

Elens commissioning

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Goals and parameters

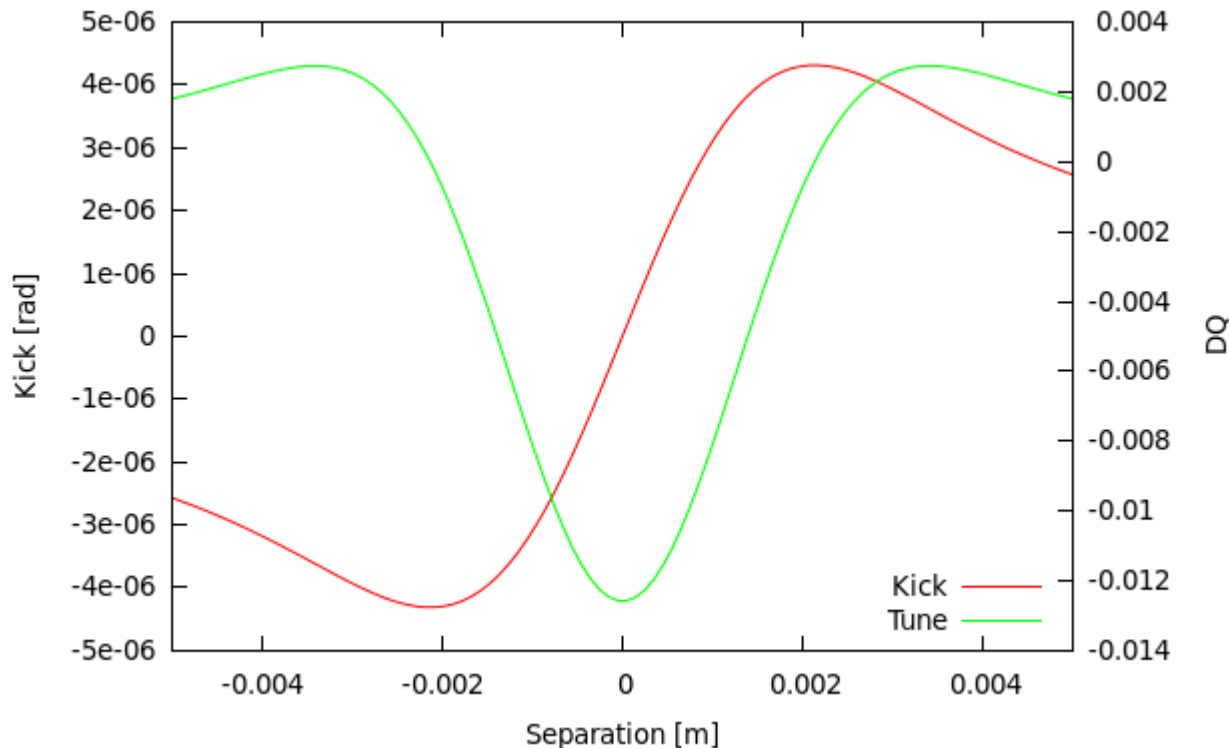
- Goal - transverse alignment of electron and ion beams
 - Done by displacing the ion beam using orbit bumps
 - Also tested displacement using the elens corrector magnets
- Relevant parameters:
 - Ions: $\sigma \sim 1.25\text{mm}$, $\beta = 11\text{m}$
 - Electrons: $N \sim 1.1 \times 10^{11}$ (0.5A), $\sigma \sim 0.5\text{mm}$, $\beta_{\text{rel}} \sim 0.2$
- Strong mismatch between electron and ion beams: expect poor lifetime
- Beam-beam parameter seen by the ions:

$$\xi = \frac{Z}{A} \frac{N_e r_p \beta}{4\pi \gamma_p \sigma_e^2} (1 + \beta_e) \approx 0.027$$

Beam beam kick and tune shift

$$\Delta x_{co}' = \frac{Z}{A} (1 + \beta_e) \frac{2 N r_p}{\gamma} \frac{1}{x} \left(1 - \exp\left[\frac{-x^2}{2(\sigma_e^2 + \sigma_i^2)} \right] \right)$$

$$\Delta Q_{co} = \xi \left(\frac{\sigma_e^2 + \sigma_i^2}{x^2} - \frac{\sigma_e^2 + \sigma_i^2}{x^2} \exp\left[\frac{-x^2}{2(\sigma_e^2 + \sigma_i^2)} \right] - \exp\left[\frac{-x^2}{2(\sigma_e^2 + \sigma_i^2)} \right] \right)$$



