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Low-level atmospheric radioactivity measurement using a NaI(Tl) spectrometer during aerosol sampling

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Content

A high-volume (900 m3/h) aerosol sampler operated by SURO within the Czech Radiation Monitoring Network has been upgraded by a NaI(Tl) spectrometric module. The module is placed directly above the aerosol filter which allows for the detection of increased levels of artificial atmospheric radioactivity already during sampling. Standard monitoring regime starts with 3 to 4-day sampling period followed by 8-hour preliminary laboratory measurement. Subsequently, 6-day final measurement is carried out after 3-4 days of decaying. The achieved detection limits for 137Cs measured with a 150 % HPGe spectrometer are approx. 10 μBq/m3 and 0.1 μBq/m3 for the preliminary and final measurement respectively. Although measurement during sampling provides a better time resolution, it is at the expense of lower sensitivity due to the high natural background.

Gamma ray background is composed mainly of 222Rn and 220Rn decay products. This is problematic not only due to the high deposited activity (~ 104 Bq of deposited activity), but also due to its high variability. The reason for this lies in different radon progenies half-lives and consequently their different activity build-up rate on the filter during the collection process. Rapid changes in the activity ratio between radon decay products in the sampled air are an equally important factor.

The article focuses on the development of a method which could accurately subtract such a complicated background from the measured signal. This goal was achieved by a robust fitting procedure which analyses spectra using a set of background measurements. Based on a given background set, a matrix of characteristic spectra is constructed and serves as an input to the optimization procedure. The sensitivity of this algorithm with respect to false positive alarm rate was studied using radionuclide sources simulating atmospheric contamination by 131I, 134Cs and 137Cs. In addition, complex studies were conducted on the set of real spectra which were artificially injected with impulses in order to simulate various scenarios with different mixtures of chosen artificial radionuclides. The achieved sensitivity for the 1 % false positive alarm rate and 1 h (24 h) measurement period was estimated to 380 (5.6) mBq/m3, 120 (5.1) mBq/m3 and 220 (1.4) mBq/m3 for 131I, 134Cs and 137Cs respectively.

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About the Presenter

Mr. Miroslav Hyza has worked at The National Radiation Protection Institute in Prague for the last six years, specializing in the field of atmospheric radionuclides monitoring. He has participated in several major projects related to the research of new concepts and innovation of aerosol sampling devices.

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