



# Status of U.S. DOE Deliverables

October 2022

*Changing the World's Energy Future*

Paul A Demkowicz



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# **Status of U.S. DOE Deliverables**

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**October 2022**

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# Status of U.S. DOE Deliverables

Prepared for the 18<sup>th</sup> Official Meeting of the VHTR Fuel and Fuel Cycle Project Management Board

# Presentation Outline: Progress 2021 – 2022

- 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]

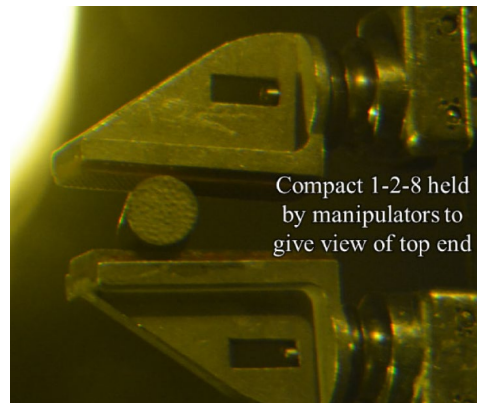
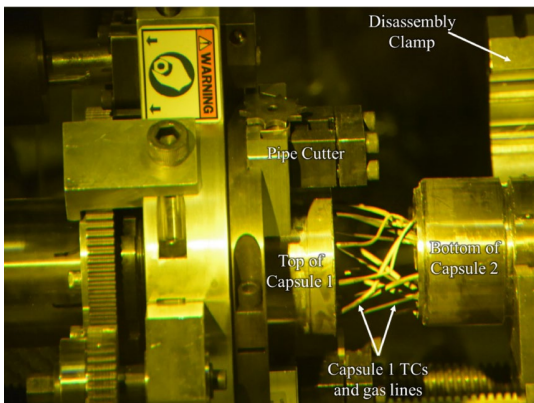
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*\* Shaded text: discussed previously and no discussion in this presentation*

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

- Final fuel qualification irradiation and performance margin test
- 194 UCO fuel compacts (~570,000 particles)
- Irradiation ended in July 2020 after 360 EFPD
- PIE began in spring 2021
  - Disassembly of all capsules complete
  - Dimensional measurement of all graphite holders and fuel compacts complete
  - Destructive fuel compact PIE in progress
  - Safety testing in progress

