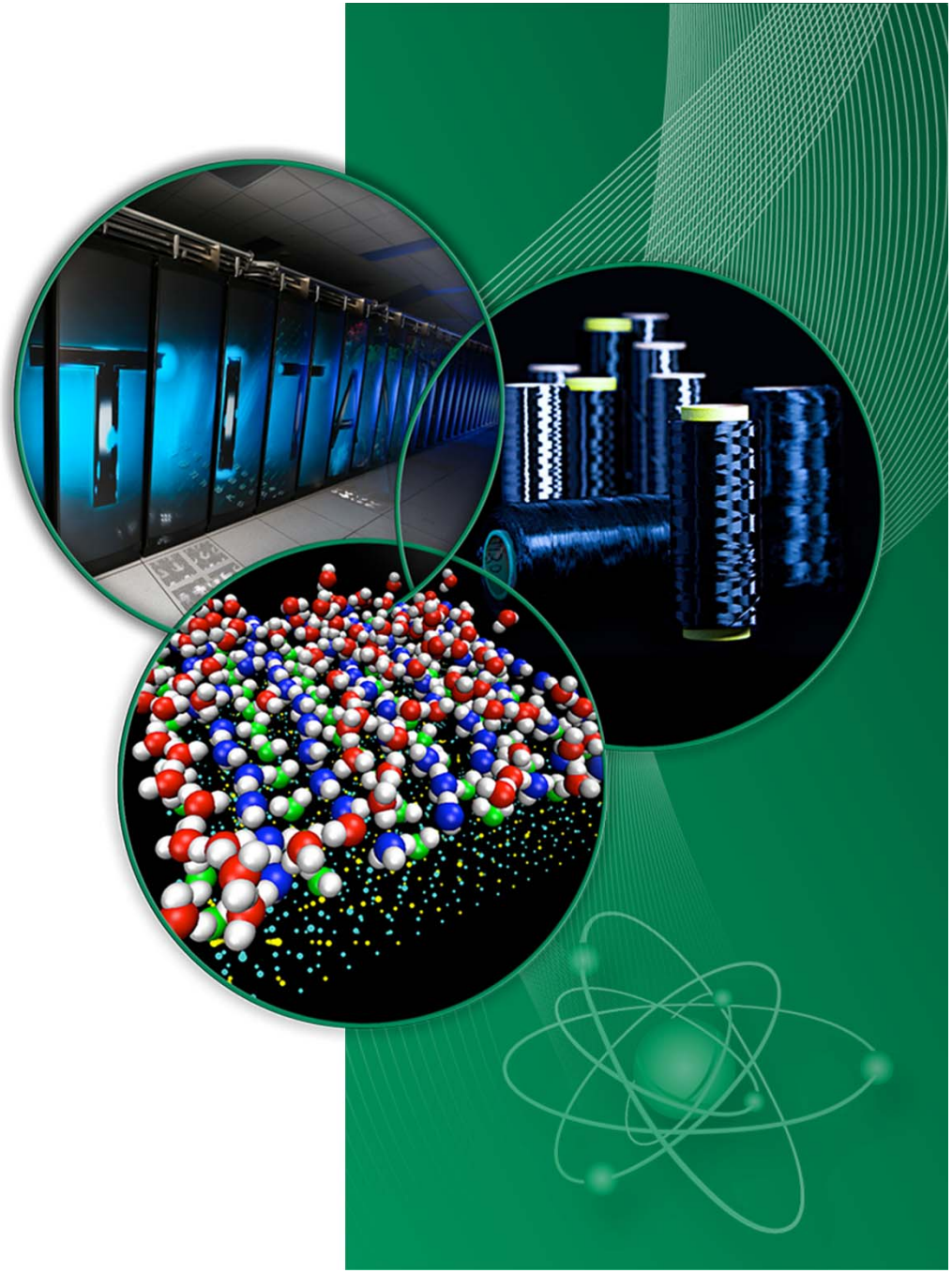
NSED Monthly Report

November 2013

Nuclear Science & Engineering Directorate



U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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NSED Leadership Changes

Announcement

Jeff Binder, Associate Laboratory Director for Nuclear Science and Engineering Directorate leaves ORNL to join the University of Illinois as director of its new Applied Research Institute

Alan Icenhour, Division Director for Nuclear Security and Isotope Technology Division, to serve as interim Associate Laboratory Director of ORNL's Nuclear Science and Engineering Directorate

CASL Test Stand deployed to EPRI

Science Highlight

Early deployment to industry for rapid enhanced testing, use, and ultimate adoption of CASL's Virtual Environment for Reactor Applications (VERA) to support real-world LWR applications

- U.S. taxpayer investments in CASL are realized as its products are deployed beyond the labs and the core CASL team to the broader nuclear industry
- CASL Test Stands fulfill a commitment made in the original 2010 Proposal
  - Allow collaborators access CASL software development on their home computer systems
  - Allow industry access to VERA for testing and assessment against "real world" applications
  - Provide a framework for direct interaction between the CASL researchers and Industry
- The new EPRI computing platform ("Phoebe") will be utilized to *test VERA fuel performance applications* (Peregrine)
- EPRI users acquired the third party library source and VERA components, using information from the CASL virtual machine
- EPRI successfully installed the CASL VERA environment and provided feedback and system information, allowing CASL the opportunity to further enhance their "Installation Procedure"

EPRI's new "Phoebe" HPC system

Gather system information from the CASL partner.

Setup a Virtual Machine of the partner's home system.

Relay information regarding potential conflicts to the partner.

Allow partner to acquire and install software

Address any issues with installation and update documentation.

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Visit by Office of Science for Fusion Energy Sciences

Gene Nardella
Chief of Staff to Associate Director of the Office of Science for Fusion Energy Sciences

Joe May
Director of Facilities, Operations, and Projects Division of the Office of Science for Fusion Energy Sciences

On November 4, discussions were held with Fusion and Materials for Nuclear Systems staff which included a tour of ORNL fusion related experiments in building 7625

Visits and Tours

Russian Federation delegation visits to discuss Molten Salt Reactor and Fluoride Salt-Cooled High-**Temperature Reactor techno**logies

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Nuclear Energy

- ORNL hosted a Russian Federation delegation seeking common interests in Molten Salt Reactor and Fluoride Salt-Cooled High-Temperature Reactor technologies on November 19-20
  - The visit was suggested by Assistant Secretary Lyons to Deputy Minister Perushkov during their bilateral meeting on June 25
  - DOE-NE staff responsible for the US-Russian bilateral agreement asked RNSD's David Holcomb to arrange the visit to ORNL
  - The delegation consisted of Vladimir Risovanyy, Joint Stock Company-Science and Innovations; Victor Ignatiev, Kurchatov Institute of Atomic Energy; Mikhail Kormilitsyn, JSC State Scientific Center, Research Institute of Atomic Reactors; and Valerii Naumov, Institute for Physics and Power Engineering

R&D 100 Award

Awards & Recognition

- NSITD researcher Zane Bell, along with members of the project team from Y-12, Fisk University, and Vanderbilt University, were awarded the 2013 R&D 100 Award at the November 7 ceremony in Orlando, Florida. The award was for the development of lithium indium diselenide semiconductor (LISe) for thermal neutron detection.

- Based on the 6LiInSe2 crystal
- First large, single-crystal semiconductor of high resistivity that contains lithium and directly detects thermal neutrons with high efficiency
- Offers significant advantages: Portability, sensitivity, simplicity, and low cost

From left to right are: Brendan Wiggins (Vanderbilt University), Arnold Burger (Fisk University), Ashley Stowe (Y-12), and Zane Bell (ORNL). Brendan is Arnold's student who will turn this material into his PhD thesis.

*News of the impending award was first noted in the June Monthly Report

AIChE Robert E. Wilson Award

Dr. Robert T. (Bob) Jubin was awarded the American Institute of Chemical Engineers (AIChE) 2013 Robert E. Wilson Award at the November 6th AIChE meeting in San Francisco, CA

- *This award recognizes outstanding chemical engineering contributions and achievements in the nuclear industry. Bob has made significant contributions in the areas of nuclear fuel reprocessing and radioactive waste treatment*

AIChE® American Institute of Chemical Engineers

*News of the impending award was first noted in the June Monthly Report

Awards & Recognition

RNSD's Rob Howard recognized at DOE-NE Fuel Cycle Technologies (FCT) Annual Review Meeting

Rob Howard was selected from hundreds of accomplished FCT contributors across the national laboratory complex to be recognized by DOE NE-5 for his outstanding contributions throughout the Department's used nuclear fuel storage, transportation, and disposal programs.

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CONGRATULATIONS

Educational Outreach

ORNL at the ANS Winter Meeting and Technology Expo in Washington, DC

- Attendance at the ORNL booth was very high and several students inquired about internships and potential ORNL employment.
- Barbara Snow, RSICC, coordinated the assistance at the booth
- In the picture to the right are ORNL employees: Andy Worrall, Bre Sweet-Kerschbaum and Bill DelCul answering questions.

Next Generation Safeguards Initiative (NGSI) program outreach

- Kim Gilligan and Adam Shephard met with the University of Florida (UF) Professor Katherine Goluoglu to discuss the lessons learned from the first offering of UF's NGSI funded non-proliferation course and the hands-on onsite mock inspection training
- Bernadette Kirk, consultant to NGSI HCD program, attended the Nuclear Engineering Department Head Organization (NEDHO) meeting during the November 2013 America Nuclear Society (ANS) Winter conference
  - Kirk specifically met with University of Florida, University of Michigan, and Virginia Tech professors to discuss NGSI HCD cooperation
- Professor Eddie Red met with ORNL staff to discuss future cooperation with Morehouse College

Next Generation Safeguards Initiative (NGSI) program

- NGSI funded graduate students enrolled in *Georgia Tech's, Elements of Nuclear Safeguards, Non-Proliferation, and Security* course to visit the International Atomic Energy Agency and Comprehensive Test Ban Treaty Organization in Vienna, Austria
  - NSITD's Dr. Kim Gilligan arranged the contract thru ORNL and coordinated the effort with ORNL Joint Faculty Appointment Dr. Glenn E. Sjoden of Georgia Tech and the NA24 Program Office under the Next Generation Safeguards Initiative (NGSI) Project

Group photo of Georgia Tech students in front of the Vienna International Center

- NGSI funded a 5 day non-proliferation workshop for the University of Michigan
  - Twelve upper level nuclear engineering students attended.

Left: University of Michigan students conducting hands-on exercises in ORNL's Safeguards Laboratory

Educational Outreach

Remote Systems takes part in Science Expo at the Knoxville STEM Academy on October 26, 2013

This event featured four hands-on activities related to nuclear science, electricity and even robotics:

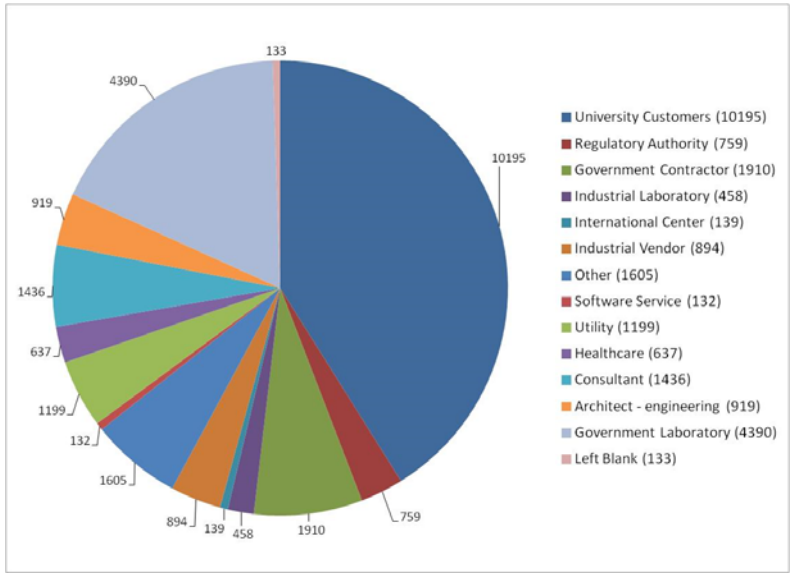
1. ANDROS Hands-On,
2. Ball Manipulator Hands-On Demo,
3. LEAP Motion Controller Hands-On Demo,
4. Omni-directional Platform Hands-On Demo

