ANNUAL REPORT
September 1, 2009 – August 31, 2010

NUCLEAR ENGINEERING AND
RADIOLOGICAL SCIENCES

University of Michigan
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Summary of Activities

This is the thirteenth Annual Report of the Nuclear Engineering and Radiological Sciences Department. The purpose of this report is to provide a record of teaching, research and service activities of the department.

The department faculty taught a total of 39 courses including special topics, independent study and doctoral research. Our undergraduate enrollment continued a rapid increase with 51 students in the NERS250, Fundamental of Nuclear Engineering and Radiological Sciences, (our introductory sophomore course for NERS majors) and 50 students in NERS311, Elements of Nuclear Engineering and Radiological Sciences (our junior level course). The NERS department awarded 39 BSE degrees and 9 Engineering Physics degrees. MS and MSE degrees were granted to 40 students. There were 9 PhD graduates in NERS.

This past year the undergraduate and graduate students were again successful in winning numerous awards. Four undergraduates were recipients of the National Academy for Nuclear Training (NANT) scholarships, thirteen received NEUP awards, and seven received American Nuclear Society (ANS) awards. Graduate students won seven fellowships from DoE, four from the National Science Foundation, four from the Nuclear Regulatory Commission, two from the National Physical Science Consortium, several from other federal agencies and professional societies, and two scholarships from ANS. In addition, many graduate students won college or department fellowships. This outstanding record of student accomplishments in attracting fellowships and scholarships will continue.

NERS faculty members continue to be recognized nationally and internationally. The American Nuclear Society presented Lumin Wang the Presidential Citation for establishing and developing a relationship between the ANS and the CNC (Chinese Nuclear Society). Rodney Ewing received Foreign Fellow status from the Royal Society of Canada. Mark Hammig received an award for the Second Best paper at the IEEE SE Michigan Nanotechnology Conference.

Faculty research continues its upward trend. Research expenditures for FY2009 reached 10.5 million dollars on some 144 external research projects from government and industry.
Faculty Honors and Awards
(January 1, 2009 – December 31, 2009)

Alex F. Bielajew
Nuclear Engineering and Radiological Sciences
Award for Outstanding Teacher
(Selected by NERS students for contributions to undergraduate and graduate education.)

Rodney C. Ewing
Royal Society of Canada
Foreign Fellow

John Foster
NASA
Faculty Fellow Award

Mark Hammig
IEEE
2nd Best Paper Presented at IEEE SE Michigan Nanotechnology Conference

Lumin Wang
American Nuclear Society
Presidential Citation for establishing and developing a relationship between the ANS and the CNC (Chinese Nuclear Society)
Student Organizations

ALPHA NU SIGMA SOCIETY

As the national honor society for NERS, the mission of the Alpha Nu Sigma Society is to “recognize high scholarship, integrity, and potential achievement in applied nuclear science and nuclear engineering among outstanding students by means of membership in the Society.”

Alpha Nu Sigma provides tutoring to help students with NERS classes. Any student within the department or taking a departmental course is eligible to use these services. At least one tutor is available five days a week to help answer questions. This program has the ability to evolve to meet student needs.

Additionally, members travel to local high schools to educate students on emerging nuclear technology, and inform them of the U-M NERS program. Another goal of the society is working alleviate fears concerning nuclear technology in the general public.

Since 1993, the Chapter has recognized a faculty member for contributions to undergraduate and graduate education. Professor Alex F. Bielajew was selected by the students as the 2009-10 recipient of the NERS Award for Outstanding Teacher.

AMERICAN NUCLEAR SOCIETY

The 2009-2010 year was a busy and successful one for U-M ANS. With increased enrollment in the NERS Department, membership in the student chapter also increased. U-M ANS participated in many outreach activities to promote nuclear science and technology. Some of these included the UM Energy Fest, Detroit Area Pre-College Engineering Program, Springfest, and Tech Day. In addition, student members also assisted the NERS Department at various campus recruiting events and welcome days.

A significant portion of the year, however, was devoted to the preparation of the National ANS Student Conference that the U-M ANS Student Chapter hosted in April, 2010. The article below, from NERS Notes 2011, is adapted in part with permission from the ANS Student Conference write up that appeared in the May-June 2010 issue of ANS News, published by the American Nuclear Society:
The 2010 ANS Student Conference, hosted April 8–11 by the UM Student Section of the Eagle Crest Conference Center, in Ypsilanti, Michigan, welcomed 665 attendees, the largest number in the history of the student conference.

“The conference’s size is a pretty good leading indicator of overall industry health,” said Darby Kimball, ANS Student Sections Committee chair, attributing the conference’s success to the leadership of Michaela Eddy and Travis Trahan, co-chairs of the conference. In keeping with the theme, “Coming Together to Split the Atom,” a special public forum brought together nearly 400 conference attendees and community members for a town-hall discussion with a panel of experts on nuclear energy. Other highlights of the conference were 157 student presentations on subjects ranging from nuclear policy to medical isotropes, six workshops, three panel discussions, tours and a career fair. There was even time for some well-deserved social activities such as a golf tournament, and an awards banquet held aboard the Detroit Princess Riverboat. “Students of all class standings, faculty and staff all pulled together to create the most professional ANS Student Conference to-date. With all the time that we spent together, and the challenges we worked through, we really learned the value of calling the NERS department our own,” says Eddy.

HEALTH PHYSICS SOCIETY

The University of Michigan student branch of the Health Physics Society was among the charter groups of student chapters formed in 1992. The Health Physics Society is dedicated to the development, dissemination and application of both the scientific knowledge of and the practical means for radiation protection. It places a strong emphasis on protection of people and the environment from unnecessary exposure to radiation. The student branch has been involved in a number of professional activities, parties, seminars, and public relation activities, including tours of radiation oncology and radiology departments. In addition, the Health Physics Society has been focused strongly on developing relations with other societies holding similar interests, such as the American Nuclear Society student chapter at the University of Michigan.
THE INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT (INMM)

The University of Michigan student chapter works to promote the INMM mission by hosting professional speakers, facilitating panels and discussions, as well as providing opportunities to increase awareness and education on the importance of nuclear materials management. The Michigan Student Chapter of the INMM was founded in the fall of 2008.

The mission of INMM as a whole is to promote the advancement and research in the area of nuclear materials management as well as implementing standards regarding professional ethics, education, and attainment of those engaged in the nuclear materials management field. Lastly, the organization strives to increase the distribution of information regarding the management of nuclear materials. The purpose of the student chapter is therefore to foster and promote these international goals.

The first full academic year as a student organization was extremely successful. The chapter was able to present six different experts from a variety of research institutions. The speakers presented on a wide variety of related topics from the “History of the Discovery of Fission to Today's Challenges in Safeguarding Nuclear Materials” to a presentation on “Lead Slowing-Down Spectrometry for the Direct Measurement of Pu in Spent Fuel.” Presenters included Prof. Sara Pozzi (University of Michigan), Dr. Alan Icenhour (Oak Ridge National Lab), Dr. Robert Mayo (Applied Physics Laboratory at Johns Hopkins), Dr. Brian Boyer (Los Alamos National Lab), Dr. Eric Smith (Pacific Northwest National Lab), and Dr. Ross Williams (Lawrence Livermore National Laboratory). In addition to hosting speakers, the chapter, with the help of the national INMM, arranged a lunch presentation at the American Nuclear Society student conference.

The mission of INMM as a whole is to promote the advancement and research in the area of nuclear materials management as well as implementing standards regarding professional ethics, education, and attainment of those engaged in the nuclear materials management field. Lastly, the organization strives to increase the distribution of information regarding the management of nuclear materials. The purpose of the student chapter is therefore to foster and promote these international goals.

The University of Michigan student chapter intends to promote the INMM mission by hosting professional speakers, facilitating panels and discussions, as well as providing opportunities to further learn the importance of nuclear materials management firsthand.
PROGRAM CHANGES

There were multiple changes made to the curriculum and courses during AY 09-10.

NERS 490 (Special Topics Course) will change from 1-3 credits to 1-4 credits.

NERS 583 (Applied Radiation Dose Assessment) will change from 4 to 3 credits. Reduction in credit hours will eliminate duplication of course materials.

NERSL 586 (Applied Radiological measurements) will change from 4 to 3 credits. Reduction in credit hours will eliminate duplication of course material. This course will still be allowed to fulfill the senior lab requirement. However, students would have to increase NERS elective credits by 1 credit hour.

NERS 590 (Thermal Fluids for Nuclear Reactor Safety Analysis) taught by Tom Downar was approved for a regular course as NERS 546. Co-requisites were determined in order to this course to be an option for seniors and graduate students. Course is predominantly taken by graduate students.

NERS 590 (Plasma Engineering) taught by John Foster was approved for a regular course as NERS 573. Course is predominately taken by graduate students but may be considered as an option for seniors.

