Stefano Redaelli, 20-03-2007

83rd Meeting of the LHC Collimation Working Group, March 5th, 2007

Present: Oliver Aberle, Ralph Assmann (chairman), Giulia Bellodi, Chiara Bracco, Markus Brugger, Francesco Cerutti, Bernd Dehning, Frédéric Delsaux, Brennan Goddard, Keith Kershaw, Daniel Kramer, Luisella Lari, Marco Mauri, Manfred Mayer, Laurette Ponce, Stefano Redaelli (scientific secretary), Stefan Roesler, George Smirnov, Vasilis Vlachoudis, Thomas Weiler.

1 Updates on FLUKA simulation of TCDQ halo loads at IR6 (L. Sarchiapone)

Lucia Sarchiapone presented her latest results of FLUKA energy deposition studies in the dump region. These simulations take as an input the proton losses within the TCSG.TCDQ and TCDQ elements as they are simulated by the ABP collimation team for beam 1 and beam 2. The halo loads for a perfect LHC at 7 TeV were discussed at the 69th meeting of the collimation working group of May 8th, 2006. Following up pending actions from this meeting, Lucia performed simulations for the commissioning scenario with missing secondary collimators (inputs provided by Chiara Bracco) and for the case of one-sided cleaning (inputs provided by Thomas Weiler). In addition, Lucia considered the nominal machine with an additional active absorber to protect the downstream superconducting magnets. We remind that the beam 2 case is the most relevant because the TCDQ losses are much bigger than for beam 1, as IR6 is immediately downstream of the betatron cleaning insertion for the counter-clock wise beam 2. The horizontal halo case was found to be more critical than the vertical one.

For the nominal machine, the local losses in the superconducting coil of the Q4 magnet downstream of the TCDQ blocks are 3.1 mW/cm^3, i.e. less than a factor 2 below the assumed quench limit of 5 mW/cm^3. Lucia Sarchiapone found that (1) without the secondary collimators of the betatron cleaning the losses reach the 200 mW/cm^3, which indicated that the total beam intensity must be limited to 1/75-th of the nominal LHC beam; (2) with a one-sided cleaning the losses are 7.2 mW/cm^3. If a TCLA-like absorber is added in front of the Q4 quadrupole, the losses for the nominal machine can be reduced by almost a factor two and brought to 1.8 mW/cm^3, i.e. a factor 2.5 smaller than the assumed quench limit (nominal setting for all movable elements and new absorber at 10 sigmas). This seems an interesting option for an **upgrade scenario for the dump region**.

R. Assmann asked which jaw of the primary collimator have been considered for the simulations of a one-sided system. If there is a preferred side to be used, for which the deposited energy is smaller, one operationally could try to make sure that the best side is always closer to the beam. Lucia Sarchiapone replied that T. Weiler provided input data for both cases and she only showed the worst case.

Follow-up after the meeting: Lucia Sarchiapone updated her slides to include results for both sides of the one-sided collimation system (left and right jaws). The new version is available on our web page. In addition, the slides have also been updated after correcting an error that was found in the normalization of the total deposited energy. According to the updated figures, in the worst case the deposited energy with the one-sided cleaning system is 4.4 mW/cm^3, which is only about 30 % more than for the full system.

R. Assmann stated that we should decide as soon as possible is we want to build an additional TCLA for the dump region. Brennan Goddard commented that this would certainly be a very wise decision.

2 Collimator handling in the LHC tunnel (K. Kershaw)

Keith Kershaw from the from the TS-IC group presented concepts for the collimator handling in the LHC tunnel. First Keith introduced his section (TS-IC-IS), which carried out the heavy handling studies for the LHC machine and experiments and has in particular experience with providing overhead cranes, special transport vehicles and installation equipment as well as remote handling. Amongst other things, the section was responsible for the equipment used for the installation of the LHC cryomagnets. Next Keith reviewed the basic principles of the collimator handling in the LHC tunnel. The solution for the LHC collimator has been developed in close collaboration with the TS collimator team. After encouraging results of experimental tests with mock-up collimators, two special trailer-cranes have been bought for the installation of the collimators. Keith Kershaw showed an animation of the typical sequence for the quick collimator installation and also photographs of a trial collimator installation in the tunnel.

The next step is to investigate the possibility of remote collimator handling in a high radiation environment. The goal is to be able to remove and replace a collimator with minimum human intervention to reduce the dose to personnel. In addition, equipment for remotely surveying the collimator position is also being developed jointly with TS/SU. A solution that is presently being considered relies on the **Train Inspection Monorail (TIM)** that can run all around the LHC tunnel. In order to handle a collimator, the monorail train could be equipped with cranes capable of transferring the collimator from its support to the monorail train and vice-versa. In addition the monorail train could also ensure the transport along the tunnel. These tasks are particularly challenging due to the very limited space for the passage however a promising solution has been found. Keith Kershaw showed an animation of how a monorail train-based remote handling collimator exchange could work. See details in Keith's slides.

In conclusion, Keith Kershaw stated that the remote installation and removal of LHC collimator seems feasible, his team have not yet looked in detail at disconnection issues, but this has been treated during the collimator design work. A promising solution has been proposed however there are still various 3D integration issues that have to be solved. Next steps of these studies will be focused on preparing a mock-up to develop remote handling equipment and techniques.

R. Assmann asked about the maximum weight that the monorail can support. Keith Kershaw replied that a the rail of the monorail can support a 2.4tonne point load, with an additional limit of 2.4 tonnes per 4.2m. The load capacity of the trailer-crane bought for installation of collimators is 500kg, as agreed during collimator design meetings. As the collimators weigh more than originally envisaged, this is barely sufficient for a collimator assembly (O. Aberle).

Bernd Dehning asked if the installation of the collimator cables can in some cases be cause problem for the collimator handling. Manfred Mayer thinks that this should not be the case because the cables normally are connected through the lower collimator support. However in various locations the cables hang from the top of the tunnel. Everybody agreed that detailed 3D integration studies should be followed up in order to make sure that there are no conflicts, especially with cooling pipes (**Action** for R. Assmann).

Bernd Dehning wondered whether a remote handling could also be foreseen for the handling of cables in the tunnel. R. Assmann commented that cable major replacements can be done during shutdown periods, when the radiation doses are smaller. However, the remote handling of components is critical for quick accesses into the tunnel, e.g. after a beam failure.

Markus Brugger wondered how the TIM could move along the whole LHC ring. There are many ventilation doors and *chicanes* that will prevent the passage. Keith Kershaw replied that it has been proposed to modify the design of ventilation doors and *chicanes* in order to ensure the TIM passage. This studies are ongoing. However Markus commented that in some case, design changes could compromise the effectiveness radiation shielding.

Keith Kershaw commented that his section are looking for clients that are interested in the use of TIM and remote handling of LHC components in order to help with justification of modifications to the doors in the tunnel. Markus Brugger commented that the radiation survey could certainly profit from the functionalities provided by the TIM. Keith Kershaw replied that a joint project with SC/RP is already underway.

S. Redaelli asked what is the speed of the TIM. Keith replied that for the moment it is limited to 3 km/h but it is going to be uprated to twice this values.

Triggered by a question from Bernd Dehning, Keith also commented that none of the TIM components are for the moment designed to be radiation hard. However this does not seem to be a serious problem for operation without beam.

The next meeting will be March 19th, 2007 at 14:30.