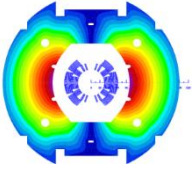


MBHSM01 Test Status

December 17, 2013



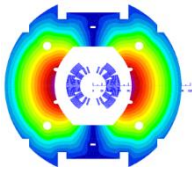
Introduction



- MBHSM01 - the first 11T dipole coil in a mirror structure w/o warm bore
- 1-m long coil (#8) made of 0.7 mm diameter Nb₃Sn RRP 108/127 and RRP 114/127 strands
 - 0.025 mm thick and 11 mm wide stainless steel core in the conductor

Main test goals are coil performance study in a different mechanical structure and under different pre-load conditions, as well as further study of the quench protection

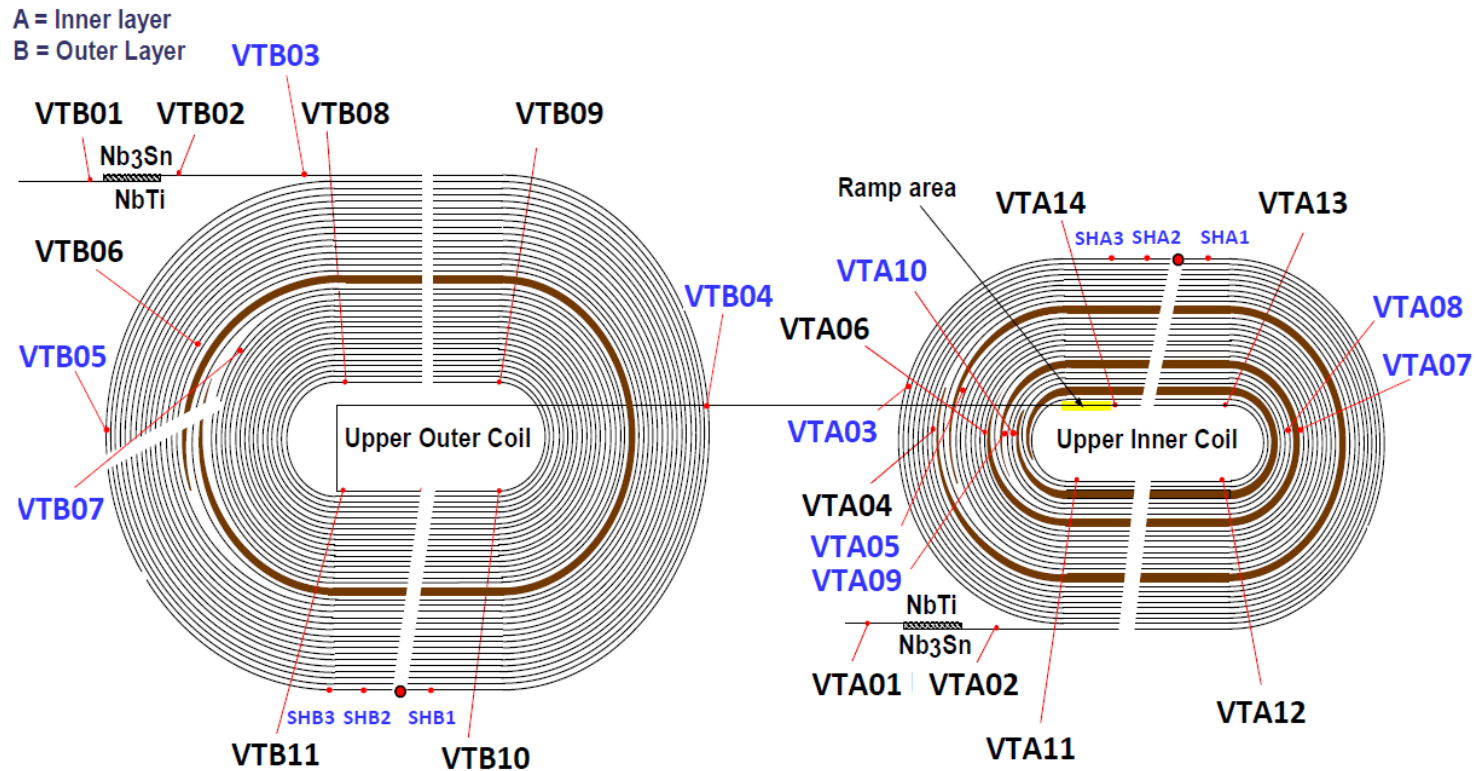
Two previous tests of the 11 T coils at FNAL demonstrated significant quench current degradation. One of the main tasks of MBHSM01 test is to understand the cause of the limited coil performance demonstrated in MBHSP01/02

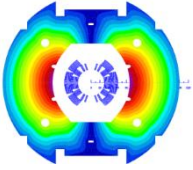


Voltage Taps in MBHSM01



Additional VT installed in the multi-layer blocks, mid-plane and around the spot heaters (shown in blue color) will help to find quench locations both in the low and high field areas





