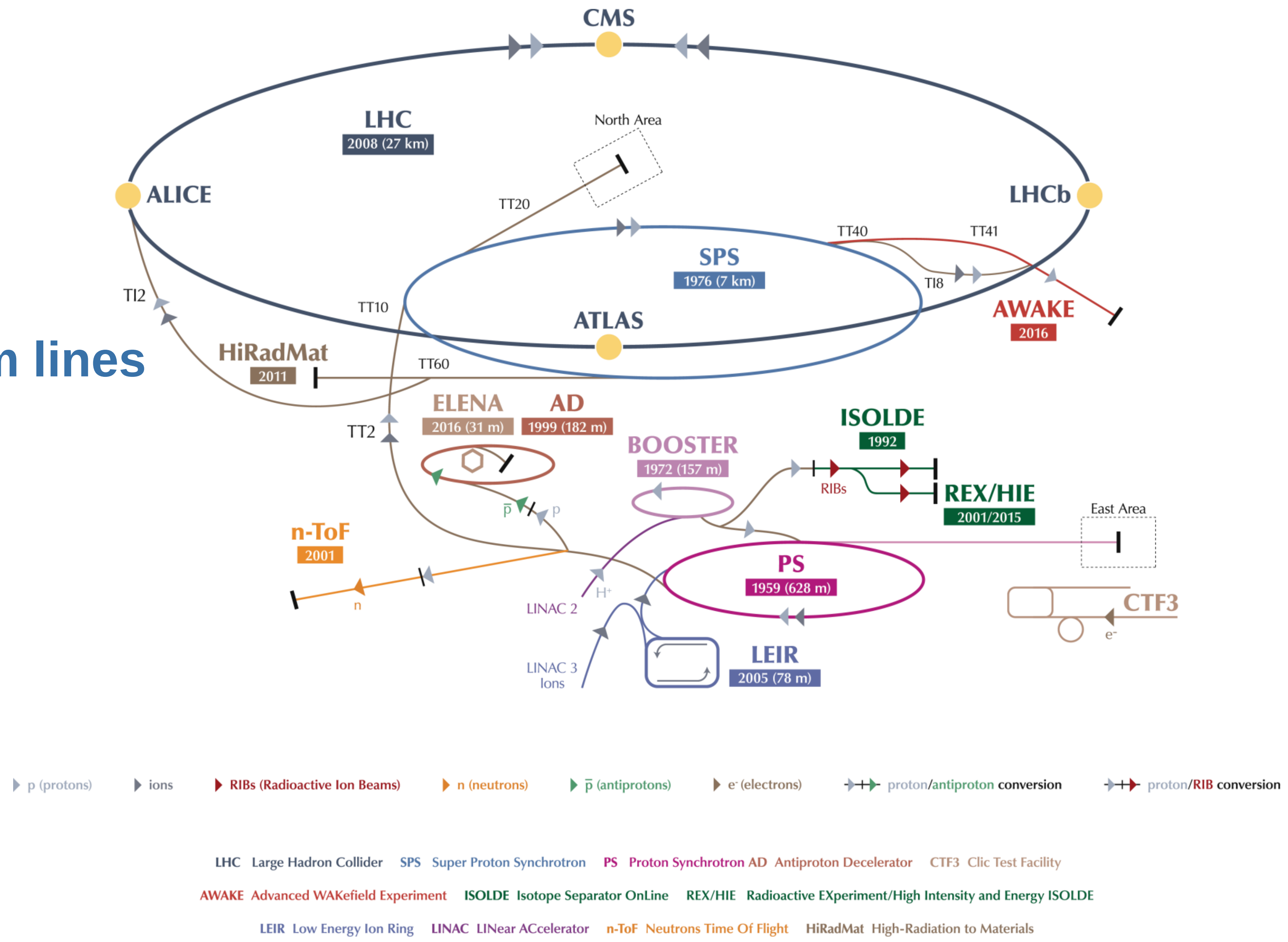
Secondary Beam Lines Exercise

First complete beam line in FLUKA

Overview

- **Purpose and users**
- **Secondary/tertiary beam lines**
- **Exercise introduction**



Purpose and Users

Secondary Beam Areas (SBA) are hosting:

- **Fixed Target experiments**: COMPASS,NA61, NA62, NA63, NA64, CLOUD, …
  - Precision studies (QCD, standard model, BSM physics)
  - Stable beam conditions for weeks and weeks

