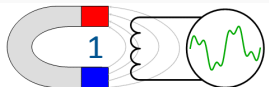


Fresca2

magnetic field angle measurement results

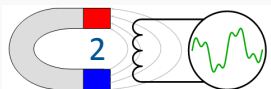
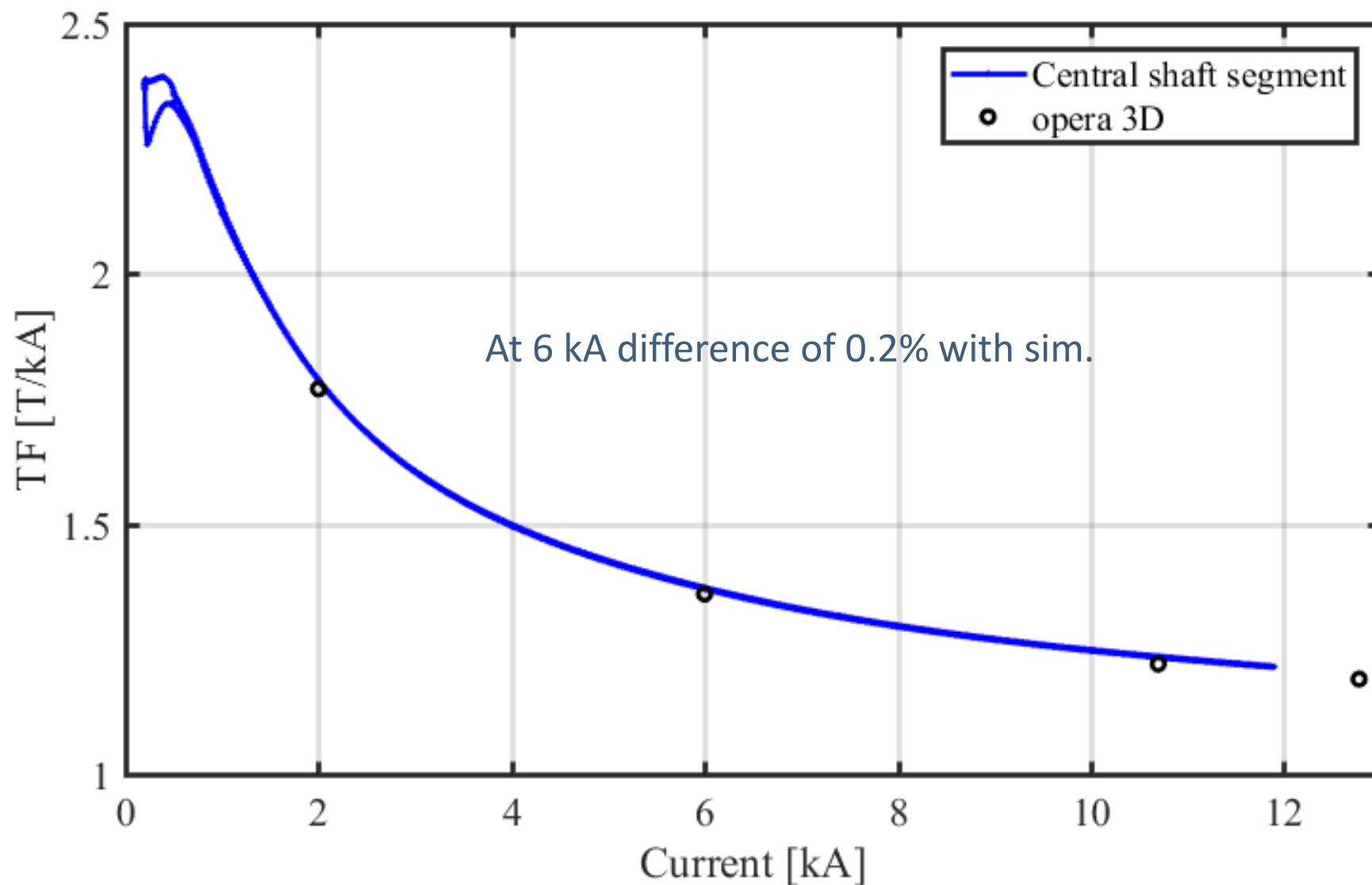
M. Bonora, G. Deferne, C. Petrone

on behalf of MM section



Results at cryogenic temperature 1.9 K measured on 2018

The peak central field is: 14.46 T at 11.90 kA

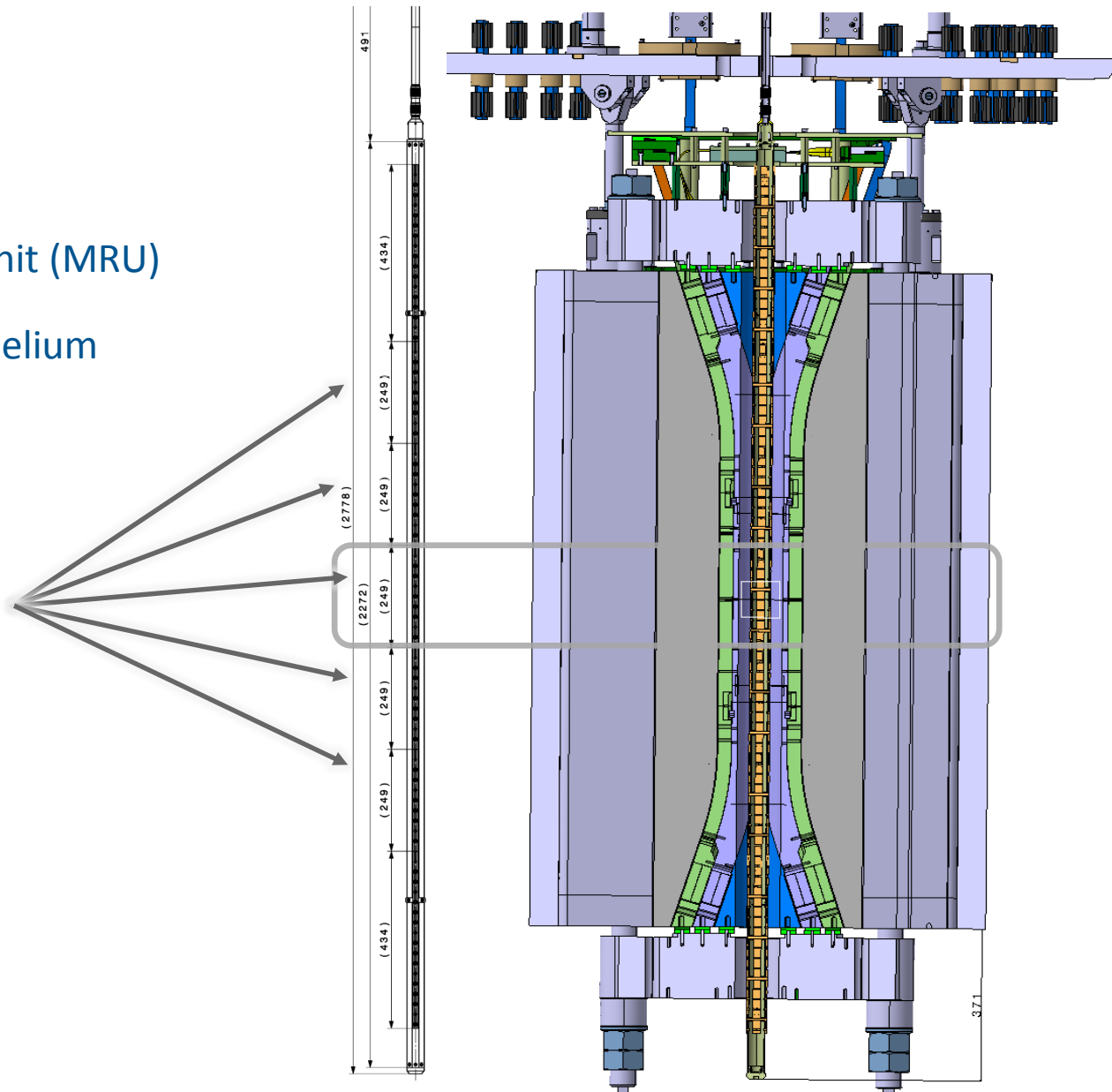
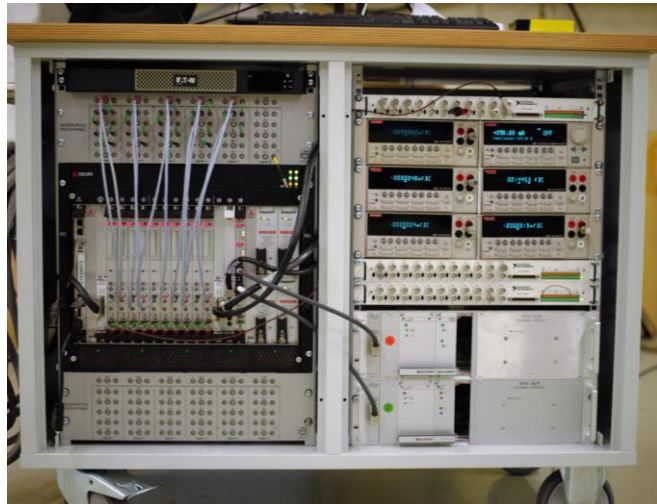