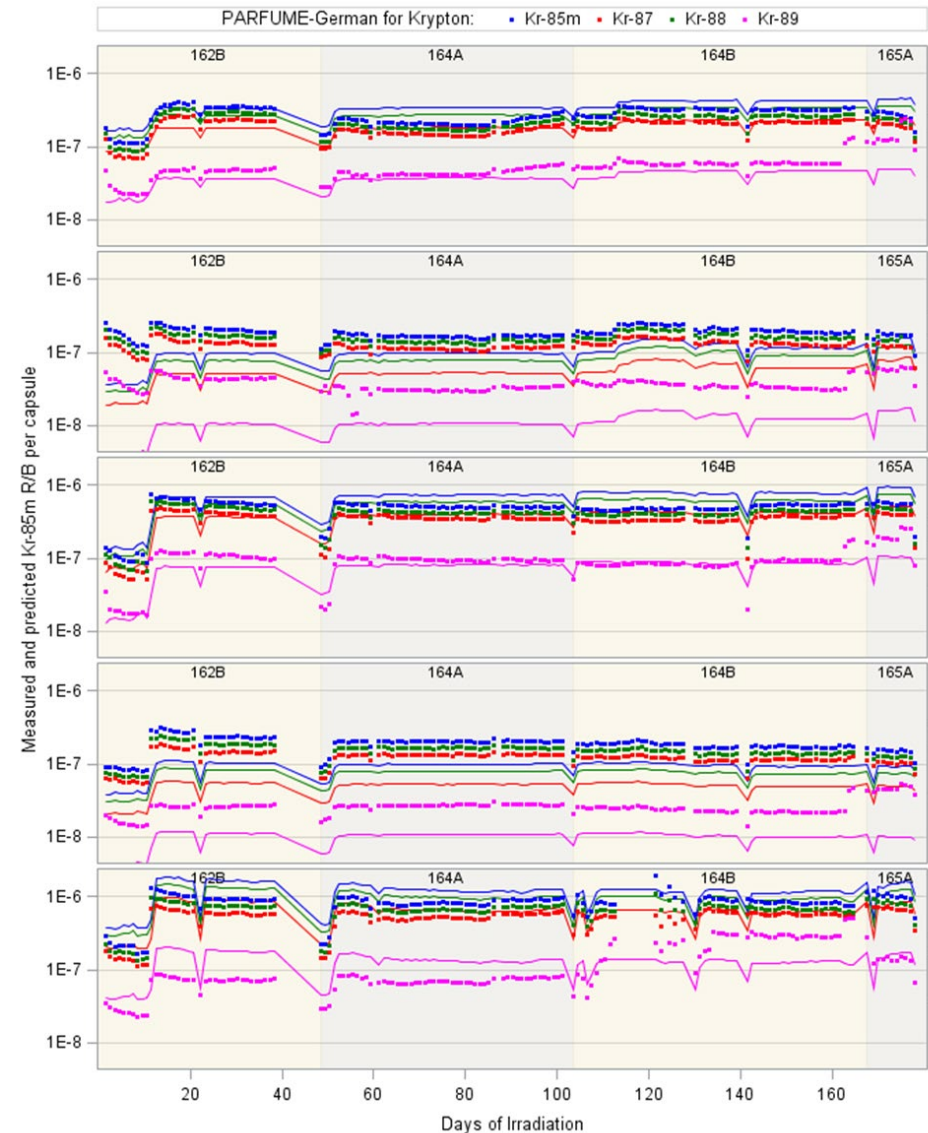




# AGR-5/6/7 Fission Gas R/B

Time-average  
peak temperature  
@ 174 EFPD

- Fission gas R/B for the first ~230 EFPD was consistent with predictions based on known particle defect and dispersed uranium fractions
- After ~230 EFPD, large fission gas release rates were observed for Capsule 1
- This resulted in loss of ability to monitor R/B in Capsule 1 and impacted the R/B data from the other capsules



824°C

944°C

1409°C

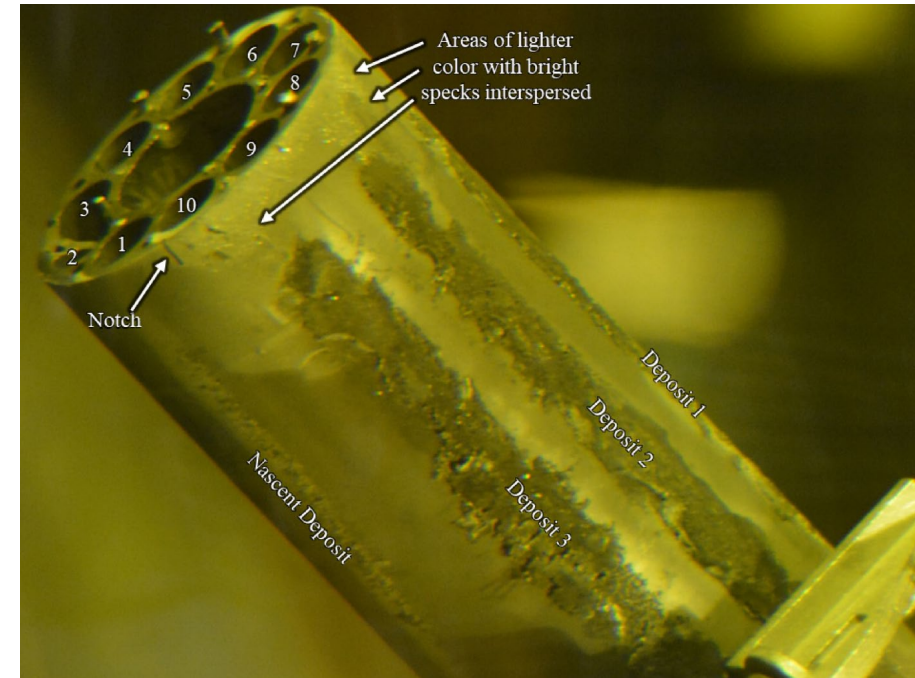
927°C

1249°C



# AGR-5/6/7 Capsule 1 Complications

- Large increase in fission gas release from Capsule 1 observed at ~240 EFPD indicating significant particle failure
- Preliminary PIE completed on Capsule 1 in April 2022
- Fuel failures caused by extensive Ni attack
- Ni originated from Type N thermocouples in the graphite holder
- Capsule temperatures exceeded the design values due to a design flaw in Capsule 1 components
- Fuel in Capsules 2 – 5 (104 compacts; ~261,000 particles) was unaffected



