Beamline components glossary

Introduction

This draft document contains a suggestion for the parameters needed to describe the beamline source and components. Its aim is to serve as an input for Optics software (targeting, for example, a future GUI for SHADOW and SRW) and for defining parameters in a HDF5 or Nexus formatted files. It could be a starting point to be able in the future to exchange information and results among different codes.

The initial idea is to reduce to the minimum the number of parameters. Each component parameters are "intrinsic", i.e., not related to the orientation, positioning or alignment in the beamline, which should be defined as external attributes.

Type of components:

- Base components (using prefix BC_)
- Compound components (using prefix CC_)
- Positioning and alignment attributes (yet undefined)

Glossary: BM (Bending magnet), ID (insertion device), H (horizontal), V (vertical)

BC_StorageRingSection

Name	Type	Units	Description and values
ElectronEnergy	Float	GeV	Electron energy in the storage ring
ElectronEnergySpread	Float	GeV (or % of ElectronEnergy)	Spread RMS of the energy of the electrons
ElectronIntensity	Float	A	Electron current intensity
EmittanceH	Float	m.rad	Horizontal emittance (at waist)
EmittanceV	Float	m.rad	Vertical emittance (at waist)
ElectronBunchSizeH	Float	m (nm)	Size RMS of the electron beam (horizontal)
ElectronBunchSizeV	Float	m (nm)	Size RMS of the electron beam (vertical)

BC_BendingMagnet

Name	Type	Units	Description and values

MagneticField	Float	T	Bending magnet magnetic field
HorizontalArc	Float	mrad	length (angular) of the BM
R	Float	m	Radius of curvature
waistH	Float	m	Distance to waist (in H)
waistV	Float	m	Distance to waist (in V)

BC_InsertionDevice

Name	Type	Units	Description and values
Type	String		Wiggler, undulator, elliptical w/u
Kh	Float	Adimensional	Horizontal K value
Kv	Float	Adimensional	Vertical K value
phase	Float	rad	Phase between H and V magnets
Gh	Float	m (mm)	Horizontal gap
Gv	Float	m (mm)	Vertical gap
N	Integer		Number of periods
PeriodID	Float	m	ID period
taperH	Float	% of Kh	Gap taper H
taperV	Float	% of Kv	Gap taper V

BC_Slit (slit or aperture)

Name	Type	Units	Occurrence	Description and values
centerH	Float	m		H center
centerV	Float	m		V center
shape	Integer			0: None (fully opened) 1: rectangular 2: elliptical 3: free form (polygon)
Stop	Integer			0: (No) aperture 1: (yes) beam stop
gapH	Float	m	shape=1,2	H gap (twice H semiaxis for ellipse)
gapV	Float	m		V gap (twice V semiaxis for ellipse)
coordH	Float(N)	m	shape=3	H coordinates for polygon defining the shape
coordV	Float(N)	m		H coordinates for polygon

				defining the shape

BC_OpticalSurface

Name	Type	Units	Description and values
limits	Integer		0: Infinite surface 1: rectangular 2: elliptical 3: free form
length	Float	m	length (twice H semiaxis for ellipse)
width	Float	m	width (twice V semiaxis for ellipse)
shape	Integer(2)		0: Plane 1: Conic • 1,0: by coefficients • 1,1: sphere • 1,2: ellipsoid • 1,3: paraboloid • 1,4: hyperboloid 2: Toroid 3: Free • 3,1: Mesh • 3,2: Polynomial
coeff	Float(10)		Coefficients, radii, semiaxes, etc. depending on shape
Geometry	Integer		0: reflecting (e.g., mirrors) 1: transmitting (e.g., lenses, Laue crystals) 2: both (e.g., diamond crystals, beamsplitters)

BC_Attenuator (attenuator or filter)

Name	Type	Units	Description and values
material	string		String describing the material (e.g., Cu, H2O, etc).
thickness	Float	m	Attenuator thickness
density	Float	g/cm^3	Material density

BC_Mirror

Uses: BC_OpticalSurface

Name	Type	Units	Description and values

coating	string		String describing the material (e.g., Cu, H2O, etc).
thickness	Float	m	coating thickness
density	Float	g/cm^3	coating density

BC_CrystalPerfect

Uses: BC_OpticalSurface

Name	Type	Units	Description and values
name	string		String describing the material (e.g., Si, quartz, etc).
thickness	Float	m	crystal thickness
Cell	Float(6)	a,b,c (Angstroms) alpha, beta, gamma (deg)	Crystallographic cell parameters
N	Integer		Number of atoms in unit cell
Z	Integer(N)		Atomic number of atoms in unit cell
X,Y,Z	Float(N)	Angstroms	Coordinates of atoms in crystallographic cell
occupancy	Float(N)		Occupancy coeff of atoms in unit cell
Temperature0	Float	K	Temperature at which unit cell is given
Temperature	Float	K	Crystal temperature
Miller	Integer(3)		Miller indices of selected reflection
Asymmetry angle	Float	Deg	Asymmetry angle (better define in vector form?)

