Emittance Control for Different FACET Beam Setups in the SLAC Linac

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1. Emittance tuning is lengthy, and big starting values, high charge, short bunch ➔ ← low charge, long bunch
2. A Dozen Points which have to be considered while steering the Linac.

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Example of Emittance Tuning (ε_y)

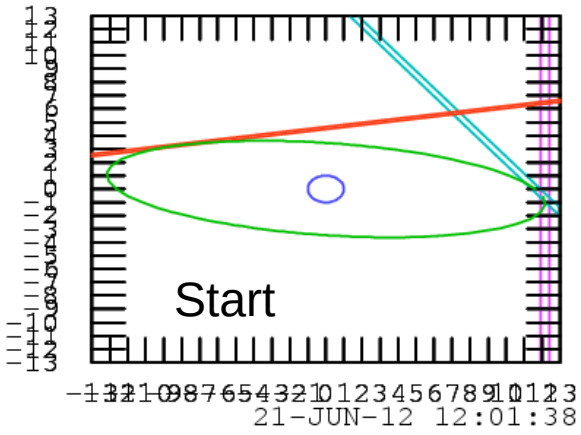
SLAC

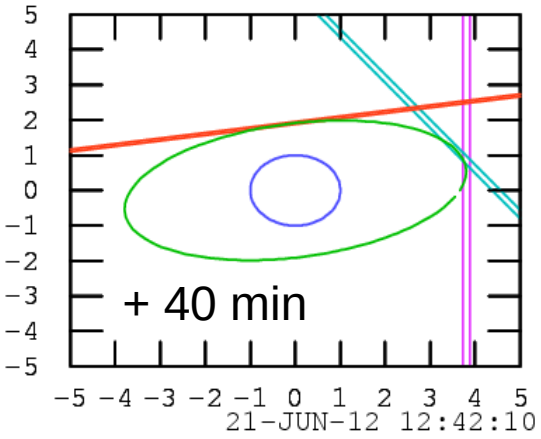
LI11 Y-PLANE SCAV

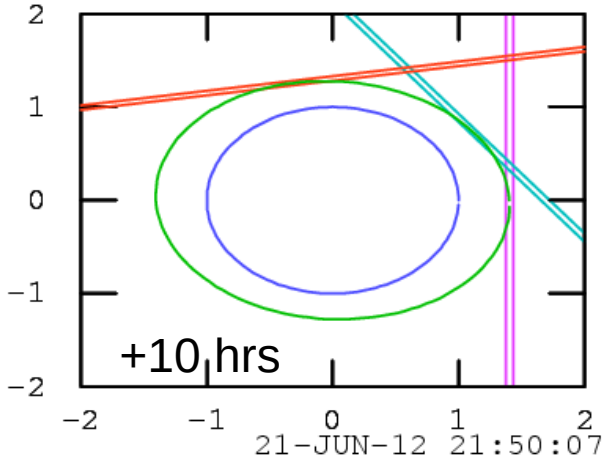
EMITTANCE(mE-5)	0.538+- 0.013	(0.300)
BMAG*EMIT(mE-5)	0.541+- 0.014	(0.300)
BMAG	1.005+- 0.005	(1.000)
BMAG_COS	0.094+- 0.033	(0.000)
BMAG_SIN	0.042+- 0.045	(0.000)
BETA (m)	12.741+- 0.439	(11.588)
ALPHA	0.741+- 0.061	(0.635)
SIG(344)(um)	62.389+- 1.248	(44.424)
SIG(444)(um)	107.001+- 2.140	(80.413)
SIG(614)(um)	55.435+- 1.109	(42.950)
INTENSITY	1.507+- 0.001	
CHISQ/DOF	0.000000	
ASYM(344)	-0.625+- 0.103	
ASYM(444)	-0.070+- 0.047	
ASYM(614)	0.042+- 0.055	

After loading new 76 deg lattice and steering the linac:

24 E-5 m-rad, 2.7 E-5 m-rad, 0.5







Any change (q, σ_z) will destroy this delicate setup

Dozen Points to "Steer Linac"

SLAC

Goal:

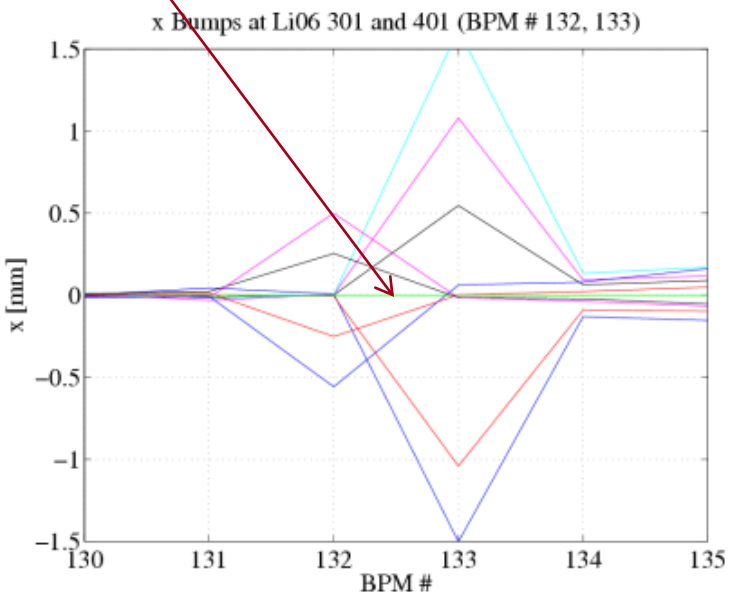
Get Linac closer to good emittances with BPMs … so tuning part is less.

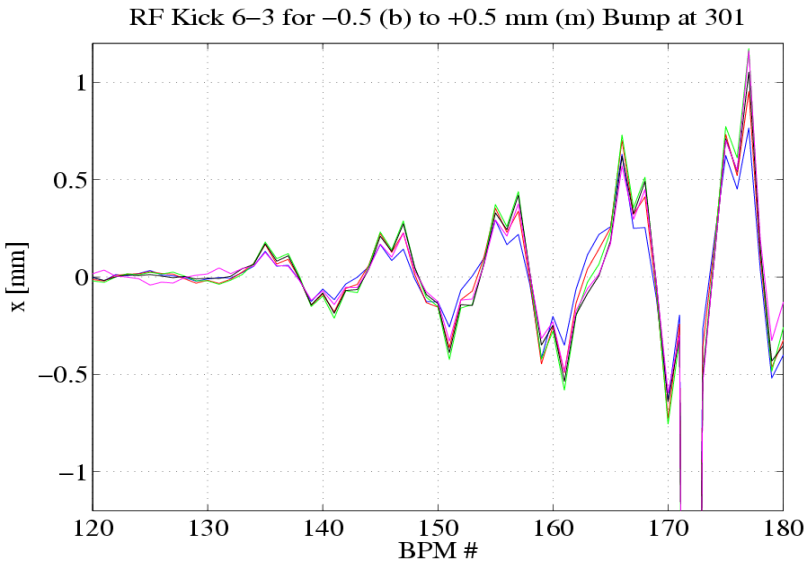
1. BPMs
2. Correctors
3. Quads (old BBA to get straight orbit): $\Delta x = cor/Q$
4. BPM-to-Quad offset: bowtie plot or quad change
5. Corrector strength (LOCO, R12 meas.) + quantify hysteresis
6. Lattice (Quad) strength: Oscillation data
7. Measure RF-kicks: a) sin-cos, b) dipole-quadrupole-lens, c) ..?..
8. Measure dispersion
9. Measure with different charge (wakefield)
10. Measure with different bunch lengths (for changes)…
11. Other: ballistic, oscillation data with different energy profile, electronic noise …