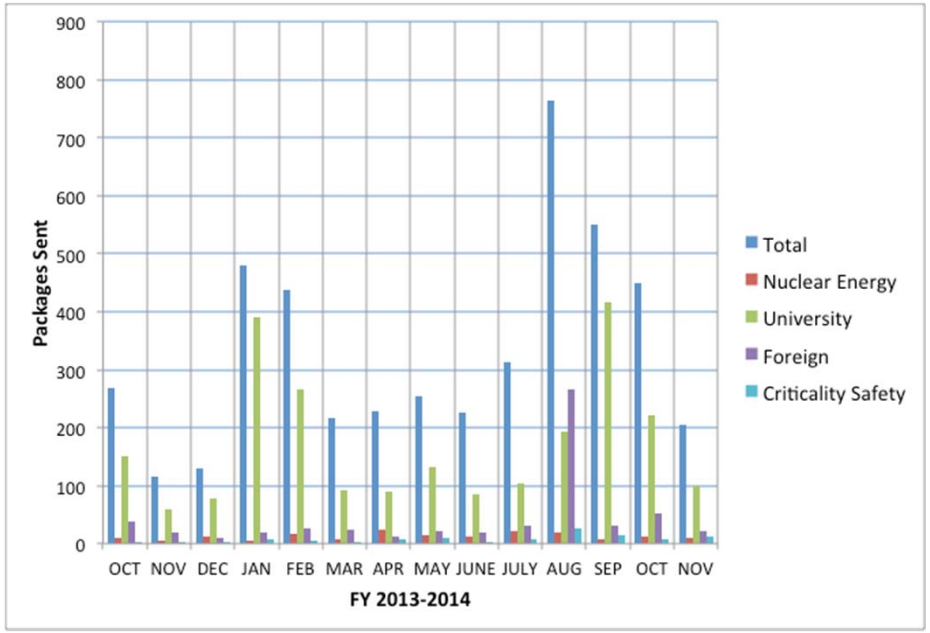
Educational Outreach

The Remote Systems Group provided numerous on-site tours and demonstrations during August through November

DATE	DAY	TIME	TOUR GROUP	# PEOPLE
13-Aug	Tuesday	12:00-12:45pm	General Public	15
27-Sept	Friday	9:30-11:30 am	Stephen Brown and Phillip Leichauer Culham Centre for Fusion Energy	2
27-Sept	Friday	3:15-4:00pm	Marshall University Society of Physics Students	9
3-Oct	Thursday	9:30am-10:15am	Rockdale Magnet School for Science and Technology	55
28-Oct	Monday	11:30am-12:30pm	Cottage Grove School physics class	6
15-Nov	Friday	4:00-4:30pm	Berea College, Physics students	9

Radiation Safety Information Computational Center (RSICC): Serving the Scientific Community for 50 years





- Software and data packages distributed FY2014: 655
- 10 package updates and revisions November 2013

Enriched stable isotope technical services and shipping

Nine shipments of 62 enriched stable isotopes were made in November

- 16 shipments of 82 enriched stable isotopes have been made in FY14 to date

No custom technical services were completed in November

- 17 technical services have been completed in FY14 to date

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Radioisotope Production

Cf-252 Production Program

- Two Cf-252 orders shipped, one ahead of schedule
- Began processing next order

Ac-225 Program

- Four shipments to two customers
- 18.85 mCi of activity

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Isotopic standards produced for the Hybrid K-edge Densitometer (HKED)

- Produced 6 new saturated KCl standards with U and began measurements
- Installed an effective filter for the Cd induced X-rays in the XRD collimator

Radioisotope Research & Development

Palladium-Gadolinium Separation for Cf-252 Production Program

- Successful separation of Pd and Gd using cation exchange resin
- Pd (yellow) in first two vials, while Gd is in the last two vials
- R&D supports recovery of Cf from Pd wire

Cf-251 Target for SHE Production

- One-sixth of ^{251}Cf sample moved to glovebox
- Cleaned using TEVA, AG50, and MP1 columns
- First electrodeposition planned for December

Transfer of Technetium Inventory to 4501

- Seven cans of Tc-99 moved to 4501 for future dispensing
- Remaining cans (20) will be moved by end of Jan 2014

Ra-228 Irradiated Target Analyzed

- One microgram of Ra-228 was irradiated for complete cycle in the HFIR
- Irradiated sample has been opened, separated and analyzed
- Th-229 produced in small quantities
- Cross section data calculated

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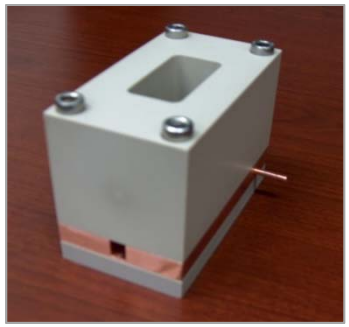
CARIBU project – Record results

NSITD

- On November 12, 2013, a successful ammonium acetate electrodepostion resulted in the production of a 1.7 Curie Cf-252 (3.3 mg) source for the Argonne National Laboratory CAlifornium Rare Isotope Breeder Upgrade (CARIBU) project.
- The deposition efficiency was 91.5% and resulted in 739 µg/cm2 of total Cf isotopes. The plate was loaded into a special forms capsule and cleaning (leaching) initiated.
- This electroplate has the largest electrodeposition of Cf-252 ever deposited onto a single target; containing over three times more Cf-252 than in any previous electrodeposition.
- The CARIBU Project's goal is to provide neutron-rich radioactive beams to users for nuclear structure, astrophysics studies and applications.



Electrodeposition unit designed for Hot Cell

Cf-252 Electrodeposition for CARIBU Source

Source being loaded into special form capsule

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ORNL: Featured lab in NTNF highlights

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National Technical Nuclear Forensics (NTNF) Highlights

November 2013

- ORNL was the featured laboratory in the National Technical Nuclear Forensics (NTNF) November highlights
- The ORNL Point of Contact (POC) for this work is Brad Patton
- ORNL will be hosting the "Overview of Nuclear Forensics for the Federal Workforce" training for the fourth time on February 11-12, 2014

Excerpts from highlights:

ORNL developed the Ultra-Trace Forensics Science Center with a highly controlled clean room environment to specifically support the high precision measurement requirements of the NTNF. The laboratory's forensics analysis capabilities include; radiochemical determinations using alpha and gamma spectroscopy and liquid scintillation, impurities high precision isotopic determinations using mass spectrometry, and neutron activation analyses. The following projects are currently underway at ORNL:

Joe Giaquinto is working on a Thermo Neptune multi-collector inductively coupled plasma mass spectrometer used for high precision isotope ratio measurements.

- Isotopic determination and age dating of High Enriched Uranium (HEU)
- High precision determinations of trace elements and trace actinides in bulk uranium and bulk plutonium
- Development of advanced techniques for high precision impurity analyses (group I and II metals, transition metals and lanthanides) in bulk uranium
- Controlled production of uranium compounds for development of uranium processing signatures
- Sampling science and development of collection techniques for nuclear forensics
- Fuel cycle modeling and simulation including 2D and 3D reactor modeling and spent fuel isotopic prediction using ORIGEN
- Post detonation nuclear forensics modeling and simulation to support debris collection, field analysis and data evaluation including the DELFIC Fallout Planning Tool
- Mentoring undergraduate, graduate and post-doctoral fellows on nuclear forensics projects to develop the next generation of expertise

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Successful conclusion of the HEU Transparency Program

A Soviet SS-21 tactical short-range nuclear missile is shown for the first time in Red Square, at the Victory Day parade in Moscow, Russia on May 9, 1985.

Inside these cylinders lies uranium that was once part of a Soviet nuclear weapon. Today it's being used in the US as fuel for commercial nuclear reactors.

- Ray Brittain attended a reception at the Russian Embassy hosted by the ambassador and also attended by Secretary Moniz to celebrate the successful conclusion of the HEU Transparency Program
  - A brief Russian documentary on the program was shown
- Many at ORNL contributed to the success of this unique program
  - ORNL, along with LANL, developed the Blend-Down Monitoring System which was the only system that monitored the conversion while no U.S. monitors were present
- Ray also participated in a visit to Peach Bottom nuclear plant, one of the reactors to receive fuel from Russian weapons

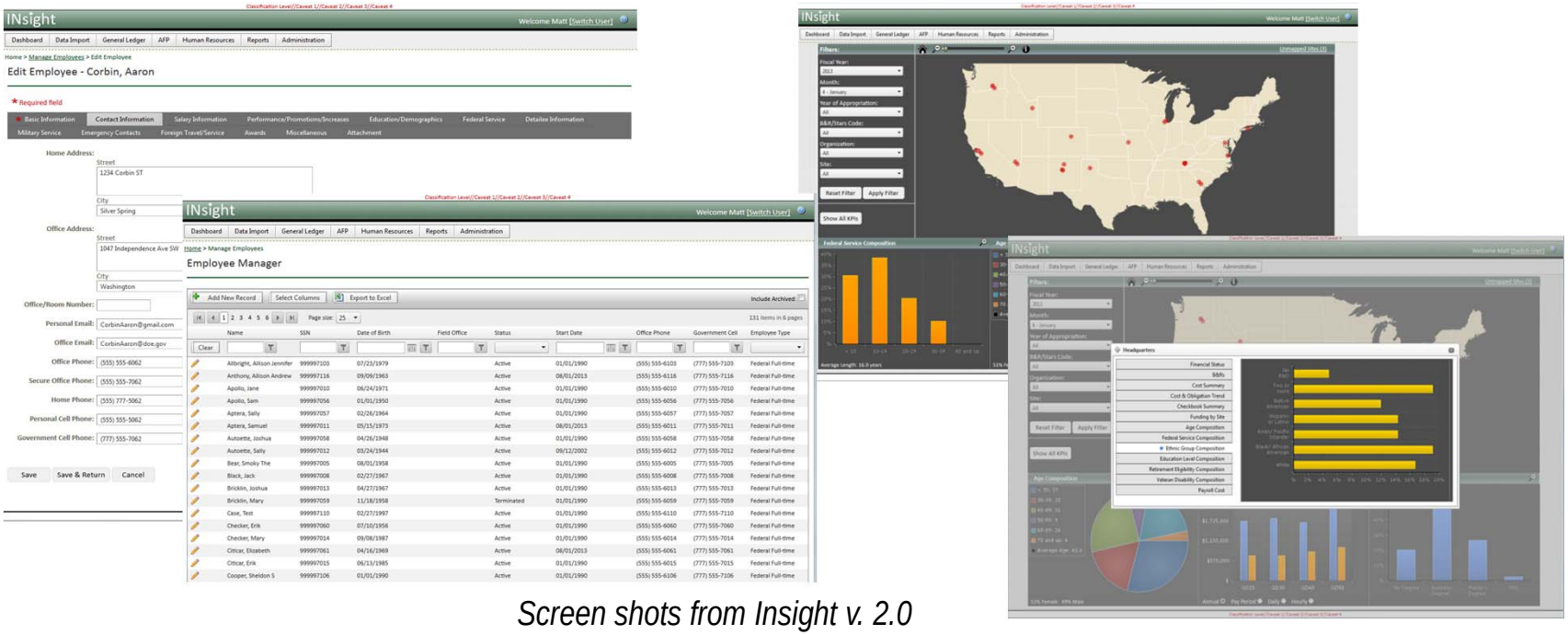
Brazil and the U.S.: Improving nuclear security culture together

- ORNL representatives conducted a workshop entitled "Nuclear Security Culture: Meeting the Needs of Practitioners" for the Department of State Partnership for Nuclear Security and the National Nuclear Energy Commission of Brazil (CNEN)
  - The event focused on the role and responsibility of all technical staff in promoting strong security culture
  - ORNL worked with a representative from Sandia National Laboratory and from University of the Witwatersrand (South Africa) to conduct the workshop which included participants from CNEN, the Brazilian military, civil defense, nuclear research facilities, and industry
  - Presentations focused on the theoretical principles and practical issues necessary to develop and enhance security culture throughout an employee's career
  - Through case studies and exchange of best practices, participants explored:
    - security considerations from employee recruitment to retirement
    - the role of a human reliability program
    - safety and security culture interfaces
    - and international efforts to address the risk posed by a potential insider

INsight version 2.0 Dashboard Application Deployment

- NSITD Nonproliferation Systems Group staff members deployed INsight version 2.0 to production in November, and introduced the new Human Resource (HR) module.
- This module is designed to help automate the Office of Intelligence and Counterintelligence HR organization's process, as well as improve data accuracy and response times associated with data calls.

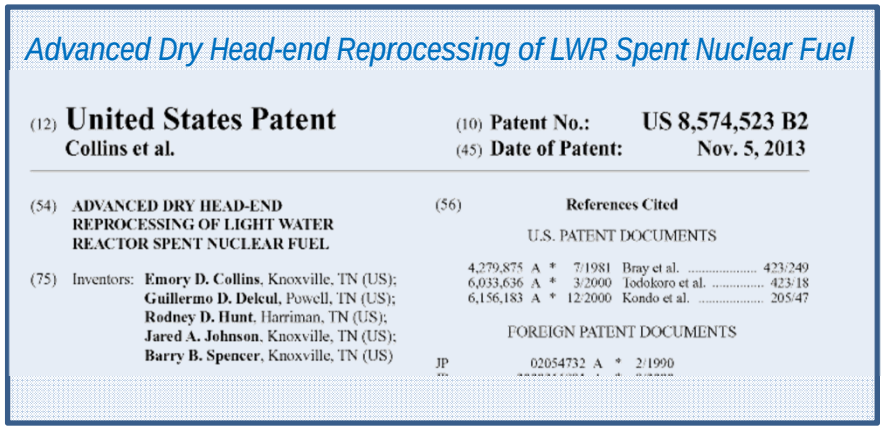
INsight swag



Screen shots from Insight v. 2.0

NSITD

Patent Granted:
Advanced Dry Head-end Reprocessing of Light Water Reactor (LWR) Spent Nuclear Fuel



Advanced Dry Head-end Reprocessing of LWR Spent Nuclear Fuel

(12) **United States Patent**
Collins et al.

