Magnetic measurements at ambient temperature on the MBRD2

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Outline

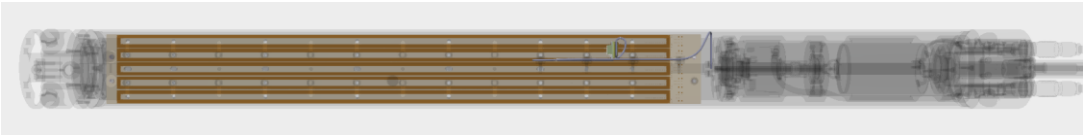
- Measurement setup
- Performed tests
- Results
- Conclusions

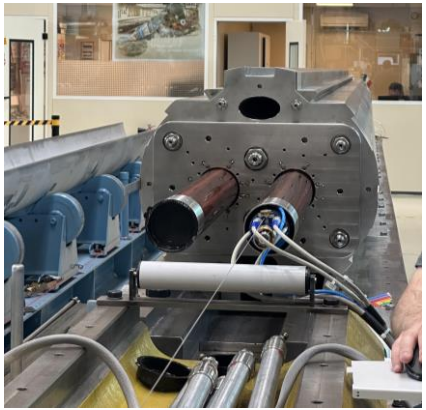
Measurement setup

- Measurements in b.180
- Rotating coil scanner
  - Overall diameter 94 mm
  - PCB coils
  - Measurement radius 35 mm
  - Active length 600 mm
  - Positioning accuracy ~0.1 mm (wire encoder)
  - On board tilt sensor

14 positions to cover the full length of the MBRD

Reference radius is 35 mm





Performed tests

- Full scan of both apertures at ±15 A
- Check at [±5, ±10, ±15, ±18] A on a few positions of V2

Results: main field

	V1					V2			
	CS	CENTER	NCS	INTEGRAL		CS	CENTER	NCS	INTEGRAL
Positions	1-2	3-12	13-14			1-2	3-12	13-14	
Current (A)	15					15			
B1	0.0047	0.0062	0.0047	0.0486		0.0047	0.0062	0.0047	0.0486
TF	0.3131	**0.4152**	0.3120	**3.2413**		0.3121	**0.4153**	0.3126	**3.2413**

