



KEKB-LER for ILC Damping Ring Study

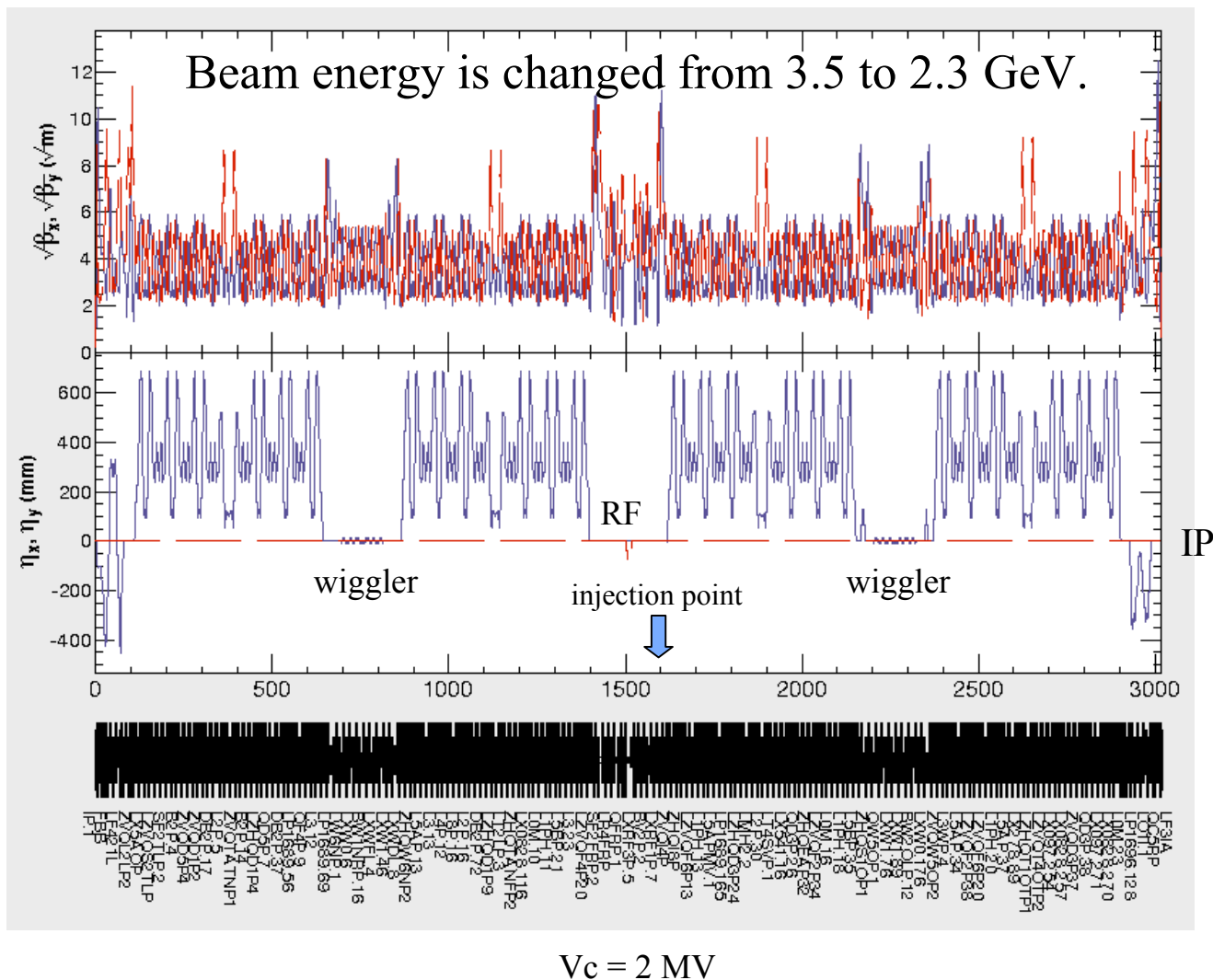
Simulation of low emittance lattice includes machine errors and optics corrections.

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Emittance and Lattice Errors

