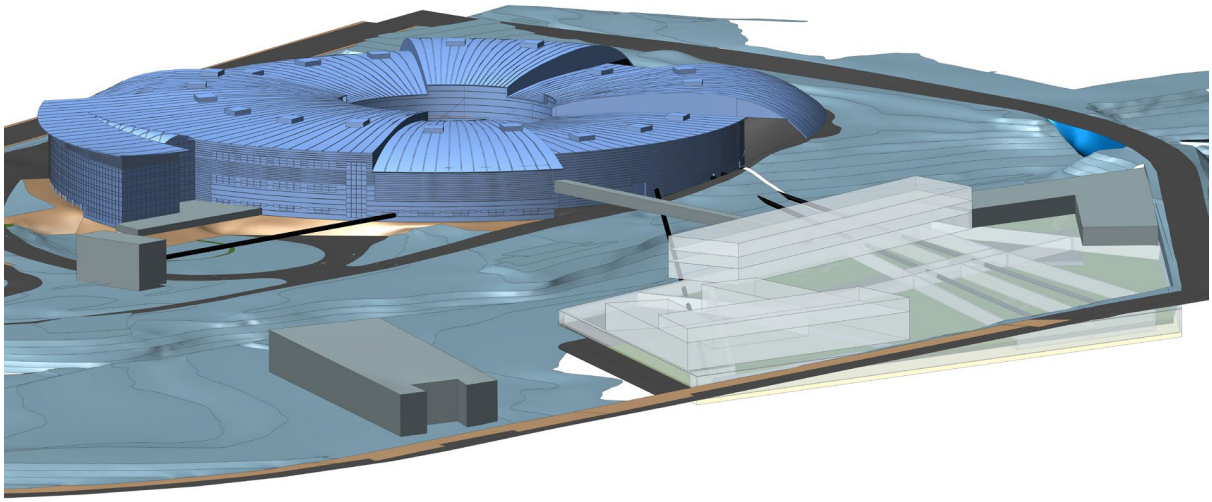
Technical characteristics of ALBA II Long Beamlines



1 Introduction

The ALBA II layout foresees the construction of up to four long BeamLines (BLs), whose general technical characteristics are summarized in this document.

The four BLs will be hosted in ports 2,3,4 and 8. Their layout is shown in Figure 1-1.