(10) **Patent No.: US 8,574,523 B2**
(45) **Date of Patent: Nov. 5, 2013**

(54) **ADVANCED DRY HEAD-END REPROCESSING OF LIGHT WATER REACTOR SPENT NUCLEAR FUEL**

(75) Inventors: **Emory D. Collins**, Knoxville, TN (US); **Guillermo D. Delcul**, Powell, TN (US); **Rodney D. Hunt**, Harriman, TN (US); **Jared A. Johnson**, Knoxville, TN (US); **Barry B. Spencer**, Knoxville, TN (US)

(56) **References Cited**

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FOREIGN PATENT DOCUMENTS

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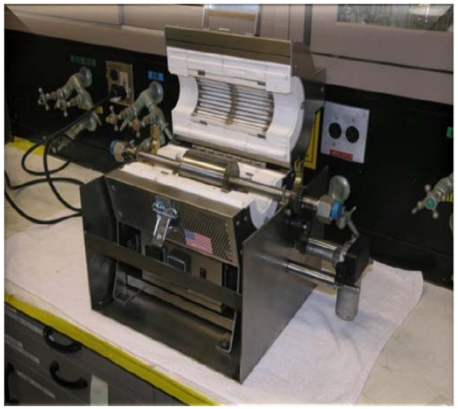
NSITD Researcher Recipients:
Emory Collins, Bill Del Cul, Rodney Hunt, Jared Johnson, and Barry Spencer

When fuel assemblies in nuclear reactors reach the end of their design life, only a small fraction of the original uranium fuel has been consumed. This advanced recycling approach takes advantage of the prolonged storage of used fuel, as presently practiced, and enables recovery of over 95% of the fuel components and cladding material to be re-used. This provides a practical, realistic, economical, and sustainable solution to reprocessing used nuclear fuel that produces only minimal amounts of legacy waste. The process is well suited for oxide-based fuels in LWRs (both Pressurized and Boiling Water Reactors) and Heavy Water Reactors such as the CANDU (Canadian Deuterium Uranium) Reactor. It may also have application to sodium-bonded metallic fuels proposed for fast neutron spectrum reactors, (e.g., actinide burners and breeder reactors).

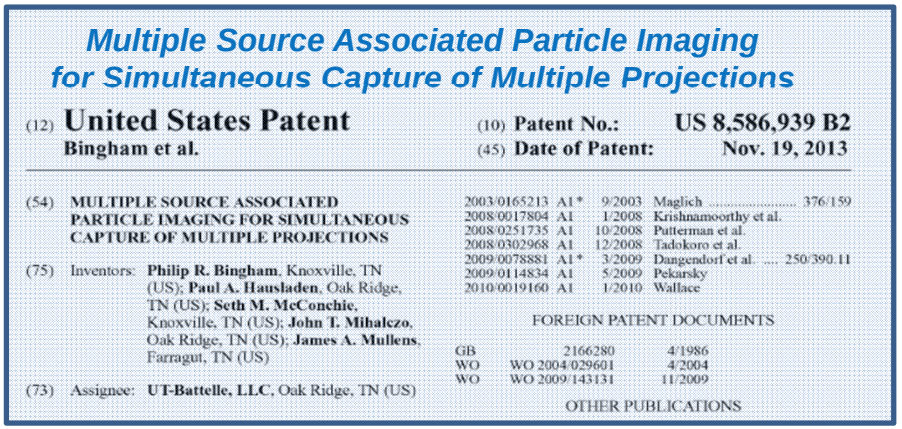


Mini reactor for NO_x treatment.

NSITD

Patent Granted:
Multiple Source Associated Particle Imaging for Simultaneous Capture of Multiple Projections

- Recipients: ORNL researchers Philip Bingham (EESRD), Paul Hausladen, Seth McConchie, John Mihalczo, and James Mullens (all of NSITD)



Multiple Source Associated Particle Imaging for Simultaneous Capture of Multiple Projections

(12) **United States Patent**
Bingham et al.

(10) **Patent No.: US 8,586,939 B2**
(45) **Date of Patent: Nov. 19, 2013**

(54) **MULTIPLE SOURCE ASSOCIATED PARTICLE IMAGING FOR SIMULTANEOUS CAPTURE OF MULTIPLE PROJECTIONS**

(75) Inventors: **Philip R. Bingham**, Knoxville, TN (US); **Paul A. Hausladen**, Oak Ridge, TN (US); **Seth M. McConchie**, Knoxville, TN (US); **John T. Mihalczo**, Oak Ridge, TN (US); **James A. Mullens**, Farragut, TN (US)

(73) Assignee: **UT-Battelle, LLC**, Oak Ridge, TN (US)

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WO	WO 2009/143131	11/2009

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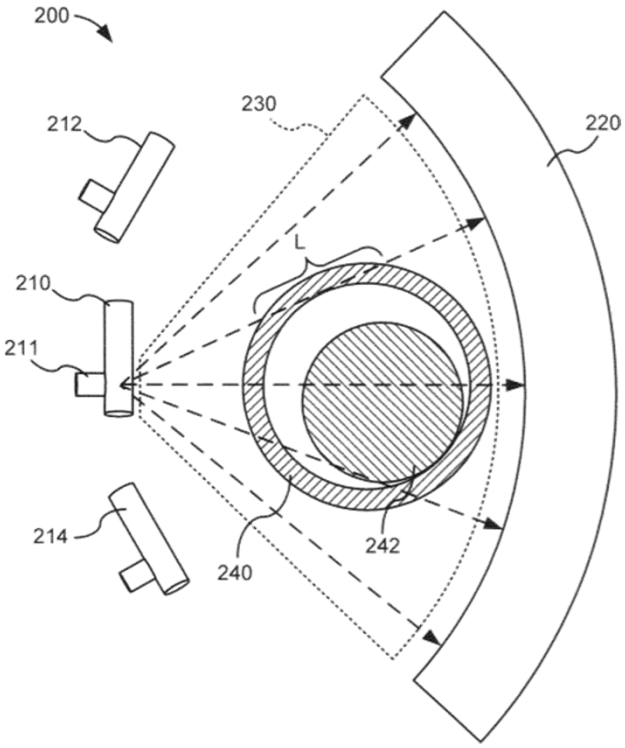


A concept schematic of the method

- This patent resulted from a multi-laboratory Battelle research initiative to develop a general technological approach for detection of contraband in air cargo
- The collaboration consisted of ORNL, BNL, INL, and PNNL in which ORNL was awarded $1M

Platform Scale Testing Center

- ORNL now has the capability to investigate and mimic the size, capacity, and function of weighing systems used in UF_6 product withdrawal station scenarios.

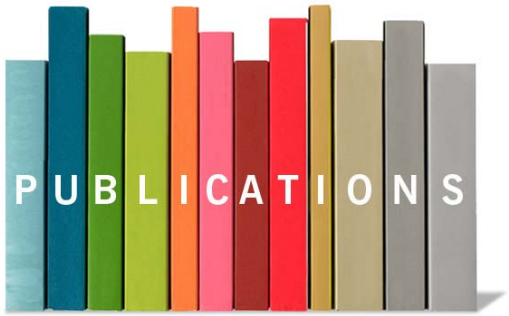
- This center, funded by NA-24, provides a means to simulate full weight profiles not previously obtainable from existing small-scale mock feed and withdrawal systems.

- NSITD International Safeguards Group Post-graduate Ross Snow completed the first draft for the executive summary announcing the installation and commissioning of a Platform Scale Testing Center, designed to investigate the accuracy, performance, and capabilities of a variety of load cell systems.

Installation of the Platform Scale Testing Center scales

Publications

- Journal Article – 4



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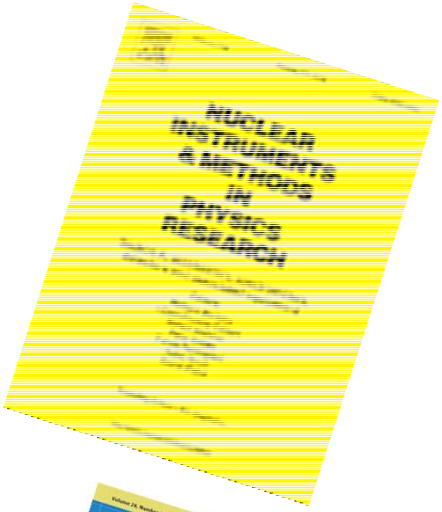

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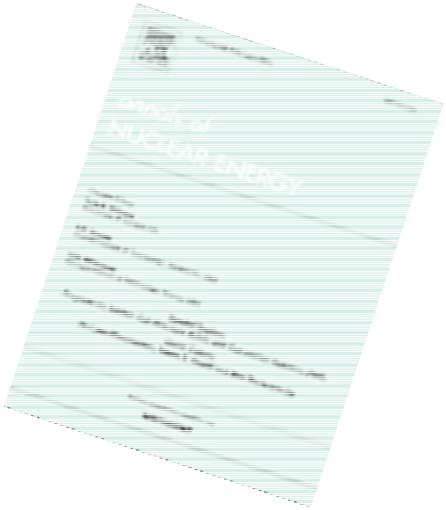

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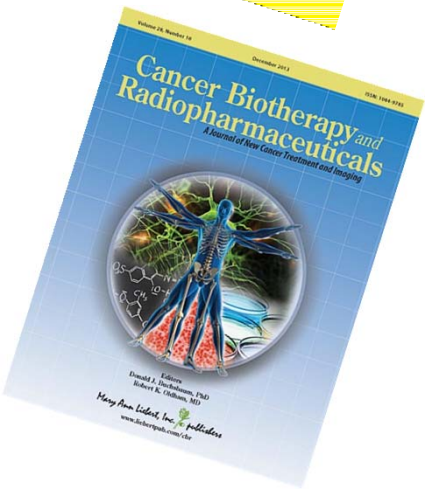

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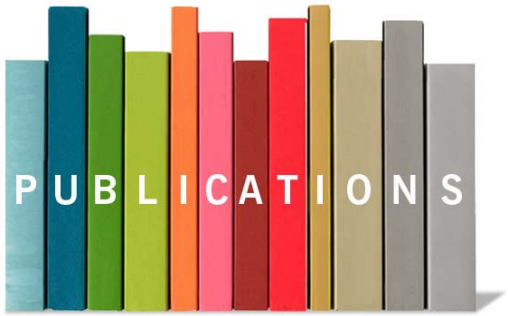

Letter Report – 1

ORNL/TM – 4

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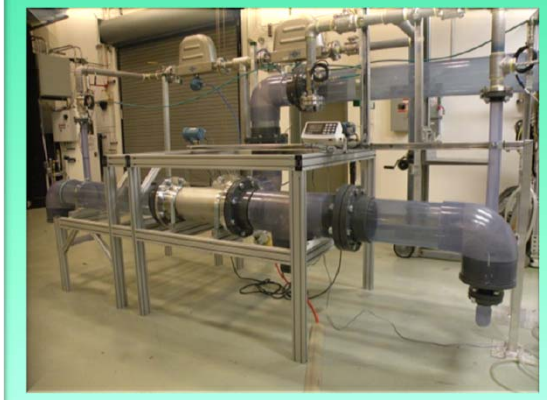
- Klaus-Peter Ziock, Chris Bensing Boehnen, and Joseph M. Ernst, *Advanced Demonstration of Motion Correction for Ship-to-Ship Passive Inspections*, ORNL/TM-2013/491, UT-Battelle, LLC, Oak Ridge National Laboratory, November 2013
- John T. Mihalczo, James Allen Mullens, James J. Henkel, and Blake A. Palles, *Extracting Characteristics of a W76 Thermonuclear Weapon from Fast Neutron Imaging Modalities, Other Time Coincidence Distributions, and Gamma-Ray Spectrometry*, ORNL/TM-2013/491, UT-Battelle, LLC, Oak Ridge National Laboratory, November 2013
- John T. Mihalczo and James Allen Mullens, C*lassified and Unclassified Characteristics of Specific Nuclear Weapons*, ORNL/TM-2013/302, UT-Battelle, LLC, Oak Ridge National Laboratory, November 2013.

Paper in Conference Proceedings (Book, CD, etc.) – 1

ITER full scale sub-header test stand installation completed



- The ITER full scale subheader test stand installation has been completed and testing initiated.
- The 200 mm diameter sub-header piping assembly will be used to evaluate the effectiveness of using compressed air to remove water from the system.
- Pressure and flow instrumentation has been installed and checked out and a leased air compressor has been connected to the system.

