4LP1-10

Design and Testing of a Demonstration HTS diploe Magnet at 77 K

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ABSTRACT

A demonstration high temperature superconducting (HTS) dipole magnet was designed, built and tested. This demonstration magnet was mainly constructed by two double-pancake (DP) racetrack coils installed with two E-shape iron yokes. The demonstration magnet was tested under both DC and 7 Hz AC conditions at 77 K. The magnetic flux density in the 5 mm air gap reached 1.0 T when the operation current was 35 A, as is predicted by the FE simulation. The equivalent field ramping rate is expected to exceed 40 T/s. The ac loss of HTS coils were also measured and compared with the simulation results.

1. INTRODUCTION

Heavy-Ion Advanced Research Facility (HIAF) is a new project for heavy ion studies at Institute of Modern Physics, Chinese Academy of Science .The dipole magnet system of HIAF will use fast cycled superconducting magnets (a central maximal field of 2.25 T, field ramping rate of 2.25 T/s). The field ramping rate of our demonstration dipole magnet is expected to exceed 40 T/s, which is favorable for the heavy ion deflection in the circular accelerators of HIAF.

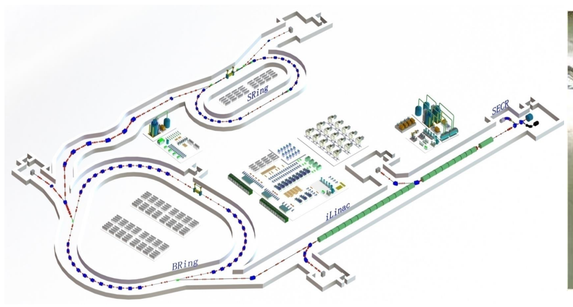


Fig.1 Vital components of HIAF.
Fig.2 The built LTS dipole magnet at IMP.

2. MAGNET DESIGN

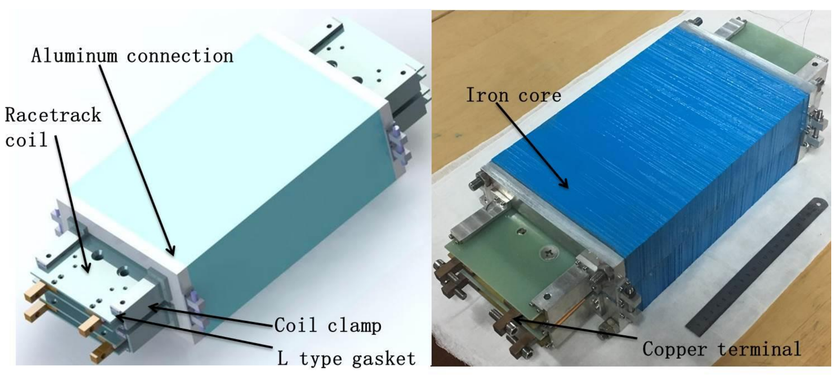


Fig.3 The assembly diagram of the dipole magnet.

