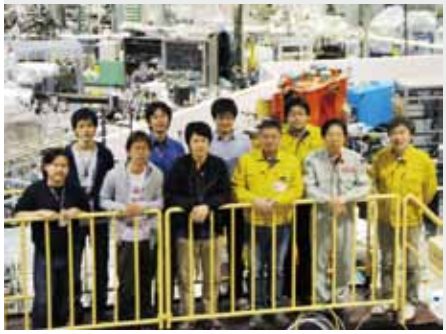
Light Source Developments by Using Relativistic Electron Beams

UVSOR Facility
Division of Advanced Accelerator Research



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This project involves researches and developments on synchrotron light source, free electron laser, beam physics and their related technologies, including application of the light sources.

1. Developments on UVSOR Accelerators

The magnetic lattice of UVSOR was modified in 2012. This was the second major upgrade of the lattice, following the first one in 2003. This time all the bending (dipole) magnets were replaced with newly designed combined function ones. They have specially designed pole shapes and edge shapes as shown in Figure 1, to produce dipole, quadrupole and sextupole fields at the same time. By this modification, the emittance was reduced from 27 nm-rad to around 15 nm-rad, which would results in higher brightness of the synchrotron radiation. The magnetic lattice function changed, as shown in Figure 2. The storage ring was successfully commissioned in July with the new lattice. Fine machine tuning is in progress. After this upgrade, the ring is called UVSOR-III.

Figure 1. New combined function bending magnet (a lower half is shown).

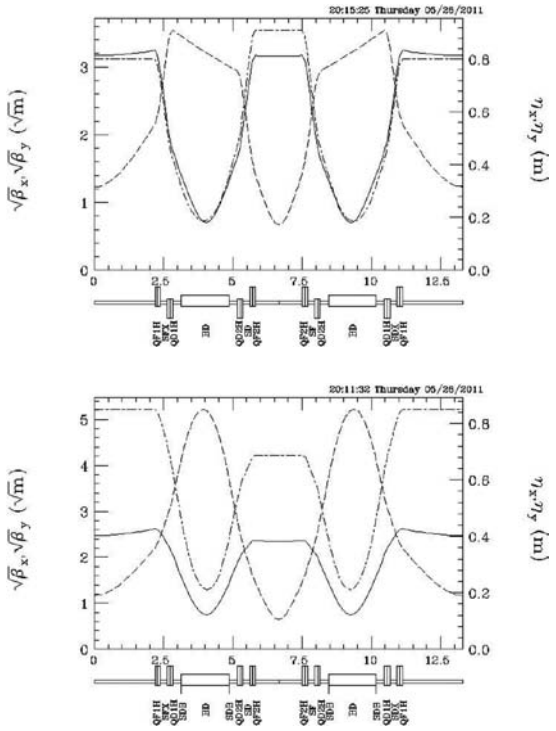

Figure 2. Lattice functions of UVSOR-II (upper) and UVSOR-III (lower). One quadrant of the ring is shown. The emittance is 27nm-rad and ~15nm-rad, respectively.

2. Construction of STXM Beam-Line

A new in-vacuum undulator was constructed and, in May 2012, it was installed at the last straight section in the ring reserved for insertion devices. This is the sixth undulator at UVSOR. It would provide soft X-rays to a scanning transmission X-ray microscope (STXM) beam-line.

Since April in 2012, the STXM beam-line, BL4U, has been constructed. Recently, its construction and installation of the STXM system were finished and their commissioning is due to start in October, 2012. We have been preparing the facilities of the beam-line, such as microscopes for pre-observations, a glove-box, an experimental hutch and infra-structures, for stating the operation in next April.

3. Light Source Developments

We have demonstrated that coherent synchrotron radiation of various properties could be generated in an electron storage ring by using an external laser source.[1–3] This research is supported by the Quantum Beam Technology Program of JST/MEXT. Under this support, a new experimental station has been constructed.[4] A new optical klystron/undulator was installed as shown in Figure 3. The magnetic field properties were verified by observing the spontaneous synchrotron radiation. The upgrade of the laser system was completed. The laser transport line, which was carefully designed as considering the effects of the air fluctuation, was also constructed. Two new beam-lines dedicated to the coherent lights in the VUV range and in the THz range has been almost completed.[5] The generation of coherent synchrotron radiation at the new site was successfully demonstrated. Some applications will be demonstrated soon in this fiscal year.

Figure 3. Experimental ser-up of Coherent Harmonic Generation at UVSOR-II.

A tunable, quasi-monochromatic ultra-short pulse and polarization-variable gamma-ray source is under development, based on a technology called Laser Compton scattering. The laser photons are Compton back-scattered by the high energy electrons and are converted to gamma-rays. The electron beam circulating in the storage ring is very thin in the vertical direction, typically in the order of 10 microns. By injecting laser light from the vertical direction to the beam, it is possible to produce ultra-short, quasi-monochromatic, energy tunable, polarization variable gamma-ray pulses. The energy tunability was successfully demonstrated.[6] An application utilizing the short pulse property was successfully demonstrated.

4. Accelerator Technology Developments

A novel beam injection scheme using a pulse sextupole magnet has been studied, in which the perturbation to the stored beam could be minimized during the injection. This is beneficial to the users experiments in the top-up operation mode. A new pulse sextupole magnet was designed and has been constructed. The field measurement is in progress. This device will be installed in the ring in September 2012.

A turn-by-turn beam position measurement system has been constructed, collaborating with the Equipment Development Center. This system enables to measure the electron beam orbit turn-by-turn just after the injection. It was proved that this device was a powerful tool for the commissioning of the storage ring.

References

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