FIELD QUALITY IN THE INNER TRIPLET AND IN THE SEPARATION DIPOLE

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With contributions from
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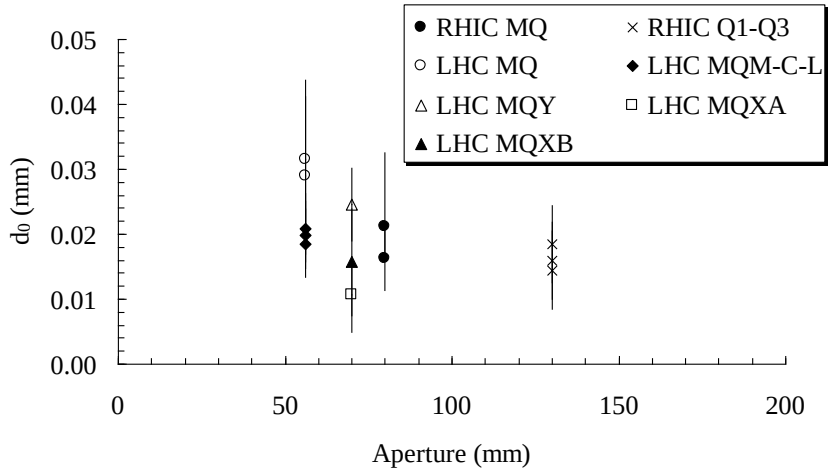
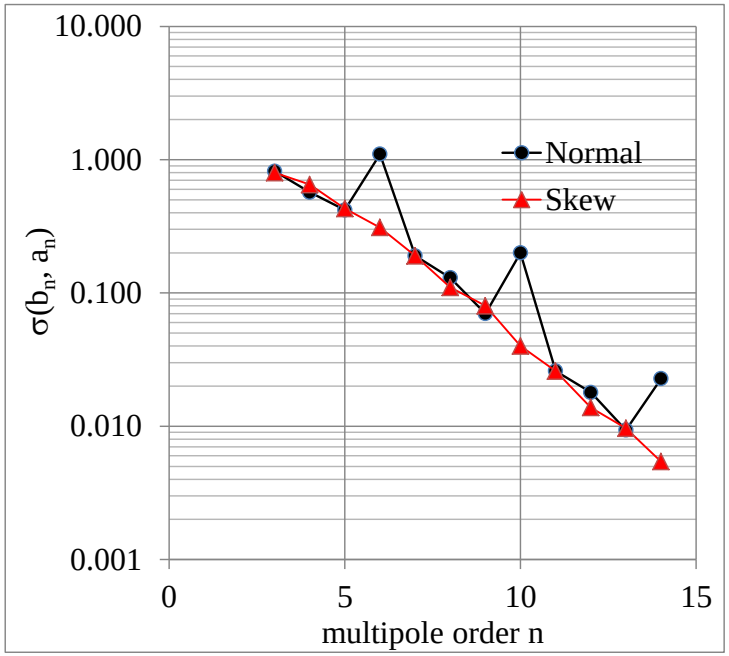
*Revised version on November 27: correction of sign of persistent current component of b_6 and b_{10} in page 4 and 7

TRIPLET: RANDOM

- Random component dominated by coil geometry (position of the cables)
  - Based on the experience of the previous projects: random displacement w.r.t. nominal of σ=30 μm
  - Four times larger for the allowed





Amplitude of displacement corresponding to measured random components
[B. Bellesia et al., Phys Rev. STAB 10 062401 (2007)]

