Colby Jensen, Ph.D., Named Transient Testing National Technical Lead

- Colby Jensen, Ph.D., was named the National Technical Lead for the Transient Testing Program.
- The National Technical Lead provides leadership and supports integration of transient testing projects conducted by the Transient Reactor Test Facility's diverse user community.
- Prior to accepting this role, Colby led a variety of Idaho National Laboratory's analytical and experimental nuclear fuel development projects including development of Loss of Coolant Accident testing capability, advanced thermal-hydraulic tests, in-pile instrumentation, and metallic fuel technology.
- Colby joined the Idaho National Laboratory in November 2014 after completing a Joint PhD in Mechanical Engineering from Utah State University in Logan Utah and in Energy Engineering from the Université of Reims in France.

Transient Testing National Technical lead, Colby Jensen

For more information:
Todd.Pavey@inl.gov

Completed Loading and Shipping the First ATF Pre-irradiated Fuel Pin to TREAT for Transient Testing since Restart

- On June 30, 2021, HFEF successfully shipped an experiment ready pre-irradiated ATF-2 fuel pin in the HFEF-15 cask to TREAT for transient testing.
- Preparations for this shipment included successful completion of HFEF-15 cask modifications and readiness, and a Management Self Assessment (MSA) and Contractor Readiness Assessment (CRA) at TREAT and HFEF.
- This effort required collaboration between operations, transportation, training, NS&T, HFEF, the cask team, and TREAT.
- This shipment paves the way for upcoming experiments supporting LWR industry goals to deploy ATF and enable fuel burnup extension.

HFEF-15 Cask being transported from HFEF

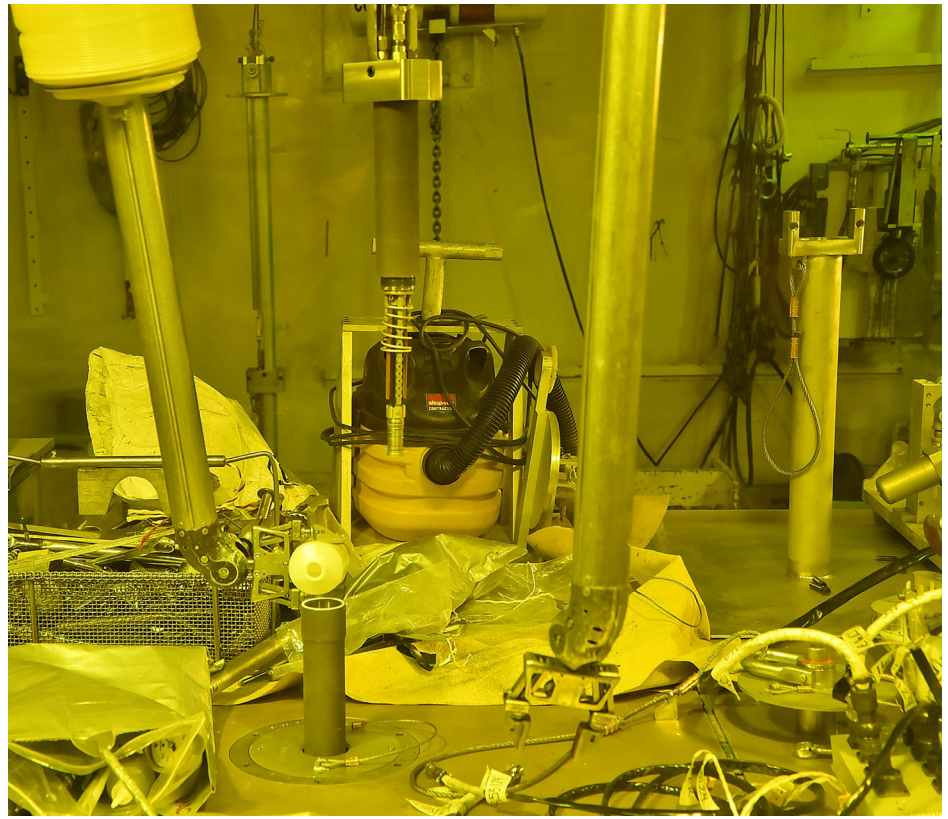
HFEF-15 Cask in cask stand at TREAT awaiting transient testing

For more information:
Todd.Pavey@inl.gov, Jason.Schulthess@inl.gov, Evander.Chambers@inl.gov, Jordan.Argyle@inl.gov, James.Angell@inl.gov

New Capability to Assemble TREAT Experiments with pre-irradiated fuel at HFEF

- ATF-R-01 assembled with pre-irradiated ATF-2 pin and shipped to TREAT in HFEF-15 cask for transient irradiation.
  - Assembly included instrumentation and leak checking both in-cell and out-cell. The in-cell leak checking is also a restored capability in the HFEF decon cell.
- This effort required collaboration between research, operations, transportation, NS&T, HFEF, and TREAT personnel both in-town and at MFC.
- This supports completing a level 2 milestone to perform the irradiation of this experiment at TREAT. This work was sponsored by the Advanced Fuel Campaign Fuel Program.

Transient Testing preirradiated fuel is a crucial capability needed to support LWR and advanced reactor fuel development and qualification.

