*Stefano Redaelli, 11-05-2005*

# 58$^{\text{th}}$ Meeting of the LHC Collimation Working Group, May 9, 2005

*Present:* Ralph Assmann (chairman), Markus Brugger, Bernd Dehning, Alfredo Ferrari, Gianluca Guaglio, Barbar Eva Holzer, Jean-Bernard Jeanneret, Igor Kurochkin, Matteo Magistris, Christian Rathjen, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Mario Santana Leitner, Suitbert Ramberger, Katerina Tsoulou, Roger Valbuena, Vasilis Vlachoudis.

## 1 Energy deposition in SC-link and fibres of IR3 (I. Kurochkin)

See slides at http://www.cern.ch/lhc-collimation/files/IKurochkin_2005-05-09.pdf

### 1.1 Simulation results

Igor Kurochkin (IK) presented his latest energy deposition calculations at IR3. These studies are targeted to estimate the deposited energy in the superconducting link (sc-link) and in the optics fibres that are installed all along this cleaning insertion. It is noted that recently the layout of the IR3 has been changed to move the sc-link to a safer location, which is as shielded as possible from the primary collimators (see minutes of the 54th meeting of the collimation working group of March 21st, 2005, A.O.B. section). IK was asked to assess this layout choice. For this purpose, IK calculated the deposited energy all along the cleaning insertion at six different transverse locations for the sc-link (see scheme in IK's slides). An additional position, corresponding to the optical fibres location, has also been considered. The dissipated power is calculated for various operational scenarios at 450 GeV and at 7 TeV.

IK found that the deposited power in the **sc-link** can reach values up to **4.2 mW/cm$^3$** at **top energy**, with an assumed minimum allowed lifetime of **0.2 h**. It is noted that in the vicinities of the primary collimators, where the sc-link climbs from the trench to above the magnets, the **new proposed sc-link location** presents a maximum deposited power of **0.35 mW/cm$^3$**. This is approximately **three times smaller** than with the original layout.

At injection, the deposited energy is driven by the **off-bucket** particles, whose population is assumed to be **5%** of the total bunch charge. For slow transient losses (time scales larger than 0.1 s), the maximum deposited energy is **43 mJ/cm$^3$**.

The **optical fibre at IR3** will get about **8 KGy per year** assuming the **10$^{16}$ protons per year** will be lost at the LHC.

### 1.2 Discussion

Ralph Assmann (RA) said that IK's results basically confirm the **new proposed layout** for the sc-link at IR3. The energy deposited into the sc-link are close to the quench limit (see next section) but the proposed location ensures the smallest deposited energy. Additional shielding shall be added if the sc-link quenches will limit the LHC performance.

Bernd Dehning (BD) pointed out that the **doses on the fibres** are high. One expects a 8 db signal attenuation for 3 KGy per year and the simulations of IK shows doses three time larger. BD asked what is the error on the simulations results. There was agreement between IK and Alfredo Ferrari that one should take at least a **factor three safety margin** on this results. The fibre location is quite far from the radiation source and this reduces the accuracy of the showering code results. It was agreed that the quoted number should be regarded as a safety margin.

# 2 Quench limit of the sc-link in IR3 (J.B. Jeanneret)

See slides at http://www.cern.ch/lhc-collimation/files/JBJeanneret_2005-05-09.pdf

## 2.1 Energy deposition versus quench limit

Based on the results by IK, Jean-Bernard Jeanneret (JBJ) discussed the quench limit for the sc-link in IR3. According to the information provided by Robert Herzog (November 2004), JBJ assumed a **steady quench limit** of **1.5 mW/cm3** for the sc-link. For the simulated scenarios of **1 h** beam lifetime, the maximum deposited power is **0.8 mW/cm$^3$**. This is compatible with a minimum allowed lifetime of 30 minutes. This should be acceptable for the first years of operations but the issue requires careful monitoring for higher beam intensities.

The assumed **transient quench limit** in the sc-link (at time scales larger than 0.1 s) is **30 mJ/cm$^3$**. For the loss flashes at the beginning of the ramp, the simulations results by IK indicate that only **3.5 % of off-bucket particles** would be allowed instead of the assumed value of **5 %**. This is certainly an issue that requires follow up. A possible solution could be to add some shielding to the trench that houses the sc-link but this possibility requires **dedicated simulation campaigns**, e.g. to determine the shielding thickness.

## 2.2 Discussion

RA said that it is probably better to wait before starting new shielding studies. RA proposed to have a restricted meeting with the people concerned (e.g., with Karl Huber Mess) to check the assumed quench limits before drawing the final conclusion.

JBJ also commented on the choice of the material for the active absorbers at IR3. JBJ believes that the same choice of **Tungsten** instead of Copper, as it is taken for IR7 (see next section) should also be applied for IR3. It is pointless to repeat for IR3 the showering studies already done by the FLUKA team for IR7. People agreed with this approach.

In conclusions, it was decided that (1) the **quench limits** for the sc-link should be **agreed with AT-MEL** and after that (2) simulations should be re-done for the full IR3 insertion by taking **Tungsten** absorbers. If new simulation results prove that the quench of the sc-link is still an issue, (3) **shielding studies** shall be started to investigate possible solutions to reduce the doses to the sc-link.

**Action:** Review the assumed quench limit for the sc-link at IR3 (J.B. Jeanneret, R. Assmann, K.H. Mess).

# 3 Update on energy deposition studies at IR7 (M Magistris)

See slides at http://www.cern.ch/lhc-collimation/files/MMagistris_2005-05-09.pdf

## 3.1 Results of latest simulations

Matteo Magistris (MM) reported on the latest studies of the FLUKA team on the energy deposition at IR7. Following up pending action, the FLUKA team team has investigated two different positions of the first active absorber (TCLA) at IR7. See the minutes of the 54th meeting of the collimation working group (March 21st, 2005). The conclusions of these studies are that **the two investigated positions**, referred to as `TCLA.A7R7.B1` and `TCLA.B7R7.B1`, are basically **equivalent** as far as the energy deposition in the cold dispersion suppressor is concerned.

