OAK RIDGE National Laboratory

High-Value Research and US NRC Interactions for Nuclear Energy

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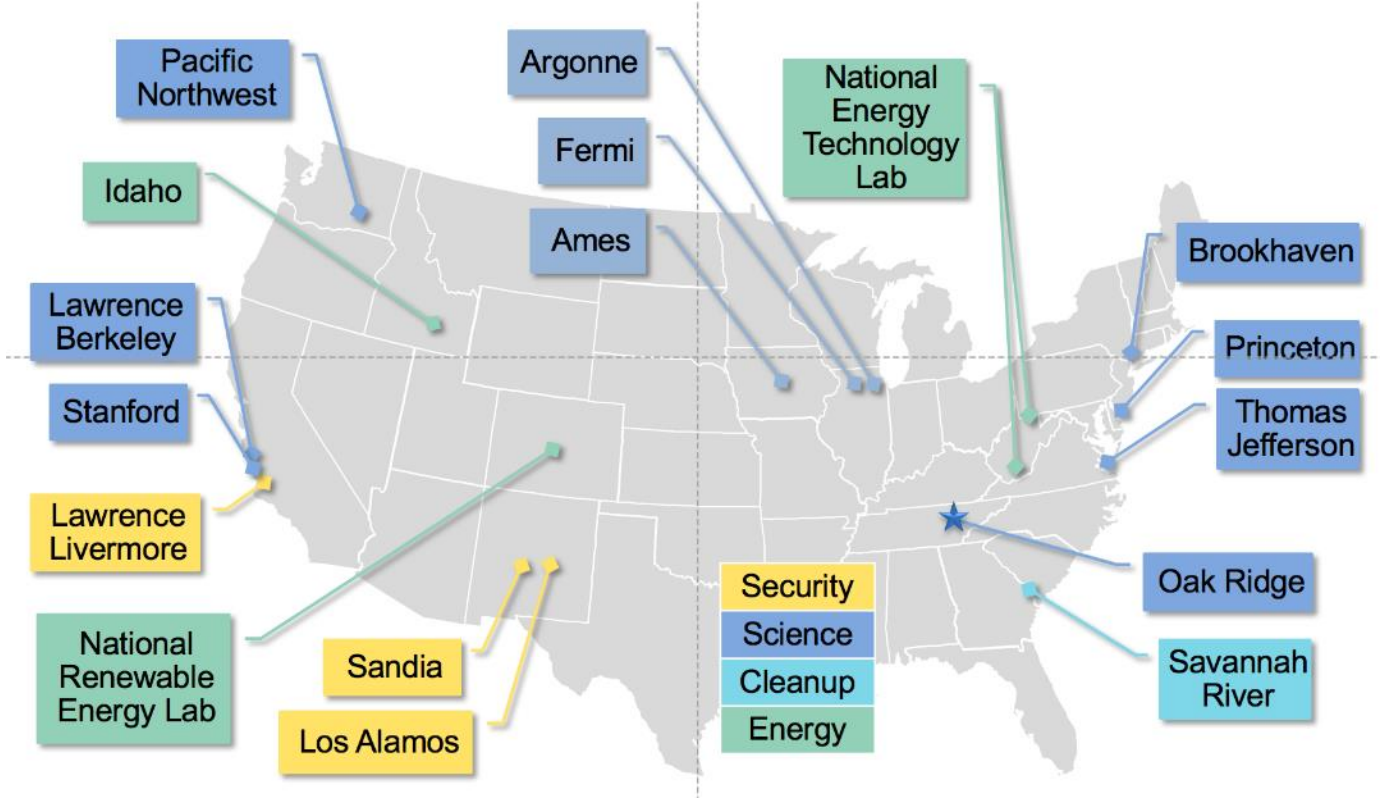
ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

The national laboratories have a unique role in energy research in the United States

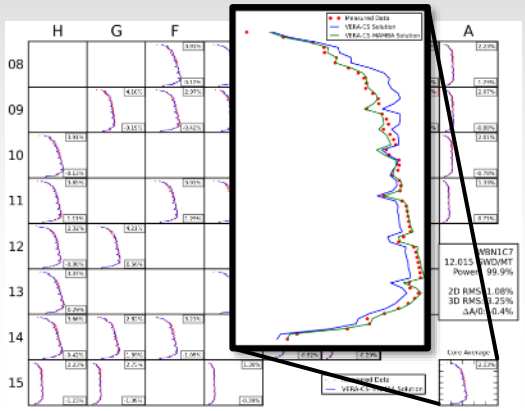
- The national laboratories perform research for many national interests.
  - Basic and fundamental properties
  - New innovations and applied research

- Combining basic to applied research can accelerate innovation and efficiently support deployment for nuclear energy.
- Partnerships, collaborations, and support with the US NRC provides an avenue for cost- and time-effective research to make meaningful impacts.



