

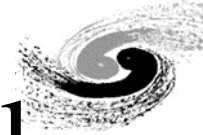
Progress of the 0.5 m Prototype for Hi-Lumi LHC orbit Corrector

WU WEI, LIANG YU, ZHOU LUNCAI, Institute of Modern Physics

LI CHAO, LI MENG, Western Superconducting Technologies Co.,Ltd

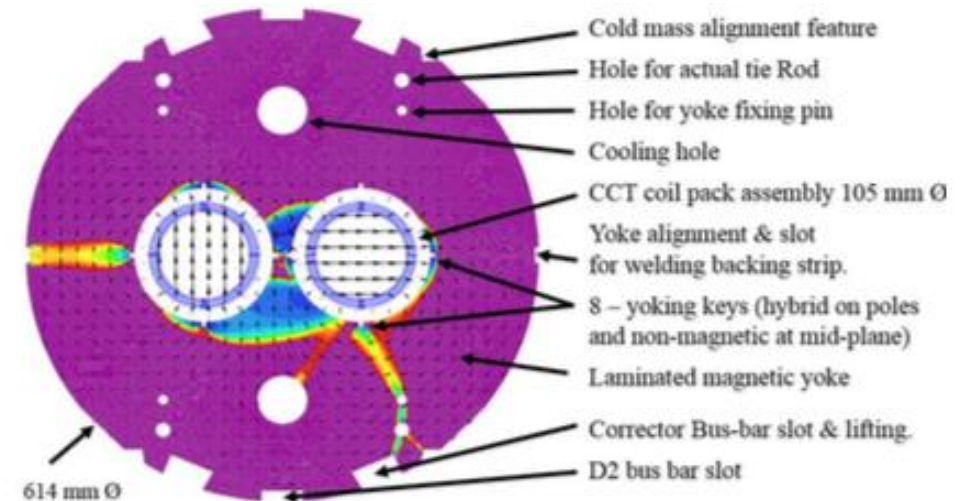
XU QINJIN, Peng Quanling, Gong Lingling, Cheng DA, Wei Shaoqing, Institute of High Energy Physics

25th July, 2018



Magnet Spec. of short 0.5 m model

- Mechanical length: 0.5 m
- Integrated field: 0.757 Tm
- Aperture: 105 mm (cold)
- Beam distance: 188.19 mm
- Current : 422 A
- Ramps rates: 100 s to target value
- Yoke: 614 mm dia

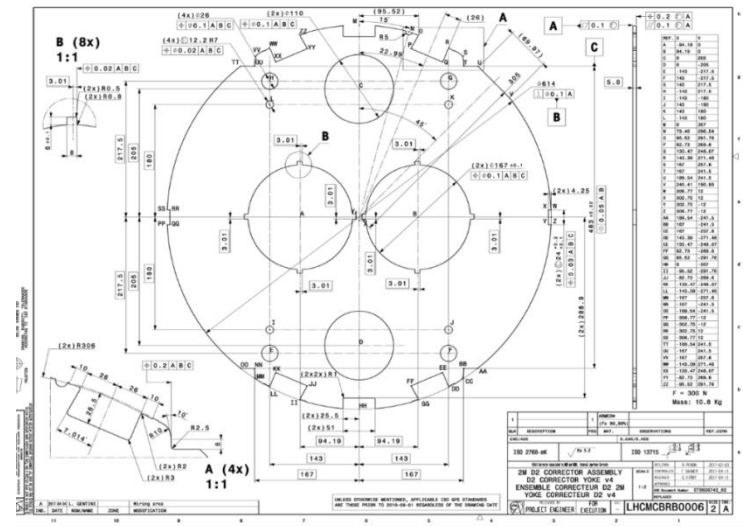
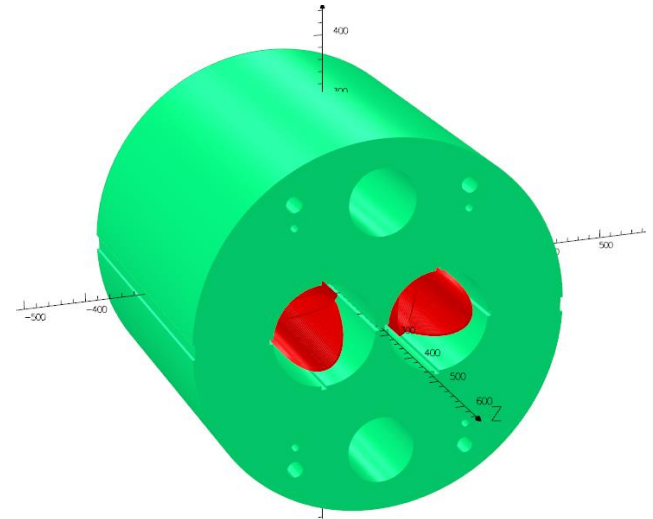


2D design from CERN



0.5 m model EM design parameters

Bore field / T	2.64
Current / A	422
Layers	5+5
CCT angle / °	30
匝间距 /mm	5.2(0.6)
Turns per layer	55
Integrated field / Tm	0.757
Peak field / T	3.1
Io/Ic	55%
Slot size in former	2 mm*5 mm,0.6 mm for rib
铁芯尺寸及长度/mm	Φ614/539.4
Inside and outside the former/ mm	The first layer: 105 /1119 ; The second layer: 119 /133
Dia of wire / mm	0.825(767A@3T 700A@4T) 0.99(with Kapton and S glass insulation)

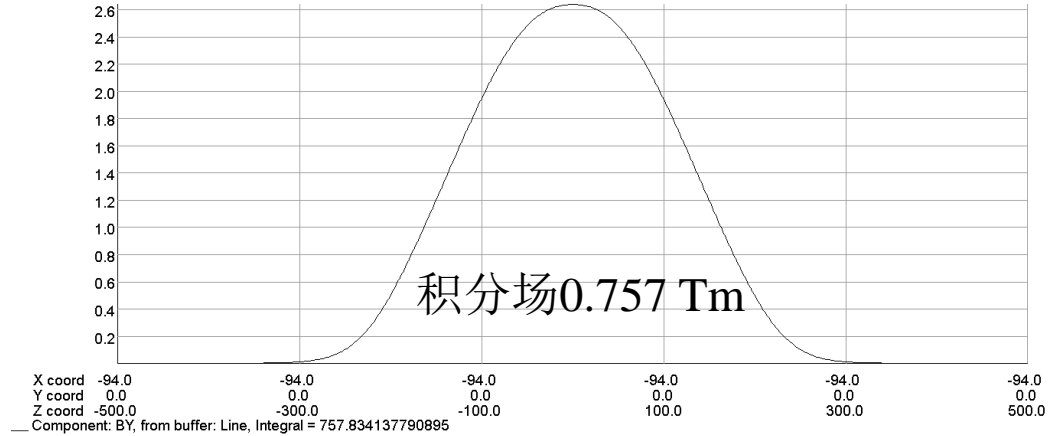
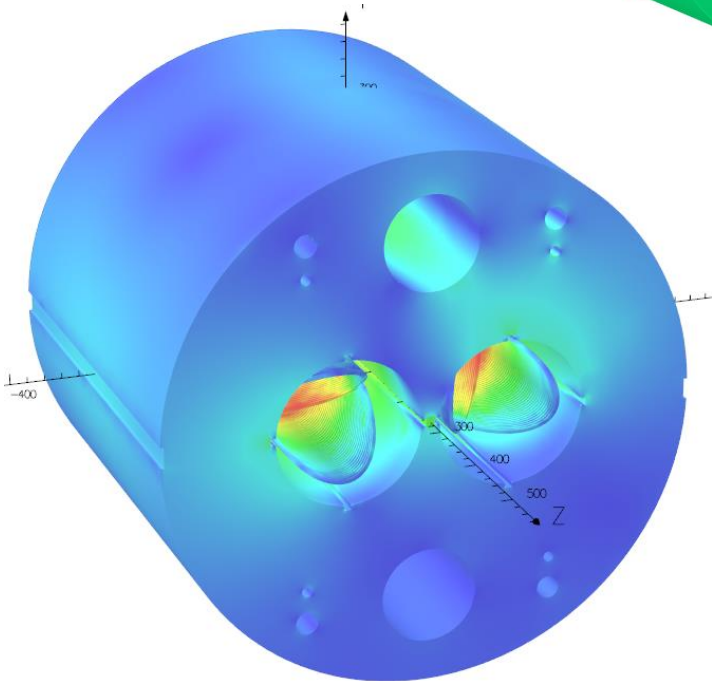
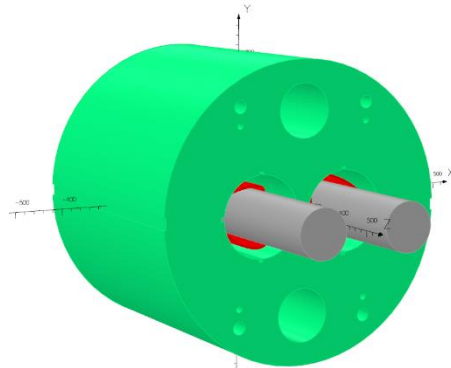


