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Materials Research Pathway Lead

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Materials Research Pathway

2024 LWRS Program Spring Review Meeting

April 30 – May 1, 2024



Objective

Provide data and methods to assess performance, damage, and mitigation options for systems, structures, and components that are essential to safe and sustainable operation of nuclear power plants

Approaches

The background of the slide is a photograph of a laboratory vacuum chamber. A prominent feature is a long, vertical, corrugated metal hose that runs from the top of the frame down towards the center. The chamber itself is made of polished metal and has several circular ports or gauges on its front panel. The lighting is warm and yellowish, creating a professional and technical atmosphere.

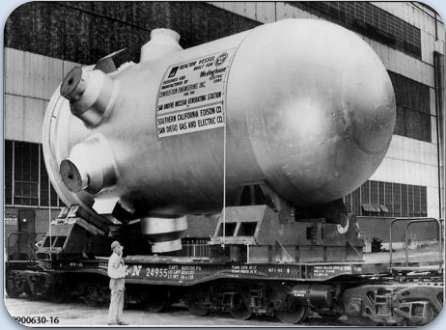
1. Measurement of degradation
2. Mechanisms of degradation
3. Modeling and simulation
4. Monitoring degradation
5. Mitigation strategies
6. Materials harvesting

Outcomes

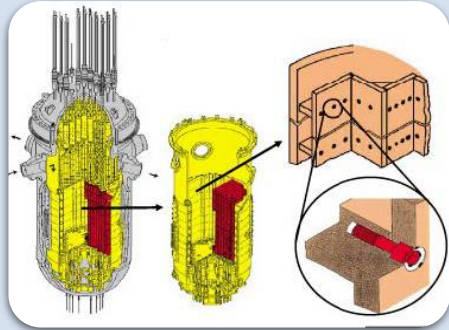
- Reduce uncertainty
- Increase operational efficiency
- Assess potential damage
- Reduce outage risk and inspection frequency
- Reduce operation costs and improve reliability



Materials Research Areas



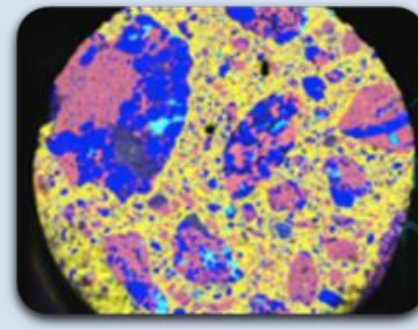
Reactor
Pressure
Vessel



Core
Internals &
Pressure
Boundaries



Mitigation
Technologies



Concrete
Degradation



Cable
Degradation

Global Collaboration and Partnership



Argonne
NATIONAL LABORATORY

CRIEPI
Central Research Institute of
Electric Power Industry



EPRI
ELECTRIC POWER
RESEARCH INSTITUTE



HOLTEC
INTERNATIONAL

INL
Idaho National Laboratory



LIVEWIRE
INNOVATION



OAK RIDGE
National Laboratory

Pacific Northwest
NATIONAL LABORATORY



STRUMAT
-LTO

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

THE
UNIVERSITY
OF UTAH

UCLA

UNIVERSITY OF
MICHIGAN

U.S.NRC



wirescan

The Japan Concrete Aging Management Program (JCAMP) and more

Metals and mitigation



M. Sokolov
RPV



Z. Zhai
Ni-alloy SCC



B. Alexandreanu
Ni-alloy SCC & EAF



G. Was
IASCC



M. Gushev
IASCC



G. Sant
IASCC



T. Lach
Baffle bolt PIE



J. Chen
Weld repair



X. Chen
Harvesting

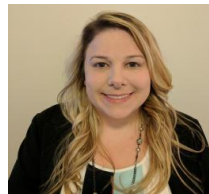
Concrete degradation



Y. Le Pape
Concrete performance
PRA of CBS



E. Tajuelo
Irradiated concrete
Harvesting



S. Sabatino
Concrete NDE

Cable degradation



L. Fifield
Cable aging and gap analysis



B. Glass
Cable NDE

Emerging areas



J. Jun



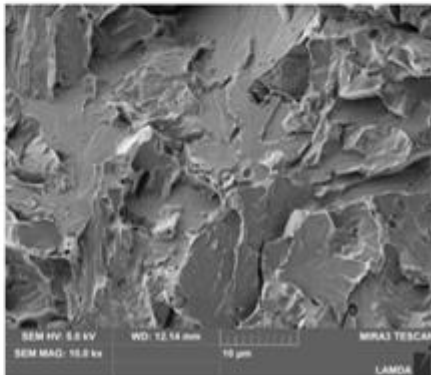
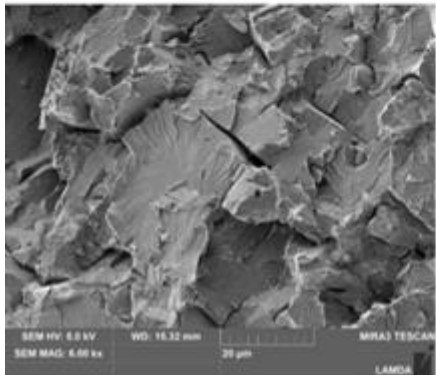
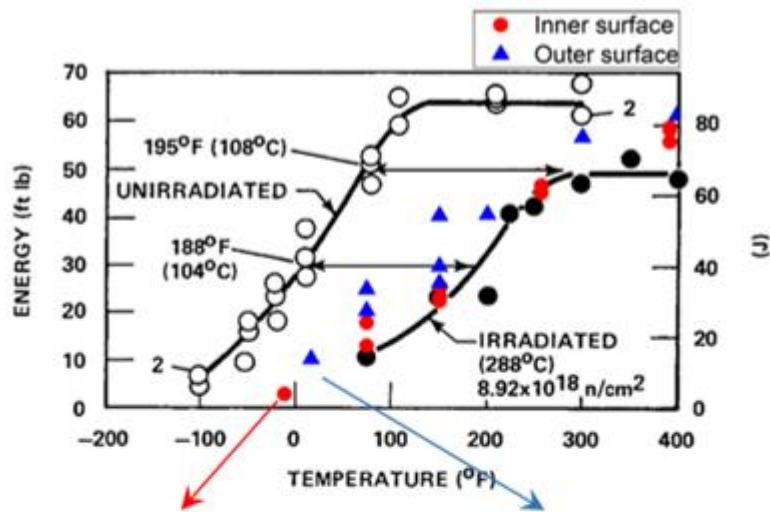
J. Keiser

