Prague, Czech Republic June 21-25, 2021

Contribution ID: **22** Type: **Oral presentation**

#08-22 Nondestructive active characterization of large concrete nuclear waste packages using photofission technique and high-resolution delayed gamma spectroscopy

Wednesday, June 23, 2021 11:40 AM (20 minutes)

Nondestructive characterization of large concrete radioactive waste packages is a major challenge. The fissile mass inside has to be estimated very precisely in order to transport and store the wastes in the safest way. Ultimately, knowing the alpha activity of the waste packages could enable to lower their activity category and thus to significantly reduce their final repository cost, e.g. in a surface vs. a geological disposal. The 870 L concrete waste drums, produced and stored at CEA Cadarache in France, represent an issue since they cannot be characterized using Active Neutron Interrogation. Indeed, their large dimensions and poorly known hydrogenous content lead to extremely penalizing uncertainties associated to high attenuation effects. This article focuses on the development of a nondestructive characterization method using Active Photon Interrogation (API) to estimate the fissile mass contained inside these large concrete waste barrels. This technique exploits the photofission reaction of nuclear materials occurring with photons of energy larger than 6 MeV. Since all actinides have similar photofission cross sections, the method cannot directly estimate the fissile mass (for example 235U, 239Pu) or the alpha activity (mainly Pu isotopes), and therefore a discrimination method is needed to identify the main nuclides of interest. This method is based on the difference of photofission product yields in actinides, and consequently on their delayed gamma ray intensities. In a first step, we present here new experimental data of more than 30 photofission product yields for 238U and 235U obtained by irradiating bare uranium samples with a Bremsstrahlung photon flux produced by a 16 MeV electron linear accelerator at the CINPHONIE facility of CEA Cadarache, France. The fission contribution of parasitic neutrons produced by photonuclear reactions in the accelerator conversion target, in the surrounding materials, and in the sample itself, was also calculated and subtracted. These measurements lead to select the most suitable gamma-ray lines for discriminating between 238U and 235U in a dense environment like a concrete package. In a second step, we use these measured photofission yields in our Monte-Carlo (MCNP6) simulations to assess which delayed gamma-rays are detectable in concrete radioactive waste drums. Since matrix effects produce a differential attenuation of these delayed gamma rays, they affect the discrimination of actinides and increase the uncertainty on the fissile mass. Therefore, we also study actinide localization methods via Monte-Carlo simulations, using specific delayed gamma rays from photofission as a probe, which will be qualified experimentally with a mock-up of a concrete waste matrix.

Primary author: DELARUE, Manon (CEA, DES, IRESNE, Nuclear Measurement Laboratory)

Co-authors: Mr ALLINEI, Pierre-Guy (CEA, DES, IRESNE, Nuclear Measurement Laboratory, F-13108 Saint--Paul-Lez-Durance, France); Dr PEROT, Bertrand (CEA, DES, IRESNE, Nuclear Measurement Laboratory, F-13108 Saint-Paul-Lez-Durance, France); Mr ECK, Daniel (CEA, DES, IRESNE, Nuclear Measurement Laboratory); Mr PAYAN, Emmanuel (CEA, DES, IRESNE, Nuclear Measurement Laboratory); Dr SIMON, Eric (CEA, DES, IRESNE, Nuclear Measurement Laboratory); Prof. COLLOT, Johann (Laboratory of Subatomic Physic and Cosmology, Université Grenoble Alpes, CNRS/IN2P3); Dr TISSEUR, David (CEA, DES, IRESNE, Nuclear Measurement Laboratory); Mr ESTRE, Nicolas (CEA, DES, IRESNE, Nuclear Measurement Laboratory)

Presenter: DELARUE, Manon (CEA, DES, IRESNE, Nuclear Measurement Laboratory)

Session Classification: 08 Decommissioning, Dismantling and Remote Handling

Track Classification: 08 Decommissioning, Dismantling and Remote Handling