



Institute for Nuclear Energy  
Science and Technology

Massachusetts Institute of Technology University Outreach  
March 19, 2012

*Marsha Lambregts, INEST Deputy Director*

# Integrating Strategic Investments



Technical Integration



Leadership and technical excellence in R&D

INL Strategic Investments are driven by mission

Linking R&D mission goals with infrastructure requirements



Connections to universities, labs, industry, and international research institutions

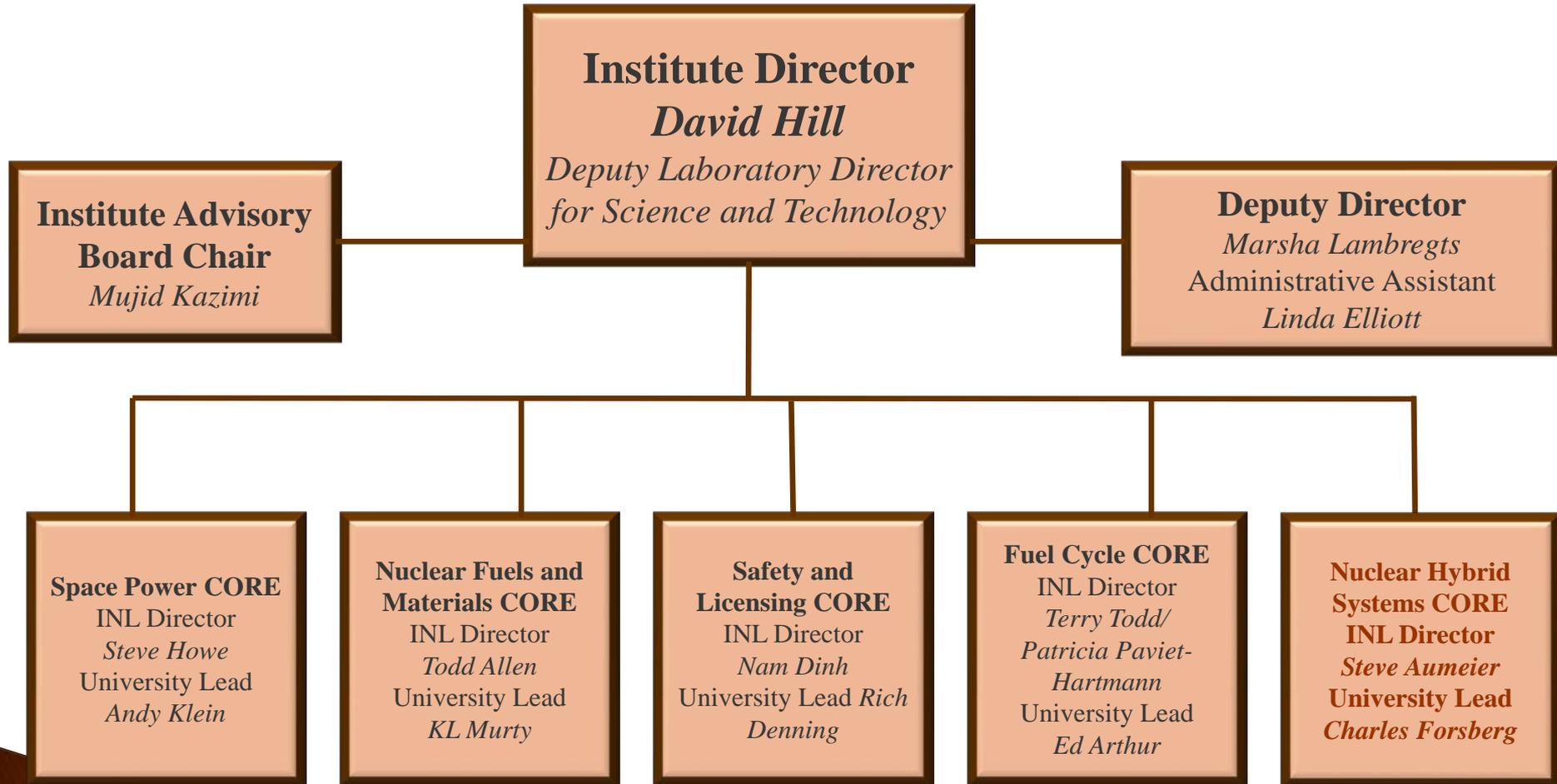


# INEST Mission/Vision

- Create a laboratory component that stimulates discovery at technology and time scales beyond the constraints of current DOE missions while establishing strong partnerships with the university research community
- Grow technology leadership reputation while building long-term capabilities, tools and techniques to advance nuclear technology
- Establish linkages with NUC universities which will stimulate innovation and technical excellence, and a source of high quality future employees

*National labs focus on the near term 0–2 year timeframe. The NE University program focuses on the 2–4 year timeframe. What the Institute should focus on is the long term, 3/4 year to infinity timeframe.*