In addition, major time and efforts have focused on preparing for the Self-Study Report for ABET and the ABET Site-Visit.
## COURSES OFFERED*

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<th>CREDIT HRS</th>
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<td>Nuclear Engineering Materials</td>
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<td>Applications of Radiation</td>
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<td>NERS 441</td>
<td>Nuclear Reactor Theory I</td>
<td>I</td>
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<td>Nuclear Power Reactors</td>
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<td>Reactor Safety Analysis</td>
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<td>NERS 471</td>
<td>Introduction to Plasmas</td>
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<td>Fusion Reactor Technology</td>
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*Roman numeral indicates term(s) the course will be offered, and number in parentheses indicates credit hours. Fall term, I; Winter term, II; Spring/Summer terms, III A/B
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# COURSE ENROLLMENTS

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Student Academics, Honors and Employment

AWARDS AND HONORS
MADE IN 2009 FOR A/Y 2009-2010

Undergraduate Scholarships for A/Y 2009-2010

• Second Year Undergraduate Merit Scholarship
  Geoffrey Gunow
  Matthew Marcath
  Hudson Rowland
  Brett Hasson

• Kikuchi Scholarship
  Lee Gunderson
  Marissa Mantey

• American Nuclear Society Undergraduate Scholarship Award
  Ross Barnowski
  Katelyn Bevier
  David Genevich
  Archis Joglekar
  Heeho Park
  Patricia Schuster

• American Nuclear Society Undergraduate Scholarship Award – Michigan Section
  Patricia Schuster

• National Academy for Nuclear Training Scholarship
  Justin Ball
  Navneet Gill
  Joshua Meisel
  Marcus Rivard

• NEUP Award
  Ginger Anderson
  Ross Barnowski
  Tyler DeVries-Wallace
David Genevich
Lee Gunderson
Geoffrey Gunow
Dyle Henning
Andrew Lacharite
Brian Linn
Andrew McKelvey
Andrew Patton
J. Kyle Polack
Patricia Schuster

• Class of 1931E Scholarship
  Ross Barnowski
• Richard Earhart Scholarship
  Hiruy Hadgu
• Ettie Cohen Sheiman Scholarship
  Andrew McKelvey
• Clarence E. Groesbeck Memorial Scholarship
  Benjamin Van Eck
• Joseph B. and Florence V. Cejka Scholarship
  Brian Linn
• Budd Student Aid Fund
  David Genevich
  Heeho Park
• Carroll J. Haas Endowed Scholarship
  Abu Shakil
• David Aspland Scholarship
  Justin Dorazio
• CoE Gift Funds
  Archis Joglekar
• James D. Butt Scholarship Fund
  Jeffrey Chenhall
• Darl F. and Lorene O. Caris Dean’s Scholar Award
  Andrew Till
• Bernard J. and Ronni S. Lacroute Scholarship
  Marc Becchetti
• CoE General Fund
Sam Beck  
Dyle Henning  
Ross Barnowski

- John S. King Scholarship Fund  
  Sam Beck
- Jane Morris Soop Engineering Scholarship  
  Sam Beck
- Joseph M. Geisinger Scholarship  
  Ross Barnowski
- Walter G. Mitchell Memorial Scholarship  
  Jeffrey Chenhall  
  Marcus Rivard
- Michigan Engineering Fund  
  Joshua Mann
- Edward H. Strohm Scholarship in Engineering  
  Joshua Mann

**Undergraduate Honors and Awards 2009-2010**

- Outstanding Undergraduate Student Award (Engineering Physics)  
  Aaron Rocca
- Outstanding Undergraduate Student Award (Nuclear Engineering and Radiological Sciences)  
  Andrew Till
- Distinguished Leadership Award  
  Maggie Hwang
- Cooley Writing Prize (Essay Division)  
  Andrew Patton
- MEPO New Student Achievement Award  
  Jejuan Toney

**Graduate Fellowships for AY 2009-2010**

- American Nuclear Society Graduate Awards  
  Emily Wolters, Travis Trahan
- American Society for Engineering Education, NASA  
  Eric Gillman
- College of Engineering Dean’s/Named Fellowship
Soren Taverniers, Aaron Wysocki
- College of Engineering Regent’s Fellowship
  Matthew Orians
- Directed Energy Professional Society
  David French
- Graduate Student Research Program, Marshall Space Flight Center
  Brandon Weatherford
- Michigan Institute for Plasma Science and Engineering
  Paul Cummings, David French, Matthew Gomez, Brad Sommers, Calvin Zulick
- NASA Aeronautics Fellowship
  Eric Gillman
- National Academy for Nuclear Training in Nuclear Engineering Fellowship
  Justin Lamy
- National Physical Sciences Consortium Fellowship
  Jacob Zier, Sonal Patel
- National Science Foundation Fellowship
  Seth Johnson, Michaela Eddy, Aimee Hubble, Jeffrey Katalenich
- Nuclear Regulatory Commission Fellowship
  Adam Hoff, Andrew Paviou, Andrew Hall, Scott Pfeffer
- Rackham Engineering Award Fellowship (renewed)
  Margaret Bacon, Efrain Hernandez-Rivera, Timothy Watson, Kaylie Thompson
- Rackham Presidential Fellowship
  Troy Becker
- Rackham Graduate Student Research Grant
  Jonathan Wierschke
- Rackham Karen and Paul Van Weelden Award
  Bryan Toth
- Rackham Pre-Doctoral Fellowship
  Emily Wolters
- U.S. Department of Energy Admiral Hyman Rickover Graduate Fellowship
  Bryan Toth
- U.S. Department of Energy Advanced Fuel Cycle Initiative, University Fellowship Program
  Andrew Wysocki
- U.S. Department of Energy Computational Science Graduate Fellowship
  Travis Trahan
- U.S. Department of Energy Forensics Fellowship
  Eric Miller
• U.S. Department of Energy Nuclear Energy University Program
  Christopher Perfetti, Tim Drzewiecki
• U.S. Department of Energy National Nuclear Security Administration
  Stewardship Science Graduate Fellowship
  Matthew Gomez
• U.S. Department of Defense National Defense Science and Engineering Fellowship
  David French, Jeffrey Katalenich, Aimee Hubble

**Graduate Honors and Awards for 2009-2010**

• College of Engineering Distinguished Achievement Award
  Matthew Gomez
• College of Engineering Distinguished Leadership Award
  Efrain Hernandez-Rivera, William Kaye
• College of Engineering Tom S. Rice Tau Beta Pi Award
  Yvan Boucher
• College of Engineering Marian Sarah Parker Prize
  Jennifer Dolan
DEGREES AWARDED BY ACADEMIC YEAR

September 2009 through August 2010

Degree Number

BSE in Nuclear Engineering and Radiological Sciences 39
BSE in Engineering Physics 9
MSE and MS in Nuclear Engineering and Radiological Sciences 40
(including 16 students continuing in doctoral program)
PhD in Nuclear Engineering and Radiological Sciences, and in Nuclear Science 9
Professional Degree (Nuclear Engineer)
### DOCTORAL THESES TITLES

**For Degrees Conferred September 2009—August 2010**

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<th>STUDENT</th>
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<td>Troy Becker</td>
<td>Hybrid Monte Carlo/Deterministic Methods for Radiation Shielding Problems.</td>
<td>Edward W. Larsen</td>
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<td>Jesse Cheatham</td>
<td>Truncation Analysis and Numerical Method Improvements for the Thermal Radiative Transfer Equations.</td>
<td>James P. Holloway</td>
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<td>Jeremy Conlin</td>
<td>Explicitly Restarted Arnoldi’s Method for Monte Carlo Nuclear Criticality Calculations.</td>
<td>James P. Holloway</td>
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<td>Gregory Davidson</td>
<td>Time-Dependent Radiation Transport Using the Staggered-Block Jacobi Method.</td>
<td>Edward W. Larsen</td>
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<td>Hao Jiang</td>
<td>Improvement of Ion-Beam Energy Resolution in a Solenoid-based Radioactive Nuclear Beam Facility.</td>
<td>Kimberlee Kearfott/Fred Becchetti</td>
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<td>Alejandro Perez-Bergquest</td>
<td>Ion Irradiation-Induced Porous Structures in Amorphous Semiconductors</td>
<td>Lumin Wang</td>
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<td>Elaine West</td>
<td>Influence of Local Stresses and Strain Incompatibilities on Intergranular Cracking of 316L Stainless Steel in Supercritical Water</td>
<td>Gary S. Was</td>
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<td>Haori Yang</td>
<td>Active Interrogation Methods for Detection of Special Nuclear Material.</td>
<td>David K Wehe</td>
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## FALL ENROLLMENT

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## EMPLOYMENT STATISTICS
### AND CONTINUING EDUCATION

**Place of First Employment of Graduates**
**September 2009 – August 2010**

### Undergraduate Students

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<td>George Fegert</td>
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<td>LeeAnn Baker</td>
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<tr>
<td>Norfolk Naval Shipyard</td>
<td>Jason Fernandez</td>
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<tr>
<td>US Navy</td>
<td>Robert Szczpankiewicz</td>
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<tr>
<td>Exelon</td>
<td>Curtis Dauw</td>
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<tr>
<td>GE Hitachi</td>
<td>Maggie Hwang</td>
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<tr>
<td>TVA</td>
<td>Christine Seifert</td>
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<td>Westinghouse</td>
<td>Rachel Eggert</td>
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<td>ERIN Engineering</td>
<td>Joshua Meisel</td>
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<tr>
<td>Reliability &amp; Safety Consulting Engineers</td>
<td>Casandra Ruch</td>
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<td>Takeshi Koike</td>
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<td>Defense Nuclear Facility Safety Board</td>
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<td>Kurt Swieringa</td>
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<td>University of Michigan</td>
<td>Nathan Bennett</td>
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<td>Kyle McMillian</td>
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Washington State University
Wayne State University
Other Graduate Schools (unknown)

Kyle Polack
Jacob Steffes
Jason Storey
Matthew Weiss
Sarah Williams
Amber Donley
Robyn Spink
Soo Jo
Geoffrey Greening
Michael Dvorak

EMPLOYMENT OUTSIDE PROFESSION
Peace Corps
Brian Crispin

UNKNOWN

BSE STUDENT
Paul Stanczak
Amir Alawi
Justin Bass
Laura Gallagher
Mahima Gupta
Brian Linn
Mark Roberts
## Graduate Student Employment for 2009-2010

### Graduate Students

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Edward Cruz
Matthew Franzi*
Efrain Hernandez-Rivera
Adam Hoffman
Aimee Hubble
Sonal Joshi
Blake Kelley
Brian Kitchen
Eric Miller
Ian Rittersdorf
William Schumaker
Jonathan Wierschke
Carlos Di Stefano
Jia Hou
Scott Ambers
Weixing Li

UM Physics
Purdue University
UC Berkeley
UM – Materials Science in Engineering
## Internships

### Undergraduate

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## Employment Patterns of Graduates
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<td>Outside the Box: Opportunities for Engineers and Scientists in Washington, DC</td>
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Research Activities

FISSION SYSTEMS AND RADIATION TRANSPORT

Genetic Algorithms to Identify Optimal Material Arrangement for Shielding High Energy Photons
J. P. Holloway, PI
DTRA
$388,563/3 yrs

This project is examining the use of genetic algorithms to develop light-weight “wearable” gamma radiation shields for first-responders in an area contaminated by a radiological dispersion device or a nuclear explosion. The goal is to see if genetic algorithms can develop unique material layering schemes that minimizes weight and overall thickness while still providing acceptable dose reduction. In addition, we wish to establish that these designs are robust against uncertainty in the gamma spectrum.

