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#08-11 Design of MICADO passive and active neutron measurement system for radioactive waste drums

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In the frame of the MICADO H2020 project, a passive and active neutron measurement system is being developed to estimate the nuclear material mass inside legacy waste drums of low and intermediate radioactivity levels. Monte-Carlo simulations have been performed to design a modular and transportable neutron system, with the main objective to reach a good tradeoff between the performances in passive mode, i.e. neutron coincidence counting, and in active interrogation mode with the Differential Die-away Technique. Different designs are compared, which mainly differ in their moderation materials, graphite and polyethylene. This parametric study allowed us to define a prototype taking into account practical constraints in view of its final implementation in a wide range of in-situ locations and nuclear facilities. The total neutron detection efficiency of the prototype is 6.75%, as calculated for an empty drum without waste matrix. The detection limit in terms of nuclear material equivalent mass have also been estimated by calculations based on assumptions for a homogeneous distribution of nuclear materials inside the drum, filled with four types of matrices covering the range of nuclear waste drums defined in the frame of the project. The most penalizing matrix is made of polyethylene with an apparent density of 0.7 g.cm-3, which leads to a mass detection limit of 519 mg of 240Pu in passive mode, and 564 mg of 235U or 349 mg of 239Pu in active mode. Measurement time is 30 min for both passive and active modes. The most favorable matrix is made of stainless steel in passive mode and of polyethylene in active mode, with an apparent density of 0.7 g.cm-3 and 0.1 g.cm-3, respectively. The calculated mass detection limits are respectively 68 mg of 240Pu, 62 mg of 235U and 39 mg of 239Pu. Next steps will be a complete investigation of matrix effects based on intensive Monte Carlo calculations and an experimental design to build appropriate corrections. Experiments will also be conducted at CEA Cadarache Nuclear Measurement Laboratory with the neutron system prototype, and mock-up drums filled with different matrices.

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