# INEST Organization Chart



# INEST Advisory Board and Steering Committees

## Advisory Board

- Mujid Kazimi – Chair (MIT)
- Regis Matzie (Westinghouse)
- Gary Bennett (Consultant)
- Edward Arthur (Chair, Fuel Cycle)
- KL Murty (Chair, Nuc. Fuels & Materials)
- Andy Klein (Chair, Space Power)
- Charles Forsberg (Chair, Hybrid NE Systems)
- Rich Denning (Chair, Safety and Licensing)

## Safety & Licensing CORE

*Nam Dinh – Director*

- Rich Denning – Chair (Ohio State)
- Bal Raj Sehgal (Royal Institute of Technology)
- Sandra Sloan (Areva)
- Paul Turinsky (NC State)
- Bob Youngblood (INL)

## Space Power CORE

*Steve Howe – Director*

- Andy Klein – Chair (OSU)
- Sam Bhattacharyya (Renmar Industries)
- Michael Houts (NASA)
- William Saylor (US Air Force Academy)
- Tom Hughes (Penn State)

## Fuel Cycle CORE

*Terry Todd/Patricia Paviet-Hartman – Director*

- Edward Arthur – Chair (UNM)
- Gordon Jarvinen (LANL)
- William Charlton (Texas A&M)
- Alena Paulenova (Oregon State)

## Nuclear Fuels & Materials CORE

*Todd Allen – Director*

- KL Murty – Chair (NC State)
- Peter Ford (Consultant)
- Doug Crawford (GE)
- Rick Holt (Queen's University)
- Kemal Pasamehmetoglu (INL)

## Hybrid Nuclear Energy Systems CORE

*Steve Aumeier – Director*

- Charles Forsberg – Chair (MIT)
- Daniel Kammen (UC Berkley)
- Bruce Dale (Michigan State)
- James Bartis (Rand)
- Zhiyuan ZHU (Chinese Academy of Science)
- Michel LeCompte (Areva)

# INL LDRD Investment Principles

## ▶ Focus

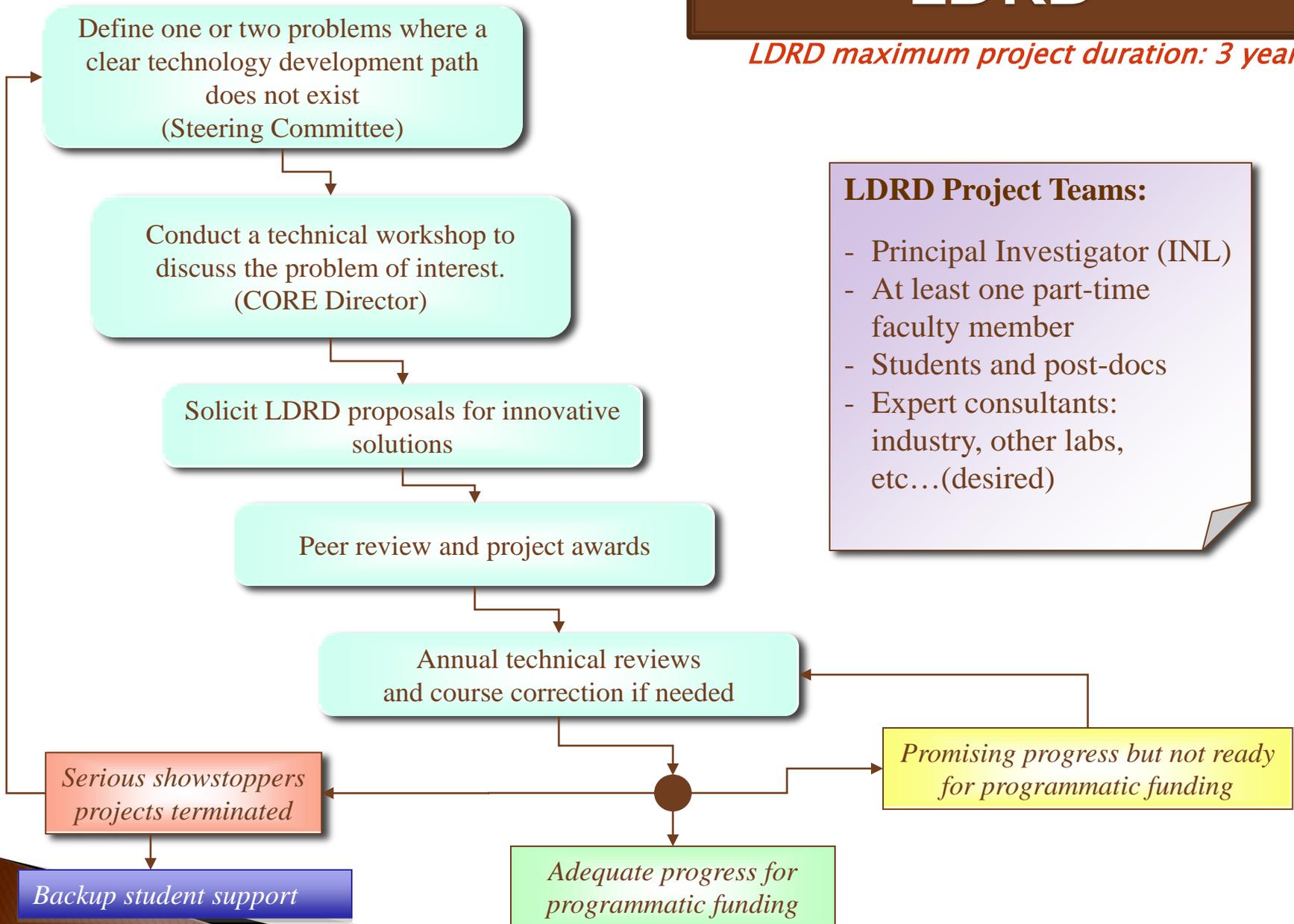
- Develop and execute a cutting edge R&D portfolio to ensure capabilities are in place to support DOE's future missions with major emphasis on the DOE-NE mission

