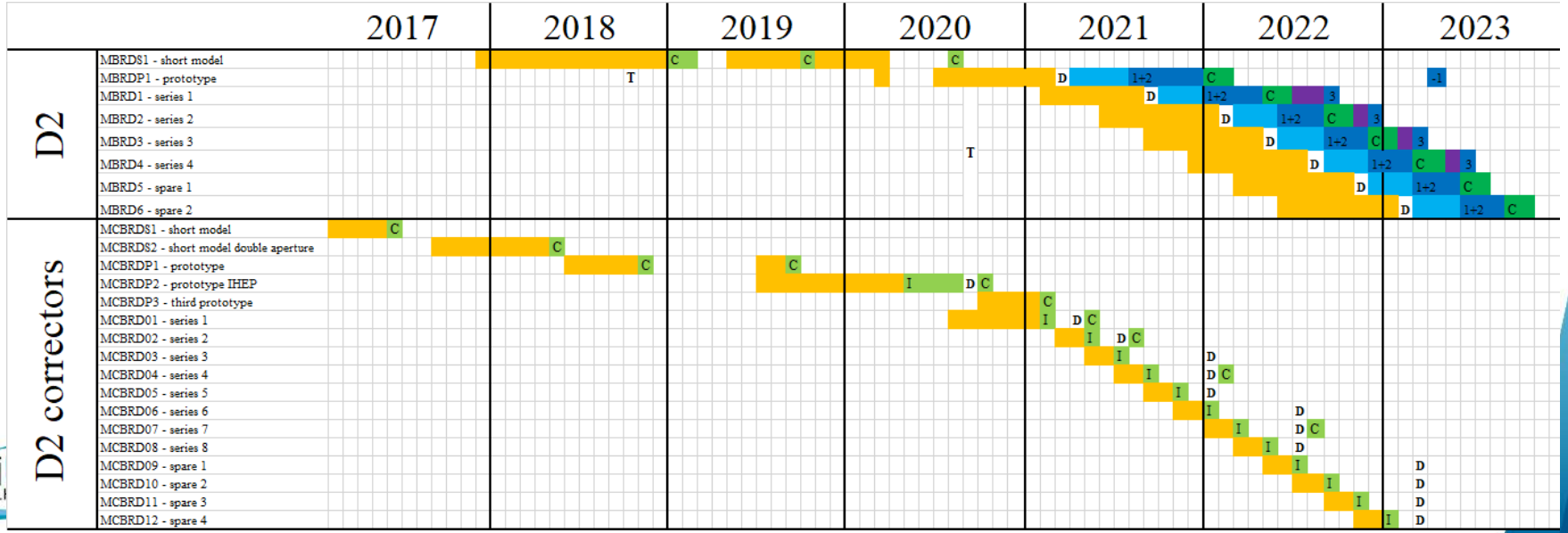
Progress of the HL-LHC CCT magnets in China

CCT Magnet Chinese Team
(IHEP, IMP, BAMA)

HL-LHC WP3 meeting – Nov 3 2020

Present Schedule

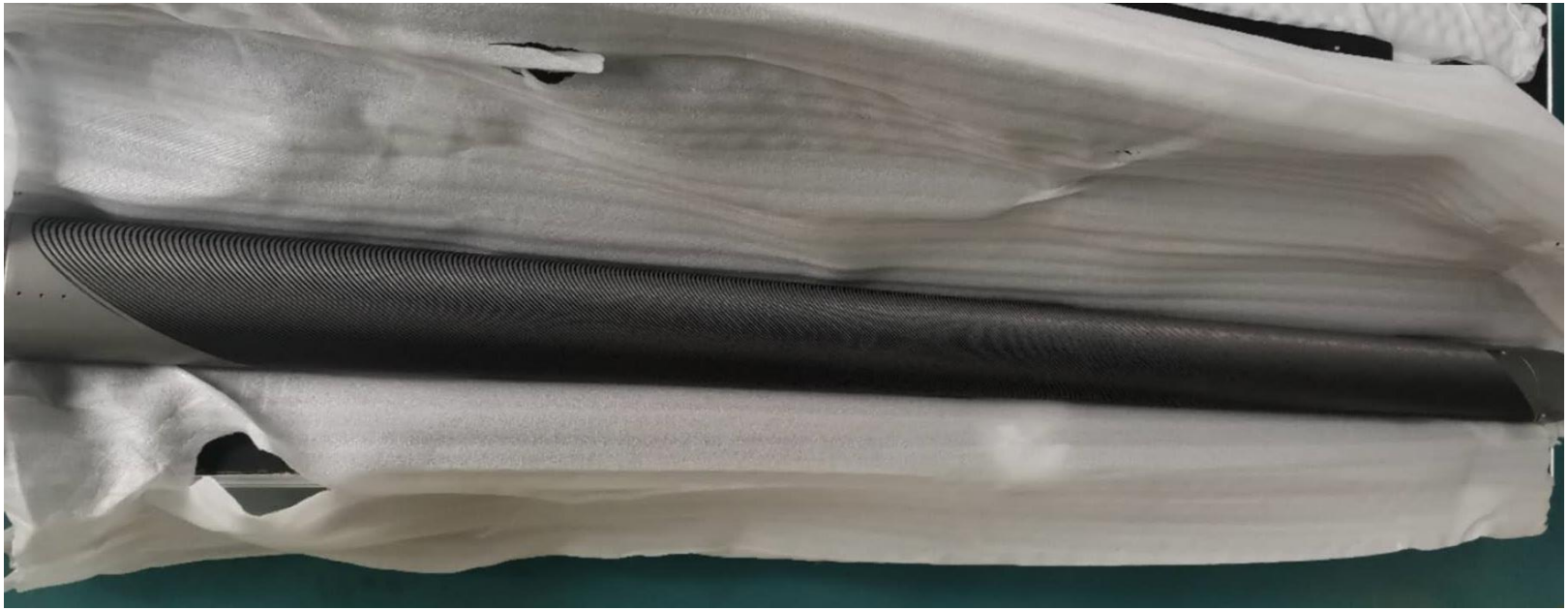
- The 1st practice coil from Bama with New VPI procedure (wet winding plus 5bar VPI) reached 530A stand-alone, after 27 times of quench, tested at 4K at IMP. Comparing with the previous coils from WST (50~60 times of quench to reach the ultimate current), significantly improved the training performance, to be confirmed by more results in future.
- Fabrication of the 1st series magnet has been started, to be completed by the end of 2020, with "dry winding" plus 5bar VPI.