Selective leaching

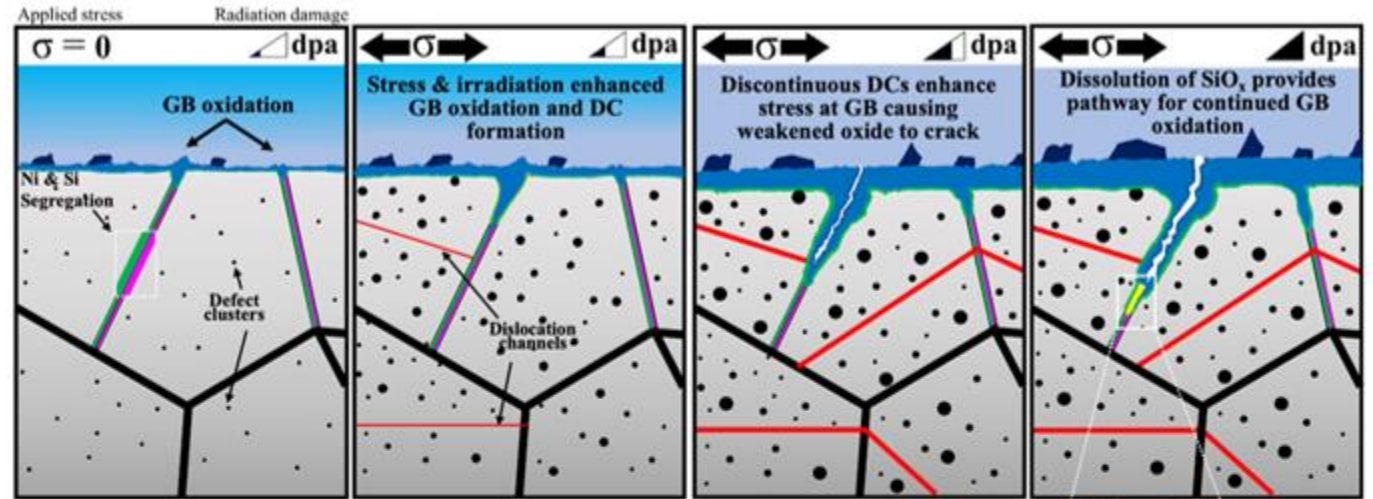


X. Chen
Ice condenser
Operation beyond 80

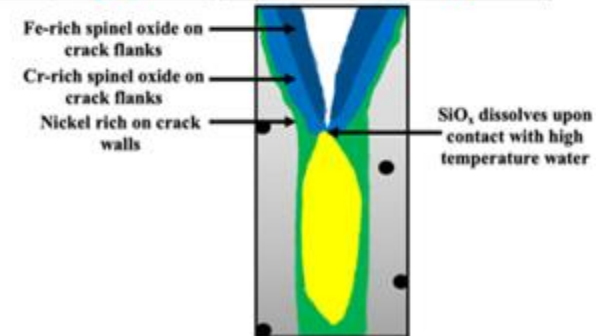
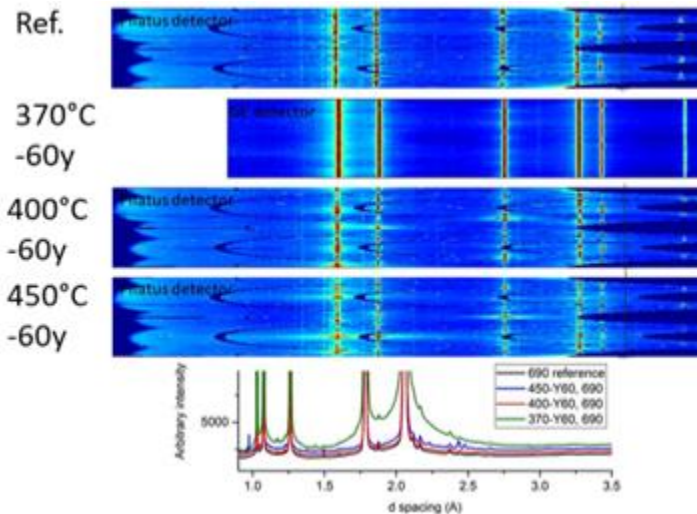
High fluence effect on RPV