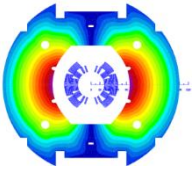
Quench Antenna



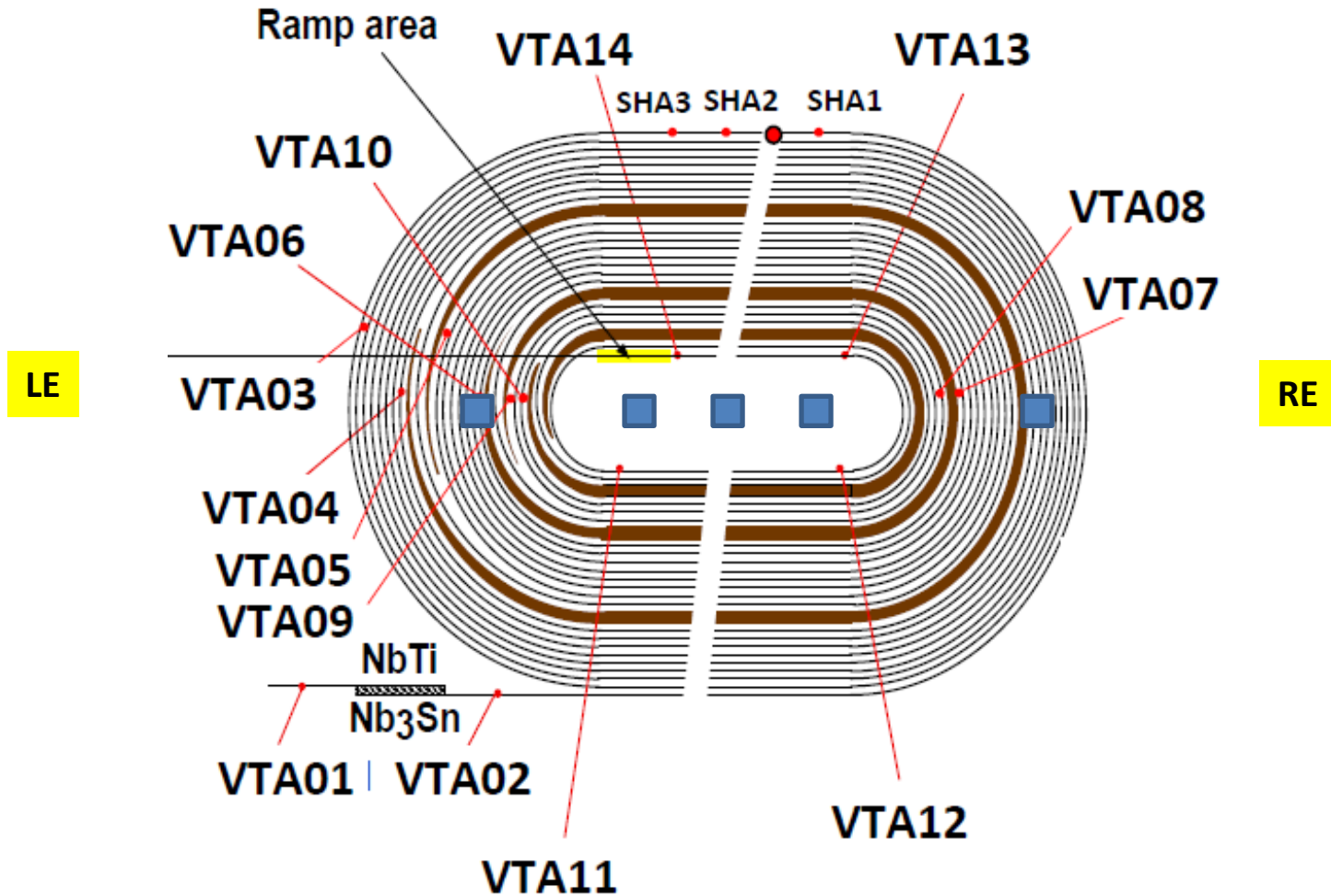
Quench antenna (QA) with 5 independent PCB-based segments installed on the inner coil surface

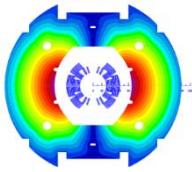
- 3-piece QA in MBHSP02 demonstrated reliable and efficient operation for the IL quenches





Quench Antenna (cont'd)