July 27, 2020
Received 50 km insulated NbTi wire

August 10, 2020
Test of insulation strength for ~14 km NbTi wire completed

July 25, 2020
Received practice coil former

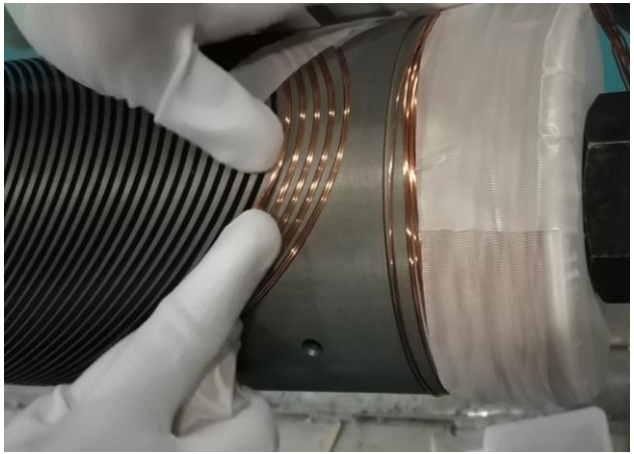


August 15, 2020
Copper wire for practice

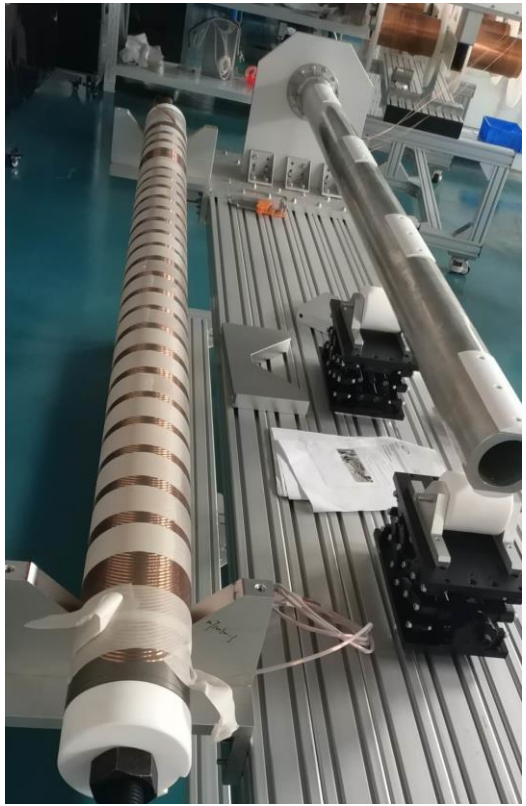
August 20, 2020
Winding machine preparation

September 1, 2020
Winding tooling preparation

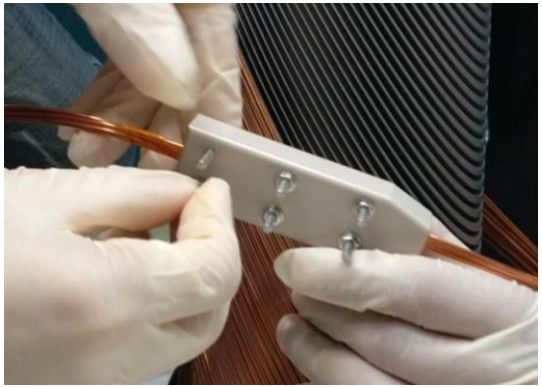
September 3, 2020
Practice coil winding with copper wire



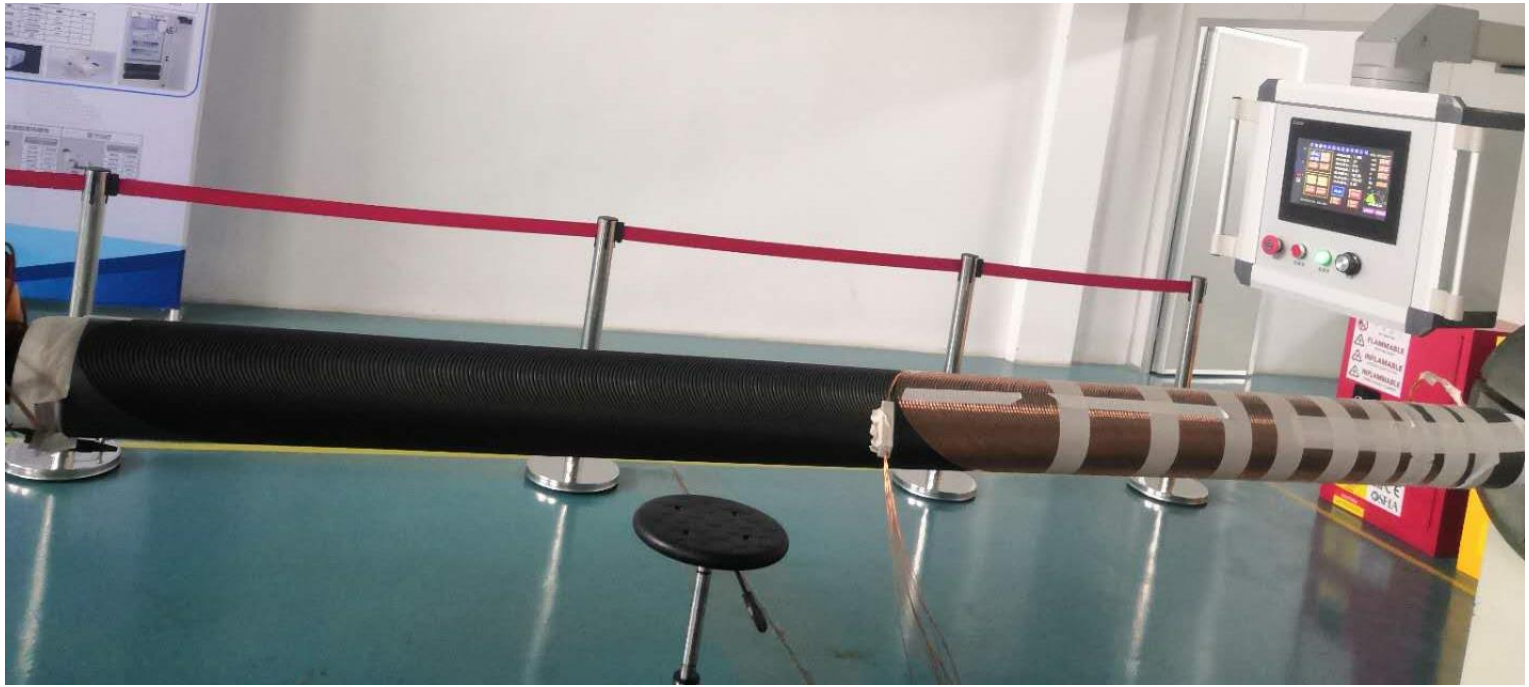
September 10, 2020
Winding of inner former completed



