Poster: 4LP3-09

Design and Test of a double pancake coil wound by HTS Roebel cable

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Introduction

When the HTS SMES system charges or discharges current rapidly, it may have two problems:

1. Numerous magnet turns number
2. Current and Magnetic field distribution among conductors

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1. Large induced E.M.F.
2. Large superconducting AC loss

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1. Insulation breakdown
2. Thermal quench

To solve these two problem, the probable solution is: **HTS Roebel cable**

1. Conductors in parallel
2. Conductors transpose position regularly

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1. Reduce number of magnet turns
2. Averaging magnetic environment on different conductors

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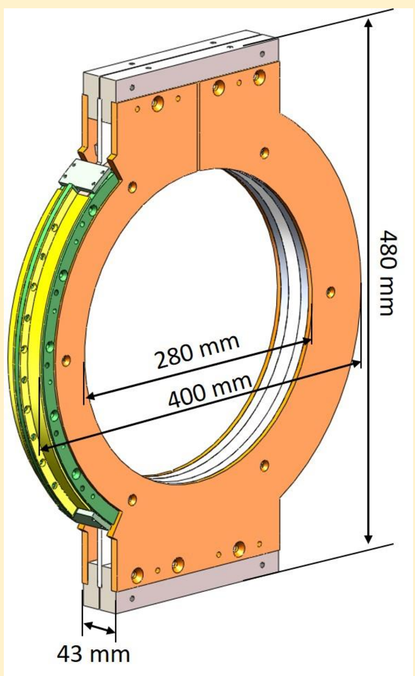
1. Lower inductance
2. Lower AC loss

In this work, a HTS Roebel cable double-pancake coil module was manufactured and its I_c was measured at 77 K.
This coil module was designed for toroidal SMES using conduction cooling method.

Coil General Parameter

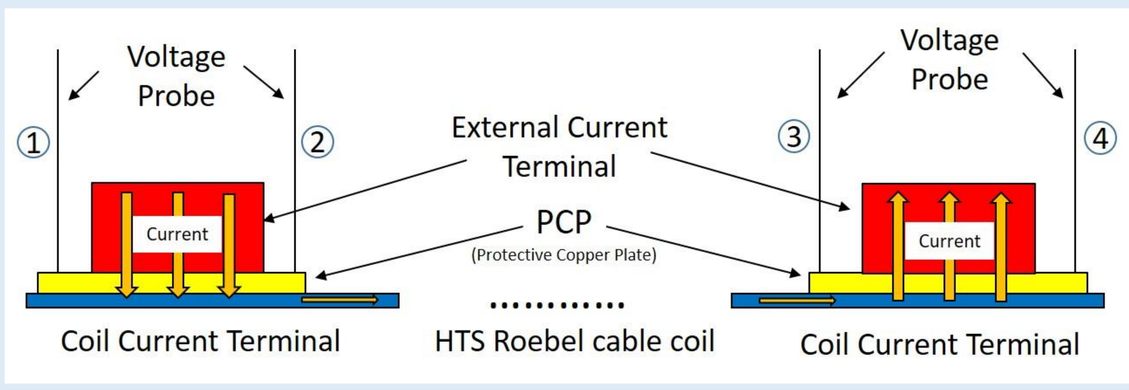
Parameter \ Item	Value \ Statement
Coil Type	Double Pancake
Total length of cable	< 10 m
HTS material	ReBCO (Fujikura, Japan)
Number of cable Strands	10
Transposition Length of Roebel Cable	300 mm
Trun number of coil	8
Inner Diameter of winiding	340 mm

This Roebel cable was manufactured by General Cable Superconductor, Ltd, New Zealand.



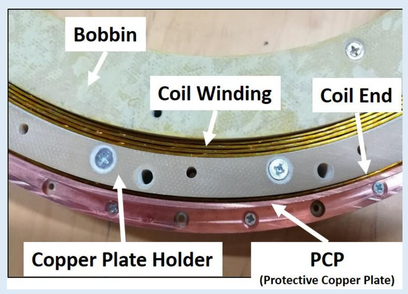
Coil Dimension

Current Terminal: PCP (Protective Copper Plate)



PCP Dimension:
as long as Roebel cable transposition length for ensuring good contact with every strand

PCP merits:
1. Protect the ReBCO layer when need soldering to external current source
2. Make current distribution homogeneous



