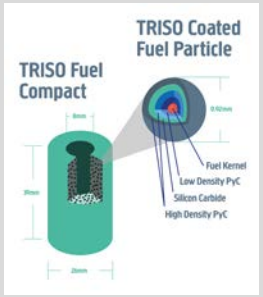
Tim Abram
University of Manchester, representing URENCO / U-Battery

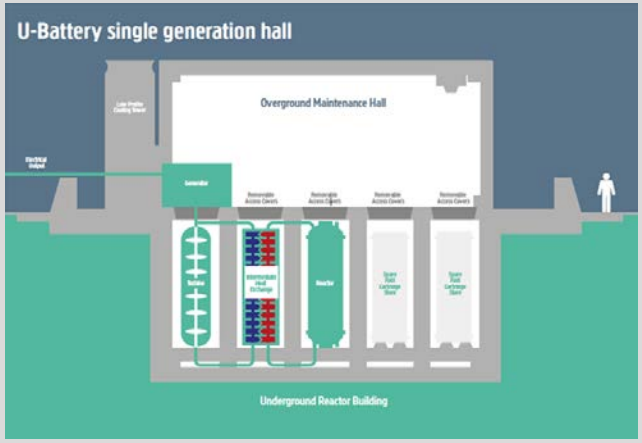
Tim Abram
Professor of Nuclear Engineering / Consultant

Prof. Tim Abram has held the Westinghouse Chair in Nuclear Engineering at the University of Manchester for 8 years. Previously he worked for over 20 years in the nuclear fuel industry in the UK and USA. He is Director of the UK Nuclear Fuel Center of Excellence and of the Rolls-Royce Nuclear Technology Center.

- Gather information on current activities and future prospects for ≤ 10 MWe SMRs in the US.
- Share perspectives for technical, commercial, and regulatory developments needed for deployment of ≤ 10 MWe SMRs in the US, UK, and elsewhere.

Technology Overview





The U-Battery is a 10 MWt (4 MWe) HTGR employing TRISO coated particle fuel within a prismatic core. The plant utilizes proven components and is designed for semi-autonomous operation between 5-year refueling outages. The He primary coolant transfers 750ºC heat via an intermediate heat exchanger to a N_2 secondary circuit employing a gas turbine. The small size and TRISO fuel form provides both inherent safety and excellent proliferation resistance, and no refueling equipment is stored on site. The project consortium is led by Urenco and includes AMEC-FosterWheeler, Atkins, Cammell-Laird, and Laing-O'Rourke.

Todd Allen
Idaho National Lab / Third Way

- Senior Fellow at Third Way
- Deputy Director for S&T at INL
- Professor University of Wisconsin
- Argonne National Laboratory-West
- U.S. Navy Nuclear Power Program.

- Understanding range of options to which nuclear can support
- Identify policy and technical (material science) needs

Technology Overview

Optional: Describe your technology relevant to this workshop in a few bullets and add a summary graphic if possible.

Yasir Arafat
Westinghouse Electric Company LLC

Yasir Arafat

Senior Innovation Engineer

Yasir Arafat is currently an Innovation Project lead at Westinghouse R&D. He has 6 years nuclear industry experience in innovation and systems design of nuclear reactors such as Westinghouse SMR and AP1000. He submitted 13 patent disclosures, of which 4 were filed. His areas of expertise lies in nuclear systems & product design, development and qualification testing to drive innovation products from concept to market

- Contribute information to ARPA-E to inform a potential new ARPA-E program on nuclear fission energy
- Guide the attributes of the Micro Reactor that can lead to the integration of nuclear in the modernized grid. Discuss technology, market, & licensing challenges

Technology Overview

Why should Nuclear play as a Decentralized Generator (DG) ?

- Socioeconomic Drivers for DG: resilient, reliable, efficient, cost effective, flexible and sustainable energy supply
- Government Policies plays a influential role in the shift to DG
- Utilities are investing capital in efficiency / demand reduction efforts, and T&D to integrate renewables and DG
- Nuclear currently does not play in DG market, which makes it a potential opportunity in accordance with Westinghouse's "Right to Grow" strategy

Stephen Bell, Naval Reactors

Director of OHIO Replacement submarine reactor design. 27+ years delivering and maintaining new reactors and reactor technologies for US Navy ships and NASA Project Prometheus.

Review compact reactor concepts and provide perspective on challenges and constraints for small nuclear power plants.

Technology Overview

Naval Reactors is a joint Department of Navy/Department of Energy organization responsible for R&D, design, delivery, and disposal of nuclear propulsion plants for ships.

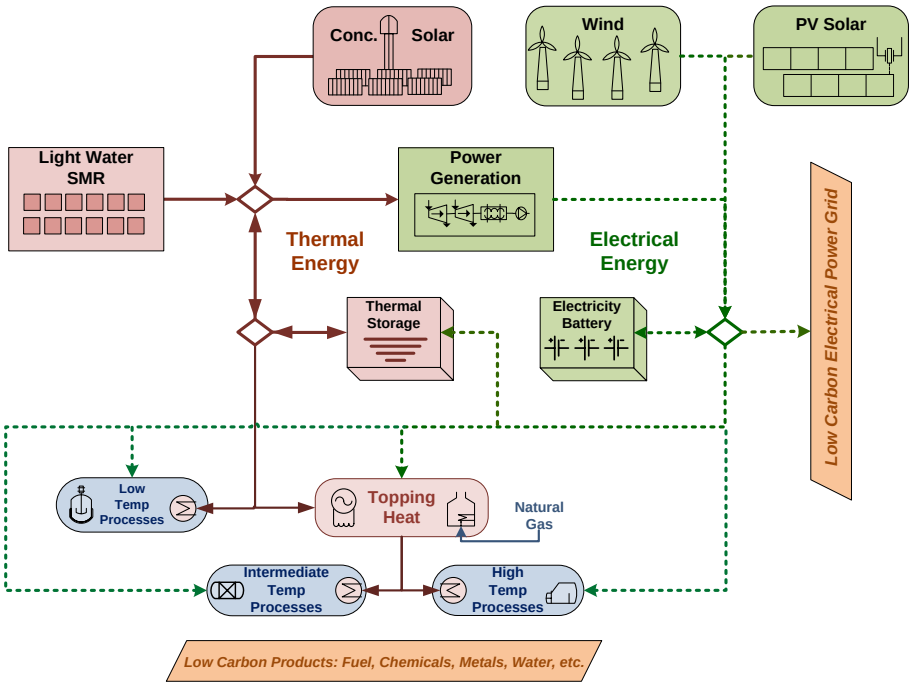
Shannon Bragg-Sitton
Idaho National Laboratory

Idaho National Laboratory

Dr. Shannon Bragg-Sitton currently serves as the Deputy National Technical Director for the DOE-NE Advanced Fuels Campaign. She also leads R&D for novel Nuclear-Renewable Hybrid Energy Systems under the DOE-NE Crosscutting Technologies Program.

- Share previous experience in the design, analysis, and nonnuclear testing of ultra-small fission systems for space nuclear power and propulsion and terrestrial applications
- Define the use case for and explore the potential of MW-class fission reactors for terrestrial applications

Technology Overview



Hybrid energy systems that seek to optimize the use of low-carbon energy sources to meet grid electricity and industrial energy needs are being investigated for small modular reactors. This concept can be translated to microreactors installed in remote regions to ensure that energy sources are used efficiently and electrical and thermal energy needs are met reliably.

Jacopo Buongiorno

Massachusetts Institute of Technology (MIT)

Education

Polytechnic of Milan	Nuclear Engineering	B.S.	1996
Massachusetts Institute of Technology	Nuclear Engineering	Ph.D.	2000

Professional Experience

2015-	**Associate Department Head, Nuclear Science and Engineering, MIT**
2015-	**Director, Center for Advanced Nuclear Energy Systems (CANES)**
2015-	**Professor of Nuclear Science and Engineering, MIT**
2011-	**Accreditation Board - National Academy of Nuclear Training (NANT)**
2011-2012	Special Committee on Fukushima, American Nuclear Society
2008-2015	Associate Professor of Nuclear Science and Engineering, MIT
2004-2008	Assistant Professor of Nuclear Science and Engineering, MIT
2000-2004	Research Scientist, Idaho National Laboratory

Awards and Honors

- Ruth and Joel Spira Award for Distinguished Teaching, School of Engineering, 2015, 2011 and 2006.
- MacVicar Award for Excellence in Undergraduate Teaching, MIT, 2014.
- Best Paper Award at the *9th Int. Topical Meeting on Nucl. Thermal-Hydraulics, Operation and Safety (NUTHOS-9)*, Kaohsiung, Taiwan, September 9-13, 2012.
- 2 most cited articles in Int J Heat Mass Transfer 2007-2012.
- Landis Young Member Engineering Achievement Award, American Nuclear Society, 2011.
- ASME Heat Transfer Division Best Paper, 2008.
- Best Paper Award at the 1st Micro/Nanoscale Heat Transfer Int. Conf., Tainan, Taiwan, January 6-9, 2008
- Junior Bose Award for Excellence in Teaching, MIT School of Engineering, November 2007
- Carl R. Soderberg Professor of Power Engineering Chair, MIT, July 2007-to present
- Graduate Teaching Award, MIT School of Engineering, 2005
- Norman C. Rasmussen Career Development Chair in Nuclear Engineering, MIT, 2004-2006
- Mark Mills Award for Best Nuclear Engineering Doctoral Thesis in the U.S., American Nuclear Society, 2001

Publications

76 journal articles, >150 conference paper, 4 patents

Alice Caponiti
DOE, Office of Nuclear Energy

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Ms. Caponiti is currently serving as the Director for Space and Defense Power Systems in the Office of Nuclear Energy's Office of Advanced Reactor Technologies. She also serves on the Experts Group for the Generation IV International Forum, a cooperative R&D framework to establish feasibility and performance capabilities of next generation nuclear systems.

