Stefano Redaelli, 17-12-2004

49th Meeting of the LHC Collimation Working Group, December 10, 2004

Present: Ralph Assmann (chairman), Markus Brugger, Bernd Dehning, Alfredo Ferrari, Alexej Grudiev, Gianluca Guaglio, Roberto Losito, Matteo Magistris, Manfred Mayer, Stefano Redaelli (scientific secretary), Guillaume Robert-Demolaize, Alexander Ryazanov, Mario Santana Leitner, Ruediger Schmidt, Katerina Tsoulou.

1 Shielding studies at RR73 and RR77 (K. Tsoulou)

See slides at http://www.cern.ch/lhc-collimation/files/KTsoulou_2004-12-10.pdf

1.1 Simulation results

Katerina Tsoulou (KT) presented preliminary results of FLUKA simulations on the effect of radiation shielding at the RR regions of IR7. An iron made *chicane* has been introduced in the FLUKA model of the IR7 tunnel. The *chicane* layout (see KT's slides, page 2) has been proposed by Roger Valbuena as a possible design that would be compatible with the present tunnel layout and with the vehicles to be used in the LHC.

With the new layout with the *chicane*, a dose of **1 to 2 Gy/y** is expected at the rack location in the RR's. The 1 MeV equivalent fluence at the RR's is of approximately 5×10^8 **particle cm^{-2}/year** and the number of hadrons with energy larger the 20 MeV is $\approx 2 \times 10^8$. With respect the layout without shielding, the doses are now reduced by a **factor 2**. An additional reduction by a factor 10 would be required to met the target dose of 0.1 Gy/y.

1.2 Discussion

Alfredo Ferrari stated that with the proposed thickness of the *chicane* it is not going to be possible to achieve the required additional reduction factor of 10. The problem is the entrances of the RR's because radiation can pass through the opening and reach the sensitive electronics. In order to avoid this effect, the legs of the *chicane* should be at least three times thicker than the RR's opening.

Ralph Assmann (RA) encouraged to try and simulate the effect of other *chicane* designs, even in they are incompatible with the specifications given by Roger Valbuena. We should try to figure out what one could *in principle* achieve with shielding. The new solutions could be used to give some inputs to the layout people.

2 Investigation of the effects of 7 TeV proton beams on the LHC collimator materials (A. Ryazanov)

See slides at http://www.cern.ch/lhc-collimation/files/ARyazanov_2004-12-10.pdf

Alexander Ryazanov (AR) presented the first results obtained at the Kurchatov Institute on the effect of 7 TeV proton beam on some materials to be used in the LHC. The studies have been focused on trying to model the phenomena through which the beam protons can transmit energy to the atomic crystal and damage the various collimator materials. Notably, the studies have been focused on radiation effects on Copper and Carbon. The deposited energy calculated with FLUKA is used as input to calculate the amount of energy absorbed by

physical processes such as excitation of electronic subsystems, excitation of electron-phonon coupling, dissipation due to electronic or phonon thermal conductivity. Particular interest was devoted to modelling the shock wave generation inside the material, which is the main responsible for material damage. The equations and the numerical constants used to model these processes are described in detail AR's slides.

AR discussed some preliminary results of these studies. He also stressed the importance of using the correct material properties in order to reliably estimate the expected radiation effects in the LHC materials. For example, the carbon porosity must be precisely known because it has a strong influence on the thermal conductivity. Also required are the spectra of produced particles in the material, as can be calculated with FLUKA. Future studies must then be carried out in close collaboration with the involved CERN teams.

2.1 Discussion

RA welcomed the preliminary results of these ongoing studies and encouraged everybody involved to get in contact with AR and to make sure that the required information will be available.

During the presentation of AR, it was noticed that the wrong beam size was used. The value of the low-β interaction points ($16\,\mu$m) was used of the values of IR7. Next studies should take into account the proper values.

Stefano Redaelli asked why one needs the beam size values. For estimating the damage due to standard LHC operation, the effect of a single impacting proton should be considered and then rescaled to the expected number of protons per year on the collimator jaws. RA said that both the case of single impacting protons and the case of 8 impacting bunches (worse accident scenario for the secondary collimators at top energy) should be addressed.

Bernd Dehning asked what is the life time of the proton induced shock wave. Its propagation inside the material should be taken into account because it could also excite some mechanical resonances. AR said that the time evolution of the shock wave is not yet studied.

The next meeting will be announced.