Cable R&D Program for 14 T MRI

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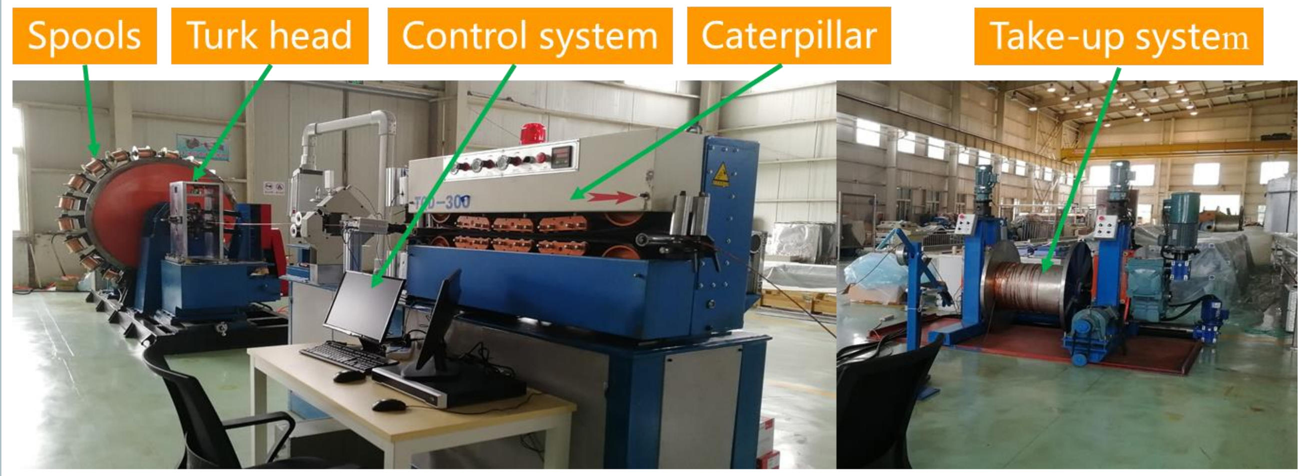
1. Introduction

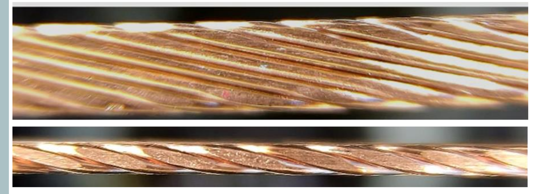
Whole body ultra-magnetic field 14 T magnetic resonance imaging (MRI) magnet is now under design at Institute of Plasma Physics, Chinese Academy of Sciences, the main coil based on the preliminary designed of Nb_3Sn Rutherford cable in Channel Conductor (RICC). Rutherford cable is a core components of the conductor. During the fabrication process of Rutherford cable, the strands were subject to server deformation, these deformation can result in significant reduction of the critical current and the Residual Resistivity Ration (RRR). A Rutherford cabling machine has been purchased which consists of 20 spools, Turks head, caterpillar, and take-up facility. Rectangular cables without a stainless steel core were developed and four types of mixed cable using 1.0 mm Nb_3Sn strand and copper strand were fabricated. Two measurements method were adopt to evaluate the critical current degradation after cabling. The first one is to measure the critical current of the strands extracted from the cable, the second method is to measure the performance of the cable. In this paper, the results of measurements of critical current are presented.

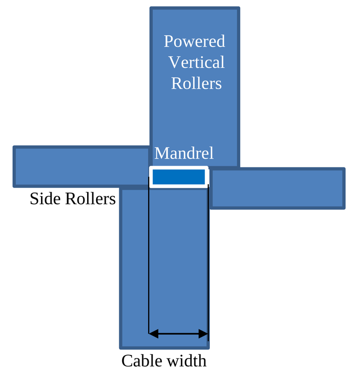
2. Experiment

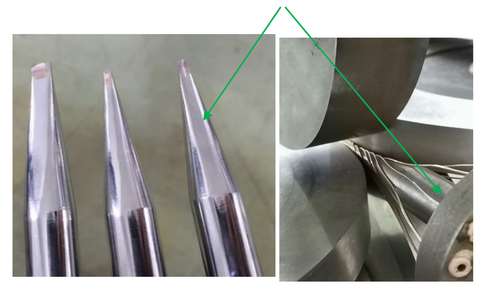
☐ Rutherford cabling machine



- 20 spools cabling machine with passive regulation of strand tension
- Continuous pitch regulation with electronic synchronization of the main wheel and the caterpillar motion
- Single stage process: cable dimension given at Turk head
- Continuous measurement of cable size using a laser instrument
- Max speed: 3m/min
- Rectangular able without core