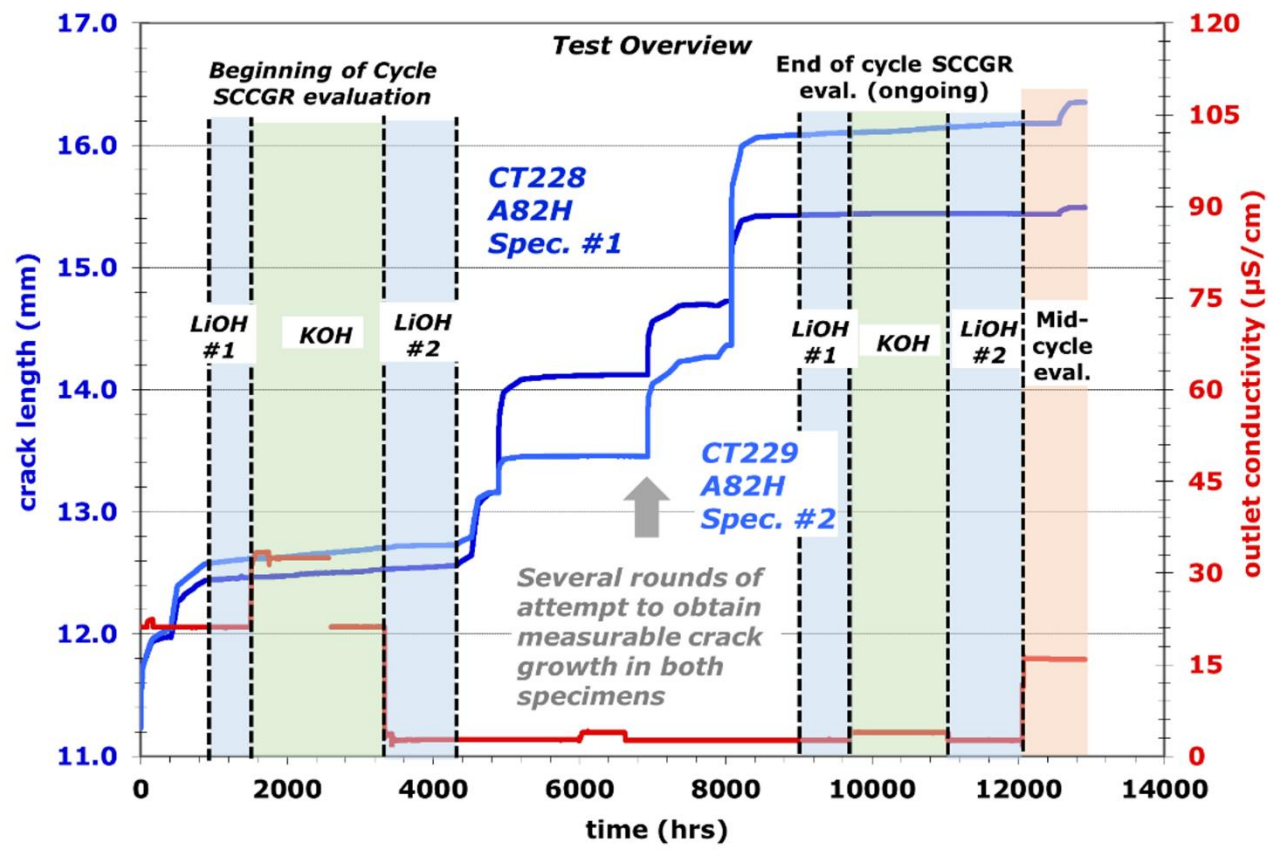
Mechanism of irradiation-assisted stress corrosion cracking



