



6th Meeting of the HL-LHC Parameter and Layout Committee

Participants: Gianluigi Arduini, Oiver Bruning (chair), Helmut Burkhardt, Samy Rama Calaga, Francesco Cerutti, Chemli, Stephane Farthoukh, Paolo Fessia, Brennan Goddard, Rhodri Jones, Roberto Kersevan, Mike Lamont, Luisella Lari, Helene Mainaud, Riccardo de Maria, Stefano Redaelli, Herve Prin, Lucio Rossi, Andrzej Siemko, Markus Zerlauth (scientific secretary)

Excused: Daniel Wollmann, Jorg Wenninger

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

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

Indico link: <https://indico.cern.ch/conferenceDisplay.py?confId=267240>

O.Bruning opened the meeting by reviewing the actions and minutes of the previous meeting.

S.Farthoukh comments that he has been given a value of 12 sigma as the aperture which can be protected by collimators. This value is assuming all tolerances to be 0 (with 10% beta beating and mechanical tolerances for ground motion, etc... of 1mm). An action is ongoing to review the situation for n1 tolerances and mechanical alignment, as a summary of which is proposed to be presented in one of the next meetings. WP2/5 needs to converge on a value for the LRIUP and Daresbury Workshops already.

O.Bruning proposed to establish a list of renovations and actions that will NOT be performed in LS1 but rather during LS2/3 to be sure to plan upcoming shutdowns accordingly. This action has been given back to PLC, the HL-TC will however first establish a list of activities that are required for HL-LHC. The latter should also become clearer during the upcoming consolidation day on the 12th of September.

Oliver highlighted a request of Ezio Todesco to define/agree on the types of correctors required in the quadrupoles of the matching section. G.Apollinari will be at CERN for a review of the conductors in ~ 1 month – it would be beneficial to have a meeting with him and the involved people.

Following the defined Action on cryogenic needs in the inner triplet a detailed presentation will be made in WP2 on the 13th of September.

Integration studies are ongoing for the Q4/Q5 at 1.9K (P.Fessia), but still need to be completed from a functional side.

The verification of helium needs for the crab cavities is still ongoing (R.Calaga to verify).

Outcome of collimation review and update on upgrade plans – (S.Redaeli - [slides](#))

S.Redaeli highlighted the scope of the collimator upgrades, with the focus of the May 2013 review being to improve the cleaning efficiency. Upgrades of some critical collimator might have to take place already in LS2 as first limitations may otherwise already arise at 7TeV.

The review committee has been asked to look into the various aspects of the presented upgrade baseline and advise in particular on the need to pursue R&D on 11T dipoles for a possible installation in the LHC for LS2.

An overview table concerning the DS collimation needs by IR has been presented. While upgrades before LS3 are thought to be required only for ion operation, the HL-LHC era will most likely also impose upgrades of IR1/5 and IR7 for proton operation.

The presentations during the review considered a minimum lifetime of 0.2h (based on the 2012 experience), which may be a pessimistic assumption. Around 10% of the 2012 fills reached however minimum lifetimes of below 0.5-1h. More detailed statistics remain to be established for fills that truly approached 0.2h, it is believed that under these conditions beams would most likely be dumped due to too high beam losses.

Depending on the models used, the intensity reach from proton cleaning in IR7 at 6.5 TeV is a factor of 3-6 times the nominal expected intensity of $2808 * 1.15 e^{11} p$. This factor is however significantly decreased for 7 TeV as the quench levels change more drastically following calculations made by A.Verweij.

For ion operation the ALICE upgrade target is a factor of 2 above the currently assumed quench limits (same limitations apply for IR1 and IR5 which have however less priority for ion runs).

No additional limitations are otherwise expected from IR1/5 until LS3 from physics debris. All the present limitations could be solved by the local DS collimator combined with 11T dipoles. A modular solution suitable for all IRs...

The following (main) recommendations have been made by the review panel:

- Strong recommendation to continue development of 11T dipole and local collimation cleaning – CERN should be ready to build by LS2 at least 4 units (1 unit being 2 magnets, by-pass cryostat and the new collimator).
- 4 units is the minimum for IR7 (if limited by quench), otherwise 2 units for IR2 ion operation (with IR1/5 that have to stop at a luminosity below the quench level)

- Finalize the analysis of quench tests (M.Sapinski, B.Auchmann - QTAWG).
- Continue studies of material studies with additional beam tests, especially the option of Molybdenum-Graphite looks interesting also in terms of reduced impedance. Following a question of O.Bruning, S.Redelli commented that additional tests are already planned as soon a High-Rad-Mat resumes operation. A first prototype is planned to be installed in the machine during the Christmas shutdown 2015 (installation requires a longer stop due to following bake-out...). For the prototype 4 new cables are needed for additional BPMs. Two spare slots have already been requested providing the required infrastructure.