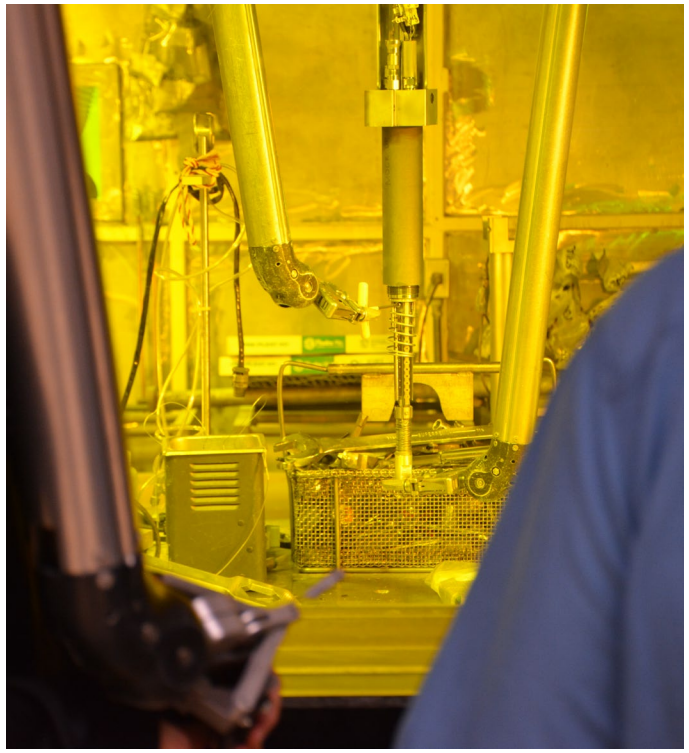


ATF-R (MARCH-SERTTA) Capsule being filled with water as part of the assembly process.

For more information:
Jason.Schulthess@inl.gov, Evander.Chambers@inl.gov, Jordan.Argyle@inl.gov

New Capability to Assemble Irradiation Experiments for TREAT in the Hot Fuel Examination Facility

- New equipment has been designed, fabricated and installed in the HFEF decon cell to perform assembly of TREAT irradiation experiments using previously irradiated fuel sourced from both test and commercial reactors. The mechanical assembly of the test vehicle was demonstrated successfully in cell.
- This work was sponsored by the Accident Tolerant Fuel Program and was performed in the Hot Fuels Examination Facility at the Materials and Fuels Complex



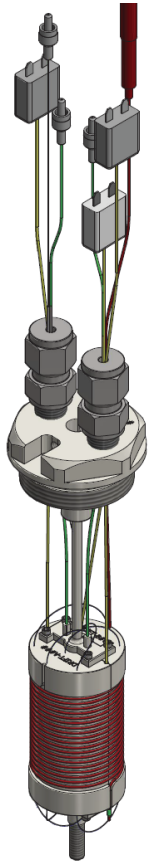
HFEF operators loading a surrogate fuel rodlet into the experiment vehicle during the mechanical assembly demonstration operation

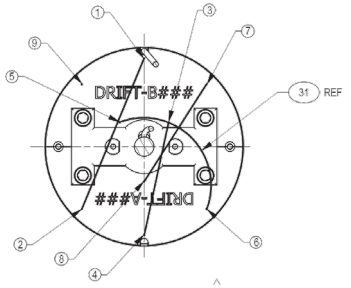
Successful installation and demonstration of new capability to assemble TREAT irradiation experiment in HFEF

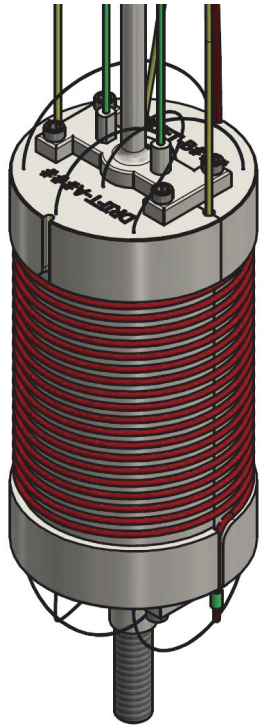
For more information:
Jason.schulthess@inl.gov, evander.chambers@inl.gov, Jordan.argyle@inl.gov, kim.davies@inl.gov, spencer.parker@inl.gov

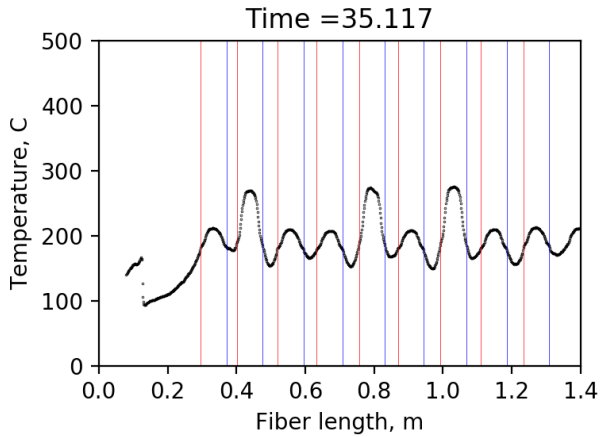
Distributed Temperature Sensing (DTS) for nuclear applications

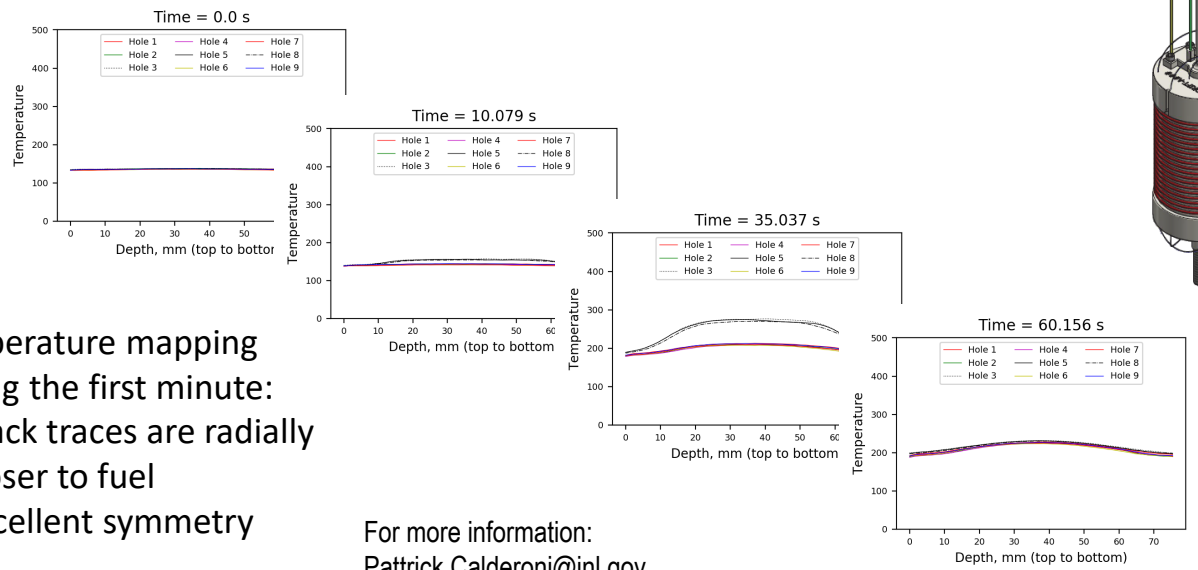
- Optical fiber based Distributed Temperature Sensing (DTS) was used in a world-first application for transient testing of nuclear fuel
  - The DRIFT experiment completed on May 19, 2021 in TREAT used commercial rad hard fibers (Thor Labs) and interrogator (Luna)
- DTS provides temperature profile along the length of a **single** fiber, enabling spatially resolved time dependent temperature mapping