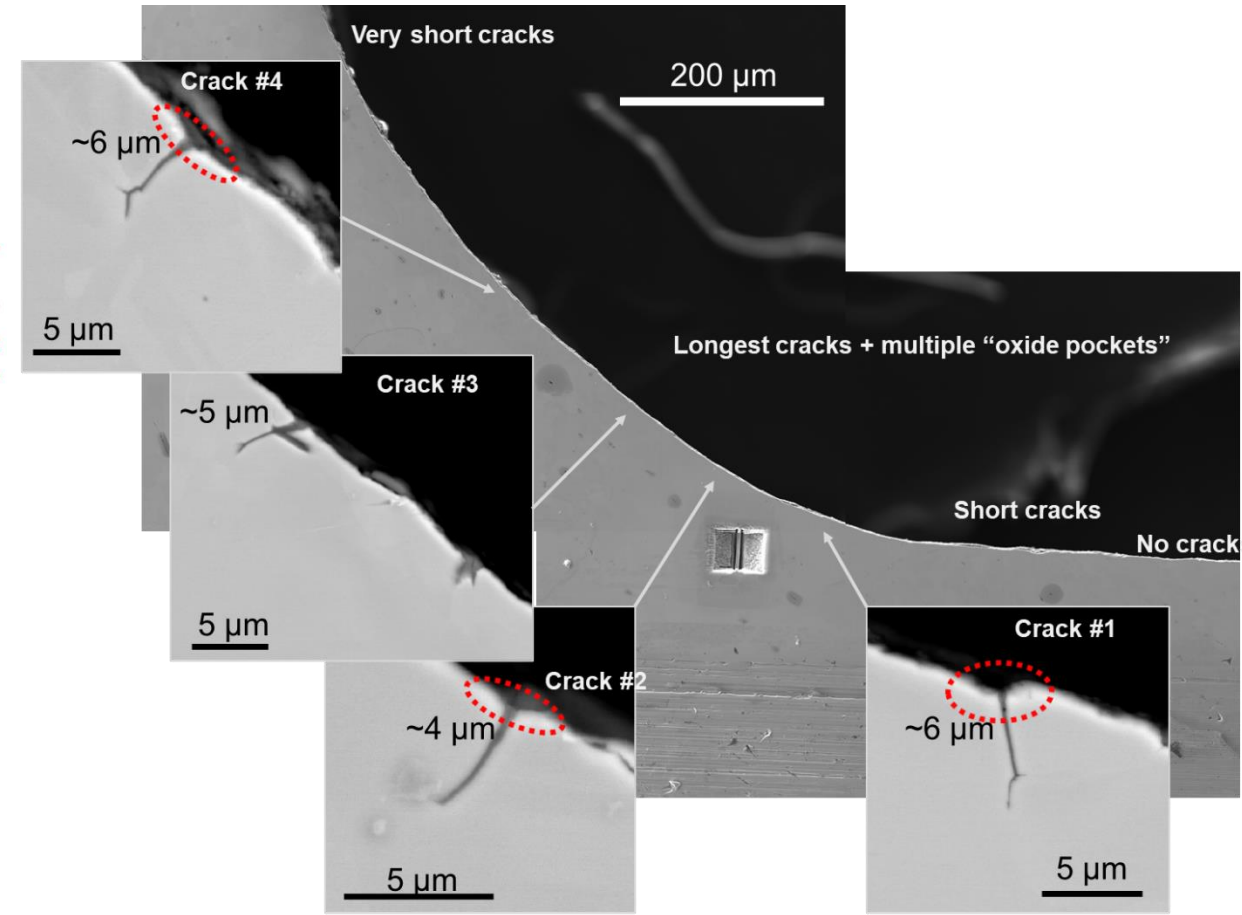
Long-term thermal aging of alloy 690



Stress corrosion cracking of metal alloys



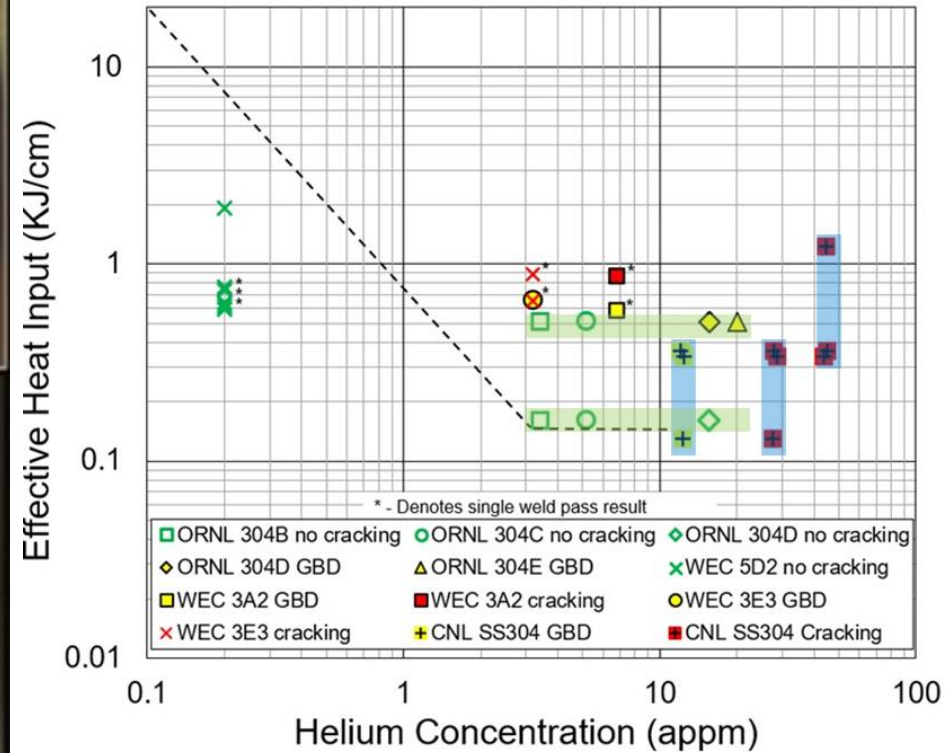
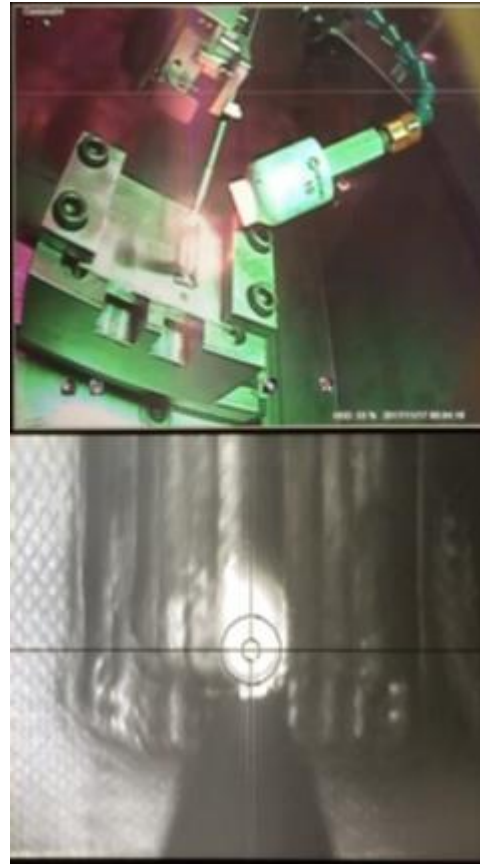
Characterization of harvested baffle former bolts



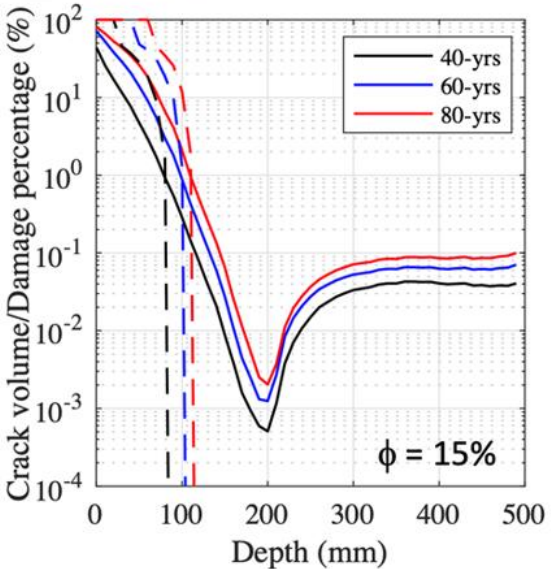
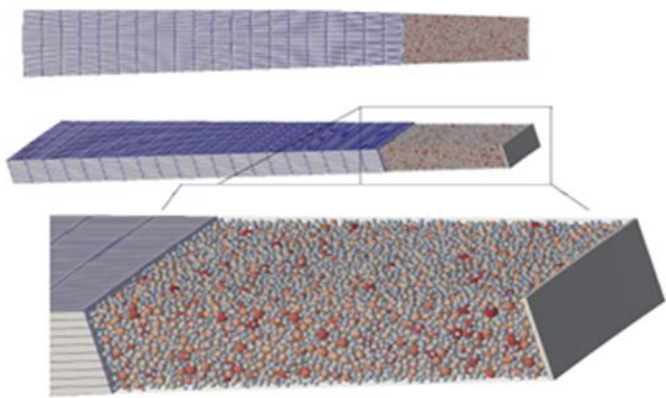
RPV surveillance capsule harvesting



