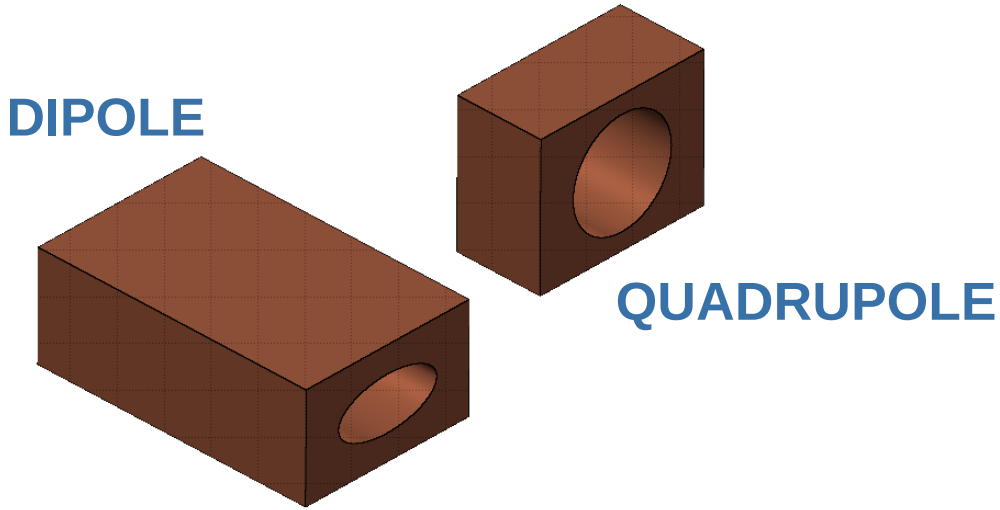
FLUKA

Exercise: geometry

Build a simple beamline using replicas (LATTICE) and practice scoring with replicas

The input file

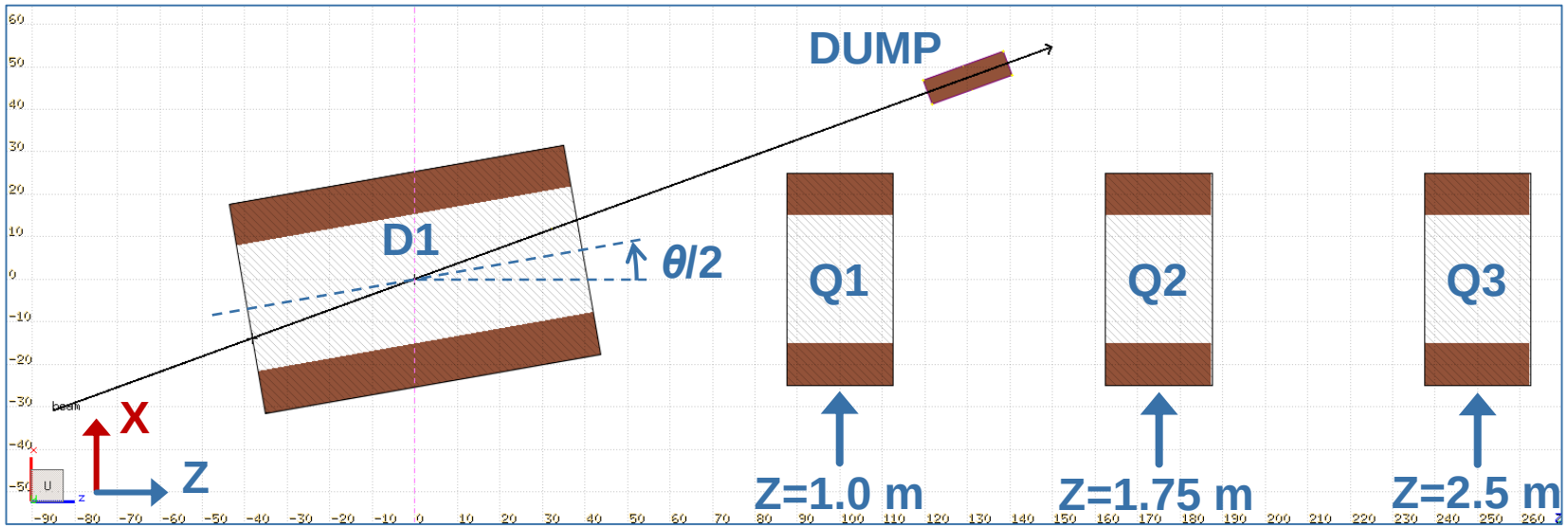
- On the x-z plane, a simple prototype dipole (L=0.8 m) and a prototype quadrupole (L=0.25 m) are “parked” along the x-axis



