26th Meeting of the HL-LHC Technical Coordination Committee – 16/03/2017

Participants: C. Adorisio, A. Apollonio, G. Arduini, V. Baglin, I. Bejar Alonso, O. Brüning (chair), H. Burkhardt, R. Calaga, O. Capatina, S. Claudet, R. De Maria, B. Di Girolamo, P. Fessia, J. Gascon, S. Gilardoni, T. Lefevre, H. Mainaud Durand, M. Martino, D. Mirarchi, Y. Papaphilippou, M. Pojer, S. Redaelli, A. Rossi, L. Rossi, L. Tavian, E. Todesco, R. Tomas Garcia, D. Wollmann, C. Zanoni, M. Zerlauth.

Excused: M. Lamont, F. Cerutti, M. Giovannozzi, M. Gourber-Pace, J. Jowett.

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/590415/

The minutes from the previous meeting were approved, with no actions to follow-up.

O. Brüning reminded about the LRBB wire compensator workshop on 20th March.

Recent results of D1 short model test (A. Musso - slides)

A. Musso reminded about the results of the cold tests of MBXFS01a in May 2016. The nominal current was reached after 13 quenches and the ultimate current was not reached. The reason for the poor performance was identified in the insufficient azimuthal coil pre-stress.

In the review in July 2016 the decision was taken to increase the coil pre-stress and the axial pre-load. The magnet was dismantled, shims were added in the mid plane, and then re-assembled (MBXFS01b) in Autumn 2016. The first part of cold tests was carried out in February 2017. Thanks to the increased pre-stress, the nominal current was reached after 2 quenches and the ultimate after 5 quenches. The plateau at nominal current lasted 1 h, the plateau at ultimate current 1 min. In February only part of the foreseen tests was carried out in KEK. An upgrade programme for the power supply is being finalized, allowing to perform the remaining tests before the end of March.

The next step is the preparation of MBXFS02, for which the cross-section needs to be changed to simplify the interconnection with adjacent magnets. The second model was foreseen for April 2017, with these changes the beginning of manufacturing will however be postponed to August 2017, but no problems are expected with the schedule.

E. Todesco underlined the importance of the good results on MBXFS01b and mentioned that discussions are ongoing with the Japanese collaboration to evaluate the need for a 3rd model, to verify the reproducibility of the results due to the change of cross-section. This would not pose problems from the schedule point of view.

G. Arduini asked if the new cross-section will have an impact on field quality. E. Todesco explained that magnet designers observed an undesired effect during tests, namely a significant contribution of the magnet ends to the straight part (20 units of b_3). Actually, the magnetic measurements agree with the computations from FE models, but this effect was not believed to be realistic before the measurements. A publication is under preparation on this topic. The effect is also visible in the single aperture 11 T model. The new design takes into account this effect and it has been checked that also for D2 this effect is not relevant (which was confirmed, it is less than 1 unit).

Results of first CC tests and non-conformity of HOM port (R. Calaga - slides)

R. Calaga gave an overview of the non-conformities of the two crab cavities manufactured for the SPS test. The first crab cavity was finalized in December 2016, the second in January 2017. All non-conformities are described in dedicated reports in EDMS/MTF. The first non-conformity regards additional grooves found on flanges for HOM coupler alignment. The second is a machining mistake after weld on the DQW HOM port cavity 1. An additional weld was introduced to adjust the length. The third non-conformity consists in a 5 mm overlength of all HOM and FPC ports for both cavities. L. Rossi asked if this non-conformity is considered 'internal' or whether it should be communicated to other WPs. R. Calaga explained that the decision to keep this non-conformity was taken in agreement with the other WPs, so they were already informed. O. Capatina added that the possibility to intervene and reduce the length of the ports was discussed and excluded, the non-conformity could still be fixed if necessary. I. Bejar Alonso confirmed that the good approach was followed, this case is considered internal as the same system performance can be achieved, so there was no reason to expose it.

R. Calaga summarized the effects of the HOM port non-conformity. Both from the heating and the impedance points of view, no significant effect is anticipated, so the decision was taken to keep this non-conformity.

