

170th meeting of the LHC Collimation Working Group 3rd February 2014

Present: R. Bruce [chairperson], G. Valentino [scientific secretary], O. Aberle, A. Bertarelli, C. Boccard, F. Carra, L. Gentini, P. Gradassi, L. Lari, R. Losito, T. Markiewicz, A. Marsili, D. Mirarchi, E. Quaranta, S. Redaelli, B. Salvachua, C. Tambasco.

Indico link

1 Overview of LS1 collimation project activities (S. Redaelli)

- S. Redaelli reminded that important upgrades are being made to the LHC collimation system during LS1. The main hardware activities include the new collimators with embedded BPMs, improved TCL layouts in IR1 and IR5, and additional passive absorbers in IR3. Other important works include an improved IR8 layout, control changes and the crystal collimation experiment in IR7.
- S. Redaelli suggested that each topic should be discussed in future collimation working group meetings, and mentioned that the following Monday, a joint meeting with the injection and dump teams to review the LS1 changes affected machine protection will be held.
- S. Redaelli presented an updated list of collimators for post-LS1 operation. A total of 29 collimators will be installed, and the system will grow to 118 collimator devices, from the 108 devices in Run 1. In addition, 3 TCPs will be temporarily removed and re-installed in the same slots. The project is on a good track to achieve all the LS1 objectives set in 2012.
- The ongoing LS1 collimation activities include the upgrade of the 16 TCTs in all IRs and of the TCSG in IP6 with the new embedded BPM design. The two CFC TCSGPs (+ 1 spare) are produced in house by EN/MME, while the 16 TCTPs (+ 4 spare) are produced externally. In addition, 2 new passive absorbers will be installed in front of Q5 in IR3 to improve the MQW lifetime (both produced in house by EN/MME). The physics debris collimators (TCLs) in IR1 and IR5 will be upgraded to include TCLs in cell 4 after the removal of the TOTEM Roman pot stations, and the cleaning will be improved further with TCLs in cell 6. Finally, the 2-in-1 TCTVBs in IR8 will be replaced by the single-beam TCTPs to improve the vacuum layout. All the activities are documented on the LS1 collimation activity webpage.
- Other LS1 activities include the upgrade of the ventilation system in IR7 (coor-

minated by I. Efthymiopoulos), the upgrade of the powering configuration of the IR7 warm quadrupoles (coordinated by P. Fessia), and the crystal collimation tests.

- Several activities were postponed or cancelled. The installation of new TCLA absorbers in IR6 were postponed, as they were shown not needed for post-LS1 operation based on updated energy deposition studies. The TDI consolidation (replacing the TDI with several collimators) was discontinued for LS1, and is outside the responsibility of the collimation project. The Tevatron hollow e-lens will not be installed during LS1 in the LHC for MD purposes, and currently work is ongoing on a design report for earliest action in LS2.
- The new collimators with integrated BPMs will drastically reduce the alignment time, therefore providing more flexibility in the IR configurations. The reduced setup error margins will lead to an increased β^* reach. S. Redaelli commented that the first 2 TCTPs arrived from CINEL (the external company) 10 days ago.
- The new passive absorbers in IR3 were introduced following the operational experience in 2011, where a significant fraction of the yearly losses occurred in IR3. These collimators will reduce the losses in the first Q5 MQW by a factor 2, and the losses in the most exposed MQW module of Q5 by 30%.
- S. Redaelli reminded the TCL layout in IR1 and IR5, and recalled that in Run 1, only the TCL5 was used. The TCL4 is already installed in both IRs, and will provide better cleaning than the single TCL5, as well as allowing the operation of the forward physics detectors by opening the TCL5 in high intensity fills. S. Redaelli mentioned that the simulation studies (L. Esposito) for the installation of the TCL6 were presented at the 168th meeting of the collimation working group, and the TCL6s are expected to reduce losses in the dispersion suppressor by a factor 100, and provide flexibility for future upgrades of the forward physics programme. The final decision of the TCL setup will be taken in the next couple of weeks. A. Bertarelli asked where the Roman pots are located. S. Redaelli replied that there are several, and the current plan is to add 4-6 pots between Q5 and Q6. The station in Q4 will be removed.
- The crystal collimation has been approved for installation in the LHC for tests. The goal is to demonstrate the feasibility of the crystal collimation concept with the LHC beam and layout conditions, and achieve an improvement in the cleaning efficiency by a factor 5-10. The setup for post-LS1 will include one goniometer per plane in IR7 of B1. The existing collimators will be used as absorbers.

