Stefano Redaelli, 22-05-2006

70th Meeting of the LHC Collimation Working Group, May 22, 2006

Present: Ralph Assmann (chairman), Giulia Bellodi, Dariusz Bocian, Chiara Bracco, Daniel Kramer, Andres Gomez Alonso, John Jowett, Laurette Ponce, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Lucia Sarchiapone, Mario Santana-Leitner, George Smirnov, Rüdiger Schmidt, Markus Stockner, Joachim Vollaire, Thomas Weiler.

1 A.O.B.

- R. Assmann stated that, in another iteration, the package for collimation phase-II R&D within the FP7 European progra has been fully supported by the CERN management.
- D. Bocian announced that controlled quench measurements are being carried out at the SM18 in order to understand the quench limits of special superconducting magnets. For the moment, only magnets at 4.5 K can be studied because the quench heaters used for these tests are not strong enough to quench magnets at 1.9 K. The preliminary results are somehow worrisome because indicate that the quench limits of some quadrupoles could be **5 to 10 times smaller** than what has been assumed so far.
  Dariusz is preparing a note on this and agreed to present his results to the collimation working group in three or four weeks. This should be a joined meeting with the machine protection working group (R. Schimdt). Both working groups do fully support the continuation of these quench studies with high priority.
- A special collimation meeting will take place in two weeks (data to be confirmed) where R. Assmann will give a dry run of his talk at the next LHC Machine Advisory Committee (MAC, held on June 15-17).

2 Proposed BLM locations based of ion studies (G. Bellodi)

2.1 Simulation results and final proposal

Giulia Bellodi presented the latest results of ion loss maps, which are done to freeze the position of the beam loss monitors downstream of IR7. These studies follow up what has been discussed in detail at the last collimation working group meetings.

In order to understand the effect of closed orbit changes on the loss patterns, Giulia used a simplified model that misaligns the magnet aperture instead of actually simulation the beam dynamics in presence of closed-orbit distortions. The aperture is either scaled uniformly in all elements or scaled by opposite factors in consecutive half cells.

As far as the BLM locations are concerned, the basic outcome of these studies is that there are two cells where there are never loss peaks whereas in some locations new peaks can be found. G. Bellodi and H. Braun suggest to (1) **remove some of the additional BLM proposed at last meeting from the regions where loss peaks are never found** and (2) **add some more where new peaks can arise**. All together, a proposal of new locations was made which foresees **30 additional BLM's per beam**. This is less than the 100 additional monitors that were proposed at last meeting. See Giulia's slides for the table with the detailed positions.

2.2 Discussion

Laurette Ponce commented that Bernd Dehning had the agreement from the BI group leader that the requested 100 additional BLM's could be absorbed into the BI budget. The new proposal is therefore welcome and we have even an additional ≈ 40 monitors that we could use e.g. in IR3 (R. Assmann).

R. Assmann commeneted that there is a significant difference between the loss patterns of beam 1 and beam 2. This is also confirmed by the proton loss study team. G. Robert-Demolaize said that this is mainly induced by differences of the dispersion functions for the two beams. Guillaume agreed to present his views on that at the next meeting (**Action**).

J. Jowett commented that misaligning the two half cells by opposite signs could be a pessimistic assumption. In order to simulate the closed-orbit effects, the misalignment should follow the phase advance. However, everybody agreed that for this study it is good to be conservative. Future studies will be more realistic.

Looking at the heights of the simulated loss peaks, R. Assmann commented that in some cases we can have losses which are up to 5 times larger than the quench limit. Since the early ion runs will have 10 % of the nominal intensity (J. Jowett), this means that in principle we could reach the quench limit already with the early ion runs. More realistic models of the imperfections should be setup to assess this preliminary results.

R. Assmann also proposed that, one could use the openings of primary and secondary collimators as a parameter to optimize the ion cleaning performance. For the moment, the canonical 6 and 7 sigma settings have been used for ions even if they have been actually optimized for the proton cleaning.

R. Assmann also stressed that the active absorbers (TCLA) must be included in the simulations. This is not yet the case.

It was also mentioned (Laurette) that simulations should also be done to fix the position of the ion BLM's in IR3. Giulia will follow this up.

3 Commissioning scenarios and loss maps with reduced collimation systems (C. Bracco)

Chiara Bracco is a PhD student working in the ABP collimation team. She presented simulation results of commissioning scenarios (performance of reduced collimation systems at the LHC startup) and of collimation failure cases. The simulations use the package of software setup for collimation inefficiency calculations and loss map studies.

