Magnetic measurements on MCBXFBP2

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with the help of colleagues from MM, TF, and CIEMAT

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Up to now…

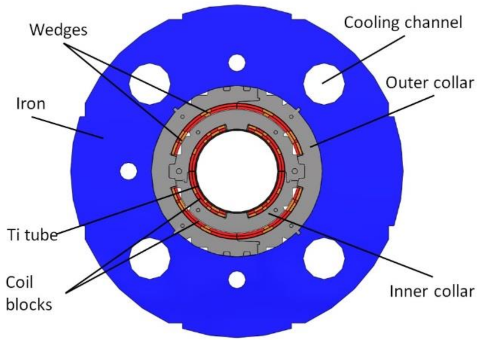
- MCBXFBP1

  - 10th April 2019
  - 1.9 K up to 600 A
  - https://indico.cern.ch/event/810843/

  - 31st July 2019
  - Ambient temperature
  - 1.9 K up to nominal
  - Combined powering up to 900 A
  - https://indico.cern.ch/event/833847/

  - 2nd October 2019
  - 1.9 K up to nominal
  - Combined powering up to nominal
  - https://indico.cern.ch/event/848426/

Introduction



Vertical field from the inner coils:

- main field B_1 (normal)

- first allowed b_3

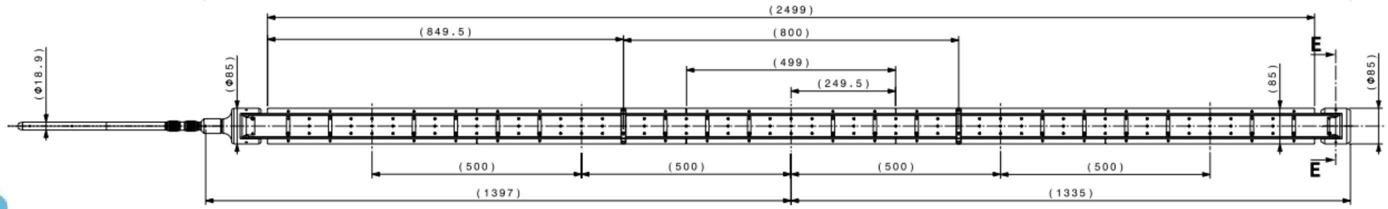
Horizontal field from the outer coils:

- main field A_1 (skew)

- first allowed a_3

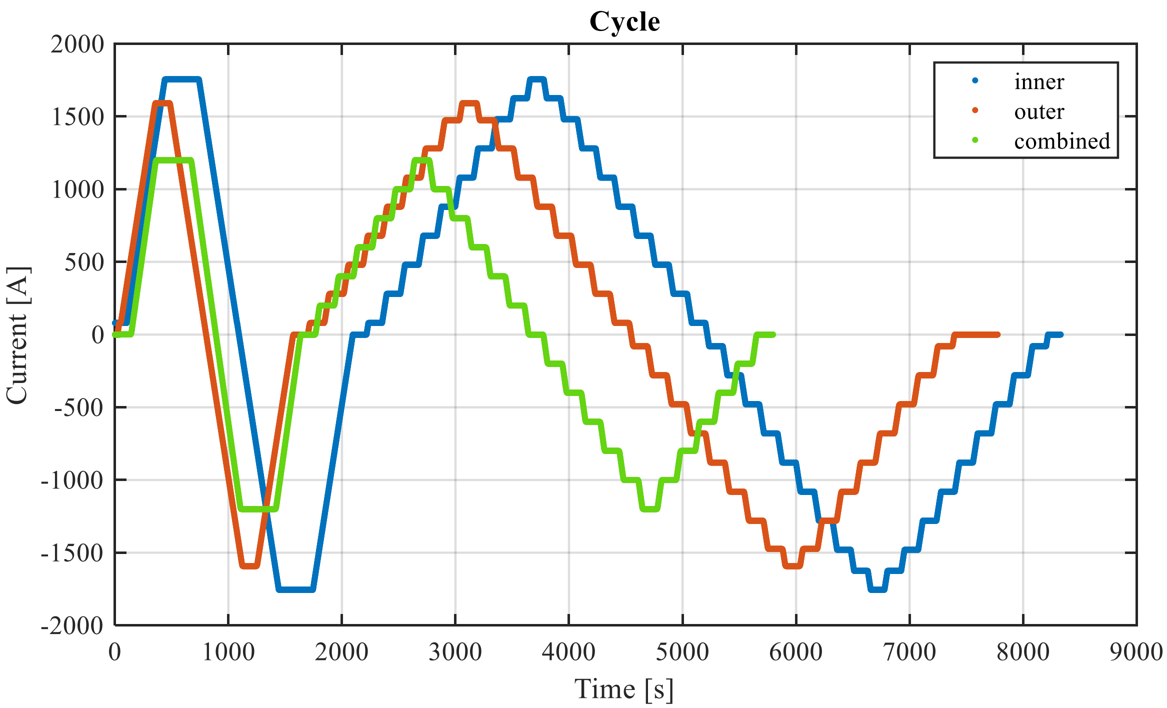
Rotating-coil in the helium bath of vertical cryostat clusterD in SM18

