Minutes of the 20th Collimation Upgrade Specification Meeting

Participants: R. Bruce (RB), L. Esposito (LE), M. Fitterer (MF), R. de Maria (RdM), L. Lari (LL), N. Mariani (NMa), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), S. Montesano (SM), B. Yee Randon (BYR), S. Redaelli (SR) (chairman), B. Salvachua (BS).
Remote: R. Appleby (RA), H. Rafique (HR), M. Serluca (MSe).

Indico event here.

1 Nominal and ATS Loss Maps Calculation with Merlin (M. Serluca)

Slides are available here (pdf).

1.1 Summary of the presentation

MS presented the result of the loss maps simulation of the ATS optics layout with Merlin, and their comparison with the same simulations performed with SixTrack.

First, MS presented the collimator settings used in the ATS simulations, and the differences with the nominal case. Then, the simulation setup was presented, notably the sequences optics used and the fact that no crossing or separation were applied for ATS.

The comparison of the beta function and dispersion between MadX and Merlin shows an excellent agreement.

The simulated loss maps were then presented both for ATS and nominal. In the nominal case, some peaks are noticeable in the arc 1–2, which are not present in the current SixTrack simulations. For ATS, the Merlin simulation reproduce the peaks in arc 7–8 and 8–1 already present in the SixTrack simulations, but also show peaks in the arc 1–2. All the peaks appear at maximums of the dispersion and beta function. Each of the smaller spikes of the arcs correspond to only one proton in these simulations; higher statistics would be needed. RdM asked if the particles are simulated with a dp/p; they are not.

Another difference is the size of the peak corresponding to the TCT in IR8: it is to be addressed [**Action: MS**].

The pre-squeeze loss maps were also presented, and do not show any critical losses. SR pointed out that the difference in peaks in arc 8–1 between pre-squeeze and collision (for ATS) is weird, because the peaks in arc 8–1 were thought to be due to the telescopic squeeze and consequently should not be present during pre-squeeze. RdM added that it only changes when the crossing angle and separation are modified. This should be checked [**Action: MS**].

MS also presented a loss map for Beam 2, and the distribution of impacts on the primary, which is very similar to what had been presented in the ColUS meeting #8.

In conlusion, Merlin loss maps for several cases were presented, and show an overall good agreement with the SixTrack loss maps. Some elements are still under work. A new scattering routine will be added to the simulations.

1.2 Discussion

RdM suggested to plot the subtraction between the optics calculated by Merlin and the ones from MadX, to show the order of magnitude of the differences.

DM pointed out that the presented losses on aperture are always under a local inefficiency of $10^{-5}\,\mathrm{m}^{-1}$, which is lower than what is simulated with SixTrack. MS confirmed, and added that higher losses have been observed in the 4 TeV case, but without obvious explanation.

2 Update on ATS loss map simulations with SixTrack (A. Marsili)

Slides are available here (pdf).

2.1 Summary of the presentation

AM presented the last updates on the ATS loss maps simulations, mainly the study of the peaks in arcs 7–8 and 8–1 with higher statistics (64 million p), the effect of extra collimators in the dispersion suppressor, and the simulations for Beam 2. The collimator settings were given. Some of the new additions to the collimation systems are the DS collimators (TCLD or TCRYO), and their settings are still under study. The settings of the TCTs were also too tight, and will be open more (unsqueezed optics).

AM presented the effect of the higher statistics on the simulated loss maps. All the peaks downstream IR7 that corresponded only to one proton lost on aperture in the lower statistics simulations (6.4 million p) were all confirmed by the higher statistics simulations. The peaks in arc 8–1 were also confirmed.

These peaks are known to correspond to dispersive losses (appear at maximums of the dispersion function for particles with $dp/p \neq 0$). AM presented the trajectory (in mm) of a particle with a $dp/p = 0.02$, making it be lost in the Dispersion Suppressor. Then, AM calculated the number of sigmas corresponding to this trajectory, showing that the beginning of the DS needs tighter settings to be protected.

The loss maps around IR7 were presented, with and without two extra DS collimators at $10\,\sigma$ in cells 8 and 10. These two collimators not only intercept all particles that would be lost in the DS, but also the ones that would be lost in the arcs. Then, the distributions of the dp/p of the particles lost in the peaks were plotted together, showing a minimum value of dp/p for any lost particle.

Then, AM presented the status of simulations for ATS Beam 2. The first step needed was to modify the existing aperture file to include the new ATS elements. The octagonal aperture shape was conservatively approximated by an an ellipse, to be usable with the current simulation post-processing tools. New aperture values were combined with new sequences to account for the elements displaced around the IPs. The crossing survey file still needs to be updated.

The loss map for B2 was presented: it shows the same features as B1. There are peaks downstream IR7, appearing at maximums of the dispersion function and due to dispersive losses.

In conclusion, the loss maps for B1 and B2 were presented. The extra peaks in the arcs were investigated, showing to come from dispersive losses in both cases. They could be limiting. The first simulations showed that extra DS collimators could solve this issue, both locally in the DS and in the arcs downstream.

2.2 Discussion

The question of using only one DS colliamtor was discussed. It is not clear as for now if only one DS collimator would be enough to protect the arcs and the DS. The distributions of momentum of the loss particles points towards it, but other effects might come into account and full simulations are needed to conclude.

The exact position of the DS collimators is not definitive. New sequences, including two shorter 11 T dipoles instead of one 8.3 T dipole and the corresponding new position of a collimator, have to be simulated.

RdM said that there might be new differences in the optics around IP8. Similarly, the aperture of the future Q2 and Q3 is now foreseen be the same as the aperture of the future Q1, with an extra 6 mm of Tungsten shielding. This makes a difference of more than 1 cm in aperture. SR added that this is more important for debris tracking simulations.

3 Studies and improvements on SixTrack simulations for crystal-assisted collimation in the LHC (D. Mirarchi)

Slides are available here (pdf).

3.1 Summary of the presentation

DM presented the status of the crystal collimation studies. After a particle-by-particle analysis of complete loss map simulation to investigate what is experienced by each particle, a major bug was found in the crystal collimation routine: for single diffractive events no energy loss was applied to the particles undergoing interactions with the crystals.

DM presented the different actions taken and tests performed to fix this bug. Different crystal interactions have been compared with real measurements from UA9 and the North Area. The now give reasonable results.

Then, the loss maps performed with and without the bug correction were presented. The debugged version shows higher (and more realistic) number of lost particles.

In conclusion, we are now confident that this simulation setup can be used to test LHC layout options.

3.2 Discussion

NMa expressed concerns about the cooling of the crystal. SR concurred by saying that it is a small volume, and that not all protons are deflected, some are absorbed.