Minutes of 48th Collimation Upgrade Specification Meeting

Participants: A. Bertarelli (AB), R. Bruce (RB), M. Fiascaris (MF) (scientific secretary), H. Garcia (HG), D. Mirarchi (DM), Y. Papaphilippou (YP), D. Perini (DP) E. Quaranta (EQ), S. Redaelli (SR) (chairman), R. Rossi (RR), H. Schmickler (HS), R. Schmidt (RS) G. Stancari (GS)
Remote: H. Rafique (HR).

Indico event here.

1 Introduction: hollow e-lenses for LHC collimation (S. Redaelli) [slides]

1.1 Summary of the presentation

SR gave an introduction to this special meeting dedicated to review the status of the hollow e-lens studies for LHC collimation. After describing the basic concept of e-lenses, he highlighted the possible use cases at the LHC and HL-LHC. Limitations of the current collimation system can arise from beam lifetimes well below 1h causing losses above the quench limits of superconducting magnets or even the design limit for collimators. In addition, in the HL-LHC a continuous control of the tail population is needed for using crab-cavities and e-lenses allow an active halo control during stable beams. SR concluded reminding the group of the strategy agreed with the CERN management. Hollow e-lens studies are fully supported and it is a high priority to work towards the preparation of a possible production of two e-lens devices for the LHC. While the design should be ready at the beginning of the post-LS1 operations, the strategy will have to be finalized depending on the operational experience of the LHC during run II. Since the time line for the deployment of hollow e-lenses is beyond LS2, it is crucial to actively study alternative methods. These will also be addressed today (see Section 4).

1.2 Discussion

RS commented on slide 12 that even if the tails were not overpopulated, ie. assuming perfect Gaussianity, we would run into problems in the HL-LHC.

2 Hollow e-lens design for the LHC and status of simulations (G. Stancari) [slides]

2.1 Summary of the presentation

After a brief description of the main features of electron lenses and of the experience that has been gained at the Tevatron collider, GS reviewed the status of the conceptual design report for the LHC. He gave some example parameters for the LHC and showed that the e-lens modulator rise time would allow operations turn-by-turn as well as train-by-train and batch-by-batch. GS also showed some results from numerical simulations, which are used to study the effectiveness of electron beam collimation at the LHC, as well as to investigate the most useful modes of operations and possible negative effects on the beam core. The candidate

locations for the electron lenses in the LHC are on each side of IR4. Preliminary integration studies have found no major obstacle so far and it is expected that the main integration effort will be on the cryogenics. Finally, GS concluded that the plan of a possible construction of two e-beam devices in 2015-2017 and installation in 2018 is technically feasible if the present conservative parameters based on the Tevatron hardware are used.

2.2 Discussion

HS asked on slide 33 what the percentages in the plots referred to. GS answered that they refer to the fraction of initial halo population.

HS commented on slide 44 about the idea of using back scattered electrons. Although he appreciated the idea of using back scattering for optimizing the overlap between beam halo and e beam, he commented that detection with scintillation would not allow to get a 2D profile of the beam halo. Hence for halo monitoring other methods giving a 2D real time measurement would be more appropriate.

YP asked what is the tolerance for the alignment of the p beam. GS answered that it is not very tight and would not cause any problem for collimation and scraping. YP also asked about any issue with impedance. GS answered that from their experience and some rough estimates they do not expect any issue with impedance provided that the tank design is optimized in collaboration with the impedance team early on.

HS asked how the cost estimates would scale to 10 devices. GS could not give an estimate.

3 Status of mechanical design for IP4 integration (D. Perini) [slides]

3.1 Summary of the presentation

DP presented the pre-design of a hollow electron lens device for the LHC. The main requirements are that the device should be compact, robust and simple to construct. DP described the main properties of the superconducting solenoid which will be cooled by liquid helium. Three vessels will be used, for liquid helium, thermal screen and vacuum. In addition to describing the coils, the vessels and their support, DP also showed drawings of the power and helium supply, the toroid section and the support frame with a rail that allows to easily try different positions. DP concluded that although some final sizing has to be done, no showstopper was found.

3.2 Discussion

DP was asked for clarifications about the corrector coils. DP answered that despite their name, these coils are not correctors of the solenoid field, but drive the electron beam. SR asked how many layers there are in the solenoid coil. DP answered that each layer is 1mm thick and there are 30 layers for a total thickness of 30 mm.

HS asked on slide 8 if the toroid coils can be removed without removing the vacuum chamber. The answer was that this is not possible, the vacuum always has to be broken. Following another question by HS, DP said that the field of the toroids should be kept above

0.3T. HS also asked if there is any need for shielding the B field and the answer was that this should be determined, and if needed, it should be decided where to put the shielding.

SR asked if the sliding support frame would work for two beams. DP answered that this design has been thought for tests with the beam on the passage side. Indeed, with two beams it would be difficult to move both sides.