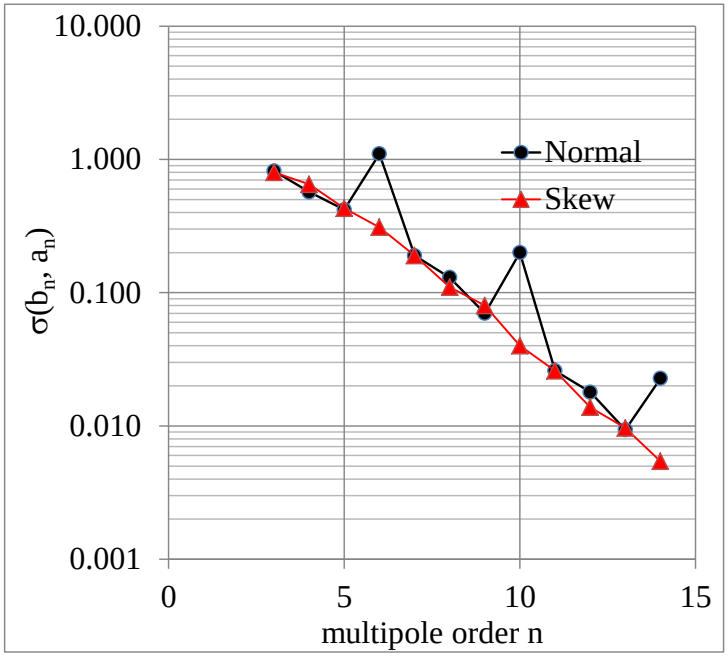
TRIPLET: RANDOM

- Random component dominated by coil geometry (position of the cables)
  - Previous estimate was based on rescaling of estimates for 120 mm case (MQXC) – small differences
- Same values assumed for uncertainty

	Uncertainty	Random		Uncertainty	Random
b3	0.89	0.89	a3	0.89	0.89
b4	0.64	0.64	a4	0.64	0.64
b5	0.46	0.46	a5	0.46	0.46
b6	1.8	1.28	a6	1.2	0.33
b7	0.21	0.21	a7	0.21	0.21
b8	0.16	0.16	a8	0.16	0.16
b9	0.08	0.08	a9	0.08	0.08
b10	0.06	0.06	a10	0.06	0.06

Field quality estimate V1 (June 2012) based on MQXC,
P. Fessia, et al., *IEEE Trans. Appl. Supercond.* **20** (2010) 140

	Normal	Skew
3	0.820	0.800
4	0.570	0.650
5	0.420	0.430
6	1.100	0.310
7	0.190	0.190
8	0.130	0.110
9	0.070	0.080
10	0.200	0.040



Field quality estimates V2 (November 2012) by X. Wang, based on MQXF 150 mm aperture cross-section by P. Ferracin, F. Borgnolutti, H. Felice

TRIPLET: SYSTEMATIC

- We have four blocks → wide ability of tuning field quality
  - Large saturation for b6: 3.2 units – corrected by the geometric

	Geometric	Saturation	High field
6	4.000	-3.200	0.800
10	0.150	0.000	0.150
14	-0.040	0.000	-0.040

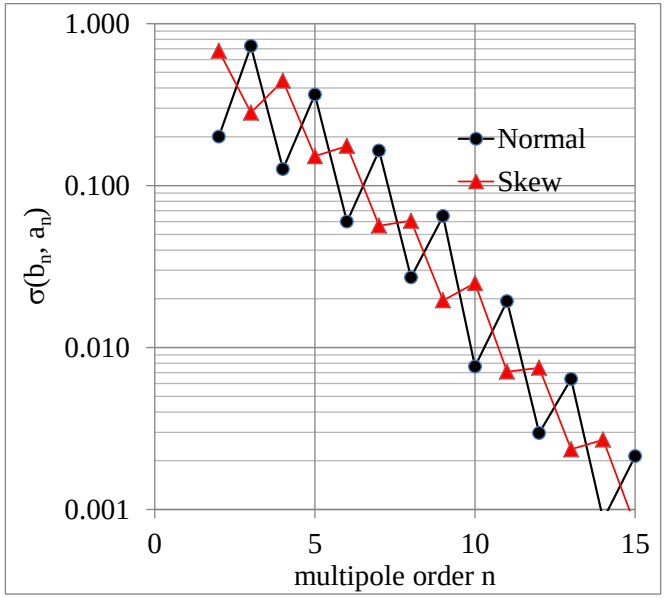
- At injection we assume -20 units of persistent current
  - This is a first guess from HQ, but there is a strong dependence on filament size, cycle, and magnet