30 units more than MBRD1 that was measured at 10 A

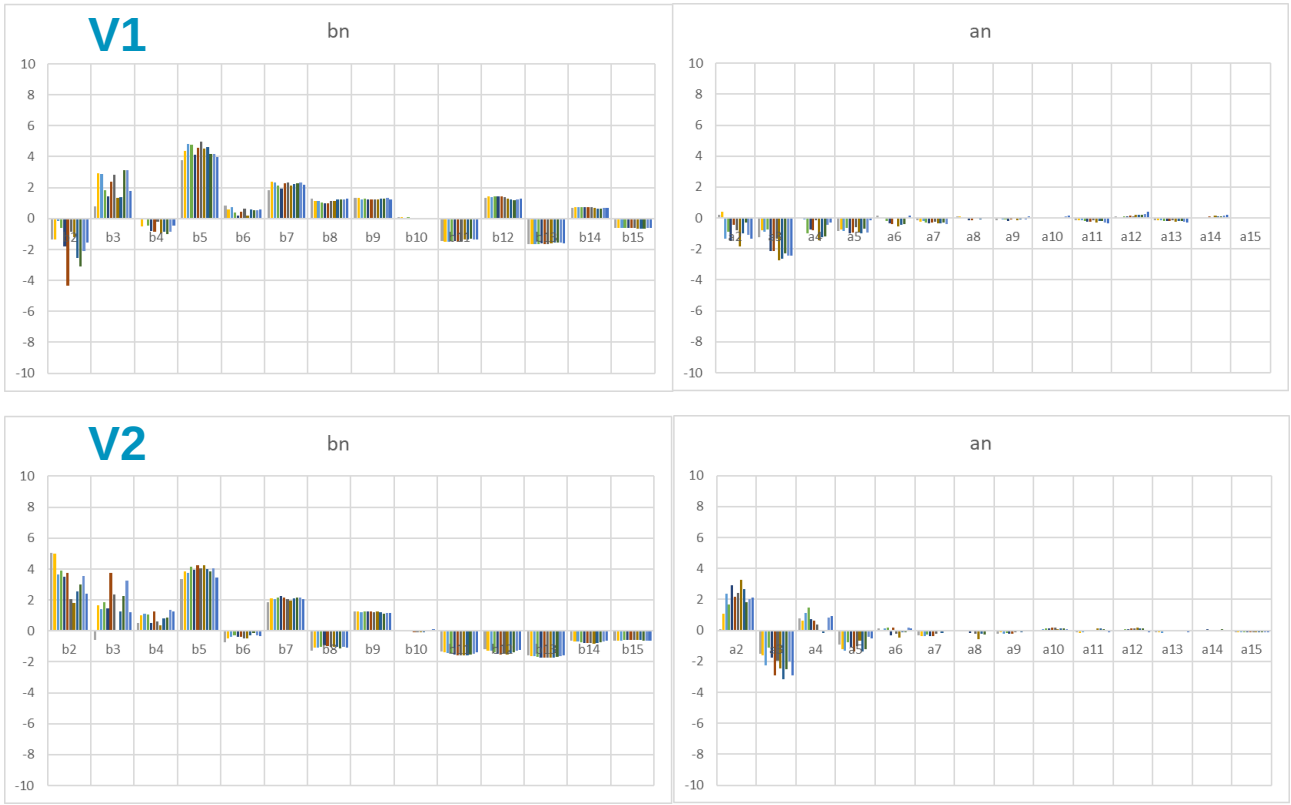
Results: bn

	V1					V2			
	CS	CENTER	NCS	**INTEGRAL**		CS	CENTER	NCS	**INTEGRAL**
Positions	1-2	3-12	13-14			1-2	3-12	13-14	
Current (A)	15					15			
b2	-16.19	-1.80	-20.51	**-5.63**		22.45	3.27	22.54	**7.72**
b3	-3.18	2.33	-5.81	**0.75**		-5.15	1.93	-6.11	**0.18**
b4	3.19	-0.66	0.24	**-0.11**		-2.07	0.90	0.37	**0.49**
b5	4.11	4.51	-0.55	**3.88**		3.71	4.02	-1.09	**3.39**
b6	1.66	0.49	0.70	**0.65**		-1.36	-0.36	-0.52	**-0.49**
b7	0.86	2.23	-0.69	**1.74**		0.87	2.11	-0.85	**1.63**
b8	1.40	1.12	1.19	**1.16**		-1.29	-1.03	-1.02	**-1.06**
b9	0.33	1.26	0.00	**1.01**		0.24	1.23	-0.09	**0.96**
b10	0.08	0.02	-0.02	**0.02**		0.04	-0.03	0.11	**0.00**
b11	-1.40	-1.43	-1.67	**-1.45**		-1.36	-1.51	-1.68	**-1.51**
b12	1.17	1.34	1.11	**1.29**		-1.06	-1.41	-1.08	**-1.33**
b13	-1.47	-1.61	-1.53	**-1.59**		-1.45	-1.68	-1.56	**-1.64**
b14	0.62	0.71	0.59	**0.69**		-0.54	-0.75	-0.55	**-0.71**
b15	-0.55	-0.61	-0.56	**-0.60**		-0.60	-0.61	-0.61	**-0.61**

Results: an

	V1					V2			
	CS	CENTER	NCS	**INTEGRAL**		CS	CENTER	NCS	**INTEGRAL**
Positions	1-2	3-12	13-14			1-2	3-12	13-14	
Current (A)	15					15			
a2	0.97	-0.88	-0.95	**-0.67**		-4.47	2.24	-0.01	**1.20**
a3	-8.97	-1.81	-0.88	**-2.53**		-8.97	-2.18	-1.46	**-2.88**
a4	0.39	-0.70	0.21	**-0.47**		0.71	0.56	0.64	**0.59**
a5	-1.66	-0.82	-0.43	**-0.88**		-2.25	-1.03	-0.77	**-1.14**
a6	0.31	-0.22	0.57	**-0.07**		0.20	-0.06	-0.02	**-0.02**
a7	-0.21	-0.31	-0.14	**-0.27**		-0.68	-0.23	-0.25	**-0.28**
a8	0.12	-0.02	0.14	**0.01**		0.15	-0.16	-0.09	**-0.12**
a9	0.02	-0.09	0.03	**-0.07**		-0.21	-0.14	-0.06	**-0.14**
a10	0.06	0.02	0.18	**0.05**		0.04	0.11	0.02	**0.09**
a11	-0.16	-0.21	-0.31	**-0.21**		-0.30	0.00	-0.15	**-0.05**
a12	0.05	0.15	0.30	**0.16**		-0.01	0.08	-0.08	**0.05**
a13	-0.02	-0.19	-0.21	**-0.17**		-0.09	-0.06	-0.13	**-0.07**
a14	0.03	0.10	0.18	**0.10**		0.01	0.03	-0.05	**0.02**
a15	-0.03	-0.04	0.01	**-0.04**		-0.12	-0.12	-0.12	**-0.12**

