



Energy extraction for WP3 magnets

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SUMMARY

- Dump resistors requirements
 - Both in HL-LHC configuration (tunnel) and in the test bench, including short models

TRIPLET: MQXF

- There is no dump resistor in the circuit (removed in 2015)
- Test configuration: MQXFA (in BNL)
 - Dump resistor of 60 m Ω used, this extracts 40% of stored energy
- Test configuration: LQXFA (in FNAL)
 - Dump resistor of 60 m Ω used, this extracts 20% of stored energy
- Test configuration: LQXFB (in CERN)
 - No dump resistor

- Short models: dump resistor in the range of 50 m Ω has been used
 - This extracts 50% of stored energy
 - Test also done without dump resistor for MIITs estimate
 - Aim to train in nominal conditions (without dump resistor) for MQXFS4 and MQXFS6

ORBIT CORRECTORS: MCBXF

- There is no dump resistor in the MCBXFB magnet circuits (not needed for protection)
- There is a 300 m Ω dump resistor in the MCBXFA magnet circuits
 - 8 resistors, bipolar circuits
 - Quench heaters are also studied, if viable the resistor could be removed from the baseline
- Test configuration: MCBXFB
 - No dump resistor
- Test configuration: MCBXFA
 - 300 m Ω dump resistor, extract 55% of the energy

HIGH ORDER CORRECTORS

- MCSXF, MCSSXF, MCOXF, MCOSXF, MCDXF, MCDSXF, MCTXF, MCTSXF (sex,oct,dec,dod)
 - There is no dump resistor in these magnet circuits (not needed for protection)
 - Test configuration (LASA): 500 m Ω dump resistor
- MCQSXF (skew quadrupole)
 - There is a 1500 m Ω dump resistor in the magnet circuit, extract 50% of energy
 - 4 resistors, bipolar circuits
 - Test configuration (LASA): 1000 m Ω dump resistor

SEPARATION DIPOLE MBXF

- There is no dump resistor in the MBXF magnet circuits (protection relies on quench heaters)
- Test configuration: MBXF (KEK)
 - 50 m Ω dump resistor
- Test configuration short model: MBXFS (KEK)
 - 50 m Ω dump resistor

RECOMBINATION DIPOLE MBRD

- There is no dump resistor in the MBRD magnet circuits (protection relies on quench heaters)
- Test configuration: MBRD (CERN)
 - No dump resistor foreseen
 - A 50 m Ω dump resistor would extract 40% of the energy
- Test configuration short model: MBRD (CERN)
 - 50 m Ω dump resistor, extract 90% of the energy

D2 ORBIT CORRECTOR MCBRD

- There is a 700 m Ω dump resistor in the MCBRD magnet circuits
 - 16 resistors, bipolar circuits
- Test configuration: MCBRD (CERN)
 - 700 m Ω dump resistor, extracts 50% of the energy

SUMMARY FOR HL-LHC

- In HL-LHC we have energy extraction for three correctors magnets
 - MCBXFA: 300 m Ω , 8 bipolar circuits
 - Current is 1.6 kA, stored energy is 223 kJ (nested), no mid grounding
 - MCQSXF: 1500 m Ω , 4 bipolar circuits
 - Current is 0.18 kA, stored energy is 25 kJ, mid grounding required
 - MCBRD: 700 m Ω , 16 bipolar circuits
 - Current is 0.44 kA, stored energy is 140 kJ (two apertures), no mid grounding
- Delay for energy extraction of 10 ms or more