USR-WS (Beijing)
Oct. 30 – Nov. 1, 2012

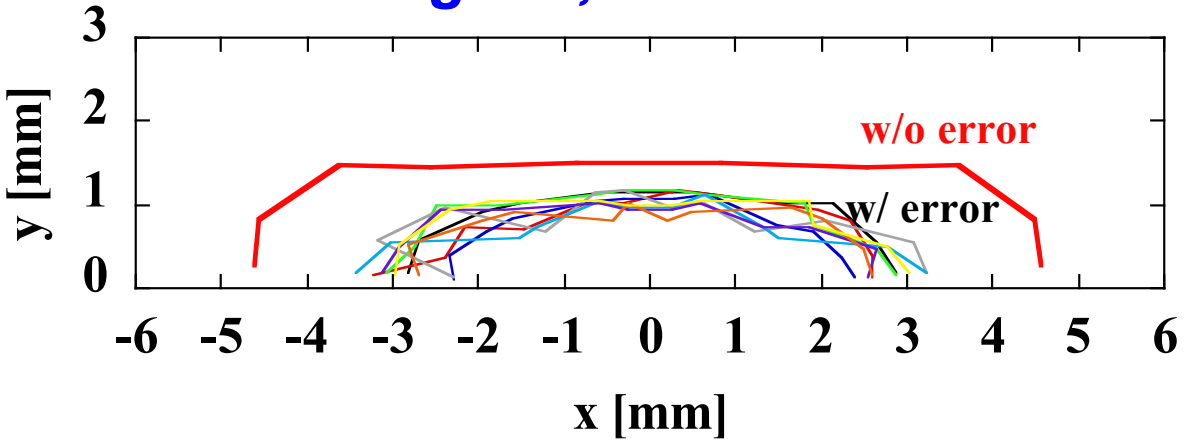
Injection Scheme for the SPring-8 Upgrade

K. Soutome (JASRI / SPring-8)
on behalf of
SPring-8 Upgrade Working Group

cf.) SPring-8 Upgrade Plan Preliminary Report (Jan. 2012)
http://www.spring8.or.jp/en/about_us/whats_sp8/spring-8_II/top.html

Issues and Our Approach

Injection to a Ring with a Small Dynamic Aperture



@ β_x = 25 m, β_y = 8 m

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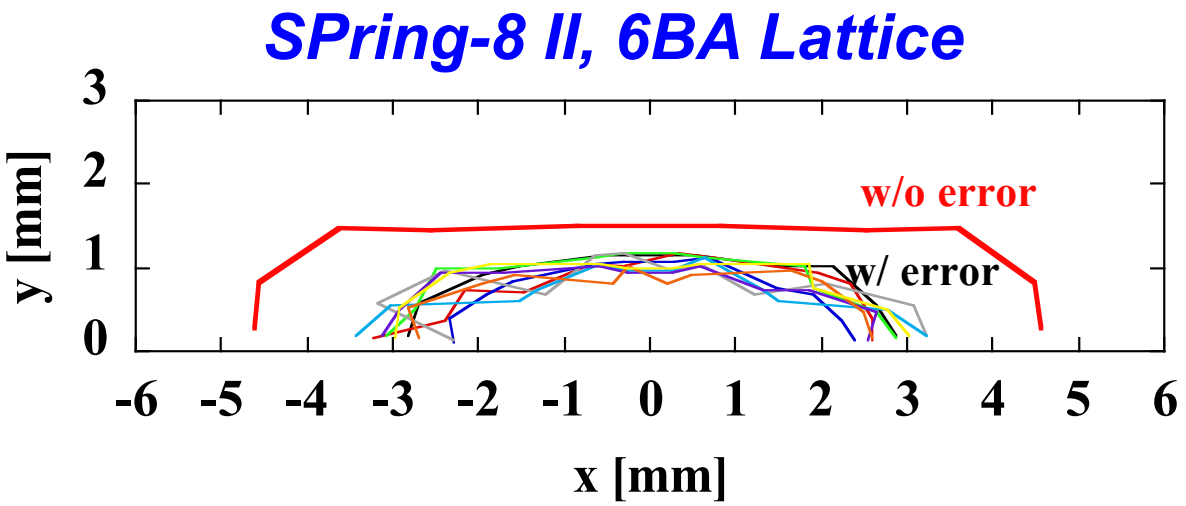