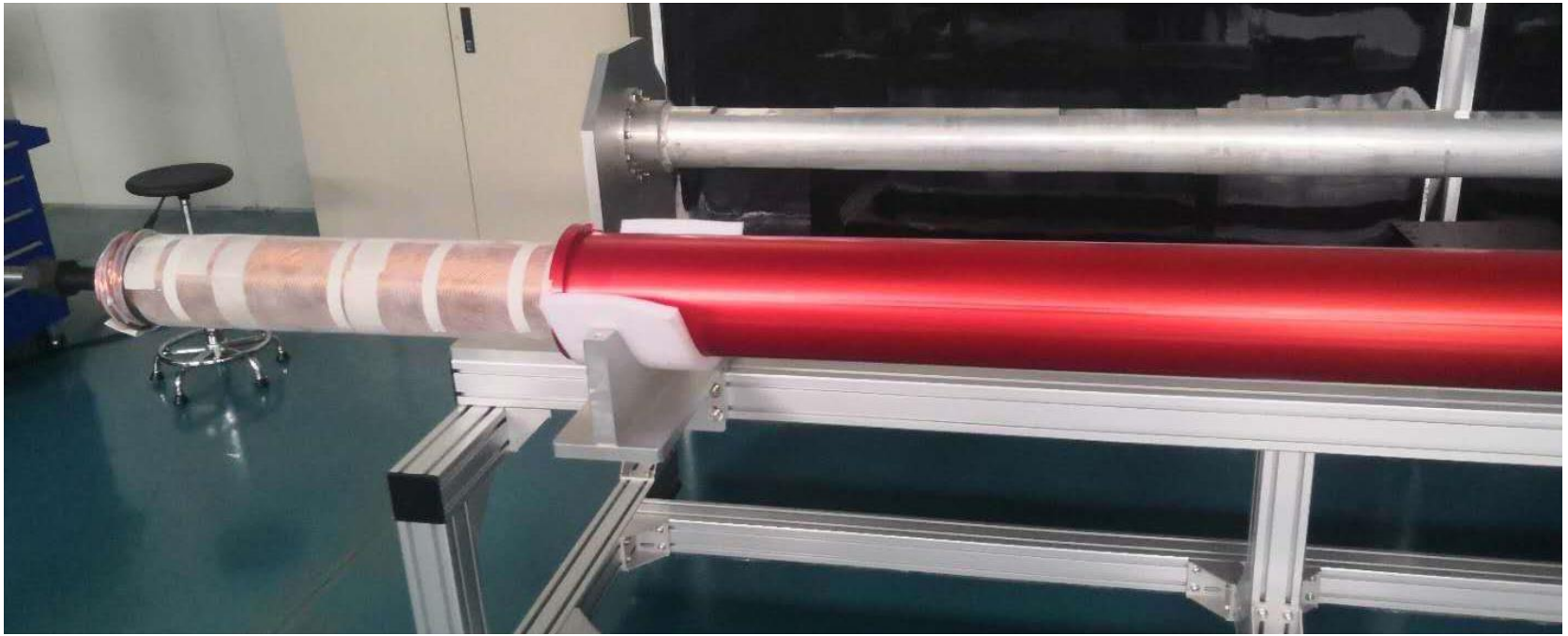
September 3-10, 2020
Solving problems related to winding tooling



