

# Design and Test a ReBCO Conduction-Cooled Solenoid Magnet without Insulation

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## Background

The Circular Electron Positron Collider (CEPC) had released the Concept Design Report. A small HTS solenoid model magnet was necessary to be designed and tested to explore the feasibility of ReBCO tapes applied to CEPC detector magnet technology. The magnet adopted NI winding process and tested at 77 K and 20 K, respectively.

## Individual Test

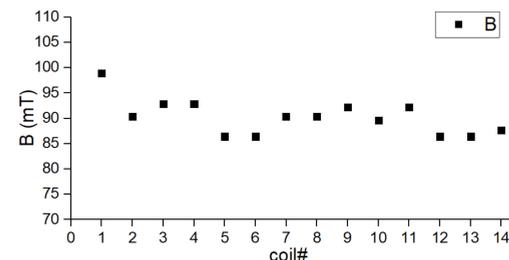
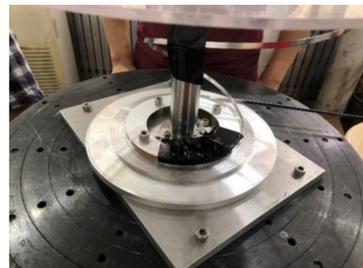


Fig. 1 Winding double pancake coils and The magnetic characteristics of 14 coils.

Sn42Bi58 solder was adopted. The results of the excitation characteristics of the different double pancake coils were carried out in the axial assembly of the magnets. The coils with better performance were placed at the ends, and the coils of the lower ones were placed in the middle, which could improve the utilization of each coil. The order of the coil from top to bottom was 1, 3, 7, 2, 14, 5, 6, 13, 12, 10, 8, 9, 11 and 4.

## Coils assembly

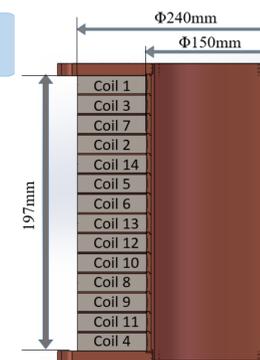
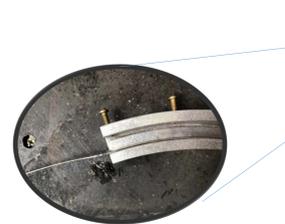


Fig. 2 Joints preparation and coils cross section...  
The resistance of coils could be between  $10\text{e-}7\sim 10\text{e-}8$ .

## Liquid Nitrogen Experiment

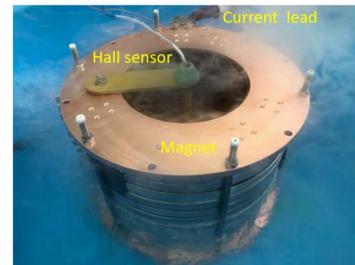
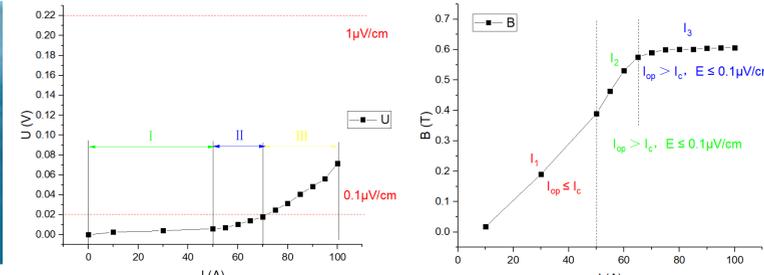
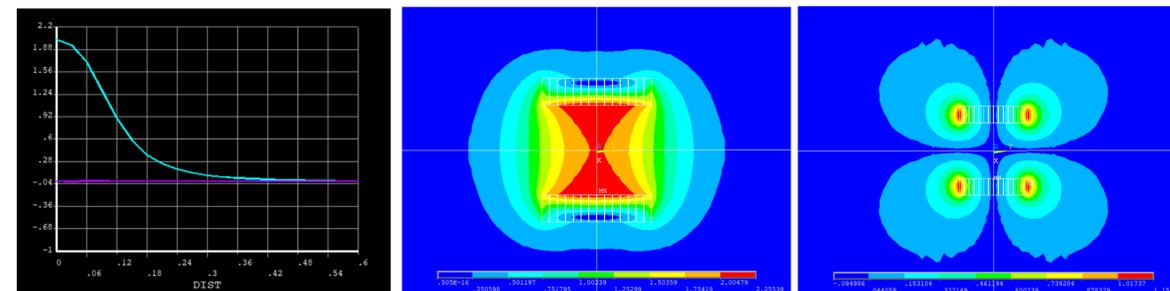


Fig. 3 Coil testing at 77 K



The experiment adopted four-lead method to test magnet, and All of the coils were immersing in a bath of liquid nitrogen at 77 K. The coils were tested by manual power supply, and a vertical hall sensor was placed at the center of the coil to measure the central magnetic field. The  $0.1 \mu\text{V}/\text{cm}$  quench criterion is more suitable. The coil generates a 0.604 T magnetic field, and the corresponding critical current is 41A, which is basically the similar as  $I_c$  (41.9A) of the coil. The delay of I-B characteristic curve is mainly due to NI winding process.

## Conduction- Cooled Experiment



Furthermore, it would be tested on the prototype to investigate the properties of the magnet at 20 K. The magnet adopted a conduction-cooled method by a GM cryocooler. The central field of the magnet would be 2 T.

## Magnet assembly



The magnet was hoisted under the GM cryocooler through 3 titanium alloy rods. The experiment was carried out in Dewar. There was a 40K thermal shielding. The axial direction of the coil was tightened with a titanium alloy rod, and the aluminum tape was tied tightly in the radial direction. A HTS tape was soldered in parallel with the end of the coil in order to reinforce the tape. 12 copper conduction cooling belt were uniformly distributed. 6 CERNOX thermometers were placed at different parts of coils. High-purity oxygen-free copper was adopted as the coil frame, which was formed by axial splicing. A copper bobbin was placed in the center in order to keep the radial position. The end part was adopted by copper end plate, and each two adjacent double pancake adopted 1 mm copper plate for conduction cooling.

Vacuum	$0.3 \times 10^{-5}\text{Pa}$
Temperature at coil	21 K
Temperature at endplate	18 K
Temperature at current lead	34 K

## Results and Conclusion

The magnetic field at 77 K was 0.604T which was similar with  $I_c$  (41.9A) and theory calculation.  
The magnetic field at 20 K was still testing in the laboratory.