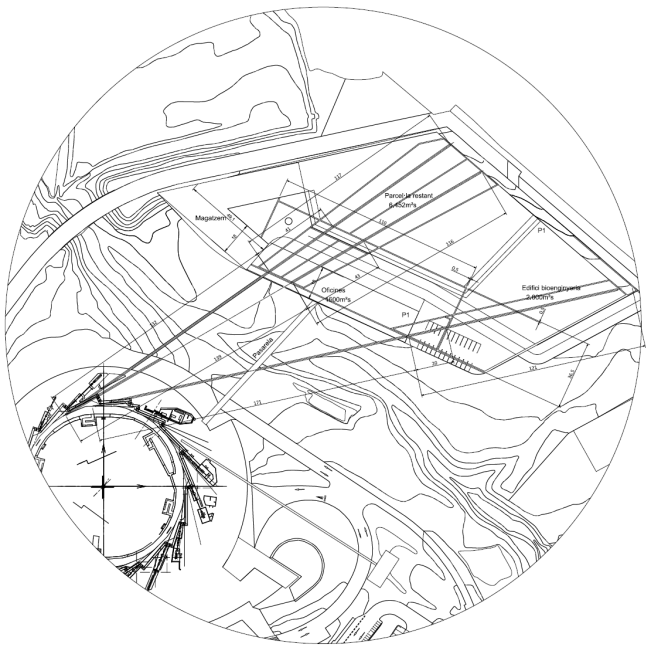


Figure 1-1 – Layout of the four long BLs

2 Parameters of the beamline

Port	*Unit*	*Value*				*Note*
Electron energy	*GeV*	3				1)
Current	*mA*	300				1)
Bunch length	*ps rms*	6 to 15				1)
time between bunches	*ns*	2				1)
Pulse current	*nC*	0.7 to 0.9				1)
Port		**BL02**	**BL03**	**BL04**	**BL08**	
Source type		Undulator	Superbend	Undulator	Undulator	
Length available for ID	*m*	2	N.A.	2	2	1) 2)
Source Size X	*um rms*	14	7.7	14	34	1) 3)
Source Size Y	*um rms*	15.1	24.8	15.1	31.4	1) 3)
Source Divergence X	*urad*	7.1	< 2000 [7)]	7.1	2.9	1) 3)
Source Divergence Y	*urad*	6.5	< 310[8)]	6.5	3.1	1) 3)
BL length within EH	*m*	25-42	28-41	25-42	22-42	1) 4)
BL length at the Far Exp. Hall	*m*	134-249	141-255	173-292	85-125	1) 5)
Position stability	*%*	10	10	10	10	1) 6)

Notes:

1) All the parameters in this table may be slightly changed as a result of the refinement of the design of the ALBA-II accelerator complex and buildings.
2) ID length is relevant since the given value allows allocating one ID, but not a tandem of IDs.
3) The specified values correspond to the rms spot sizes of the electron beam. For low photon energies, the actual size and divergence are dominated by the diffraction of the photon beam.
4) The beamline has some space available at the experimental hall of the main building of ALBA. That space can allocate part of the optical components, or some experimental station, if the design allows for it.
5) The space available for the beamline at the far experimental hall, allow installing components betwen the minimum and maximum distances given here.
6) The position of the electron beam is stabilized by an active correction system up to 100 Hz. The target stability tolerance is 10% of the electron beam size. The same stability criterion is maintained for the photon beam on sample, although there may be cases for which physical limitations of beamline components prevent from reaching this stability value.
7) The horizontal divergence of the superbend magnet is limited by the acceptance of the BL optics. Typical values do not exceed 2 mrad, limited by available length of mirrors or the resulting aberrations in sagittal focusing systems. A larger fan can be accepted in absence of such limitations.
8) The provided value corresponds to the vertical divergence at 1 keV.

3 Selected reference performances

In this section we provide some example values of the expected performances of the source and beamlines. These are based on examples of existing devices or typical optical designs. The examples provided here are not optimized for any particular scientific case, and the performance values are to be considered only as orientative.

3.1 BL02, BL04 source characteristics

The flux reachable by different type of undulators is given in the following plot. We consider four undulators, that cover the energy range between 10 eV to about 40 keV.

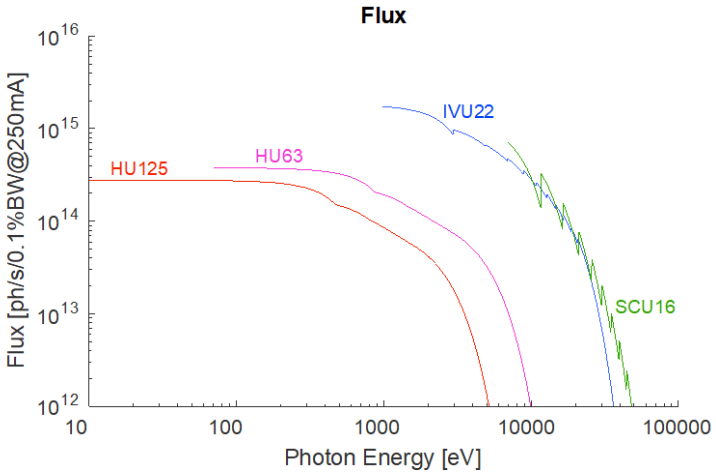


Figure 3-1. Flux emitted by different undulators within the energy range of ALBA2

The source size and divergence for these undulators depend only on the energy and the characteristics of the machine. The values expected for undulators taking the full available length of the straight sections are given in the following plots. The plots indicate the contributions of the electron beam size and divergence (constant dashed lines) and of the diffraction limit (wavelength dependent)

