Faculté de physique et ingénierie
Université de Strasbourg

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Summer School

Neutrino Physics Beyond Standard Model

29th June – 11th July 2025 (Strasbourg and Hamburg Universities)

Experimental Work (9th to 10th of July)

Institut Pluridisciplinaire Hubert Curien – Strasbourg

Practical work	Title	Description	Supervisor (s)
1	Rutherford/Mott cross sections at the 4 MV Accelerator	The scattering of alpha particles on gold foil lead to our picture of the atoms, that are composed of a dense, heavy and tiny core with a much larger electron cloud surrounding it. The scattering process is reproduced by the so Rutherford curve describing the angular dependency. This cross section is modified when the beam and the target are identical particles with an oscillating pattern from interference processes due to the quantum nature of the scattering process. In that sense, reproducing such an experiment putting hands on the equipment and analyzing the data allows direct experiencing phenomena and techniques, that are otherwise just appearing in textbooks. All it needs to reproduce these results is a suited accelerator and detection system where the iCube 4MV accelerator and the 4MV-EX2 scattering setup are available. A beam of 12C will be directed onto a thin 12C or 197Au target foil with measurements of the counting rate of scattered particles at different angles. Data are then calibrated, analyzed (normalized and compared to theoretical curves). The students will be introduced into the technical aspects of experimenting with nuclear physics background. They will be deeply involved in the planning, calibration and monitoring of the data taking. Analysis code will be provided in C/C++ (ROOT) and the students have support to develop their own analysis. The aim is to calculate cross sections that reflect the oscillating nature of the scattering process, and to quantify the accuracy of the measurement.	Dr. HEINE Marcel marcel.heine@iphc.cnrs.fr
2	SITRINEO	We propose a hands-on practical session using a tabletop tracking system composed of four monolithic active pixel sensors and a movable permanent magnet generating a 0.5 Tesla magnetic field. Data acquisition will be performed using a radioactive strontium-90 (Sr-90) source, which emits electrons with energies in the MeV range. During the session, students will have the opportunity to initiate acquisitions, explore different detector configurations, and carry out data analysis. This setup allows them to work with silicon detectors similar to those used in vertex detectors of modern particle physics experiments, providing valuable insight into tracking systems and the challenges of track reconstruction. Additionally, pre-recorded data from a 24 MeV beam line will be available for advanced analysis, time permitting.	*Dr. CHABERT Eric* *eric.chabert@iphc.cnrs.fr* *Xavier Madre* *xavier.madre@etu.unistra.fr*
3	Characteristics comparison of different photon detectors	To fully investigate the structure of a nucleus, spectroscopic studies require a high precision energy and timing measurements with the highest possible detection efficiency. Unfortunately, the « ideal » photon detectors does not exist. Either semiconductor detectors will give an excellent energy resolution but with a rather poor detection efficiency and timing measurement. Either fast scintillators will give a high detection efficiency and a good timing measurement but with a rather poor energy resolution. We then propose in this project to compare and to characterize the performances of a Highly Pure Germanium Detector (HPGe) with a rather new type of scintillators, the Lanthanum Bromide detector. After a short introduction to the detection principles, the students will have to perform an energy resolution measurement with these two kinds of detectors and compare them.	Pr. DORVAUX Oliver Olivier dorvaux@iphc.cnrs.fr

4	HPGe Gamma Spectrometer Simulation	Natural radioactivity and cosmic rays are a major source of background in the detector used for neutrino experiments. The precise characterization (energy distribution, identification of radionuclides) of this background is important to optimize the acquisition process and data analysis. Monte Carlo simulation software are widely for this application. This project introduces the Monte Carlo (MC) simulation tools Geant4/GATE through a gamma spectrometry application. After a brief overview of the fundamental principles of MC simulation —covering geometry, particle sources, and physical processes—participants will have the opportunity to develop their own code based on an existing example. They will model a high-purity germanium (HPGe) gamma spectrometer, and compute the energy spectrum corresponding to the main natural radionuclides and to the cosmic muons. The simulated data will be analyzed, similar to experimental ones, using python script. While basic skills, on Linux and python, will be beneficial, they are not essential for participating in this workshop.	Dr. ARBOR Nicolas nicolas.arbor@iphc.cnrs.fr GARCIA GARCIA Lucia Victoria lucia-victoria.garcia-garcia@iphc.cnrs.fr
5	Muon Telescope	Muons produced in the atmosphere are an ubiquitous background to several classes of experiments. One solution to alleviate this issue is to build detectors deep underground, however even in that situation the muon flux traversing the detector is not exactly 0. Identifying and possibly tracking the remaining muons is of utmost importance for these experiments. In this project we propose to investigate the muon tracking using a plastic scintillator detector built using the remaining panels of the OPERA Target Tracker and which serves as a prototype for the JUNO Top Tracker. We propose for the students to participate in data taking using this detector, followed by an analysis to identify muon tracks in all the collected data. Finally, once muons will have been identified, muon tracks can be reconstructed to obtain the muon distribution onsite. Time permitting, we can also use this data to evaluate the efficiency of the panels of plastic scintillator used in this prototype.	Dr. *ATHAYDE MARCONDES DE ANDRÉ João Pedro* jpandre@iphc.cnrs.fr
6	Muon Life Time	Cosmic muons are unstable elementary particles produced by the interaction of primary cosmic rays with nuclei in the upper atmosphere. The resulting muon flux, approximately 1 muon/cm²/minute, reaches the Earth's surface at sea level. Muons decay predominantly via the weak interaction according to the process: $\mu^{\pm} \rightarrow e^{\pm} + \overline{\nu}_e + \nu_\mu$ The objective of this practical work is to measure the muon lifetime. For this purpose, the experimental setup consists of a scintillating plastic paddle coupled to a photomultiplier tube (PMT). The detection signals will be acquired using a high-frequency programmable oscilloscope.Students will be responsible for data acquisition and offline analysis, including the estimation of the muon lifetime while accounting for accidental coincidences and background noise. By completing this practical work, students will: - Become familiar with particle detection techniques using scintillators and PMTs. - Learn to operate a digital oscilloscope for high-resolution timing measurements. - Develop skills in data analysis, including histogramming and fitting exponential decay. - Identify and correct for systematic errors such as accidental coincidences.	Dr. LABIT Loïc loic.labit@iphc.cnrs.fr
7	Calibration of a Photomultiplier response	Photomultipliers are important devices in nuclear instrumentation. They are used to convert light into electrical signal. This practical work proposes to become familiar with a procedure used to calibrate one photomultiplier. A dedicated experimental setup has been elaborated with a light injector system able to perform this absolute calibration. In the first part of the work, the students will use an oscilloscope to read and understand the signal coming from light impulsion. All data will be treated using dedicated routine in ROOT environment using statistical models to extract the calibration parameters.	Dr BAUSSAN Eric eric.baussan@iphc.cnrs.fr