



Status of U.S. DOE Deliverables

September 2021

Changing the World's Energy Future

Paul A Demkowicz



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September 2021

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**Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**

September 14, 2021

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Prepared for the 17th Official Meeting of the VHTR Fuel and Fuel Cycle Project Management Board

Presentation Outline: Progress 2020 – 2021

- 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
- 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]

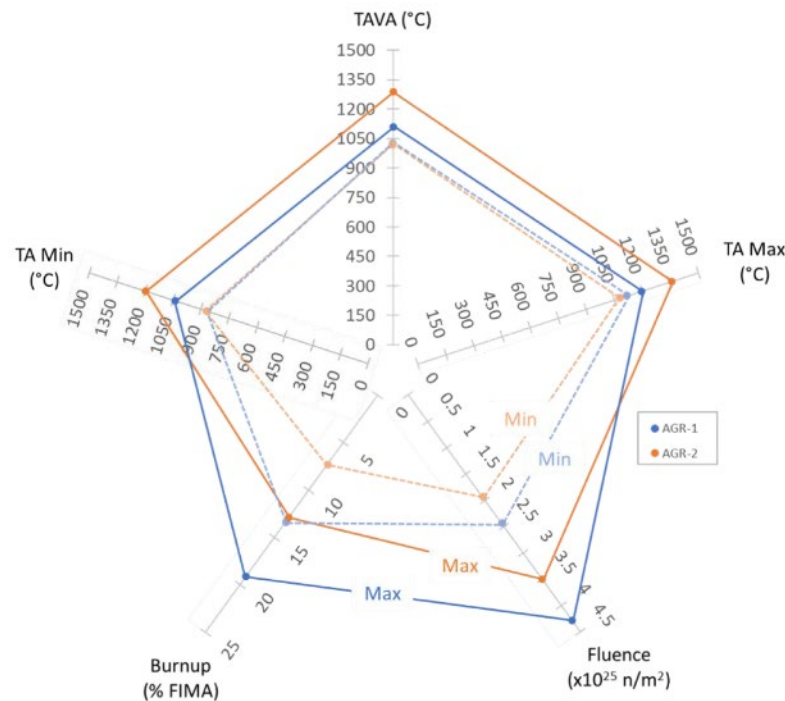
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** Shaded text: discussed previously and no discussion in this presentation*