- 5 segments (500 mm each, 2.5 m total)
- Not the same as for MCBXFBP1



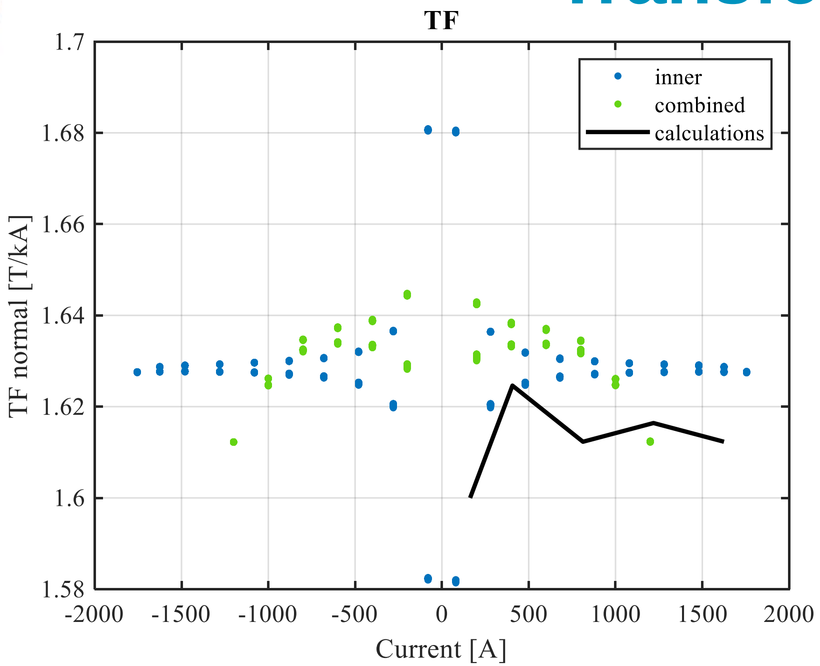
Reference radius 50 mm

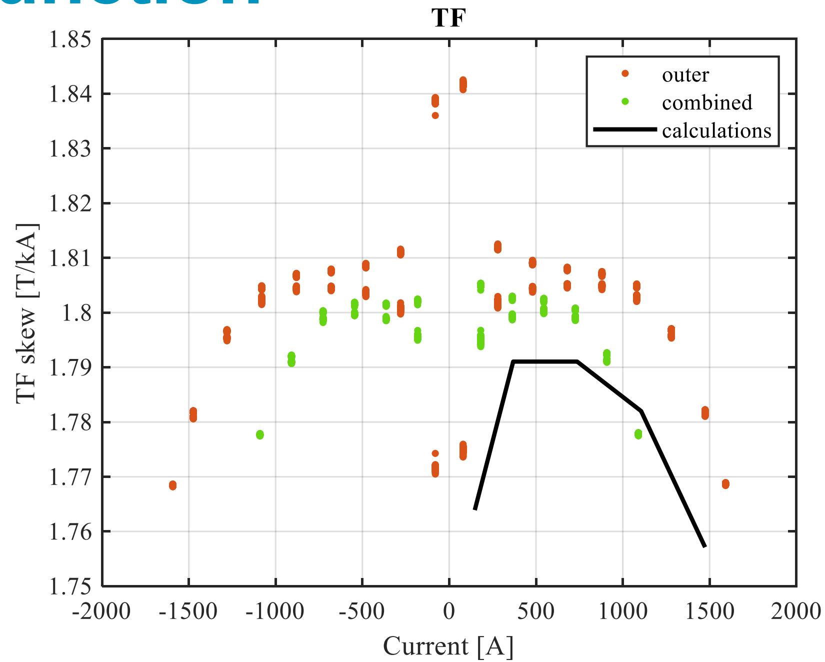
Powering cycles



- First time we use a 4-quadrants converter able to reach ultimate

