Minutes of the 32nd Collimation Upgrade Specification Meeting 6th of December 2013

Participants: C. Adorisio (CA), J. Barranco (JB), A. Bertarelli (AB), R. Bruce (RB), L. Esposito (LE), P. Hermes (PH), L. Lari (LL), A. Lechner (AL), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), S. Redaelli (SR) (chairman), M. Schaumann (MS).
Remote: R. J. Barlow (RJB) (Huddersfield University), T. Markiewicz (TM) (SLAC).

Indico event here.

1 Status of Crab Cavity Implementation in MADX and SixTrack (J. Barranco)

Slides are available here (pdf).

1.1 Summary of the presentation

JB gave an introduction of the Crab Cavities (CCs) and how they are implemented in SixTrack. The CC ensures head on collisions at the IP by kicking transversely particles in function of their longitudinal position within the bunch. In the local scheme configuration this kick is closed around the IP. The voltage in the CC is defined by the crossing angle, the energy, β at the CC and $\beta^\star$, the phase advance between CC and IP and the RF frequency. More than one CC is considered in each set, in order to decrease the voltage in a single cavity; in addition, the redundancy makes is safer regarding machine protection.

JB presented how to add the crab cavities in MadX. For now, the CC are implemented for MadX tracking purposes only. If twiss functionalities are needed, an other element called "RF dipole" can be used with the proper phase as crab cavity. Additional options include voltage and phase change over a few turns (for the CC element only, not the RF dipole). JB pointed out several inconsistencies in the units between SixTrack and MadX – only relevant for simulations with phase errors.

Installing the CCs in a particular lattice is done in two steps. First, a kicker is installed in place of the CC to calculate the kick needed. The kick is now hard-coded for SLHCV3.1b optics. Then, the kickers are replaced by CCs with the same kick, and a voltage calculated from their parameters. The final user they will just need to call the script with the MADX macros to install the CCs. A new version of SixTrack including more user-friendly CC, lattices with CC installed, and consistency checks on definitions and units should be released at some point in December.

JB gave an example of the implementation of CCs in SixTrack. Horizontal CC have an identifier of 23 (vertical have -23). The initial phase is defined differently differently in different code. This is not an issue if the phase is null. A new module of SixTrack allowing a time variation of phase and voltage (and generally any parameter like magnet strength...) might be integrated to the release version.

In conclusion, this new version of SixTrack including more user-friendly CC and consistency checks on definitions and units should be released before the annual closure.

1.2 Discussion

SR asked if the latest LHC lattices are ready to be used with CC. JB answered that it is not the case yet: one would have to install the element manually (using a MadX macro, similar to loading magnets errors, etc.), and set it to one. However, they could be installed by default in the new version of SixTrack which will be released before the end of year break.

RB asked if all the inputs are fine once the CC are installed and the fort.2 file is generated. JB answered that it is not the case: the voltage is fine but there is still a bug with the phase: it is fine only if set to 0. In Nominal operation the phase for the CC should be zero to be crabbing so the units errors in the translation between MadX and SixTrack does not affect. Using different phase values would make only sense for phase errors studies for example.

SR raised the question of the branching between the version of SixTrack used for collimation studies and the version used in with the CC implementation in machine protection studies. AM answered that BYR started from the same version as the collimation studies, so the two versions should be relatively close. More collimation studies will be performed with BYE's version: halo tracking with no CC failure [**Action: AM**].

SR asked for confirmation that there is no problem with particles at high amplitude, i.e. during dynamic aperture studies. JB answered that there is no issue that he knows of.

LL mentioned that she has a different version, which was developed by F. Bouly.

2 FLUKA studies: channeled ions on LHC TCSGs at IP7 (L. Lari, D. Mirarchi)

Slides are available in pdf and pptx .

2.1 Summary of the presentation

LL and DM presented the different steps needed for the simulation of the energy deposition in the secondary collimators (TCS) that would be used to absorb the ion beam deflected during crystal tests. SR also reminded that the crystal are intended to be used with ions, because the intensity would be much smaller than for protons. The goal is to see if the TCS can withstand the energy deposition associated with the lifetime drops down to 0.2 h and the nominal beams after LS1.

The crystals should be installed in the LHC by the end of February 2014 in IR7, just downstream the primary collimators and upstream the secondary collimators groups (cf. DM's presentation at UA9). The considered secondary collimators are TCSG.B4L7.B1 and TCSG.6R7.B1.

The part of SixTrack code dealing with crystals was benchmarked with data from UA9, for both protons and ions. In this case, at 270 GeV, the size of the channeled beam measured by the Medipix was the same for ions and protons. Since the SixTrack simulations are not yet possible for ion beams, the size of the proton beam was use for the LHC simulations. This is calculated for two horizontal TCSG slots that can be used for intercepting the channeled beam.

Then, LL presented the FLUKA inputs for the two TCS considered and the geometries: the distributions of impacts from SixTrack, and the conditions of the simulations. The first result of the simulations is that most of the power is deposited in a small fraction of the jaw. This is the case for the different lifetime considered. LL also showed how the deposited power is distributed in different parts of the collimator geometry. The integrated power load is 300 W.

In conclusion, the energy deposition values for worst cases were presented for 2 different impact cases on TCSGs. Results show low energy deposition values, but in small volumes. Fluka maps have been provided to the MME team for needed detailed structural analysis, and local degradation of the CFC material should be evaluated. The location of the channeled spot is always inside of the TCSG in case of orbit errors.

2.2 Discussion

AL asked about the errors of the crystal angle, which could lead to impacts on the magnets instead of the TCS. SR and DM answered that this is a very critical consideration, which was studied during the layout design. There are strong requirements on this angle, and precise measurements are requested to have the best knowledge on the crystal angle before installation in the LHC. In addition, DM specified that the 55 μrad baseline angle of the crystal was designed with a safety margin of 5 μrad.

AB asked if a phase 1 collimator geometry that was used in simulations. LL answered that this is correct.

RB said it would be interesting to know the power deposition in the bins next to the highest one. AL added that a radial distribution could be used. AL asked about the longitudinal dimension of the bins, which is 1.5 cm.

SR reminded that this study was meant to see if a present TCS could be used as absorber for ions.

3 A. O. B.

This meeting being the last of the year, SR wished everyone happy holidays, and provided drink to celebrate the end of the year, which was highly appreciated.