



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

**Office Of Nuclear Energy
Sensors and Instrumentation
Annual Review Meeting**

**Micro-Pocket Fission Detectors (MPFD)
Troy Unruh
Idaho National Laboratory**

September 16-18, 2014



Project Overview

■ Goal, and Objectives

- Develop, fabricate, and evaluate the performance of prototype, high temperature, compact, multi-purpose, fast and thermal fission chambers with integral temperature sensors

■ Participants

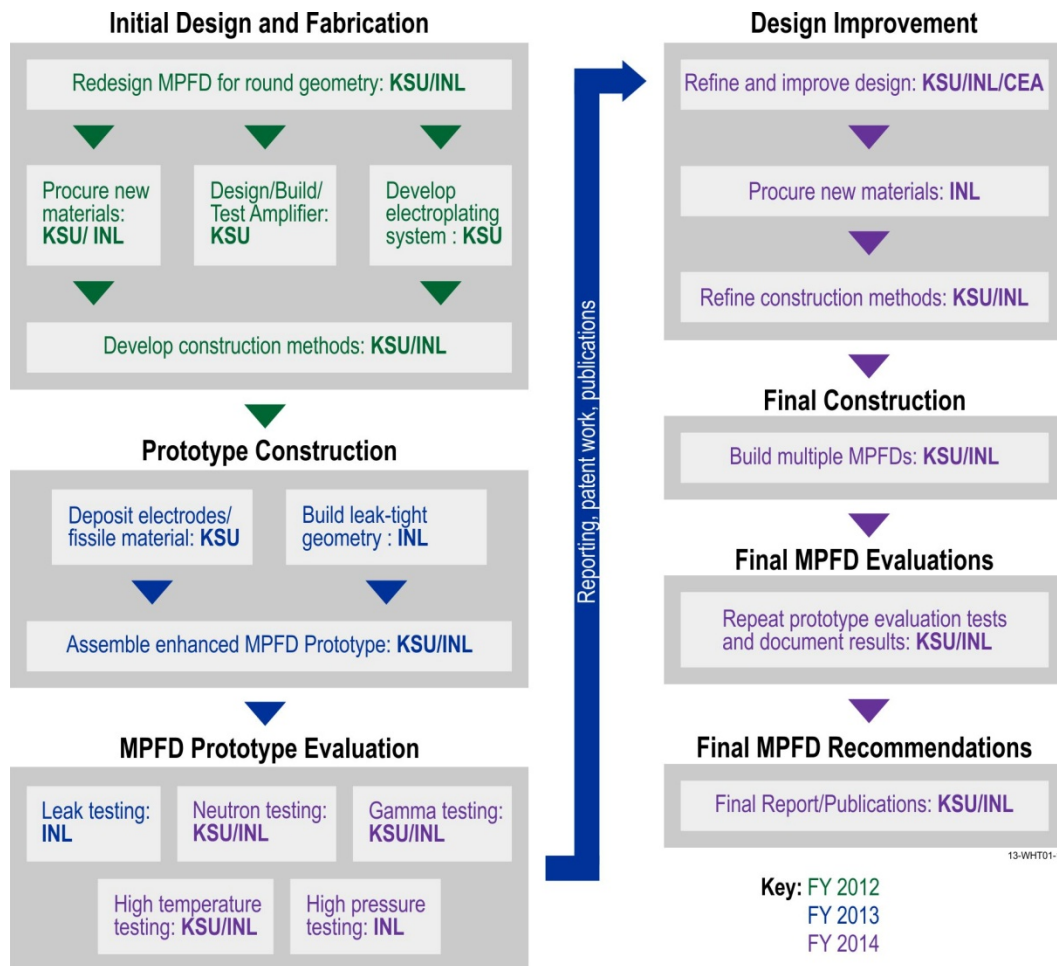


- » Troy Unruh and Joy Rempe; Idaho National Laboratory
- » Philip Ugorowski, Douglas McGregor, and Michael Reichenberger; Kansas State University
- » Jean-François Villard; Commissariat à l'énergie atomique