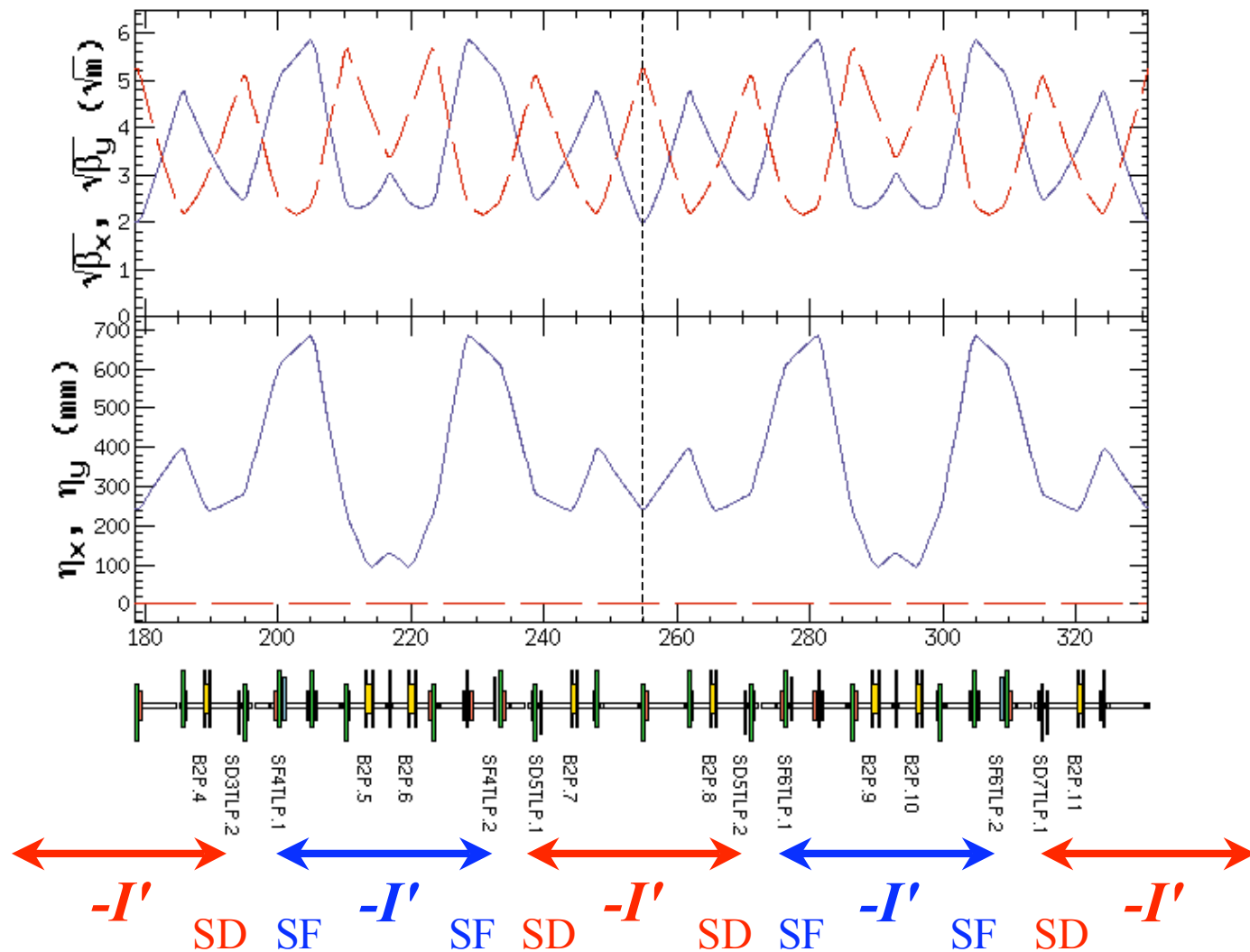
- The purpose of this study is to check a feasibility of the **low emittance** with **optics corrections** for the KEKB-LER.
 - For the preparation of e-cloud study(?)
- Evaluate KEKB-LER lattice includes **machine errors**.
 - magnet alignment errors(displacement and rotation) and field gradient errors.
- BPM accuracy should be checked.
 - BPM error consists of **alignment error + jitter error**.
 - In the case of KEKB, **alignment errors** is estimated to be **$\sim 40 \mu\text{m}$** and **a few μm** for **the jitter error**. (H.Fukuma, M. Masuzawa)
 - BPM system is **an averaged mode(not single-pass)**.
- Simulation study
 - The errors are generated according to Gaussian distributions with random seed numbers in the simulation.

KEKB-LER Lattice for ILC Damping Ring Study

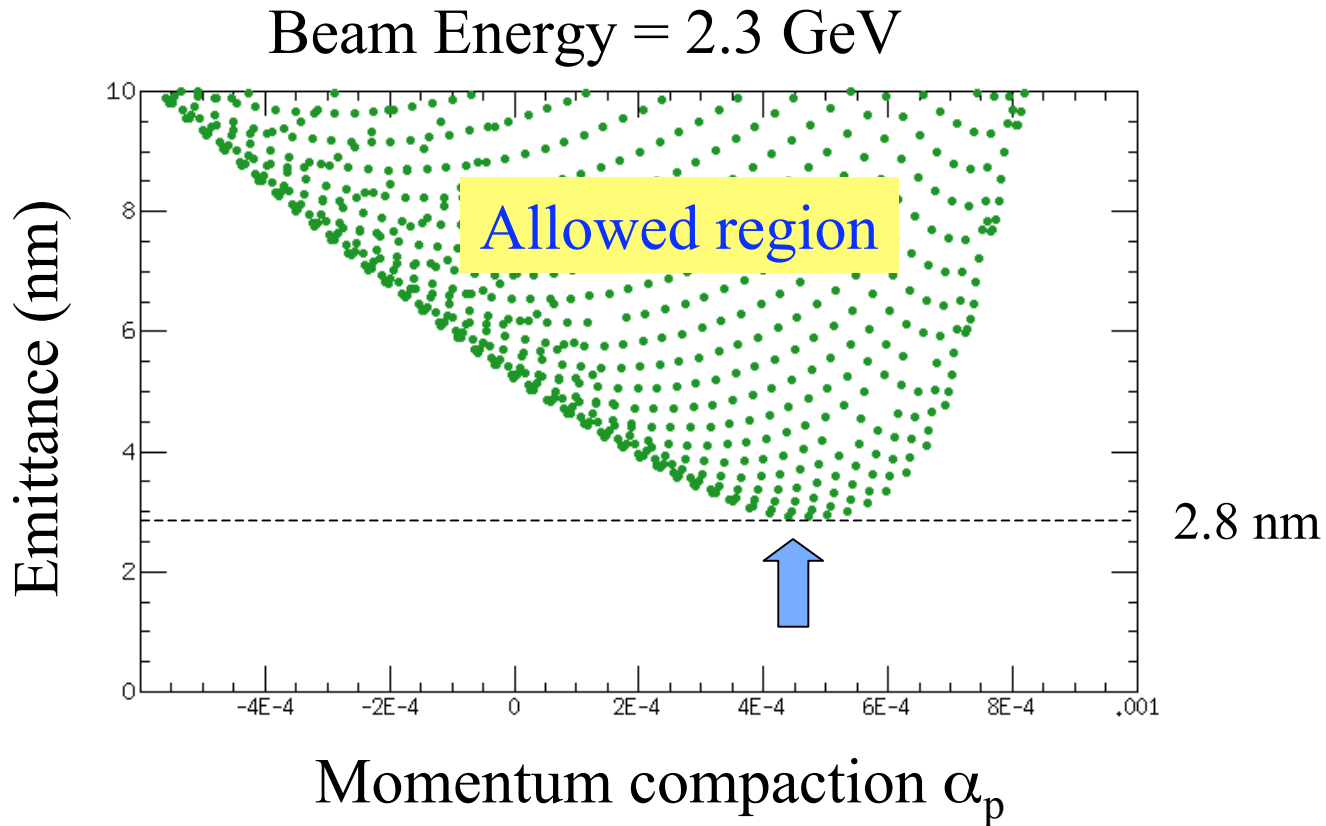


E (GeV)	2.3
ϵ_x (nm)	1.5
ν_x	47.53
ν_y	42.59
ν_s	-0.013
α_p	2.5×10^{-4}
σ_z (mm)	4.3
τ_s (ms)	75
β_x^* (cm)	90
β_y^* (cm)	3

