

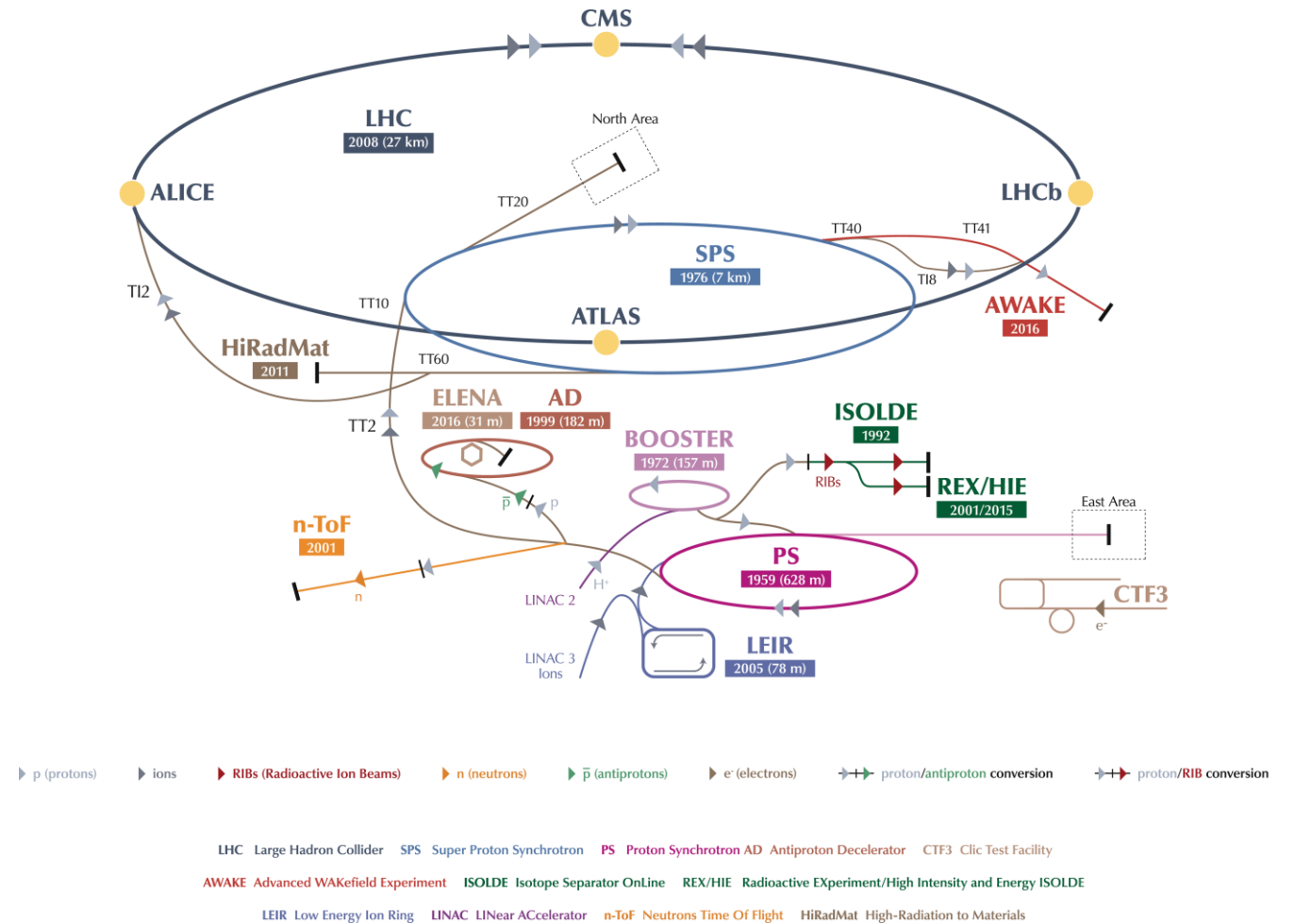


Secondary Beam Lines Exercise

First complete beam line in FLUKA

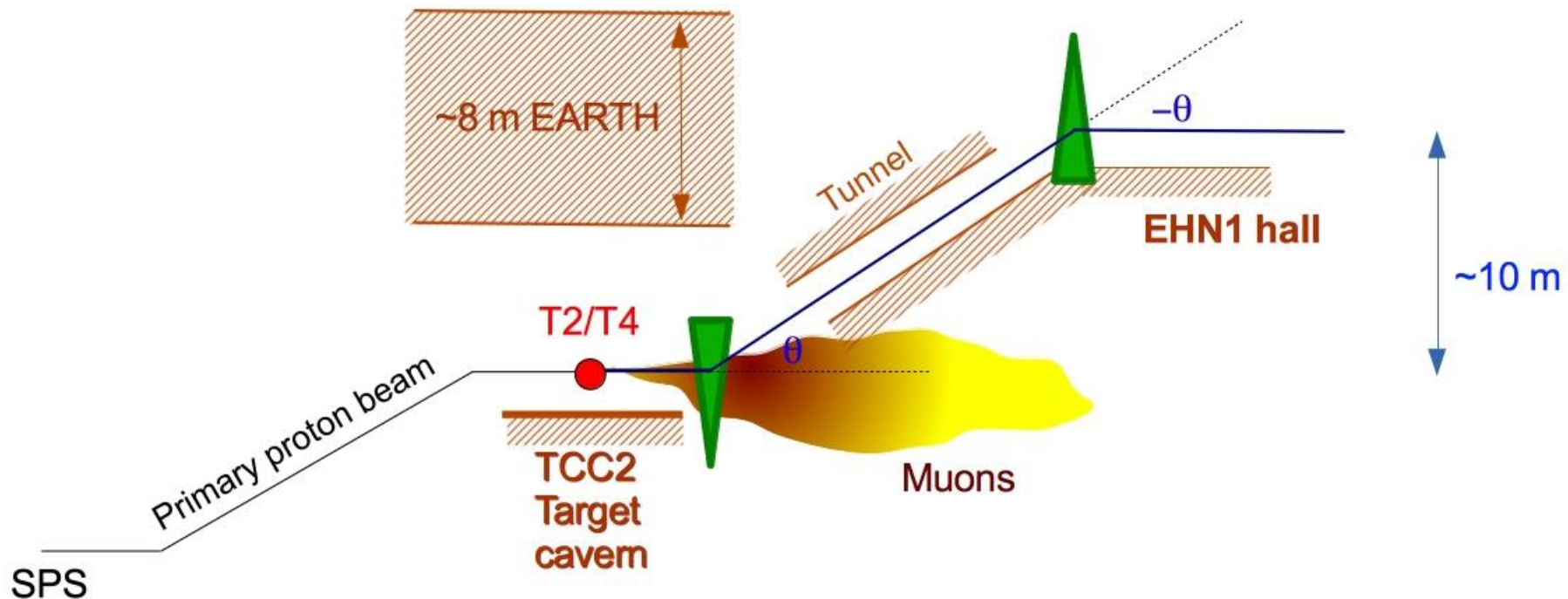
Overview

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



North Area beamline design considerations

- Flexibility of particle type and beam settings
- Muon range (absorb underground)
- Charged pion lifetime
- Momentum selection ($2 \cdot 10^{-4}$)



Purpose and Users

Secondary Beam Areas (SBA) are hosting:

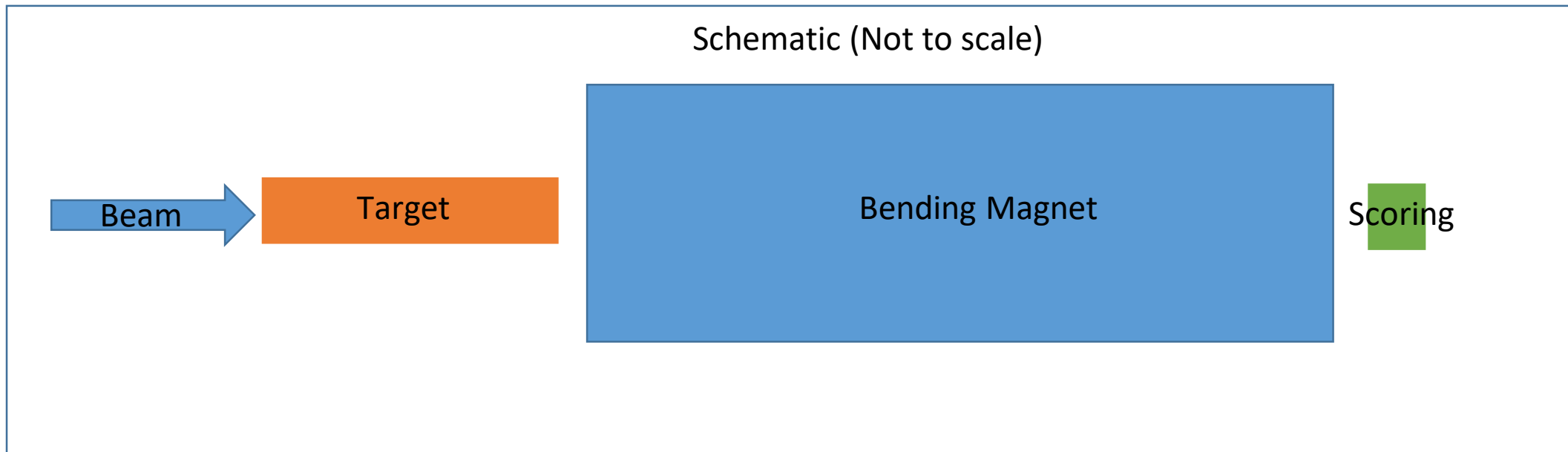
- **Fixed Target experiments:** COMPASS, NA61, NA62, NA63, NA64, CLOUD, ...
 - Precision studies (QCD, standard model, BSM physics)
 - Stable beam conditions for weeks and weeks
- **Irradiation facilities:** HiRadMat, Charm, Irrad, GIF++
- **Test beams:**
 - Detector prototype tests
 - Detector calibration
 - e.g. for LHC, linear colliders, space & balloon experiments
 - Outreach
 - Usually require a large spectrum of beam conditions within few days



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=-10cm.

```
Define the beam characteristics
* BEAM      Beam: Momentum ▼    p: 400.0      Part: PROTON ▼
  Δp: Flat ▼    Δp: |          Δφ: Flat ▼    Δφ:
  Shape(X): Rectangular ▼    Δx:          Shape(Y): Rectangular ▼    Δy:
```

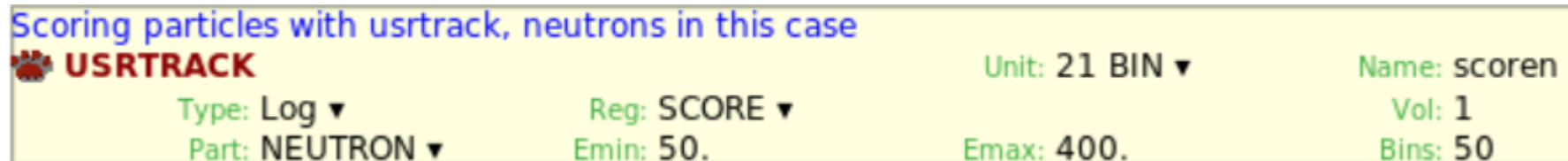
- Create a cylindrical beryllium target of 2 mm diameter and 400 mm long starting at (0,0,0).
- Create a magnet region in vacuum that starts 1cm after target with dimensions-1mx1mx5m in x,y,z respectively.
- Add a **MGNFIELD** card and associate it with the magnet region. Add a field in Y of 2 Tesla. Leave the other entries of the **MGNFIELD** blank.
- Define a scoring region in vacuum of 1cmx1cmx1cm dimensions 1 cm after the magnet. Define a scoring card to score particles in the scoring region.