L.Rossi commented that the intensity reach has been calculated based on nominal performance ($1.15e11p/bunch$), however after LS2 we might approach ultimate values, hence the margins could potentially decrease by a factor of 1.5.

Additional items potentially subject to upgrades were presented, aiming at improving the cleaning performance, impedance and robustness of collimators, operational efficiency and protection aspects of e.g. warm magnets in cleaning insertions and to support new layouts in experimental IRs.

In the high-lumi insertions IR1 and IR5 a new TCT might become necessary to increase the protection of the Q4 in case it becomes a limitation. This is being investigated by the COLL/FLUKA team along with a TCL to protect against increase physics debris from the outgoing beam. O.Bruning recalled that space reservations for such additional items should be made early on in case this need is confirmed.

In IR7 spare slots for new collimators are already foreseen and fully equipped. The plan is to replace/add new secondary collimators with BPMs and further reduced the impedance (first prototype test in the LHC planned in 2015).

Presently there are no plans to modify the primary collimators and absorbers other than revising the spare policy (all new collimators should be equipped with BPMs). A first experiment for testing of crystal collimation during dedicated MDs is being prepared in IR7.

IR2/3/8 currently have less priority/need for changes. In IR3 spare slots are available to replace (add) new secondary collimators with BPMs and reduced impedance. An ongoing activity with magnet and FLUKA teams is aiming at and improved lifetime of the normal conducting magnets in the cleaning insertions.

IR4 is the only collimator free IR but is a potential candidate solution for the installation of a hollow e-lens for beam halo control (requires collimators in IR7 to be correctly positioned nevertheless).

The goal is to be ready to start construction of 2 elements in ~2015 in case operational experience after LS1 indicates the need for such devices in prospect of HL-LHC. At present the design effort is concentrated at FNAL within the US-LARP collaboration. Space reservations in IR4 also have to consider new/upgrades of devices such as:

- Higher Harmonic superconducting 800 MHz RF system
- Electron lens for beam halo control
- LHCb Velo like installation for 3d bunch imaging
- Upgrade of the LHC transverse damper
- High bandwidth damper system for beam stabilization with e-cloud.
- Stochastic cooling system for ion beam operation.

Action: Establish a list of items to be newly installed/upgraded IR4 and report in next HL-PLC (P. Fessia)

Progress with naming conventions, hardware baseline, preliminary layout (S.Chemli - [slides](#))

S.Chemli presented the preliminary layout of LSS1 left (based on the optics file received by R. de Maria). Dedicated drawing codes have been created, for the time being no control or archiving is however being done. There is an ongoing action for the integration team to provide first simplified 3D models (requires further work to define outer envelopes of cryostats...).

While the triplet region is by now well defined, there is no detailed integration for the D1-D2 beam separation area yet (requires additional work include CC, TAN...). The goal is to clarify this before the HL meeting in Daresbury in order to provide a version 0 as a first baseline.

S.Chemli added that collimators are equally not yet integrated.

L.Rossi commented that he layout should also be optimized/completed with VAC equipment, TAN...

Naming definitions have been done for magnets, cryo-assemblies, cavities and the Beam Beam compensator (BBC), items that still need official names to be defined are e.g. the new refrigerators in Point 4, superconducting links, DFBs, Absorbers (TAN, TAS), beam instrumentation....

P. Fessia noted that additional names also have to be defined for the cryogenic power plant in IR1/5, QRL and vertical links.

S.Fartoukh commented that the shown magnet names should be crosschecked as e.g. the skew sextupole in the triplet should rather be named MCSSXF then MCSXFS if we follow the logic applied for the LHC naming.

New equipment codes will most likely require their length to be increased to 8 characters – technically this looks feasible so far for Layout, MTF, EDMS and the Naming database but remains to be verified for CDD.

In the LHC hardware baseline the first nodes are already defined (Q1, Q2, Q3-D1, D2 – related corrector packages). These are however only top nodes for the time being, the detailed structure is still to come.

Currently no versioning is applied (current version is V0), but is possible to be applied if needed.