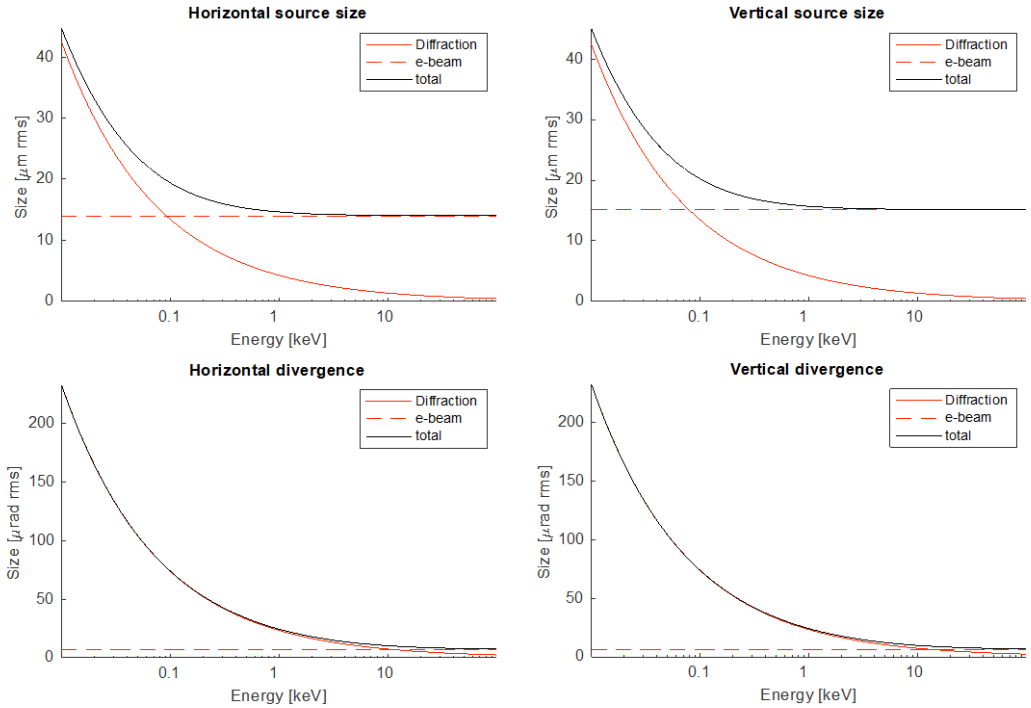


Figure 3-2. Source size and divergence for ALBA2 ports BL03 and BL04

The finite size of the electron beam leads to reduction of the coherent fraction of the emission. This is, the fraction of the emitted flux that could be accepted by a pinhole optimally placed to obtain full transversal coherence.

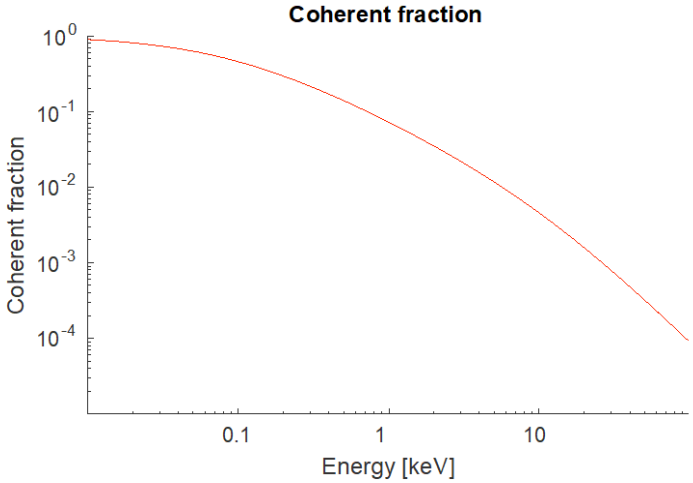


Figure 3-3. Coherent fraction of the sources of ports BL03 and BL04, for ALBA2

3.1.1 Spot size on sample for BL02 and BL04

Both ports feed beamlines that can be more than 150 m long. Such length can be used to obtain a nanometer scale focus. The achievable spot size depends on the used technology: mirrors, capillaries, Fresnel zone plates, etc. Here we consider only reflective optics. Also in this case, the results depend strongly on the distance to sample, and on the photon energy. Some reference values of the achievable RMS spot size are given in the following plot. The provided values are just for reference, since the actual achievable spot size depends on many other parameters, like coating, incidence angle, flux acceptance, surface errors or allowable curvature radius.

