Tests of a Fast Magnet Current Change Monitors (FMCCM) for additional protection in LHC and SPS-LHC Transfer Lines

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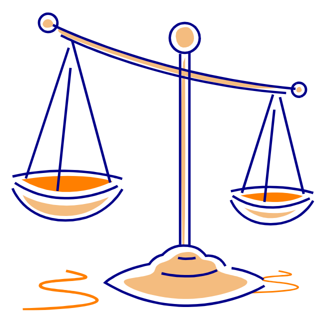
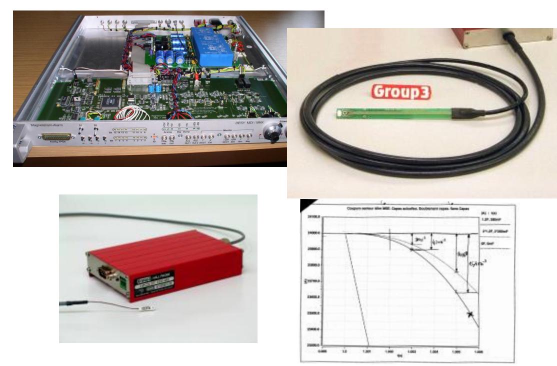
A bit of history

- Famous studies for the criticality of the D1 separation dipole and the SPS extraction septa MSE already in 2003 V. Kain
- Basic prototyping with hall-probes, voltage pick-ups
- Presentation of first ideas in Nov 2003 (MPWG)
- Further studies of injection scenarios revealed further uncovered failure cases
- Similar beam incident in HERA led to the design of an additional active protection system, now already in operation (~15 units) M. Werner
- TT40 incident end of 2004
- Tests of the HERA system on dedicated test benches at CERN

480 kCHF/circuit,
Technically feasible

Passive / Active





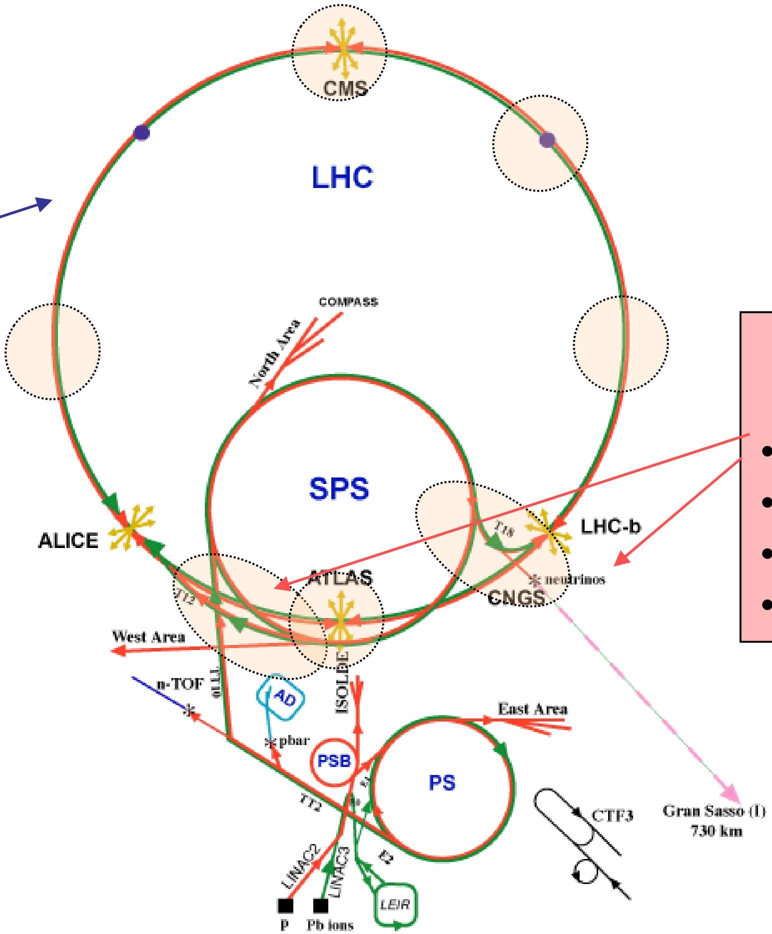
15 kCHF/circuit,
Technically feasible??