SEPARATION DIPOLE D1: RANDOM

- Random component dominated by coil geometry (position of the cables)
  - Based on the experience of the previous projects: split the random displacement by family giving a σ of displacement in each family
  - We use the LHC MB case (same cable – but two layers and 2-in-1)

	Assumed random displacement (μm)	
	Normal	Skew
Odd	40	15
Even	10	30

  - RHIC (one layer) gives similar values

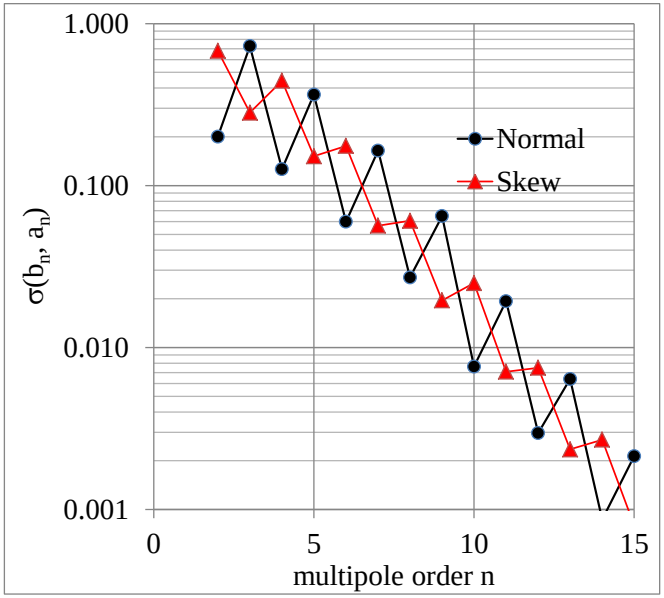


Amplitude of displacement corresponding to measured random components
[B. Bellesia et al., *Tenth European Particle Accelerator Conference* (2006) 2601-3)]

SEPARATION DIPOLE D1: RANDOM

- Random component dominated by coil geometry (position of the cables)
  - Based on the experience of the previous projects: split the random displacement by family giving a σ of displacement in each family

	Normal	Skew
2	0.200	0.679
3	0.727	0.282
4	0.126	0.444
5	0.365	0.152
6	0.060	0.176
7	0.165	0.057
8	0.027	0.061
9	0.065	0.020
10	0.008	0.025
11	0.019	0.007



SUMMARY: TRIPLET

	Triplet field quality version 2 - November 6 2012								
	Systematic					Uncertainty		Random	
Normal	Geometric	Saturation	Persistent	Injection	High Field	Injection	High Field	Injection	High Field
3	0.000	0.000	0.000	0.000	0.000	0.820	0.820	0.820	0.820
4	0.000	0.000	0.000	0.000	0.000	0.570	0.570	0.570	0.570
5	0.000	0.000	0.000	0.000	0.000	0.420	0.420	0.420	0.420
6	4.000	-3.200	-20.000	-16.000	0.800	1.100	1.100	1.100	1.100
7	0.000	0.000	0.000	0.000	0.000	0.190	0.190	0.190	0.190
8	0.000	0.000	0.000	0.000	0.000	0.130	0.130	0.130	0.130
9	0.000	0.000	0.000	0.000	0.000	0.070	0.070	0.070	0.070
10	0.150	0.000	4.000	4.150	0.150	0.200	0.200	0.200	0.200
11	0.000	0.000	0.000	0.000	0.000	0.026	0.026	0.026	0.026
12	0.000	0.000	0.000	0.000	0.000	0.018	0.018	0.018	0.018
13	0.000	0.000	0.000	0.000	0.000	0.009	0.009	0.009	0.009
14	-0.040	0.000	0.000	-0.040	-0.040	0.023	0.023	0.023	0.023
Skew									
3	0.000	0.000	0.000	0.000	0.000	0.800	0.800	0.800	0.800
4	0.000	0.000	0.000	0.000	0.000	0.650	0.650	0.650	0.650
5	0.000	0.000	0.000	0.000	0.000	0.430	0.430	0.430	0.430
6	0.000	0.000	0.000	0.000	0.000	0.310	0.310	0.310	0.310
7	0.000	0.000	0.000	0.000	0.000	0.190	0.190	0.190	0.190
8	0.000	0.000	0.000	0.000	0.000	0.110	0.110	0.110	0.110
9	0.000	0.000	0.000	0.000	0.000	0.080	0.080	0.080	0.080
10	0.000	0.000	0.000	0.000	0.000	0.040	0.040	0.040	0.040
11	0.000	0.000	0.000	0.000	0.000	0.026	0.026	0.026	0.026
12	0.000	0.000	0.000	0.000	0.000	0.014	0.014	0.014	0.014
13	0.000	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.010
14	0.000	0.000	0.000	0.000	0.000	0.005	0.005	0.005	0.005