- Understanding the potential for mega-watt sized nuclear power as an additional option for electricity generation and broader energy production.

Technology Overview

- The mission of the Department of Energy, Office of Nuclear Energy (DOE-NE) is to advance nuclear power as a resource capable of meeting the Nation's energy, environmental and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development and demonstration (RD&D).
- The mission of the Office of Space and Defense Power Systems is to provide nuclear power systems for space exploration and national security applications, through design, development, fabrication, testing and delivery, and to conduct safety assessments to support their use.

Sacit M. Cetiner
Oak Ridge National Laboratory (ORNL)

Sacit M. Cetiner
R&D Staff

Dr. Sacit M. Cetiner is an R&D Staff member in Advanced Reactor Systems and Safety at ORNL. His primary research focus is modeling and simulation of nuclear power systems, large-scale complex system optimization, and autonomous decision-making methods.

- Understand the mission and objectives of a potential ARPA-E program on fission energy systems
- Introduce recent design activities on small modular advanced reactors at ORNL

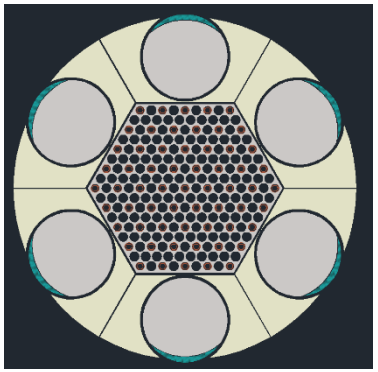
Technology Overview

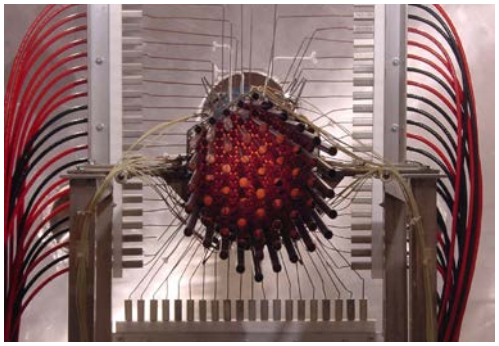
SmAHTR:
Small
Modular
Advanced
High-**T**emperature
Reactor

The Oak Ridge National Laboratory staff have invented and demonstrated multiple nuclear reactor classes. Recent areas of emphasis include both commercial and research reactors, as well as special-purpose reactors—such as space power and homogeneous reactors for medical isotopes.

ORNL has extensive experience in conducting technology gap analyses for new designs to develop technology development roadmaps and performing viability assessments to support down selection of reactor concepts.

Dasari V. (“DV”) Rao
Los Alamos National Laboratory





DV Rao is LANL Program Director for Civilian Nuclear Programs. He is also conducting research into nuclear fuels and nuclear testing requirements for micro- and advanced reactors

- Understand ARPA-E needs for nuclear prototyping and testing
- Understand potential for collaboration with other designers and developers.

High-Fidelity Nuclear Tests

- Sub-scale
- Full-scale
- Cross-sections
- Hot-Criticals
- Cold-Criticals
- Kinetics
- Rossi-Alpha
- Feed-Back

Leslie Dewan, Ph.D.
Transatomic Power

TRANSATOMIC

Leslie is the CEO of Transatomic Power. She received her Ph.D. in nuclear engineering from MIT, with a research focus on computational nuclear materials. She is a member of the MIT Corporation, MIT's board of trustees. She is a TIME Magazine "30 Under 30" and a World Economic Forum Young Global Leader.

- Domestic and international market scope for MW-scale nuclear reactors
- US regulatory and commercialization pathway for advanced small reactors

Technology Overview

Full-scale commercial product is a 520 MWe molten salt reactor consuming both spent nuclear fuel and low-enriched fresh uranium fuel. The design enables the following features:

- Walk-away safety
- High burnup and reduced waste
- Centralized, modular manufacture
- Cost-competitive with fossil fuels

Robert (Bob) Ferencz
Lawrence Livermore National Laboratory

Dr. Robert Ferencz currently serves as the Division Leader for Computational Engineering at LLNL. He has 30 years experience in code development for modeling & simulation in solid/ structural mechanics and multi-physics.

- Get an overview of the technological opportunities and regulatory challenges to fielding a portable 10-MW reactor system
- Explore opportunities for advanced modeling & simulations to help identify design solutions at multiple scales

Technology Overview

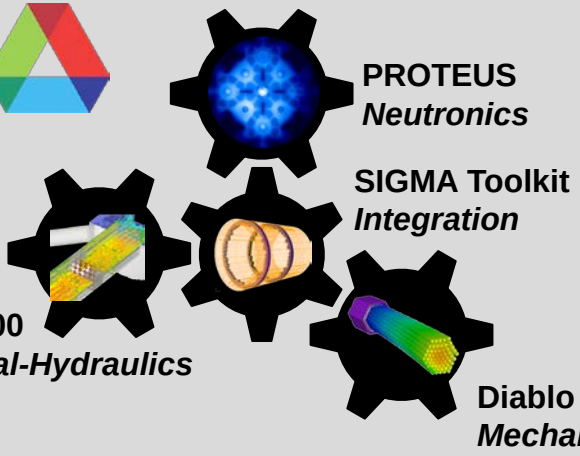
Participating in DOE's NEAMS program as a partner to Argonne National Laboratory team in constructing a multi-physics simulation system

NEAMS
NUCLEAR ENERGY ADVANCED MODELING & SIMULATION PROGRAM

SHARP Reactor Simulator

SHARP Brochure

Argonne NATIONAL LABORATORY



Claudio Filippone, Ph.D.
Filippone & Associates LLC

Claudio Filippone
President

Dr. Filippone is an expert in nuclear engineering and power producing systems with decades of problem solving experience. He has authored several patents on energy producing and conditioning systems and worked on light-water and advanced nuclear, fossil fueled, and renewable energy power plants since 1996.

- Author of specialized technical-economic reports on LWRs and SMRs, and designed hardened small modular reactors for military applications.
- Assisting ARPA-E to explore the potential of making safe & secure 10-MW size nuclear reactors in factories, certifying (once only) in factories, and transporting to user sites without recertification.

Technology Overview

- Air-cooled <10% enriched, melt-tolerant fuel, “Holos”: 10MWe reactor formed by integral components enabling factory assembly, testing as a whole system, and certification.
- >10 years autonomy, deployable via conventional transportation platforms, fully integrated and shielded within ISO containers.

Massimiliano (Max) Fratoni
University of California, Berkeley (UCB)

Max Fratoni
Assistant Professor

NUCLEAR ENGINEERING
University of California, Berkeley

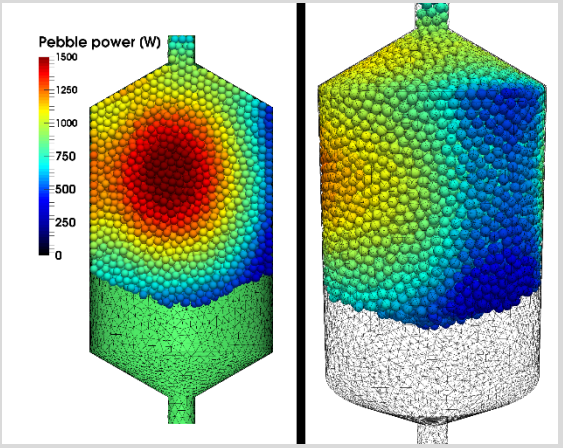
Dr. Max Fratoni is currently assistant professor at UCB. Previously, he worked at the Lawrence Livermore National Laboratory and PennState. His research focus is on advanced reactor design and analysis for improved resource utilization and waste minimization.

- Gather information on a potential new ARPA-E program on nuclear fission energy.
- Explore how our neutronics and multi-physics modeling capabilities could help in designing safe & secure 10-MW size nuclear reactors.

Technology Overview

Experience with numerous advanced reactor technologies:
- Molten Salt Reactors, both solid and liquid fuels
- Sodium-cooled fast reactors
- Lead-cooled fast reactors
- Battery type reactors (ENHS)
- Reduced Moderation BWR
- and more

State-of-the-art and unique modeling tools:
- Uncertainty quantification based on Monte Carlo GPT and XGPT
- Coupled Monte Carlo–OpenFOAM for multi-physics modeling



Coupled Serpent-OpenFOAM simulation of a control rod insertion in a Pebble Bed Flouride-cooled High-tempreature Reactor

E. Travis Gitau
Pacific Northwest National Laboratory (PNNL)

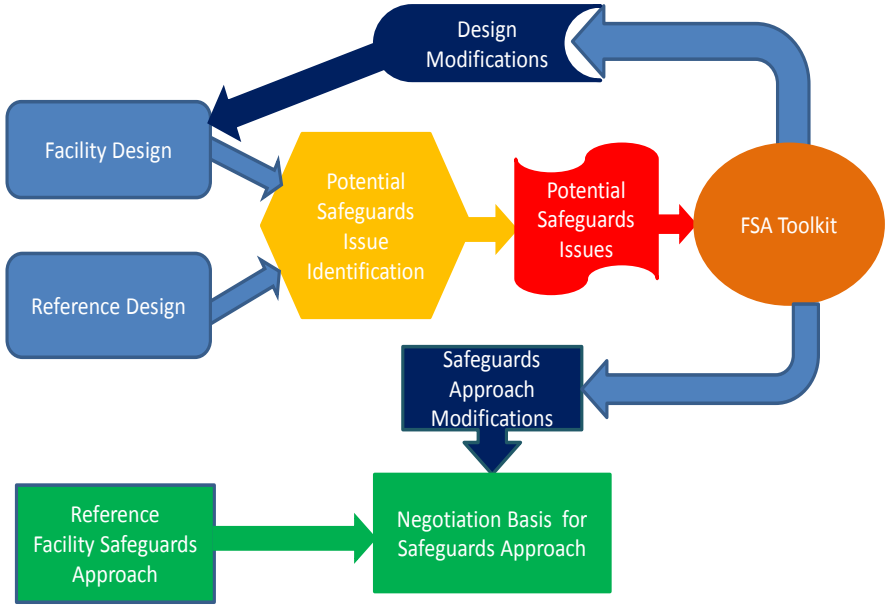
Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by **Battelle** *Since 1965*

E. Travis Gitau is a international safeguards analyst and nuclear engineer at PNNL. For the last 5 years at PNNL his research has focused in safeguards implementation for emerging SMR designs and the impact of the fuel cycle on nonproliferation policy.

