63rd Meeting of the HL-LHC Technical Coordination Committee – 13/12/2018

Participants:, C. Adorisio, A. Apollonio, G. Arduini, V. Baglin, I. Bejar Alonso, H. Burkhardt, P. Chiggiato, S. Claudet, R. De Maria, B. Delille, P. Fessia, S. Gilardoni, S. Kostoglou, A. Lechner, P. Martinez Urios, M. Martino, F. Menendez Camara, E. Metral, M. Modena, C. Noels, M. Pojer, Y. Papaphilippou, S. Redaelli, G. Riddone, M. Rodriguez Perez, J. Serrano, G. Sterbini, D. Wollmann, M. Zerlauth (chair).
Excused: O. Brüning, R. Jones, L. Rossi.

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 minutes of the previous meeting were approved without further comments. There were three decisions recorded, including the endorsement of the recommendation to change the location for the DS collimators (TCLD) and 11 T from cell 8 to cell 9, and the circulation of the updated ECR. P. Fessia mentioned the current work of the survey team regarding the position of the racks in P7, expecting to have the full view by the end of January. The TCC also endorsed the proposal to move two wire collimators from beam 2 to beam 1 of the LHC, during LS2**.**

Roadmap for new version of HL-LHC TDR + HiLumi book – C. Noels, I. Bejar Alonso - slides,TDR link

On behalf of L. Rossi and O. Brüning, C. Noels announced the planned release of the 2nd edition of the HiLumi book. She first reviewed its scope, summarizing the scientific and technological developments of the project, including performance, machine layout, and goals. It is complementary but not a repetition of the TDR, providing the reasoning behind the various choices. Currently 25 chapters are foreseen, including an Appendix. The list of contributions and expected length were sent to the corresponding authors after the meeting. The detailed structure will be presented on the 10th of January and a first draft is expected by the 25th of February for global editing on the 25th of May. G. Arduini stressed that this schedule is very challenging. Finally, a list of templates, guidelines from publishers and file-naming rules are given.
The link with the structure and guidelines for the HL-LHC TDR V.1 is presented. The structure is completely different as compared to the previous version. The deadline for sending the first draft to the corresponding editor is again the end of February 2019. Two rounds of comments and answers will follow. The final editing by the Executive editor, including the comments of the Editorial board is foreseen for June 2019. A list of general and specific guidelines is given. For example, it is stressed that all tables will have to be "MS Word" editable. Every chapter will have one or two corresponding authors. P. Fessia points out that the layout, regarding cryogenics and vacuum is being currently finalised and will not be available on time for the given deadline end of February. I. Bejar Alonso answers that indeed some intelligence should be injected in the writing procedure in order to reflect technical points that are being currently finalised. A Sharepoint site with the versioning of the chapters will be created. M. Martino asks if the corresponding TDR chapters should reflect the accepted ECRs. P. Fessia comments

that budget should not be included. I. Bejar Alonso clarifies that the TDR should reflect what is known and approved in the project by the 31st of December 2018, but also changes that are currently drafted and supposed to be accepted during the writing. G. Arduini questions the procedure of having to draft two documents at the same time and stresses that it would have been desirable to have a prior discussion with the WPs during the PSM. M. Zerlauth adds that this comes as a surprise to many, in particular because the period of January and February is a very busy one.

C. Noels suggests to forward these questions to L. Rossi and O. Brüning.

Operating temperature of Q5 in Point 6 based on 2018 hardware tests – R. De Maria, slides