## ▶ Benefits

- Provides science and technology underpinning to support INL mission objectives
- Improves research reputation which is essential for attracting and maintaining the technical human resources needed to respond to future mission needs

# LDRD

*LDRD maximum project duration: 3 years*



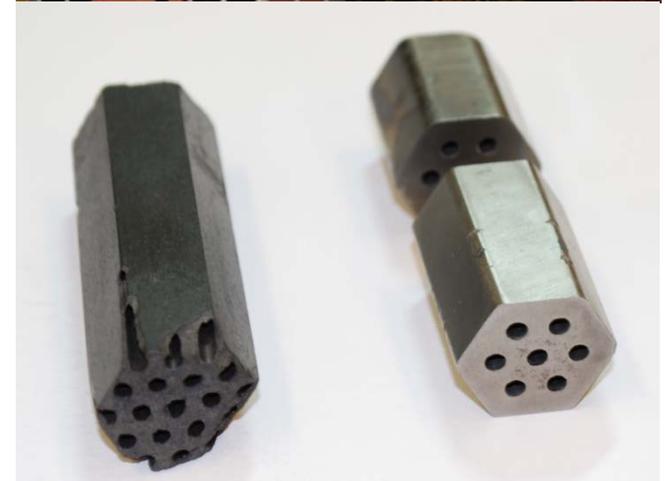
## LDRD Project Teams:

- Principal Investigator (INL)
- At least one part-time faculty member
- Students and post-docs
- Expert consultants: industry, other labs, etc...(desired)

# FY2012 INEST LDRD Portfolio

## \$3.2 M Investment

- Research projects are distributed between 4 CORE's (New Hybrid Nuclear Energy Systems CORE not yet included-mid year 2012 call just released)
- Require university participation
- CORE meetings and workshops are used to hone topical areas and generate university interests