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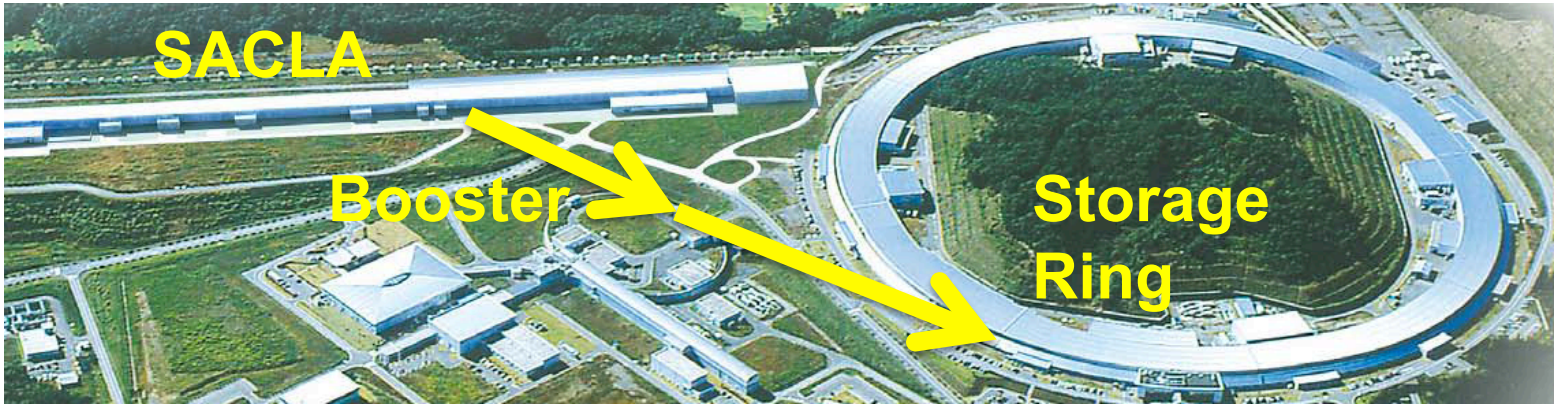

Beam Parameters (8GeV)

Emittance: ~ 60 pmrad (projected)
Energy Spread: 0.05 % (rms)
Bunch Length: < 100 fs (rms)
Electron Charge: ~ 300 pC
Repetition Rate: 1 Hz (~ 60 Hz)

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But *for achieving higher brilliance, low-beta is favorable.*

Issues and Our Approach

Injection to a Ring with a Small Dynamic Aperture

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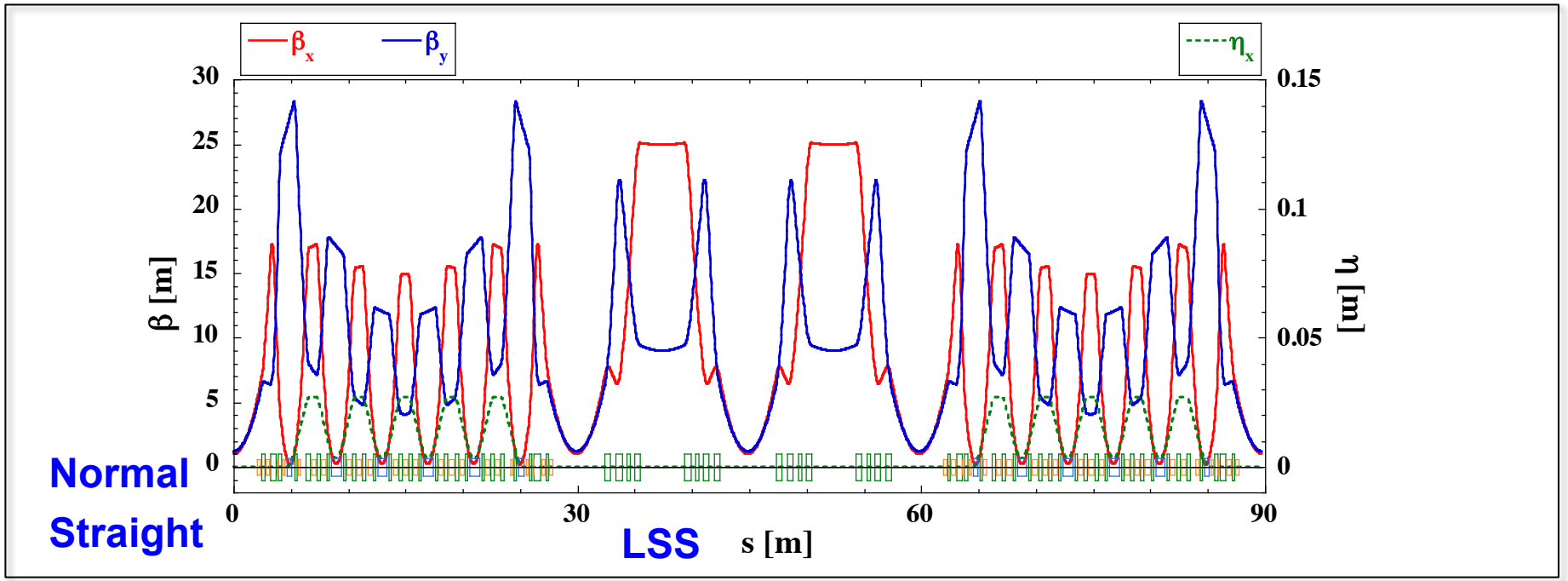
→ Long straight section is used for injection.

High-Beta at LSS and Low-Beta at Normal Straight



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High-purity single bunch is possible (at high-current).

On-axis injection is also possible.

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→ Top-Up (+ Bunch Length Control, Coupling Control ...)

