

ATF2 FB/FF layout

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Introduction

- Goal: adaptation of upstream FONT system for ATF2
- Beam stability by means of a combination of feed-forward (FF) correction and fast feedback (FB) stabilisation
- This system is conceived mainly for cancellation of transverse drift produced by the extraction kicker. FF + FB is most required in the vertical plane (more sensitive)
- FF+ FB systems in the ATF2 extraction line (EXT):
 - Two pair of kickers for the correction of (x,x') and (y,y')
 - The kickers are common for FF and FB
 - Each kicker has an adjacent pickup that is used for FF/FB matrix measurements
 - The FB downstream pickup pair is also used for FF residue measurement
 - Pickups (BPMs) in the ATF2 EXT are adjacent to quadrupoles

Kicker arrangement

- Single plane stripline kickers
- Locations at relatively high betatron functions (higher resolution tolerances)
- The optimal phase advance in a kicker pair or a pickup pair is $\pi/2$
- Suggested positions for the FONT FF/FB kickers in the extraction line. A. Kalinin schemes:

	#1 s [m]	#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

(See A. Kalinin's presentation, ATF2 Weekly Meeting, July 27, 2007, & A. Kalinin' presentation in this meeting)

Kicker parameters

(Rough estimation)

Kicker angle:

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

The deviation at distance d from the kicker to a downstream BPM:

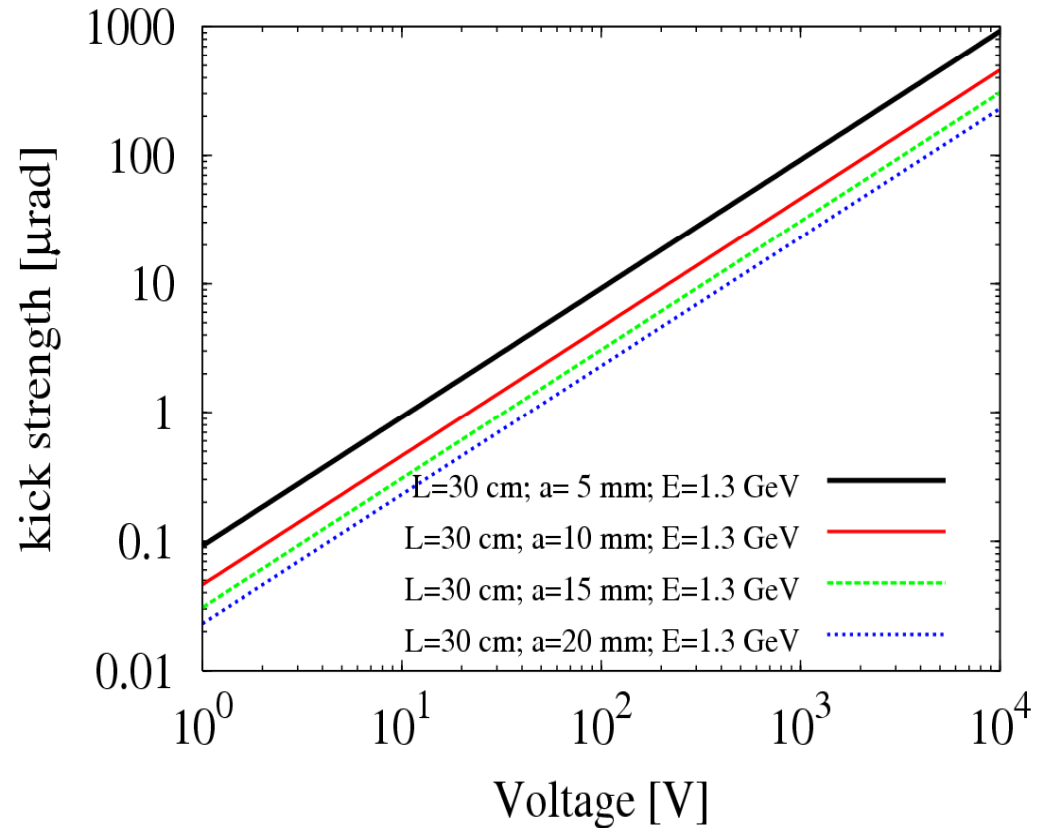
$$\Delta_{x,y} \approx \frac{2eV}{E} \frac{L}{a} d$$

V : voltage

E : beam energy (1.3 GeV)

L : kicker length (30 cm)

