Stefano Redaelli, 23-03-2005

54th Meeting of the LHC Collimation Working Group, March 21, 2005

Present: Ralph Assmann (chairman), Alessandro Bertarelli, Hans Braun, Bernd Dehning, Alfredo Ferrari, Gianluca Guaglio, Matteo Magistris, Paul Proudlock, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Alexander Ryazanov, Mario Santana Leitner, Rüdiger Schmidt, Katerina Tsoulou, Vasilis Vlachoudis, Joachim Vollaire.

1 Final layout of IR7

1.1 Results of latest simulations (M. Magistris)

See slides at http://www.cern.ch/lhc-collimation/files/MMagistris_2005-03-21.pdf

Matteo Magistris (MM) and Mario Santana Leitner (MS) presented the results of their latest simulations of energy deposition at IR7. New layouts with a **up to 5 active absorbers (TCLA)**, which included **6 different possible longitudinal locations**, have been considered. The goal of these studies is to find the layout that provides the best cleaning performance. The motivations to consider new layouts with respects to the ones presented in previous studies are that (1) the new simulations with larger statistics have shown that the cleaning performance obtained before (see, e.g., the minutes of the 51st collimation working group meeting of February 14th, 2005) did not guarantee a sufficient safety margin in preventing quenches; (2) A recent workshop on proton induced quenches of superconducting magnets has revealed that the quench limit of the Q6 quadrupole may be up to a factor 5 tigher than what was assumed. Q6 is the first superconducting magnet downstream of the warm IR7 insertion. In particular, the item (2) has suggested to consider a configuration with 4 absorbers upstream of Q6, which was not considered in previous studies.

The most promising configuration has **4 absorbers upstream of the dogleg** and **1 absorber downstream of the dogleg**. These absorbers have **1 metre long Copper jaws** (same design of the secondary collimators) and their nominal settings are $\mathbf{10}\,\sigma$. The corresponding length of the vacuum tank is **1.48 m**, as for all the other primary and secondary collimators. It is noted that last week a meeting was held with the TS colleagues that work on the 3D integration of the ring components (Samy Chemli, Catherine Magnier). It has been verified that **all the proposed locations** are **compatible** with the present tunnel layout (LHC optics version V6.501).

The proposed solution with 4 absorbers upstream of Q6 allows reducing the energy deposition in this magnet by a factor 2 with respect to the case with 3 absorbers. The total deposited energy is $\mathbf{0.8\,W/cm^3}$. The maximum peak energy deposition in the downstream cold magnets is approximately $\mathbf{0.8\,W/cm^3}$ for the quadrupoles and $\mathbf{0.4\,W/cm^3}$ for the dipoles. In the following table, the active absorber locations are summarized. The position of **centre** of the absorber jaws is given.

Name	Orientation	Distance from IP1 [m]
TCLA.A6R7.B1	Vertical	20149.075
TCLA.C6R7.B1	Horizontal	20180.035
TCLA.E6R7.B1	Vertical	20213.745
TCLA.F6R7.B1	Horizontal	20216.8191
TCLA.A7R7.B1	Horizontal	20232.845

As a **reserve position**, the installation of an additional absorber TCLA.B7R7.B1 at **20244.685 m** from IP1 could be regarded as a possible solution to further improve the performance of the system.

1.2 Radiation doses at the RR/UJ regions of IR7

Katerina Tsoulou commented that, since the final layout as discussed in the previous section has been finalized in the last days, she had no time yet to recalculated the radiation doses at the UJ and RR regions for the new cases. She will do that as soon as possible. Nevertheless, she does not expect significant differences with respect to the results of previous simulations with 4 absorbers instead of 5.