Magnetic Field Calculation in OPERA-3D

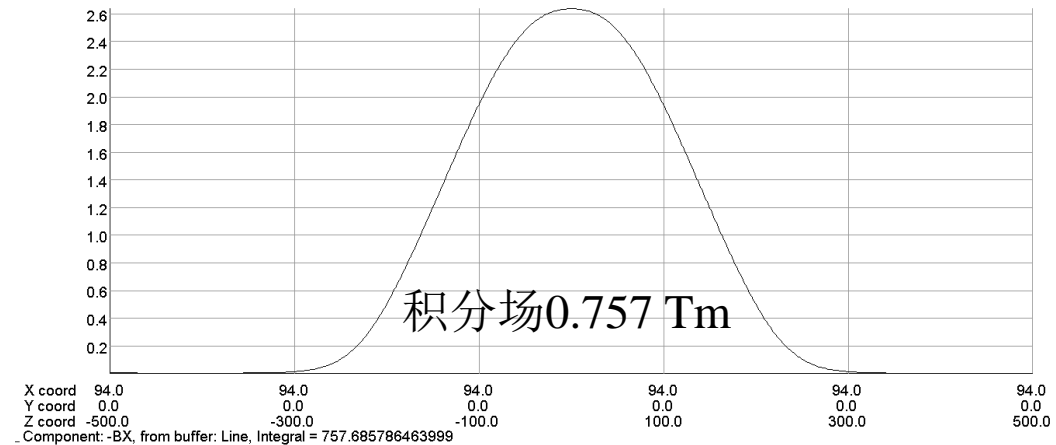


模型网格参数:

- 线圈气隙: 15
- 铁芯: 30
- 空气背景: 120



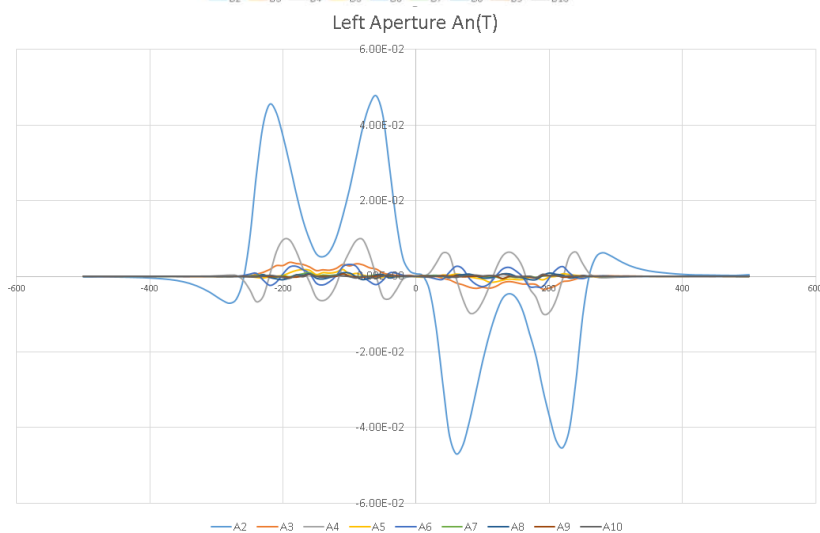
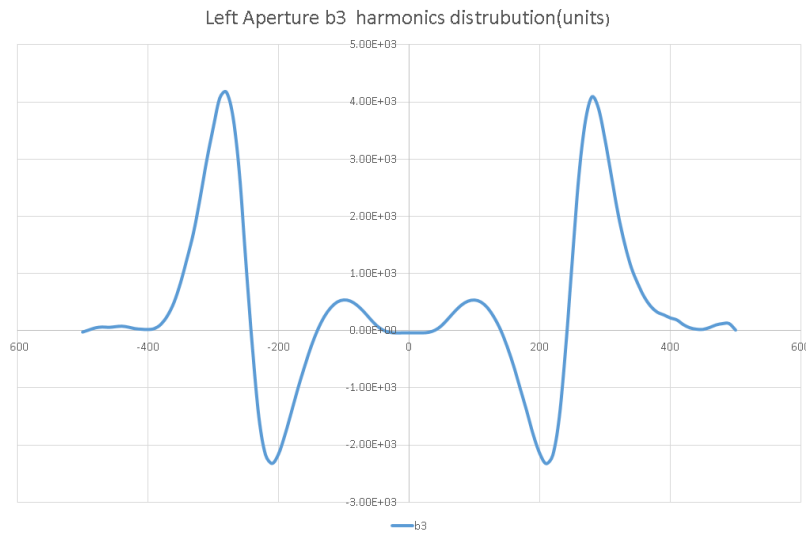
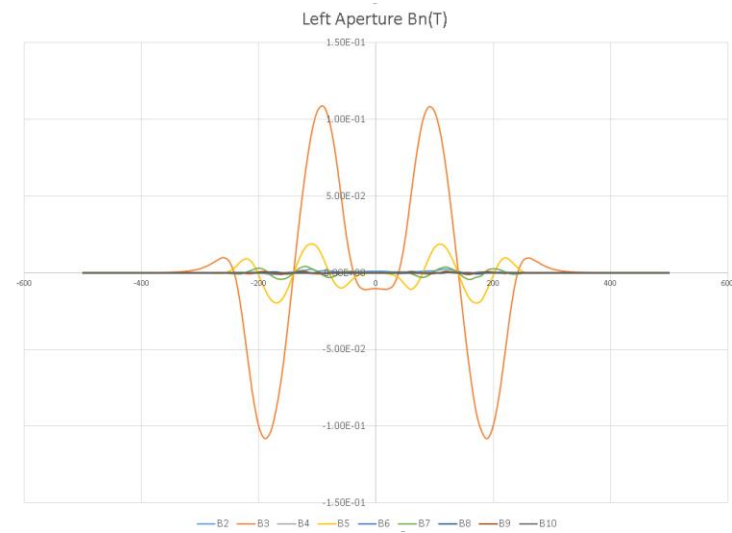
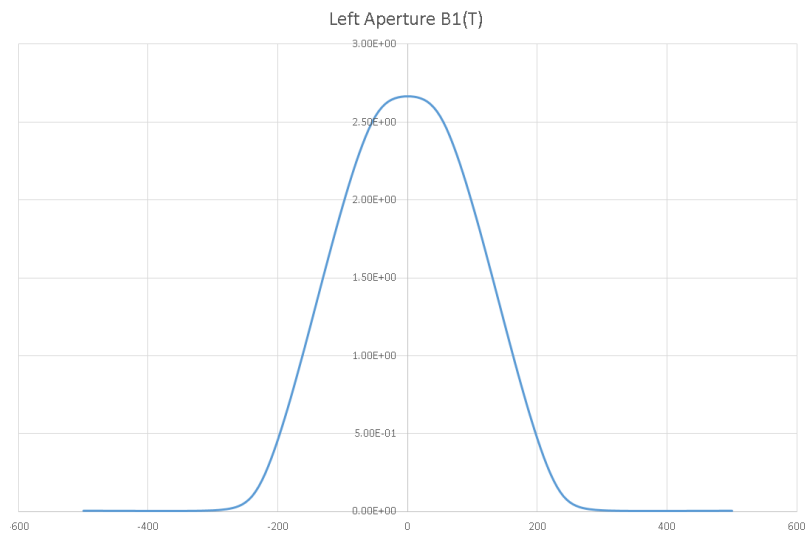
B_y along the axial direction (left aperture)



B_x along the axial direction (right aperture)

