HiLumi

LARGE HADRON COLLIDER

Research supported by the High Luminosity LHC project

HiLumi LHC:
Impact of Bad b_6 in Inner Triplet Magnets

F.F. Van der Veken, M. Giovannozzi

Outline

Aim

- The body of the MQXF magnets might have a much larger b_6 error than currently given in the error tables, up to -4 units. We want to investigate
  - the impact on DA of a large b_6 error (-4 and -6) in all MQXF magnets simultaneously
  - the impact on DA of a large b_6 error (-4) in one or a few of the MQXF magnets
  - if the strength assignments of the NLC package do not exceed 100% of their design values for the above scenarios

Setup

- In total **124** studies, with on average **4260** jobs each
- 0.5M jobs on a tight time schedule

  $\Rightarrow$ calculations on the CERN batch system

Many thanks to A. Mereghetti for the new scripts,

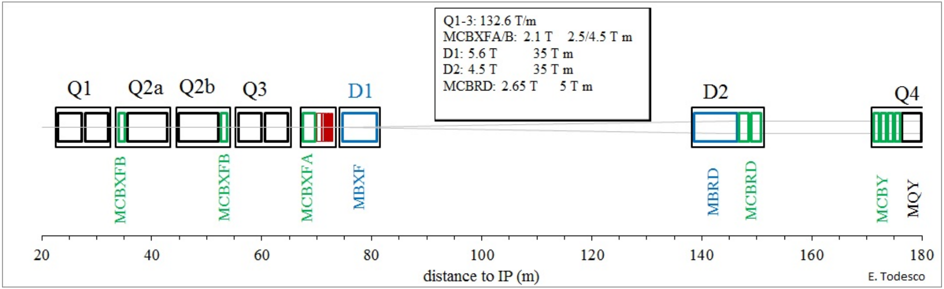
- DA is calculated over:
  - 11 angles
  - 60 random realisations of the machine ('seeds')
- HLLHC 1.3 optics, nominal errors (but no MCBXF errors)

$$\beta^* = 0.15/0.15/0.15/0.15\text{m},\ Q_x = 62.31,\ Q_y = 60.32$$

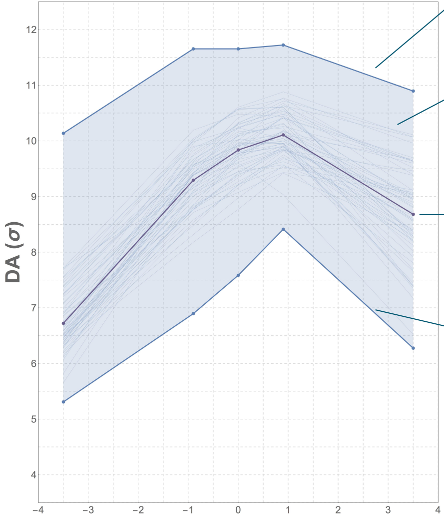
$$\mu_x^{1\to5} = 31.379°,\ \mu_y^{1\to5} = 30.331°$$

$$d_{\text{sep}}^{1,5} = 0.75\text{mm},\ \theta_c = 295\ \text{mrad}$$

Setup


Q1-3: 132.6 T/m
MCBXFA/B: 2.1 T 2.5/4.5 T m
D1: 5.6 T 35 T m
D2: 4.5 T 35 T m
MCBRD: 2.65 T 5 T m
Q1
Q2a
Q2b
Q3
D1
D2
Q4
MCBXFB
MCBXFB
MCBXFA
MBXF
MBRD
MCBRD
MCBY
MQY
20
40
60
80
100
120
140
160
180
distance to IP (m)
E. Todesco

Example DA plot



absolute maximum
(maximum angle over all seeds)

