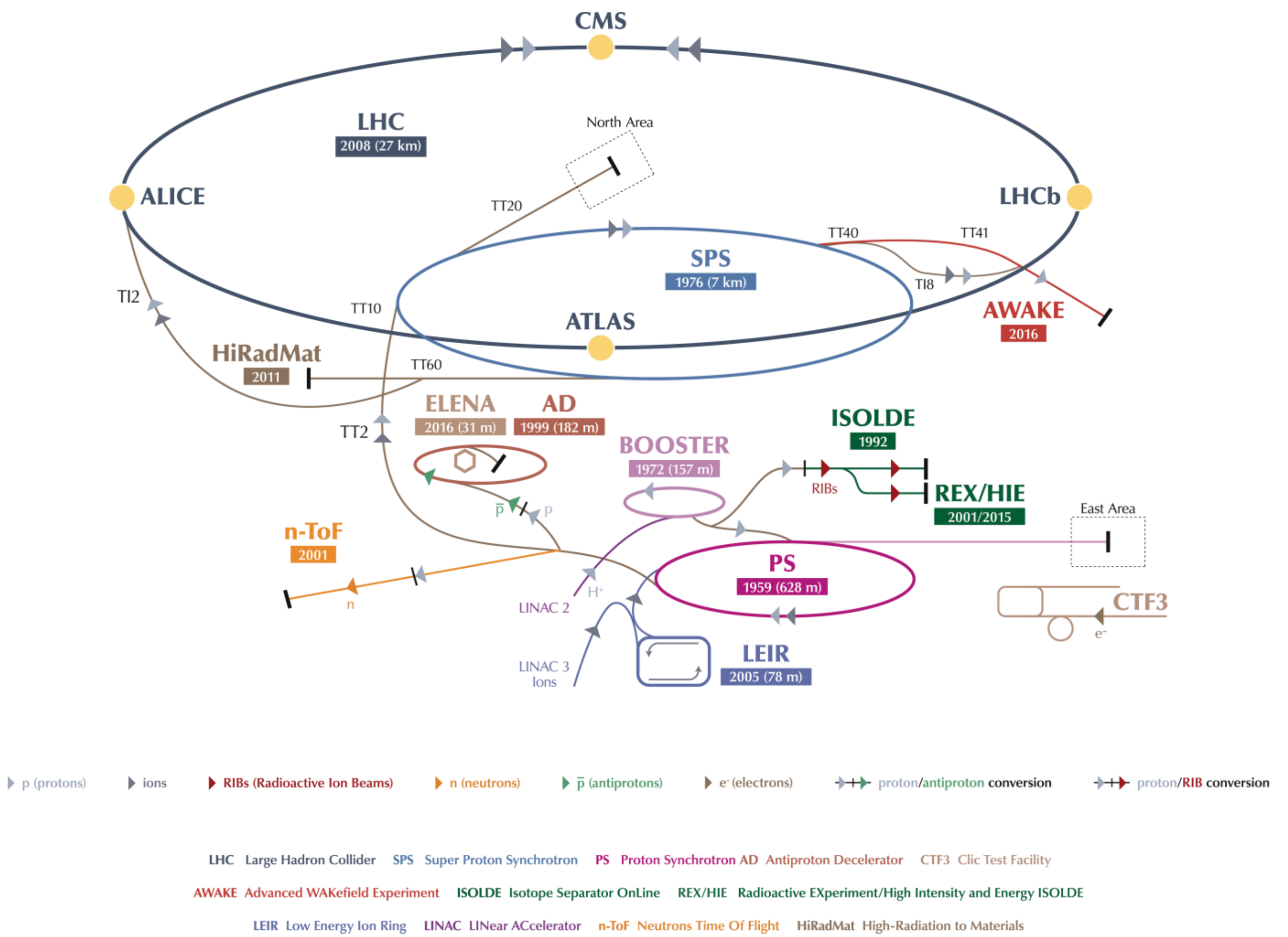
Secondary Beam Lines Exercise

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:

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

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

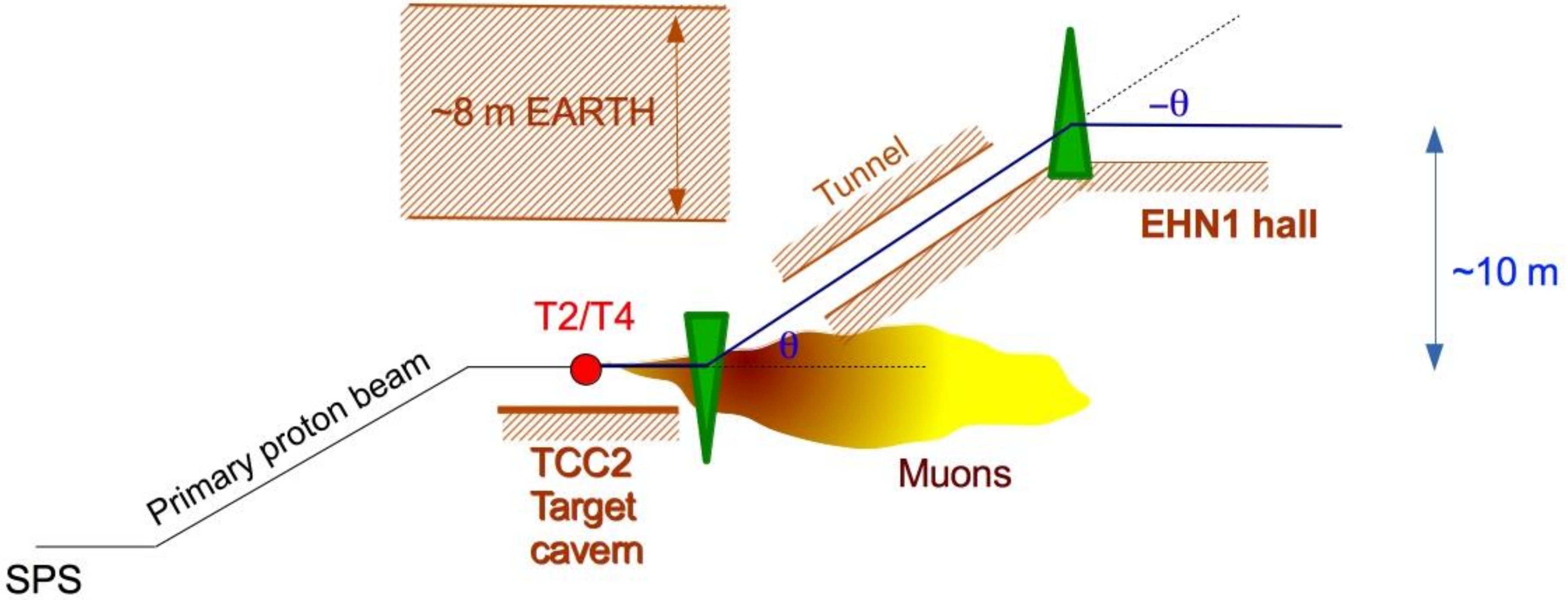
- **Test beams:**
  - Detector prototype tests
  - Detector calibration

