Exercise: source routine

First practice the “new” source routine

Starting Flair project

Based on the basic template

Beam

- Proton beam with 145 MeV energy

Geometry

- Target is removed
- Everything is in vacuum
- An ideal sphere (R=10cm) encloses the beam's starting location

Scoring

- **`USRBIN`** scoring of **`ALL-PART`** fluence – To see where the beam goes
- **`USRBDX`** scoring of **`PROTON`** fluence and **`ELECTRON`** fluence crossing the sphere

Exercise 0 – Adding the source routine

In this exercise we will add the default “new” source routine to a Flair project and test if it is working correctly.

1. Start with the provided template project
2. Add the “*Ex_source_routine.f*” to the project - [Complie] tab [Add] button
3. Give a name to the custom executable
4. Compile the custom executable – [Build] button
5. Add an empty **`SOURCE`** card to the input
6. Verify that the custom executable is selected on the [Run] tab for the *run/source_routine* simulation
7. Run the simulation
8. Verify that the source routine is called:

   Check the *.log* files for the debug output of the source routine

Exercise 1A – Beam divergence

Task:

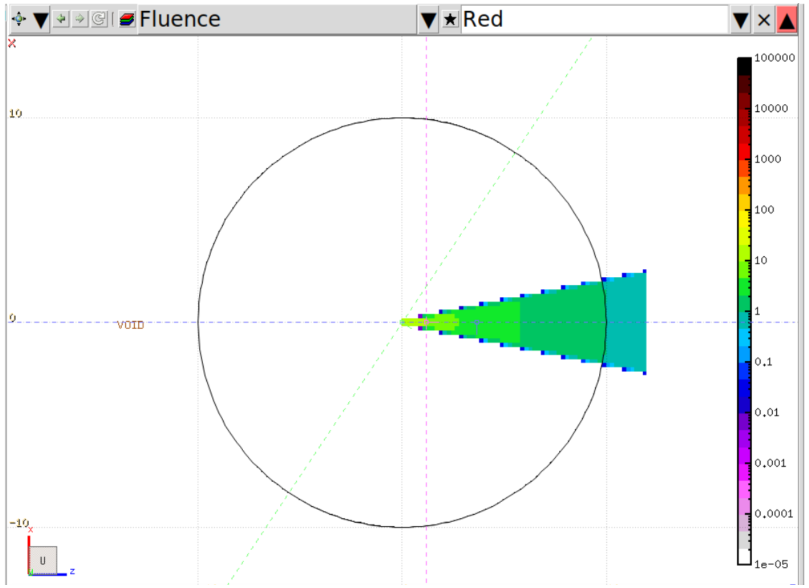
- Set a flat beam divergence:
  - X (X-Z plane): 400 mrad

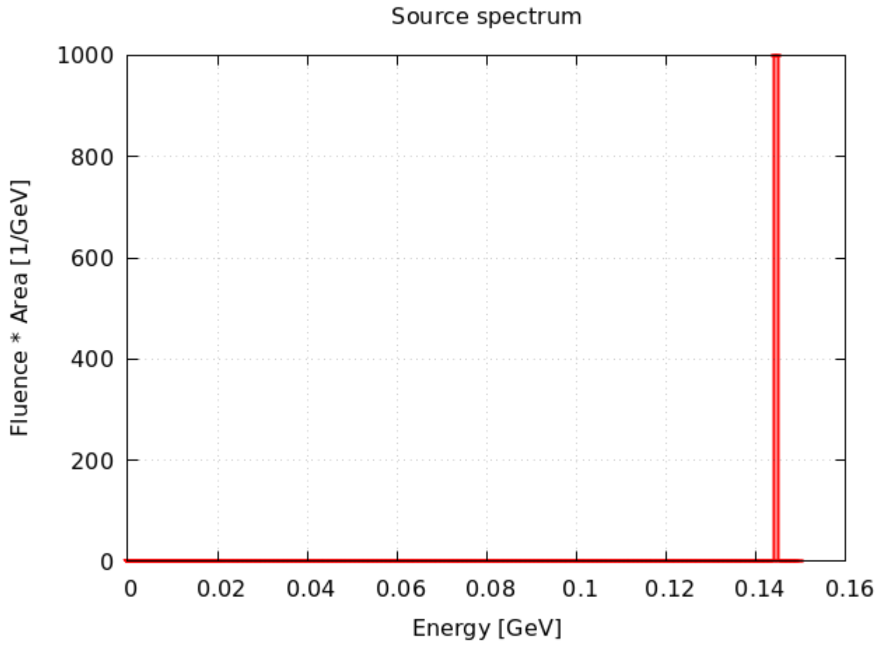
Steps:

