R2E STRATEGY AND ACTIVITIES DURING LS1

A. L. Perrot on behalf of the EN/MEF and R2E Mitigation Project teams, CERN, Geneva, Switzerland

Abstract

The level of the flux of hadrons with energy in the multi MeV range expected from the collimation system at Point 7 and from the collisions at the interaction Points 1, 5 and 8 will induce Single Event Errors (SEEs) of the standard electronics present in the equipment located around these Points. Such events would perturb LHC operation. As a consequence, within the framework of the R2E (Radiation to Electronics) Mitigation Project, the sensitive equipment will be shielded or relocated to safer areas.

These mitigation activities will be performed mainly during Long Shutdown 1 (LS1). About 15 groups (including equipment owners) will be involved in these activities with work periods from a few days to several months. Some of them will have to work in parallel in several LHC points. This document presents these mitigation activities with their associated planning, organization process, and main concerns as identified today.

INTRODUCTION

The R2E Mitigation Project assists LHC operation and equipment owners with expert knowledge and assessments of radiation-induced failures in electronics. It is responsible for implementing a mitigation plan to minimise radiation-induced failures in electronics and respectively optimise LHC operation. Within the framework of the R2E Mitigation Project the EN/MEF group is in charge of the relocation and shielding activities integration, planning, and implementation tasks [1].

The level of the flux of hadrons with energy in the multi MeV range expected from the collisions at the interaction Points 1, 5 and 8 and from the collimation system at Point 7 will induce Single Event Errors (SEEs) in the standard electronics present in much of the control equipment. Furthermore, a risk of SEEs induced by thermal neutrons cannot be excluded. Such events would perturb the LHC, possibly leading to a stop of the machine [2-9]. The R2E Mitigation Project foresees shielding or relocating the equipment sensitive to radiation, which is presently installed in these critical areas, into safer areas. The majority of these mitigation activities will be performed in parallel during LS1 in Points 1, 5, 7 and 8 (see Fig. 1). In view of the large amount of work, several activities have already been anticipated and carried-out during the 2011-2012 winter shutdown.

This document reports on these mitigation activities and their associated foreseen improvements. It presents the planning, organization process, and main concerns about the R2E mitigation activities to be performed during LS1.

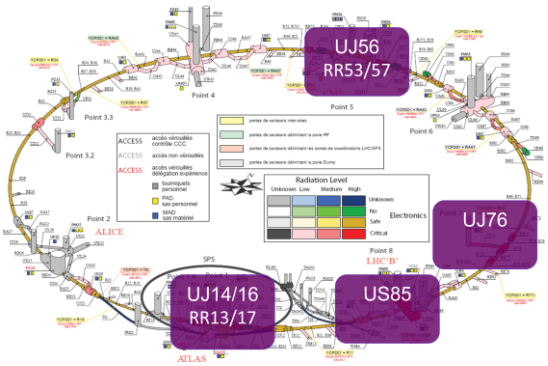


Figure 1: LHC critical areas considered by the R2E Mitigation Project.

MITIGATION ACTIVITIES

The main critical areas in terms of hadron fluence / SEEs considered today within the framework of the R2E Mitigation Project are the UJ14/16, UJ56, UJ76, US85, RR13/17 and RR53/57. Sensitive equipment located in these areas will have to be relocated or protected by new shielding walls [10]. Equipment that can neither be relocated nor be sufficiently shielded has to be developed to be radiation tolerant.

During the 2011-2012 Winter Shutdown

Several activities were carried-out during the 2011-2012 winter shutdown to ensure safe LHC operation in 2012. Others were anticipated to reduce the amount of activities foreseen during LS1. In Point 1, new shielding walls were installed in the RBs and UJs [11] (see Fig. 2-4). The smoke air sampling detectors (analyzing units) located in the UJs14/16 and RRs13/17 were relocated in the US15 [12]. In Points 4 and 6, sensitive cryogenics PLC CPUs were relocated from the UX to one of the ULs (see Fig. 7).

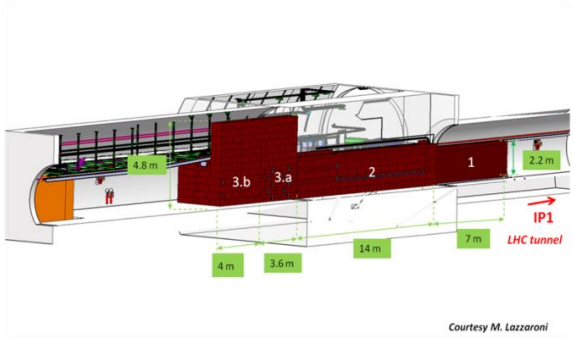


Figure 2: Shielding walls installed in the RBs and UJs.