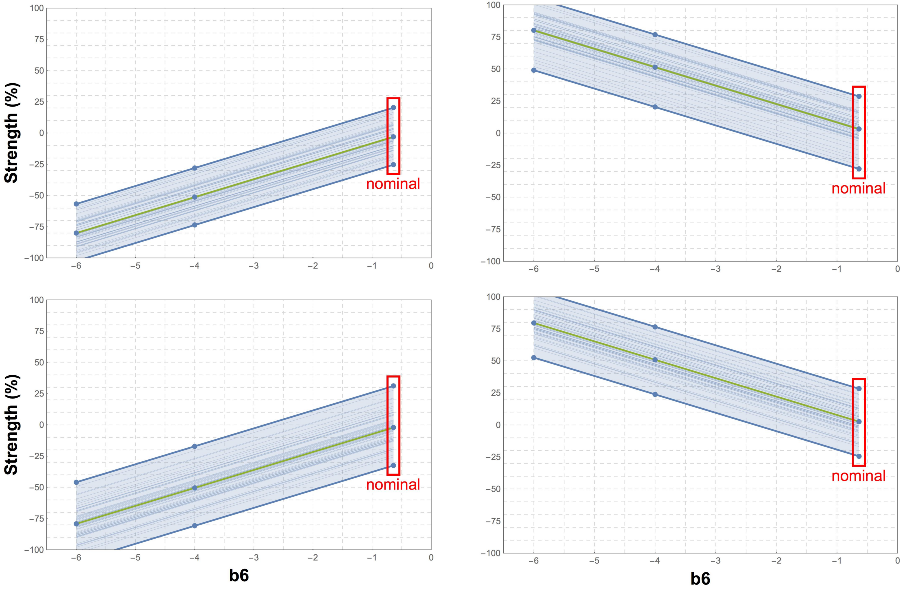
individual seed lines
(average over angles per seed)

average DA
(average over angles and over seeds)

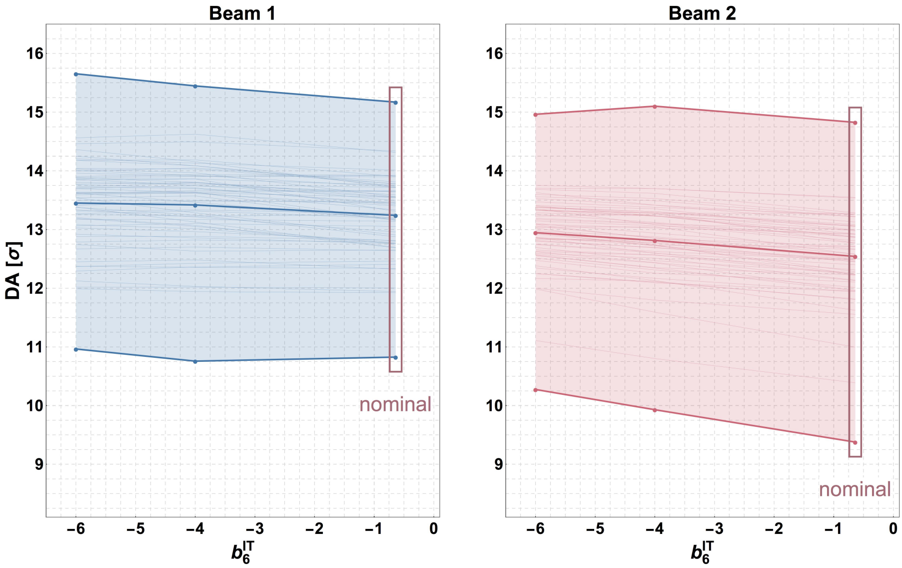
absolute minimum
(minimum angle over all seeds)

Outline

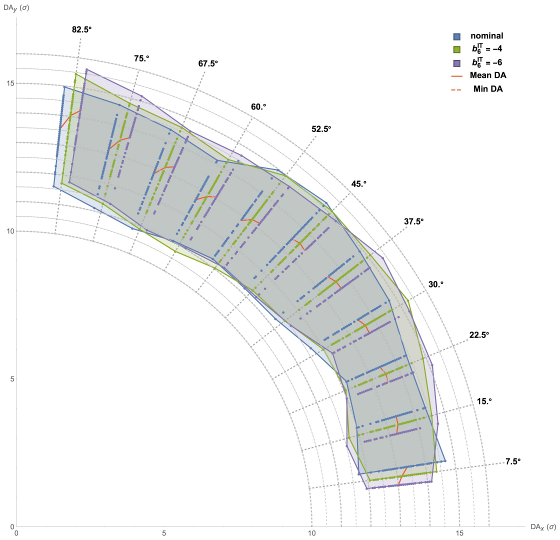
Dodecapole corrector strength in function of b_6 error of all IT magnets