1. Open the source routine with your preferred text editor
2. Enable the lines related to Exercise 1A
3. Set the value of the divergence
   - Use double precision formatting for numbers,
   - The unit is [radians] in the source routine, while [mrad] on the `BEAM` card

Exercise 1A – Beam divergence

4. Recompile your custom executable
5. Rerun the simulation
6. Process the data
7. Verify the divergence on the [Geometry] tab – Use the [Refresh] button
8. Plot the spectrum of the beam on the [Plot] tab





Exercise 1B – Beam divergence via SOURCE card

Task:

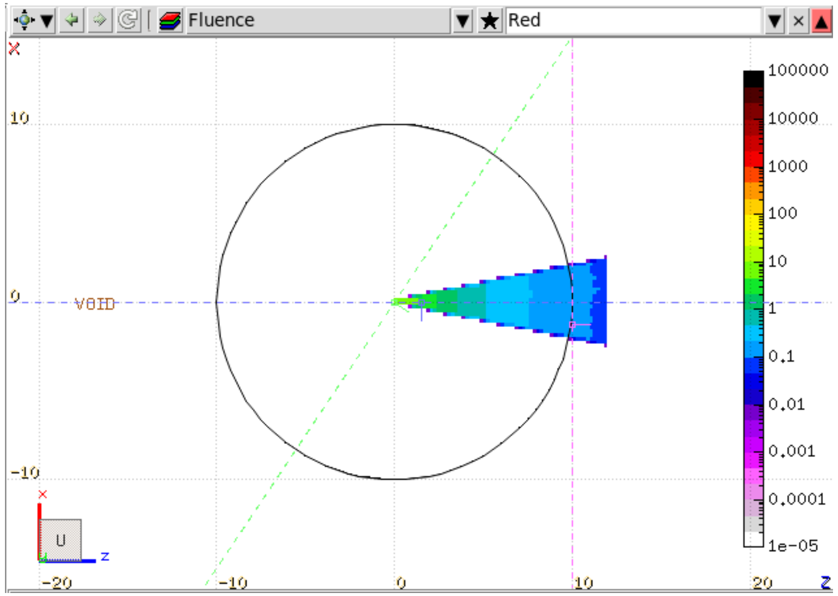
- Set a flat beam divergence:
  - Y (Y-Z plane): 200 mrad