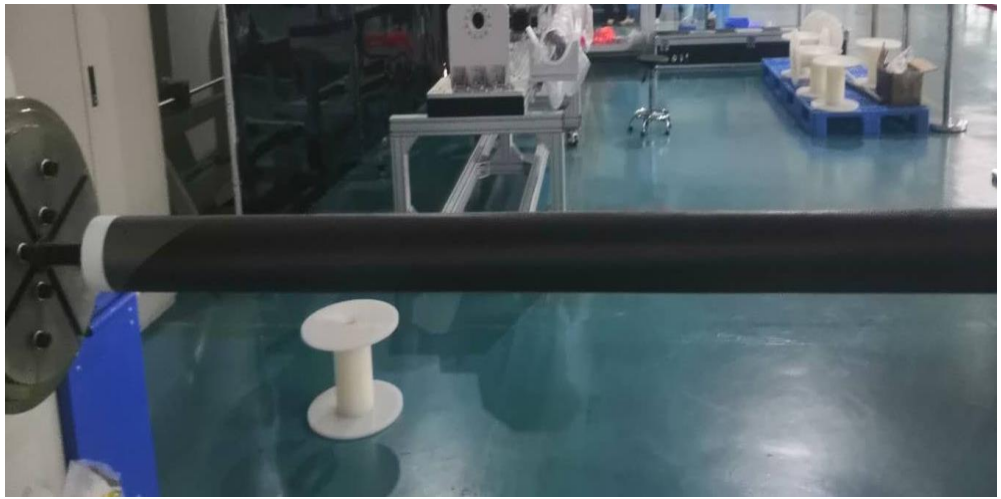
September 14, 2020
Winding outer former



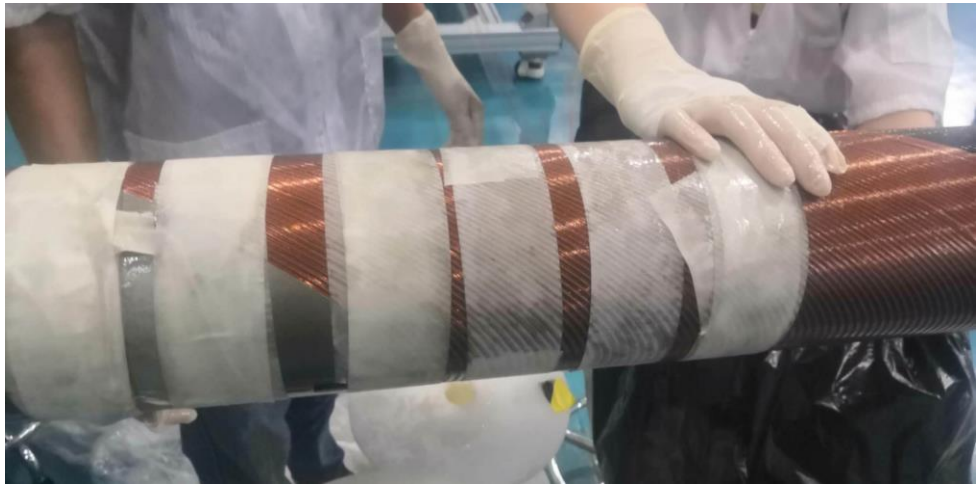
September 15, 2020
Practice coil winding with Cu wire completed



September 16, 2020
started to split the 14 km NbTi wires
and preparation of coil winding with NbTi wires

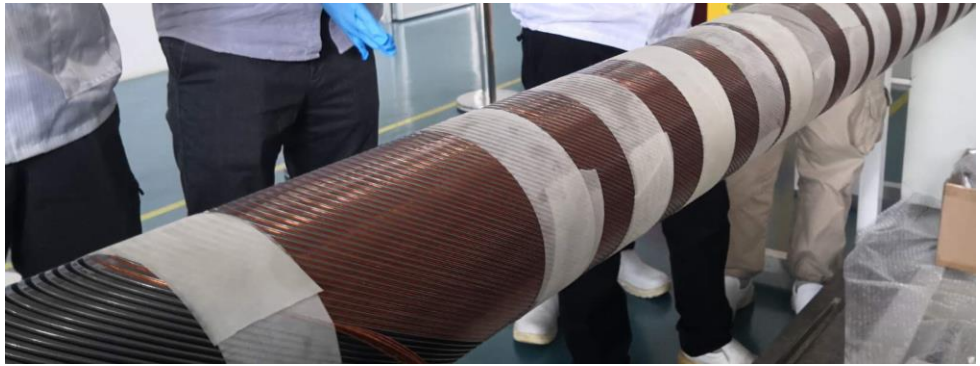


September 17, 2020
Ready for winding.



New VPI procedure for practice coil
Wet winding with CTD-101K,
pre-curing,
and 5-bar VPI

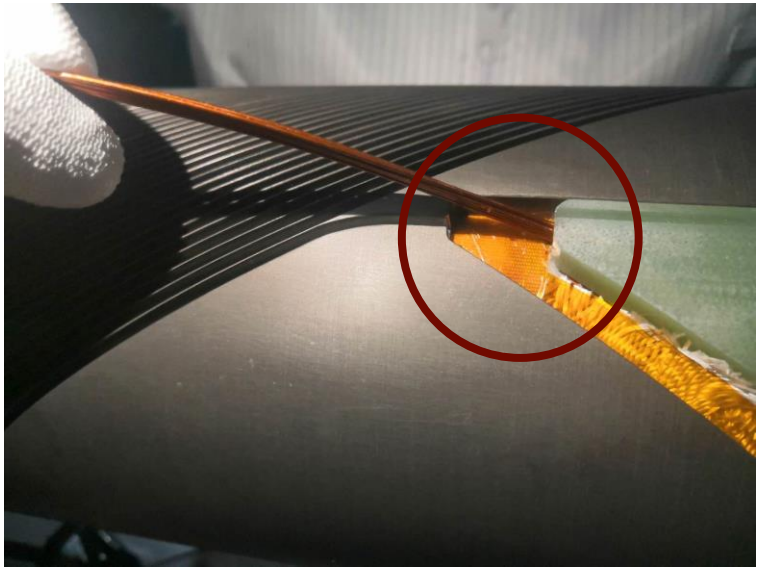
September 18, 2020
Inner coil winding 1/3



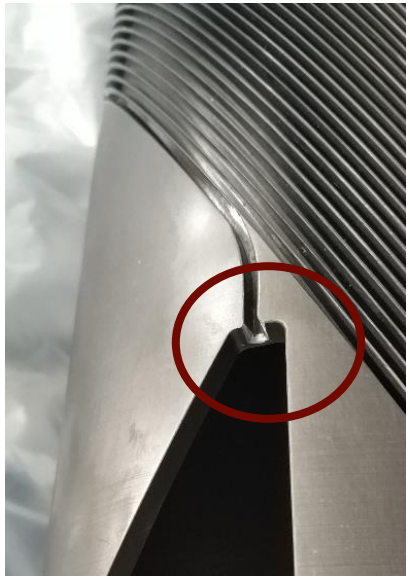
September 19, 2020
Inner coil winding 2/3

September 20, 2020
Inner coil winding completed and wrapped with glass fiber outside.

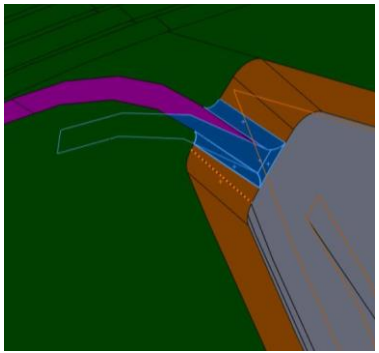
September 21, 2020
Inner and outer former assembly completed.
Insulation of wires damaged at some corner and repaired.

