



Exercise: Scoring I

Aim of the exercise:

- Learn how to use **USRBIN** scoring cards
- Learn how to look at simulation results
- Plot a Bragg peak
- Bin size choice
- Scoring by region vs. scoring in a mesh

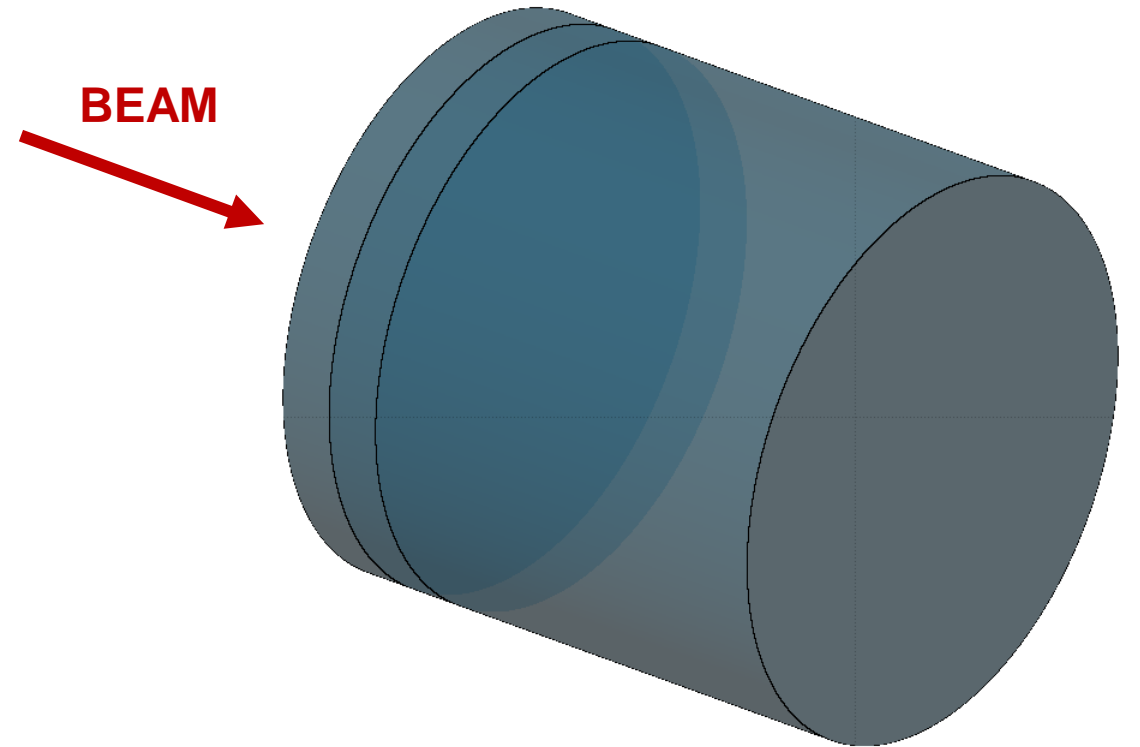
The input file

- Geometry

- Cylindrical water target, centered on and parallel to z-axis
- $L = 10$ cm, $R = 5$ cm
- Split into 3 parts along z-axis (1-1-8 cm) for scoring purposes

