Machine Protection Working Group

Minutes of the 26th meeting held on October 3rd 2003

Present: J.-C. Billy, E. Carlier, B Dehning, R. Denz, U. Epting, R. Filippini, C. Fischer, B. Goddard, B. Holzer, V. Kain, V. Montabonnet, B. Puccio, R. Schmidt, L. Scibile, F. Szoncso, J. Uythoven, J. Wenninger, C. Zamantzas, M. Zerlauth

Excused : R. Assmann, B. Jeanneret, D. Macina,

Topics of this meeting:

- Beam Interlock Controller :
  - Experience from SPS tests (B. Puccio)
  - Safety beam and masking of input signals (R. Schmidt)
  - General strategy and interfaces to users (R. Schmidt)
- Fast detection of magnet failures (M. Zerlauth)
- AOB

Experience from SPS tests of the BIC (B. Puccio)

B. Puccio reminded everyone that the hardware for the future beam interlocks systems of the LHC ring, SPS ring and SPS extraction will be identical. For that reason the tests performed for the TT40 extraction are a very good test bench for the BIC modules and its software suite. For the TT40 test, the interlock signals included vacuum, extraction kicker status, position of the SPS beam before extraction and the surveillance of more than a dozen power converters (merged into 3 signals – one per power converter controls crate). When all clients gave green light, the BIC gave an extraction OK signal to the extraction kicker to fire the beam into the extraction channel. A JAVA supervision program presented the module status (inputs, output, masks…) to the operator in the control room. It also gave access to the history buffer. All the data has been in principle logged. Masking of input channels was heavily used during most of the MD (with pilot bunch beam intensity) in order to obtain extraction while the settings of the power converters were scanned to probe the aperture of the extraction channel.

B. Godddard commented that during the test, a number of extractions have been interlocked – apparently by the BPM position interlock although the beam position seemed to be correct. To understand this issue, **J. Wenninger** will analyze the logged data**. U. Epting** wondered if some software look-and-feel standards where actually applied for the supervision programs, but **B. Puccio** did not know any details.

Beam Interlock Controller: General strategy and interfaces to users. Safety beam and input signals masking (R. Schmidt)

R. Schmidt presented a number of ideas and options for the realization of the beam interlock system and asked for feedback from the clients. Each beam permit loop will actually consist of 2 independent signals travelling in opposite direction, the later point yielding a gain of time for the signal between client and beam dumping system. With two signals per loop it is possible to implement a test mode where one signal is under test and the other is always cut, thus ensuring that one cannot by accident give beam permit in the test mode.

R. Schmidt gave an overview of the clients that act on B1, B2 and on both beams at the same time. For B1+B2, the maximum number of clients is 7, for the single beams the maximum is 4**. E. Carlier** pointed out that the aperture kickers must also be considered as clients, but not the injection kicker. **J.C. Billy** confirmed that the vacuum system will always give two separate signals for B1 and for B2. In the IRs where the beams travel in the common beam pipe, the vacuum interlock system will take care of correctly handling the 2 beams. **B. Goddard** questioned the possible safety problem of using one single unit for signals for B1 and B2, but **R. Schmidt** answered that it is considered to use different connectors for the 2 beams to avoid cable crossing.

Another point under study is the problem of masking interlocks when the intensity is in the range of the safety beam. In particular, one question concerns the possibility to mask some input for any beam intensity. For the moment it seems safer to consider this possibility.

R. Schmidt also wondered how many systems, in addition to the vacuum system, needed the information on the beam permit status. For the moment he thinks that is sufficient to provide a non-redundant signal for the beam permit status. This point was questioned by **B. Dehning** who thinks that this signal should also be redundant. **J. Uythoven** pointed out that the BLM systems should not provide beam permit in test mode, and therefore no redundancy would be required. The general feeling was however that the redundancy is not required at that level.

The specifications for the LHC BCTs are presently being finalized and the safety requirements are also part of the specification. Are needed in particular

- a safe information on beam intensity,
- a safety beam flag for interlock masking,
- an interlock on dI/dt (weighted or not by the beam energy).

As a consequence the BCT becomes a safety instrument (SIL2 or SIL3) and the beam intensity must be distributed to the SPS and the LHC. The responsibility for generating and distributing the intensity signal must be defined. **R. Schmidt** proposes to use the same distribution as for the safe beam energy (ACTION: E.Carlier and R. Schmidt).

Fast detection of magnet failures (M. Zerlauth)

M. Zerlauth presented new ideas to detect fast di/dt changes as required for example for the D1 magnet failure in the LHC. This method might be an alternative to

the proposal to add a solenoid in series with the D1 magnets that costs around 1 MCHF (for two systems in the surface buildings of points 1 and 5). The new detection method was tested on the SPS extraction septa MSE that consists of 6 magnets with a time constant of 23 ms. The interlock system foreseen to survey the currents is limited by the ROCS control system and the acquisition run every 1 ms, and taking into account delays will probably not be able to survey the last 5 ms before the extraction time. In an unlucky case of a trip just after the last possible moment of surveillance, the current might have dropped below the tolerance window. The new method aims for a fast detection of the voltage drop over the magnets of a few Volt (due to the very high di/dt of ~ 20 kA/s). A simple electronics was developed to perform the tests on the SPS MSE. The first results are very promising.

A second option consists of a fast measurement of the magnetic field. A device based on Hall probes was found on the market. The bandwidth of the device is 10 kHz for a very high accuracy of the order of few 10^{-4}. The Hall probe system will be ordered and tested.

If such system could be made to work reliably, it would allow to monitor any critical magnet that has a short time constant (SPS extraction, LHC injection and extraction, etc.). Therefore it is proposed to pursue these studies.

AOB

V. Kain presented results of the temperature rise in a Copper block (representing a magnet coil) just downstream of a 2 m long transfer line Carbon collimator hit by 288 bunches of one SPS extraction. The maximum temperature increase is 200°. The temperature rise is highest on the side opposite to the impact point due to particles escaping the jaw. A presentation is planned for the next MPWG.

R. Schmidt proposed to inform the LTC in 4 weeks time on the studies for fast detection of magnet failures, and to propose the usage of a safety beam flag in the interlock system.

R. Schmidt finally mentioned the possibility to organize a review of the beam interlock system and its main clients (Beam loss monitors, Beam dumping system) in March 2004. The review should concentrate on the interfaces and on the aspects related to controls / electronics. A more detailed suggestion would be discussed in the next session of the MPWG.