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Development of Al-stabilized superconductor

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Outline

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2. Background
3. Rutherford cable
4. Al-stabilized superconductor
5. Summary

Company Profile

Toly Electric

金杯电工 GOLD CUP ELECTRIC

统力电工 TOLY ELECTRIC

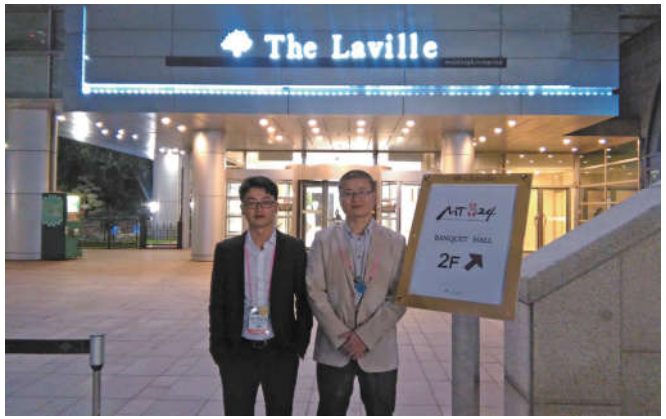
- Wuxi Toly Electric Works Co.,Ltd was established in 1992
- Application areas: power equipment, new energy, superconducting magnet

Background

Toly& WST

Toly& Hyper Tech

Toly& IHEP



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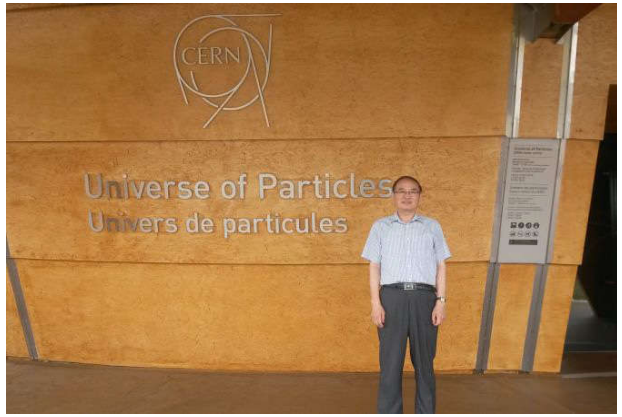


