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#5-34 CeBr3 gamma-ray logging probe qualification for uranium mining applications

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The development and optimization of gamma-ray spectrometry tools is crucial for ORANO Mining and uranium geophysical exploration. This study presents a comprehensive characterisation of the ALT QL40-SGR-2G spectrometric probe, equipped with a cerium bromide (CeBr3) detector. This characterization was carried out at the Nuclear Measurement Laboratory of IRESNE, at CEA Cadarache, France. We report different measurements of its energy calibration and resolution, detection efficiency, crystal length, angular response, count losses due to dead time or gamma self-absorption, and spatial sensitivity with depth profile measurements at different radii inside a calibration sand silo. We also report the validation of the CeBr3 probe numerical model through a comparison between experimental data and MCNP simulations, showing a very small discrepancy (2.4 % in average) across the whole energy spectrum for a series of standard gamma sources measured at 15 cm. The investigations on the crystal length with a finely collimated 137Cs source confirm the manufacturer specifications, while the angular characterization shows variations lower than 4 %. The use of the two-source method allowed a dead time estimation, which remains lower than 5 % up to 5000 ppm of uranium. Finally, the spatial response of the probe, measured with a 137Cs source moved in the instrumentation channels of the sand silo, also shows a good agreement with the MCNP profiles at different radii, validating the ability of the MCNP model to reproduce gamma logging profiles in a realistic environment. Future tests will be performed in real boreholes of uranium ISR (in situ recovery) mines, in Kazakhstan, in view to correct for the radioactive imbalance in roll fronts thanks to innovative spectroscopic approaches, and thus to better estimate the uranium grade.

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