Multipoles versus position



Comparison with measurements from ASG

Differences ASG (18 A) – CERN (15 A)

	V1				V2			
	CS	CENTER	NCS	**INTEGRAL**	CS	CENTER	NCS	**INTEGRAL**
Δ b2	4.40	1.97	8.27	**2.04**	-7.03	-2.16	-8.09	**-2.36**
Δ b3	0.78	-0.35	1.86	**-0.46**	1.00	0.02	2.93	**-0.08**
Δ b4	-0.81	0.72	0.82	**0.68**	1.30	0.72	1.27	**0.67**
Δ b5	0.82	0.87	1.78	**0.50**	0.49	0.79	2.47	**0.55**
Δ b6	-0.18	0.19	0.76	**0.23**	0.99	0.54	0.70	**0.58**
Δ b7	0.22	-0.30	-0.23	**-0.47**	0.43	-0.47	0.36	**-0.45**
Δ b8	-0.94	-0.90	-0.90	**-0.90**	-1.66	-0.96	-1.11	**-1.00**
Δ b9	-0.35	-0.41	-0.59	**-0.56**	0.02	-0.08	0.39	**-0.14**
Δ b10	-0.92	-0.65	1.09	**-0.39**	0.30	0.42	0.59	**0.42**
Δ b11	1.29	1.20	-0.08	**1.03**	2.73	1.76	2.20	**1.97**
Δ b12	0.83	0.83	2.78	**0.98**	2.16	1.54	1.80	**1.70**
Δ b13	1.56	1.46	0.57	**1.36**	3.23	1.75	2.08	**2.05**
Δ b14	0.60	0.70	1.20	**0.67**	0.58	0.40	0.28	**0.44**
Δ b15	0.03	0.16	0.03	**0.15**	0.11	0.19	0.06	**0.18**

Comparison with measurements from ASG

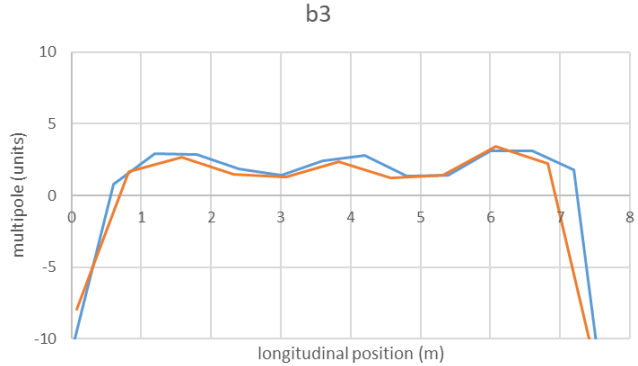
Differences ASG (18 A) – CERN (15 A)

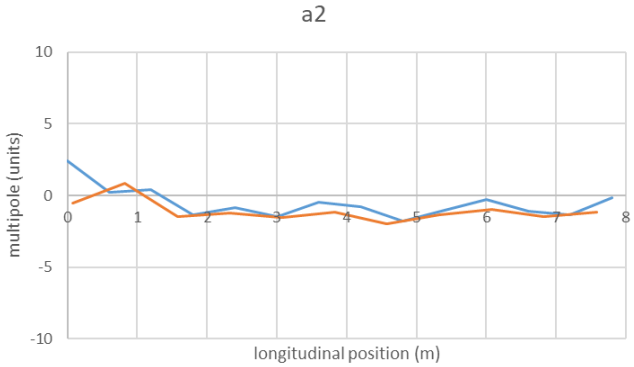
	V1				V2			
	CS	CENTER	NCS	**INTEGRAL**	CS	CENTER	NCS	**INTEGRAL**
Δ a2	-0.70	-0.52	-0.42	**-0.38**	5.48	-0.52	0.60	**0.14**
Δ a3	1.90	-0.43	-0.73	**-0.25**	0.59	-0.81	-0.70	**-0.67**
Δ a4	-1.24	-1.36	-0.25	**-0.98**	-1.05	-1.52	-0.31	**-1.20**
Δ a5	0.82	0.48	0.29	**0.50**	1.13	0.74	1.06	**0.83**
Δ a6	0.66	0.17	1.09	**0.44**	0.48	0.00	1.19	**0.28**
Δ a7	0.60	0.51	0.57	**0.53**	2.63	1.74	2.04	**1.83**
Δ a8	0.08	-0.38	0.21	**-0.18**	0.11	-0.65	-0.21	**-0.41**
Δ a9	-0.25	-0.39	-1.36	**-0.48**	-1.52	-0.61	-0.91	**-0.76**
Δ a10	-0.33	-0.07	0.38	**-0.03**	-0.29	0.10	0.24	**0.04**
Δ a11	-1.79	-1.96	-2.69	**-1.92**	-0.83	0.39	0.24	**0.14**
Δ a12	0.41	0.60	0.86	**0.57**	0.67	1.15	1.42	**1.04**
Δ a13	-0.17	-0.43	-0.40	**-0.34**	0.65	1.32	1.48	**1.17**
Δ a14	1.52	1.39	1.29	**1.31**	2.58	1.70	2.02	**1.79**
Δ a15	1.34	1.16	1.29	**1.15**	0.53	1.00	1.09	**0.89**

