CLIC issue: *Machine Protection*

1. Short technical description and corresponding category(ies) of issues :

Passive and active protection systems for the various beams and accelerator components of the CLIC installation.

Feasibility	Performance	Cost
x	x	

2. CLIC nominal parameter issues and comparison with state of the art (in text and/or table):

The charge density of the nominal CLIC main beam and the CLIC drive beam are several orders of magnitude above that for melting copper.
Protection of all accelerator components shall be provided for two types of failures, slow failures (up to 2 ms before next beam pulse) and fast failures (shortly before beam pulse or during beam pulse)

“Slow losses”:
A beam permit system will provide the protection against slow failures detected up to 2 ms before the next pulse (power supply failures and vacuum system failures).
The magnet powering circuit will have to be sufficiently slow to stay within acceptable tolerance for the 2ms after detection of the failure. For vacuum valves (if they could at all reach the beam during 2 ms) the closure must be inhibited during the 2 ms following the next-pulse warning. Slow drifts of the machine are detected by post pulse analysis.

The concept of the current LHC machine protection system represents the state of the art for machine protection systems and the technical solution fulfills the requirements for the CLIC machine protection against slow failures.

“Fast losses:”
(RF breakdown, kicker failures Klystron trips) are more difficult to deal with as it will be difficult to dispose of the beam once the beam has been committed. The protection system for fast losses should rely on passive protection.

The detailed requirements for the passive protection against fast losses have to be studied case by case for various failure modes. More specifically, the effects of RF breakdown on the main and drive beam have to be studied; the study should either certify that the corresponding induced beam losses are low enough not to cause any structural damage or should lead to a design for an adequate protection based on passive absorbers or spoilers.

3. **R&D program presently set-up**:

The two beam test stand will allow to study the effect of RF break down on the two different beams of CLIC and to confirm simulation studies.

Simulations for optimal placement of beam loss monitors for diagnostics of the accelerators; or as active components in protection chains.

4. **What performances will realistically be achieved (Target Performances):**
    - **by end 2010**

Full inventory of failure modes, simulation of their impacts on the accelerator structures
Detailed requirements for passive machine protection.
Evaluation of the requirements for beam observation systems to detect the onset of instabilities in drive and the main beam (i.e. beam loss, beam intensity loss, position and emittance).
Proof of feasibility for magnet power circuits with guaranteed tolerance for 2 ms after the onset of failure.
Required tolerance for all magnet circuits for safe operation with nominal beams.
Establish the procedure to reach nominal CLIC operation starting from a "cold" machine, based on successive beams of increasing intensity and brilliance.
Evaluate the unavailability of the machine for nominal operation due to various interlock conditions and equipment failures.

- **by end 2012 (including FP7)**

Complete and validated design of passive protection system.
Detailed scenario for machine protection checks
Detailed design of "next beam permit" machine protection system for slow failures.

5. **Comments on validation of CLIC parameters issues by comparison with Target Performances:**

6. **Optional: What additional R&D could be set-up to eventually reach the validation of nominal CLIC parameters (estimation of resources and schedule?)**

Study /test material damage in Copper RF structures by dense electron beams.
Simulation of failure modes,
Simulation of beam loss due to failure modes.
Study of activation of accelerator component caused by beam loss. A) implications for control electronics, b) implications for personnel safety (i.e. access restrictions due to hot spots).