SPring-8 Beam Performance

Optimization of Nonlinear Optics of the Storage Ring

While the top-up injection has already been indispensable for user experiments at the SPring-8 storage ring, the insertion devices (IDs) have perturbed the stability of the top-up injection. When users change the gaps of the IDs, the betatron tunes are shifted from the initial values. For some IDs, this tune shift is large and when the working point moves closer to a nearby nonlinear resonance, the injection efficiency is largely affected. Here, sextupole magnets are usually utilized to correct the linear chromaticity to ensure stable electron motion, but these nonlinear fields also cause various dynamic phenomena such as the nonlinear resonances mentioned above and the dependence of the betatron tune on the oscillation amplitude. In order to optimize the sextupole magnetic fields to improve the top-up injection efficiency and beam lifetime, we newly built a correction scheme and applied it to the SPring-8 storage ring. In Fig. 1 and Fig. 2, the dependences of the vertical tune on the horizontal amplitude before and after the optimization are respectively shown. The experimentally observed tune shift is in good agreement with the theoretical shift, and it became almost flat against the horizontal amplitude after the optimization. The dependence of the horizontal tune on the horizontal amplitude was also corrected in the same way. By optimizing the sextupole magnetic fields, the injection beam loss observed within 100 turns was suppressed, and the top-up injection efficiency was improved from about 80% to 90%. The momentum acceptance was slightly decreased from 3.3% to 3.1%, but this change is negligible for beam lifetime. The new set of sextupole magnetic fields have been applied in user operation since October 2015.

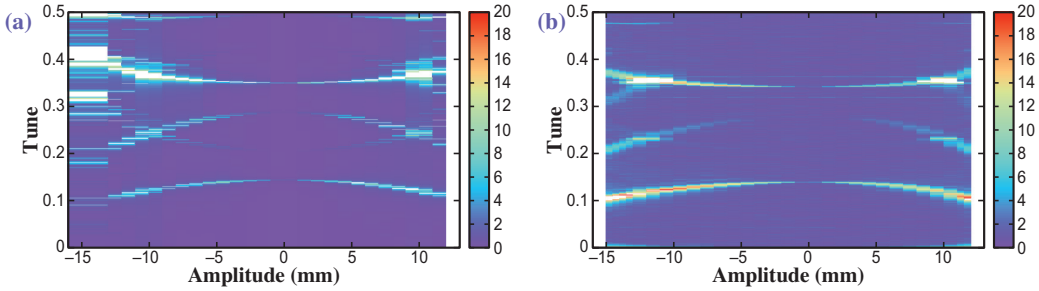

Fig. 1. Dependence of the vertical tune on the horizontal amplitude before optimizing the sextupole magnetic fields. Simulation results **(a)** are compared with experimental data **(b)**.

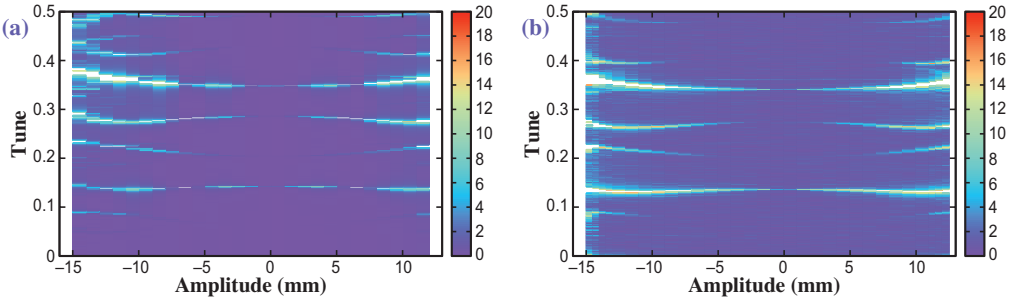

Fig. 2. Same as Fig. 1 but after optimizing the sextupole magnetic fields.

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