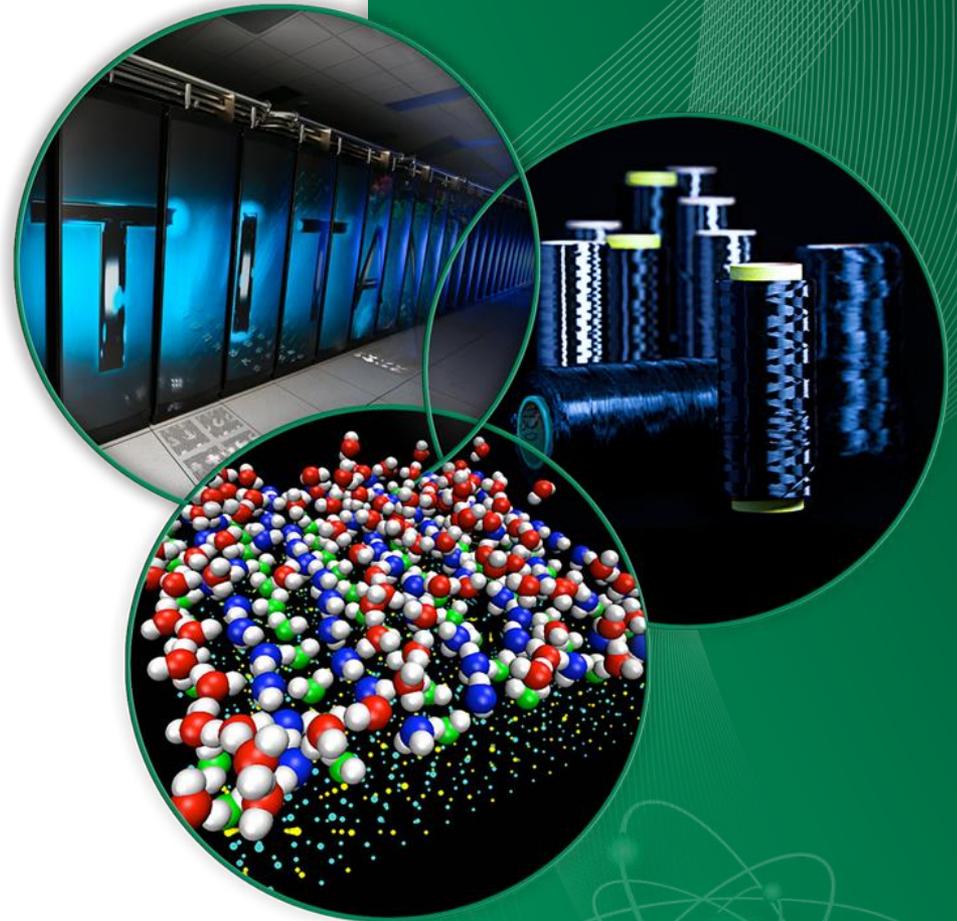


NSED Monthly Report

March 2013

Nuclear Science & Engineering Directorate

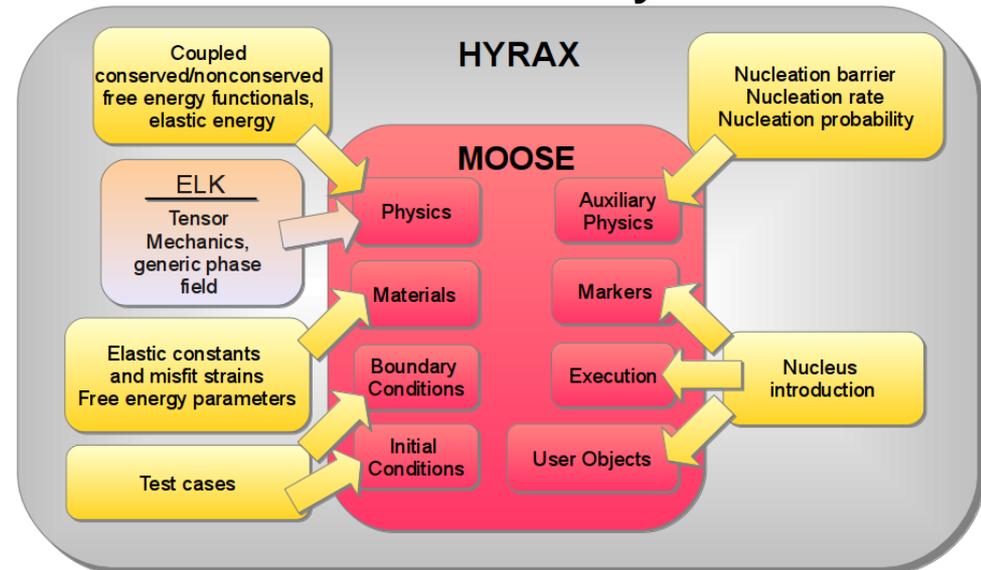


Demonstration of Hyrax: A model for studying zirconium hydride microstructure formation and evolution

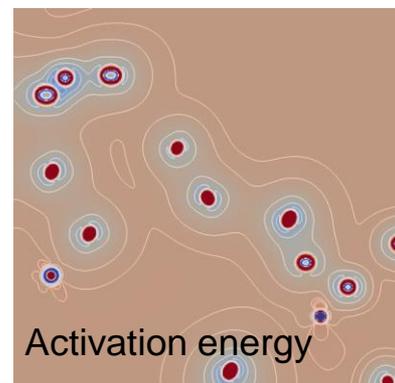
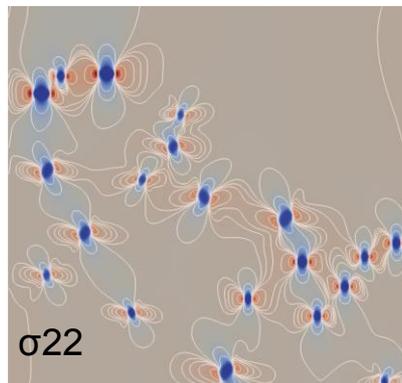
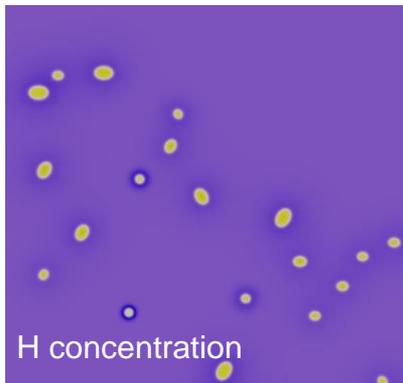
Hyrax: Hyrax is a phase field model of Zr-hydride precipitation and growth

- Assumes linear elasticity
- Incorporates classical nucleation theory
- Uses explicit nucleation algorithm that works with adaptive meshing
- Can be parameterized for γ - or δ -hydrides
- Scales efficiently to thousands of processors

Structure of Hyrax



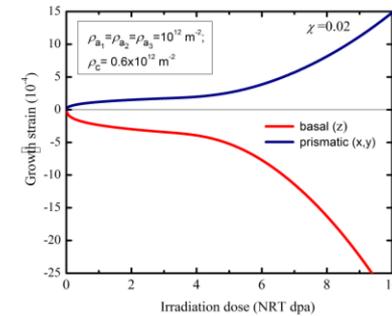
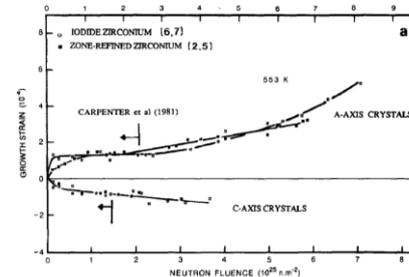
Contributors: A. M. Jokisaari, K. Thornton (UM)



Outcome: Hyrax can be used to study the effect of applied stress, hydrogen flux and existing microstructure on hydride microstructure evolution.