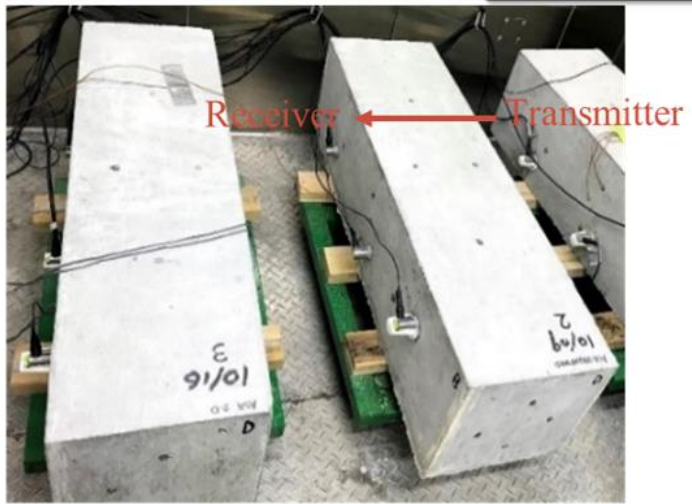
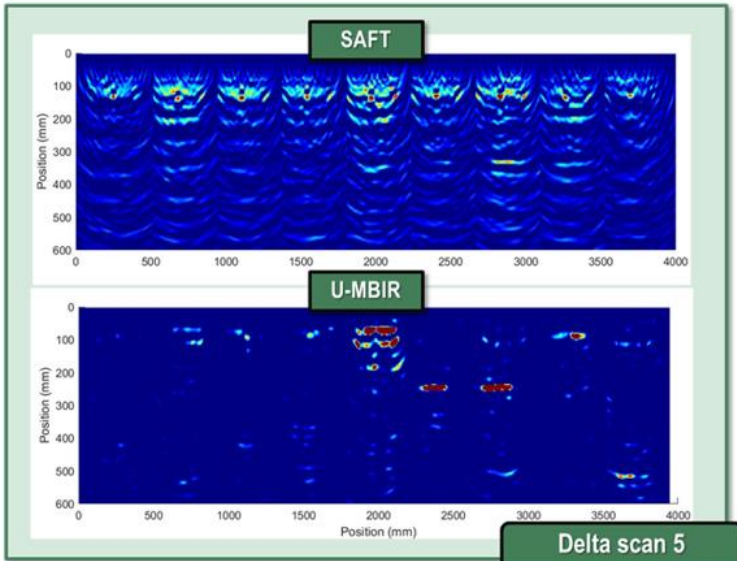
Weld repair on irradiated stainless steels and Ni alloys



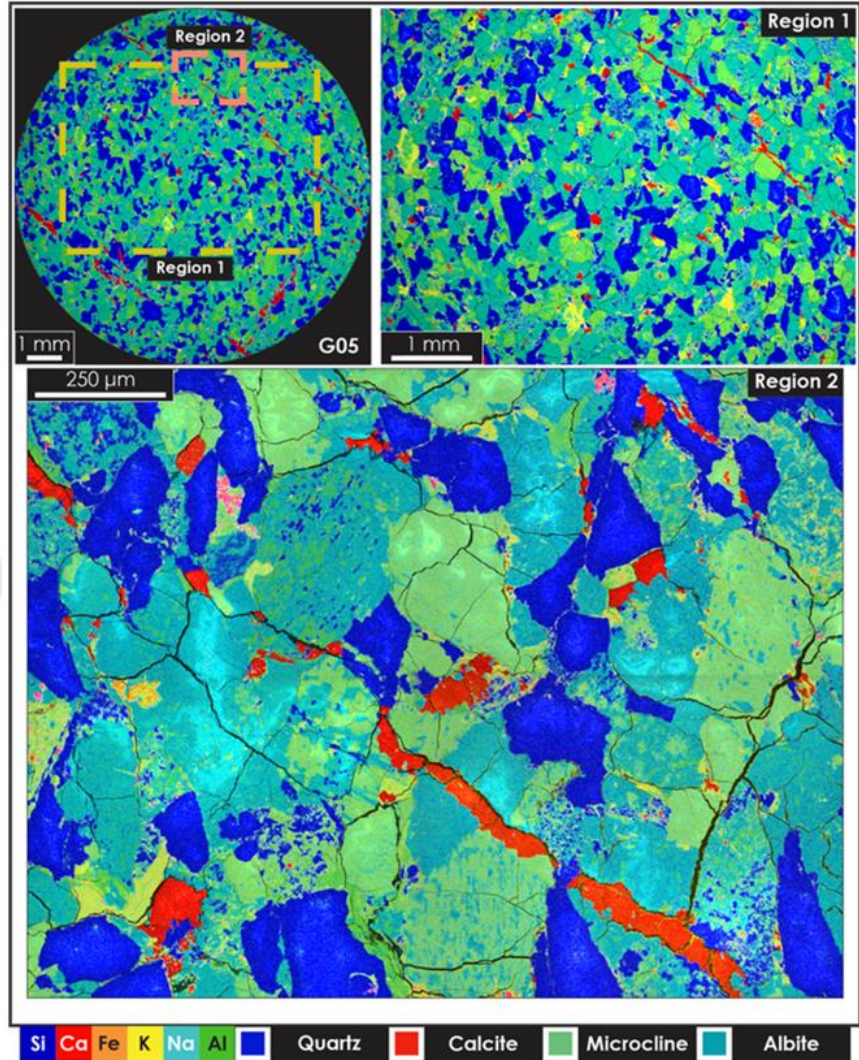
Modeling and simulation of irradiated concrete