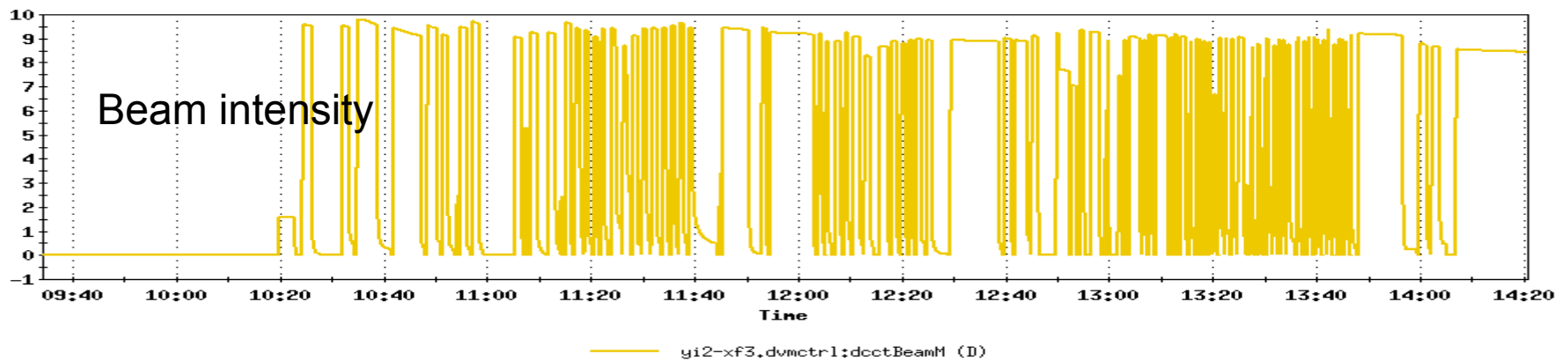
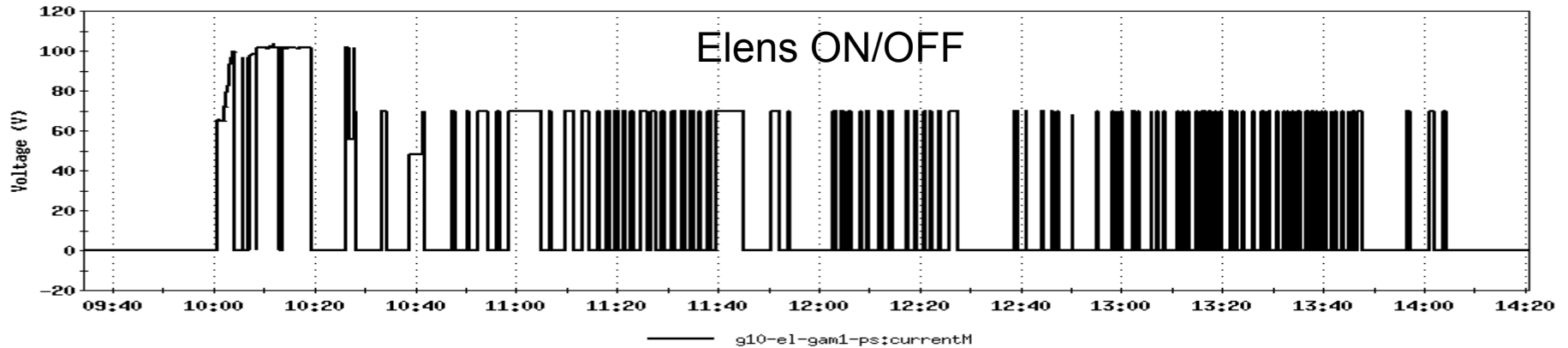
→ Both should be measurable

→ Tune not defined due to the beam-beam tune spread

→ Where the PLL will lock is unpredictable

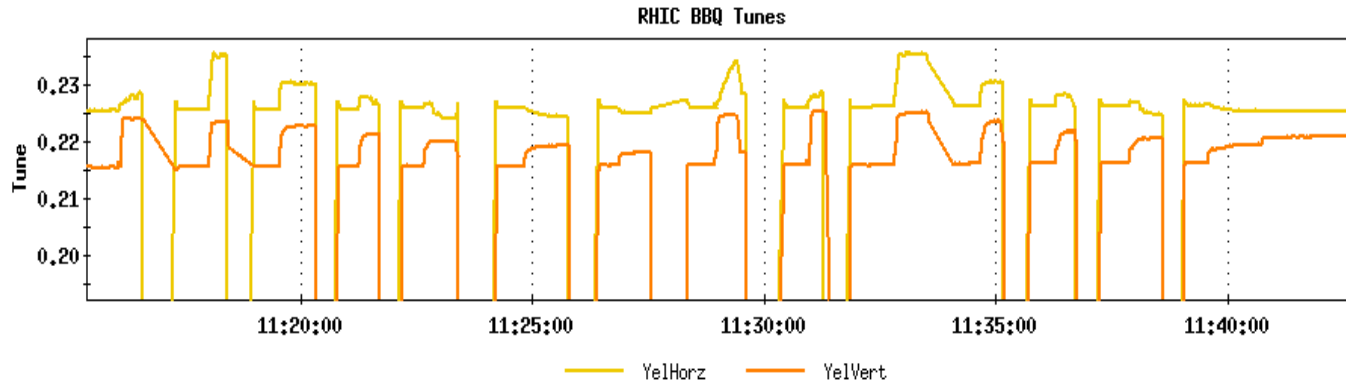
→ Orbit distortion is zero and tune change is maximum when the beams are aligned

