Minutes of the 28th Collimation Upgrade Specification Meeting, 20th of September 2013

Participants: C. Adorisio (CA), A. Bertarelli (AB), R. Bruce (RB), F. Cerutti (FC), A. Ferrari (AF), F. Galluccio (FG), L. Lari (LL), N. Mariani (NM), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), S. Montesano (SM), S. Redaelli (SR) (chairman), B. Salvachua (BS), P. Schoofs (PS), M. Serluca (MSe), G. Smirnov (GS), C. Tambasco (CT), G. Valentino (GV).
Remote: T. Markiewicz (TM) (SLAC), J. Molson (JM), H. Rafique (HR).

Indico event here.

1 Agenda of the WP5 for the annual meeting in Daresbury (S. Redaelli)

SR first suggested a list of date for the next Collimation Upgrade specification meetings, and the corresponding topics. The aim is to discuss the critical points in preparation of the Daresbury meeting. The list is available here (pdf).

Then, SR presented an updated agenda of the annual LHC-LARP collaboration meeting in Daresbury. The list is available here (pdf).

The main modification include an extra talk about non-linear optics, by J. Resta Lopez. The planning of the common session will be prepared by SR and G. Arduini. The simulation workshop is still planned for the Friday, in Manchester.

FC commented that there was a mistake on the indico schedule: an overlap between joint session. SR answered that this mistake was known and about to be fixed. The half session is planned for the Thursday. The web page for the Daresbury meeting is at this link.

2 Update on the modeling of crystal channeling for FLUKA (P. Schoofs)

Slides are available in pdf or pptx.

2.1 Summary of the presentation

PS presented a model to represent crystals in FLUKA. Within FLUKA, the crystal is a standard region with a specific flag, and the particles can be channeled. It includes the usual FLUKAinteractions plus the crystal-specific ones, such as Channeling, Volume Capture (VC) and Volume Reflection (VR). For now, the models are still outside FLUKA. They have not been integrated yet, and are not available for the FLUKAuser.

The crystal planes are defined independently of the crystal shape by two vectors inside the crystal. This provides a natural reproduction of the miscut. Crystal torsion can also be reproduced.

The potential of a string of atoms is represented as continuous. Two of these strings create a potential well between two crystal planes, in which the protons can be channeled. Bending the crystal reduces the potential barrier on one side. The initial kinetic energy of a particle

is known; the potential energy is determined from its initial transverse position. This allows to select which particles will be channeled and which will escape.

Once channeled, a particle will oscillate within the planes with an amplitude proportional to its energy. PS specified that the multiple Coulomb scattering model used in a crystal is different than the one used in FLUKA. The other crystal–specific aspects are also taken into account. Volume Capture happens when a particle has a trajectory that does not match the crystal plane initially; but further in, due to bending, the crystal plane becomes tangent to the trajectory, and the particle can be channeled. The particle can also simply be scatter in a different direction that the crystal plane (Volume Reflection). SR asked if the particle can still undergo simulated interactions after a VR. PS answer that it is the case: the particle is tracked in amorphous mode.

PS then presented the benchmarking comparisons between measurements (angular scans) and simulations. Then, PS showed the analysis of the deflection angle measured at UA9, and of the channeling orientation. Again, results and measurements are in good agreement. PS noted that the channeling of Volume Capture particles seems more frequent in measurements.

In conclusion, PS presented a semi-classical microscopic model of the crystal for FLUKA, which is in very good agreement with the available data. The next steps include the integration in FLUKA, and the effects of ionization.

2.2 Discussion

RB asked if PS had compared his results with the code that DM is using. PS answered that the two codes are different, since his uses the physics models of FLUKA; no detailed comparison has been done. FC added that one of the goals of this code was to use a few external parameters as possible. SR mentioned the ColUSM #26, where A. Sytov gave a presentation on the code he uses for crystal simulations. FC and SR agreed on the fact that more measurement data would be needed for further comparison.

