

Education Program at the Doctoral School run in the Units

National Center for Nuclear Research and Institute of Nuclear Chemistry and Technology

Program assumptions

The need to establish a doctoral school by two scientific and research units: the National Center for Nuclear Research (NCBJ) and the Institute of Nuclear Chemistry and Technology (IChTJ) has existed for a long time. It results from the common history of institutes dating back to the 1950s, the complementarity of their research, and recently from the growing needs of the economy and science awaiting specialist training of staff for the Polish Nuclear Power Program (PPEJ) and constantly developing applications of ionizing radiation. It is also necessary to strengthen the staff in Polish science due to its increasing position in the global research area and the emphasis placed on innovation. Both research institutions and universities, as well as state administration units implementing programs related to atomic science, expect educated employees with extensive interdisciplinary knowledge in the field of nuclear physics and chemistry. Talented graduates of doctoral studies with in-depth specialist knowledge in the field of nuclear physics, astrophysics, as well as radiochemistry, radiation chemistry and radiobiology will significantly contribute to the Polish scientific staff. Globalization of scientific research and open research space in Europe guarantee work not only in the country, but also in numerous foreign institutions.

The institutes establishing the Doctoral School are the leading units in their disciplines (in the last categorization NCBJ-A +, IChTJ-A, in the previous one: NCBJ-A, IChTJ-A +). As part of the individual doctoral studies currently conducted in these units, education is offered which is not available in any of the university centers in the country. In this aspect, the creation of a doctoral school offering systematic studies in the field of exact and natural sciences, and more specifically in the disciplines of physical and chemical sciences, is perfectly appropriate. New solutions, extension of the study program, and a strictly defined system of evaluation of doctoral students and supervisors will allow to improve the quality of doctoral dissertations and their timely implementation. A stable scholarship system, clear recruitment criteria and professional school management will help in this.

The development of modern science increasingly depends on the use of worldwide unique research devices built and operated by international teams of scientists. Large research devices, such as the Maria reactor located in NCBJ and the unique device for structural research POLFEL, which is being built in Świerk, provide valuable opportunities for research conducted as part of the Doctoral School. The results of research obtained on such devices have both cognitive and practical importance in such fields as physics, structural chemistry, biology, medicine and materials research.

One of the features of the Doctoral School is the interdisciplinary nature of its teaching. The combination of the potential of two scientific disciplines will allow for a change in the teaching model through a joint program of the Doctoral School broadening the profile of education, and in the future also for the integration of activities stimulating the search for new research fields enabling the preparation of interdisciplinary dissertations. Among the research fields that currently require special integration, three domains can be mentioned, which are present in the statutory research programs of both institutes. These are: nuclear energy, radiopharmaceutical and material research.

1. Research in the field of nuclear energy and material physics

The Polish Nuclear Power Program, adopted by the Council of Ministers on January 28, 2014, requires "to ensure the supply of specialized human resources / human capital" and to build "technical, scientific and research facilities for Polish nuclear energy". Provision of facilities supporting the nuclear supervision and government administration in the field of safe operation of nuclear power facilities in accordance with IAEA guidelines requires the preparation of specialized personnel. We need high-class

specialists in nuclear physics and chemistry who can implement the next stages of the nuclear program, correctly assess the technical solutions introduced and guide the commissioning of new facilities. Qualified staff in research and development units, which strengthen the PPEJ, and the leaven of the technical support unit - TSO, are also needed. It is also in line with the Responsible Development Strategy and allows to support the development of National Smart Specializations (NSS).

The competences of the two institutes establishing the Doctoral School are complementary and adequate in the context of the created TSO, an organization whose future employees will be recruited, inter alia, from specialists educated at the School. The NCBJ domain is nuclear physics and reactor physics, while the IChTJ develops nuclear chemistry. Material tests are carried out in both units.

2. Research in the field of radiopharmacy

Poland, operating the Maria research reactor, is currently one of the most important suppliers of radiopharmaceuticals in the world. The producer and distributor of radiopharmaceuticals is the POLATOM Radioisotope Center, which is part of the NCBJ. In the near future, the cyclotron, developed under the CERAD project, will be added to the list of isotope generating devices. Isotope preparations produced in the center are used in medicine, science, industry and environmental protection. The conducted research is application-oriented and relate to radiopharmacy, chemistry and nuclear technology, as well as such scientific disciplines as: radiochemistry, biochemistry and immunology. The result of the research is the development of own technologies, which are then implemented in the unit. At the same time, more fundamental work in the field of radiopharmaceuticals is carried out at IChTJ, where new radiopharmaceuticals are designed and synthesized for both diagnostics and therapy. Due to the great achievements in the field of radiopharmacy of two centers - IChTJ and NCBJ - intensive development of this subject is purposeful. In the future, radiopharmacists educated at the Doctoral School will not only supply mother institutions, but also other centers that are emerging rapidly, producing radiopharmaceuticals for diagnostic tests performed with the positron emission tomography (PET) technique.