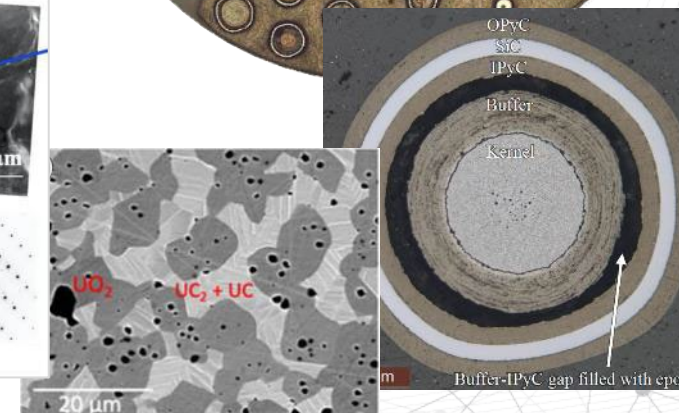
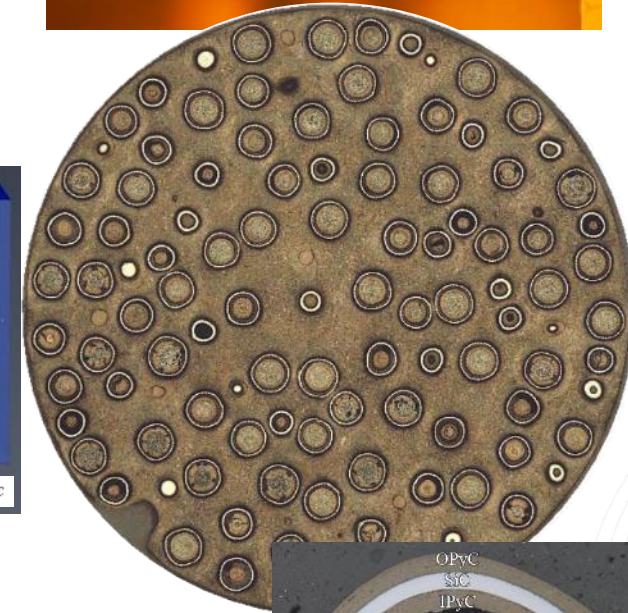
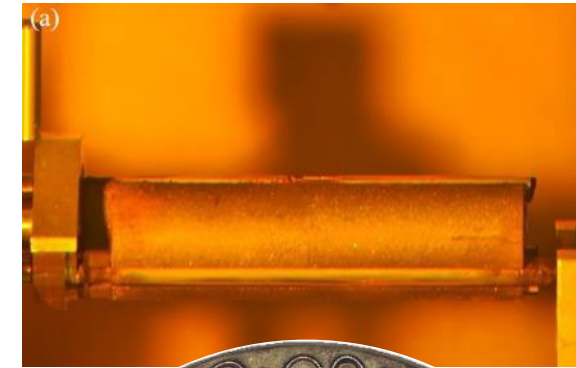
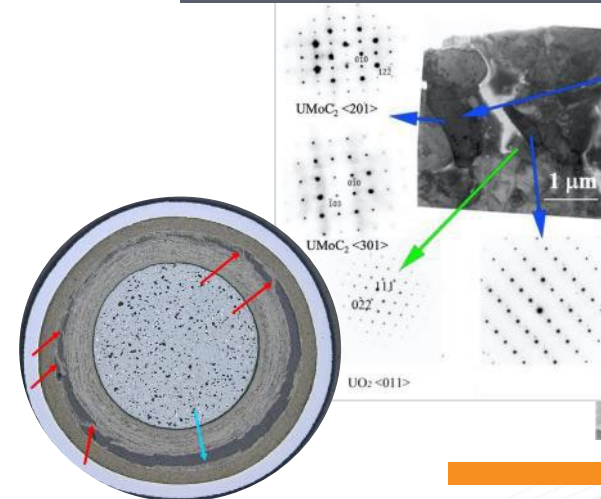
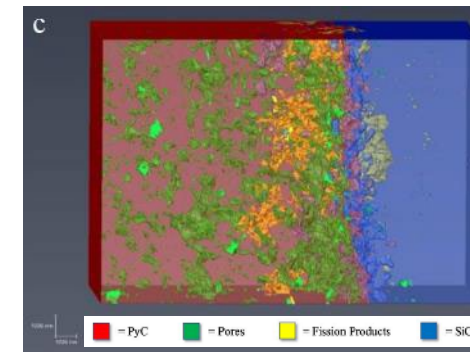
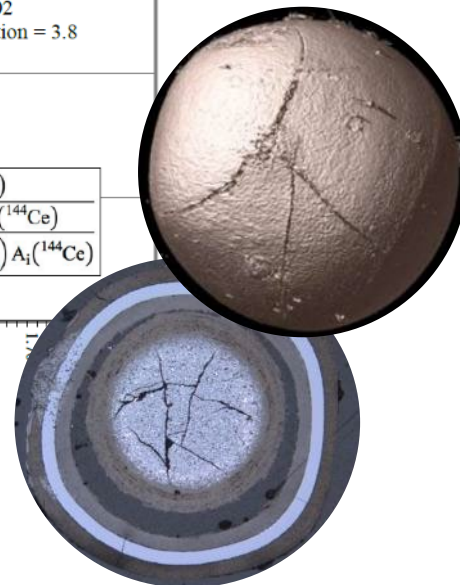
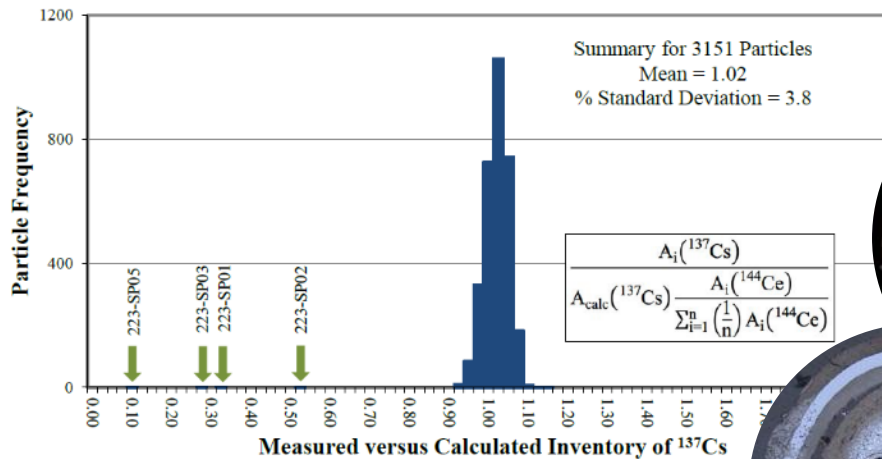
Task 1-4: AGR-2 PIE

- Major components of the AGR-2 PIE have been completed
- Final PIE report issued on Sep 9, 2021
- Includes major conclusions about in-pile behavior of UCO and UO_2 TRISO fuel under a range of irradiation conditions



