24th Meeting of the HL-LHC Technical Coordination Committee

Participants: C. Adorisio, A. Apollonio, A. Ballarino, O. Brüning (chair), O. Capatina, E. Coulinge, D. Delikaris P. Fessia, C. Gaignant, H. Garcia Gavela, J. Gascon, J. Jowett, H. Mainaud Durand, M. Martino, V. Parma, M. Pojer, S. Redaelli, L. Rossi, L. Tavian, J. P. Tock, R. Tomas Garcia, D. Widegren, D. Wollmann, M. Zerlauth.

Excused: G. Arduini, R. De Maria, M. Giovannozzi, F. Rodriguez Mateos, E. Todesco.

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

HL-LHC TCC homepage: https://espace.cern.ch/HiLumi/TCC/Default/Home.aspx

Indico link: https://indico.cern.ch/event/590398/

O. Brüning announced that the minutes of the 22nd HL-LHC are not ready yet, they will be distributed as soon as possible. He then recalled the action from the 23rd HL-LHC TCC, concerning the report on the readiness of the LRBB hardware for 2017 operation (A. Rossi). The minutes were approved.

L. Rossi introduced Christelle Gaignant, the deputy safety officer of the BE department, who joined the HL-LHC project as deputy project safety officer, particularly for WPs in which the BE department has the lead (WP2, WP4, WP5, WP13).

Summary of HL-LHC session in Chamonix and CMAC recommendations (D. Wollmann - slides)

D. Wollmann recalled the discussions from the HL-LHC session of the Chamonix workshop. The first presentation by Y. Papaphilippou addressed the sensitivity of HL-LHC performance on parameter changes. He recalled the observations on the luminosity decay at the start of collisions, showing faster decay than what can be explained by burn-off. This is under study and is possibly related to a dynamic aperture below 5 σ. Good lifetime is observed for a dynamic aperture around 6 σ. He recalled the long range beam-beam wire compensators as a measure to improve the dynamic aperture (by an additional 1-2 σ). Different levelling options (crossing angle, separation, β*) were discussed. In the discussion related to this presentation it was mentioned that studies including field errors should still be performed. It was also mentioned that for a successful validation of the proposed mitigation measures in 2017 (e.g. LRBB compensator) high priority should be given to the related MDs.

The second talk was given by R. De Maria on the possible simplification of the corrector circuits for HL-LHC. HL-LHC requires extra-correctors strength in the matching section for orbit adjustments and crab cavities. A reduction of the number of correctors in Q4/Q5 from 4 to 3 implies that no change of crossing plane will be possible. Flexibility could be re-gained by installing the new Q4 (MQYY) and its correctors, presently not in the baseline. In the discussions, the possibility of powering magnets having the same function in one circuit was mentioned (e.g. two orbit corrector magnets that act in the same plane), but consequences on availability should be considered. R. Garcia Tomas pointed out that the Q4 is a critical magnet, especially when considering non-conformities.

The need for having additional sextupole correctors in Q10 for IP1 and IP5 was discussed. The use of ATS optics requires 170 T/m for the Q5 magnet on the left side of IP6, which would require operation at 1.9 K (today's limit at 4.5 K is 160 T/m). L. Rossi suggested having an action for WP16 to clarify when the tests related to this magnet could be carried out and having a presentation in the HL-LHC TCC before going to the LMC. M. Pojer confirmed that discussions will be launched with all involved parties and that for the test the risks and implications for the LHC should be considered. When the first discussions on the subject were triggered, V. Montabonnet pointed out that the present power converter and DCCT is limited to 4 kA and thus an upgrade to a 6 kA-type will become necessary already for the type test as well as for the change of baseline to 1.9K. P. Fessia stressed that the modification of this magnet was shifted to LS3, L. Rossi commented that knowing before LS2 if the required gradient could be reached is very valuable.

ACTION: M. Pojer should clarify feasibility of pushing the Q5 gradient in IR6 to 170 T/m before LS2.

The last point regarded the need of having the 120 A trim of Q2a/b. This would not be necessary if response functions were included in the magnetic model. P. Fessia stated that measuring the transfer function of Q2a/b implies sorting the magnet, identify and correct problems, which could lead to more complex logistics in preparing installation. ACTION: E. Todesco should clarify the need for the 120 A trim of Q2a/b and the implications of measuring the transfer function.

M. Giovannozzi gave a summary of the non-conformities in the LHC circuits, which are assumed to be removed in view of HL-LHC. J.P. Tock commented that an effort will be made to remove all the known non-conformities, but some of them are not fully understood and can therefore not be easily corrected. O. Brüning asked if all correctors were commissioned to 7 TeV, M. Pojer confirmed that all circuits in 2013 were commissioned to 7 TeV (except for the main circuits and RD3.L4). No critical non-conformities were identified. Nevertheless HL-LHC will be more sensitive to non-conformities due to the use of ATS optics (and the implied non-symmetry of the arcs wrt each other).

