Jitter propagation in ATF2 beamline

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Orbit jitters in the EXT line

Estimated from measurements in ATF [ATF2 Proposal, Volume 1, pg. 41; M. Ross et al., ATF-04-05, 2004]:

- x jitter 20 µm (20 % of the beam size)
- y jitter 2-3.5 µm (~40 % of the beam size)
- x' jitter 1.0 mrad
- y' jitter 2 µrad

Suggested positions for the FONT FF/FB kickers in the extraction line :
Case #1: M. Woodley lattice (v.3.6+v.3.7)
Case #2: A. Kalinin

	Case #1 S [m]	Case #2 S [m]
KY1 (for y correction)	25.35	26.96
KY2 (for y' correction)	26.96	30.14
KX1 (for x correction)	21.09	25.35
KX2 (for x' correction)	23.88	28.89

Kicker parameters

$$\Delta\theta_{x,y} = \frac{2\,e\,V}{E}\frac{L}{a}$$

$$\Delta\theta_{x,y} \approx \frac{\Delta_{x,y}}{L}$$
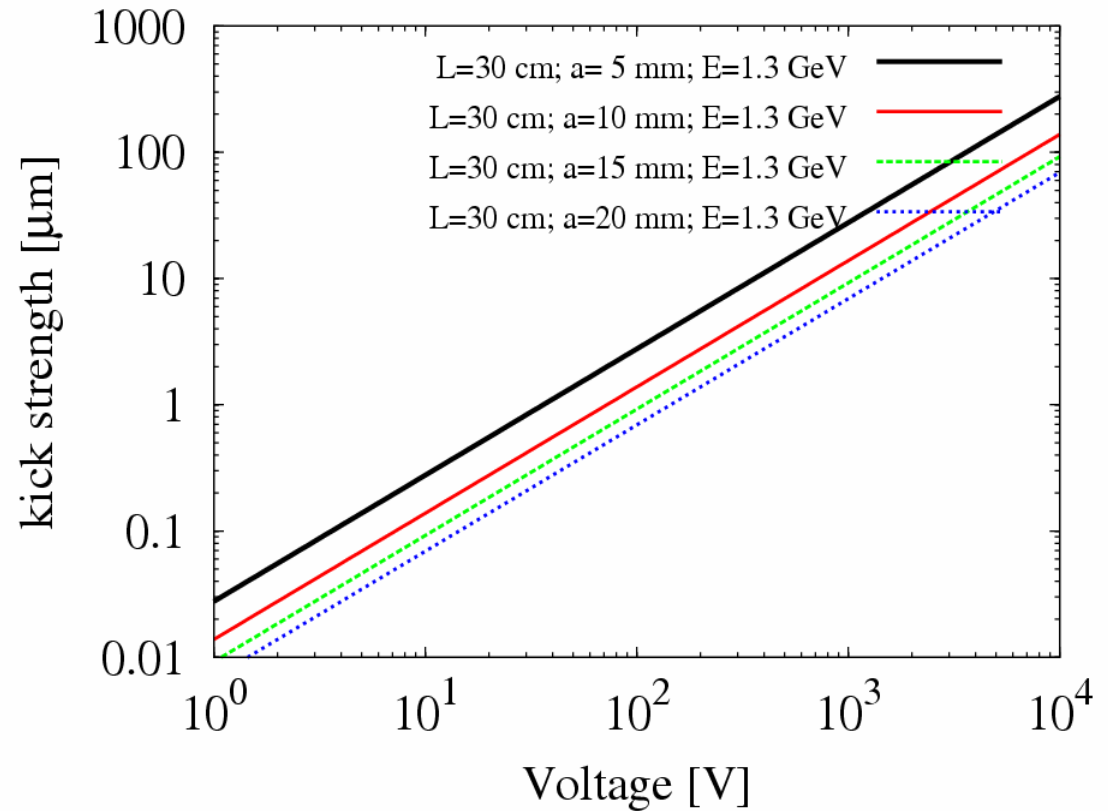
$$\Delta_{x,y} \approx \frac{2\,e\,V}{E}\frac{L^2}{a}$$