Temperature mapping during the first minute:

- Black traces are radially closer to fuel
- Excellent symmetry

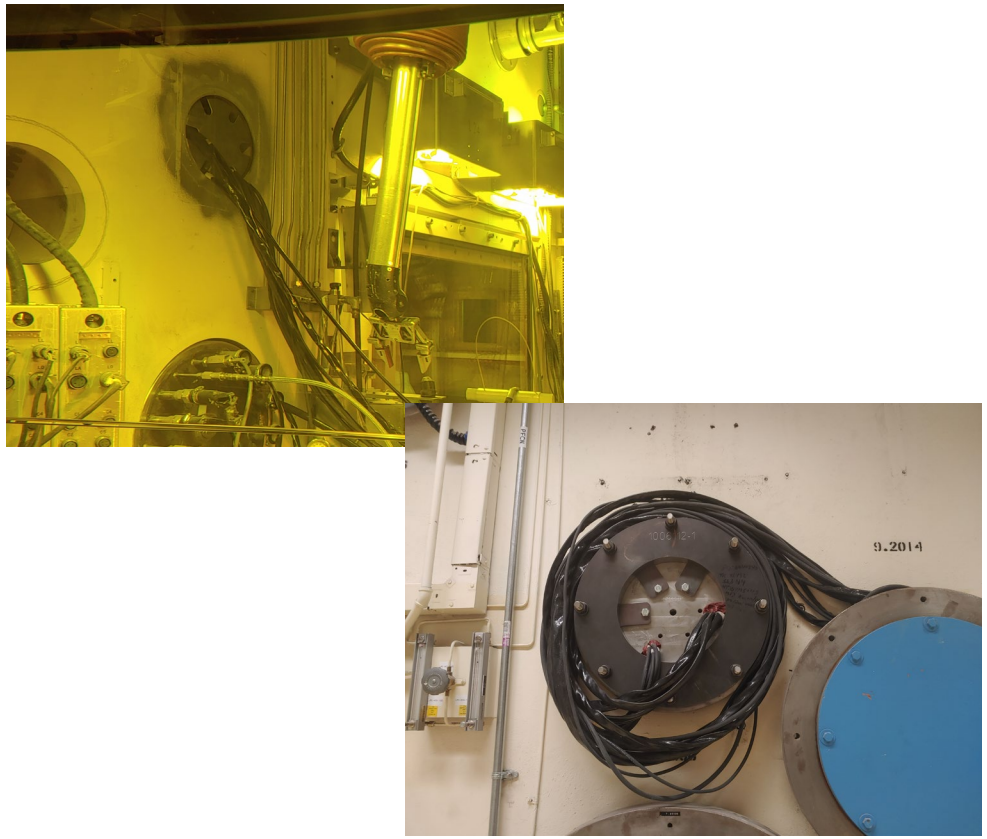
Optical fiber DTS provides a transformational approach to temperature measurement in nuclear experiments

For more information:
Pattrick.Calderoni@inl.gov

New Capability 12-inch Welding Feedthru and Welder Cables Installed in HFEF Decon Cell

- Feedthru will enable the use of two remote welding systems, a lathe circumferential welder and a weld under pression system, to build pressurized fuel rodlets from pre-irradiated material.
- This completes a level 3 milestone in support of a PEMP Notable Outcome (#1.1.B) which is due for completions later this fiscal year. This work was sponsored by the Advanced Fuel Campaign Program and was performed in the Hot Fuels Examination Facility at the Materials and Fuels Complex

Significant Progress towards major new capability at HFEF

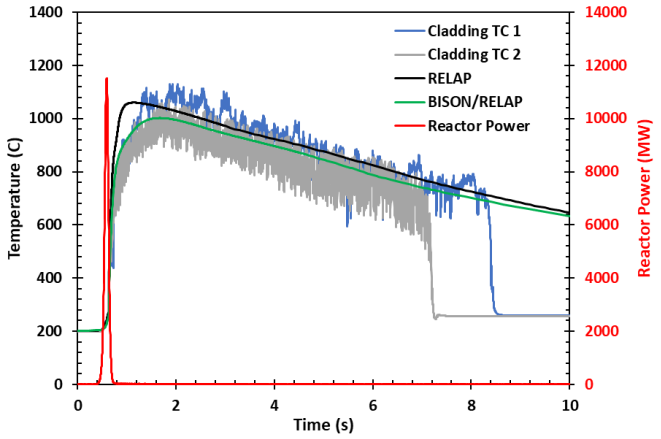


Welder feedthru installed with cables for two welders to be installed in-cell later this year.

