The Euratom project MICADO and its innovative characterization process of the Nuclear Waste Packages

M. Morichi, E. Fanchini, A. Iovene, F. Giordano, A. Pepperosa on behalf of the MICADO Collaboration - **ID:107**

This project has received funding from the European Union's Horizon 2020 innovation action programme NFRP-2018 under grant agreement No 847641. This text reflects only the author's views and the Commission is not liable for any use that may be made of the information contained therein.

www.micado-project.eu

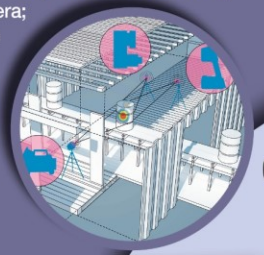
micado

Gamma characterization, dosimetry and hot spot identification techniques

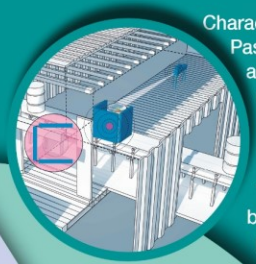
Development of the gamma emitters detection station, an automatic and integrated multi-technologies system to improve the overall characterization quality and speed up the analysis of the gamma characterization of the D&D waste. It combines in a single station:

- Dosimetry and Spectroscopic measurements in open geometry with a the RadHand;
- Gamma imaging in open geometry with the Nanopix camera;
- Segmented gamma scanning, angular scanning, emission and transmission tomography with an innovative gamma scanner.

The station also provides multiple Radiological Waste Package (RWP) sizes accommodation and characterization, estimation of the matrix material and density, hot-spot source localization and radioisotopes identification.



Photofission



Characterisation of large concrete nuclear waste packages remains a critical issue. Passive non-destructive techniques can be limited by the background of the package and/or the absorption of spontaneous gamma and neutron emission, due to the concrete wall thickness of the waste package. The photofission is the best option to evaluate the U and Pu activities for high-density and highly hydrogenated waste packages.

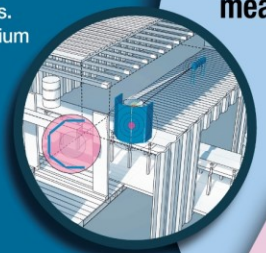
This active non-destructive technique is based on photon-induced fission and can be applied if incident photons have energies exceeding 6 MeV. Since an intense photon flux is required to compensate low photofission cross-sections, this technique is deployed using a linear electron accelerator (LINAC).

The integration of the photofission technique in MICADO aims at optimizing a stationary non-destructive measurement cell to characterize large concrete nuclear waste packages, especially those identified as legacy waste.

Active and passive neutron measurements

Passive neutron coincidence counting of spontaneous fission neutrons is a non-intrusive characterization method providing information on the quantity of actinides present in the RWP. It is used when plutonium gamma rays are masked by other intense gamma emitters like fission or activation products.

When other spontaneous fission emitters like curium isotopes mask the signal of plutonium, active neutron interrogation with a neutron generator and the detection of induced-fission prompt neutrons may become necessary to infer the fissile mass in the RWP. Both passive and active neutron measurements are in complementary to gamma spectroscopy in view determine the amount of uranium and plutonium in radioactive waste packages.



The D&D process of nuclear infrastructure increasingly demands methods for full traceability of waste material to improve quality management and operational safety. The absence of a consistent and straightforward solution for digitizing the enormous amount of data is a critical issue, which challenges the operator's ability to maintain high operational quality assurance and measurement precision. The usage of instruments of different kind have forced operators to devise management systems like logbook notations. It is within this framework that the MICADO project aims to provide a standardize method of measurement and an analysis platform to improve the operations, safety of the operators and reduce costs.

Combination of measurements and uncertainty assessment

Several issues can be identified in current practice, related to the uncertainty quantification for radiological measurements of waste packages: the systematic uncertainties related to scaling factors and those for calibration factors/efficiencies are often neglected. While for laboratory conditions the result might not be affected, things may look a lot different when taking measurements on the field where higher term of their Taylor's expansion come to play.

Our solution will tackle these problems directly investigating all sources of uncertainties and using intense simulation to well describe their effect on the final measurement.

RCMS DigiWaste Platform

The RCMS (Radiological Characterization & Monitoring System) DigiWaste Platform is a fully comprehensive solution which provides seamless digitization of D&D activities. The system offers easy tracking of any type of RWP using radiation tolerant UHF RFID tags, the integration of multiple detection technologies for the characterization and monitoring. Each device transmits in real time information on instrument status, location, measured radioactivity levels and alarm status and the RFID tag inventory. Information provided is uploaded, collected and processed by the customizable database framework.

Monitoring Grid

The composition of the radioactive waste can be very different, and in general it is categorised according to its activity. However, from the monitoring standpoint we can make a distinction between two main categories: radioactive waste emitting neutrons or gamma rays.

At the current time, technologies exist for decades for detecting gamma-rays and neutrons emitted by a nuclear waste package. However, considering requirements set by a long-term monitoring, there is currently no technological solution enabling an individual monitoring of nuclear waste packages at large scale in a specific repository site.

In MICADO we will use a system for the online real-time monitoring of radioactive waste repositories based on two different technologies: the "SciFi" gamma ray monitoring and the "SiLiF" neutron monitoring sensors.