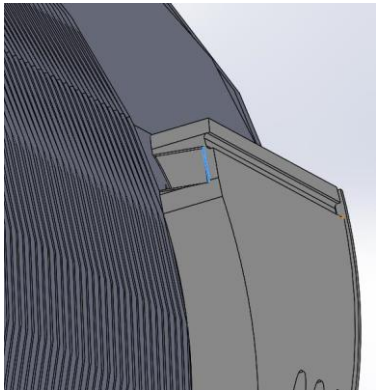


Repairing some sharp edges manually

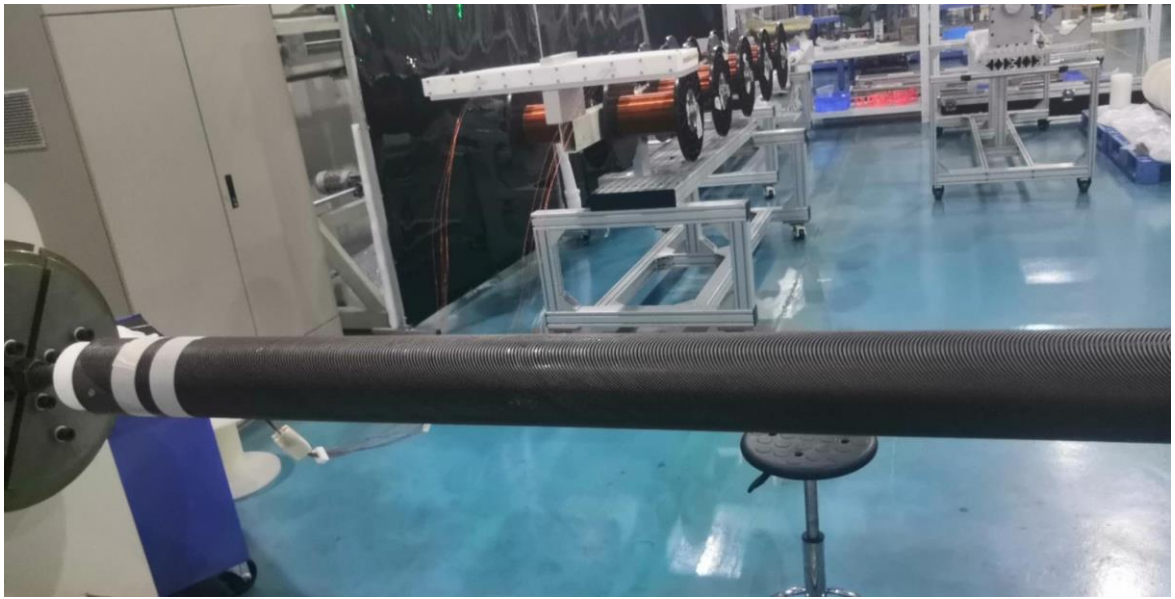


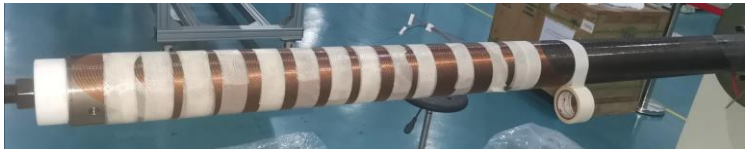
Proposed drawing modifications

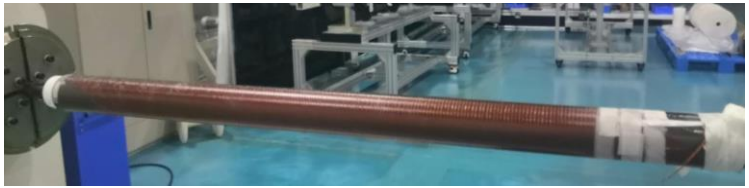




September 22, 2020
Using 20*0.1 glass fiber to wrap around the inner coil and brush the resin.



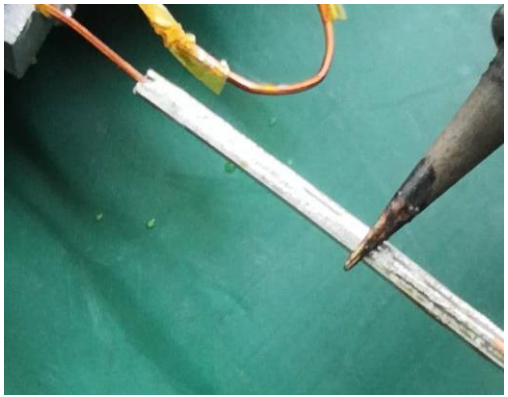




September 23-25, 2020
The outer coil winding completed.
Wire of each spool is 476 meters long. The remaining wire afer winding is about 40 meters.
The temperature sensors were installed.