2.5 π Non-interleaved Sextupole Arc Cells

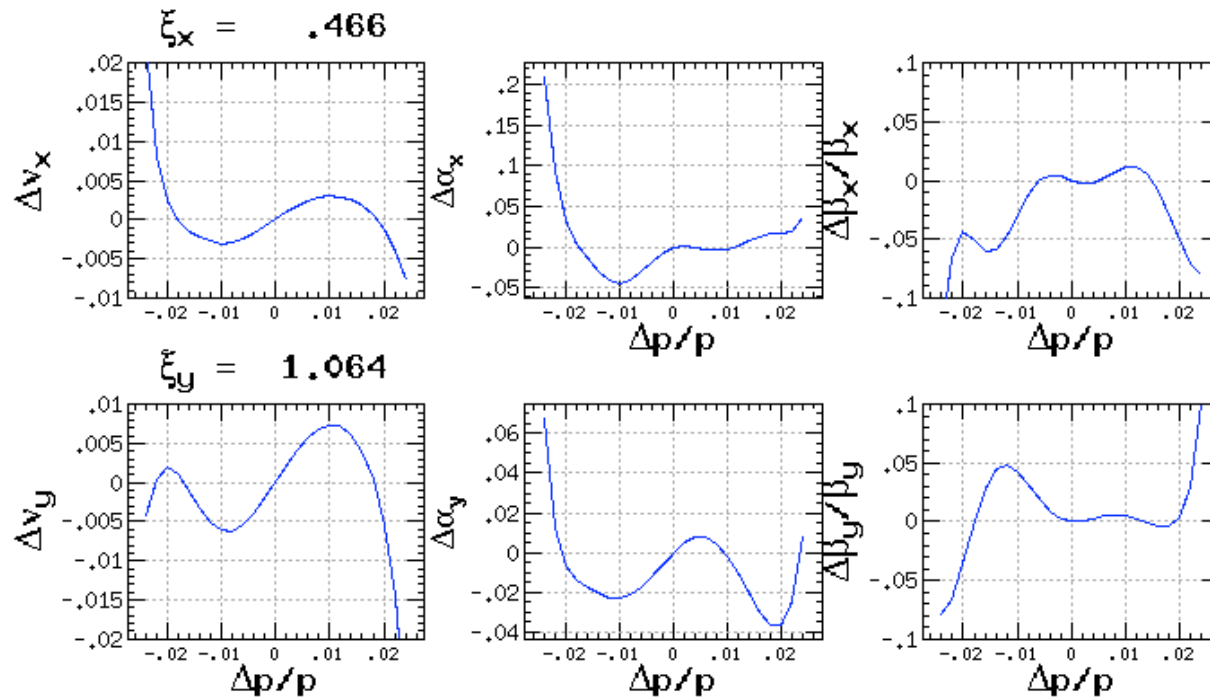


Flexibility of Arc Cell

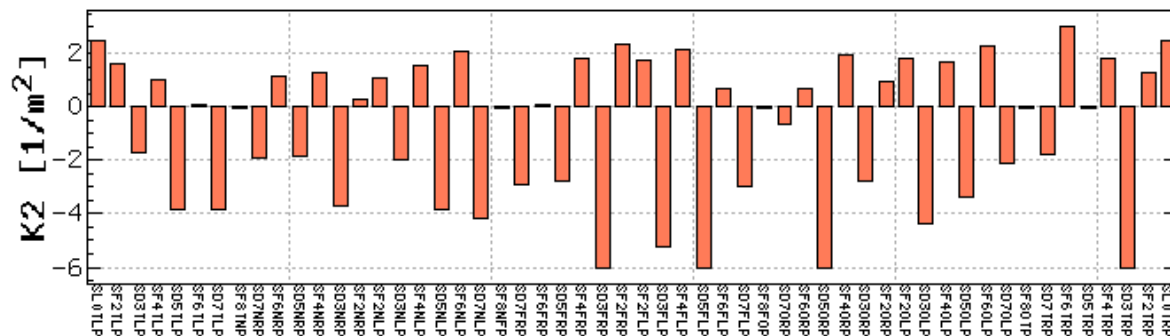


Contribution of wigglers is the same as the arc cells.

Chromaticity Correction



54 sextupole families



Simulation Study for Low Emittance Lattice at KEKB-LER

Optics correction is performed to the lattice including machine errors to confirm the feasibility of the low emittance lattice. Especially, requirements for the BPM system...

Single particle issue

Lattice Errors

Multipole components and fringe field have been included in the model lattice.

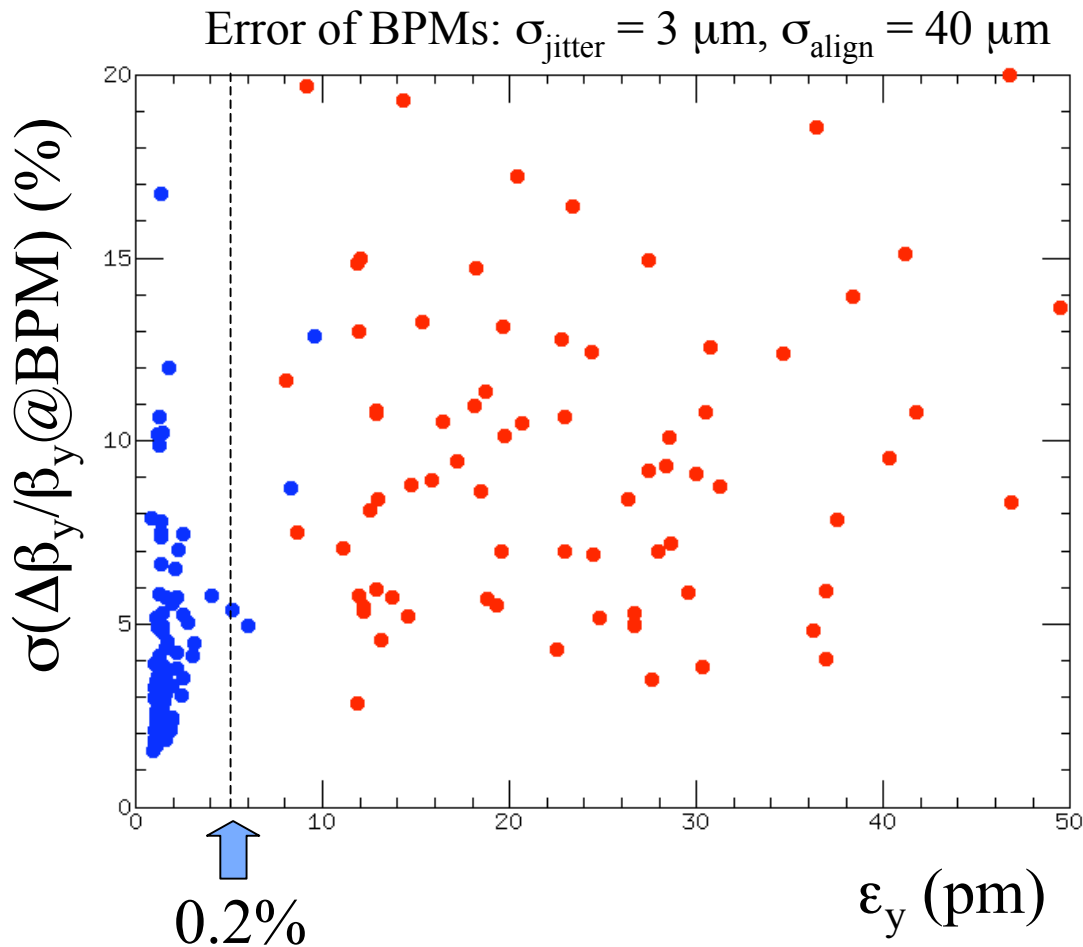
Following errors are produced with random numbers according to Gaussian. These numbers are one standard deviation(σ).

