HK 5: Instrumentation II

Time: Monday 15:00–16:30 Location: SR Exp1B Chemie

HK 5.1 Mon 15:00 SR Exp1B Chemie

Geant4 Simulations of a Neutron Irradiation Setup — •Maximilian Loepke, Reinhard Beck, Dieter Eversheim, and Dennis Sauerland — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

The Bonn Isochronous Cyclotron provides a beam of protons, deuterons or α-particles with a kinetic energy ranging from 7 to 14 MeV per nucleon. Since 2019, a proton beam is utilized for irradiation of e.g. silicon pixel detectors for radiation hardness studies.

It is planned to extend the facility's irradiation and experimentation capabilities by providing a neutron beam in the near future. The neutrons are produced by splitting-up deuterons into protons and neutrons in a thick target converter. Protons are stopped in the converter whereas the neutrons' flux and angular energy distribution is optimized by a subsequent copper/tungsten collimator. After collimation, the neutron beam can be used for irradiation.

This talk gives an overview of Geant4 simulation results and literature comparisons regarding the neutron field, with its flux and energy distribution generated by light elements (Li, Be, C) being bombarded with protons, deuterons and α-particles compared against literature. Additionally, simulations concerning isotope production and dosimetry were carried out and are compared against experimental results.

HK 5.2 Mon 15:15 SR Exp1B Chemie

Monte Carlo simulation framework for the neutron lifetime experiment τSPECT — •Niklas Pfeifer for the tauSPECT-Collaboration — Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The τSPECT experiment aims to measure the free neutron lifetime with an uncertainty goal of sub second by storing ultra-cold neutrons (UCNs) in a fully magnetic bottle using the spin flip technique. Monte Calo simulations of neutron dynamics in the experiment is a key element to study and understand systematic effects, reduce uncertainties and improve the experimental design. Based on different software packages specialized on Monte Carlo simulations, we developed a simulation framework to accurately simulate the production, transport and capture of UCNs in τSPECT.

This talk will summarize the different sub systems of the simulation framework, latest results and challenges of simulations for τSPECT as well as possible future optimizations and performance improvements.

HK 5.3 Mon 15:30 SR Exp1B Chemie

MC simulation of an ultra-low background HPGe detector for meteorite analyses — •Marie Pichotta[1], Axel Boeltzig[2], Steffen Turkat[3,4], and Kai Zuber[1] — [1]Technische Universität Dresden, Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [3]Università degli Studi di Padova, Padova, Italy — [4]Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Italy

An ultra-low-level gamma-ray counting setup was commissioned at the Felsenkeller shallow-underground laboratory, located at a depth of 140 m.w.e., in Dresden, Germany. This setup features a high-purity germanium (HPGe) detector with 163% relative efficiency, enclosed within both passive and active shielding. These shielding types reduce the remaining background rate to 116(1) counts $\mathrm{kg}^{-1}\mathrm{d}^{-1}$ within the energy range [40 keV, 2700 keV], making it the most sensitive HPGe detector in Germany and enabling the investigation of samples with activities well below 1 mBq.

In addition to describing the setup design, this contribution will present the Monte Carlo simulation of the detector. A current application of this work is the measurement of a rare meteorite sample, where 3D scanning techniques and simulations were used to determine the specific activities of cosmogenic radionuclides.

HK 5.4 Mon 15:45 SR Exp1B Chemie

Determining the Neutron Detection Efficiency of Lithium-Glass Detectors — •Felix Panholzer — Goethe Universität, Frankfurt am Main, Germany

A novel approach to measuring neutron capture reactions in inverse kinematics is based on Coulomb photo-dissociation. However, this method relies on the detection of the separated neutrons and thus the detection efficiency needs to be determined.

The objective of this talk is to elaborate on the aim of determining the neutron detection efficiency of lithium-glass scintillators. In particular, the Li(p,n)Be reaction is employed for the production of neutrons, which are subsequently measured by a Li-glass detector that partly relies on the ^{6}Li(n,α)T reaction. On the other hand, in order to ascertain the precise number of neutrons produced, the radioactive gamma decay (with an energy of 478 keV) of the ^{7}Be nuclei will be quantified using Broad Energy Germanium (BEGe) detectors. The ratio of these two measurements provides an accurate estimation of the Li-glass detector's detection efficiency.

HK 5.5 Mon 16:00 SR Exp1B Chemie

Development and Commissioning of an RFQ Cooler-Buncher for Laser Spectroscopy — •Finn Köhler[1], Bernhard Maass[1,2], Julian Palmes[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Physics division, Argonne National Laboratory, USA

At rare-isotope beam facilities, radio-frequency-based beam cooler-bunchers (RFQCB) are used to prepare ion beams for low-energy experiments. They can accumulate rare beams and emit ion bunches with a short time and energy width. This contribution will report on the development of a new RFQCB that produces bunch profiles well suited for laser spectroscopy measurements at the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) in Darmstadt. Additionally, the new RFQCB will serve as a prototype for the laser spectroscopy beamline of the N=126 factory at Argonne National Laboratory (ANL). A two-level differential pumping scheme allows having a high-pressure region at the entrance of the RFQCB to efficiently capture incoming ions despite the short length of the design. The performance of the new design was estimated using Simion flight path simulations that reproduced experimental results from ANL. We will report on the assembly and first commissioning results at COALA. This project was supported by DFG (Project-ID 279384907 - SFB 1245).

HK 5.6 Mon 16:15 SR Exp1B Chemie

Evaluation of different scintillating materials for neutron detection — •Valerii Dormenev, Kai-Thomas Brinkmann, Dzmitry Kazlou, and Hans-Georg Zaunick — 2nd Physics Institute, Justus Liebig University, Giessen, Germany

Non-destructive inspection, safety systems and scientific research use a wide range of physical methods and equipment for detection of different types of ionizing radiation. Among them, neutron counting in a wide energy range is one of most challenging tasks. The method of thermal and epithermal neutron measurements is often based on the interaction with several light isotopes such as ^{3}He, ^{6}Li, ^{10}B or heavy isotopes like ^{155}Gd and ^{157}Gd with high neutron capture cross-section. Scintillation detectors combine nuclei with high neutron capture cross-section and scintillation centers in a single detection medium open an opportunity for the particle identification and separation utilizing pulse shape discrimination (PSD) method. Here we report test results obtained at HZDR (Helmholtz-Zentrum Dresden-Rossendorf, Germany) with 14.1MeV neutrons from deuterium-tritium generator. The response to monoenergetic neutrons and thermalized neutrons after 16 cm of standard polyethylene moderator were measured for different scintillators: $Gd_3Al_2Ga_3O_{12}$:Ce/Mg, $(Gd_x\text{-}Y_{(1-x)})_3Al_2Ga_3O_{12}$:Ce, $Lu_{2(1-x)}Y_{2x}SiO_5$:Ce, $Lu_{2(1-x)}Gd_{2x}SiO_5$:Ce as monocrystalline materials, $(Gd,Lu,Y)_3Al_2Ga_3O_{12}$:Ce/Mg in form of translucent ceramics, PEN as organic scintillator, two types of glass ceramics materials contained Gd and Li. The aim of the tests was evaluation of the PSD method separation of different particles for the different scintillators.