V: voltage
E: beam energy (1.3 GeV)
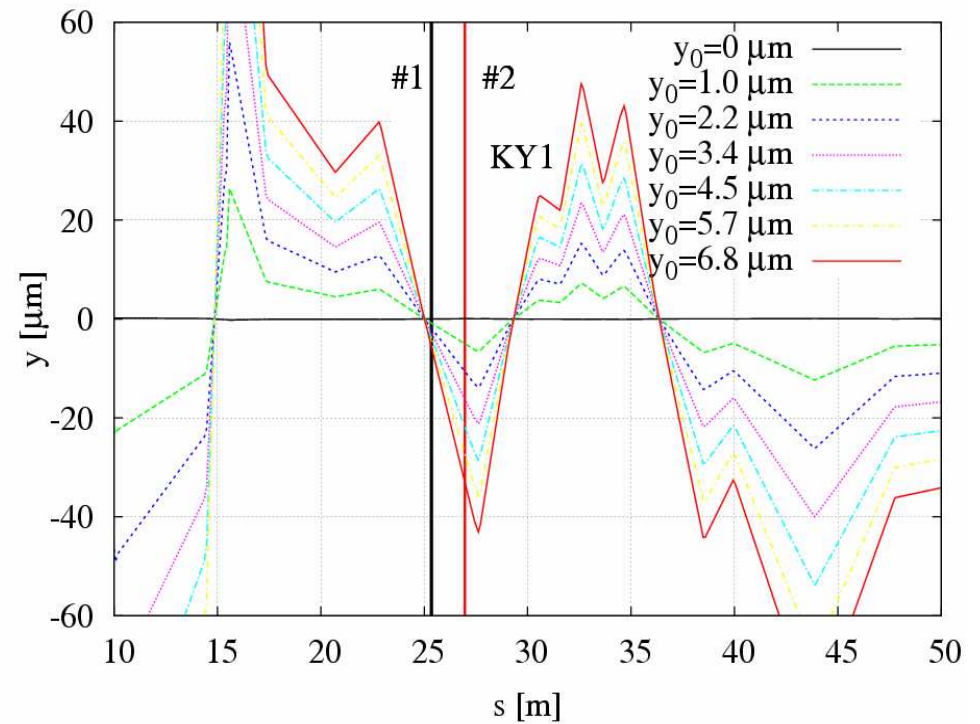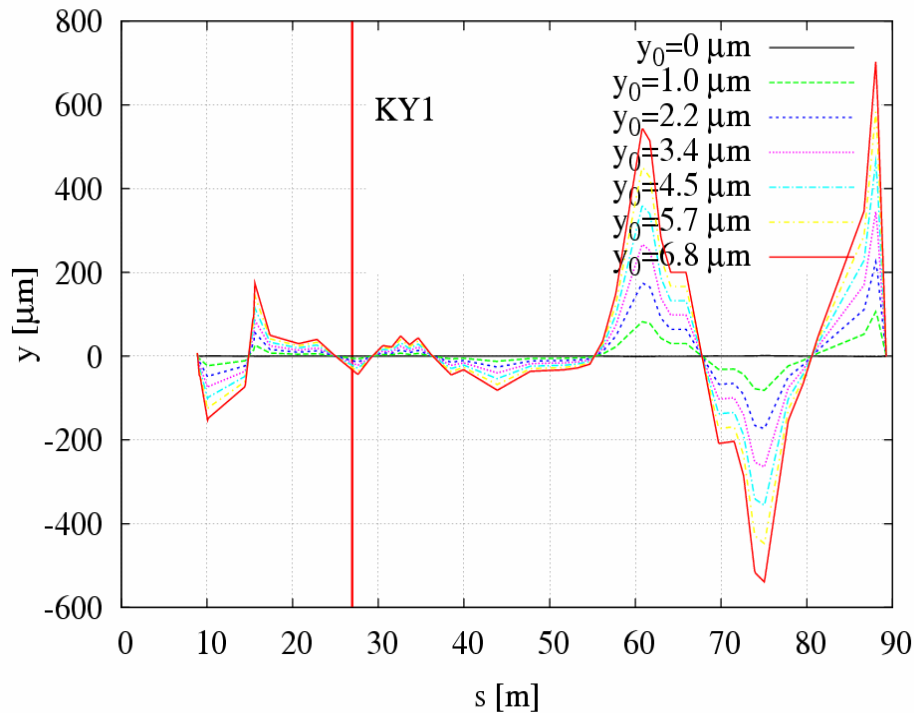L: kicker length (30 cm)
a: kicker aperture

Constraint: $a < 20$ mm (beam line aperture)

Plot legend:
L=30 cm; a= 5 mm; E=1.3 GeV
L=30 cm; a=10 mm; E=1.3 GeV
L=30 cm; a=15 mm; E=1.3 GeV
L=30 cm; a=20 mm; E=1.3 GeV

Axes: kick strength [μm] vs Voltage [V]