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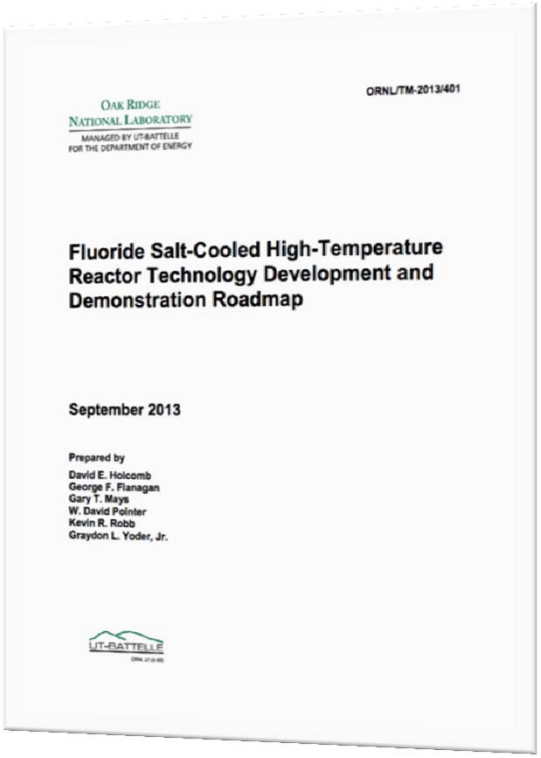
Used Fuel Systems Expertise Tapped by Sponsors

- Rob Howard and Josh Jarrell presented at the Nuclear Waste Technical Review Board Meeting and Technical Workshop in regards to the potential impacts of dry fuel storage standardization and repackaging (Washington DC, November 18–20, 2013).
- Matt Feldman, Josh Jarrell, and John Wagner presented at the DOE-NE Fuel Cycle Technologies Annual Review Meeting in regards to the Nuclear Fuels Storage & Transportation Campaign (Argonne National Laboratory, November 5–7, 2013).
- John Wagner attended the invitation-only Nuclear Waste Strategy Coalition 2013 Fall Meeting to discuss a strategy for a path forward for nuclear waste policy (Washington DC, November 12, 2013).

ORNL Continues to Lead U.S. Liquid Salt Reactor Technology

- Team from RNSD completed an FHR technology development and demonstration roadmap report presenting the first broad scope evaluation of the overall reactor class development issues
  - http://info.ornl.gov/sites/publications/Files/Pub45913.pdf
- David Holcomb represented the U.S. at (and co-chaired) the GIF Molten Salt Reactor system steering committee workshop (November 6–8) at the University of Paris-South



ORNL/TM-2013/401

Oak Ridge National Laboratory
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Fluoride Salt-Cooled High-Temperature Reactor Technology Development and Demonstration Roadmap

September 2013

Prepared by
David E. Holcomb
George F. Flanagan
Gary T. Mays
W. David Pointer
Kevin R. Robb
Graydon L. Yoder, Jr.

UT-BATTELLE

GEN IV International Forum℠

FHR Fluoride Salt Cooled High Temperature Reactor

International engagement in reactor technology activities

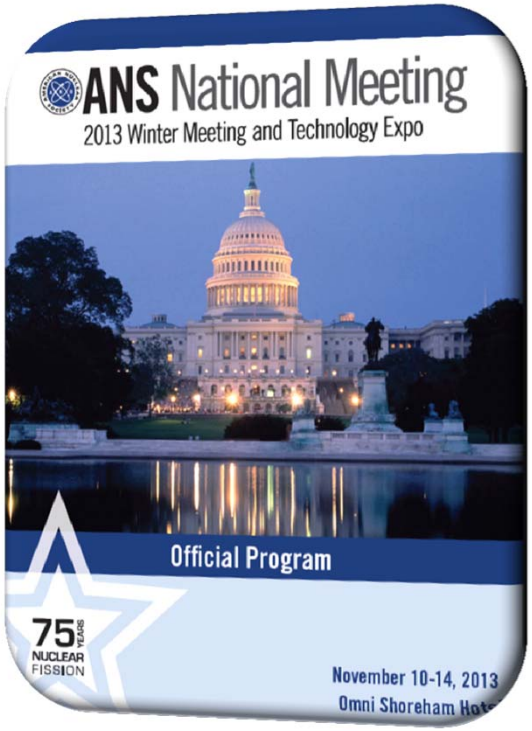
- The 2nd International Meeting on Accident Tolerant Fuels (ATF) for LWRs was held at NEA Headquarters in Paris on October 28–29, 2013.
  - The meeting was attended by Larry Ott and Lance Snead from ORNL
  - A major result of the meeting is that a proposal will be made to the NEA Nuclear Science Committee that an Expert Group on ATF Development be formed

- T. Jay Harrison attended the Economic Modeling Working Group meeting in Brussels, Belgium, as part of ORNL's involvement in the Gen IV International Forum
  - The basis of the meeting was to discuss potential collaboration opportunities in nuclear power economic modeling
  - Meeting attendees represented France, Canada, IAEA, and the Euratom.

- Richard Wood chaired the IAEA Consultancy Meeting on I&C for SMRs
  - The meeting was held in Vienna, Austria, on November 19–22 and was attended by representatives of Argentina, Canada, China, India, Italy, South Korea and the USA

RNSD papers presented at the American Nuclear Society (ANS) national meeting

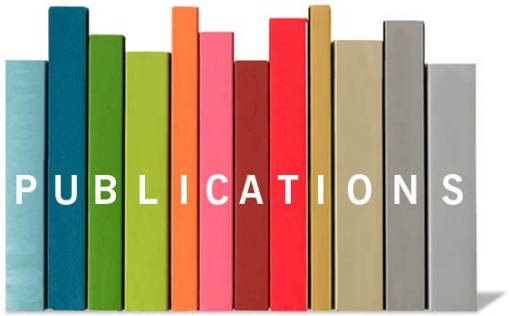
- 27 staff members participated in the ANS 2013 Winter Meeting and Technology Expo, "The 75th Anniversary of the Discovery of Nuclear Fission," held in Washington, DC, November 10–14, 2013
- Staff co-authors on 20 papers
- 11 papers presented by staff members
- Staff chaired for technical sessions
- David Pointer presented a lecture on "Nuclear Energy 101," at the U.S. Capitol as part of the ANS Washington Seminar Series. Participants included Congressional staffers, DOE staff and others from the D.C. area
- George Flanagan chaired the ANS consensus standards committee on Research and Advanced Reactors
- Doug Bowen and Ernie Elliott chaired NCS and NDA standards working group meetings



RNSD

Publications

- Journal Article – 2



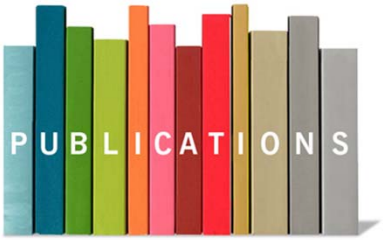
Joshua J. Jarrell, Thomas M. Evans, Gergory G. Davidson, and Andrew Godfrey, "*Full Core Reactor Analysis: Running Denovo on Jaguar,*" Nuc. Sci. Engr. Vol. 175, No. 3, p. 283-291, November 2013.

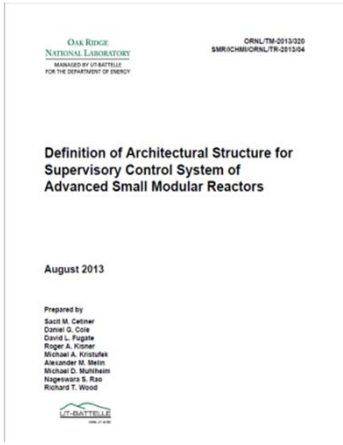
Thomas M. Evans, Scott W. Mosher, Stuart R. Slattery, and Steven P. Hamilton, "A Monte Carlo synthetic-acceleration method for solving the thermal radiation diffusion equation," *J. Comput. Phys*., Vol. 258, p. 338-358, February 2014 (available online November 2013).

RNSD

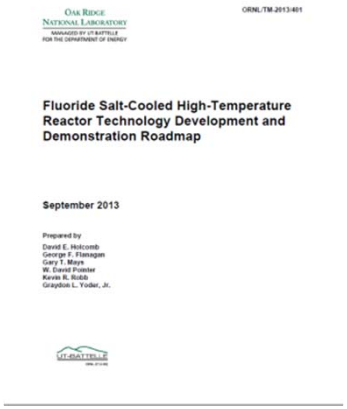
Publications

- Journal Articles - 2
- Letter Report -1
- ORNL Reports - 3
- Conference Papers - 2

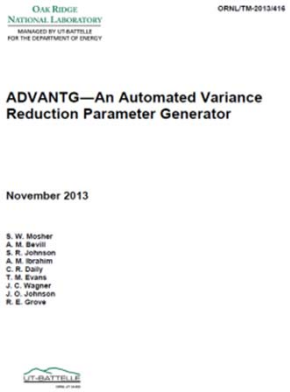




Sacit M. Cetiner, et. al., *Definition of Architectural Structure for Supervisory Control System of Advanced Small Modular Reactors,* ORNL/TM-2013/320 (SMR/ICHMI/ORNL/TR-2013/04), UT-Battelle, LLC, Oak Ridge National Laboratory, August 2013.



David E. Holcomb, et. al., *Fluoride Salt-Cooled High-Temperature Reactor Technology Development and Demonstration Roadmap,* ORNL/TM-2013/401, UT-Battelle, LLC, Oak Ridge National Laboratory, September 2013.



S. W. Mosher, et. al., *ADVANTG—An Automated Variance Reduction Parameter Generator,* ORNL/TM-2013/416, UT-Battelle, LLC, Oak Ridge National Laboratory, September 2013.

Materials irradiation – November 2013

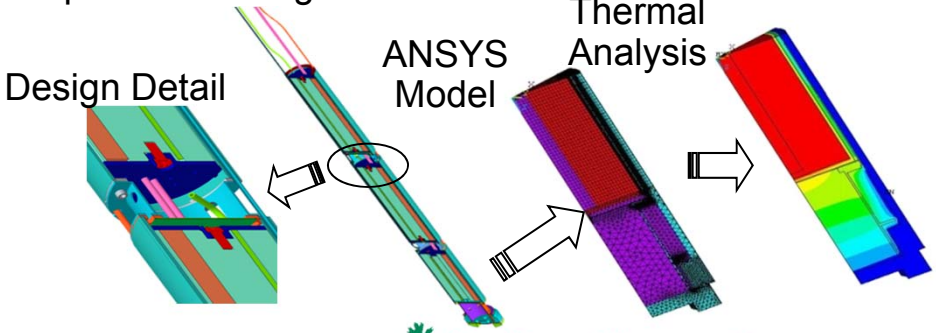
RNSD

Project	Format	Sponsor	Stage					Notes
			Newly proposed	In Design	In Fabrication	In Reactor	Removed	
Steel Screening	Rabbit				5			Cycle 451
Titan Metal	Rabbit	DOE, FE US-Japan				2	28	Tungsten and steel
Composite Flexure	Rabbit	DOE, FE				8		SiC
Mini-Composite	Rabbit	DOE, FE				3	1	SiC
Round-bar Tensile	Rabbit	DOE, FE		4+		TBD 2013		Steel
Hydrided Clad	Target	DOE, NE					4	Zircaloy
Ibiden	Rabbit	WFO, Ibiden				25	13	Graphite
Nippon	Rabbit	WFO, Nippon		31		Cycle 452		Graphite
Toyo Creep	Target	Toyo Tanso			1	2, Cycle 449		Graphite
Inconel springs	Rabbit	AECL		13		8, Cycle 451	2	
Graphite Creep	Rabbit	EDF		4		5, Cycle 449		Irr. Graphite
SHINE	Rabbit	DOE		9		FY 2014		Mo-99
Exotic Ceramic	Rabbit	DOE, FE				6	3	
SiC Joining tests	Rabbit	DOE, FE		21	5	Cycle 452		SiC
HTV Capsule	Target	DOE NE		1		2014		Graphite
FCR&D Rabbits	Rabbit	DOE NE		1		2014		DU fuel samples
General Atomics Rabbits	Rabbit	General Atomics				0, Cycle 449	5	SiC
FeCrAlY	Rabbit	Fusion				2, Cycle 450	3	FeCrAlY
Pu238		DOE				7, Cycle 450		Flow testing
EPRI Rabbits	Rabbit	EPRI			7	Cycle 453		
TOYO Rabbits	Rabbit	TOYO TANSO				13	11	Graphite

Irradiation

Experiment Fabrication

Experiment Design



OAK RIDGE NATIONAL LABORATORY
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CASL Represented at American Nuclear Society (ANS) Winter Meeting

November 10-14, 2013

- CASL was represented by 20 authors presenting 34 papers
- Nam Dinh, NCSU professor and CASL Validation Data Product Integrator was name an ANS Fellow for:
  - Innovative research that has enabled the development and installation of severe accident mitigation devices for Generation III LWR
  - Furthering the understanding of complex thermal hydraulics phenomena important to reactor safety, and resulting in advanced models and computational methodology for the simulation of two-phase flow

ANS News

A PUBLICATION OF THE AMERICAN NUCLEAR SOCIETY NOVEMBER/DECEMBER 2013

New ANS Fellows named

Two members of the American Nuclear Society were recently honored with the highest grade of membership in recognition of their outstanding contributions to the advancement of nuclear science and technology. The new Fellows were recognized by ANS President Donald Hoffman on November 11 during the opening plenary session of the 2013 ANS Winter Meeting.