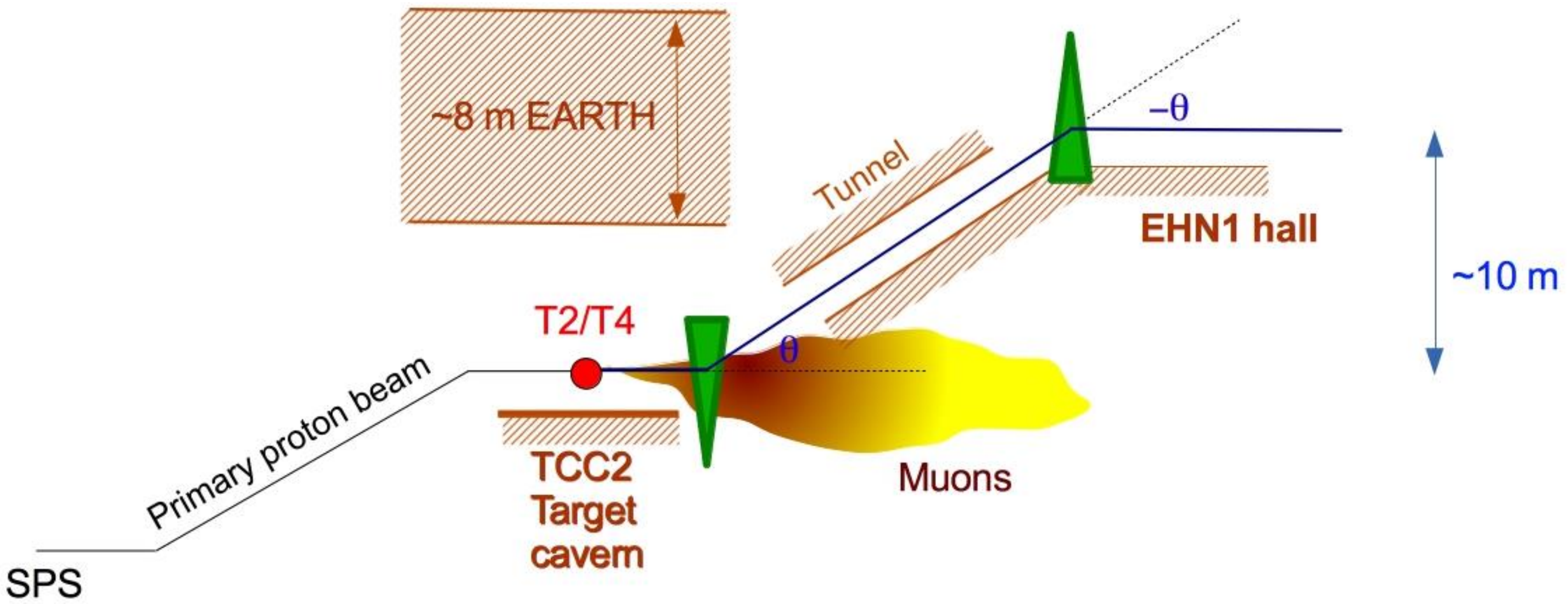
- **Irradiation facilities**: HiRadMat, Charm, Irrad, GIF++

- **Test beams:**
  - Detector prototype tests
  - Detector calibration

    e.g. for LHC, linear colliders, space & balloon experiments
  - Outreach
  - Usually require a large spectrum of beam conditions within few days

North Area beamline design considerations

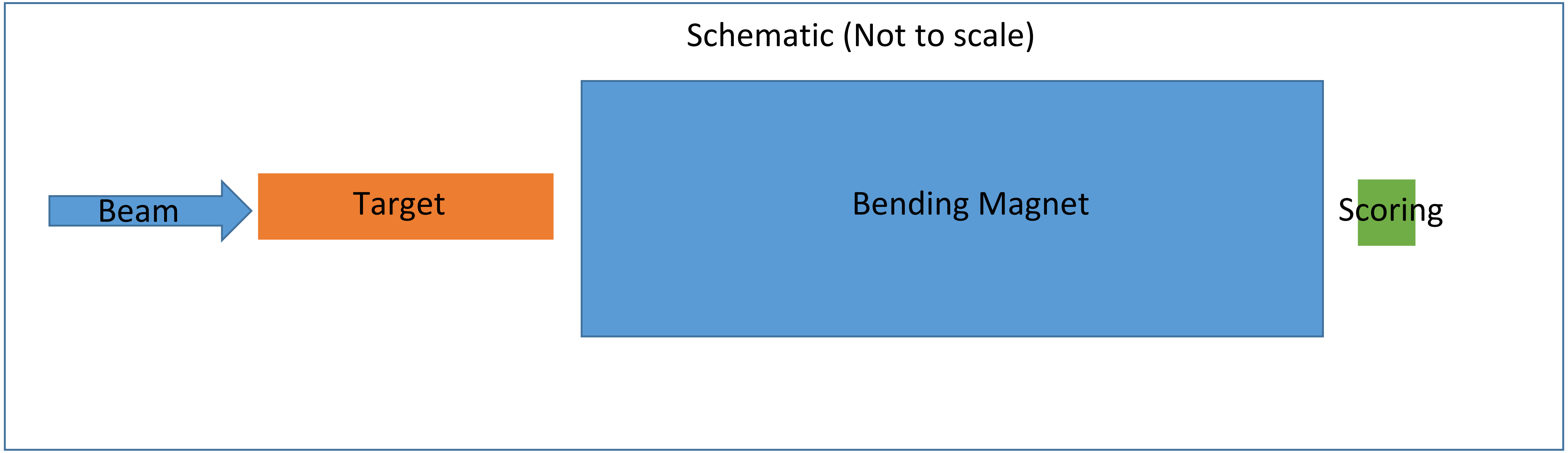
- Flexibility of particle type and beam settings
- Muon range (absorb underground)
- Charged pion lifetime
- Momentum selection ($2\cdot10^{-4}$)



