UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

Grant # 31310022M0003
Grantee: University of Cincinnati
Title of Grant: In Vivo Measurement of Low Energy Photon Associated with an Internal Deposition of Mixed Oxide Nuclear Fuel
Period of Performance: 11/1/2021-10/31/2024 (FY2021 Notice of Funding Opportunity NOFO)

Executive Summary

The goal of this proposed research is development of a practical, robust method to evaluate direct, in vivo measurement results of internally deposited, isotopic mixtures of uranium, plutonium, and americium relevant to the composition of new and mixed oxide nuclear fuels and waste streams commensurate with small modular and advance reactor designs. The lack of a predictable isotopic composition for these fuels and potential waste streams plus the predominance of low energy photon and x-ray emissions from these isotopes makes it challenging to accurately measure and rapidly evaluate an internal deposition using in vivo measurements, especially when decisions about remedial actions must be made in a timely manner to be effective following accidental exposure. Existing gamma spectroscopy programs are not sufficient to resolve the low energy x-rays and photons produced by mixtures of these isotopes. This project will develop a new method to analyze low x-ray and photon energy spectra generated by in vivo measurement of isotopic mixtures of internally deposited uranium, plutonium, and other transuranic isotopes. The method will utilize a matrix of response functions for an array of high-resolution germanium detectors using a combination of Monte Carlo simulations to predict photon interactions in the detectors plus empirical measurements using anthropometric phantoms having known distributions of 241Am, 235U, 238U, and 239Pu arranged in lungs, skeleton, liver and axillary lymph nodes. The phantoms will be designed and constructed as part of this project and measured at the University of Cincinnati In Vivo Radiation Measurement Laboratory. The isotopic mixtures used in the phantoms will be guided by the outcome of mathematical simulations that predict photon interactions and the x-ray and photon energy spectrum generated by the detector array.

Principal Investigator: Henry B. Spitz, henry.spitz@uc.edu

Presentations and Publications

The list of publications was submitted with the final report after grant expiration.

- Journal: Tissue substitutes for the Lawrence Livermore torso phantom suitable for a continuous spectrum of low energy photons

Patents

The University of Cincinnati received patent # 12089982 “Calibration Phantom for Radiotherapy” on 9/17/24 which describes optimization method.