Basic-to-applied research has the power to advance and accelerate reactor technology deployment

VERA Core Simulator uses coupled codes to accurately predict CRUD induced power shift



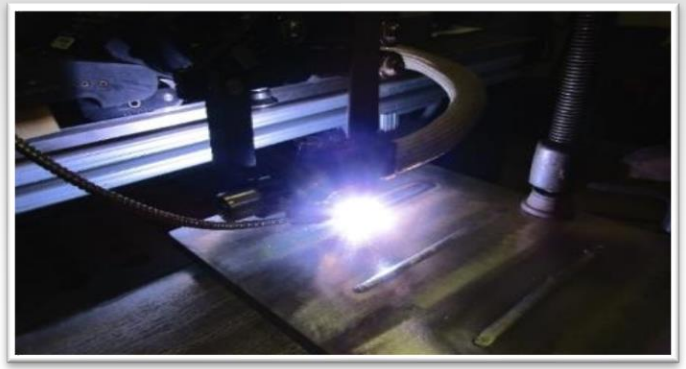
Domestic loss-of-coolant accident test capability was re-established and demonstrated

New approaches shorten the development and qualification cycle

TRIstructural-ISOtropic (TRISO) fuel pebbles

Chloride salt purification system was conceived, built, approved for use, and operated in a 3-month period

New remote weld repair developed to remediate nation's aging spent nuclear fuel canisters



Accident-tolerant fuel (ATF) FeCrAl cladding

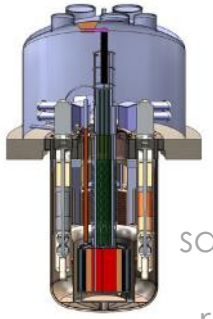
Industry is actively pursuing advanced reactor concepts (including molten-salt reactors (MSR's))

Intrinsically safe designs, lower costs, high burnup, minimal waste

Retain or increase electricity baseload in lieu of retiring light water reactor fleet