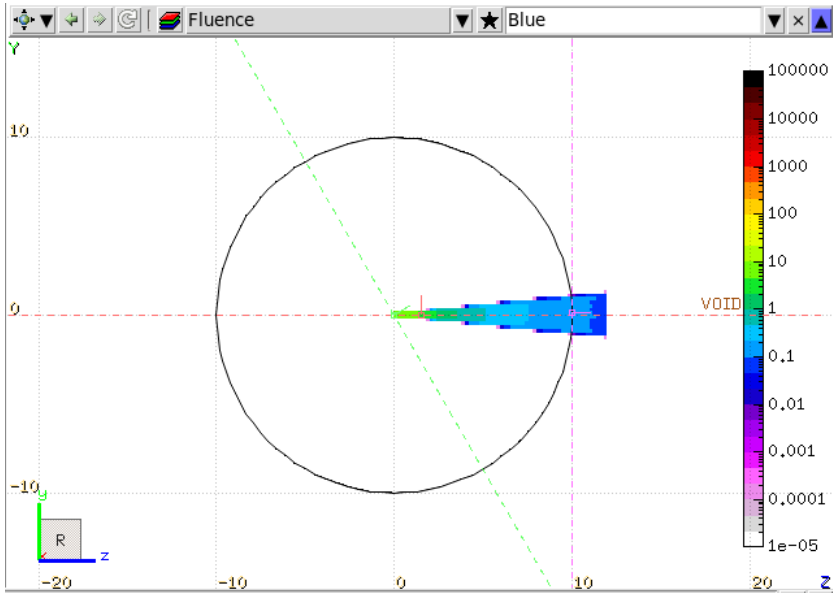
Steps:

1. Set the divergence in the **`SOURCE`** cards #1 field
   - The unit is [radians] in the source routine, while [mrad] on the **`BEAM`** card
2. Enable the lines related to Exercise 1B
3. Set the value of the divergence
   - Use the **`WHASOU(1)`** variable to access the #1 filed of the **`SOURCE`** card

Exercise 1B – Beam divergence via SOURCE card

4. Recompile your custom executable
5. Rerun the simulation
6. Process the data
7. Verify the divergence on the [Geometry] tab





Exercise 2 – Beam starting location

Task:

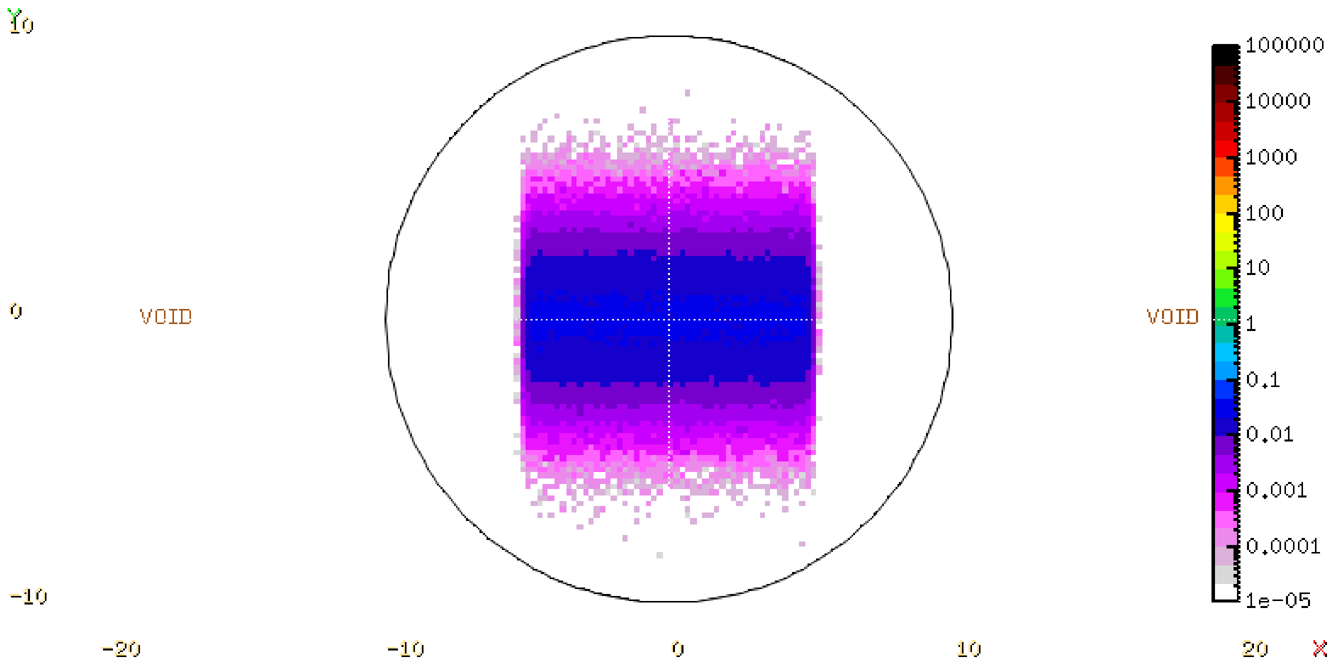
- Sample the starting location of the beam with built-in sampling functions
  - X coordinate: Uniform sampling between -5 and 5 cm
  - Y coordinate: Gaussian sampling around the origin with 4 cm FWHM

