Machine Protection Working Group

Minutes of the 33rd meeting held on May 28th 2004

Present: B. Dehning, E. Carlier, R. Filippini, R. Giachino, G. Guaglio, E.B. Holzer, B. Puccio, P. Pugnat, F. Rodriguez Mateos, B. Todd, J. Uythoven, J. Wenninger, C. Zamantzas, M Zerlauth

Excused: R. Denz, R. Assmann

Topics of this meeting:

- LHC Beam Loss Monitors – design of the digital electronics (C. Zamantzas)
- Requirements for a 'proper' beam dump (J. Uythoven)
- AOB

LHC Beam Loss Monitors – design of the digital electronics (C. Zamantzas)

C. Zamantzas described the digital electronics used to acquire and process the BLM data for the LHC. The electronics is mainly composed of Current-to-Frequency converters, 12 bit ADCs, radiation hard tunnel FPGAs, optical links from tunnel to surface and finally another FPGA installed on the surface electronics. Data is transmitted every 40 μs from the tunnel to the surface. To ensure error-free transmission of the data, a number of measures are taken: a redundant optical link, a CRC-32 error checking algorithm and ~~a~~an 8bit/10bit encoding. One option for the optical link is to use a radiation hard chip developed for the LHC experiments (GOL) instead of making a custom design, and a decision will be taken in the near future. A system of bar code will be used to help the indexing of all the parts (i.e. the monitors, cards, cables etc). The redundancy and error-checking algorithms make it possible to continue operation of the system even with certain classes of transmission errors (i.e. when al least one of the 2 redundant signals is error free). This will enhance the availability of the system while providing a detailed error reporting tool. The surface FPGA- processes in parallel 16 monitors and for each of them continuously maintains 12 running sums over time intervals of 40μs to 1 ms, 1 ms to 5 ms and 5 ms to 100 s. A unique 2D (energy & time interval) threshold table is used for each monitor to define its dump thresholds and is stored in a non-volatile memory at the surface card.

Each card will provide every second roughly 2 kB of data to the logging system. With maximal 16 cards per crate and 24 crates in the ring, the total data volume can reach 800 kB, but it will be less in reality since not all channels are occupied. Two circular buffers are used for the post-mortem system. The PM freeze is triggered by a TTC signal. Each card will provide 240 kB of data, each crate (16 cards) will provide 3.8 MB and the total for the machine could reach around 90 MB. Again the actual data volume may be less since not all channels are occupied.

In the discussion **R. Schmidt** said that the time scale of 100 seconds for one of the running sums seemed to be very long, and **B. Dehning** answered that this number comes from the specifications and was motivated by the time response of the helium temperature measurements. **R. Schmidt** indicated that at the moment, one idea was to use 2 dump signals from the BLM system, one with a fixed (and high) threshold that is used to prevent damage to the machine and that cannot be disabled, and another one with a tunable threshold that can be disabled for a low intensity beams (Safe Beam Flag set). **C. Zamantzas** and **B. Dehning** said that presently the system is designed for a single dump signal. Another question is also how to disable a faulty arc BLM channel. Presently any channel above threshold will generate a beam dump. To get around the issue of two separate dump signals, **E. B. Holzer** proposed to use a scale factor on the threshold for tuning, the scale factor being necessarily smaller than 1. This would provide a reasonably simple mechanism for threshold tuning. **R. Schmidt** said that this point must be followed up in the coming months. Concerning the post-mortem trigger via the TTC, **R. Schmidt** wondered about the TTC reliability. In fact it was proposed some time ago to use the timing system(s) to transmit the PM trigger to the equipment systems, since it is available to all systems requiring PM triggering. This avoids the installation of a dedicated PM trigger distribution throughout the entire LHC. The timing system will distribute the trigger to the TTC master in the control room. The beam position monitor system will stop working properly without TTC in some modes, and it is possible that the BPMs used to interlock the beam position around the beam dump will issue a dump request as soon as the TTC signal is absent (to be confirmed).

Requirements for a 'proper' beam dump (J. Uythoven)

J. Uythoven presented the list of requirements to ensure that the beam is dumped safely. A clean beam dump can only be performed if the beam dumping system functions according to specifications, if other machine elements perform according to specifications and if the beam parameters remain within a certain envelope. One of the equipment that needs to be monitored is the current/kick of the Q4 quadrupole that contributes to the beam dump kick. The current will be monitored by the BEM/BET system with a tolerance of ±0.5%. The nominal energy of the LHC is defined by the main dipoles, but RF frequency and orbit correctors can be used to change the energy. Since the LHC may tolerate energy excursions that are much large than what can be tolerated by the beam dumping system (±0.45%), both RF frequency and orbit corrector settings must be interlocked. For the RF frequency an interlock level of ± 240 Hz should be implemented by the RF system. This point will be discussed at the next MPWG meeting. For orbit correctors the situation is more delicate since the correctors are distributed over a large number of crates. A central software surveillance may be sufficient. The beam position in IR6 will be interlocked, but it must be studied how the TCDQ position is maintained within 8-10σ from the beam. Constraints on the optics (tune & beta-beating) are not easy to implement, since there are neither permanent nor reliable measurements available. It is clear however that some form of verification of the tune must be implemented, in particular for MDs! The vacuum in the TD62/TD68 extraction lines must be surveyed and interlocked: the interlock signal should go the BIC modules in IR6 via the vacuum system interlocks. Concerning the N2 pressure in the beam dump block, it

is not clear if and how this will be interlocked. This point must be clarified with **L. Bruno** and **M. Jimenez**.

AOB

R.Schmidt presented a list of upcoming events related to machine protection:

- 11th June: half day mini-workshop on safe injection into the LHC.
- 30th June- 1st July: collimation system review.
- 12th-14th July: short presentation on machine protection at the MAC.

The next meeting will take plane 25th June with a presentation on RF frequency interlocking and a report from the sub-WG on reliability.