BC_Multilayer

Uses: BC_OpticalSurface

Name	Type	Units	Occurrence	Description and values
aperiodic	Integer			0: (No) Periodic multilayer 1: (Yes) Free multilayer
LateralGradient	Integer			0: No 1: Yes (linear variation) 2: Yes (Gamma2 vs length coordinate)
LateralGradientCoeff	Float(2)		LateralGradiant=1	Coefficients for: Gamma2 = LateralGradientCoeff[0] + LateralGradientCoeff[1]*length_coordinate
LateralGradientArray	Float (2,npts)		LateralGradiant=2	Gamma2 vs length_coordinate
MaterialSubstrate	string			String describing the material (e.g., Si, W, B4C)

DensitySubstrate	Float	g/cm^3		Density of substrate
RoughnessSubstrate	Float	Angstroms		Roughness RMS of substrate
MaterialSublayer1	string		aperiodic=0	String describing the material (e.g., Si)
MaterialSublayer2	string			String describing the material (e.g., Si)
MaterialToplayer	string			String describing the material (e.g., Si)
Period	Float	Angstroms		Period of main layers (thickness of sublayer1 plus thickness of sublayer2)
Gamma2	Float			Ratio: thickness_sublayer2/Period
DensitySublayer1	Float	g/cm^3		Density of sublayer1
DensitySublayer2	Float	g/cm^3		Density of sublayer2
DensityToplayer1	Float	g/cm^3		Density of toplayer
RoughnessSublayer1	Float	Angstroms		Roughness RMS of sublayer1
RoughnessSublayer2	Float	Angstroms		Roughness RMS of sublayer2
RoughnessToplayer	Float	Angstroms		Roughness RMS of toplayer
ThicknessToplater	Float	Angstroms		thickness of toplayer (ero means no toplayer)
MaterialArray	String(N)		aperiodic=1	Material for individual layers
ThicknessArray	Float	Angstroms		Thickness of individual layers
DensityArray	Float(N)	g/cm^3		Density of individual layers
RoughnessArray	Float	Angstroms		Roughness RMS of individual layers

BC_LensSingle

Uses: BC_OpticalSurface(2)

Name	Type	Units	Description and values
material	string		String describing the material (e.g., Si, Be, etc).
thickness	Float	m	lens thickness
density	Float	g/cm^3	lens density

Compound elements

Name	Needs	Description and values
CC_Source	BC_StorageRingSection and BC_bendingMagnet or BC_InsertionDevice	Synchrotron source
CC_Monochromator	BC_CrystalPerfect(N) or/and	monochromator

	BC_Multilayer	
CC_CRL	BC_LensSingle(N)	CRL as an array of single lenses
CC_Transfocator	CC_CRL(N)	Transfocator as an array of CRLs

To do list, some thoughts and questions

Add basic components:

- BC_Grating
- BC_CapillarySingle
- BC_CapillaryMulti (or BC_Kumakhov)

Discuss on how to position components:

- Distance to previous component, or distance to source (along optical path?)
- Define full orientation by either
  - Default
  - Incident angle only (default for the others)
  - Incident angle, "mirror orientation angle", and "mirror movement (6)" (as in SHADOW)
  - Pitch, roll and yaw angles?
  - Euler angles?
  - Other?
- Define automatic positioning as a function of the "working conditions" (e.g., define working photon energy, and calculate Bragg angles?)

Discuss in the name of variables:

- Capitalized? Using underscores? Using capital letters to separate words?
- Long versus short (abbreviated) names?

Units:

- Shall we adopt as far as possible the SI or cgs? (e.g. , all lengths in m, temperatures in K, etc)
- Shall we prefer not to use multipliers (e.g., eV preferred to GeV or keV, etc)
- Shall we provide (as in Nexus) the possibility of using different units?

Names:

- Shall we add the possibility to add parameters depending on the user needs? If so, shall we define a "used defined" prefix?

- Shall we add the possibility to define "derived" parameters, e.g., wavelength as a function of the energy (WAVELENGTH=12.39842/ENERGY)?

How to define and position the "detectors", observation planes, etc. Should be defines as "components" (like in McXtrace)?

Could basic components use other basic components? (e.g., I defined the optical surface shape separated from the nature of the element (mirror, crystal, etc). Or only "compound" components could do that?