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EUROPEAN SYNCHROTRON RADIATION FACILITY

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European Synchrotron Radiation Facility (ESRF) is the first representant of a new (the third) generation of synchrotron radiation sources delivering high brilliance radiation in the hard X-rays. The *first generation* sources were initially built as part of high-energy physics programs and used as synchrotron radiation sources in a parasitic mode. Some are still used this way, some are operated for both programs in a time-sharing mode while others have been totally converted into dedicated synchrotron radiation sources. The *second generation* sources are those which were exclusively designed as dedicated synchrotron radiation sources. They have emittances in the range of 100 nm rad. The main radiation sources are bending magnets, a few insertion devices may have been added. The *third generation* sources finally have a lower emittance (< 20 nm rad) and many long straight sections for a maximum of insertion devices.

In the following we give a short review of the *history of the ESRF*:

13 September 1976	1st meeting of a working group on "Synchrotron Radiation" created by the European Science Foundation (ESF) Chairman: H. Maier-Leibnitz
December 1977	Black Book
May 1979	Blue Book (Ed. Y. Farge)
December 1982	Yellow Book (Ed. J. Als-Nielsen)
October 1984	Green Book (Eds. B. Buras, S. Tazzari)
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April 1985	Decision on the site: Grenoble
June 1985	1st meeting of the provisional ESRF Council
December 1985	Memorandum of Understanding concerning the Preparatory Phase of the ESRF: France, Germany, Italy, U.K., Spain

April 1986	Start of work of the ESRF team
January–June 1987	1st prolongation of the Preparatory Phase
February 1987	Red Book (Foundation Phase Report) submitted to the Council
July–December 1987	2nd prolongation of the Preparatory Phase
December 1987	Protocol: France, Germany, Italy, U.K., Spain, Switzerland, and 4 Nordic countries (Denmark, Finland, Norway, Sweden)
January 1988	Start of construction
16 December 1988	Signing of Convention, Statutes and Final Act by France, Germany, Italy, U.K., Spain, Switzerland, Belgium and 4 Nordic countries (Denmark, Finland, Norway, Sweden)
February–September 1989	Execution of building construction contract A: Excavation, drainage and sewers
1 December 1989	Signing of building construction contract B: Machine utility buildings, storage ring tunnel, experimental hall, technical utility buildings
April 1990	Start of building construction; 60% of equipment for the accelerator ordered
November 1990	Start of installation of the Booster Synchrotron
12 November 1990	Foundation of a consortium BENESYNC aiming at the accession of the Netherlands to ESRF in the framework of a consortium with Belgium which was already contracting party of ESRF
21 December 1990	Signing of building construction contract C: central building (for laboratories and offices), joint ESRF/ILL building, landscaping
January 1991	Delivery of preinjector (linear accelerator); Experimental confirmation (by an ESRF team in collaboration with NSLS, Brookhaven) of the potential of cryo-cooled silicon single crystals to preserve the high brilliance of ESRF's X-ray beams
16 May 1991	First electron beam in the preinjector
2 September 1991	First electron beam (200 MeV) in the Booster Synchrotron
12 November 1991	Acceleration to 6 GeV
9 December 1991	Accession of the Netherlands to the ESRF Convention The list of the Contracting Parties of the ESRF and their financial contributions to the construction/ /operation costs (in%) now reads as follows:

	France (33/27.5)
	Germany (23/25.5)
	Italy (14/15)
	United Kingdom (12/14)
	BENESYNC (Belgium, The Netherlands) (4/4)
	NORDSYNC (Denmark, Finland, Norway, Sweden) (4/4)
	Spain (4/4)
	Switzerland (4/4)
28 February 1992	First electrons circulating in the storage ring
June 1992	6 GeV (target value achieved);
	100 mA in multi-bunch mode (target value achieved);
	3 mA in single-bunch mode (target value: 7.5 mA);
	2 hours lifetime at 100 mA (target value: 10 hours);
	8 nm rad emittance at low intensity (target value: 7 nm rad for all intensities)
3 July, 1992	First X-rays from an undulator in the experimentall hall

The commissioning period of the source will finish before the end of 1992, i.e. 6 months earlier than initially foreseen in the Foundation Phase Report (1987).

The beamline program foresees *30 ESRF-Funded Beamlines.* The main characteristics of the first 20 beamlines are given in the following Table. For a first set of (at least) 7 beamlines the commissioning period will start in 1993, users operation is foreseen to start in 1994.

TABLE

ESRF-Funded Beamlines.

	Beamline	Scientific goals	Source
1.	Microfocus	Microdiffraction; Small-angle scattering; High pressure	Undulator 0.8–3.0 Å
2.	Multipole wiggler/ Materials science	Small molecule crystallography; Magnetic scattering	Wiggler 4–60 keV
3.	Multipole wiggler White beam	Laue protein crystallography; High pressure ED; Monochromatic option	Wiggler 4–60 keV
4.	High brilliance	Real time small-angle scattering; Monochromatic macromolecular crystallography	Undulator λ tunable around 1 Å
5.	High energy X-ray scattering	Gamma-ray diffraction; Small-angle scattering; Compton scattering	Wavelength shifter
6.	Circular polarization	Dichroism in EXAFS, SEXAFS; Spin-dependent photoemission; Microscopy at 2.5 keV	Helical undulator $E \leq 4$ keV

7.	Surface diffraction	Surface structural studies; Phase transitions; Growth mechanisms; Liquid surface diffraction	Undulator $K_{max} = 1.85$
8.	Dispersive EXAFS	Time-resolved structural studies	Wiggler, or tapered undulator
9.	Undulator "open" beamline	Multiple experimental station for test experiments	Undulator
10.	Bending magnet "open" beamline	Test experiments	Bending magnet
11.	Mössbauer/ High resolution inelastic	Nuclear Bragg scattering; High resolution (5–10 meV) inelastic scattering at 0–5 eV energy transfer; Electronic and vibrational excitations	Undulator ~ 14 keV
12.	Asymmetric wiggler beamline	Magnetic scattering	Asymmetric wiggler
13.	Surface science	SEXAFS and standing waves techniques	Undulator
14.	High-energy wiggler	Microtomography; possibly Angiography	Wiggler
15.	Powder diffraction	Powder diffraction for structure determination	Bending magnet; later undulator
16.	Wiggler long beamline (75 m)	Topography (possibly second Laue station)	Multipole wiggler
17.	Anomalous scattering	Anomalous scattering in materials science	Undulator 0.4–3 Å
18.	EXAFS	2 EXAFS stations	Bending magnet
19.	Multiple wavelength anomalous diffraction	Multiple wavelength anomalous diffraction	Bending magnet
20.	Monochromatic macromolecular crystallography	Macromolecular crystallography	Undulator

Besides the 30 ESRF-Funded beamlines, mostly on insertion devices, there will be a number of beamlines on bending magnets, which are financed and operated by Collaborating Research Groups (CRG) from the member countries under special arrangement with ESRF.