Physically-based quantitative radiation growth model for Zr-Based alloys

- Dimensional instability in irradiated Zr-based alloys is driven by radiation growth (RG), which occurs in unstressed materials, and radiation creep (RC) which is determined by stress. A model developed by the ORNL team [1,2] has provided the first quantitative description of RG and answered a 50 year-old technical question regarding the relevant mechanisms.



Comparison of dose dependence of RG in annealed Zr measured (left) and calculated by the RG model (right)

- Real materials are multigrained so internal stresses always lead to the simultaneous operation of RG and RC even in the absence of external stress. The RG model, with a quantitative description of dislocation climb, provides a unique way of predicting RC in the framework of the climb-assisted glide mechanism:

$$\frac{d\varepsilon_j}{d\phi} \approx \sqrt{\pi} \sigma \frac{\rho_j V_j}{\mu \sqrt{\rho}}, \quad (j = a_1, a_2, a_3, c),$$

where $\sigma, \rho, \rho_j, V_j$ are the stress, total dislocation density, density of mobile dislocations and climb velocities. The composite model and its implementation in the LANL multigrain VPSC code were discussed in January during an ORNL-LANL team meeting and subsequent teleconferences.

The results provide a physically-based quantitative description of dimensional instability in Zr-based materials in accordance with the main CASL objectives.

- S.I. Golubov, A.V. Barashev, and R.E. Stoller, ORNL/TM-2011/473.
- A.V. Barashev, S.I. Golubov, and R.E. Stoller, ORNL/TM-2012/225.

Quarter core Monte Carlo reference solution for zero power core physics test

Purpose

- Prepare a high fidelity neutronics solution for code comparison of solutions for predicting reactor startup and physics testing
- Use of continuous energy Monte Carlo method with well established pedigree

Contributors

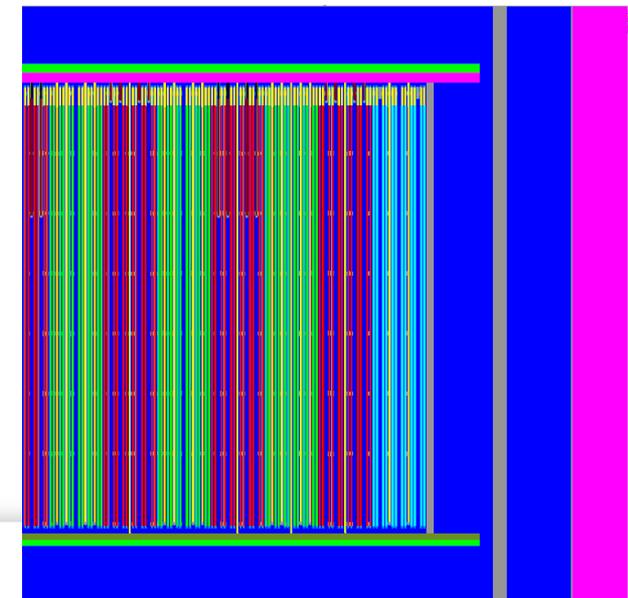
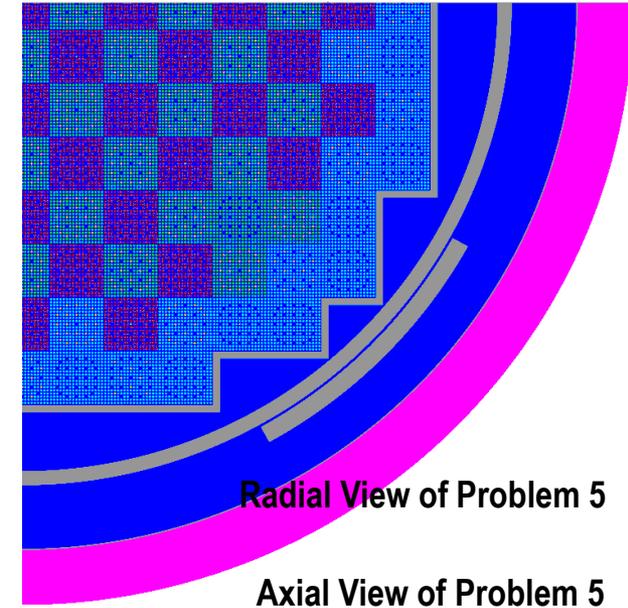
Andrew Godfrey
Cole Gentry
Kursat Bekar

Execution

- Completed specification for Problem 5 based on publically available data similar to the CASL Physical Reactor
- Generated detailed KENO-VI model at startup conditions
 - Control Banks
 - Core baffle and barrel
 - Spacer Grids
 - Instrument Thimbles

Results

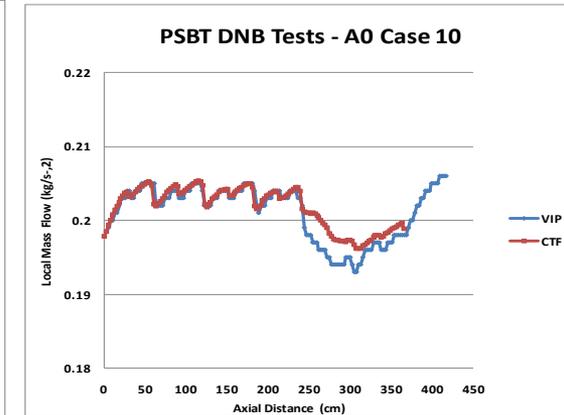
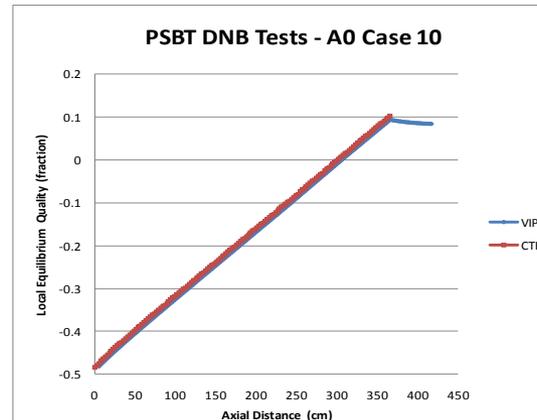
- Model created and results generated for reactor criticality, rod worths, and reactivity coefficients consistent with those tests performed at Watts Bar Nuclear 1 Cycle 1
- VERA Core Physics Benchmark Progression Problem Specifications, Revision 2 (CASL-U-2012-0131-002) updated
- 3D pin-by-pin fission rate distribution not calculated



Description and Completion

- First milestone in Departure from Nucleate Boiling (DNB) and safety Challenge Problems
- DNB data collection
- Baseline thermal hydraulics (T/H) code solutions
- Initial application of VERA T/H code COBRA-TF

COBRA-TF/VIPREW Comparison



Result Summary and Significance

- Industry-quality DNB test data collected, reviewed and transmitted for CASL use
- Baseline code solutions (VIPRE-W and STAR-CCM+) reflect current industry capabilities
- Initial assessment indicated VERA subchannel code COBRA-TF predictions of DNB parameters are in good agreement with VIPRE-W

Experience & Lessons Learned

- Established a working group to promote collaboration among CASL partners (Westinghouse (WEC), INL, NCSU, MIT, Sandia, etc.) as well as utilizing expertise from the industry (e.g., WEC)
- Main issue encountered: VERA software installation and execution
 - COBRA-TF experience at WEC and INL as an example

President/CEO, Chairman of TVA and UT President visit ORNL

On March 26, Cecil Parks, Tom Evans, and Gary Mays participated in a protocol visit with visitors from the Tennessee Valley Authority (TVA) and the University of Tennessee (UT): Bill Johnson, President/CEO, TVA; Bill Sansom, Chairman, TVA; and Joe DiPietro, President, UT.



Bill Johnson (TVA)



Bill Sansom (TVA)



Joe DiPietro (UT)

Jess Gehin appointed to the faculty of the Bredeesen Center for Interdisciplinary Research and Graduate Education

Jess Gehin of RNSD has been appointed to the faculty of the Bredeesen Center for Interdisciplinary Research and Graduate Education. His accomplishments and credentials were reviewed by the Credentials Committee of the Bredeesen Center's current faculty and found to be of the high caliber appropriate for this innovative and new interdisciplinary doctoral program in energy science and engineering. He joins a faculty of 38 that were appointed in December of 2010.