Measurement system at cryogenic temperature

Cryogenic temperature in SM18

- FFMM software
- Fast Digital Integrators (10x)
- Motor + **encoder** + slip-ring unit (MRU)
- Vertical rotating shaft in the helium
 - L = 249 mm

Number of turns	-	36
Magnetic surface	m ²	0.10
Radius	mm	21.5



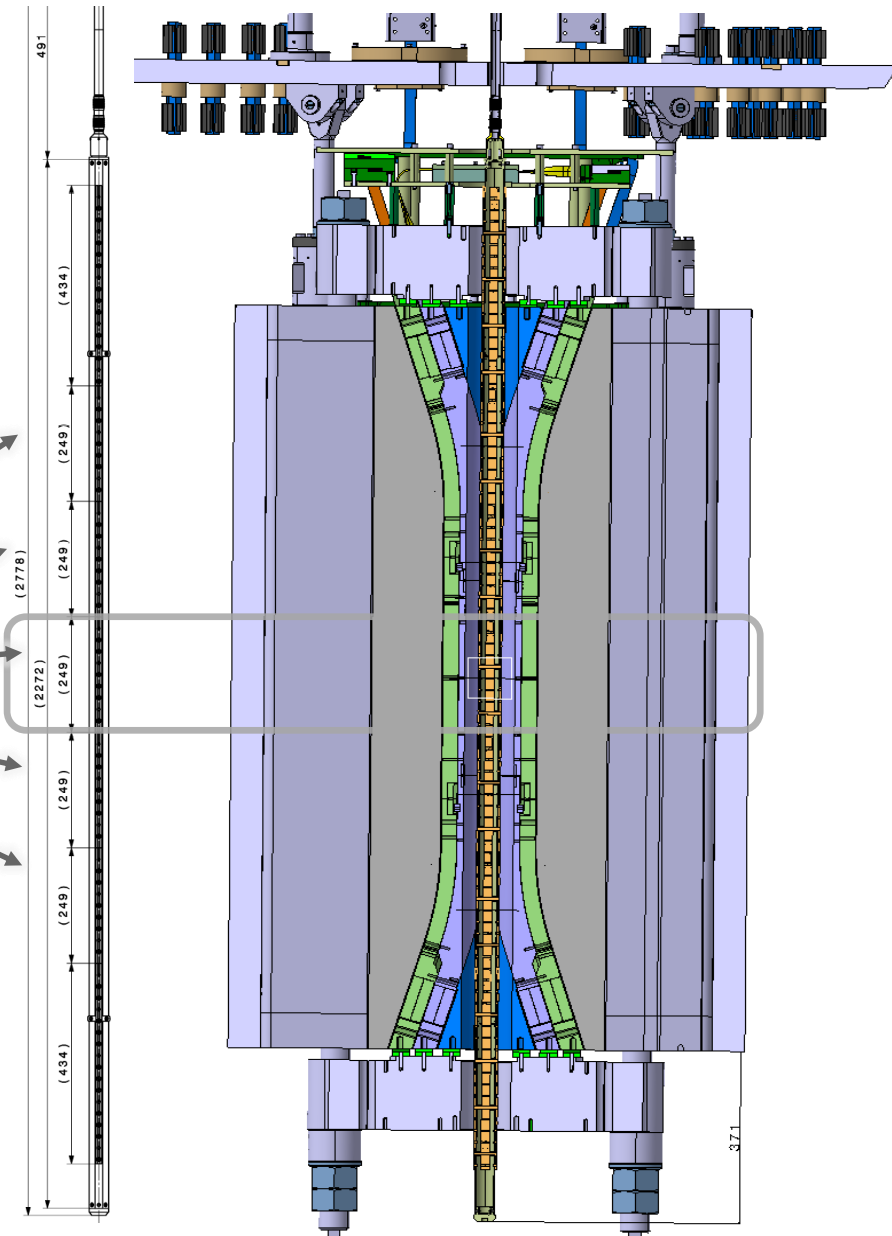
Measurement system at cryogenic temperature

Cryogenic temperature in SM18

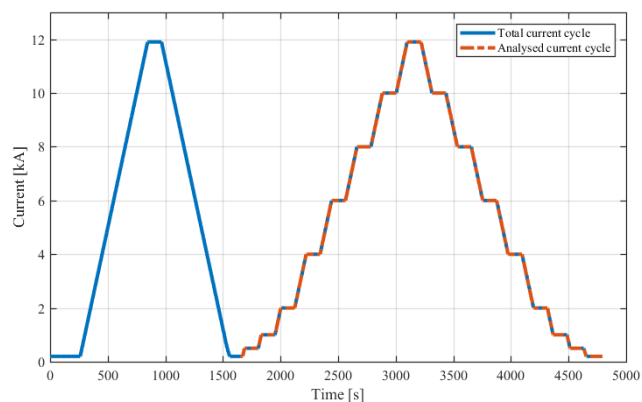
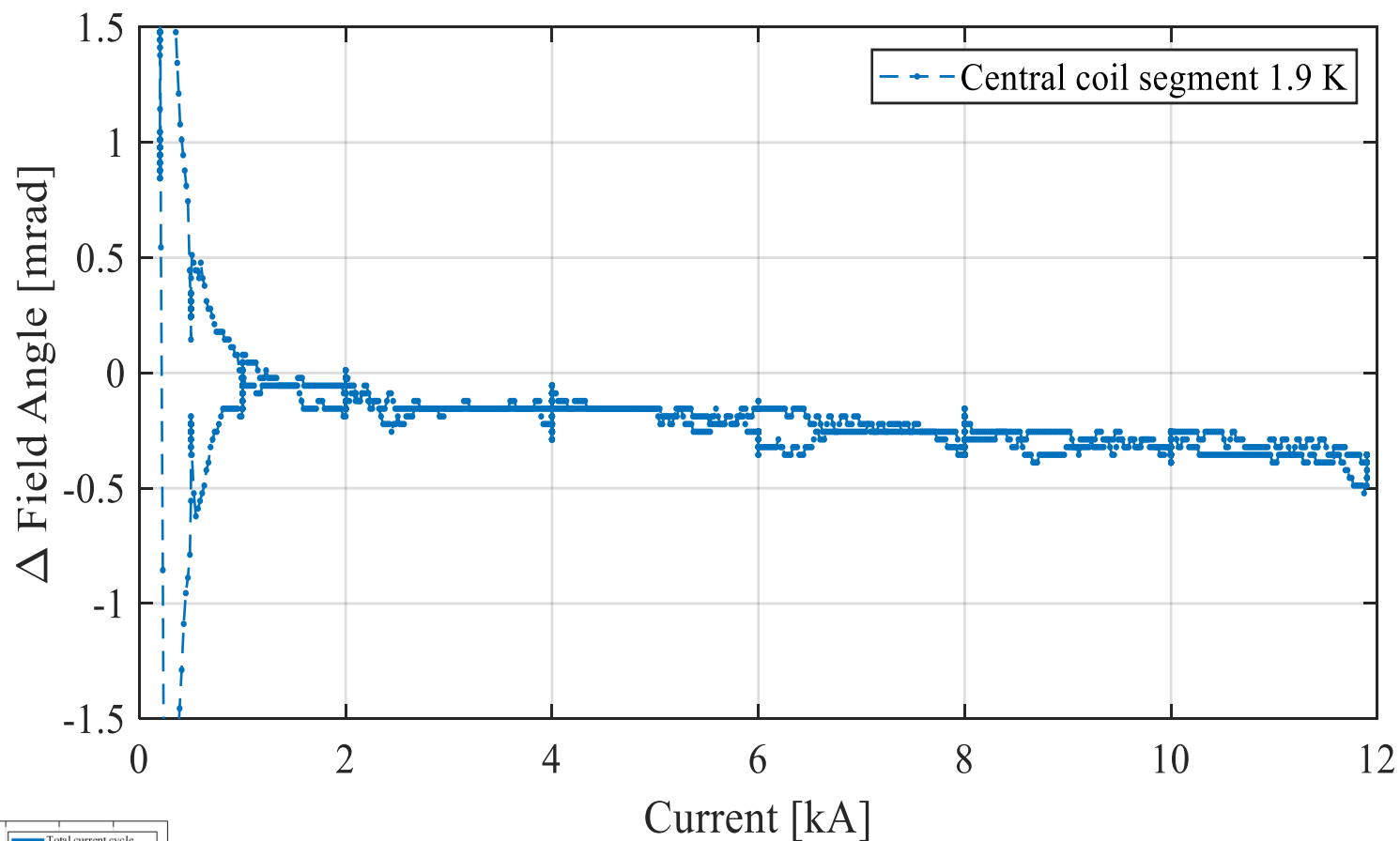
- FFMM software
- Fast Digital Integrators (10x)
- Motor + encoder + slip-ring unit (MRU)
- Vertical rotating shaft in the helium
 - $L = 249$ mm