a : kicker aperture



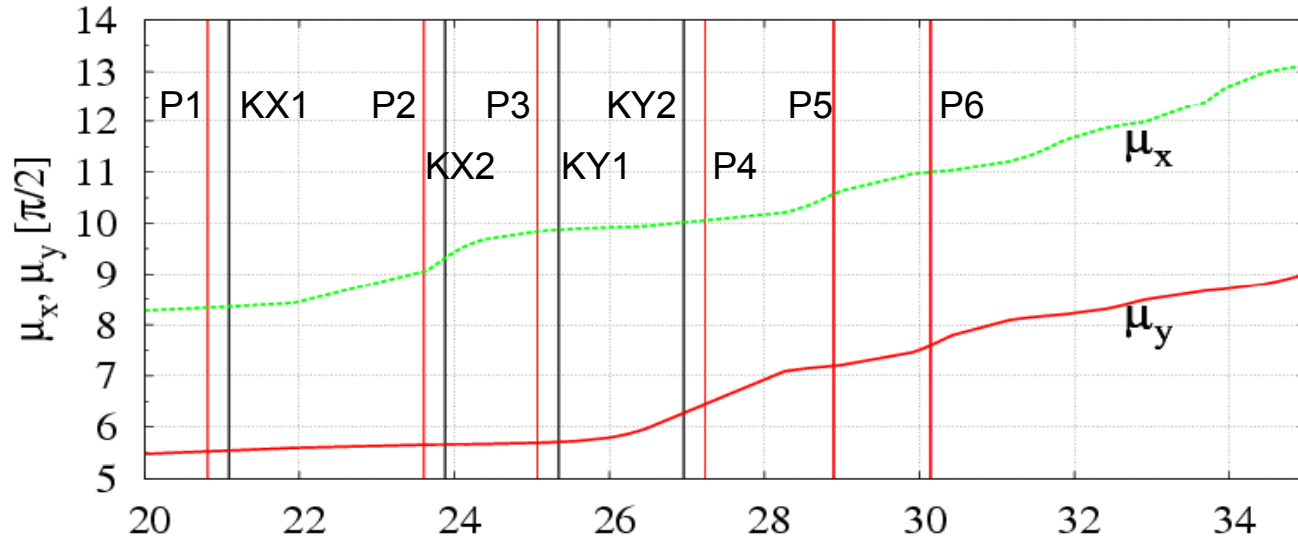
Constraint: $a < 20$ mm (beam line aperture)

For example: $a=10$ mm; kick of 10 μ rad * ⌚ 0.3 kV

$a=10$ mm; kick of 100 μ rad * ⌚ 2.0 kV

Optimal phase advance positions

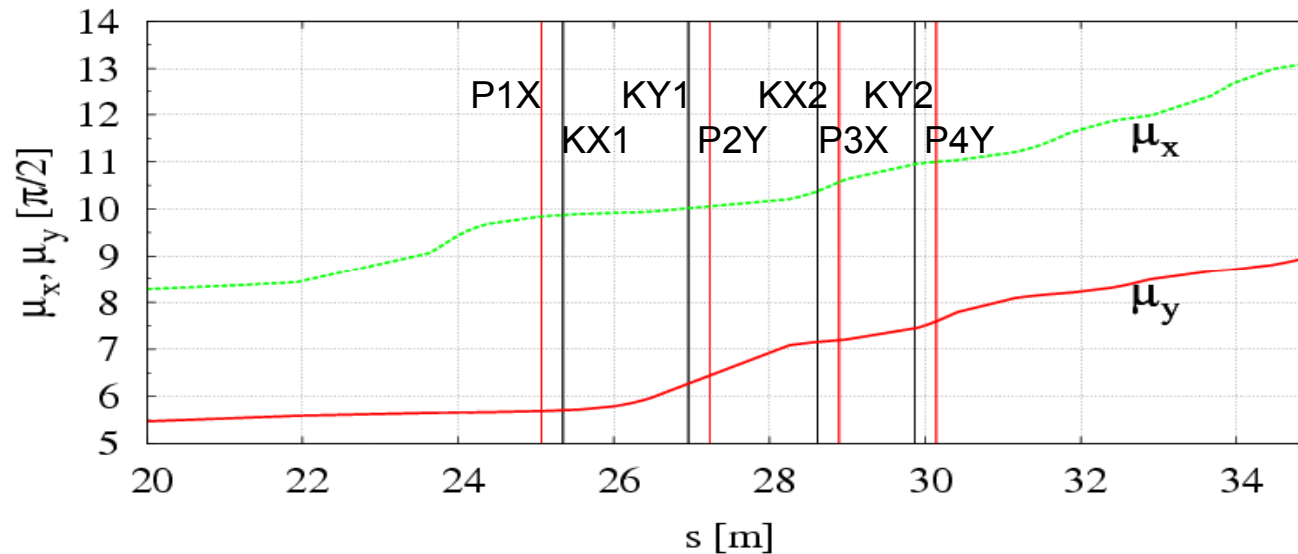
From M. Woodley's ATF2 lattice v3.7



Scheme #1:

BPMs in the lattice:

- P1 (ML7X)
- P2 (ML8X)
- P3 (ML9X)
- P4
- P5
- P6



Scheme #2:

BPMs in the lattice:

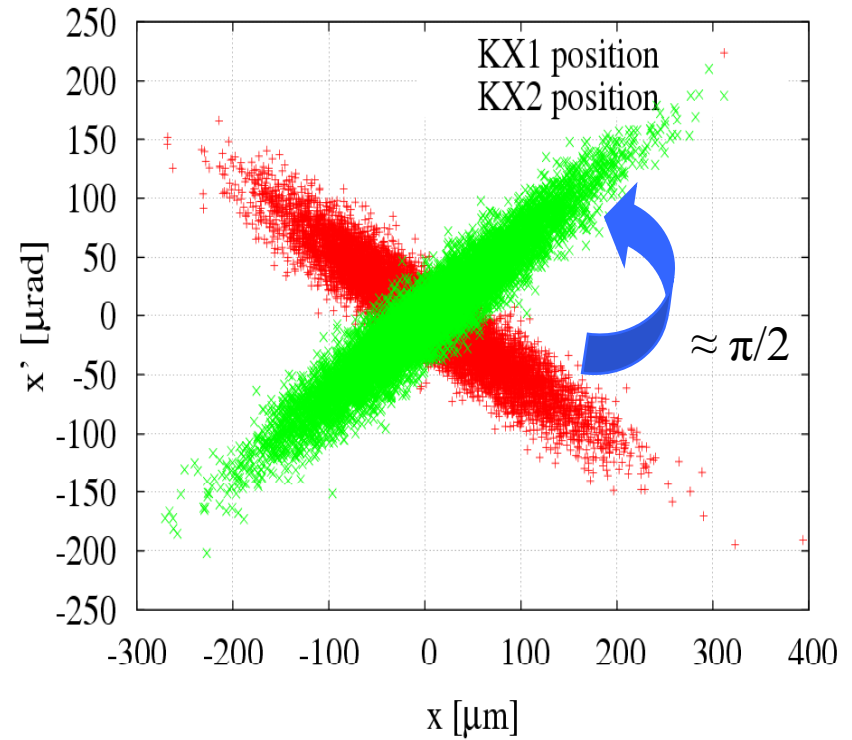
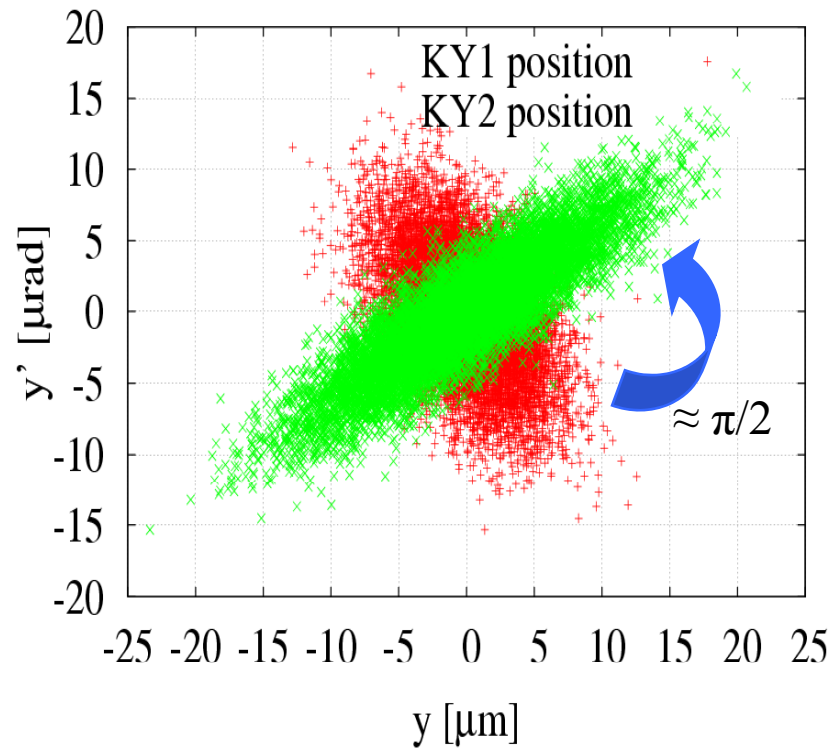
- P1X \rightarrow P3
- P3X \rightarrow P5
- P2Y \rightarrow P4
- P4Y \rightarrow P6

Placet based model for ATF2

- Tracking of initial transverse gaussian distribution of 10000 macro-particles
 - 0.08 % energy spread
 - Nominal energy $E_0=1.3$ GeV
 - Vertical normalised nominal emittance $\gamma\varepsilon_y=3 \times 10^{-8}$ m⊙rad
 - Horizontal normalised nominal emittance $\gamma\varepsilon_x=3 \times 10^{-6}$ m⊙rad
- In Placet the correctors are represented as dipoles
- Study of jitter propagation, kicker response in the downstream BPMs
- Possibility to apply ground motion effects (Andrei Seryi's models) and dynamics corrections
- Steering FF/FB corrections using the FONT kickers and BPMs in progress

Phase advance between kickers

(#1 scheme)



Phase advance between kicker pairs of $\approx \pi/2$

Orbit jitters in the EXT line

Main sources: extraction kicker errors, energy jitter in DR and residual dispersion 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 (? Too big!)
- y' jitter 2 μrad

