Crosstalk between beam-beam interaction and lattice nonlinearities in the SuperKEKB
- Preliminary results

D. Zhou, K. Ohmi, Y. Ohnishi

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1. Motivation

sler_1670: Dynamic aperture (w/o beam-beam)

Real space

Frequency map analysis

D. Zhou et al., SuperKEKB optics meeting, Jul.17, 2012

Resonance lines:
Blue: 4th order
Green: 5th order
Yellow: 6th order
Cyan: 7th order
1. Motivation

**sler_1670: Dynamic aperture (w/ beam-beam):**

Real space

Tune space

**Frequency map analysis**

D. Zhou et al., SuperKEKB optics meeting, Jul.17, 2012

**Resonance lines:**
Blue: 4th order
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1. Motivation

**Question:**
How lattice nonlinearities affect the luminosity performance of SuperKEKB?

**Proposals for simulations:**
1) Beam-beam simulation based on SAD: all lattice nonlinearities included
2) BBWS code: pure beam-beam with simple one-turn linear map
3) Simulate all the knob-scans in the control room and compare with the results of BBWS
2. Simulation based on SAD

TABLE 1 Machine parameters. * indicates values at IP.

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<th>LER</th>
<th>HER</th>
<th>Unit</th>
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<td>GeV</td>
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<td>$L$</td>
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<td>cm$^{-2}$s$^{-1}$</td>
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Beam-beam simulation with SAD:
1) Intra-beam scattering (IBS) affect the emittance but hard to model in tracking $\Rightarrow$ IBS neglected.
2) Close the radiation damping and quantum excitation in SAD $\Rightarrow$ Add damping and excitation manually and set the emittance (zero beam current) to design values.

Y. Ohnishi et al., Prog. Theor. Exp. Phys. 2012 (to be published)
2. Simulation based on SAD

Other simulation conditions:

➢ SAD: NP=1000 (limited by CPU time, 2 days for one simulation), nturn=40000, Design lattice (No magnet errors)

➢ BBWS: NP=10000 (2.5 hours for one simulation), nturn=40000, Simple one turn map

Luminosity

SAD simulation example

\[
\langle x^2 \rangle
\]

\[
\langle y^2 \rangle
\]

Red: NP=1000
Blue: NP=10000
3. Simulation results

Specific luminosity:

Number of particles:
SAD: NP=1000
BBWS: NP=10000

- BBWS, $\beta_x^* = 32$ mm
- BBWS, $\beta_x^* = 38$ mm
- sler_1682
- sler_1670
3. Simulation results

Horizontal beam size:

Number of particles:
SAD: NP=1000
BBWS: NP=10000

![Graph showing beam size simulation results](image)

- BBWS: $\beta_x^* = 38$ mm
- Design: $\beta_x^* = 32$ mm
3. Simulation results

Vertical beam size:

Number of particles:
SAD: NP=1000
BBWS: NP=10000

![Graph showing vertical beam size and linearity tests for SAD and BBWS.]

- SAD
- BBWS
- βₓ* = 38 mm
- βₓ* = 32 mm

Design
4. Tentative conclusions and Future work

Tentative conclusions:
➢ Lattice nonlinearities may affect luminosity performance (~10%)?
➢ The effect depends on lattice design

Future work:
➢ Understand the anomalous beam size blow-up
➢ Repeat the study for HER
➢ Simulate all the knob-scans in the control room and compare with the results of BBWS
➢ Consider effects of errors
➢ Investigate lattice nonlinearities