➔ Studies showed the need for fast detection for a number of normal conducting circuits in the LHC and the transfer lines

➔ Current changes in the order of 5*10E-4 to be detected and beams have to be dumped in < 1ms

LHC

- D1 in IR1 and IR5
- Dump septa in IR6
- Maybe IR3, IR7 for combined failures



TI2, TI8, CNGS, TT41

- Septas (MSE, MSI, MST)
- MBB, MBG
- MBI, MBHC
- MBIBH

See Verena's talk for details

Failure case : Powering failure in magnets with effects on the beam very shortly after the failure

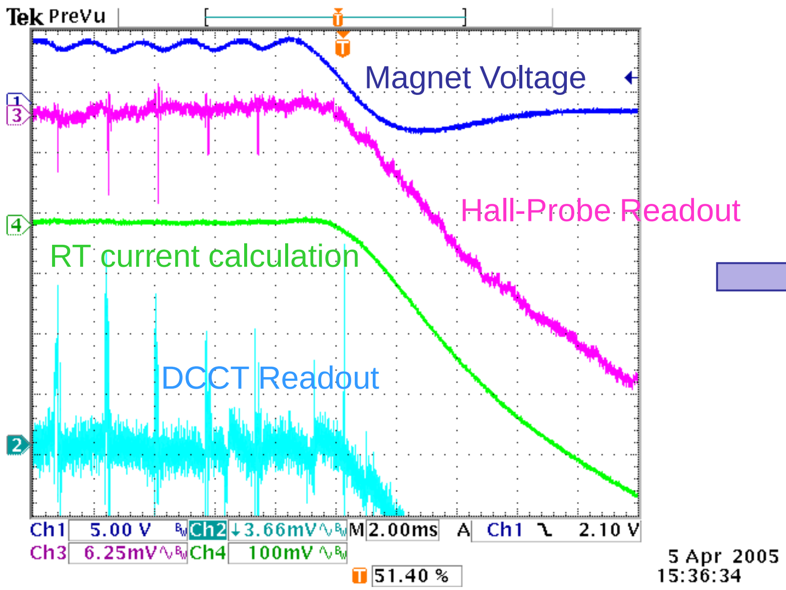
- For superconducting magnets, the large natural time constant relaxes the required detection time -> Power Interlock Chain is sufficient
- For a number of normal conducting magnets (T ~ sec) such as septas and separation dipoles, current changes of 5*10E-4 can be hazardous and beams have to be dumped in < 1ms
- Very fast losses occur (due to the quickly decaying field)
- Present powering interlock system (together with converter controls) provides NO redundancy to BLMs (LHC) or leaves uncovered failure scenarios (TI2/TI8)
- Idea of a Fast Magnet Current Change Monitor, initially developed at DESY and recently successfully tested for the SPS extraction septa and the LHC separation dipole D1

With courtesy of M. Werner

Failure case : Powering failure in magnets with large effects on the beam

- Measurement of fast current changes (typical for powering failures), instead of absolute values -> Less dependant on noise
- Based on measurements of the magnet voltage rather than a DCCT readout
- RT calculation of the current based on a model of the circuit impedance

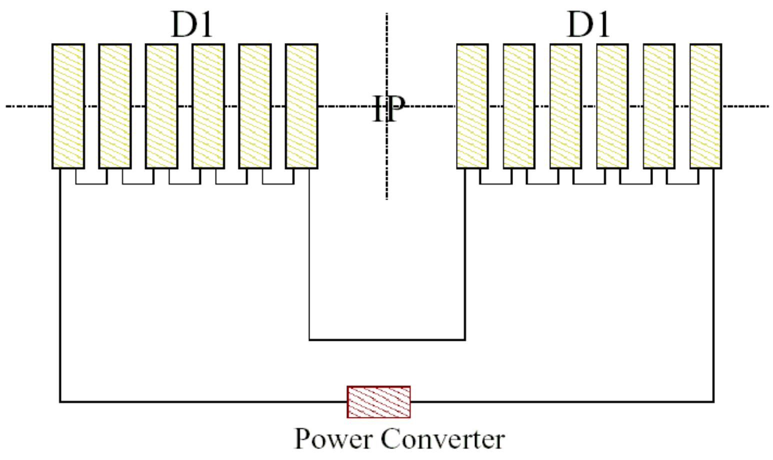
Example of measurements during a shut down of a nc separation dipole (D1):