For more information:
Jason.Schulthess@inl.gov, Evander.Chambers@inl.gov, Spencer.Parker@inl.gov, Jordan.Argyle@inl.gov

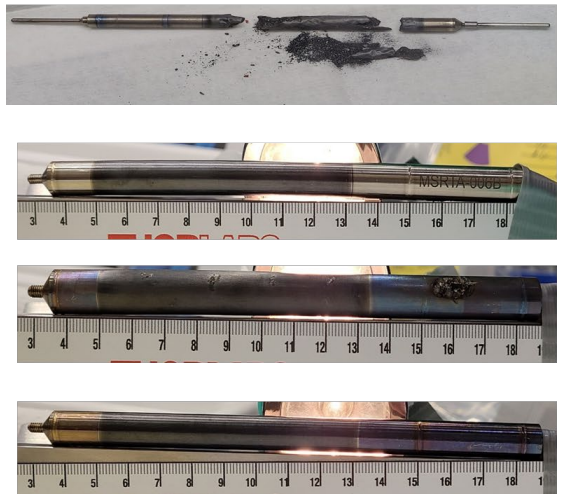
Completed Commissioning Tests of Water-based RIA Experiments at TREAT

- Successfully completed the commissioning tests for reactivity-initiated accident experiments in the water-based MARCH-SERTTA capsule in TREAT
- Commissioning series included a calibration experiment followed by five experiments at varying energy depositions, initial temperature and pressure, and instrumentation configurations
- Tests include novel instrumentation to measure cladding temperatures, rodlet plenum pressure, electro-impedance boiling detectors, and cladding elongation
- These tests pave the way for upcoming experiments supporting LWR industry goals to deploy ATF and enable fuel burnup extension.



ATF-RIA-1-E experiment cladding thermocouple results along with RELAP5-3D modeling predictions and coupled BISON/RELAP5-3D modeling predictions

PIE visuals of first four rodlets compared to historical tests. Rodlet conditions show good agreement with historical SPERT-IV fresh fuel RIA tests.

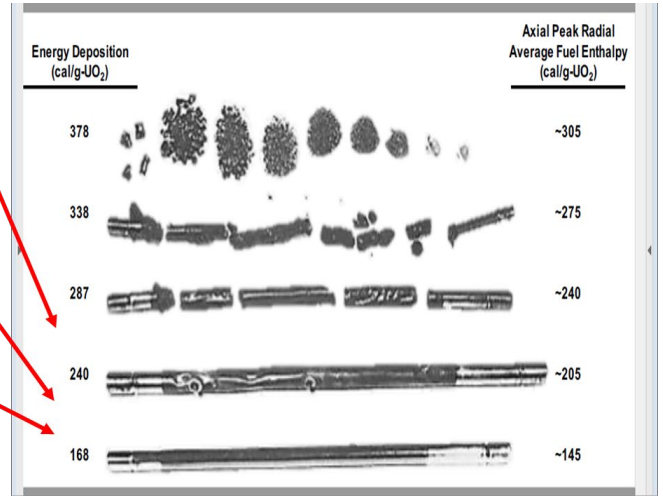


1B, 1100 J/g (~263 Cal/g)

1A, 890 J/g (~212 Cal/g)

1D, 750 J/g (~179 Cal/g)

1C, 550 J/g (~131 Cal/g)

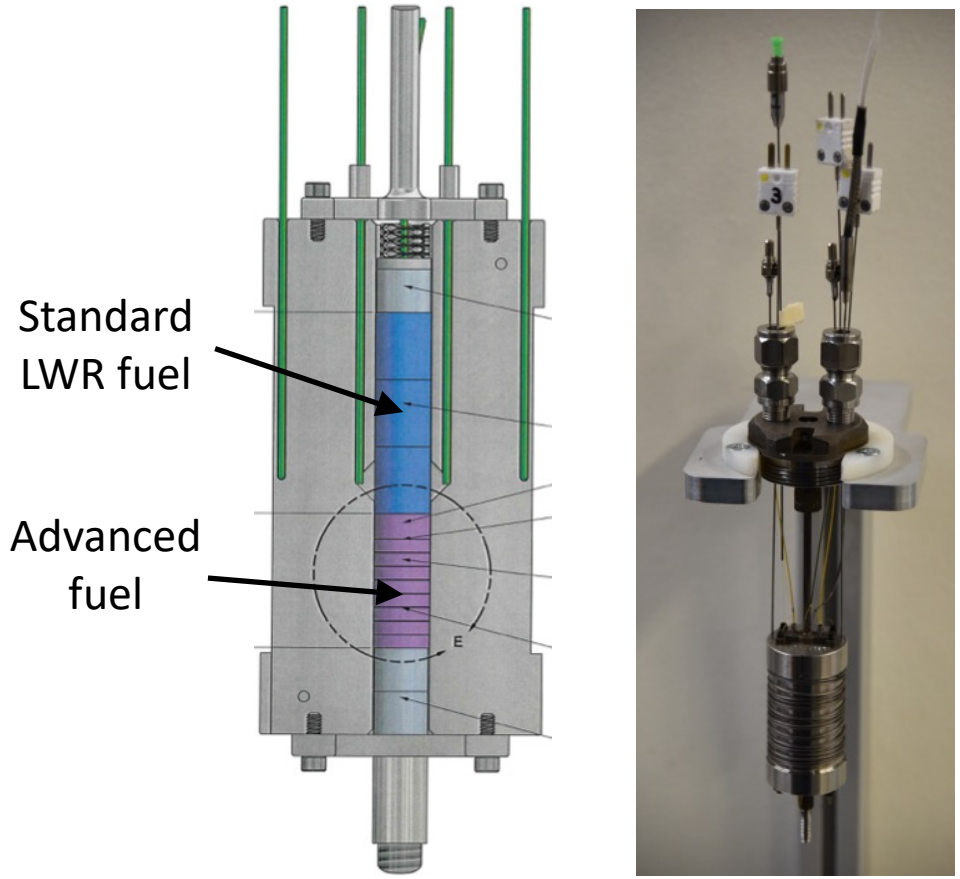


Completed commissioning tests for high energy reactivity-initiated accidents in a water environment in TREAT.