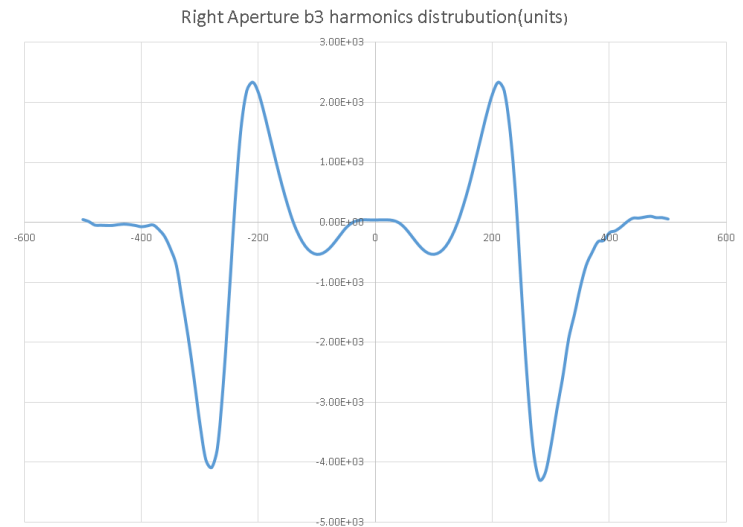
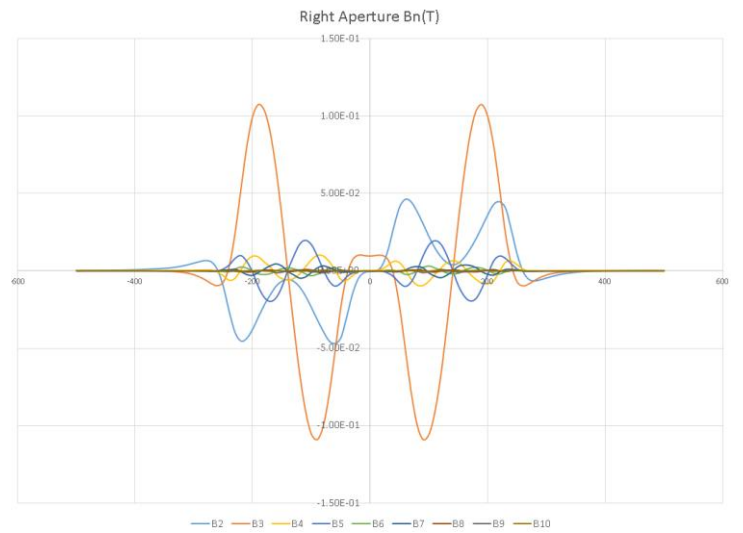
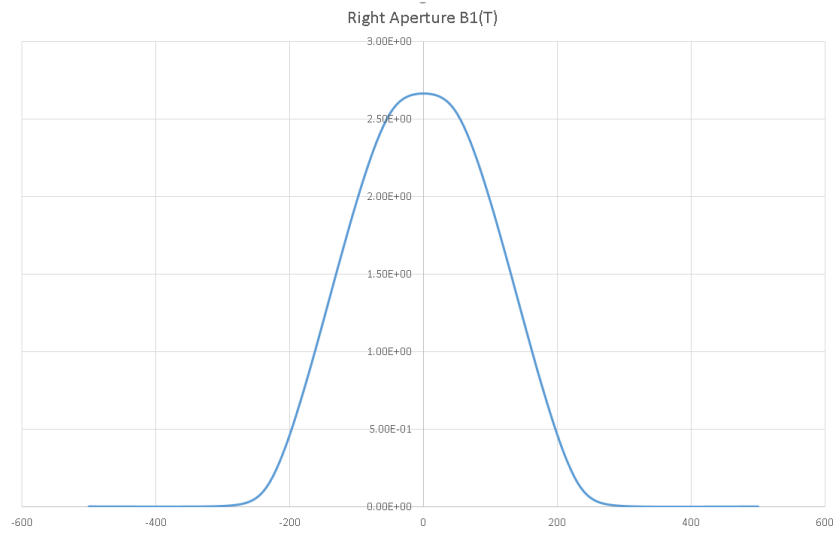


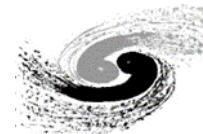
High order data analysis(left)





High order data analysis(right)





High order data analysis

积分场高阶量计算 ($r=35\text{mm}$)

Left Aperture

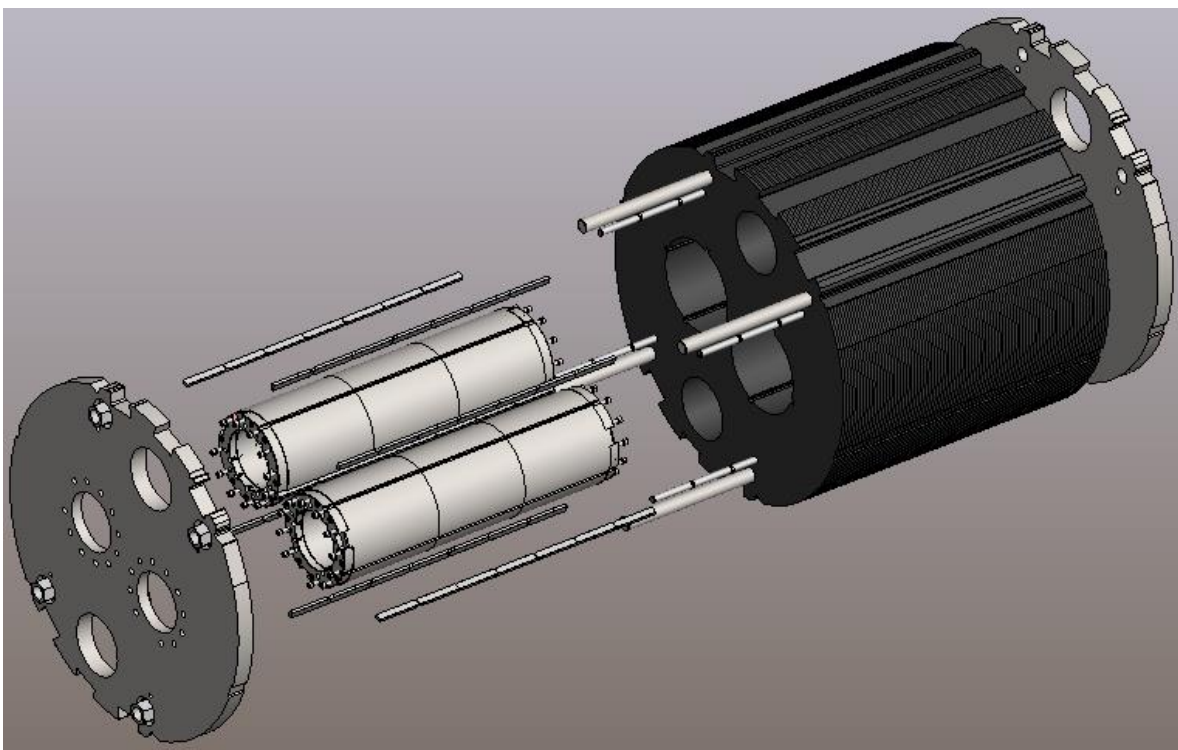
n	Sin term	Cos term	Bn/B0
0	0.0	757.8155	10000.0
1	0.081978	0.369862	4.880633
2	0.043137	0.277679	3.664209
3	3.16E-03	-2.2E-03	-0.02956
4	0.022802	-0.12452	-1.6432
5	0.023356	1.86E-05	2.46E-04
6	0.023745	-9.9E-03	-0.13079
7	0.033549	-8.0E-03	-0.10619
8	-6.3E-03	-0.01987	-0.26216
9	7.6E-03	-0.01588	-0.2095

Right Aperture

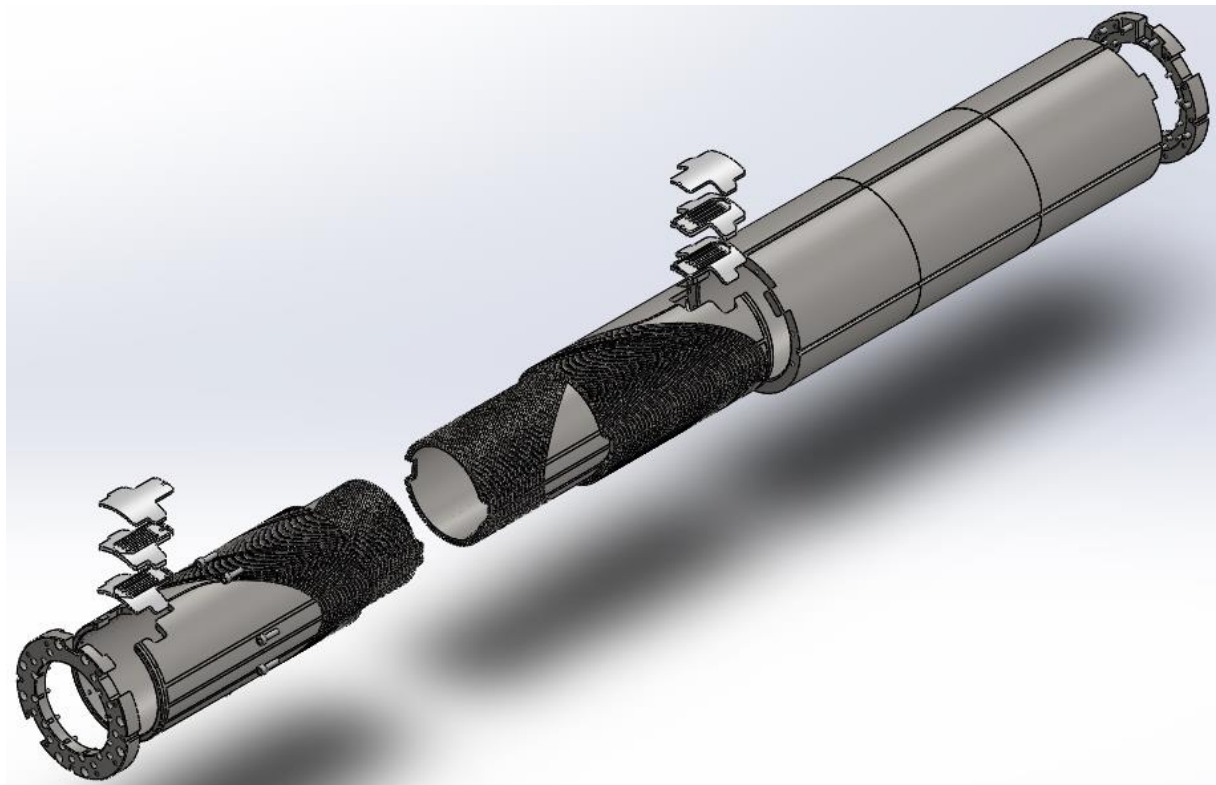
n	Sin term	Cos term	Bn/B0
0	0.0	757.7162	10000.0
1	-0.10566	-0.25834	-3.40952
2	0.026143	-0.44256	-5.8407
3	-0.04156	0.036916	0.487196
4	-0.01101	-0.07643	-1.00875
5	-0.05552	-3.1E-03	-0.0403
6	-0.01365	0.033194	0.438076
7	-0.01236	-2.7E-04	-3.5E-03
8	-5.4E-03	-0.03879	-0.51187
9	3.03E-03	-1.7E-03	-0.02233