- S. Redaelli discussed several other ongoing activities. A consolidated temperature acquisition system is being developed, the controls infrastructure is being updated, and 2 TCSM slots for the installation of a new TCSx collimator with BPMs during the 2015 Christmas stop. S. Redaelli pointed out that there are 30 TCSM slots, which should be ready to use at any time, and asked O. Aberle to look into whether they are ready for a quick installation if required. In addition, regular maintenance is being performed, and the issue with the collimator screws is being followed up.
- There is also work ongoing outside the tunnel. The SLAC rotatable collimator was received at CERN in November 2013, and a dedicated control test stand on surface will be used to perform vacuum compatibility, positioning accuracy and impedance tests. A second test stand is being set up by A. Masi's team for the TCTP prototype, with the objective of testing the complete control chain. In addition, a third control test stand will remain operational with the old collimator. Other ongoing studies include the preparation of the HRM2 tests, the design and prototype of the TCSX collimators, and the finalization of the TCLD design.

2 Status of external production (TCTP) (O. Aberle)

- O. Aberle presented a list of all the collimators that will be produced and replaced in LS1. A total of 16 (+ 4 spare) TCTPs, 2 (+ 1 spare) TCSPs and 2 (+ 1 spare) TCAPDs will be produced. In addition, 2 spare TCLPs and 1 spare TCP will be prepared. Due to the layout modification in IR8, where the 2 two-beam TCTVBs will be removed, the nearby TCLIA will be shifted. Three TCPs in left of IR7 and one in right of IR7 will be temporarily removed for the ventilation door installation, to prevent damage. The skew TCP in IR7 B1, for which temperature issues were observed, will be replaced. Four of the old TCTs will be moved to IR1/IR5 to act as TCL6 collimators.
- S. Redaelli asked if there are any plans for on-surface recommissioning of the 4 TCPs that will be temporarily removed from the tunnel. O. Aberle replied that the screws will be checked, and two of the collimators have been opened and will be then baked out for vacuum. Due to lack of manpower resources in the vacuum group, the other two collimators will be kept closed. The mechanical plane and torque have been re-measured, and the screws have been replaced where necessary and regreased. S. Redaelli commented that when the work is completed, the operational database should be updated. O. Aberle mentioned that the old structure of MTF is still used, and extra steps will be added for this. The screws will be analysed from the material side: a completely new screw, a new Phase I screw and a screw recovered from the tunnel and reconditioned will be tested via cycles.

- O. Aberle recalled that for the external production of the TCTPs, a contract was signed in 2012 with a French company for 20 collimators (16 for installation, 1 pre-series and 3 spares). They performed mainly qualification (e.g. brazing, welding), while the machining and assembly work was subcontracted to an Italian company (CECOM). The French company was in difficulties at the end of 2012 due to the financial crisis, and pulled out of the contract. A new contract was signed in the beginning of 2013 with CINEL to supply the vacuum tanks and the jaws, while CERN would deliver the mechanical tables which would arrive from CECOM.
- O. Aberle presented the production schedule, with the installation dates provided by J. Coupard and the promised delivery dates from CINEL and CECOM. The overall progress is good, with the first two TCTPs delivered at CERN on 22.01.2014. It is foreseen that 4 TCTPs will arrive at CERN every month, and they will all be delivered by mid-June 2014. The TCTPs that have arrived are currently undergoing vacuum tests. If the tests are successful, the full production sequence will be approved. The metrology and BPM measurements have already been performed. O. Aberle is confident that the target delivery dates can be achieved, as the jaws have already all been produced in advance by the company, at a rate of approximately 1 jaw per day.
- O. Aberle mentioned that a virtual leak (topic on the DN 60 flange) was detected during bake-out for one of the TCSP. Possible modifications that may be required are currently being evaluated. R. Losito asked whether the flange is located on the tank. O. Aberle replied that it is the lateral flange on the tank (one of the feedthroughs), and collects the BPM and temperature signals. No issues were noticed for the other TCSP.
- S. Redaelli commented that there is a very relevant failure rate in terms of leakage (20%). O. Aberle replied that a leak was found for 1 flange at CERN as well as another flange at CINEL. The next step is to determine the origin and see whether the leak is due to the brazing, welding or from mechanical damage. The components were successfully tested before by the producer and by CERN, but during the assembly and bake-out work, the leaks were detected. C. Boccard has re-ordered new flanges with a modification for a connecting outgassing hole, and the leaking ones will be sent back to the producer for repair. However, there could be a shortage of spare parts if the rate of issues remains the same.
- S. Redaelli asked whether it is sure that the modification will result in no additional issues. C. Boccard replied that the procedure should be quite straightforward. S. Redaelli asked whether there is need to retrofit the change on collimators which have been already approved. C. Boccard pointed out that if the cable is removed and put back more than 2-3 times, it becomes difficult to unscrew.

O. Aberle mentioned that there was a similar problem with the RF fingers for the bake-out. The more vacuum cycles, the smaller the chance that it can be screwed back successfully. F. Carra commented it is not yet sure that this is the only source of the outgassing, and the validated TCSP should not be opened unless there are very strong motivations.