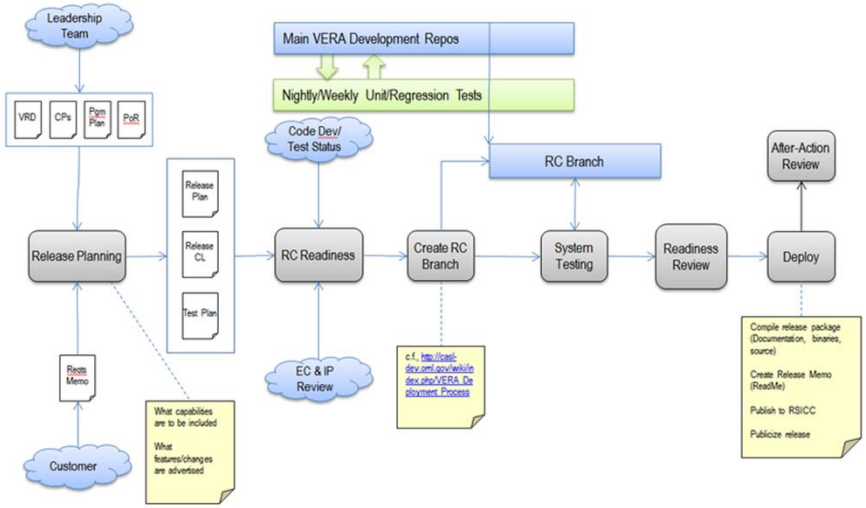
Nam Truc Dinh, ANS member since 1998 and professor of nuclear engineering at North Carolina State University, for his innovative research that has enabled the development and installation of severe accident mitigation devices for Generation III light-water reactors, furthered the understanding of complex thermal hydraulic phenomena important to reactor safety, and resulted in advanced models and computational methodology for the simulation of two-phase flow.

CASL Released its Virtual Environment for Reactor Applications (VERA) thru the ORNL Radiation Safety Information Computational Center (RSICC)

CASL

Milestone description

- First release of key virtual reactor components to non-CASL partners
- Expected target organizations for this release include:
  - Independent Software Vendors, to get an early look at the software to support software interoperability objectives
  - U.S. universities and national labs, for research purposes
  - Industry users, for early evaluation.



VERA components in release

Component	Included	Not Included	Comments
Physics Components			
COBRA-TF	X		Standalone with VERAIn input.
Insilico	X		Sn/Spn with Scale/XSProc and VERAIn input
Coupled Insilico + COBRA-TF	X		Single assembly
Hydra-TH		X	
MPACT	X		Lattice physics, no 3D
MAMBA-2D		X	
Peregrine		X	
Tiamat (CTF + Insilico + Peregrine)		X	
Coupled COBRA-TF + MAMBA-2D		X	
Shift		X	
Infrastructure Components and TPLs			
Trilinos	X		
TriBITS	X		
VERAIn	X		Common VERA input parser
Dakota	X		
LIME	X		
DataTransferKit	X		
MOOSE		X	
Other Required TPLs	X		As defined in the VERA Installation Guide.

Accomplishments & lessons learned

- This release is not publicly available (as in open source downloadable via web)
  - CASL will review and approve applications to obtain the code from RSICC under a Test & Evaluation license
- "Dress rehearsal" of the process for future public releases
- Established a user support protocol and supporting toolset
- After-action review was held to identify process improvements and lessons learned

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CASL Activities

CASL

- Value Proposition Subcommittee
- ANC/VIPRE/BOA Discussion
- Cross Section Calibration and Uncertainty Quantification
- PWR Owner's Group Meeting Preparation
- EPRI Test Stand Coordination
- COBRA-TF Working Group Meeting
- Renewal Proposal
- Milestone Review

VOCC Tours

5 Tours for November 2013

- Virginia Tech Students (17)
- ORNL Legal Interns
- Chattanooga State Community College (26)
- TN Air National Guard and TEC TV Tour & Technology
- Eric Reagan

Meetings

2013 ANS Winter Meeting & Nuclear Technology Expo, Nov 10-14

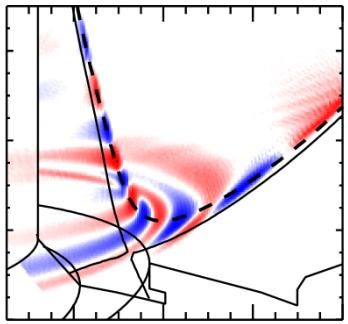
Supercomputing 2013, Nov 16-22

ORNL Experimental Plasma Physics Group

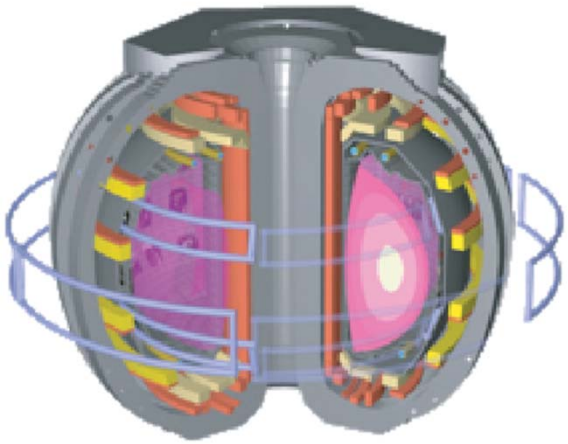
Three APS invited talks by early career scientists

- "Projecting High β Steady State Scenario from DIII-D Advanced Tokamak Discharges." J-M Park
- "Plasma Response Measurements of Non-Axisymmetric Magnetic Perturbations on DIII-D Using SXR Imaging." Morgan Shafer
- "Understanding the Physics of Thermal Quench Mitigation." Nicholas Commaux

3D Edge Perturbations via SXR Imaging



Presented at the
55th Annual APS Meeting
Division of Plasma Physics
Denver, Colorado
November 11–15, 2013



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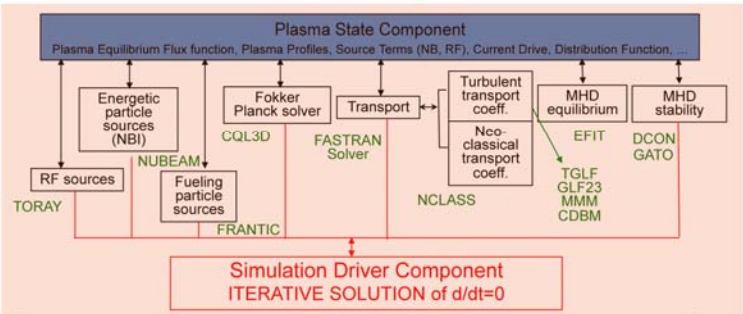
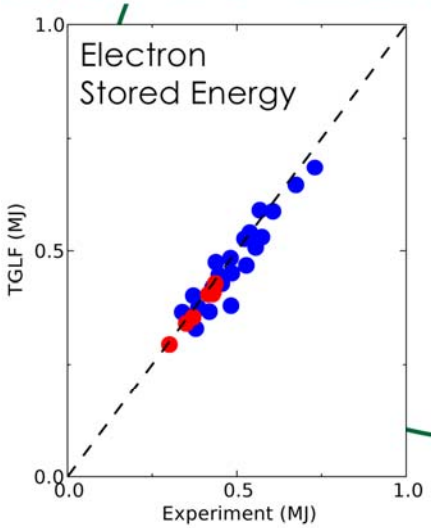
Projecting high β steady state scenario from DIII-D advanced tokamak discharges

Integrated Modeling FASTRAN/IPS

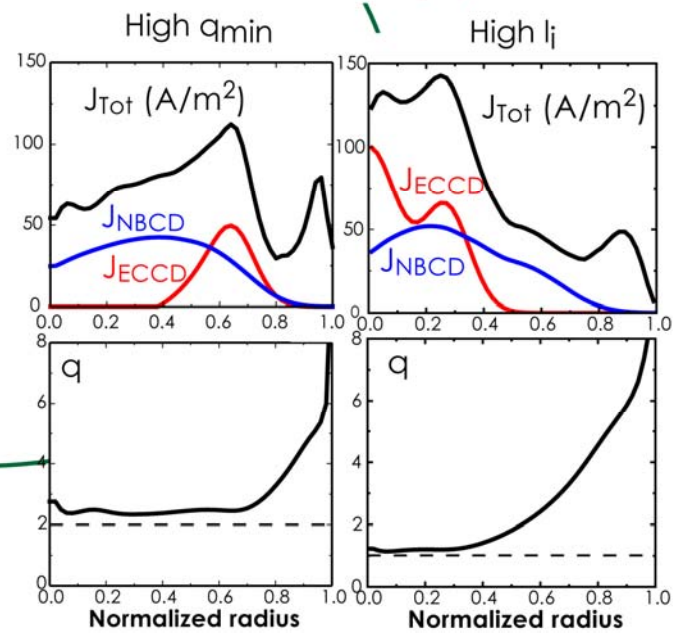


- ORNL's FASTRAN/IPS integrated theory-based modeling validated against DIII-D experiment guides the development of high β steady state scenarios for ITER, FNSF and DEMO
- Two self-consistent fusion reactor relevant β_N=5 steady state solutions found: high q_{min} and high l_i

Experimental Validation



Scenario Prediction/Optimization



J.M. Park
Experimental Plasma Physics Group

OAK RIDGE NATIONAL LABORATORY
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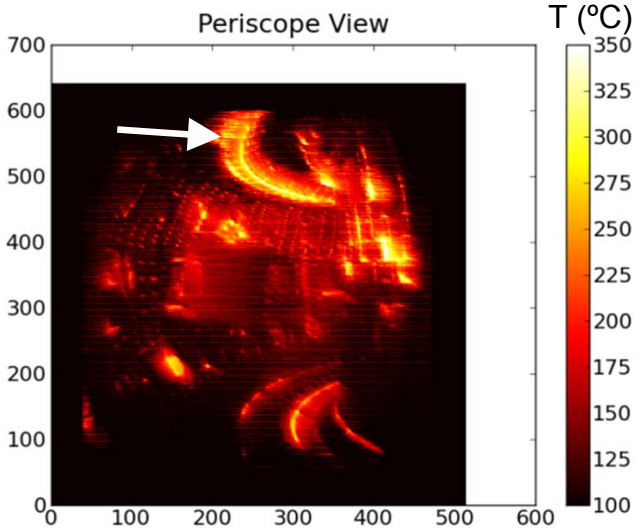
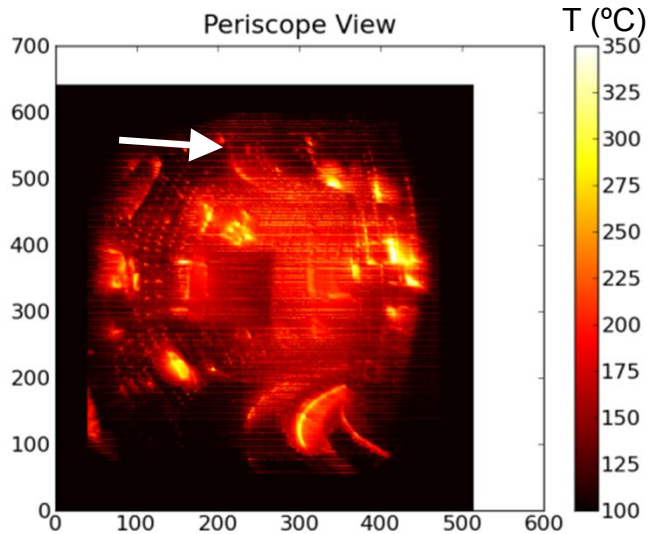
FMNSD

Understanding the physics of disruption mitigation in ITER



IR View of the DIII-D vessel after an unmitigated disruption



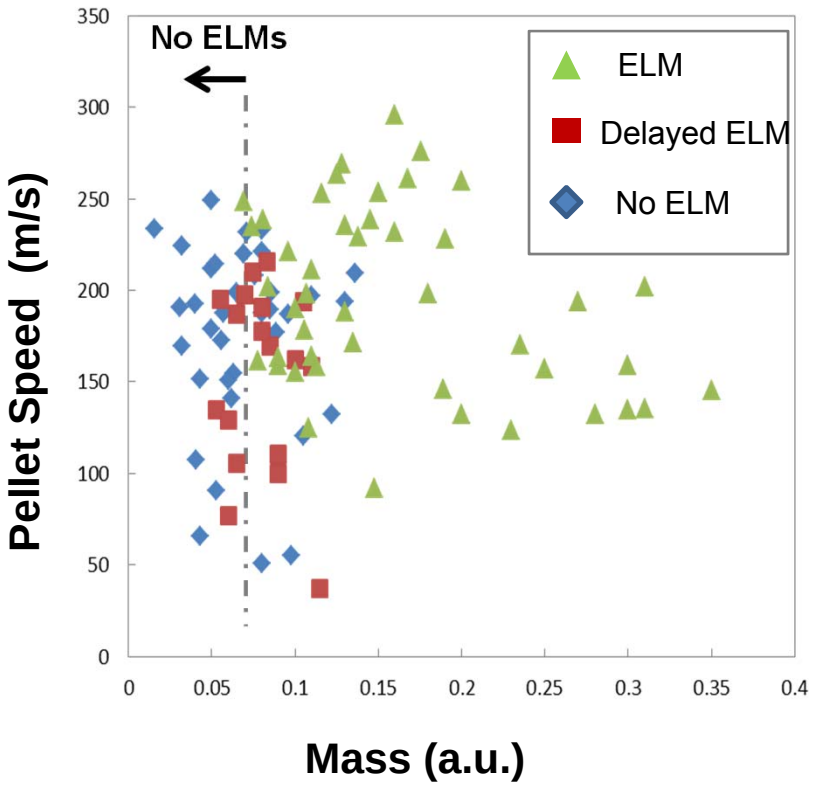
IR View of the DIII-D vessel after an impurity mitigated disruption