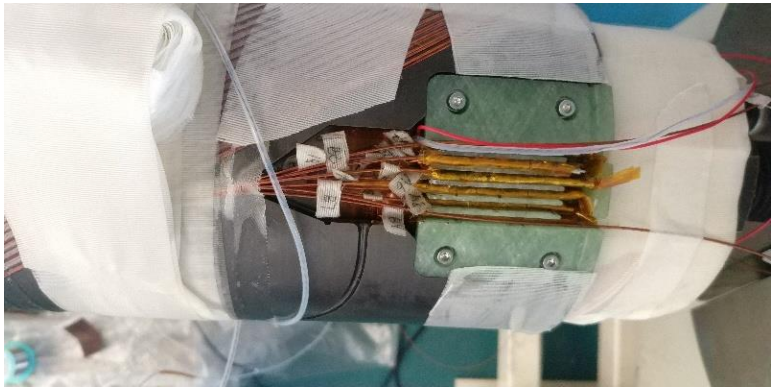
The CCS Temperature Sensor number

Similar joints that have been made by Bama

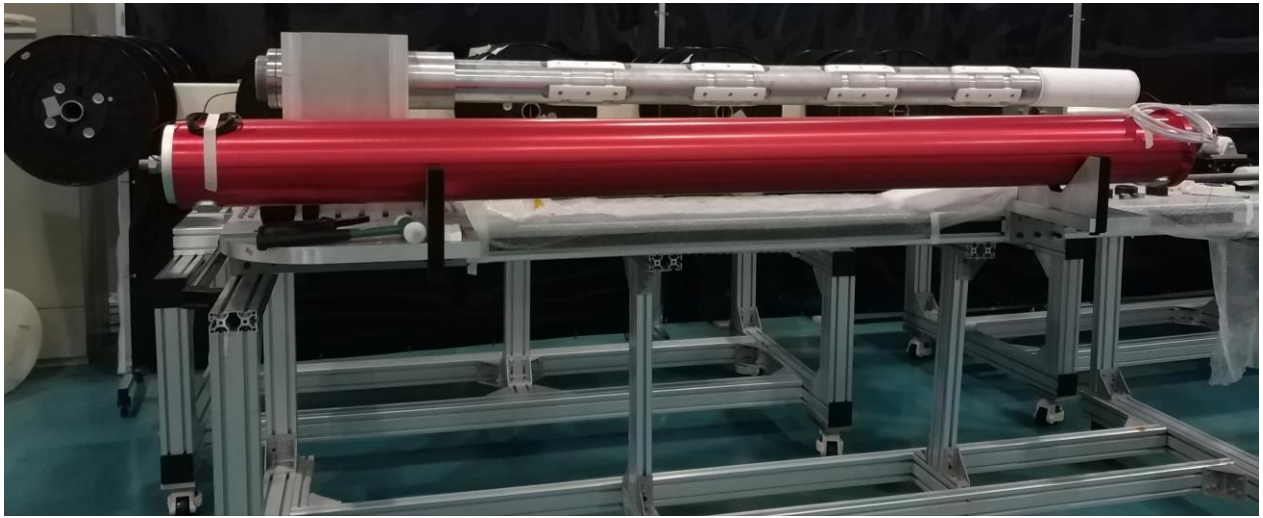


Practice joint welding

September 26, 2020
All joints completed



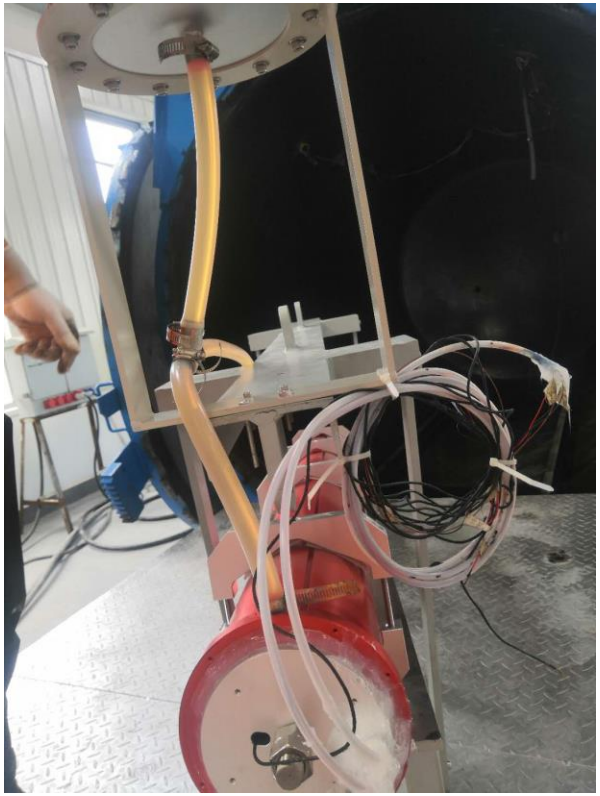
September 28, 2020
The outer support tube and VPI tooling installation completed



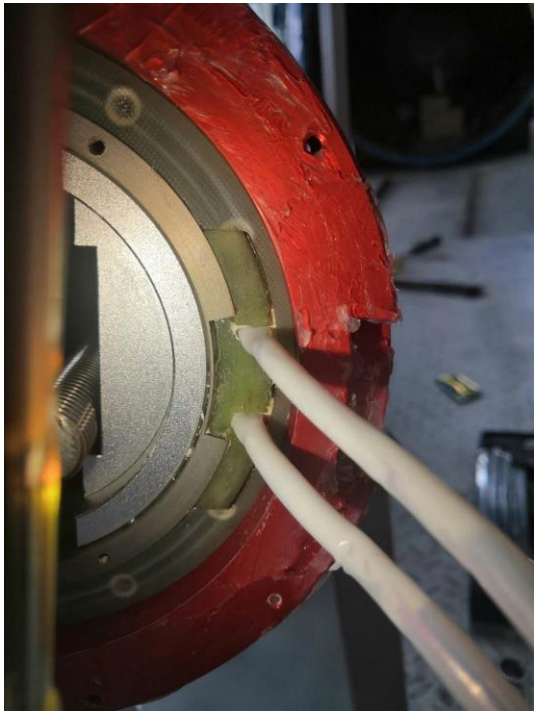
October 1, 2020
VPI tooling assembly and pre-curing completed. Moved to VPI furnace