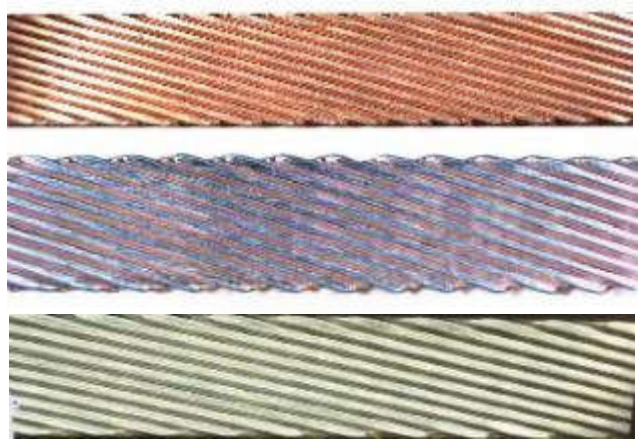
CERN

HTS magnet committee

Rutherford cable

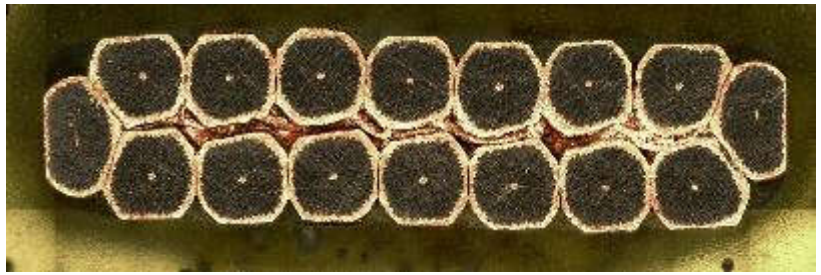
Features

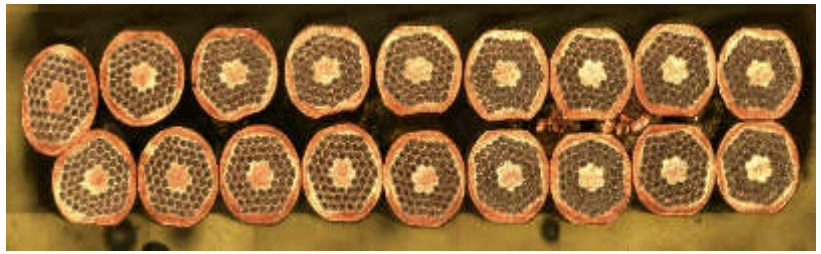
- High filling factor
- High Jc
- High mechanical strength