DA in function of b_6 of all IT magnets (chrom 3, I_{oct}=0A)



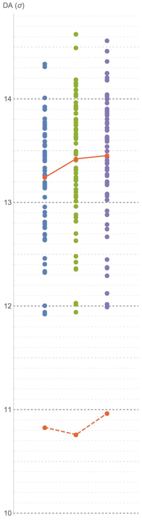
DA in function of b_6 of all IT magnets (chrom 3, I_{oct} = 0A, beam 1)

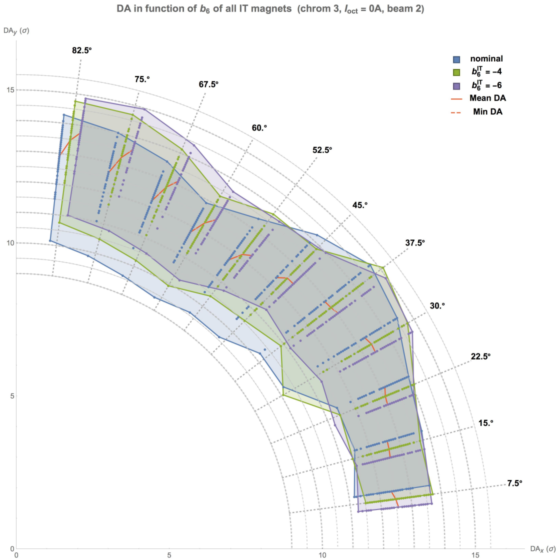


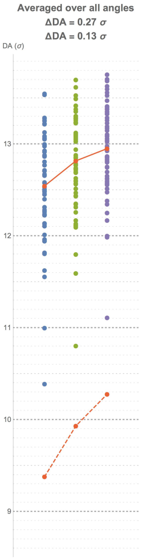
Averaged over all angles

ΔDA = 0.18 σ

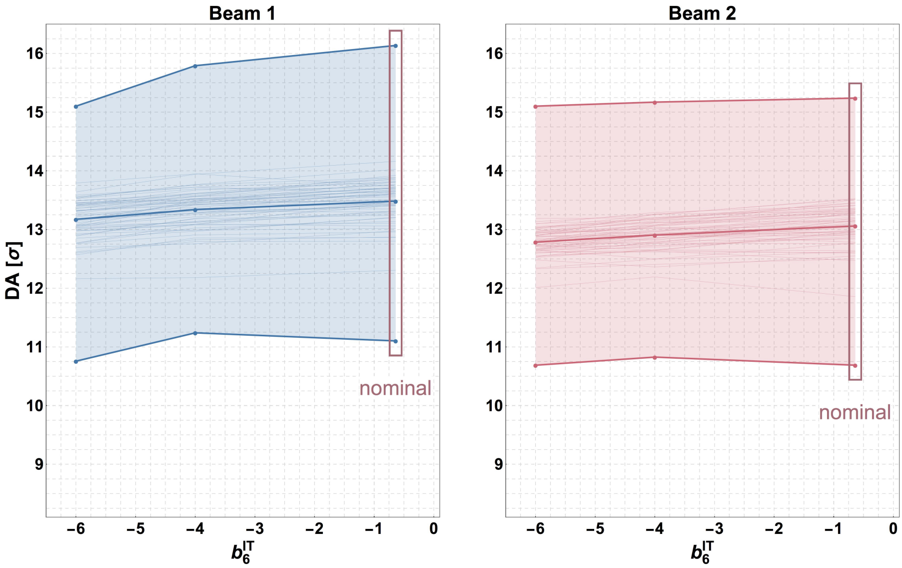
ΔDA = 0.03 σ

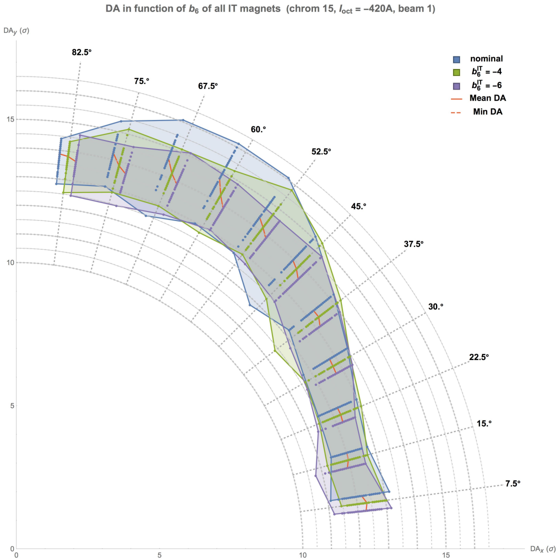



DA in function of b_6 of all IT magnets (chrom 3, I_{oct} = 0A, beam 2)
DA$_y$ (σ)
DA$_x$ (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