- Gain a greater understanding of designer efforts to incorporate nonproliferation and safeguards considerations as part of design efforts
- Explore the safeguards challenges that the manufacture, operation, and decommissioning of ≤10 MW nuclear plants present

Technology Overview



The Facility Safeguards Assessment (FSA) process (graphically represented above) was developed to provide facility designers and safeguards SMEs a means to identify potential safeguards challenges that new and emerging nuclear facility designs may raise. This process represents one tool/resource that the international safeguards community has developed to inform and engage designers and countries on “safeguards by design”.

PNNL-SA-116541

Chris J. Hamilton

Ultra Safe Nuclear Corporation - NGNP Industry Alliance

USNC
ULTRA • SAFE • NUCLEAR

NGNP

NGNP Industry Alliance
High Temperature Gas-cooled Reactors

Mr. Hamilton is the COO of USNC and the Executive Director of the Next Generation Nuclear Plant Industry Alliance.
Previously, he was Director of Business and Technology for General Atomics. He has worked on advanced reactors and defense projects.

Need for Intrinsically Safe Reactors
to realize High Value Applications at 1 -10 MWe

Technology Overview

Existing technology and components could be utilized to assemble 1 to 10 MWe, intrinsically safe reactors. Existing technology includes:

•High Temperature Gas-cooled Reactors
•TRISO coated particle fuel in graphite block

Advanced technology and components will subsequently be employed to reduce cost, size and weight for additional market applications. Advanced technology and components include:

• Higher temperature & conductivity materials
• Higher power density configurations
• Helium gas turbine direct conversion

Hooshang Heshmat, Ph.D.
Mohawk Innovative Technology, Inc. (MiTi)

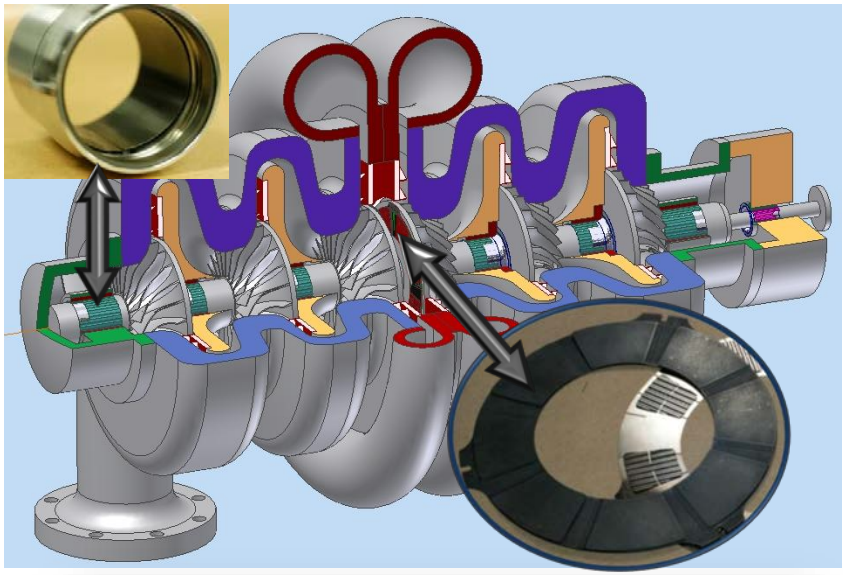
Hooshang Heshmat, Ph.D.
President & CEO/Technical Director

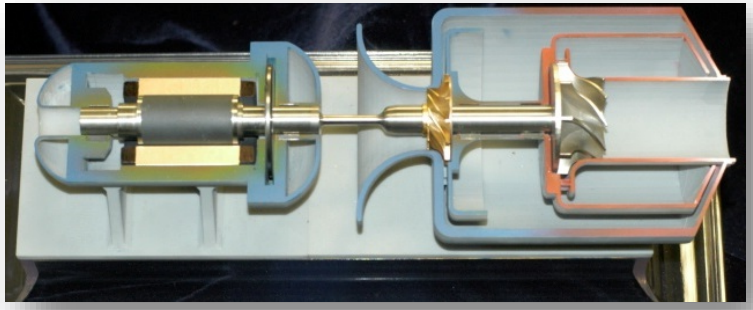
Dr. Heshmat is President & CEO / Technical Director of MiTi, an applied research and product development company dedicated to green technology, specializing in advanced rotating machinery development. He has directed over 300 advanced technology development programs specifically aimed at Oil-Free, High-Speed and Temperature Rotating Machinery.

Expected Primary Takeaways.

1) Understanding of Overall Objectives and Requirements for Large Scale Semi-Portable SCO2 Power Systems
2) Key Techno-Economic Challenges & Metrics for Success of Turbomachinery to be Used in Such Large Scale SCO2 Power System

Technology Overview





High-Speed, Pressure, Temperature And Efficiency, Oil And Maintenance Free Rotating Machinery From Watts to Megawatts Using MiTi's Advanced Korolon Coated Foil Bearings And Seals

Bill Horak
Brookhaven National Laboratory

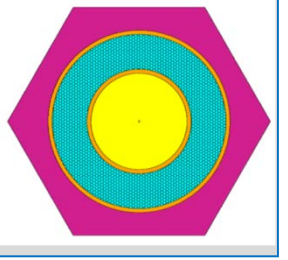
BROOKHAVEN NATIONAL LABORATORY

Chairman, Nuclear Science and Technology Department, Brookhaven National Laboratory
Manage technical projects in material and chemical sciences, advanced reactor designs, nuclear safety, and non-proliferation

- Advanced materials for small reactors
- Materials and manufacturing techniques for small reactors
- Advanced conversion cycles

Technology Overview

- A small reactor for power production for industrial applications, large institutions, and small villages with cogeneration option.
- Potential candidates for the particle fuel include variants of “conventional” TRISO fuels, or coated fuel particles based upon an approach developed by the SNTP program referred to as “Infiltrated Kernel” (IK).
- The ability to remove 3 MW/liter from a particle bed using water at ambient conditions has been demonstrated
- The potential to dump the fuel into a critically safe, cooled ex-core configuration offers significant safety benefits.



Mike Houts
NASA Marshall Space Flight Center

Dr. Houts serves as Nuclear Research Manager for NASA's Marshall Space Flight Center. He has a PhD in Nuclear Engineering from MIT, and previously worked at Los Alamos National Laboratory as Team Leader for Criticality, Reactor, and Radiation Physics and Deputy Group Leader for LANL's Nuclear Design and Risk Analysis group.

Gather information related to potential safe and secure MW-scale nuclear power plants.

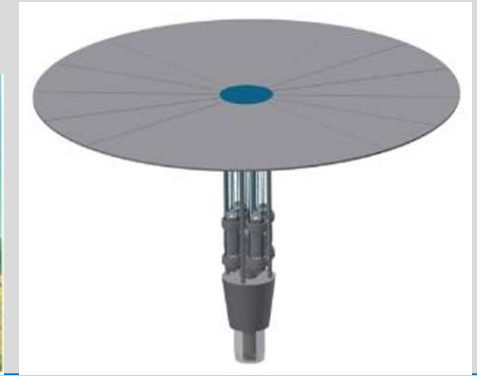
Find synergies between those systems and space nuclear power and propulsion systems.

Technology Overview

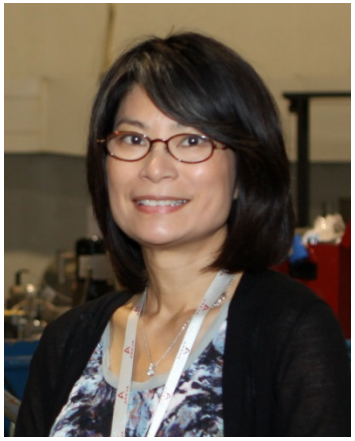
There are many potential commonalities between safe and secure MW-scale nuclear power plants and space nuclear power and propulsion systems.

At a top level, both MW-scale nuclear power plants and space nuclear power and propulsion systems need to be safe, compact, low-mass, reliable, and long-lived. The also need to operate semi-autonomously, require little or no maintenance, and be able to operate without a water heat sink.

Both would also benefit from high temperature fuels and high temperature / high efficiency power conversion.



