INL/MIS-23-73462-Revision-0

Status of U.S. DOE Deliverables 0 July 2023

July 2023

Paul A Demkowicz

Changing the World's Energy Future

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Paul A Demkowicz

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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Paul Demkowicz, Ph.D.
Idaho National Laboratory

Status of U.S. DOE Deliverables

Prepared for the 19th Official Meeting of the VHTR Fuel and Fuel Cycle Project Management Board

ART
Advanced Reactor Technologies

Previous Work Plan: Progress 2022 – 2023

- Task 1-1:
  - Establish capability for reirradiation of loose particles and compacts [Complete]
- Task 1-4
  - AGR-2 post-irradiation examination [Complete]
  - AGR-5/6/7 irradiation [Complete]
- Task 2-3:
  - LBL round robin [Complete]
- Task 2-4:
  - Accident test benchmark [Complete]
- Task 3-2:
  - Develop furnace system for air/steam tests on irradiated fuel
- Task 3-3:
  - AGR-2 safety testing [Complete]
- Task 3-4:
  - AGR-3/4 PIE
  - AGR-3/4 heating tests
  - Individual particle heating tests [Complete]
- Task 3-5:
  - Moisture oxidation tests on matrix material [Complete]
- Task 3-6:
  - Licensing topical report on UCO TRISO fuel performance [Complete]

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** Shaded text: discussed previously and no discussion in this presentation*

Task 2-3: LBL Round Robin

- ORNL has issued final report on LBL results
- INET and KAERI will prepare similar final reports
- US (ORNL) will prepare a summary of results for submission as GIF deliverable

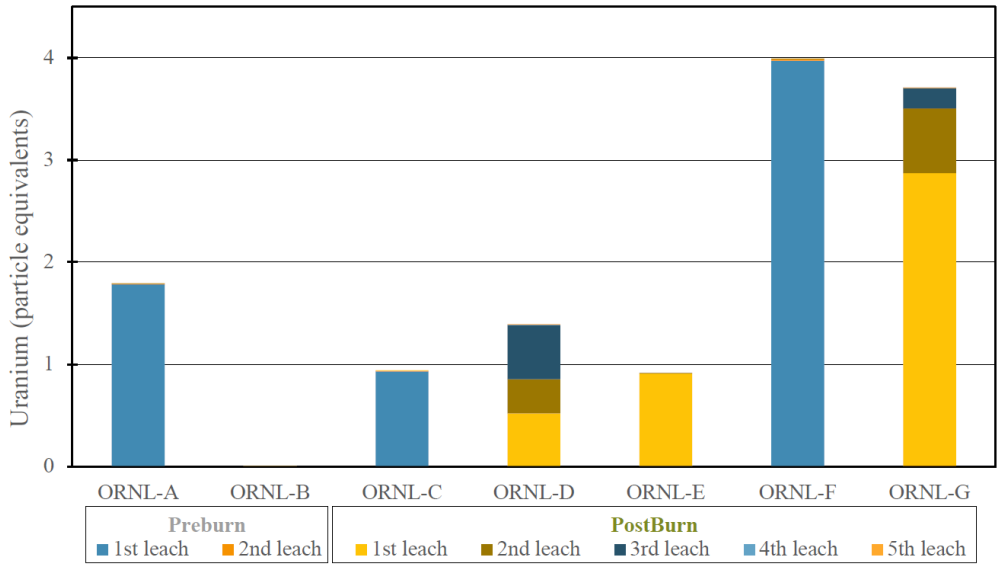
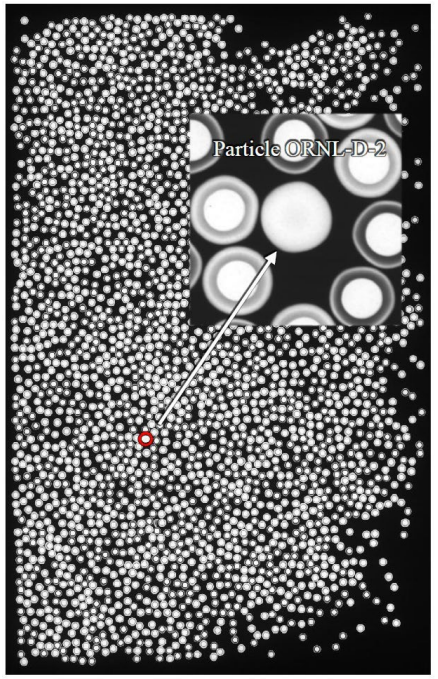
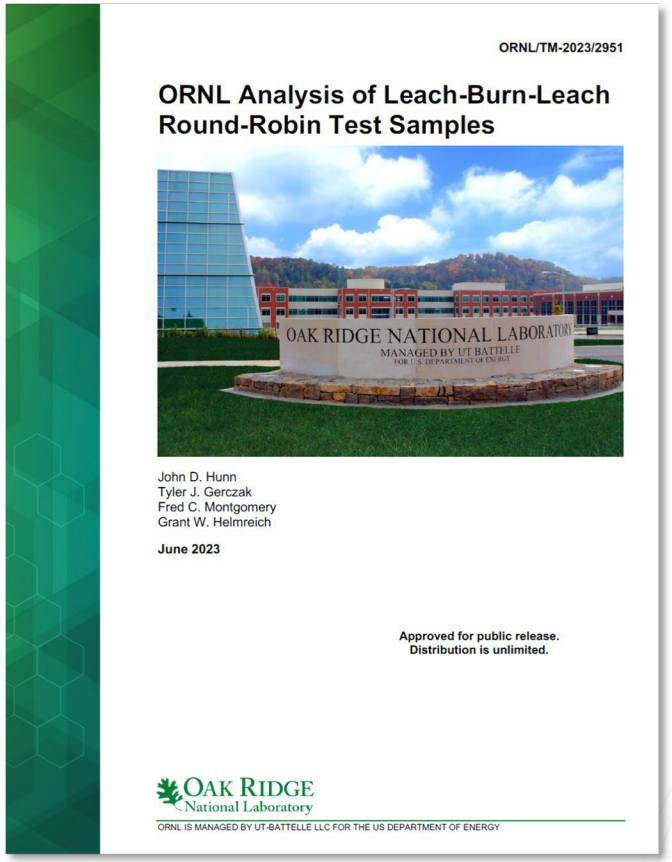