It is noted that the contribution from **tertiary beam halo** is not yet fully taken into account in these simulations. An approximate particle distribution of tertiary halo within the TCLA has been included on the base of simulation results provided by Stefano Redaelli. The differences are of the order **20 %**. However, taking into account the tertiary halo contribution does not change the conclusion that the investigated positions for the firth TCLA are equivalent.

The new studies also confirmed the preliminary conclusions presented at the previous meeting on the material for the TCLA jaws. **Tungsten** is a preferable choice than Copper.

## 3.2 Discussion

Based on the simulations results, it was agreed that we should confirm the position `TCLA.A7R7.B1`. Below, a table with the final position is given. Given are the position of the **centre** of the collimator jaw with respect to IP1.

| Name | Orientation | Distance from IP1 [m] |
|---|---|---|
| `TCLA.A6R7.B1` | Vertical | 20148.330 |
| `TCLA.C6R7.B1` | Horizontal | 20179.290 |
| `TCLA.E6R7.B1` | Vertical | 20213.000 |
| `TCLA.F6R7.B1` | Horizontal | 20216.074 |
| `TCLA.A7R7.B1` | Horizontal | 20232.100 |

Concerning the **material for active absorbers**, it was **decided** that the baseline will be **Tungsten**.

Stefano Redaelli said that from the beam loss simulations there are indications that horizontal and vertical halos might have different effects on the losses. SR then asked if we should envisage to install an additional absorber, in necessary, at the position `TCLA.B7R7.B1`, which is in any case reserved. RA replied that this could be an option and that we should therefore keep the space reservation for this additional location.

Some future work was also discussed (see also next section).

**Action:** Provide impacts of tertiary halo protons in the TCLA's of IR7 (S. Redaelli, G. Robert-Demolaize).

**Action:** Study the option of having 0.6 m long primary instead than 0.2 m (R. Assmann, S. Redaelli, G. Robert-Demolaize, FLUKA team).

**Action:** Calculate the radiation doses in the optical fibres at IR7 (FLUKA team).

**Action:** Provide to C. Rathjen the updated numbers of energy deposited in the warm elements at IR3 and IR7 - see also next section. In particular, provide the deposited energy into the vacuum pipes even in the drifts and not only inside the magnets (IHEP team , FLUKA team).

**Action:** Include in the IR7 layout the **passive absorbers** (FLUKA team).

# 4 A.O.B

## 4.1 Status of the IR7 layout integration (R. Valbuena)

Roger Valbuena (RV) reported on the status of the integration of the various collimators in the LHC layout. The **locations of all collimators** have been **frozen**. An EDMS document with the final layout has been send out for approval to everybody concerned. RA asked that Alfredo Ferrari and Bernd Dehning should be included in the list of people to approve this document. VB will include them as asked.

There are the following issues which are still pending and require input from the collimation team: (1) the design of the passive absorbers has not been provided yet. For the moment, there is only a space reservation. (2) The position of the ventilation units in IR7 are not defined. (3) Electric boxed for various usages shall be included in the layout but their locations have note been decided. (4) In addition, RV asked to have an ECR with the final positions of the passive absorbers.

In answer to the RV's requests, it was discussed that: (1) For the passive absorbers, we know the requirements but the detailed deign is not yet available and will be finalized as soon as possible; (2) The position of the ventilation units is not under responsibility of the collimation project. The solution for their locations should be carried out by RV's team in collaboration with TS; (3) Electric boxed are not needed for the collimators and hence there are no special requests from the collimation project. These boxes can be place anywhere provided that they do not interfere with the collimator equipment. Due to the high radiation levels, special radiation hard material could be required for these boxes. (4) RA will prepare the ECR for the active absorbers within a couple of weeks.

## 4.2 Estimate of the deposited energy in the vacuum chambers of IR3 and IR7 (C. Rathjen)

See slides at http://www.cern.ch/lhc-collimation/files/CRathjen_2005-05-09.pdf

Christian Rathjen (CR) needs to know the amount of energy deposited into the vacuum chambers of the various elements in the warm cleaning insertions. This information is required to define the vacuum chamber specifications. It is important to have this done as soon as possible because this issue can have a big impact on the overall cost of these components. In addition, it is also important to assess the survival of various components, such as for example the bake out system of some particularly hot elements.

CR has gone through the minutes of the various collimation working group meeting were energy deposition studies have been discussed and have prepared a tentative list of deposited energy values for the various components. CR asks the help of the collimation study team to get feedback on the numbers that he has prepared.

It was agreed that it would be very useful the setup systematically the values of deposited energies in the various components. It was then decided that this issue should be followed up by the people concerned (CR, FLUKA team, IHEP team, Suitbert Ramberger, ...). People will meet as soon as possible to revise the available numbers.

It was asked which **safety factor** should be taken on the simulation results. Alfredo Ferrari said that on the elements close to the beam pipe (vacuum chambers, flanges, magnet coils, ...) the simulation accuracy should be fairly good. A **safety factor of two** should be taken. IK also agreed. RA pointed out that the machine components should be designed for the **ultimate LHC performance**. Therefore, an additional factor 1.6 should be taken with respect to the simulation results. Together with the uncertainty factor from the showering code results, a total **safety factor three** should be taken for the component design.

**The next meeting will be defined.**