

8. SYNCHROTRON CRYSTALLOGRAPHY

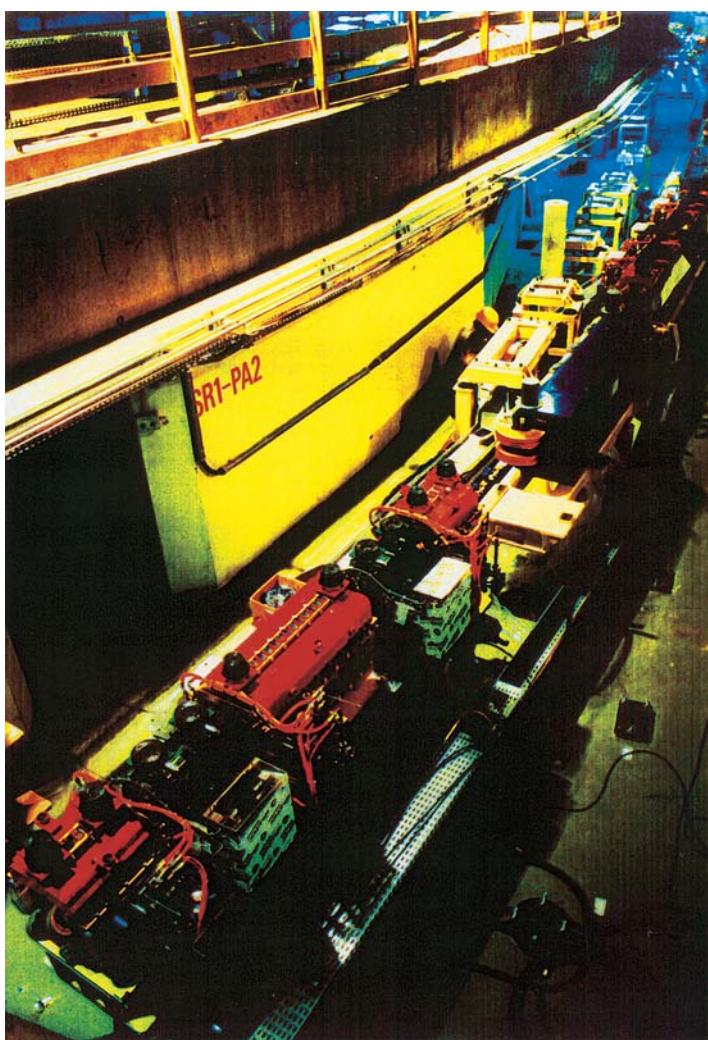


Fig. 8.1.2.3. The ring tunnel and part of the machine lattice at the ESRF, Grenoble, France.

sets a sample acceptance requirement to be met by the X-ray beam and machine emittance. A machine with an emittance that matches the acceptance of the sample greatly assists the simplicity and performance of the beamline optics (mirror and/or monochromator) design. The common beamline optics schemes are shown in Fig. 8.1.4.1.

In addition to the focal spot area and convergence angles, it is necessary to provide the appropriate spectral characteristics. In monochromatic applications, involving the rotating-crystal diffraction geometry, for example, a particular wavelength, λ , and narrow spectral bandwidth, $\delta\lambda/\lambda$, are used. Fig. 8.1.4.2(a) shows an example of a monochromatic oscillation diffraction photograph from a rhinovirus crystal as an example recorded at CHESS, Cornell. Fig. 8.1.4.2(b) shows the prediction of a white-beam broadband Laue diffraction pattern from a protein crystal recorded at the SRS wiggler, Daresbury, colour-coded for multiplicity.

Table 8.1.4.1 lists the internet addresses of the SR facilities worldwide that currently have macromolecular beamlines.

