Measured Multipole Errors in PEP-II and SPEAR3 Magnets

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Thank Nanyang Li for providing the original data.

Dipole Magnets for PEP-II

Fit the average to a fourth order polynomial. We have:

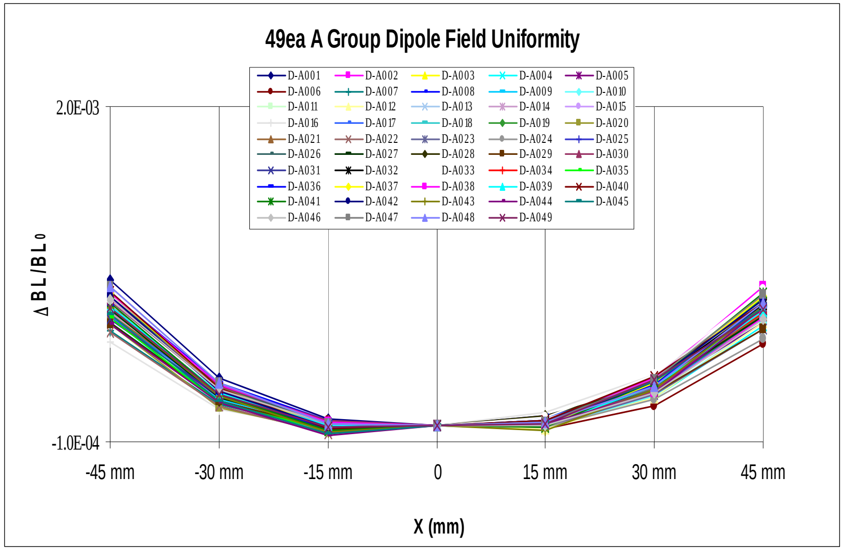
$b_3=1.6\text{x}10^{-4}$

$b_4=-1.6\text{x}10^{-5}$

$b_5=7.6\text{x}10^{-5}$

At a reference radius of r_0=0.03m with a definition of multipole errors:

Measured magnetic field

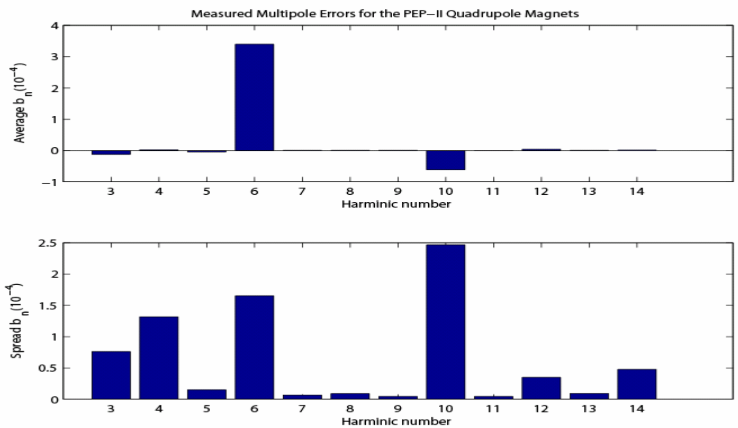


49 magnets are included in the estimate.

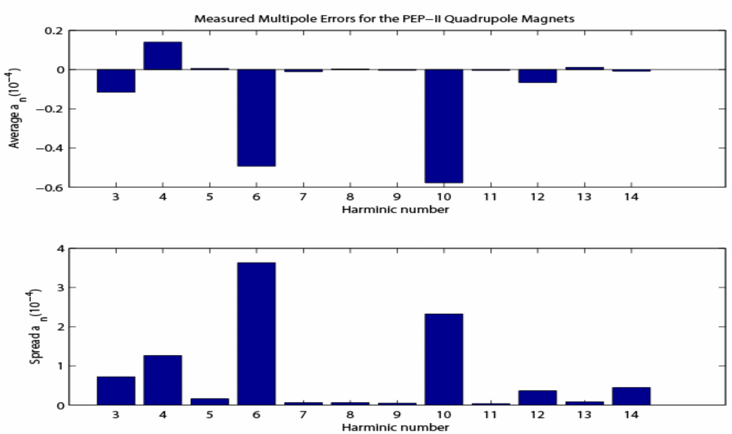
$$(B_y + iB_x) / B(r_0) = \sum_{n=1} (b_n + ia_n)(\frac{x}{r_0} + i\frac{y}{r_0})^{n-1}$$