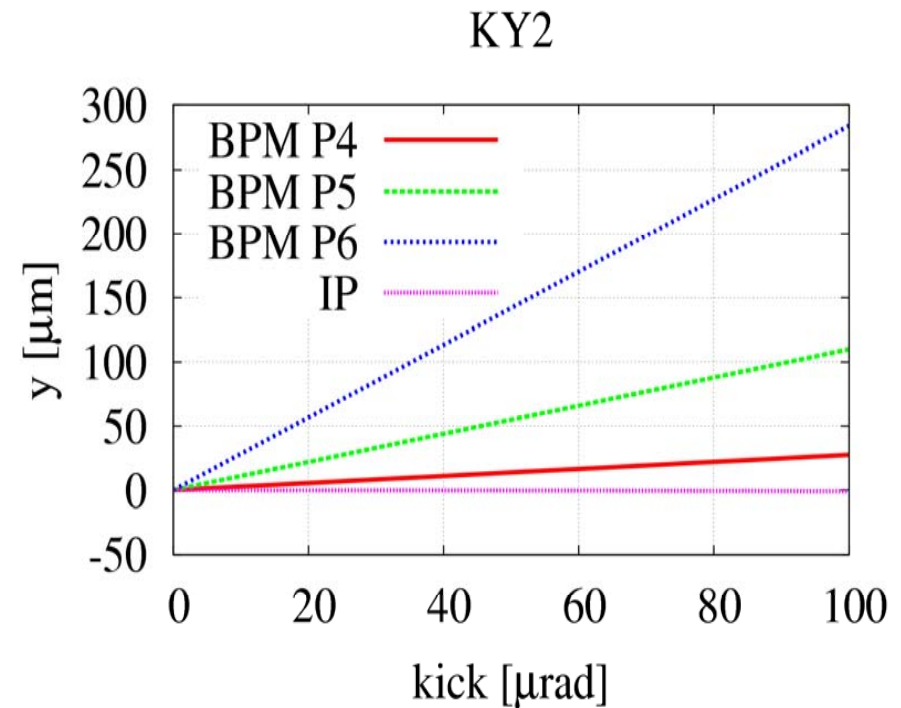
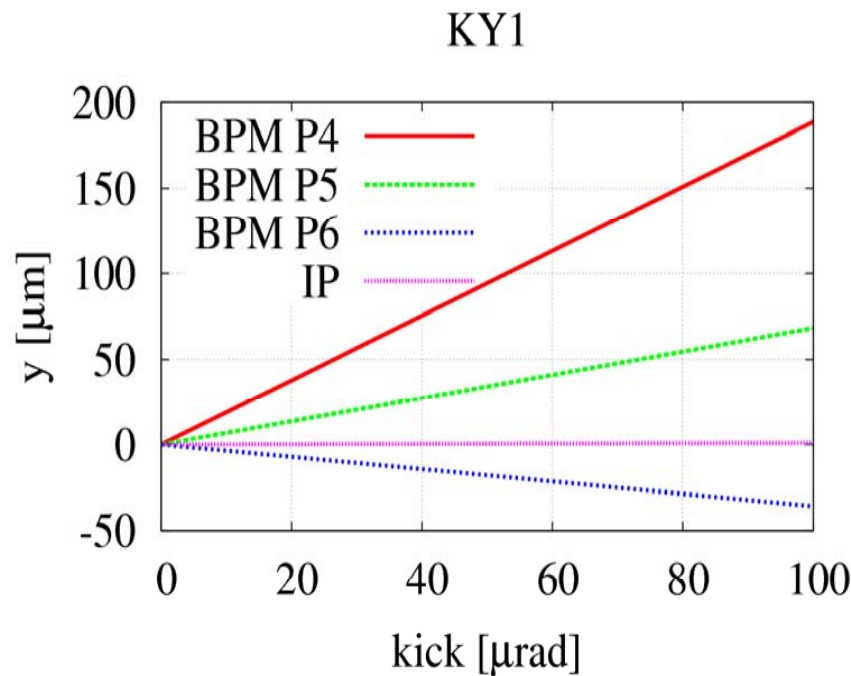
Should we use this values as a reference for the ATF2 beam dynamics simulations ?

Kicker response in the downstream BPMs

Vertical kickers

Checking the linearity of the kicking strength for each kicker versus the orbit response

(#1 scheme)