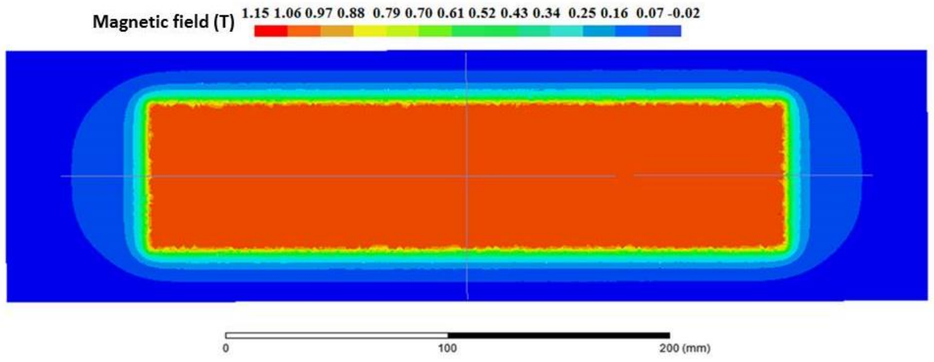


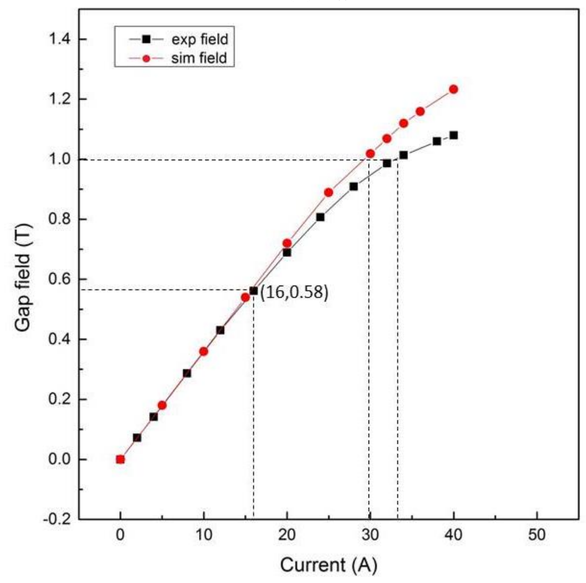
Fig.4 The uniformity of gap magnetic field.

PARAMETERS OF THE DIPOLE MAGNET

Parameter	value
Gap dimensions	77 mm x 290 mm x 5 mm
Iron core dimensions	290 mm x 180 mm x 110 mm
Gap field	1.02 T（under the 30-A-current ）
Field uniformity	60 mm x 274 mm，0.05%
Coil type	HTS double pancake racetrack coil
Working temperature	77 K
Designed critical current	46 A（under the 0.18 T vertical magnetic field）
Actual critical current	40 A
AC frequent	7 Hz
Designed/Tested field ramping rate	40 T/s (21.8 T/s)
HTS type length (turns)	DI-BSCCO H 64 m (72 turns) DI-BSCCO HT-SS 67 m (68 turns)

3. DC AND AC TESTS

A. DC test for gap field and coils' voltage



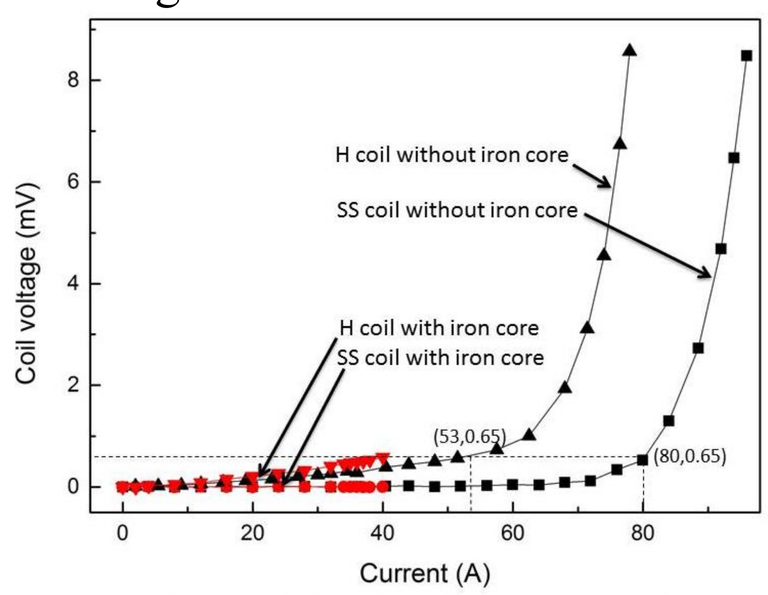
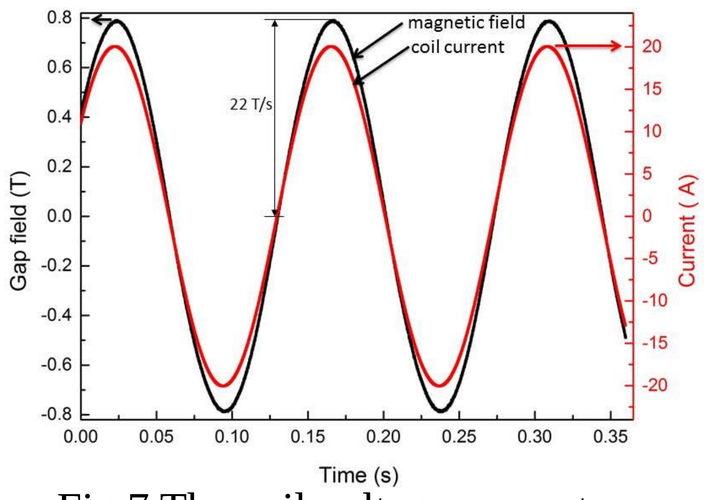


