Project of Decommissioning and Contaminated Water Management - Development of Small Neutron Detector

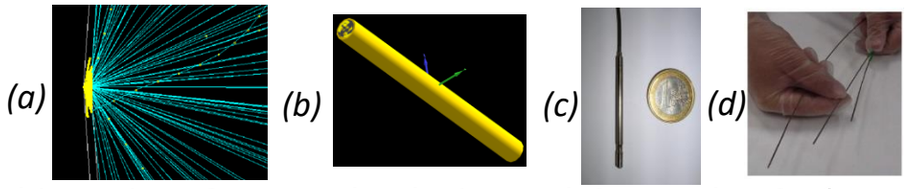
ONET TECHNOLOGIES – Summary of the Project for Small Neutron Detector Development (phase 1)

Outline of the project

ONET Technologies and CEA Tech LIST proposed to apply to the Project of Development of a Small Neutron Detector to support the decommissioning challenge of Fukushima Daiichi NPS in the Fukushima damaged reactors in order to detect the fuel debris inside the PCV.

The project stands in three phases :

- Phase 1: Feasibility study of a **S**m**A**ll **N**eutron **D**etection s**Y**stem (**SANDY**)
- Phase 2: Manufacturing and test of a small neutron detector prototype
- Phase 3: On site deployment in the units 1, 2 and 3 of Fukushima Daiichi NPS



(a): Fission Chamber Modelisation *(c), (d): Fission Chamber Pictures*
(b): Fission Chamber Monte-Carlo Model

ONET Technologies and CEA Tech LIST have been awarded for the phase 1. In the frame of this project ONET Technologies and CEA Tech LIST focus their research on the fission chamber technology for the neutron detection. Taking into account the severe conditions in the 3 units (dose rate, humidity) and the size constraints the system must enforce to be deployed within the PCV, fission chamber was the most performing technology among a large panel of available neutron detectors. The outcomes project phase 1 is a feasibility study for SANDY Basic Design (design of the neutron detection head by Monte Carlo simulation and experimental validation of the fission chamber technology)

Project outcomes obtained so far

Performance under high gamma dose rate:

Irradiation test performed in order to detect the ability to count neutron only in high radioactive environment:

Outcomes obtained:

- No false positive counted until 8kGy/h
- No impact on the counting rate at 1kGy/h
- No degradation of the performance following a 2kGy integrated dose

Choice of a reference detector:

Choice of an existing detector as baseline design in order to move forward for a specific detector for Fukushima

Outcomes obtained:

- Choice of the fission chamber CFUF34 proposed by PHOTONIS®
- 4.7mm x 85mm – m=30gr – Sensitivity = 10^{-3} $c.s^{-1}/n.cm^{-2}.s^{-1}$

Improvement of the reference detector:

Design improvement of the reference detector to enforce size and sensitivity constraints

Outcomes obtained:

- Detector CFUF34-MOD (20mm x 40mm – Not able to detect 0.1n/cm²/s in less than 1h – Operable under 1kGy/h)
- Detector CFUF34-MH (20mm x 60mm – Able to detect 0.1n/cm²/s in less than 1h – Operable under 1kGy/h)
- Monte-Carlo simulation in Fukushima context

Fine fuel debris localization

Development of a methodology based on inverse problem approach to improve the localization of the fuel debris

Outcomes obtained:

- Proof of principle validated on simulated data

On site implementation on IRID robot B2'

Outcomes obtained:

- Implementation solution carried out for IRID robot B2' with two design options

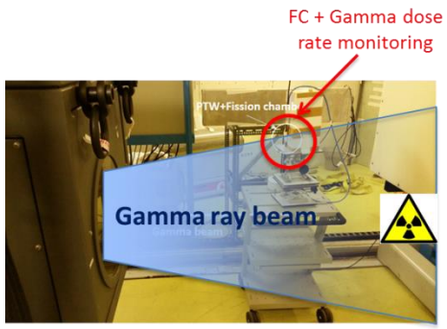


Fig.1: Irradiation test bench

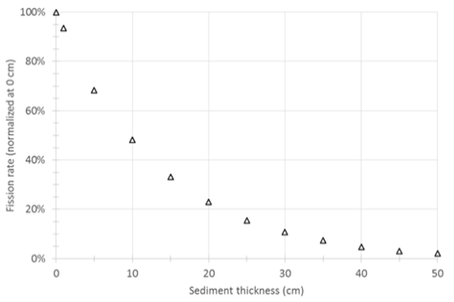


Fig.2: Counting rate Vs distance to fuel debris

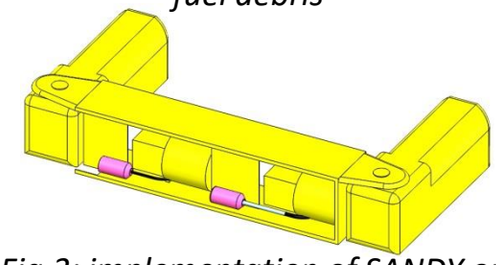


Fig.3: implementation of SANDY on IRID robot B2'