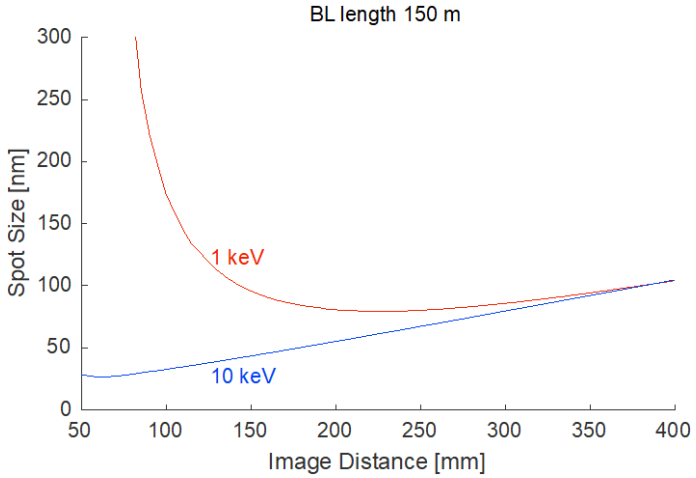


Figure 3-4. Achievable spot size as a function of the image distance to the sample for low and high photon energies.

3.2 BL03 superbend beamline

BL03 is fed by a 3.2 T bending magnet. The flux emitted by the source is given in the following plot:

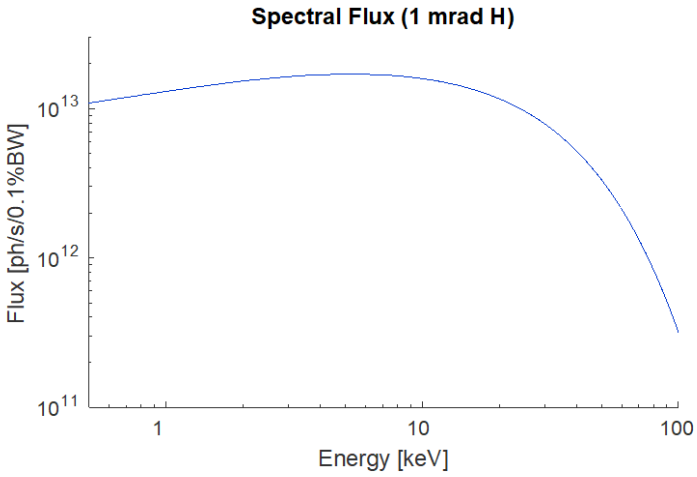


Figure 3-5. Flux emitted by the BL03 superbend source, assuming the full vertical divergence of the beam is collected, and 1 mrad beamline acceptance.

The horizontal divergence of the beam is limited by the acceptance of the beamline. The vertical divergence is mostly contributed by the diffraction limit of the source.

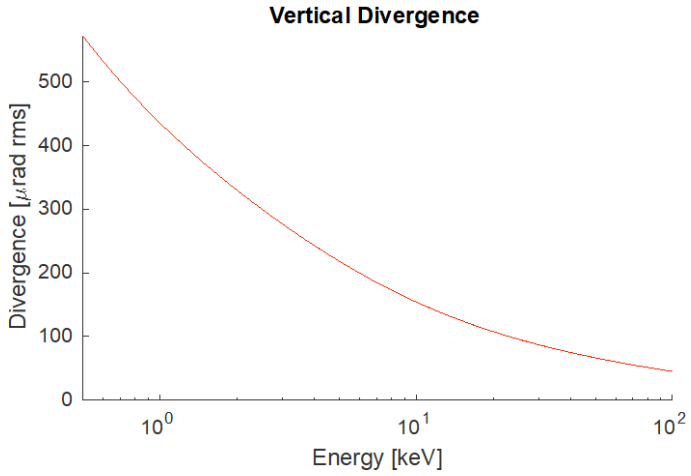


Figure 3-6. Vertical divergence of the beam emitted by the BL03 superbende source.