Concrete NDE



Irradiated concrete



Cable aging research



MAaD Science
Materials Aging and
Detection Science
@PNNL

- Accelerated Aging
- Polymer Testing & Characterization
- Advanced Data Analysis
- Performance Prediction

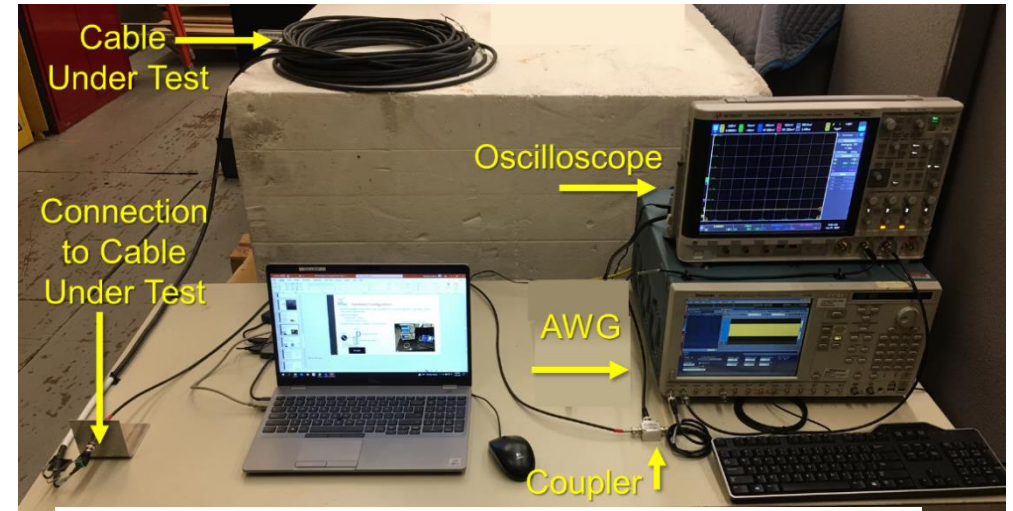


ARENA
Accelerated and Real-Time
Environmental Nodal Assessment
@PNNL

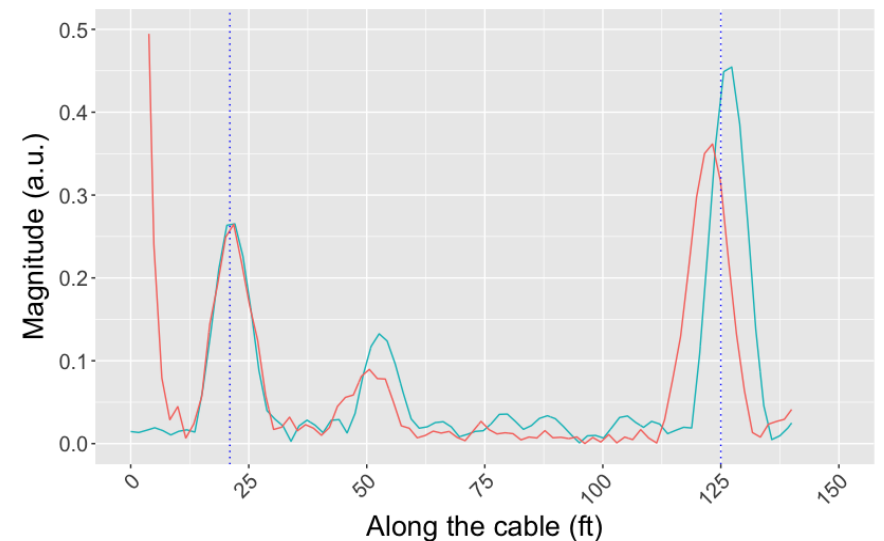
- Non-destructive Evaluation
- Condition Assessment
- Online Monitoring
- Digital & Physical Twins



Cable NDE and online monitoring

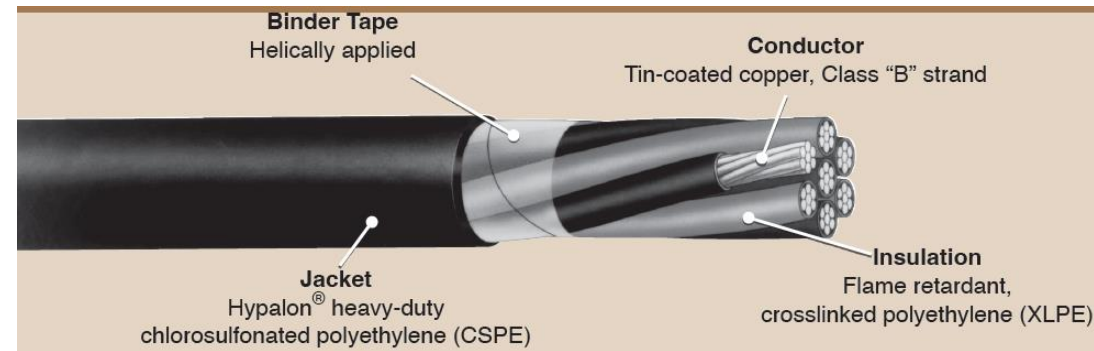


LiveWire, 48 MHz PNNL SSTDR, 50 MHz



DecaBDE Response Team received DOE Secretary's Honor Achievement Award

The team's efforts have been pivotal in navigating the complex challenges posed by environmental regulations on the nuclear industry. The Environmental Protection Agency's ruling on the manufacturing, processing, and distribution of DecaBDE, a flame retardant used in wire and cable insulation, necessitated a swift and effective response to ensure compliance while maintaining the integrity of critical infrastructure. The team's work underscores the importance of interdisciplinary collaboration in addressing environmental concerns within highly technical and regulated industries.



