Triplet orbit corrector layout and strength specifications

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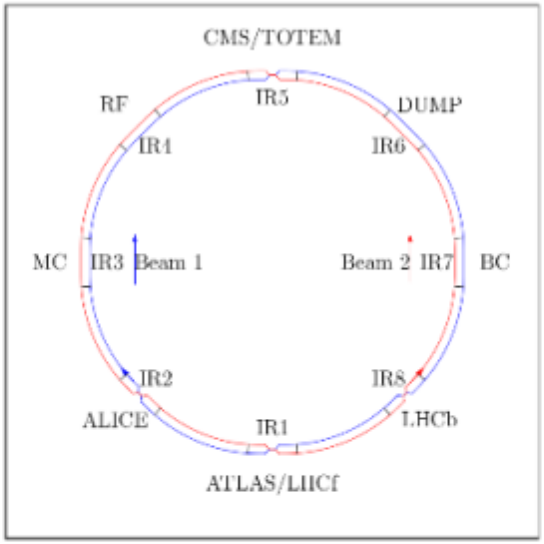
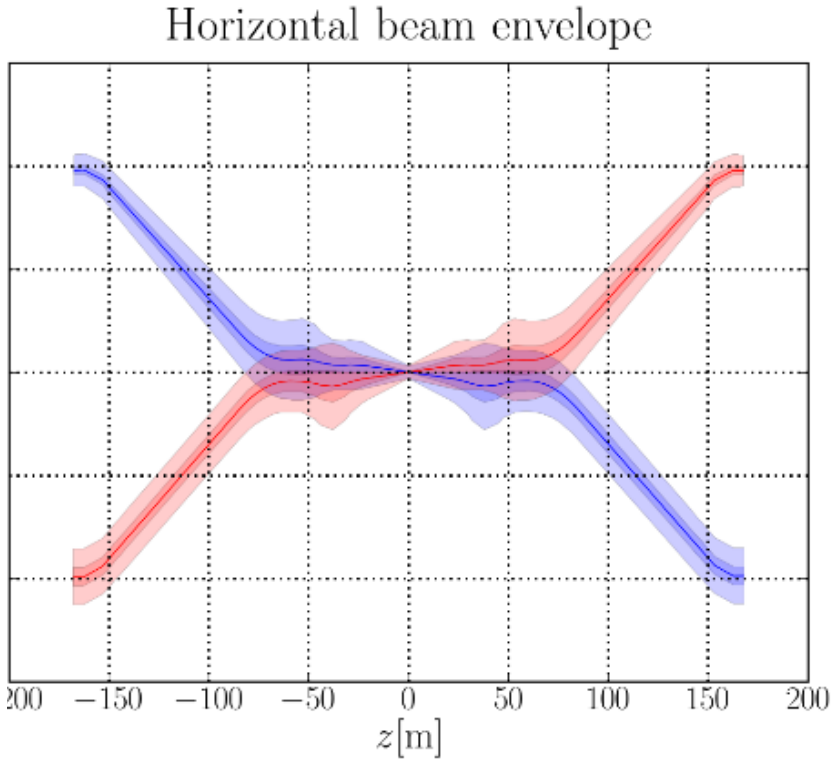
The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Outline

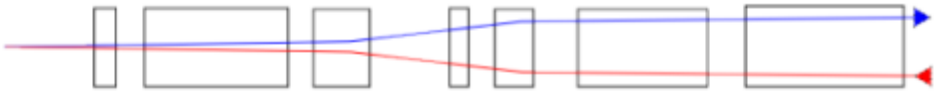
- Introduction
- New layout of correctors
- Strength specification of correctors
- Open questions