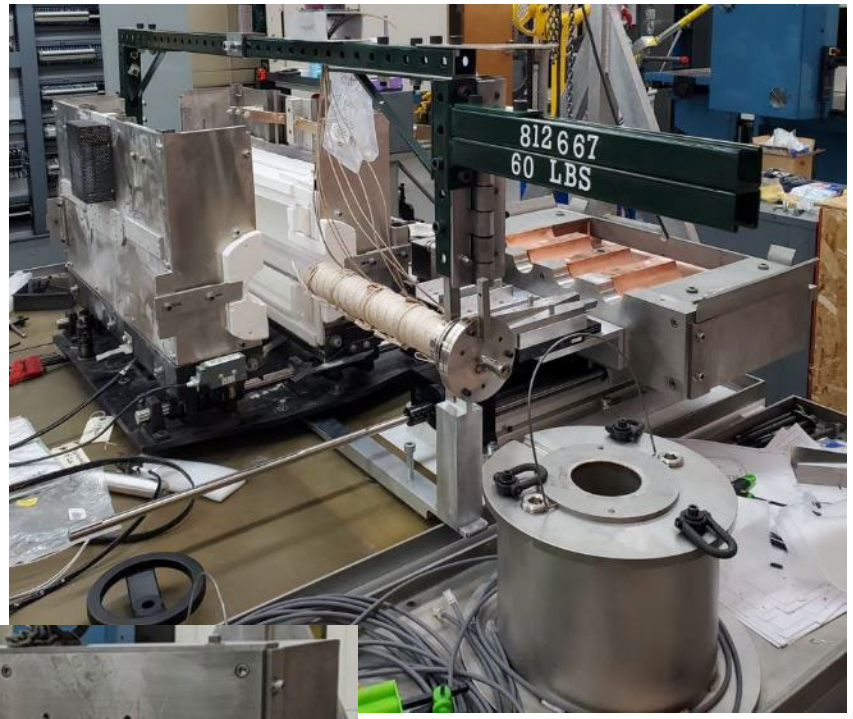
Figure 4-2. Fraction of uranium single particle equivalent content in each leach.