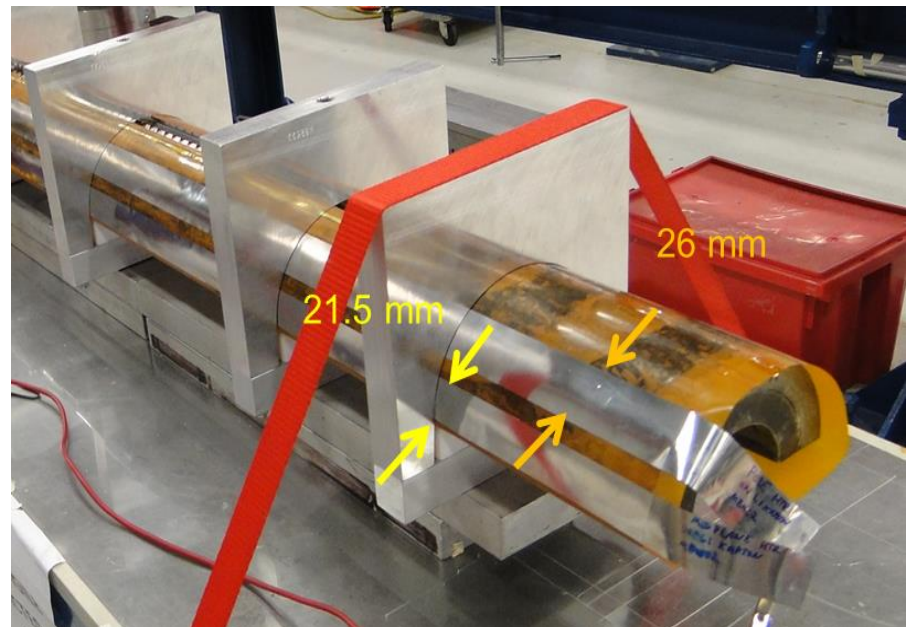
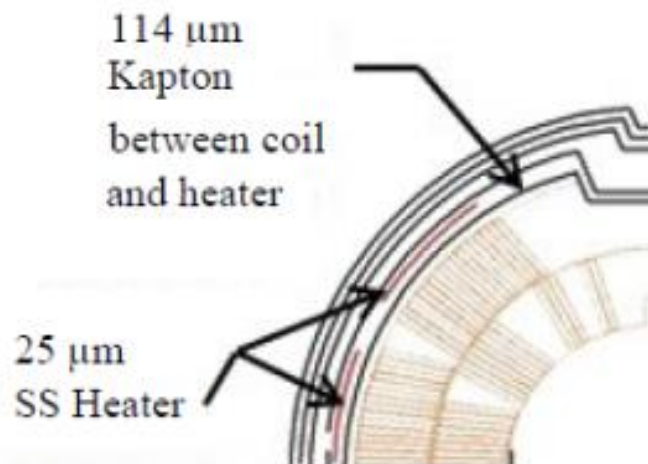


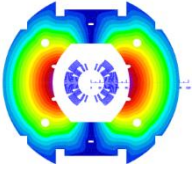
MBHSM01 Strip Heaters



Coil is equipped with 2 protection heaters placed between the first and second ground insulation Kapton layers on the outer coil surface

Heaters are composed of 1000 mm long, 0.025 mm thick and 21.5 mm wide (in mid-plane) or 26 mm wide (in pole area) stainless steel strips



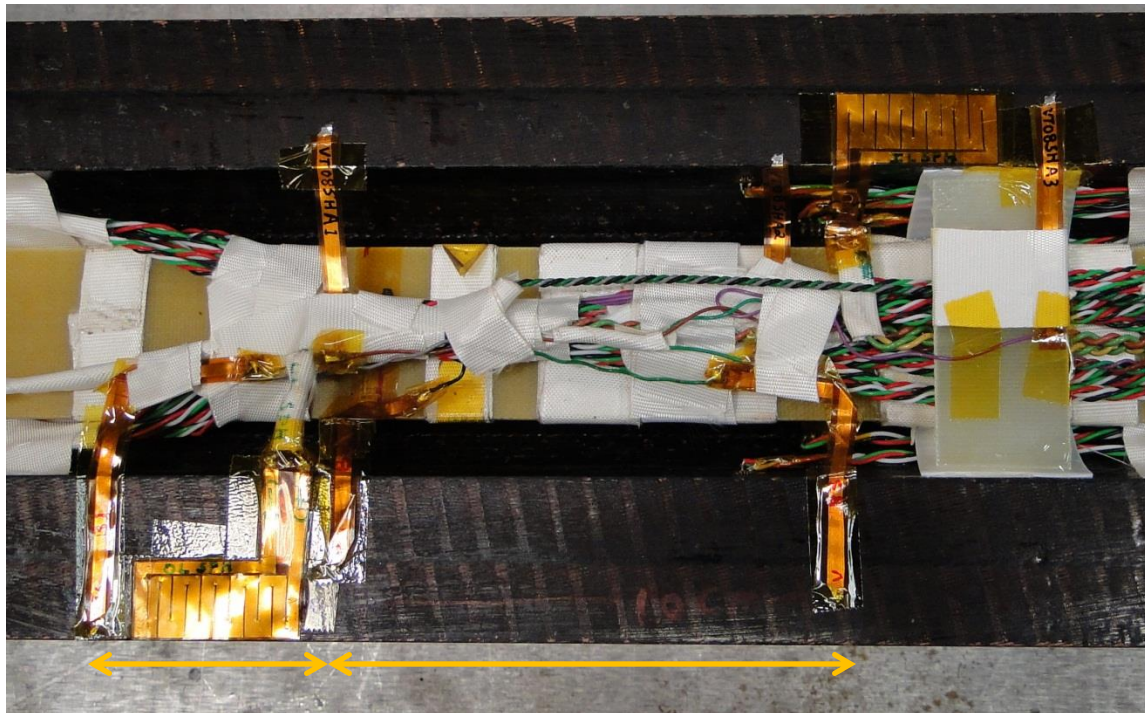


Spot Heaters



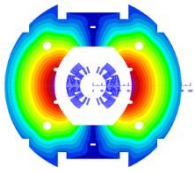
Spot heaters (SH) installed for the quench propagation study, as well as for the quench temperature studies