Introduction





IR1 and IR5 layout:
IP TAS Q1-Q3 D1 TAN D2 Q4-Q6 Q7-Q13

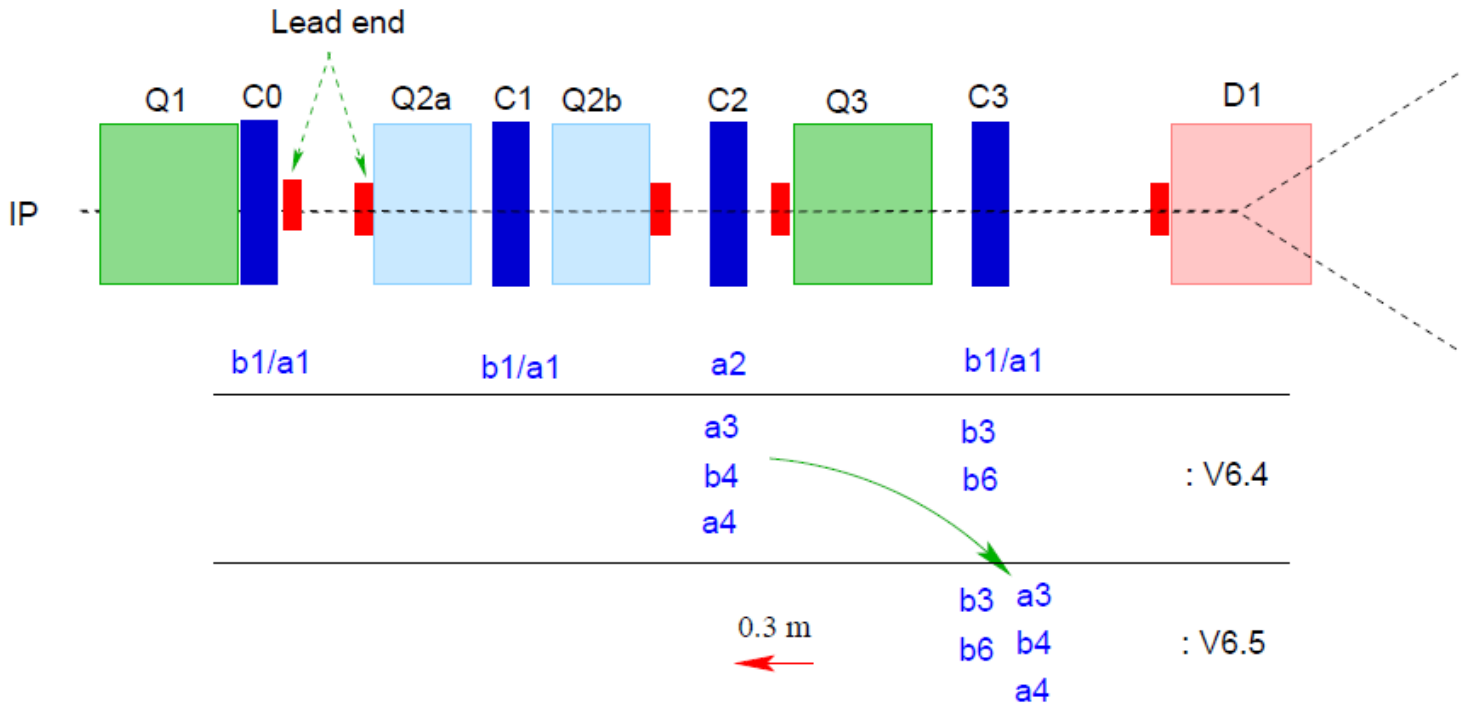


IR5 With horizontal crossing angle

Introduction

Situation in nominal LHC:

MCBX1-3: 1.5Tm@7TeV, l=0.45m



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New layout of correctors

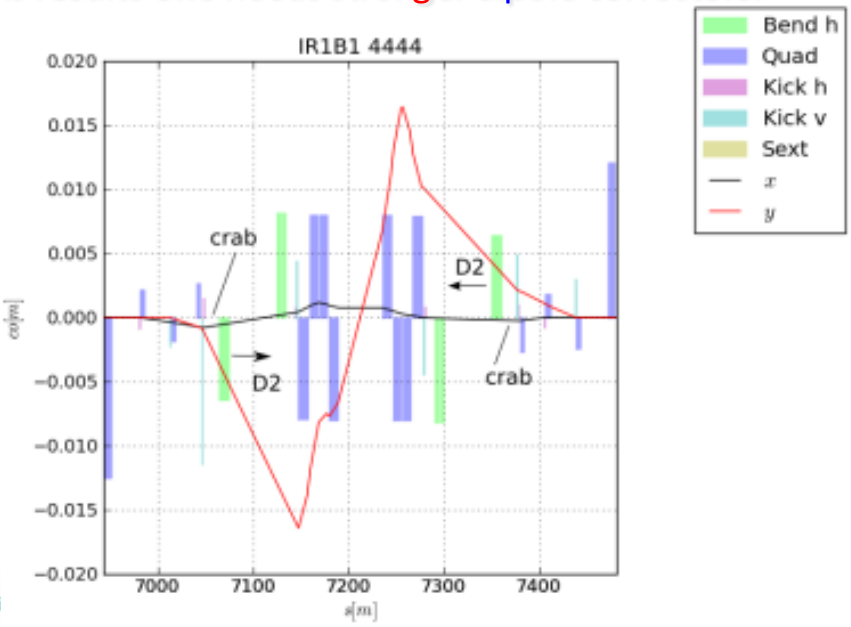
The triplet dipole correctors are used to:

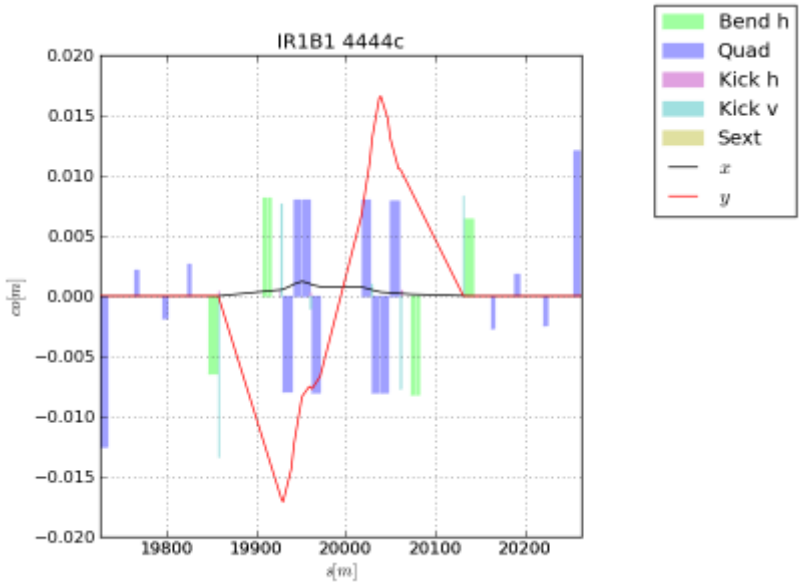
- Contribute to the crossing and separation scheme,
- Compensate mechanical misalignments of the triplets.

For the HL-LHC:

- The crossing angle and bumps are x2 larger than nominal
- The crab cavities impose that the crossing and separation bumps are closed in D2 implying correction of Beam1 and Beam 2 not independent and correctors with shorter lever arm.

As results one needs stronger dipole correctors.

