U.S. DEPARTMENT OF ENERGY
Nuclear Energy

LANL Civilian Nuclear Programs

What begins here truly changes the world!

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Extended Summary

My name is Dr. Dasari V. Rao. I received my Ph. D in Nuclear Engineering from the University of New Mexico (1990). I also taught briefly at UNM and continued collaborative research at UNM. I served in different senior management positions at LANL. I am presently Office Director for the Office of Civilian Nuclear Energy Programs. We strongly leverage Nuclear Weapons Program investments into nuclear infrastructure and work closely with other National Laboratories to perform exciting research and development.

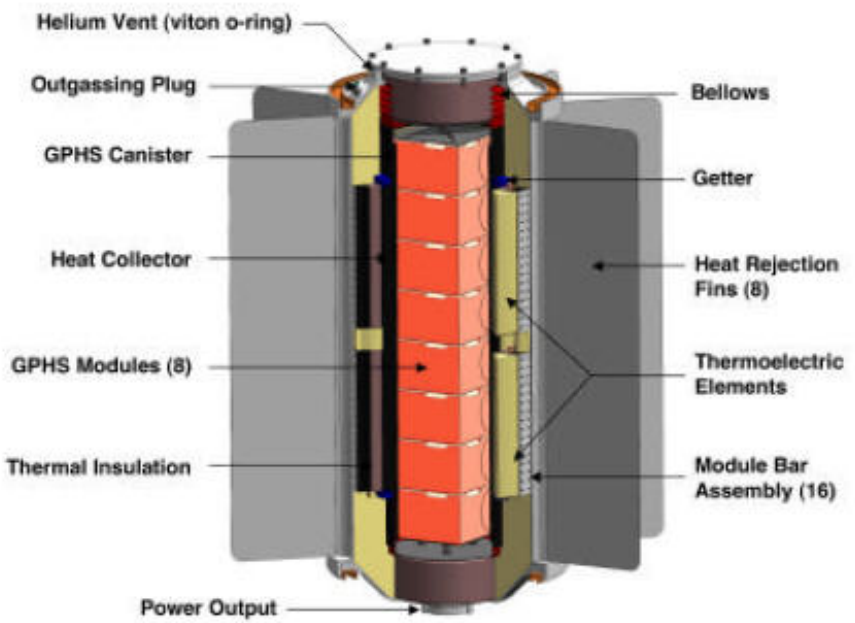
Our R&D spans some very important areas of national and global importance. First, we make small compact nuclear power sources that have powered numerous spacecraft – almost all planetary missions are powered by our technology. We are making great strides into improving these power sources to provide higher power for NASA missions.

Coming back to earth, our work spans entire nuclear fuel cycle. I will chose however to talk about two areas: (1) Accident tolerant fuels and (2) Multi-Physics Modeling and Computer Simulations of Nuclear Reactors. Both these are growing programs aimed at transforming the types of fuels used in this and future generations (Gen 3+) of Light Water Reactors.

Even closer to home, we have tools, technologies, and experts ready to assist our great state to examine and ultimately build Small Modular Reactors. In the past we have performed siting studies for SMRs in NM. Similarly we also recognize the important role NM communities could play in Used Fuel Disposition; we stand by to assist these communities partnering through LANL's NM Consortium.

Our Compact Nuclear Sources Power the Spacecraft

- Heat Produced from natural alpha decay of 238Pu is directly converted to electricity using thermo-electrics (6-8% efficiency).
- In some applications heat is directly used for keeping components warm.
- We (US and Western Europe) face shortages in 238Pu. We are working with DOE and NASA to identify alternatives.