Next Generation Safeguards Initiative (NGSI) activities

Kimberly Gilligan met with University of Florida's Dr. Sedat Goluoglu to discuss curriculum development of a new safeguards class at UF and the associated Nonproliferation Workshop to be held at ORNL in July. The new class and the workshop are NGSI funded



Next Generation Safeguards Initiative (NGSI) activities

Safeguards Lab Nonproliferation Workshops



Clemson University



Georgia Institute of Technology



North Carolina State University



NGFI funded Nonproliferation Workshops in the Safeguards Lab for nuclear engineering classes from Clemson University, Georgia Tech and North Carolina State University

Next Generation Safeguards Initiative (NGSI) activities

A University of Tennessee nuclear engineering class was funded to have “In Situ Object Counting Systems on Special Nuclear Material” training in the Safeguards Lab on March 11th.

Note: Seven nonproliferation related intern projects were selected to host NGSi funded summer interns

Robotics-March 9th

- Adam Carroll presented “Robotics: Past, Present, and Future”
- ANDROS, Omni Directional Wheel Platform and Ball Manipulator were available for the students to utilize



Wheel Platform



ANDROS



Left to right: Natty Zaharia, Adam Aaron, Adam Carroll, Dominic Guiliano, and Mark Noakes



Ball Manipulator

Nuclear detectors-March 16th

- Alex Enders presented an overview on radiation, detection, and how a detector works.
- Two experiments were provided
 - build a photo-resistor; and LED circuit to measure the “light intensity”
 - measure radiation using hand-held Geiger-Muller detectors



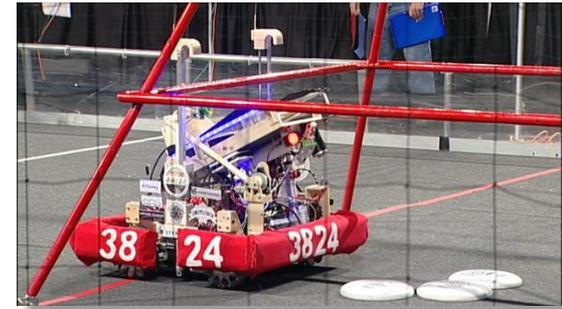
Demonstrators Jessica Shevmaker and Mark Noakes



Students using GM detectors to find sources

Robotics demo and science fair at local schools

- Members of the Remote Systems Group, along with members of the Oak Ridge High First Robotics Team gave hands on demonstrations of 5 different robots.
- The group also stood as judges for the students' science projects at Farragut Intermediate School Science Fair, March 21st.
 - The winners were as follows (<http://farragutis.knoxschools.org/>):
 - 1st Brenna Bocik
 - 2nd Owen Cianciolo
 - 3rd Julie Gray

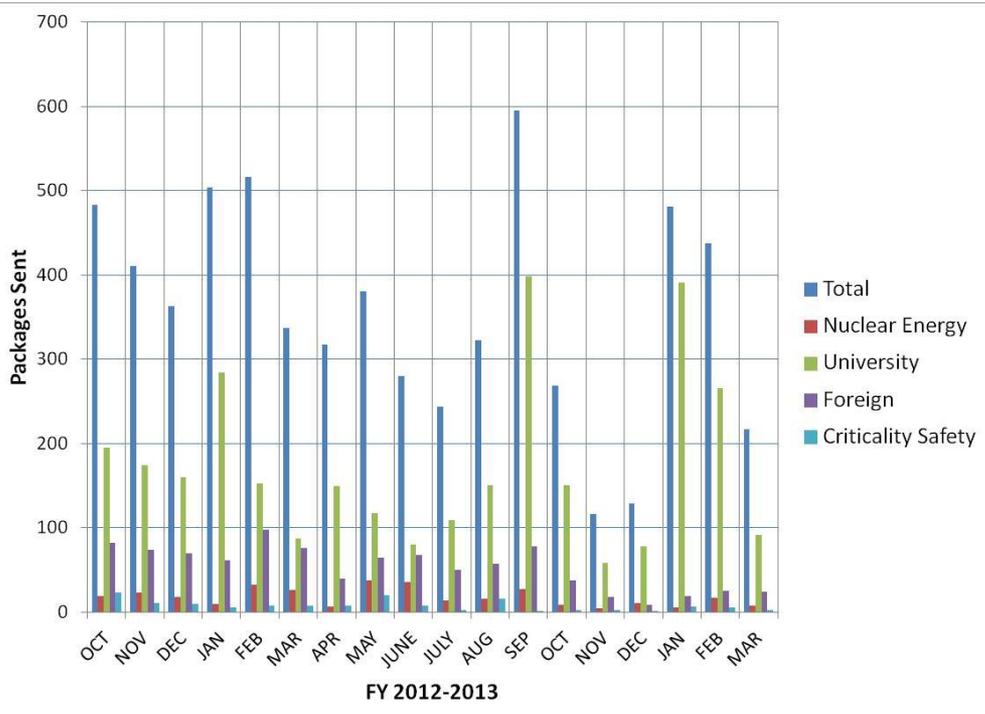
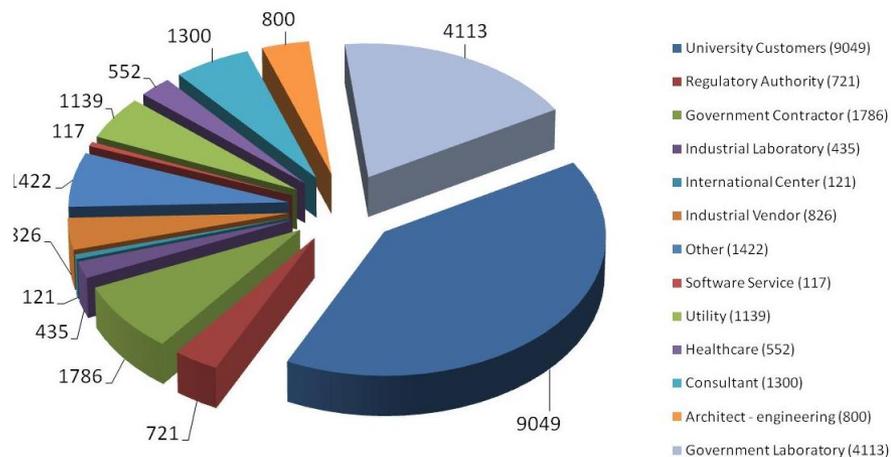


Other winners:

Zoology	Isle Kaeuper
Physical Science	Ian Rainey
Botany	Colin Ross
Math and Computer Science	Christopher Arnold
Engineering	Davis Nussbaum
Earth Science	Caden Farley
Health	Ben Darden

Radiation Safety Information Computational Center (RSICC): serving the scientific community for 50 years

RSICC Customer Base



- Software and data packages distributed FY2013: 1650
- 8 package updates and revision March 2013

Radioisotope production

- Continued cold testing of the Catalyzed Electronic Plutonium Oxide Dissolver (CEPOD) for Ag recovery via electro-deposition.

Curium Feedstock Processing



- Analysis of Am-Cm-Ln oxides product and the consolidation of rework are in progress.

Americium-Curium Processing



- Campaign 74 Rework: Ongoing for upcoming Cf-252 orders.
- Stripped last two C74 Cf packages
- Completed two shipments

Cf-252 Production



- Completed installation of new fiber optic cables into the hot cells
- UV-Vis and NIR studies of various Np solution continue
- Successfully completed the preparation of NpO_2 powders and pressed pellets to be used in the assembly of partially loaded targets for Cycle 447.