- A beam is already defined:
  - 1 GeV/c protons, no momentum spread
  - Pencil beam: point source, no divergence
  - Propagation on the x-z plane from its point of origin towards the origin of the geometry coordinate system, at an angle θ=20° (already **`#define`**’d as *Theta*) with respect to the z-axis

- A small beam dump is already present along the beam path.

Building the geometry



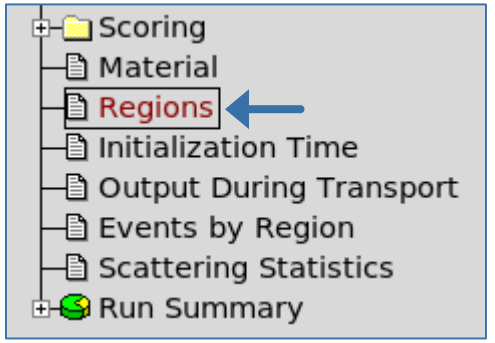
- First, enclose the prototypes in a “parking” region, isolating them from the rest of the geometry
- Create a replica of the dipole centred at the origin and rotated by an angle $\theta/2=10°$ around the y-axis
- Create three replicas of the quadrupole and place them as shown above (the drift space between Q1-Q2 and Q2-Q3 should be 0.5 m)
- Remember:
  - The replica container should be identical to the prototype container
  - You need to define the empty lattice regions, the relevant transformations and add the necessary LATTICE cards

Scoring

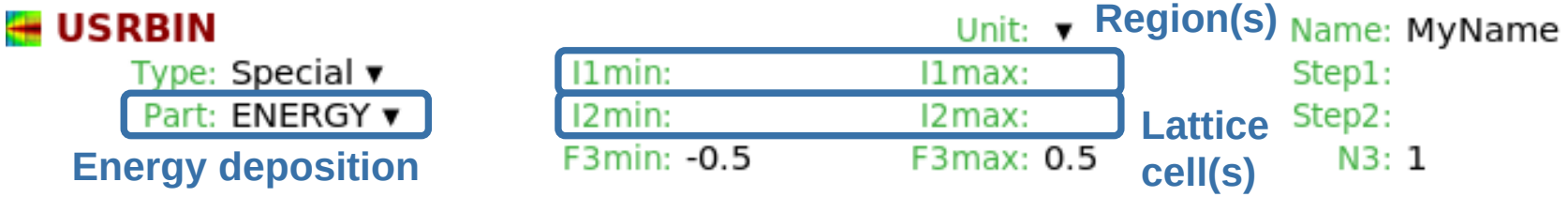
1. A USRBIN proton fluence scoring is already included covering the area of the beamline and dump

2. Add a USRBIN region scoring requesting the energy deposition (ENERGY) in the QUADYOKE region (i.e. in the prototype)

Special USRBIN scoring



- To define special USRBIN scorings, you will need to retrieve the region and lattice cell numbers. Execute a quick run (1 primary is enough) and look for them in the standard output file (…`001.out`) →
- The first discrete variable in the card corresponds to the region(s) and the second one to the lattice cell(s); the third continuous one is not used here and is zero by default, so just add one bin around zero:



3. Add a special USRBIN scoring (i.e. per region per lattice) requesting the energy deposition (ENERGY) in each quadrupole replica (the relevant region is QUADYOKE)
4. Add a special USRBIN scoring (i.e. per region per lattice) requesting the energy deposition (ENERGY) in the dipole prototype and the dipole replica (the relevant region is DIPYOKE).
   - Remember: the prototype is always assigned the lattice cell number 0