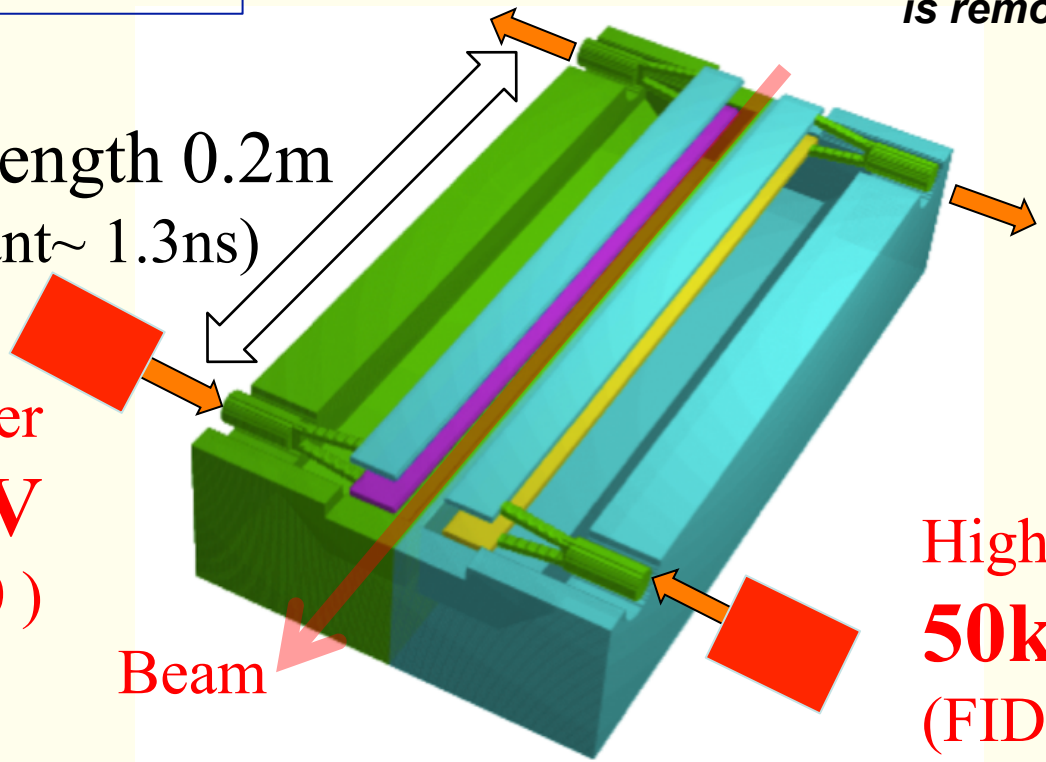
Fast Kicker System

Kicker Design and R&D for New Injection Scheme
by T. Nakamura

Fast TEM mode Kicker (~ 2ns)

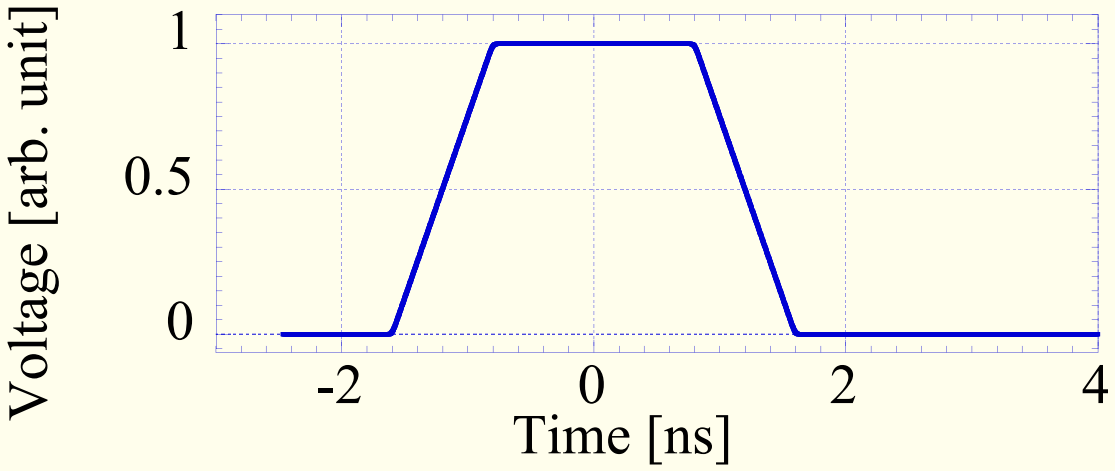
Kicker : Unit x 5

** Upper outer conductor is removed.*



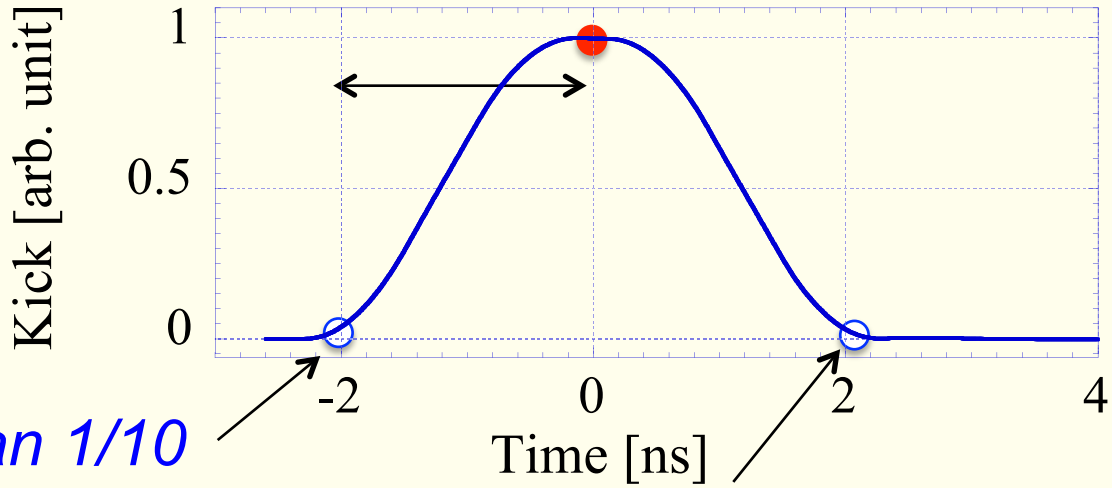
Fast Kicker System: Time Structure

Output of
High Power Pulser
50kV (FID FPG-50)