Experiment

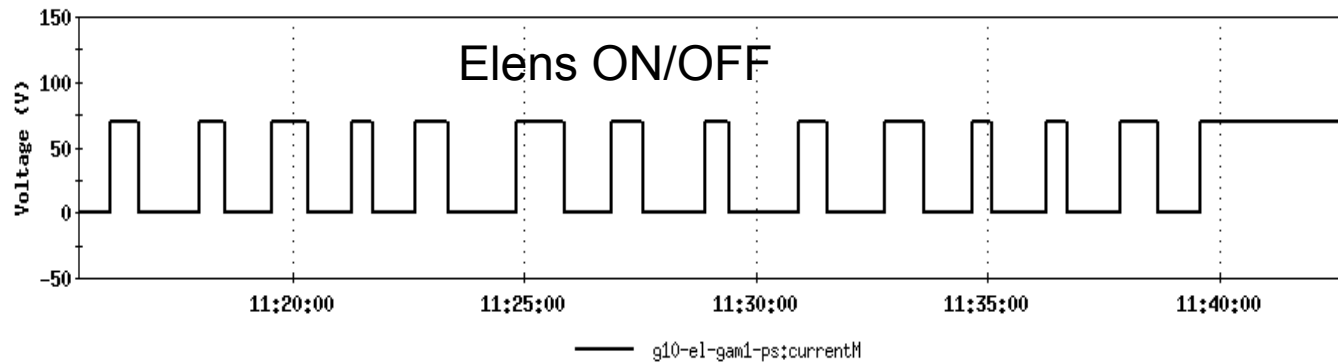


- As soon as the elens is turned ON the ion beam is lost in a few seconds
- Decided to reduce the elens current to 0.5A instead of the nominal 1.0A
- Enough to observe orbit and tune changes: analysis may be difficult, instrumentation

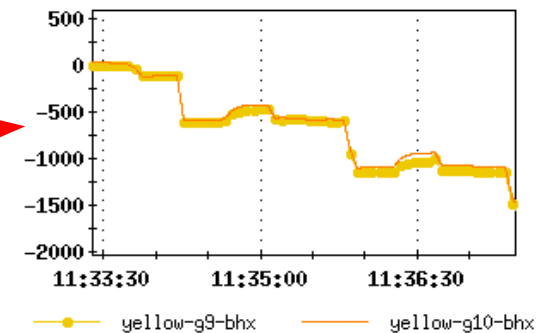
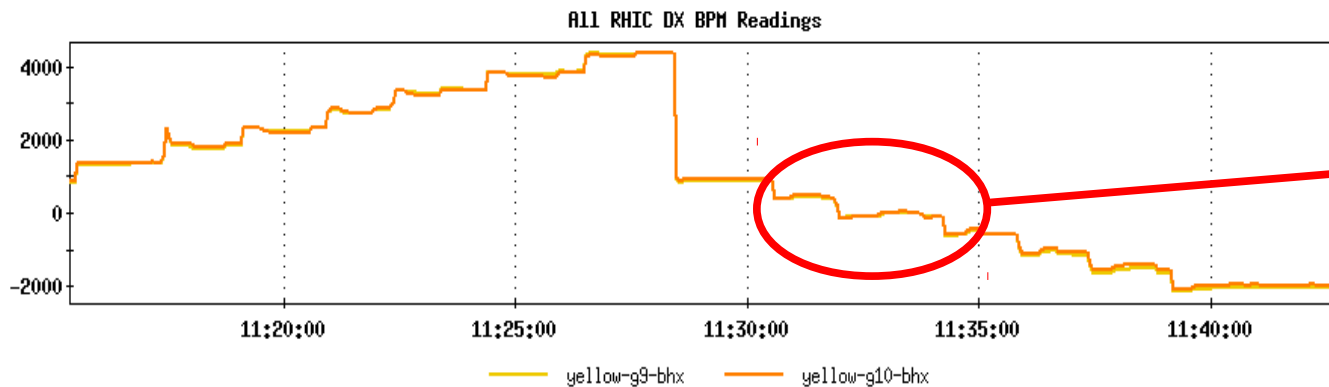
Measured orbit and tune shift