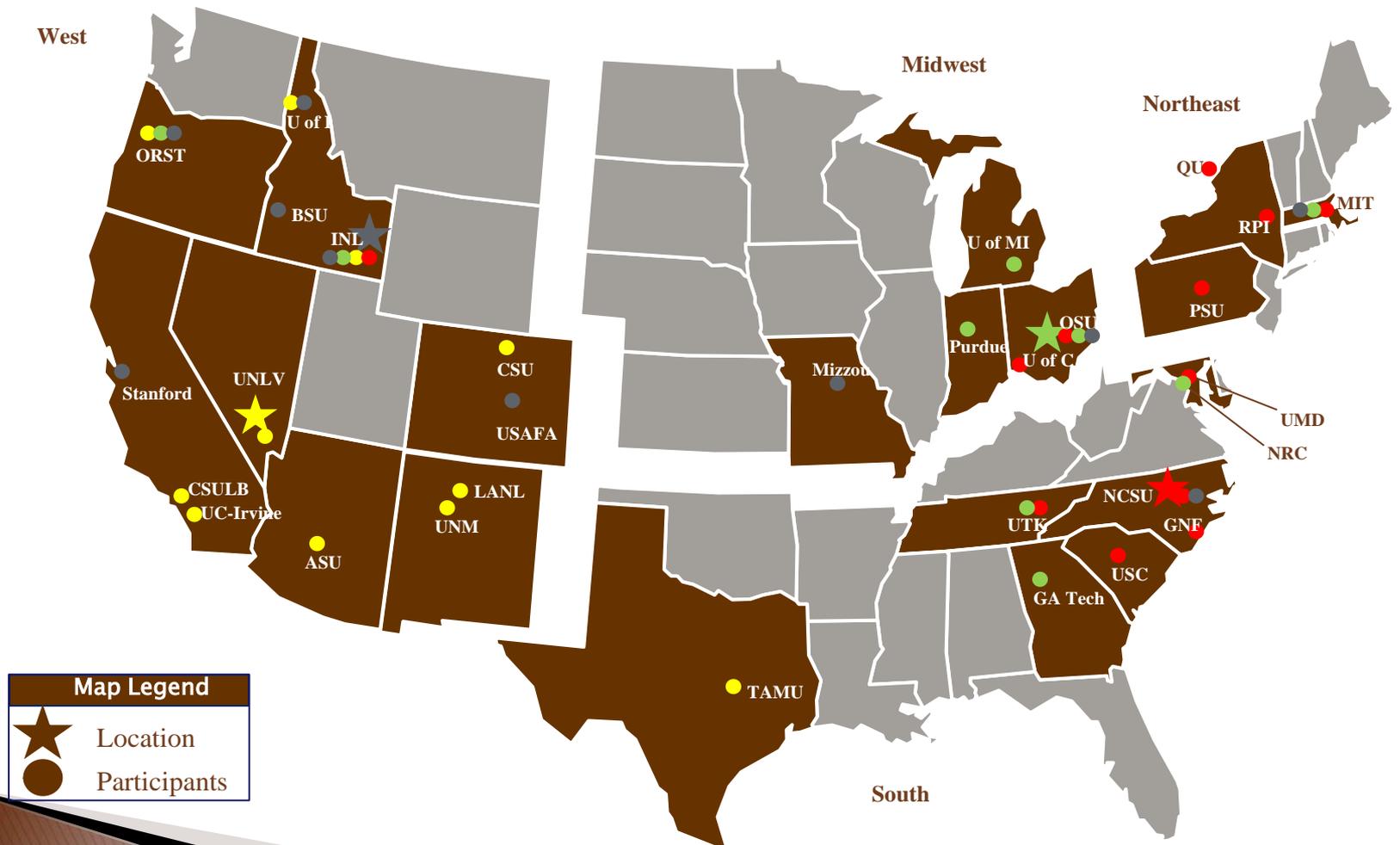
# LDRD Portfolio

No.	AGE	TITLE	PI	Co- Investigators	University Involvement	CORE
12-056	New	Recovery of Precious Metals from Used Nuclear Fuel and Electronic Waste Using Sulfur-Impregnated Nano-scaffolds	Peter Zalupski	Linda Nazar	University of Waterloo, Canada	Fuel Cycle
12-059	New	Chemistry and Flowsheet Development for Lanthanide Separations	R. Scott Herbst	Peter Zalupski, Mikael Nilsson	University of California - Irvine	Fuel Cycle
10-032	Mortgage	Investigation of Molten Bromide Salts Systems for Separation and Recovery of Actinides from Fission Products	Lister, Ted	Shelly Li, Steven Herrmann		Fuel Cycle
11-006	Mortgage	Supercritical Fluid Extraction of Actinides from TRISO Reactor Fuels	Mincher, Bruce	Chien Wai	University of Idaho	Fuel Cycle
12-090	New	Development of emissivity-tuned, robust encapsulated radioisotope heat sources for NASA's new advanced Radioisotope Thermo-Photovoltaic (RTPV) power system	Dr. Carl M. Stoots	Dr. Robert C. O'Brien Dr. Daniel Kramer Dr. James Sears Dr. Andy Klein Dr. Mark Hartman	University Space Research Assoc. University of Dayton University of South Dakota Oregon State University University of Michigan	Space Power
10-081	Mortgage	Design and Testing of a Mars Hopper	James O'Brien	Robert O'Brien, Dr. Hensen, Dr. Klein, Dr. Crepeau, Barbara Dolphin	Oregon State University, Utah State University, University of Idaho	Space Power

# LDRD Portfolio (con't.)

No.	Age	TITLE	PI	Co-Investigators	University Involvement	CORE
12-043	New	Science-Based Simulation Model of Human Performance for Human Reliability Analysis	Dana L. Kelly	Ron Boring (INL), Ali Mosleh Carol Smidts	University of Maryland Ohio State University	Safety and Licensing
12-007	New	Uncertainty Quantification of Safety Codes using a Bayesian Approach with Data from Separate- and Integral-Effects Tests	Dr. Dana Kelly	Prof. Jacopo Buongiorno	MIT	Safety and Licensing
12-077	New	Observation of zirconium oxidation at atomic level using non-linear optical spectroscopy	Marat Khafizov	Kenan Gundogdu Izabela Szlufarska	North Carolina State University University of Wisconsin	Fuels and Materials
12-026	New	Protectiveness and stability of the zirconium oxide in early-phase corrosion of zirconium alloys - predictive relations to surface structure and composition	Xianming (David) Bai	Bilge Yildiz	MIT	Fuels and Materials
10-008	Mortgage	Irradiation-induced Evolution of Defects and Microstructures in Nanocrystalline BCC Mo	Millet, Paul	Yuntian Zhu	North Carolina State University	Fuels and Materials
10-058	Mortgage	Microstructural Evolution of UO <sub>2</sub> and U Under Irradiation	Osuniewski, Maria	Kevin Lynn, Marc Weber, Jian Gan	Washington State University	Fuels and Materials
10-083	Mortgage	In situ Characterization of an Oxide Film for Prediction of Stress Corrosion Cracking Susceptibility	Teyseyre, Sebastian	Brian Gorman, David Hurley, Tedd Lister	Colorado School of Mines	Fuels and Materials
11-041	Mortgage	In situ Micro-Raman Spectroscopy and Modeling of Breakaway Oxidation of Zircaloy Cladding	Khafizov, Marat	Haitham El Kadiri	Mississippi State University	Fuels and Materials
11-043	Mortgage	Characterization of Nanomechanical Response of Material to Determine Key Variables in Stress Corrosion Cracking	Meyer, Mitch	William Gebdrich, K Andre Mkhoyan	University of Minnesota	Fuels and Materials