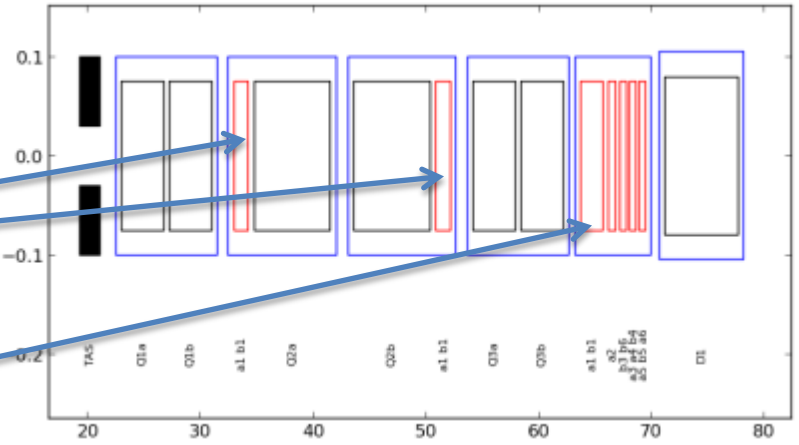


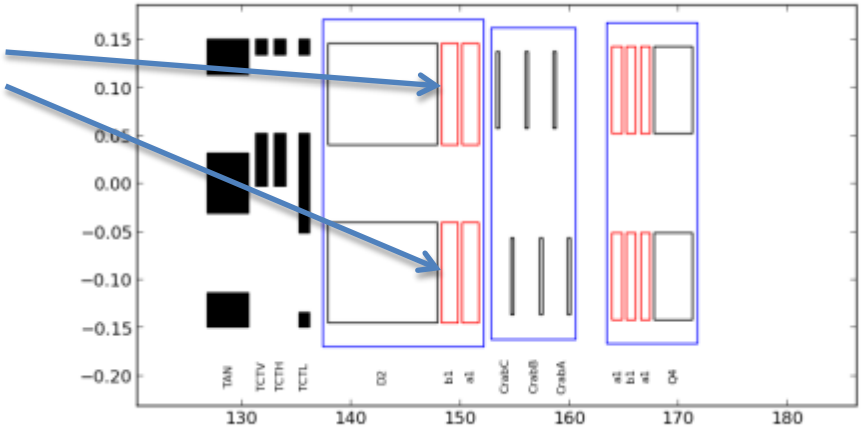


New layout of correctors

The HL-LHC layout foresee three types of h/v orbit correctors around the triplet:

- MCBX1 and MCBX2 on the left/right of Q2a/Q2b (nested 1.3m)
- MCBX3, roughly double (nested 2m) of MCBX1/2 in the corrector package
- MCBRD, 2-in1 in the non-ip side of D2 even stronger than MCBX3 (separated 1.5m each).