Secondary Beam Lines

Study of CERN secondary beam lines:

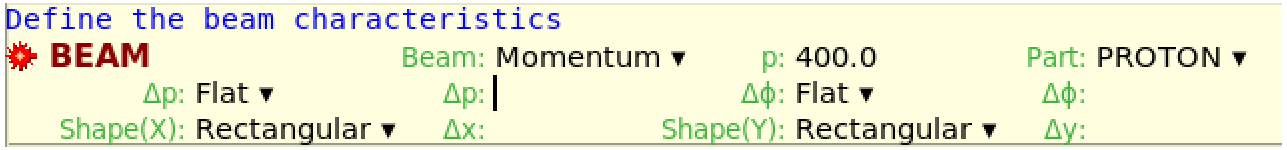
- Create your first complete beamline from scratch:
  - Define a primary proton beam
  - Define a target on which the proton beam will collide
  - Define a bending (sweeping) magnet after target
  - Score neutrons and protons after the magnet



Secondary Beam Lines – To be done

Preparation of the input file

- Start from scratch → no input given. You can use the predefined basic examples in FLAIR.
- Define a pencil proton beam (0 divergence and 0 spatial distribution in X,Y) with 400 GeV/c momentum. The beam starts on axis at z = -10 cm.



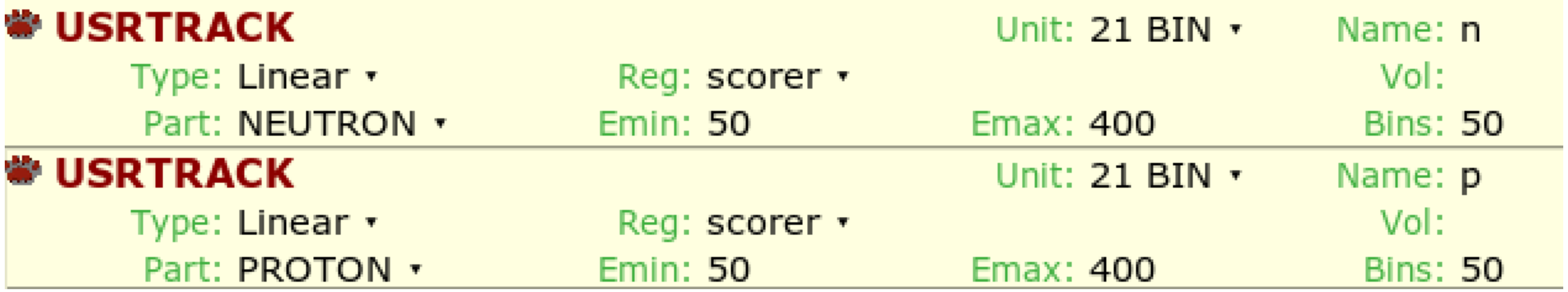
- Create a cylindrical beryllium target of 2 mm diameter and 400 mm long starting at (0,0,0).
- Create a magnet region in vacuum which starts 1cm after the end of the target, with a box of size 1 m × 1 m × 5 m in (X,Y,Z).
- Add a **`MGNFIELD`** card and associate it with the magnet region. Add a field in Y of 2 Tesla. Leave the other entries of the **`MGNFIELD`** blank.
- Define a scoring region in vacuum with a box of size 1 cm × 1 cm × 1 cm, placed 1 cm after the magnet.

