LHC EXPERIMENTS UPGRADE AND MAINTENANCE

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Abstract

The LHC experiments have planned significant maintenance and upgrade efforts for LS2. ALICE and LHCb will implement major upgrades with important changes to the entire apparatus, while ATLAS and CMS will perform their major detector upgrades only during LS3. However, the overall scale of the LS2 operations is quite similar for all experiments. The presentation will review the LS2 plans of the experiments and focus on aspects related to support needed from the technical sector.

INTRODUCTION

A very first assessment of the needed support for the LS2 plans of ATLAS, CMS, ALICE and LHCb has been performed. The plans will of course be refined during the coming years, so some flexibility and close involvement in the LS2 planning are important. Standard maintenance of equipment by EN-EL, EN-CV, TE-VAC as well as access to the EN-MEF cabling and scaffolding contract are assumed to be implicit and are therefore not detailed in the specific experiment needs.

ALICE and LHCb install massive amounts of fibers (10k/17k) to ship all data in a "triggerless" fashion from the cavern to the counting rooms. ATLAS and CMS will also need additional fibers for their upgrades. It has to be ensured that the EN-EL frame contract for fibres is competitive and properly adapted.

Advancing the installation of the new TAS from LS3 to LS2 for ATLAS and CMS is unfortunately not feasible but many other preparatory changes must be performed in LS2 in order to follow ALARA principles and ensure that the upgrades can be implemented in the foreseen time frame. ALICE and LHCb have an extremely tight planning for the LS2 upgrade implementation, which is partially already organised in shifts. Availability of sufficient survey personnel and safety coordination are therefore very important. In general, support from the technical sector will be required already well before LS2.

The LS2/LS3 upgrades of the LHC experiments are usually referred to as Phase1/Phase2 upgrades.

ATLAS

ATLAS has implemented many upgrades and medium term consolidation items for Run2+Run3 already during LS1. A new central beam pipe and an additional layer of Pixel detectors, the insertable B-Layer (IBL), were installed during LS1. New service panels for the Pixel detector as well as a new thermosiphon cooling system were implemented as well. The experimental beam pipes made from Fe were changed to Beryllium and Aluminium for reasons of background and activation (ALARA).

The planned PHASE1 upgrade for ATLAS is detailed in 4 technical design reports and refer to the New Small Wheel, the Fast TracKer, the Liquid Argon Calorimeter and the TDAQ system. Beyond the standard maintenance there are at this moment no major foreseen implications on the technical department.

CMS

The CMS Phase1 upgrade is distributed between the 2015-2018 YETS and LS2 and is detailed in 3 technical design reports. They refer to the upgrade of the Level-1 trigger (ready for 2016 data taking), the new pixel detector (implemented in the 2016/2017 EYETS) and the HCAL photo-detectors and electronics upgrade of the HCAL (HF 2015/16 YETS, HB/HE LS2).

The central beam pipe was changed in LS1, the forward experimental beam pipes will be changed to Al in LS2. The 4+1 500kVA UPS system will be upgraded to 7+1 500kVA and the electrical infrastructure has to be upgraded. A possible re-siting of battery banks is discussed.

The control room is being revised and a UPS unit will have to be moved. An increase of chilled water production (+1.5MW) and a dry gas (air/N2) system upgrade for Phase2 detectors will be implemented as well. A multi-purpose extension of the surface assembly hall (1000m2) will need support from the technical departments.

The refurbishment of the magnet control and safety system and a freewheel thyristor for immunity from power converter glitches are planned.

The installation of a second UXC crane with suspended cage for personnel access and replacement of the elevator will also be done during LS2.

Since the detector will be completely opened, the upgrades and detector maintenance efforts are on the same scale as LS1, so transport, rigging, survey & FSU support on same scale as LS1 are needed.

ALICE

The Phase1 upgrade of ALICE will see major changes to the entire apparatus in order to be able to read the full 50kHz of Pb-Pb collisions in trigger-less mode. This upgrade is detailed in 5 technical design reports referring to the Inner Tracking System (ITS), the readout and trigger system, the Time Projection Chamber (TPC), the Muon Forward Tracker (MFT) and the Online-Offline System.

Since the computing farm will need a massive extension it has to be studied whether the available space and electrical infrastructure are sufficient.

A new central beam pipe as well as mobile bake-out equipment have to be developed. A modification of Miniframe beam-pipe, the displacement of the central gauge as well as the implementation of an ion pump in Aluminium are foreseen. 10k fibres have to be installed in ALICE, and the possibility of installation during the EYETS 2016/2017 are studied. A new cooling plant is needed for the new ITS detector and a possible new dry air ventilation system is studied. The change of the elevator to the UX cavern, that dates from LEP times, is essential at the earliest possible time.

Vacuum consolidation in the LSS around ALICE in order to arrive at the lowest possible vacuum pressure and therefore the lowest possible level of beam-gas background are essential. As part of this effort, a new TDI to limit high vacuum pressure from outgassing is foreseen. To allow maximum Pb-Pb luminosity, collimators in dispersion suppressor region need to be implemented. From the machine side, the infrastructure for increase of Pb-Pb luminosity to more than of 6x1e27 must be implemented.

LHCb

The Phase1 upgrade of LHCb foresees major changes to the apparatus. All frontends are upgraded to read events at the full 40MHz collision rate into the online farm and several detector systems are exchanged in order to cope with much higher readout frequency. The upgrade is detailed in four technical design reports referring to the Vertex Locator (Velo), the Tracker, the Particle Identification (PID) and the Trigger and Online system.

A large new computing farm (2MW) will have to be housed in a new surface building or a dedicated container. The strategy for cooling and operational temperature as well as possible UPS needs are being worked out. All beam pipes in the cavern must be removed and then reinstalled during LS2, but no new beam pipes are planned. Probably a TAN will have to be installed around LHCb. 17k optical fibres have to be installed from the experimental hall up to the surface, possibly already in EYETS 2016/2017. The new Scintillating Fibre Tracker (SciFi) cooling plant (-40C monophase Freon for SiPMs) has to be developed and the present OT/PS/SPD cooling plant has to be adapted for the SciFi electronics cooling. The planned changes of elevator and crane have to be properly scheduled.

For integration of cables, cable trays, cooling lines, access platforms as well as supervision of the service installation activities LHCb relies on EN-MEF.