- Beam

- 100 MeV protons (zero beam size and divergence) hitting centre of front face

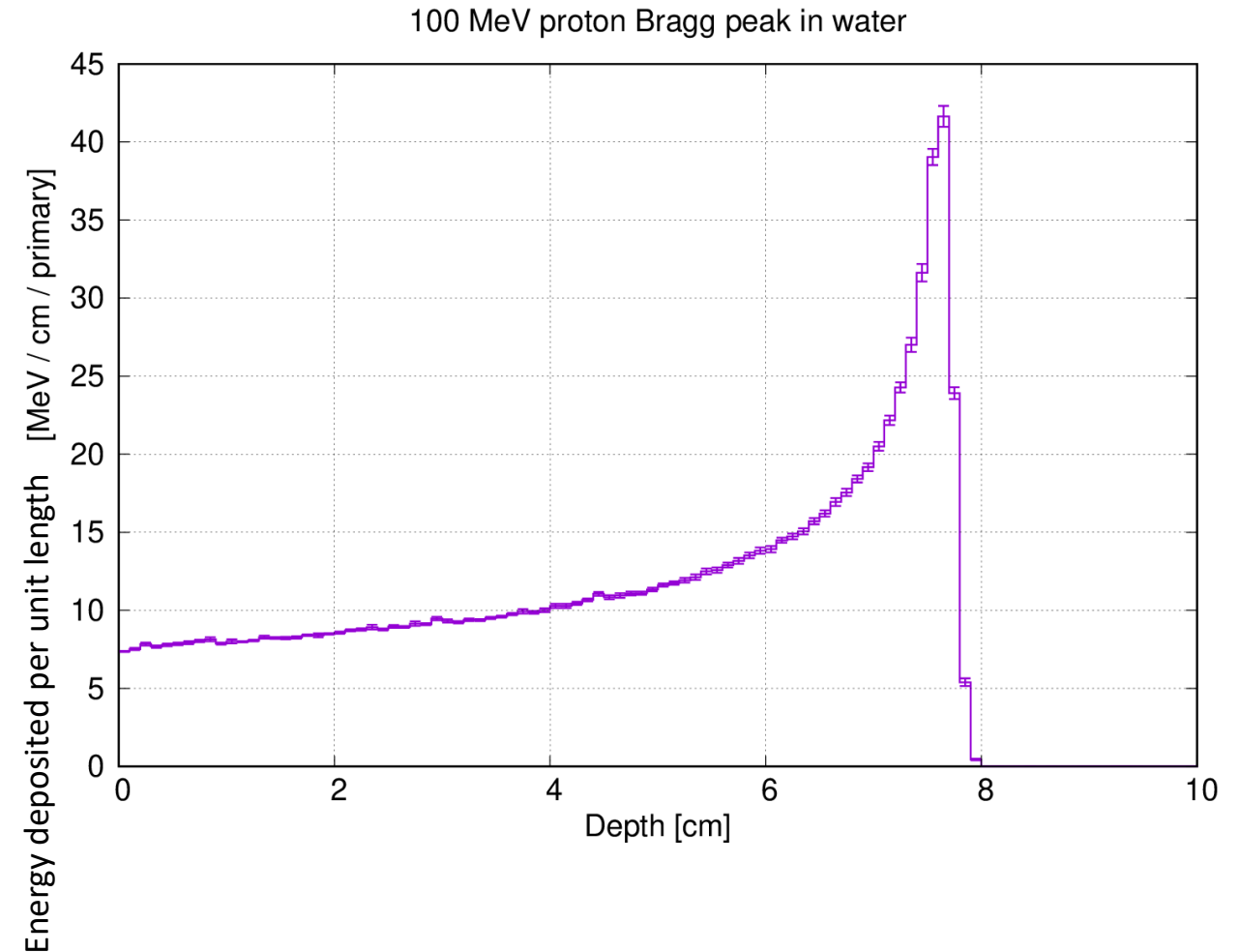


Add these scorings to the input file and run

1. Plot the energy deposition per unit length [MeV/cm]. Observe the Bragg peak.
 - Add a **USRBIN** covering the target to score ENERGY with a 0.1-cm R-bin, 1 Φ -bin, 0.1-cm z-bins
 - Think what you will need to plot: **1D Projection** or **1D Max**?
 2. Compare results with different bins sizes.
 - Add a **USRBIN** covering the target to score ENERGY with a 0.2-cm R-bin, 1 Φ -bin, 0.1-cm z-bins
 3. Compare values obtained via **USRBIN** per region and on a mesh.
 - Add a **USRBIN** covering the target to score ENERGY with a 1 R-bin, 1 Φ -bin, 10 z-bins (1-cm)
 - Add a **USRBIN** to score ENERGY by region
- Run 5 cycles, 1000 primaries each, process the data files
 - Try running with different number of primary/cycles, and look at statistics

1: Plotting the Bragg peak

- In the Plot tab, click "Add" (yellow +), and select **USRBIN**
- Select the binary file associated with your first **USRBIN** card, and plot a **1D Projection (Z)** ("Type")
- How to get energy deposition per unit path length [MeV/cm] starting from energy deposition density [GeV/cm³]?
 - You will need to multiply by the transverse scoring area and convert GeV to MeV