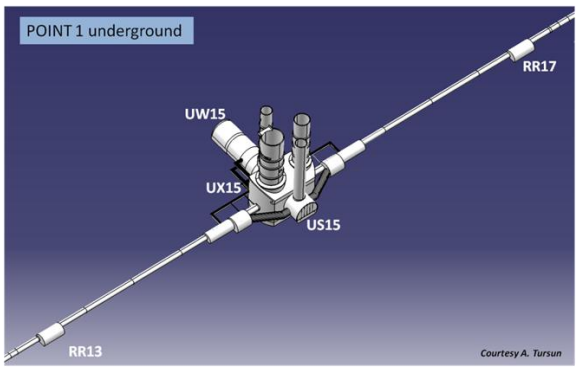


Figure 3: Point 1 underground – general view

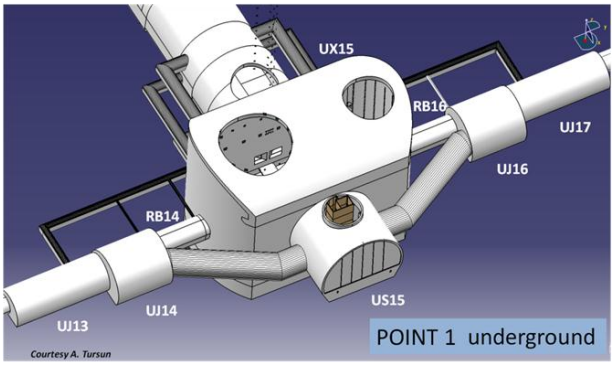


Figure 4: Point 1 underground – zoom

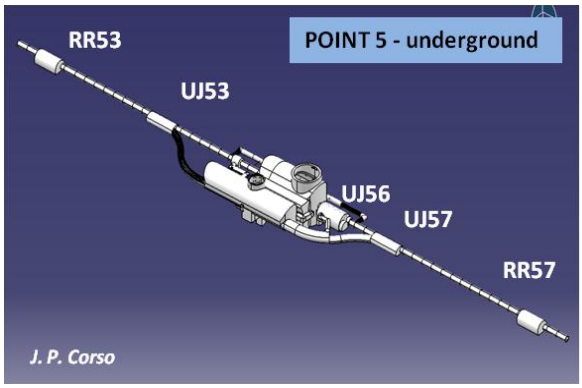


Figure 5: Point 5 underground - general view

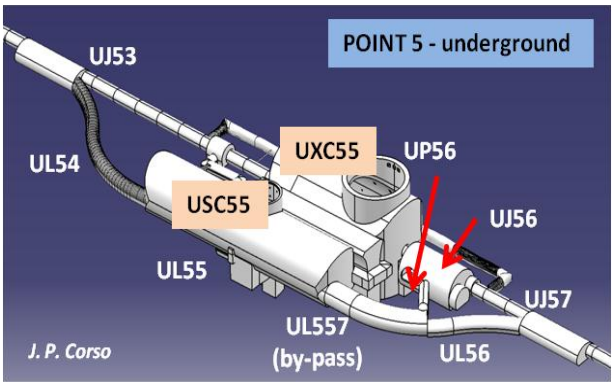


Figure 6: Point 5 underground - zoom

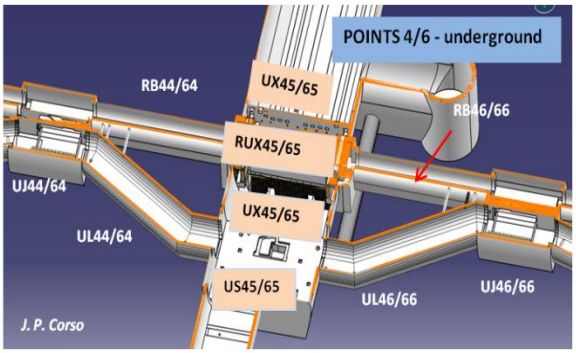


Figure 7: Points 4/6 underground - general view

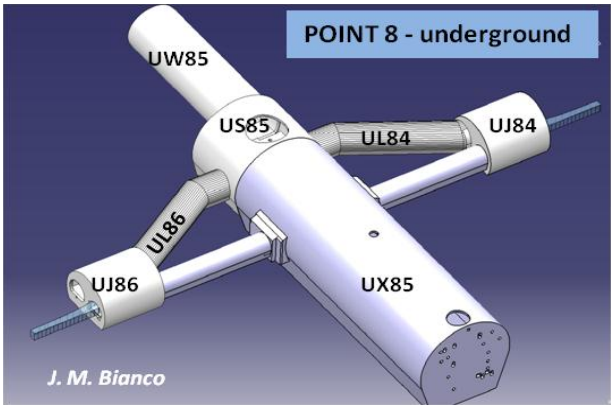
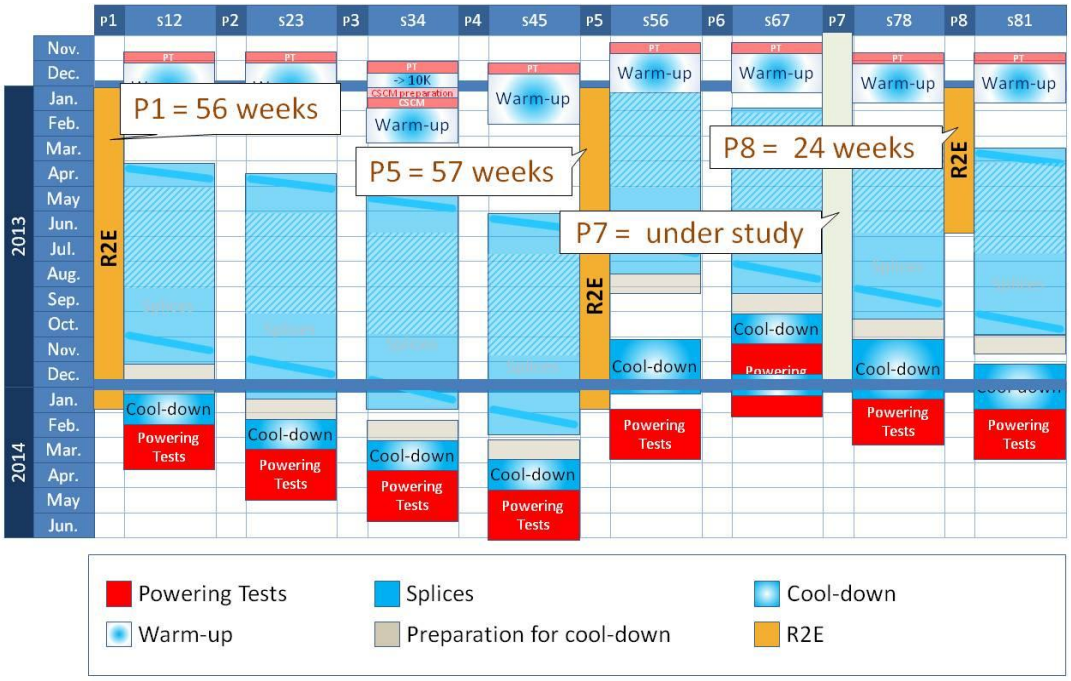


Figure 8: Point 8 underground - general view



Courtesy M. Barberan, K. Foraz

Figure 9: LS1 schedule of the R2E activities.

In Point 5, part of the civil engineering activities in the UL557 (ducts to allow a passage for cables and pipes) were anticipated, UPS units and PIC electronics located in the UJ56 were relocated respectively in the by-pass and USC55 (see Fig. 5 and 6).

In Point 8, the QURCb, the QURA and the Ethernet *star-point* located in US85 were relocated on the ground floor of US85 and in ULs 84/86 (see Fig. 8). The WIC and timing racks were relocated from the 2nd floor of US85 to UA83.

Without these mitigation actions and equipment software and hardware upgrades the expected number of beam dumps (extrapolated from the measurements taken during the 2011 runs) would have been about 200. This number is now expected to be 30-50 [13].

During LS1

The major part of the R2E mitigation activities will be performed during LS1. Ten groups will be involved in the activities in Point 1: they will relocate 15 racks and 2 power converters and replace the existing concrete shielding wall in the RRs by a cast iron wall. Similarly, twelve groups will work in Point 5: they will relocate 35 racks and 2 power converters, and replace the existing concrete shielding wall in the RRs by a cast iron wall. In Point 7, 11 groups will work to relocate 40 racks. Seven groups will be involved in the activities in Point 8: they will relocate the remaining 2 UPSs, 4 racks and 24 valve positioners. An additional shielding wall will be installed on the ground floor of US85. Civil engineering works are foreseen in Points 5 and 7. Ducts will be drilled between the machine and UJ56 and between UJ56 and UL557 for cable and pipe passages. The TZ76 separating wall will be demolished in TZ76 to provide space for the relocated racks and future equipment (to be installed during LS2).

These mitigation activities and equipment software and hardware upgrades are expected to reduce the number of beam dumps (extrapolated from the measurements taken during the 2011 runs) from about 600 to less than 20 [14].

