



23rd Meeting of the HL-LHC

Technical Committee

Participants: C.Adoriso, G.Arduini, A.Ballarino, V.Baglin, I.Bejar Alonso, M.Bernardini, O.Bruning (Chair), R.Calaga, S.Claudet, B.Delille, I.Efthymiopoulos, P.Feracin, P. Fessia, M.Fitterer, J.Gascon, B.Di Girolamo, E.Jensen, R.Jones, T.Otto, Y.Papaphilippou, H.Prin, S.Redaeli, F.Rodriguez Mateos, L.Rossi, G.Rumolo, A.Siemko, J.-P.Tock, E.Todesco, R.Van Welderen, S.Weisz, D.Wollmann, M.Zerlauth.

Excused: F.Bertinelli, E. Cennini, P.Collier, G.De Rijk, M.Lamont, L.Tavian

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

HL-LHC PLC/TC homepage: <https://espace.cern.ch/HiLumi/PLC/default.aspx>

Indico link: <https://indico.cern.ch/event/373542/>

O.Brüning opened the meeting highlighting some actions, as were reported on the minutes of the 22nd TC. Regarding the comment about the circuit current ratings, J.P.Burnet and A.Ballarino will clarify this in the next PLC (4th of June). There was also an action on himself and L.Rossi for converging with B.Goddard on the final location of the CC in the SPS. There was a final action on WP2, WP3 and WP6, for finalizing the powering configuration of triplets and different options. G.Arduini mentioned that a first discussion was organized by M.Giovanozzi. L.Rossi stressed that, in the future, this item should be taken over by Mr.Circuit (1st point of today's agenda). Finally, the actions for space requirements (downstairs versus surface option) will be described by I.Bejar-Alonso today (new baseline).

O.Brüning proceeded by introducing today's agenda and AOBs.

Mandate of Ms.Inner triplet STRING and Mr.Circuit for HL-LHC, L.Rossi – [mandate1](#), [mandate2](#)

L.Rossi introduced the mandate of Mr. Magnet Circuit, a function that existed in the LHC, although appeared quite late. In the HL-LHC project, this appointed person will lead the optimization and quality of the electrical circuits for the magnets. WP2, WP3, WP6, WP7 and WP11 are indeed involved with this optimization but Mr. Circuit is supposed to coordinate and monitor these activities towards the operational conditions. In fact, the number of circuits is impressive and the optimization should focus on magnet design and performance, magnet and circuit protection, optics and operations constraints, cold and warm powering. The appointed person (F.Rodriguez Mateos) will be free to decide the organization of this task. The mandate includes the monitoring of the activity through HW commissioning (similar to the role of EE working group during the LHC times). A.Siemko asked whether the

mandate included the warm DC cabling between feed-box and PC. L.Rossi answered that this is a water cooled cable and it should be on the responsibility of EN-EL group, as part of the warm powering WP. He added that both mandates will soon be published as EDMS documents. O.Brüning stressed that F.Rodriguez Mateos will be invited in PLC and TC committee from now on.

L. Rossi proceeded by introducing the need for coordination of the inner triplet string. This was approved by the enlarged management board. M.Bajko is appointed as responsible of this task. The leader should prepare a test plan and decide suitable way to carry out the work (task force, working group, or other). A.Siemko asked what is included on the budget for this task. L.Rossi answered that there is only limited budget allocated (the task is about coordination), as the equipment is part of WPs. Only manpower is included. A.Siemko further questioned about the inclusion of the interconnect budget. Again, L.Rossi replied that the budget should come from the relevant WPs budgets. He stressed that logistics and test plan are important for the task. The leader of the task will be consultant of the HL-LHC project. She will report to the project management and the decisions validated by the TC or PLC.

