Neutron activation analysis and related analytical techniques in environmental and life sciences

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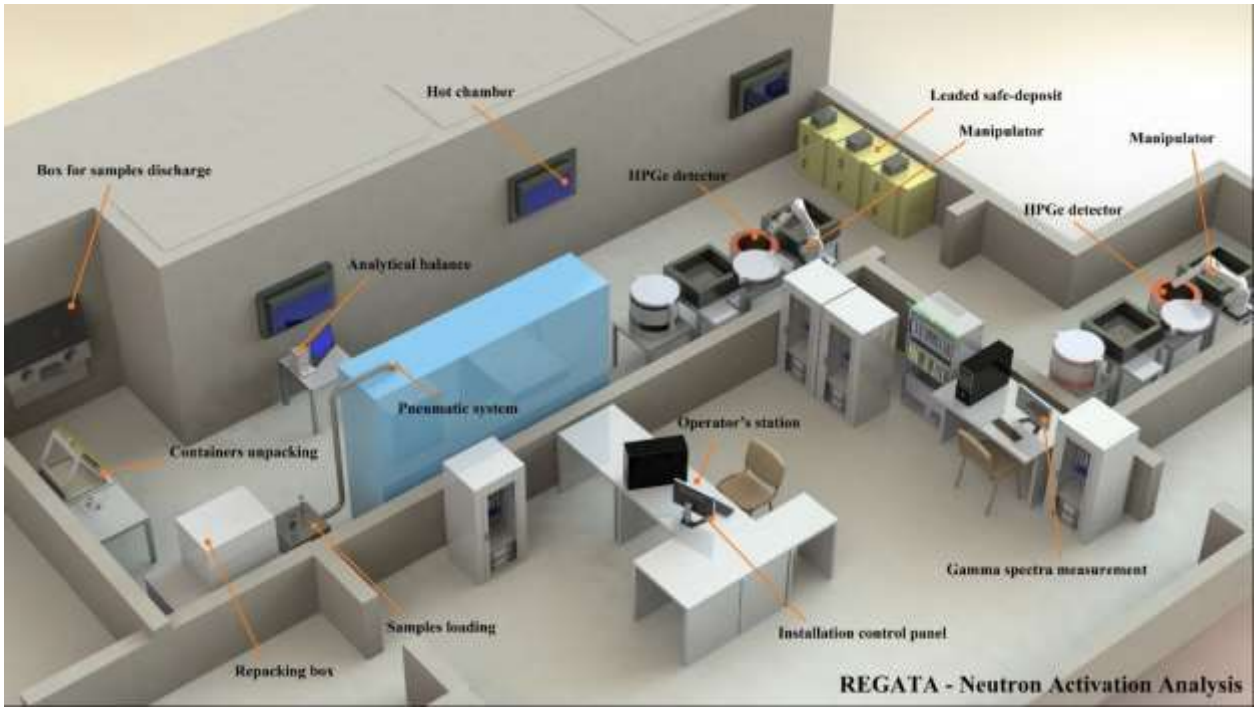
Pneumatic transport REGATA at the IBR-2 reactor is designed to determine the elemental composition of the samples with different matrices using instrumental neutron activation analysis. The technique is based on the nuclear process of interaction of stable nuclei of elements with neutrons during the irradiation of analyzed samples and reference materials in the neutron flow of a nuclear reactor. As a result of the interaction, radioactive nuclides are formed. Each radionuclide has a certain rate of reduction of radioactivity, which is characterized by the half-life period $T_{1/2}$, and also has only its own spectrum of gamma radiation (distribution of gamma-quanta by energies and intensities).



The scheme of the installation

Irradiations on the REGATA facility are carried out in two horizontal experimental channels of the reactor. Transport containers with samples using a pneumatic transport system are moved to the radiation channels located around the moderators of the active zone of the reactor. In the K2 radiation channel, the radiation is produced by the full spectrum of reactor neutrons. The flow density of thermal neutrons in this channel is approximately $2x10^{12}$ cm^{-2} sec^{-1}. The second radiation channel K1 has a cadmium jacket, therefore the irradiation is mainly carried out by supercadmium, E>0.6 eV, neutrons. The density of the flow of resonant neutrons in the K1 channel is approximately $1.5x10^{11}$ cm^{-2} sec^{-1}. As a rule, channel K2 is used for short irradiations, and K1 – for long irradiations.

After radiation, the spectrum of the induced gamma activity of radionuclides is measured using spectrometers based on semi-conductor especially pure germanium detectors and high-resolution spectrum analyzers. Spectra processing is done using Genie2000.

Elements, which can be determined in analyzed samples: Na, Mg, Al, Si, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Sr, Y, Zr, Nb, Mo, Ag, In, Rb, Sn, Sb, I, Cs, Ba, La, Ce, Sm, Eu, Gd, Tb, Dy, Nd, Er, Tm, Yb, Lu, Hf, Ta.

Main scientific directions:

1. Control of air quality (aerosol filters, biomonitoring using mosses, lichens, leaves)
2. Assessment of the state of water bodies
3. Bioremediation of soils and wastewater treatment
4. Geology and geoecology
5. Analysis of food, medical plants
6. Nanotoxicology
7. Material science
8. Biotechnology (development of new medical preparations and sorbents)
9. Archeology
10. Analysis of objects of extraterrestrial origin.

Beside neutron activation analysis in the Sector of neutron Activation analysis and applied research are available:

1) Inductively coupled plasma - optical emission spectrometry;
2) Atomic absorption spectrometry;
3) DMA-80 Direct Mercury Analysis System;
4) Low-background detector.

Publications

Main part of the publications can be found at https://www.researchgate.net/profile/Inga-Zinicovscaia

Description of the project

The project includes theoretical lectures on neutron activation analysis and other techniques available in the Sector of Neutron Activation Analysis and Applied Research and practical exercises as well as solution of the scientific task, which may depend on student specialty.