Kick Strength
(L = 0.2m)
with MAFIA-T3

2ns : bucket spacing



Should be smaller than 1/10

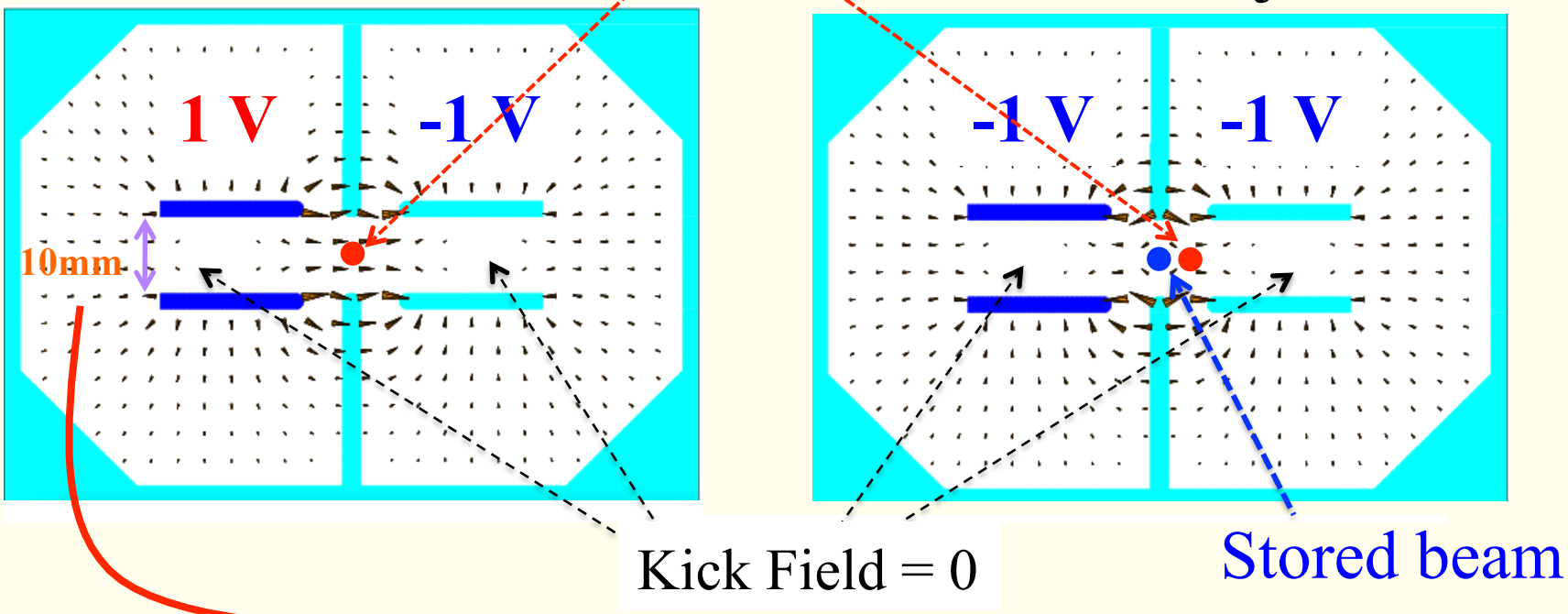
Additional Correction Kicker might be required for neighboring bunches.