# 2011 INEST Outreach Workshop Involvement



# INL Student Collaboration Options

- ▶ **University Blanket Master Contract with individual releases**
- ▶ **INL Collaboration Internship**

Current Goal: Develop standardized process and policy



Experience  
THE FUTURE

# Current INL Mechanisms

	Funding Guarantee	Tuition, Books, and Fees	Tuition, Books and, Fees Taxability	Employee Status	Health Insurance	Health Insurance Taxability	Foreign National	Visa Reimbursement
University Blanket Master Contract	No <sup>1</sup>	✓	Non-Taxable	W-2 <sup>3</sup>	✓	Non-Taxable	Driven by Export Control	Yes <sup>4</sup>
Internship	No <sup>1</sup>	✓	Taxable above \$5,250 <sup>2</sup>	W-2	Would Require Policy Change	Non-Taxable	Driven by Export Control and limited to F, M, H-1 B Visa <sup>4</sup>	No <sup>4</sup>

1. Funding guarantee is outside BEA's control, dependent on Congressional appropriations and falls under Antideficiency Act 31 U.S.C. §. § 1341(a), 1342, or 1517 (a)
2. Taxability determination currently under review.
3. Students are under a W-2 employee relationship with either BEA or the university.
4. Currently under review, DOE-HQ stance not to reimburse student for visa costs.

# University Blanket Master Contract Process

- ▶ Funded by INL project (LDRD, programmatic, etc.)
- ▶ Participants are subject to all terms and conditions, regulations and requirements (including work control) as a subcontractor
- ▶ Tuition, Fees, and Books paid directly to University and fellowship to student
- ▶ Provides INL access
- ▶ Student not incorporated into Education Programs internship program

# Collaboration Internship

- ▶ Funded by INL project (LDRD, programmatic, etc.)
- ▶ Mentoring/protégé responsibilities are shared between INL and University
- ▶ Student aligns academic thesis/dissertation research interest into collaboration scope
- ▶ Provides INL access
- ▶ Encompasses student into Education Programs fostering an academic enhancement experience



# Summary INEST Year 2

- ▶ Added a new CORE
- ▶ ~\$3.2M LDRD Funds allocated towards 2012 INEST projects (7 new project starts)
- ▶ 36 Universities involved in INL LDRD projects
  - 16 in INEST LDRD projects
  - 4 NUC schools involved
- ▶ Collaborative Student Opportunities (Fellowships) under development



# Benefits

## TO INL:

- Sustained long-term relationship with a diverse university faculty
- Access to next generation nuclear scientists – workforce pipeline
- Program and capability development in critical areas
- Technical leadership in key energy technology areas critical to the nation

## TO UNIVERSITIES:

- Sustained long-term relationship with laboratory staff
- Ability to work in cross-disciplinary, cross-institutional teams on challenging problems
- Facilitate transfer of knowledge to the next generation of nuclear scientists
- Stable student support
- Technical leadership in key energy technology areas critical to the nation

## TO INDUSTRY:

- Establish centers of excellence driving industry-relevant technological breakthroughs and solutions in high risk areas
- Establish knowledge repositories in key technology areas
- Intellectual connections to laboratory and university staff

## TO THE NATION:

- Technological breakthroughs in high-risk, multiple discipline areas not covered under technology development programs.
- Establish stretch goals for science programs
- Workforce education, development, and mentorship
- Cross-disciplinary technology leadership

# Fuels and Materials CORE FY 2012 GOALS AND OBJECTIVES

- **Workshop Series**
  - May 2012 Uranium Fuel Science
  - Invite ~10 junior faculty new to INL as well as INL staff
- **Outreach Events**
  - March 2012 Regional Workshop (MIT)
  - Overview of INEST F&M CORE paired with MIT workshop on advanced fuels
- **LDRD Focus**
  - 2012 Uranium Fuel Science
- **New Fuels & Materials CORE white paper (set objectives for next three years after FY12)**

# Space Nuclear Power CORE

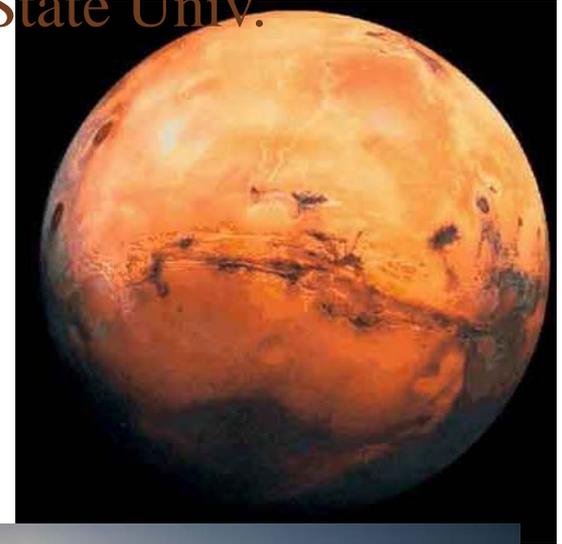
Steven D. Howe, CSNR/INL

Andrew Klein, Oregon State Univ.