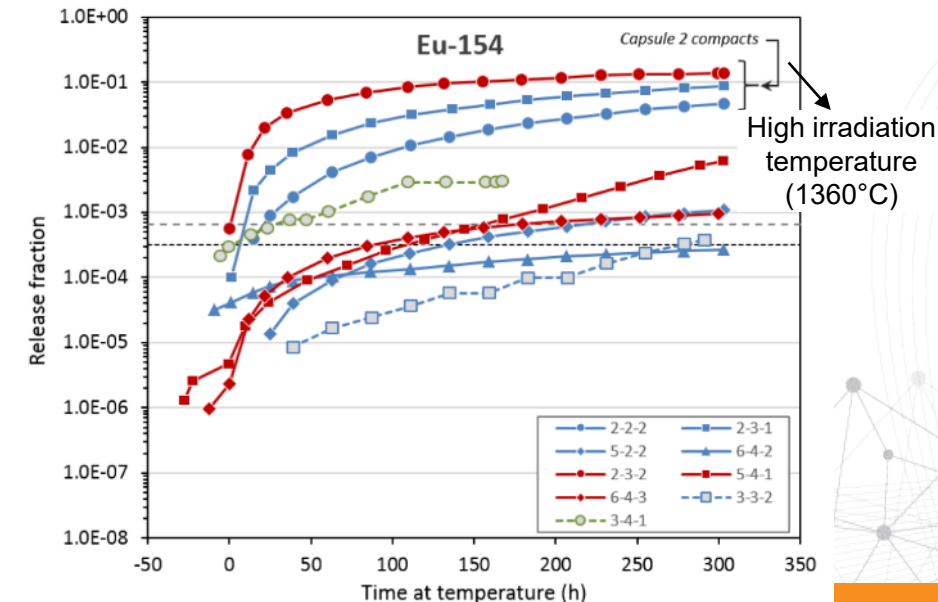
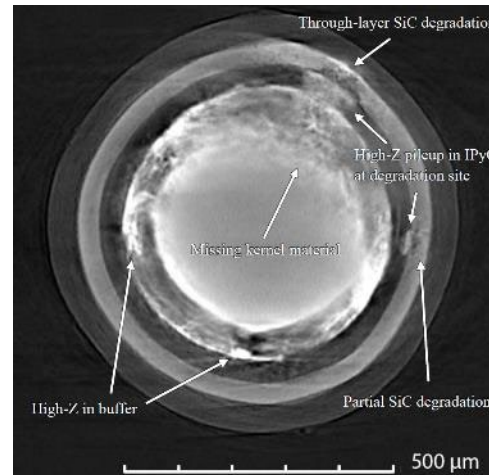
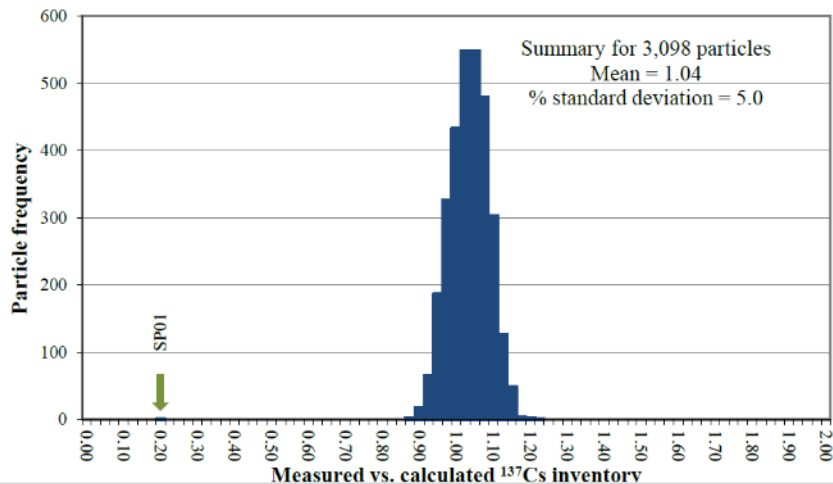
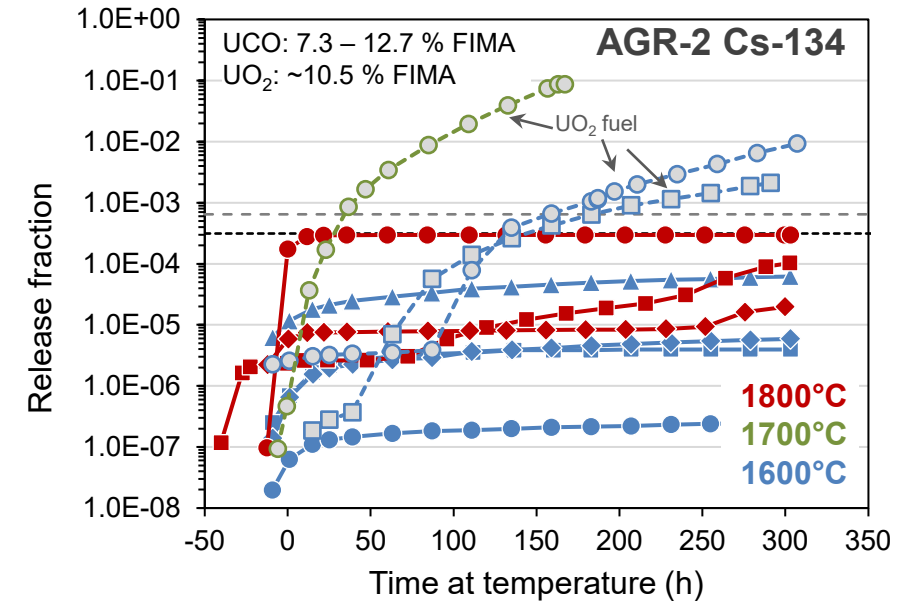
Task 1-4: AGR-2 PIE (cont'd)