	alignment error Δx (μm)	alignment error Δy (μm)	rotation error $\Delta\theta$ (mrad)	gradient error $\Delta k/k$
Bending magnet	200	200	0.1	5×10^{-4}
Quadrupole magnet	100	100	0.2	1×10^{-3}
Sextupole magnet	200	200	0.2	2×10^{-3}

Optics Correction

- Correction of closed orbit distortion
 - 454 BPMs
 - 166 horizontal and 208 vertical steering magnets
- XY coupling correction
 - measurement:
 - vertical orbit response induced by a horizontal single kick due to a steering magnet.
 - corrector:
 - **symmetric vertical local bumps** at sextupole pairs(-I' connection)
- Dispersion correction
 - measurement:
 - orbit response changing rf frequency.
 - corrector:
 - **asymmetric local bumps** at sextupole pairs(-I' connection)
- Beta correction
 - measurement:
 - orbit response induced by a single kick due to a steering magnet.
 - corrector:
 - fudge factors to quadrupole magnet power supplies(families)

One of Results Before Optics Correction and After



#samples : 100

Each point means a different seed number to give machine errors.

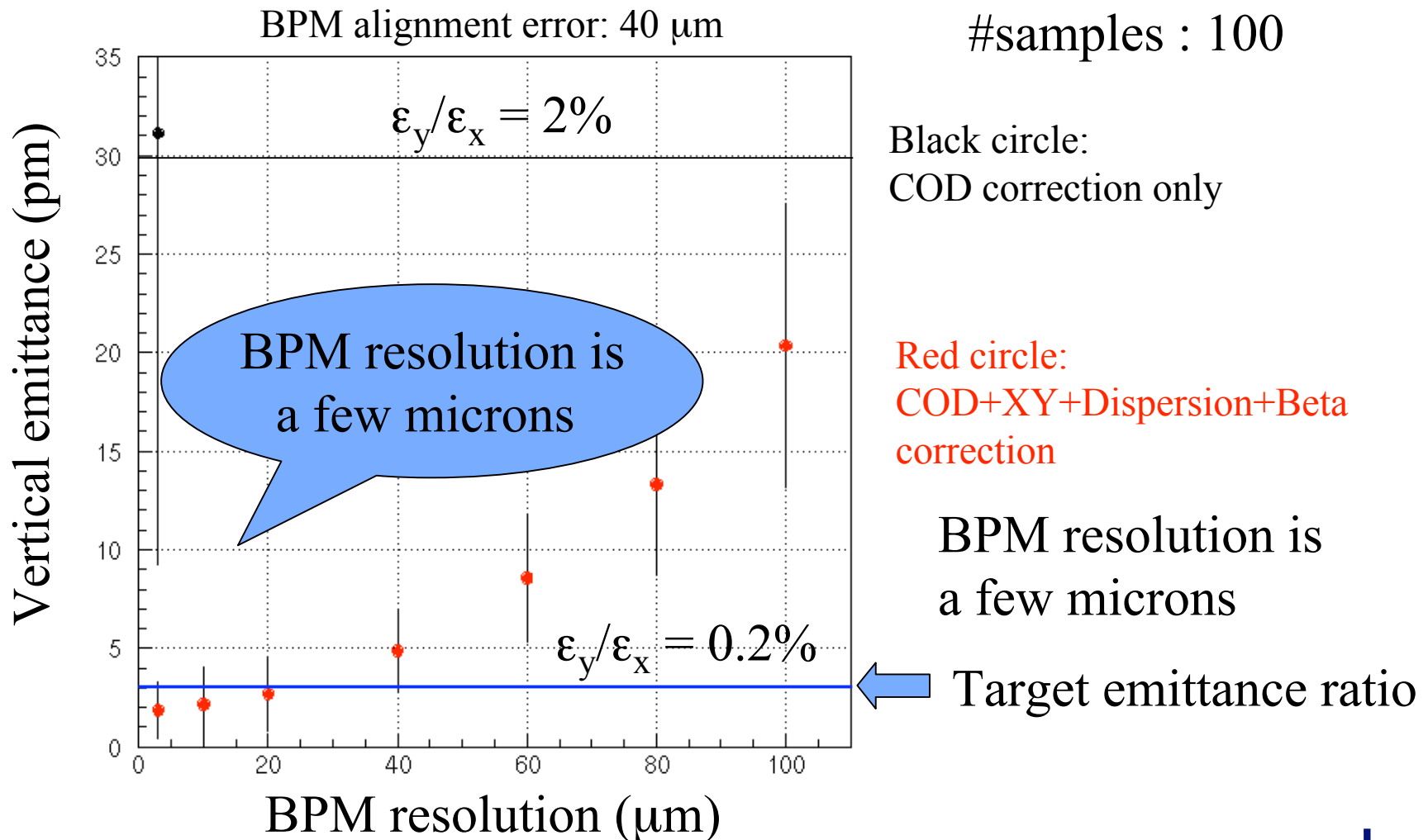
COD correction only

COD+XY+Dispersion+Beta correction

- Optics corrections can achieve $\epsilon_y/\epsilon_x=0.2 \%$, where $\epsilon_x=1.5 \text{ nm}$.
- BPM accuracy of $3 \mu\text{m}$ resolution(pulse-to-pulse jitter) and $40 \mu\text{m}$ alignment error is enough to correct the lattice.