Parameter design

- Number of strands/wire diameter
- Pitch/twisting angle
- Filling factor

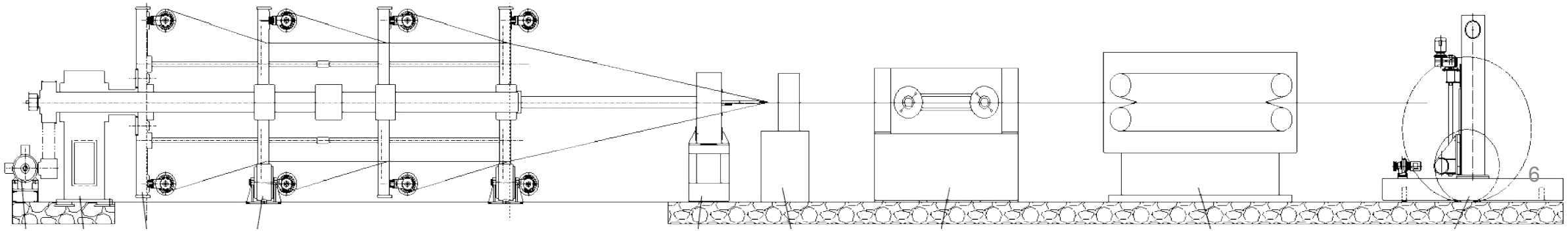




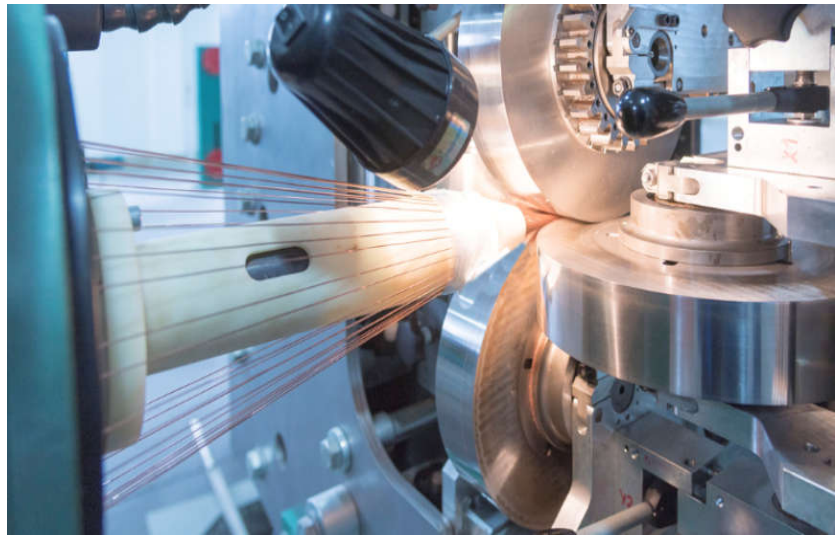
Rutherford cable


machine

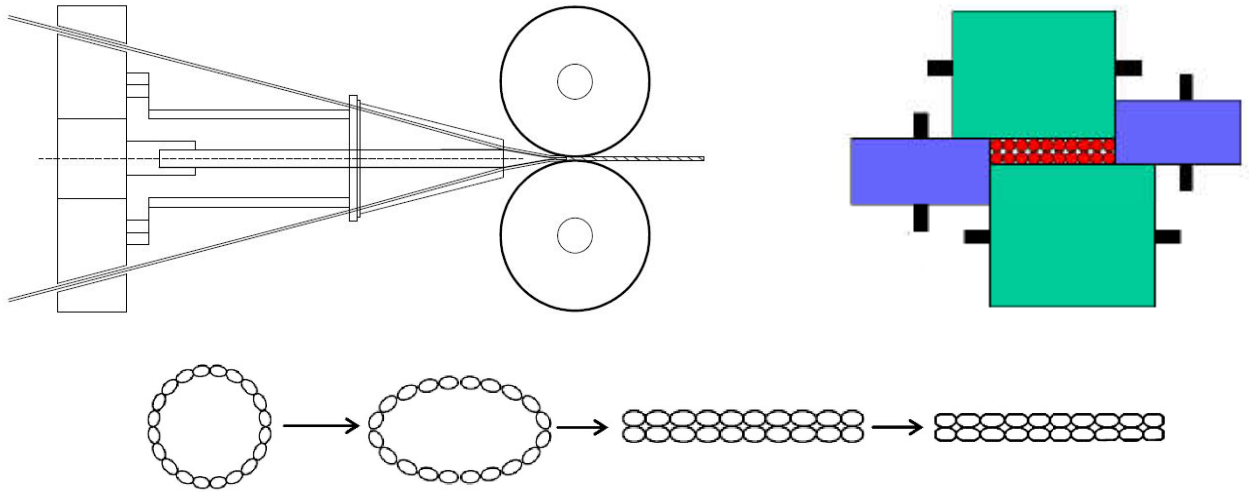
Items	Value
Wire numbers	12×4=48
Diameter	φ0.5~1.5mm
Wire tension	0~40N
The speed of rotary movement	12.5rpm
The speed of production	0~10m/min



Rutherford cable



Rolling head



Change in cross section of cable

- The processing technology：
  - Twisting
  - Shaping
- The main mould：
  - Mandrel
  - Rolling head

Al-stabilized superconductor

Pre-processing equipment

Extrusion machine

Parameter	Extrusion wheel diameter/mm	Rod diameter/mm	Cable thickness/mm	Cable width/mm
Value	400	2*9.5~12	3.0~30.0	10.0~70.0