R. Calaga presented the results of the first DQW test, in which a voltage of 5 MV was reached (nominal is 3.4 MV). The goal is to keep this margin also after cavity dressing. R. Calaga stressed that the performance target and margins for operation should be defined for series production, this was an explicit request from the US-LARP collaboration. O. Brüning commented that in the future, if sufficient margins exist, the performance could be pushed above 3.4 MV to achieve full compensation of the crossing angle even with only 2 crab cavities installed. R. Calaga commented that the implications on machine protection and cryogenics should be evaluated (e.g. higher risk of quench). L. Rossi suggested to discuss this topic in the next LARP meeting. R. Calaga added that in the past in functional specifications the 5 MV were already quoted as 'pushed performance'. O. Capatina commented that this is not an easy estimate, as this is the first time these cavities are produced. The answer will come from the first cavity tests.

The first US-LARP DQW was tested up to 5.7 MV. This cavity also is non-conform, it cannot be used for the SPS tests. There's a lack of information concerning the fabrication process, and difference in dimensions from nominal may require considerable adaptation of the cryostat. An effort could be made to adapt the cryomodule design to house this cavity.

R. Calaga commented that the fact that two cavities with different fabrication processes give similar results gives confidence that the geometry and surface treatments being applied are correct.

For the US-LARP RFD cavity there's a suspicion that inadequate chemistry was performed after the final welds, resulting in a quench at 4 MV. The cavity is being re-processed and will be tested again in the coming weeks. L. Rossi commented that for the RFD the change of slope of the curve of Q0 as a function of cavity voltage seems to be steeper and its onset earlier than for the DQW. R. Calaga explained that this behaviour is due to field emission and could be explained with the inadequate chemistry mentioned above. The second RFD is also available for tests, it will be measured before the LARP meeting.

The power couplers reached 30 kW CW, which is comparable to LHC values.

Y. Papaphilippou asked if in this setup one could measure the effect of noise. R. Calaga explained that this is not possible, as the boundary conditions are too good to measure anything relevant.

R. Calaga mentioned that the nominal surface resistance is 10 nΩ at nominal field, with a total load of 35 W, 3 W of dynamic load. The current design gives 5 W of dynamic heat load, but this shouldn't be a problem. The goal should be to keep the same Q_0 after dressing of the cavity. L. Rossi asked if the fact that the RFD has a lower surface resistance is intrinsic to the design. O. Capatina commented that the processing steps are different, this effect is not related to the geometry, nor to the lower magnetic field. L. Rossi asked if the same type of niobium is used. O. Capatina confirmed that the same niobium is used, but from different batches. R. Calaga added that all batches are within specifications concerning the RRR, but this can have a distribution, which could lead to the difference.

Integration study of hollow e-lens in IR4 (M. Alcaide Leon - slides)

M. Alcaide Leon presented a preliminary study on the integration of hollow e-lenses in the LHC. She remarked that these considerations are preliminary and do not yet account for beam instrumentation needs.

M. Alcaide Leon showed a possible integration of the hollow e-lens in LHC LSS4 (left). The device would be placed between the D3 magnet and the ADT. The integration study was done considering the dimensions from the conceptual e-lens design. The integration should take into account also space reservation for a possible RF upgrade. The current dimensions of the e-lenses could be extended when introducing beam instrumentation, or if a splitting of the solenoid is required. L. Rossi commented that

a splitting of the solenoid could be expensive. A. Rossi explained that D. Perini is working on this option, some flexibility should be kept for the moment. S. Redaelli added that the design could also be shorter if the studies will reveal that it's possible to operate with higher electron current.

L. Rossi asked what are the plans for the ADT upgrade. R. Calaga explained that at the moment there's no official proposal for an ADT upgrade. L. Rossi pointed out that space is reserved for the upgrade and that the input on the need for an upgrade should come from beam physics considerations. G. Arduini stated that there's no need for an ADT upgrade at the moment, the interest is more towards a wide-band feedback system.

P. Fessia explained that what is proposed with this scheme is to put together all the space reserved for RF, then this space could be managed autonomously by the RF group, including possible upgrades and new systems.

R. Calaga commented that moving the ADT would have implications on the cabling, as the length is set for precise phase pick-up.

M. Alcaide Leon added that additional space could be gained from a redesign of the vacuum chamber supports. With the vacuum group it was agreed to install a sector valve for possible cathode exchange. V. Baglin pointed out that space should be reserved for a differential pumping station.

For beam instrumentation BPMs and BCMs for the electron beam could be added. O. Brüning pointed out that for the e-lenses in RHIC also monitoring of backscattered electrons is available, A. Rossi confirmed that this is being considered also for the LHC.