Safety aspects for HL-LHC, T.Otto – [slides](#)

T.Otto introduced the safety framework for HL-LHC. After one year experience, there is enough evolution to present the way it is implemented in practice. The goal of the task is to produce/procure safe equipment in a safe way. S.Weisz mentioned that installation and operation should be included and T.Otto agreed that these aspects should be also treated, although they are out of the scope of the project for the moment. He proceeded by explaining the two flavors of safety: conformity and occupational health and safety (OHS). He outlined the approaches: for the conformity aspect, it starts with functional analysis (hazard register), leading to the launch of safety agreement (LSA), including rules deliverable, certificates, etc. Following the HSE safety clearance, a LHC safety file is issued (by the safety officer or safety unit responsible). The OHS branch includes the production of the equipment with the following steps: Process analysis, recommendations, implementations and follow up. This part is in the hands of the department safety plan. For example, the 11T dipole as an equipment design should follow the conformity branch (e.g. mechanical and electrical codes) for satisfying regulations. The process (or production) part will look at the places, which is assembled and tested. Analysis of work processes has been already started, including machines used for the work, and proceeding deeper to the analysis of how people use these machines, with the goal to finally give recommendation to the department for its safety plan.

Regarding system identification, a graph from WP3 was shown with all different magnets. Every time there is cryoassembly, some safety documentation is needed. There is one LSA for all magnets (they are identical from the safety point of view). There is a hazard identification step (OHS and conformity branches), before proceeding to the safety agreement (LSA) for conformity. This is a 30-40 pages document and there is mutual engagement of safety unit and T.Otto for establishing it. For the OHS and regarding the safety analysis of workplaces, established methods are followed (rules according to existing

status-quo at CERN). T.Otto proceeded by describing the different roles in the process. The hazard identification process is triggered and finally approved by the PSO, after registered and reviewed by the WP leader. After this, the LSA memorandum is issued and reviewed. The HES unit gives the clearance. I.Efthymiopoulos mentioned that regarding radioactive regions, an intervention should pass by the WP hazard register and, consequently, it should be organized within the WP, in the optimal way for radiation protection, following ALARA. T.Otto completely agrees with this point. L.Rossi and O.Brüning both stress that in order to guarantee continuity of the work and maintain a global vision, the group leader should appear with some role. A.Siemko adds that the hazard identification, being a deeply technical matter, should be first approved by the group leader and then by the PSO. T.Otto agrees also with that point.

T.Otto proceeds with the description of the OHS branch. The machine conformity is assured by an external company (DEKRA). After the workplace analysis, recommendations are given to the responsible of the workshop and eventually to the department, triggered by the PSO. Some open questions: Regarding the safety analysis for workplaces, TE has agreed, but agreement needs to be met with other DSOs. Areas outside of CERN premises (i.e. collaborating labs) are not in the scope of OHC regulations. The 2nd open question is the scope of LSA, as the project needs planning certainty also for RP aspects. He finally gives the status for WPs treated with respect to safety. The process will be started for the remaining WPs with a rate of about 2/month.

Discussion

S.Weisz mentioned that there should be a link with the LHC safety file for installation aspects. O.Brüning came back to the points on the radiation aspects (taken care by RP) and the fact that group leaders should be added to the approval process.

Actions: Group leaders should be added in the safety approval process. T.Otto will discuss with the HSE unit on the procedure for integrating radiation aspects in the safety procedures and report back to the HL-LHC TC.

Vibration study and measurements for HL-LHC civil engineering, P.Fessia – [slides](#)

P.Fessia summarized the half-day meeting organized with G.Arduini, for possible impact of CE works in the LHC. The agenda covered several topics: general plan, vibration source, LHC limit, orbit feedback, reviewed literature from data, other possible HD test, results of SM18 tests, ideas for measurements and MDs, work on CLIC and conclusion. He proceeded briefly reviewing the conclusions and actions for each talk:

J.Osborne presented the CE planning and the vibration sources. Regarding this latter, he showed an estimate that at 45m from source, a 0.6 μ m displacement should be expected. There are several doubts though about the robustness of the estimation (coming from ARUP consultant). He also showed spectra, pointing to frequencies between 20 and 100Hz. A discussion should be organized between MME and ARUP to clarify the approach and the

impact of the different physical quantities to the spectrum.