- VT installed around the spot heaters



5 cm

10 cm

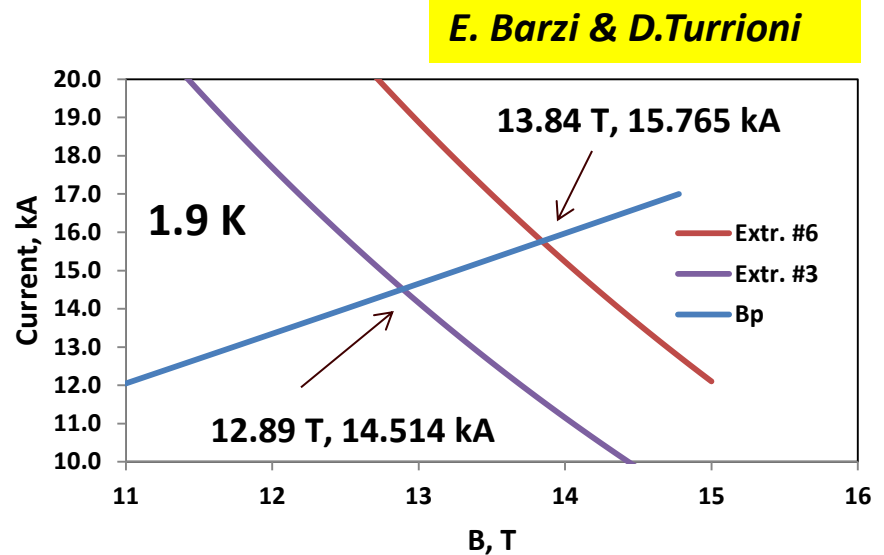
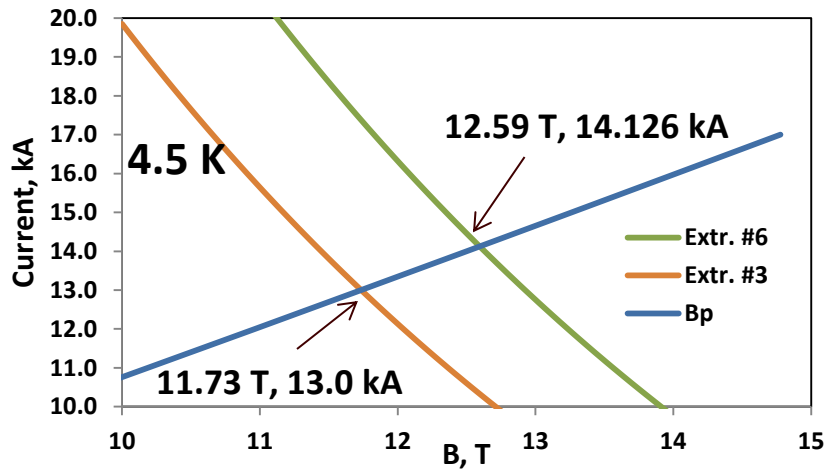


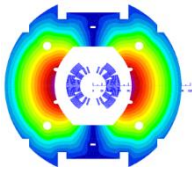
Witness sample data



Large spread of witness sample results. Two extremes – the lowest and the highest SSL estimates are presented below

Currently not clear what is the fraction of strands of each type in the conductor