Finally HS pointed out that for the BBLR (beam-beam long range compensation) application there should be studies to qualify the design for high neutron fluxes. SR commented that there was some interest at Fermilab to study radiation maps at special locations around IR1 and IR5. Currently there are no available figures for the flux, but this should be kept in mind especially since the design includes some plastic components. DP commented the plastic in the coils is rather resistant to radiation. Once the amount of radiation is known it will be possible to assess if it is strong enough.

4 Plans for beam test on alternative methods (R. Bruce)

[slides]

4.1 Summary of the presentation

Hollow electron lenses for beam halo removal is a powerful method, but it will not be available before LS2. RB presented alternative methods for halo removal such as tune modulation and transverse damper (ADT) narrow-band excitation. Both these methods rely on detuning with amplitude of the beam and on a good knowledge and on the stability and reproducibility of the tune. However, while ADT excitation does not need any hardware modification, investigations are still ongoing to assess the hardware limits on tune modulation. RB discussed the current studies on these hardware limits, given by the power converter capabilities and the magnet transfer functions, using warm trim quadrupole magnets in IR7. He concluded the presentation with a discussion of the plans for 2015 test beams.

4.2 Discussion

HS asked if the ADT excitation method will be compatible with the transfer damper. RB answered that this issue still has to be discussed, for now only tests during MDs were considered. HS commented that in order to have a narrow tune, the transfer damp will probably need to be off.

YP and SR discussed about the possibility of modulating non-linear elements, like octupoles, for halo removal. This might allow to enhance the halo, but it would be necessary to use a number of elements around the ring. This point will be investigated.

HS asked if for the trim quadrupoles the horizontal and vertical beta are the same. RB answered that although they are not, the differences average out if all available quadrupoles are used at the same time.

There was a discussion about the measurement planned for beam tests in Run2. SR commented that the first thing to do would be to measure the emittance and check that the core is unaffected. HS asked if the plan includes having collisions at injection energy. This could allow to measure the luminosity (which must be unaffected) in conditions with colliding footprints. SR commented that having many bunches at injection might be challenging. Other questions by HS concerned the estimation of the halo population. One could use a

high-resolution mode of the wire scanner which, despite saturating would at least allow to estimate the halo. SR added that one could also overpopulate the tails to reach the sensitivity of the wire scan. Another idea proposed by HS was to have two subset of samples, one being used as control sample and using tune modulation for removing the halo on the other sample. The wire scan data could then be used to compare the control and cleaned sample.

Finally, the discussion was extended to e-lenses. A decision for e-lenses has to be taken by the end of 2015 to be ready by 2018. However for a full test on these alternative methods, they should be tried with full 7 TeV energy and not only at 450 GeV. SR commented that we could try to make some tests at end of fill. One concern by HS regarding the alternative methods is whether they would work during squeeze. Electron lenses do, but for these alternative methods it would be very challenging due to the poor knowledge of the tunes.

5 Ideas for TEL-2 at CERN: electron beam test stands (H. Schmickler) [slides]

5.1 Summary of the presentation

HS presented the plans for an e-beam test stand at CERN. A test stand for the development of electron cooler equipment already exist at CERN in building 236. The idea is to install in the same building another test stand, borrowing for several years the complete TEL-2 Tevatron electron lens installation. Some development of the TEL-2 installation have to be made, including an increase in the e-beam current and a modulation of the beam intensity. In addition, an instantaneous beam profile measurement has to be developed and the current proposal is to use a gas jet monitor developed for CLIC. HS also presented two ideas for halo monitoring, namely a coronagraph and a high dynamic range camera.

5.2 Discussion

Concerning the proposal of borrowing the complete TEL-2 test stand, SR asked if there is significant added value in setting up a system with superconducting solenoid. HS answered that it would be closer to the initial setup.

RS asked for clarification about the gas jet monitor and how it is different from standard fluorescence monitoring. HS explained that with this method fluorescence is suppressed in favor of ionization. The trick is to use oxygen to enhance the otherwise very small signal.

SR commented that the proposal will be brought up at the High-Lumi annual meeting in Japan for discussion with the US-LARP management.

6 Status of ELENA electron cooler (G. Tranquille) [slides]

6.1 Summary of the presentation

GT presented the electron cooler parameters needed for ELENA. At ELENA it is needed to cool down the electrons to momenta of 35 MeV and 13.7 MeV in order to have bunches with sufficiently low emittance. The mechanical system design is ongoing. A test stand for the electron cooler is in building 236. GT showed the plan of building 236 and briefly described the ongoing refurbishing work.

6.2 Discussion

SR asked how long the cooling takes. GT answered that it is expected to take 20-25s. At GS questions about the typical displacement of the electron beam at bending, GT answered that it would be 4mm without corrector.

Other questions by HS were about the space arrangements in building 236. The upper space can be used as an office, the plan is to add a window and there is already an emergency exit to the back.

SR asked if there is instrumentation that can be used for both the LHC and ELENA test-bench given the different order of magnitudes between the beams. GT answered that the monitoring proposed by HS could be used for both systems.