Initial jitter $\langle y_0 \rangle$
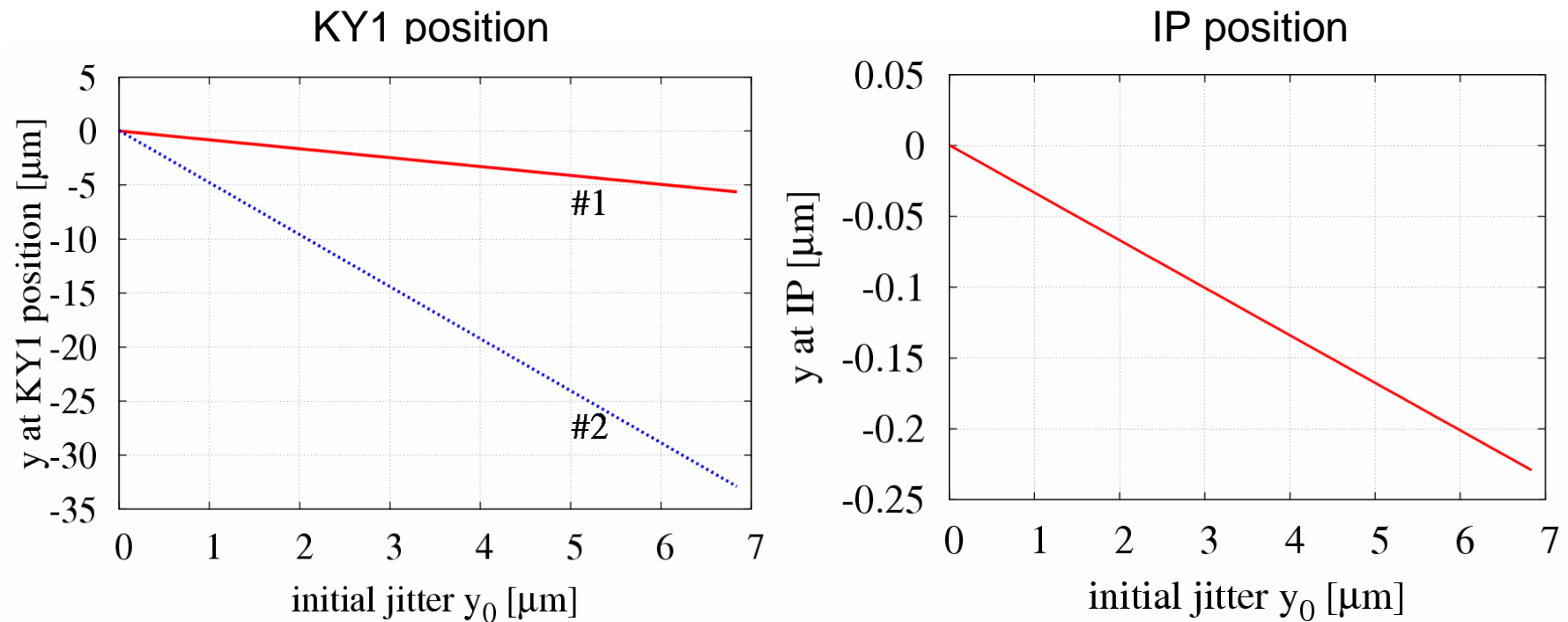
Beam centroid trajectory $\langle y \rangle$:

Initial transverse gaussian distribution of 10000 macroparticles
- $E_0 = 1.3$ GeV
- 0.08 % energy spread
- $\gamma \varepsilon_y = 3 \times 10^{-8}$ m·rad
- $\gamma \varepsilon_x = 3 \times 10^{-6}$ m·rad
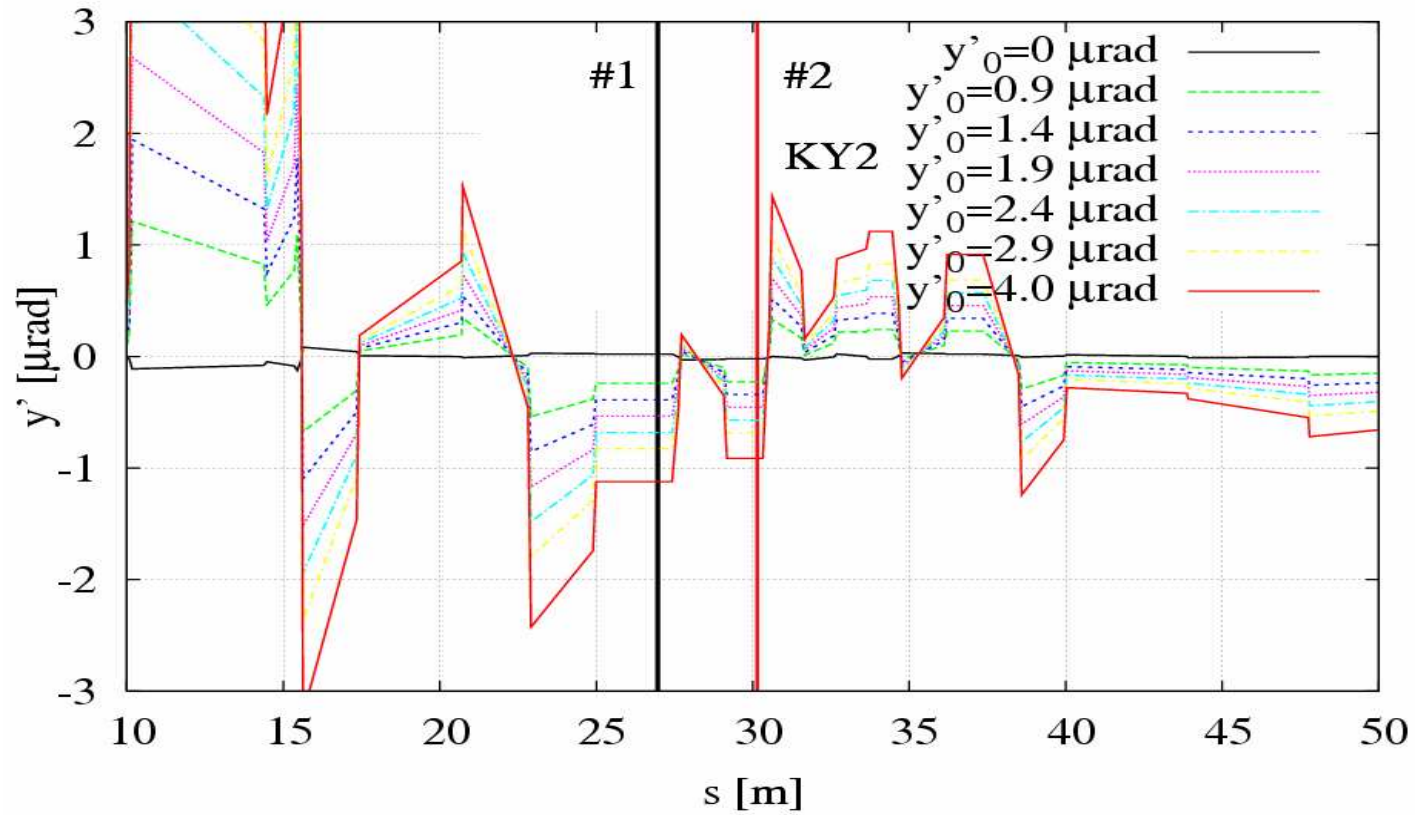
Initial jitter $<y_0>$