Al-stabilized superconductor

Al rods/cable releaser

Ultrasonic cleaning

Extrusion machine

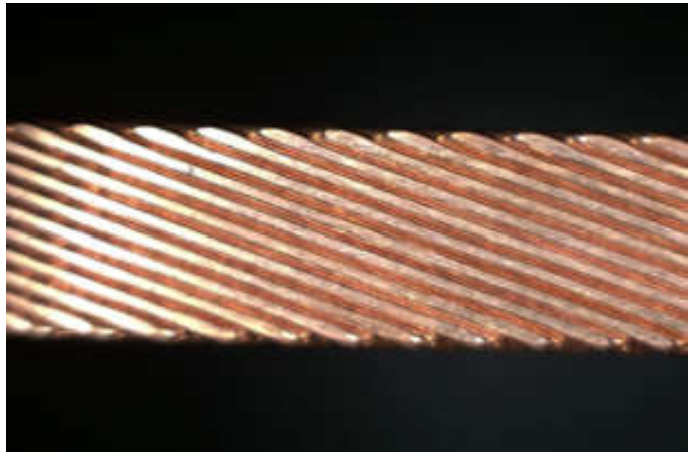
Cooling system

Caterpillar tractor

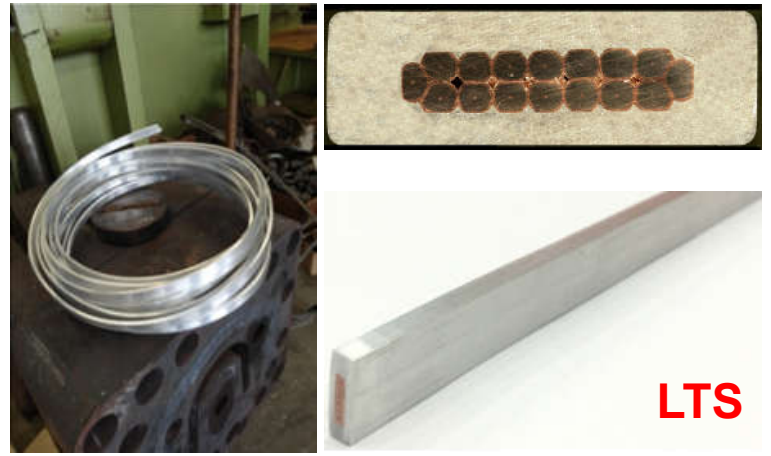
Take-up machine

Al-stabilized superconductor

NbTi strand

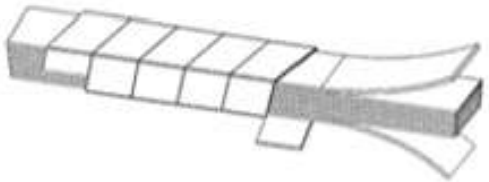


Rutherford cable

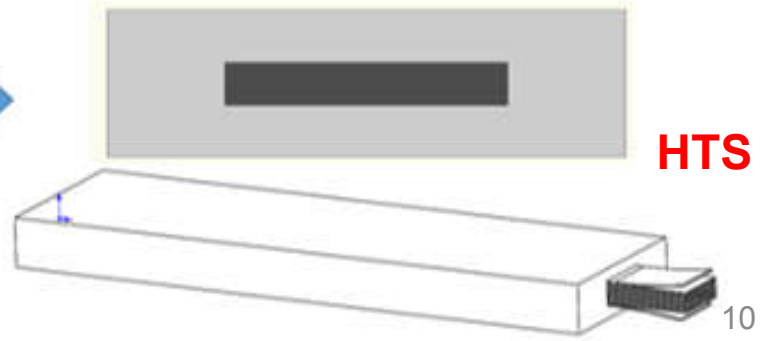


Al-stabilized NbTi/Cu superconductor

ReBCO tape

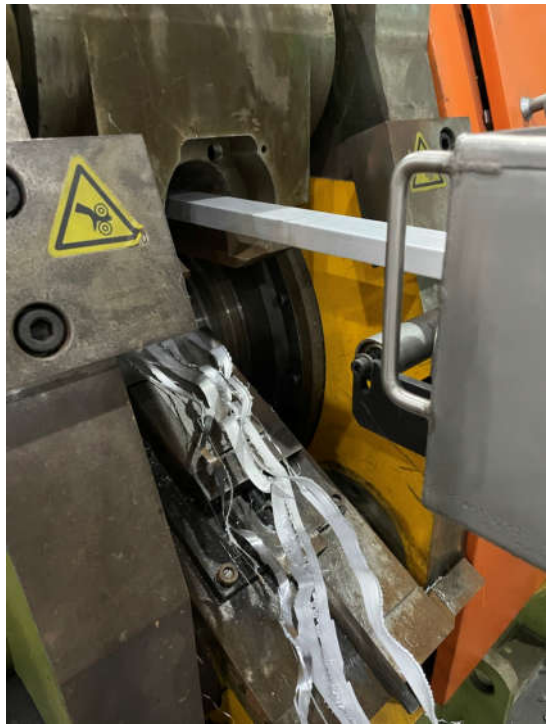


ReBCO Stack Cable



Al-stabilized ReBCO Stacked tape cable

Dummy cable for CEPC detector magnet



☐ The production of dummy cable

- Dimensions
- Surface quality
- Mechanical properties

Key process control: the mechanical strength of the aluminum rod, the rotation speed of the extrusion wheel, the preheating temperature of the cavity mold, the gap between extrusion wheel and mold.

