Minutes of the 41st Collimation Upgrade Specification Meeting 25th of June 2014

Participants: R. Bruce (RB) (chairman), L. Esposito (LE), A. Marsili (AM) (scientific secretary), D. Wollmann (DW).
Remote: R. De Maria (RdM), H. Garcia Morales (HGM), T. Markiewicz (TM) (SLAC), J. Molson (JM), M. Serluca (MSe).

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1 Crab Cavities studies with SixTrack (A. Marsili)

Slides are available in here (pdf).

1.1 Summary of the presentation

AM presented the current state of the Crab Cavities studies with SixTrack. These studies follow the CC failure studies done by B. Yee Rendon: the same version of SixTrack, and the same inputs, were used. However, in this case no failure is considered: there is no variation in the voltage of the CC. This version of SixTrack gives exactly the same results as the usual one for the same initial distribution and same random seed.

Firstly, AM presented the changes done to the code of SixTrack. The current version of SixTrack can't generate a distribution taking into account the effect of the CC (tilted bunch): the tracking has to start outside the local CC bump (IP2 in this case). In order to study the effect of the CC, the full distribution of particles is needed at different positions, from the "checkturns" version. However, the distributions can't be saved at each element, the file would be too big. The index of the elements (counted from the start of the tracking) where the distribution is saved is hard-coded in SixTrack. AM suggested that this should be changed and passed as an argument. A specific version of SixTrack was generated where the distributions are saved around the CC, at IP1, and at the TCP in IR7, for a tracking starting in IP2. AM also mentioned a bug in the calculated orbit at the CC, where all values are 0; however, this does not affect the effect of the CC in the tracking. This has been reported and is investigated [**Action: RdM**].

With this setup, the effect of the CC is visible at IP1: the distribution in the y plane (vertical crossing at IP1) versus the position in the bunch l is "tilted". This effect is only visible at the IP: though the phase advance between the CC and the IP is around 90°, it is nearly constant up to the last element before the IP. The slight kick given by the CC can still be shown by singling out different particles. AM presented the differences in distributions at the IP for CC on or off, for same initial distribution and same random seed. At the IP, the standard deviation of the displacement (y for IP1, x for IP5) is $2.3\,\sigma_\beta$ instead of 1. The distribution of kicks in the same plane is slightly different; all other coordinates are exactly the same. They are centered around the value of the crossing angle, because the value of the orbit at this element is not subtracted, as it is the case in the initial distribution file. The value of the orbit is not recalculated for each particle of the distribution, hence why the x' distribution still appears tilted in the initial distribution file.

AM showed the values of the average and standard deviation of the y coordinate in IR1. The mean follows crossing angle, the standard deviation follows the beta function. The only visible difference is at the IP, where the std. dev. changes from 1 to 2.3 when the CC are on. An extremely slight change in momentum ($\sim 450\,\mathrm{eV}$) was observed; RdM stated that it could be due to a bug that has been fixed in a more recent version.

The same values were calculated over 1000 turns for a 6D Gaussian bunch, and stay constant (with oscillations). After 1000 turns, the standard deviation of the displacement is still $\simeq 1\sigma_\beta$, showing that the emittance is conserved. l and dp stay also constant and oscillate together. The size of the distribution in the phase spaces stays constant. The same tests were done with a halo distribution: after 1000 turn, the halo is conserved, and so is the emittance. However, the average of the l distribution is not constant: it keeps increasing with time. RdM said that it could be due to the same bug.

The next step for the debris simulations was to generate the input, taking into account both the effect of the collisions and the CC. A first order effect was considered, tilting the distribution by the value of the crossing angle, since the distribution of y/l for the bunch is centered around this value. However, the resulting y distribution without collision effects is slightly wider, by $0.37\,\sigma$. RB pointed out that this effect may be too big to be neglected.

AM presented the first results with debris and CC, with and without TCL4 @15σ. The two loss profiles are not very different: the TCL only has an effect over a few meters. The study of the loss peak directly downstream the TCL shows that the losses are mainly concentrated in the vertical plane; the TCL being horizontal, it doesn't catch many particles. Tighter TCL settings might make more of a difference.

In conclusion, the setup for simulation with CC is ready; the behaviour of the CC in SixTrack is well understood and consistent. The debris with CC and collisions were generated. The first series of simulations revealed small issues: small effect of the TCL4, and possible issue with orbit subtraction in checkturns where relevant. No halo simulations were presented because of an issue with the recentering of the s position when starting from IP2. The next step is to address these issues, and launch a full simulation campaign.

1.2 Discussion

RdM said that the possible bug has been fixed in SixTrack release 4499. AM answered that the CC should be installed in sequence HL-LHC V1 for the next simulations, and so the new version of SixTrack could be used as well, to be all up to date. [**action: AM, RdM**].

2 Preliminary studies on triplet aperture (H. Garcia Morales)

Slides are available here (pdf).

2.1 Summary of the presentation (H. Garcia Morales)

The HL-LHC based on the ATS scheme requires a new IR layout, and the triplet is only protected by the two TCTs. HGM studied the cleaning losses in the triplet magnets depending on the decrease of the triplet aperture. The lattice version is HL-LHC V1, with the TCTs fully open, and a horizontal halo.

HGM presented the beam envelope around the IP, comparing nominal and Hi-Lumi apertures, and showing the most likely loss location for off momentum losses. Q2 would be in the aperture bottleneck area. The first loss maps were produced with the nominal set-up, then the aperture of Q2 was scanned from 59 mm down to 20 mm, in both transverse planes. At 20 mm aperture, Q2 is the highest loss location. Between 32 and 52 mm, the local inefficiency varies from 10^{-3} to less than 10^{-5}. At 59 mm, no losses are recorded on Q2.

HGM presented the longitudinal distributions of losses in Q2 for the different aperture values. RB pointed out that the calculation of the value of σ didn't take into account the crossing angle, which should be subtracted to give comparable results.

Finally, HGM presented the peak losses in Q2 and average inefficiency over Q2 depending on aperture. Above 55 mm, no losses are recorded. The next steps include the simulations with vertical halo, Beam 2 simulations, TCTs at nominal settings, and then possible error models and scans of the matching region.

2.2 Discussion

RB added other studies possibly needed, such as FLUKA studies of energy depositions and possible heat deposition studies. The design values of the quench levels are considered too conservative, which could loosen the requirement on aperture.

JM asked about lattices with TCLDs, which are available, and about BLM comparison. AM answered that a good summary of comparison with measurement will be found in the article by R. Bruce, which will be published at the beginning of August.