INSTALLING COLLIMATORS IN THE NEXT LONG SHUT-DOWN: PLANS, STATUS AND CHALLENGES

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Abstract

The first part of the collimation upgrade plan features the installation of 4 collimators in the 2 DS of point 3, in addition to the upgrade of the existing collimation system.

What makes this upgrade so special is that for the first time collimators will be placed within the continuous cryostat of the LHC sectors. For this purpose, 16 main dipoles and 8 main quadrupoles will have to be disconnected and displaced by about 4.5 m, as well as the 2 electrical feedboxes (DFBAs) on either side of the DS, in order to create the space required for installing the additional collimators. The collimators themselves, although remaining of the warm type, feature a design substantially different from the others, mainly imposed by tight space constraints. These collimator modules will have to be complemented by a special bypass cryostat whose function is to preserve the continuity of the technical systems along the arcs (magnet powering, cryogenics and insulation vacuum), while providing cold to warm transitions to the beam tubes where the collimators are placed.

The status of this collimation upgrade project is presented, with special emphasis on the collimation in the DS of point 3; design & integration studies in this point, as well as the status of the design and manufacturing of all the associated new equipment (DS collimators, Short Connection Cryostats, and new cryogenic extensions to the QRL) are outlined. An overall plan of the surface and tunnel preparation activities, in the perspective of a 2012 shut-down implementation, is discussed.

INTRODUCTION

This first collimation upgrade is aimed at improving the collimation efficiency by a factor 5-10, and to implement flexibility in the loss locations of IR3 and IR7. These goals call for the installation of 4 horizontal collimators in the DS regions around point 3, and the installation of vertical collimators, in the warm regions of point 3, the latter providing the possibility of betatron cleaning in IR3 in case of SEU problems in point 7.

In addition, debris absorbers are planned to be installed around the experiments in IR1 and 5, and the possibility of tertiary collimators around point 2 are under discussion. Table 1 summarizes numbers and positions for the collimation upgrade of the next long shut-down.

THE DS COLLIMATORS IN PT.3

In order to create the space required for fitting compact warm collimators within the continuous cryostat of the Dispersion Suppressors (DS) zones, the DFBAs, together with the Q7 and two adjacent dipoles have to be moved by 4.5 m towards IP3, whereas a new 4.5 m shorter connection cryostat (so-called Short Connection Cryostat, (SCC) will allow moving the Q10 and two adjacent dipoles towards Q11. As a consequence two slots, each of 4.5 m long, become available for integrating the 2 new DS collimator assemblies close to Q10 and Q8. The magnets between Q10 and Q8 will have to be moved towards the center of the machine by 46 mm to comply with the new optics layout. The longitudinal translation of the DFBAs forces the displacement of its proximity ancillaries (instrumentation and control panels and electronics racks) and of adjacent equipment like the TCLA, DQS (and BTVM in 3L, for which a suitable position is still to be decided). The layout changes to the DS zones are schematically illustrated in Figure 1. Space constraints in the tunnel in these locations make the integration studies particularly challenging and though most of the issues have been solved, a few outstanding issues still need to be tackled. Since the QRL will not be modified, the new position of the cryogenic feeding of the magnets and DFBAs require new transfer lines to bridge the longitudinal gap to the QRL distribution points. Their integration above the main cryostat or along the QRL has been studied and is now almost final. As an example, Figure 2 illustrates the integration study around Q7 in L3. Accessibility over the interconnection between Q7 and the adjacent dipole is limited obliging the interconnecting work to be done prior to the installation of the cryogenic distribution link.

Table 1: Collimators for the upgrade, part 1.

Type	**Orient.**	**To be installed**	**Location**
DS coll.	Hor.	**4**	DS pt.3
TCP (primary)	Ver.	2	LSS pt.3
TCSG (secondary)	Ver.	8	LSS pt.3
TCLP (debris absorber)	Hor.	4	LSS pt.1,5
TCTVA (tertiary), to be confirmed)	Ver.	2	LSS pt.2
Totals		20	