Achieve greenhouse gas reductions and clean air goals

TerraPower

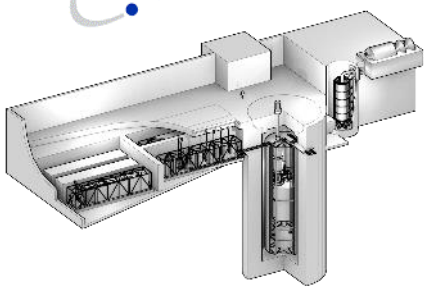


salt-fueled fast reactors

TERRESTRIAL ENERGY

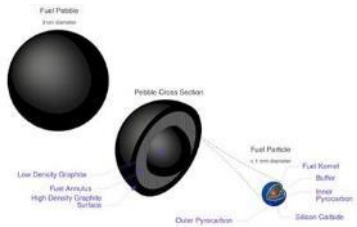
Integral molten salt thermal reactor

Flibe ENERGY



Liquid fluoride Thorium thermal reactor

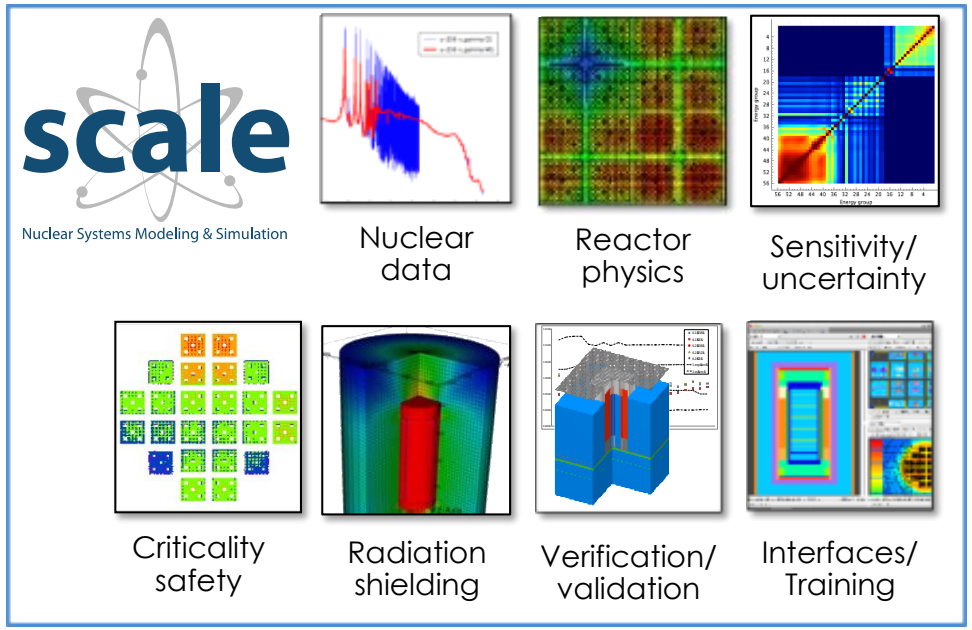
Kairos Power



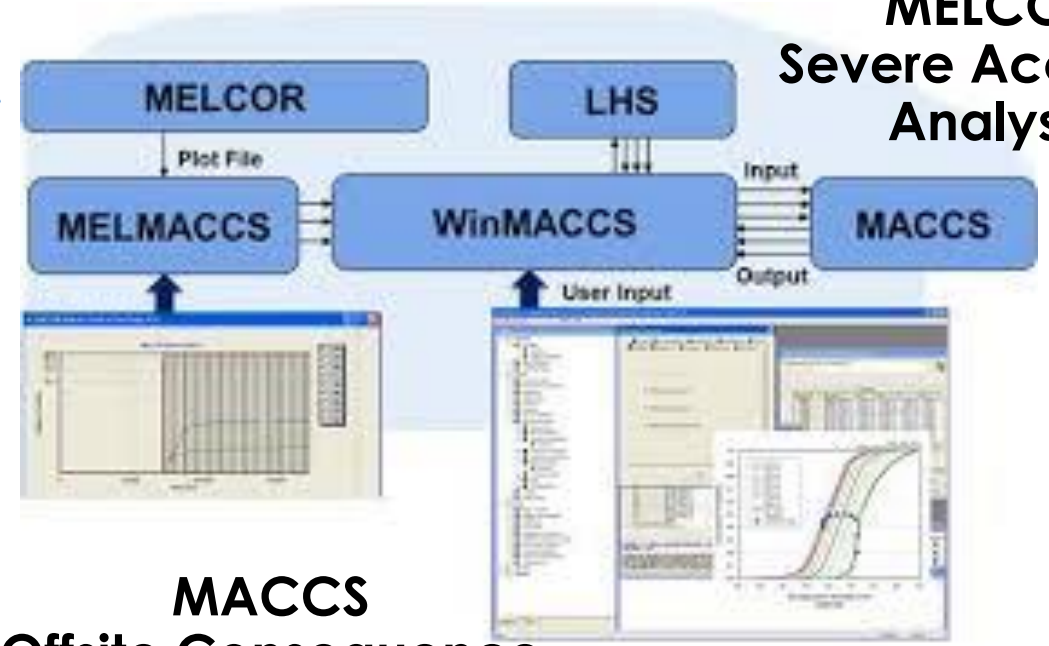
Liquid fluoride cooled thermal reactor (FHR)

- Interactions between US NRC, developers, and customers are developing a common understanding and expectations (e.g. gap analysis report and phenomena-identification and ranking table (PIRT) processes).
- New capabilities help developers successfully develop and license MSRs (e.g. design and licensing workshops).
- Developing MSR specific design criteria though ANS 20.2 and other key regulatory bodies supports future deployment.

National laboratories are partnering with NRC to extend codes, data, validation, and methodologies to enable reviews of accident tolerant fuels and non-LWRs