Pu238 Operations



- Shipments: Four Ac-225 Shipments with a total of 20.4 mCi shipped
- 2nd announcement was released for 8th International Symposium on Targeted Alpha Therapy (TAT).
- Website for the TAT symposium is active

Actinium Production



- Cubicle 1 transfer arm detailed drawings in progress
- Cubicle 2 procurement specifications/requirements for new welding lathe system have been developed and issued for internal review
- Cubicle 3 replacement components for pellet press punch/die handling fixture being fabricated
- Completed baseline project plan for Phase 2

Target Fabrication Equipment Upgrade



- Additional tracer-level separation using ^{241}Am and ^{249}Cf was complete using EiChrom's LN Resin.
- Equipment purchases for the new glovebox to support this activity are in progress



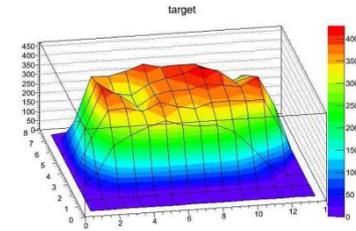
Cm-248 recovery from Cf-252 Decay

- Compositing and evaporated ion exchange cuts (e.g., preconditioning solutions and strip solutions that contained too much plutonium to be disposed as waste) in preparation for an additional ion exchange separation.



PuBe Operations

- Completed radiographic images of electrodepositions using Sm-153 as a surrogate for Cf-251
- 3-D radiographic image of target shows relatively uniform distribution of Sm-153



LDRD Cf-251 Separations

Enriched stable isotope technical services and shipping

Fourteen shipments of 22 enriched stable isotopes were made in March

- 67 shipments of 200 enriched stable isotopes have been made in FY13 to date

Sixteen custom technical services were completed in March

- Enriched Ca-40 and Ca-43 metals alloyed to dilute the very expensive Ca-43 (over \$500/mg) to the lower, desired enrichment. The alloy was cut into ~ 1 mm x 1 mm x 0.65 mm pieces; equal portions were loaded into 4 vacuum ampoules
- 86 technical services have been completed in FY13 to date

ISO-9001 Recertification Achieved for Stable Isotopes

- Certification assessment by UL/DQS (Underwriters Laboratories) with no findings

Special team and individual recognition



Julie Ezold is featured in DOE's Women in STEM:

In an online feature of women who work in STEM at the Energy Department and in honor of Women's History Month, the Energy Department's Office of Economic Impact and Diversity is featuring Women in STEM on energy.gov. Through sharing profiles and stories of women in STEM, we can

- showcase the mission-critical work women are actively doing in STEM throughout the Department; and,
- offer role models for women and girls who are critically underrepresented in these fields.

Profile can be viewed at: <http://energy.gov/diversity/articles/women-energy-julie-ezold>

Second Line of Defense (SLD) conducts its first web-based remote training with an international partner: NNSA's Anne Harrington has recognized the SLD Team for its Data Analysis Reporting Tool (DART) Training. The team successfully conducted its first web-based remote training with its first international partner, the Polish Border Guard. DART allows partner countries to assess status of health of detectors, alarm rates, and other key information on the RPM system operation.



Matt Feldman elected new chair of ANSI's N14 committee:

Matt Feldman has been elected the Chair of the American National Standards Institute Accredited Standards Committee N14 Packaging and Transportation of Radioactive and Hazardous Material.



New funding/New projects

Extraction of High Purity Thorium-229 from UTHX

- Funding - for processing Calutron-enriched uranium-233 batch UTHX.

OLEM Enrichment Module Project

- Funding - from the United States Support Program (USSP) for the On-line Enrichment Module Project (OLEM). This project could benefit facilities by enhancing safeguards and security issues.

New Electromagnetic Isotope Separation (EMIS) Project

- Funded by DOE-Office of Science - Nuclear Physics – Isotope Program. This two year, \$1.03M project will develop high-current and high-resolution EMIS technology to support the recommendations of the NSAC Isotope Subcommittee

Funding of new Isotope Program work

- Funding of \$300K was awarded in response to the Office of Nuclear Physics/Office of Science Isotope Program LAB 12-743 Call for “Experimental Validation of the Optimization of Transcurium Isotope Production Model”.
Period of Performance: 1 Year

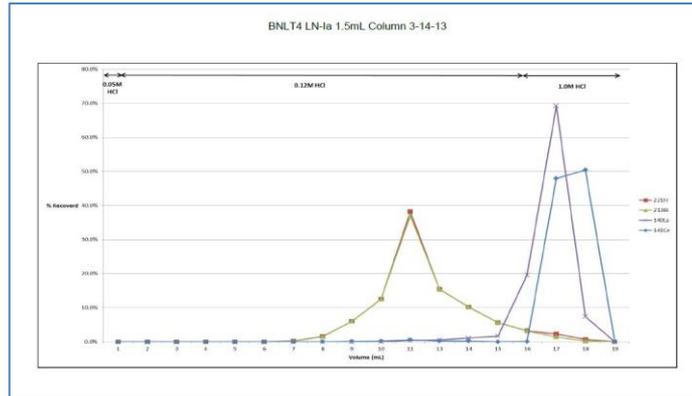
Notable Outcome in medical radioisotope research

Actinium-225 Production from Proton-Irradiated Thorium-232:

The ORNL Medical Radioisotope Program received the fourth proton-irradiated thorium target from Brookhaven National Laboratory (BNL). The foils (two foils ~800 mg each) were immediately transferred to Hot Cell C in building 4501 and dissolved separately.



Dissolved Th target exhibiting blue glow from Cherenkov radiation.



Due to a very high radiation dose, further purification of the Ac-225 from La-140 and Ce-141 impurities was performed in three small, separate batches in a glove box.

Elution profile of Ac-225 separation from La-140 and Ce-141 on an Eichrom LN resin in HCl media

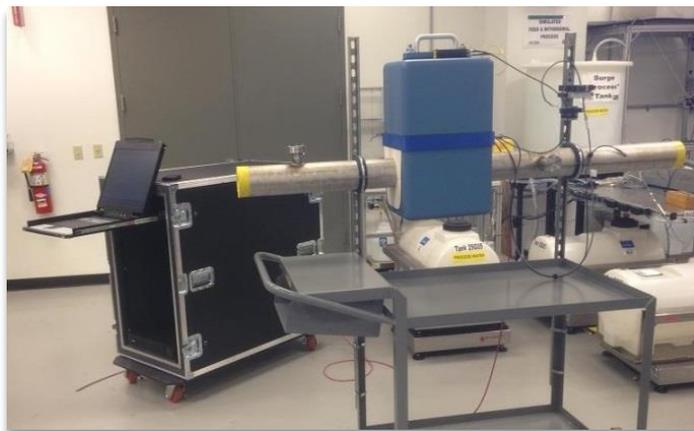
The combined purified actinium was subjected to standard QA, and a 3-mCi generator, which is currently under evaluation, has been constructed. The yield of Ac corrected to the end of bombardment was similar to previous runs at ~9 mCi per foil. The yield of Bi-213 from the generator is >90 %, and breakthrough of Ac-225 in 10 elutions, expanded over 16 days, is at an acceptable level of $<10^{-3}$ % with $\sim 10^{-5}$ % contamination with Th-227 (decay daughter of Ac-227). Detailed data on generator performance will be provided in the next monthly report.



3-mCi generator

US support program – On-line Enrichment Monitor (OLEM) phase II kickoff

The On-line Enrichment Monitor (OLEM) phase II kickoff meeting was held in March. This is a collaborative effort between ORNL and LANL. The OLEM collection node and field trial junction box were exhibited in the laboratory.



“Free” NaI Detectors Received

ORNL was fortunate to be the recipient of a large number of DHS/DNDO NaI(Tl) detectors by making a strong case for using them in research and for ongoing projects



NaI Detectors

Transport security project training in Yerevan, Armenia

A team of three transportation security experts from ORNL conducted a 1-day security awareness workshop with a select group of officials representing the Armenian government

- A representative of the Armenian Nuclear Regulatory Authority (ANRA) also provided a summary of security regulations (laws and resolutions) as well as information about radioactive source inventory registration activities since 2001
- A total of 18 people participated in this workshop, which is a prelude to a 4.5-day course that focuses on the operational aspects of transport security



RUSSIAN FEDERAL NUCLEAR CENTER
All-Russian Research Institute of Experimental Physics
A SC «ROSATOM» COMPANY

Material Protection, Control & Accounting (MPC&A) upgrades at all Russian Scientific Research Institute of Experimental Physics (VNIIEF)

- ORNL, Y-12 National Security Complex and LANL conducted a technical exchange with VNIIEF on the use of Process and Item Monitoring to extend intervals between physical inventories in March 2013.
- This technique uses the process control data collected by operations and safety systems to provide real time information on the location and movements of nuclear material.
- The U.S. Project Team will be working with VNIIEF to implement a pilot project at one material balance area at the site.



