Machine Protection Working Group

Minutes of the 27th meeting held on October 24th 2003

Present: J.-C. Billy, E. Carlier, R. Filippini, B. Goddard, B. Holzer, M. Huhtinen, V. Kain, P. Ninin, R. Schmidt, L. Scibile, F. Szoncso, J. Wenninger, M. Zerlauth

Excused : R. Assmann, B. Jeanneret, D. Macina, B. Puccio, J. Uythoven

Topics of this meeting:

- Possible consequences of LHC beam losses for CMS (M. Huhtinen)
- Simulations for the TCDI collimators (V. Kain)
- AOB

Possible consequences of LHC beam losses for CMS (M. Huhtinen)

M. Huhtinen presented investigations on consequences of LHC beam losses in IR5 for CMS. Some parts of the study, in particular beam losses on the TAS also apply to ALTLAS. For failures related to beam dump triggering, the situation is different for ATLAS due to the presence of the collimation systems in IR3 and IR7. This study focused on the effects of local losses of a full beam, spread in time and space around IR5. For both cases the aim was to estimate doses (integrals and rates) and possible detector damage. Due to the very high interaction rate at nominal luminosity, the dose due to a full beam loss corresponds to the equivalent dose of 10 days of normal LHC operation. Since CMS is designed to survive for at least 10 years under normal operating conditions, this additional dose is in itself not a worry.

A single kicker misfiring and an unsynchronized abort were studied in collaboration with **N. Mokhov**. Simulations were performed with MARS (for the machine part) and FLUKA for the CMS detector. For those failures, a large amount of energy is deposited in the low-beta triplets, with densities well above quench (and probably damage) limits. The installation of absorbers in front of the triplets (on the side away from the IP) can significantly reduce the energy deposition. While the integrated dose accumulated during such an event is negligible, the dose rates on the inner edge of the tracker are factors of $\sim 10^8$ higher than the normal rates. It should be noted that this study was made before it was decided to install the TCDQ absorber in front of Q4 in IR6 to protect the machine against unsynchronized aborts. If the TCDQ is properly positioned, those failures should not lead to any beam loss in IR5.

Simulations of beam loss on the inner edge of the TAS indicate that this failure is much worse than an unsynchronized abort. Contrary to the case of the unsynchronized abort, a loss that develops on the TAS may be counteracted by early detection and a fast beam abort. For that reason a proposal was made to install as Beam Condition Monitor

(BCM) a set of small diamond detectors very close to the central vacuum chamber of CMS (radius 4 cm). This detector should monitor the background conditions and detect any excess. The reaction may range from a ramp-down of detector voltages to a beam dump request. The BCM is designed for a sampling time of 100 ns. There will be a total of 8 detectors around the vacuum chamber and potentially another 8 behind the forward calorimeter.

M. Huhtinen concluded that the integrated doses due to catastrophic beam losses are negligible but that the dose rates are ~ 10^8 times higher than under normal conditions. Beam tests at the CPS have shown that the CMS Si-trip tracker survives such conditions. CMS will design a dedicated Beam Condition Monitor to detect at an early stage beam losses in IR5. This system will be connected to the slow control system and to the beam interlock system of the LHC.

R. Schmidt commented that CMS should provide one single signal for beam aborts. Abort triggers generated by different CMS sub-detectors should be merged inside CMS into a single signal. He also insisted that for Post-Mortem information it is very important that machine and CMS use a common clock. **B. Goddard** and **R. Schmidt** both commented that the tertiary collimators will be extremely useful as additional protection against unsynchronized beam aborts, in particular because they give some flexibility for the positioning of the TCDQ. **M. Huhtinen** stressed that from the point of view of CMS, the tertiary collimators in IR5 alone do not bring a significant improvement in dose rates in case of a beam dump failure. For CMS it is extremely important to have an efficient protection by the TCDQ.

Simulations for TCDI collimators (V. Kain)

V. Kain presented simulation results of beam impact on a TCDI collimator. The aim of the simulation was to determine the required collimator length and the protection potential. The simulations correspond to the impact of a 4-batch SPS extraction (288 bunches) and the following parameters were varied:

- the jaw length : 1 m, 2m, 2.5m and 3m.
- the impact position.
- the beam profile : pencil or Gaussian.
- the presence or absence of an iron mask installed behind the collimator.

The reference impact position was 1σ from the edge of the jaw. Most of the energy is deposited in the quadrupole downstream of the collimator. The vacuum transitions do not pose a problem. Without additional Fe mask, the temperatures may locally reach 180° C on the quadrupole even for a 3m long jaw. With the Fe mask, a 1m long collimator is sufficient to protect the quadupole and limit the temperature rise to 100° C. This opens the possibility to use a standard LHC secondary collimator instead of designing a special collimator for the transfer lines.

AOB

R. Schmidt will report some issues discussed in the MPWG to the LTC next week. Presentations at the same committee by **V. Kain** (fast failure scenarios) and **M. Zerlauth** (detection of fast current changes) are foreseen for the near future.

The proposed installation of collimators in the SPS and collimator and material tests in TT40 were presented at the ATC on 23rd October. All proposals were accepted, but discussions on MD scheduling and on the possibility a prolongation of the SPS run still have to take place.