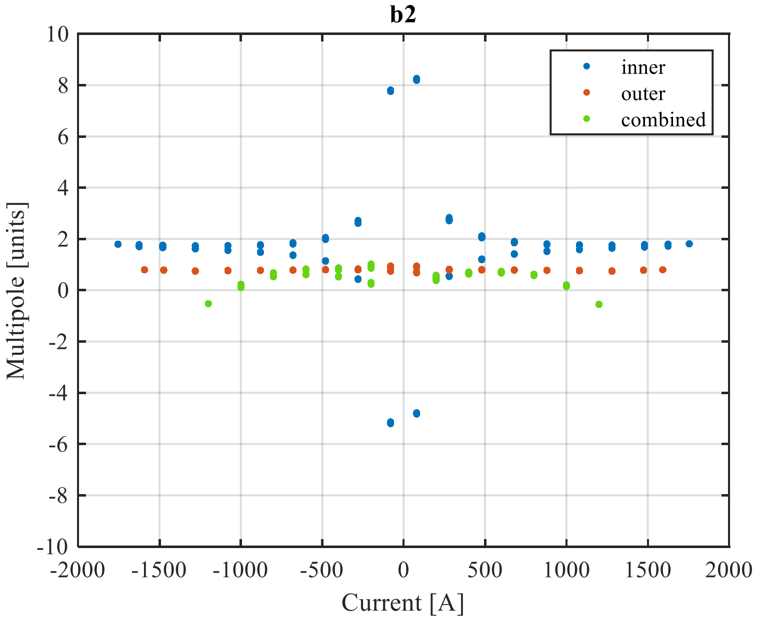
Transfer function

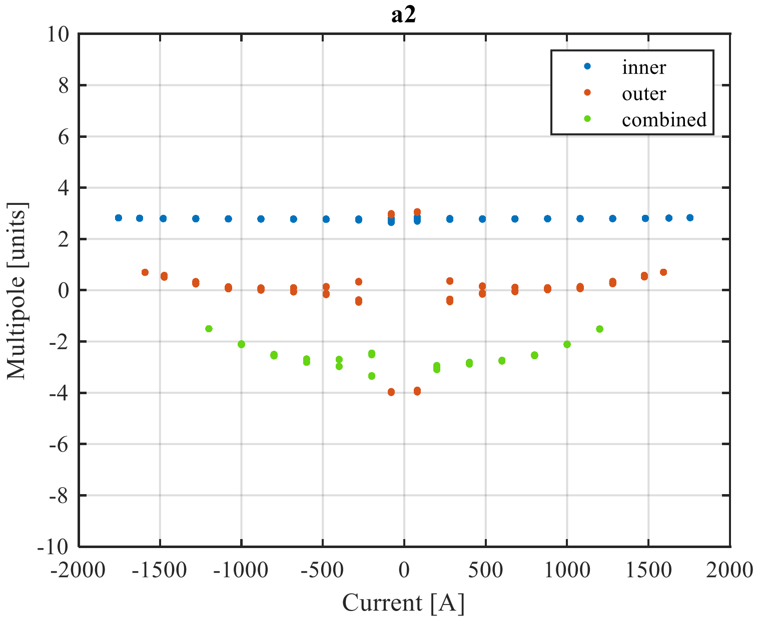




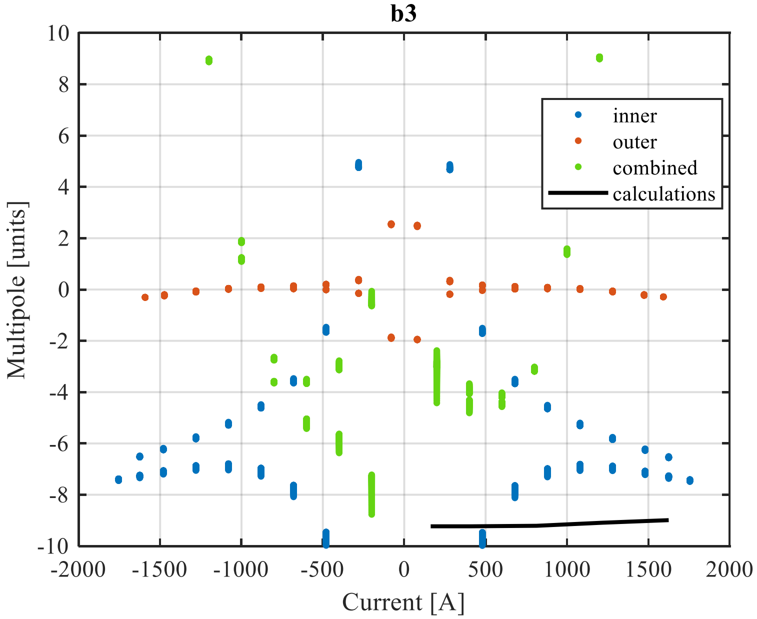
3D model	Units	Inner Dipole	Outer Dipole
Nominal current	A	1625	1474
Nominal integrated field	T m	2.62	2.59
Diff vs MM	**%**	-0.9	-1.3

