



Minutes of the 127th WP2

Meeting held on 21/08/2018

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1 GENERAL INFORMATION (G. ARDUINI)

The minutes of the two previous meetings have been circulated. **Gianluigi** went over the actions of the previous meetings. **Nicolo** reported that the measurements of the TCLD have been finished, the latest data on HOMs is consistent with simulations. The results will be presented at the next Impedance meeting, after which an AOB can be done at WP2.

David has supplemented his analysis of TMCI threshold with two scenarios for HL-LHC with uncoated Molybdenum-Graphite (MoGr) secondary collimators: the first case corresponds to the full collimator upgrade, and the second – to the LS2 subset.

Nicolas started looking into the potential of using short, 12 bunch, trains for stability studies. According to his past research, the impact on TMCI threshold is expected to be minor – 20% with the full ring. **Gianluigi** emphasized that the point is to understand if a measurement can be done and if it can yield new information now that the trains are available. **Elias** commented while the test is certainly possible, obtaining the predictions might require some work and the impact seems small. **Nicolas** noted that the simulation data would need to be cross-checked with particle tracking. **Gianluigi** proposed to make a measurement and see if there is a discrepancy with the present model. **Rogelio** suggested a test could be done during MD4.

Massimo is returning next week and will present **Frederik's** results on the impact of systematic b6 errors on the Dynamic Aperture (DA). **Riccardo** will get in touch with **Frederik** to discuss the constraints on tunability to be used in the future DA studies.

Stefano reported that the orientation of the CFC blocks has been checked with **Oliver Aberle**, according to whom the possibility to install them along the orientation with a lower conductivity was excluded by the geometry of the material blocks. **Gianluigi** inquired if it still makes sense to perform a measurement in the lab. **Stefano** replied such a test can be done; there is a CFC block and a spare collimator available for measurements. **Nicolo** noted the measurement would be easier to perform on a block sample. **Elias** proposed to invite **Oliver Aberle** to explain the argument at WP2.

Xavier mentioned he performed additional studies for asynchronous collapse of separation bumps. A large amount in the required ATS strength can be gained. **Riccardo** asked if the current operational (OP) scenario should be kept as is until the feasibility of the alternative is proven. **Gianluigi** pointed out one needs to understand the constraints, in particular if one can stop after LS2 with the collimator upgrade

ACTION (Stefano): Provide a spare CFC block to Nicolo for resistivity measurements.

ACTION (Stefano): Contact Oliver Aberle to see if he can present on the details of fabrication and installation of CFC blocks in the LHC collimators

2 UPDATE V1.4 OPTICS (R. DE MARIA)

Riccardo reported on the progress with the new optics. The changes involve the number of crab cavities per IP side (4 to 2), Q4 and Q5 quadrupoles, remote alignment system, extended D1 dipole beam screen, TCTPV/H and TCLX collimators, corrector lengths and strengths, IR7 and IR2. The yet missing parts include the final positions of corrector within the Corrector Package (CP), a comparison with mechanical drawings, accounting for the nominal vs design magnetic length, and a possible Beam Position Monitor (BPM) displacements close to D2.

For the optics, the crossing bumps have been optimized and new aperture estimates have been produced to take advantage of the remote alignment system. The new set of optics is dedicated for 7 TeV operation, feature an IR4 optimization for instrumentation and electron lens, and $1.5 \text{ m } \beta^*$ in IP8. An open question remains whether to implement the telescope optics (ATS) during the Squeeze.

A novelty in v1.4 is a study of the crabbing angle. If an asymmetric crab cavity layout is allowed in IP1 and 5, the angle can be increased by up to 3% via changing the position of the crab cavities: $388 \mu\text{rad}$ vs $375 \mu\text{rad}$ for 200 T/m strength of Q7. An extra improvement is possible with a higher Q7 current. The plan is to ask TCC for a measurement of Q7 at the Ultimate field of 214 T/m.

The orbit corrections are done as usual at the relevant BPMs. The BPM errors in the triplet are what drives the orbit errors. The situation may improve if the new BPMs prove to be more accurate than the present one.

The IR4 optics is taken from the one proposed in the last WP2 meeting, without introducing an optics transition in the ramp. The work is currently in progress to obtain a smooth squeeze procedure for round optics for Beam 1, for which the challenge is a large variation of the internal phase advances. A global re-optimization of the phase advance is probably needed. The round optics for Beam 2 and the flat optics for both beams are OK.

