#

# Input for various IR-6-Simulations

This document describes the format for the input files provided to allow for simulations of the acceptance for different physics observables, synchrotron radiation, beam gas background and design of the vacuum system.

What is not yet done:

* The beam pipe beyond the detector region is not yet fully designed.

**Current IR Layout of IP-6:**

This figure is a top view of the IR, ring-inside is in positive x direction and ring-outside towards negative x-direction.



**General agreements / understanding for the files:**

* The entire crossing angle is 25 mrad
* The electron beam had 8 mrad and the hadron beam 17 mrad
* The magnet positions for the hadron beam elements and inner aperture are in

IP6\_50cm\_shift\_magnets\_and\_detectors\_FF\_correct\_coordinate\_system.xlsx (tab 1 and 2)

They are aligned that the entire crossing angle is in the hadron beam.

**Please note the convention between the BMAD files and this excel** **one for the quadrupoles is different the BMAD quadrupole fields need to be multiplied by -1**

The placement of the detectors are listed in the 2nd tab.

* The magnet positions for the electron beam elements, inner aperture and beam optics information are in the files labeled like esr-ir6-041-05.txt. There is one file per energy combination.
* The magnet positions for the hadron beam elements, inner aperture and beam optics information are in the files labeled like hsr.210405b-041-05.txt. There is one file per energy combination
* The correct magnets positions are the ones labeled IP6

The relevant files are provided from BMAD, which have the full layout of the hadron and electron machine integrated.

**The hsr.210405b-041-05.txt and esr-ir6-041-05.txt files hold the optics and its format is**

The IR is indicated by the Marker labeled IP6

BETX, BETY = beta functions in horizontal and vertical plane
ALFX, ALFY = slope of the beta functions
X Dispersion = dispersion function in the horizontal plane

X Dispersion’ = slope of the dispersion function

To calculate the beam size in x and y one needs the emittance as this is a global beam parameter, not IR dependent they are listed in the CDR (<https://www.bnl.gov/ec/files/EIC_CDR_Final.pdf>) in table 3.3 to 3.5

The angle of the magnets should be calculate from the entrance and exit position in the files.

**Some important facts and relations to use:**

* The fundamental limit on xL acceptance is xL< 1-10sd with sd being the beam energy momentum spread
* RMS beam size at IP: s\*x,y = √eb\*x,y with e being the geometric emittance
* RMS beam size somewhere in the ring: sx,y = √ebx,y with e being the geometric emittance
* RMS angular beam divergence s\*x,y = √e/b\*x,y
* The beam size at the 2nd focus needs to be calculated accounting for the Dispersion D

$σ\_{x,y}=\sqrt{β(z)\_{x,y}ϵ\_{x,y}+\left(D\_{x}\frac{δp}{p}\right)^{2}}$ and $x\_{L}<1-10\sqrt{\frac{β(z)\_{x,y}ϵ\_{x,y}+D\_{x,y}^{2}σ\_{δ}^{2}}{D^{2}}}$

**How to scale the magnetic fields for different energies:**

**Note:** The B0 has the same field at all energies

* L: length of the element
* ANGLE = bending angle of a dipole
* K1 = quadrupole strength (K1\*L=integrated quadrupole strength)

The fields of the magnets can be calculated following the prescriptions

Dipole field in T: Brho\*ANGLE/L
Quadrupole gradient in T/m: Brho\*K1

The Brho is beam energy dependent:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **5 GeV** | **10 GeV** | **18 GeV** |
| Electron Brho (T-m) | 16.6782 | 33.3564 | 60.0415 |
|  | **41 GeV** | **100 GeV** | **275 GeV** |
| Hadron Brho (T-m) | 136.7255 | 333.5494 | 917.2959 |

**Files for Background simulations:**

The files synchrotron radiation to estimate the occupancy are in the tar file named SR.10GeV\_5kVthreshold.tar.gz. This file includes a READMe file, which describes how to use the synchrotron files.

**Location of files:**

Indigo: https://indico.bnl.gov/event/10974/contributions/ , the direct link is https://indico.bnl.gov/event/10974/contributions/51260/

The presentations discussing the design in more detail are at https://indico.bnl.gov/event/12273/