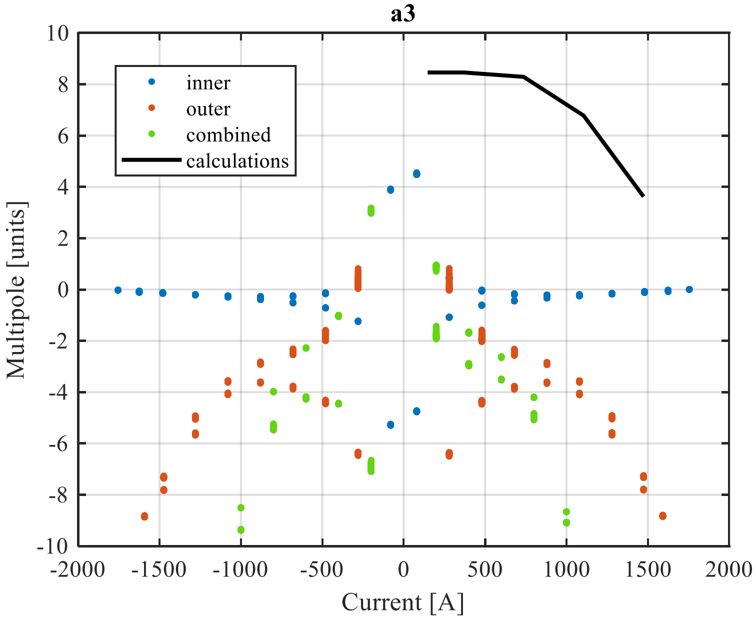
Multipoles vs current





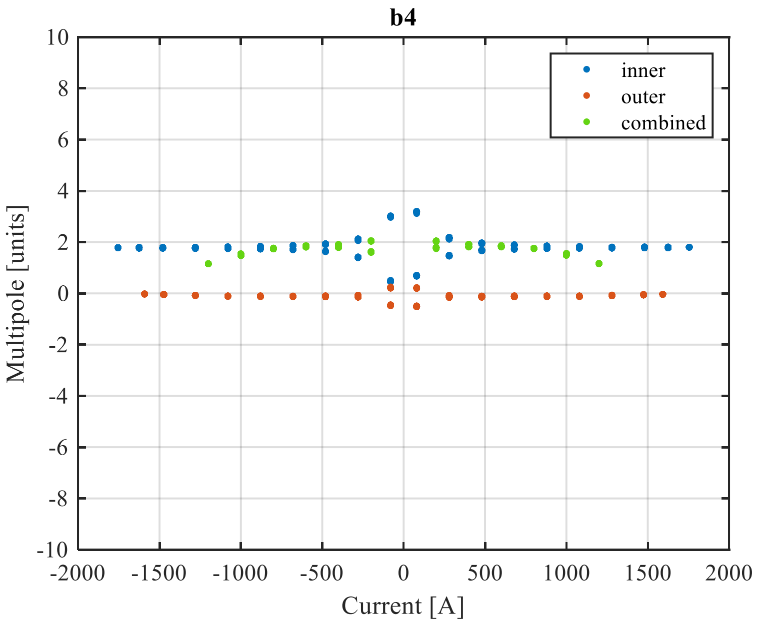
Multipoles vs current

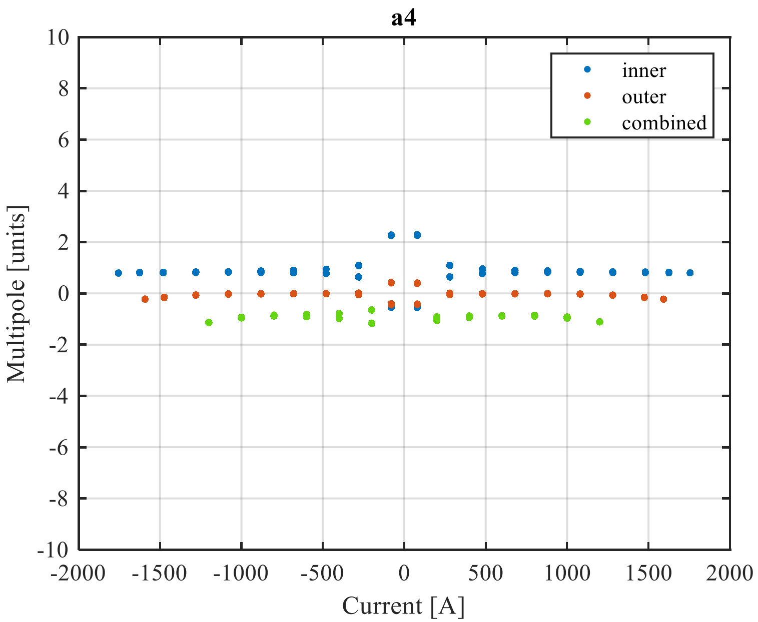




- a3 of outer plane
  - calculations show an offset of +11 units
  - saturation well modelled