1.3 Discussion and final decision on the IR7 layout

RA welcomed the final results of the energy deposition studies. The proposed solution with 5 absorbers provides the best performance than all the other considered layout and should then be taken as the final solution. The information should be passed to Samy Chemly and Catherine Magnier for the integration in the LHC layout. Some margin is kept to finalize the position of the fifth absorber. The location for the `TCLA.B7R7.B1` should be **reserved** as a possible solution to improve the deposited energy in the dispersion suppressor, if needed. It should also be verified if the `TCLA.B7R7.B1` location provides a better performance than the location `TCLA.A7R7.B1` for the layout with 5 absorbers (see also next section).

MM pointed out the an additional absorber could certainly reduce the energy deposition in the dispersion suppressor but could not help in case of problems with Q6. Alfredo Ferrari said that there is basically nothing that we can do to further reduce the energy deposition in this magnet. RA proposed to reduce the gap of the active absorbers. AF believes that this will not improve much the energy deposition in Q6 because the heating is induced by shower products and is poorly affected by the opening of the active absorbers.

Katerina Tsoulou asked if the beam 2 is taken into account in the energy deposition studies. MM replied that most of the heating is induced by the showers in the forward direction. The contribution from the back scattering is practically negligible and this justify considering beam 1 only.

1.4 Future studies

It was agrees that the following items should be addressed in future studies:

- Evaluate the radiation doses at the **UJ and RR regions** with the new proposed layout of IR7.
- Estimate the performance of a system with 5 active absorbers but with the absorber `TCLA.B7R7.B1` instead of the `TCLA.A7R7.B1`, i.e., estimate the difference in performance for the two possible locations downstream of the dogleg.
- Include in the simulations the contribution from the **tertiary halo**.
- Decide the **material** of the TCT jaws.
- Investigate the performance of a layout with **longer primary collimators** (active length of **0.6 m** instead of 0.2 m, as it has been proposed for IR3).
- Investigate possible reductions of the energy deposition in the superconducting coils by reducing the opening of the passive absorbers.
- Define the locations of **passive absorbers** to protect the warm magnets.

1.5 A.O.B.

- In the discussion it was mentioned that the layout of the **cooling at IR7** remains an issue. Paul Proudlock commented that the infrastructure layout is basically defined (see the presentation by Paul Collier at the 51st collimation working group meeting of February 14th, 2005) We can go ahead with the proposed collimator layout of IR7. The problem of the cooling can be addressed later but it remains an high priority issue.
  Rosario Principe should be contacted as soon as possible to investigate the various options.
  RA commented that the collimator cooling itself should not be a big issue. The problem rather comes from the other warm magnets.
  Markus Brugger commented that simulations of water activation studies are being carried out to confirm old results for the new layout. Results should be ready soon and will be presented in one of the next collimation working group meetings.

- RA commented on the **final layout of IR3**. There was a problem of a superconducting link that passes through the warm region and could be exposed to high radiation doses from the collimators. This issue as been solved as follows: the link will be shielded with concrete until it passes downstream of the first primary collimator. Additional shielding could be put on top of the link if required. Studies from the IHEP colleagues have not be carried out yet but this proposed solution is necessarily better that what was foreseen before. Everything is under control and the layout is frozen and available for the LHC optics version V6.501.

2 Effect of irradiation on graphite materials for the LHC collimators (A. Ryazanov)

See slides at http://www.cern.ch/lhc-collimation/files/ARyazanov_2005-03-21.pdf

Alexander Ryazanov (AR) discussed the effect of irradiation on graphite materials to be used in the LHC collimators under various fusion and fission conditions. In particular, AR discussed the experimental results of various experiments worldwide which are relevant for understanding and predicting the effect of high energy proton beam on the graphite collimator jaws. Details con be found in AR's slides.

AR believes that an important effect for the LHC collimator jaws will be the accumulation of H and He molecules inside the graphite. This effect is being studies in detail at the Kurchatov institute by using as input the simulations results from FLUKA, provided by the CERN team. At his next visit to CERN, which will probably occur in summer 2005, AR will report on the obtained results. In particular, the degradation of thermo-mechanical graphite properties due to the impacts of 7 TeV protons will be investigated.

The next meeting will be to be defined.