Quench detection and protection system for the CBM dipole magnet.

P. Kurilkin[*1], *P. Szwangruber*[2], *H. Ramakers*[2], *E. Floch*[2], *and F. Toral*[3]

[1]LHEP-JINR, Dubna, Russian Federation; [2]GSI, Darmstadt, Germany; [3]CIEMAT, Madrid, Spain

The CBM dipole magnet has very large dimensions and stores about 5.15 MJ. An adequate protection of the superconducting CBM dipole magnet means minimizing of the coil peak temperature and of the resistive-inductive voltage imbalances, which can generate large voltages to the ground.

The quench protection of the CBM dipole magnet will be based on the extraction of the stored magnetic energy in an external dump resistor to avoid vaporization of helium. Fig.1 and Fig.2 present the results of 3D quench calculation using GSI[1] and CIEMAT[2] code. The detailed information about the data used in the calculation can be found in Ref.[3]. Both models predict a maximum hot-spot temperature on the level of 70 K. The maximum quench voltage equals to 249 (190) V, for GSI[1] and CIEMAT[2] computations, respectively. The maximum voltage across the magnet (1441 V) occurs when the dump resistor turns on. The difference between the calculated results is related to the different field map distribution in the coil and to the different material data bases used in GSI[1] and CIEMAT[2] programs. Fig.3 shows the power supply (PS) scheme, the
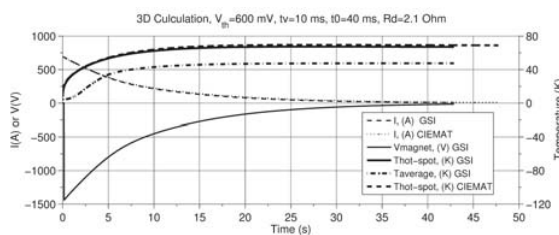

Figure 1: 3D quench calculation of the CBM dipole – magnet current, magnet voltage and the maximum (hot spot) coil temperature.
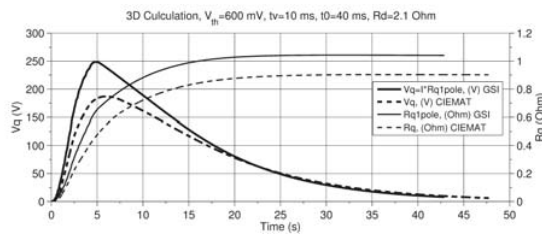

Figure 2: 3D quench calculation of the CBM dipole – the quench voltage and the quench resistance.
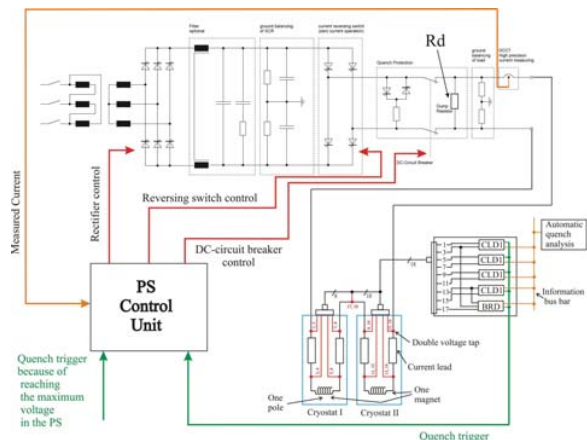
* pkurilkin@jinr.ru

Figure 3: Quench detection and protection scheme (including power supply and voltage taps).

simplified PS control unit scheme the magnet, the dump resistor (for quench protection) and the quench detection system. Each magnet pole has a separate cryostat. The current is brought from the room temperature to the cryostat (4.5 K) by current leads (CL). There are 4 current leads (two per one pole). The quench detection system consists of:

- 4 voltage detectors (CLD1) used for current leads
- 1 classical bridge detector (BRD) used for the magnet
- Voltage threshold in the power supply unit (safety trigger).

During the normal operation the DC-circuit breaker is closed. When a quench occurs a quench trigger is given by detection system.

After the quench trigger, the DC-circuit breaker disconnects the PS and the magnet current is dumped via the dump resistor. The use of a dump resistor of 2.1 Ω provides the evacuation of about 85% energy stored in the magnet.

References

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