Radiation Transport Methods Research for Stochastic Media and Semi-Implicit Time Discretizations
E. W. Larsen, PI
U.S. Department of Energy/LANL
$69,000/1 yr

The goal of this work is to research and develop new numerical methods for radiation transport that are more accurate or are obtained more efficiently.

The first area of proposed work is to research and develop a numerical transport method for electron transport through stochastic media, such as the human lung. Atomically mixing the different materials gives the incorrect solution under most situations. Incorrect solutions adversely affect the probability of cure in radiation cancer therapy treatments. For large, multi-physics simulations, incorrect atomic-mix solutions represent wasted computational effort because the errors cannot be corrected by increasing the resolution in other independent variables. By exploring ways to extend the atomic mix model to improve its accuracy, new methods can be formed that hopefully will improve accuracy without substantially changing the existing infrastructure of transport software.
The second area of work is to investigate explicit and semi-implicit time discretization methods for deterministic thermal radiation transport. The successful implementation of these methods into existing ASC codes should allow the execution of high-fidelity problems that cannot be run with current methods on existing computing platforms. The possible gains with this approach are application of high-order transport to new mesh geometries, dramatically reduced memory requirements, and speed performance at least equal to that of current transport technology.


**Hybrid Monte Carlo/Deterministic Radiation Transport Simulations for Source-Detector Problems**

E. W. Larsen, PI  
U.S. Department of Energy (NA-22)/Oregon State University  
$320,000/3$ yrs

**A New 2D-Transport 1D-Diffusion Approximation of the Boltzmann Transport Equation**

E. W. Larsen, PI and T. Downar, Co-PI  
U. S. Department of Energy (NEUP 09-815)  
$391,000/3$ yrs
The Suppression of Energy Discretization Errors in Multigroup Transport Calculations
E. W. Larsen, PI and W. R. Martin, Co-PI
U. S. Department of Energy (NEUP 09-839)
$483,000/3 yrs

An Advanced Neutronic Analysis Toolkit with In-line Monte Carlo Capability for VHTR Analysis
W. R. Martin, PI and J. C. Lee, Co-PI
U.S. Department of Energy/NERI
$600,000/3 yrs

The goal of this project is to develop, implement, and test a lattice physics code for very high temperature reactor (VHTR) neutronic design and analysis. This code is based on a production-quality lattice physics code used in LWR analysis and is augmented by Monte Carlo capability to treat resonance absorption in TRISO particle fuel. The approach takes advantage of the highly developed capabilities available for light water reactor neutronic analysis, in which lattice physics codes generate effective cross sections at the assembly level. These cross sections can be used in nodal codes to allow efficient calculation of global flux/power distributions and keff as a function of fuel depletion and temperature.

This project will incorporate the capability of the nodal Monte Carlo code, MCNP5, directly into the lattice code, CPM-3, to establish "proof-of-principle." Code linking will be accomplished through an interface that will enable the MCNP5 capability to be extensible to other cross-section generation codes as well. This capability will be demonstrated by linking MCNP5 to CASMO-4. The resultant package will inherit the substantial downstream capabilities of CASMO-SIMULATE, including cross-section generation for global nodal analysis and depletion, systematic preparation of cross-section sets for accident analysis, and efficient fuel cycle analyses and assessment of alternative fuel management schemes. The final result will be a validated neutronics methodology for VHTR design and analysis, including cross-section generation, global reactor analysis, depletion, and fuel management.

Collaborating Organizations: Studsvik of America, Idaho National Laboratory, Los Alamos National Laboratory, General Atomics, Oak Ridge National Laboratory, and TransWare Enterprises, Inc.


Technical Challenges of Plug-In Hybrid Electric Vehicles and Impacts to the U. S. Power System
G. S. Was, PI, P. Sweatman and J. C. Lee, Co-PIs
Pacific Northwest National Laboratory/ U. S. Department of Energy
$1,000,000/24 mos

As part of this multi-disciplinary consortium headed by the Pacific Northwest National Laboratory, our effort has been to develop a stochastic model to evaluate the performance of the electric distribution system subject to large-scale deployment of plug-in electric vehicles. The project aims to adapt the probabilistic risk assessment (PRA) techniques, developed for nuclear power plants, to the reliability analysis of the electric grid. Initial effort has been successfully made to develop a PRA model of the grid via the SAPHIRE code.

Adaptation of the SHARP Modeling and Simulation Capability for the VHTR Development and Design
W. R. Martin, T. J. Downar, E. W. Larsen, and J. C. Lee, Co-PIs
Argonne National Laboratory
$199,928/1 yr

The project consisted of several tasks to develop and demonstrate Monte Carlo capability for SHARP that will be applicable to VHTR configurations. This includes (1)
VHTR benchmarks, (2) hybrid deterministic-Monte Carlo transport methodology, (3) generation of multigroup cross sections from Monte Carlo calculations, (4) coupled nuclear-thermal-hydraulic methodology for VHTR, and (5) determination of anisotropic diffusion coefficients for full-core VHTR calculations.

**Creation of a Full-core HTR Benchmark with the Fort St. Vrain Initial Core and Validation of the DHF Method with Helios for NGNP Configurations**
W. R. Martin and J. C. Lee, Co-PIs
U.S. Department of Energy/NEUP
$421,288/2 yrs

This project will develop a benchmark computer model based on the physics test date from the Fort St. Vrain high-temperature gas-cooled reactor. The Monte Carlo capability developed under a previous NERI grant will provide the basis for the project work.
MATERIALS

Structure, Properties and Relaxation of Shear Bands in Metallic Glasses
M. Atzmon, PI
National Science Foundation, Division of Materials Research
$426,898/4 yrs

In crystalline solids, the atomic scale structure has been understood for a long time. On the other hand, the structure of some nonequilibrium materials is still the subject of current research. In amorphous materials, the density is variable and is a function of the thermomechanical history. Structural relaxation has a significant effect on the properties. Since mechanical deformation introduces shear bands whose density is lower than that of the matrix, it is important to understand their structure and effect on mechanical and transport properties. In recent work, the anelastic deformation of metallic glasses has been used to characterize defects produced by permanent deformation. One significant result is the existence of at least four distinct types of anelastic sites, in contrast to the two types generally-assumed in the glass-science community.


Particle-Induced Amorphization of Complex Ceramics: Structural and Bonding Controls
R. C. Ewing, PI and L. M. Wang, Co-PI
H. Xiao, Visiting Research Investigator; W. Li, Grad. Student (MSE);
and J. Lian, Assistant Research Scientist (GeoSciences)
U.S. Department of Energy, Office of Basic Energy Sciences
$853,201/3.5 yrs

The crystalline-to-amorphous (c-a) phase transition is of fundamental importance. Particle irradiations provide a highly controlled means of investigating this phase transformation and the structure of the amorphous state. The interaction of heavy-particles (alpha-recoil nuclei, fission fragments and implanted ions) with ceramics is complex because these materials have a wide range of structure types, complex compositions, and because chemical bonding is variable (not only from structure-type to structure-type, but also within a single structure). Radiation damage and annealing can produce diverse results, but most commonly, single crystals become aperiodic (the metamict state) or break down into a polycrystalline aggregate (sometimes not the same as the original phase). In this research program, the transitions from the periodic to aperiodic state of various nonmetallic materials (both natural and synthetic) are studied by detailed x-ray diffraction analysis, in-situ transmission electron microscopy, high resolution transmission electron microscopy, x-ray photoelectron spectroscopy,
extended x-ray absorption fine structure spectroscopy/x-ray absorption near edge spectroscopy and other spectroscopic techniques. A theoretical model is also being developed to predict the relative susceptibility of ceramic materials to radiation-induced amorphization based on the experimental results.


**Enhancing the Research and Teaching Capabilities of the University of Michigan to Support the Expansion of the Nuclear Industry**

M. R. Hartman, PI and G. S. Was, Co-PI
U.S. Department of Energy
$228,927/yr

**Accelerator-Based Study of Irradiation Creep of Pyrolytic Carbon Used in TRISO Fuel Particles for Very High Temperature Reactors (VHTR)**

L. M. Wang, PI and G. S. Was, Co-PI; R. S. Zhou, Post-doctoral Scholar and A. Davis, Graduate Student
U.S. Department of Energy, Nuclear Energy Research Initiative (NERI)
$616,851/3 yrs
Pyrolytic carbon (PyC) is one of the structural materials in the TRISO fuel particles which will be used in the next generation of gas-cooled very-high-temperature reactors. When the TRISO particles are under irradiation, creep of the pyrocarbon layers can cause radial cracking leading to catastrophic particle failure. Therefore, a fundamental understanding of the creep behavior of PyC during irradiation is required to predict the overall fuel performance.

The primary objective of this project is to characterize the creep behavior of PyC through a systematic program of accelerator-based proton irradiation and in-situ measurements under stress at various temperatures between 400°C and 1,200°C. Test data will be analyzed to determine creep coefficients, which will then be correlated to existing coefficients measured under neutron irradiation. In addition, initial experiments on the transport of select fission products (e.g., Ag and Sr) in PyC under irradiation and stress will be conducted by implanting ions into the sample surface. The PyC microstructure will be studied with advanced analytical transmission electron microscopy (TEM).

