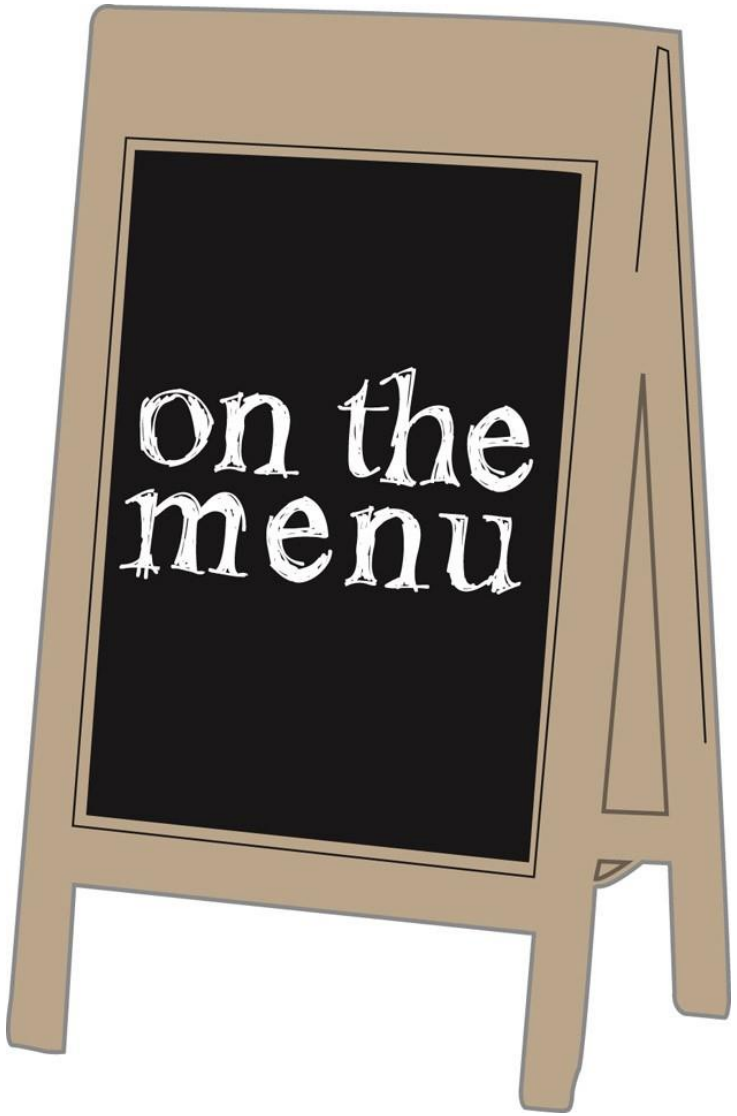
Beamline for Schools

A Physics competition for high-schools students

Overview of the competition

- Requirements to take part
- Test-beam facilities
- Particle detectors

Q&A session ~35’

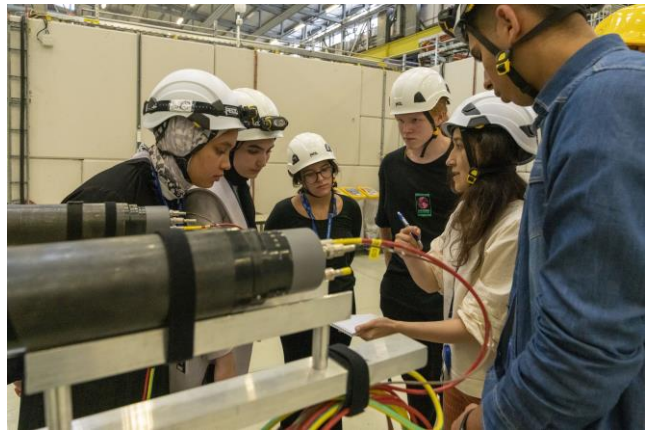


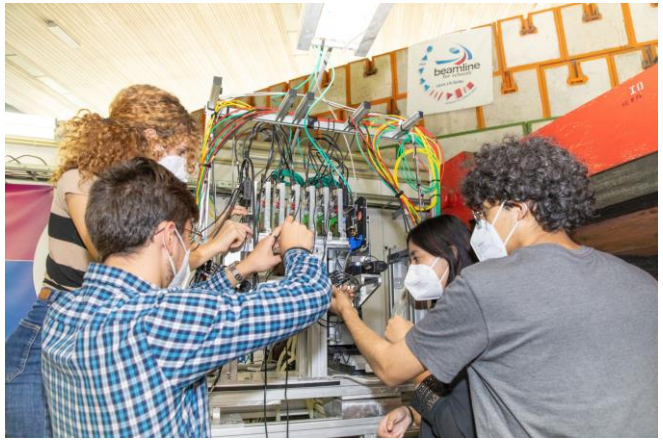
Beamline for Schools – About it

Teams of high-school students can propose an experiment to be performed at the test-beam facility of a particle accelerator.

It is a great opportunity to get in touch with the world of physics research.

You can interact with scientists from CERN, DESY and many other institutions around the world.





Practical information

- Teams: min 5, max 9 people, ≥ 16 years old (Sept. 1 2023).
- Enrolled in high-school in the school year 2022-2023.
- Each team has to be led by an adult, «coach », max 2 per team.

Prizes:

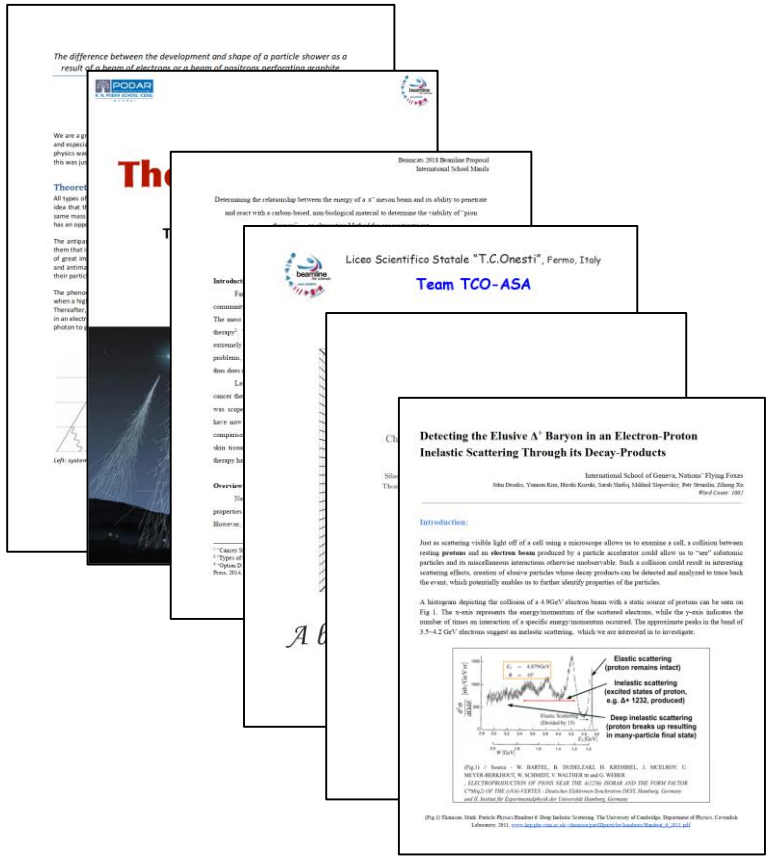
- Three teams will perform their experiments at CERN (2 teams) or DESY (1 team).
- Up to 30 teams included in the shortlist.
- Special award for the best video.
- Up to 10 «physics outreach » awards offered by «Stars shine for everyone » (SSVI).
- Participation certificates for all participants.


