Minutes of 45th Collimation Upgrade Specification Meeting

Participants: C. Adorisio (CA), C. Bracco (CB), R. Bruce (RB), L. S. Esposito (LE), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), S. Redaelli (SR) (chairman), A. Santamaria (AS), K. Sjobaek (KS), G. Valentino ((GV).
Remote: T. Markiewicz (TM), N. Sammut (NS).

Indico event here.

1 Simulations of TCT beam impacts for different scenarios (E. Quaranta)

Slides are available in pdf and pptx.

1.1 Summary of the presentation

The scope of this study is to estimate the robustness and the damage limit of the tertiary collimators, with realistic particle impacts and energy deposition from simulated failure cases. These studies provide important inputs to the collimator material R&D. EQ described the whole simulation chain: particle tracking with Sixtrack give realistic distributions of impacts on collimator jaws, which should be used as input for FLUKA to simulate the energy deposition. The last step consists in performing structural response simulations with ANSIS or shock wave simulations with Autodyn.

The failure case considered is an asynchronous fire of the beam dump kickers for the case of single module pre-fire followed by re-triggering (this gives the slowest sweep of the kicker field). The TCDQ and a TCSG are designed to protect the machine from this type of failure by intercepting particles above a certain kick amplitude. Errors are added to the models in order to simulated conditions when particles from several bunches are hit directly the TCTs.

After presenting the simulation setup, EQ explained which cases were selected and why, depending of the number of impacting protons as a function of the setting of different TCTs. The results show different outcomes, in order of criticality: safe situation, plastic deformation, fragment ejection and "5th axis limit". The number of simulation runs per case are adjusted in order to achieve the same statistics of particles on the jaw, in preparation for the energy deposition studies. EQ raised the question of whether these numbers are high enough for accurate FLUKA simulations. The statistics can be adjusted if more particles will be needed.

EQ presented the results: the distribution of impact parameters (depth of the inelastic interaction) in each jaw, for different bunches which receive different kicks. The simulation setup allows to distinguish hits from primary beam protons from secondary protons outscattered from the TCSG in IR6, and to identify contributions from individual bunches (i.e. resolving the 25 ns structure). The average impact parameters can be calculated for the different cases. The most critical case is the one for ATS B2 2015, dominated by primary protons that reach directly the tertiary collimators. CB asked for the setting of the TCDQ in this case, which is $9\,\sigma$. This simulate error scenarios when the TCT reach the same aperture as the dump protection (e.g. due to local orbit errors).

In conclusion, 6 scenarios have been studied to have a selection of cases with: different amount of total particles hitting the TCT; different impact distributions; and different amount of primary and secondary halo particles. Some of these cases must now be selected for the FLUKA + Autodyn simulations.

1.2 Discussion

GV asked if the time profile of the rising of the kick is measured or theoretical. EQ answered that it is still theoretical. SR clarified that it has been measured for individual modules, but not in total. J. Uythoven from the had suggested to use profiles measured with the complete dump system. This could be used for a more refined simulation set.

Action (AB, RB, EQ, SR,): define a subset of cases for detailed energy deposition and structural simulations.

2 SixTrack & Crab Cavities: Simulations Results

Slides are available here.

2.1 Summary of the presentation

This presentation is a follow-up of the one the one given by AM in July, where the behaviour of the Crab Cavities in SixTrack was validated for collimation studies and the results were presented (including the first results of collimation cleaning). However, a few checks still needed to be performed before starting the full simulation campaign.

AM presented the different validations of CC in SxiTrack, mainly done with a single bunch over a single pass (checks of CC kick), then over 1000 turns (conservation of bunch size). All tests are done with optics SLHC V3.1b, the only one available so far with Crab Cavities for now. Some extra checks were then performed, such as making sure that the full loss map with CC off is the same as the loss map without crab cavities. A new bug in the "checkturns" version of SixTrack was found: the last 64 particles are not recorded. The inputs for the debris studies were generated, taking into account both the effects of the collisions and the CC at the IP.

AM presented the simulated loss maps for the latter case with CC on, with different settings of the TCL 4, 5, and 6. The CC do not modify the single pass debris losses immediately downstream of the interaction point. AM warned about the peaks due to steps in aperture, which may be smoothed out by a lower longitudinal resolution, but may be an issue in the real machine.

AM also presented the results for multiturn halo simulations. SixTrack cannot generate a "tilted" bunch in IP1 which would include the effect of the CC; the tracking has to start in IP2. This created an issue with input files starting at IP1; it is now solved. So far, no conclusion of previous studies needed to be changed. AM presented the results, comparing the cases with CC on or off. The resulting loss maps are similar. SR pointed out that the peaks in the arc 8-1 seem to have a different shape; simulations with higher statistics would be needed to judge.

In conclusion, theis first simulation set suggest that we shoul expect no major issues for collimation cleaning in presence of CC. The full setups for both halo and debris simulations

are available. The results for both simulations were presented for B1, and addition of CC do not create any extra losses.

2.2 Discussion

SR commented that the loss maps looked very similar with CC on and off, which is a bit surprising. AS answered that during her own CC failure studies, she observed the same similarity, due to the fact that the longitudinal distribution of particles in the bunch is not very wide: $3\,\sigma_z$ at maximum. In order to see a strong effect of the CC, the particles would have to reach $5\,\sigma_z$; AM added that the statistics is not enough in the standard case (barely 1 particle per simulation, 1000 in total).

SR recalled that AS is a student who joined WP8 and is working with H. Burkhardt on IR machine protection aspects for HL-LHC. SR suggested that AS presents the status of her simulations at one of the next ColUSM.

3 A.O.B.

AM contract is finishing; he won't be Scientific Secretary of the ColUSM any more. He especially enjoyed this aspect of his work, quite different from the rest, and wishes good luck to his yet unknown replacement. SR kindly acknowledged AM for his work in the collimation team and wished him best wished for his future career.