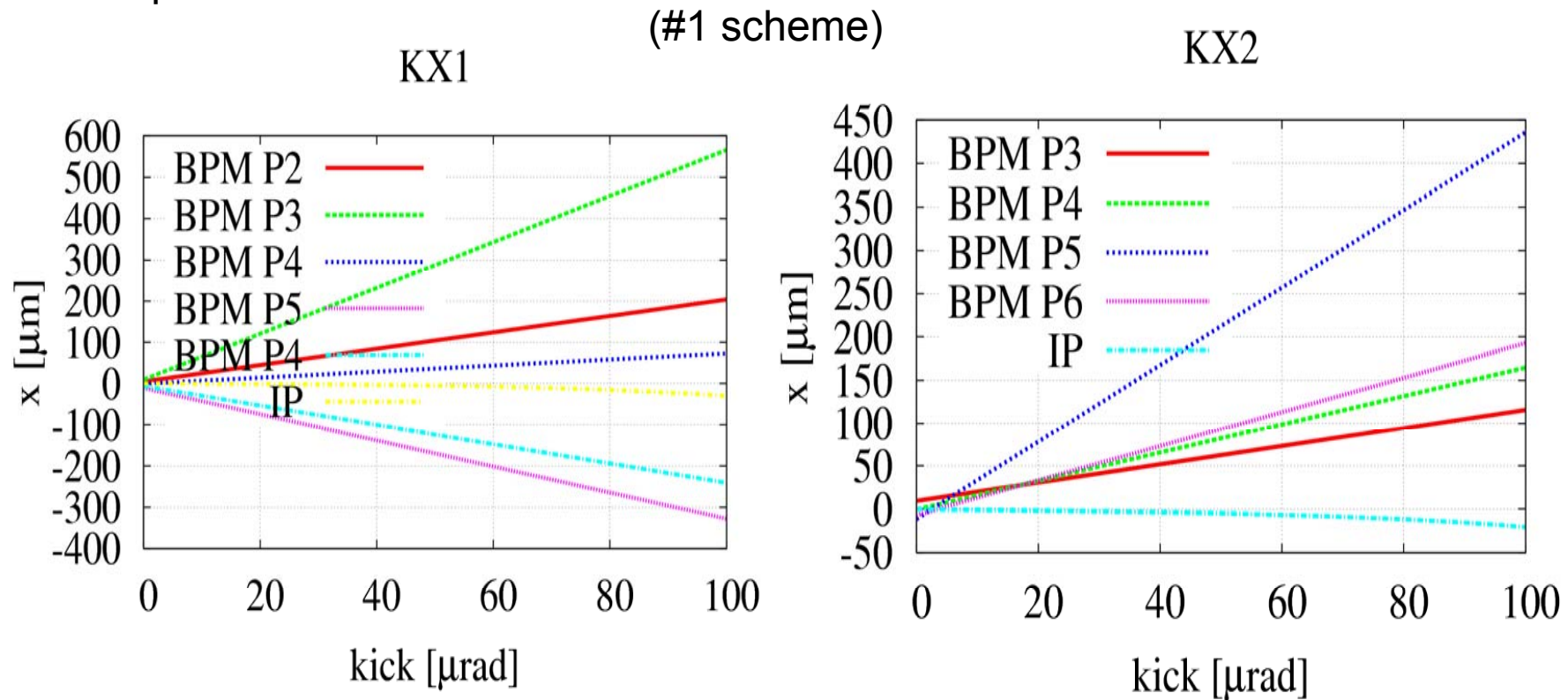


For kicks in the range of interest ($\leq 100 \mu\text{rad}$) the transport is basically linear

Kicker response in the downstream BPMs

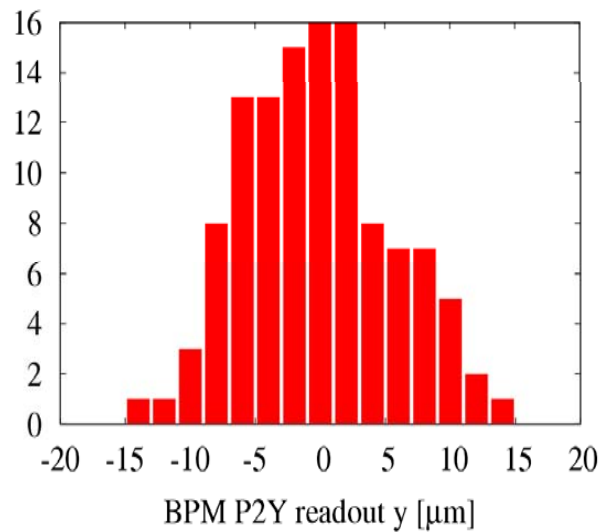
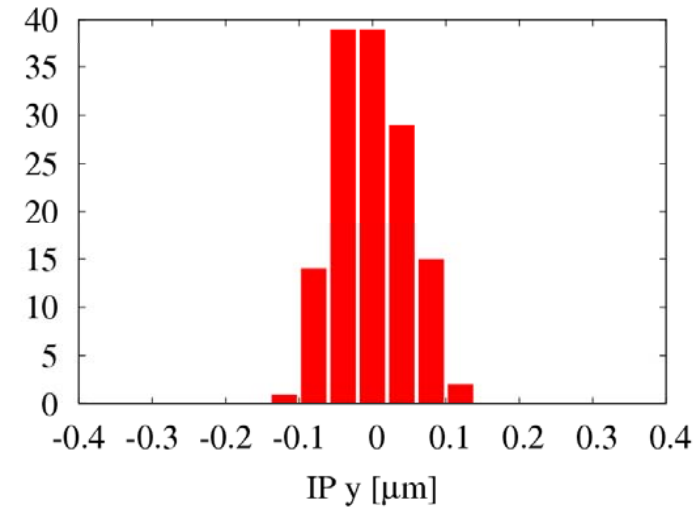
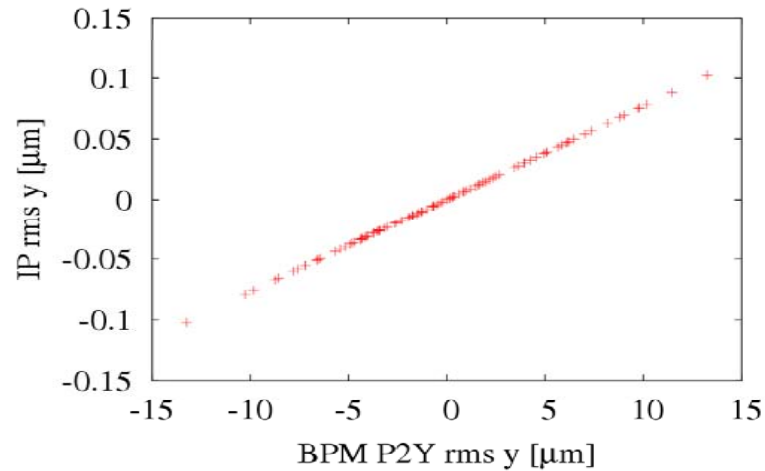
Horizontal kickers

Checking the linearity of the kicking strength for each kicker versus the orbit response