Hamburg
Geneva
DESY.
CERN
North Sea
Denmark
Copenhagen
Ireland
Dublin
Hamburg
Bremen
Berlin
Poland
Warsaw
Germany
Dortmund
Düsseldorf
Cologne
Belgium
Brussels
Antwerp
Frankfurt
Stuttgart
Munich
Nuremberg
Leipzig
Dresden
Prague
Czechia
Vienna
Bratislava
Slovakia
Austria
Hungary
Budapest
Switzerland
Zurich
Liechtenstein
Paris
Luxembourg
Guernsey
Jersey
Milan
Venice
Bologna
Florence
Italy
San Marino
Croatia
Slovenia
Zagreb
Bosnia and Herzegovina
Serbia
Montenegro
Kosovo
Rome
Barcelona
Zaragoza
Porto
Marseille
Lyon
Geneva

Experiment proposal

Written proposal (~1000 words):

- Give us your motivation (~ 100 words)
- Detail how you would like to use the beam (~800 words)
- What you hope to take away from this experience (~100 words)



Realise a **creative video** to explain your idea. 1 minute, optional.

The submission form will open in January

Deadline: April 12 2023!

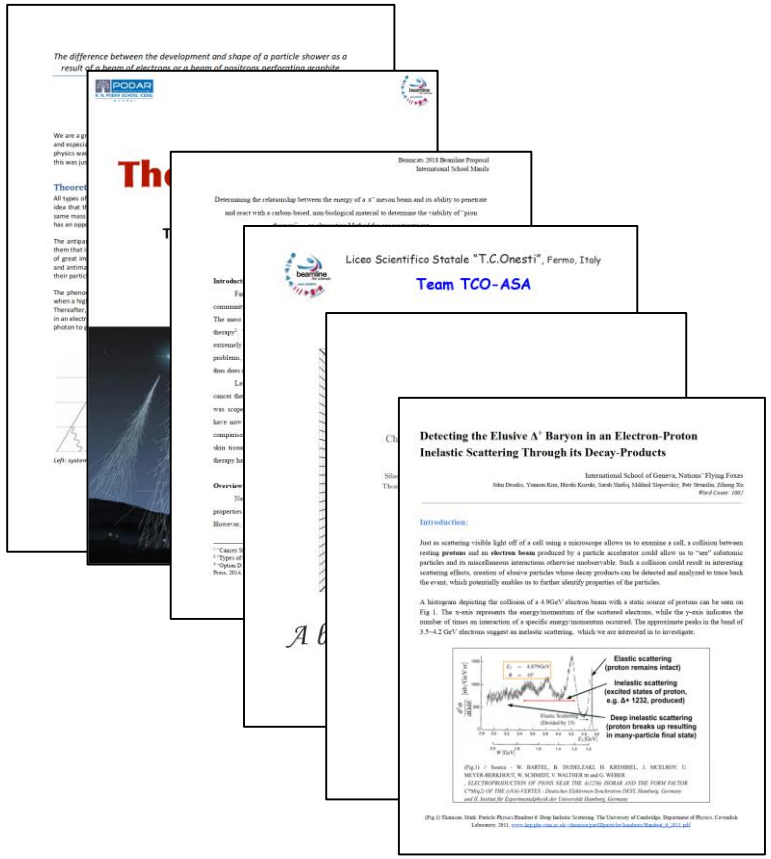
Submit it here

Experiment proposal

The proposals will be evaluated by a committee of scientists.

Evaluation Criteria:

- Feasibility of the experiment.
- Motivation of your experiment idea and your participation.
- Creativity of the experiment.
- Ability to follow the scientific method



You are not alone!

Get in touch with the national contacts or with us at : bl4s.team@cern.ch

Proposal Extension

Use ~100-200 extra words to describe an outreach/education activity that you plan to organise for promoting science in an inclusive way!

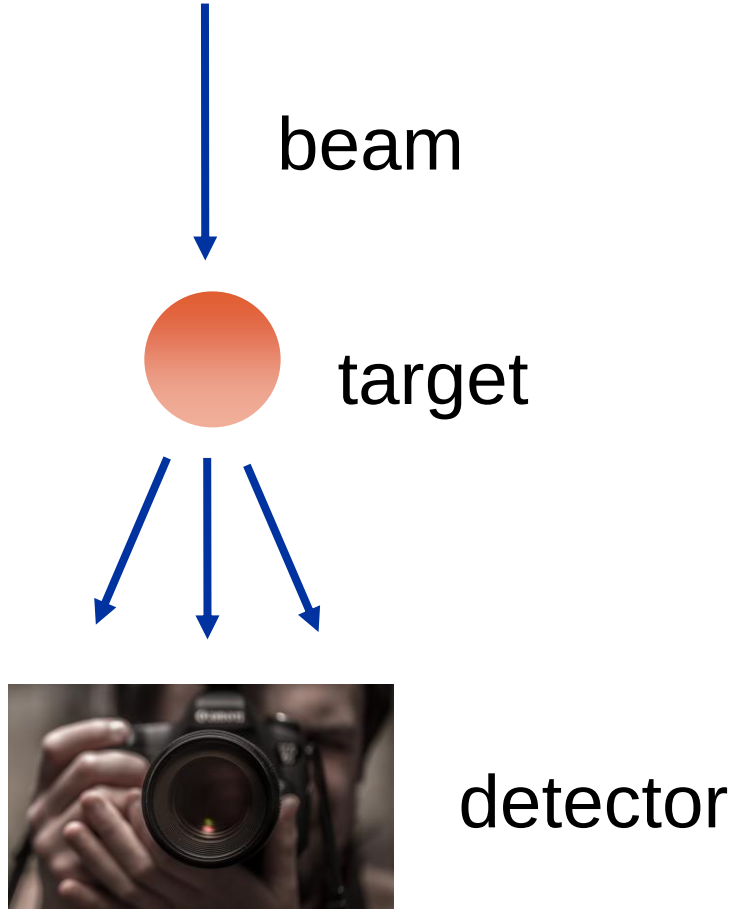
Target audience: a part of your community usually less exposed to science.

