Machine Protection Working Group

Minutes of the 45th meeting held on June 3rd 2005

Present: R. Assmann, J.C. Billy, M. Calvi, E. Carlier, B. Dehning, G. Guaglio, M. Lamont, D. Macina, V. Montabonnet, B. Puccio, P. Pugnat, R. Schmidt, R. Steinhagen, B. Todd, J. Uythoven , J. Wenninger, C. Zamantzas, M. Zerlauth

Topics of this meeting:

- Stability Analysis of the Cables for the LHC Magnets (M. Calvi)
- Update on the Beam Energy Tracking system (E. Carlier)
- AOB
  1. Objects that can move towards the beam
  2. Upcoming MAC

Stability Analysis of the Cables for the LHC Magnets (M. Calvi)

M. Calvi presents first quench simulation results for the superconducting cables used in the LHC (see slides).

The minimum quench energy (MQE) is the required energy to initiate an irreversible quench in the superconducting cable. This value determines the BLM interlock threshold. The calculations assume a homogeneously distributed energy deposition over the cable volume ΔV (length) during the perturbation duration Δt.

The MQE Δt dependence that is observed between 0.1 and 10 ms vanishes for quench sources that are larger than approximately 100 mm. **B. Dehning** comments that the anticipated energy deposition by particle showers are generally much longer. The Helium surrounding the insulation is not taken into account yet. For the simulations two extreme cases were considered:

- Dry cables with no direct contact between strands and helium: The estimated MQE converges to about ~ 2.3 mJ/cm^3 for length above 100 mm.
- Soaked cable where 3% of the cable cross section is filled with helium (design: 5%): Neglecting the time dependence of the enthalpy of the surrounding helium, the MQE converges to ~ 22.5 mJ/cm^3.

The presented results are preliminary. A full report will be published in the coming weeks.

Update on the Beam Energy Tracking system (E. Carlier)

E. Carlier gives an update on the architecture and prototype of the Beam Energy Tracking and Interlock System, covering the involved subsystems that are developed for the LHC (see slides).

The Beam Energy Acquisition subsystem (BEA) surveys the current of one main dipole string, as measured in the main dipole power converter and in the main dipole magnet, using a dedicated direct current transformers. In the faultless case these measured currents should be equal. There are in total two BEA systems that monitor the main dipoles in sectors 4-5 and 7-8. Each BEA input is converted through the beam energy

metre (BEM) to an energy signal and transmitted to the client systems. One of these signals is used as reference energy and defines the voltages of the kicker magnets.
The Energy Tracking Interlock System uses the following inputs signals:

- the other BEA/BEM channel,
- the surveyed power converters and magnet currents of the Q4 and MSD magnets,
- the measured voltages of the kicker generators.

A potential energy tracking system interlock is maintained until all involved subsystems (BEA, BEM, kicker, MSD etc.) are rearmed and ready.
E. Carlier notes that the weak point of the system may be the use of the same table in the BEM for deriving the energy from the main bend currents for the reference energy signal and energy interlock system. In case of a single false entry, this table might create a common failure in the energy reference and interlock system that may not be detected. In order to meet/maintain the SIL3 safety he suggests that it would be favourable to use another independent method to retrieve the beam energy for the energy interlock. **J. Wenninger** notes that this failure scenario is covered by the fact that the lookup tables for the Q4 and MSD magnets significantly differ from the one used for the main bend circuits and hence may be sufficient as independent signal for the energy interlock channel.
E. Carlier suggests a software interlock on the integrated horizontal orbit corrector field and an interlock on the RF frequency since both affect the energy and are not covered by the BET. The role of the momentum collimation system in limiting RF frequency excursions is yet unclear. ***ACTION: R. Schmidt***

AOB: (R.Schmidt)

- Objects that can move towards the beam:
  The 'Roman Pots' must be controlled by the collimation system in order to insure the machine protection. Through software requests, TOTEM may control the pot position within safe windows defined by the collimation system. **R. Schmidt** asks to record this in the appropriate documents and specifications where required.
  ACTION: D. Macina
  D. Macina reports that TOTEM worries about the fact that the operation team is able to move their 'Roman pots' during 'data-taking'. **R. Assmann** stresses that in case of problems (e.g. slowly moving pots) the operations team has to be able to move the pots away from the beam.
  R.Schmidt worries whether the people involved in the experiments are sufficiently aware of the in the beam stored energy, its potential risk and the mechanisms to severely damage the machine.

- **R. Schmidt** will report during the next machine advisory committee meeting about the past machine protection review.

- Fast current change monitor:
  The LTC supports this system. The total number of circuits that must be protected has to be finalised. ***ACTION: (R. Schmidt & M. Zerlauth)***