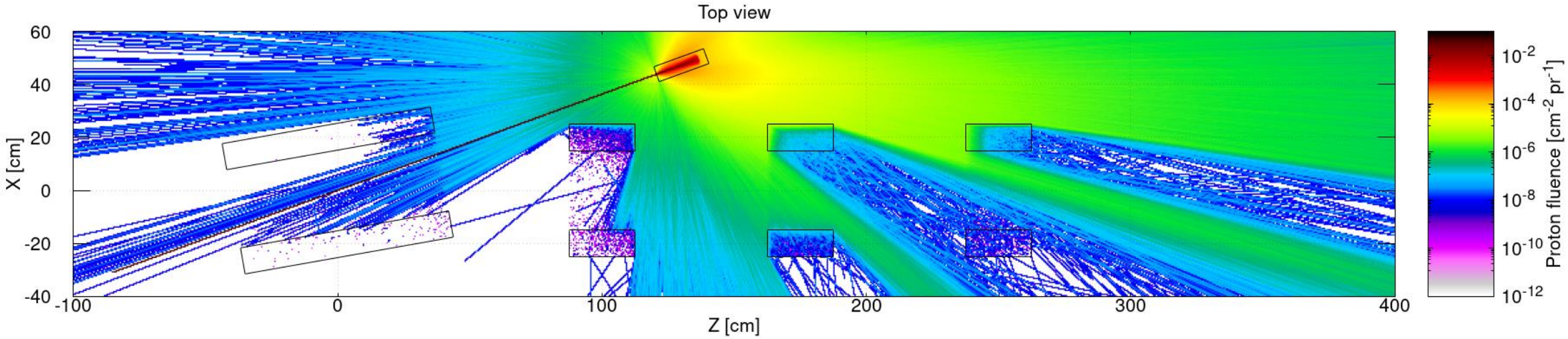
Run

- When you are ready, run 5 cycles with 5000 primaries each (~1 minute). If you have more than one core available, use the Spawn feature in Flair to generate the corresponding number of jobs.

Plot and analyse results

Plot and analyse results

1. Plot a top view (x-z plane) of the proton fluence USRBIN scoring. The beam should be hitting the beam dump, as shown below (with better statistics)



Plot and analyse results

2. Plot the energy deposition in the QUADYOKE region. Note down the value.

3. Plot the energy deposition in the quadrupole replicas.
   - Which quadrupole is most impacted?
   - How do the energy deposition values in the three quadrupole replicas relate to the value you previously noted down?

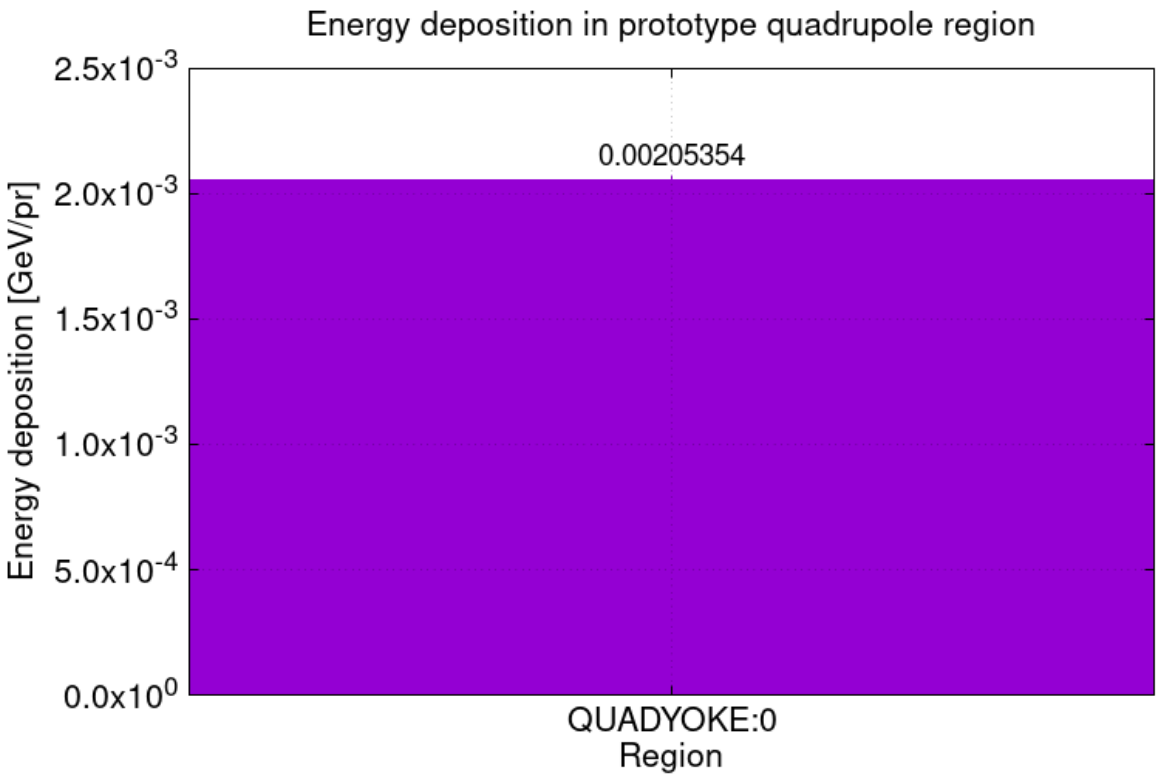
4. Plot the energy deposition in the dipole prototype and replica.
   - How much is the energy deposition in the prototype? Is this what you expected?