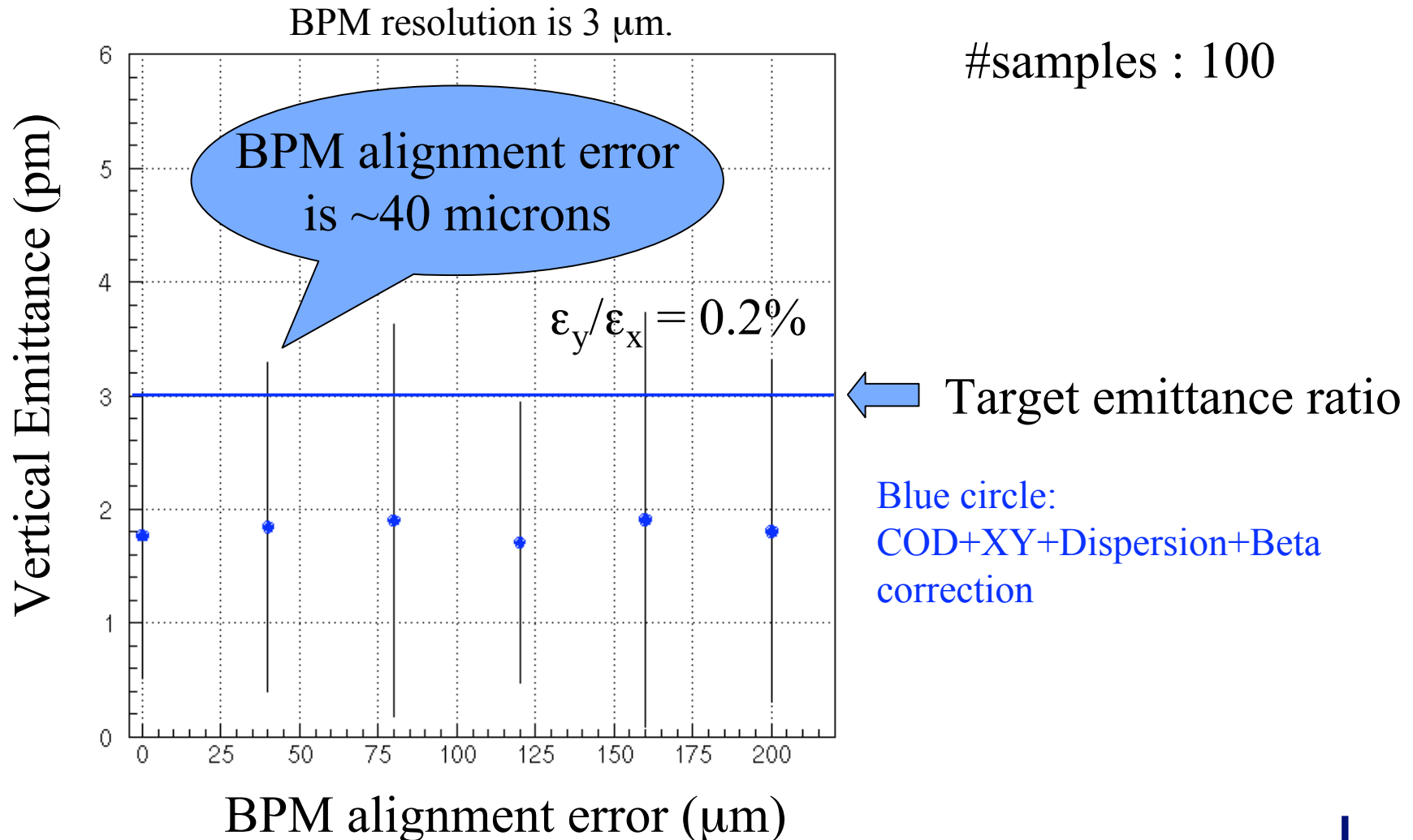
BPM Resolution and Optics Correction

Jitter errors of BPM affects corrections of the lattice.



BPM Alignment and Optics Correction

Alignment errors of BPM does not affect corrections of the lattice.

