Minutes of 12th Collimation Upgrade Specification Meeting

Participants: M. Cauchi (MC), F. Cerutti (FC), F. Galluccio (FG), J. Jowett (JJ), L. Lari (LL), A. Marsili (AM) (scientific secretary), D. Mirarchi (DM), T. Pieloni (TP), V. Previtali (VP) (Fermilab), E. Quaranta (EQ), B. Yee Randon (BYR), S. Redaelli (SR) (chairman), B. Salvachua (BS), M. Schaumann (MS), H. Schmickler (HS), G. Valentino (GV). **Remote:** R. J. Barlow (RJB) (Huddersfield University), T. Markiewicz (TM), J. Molson (JM), H. Rafique (HR) M. Serluca (MSe), G. Stancari (GS).

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1 Program for WP5 discussions at HiLumi/LHC-LARP meeting (S. Redaelli)

Slides are available at this link.

1.1 Summary of the presentation

SR introduced the 2nd Joint HiLumi LHC–LARP Annual meeting, which will take place in the INFN Frascati laboratory near Rome on Nov. 14-16, and presented a first draft of the agenda of the WP5 collimation sessions. There will be 2 dedicates sessions for WP5, the first covering the HiLumi topics and a second one more oriented to the US-LARP activities. In addition, SR and S. Fartoukh are organising a joint mini-session between WP2 and WP5 to discuss topics that concern both WP's. A draft agenda was presented for comments.

SR also informed about other general aspects of the collimation activities: (1) an internal review for the usage of the Tevatron hollow e-lens in the LHC or SPS is being organized; (2) a new fellow from Royal Holloway will start working at CERN on WP5 within a few weeks. A second fellowship post has been open; (3) L. Lari has been hired as Hi-Lumi fellow as a joint collaboration between CERN and Valencia. In addition, SR mentioned that he is preparing a proposal for new activities on material irradiation studies at BNL within the US-LARP framework.

1.2 Discussion

SR asked if anybody from the ion team is planning to attend the workshop. We should have a talk on ion collimation in this case, otherwise SR should cover the key aspects in his introductory talk. JJ commented that he is considering to attend the workshop. He will inform SR as soon as possible to update the agenda accordingly.

FC commented that there is no report from energy deposition studies. He will attend the workshop and could report on the recent news on TCL simulations. SR replied that the WP10 is not in the HiLumi project and there is no dedicate section on that at workshop. SR, FC and L. Rossi will discuss and see what is the best way to present this work.

LL pointed out that a remote connection should be provided so people who are not coming to Frascati can still participate.

HS asked about the TOTEM experiment layout after LS1: will the "close" station be in cell 4? SR replied that the plans for LS1 are to replace this station with a TCL collimator. This aspects will not be discussed at the Frascati workshop because they concern LS1 activities.

GS suggested that there could be a talk presenting VP's work on the collimation section on LARP activities. SR agrees. He however thought that she could participate to the special session on USA fellows. However, it it not clear how this session will be organized. TM suggested that VP could present there her work on the hollow e^- lens simulations.

2 Review of the experimental results for the crystal assisted collimation in the UA9 experiment (D. Mirarchi)

Slides are available at this link.

2.1 Summary of the presentation

DM introduced the basic theory of crystal channeling and reviewed the results of crystal beam tests at the SPS on behalf of the UA9 experiment that has been going on since 2008. The main goal of the experiment is to assess whether bent crystals can replace a primary collimators in the standard multi-stage cleaning system. In a crystal, the potential seen by the protons from the crystalline plane is such that the particles can be channeled between two planes, instead than being scattered as in the current amorphous collimators. This can results in large effective kick angles in bent crystals without experiencing nuclear interactions.

The SPS experimental setup included two different silicon crystals bent at $\sim 0.165\,\text{mrad}$. Losses were measured at many different places. The more sigificant are at the crystals and further downstream in the high dispersion area (TAL absorber). The tests included angular scans, a LHC-collimator scan, a scraper linear scan and an SPS loss map around the full ring (comparison between amorphous and channeling). A crucial point of the analysis was the normalisation by the flux, but intensity can be used at first order if the lifetime doesn't change.

The angular scans show a reduction of the losses at the crystals for the proper channeling angle. The factor gained depend from the system settings, in average is about 10. Study on the best system settings still ongoing during the SPS tests. The crystal channeling showed a remarkable repeatability during the different years of test at the SPS, and good agreement between the changes in the aperture and in the crystal orientation to get in channeling. The collimator scans showed a multi-turn channeling efficiency of 80% with protons, and 70% with ions. The scraper linear scan showed a reduction of the tertiary halo of a factor 5 for protons and 10 for ions in dispersive regions.

In conclusion, seeing the good results achieved, the LHCC approved the move of the apparatus from the SPS to the LHC. The SPS tests will continue until the end of the year. DM is now studying in detail possible layouts for beam tests at the LHC.

2.2 Discussion

JJ asked where would these crystals be installed in the LHC. DM answered that they would be installed in IR7, but 6 different locations are still under discussion. Ongoing `SixTrack` simulation will give an answer.

LL commented that there will be issued of energy deposition in Tungsten for the channeled beams in the LHC. DM commented that this is a well-known issue; the tests would start with reduced intensity. Currently, a TCS can not stop the full channeled beam.

3 Status of multi–turn particle debris tracking (A. Marsili)

Slides are available at this link.

3.1 Summary of the presentation

AM presented the follow-up of his work on collision debris tracking simulation. The tools are now fully set-up, and first physical results were obtained. The first goal is to benchmark the `SixTrack` simulations against the measured losses at 4 TeV in the matching sections of IR1 and IR5 (losses in the different magnets during TCL scans).

The particle distribution inputs are generated from the initial beam distribution at the IPs by adding the effect of collisions calculated with FLUKA: additional transverse kicks x', y' and a momentum shift. Collision products are provided by FC.

The first results showed extra losses (w.r.t. the usual halo tracking simulation) downstream the TCL, in the matching section and in the dispersion suppressor. Most particles are lost during the first two turns after collisions, but a multi-turn component exist. AM presented the distribution of losses at the TCL, and the reconstruction of the initial distribution of particles hitting the TCL (track-back). The fact that there is no obvious cut in these distributions is surprising and will be investigated further.

AM presented the simulation of a TCL scan: the `TCL.5R1.B1` is moved from its nominal setting of $10\,\sigma$ out to $60\,\sigma$, as it was measured in the LHC on the 15th of May 2012. The effect of this scan is that the loss at the TCL decrease by a factor up to four; and the losses downstream the TCL increase by a factor 50, showing the protection provided by the collimator. In addition, the losses downstream are increasing progressively, starting from the furthest away from from the TCL towards the TCL.

Part of the observed behaviour is reproduced in simulation: the losses downstream the TCL get closer to the TCL with the gap increase. The value of the highest loss also increases. The loss at the TCL decreases as foreseen. However, the total number of particles lost downstream the TCL decreases with the increase of the gap. In addition, no losses are observed at the Q9. Clearly, this problems need to be addressed.

A similar scan was simulated with the TCLP in cell 4, all the other collimators being at their nominal settings. The same scan will be performed with the TCP fully open. The Beam 2 case was also simulated successfully.

In conclusion, some of the observation of the TCL scan were reproduced; some points are still not understood, but will be checked with the specific version of `SixTrack` writing trajectories. New distribution with looser cuts will be provided by FC. These studies will carry on.