BPM resolution

Vertical position
(#2 scheme) BPM P2Y

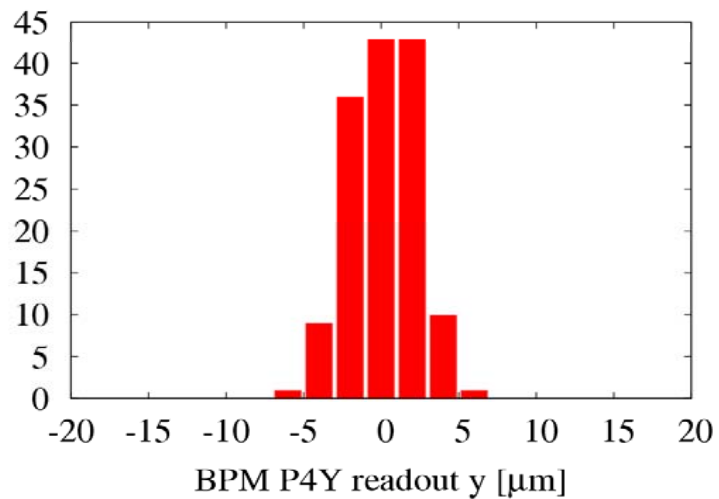
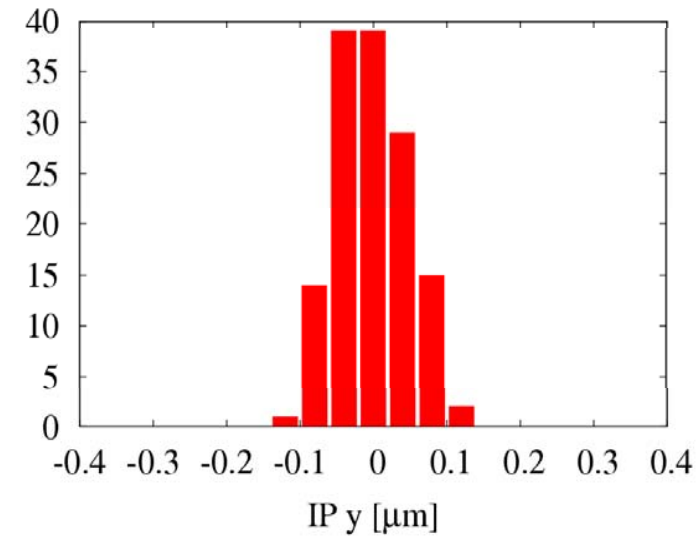
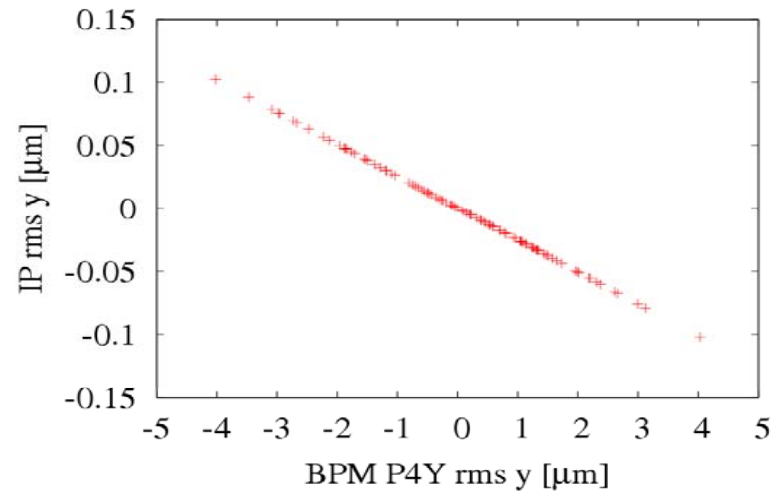


Montecarlo tracking simulation:

- Normal random distribution of 100 initial vertical jitter positions with $\pm 40\% \sigma_y$ (initial rms beam size)
- Assuming a perfect machine
- Study of the IP-BPM beam position correlation

BPM resolution

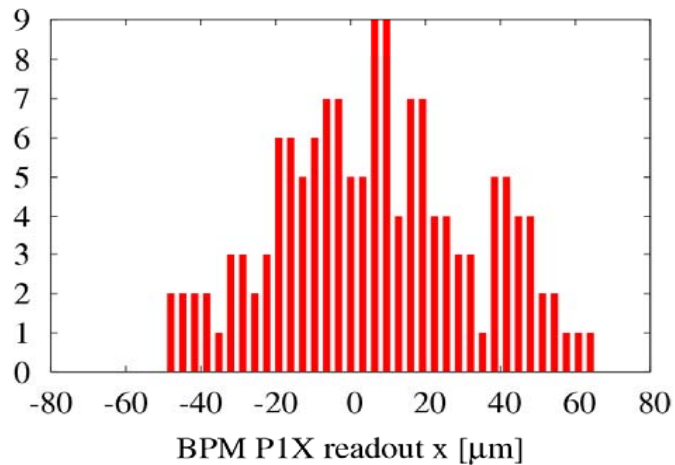
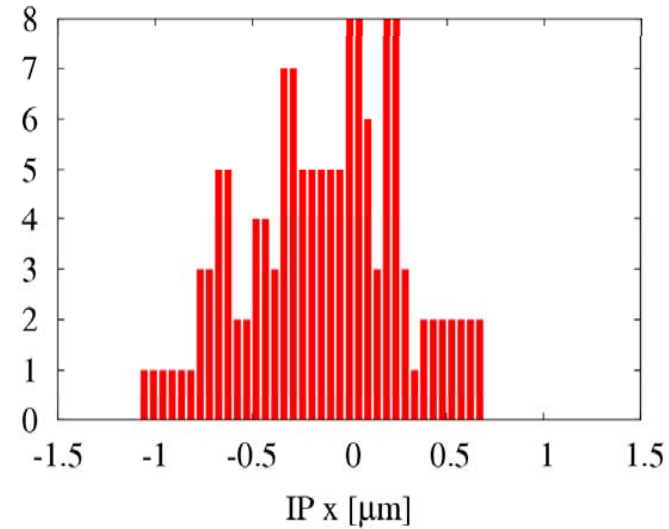
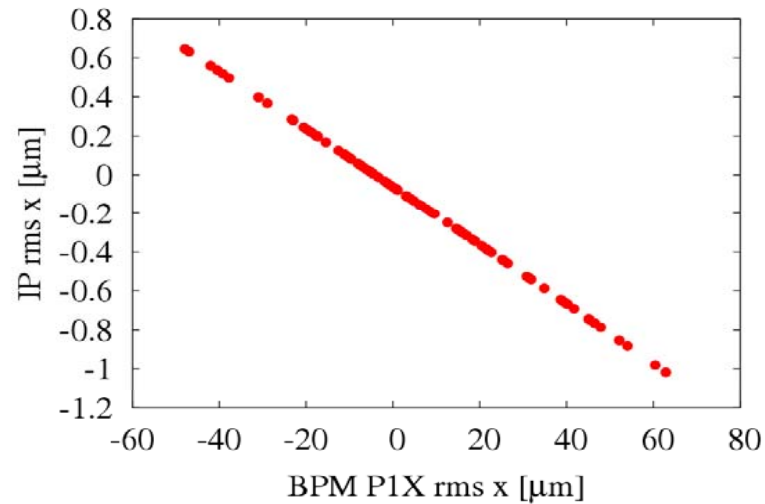
Vertical position
(#2 scheme) BPM P4Y



