Summary of October 2023 Sextupole Studies

Primary goals

Measure misalignments for sextupoles on girders which were moved during the summer down (26W, 32W, 33W (regrout), 36W, 43E, 34E, 43E, 34E, 16E).

Measure misalignments and calibrations for sextupoles where CBPM processors were newly re-installed on 2 October 2023 (32W, 45E, 34E, 25E, 09AE).

Measure misalignments and calibrations for sextupoles where BPM gain calibrations and quad centering was done (26W, 35W, 36W, 42W, 34W, 44W, 43W, 43E, 18E, 16E).
K2 scans were done with both increasing and decreasing settings to look for hysteresis effects.

Repeat measurements for sextupoles which have previously shown anomalously large misalignments (33W, 34W, 18E, 16E, 26W, 09AE). See Accelerator Group talk of 19 July 2023.

Analysis underway.

Presented today

Do a fine tune scan around sextupole resonance lines for studying calibration sets.

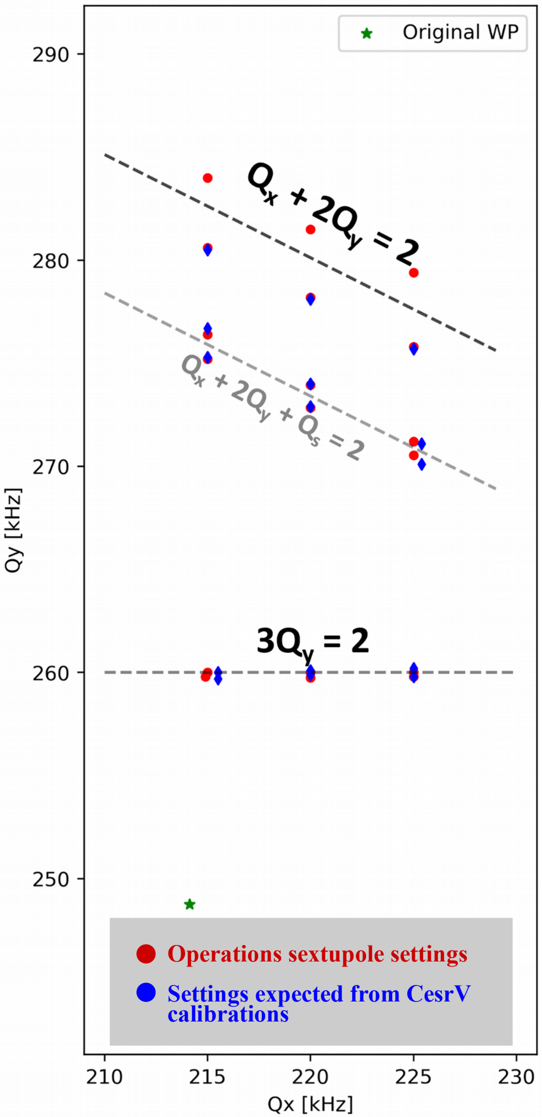
Bonus: development CesrV turn-by-turn orbit data analysis and display.

Jim Crittenden

CESR Machine Studies Meeting

19 October 2023

Fine tune scan of sextupole resonance lines
5 October – JSh, JAC. Follow-up to 16 April.



Goal

Find a method to validate sextupole calibration correction factors measured with the CesrV procedure using tune change with sextupole strength settings versus beam position.
Dynamic aperture should improve with design sextupole settings.

Procedure

Measure value of f_Y at which beam lifetime suffers for three values of f_X. We found that the edges are very sharp.
Repeat for values of f_Y which approach the sextupole line from below and above.
Repeat with sextupole settings calculated using CesrV calibration correction factors. Keep total chromaticity constant: H/V = 2.1/1.1

Results

* The line widths do not depend on the sextupole settings at the level of the calibration correction factors. These vary from sextupole to sextupole by an RMS of 11% measured to an accuracy of 1% (see IPAC22 and more recent presentations).

* The line widths vary dramatically: 0.2, 0.8, 3.8 kHz.

Fine tune scan of sextupole resonance lines - Ongoing studies -

Modeling

The Cornell ERL/EIC group has developed methods for calculating resonance line widths which can be applied to the CESR lattice and conditions.

Grad student Jonathan Unger is calculating frequency maps for these sextupole settings, incuding the effects of sextupole misalignments.

