Open Announcement of Simulation Code Benchmark

At the European XFEL we will need extensive simulations of the spontaneous radiation to investigate heat load, energy loss of electrons, quantum diffusion of the energy spread and background signal on detectors. We propose a first benchmark to compare different outputs. In this document we specify the parameters of the benchmark.

We propose to study two cases:

A) BENCHMARK PARAMETERS FOR THE STUDY CASE SASE 1 - SPONTANEOUS RADIATION:

i) Electron beam parameters: assume for this benchmark a Gaussian longitudinal and transverse distribution.

*) Electron energy	17.5	GeV
*) Bunch charge	1	nC
*) Peak Current	5	kA
*) Bunch length	25	μm
*) Normalized emittance (rms)	1.4	mm mrad
*) Energy spread	1.5	MeV
*) Bunches per RF pulse	3000	
*) Repetition Rate	10	Hz

ii) Undulator system: the undulator system is composed of 33 cells, each consisting of a 5 m long undulator and a 1.1 m long intersection (for a total undulator length L_w = 201.3 m). Each intersection contains a phase shifter, corrector coils and an adjustable quadrupole. The code must later allow to study the effects of field errors and misadjustment / sensitivity in terms of phasing. For now, just consider perfect phasing, and fixed beta function as below.

*) K	3.3	
*) Gap	10	mm
*) Max B field	1.0	T
*) Period length	35.6	mm
*) Beta function	32	m
*) Cell length	5 + 1.1	m
*) Number of cells	33	

iii) Observation distances from the exit of the undulator system

*) z_1	50	m
*) z_2	275	m
*) z_3	400	m
*) z_4	518	m
*) z_5	960	m

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iv) Output. For each observation distance we propose to calculate

- *) spatial flux density [N_{ph} / (s * 0.1% BW * mrad^2)] at
  - I harmonic
  - III harmonic
  - V harmonic
- *) Spectral flux [N_{ph} / (s * 0.1% BW)]
  - on axis (specify aperture used)
  - angle-integrated through a 20x20 mm^2 aperture centered on axis @ z_5
  - angle-integrated through a 10x10 mm^2 aperture centered on axis @ z_4, z_3
  - angle-integrated through a 5x5 mm^2 aperture centered on axis @ z_2
  - angle-integrated through a 2x2 mm^2 aperture centered on axis @ z_1
- *) Total power (integrated over angles and frequency) [W]
- *) Total electric field, including polarization at z_1=50 [V/m]
- *) Please specify the mesh used in space and frequency, the machine time, and the computer you are running with.

B) BENCHMARK PARAMETERS - SPONTANEOUS RADIATION – NO EMITTANCE/ENERGY SPREAD:

i) Electron beam parameters: assume for this benchmark a Gaussian longitudinal distribution

*) Electron energy	17.5	GeV
*) Bunch charge	1	nC
*) Peak Current	5	kA
*) Bunch length	25	μm
*) Normalized emittance (rms)	NO EMITTANCE	
*) Energy spread	NO ENERGY SPREAD	
*) Bunches per RF pulse	3000	
*) Repetition Rate	10	Hz

ii) Undulator system: for this benchmark we propose a simplified undulator, without intersections

*) K	3.3	
*) Gap	10	mm
*) Max B field	1.0	T
*) Period length	35.6	mm
*) Undulator length	201.3	m
*) Number of periods	5655	

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iii) Observation distances from the exit of the undulator system

*) z_1	50	m
*) z_3	400	m
*) z_5	960	m

iv) Output. For each observation distance we propose to calculate

*) spatial flux density [N_{ph}/(s * 0.1% BW * mrad^2)] at
- I harmonic
- III harmonic
- V harmonic

*) Spectral flux [N_{ph}/(s * 0.1% BW)]
- on axis (specify aperture used)
- angle-integrated through a 20x20 mm^2 aperture centered on axis @ z5
- angle-integrated through a 10x10 mm^2 aperture centered on axis @ z3
- angle-integrated through a 2x2 mm^2 aperture centered on axis @ z1

*) Total power (integrated over angles and frequency) [W]

*) Total electric field, including polarization at z_1=50 [V/m]

*) Please specify the mesh used in space and frequency, the machine time, and the computer you are running with.

C) IMPORTANT NOTES:

i) In the future we will need to calculate the influence of reflections and wave guiding from the vacuum pipe on the radiation output. Is your program capable of accomplishing this task, or can it be modified to include this effect?

ii) Other important physical effects, which are of importance to us, are the energy loss by electrons, and the quantum diffusion of the energy spread. These effects will be most important at SASE 3. Is your program capable of accounting for them, or can it be modified to include them?

iii) Please specify the accuracy of your calculation, the mesh used (both in space and frequency), the machine time and the computer you are running with.

iv) Is your code capable of accounting for a generic bunch profile and energy spread profile?

v) OUTPUT FORMAT: it should be Origin-readable (e.g. ASCII scientific format)

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