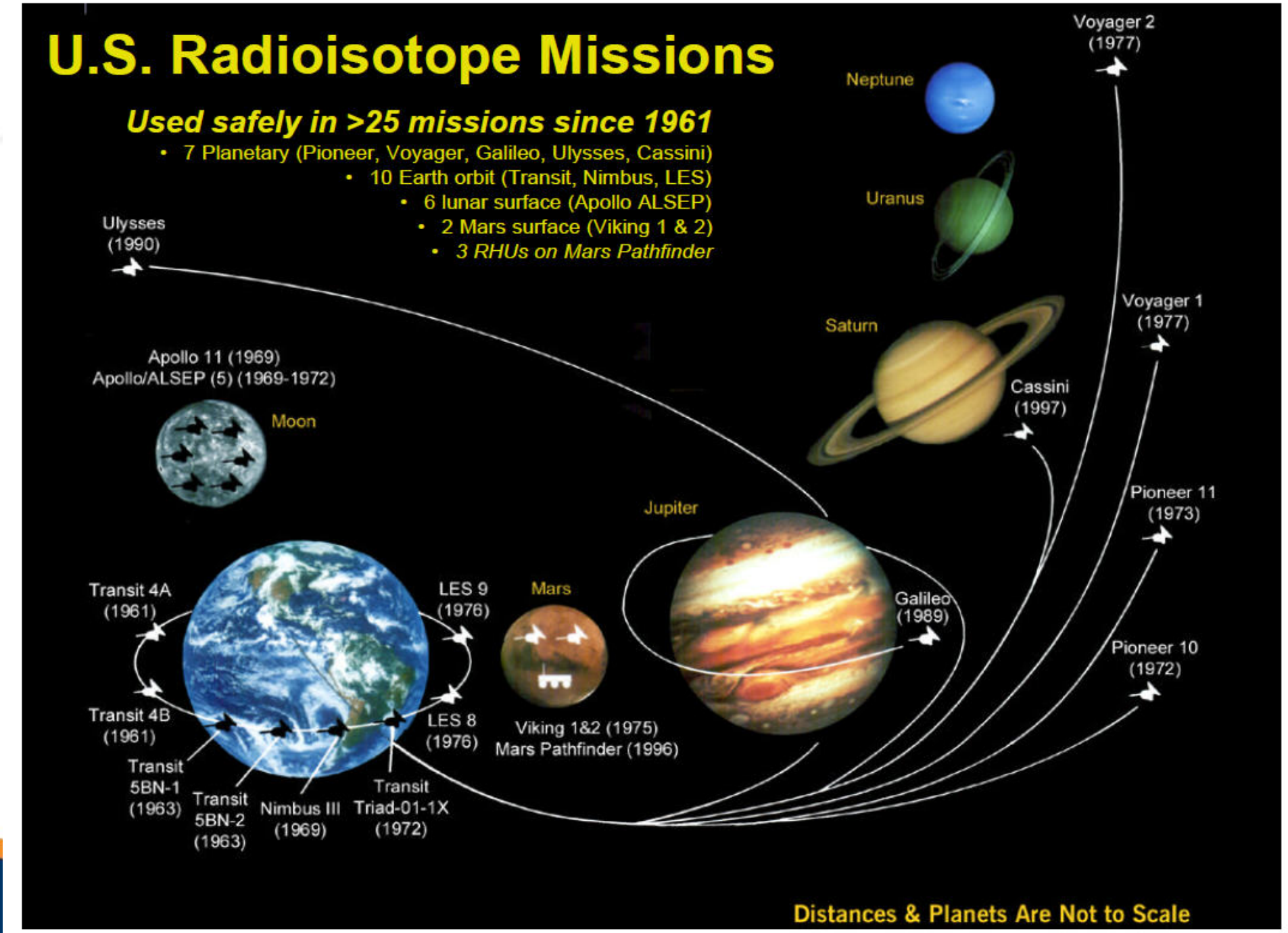


MMRTG Configuration

U.S. Radioisotope Missions

Used safely in >25 missions since 1961

- 7 Planetary (Pioneer, Voyager, Galileo, Ulysses, Cassini)
- 10 Earth orbit (Transit, Nimbus, LES)
- 6 lunar surface (Apollo ALSEP)
- 2 Mars surface (Viking 1 & 2)
- *3 RHUs on Mars Pathfinder*