The **mission** of the Space Nuclear Power CORE of the INL INEST is to develop the technology and people needed to implement space nuclear power and propulsion applications and to position INL and CSNR to be win major research programs in space power and propulsion from NASA, DOE, DOD and ESA as the programs become available.

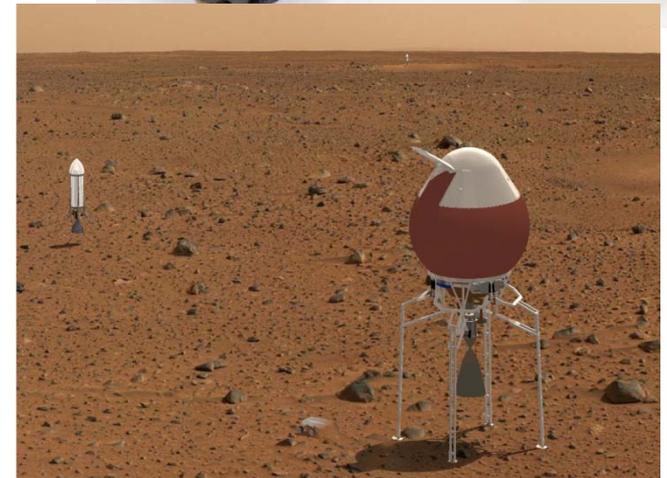
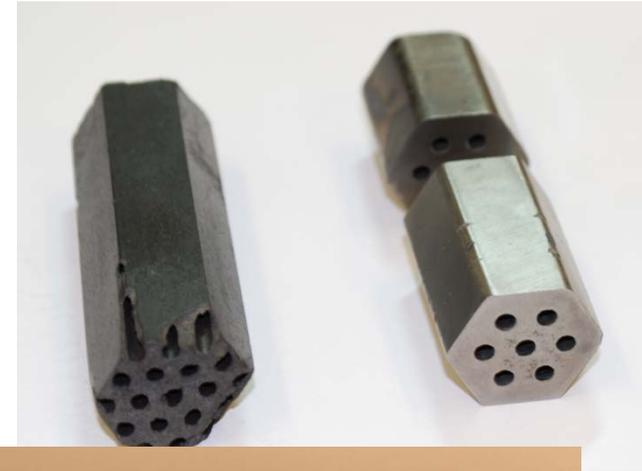
Current projects and sponsors

- 1) Mars Hopper prototype – INL LDRD
- 2) NTR fuel fabrication - Aerojet Corp



# SNP CORE SUMMARY

- Nuclear technologies enable missions with significantly higher performance than current technologies for space and planetary exploration
- The CSNR is developing new encapsulation technology that is applicable to several nuclear systems
- The Mars Hopper concept can revolutionize planetary exploration and provide dramatically greater science per launch dollar
- The SNP Core/CSNR has performed several mission studies that show the benefit of the NTR and the tungsten-cermet fuel
- The SNP CORE is working with universities and seeks more collaborations



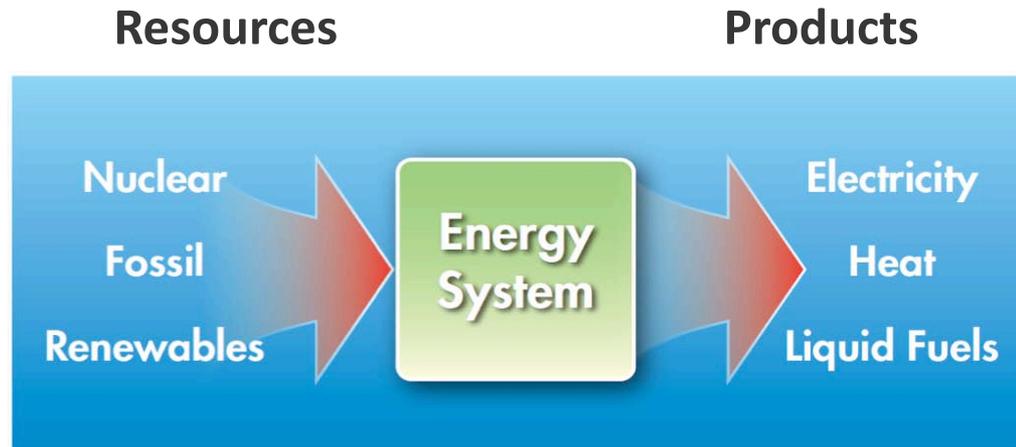
# Safety and Licensing Thrust Areas

- Redefined as the result of Fukushima accident
- Severe accident research
  - Advanced simulation
  - SAMG validation
- Risk-informed assessment of external events
- Risk-informed assessment of spent fuel storage alternatives
- Improved risk perspective
  - Societal risk (Societal Safety Goal Workshop in March)
  - Methods for the assessment of risk of passively safe reactors

