Proposal of nonlinear optics measurements and correction in the IOTA ring

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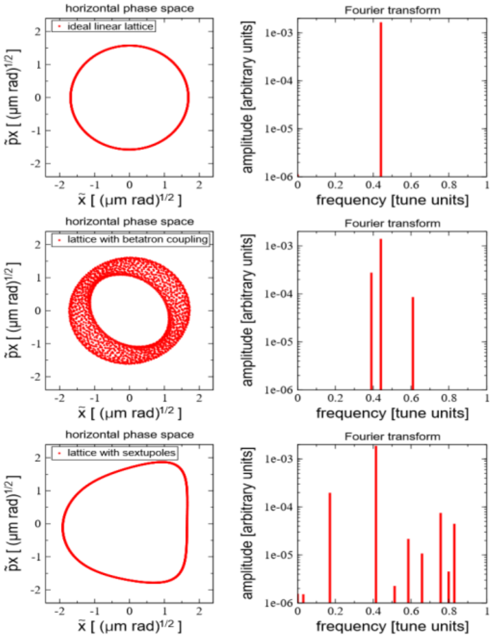
Motivation

$$h_x^- = x - ip_x = \sqrt{2I_x}e^{i(2\pi\nu_x N + \psi_{x_0})}$$
$$-2i \sum_{jklm} jf_{jklm} (2I_x)^{(j+k-1)/2} (2I_y)^{(l+m)/2}$$
$$\times e^{i[(1-j+k)(2\pi\nu_x N+\psi_{x_0})+(m-l)(2\pi\nu_y N+\psi_{y_0})]}$$

- Goal of the proposed study is to measure resonance driving terms (RDT) in the IOTA ring
  - Localized measure of the distortion in phase space due to particular resonance
  - Longitudinal variation of amplitude of RDT used to determine sources of nonlinearities and potentially correct for
- Two major nonlinear sources in IOTA (by design):
  - Chromaticity sextupoles
  - NL insert should not change RDT variation around the ring
- Results allow to benchmark nonlinear model of accelerator, identify unknown sources and used as input to refine simulations/calculate corrections
  - Parasitically, analysis also yields optics information

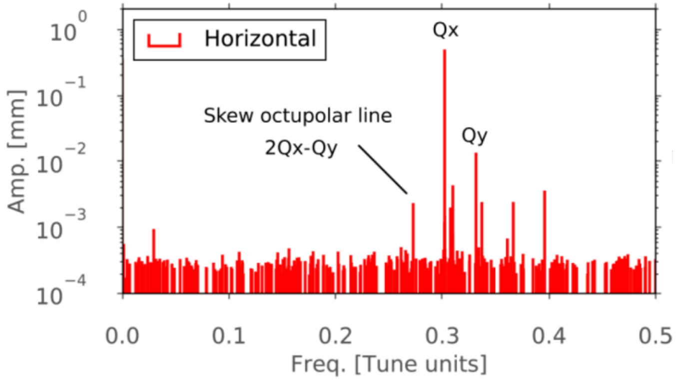


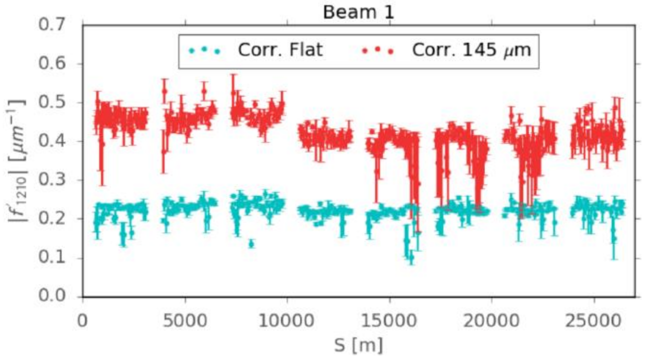
A. Franchi et al., arXiv:1402.1461

Method

- Measurement procedure similar to previous experiments on octupole channel and NL
  - Large amplitude excitations with kickers/pinger (preferably in both horizontal and vertical)
  - Spectral decomposition of captured turn-by-turn data from BPMs and further postprocessing

- Limitations:
  - Limited amount of turns due to decoherence
    - Secondary line (m,n) decohere faster with $\left|m + n\frac{\nu_{yx}}{\nu_{xx}}\right|$ in horizontal spectra, ν being the amplitude detuning
  - Nonlinearities in the BPM can cause additional lines in spectra

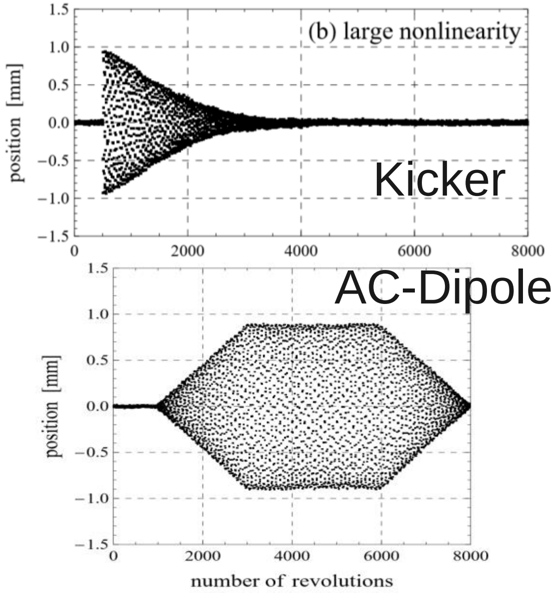




F. Carlier et al., Correction of skew octupoles with Resonance Driving Terms

Setting & requirements

- Hardware:
  - In basic case, no reconfiguration or hardware installation expected
  - Excitation with kickers/pinger both horizontal and vertical
    - Optionally, reconfiguration of transverse feedback to use as AC-dipole
    - Allows coherent excitation of betatron oscillation, overcoming the problem of rapid decoherence but also introducing new spectral lines
- Beam & optics:
  - High charge beam to provide clean BPM signal
  - Chromaticity correction close to zero with sextupoles
  - Knobs to adjust working point
- Time:
  - Ideally 3 shifts á ~5h, scheduled preferably on non consecutive days
  - Can share also beam time with other experimental studies on octupole channel and NL



From R. Miyamoto, FERMILAB-Thesis-2008-48

Procedure

- Initial assessment of RDTs with NL and octupole channel depowered and chromaticity well corrected
  - Check configurations trying to establish optimal conditions
  - Depending on previous data, possible explore different working points enhancing sextupolar RDTs or moving tunes apart for coupling measurement

- Repeat with NL or octupole channel powered on
  - Possibly explore working point enhancing octupolar RDT
  - Both octupole channel and NL being major sources of amplitude detuning, decoherence might limit max. strength at which measurements can be conducted
  - Optionally, test effect of an alternative sextupole powering schemes, different levels of coupling or repeat with momentum offset

Thank you for your attention

Questions?