Number of turns	-	36
Magnetic surface	m ²	0.10
Radius	mm	21.5

**NO link
between field angle
and magnet mechanical
references**



Results at cryogenic temperature 1.9 K measured on 2018

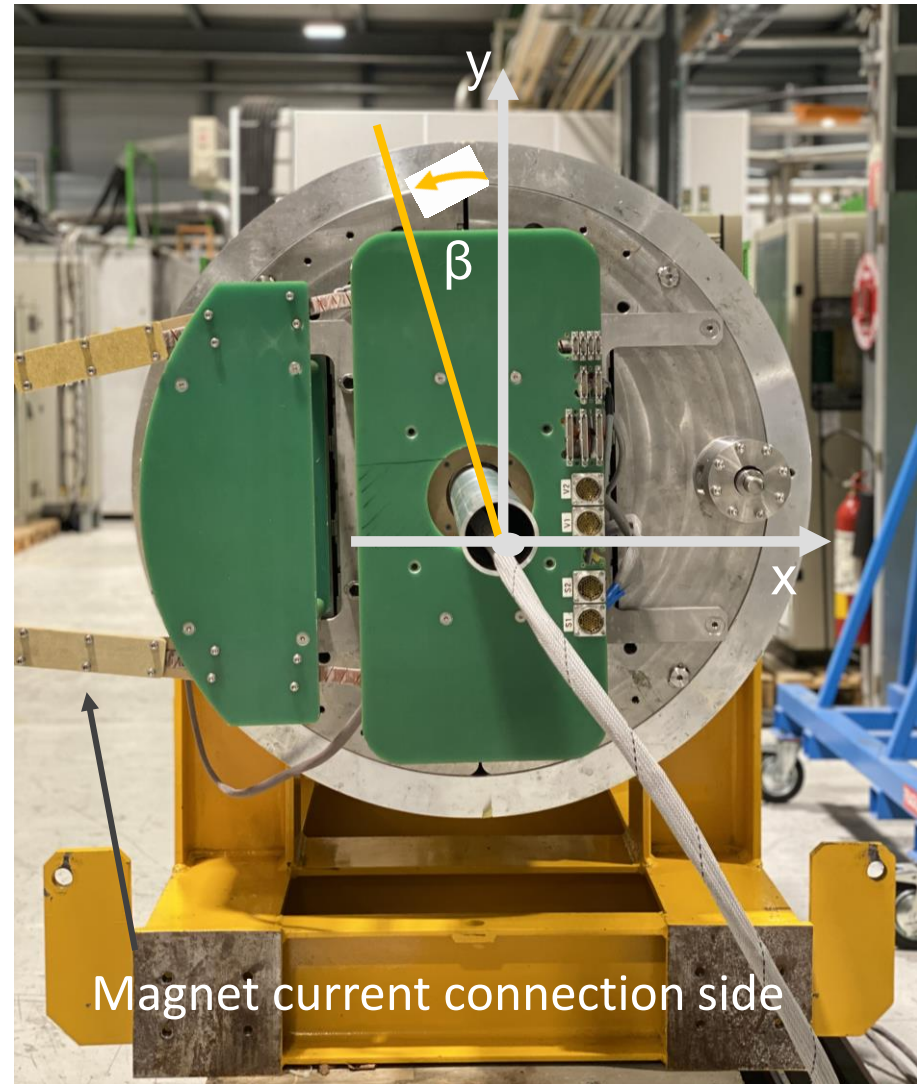


Relative angle variation from 200 A to 12 kA < 0.5 mrad



Field direction measured at room temperature in SM18 by

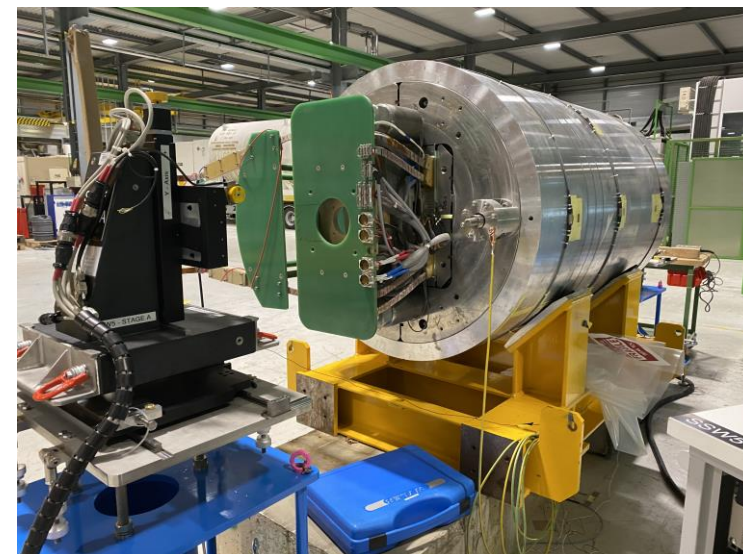
1. Single stretched **wire**
2. Rotating **coil** scanner



Field direction measurements: stretched wire

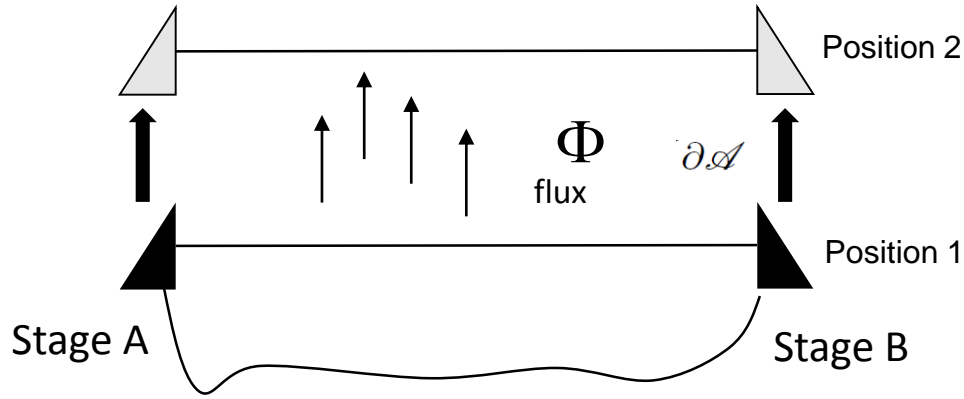
Single stretched wire

- Mechanically aligned to gravity during the installation
- System offset calibration on reference magnet in 311