# S&L LDRD Opportunity

- Currently funded research
  - Human reliability analysis
  - Bayesian approach to code validation
- Safety and Licensing CORE has targeted LDRD funds available for innovative safety and licensing research
- Rich Denning can help establish communications with potential INL collaborators
- 614 292-2544
- [denning.8@osu.edu](mailto:denning.8@osu.edu)

# Nuclear Hybrid Energy Systems CORE



## ➤ NHES CORE Mission

- Nurture strategic research partnerships between INL, academia, and industry to advance NHES
- Reduce technical, economic, and regulatory risk of NHES through targeted research
- Help train and recruit energy scientists
- Establish U.S. leadership in sustainable energy technologies

# Calendar

Date	Function
January 10-11	Fuel Cycle CORE Workshop Charlotte, SC
February 2	Space Power CORE Regional Outreach Ohio State University, Columbia, OH
February 21	Fuel Cycle CORE Regional Outreach Oregon State University, Corvallis OR
March 19-20	Nuclear Fuels and Materials Regional Outreach MIT, Cambridge, MA
March 20-21	Safety and Licensing CORE Regional Outreach and Workshop University of Maryland, Washington, DC
~April 4-5	Nuclear Hybrid Systems CORE Workshop Idaho Falls, ID
May 16-17	Nuclear Fuels and Materials CORE Workshop Idaho Falls, ID

