ADVANCED NUCLEAR FUELS AND SPENT NUCLEAR FUEL RESEARCH

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OUR MISSION

Mission:

- Advance nuclear technology, enhance safety, support national security needs, and develop the future nuclear workforce.

Vision:

- Drive innovation in nuclear science through collaboration with industry and national labs.

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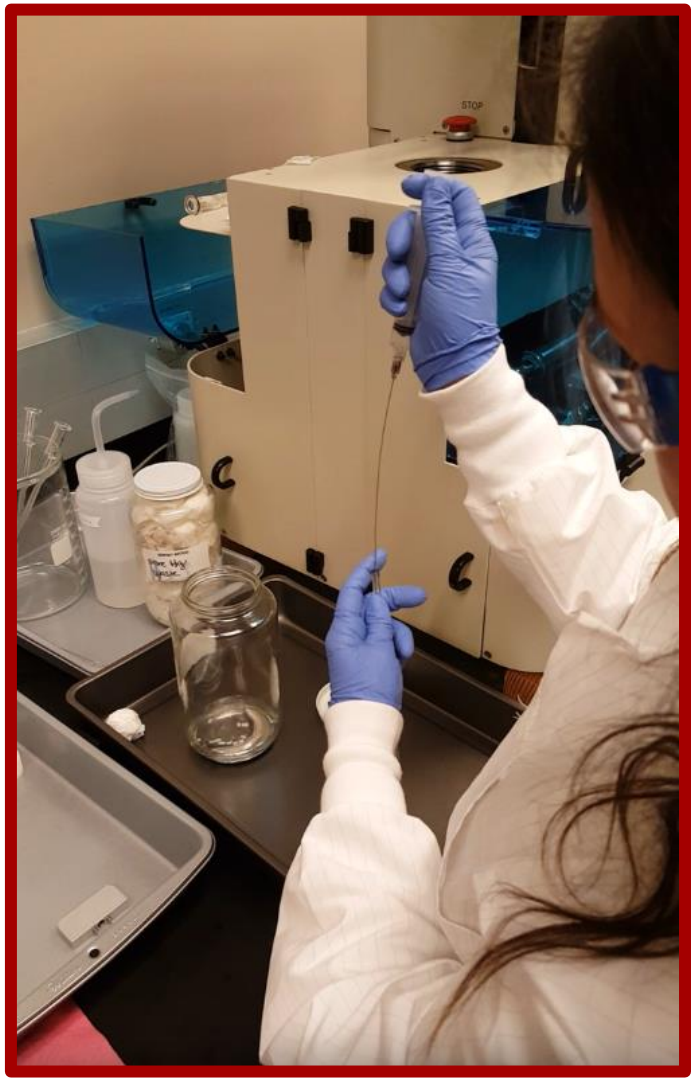
OUR RESEARCH FACILITIES

- Used Fuel Storage and Disposition (UFD) Laboratory
- Advanced Nuclear Materials Laboratory
- Proposed Actinides Laboratory



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USED FUEL STORAGE AND DISPOSITION LABORATORY

Focus:

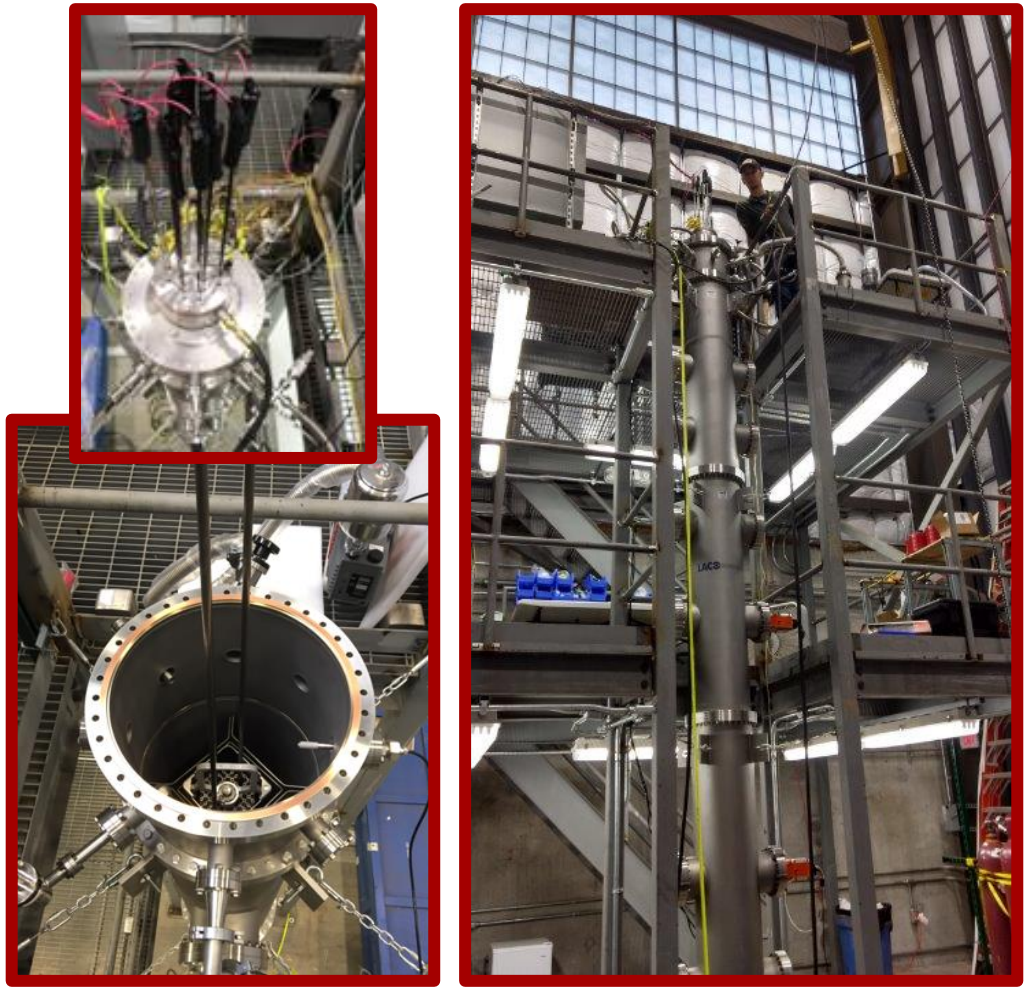
- Safe handling, managing, drying, and storage of spent nuclear fuel.

Capabilities:

- Full-scale testing replicating various spent nuclear fuel conditions (temperature, pressure, humidity).

Experience:

- Handling both commercial (Zr-clad) and defense-related (Al-clad) fuels.



Full-Scale Single Fuel Assembly for Spent Nuclear Fuel Research

ADVANCED NUCLEAR MATERIALS LABORATORY

Focus:

- Developing advanced nuclear fuels and nuclear materials.

Capabilities:

- State-of-the-art equipment for material synthesis and characterization.

Experience:

- Accident tolerant fuels, ceramic fuels, coated particle fuels, advanced claddings, and molten salts.

Advanced Nuclear Materials Facility Instrumentation

PROPOSED ACTINIDES LAB

Focus:

- Support basic science, national security, waste form development, and workforce development.

Capabilities:

- Unique university facility for research on macroscopic actinide materials (^{242}Pu and ^{237}Np), focusing on materials research in contrast to molecular studies.

Research:

- Enables synthesis and property analysis with small quantity of actinide materials (~1 gram inventory levels).

Status:

- Feasibility analysis and conceptual plan completed.
- Currently contracting for full laboratory design.

Plutonium and Neptunium Lab Design

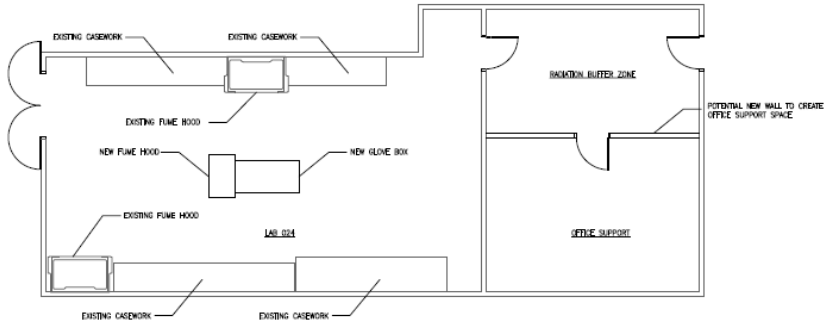
Prepared for:
University of South Carolina

DLS LABORATORY CONSULTANTS

Prepared by:
Diversified Laboratory Sciences, Inc.

