25th Meeting of the HL-LHC Technical Coordination Committee

Participants: C.Adorisio, A.Apollonio, V.Baglin, R.Bruce, O.Brüning (chair), H.Burkhart, O.Capatina, D.Delikaris, B.Delille, A.Fabich, B.Di Girolamo, S.Gilardoni, J.M.Jimenez, R.Jones, H.Mainaud Durand, M.Martino, A.Mereghetti, Y.Papaphilippou, M.Pojer, A.Rossi, L.Rossi, F.Sanchez Galan, E.Todesco, R.Tomas Garcia, R.Van Weelderen, A.Will, D.Wollmann, M.Zerlauth

Excused: G.Arduini, M.Giovannozzi, S.Redaelli.

O.Brüning opened the meeting by reviewing the agenda.

The minutes of the last meeting have been approved with the comments sent to A.Apollonio. The Indico Page contains the latest version. There were eight actions in total. The first concerned the feasibility to push the gradient of Q5 in IR6 to 170T/m before LS2 and the second was related to the possible need for a 120 A trim of Q2a/b and the implications of measuring the transfer function. The third action was on a statement on the selected RF system option (200 MHz) for HL- LHC. O.Brüning indeed mentioned that P.Fessia will present in the next meeting an update on the space requirements in IR4. The next action was on an update of the results from COLDEX. The following two concerned cryogenics and vacuum, regarding the impact on the cold bore thermal load transfer to the cold mass with higher beam screen temperature, and the results on the Laser Engineered beam Screen Surfaces (LESS), as an input for following the idea of coating of all matching section quadrupoles. D.Delikaris mentioned that for the cryogenic team, this is on-going work and the results could be presented early next year. The last action was on the implication for treating the beam screens of the MS magnets in IR2 and IR8 during. B.Di Girolamo mentioned that he started discussions with vacuum and will let know the TCC team for scheduling a presentation.

Use and prospects of HiRadMat for HL-LHC, A. Fabich– slides

A.Fabich started with an overview of his presentation. He first explained the motivation behind HiRadMat by showing the various irradiation test facilities at CERN. In particular, there is the experimental North and East areas, where prototype of physics detectors can be tested and the CHARM/IRRAD facilities, e.g. for R2E studies. HiRadMat was proposed in 2008 and started in 2012 in order to fill the gap for a dedicated facility for accelerator component tests, as it was clear that testing in operating rings is difficult due to the existing physics program. It is located in the former West Area, where the old neutrino facility WANF functioned until 1998 and a 3D sketch of the target area is presented. The beam parameters used are close to LHC injection, with the only small difference of the slightly lower energy of 440 GeV, for safety reasons. The big advantage of the facility is that the beam parameters can be varied to the

needs of experiments, and most importantly the beam focus, which determines the density of the deposited energy in the target. A limited number of experiments per year are scheduled, still allowing people to access and install their equipment without major implications by RP safety. Classical irradiation can be done in other facilities complementary to HiRadMat. In the question of L.Rossi about the maximum intensity and the possibility to use the LIU parameters, A.Fabich replied that presently they cannot be above 1.3e11 ppb for full LHC batches from the SPS, due to limitations of the SPS RF system, which will be eventually solved through LIU, increasing it to 2-2.3e11 ppb. The repetition rate is slow (18s cycle nominally, in practice more than half a minute) since the HiRadMat cycle has to share the supercycle of the SPS with other users, typically the North Area ones. A typical experiment is presented related to the option of using glassy carbon for vacuum windows, a possible option for HiRadMat itself.

A typical schedule is further illustrated by presenting the one foreseen for 2017. Every four to five weeks there is one experimental beam slot. A short overview of the context of the experiments during 2017 is given, with the biggest part taken by the LHC, mainly for collimators. There are also twelve non-LHC experimental tests and a few external users, as HiRadMat is a Trans National Access facility providing travel funds (at present from EUCARD2 and in the future from ARIES). An example of such an external user experiment is shown for the testing of an optical microphone. A typical beam program is further presented, where the tests can last from a few hours up to days. The operation is done in single pulse mode on request by the experiment. For example, in 2015, the total SPS cycle time provided was around 100 hours, with a total of 3e15 pot, with a large flexibility of beam intensities from the injectors. A past highlight test is shown for the BPM diamond detectors and a recent proposal made by ATLAS for the pixel/strip modules.

The online monitoring capabilities of HiRadMat include the beam intensity and position/profile, but also radiation (monitors and BLMs). An example of such monitoring is presented for the AD targets tests. The electronics in the TT61 are further described, where additional shielding was installed in 2015 for reducing radiation levels. Further optional countermeasures can be considered with an increased distance from the target.

An important part of the tests is taken by collimator studies, where numerous signals are installed with high read-out frequency. Several systematic studies were performed for destruction limits of materials. The MultiMat experiment in 2017 will use a newly constructed rotating barrel with up to 16 independent target stations, allowing the study of several materials during the same experimental slot. The barrel and its containment is designed to be re-used for future experiments.

There are several interesting proposals for tests in 2017 and beyond, including FCC collimators, vacuum windows for high-power beams, production targets (as part of the “Physics beyond colliders” study), HP proton targetry, beam monitoring for BI in a permanent test bench, BLM studies and basic research on (pre-irradiated) materials.

There are also active collaborations with other institutes (FNAL, BNL, GSI, CERN, PSI) which provide already irradiated samples and use HiRadMat to explore damage limits. Experiments on cable strands were suggested in 2015, motivated by HL-LHC failure cases. The current

experimental campaign includes the estimation of the insulation's and critical current's degradation of Nb-Ti. The cryogenic infrastructure and operational procedures are currently in preparation.