Project Overview

■ Schedule

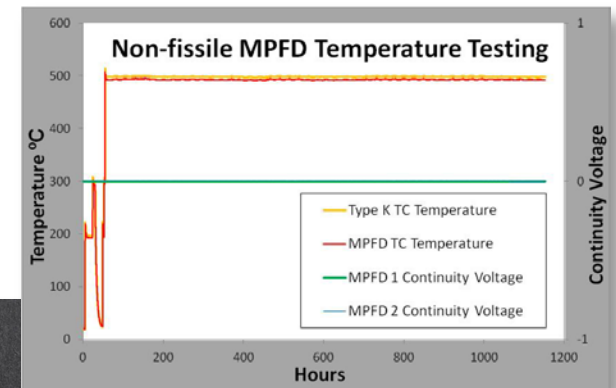
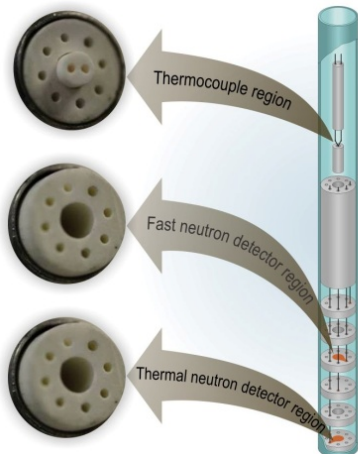




Accomplishments

■ FY14 Milestones, Deliverables and Outcomes

- Refined MPFD design
- Successfully completed enhanced MPFD for leak-tightness evaluations
- Successfully completed enhanced MPFD long duration performance in high temperature furnaces
- Successfully completed enhanced MPFD evaluations at KSU TRIGA reactor

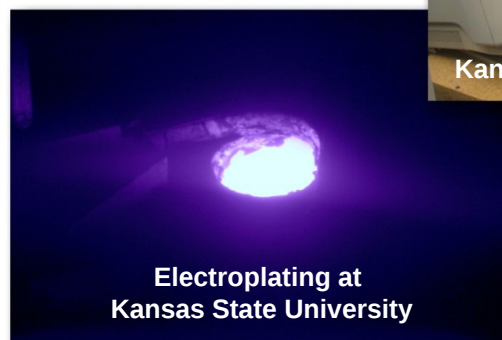
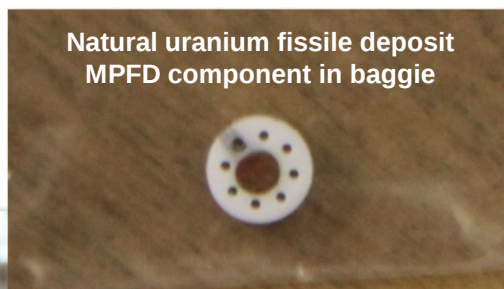
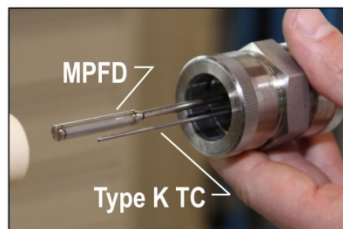




Accomplishments

■ FY14 Milestones, Deliverables and Outcomes (cont.)

- Issued final program report, INL/EXT-14-33026 **“NEET Micro-Pocket Fission Detector- Final Project Report ”**
- Conference Publication, "Enhanced Micro Pocket Fission Detector Evaluations", for *9th International Topical Meeting on Nuclear Plant Instrumentation, Control, and Human Machine Interface Technologies (NPIC&HMIT 2015)*