Secondary Beam Lines

Preparation of the input file

Task : Score particles after bending magnet

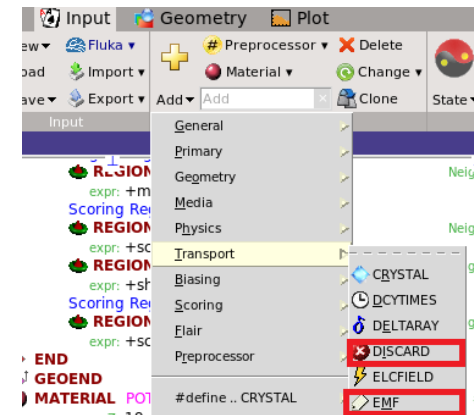
- Use USRTRACK to track particles in the scoring region



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

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

See next slide...

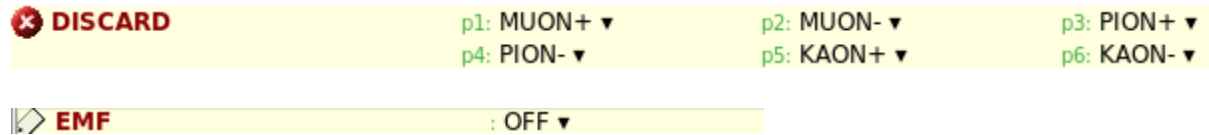


Secondary Beam Lines

Preparation of the input file

Task : Add two transport cards

- The two added cards should be set to:



- After setting the cards, run 2 cycles with 50000 primaries.

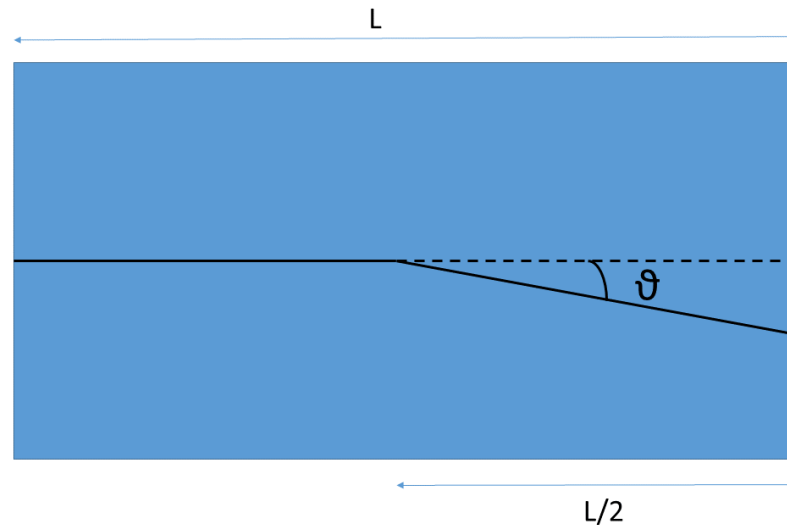
Secondary Beam Lines

Plotting results

- Using 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). Calculate the maximum size that your scorer can have in x in order to not detect 400 GeV/c protons.
- Hint: Use the formula $\vartheta[\text{rad}] = (0.29979 * B[\text{T}] * L[\text{m}]) / p[\text{GeV}/\text{c}]$ 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 50cmx50cm and 1cm thickness is placed on axis at z=7*m.
- Add a concrete block between your beam line and this detector, using an RPP, e.g.:

Shielding
 RPP shield

Xmin: -100	Xmax: 100
Ymin: -100	Ymax: 100
Zmin: 643	Zmax: 693

- Run 2 cycles with 5000 primaries and score using usrtrack:

```
Scoring neutron at the experiment
USRTRACK                               Unit: 22 BIN ▼   Name: score1|
Type: Log ▼                             Reg: SCORE1 ▼   Vol: 2500
Part: NEUTRON ▼                         Emin: 50.       Emax: 400.     Bins: 50
```

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

