Run3 programmed stops and inputs for LS3

Joint Accelerator Performance Workshop (JAPW), 2022

F. Pedrosa (EN-ACE-OSS) on behalf of RUN3 IC team and EN-ACE group

2022-12-08
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Long Term Master Schedule

- Released version (EDMS 2311633)

- Run 3 Installation Coordination covers the period up to LS3
- EYETS 2024-25 will include anticipated and preparatory activities for LS3 so it should be covered by the LS3 coordination (as it was the case for LS1 & LS2)
- Start the LS3 in the Injectors and the LHC at the same time. Should the simultaneous start of LS3 in all machines be revisited?
- A delay in the start of LS3 in the injectors will push one more year on ageing equipment, especially in the NA
Long Term Master Schedule

- **Version with the energy saving scenarios**
  - YETS2023-24 converted into a EYETS (4 weeks more managed with the same limited resources);
  - EYETS2023-24, EYETS2024-25 and LS3 starting end of October (shorter run periods)
  - **Note:** The impact of the compensation of the crisis leave in 2023 is not taken into account

| Year | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 2022 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2023 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2024 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2025 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2026 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2027 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2028 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2029 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Legend:
- LHC
- SPS
- PS
- PSB
- L4

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## The complexity of an accelerator

<table>
<thead>
<tr>
<th>LINAC4</th>
<th>PS Booster</th>
<th>PS</th>
<th>SPS</th>
<th>LHC</th>
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</thead>
<tbody>
<tr>
<td>86 m long</td>
<td>157 m long</td>
<td>628 m long</td>
<td>7 km long</td>
<td>27 km long</td>
</tr>
<tr>
<td>12 m underground</td>
<td>15 m underground</td>
<td>Surface</td>
<td>65 m underground</td>
<td>100 m underground</td>
</tr>
<tr>
<td>160 MeV</td>
<td>2 GeV</td>
<td>26 GeV</td>
<td>450 GeV</td>
<td>7 TeV</td>
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</table>

## Programmed stops

- Technical stops (**TS**)
- Year End Technical Stops (**YETS**)
- Extended Year End Technical Stops (**EYETS**)
- Long Shutdown (**LS**)

## The lifecycle of the chain

- ~ 4 years of **beam run operation**, including:
  - 1 (E)YETS/year
  - 2-3 short technical stops/year
  - 3 years (LHC) and ~ 1.5 year (Injectors) of **LS**
Common coordination

Different accelerators … … BUT sharing:

• Resources
• Tools (also Exp. Areas)
• Expertise

Technical expertise

Project management standards

Common coordination for installation → EN-ACE for the LHC and its injectors

OpenSE

✓ A common understanding of a facility or system lifecycle
✓ A common understanding of the expected results
Accelerator, Coordination and Engineering (ACE)

**COS team:** site management coordination, giving on-site support, safety coordination and issues resolution, coordination of the interventions, study of the facilities layout, definition of the worksites and the activities.

**OSA team:** to define the worksites and activities.

**AQS team:** to cover quality standards for the documentation and process of all interventions, ensuring a common approach.

**CL and INT teams:** to trace and validate the new equipment installation and the modifications to the facilities layout.

**OSS team:** to coordinate the installation, manage co-activities, schedule, follow up, and report on all the interventions foreseen for Accelerator complex.

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From Long term to detailed schedule: YETS 21-22

Long Term Schedule - Strategic

Master Schedule - Operational

Homogenized process through the LHC and the injectors
Major change approved in October 2022:
Extension of the YETS for social responsibility and economic reasons:
  • YETS 22-23: start to 2 weeks in advance (+ 2 weeks extension)
  • (E)YETS 23-24: start to 6 weeks in advance (+ 4 weeks extension)
Programmed stop preparation – Strategic level

Long Term Schedule - Strategic

- More than 1600 activities were created in the first PLAN RUN3-LS3 exercise, in 2021-22

RUN3 installation coordination has an important role to play to optimize the Long Term Schedule:

- Anticipate activities into the Run3 programmed stops (EYETS, TS) to limit the workload during LS3, especially for critical teams;
- Detect possible blocking points and define mitigation measures to minimize the impact (e.g. safety, cables availability, space, ECRs, logistics and space management, …);
- Identify synergies to optimize resources (e.g. group equipment installations per vacuum sectors, de-cabling, …)
Programmed stop contributions – Strategic level

