

Minutes of the 44th WP2 Task Leader Meeting held on 20/03/2015

Participants: G. Arduini, D. Banfi, R. De Maria, I. Efthymiopoulos, E. Métral, Y. Papaphilippou, T. Pieloni, A. Valishev.

Minutes, Follow-up of Actions, General Information (Gianluigi)

Minutes were approved without comments.

Gianluigi added a link to the apertures and material composing the collimators in the beam parameter page of the WP2 website.

At one of the last technical committee there was a presentation on string test and magnetic measurements. Gianluigi asked a more detailed plan of measurements and whether one could apply sorting strategies. Stefano presented an updated baseline of the collimator upgrade with news on metallic collimators. The following meeting will be devoted to the matching section power scheme strategies.

Final version of Milestone report 32 will be circulated soon.

Minimum crossing angle in IP2 and IP8 (D. Banfi)

Danilo presented a summary of the round optics simulations; he showed the normalized beam-beam long-range separation of the parasitic encounters as a function of the distance from the IP. Gianluigi asked whether those with minimum separation are included. Danilo replied that this should be the case and he will verify. **Action: Danilo.** After the meeting Tatiana verified and can confirm we use 19 LR, we also have verified the impact of LR in the D1.

A summary plot of simulations in the case of beta* levelling show that baseline and ultimate scenarios are beta*=15 cm are robust and some margin is left to reduce the crossing angle if needed. For the virtual luminosity the criterion of a dynamic aperture of 6 beam sigma is satisfied also for a crossing angle of 450 μ rad. Danilo showed the impact of the addition of IP2 and IP8 (assuming the worst case of collisions without offset) on dynamic aperture and concluded that for the proposed crossing angles the impact is negligible (of maximum 0.6 σ). Gianluigi pointed out that the simulations have been performed with ± 280 μ rad half-external crossing angle, despite it was assumed ± 250 μ rad half-external crossing angle for the proposed operational scenario. Tatiana comments that simulations have been performed with two different external crossing angles ± 170 and ± 280 showing a maximum effect of 0.7 σ for the full squeezed cases. Therefore results with ± 250 μ rad should be of 0.5 σ impact for the baseline scenario and 0.65 σ for the fully squeezed. Since for baseline and ultimate scenarios we have margin the reduced angle of ± 250 μ rad is acceptable. Yannis asked if one could simulate different scenarios always placing the zero-amplitude tune on the same point. Tatiana answered that this might lead to overlap with a 3rd order resonance which is known to give an important reduction of DA. Yannis suggested to start performing tune scans to try to optimize the working point. Riccardo commented that it would be useful to verify whether an optimal working point is still optimal for the different pacman bunches. Gianluigi proposes that simulations and optimization of the working point are performed for the operational scenario that has been circulated.

Tatiana mentioned that some tune scans have been done for HL-LHC to check the working points and to identify the various resonances impact (presentation in Daresbury 2013). It seems that the present

working point is good, an increase of the dynamic aperture by 0.5σ can be obtained by reducing both horizontal and vertical tunes by 0.005.

The situation at injection should be verified as well. **Action: Tatiana and Yannis.**

Riccardo commented that the new crossing scheme for IR8 (3.5 mm separation and angular offset proposed by Stephane for 2015 run) is not yet implemented in the optics. **Action: Riccardo to build injection optics with new IR8 crossing scheme.**

Gianluigi asked about the limit of IR8 crossing angle. Riccardo mentioned that the limit at 7 TeV is mostly coming from the corrector strength. **Action: Riccardo to provide limits in IR8 for different β^* .**

HL-LHC optics follow-up (R. De Maria)

Riccardo presented a follow-up on several topics related to HL-LHC optics and layout.

Review of aperture at injection. Riccardo summarized the parameters and tolerances to be used in the calculation of the aperture margins in comparison of the old n_1 methods. For injection optics, the target is yet to be defined (a WP2/5/14 meeting scheduled on 17/4 will be dedicated to the topic). Riccardo presented a comparison of aperture margin from old n_1 and new method at injection showing that for the arc additional margins emerge due to smaller tolerances taken for energy error, spurious dispersion and beta-beating. Apertures for IR1 and IR5 in the triplet area are well above 12σ , therefore showing not to be an issue. Experimental beam pipes were not included in the calculation. **Action: Riccardo to include experimental beam pipe in the aperture calculations.** For collision optics, the target has not changed and it is 12σ for apertures protected by TCT. For the sake of comparison, Riccardo showed the aperture margins plot for Round, sRound and an LHC 2015 40 cm and $\pm 145 \mu\text{rad}$ (11σ BB separation at 6.5 TeV and emittance $2.5 \mu\text{m}$ require $\pm 165 \mu\text{rad}$, which is then more optimistic by 1.35σ as compared to the HL-LHC criteria). Round optics is below the target by 1σ , sRound approaches 8.5σ , while LHC 2015 40 cm is halfway in between (9.25σ in this optimistic scenario). Gianluigi asked clarifications on the crossing angle and the reason behind the large difference in margin between LHC and HL-LHC. Riccardo mentioned that the reasons are tighter TCT settings and margins (in particular, after checking with Roderik after the meeting 8.8σ instead of 10.5σ due to the more favorable phase advance, 5% beta-beating instead of 20%, no energy error, 0.5 mm instead of 2mm based on Run I experience, see [slides](#) and Table 2 in [note](#)). Gianluigi mentioned that the argument of the phase advance should be evaluated together with the crossing plane. **Action: Gianluigi to verify with Stefano and re-trigger the action on obtaining the TCTH, TCTV individual minimum retraction.**