RSCC Firewall[®] III control cable



U.S. DEPARTMENT OF
ENERGY



A. Hahn

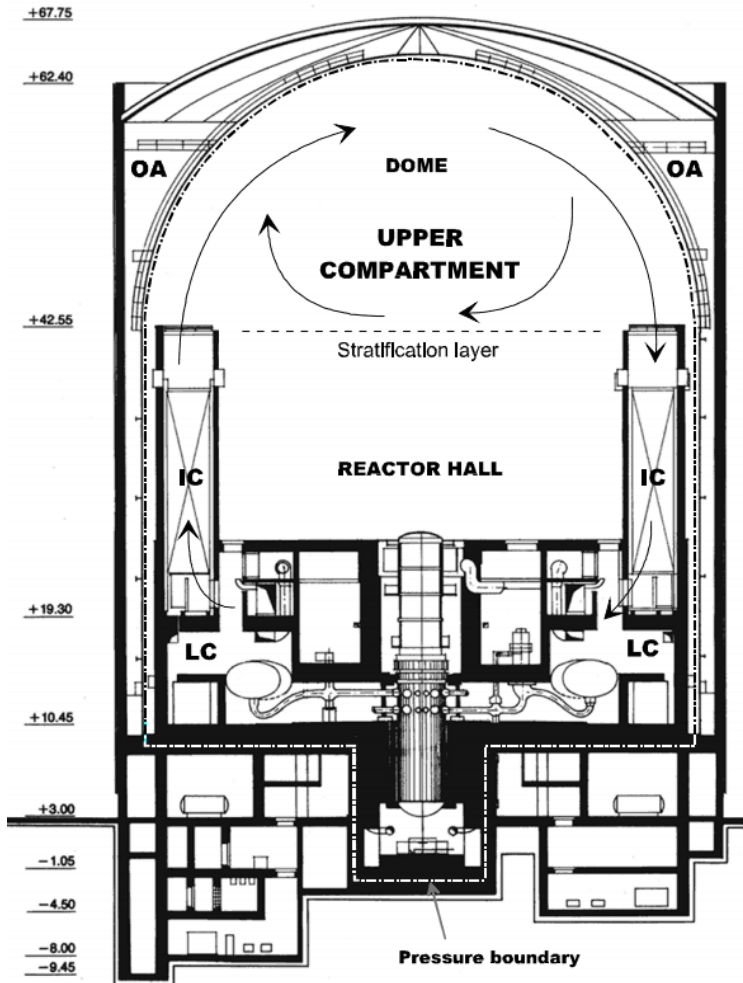


B. Hallbert



X. Chen

PWR Ice condenser replacement



Schematic of the containment building

Considerations for Replacement of Ice Condensers with Endothermic Materials



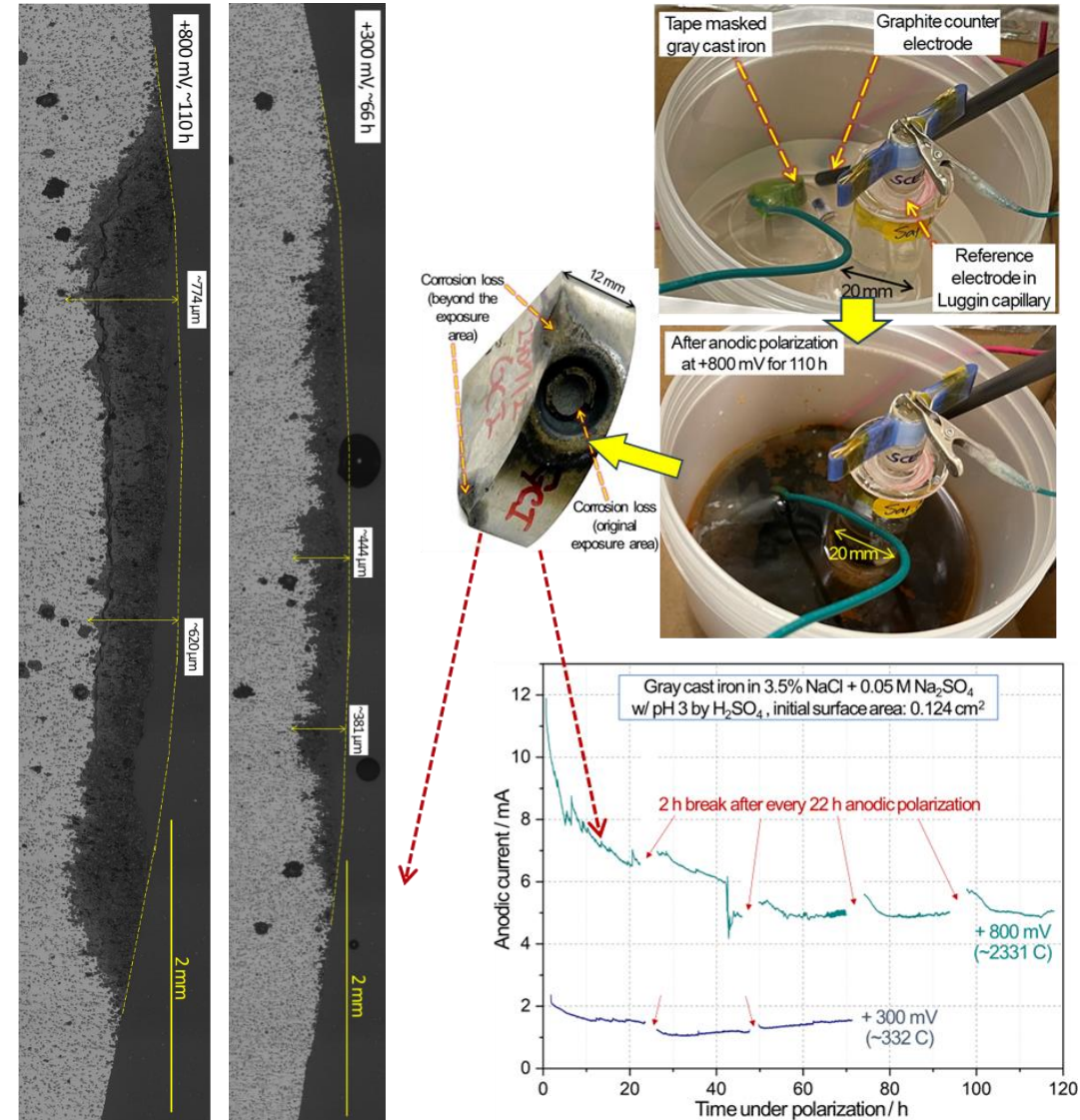
Adrian S. Sabau
Jiheon Jun
Xiao-Ying Yu
Xiang (Frank) Chen
September 2023