- In the exercise on magnetic/electric fields, you will apply magnetic fields to the magnets and transport the beam through the beamline!

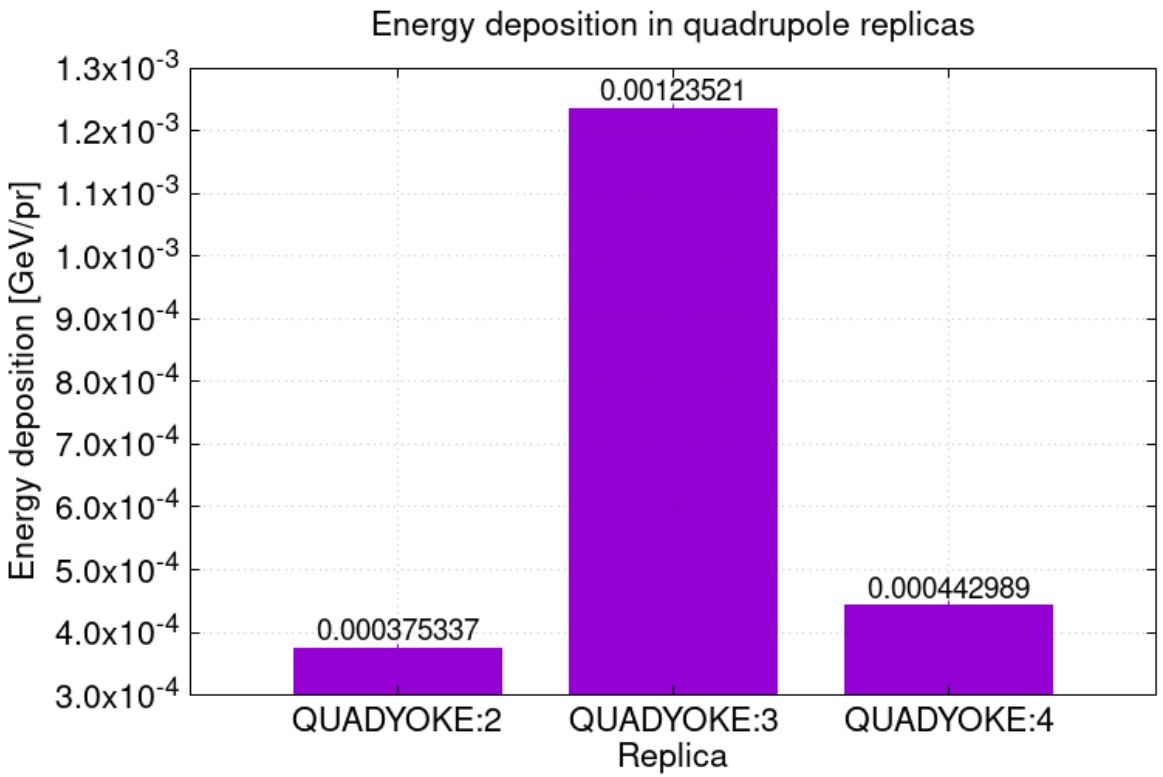
Results

Energy deposition in the quadrupoles

QUADYOKE region (prototype)