SR pointed out that different codes are developed for different purposes: Monte Carlo approach for SixTrack versus equation integration for crystal only. For instance, SixTrack uses many particles; a fine microscopic structure would be limiting.

3 EuCARD^2 ColMat-HDED kick-off meeting (A. Rossi)

Slides are available in pdf or pptx.

3.1 Summary of the presentation

AR presented the kick-off meeting for EuCARD2 ColMat-HDED, which will focus on material tests. They would be characterized in order to consider their use in future collimators, but also in other application. The irradiation tests can be performed with different ions and different energies. Another added value is that some test benches are situated in GSI.

AR clarified that the current tests for material specification are performed at low energy and high intensity. One of the goals would be to assess how to scale these tests to the 7 TeV LHC case.

In conclusion, AR specified that the point of the kick-off meeting would be to "restart the engine" and decide on the next tasks. The measurements in GSI are for now the most important.

3.2 Discussion

AB asked about the contents of the kick-off meeting, if it would already include the future tasks. AR answered that it would simply be a first presentation of the project. It would be followed soon by an actual task meeting, where the tasks would be distributed. All this would take place after the Daresbury meeting.

SR specified that a work plan is needed: who does what, with which tool, which energy, which intensity, etc. This could be discussed during the task meeting. SR suggested to focus on experimental tests on materials and simulation work to understand the scaling to the LHC regime.

4 Update on MERLIN–SixTrack comparison and ATS optics (M. Serluca)

Slides are available here (pdf).

4.1 Summary of the presentation

MS presented the status of the benchmarking between Merlin and SixTrack, which was necessary before adding new features to Merlin. He presented the settings used and the few differences still existing at the time of the simulations.

The optics as generated by both Merlin and MadX match very well. MS presented, for different twiss parameters, the difference between the values calculated for Merlin and MadX. They are small enough to be considered negligible.

The different initial distributions used in the two codes were presented. They are different because SixTrack generates a halo, a circle in the normalised phase space for the considered plane, whereas Merlin generates the particle at the collimator. Both distributions are consistent.

MS presented the loss maps, as calculated by both codes. They look qualitatively very similar, with the same peak at the same location and the same values relatively to each other. However, there seems to be a factor 10 in the value of the particles lost on the aperture. SR suggested to check if the normalisation to bin size is fine, since SixTrack loss maps are represented with $\Delta s = 10\,\mathrm{cm}$ [**action: MS**]. Another difference is the spikes around IR2 and IR8. This is due to the settings of the TCT, which are different in the two cases.

The distributions of impacts in the primary collimator were presented. They show good similarities. The main difference is in the longitudinal distribution of impacts in the jaw. RB pointed out that this could be due to the overall smaller impact parameter used in Merlin. This means that particles could escape before the end of the jaw, so most interactions take place at the beginning of the jaw. RB asked if only inelastic scattering is considered for a particle absorption. MS answered that it is the case.

MS specified that the single diffractive scattering has been improved, and now uses a fit from the data. In SixTrack, it is only a decreasing exponential, whereas the data show different fits at different places. In addition, the input is 2–dimensional: there are different plots for different time constants.

In conclusion, MS presented the current state of Merlin, which is now ready to produce a quantitative comparison with SixTrack. The new Single Diffractive and Elastic scattering routines are almost ready. The next steps include fixing a small issue with the dispersion for ATS optics with both crossing and dispersion correction; and to define quantities that could be use for an easy comparison of the loss maps. The fact that both dispersion correction and crossing angle give correct results when used separately, but not together, could hint at compatibility or overwriting issues between the two controls.

SR asked if this comparison could be ready for Daresbury; MS answered that hopefully it would.

The remaining actions are:

- Correct the few remaining layout inconsistencies
- Work on ATS pre-squeeze optics (loss maps) for Daresbury presentation
- Check quantitatively losses in collimators outside IR7 (CT's tools and STD loss plots)
- Converge on ATS optics with Merlin

[**action: MS**]