Insertion Devices

The general strategy for the SPring-8 insertion device (ID) program is; (1) Hard X-rays of several 10 keV should be obtained by the first harmonic of undulator radiation since the coherence property of the undulator radiation is very important. (2) Exotic devices, helical, elliptical, vertical and figure-8 undulators, should be positively introduced. According to the above strategy, the construction of various IDs has been scheduled. At present (March 2000), twenty IDs have been operated successfully as shown in Table 1. Fifteen of these IDs are of the in-vacuum type, which is the most important feature of the ID program at SPring-8. From April 1999 to March 2000, we installed four insertion devices, two standard in-vacuum undulators for BL12 and BL35, an in-vacuum helical undulator for BL40 and a revolver undulator for BL15. In this report, a brief description is presented of the latter two devices. Fig. 1 shows the calculated spectral brilliances obtained from these two devices in comparison with those obtained from a standard in-vacuum X-ray undulator.

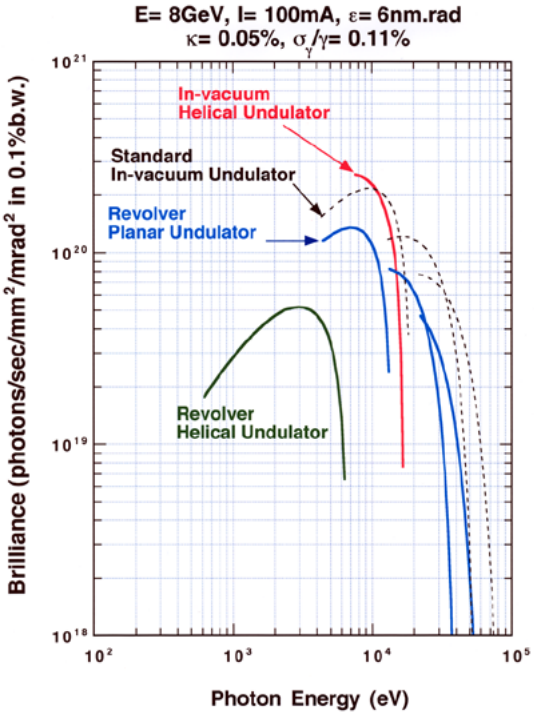

Fig. 1. Calculated spectral brilliances obtained from the in-vacuum helical undulator and the revolver (planar and helical undulators) in comparison with that of the standard in-vacuum X-ray undulator.

1. In-vacuum Helical Undulator

An in-vacuum helical undulator has been developed for the beamline, BL40, called the high-flux beamline where only the high photon flux of radiation with a moderate energy resolution is desired. Since this beamline has no monochromator, the intrinsic bandwidth of the undulator radiation should be narrower than 2 % and the components for the higher harmonics should be as small as possible. It is well known that the on-axis radiation from helical undulators has no higher harmonic in principle. Therefore, we can obtain a quasi-monochromatic X-ray by using only a spatial filter. The period length of the undulator is 36 mm, the number of periods 125. The maximum field of 0.36 tesla is obtained at the gap

Table. 1 Insertion devices in operation (at March 31, 2000)

	λ_u mm	N	G_{min} mm	B_{max} T	K_{max}	Pol	n=1 keV	n=3 keV	n=5 keV	Beamline
Standard In-Vac X-ray U	32	140	8	0.84	2.5	hor	4.8-18.5	14.5-51	24-80	BL09,10,11,12,29 35,39,41,44,47
In-Vac Hybrid U	24	187	5	1.1	2.6	hor	6.6-25	20-70	34-100	BL46
In-Vac Figure-8 U	26 52	172 86	5 5	1.05 0.34	2.6 1.7	hor ver	4.1-20			BL24
In-Vac Helical U	36	125	7	0.33	1.1	cir	7.6-16.5			BL40
In-Vac Tandem Vertical U	37	2×37	8	0.5	1.7	ver	6.6-16	20-40	33-70	BL45
In-Vac U (Industrial Appl)	40	112	15	0.59	2.2	hor	4.4-14.5	13.3-40	22-60	BL16
Revolver	44 92	102 48	20 20	0.5 0.36	2.05 3.1	hor cir	4.5-13.5 0.63-6	13.5-35	22-60	BL15
SX Figure-8 U	100 200	44 22	30	0.74 0.23	6.9 4.3	hor cir	0.17-5.8			BL27
SX Helical U	120	2×12	30	0.41	4.6	cir	0.22-5			BL25
SX Helical U	120	16				cir	0.3-5			BL23
Elliptical Wiggler	120	37	20	1.17 0.11	13.1 1.24	cir				BL08

