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Injection Kickers as Vertical Pingers

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One of the methods of measuring tunes in a hadron storage ring involves inducing a coherent betatron oscillation of one bunch by *pinging* the bunch with a single kick. One or more of the injection kicker modules should provide a sufficient kick for the vertical plane. Coupling through sextupoles may eliminate the necessity for a horizontal pinger.

Each RHIC ring has four injection kicker modules which will provide up to 1.9 mr of vertical bend for a beam whose rigidity is $p/q = 100\mathrm{T}\cdot\mathrm{m}$. Even at stored energies ($p/q = 840\mathrm{T}\cdot\mathrm{m}$) the corresponding kick of 0.23 mr would most likely kick a single bunch out of the ring within one turn. It should be possible to fire the kickers reliably at one quarter of their usual strength. Each module has a separate Blumlein pulser. Although the four pulsers are charged from a single power supply, high voltage switches will allow only selected pulsers to charge, so that just one module may be fired. This factor of 16 in the dynamic range yields kick angles from 0.014 to 0.23 mr at storage energies, and from 0.12 to 1.9 mr at injection.

The effect of a kick θ_k translates into a beam offset given by the formula

$$\delta y(s) = \theta_k \sqrt{\beta_0 \beta(s)}\, \sin \psi(s),$$

where β_0 is the vertical β-function at the kicker, and $\beta(s)$ and $\psi(s)$ are the respective β-function and phase advance at location s. Table 2 lists β_v and relative phase advances for the injection kicker magnets of the Yellow ring.

Table 1. β_v at Kickers

Kicker	β_v [m]	ψ [mr]
yki1	38.3	0.0
yki2	33.1	37.3
yki3	28.4	80.5
yki4	24.3	130.9

Taking kicker **yki4** with the smallest $\beta_0 (= 24.3\mathrm{mr})$, typical maximum deflections around the ring are shown in Table 2 for the extreme values of pings at injection and storage. The $\beta_\mathrm{max} = 50$ m occurs in the arcs, whereas the other values 150, and 1500 m occur in the triplets for $\beta^* = 10$ m and $\beta^* = 1$ m, respectively.

Table 2. Maximum Offsets

	Injection		Storage	
β_max	$\delta y(\theta_k = 0.12\mathrm{mr})$	$\delta y(\theta_k = 1.9\mathrm{mr})$	$\delta y(\theta_k = 0.014\mathrm{mr})$	$\delta y(\theta_k = 0.23\mathrm{mr})$
50 m	4 mm	66 mm	0.5 mm	8 mm
150 m	7 mm	115 mm	0.9 mm	14 mm
1500 m	†23 mm	†360 mm	2.7 mm	44 mm

† $\beta^* = 1$ m is not used at injection.

For stored beam, a single kicker module will probably work quite well. Pinging the beam at injection may be unnecessary, since we can detune the injection damper.