Following up the Chamonix2006 sections of staged LHC scenarios, is has been decided to simulate in detail the performance of reduced collimation systems at the LHC startup, when the circulating beam intensity will still be well below nominal. R. Assmann outlined various scenarios with a reduced number of collimators to be used and/or with relaxed operational settings (see R. Assmann paper at Chamonix2006). Chiara simulated the performance of the betatron cleaning system without secondary collimators (one stage cleaning with the TCP's at 6 sigmas + TCLA shower absorbers at 10 sigmas). Simulation results suggest that this reduced system could be suitable for **10 %** of the nominal LHC intensity, i.e. could be used up to intensities corresponding to the 75 ns operation (see details in the tables included in Chiara's slides).

Like it is done for the standard simulations, distributions of beam impacts in the collimator jaws were also provided to the FLUKA team for energy deposition studies. Preliminary results (as of Dec. 2005) suggested that the doses in the SC magnets could be about 7 times larger. New simulations will be done within 3 or 4 weeks (these studies were put in low priority because the colling of the passive absorbers needed urgent followup).

C. Bracco also simulated a failure scenario with a secondary collimator becoming a primary collimator. The main motivation for this study is to provide to the BI colleagues larger statistics on the loss maps locations. These data are being used by Laurette Ponce to study in detail the critical BLM locations all around the ring.

R. Schmidt commented that it is encouraging to see that if one changes a TCS jaw by

300 μm one finds losses that are 100 time larger at some locations. This could be used to understand if the system is badly setup. R. Assmann agreed however he noticed that the peak amplitude has to be normalized with the beam lifetime. Even the largest peaks might not be seen if the beam is very stable.

4 Status of IR loss simulations (T. Weiler)

T. Weiler reported on the last tracking collimation studies and discussed the plans for his future work. Notably, T. Weiler showed **first results on beam 2 loss maps**, which have been done by using the latest loss map simulation package setup earlier this year within the ABP collimation team (G. Robert-Demolaize , S. Redaelli). T. Weiler has thoroughly reviewed the (many) **LHC optics configurations** relevant for collimation studies, which now include various LHC "early" operation scenarios (e.g., early collision schemes with lower β^* at IP8). Last but not least, Thomas is working on dedicated simulation setups for **loss studies at the TCDQ**, for **background studies at the IP's** and for **impedance studies** (how much can we retract the TCT's?). Details of Thomas's results can be found in his transparencies.

T. Weiler has recently provided inputs for energy deposition studies in IP6, both for beam 1 and beam 2. The issue is that the beam dump collimators (TCDQ elements) intercept the secondary and tertiary beam halos, which increases the losses in the downstream cold magnets. The results of these studies were discussed by L. Sarchiapone in the meeting of May 8th, 2006. This issue will also be brought up at the next machine advisory commitee of June 2006. T. Weiler has also verified the effect of a reduced one-sided system on the TCDQ losses. The difference with respect to the full system is negligible. However, R. Assmann does not believe that and recommends to investigate both collimator sides because the halo distribution can be significantly asymmetric.

Future studies will be focused on setting up loss simulations to include the **exact geometry of the Roman pots** of IP1 and IP5. This will provide further inputs for background studies. T. Weiler will also investigate simulations with **"sheet" beams** for an optimized CPU usage of simulations.

It was also noted that inputs have been provided to Nicholai Mokhov (FNAL) for background studies at IP1 and IP5. Distributions of inelastic impacts at the tertiary collimators will be used as an input to start energy deposition studies around the IP. Results are expected soon from Nikolai.

Actions (ABP inputs followed-up by L. Sarchiapone FLUKA simulations): calculations of deposited energy from halo loads in the TCDQ elements in case of reduced collimation system: (1) missing secondary collimators (C. Bracco) and (2) one-sided cleaning (T. Weiler).

The next meeting will be announced.

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Action Items:

- ▷ Differences of loss patterns between beam 1 and beam 2. Effect of the dispersion functions? (G. Robert-Demolaize).
- ▷ FLUKA energy deposition studies for beam 2 (FLUKA team, inputs from ABP proton collimation team).
- ▷ Next ion studies should include the active absorbers TCLA (ion team).
- ▷ Ion cleaning and loss maps for different settings of TCP's and TCS's (ion team).
- ▷ Ion BLM's at IR3 (ion team).