Source routine

Exercises

Exercise 1A

- Mockup for the Antiproton Decelerator Target at CERN

- Use the provided input file and set up a beam with the following parameters:
  - Particle: Proton (particle code: 1)
  - Momentum: 26 GeV/c
  - Momentum spread: Gaussian, $\Delta p/p = 1.31 \cdot 10^{-3}$ @ 2σ
  - Position: x = 0, y = 0, z = -10 cm
  - Shape: Gaussian, x = 1 mm @ 1σ, y = 0.5 mm @ 1σ
  - Divergence: Gaussian, x = 1 mrad FWHM, y = 0.5 mrad, FWHM
  - Enable the debug output

- Run 5 cycles with 5000 primaries each, and verify that the source routine works, with the provided scorings

Exercise 1A / 1B

Note the required time to run the simulation. How much CPU-time would it require to simulate 25 million primaries?

Imagine you need to optimize the antiproton beamline downstream of the target

Instead of simulating the time-expensive antiproton production every time, you can do a two step simulation:

- Record the exiting antiprotons
  (See the upcoming lecture and exercise for **`MGDRAW`**)
- Replay the recorded antiprotons as phase-space source

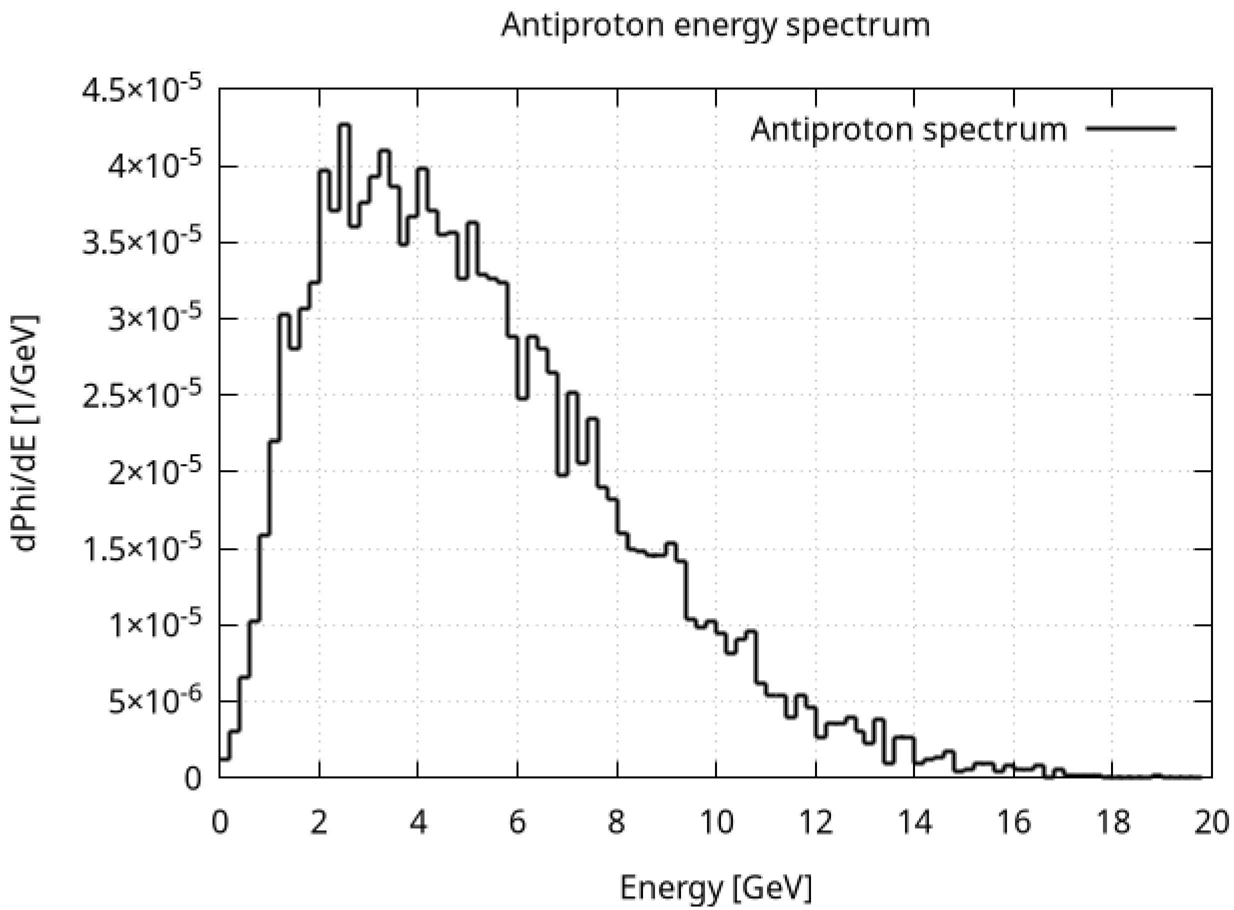
Exercise 1B

- Use the provided phase-space file as the antiproton source (The phase-space file was created with 25 million primary protons)

- Run the recorded antiprotons in one cycle, sequentially.

- Use the provided scorings to verify the sampling works

- What is the correct normalization factor?



Exercise 2A

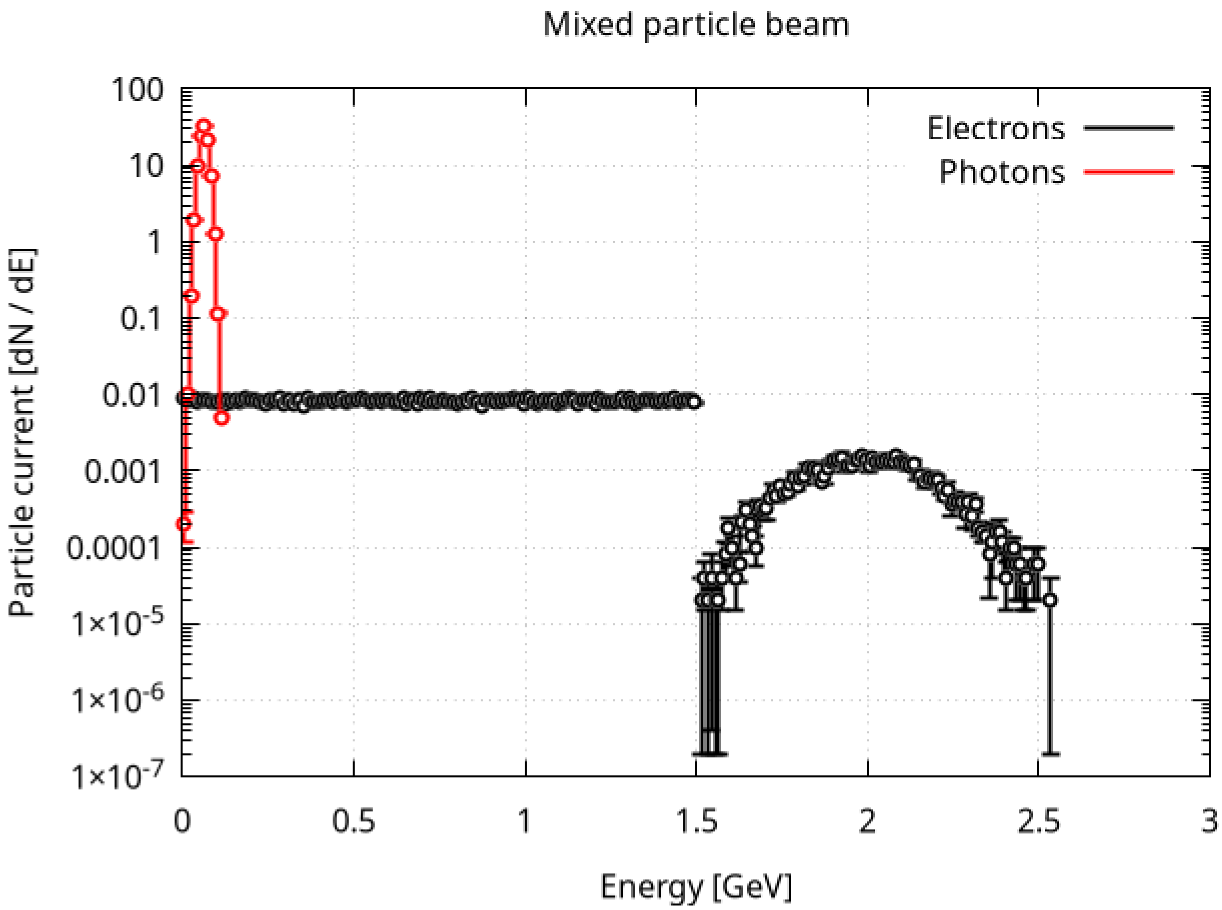
- Set up a mixed beam source
- In laser-driven electron acceleration experiments one can expect a following mixed beam source:
  - Quasi mono-energetic electrons
    Gaussian energy distribution with 2 GeV Mean and 0.4 GeV FWHM
    Intensity: 100 pC / shot
  - Low energy background electrons
    Flat energy distribution between 0 and 1.5 GeV
    Intensity: 2000 pC / shot
  - Background photons
    Gaussian energy distribution with 64 MeV Mean and 28 MeV FWHM
    Intensity: 10^{12} photon / shot
- Use USRBDX current scorings to visualize the electron and photon spectrums

