COUPLING CORRECTION IN NSLS X-RAY RING

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Abstract

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

CORRECTION METHOD

There are 17 skew quadrupoles (Table 1) distributed around the X-ray ring, as well as beam profile, could be measured on pin-hole camera monitor (Fig.1). All this is enough to try to find the optimal skew quad configuration to minimize vertical beam size.

Varying one skew quad setting in defined range will affect the beam size change. So, one iteration cycle has this sequence: 1) find optimal quadrupole setting for minimal vertical beam size; 2) set it up and then turn to vary next quads; 3) make one pass for all quadrupoles; and 4) correct beam displacement after each pass or keep beam position feedback on all the time.

Optimal skew quadrupole setting

The quadrupole variation range was made small, to avoid disturbing beam position too much or reaching the trim-current saturation limit if orbit feedback is running all the time. The skew quadrupole current was varied in 5 equal steps and beam size was measured by pin-hole camera beam profile monitors at every step. Then a polynomial curve fit on measured data was used to find the local extremum. Three possible types of extrema could be found in that way (Fig. 2): 1) extremum located on one of the edges of the range; 2) inside range; and 3) value corresponding to maximim, not minimum, beam size—in this case, sign check of second derivative always followed finding the value .

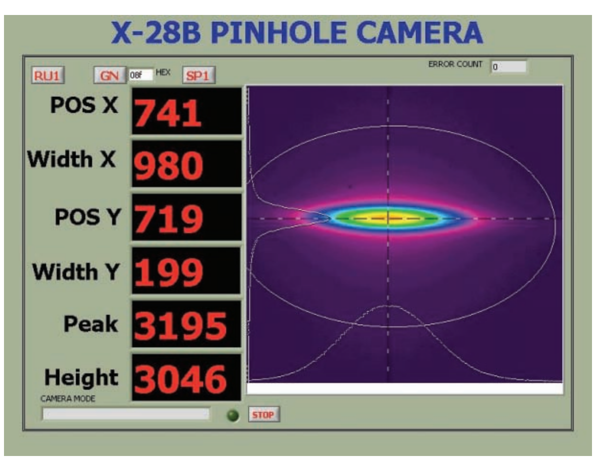

Figure 1: Pin-hole camera monitor located at X28 beamline used for beam profile measurements.

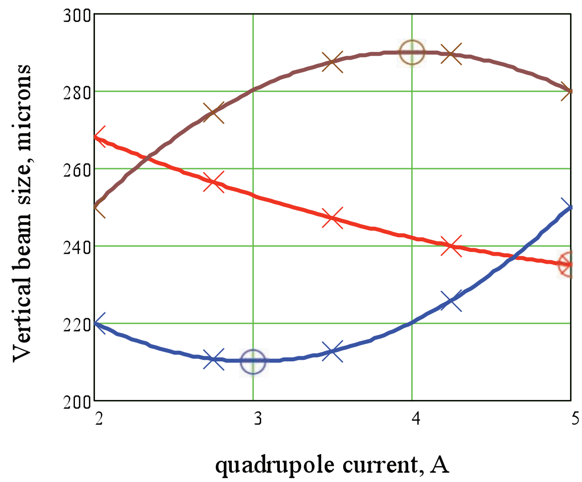

Figure 2: Three different types of local extremum: extremum located on one of the edges of the range (red curve), inside range (blue curve), and extremum value correspond maximum beam size (brown curve)

CORRECTION SCANS

Before starting the correction process, all skew quadrupoles are set to zero. After the first pass, skew quadrupole settings bring vertical beam size down from 570 μm to 425 μm. Each other iteration step changes size value down, and after 9 passes goes below 300 μm. Every beam profile measurement is averaged over 10 seconds, so each quadrupole scan takes about 1 minute, and a whole pass about 20 minutes.

Skew quadrupole scan history is presented in Fig. 3 and vertical beam size changes in Fig. 4. It is noticeable that some quadrupoles reach saturation when making big steps in iterations. During the scan all three types of local extrema were observed but logic in the script code makes it choose the correct value.

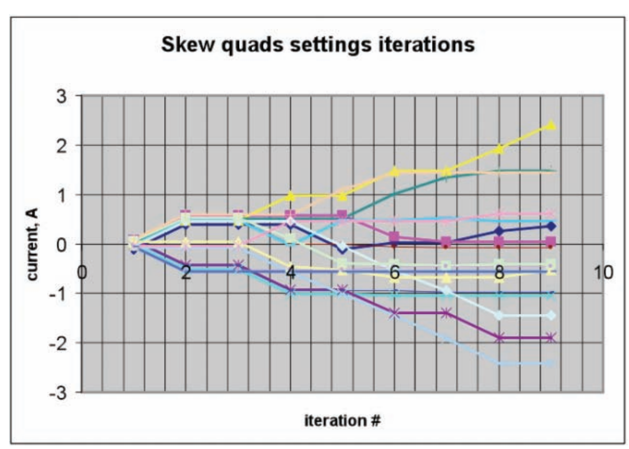

Figure 3: History of skew quadrupole current settings.

SUMMARY

The skew quad iteration method was verified on NSLS X-ray storage ring. After 9 passes coupling was significantly reduced but still exceeds current operational value. Present iteration method needs improvement to speed up convergence of iteration passes—for example, increasing the variation range or finding the optimal skew quad sequence.

ACKNOWLEDGEMENTS

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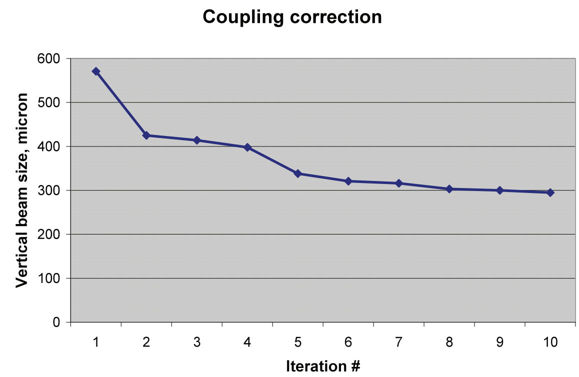

Figure 4: Changes of the vertical beam size after every iteration pass.