

ID16A - Nano-imaging Beamline

The beamline is part of the ESRF Upgrade project UPBL4 NINA. The 185 m long beamline provides nano-focused beams for analytical imaging. The nano-imaging beamline addresses problems in biology, biomedicine and nano-technology using X-ray fluorescence microscopy and nano-tomography. It is optimised for ultimate hard X-ray focusing of a beam with a large energy bandwidth at specific energies (17 keV or 33.6 keV). Cryogenic sample preservation is available for 2D and 3D imaging. More information on the beamline can be found here: <http://www.esrf.eu/UsersAndScience/Experiments/XNP/ID16A>

The main publication on the beamline nanofocusing performance is [1]. The simulations shown in the school are based on this configuration.

Magnetic lattice

The tables below are compiled from [2, 3].

Table 1: Main parameters of the present (ESRF) and future (ESRF-EBS) storage rings.

	ESRF	ESRF-EBS
Lattice type [†] :	DBA	HMBA
Circumference [m]:	844.930	843.979
Beam energy [GeV]:	6.04	6.00
Beam current [mA]:	200	200
Natural emittance [pm·rad]:	4000	147
Energy spread [%]:	0.0011	0.00093

[†] DBA stands for double bend achromat and HMBA for hybrid multi-bend achromat.

Table 2: Electron beam parameters for the low- β straight sections of the ESRF and the ESRF-EBS.

	ESRF (high-β)	ESRF-EBS
σ_e horizontal [μm]:	410.3	30.3
σ'_e horizontal [μrad]:	10.3	4.4
σ_e vertical [μm]:	3.4	3.6
σ'_e vertical [μrad]:	1.2	1.4

r.m.s. values.

U18.3 - Undulator

Table 3: U18.3 undulator main parameters.

Magnetic period (λ_u) [mm]:	18.3	
Number of periods (N):	77	
ID length (L) [m]:	1.4091	
Harmonic used:	1 st	
	ESRF	ESRF-EBS
Magnetic field (B) [T] [†] :	0.25943	0.24065
Deflection parameter (K) [†] :	0.44510	0.41121
Single electron X-ray source size (σ_u) [μm] ^{†‡} :	2.1959	
Single electron X-ray source divergence (σ'_u) [μrad] ^{†‡} :	4.9315	

[†] values given for E=17.225 keV; [‡] r.m.s. values.

Table 4: Photon source sizes and divergences at the centre of the U18.3 undulator for the electron beam parameters at the low- β straight sections of the ESRF and the ESRF-EBS (tables 2 and 3) for E=17.225 keV.

	ESRF (low-β)	ESRF-EBS
Σ horizontal [μm]:	410.31	30.38
Σ' horizontal [μrad]:	11.42	6.61
Σ vertical [μm]:	4.05	4.22
Σ' vertical [μrad]:	5.07	5.13

r.m.s. values.

Optical setup

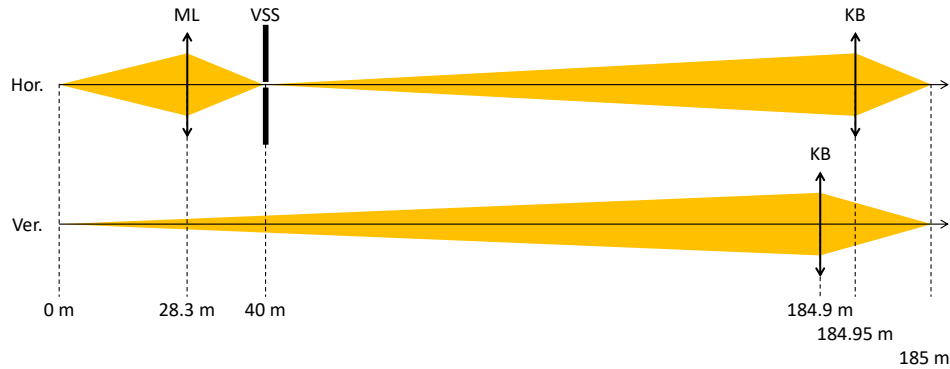


Figure 1: Schematic of the ID16A beamline showing the horizontal (top) and vertical (bottom) planes and the position of the main optical elements. In the sketch ML stands for the focusing multilayer monochromator; VSS for virtual source slit; and KB for the Kirkpatrick-Baez set of mirrors. The sketch is drawn out of scale.

Table 5: Main beamline optical elements parameters.

Optical element:	Multilayer	VSS	KB (vert.)	KB (horz.)
sagittal size [mm]:	13.00	0.05	20.00	20.00
meridional size [mm]:	120.00	3.00	60.00	26.00
incident angle [mrad]:	31.42	-	14.99	14.99
p [m]:	28.30	-	184.90	144.95
q [m]:	11.70	-	0.10	0.05
bounce:	right	-	down	right

References

- [1] J. C. da Silva, A. Pacureanu, Y. Yang, S. Bohic, C. Morawe, R. Barrett, and P. Cloetens, “Efficient concentration of high-energy x-rays for diffraction-limited imaging resolution,” *Optica*, vol. 4, pp. 492–495, May 2017.
- [2] ESRF, *The Orange Book*. 2014.
- [3] ESRF, *ESRF Highlights 2016*. 2017.