



12th Meeting of the HL-LHC

Technical Coordination Committee

Participants: A. Apollonio, M. Bajko, M. Barberan Marin, V. Baglin, I. Bejar Alonso, H. Burkhardt, R. Bruce, O. Brüning (chair), M. Brugger, R. Calaga, O. Capatina, F. Carra, R. De Maria, S. Danzeca, D. Delikaris, P. Fessia, M. Giovannozzi, A. Lechner, T. Lefevre, H. Mainaud Durand, A. Rossi, L. Rossi, R. Rossi, F. Rodriguez Mateos, F. Sanchez Galan, F. Savary, A. Siemko, E. Todesco, D. Wollmann.

Excused: G. Arduini, Y. Papaphilippou, M. Zerlauth.

O. Brüning opened the meeting by reviewing the agenda. The foreseen AOB on the updated civil engineering volume has been postponed because it is not yet finalized. L. Rossi will give an update on the progress of the re-baselining.

The minutes of the last meeting have been approved with the comments received by Y. Papaphilippou. The [Indico Page](#) contains the final version. O. Brüning asked clarifications on the timescale for the finalization of ECR on the updated circuit specifications. I. Bejar Alonso will comment during her presentation.

Feedback on quench heaters vs EE on MCBXFH/V, F. Rodriguez Mateos – [slides](#)

F. Rodriguez Mateos presented an update on quench protection strategy for the MCBXFA/B magnets following the circuit review.

He started reminding the TCC that energy extraction options are being discussed also for the super-ferric skew quadrupole corrector MQSXF, and the D2 orbit correctors MCBRD, but today's presentation will focus on the MCBXA/B only.

L. Rossi reminds the TCC that the reviewers were presented a scenario that avoided energy extraction for all new correctors and that they recommended to study an energy extraction solution only for MCBXFA/B. P. Fessia confirmed that no energy extraction device is being considered in the integration studies. E. Todesco confirmed that energy extraction solutions are anyhow being studied not only for the MCBXFA/B but for the magnets indicated above. D. Wollmann confirmed that energy extraction is still included as a viable option in the latest circuit parameter table.

While presenting the specification table of the MCBXFA/B, F. Rodriguez Mateos stressed that the stored energy, in particular for the MCBXFA, cannot be considered negligible.

A protection solution based on a crowbar implies a voltage limit of 50 V from the power converter side (assuming 30 Ohm) and, according to simulations, large peak temperatures that are above the 355 K limit and which would scale up to 410 K for 108 % of the nominal current. The reported temperatures assume no quench heaters, which one would expect being able to halve the peak temperatures.

Some ingredients are not included in the models used for the simulation, which may affect the results in both optimistic and pessimistic way as follows: transverse thermal conductivity, quench back, realistic boundary conditions, AC losses, approximated field maps, actual material properties. For this reason, it was decided to include quench heaters in the short prototype in order to verify heating effects and the feasibility and reliability of installing quench heaters.

Due to the complication and risk of quench heaters, energy extraction at 100 V or larger should be explored.

TE/MPE is following two alternatives for a 2 kA energy extraction system: IGBT-modules and vacuum switches (in the order of 10^{-3} or 10^{-4} bar). Both options have pros and cons and are developed in parallel. An IGBT module (1 kA) is being built at CERN and two modules can be stacked to meet the specifications. The vacuum switches are studied in collaboration with Łódź University of Technology and devices already exist up to 800 A. The switches have the advantage of low forward losses and low maintenance. The reaction/opening time is in the order of several milliseconds for the vacuum switches, sub-millisecond for IGBTs.

Standard LHC quench heater discharge supplies can be used, for which there is large experience, and are proved highly reliable. The trigger time has to be reduced from 4-5 ms to 1 ms. A few units have been sent to KEK and similar ones are being used at FNAL for the magnet tests within the HL-LHC programme.

