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Real Time In-Core Instrumentation: From Fuel and Materials Irradiation tests to Advanced Reactor Demonstration -Flux Sensors

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Changing the World's Energy Future

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Real-time In-core Instrumentation: From Fuel and Materials Irradiation Tests to Advanced Reactor Demonstration – Neutron Flux Sensors

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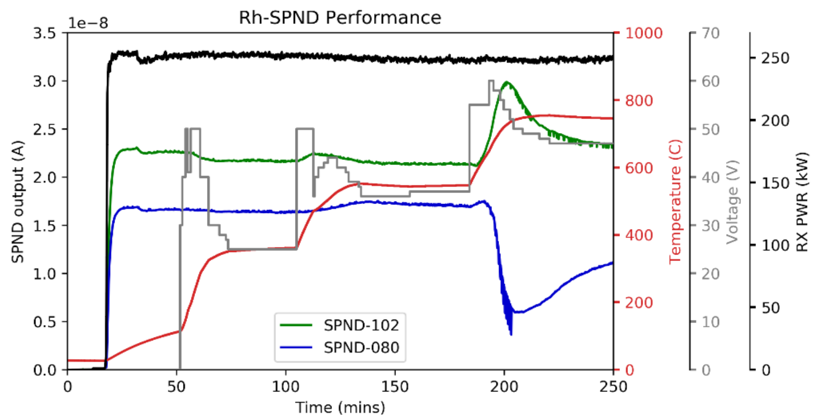
Project Description: In-core neutron flux sensors provides localized neutron flux data in real-time. This data is crucial for supporting advanced fuel cycle development as well as monitoring and controlling existing and advanced reactors. This project directly addresses the development and qualification of the sensor technologies. Activities include designing a sensor, establishing a fabrication/procurement pipeline, and demonstrating sensor performance in representative advanced reactor environments. In fiscal year (FY) 2021, work was primarily focused on the demonstration of rhodium-based self-powered neutron detectors (Rh-SPNDs) that were designed and fabricated in FY 2020 for steady-state reactor operation and use in high-temperature (upwards of 800°C) environments. The micro-pocket fission detector (MPFD) had also undergone a design update with irradiation testing alongside the Rh-SPNDs.

Impact and Value to Nuclear Applications: Performance characterization of SPNDs and fission chambers in research reactors provides a calibration pathway for the development and use for in-core flux sensors —a crucial step toward qualifying sensors for neutron flux measurements. The demonstration and comparative assessment of neutron flux sensors will provide local neutron measurements for material test reactor irradiations as well as advanced reactor deployments requiring active flux-sensing technologies.

Recent Results and Highlights: SPND testing and benchmarking against fission chambers and dosimetry were performed in three reactor facilities: Idaho National Laboratory's Advanced Test Reactor Critical facility, Neutron Radiography facility, and Idaho State University's AGN-201m test reactor facility. Additional high-temperature testing was also performed at the Neutron Radiography facility. These experiments demonstrated SPND signal linearity in response to thermal flux for over five decades in magnitude. The data collected provides calibration factors for the SPNDs, provides information for the sensitivity models under development, and serves as the basis for developing active temperature compensation tools.

Sensor insertion into NRAD heated rig.



SPND performance in heated irradiation at NRAD.