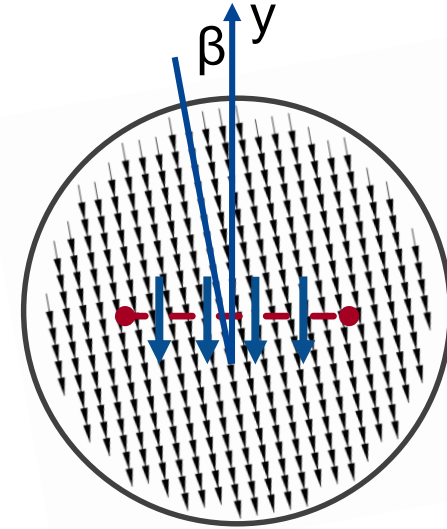


Field direction measurements: stretched wire DC

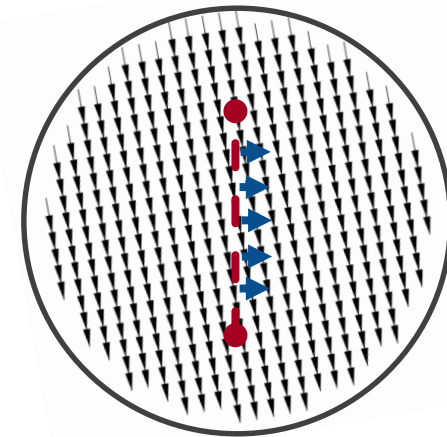
Principle: Faraday's law



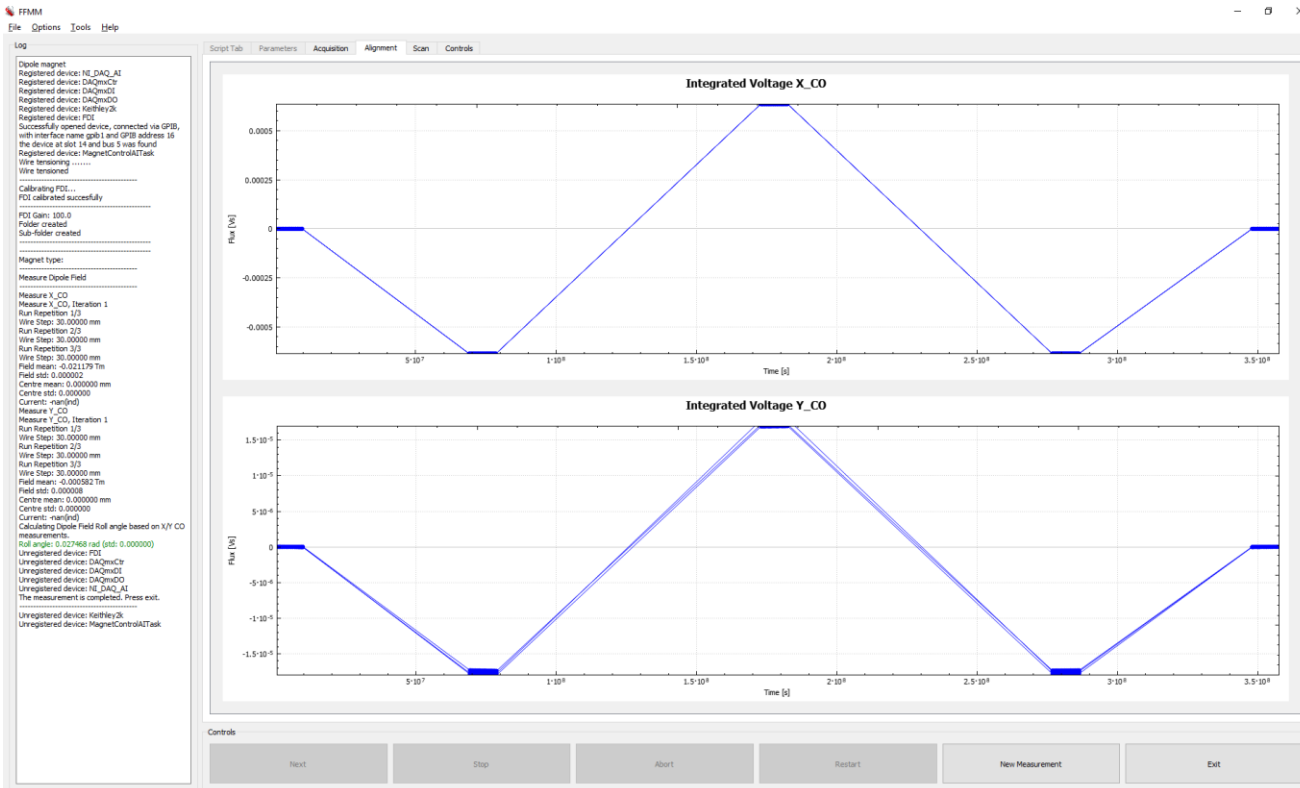
Horizontal wire motion: B_y



Vertical wire motion: B_x



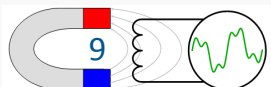
$$\beta = \arctg\left(\frac{B_x}{B_y}\right)$$



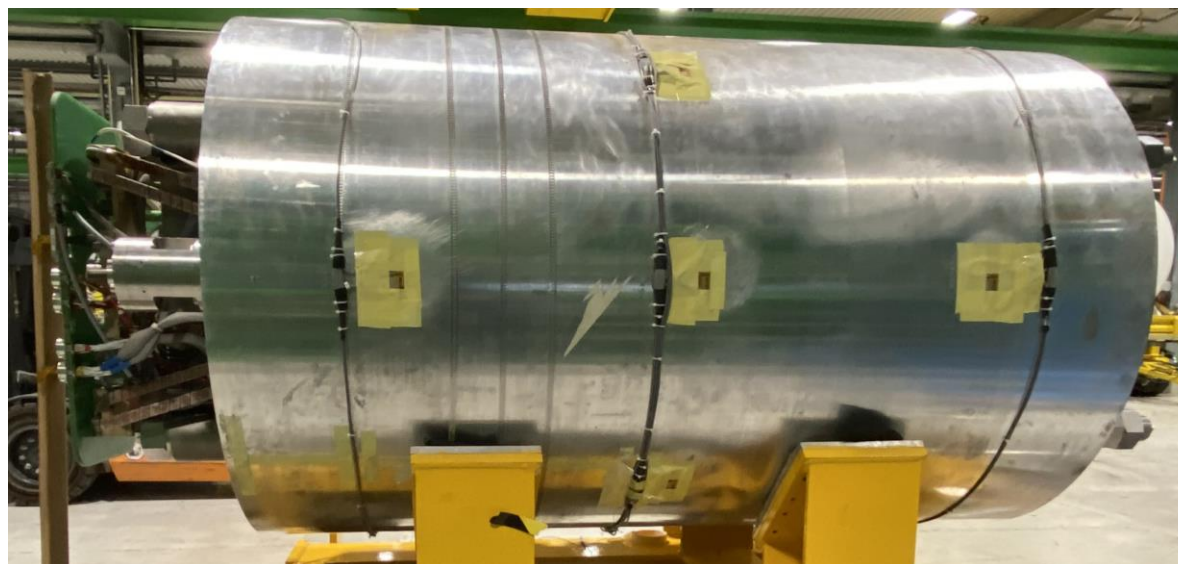
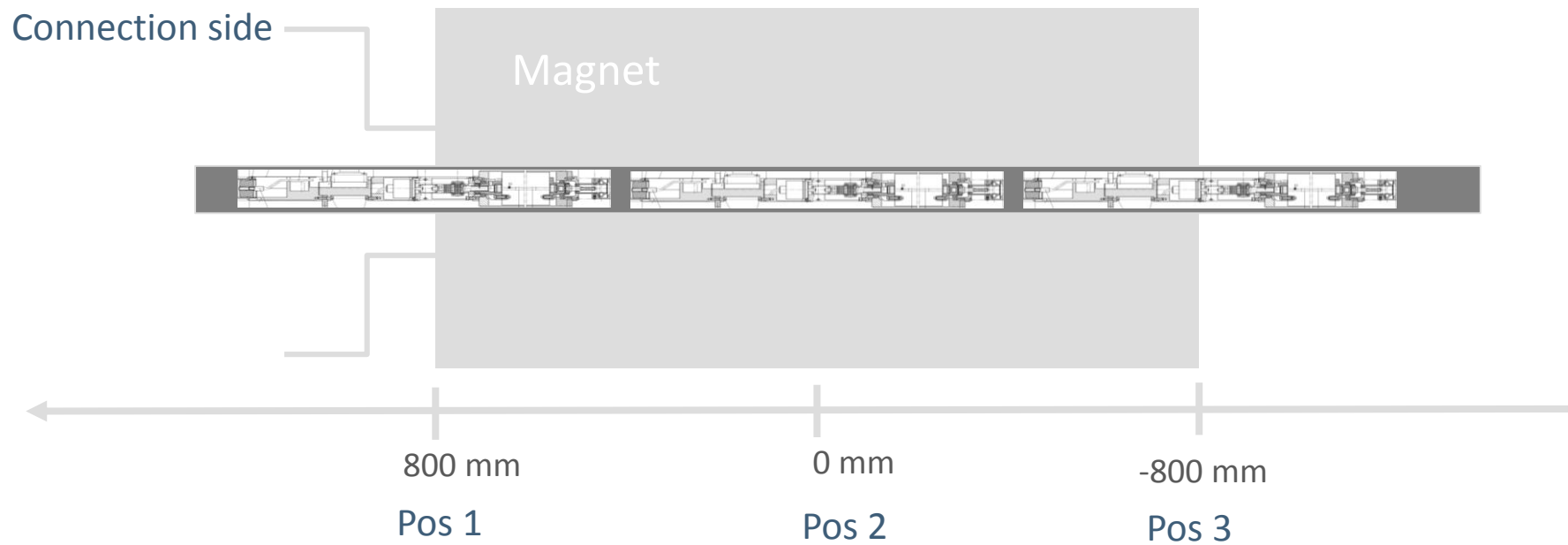
Field direction measurements: stretched wire DC