Secondary Beam Lines – To be done

Preparation of the input file

Task : Score particles after bending magnet

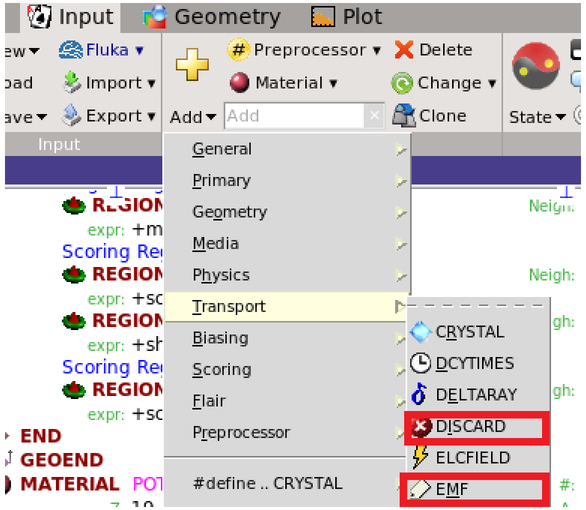
- Use **USRTRACK** to score neutron and proton fluence in the scoring region



Secondary Beam Lines – To be done

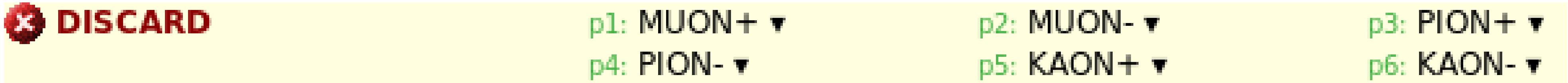
Preparation of the input file

Task : Add two transport cards



- Add two transport cards that you can find in FLAIR →

This will make your simulations faster and discard some particles that are not relevant for our exercise.



- After setting the cards, run 4 cycles with 25000 primaries.

Secondary Beam Lines – To be done

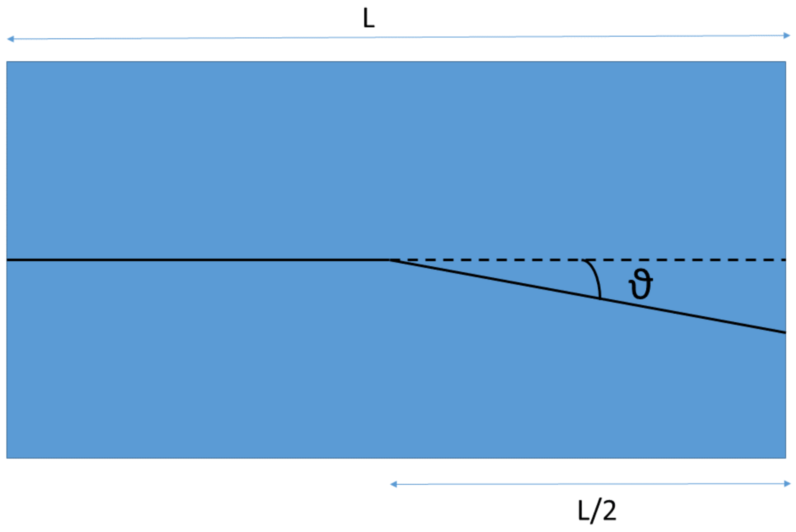
Plotting results with Flair

- Plot the magnetic field in the magnet region
- Plot particles fluence after the magnet (in the scoring region) for protons and neutrons. Do the spectra show what you expect?

Secondary Beam Lines – Optional Task

- Assuming that some primaries do not interact on target and exit it undisturbed – this is a good approximation in our case (why?) –, calculate the maximum size that your scorer can have in X to not detect 400 GeV/c protons.

- Hint: Use the formula $\vartheta[rad] = \frac{0.29979\times B[T] \times L[m]}{\mathrm{p}\left[\frac{\mathrm{GeV}}{\mathrm{c}}\right]}$ to calculate the bending angle of the bending magnet.



Secondary Beam Lines – Optional Task

- It's quite common in secondary beams to have two or more experiments placed close by. In this case it's important that none of the experiments create backgrounds for the neighboring ones.