- Destructive exam on 14 fuel compacts
- Thousands of particles gamma counted and sorted
- Several thousand particles examined in cross section; many examined with advanced microanalysis techniques



Task 3-3: AGR-2 Accident Safety Testing

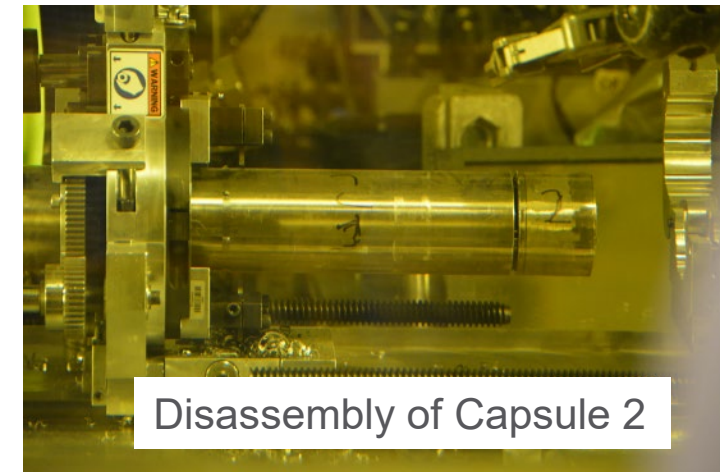
- 16 high-temperature safety tests on 18 fuel compacts
- Temperatures 1500 – 1800°C
- Extensive post-test analysis to identify and study compromised particles and determine cause of layer failure



Task 1-4: AGR-5/6/7 Irradiation

- Final fuel qualification irradiation and performance margin test
- 194 UCO fuel compacts (~570,000 particles)
- Large increases in fission gas release from Capsule 1 in Oct 2019 indicate significant number of particle failures
- Cause remains unknown, but nature of the release suggests it is induced by the experiment (i.e., this is most likely not intrinsic fuel failure); PIE needed to fully understand this behavior
- Experiment terminated early in July 2020 after approximately 360 EFPD and peak burnup ~15% FIMA
- PIE began in spring 2021
 - Non-destructive exam of all five capsule (neutron radiography and gamma scanning)
 - Disassembly of Capsule 2 is in progress

Neutron radiograph of Capsule 1



Task 2-3: LBL Round Robin

- All that remains is final reporting.