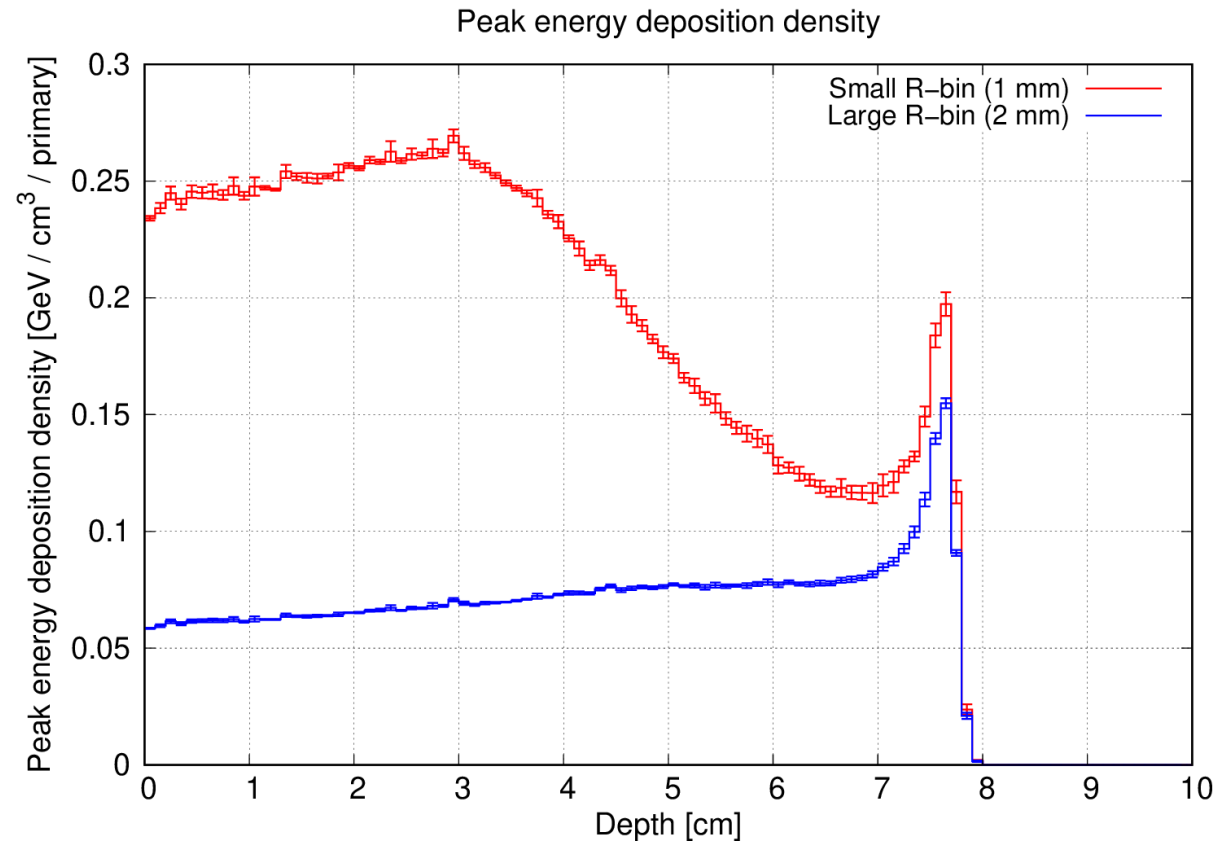


2: Comparing results with different R-bin sizes

- For each of the first two **USRBIN** scorings (different radial bin sizes), plot a **1D Max** curve (Z) to obtain the peak energy deposition density along the Z axis.