R2E ACTIVITIES SCHEDULE

The planning of the R2E activities for LS1 is available today for Points 1, 5 and 8 [15]. It is under study for Point 7. 56 weeks of activities are foreseen in Point 1, 57 weeks in Point 5 and 24 weeks in Point 8. The activities in Point 5 are scheduled with 2 shifts per day for the EN-EL and the civil engineering teams. The activity in Point 8 is small in comparison to the other points since a lot of work has already been anticipated during the previous winter shutdowns and technical stops (2010 to 2012). The present LS1 LHC schedule skeleton shows that the R2E activities will delay by a few weeks the cool-down in Sector 81 and in Sector 56 (see Fig. 9). The amount of work to be carried out by EN-EL and EN-CV for R2E is considerable: between 36 to 42 weeks are foreseen per point for EN/EL and between 14 to 31 weeks per point for EN/CV.

ORGANIZATION

Process Towards LS1 Installation

The present goal is to finish the integration and planning studies by the end of March 2012. This implies all the new rack and equipment locations being defined, all the corresponding activities identified and all works sequences defined. Activities will then be focused on finalising the schedule, procuring material and writing documentation.

Starting in April 2012, the EN-MEF-LPC team will merge the R2E LS1 planning with the overall LHC LS1 activities planning. The estimate of the real intervention slots for each group should then become available, effectively allowing the teams to finalise their manpower requests during the summer of 2012.

All the material requests will be identified by the end of March 2012. In April all the remaining contracts and material orders will be launched respecting delivery deadlines to ensure installation in due time. Starting in April 2012, a follow-up of the material delivery will be performed in the 'R2E shielding and relocation meetings' held every 2 weeks.

A major effort on documentation will start in April 2012 (ECRs, Safety documentation, installation procedures and installation drawings). All the documentation should be written by autumn 2012.

Critical Points During LS1

In view of the tight planning with respect to the non R2E activities, the main challenge will be to avoid delays during the material procurement and installation periods. For this purpose, equipment owners and service teams will have to ensure the strict follow-up of the material procurement with weekly reports to R2E Mitigation Project colleagues. An occupancy planning of the temporary storage areas (located in surface and underground) will have to be performed to allow a continuous flow of material towards its installation location. Intermediate survey scans and cross-checks with the 3D models of the LHC integration will have to be performed to avoid installation nonconformities. In view of the space constraints, it is clear that equipment not installed in the foreseen location will have to be removed and re-installed. The detailed installation planning with its critical path will have to be updated weekly to understand the impact generated on or by the non-R2E works.

MAIN CONCERNS

The integration of Point 7 is still under study. The main issue concerns relocating EN/EL equipment currently installed in the UJ76 safe room. A solution for the stand-alone fire-proof racks is being studied: it remains to be agreed between EN/EL and DGS/SEE to allow its implementation. Space constraint in TZ76, and in particular at the UJ/TZ76 junction, is a major issue. Once the equipment relocation foreseen within the R2E framework will be carried out, the passage of cables between the UJ and TZ will not be possible anymore. Future installation of new equipment after LS1 in TZ76 will most likely require civil engineering activities to allow passage of cables from the machine tunnel to TZ76.

Five design offices (GS/SE, EN/CV, EN/EL, EN/HE and EN/MEF) are involved in the R2E integration studies. A synergy and simultaneous effort of these design offices is necessary to finish the integration study of Point 7 by the end of March 2012. This integration study is mandatory to finalise the planning study to then go ahead with the rest of the relocation project process.

To be ready for LS1, all the needs should be identified and the remaining orders launched.

The services teams and equipment owners still have to finalise their manpower requests for R2E activities. For this purpose they need to have a clear idea of the tasks to be performed by their teams simultaneously in the different LHC points for the different projects. This will be done once the R2E and non-R2E activities have been merged together in a single planning.

A daily supervision of the works in-situ is needed to solve any problems as and when they occur to avoid delays in the implementation. To ensure this supervision, additional support in terms of manpower is needed. Three FTEs are necessary. Ideally they would start working part-time in the summer of 2012. An initial discussion was held with BE/OP colleagues who might be able to provide such manpower.

SUMMARY

The R2E relocation and shielding activities will be carried out by 15 groups working in parallel in Points 1, 5, 7 and 8. The intervention period in Point 5 is currently estimated to be the most important with 57 weeks and work to be performed in 2 shifts per day by the EN/EL and civil engineering teams. The amount of work to be performed by EN/EL and EN/CV within the framework of the R2E Mitigation Project is considerable. An agreement between EN/EL and DGS/SEE on the proposed solution for the relocation of EN/EL equipment today located in the UJ76 safe room to be relocated in TZ76 is needed. This is a driving factor for the relocation project process. Without it, the integration and planning studies of Point 7 cannot be completed: this could lead to possible delays in the overall organization process. In view of the considerable amount of work today estimated for the R2E activities, a daily supervision of the works in-situ is needed during LS1. It will help to solve any problems as and when they occur, thus avoiding delays. To ensure this supervision, additional support in terms of manpower is needed.

ACKNOWLEDGEMENTS

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