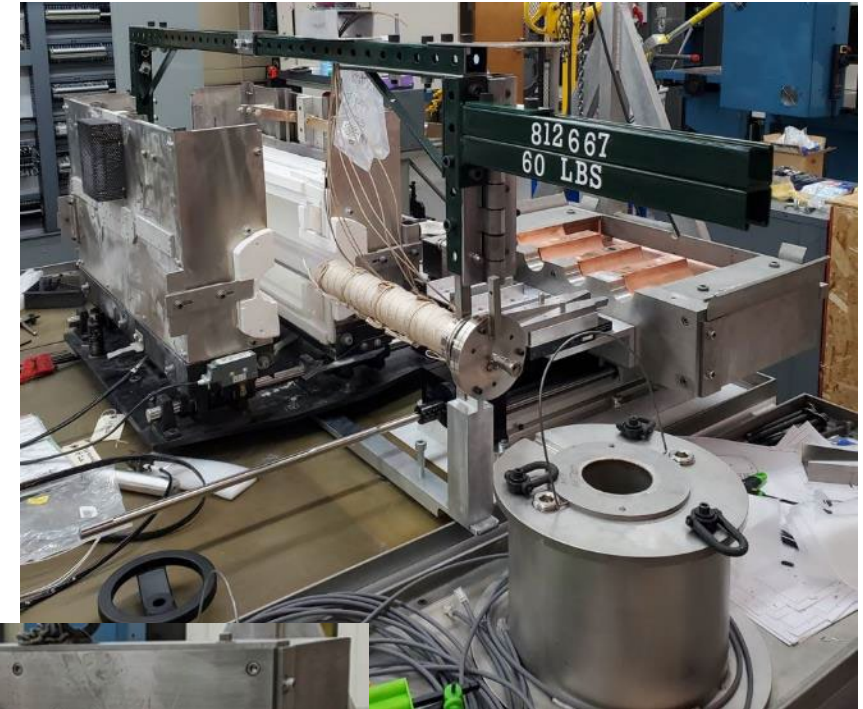
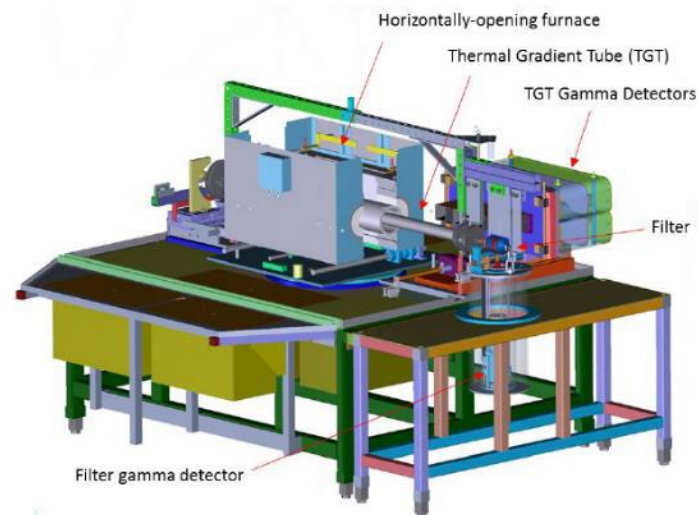
Task 2-4: Accident Test Benchmark

- Final report issued October 2020



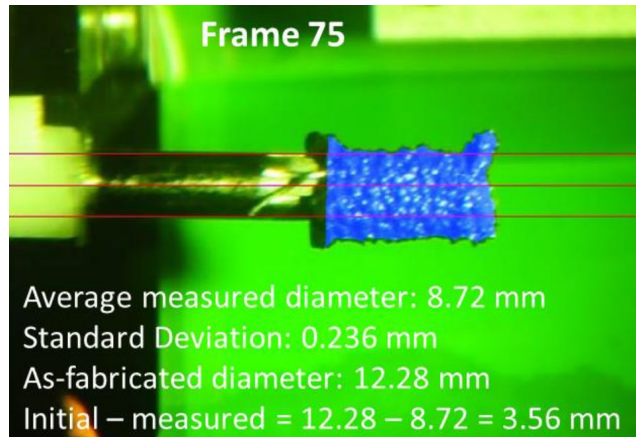
Task 3-2: Develop furnace system for air/steam tests on irradiated fuel