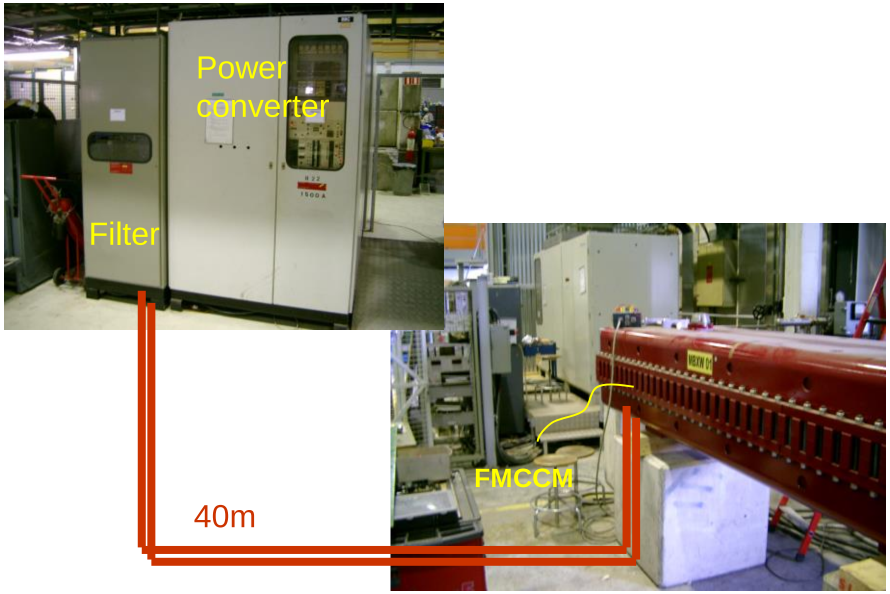


Calculation and filtering for typical di/dt's allows for generation of fast and reliable interlock signals

Talk of Matthias

- Simulations have shown the D1 separation dipole (IR1 and IR5 of LHC) and the SPS extraction septa (MSE) to be the most critical ones
- Goal was to validate the functionality of the FMCCM for these two circuits
- Specific test setups for those two cases



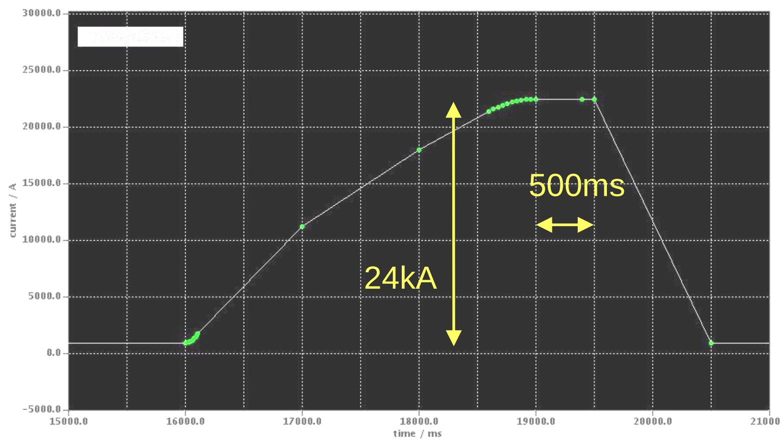


LHC:
12 MBXW in series in one circuit
LHC type power converter on surface
Time constant around 1.2 seconds

Test Setup:
1 MBXW on the test bench in 867
Power converter from 60's with additional passive filter
Time constant around 1.2 seconds
Large noise level

Tests Setups – SPS extraction septa

Nominal Ramp for MSE septa



SPS - Transfer line TI8:
5/6 MSE in series in one circuit
SPS type power converter
Time constant around 23 msec

Test Setup:
1 MSE on the test bench in 867
Power converter from 60's
Time constant around 39 msec
Large noise level