Structural scheme

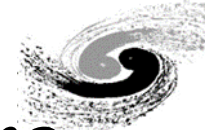


The whole structure



The coil structure

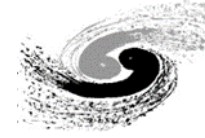
- Segment former design
- Segment bonding design



Parameters of superconducting wire

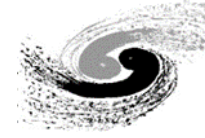
Insulated size[mm]	Insulation material	Number of filament	Cu/nonCu ratio	Critical current/4.22K [A]	RRR(273 K/10K)
$\Phi 0.99 \pm 0.01$	Kapton+玻璃丝布	≥ 192	1.3 ± 0.13	>767@3T >700@4T	>100
Insulation voltage >2500V					

Three-coordinate measuring result of outer former

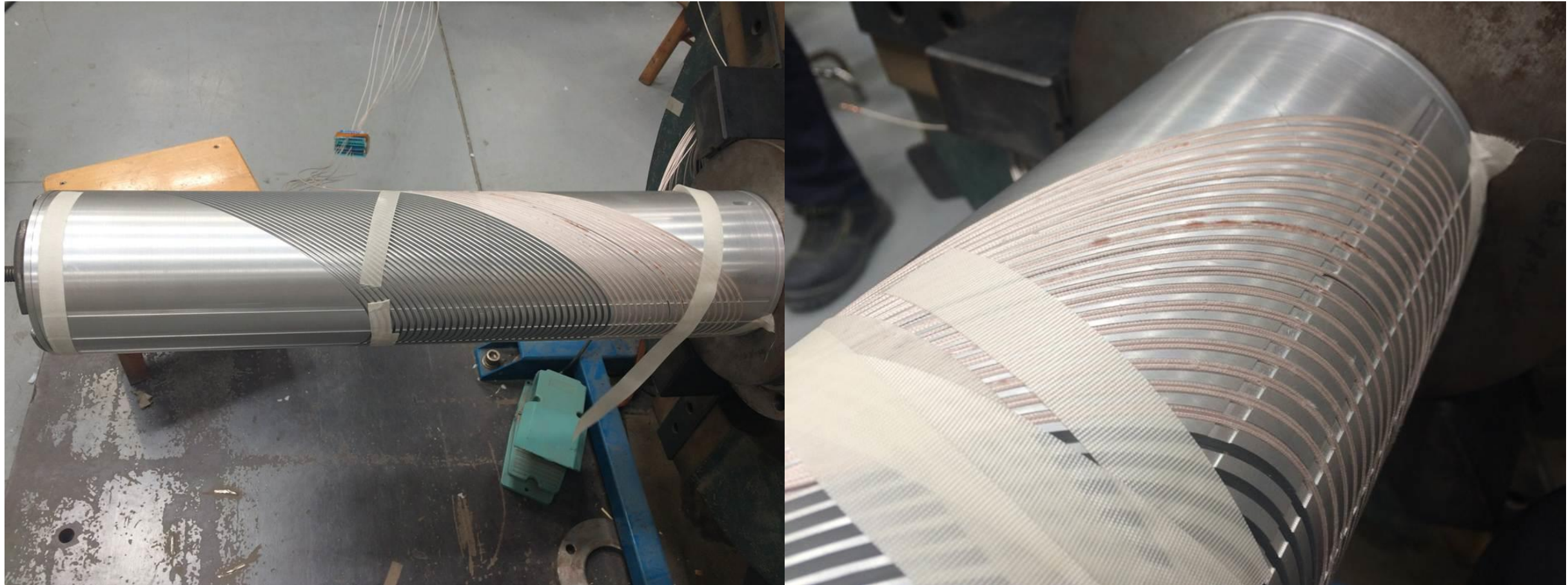


	1# outer former1	2# outer former1	1# outer former2	2# outer former2	Criterion
Groove bottom size (different grooves)	-0.0239	-0.0437	-0.0983	-0.0442	122.6-123
Groove bottom size (same groove)	-0.0218	-0.0377	-0.0415	-0.0121	122.6-123
Inner circle size	-0.0214	-0.0118	-0.0066	Qualified	118.98-119.035
Outer circle size	0.0029	Qualified	Qualified	Qualified	132.97-133.028
Groove width	Qualified	1.9965	Qualified	Qualified	2-2.04
Groove profile	Qualified	Qualified	Qualified	Qualified	0.05
Inner circle roundness	Qualified	Qualified	Qualified	Qualified	0.03
Outer circle roundness	Qualified	Qualified	Qualified	Qualified	0.03
Coaxially	Qualified	Qualified	Qualified	0.0329	0.03

Because of different materials and processes, there will be some deformation in the process.

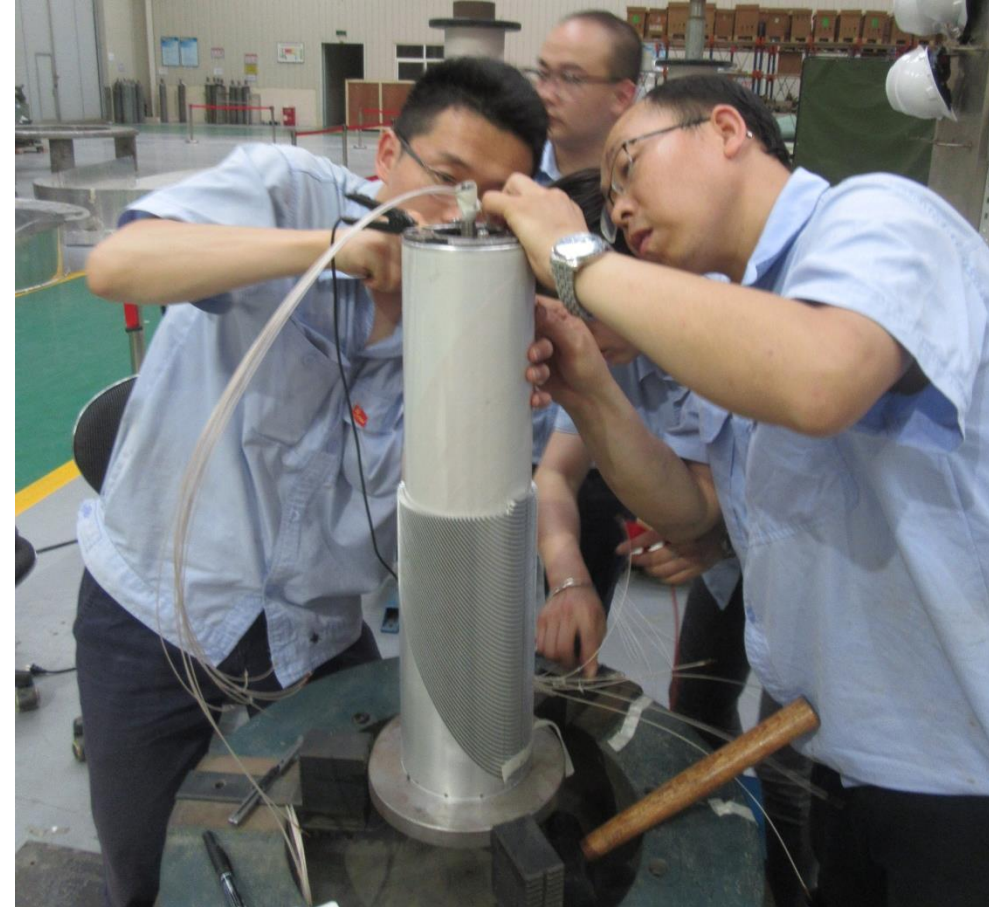
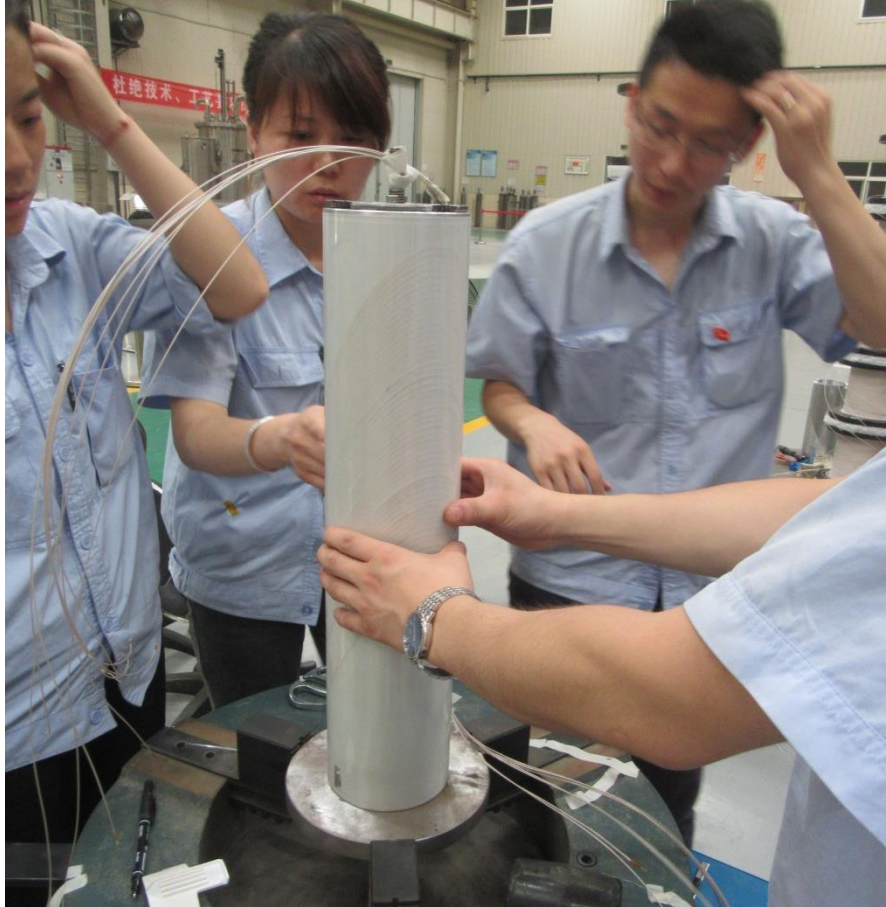
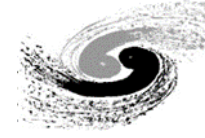