• PLAN is a key tool to keep all groups on the same page and to help smooth the resources by anticipating activities when possible
  • More than 7000 contributions were requested in the first PLAN RUN3-LS3 exercise
  • Was not fully successful for this YETS 2022-23 because of the lack of accurate information and the absence of discussion between activity responsible and the contributors (Support by the management might help)

• How can we ensure timely answers from the teams?
  • Anticipate activities and smooth resources will be possible only with a timely and detailed declaration performed by the groups
  • A possible target of contributions per group could be defined if required by the groups
Programmed stop preparation – Operational level

- The YETS master schedule preparation starts always from the minimum YETS duration (to be redefined based on the ISTs declared this year) and then gets modified based on:
  - RUN conditions (Ion RUN, stop of high intensity beams, …)
  - Commissioning required based on the machine changes
  - Energy crisis aspects
Reserved test weeks appeared this year from some groups with the main argument that they need flexibility to test and they cannot provide details when inside these weeks the equipment will be tested (1 week at the beginning and 2 weeks before moving to HWC) – Should this approach be challenged or shall we accept it?

Is this a good strategy in terms of energy efficiency?

This new approach limits the type of works possible during those 3 weeks, and consequently the 4 weeks extension in the next years shall be considered only as 1 week extension for works.
Programmed stop preparation – Detailed level

Detail Linear Planning

- Inputs from the groups to prepare a detailed schedule:
  - Presentations from the groups;
  - Individual System Test risk assessments
- Regular link with the IEFC

YETS preparation

YETS Execution Period
- Coordination meetings
  - Collected feedback on the previous YETS and known observations to be send to YETS

YETS Execution Period
- Work with the groups on the open questions and details
  - IEFC presentation
    - Final draft of the YETS planning and baseline master schedule
  - IEFC presentation
    - Considered K/EYETS planning and revised baseline master schedule
  - IEFC presentation
    - Start of 9 YETS

SPS MACHINE

PS COMPLEX

<table>
<thead>
<tr>
<th>June 2022</th>
<th>02 Jun</th>
<th>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</th>
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<tbody>
<tr>
<td>May 2022</td>
<td>19 May</td>
<td>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</td>
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<tr>
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<td>12 May</td>
<td>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</td>
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<td>April 2022</td>
<td>28 Apr</td>
<td>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</td>
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<td></td>
<td>21 Apr</td>
<td>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</td>
</tr>
<tr>
<td></td>
<td>07 Apr</td>
<td>Joint LINAC3, LINAC4, PSB, PS&amp;TT2 Coordination meeting</td>
</tr>
</tbody>
</table>

April 2022
- 27 Apr | SPS Planning meeting for YETS 2022-23 No.06
- 06 Apr | SPS Planning meeting for YETS 2022-23 No.05

March 2022
- 30 Mar | SPS Planning meeting for YETS 2022-23 No.04
- 23 Mar | SPS Planning meeting for YETS 2022-23 No.03
- 16 Mar | SPS Planning meeting for YETS 2022-23 No.02
- 28 Feb | SPS Planning meeting for YETS 2022-23 No.01

Inputs for LS3
Programmed stop monitoring – Detailed level

**Monitoring** the baseline deviations:

- On-site follow-up & coordination meetings
- Broken Line & Readiness curves
- Track-It

**Reporting** the advancement of the works to guarantee alignment with the management guidance

Good communication & flexibility are essential for an effective programmed stop coordination
Programmed stop - unexpected events

Unexpected events during LS2: Covid-19, asbestos, short-circuit in a magnet, …

**Bottom-Up approach**

- Reassessment of the Work Package Analysis.
- Onsite Visit d’Inspection Commun (VIC) to adapt the procedures to the new safety conditions.
- Prioritisation and rescheduling of the remaining activities.

Detail Linear Planning | Master Schedule - **Operational** | Long Term Schedule - **Strategic**

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Programmed stop - Finalisation

To keep the **CAD technical document of the accelerator chain** up-to-date related to operation run periods (i.e. evolution of the configuration), we need to **complete the quality process post-LS2**.

Integration Office is facing difficulties to release the layout (3D models and 2D drawings) post-LS2 (i.e. 2021 for the injectors) due to **many mechanical assemblies** (3D and 2D drawings) **not released**.

