EFFECT OF THE SEXTUPOLE DISTRIBUTION ON THE MOMENTUM APERTURE IN THE SMALL COOLING RING LATTICE AT FERMILAB*

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In the process of cooling and accumulating antiprotons for use in p-$\bar{p}$ collisions, rings must be designed with a large usable momentum aperture, on the order of 3% or larger. Since long straight sections and dispersionless regions are generally required, the sextupole field correction system for "chromatic aberration" is an important aspect of the overall lattice design.

The Fermilab small cooling ring, whose purpose is to demonstrate the feasibility of cooling and accumulating protons (and antiprotons) with electrons, is a particularly simple system. We will use this lattice to show the sensitivity of the momentum aperture to the sextupole correction system distribution.

The lattice is basically a racetrack arrangement with two arcs and two dispersionless straight sections. The arcs are each composed of roughly 2 FODO cells and momentum match regions where the dispersion is brought to zero. There is also a "high dispersion" small straight in each arc. This straight section is used for a kicker needed for injection when phase displacement stacking is employed. The long straight sections are cooling regions where the electron beam can be injected and extracted. In the first Fermilab tests only one electron beam is used, thus destroying the two-fold lattice periodicity. The electron beam has a focusing action on a proton beam and we take the strength to be given by $\Delta\nu \sim 0.1$.

The arcs, as we have said, each have 2 FODO cells. Thus, there are four appropriate locations for sextupoles per superperiod, two having their effect mostly on the vertical chromatic aberrations (SD sextupoles), and two horizontal sextupoles, SF. We treat 2 cases:

A) a single SF and a single SD per superperiod - $\Delta\nu \sim 0.1$.

B) two SF and two SD per superperiod, powered in series - $\Delta\nu \sim 0.1$.

To see the effect of the sextupole distribution, we plot in Fig. 1 the tune as a function of momentum for orbits across a 3% momentum spread. The sextupole strengths are chosen to give a zero linear chromaticity. The corresponding β-function variations are shown in Fig. 2 and the dispersion function variations are given in Fig. 3.

Contrasting A) and B) we can see the dramatic impact of an added sextupole, that is, of smoothing the sextupole distribution. We might also conjecture that if there is the future expectation of lengthening the straight sections and adding more electron beams ("tromboning" the small cooling ring), there should be some thought given to the possibility of a more elaborate sextupole field correction system.

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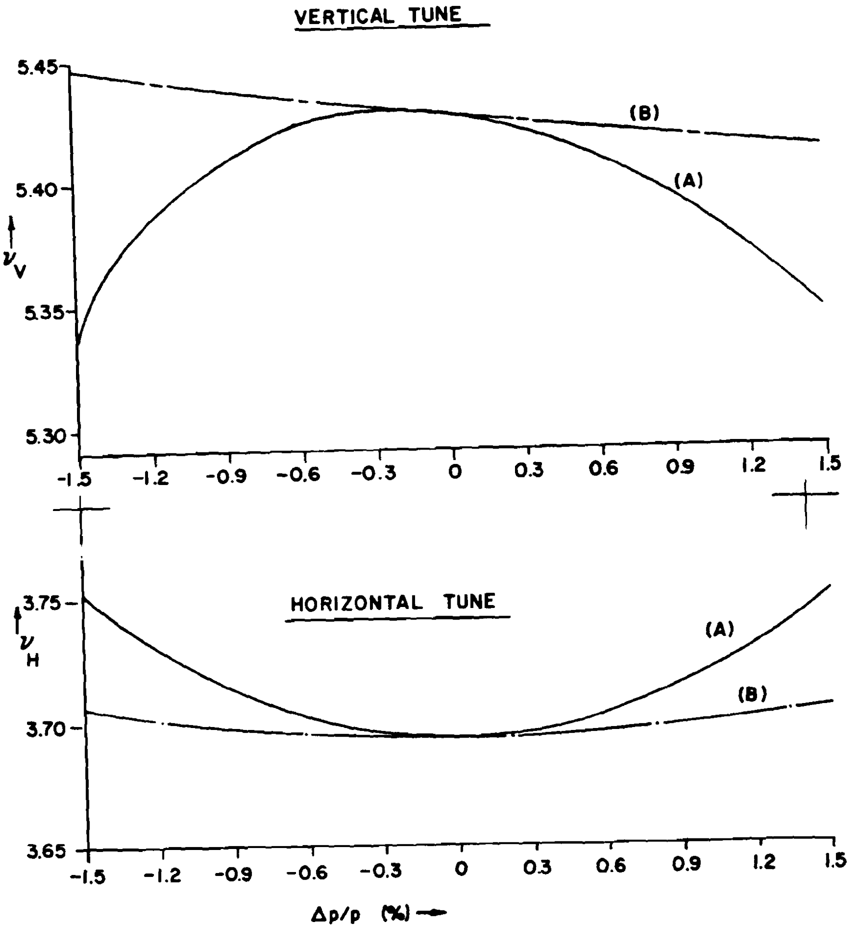