Lin-Wen Hu
MIT Nuclear Reactor Laboratory



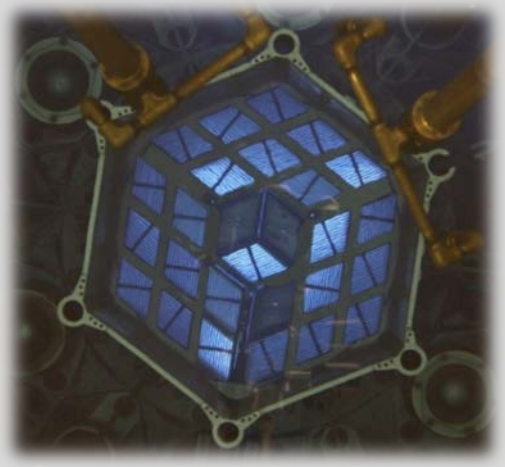
Lin-wen Hu

Director for Research

Dr. Lin-wen Hu is Director for Research and Services at MIT-NRL. She has more than 20 years of experience in nuclear reactor design, safety analysis, licensing, operations and maintenance and in-pile materials and instrumentation irradiation tests.

- MIT-NRL operates the 6-MW MIT Reactor (MITR) and has more than 50 yrs of experience in small reactor design, licensing, and operation.
- An international leader in innovative reactor experiments and reactor physics modeling.

Technology Overview



- Base-load reactor with variable output
- Leveraging $12M+ DOE-NE univ. grant for Fluoride salt cooled High-temperature Reactor (FHR), MIT-NRL designed a 10 MW Transportable FHR for off-grid applications.
- Design features: high temperature salt 600-700 C; high efficiency air brayton cycle; compact core ~ 2 m dia.; fuel cycle 5-yr (optimization in progress > 10 yrs)
- Materials irradiation at in Flibe salt at 700 C on-going at MITR; Completed a conceptual design of a reactor driven subcritcal facility for first demonstration of FHR.

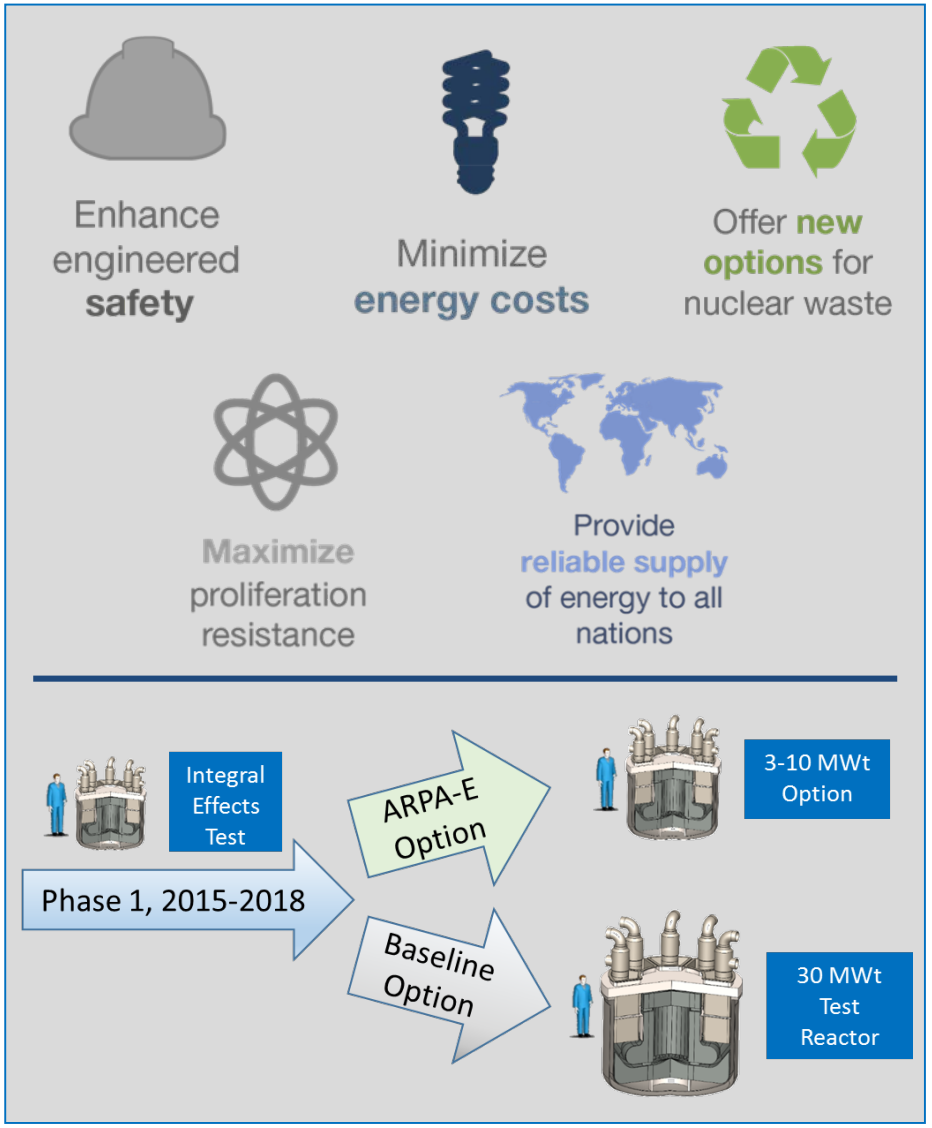
Jeff Latkowski
TerraPower, LLC

Jeff Latkowski
Director, Innovation

Dr. Jeffery Latkowski is TerraPower's Director of Innovation and Program Leader for the Molten Chloride Fast Reactor (MCFR). Jeff provides technical and business leadership for evaluation of new concepts and product lines ranging from advanced reactors to non-electric products to medical isotopes. Previously, Jeff spent 21 years at Lawrence Livermore National Laboratory – working mostly on laser fusion.

- Interested in learning about ARPA-E's view of the market for small nuclear reactors.
- Would like to learn if our MCFR might have a role to play.

Technology Overview



JESSICA LOVERING

DIRECTOR OF ENERGY RESEARCH
THE BREAKTHROUGH INSTITUTE

Jessica Lovering is the director of energy research at the Breakthrough Institute, a pioneering research institute changing how people think about energy and the environment. Her research focuses on nuclear energy and explores how policies can jumpstart innovation to create the disruptive technologies needed to mitigate climate change and increase modern energy access. She also looks at long-term energy trends and future scenarios. Jessica has a BA and MS in Astrophysics and an MS in Environmental Policy with a focus on energy issues.

- Understand the potential for nuclear reactors to be produced and sold as a modular product rather than a large infrastructure project.
- Gather information of the companies working on such reactors and the obstacles they face to commercialization.
- Help create potential policies that would accelerate commercialization and licensing of such reactors.

BREAKTHROUGH
INSTITUTE

William R Martin
University of Michigan

Bill Martin is Professor of Nuclear Engineering and Radiological Sciences at the University of Michigan. He received his PhD degree in Nuclear Engineering from the University of Michigan in 1976, spent a year at Combustion Engineering, and then joined the Michigan faculty in 1977. He also served in the US Navy (Naval Reactors) from 1969-1973.

- I am interested in learning about small reactors and the state of the art for analysis of these reactors.

Technology Overview

- I am the Lead for the Radiation Transport Methods Focus Area for CASL that is developing a virtual reactor (VERA – Virtual Environment for Reactor Analysis) for commercial PWRs with limited application to BWRs. CASL is the Consortium for Advanced Simulation of Light Water Reactors and consists of 4 national labs (Oak Ridge (Lead), Idaho, Los Alamos, and Sandia), 3 industrial organizations (Westinghouse, TVA, and EPRI), and 3 universities (Michigan, MIT, and NC State)
- I am interesting in exploring potential collaborations with other institutions for analysis of SMRs.

Patrick McClure
Los Alamos National Laboratory

Los Alamos NATIONAL LABORATORY EST. 1943

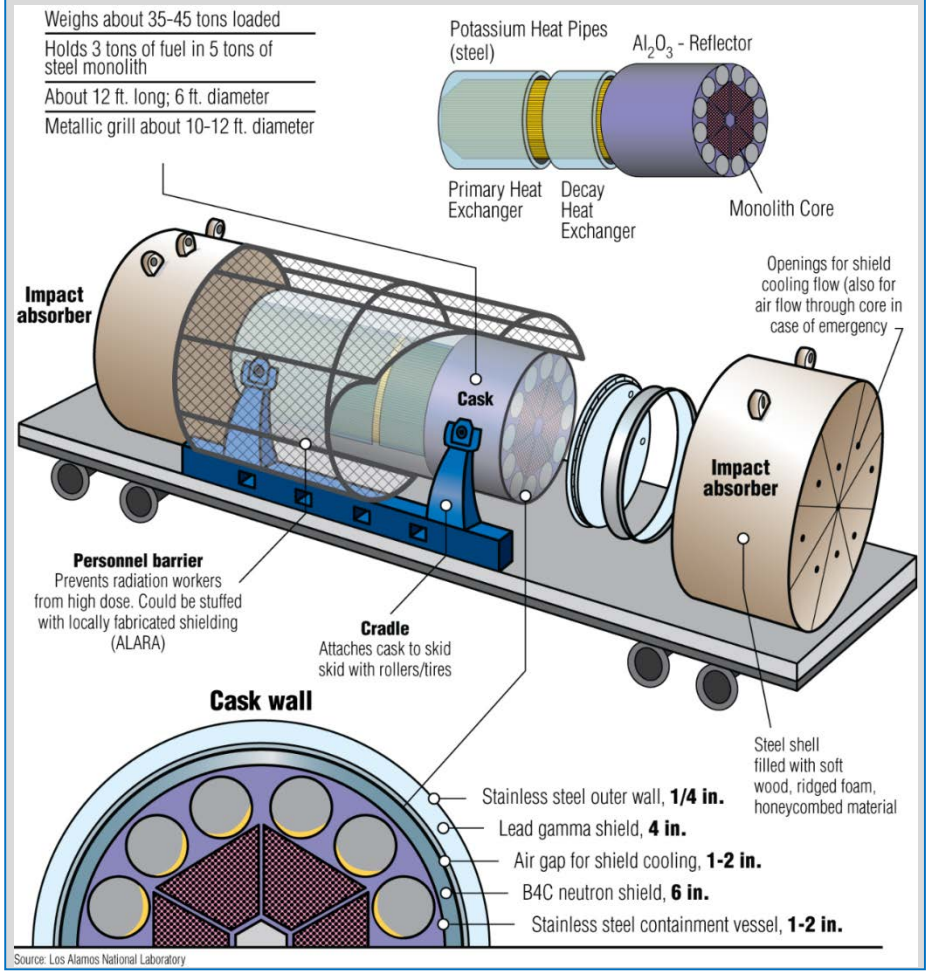
Patrick McClure is the LANL Principle Investigator for nano to micro reactor concepts. Current projects include a 1 kWe space reactor (KiloPower) and a 1 MWe portable reactor (Mega Power).

