Minutes of 77th Collimation Upgrade Specification Meeting

Participants: C. Adorisio (CA), F. Antoniou (FA), G. Arduini (GA), A. Bertarelli (AB), O. Bruening (OB), C. Bahamonde Castro (CB), R. Bruce (RB), R. Calaga (RC), F. Carra (FC), M. Fiascaris (MF) (scientific secretary), G. Gobbi (GG), J. Guardia Valenzuela (JGV), A. Frainer (AK), A. Lechner (AL), E. Metral (EM), D. Mirarchi (DM), J. Molson (JM), D. Perini (DP), S. Redaelli (SR) (chairman), A. Rossi (AR), D. Wollmann (DW), C. Zanoni (CZ).

Remote: M. Fitterer (MiF), T. Markiewicz (TM), H. Rafique (HR), G. Stancari (GS), S. Tygier (ST), A. Valishev (AV), G. Valentino (GV).

Indico event here.

1 Actions

Actions from this meeting:


- On HEL design: investigate solutions with superconducting solenoid in e-gun region with larger bending angles than 30°. Assess if kick from SC solenoids at the extremities poses threads to beam operations (DP).

- On passive absorber studies for IR7:
  - Run simulations with two TCAPs changing the material for the second absorber to tungsten (CB).
  - SR to present this conclusions at the CONS project management, requesting to add new absorbers in the baseline for LS2 activities.

2 Hollow lens review (O. Bruening)

2.1 Summary of the presentation

OB presented the hollow lens review (indico link) planned on October 6-7, 2016, which aims to discuss the needs and potential benefits of an active halo depletion system for the HL-LHC and give a recommendation for adopting it into the HL-LHC baseline. Given the recent HL-LHC project re-scoping, it is now the appropriate moment for considering this option for the baseline. OB explained that the scope of the review is to examine the two initial motivations (loss spikes during operation and machine protection aspects for operation with Crab Cavities) and determine from beam physics if halo depletion is needed. OB stressed that the technical aspect of how we intend to deplete the halo is outside the scope of this review and is planned to be addressed in another technical review in the future. The program of the review is divided into two parts, one dedicated to the operational experience and another one on HL-LHC system specifics.

The list of speakers is being finalised. Speakers will be asked to provide a list of keywords rather than an abstract. OB pointed out that the reviewers requested the presentations to
be available a couple of days before the review, even if they are not the final version. SR announced that there will also be a dry run before the review. This will be organised as a special CoLUSM (link).

### 2.2 Discussion

GS explained that they proposed two topics, a summary of observations and measurements at the Tevatron and a presentation on simulations, and that suggestions for possible other topics are welcome. SR proposed to discuss also the experience of loss spikes at the Tevatron. There were some discussions on how the experience at Tevatron and RHIC can be extrapolated to the HL-LHC. OB suggested to comment on whether the system answered the expectations, on the confidence in simulations and the experience gained with HEL operations. Although loss spikes cannot be easily scaled to the HL-LHC, general background information about losses can still be useful for the review.

### 3 Status of IR4 integration for HEL (A. Rossi) [slides]

#### 3.1 Summary of the presentation

AR discussed the status of the integration of HEL in IR4, the RF insertion. Several aspects have to be considered for the integration, namely the longitudinal and transverse space, availability of cryogenics and proximity of a parallel tunnel with room for electronics. The locations evaluated so far are at ±40 m from IP4, in the dog-leg, where the beam is almost round, and at ±88.6 m from IP4, where the ratio $\sqrt{\beta_x/\beta_y} \sim 1.2$. The effect of having non-round beams was investigated in simulations by M. Fitterer with Lifetrac and H. Rafique with Merlin. Merlin simulations assumed an ideal case and no beam-beam or other effects. None of the simulations took into account machine imperfections. The two simulations did not consider the same optics, therefore they cannot be compared directly but illustrate qualitatively the expected results. Both Merlin and Lifetrac simulations show a loss in the halo-removal if the hollow e-beam shape is not matched to the proton beam (round e-beam around non-round p-beam). M. Fitterer investigated if coupling may help but found it had little influence. In both studies, pulsed mode was found to be faster compared to the DC operating mode. Further simulation studies are required.