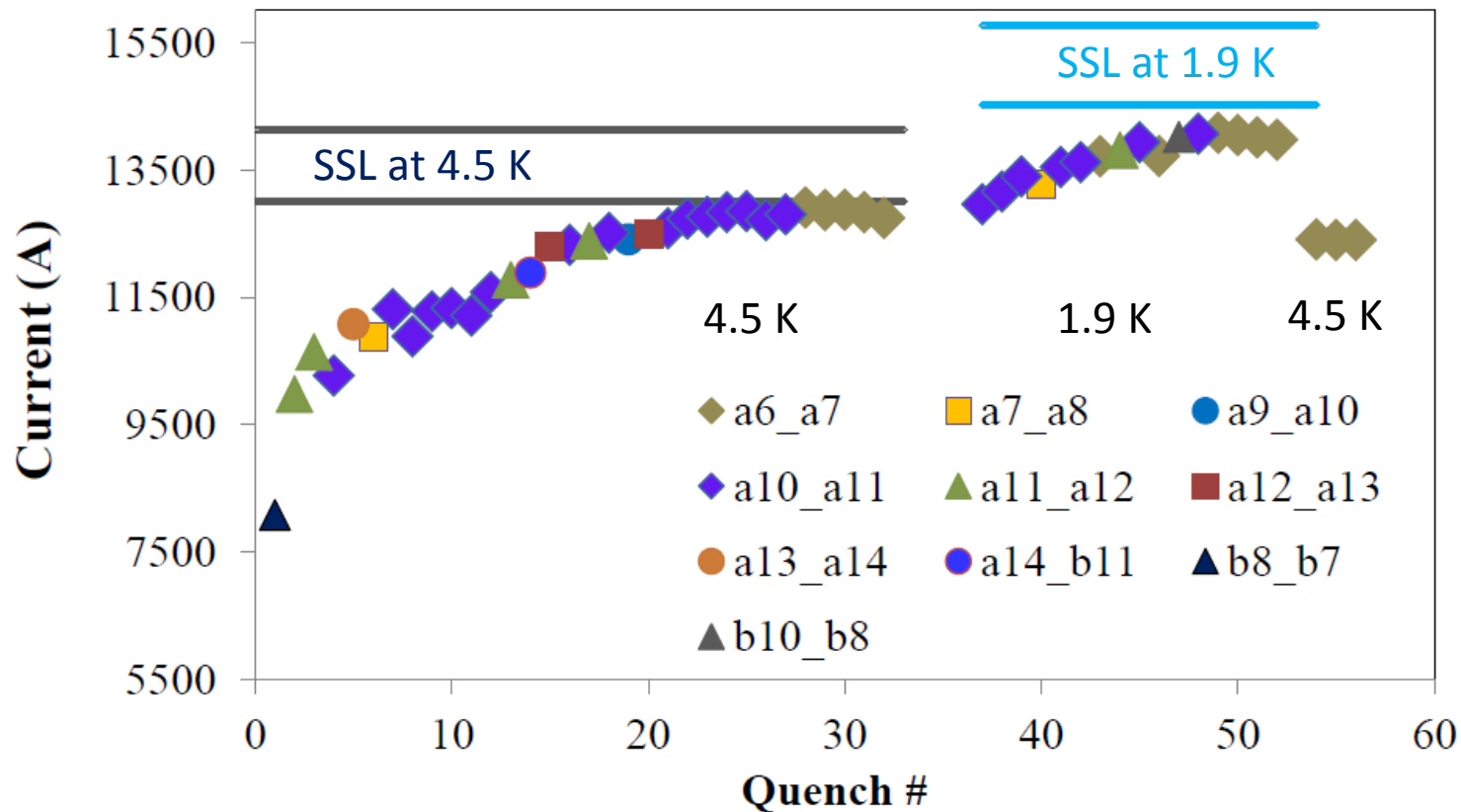
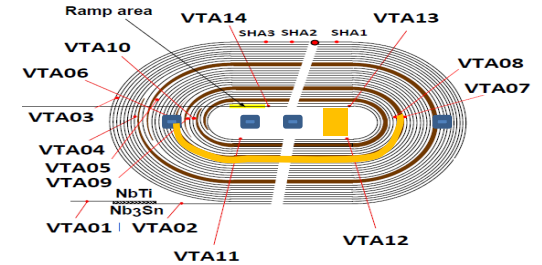


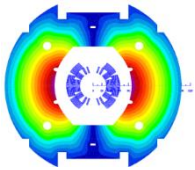


MBHSM01 Quench Training



Highest quench current at 4.5 K: 12.9 kA (92-100) % of SSL
at 1.9 K: 14.1 kA (89-97) % of SSL