- Understand ARPA-E program on nuclear fission energy and applicability to LANL technology
- Understand potential requirements and/or constraints on reactor technology in ARPA-E program.

Technology Overview

MegaPower Reactor

2 MWe (5 MWth) Mobile Reactor Package



Rob McHenry
Palo Alto Research Center (PARC)

Rob McHenry
Vice President

parc®

The Business of Breakthroughs

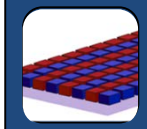
Rob McHenry leads PARC's public sector business and research strategy. As a DARPA PM, he applied nuclear engineering principles to high-assurance autonomous systems. As a nuclear submarine officer, he has experience with small reactor design and operations.

- Explore application of novel energy conversion, harsh environment sensors, advanced materials and manufacturing methods, high-assurance control systems, and cyber-physical security to modular reactors
- Explore novel ways to achieve anti-proliferation and guaranteed containment for nuclear materials

Technology Overview

Energy Conversion

High Efficiency Thermo-Photovoltaic Conversion



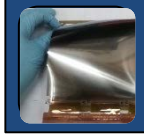
Large-Area Thermo-Electric Conversion

Low-Cost MgB2 Superconductors

Extreme Sensors

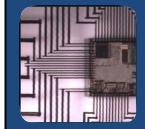
Optical Sensing Inside Li-ion Batteries

Wireless Thermionic Sensor Platform at 1600 C

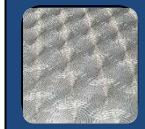


Flexible Large-Area Radiation Imagers

Integrated Digital Manufacturing



Hybrid Printed Electronic Systems



Large-Area Metamaterials for Thermal Management

Co-Extrusion of Thermally Enhanced Fuel Pins

Control & Security

Artificial Intelligence Supported Design Tools

Hybrid Deep Learning and Model Based Control Systems

Cyber-Physical Security for Digital Manufacturing

Michael Mohar

Nevada National Security Site (formerly the Nevada Test Site)

Michael Mohar, Ph.D.
Principal Visionary
NNSS Emerging Programs

Nevada National Security Site

National Security Technologies LLC
Vision • Service • Partnership

Dr. Michael Mohar is a scientific advisor for emerging programs at the NNSS. He is the former Deputy Director of the NNSA Remote Sensing Laboratory and knows a thing or two about non-proliferation technology, nuclear safeguards, and commercial tech transfer.

- Discuss a Government/Commercial alliance to validate, test, demonstrate, and license advanced SMR designs without compromising safety, security, or regulatory roles.
- While we're at it, why not make the process affordable and expeditious, too?

The Goal

Validate

Test

Demonstrate

License

Safe, Secure, Affordable, and Timely

Bringing National Laboratory Technology to the Field for 65 Years!

Bojan Petrovic
Georgia Tech, Nuclear and Radiological Engineering

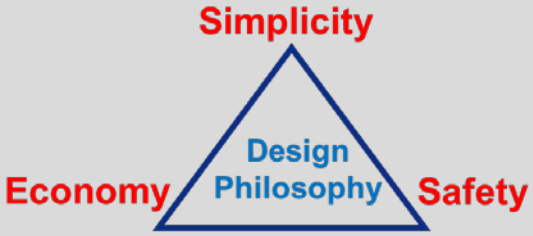
Georgia Tech

THE NUCLEAR AND RADIOLOGICAL ENGINEERING PROGRAM IN THE GEORGE W. WOODRUFF SCHOOL

Dr. Bojan Petrovic is Professor at Georgia Tech. His research focuses on advanced reactors, nuclear fuel cycle, and numerical simulations of nuclear systems. Prior to joining Georgia Tech (nine years ago), he spent eight years as Fellow Scientist at Westinghouse R&D working on novel SMR design and advanced fuels.

- Understand ARPA-E motivation, objectives and scope of the new program on fission energy
- Provide relevant expertize based on industry and academia experience and research to contribute to defining the framework, requirements and criteria for a 10-MW reactor

Technology Overview



It is necessary to develop safe, economic and sustainable nuclear power (and renewables) to provide a viable path tor timely phasing out of fossil.

During industry/academia research career, involved in research and development of several technologies highly relevant for this workshop:

- Inherently safe SMR (IRIS reactor)
- Inherently safe large reactor (I^2S-LWR, LSCR)
- Enhanced safety for reduced emergency planning zone
- SMR for power and non-electricity applications
- Economics and construction of SMRs
- Hybrid nuclear-renewables power systems (with energy storage)
- Advanced LWRs
- Next generation non-water-cooled reactors
- Accident tolerant nuclear fuel

Alex S. Polonsky
Morgan Lewis & Bockius LLP

Morgan Lewis

Alex Polonsky is a partner in the Nuclear Energy Practice at Morgan Lewis. He counsels clients on regulatory matters before the NRC and DOE. He works with nuclear technology start-ups. He is the co-author of "Fundamentals of US Nuclear Regulation.

- I am participating on the Thursday panel on nuclear safety, security, and proliferation.
- I hope to learn about the new nuclear technologies being developed and to help bring the next commercially-viable idea to market.

Technology Overview

I am an advisor.

Michael Purdie
Nuclear Energy Institute

NUCLEAR ENERGY INSTITUTE

Michael Purdie currently serves as NEI's Manager of Energy and Economic Analyses. He maintains all of NEI's statistics and economic data to provide information and value to members and stakeholders. Is part of NEI's Advanced Reactor Working Group led by Dr. Everett Redmond. He worked at the Nuclear Regulatory Commission for six years with expertise in new reactor applications, decommissioning, and rulemaking. He has been at NEI for approximately one year.

- Gather information on a potential new ARPA-E program on nuclear fission energy.
- Find and locate potential areas where the Nuclear Energy Institute can provide support and information for ARPA-E, current members, and potentially future members.

R. Chris Robinson
Y-12 National Security Complex

Director, Nuclear Materials Initiatives

Mr. Chris Robinson is the Director of Nuclear Materials Initiatives at the Y-12 NSC. He has 28 yrs of experience at Y-12 having served in a number of senior technical and leadership roles within engineering and program management.

To identify and assess the interest in the initiatives for kW- and MW-size special purpose reactors in which Y-12 is working with LANL/NASA.

Technology Overview

- Y-12 is the nation's Uranium Center of Excellence, as designated by the DOE/NNSA, with about 70 years of expertise in handling up to HEU and other special materials.
- Y-12's understanding of uranium, coupled with the site's work with enriched uranium metal, alloys, oxides, compounds and solutions, is unique in the Nuclear Security Enterprise
- Currently Y-12/NNSA performs "work for others" using a marginal cost model. Keep in mind that NNSA can change cost models in the future.

Marginal Cost – The cost of an activity over and above what the NNSA is spending to support its own activities.

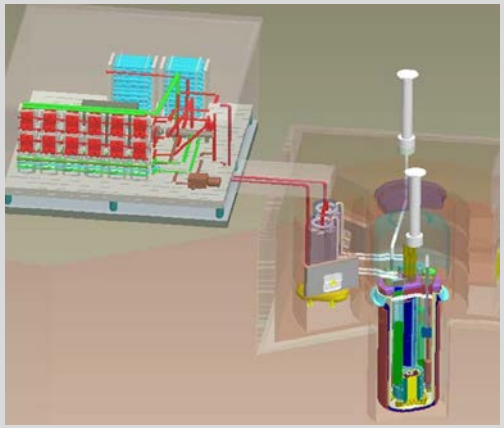
Gary E. Rochau
Sandia National Laboratories

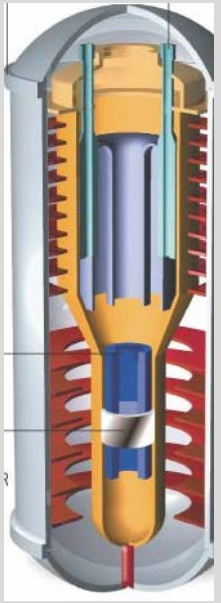
Sandia National Laboratories

Mr. Gary Rochau is manager of the Advanced Nuclear Concepts Department. Portfolio includes advanced energy conversion technology; space power systems, small modular reactors for commercial and defense applications.

