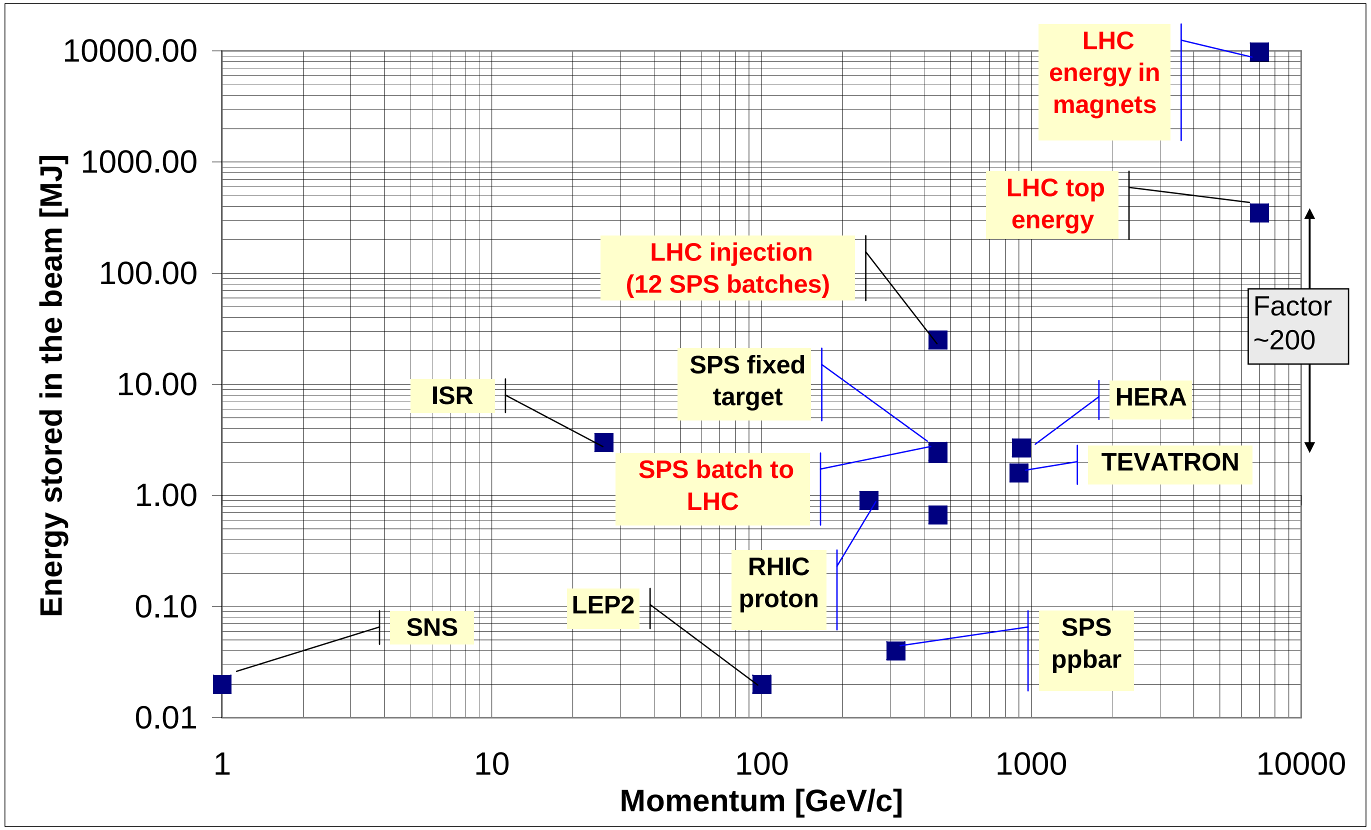
Close-out

Introduction



- The problem is obvious:
  - Magnetic field increase only a factor of 2
  - Energy increase only a factor of 7
  - Stored energy increase > 2 orders of magnitude (damage/quench)

General

The Committee wishes to commend the speakers for the presentations. A great deal of hard work has obviously gone into the planning, design and in some cases realisation of the various sub-systems.