M.Fitterer presented the LHC limits. Based on a worst-case scenario, alternated or side-alternated movement of IT is the most probable. 1 μm of displacement in the IP is translated to a maximum of 340 μm on the collimators, stressing that high-loss spikes were observed in 2012, for 40 μm displacement at the primaries. Fast orbit feedback could be envisaged and magnet specs seem reasonable. TBT data measurement analysis show spectrum peaks at 8 and 20Hz, compatible with triplet resonances measured at SM18. G. Arduini explains that the 20Hz line may be close to the synchrotron tune at collision. It can be associated to mechanical vibration if the amplitude increases during the squeeze, while the voltage is constant.

J.Wenninger analyzed the possibility to install a new feedback system. The present one cannot cope with a range between 100-200Hz. A feedback loop at 1kHz requires new acquisition system, new Ethernet network, new controller, adequate magnets and PCs. It should be a fallback system but not the solution for LHC. J.Wenninger will proceed to a rough evaluation because it may be needed for HL-LHC, in any case.

L.Lancy reviewed measurements performed around the world. The data is interesting but not really relevant for the particular case in the LHC.

P.Fessia presented possible other HW tests, with main candidate measuring the vibration from SPS to LHC. They were organized to be performed on the 5th of May.

M.Guinchard presented the measurement results in SM18, where the vibrations were amplified by a factor of 1-100 from the cryostated triplet. Analysis is still on-going but two alternative measurements were already proposed, for getting more information about the spectrum.

M.Fitterer presented two MD requests for tests in the LHC, and these should be treated with the highest priority.

S.Janssens revised the CLIC technology for vibration damping, which, although interesting, is not applicable to the case of the LHC.

P.Fessia then presented some highlights and finished with the HL-LHC consequences: the future HL-LHC triplet should be designed in a way to damp the ground motion excitation. WP3 should take this aspect into account for the design of the cold mass support, the cryostat and the cryostat support. According to result coming from WP3 analysis, an intervention on the tunnel floor, in order to make it "vibration absorbing", could be studied and implemented but with non-negligible impact on LS3 schedule.

The final conclusions are: Presently there does not seem to be any margin to perform CE engineering work during operation. A fast feedback system (which is presently not required for LHC machine operation), can be developed, but it can only be a fall back mitigation plan in case of delays. Such a system could be useful for HL-LHC if no other means can be found to damp the HL-LHC triplet vibrations. Vibration studies will go on for better quantification but, at present, the only viable way is not to perform CE work during beam time, profiting

from a delayed LS2 and its extension. A CE review will follow this summer.

Discussion

O.Brüning pointed out that there is a need to revisit the schedule and make sure that CE can be finished without interfering with operation. Another important point is the vibration studies, which should be pursued. It seems that even for cultural noise, there is need for mitigation measures in the HL-LHC (e.g. halo e-lens for collimation, cold mass redesign).

P.Fessia added that there is a worrying point to take into account for the future, due to the various geothermal drillings foreseen in the area in the next few years. There is indeed an area of exclusion, but there may be some influence to the LHC. L.Rossi pointed that we should be informed about the area of exclusion and take action before it is too late.

Summary of US-LARP meeting, L.Rossi – [slides](#)

L.Rossi introduced the US-LARP meeting, which took place this month at Fermilab. He did not go through all the talks but mainly highlighted the most important topics. Regarding magnets, the QXFS is near completion. A complete CERN impregnated coil is ready to be sent to the US and tested by end of 2015. P.Feracin mentioned that test results may be available for the next collaboration meeting during this fall. L.Rossi added that there were a lot of discussions about cable specifications. The functional requirements have started, and this is a very important deliverable for DOE. There were interesting discussions on aperture, to be reviewed and followed by WP2.

Regarding CC, there was very good progress and now engineering solutions are presented. The crisis on SC material was mitigated, designs are on track and UK is playing an important role in the cryomodule development. The SPS test may slip with respect to schedule but quality should be assured even if there are delays. The impedance impact is very important and should be further understood. O.Brüning pointed out that the previous estimates were more than an order of magnitude far from the stability margin, but now they are within a factor of 2. L.Rossi agreed but feels that a factor of 2 is still important and enlarging the aperture may be penalizing the performance. At the same time, L.Rossi praised the perspicacity of E.Jensen who preferred to keep some margin for the unknown and did not proceed to the reduction of aperture when this question came up two years before. Regarding collimation, the layout is near to final. There is a worry about the Mo-graphite, which appears to be not stable (debris were reported) and need a follow-up. It actually behaved in a worse way than other materials under very high irradiation doses.