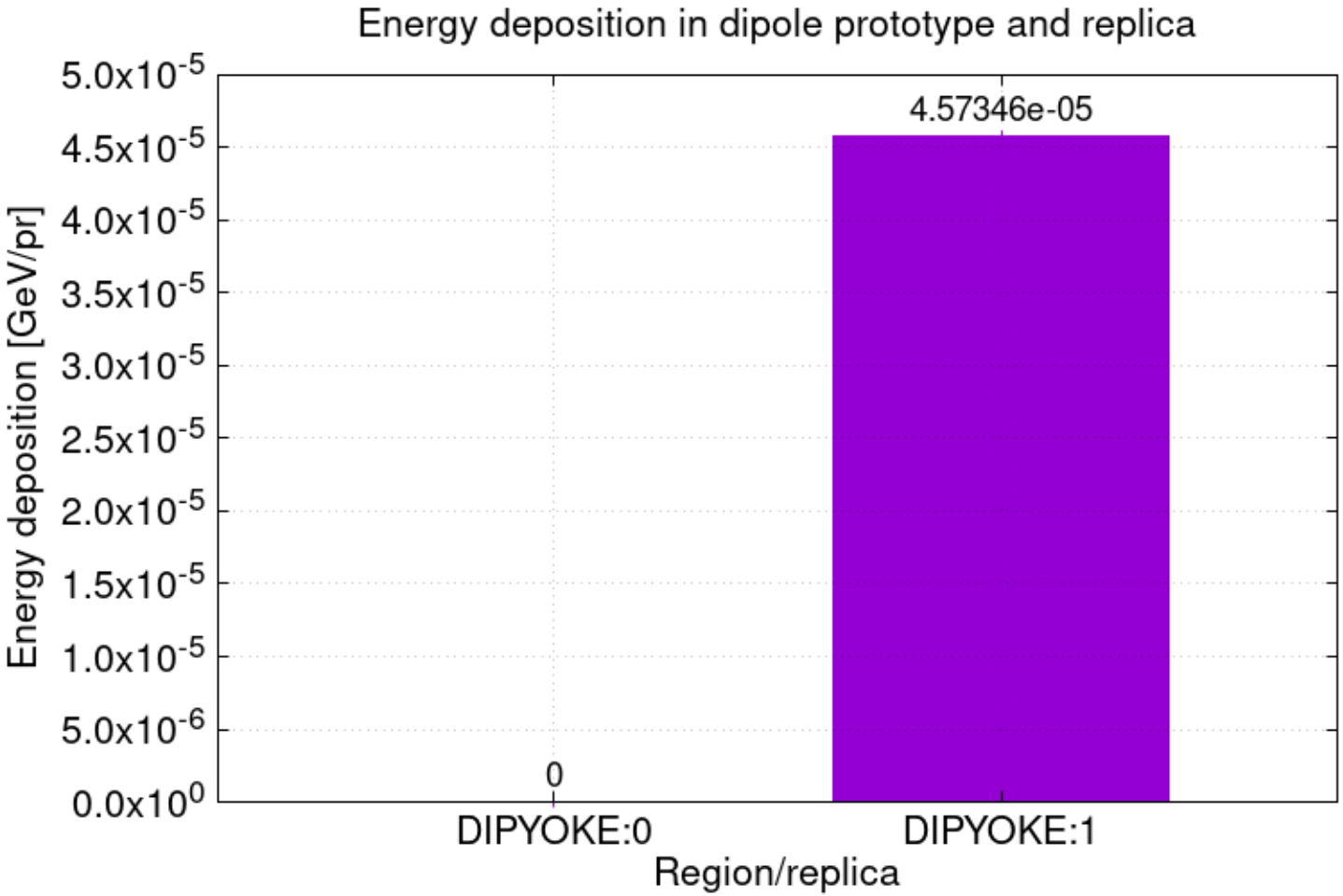


Quadrupole replicas



- The energy deposition in the prototype (when scoring simply per region) is the sum of the energy deposition in the replicas

Energy deposition in the dipole



- When scoring per region per lattice, the energy deposition in the prototype is zero (since it was isolated from the rest of the geometry)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