3. Basic research in chemistry and physics

By integrating some research domains, we want to further develop many fields that have so far been the pride of institutes and generate interesting topics for doctorates. These are:

- Biochemistry
- Radiation chemistry
- Nuclear Physics
- Physics of Condensed Matter
- Plasma physics
- High Energy Physics
- Physics of cosmic rays, astrophysics, cosmology

Basic research guarantees the constant development of disciplines by maintaining contact with world science and introducing innovative solutions. The Doctoral School will be created with a view to strengthening the international prestige of both research and development centers, which can boldly compete with leading foreign units in the field of research, and supplement education at Polish universities in the field of physical and chemical sciences.

General arrangements

1. Doctoral students are required to implement an individual study program agreed with their supervisors and approved by the School Council.
2. Classes organized by the School will be available to students regardless of the year of study.
3. Before the beginning of each semester, the School publishes the list of proposed classes and assigns them the number of ECTS points (except for the obligatory examinations referred to in the description of the 1st program block below). Depending on the number of people willing to participate in a given class, the School Council will select the classes to be conducted in the coming semester.
4. Classes can be conducted in tutorial mode.
5. Classes may be conducted in the e-learning mode.
6. Classes may be conducted in the usual semester mode, in the form of short series of several weekly lectures or in the form of intensive workshops lasting for a shorter period.
7. All classes conducted as part of the doctoral school will be made available to students of universities and other scientific units that have concluded a cooperation agreement with one of the Units running the Doctoral School.
8. Classes within the framework of the School are conducted in English.
9. The school will try to support (based on a grant for young scientists or otherwise from the units' own resources)
 - a. acquiring foreign language qualifications, including Polish language courses for foreigners
 - b. participation of students in summer and winter schools for doctoral students

Program blocks and requirements

The classes offered at the school are grouped into blocks used to formulate the requirements for passing the curriculum. It is assumed that a significant part of the activities conducted by the School may be attractive to students, regardless of the primary discipline in which they conduct their research.

I. Basic knowledge block

These classes cover the basic sections of physics and chemistry. In the discipline of physics, this block covers Mechanics, Quantum Theory, Electrodynamics, and Statistical Physics. In the field of chemistry, this block covers Physical Chemistry, Radiation Chemistry, Fundamentals of Radiobiology, Chemistry and Nuclear Energy. Classes in this block are not compulsory, but an examination is required on the date set by the teacher. Students must pass these examinations prior to the mid-term evaluation.

II. Block of methodological classes

For example:

- Machine Learning and Data Science
- Mathematical methods
- Computational methods in chemistry and physics
- Statistical methods in the analysis of experiments
- Programming tools and the pragmatics of programming large computing clusters
- Parallel processing
- Linux / Bash / Python development environment

It is required to obtain a minimum of 6 ECTS points from this block during the first 4 semesters of study.

III. Block of specialized lectures

This block includes lectures for doctoral students conducted at universities (in particular those with which the Units have a teaching cooperation agreement), as well as monographic lectures conducted as part of the School.

For example:

- Extragalactic Astrophysics
- Radiopharmaceutical chemistry
- Quantum chromodynamics
- Nuclear physics
- Material physics including radiation effects
- The physics of neutrinos
- Radiobiology
- Radiochemistry with radiation chemistry

It is required to obtain a minimum of 12 ECTS points in this block during the first 6 semesters of study, including a minimum of 6 ECTS points in the first 4 semesters.

IV. A block of research and development issues

For example:

- Nuclear energy
- IP protection, commercialization, cooperation with the industry
- High-temperature reactors
- Application of large research devices
- Application of nuclear methods in science, industry and medicine

It is required to obtain a minimum of 3 ECTS credits during the first 6 semesters.

V. Block of seminars

- Weekly doctoral seminars conducted by the School
- Weekly specialist seminars held at the Units or at other centers

Each doctoral student is obliged to participate in at least one specialist seminar throughout the study period and to actively participate in one of the Doctoral Seminars conducted by the School throughout the study period. Participation in seminars must be confirmed by an entry in the index after each semester.

VI. Block related to the presentation of results and applying for research funds

For example:

- Classes on the preparation of presentations, publications, seminars and conferences
- Classes on the preparation of grant applications
- Popularizer workshop
- Classes on voice emission and other aspects of public speaking

It is required to obtain a minimum of 3 ECTS credits during the first 4 semesters of study.

VII. Block of apprenticeships

- Classes for lectures at the doctoral school (may be conducted by doctoral students after the mid-term evaluation)
- Taking care of interns, apprentices and students who perform exercises in the studio

Classes in this block are not compulsory.

Passing

The results of credits and exams are entered into the doctoral student's index by the person conducting the classes.

1. With regard to classes carried out outside the School, the rules of obtaining credits adopted in the unit organizing the classes shall apply.
2. Classes conducted by the School may end with an examination or a credit without an examination.
3. In the case of classes conducted by the School, the doctoral student may take the exam on the first or second date set by the lecturer. If the doctoral student does not obtain a positive grade in the normal manner, then in justified cases, he / she may apply for an exam before the School Council.
4. The grading scale provided in the School Regulations is valid.