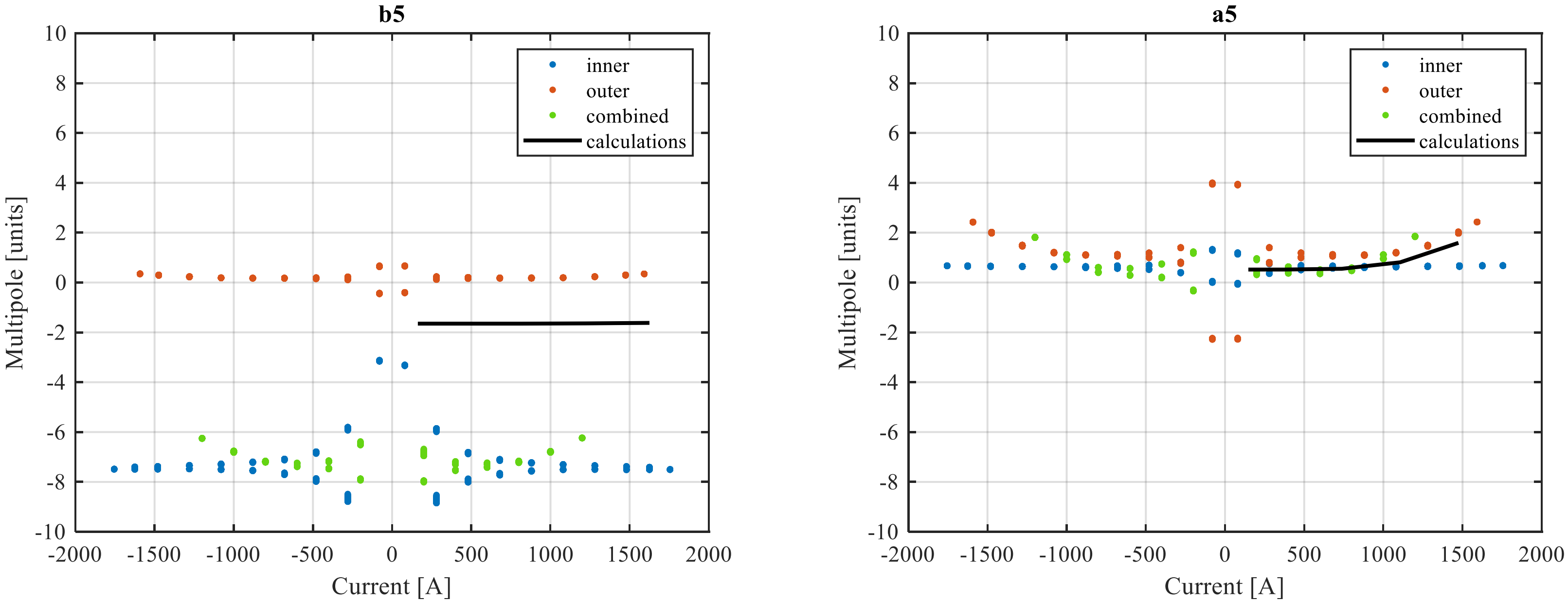
Multipoles vs current





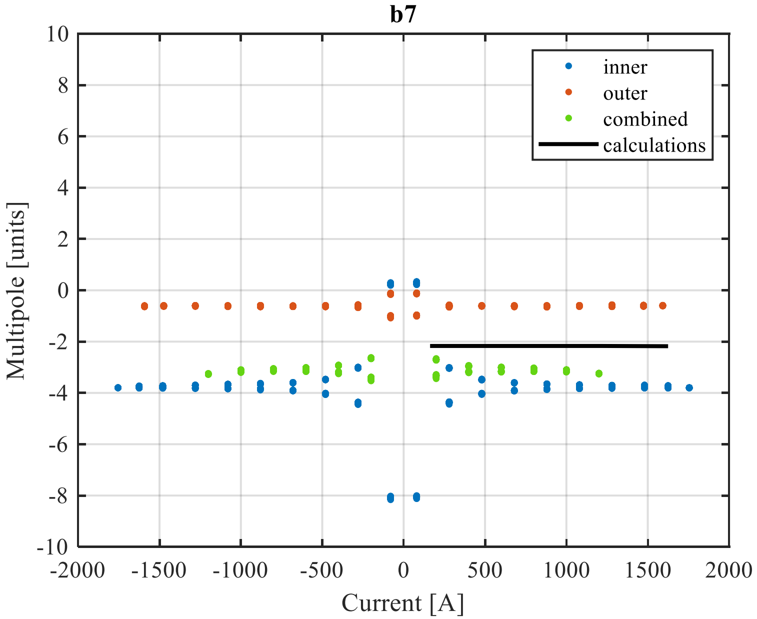
HiLumi
HL-LHC PROJECT

