Minutes of 51th Collimation Upgrade Specification Meeting

Participants: C. Adorisio (CA), B. Auchmann (BA), R. Bruce (RB), F. Carra (FC), F. Cerutti (FCe), D. Duarte Ramos (DDR) M. Fiascaris (MF) (scientific secretary), L. Gentini (LG), P. Gradassi (PG), P. Hermes (PH), J. Jowett (JJ),
A. Lechner (AL), T. Mertens (TM), V. Parma (VP), S. Redaelli (SR) (chairman), F. Savary (FS), B. Salvachua (BS), M. Schaumann (MS), E. Skordis (ES),
Remote: A. Bertarelli (AB), T. Markiewicz (TM),

Indico event here.

1 Actions

Actions from this meeting:

- Get official confirmation of quench limit value for Nb3Sn-based 11 T magnets (L. Bottura from magnet team).
- Follow up on possibility of using orbit bump to shift losses into the connection cryostat, also for the case of IR2 (ion collimation team).
- Perform studies on ions with one DS collimator only (PH, RB).
- Decided to opt for a TCLD collimator of 60 cm.
- WP11 to assess the feasibility of two integration options and soon take a decision.

2 Power deposition in DS magnets due to ion collision debris (BFPP1) in IR1/5 (A. Lechner) [slides]

2.1 Summary of the presentation

AL presented the validation of the BLM simulations against 2011 data and a summary of the power deposition results for IR1/5 and IR2 with ion collisions. He investigated two options to reduce power density: TCLD collimators with 11 T dipoles and, for IR1/5 only, orbit bump.

The measurement of BLM signals using 2011 of Pb-Pb collision data validates the FLUKA simulations, with an agreement at the level of $\sim$25%. AL then showed the estimated peak power deposition in IR2 in the MB magnet coils without TCLDs and in 11 T magnets in presence of one TCLD per beam. He concluded that with TCLDs the peak power density can be significantly reduced with no risk of quenches even for short jaws of 50 cm of Cu, assuming an impact parameter of 2 mm.

Finally, AL considered losses in the DS around IR1 and IR5. He presented results on the power density in the coils with and without orbit bump and showed that if the loss location lies in the connection cryostat, as predicted with 2015 optics, the power density in the coils is effectively reduced. He concluded that if losses can be shifted into the connection cryostat no TCLDs are needed in IR1/5. However, it should be still checked if the power load is an issue for the connection cryostat.

2.2 Discussion

SR pointed out that the value for the quench limit of Nb3Sn-based 11 T magnets for protons should be confirmed, since it is very important for our studies. **Action** for getting official confirmation of this value has been already triggered with the magnet team (L. Bottura) who will review the results presented at the ColUSM by P.P. Granieri. JJ suggested that in any case a factor of 2 on this value should be taken for a safety margin.

SR commented that the results on orbit bumps are very reasurring and that a dedicated discussion on this should follow, covering also the case of IR2 for the post-LS1 operation. (**Action** for the ion collimation team.)

JJ asked if it will be possible to build more than 4 TCLD collimators for installation in LS1. In case the 11 T dipoles were needed in IR7 and an alternative solution for IR2 could be found by moving with orbit bumps the ion losses at the missing dipole location, then one migh need 4 collimators. SR commented that this should be no issue at all.

3 Updated power deposition simulations for DS collimators in IR7 (proton operation) (E. Skordis) [slides]

3.1 Summary of the presentation

ES presented updated results on the prediction of power density in the DS magnets for proton collisions at 7 TeV. He compared the present layout (no DS collimators) with a layout with one or two DS collimators next to IR7, as a previous action to study possible improvements of the IR7 cleaning during Run III for the scenario where only 4 11 T dipoles were available. He considered for his studies TCLD collimators 65 cm long instead than the previous baseline of 80 cm.

For the present layout, ES showed that the predicted peak power deposition in cell 9 is lower than what found in previous studies thanks to improvements in the FLUKA geometry. In a layout with one TCLD, the peak power density in the first cluster of DS losses is reduced by a factor of $\sim$5. The second cluster is instead reduced by 25% becoming the limiting location with 3mW/cm^3. A second TCLD further reduces this second cluster by $\sim$10 %. Note that in both cases we remain under the quench limit for the LHC parameter post-LS2.

3.2 Discussion

SR clarified that the option of having one TCLD in IP7 is interesting in case we would need to better equip IR7 already for Run3. In that case the priority between equipping with TCLDs IP2 for ion runs or IP7 for proton runs should be evaluated. From ES results, SR concluded that the solution with one TCLD improves overall peak losses by about a factor of 4.5 (which could be improved by tightening further settings). Thus, this is a viable option in case of unexpected problems in IR7.