The Committee thinks that the front-end system design for both the machine protection system and the associated sub-systems are quite mature.

Knowledgeable personnel

TI-8 tests proved useful (in more than one way)

Radiation tolerance testing in the SPS beamline & PSI

Do you consider the overall strategy for the machine protection adequate ? And what could be the main risks ?

- The Committee feels that the fundamental strategy is sound:
  - Failsafe/redundancy
  - Pilot beam
  - Safe-beam concept
  - Injection protection well done
  - Aperture defined by collimators
  - Mask-able states
  - Comprehensive in the use of the various sub-systems
- The system represents a reasonable extension of existing systems

Do you consider the overall strategy for the machine protection adequate ? And what could be the main risks ?

- **The Committee feels that configuration control represents the main risk of machine damage**
  - Highly complex
  - Many elements
  - Mode changes
  - Software logic/release control

- **All Doomsday scenarios (350 MJ) appear to involve the dump kickers in one way or another**

Are there mechanisms for beam losses not being considered that could impact on the strategy ?

- While the Committee can imagine other beam loss scenarios we do not feel that the overall strategy would be changed in any significant way

Are the interfaces between the different systems clearly specified ?

- The hardware interfacing to the Beam Interlock Controller is well defined in most cases. Likewise the majority of the input signals are determined. The Committee notes the system is trivially capable of expansion (reduction !).
- We feel that the software interfaces are less well determined
  - BIC, BLM & Beam Dump control/interface software
  - Post mortem data
  - State control

Are there other protection devices that should be considered ?

- **We feel that while the postulated protection devices are suitably comprehensive there may be a role for diversified independent back-up systems for the beam dump triggers and energy tracking (Doomsday scenarios). The backup systems would be expected to have much wider operational tolerances.**
  - Possibly hire some professional outfit to look at this

Are there other input channels to the Beam Interlock System that should be considered ?

- Nothing Obvious
  - Faster response from the Power Converters ?
  - Control system inputs ?
  - Network failures ?

Will the protection system have the required safety ?

- As designed it should. Two caveats:
  - The Committee strongly queries the utility of a device such as the aperture kicker given the potential risk inherent in it's operation.
  - In a similar vein the use of fast vacuum valves is also something that needs to be carefully justified.

Will the protection system allow for efficient operations (availability) ?

- The main risk would appear to involve not achieving suitable luminosity rather than not being able to run the machine with beam
  - Achieving design luminosity will require a beam loss rejection of 10E-4 to avoid quenches. This requires tight tolerances and has not been demonstrated in any existing machine.
  - It is less than obvious to the Committee that the collimator efficiency can be validated in an operational way.
- Reliability calculations provide a mechanism to determine the optimal strategy to allocate fixed resources among the various sub-systems.

Based on experience elsewhere what is most critical and where have been surprises ?

- **Power supplies gave the worst problems in the initial stages at all machines.**

- **Every machine has had at least one event that would have been catastrophic with LHC beam. There is no obvious single root cause. We believe that these failures have all been potentially addressed in one way or another in the LHC machine protection system.**

- **Commission of necessity involves a large amount of equipment failure/repair and associated downtime. It is an inherently risky time. Additional care must be taken to avoid 'shortcuts'. Responsibilities must be well defined.**

Comments

- Validation cycle for a 'warm' start - semi safe beam state
  - Reproduceability ?
- Post mortems are crucial to the machine operation. Data gathering and archival functions need definition for subsequent analysis and re-qualification.
- Formal qualification for the MPS system software ?
- Diverse systems for critical functions
- Define 'failsafe' in operational terms

Comments

- Spares for the dump septum
- Distribution of the safe beam parameters slightly vague
- SPPS dump integrity
- DC beam measurement was too slow (~100 ms)

Comments

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