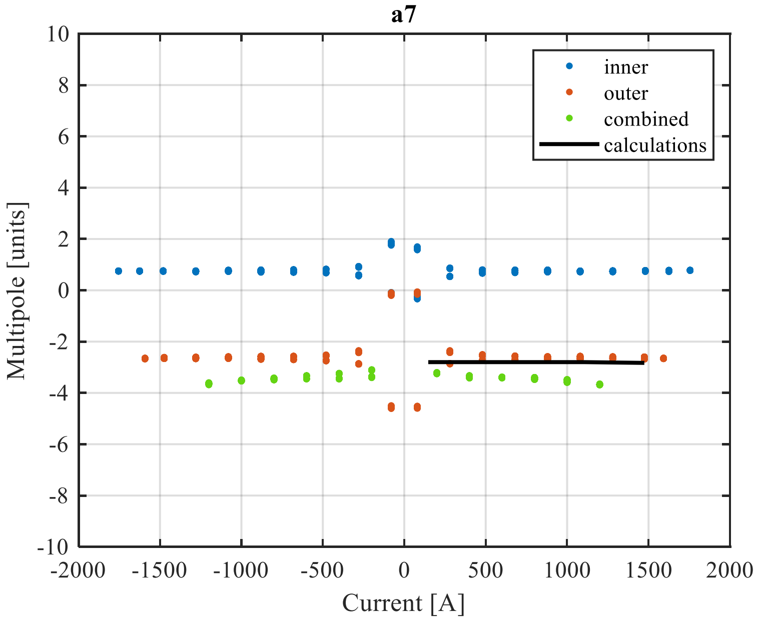
Multipoles vs current



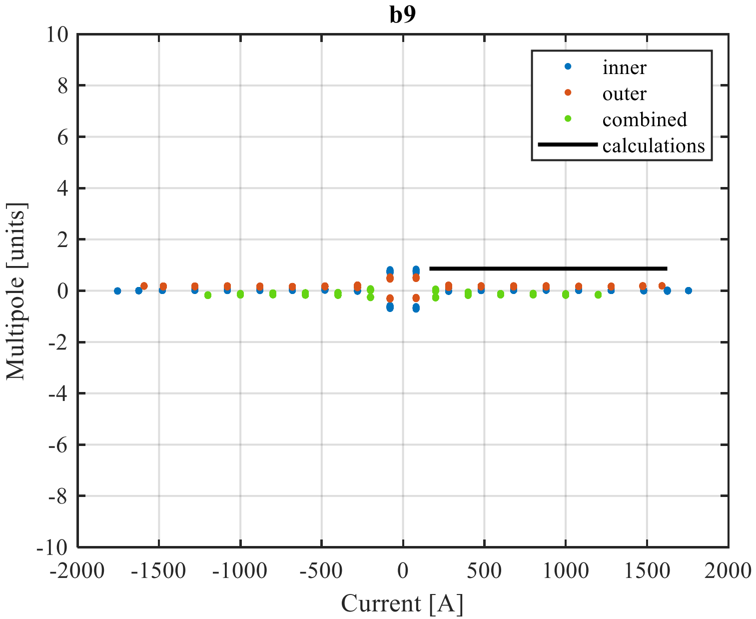
- b5 of inner plane
  - calculations show an offset of +5 units