KY1 position

IP position

Practically linear transport!

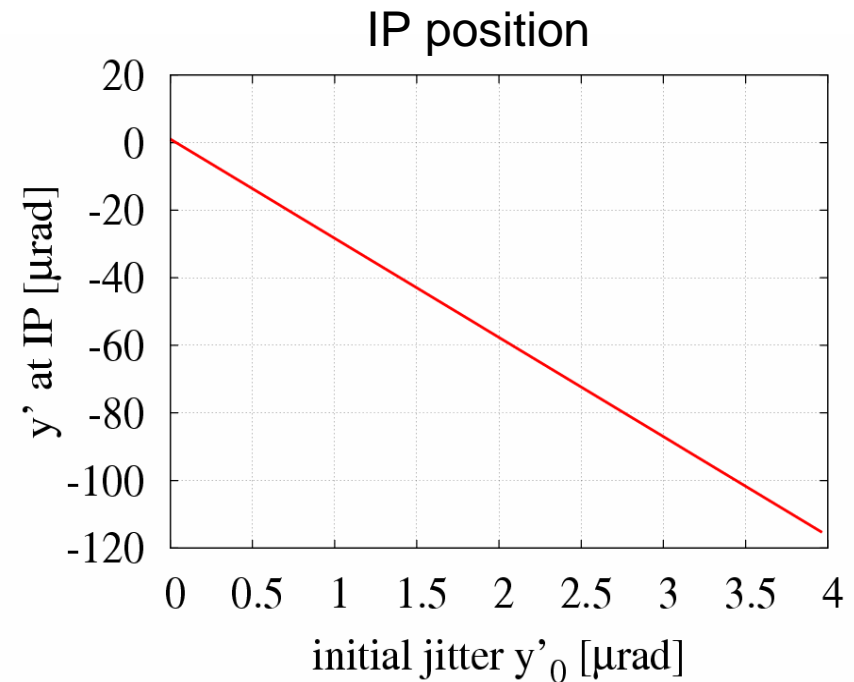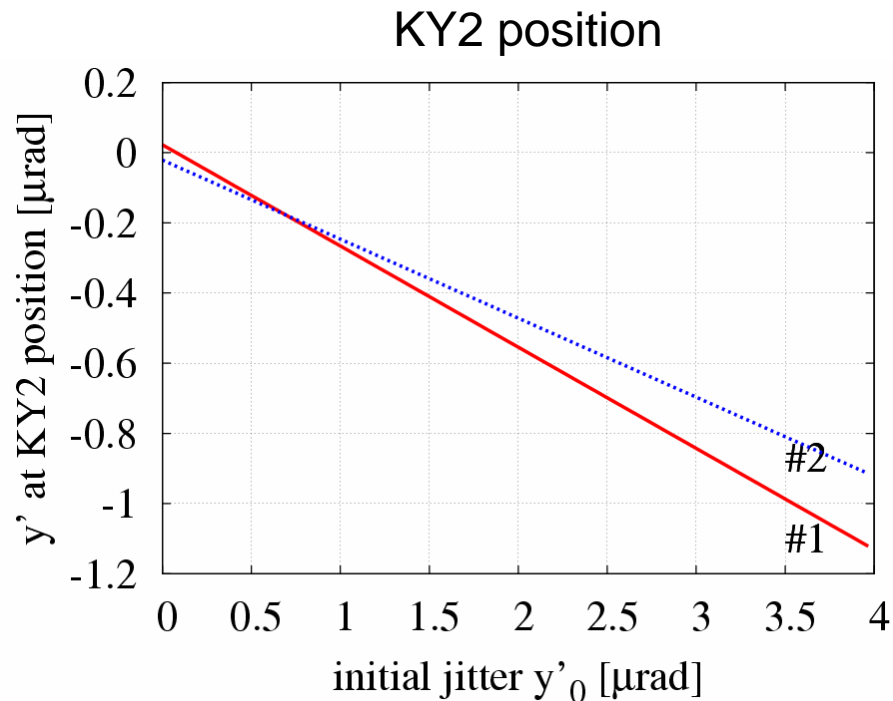#1: A initial jitter of 3.5 um → kick correction of ≈ +5 um (+17 urad) at KY1
#2: A initial jitter of 3.5 um → kick correction of ≈ +15 um (+50 urad) at KY1