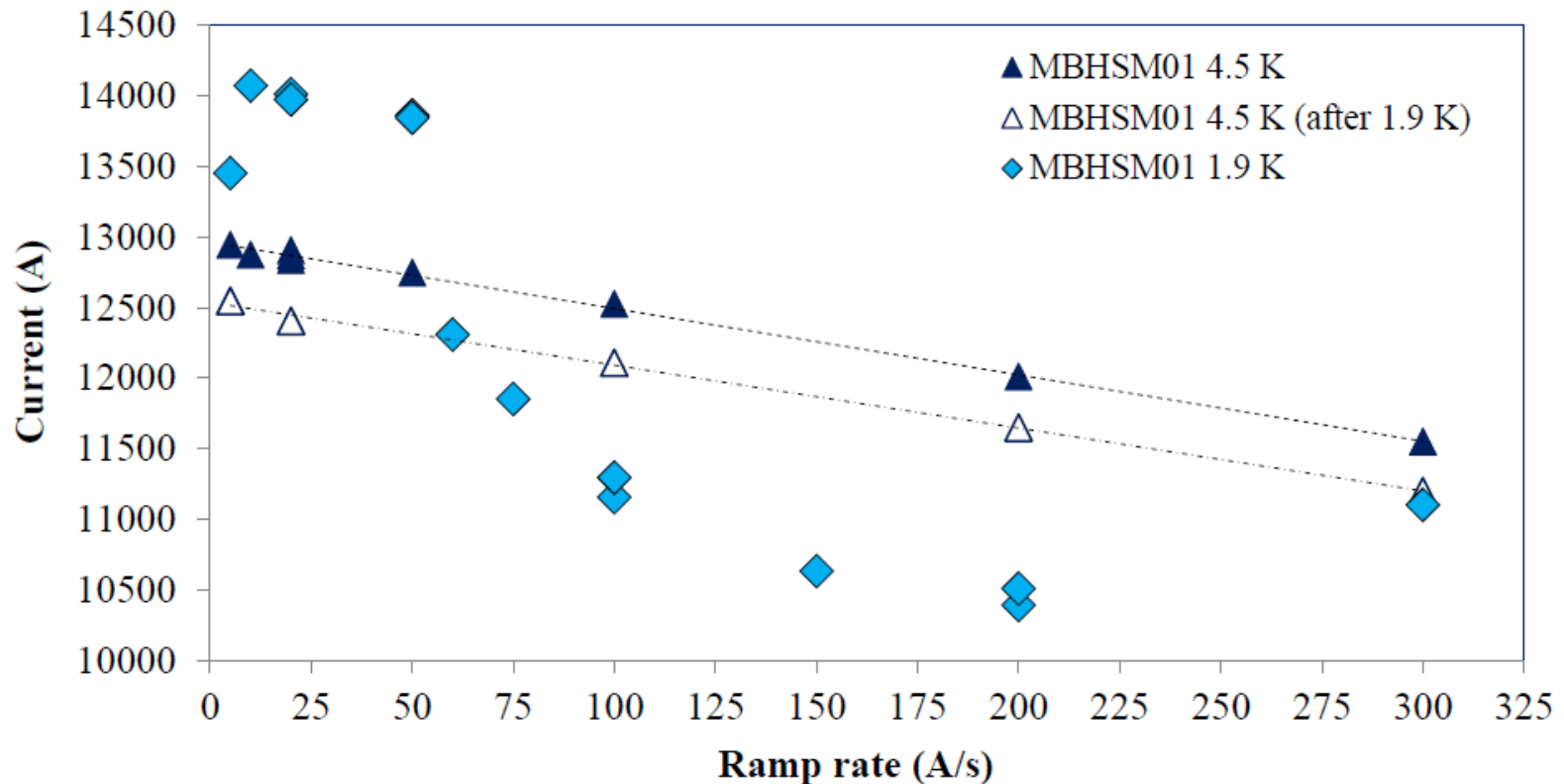




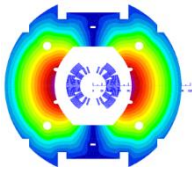
Ramp Rate Study



Quench locations: A6-A7 (low ramp rates at 4.5 K and 1.9 K), A7-A8 (above 50 A/s at 4.5 K) and A11-A12 (above 50 A/s at 1.9 K)



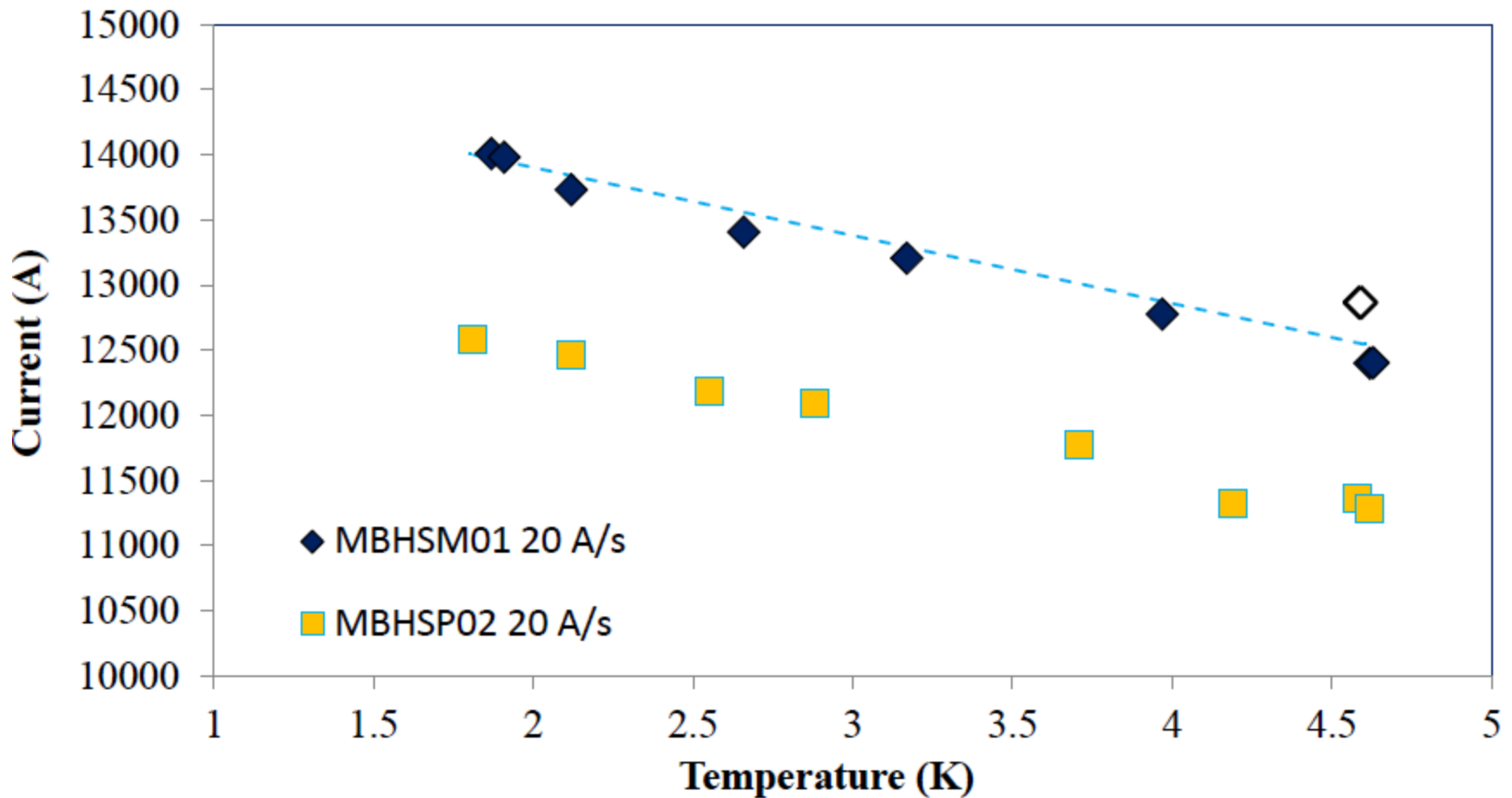
No quench observed at 1.9 K when ramping down from 13 kA at 200 A/s