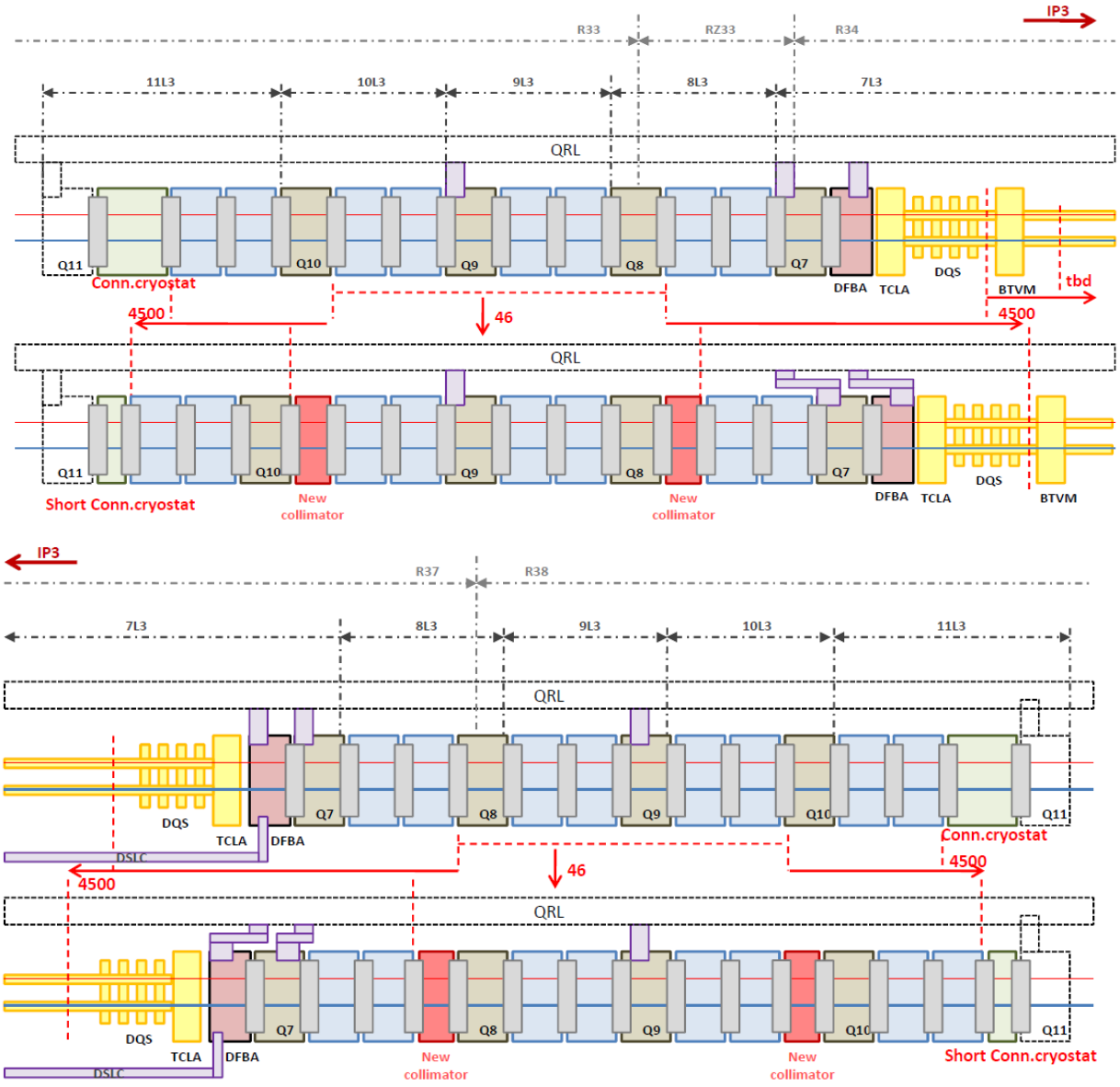

Figure 1. New proposed DS layouts around Pt3.

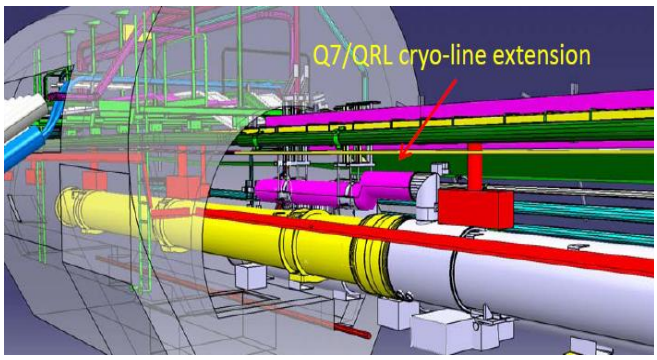

Figure 2: Integration study 3L: cryogenic extension to Q7

A challenging work will be the re-routing of the bundles of several hundreds of cables in the limited space of this zone. The drilling of a new cable duct through the wall between UP33 and R34 is being studied to create a new routing for some of the cables.

The DS collimator assembly (TCL)

The DS collimator assemblies are composed of a cryostat bypass which provides the continuity of the technical systems along the arcs (magnet powering, cryogenics and insulation vacuum), while providing transitions to warm beam tube segments where the collimators are placed (Figure 3).

The cryostat and the collimators are physically two separate entities which allow installation of the cryostat part first whereas the collimators can be installed later.

The two equipments stand on independent supporting systems. The advantage of this approach is double-fold: firstly it allows the continuous cryostat to be completed with the DS cryostat, which enables the test and commissioning of the technical systems in advance (the collimator can be installed later and removed from the cryostat independently in case of need, provided warm beam tubes are installed in its place); secondly, the precise mechanical positioning and adjustment of the collimators is ensured independently from that of the cryostat which is intrinsically less precise and stable due to the large vacuum forces involved. The drawback of this approach is that the integration of the collimator in the reduced space of the cryostat is not easy, in particular due to the presence of the line X cooling tube with its cryostat vessel, positioned in the top part of the center plane of the cryostat. The design of the DS collimator cryostats and collimator module is well advanced and the manufacturing drawings should be released in April 2011.

