66th Meeting of the HL-LHC Technical Coordination Committee – 06/02/2019

Participants:, G. Arduini, V. Baglin, M. Bajko, O. Brüning (chair), H. Burkhardt, S. Claudet, D. Delikaris, R. De Maria, B. Delille, P. Fessia, H. Garcia Gavela, R. Jones, H. Mainaud Durand, P. Martinez Urios, M. Martino, R. Martins, P. Martinez Urios, M. Modena, Y. Papaphilippou, A. Perin, M. Pojer, F. Rodriguez Mateos, L. Rossi, F. Sanchez Galan, J. Serrano, L. Tavian, J. P. Tock, R. Tomas, D. Wollmann, S. Yammine, M. Zerlauth.
Excused: A. Apollonio.

The slides of all presentations can be found on the website and Indico pages of the TCC.

After a review of today's agenda, the decisions of the last meeting where reviewed, namely the endorsement of the location of the 200 A and 120 A corrector packages' power convertors and the modification of the technical galleries and building interfaces at Point 1 and 5. A summary of open actions was also presented and proposals will be made for treating them during the next TCCs. O. Brüning noted that for better coordination, future WP presentations in the PSM will be as of now preceded by a short technical update of the WP in a prior TCC. In this respect, the PSM will mainly focus on budget and planning aspects.

IT-STRING configuration and options (Review action follow-up) – M. Bajko - slides

M. Bajko reviewed the different configurations of the STRING considered during the review and compared to the baseline, in particular for budget and planning. The STRING baseline includes all magnets from D1 to Q1 including the service module and corrector packages, the corresponding electrical circuit with associated PCs, but not the beam screen and associated instrumentation. This change requires an ECR which will be soon launched. O. Brüning reminded the action triggered by a question of G. Arduini, for the possibility to include the beam screen in the stand-alone magnets. M. Bajko answers positively. O. Brüning suggests that discussions should take place between WP2, WP3, vacuum and cryogenics, in order to include in the ECR the associated measurements and necessary resources.
The configuration option without Q1 increases the cost by 110 kCHF due to the additional work for the service module with phase separators and end cover on Q2a, including installation and manpower. The configuration options without Q3 or Q2a/ Q2b are almost cost neutral. It is stressed though that missing any of the main triplet magnet has a major implication in the validation of the quench detection and overall circuit topology. For a configuration option with two missing triplet magnets, apart from the extra cost of around 30 kCHF, the configuration is degraded extensively, penalizing completely the validity of the STRING test. The configuration without corrector packages (CP) will incur an additional cost of 125 kCHF. This configuration excludes however the testing of the 2 kA energy extraction system for the corrector magnets and EM coupling during fast power aborts on other circuits. The configuration without D1 has an important extra cost of 175 kCHF due to the modification of the Q3 extremity and connection to the DFX. An additional modification will be needed for getting back the configuration compatible with the layout in the tunnel. The configuration without D1 and CP has a big cost increase of more than 500 kCHF.

The possibility of cooling the STRING to only 80 K was studied by A. Perin with two possible options. M. Bajko made preliminary estimates for the additional cost, which sums up to a total of 2.4 MCHF. The validation of electrical circuits, quench detection, protection, electromagnetic coupling and even alignment issues cannot be studied in such configuration in a representative way however.
Following the question of O. Brüning regarding the cost of the test at 2 K, M. Bajko replies that it is 7.4 MCHF (with a non-approved extra cost of 1 MCHF), which means that there is a reduction of around 4 MCHF for a test at 80 K. She stresses though that this test is not appealing for most teams. She clarifies also that personnel costs are not included but the saving for this aspect is negligible. A summary of all the configurations is given. It is again pointed out that options with one of the last three magnets (Q2a, Q2b or Q3) missing from STRING could be considered but always with an extra cost associated to such a modification.
Regarding savings, the decision of removing the beam screen from the STRING reduces the cost by 749 kCHF directly from WP12 and vacuum, and 30 kCHF for the reduction in the cryogenics instrumentation. A very complete EDMS document has been prepared with the initial plan, alternative configurations and the retained solution. The second savings' option is regarding the non-refurbishment of the old compressor, which allows for a reduction of 200 kCHF linked to the cold compressor. A schematic with the number of tests versus time and the required cooling flow is presented. Reinforcing the STRING with an extra compressor implies the possibility to run up to 12 g/s, whereas with one compressor the pumping is reduced by half to 6 g/s. This can still be acceptable with some extra effort on organization and optimization of the tests, considering the detail magnet arrival schedule. A. Perin agrees that with continuous coordination the situation can be improved. M. Bajko comments that if the cold compressor is put in line with one pumping unit, this is in favor of STRING, but, at the same time, the test stand and RF will lose in their capacity. A. Perin adds that it is difficult and time-consuming to switch back and forth from one to the other system. The cost saving is moderate (200 kCHF) but it is also one year less of work. The third potential saving concerns the warm powering (around 250 kCHF). In this respect, the final design of connections between current leads and power converters has to be confirmed. In summary, the cost reduction associated to the removal of BS and cold compressor is around 1 MCHF. In this respect, the non-accepted budget of 7.4 MCHF is brought again back to the approved sum of 6.4 MCHF.
A number of changes were also implemented in the planning, in particular adapting the work and arrival of several components following the delay for the arrival of the US magnets. The number of quenches during the test campaign was reduced by 40%, as all the magnets are connected in series and will quench at the same time, thereby not following the initial plan of individual magnet quenches. The time for ELQA work but also for cooling/warming and studies were further revised. This is still work in progress and can be further optimised, when the arrival dates of the US magnets are better known. L. Rossi agrees that it is not useful at this point have a fully detailed planning with this level of uncertainty. He reminds that today there is not even one working long prototype, therefore the schedule can be re-assessed in the future. O. Brüning adds that the decision of the review is to try and fit the test in 1 year, although presently this seems to be estimated to 20 months (end of October 2023). M. Pojer comments that the 2nd thermal cycle will most likely not be necessary, due to the fact that the magnets have good memory, as pointed out during the review. This can reduce the test plan by 5-6 months. M. Martino adds that some further optimization can be achieved with respect to the schedule also from the point of view of warm powering. L. Rossi thanks all the people involved and proposes to endorse the conclusions of the STRING review. It would be useful to prepare an EDMS document with the underlying reasoning and also provide it to the reviewers. M. Bajko answers that interface documents are written for components and budget. Following the question of B. Delille, M. Bajko answers that the Q2a prototype is