    e.g. for LHC, linear colliders, space & balloon experiments
  - Outreach

  Usually require a large spectrum of beam conditions within few days

NA beamline design considerations

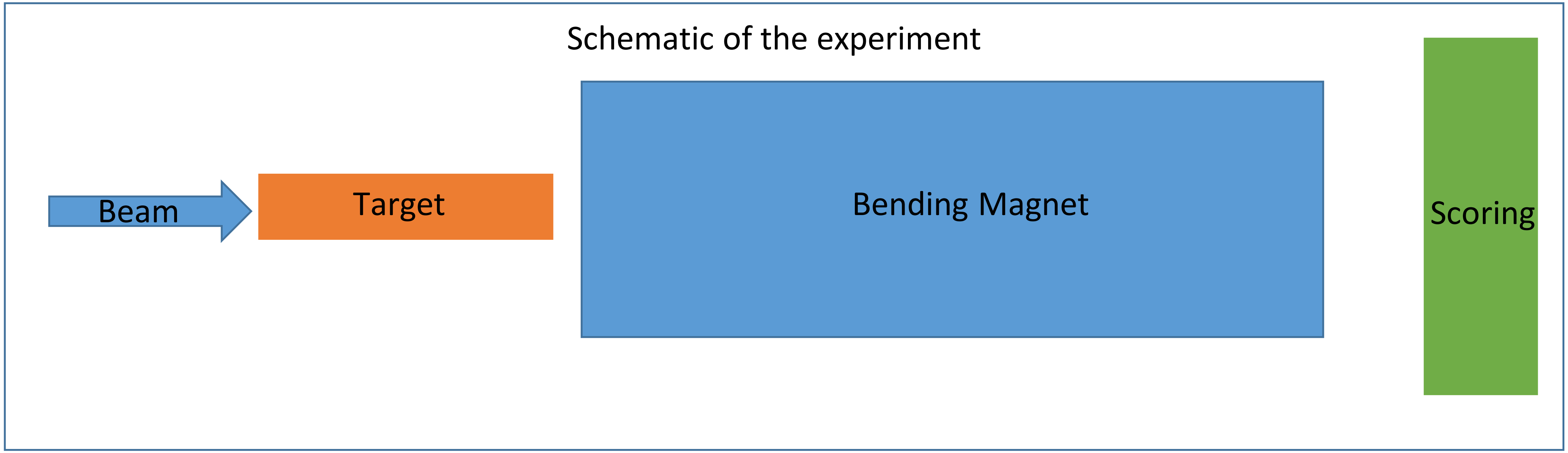
- NA beams were originally (end of 1970's) designed for the fixed target experiments. Design considerations were
    - Muon range (absorb underground)
    - Charged pion lifetime
    - Momentum selection ($2 \cdot 10^{-4}$)



Secondary Beam Lines

Study of CERN secondary beam lines:

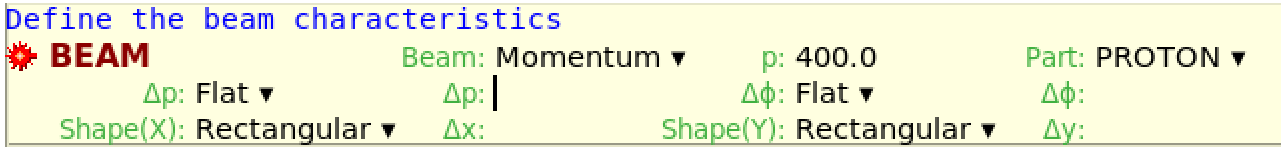
- Create your first complete experiment from scratch:
    - Define a primary proton beam
    - Define a target on which the proton beam will collide
    - Define a bending (sweeping) magnet after target
    - Score particles after the magnet



SBL – 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.



- Create a cylindrical beryllium target of 2 mm diameter and 400 mm long.
- Create a magnet region in vacuum after target of 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
- Define a scoring region in vacuum of 1cmx1cmx1cm dimensions 200 cm after the magnet. Define a scoring card to score particles in the scoring region.

SBL

Preparation of the input file

Task : Score particles after bending magnet

- Use USRTRACK to track particles in the scoring region

Scoring particles with usrtrack, neutrons in this case

USRTRACK		Unit: 21 BIN ▾	Name: scoren
Type: Linear ▾	Reg: SCORE ▾		Vol:
Part: NEUTRON ▾	Emin: 1.	Emax: 400.	Bins: 399

- Run 1 cycle with 10000 primaries.

SBL

Plotting results

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

SBL-Optional Tasks

- 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.

- Use the formula $\vartheta[\text{rad}] = (0.29979 * B[T] * L[m])/\mathrm{p}[\mathrm{GeV/c}]$ to calculate the bending angle of the bending magnet.

SBL-Optional Tasks

- Try using an aluminium target and compare the neutron fluence to your current results.

SBL-Optional Tasks

- Add a concrete (PORTLAND-concrete, defined in FLUKA materials) shielding around your experiment, start using use a thickness of 40 cm.

- The shielding should be created subtracting one RPP to the other in order to create a layer of concrete around the experiment.

- 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 low energy neutron detector of transverse dimensions of 1mx1m and 1cm thickness is placed on axis at z=20*m. Run 1 cycle with 1000 primaries and score using usrtrack as previously defined . Check the fluence for low energy (<10 GeV) and make sure it's less than 0.001 cm/GeV.

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