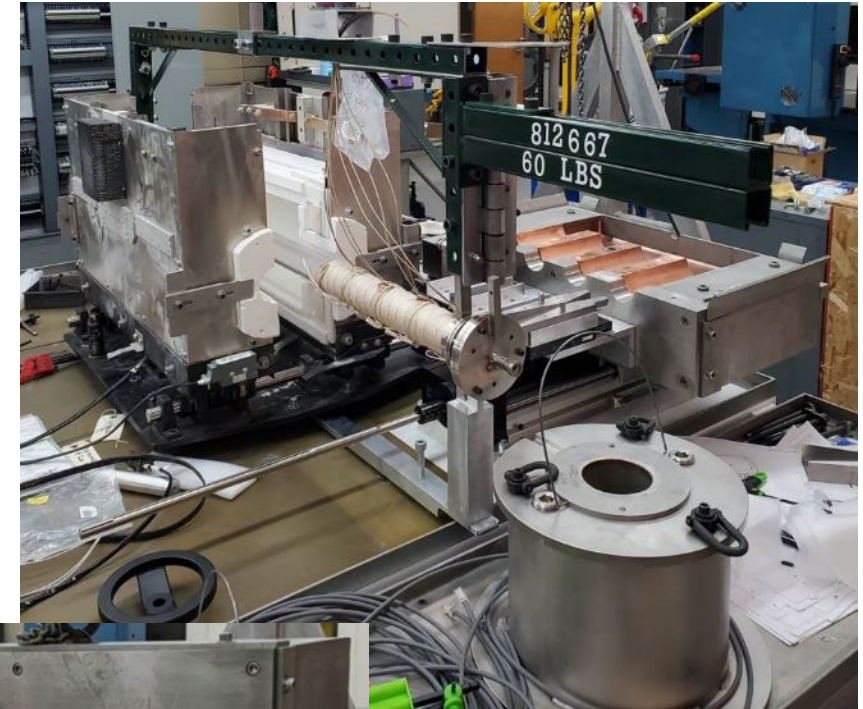
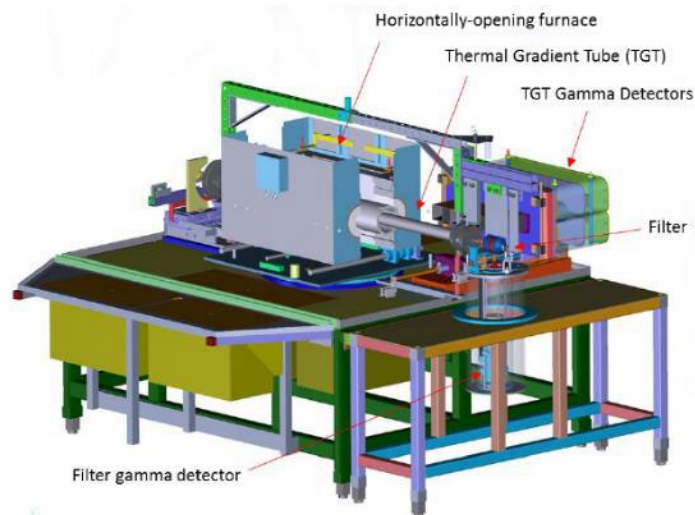


## Task 2-3: LBL Round Robin

- Participants are working on final reports to be compiled into GIF deliverable.

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

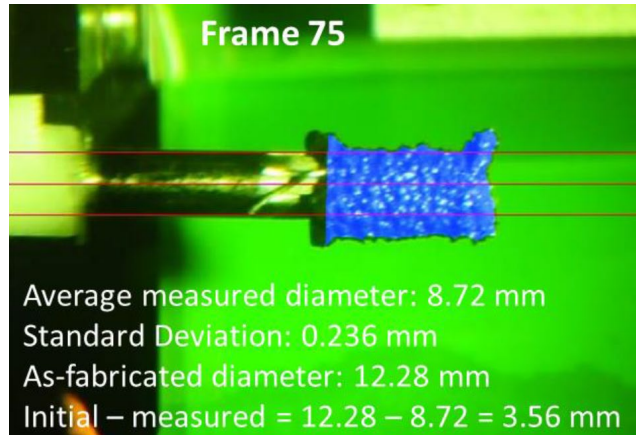
- Development of the Air Moisture Ingress Experiment (AMIX) furnace system continues at INL.
- System will be used to perform post-irradiation heating tests on fuel and materials specimens in oxidizing atmospheres while measuring the release of fission products
- System is expected to be operation in 2023



