Stefano Redaelli, 15-03-2005

53rd Meeting of the LHC Collimation Working Group, March 14, 2005

Present: Ralph Assmann (chairman), Bernd Dehning, Brennan Goddard, Gianluca Guaglio, Barbara Eva Holzer, Roberto Losito, Matteo Magistris, Andy Presland, Christian Rathjen, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Adriana Rossi, Alexander Ryazanov, Mario Santana Leitner, Rüdiger Schmidt, Katerina Tsoulou, Helmut Vincke.

1 Overview of collimator pumping modules (A. Rossi)

See slides at http://www.cern.ch/lhc-collimation/files/ARossi_2005-03-14.pdf

Adriana Rossi (AR) gave an overview of the various collimator pumping modules. Details of the module design are given in AR's presentation. Depending on the nearby elements, the pumping modules require various types of vacuum connections, have different lengths, flange types and connection pieces. In total, for phases I, II and III (which have been merged for the pumping module production), **177 different pumping** modules are required. AR has prepared a detailed list of all these modules and she is ready for the market survey, which will go out in three weeks. The supply to CERN should be completed in June 2006. CERN will provide to the manifacturer the execution drawings and the bellows. By contract, also some prototypes of the pumping modules will be produced and will be available as soon as possible for test at CERN.

A key point of the pumping module design is the **flange**. In order to reduce the intervention time in case of collimator replacements, a special flange design based on a clamping system was developed (See the presentation by Christian Rathjen at the 50th collimation working group meeting of January 30th, 2005). This allows reducing the mounting/remounting time by a factor 2 or 3 depending on the location. Unfortunately, it is not always possible to have this kind of quick connection on both sides of the pumping module. For example, if on one side a collimator is too close to the nearby element, there is no enough space for the transition and standard flanges must be used. In total, 6 of such cases occur over a total of 177 pumping modules.

1.1 Discussion

Helmut Vincke (HV), who attended the collimation meeting on behalf of Stefan Roesler, said that the radio protection team has to be informed about the critical locations where the fast collimator replacement is not possible. He will transmit this information to Stefan Roesler and Markus Brugger so that they will be able to follow this issue up.

RA asked how much it would cost to have quick flanges at every pumping module. Christian Rathjen (CR) replied that this depend on the location (see also next section). In some cases, there is simply not enough space for the transition and one could solve the problem by moving some elements. The list of critical location is now available and this issue should be followed up.

Stefano Redaelli asked how often the pumping modules should be replaced. CR replied that these are simple and reliable components that should not required to be changes unless serious problems occur. The maintenance issues are rather related to the nearby components such as collimators or magnets.

RA suggested to have a **final cross-check** of the total pumping module number with Oliver Aberle. He also underlined that it will be very important to **assess the functionalities of the proposed design at CERN**, possibly by connecting a module prototype to an LHC collimator. All the critical issues should be verified in experimental conditions as close as possible to the ones expected in the LHC in order to properly validate the proposed

design. HV asked to check also the radiation hardness. CR replied that the pumping module itself is entirely made of steel but some grease might indeed be affected by radiation. HV proposed to replace the grease with graphite.

Another critical issue that was mentioned is the **RF contact** of the pumping module in case of **offsets** with respect to the collimators **during bake out**. A. Rossi had assumed that during bake out the elements adjacent to the pumping module would be realigned to the nominal position, so to avoid mechanical stresses due to asymmetric positions of the RF fingers. RA said that this might not be the case because, if there is the need of beking out a long section of the machine, we want to be able to do so without realigning the lattice elements. Future tests with the prototype of the pumping module should investigate if the RF connections keep their functionalities after bake out (possibly with asymmetric heating).

Roberto Losito commented that, according to the project specification, the collimators can only be moved upwards but not downwards. RA said that this cannot be the case because we want to keep the freedom to move them up or down depending on our needs! This items should be followed up.

Remark (16.03.05): After the meeting, RA checked that the collimators can indeed be moved BOTH upwards and downwards!

2 Integration issues of collimator pumping modules (C. Rathjen)

See slides at http://www.cern.ch/lhc-collimation/files/CRathjen_2005-03-14.pdf

Christian Rathjen discussed some critical issues on the installation of the collimator pumping modules and on the collimator layout in general. In the region between the D2 magnet and the TAN at **IP5**, CR could identify approximately **25 critical items** that require *ad hoc* solutions for the final 3D integration. **12** of this locations are **related to the collimator installation**. The problems are mostly related to the limited longitudinal space, which does not leave enough space for the installation of the pumping modules and the required transition pieces. In some cases, it will not be possible to use the quick-connect flange and this will result in longer intervention times in case of collimator replacement.

Another problem is related to the installation of two adjacent collimators between two Q5 modules at IR3. Due to the limited space, there is not enough space to install the two required pumping modules. Possible solutions could be to move 6 MQW modules by 1 m or to move the collimators by up to 0.5 m. The latter solution may require the installation of one pumping module only instead of two.

CR stressed that it is important to freeze as soon as possible the LHC layout and these items should then be addressed with high priority.