nominal
b_6^{IT} = −4
b_6^{IT} = −6
Mean DA
Min DA

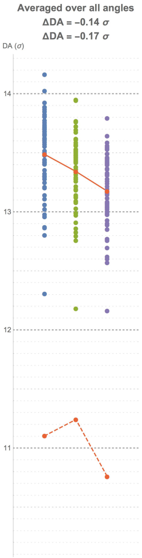

Averaged over all angles
ΔDA = 0.27 σ
ΔDA = 0.13 σ
DA (σ)

DA in function of b_6 of all IT magnets (chrom 15, I_{oct}=−420A)

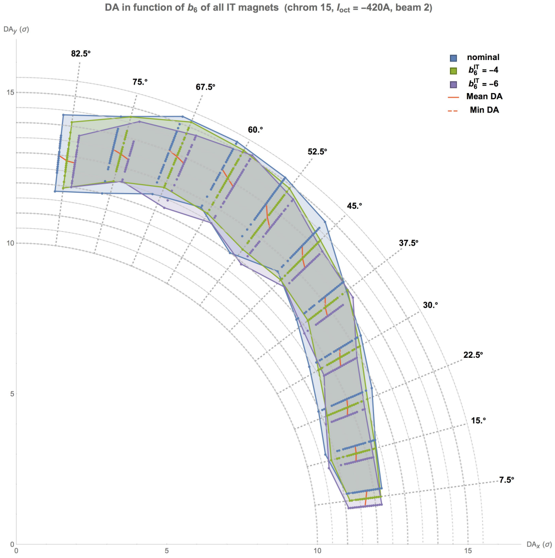




DA in function of b_6 of all IT magnets (chrom 15, I_{oct} = −420A, beam 1)
DA_y (σ)
DA_x (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
nominal
b_6^{IT} = −4
b_6^{IT} = −6
Mean DA
Min DA



Averaged over all angles
ΔDA = −0.14 σ
ΔDA = −0.17 σ
DA (σ)