**Ministry of Defence of the
Russian Federation**

Russian Federation (RF) Ministry of Defense (MOD) upgrades and sustainability

- ORNL representatives along with both DOE and DTRA sponsors participated in the observation of training developed to support self-inspections for the RF MOD sensitive sites.
- The inspections will cover areas of both physical security and material control and accountability and are scheduled to begin in April 2013.
- ORNL is the lead laboratory in supporting activity for this project and is working with both the DOD DTRA and NNSA's Office of Nuclear Warhead Protection (NA-251) as a joint effort.

NSITD publications - March

- **Abstracts – 5**
- **ORNL/TM – 9**
- **Paper in Conference Proceedings (Books, CD, etc.) – 1**
- **Presentations – 23**



CASL code verification & software quality assurance

Survey identified gaps and best practices

- SQA Practices:
 - Ensure software is implemented correctly with minimal defects
 - Are requirements, testing, defects, etc. being managed effectively?
- Verification: Are the equations being solved correctly?
 - *Code verification* extends SQA practices to address mathematical properties of the software, especially behavior under mesh refinement
 - *Solution verification* provides an estimate of the error in the solution to a specific problem, which contributes to overall uncertainty

	COBRA-TF	Hydra-TH	Denovo	MPACT	Peregrine	MAMBA	MAMBA-BDM	DTK	Dakota
SQA Standard	Green	Green	Green	Green	Green	Green	Green	Green	Green
SQA Plan	Green	Green	Green	Green	Green	Green	Green	Green	Green
Life cycle	Green	Green	Green	Green	Red	Green	Red	Green	Green
Requirements	Green	Green	Green	Green	Green	Green	Green	Green	Green
Design	Red	Green	Green	Green	Green	Green	Green	Green	Green
Code standards	Red	Green	Green	Green	Green	Green	Green	Green	Green
Code reviews	Red	Green	Green	Green	Green	Green	Red	Green	Green
Configuration control	Green	Green	Green	Green	Green	Green	Green	Green	Green
Automated builds	Green	Green	Green	Green	Green	Green	Green	Green	Green
Unit testing	Red	Green	Green	Green	Green	Green	Red	Green	Green
Regression testing	Green	Green	Green	Green	Green	Green	Green	Green	Green
Test reporting	Green	Green	Green	Green	Green	Green	Green	Green	Green
Test coverage	Green	Green	Green	Green	Green	Green	Red	Green	Green
Defect tracking	Green	Green	Green	Green	Green	Green	Green	Green	Green
User manual	Green	Green	Green	Green	Green	Green	Green	Green	Green
Installation manual	Green	Green	Green	Red	Green	Green	Green	Green	Green
Developers manual	Red	Green	Green	Green	Green	Green	Green	Green	Green
Tutorials/examples	Green	Green	Green	Green	Green	Green	Green	Green	Green
Release management	Green	Green	Green	Green	Red	Green	Green	Green	Green
Theory manual	Green	Green	Green	Green	Green	Green	Green	Green	Green
Numerical analysis	Green	Green	Green	Red	Green	Green	Green	Green	Green
Verification problems	Red	Green	Green	Red	Green	Green	Red	Green	Green
Formal code verification	Red	Green	Green	Red	Red	Green	Red	Green	Green

■ Needs Work
 ■ Opportunity to Improve
 ■ Acceptable

Results

- VERA physics components are in various stages of maturity
- SQA practices are generally in good shape, but there are plenty of opportunities for improvement
- Identified a few instances where increased focus on documentation is needed
- Some code verification is taking place, but more, with more formality, is needed

Key personnel: Mike Pernice (VUQ), Matt Sieger (QM)

Next Steps

- Addressing gaps in code verification planning and practices
- Extending survey to cover Solution Verification and Validation practices
 - Are the correct equations being solved?
 - High quality data is essential
 - Survey of to provide DOE-NE ranked validation data needs for CASL
- Applying a graded approach for SQA practices that comprehends stages of technology maturity

VOCC democratization strategic engagement

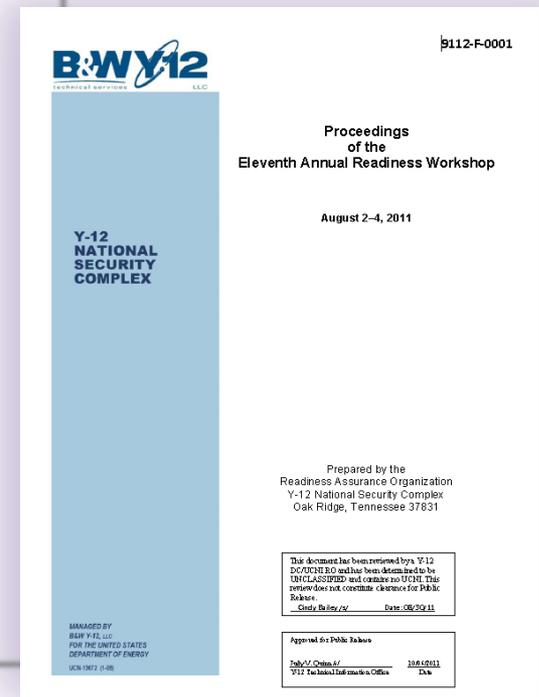
Virtual Office, Community,
and Computing



“CASL CIO met with Y-12 representatives to discuss the possibility of virtual support to future Operational Readiness Workshops”

Purpose of Discussion

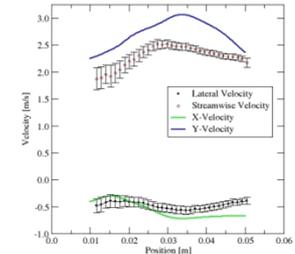
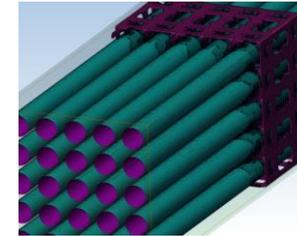
- The value of these workshops are to facilitate knowledge sharing amongst DOE managers to improve nuclear site operational readiness programs.
- VOCC would minimally provide a way for Y-12 to hold virtual meetings and to improve information sharing processes.
- Follow-up discussions are planned in April 2013



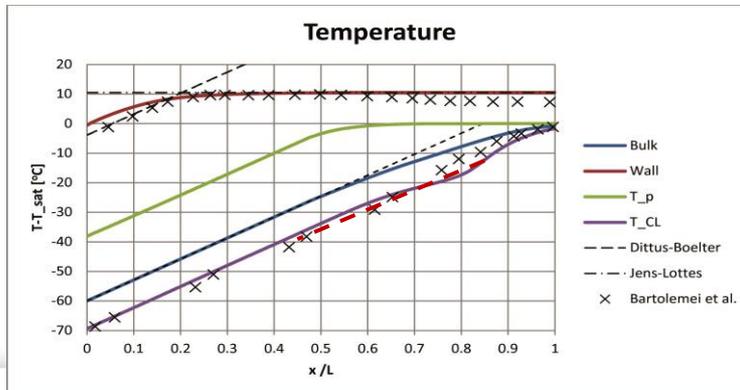
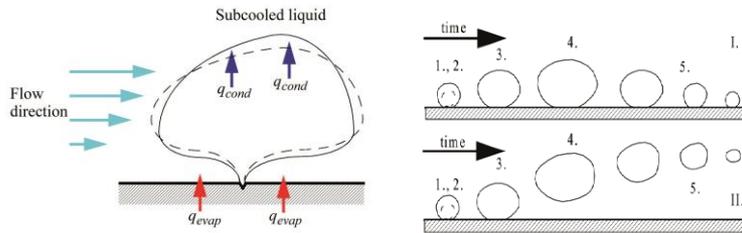
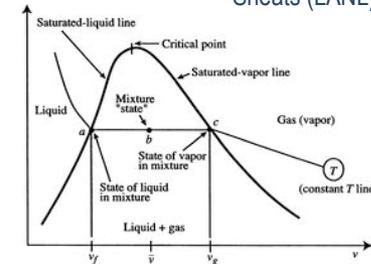
Evolution of CASL thermal-hydraulics simulation capability (Hydra-TH)

