Verena Kain, 2004-25-03

36$^{\text{th}}$ Meeting of the LHC Collimation Working Group, March 19, 2004

Present: Ralph Assmann (chairman), Verena Kain (scientific secretary), Brennan Goddard, Bernd Dehning, Alfredo Ferrari, Stefano Redaelli, Barbara Holzer, Peter Sievers, Luca Bruno, Fritz Caspers, Helmut Burkhardt, Oliver Aberle, Christian Rathjen, Laurette Ponce, Wim Weterings

1 Survival of thin coatings with beam impact (A. Ferrari)

See slides at http://www.cern.ch/lhc-collimation/files/AFerrari_19Mar04.pdf.

A. Ferrari (AF) presents the results of FLUKA simulations for energy deposition in graphite collimators with none, 100μm, 10μm and 1μm Cu-coating. Coating might be useful to reduce the resistive impedance contribution of the collimators (especially the secondary collimators, TCS). The simulations were done for the dump kicker failure, not with the latest numbers of 8 bunches impacting but the old number of $2 \cdot 10^{12}$ protons for comparison reasons with old simulations. No mechanical tolerances were added, the set-up was simulated geometrically perfect. AF adds that including mechanical tolerances will most likely make the situation worse. The beam impacts with comparatively large impact parameters on the C part of the jaw. The energy deposition was converted into instantaneous temperature rise. P. Sievers (PS) remarks that the cooling via heat diffusion might not be negligible over 200ns (8 bunches with 25ns spacing) for a diffusion speed of 15 μm/μs (3μm over 200ns).

For the temperature rise in the graphite bulk material "no coating" gives the best results; 100μm coating gives unacceptable temperature rises in the C; with 10μm and 1μm there is essentially no difference for the C bulk material compared to the non-coated case. The heat transfer from the Cu to the C was not included.

R. Assmann (RA) concludes that AF's results indicate that a collimator with e.g. 5μm Cu-coating plus surface flatness ($\rightarrow$ 10μm coating) would survive the dump failure and could be envisaged to improve the impedance.

F. Caspers (FC) asks whether other structures, like a wire mesh, instead of a homogeneous surface as coating on the collimator should not also be considered for impedance reduction. RA replies that for impedance a mesh is not better than a homogeneous surface.

Using Titanium might not improve the situation: although the heat resistivity is much better, the electrical conductivity is a factor of 3 below the Cu value. Also μm-diamond-films as coating, which are in one direction very good electrical conductors, were discussed.

PS asks whether it is possible to put a layer of only 1μm Cu on C. RA reports on news from S. Calatroni, who used sputtering to coat the jaw. To make the Cu adhere to the C a nm Ti layer was put beneath the Cu.

RA proposes to have a test where the coated jaw is heated to 300° and to check the integrity of the coating afterwards (see whether it peels off. . .).

It is not desirable to have the coating on all the collimators due to the small impact parameters on primary collimators. There it is probable that the beam hits the Cu layer instead of the C. Additionally, coating of primary collimators is not good for ion collimation.

2 Surface Resistance on collimator jaw material (O. Aberle)

See slides at http://www.cern.ch/lhc-collimation/files/OAberle_19Mar04.pdf.

See info at http://www.cern.ch/lhc-collimation/files/FCaspers_19Mar04.pdf.

O. Aberle presents the results of resistance measurements he did together with FC. Several samples were measured, CFC materials (different orientations and conditions of the fibers) as well as graphite samples.

Coating the materials was tested after a heat treatment (1000°/2h). One side per sample was foreseen with 1μm Cu coating, the other side with a Ti flash followed by 1μm Cu coating. The thickness of the coating depends on different parameters and effects like the surface flatness and shadow effects. There are several methods of measuring the thickness of the coating: by means of a step profiler, x-ray fluorescence or weight. For these tests only a step profiler and x-ray fluorescence was used.

Well-known ways of measurement for surface resistance were applied (4-pin measurement) for the bulk material. The different sample size posed an additional difficulty for the measurement. The sample (from SNECMA) which gave the lowest resistance and best high temperature resistivity has unfortunately a long delivery time.

The way of measuring the resistance with coating has not been sorted out yet. The contact resistance between layer and bulk (although it is perpendicular to the beam direction (FC)), RF fingers, the clamping structure, ... will have to be estimated, and there also a proper a way of measuring will have to be found.

3 Discussion of detailed aperture model (S. Redaelli)

See slides at http://www.cern.ch/lhc-collimation/files/SRedaelli_19Mar04.pdf.

See slides at http://www.cern.ch/lhc-collimation/files/BHolzer_19March04.pdf.

S. Redaelli (SR) presents the requirements and status of a 1m-scale aperture model for the LHC. This model will be crucial input for simulations of beam loss patterns.

Each element in the MAD sequence shall have an aperture definition. Markers with aperture have to be introduced at the beginning and end of each beamscreen as well as each warm vacuum chamber. Elements such as the TAN, recombination chambers,... must be treated specially. The aperture of collimators and movable absorbers will have to be defined by the user in the MAD input (note: collimators and absorbers are defined as "rcollimator" in the sequence; the allocation of aperture for rcollimators does not work; a possibility if tracking with MAD is to define them as markers).

To have elements with aperture every m, interpolation tools to introduce additional markers can be used. The Mathematica-MAD application by J. Jowett for example could be used for this purpose.

The data-base team already provided a file with markers at the beginning and end of the beamscreens. If needed this file can be called in the MAD input and installs the markers in the sequence (note: the additional markers are not in the sequence file). It was set up for sequence version V6.4 but is compatible with V6.5. Several cases have to be treated specially; the orientation of some beamscreens in sequence elements (magnets, DFBs, ...) have to be changed by dedicated scripts. Overall consistency will have to be checked.

The treatment of transitions between beamscreens is not clear yet. For a 1m-scale aperture model, transitions shorter than 1m can be neglected. For transitions longer than 1m additional markers have to be introduced. E.B. Holzer (BH) points out that for BLM studies where aperture models down to a 10cm-scale might be needed, this approach is not sufficient. Interpolating from the information provided by the 1m-scale aperture model would introduce errors in a 10cm-scale aperture model (could for example lead to unrealistic beam losses in the simulation at locations with in fact bigger aperture, if the regions of different aperture are shorter than 1m). The decision so far is to first of all finish a 1m-scale aperture model.

For the warm parts of the machine the status of the aperture model is not as well advanced. The vacuum group has provided the data-base team with information on IR1, IR4, IR2 and IR8. For collimation studies insertions 3 and 7 have high priority. Preliminary aperture information for the collimation insertions could be used as a starting point.

4 AOB

RA reports on news from SLAC. The phaseII-collimator R&D will be done at SLAC.

The next meeting will be announced.