New Laboratories for Radiation Protection and Radioecology at IMROH

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ABSTRACT

Institute for Medical Research and Occupational Health (IMROH) is at the end of multiyear project: Research and Educational Centre of Environmental Health and Radiation Protection - Reconstruction and Expansion of the IMROH. At the end of the project, the Institute will be expanded with a new building of 6,785.15 m2, while its existing building of 2,067.41 m2 will be completely renovated. Radiation Protection Unit at the Institute specializes in radioecology and radiation protection, and it is continuously engaged in research of radioactive contamination of the environment by natural and fission radionuclides. This contribution presents new laboratories and current capabilities of Radiation Protection Unit at the Institute. Our new laboratories include three new coaxial HPGe gamma spectrometry systems with relative efficiencies up to 130%, electrically cooled in-situ HPGe detector, alpha and beta radiation counting systems, radon detectors, in-situ measurement instrumentation, H*(10) dosimeters for continuous monitoring, sample preparation systems and modelling simulation software solutions.

Keywords: *New Facilities, Instrumentation and methods*

1 INTRODUCTION

The Institute for Medical Research and Occupational Health (IMROH) is a multidisciplinary scientific institution with more than 70 years of experience in researching the mechanisms of action of various harmful chemical and physical factors and lifestyles on health and the environment. The Institute has a leading role in Croatia in research in the fields of general, genetic and molecular toxicology, allergotoxicology, dosimetry and protection against ionizing radiation, radiobiology, protection against chemical weapons, radiocontamination, environmental quality, air quality, drug abuse identification, metal distribution and inorganic and organic pollution in the environment, as well as human exposure to these pollutants and psychogenic factors of that medicine.

In 2017 Institute has enrolled in a project "Research and Educational Centre of Environmental Health and Radiation Protection - Reconstruction and Expansion of the IMROH". Five years later, today, the project is nearly finished.

The purpose of this project was to increase and improve the current IMROH infrastructure and its research equipment, and with the accompanying organizational reform to establish a Research and Education Center for Health and Medical Ecology and Radiation Protection - ReC-IMI. In order to realize the numerous scientific research and professional potentials of the Institute, over a period of several years the existing building of the Institute will be reconstructed and upgraded, and the ReC-IMI Center will be established which will be important for the Republic of Croatia and the wider region. At the end of the project, the Institute will be expanded with a new

building of 6,785.15 m2, while its existing building of 2,067.41 m^2 will be completely renovated. The Center is conceptualized as an administrative-organizational entity within the Institute, the backbone of which will consist of approximately 160 employees employed in scientific, collaborative, and professional positions of the Institute. The work of the Center will be primarily oriented towards basic and applied research in the field of occupational medicine, health ecology, radiation science and related disciplines, while the new spatial capacities will enable better implementation of teaching and popularization activities of the Institute. [1].

Goal of this paper is to present current capabilities and highlights of the new laboratories for radiation protection and radioecology at Radiation protection unit at IMROH.

2 NEW LABORATORIES

Radiation protection unit at IMROH will be significantly expanded with several laboratories and spectrum of new research equipment. Radiation Protection Unit at the Institute specializes in radioecology and radiation protection, and it is continuously engaged in research of radioactive contamination of the environment by natural and fission radionuclides. Thus, gamma spectroscopy was always the backbone of the unit's scientific and professional work as it houses Europe leading experts in the field and now, cutting edge scientific instrumentation. This instrumentation includes sample preparation and measurement instruments, the most important of which are described below.

2.1 Gama spectroscopy

Gama spectroscopy laboratory will be additionally equipped with three high purity germanium (HPGe) coaxial radiation detectors made by Ortec, which are used for high resolution gamma spectroscopy. Detectors are housed in enclosure with beryllium window and equipped with vertical cryostats and 30 l dewars. Detectors have relative efficiency up to 130% for a 1.3 MeV gamma rays and useful energy range that spans from 40 keV up to 5 MeV with energy resolutions 1.2 keV @ 122 keV and 2.1 keV @ 1332 keV. All detectors are equipped with accompanying electronic and software modules and lead and copper shields [2].

Angle software allows for the accurate determination of the activities of gamma spectroscopic samples. This is achieved by the calculation of detection efficiencies based on a solid and well-known theoretical background, using the so called "efficiency transfer" method which is a semi empirical approach – it is a combination of both experimental evidence and mathematical elaboration.[3]

2.2 Alpha spectroscopy

The Mirion Alpha Analyst integrated spectrometer along with Apex-Alpha software is the complete solution for both routine and non-routine alpha spectroscopy applications. Passivated Implanted Planar Silicon (PIPS) detectors are a product of modern semiconductor technology whose performance surpasses that of traditional silicon surface barrier (SSB) type detectors and diffused junction (DJ) type devices. The PIPS detector has a number of advantages over the older technologies for room temperature detection of alpha particles [4].

2.3 Counting laboratory

Counting laboratory will be equipped with beta and scintillation counters. DTU Physics Low-level beta GM multicounter is a low-level gas flow beta multicounter system for the measurement of 5 samples simultaneously [5].

Hidex 300 SL Super Low Level scintillation counter incorporates triple photomultiplier tube detector technology used for triple to double coincidence ratio measurements and facilitating high counting efficiency up to 70% and higher for ^{3}H, 96% for ^{14}C, and 95% for alpha radiation (^{210}Po, $^{234}U/^{238}U$, ^{241}Am, ^{222}Rn, ^{226}Ra) [6].

2.4 Radon measurement instrumentation

AlphaGUARD is often used as reference instrument in radon monitoring. It offers high detection efficiency, a wide measurement range (2 Bq/m³ – 2 000 000 Bq/m³), fast response and permanent, maintenance-free operation with long-term stable calibration. In addition to the Radon concentration, AlphaGUARD simultaneously measures and records ambient temperature, relative humidity and atmospheric pressure with embedded sensors [7]. Our AlphaGuard instrument configuration also contains radon/thoron discrimination and measurements in air, soil and water.

2.5 Special in situ measurement instruments

Aegis Portable HPGe (High purity germanium) Spectrometer is the Mirion's newest transportable, battery-powered HPGe gamma spectrometer that offers many state-of-the-art features, such as a thermal-cycle free cryostat, an integrated all-in-one design and laboratory-grade energy resolution, while offering typical relative efficiency of 40%. All of that is combined with larger HPGe crystals and the option to provide the portable spectrometer with a Remote Detector Chamber (RDC) cryostat (enabling detector backshielding) [8].

Else Nuclear Discovery IC is a highly sensitive ionization chamber capable of continuous monitoring and measurements from 10 nSv/h to 100 mSv/h within energy range from 30 keV to 10 MeV [9].

3 DISCUSSION AND CONCLUSION

Goal of this paper was to present current capabilities and highlights of the new laboratories for radiation protection and radioecology at Radiation protection unit at IMROH that were equipped in the ReC-IMI project. We have presented new equipment in gamma and alpha spectroscopy, counting laboratory, radon measurement instrumentation and some of the special in situ measurement instruments.

We believe that building appropriate spatial infrastructure and investing in modern scientific equipment will significantly increase the scientific excellence and visibility of IMROH in the field of existing research.

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