Al-stabilized superconductor for CEPC detector magnet

☐ The process of secondary extrusion

- The first time with high-purity aluminum：10*33mm
- The second time with aluminum alloy：22*56mm

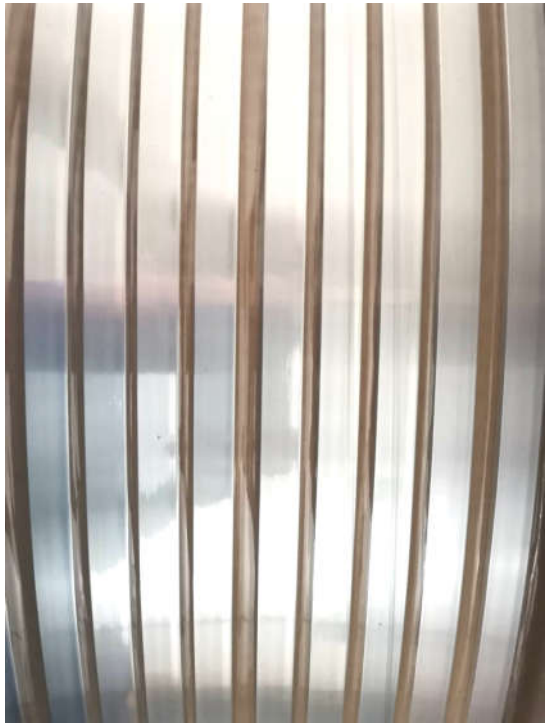
☐ Doped aluminum alloy materials

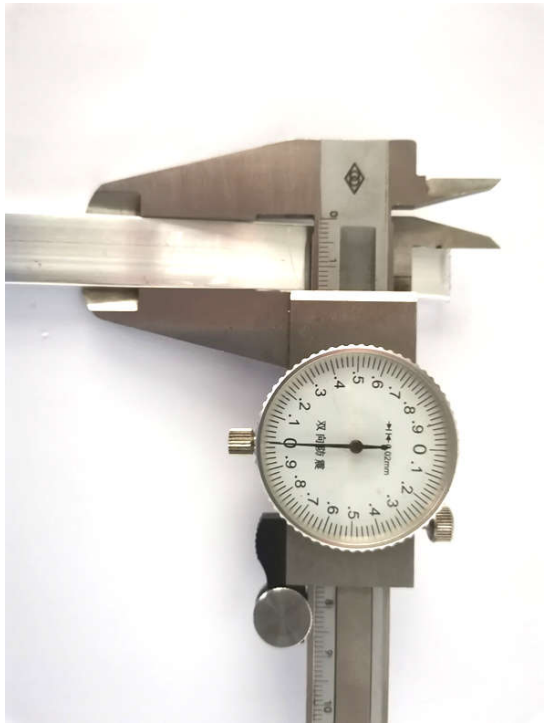
- Goals: high mechanical strength, high RRR value

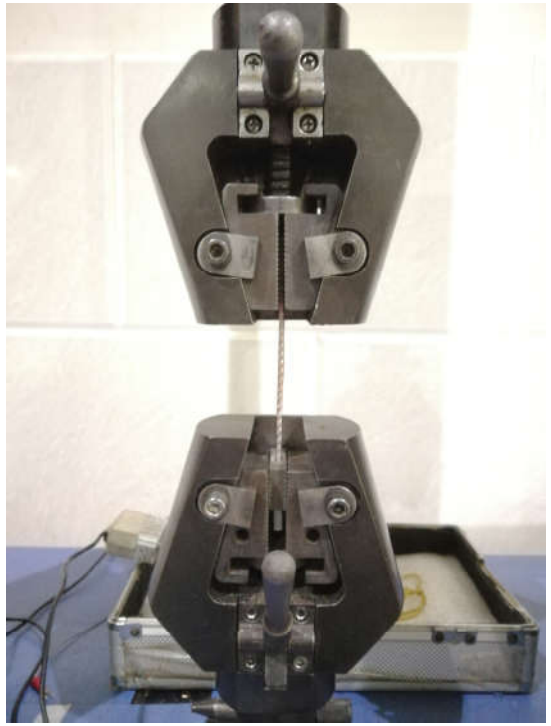
Al-stabilized superconductor for the Emus project

- Kilometer length al-stabilized superconductor
  - Length:1490m,1517m,1550m
  - Dimension：4.7*15mm