The long-lead components have been launched; those which are today on the critical path are the bus-bar sets which are being produced at CERN by TE-MSC in a newly set-up facility.

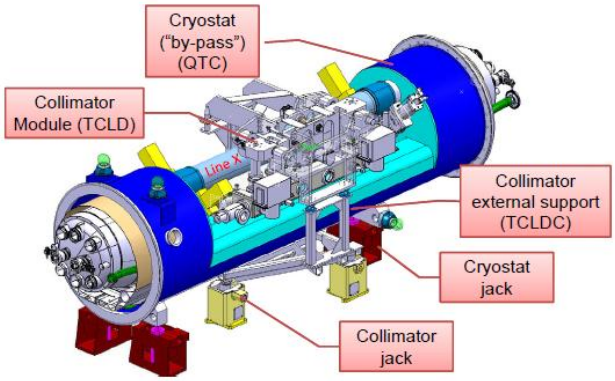

Figure 3: DS collimator assembly

The Short Connection Cryostats (SCC)

The SCC is a shorter version of the existing connection cryostats of the machine, which allows a 4.5-m gain in length in each DS. Due to their shorter length (8 m), their cold mass can be supported on 2 internal supports only, yielding a simpler and mechanically sounder iso-static configuration. The design is essentially based on existing solutions and components, though a major change concerns the design of the bus-bars which will have one lyra box at one side of the cryostat. Most of the components are available except the vacuum vessels for which the procurement is to be launched this year, and the bus-bar sets which are also to be produced by TE-MSC. The design of the SCC is close to final and the manufacturing drawings will be ready by end March 2011.

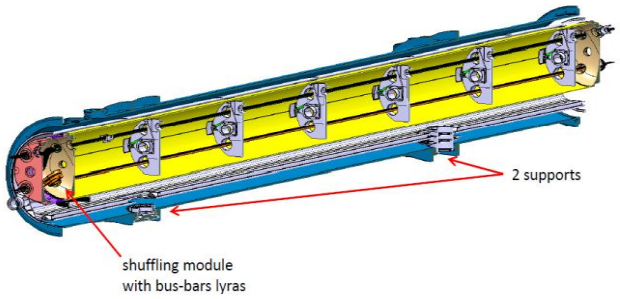

Figure 4: Short Connection Cryostat

SCHEDULES OF SURFACE AND TUNNEL WORK

The preparation of the new equipment is progressing steadily and is aimed at being ready for installation during a long shut-down in 2012. The schedule for the construction of the collimators (based on input given by EN-MME in November 2010) [1], yield availability dates stretching between February 2011 and April 2012, the DS collimators being the latest ones to become available. However, the preparation of the DS collimator cryostats, with their assembly starting in June 2011, will make the first cryostat available starting in March 2012 and the last unit will be available only by December 2012. According to these dates of availability, the provisional tunnel work schedule shows that the shut-down related to the installation of DS collimators in IR3 would not be terminated before September 2013.

The schedule for tunnel work has been elaborated under the following assumptions:

- first estimate of activity durations given by system responsible;
- work on single shifts, with night shifts dedicated to transport;
- 3L and 3R work mostly done in parallel;
- all magnets moved up to surface;
- DFBAs moved and stored in P4;
- re-cabling done by 4 teams;
- no resource sharing with other shutdown activities/projects;
- no sharing of transport with other shut-down activities/projects;
- no co-activity interference;
- no contingency.

These assumptions will have to be checked when elaborating an integrated shut-down schedule.

Under these assumptions, and assuming that the new equipment (DS collimators, SCC, ...) is ready on time for installation, the shut-down activity for the DS collimators project would last at least 8 months. These conditions would typically be those of a 2013 shut-down, for which the installation would take place between February and September 2013.

SUMMARY AND OUTLOOK

The Collimator Upgrade (part 1) project, aimed at improving collimation efficiency (by a factor 5-10), has started in July 2010, is now structured and proceeding full steam. The DS collimators part requires a challenging re-layout and integration study, which is well advanced but with some issues still outstanding (but no show-stopper have been encountered so far).

The design of the new DS equipment (DS collimators, and Short Connection Cryostats) is well advanced, and will be finished by Spring 2011.

The manufacture of bus bars at CERN is in good progress but deserves close follow-up as it is, so far, on the critical path for a shut-down in 2012.Procurement of other long-lead components is under control.

Planned availability dates for installation of the DS collimator cryostats are: 1st unit available in May 2012, 4th unit available in December 2012.

A preliminary schedule for a 2012 shut-down, conditioned by the availability dates of the DS cryostats and SCC, yields a ~12 months installation for the DS collimators (including the installation or the LSS collimators), in the period February 2012 – February 2013. The same schedule shifted to a 2013 shut-down, yields a ~8 months installation, in the period February-September 2013.

This preliminary schedule needs consolidation and matching with those of other shut-down projects (resources allocation, co-activity, transport sharing, etc.) so its duration could result longer.

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REFERENCES

[1] Minutes of the 3rd DS collimators Technical Coordination meeting, November 2010.