To compensate external influences (e.g.: the Earth magnetic field) measurement performed at ± 8 A

Measurement	Current [A]	Field By [Tm]	Field Bx [Tm]	Angle [mrad]
SSW	8	-0.021257	-0.000585	27.5
SSW	-8	0.021526	0.000580	26.9
			Average	27.2

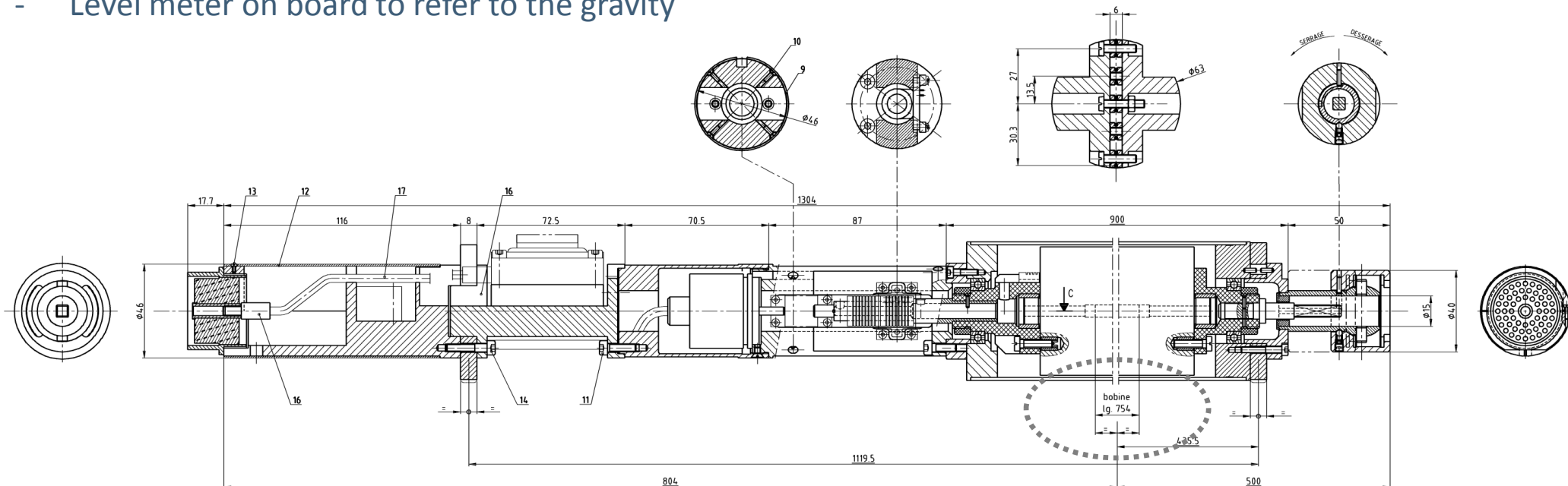


How the angle changes longitudinally? Horizontal rotating coil scanner



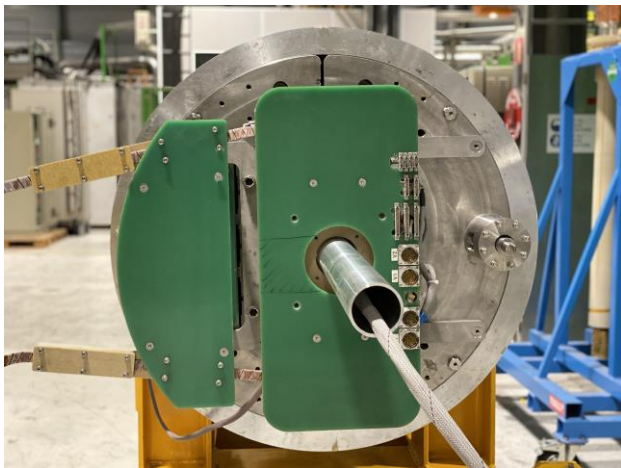
Horizontal induction coil scanner

- A tube of 70 mm inner diameter was needed to support the measurement head
- A measurement head (68 mm max diameter), an induction coils of **754 mm**
- Level meter on board to refer to the gravity