F. Rodriguez Mateos presented a summary comparison between energy extraction and quench heaters, for which he stressed that costs should not be taken as the only figure. F. Rodriguez Mateos is uncertain on the development cost for quench heaters. E. Todesco commented that they are easy and the main risk is rather to slow down the development of the magnet in case of unforeseen problems. He endorses the strategy of studying quench heaters and energy extraction methods in parallel with a decision point at the end of 2017.

The discussion followed-up on the other magnet types mentioned at the beginning of the talk. P. Fessia asked, if the temperature will rise too high and if yes, by how much. E. Todesco replied that for the MCBRD the design is in a too early stage to be simulated in quench protection studies. A short model is expected for tests by the middle of 2017. The MQSXF has a current of 600 A and is easier since it needs only components that already exist.

D. Wollman added that the most expensive options are proposed in the upcoming Cost and Schedule review.

L. Rossi asked where the 50 V limitation for the crowbar comes from. F. Rodriguez Mateos explained that the limit comes from the maximum common mode voltage that can be applied

to the power converter electronics, which is already pushed from the standard 30 V of the present power converters.

News on TDR and ECR, I. Bejar Alonso– [slides](#)

Following the re-baselining and the new version of the TDR (v0.1) needed for the Cost & Schedule Reviewers by October, I. Bejar Alonso presented the procedure that the WPs need to follow. The deadline of the new TDR version is the 31st of August.

Each WP leader will also present one single ECR for all the changes occurred from the PDR (not TDRv0.0) after the delivery of the new TDR version. F. Rodriguez Mateos will prepare a transversal ECR for the circuits and will share it with the concerned WPs at the same time. All the non-approved ECRs should be marked as obsolete whenever a new ECR can replace them. Afterwards, B. Delille will prepare and discuss a budget difference list for each WP.

R. Calaga asked about options that are still open for crab cavities. L. Rossi commented that the only difference he expected from the re-baselining is coming from the reduction of the number of crab cavities and the associated correction in the cooling and ventilation that has been recently applied (i.e. the power needed would be 2.4 kW for 4 cavities and then 1.2 kW for 2 cavities).

L. Rossi reminded that all LHC ECRs related to HL-LHC should be presented to the TCC before being discussed at the LMC and the approval list should include the project leader and the members of the project office.

Collimation ECRs, R. Bruce - [slides](#)

R. Bruce presented the ECRs related to the collimation system foreseen in the EYETS 2016-2017, that is TSCPM, TCPP, Crystals and long-range BB compensation wire in collimators.

TSCPM: TSCPM will be ready for installation in Feb 2017 in an empty collimator slot to test the material properties during MDs and potentially in normal operations. L. Rossi asked that the project leader and project office are included in the approval list as for any ECRs involving HL-LHC. V. Baglin asked who would manufacture the coating: CERN will coat one stripe and a company in Denmark another one.

TCPP: It is a new design of a TCP, which includes a pair of BPM that are developed to and to provide continuous monitoring of the orbit at the collimator and to reduce the alignment time (from minutes to seconds if fully automatized). It is advantageous in the context in which all collimator jaws align automatically at the same time. The collimator is part of the consolidation budget. D. Wollmann added that there are also potential performance improvements in case a more reliable alignment and the total impedance allow tighter collimation settings. After the meeting, and in a question of O. Brüning, R. Bruce clarified that, if impedance allows, the tighter collimator settings (i.e. reduced values in σ and mm), could

help gaining in protected aperture and hence in β^* reach. This aperture gain could be used to allow more open collimator settings at constant β^* to reduce the impedance impact.

Crystals: The crystal tests were successful but still with some issues that new hardware could mitigate. In particular, a new pair of goniometers is proposed on B2 which allows additional experiments with both beams. The hardware is part of WP5 except for the crystals themselves, which are provided by UA9, and the cabling.

