PRESENT STATUS OF UVSOR

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ABSTRACT

Main feature and the status of UVSOR light source and its surrounding instruments in August 1984 are presented. UVSOR is a 600 MeV (max. 750 MeV) electron storage ring dedicated to synchrotron radiation research mainly in molecular science. It had been constructed since 1981 and was commissioned on 10th November 1983. Maximum current so far is 170 mA. The ring is composed of eight bending sections, and four long and four short straight sections. From one bending section, two outlets of synchrotron radiation with horizontal angle of 80 mrad are available. A wiggler with superconducting magnets and an undulator with permanent magnets have been constructed. Single bunch operation was tried successfully. The connection of monochromators to synchrotron radiation outlets is under way.

INTRODUCTION

UVSOR is a dedicated VUV synchrotron light source[1] for molecular science and related fields. Its construction was started in 1981 and the first beam was accumulated on 10th November 1983. The optical instruments had been constructed since 1980. In this paper, main feature and the status of light source and its surrounding instruments in August 1984 are represented. Correction of design parameters given in previous paper[2] is also given. Detailed descriptions for vacuum system, position monitor and single bunch operation will appear in this proceedings.

The light source is a 600 MeV (max. 750 MeV) storage ring, the injector of which is a 600 MeV synchrotron with a 15 MeV linac. The circumference of the ring is 53.2 m, which is twice as long as that of

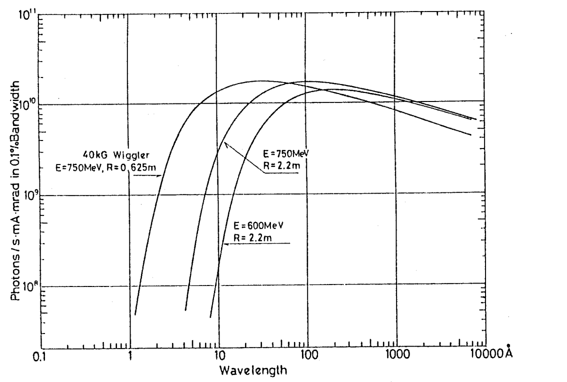

Fig. 1. Intensity distribution of synchrotron radiation in UVSOR.

the synchrotron. The orbit radius in bending magnets of the ring is 2.2 m. In Fig. 1 is shown photon flux distribution from UVSOR. Two curves show photon flux from ordinary bending section at 600 MeV and 750 MeV, and one curve, that from a superconductiong wiggler (40 kgauss) at 750 MeV, which was installed at S_7 straight section. The energy and the radius were chosen so that the photon flux covers the range from fundamental absorption edge to K-edge of light elements such as carbon, nitrogen and oxygen which are included in many molecules. An undulator which emitts quasimonochromatic light above 150 A has been constructed. Far infrared radiation will be utilized at an ordinary bending section.

Fig. 2 shows the plane view of the UVSOR facility. The synchrotron and the storage ring are underground for radiation safety. Electrons of 600 MeV

