

Nuclear Physics in the Activity of Vasil Levski National Military University

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Abstract. The training in nuclear physics and related disciplines is embedded in the curricula of cadets and students in the specialties ZNI and ZNBK. The trainees have the opportunity to get acquainted in person with the activities of Kozloduy NPP and INRNE at BAS. The problem is the outdated material base, but although it is outdated, it is still working. During a visit to JINR Dubna, the possibility of using their electronic systems for conducting laboratory exercises in nuclear physics, similar to the Faculty of Physics at Sofia University, was discussed. We are applying under the NRA program for joint research with JINR, which will give a modern picture of the state of the ecological situation in the Rila-Rhodope massive. In this way it will update and enrich the research done by PU 10 years ago. In parallel, for the fifth year we are holding a scientific forum “Radiation Safety in the Modern World”, and this year we had 38 reports, and all guests presented their reports online. Two of our poster competitions were also on nuclear physics and nuclear energy.

Keywords: JINR Dubna, laboratory exercises, nuclear physics, poster competitions, research, scientific forum.

1 Introduction

In April 2019, Vasil Levski National Military University hosted the 47th national conference on physics education and we received many positive reviews. It raised the issue of quantitative and qualitative training of specialists in the field of nuclear physics and nuclear energy. As one of the sponsors of the conference, Kozloduy NPP raised this issue and its representatives outlined the lack of specialists to be felt in the coming years. A public tender for the construction of our second nuclear power plant is currently underway, and if the Belene NPP is to be built and operated soon, this shortage will be even more noticeable. Such a trend can be seen in neighboring Romania. The Ministry of Education also found a lack of such specialists and a general lack of engineering staff. Therefore, training in nuclear physics, nuclear energy and related disciplines for the needs of our nuclear facilities can now become a national priority.

In recent decades, there has been a significant outflow of people willing to study in the field of science and mathematics [1]. Even the Faculty of Physics of Sofia University „St. Kliment Ohridski“ and TU Sofia, it is very difficult to recruit students to study nuclear physics and to join the army of future Bulgarian power engineers. The study groups are not full and many give up because training in these specialties requires significantly more effort. Adding the broken relations with MEFH and MEI Moscow, which have prepared a large part of the Bulgarian energy sector, the picture gets a really bad dimension. This will be felt in the very near future, because the average age of specialists in the field of nuclear energy is constantly increasing and will soon pass the critical level. The groups at

the Faculty of Physics at Sofia University are chamber, and in Moscow there are no students at MEI for many years, although almost the entire teaching staff of the Department of Nuclear Power Plants has passed through our NPP, and there are colleagues who speak relatively good Bulgarian. During the celebration of the 45th anniversary of Kozloduy NPP in September 2019, the dean of the department, Professor Konstantin Nikolaevich Proskuryakov, visited.

2 The Training in Nuclear Physics at the Vasil Levski National Military University

Vasil Levski National High School does not have the possibilities of other universities for specialized training in nuclear physics and the resulting disciplines, but still we have some traditions over time [2]. A few decades ago, dosimeters were trained for the Bulgarian Army in the specialty “Nuclear, Chemical and Biological Protection and Ecology”, who had good training, and in addition to the army, many were professionally realized after completing their service in the military [3]. During the Chernobyl accident in 1986, the Vasil Levski National High School was one of the first to measure the change in the radioactive background, and the then leadership of the Bulgarian People’s Army took action to limit the impact on servicemen. After the change of the situation in Eastern Europe, our students have been acquiring the specialty “Protection of the population from disasters, accidents and catastrophes” for several years and in the specialty “Protection of the population and infrastructure” with a focus on emergency situations. Radiation accidents and catastrophes, preventive work to prevent them and reduce and eliminate their consequences are also considered as part of these situa-

tions [4]. Therefore, the training in nuclear physics in our country is carried out in a slightly different light, covers specific areas of its application and has a different professional realization of the students. Our university prepares staff, which are then realized not only in the structures of the Ministry of Defense but also in the Ministry of Interior and in particular in the General Directorate “Fire Safety and Protection of the Population”, municipal and regional structures and others. They are also used in a number of private and state companies.

Students in the specialty “Protection of the population from disasters, accidents and catastrophes” in the last curriculum of 2016 conduct training in “Nuclear Physics” in the IV semester of bachelor’s degree after completing training in general education subjects and after acquiring basic knowledge and skills in physics. The schedule of the discipline is 45 teaching hours, which include lectures, practical classes and tests. Due to the fact that we do not have working laboratory models, the students cannot conduct experiments on their own. During the course, students acquire basic knowledge about the structure of the atom, the types of radioactivity, the interaction of particles and rays with matter, basic information about neutrons and their interaction [5]. The principle of operation of basic measuring instruments used in military dosimetry is also studied. Basic information on the practical use of nuclear energy in nuclear power plants, fusion, medicine and technology is also given. The difference between the use of nuclear fission in nuclear power plants and nuclear weapons and how the speed of the reaction is controlled is indicated [6].