Al-stabilized superconductor for the Emus project





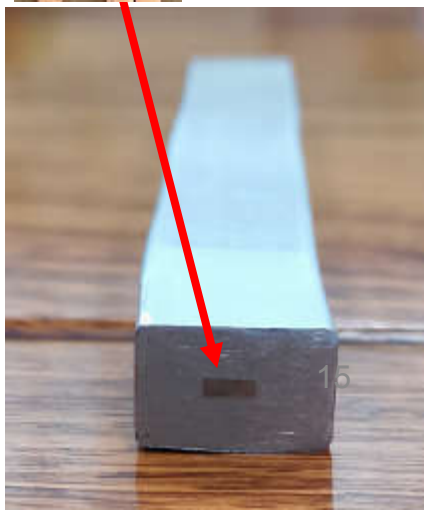


- Test result：
  - Yield strength：159MPa
  - Shear strength：36MPa

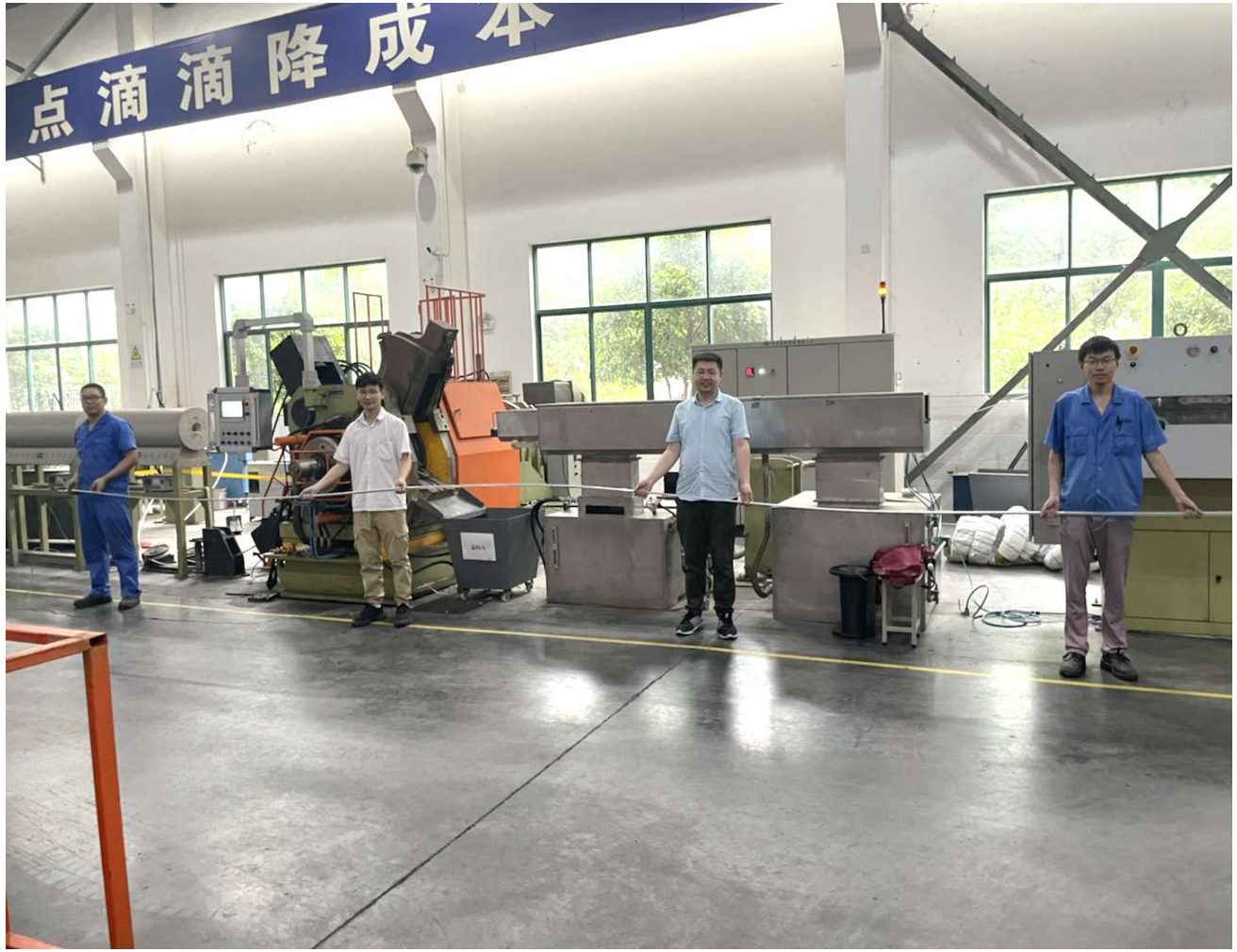
Al-stabilized superconductor for CEPC detector magnet （HTS）