To complete this quality process, it is required that the **equipment owners** check and ensure that their CAD documentation are **up-to-date** and **released** concerning the LS2 installation (same for YETS versions).

**Note:** the current PDM/PLM (Smarteam/CDD) will migrate to a new PDM/PLM (Aras) changing from document-centric to item-centric approach. We highly recommend the equipment owner to ensure with their design office that the lifecycle of their CAD document are completed to release state for all asset already produced/installed before the migration.
Quality Lifecycle for Design Offices

Post-LS2 Layout Update Status 02-Dec-2022

The LIU Project contributed to the LS2 preparation by financially supporting groups in the delivery of the required CAD data.

What’s next?

• Groups to provide the necessary data on their budget but difficult when several groups are involved.
• Extra recurrent budget for EN-ACE-INT to update and release the needed CAD technical documentation directly or by financing the relevant jobs in other design offices.

This would result in an improvement of the process until LS3 and later.

Risk to not being able to complete all integration studies and related differential drawings for the YETS22-23 (impact on the ECR validation)

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Plan Exercise 2021-22: lessons learnt

- The first Run3-LS3 PLAN exercise was challenging due to:
  - Parallel tool development;
  - Unclear end date for PLAN LS2;
  - Simultaneous management of data from LS2;
  - Last minute reaction from some groups;
  - PLAN exercise running in parallel with the management approval process (MTP, ATSMB, projects approval….)

Despite the challenge, more than 1600 activities and 7000 contributions were declared for version 1 of Run3-LS3 PLAN.
Plan Exercise 2021-22: lessons learnt

- One version per year will allow:
  - to update the information available in PLAN from the previous version;
  - to declare new activities that were not known the year before;
  - ...

**Declaration of activities**

**Prioritization**

**Resources allocation**

**Approval**

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Inputs to LS3 preparation

- The transition from LS2 coordination to the RUN3 Installation Coordination was a bumpy road. ACE methodology is the common path across the time for the LHC and injectors. Clear and timely transition from RUN3IC to LS3C shall be defined.

- Considerable amount of LS3 activities have been already collected in PLAN during this first exercise. A lot of LS3 activities require preparation during the RUN3 period (e.g. integration, ECRs, development, testing, ...); How to manage these data? Who and how to challenge the groups and départements?

- Non alignment of PLAN milestones with other processes (MTP, projects approval) affects the PLAN process.

- Communication between activities responsible and contributors is key, but unfortunately seems not natural. Effort to clarify PLAN activities and contributions shall not be neglected. Run3 IC team can help but cannot manage all interactions between responsible and requestors.

- The effort invested to improve data quality is helping the teams to get better information in PLAN.
Next steps

- Definition of new frames for all the Machines, considering the extension of the YETS during run 3: repartition of extra time between tests, works and HWC

- Consideration of energy consumption optimisation aspects in the EYETS / YETS (/LS3) preparation;

- Assessment and improvement of decisional and arbitration process during run 3. (Is it possible to anticipate more activities from LS3?)

- Definition of the transition from Run3 IC to LS3C

Open Points

- Decabling
- Electrical Safety
- Scarcity of some resources during (E)YETS and LS, especially for (de-)cabling
Conclusion

- EN-ACE has a solid and consistent methodology to manage programmed stops in the LHC and Injectors. A continuous improvement process is in place to adapt to changes, and support the coordination committees (LS1C, LS2C, Run3IC, …)

- The new RUN configuration adds a considerable effort to the teams managing the programmed stops:
  6 more weeks allocated to the programmed stops

- Following the increased programmed stops time during run 3, the impact on projects and other surface activities must be carefully analysed.
  It could be beneficial to challenge the groups, to anticipate LS3 activities during the Run3, but…

- PLAN is a great tool to collect activities and contributions,
  - It triggered clarifications between activities responsible and contributors – still room for improvement
  - Its integration in the strategic decisional process has to be clarified
  - Many LS3 activities have been declared in PLAN; more will come in the next versions. (but this doesn’t necessarily reflect the effort for the teams)
Conclusion

• LS3 is outside the scope of the RUN3IC, avoid creating a gap is crucial and a timely definition of the transition is needed.

• Very challenging years in front of us.

• Flexibility will be required to allow integration of diverse activities under definition like NA-CONS + ECN3, PBC, FPF,… in parallel with the preparation of the LHC experiments upgrades and the full exploitation of the LHC with the coming HL-LHC installation.