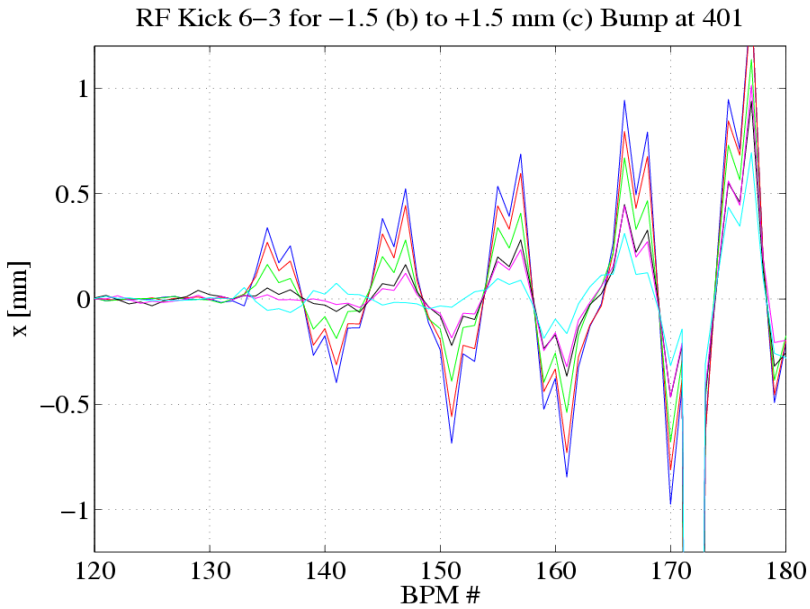
RF Kicks for Different Trajectory Bumps

A three corrector bump of +1 mm **at the end** of the structure cancels the RF kick (with dispersion?)

[Klystron 6-3 is between BPM # 132 and 133]

