**Cultural heritage investigation**
**using neutron activation analysis and related analytical techniques.**

While practice at JINR, students (preferably future physicists or chemists) will have the opportunity to join the team that investigates unique samples of cultural heritage: wall painting, biological remains, archaeological glass, metals and alloys, and, of course, ceramics – most frequent type of archaeological findings [1–3].

Our main technique for elemental composition determination is neutron activation analysis (NAA). During the NAA, the studied samples are irradiated in neutron fluxes. For irradiation basic facilities of Frank Laboratory of Neutron Physics (FLNP) are used: the IBR-2 reactor and the pneumatic transport system REGATA-2 [4] at the IREN research facility. During irradiation, atoms capture neutrons and pass into an excited state. In the end, the excitation is removed by the emission of gamma quanta. After irradiation, spectra of induced gamma activity are measured using high-purity germanium detectors. Each isotope on the spectrum has its own set of peaks. By calculating peak areas, it is possible to perform quantitative elemental analysis.

NAA is a reference technique [5]. It allows to find out elemental composition with sensitivity of at least ppm, in some cases – ppb. It is possible to carry out simultaneously high-volume (up to several dozen samples) multi-element (30-40 chemical elements) analysis.

We will provide participants with opportunity to properly prepare samples for neutron irradiation. We will tell about working with samples during and after irradiation. We will teach how to process the spectra of induced gamma activity and calculate mass fractions of detected elements. We will explain how the obtained data can be treated using statistical methods. We will demonstrate examples of historical issues solving based on the results obtained.
If necessary, we will provide some examples of using complementary methods, such as FTIR and Raman spectroscopy, optical microscopy, etc.

As a result of the practice, the participants will prepare a report-presentation in which they will talk about the acquired knowledge and skills.

Project Investigator – Andrey Dmitriev,
Phd, Head of the Sector of interdisciplinary research of cultural heritage, FLNP, JINR.

We look forward meeting you in JINR!

References.


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[4] Lobachev V V., Dmitriev AY, Borzakov SB, Smirnov AA, Zhironkin IS, Golubkov EA, et al. Pneumatic Transport System REGATA-2 for Automation of Activation Analysis at the IREN Facility, FLNP JINR. Phys Part Nucl Lett 2023;20:1064–72. https://doi.org/10.1134/S1547477123050503.

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