Installation procedure

Signal cable insertion
from Side B



Measurement head
from Side A



Signal cable connection
from Side A



Connect all cable needed
to the electronic rack

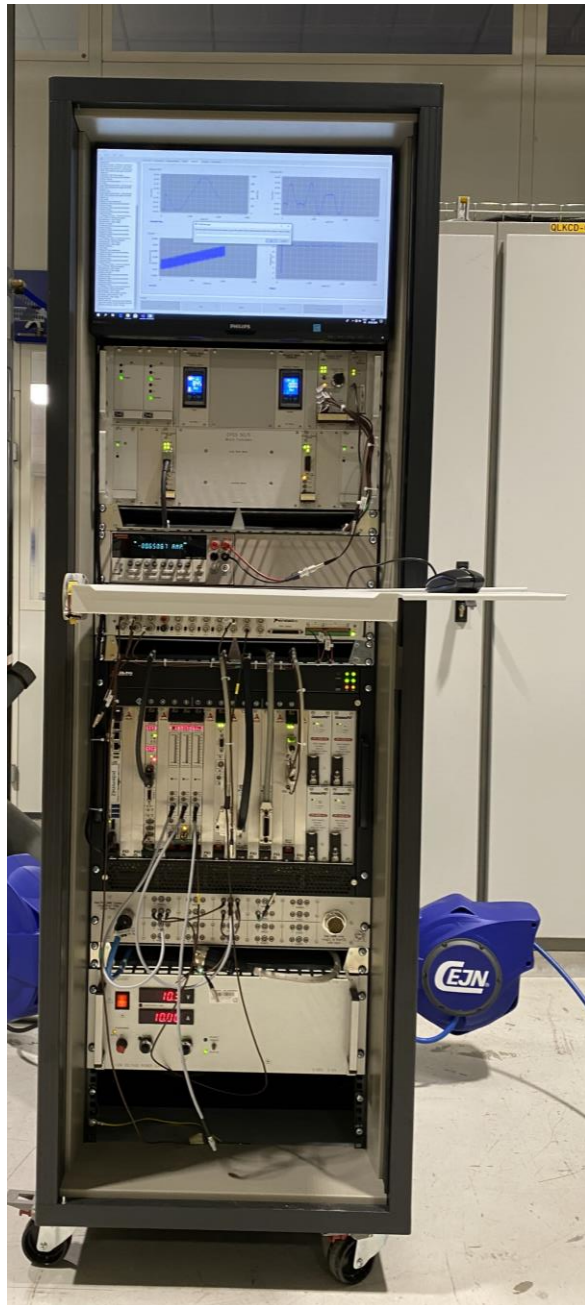


Connection mechanical extension
from Side A



Insertion the head
from Side A

Electronic rack and measurement procedure



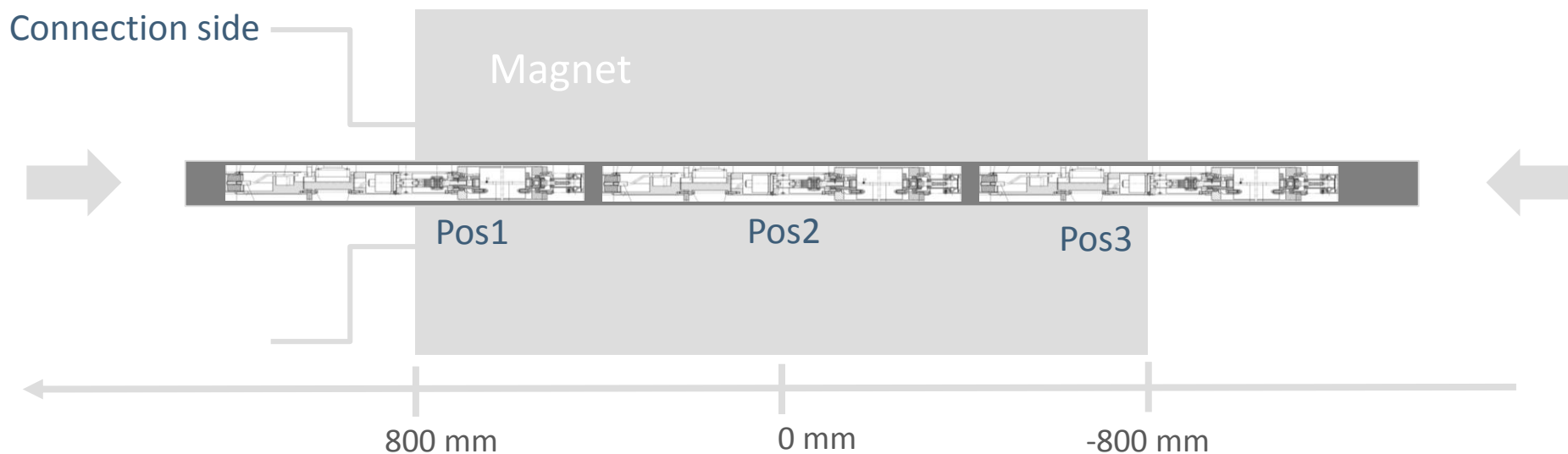
Measurement procedure driven by C++ Framework (FFMM)

- On board power supply provides the magnet current
- A control loop drives a motor to align the “mole” to gravity
- Pneumatic break block the position found
- Internal measurement coils start to rotate and measurements are taken rotating forwards and backwards to compensate system offset
- Process can start in next longitudinal position



Rotating induction coil

Measurements in three different **positions** and from both magnet **sides** to compensate system **offset** angles



	Pos1 [mrad]	Pos2 [mrad]	Pos3 [mrad]
Averaging ± 8 A	27.9	23.5	22.9
Deltas with Pos2	4.36	0.00	-0.65

