BEAM PROFILE MEASUREMENT DURING TOP-UP INJECTION WITH A PULSED SEXTUPOLE MAGNET AT THE PF RING

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In recent synchrotron radiation (SR) sources, it has become mainstream to keep a stored beam current constant with a top-up injection. Suppressing stored beam oscillation during beam injection became important in this injection and a beam injection system with a pulsed sextupole magnet (PSM) was proposed as promising solution [1]. We measure the turn-by-turn profiles of the stored beam following the injection kick by using a fast-gated camera and experimentally confirm that the disturbance to the stored beam in the PSM injection is smaller than that in the pulsed quadrupole magnet (PQM) injection.

The turn-by-turn stored beam profiles were measured by observing the SR emitted from a bending magnet BM27 that is located within the injection bump orbit of the PF-ring [2]. The optical layout of the profile measurement is shown in Fig. 1. The visible light components of the SR are extracted from a vacuum chamber by a water-cooled mirror made of beryllium (Be) and fed to the optical hatch where the fast-gated camera is installed. The distance from the source point in BM27 to the slit is approximately 8 m. A conversion factor from pixels on

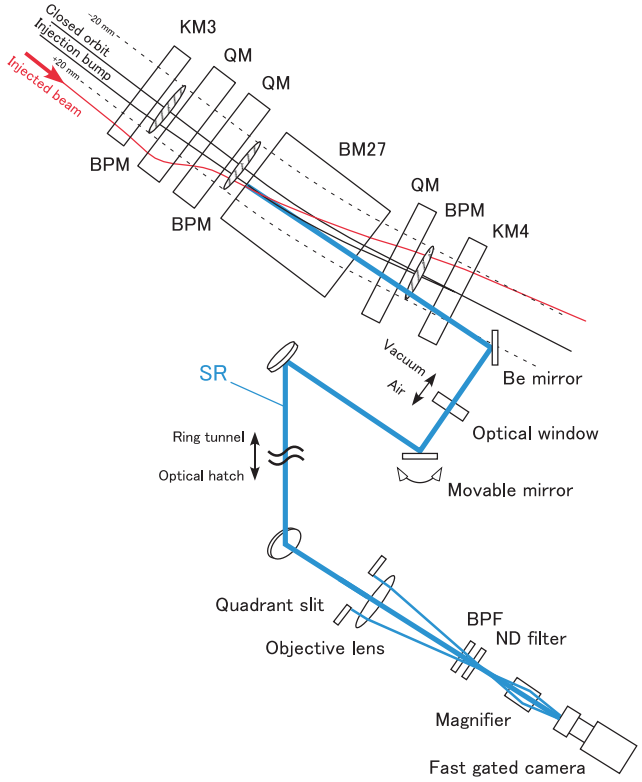

Figure 1: Optical layout of the turn-by-turn profile measurement. Blue bold line corresponds to the SR orbit. The SR source BM27 is located within the injection bump orbit produced by 4 kicker magnets KM1-KM4.

CCD to meters at the source point has been calibrated by using a displacement of the source point associated with an error of the acceleration frequency of the ring.

Before proceeding to experimental observations, we simulated the turn-by-turn profile measurements in the PSM and PQM injections, employing the particle tracking simulation code SAD. The stored beam is represented by 1000 particles with Gaussian distributions in the 6-D phase space. The horizontal emittance and the emittance coupling are assumed to be 35 nmrad and 1%, respectively. Each profile is calculated at the entrance of BM27. The beam injection is initiated at the turn number six. The upper picture is the beam profiles in the PQM injection at the PF-ring, which was simulated by virtually-installing the PQM at the same point as the PSM. The lower picture shows the beam profiles in the PSM injection. Almost no fluctuations in the beam position and the beam profile are observed after the injection. Although there is no dipole oscillation of the stored beam as well as the PSM injection, the modulation of the beam profile is excited by the horizontal kick of the PQM.

The turn-by-turn stored beam profiles measured by a fast-gated camera during the PSM injection are displayed in Fig. 3. All profiles are single-shot images (not integrated) applied a background correction. The experimental results are qualitatively in good agreement with the expectation from the tracking simulation, it has been demonstrated that the PSM injection can realize an ideal top-up injection, which both the stored beam position and profile do not fluctuate at every injection.

References

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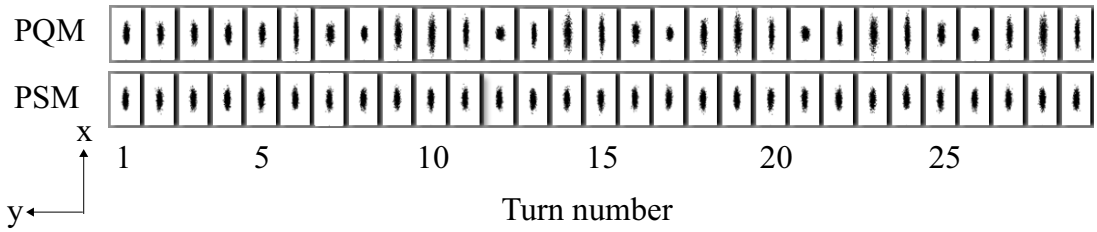

Figure 2: Turn-by-turn stored beam profiles in the kicker, PSM, and PQM injections simulated by SAD code.

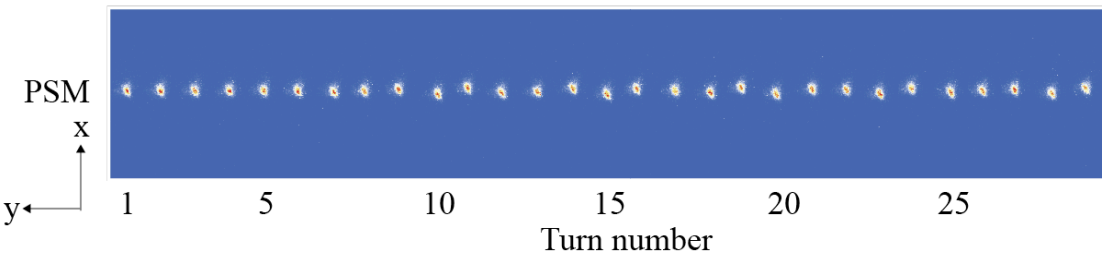

Figure 3: Turn-by-turn stored beam profiles in the PSM injection measured by using a fast-gated camera.