Uranium laboratory to be converted for work with transuranic isotopes

Planned renovation for actinide laboratory



RESEARCH FOCUS AREAS

Back End of the Fuel Cycle:

- Handling, drying, and storage of spent nuclear fuel
- Monitoring and instrumentation technologies

Advanced Nuclear Fuels and Materials:

- Accident tolerant fuels
- Molten salts
- Particle coated fuels
- Ceramic fuels for commercial and space applications

Modeling and Simulation:

- Safety analysis (e.g., accident analyses and radiological assessments)
- Advanced reactor design and performance

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BACK END OF THE FUEL CYCLE

Research:

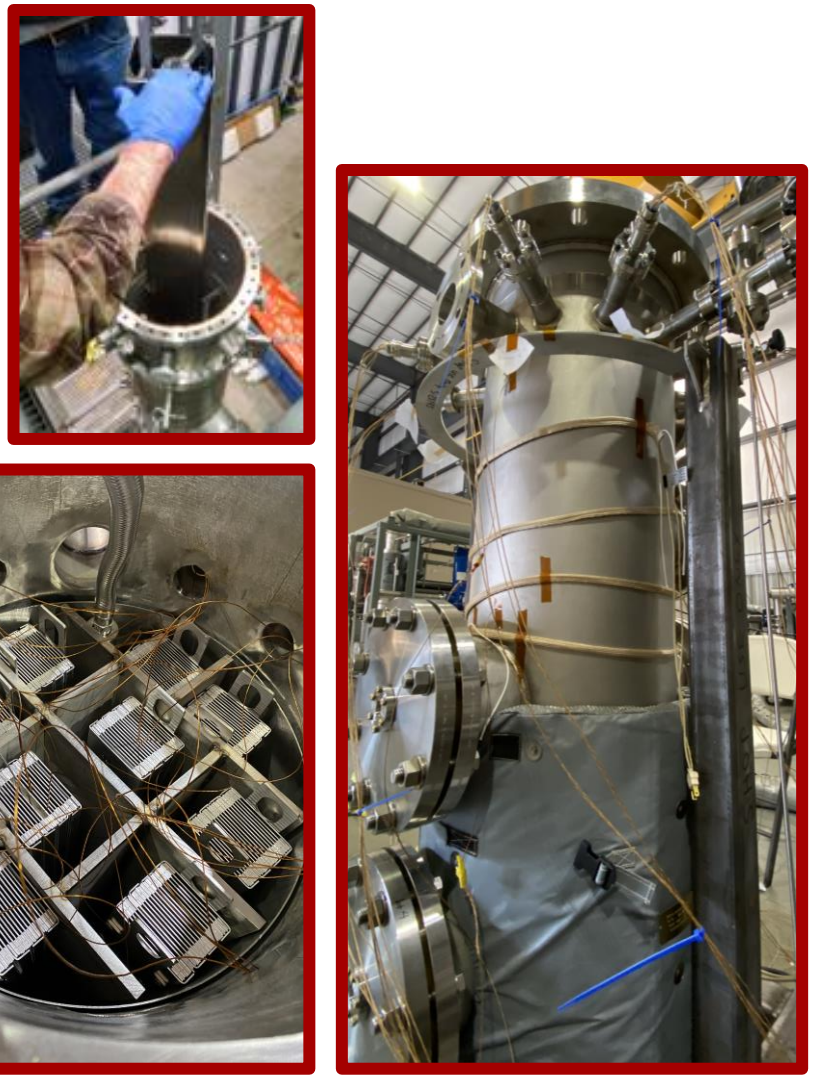
- Handling, inspection, treatment (drying), and storage of spent nuclear fuel.

Challenges:

- Managing diverse fuel types with varying compositions, enrichments, geometries, and materials.

Expertise:

- Experience with both commercial (Zr-clad) and defense-related (Al-clad) fuels.



Spent Nuclear Fuel Instrumentation

BACK END OF THE FUEL CYCLE CONT.

Monitoring:

- Development of wireless sensors for monitoring spent nuclear fuel conditions.