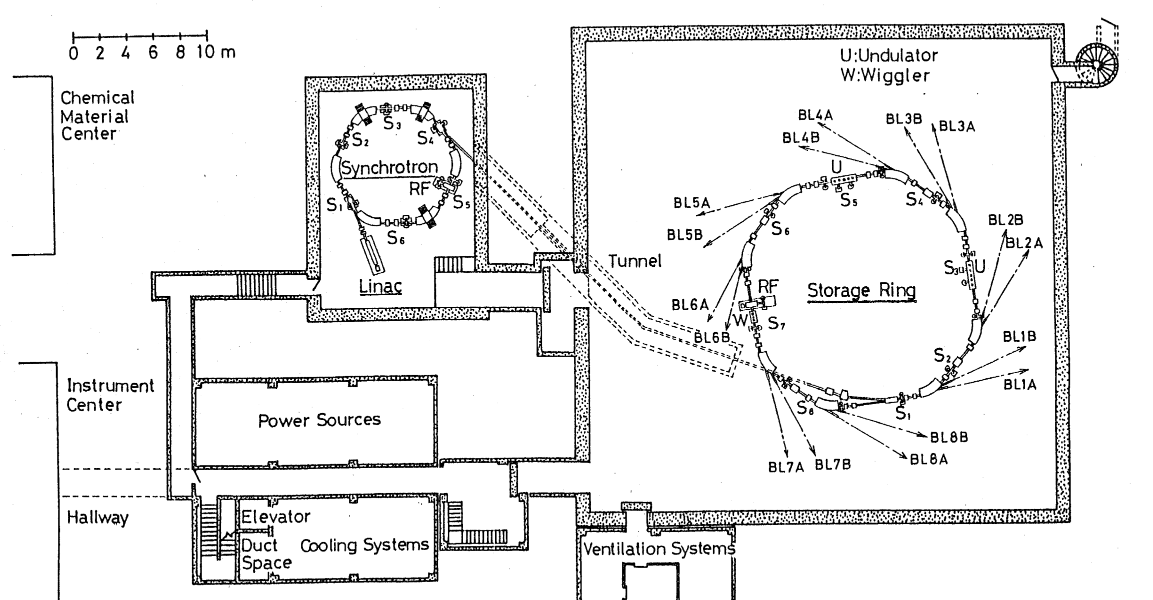

Fig. 2. Plane view of UVSOR facility.

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extracted from the synchrotron are transported under the floor of the storage ring room and injected from the inner side of the ring. Optical instruments are installed around the ring. During the injection period, experimenter should be out of the storage ring room and after the injection, they can reenter the room making measurements. Shield blocks against the radiation due to the decay of stored current will be put up around the ring.

LINAC

The maximum energy of the linac is about 18 MeV by the use of 7 MW klystron. The RF frequency is 2856 MHz. Two pulse widths can be chosen, 1.5 μs for ordinary operation and 5 ns for single bunch operation. Fig. 3 shows the energy distribution of 1.5 μs beam measured by an analyzer magnet inserted between the exit of the linac and an entrance of an inflector of the synchrotron. The energy spread (FWHM) is 1.6 %. The total current is 40 mA. Fig. 4 shows the beam size at the exit of the linac measured by a wire scanned across the beam orbit. The diameter (FWHM) is 4 mm.

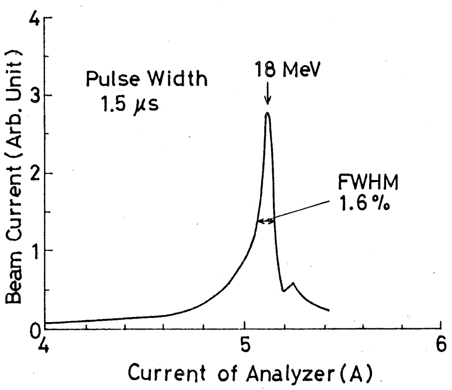


Fig. 3. Energy distribution of the linac beam.

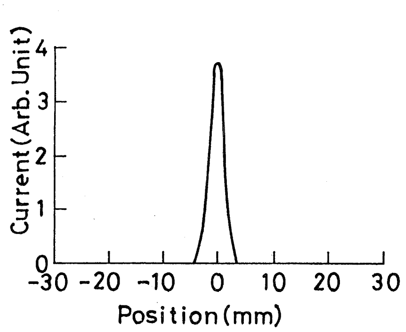


Fig. 4. Position dependence of beam current of the linac at the exit.

SYNCHROTRON

The synchrotron is composed of six bending sections and six straight sections as shown in Fig. 2. At each straight section, a doublet of quadrupoles are installed. An inflector is located at S_1 straight section, three perturbators,[3] at S_1, S_2 and S_6 sections, and a fast kicker and a deflector for extraction, at S_2 and S_4 sections. An RF cavity is installed at S_5 section,[4] the resonance frequency of which is 90.12 MHz. Electrostatic position monitors are set at each midpoint of quadrupole doublet.[4] Current monitors with a ferrite core are situated at S_2 and S_3 sections. Fig. 5 shows the picture of the synchrotron assembled. The gap and the width of the bending magnets are finally 4.8 cm and 18 cm, respectively.[5]

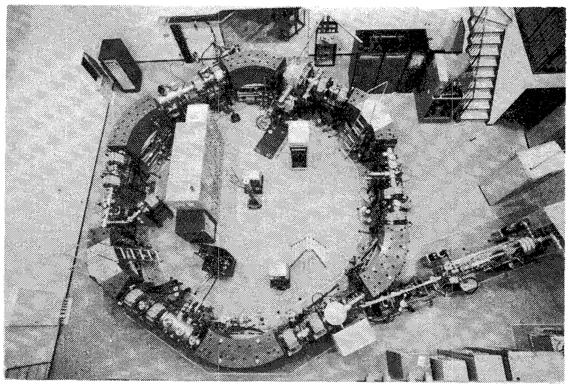


Fig. 5. The injector synchrotron.