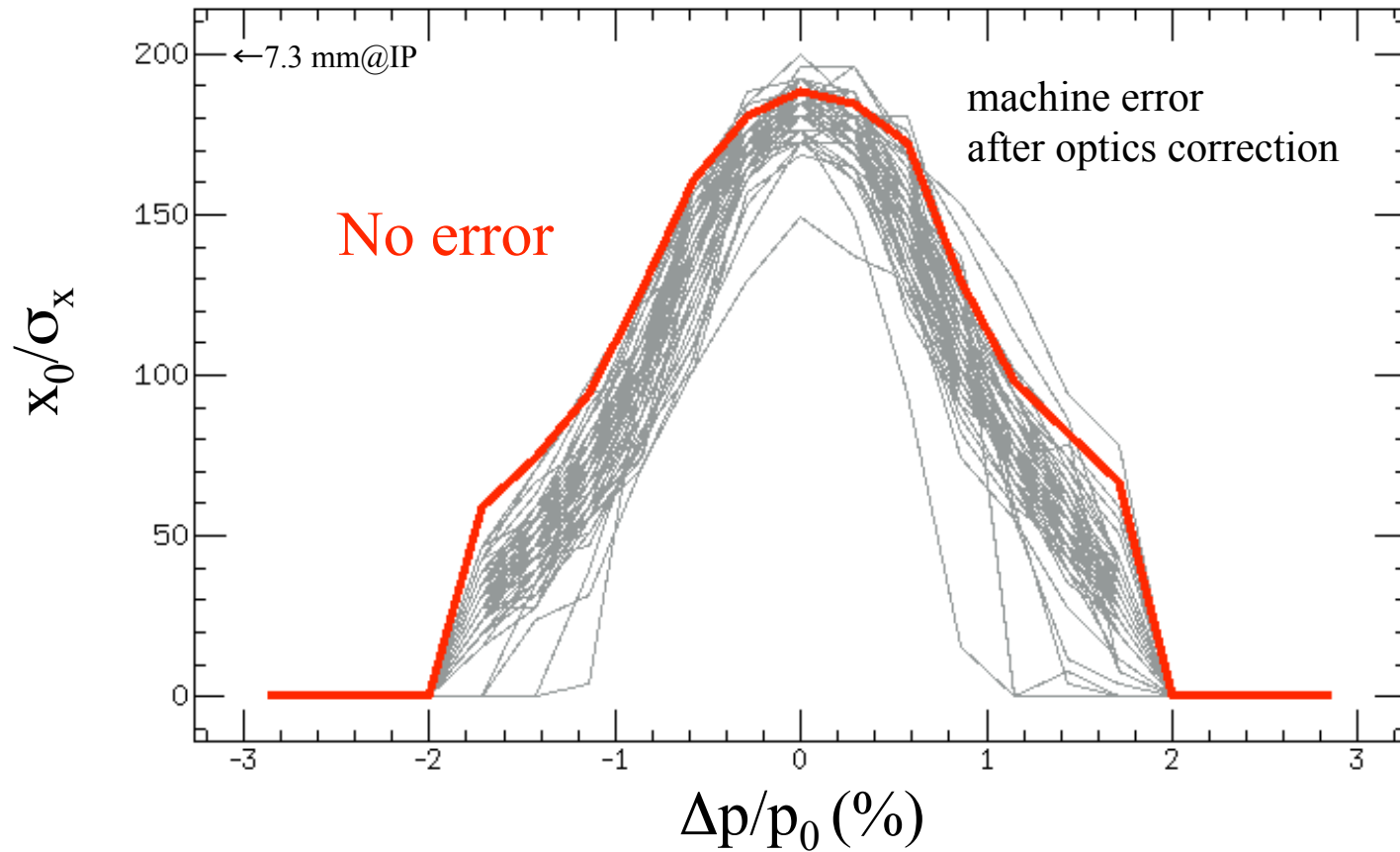


Dynamic Aperture Survey at KEKB-LER

Low Emittance Lattice

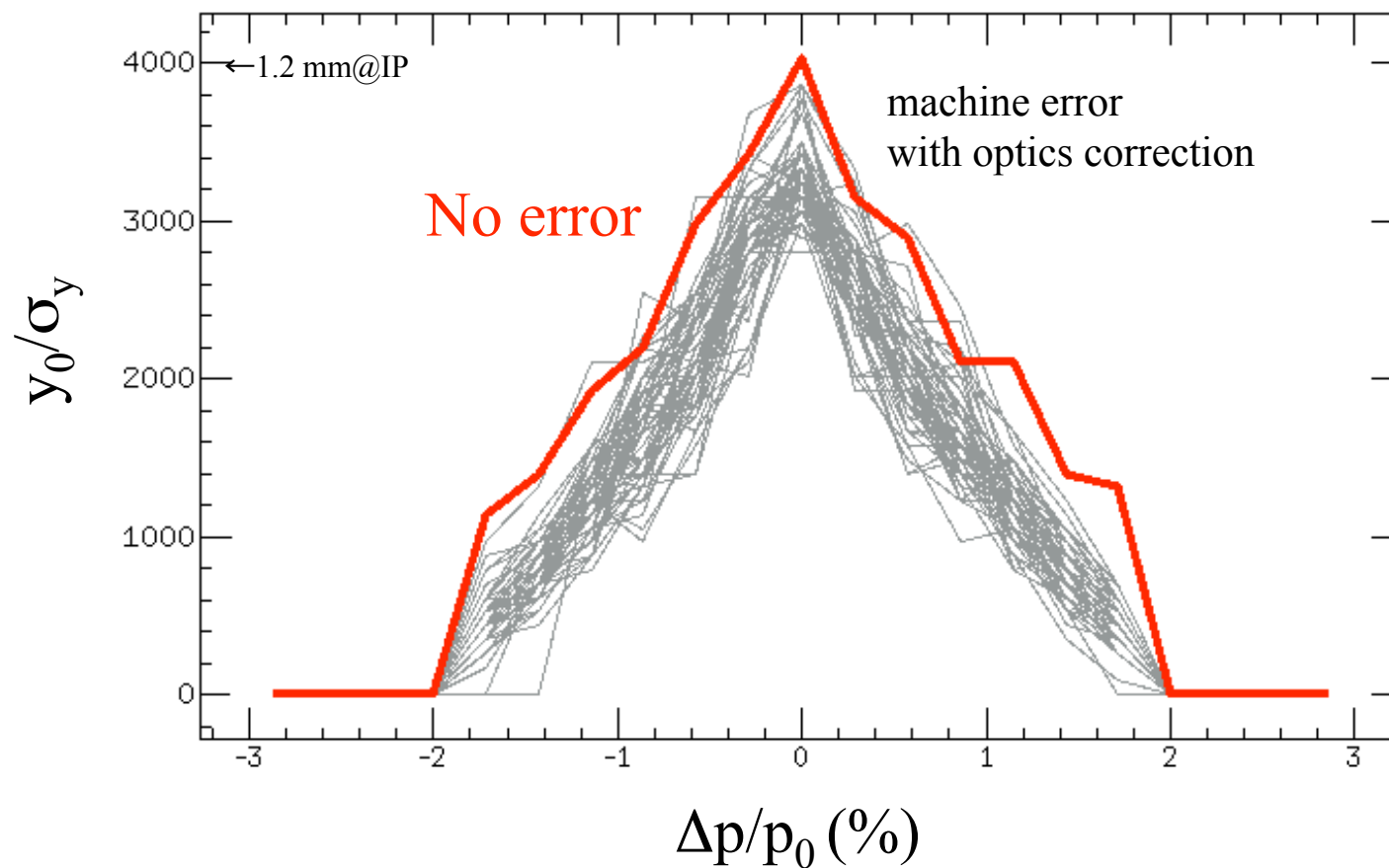
