Machine Protection Working Group

Minutes of the 10th meeting held on February 1rst 2002

Present: F. Balda, J.C. Billy, F. Bordry, E. Carlier, E. Ciapala, B. Dehning, J. Dieperink, R. Giachino, B. Jeanneret, G. Mugnai, B. Puccio, R. Schmidt, L. Serio, J. Wenninger, M. Zerlauth

Main topics of this meeting:

- Energy Tracking for Beam Dump and other Users (R. Schmidt)
- Beam Dump Synchronization (E. Carlier)
- AOB :
  - Interfaces to the PIC (B. Puccio)

Energy Tracking for Beam Dump and other Users (R. Schmidt)

R. Schmidt presented an update on the status of the Beam Energy Meter (BEM). **J. Pett** was not able to attend the meeting due to other commitments. At the origin of the work on the BEM is the requirement of the LHC beam dump septa and kickers to track the beam energy within 0.5%. To simplify the work at the level of the PCs, it was proposed to use a standard PC and controller for the septa magnets. The septa PCs will therefore be driven using standard ramp functions incorporating energy ramp and magnet transfer functions. As a consequence of this decision, a dedicated instrument, the BEM, is required to convert the DCCT output from a given PC into an energy information that can be used to implement an interlock on energy tracking for critical devices. The energy obtained from 4 different BEMs, connected to the DCCTs of the main dipoles of sextants 5-6 and 6-7 and the septa magnets of the two beams, are compared and a beam dump request is issued whenever the energies do not agree. This action requires an additional module ("make energy") to compare the different energies, generate am interlock and publish the energy information.

Last year **J. Pett** agreed to design a BEM prototype in the SL-PO group which has now been finished and tested. Some documentation is added to the minutes of this meeting. The hardware cost of the BEM is small. The questions that need to be defined now are who continues the work (possible candidates are SL-BT, SL-CO, SL-PO, …) and how to distribute the energy information. So far the main clients of the BEM are the septum magnets, the extraction and the dilution kickers of the beam dump system. Other systems that will require energy information are BI and RF. One idea would be to distribute the energy information over the timing system. The exact precision that is required for the BEM needs to the checked (0.5 or 1% ?).

In the discussion **F. Bordry** asked which group has the responsibility for LHC machine protection. **R. Schmidt** answered that so far, the responsibility for the beam and powering interlock system is in SL-CO and AC-TCP. **J. Dieperink** launched a discussion on the SIL levels which he thinks should be defined for all systems and components (including the BEM). He proposed to adopt for all systems the SIL definitions given by **F. Balda** in the previous meeting (December 14th 2001). **R. Schmidt** said that the SIL level proposal had been made with exactly this objective in mind. He also proposed that all systems try to estimate the SIL levels that they require. Each system responsible should, if possible, make a presentation in a future MPWG meeting. He also asked **F. Balda** to present his study on the SPS access system. **J. Dieperink** agreed to discuss SIL levels for the beam dump system in the next meeting.

Beam Dump Synchronization (E. Carlier)

Some aspects of the LHC beam dump synchronization were presented by **E. Carlier**. He stressed that his presentation reflects the current status of thinking and that this is not yet a real proposal. The key question for synchronization is : how can one guarantee the correct phase between the rising edge of the extraction kicker pulses and the particle free gap (PFG) which is 3 μs long (equivalent to 119 bunches). The tolerance on the phase synchronization is 100 ns. In the SPS there is presently no synchronization for the emergency beam dump. Scheduled dumps are synchronized using the SPS revolution frequency signal. For LEP all dumps were synchronized with the LEP BST (Beam Synchronous Timing) signal. At the LHC there will be three sources of beam dump requests : the machine protection system, the access system and the beam dump itself. All requests must be properly synchronized to the PFG. Possible errors are :

- The PFG has the wrong phase.
- The PFG is filled with particles.

From the point of view of synchronization, there are essentially two key modes, namely :

- Injection (filling) where synchronization must be established, checked and locked.
- Ramp and physics where synchronization must be maintained.

The injection process is clearly the most critical from the point of view of synchronization. Since all RF frequencies will be re-synchronized before the start of filling, the initial state is a priori well known. The signal for the PFG will come from the RF group. It needs to be clarified if the required delay would be done within the RF system, or by the beam dump system. **E. Carlier** presented a list of possible errors that might occur during filling of the LHC. He indicated that by gating off the injection kicker during a certain time window around the nominal position of the PFG, it is possible to avoid some problems. In most cases the beam with incorrect synchronization would be send to the TDI. A delicate problem is due to the fact that the duration of the gating for the injection kicker depends of the number of batches to be injected (3 or 4). Using the gate length for 4 batches works in all cases except for the last injection which must be a 3-batch injection. For this injection the gate duration must be reduced. If by accident 4 batches are injected at that moment, the PFG will be filled and some bunches of the first injected batch will be kicked out by the tail of the injection kicker pulse. During ramp

and physics a PLL system is used to track the PFG. If any error is detected (loss of revolution frequency signal, drift of the revolution frequency wrt. the PFG…) the beam will be dumped synchronously.

E. Carlier concluded that a solution exists to track the PFG during ramp and physics. During ramping and physics, filling of the PFG with particles is not taken into account by the synchronization system. Tracking of the PFG during injection is the most difficult task. An injection kicker inhibition covers most, but not all possible sources of errors.

Following this presentation it was agreed that the monitoring and possible cleaning of the particle free gap should be addressed in a MPWG meeting in April/May (presentation by BI and RF).

AOB

B. Puccio presented an update on the interfaces between the equipment systems and the PIC. The QPS, PC and PIC teams have adopted a new solution which lowers the PIC reliability requirements (at least from the point of view of machine protection). Initially the connection between QPS and PC went over the PIC, as is done now at STRING II. This implied a high reliability for the PIC to ensure that the fast PC abort signal arrives at the PC in case of a quench. In the new scheme (see slides) the fast abort signal is connected in series to PIC, the power converter and the quench protection electronics.