CesrV code development by David Sagan 2017

Calculating Sextupole Strength and Placement From Shaking Data

April 19, 2017

1 General Resonance Analysis

Given a second order one-turn map, we want to find the resonance amplitudes and phases. The one-turn map is of the form

$$\mathbf{x}(n+1) = \mathbf{M}_x\,\mathbf{x}(n) + \mathbf{T}_x\,\mathbf{x}(n)\,\mathbf{x}(n) \tag{1}$$

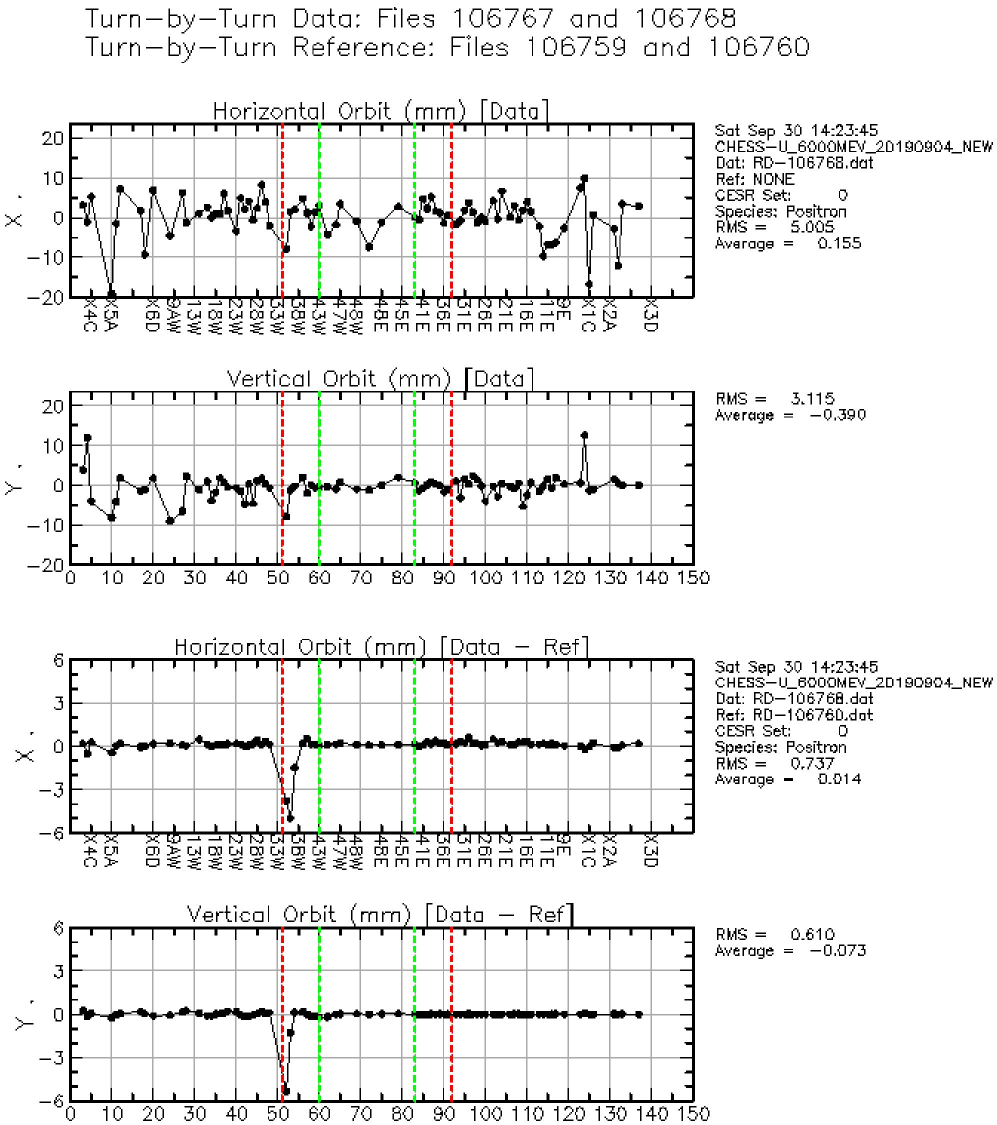
2 Overview

The idea is to measure the phase and amplitude of the horizontal and vertical resonance lines at all BPM's while resonantly shaking at both the horizontal and vertical betatron resonance frequencies. This information allows the calculation of sextupole strengths and locations.

CesrV code exists, but must be resurrected.

David: “Can be as easy as a phase measurement.”

Turn-by-turn, BPM-by-BPM data display
(BPM button gain calibrations - 30 September 2023, ATC, JSh, JAC)



<u>CesrV code development ongoing</u>

Turn-averaged orbits and orbit differences are now available.

Example: button gain calibration procedures use bumps to make a grid of beam positions at the BPM.

The development of TBT data display in CesrV provides a quick and convenient way to check that the bumping is having the desired position and amplitude.