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:

* Ideal components, the components reduced to simplest idealizations (using prefix IC\_)
* Base components, to define as close as possible the real ones (using prefix BC\_)
* Compound components (using prefix CC\_), made by combination or repetition of ideal or base components

Note that this document describes only the physical parameters of the components. The positioning and alignment attributes are yet undefined, as well as the calculation parameters (e.g., number of sampling points, grids, scans, etc.) that will depend on the kind of simulation to be done.

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

# IC\_PhotonBeamPencil

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Units | Description and values |
| energyMin | Float | eV | Minimum photon energy |
| energyMax | Float | eV | Maximum photon energy |

# IC\_DriftSpace

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Units | Description and values |
| d | Float | m | distance |

# IC\_Lens

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Units | Description and values |
| FH | Float | m | Focal length in H |
| FV | Float | m | Focal length in V |

# BC\_ElectronBeamGaussian

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Name | | Type | Units | | Occurrence | Description and values |
| ElectronEnergy | | Float | GeV | |  | Electron energy in the storage ring |
| ElectronCurrent | | Float | A | |  | Electron current intensity |
| OrbitOffset | | Float(6) |  | |  | Orbit offset (x,x',y,y',s,) from where initial conditions are defined |
| InputType | | Integer |  | |  | 0=Twiss description  1=Full description |
| ElectronEnergySpread | | Float | Adimensional | | InputType=0 | Spread RMS of the energy of the electrons  E/E |
| EmittanceH | | Float | m.rad | | Horizontal emittance (at waist) |
| EmittanceV | | Float | m.rad | | Vertical emittance (at waist) |
| BetaH | | Float | m | | Beta function (horizontal) |
| BetaV | | Float | m | | Beta function (vertical) |
| AlphaH | | Float |  | | Alpha function of the Twiss parameter (horizontal) |
| AlphaV | | Float |  | | Alpha function of the Twiss parameter (vertical) |
| BuchLength | | Float | m | | Bunch length |
| DispersionH | | Float | m | | Dispersion H |
| DispersionV | | Float | m | | Dispersion V |
| DispersionDerivH | | Float | Adimensional | | Dispersion derivative H |
| DispersionDerivV | | Float | Adimensional | | Dispersion derivative V |
|  |  | | |
| SIGMA matrix | | Float(6,6) |  | | InputType=1 | See appendix |
| M matrix | | Float(6,6) |  | |

# BC\_BendingMagnet

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Units | Description and values |
| MagneticField | Float | T | Bending magnet magnetic field |
| MagneticFieldErrors | Float(2,N) | % | Tabulation of magnetic field errors |
| HorizontalArc | Float | mrad | length (angular) of the BM |

# BC\_InsertionDevice

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Type | Units | Occurrence | Description and values |
| Type | String |  |  | Wiggler, undulator, elliptical w/u |
| InputType | Integer |  |  | 0=Reduced description  1=Full description (B from Harmonics)  2=Full description (B from table) |
| PeriodID | Float | m |  | ID period |
| N | Integer |  |  | Number of periods |
| Kh | Float | Adimensional | InputType=0 | Horizontal K value |
| Kv | Float | Adimensional | Vertical K value |
| phase | Float | rad | Phase between H and V magnets |
| taperH | Float | % of Kh | Gap taper H |
| taperV | Float | % of Kv | Gap taper V |
| Bharmonics | Float(N,2) | T | InputType=1 | List of N harmonics, and their H and V intensities |
| Btable | Float(2,N) | T | InputType=2 | (BHorizontal,Bvertical) vs s |

# 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/cm3 | Material density |

# BC\_Mirror

|  |  |  |  |
| --- | --- | --- | --- |
| 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/cm3 | coating density |

# BC\_CrystalPerfect

|  |  |  |  |
| --- | --- | --- | --- |
| 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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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/cm3 |  | 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/cm3 | Density of sublayer1 |
| DensitySublayer2 | Float | g/cm3 | Density of sublayer2 |
| DensityToplayer1 | Float | g/cm3 | 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/cm3 | Density of individual layers |
| RoughnessArray | Float | Angstroms | Roughness RMS of individual layers |

# BC\_LensSingle

|  |  |  |  |
| --- | --- | --- | --- |
| 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/cm3 | lens density |

# Compound elements

|  |  |  |
| --- | --- | --- |
| Name | Needs | Description and values |
| CC\_Source | BC\_ElectronBeamGaussian and  BC\_bendingMagnet or BC\_InsertionDevice | Synchrotron source |
| CC\_Monochromator | BC\_CrystalPerfect(N) or/and  BC\_Multilayer | monochromator |
| 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 ideal and basic components:

* IC\_PhotonBeamGaussian
* IC\_PhotonBeamGeometric (geometrical source, like in SHADOW)
* BC\_Grating
* BC\_CapillarySingle
* BC\_CapillaryMulti (or BC\_Kumakhov)

How to represent undefined parameters

* Skip mentioning them in the list
* Assign a default value (this may be confused)
* Assign a "None" value (like in python)

Discuss on how to position components:

* Distance to previous component (using IC\_DriftSpace), or distance to previous element (along optical path)
* Define full orientation by either
  + Default
  + Incident angle (tangential), orientation angle (sagittal)
  + 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?)
* How to define and position the monitors, observation planes, "detectors", etc. Should be defines as "components" (like in McXtrace)?

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)?

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?