Exercise 2A

- In the source routine:
  - Calculate the probability for each component (1 C ≈ $6.24 \cdot 10^{18}$ electrons)
  - Use a random number to select between them
  - Particle codes: Electron = 3, Photon = 7

- Run 5 cycles with 1 million primaries each
- Plot the results with logarithmic y axis

Exercise 2A



- Notice the higher uncertainties in the high energy electron part

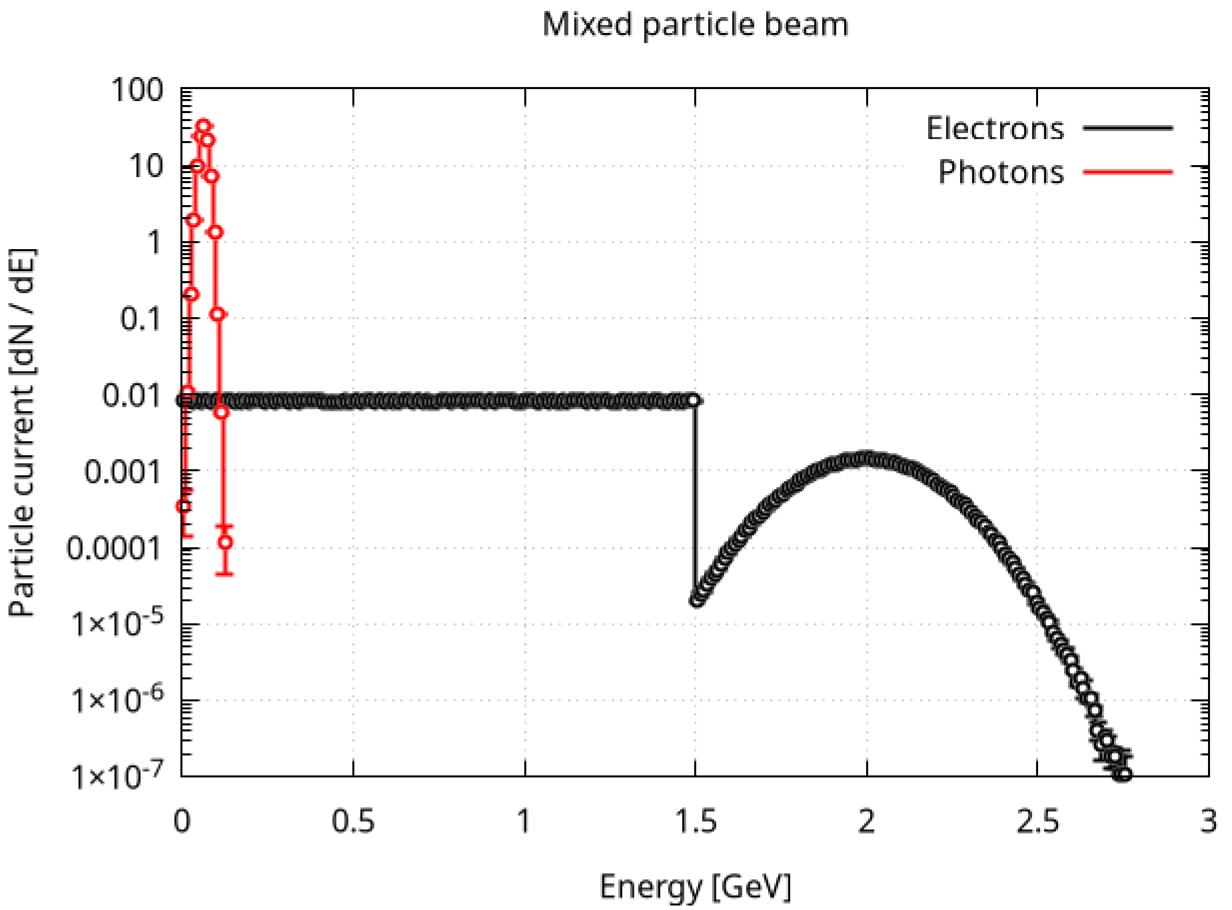
Exercise 2B

- Modify the source routine to sample each beam component with the same probability

- Use the predefined constants:
  - `ONETHI` = $\frac{1}{3}$
  - `TWOTHI` = $\frac{2}{3}$

- Set the appropriate weights to keep the particle spectrum unchanged

Exercise 2B



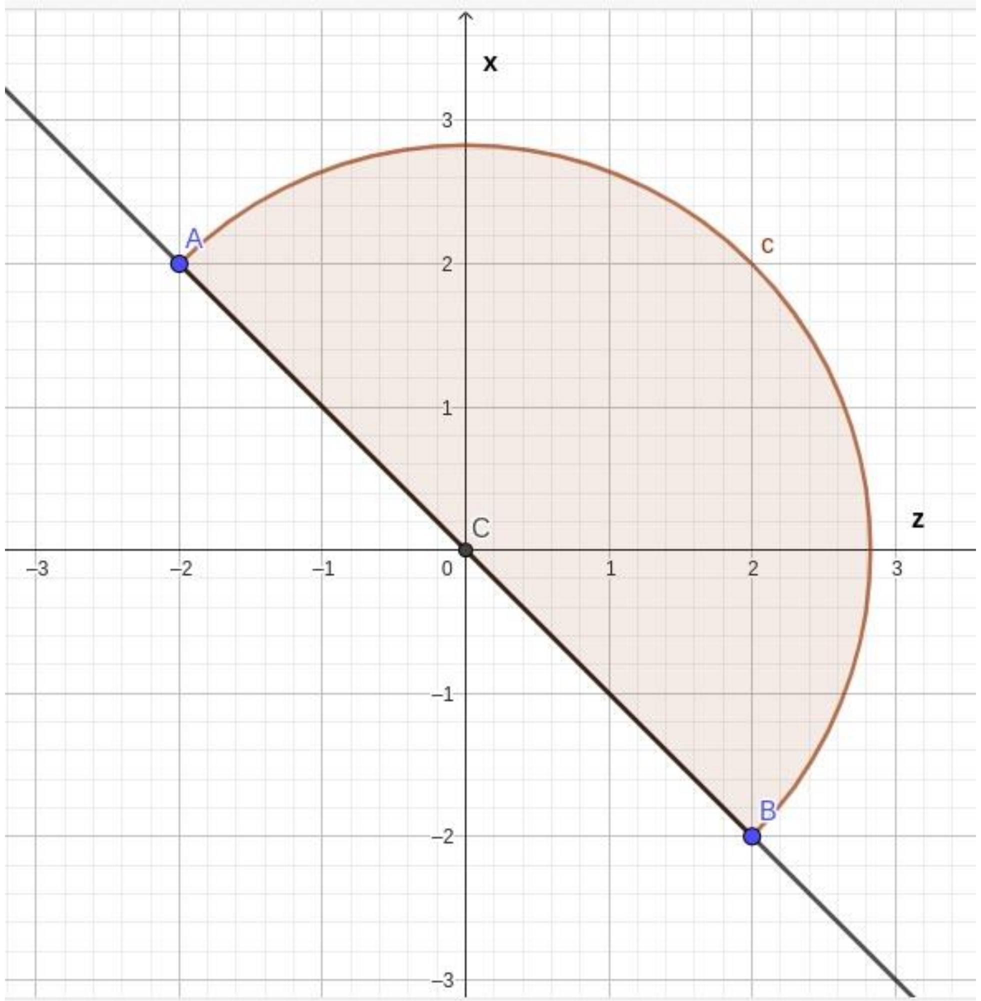
- Good statistics in the whole energy range