October 2-4, 2020
Vacuum baking at 100 ℃

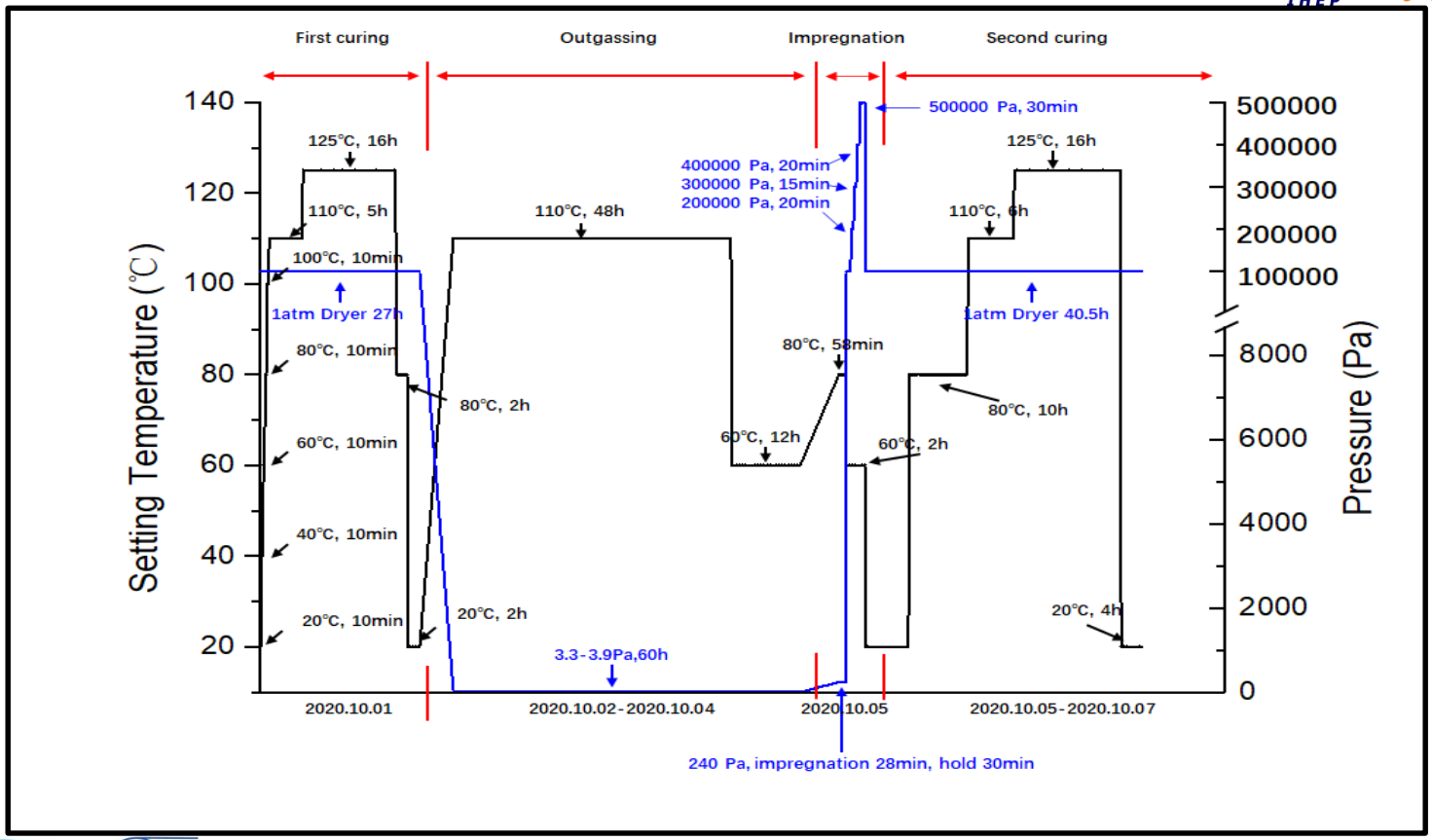
October 5-7, 2020
VPI with maximum 5bar



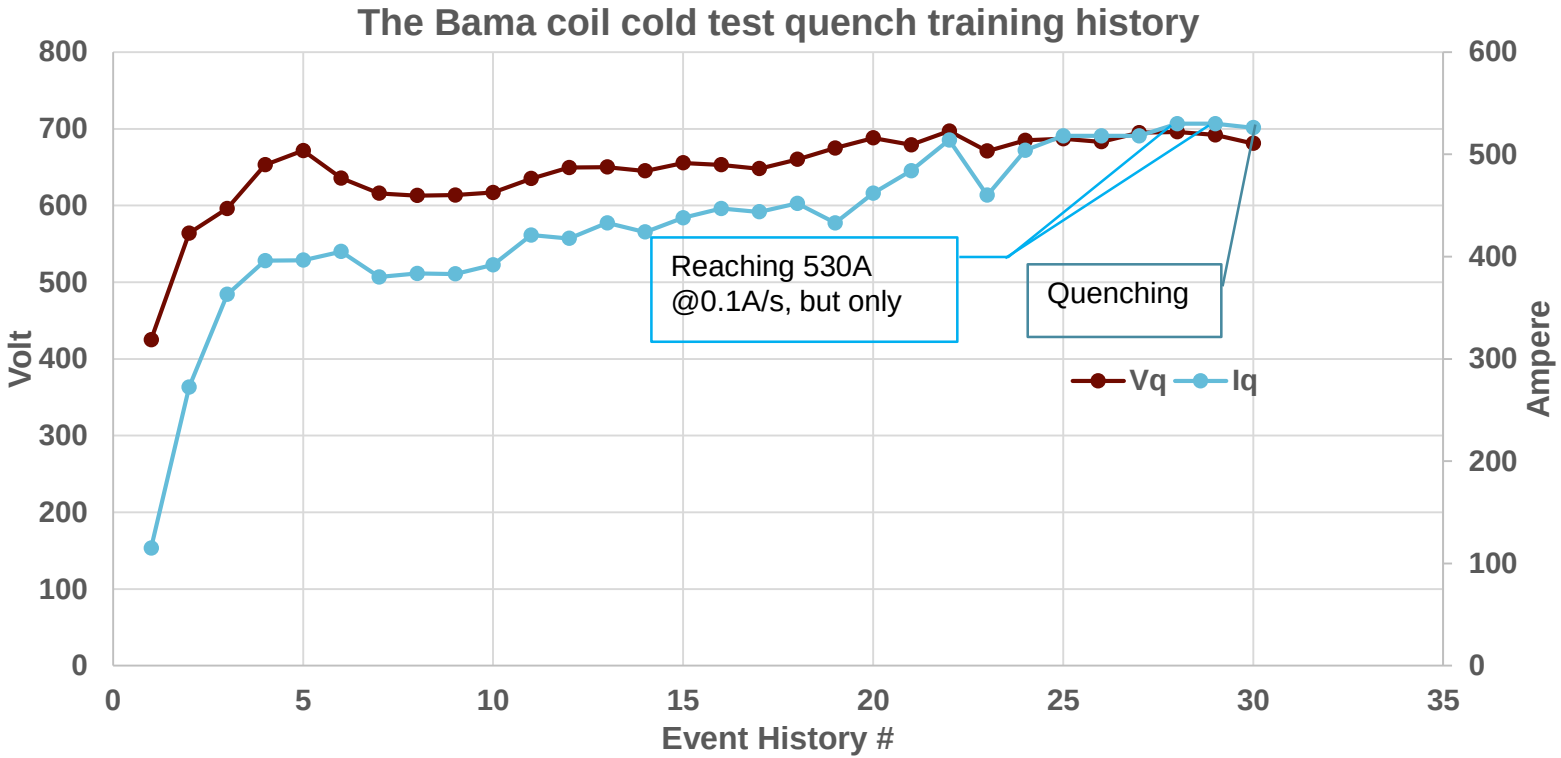
October 5-7, 2020
Moving from furnace to oven