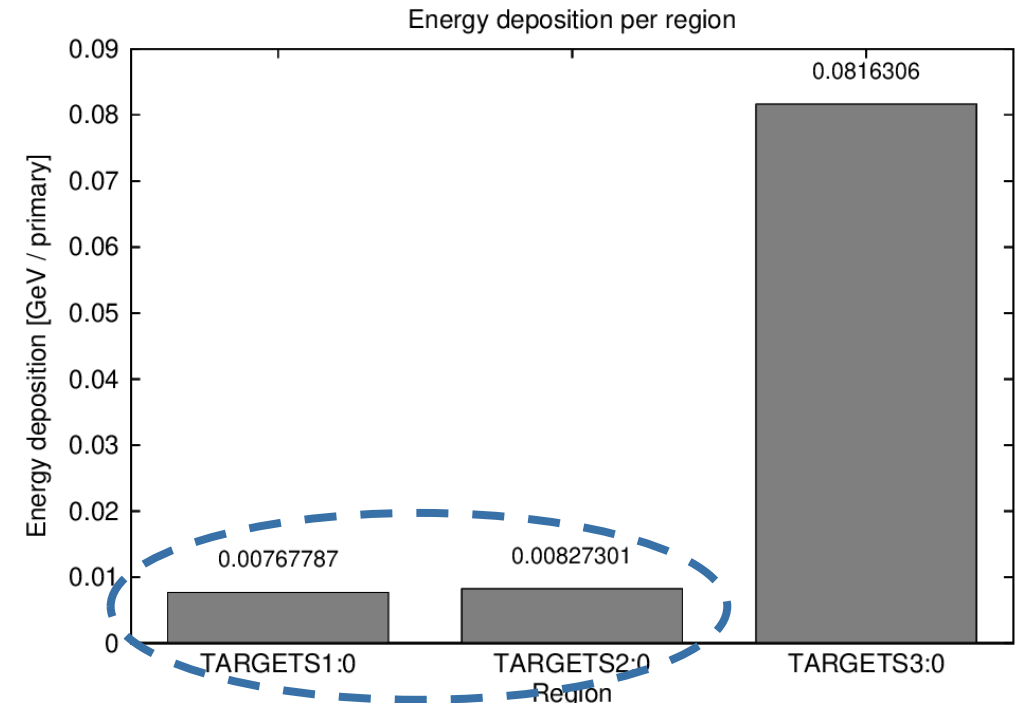
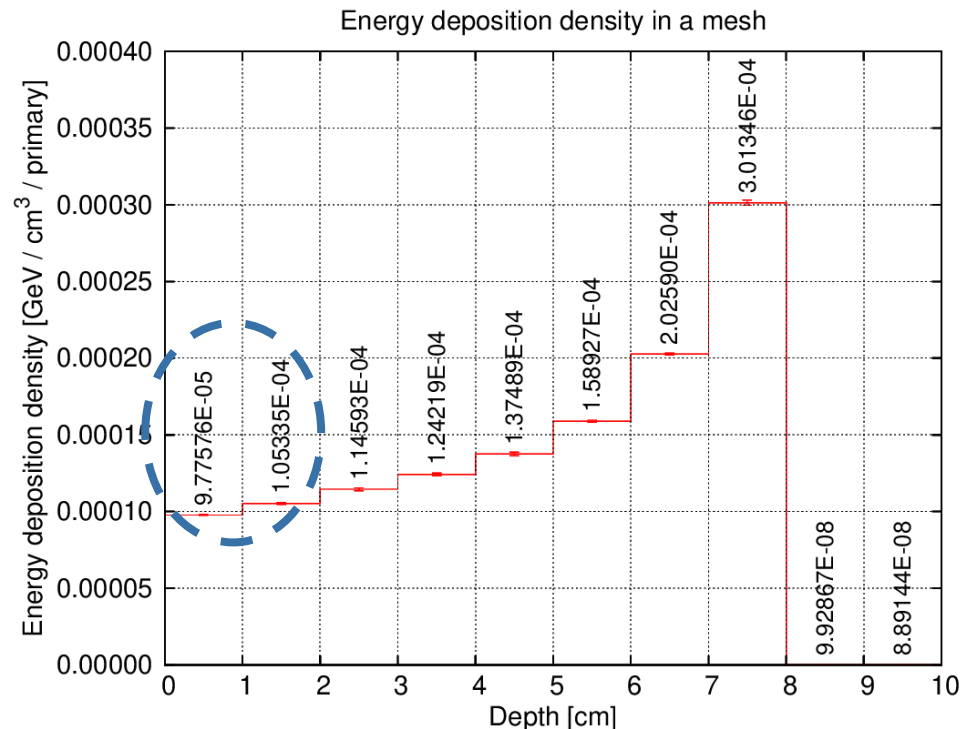
Hint: In the Plot tab, click "Add" (yellow +), and create a new **USRBIN** plot for each mesh.