In the same semester the discipline “Dosimetry” is studied, in which they acquire practical and theoretical habits for working with dosimetric devices used in the Bulgarian army. The schedule of this discipline is 45 hours, and most classes are practically focused. Here we have ID-1 dosimeters and other military devices that measure radioactive radiation [7]. Although old, these devices work and perform good measurements. It is necessary to carry out repairs independently and when burning an appliance from several defective old appliances to assemble 1 working. A weakness of the current curriculum is the study of the two disciplines in one semester, while in the previous curriculum they were in two consecutive semesters – “Nuclear Physics” in the III semester, and “Dosimetry” in the IV semester and the measurement of dosimetric quantities followed the preliminary initial training in nuclear physics. A new curriculum needs to be developed next year and this gap needs to be addressed because there is a lack of further development of knowledge from one subject to another. It turns out that students begin to study the operation of measuring instruments without being familiar with the basic processes that take place in the atom and nucleus. The instruments and appliances used in these disciplines are already of a decent age, but due to coincidence no new ones are expected to be purchased. It is good that there are still devices that work, and even quite well, and in this way practical measurements are made of the radiation background.

I should also note that we have returned to the NRA all

radioactive sources and devices with such sources and currently do not have such. Our license to work with radioactive sources and ionizing radiation expired ten years ago and at the moment we cannot own such sources and perform any activity with sources and we comply with these requirements. We need to renew our license to work with radioactive sources in order to be able to handle calibrated ones, which are necessary for training and conducting practical classes. We will also be able to organize training courses that are within our competence and are required by the current national legislation. The policy of some of the previous managements of the university was to reduce some activities that are on the permit regime and at that stage of development we did not take action to continue working with ionizing sources. In order to improve the quality of training, better interaction should be sought with the Nuclear Regulatory Agency and other state bodies to overcome the weaknesses in previous years and improve the conditions for conducting a quality and comprehensive training process. After the renewal of the license we will have greater opportunities for training, as well as for research, scientific and training activities.

The curricula of the disciplines are changed and updated almost every year so that they are up-to-date and follow the state of development of nuclear physics and its practical orientation. In the following courses, students and cadets study other disciplines related to nuclear physics and radiation accidents in this field. The aim is for each subsequent discipline to develop the knowledge acquired earlier and to be focused on the practical use of what has been learned. The working hours of each of the disciplines are 45 or 60 hours and include both a lecture course and practical classes [8]. In some of the disciplines I use the help of the regional hospital for multidisciplinary treatment and the complex oncology center in Veliko Tarnovo, where they also demonstrate the practical use of various sources that are used in the diagnosis and treatment of various diseases. They are always very kind to us and show us the work of their modern equipment for diagnosis and treatment. From the point of view of the occupancy of the equipment, we spend these hours in the afternoon so that they can be as productive and efficient as possible. The Complex Oncology Center also expresses concern about the lack of staff in the field of ionizing radiation and medical physics and even seeks our assistance in filling vacancies. The people working there are 30–40 years old, but the workload is also high, they work many overtime hours and there is a shortage of specialists.

In December 2019, I had the pleasure of attending the XIV International Week at the Joint Institute for Nuclear Research in Dubna, Russian Federation with colleagues from other countries. These events have been held for 3-4 years and are gradually gaining popularity among academics. There I met many colleagues from other universities, including Ms. Victoria Belaga from the University of Dubna and JINR, who presented interesting online laboratory exercises in nuclear physics, which were developed there [9]. Even colleagues from the Faculty of Physics at Sofia University already use them in practice in conducting laboratory exercises, adapting them to their conditions. Tak-

ing into account the technical capabilities and the material base of our university, I will try to include them in the educational process with us, but this will happen from the academic year 2021/2022 or with the adoption of the new curriculum. In this way I will try to compensate for the lack of material base with the introduction of a modern training product and thus the trainees will be able to touch the interesting world of elementary particles. During the training at JINR I had the opportunity to get acquainted with other interesting developments, which I will try to include in the training process in “Nuclear Physics” and other disciplines related to nuclear physics. We have signed a contract with the Joint Institute for Nuclear Research and I hope to find common ground between the institutions. This turned out to be a very topical topic in the last month in connection with the passage of distance learning in the introduced emergency situation in connection with the development of the coronavirus. Perhaps this will be a catalyst for faster introduction of these laboratory exercises into the curriculum. As well as the use of lectures and practical classes that JINR has developed and can be used by teachers and students to conduct the training process. And there are enough such materials on the website of the Joint Institute after registration and admission for some of them [10].