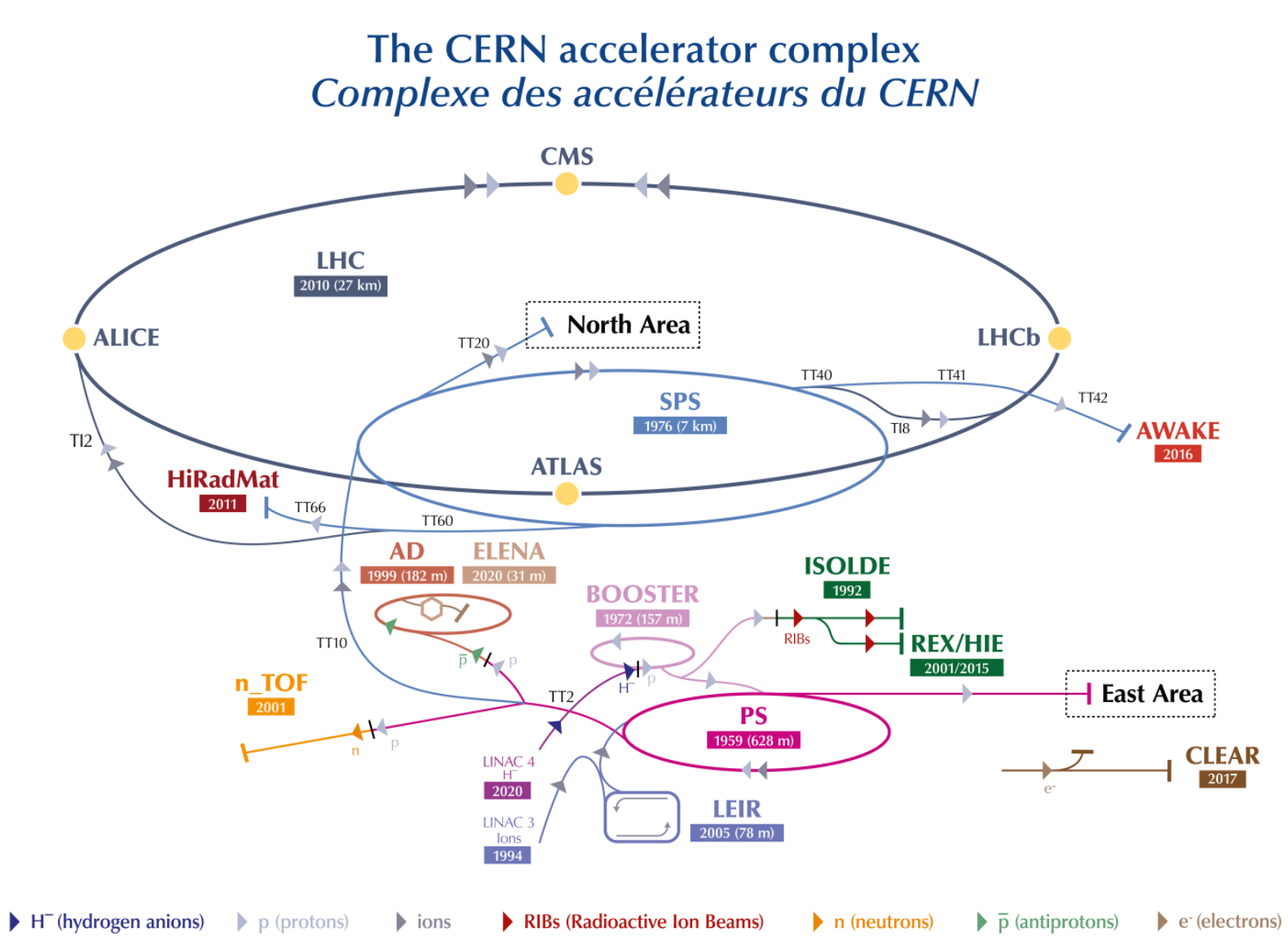
We encourage to make good use of what you will learn through BL4S!

This extra proposal will give you access to the prizes offered by SSVI: optical telescopes.

Experiment requirements

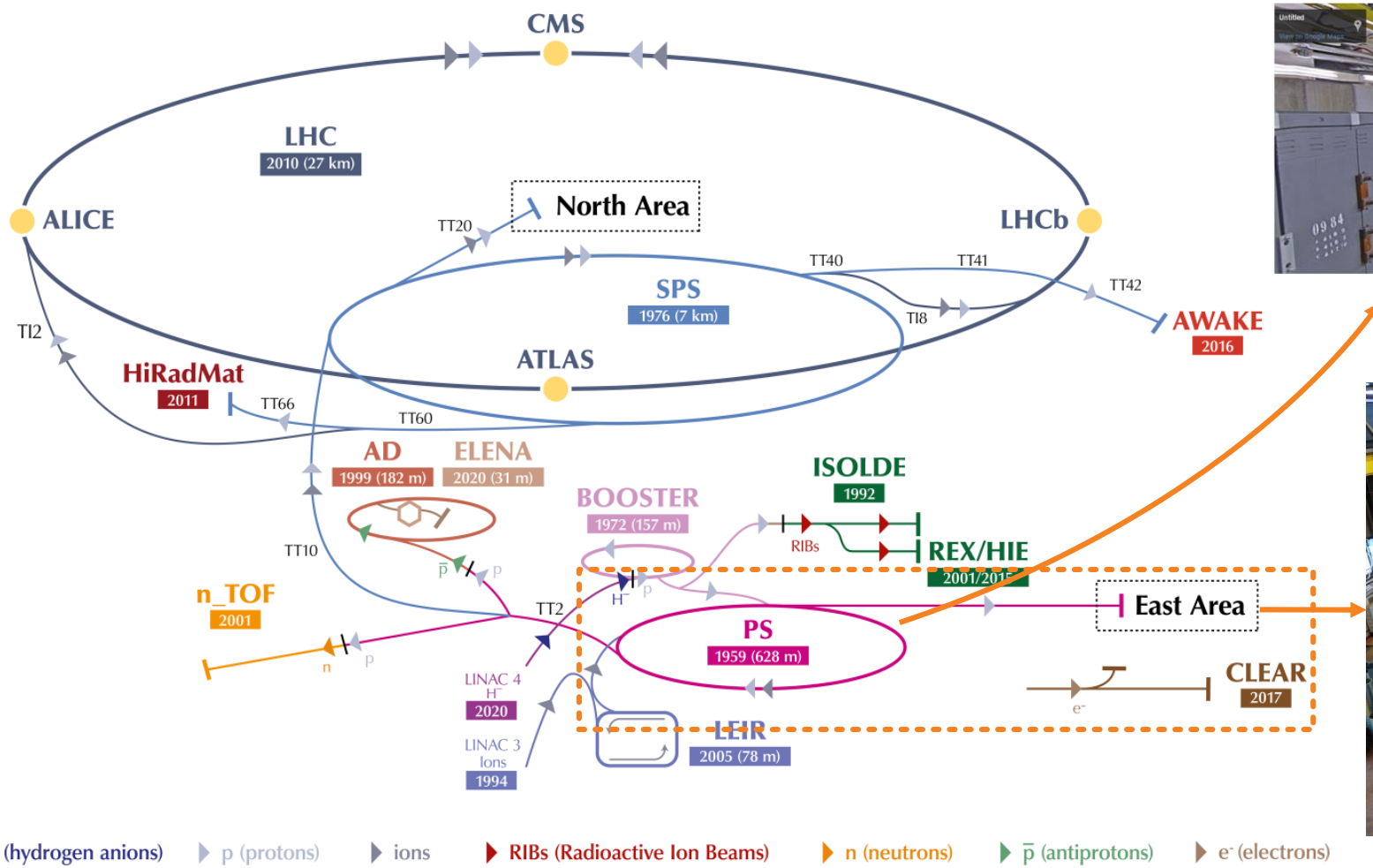
- The proposal has to be design for the test-beam facility in fixed target configuration.
- Fixed target configuration: particle beam crossing or passing close to a target (solid, liquid, gas).
- Experiment design:
    1. Beam
    2. Target
    3. Detectors
    4. Trigger/readout