**Nanostructure Patterning Under Energetic Particle Irradiation**

L. M. Wang, PI  
U.S. Department of Energy, Office of Basic Sciences  
$517,493/4 yrs

**Consortium on Cladding and Structural Materials for Advanced Nuclear Energy Systems**

G. S. Was, PI and L. M. Wang, Co PI; with U. Wisconsin, U. C. Berkley, U. C. Santa Barbara, Penn State Univ., and Alabama A&M  
Cheng Xu, graduate student  
U.S. Department of Energy, Nuclear Energy Research Initiative (NERI) and Electric Power Research Institute  
$3,500,000/3 yrs

The goal of this consortium is to address key materials issues in the most promising advanced reactor concepts that are yet to be resolved, or that are beyond the existing experience (dose/burnup) base, in order to 1) provide for a sound fundamental and engineering basis for operation in the intended application, 2) bring together key university, national laboratory and industry capability and support in order to provide the most comprehensive approach possible, and 3) create a long term, evolutionary program that seeks to address these and future nuclear materials issues in a
progressive manner. This consortium will serve as a nucleation site, about which materials research activities will be catalyzed and grown among the leading individuals and institutions from academia, the national laboratories and industry. It represents an unprecedented opportunity to combine expertise and facilities in an effort to attack the challenge of materials behavior under irradiation on a scale that is not feasible for a single individual or institution.

The objectives of the initial three-year phase of the consortium are to:

- Develop an understanding of the high dose radiation stability of candidate sodium fast reactor (SFR) cladding and duct alloys under a range of temperatures and doses expected in the SFR, using a closely integrated program combining targeted charged particle and neutron irradiations, in-situ irradiation and computer simulation of defect microstructure
- Determine the stability of oxide dispersion strengthened (ODS) steel and ultrafine, precipitation strengthened (HT-UPS) austenitic steel
- Characterize and understand the mechanisms of irradiation creep in SiC in TRISO fuel, ferritic-martensitic (F-M) alloys and ODS and UT-UPS steels
- Develop barrier layers for protection of F-M alloys from fuel-clad chemical interaction, and of alloy 617 from attack by coolant impurities in the VHTR intermediate heat exchanger
- Develop modeling tools to explain the behavior of F-M steels under irradiation, and predictive tools to extend the reach of our understanding beyond the experimental database

The objectives will be accomplished in a research program consisting of three major thrusts: 1) high dose radiation stability of advanced fast reactor fuel cladding alloys, 2) irradiation creep at high temperature and 3) innovative cladding concepts embodying functionally-graded barrier materials. While the initial three-year program will emphasize ion irradiation and irradiated microstructures, we expect that, if successful, the second three-year program will increasingly emphasize reactor irradiations and will include mechanical property determination through national user facilities.

Industry partners (EPRI and GE) will utilize the core program as leverage to guide or support additional activities that are of special interest to them, and that fall within the scope of the core program. National laboratory partners (ANL, INL, LANL, ORNL and PNNL) will provide additional capability and direction to various aspects of the core program that are of interest to them. Our technical society partner, ASME, will introduce the data generated by the consortium into the ASME Codes & Standards (C&S) process.

Beyond scientific achievements, this consortium will provide substantial additional outcomes that are expected to provide long term benefits to the advanced reactor program, including the education of around eight graduate students and several post-
docs, inclusion of minority students into the radiation effects and reactor materials fields through the participation of Alabama A&M University (a HBCU institution), creation of new working relationships between universities, laboratories and industry in an unprecedented manner and to an unprecedented degree, and establishment of a pathway to begin to incorporate data generated by the research thrusts into the ASME codes and standards that will be crucial for success of the advanced reactor programs.


**Ion Irradiation-Induced Degradation of Reactor Structural Materials**
G. S. Was, PI
Institute for Nuclear Safety Systems
$150,000/3 yrs

**Potential for Atom Probe Tomography in Understanding IASCC**
G. S. Was, PI and Z. Jiao, Co-PI
Electric Power Research Institute (EPRI)
$252,700/3 yrs

Irradiation assisted stress corrosion cracking (IASCC) refers to intergranular stress corrosion cracking (IGSCC) that is enhanced or accelerated by irradiation over the unirradiated state in light water reactor core components. IASCC has been a problem in the nuclear industry for over 30 years. It is the primary form of core component cracking in boiling water reactors (BWR). It is also an issue of growing importance in pressurized water reactors (PWR). It is probably the most severe potential problem in the supercritical water reactor concept of the DOE Generation IV program. An understanding of the mechanism of IASCC is required in order to provide guidance for the development of mitigation strategies in all these reactors.

Conventional tools such as SEM, TEM, and AES etc. have proved very useful in studying IASCC mechanism within their limitations. Atom probe field-ion microscope (AP-FIM) was proposed in the study of the interaction of impurity atoms with defects in late 1970’s. Since then, atom probe has emerged as a complementary tool in studying nuclear structural materials, especially in the field of radiation induced segregation.
Early atom probes are very limited by their design and data collection and processing power. In recent years, atom probes have been significantly improved. Data collection and processing are no longer a bottleneck with modern computers. A large volume of atoms on the order of $10^6$ nm$^3$ can be analyzed in a significantly short time. The application of atom probe as a complementary tool in the study of IASCC mechanism becomes more practical and important.

The objective of this project is to explore the potential of atom probe tomography (APT) as a tool for understanding the mechanism of irradiation assisted stress corrosion cracking of austenitic alloys in light water reactor core components.

**Localized Deformation in IASCC**
G. S. Was, PI
Electric Power Research Institute
$60,000/3$ yrs

**Radiation-Induced Segregation and Phase Stability in Candidate Alloys for the Advanced Burner Reactor**
G. S. Was, PI; J. Peniste, Graduate student
U.S. Department of Energy, Nuclear Energy Research Initiative (NERI)
$750,000/3$ yrs

The primary objective of this project is to investigate the effect of irradiation on the segregation and phase stability in candidate alloys proposed for application as structural materials for transmutation in the advanced burner reactor. The project will focus on two ferritic-martensitic alloys, and will also include an experimental ODS alloy and an advanced austenitic alloy in a coordinated experimental and modeling effort to investigate the complex electronic–magnetic–elastic interactions between Cr and radiation induced defects controlling radiation induced segregation in F-M alloys. This project will provide a mechanistic understanding of segregation and phase stability that can be used to develop predictive irradiation performance models. It will also provide data against which forthcoming in-reactor irradiations can be interpreted and understood, as well as guidance and direction for those experiments.

This proposal is centered on the two F-M alloys; T91 and HT-9 as both are viable candidates for the ABTR and form the basis for more advanced alloys for the ABR, and will focus on Cr RIS and phase stability in these alloys under irradiation, as these are potentially limiting processes for their application. However, the full, irradiated
microstructure needs to be considered as the radiation effects processes are interrelated. Also included in the workscope is a ferritic ODS alloy because of its superior irradiated microstructure stability and strength. In addition, an advanced austenitic candidate alloy, D9, is included because it is the leading austenitic alloy, and yet it potentially can suffer from RIS (of Si) and the formation of deleterious phases (silicides) that could affect performance. Experiments will be conducted by proton and heavy ion irradiation over the dose range 3-100 dpa and the temperature range 350-550°C with the inclusion of He at the highest doses. Analysis of RIS, phase microstructure, dislocation microstructure and hardening will be conducted on all conditions to provide a systematic set of data.

The modeling tasks will involve ab-initio electronic structure calculations to investigate the configuration-dependent binding and migration energies of Cr with vacancy and interstitial defects, including small clusters. These values will enable development of atomistic-based kinetic Monte Carlo models similar to those employed previously to evaluate He diffusion in Fe and specifically designed to investigate the Cr diffusivity by interstitial and vacancy mechanisms. The RIS tendencies of Cr in F-M alloys will be predicted as a function of temperature and dose, based on migration mechanisms and energies obtained from ab initio calculations. The outcomes of this modeling task will be mechanistic interpretation of the complex Cr RIS behavior, and key diffusional parameters for both continuum level rate theory models and the development predictive RIS models of Cr and Si in F-M alloys.

The combined experimental-modeling program is designed to provide a set of data on the behavior of RIS, phase microstructure, dislocation microstructure and hardening as a function of dose and temperature in the range 350-550°C and 3-100 dpa. This data will be used to benchmark RIS and dislocation microstructure models developed from ab initio electronic structure calculations and extended to kinetic Monte Carlo and continuum rate theory (MIK) models.


**Localized Deformation and Intergranular Fracture of Irradiated Alloys under Extreme Environmental Conditions**

G. S. Was, PI  
U.S. Department of Energy, Basic Energy Sciences  
$844,000/3$ yrs
PLASMAS AND FUSION

Optimization of an ECR Plasma as a Source for Electric Propulsion Systems
J. E. Foster, PI
NASA GSRP
$29,000/yr

An Investigation of Plasma Discharge Ignition in Bubbles in Water with Applications for the Treatment of Contaminated Water
J. E. Foster, PI
National Science Foundation
$60,000/yr

Demonstrated bubble perturbation via low frequency field.

ECR Plasma Neutralizer
J. E. Foster, PI
NASA GSRP Grant
$90,000/3 yrs

New neutralizer design allowed for 4 A of electron extraction, well over design requirement.

Non-Intrusive Measurement of Electric Field in Pulsed ns Discharge for Plasma Aided Combustion
J. E. Foster, PI
NASA GSRP Grant
$90,000/3 yrs

Preliminary Stark measurements made; bell jar for experiment transferred to lab
Relativistic Magnetron Priming Experiments and Theory
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
Air Force Office of Scientific Research
$1.85 million/5 yrs

This research is a study of the relativistic magnetron for generating 200-500 MW microwave pulses.


Basic Studies of Distributed Discharge Limiters for Counter HPM
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
UW-AFOSR
$190,000/ 3-5 yrs

Experimental and Theoretical Studies of Magneto Rayleigh Taylor Instability
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
DoE-NSF
$445,000 + $5000 undergrad NSF supplement/3 yrs

Studies the growth and stabilization of the Magneto Rayleigh Taylor instability of foil plasmas driven by 1-MA LTD recently built at UM.

Ionization Dynamics of Wire Z-Pinches
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
Sandia National Labs
$140,000/2 yrs

The purpose of this work is to perform detailed diagnostics on expanding plasma ionization dynamics of a new z-pinch plasma experiment built at UM. Discovered a new, azimuthal-correlation instability in wire array z-pinches at Cornell.

