# Machine Protection Working Group

*Minutes of the 63rd meeting, held 9th March 2007*

**Present:** R. Alemany-Fernandez, D. Bocian, B. Dehning, A. Gomez-Alonso, E.B. Holzer, S. Jackson, L. Jensen, V. Kain, D. Kramer, D. Macina, V. Montabonnet, L. Ponce, R. Schmidt, R. Steinhagen, M. Stockner, J. Uythoven, J. Wenninger, C. Zamantzas

**Meeting Agenda:**

- Remote Setting of the BLM Thresholds [L. Ponce]
- Encoding Scheme for the LHC Energy and Intensity over the Timing Systems [R. Schmidt]

**Remote Setting of the BLM Thresholds [L. Ponce]**

With her presentation, **L. Ponce** provides an overview on the BLM architecture and previous discussions on changes of BLM threshold settings (see slides for details). The system architecture and issue of the remote change of BLM quench and damage threshold settings has been earlier discussed during MPWG meeting #55.

It is foreseen that the initial BLM interlock thresholds settings will be based on estimates derived from beam loss maps, secondary shower and quench simulations as well as complemented by measurements performed on a seed of selected magnets. With respect to settings management, **L. Ponce** distinguishes two main BLM families:

- BLMs on cold machine elements for the protection against quenches
- BLMs on warm elements for the protection against material damage

The thresholds minimising quenches are usually lower than those required to protect elements against damage. In a first iteration, the initial interlock threshold settings for the BLMs protecting cold elements will be set to 30% with respect to the expected quench level and the BLMs protecting warm elements will be set to 10% of the expected element damage levels. However, the levels are affected by significant uncertainties and the threshold level is will be defined by mutual consent with the expert of the equipment that is to be protected by the BLM.
Similar to earlier meetings (see MPWG meeting #55), the main uncertainty on the necessity of threshold changes remains due the uncertainties on the exact quench and damage thresholds as well as the lack of experience with reduced operational efficiency due to quenches.

**R. Schmidt** proposes to lower the thresholds of BLMs on warm elements, in order to prevent quenches in the superconducting magnets downstream. He inquires on how the operational damage threshold will be established.
***ACTION: L. Poncet, BI-BLM team***

In the same line **D. Bocian** will provide an update on the status of the quench level estimates during one of the following MPWG meetings. The proposed presentation will be scheduled in about two month.
***ACTION: D. Bocian, R.Schmidt, J. Wenninger***

**L. Jensen** inquires whether all BLMs have to be provided with an individual lookup table.
**C. Zamantzas** confirms this and add that nevertheless most BLMs can be grouped into sub-families and are expected to use the same table. **L. Ponce** explains that, for example, the BLMs located in the arc can be grouped and to roughly 6 families. **E. Holzer** comments that the total number of required tables is in the order of a few hundred.

Presently the individual BLM tables are derived through linear scaling of the BLM 'master table' and stored alongside this table in a database. Since the individual tables are based on scaling of the master table, **R. Steinhagen** recollects that for greater safety, simplicity and higher efficiency it would be preferable to maintain a single master table that is loaded into each BLM DAB and to supply only a single scaling factor for each individual BLM acquisition card. **C. Zamantzas** explains that the present DAB design already exploits 97% of the available FPGA resources and does not permit further multiplications and divisions required for the in-situ scaling.

It was agreed on to re-iterate the on BLM thresholds during one of the coming MPWG meetings.
***ACTION: R. Schmidt, J. Wenninger***

**Encoding Scheme for the LHC Energy and Intensity over the Timing Systems [R. Schmidt]**
In his presentation, **R. Schmidt** gives an update on the transmission of the LHC safe beam flag, beam energy and beam intensity through the general machine timing system (see slides for details). The system has been previously presented during the MPWG meeting #49.

The general machine timing system is extended by a safe beam flag generator (CSG) that combines the readings of the beam current transformers and main dipole circuit current to the safe beam flag (SBF) as well as re-transmits the information on beam intensity and beam energy itself. The safe beam flag is computed based on whether beam energy * (beam intensity)$^{1.7}$ drops below or exceeds a specified threshold. The SBF, energy and intensity information will be published at a rate of 10 Hz. Being also connected as a receiver to the timing system, the CSG further validates and checks the transmission of these parameters, and request a beam interlock in case of missing or mismatched 'send' and 'received' beam energy and intensity event signals.

It was decided to use the standard event delivery mechanism. Using this scheme the hexadecimal timing event code for the energy is '0x1405' followed by a two byte payload. The energy is quantized to 120 MeV. Thus 7 TeV corresponds to the hexadecimal representation '0xE3DD' and an energy of 450 GeV to the hexadecimal number '0x0EA6'. In case of a transmission failure, all payload bits are set ('0xFFFF') which corresponds to a (beyond design) energy value of 7.864 TeV.

The hexadecimal timing event code for the beam intensity is defined as '0x1406' for beam 1 and '0x1407' for beam 2 followed by a two byte event payload. The intensity is quantized in units of $10^{10}$ protons per beam. The nominal beam intensity ($3 \cdot 10^{14}$ protons per beam) is thus represented by the hexadecimal number '0x7530'. In case of a transmission failure, all payload bits are set ('0xFFFF') which corresponds to a (beyond design) beam intensity of $6.5 \cdot 10^{14}$ protons per beam.

**J. Uythoven** suggests to foresee sufficient redundancy of the beam intensity acquisition and transmission in order to guarantee the required safety-integrity-level (SIL) qualification.

In order to improve the robustness and reduced the dependability on other systems, **J. Wenninger** suggests to fix the CSG SBF thresholds and to remove SIS involvement that would be required otherwise to verify the correct settings.
***ACTION: B. Puccio***