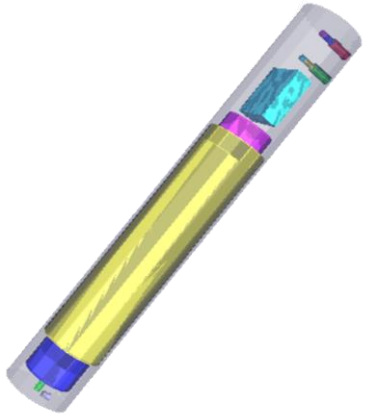
Safety:

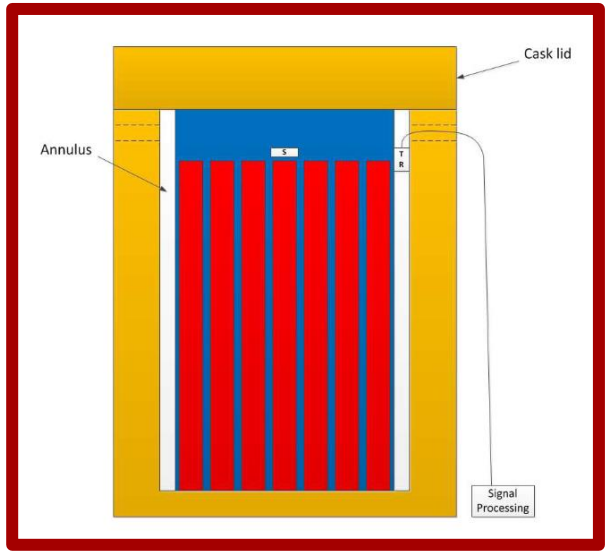
- Boral research to ensure subcriticality for safe fuel storage.
- Investing in new technologies to reduce the volume, toxicity, and environmental footprint of nuclear waste.

Public Confidence:

- Building trust and shaping perception of nuclear waste.
- Building public trust through education and transparent communication about nuclear safety.

Boral degradation examination





Wireless sensor for monitoring spent nuclear fuel storage

ADVANCED NUCLEAR WASTE FORMS

Focus:

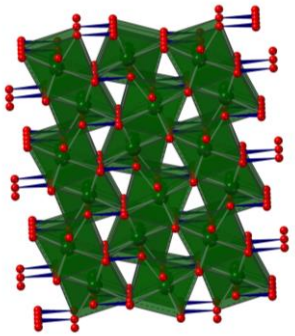
- Developing advanced nuclear waste form materials for Np, Pu, Am, Cs.

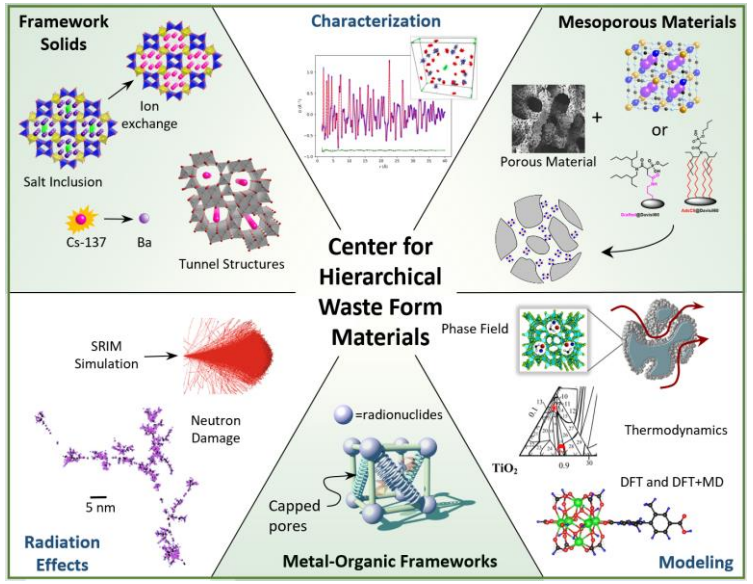
Capabilities:

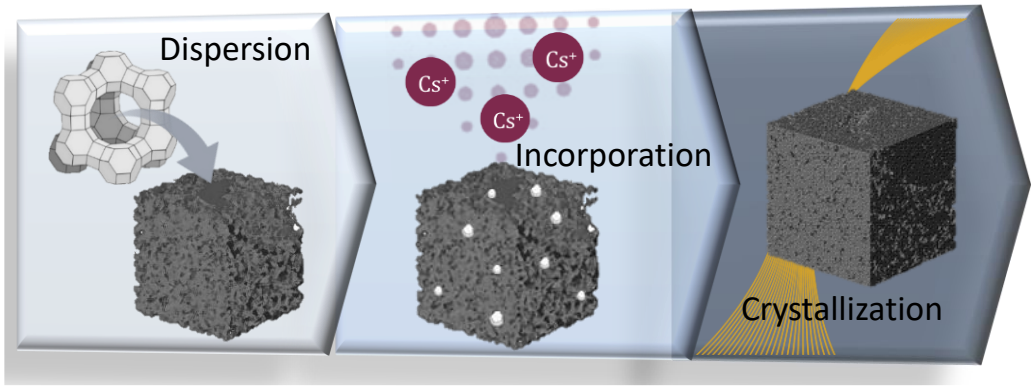
- DOE-funded *Center for Hierarchical Waste Form Materials* at USC focused on new actinide materials for waste sequestration.

