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LHC and injectors schedule for the next decade

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Abstract

This document summarizes the schedule of the different machines during the next decade.

Please note that this note has been approved by the Director General.

Preamble - Vocabulary and definitions

- **LHC Technical Stops**: 4 days each 6 weeks in order to anticipate maintenance, to solve non conformities and inspect the different equipment in the machine and experimental areas - Followed by a 5th day for re-commissioning with beam.
- **Christmas break**: mid period stop, between 2 years of operation - 9 weeks to perform minimal maintenance in order to be in conformity with legal and safety requirements, and run for another year.
- **Shut-Down**: major stop of operation with major consolidations and full maintenance of the different systems
- **“Normal operation mode”**
During “normal operation”, the LHC will be operated on a 3 year basis as following:
 - Periodic time windows of 6 weeks: Operation during 5.2 weeks and Technical Stops of 4 days.
 - At the end of each year: a heavy Ion run of 4 weeks, preceded by a period of beam setup.
 - Christmas Break of 9 weeks between the first and second year to perform minimal maintenance
 - Christmas Break of around 3 months between the second and third year to perform intermediate maintenance

LHC and injectors schedules are synchronized. During the technical stops, 4 days are foreseen for both Machine Development and technical stops, in the injectors. The Christmas Break is reduced by one week compared to LHC in order to reserve one week for start up before injection in LHC.

2010 – 2011: “normal mode” at 3.5TeV

LHC and injectors will be operated in a “normal operation mode”.

2012 -- Shutdown ~15 months

LHC

Major consolidation will be performed in the machine in order to allow running safely at 7TeV/beam:

15 months are foreseen for the *interconnection consolidation* and hardware commissioning of the circuits to 7TeV. In the shadow of this activity, the different works for the R2E project (Radiation to Electronics) will be carried out in the LHC machine.

The activities linked to the collimation project – phase 2 in IR3 will be inserted into the schedule as soon as appropriate technical solutions have been found. Two options are possible:

- Collimators ready mid 2012: schedule will need to be reviewed – additional resources may be necessary to stay within 15 months
- Collimators not ready in 2012: installation in 2015.

In the shadow, in addition to maintenance, the following activities will be performed by the experiments:

- ATLAS: consolidation and installation of a new forward beam pipe
- ALICE: commissioning of TID and some calorimeter modules
- CMS: Forward Muons Upgrade + works on the infrastructure and consolidation
- LHCb: improvements, exchange of the bigger part of the conical beam pipe

Injectors

For economy reasons, there is a possibility that the CERN injectors will not be operated in 2012, hence they will be in shutdown for nearly the same duration as the LHC.

2013-2014-2015 “normal mode” towards 7TeV

LHC and injectors will be operated in a “normal operation mode”.

A training period of the magnets may be necessary to run the machine at 7TeV.

2016 shutdown

LHC

- The length of 2016 shutdown is driven by the activities in the experiments:
 - ATLAS: After accumulating 30 to 50 fb⁻¹, and before reaching “ultimate” luminosity ($\geq 2 \times 10^{34}$ cm⁻²s⁻¹), ATLAS will need to insert the new pixel layer. In parallel various systems will be upgraded and the level one trigger (LV1) will be modified.
 - ALICE will upgrade its detector, with the installation of a smaller beam pipe and a new vertex detector. The outer detector will be upgraded in shorter shutdowns (Christmas breaks).
 - CMS needs to complete the Forward Muon Upgrade, change the photodetectors of the hadron calorimeters, install a new beam pipe and a new 4-layer pixel tracker.
 - LHCb will rebuild the vertex detector and increase the readout rate to 40MHz. (*not ready before the end of 2016*)
- In the shadow:
 - The full maintenance of all existing equipment (machine and experiments) will be performed,
 - The completion of the collimation project – phase 2
 - The installation of a separate cryogenic system for the RF.
 - The preparation for installation of crab cavities in IR4.

Injectors

A shutdown of 9 months is foreseen in order to:

- Connect LINAC4 to PSB

- Upgrade the PS booster, for ≤ 2 -GeV operation

2017-2018-2019 “normal mode”

LHC and injectors will be operated in a “normal operation mode”.

2020 -2021 shutdown

LHC

Once the detectors have been exposed to 300 to 600 fb⁻¹, the inner detector trackers of CMS and ATLAS will need to be replaced. One can also expect that the 2 detectors will have to face at the same time a major upgrade of all the front-end and back-end electronics and the online computing systems.

In the shadow, ALICE will upgrade its second vertex detector, while in the machine side the new Inner Triplets and the crab cavities will be installed.

Injectors

During the 2020-2021 shutdown the injectors will run in a “normal mode”, with 3.5 months shutdowns at the end of 2019 and 2020.

Table 1. Provisional Planning for the next 10 years