MELCOR
Severe Accident Analysis

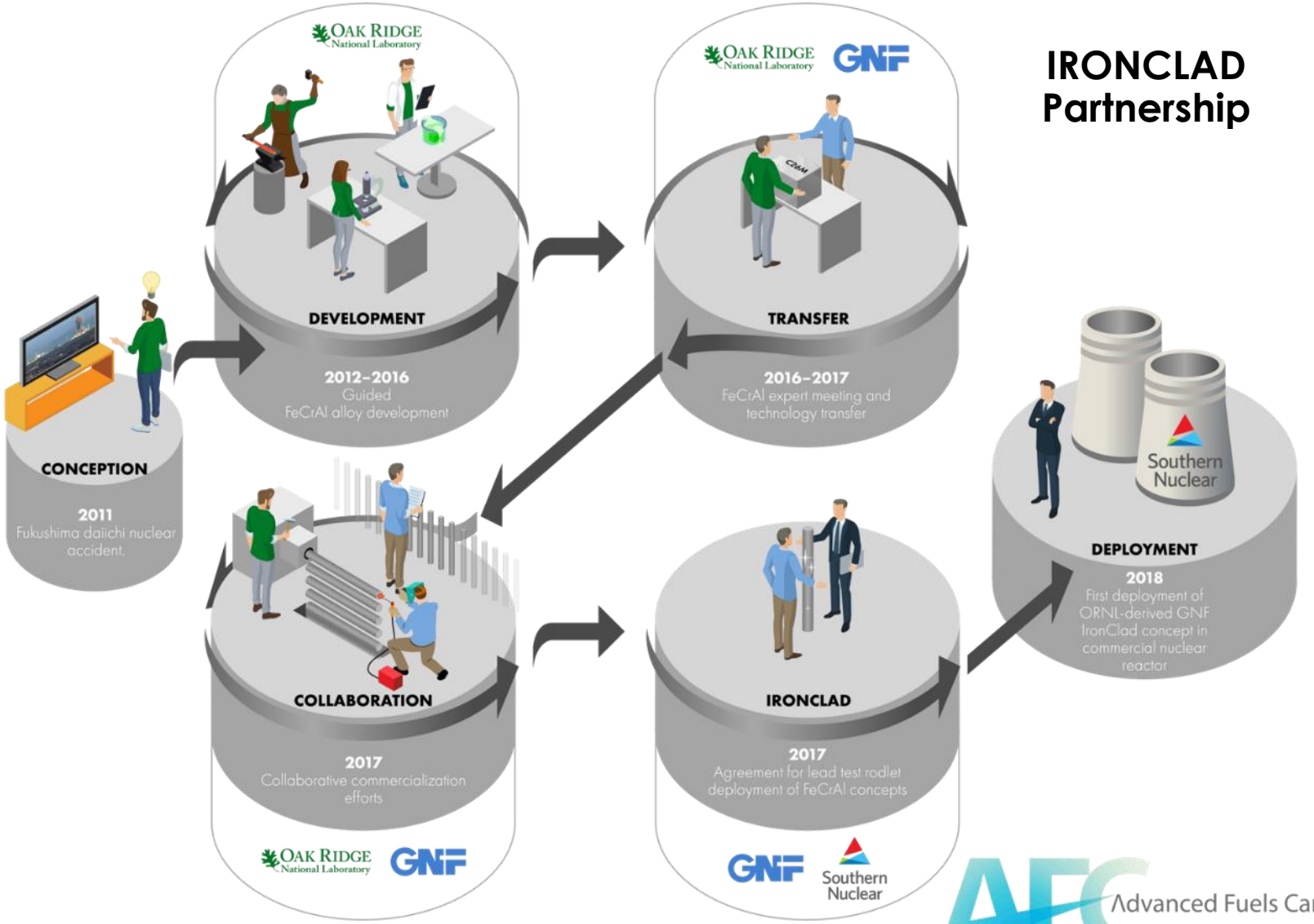


MACCS
Offsite Consequence Analysis

- Experimental coupling and validation are essential to any tool development.
- Combined, these validated codes provide tools for understanding, mitigating, and preventing accident scenarios.

National laboratories are now pushing low-TRL level technologies to deployment through industry support

- ORNL developed and GE-Hitachi deployed ATF cladding technology based on FeCrAl alloy
- Increased accident tolerance without sacrificing normal operation
- First non-Zr based fuel clad inserted into a LWR in decades
- Data is compiled in materials handbook
- Provides unique training and collaboration opportunity with US NRC Staff