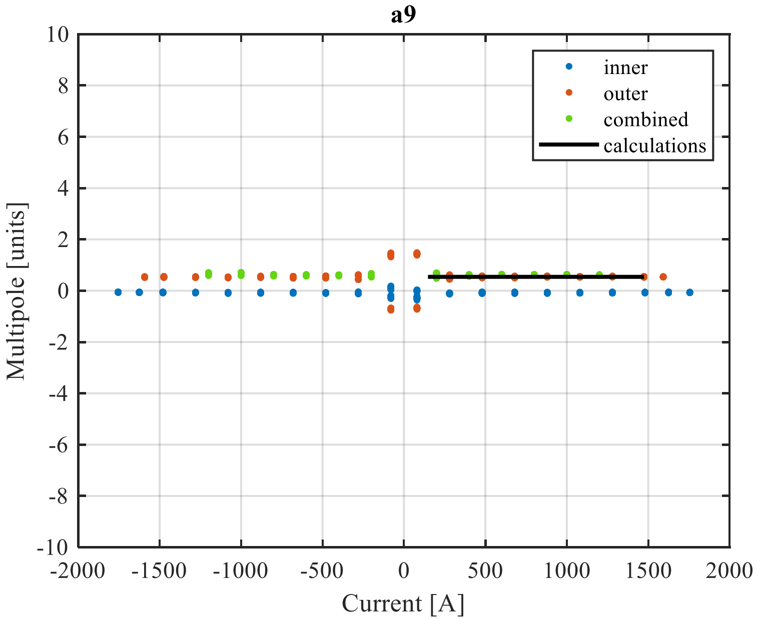
Multipoles vs current



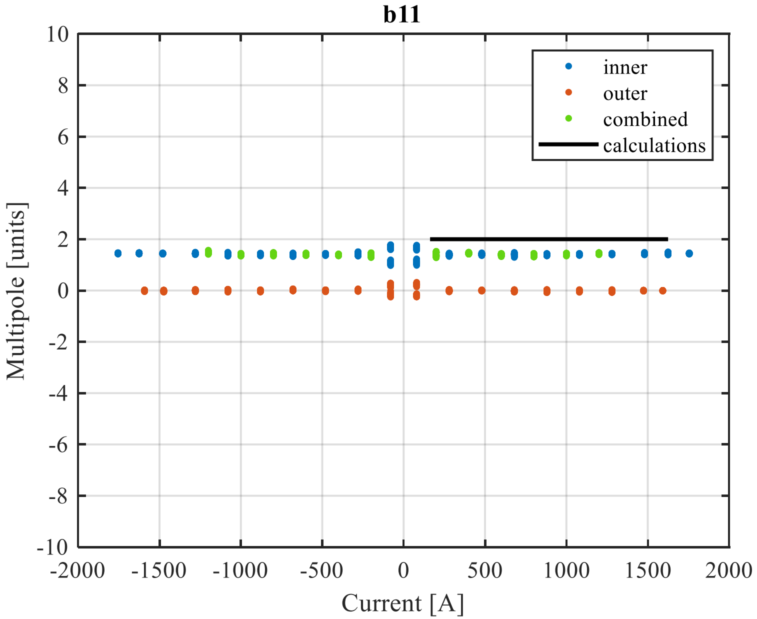


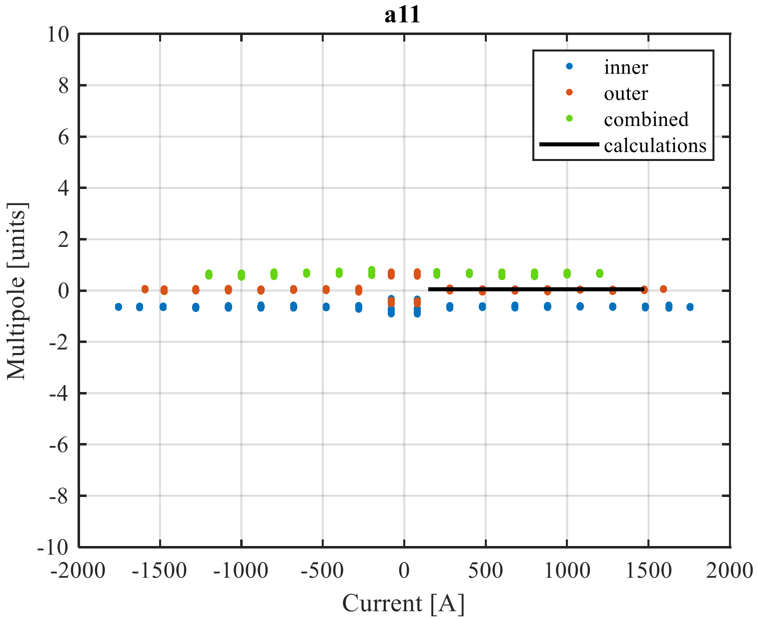
Multipoles vs current



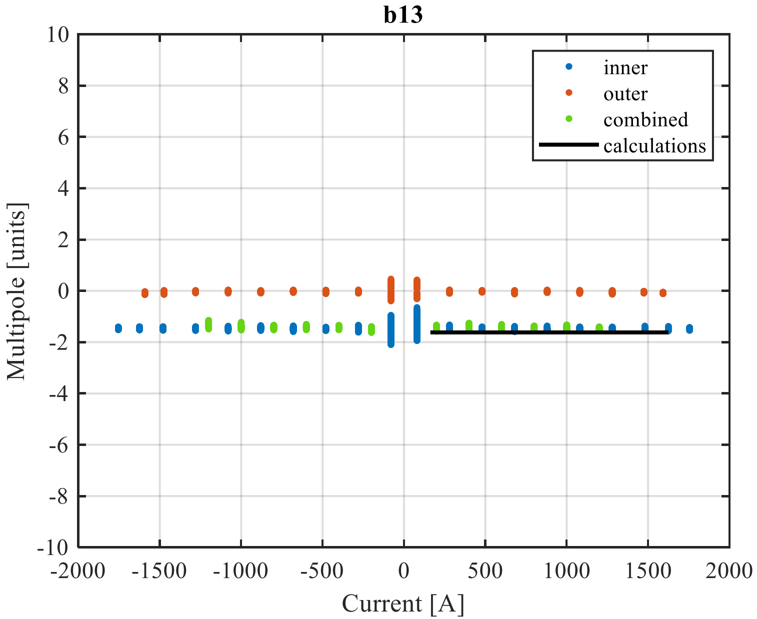


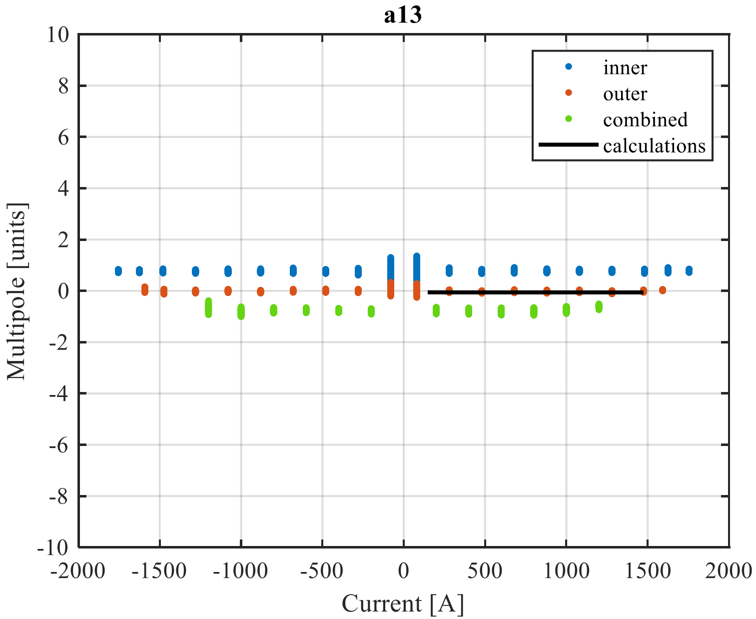
Multipoles vs current





Multipoles vs current





Field-quality table

INNER at 1625 A OUTER at 0 A			INNER at 0 A OUTER at 1474 A			INNER at 1200 A OUTER at 1090 A		
n	bn	an	n	bn	an	n	bn	an
2	1.75	2.81	2	0.78	0.55	2	-0.54	-1.51
3	-6.91	-0.07	3	-0.22	-7.56	3	8.99	-15.42
4	1.78	0.81	4	-0.05	-0.16	4	1.16	-1.12
5	-7.45	0.67	5	0.29	2.00	5	-6.24	1.83
6	1.33	-0.18	6	0.09	0.70	6	1.36	0.90
7	-3.77	0.76	7	-0.61	-2.64	7	-3.26	-3.66
8	0.11	-0.08	8	0.07	-0.15	8	0.01	-0.08
9	0.00	-0.06	9	0.17	0.54	9	-0.17	0.64
10	-0.80	0.38	10	-0.05	-0.02	10	-0.71	-0.37
11	1.45	-0.64	11	-0.01	0.02	11	1.46	0.65
12	0.89	-0.24	12	0.02	0.03	12	0.87	0.26
13	-1.47	0.77	13	-0.06	-0.02	13	-1.38	-0.63
14	-0.06	-0.13	14	0.00	0.00	14	-0.06	0.12
15	0.12	0.06	15	-0.04	0.01	15	0.19	-0.02

Units of 10^{-4} at the reference radius of 50 mm

Conclusions