Fast Kicker System: Field Distribution

Dipole Kick
for **On-axis** Injection

Injected beam

Quadrupole Kick
for **Off-axis** Injection

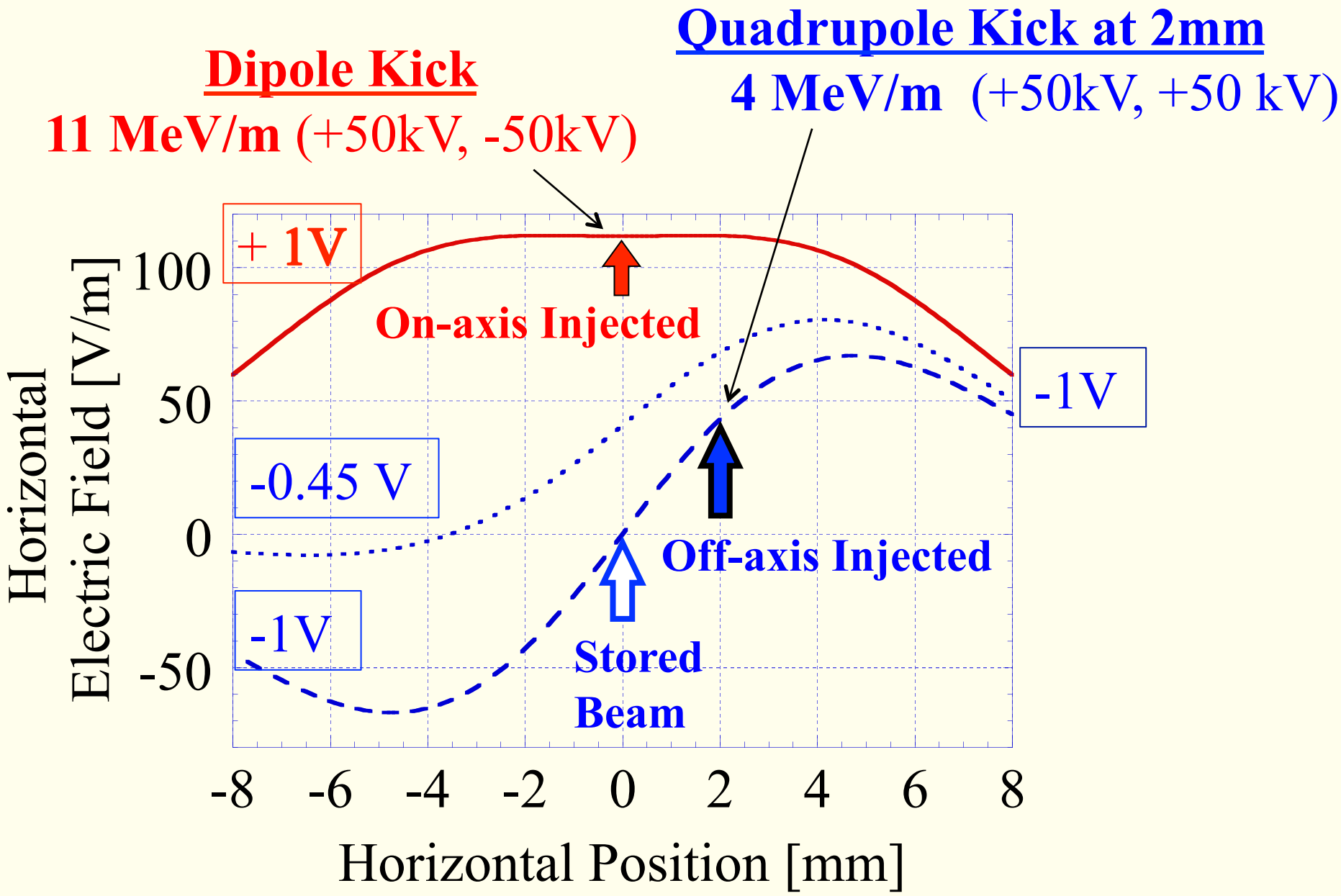


Field Strength ~ 1/(**vertical gap**)

Counter Propagating TEM Mode

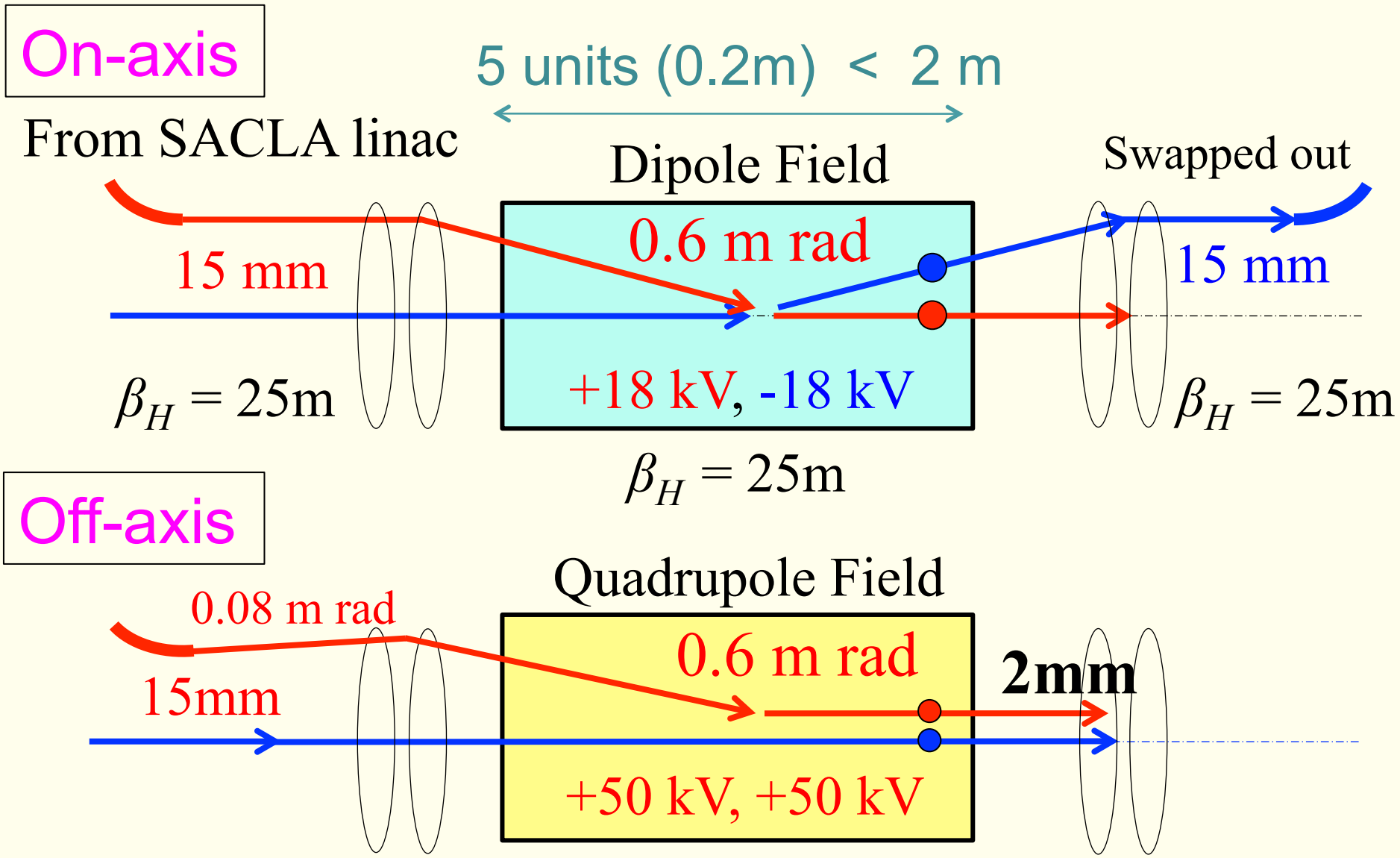
(Kick by Ex) = (Kick by By) => Total Kick = 2 Ex