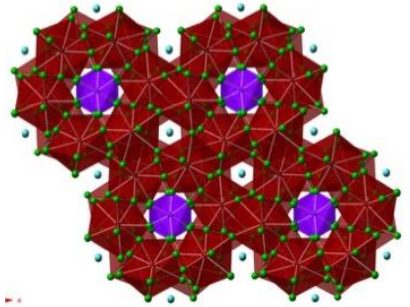
Expertise:

- Crystal growth of resilient novel transuranic-containing materials. [Collaboration between Molinaroli CEC and College or Arts and Sciences].









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ADVANCED NUCLEAR FUELS

Accident-tolerant Fuels:

- Developing fuels that can enhance reactor safety and withstand extreme conditions.
- Analyzing fuel behavior under accident scenarios to validate performance.
- Providing empirical data to inform fuel performance codes and support regulatory qualification.

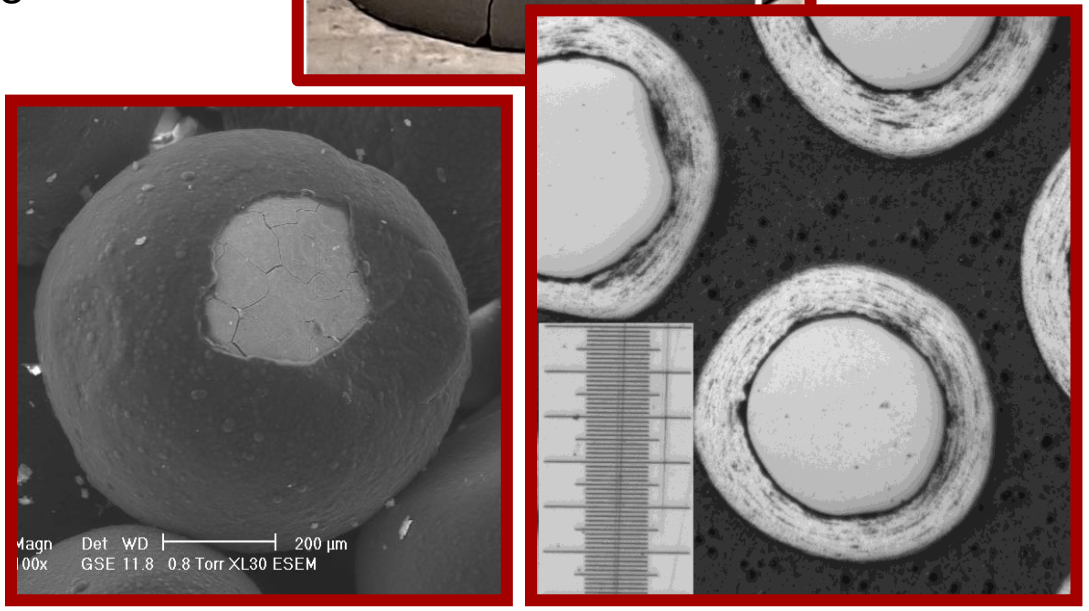
Advanced Coated Particle Fuels:

- Enhance reactor safety by containing fission products within the fuel particle.

Ceramic Fuels:

- High-temperature and radiation resistant.
- Commercial applications (Uranium Nitrides).
- Space applications (Uranium Carbide).

Accident-tolerant Analysis of WEC ADOPT Nuclear Fuel



Coated Particle Fuels Produced at USC

ADVANCED NUCLEAR FUELS CONT.