- Transfer function at nominal level
  - Inner plane 2.646 Tm (+0.9% wrt 3D calculations)
  - No saturation on inner plane with individual powering

  - Outer plane 2.626 Tm (+1.3% wrt 3D calculations)
  - Saturation on outer plane -1.4% with individual powering

  - Very close to MCBXFBP1 (~10 units)

- Field quality at nominal level
  - Inner plane
    - b3 of -6.9 units with individual powering
    - b5 of -7.5 units with individual powering

  - Outer plane
    - a3 of 7.5 units with individual powering

Measurement at ambient temperature

INNER at 5 A OUTER at 0 A			INNER at 0 A OUTER at 5 A		
n	bn	an	n	bn	an
2	0.08	2.88	2	0.94	0.90
3	-5.67	0.54	3	-0.18	-5.18
4	-0.10	0.70	4	0.14	0.26
5	-7.28	0.15	5	-0.02	-1.15
6	0.07	0.01	6	0.13	0.28
7	-3.80	0.02	7	0.04	-2.82
8	0.00	0.12	8	0.03	0.07
9	-0.24	0.00	9	0.01	-0.52
10	-0.10	0.32	10	0.00	0.00
11	1.79	0.00	11	0.01	0.02
12	0.11	-0.31	12	-0.05	-0.02
13	-1.70	-0.18	13	-0.06	0.03
14	-0.05	0.04	14	-0.02	0.02
15	0.10	-0.01	15	0.02	-0.01

Units of 10^{-4} at the reference radius of 50 mm

Measurement at ambient temperature