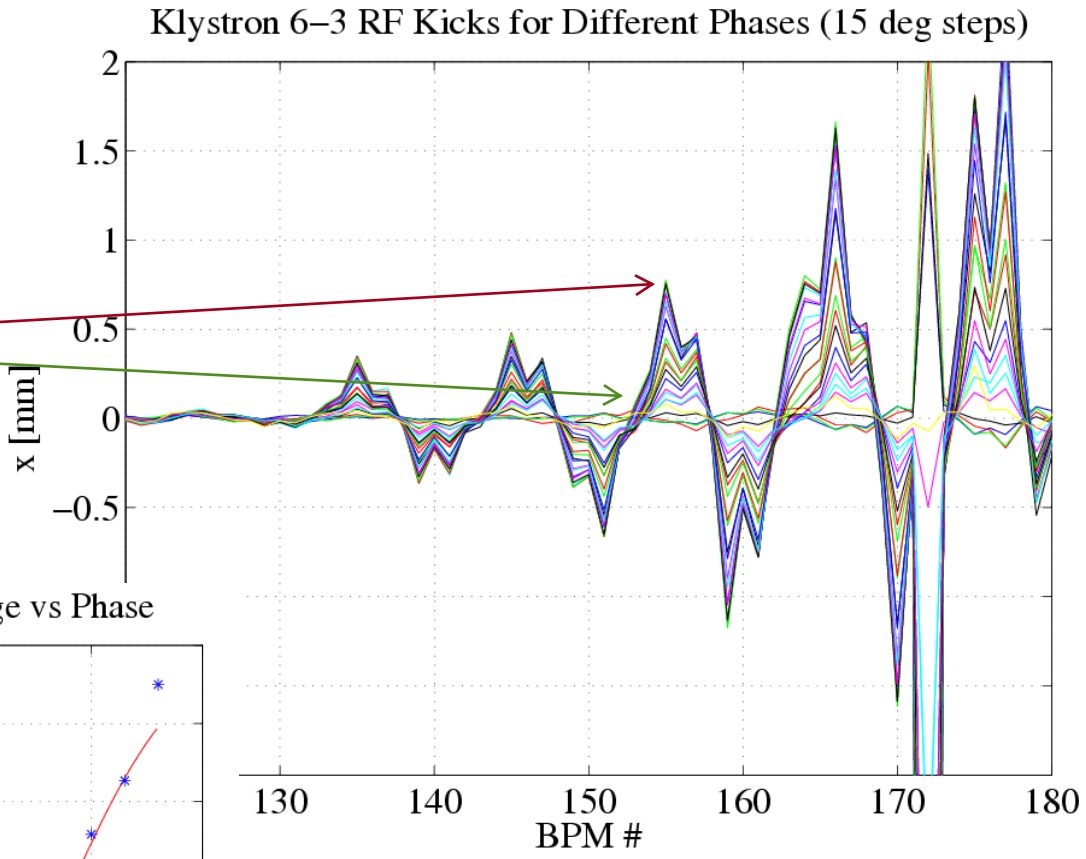


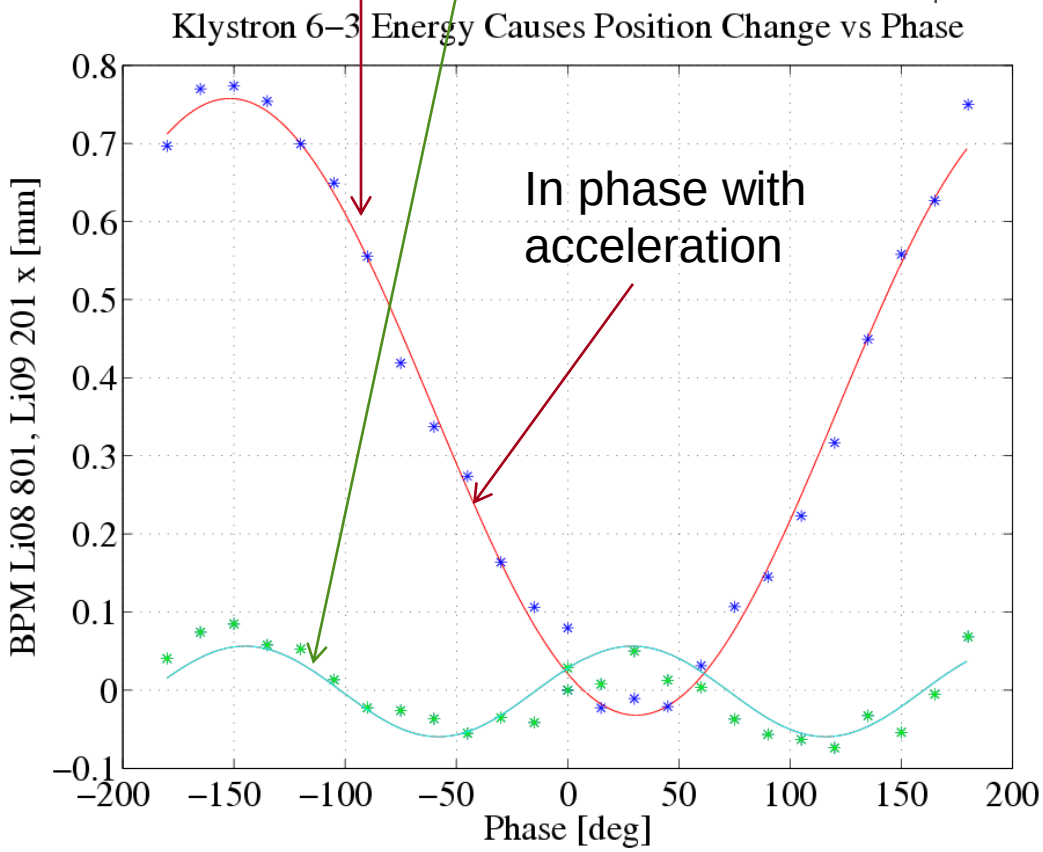




Kicks versus Phases

BPM #155, 153 ($2 \cdot f_{rf}$?)