R. De Maria presents slides prepared with M. Pojer and M. Solfaroli regarding the operating temperature of Q5 in P6 based on the recent hardware tests. The left side Q5 reached 4000 A while the right had a smooth progression until the target. M. Pojer clarified that both magnets show similar quench behavior. At the beginning of the year, there was a smooth progression of the current, but the training process was stopped due to the large number of quenches. The Q5L6 reached 4000 A stably. The Q5R6 has similar behavior but showed some detraining. The ultimate current of 3.9 kA could be stably reached. The erratic behavior at high current can be explained as we are at 90-95% of the short sample. According to A. Verweij, the great majority of SC magnets do however not show erratic behavior at 90-95%, including almost all MB's during the SM18 tests. The 50 A margin has been sufficient to assure stable operation as suggested by MP3. If there is significant energy deposition, the stable current will be lower. The requested gradient margin for optics correction is 1%. Based on these results, at 7 TeV, the operating temperature of 4.5 K is sufficient for both magnets assuming 3900 A of stable current. For 7.5 TeV, an upgrade to 1.9 K is needed in particular for Q5L6. The energy deposition is an unknown which could change this picture however, especially as the Q4 and Q5 in IR6 are subject to additional losses during the beam dump. D. Wollmann adds that indeed it is not desirable that the Q5 quenches due to these losses every time during a regular beam dump. M. Pojer stresses that the 50 A margin is not a fixed value. M. Zerlauth wonders if it is possible to quantify better this empirical margin. D. Wollmann suggests to have some input from the FLUKA team. R. De Maria points out that there were no quenches observed during normal tests and G. Arduini adds that this is true also during operation with beam, although the operation current is presently much lower than what is needed during HL-LHC. M. Pojer suggests to wait until run 3, and gain experience for stable operation, in particular if the LHC manages to run at 7 TeV. Some quench tests with deliberately induced beam losses can be then foreseen. M. Zerlauth stresses that the second part of the tests suggests that 7.5 TeV are not viable for the moment. S. Claudet adds that the cryo work for reaching lower temperature includes a modification of the service module, the jumper and heat exchanger. Work should start at 2022 to be finalised by 2025. R. De Maria reminds that 7.5 TeV running of the HL-LHC is foreseen at earliest for Run 5. M. Martino informs that for reaching currents above 4 kA in particular for Q5L6 and 7.5 TeV, it is desirable to confirm the need to use DCCTs with appropriate ratings for these increased current levels, including the definition of a timeline for any required circuit change. Such devices were already purchased for Q4. G. Arduini stresses that the current requirements are already known and shown in the corresponding tables. The question was mostly regarding the operating temperature for reaching these currents.

Summary of observations on noise for LHC and projections for HL-LHC – S. Kostoglou - slides

The motivation of the presentation by S. Kostoglou is to show the observations of the power convertors noise impact as measured in the LHC beam and projections to HL-LHC beam dynamics. As an introduction, she explains the two underlying mechanisms for noise effects, namely tune modulation from inner triplet quadrupole noise and orbit modulation coming from the main bends. In the first case, sidebands appear around the main resonant lines of the frequency map whereas in the latter case, fixed frequency lines distort the diagram (50 Hz harmonics) and are important when located close to the tune (around 3.5 kHz).

Regarding the inner triplets, early studies investigated the impact of voltage tones, by observing the reduction of DA for individual frequencies with different amplitudes and compare with the PC specifications. The major reduction is observed for frequencies between 300 to 600 Hz and corresponding tune-shifts of 10^{-4}, similar to the LHC. It is indeed shown that for all the scanned frequencies, the PC specifications correspond to tune-shifts that are far below this (for both the sum and rms of the individual contributions). In fact, switched mode PCs are not expected to show excitation for the most critical frequency ranges. G. Arduini suggests checking this for the ultimate HL-LHC scenario as well. M. Martino comments that the assumption of constant inductance may not be true, as it is expected to decrease with frequency. On the other hand, the magnet and beam screen will filter any field. So, the superposition of the two effects, will end-up with a reduced impact. On the other hand, the constant inductance assumption is a good first approximation, as a worst-case scenario. He adds that, at present, the impact of the switching frequency of the power convertor is not yet clear, in particular for the high frequency regime of 20-40 kHz. Simulations done with MPE agree on the shielding effect. M. Zerlauth suggests to compare the measurements and simulation results in detail. M. Martino adds that the mechanical measurements on the beam screen in SM18 (MQXF) seem to confirm the model. D. Wollmann stresses that the SM18 measurements done by MPE following CLIQ discharges do not fully agree yet with the simulations. G. Arduini points out that the knowledge of the possible scale of switching frequencies is important, in particular if they are close to tune harmonics.

