

Minutes of the 4th Meeting of the Quench-Test Analysis Working Group, 18.10.2013

Present: Vera Chetvertkova, Pier-Paolo Granieri, Anton Lechner, Agnieszka Priebe, Mariusz Sapinski, Nikhil Shetty, Chiara Bracco, Eleftherios Skordis, Daniel Wollmann, and Mateusz Bednarek.

Mateusz: Q6 QT oscilloscope results

Mateusz presented analysis of scope signals registered during the Q6 quench test and the same signals obtained during training quenches or due to firing quench heaters. There is no doubt that during the Q6 test a beam-induced quench was generated. Quench heaters fired in response to appearance of resistive voltage due to coil heating by shower particles. What remains not clear is the origin of the initial spike in the QPS signal (voltage) and drop of the current seen by power converter (cannot be explained by resistive zone creation). Can these be purely electrical effects? Maybe magnetic field plays a role as well? Further modeling of the effect is needed but cannot guarantee explanation of the observations.

Bernhard: Q6 QT QP3 results

Bernhard's presentation contains QP3 calculations of MQM magnet quench level for magnet currents 2000 A (attempt without quench) and 2500 A (at which magnet quenched). FLUKA input for QP3 calculation – the radial distribution of energy deposit in the coil - is recalled (originally presented by Nikhil, QTAWG2). QP3 results are presented as a function of loss duration, showing that for losses shorter than 100 μ s no change in calculated quench level is expected. QP3 gives quench level between 16 and 20 mJ/cc while FLUKA result is about 30 mJ/cc (always maximum energy deposition in the cable). Therefore there is factor 2 discrepancy.

Pier Paolo commented that OD results agree better with FLUKA than QP3 results.

Vera: conclusions from MAD-X simulations of fast losses ADT QT

Vera presented results of parameter variations study of the loss pattern for ADT fast loss quench test. The varied parameters are: tune, beam size and bump amplitude. In general the observed longitudinal loss pattern variations are small except of one case with tune on 3rd order resonance, which is considered not realistic. In the simulations the MQ magnetic errors are taken into account.

A very interesting result of the simulations is a linear dependence of the impact angle on the position along the magnet which means that the impact angle depends solely on integrated

magnetic field along the path of the lost protons and does not depend on assumed loss scenario. For realistic cases the impact angle varies within 50 μ rad in the loss maximum.

Vera: Update on the MAD-X simulations for steady-state-loss ADT QT

Vera reminded the experimental setup and the experiment itself. She presented study of loss pattern variation with ADT kick strength (gains between 25% and 115%). Lower ADT gain gives more concentrated loss. The temporal pattern of the simulated loss is (again) very different from observed one, but this maybe only due to small statistics of simulated particles ($1e4$). All the particles simulated are lost within 1 s, while in the experiment a loss of 20 s was observed. Vera estimates that in order to reach this loss duration a small ADT gain must be used (6%). This simulations, also with larger number of particles (50 000), will be attempted.

Anton commented that dependence of the simulation results on the used random seeds shows lack of convergence of the simulations, therefore significantly higher statistics should be simulated. Simulation of large number of particles is technically difficult and CPU-consuming. Vera is already using lxbatch cluster. Agnieszka suggested running simulations in many queues and asking for special permissions (possible for a limited time).

Nikhil: Fast ADT test: dependency of the simulated energy deposition on the loss distribution

Nikhil presented FLUKA results for 3 loss scenarios provided by Vera, including the most realistic scenario and the scenario with tune on 3rd order resonance. The BLM signals show very small sensitivity to different scenarios. The energy deposits in the coil are also similar in maximum (250 mJ/cc for realistic scenarios and 280 mJ/cc for tune resonance scenario). In the second part of the study Nikhil artificially stretched the loss distributions by factor 2 (keeping total amount of lost protons constant). The BLM signals changed rather little but the maximum energy density in the coil decreased from 250 mJ/cc to about 160 mJ/cc. This can be explained by the different sizes of the shower in the coil location and in BLM location. The impact angle also affects much stronger the energy in the coil than the BLM signals.

Agnieszka: Reminder of 2010 dynamic orbit bump QT analysis with GEANT4

Agnieszka reminded how the quench test in 2010 was performed (dynamically increasing orbit bump) and the main measurements: BLM signals for consecutive seconds of loss and beam current decay. She reminded how the Geant4 simulations are performed and stressed that lacking MAD-X loss pattern simulations she had to use an iterative procedure in which the loss distribution is found based on the most fitting BLM signal. The final BLM obtained with simulation signal is slightly underestimated (but less than for fast ADT quench test simulations). The power in the coils at which the quench occurred seem to reach very large values between 300 mW/cc and 700 mW/cc, however at this test the collimators were not open and significant

amount of protons was lost there, what is not taken into account in BLM signal and energy deposition in the coil estimations. The QP3 result for this loss is 170 mW/cc (scaling total energy deposited during loss time the same way as for Geant4 result). Agnieszka foresees using loss pattern from MAD-X when it is ready.

Anton commented that shot-to-shot BLM signal variation observed during wire scanner quench test is a good indication of BLM measurement accuracy in these experiments.

Agnieszka: Fast Loss Quench Test - Quench limits based on GEANT4 simulations

Agnieszka presented results of Geant4 simulations for the 3 benchmark loss cases from Vera. Side-by-side comparison of FLUKA and Geant4 results reveals good agreement in energy deposition in the coil. The same for BLM signals shows that in Geant4-based simulation a factor 2-3 is missing. Anton asked whether in these simulations the energy deposition in gas tube has been registered. Answer is no.

Mariusz and Bernhard: Proposal of guidelines for presentations using quench test data (for discussion) and paper presentation

Presented proposal for quench test names (unofficial, for working group purposes), a suggested terminology concerning most often used terms. Presented also a proposal of authors for publications/presentations for each test. At the end a quench test paper to be published in peer-reviewed journal, was discussed with writing schedule and names of responsible for each subsections for various tests. The schedule has been modified after remarks concerning the HL-LHC workshop in the middle of November.