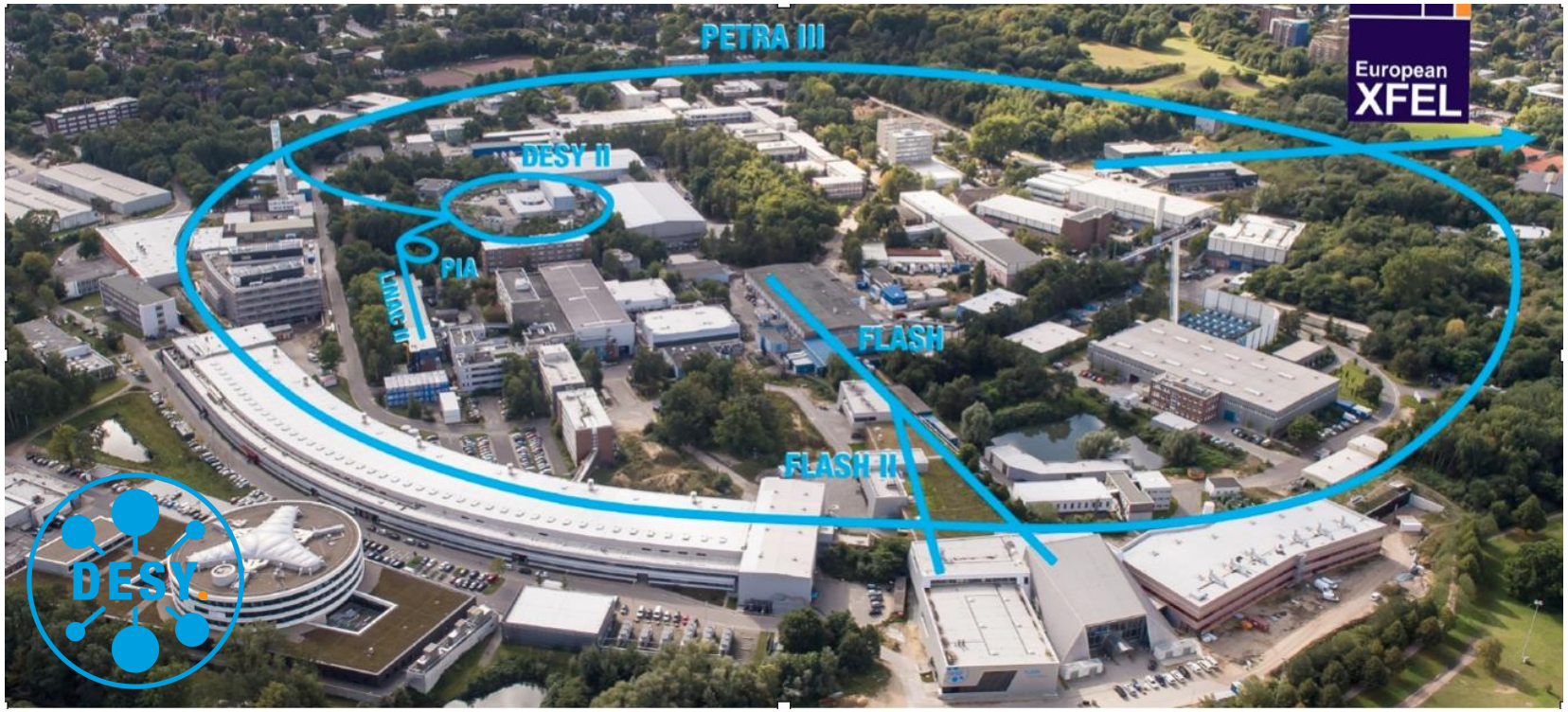




- Particles are accelerated for different purposes.
- Different types of particles are available for fixed experiments (ATLAS, CMS, ALICE, LHCb, etc..) and for temporary users.
- BL4S winners are temporary users of the CERN beams.

The CERN accelerator complex
Complexe des accélérateurs du CERN





- Electron accelerator complex.
- PETRA III is the larger accelerator, a synchrotron providing photons for experiments in material science, chemistry, geology, etc..
- BL4S winners are temporary users of the DESY II beam lines.

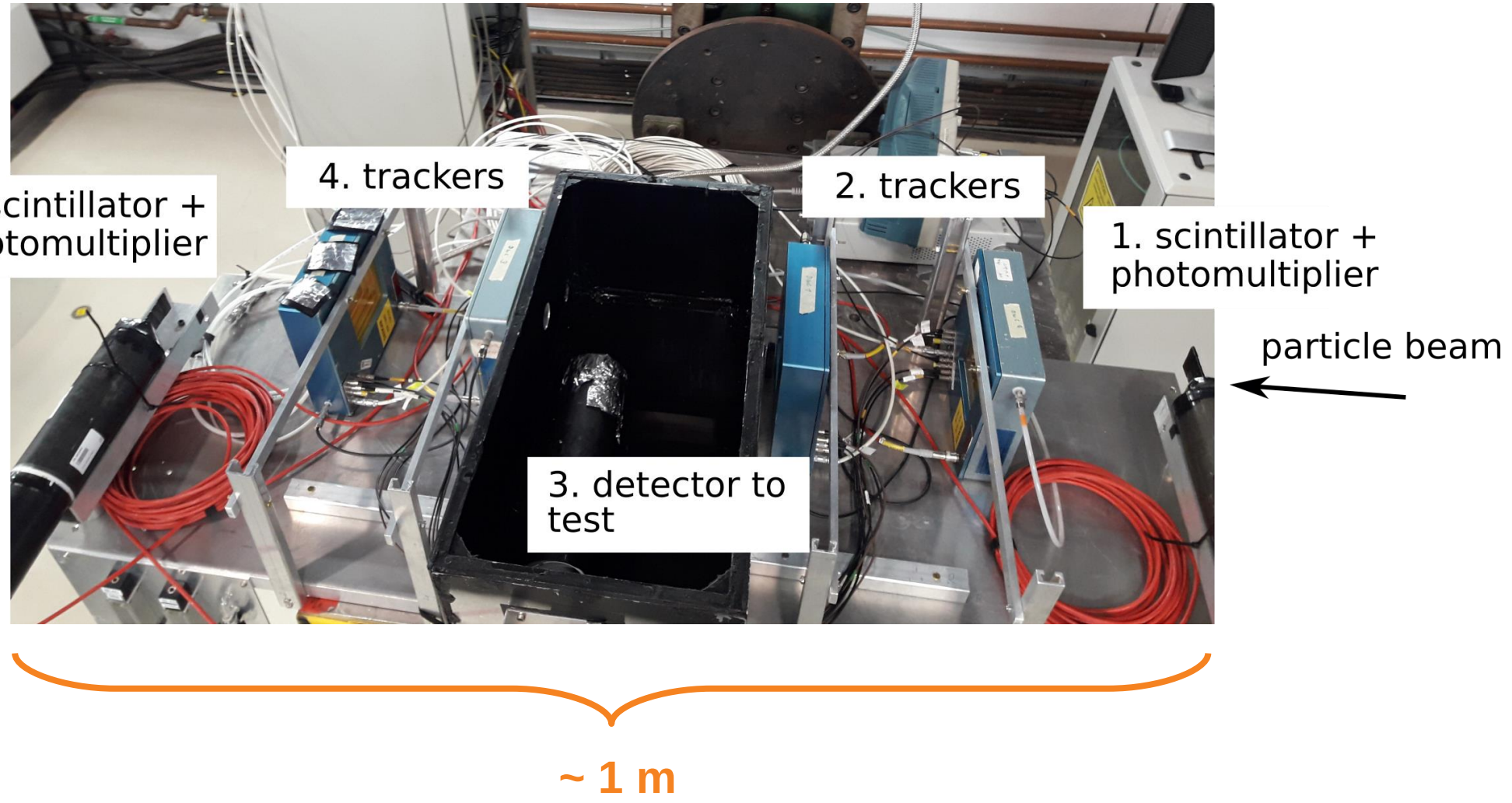

PETRA III
European
XFEL
DESY II
PIA
LINAC II
FLASH
DESY.


T24/1
T24
T22
T21
Hut 24
Hut 21/22
Hut 23

A Beamline

- The beam is extracted in dedicated rooms.
- It might look empty, but you will fill it with your experiments !