Manufacture-The winding process



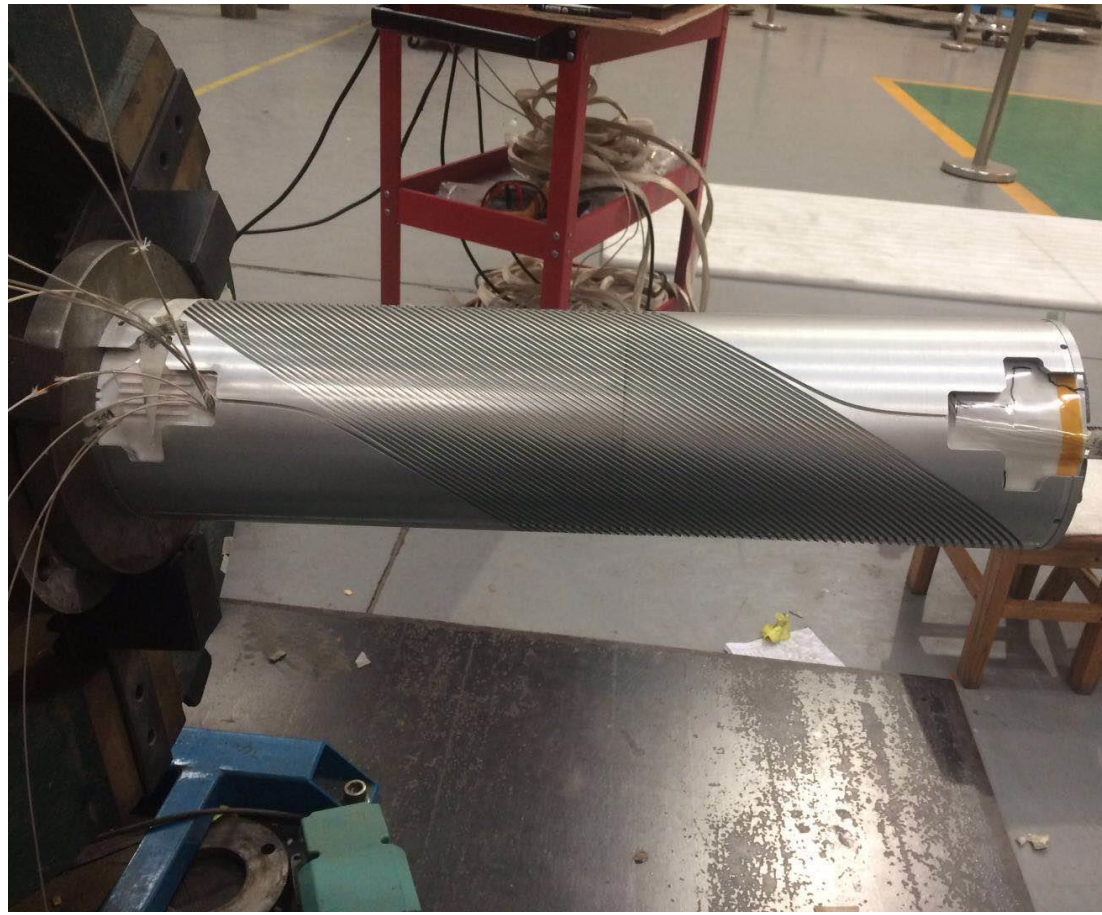
Inner coil: higher 0.2mm-0.3mm.

Manufacture-The winding process



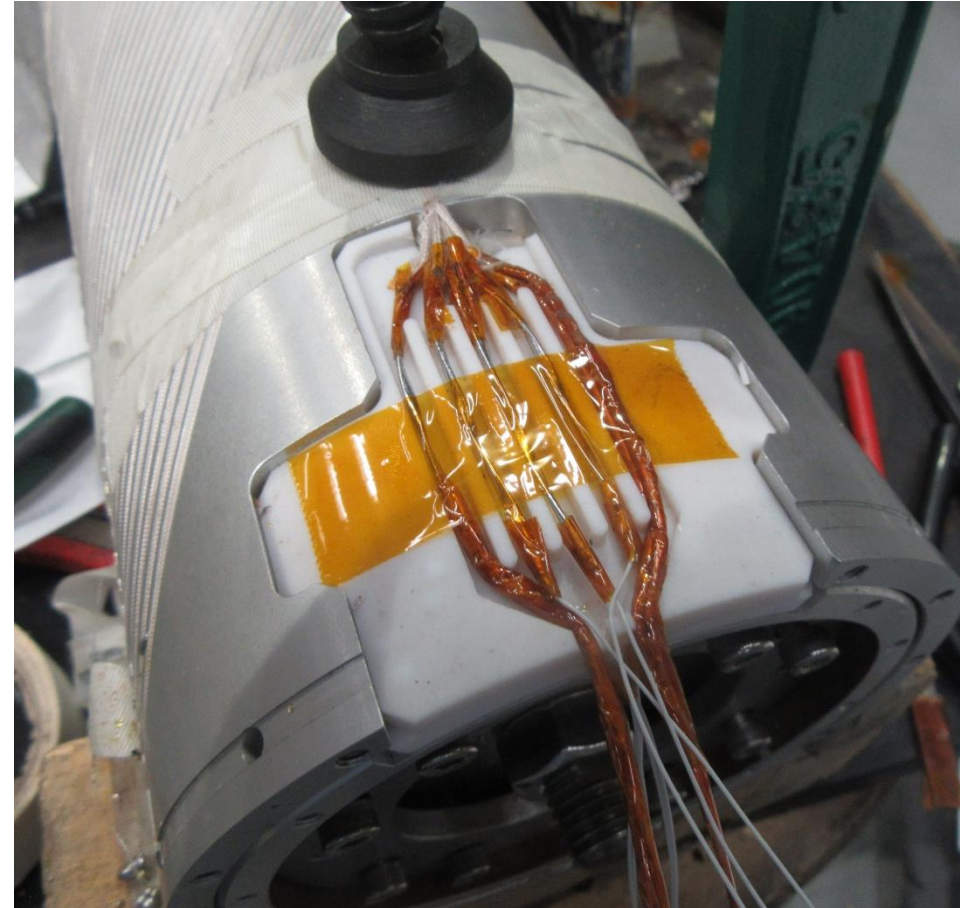
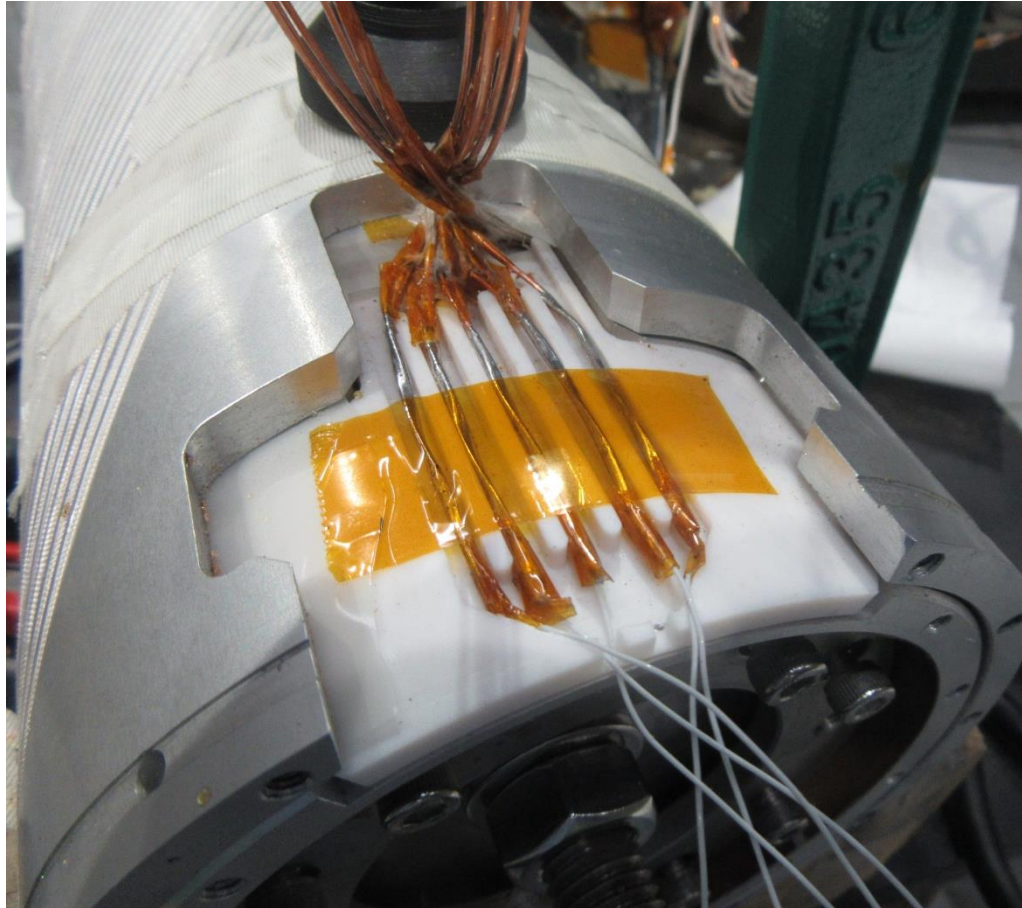
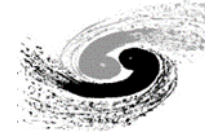