A potential constraint for the new optics is the TCDQ interlock margins. Unless the margins on the TCDQ gap are relaxed, a solution cannot be obtained for the present TCDQ design at flat top for flat optics (at the end of squeeze only flat optics can accept larger gaps).

From the aperture point of view, there is a sufficient margin for round optics for any crossing plane thanks to remote alignment. Additional aperture margins can be obtained for round optics imposing a Vertical crossing in IP5. However, a Vertical crossing in Point 5 limits much more the flat optics, because of the aperture bottleneck is in the Horizontal plane (limited by the TCT-TCDQ phase advance) and the difficulties with IR6 optics. The choice of vertical crossing with crab cavities will limit the β^* reach in the parallel separation plane (V), whereas the increased aperture in the crossing plane (H) can only be used to relax the collimation settings and not decrease β^* which does not improve performance any further below 18 cm.

- For the mechanical drawings, **Gianluigi** proposed to set a deadline in time for the TCC presentation as a deadline to include additional changes.
- For the actual magnetic length, **Gianluigi** inquired how it was done for LHC. **Riccardo** replied that for LHC the magnetic lengths on the drawings are not consistent with the real values. For the HL-LHC the magnetic centers will be indicated, but mechanical engineers oppose putting the measured magnetic lengths on the drawings in order not to create a confusion. **Gianluigi** proposed raising the matter at the TCC.
- Concerning including the ATS procedure, **Gianluigi** emphasized the, first, one needs to converge on settings that satisfy both DA and stability requirements. **Xavier** proposed having a higher telescopic index and adjusting the octupole current in required by DA concerns. **Riccardo** noted that having a too large telescopic index might have negative side effects, i.e. for optics correction. **Rogelio** commented that a high telescopic index of up to 3.0 is tolerable from the correction perspective. **Elias** stressed the need to have a larger index, noting that the stability “margin is not a margin”, in a sense that it is required to account for the less-explored detrimental effects like noise. **Gianluigi** proposed Xavier to suggest 2-3 settings to be studied from the point of view of DA. **Gianluigi** summarizes that the first priority is define a stability scenario compatible with DA then the squeeze procedure can be defined.
- For the choice of the crossing plane, **Gianluigi** proposed leaving it as is for the moment: Horizontal in IP1 and Vertical in IP5 but the pros and cons should be reviewed taking into account the impact on flat optics (including those versions with crab cavities).The gain in crossing angle with an asymmetric layout seem marginal to justify an asymmetric layout. .
- For the solenoid, **Stefano** confirmed the change in the aperture. **Riccardo** identified the next step as identifying the exact length of the device. **Stefano** replied that the integration envelope has not changed.
- Concerning the TCDQ constraint, **Stefano** raised a doubt that a decision could be made without the experience of Run III. **Gianluigi** asked if a change of beam position could help gaining a little margin. **Riccardo** replied it does not help in general. **Rogelio** proposed changing the β -function. **Riccardo** explained it cannot be done at Injection and would require redoing the transition. **Gianluigi** asked to clarify how critical is the problem. **Riccardo** explained that if nothing is done, presently it is impossible to reach the Ramp. **Stefano** noted that there might be no time to work on the TCDQ until mid-LS2, making the upgrade difficult for Run III, but it can be done for Run IV. **Gianluigi** emphasized the importance to understand where the 0.5 mm interlock margin for Run

III comes from (for Run II it is 0.9 mm and HL-LHC is 1.2 mm) and if it can be assumed for Run IV as well; if not – why. **Elias** proposed to quantify the impact on the beta* in the TCDQ is not upgraded and one cannot reach the required 0.5 mm in the interlock margin. **Gianluigi** concluded that there are two options: either reduce the margin, based on the experience from Run III, or act on the TCDQ, and emphasized that the issue has to be brought to the TCC.

- For the aperture margins, **Gianluigi** proposed not quoting the numbers without the remote alignment. **Elias** inquired which IP is assumed when quoting the crossing plane. **Riccardo** clarified it is IP5.
- The IP7 absorber protecting the MQW magnets planned for installation in LS2 should be added

ACTION (Xavier): Summarize in an e-mail the ATS squeeze factors to be studied for DA.

ACTION (Stefano): Discuss the values for IR6 TCDQ interlock constraints for Run III and HL-LHC with WP14 and come back with a proposal.

ACTION (Riccardo): Assess the impact on β^* if the TCDQ is not upgraded and the 0.5 mm interlock cannot be reached.