- 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 2023

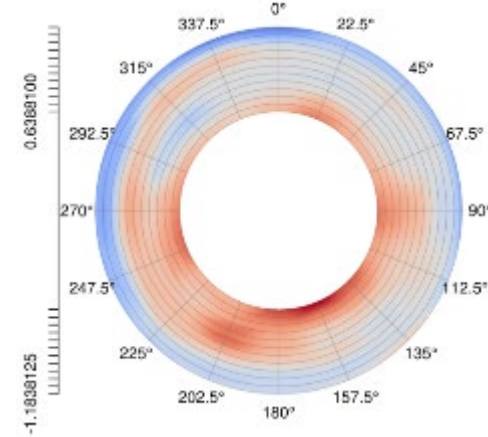


Task 3-4: AGR-3/4 PIE

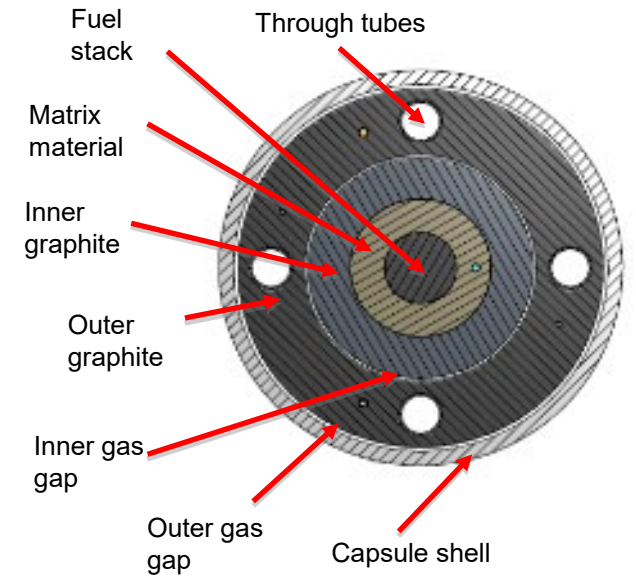
- AGR-3/4 PIE activities are mostly completed
- Primary remaining activity is destructive examination of fuel compacts by “radial deconsolidation-leach-burn-leach”.
- ## compacts have been analyzed



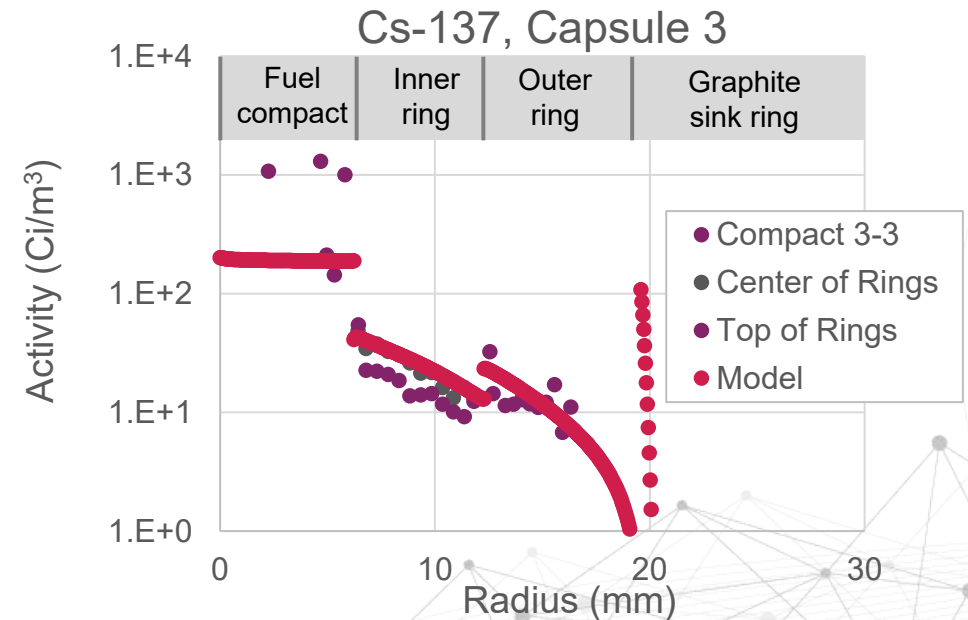
Compact after several deconsolidation steps, leaving only the core



IR-07 Cs-134 activity distribution



AGR-3/4 Capsule Cross Section





Task 3-4: AGR-3/4 Heating Tests

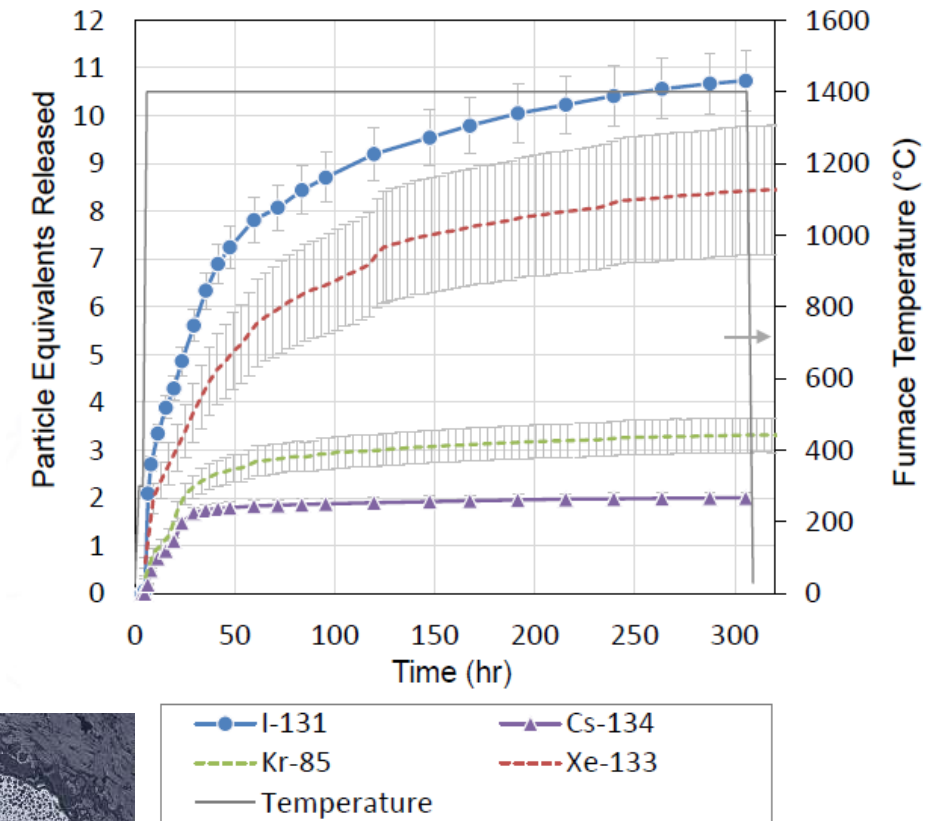
- [Insert information from Stempien Program Review slides]

