PROGRESS OF HTS MAGNET TECHNOLOGY DEVELOPMENT FOR THE NEXT GENERATION FUSION DEVICE AT ASIPP

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High magnetic field is one of the important conditions required for nuclear fusion device using magnetic confinement method to shape and maintain the high temperature plasma within the tokamak vessel. Superconducting magnets for fusion reactors which has been established or under construction are all based on Low temperature superconducting (LTS), which are limited operation under a maximum magnetic field lower than 15 T. Therefore, attentions are moved to high temperature superconductor (HTS) magnet technology development, the aim is to fulfil the critical operation conditions of carrying a current of 46.5 kA under a peak magnetic field of around 20 T, as shown in Fig. 1, which is required for the hybrid central solenoid coil (CS) of the next generation fusion device. The design of the HTS CS coil is currently being completed, it includes 6 modules which are expected to be manufactured based on the REBCO cable in conduit conductors (CICC). To develop and verify the REBCO CICC coil technology, two pairs of CICC samples have been manufactured and tested at Sultan lab, the stable transport current was increased from 47 kA to 80 kA at 10.85 T, 4.5 K based on the design and manufacture technology optimization. The CICC uses 288 tapes wound into six strengthened sub-cables, making it capable of having a current sharing temperature, T_{cs}, of around 39 K when operated with a current of 40 kA under 10.85 T. Scaled to 20 T peak field and 46.5 kA transport current, this provides a temperature margin of over 10 K with respect to an operating temperature of 5 K.

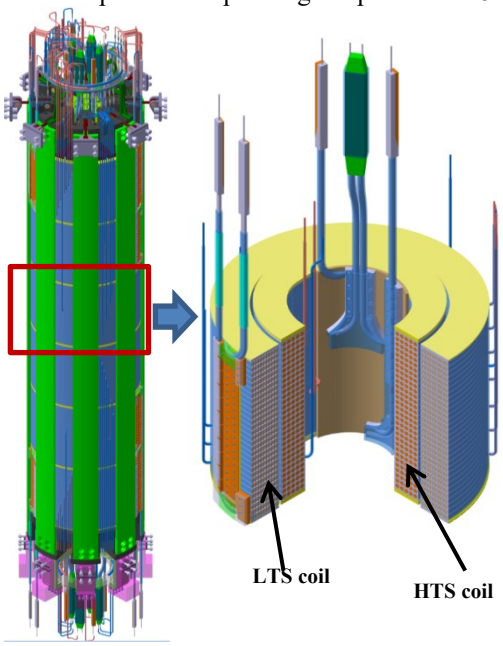

Fig. 1 Schematic of the designed hybrid CS coil for the next generation of fusion device at ASIPP

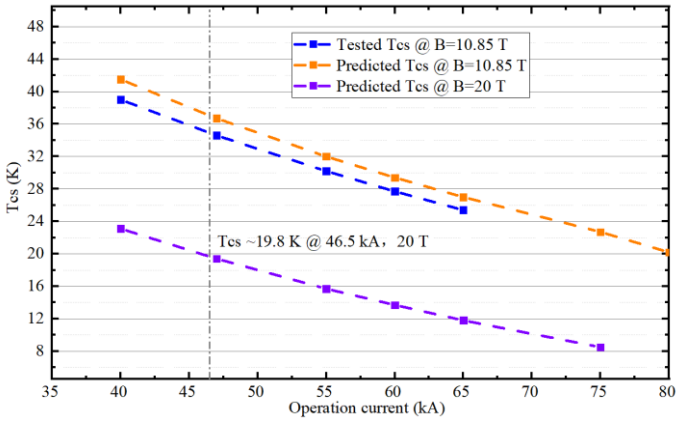

Fig.2 The tested and predicted *Tc*s of the HTS CICC under different operation conditions

Then, a long length REBCO CICC production line was designed and built, hundreds meter long verification conductor sample was manufactured, samples were sectioned after every critical step and tested at 77 K self-field. Due to the space limitation, another critical condition is the small three dimensional bending radius required for the coil winding. Kinds of methods have been tried to overcome the deformation and performance was also verified at 77 K and self-field. Now, long length conductors with lengths of around 250 m and 350 m are being manufactured, which shall be connected by a joint as shown in Fig.1 for a CS module manufacture. The coil shall be tested at 77 K and inserted into a low temperature superconductor coil for operation performance testing before mass production, all these work shall be finished this year. Technologies including but not limited to the REBCO CICC, coil winding, low resistance joint design and manufacture are under development and the progress shall be reported here.

Fig. 3 Long length REBCO CICC manufacture