8.1.5. Evolution of SR machines and experiments

8.1.5.1. First-generation SR machines

The so-called first generation of SR machines were those which were parasitic on high-energy physics operations, such as DESY in Hamburg, SPEAR in Stanford, NINA in Daresbury and VEPP in

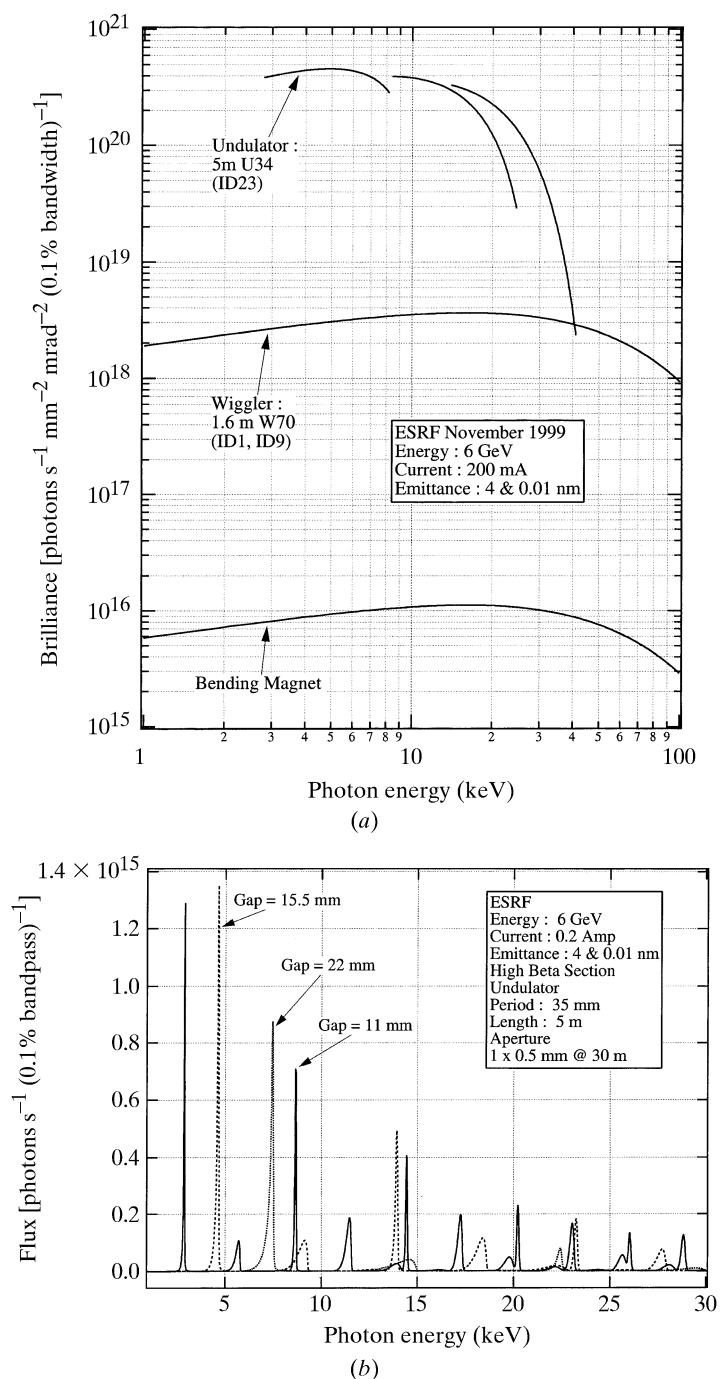


Fig. 8.1.2.4. SR spectra. (a) Brilliances of different SR source types (undulator, multipole wiggler and bending magnet) as exemplified by such sources at the ESRF. For the undulator, the tuning range (*i.e.* as the magnet gap is changed) is indicated. (b) Undulator-emitted spectra at the ESRF, shown as photon fluxes through a 1×0.5 mm aperture at 30 m, for three different gaps, *i.e.* widening the gap shifts the emitted fundamental and associated harmonics in each case to higher photon energies. Kindly provided by Dr Pascal Elleaume, ESRF, Grenoble, France.

Novosibirsk. These machines had high fluxes into the X-ray range and enabled pioneering experiments. Parratt (1959) discussed the use of the CESR (Cornell Electron Storage Ring) for X-ray diffraction and spectroscopy in a very perceptive paper. Cauchois *et al.* (1963) conducted *L*-edge absorption spectroscopy at Frascati and were the first to diffract SR with a crystal (quartz). The opening experimental work in the area of biological diffraction was by Rosenbaum *et al.* (1971). In protein crystallography, multiple-