For more information:
Charles.folsom@inl.gov

Series of Separate-Effects Fuel Fracture Experiments Irradiated in TREAT

- The DRIFT (Dry In-Pile Fracture Test) fixture was developed for separate-effects testing of light water reactor (LWR) fuel in the TREAT reactor.
- DRIFT uses a heat sink to replicate the thermal conditions of LWR fuel in steady-state operation using a transient reactor.
- A set of 5 tests (1 calibration test, 4 other transients) using the DRIFT test holder were recently irradiated in TREAT
- Standard LWR fuel and advanced fuel containing molybdenum discs for enhanced heat transfer were tested.
- Advanced instrumentation included pyrometers and distributed temperature sensing optical fibers.
- Thermal data and forthcoming images from post-irradiation examination will provide validation data for BISON fuel fracture models.

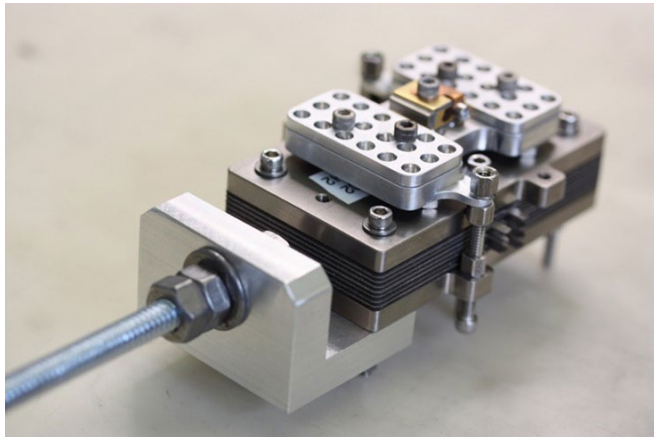


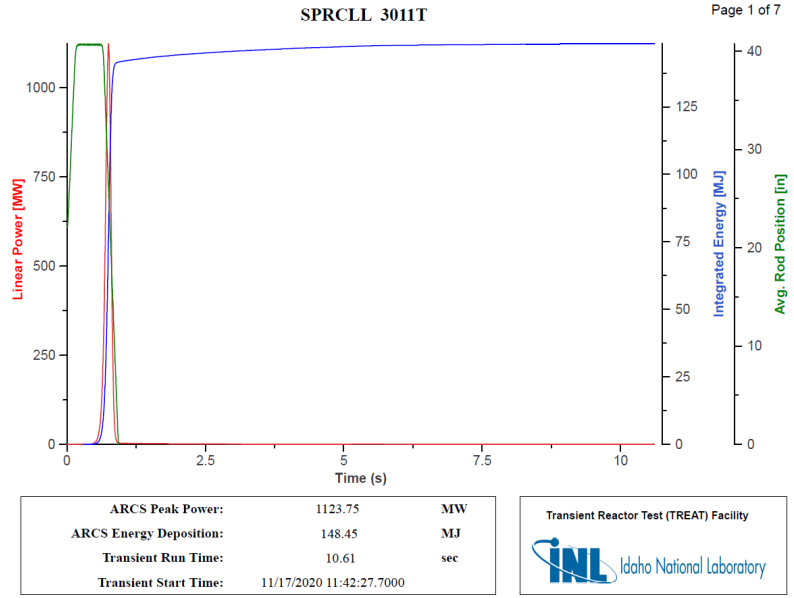
Drawing showing cross-section of DRIFT test capsule including standard LWR fuel and advanced fuel (left), and assembled test capsule (right)

For more information:
benjamin.spencer@inl.gov, leigh.astle@inl.gov

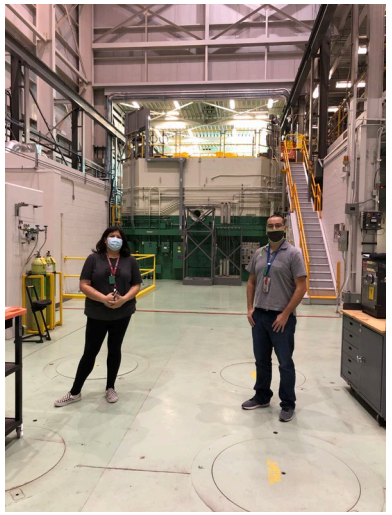
Transient Reactor Test Facility (TREAT) Completed First Transient Test for Los Alamos National Laboratory (LANL)

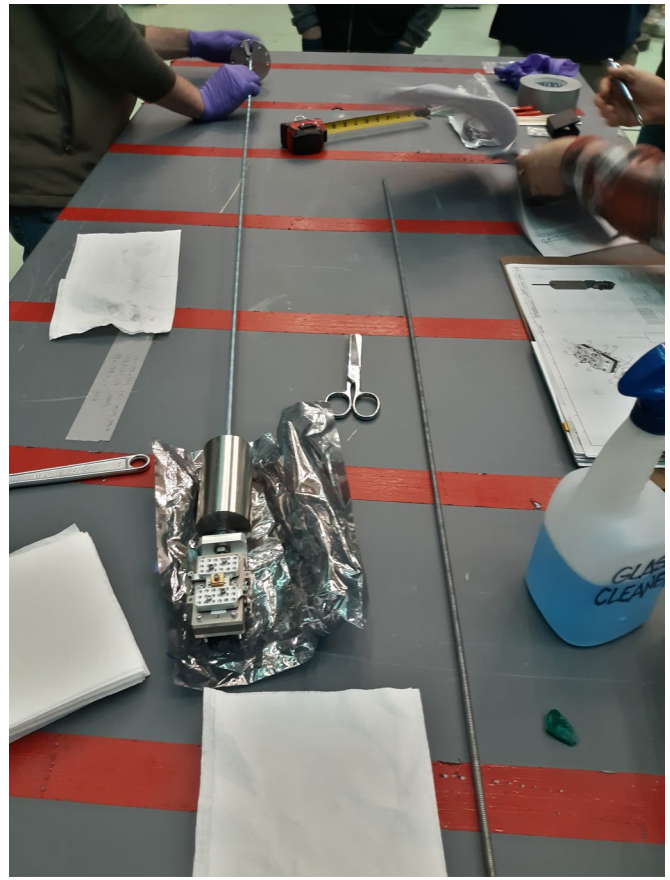
- In March 2020 LANL requested the transient testing program run a transient on a LANL Super Cell dummy specimen to include physics measurements and transient operation demonstration.
- November 17, 2020 Transient Reactor Test (TREAT) ran a transient test on the LANL Super Cell dummy specimen completing the first of many tests for LANL at TREAT.