Quadrupole Magnets from PEP-II

normal



skew



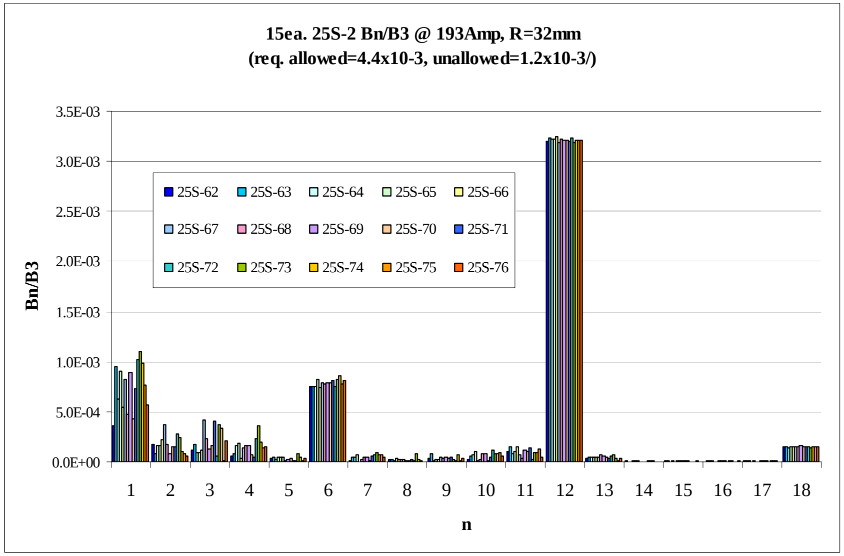
- Multipoles were measured using rotating coil
- 77 magnets are included in the analysis
- Both amplitudes and phases are used
- The global phase redefined assuming b6>0, which is the first allowed multipole in quadrupole magnet

Values of Multipole for Quadrupole Magnets

n	<bn>	σ[bn]	<an>	σ[an]
3	-1.24E-05	7.61E-05	-1.15E-05	7.25E-05
4	2.30E-06	1.32E-04	1.41E-05	1.27E-04
5	-4.30E-06	1.50E-05	6.20E-07	1.62E-05
6	3.40E-04	1.65E-04	-4.93E-05	3.63E-04
7	3.00E-07	6.70E-06	-1.02E-06	6.60E-06
8	6.00E-07	8.90E-06	3.80E-07	6.60E-06
9	6.00E-07	4.60E-06	-2.80E-07	4.90E-06
10	-6.17E-05	2.46E-04	-5.77E-05	2.33E-04
11	-2.00E-07	4.20E-06	-3.80E-07	3.50E-06
12	3.60E-06	3.48E-05	-6.53E-06	3.66E-05
13	6.00E-07	9.20E-06	1.20E-06	8.60E-06
14	1.00E-06	4.76E-05	-7.40E-07	4.46E-05

Sextupole Magnet from SPEAR3

Measured multipoles



- 15 magnets were measured
- The reference radius r_0=0.032m
- Estimate of multipole errors: $b_4=2\times10^{-4}$, $b_6=7\times10^{-4}$, and $b_{12}=3.2\times10^{-3}$ and the rest 1×10^{-4}

Systematic:

dipole 0.030
3

n	b_n	a_n
3	1.60E-04	0.0
4	-1.60E-05	0.0
5	7.60E-05	0.0

quadrupole 0.050
12

n	b_n	a_n
3	-1.24E-05	-1.15E-05
4	2.30E-06	1.41E-05
5	-4.30E-06	6.20E-07
6	3.40E-04	-4.93E-05
7	3.00E-07	-1.02E-06
8	6.00E-07	3.80E-07
9	6.00E-07	-2.80E-07
10	-6.17E-05	-5.77E-05
11	-2.00E-07	-3.80E-07
12	3.60E-06	-6.53E-06
13	6.00E-07	1.20E-06
14	1.00E-06	-7.40E-07

sextupole 0.032
11

n	b_n	a_n
4	2.00E-04	0.0
5	1.00E-04	0.0
6	7.00E-04	0.0
7	1.00E-04	0.0
8	1.00E-04	0.0
9	1.00E-04	0.0
10	1.00E-04	0.0
11	1.00E-04	0.0
12	3.20E-03	0.0
13	1.00E-04	0.0
14	1.00E-04	0.0

Random:

dipole 0.030 ← r
3

n	b_n	a_n
3	8.00E-05	0.0
4	8.00E-06	0.0
5	3.80E-05	0.0

quadrupole 0.050
12

n	b_n	a_n
3	7.61E-05	7.25E-05
4	1.32E-04	1.27E-04
5	1.50E-05	1.62E-05
6	1.65E-04	3.63E-04
7	6.70E-06	6.60E-06
8	8.90E-06	6.60E-06
9	4.60E-06	4.90E-06
10	2.46E-04	2.33E-04
11	4.20E-06	3.50E-06
12	3.48E-05	3.66E-05
13	9.20E-06	8.60E-06
14	4.76E-05	4.46E-05

sextupole 0.032
11

n	b_n	a_n
4	1.00E-04	0.0
5	3.00E-05	0.0
6	1.00E-04	0.0
7	3.00E-05	0.0
8	3.00E-05	0.0
9	3.00E-05	0.0
10	3.00E-05	0.0
11	3.00E-05	0.0
12	1.00E-04	0.0
13	3.00E-05	0.0
14	3.00E-05	0.0

Dipole: B(r)=B0
Quad: B(r) = B'r
Sext: $B(r)=B''r^2/2$

$$(B_y + iB_x)/B(r) = \sum_{n=1} (b_n + ia_n)\left(\frac{x}{r} + i\frac{y}{r}\right)^{n-1}$$