Fast Kicker System: Field Strength

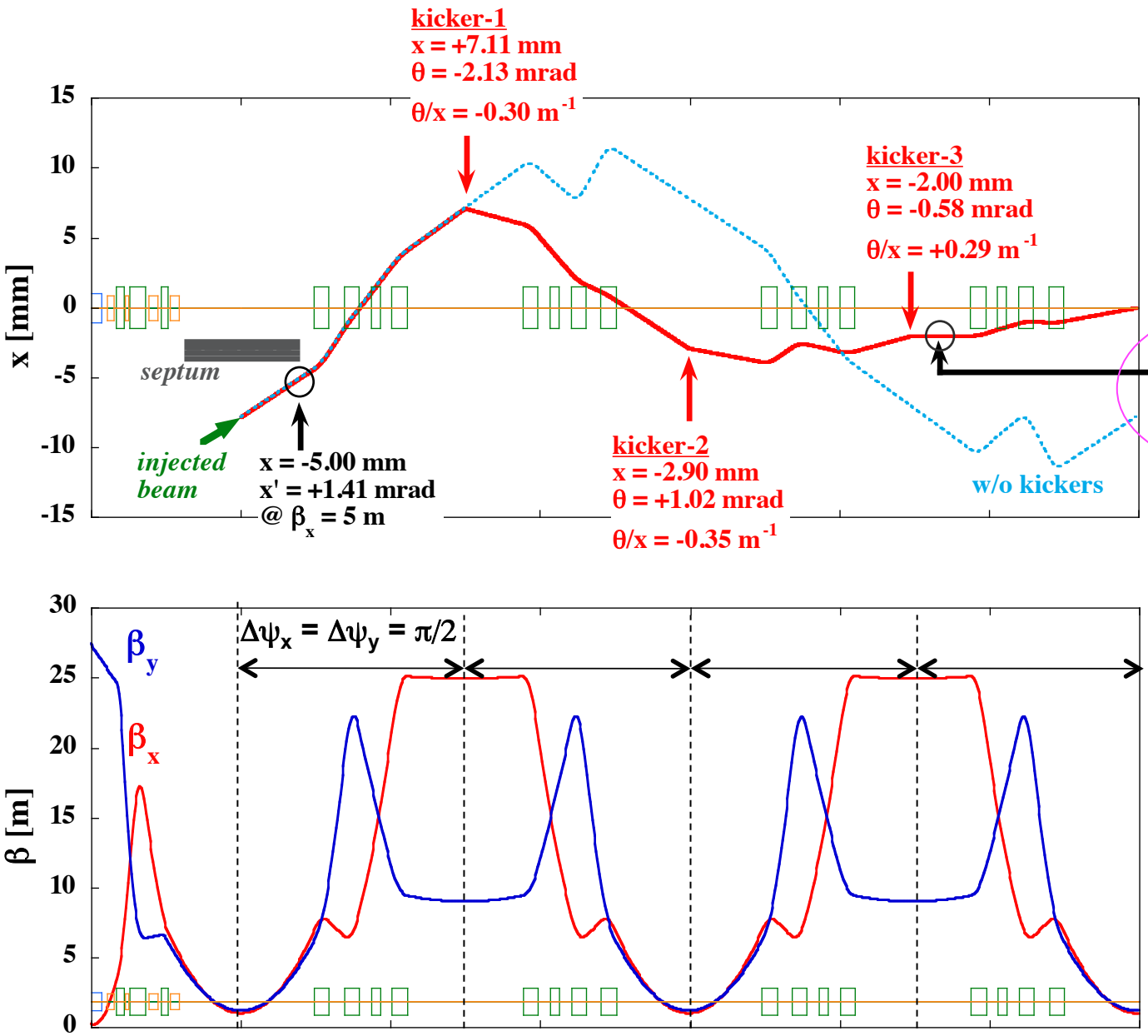


Fast Kicker System: Injection (Schematic)

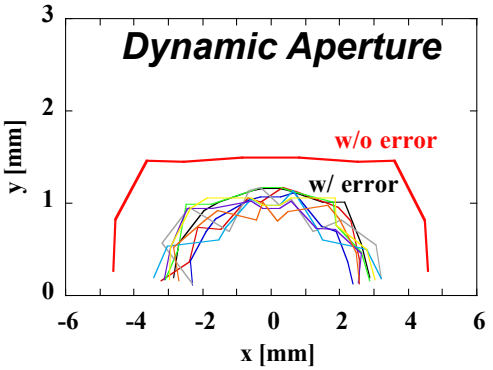
0.6 m rad x 6 GeV = 3.6 MeV



Injection at LSS



Example Scheme with Three Sets of Fast Kickers (Off-Axis)