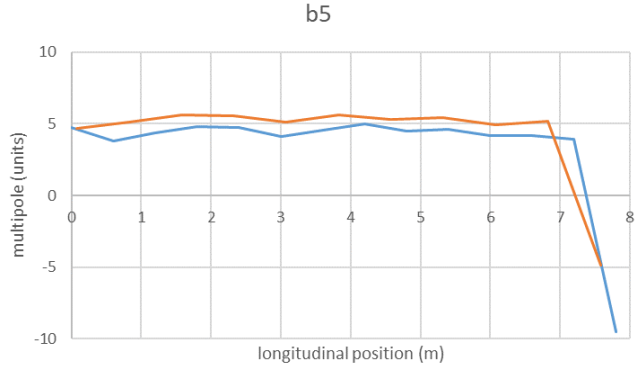
V1

ASG
CERN


b2
multipole (units)
longitudinal position (m)

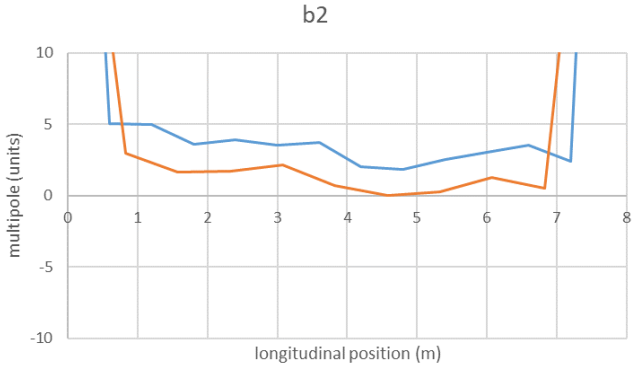

b3
multipole (units)
longitudinal position (m)

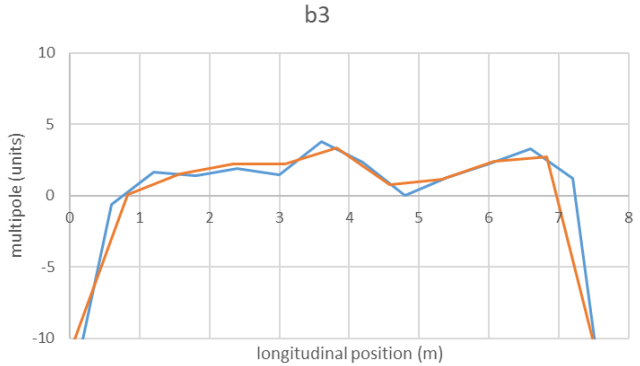

a2
multipole (units)
longitudinal position (m)

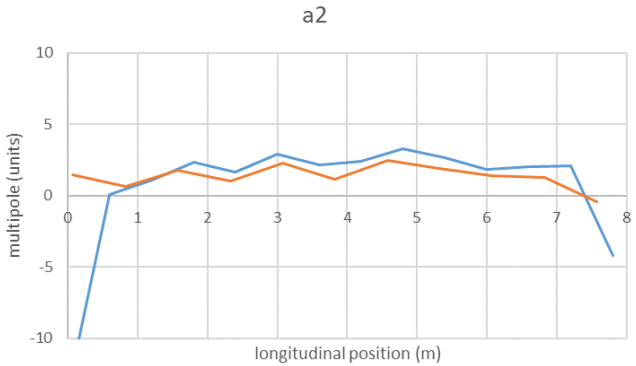

b5
multipole (units)
longitudinal position (m)