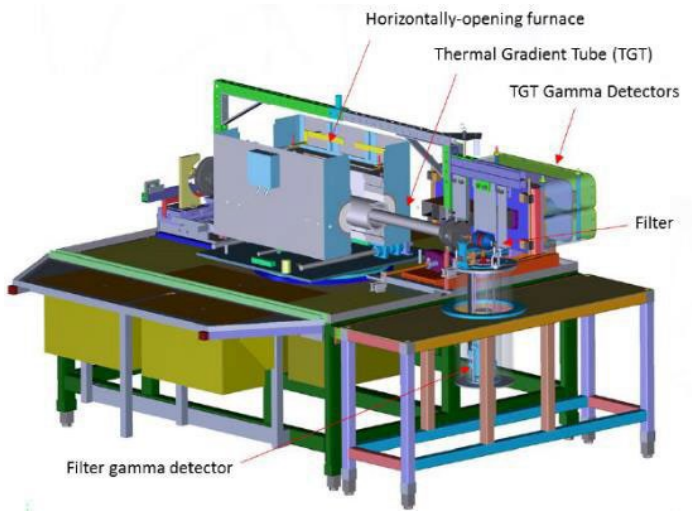




Task 3-2: Develop furnace system for air/steam tests on irradiated fuel

- Development of the Air Moisture Ingress Experiment (AMIX) furnace system continues at INL.
- System will be used to perform post-irradiation heating tests on fuel and materials specimens in oxidizing atmospheres while measuring the release of fission products
- System is expected to be operation in 2024

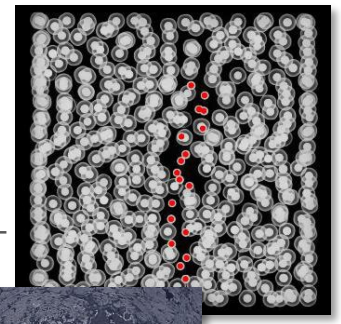




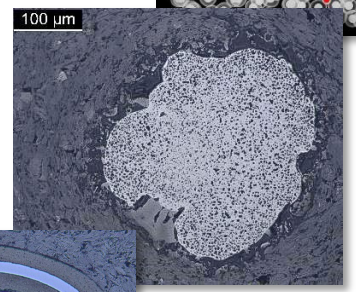
Task 3-4: AGR-3/4 PIE and Heating Tests Completed

- Fission product mass balance in 12 capsules
- Fission product profiles from 8 capsules
  - (inner and outer rings)
- Fuel compact microscopy
- Fuel compact heating tests
  - 4 as-irradiated (post-ATR irradiation)
  - 5 re-irradiated (post-TRIGA re-irradiation)
- Fuel compact radial deconsolidation
  - 21 compacts
- Effort is currently focused on data analysis to refine fission product transport parameters for graphite and fuel matrix
- Oxidation tests of additional compacts and matrix/graphite specimens are planned

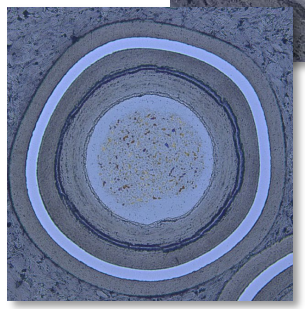
X-radiograph of unirradiated AGR-3/4 compact; DTF highlighted by red dots

