



# Summer Nuclear Forensics School

**September 13 – September 15, 2023, IDDA NRD, Azerbaijan**

**Supported by the US Department of Energy and the European Commission**

Ukrainian Science and Technology Center, Nuclear Research Department of Innovation and Digital Development Agency - Azerbaijan, Institute for Nuclear Research of the National Academy of Sciences of Ukraine, European Commission JRC and US DOE-NSDD invite senior students of science faculties from the GUAM member states (Georgia, Ukraine, Azerbaijan and Moldova) to the Nuclear Forensics Summer School. The goal of the school is to stimulate students' interest in continuing their studies in scientific disciplines related to nuclear forensics.

The summer school will be held at the Nuclear Research Department of Innovation and Digital Development Agency, Baku, Azerbaijan, **from September 13 to September 15, 2023**. Experts from Nuclear Forensics Laboratories of GUAM countries, from JRC Karlsruhe, and from US national laboratories will give lectures and conduct practical exercises on the analysis of nuclear and other radioactive materials.

The school will focus on using available instruments, equipment, and methods to characterize nuclear materials (such as uranium and plutonium), and other radioactive materials. Presentations will include scientific aspects, operational considerations as well as examples of real cases of nuclear or other radioactive material found out of regulatory control.

Training will be conducted in the following areas:

- Fundamentals of nuclear physics and radiochemistry
- Production and characteristics of nuclear materials
- Non-destructive analysis of nuclear and other radioactive materials
- Brief Reviews:
  - Radiometry and Dosimetry;
  - Alpha/Beta/Gamma Spectroscopic Methods;
  - XRF analysis;
  - Differential Thermal Analysis Method.

The program of the school involves a guided tour to the Nuclear Research Department.

The language of instruction is Russian with simultaneous translation into English.

Those who wish to participate in the Summer School should send an application, resume and letter of recommendation from a university teacher before **June 30, 2023**.

Foreign students will receive financial compensation for tickets to the Summer School and accommodation. All School participants are provided with meals, as well as grants.

Please send your applications for participation in the Summer School by e-mail: [elena.taberko@stcu.int](mailto:elena.taberko@stcu.int).



# Building the next generation of Nuclear Forensic Scientists: the GUAM Nuclear Forensics Summer School 9 – 13 September 2019, Kyiv, INR of NAS of Ukraine

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## 1. Introduction

In the framework of an STCU (Science and Technology Centre in Ukraine) project on "Next Generation of Nuclear Scientists", a staged approach has been taken to attract young researchers to the area of nuclear forensics and thus enable a smooth transition to the next generation. The project comprises Georgia, Ukraine, Azerbaijan, and Moldova (GUAM countries) includes grants for internships at the graduate level (three months), fellowships for post-doctoral students (two years) and a summer school (one week) for undergraduate students that was conducted on 9-13 September 2019 at the Kyiv Institute for Nuclear Research (KINR).



## 2. The summer school was aimed at:

- Raising awareness for the field of nuclear forensics among students of physics, chemistry or other scientific disciplines
- Communicating the principles of conducting a nuclear forensic investigation
- Teaching the scientific fundamentals (including elements of radiochemistry, nuclear physics, instrumental analysis)
- Providing examples of nuclear and other radioactive materials seized from illicit trafficking



The agenda had been jointly developed under the leadership of KINR by experts from GUAM countries together with international experts. A combination of lectures, table-top exercises, interactive elements, technical visits, and demonstration as well as hands-on exercises resulted in a full week with a highly focused agenda. This regional event was attended by some 20 students from GUAM countries.

The Summer School benefitted from the training facilities as well as from the equipment (hand-held devices for detection, localization and initial identification of material; laboratory instruments for characterization of seized samples; infrastructure for handling nuclear and other radioactive materials) available at KINR.

## 3. Lectures

During this summer school, students have attended a series of lectures:

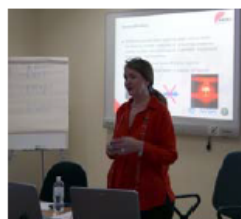


**"Nuclear Physics. Basic concepts"**, which included the following questions: radioactive and stable isotopes; radioactive decay; activity units; alpha- and beta-decay; gamma- and neutron-radiation; internal gamma-ray conversion; nuclear isomerism, and nuclear fission.

- **"Radiation safety at the handling of radioactive materials seized from illicit traffic"**: physical nature of ionizing radiation; biological impact of radiation, the

consequences of violations at work with the ionizing radiation sources; characteristics of the ionizing radiation sources used in the industry and medicine; basis of radiation safety and rules of personal hygiene at work with the radioactive sources; methods of the ionizing radiation characteristics measuring.

**"Interaction of gamma radiation with matter"**: detectors of ionizing radiation (ionizing chambers, proportional counters, Geiger-Muller counters, scintillation detectors, semi-conductor detectors); detection of neutrons (interaction of neutrons with the matter, slowing of neutrons, neutron detectors, instantaneous and delayed neutrons,



methods of detection, neutron sources, pulsed neutron sources); detection of charged particles (electrons and alpha-particles detection).

**"Nuclear materials"**: categories of nuclear materials; typical closed-cycle fuel cycle scheme; nuclear-physical properties of uranium; classification of uranium enrichment; some fuel characteristics of water-cooled reactors; properties of plutonium isotopes (the main ways

of operating plutonium in irradiating uranium with neutrons, nuclear properties of plutonium isotopes).

**"Data-bases for nuclear forensics"**

**"Development of nuclear forensics in Ukraine"**

**"Non-destructive analysis of nuclear and other radioactive materials"**: basics of gamma spectrometry; apparatus for gamma spectrometry; measurement of uranium enrichment; gamma spectrometry of plutonium

isotopic composition; X-ray fluorescence analysis; passive and active methods of analysis of large samples with the use of neutron counting, and principles of calorimetric analysis.

**"Methods of destructive testing"**: alpha-spectrometry (alpha decay, the Geiger-Natola

law, interaction of  $\alpha$ -particles with matter, detectors for  $\alpha$ -spectrometry, alpha spectra); mass-spectrometry (inductively coupled plasma source, action of the magnetic field, electrostatic field, types of ion detectors, dispersion and resolution, high-resolution ICPMS); electron microscopy (electron and ion optics, electron scattering, scanning electron microscopy,

transmission electron microscopy).

## 4. Excursions and Practical Exercises

During the summer school, students also have some excursions and practical exercises: acquaintance with the reactor of the Kyiv Institute for Nuclear Research, visiting the repository of samples, seized from illicit trafficking; gamma-spectrometric methods using NaI and HPGE detectors; determination of isotope composition of uranium samples

using IMCA and MGAAU, FRAM, and MGA methods; acquaintance with the work of ICP-MS, electron microscope, and alpha-spectrometer; crime scene management.



## 5. Conclusions

Student feedback indicated that the course generated significant interest in, and knowledge of, a variety of aspects of nuclear forensics. All of the participants shared the fascination of this scientific area and appreciated the opportunity to gain insights in the many avenues of professional and scientific endeavour this discipline covers.

In summary, students and participating experts agree that the Nuclear Forensic Summer School for GUAM Countries was a valuable undertaking, with a lasting impact on all participants. It will certainly serve as a model to be transferred to other regions.

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