D. Wollmann summarized the presentation given by P. Fessia on the impact of vibrations on operation. Studies and experimental investigations estimate a transverse movement of the magnetic center in the LHC triplets by up to 2 nm at different frequencies. H. Mainaud Durand asked how these 2 nm were calculated and P. Fessia explained that for the different scenarios that were considered, 2 nm is the worst case in case of an appropriate choice of the excavation tools. P. Fessia added that WP2 should specify what is the range of tolerable vibrations for operation, as this is required for advancing with the design of the cryostat and the supports. V. Parma commented that a ‘static’ design is ongoing and then by mid 2017 this design will be compared with the specifications, once available.

D. Wollmann recalled the presentation given by S. Redaelli on the need for hollow e-lenses for halo depletion, including the recommendations from the international review held in October 2016. In the discussion it was pointed out that the use of e-lenses are not improving performance, but would serve as a tool to avoid unexpected shortfalls, for example related to crab-cavity failures. S. Redaelli commented on the point raised by E. Chapochnikova in Chamonix concerning instabilities caused by halo removal. E. Metral clarified that while it is true that removing the tails can induce instabilities, the stability estimates for the HL-LHC beams never relied on contributions from the beam tails to the Landau damping and the impact of the halo removal should therefore be acceptable from the beam stability point of view.

D. Wollmann summarized the last presentation of the session, concerning beam collimation and the possibly resulting limitations for operation. The only remaining concern is related to the cleaning for ion operation, as quench experiments showed a maximum allowed beam intensity a factor 4 below the HL-LHC requirements. A reduction of the phase advance between dump kicker and collimators would allow nearly recovering a $\beta^* = 15$ cm. In the discussion it was mentioned that a prototype collimator with 3 different material combinations is being installed in the LHC to measure impedance effects. E. Metral reminded the TCC that 350-500 A octupole current is required only if the tails are cut and assuming the ADT will be working as expected (otherwise a much higher current would be required). M. Zerlauth mentioned the importance of BPM buttons not only for reducing the commissioning time but also for interlocking with ATS optics.

D. Wollmann then presented the CMAC findings and recommendations. Based on these, O. Brüning stated that priorities should be set for the relevant MDs in 2017 (e.g. LRBB compensation). The CMAC stressed the importance of addressing the impact of e-cloud and define possible mitigation strategies, R. Garcia Tomas commented that this probably refers to the possibility of extended coating in the MS, the 8b+4e scheme and the 200 MHz RF option. The implications of coating the beam screens of the MS magnets came also up during the presentation by V. Baglin.

O. Brüning remarked the importance of having achieved a consistent set of parameters between HL-LHC and LIU. L. Rossi added that for the RF options, following the Chamonix session, it is now clear that the focus will be on the 200 MHz system and suggested having a statement on this in the HL-LHC TCC. O. Brüning suggested scheduling this on 3rd March, as a summary of the studies of the implications of the installation of hollow e-lenses will pose constraints on the available space in IR4.

ACTION: E. Jensen should make a statement on the selected RF system option for HL-LHC (200 MHz).

M. Pojer pointed out that the IPD RD1.R8 is working with only one quench heater, but it is not foreseen to be replaced in LS2. Instead, it is suggested to replace it in LS3. L. Rossi stated that one spare is available for this (one full spare and one cold mass).

O. Brüning recalled the discussions from the last LMC on the observed movement of the CMS cavern and asked if a study is ongoing to quantify the impact of the double decker excavation. H. Mainaud Durand confirmed that it is planned to install a monitoring system during the run to measure the movements.

Use of EAM/MTF for production follow-up of HL-LHC components (D. Widegren - slides)

D. Widegren gave an overview of the available tools at CERN to manage assets over the accelerator lifecycle. For manufacturing and installation MTF is used as an interface, for operation and maintenance INFOR EAM is in use, while for waste disposal and management the tool is TREC.

L. Rossi asked if any changes were made from the LHC approach to HL-LHC. D. Widegren explained that tools have been upgraded, TREC is new, but in general it is a very similar platform than for the LHC.

INFOR EAM comprises about 2 million items and manages 150000 work orders per year. The tool is widely used as CERN across several groups and departments. L. Rossi noted that not all experiments are using it. D. Widegren explained that at the beginning of the LHC design the experiments were using different tools, but they are now slowly converging towards INFOR EAM, especially for the safety systems.

MTF is the tool in use for manufacturing follow-up, with the possibility of labelling equipment and associate to it technical parameters, manufacturing workflows and tests. It allows for example managing non-conformities. O. Brüning asked who enforces the deadlines entered in the tool. D. Widegren commented that most of the times it's the system responsible that is in charge of this follow-up. MTF can be used as an operations and maintenance tool, for example scanning barcodes allows retrieving the history of the components, including manufacturing history. This helps scheduling of maintenance activities and the management of spare parts.

MTF is already in place for most of the HL collaborations and for the QUACO project.