#### 3.2 Discussion

OB asked if the non-round beam could be matched with the shape of the cathode. AR explained that this has been looked at and found that the image current induced in the vacuum chamber (round) would in turn induce forces on the non-round e-beam leading instabilities that would cause the beam to curl up. One could then match the shape of the chamber to the e-beam, but everybody agreed that this would generate more complications than solving problems. There were some discussions on the effect of having a non-round beam from difference in emittance in the two planes. SR argued that would not be an issue because the collimator cut (with collimators placed at 2 sigma retraction) would be consistent, while in the case of different betas a different cut is applied in each plane. Under request from SR, GS agreed to check on the issue of roundness of the beam at the Tevatron.
SR pointed out that a benchmarking between the simulations from MiF and HR should be performed and AR confirmed that this is indeed planned [ACTION: MiF, HR].

4 Update on hollow lens design (D. Perini) [slides]

4.1 Summary of the presentation

DP recalled the main requirements for the HEL: a construction that is compact (given the space limitations and a beam-to-beam distance of 420mm), robust and reasonable simple, easy installation, maintenance and modifications. The initial version of 2015 was optimised to have a smaller diameter for the main solenoids, and more compact bending regions counting one solenoid less. DP showed the drawings of each of the main components. The main solenoid’s diameter was minimised from 250 to 200 mm. Parameters for a resistive e-gun solenoid requiring a field of 0.4-0.5 T were shown. DP then showed two possibilities for the e-gun region: one with e-gun and collector regions without intermediate coils and another one with e-gun and collector region with one strong intermediate coil. In the first solution, the entry angle is 70°, but this is very sensitive to changes in the fields ratio. In the second case, the entry angle is 30° and no solenoid on the collector side is necessary.

First estimates of the collector thermal and mechanical loads were performed and it was concluded that it is possible, within the space constraints, to design a collector that is able to evacuate the heat coming from the energy of the electrons and that can amount up to 50 kW. DP also explained that a test e-gun has been produced at CERN EN-MME starting from drawings received from FNAL and that a problem with the flange is being fixed. Finally DP summarised the programme for the cathode production and showed some possible alternative compact geometries.

DP concluded with a timeline for final drawings, construction and tests in case HEL would be included in the baseline.

4.2 Discussion

GS thanked Diego for the amount and quality of the work. He commented that the CERN e-gun is now being commissioned. Regarding the second option for the e-gun region, GS commented that having a superconducting solenoid is a good idea, but one issue with bending the solenoid by 30° is a strong transverse kick to the p-beam. DP answered that this will be looked at and that a solution with larger angles can be found [ACTION: DP].

5 Update on new TCAP collimators (C. Bahamonde Castro) [slides]

5.1 Summary of the presentation

CB gave a follow up from the previous ColUSM about new passive absorbers in IR7 [link]. She reminded the goal of the studies: with the modifications of the warm section in IR7 planned in LS2, the MQWA.E5 will be removed and a new absorber is needed to provide as a good shielding to the downstream magnets as the removed magnet. As suggested at the last ColUSM, CB performed simulations with two TCAPs before the warm magnets: in
one case a new TCAP was added just after the existing one, effectively doubling its length, while in the second case the new TCAP was installed just before the MQWA.D5 magnet. The peak dose in the magnet coils and in the plastic shimming between coils was shown for each configuration. Neither of the two solutions was sufficient to reduce the peak dose to the level of those with the MQWA.E5 magnet. Possible solutions for the passive absorber were proposed: material change (using tungsten instead of copper), length increase or complete new design.

5.2 Discussion

AL commented that one solution could also be to put several absorbers (eg. 4 or 5) one next to the other. It was agreed with SR to run again simulations for the last case changing the inner part of the second TCAP to tungsten [ACTION: CB].

As also concluded at the previous meeting, everybody agreed on the need for additional absorbers. Therefore SR, will present this conclusions at the CONS project management, requesting to add new absorbers in the baseline for LS2 activities [ACTION: SR]. More studies are necessary to determine whether it is possible to achieve the design goals with a reasonable TCAP design. This will continue in parallel.