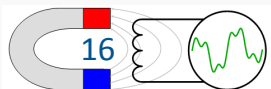
Integral field angle: **27.2** mrad

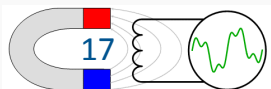
Central field angle: **23.5** mrad

Measurement with respect to **gravity** on the magnet at present location

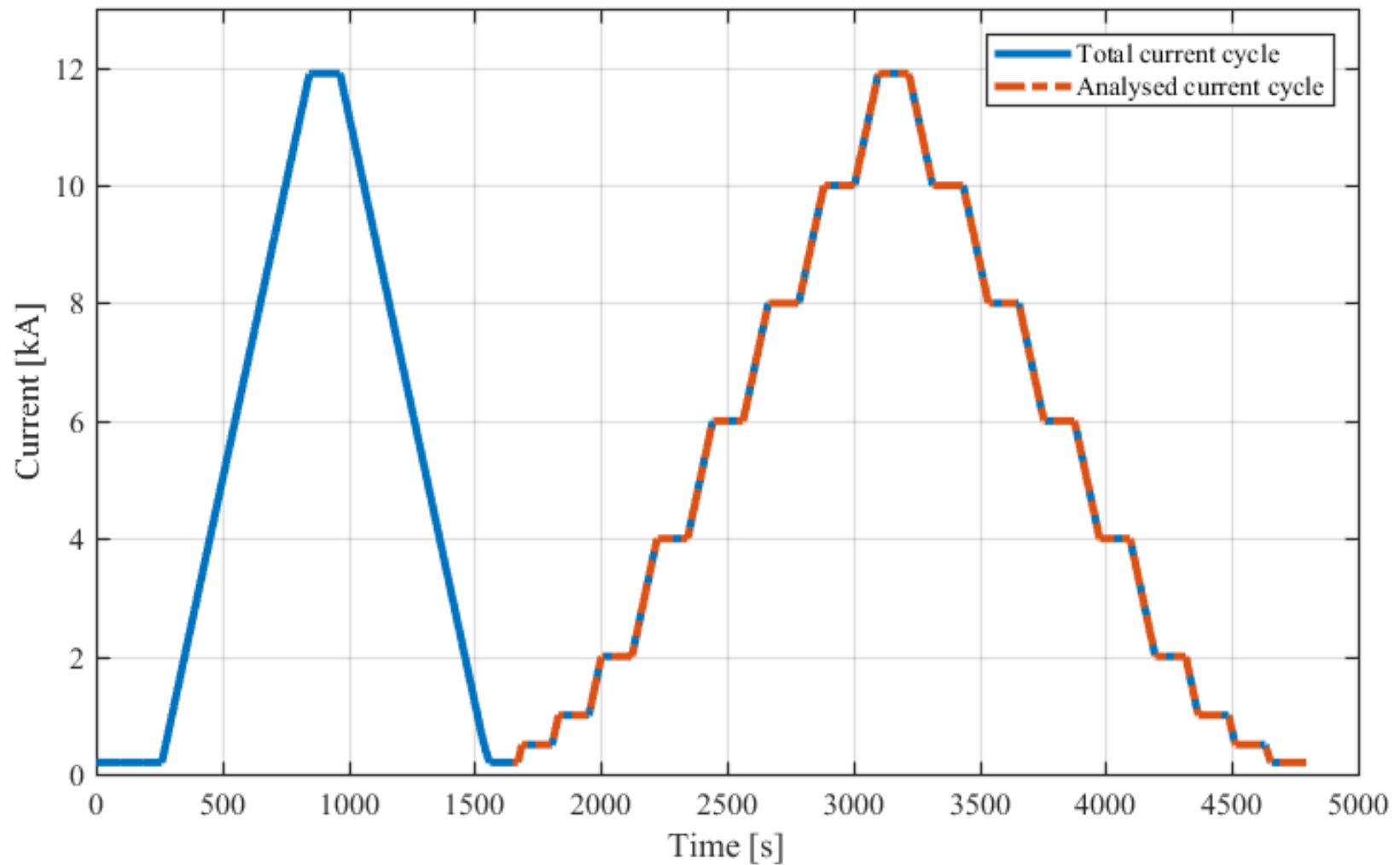


Thank you for your attention

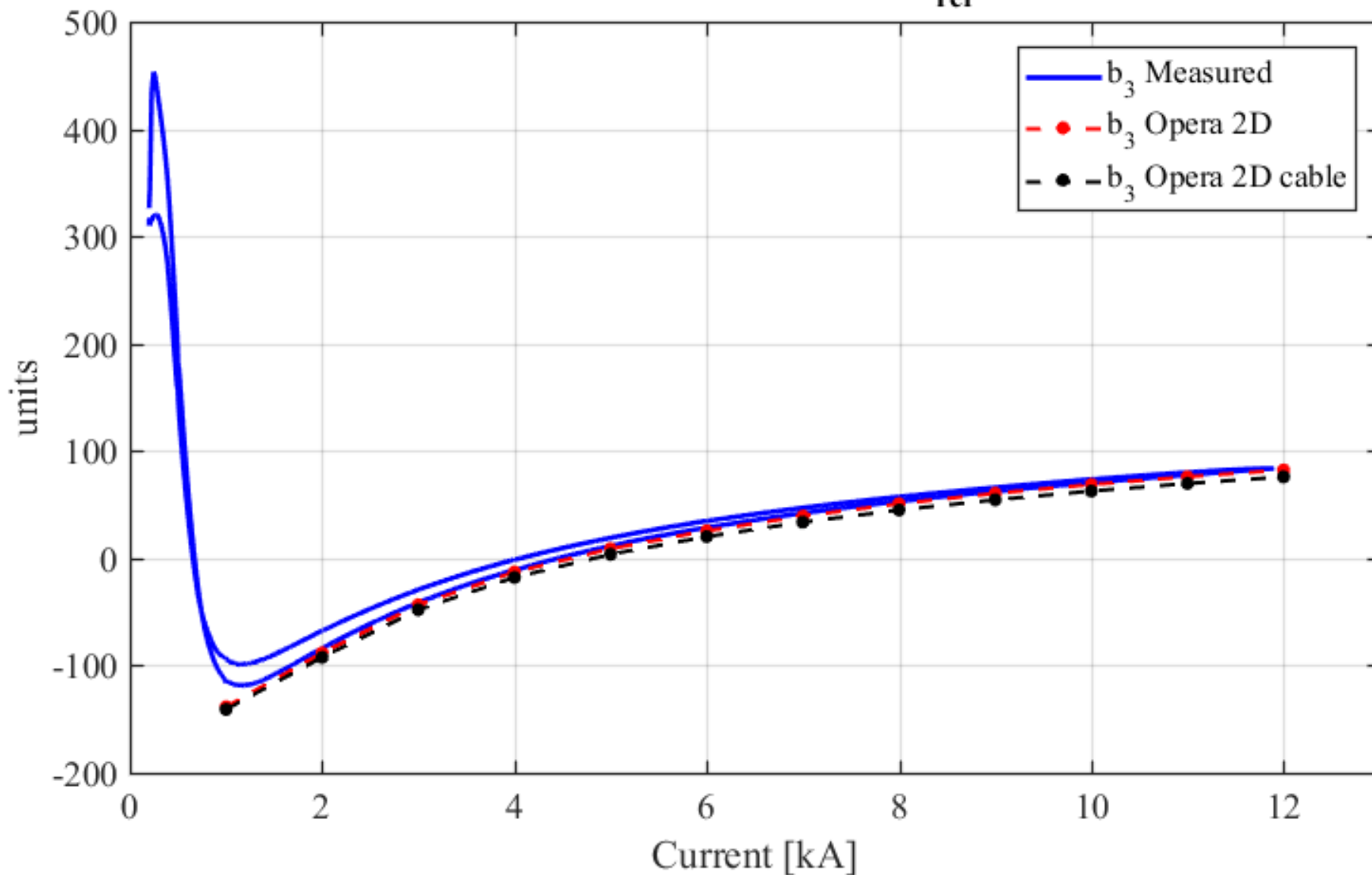




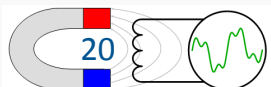
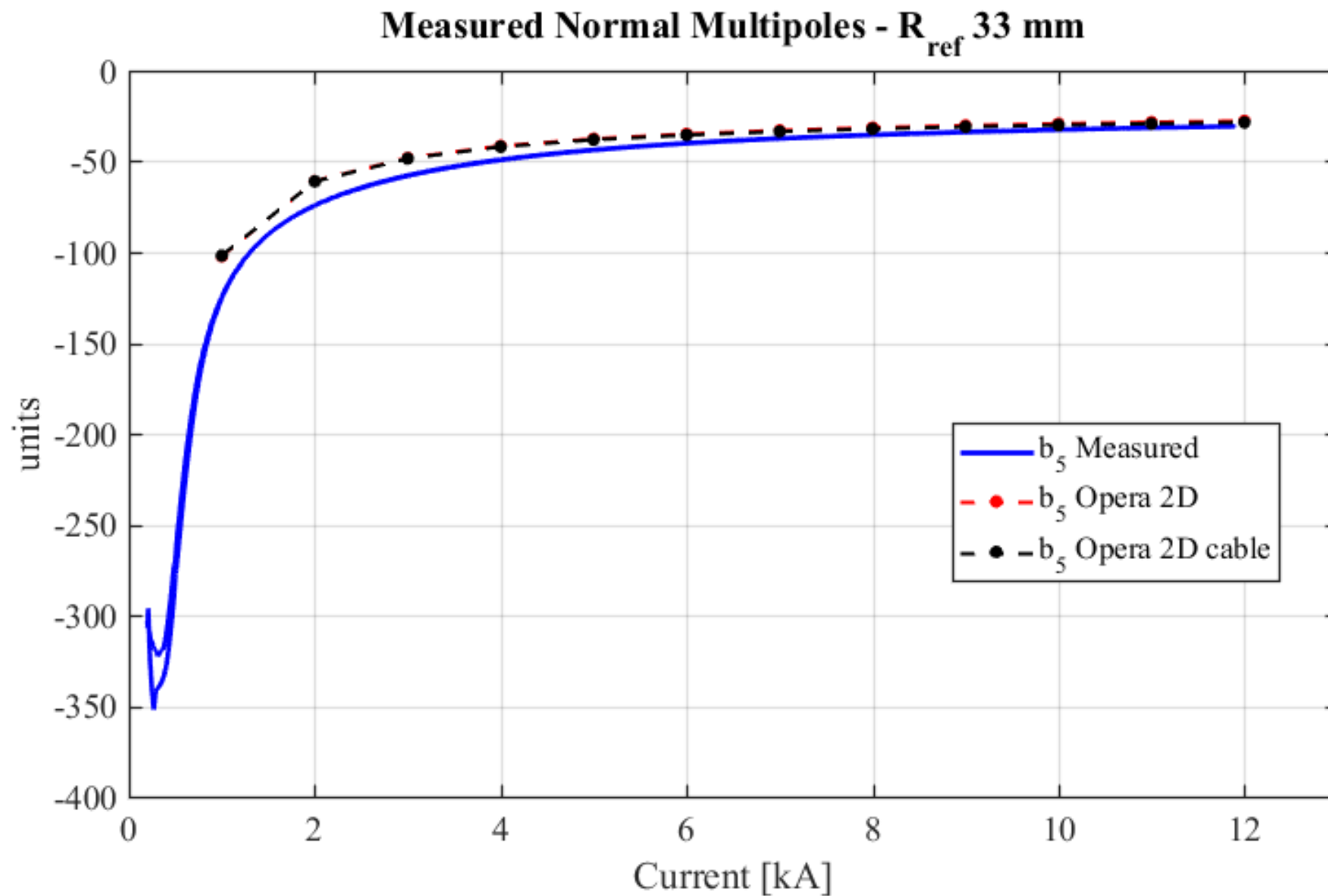
Results at cryogenic temperature 1.9 K: current cycle