JJ asked if from these results one can conclude that one TCLD is a better option than two. SR answered that although this might be true for Run III, the situation is different for the HL-LHC where the second collimator also gives much better off-momentum cleaning, removing losses around the ring for the ATS optics. JJ suggested that the situation in IR7 should be assessed also for ion collisions. First studies by PH considering two TCLDs showed that the first collimator catches the most dangerous species. However studies on ions should be done with one collimator only. (**Action: PH, RB**).

Since these studies showed no big difference in the performance between 80 cm and 65 cm long collimators, SR concluded that **65 cm long collimator can be considered safe**.

4 Outcome of the 11T review (F. Savary) [slides]

4.1 Summary of the presentation

FS gave a summary of the international review of the HL-LHC 11 T dipole magnets held on December 8th-10th 2014. After an overview of the mandate and the program, FS reported on the main outcomes.

It was highlighted that the goal of the project is the successful operation of 11 T dipoles in the LHC by 2019 as a pioneering application of the Nb_3Sn magnets in the HL-LHC. The tight time scale and hence the need to proceed quickly to the construction stage with little room for design changes was emphasized.

The point most relevant for the collimation team (in addition to the concerns about the schedule) is that the review panel requested to investigate the possibility to reduce the TCLD collimator down to 60-65 cm in order to free space for magnets and interconnections. The final length shall be finalized by mid-March.

Furthermore updates of the 11 T project status will be discussed at a workshop aiming at reviewing the collaboration between CERN and FNLA will be organized in May.

4.2 Discussion

SR asked for clarifications about how reducing the collimator lenght can give a gain in the field. FS explained that the field gain would be very little, but one could increase the margin on the load, which is currently at the level of 20%.

5 Status of integration design (D. Duarte Ramos) [slides]

5.1 Summary of the presentation

DDR presented the integration design for the by-pass cryostat. After summarizing the specifications, constraints and goals, he briefly described the first concept of the layout (from December 2013), which allowed for a collimator of lenght of 80 cm. This concept assumed that the busbar by-pass could be made in the shadow of the beam. Once realized that this was not possible, as there is not enough space to bend the busbar cables, a new approach was developed.

DDR then presented the current design, where a connection cryostat between two 11 T dipoles is used to integrate the collimator. There are currently two options open for the drift vacuum chamber. The first one foresees a warm vacuum chamber and would only allow for a 60 cm long collimator since cold to warm transitions would be needed. The second option is to have a cold vacuum chamber, thus avoiding transitions and allowing for a 65 cm long collimator. Both cold and warm versions require validation with physical mockups and prototypes before a decision for one or the other can be taken.

5.2 Discussion

6 Status of TCLD design and implications of shorter jaws (L. Gentini) [slides]

6.1 Summary of the presentation

After a brief overview of the changes in the TCLD layout between the old (100 cm long) to present baseline (80 cm long) design, LG showed some preliminary design studies. He described in details the jaws with the cooling system, instrumentation and RF system. The new design addresses problems that were pointed out in the 30th ColUSM meeting held on 18/10/2013. The actuation system now includes two motors per jaw and features longer stroke between -5 to 30 mm as well as jaw tilting, and a spring-back. The tank is manufactored in electron beam welded stainless steel. The extremities hava a new design, with the bellows integrated in the conical tank transition to gain more space.

LG concluded that with the current design the collimator active lenght can be shorter up to a minimum of 55 cm. This preliminary design is now in stand-by until a required length is specified. Answering a question by SR, LG commented that the length could be adjusted for a final production after a prototyping phase. So, we do not need to decide now the length of the TCLD prototype foreseen in 2015 to within better than 10 cm.

7 Conclusions and decisions taken

From the collimation point of view, simulation results and TCLD design show that shorter collimator jaws are acceptable for IR7 and there is no strong argument for a lenght of 65 cm over 60 cm for proton cleaning. Ion simulations are not yet available but there is no reason to expect different conclusions. Differences in the performance can be compensated for by better material choices than the tungsten allow presently foreseen. In this way, we can keep the same design for the implementation in the dispersion suppressors around all LHC insertions.

From the integration point of view, a 60 long collimator poses no problems and gives the possibility of choosing between the cold or warm drift vacuum chamber option. It was therefore **decided** to opt for a TCLD collimator length of **60 cm**. In the meanwhile, WP11 should assess the feasibility of the two integration options and take a decision soon, following the time line of the 11 T dipole production. In parallel, more collimation material studies will also be made.