Readout vertical position at the BPM P4Y:
 $\pm 5 \mu\text{m}$

BPM resolution

Horizontal position
(#2 scheme) BPM P1X

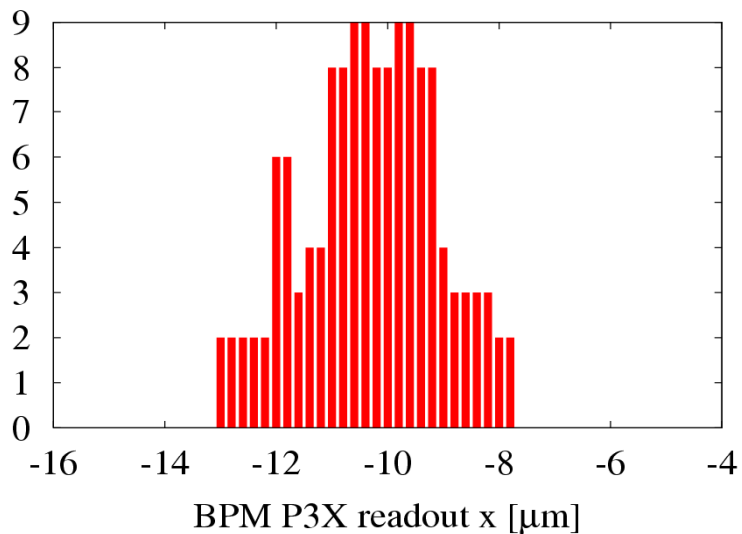
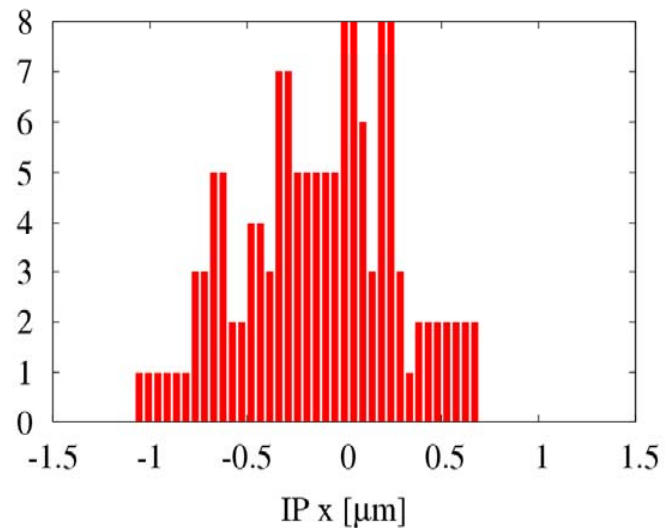
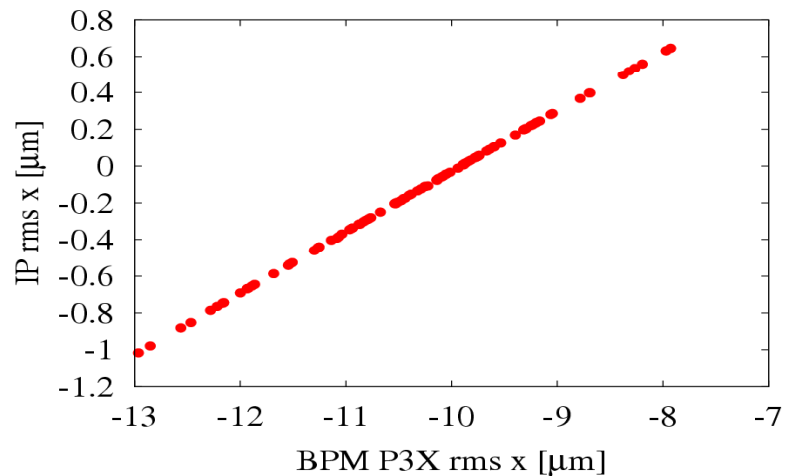