- Compare the two results in a single plot, using the **USR-1D** plot in Flair (click "Add" again, and create a new "USR-1D"). Select *histererror* to plot statistical errors
- Note that:
 - The 2-mm binning gives a lower peak value: be careful with bin size, without exaggeration. The choice depends on beam, geometry, thresholds.
 - The 1-mm binning has larger statistical errors: too small bins can cause slow convergence, and might be meaningless

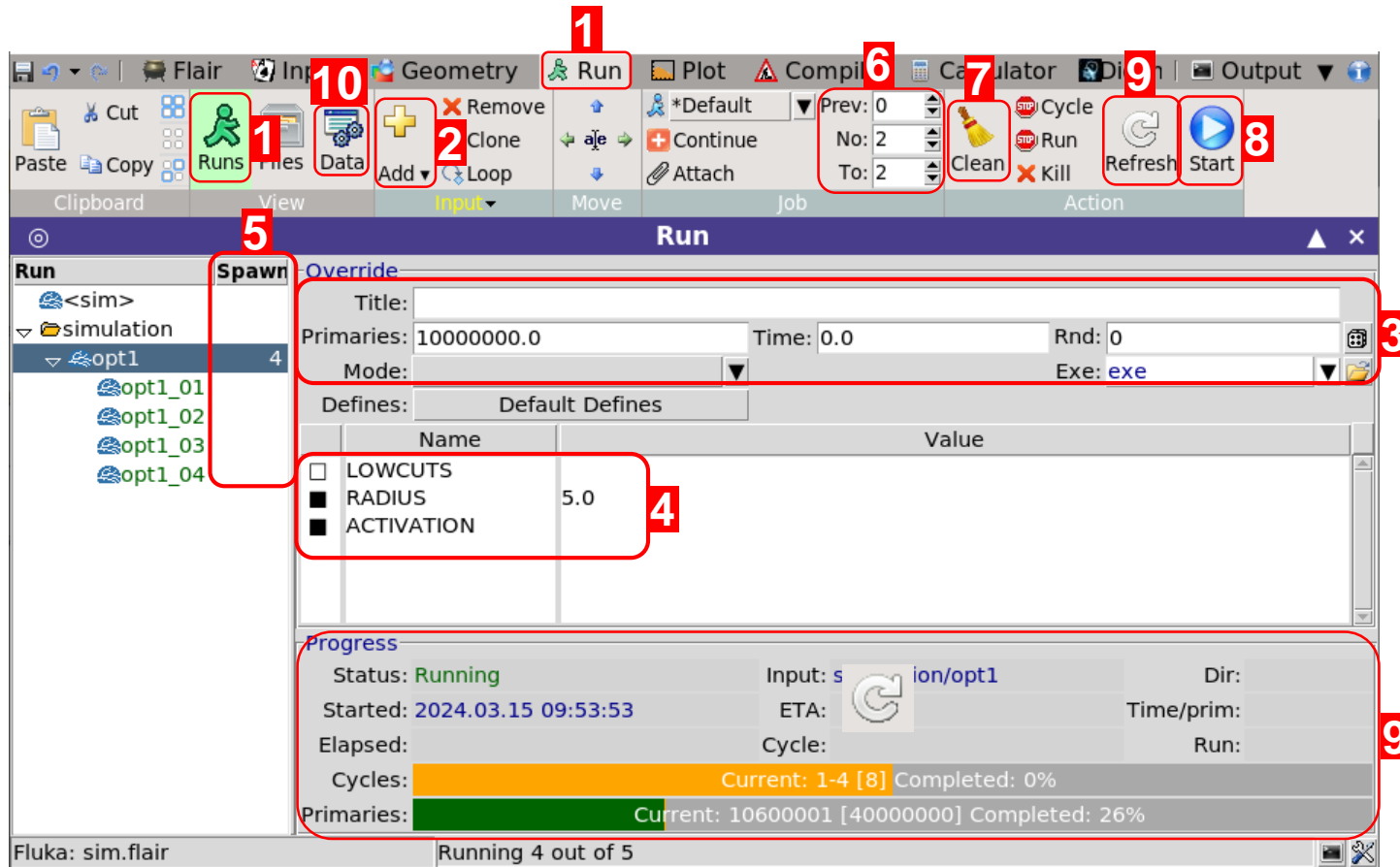


3: Comparing scoring by regions and in a mesh

- Plot the 3rd **USRBIN** scoring (energy deposition density in a mesh with a single radial bin, left) and the 4th **USRBIN** scoring (energy deposition per region, right) with 1D projection.
Hint: In the Plot tab, click "Add" (yellow +), and create a new **USRBIN** plot for each mesh.
- The first two bins of the mesh scoring (left plot) correspond to the regions TARGETS1 and TARGETS2 (right plot), respectively.
 - Do you see why the values are different between the left and right plots? The scaling factor is 78.5398...



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!



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

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