We conduct R&D across the nuclear fuel cycle

Front End

Back End

Uranium Resources

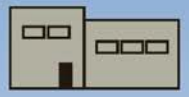
- U from seawater
- ISR of U

Fuel Fabrication

- Ceramic fuels
- Core materials
- PIE

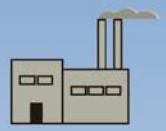
Reactors

- NEAMS
- CASL
- SMR



Interim Storage

- Corrosion
- NDE methods
- Used fuel security



Recycle

- Separations
- Waste forms

Disposal

- Geology
- Geomaterials
- Disposal models
- Salt thermal test

MPACT: Next generation nuclear materials management

Modeling and Simulation for Nuclear Energy

CASL – The Consortium for Advanced Simulation of Light Water Reactors

Core Partners

LANL's Role CASL

Leverage

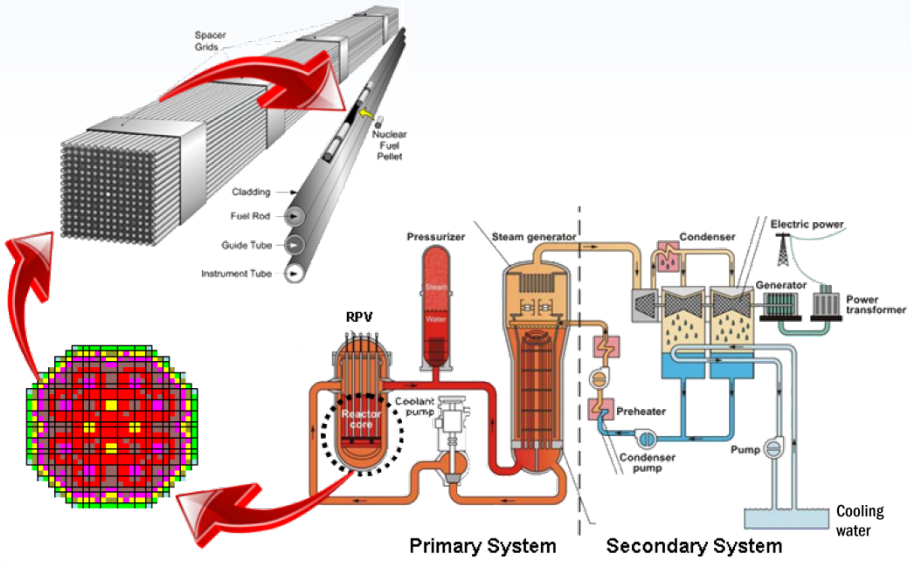
- Current state-of-the-art neutronics, thermal-fluid, structural, and fuel performance applications
- Existing systems and safety analysis simulation tools

Develop

- New requirements-driven physical models with efficient, tightly-coupled multi-scale/multi-physics algorithms and software with quantifiable accuracy
  - Acting THM Focus Area Lead
  - FMC Focus Area Lead Improved systems and safety analysis tools
- UQ framework

Deliver

- An unprecedented predictive simulation tool for simulation of physical reactors
- Architected for platform portability ranging from desktops to DOE's leadership-class and advanced architecture systems (large user base)
- Validation basis against 60% of existing U.S. reactor fleet (PWRs), using data from TVA reactors
- Base M&S LWR capability



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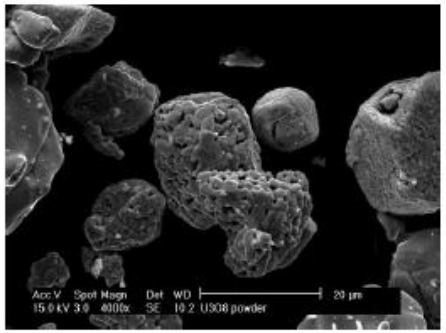
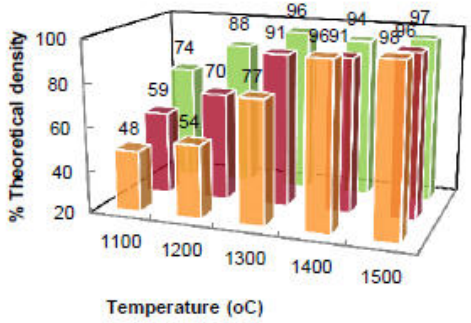
Advanced and Accident Tolerant Fuels