Review of TAS aperture with IP offset. Riccardo recalled the decision to pass from 60 mm to 54 mm from HLLHCV1.0 and HLLHCV1.1 based on the argument that the experiments might be more protected in case of failure scenarios although no concrete failure scenario has been identified so far. **Action: I. Efthymiopoulos to launch studies to determine the maximum aperture of the TAXS that would protect the experiments in case of failure scenarios taking into account realistic alignment tolerances.** 54 mm TAXS aperture has been chosen because is the minimum aperture that is not a bottleneck compared to the triplet for the standard optics. Since then further studies confirmed also for HL-LHC that an offset at the IP may be used for aperture optimization or upon request of the experiment in case of detector misalignment (as already requested by CMS in Run I), the TAXS aperture has been re-evaluated including offsets in both planes. The analysis showed that indeed the TAXS in certain cases could become a bottleneck in the presence of IP offset. **Action: Riccardo to evaluate the new aperture that would prevent TAS being a bottleneck.** After the meeting, Massimo observed that experiments should be asked to by how much an offset can be applied for the sake of aperture optimization and by how much

the experiments expect the IP should be offset in case of detector misalignment. **Action: Gianluigi to bring the question to the coordination committee.**

Review of the D2/Q4 aperture with new beam screen. Riccardo presented new apertures estimates based on the new beam screen design made by C. Garion. The new model has smaller aperture with respect to the one assumed for HLLHCv1.1 since the cold bore thickness increased from 2 to 4 mm, and the cooling tubes from 5 to 6 mm. The resulting aperture has been reduced, but it is still within the target 12σ possible with the TCT 5 for all optics, but the Sflatv. After discussions Cedric mentioned it would be possible to reduce the cold bore thickness to 3 mm, which would allow recovering some of the lost margins. **Action: Paolo, Ezio, Cedric to confirm 3 mm thickness is possible.** A first estimate for the beam screen of Q4 has been provided based on an octagon shape, showing to be closer to HL-LHCv1.1 version. New aperture estimates will be computed with final proposals. **Action: Cedric to provide a final design for the beam screen in Q4.**

Update on error assignment routine and mask for Beam 2 (beam 4 in MAD-X jargon). Riccardo presented a summary of all the present assumptions and sign conventions on error routines for new HL-LHC elements. In particular it is important to verify:

1. if accelerator conventions (instead of magnetic measurements) and V1 apertures for 2-in-1 magnet are used by Ezio in communicating error tables. Massimo asked already Ezio who replied that it is already the case only based on the fact the no changes of conventions occurred in the last few years.
2. the orientation of the magnets in IR1 and IR5. At the moment IP mirror symmetry and symmetry IR1 and IR5 is always applied from the official drawings of the IR5 right. The baseline for Q5, Q6 is presently being discussed within the integration and cryogenic team lead by Paolo. Riccardo will update the model as soon as a solution is provided. **Action: Paolo to communicate and confirm final magnet orientation for IR1 and IR5.**

Error routines and mask files have been updated to be compatible with Beam 2 (Beam 4 in MAD-X jargon - final tests are on going). For what concerns orbit correctors, the choice is to use absolute error table since the powering of the correctors in the models do not include the imperfections that would lead to higher currents and worst case field imperfections. Data for the MCBRD and MCBYY are available for several powering scenarios from [slides](#) in WP3 meeting. **Action: Riccardo to complete the test and release the new routines before Easter.** No update has been done and planned on the beam-beam macros to allow Beam 2 (beam4 in MAD-X jargon) simulations. **Action: Tatiana and Yannis to perform a simulation on Beam 4 with beam-beam, to assess possible asymmetry in DA.**

Update on squeeze sequences. Riccardo summarized all squeeze sequences already available and needed. In particular for the new layout all optics and squeeze for IR1 and IR5 need to be redone. For IR2 and IR8 the squeeze from injection to VDM optics, and for IR8 from 3 m to 50 cm need to be done. **Action: Gianluigi will ask if 50 cm are needed for proton-ion operation for LHCb.** A review of IR6 is needed not only because of layout changes (but this would imply minor changes in the optics), but also and more importantly because Jan recently communicated additional constraints (product of beta not smaller than 90% of nominal) for all intercepting devices in IR6. Riccardo produced plots during the squeeze of all the devices showing that one critical branch is for TCDQM (Flat, Sflat, Sflatv), for TCDQA and TCSG (Flat, Sflat). **Action: Riccardo to iterate on the squeezed optics to mitigate the β changes in IR6 during the squeeze and Jan to see if some constraints can be relaxed.**

Report from Task Leaders:

Task 2.4 (Elias): A task 2.4 Meeting took place on Wednesday 18/3 dedicated to review of the past recommendations for the impedance of the Crab Cavities and of the operational scenarios (in particular for the longitudinal parameters at injection). Yannis mentioned that a Technical Committee meeting will take place to review the aspects related to crab cavities and the limits. Elias added that the next Task 2.4 meeting (Wednesday 25/3) will be dedicated to the finalization of the operational scenarios. **Action: Elias to finalize the note on the operational scenarios by the end of next week.**

Task 2.5 (Tatiana, Yannis): Miriam crossed check with Javier beam-beam simulation with noise and it was found that 3.75 μm was used instead of 2.5 μm as beam emittance for the beam-beam lens. Beam-beam lens update not finalized yet. **Action: Beam-beam and SixTrack team to quickly converge on the final implementation.**

Reported by Riccardo and Gianluigi