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Measurement of the absolute energy and energy spread of the ESRF electron beam using undulator radiation

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Two simple methods of characterization of the energy and energy spread of the electron beam have been developed at the ESRF. Both are based on the analysis of the x-ray spectrum from an undulator.

The first allows the absolute energy of the electrons to be determined. It is based on the dependence between the harmonics' wavelengths and the electron beam energy. The x-ray beam is monochromatized at 21 keV by a silicon crystal in backscattering geometry. By adjusting the magnetic gap, one makes the undulator third harmonic coincide with the energy selected by the crystal. The electron beam energy is deduced from the gap value and the knowledge of the undulator period and photon wavelength. The main errors come from the uncertainties regarding the undulator parameters (magnetic field and period). The effects of the uncertainties in the magnetic field are minimized by working at low field (K=0.37). The accuracy currently obtained is better than 10^{-3}.

The energy spread measurement is performed by a second method which is based on the change in the shape of the harmonics' profile with energy spread. It is deduced from the measured ratio between the height of the seventh harmonic peak at 29 keV and that of the secondary maximum. The measured low current energy spread is 1.1×10^{-3} +/- 20%. It increases with the single bunch current due to turbulent bunch lengthening.