COUPLING CORRECTION IN NSLS X-RAY RING

M. Fedurin[#], I. Pinayev, BNL, Upton, NY, 11973, U.S.A.

Abstract

In this paper we present algorithm of coupling correction in storage ring based on monitoring the vertical size of a stored beam, while varying skew quadrupoles. The details of the algorithm realized as Matlab script and experimental results of its application are present.

CORRECTION METHOD

The NSLS X-ray ring has 17 skew quadrupoles for correction of coupling and vertical dispersion. Generally, coupling correction is done using cross-plane response matrices [1] (vertical BPMs vs. horizontal trims, horizontal BPMs vs. vertical trim, vertical dispersion). Such approach required precise measurements of beam position. Also, it is often impossible to measure response matrix in the operational lattice with insertion devices. We suggest usage of beam profile measurements with a pin-hole camera or other beam size monitor.

Varying one skew quad setpoint will affect the observed beam size. One iteration cycle has the following sequence: 1) find setting of particular skew quadrupole setting for minimal vertical beam size, 2) set it up and then proceed with next quad, 3) make one pass for all skew quadrupoles, 4) correct beam orbit after each pass or keep beam position feedback turned on all the time. Fig. 1 shows the output window of the NSLS X-ray ring pinhole camera.

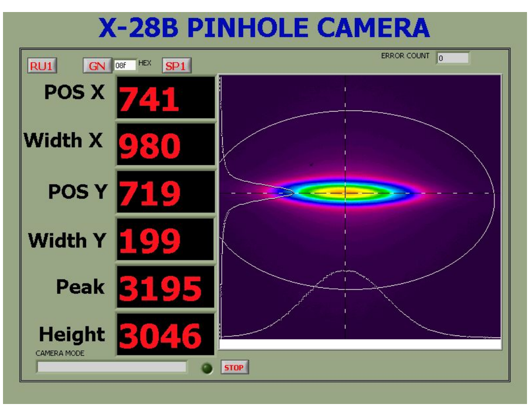

Figure 1: Screenshot of pinhole camera monitor located at X28 beamline and used for beam profile measurements.

Skew quadrupole current varied in 5 equidistant setpoints and beam size measured at every step. Then polynomial curve fit was done on measured data to find extremum. In order to reduce disturbance of beam orbit, limited range was chosen for varying skew quadrupoles. Three possible scenarios could be found (as illustrated in Fig. 2): 1) minimum is the inside range; 2) extremum located outside the range; and 3) maximum is found inside the range. In case 1 the new setpoint was chosen to correspond to the location of minimum. In cases 2 and 3 the outer point with smallest beam size is chosen for the new setpoint.

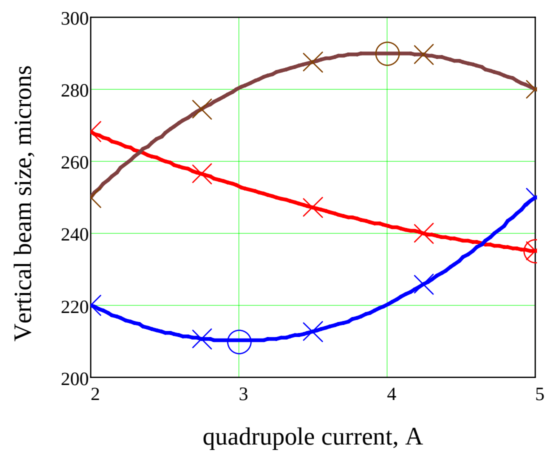

Figure 2: Three different types of local extremum: extremum located on one of the edges of the range (red curve), inside range (blue curve), and extremum value correspond maximum beam size (brown curve).

EXPERIMENTAL RESULTS

Before a start of correction process, all skew quadrupoles were set to zero. After the first pass skew quadrupole settings bring vertical beam size down from 575 µm (Fig. 3) to 425 µm. Each other iteration changed size value down and after 9 passes the size became below 300 µm (Fig. 4) and tilt of beam profile was reduced as well.

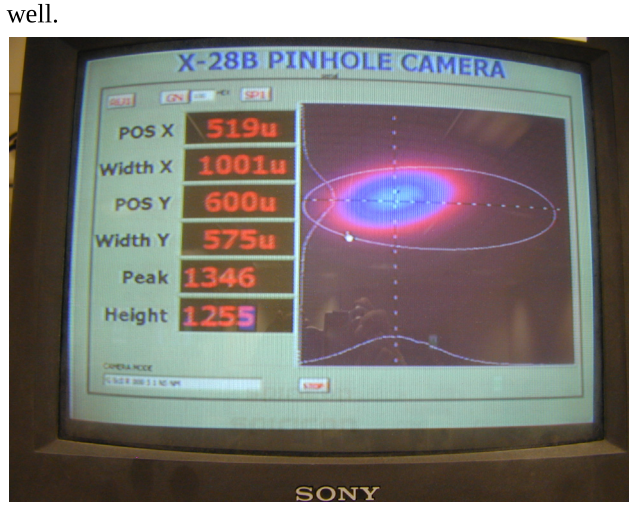

Figure 3: Image of the electron beam with zeroed skew quadrupoles.