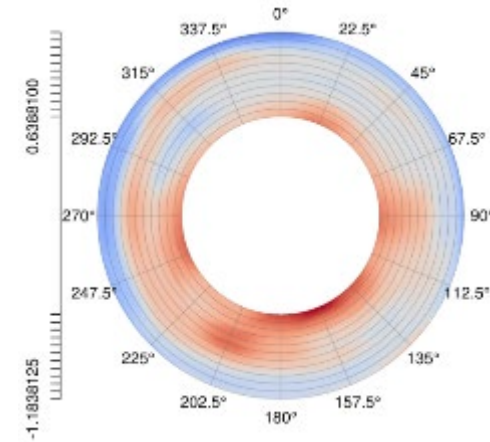


## Task 3-4: AGR-3/4 PIE

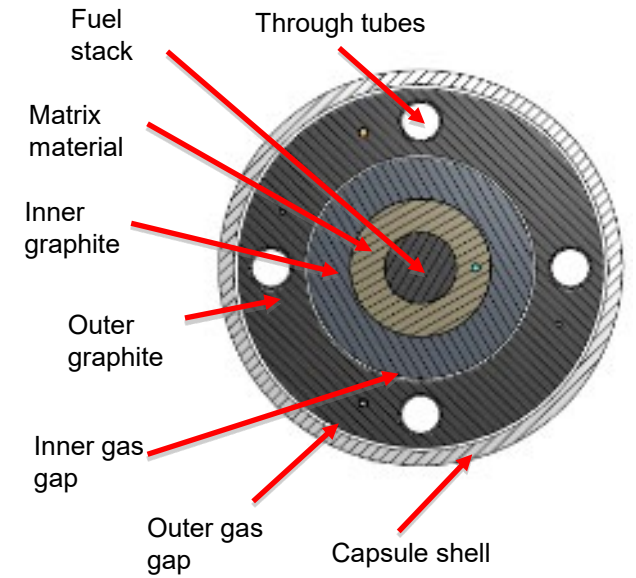
- AGR-3/4 PIE activities are mostly completed
- Primary remaining activity is destructive examination of fuel compacts by “radial deconsolidation-leach-burn-leach”.
- 17 compacts have been analyzed
- 4 compacts still to be analyzed



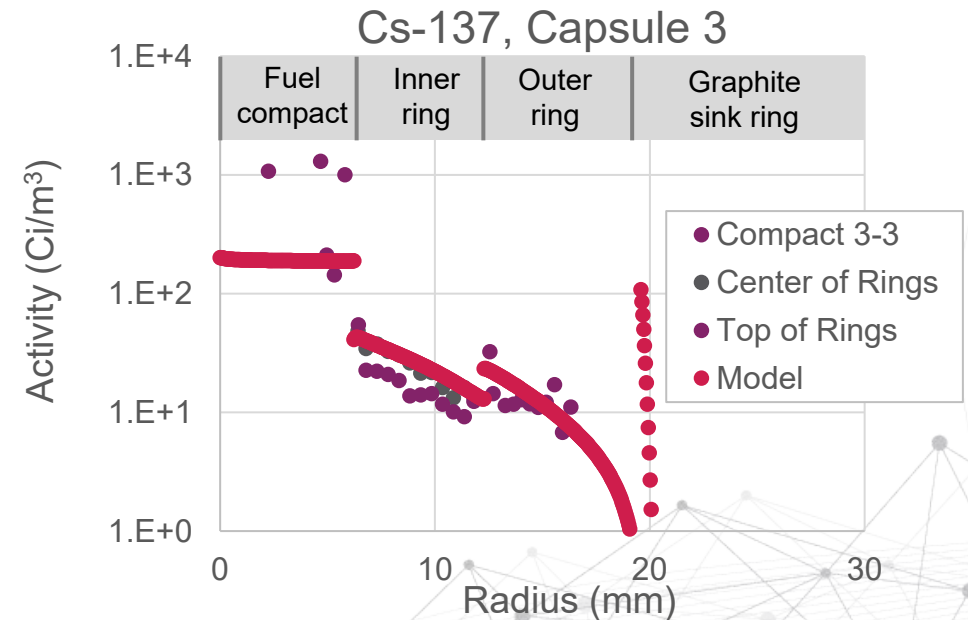
*Compact after several deconsolidation steps, leaving only the core*