Initial jitter $\langle y'_0 \rangle$

Beam angular divergence $\langle y' \rangle$:

Initial jitter <y'₀>
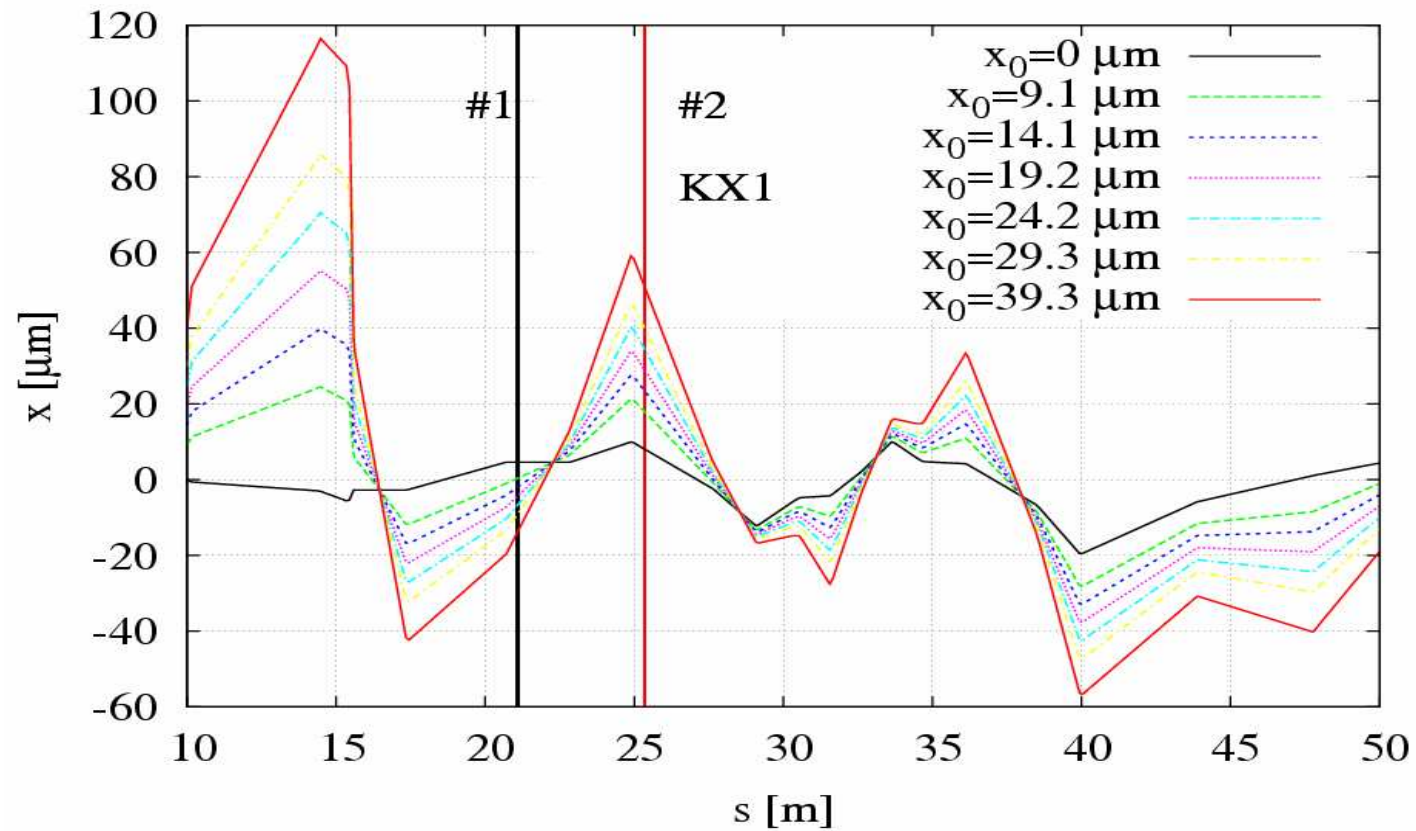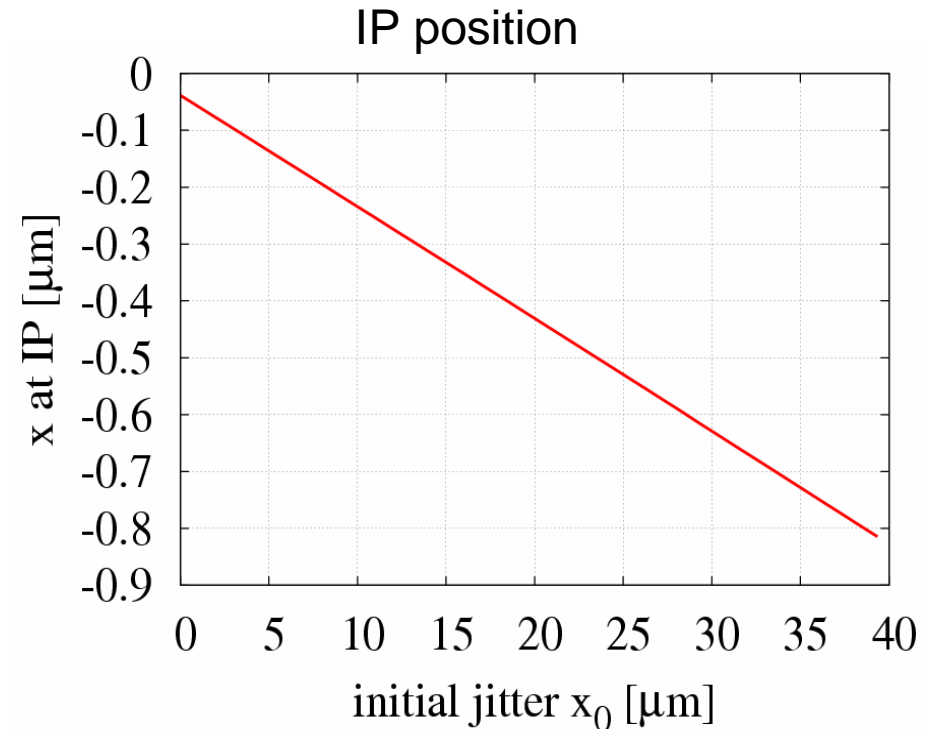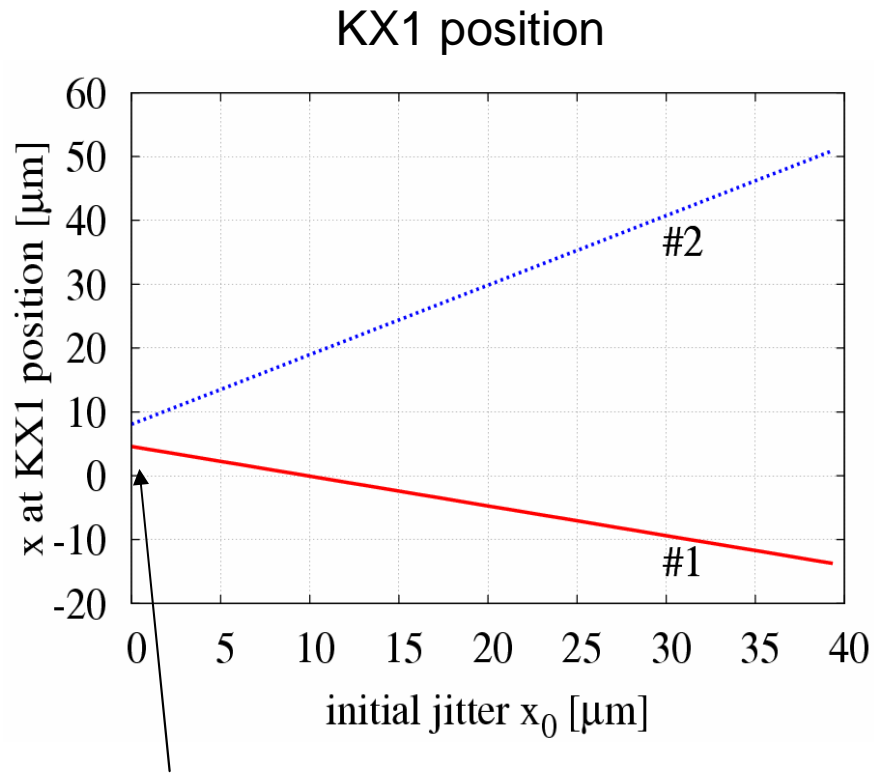

