person · mSv
- PS Booster: 19
- AD-Target: 2
- ISOLDE: 1
- East Hall Target: 1
- nTOF: 1
- MEDI_CIS & Target Area: 1

SPS complex:
- SPS: 51 person · mSv
- North Area Beam Lines: 1
- AWAKE: 1
- HiRadMat: 1
- GIF: 1
- NA62: 1
- Neutrino Platform: 1

LHC complex:
- CMS: 5
- Atlas: 2
- LHCb: 1
- Alice: 0
- LIGHT: 0

* Top 7 contributors
LS2 Dashboard
https://acc-dashboard.web.cern.ch/ls2
(CERN Single Sign On required)
PSB Update

- **Ring beam lines**
  - New RF Finemet Cavities
    - The whole systems are installed and operational. Individual system tests started
  - New Injection Region (H-)
    - Ready for individual system tests
  - New Beam Instrumentations
    - Detectors being vacuum tested before installation
  - New Absorbers
    - Final equipment to be installed in March

- **Transfer lines**
  - Injection (BI line)
    - Final smoothing/alignment this week of the line before starting the individual systems tests
  - Ejection to PS (BT line)
    - Final smoothing/alignment next week of the line before starting the individual systems tests
  - Ejection to ISOLDE (BTM line)
    - Final smoothing/alignment in two weeks of the line before starting the individual systems tests

- **General Services**
  - Cabling completed
  - Cooling system being tested
PSB Update

New Wire Scanners

New RF Finemet Cavities

New extraction line bending magnets

New PS Booster injection system
- Most of the LS2 activities are on track or in advance
- Individual SystemsTests (ISTs) already started in some specific locations
- Most of ISTs will start with the availability of the water cooling the 3rd of March 2020
Most of the LS2 activities are on track or in advance
Galleries cleaning completed
Individual Systems tests (ISTs) will start soon for some specific equipment in the ring

PS Ring and PS SwitchYard

New BusBars
New RF10MHz cooling
New WireScanners
New F16 Beam Stoppers

SMH16 back to the machine

BI line and LBS under vacuum connection

New WIC system

BTP line connected, aligned and under vacuum

Last MU back to the machine

BTP line and LBS under vacuum connection

New rigid RF 40&80 MHz lines

LHCC Feb'2020
SPS Update

- CE works in ECX5 completed on Schedule.
  - Installation of Auxiliary systems in ECX5 is ongoing.
- De-Cabling/Cabling & Installation of Auxiliary systems in LSS3 are completed.
  - Re-installation of RF cavities in LSS3 is ongoing.
- Re-installation of Beamline in LSS1 has started.
- PPS Project:
  - 10 of 12 new access systems installed.
- aC Coating project:
  - 11 of 12 sectors are completed.

Fire Safety Project:
- WP1: Fire Doors
  - 11 of 21 doors installed.
- WP2: Fire Detection
  - 75% installed. (2 of 6 zones fully operational)
- WP3: Dry Risers
  - 80% completed. (Only BA3 shaft, TT20, Arc 4+, Arc 5- to complete)
- WP4: Sprinklers
  - 70% Completed. (6 of 11 circuits fully operational)

SPS Vacuum Sectors Dashboard Sectors Closed

Overall delay of 6 sectors (will be caught up in March)
SPS Update

CE works in ECX5 complete on time.

LSS1 Re-installation

New PPS BA1

WP2, 3 & 4 installed in LSS5

Re-installation of magnets and RF cavities in LSS3

aC coating about to start its final sector

WP1 installed in LSS6+
Status 7th February 2020 wrt baseline 2.4
DISMAC

- Sector 8-1 all works done
- Diodes electrical insulation consolidation fully completed
- DISMAC progression shows a small delay according to the baseline

28th January 2020: Last Diode box consolidation
• All cryomagnets (not including HL WP11 – LSS7) have been disconnected, removed and reinstalled; last pressure tests remain to be done
• Reconnection almost completed for the magnets that have been reinstalled.
  • CC-11R2 showed a NC but has been already fixed and currently being connected
LHC external beam dump block (TDE) works during LS2

- At the end of January the two spare dumps have been successfully removed from the UD62/68 to the UX65
LSS5 Realignment \(\rightarrow\) Planning consolidated

Phase I – Realignment from Q7 to Q5 \(\rightarrow\) 14\textsuperscript{th} Sep to 10\textsuperscript{th} Oct 2019

**Phase II – Realignment between Q5 to Q5** \(\rightarrow\) in progress (From January 2020 to May 2020)

- Q5-D1 (6 MBWX, 1 Q4, 1 D2, 1 TAN, 4 pick-ups and 4 Collimators)
- Q1L-Q1R (2 TAS, VAS and 2 BPMWK)
- In total 38 equipment

**Q1 – DFBX** \(\rightarrow\) Alignment on the Inner Triplet area project (V Parma) LSS5L w5, LSS5R w11

**TAS (Right side)** (F Sanchez Galan) \(\rightarrow\) w11 in // with the DFBX LSS5R
IT Consolidation

- On all 8 triplets (starting with Pt2 and 8, learning in low radiation areas)
- 1 working day per triplet for a team of 4 (from SIT) + support by Survey team
- March-April

Trial assembly with mock-up tie-rods in Pt.5
WCC Hose exchange

RR53 & RR57 replacement completed ➔ waiting Short Circuit Tests

RR13 & RR17 in progress
- DFBA And DFBL cables replacement completed, new water hoses installed.
  ➔ Waiting for Dielectric tests

LSS2R: hose replacement in progress

LSS2L: DFBX + DFBA + DFBM ➔ LS2 critical path

LSS2L: DFBX + DFBA + DFBM ➔ LS2 critical path
HL-LHC civil engineering

LHC P1

LHC P5
HL-LHC civil engineering
Cryostat Connection HL-WP11 LSS2

Installation completed!!!!
Re-Connection in progress
S1 successfully qualified

S2 @ SM18, cooldown, to be tested wk8-9

S3 failed the test, back to workshops Bldg.180/SMI2

S4 ready for test in SM18, wk10-11
Handover to RUN 3 and beyond (PSB case)
Handover to RUN 3 and beyond (LHC case)

LS2 Coordination

BE-OP Coordination

LS2 ends before Powering tests
Closing remarks

Excellent progress and follow-up
- Changes in linear schedule to cope with minor delays / problems
- Equipment readiness followed closely and so far no strong showstopper identified
- “Safety First” remains LS2 priority and intensification of support / controls
- Master resource-loaded schedules reviewed to version 2.5 by end of February 2020 with no date change for Hardware Commissioning (end of LS2)

QA and documentations just on time
- 3D integrations, differential layout drawings and ECRs available on time.

Daily follow-up towards a successful completion of LS2 activities
- Intensive field coordination and safety follow-up (tunnel and surface)
- Radiation dose to personnel perfectly handled, same for radioactive transports
Warm thanks to:
✓ All Contributors to this presentation
✓ LS2C Representatives for their help in the LS2 preparation and follow-up

Congratulation to:
✓ CERN Teams and Collaborators from Institutes and Universities
✓ Industrial Support Teams

Keep going! ...and my warm thanks to the LS2 Team 😊