An experimental setup



Some useful questions

1. How do high-energy particles interact with matter?
2. How can we detect them?
3. What can we learn from the particle matter interaction?
4. How can we use these effects?

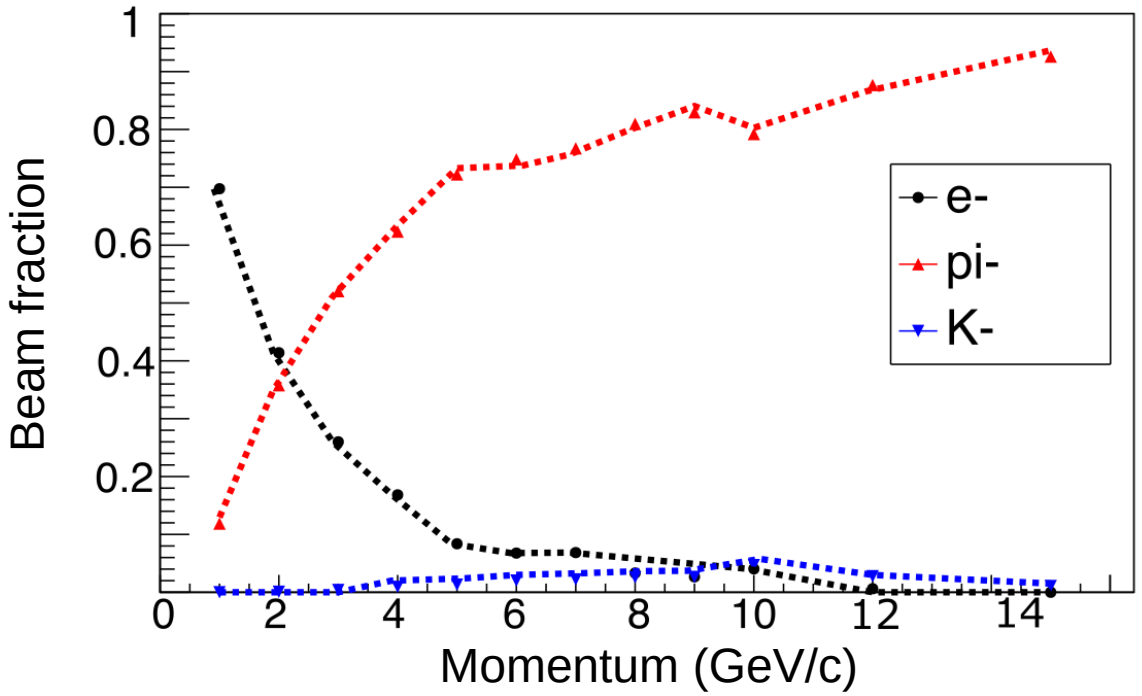
Identify a phenomenon that triggers your curiosity and
Start to conceive your experiment!

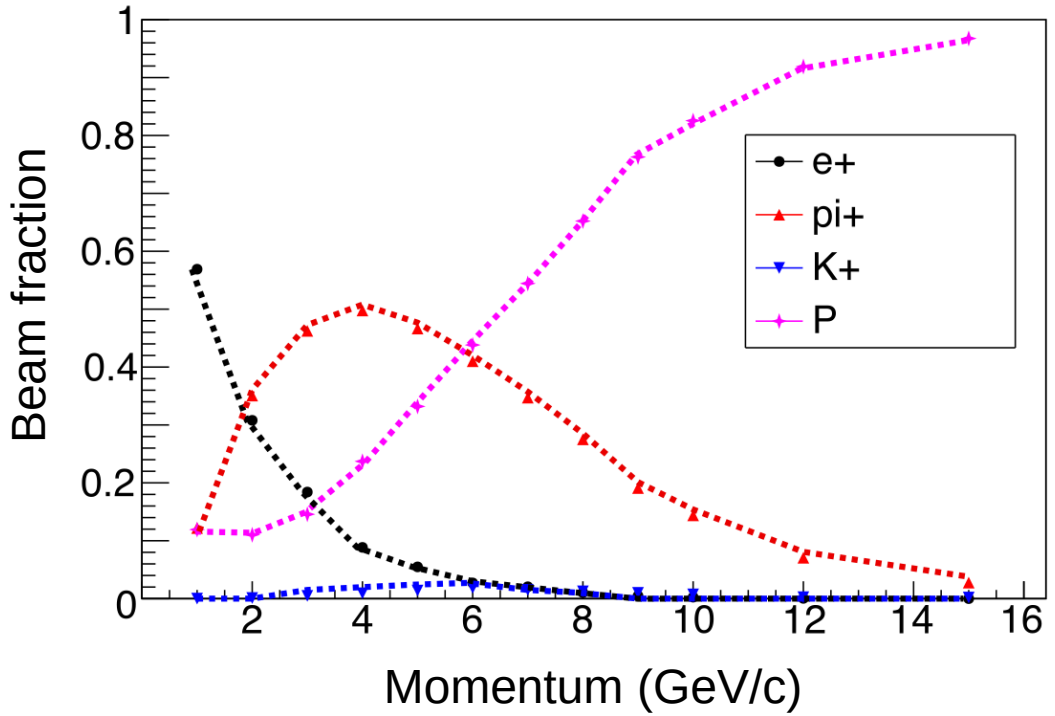
Example experiments

Beam properties at CERN

- Protons accelerated by the PS (up to 26 GeV) are smashed into a target.
- The debris resulting from this interaction form a beam of particles, «secondary beam », available for the users.
- Users can select the particle type (positive or negative), their energy, the opening of collimator.
- Beam-spot size: diameter of ~ 2 cm