LANL and SNL visited TREAT to assist with assembly and watch the transient. Pictured Left: Danielle Readhouse (SNL), Right: Ed Lum (LANL)





LANL Super Cell assembly

For more information:
Dan.Wachs@inl.gov, Nicolas.Woolstenhulme@inl.gov, Todd.Pavey@inl.gov.

Post Transient Examination of the SETH-F and -G Accident Tolerant Fuel (ATF) Reactivity Initiated Accident Test

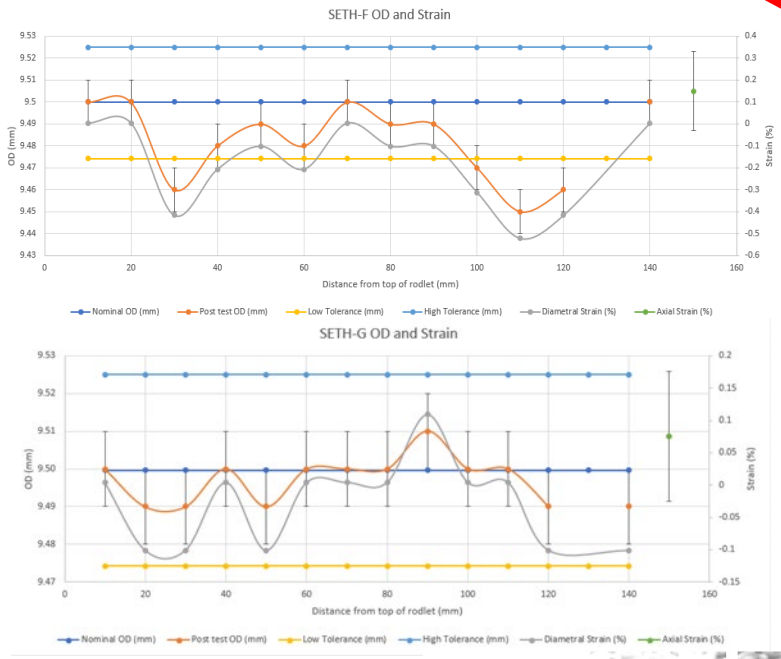
- The SETH-F and G transient irradiation experiments are an ATF concept consisting of U3Si2 fuel in standard Zircalloy-4 cladding.
  - SETH F was irradiated under a Reactivity Initiated Accident (RIA) shaped transient and achieved a peak cladding temperature of approximately 1250C.
  - Post transient examination revealed
    - Diametral creep down of the cladding and axial elongation.
    - Localized melting or pellet cladding interaction was identified in the hottest zone of the rodlet during optical microscopy.
  - SETH-G was irradiated under a RIA shaped transient and achieved a peak cladding temperature of approximately 1650C.
  - Post transient examination revealed
    - Diametral creep down of the cladding and axial elongation.
    - Localized melting or pellet cladding interaction and chemical species diffusion was identified in the hottest zone of the rodlet during scanning electron microscopy.

- This work is sponsored by the ATF Program and was performed in the Electron Microscopy Laboratory at the Materials and Fuels Complex.

For more information:
Jason.schulthess@inl.gov, alexander.Winston@inl.gov, alex.pomo@inl.gov.

SETH-F

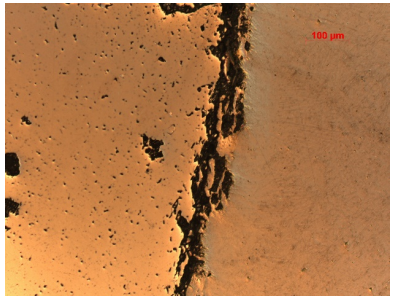
Left and Right: neutron radiography post transient showing pellet gap resulting from axial elongation.



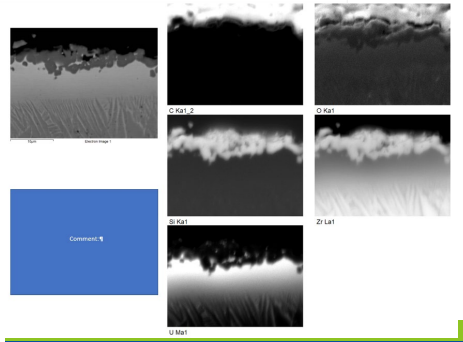
Above: post transient dimensional inspection showing cladding creep down and axial elongation.

SETH-G

Scanning electron microscopy showing localized melting/pellet cladding interaction and chemical species diffusion between the fuel and the cladding in SETH-G.