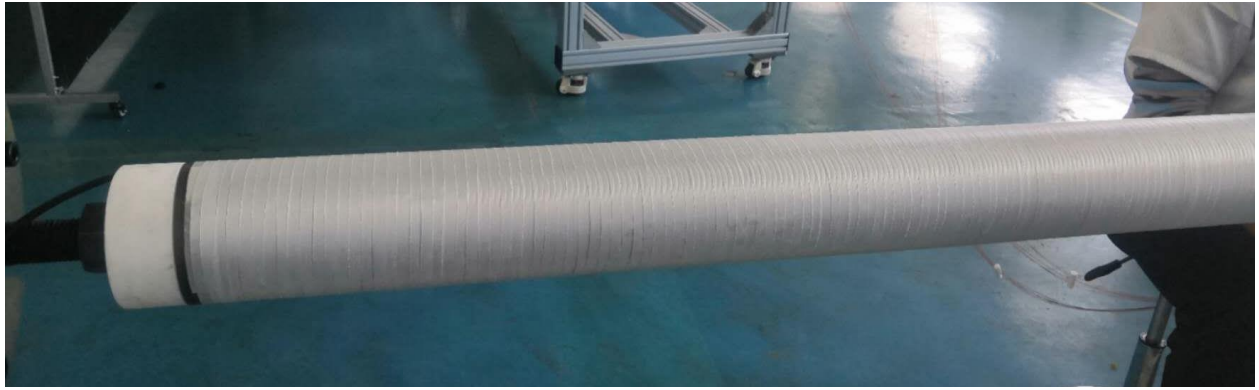


October 7, 2020
VPI completed


First curing
Outgassing
Impregnation
Second curing
Setting Temperature (℃)
Pressure (Pa)
140
120
100
80
60
40
20
500000
400000
300000
200000
100000
8000
6000
4000
2000
0
125℃, 16h
110℃, 5h
100℃, 10min
1atm Dryer 27h
80℃, 10min
60℃, 10min
40℃, 10min
20℃, 10min
80℃, 2h
20℃, 2h
110℃, 48h
3.3-3.9Pa,60h
400000 Pa, 20min
300000 Pa, 15min
200000 Pa, 20min
500000 Pa, 30min
80℃, 58min
60℃, 12h
60℃, 2h
125℃, 16h
110℃, 6h
1atm Dryer 40.5h
80℃, 10h
20℃, 4h
2020.10.01
2020.10.02-2020.10.04
2020.10.05
2020.10.05-2020.10.07
240 Pa, impregnation 28min, hold 30min

October 7, 2020
Transport to IMP Lanzhou
for the test at 4K

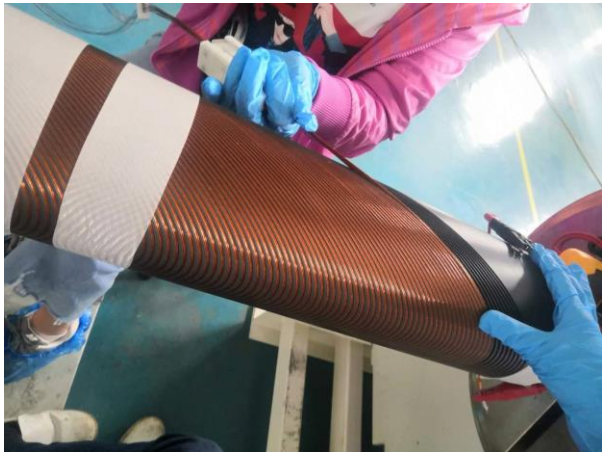

The Bama coil cold test quench training history
Volt
Ampere
Event History #
Reaching 530A
@0.1A/s, but only
Quenching
Vq
Iq
800
700
600
500
400
300
200
100
0
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35

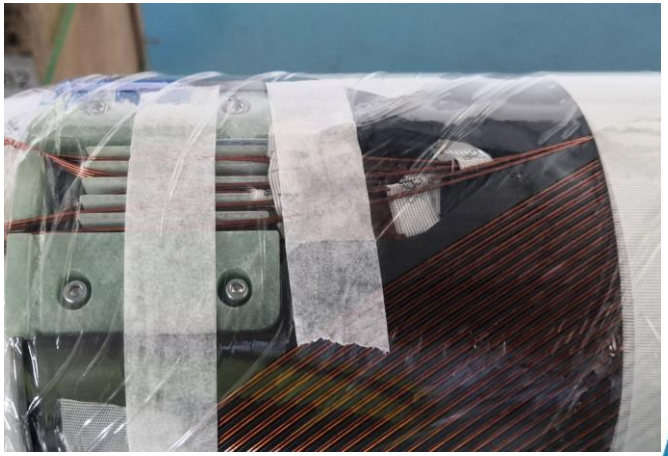


October 23, 2020
Inner coil winding of the 1st magnet V aperture Completed
“dry winding”

Nov 2, 2020
outer coil winding of the 1st magnet V aperture Completed

Preparing for making joints





Plan from now to Apr 2021

November 12, 2020 1st magnet V aperture transport to IMP for cold test stand-alone

November 30, 2020 1st magnet H aperture completed. Starting to assemble the magnet

End of December 2020 1st magnet ready for test

End of February 2021 1st Magnet ready for delivery to CERN

End of April 2021 2nd Magnet ready for delivery to CERN

IHEP

IMP

Supercondutor Technology

苏州八匹马超导科技有限公司

Thanks for your attention

CERN