*IR-07 Cs-134 activity distribution*



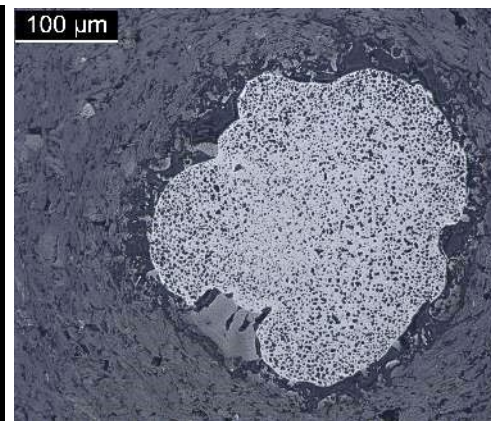
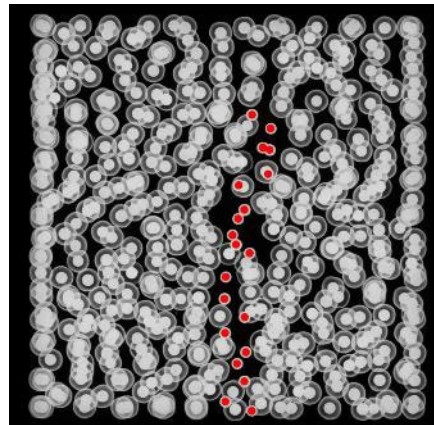
*AGR-3/4 Capsule Cross Section*



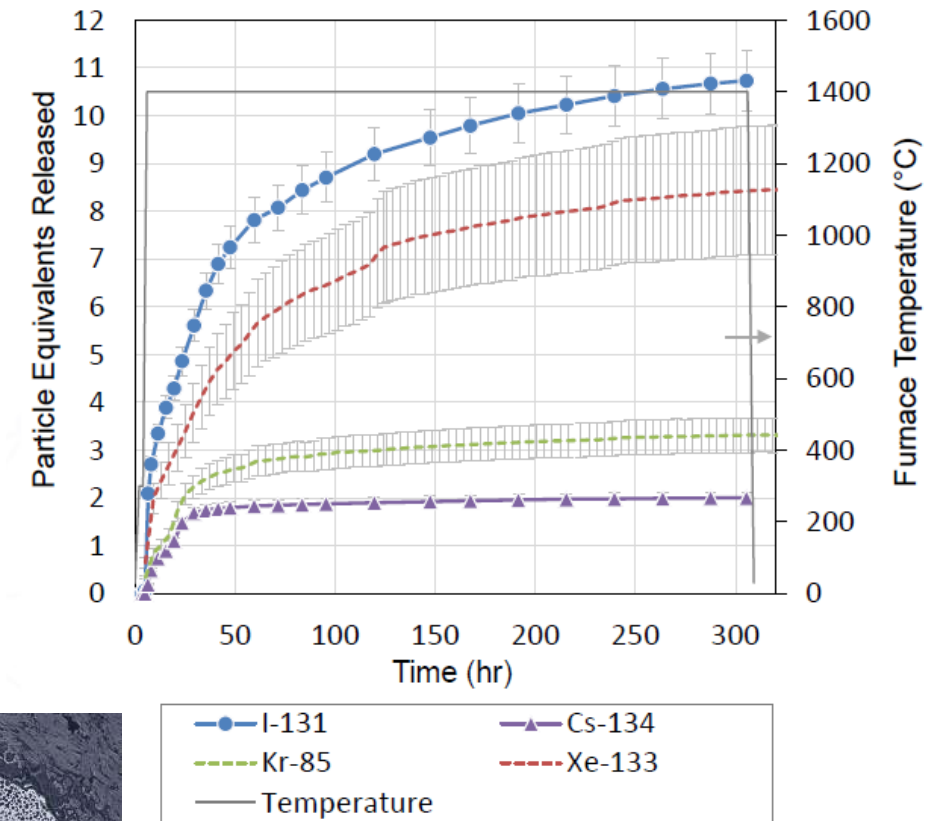
## Task 3-4: AGR-3/4 heating tests

- 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
  - 5 “re-irradiated” compacts
- Radial deconsolidation of heated compacts:
  - 5 complete
  - 4 remaining