Research Highlights: Built new 1 MA UM generator from Siberia.


\textbf{Ultrawideband Antenna Research for Biological Applications}

R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI, and M. D. Uhler, Co-PI (UM Medical School)

AFOSR

$450,000/3 yrs

This project concerns the development of new ultrawideband antennas that can be used for biological applications, such as electrochemotherapy. This is an innovative research project that explores the fundamental interactions of non-ionizing RF radiation with biological cells. The ultimate goal is RF electroporation of tumor cells for chemotherapy. Discovered that Ultrawideband electroporation of Biological Cells only occurs when conduction current flows through cells. Displacement current does not electroporate cells.


\textbf{MURI on Cathodes and Windows for High Power Microwave}

R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI

Air Force Prime – University of Wisconsin Subcontract

$436,000 for 5 yrs

This project concerns several cathode and window issues in microwave generation from relativistic magnetrons


**Phase Locking of High Energy Magnetrons**
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
University of New Mexico subcontract of ONR project
$370,000/1.5 yrs

**Renewal of Phase Locking of High Energy Magnetrons**
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
University of New Mexico subcontract of ONR project
$475,000/3 yrs

Explores basic science of phase locking high power magnetrons


**Radiography Experiments and Theory**
R. M. Gilgenbach, PI and Y.Y. Lau, Co-PI
Sandia National Labs
$75,000/2 yrs

**Industrial Affiliates Program (L-3 Communications)**
R. M. Gilgenbach, PI and Y. Y. Lau, Co-PI
L-3 Communication Electron Devices
$10,000/yr
This gift from L-3 Communications facilitates communication with researchers in the UM Intense Energy Beam Interaction Laboratory.

**Industrial Affiliates Program (Northrop Grumman)**

R. M. Gilgenbach, PI and Y. Y. Lau, Co-PI
Northrop Grumman Corporation
$10,000/2 yrs

This gift from the Northrop Grumman Corporation facilitates communication with researchers in the UM Intense Energy Beam Interaction Laboratory.

**Nanophysics of Electron Emission and Breakdown for High Power Microwaves**

R. M. Gilgenbach, PI and Y. Y. Lau, Co-PI
U.S. Department of Defense/Air Force/Univ. CA-Davis
$350,000/5 yrs

This project concerns several issues in microwave generation from vacuum electron microwave devices.


Phase Locking of Commercial Magnetrons
R. M. Gilgenbach, PI and Y. Y. Lau, Co-PI
U.S. Office of Naval Research/University of New Mexico
$370,000/3 yrs

This project studies mode locking of high power microwave devices, in collaboration with the University of New Mexico.


Active Interrogation using Radiation Generated from Intense Laser Produced Electron Beams
K. Krushelnick, PI
National Science Foundation/DNDO
$1.835million/5 yrs

Intense Laser Interactions with Low Density Plasmas using OMEGA EP
K. Krushelnick, PI
U.S. Department of Energy/NNSA
$180,000/2 yrs

Collimated Fast Neutron Beam Generation Using Intense Laser Plasma Interactions
K. Krushelnick, PI; Co-PI (Maksimchuk, Yanovsky, Nees EECS)
U.S. Naval Research Laboratory
$917,716/1 yr
Intergovernmental Personnel Act (IPA) Assignment at Air Force Research Laboratory
Y. Y. Lau, PI
U.S. Department of Defense, Air Force
$116,787/1.5 years

This is to support AFRL on high power microwaves.


Optimizing Multi-Carrier Uplink Signal
Y. Y. Lau, PI
Jet Propulsion Lab, NASA
$55,214/yr
RADIATION MEASUREMENTS AND IMAGING

Silicon-based Examination of Gamma-ray and Neutron Interactions With Solid-state Materials
M. D. Hammig, PI
U.S. Department of Defense, Defense Threat Reduction Agency (DTRA)
$451,402/3 yrs

Silicon-based 3D Position-Sensitive Scatter Detector with Integrated Amplification
M. D. Hammig, PI
Department of Homeland Security
$510,025/2 yrs

Constructing 3D CdZnTe Polaris II Isotope Identifier
Z. He, PI
U.S. Department of Energy/Battelle Pacific Northwest Laboratories
$887,000/3.5 yrs

This project develops the first array system using 3-dimensional position-sensitive CdZnTe gamma-ray spectrometers for isotope identification. This system will employ 18 1.5x1.5x1 cm$^3$ modular detectors, having a total detection volume of 40.5 cm$^3$. The expected energy resolution is about 1% FWHM or better at 662 keV gamma-ray energy and angular resolution less than 20 degrees within a 4$\pi$ solid angle. The applications are for nuclear non-proliferation and homeland security.


Detection of Shielded Uranium and Plutonium
Z. He, PI
Department of Defense, Defense Threat Reduction Agency (DTRA)
$6,495,000/5 yrs
This project is to develop unprecedented array systems using 3-dimensional position-sensitive CdZnTe and HgI₂ gamma-ray imaging spectrometers, which will have total detection volume of more than 100 cm³ per system. These systems will be tested against real special nuclear materials at the end of the project.


**Development of High Resolution 3-Dimensional Position-Sensitive CdZnTe Gamma-Ray Spectrometers**
Zhong He, PI
Department of Energy, NA-22 office
$1.65 million/6 yrs

**Development of Integrated Real-Time Imaging and Isotope Detection Algorithms for 3-Dimensional Position-Sensitive Semiconductor Gamma-Ray Imaging Spectrometers and Sensor Networks**
Zhong He, PI
Department of Homeland Security, Domestic Nuclear Detection Office
$1,993,290/5 yrs

**Development of TlBr Gamma-Ray Spectrometers**
Zhong He, PI
Sub-contract from Radiation Monitoring Devices
Prime sponsors: DNDO of Department of Homeland Security and DTRA, Department of Defense
$425,000/3 yrs

**Target-Linked Radiation Imaging (TLRI)**
Zhong He, PI
General Electric Company
$407,279/2 yrs
Development of HgS and HgO Semiconductor Gamma-Ray Spectrometers
Zhong He, PI
Radiation Monitoring Devices
$90,000/2 yrs

Development of TIBrI and InBrI Semiconductor Gamma-Ray Spectrometers
Zhong He, PI
Radiation Monitoring Devices
$125,000/3 yrs

For publications of Professor Zhong He’s group, see website at:
http://czt-lab.engin.umich.edu

Characterization of the Capture-Gated Liquid Scintillator BC-523A
S. A. Pozzi, PI
Department of Energy/NA-24 (subcontract)
$68,000 /yr

This work is a continuing collaboration with the Institute for Reference Materials and Measurements (IRMM), the Institute for the Protection and Security of the Citizen (IPSC), and Oak Ridge National Laboratory (ORNL). The aim of the collaboration is to pool resources and competencies in the area of detector development and Monte Carlo simulations. In this part of the research project, the response of the capture-gated detector BC-523A to monoenergetic neutrons will be measured at the Van de Graff facility at the Institute for Reference Materials and Measurements in Geel, Belgium. The results of these measurements will be used to develop new physics models to be included in the Monte Carlo simulations for this type of detector.


Monte Carlo Simulations for Tunable, Mono-energetic Gamma-ray Source for Detection of Embedded SNM
S. A. Pozzi, PI
Department of Homeland Security/Domestic Nuclear Detection Office (subcontract)
$266,500/3 yrs

In this project we develop algorithms and Monte Carlo models to determine the detector response for various gamma ray detectors. The results of this modeling are compared to experiments performed at the University of Nebraska. The final goal of this project is to develop a source that could be used to detect and identify shielded special nuclear materials.


Basic Physics Data: Improved Fission Neutron Data base for Active Interrogation of Actinides
S. Pozzi, PI
Department of Energy/Office of Nuclear Energy/Nuclear Energy’s University Programs Initiative
$690,000 /3 yrs

This three-year project proposes to build a team of four top universities and of one national laboratory to develop innovative neutron detection system for active interrogation measurements. Many active interrogation methods to detect fissionable material are based on the detection of neutrons from fission induced by fast neutrons or high-energy gamma rays. The energy spectrum of the fission neutrons provides data to
identify the fissionable isotope(s) and materials such as shielding between the fissionable material and the detector. The challenges for making confident measurements are the detection of neutrons in the energy ranges of 0.01 – 1 MeV and above 8 MeV. These regions are also where the basic data on the neutron energy spectrum emitted from fission is the least-well known. In addition, improvements in the specificity of neutron detectors are required throughout the complete energy range: they must be able to clearly distinguish neutrons from other radiations, in particular gamma rays and cosmic rays. We believe that all of these challenges can be addressed successfully with emerging technologies under development by this collaboration. In particular, the collaboration will address the area of fission neutron emission spectra for isotopes of interest in the advanced fuel cycle initiative.

**New Detectors, Electronics, and Algorithms for Fast Neutron Spectroscopy in a Scalable Measurement Platform**
S. Pozzi, PI
Department of Homeland Security/Domestic Nuclear Detection Office/National Science Foundation
$2,000,000 / 5 yrs

In this project, a novel neutron detection systems based on organic scintillators will be designed which will preserve the incoming neutron energy information while maintaining high detection efficiency and allowing neutron/gamma ray discrimination. The information provided by this approach will (i) increase the sensitivity to shielded SNM and (ii) allow the system to differentiate among neutron sources of various types. The project will also help develop and train the much-needed next generation of nuclear scientists and engineers by engaging them in cutting-edge research activities.