- Interested in the application and market of small reactor systems deployable to the universe.
- Desire to construct an indestructible reactor system that can be fielded anywhere and decommissioned to green field.

Technology Overview





Baseline Concept

- *25 MWe*
- *Compact Brayton sCO_2 Turbines*
- *20 year fuel, extendable to 30 years*
- *Intermediate heat exchanger (IHX)*
- *Skid Mounted*

Target System

- *Single Cartridge, Nuclear Battery*
- *Completely sealed (internal Brayton turbines)*
- *IHX Internal to Power Module*
- *30 year fuel*

Paul E. Roege, P.E.
Partner, Creative Erg, LLC

Paul E. Roege co-owns Creative Erg, LLC consulting. He managed construction and engineering in the Army and energy industry. He led engineering and nuclear safety in DOE nuclear facilities for 16 years and managed a DARPA program to build a mobile SMR.

- Nuclear energy offers unique attributes. Very small reactors may be very valuable in remote, austere, or distributed energy use cases.
- Need to characterize critical attributes such as safety, ruggedness and simplicity, then pursue innovative approaches.

Technology Overview

DARPA Program focused on 5-10MWe SMR that could provide power and water in austere locations worldwide.

Key requirements:
•Rapid deployment/setup
•Timely retrieval (by air)
•Simple operation
•Limited hazard if attacked
•Low potential for weaponization if stolen

Major technology challenges:
•Ruggedizing core and fuel
•Limiting radiation/decay heat after shutdown
•Automatic load following, shutdown
•Modular design, transportation, assembly

Anticipated contributions
•Expeditionary energy/water supply
•Expedited prototyping process
•Public/policy dialogue

Raluca Scarlat
University of Wisconsin Madison, Engineering Physics

DEPARTMENT OF
Engineering Physics
UNIVERSITY OF WISCONSIN–MADISON

Raluca Scarlat is an assistant professor at UW Madison in the Department of Nuclear Engineering and Engineering Physics. Her research interests are in the area of heat and mass transport, tritium transport, reactor safety and design, and engineering ethics.

- Learn about opportunities for molten salt reactors for 10MW-sized applications
- Find ways in which UW research capabilities in molten salt and power conversion cycles can be leveraged

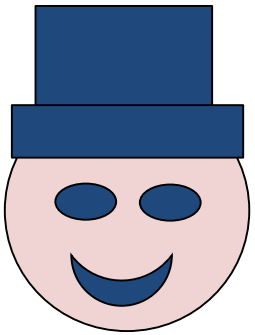
Technology Overview

Molten Salt Reactors

- Are compact
- Have inherent safety features
- And passive safety
- Systems
- Can provide high temperature heat, for high efficiency power conversion systems.

Image of the Molten Salt Reactor Experiment (8 MW) It went critical In 1965.

Bob Schleicher
General Atomics



I didn't have a picture so I am supplying this rendering – pretty good?

Bob Schleicher is the Chief Engineer for Nuclear Technologies and Materials at General Atomics. He has 40 years of experience at GA and has worked on varied energy concepts. He has a PhD physics from Cornell University

- Interest in small nuclear applications.
- Looking for information on customer needs
- Looking for requirements

Technology Overview

GA technologies include:

- High temperature nuclear reactors
- Small, high-speed generators
- High efficiency frequency conversion
- High temperature nuclear fuels
- High temperature materials (SiC-SiC)
- Advanced thermal-photovoltaic devices

Michael Short
Massachusetts Institute of Technology (MIT), Nucl. Sci. & Eng.

MNM Mesoscale Nuclear Materials Group

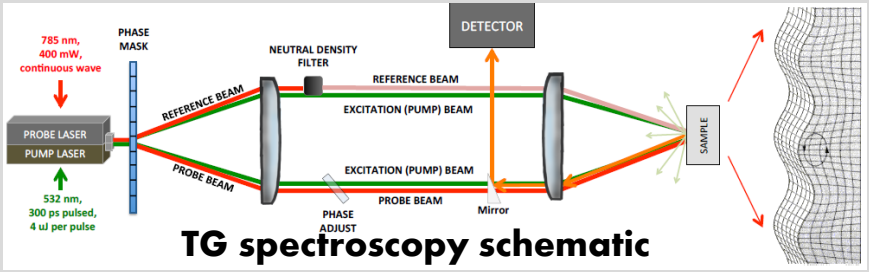
Massachusetts Institute of Technology

Prof. Short joined MIT in 2013, focusing on alloy/coating design and *in-situ*, non-destructive quantification of radiation damage & resistance. We span applied physics and industrial-scale engineering, delivering science-informed solutions to the nuclear industry.

- Discover materials challenges in proposed, novel reactor designs
- Spread awareness and find use cases of new radiation damage quantification techniques for reactor material qualification

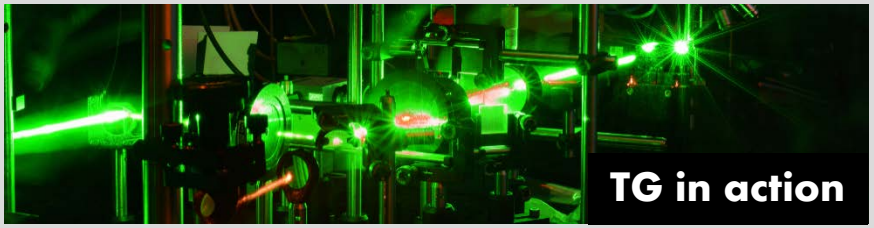
Technology Overview

- **We use transient grating (TG) spectroscopy to measure elastic, thermal, and acoustic material properties *in-situ*, during irradiation.**
- **TG uses four lasers to turn a specimen into a *transient* diffraction grating, then measure its decay & resulting surface acoustic waves (SAWs). These reveal material properties as radiation changes them.**



TG spectroscopy schematic

- **We hope to use this technology to perform ultra-rapid qualification of alloys, ceramics, and coatings for nuclear service, both for fission and fusion systems.**


TG in action

Carol Smidts
The Ohio State University

Carol Smidts
Professor

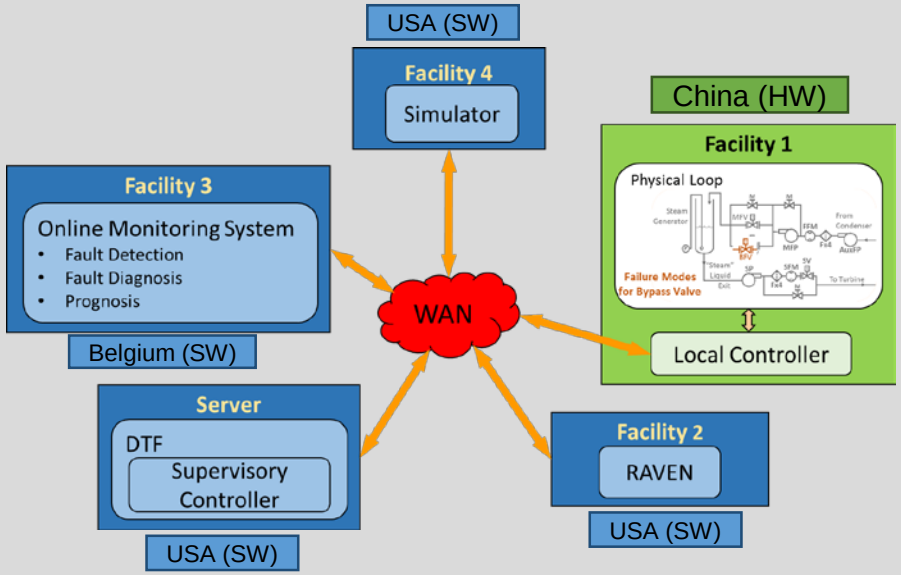
THE OHIO STATE UNIVERSITY

Dr. Carol Smidts is a Professor in the Nuclear Engineering Program at The Ohio State University (OSU). Her research focus is on digital instrumentation and control systems, dependability of software systems, human reliability, and probabilistic risk assessment methodologies.

- Discuss the scope of implementing networked control system for safe and reliable autonomous operation
- Determine how Probabilistic Risk Assessment (PRA) methods would need to be adapted to the Safe and Secure MW-scale Nuclear Power concepts

Technology Overview

Distributed Test Facility (DTF)



- DTF assembles remotely distributed components to test the reliability, safety, security and risk aspects associated to digital systems within their possible operational environments.
- Basic architecture and implementation of prototype DTF system with nuclear hardware and software components has been established and is currently being refined.

Nicholas Smith
Southern Company

Nicholas Smith
Senior Engineer

Nicholas Smith is a Senior Engineer at Southern Company Services (SCS). He is the SCS technical lead on Gen IV nuclear reactor R&D. His background includes work in electrical power quality, production cost modeling, and Molten Salt Reactors.

- Learn about innovative approaches to fission reactor design
- Meet like minded technologists in the advanced nuclear field

Technology Overview

More than 4.4 million customers and approximately 46,000 megawatts of generating capacity, Atlanta-based Southern Company (NYSE: SO) is the premier energy company serving the Southeast through its subsidiaries.

Southern Company has partnered with TerraPower, Oak Ridge National Lab, and EPRI to pursue the development of a Molten Chloride Fast Reactor (MCFR). The MCFR is a commercially deployable, liquid fueled MSR which enables a transition to flexible, robust, and low carbon energy infrastructure. This team was recently selected for a $40M award by DOE as part of an Advanced Reactor Concepts FOA.