Measured Normal Multipoles - R_{ref} 33.33 mm

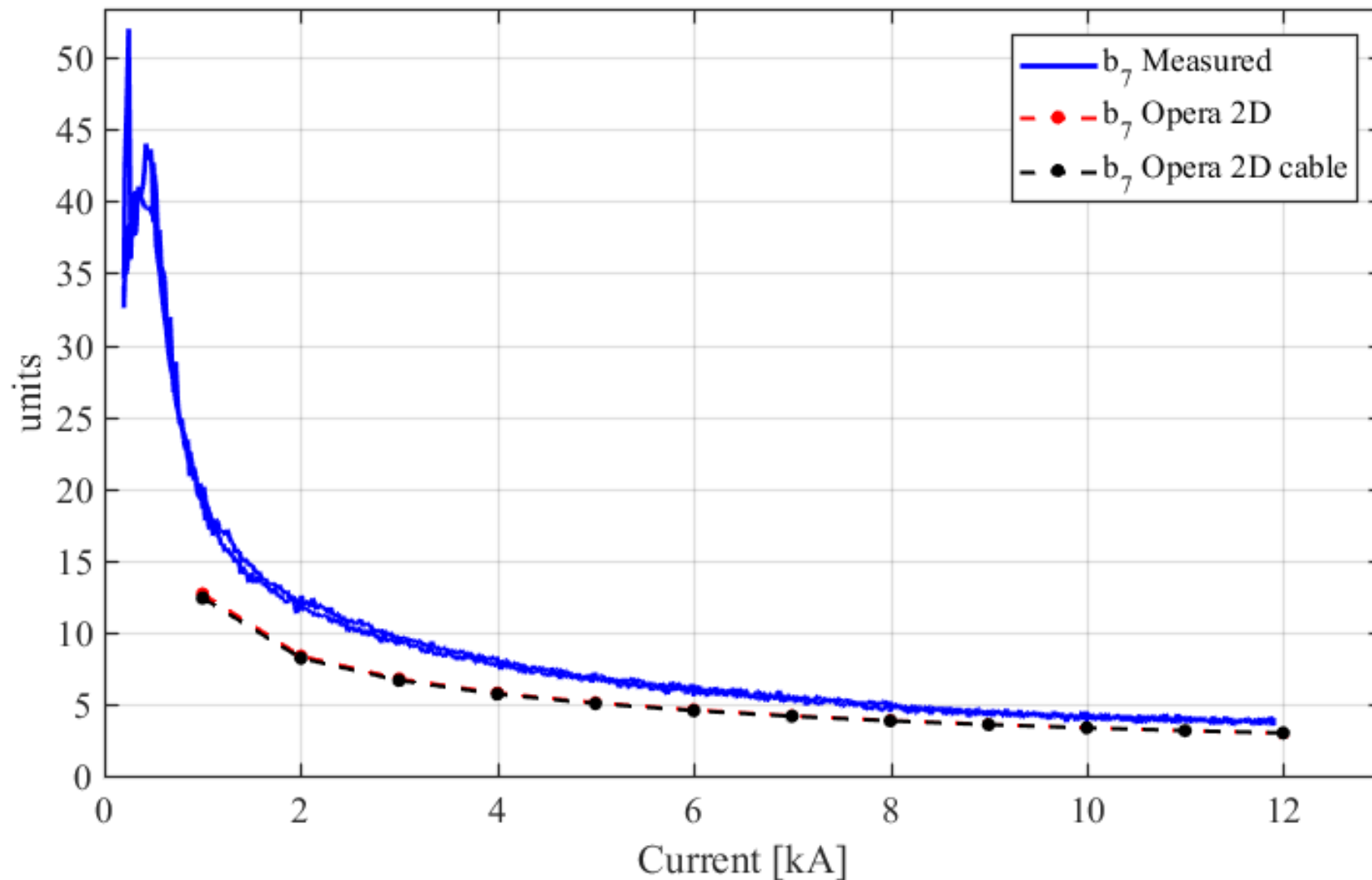


Results at cryogenic temperature: multipoles



Results at cryogenic temperature: multipoles

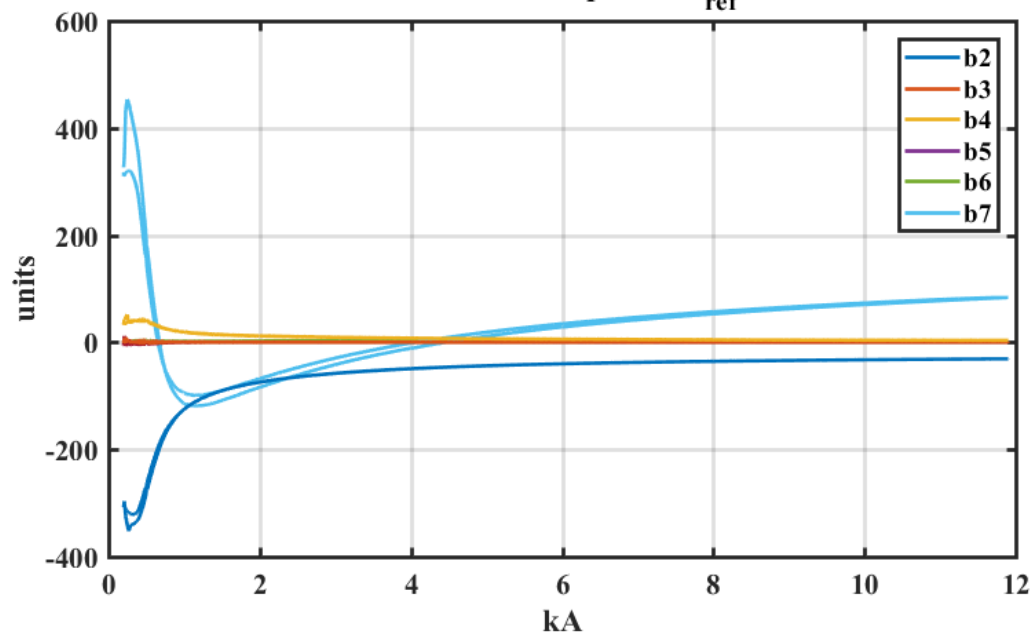
Measured Normal Multipoles - R_{ref} 33.33 mm



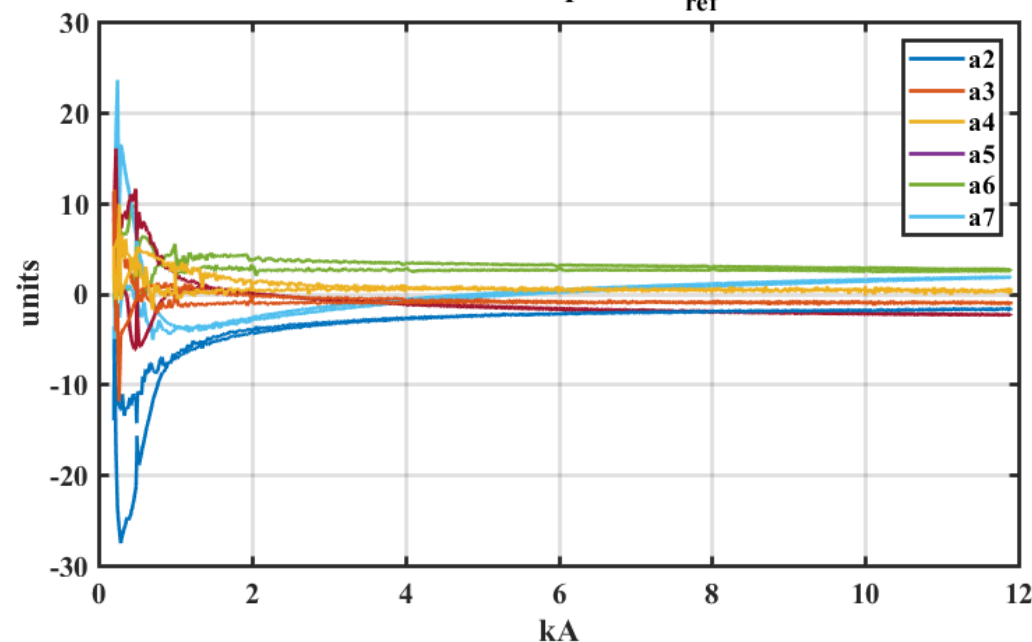
6 kA			
n	bn	an	bn Opera 2D
2	2.6	2.8	0
3	31.7	0.2	25.7
4	0.1	-1.6	0
5	-39.9	-2.2	-34.8
6	0.2	-0.9	0
7	5.9	0.52	4.6

8 kA			
n	bn	an	bn Opera 2D
2	2.6	2.8	0
3	55.2	0.9	50.8
4	0.1	-2.0	0
5	-35.3	-1.9	-31.3
6	0.3	0.9	0
7	4.8	0.4	3.9

Measured Normal Multipoles - R_{ref} 33.33 mm



Measured Skew multipoles - R_{ref} 33.33 mm



Consistency with measurements performed in 2017