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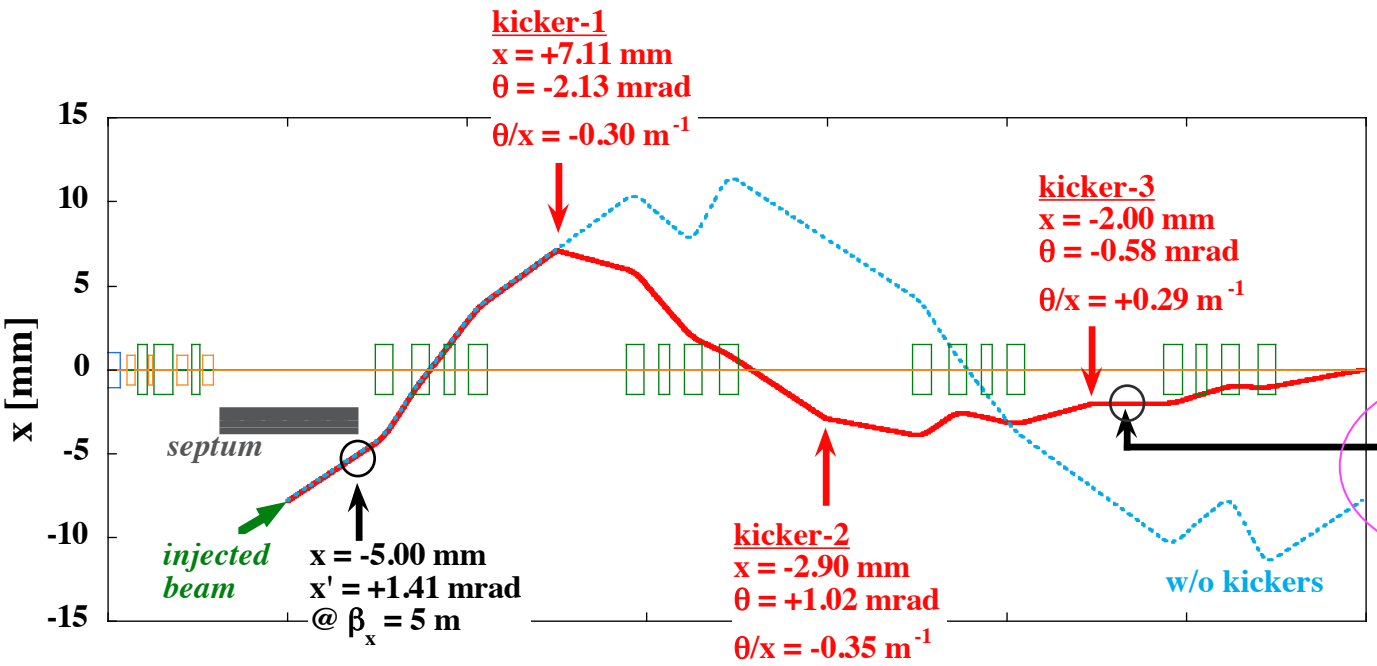


Example Scheme with Three Sets of Fast Kickers (Off-Axis)

stored beam

$\sigma_x \sim 0.02$ mm

1 mm (@ β_x = 5 m)