☐ Fabrication of Nb_3Sn Rutherford Cable

Item	Cable-1	Cable-2	Cable-3	Cable-4
Strand diameter [mm]	1.0			
Stack design	54			
Cabling pattern	4Sc+6Cu			
Cable width, mm	5.1	5.3	5.5	5.7
Cable thickness, mm	1.9			
transposition angle, °C	14.66	15.21	15.76	16.30
Pitch length, mm	39.0			
Packing factor, %	83.76	80.80	78.05	75.53

The ratio of the twisting cage rotation speed *w* with the forming speed *v* was the same which can make the pitch length of the cable were the same.

$$L_p = v/w_c$$

v: forming speed, m/min
w_c: the twisting cage rotation speed, RPM
L_p: the pitch length, m

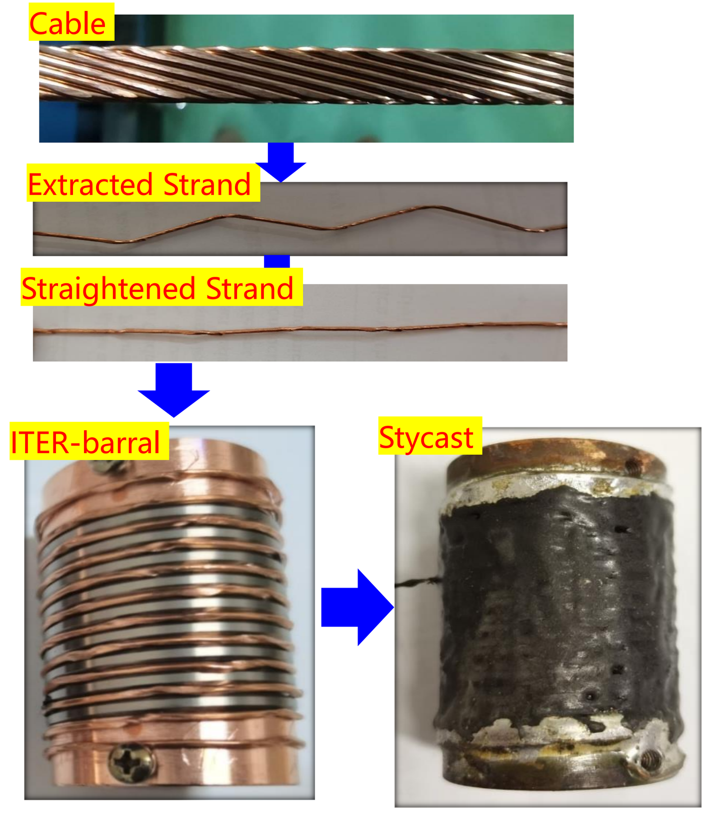
$$PF \cong \frac{\pi N \cdot D^2}{4 \cdot (w \cdot t) \cdot \cos\theta}$$