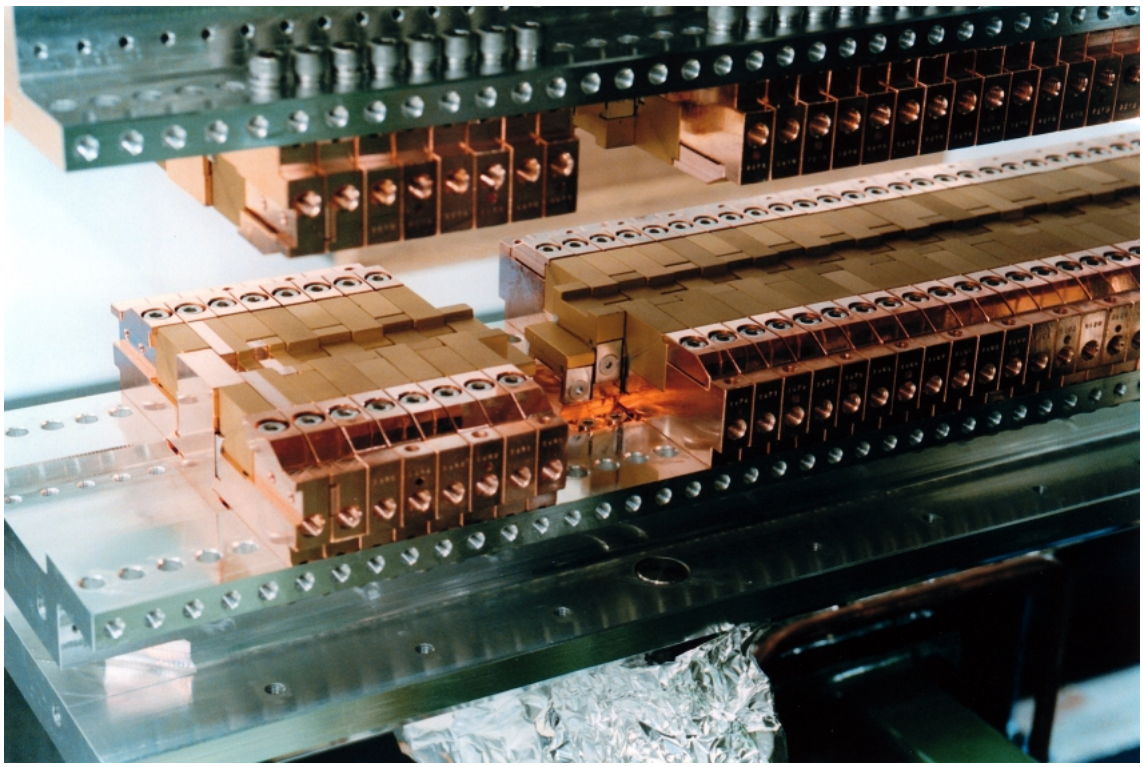

Fig. 3. Magnet arrays of the in-vacuum helical undulator under construction.

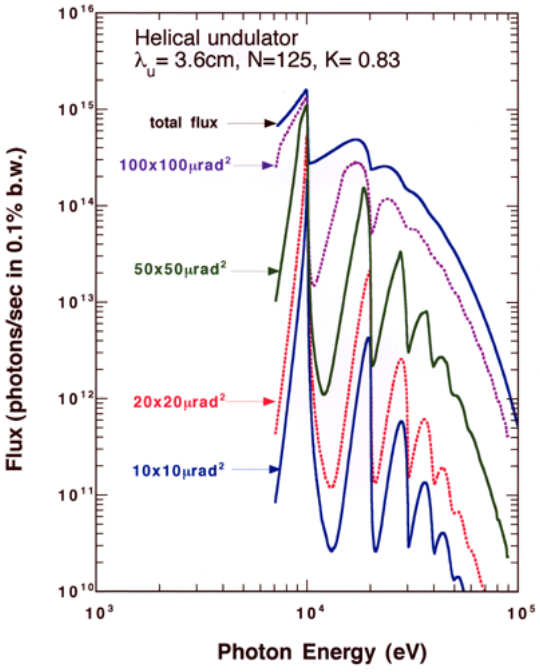

Fig. 2. Calculated spectral flux from the in-vacuum helical undulator for various slit apertures.

of 7 mm. The available photon energy ranges from 7.6 keV to 16 keV as shown in Fig. 1. Figure 2 shows the effect of the XY slit system on the profile of the spectral flux. By narrowing the aperture of the slit system, the fundamental is found to become sharper with the capability of suppressing higher harmonics with greater efficiency. Finally, the relative bandwidth

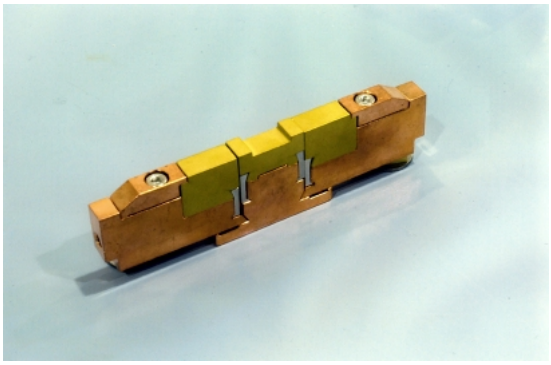

Fig. 4. Magnet unit for the in-vacuum helical undulator.

is obtained as 1.6 %, which is small enough to make small-angle scattering experiments in the attached beamline. As a matter of course, the radiation is polarized circularly, which is not important for the purpose of the present beamline. Therefore, the device has no switching system of helicity. Figure 3 shows magnet arrays for the undulator under construction. Figure 4 shows a magnet unit composed of three permanent magnet blocks. The central magnet block generates a vertical field, while the outer two blocks generate a horizontal field.

2. Revolver

A revolver has been developed for the beamline, BL15, which is a contract beamline belonging to the National Institute for Research in Inorganic Materials. Since a wide photon energy range from soft X-ray to

Fig. 5. Complete revolver just prior to installation into the SPring-8 ring.

hard X-ray is required, this revolver has two undulators, a planar undulator for the hard X-ray region and a helical undulator for the soft X-ray region. The period length of the planar/helical undulator is 44/92 mm, the number of periods 102/48. Figure 5 shows the complete revolver just prior to installation into the SPring-8 ring. To minimize flexion by magnetic force, each rotatable beam is supported by six bearing systems as shown in Fig. 5. The available photon energy ranges from 0.63/ keV to 6/ keV for the helical/planar undulator (Fig. 1).