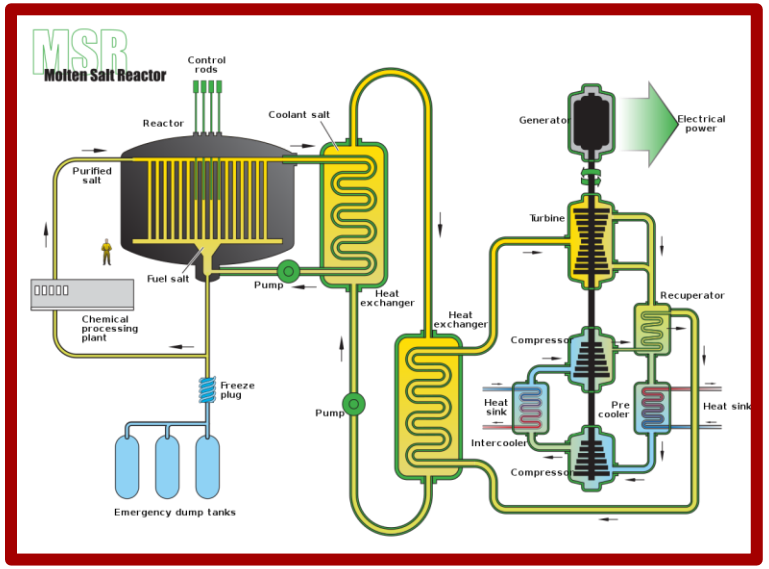
Molten Salt Research:

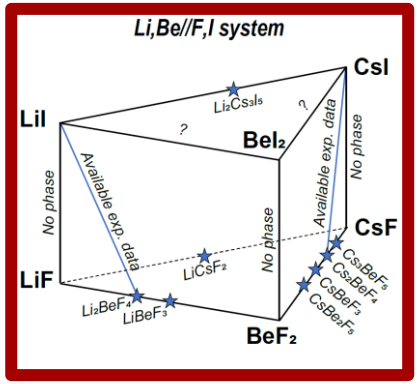
- Modeling thermochemistry of complex salts and building a database as an international resource.
  - *Molten Salt Thermal Properties Database-Thermochemical* is a USC-copywritten library of chemical thermodynamic values.
- Has become widely recognized/utilized.

Applications:

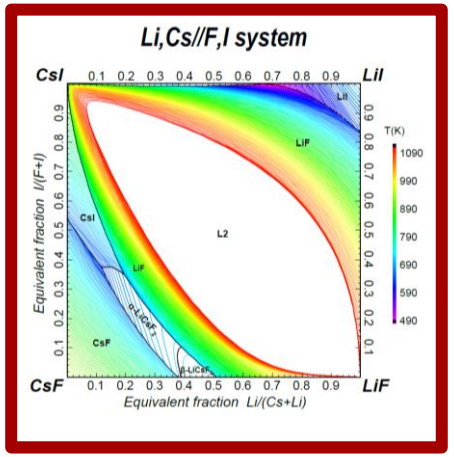
- **Thermodynamic calculations:** Prediction of salt thermal behavior, including coupling salt state calculations with reactor behavior modeling.
- **Fuel Processing:** Pyro-processing, elemental separations, and actinide purification.

Conceptual Commercial Molten-salt Reactor (MSR)





Computed compound formation



Computed precipitation temperatures for salt compositions

MODELING AND SIMULATION

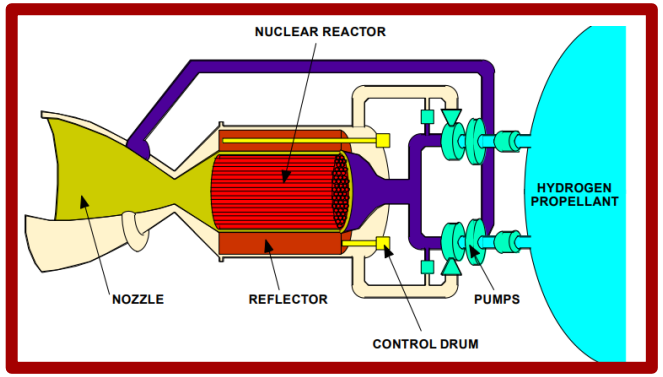
Advanced Reactor Design and Analysis

- Transportable Reactors (SMRs/Microreactors)
- Nuclear Thermal Propulsion

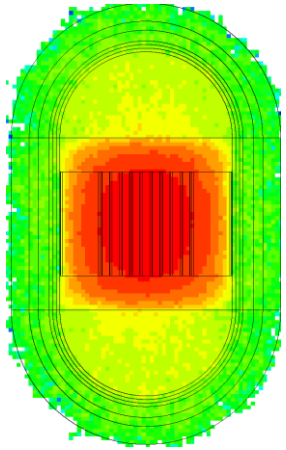
Safety Analysis

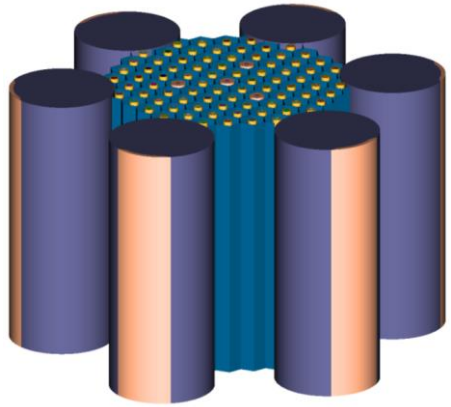
- Accident Scenarios
- Radiological Site Assessments

