LHC Injectors Upgrade days 2019: Introduction and Session 1 on LIU beam performance

13 – 15 February, 2019
Hotel Royal Plaza, Montreux (CH)
Schedule – Day 1

15h00 – 15h30 – Welcome coffee
15h30 – 16h00 – Session 0 Workshop/LIU introduction
16h00 – 17h30 – Session 1 LIU beam performance (1.5h)
17h30 – 18h00 – Leg stretch
18h00 – 19h30 – Session 1 LIU beam performance (1.5h)
20h00 – Dinner
Schedule – Day 2

8h30 – 10h00 – **Session 1 LIU beam performance** (1.5h)
10h00 – 10h30 – Coffee break
10:30 – 12h00 – **Session 2 LS2 system readiness and shutdown execution** (1.5h)
12h00 – 13h30 – Lunch
13h30 – 15h00 – **Session 2 LS2 system readiness and shutdown execution** (1.5h)
15h00 – 15h30 – Coffee break
15h30 – 17h00 – **Session 2 LS2 system readiness and shutdown execution** (1.5h)
17h30 – 18h45 – Leg stretch + 1h reserved buffer
19h00 – Aperitif
20h00 – Dinner
Schedule – Day 3

8h30 – 10h30 – Session 3 LIU hardware and beam commissioning (2h)
10h30 – 11h00 – Coffee break
11h00 – 13h00 – Session 3 LIU hardware and beam commissioning (2h)
13h00 – 14h00 – Lunch
14h00 – END
Introductory talk – Setting the scene for LIU (Malika)

• Motivations and goals of the workshop
• Snapshot of the project items for the different machines (key interventions, why they are key, what has already been achieved)
• Status of the project in terms of budget, manpower and schedule
• LIU project lifecycle and organisation
  • LIU within CERN: current structure of the project, benefits, drawbacks
    • Activities by machine with safety, planning and budget overall
    • Core meetings: LIU-PT, LIU Beam Performance, LIU with equipment groups
    • Reporting lines (including LIU/HL-LHC Executive committee, C&S reviews)
    • Interface with HL-LHC
  • LS2 project phase and structure
S1: LIU beam performance
(Giovanni + Heiko)

- Present HL-LHC target and sensitivity of integrated performance reach to variations in LIU delivered parameters – analyse alternative production schemes
- Wrap-up LIU beam performance reach – baseline and mitigation scenarios for both protons and ions
- Summarise conclusions from run 2 MD and operation in 2018, in context of LIU parameters and performance – including mitigations for risk items
- Identify beam performance related activities for 2019-2020 (LS2) – data analysis, simulations, code development …
- List LIU beam measurements needed during run3 (in collaboration with S3)
- List hardware related improvements postponed to post LS2 and performance impact
- List any items needing upgrade that were missed from LIU
## Session 1 overview

<table>
<thead>
<tr>
<th>Time slot</th>
<th>Talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed 16:00 – 16:30</td>
<td>HL-LHC target</td>
</tr>
<tr>
<td>Wed 16:30 – 17:00</td>
<td>LIU beam performance reach</td>
</tr>
<tr>
<td>Wed 17:00 – 17:30</td>
<td>Linac4</td>
</tr>
<tr>
<td>Wed 18:00 – 18:20</td>
<td>PSB injection, brightness</td>
</tr>
<tr>
<td>Wed 18:20 – 18:40</td>
<td>PSB longitudinal</td>
</tr>
<tr>
<td>Wed 18:40 – 19:00</td>
<td>PS emittance preservation</td>
</tr>
<tr>
<td>Wed 19:00 – 19:20</td>
<td>PS intensity/quality reach</td>
</tr>
<tr>
<td>Thurs 8:30 – 8:50</td>
<td>SPS transverse</td>
</tr>
<tr>
<td>Thurs 8:50 – 9:10</td>
<td>SPS longitudinal</td>
</tr>
<tr>
<td>Thurs 9:10 – 9:40</td>
<td>Ions across the injectors</td>
</tr>
<tr>
<td>Thurs 9:40 – 10:10</td>
<td>Beyond-LIU performance</td>
</tr>
</tbody>
</table>
S1: LIU beam performance
(Giovanni + Heiko)

- HL-LHC target and scenarios (protons + ions) – Rogelio 30’
  - Baseline beam parameters, assumptions (e.g. beta*, crossing angle compensation, efficiency, etc.), desiderata on bunch-by-bunch variations within trains
  - Relevance of alternative filling schemes (BCMS, 8b4e, 50 ns)
  - Sensitivity to beam parameters (lower intensity for target brightness, lower brightness for target intensity) and sensitivity of LHC availability to beam parameters

- LIU beam performance, uncertainties and mitigations (protons + ions) – Hannes 30’
  - Baseline proton parameter reach, assumptions
  - Ion operation post-LS2, baseline reach and alternative schemes
  - Alternative production schemes examined in the LIU framework (BCMS, 8b4e, 50 ns)
  - What we can definitely tick out from Run 2 experience and what we still need to study in LS2 and prove in Run 3 (simulation and post-LS2 needs)
S1: LIU beam performance
(Giovanni + Heiko)

• Linac4 (including source) – Alessandra/Giulia/Jean-Baptiste/Daniel 30’
  • Achievements in 2018 in terms of beam quality, reliability, typical operational scenarios, integration in operation
  • More to come (e.g. source/RFQ/LEBT improvements, LBE tests in 2019)

• PSB
  • ‘Transverse’ challenges (overview on 160 MeV H- injection and new brightness line, transverse stability, understanding of emittance measurements) – Fanouria 20’
  • ‘Longitudinal’ achievements (experience with Finemet and LLRF, longitudinal emittance blow up, new 2 GeV cycle, longitudinal stability, injection in h=1+2+3?, LLRF requirements for increased flexibility?) – Simon 20’

• PS
  • Emittance growth at injection: all potential contributors (mismatch, kicker waveforms, injection bump, space charge, injection settings), post-LS2 operational scenarios – Matthew 20’
  • Longitudinal parameter reach (intensity/longitudinal emittance) and beam quality, e.g. bunch shape, bunch-by-bunch parameter variation (2018 and post-LS2) – Alexandre 20’
S1: LIU beam performance
(Giovanni + Heiko)

• SPS
  • Experience with high intensity beams and expectations after LS2
    • Transverse (stability & flat bottom losses): Momentum aperture, emittance growth, transverse stability, $Q_{20} \text{ vs } 22 \text{ vs } 26$, e-cloud – Kevin 20’
    • Longitudinal (stability & flat bottom losses): Impact of RF power upgrade, impedance reduction, new LLRF – Elena/Markus 20’

• Ions
  • Linac3, LEIR, PS, SPS: performance & reproducibility, what else can be improved, lessons learnt in 2018 – Nicolò 30’

• Expected performance after and beyond LIU – NA 30’
  • Upgrades proposed, but not covered by baseline or postponed to after LS2
  • Items needing upgrade that were missed by LIU?
  • Impact on beam performance and possibilities to further improve injector performance or performance robustness beyond reach of LIU, needed beam studies