→ Both the tune and orbit distortion clearly observed

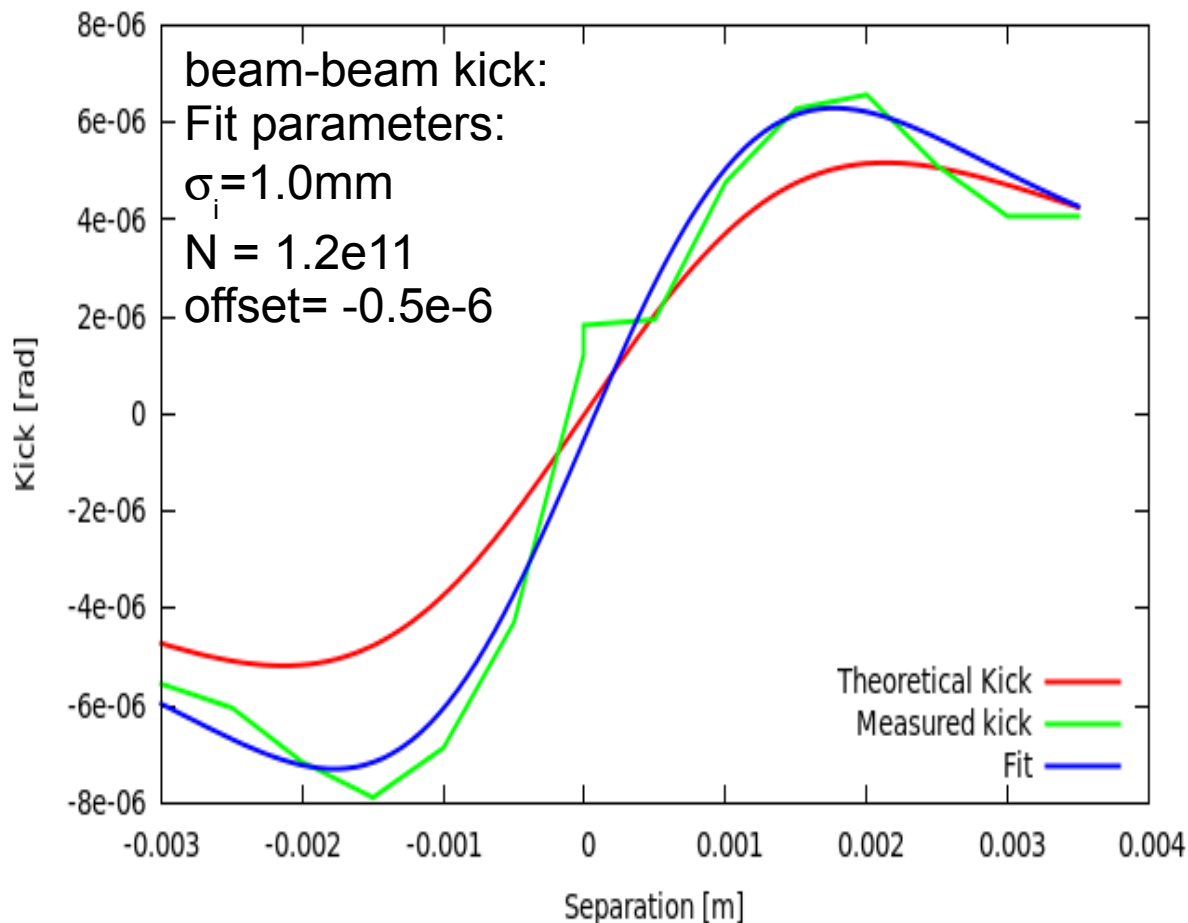


→ Looking at difference with elens ON/OFF as a function of separation



Full scan - preliminary

Closed orbit formula:
$$x(s) = \sum_i \frac{\sqrt{\beta(s_i)\beta(s_0)}}{2\sin\pi\nu} \cos(\pi\nu - |\varphi(s) - \varphi(s_i)|) \theta_i$$



→ Good agreement between Measured and expected values

→ Should look at the full orbit to Derive some systematics etc...

→ Although some effect is observed on the tune could not make sense of the data so far

→ PLL lock rather unpredictable

Summary

- Performed the first test of transverse alignment at injection energy:
 - Clear lifetime issue: low energy, beam mismatch. Should be solved at top energy
 - We were able to align the beams in both planes using orbit data: fits expectations
 - Also tested movement of electron beam
- Lots of data acquire: full analysis will take some time

Beams aligned in X and Y:
almost no difference in rms
orbit whether the elens is ON
or OFF

