A Fast Magnet Current Change Monitor for Machine Protection in HERA and the LHC

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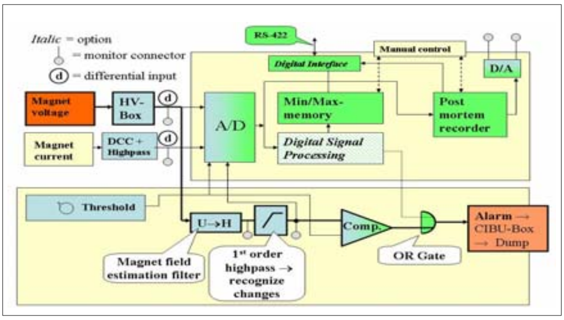
Abstract

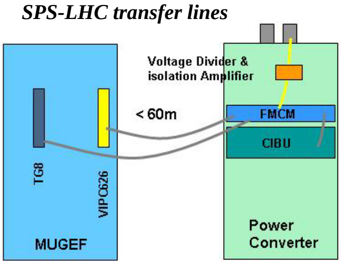
The protection of the electrical system for high intensity machines such as HERA at DESY and the Large Hadron Collider (LHC) currently being built at CERN is a major challenge due to the unprecedented complexity and the large stored energies.

Fast Magnet Current Change Monitors (FMCM) are deployed in HERA and the LHC and the SPS-LHC-CNGS transfer lines. The monitors issue beam dump requests or inhibit extraction of beam in case of powering failures that would have fast effects on the particle beam(s).

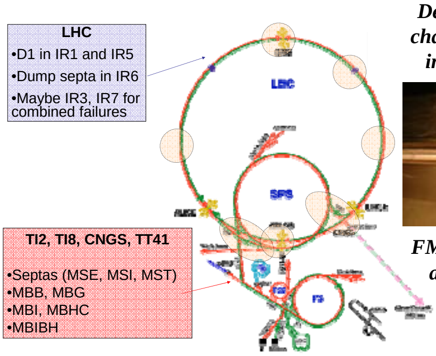
While the system is already operational at DESY, the CERN version is currently in development in close collaboration with DESY and will be deployed for high intensity operation of the accelerators in 2006.



System architecture for SPS-LHC transfer lines



FMCM



Destroyed vacuum chamber after beam incident in TT40

FMCM is designed to avoid such events

Why do we need Fast Magnet Current Change Monitors and how do they work?

- *Detection of powering failures has the advantage of detecting failures even before the beams start to move or beam losses occur*
- *Absolute current measurements with common DCCTs or hall-probes require filtering and as such time to achieve accurate measurements*
- *FMCM will detect fast changes of the magnet current (after powering failures) and trigger a beam dump or an extraction inhibit*
- *Due to its fast reaction time, the FMCM is capable of capturing failures such as the ones causing the beam incidents in the TT40 extraction line of the SPS and the HERA experimental area in 2004*

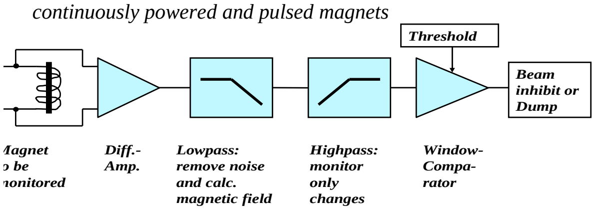
Sensitivity requirements *with respect to the nominal magnet current*

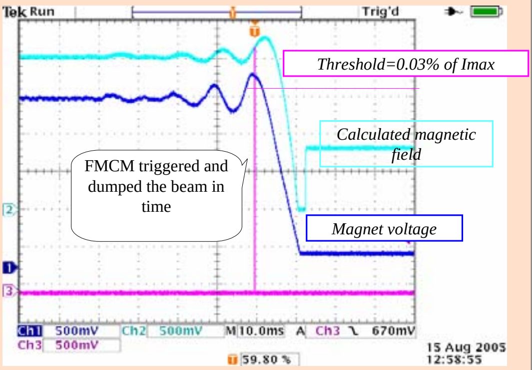
HERA:	***0.5 %*** *change to be detected in* ***1.0 ms***
CERN-LHC:	***0.03 %*** *change to be detected in* ***0.6 ms***
CERN-Beam transfer lines:	***0.2 %*** *change to be detected in* ***0.1 ms***

Additional features

- *Post mortem data recording with UTC synchronized time stamps*
- *Remote control via RS422 for CERN version*

Working principle of FMCM – *applicable for continuously powered and pulsed magnets*





Post mortem recording of an FMCM in HERA:

A HERA magnet power supply started to oscillate, and the FMCM dumped the beam before beam loss could happen

Conclusions

At HERA, 14 devices are already operational since several months and have proven their functionality by triggering a beam dump after a power converter instability. Tests of the FMCM at CERN have been successful and an adapted version of the FMCM will be provided in the frame of a collaboration in between DESY and CERN for high intensity operation in 2006.

References

M.Werner: FMCM presentation, HERA-Seminar, Grömitz, Germany

M.Werner: FMCM patent, to be achieved, Germany

M.Werner, M.Zerlauth: 'FMCMs for the LHC and SPS-LHC transfer lines', CERN, DESY