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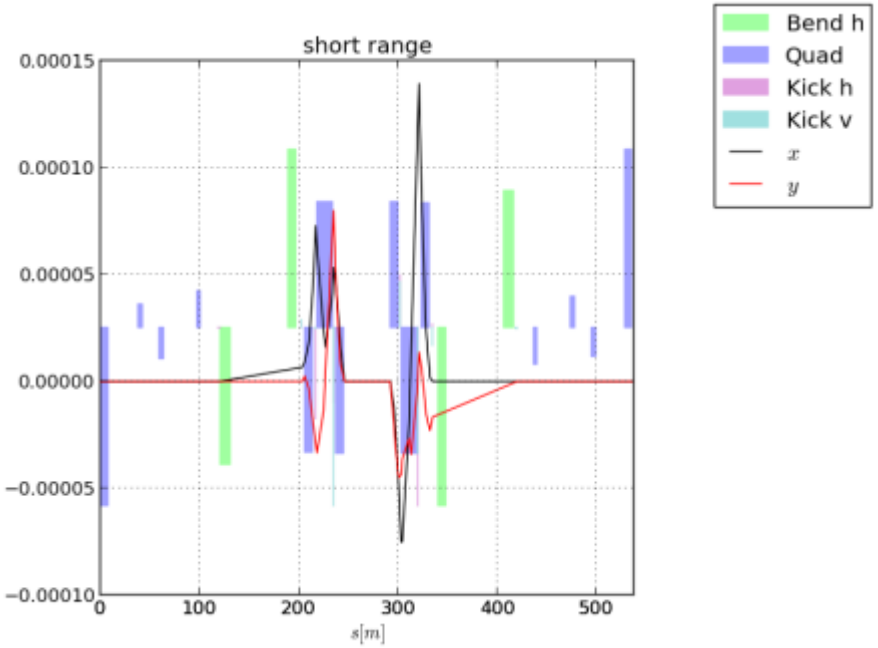
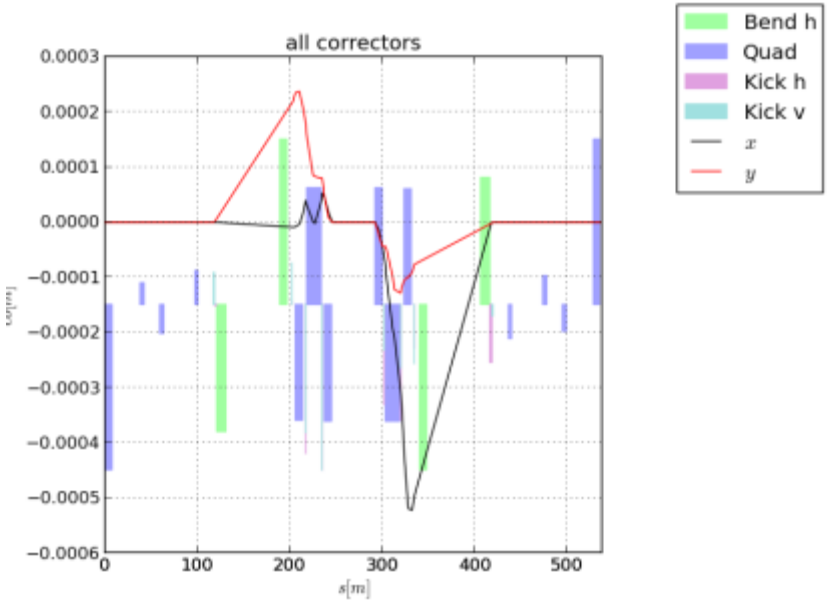
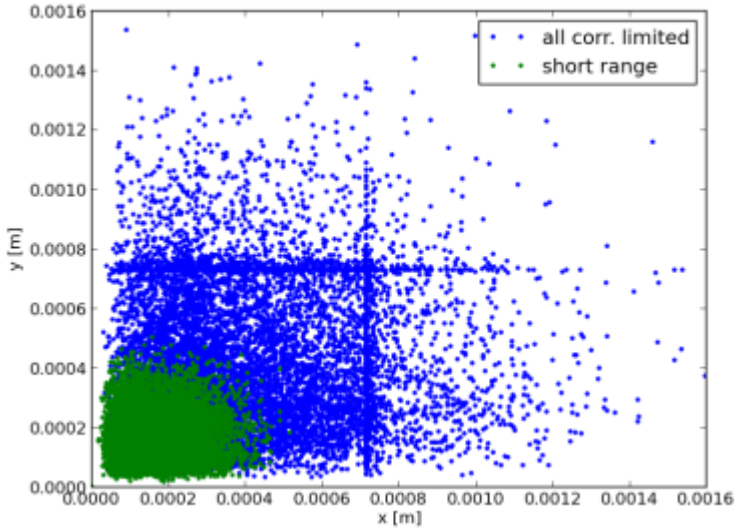
Misalignment correction

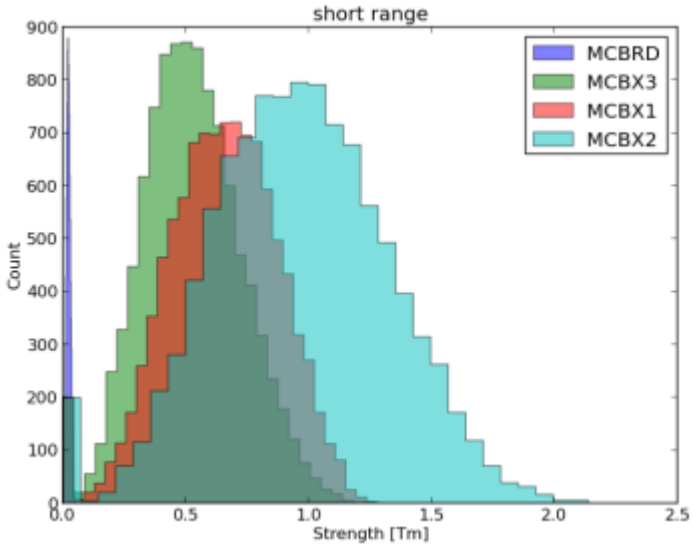
- Assuming uncorrelated transverse misalignment of +-0.5mm between all modules
- Two types of correction strategies:

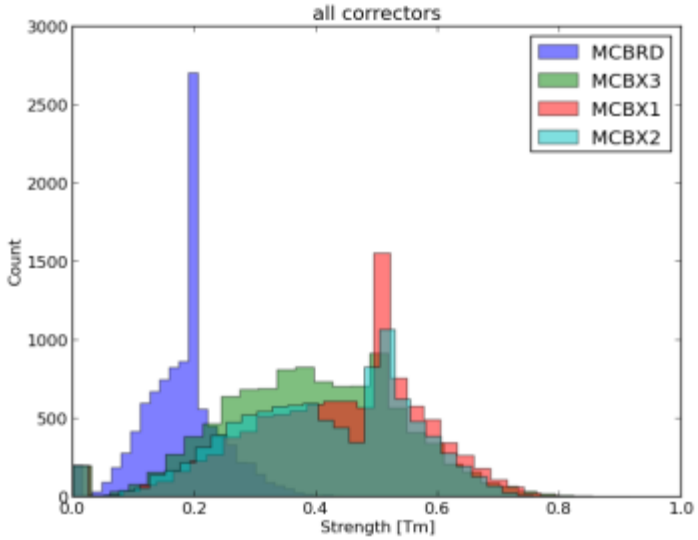




Misalignment correction





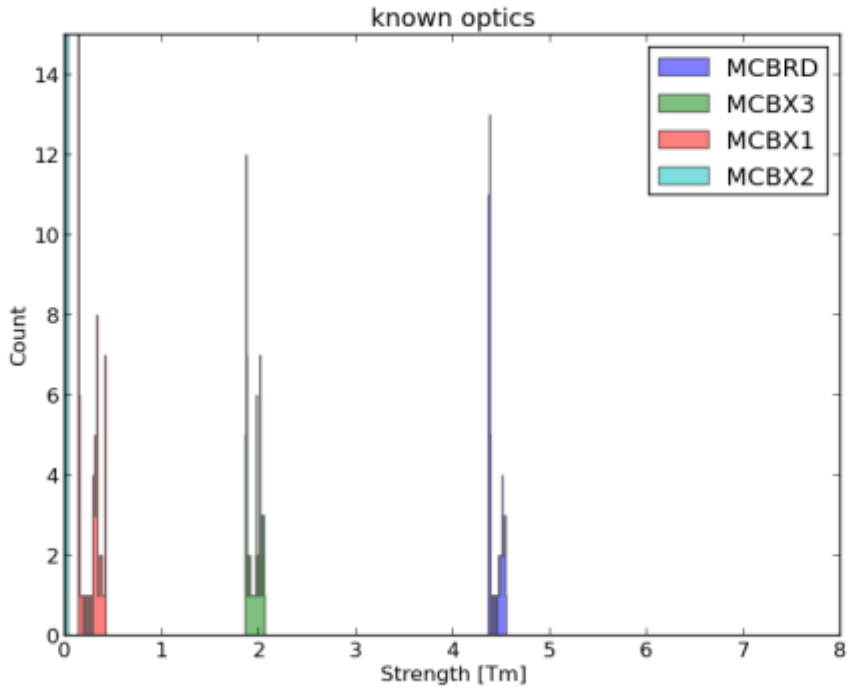


Short range: factor 2 to 3 smaller orbit
MCBX1: 1.2 Tm; MCBX2: 2 Tm;
MCBX3: 1.2 Tm; MCBRD: 0.1 Tm; orbit: 0.5 mm

All correctors: factor 2 smaller MCBX1/2
MCBX123: 0.8 Tm; MCBRD: 0.4 Tm;
orbit: 1.4 mm

Crossing scheme support

- For a case with beta*=15cm and a crossing angle of 590murad and parallel separation of 1.5mm.
- Using the optics scenarios available: squeezed, squeeze (courtesy M. Korostelev), injection at 6 m, 11 m, 18 m.