Nicolas Commaux, Experimntal Plasma Physics Group

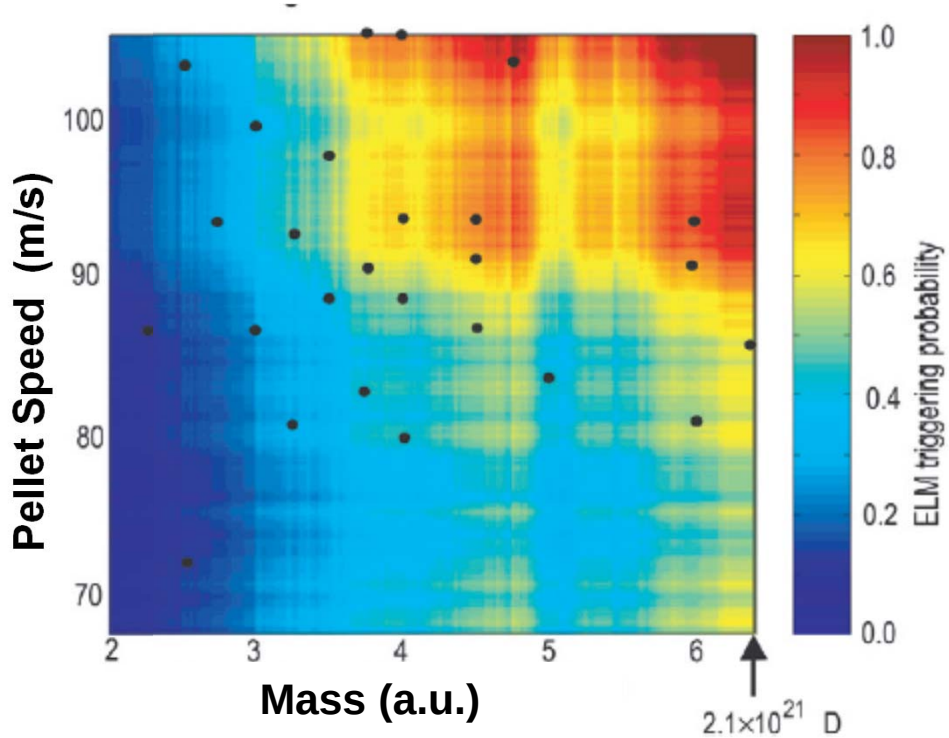
- Disruptions are sudden losses of confinement that could have deleterious effects on ITER (melted wall, damaged structures…)
- Recent results presented at the APS showed that efficient mitigation of local heat flux ("hot spots") by preemptive injection of radiating impurities is very efficient
- FMNSD is working at DIII-D to understand the physics of disruption mitigation on ITER in order to develop that system
- The ITER disruption mitigation system is expected to protect the device: it is an ORNL procurement

Experiments demonstrate that pellets of sufficient size/speed are needed to trigger ELMs

DIII-D ITER-Like Scenario



JET ITER-Like Wall



Lang et al. Nuc.Fus. 2013

~ 1.7mm

- Pellets that are < 0.8-mm size do not trigger ELMs on DIII-D. Pellet speeds above 100 m/s are more likely to trigger ELMs. Scaling to ITER predicts a ~3-mm size pellet is needed.

Collaboration with Italian researchers on high-speed pellet injection

- ORNL has been working with ENEA-Frascati on this since the early 1990s – recent R&D is in support of the proposed IGNITOR experiment.
- Dedicated test facility at ORNL includes four pipe guns and four two-stage light gas guns.
- ENEA-Frascati has procured a new cryogenic refrigerator for the project (more power!!).
- ORNL researchers have installed/tested the new cryo-cooler, recording the lowest barrel temperatures to date (~7.1 to 7.5 K).

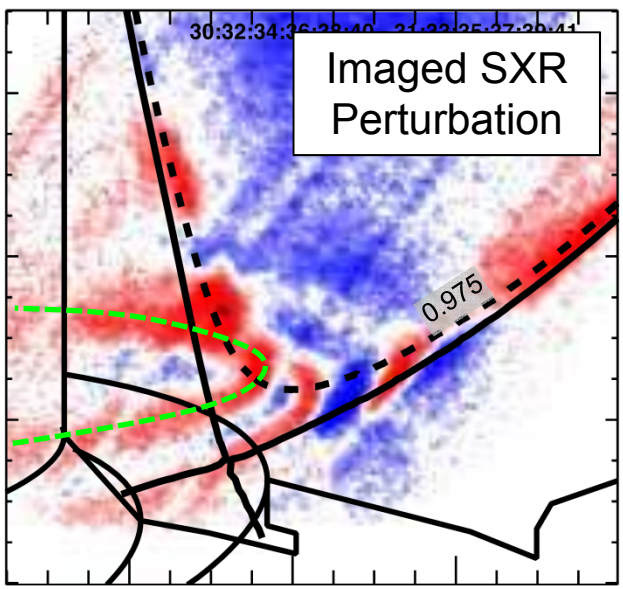
- With D_2 pellets, the solid strength increases as the temperature decreases.
- "Strongest" possible pellets are needed to survive the high acceleration forces required to achieve the highest pellet speeds.
- The next joint experimental campaign will be scheduled soon with the objective of demonstrating pellet speeds of ~3000 m/s (or ~3 times more than for single-stage light gas gun).

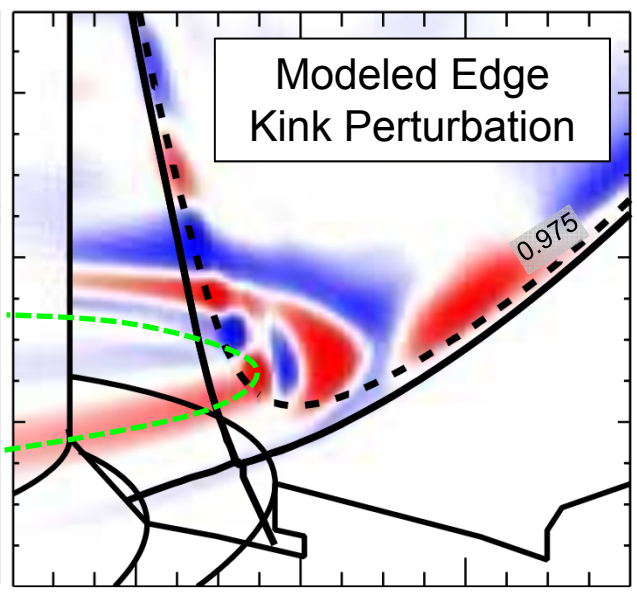
Imaging plasma response to 3D magnetic fields shows need for extended MHD models

ELM control on ITER may rely on applying small ($\delta B/B \sim 10^{-3}$-10^{-4}) 3D magnetic perturbations, but how does the plasma respond?

- Open question: Does a fast rotating plasma shield applied perturbations?

- New extended (two-fluid, resistive) magnetohydrodynamic (MHD) modeling (M3D-C[1] code) predicts edge screening response at high *electron* rotation, creating a static kink perturbation.
- Soft X-Ray Imaging on DIII-D shows 3D edge helical kink perturbation to applied fields, consistent with modeling.

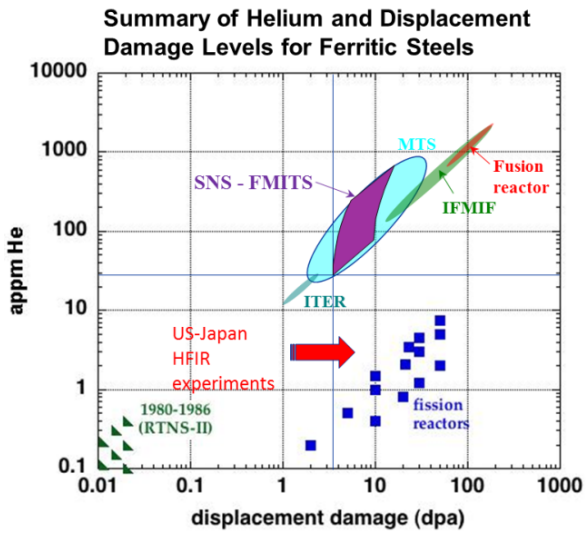


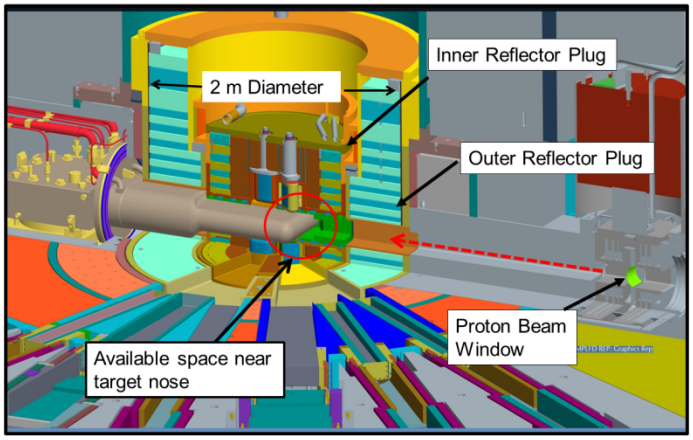


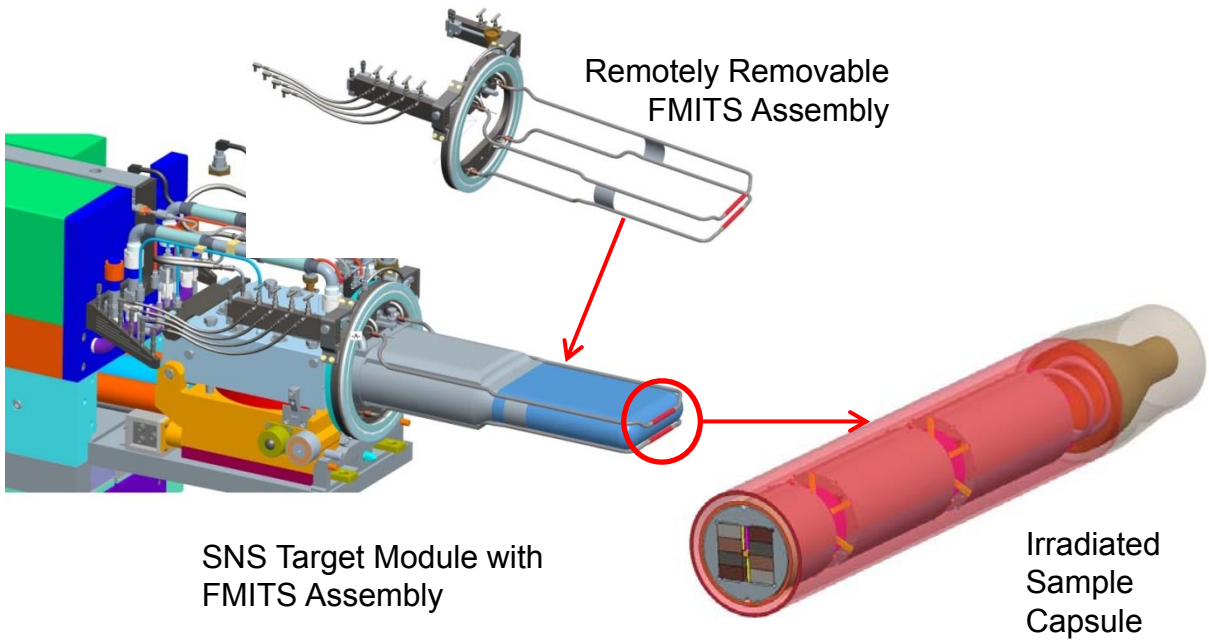
Morgan Shafer, Experimental Plasma Physics Group

Fusion Materials Irradiation Test Station (FMITS) conceptual design underway

- Critical unanswered questions in Fusion Materials involves high energy neutron damage and He and H embrittlement affects
- FY12 design study concluded an external harness could be added to the SNS target module to provide a relevant fusion irradiation environment without constructing a dedicated facility
- FY14 OFES & FMNSD funding received to further the existing concept & reduce potential risks to the SNS neutron science program
  - Conceptual Design review is set for June 2014
- Current mechanical design efforts are focused on integrating FMITS with new SNS target water shroud design