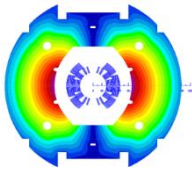


Temperature Dependence



All MBHSM01 quenches initiated in A6-A7 segment

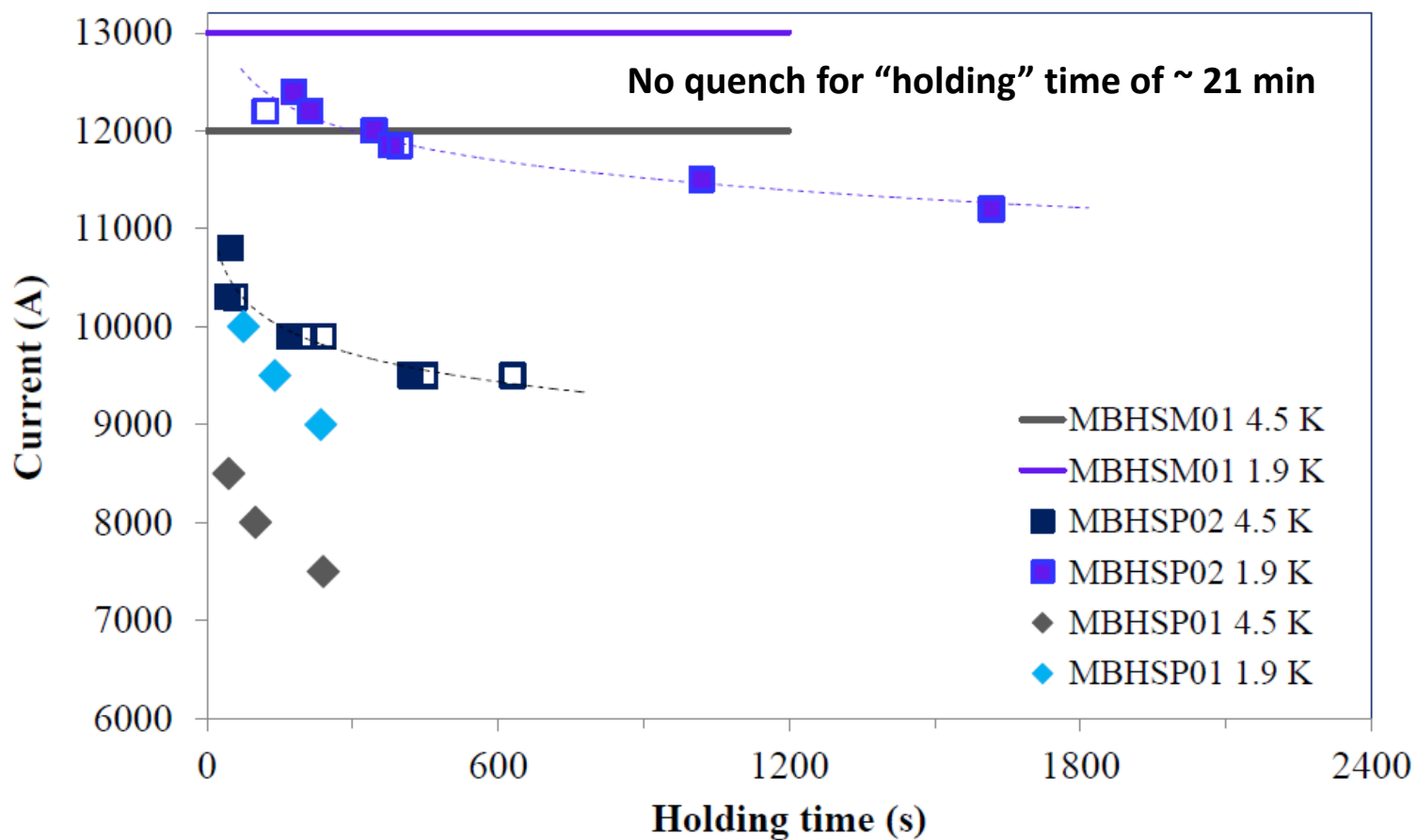


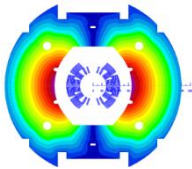


“Holding quenches”