Task 3-4: Source Term Experiments

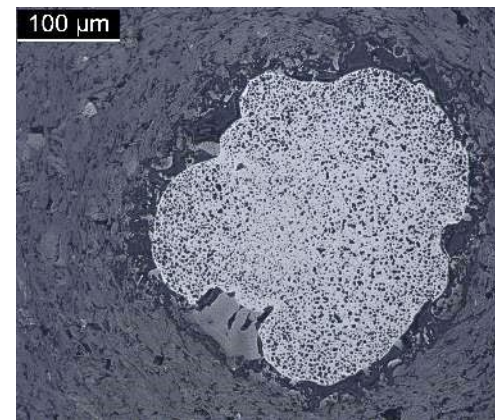
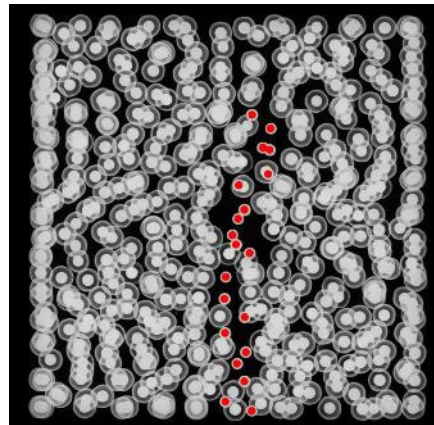
AGR-3/4 Compact heating tests

- Post-irradiation heating of AGR-3/4 compacts at 1200 – 1700°C while measuring fission product release in FACS furnace
- Some compacts are re-irradiated in the NRAD TRIGA reactor prior to heating tests (Task 1-1)
- Explore fission product release from “designed-to-fail” particles (exposed kernels) to help understand transport behavior
- Tests completed:
 - 4 “as-irradiated” compacts
 - 3 “re-irradiated” compacts

AGR-3/4 Compact 10-1 (1400°C)



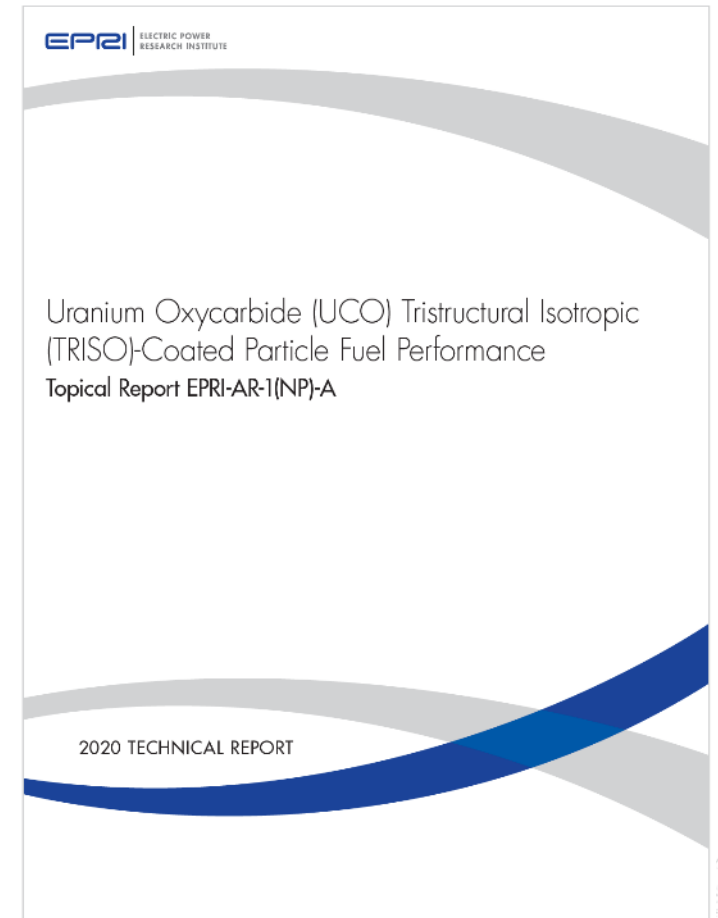
X-radiograph of unirradiated AGR-3/4 compact; DTF highlighted by red dots