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

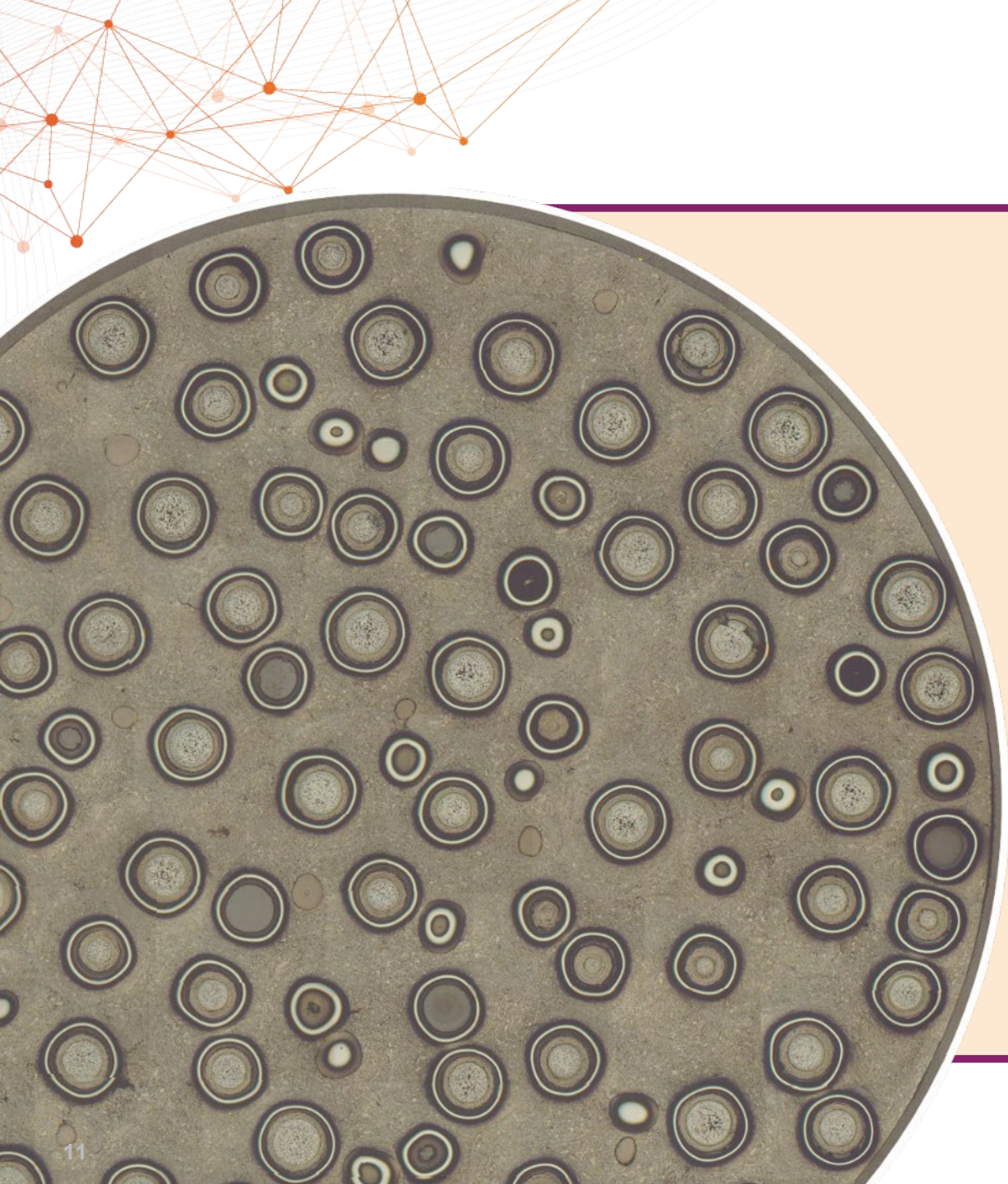


AGR-3/4 Compact 10-1 (1400°C)



Irradiated DTF particle cross section





***Thank you for your attention***

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