**Digital Waveform Sampling of Neutron and Gamma Ray Signals from Scintillators, Stewardship Science Academic Alliances Program**
S. Pozzi, PI
Department of Energy/National Nuclear Security Administration.
$490,000 / 3 yrs

The objective of the project is to develop and validate new techniques for pulse data analysis that will be used in neutron and gamma ray measurement systems based on the use of various scintillation detectors. A primary goal of the proposed work is to significantly extend the current pulse shape discrimination capabilities to neutron energies well below 1 MeV and perhaps as low as 100 keV. Specifically, the performance of various detection systems will be assessed by using fast waveform
digitizers, and the efficiency of neutron and gamma ray detection and energy resolution will be evaluated using the state-of-the-art research facilities at the University of Michigan (UM) and at LANL’s LANSCE facility. The measurement results will be used to validate Monte Carlo techniques for the simulation of these types of detectors, pioneered by our group at UM.

**Development of a New Graduate Level Course in Nuclear Safeguards at the Department of Nuclear Engineering and Radiological Sciences of the University of Michigan**

S. Pozzi, PI  
Department of Energy  
$23,000/3 mos

This project provided funding for 17 students from the Department of Nuclear Engineering and Radiological Sciences at the University of Michigan to travel to Oak Ridge National Laboratory for a week-long laboratory experience as a part of the course Nuclear Safeguards.

**Mobile Robotics and Sensing – University Research Program in Robotics**

D. H. Wehe, PI  
U.S. Department of Energy  
$852,500/yr

The University of Michigan extends the capabilities of current mobile robots to provide increased autonomy of remote operations, so that sensors and other technologies can be quickly and safely delivered to interior and outdoor environments of large expanses. The University of Michigan also develops advanced radiation sensing technologies for use in DOE environments. Current projects include the development of hybrid gamma ray imagers, development of unique digital pulse processing techniques, active interrogation for surveillance and monitoring, and micro-mechanical radiation detectors.
## Fiscal Year 2009 Research Expenditures

(July 1, 2008 – June 30, 2009)

Research Expenditures Attributed to an External Sponsor

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<td>Atzmon</td>
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<td>Structure, Properties and Relaxation of Shear Bands in Metallic Glasses</td>
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<td>Downar</td>
<td>Autoridad Regulutoria Nuclear</td>
<td>RELAP5/PARCS Analysis of Atucha-II</td>
<td>N010590</td>
<td>(24,665)</td>
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<td>Downar</td>
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<td>Support of Pirt Analysis of Atucha II and the Dev. of Uncertainty</td>
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<td>EPRI</td>
<td>Identifying Mechanisms and Mitigation Strategies for Irradiation</td>
<td>N010827</td>
<td>229,300</td>
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<td>Was</td>
<td>DoE</td>
<td>Sub of F015452-Accelerator Based Study on Irradiation Creep In Pyrolytic Carbon Used in TRISO Fuel Particles for VHTR</td>
<td>F015795</td>
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<td>F015828</td>
<td>(50,869)</td>
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<td>Radiation-Induced Segregation and Phase Stability in Candidate Alloys for the Advanced Burner Reactor</td>
<td>F018205</td>
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<td>Consortium on Cladding and Structural Materials for Advanced Nuclear Energy Systems</td>
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<td>Was</td>
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<td>Sub of F018506-Alabama A&amp;M Consortium of Cladding and Structural Materials for Advanced Nuclear Energy Systems</td>
<td>F018702</td>
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<td>Sub of F018506-U/CA Santa Barbara-Consortium of Cladding &amp; Structural Materials for Advanced Nuclear Energy Systems</td>
<td>F018703</td>
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<td>Sub of F018506-U/WI-Madison-Consortium on Cladding and Structural Materials for Advanced Nuclear Energy Systems</td>
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<td>Was</td>
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<td>056649-Sub of F018506-U/CA-Berkley-Consortium on Cladding and Structural Materials for Advanced Nuclear Energy Systems</td>
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<td>Sub of F018506-Penn State-Consortium on Cladding and Structural Materials for Advanced Nuclear Energy Systems</td>
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<td>Localized Deformation and Intergranular Fracture of Irradiated Alloys Under Extreme Environmental Conditions</td>
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<td>Sub of F021533-Localized Deformation and Intergranular Fracture of Irradiated Alloys Under Extreme Environmental Conditions</td>
<td>F021748</td>
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<td>Was</td>
<td>DoE/NERI Subcontract</td>
<td>Alloys for High Temperature Service in the Next Generation Nuclear Plant: 850-900A C</td>
<td>F014792</td>
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<td>Sodium Compatibility of Advanced Fast Reactor Materials</td>
<td>F022060</td>
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<td>Identifying Mechanisms and Mitigation Strategies for Irradiation</td>
<td>F022700</td>
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<td>Corrosion and Creep of Candidate Alloys in High Temperature He and Steam Environments for the NGNP</td>
<td>F023807</td>
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<td>Intergranular Attack and Stress Corrosion Cracking in Nickel-Base Alloy 600 Materials</td>
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<td>Aging and Embrittlement of High Fluence Stainless Steels</td>
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<td>Ion Irradiation-Induced Degradation of Reactor Structural…</td>
<td>N010334</td>
<td>39,668</td>
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<td>Wehe</td>
<td>Mobile Robotics and Sensing-Univ Research Prog in Robotics</td>
<td>F010788</td>
<td>486,947</td>
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<td>Support for the Development of a Solid State Photomultiplier Opt...</td>
<td>F019624</td>
<td>48,975</td>
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Sub Total: 10,501,398

* Amounts in parentheses were accounting adjustments.

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<td>Total Research Expenditures Attributed to an External Sponsor</td>
<td>10,501,398</td>
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<tr>
<td>Total Research Expenditures Not Attributed to an External Sponsor</td>
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<td>Sub Total</td>
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<td>GSRA RIP3 Outstate Differential</td>
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<td><strong>GRAND TOTAL</strong></td>
<td><strong>$11,550,463</strong></td>
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</tbody>
</table>
FISSION SYSTEMS AND RADIATION TRANSPORT

Journal Articles


*Publication of work done as a current or former student in the Department of Nuclear Engineering and Radiological Sciences at the University of Michigan


**Conference Papers and Presentations**


MATERIALS

Books/Chapters in Books


Journal Articles


Conference Papers and Presentations


PLASMAS AND FUSION

Books/Chapters in Books


Journal Articles


**Conference Papers and Presentations**


**Patents**

J. E. Foster and M. J. Patterson, ”Very Large Area/Volume ECR Plasma and Ion Source,” US Patent 7,493,869, February 24, 2009

Journal Articles


**Conference Papers and Presentations**


Simulations of Multiplicity Measurements of the Plutonium BeRP Ball,” Institute of Nuclear

E. C. Miller, S. D. Clarke, M. Flaska, S. A. Pozzi, and P. Peerani, “Monte Carlo Simulation of
the Full Multiplicity Distributions Measured with a Passive Counter,” International Conference
on Mathematics, Computational Methods & Reactor Physics (M&C 2009), Saratoga Springs,

S. A. Pozzi, “Fast Neutron Spectrum Unfolding for Nuclear Nonproliferation and Safeguards

S. A. Pozzi, “Measurement and Analysis Systems for Nuclear Nonproliferation, Safeguards, and

S. A. Pozzi, “Technical Challenges and Recent Advances in Nuclear Nonproliferation and

S. A. Pozzi, “University of Michigan Curriculum in Nuclear Nonproliferation and Safeguards”,
LANL/TAMU NGSI Human Capital Development Workshop, Los Alamos National Laboratory,
Santa Fe, New Mexico, August 10, 2009.

Detector Design for Safeguard Applications in Brazilian Fuel Cycle Facilities,” 2009 International
Nuclear Atlantic Conference - INAC Rio de Janeiro, Brazil, September 27 to October 2, 2009.

M. L. Rodrigues*, Z. He, and A. S. Serra, “Maximizing Signal-to-Noise Ratio (snr) in 3-D Large
Bandgap Semiconductor Pixelated Detectors in Optimum and Non-Optimal Filtering
Conditions,” 2009 International Nuclear Atlantic Conference - INAC Rio de Janeiro, RJ, Brazil,
September 27 to October 2, 2009.

C. L. Thrall*, C. G. Wahl*, and Z. He, “Directional Isotope Identification Using 3-D
Semiconductor Gamma-Ray Imaging Spectrometers,” IEEE Nuclear Science Symposium and

C. L. Thrall*, C. G. Wahl*, and Z. He, “Performance of Five-or-More-Pixel Event Sequence
Reconstruction for 3-D Semiconductor Gamma-Ray-Imaging Spectrometers” DNDO ARI
Workshop, Washington D.C. April 7 - 9, 2009.

C. G. Wahl* and Z. He, “Source Detection Using Imaging 3-D-Position-Sensitive CdZnTe
Detectors,” DNDO ARI Workshop Washington D.C. April 7 - 9, 2009.


Journal Articles


Conference Papers and Presentations


Service
(January 1, 2009 – December 31, 2009)