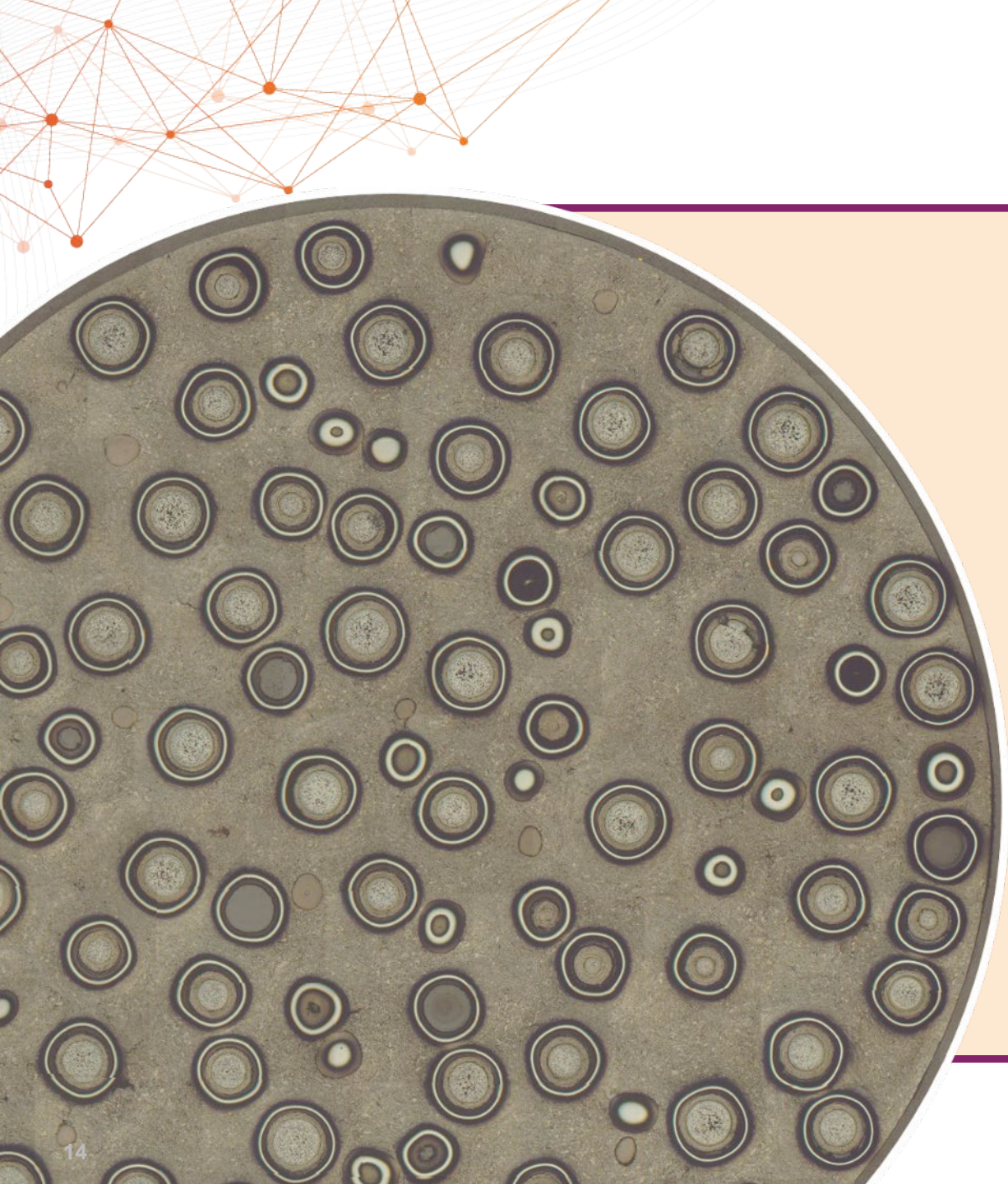


Irradiated DTF particle cross section

Task 3-6: Licensing topical report on UCO TRISO fuel performance

- EPRI UCO TRISO Topical Report was submitted to the NRC in May 2019
- NRC completed their review and issued a formal Safety Evaluation in August 2020
- Final “approved” version of the topical report was issued in November 2020





Thank you for your attention

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