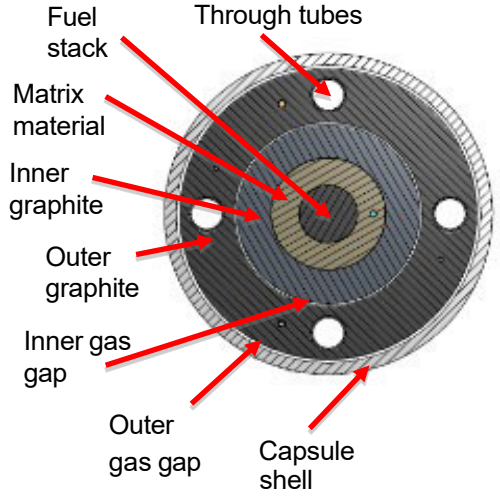


Irradiated designed-to-fail particle

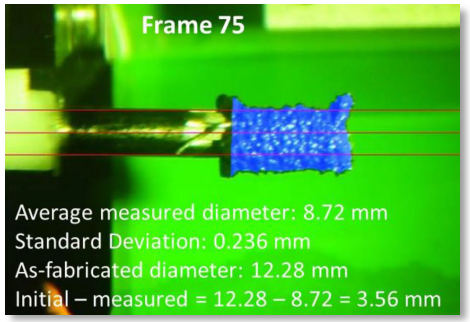


Irradiated driver fuel particle



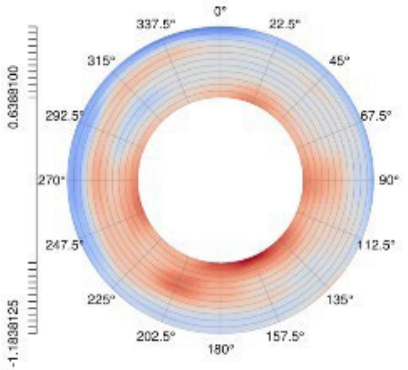


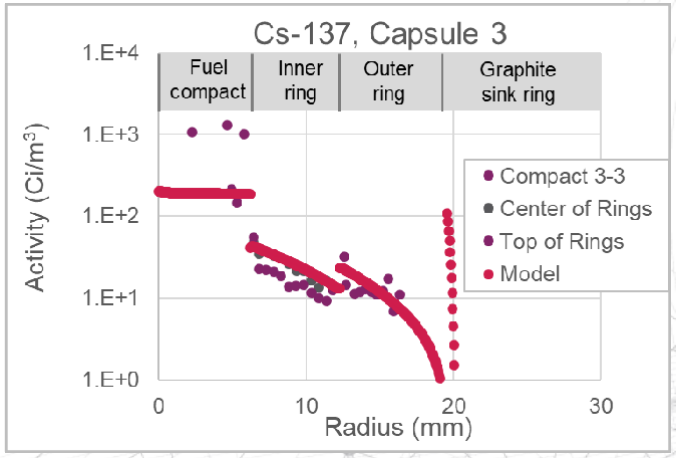
AGR-3/4 Capsule Cross Section



Compact radial deconsolidation

IR-07 Cs-134 activity distribution





Additional US TRISO Fuel Qualification Activities

- AGR-5/6/7 Capsule 1 thermal analysis
- AGR-5/6/7 PIE

AGR-5/6/7 Capsule 1 Updated Thermal Analysis

- Updated thermal analysis of AGR-5/6/7 Capsule 1 was performed
- Analysis accounts for nonuniform heat transfer gaps around the capsule circumference
- Results identified the most likely graphite fuel holder offset geometries
- Peak fuel temperatures were likely >1550°°C
- Peak thermocouple lead temperatures were likely well in excess of 1200°C
- Supports conclusion that in-pile thermal degradation of thermocouples led to Ni dispersal in the capsule and degradation of SiC, causing TRISO failures