Discussion

O.Brüning asked if the facility could be used for the impact of radiation on the crab cavities. A.Fabich answered that this damage corresponds to accumulated neutron dose over the years and this cannot be tackled by HiRadMat but by dedicated facilities, with a regular neutron flux.

L. Rossi asked about the status of the irradiation of cables tests. D.Wollman answered that there is some post irradiation analysis of the HiRadMat experiment "CableStack" using magnetization measurements on the single strands, for exploring the degradation of the SC cable properties, in collaboration with the Un. of Geneva. There are also high voltage tests in blg. 112 on the cables stacks for investigating the degradation of insulation. The CabelStack experiment operated at ambient temperature. The cryostat for the cryogenic experiments is currently in the design phase.

AOB: Installation of BLMs or diamond BLMs at COLDEX, R.Jones - ECR document

R.Jones stated that the BLMs are ready for operation this year, as they are installed at COLDEX during this EYETS, following the request of V.Baglin. These are ionization chambers. In the question of O.Brüning why diamond BLMs are not used, R.Jones explained that ionization chambers are more convenient, at present, for correlating the COLDEX observations with the measurements in the LHC.

AOB: Readiness of installation of LLRB, A.Rossi - slides

A.Rossi presented a brief summary of the status of the collimators equipped with wires. The TCTPH.4R5.B2 is installed, aligned, pumped and baked out. The wire connection is on-going. The PC power module is still missing. The acquisition box is tested in the lab and will be installed to test the wire in the collimator. Wire tests are foreseen in mid March, including the effect of current on the inner wire (already measured in the lab by EN/STI) and wire tension recalibration. Both inner and outer wires can be brought up to a maximum current of 350 A. In the question of L.Rossi on what are the limits for setting the maximum current, A.Rossi replied that the wire has been design to such current (actually to 378A) and interlocks on the wire temperature (via measuring the wire tension or the jaw temperature) will make sure that neither the wire nor the collimator will be damaged by overheating.

Regarding the TCL.4L5.B2, the collimator is installed, aligned and will be sector pumped next week, and the bake-out will take place in two weeks. The workshop for the experimental BBLR compensation tests was already announced (20th of March) and the invitations to the speakers will be sent by tomorrow. She kindly asked the invited people to be registered ASAP, through the indico web-site.

AOB: Preliminary discussions on the test of Q5.L6 above nominal current, M.Pojer - slides

M.Pojer reported on the discussions regarding the test of Q5.L6 for reaching current above the nominal. He reminded the TCC that the present nominal current is 3610 A for a gradient of 160 T/m, while the ultimate current is 3900 A (corresponding to around 170 T/m). The HL-LHC request of 180 T/m, corresponding to 4060 A for Beam 1. The optics requirements allow Q5.L6 to stay at a lower gradient and at 3750 A for beam 2. Following a question of O.Brüning, he clarified that all the values correspond to 7 TeV. The power convertor is able to reach 6 kA and the DCCT can accommodate continuous operation for 105 % of nominal, so there are no limitation from this hardware. The warm cable can also accommodate 4.2 kA.

Regarding the performance, this particular magnet had only 2 training quenches in the LHC, both between 3.5 and 3.6 kA. MP3 does not see any particular problem in trying to push it to 4.1 kA, possibly with a predefined maximum number of training quenches. L.Rossi reminds that the tests in block 4 were done in a vertical cryostat at 4.5 K and this configuration is less prone to forming bubbles in the He bath, so it is important to understand the limits in an horizontal configuration.

M.Pojer transmits also the opinion of L.Bottura who does not see any counter-indication to this test, with some recommendations on the critical observations for each quench. In conclusion, M.Pojer states that there should be no problem from the HW point of view to test the magnet up to the HL-LHC requirements. O.Brüning asks if there are spares and E.Todesco answers positively. L.Rossi reminds that the LMC should give its approval for pursuing with these tests before LS2. E.Todesco recalls the reasoning behind this test. This was foreseen to be initially a double magnet to give the higher gradient required by ATS. In light of the ABP partial relaxation on higher gradient, dictated by the optics, the baseline could be changed to only one magnet at 1.9 K temperature (rather than the present 4.2 K) to gain the margin necessary for the 180 T/m gradient. A test of a similar magnet type (MQY) showed its ability to reach 180 T/m at 1.9 K. In the case of 1.9 K operation, there should be a modification of the cold mass as agreed with cryogenics. On the other hand, at 4.5 K, the magnet works at 84 % from its maximum, so maybe it will be possible to have it operating at 95 %. L.Rossi stressed that this would though be the only LHC magnet working beyond ultimate and this is why the HW test seems to be mandatory. E.Todesco agreed that there is a clear risk, and that in the opposite case the optics will suffer. L.Rossi added that in case the magnet shows that it is too prone to quench (e.g. due to beam losses) during Run 4, there will still be time to replace it during LS4. E.Todesco finally stressed that if this test shows good results, it will lead to a change of the baseline.

AOB

Before closing the meeting, O.Brüning asked F.Sanchez Galan about an estimation for an update for the Q1 and TAX considerations. F.Sanchez Galan replied that it would be possible in the next couple of months. L.Rossi finally proposed that the presentation of R.Calaga is not just a short AOB but that it includes the outcome of the performance reach of the first crab cavity prototype tested by US-LARP (both DQW and RFD) and at CERN (SPS double quarter wave).

The next TCC meeting will take place on the 16th of March 2017.