INL/EXP-19-55006-Revision-0

Pulse Mode Calibration of the Micro Pocket Fission Detector

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August 2019

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

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Prepared for the
U.S. Department of Energy

Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

www.inl.gov

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Pulse-Mode Calibration of the Micro-Pocket Fission Detector

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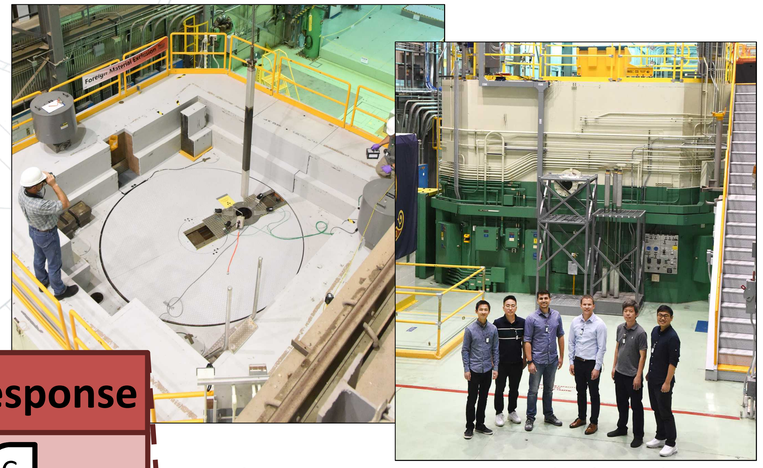
Detector Background

The MPFD is a neutron sensor which has the capability to observe the real-time neutron population inside a reactor core while surviving the harsh radiation, and temperature conditions, which sets it apart from most neutron sensitive devices. It is currently under development in the High Temperature Test Laboratory (HTTL) for use as a supporting instrument during material testing experiments performed at TREAT. To further the technology, the next step is to develop a procedure to calibrate the detector to be sensitive to absolute localized neutron population, as known as pulse-mode operation.

Goal

Develop a procedure to calibrate pulse-mode operation of the Micro-Pocket Fission Detector (MPFD) using a nuclear reactor such as the Transient Reactor Test Facility (TREAT).



The **T**ransient **Rea**ctor **T**est Facility (TREAT)

Neutron Environment

- Theoretical Neutron Spectrum (A)
- Dosimetry Activation (B)

Effective Mass Coefficient

- Based on experimental conditions:
  - ◊ Temperature
  - ◊ Co-deployed instruments
  - ◊ In-core location

Detector Response

- Experimental (C)
- Theoretical

Effective Mass

$$M_e = \frac{C}{R}$$

Detector Count Rate

Fissile Coating Response

Chamber Simulations

- Ionization simulation
- Particle track simulation

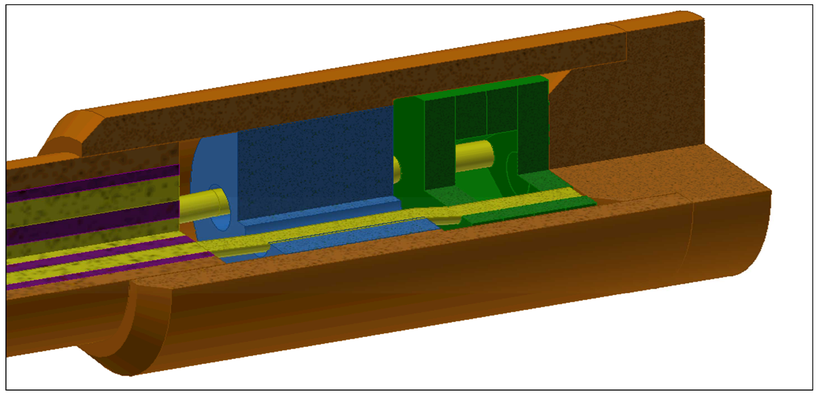
Detector Chamber Characteristics

- Fissile mass measurement using alpha spectroscopy
- Gas type & pressure
- Chamber dimensions

(C) Detector count rates will be recorded for varying Lower Level Discriminator (LLD) settings during deployment at TREAT while undergoing steady state operations.

(A) The theoretical neutron energy spectrum will be determined using a simulation code, MCNP, prior to detector testing.

(B) Dosimetry, in the form of activation foils and wires, will be deployed during MPFD testing to determine the localized neutron environment in the reactor.



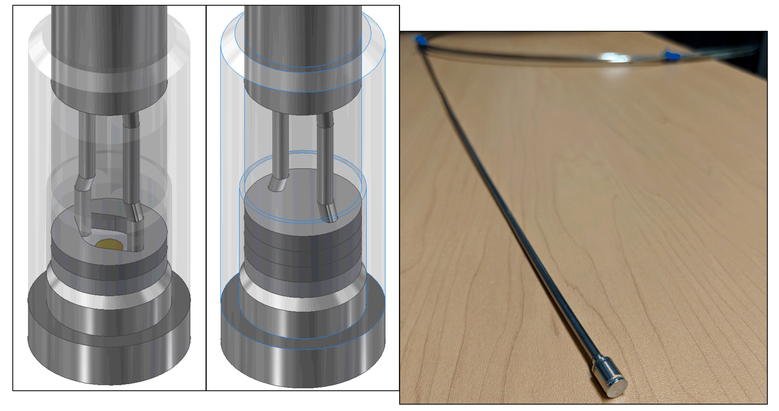
CAD model of the chamber highlighting the various internal components

Results & Impact

A procedure was developed, outlining the calibration process for this highly neutron-sensitive detector in pulse-mode operation. This MPFD will play a vital supporting role in the upcoming development of small-modular reactors and microreactors by providing real-time in-core neutron population measurements.

Acknowledgements

This work was supported in part through the Department of Energy In-Pile Instrumentation program under DOE Idaho Operations Office Contract DE-AC07-05ID14517. Special thanks to the TREAT Experiment Engineers, Plant operations, and RadCon.



CAD model of the chamber and image of a fully-assembled MPFD

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