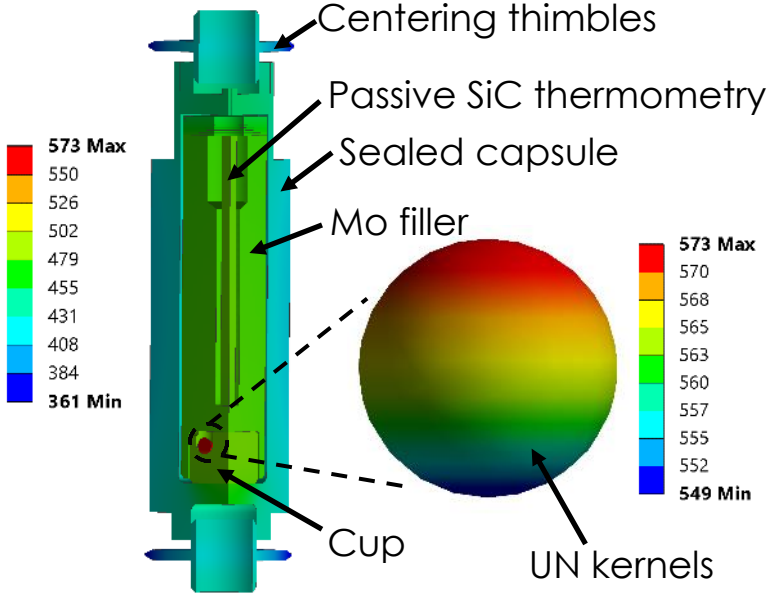
IRONCLAD Partnership

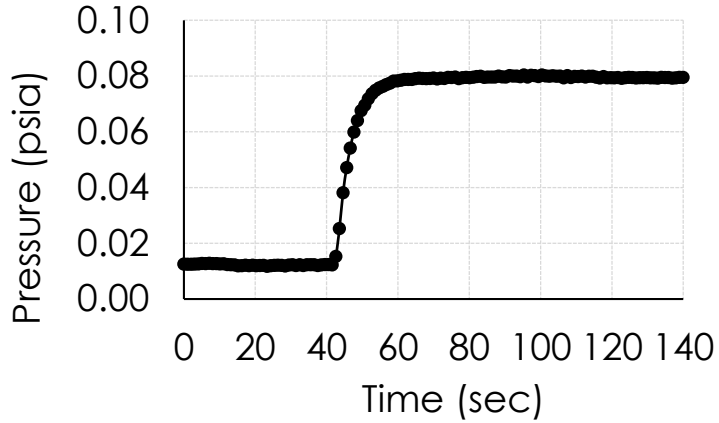
OAK RIDGE National Laboratory

AFC Advanced Fuels Campaign

New "mini-fuel" experiments may provide insights into high-burn up performance

- The new testing capability simplifies experiment design and analysis—accelerating fuel qualification and enabling understanding of basic nuclear fuel behavior.
- Approach minimizes variables and experimental uncertainty, leading to higher quality data.
- First tests focused on fission gas release and swelling of uranium nitride fuel for light water reactors—a fuel lacking any current performance data.



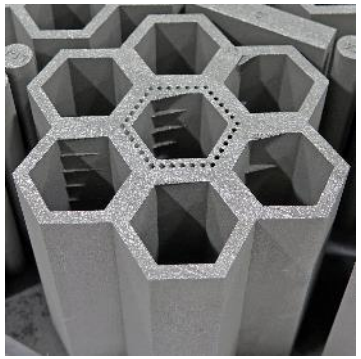


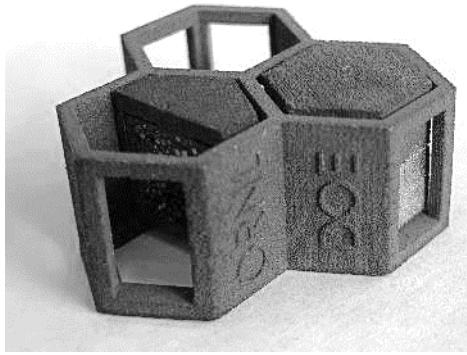
Pressure rise during puncturing

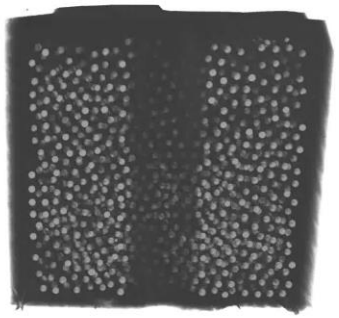
In-cell puncturing apparatus for measuring fission gas release of first MiniFuel capsule

Advanced tools have the potential to accelerate future innovations in nuclear

- Modern tools in other fields have greatly expanded the "state of the art."
  - Advanced manufacturing
  - Artificial intelligence
  - Advanced sensors and controls
- These tools may dramatically reduce deployment costs and timelines of nuclear energy systems while maintaining safety and simplifying operations.
- Collaboration with the US NRC is an opportunity to identify gaps in adoption of these new methodologies.
  - Code qualification/standards
  - Big data needs
  - Licensing







- Science and technology research at the national laboratories is driving new innovation in nuclear energy as new tools become available in other fields.
  - Advanced reactor designs
  - Accident tolerant fuels
  - Many other areas
- State of the art tools may further improve safety, efficiency, and economy of nuclear power.
- Engaging with the US NRC is welcome and mutually beneficial.