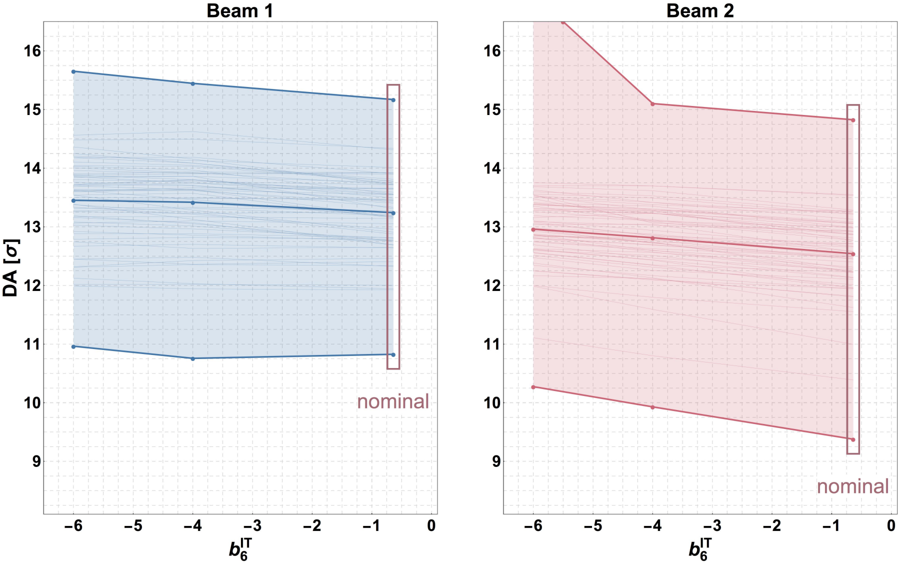


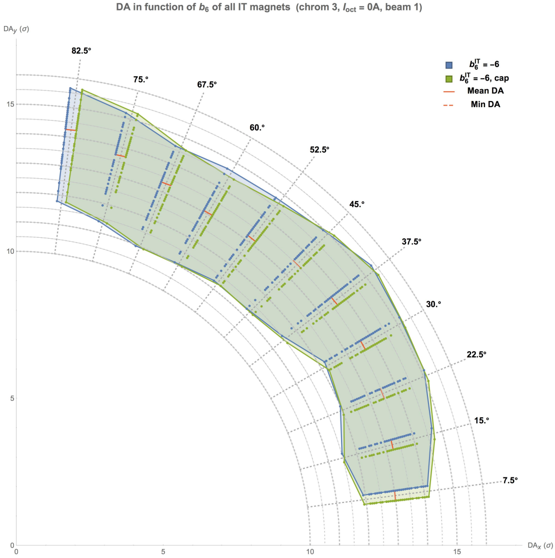
DA in function of b_6 of all IT magnets (chrom 15, I_{oct} = −420A, beam 2)
DA_y (σ)
DA_x (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
nominal
b_6^{IT} = −4
b_6^{IT} = −6
Mean DA
Min DA

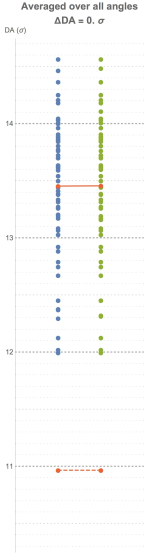
Averaged over all angles
ΔDA = −0.15 σ
ΔDA = −0.12 σ
DA (σ)

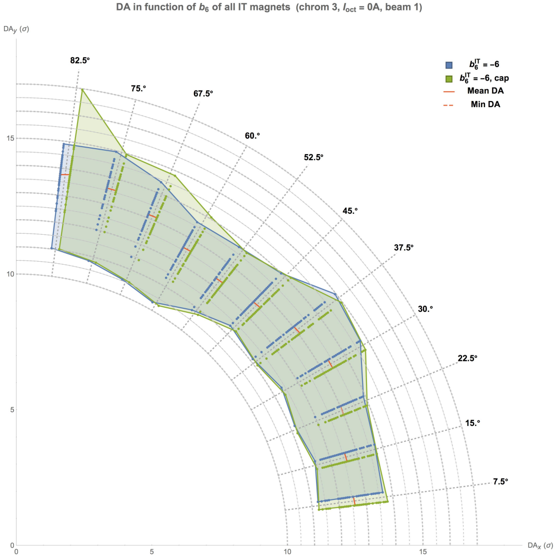
Outline

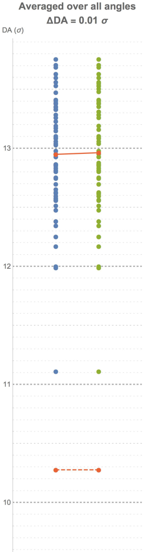
DA in function of b_6 of all IT magnets, capped correctors (chrom 3, I_{oct}=0A)