Action: S.Redaeli should present in one of the following TCs the updated results and an action plan for the Mo-graphite collimator material.

There were discussions about the test bench for the e-lenses, and the hollow e-lens option for halo control. Regarding the possibility that the hollow e-lens becomes a baseline, O.Brüning stressed that the key ingredient is the observation of losses when beams are brought into collision at 6.5TeV. From operational experience and the tests of alternative methods conclusions may be drawn. After the meeting, S.Redaeli pointed out that, for

collimation, one of the main concerns is the spiky behavior of losses throughout the cycle, according to the observations in 2012.

Finally, there were several presentations for the use of e-beams for BBLR compensation and its benefit on DA but also lifetime, for some alternative parameter options.

Just before the meeting, the HiLumi budget of DOE was presented (181M\$ versus the requested 220M\$). LARP management will fight for an increase by roughly 10%. In addition, an International Collaboration agreement was signed between CERN and DOE. O.Brüning stressed the importance of milestones in the US part of the project (CDO) and that an update of the schedule should be communicated to LARP.

Discussion

B.Delille asked what is the impact if the DOE budget cut persists. L.Rossi replied that G.Apolinari is working on this, as the information was still very fresh to have a clear action plan. R.Calaga asked whether there is a procedure for accepting non-baseline items. O.Brüning replied that the implementations should be first discussed in the PLC. For certain items, as the e-lens there is also a budget impact. R.Calaga mentioned that the 25ns run will be also important for the decision about the inclusion of an harmonic system in the HL-LHC. L.Rossi mentioned that in one of the following TCs, the impact on cryogenics will be discussed also for the installation of the harmonic system. R.Calaga mentioned that this is already communicated to S.Claudet. R.Jones mentioned that there is also an option for a second undulator L.Rossi proposed that this should be treated during a dedicated TC. S.Weisz pointed out that, as he is responsible of the integration of point 4, he would like to be kept in the loop about this.

AOB - First feedback from WP leaders for new/proposed CE baseline, I.Bejar Alonso – [slides](#)

I.Bejar Alonso mentioned that for the moment no show-stoppers were found for the double-decker solution. She presented some drawings with several different views of the area, including dimensions and other details. She would like to circulate this before the next PLC, so any feedback should be communicated to her before next Tuesday.

AOB - Closure of conceptual design specifications, I.Bejar Alonso – [slides](#)

I.Bejar Alonso mentioned that after finishing the PDR, it was important to close all specifications, clarify naming conventions and add eventual comments. She received some comments already from P.Fessia and relevant documents were modified. From now until the end of June, P.Fessia will contact everyone in case there are further modifications. G.Arduini questioned if the changes in the triplet will be included. I.Bejar Alonso answered that these changes will be reflected in the TDR but not in the conceptual design specs, for the time being. On the 5th of June, the editorial board of the TDR will meet and the list of additional

modifications will be established. O.Brüning pointed out that the specifications should be indeed updated. I.Bejar Alonso explained that there will be two versions: Version 1 will reflect the specifications as in October 2014 (PDR) and version 1.1 will be in work for including all additional modifications, as they will appear in the TDR. I.Bejar Alonso also added that Radiation Protection needs some specific knowledge on the volume for installation in order to evaluate the radiation limits. M.Bernardini made a first check were no showstoppers were found, but it depends on the associated shielding. L.Rossi stressed that margins are needed, as legislations may change during the years to come and one should think of several decades ahead for the level of radiation. C.Adorisio mentioned that the clearance to the tunnel is given for an annual dose limit not higher of 6mSv/year in case of accident (corresponding to beam lose in the worse possible point) for category B worker. A safety factor will be also included. O.Brüning suggested that a follow up should be pursued and discussed during a future PLC.

Action: Radiation protection issues for installation should be followed up and presented in one of the next TCs.

Next TC on the 18th of June.