Although the level of students has decreased over the years, there are still cadets and students who show a keen interest in the problems of nuclear physics. In one of the previous poster competitions, I had a participant who had made a model of the Large Hadron Collider at CERN. This prompted me to get in touch with colleagues from CERN and to organize an online sightseeing tour of the institute and a meeting with Bulgarian scientists there. This is about to happen, and we are still specifying the date for the event at a convenient time for both parties. Unfortunately, the state of emergency and the closure of CERN, even for online connections, postponed this event most likely for the autumn. This will be something new at our university and already students from our specialization and other specializations are interested in when the event will be, in order to get rid of other commitments, typical for our training. With the made model we participated in the exhibition for youth creativity in the town of Gorna Oryahovitsa in 2018. In 2019 we expanded our participation with more models and we want to develop further in this direction. And in 2020 we took part in the exhibition with 3 printed models from a 3D printer, presented in 2019. Despite the repeated postponement of the event in Gorna Oryahovitsa, it was held in November 2020 in a mixed mode. On the first day, participants from the educational organizations close to our area presented themselves, and on the second day the more distant participants presented themselves online. Despite the difficulties, the exhibition passed with great interest and was broadcast on YouTube. We managed to win an internal competition for the establishment of the Curious Club and in 2021 it will start operating. In this way, those who wish to enrich their knowledge and skills will be given the opportunity to express themselves. Here I must also include the presence of students and cadets who are interested in the relation-

ship between nuclear physics and nuclear processes that take place in space with the desire to enrich knowledge of astronomy and the structure and development of the universe [11]. There is a specialized club at the university that works in this field and performs well at domestic and international scientific forums and events in this field [12].

During the course in “Nuclear Physics” with the cadets and students we visit the Institute of Nuclear Research and Nuclear Energy at BAS, where in practice they see the Bulgarian experimental reactor [13] and other equipment at the institute. The staff of the INRNE always treats us with understanding and strives to show as much as possible to the students during the visit, and I want to thank their management and the head, Associated Professor Maria Manolova, for the kind hospitality. Here our boys and girls see in practice what they have learned and how the various techniques and laboratories for emergency response with the release of radioactive, chemical or biological substances are deployed. Although at our university they work with such equipment, it is interesting for them to get acquainted with other modifications of specialized equipment and measuring equipment.

Traditionally, we take our students to Kozloduy NPP, where they get acquainted with the activities of the reactors and what is more interesting for them and their training with the activities of the emergency response center. There, they practically see real actions in staging an accident in the reactor core or some other situation with a change in the radiation background. This is very interesting for them because it is directly related to their specialty and we often meet alumni of our university. Moreover, representatives of the NPP at the last scientific forums raise the issue of the need for personnel for our nuclear energy. Unfortunately, these visits last several hours and we are unable to see everything and answer the many questions.

In this way, at Vasil Levski NMU we manage to show the practical application of nuclear physics in our everyday life. Thus, future specialists manage to get acquainted with the practical use of this interesting science and what measures must be taken to make it work for the benefit of mankind and to prevent radiation accidents, which have very serious consequences for the state of our planet.

Traditionally, spring competitions for making posters and an autumn photo competition are held at the Vasil Levski National Military University [14]. Last year I organized for our students and pupils and students from other schools and universities a poster competition entitled “The development of nuclear energy in Bulgaria and around the world”. The deadline for sending the posters was 30.04.2020 and despite the pandemic situation in connection with COVID 19 there was interest in the event, as in previous years. In different years, the title of the competition was different, but always related to physics and nuclear physics [15]. The best works were shown at our university during the fifth scientific conference “Radiation safety in the modern world” on 20.11.2020. Due to the complex situation we did not organize a solemn award ceremony, and the awards were sent to the winners.



Figure 1. Some of the participants in the conference “Radiation Safety in the Modern World”, November 20, 2020.



Figure 2. One of the winning posters from the competition in 2020.

On November 20, 2020, for the fifth consecutive year, the traditional conference “Radiation Protection in the Modern World” is organized. Despite the specifics of the topic, the number of participants is constantly increasing, and there is an increase in the quality of the presented scientific reports. Last year we had 30 reports, and this year there were 39 reports with about 50 participants. Traditionally, we had participants from Latvia and Russia, but this year we expanded our participation with representatives from Romania and Georgia. Due to the pandemic situation, the conference was held in a mixed mode - present for representatives of NMUs and online for external participants, representatives of foreign universities and some of our students. Our ambition is in this 2021 to make an even more interesting scientific forum

Due to the development of the coronavirus pandemic and the prolongation of the state of emergency, some of the events underwent a change in the deadlines, but this did not and will not prevent their implementation, but only in changing the implementation and timing of the final measures they also depend on other events beyond our control. This only allowed for flexibility, maneuverability and the use of new methods and technologies, as well as the need for the introduction of digital technologies.

In 2020 I won projects for equipping 2 training laboratories and this year and next we will implement it with the team. These will be applied electronics laboratories and

3D printers, something new for our university. At the 47th Physics Conference at our university, a proposal was made to equip a physics laboratory, but we had great difficulty in finding funding. We tried to find funding, but unfortunately we didn't succeed. In the next programming periods we will try to find and fund the laboratories of physics and nuclear physics.

3 Conclusion

1. Nuclear physics training is necessary in view of the current international situation. After passing it, students acquire basic knowledge, skills and habits for the construction of the atom and the practical use of nuclear reactions in economics and military affairs.
2. The use of modern teaching methods must be tolerated and materials from other institutions must be used. This will increase the level of students and increase interest in these disciplines.
3. Great attention should be paid to extracurricular activities, such as visiting sites that use nuclear energy, organizing events that promote nuclear physics and its achievements, which should have a wider scope and include participants outside our university.

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