Fig. 1. Tune versus momentum (A) single F and D sextupoles per superperiod; (B) two SF and two SD sextupoles per superperiod (in series).

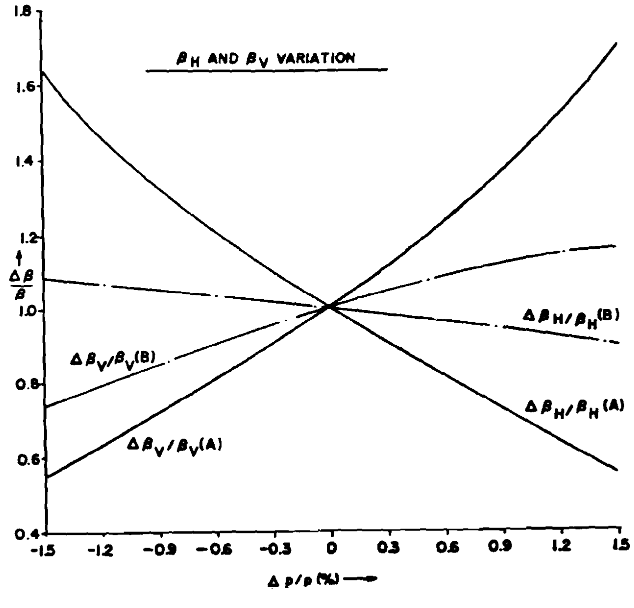

Fig. 2. β function versus momentum (A) single F and D sextupoles per superperiod; (B) two SF and two SD sextupoles per superperiod (in series).

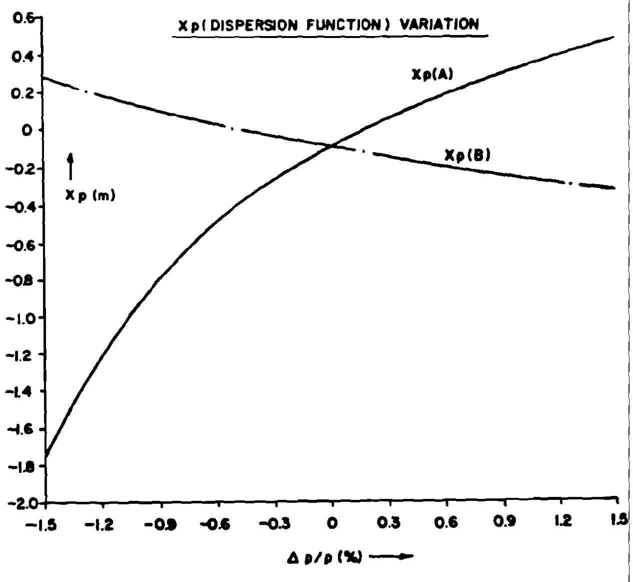

Fig. 3. X_p (Dispersion Function) versus momentum.