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Multi-modality photofission-based technology for nuclear waste packages characterization: a solution to address safety, economic and societal aspects

In the past decades, the problem of nuclear waste packages characterization has become one of the foremost challenges for countries with nuclear energy programmes. This problem is not only driven by the necessity to have a more accurate information about the inventory of fissile materials contained in such packages for making better supported decisions for nuclear waste management policies and regulations, including those related to safety, but also from the economic and societal sides, two additional important aspects related to sustainability of nuclear programmes. The public concern about the stock and management procedures with nuclear waste has become one of the hot topics in recent years due to the growing amount of nuclear waste, associated risks and impact on the environment. Characterization of nuclear waste packages is a challenging task, requiring
adequate tools for qualitative and quantitative assessment of the inventories. Moreover, recently dismantling and decommissioning (D&D) tasks have joined these activities also since large volumes of various nuclear wastes are generated during these operations. The challenges for characterization tasks arise from homogeneous/non-homogeneous matrices of such waste packages, presence of neutron moderating and absorbing elements, as well as low amounts of characterizing fissile materials. However, the most significant challenge is attributed to concrete containing packages, the presence of which limits the performance of the traditional measurement methods used for such tasks. Coupled with the necessity to have not only the information about the total fissile mass, but also the information about the actinide isotopic composition it represents a new challenge to take up. In this work, a multi-modality photofission-based measurement technology is proposed to tackle such a scope of tasks in application to nuclear waste packages characterization. The first modality features the multi-energy photofission method to unfold the information about the relative isotopic abundancies of actinides present in the package. The second modality features mono-energy photofission method to determine the total mass of actinides. The goal is to define an innovative methodology for nuclear waste packages characterization tasks, discuss the data unfolding routines and detection methodologies capable to tackle the associated analytical challenges as well as to address the sustainability concerns of the toolbox of characterization techniques.

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