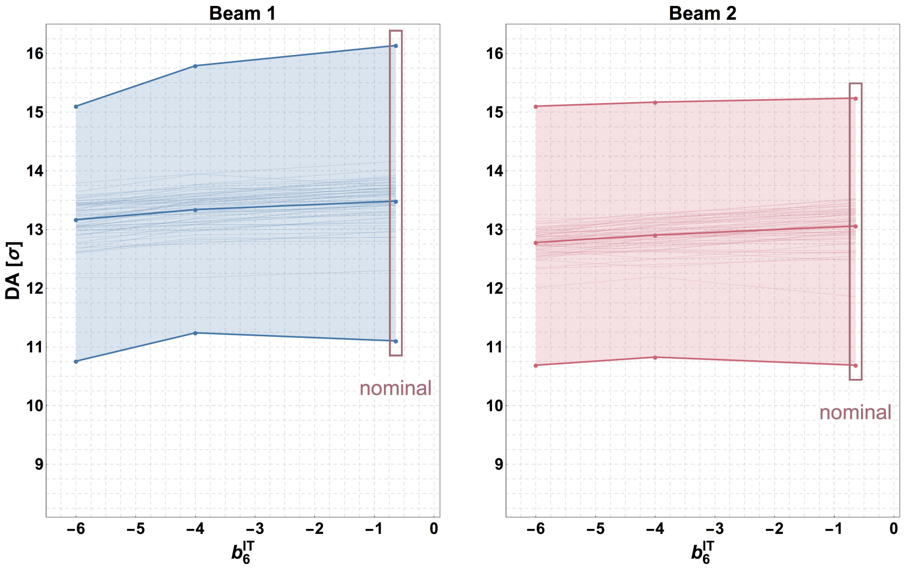

DA in function of b_6 of all IT magnets (chrom 3, I_{oct} = 0A, beam 1)
DA_y (σ)
DA_x (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
$b_6^{IT} = -6$
$b_6^{IT} = -6$, cap
Mean DA
Min DA
0
5
10
15

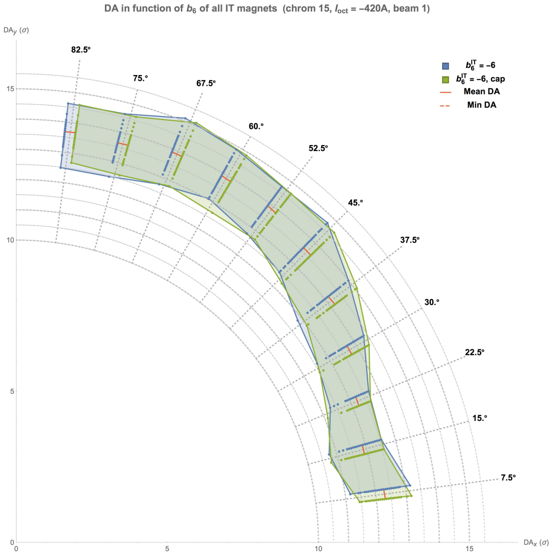

Averaged over all angles
ΔDA = 0. σ
DA (σ)
14
13
12
11

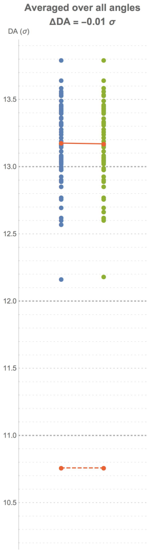

DA in function of b_6 of all IT magnets (chrom 3, I_{oct} = 0A, beam 1)
DA$_y$ (σ)
DA$_x$ (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
b_6^{IT} = −6
b_6^{IT} = −6, cap
Mean DA
Min DA
0
5
10
15

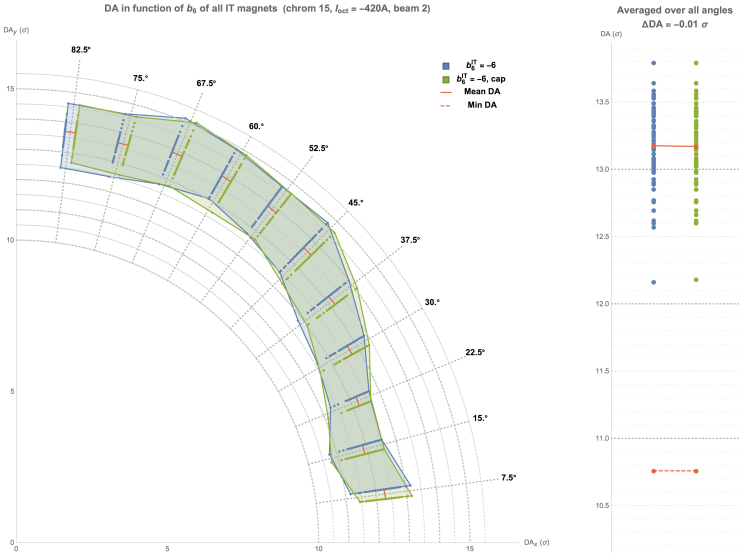

Averaged over all angles
ΔDA = 0.01 σ
DA (σ)
13
12
11
10

DA in function of b_6 of all IT magnets, capped correctors (chrom 15, I_{oct}=−420A)