The second part of the talk is dedicated to the dipole perturbations from noise in the main bends. Signals from the LHC BBQ have shown since quite some time (Run 1) multipole harmonics of 50 Hz. Is should be stressed that ramping convertors should be excluded, as these harmonics do not follow the tune, which means that the effect is dipolar, and constant along the cycle. Frequency analysis of data from the ADTObsbox and DOROS BPMs show the same cluster of high frequency components around 7.5-8 kHz, pointing to power convertors with Silicon Controlled Rectifiers (SCR), i.e. the warm quadrupoles or most importantly the main bends (MBs). The 50 Hz harmonics are observed for both beams and planes (mainly horizontal) and oscillate with time. This oscillation is correlated with the main network, as it is also observed in all the DCCT signals of the LHC main dipole converters but also in the SPS B-trains. It is clear that these harmonics are not instrumental, because they follow the beam phase advance (either between the Q7 and Q9 BPMs or while changing the phase advance between IP1 and 5 during an MD). There are strong indications that these lines come from the MBs, as shown by the impact on the amplitude of these harmonics, while switching off and back on the active filters of the corresponding PCs. The impact of the filters is different for the beams and the corresponding part of the cycle. There are on-going studies for understanding the transfer function of each sector in order to make precise predictions for the HL-LHC. As a preliminary approach, the lumped kicks observed in the ADT BPM at Q7 are used as input to the simulations, with changing amplitude and frequencies. A major reduction of the DA is observed at 7.7 kHz and for offsets similar to the LHC observations of 0.4 µm.

M. Zerlauth suggests to contact the ELQA team who made a series of measurements on the MB circuits and may be able to provide information for the TF of the magnet chain of each sector. M. Martino adds that the whole circuit chain with all the magnets may have a completely different response, including the effect of the beam screen, although he believes that these high frequencies should be screened. They may come from the UPS. M. Zerlauth recalls that since LS1, UPS power is by default not provided by a bypass to the normal AC network anymore, but now continuously converted, which could introduce additional switching noise. M. Martino adds that these noise lines at around 8 KHz were actually interfering with the PC DCCT signals and were subsequently removed by powering them directly to an AC plug and not using the UPS.

Outgassing of low impedance collimators and baseline for LS production – V. Baglin, S. Redaelli

V. Baglin summarises the discussions on the vacuum conditioning of the low impedance collimators. From the vacuum point of view, there was no show-stopper to install these collimators. However, it was recommended that the team in charge for the production takes all possible measures to improve the porosity of the surface in order to improve performance in the future. There is a memo in this respect that can be attached to the meeting Indico site. S. Redaelli comments that the requested MD did not take place, and a recommendation was approved by the LMC to leave the collimator installed. A. Lechner added that there is an on-going discussion for the danger for damaging the coating, if the collimator is taken out of the machine for inspection. P. Fessia thinks that if the inspection is carefully done with an endoscope, the risk of damage is minimized. Exposure should be of course avoided and the integrated dose should be minimised. S. Redaelli thinks that a visual inspection can be done in situ, as it was conducted for the primaries in the past. This should be clarified by EN-STI. The collimator will stay in the machine for run 3, in order to measure further its stability over several years of beam operation. A. Lechner states that EN-STI is in principle not in favor of this solution, but it can be further discussed and the team will come back with the conclusions to the TCC.

ACTION: The collimator team and EN-STI should report in the TCC the outcome of the discussions for the possibility to inspect the surface of the low impedance collimator presently installed in the LHC.

A special TCC meeting will take place on the 19th of December 2018.