# Background

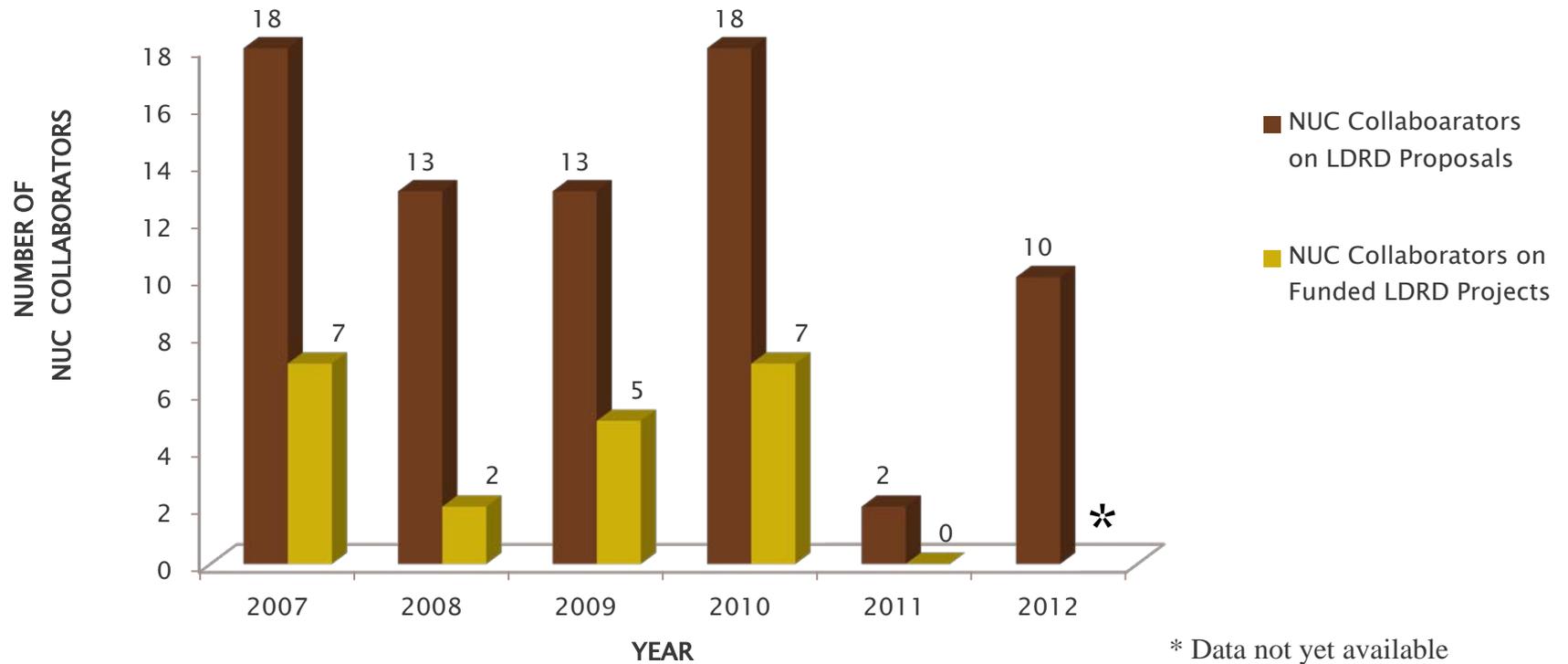


# INEST Measures of Success

MEASURE	STATUS
Publications including conference, journal, and special workshop reports	19
Pending Publications	30
Number of students/post-docs supported	38
Conference Talks	5
Staff exchanges	5
Intellectual Property (Patents or Invention Disclosures)	3
Community interface	3
External grants stimulated at partner institutions (BES, NSF, etc.)	2
Number of stimulated invited talks	1
Reports (similar to MIT Center for Advanced Nuclear Energy Studies (CANES) or National Laboratory Reports)	2

# NUC Engagement

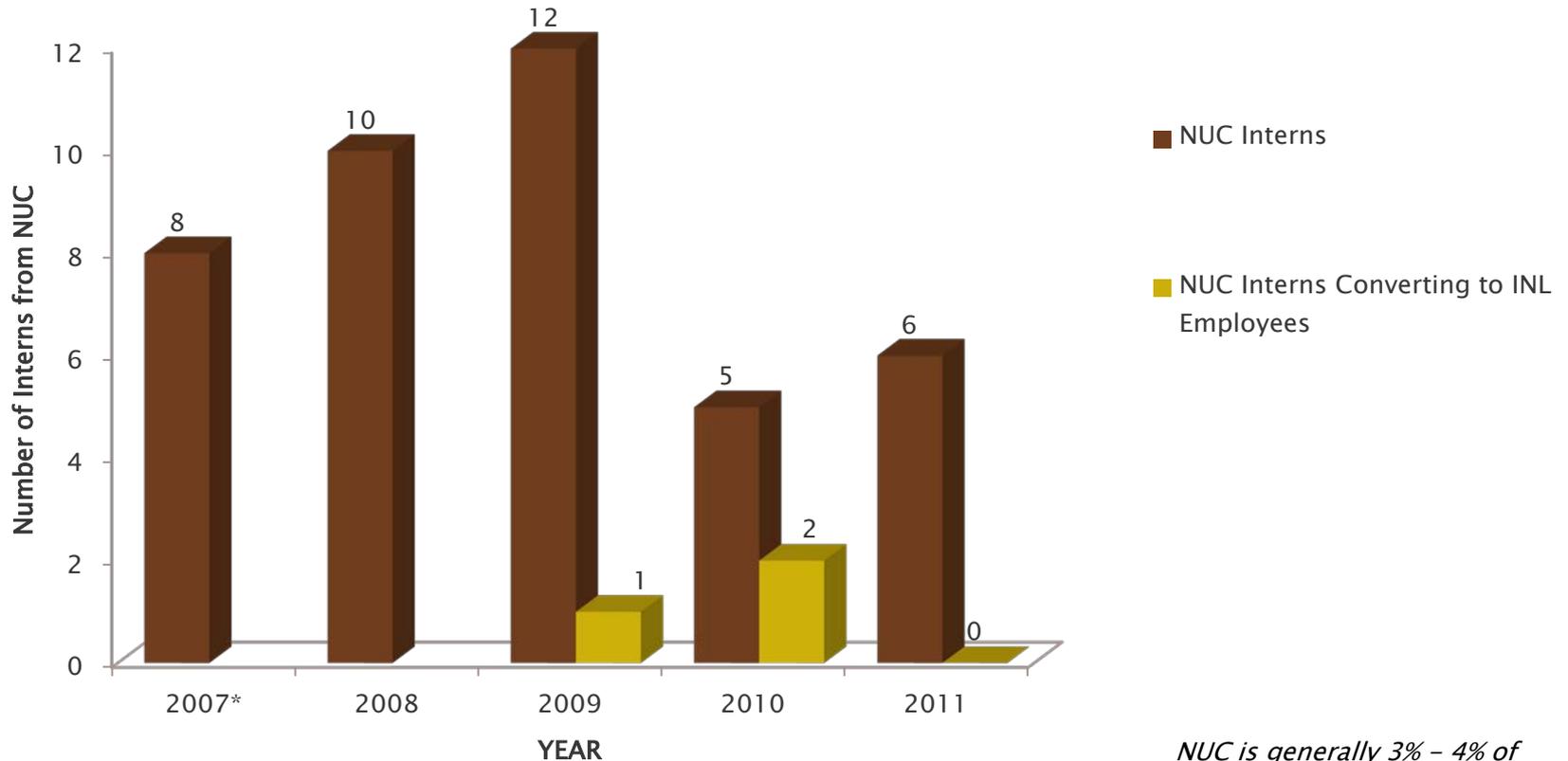
## NUC COLLABORATIONS ON LDRD New Starts Only



\* Data not yet available

# NUC Engagement

## NUC Internships



*NUC is generally 3% - 4% of total internships*

# NUC Engagement

NUC University Subcontracts New Starts