#1: A initial jitter of 2 urad → kick correction of ≈ +0.6 urad (+0.18 um) at KY2
#2: A initial jitter of 2 urad → kick correction of ≈ +0.4 urad (+0.12 um) at KY2

Initial jitter $\langle x_0 \rangle$

Beam centroid trajectory $\langle x \rangle$:

Initial jitter $\langle x_0 \rangle$
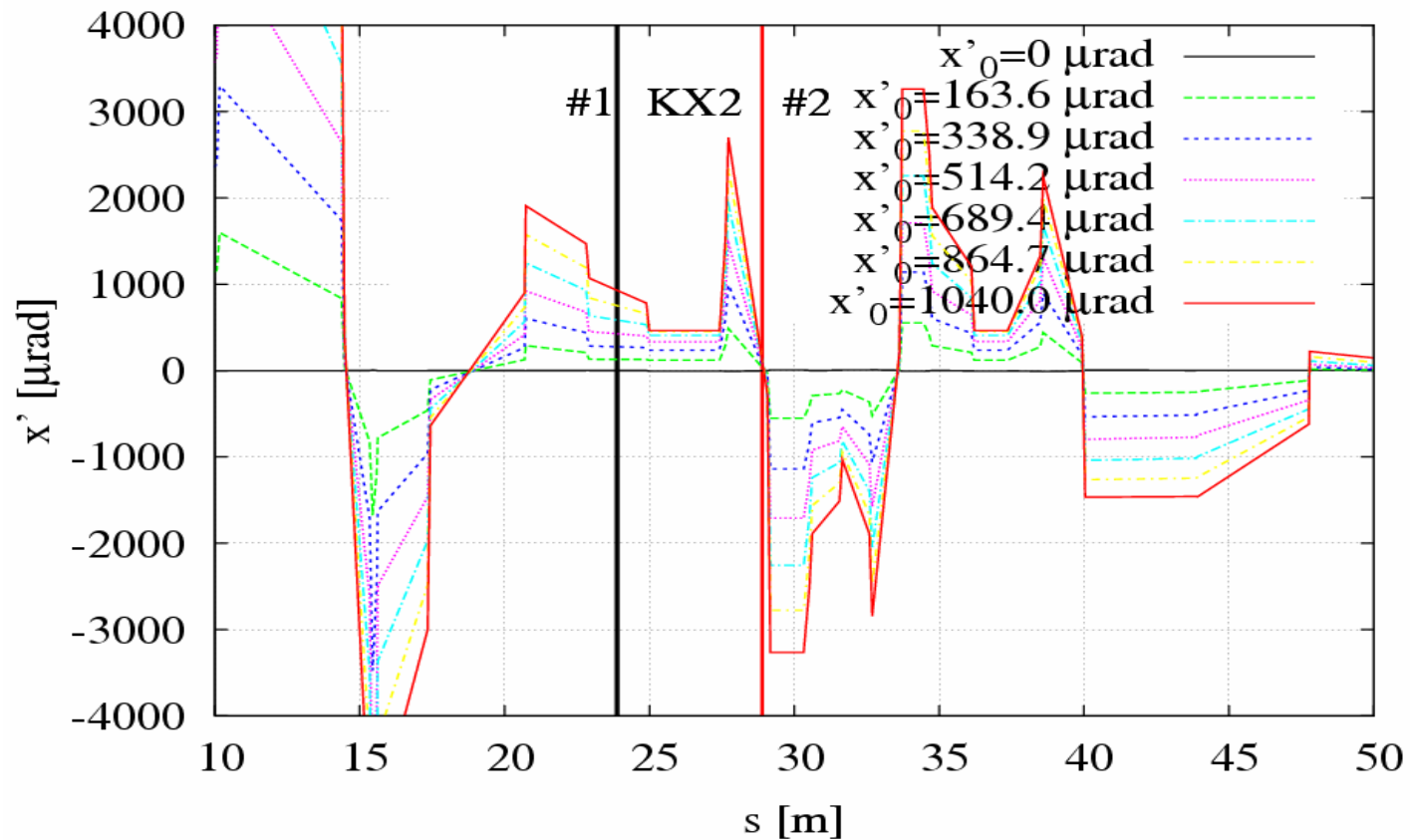
KX1 position

IP position

$\langle x \rangle \neq 0$ at $x_0{=}0$ due to SR effects in bending magnets $\rightarrow$ $\langle x \rangle = R_{16} \dfrac{\Delta E}{E}$

#1: A initial jitter of 20 um $\rightarrow$ kick correction of $\approx$ +5 um (+17 urad) at KX1