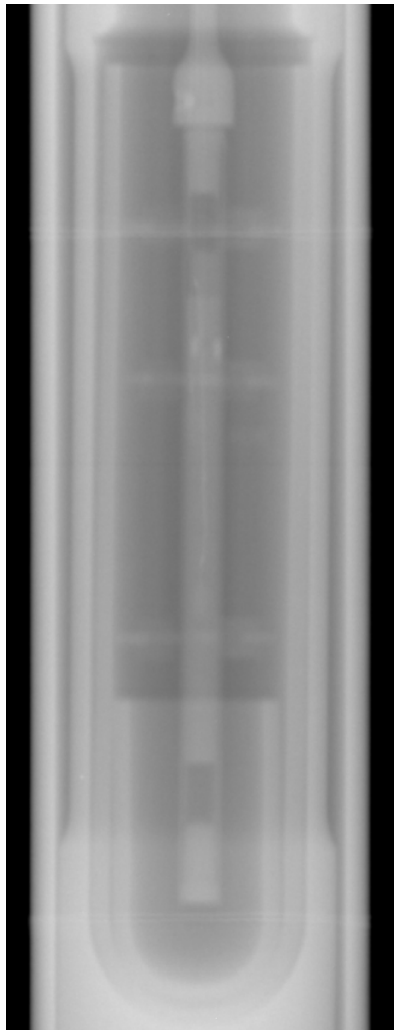


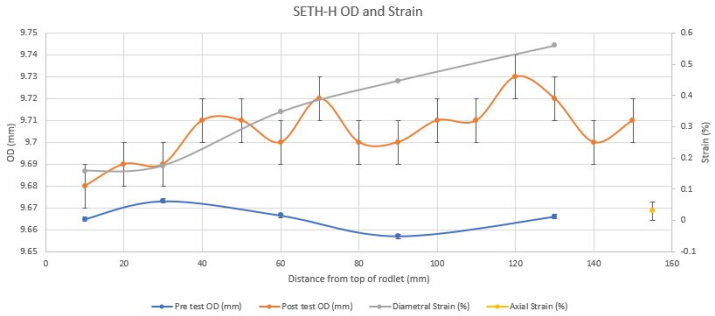
Optical microscopy showing localized melting/pellet cladding interaction in the hottest zone of the fuel of SETH-F.



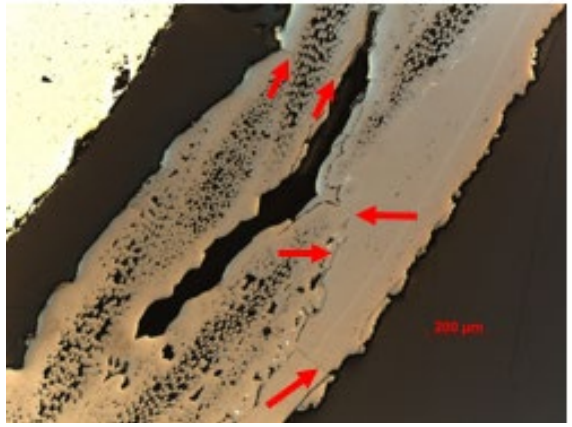
Post Transient Examination of the SETH-H Accident Tolerant Fuel (ATF) Reactivity Initiated Accident (RIA) Test

- The SETH-H transient irradiation experiment is an ATF concept consisting of U3Si2 fuel in Silicon Carbide Composite cladding (SiC/SiC).
  - It was irradiated under a RIA shaped transient and achieved a peak cladding temperature of approximately 1150C.
  - The test was designed with a larger initial pellet cladding gap to evaluate the cladding response to low displacement strain loadings due to pellet thermal expansion.
- Post transient examination revealed
  - Diametral strain of the cladding and no axial strain.
  - No localized melting or pellet cladding chemical interaction or chemical species diffusion was identified.
  - Cracks propagating through the wall of the cladding were identified during destructive exams.
- This work is sponsored by the ATF Program and was performed in the Electron Microscopy Laboratory at the Materials and Fuels Complex.





Left: neutron radiography post transient showing intact rodlet. Above: post transient dimensional inspection showing diametral strain and no axial strain.

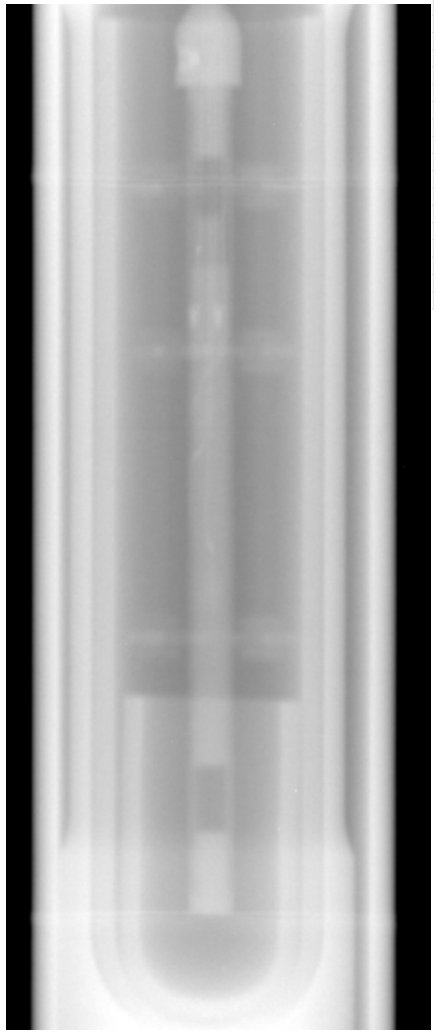


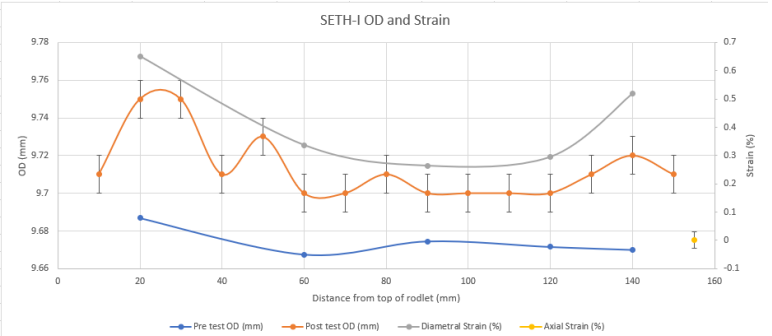
Optical microscopy showing cracks in the SiC/SiC cladding.