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[#]fedurin@bnl.gov

Skew quadrupole scan trends are presented in the Fig. 5. It is worth mentioning that some quadrupoles reach constant level when others continue significantly changing during iterations. The scan showed all three types of extremum.

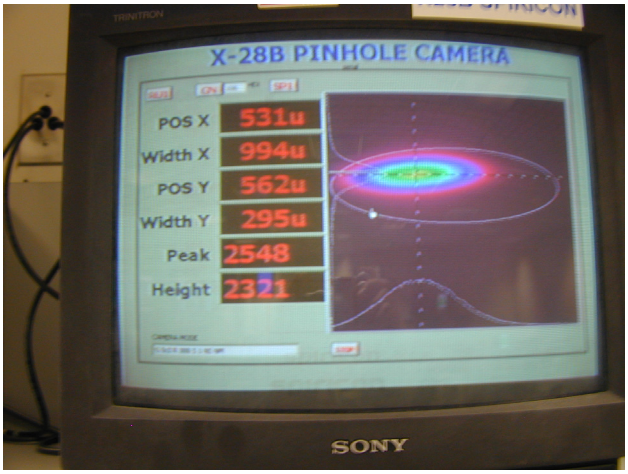

Figure 4: Image of the electron beam after nine iterations.

Every beam profile measurement was averaged over 10 seconds. So, each quadrupole scan takes about 1 minute, and whole one pass about 20 minutes.

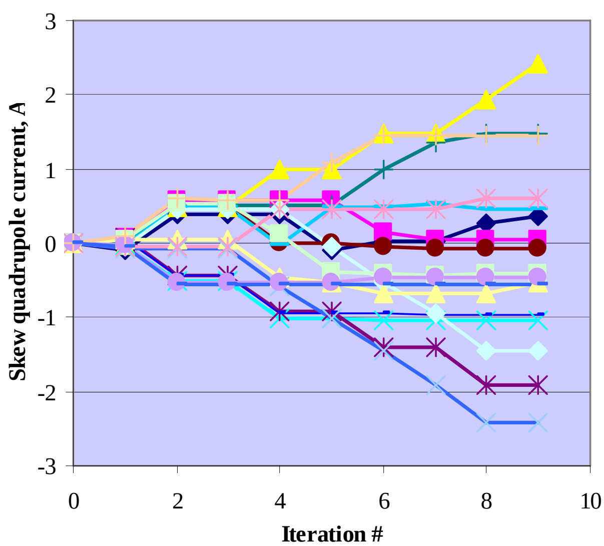

Figure 5: History of skew quadrupole current settings.

After first successful attempt we have done few more with different starting points. The trends of the beam size with iterations are shown in Fig. 6. The upper curve corresponds to the iteration starting with zero skew quadrupoles.

The method converges to the same values of skew quadrupole setpoints but speed is rather slow. In order improve convergence rate we will try to increase the range for scan and different sequencing such as looking for the most efficient skew quadrupole.

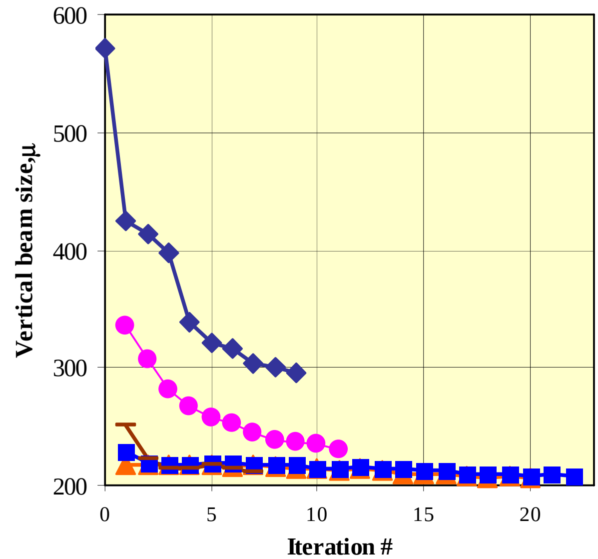

Figure 6: Changes of the vertical beam size after every iteration pass

SUMMURY

Coupling reduction method, using skew quad iterations combined with beam size measurement, was verified on NSLS X-ray storage ring. Procedure demonstrated applicability for coupling reduction but still needs improvement to speed up convergence.

ACKNOWLEDGEMENTS

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REFERENCES

[1] J. Safranek and S. Krinsky, “Plans to Increase Source Brightness of NSLS X-Ray Ring”, Proc. of PAC’93.