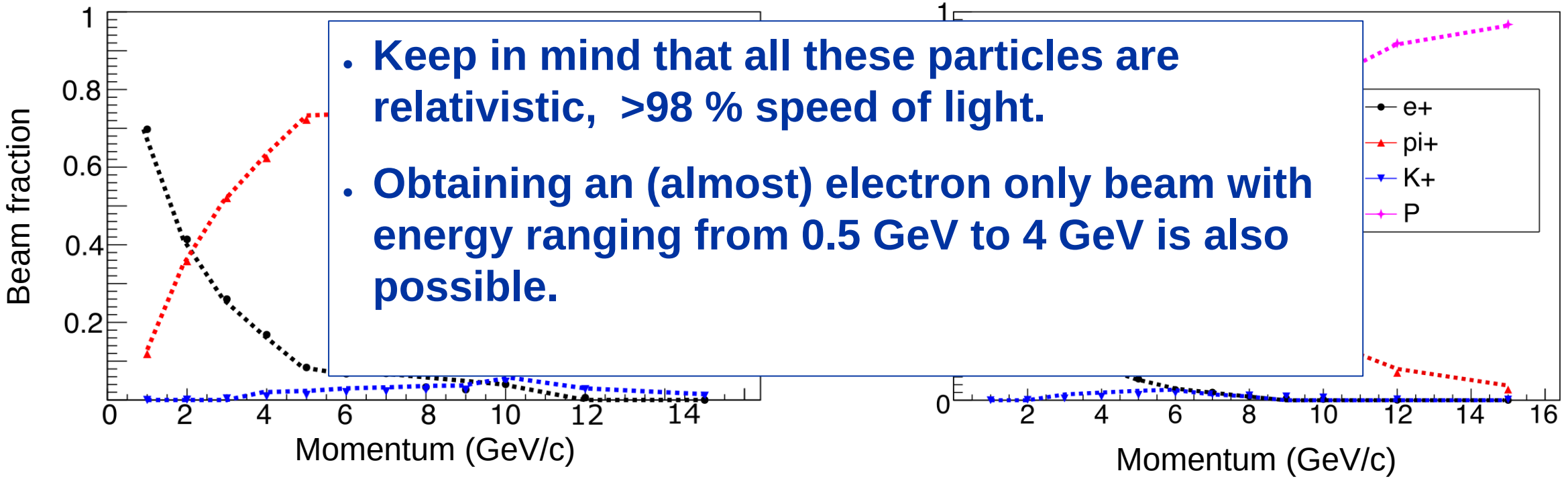
Beam properties at CERN





Protons and pions are the most abundant particles
Energy range : 0.2-15 GeV

Beam properties at CERN

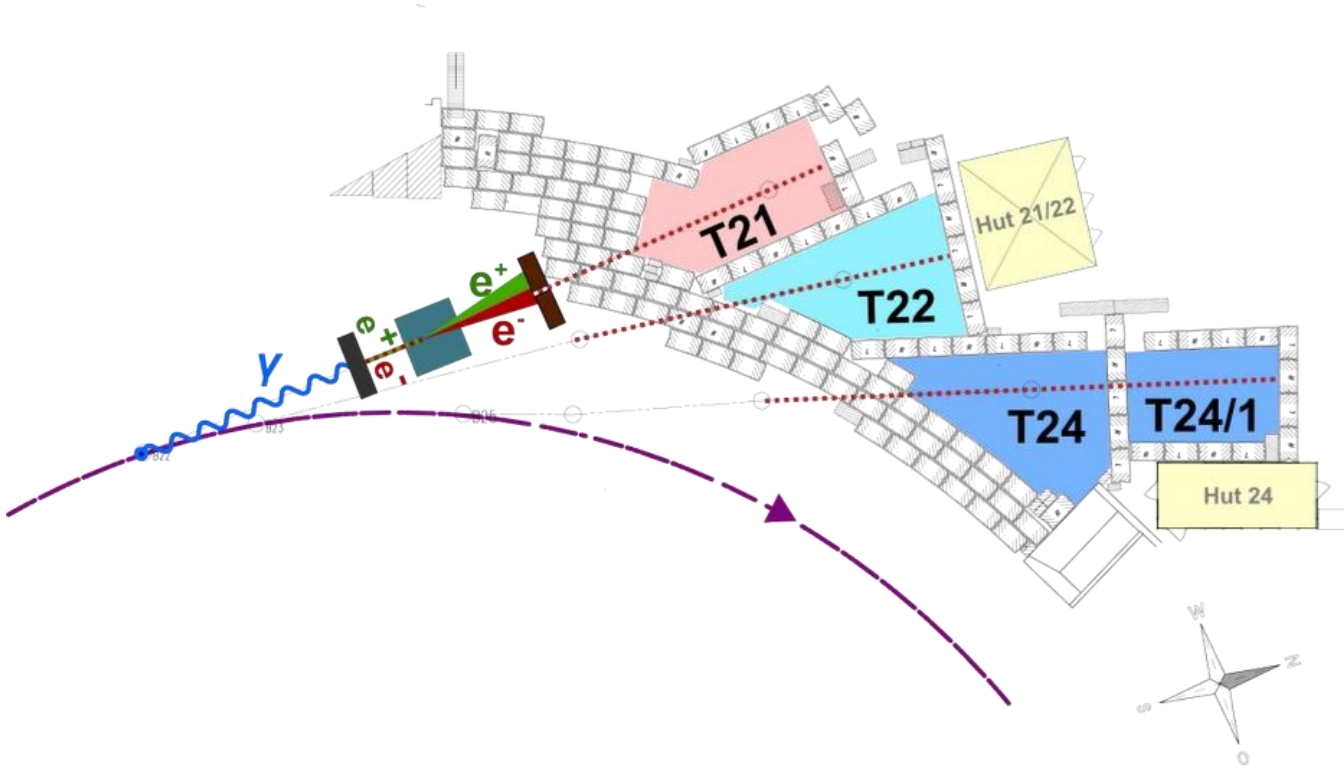


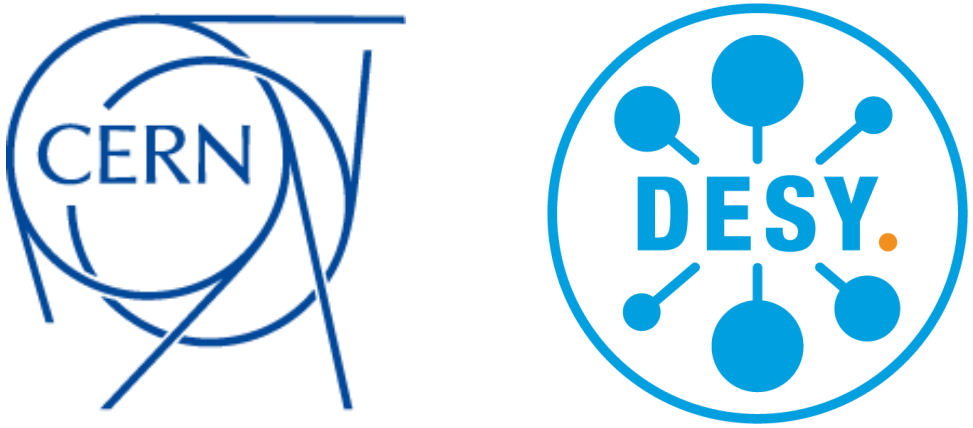
- **Keep in mind that all these particles are relativistic, >98 % speed of light.**
- **Obtaining an (almost) electron only beam with energy ranging from 0.5 GeV to 4 GeV is also possible.**

Protons and pions are the most abundant particles
Energy range : 0.2-15 GeV

Beam properties at DESY

- Photons produced by electrons accelerated by the DESY II up to 10 GeV and smashed into a target.
- Electron/positron pairs are produced at different energies.
- The user can select the particle type (positive or negative), their energy, the opening of collimator.
- Beam-spot size: diameter of ~ 2 cm





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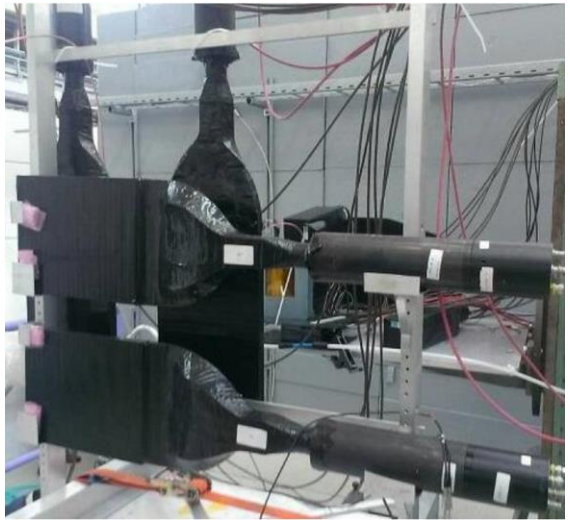
You don’t need to express a preference, build your experiment according to your scientific needs.
The evaluation committee will assign you to the laboratory that better fits your experiment’s requirements.