Fig.5 The simulation and experiment gap field of the dipole. The gap field can reach 1.0 T at around 34 A.
Fig.6 The coil voltage-current curve. The voltage of coils with iron core is higher than that without respectively. The entire maximum current of the magnet is around 40 A, lower than the critical currents (53 A / 80 A).

B. AC tests for gap magnetic field and AC loss without iron core



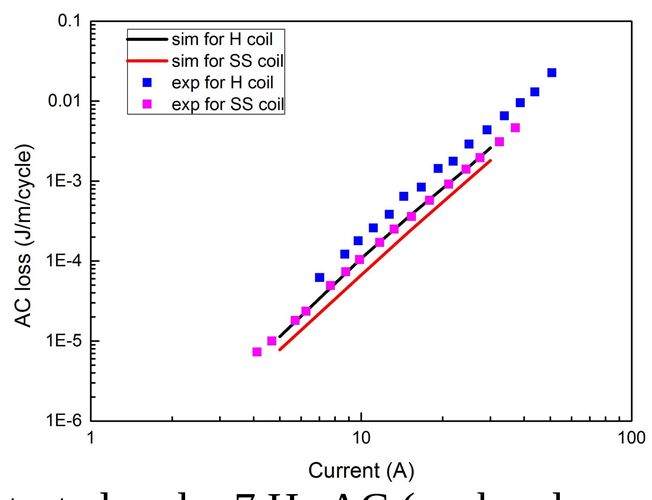


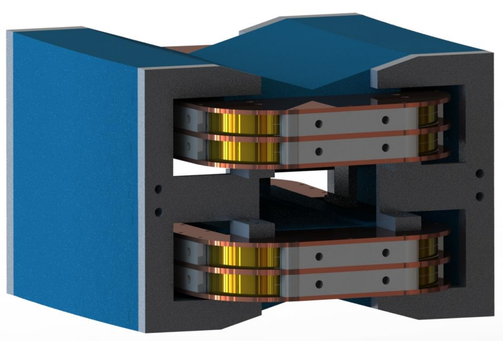
Fig.7 The coil voltage-current curve, tested under 7 Hz AC (peak value 20 A). The field ramping rate exceeds 21 T/s.
Fig.8 The AC loss of two racetrack coils. The H coil's loss is higher.

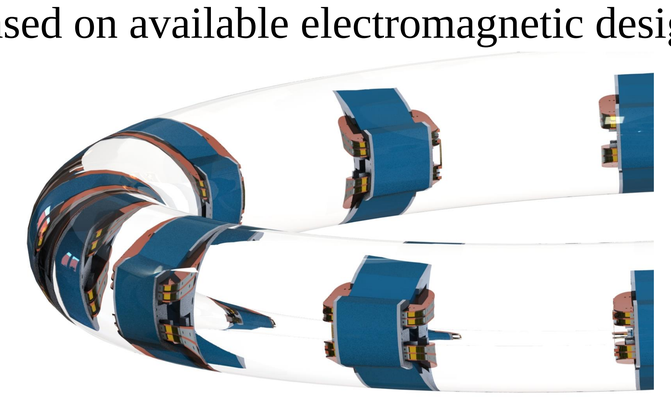
4. CONCLUSION

- A 1/10 scaled demonstration HTS dipole magnet was built and tested. The magnetic field reaches 1.0 T and the field ramping rate exceeds 22 T/s.
- Tested under 20 A/14 Hz AC, the H coil's AC loss is 0.7 W and the SS coil's is 0.47 W, which may result from the larger space between types of SS coil.

5. FUTURE WORK

- We have planned to design a kidney shaped HTS magnet for particle accelerator.
- We will make subsequent design based on available electromagnetic design.





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