Hydra-TH V&V, High-Performance Steam Properties, Mechanistic Boiling Model

- Perform and document V&V tests, THM benchmark problems, generate Hydra-TH V&V manual
- Implement and deliver library for fast lookup of tabular steam data for multiphase flows. Preliminary integration in Hydra-TH
- Develop advanced mechanistic heat flux partitioning closure model for subcooled boiling at PWR conditions



Key personnel: Luo, Xia (NCSU), Bakosi, Christon, Pritchett-Sheats (LANL), Nourgaliev (INL)



Key personnel: M. Podowski, D. Shaver (RPI)

Milestone Accomplishments

- Delivery of initial V&V, THM benchmark suite for Hydra-TH with all input files, results and documentation (LA-UR-13-22017)
- UTri library for steam table interpolation using IAWPWS-IF97 standard. Prototype implementation in Hydra-TH with preliminary steam-table database
- Initial verification and validation of mechanistic model for subcooled boiling. Model transferred to U. Michigan for testing in STAR-CCM+.

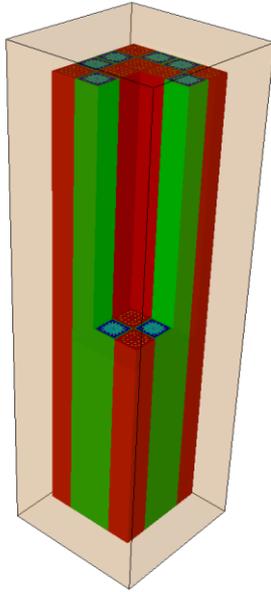
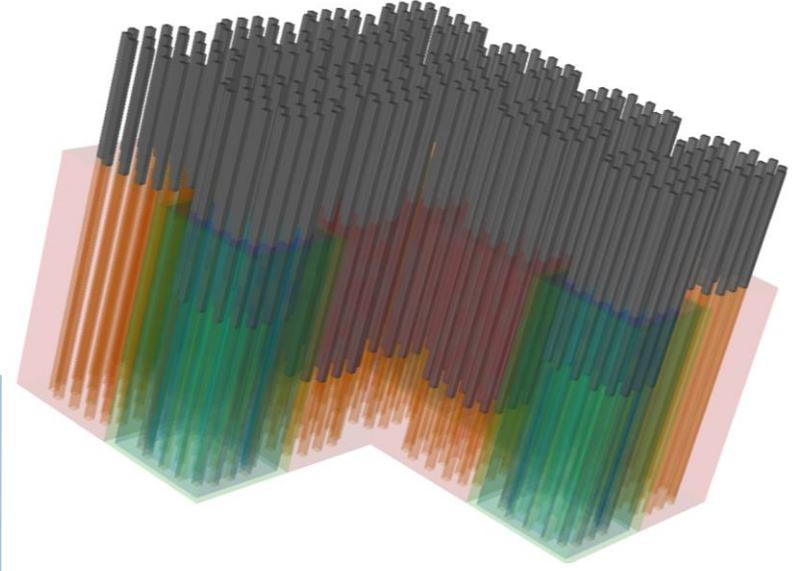
Progress toward 3D pin-resolved neutronics

Purpose

- Provide capability to model 3D reactor problems using the 2D/1D method in the MPACT code
- Compare accuracy of the 2D/1D to internationally accepted benchmarks

Execution

- Implement 2D/1D methodology with Radial Method of Characteristics and Diffusion in axial direction
- Implement parallel discretization for each plane
- Perform comparisons of eigenvalue and power distribution for C5G7 benchmark cases



Results:

Rodded C5G7		Axially Integrated Powers						Slice Power Differences				
		keff	Min	Max	Inner UO2	MOX	Outer UO2	Slice	Max	Inner UO2	MOX	Outer UO2
Unrodded	MPACT	1.14170	0.24	2.48	490.07	212.89	140.15	1	-0.78%	-0.78%	-1.38%	-1.64%
	Diff From MCNP	138	--	-0.18%	-0.23%	0.09%	0.54%	2	-0.17%	-0.24%	-0.82%	-0.91%
								3	3.07%	3.35%	4.00%	2.75%
Rodded A	MPACT	1.12744	0.26	2.25	461.13	221.62	151.63	1	-0.02%	-0.22%	-0.80%	-0.98%
	Diff From MCNP	62	--	0.05%	-0.02%	-0.04%	0.15%	2	-0.98%	-0.83%	-0.61%	-0.60%
								3	2.62%	3.67%	3.71%	2.87%
Rodded B	MPACT	1.07751	0.35	1.83	395.24	236.73	187.30	1	-0.70%	-0.60%	-0.47%	-0.59%
	Diff From MCNP	26	--	-0.16%	-0.04%	0.05%	0.00%	2	-0.16%	0.39%	-0.70%	-0.37%
								3	3.73%	3.12%	3.64%	2.63%

Very good agreement with a standard Monte Carlo reference case (MCNP)

CASL Industry Council meeting

Cranberry Township, PA March 26-27, 2013

- Industry Council engaged in a number of key discussions including:
 - Value proposition for key CASL drivers: Value proposition for one driver is being developed.
 - Modularity of VERA: Further discussions with commercial vendors to identify a specific project are planned.
 - External Test Stands Several Industry Council members expressed interest in deploying a Test Stand.
 - TVA and EPRI perspectives on CASL.

- Industry Council membership increased and chair has changed:
 - New membership includes: 1) utilities with strong fuel analysis capability, 2) SMR vendors, and 3) engineering simulation software vendor.
 - Heather Feldman of EPRI assumed the role of CASL Industry Council Chair.



CASL Collocation

CASL Vision: 2nd half
PoR-7 Level 1 Milestones
PoR-7 Science Challenges
PoR-7 Risks for L1
PoR-6 Retrospective
PoR-7 Baseline Plan and Risks
Challenge Problem Planning Kick-off
CRUD Product Integrator Plan
DNB, GTRF, RIA/LOCA, PCI
Product Applications
Industry Council Test Stands and Applications
L3:VRI.VERA.P6.06
Demo of CASL-specific NiCE workflow capability
Partner Review: common themes
Upcoming Actions Summary (ACTS)
L3:PAC.P6.02
Focus Area Scope and Risks
Education Program (training session targets, workshops, etc.)
Partnerships (IPMP revision, deployment, NDAs, etc.)
Science Council & Industry Council
Focus Area Open Planning
Discussions & Integration
DNB-CP Milestone Working Group
DOE Reportable Milestones in PoR-7
PoR-7 Status

VOCC Tours



Bill Johnson, TVA CEO
Bill Samson, TVA Chairman
Dr. Joe DiPietro, University of Tennessee President

Gwyneth Cravens,
Author – *The Power to Save the World*

Y12 Readiness Workshop

Meetings

THM Workshop,
Boston, MA
March 19

Industry Council,
Cranberry, PA
March 26-27

AMA Workshop,
Cranberry, PA
March 27

RW-859 data

- Assembly ID
- Assembly type
- Initial enrichment
- Discharge burnup
- Cycle start and end dates

Assembly data

- Geometric configuration
- Materials of construction
- Design dimensions
- Control components