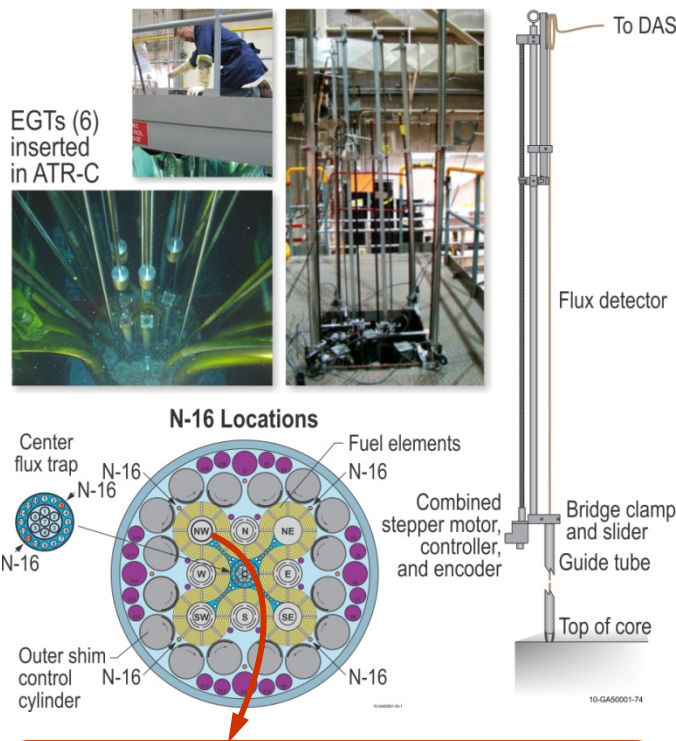


Technology Impact

- **Collected list of customer requirements through interactions with cognizant leads in NGNP, ARC, SMR, LWRS, FCRD, TREAT restart, and ATR NSUF programs**
 - Neutron sensitive (BOTH fast and thermal)
 - Temperature sensitive with integral high-temperature thermocouple
 - Compact size
 - Radiation resistant
 - High temperature and pressure compatibility using appropriate materials
 - High accuracy, high resolution
 - Flexibility (variable sensitivities, lifetimes and detector responses)
 - Fast response
 - Long lifetime
- **State-of-the-art sensor positions U.S. for leadership in irradiation testing**
 - Minimizes flux perturbation associated with typical real-time in-core sensors
 - Permits 3D modeling and triangulation of data for validation
 - Higher fidelity data for modeling and simulation of materials and fuels
 - Potential to increase US MTR customer base (DOE-NE, NR, industry, regulators, etc.)



Technology Impact (Cont.)



■ FCRD

- Enables in-pile measurement of fast flux, thermal flux, and temperature in high temperature irradiation tests and in transient tests
- Multi-purpose sensors provide high accuracy data required for validating new multi-scale fuel models

■ ATR NSUF

- Enables in-pile measurement of fast flux, thermal flux, and temperature in high temperature ATR NSUF irradiations
- Provides US MTR users high accuracy, high temperature flux and temperature data
- Ideally suited for cross-calibrations using specialized fixturing from previous NSUF detector calibration project



Technology Impact (Cont.)

■ NGNP

- Enables in-pile measurement of fast flux, thermal flux, and temperature in high temperature irradiation tests and on-line monitoring of conditions in first plant
- Multi-purpose sensors provide real-time data to validate model predictions during irradiation and during reactor operation
- Higher temperature version to be developed and evaluated in recently-awarded NEET project.

■ LWRS / Industry Programs

- Enables in-pile measurement of fast flux, thermal flux, and temperature in fuels and materials irradiation tests
- Multi-purpose sensors provide data required for demonstrating performance of accident tolerant fuels during irradiation testing during steady-state and transient conditions
- Multi-purpose sensors provide real-time data for characterizing conditions during materials irradiations.



Technology Impact (Cont.)

■ TREAT Restart

- Enables in-pile measurement of fast flux, thermal flux, and temperature in irradiation tests
- To be evaluated in recently-awarded TREAT Instrumentation IRP
- Multi-purpose sensors provide data for validating new multi-scale models.

■ Advanced SMR

- Enables in-pile measurement of fast flux, thermal flux, and temperature in high temperature irradiation tests
- Multi-purpose sensors provide high temperature real-time data to validate fuel and material properties during irradiation
- Long lifetime sensor ideal for in-vessel operational measurements where vessel stays closed



Conclusions

- **Three year Micro-Pocket Fission Detectors (MPFD) NEET project successfully completed all proposed work to develop a viable new sensor for simultaneous detection of thermal flux, fast flux, and temperature.**
- **Compact, multi-purpose advanced neutron detector is essential for high temperature, high pressure, high flux irradiations identified by LWRS, NGNP, ATR NSUF, FCRD, and Industry Programs**
- **Data from fast response, accurate, miniature neutron detector will be a critical tool for validating new high-fidelity multi-scale codes under development by DOE-NE**