injected beam after revolutions

1 mm

Septum

2 mm

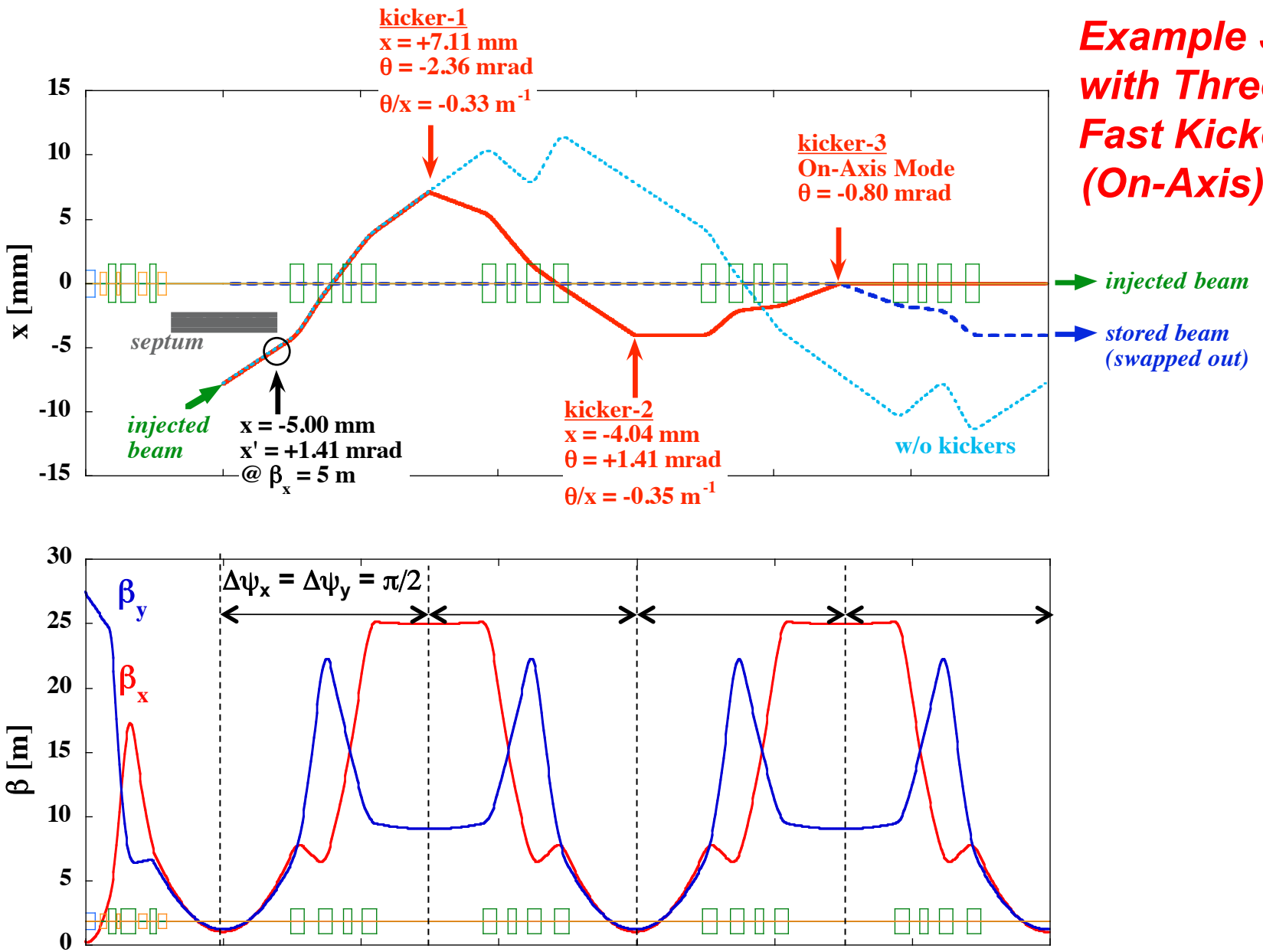
1 mm

clearance > 6σ

injected beam

σ_x = 0.05 ~ 0.15 mm (CSR dependent)

Injection at LSS



Example Scheme with Three Sets of Fast Kickers (On-Axis)

Summary of Our Injection Scheme

> SACLA (XFEL) Linac *(A beam transport line to the booster extraction point is under construction. Beam test is planned.)*

> High Quality Injection Beam for Small Dynamic Aperture

> 30m Long Straight Section for Injection

> Fast Kicker System for Bucket-by-Bucket Injection

> On-Axis Swap Injection for Beam Tuning

Off-Axis Injection for User-Operation at 300mA

(Operation at 100mA is possible by on-axis swap injection.)

> Flexibility of Filling Pattern

> Top-Up for Short Beam Lifetime

NOTE: Suppression (or control) of CSR effects in the beam transport line (~ 750m) is important, and this is under discussion.

Another Possible Scheme:

Injection with Pulsed Multipole Magnets

Injection with a Pulsed Quadrupole Magnet

K.Harada et al., PRST-AB 10 (2007)123501 @ KEK

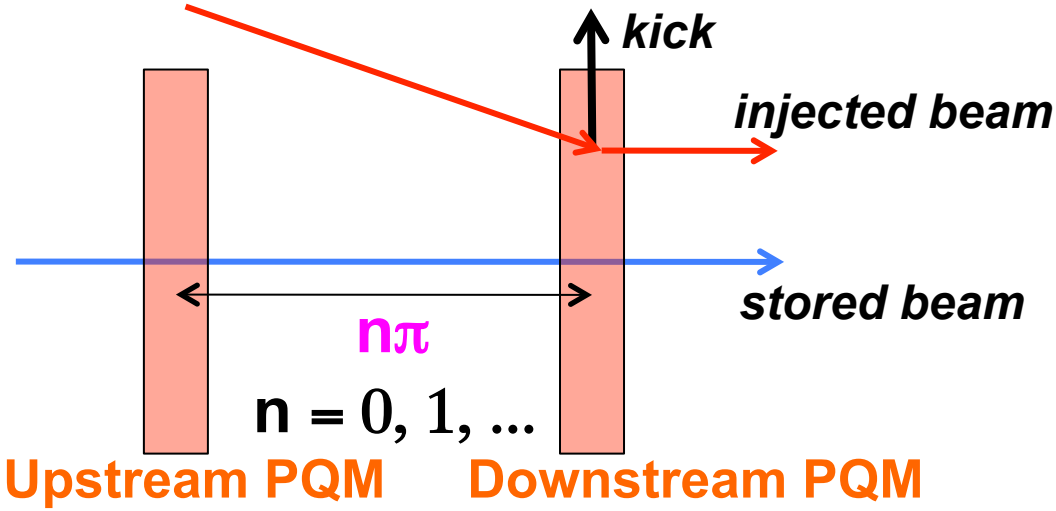
Injection with a Pulsed Sextupole Magnet

H.Takaki et al., PRST-AB 13 (2010) 020705 @ KEK

S.C.Leemann, PRST-AB 15 (2012) 050705 @ MAX IV

⇩ ***Double-PQM Scheme by M.Takao***

Additional upstream pulsed quadrupole magnet separated by nπ in betatron phase will suppress the quadrupole oscillation mode of a stored beam.



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