expected during this year. L. Rossi points out that there is indeed uncertainty not only for the US magnets but also for the ones in house.

DECISION: The TCC endorses the proposal to maintain the magnet configuration baseline of the STRING test and not to pursue the 80 K test option. It further endorses the proposal to modify the baseline of the STRING test by removing the beam screen and one cold compressor. The TCC encourages the optimisation of the planning in order to reduce it to the level of the STRING review proposal (1 year).

AOB: Cold diodes for baseline of HL-LHC IT – D. Wollmann, slides

D. Wollmann presents the irradiation studies in the CHARM facility of three different cold diode types, intended to be used as bypass diodes for the HL-LHC IT string. The tests finished in November 2018 with an accumulated dose of around 11 kGy (lower than the target) and an accumulated fluence of 2.3e14 1MeVneq/cm^2 (achieving the target), followed by annealing tests in December 2018. The estimated radiation levels in the tunnel show a steep increase from 10 to 350 kGy depending on the final positioning of the diode, whereas the fluence remains to 2e14 1MeV neutron equivalent per cm^2. Following a comment by O. Brüning, D. Wollmann answers that the attractive positions are located where both the integrated does and fluence curves are rather flat, at around 83 m from the IP. Some preliminary data is shown for the forward voltage as function of neutron fluence and for the three different type of diodes (LHC reference, thin base and very thin base one). There is a continuous increase of the voltage by up to 40-80% as a function of the increased radiation. Annealing reduces the voltage increase to around 25-50%. Following a question by L. Rossi, D. Wollmann replies that two thermal cycles were performed, but the second one does not essentially change the final voltage. He further adds that the model predicts the linear behavior for high neutron fluences. At lower fluence, there is a non-linear behavior which is shorter for LHC type of diodes, whereas the non-linear part is longer for the thin base diodes. R. Garcia Alia explains that the previous experiments did not reach similarly high fluence (i.e. they corresponded to one order of magnitude lower fluence) in order to exhibit the now clearly observed linear behavior. Based on these results, D. Wollmann asks the TCC to endorse the proposal for using cold diodes as baseline for point 1 and 5. There is still some internal discussion for the selection of the exact type of diode but from the present results, all diodes seem compatible. Following the question of L. Rossi, D. Wollmann answers that the costs of the different diodes is very similar and the final choice will depend on robustness, experience levels and the circuit requirements. He adds that there is a lot of experience with LHC diodes but not with the other types. It is recommended to review all implications with WP3 and the circuits (DFX). F. Rodriguez Mateos points out that the global circuit ECR has to be modified in order to include the diodes as the baseline and not as an option. O. Brüning encourages to continue the studies and come back to the TCC to report the progress.

DECISION: The TCC endorses the proposal of using cold diodes as the baseline for the HL-LHC IT in IP1 and 5. The final decision for the exact type of diodes will be taken, pending further design optimisation and integration studies.

AOB: Responsibilities for HL-BPM integration – R. Jones, slides

R. Jones' presentation is a follow-up from the TCC of 15th of November 2018, where WP13 made a proposal for the responsibilities on the cryogenic BPM integration, shared by WP13 (BE-BI), WP12 (TE-VSC), WP3 (TE-MSC) and WP15. A memorandum is in preparation in order to detail the various responsibilities. A schematic of the location of the cryogenic BPMs in the triplet area is given which now includes the BPMs of D2. In the memorandum, it is explained that WP13 is responsible for cable design, procurement and installation, with the integration performed by WP3. The deliverables of WP12 are still under discussion and include connection tubes and welds (with cost sharing) and final leak tests and conditioning. The deliverables of WP3 include the integration into the service module and delivery of a complete mock-up of the service module to test the final integration and installation. WP15 is responsible for survey and alignment. A detailed sequence of the works was defined and integrated in the final memo, which will shortly be circulated for comments. O. Brüning asks who is doing the final system check out and who is the equipment owner. R. Jones answers that WP13 is the HW owner, but WP12 is responsible for the final vacuum testing. The RF tests are done by BI. B. Delille asks if it is possible to simplify the procedure and instead of sharing the cost to transfer the budget for the welds from WP13 to WP12. L. Rossi agrees with the proposal. R. Jones clarifies that the integration is the full responsibility of WP3. WP12 is responsible for the welding on the beam screen and the drawings related to space requirements for welding machines are sent to WP3 for the integration. L. Rossi concludes that the WU should reflect that this is indeed work for WP13 and asks R. Jones to update the budget proposal and present it in the PSM.

The next TCC meeting will take place on the 14th of February 2019.