Results of beam-based alignment in undulator section

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Goal:
align all quadrupoles between undulator modules
to get straight trajectory in undulator section
to increase the overlap between electrons and photons
so that the SASE process can take place in the whole undulator section
BBA in undulator: steps (overall plan)

1) measure relative offset between quadrupoles and BPM (or wire-scanners)
2) align quadrupoles to the beam (after de-Gauss of undulator quadrupoles)
3) measure dispersion in undulator section (masking incoming dispersion) and correct

up to now: step 1 done, step 2 (only vert. plane)
Procedure
Procedure

measure beam position and move quad
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→ all quads are steering free
→ no dispersion generated by quads
Results from BBA in the vertical plane

red: Soll position of quads (for steering free)  \[=\]  black: Ist position of quads

blue: measured beam position
First try of BBA in the horizontal plane ...failed...

...already here

0.1 mm quad $\rightarrow$ 0.5 mm next WS
Last try of BBA in the horizontal plane ...failed...

... BUT the relative distance between quads is same as SOLL
The horizontal trajectory can be made flat

black: beam position measured with wirescanners
red: beam position measured with BPMs (averaged over 100 points)
→ spontaneous emission increased in forward direction

→ more straight orbit?

→ or beam losses?
Why de-Gauss of quads?

to get rid of the dipole component
Typical quad field

TQG quad: current from 75 A to 10 A
TQG quad: current from 75 A to 0 A

By

-3 0 3

x

B [mT]

-3 -2 -1 0 1 2 3

x=-3 mm

x=0

x=3 mm

-100 -50 0 50 100

z [mm]
By dipole field

TQG quad: current from 75 A to -1 A

\[ \int B \, dz = 0.11 \, \text{Tmm} \]
quadrupole TQG 18 : current = 0

B [mT]

x=-3 mm (from 75 A)

x=0

(after de-Gauss)

x=3 mm

z [mm]
Measurements of the quad center vs current (on spare quad)

\[
\text{By} \quad \uparrow \uparrow \uparrow \downarrow \downarrow \quad x \quad 0 \quad \text{By} \quad \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \quad x \quad 0 \quad \text{By} \quad \uparrow \uparrow \uparrow \downarrow \downarrow \quad x
\]

quad field  +  dipole field  =  quad field (shifted)

\[
\int B \ dz = -0.11 \ \text{Tmm}
\]
\[
\int g \ dz = 0.085 \ I[A] + 0.076 \ \text{T}
\]