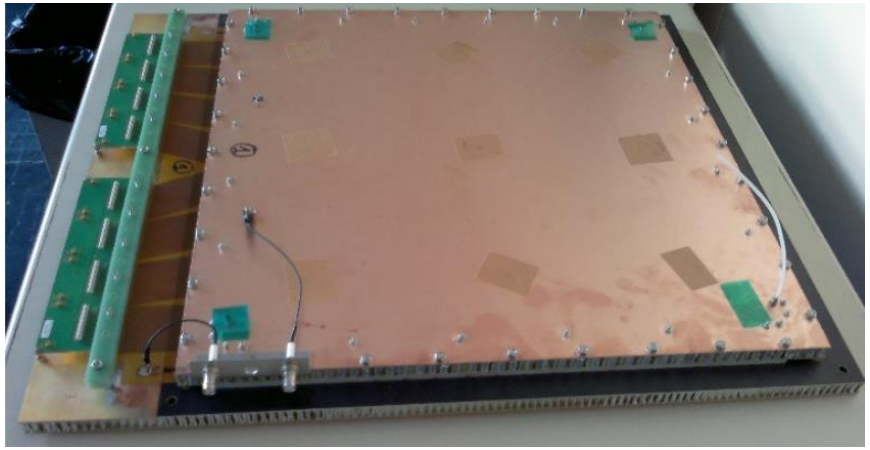
Detectors

- Different detectors are available for BL4S.
- The choice depends on the purpose of your experiment.
- Each detector has its own readout system.
- The data-acquisition systems controls all the detectors and the experiment (you don’t need to worry about that).

Detectors

- Scintillators + photomultipliers – particle counting, trigger, TOF measurements. At least 6 available.
- Delay Wire Chamber – 2D tracker – active area 10x10 cm, resolution 200-300 um.
- MicroMegas detectors – 1D tracker – 40x40 cm, resolution 200 um. 4 available
- Silicon pixel detectors – 2D tracker – 2x2 cm, resolution ~ um – contact us if interested.





Detectors

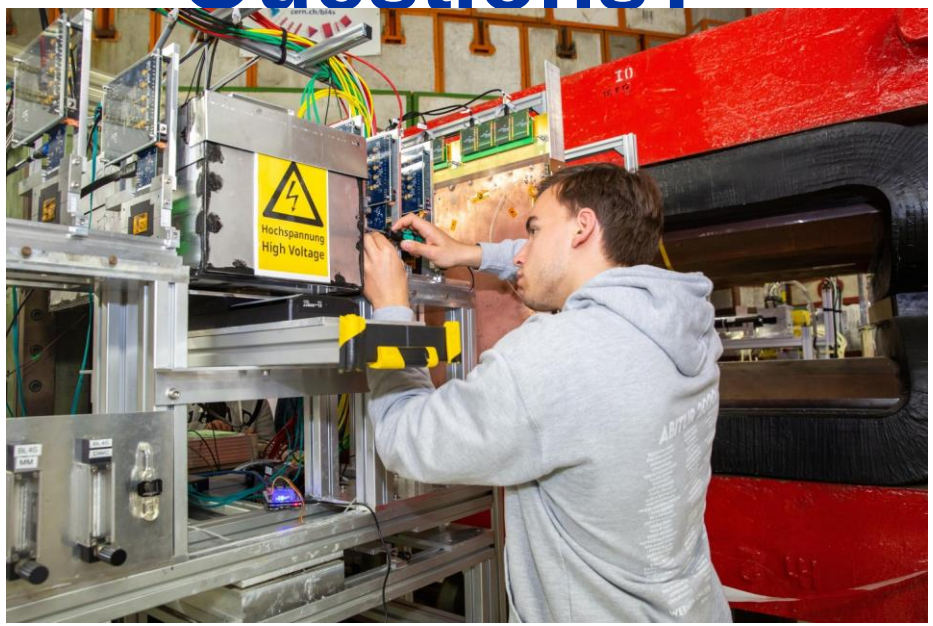
- Muti-gap resistive plate chambers (MRPC)-trackers – 30x30 cm, suitable for time of flight measurements (particle speed), time resolution 100 ps (10^{-10} s).
- Cherenkov detectors – gas detectors that can give information on the particle type.
- Lead crystal calorimeter – Energy of particles – 16 available, 10x10x37 cm.
- You are free to conceive and test your own detector!

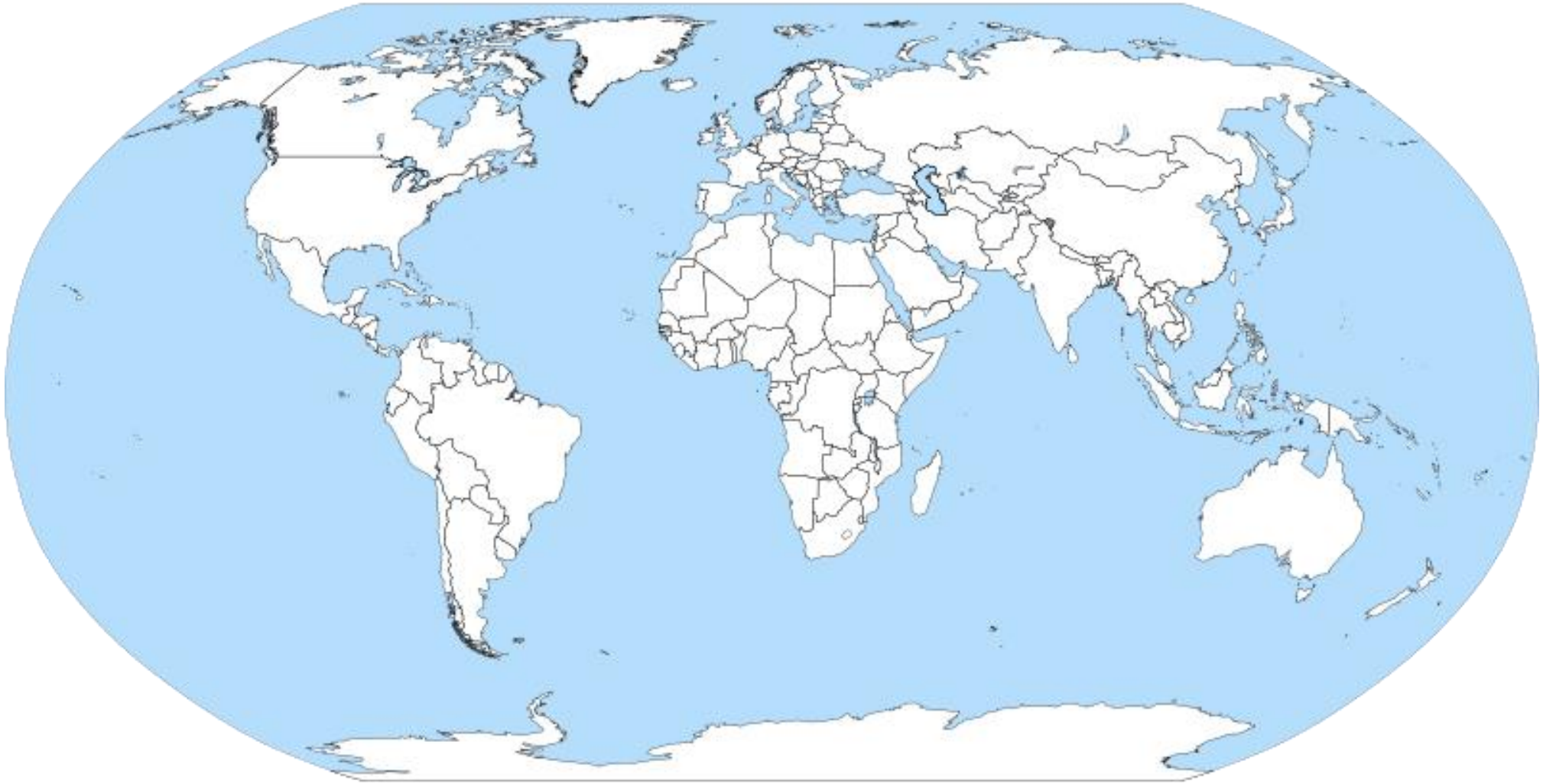
It’s time to build your experiments!

