Overview
- Goal: Measure critical fuel performance parameters with quantified uncertainty
- Advanced instrumentation is key to unraveling the complex multiphysics involved during transient irradiation experiments including development and validation of modern modeling and simulation tools.

- A science-based, engineering focus for nuclear fuels and materials development requires access to data streams beyond those historically available

- The success of advanced fuels and materials development programs hinge on well-coordinated and innovative instrument R&D covering full range of technical readiness levels

Development and Qualification
- The High Temperature Test Laboratory at INL is development hub
- Primary challenge is the integration of instruments into the test device and demonstration of interfaces and instrument performance under experiment conditions

Current Sensor Development
- Current development focused on Multi-SERTA deployment for Reactivity Initiated Accident (RIA) up to PWR conditions

Micro-Pocket Fission Detector
- Goal: Measure real-time neutron flux near test specimen
- State-of-the-art: SPND
- Requirements: compact, wide flux range, high temperature and pressure, ~ms response
- Approach: Adapt MPFD for TREAT application using pulse and current mode - R&D on sensor response to pulsed, high power flux

Infrared Pyrometer
- Goal: Measure cladding temperature with fast response and minimal impact on cladding (non-contact)
- State-of-the-art: Thermocouple
- Requirements: ~ms response time, non-contact, use in gas, water, steam
- Approach: R&D for commercial technologies and complete custom approach - R&D of effects of design and environment

Capacitive Void Sensor
- Goal: Detect departure from nucleate boiling (DNB) and void fraction
- State-of-the-art: Ultrasomics, temperature/pressure sensors
- Requirements: ~ms response, sensitivity to DNB/void fraction
- Approach: capacitance sensor

Instrumentation for Transient Testing
- Instrumentation used in in-pile transient testing:
  - Thermocouples
  - Ultrasomics thermometers
  - Pressure transducers
  - Linear Voltage Differential Transducer
  - Strain gauge
  - Dosimetry – wires, foils, etc.
  - Self-Powered Neutron Detector (SPND)
  - Acoustic sensors
  - Void sensors
  - Coolant column velocity
  - Flow meters
  - High-speed video
  - Hodoscope

Challenges and Opportunities
- Visualization:
  - visible, IR, advanced holography, ultrasonics
  - Miniaturization
  - less obtrusive, increased resolution/quantity
  - In-core electronics
  - Signal conditioning, A/D conversion
  - Enabling technologies
    - feedthroughs, hot-cell implementation, etc.

Collaborations
- NEUP Projects
  - Advanced Instrumentation for Transient Reactor Testing IRP – Advanced holography, diamond thermistor, distributed temperature fiber, HTIR, ultrasomics thermometer, nozzle probe, in-pile testing
  - Benchmarking for Transient Fuel Testing IRP – in-pile instrument testing at MTRR and TREAT
  - A Transient Reactor Physics Experiment with High Fidelity 3-D Flux Measurements for Verification and Validation
  - International collaborations
    - IRSN (France), CEA (France), Halden (Norway), NNC (Kazakhstan), KAERI (Korea)

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