Exercise 3A

- Set up an isotropic direction sampling only in a half space as shown in the picture:

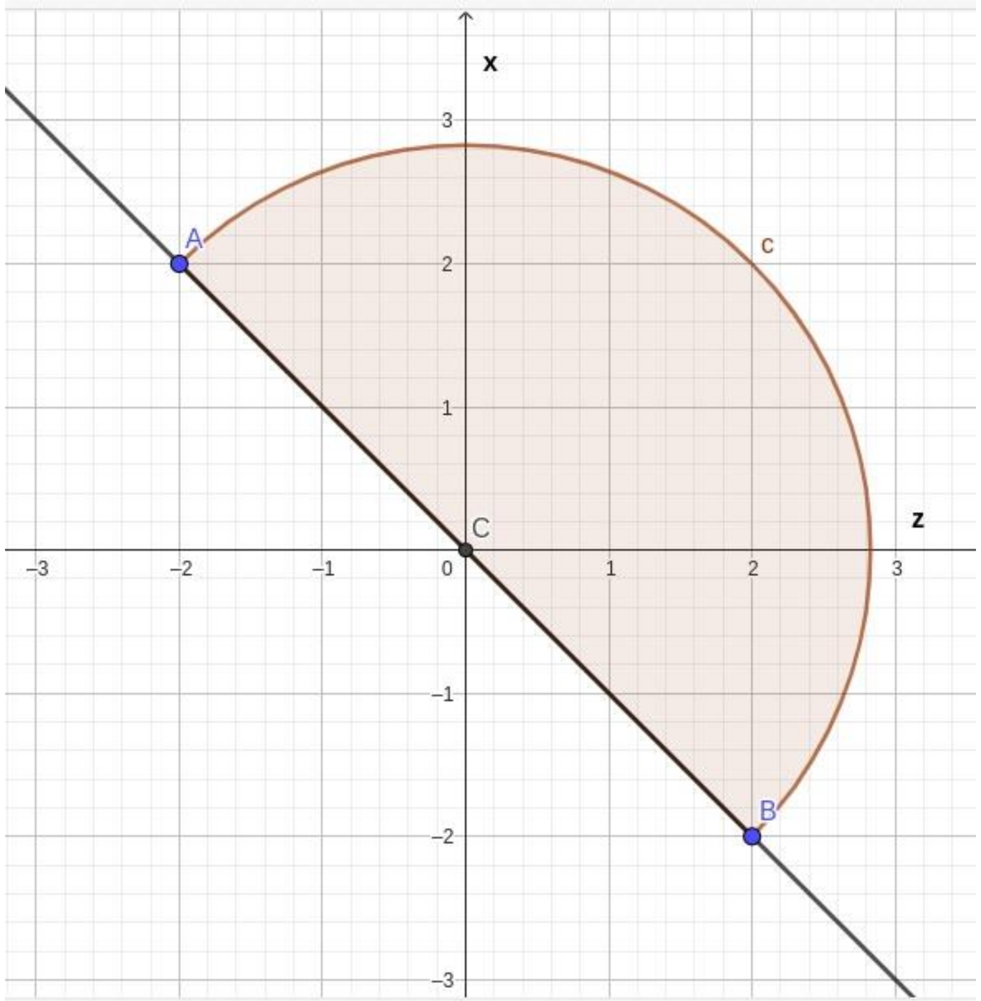
- In the source routine use a **`do while`** loop to reject the unneeded directions