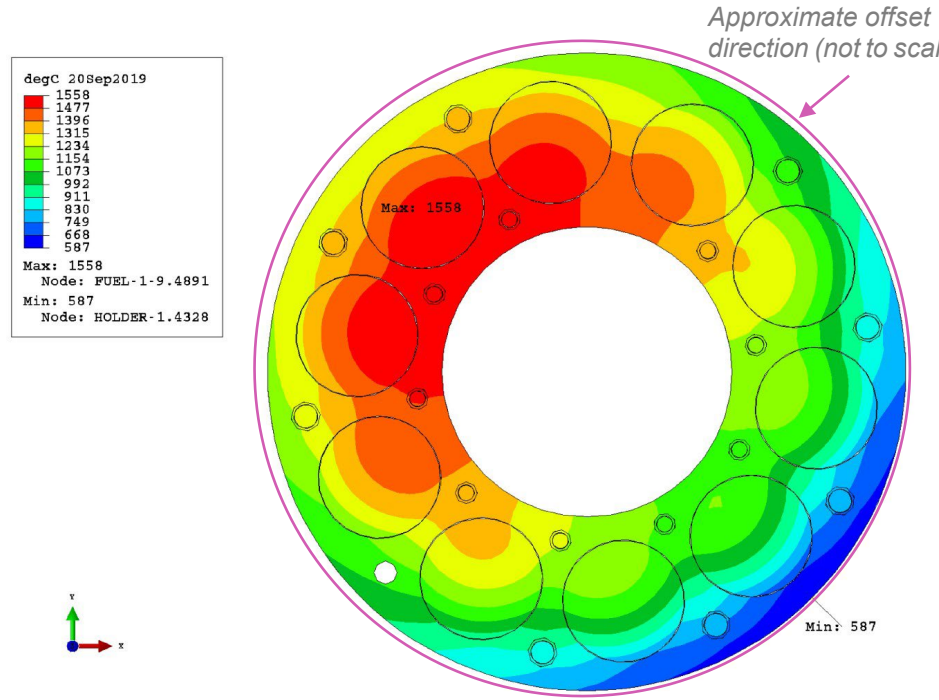
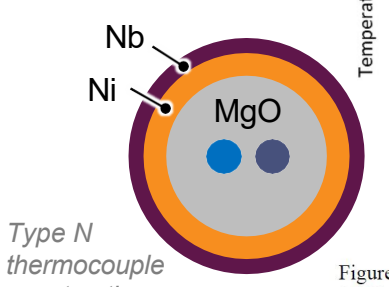


Figure 48. Temperature (°C) contour plot of the 0.25 in. slice (level 7) in which the highest temperature occurs for September 20, 2019 , with the offset position being 0.006 in. top northwest and 0.006 in. bottom northwest.



Type N thermocouple construction

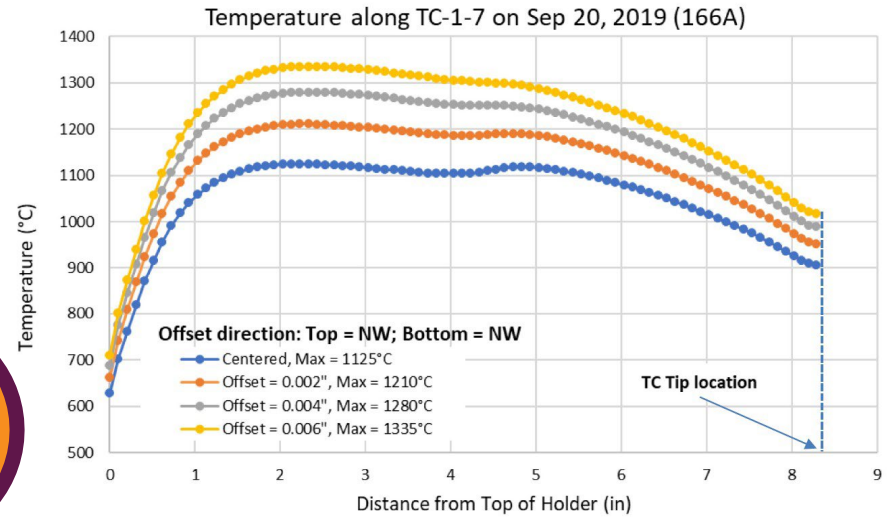
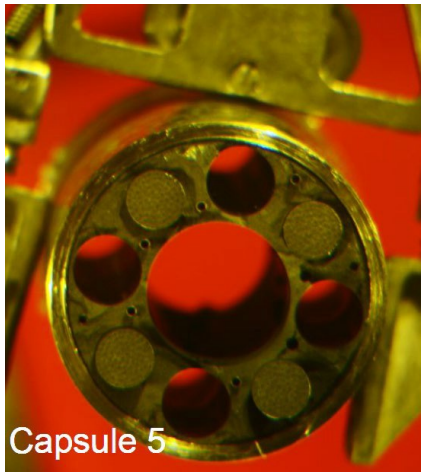
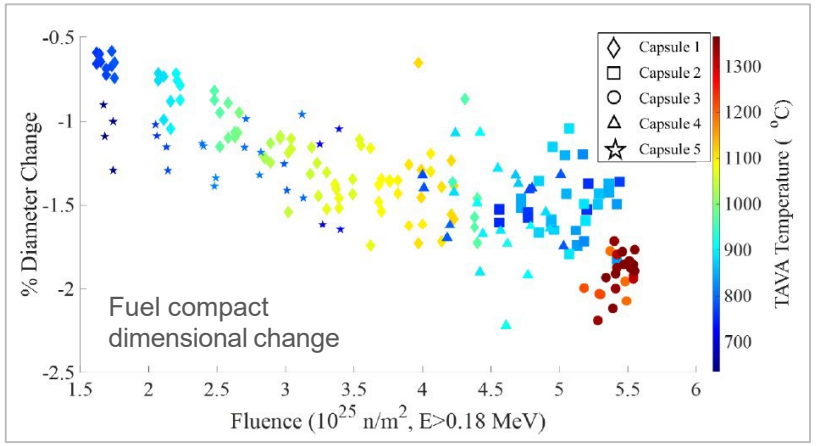