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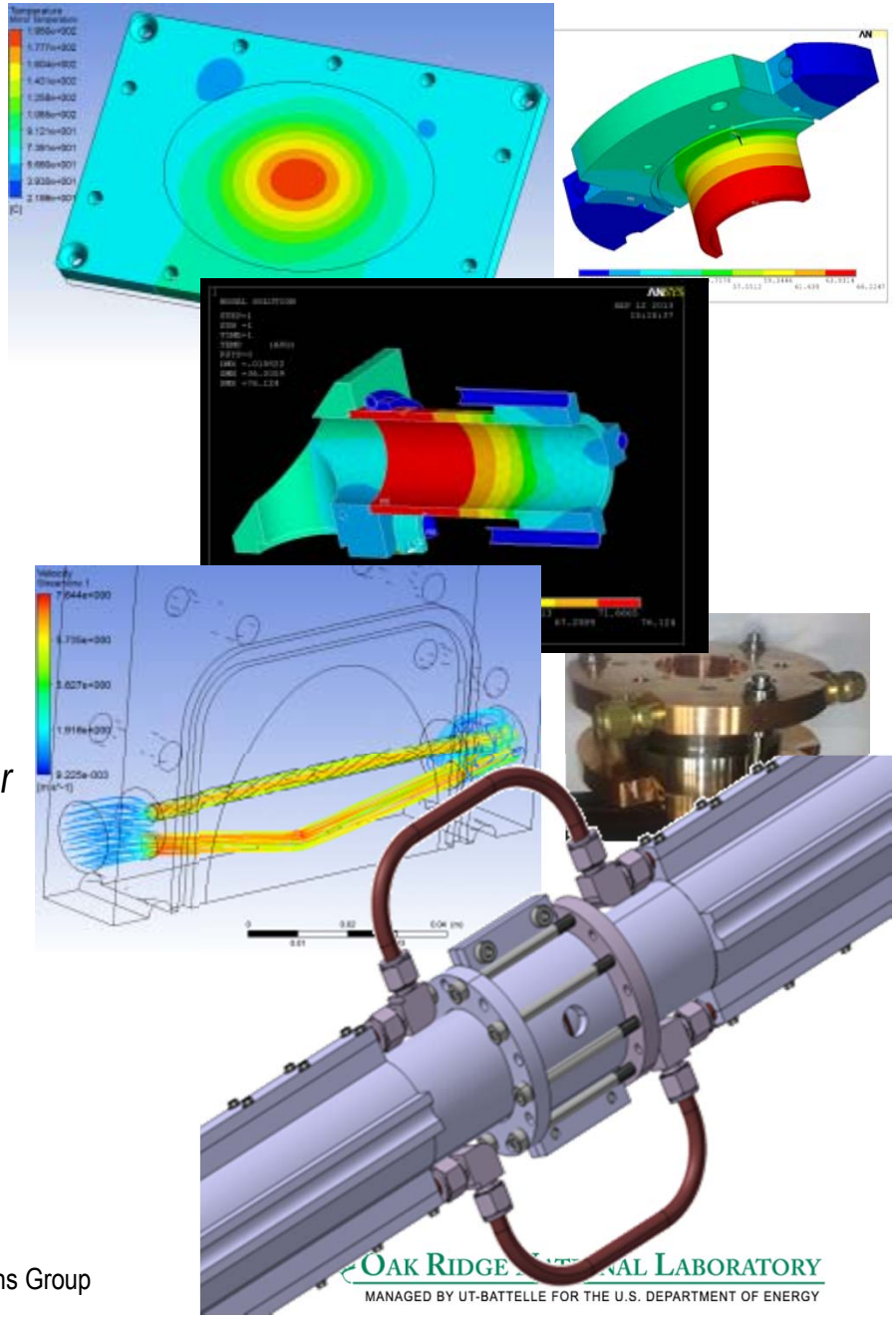
ITER ECH Transmission Line analysis completed

- An intermediate design review was successfully completed (October 28-30) for the ITER Electron Cyclotron Heating (ECH) transmission line
- Tim Bigelow, Mike Kaufman, and Arnie Lumsdaine participated in the review, led by Greg Hanson
  - Representatives from ITER IO, and the domestic agencies of the EU and Japan also served as reviewers
- Arnie Lumsdaine led a mechanical engineering team that performed design and analysis tasks on a variety of components for the ECH TL system.
  - From the meeting report – "*it is recommended to share the analysis reports with the designers of the UL ex-vessel couplings, which are required to undergo a similar process of re-design.*"
- Mike Kaufman performed a study to evaluate waveguide performance based on manufacturing tolerances, tilt and sag.
  - *From the meeting report – "it would be useful to share the analysis methodology and results with the ITER Neutral Beam group, since a similar approach could be followed to characterise the transmission losses in the HNB Residual Ion Dump . . ."*



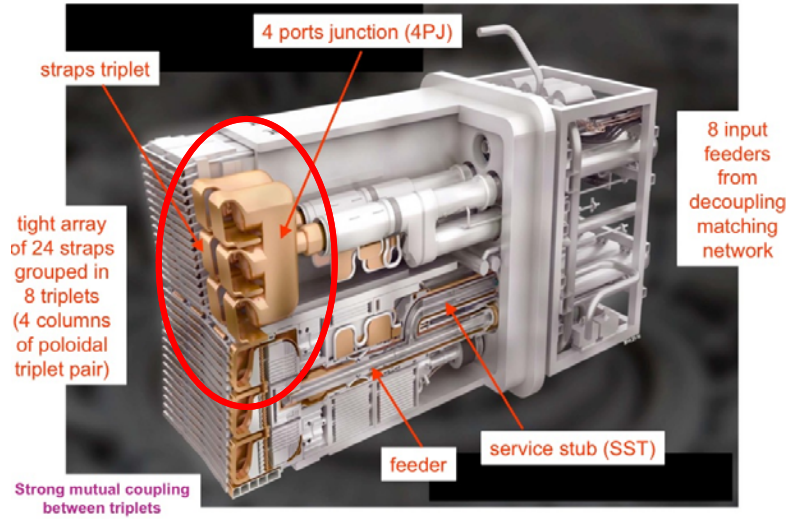
ITER Ion Cyclotron component testing

FMNSD

- A 6-MW power splitter test article for the ITER Ion Cyclotron system has been delivered by the supplier, MEGA Industries, LLC, and assembled onsite at the 7625 Multi-Purpose High Bay Facility.
- The device takes 6 MW of radiofrequency (RF) input power and divides it up into two equal, isolated output streams feeding top and bottom halves of an antenna quadrant.
- Also provides passive impedance matching for the RF sources during fast antenna loading changes caused by Edge Localized Modes and other transient changes in the plasma density close to the antenna.
- Initial characterization has been performed, with all parameters falling within required range.

6 MW RF Power Splitter Test Article

ITER antenna quadrant fed by single power splitter



Multi-Program High Bay Facility (7625/ 7627) operations

- Several experiments continued operations during the period including Proto-MPEX Phase II (PhIX), Microwave Assisted Plasma (MAP), Carbon Fiber Line, and FMIT
- Preparations continued to connect new vacuum breaker switchgear in Building 7627. Connection planned for early December.
- Completed placement of calculation-based arc flash labels throughout both buildings. Final draft of report in review.
- Continued to work with subcontractor to finalize NEC Compliance Assessment Report.
- Performed hi-potting on new transformer using recently developed procedure
- Assembled prototype RF splitter for testing in the Resonant Ring

Physics Integration Experiment (PhIX)

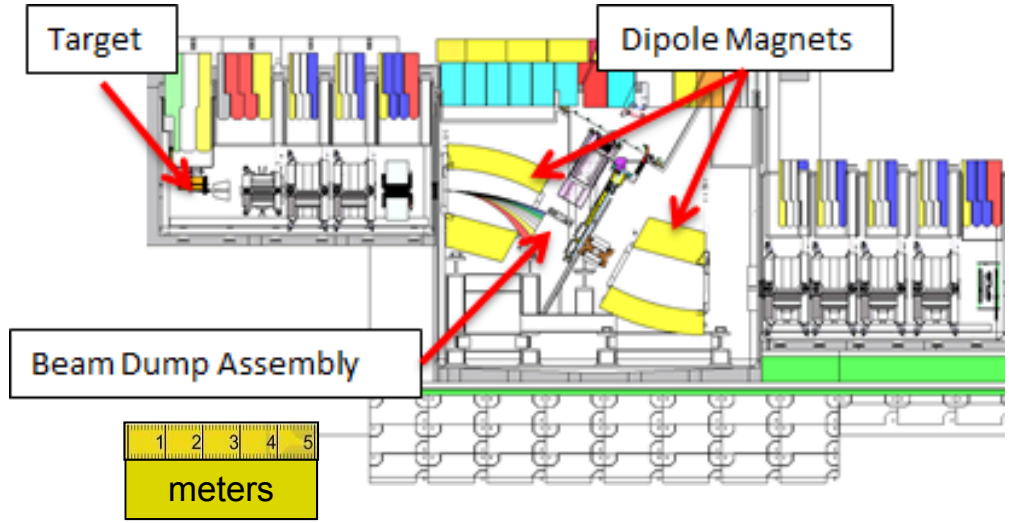
FMIT Operational

Assembly of Prototype Splitter

ORNL hydro-dynamic flow testing of the FRIB Beam Dump was successfully completed

ORNL Remote Systems has led and assisted in FRIB Beam Dump R&D and design beginning in 2009

- Facility for Rare Isotope Beams (FRIB), a DOE-SC National User Facility
  - To be constructed on campus of Michigan State University
  - Primary heavy ion beams up to 400 kW, 200 MeV/u uranium
  - Unique rotating water cooled drum serves as a beam stop for up to 100% of primary beam power
- High beam power capacity nominally 325 kW, with small mm dia. size beam spots
  - Extreme power densities up to ~ 10 MW/cm3
  - High radiation and vacuum operating environment
- Rotating (400 rpm) water-cooled (60 gpm) Ti drum with 0.5 mm outer wall (heavy ion beam window) baseline design chosen
- **ORNL full-scale flow mockup has verified complex, multi-physics, computational flow analysis**
  - **Phase I hydro-dynamic flow parameter verifications completed in June 2013**
  - **Phase II hydro-dynamic flow visualization and analysis benchmarking completed in September 2013**



REDC (7930) PaR Manipulator System factory acceptance test successfully completed

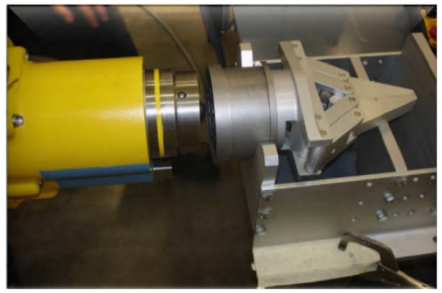
- Remote Systems (RS) personnel are assisting with the design and replacement of the REDC (building 7930) Cell-G manipulator system
- The PaR replacement manipulator fabrication, assembly and factory acceptance testing were successfully completed in November
  - ORNL personnel attended the factory acceptance test at the PaR Shoreview, Minnesota facilities
- In addition, the deliverables list and the shipping plan were approved
- Delivery to ORNL Building 7603 is planned for December

Travel and Speed Tests

Control Console Test

System Wiring Test

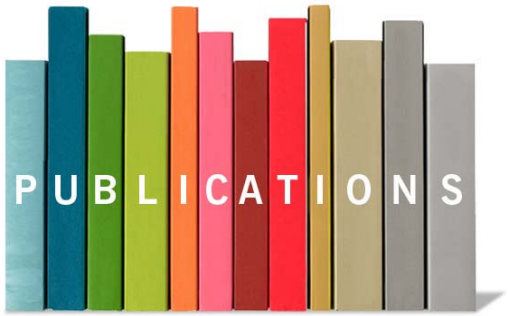
Load Test



End-effector Replacement Tests

Publications

Journal Article - 2



A. Bader, D. T. Anderson, C. C. Hegna, Y. Feng, J. D. Lore, J. N. Talmadge, "Simulations of edge configurations in quasi-helically symmetric geometry using EMC3–EIRENE," *Nuclear Fusion* 53(11). doi:10.1088/0029-5515/53/11/113036

C. M. Silva, T. B. Lindemer, R. D. Hunt, J. L. Collins, K. A. Terrani, L. L. Snead, "Evaluation of sintering effects on SiC-incorporated UO_2 kernels under Ar and Ar and Ar-4%H_2 environments," *Journal of Nuclear Materials*, 443, Issues 1-3, Pages 596-602.