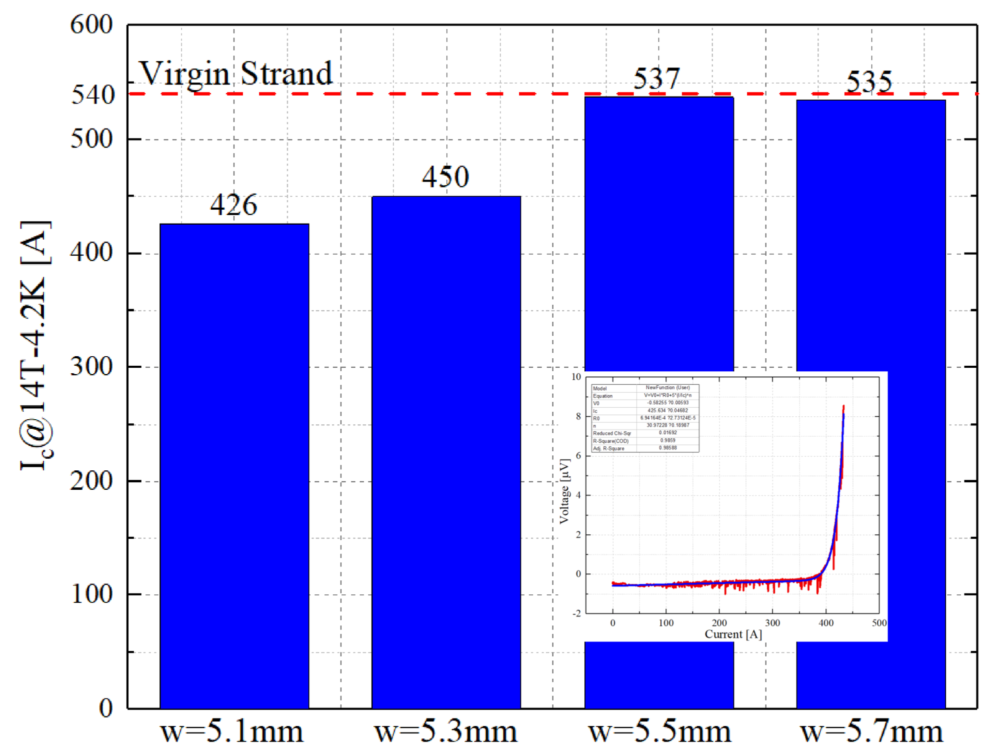
N: Number of strands
D: Diameter of strand
w: Cable width
t: Cable thickness
θ: Transposition angle

3. Results

☐ Method 1

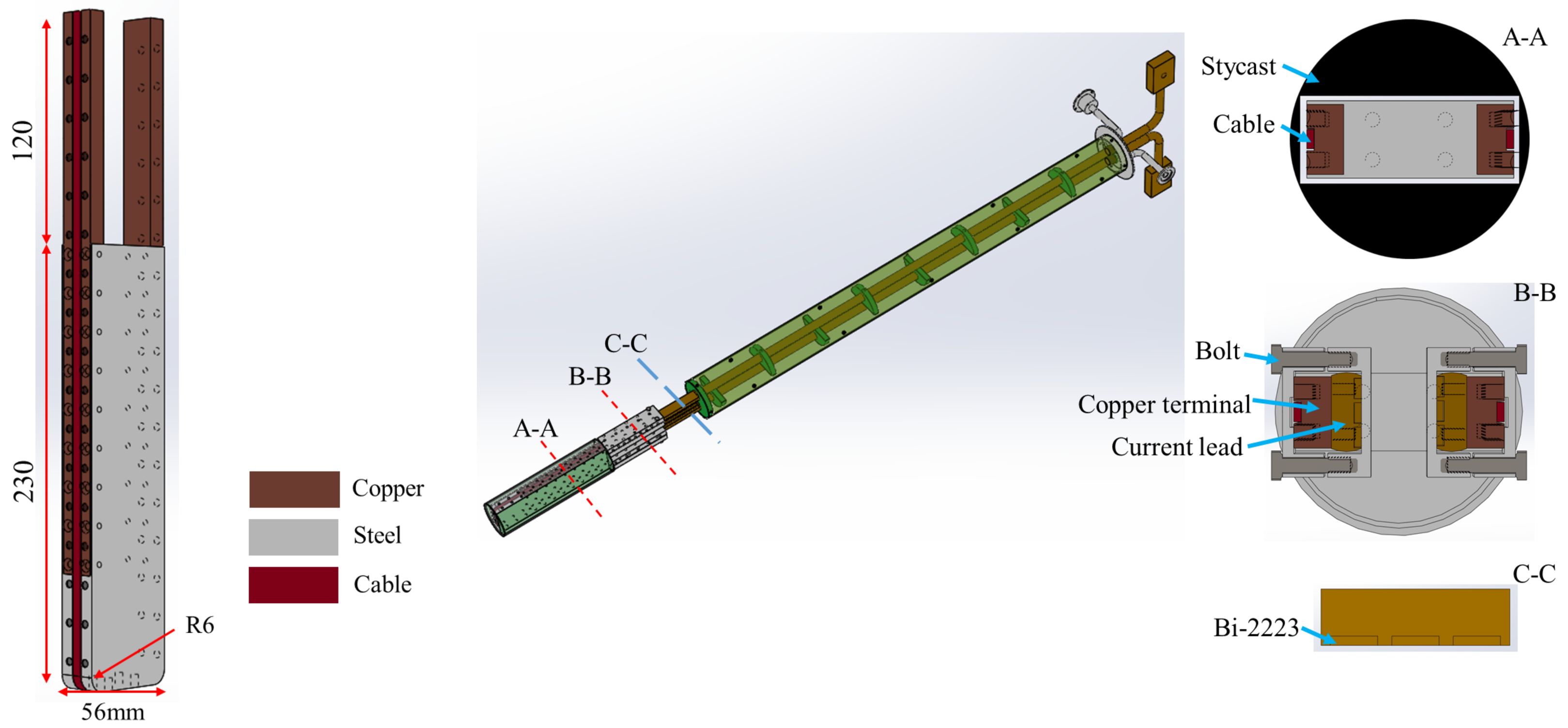
Method 1 is to measure the critical current of the strand extracted from the cable.