The process of ReBCO Stack Cable

The process of Al-stabilized ReBCO Stacked tape cable



Al-stabilized superconductor for CEPC detector magnet （HTS）

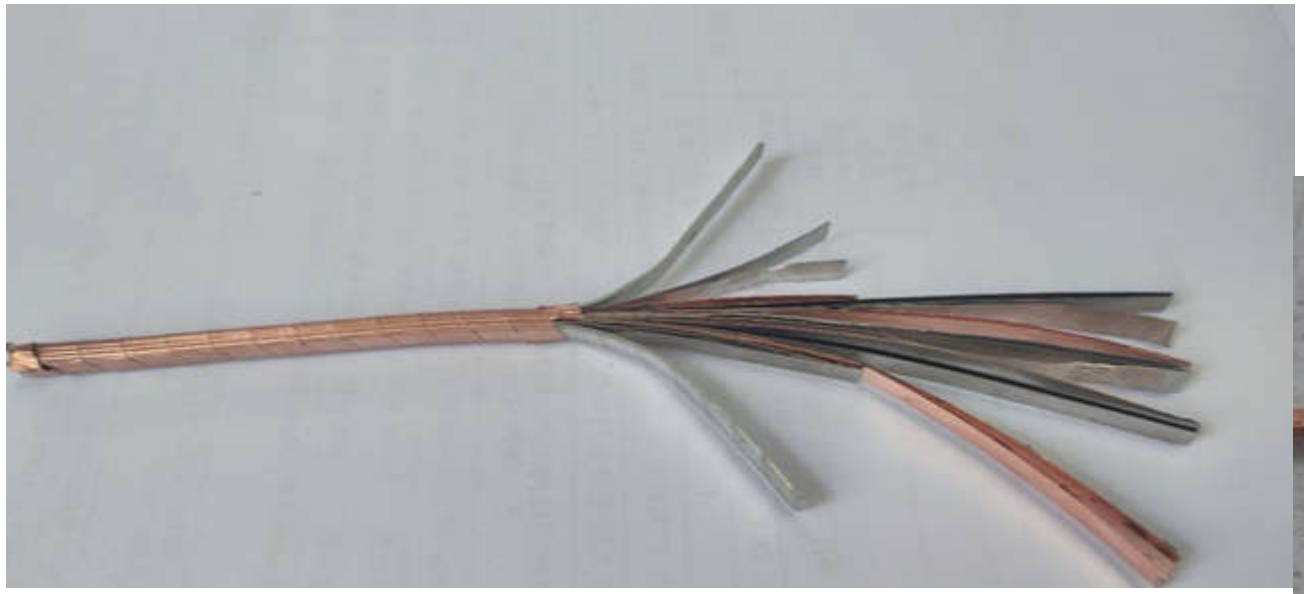


☐ Short Al-stabilized ReBCO Stacked tape cable

- Tensile strength of aluminum rod ： 60MPa
- Temperature of the cavity mold ： 500℃

Problems： the core cable is not centered, and the contact time during high temperature procedure is too long

Al-stabilized superconductor for CEPC detector magnet （HTS）



Short ReBCO Stack Cable

Short Al-stabilized ReBCO Stacked tape cable

- We have carried out the production of short cable for many times……
- We will make long cable in the next three months

Summary

- Toly Electric is participating in several pre-research projects of CEPC, mainly responsible for the fabrication of superconducting cables.
- We have found some difficulties and problems in the R&D .We are working hard to find new solutions.
- In the future, the group will increase budget for the R&D of Al-stabilized superconductor.

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Thanks for your attention!