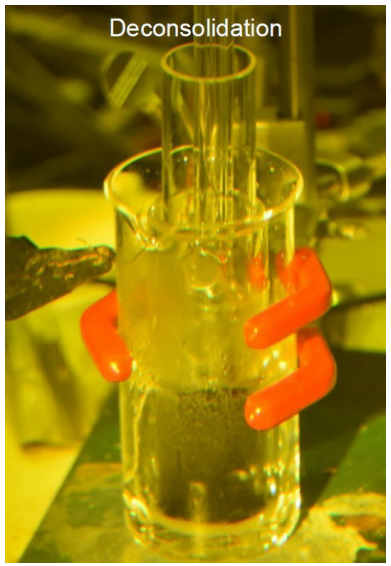
Figure 49. Temperature distribution along TC-1-7 from the holder top to tip, for four offset options: zero, 0.002, 0.004, and 0.006 in. for both the top and bottom shifted northwest.

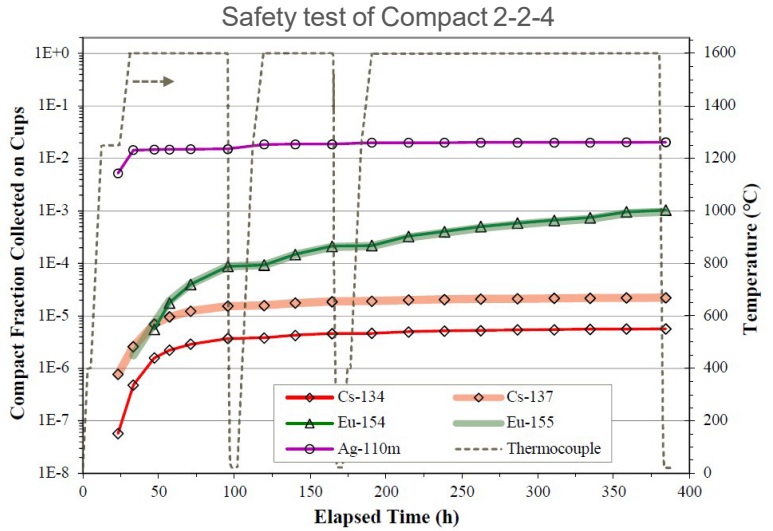
AGR-5/6/7 Post-Irradiation Examination and Safety Testing