Lance Snead
MIT

Specialized in irradiation effects, development and licensing of nuclear fuels, graphite, and structural materials for advanced reactors.
Patent holder on fully ceramic microencapsulated fuel.
Developer of nuclear-grade SiC composite.

Gain understanding of current systems and how advanced materials can be utilized to extend performance.

Technology Overview

MIT Nuclear Reactor Laboratory

NSUF Nuclear Science User Facilities

NSE
Nuclear Science & Engineering at MIT
science : systems : society

through its internal Departmental, Laboratory resources and affiliated User Facilities MIT has been central to advancing new nuclear systems and the materials enabling those systems.

Tanju Sofu
Argonne National Laboratory

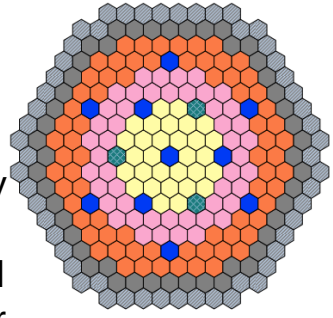
Dr. Sofu manages Engineering Analysis Department at Argonne's Nuclear Engineering Division and coordinates the multi-laboratory activities for the “Fast Reactor Methods and Safety R&D” technical area under DOE’s Advanced Reactor Technologies program. He co-chairs two of OECD-Nuclear Energy Agency Gen-IV International Forum (GIF) committees.

Establish synergies between Argonne capabilities and ARPA-E program needs in following areas:

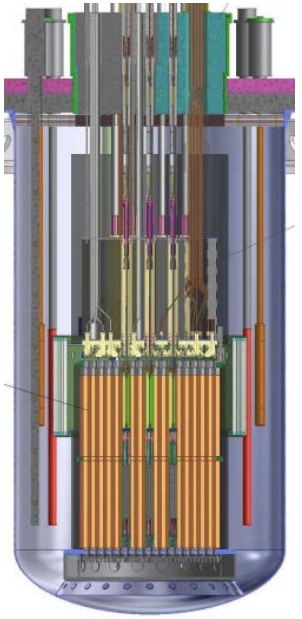
- Development and licensing of innovative nuclear reactor concepts.
- Development of advanced modeling and simulation methods.
- Engineering simulations, safety analyses, and risk assessments of nuclear reactors.

Technology Overview

Argonne participates in DOE-NE's Advanced Reactor Technologies (ART) program to support RD&D activities on innovative Generation IV nuclear energy technologies with a focus on improving the technology readiness level of advanced concepts and reducing the technical and regulatory uncertainties for their deployment. Argonne also participates in international collaborations conducted through bilateral and multilateral agreements, including OECD-NEA's Generation IV International Forum.



Argonne's efforts support high-impact research for long term concepts, R&D needs for promising mid-range concepts, the development of innovative technologies that benefit multiple concepts, and stimulation of new ideas for transformational future concepts.



Olga Blum Spahn
Sandia National Laboratories

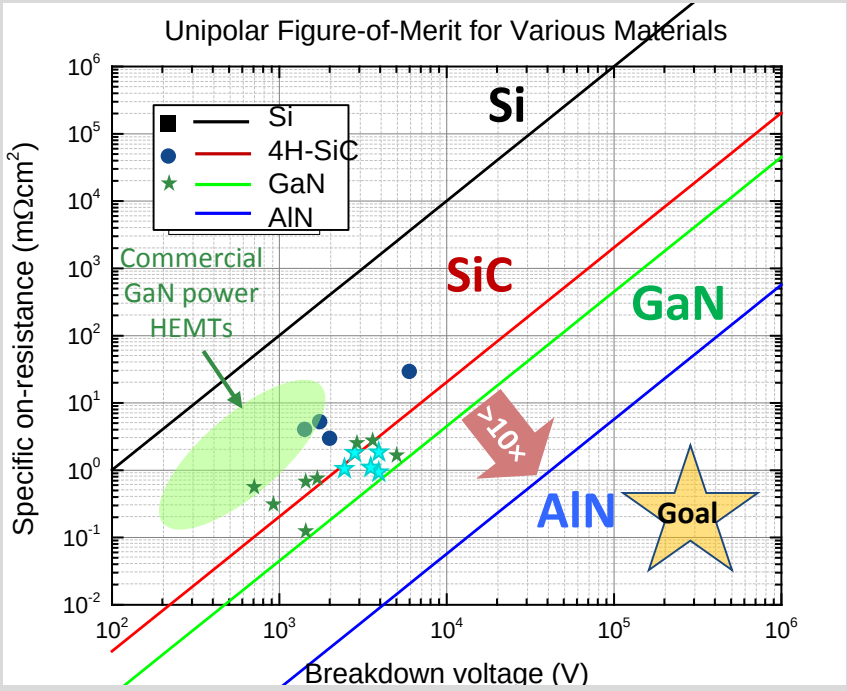
Sandia National Laboratories

Dr. Spahn manages Semiconductor Material and Device Sciences department at Sandia, and Ultra Wide Bandgap Power Electronics Grand Challenge program. She has worked at SNL for 23 years in several areas such as area semiconductor materials and devices and laser material processing

- Learn about power management and monitoring needs of MW-scale nuclear power
- Explore opportunities for ultra wide bandgap semiconductor technology in realization of extreme environment advanced instrumentation and controls for the needs of small modular reactors

Technology Overview

- III-Nitride semiconductors, such as AlGaN are ideal (U)WBG materials for extreme environment applications, such as radiation, high power density and high temperature
- These favorable material properties are enabled by a larger bandgap (E_g) then conventional Si or even SiC materials
- SNL is executing a major device and material program in this area



Bret Strogen
MEI Co., SETA Contractor to OSD Office of Operational Energy

Dr. Bret Strogen evaluates alternative energy technologies and policies for the DoD, and is the Exec. Secretary for a DSB study on the feasibility of vSMRs for military bases. His academic work comprises life-cycle environmental, economic, and public health assessment of fuels and infrastructure.

- Better understand vSMR technical concepts, design criteria, licensing and funding pathways, and potential non-military first/ early adopters.
- Provide insights and share resources acquired through supporting the DSB study.

Technology Overview

Below are considerations that have been discussed for hypothetically designing a vSMR for military use (which may or may not be relevant for civil use).

Size & Transportability
25-40 tonnes; truck or C-17 compatible

Useful Outputs
≤10 MWe, heat, water, H_2/ hydrocarbons

Refueling frequency
≥1 year

Ultimate heat sink
Air (vs. water)

Time to install
12-72 hours

Time to shutdown, cool, and remove
6 hours to 7 days

Health & Safety
Negligible net increase in risk to public, military personnel, environment

Proliferation risk
Negligible

Pavel V. Tsvetkov
Department of Nuclear Engineering, Texas A&M University

Pavel Tsvetkov
Associate Professor, Texas A&M University

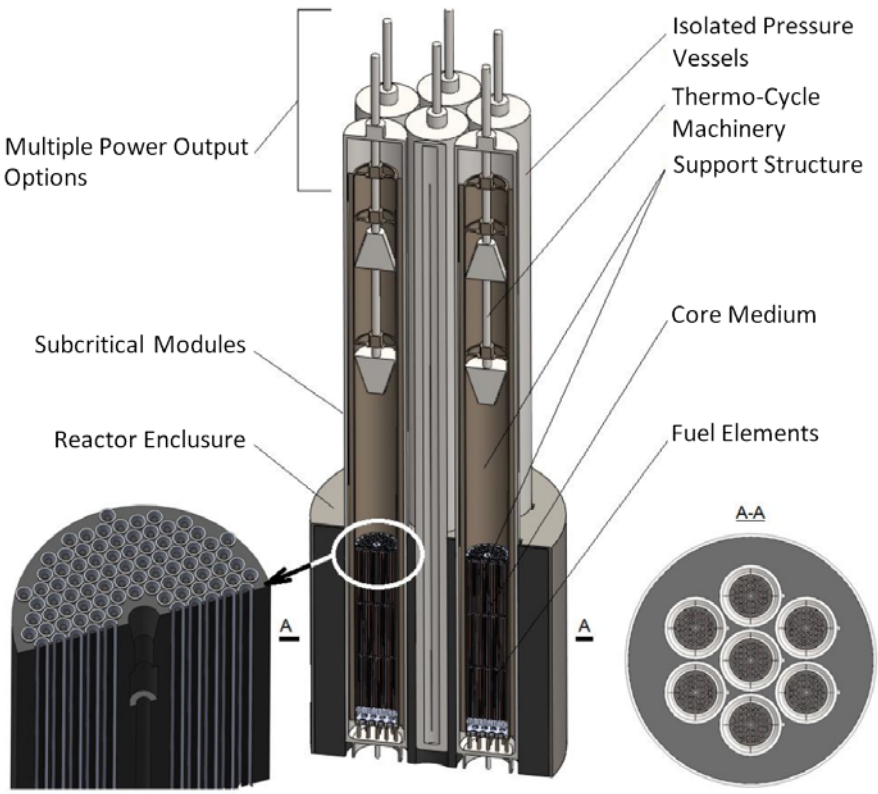
TEXAS A&M ENGINEERING

NUCLEAR ENGINEERING
TEXAS A&M UNIVERSITY

Dr. Pavel V. Tsvetkov is an Associate Professor at Texas A&M University. He has authored and co-authored 300+ publications. 100+ PhD., MS., BS. students went through his program since 2005. His focus is on nuclear systems, design, analysis, and optimization.