Nuclear Thermal Rocket Design

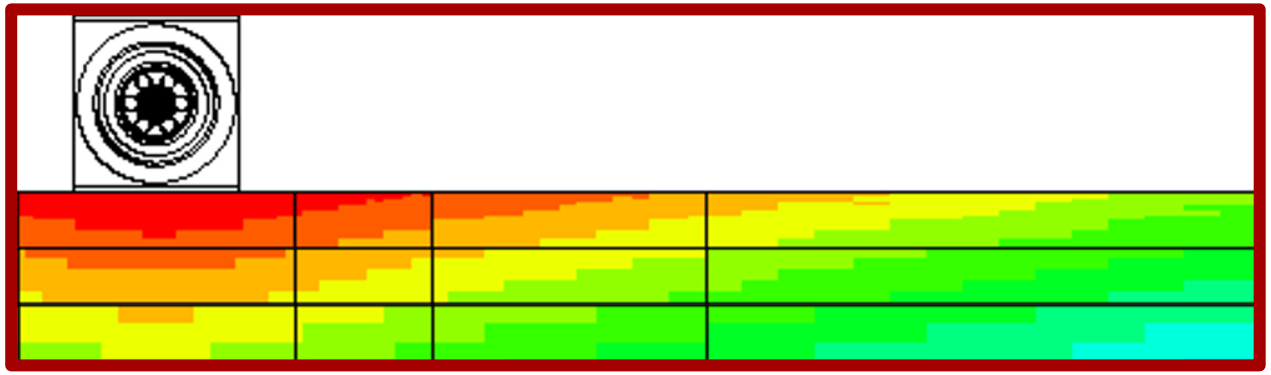


Reactor Physics Model

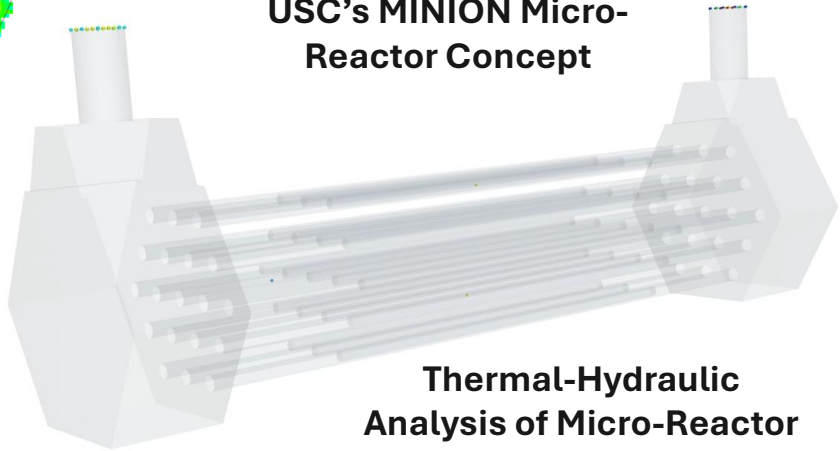




USC's MINION Micro-Reactor Concept



Radiological Site Assessment of Transportable Micro-Reactor



Thermal-Hydraulic Analysis of Micro-Reactor

MODELING AND SIMULATION

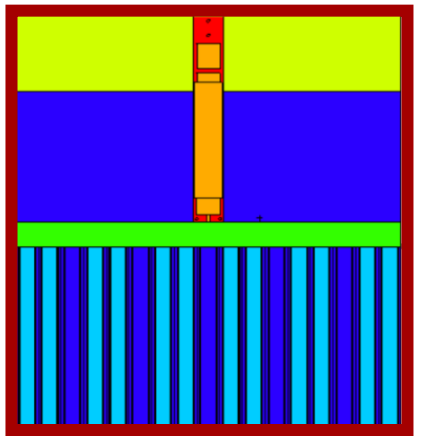
Fuel Performance Modeling

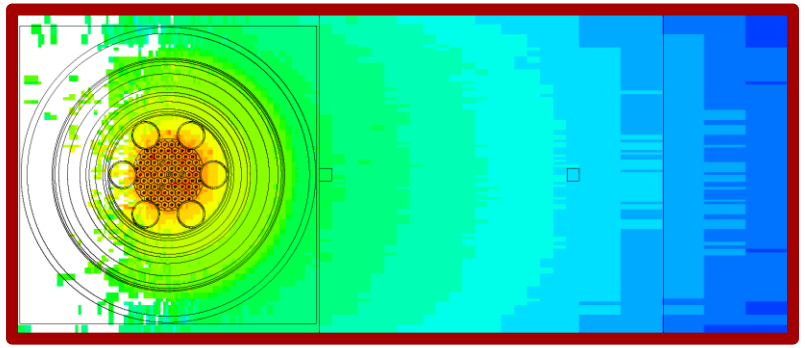
- Advanced Fuels (ADOPT, U-C, U-N, U-Si)
- Molten Salts

Radiation Shielding Design and Analysis

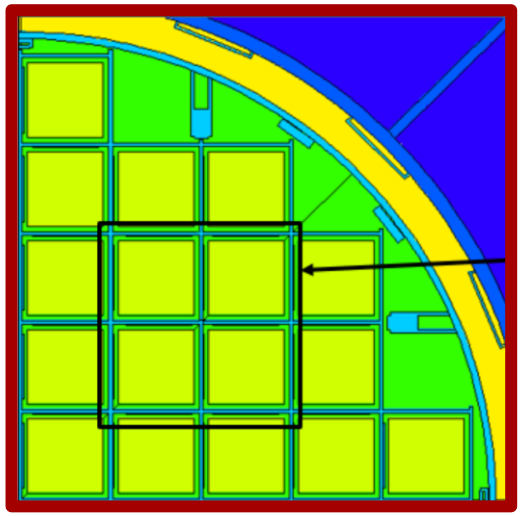
- Transportable Reactors
- Spent Nuclear Fuel Storage
- Spent Nuclear Fuel Instrumentation

Radiation Shielding Design of Wireless Sensor for SNF Storage

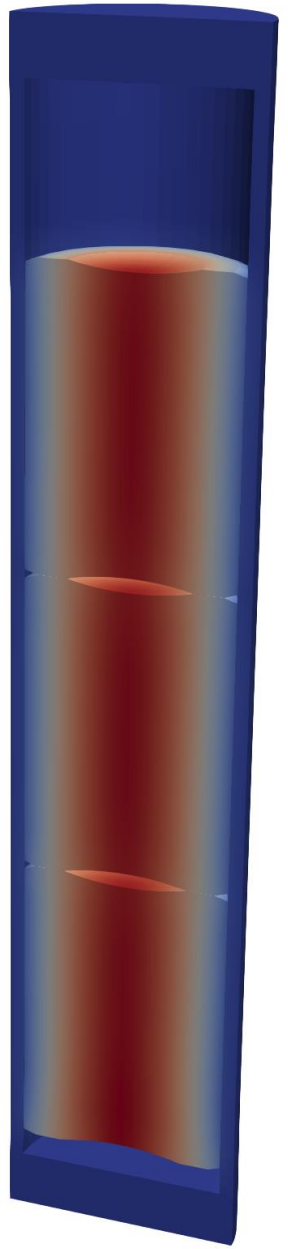




Radiation Shielding Design Analysis of Transportable Reactor



Radiation Analysis of Spent Nuclear Fuel Storage



Fuel Performance Model

COLLABORATIONS AND PARTNERSHIPS

National Labs:

- Savannah River National Laboratory (SRNL).
- Idaho National Laboratory (INL).
- Argonne National Lab (ANL).
- Oak Ridge National Lab (ORNL).
- Sandia National Lab (SNL).

Government:

- NASA.
- NRC.
- Savannah River Site.

Industry:

- Westinghouse Electric Company.
- Orano Group.
- Framatome.
- Antares.
- Terrestrial Energy.
- Holtec International.
- Metatomic.

IMPACT ON SOCIETY

- Developing fuels for next generation reactors.
- Enhancing nuclear safety and efficiency.
- Advancing space exploration through nuclear propulsion research.
- Supporting national security and non-proliferation efforts.
- Commitment to workforce development and education.

THANKS!

QUESTIONS?

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