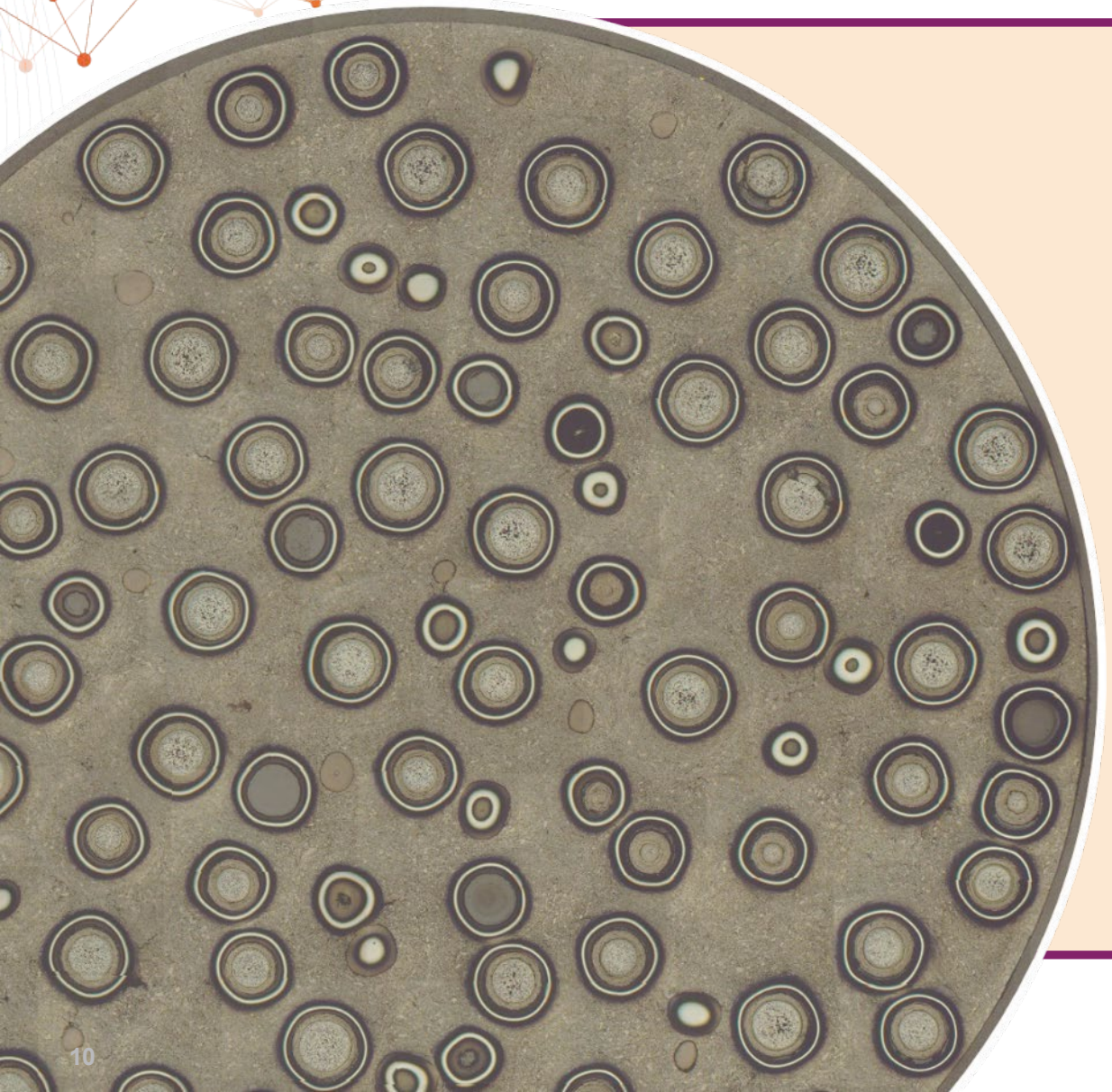
- Disassembly and dimensional measurements
- Fission product mass balance in all 5 capsules
- Fuel compact microscopy
- High-temperature safety testing
- Compact destructive exams
  - Deconsolidation and leach-burn-leach
  - Particle gamma counting
  - Particle microanalysis
- Oxidation testing











Thank you for your attention

Paul Demkowicz
paul.Demkowicz@inl.gov