OAK RIDGE
National Laboratory

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ORNL/TM-2023/3010

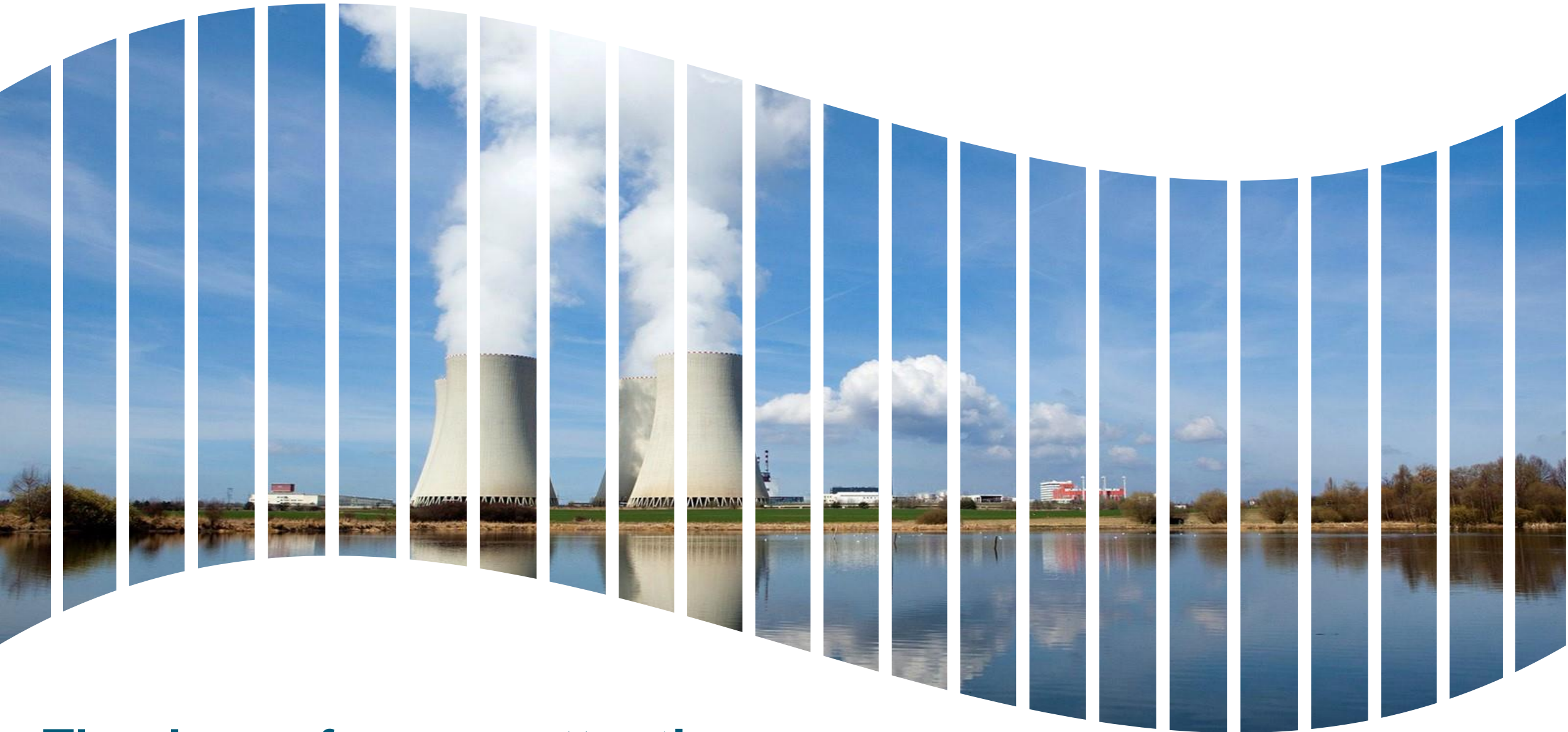
Selective leaching



Examples of Collaborative Activities

- **EPRI**
 - Repair welding of irradiated internals
 - Environmentally-assisted fatigue testing of additively manufactured 316L
 - Concrete NDE
 - Condition-based cable aging management
- **NRC**
 - Long-term SCC initiation testing on blunt notch high Cr Ni-based weld
 - Long-term thermal aging on performance of High-Cr Ni-based alloys
 - Concrete harvesting and testing
 - Condition-based cable aging management
- **PWROG**
 - RPV harvesting and archive material testing
 - Evaluation of ice condenser replacement
- **International**
 - Civil Nuclear Energy Research and Development Working Group (CNWG)
 - Canadian Nuclear Laboratories
 - EDF LTO





**Thank you for your attention
Questions?**