Reactor data

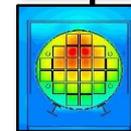
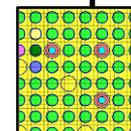
- Cycle specific burnup
- Soluble boron
- Rod insertion history
- Batch loadings
- Axial burnup profiles
- Moderator temperature

Cask data

- Geometric configuration
- Materials of construction
- Design dimensions
- Cask loading patterns
- Component loading

Models

- Depletion: TRITON, ORIGEN
- Thermal: COBRA-SFS
- Criticality: KENO-VI



UNF-ST&DARDS: A Used Nuclear Fuel: Storage, Transportation & Disposal Analysis Resource and Data System

Initial version completed in March

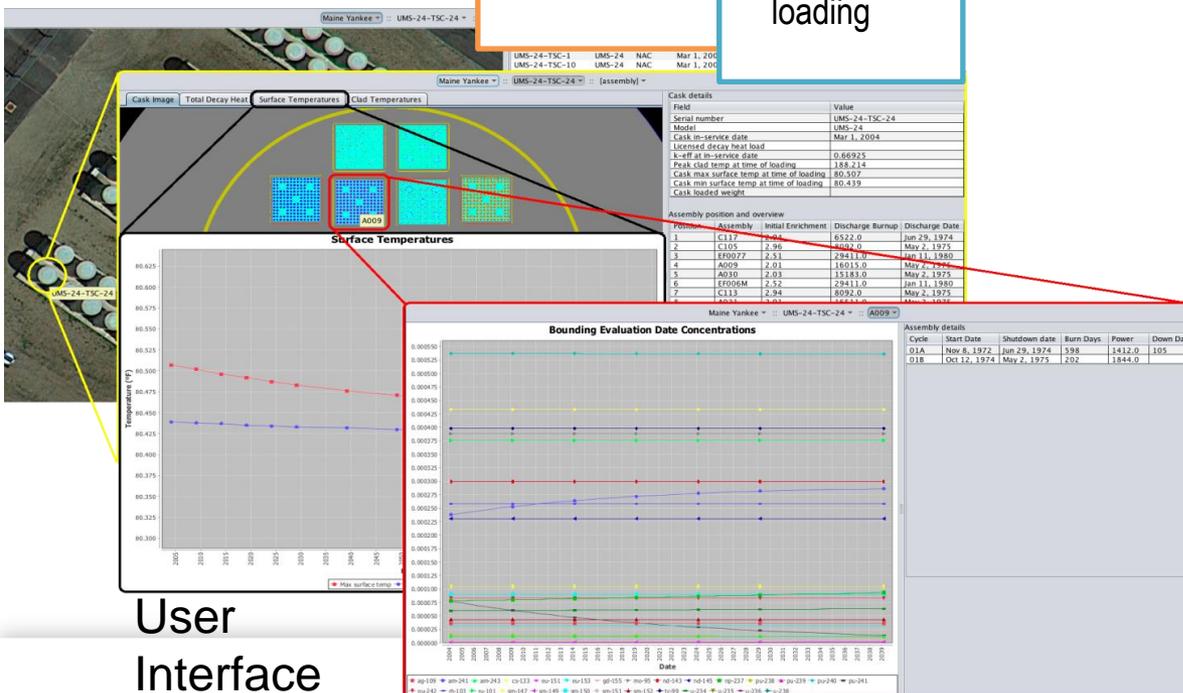
Couples a UNF database with M&S capabilities for performing out-of-reactor nuclear safety analyses

Interface for characterizing the UNF inventory as a function of time

Facilitates justification of more realistic safety margins and conditions

Provides the framework for an integrated nuclear waste management system

Collaborative effort between ORNL, PNNL, SRNL, NEI, Utilities

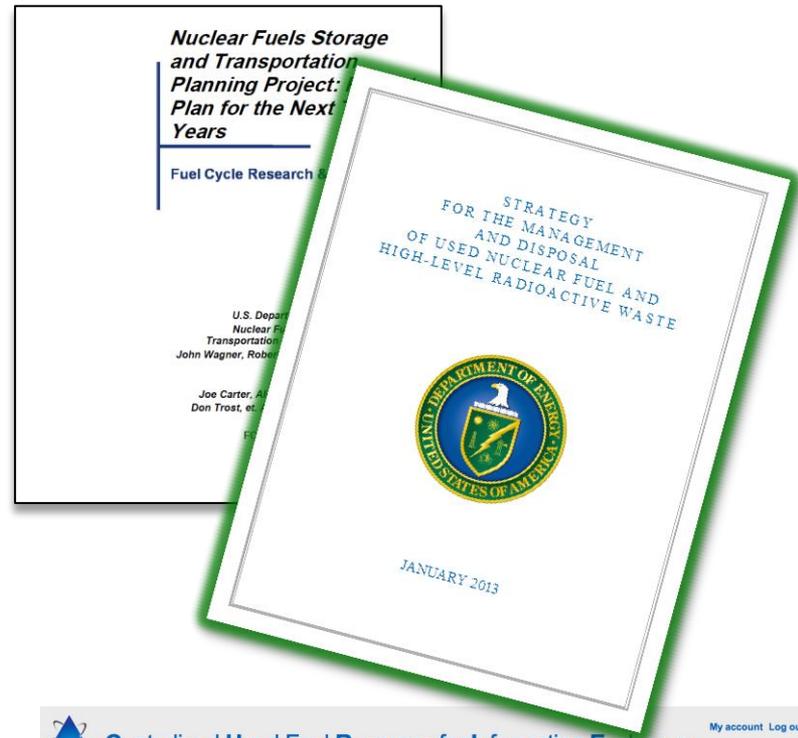


User Interface

DOE-NE NFST Project completes plan and information website

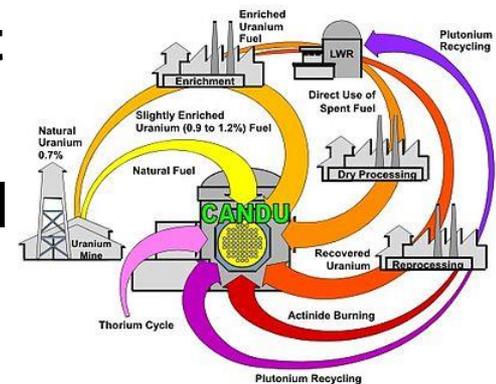
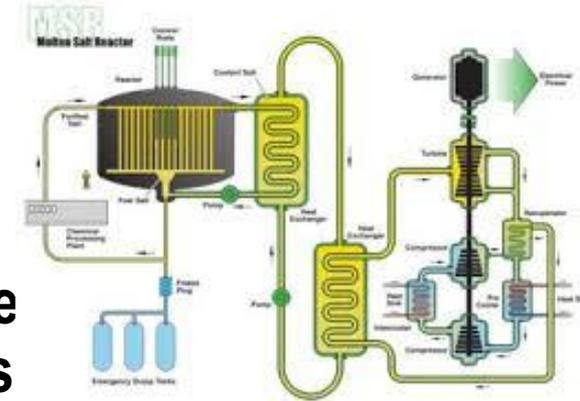
- Nuclear Fuel Storage and Transportation (NFST) Project Plan Completed
 - Describes the activities and milestones necessary to meet the Administration’s Strategy for siting, designing, and constructing interim storage.
 - Collaborative effort involving ANL, ORNL, SRNL, and TechSource, Inc. and will undergo extensive DOE review in the coming months

- The Centralized Used Fuel Resource for Information Exchange (CURIE) website went live March 1st at curie.ornl.gov
 - Provides the ability to share documents, access images, and support public outreach
 - Uses an intelligent, optimized search algorithm using open source Apache Solr



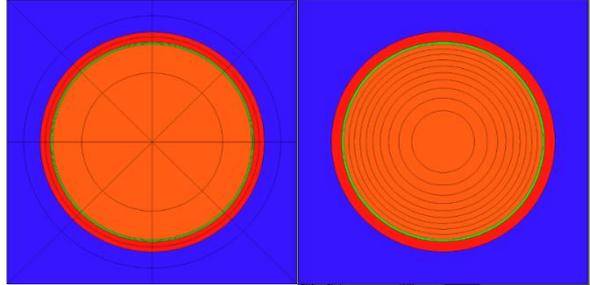
Fuel Cycle Data Packs (FCDPs) delivered for DOE-NE Fuel Cycle Options Campaign

- FCDPs generated for all of those fuel cycles containing molten salt reactors or heavy water reactors.
- Fuel Cycle Options Campaign has generated standard data sets (FCDPs) to enable 40 fuel cycle groups to be evaluated against newly developed sets of metrics.
 - » NSED also involved in developing metrics as part of Evaluation Screening Team.
- Engaged in peer review and critique of 14 additional FCDPs generated by other labs.
 - » Multiple reactor types and fuel cycles (open, closed etc.).