Support for the use of the tool is provided by the EN/ACE/AAM section (CMMS.Support@cern.ch).

C. Gaignant asked if additional documentation can be added to the defined workflow steps in MTF. D. Widegren confirmed this is the case and added that documentation and procedures can be generalized for a given 'equipment type'.

P. Fessia mentioned that for HL-LHC installation the changes will regard equipment which is already installed. He will therefore get in touch with D. Widegren to define the best approach to do this.

Optimal temperature window of the beam screens in the IT (V. Baglin - slides)

V. Baglin presented an update on the definition of the optimal temperature window for the beam screen in the triplets (IP 1 and 5). He recalled that the temperature window of the beam screens in the MS has been fixed to 5-20 K.

The current baseline window for the triplets is 40-60 K, which was set to optimize the cryogenic cooling scheme and to increase the pumping speed of the holes in the beam screen and to minimize the gas physisorption onto the beam screen.

Measurements show that a 500 nm thick aC coating is porous. The impact of porosity is assessed with thermal desorption spectroscopy. Measurements were carried out for different gas coverages, highlighting that the larger the coverage, the lower the desorption temperature. Also, binding energies decrease with surface coverage. During beam operation the gas desorption is mainly determined by the synchrotron radiation produced by the curvature coming from the D1 and D2 magnets. The photon flux was estimated to be 10 % compared to the arc. The requirement for the acceptable background in the experiments is 10^{-10} mbar (average over all the LSS). V. Baglin stressed that this is an average value, there's a pressure profile in the LSS which is higher in cold elements.

Tests in COLDEX were carried out with a cold bore temperature of more than 150 K, which implies no pumping through the beam screen holes. Measurements show the pressure profile as a function temperature for different gases and coverages. Pressure peaks can be observed for H_2 in the selected temperature window (40-60 K), while N_2 and CO are desorbed above 80 K. This suggests the optimal temperature window could be 60-80 K. Preliminary studies were carried out with the cold bore at 2.8-3.2 K. These studies confirm the new proposed temperature window.

V. Baglin mentioned that a setup is available to study this in 2017, the first results will be available by summer.

ACTION: V. Baglin should come back to the HL-LHC TCC to show the latest results of the experiments in COLDEX.

The 40-60 K temperature window was selected in order to allow for efficient thermal interception of high heat loads (1kW equivalent per side) on the new ITs. Following recent measurements at COLDEX, it is proposed to change this to 60-80 K. The impact on the cryogenic system must be taken into account for the decision. D. Delikaris confirmed that thanks to the new cryo-plants for HL-LHC in Pt 1-5, the proposed temperature window can be taken into account. Nevertheless, the impact on the cold bore thermal load transfer to the cold mass is under verification at the CryoLab, so the decision should be postponed until this point is clarified.

ACTION: S. Claudet should present the study on the impact on the cold bore thermal load transfer to the cold mass with higher beam screen temperature, before taking a decision on the final triplet beam screen temperature window.

O. Brüning asked if it is planned to repeat these measurements with the laser treated beam screen surface (LESS). V. Baglin mentioned that two 2.2 m-long beam screen should be ready for tests, and an according MD request should be approved by the IEFC for the first session in June; therefore a first report could be done in July.

ACTION: V. Baglin should present the results of the LESS tests in July.

M. Pojer recalled the discussion in Chamonix concerning the possible extension of the aC coating to 8L and R2 entire LSS in Pt 2 and 8. D. Delikaris commented that the beam screen temperature will remain unchanged (4.5 – 20 K) due to the presence of the existing cryogenic plants. He added that the priority should be the study of the e-cloud behaviour in terms of heat loads in the different sectors, especially profiting from the thermal cycle and ongoing cooling-down of S12 after the EYETS.

V. Baglin introduced the idea of a pilot run with aC coating in the LHC in 2018 (for example in left of Pt2) to allow for direct measurements. L. Rossi commented that for the moment it is not foreseen to open any sector in the YETS 2017-18. D. Delikaris added that in the last LMC there was the proposal to limit the YETS duration to 14 weeks. The possibility of a CMS re-alignment must also be considered, the cryo-team is therefore studying the implications and possibility for the triplet warm-up.

L. Rossi asked if there would be any implications of coating all the MS on impedance. E. Metral stated that this should not have any impact. V. Baglin added that nevertheless how to do the coating should be studied for this option. P. Fessia mentioned that these activities might interfere with the TANb installation. B. Di Girolamo and F. Sanchez Galan should be involved in the discussions and they should come back to the TCC with a presentation on the feasibility and impact of coating or LESS treating not only the triplet magnets but also the MS beam screens in IR2 and IR8 during LS2.

ACTION: B. Di Girolamo should present the implication for treating the beam screens of the MS magnets in IR2 and IR8 during LS2 to the TCC.

AOBs

O. Brüning reminded the TCC members about the action list presented by A. Apollonio in the 23rd HL-LHC TCC and invited the WP leaders to provide their feedback and to propose dates for follow-up of the open actions.