Tunability of Betatron Functions in the SPring-8 Storage Ring

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A lattice structure of the SPring-8 storage ring is of double-bend achromat (DBA) type. It is designed so that one can choose a hybrid mode operation or a high-β mode operation. In the hybrid mode operation the horizontal betatron function β_x takes a large value (~20m) and a small value (~1m) alternately in the straight sections (see Fig.1), while in the high-β mode operation β_x takes a large value in all straight sections. In the present report we will clarify the range of tunability of betatron functions in the straight sections where insertion devices are installed. Such information will be useful for synchrotron radiation (SR) users.

Emittance is an important parameter in SR facilities. In the DBA lattice it is determined by the structure of an "arc section" where the dispersion function takes non-zero values. In Fig. 1 This section is indicated by two dotted lines. Since it is desirable that the emittance is fixed during the search of a tunability range, we fix the Twiss parameters α, β, γ in this section. Then, variables are QD1, QF2 and QD3 in high-β side and QD6, QF7 and QD8 in low-β side. We also impose a condition that $\alpha=0$ at the middle of the straight section. (In actual calculations, however, we used a condition of the form $|\alpha|<$tolerance(=0.1).) The results are shown in Fig. 2, where horizontal and vertical betatron functions at the middle of the straight sections are denoted by β_x and β_y, respectively. A small dot represents that this point can be realized if all quadrupole magnets have sufficient maximum strengths, while a large dot represents that this point is in a current scope of operation (achievable without any additional power supplies). We then changed the lattice structure in the arc section and hence the emittance. We performed similar calculations for four different optics and obtained the results shown in Fig. 3. We also performed calculations by breaking the achromat condition in order to reduce necessary strengths of quadrupole magnets. This is because achievable range of β_x and β_y is limited by their maximum strength. The results show that, however, necessary strengths cannot be reduced drastically.

Though all calculations were performed for the SPring-8 storage ring, the same tendency as obtained here will be observed generally in any DBA lattice.

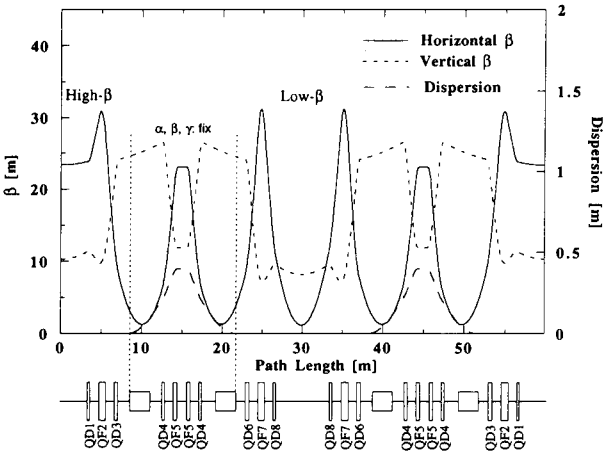

Fig.1. A typical hybrid mode lattice with the emittance of 6.9nmrad.

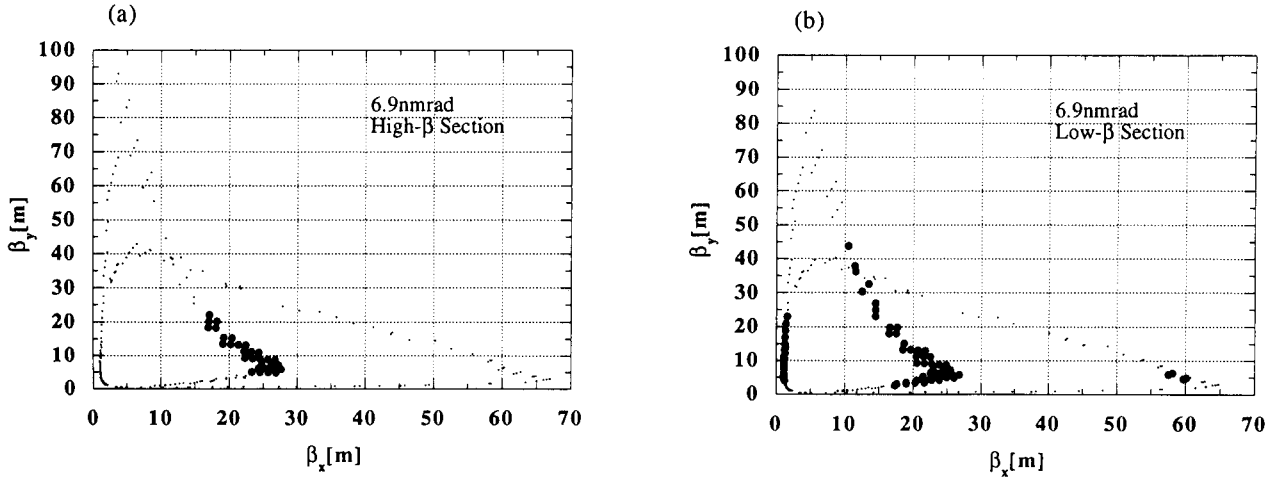

Fig.2. Tunability of betatron functions in the straight sections. (a) high-β section; (b) low-β section.

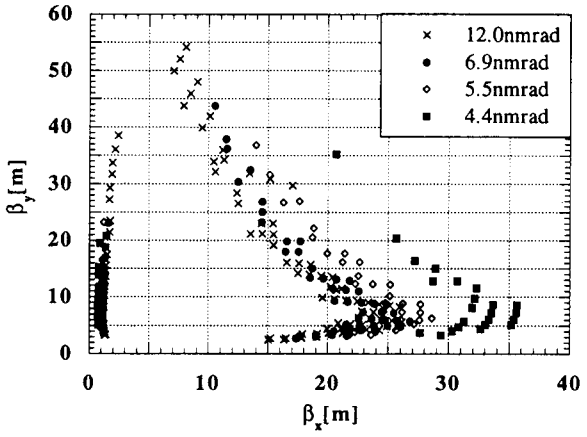

Fig.3. Same as Fig. 2(b) but for four different optics having the emittance of 4.4, 5.5, 6.9 and 12.0 nmrad. Only a meaningful area is displayed.