For the cryogenic supply, two options are possible. The first involves existing jumpers from D3 or RF modules. This option is unlikely to work, as confirmed by S. Claudet, due to the difficulty to control the supply with enough precision. The second option involves a new service module. There's also the possibility to use normal-conducting solenoids for the source and collector coils, but it this is unlikely as commented by S. Redaelli.

M. Alcaide Leon then illustrated the options for integration of technical services in the service caverns. She summarized the overall needs for racks (slide 25) and the corresponding possible locations, providing two options. R. Calaga pointed out that the second option could prevent the use of RF lines for the possible installation of the 200 MHz RF system, this has to be verified.

O. Brüning recalled that one of the motivations for this presentation was to synchronize with the RF group on the space reservation in LHC point 4, therefore feedback from the RF group is expected on the proposed integration.

Integration procedure for R2E requirements (M. Alcaide Leon - slides)

M. Alcaide Leon presented the procedure and workflow for integration with respect to R2E requirements.

Two documents should be compiled, an integration equipment note and an area integration report. P. Fessia stressed that this workflow was approved with the R2E management, this will become the standard procedure.

Parameter update for nominal HL-LHC: standard, BCMS, 8b+4e (R. Tomas Garcia - slides)

R. Tomas Garcia gave an overview of the assumptions leading to the updated HL-LHC parameter list. The main update regards the new assumption for the longitudinal bunch profile, following discussions with E. Shaposhnikova. β* levelling is assumed to be performed when a deviation from the target value of 2 % is detected. L. Rossi asked why the levelling is not done continuously. O. Brüning explained that all settings are based on set points, continuous levelling would be impractical. G. Arduini added that the adaptation of the β* should follow a change on the instantaneous luminosity measured with a certain degree of confidence, 2 % is an educated guess for this.

L. Rossi asked a clarification on the conservative assumption for BCMS emittance. R. Garcia Tomas explained that it is assumed to be the same as standard beams, keeping a margin for possible unknown sources of emittance blow-up.

R. Garcia Tomas explained the updated assumption for the longitudinal bunch profile, moving away from the Gaussian distribution. The tails of the distribution are more populated, the profile becomes Gaussian after a few hours due to IBS and synchrotron radiation. The stability threshold is related to the Full Width Half Maximum (FWHM) of the distribution, which should be preserved. The possibility that a longitudinal blow-up should be performed for HL-LHC operation cannot be excluded. R. Calaga pointed out that for the time window where luminosity production is relevant, the non-Gaussian distribution must be considered. The new bunch profile can be derived as a particular case of the q-Gaussian distribution. This distribution has a different RMS with respect to the Gaussian distribution, but the same FWHM.

R. Tomas Garcia presented a table summarizing the new parameters for HL-LHC for standard, BCMS and 8b+4e beams. Different definitions of bunch length were kept in the table, to allow for a smooth transition from the old table values. O. Brüning

commented that the bunch length in ns is missing. L. Rossi suggested having all parameters expressed in the same units (e.g. all luminosities in units of 10^{34} $cm^{-2}s^{-1}$).

R. Garcia Tomas showed the corresponding update on the yearly integrated luminosity estimates (slide 9).

L. Rossi asked why the estimated goes down to 234 fb^{-1}, compared to the 240 fb^{-1} presented before. G. Arduini explained that the change reflects the change of bunch length, which should be kept constant at the FWHM.

O. Brüning recalled that in the Chamonix workshop the BCMS+ option was also discussed. This is pending inputs on the robustness of the TCDI within the LIU studies (agreed to be studied with S. Gilardoni). S. Redaelli added that additional tests in HiRadMat are ongoing also for collimators in IR7, there's a synergy for tests for the TDIS.

S. Redaelli asked if the assumption of 50 % efficiency includes the major failures observed during 2016. A. Apollonio confirmed that this is the case.

O. Brüning proposed to delay the parameter update until the release of the TDR, such that the change could be referred to it.

R. Calaga recalled the discussion on how to store information related to additional system margins with respect to nominal performance. O. Brüning pointed out that all systems should in any case be designed for ultimate parameters. L. Rossi asked what is the voltage for ultimate beam energy (7.7 TeV) for the crab cavities. R. Calaga explained that this scales linearly with energy, so 7 % more voltage should be considered. A separate discussion should be organized on how to store this information.

AOBs

O. Brüning reminded about the circuit review on 17th March and the LRBB wire compensator workshop on 20th March.

The next HL-LHC TCC meeting will be held on 30th March.