- Assuming that a high energy neutron detector of transverse dimensions of 50 cm × 50 cm and 1 cm thickness is placed on axis at z = 7 m.
- Add a 50-cm concrete block between your beam line and this detector, using an RPP, e.g.:

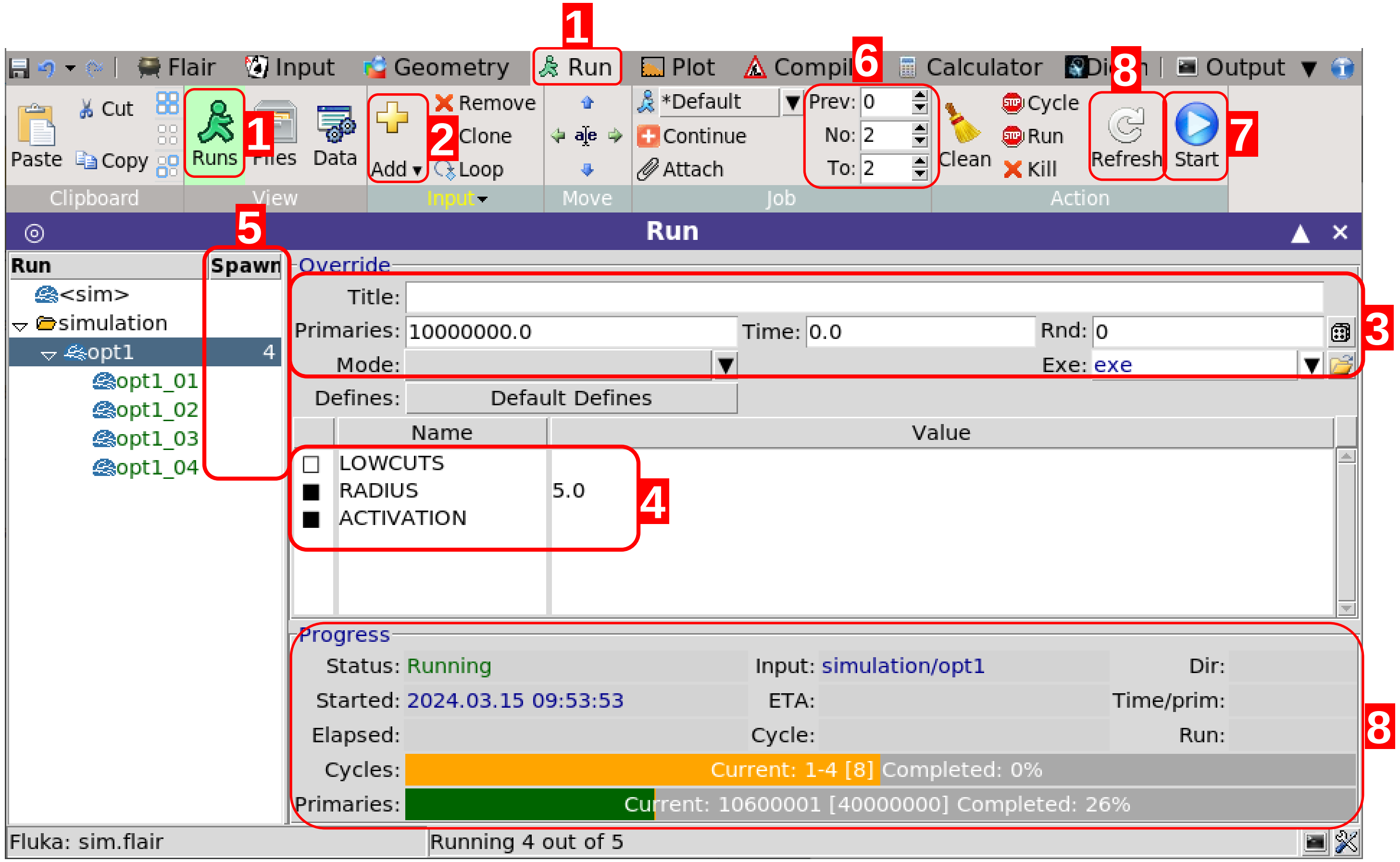
RPP	shield	Xmin: -100	Xmax: 100
		Ymin: -100	Ymax: 100
		Zmin: 591	Zmax: =what(5)+50

- Run 4 cycles with 2500 primaries and score using **USRTRACK**:

USRTRACK		Unit: 22 BIN	Name: n
Type: Linear	Reg: detector		Vol:
Part: NEUTRON	Emin: 50	Emax: 400	Bins: 50

- Check the fluence for high energy (>50 GeV) and make sure it's less than $3 \cdot 10^{-6}$ cm^{-2} GeV^{-1}.

Flair Cheat Sheet



Remember!

- You can **STOP** or **KILL** the run.
- **CLEAN** run files after major changes to the run settings.
- 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 options + define variables.
5. **Recommended:** Increase number of spawns
6. Set number of cycles per spawn
   - Recommend at least 5 cycles in total.
   - **n_cycles_tot = n_cycles_per_spawn × n_spawns**
7. Click ***Start*** to launch simulations.
8. Monitor the progress. Click ***Refresh*** to force update.

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