# Machine Protection Working Group

*Minutes of the 57th meeting, held 9th June 2006*

**Present:** A. Butterworth, E. Carlier, B. Dehning, V. Kain, V. Montabonnet, L. Poncet, J. Serrano, R. Schmidt, R. Steinhagen, M. Zerlauth

**Meeting Agenda:**

- Status of the FMCM production and installation [M. Zerlauth]
- Results of EMC tests for Beam Interlock System hardware [B. Todd]

**Status of the FMCM production and installation [M. Zerlauth]**

In his presentation, **M. Zerlauth** gives an update on the present production and installation status of the Fast Magnet Current Change Monitors (FMCM). First results obtained during the CNGS transfer line tests are shown (see slides for details).

The FMCMs will be used in the SPS and LHC to detect fast current changes of critical magnets after failures in the powering of the magnet / magnet chain. In the event of a hardware failure, the voltage pickups from the PC output that exceed given limit are used to trigger a beam dump or to inhibit the extraction. For details on the system see minutes #43.

The first three FMCMs, based on the original DESY design, are already available and presently used to survey and interlock the TT40 extraction septum (MSE), the CNGS transfer line's main dipole string (MBG) and MBSG dipoles that are used to switch between the TT41 and TI8 transfer line. The present baseline foresees the acquisition of 30 more systems, adapted by DESY to some additional CERN requirements such as the remote control and PM readout. The number may be further increased if required.

**M. Zerlauth** presents first results of the measurements performed during early CNGS commissioning (see slides for details). The tested systems show an good overall performance and are able to detect a relative current change of about $10^{-4}$ w.r.t. the MBG, a relative change of $1.3 \cdot 10^{-4}$ w.r.t. the MBSG and $1.5 \cdot 10^{-4}$ w.r.t. the MSE reference current. **B. Dehning** inquired the cause of the additional 'enable' signals prior to the actual MSE extraction permit. **M. Zerlauth** explained that these additional extraction permit signals during the magnet ramp up are inevitable due to the functionality principle of the FMCM, but they are masked by the ROCS front-end (verifying the absolute current value) using timing conditions and are not an issue for protection. However, they increase the number of events appearing in the BIC history buffer. He further noted that the established thresholds contain safety margins of a factor five. However, the thresholds including this safety margin are a still a factor five below the specification.

The FMCM system provides a post-mortem buffer for failure analysis and stores the device state from 100 ms before and 20 ms after the post mortem trigger is emitted. The buffer has a temporal resolution of 20 us in case of the SPS and 40 us for LHC systems, respectively. **J. Serrano** offers a dedicated timing card for the FMCM in case a more precise timing is required.

Summarising, the FMCM design and hardware has been verified with beam and produces reproducible extraction windows for the presently surveyed magnets. The production of the voltage dividers, required for the FMCM, is well advanced and the re-design to meet the CERN requirement and specification is completed. The official offer and production by the DESY collaboration is expected to be finalised and will start soon.

**Results of EMC tests for Beam Interlock System hardware [B. Todd]**
Electro-Magnetic Compatibility (EMC) tests were carried out using a burst generator placed on the electrical interfaces between the Beam Interlock Controller (BIC) and User Interface (CIBU) and User Interface to User Systems. An overview of the BIC and CIBU systems can be found in the MPWG minutes #40 and minutes #48 and corresponding presentations.
The CIBU are connected to the BIC via CERN standard NE12 cables, each carrying five RS485 channels allowing cable lengths up to 1200 m. The individual User Systems are connected through current loops to the CIBU that have a maximum specified length of 4m. Tests were based on the 'IEC-61000' standard for high power systems, which is grouped into four severity levels that subject the test system to maximum voltages between and 0.5 and 4 kV. The results have been grouped into four classes 'A' to 'D':

- 'A' corresponds to 'no noticeable fault'
- 'B' to a corrected fault that was caught and compensated for by the BIC
- 'C' to a fault that is not compensated by the BIC
- 'D' to a "complete failure" including the loss of power and/or control.

In the ideal case, the tested links and systems would perform to 'A' at a maximum transient of 4kV. In every case two tests were carried out to observe whether the EMC induces a spurious transient: transition from:

- 'FALSE' to 'TRUE' where disturbances reduce the safety of the system (false-negative) and
- 'TRUE' to 'FALSE' where disturbances correspond to false dump (false-positive) requests and reduced availability of the machine. See the slides for a breakdown of the results

The tests confirmed the specification, requiring that the BIC to CIBU interface have fully shielded cables with both ends properly connected to the ground. The same type of interconnection is obligatory between the CIBU and specific User Systems. Using a different type of connection, as for example with no ground or pig-tail connected grounds, makes the system susceptible to EMC, even at 500V level tests.

Power supplies were also tested, confirming both the VME rated protection and the supply used for the CIBU. The CIBU PSU failed the 4kV tests, at which point the PowerPC and Ethernet controller of the BIC crashed - this is to be investigated.

**B. Todd** summarised that the current loops between CIBU and user systems are potentially the weakest links with respect to EMC, the results show that the implementation of these links is non-negotiable, and will be rigorously enforced by AB/CO/MI. Specifications are published in EDMS for these links. An approval list will be made to ensure User Systems are aware of their obligations.

A second sequence of tests will be carried out in spring 2007 with an upgraded CIBU and complete chassis shielding, including a new prototype of the CIBO optical transceiver.