Agenda MPWG 3 September 2004

- **Comments to minutes**

- Generation and distribution of safe beam parameters (B.Puccio)
- Proposal for a review on beam interlocks and machine protection (R.Schmidt and J.Wenninger)

- AOB

MAC July 2004

Machine Protection System (comment of a 35 min presentation)

- The presentation on the machine protection system gave the Committee a good overall picture of this important and complex system. The Committee is concerned that, given the complexity, the work may be a little behind. Decisions to be made before long must be backed up by deep studies of how the conflicting requirements of protection and availability of the machine are reconciled, especially in the phase of commissioning with beam. Rare double-fault conditions must be taken into account.

- The Committee looks forward to hearing more details, particularly on system analysis, in the next meeting.

Collimation Review June 2004 (see collimation site)

- The requirements for the Machine Protection System (MPS) and their connection to the collimation system need further definition.
- A detailed plan for the control system was not presented, especially in view of the high reliability which is required to fulfil the function of a MPS.
- Failure of MPS: The collimation system is expected to protect downstream components including bend magnets from various machine failures, including abort kicker errors (inadvertent single cell firing, or missed abort gap). If the collimator jaws are incorrectly positioned and such a fault occurs, substantial downtime could result.
- A general concern is connected with the anticipated role of the collimation system as machine protection system and the necessity to use relatively complicated algorithms for the proper positioning of the jaws.
- One should try to design the control system as reliable as possible and toinclude hard wired interlocks wherever possible. A detailed plan for the jaw adjustments in the individual machine conditions has to be developed. Tolerances for the jaw positions within which machine protection is ensured have to be determined.

Proposal: Review on LHC Beam Interlocks and Machine Protection (R.Schmidt and J.Wenninger)

Safe operation of the LHC in presence of the energy stored in one beam of up to 360 MJ requires coherence across several systems: collimators and beam absorbers, beam dump, beam monitoring, beam interlocks etc.

Collimators and beam absorbers must be correctly adjusted, during injection, when dumping the beam, but also when accelerating and during store.

In case a failure is detected, the beam interlock system transmits a beam dump request to the beam dumping system, and the beam is extracted into the beam dump block.

The review is centred on the strategy of the LHC machine protection and on the Beam Interlock System and the systems connected to it. The review will discuss interlocking the LHC, in particular the signals that are exchanged between different systems, and the LHC and SPS. Main emphasis is on interfaces between systems, operation and controls.

Objectives

- Are there mechanism for beam losses not been considered that could impact on the strategy for protection?
- Will the protection systems protect the LHC as required (reliability)?
- Will the protection systems allow for efficient operation (availability)?
- Are there any other input channels for the Beam Interlock System that have not been considered?
- Are there any other protection devices that should be considered?
- Is it recommended to install a sacrificial beam absorber?
- Are the priorities for the various protection devices correct?

Outside the review

- Beam cleaning and collimator design (has been reviewed recently)
- Powering and quench protection (has been reviewed)
- Systems for safety of personnel (access system, others, ….)

Main systems that are involved in the protection of the LHC

- LHC Beam Interlock System
- Beam Loss Monitors
- Beam Dumping System
- Collimators
- Beam Absorbers (TCDQ, injection protection, …)
- Quench Protection and Powering Interlock Systems

Other equipment to be considered

- Highly reliable energy tracking
- Beam Monitors
  - Beam Current decay monitoring
  - Beam position monitoring
  - Abort gap monitoring
- Monitors for fast magnet current changes etc.
- Generation and Distribution of safe LHC parameters
  - Safe Beam Flag
  - Beam Presence Flag
  - Energy
  - Others

Systems with interfaces to the beam interlocks

- RF
- Transverse feedback
- Powering
- Vacuum
- Experiments
- Access
- SPS
- others (?)

Introduction

- **Introduction: Protection of the LHC**
- **Damage and quench levels**
- **Overview of collimators & absorbers**
- **Introduction into Reliability and Availability**

Single turn beam losses and protection

- Injection: from SPS to LHC first turns
  - **Error budget**
    - **Errors from SPS & Transferlines, by kickers and septum magnets**
  - **From SPS to LHC injection**
    - **SPS extracxtion, Collimators in transfer line**
  - **Injection and first turns**
    - **Injection protection**
  - **Ensure that injection kicker only deflect the beam at injection**
  - **Interlocks**

    Extraction interlocks, Transfer line interlocks, Injection interlocks, Beam presence flag & first turn , SBF & Co
- Beam dump
  - **Beam dumping system overview**

    Kickers, septa, dilution, dump, absorbers
  - **Requirements for a clean beam dump**

    Interlocks on position, RF, quad current....
  - **Safe beam energy**
  - **Beam dump failures (asynch, prefiring, …)**

    TCDQ, TCDS
  - **Abort gap cleaning**

    Synchronisation, Cleaning, What happens if it fails
  - **Beam dump reliability and availability**
- Other fast kickers (Q-measurement, aperture kicker)
  - **Q-measurement, aperture kicker**

Multiturn beam losses and protection

- **Mechanisms at various energies, squeezed and unsqueezed**
  - Magnet failures
    - D1 and warm magnets, Quench of dipoles and other magnets...
  - RF and Transverse damper
  - Others ??
- **Instruments used for Protection**
  - Beam Loss Monitors
    - At collimators and aperture restrictions
    - Around the ring
  - BLMs reliability and availability
  - Quench protection and beam dump requests
  - Fast magnet current interlocks
  - Fast beam current decay measurement
  - Fast orbit drift measurement

Hardware systems

- Beam interlocks LHC and interfaces to SPS
  - Their inputs (RF, vacuum, access, experiments, PIC, others,...)
- Beam interlock system reliability and availability
- Generation and Distribution of Safe LHC parameters
  - Beam energy and safe beam flag, beam presence flag..

Collimators and beam absorbers

- Settings for protection
  - Injection, ramp, squeeze, How to ensure correct settings?
- Do we need additional collimators for protection??
- Sacrificial absorbers

Commissioning and operation

- Commissioning and machine protection (bootstrapping...)
- ....or rather take the approach from interlock side ?

To be defined

Review organisers at CERN: Who?

Reviewers

Ideas: M.Harrison, G.Ganetis, R.Bacher, K.Wittenburg, someone from Fermilab, from SNS, from

Chairpersons

When: Possibly 13-15 December, 2.5 days