Dynamic Aperture

Horizontal aperture with $J_y = 0$

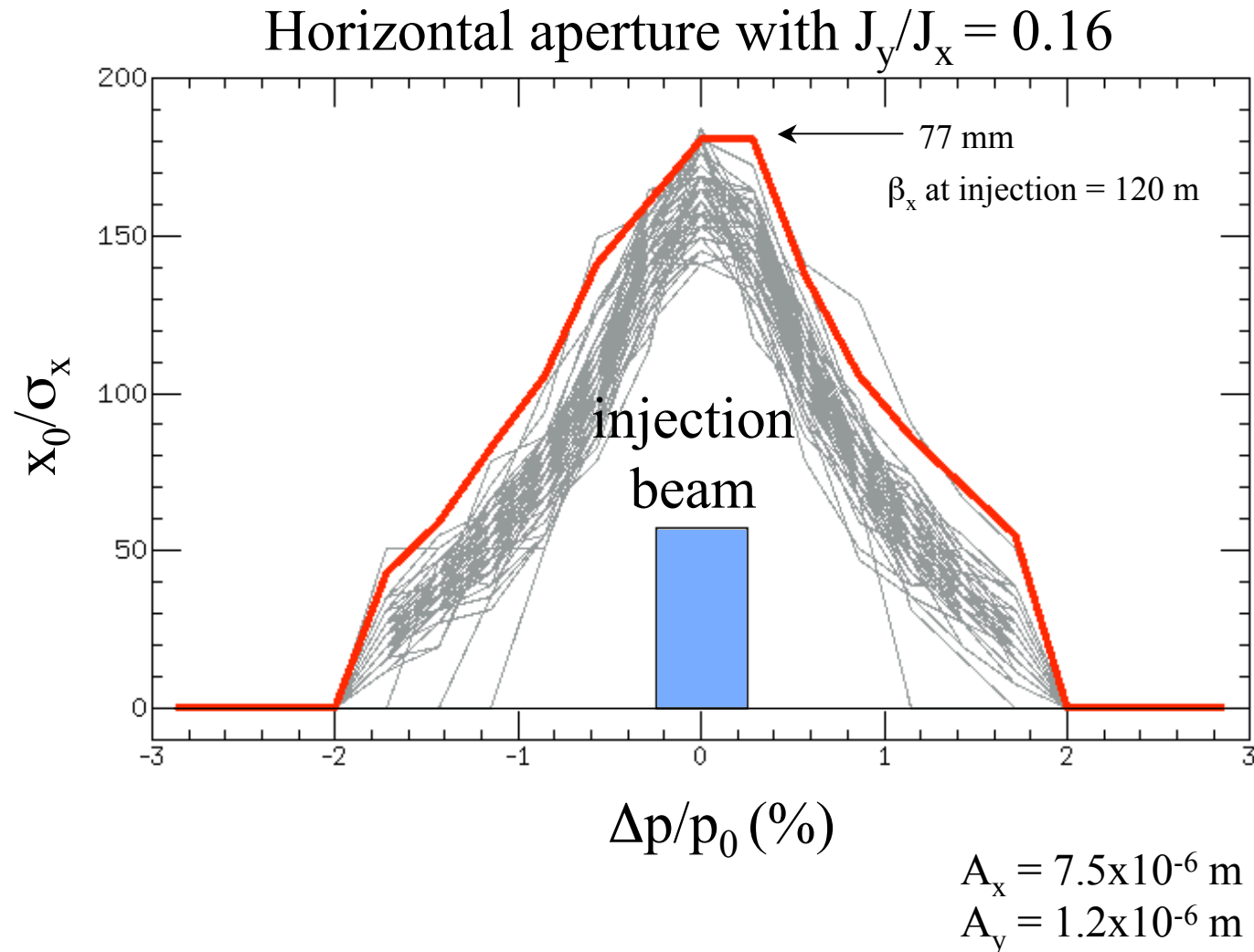


Dynamic Aperture (cont'd)

