Machine Protection Working Group

Minutes of the 50th meeting held on October 14th 2005

Present: E. Carlier, C. Ilgner, M. Lamont, D. Macina, V. Montabonnet, B. Puccio, R. Schmidt, J. Wenninger, T. Wijnands.

Topics of this meeting:

- Interlocking from the experiments
- AOB

Interlocking from the experiments (D. Macina)

A functional specification "LHC Experiments Beam Interlocking", LHC-CIB-ES-0002, ver.0.2, EDMS Id: 653932 is currently under approval. All LHC experiments insist that their input (USER PERMIT) to the Beam Interlock System is NON-MASKABLE. Instead, they suggest that their signals would be maskable on their side under their responsibility.

For masking interlock signals, the Safe LHC Parameter system has been foreseen by the LHC machine. This allows masking of an input signal to the beam interlock system ONLY when the beam is considered to be safe (SAFE BEAM FLAG = TRUE). It needs to be discussed how masking on the side of the experiments is performed in a safe manner. In principle, the experiment could also use the SAFE BEAM FLAG. **M. Lamont** commented that USER PERMIT = TRUE for all non-maskable inputs would be required during machine checkout periods, some time before first beam, in order to perform equipment tests.

Each experiment can provide up to 3 different hardware interlock signals:

- Injection inhibit (directly to the injection interlock system)
- Beam dump request (to BIC)
- Position interlocks from movable devices (to BIC)

Injection inhibit: The experiments have asked for the possibility to inhibit injection without dumping the beam. The injection inhibit is based on the state of the detectors and not on data from radiation monitors (apart from the requirement that the radiation monitors are operational). It indicates that the detectors are not in a safe state to cope with comparatively high backgrounds that will occur during injection and ramp. Should one of the injection interlock become FALSE during injection, beam already circulating will not be dumped. Injection will also be inhibited after a beam dump has been triggered by the same experiment, pending assessment of the causes of the dump.

This implies the realisation of a link to the injection interlock system. The hardware for inhibiting injection exists, both in point 2 and in point 8. However, it is not clear how the signals travel from the experiments to the injection interlock crate. Budget and manpower to realise the transmission system needs to be discussed as soon as possible to have it ready for the LHC start-up **(Action: D.Macina, J.Wenninger, R.Schmidt)**.

Beam dump requests: The experiment dump request is based on data from the radiation monitors that, combined by the experiment with the state of the detector, indicates that there is an immediate danger of damage to the detector. Beam dump will be done with a fail-safe system.

Position interlocks from movable devices: This interlock is related ONLY to the position of the movable devices since their position with respect to the beam (between 10-70 σ) may directly interfere with beam operation. Interlocks from to the system housed in the Roman pots or in VELO and from the radiation monitors will not go through the position interlock signal but through the injection inhibit and beam dump signals as described above.

End-switches define the garage position. The interlock signal is fed into the BIC and it becomes FALSE when the garage position is left unless the machine mode is in STABLE BEAM (to allow data taking) or in UNSTABLE BEAM. UNSTABLE BEAM is a mode to allow the operator to intervene on the beam as soon as possible, if necessary, without waiting for VELO and Roman Pots being in their garage position, since this may take some minutes.

If the conditions degrade slowly, the operator should go to ADJUST mode and wait until Roman Pots and VELO are in the garage position. If the operator would go directly into ADJUST mode with movable devices not at the end switch, a beam dump would be triggered.

ALICE-ZDC: The ZDC can move in the vertical plane and its data taking is at the beam plane. However, no dump trigger is connected to the position of the ZDC. Only an injection inhibit on beam1 is foreseen if the ZDC is not in the garage position (end-switch). The interlock is required to protect the ZDC, since it cannot interfere with the beam.

Interlocking of the experimental spectrometer magnets:

Only the dipole magnets have a large effect on the beam, as they are part of the crossing scheme at IP2 and IP8. However, the time constant are not as critical as for many magnet in the accelerator (beam moves by 1 σ in several hundreds milliseconds).

All dipoles, toroids and solenoids will be interlocked.

In case of magnet fault, the signal must be sent to the machine interlock 10 ms before the magnet power converter switches off.

There will be one signal per experiment (4 signals in total).

Ready for increased risk procedure: such procedures have been agreed between experiments and machine operation. Since the issue does have no direct relevance for machine protection, it is discussed in LEADE and LHC-OP.

Discussion:

- How is the current of the experimental magnets controlled? Some of the magnets are controlled with standard FGCs, since their operation has a direct impact on the beam, and the magnet fields must be ramped together with all other magnets. For the superconducting magnets the controls and the interlocking should be clarified before final approval of the specification **(ACTION: D.Macina, J.Wenninger)**.
- The names for the different signal must be finally defined, say, in the coming two months.
- Injection interlock: At is has been stated in the specification, responsibility and budget for this system needs to be defined. The interlock team could provide user boxes in IR2 and IR8, for the experiments to connect their injection permit signal to this box. There are several ways to bring signal from the experiments to the injection interlock controllers in IR2 and IR8. **B.Puccio** commented that one option would be the installation of an injection loop

using the same hardware as for the Beam Interlock System, with VME crates at all four points. This would not require any development, but would be rather expensive. **E.Carlier** commented that a link from the Beam Dumping System to the injection kicker or injection interlock system is also required. There are other option to realise such link.

- **T.Wijnands** commented that after a beam dump at TEVATRON triggered by the experiments, there is a long procedure to re-initialise beam permit. The LHC operation team and machine protection experts should better understand what inputs the experiments will use for this system.

AOB

Preliminary future agendas: see MPWG Web page