In order to make tracking easy, the excitation of magnets is made as follows. The quadrupole has a main and a sub coils. The main coils of the quadrupoles and the coils of the bending magnets are connected in series. Greater part of required magnetomotive force in the quadrupoles is obtained with the current flowing in the main coils. The deviation of current dependence of magnetic field in quadrupole from that in bending magnet is compensated by adjusting the current of sub coils. The main coils are excited by a 24 phase controlled thyristor rectifier backed up with a transistor chopper and sub coils are excited by two transistor choppers. All power supplies satisfy the stability requirement of the current of 4×10^{-3} (peak to peak) in whole excitation range. Present operation point (Q_x, Q_z) is (2.20, 1.43).

Fig. 6 shows the current wave forms of succeeding two pulses during the acceleration time of 150 ms observed by the core monitor. At higher current case, 30 mA is stacked with multi-turn injection, but 15 mA is accelerated upto 600 MeV. The cross section of the 600 MeV beam is small enough to pass the aperture of the deflector (5 mm x 5 mm), due to the adiabatic and the radiation damping. Three or four bunches are extracted in one pulse in ordinary operation.

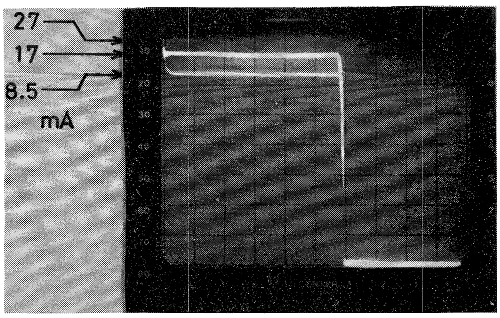
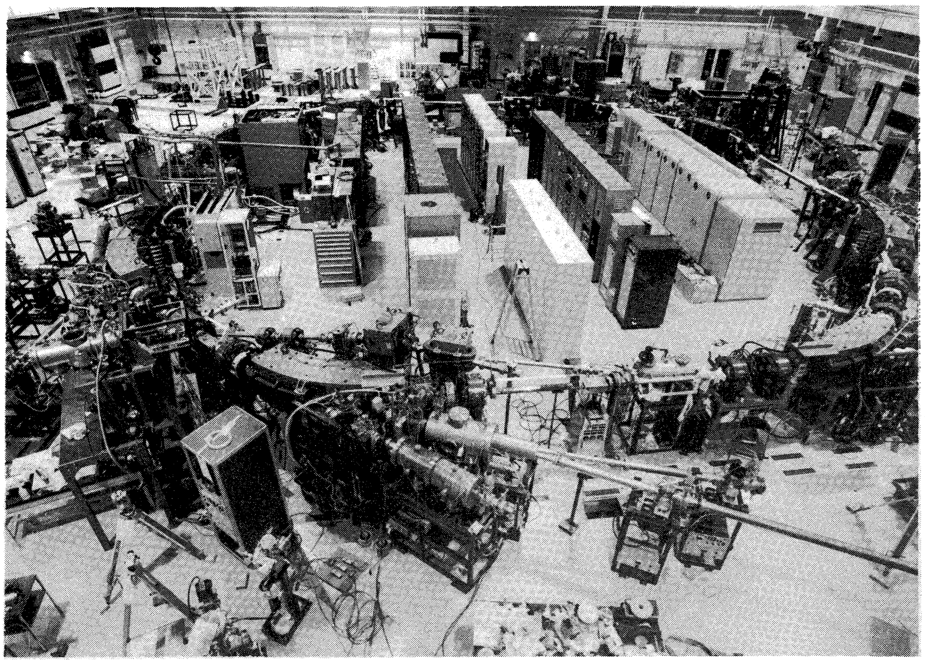


Fig. 6. Current wave forms during the acceleration.