Vertical aperture with $J_x = 0$



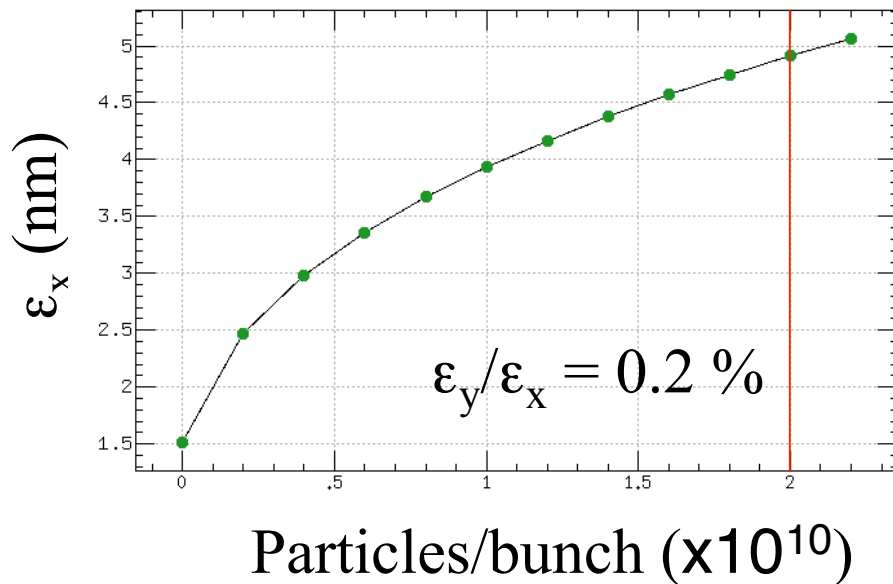
Dynamic Aperture for Injection Beam



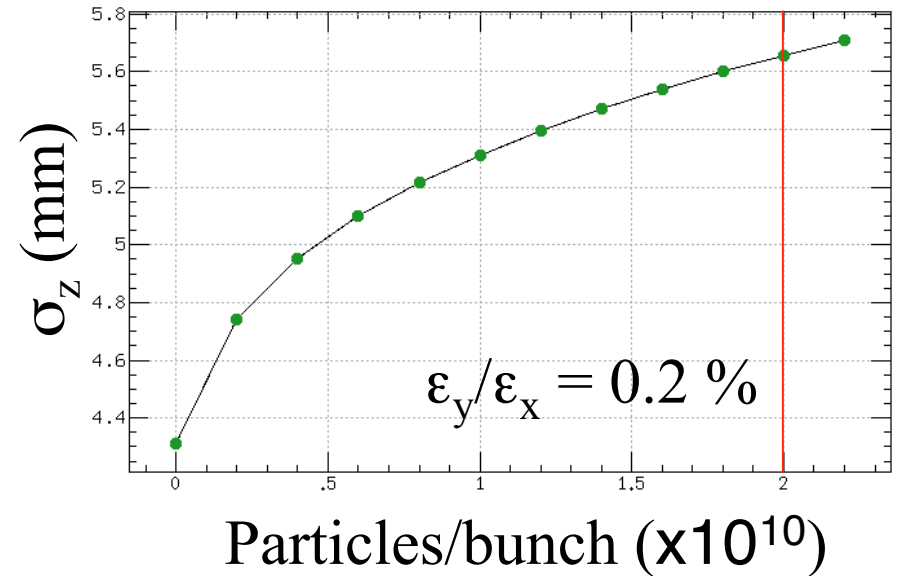
Intra-beam Scattering

$E = 2.3 \text{ GeV}$

Emittance



Bunch Length



Touschek lifetime $\sim 130 \text{ min} (\epsilon_y/\epsilon_x = 0.2\%, N = 2 \times 10^{10})$

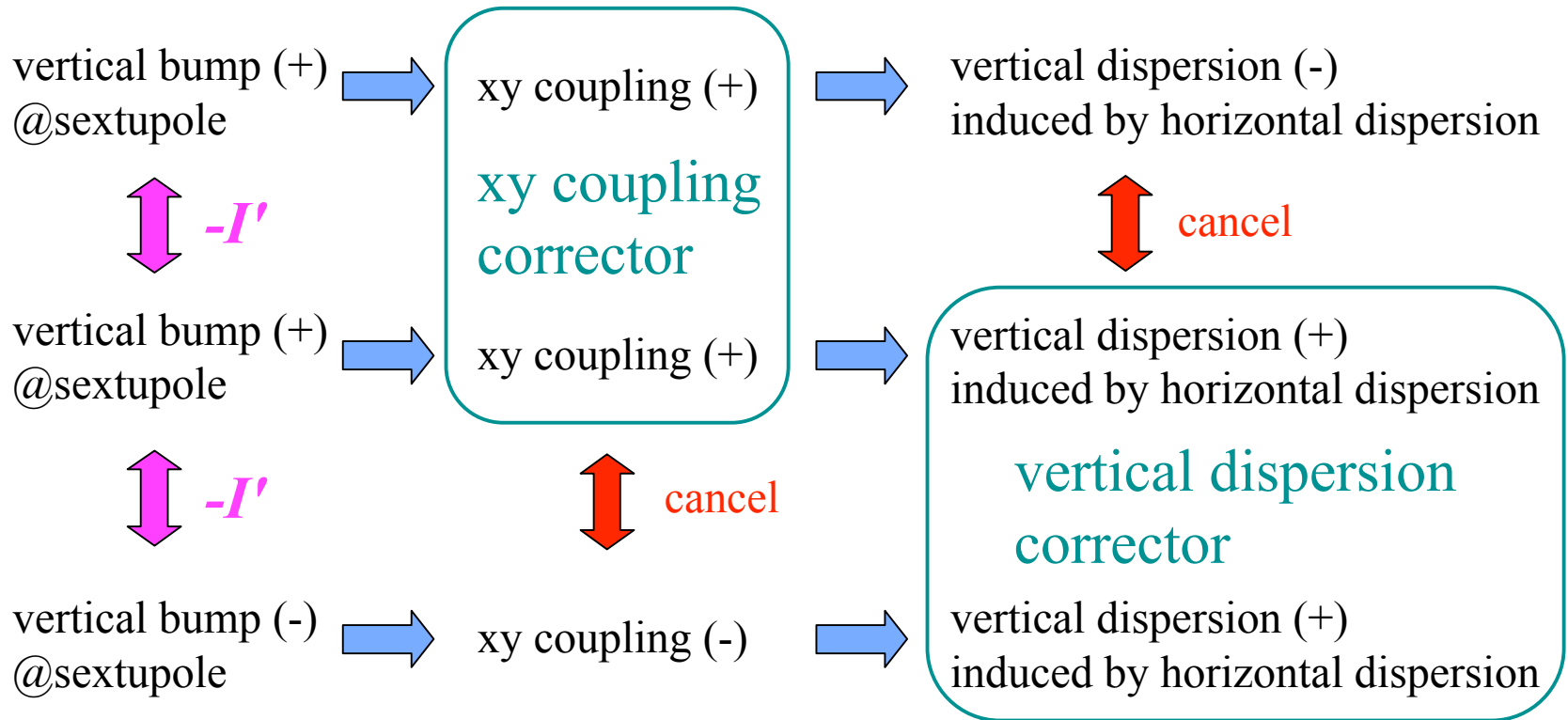
Summary

- KEKB-LER (2.3 GeV):
 - Emittance: $\varepsilon_x = 1.5 \text{ nm}$, $\varepsilon_y/\varepsilon_x = 0.2 \%$
- Requirements for the BPM system is:
 - BPM resolution should be less than $20 \mu\text{m}$.
 - ☞ A few μm is achieved at KEKB.
 - BPM alignment error is not sensitive to the lattice after the optics correction.
 - ☞ Alignment error is estimated to be $\sim 40 \mu\text{m}$.
- Dynamic aperture
 - Dynamic aperture is enough for the injection beam.
 - Touschek lifetime is estimated to be $\sim 130 \text{ min}$ ($N=2 \times 10^{10}$, $\varepsilon_x \rightarrow 4.9 \text{ nm}$) from the dynamic aperture ($\varepsilon_y/\varepsilon_x = 0.2\%$).

Backup Slides

Optics Corrections by using sextupoles (1)

- Sextupoles are located at arc sections and LCC(LEP only).



Optics Corrections by using sextupoles (2)

- Sextupoles are located at arc sections and LCC(LER only).