3.3 BL08 source characteristics

While the total flux of an undulator installed at BL08 is exactly the same as for BL02 and BL04. The source characteristics of this straight section are different. The beam is more collimated by the source is larger. The sizes and divergences for a source installed at BL08 are given in the following plot. The different source characteristics yield to a slightly different coherent fraction.

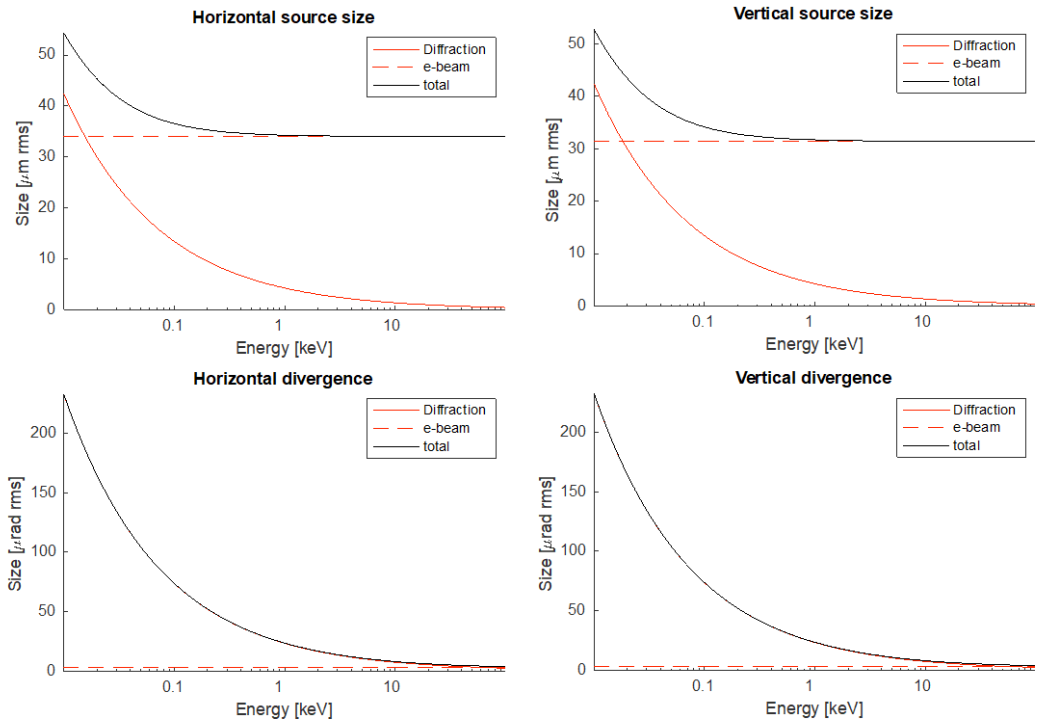


Figure 3-7. Source sizes and divergences for an undulator source installed at BL08

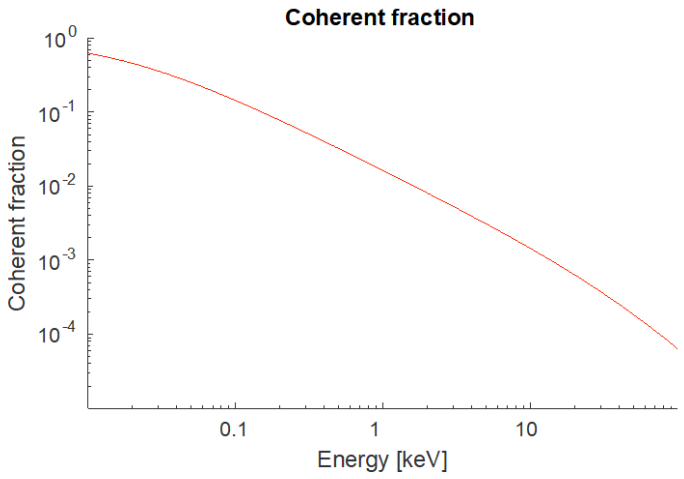


Figure 3-8. Coherent fraction of the flux emitted by an undulator installed at BL08