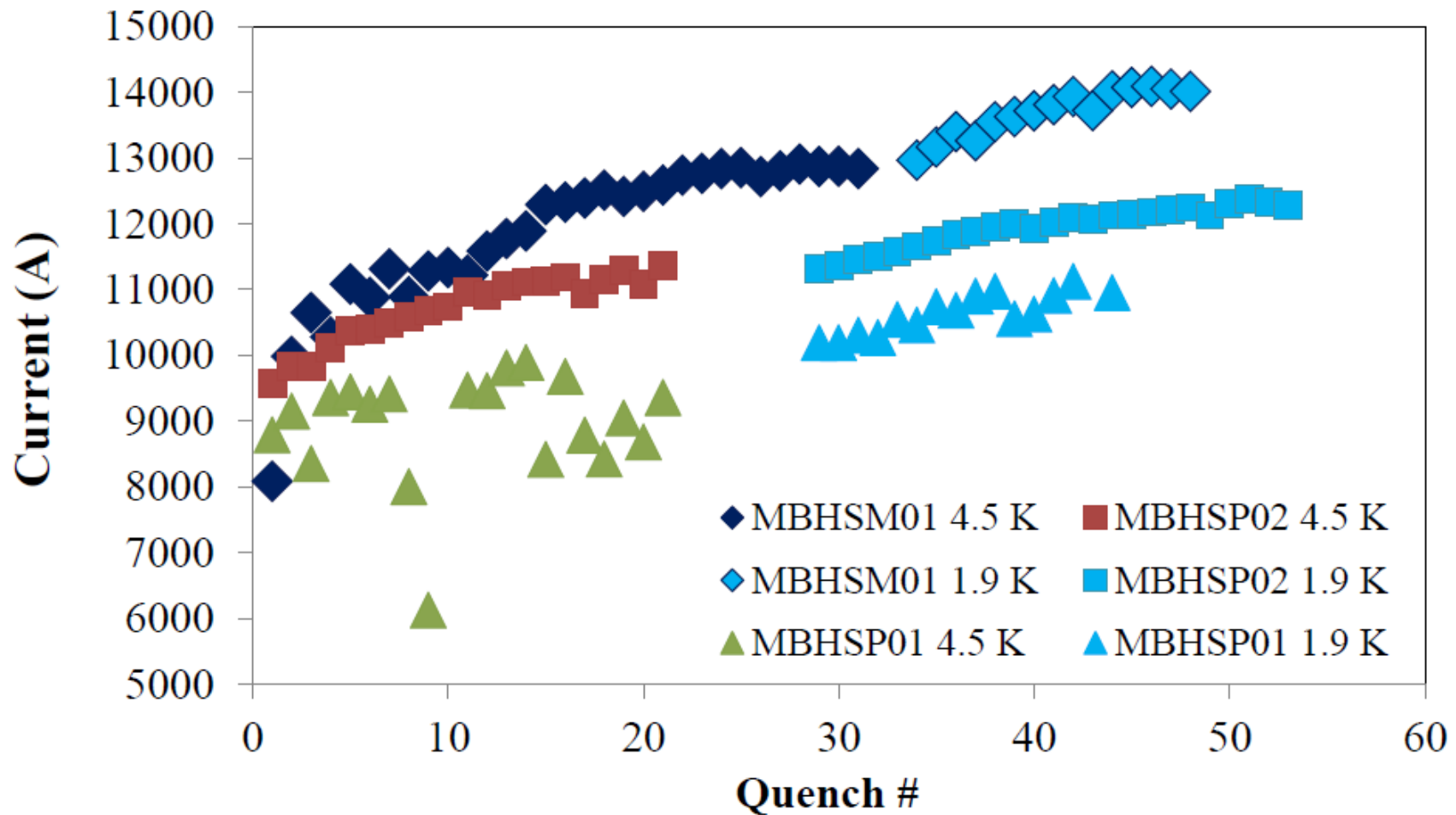


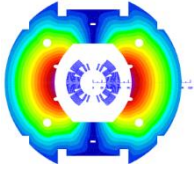
MBHSP01/02 showed so called “holding quenches”, when magnet is quenching at fixed current after holding it for a certain time





MBHSM01 Test Results





Summary/Test Status



Currently MBHSM01 test in progress. Quench training and ramp rate studies completed both at 4.5 K and 1.9 K

The magnet reached ~ 13 kA or (92-100)% of SSL at 4.5 K and 14.1 kA or (89-97)% of SSL at 1.9 K

No spontaneous quench observed when “holding” 12 kA at 4.5 K or 13 kA at 1.9 K for ~ 21 minutes

Temperature dependence of the quench current shows similar minor degradation at all temperatures

Next step is quench protection study and comprehensive analysis of data