NNFD FY 2014 cumulative facility metrics

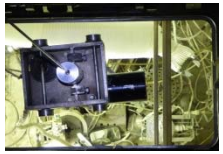
Hot Cell Availability

Bldg. 7920 November	99.7%
Cumulative	93.9%
Bldg. 7930 November	100%
Cumulative	99.6%
Bldg. 3525 November	100%
Cumulative	100%
Bldg. 3025E November	90.0%
Cumulative	95.0%

Facility Upgrades and Maintenance Activities

7920

- Programmed maintenance operations
- Completed Annual and Biennial testing of Hot Cell Fire Protections Systems
- Replaced Transfer Case Door Lock Latches and Operating Mechanisms
- Glove Box Installations
- Installed Cubicle 3 Pellet Press Assembly
- Completed repair and installation of Cubicle 3 Trolley



- RHTRU Waste Removal Operations

7930

- Programmed maintenance operations
- Installed pressure boosting relay on S-13 and commenced testing for future installation and repair of S-15 supply damper
- Began PAR - Phase 1 facility electrical modifications
- Painting of various second floor areas
- PaR acceptance testing completed SAT at factory. PaR preparing to ship manipulator and shield plug frame to ORNL

3525

- Programmed maintenance operations
- North Cell crane repairs
- K14 Building Supply System Steam Leak Repairs
- K13 Building supply motor replacement

- K9 Office area supply condensate drain repairs
- Asbestos abatement in 3525 Equipment Room
- Replaced 30+ year old fork lift propane to electric

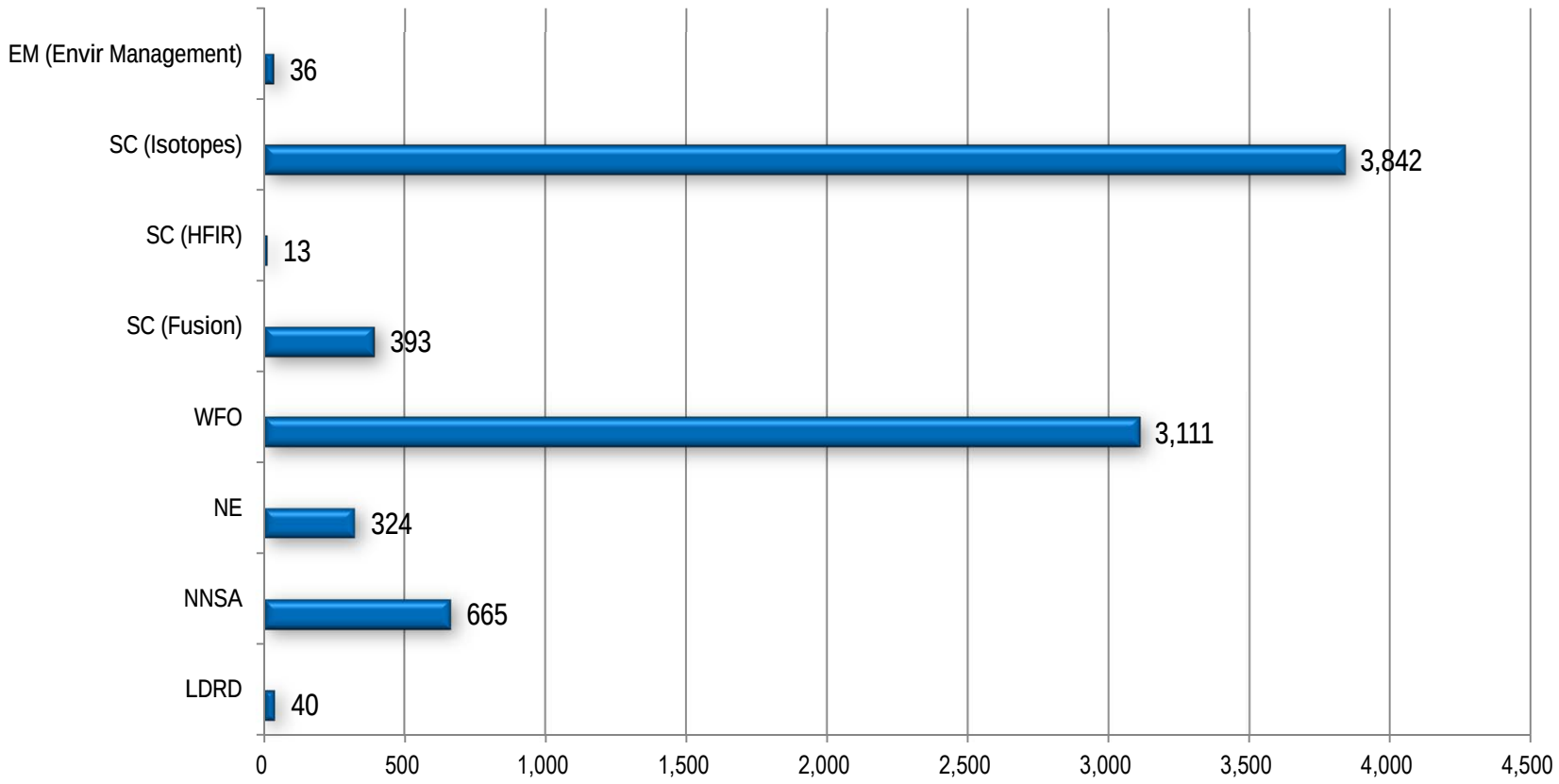
3025E

- Programmed maintenance operations
- Completed corrective maintenance on several MSM units
- Completed repairs to steam system leak in CAA
- Replaced two PCM-1B units with Canberra Argos-5AB units
- Removed Roots blower and motors from Cell 6 ventilation system
- Completed repairs to Cell 5 annunciator alarm circuit
- Completed replacement of anti-room filter housing pre-filters

NNFD FY 2014 business volume by customer metrics

ORNL Hot Cell Usage by Sponsor

(12-month period ending Nov 30, 2013, $K)



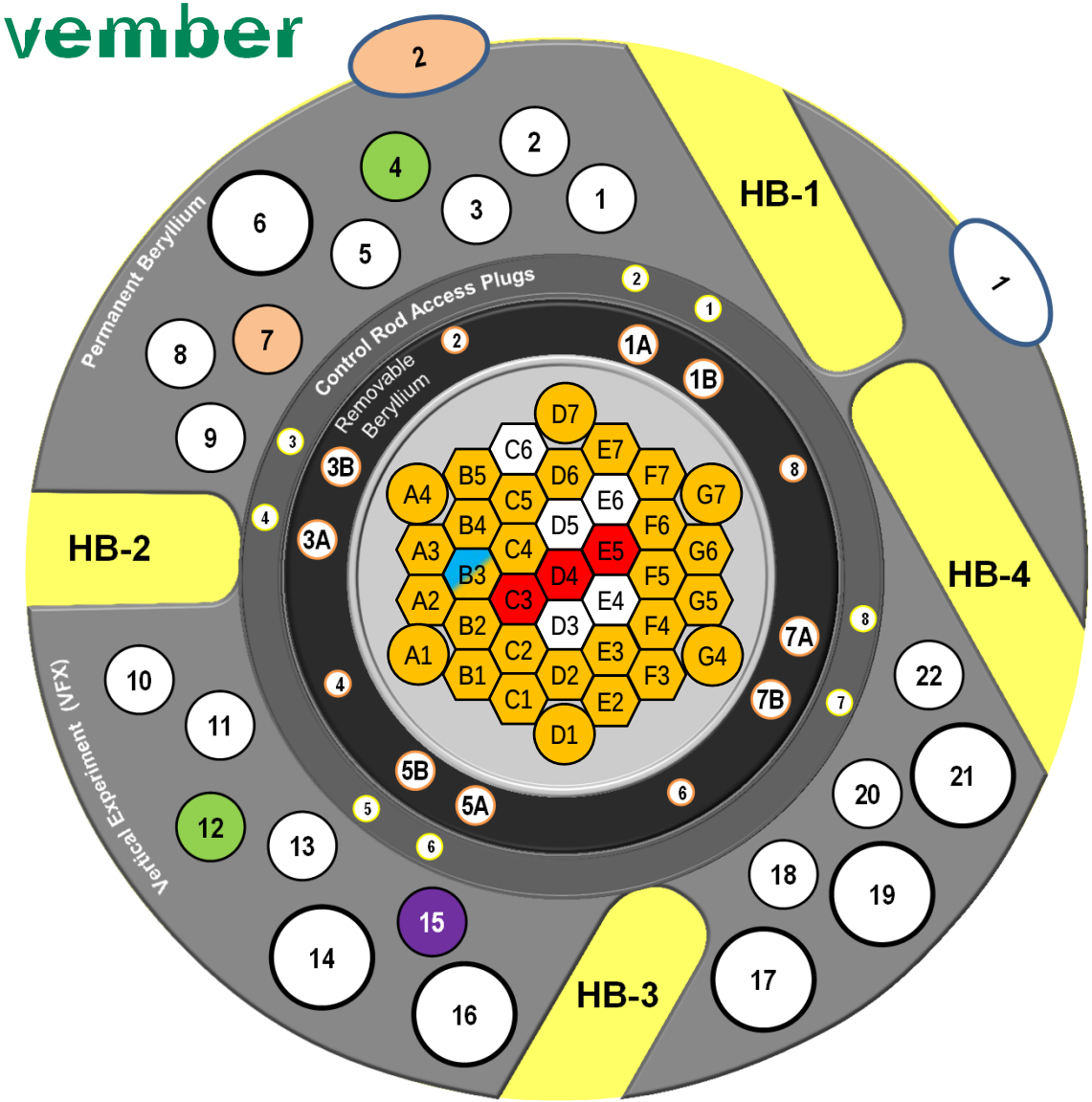
HFIR remained in an extended maintenance outages through November

HFIR

November 2013						
SU	M	T	W	TH	F	SA
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Reactor OFF

Reactor ON



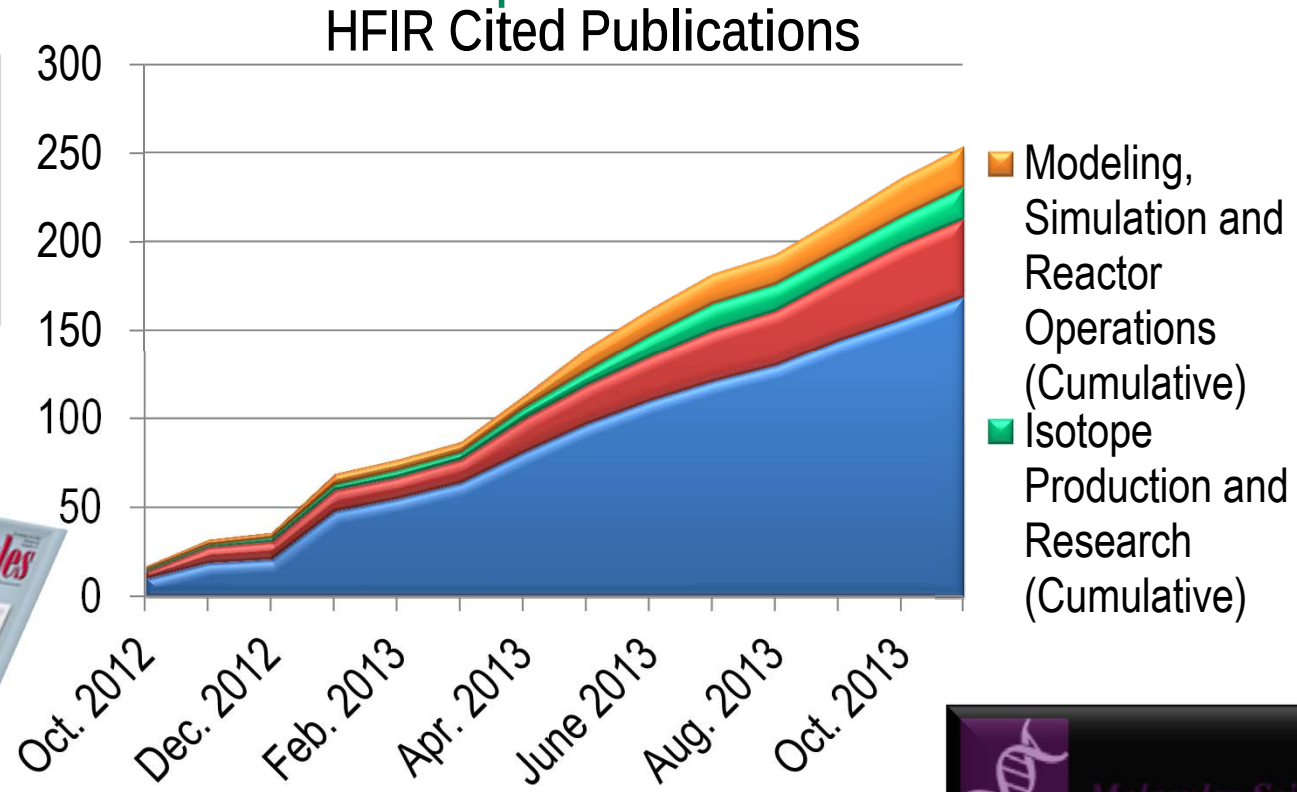
- Isotope Production
- Isotopes for Research
- Materials Experiment
- Fuels Experiment
- Pneumatic Facility NAA
- Hydraulic Facility
- Neutron Scattering
- Available Positions

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY

HFIR

18 new publications in November that cite HFIR in neutron scattering, material science, reactor system, simulation and isotopes

- 13 Neutron Scattering
- 2 Materials Science
- 2 Isotopes
- 1 Reactor ops and simulation



Molecular Sciences

Physical Review B
condensed matter and materials physics

Physical Review Letters
moving physics forward

Central Campus Legacy Material Removal Project

NNFD/D&D

2026 Activities

- Installed permanent lighting in Hot Cells 5 and 6
- Approved work plan for clean-out of Hot Cells 5 and 6
- Completed construction of containments for cell entries
- Completed clean-out of Hot Cells 5 and 6
- Completed waste packaging and load-out of Hot Cell 5
- Initiated waste packaging and load-out of Hot Cell 6

Hot Cell Before Clean-out

Decon Activities After Clean-out

EM Project Integration Support

NNFD/D&D

- Continued characterization activities on a drum of unknown materials transported to Building 3525 from Building 3038 by UCOR. Drum contents segregated into 8 distinct packages. Received UCOR over-pack for shipping. UCOR will pickup in December.

- Continued water and sewer service curtailment work at the 7078 Trailer Area. Upon service curtailment UCOR will remove the trailers from ORNL.