A fundamentally different approach to synthesizing, fabricating and qualifying nuclear fuels

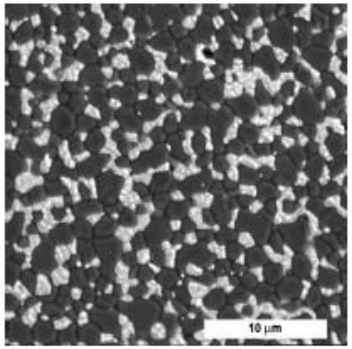
Working closely with DOE/NE and Westinghouse Nuclear to bring these fuels to the industry

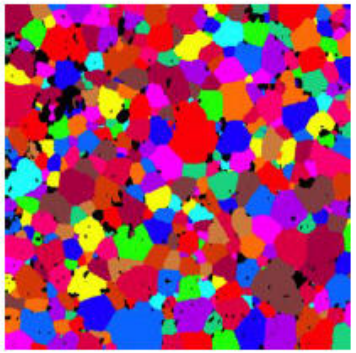
Processing



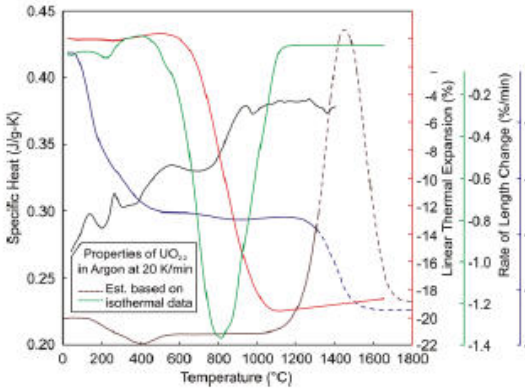


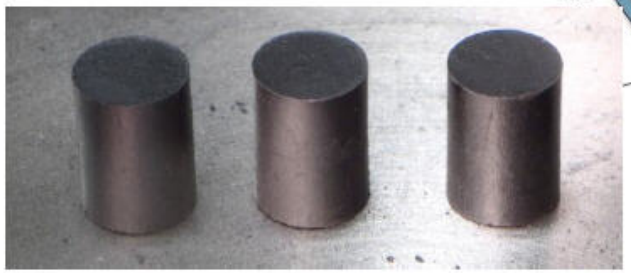
Structure



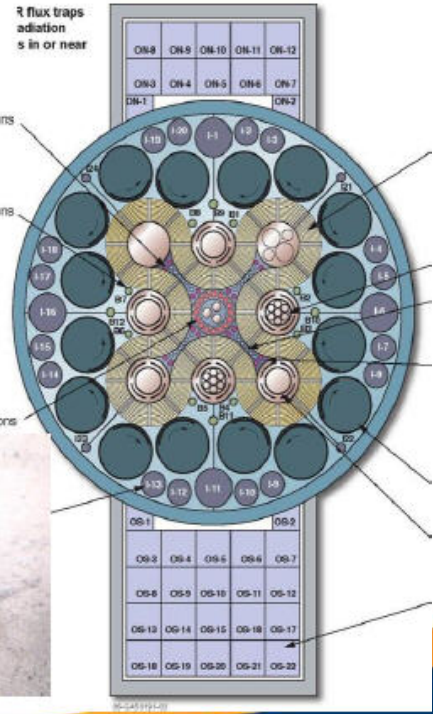


$T_m, C_p, \kappa, \lambda, C_{ij}$, etc





In-pile Performance



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Small Modular Reactors

Many concepts. What's best for NM's economy?

- Technology & Licensing readiness
- Water use
- Load following
- Electric Network
- Role in fabrication and supply chain