Minutes of the 31st Collimation Upgrade Specification Meeting 1st of November 2013

Participants: A. Marsili (AM) (scientific secretary), E. Quaranta (EQ), B. Yee Randon (BYR), S. Redaelli (SR) (chairman), B. Salvachua (BS), C. Tambasco (CT), G. Valentino (GV).
Remote: H. Rafique (HR), M. Serluca (MSe).

Indico event here.

1 Update on MERLIN-SixTrack comparison and ATS optics (M. Serluca)

Slides are available here (pdf).

1.1 Summary of the presentation

In preparation of the discussions at the Annual meeting in Daresbury, MSe presented a follow-up of the actions decided during his last presentation on the comparison between Merlin and SixTrack.

MSe showed the initial particle distribution used in these simulations, which do not include any cuts in phase space in order to be as close as possible to the SixTrack settings. The TCDQs now have only one jaw in the simulation. The settings of the TCTs and the position of TCTVA in IR2 and IR8 have been corrected, and the corresponding losses seen previously in IR2 and IR8 have disappeared. The extra TCLs of cells 4 and 6 of IR1 and IR5 have been added. SR pointed out that they are not installed yet in the machine, but for the comparison, the same layout as SixTrack is useful.

SR also asked about the bin width normalisation, which had been mentioned as a possible issue during the last presentation. MSe answered that indeed there was previously an issue in the plotting, which has now been corrected.

The loss maps of IR7 were presented, which now look similar to the SixTrack ones: they show collimator losses and aperture losses at the same positions and same local inefficiency. The only difference is a spike at the end of the second loss cluster. SR mentioned that such spikes – on individual 10 cm bins – have already been observed in SixTrack simulations, and suggested to compare the aperture models of the two codes, especially horizontal [**action: MSe**]. BS pointed out that the losses in the warm elements of IR7 seem to be underestimated by Merlin.

MSe showed the impacts on the primary collimators, as simulated by SixTrack and the old and new version of Merlin. The origin of an extra spike at the front of the horizontal TCP jaw was confirmed: it was indeed an effect of the initial distribution of the injected beam, and disappeared with the suppression of the cuts on the initial distribution.

BS expressed the need to find a way to compare these curves which all look similar and have different scales, and suggested using a different normalisation. AM added that most these curves show exponential decays, and will then show as straight lines in log scale. The slope of these lines are then easy to calculate and can show differences between curves quite simply. MSe presented different ways to compare the results of the two code, including the relative difference, which leads to issues with showing losses for one code and not the other.

The issues with dispersion were investigated by plotting single pass tracking of one off-momentum particle. The results of SixTrack and Merlin are similar, the only difference being the point of the element where the position is recorded (middle of the element in Merlin, end of the element in SixTrack). SR asked about the possible over-writing of the dispersion correction flag and the crossing angle flag. This has not been investigated yet.

In conclusion, the Merlin/SixTrack comparison is almost ready, and the benchmarking with SixTrack showed excellent agreement. The next steps include implementing the new scattering routine, the error models, and the Squeeze optics. Long term plans include new mixed materials and correct synchrotron motion.

1.2 Discussion

SR requested that the synchrotron motion should be added with very high priority, as it may affect loss maps simulations [**action: Merlin team**].

SR asked about the time taken by Merlin to track six millions of particles. MSe answered that it takes a bit more than one day, which is similar to the time scale of SixTrack. However, a question by RB brought up the fact that the Merlin results are achieved on 40 cores on parallel, whereas the SixTrack one use up to several hundreds. This would indicate that Merlin simulations are actually faster than SixTrack.

2 Collimator alignment error models in SixTrack (A. Marsili)

Slides are available here (pdf).

2.1 Summary of the presentation

AM presented a study of the effects of different error models in SixTrack on collimation cleaning for the ATS optics at $\beta^\star = 15\,cm$, with and without TCLDs. Mainly four errors are considered: on the gap, the beam center (offset), the jaws' tilt and their flatness. Typical values for these errors were presented, from experimental data as mentioned in C. Bracco's thesis.

First, separated simulations were performed for each error. As illustrations of the effect of the different errors, AM presented the distributions of particles absorbed on primary collimators, first impacts on primary collimators, and particles lost per turn. The corresponding loss maps in IR7 were presented. SR commented that even if the results seem qualitatively valid, they should not be use to draw any conclusion because only correspond to one seed, and one specific case. More statistics (seeds) would be needed.

Then, simulations were performed for all the errors together, for several seeds, with and without DS collimators. AM presented the same distributions and loss maps for the case without error models, and one example of all error models for comparison. As expected, the comparison between the loss maps show that in average the cleaning deteriorates with error. However, even in the worst case scenario (TCLD opened at $15\,\sigma$ and all error models), the TCLD provide a good protection. AM presented values of the average global inefficiency and its standard deviation over all seeds, showing an improvement by a factor 30 to 45.

Another important point in the simulation of the non-flatness of the jaws by a 2nd order polynomial is that the jaw can be bent inwards or outwards. Both cases were simulated. The global trend is that the cases for jaws bent towards the beam give on average a better cleaning than the case without error. This is also because the gap decreases with jaws bent towards the beam.

In conclusion, even in a worst case situation with bigger settings and error models, the TCLD still provide a good protection. Loss clusters situated just downstream the position of the possible TCLD disappear when the TCLDs are added to the simulation. Moreover, all loss clusters downstream IR7 also disappear, even with the error models. The improvement in local inefficiency would be even higher, up to a factor 100. SR asked for a detail study of the main loss clusters downstream IR7. AM reminded that these studies are extremely resource consuming (800 years of CPU). An important point is that the error models leads to a mismatch between the halo setting and the primary collimator setting, thus decreasing the statistics: particles do not interact with collimators. A suggestion for further work would be to compensate for this effect.

2.2 Discussion

RB mentioned that a new measurement campaign of the same errors took place recently, and that some of these values have been updated. New simulations with these values could be considered.

SR asked if the position of the halo relative to the primaries is corrected to avoid high values of impact parameters. AM answered that this is not the case, because the impacts parameters were still comparable to the ones in simulations with no error. However, this could be considered in future studies, especially with the new pencil beam routine developed by R. Bruce, allowing for a precise control of the impact parameter.

SR reminded that without TCLDs, there are also loss cluster in the arcs. The study for global inefficiency will be performed for the main loss clusters separately, and the corresponding loss maps will be added.

3 Collimator failure losses for various HL-LHC configurations (L. Lari)

Slides are available in pdf and pptx.

3.1 Summary of the presentation

LL presented the talk which will be given at the annual meeting in Daresbury. It is about the simulation of an asynchronous dump, and their validation. An asynchronous dump happens when a kicker fires outside the abort gap, kicking circulating bunches at intermediate field values.

LL presented how the kick is simulated in SixTrack, and their results of the following tracking. In the ATS optics, the MKD.406 has a phase advance of nearly 90°, which is critical. The most exposed collimator is a TCT, directly downstream of IP6; it is different for each beam. The simulation results were presented for different cases and different settings, including the nominal ones and a $2\,\sigma$ retraction, and different TCDQ alignments. The limit of plastic damage on Tungsten collimators (5×10^9 p) is reached and exceeded in some nominal cases.

3.2 Discussion

SR commented that the way the plastic deformation limit is displayed on the loss map is misleading, since many collimators are not in Tungsten but Carbon and Copper. This should be updated for the talk at the Annual Meeting in Daresbury.