- Use a USRBIN scoring to show the created radiation field



Exercise 3B

- Set up an isotropic direction sampling only in a half space as shown in the picture:

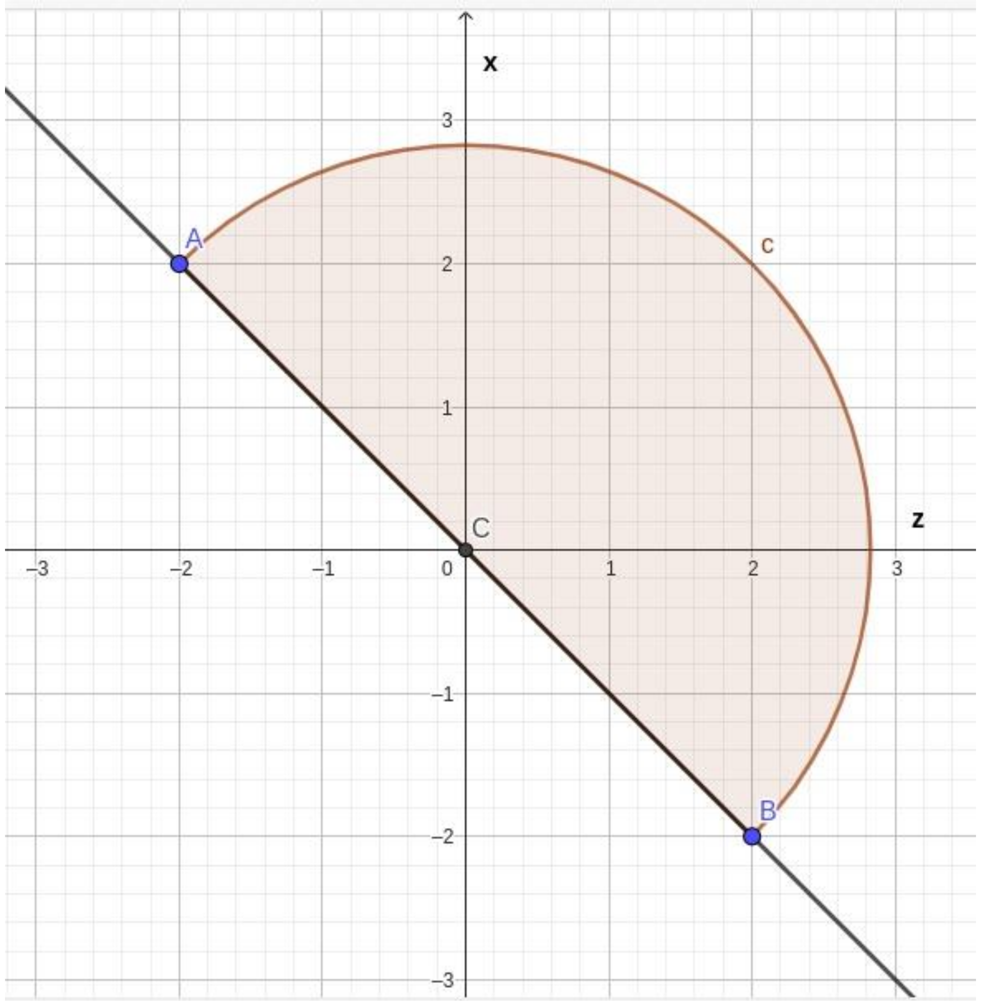


- Instead of the rejection method used in 3A:
- Mirror the Z < 0 half space of the isotropic direction sampling onto the Z > 0 part
- Apply a counterclockwise rotation around the Y axis to the sampled directions

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

Exercise 3C

- Set up an isotropic direction sampling only in a half space as shown in the picture:

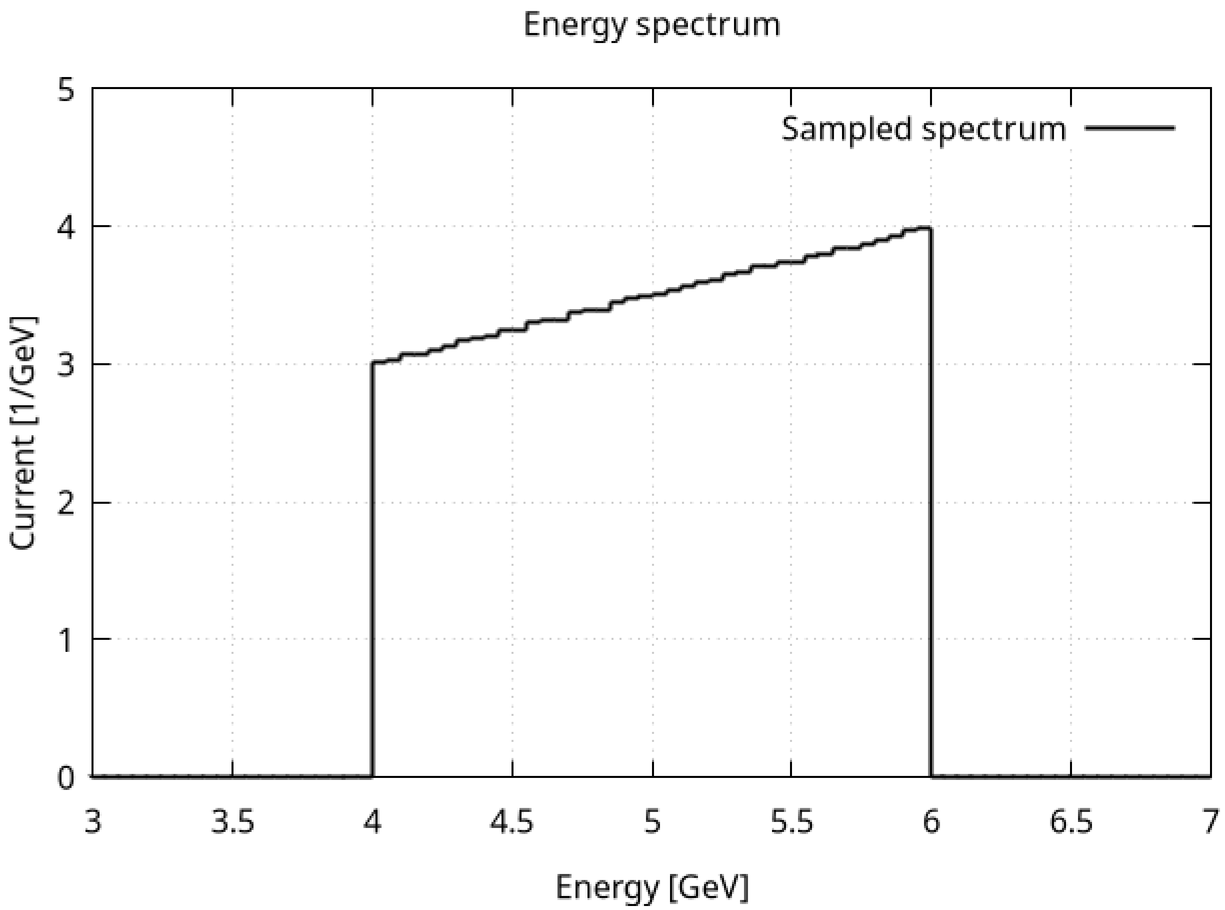


- Modify the source routine used in 3B to have the rotation as a separate subroutine

Exercise 4

- Set up an energy sampling from the following arbitrary function:

$$f(x) = \begin{cases} 0, & \text{if } x < 4 \\ \frac{1}{2}x + 1, & \text{if } 4 \le x < 6 \\ 0, & \text{if } 6 \le x \end{cases}$$



FLUKA