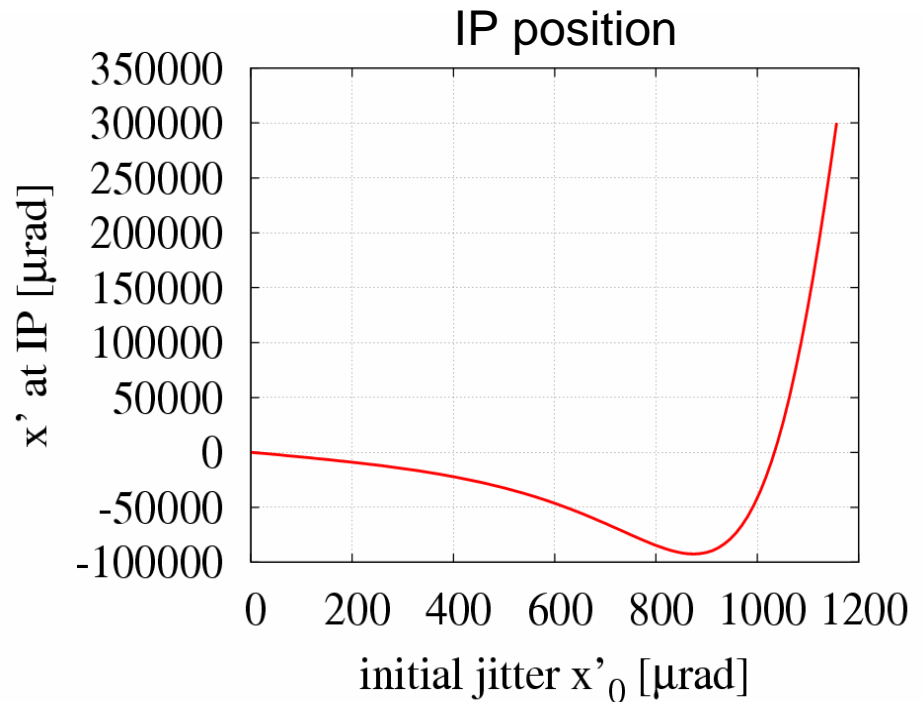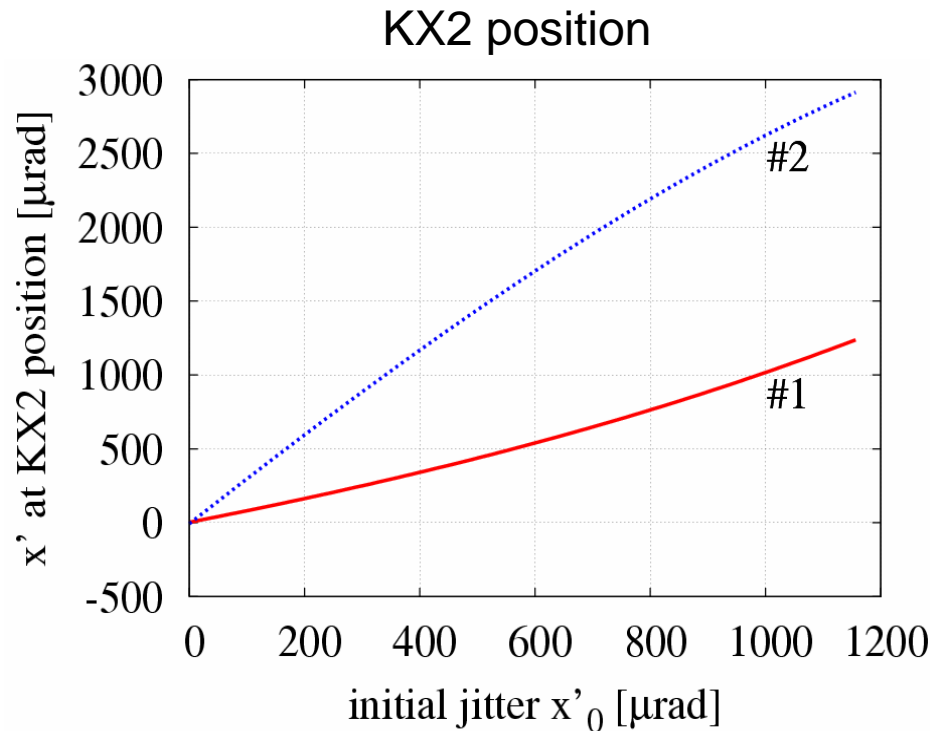#2: A initial jitter of 20 um $\rightarrow$ kick correction of $\approx$ -30 um (-100 urad) at KX1

Initial jitter $<x'_0>$

Beam angular divergence $<x'>$:

Initial jitter $\langle x'_0 \rangle$

Nonlinear transport for high x'_0 !

#1: A initial jitter of 1000 urad → kick correction of ≈ -1000 urad (-300 um) at KX2
#2: A initial jitter of 1000 urad → kick correction of ≈ -2500 urad (-750 um) at KX2