Examples of Experiments suitable for the DESY Beam Lines

Beamline for Schools 2021

CERN-OPEN-2020-015
15/12/2020

Note

In order to succeed in Beamline for Schools you can either propose a creative experiment or idea yourself or take one of the examples and work out the details of that experiment.

Contents

Measurement of the beam absorption properties of materials 3

Characterization of MicroMegas (or other) particle detectors 3

Build and test your own detector 3

Measurement of the beam composition of the DESY beam line at various beam momenta 4

Explore the world of Antimatter 4

Searching for new particles 4

Measurement of the beam absorption properties of materials

125 years ago Wilhelm Conrad Röntgen has discovered that certain types of electromagnetic waves (he called them X-rays) can be used to make images of the internal structures of objects because different materials are absorbing these rays in different ways.

Later physicists realized that other particles, for example electrons, could be used in a similar way. What happens to an electron or positron beam when it crosses the matter? If you measure how different materials absorb particles you may even be able to look inside an object using the electron / positron beam as it can be done with X-rays.

Please note: You can look at solids, liquids or gas but only non-combustible, non-biological materials can be tested at DESY.

Characterization of MicroMegas (or other) particle detectors

Recently, the Beamline for Schools scientists built four state of the art MicroMegas particle detectors (you can find a description in the "beam and detectors" document). Studying them in full is a long ongoing process that requires a series of measurements in a number of conditions. What is the maximum rate of the detectors? What is their spatial resolution? How do the environmental conditions affect their performance? Many more questions are waiting to be answered. Propose a series of measurements at the DESY beam lines that will allow the characterization of the detectors and will expose their limits. This is your chance to drive our continuous R&D efforts. MicroMegas are not the only detectors at your disposal. Feel free to browse the "beam and detectors" document and propose a series of measurements to study any one of them and help us to improve them.

Build and test your own detector

Design your own detector and calibrate it with the beam at DESY! A particle detector does not have to be a high-tech device that is beyond the reach of a team of students. In the early days of particle physics, cloud chambers and photographic emulsions have been used as particle detectors. Even some electronic detectors are not that complicated to make. You can think about testing an "every-day life" object as a particle detector. In 2016 one of the two winning teams tried to use a camera's image sensor as a particle detector. You could also consider the possibility to build your particle detector following the instructions for "Do-it-yourself" detectors that you can find on the web. You should find tutorials to build a cloud-chamber, a silicon detector or even a spark chamber.

Measurement of the beam composition of the DESY beam line at various beam momenta

The 6.3 GeV primary electron beam of DESY II impinges on a carbon fiber target producing photons, which are then converted again into electron/positron pairs. The secondary beam line is set up to select the particles of various momenta, between 0.5 and 6 GeV/c (you will be able to find more details in the "beam and detectors" document.). This selection is based on the deflection in the bending magnets and the collimators. The momentum composition of the beam is well known but we at Beamline for Schools have never measured it. Propose a series of measurements to look at the momentum distribution or to identify different particles and in the process you may discover rare particles that are not described in the “Beam and detectors” document.

Explore the world of Antimatter

The particles in the beam at the DESY beam line are either electrons or positrons, the electrons’ antiparticles. Some of the properties of antimatter have only been theoretically predicted but never been measured in an experiment. Right now professional physicists at CERN are preparing experiments to measure the properties of antimatter, for example the effect of gravity on antimatter particles. While such experiments are not feasible within the boundary conditions of BL4S, you could compare the properties of electrons and positrons, for example by observing how they are deflected in a magnetic field or absorbed by a material.

Searching for new particles

Many theories predict new very weakly interacting particles, which pass through matter almost without any interaction. These particles can be produced by dumping a particle beam onto a target and then searching for particles behind it. If you find a particle that was not in the original beam and that does not come from another known source, this could be the evidence of the product of the interaction between the beam and the target. For example, one of the winning teams in 2019 looked at the formation of the Δ^+ particle: a product of the interaction between an electron from the beam and a proton of the material.