ACTION (Riccardo): Check with Rama if there are arguments against breaking the crab symmetry on their side.

ACTION (Riccardo): Supply to BI a specification on orbit accuracy requirements of the new BPMs

ACTION (Riccardo): Add absorber protecting MQW magnets in IR7

3 GUIDED DISCUSSION ON THE CURRENT STATUS OF WP2 ACTIVITIES (R. TOMAS)

Rogelio presented MD proposals for MD3 and MD4 blocks. Due to a limited MD time priorities have to be set up. The MDs were separated in several groups: ATS, Heat load and electron cloud, Impedance and instabilities, BBLR wire compensation, optics control, crystal collimation, collimation.

- **Stefano** made a general comment that it is clear that all the aspects of machine performance will not be used in the first year of Run III, thus some ideas can be tested after LS2. **Stefano** also asked about the need to schedule MD4 activities this much in advance. **Rogelio** explained that MD4 will have only three days, it is therefore of utmost importance to schedule all high priority items that do not fit in the MD4 during the MD3.
- Considering the ATS MDs, **Gianluigi** inquired on the need to do a study with round optics and a large number of bunches. **Gianni** replied the goal is to study beam stability for Run III; if there is no plan to have ATS from day 1 in Run III, confirming the stability with bunch trains now is not critical. **Rogelio** made a comment that it is not clear if another flat optics MD is needed. **Gianluigi** asked about the purpose of the TCDQ leveling study. **Stefano** replied that he was not fully aware of all MD details but the procedures involved in the MD looked rather standard.

- **Gianluigi** emphasized the top priority are the heat load studies, since the heat load is what potentially limits performance. **Gianni** identified the 8b4e and the 12-bunch trains as the most important studies that cannot be cut. The doublet beam can have a lower priority or be completely dropped.
- For the impedance and instability studies, **Xavier** stressed the new damper pick-up electronics must be tested before LS2. **Gianluigi** inquired on the progress with disentangling the impact of different noise sources. **Xavier** replied that it is difficult to design such an experiment. **Gianluigi** asked if one can measure an impact of a real noise in the machine on beam stability by studying the stability in the presence of higher noise from the main power converters (active filters off) and at different phases of the cycle. **Xavier** replied this can be done at the end of the fill, but octupole threshold measurements has large error bars. The performance limitation comes from the noise-induced emittance growth. Regarding the train MD studies, **Gianluigi** commented that the effect of coupled-bunch motion on the Transverse Mode Coupling Instability (TMCI) threshold seems small. **Gianluigi** asked to clarify what an ‘anti-damper’ stands for. **Sergey** explained the idea to use the ADT feedback to probe the strength of Landau Damping created by the octupole system.
- Regarding the crystal collimator, **Gianluigi** proposed putting the MD in the ion run. **Stefano** noted that having the procedure tested with a proton beam would be useful to understand the feasibility.
- For the collimation, a proton quench margin in IR7 MD has been identified as a high priority test. **Stefano** mentioned that the team wants to perform a destructive test of the TCSPM collimator prototype. **Rogelio** replied that in any case this study could only be done at the end of the run, when only ions will be available and it is unclear if ions can actually damage the collimation coating.

4 ROUND TABLE

The next meeting is scheduled on the 28st of August. Sergey’s talk has been postponed until the next meeting.

5 FOLLOW-UP ON THE ACTIONS

Stefano provided a follow-up on the actions from this and previous meetings. According to the Hollow Electron lens design team, a reduction of the aperture to 50 mm seems beneficial. Oliver and Inigo have been asked to provide CFC samples for impedance measurements. Stefano and Roderick are meeting Brennan next week to discuss software interlocks in IR6 and will provide an update after that.

Benoit reported that the 80 mm valves are indeed in the baseline for HL-LHC, according to Jaime Perez Espinos, who is in charge of the vacuum layout, and Francisco Galan, the WP8 leader. WP12 leader Vincent Baglin is on holidays. **Benoit** will check both with Jaime and Vincent next week to clarify the situation once again.

Concerning the resistivity measurements, the beam screen samples are still not cut. According to **Sergio**, the plan is to have them cut next week, after which there should be 10 days for the RRR measurements (i.e. mid to end of September). The metallurgic results from Stefano Sgobba for these samples (electronic microscopy-EDX) indicate that the copper of the beam screen that saw beam is in a very good shape (both thickness-wise and pollution-wise).