

Minutes of 49th Collimation Upgrade Specification Meeting

Participants: A. Bertarelli (AB), M. Borg (MB), F. Carra (FC), M. Fiassaris (MF) (scientific secretary), H. Garcia (HG), R. Kwee (RK), E. Metral (EM), D. Mirarchi (DM), E. Quaranta (EQ), S. Redaelli (SR) (chairman), G. Valentino (GV) J. Jowett (JJ).

Remote: T. Markiewicz (TM), L. Nevay (LN), C. Trautmann (CT)

Indico event [here](#).

1 Pending Actions

- From meeting #46: SR and EM to verify the setting and position of the collimators to make sure that they are compatible with stability criteria.
- From meeting #47 on the talk by L. Nevay on BDSIM, identify clear comparison criteria for the 4 TeV case; reverify with the optics section the issue with orbit non closure from survey files.
- From meeting #48 (hollow e-lenses) on D. Pierini talk about mechanical design for IP4 integration: need studies to qualify the design for high neutron fluxes for BBLR.
- From meeting #48 on R. Bruce talk about beam tests for alternative methods: investigate possibility of modulating non-linear elements for halo removal; possibility to try methods with full 7 TeV energy.
- From meeting #48: proposal to borrow complete TEL-2 test to be followed up.
- From meeting #49: Immediate actions from HiLumi annual meeting (long list, see slide 15 of [SR presentation](#))
- From meeting #49: How to estimate the effect of radiation damage on resistivity in graphite and measurement plan for the primary collimator taken out after Run 1 (EM, SR, AB).

2 Summary of annual meeting (S. Redaelli) [[slides](#)]

2.1 Summary of the presentation

SR gave a summary of the [HiLumi Annual Meeting](#), covering a short selection of topics relevant to the collimation system. One of the highlights of the meeting was the presentation by RB of the first complete conceptual layout for the HL-LHCm. The finalized layout includes the addition of a pair of TCT's in front of Q5 in IR1 and IR5 for increased protection against both cleaning losses and fast failures. Furthermore, a proposal to modify the design of TCL collimators on the outgoing beam to catch physics debris in IR1/IR5 was shown.

Many new results on collimation design were also presented, including a preliminary hollow e-lens design and studies for low-impedance collimators. SR briefly reported on the joint sessions with the Machine Protection and Injection & Dump work packages and on the collaboration work with US-LARP for rotatable collimators, hollow e-lens and material irradiation studies.

SR concluded highlighting the good progress made in collimation activities in the past year and summarizing the deliverables for the future. In particular, immediate actions are needed on the TCLDs (input needed from the vacuum team for the collimator length), on new TCL design downstream of IR1/IR5, on the masks design in the IR's and on several simulation priorities.

2.2 Discussion

On the left-hand plot on slide 7, where the effect of TCT5 collimators on Q5 magnet losses was shown, AB asked what is an acceptable threshold on the inefficiency. SR answered that it is difficult to quantify since it depends on quench limits and error models. However additional collimators are justified to avoid potential problems with losses at apertures above 12σ . After a question from AB, EQ clarified that the right-hand plot on slide 7 shows the impact of TCT5 in case of asynchronous dump (ie. for instantaneous losses).

On slide 10 (impedance estimates), AB asked if there is any gain expected from new materials, given the current working points. EM answered that if the TSCG will be replaced by a low impedance design the collimators will not be the main contributor to the impedance but the crab cavities will.

Regarding the actions needed for alternative ion solutions in IR2 based on orbit bumps to move losses at the location of the missing dipole (slide 15), JJ pointed out the need to discuss also with hardware people about integration needs. Following a question from AB on the timescale for the masks in the IR's, SR specified that they are foreseen for LS3. Finally, answering to a question from RK, SR confirmed that this should be the final conceptual solution to be used in simulations.

3 Agenda of WP11 meeting at GSI (A. Bertarelli) [\[slides\]](#)

3.1 Summary of the presentation

AB presented the agenda of the second EuCARD2 ColMat HDED annual meeting which is taking place on the 4th and 5th of December 2014. The first day of the meeting is dedicated to present and discuss the progress made by all partners. The morning covers the thermo-mechanical aspects of collimator material, while the afternoon is dedicated to irradiation tests. A wrap-up is foreseen at the end of the first day.

During the second day, different methods to calculate DPA (Displacement Per Atom) will be discussed and compared. The aim is to reach consensus on how to calculate DPA and agree on a plan for future studies and extrapolations.

3.2 Discussion

The values of resistivity for graphite and the effect of radiation damage on resistivity were discussed between EM, SR and AB. So far it could not be concluded from data if there is an evolution with radiation damage. SR suggested to make a measurement on a collimator, however this will not be feasible if the collimator has to be opened.

GV asked if radiation damage can affect the cleaning performance. SR and AB explained that radiation damage could cause problems if it causes swelling that changes the collimator

hierarchy. Although a significant change of density should not happen, changes in impedance and resistivity could be problematic.

4 Updated failure scenarios and damage limit of TCTs and status of SixTrack simulations (E. Quaranta) [slides]

4.1 Summary of the presentation

EQ presented a preliminary draft of the talk that will be presented at the WP11 meeting at GSI. EQ gave a brief introduction on the need for collimation upgrade studies that aim in particular at investigating new materials and new designs for secondary collimator jaws to improve robustness and impedance. The work presented is part of the task 11.4, which should provide feedback on the material specification by using simulations.

The first part of EQ's talk described the ongoing simulations to calculate TCT damage limits for fast dump failures. EQ performed SixTrack simulations with different TCT's settings and showed the resulting impact parameter distributions. FLUKA simulations to compute the energy deposition in the TCTs and hydrodynamic simulations to estimate the new damage thresholds are ongoing.

The second part of the talk discussed SixTrack simulations for two novel advanced composites for secondary collimators: MoGr and CuCD. The SixTrack material database has been updated and the cleaning efficiency with the new materials has been investigated by producing loss maps for different scenarios. In each scenario, the new material was used instead of CFC in all or some parts of the collimation system. The loss maps showed no significant difference in the cleaning performance with the new materials, as expected, and in some cases a slight improvement was observed.

4.2 Discussion

On the FLUKA energy deposition map of slide 17, FC asked for clarifications on how many bunches contribute to the plot. EQ and SR explained this is the sum of all 14 bunches, which in reality are spaced by 25ns. The FLUKA simulation was not repeated for each individual bunch because it would not make a visible difference. AB commented although this is fine for this part of the study, it might lead to a conservative results in the thermodynamical studies.

On slide 26, SR commented that collimators in IR6 should not be replaced with new ones. AB asked if, from the comparison of the different cases, one can conclude that changes in IR3 are not important. SR pointed out that with these simulations the statistics in IR3 is too poor to draw conclusions. For a consistent comparison, one should have a starting distribution with off-momentum particles. It was concluded that the small effect in IR3 observed from these studies should not be emphasized.

On slide 27 SR suggested to add plots showing the ratio of total losses in different collimators using the reference and new materials. These plots should aid the comparison and show, for example, if there is any change in the distributions in IR7.