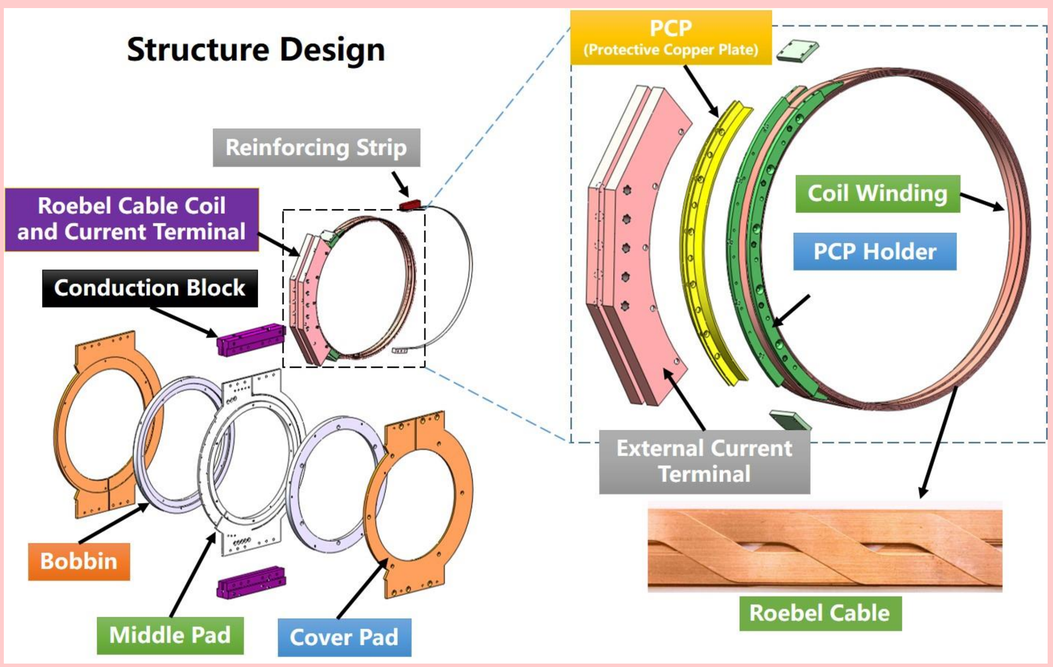
PCP position picture

Ideal additional resistance of coil due to PCP（Soldering material: 60Sn-40Pb）

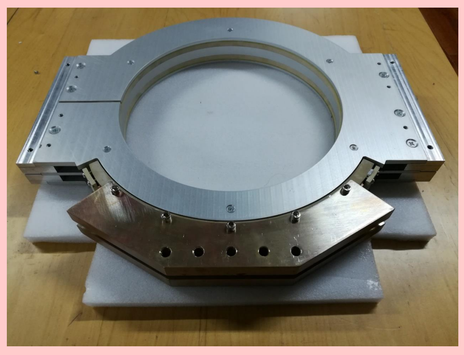
77 K: [2.2 nΩ (solder layer) + 4.2 nΩ (PCP)] ×2 = 12.4 nΩ
20 K: [0.3 nΩ (solder layer) + 0.34 nΩ (PCP)] ×2 = 1.28 nΩ

One coil has two PCPs

Structure Design Detail

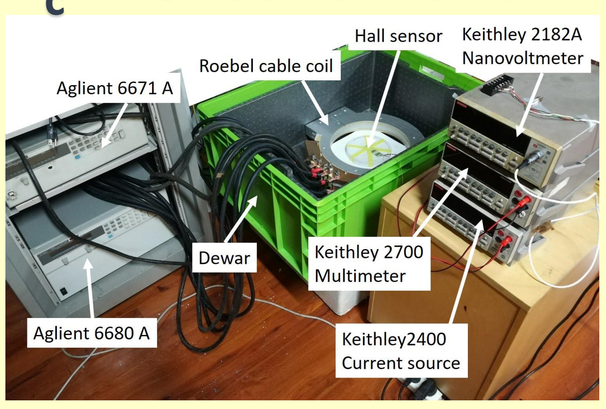


Bobbin & PCP Holder: *epoxy resin for insulation*
Middle & Cover Pad: *Al alloy for cooling conduction; carve slots to avoid eddy current*
Conduction Block: *Al alloy, for supporting and cooling conduction*
Reinforcing Strip: *stainless steel, for reinforcing the coil winding strength*
Impregnation: *paraffin wax, avoid delamination and maintain thermal contact between conductors*



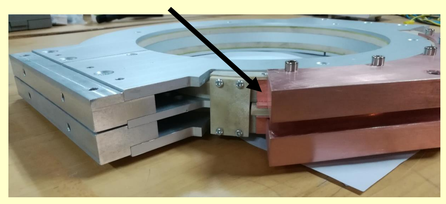
Coil picture

I_c Measurement

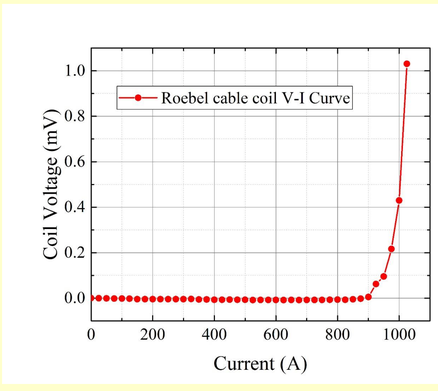


Measurement Instruments

Voltage Probe soldered on PCP

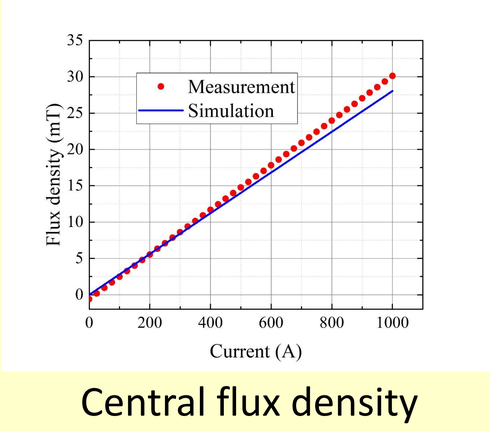


Probe 2 & 3 were chosen for four-probe measurement (as shown in above segment)



I_c measurement result

The Roebel cable coil I_c : **1025 A**
(77 K, self field, 1 μV/cm criteria)



Central flux density

The PCP has little interference on I_c measurement

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