Montecarlo tracking simulation:

- Normal random distribution of 100 initial horizontal jitter positions with $\pm 20\% \sigma_x$ (initial rms beam size)
- Assuming a perfect machine
- Study of the IP-BPM beam position correlation

BPM resolution

Horizontal position
(#2 scheme) BPM P3X

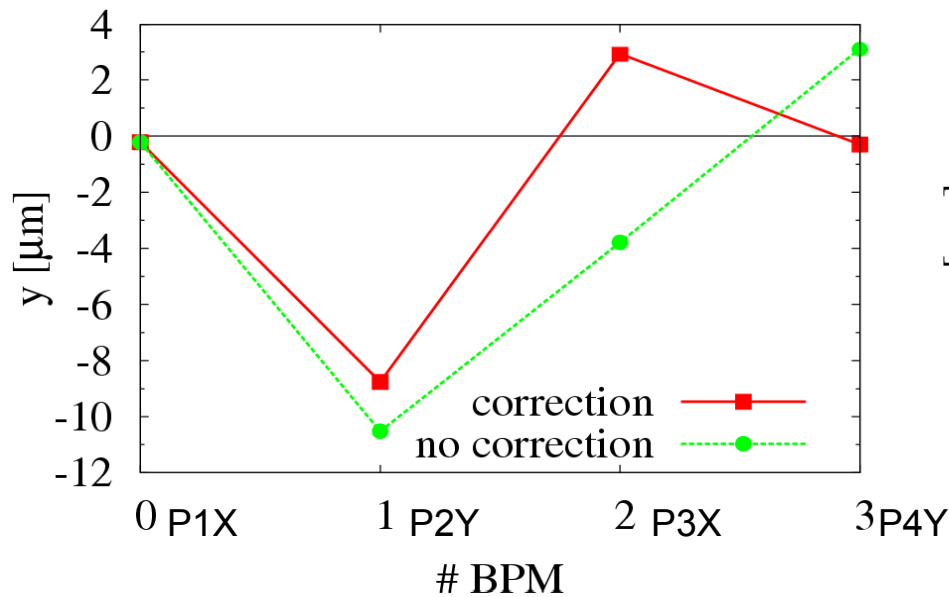


Readout horizontal position at the BPM P4Y
centered at \odot - 10 μm

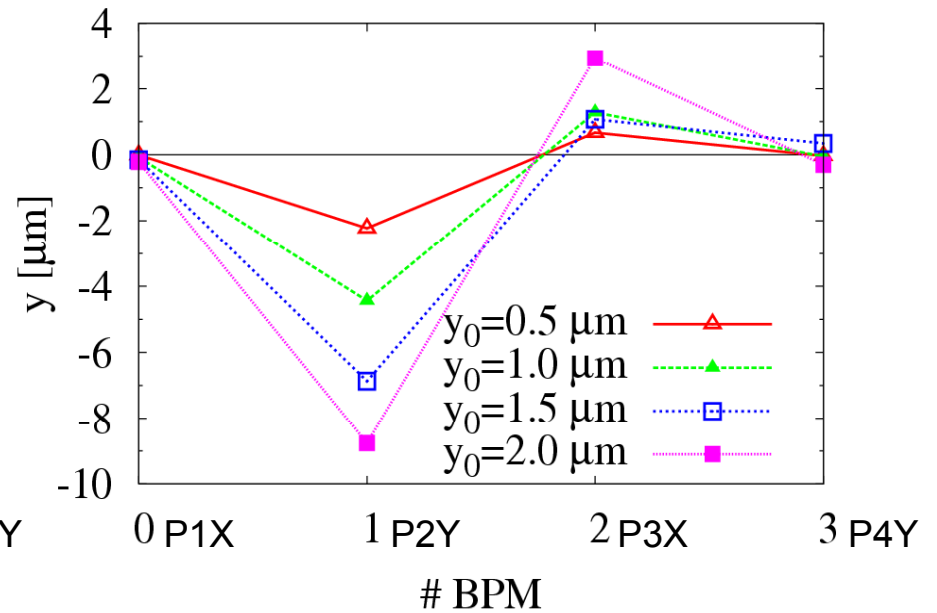
Position jitter correction (#2 scheme)

- Correction of the position jitter using the FONT correctors and stripline BPMs
- Response matrix reconstruction and 1-to-1 steering algorithm applied
- Assuming very small x-y coupling (neglected)
- Using KY1 & KY2 for y-y' correction

BPM readings:



For initial rms beam position $y_0=2.0 \mu\text{m}$



Summary and ongoing studies

- Optimal locations have been chosen for the kicker and BPM pairs of the FONT FF/FB system
- The required FONT kicker performance is being studied in order to define a complete mechanical model
- Placet based beam dynamics simulations using a single bunch has been performed: initial jitter propagation, kicker response, residue propagation, position jitter correction
- In the kick range [0-100] μrad the (x,x') and (y,y') transports are practically linear
- Multibunch tracking simulation studies are planned to study the performance of the FF/FB system for 20 bunches
- EPAC 2008 paper on FONT @ ATF2 simulations ?