Long Range BB compensation wires in collimators: A TCL and TCT in IR5 are replaced with equivalent devices with integrated wires for testing beam-beam long range compensation. L. Rossi asked why the experimental test now foresees collimators only in IR5, since IR1 was also included in the initial proposal. A. Rossi and O.Brüning clarified that following the last Beam-Beam workshop, the teams reached consensus that an experiment with parasitic crossing in only one plane could be conclusive for the test. After the meeting, Y. Papaphilippou clarified that the compensation in IR1 is in the plan, for the following year (2018). L. Rossi asked about the temperature of the cable for the maximum current of 350 A. The temperature will be around 200 Celsius in a small volume, where the wire leaves the collimator volume. Within the jaw, the wire remain below 70deg, called by the collimator cooling system. A. Rossi added that the wires are planned to be tested also at 100 A when they are at an ideal distance from the weak beam.

As a general comment, V. Baglin reminded to include radiation protection teams in the ECRs in particular for the work foreseen in IR7 due to the large cooling time needed.

Update on the re-baselining – L. Rossi

L. Rossi updated the progress made in the re-baselining process. 70-75 MCHF were saved in the technical sector and the rest needed to meet the target of 120 MCHF was found in the infrastructure thanks to the reduction of surface buildings and underground volumes. A new proposal will be discussed with the DG to keep the full reversibility of the former project baseline. The reversibility option will cost approximately an additional 5 MCHF in the infrastructure, which does not obviously include the technical equipment that has been saved in the re-baselining, but it would allow further upgrades in the future if needed and additional resources become available.

P. Fessia wanted to remind that he is organizing a transport review to make sure that all the transport requirements are properly accounted by the respective work packages. The aim is a complete review by the middle of September. L. Rossi, while acknowledging the importance of this exercise, clarified that the completion of the TDR has the first priority.

Update on the HL-LHC annual meeting, L. Rossi – [plenary](#), [parallel](#).

L. Rossi and O. Brüning presented the structure of the annual meeting: plenaries are scheduled on Monday and Wednesday and parallel sessions on Tuesday.

Monday will be devoted to the collaboration board and a set of plenary sessions to represent the collaborating institutes. In addition, a report on the Cost and Schedule review will be given, as well as an update on the new baseline scenario and recent progress on magnet development. In particular, L. Rossi clarified that the talk on the D1 progress has been chosen to represent the Japanese collaboration thanks to their important technical advancement.

Several difficult choices were needed to select the plenaries on Wednesday. The venue imposes a limit in the number of talks since it closes at 18h00. L. Rossi and O. Bruning highlighted the talk on VAX integration and TREX should present a solution signed up by the experiment otherwise the talk will be replaced. F. Sanchez expressed concerns on the time scale, but O. Bruning insisted that one should try as much as possible to achieve this result since the time window between ECFA and the HL-LHC meeting appears to be adequate. In general, it was decided not to include a specific talk from the experiments, since the ECFA workshop is preceding the HL annual meeting and will address many topics related to HL-LHC, including a report from the newly appointed pile-up working group.

H. Mainaud Durand highlighted that there is no plenary on survey and alignment. L. Rossi commented that during the next annual meeting one would give the occasion to discuss an inclusive overview of the alignment strategy for both machine and experiments.

T. Lefevre asked the rationale behind the series of three talks in closely related topics: technical infrastructure, civil engineering and integration. L. Rossi replied that the main motivation is to give a detailed account of all the activities that represent a large fraction of the project budget.

The parallel sessions are constrained by the venue opening hours as well. Several talks could be merged in one since their topics partially overlap. Potential conflicts may arise, since several WP may not be represented in all sessions. T. Lefevre expresses concerns on the effectiveness of a dedicated BI parallel session, since the work package has already tight connections with its collaborators. Instead he would propose to spread the BI talks in relevant shared sessions due to the added value of crossing work package boundaries. O. Bruning encouraged T. Lefevre and anyone else with similar requests to send them to him in form of an email as soon as possible (deadline one week): the goal is to finalize a preliminary program for the parallel sessions by the end of next week.

L. Rossi commented on the need to reduce the number of participants. In particular, despite the closeness of the Paris venue, the department head policy is to limit travels, taking also into account that the periodic annual meetings organized at CERN offering attendance to all CERN people concerned.

The next TCC meeting will take place on the 4th of August.