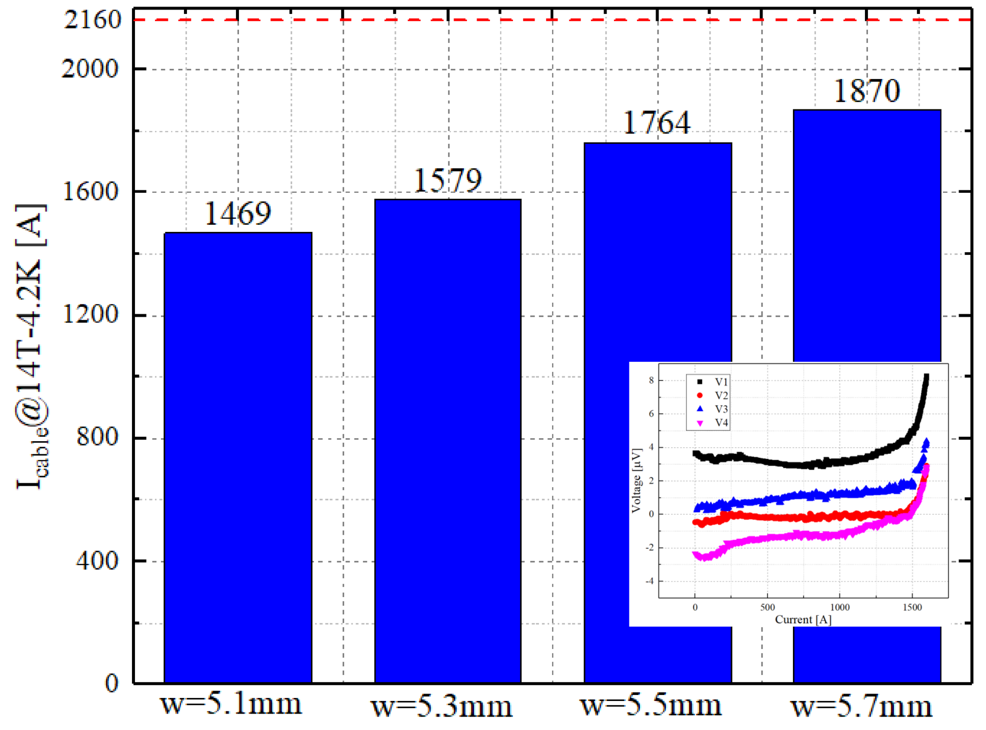




☐ Method 2

Method 2 is to measure the critical current of the cable. The cable is bent onto the U-shaped mold.





- The strand performance didn’t degradation when the width of the cable is 5.5 mm and 5.7 mm；
- The cable performance is lower than the expected value which is extrapolate by the results of the strands.

4. Conclusions

Nb_3Sn Rutherford cable is core component for 14 T MRI. A Rutherford cabling machine was purchased and cabling technology was also mastered. Four mixed Nb_3Sn Rutherford cable was fabricated by this machine. Two method was adopted to evaluate the performance of the cable. The result measured by first method show that the performance of the strand extracted from the cable have no degradation when the width of the cable is 5.5 mm and 5.7 mm, while the performance of the cable is lower than the expected value. Self field, thermal strain, cabling damage can cause the cable performance lower than expected value.