DA in function of b_6 of all IT magnets (chrom 15, I_{oct} = −420A, beam 1)
DA_y (σ)
DA_x (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
b_6^{IT} = −6
b_6^{IT} = −6, cap
Mean DA
Min DA
0
5
10
15

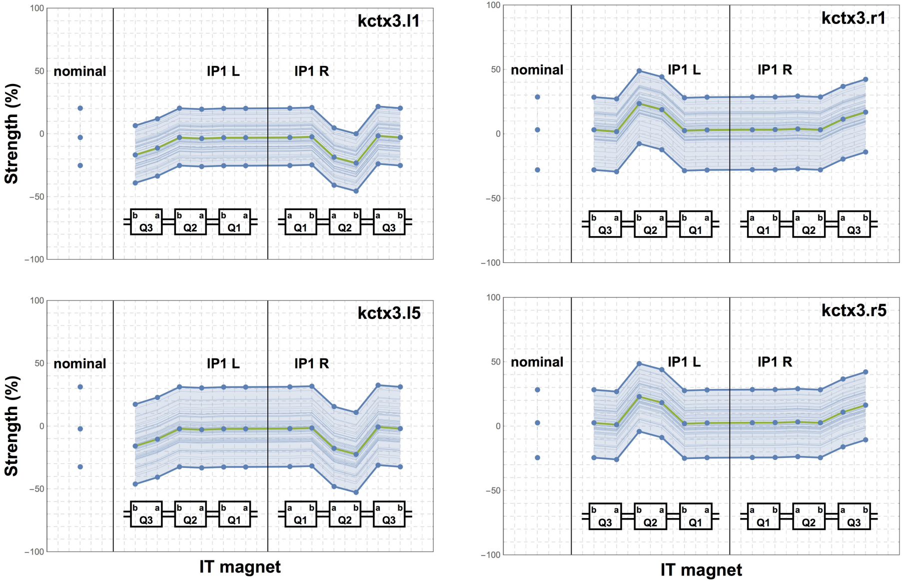

Averaged over all angles
ΔDA = −0.01 σ
DA (σ)
13.5
13.0
12.5
12.0
11.5
11.0
10.5



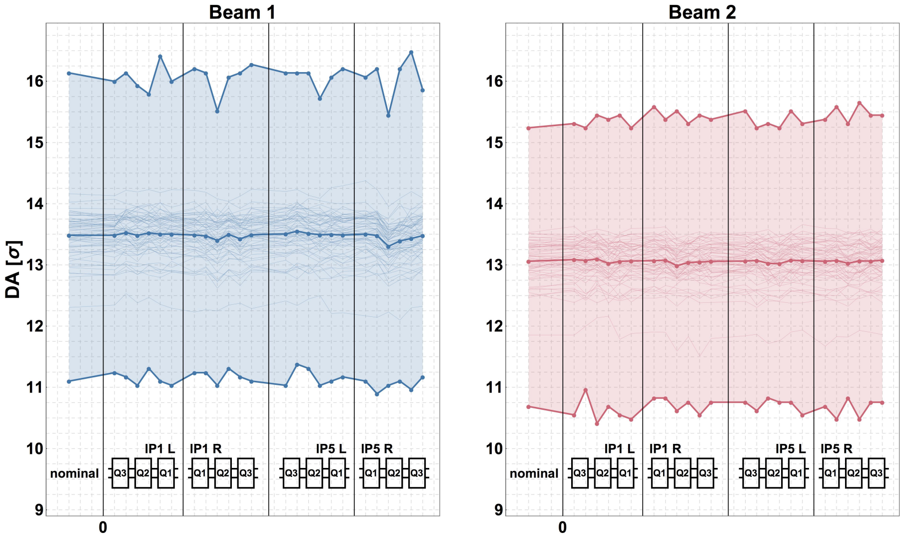
DA in function of b6 of all IT magnets (chrom 15, Ioct = −420A, beam 2)
DAy (σ)
DAx (σ)
82.5°
75.°
67.5°
60.°
52.5°
45.°
37.5°
30.°
22.5°
15.°
7.5°
b6IT = −6
b6IT = −6, cap
Mean DA
Min DA
0
5
10
15
Averaged over all angles
ΔDA = −0.01 σ
DA (σ)
13.5
13.0
12.5
12.0
11.5
11.0
10.5