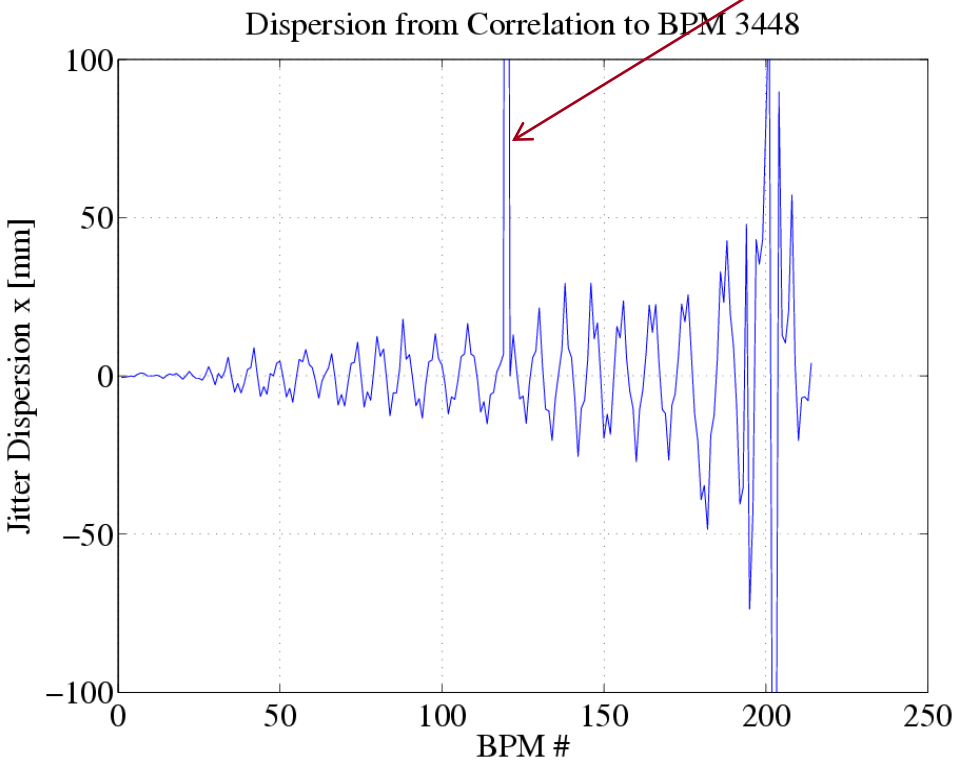
→ MOPB001: Emittance Control

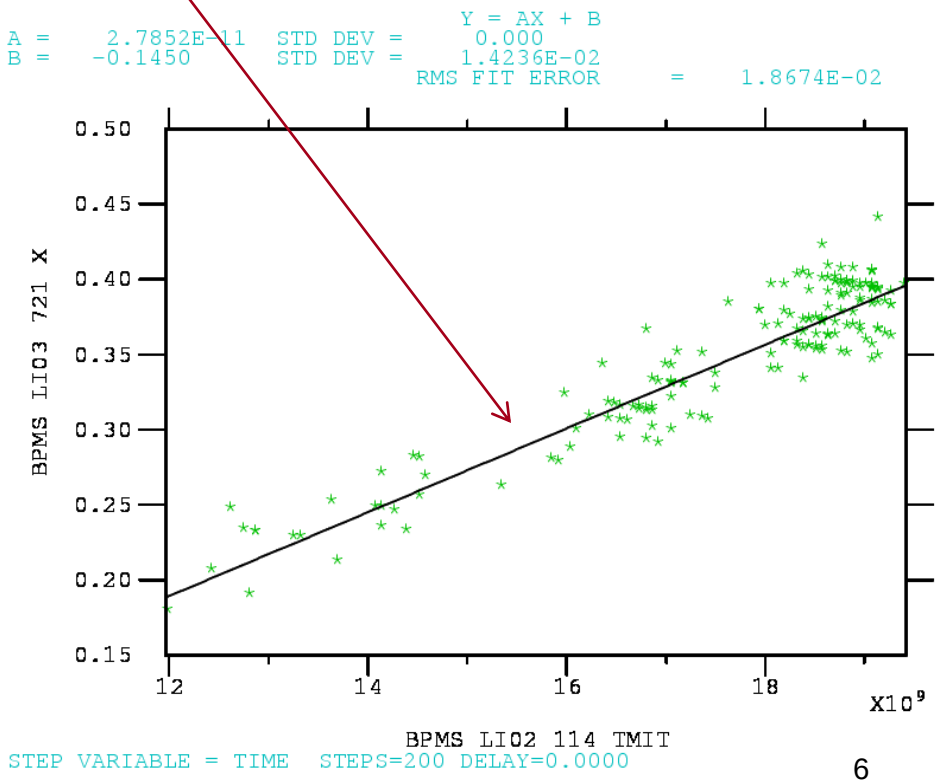
Dithering Energy or Charge

Dispersion seen before and after Li10 chicane:

Spot size: 20 mm * 1.5 % = 300 μm

What needs to change to reduce charge dependence?





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Summary

Emittances can be tuned down (lengthy), but the setup is VERY sensitive to changes

Changes: Charge, bunch length, energy (klystron kick)

We need to understand and quantify all effects

1. Energy dependence: dispersion, (chromaticity)
2. Charge dependence: “dispersed by charge” (wakefields)
3. Bunch length dependence: “dispersed by length (phase)”
4. RF kick dependence: “…”

Bring more ideas: MOPB001