Service to the College of Engineering
Member, NERS Curriculum Committee Atzmon
Member, MSE Graduate Committee Atzmon
Member, Interdisciplinary Engineering Degree Program Review Committee Atzmon
Advisor, Engineering Physics Atzmon
Director, NERS Undergraduate Program Bielajew
Coordinator, ABET for NERS Bielajew
Member, Engineering Faculty Library Advisory Committee Bielajew
Member, MSE Graduate Committee Atzmon
Member, Interdisciplinary Engineering Degree Program Review Committee Atzmon
Advisor, Engineering Physics Atzmon
Director, NERS Undergraduate Program Bielajew
Coordinator, ABET for NERS Bielajew
Member, ENG 101 Steering Committee Bielajew
Chair, Graduate Committee Downar
Member, Executive Committee Downar
Advisor, Faculty-Student ANS Foster
Chair, Winter 2009 Graduate Committee Gilgenbach
Member, COE Commission on Undergraduate Engineering Education Hartman
Member, COE Safety Committee Hartman
Member, NERS Chair Search Committee Hartman
Chair, NERS Committee for Preparation of Doctoral Examinations in Radiological Health Engineering Kearfott
Chair, NERS, REM Option Kearfott
Member, NERS Curriculum Committee Kearfott
Member, NERS Committee for Preparation of Doctoral Examinations in Nuclear Imaging and Measurements Kearfott
Member, Ford Nuclear Reactor Decommissioning Review Committee Kearfott
Member, Radiation Policy Committee Kearfott
Member, Radiation Policy Committee, Authorization Review Subcommittee Kearfott
Member, Radiation Policy Committee, ad hoc Radon Subcommittee Kearfott
Member, Goldwater Scholarship Committee Kearfott
Member, NERS Committee for Revision of Doctoral Candidacy Examination Kearfott
Organizer, College of Engineering, Luncheons for Women Faculty Kearfott
Director, COE Undergraduate Admissions Kearfott
Advisor, COE Student Alliance of Gay Engineers (SAGE) Kearfott
Member, Honors and Awards Committee Krushelnick
Chair, NERS Colloquium Committee Larsen
Chair, Curriculum Committee Larsen
Chair, Promotion/Tenure Committee for Professor Sara Pozzi Larsen
Member, Engineering College Curriculum Committee Larsen
Counselor, NERS Undergraduate Student Advising  
Chair, Plasma Option  
Member, Curriculum Committee  
Member, Colloquium Committee  
Member, Scholastic Standing Committee  
Representative, Faculty Recruitment  
Chair, Department Chair Search Committee  
Member, Honors and Awards Committee  
Member, NRC Fellowship Committee  
Member, Dean’s Advisory Committee on Diversity  
Member, NERS Department Chair Search Committee  
Member, NERS Executive Committee  
Member, NERS at 50 Planning Committee  
Member, NERS Committee for the Evaluation of the Candidacy Exam  
Member, Qualifying Exam Committee  
Chair, Internal Review Committee  
Member, Graduate Committee  
Member, Promotion Committee  
Member, NERS Chair Search Committee  
Member, College of Engineering, International Program Committee  
Director, EMAL  
Director, Michigan Memorial Phoenix Energy Institute  
Member, NERS Graduate Committee  
Chair, Measurements Option  
Member, Committee for Role Effort  
Member, Curriculum Committee  
Member, Graduate Committee  
Member, Mclvor Award Committee  
Member, NERS WF Committee

**Service to the University**

Member, SACUA Library Committee  
Speaker, Michigan Research Community (MRC) Seminar  
Member, Bridges to the PhD Rackham Committee Program  
Representative, NSBE Faculty  
Member, AGEP (Alliances for the Graduate Education in the Professoriate)  
Director, Neutron Science Laboratory  
Member, Senate Advisory Committee on University Affairs (SACUA)  
Government Relations Advisory Committee  
Member, Senate Advisory Committee on University Affairs (SACUA)  
Committee for a Multicultural University
Member, University of Michigan Senate Assembly
Vice President, University of Michigan Chapter of the American Association Of University Professors
Advisor, University of Michigan Health Physics Society Student Branch
Member, Executive Committee, Center for Ultrafast Optical Science (CUOS)
Member, NERS Chair Search Committee
Member, NERS Graduate Committee
Member, NSF PSC-FOCUS Council
Member, NERS Internal Review Committee
Associate Director for High Field Science at CUOS
Thrust Leader, High Field Science (Major Research Component 1) in FOCUS Physics Frontier Center

Member, Brookhaven National Lab, External Advisory Panel, Accelerator Science
Advisor, First Institute of Nuclear Materials Management Student Chapter
Director, Electron Microbeam Analysis Laboratory (EMAL)
Member, MMPEI Executive Committee

Service to the Nation
Member, NNSA – Department of Energy ReNeW Panel
Member, Density Laboratory Plasma (HEDLP) Research Needs Workshop
Reviewer, King Abdulaziz City for Science and Technology
Member, National Council on Radiation Protection (NCRP) Scientific Committee
Member, Omega Laser Facility, DOE Laboratory for Laser Energetics, University of Rochester
Reviewer, Proposals US Department of Energy
Reviewer, Proposals National Science Foundation
Reviewer, Proposals European Union Funding
Reviewer, Proposals AFOSR, Department of Energy International Science and Technology Center
Faculty Appointee, Naval Research Laboratory
Faculty Appointee, Intergovernmental Personnel Act Assignment (IPA)
Air Force Research Lab
Member, International Advisory Committee, Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology
Member, Review Panel for the INCITE 2008 awards, DOE Office of Science
Chair, Communications Committee, Institute of Nuclear Materials Management
Member, Students Activities Committee, Institute of Nuclear Materials Management
Member-at-Large, Central Chapter, Institute of Nuclear Materials Management
Reviewer, Nuclear Energy University Program, U.S. Department of Energy
Office of Nuclear Energy (DOE-NE)  
Reviewer, Proposals DOE Basic Energy Sciences SCFG Program  
Reviewer, Proposals DOE Basic Energy Sciences SISGR Program  
Reviewer, Proposals DOE Basic Energy Sciences Core Program  
Reviewer, Proposals INL LDRD  
Member, DOE Interagency Forensics Panel for Nonproliferation and Arms Control  
Reviewer, DOE NA-22, DNDO and DTRA Program for Radiation Detection Projects.

Service to the Profession

Member, Steering Committee, International Symposium on Metastable, Mechanically Alloyed and Nanocrystalline Materials  
Member, Chemistry and Physics of Materials Committee, TMS  
Session chair, AIAA Joint Propulsion Conference on Helicon Plasmas  
Member, AIAA Joint Propulsion Conference Best Paper Selection Committee  
Chair, IEEE Plasma Science and Applications Technical Committee  
Member, IEEE AdCom of NPSS  
Member, APS Fellow Committee, APS Division of Plasma Physics  
Member, Executive Committee of the Michigan Section of the American Nuclear Society  
Member, Oregon State TRIGA Reactor (OSTR) Reactor Operations Committee  
Member, of the LDRD Review Committee on Project Design, Synthesis, and Theory of Molecular Scintillators, Los Alamos National Laboratory  
Member, program committee of SPIE International Symposium on Optical Science, Engineering, and Instrumentation (Hard X-Ray and Gamma-Ray Detector Physics, Optics, and Applications)  
Member, Health Physics Society Academic Education Committee  
Member, Great Lakes Health Physics Society Chapter Executive Council  
Member, Health Physics Society Decommissioning Section Executive Board  
Member, Health Physics Society Academic Education Subcommittee on Travel Grants  
Member, Planning Committee, American Nuclear Society  
Member, Great Lakes Health Physics Society Chapter Executive Council  
Member, Academic Education Committee, Health Physics Society  
Member, Planning Committee, American Nuclear Society  
Session Leader, Advanced Accelerators Workshop Program Committee  
Member, Laser Acceleration Workshop  
Member, Technical Review Committee for the Mathematics & Computation Division of the American Nuclear Society  
Member, Program Committee IEEE International Conference on Vacuum
Electron Devices

Member, International Advisory Committee, Department of Nuclear and Quantum Engineering, Korea Advanced Insititue of Science and Technology

Keynote Speaker, 50th Anniversary Celebration, Department of Nuclear Engineering, Seoul National University

Member, International Advisory Board, International Summer School of Nuclear Power Plants, University of Tokyo

Chair, Honors and Awards Committee of the Radiation Instrumentation Steering Committee, IEEE Nuclear and Plasma Sciences Society

Chair, Communications Committee of the institute of Nuclear Materials Management (INMM)

Member, Radiation Instrumentation Steering Committee of IEEE Nuclear and Plasma Sciences Society

Co-Chair, Advanced Accelerator Concepts Working Group (Annapolis, MD)

Member, ANS International Program Committee

Vice-Chair, International Cooperative Group on Environmentally Assisted Cracking

Member, TMS Nuclear Materials Committee and TMS Corrosion and Environmental Effects Committee

Member, Special Programs Committee, MRS

Member, AFCI/GenIV Materials Working Group, LANL

Member, Organizing Committee, International Conference on Environmental Degradation of Materials in Light Water Reactors

Member, Materials Review Capability Team for Los Alamos National Laboratory

Organizer, TMS Symposium on Microstructural Processes in Irradiated Materials

Chair, Symposium on Radiation Measurements and Applications (SORMA XII)

Member, Conference Organizing Committee, XII Radiation Measurements and Applications Conference (U-CA Berkeley)

Member, IEEE Radiation Instrumentation Steering Committee

Editorial Services

Associate Editor, Physics of Plasmas

Associate Editor (Operational Topics), Health Physics

International Advisory Board Member, Plasma Physics and Controlled Fusion

Editorial Board Member, Transport Theory and Statistical Physics

Member, Editorial Board, Journal of Nuclear Materials

Member, Editorial Board, Metallurgical Transactions A.

Editor, TMS Symposium on Microstructural Processes in Irradiated Materials

Editor, International Conference on Fusion Reactor Materials

Editor, Nuclear Instruments in Physics Research

Editor, Nuclear Energy and Technology (honorary position)
Personnel

(September 1, 2009 to August 31, 2010)

FACULTY

Yugo Ashida
Assistant Research Scientist
PhD (Machine Intelligence and Systems Engineering) Tohoku University, 1999
Irradiation assisted stress corrosion cracking in neutron-irradiated stainless steels in light water reactor systems.

Michael Atzmon
Professor
Also Professor, Materials Science and Engineering
PhD (Applied Physics) California Institute of Technology, 1985
Thermodynamics of materials, diffusion of solids, amorphous metal alloys, ion beam modification of materials

Alex F. Bielajew
Professor
PhD (Theoretical Physics) Stanford University, 1982
Theory of electron and photon transport, Monte Carlo theory and development, radiation dosimetry theory, radiotherapy treatment planning algorithms

Shaun Clarke
Assistant Research Scientist
PhD (Nuclear Engineering & Radiological Sciences) Purdue University, 2007
Simulation techniques for active-interrogation systems using high-energy photons. Methods under investigation include photoneutron energy spectra and multiplicity analysis

Thomas Downar
Professor
PhD (Nuclear Engineering) Massachusetts Institute of Technology, 1984
Computational nuclear reactor physics, nuclear reactor dynamics, and the development of coupled neutronics and thermal-hydraulics methods for power reactor safety analysis

James J. Duderstadt
President Emeritus, University of Michigan  
University Professor of Science and Engineering  
Director, The Millennium Project  
PhD (Engineering Science and Physics) California Institute of Technology, 1967  
Nuclear systems, computer simulation, science policy, higher education

Rodney C. Ewing  
Professor  
Also Professor, Materials Science and Engineering  
and Professor, Geological Sciences  
PhD (Mineralogy/Geology) Stanford University, 1974  
Nuclear waste management, radiation effects in glasses

Marek Flaska  
Assistant Research Scientist  
PhD (Nuclear Engineering) Delft University of Technology, Delft, The Netherlands, 2006  
The development of new methods for accurate identification and characterization of special nuclear material and radioactive sources for applications in nuclear nonproliferation, nuclear safeguards and homeland security; Monte Carlo simulations and experiments and analyses with organic scintillators and capture-gated detectors.