STORAGE RING

The storage ring is composed of eight bending sections, and four long and four short straight sections as shown in Fig. 2. At each long straight section, two doublets of quadupoles and two steering magnets (vertical) are installed, and at the midpoint of the down-stream doublet, a skew quadrupole is located. At each short straight section, a triplet of quadrupoles and that of sextupoles are installed. An inflector is located at S_1 straight section, three perturbators, at S_1, S_2 and S_8 sections. An undulator under magnetic field measurement will be installed at S_3 section. An RF cavity excited with the same



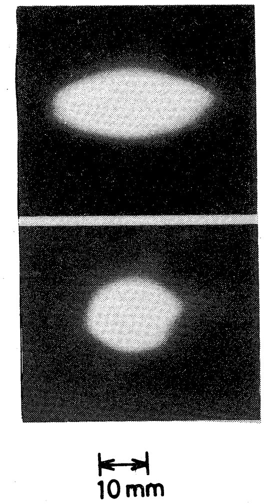


Fig. 9. Beam profiles.

Fig. 7. The UVSOR storage ring.

frequency as the synchrotron's one and the three poles wiggler were set at S_7 section. A DCCT and a core monitor are located at S_1 and S_4 sections. Button monitors are attached at up- and down-stream of bending sections. The bending magnet has a correction coil. The bending and the quadrupole magnets of the ring have the same cross sections as those of the synchrotron. The field index of the bending magnet is 0. Fig. 7 shows the picture of the storage ring.

Fig. 8 shows feature of accumulation and damping of the beam observed at the end of February 1984. The current was measured by a DCCT at S_1 section. Injection rate was three times per second. A current of 160 mA was accumulated within 10 minutes. The lifetime in which the stored current of 100 mA decayed till 1/e was 20 minutes. The short lifetime seems due to the poor vacuum of 1×10^{-8} Torr with stored beam of 100 mA. The vacuum will be improved in near future with baking and argon discharge cleaning. Present operating point (Q_x, Q_z) is (3.27, 2.80). The betatron number shifts with the increase of stored current. The correction of the closed orbit distortion was made in July. Single bunch operation was performed with a current of 1 mA.

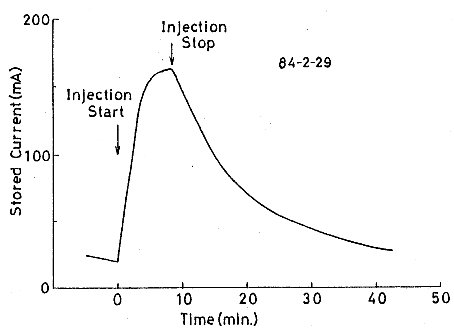


Fig. 8. Accumulation and damping of the beam.

Fig. 9 shows two examples of profile of stored beam at different operating condition at the beam current of 10 mA. The profiles change with the change in operating condition and the amount of stored current. Profiles in Fig. 9 look like a ellipsoid and a circle. These pictures were taken by the use of TV camera. The design values of 2 σ_x and 2 σ_z are 0.6 mm and 0.4 mm. At present it is difficult to estimate these values quantitatively from the picture given in Fig. 9, however these values seem somewhat larger than the design value.

BEAM LINES AND MONOCHROMATORS

From one bending section, two outlets of synchrotron radiation are available. Through an outlet, synchrotron radiation with horizontal angle of 80 mrad can pass. A front end of beam lines is composed of a beam shutter, a tightly closing valve and a fast closing valve with finite conductance, which protect the vacuum of the ring against accidental leakage from optical systems. Closing time of the fast closing valve is 10 ms. Acoustic delay lines which can delay the speed of the leakage, are inserted just before entrance slits of monochromators, in the case that the distance between the front end and the entrance slit is not longer than 10 m.

At present, three 1 m Seya-Namioka monochromators are being connected to the beam lines, BL2A, BL2B2 and BL7B. A 3 m normal incidence monochromator is being connected to BL3B, a plane grating monochromator (PGM), to BL8B2 and a double crystal monochromator, to BL7A. The beam line BL6A will serve as a far infrared port and another PGM port.

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