Machine Protection Working Group

Minutes of the 31st meeting held on March 19th 2004

Present: R. Assmann, J.C. Billy, E. Carlier, A. Czizsek, B. Dehning, R. Denz, R. Filippini, R. Giachino, G. Guaglio, B. Holzer, C. Ilgner, L. Ponce, B. Puccio, P. Pugnat, F. Szoncso, J. Uythoven, B. Todd, J. Wenninger

Excused: R. Schmidt, M. Zerlauth

Topics of this meeting:

- Report from DESY visit (J. Wenninger)
- BCT specifications (C. Fischer)
- AOB

Report from DESY visit (J. Wenninger)

J. Wenninger reported from a DESY visit of some members of the MPWG that took place on March 8th 2004. The aim of the visit was to understand recent problems of HERA with very fast beam failures. Details of the HERA problems and cures can be found in the appended report.

The fast losses at HERA have now been understood to originate from failures of normal conducting quadrupoles with circuit time constants of less than 100 ms. A failure of such an element cannot be detected and intercepted by the HERA BLM system with its time resolution of 5 ms. The number of fast losses increased significantly with the HERA upgrade because the number of critical circuits increased from 6 to 14. At the same time, the Mean Time Between Failure (MTBF) of those circuits was down to ~ 300 hours which led to frequent uncontrolled losses. Simulations showed that the beam is lost with 0.5-1 ms with exponentially growing amplitudes and losses. The problem seems to be now under control thanks to the following measures :

- The MTBF of the critical circuits was increased to 1000-2000 hours by a regular inspection / revision / maintenance of the critical PCs. Extended maintenance procedures are followed for such power converters.
- The processing time of internal alarms (interlocks) in the PCs was reduced to 200 μs by generating the interlock signal directly from the gate electronics of the thyristors instead of going via the controlling PLC (which implies longer cycle times).
- An external surveillance of the PC currents is in the development phase.
- A fast interlock on the beam lifetime was developed and made operational.
- The delays in the alarm loop and beam dumping system were minimised.

Following this visit, a number of possible collaborations are foreseen with DESY :

- Installation of fast LHC BLMs near the HERA collimators to measure and understand fast losses of a fraction of the beam.
- Collaboration for the detection of fast magnet failures.
- Collaboration for the development of fast lifetime measurements.
- Collaboration on the understanding of fast beam losses.

In the discussion **R. Assmann** stated that he was extremely interested in studies of fast losses at HERA, since those could be a problem at the LHC. He also wondered if the quality of the LHC power converters will be sufficient to prevent beam losses due to power converter ripple from sags of the electrical network… **F. Szoncso** answered that as long as the electric equipment design was complying to CERN/LHC specifications in terms of filtering, noise, etc there should not be a problem. Furthermore the compensators used at CERN to protect the electrical network should largely reduce this problem.

BCT specifications (C. Fischer)

The main points of the functional specification for the LHC Beam Current Transformers were presented by **C. Fischer.** The Fast BCT (FBCT) is able to resolve individual bunches and will operate with 2 intensity ranges. The DCCT that only measures the total beam current will operate with 3 distinct ranges. The resolution of the DCCT in the lowest range corresponds to 1 μA/s. Switching between intensity ranges will a priori be done automatically by the instruments.

The requirements from machine protection concerning the Beam Presence Flag, Safe Beam Flag are met without problem. For the lifetimes, a 'slow' measurement of a one hour lifetime for a nominal beam (loss of 10^{11} p/s) within one second or less does not pose a problem. Such a 'slow' lifetime signal can be used to dump the beam if the low lifetime conditions last for a time span that would lead to collimator damage. Concerning a fast loss measurement of 0.1% of the nominal beam intensity (3×10^{11} p) within one turn, first laboratory test indicate that the noise level is too high. The rms noise is 1 mA for one turn, corresponding to 0.2% (± 0.6% peak-to-peak). A noise reduction of ~ one order of magnitude must therefore be achieved to reach the target values with the presently foreseen technology.

In the discussion **R. Assmann** and **J. Wenninger** were worried about the switching mechanism between the BCT ranges, since this can introduce artificial jumps in the currents. It was suggested to provide the possibility to inhibit an automatic range switching by operation. **R. Assmann** insisted that a good lifetime/loss measurement over a single turn would provide an excellent redundancy for protection against fast losses and that the MPWG should insist on the request for 0.1% detection levels. **J. Wenninger** proposed to maintain the request in the specification and to investigate on possible options for improving the measurements. He also proposed to follow up the topic with the colleagues from DESY, in particular to obtain more precise estimates on the DESY lifetime resolution.

AOB

J. Wenninger informed the audience that the sub-working group on reliability issues had been created and was now meeting regularly. A link to the sub-group's WEB page is available from the MPWG home page. **F. Szoncso** presented a new doctoral student, **A. Czizsek**, who will work on LHC risk analysis (safety systems, fire,…). She will join the reliability sub-working group.