For more information:
Jason.schulthess@inl.gov, alexander.Winston@inl.gov,
alex.pomo@inl.gov

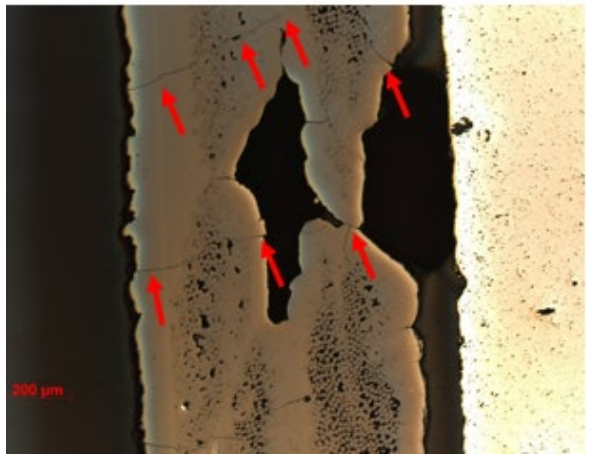
Post Transient Examination of the SETH-I Accident Tolerant Fuel (ATF) Reactivity Initiated Accident (RIA) Test

- The SETH-I transient irradiation experiment is an Accident Tolerant Fuel concept consisting of U3Si2 fuel in Silicon Carbide Composite cladding (SiC/SiC).
  - It was irradiated under a Reactivity Initiated Accident shaped transient and achieved a peak cladding temperature of approximately 1850C.
  - The test was designed with a smaller initial pellet cladding gap to evaluate the cladding response to higher displacement strain loadings due to pellet thermal expansion.
- Post transient examination revealed:
  - Diametral strain of the cladding and no axial strain.
  - No localized melting or pellet cladding chemical interaction or chemical species diffusion was identified.
  - Cracks propagating through the wall of the cladding were identified during destructive exams.
- This work is sponsored by the Accident Tolerant Fuel Program and was performed in the Electron Microscopy Laboratory at the Materials and Fuels Complex.





Left: neutron radiography post transient showing intact rodlet. Above: post transient dimensional inspection showing diametral strain and no axial strain

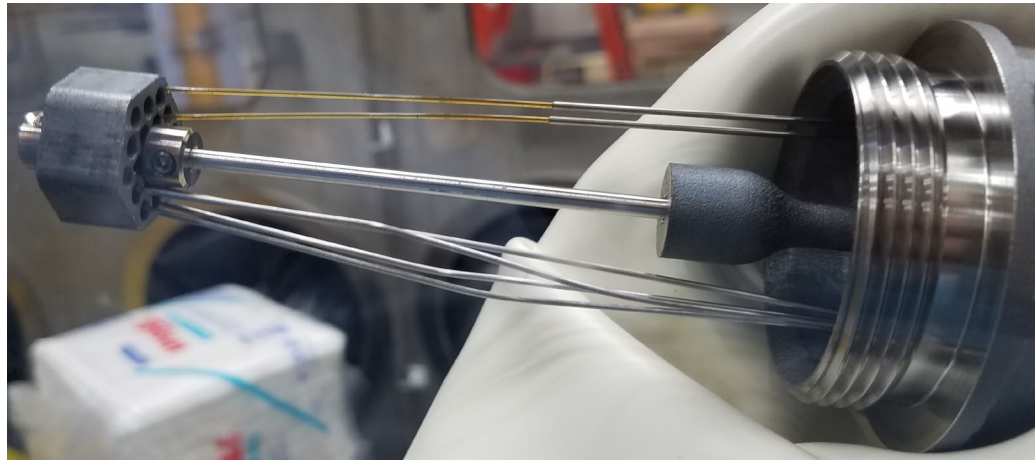


Optical microscopy showing cracks in the SiC/SiC cladding.

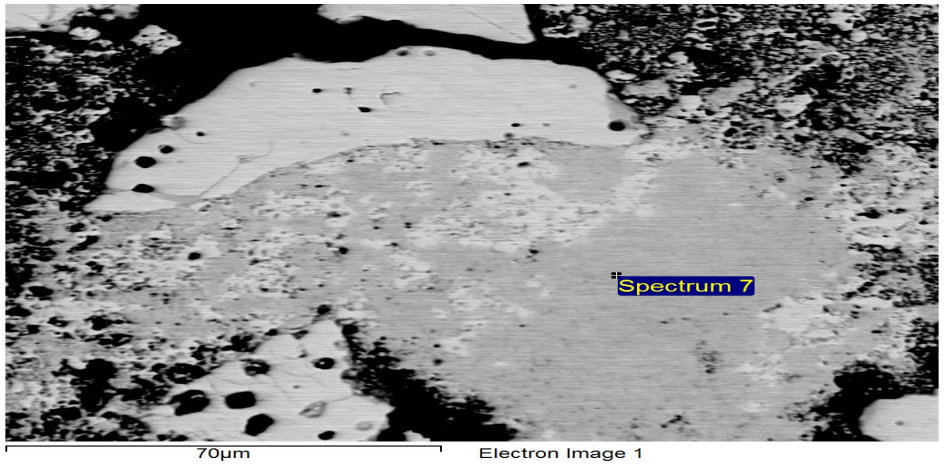
For more information:
Jason.schulthess@inl.gov, alexander.Winston@inl.gov,
alex.pomo@inl.gov

Post Irradiation Examination of SIRIUS-CAL Nuclear Thermal Propulsion Experiment

- This calibration experiment provides the basis for power coupling between the TREAT reactor and the fuel. PIE provides information on material performance under calibration irradiation conditions.
- The cermet specimen of a tungsten-rhenium matrix with dispersed uranium-nitride fuel was found intact upon visual inspection. Scanning electron microscopy revealed a partially sintered specimen with notable porosity.
- This work is sponsored by NASA and was performed in the Electron Microscopy Laboratory at the Materials and Fuels Complex.



Intact specimen immediately following disassembly from experiment capsule.



Partially sintered specimen shown via back scatter SEM imaging

First Post Irradiation Examination of Nuclear Thermal Propulsion Fuel Irradiated in TREAT

For more information:
Jason.schulthess@inl.gov, alexander.Winston@inl.gov,
alex.pomo@inl.gov