Beam &Detector Document

Example Experiments

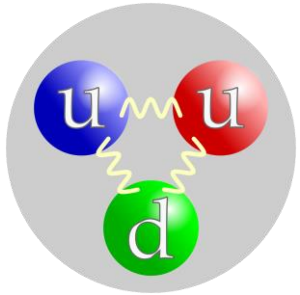
Questions?

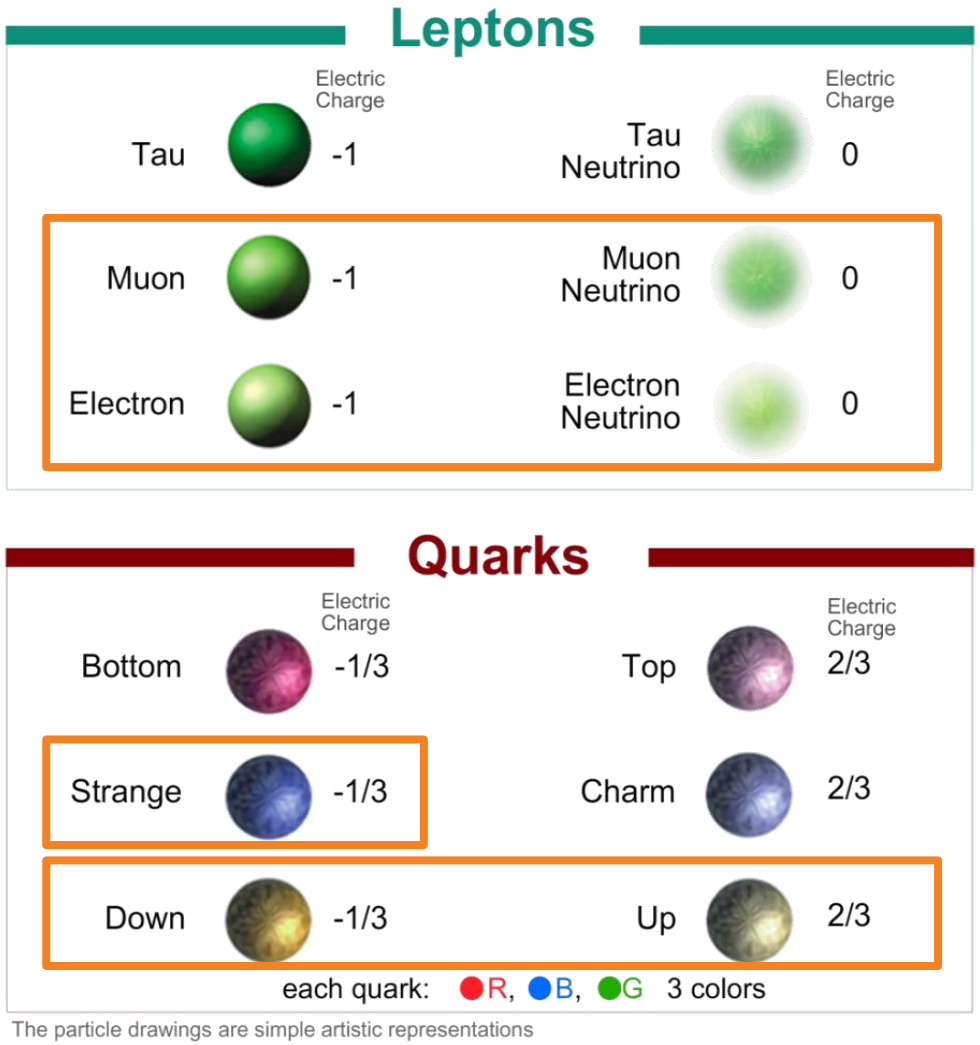


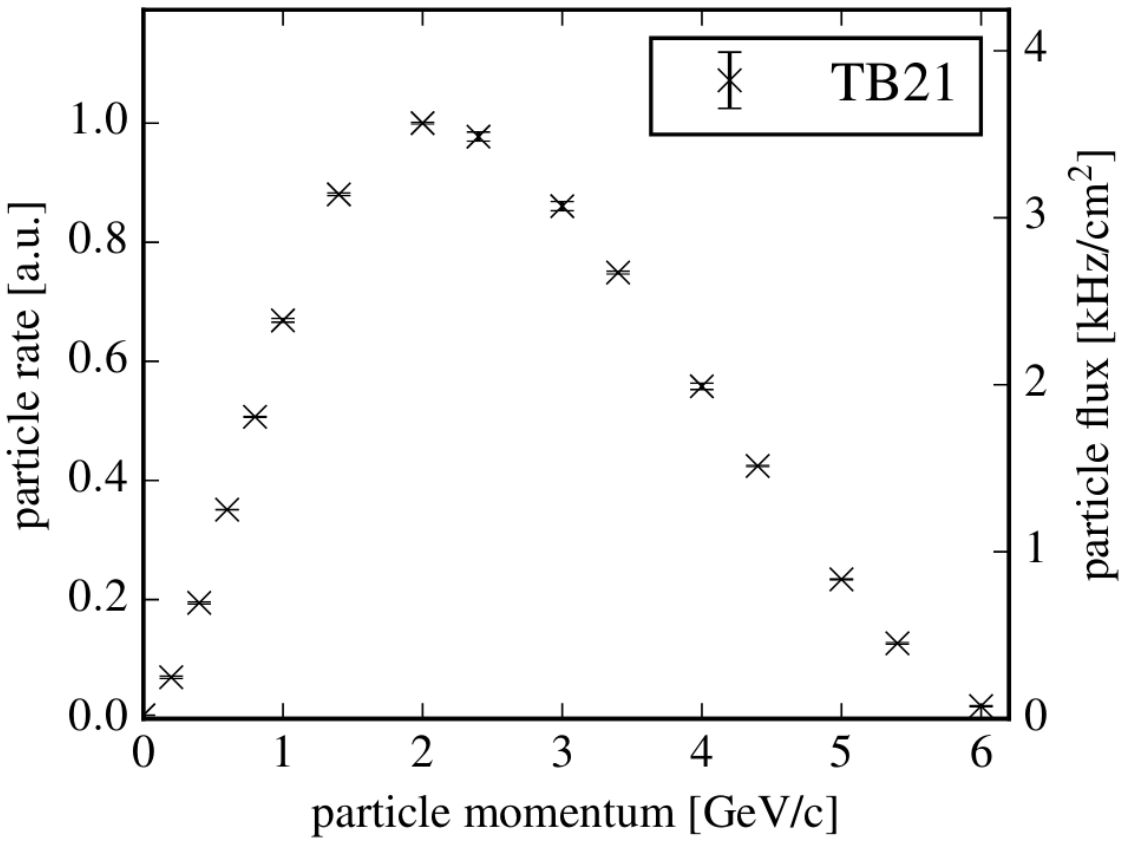


Beam properties

- Protons : uud
- When they interact with a target they can produce different particles, both elementary and not.
- Given the energy provided by the PS, one can have **electrons, muons and particles composed of u,d, and s quarks (pions and kaons)**.






TB21
particle rate [a.u.]
particle flux [kHz/cm^2]
particle momentum [GeV/c]
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5
6