Manufacture-The winding process



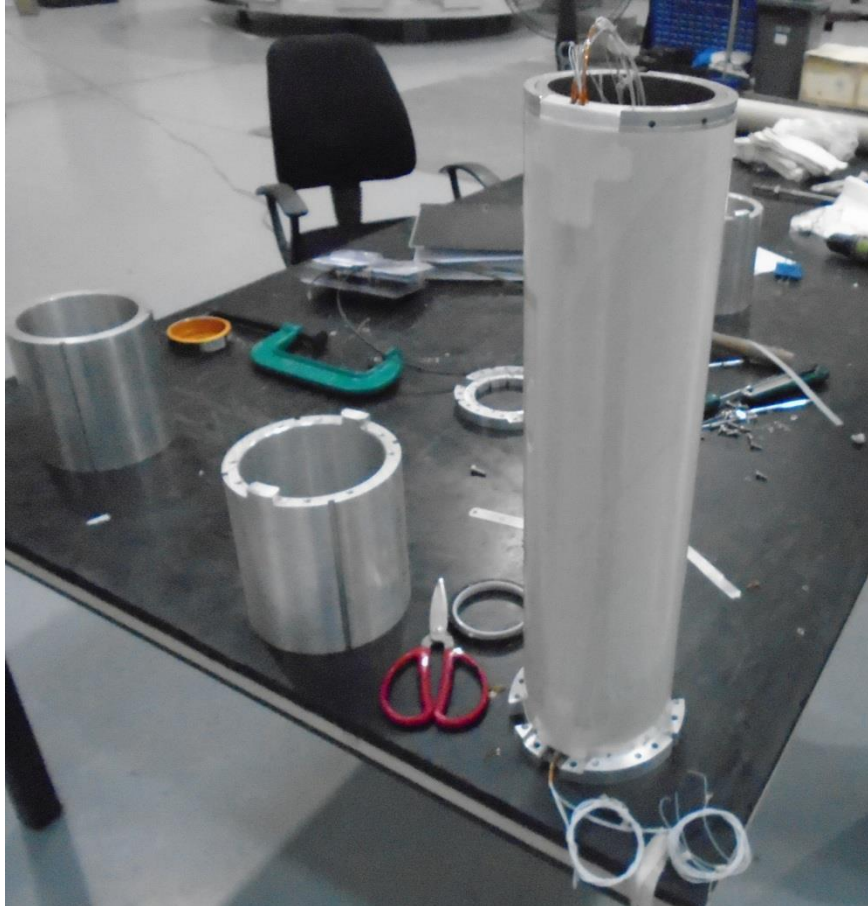
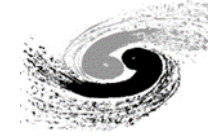
Outer coil

Manufacture-Terminal connection



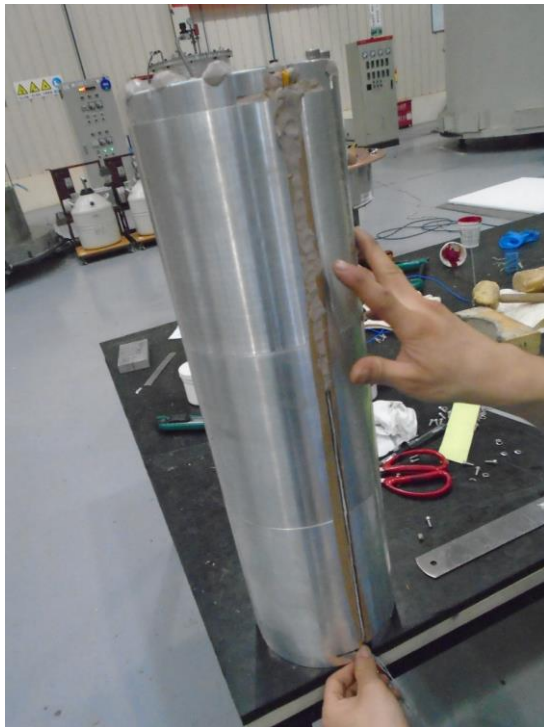
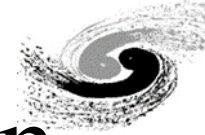
Twist and soldering

Manufacture-Assemble



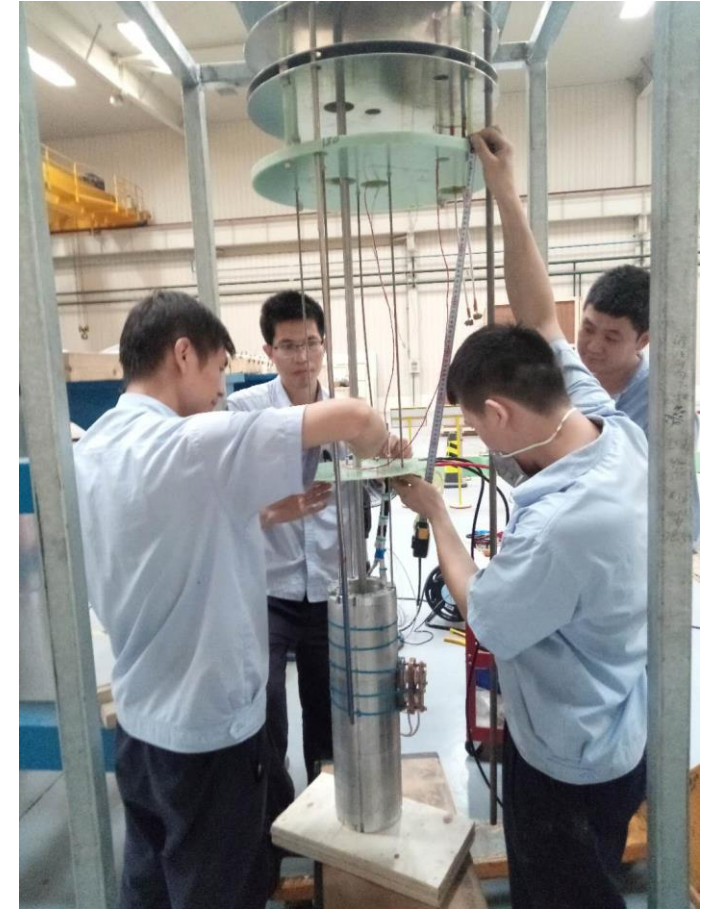
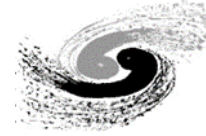
Install tighten aluminum cylinder after heating(90°C)

Manufacture- Vacuum impregnation



The whole structure vacuum impregnation

Test



Test preparation



Test---cooling by LN2

文件(F) 编辑(E) 查看(V) 项目(P) 操作(O) 工具(T) 窗口(W) 帮助(H)