Ronald F. Fleming  
Professor  
PhD (Nuclear Engineering) University of Michigan, 1975  
Neutron activation analysis, materials analysis using nuclear techniques, radiation measurements

John E. Foster  
Associate Professor  
PhD (Applied Physics) University of Michigan, 1996  
Low-temperature plasma physics including applications in the areas of space propulsion plasmas, environmental plasmas, space and atmospheric plasma phenomena, energy conversion plasmas, and processing plasmas

Ronald M. Gilgenbach  
Professor  
Also Professor, Applied Physics Program  
Director, Intense Energy Beam Interaction Laboratory  
PhD (Electrical Engineering) Columbia University, 1978  
Plasmas, fusion, lasers, electron beams, interaction of intense laser and particle beams with plasmas and materials

Mark Hammig
Assistant Research Scientist
PhD (Radiation Measurements) University of Michigan, 2004
Development of miniature sensors that use mechanical rather than electrical signals to detect ionizing radiation

Michael Hartman
Assistant Professor
PhD (Nuclear Engineering) University of Michigan, 2005
Application of radiation probes to the study of materials. Design and analysis of advanced reactor concepts

Zhong He
Professor
PhD (Physics) University of Southampton, United Kingdom, 1993
Room-temperature semiconductor and scintillation detectors for x-ray imaging and spectroscopy

James Paul Holloway
Professor
Associate Dean of Undergraduate Education
PhD (Engineering Physics) University of Virginia, 1989
Kinetic theory (plasmas, radiation), inverse problems

Zhijie Jiao
Assistant Research Scientist
PhD (Materials Science) Polytechnic University, New York, 2004
Irradiation effects and environmental degradation of cladding and structural materials for reactor systems

Kimberlee J. Kearfott, CHP
Professor
Also Professor, Biomedical Engineering
ScD (Nuclear Engineering) Massachusetts Institute of Technology, 1980
Radiation detectors, dosimetry, radiation protection policy, dose assessments, digital mammography, image reconstruction and analysis for nuclear medicine images

Karl M. Krushelnick
Professor
Associate Director, Center for Ultrafast Optical Science
Also Professor of Electrical Engineering and Computer Science
Also Professor of Physics, College of Literature, Science, and the Arts
PhD (Physics) Princeton University, 1994
Plasma physics, ultra-high intensity laser system development, inertial confinement fusion, compact laser-based particle accelerators and applications

Mark Kushner
Professor
Also Professor Electrical Engineering and Computer Science
PhD (Applied Physics) California Institute of Technology, 1979
Computational low temperature plasma science and engineering, materials processing, propulsion, lasers, electromagnetic, plasma chemistry, biological and environmental applications

Edward W. Larsen
Professor
PhD (Mathematics) Rensselaer Polytechnic Institute, 1971
Analytic and numerical methods for nuclear reactor theory, neutron transport, non-linear radiative transfer, electron and photon transport

Yue-Ying Lau
Professor
Also Professor, Applied Physics Program
PhD (Electrical Engineering) Massachusetts Institute of Technology, 1973
Plasma physics, physics of charged particle beams, radiation sources, vacuum microelectronics

John C. Lee
Professor
PhD (Nuclear Engineering) University of California, Berkeley, 1969
Nuclear reactor physics, reactor safety analysis, dynamics and control of nuclear power plants, nuclear fuel cycle

William R. Martin
Professor and Chair
PhD (Nuclear Engineering) University of Michigan, 1976
Computational methods development for the solution of the Boltzmann transport equation, including utilization of advanced computer architectures

Sara A. Pozzi
Associate Professor
PhD (Nuclear Engineering) Polytechnic of Milan, 2001
Nuclear materials measurements for nuclear nonproliferation, nuclear material control accountability and national security. Monte Carlo code development for neutron and photon transport
Volkan Seker  
Assistant Research Scientist  
PhD (Nuclear Engineering) Purdue University, 2007  
High temperature gas cooled reactor physics and thermo-fluids, computer code development in nuclear reactor analysis, and parallel and high performance computing

Alexander Thomas  
PhD Physics, Imperial College London, UK, 2006  
Plasma physics, ultra-high intensity laser-plasma interactions, compact laser-based particle accelerators, particle-in-cell simulation, radiation generation and back-reaction, laser propagation in plasma at high intensity, inertial confinement fusion, Vlasov-Fokker-Planck modeling, non-local transport, magnetized plasmas, electromagnetic and electrothermal instabilities

Lumin Wang  
Professor  
PhD (Materials Science) University of Wisconsin-Madison, 1988  
Ion beam modification of materials, transmission electron microscopy, monocrystalline materials, and nuclear materials

Gary S. Was  
Professor  
Also Professor, Materials Science and Engineering  
Director, Michigan Ion Beam Laboratory (MIBL)  
Director, Michigan Memorial Phoenix Energy Institute (MMPEI)  
ScD (Nuclear Materials Engineering) Massachusetts Institute of Technology, 1980  
Radiation effects on materials, ion beam modification of materials, hydrogen embrittlement, stress corrosion cracking, nuclear fuels

David K. Wehe  
Professor  
PhD (Nuclear Engineering) University of Michigan, 1984  
Gamma ray imaging, neutron physics, radiation spectroscopy, artificial intelligence and robotics applications, power plant reliability

Feng Zhang  
Assistant Research Scientist  
PhD (Nuclear Engineering & Radiological Sciences) University of Michigan, 2004  
Room-temperature semiconductor detectors, ASIC readout systems and reconstruction of radiation interactions, 4th-generation 3-D position sensitive CdZnTe detector array system.

EMERITUS FACULTY
A. Ziya Akcasu  
Professor Emeritus  
Also Professor Emeritus, Macromolecular Science and Engineering  
PhD (Nuclear Engineering) University of Michigan, 1963  
Dynamics of polymer solutions and blends, stochastic differential equations, reactor physics, kinetics

Terry Kammash  
Stephen S. Attwood Professor Emeritus of Engineering  
Professor Emeritus  
PhD (Nuclear Engineering) University of Michigan, 1958  
Fusion reactor physics and engineering, plasma physics, physics of intense charged particle beams, space applications of fusion energy

William Kerr  
Professor Emeritus  
PhD (Electrical Engineering) University of Michigan, 1954  
Reactor safety analysis, probabilistic risk analysis, radiation protection, reactor shielding, energy production

Glenn F. Knoll, PE  
Professor Emeritus  
PhD (Nuclear Engineering) University of Michigan, 1963  
Radiation measurements, neutron cross sections, nuclear measurements, radiation imaging

Dietrich H. Vincent  
Professor Emeritus  
Dr. Rer. Natl. (Physics) Universität Göttingen, Germany, 1956  
Gases in metals, ion beam analysis, radiation effects on materials

**ADJUNCT FACULTY**

Forrest Brown  
Adjunct Professor  
PhD (Nuclear Engineering) University of Michigan, 1981  
Research and Development Scientist, Los Alamos National Laboratory  
Research Professor University of New Mexico

Frederick W. Buckman  
Adjunct Professor  
PhD (Nuclear Engineering) Massachusetts Institute of Technology, 1970
Chairman and CEO of Trans-Elect  
Formerly CEO of PacifiCorp and Consumers Power Company,  
Nuclear plant design and nuclear reactor safety

Jeremy Busby  
Adjunct Assistant Professor  
PhD (Nuclear Engineering and Radiological Sciences) University of Michigan, 2000  
Radiation effects on materials, stress corrosion cracking, electron microscopy

Jack Davis  
Adjunct Professor  
PhD (Physics) Imperial College of Science, London, 1967  
Development of theoretical models and numerical simulations describing the behavior of laser produced plasmas, z-pinch plasmas, radiation transport, non-LTE emissivity models

Michael J. Flynn  
Adjunct Professor  
PhD (Nuclear Engineering) University of Michigan, 1975  
Senior Staff Scientist, Henry Ford Health System  
Medical imaging, image analysis, bioengineering, radiation detection

Mitchell M. Goodsitt  
Adjunct Professor  
PhD (Nuclear Physics) University of Wisconsin, Madison, 1982  
Professor of Radiological Sciences, Radiology, University of Michigan  
Professor of Radiological Health, University of Michigan

John Luginsland  
Adjunct Associate Professor  
PhD (Nuclear Engineering) University of Michigan, 1996  
Scientist, NumerEx, LLC

Ruth Weiner  
Adjunct Professor  
PhD (Chemistry) Johns Hopkins University, 1962  
Sandia National Laboratories  
Member, Advisory Committee on Nuclear Waste

Scott Wilderman  
Adjunct Research Scientist  
PhD (Nuclear Engineering) University of Michigan, 1990
VISITING FACULTY

Han Gyu Joo  
Visiting Professor  
Seoul National University, Korea  
Invited by Professor Thomas Downar

Kun-Dar Li  
Visiting Research Scientist  
Hsing-Kuo University of Management, Taiwan  
Invited by Professor Lumin Wang

Yunlin Xu  
Visiting Associate Research Scientist  
Argonne National Laboratory  
Invited by Professor Thomas Downar

POST DOCTORAL RESEARCH FELLOWS

Andreas Enqvist  
Jae Cheon Kim  
Louise Willingale

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