- R. Bruce asked about the status of the ferrites, as heat treatment had rendered them discoloured and brittle. O. Aberle mentioned that there was one batch of ferrites for which this behaviour was observed. The ferrites were checked one by one, and separated into two groups depending on whether they had any defects. Then, a light machining was done by hand to remove the edges to avoid that there are any loose particles. Vacuum tests as well as RF measurements were done for impedance, and the acceptance has been given. However, there are not enough ferrites, and so more have been ordered. The heat treatment will be done at another company. This issue is only affecting the spares, and not the installation schedule.

3 Status of MME production (TCSP and TCAPD) (F. Carra)

- F. Carra provided a status update on the in-house production of the TCSP and TCAPD collimators.
- F. Carra reminded that the objective was to deliver two TCAPDs to EN/STI by the end of 2013. There was a 2-month delay in the procurement of the raw material (copper), but this delay was almost entirely absorbed thanks to a crash program. Hence, the two TCAPDs were completed on 16.01.2014, including machining, welding, metrology and final mechanical assembly of the support structures. The TCAPDs have now been moved to bat. 272 (EN/STI) for the final tests. S. Redaelli asked whether spares are needed for the TCAPDs. O. Aberle replied that the risk of failure is not very high.
- Three TCSP collimators were produced (2 for installation + 1 spare). There were delays due to high outgassing rates in the BPM cables. The problem was solved by the supplier with the help of CERN experts, but the cables arrived in the MME group only in September 2013. The collimators were then ready for EN/STI by the third week of November. EN/STI is currently performing the final operations, and the bake-out should be completed by mid-January.
- F. Carra mentioned that vacuum issues (high outgassing rate) were discovered 10 days ago for the second TCSP, where air was trapped inside and therefore not compliant with the LHC vacuum specifications. The air is possibly trapped when the connector is screwed. The issue could be solved by a very long bake-out. The outgassing rate was decreased by a factor 10 between the 2nd and 3rd vacuum

test, and it was concluded that a bake-out length of 10-20 standard bake-outs would be required. Another option would be to create a groove using elector-erosion cutting on the BPM connector, if this is the source of the outgassing issue.

- The third TCSP is now being vacuum-tested, and if the test is successful it will possibly replace the second TCSP. A BPM flange had to be replaced due to a leak. In parallel, the vacuum tests on the second TCSP are ongoing.
- R. Bruce asked when the TCSPs are scheduled for installation. O. Aberle replied that the installation date was last week, and will need to be rescheduled. A. Bertarelli asked whether it would be better to modify one of flanges, test it and then confirm the modification of all flanges, or go on anyway with the production of the TCTPs. If the flange is the source of the issue, then one would need to modify all the flanges which are currently in the pipeline for the TCTPs. The modification, re-installation and additional pumping will take several weeks. O. Aberle commented that CINEL has already been informed about the issue, however no guidelines have been provided as to what action should be taken. Four tanks have been assembled as of now. The third and fourth tanks will be closed next week.
- C. Boccard pointed out that the modification should be performed. In a first step, the modification will be done on the flanges at CERN, and verify that it does not destroy the electrical parameters. Then, CINEL should be informed. B. Salvachua asked how long it would take to perform the electrical test. C. Boccard replied that the test duration would be determined at the end of this week after the availabilities are assessed. The longest test would be the vacuum test. L. Gentini commented that a couple of days would be needed for the machining. A. Bertarelli asked how many flanges will be modified. C. Boccard replied that all spares are at CINEL. A. Bertarelli commented that during the modification, one should assume that there will be losses. One should not risk losing some of the flanges.
- F. Carra asked what is being done with the second TCSP, which is on the vacuum test bench. O. Aberle replied that the flanges will be modified, cleaned, remounted and re-tested without testing the flanges themselves, to gain time. C. Boccard mentioned that there are two prototype flanges, and these could be already modified to validate the machining and cleaning procedures, and then machine the real flanges.
- R. Bruce asked what is the time estimate for the repair per collimator. A. Bertarelli replied that the machining itself should not take more than 2 days, but the re-pumping will be the bottleneck. S. Redaelli mentioned that there should

be a wrap-up meeting on Thursday after the vacuum results arrive. Ideally, there would be both TCSPs ready (1 and 3). If the TCSP3 also has a problem, then the modification would need to be done as quickly as possible. O. Aberle commented that the more time is taken for the modifications on the TCSPs, the more the TCTP schedule is delayed. S. Redaelli pointed out that we should try not to accumulate much delay for IR6 as there would be pressure from the kicker team to close the vacuum.

Next meeting

- The next meeting will be held on the 17.02.2014.