西安聚能
超导磁体科技有限公司
XI'AN SUPERCONDUCTING MAGNET TECHNOLOGY CO.,LTD

CCT 超导磁体测试平台

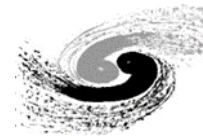
磁体型号: [REDACTED] 开始时间: 2018-6-28 20:09:52 记录按钮: [REDACTED]

(h) [REDACTED] (min) [REDACTED] 现在时间: 2018-6-28 21:56:59 记录周期: 30

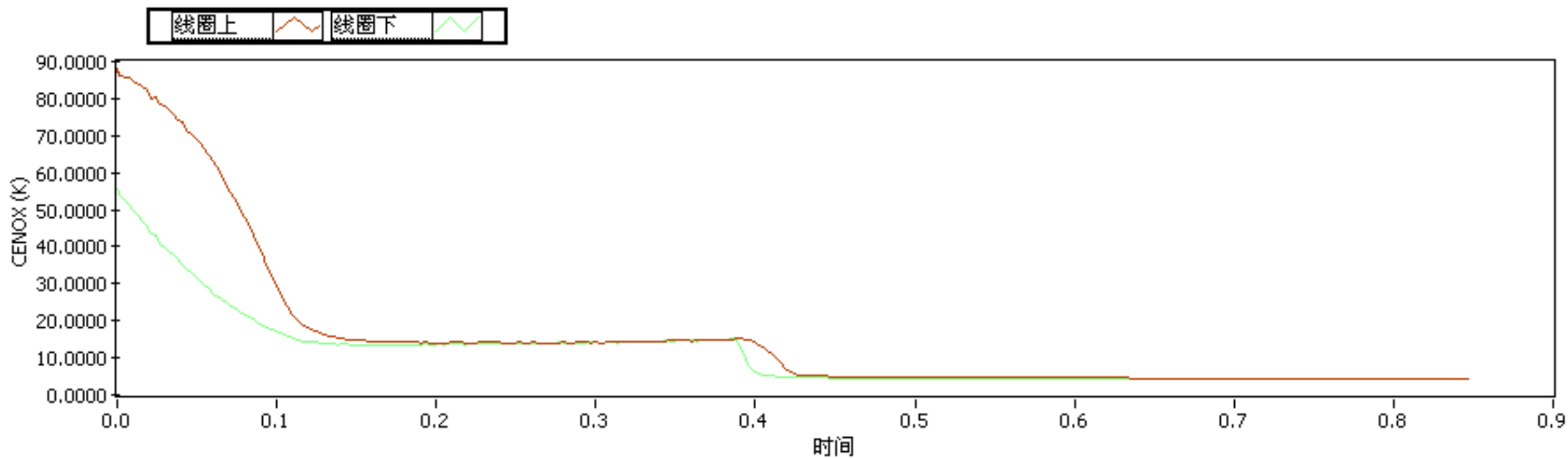
2000表: [REDACTED] 线圈温度 (K): 82.825
Lakeshore: GPIB0::12::INSTR coil up X104292: 79.003
coil down X104291: 79.003

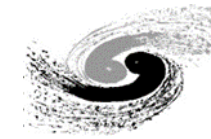
磁场 (T): B1(2124): 0.0000 Voltage (V): 0.0000 Current (A): 0.0000

B1 pressure: 151.95



Test ----cooling by LHe





Test ----1# coils test procedure

CCT magnet test procedure			
data	time	details	comment
2018/7/14	8:40	cooling by LN2	check, zero resistance
2018/7/14	9:20	cooling by LN2	76K, 75k
2018/7/14	10:05	discharge of LN2	77K.76k
2018/7/14	11:00	dry under nitrogen	98K,88K
2018/7/14		dry with heating	
2018/7/14	12:20	cooling by LHe2	102K ,95k
2018/7/14	13:50	cooling by LHe2	41cm
2018/7/14	14:05	excitation 1A/s	
2018/7/14		excitation 2A/s	483A quench
2018/7/14	15:10	excitation 3A/s from 0 to 460A, 1A/s from 0 to 470A, pause, excitation	471A quench
2018/7/14	15:18	excitation 4A/s	469.4A
2018/7/14	15;28	excitation 4A/s	529A
2018/7/14	15:44	excitation 4A/s	543A
2018/7/14	15:49	excitation 4A/s	520A last 20 min, 551A quench



Test ----1# coils test procedure

文件(E) 编辑(E) 查看(V) 项目(P) 操作(O) 工具(T) 窗口(W) 帮助(H)

西安聚能
超导磁体科技有限公司
XI'AN SUPERCONDUCTING MAGNET TECHNOLOGY CO.,LTD

CCT 超导磁体测试平台

磁体型号: cct
开始时间: 2018-7-14 15:49:38
现在时间: 2018-7-14 16:12:36
记录周期: 0

2000表: GPIBO::13::INSTR
Lakeshore: GPIBO::12::INSTR

线圈温度 (K)
coil up X104292: 4.1470
coil down X104291: 4.1510

电压 (V): -0.043072
Current (A): 551.01
B1(2124) (T): -2.5734

线圈上 线圈下

CEM0X (K)

B1 (KG)

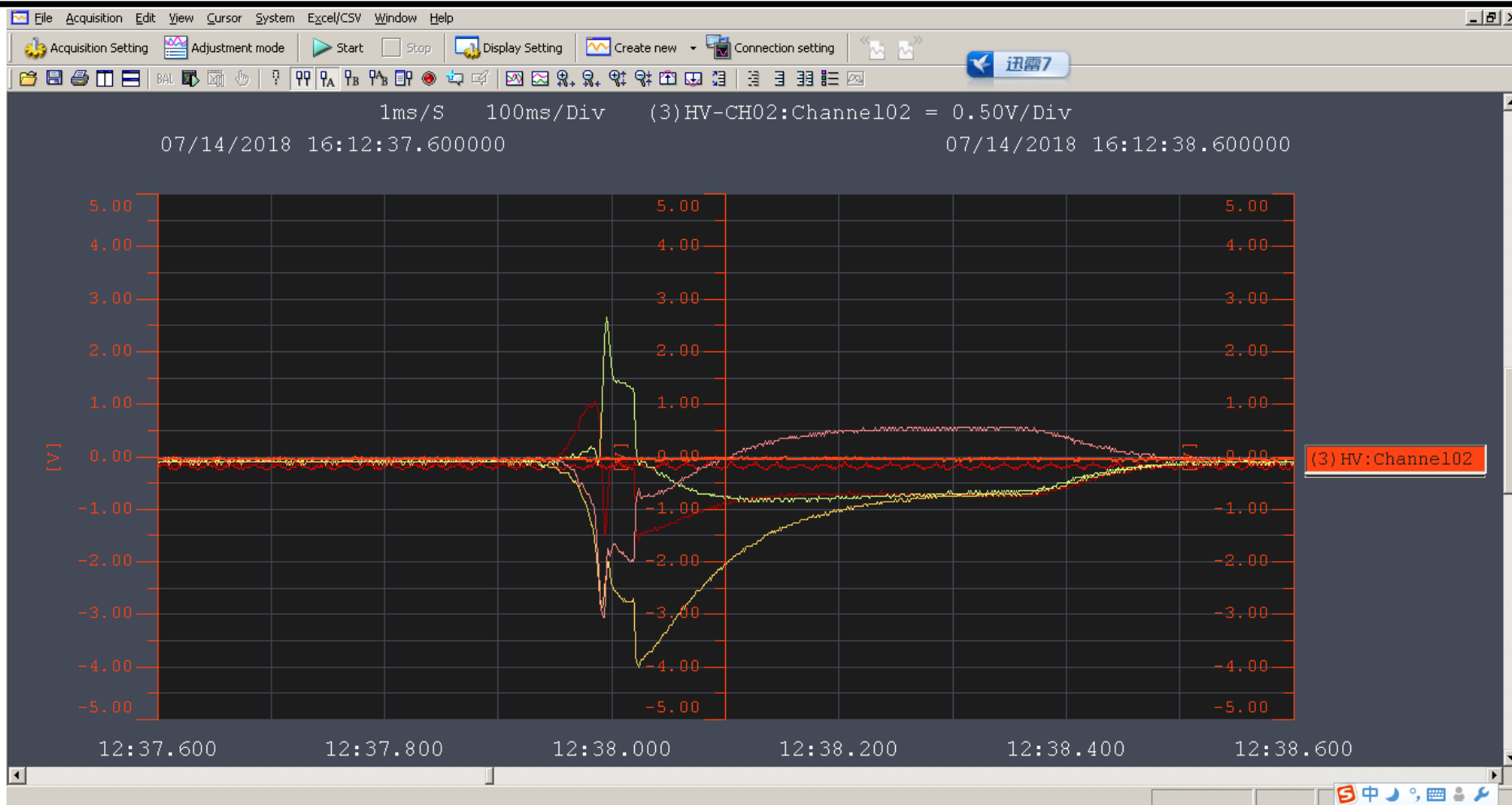
Current voltage

电压 (V) 电流 (A)