2.1 Discussion

RA commented that the modification of the MQW longitudinal position is a major change for the LHC optics layout and should then be avoided. The possibility of shifting the collimators in less complicated and could be envisaged if needed.

Adriana Rossi asked if it possible to reduce the number of pumping modules from 2 to 1. Indeed, she asked if there is any specification on the maximum allowed out-gassing. She has some concerns that the **out-gassings** may be larger than expected and this could even saturate the NEG coating and then generate electron could build up. RA quoted some specifications provided by Miguel Jimenez, who stated that the out-gassing is acceptable if the collimator jaw temperature is kept below 75° C. RA agrees that the collimator out-gassing is a concern and he proposed that **A. Rossi should present the expected values** as soon as possible at one of the next collimation working group meeting. Francesco Ruggiero

and Frank Zimmermann should also be invited because this problem has strong implications for the electron cloud.

3 Performance analysis of IR6 TCDQ system for different load cases (A. Presland)

See slides at http://www.cern.ch/lhc-collimation/files/APresland_2005-03-14.pdf

Andy Presland (AP) presented the results of energy deposition studies in the TCDQ/TCS system of IR6 and in the downstream elements for the following load cases: (1) Asynchronous damp failure case; (2) Normal dump; (3) Secondary halo with low beam lifetime. The simulations are performed with FLUKA with a simplified geometry of the various components. From the deposited energy per unit volume, the instantaneous temperature rise is calculated and compared with quench/damage limits of the various components. The following settings are assumed:

- Injection: TCDQ at $8\,\sigma$; TCS at $7\,\sigma$;
- 7 TeV: TCDQ at $10\,\sigma$; TCS at $9\,\sigma$.

RA said that the nominal settings are now different. According to Brennan Goddard (BG), the effect is small for the cases under investigation.

The conclusions of AP's study can be summarized as follows:

- In case of **asynchronous dump at 7 TeV**, all the elements are protected against destruction. The primary objective of the system is therefore fulfilled.
- The load from the **secondary beam** halo both at **450 GeV** and at **7 TeV** induces a localized **energy deposition** which is up to **100 times larger than the assumed quench limits** of the superconducting Q4 magnet. The total deposited power is instead acceptable.

It should be noted that there is some uncertainty on the assumed quench limits. As a reference, the standard values of the LHC Project Report 44 have been considered.

AP commented that there is a number of issues to be addressed to obtain more realistic results. Future simulations will be based on a more detailed models for the secondary halo shape and a more complete FLUKA geometry (to included, for example, cold bore and beam screens). The possibility to relax the settings of TCDQ and TCS shall also be investigated. In addition, It was stressed that there is still an uncertainty on the assumed quench limits for the Q4 magnet.

3.1 Discussion

RA said that a **more detailed FLUKA model** should definitely used to provide more accurate estimates. In particular, the metallic components behind the carbon jaws should also be taken into account because they can experience large temperature increases under the beam load. A know issue, for example, is the heating of the cooling water, which may induce large instantaneous pressure rises in the coils. The final results of energy deposition studies should be then given to Alessandro Bertarelli for studying the effect on the mechanical structure with ANSIS. In addition, RA asked to verify the assumed damage level for the graphite. GB said that their assumed numbers have been provided by Luca Bruno.

Alexander Ryazanov stated that not only the temperature rise but also the mechanical stresses should also be taken into account in order to realistically estimate damage levels for the various components.

RA said that the amount of energy that goes through the beam pipe should also be taken into account. This energy is likely going to be lost in the downstream cold elements.

Ruediger Schmidt said that future studies should also take into account the corrector magnet installed upstream of Q4, in the same cryostat.

As a possible solution to reduce the energy deposition in Q4, it was mentioned that there is some space left between the beam screen (56 mm diameter) and magnet aperture (70 mm). RS encouraged to investigate if it is possible to install some kind of mask in this area. BG said that more likely this is not going to be possible. This should be verified.

4 Status of energy deposition studies at IR7 (M. Magistris)

See slides at http://www.cern.ch/lhc-collimation/files/MMagistris_2005-03-14.pdf

The definition of the final IR7 layout with the new active absorbers, originally schedules for today, has been postponed by one week. The FLUKA team asked for one additional week before the final decision because they had to consider additional options. Matteo Magistris reported that with the present layout with 4 absorbers, as discusses at the 51st meeting of the collimation working group (February 14th, 2005), all the superconducting magnets are below quench limit but there is some concerns that the safety margin is not sufficient. The additional performed simulations have shown that the calculated deposited energies are close to the statistical error. Other solutions with five or six absorbers have then being considered to further reduce the energy deposition in superconducting magnets. Discussions with the installation group have shown that the proposed locations are comparable with the present layout. The new simulation results will be discussed in **one week** and the **final decision** will be taken.

Katerina Tsoulou is waiting for the final layout to calculate the doses at the RR and UJ regions.

The presentations of Guillaume Robert-Demolaize and Stefano Redaelli, who wanted to report on cleaning inefficiency and loss maps with the new layout, were also postponed to the next meeting.

The next meeting will be March 21st, 14:30, J.B. Adams room.