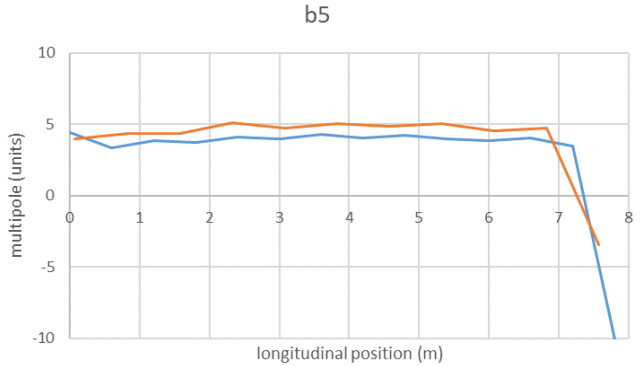
V2

ASG
CERN

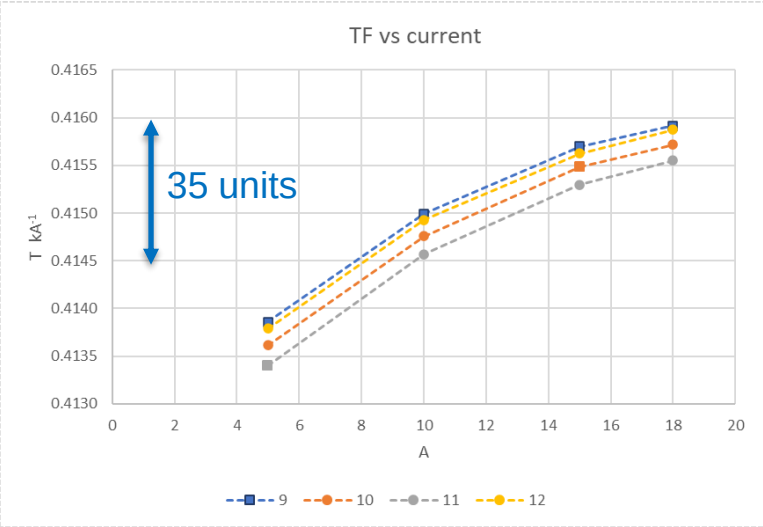

b2
multipole (units)
longitudinal position (m)

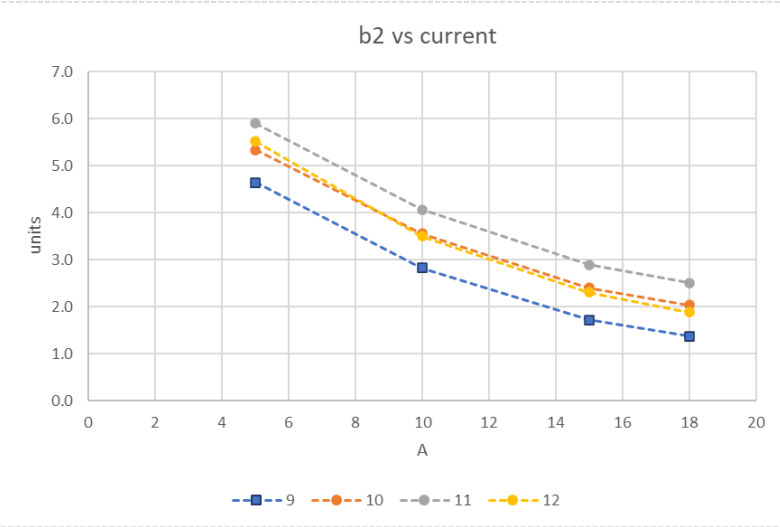

b3
multipole (units)
longitudinal position (m)


a2
multipole (units)
longitudinal position (m)


b5
multipole (units)
longitudinal position (m)

Change of TF and b2 versus current





Conclusions

- MBRD2 measured at CERN, before integration in the cold-mass, at ambient temperature
- Main results
  - Transfer function in line with MBRD1
  - b2 is -5.6 / 7.7 units
  - b3 is 0.8 / 0.2 units
  - b5 is 3.9 / 3.4 units
  - General agreement with measurements performed at ASG
  - Change of TF (~30 units) and b2 (~3 units) from 5 A to 18 A
    - Same effect already seen on MBRD1