SUMMARY: D1

	Separation dipole field quality version 1 - November 6 2012								
	Systematic					Uncertainty		Random	
Normal	Geometric	Saturation	Persistent	Injection	High Field	Injection	High Field	Injection	High Field
2	0.000	0.000	0.000	0.000	0.000	0.200	0.200	0.200	0.200
3	-1.800	0.900	-14.200	-16.000	-0.900	0.727	0.727	0.727	0.727
4	0.000	0.000	0.000	0.000	0.000	0.126	0.126	0.126	0.126
5	0.500	-0.500	-1.000	-0.500	0.000	0.365	0.365	0.365	0.365
6	0.000	0.000	0.000	0.000	0.000	0.060	0.060	0.060	0.060
7	1.600	-1.200	-0.700	0.900	0.400	0.165	0.165	0.165	0.165
8	0.000	0.000	0.000	0.000	0.000	0.027	0.027	0.027	0.027
9	-0.680	0.090	0.020	-0.660	-0.590	0.065	0.065	0.065	0.065
10	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.008
11	0.440	0.030	0.000	0.440	0.470	0.019	0.019	0.019	0.019
12	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.003
13	0.000	0.000	0.000	0.000	0.000	0.006	0.006	0.006	0.006
14	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
15	-0.040	0.000	0.000	-0.040	-0.040	0.002	0.002	0.002	0.002
Skew									
2	0.000	0.000	0.000	0.000	0.000	0.679	0.679	0.679	0.679
3	0.000	0.000	0.000	0.000	0.000	0.282	0.282	0.282	0.282
4	0.000	0.000	0.000	0.000	0.000	0.444	0.444	0.444	0.444
5	0.000	0.000	0.000	0.000	0.000	0.152	0.152	0.152	0.152
6	0.000	0.000	0.000	0.000	0.000	0.176	0.176	0.176	0.176
7	0.000	0.000	0.000	0.000	0.000	0.057	0.057	0.057	0.057
8	0.000	0.000	0.000	0.000	0.000	0.061	0.061	0.061	0.061
9	0.000	0.000	0.000	0.000	0.000	0.020	0.020	0.020	0.020
10	0.000	0.000	0.000	0.000	0.000	0.025	0.025	0.025	0.025
11	0.000	0.000	0.000	0.000	0.000	0.007	0.007	0.007	0.007
12	0.000	0.000	0.000	0.000	0.000	0.008	0.008	0.008	0.008
13	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.002	0.002
14	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.003
15	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001

CONCLUSIONS

- We proposed very challenging field quality estimates for the inner triplet and D1
  - The best we can expect – it will be probably worse
  - To improve: magnetic shimming to correct non allowed larger multipoles
- Hypothesis:
  - Fine filaments
  - Cored cable (no ramp rate effects)
  - Same ability of coil positioning as in Nb-Ti
- Coming soon : Q4 and (a bit later) D2