Scanning and direct measurement of gross alpha and beta radioactivity in surface soil based on ZnS(Ag) and PVT scintillators

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Vehicle-based mobile radiation scanning system, which can analyze radiologically contaminated soil by providing information including gross alpha, gross beta, and gamma radioactivity as well as gamma dose rate, was developed, as shown in Fig. 1. By previously condutcted study on the system, it was found that two 2× 4 × 16-in. NaI(Tl) scintillators could effectively scan gamma radiation in soil, where Compton radiation was suppressed by surrounded polyvinyltoluene (PVT) scintillaotors. In cases of nuclear decommissioning sites adopting 0.1 mSv/yr release criteria, for example, the gamma spectrometer with ~ 10 km/h scan speed was capable of finding position and direction of hotspot and characterize radioisotopes existing in the soil sites. Also, the spectrometer showed its performance to estimate depth profiles up to 0.1 m, by comparing ratios of photopeak to Compton counts. Besides the gamma spectrometer, in this study, we test effciencies of the gross alpha and beta detector array based on the five ZnS(Ag) and PVT phoswich detector. We use five Po-210 sealed source to test the gross alpha sensitivity, and for the gross beta sensitivity, Sr-90 open sources distributed on acrylic frame that contains 1.2 g/cm^3 density soil with effective area of 0.1×0.2×0.02 m^3. In order to harden the Sr-90 diluted in distilled water, we mix it with NaCl, and NaOH, poly(acrylic acid), and poly(diallyldimethylammonium chloride) and pour them into the frame before soil is contained together. We qauntitatively evaluate static and scan minimum detectable concentration of the detector array, by differentiating distance from ground and buried depth of isotopes. Futhermore, we discuss feasibility of handheld portable radiation probe rod with Φ12 × 20-mm PVT scintillator to find gross beta radioactivity concentration profiles up to 0.1 m depth in detail.

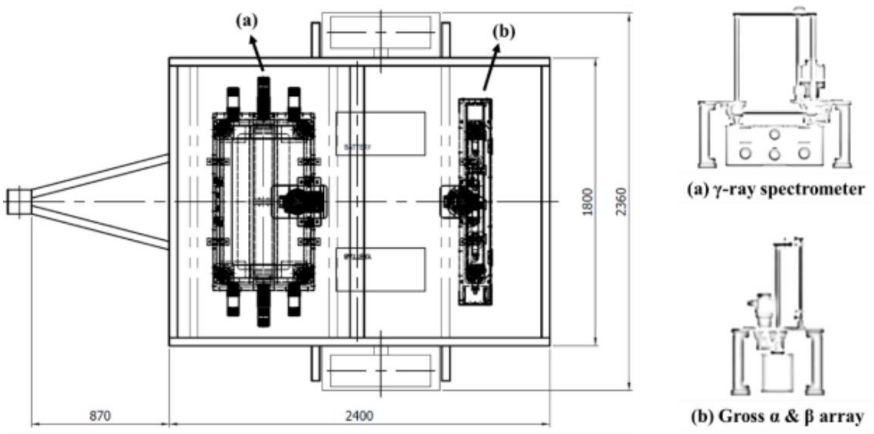

Fig. 1. Vehicle-based mobile radiation scanning system
[C. Lee et al., Nucl. Instrum. Methods Phys. Res. A 966, 163833 (2020)].

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