- Meet the MW-size nuclear reactor development community, establish collaborations, and learn about ARPA-E plans
- Engage and discuss way to address potential, options, enablers and challenges for 10-MW size nuclear energy units.

Technology Overview



Concept: Multi-Functional Configurable Power Units for Variable Multi-Product Output to Meet Grid and Energy Needs

Functionality: Process Heat, Water, Electricity

Licensing: Subcritical Module

Design: 3S = Safety, Security, Safeguards by Design

Technology: Off-The-Self Reactor Component Solutions - Materials, Fuel, Energy Conversion Sub-Systems

Richard (Rick) Uhlman
Naval Reactors

Rick Uhlman is an engineering design manager for prototype and VIRGINIA-class submarine reactors. He has worked at Naval Reactors for 10 years.

- Gather information on technology developments to potentially improve Naval core capabilities or decrease cost.
- Offer perspective on small reactor challenges.

Technology Overview

Naval Reactors is a joint Department of Navy/Department of Energy organization responsible for R&D, design, delivery, and disposal of nuclear propulsion plants for ships.

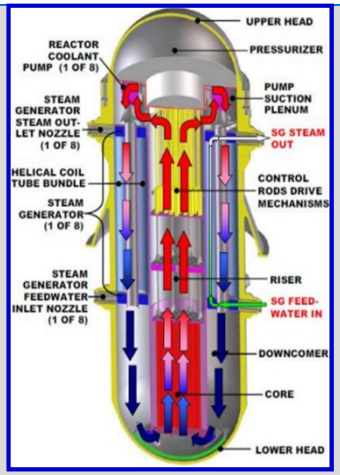
Belle R. Upadhyaya
University of Tennessee - Department of Nuclear Engineering

THE UNIVERSITY OF TENNESSEE KNOXVILLE
COLLEGE OF ENGINEERING

Dr. Belle Upadhyaya is a professor of Nuclear Engineering at the University of Tennessee. His areas of technical interest include power plant dynamics, Instrumentation & Controls (I&C), plant monitoring and diagnostics, small modular reactors, and sodium fast reactors.

- To understand the constraints on small reactors and their deployment strategy.
- Prioritization of reactor type: water-cooled, gas-cooled, liquid metal-cooled, etc. Technology development needs for remote operation, instrumentation, and control.

Technology Overview



Integral Reactor

Instrumentation and control strategies are essential to the safe and economic operation of nuclear power generation systems. Small modular reactors (SMRs) and integral reactors are being developed in the 25-200 MWe range. Instrumentation challenges for 10-MW reactors have to be investigated in light of the compactness of the modules. Remote operation requires supervisory and autonomous control strategy, along with fault-tolerant features. Model-based control, combined with on-line monitoring need to be considered for extended fuel cycle reactors.

Jurie Van Wyk
Westinghouse Electric Company LLC

Jurie Van Wyk
Principal Engineer

Jurie Van Wyk is a Modular Construction lead at Westinghouse. His expertise is in composite material, life cycle integration based on system engineering methodologies and module design. He has 16 years nuclear industry experience in the modular design of nuclear reactors such as the Pebble Bed Modular Reactor , Westinghouse Small Modular Reactor and AP1000

- Contribute information to ARPA-E to inform a potential new ARPA-E program on nuclear fission energy
- Guide the attributes of the Micro Reactor that can lead to the integration of nuclear in the modernized grid. Discuss technology, market, licensing and security challenges

Technology Overview

MicroReactor Concept Drivers

1. Factory Built, assembled, tested and certified
2. Less than 7 days on-site construction
3. Autonomous Operation by design and by licensing
4. Fuel Cycle >10 years: Nuclear Battery Concept
5. Combined heat and electric power (market specific)
6. Energy Demand Management (market specific)
7. Monitoring, control and inspection
8. Transportation: Air, ground and marine
9. Infrastructure needs
    - Factory
    - Transportation infrastructure
    - Commercial fuel fabrication: > 20% enrichment

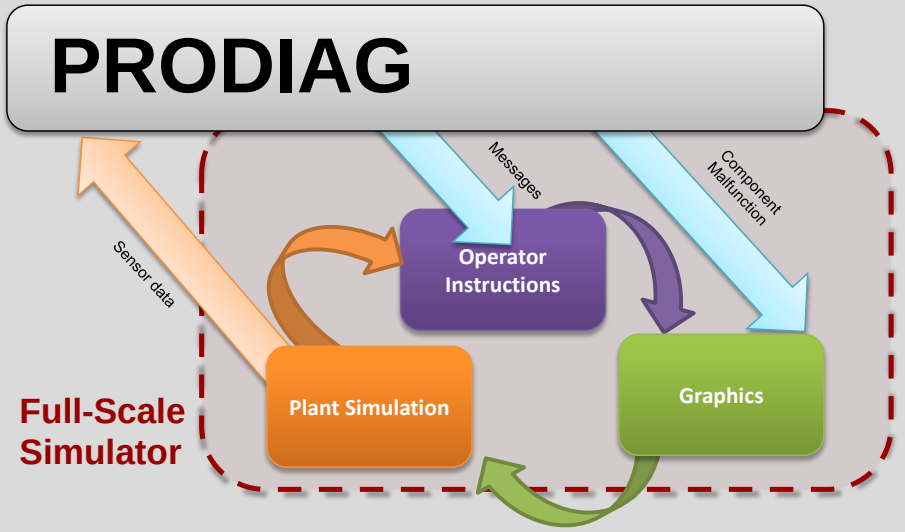
Richard Vilim
Nuclear Engineering Division, Argonne National Laboratory

Richard Vilim

Dr. Richard Vilim leads the Plant Analysis and Control Section in the Nuclear Engineering Division at Argonne National Laboratory. He has authored over 200 publications and reports and six US patents dealing primarily with instrumentation and control in nuclear facilities.

- Engage developers of new reactor concepts by providing technical expertise in the areas of safety and thermal hydraulics.
- Provide awareness of national laboratory technical capabilities in the areas of instrumentation and control for improved safety and enhanced operational performance.

Technology Overview



- Over 30 years experience designing, analyzing, and modeling energy systems including their control and protection. Application of these technologies to nuclear power plants, advanced gas-turbine energy conversion cycles, and industrial processes.
- Developing advanced control strategies for nuclear power plants including approaches to control for passively safe reactors.
- Developing automated reasoning methods for the detection and identification of equipment failures.

JUAN A. VITALI – HQDA G4

Organization logo

Dr Vitali, is Chief S&T at HQDA G4. He is an acquisition professional, with professional experiences in S&T (AFRL, Georgia Tech Research Institute, JPEO/CBD, ATEC). Ph D in Nuclear Eng. Oversees Log Optimization Strategy which includes Future Contingency Base Operational Energy Needs Requirements Analysis.

Evaluate technology readiness, operational requirements conformation, and suitability of Micro Modular Reactor Concepts for use in Future Army Contingency Bases.

Technology Overview

Lars F. Voss
Lawrence Livermore National Laboratory

Lars Voss
Scientist

Dr. Lars Voss is a staff engineer at Lawrence Livermore National Laboratory. He is the author of more than 50 journal articles and 4 patents in the areas of semiconductor physics, detectors,devices, and materials. He has recently worked on several gamma and neutron detectors, energy harvesting devices, and power electronic devices.

- Assess the needs of the community for advanced sensors, electronics, and radiation hard materials
- Disseminate potential areas of impact to other scientists at the laboratory

Technology Overview

- Radiation detectors
  - Si/^{10}B thermal neutron detector
  - Next generation CdZnTe and TlBr room temperature gamma spectrometers
- Radiation hard semiconductors for power and energy
  - GaN
  - SiC
  - Selenium
  - Liquid semiconductors

Lawrence Livermore National Laboratory

Bradley Williams
DOE, Office of Nuclear Energy

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

Mr. Bradley Williams has been with the U.S. Department of Energy, Office of Nuclear Energy for the past eight years and currently serves as a Senior Advisor to the Assistant Secretary for Nuclear Energy with responsibility for performing broad and extensive analysis and strategic planning related to technical, economic, and policy aspects of nuclear energy.

- Understanding the potential for mega-watt sized nuclear power as an additional option for electricity generation and broader energy production.

Technology Overview

- The mission of the Department of Energy, Office of Nuclear Energy (DOE-NE) is to advance nuclear power as a resource capable of meeting the Nation's energy, environmental and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development and demonstration (RD&D).

- DOE-NE has established the **Gateway for Accelerated Innovation in Nuclear (GAIN)** to provide the nuclear community with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet.

Steven J. Zinkle, University of Tennessee-Knoxville (UTK) Dept. of Nuclear Engineering and Dept. Mater. Sci. & Eng.

THE UNIVERSITY OF TENNESSEE KNOXVILLE
COLLEGE OF ENGINEERING

OAK RIDGE National Laboratory

Steve Zinkle is Governor's Chair for Nuclear Materials at UTK, after a ~30 year research and management career at Oak Ridge National Laboratory. His research interests are at the intersection of materials science and nuclear energy, including structural materials, advanced manufacturing and radiation effects.

- Utilize 21st century high performance, economical materials for 21st century nuclear reactors
- Development of a robust, safe, cost-effective low carbon energy option

Technology Overview

- Materials science has made dramatic strides over the past 50 years (computational thermodynamics, deformation mechanism maps, nonconventional structural materials)
- Similarly, our understanding of radiation effects in materials has dramatically advanced over the past 50 years.
- Significant improvements in creep strength, fabrication (e.g., reduction in # of welds), and irradiation resistance are achievable compared to current LWR materials at no significant cost penalty.