O.Bruning requested to include the DFB/powering Layout for IR1/5 for Daresbury meeting. The collimator upgrade in IR2 should be added once a first integration study is done.

P.Fessia stated that the resources for these integration studies are currently very limited – still the focus is currently on the high-lumi project. He pointed out a conflict in longitudinal length of the DS collimator (between magnet and collimator length) – integration can only start once this issue resolved by equipment integration first.

S.Fartoukh commented that a longer Q5 will be required in IR6. S.Chemli confirmed that this will be integrated accordingly once the work for IR6 has started.

S.Chemli concluded his presentation pointing out that nothing has been done yet in the Layout DB for this – not yet inserted the sequence file. Once this is required will create a version 0 and start inserting this.

Action: Establish a bullet point list of HL-LHC items that are not yet included in the layout/EDMS (S.Chemli, P.Fessia, HL-PLC)

O.Bruning concluded that the work is progressing well and requested that regular updates on the progress will be presented in forthcoming meetings.

P.Fessia added that along with Samy he is developing a new template for functional specs for HL-LHC. The idea is that detailed integration work will only start after approval of a basic functional spec of a few pages pages.

Action: Organize a dedicated meeting for required voltage of crab cavities as an outcome of the latest SM18 tests and new crabbing schemes/layout to converge on final voltage value and need of a Q7bis (HL-PLC)

Action: Assess radiation impact on crab cavities and report in future meeting (F. Cerutti, R.Calaga)

HL-PLC Glossary – Update and additional definitions (M.Zerlauth - [slides](#))

The progressing HL-LHC design and future operation requires the continuous maintenance and extension of the glossary and definitions to ensure coherence across the various activities and to prepare the future integration into e.g. the existing Layout Database.

A number of additional definitions concerning pile-ups, pile-up densities, luminous region and the various luminosity reduction factors have been proposed by F.Gianotti and will be added to the glossary.

Action: Comment on calculation of total luminosity reduction factor tbc with O.Bruning/H.Burkhardt

Definitions to quantify machine statistics have been presented, which require to clearly delineate normal operational cycle from faults, downtime, technical stops, MDs / special physics runs, etc.

Assessing fault/downtime of the machine is by far not obvious and requires dedicated tools to identify blocking faults, fault origins....

Following several discussions, LHC operation and the Availability Working Group (AWG) [Evian 2012] endorsed to adopt the simple definitions contained in the slides with the main aim to

Allow for comparison of data sets (operation years/runs...)

Allow an easy calculation/implementation of definitions with current and future data (on-line statistics)

Allow for luminosity predictions for post LS1 and HL-LHC

The consensus of the discussion was that the presented definitions are a good basis but additional ones might be required for more detailed performance analysis of the LHC.

AOB (all)

- H. Mainaud commented that the action in defining space reservations for the survey around the crab cavities is still ongoing. She will report back in an upcoming meeting.
- R.Jones gave an update on BPM development and installation foreseen for the high-lumi insertions ([slides](#)).
It is important to note that the aperture of the BPM is NOT related to the length and a given BPM can be adapted for any aperture. Large aperture however means less signal and lower final resolution.

The final choice of length will be 220mm minimum for a cold stripline BPM, respectively at least 285mm for a warm stripline BPM. The needs for larger aperture are an issue just before the Q2b, Q3 and the corrector package. A tungsten body of the BPM is not a big benefit as continuous shielding at small radii is required. The only solution for the three BPMs where large aperture is an issue is to increase the aperture, rotate the BPMs by 45 degrees and add Tungsten inserts on mid-planes to maintain the aperture of the beam screen.

The detailed integration of the devices needs to be done between the BI and VAC group (at the end of the beam screen). The thickness of the inserts is not

considered a big issue (body normally stainless steel). C. Boccard is currently working on a more detailed design. Gianluigi suggested that impedance aspects are considered early in the design because of the large beta functions at the triplets.

For simplicity the Q1/Q2 BPMs might be using the same design as the ones further downstream.

- The progress report on optics validation has been postponed to the next meeting.

The 7th PLC meeting will be held on the 3rd of December at 09:30 with the following tentative agenda:

- Radiation constraints versus lifetime of nc magnets in IR3/7 – P.Fessia
- Status of BBC – R.Steinhagen
- IR4 space integration – P.Fessia
- n1 clarification and alignment and error budget – R.Bruce
- AOB
 - Progress with Optics validation – R. de Maria
 - Survey space reservations around crab cavities – H.Mainaud