

Physics - workshops

Workshops in research teams. Each candidate will declare their willingness to cooperate with a given research team at the recruitment stage, selecting the appropriate topic. These will be stationary classes carried out in modern research laboratories. Each student has to obligatorily complete one topic from presented below:

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1. Experimental studies of nuclear interactions

Elżbieta Stephan, PhD, MSc, Assoc. Prof., Andrzej Wilczek, PhD

Nuclear interactions, following from strong interactions, are the main subject of the studies. Modern models of nuclear interactions can be tested on the basis of precise measurements of observables in breakup of deuteron in collision with proton. Such experiments were performed at KVI Groningen (The Netherlands) and FZ-Juelich

(Germany) and are being continued at Cyclotron Center Bronowice (CCB) in Cracow. Tests of new parts of the BINA detector are carried out in our laboratory.

Student will have opportunity to work on:

- preparation and tests of new elements of the detection system,
- data analysis and simulations.

Visit at CCB to see a complete BINA detector is also considered.

2. The perovskite solar cells in the context of green/renewable energy characterized by X-ray photoemission spectroscopy analysis

Michał Pilch, PhD

Laboratory classes in the ultra-high vacuum XPS photoelectron spectroscopy laboratory are intended to familiarize students with the characterization of materials by analyzing the electronic structure and physicochemical processes in ultra-high vacuum conditions, as well as to familiarize them with the working conditions on this type of cluster.

3. Advanced microscopy techniques in the analysis of mitochondrial dynamics

Robert Gawecki, PhD

Planned research focuses on the dynamics of mitochondria in glioma and breast cancer cell lines. The aim of the study is to evaluate the effect of iron metabolism disturbances, induced by the use of both commercial and newly developed iron chelators, on mitochondrial morphology and dynamics. The analysis will be conducted using an advanced confocal microscopy system equipped with fluorescence lifetime imaging technology and high-resolution modes, enabling detailed examination of subcellular structures. The collected data will be subjected to comprehensive quantitative analysis to assess changes in mitochondrial dynamics in response to alterations in cellular iron homeostasis.

4. The basics of Automatics and Robotics

Kajetan Koperwas, PhD, MSc, Assoc. Prof.

The course intends to familiarize the participants with the idea and principles of robot programming. During the course, participants will learn not only about the basics of

robot control but also about the programming environment based on the Python language.

The laboratory classes aim to program an independently working robot that moves to the goal and simultaneously avoids the obstacles it encounters. The principles of its actions will be based on the proportional controller and the "hard switching" method of selecting the priority. Therefore, the course participants will learn the basic methods used to control the robot's movement (by setting the motors at a given state) and specify the current goals of the performed activities. As a result, during the classes, participants will face not only programming difficulties but also logical problems resulting from the need to translate the "human" way of thinking into the "language of a robot".

5. Measurement of the natural radioactivity of environmental samples

Beata Kozłowska, PhD, MSc, Agata Walencik-Łata, PhD

Measurements carried out in the Laboratory of Low Activity Studies IF concern the assessment of radioactivity in the natural environment, i.e. in air, soil and water, in particular with regard to the measurements of radon and its decay products, but also other natural radionuclides with long half-lives. The research is carried out using nuclear radiation spectrometry α , β , γ .

The aim of the proposed project is to measure radon directly in the field in a selected water intake using a portable radon detector RAD7 in combination with the RAD7_AQUA adapter and in the air around this intake. If necessary, the water samples can also be analyzed in the laboratory using a α/β Tricarb, Canberra, liquid scintillation spectrometer. The background of gamma radiation in the area surrounding the intakes will be estimated using a laboratory gamma - spectrometer with a HPGe detector.

6. Piezoelectric and optical properties of ABO₃ perovskites

Iwona Lazar, PhD, MSc, Assoc. Prof., Prof. Krystian Roleder

The studies will concern the piezoelectric and optical properties of perovskites ABO₃ in the form of crystals and ceramics. A student will learn methods for determining anisotropic electromechanical and optical properties. In our laboratories, we perform tests that classify materials for applications.

7. Preparation of liposomal carriers by the thin lipid film method and size reduction techniques

Patrycja Rawicka, PhD

The laboratory classes on liposome preparation aim to familiarize students with methods for obtaining liposomal carriers and various techniques for reducing their size. During the classes, students will learn about the process of liposome formation using the thin lipid film method, as well as selected homogenization techniques such as sonication and extrusion.

8. Theoretical description of the processes that break the lepton number and their experimental verification

Prof. Janusz Gluza, Bartosz Dziewit, PhD, Levgen Dubovyk, PhD

<https://us.edu.pl/instytut/ifiz/nauka/zespoly-badawcze/teoria-i-fenomenologia-fizyki-czastek/>

The student will get acquainted with the theoretical description of the weak interactions and possible theoretical generalizations leading to the processes breaking the lepton number. Practical classes at the blackboard and with the use of own and publicly available programs used to simulate interactions, thanks to which it is possible to determine the probability of discovering such processes in future lepton and hadronic accelerators, neutrino oscillations, low-energy processes.