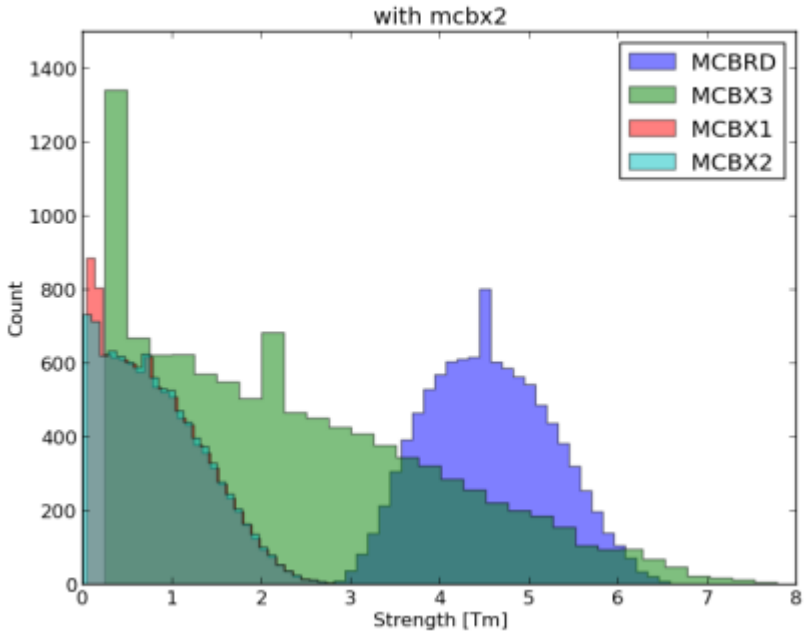


In the crossing plane:
MCBX1: 0.4 Tm;
MCBX3: 2.1 Tm;
MCBRD: 4.5 Tm;

In the separation plane:
MCBX1: 0.15 Tm;
MCBX3: 0.24 Tm;
MCBRD: 0.14 Tm

Crossing scheme support

- For a case with beta*=15cm and a crossing angle of 590murad and parallel separation of 1.5mm.
- Assuming randomly powered triplet at +-5Tm