Steps:

1. Enable the lines related to Exercise 2
2. Set the input variables of the sampling functions according to the task

Exercise 2 – Beam starting location

4. Recompile your custom executable
5. Rerun the simulation
6. Process the data
7. Verify the beam starting location on the [Geometry] tab (X-Y plane)



Exercise 3 – Beam energy

Task:

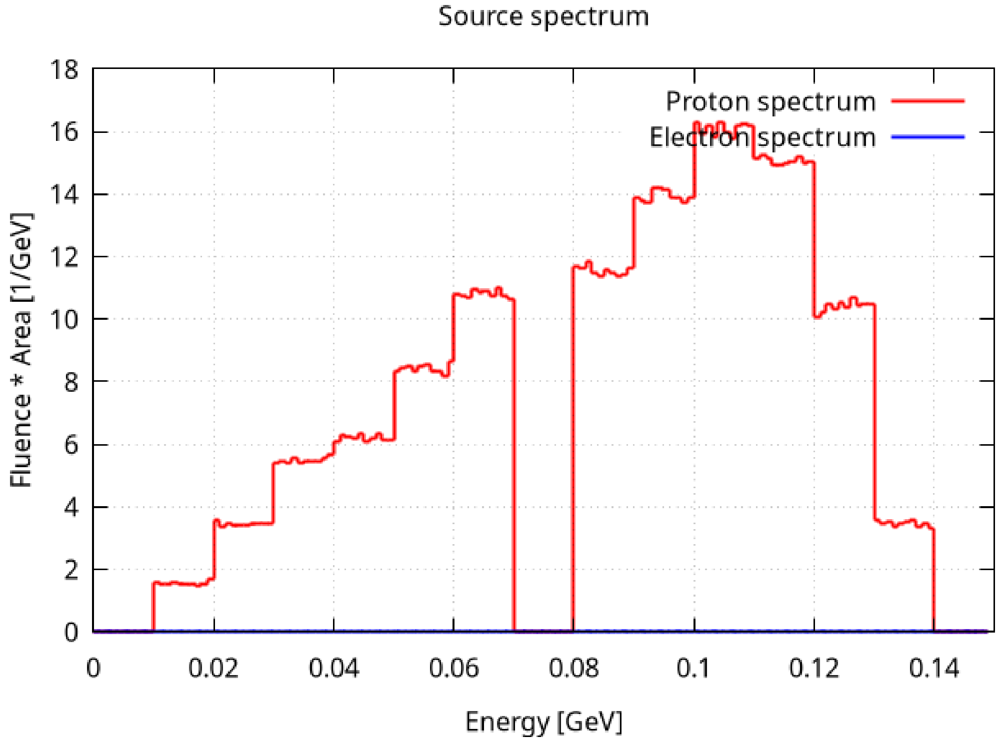
- Sample the beam energy using an external histogram file
  - Filename: “histogram.txt”
  - Units: “MeV”

Steps:

1. Enable the lines related to Exercise 3
2. Set the input variables of the sampling function according to the task

Exercise 3 – Beam energy

4. Recompile your custom executable
5. Rerun the simulation
6. Process the data
7. Plot the spectrum of the beam on the [Plot] tab



Exercise 4 – Two simultaneous beam

Task:

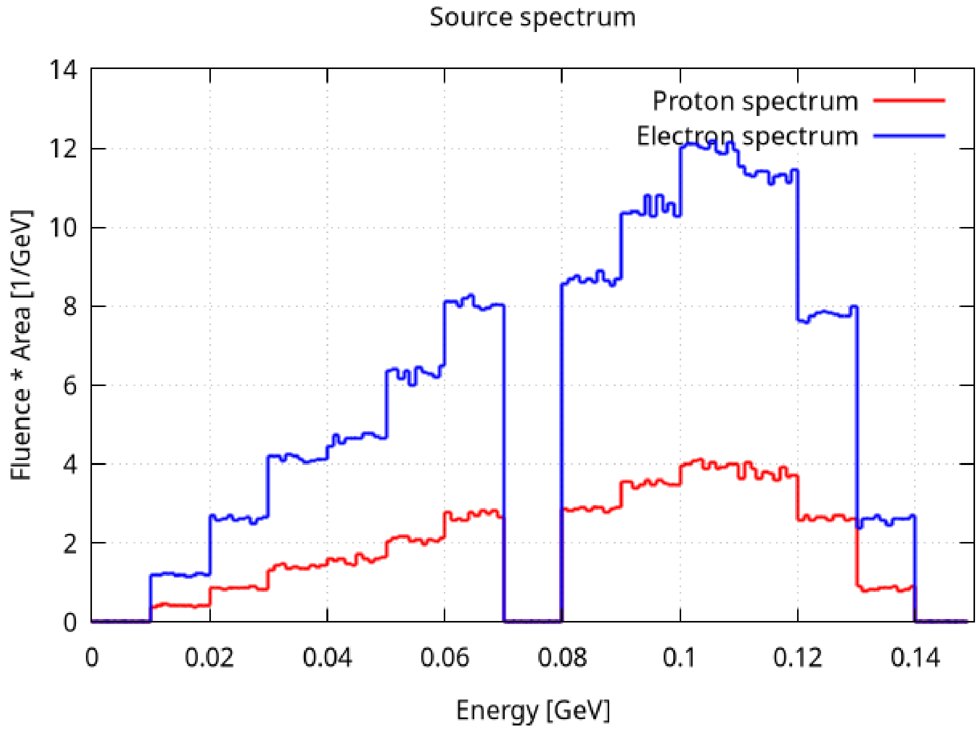
- Set the primary particle to protons and electrons with a relative ratio of 1:3

Steps:

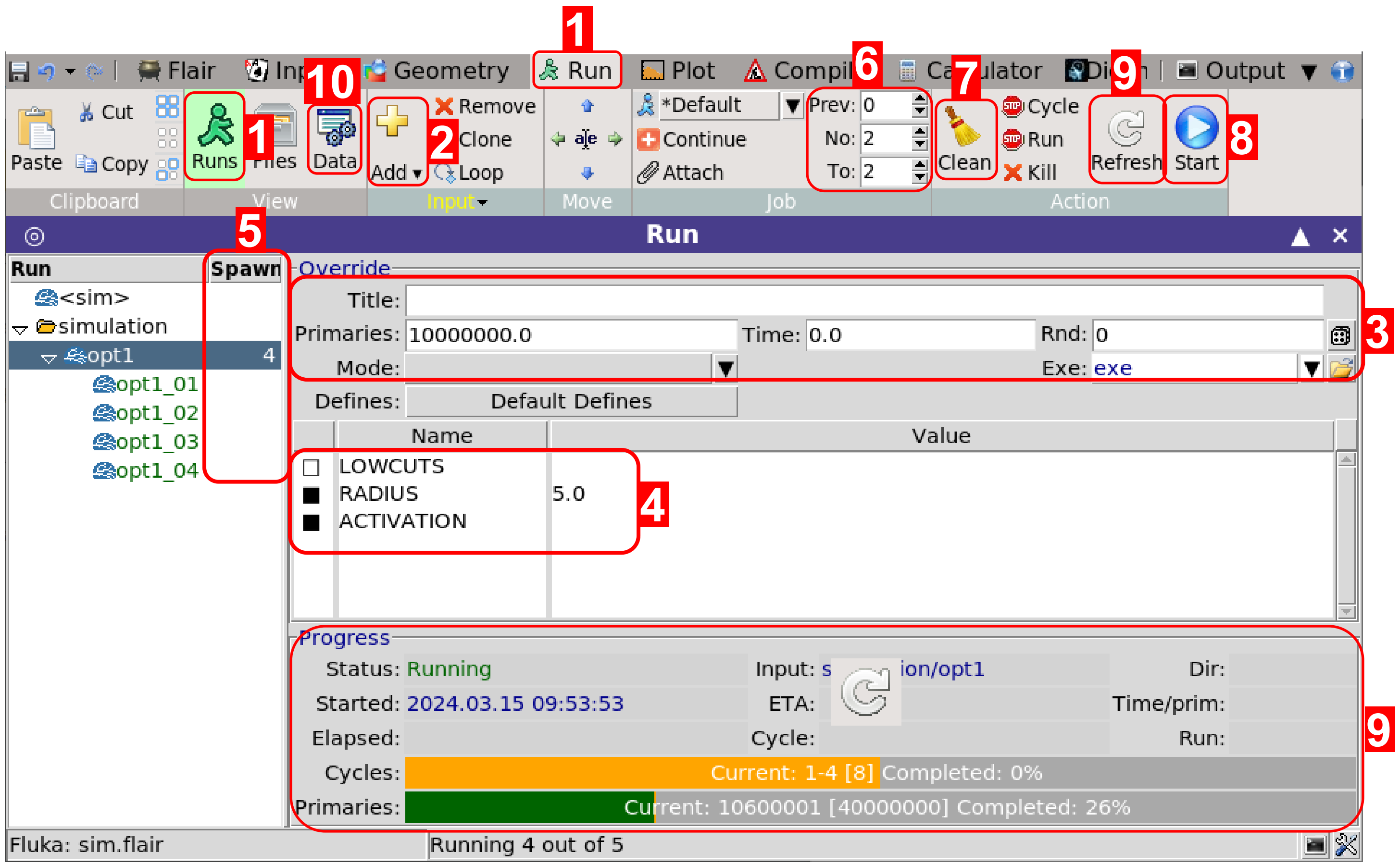
1. Enable the lines related to Exercise 4
2. Set the total (!) ratio of the protons in the `proton_ratio` variable
3. Set the particle codes for electrons and protons
   - The list of particle code are available at https://flukafiles.web.cern.ch/manual/chapters/particle_and_material_codes/particles_codes.html

Exercise 4 – Two simultaneous beam

4. Recompile your custom executable
5. Rerun the simulation
6. Process the data
7. Plot the spectrum of the beam on the [Plot] tab



Flair Cheat Sheet



Remember!

- You can **STOP** or **KILL** the run.
- You can edit your input while the simulation runs.

!!! WARNING !!!

- Mind the memory and CPU usage of your simulations!

1. Go to the ***Run* tab**, select ***Runs* view**.
2. Add **new folder** + Add **new run**.
3. Override the input run info:
   - **Number of primaries**
   - Title / Max. time per cycle / Seed / Exec.
4. Override/Define variables.
5. **Recommended:** Increase number of spawns
6. Set number of cycles per spawn
   - Recommend at least 5 cycles in total.
   - `num_cycles_tot = num_cycles_per_spawn * num_spawns`

7. ***Clean*** run files after change to input or run settings.
8. Click ***Start*** to launch the simulations.
9. Monitor the progress. Click ***Refresh*** to force update.
10. After all cycles end:
    - Go to the ***Data*** ( ) tab.
    - Click ***Process*** ( ) to combine all cycles and create simulation data files.
    - You may need to refresh ( ) and scan ( ) if detectors are missing.

FLUKA