Outline

Dodecapole corrector strength, setting low b_6 per IT magnet, one−by−one



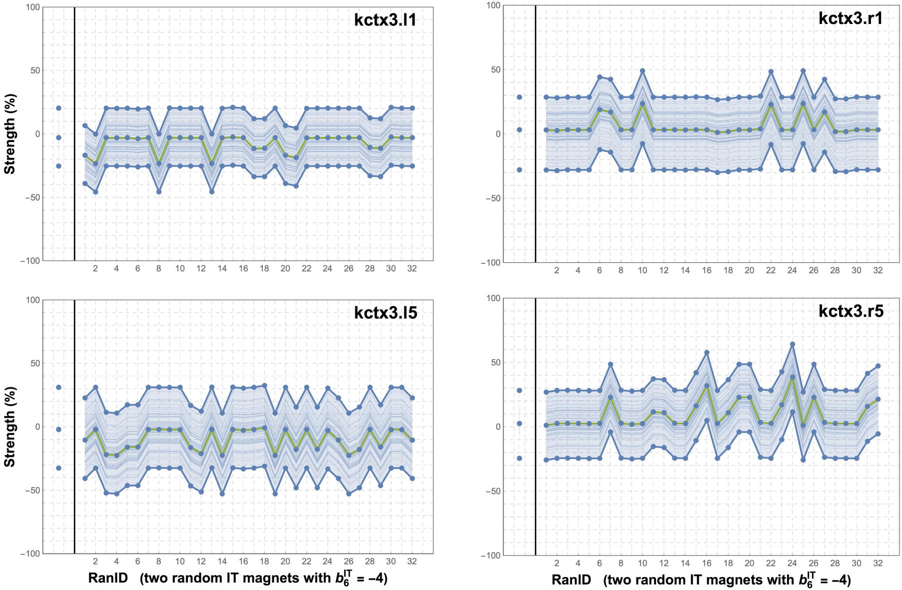
DA for $b_6 = -4$, one magnet at a time (chrom 15, $I_{oct}=-420A$)



Outline

RanID					
1	Q3b.L1 & Q3a.L5	12	Q2b.R5 & Q3a.R5	23	Q2a.R5 & Q3b.R5
2	Q1b.L1 & Q2b.R1	13	Q2b.R1 & Q1a.R5	24	Q2b.L5 & Q2a.L5
3	Q1b.R5 & Q2b.R5	14	Q1a.L1 & Q2b.R5	25	Q2b.L1 & Q3a.L5
4	Q1a.L1 & Q2b.R5	15	Q1b.R1 & Q3b.R5	26	Q2b.L5 & Q2b.R5
5	Q3b.L5 & Q1a.L5	16	Q2a.L5 & Q3b.R5	27	Q3b.R1 & Q2a.R5
6	Q2a.L1 & Q3b.L5	17	Q3a.L1 & Q1b.L1	28	Q3a.L1 & Q1b.R1
7	Q3b.R1 & Q2b.L5	18	Q3a.L1 & Q3a.R5	29	Q3a.L1 & Q3b.L5
8	Q2b.R1 & Q1a.R5	19	Q2b.L5 & Q2b.R5	30	Q1b.R1 & Q1a.L5
9	Q1a.R1 & Q1b.L5	20	Q3b.L1 & Q2b.L5	31	Q1b.L5 & Q3b.R5
10	Q2b.L1 & Q1a.L5	21	Q2a.R1 & Q2a.R5	32	Q3a.L5 & Q2b.L5
11	Q2a.R5 & Q3a.R5	22	Q2b.L1 & Q1b.L1		

Dodecapole corrector strength, setting low b_6 for two IT magnets at random



Thank you for your attention!

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