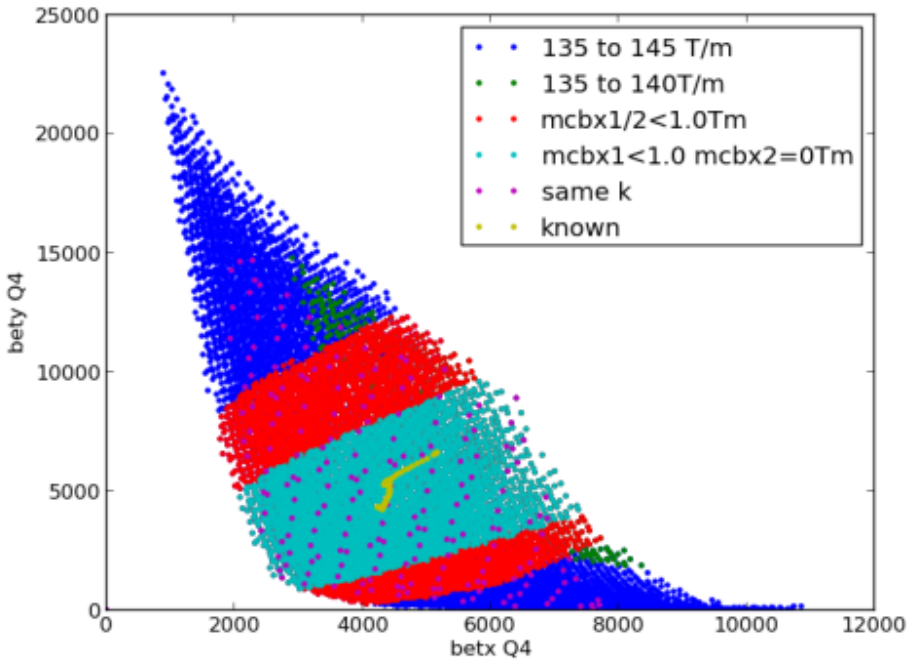


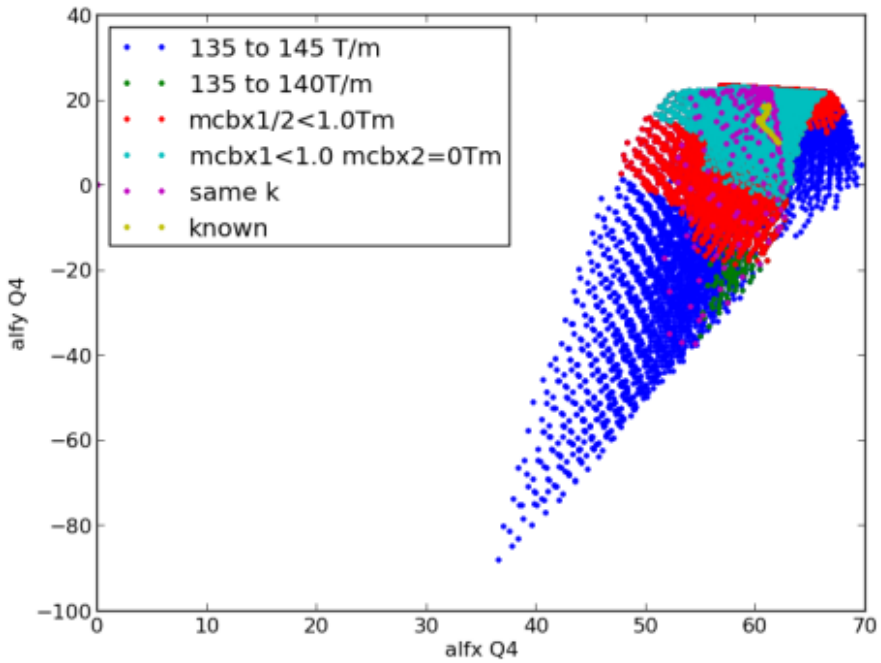
In the crossing plane
MCBX12: 2.5Tm;
MCBX3: 8Tm;
MCBRD: 7Tm.

In the separation plane
MCBX12: 0.25Tm;
MCBX3: 0.45m;
MCBRD: 0.20Tm

Crossing scheme support

- For a case with beta*=15 cm , crossing angle of 590 murad and parallel separation of 1.5 mm.
- Assuming randomly powered triplet at +-5 T/m.





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Strength specification of orbit correctors

- Summary of dipole correctors:

	MCBX1 [Tm]	MCBX2 [Tm]	MCBX3 [Tm]	MCBRD [Tm]
Orbit correction both planes				
Short range (0.5mm)	1.2	2	1.2	0.1
All correctors (1.4mm)	0.8	0.8	0.8	0.4
Crossing angle, 590murad				
Operational values	0.5	0.0	2.1	4.6
Tunable range	1.3	0.0	3.7	5.4
Extended tunable range	2.8	2.8	7.8	6.6
Parallel separation, 1.5mm				
Operational values	0.15	0.0	0.25	0.15
Extended tunable range	0.5	0.0	0.42	0.25

Open questions:

- Can we rely on better mechanical (re)alignments?
- Which optics flexibility do we need to support?
- Adding another MCBX in between Q2a and Q2b?