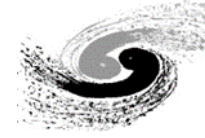
时间



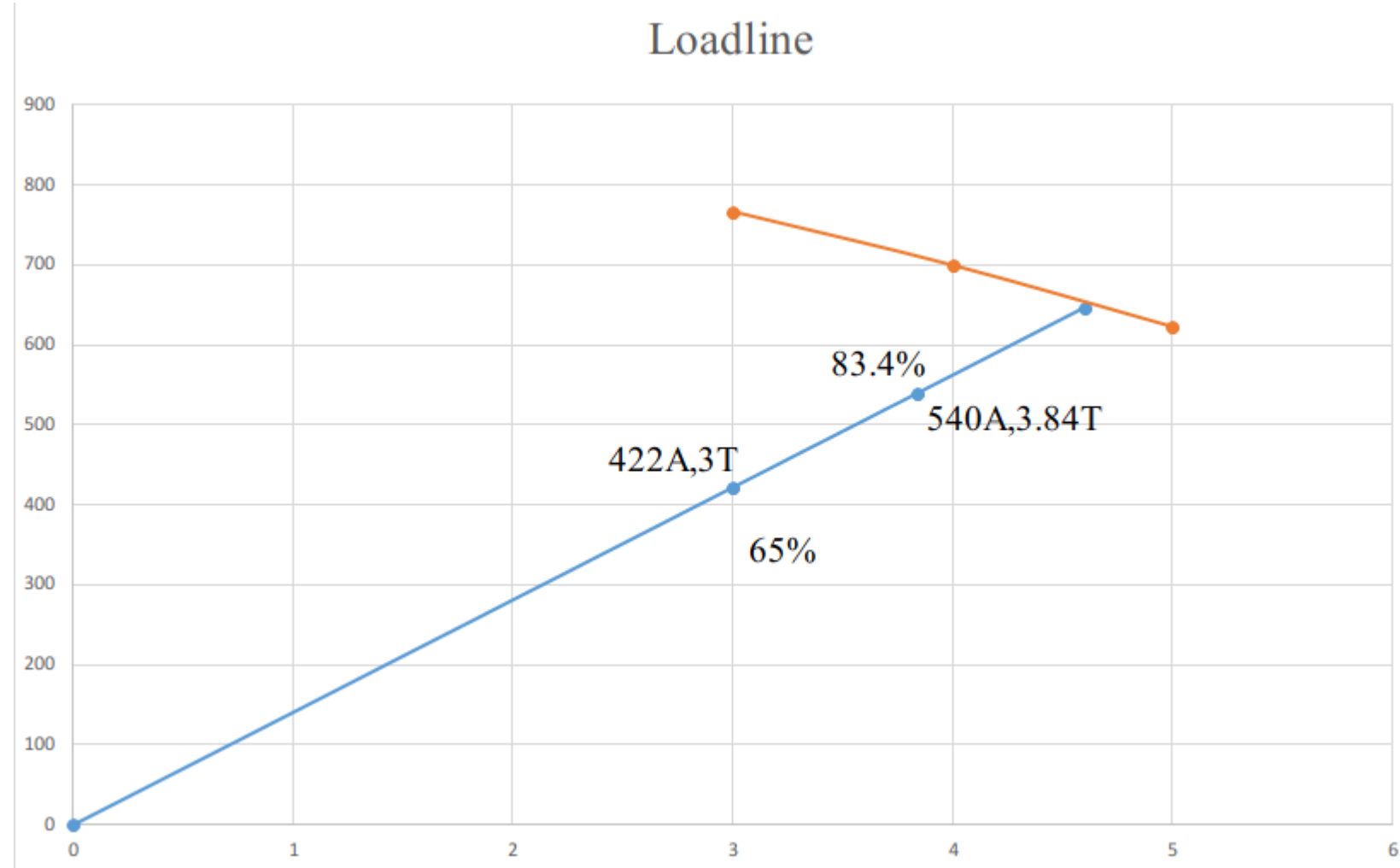
Test ----1# coils test procedure



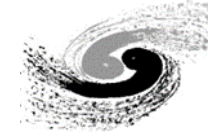
First , the wire of inner 6# and outer 5# quench, then, the wire of inner 7# and outer 2# quench.



Test ---- 1# coils test loadline



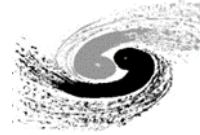
problem



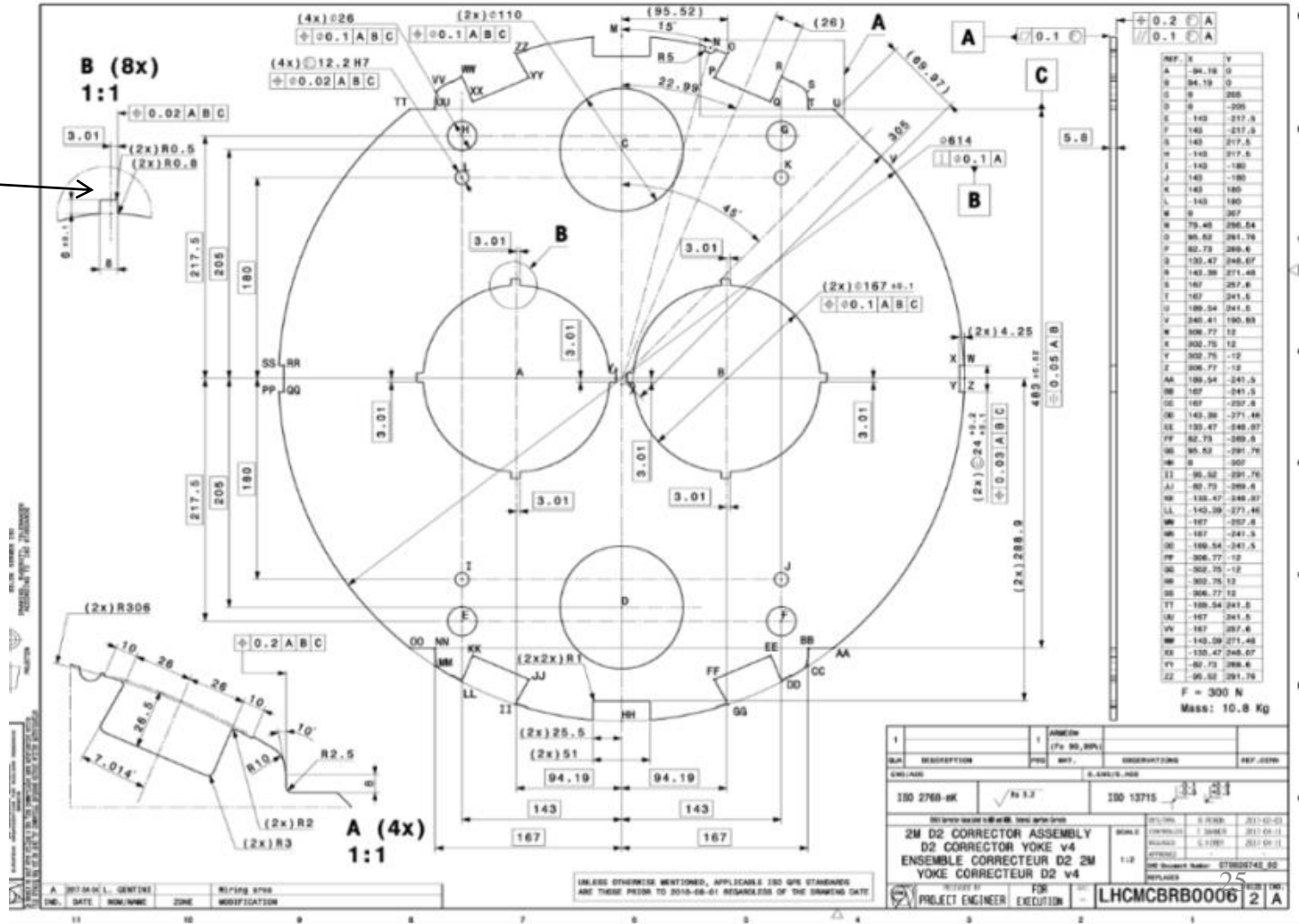
1、material

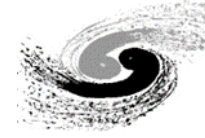
名称	CERN material	WST material
Inner and outer former	6082 T4	6082 T6
The connection end plate of inner and outer coils	6082 T4	6082 T651
External pipe	5083 (H116)	6082 T651

problem



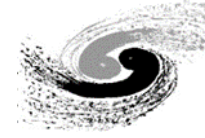
2、 View B:
The position of groove is eccentric groove.





Production plan

序号	日期)	班组/部门	计划进度																						备注	
	内容		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
			7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10	8/11	8/12	8/13	8/14	8/15		
1	轭铁加工	物资供应部	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
	2#内骨架维修	物资供应部	■	■																						
3	2#外骨架绕线	生产		■	■			■	■																	
4	2#绕组组装	生产								■	■															
5	2#绕组固化	生产									■			■	■	■										
6	2#绕组低温测试	生产																■	■							
7	整体组装	测试																			■	■				
8	整体测试	生产																					■	■		



Thanks!