SCALE version 6.1.2 released

- The SCALE Team released SCALE Version 6.1.2, providing users with enhanced capabilities in several key areas, especially for reactor depletion and radioactive material decay analysis. Detailed information is available online at http://scale.ornl.gov/downloads_scale6-1.shtml.
- Brad Rearden and B.J. Marshall traveled to Stockholm, Sweden to provide training to SKB, the Swedish Nuclear Fuel and Waste Management Co., in the use of SCALE criticality safety and sensitivity/uncertainty analysis methods for use in design and licensing of the Swedish geological repository for used nuclear fuel.
- New SCALE Polaris LWR lattice physics code delivered to NRC.



Variable mesh options for PWR fuel pin

RNSD's Brad Rearden participated in an expert review panel for Candu Energy

Brad Rearden participated in an expert review panel for Candu Energy to assist with their use of SCALE/TSUNAMI sensitivity/uncertainty analysis methods in the licensing of Advanced-Build CANDU reactors. Rearden and two other panel members appeared before the Canadian Nuclear Safety Commission and the CANDU Owners Group to present the methodology and provide an open discussion.



RNSD papers presented at the international nuclear data conference (ND2013)

- Nine staff members participated in the 2013 International Conference on Nuclear Data for Science and Technology (ND2013) held in New York, NY, March 4-8, 2013.



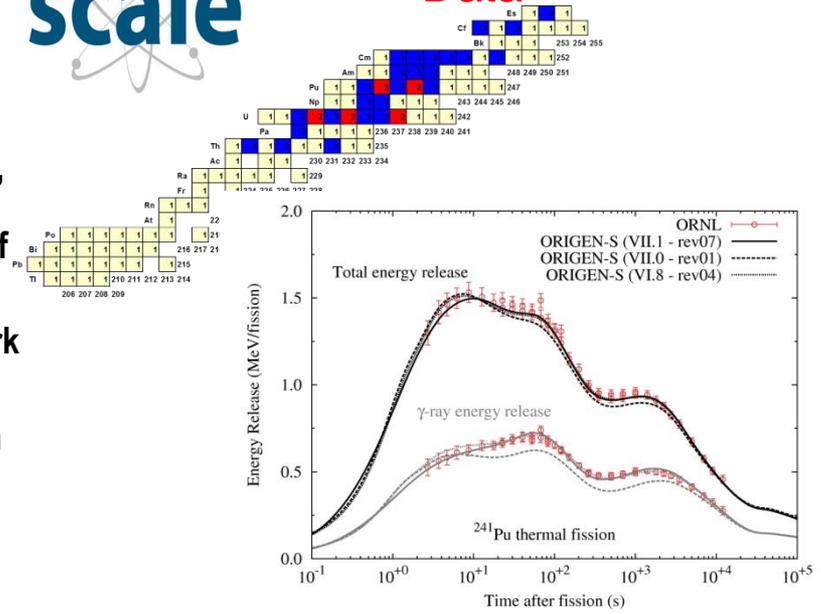
- These staff members represented expertise in measurements, evaluation, processing, and validation of nuclear data.

- The following RNSD papers were presented at the ND2013 conference:

- Arbanas: “Inverse Sensitivity/Uncertainty Methods Development for Nuclear Fuel Cycle Applications”
 - Gauld: “Validation and Testing of ENDF/B-VII Decay Data”
 - Guber: “Neutron Induced Cross-Section Measurements of Calcium”
 - Leal: “²³⁹Pu Resonance Evaluation for Thermal Benchmark System Calculations”
 - Pigni: “Evaluation of Tungsten Neutron Cross Sections in the Resolved Resonance Region”
 - Sobes: “New Resolved Resonance Region Evaluation for ^{63,65}Cu for the Nuclear Criticality Safety Program”
 - Williams: “Application of Nuclear Data Covariance to Criticality Safety and Spent Fuel Characterization”

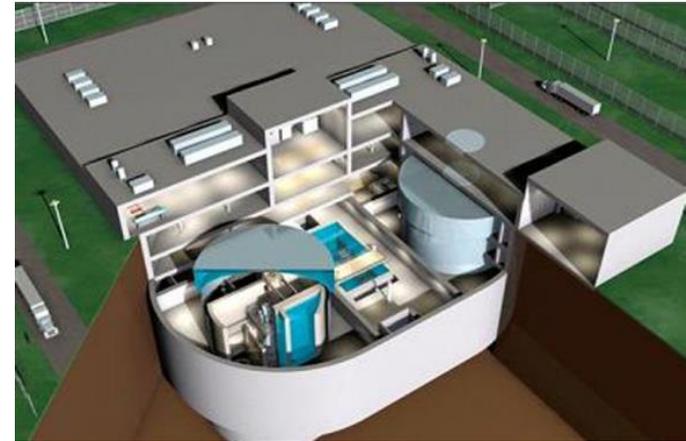


ORIGEN Testing of ENDF/B-VII Decay Data

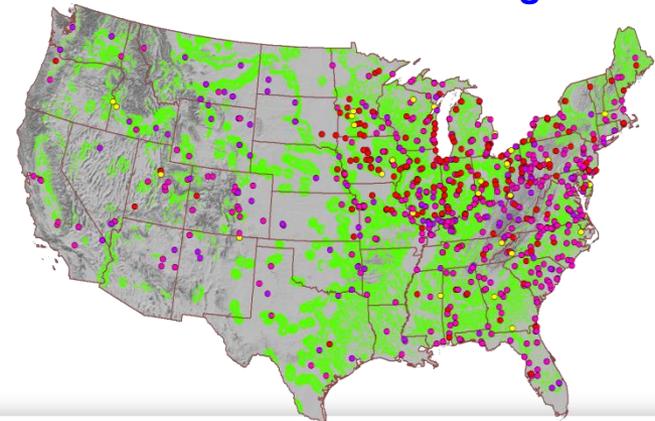


ORNL completes milestone reports to assist DOE-NE in examining options and issues for deployment of Small Modular Reactors

Cutaway view of 2-unit m-Power SMR design



Existing coal plant sites relative to suitable areas for siting SMRs



- Completed recent report for DOE-NE AdvSMR program – evaluated 34 coal plant sites nationwide for repowering with SMRs.
 - 26 of sites could potentially support an SMR.
 - Potential for replacing 7.3 GW(e) of electrical generation capacity for these 26 sites.
- Completed second report for DOE-NE-AdvSMR program – evaluated 5 DOE sites and 10 DoD sites for siting SMRs.
 - 4 DOE sites and 9 DoD sites judged favorable for siting SMRs.
 - SMRs are options for single-purpose power production to meet presidential directive for federal agencies to reduce carbon footprint.
- ORNL leads discussions on economic factors for SMRs.
 - US-French (EdF, AREVA, CEA) evaluate cost advantages.
 - Proposed changes to economic model for Generation IV member nations for modeling of SMRs.

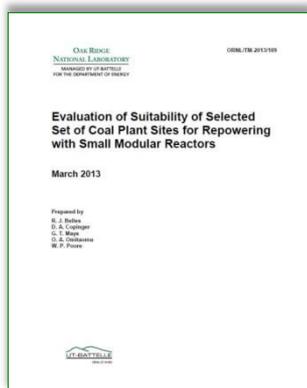
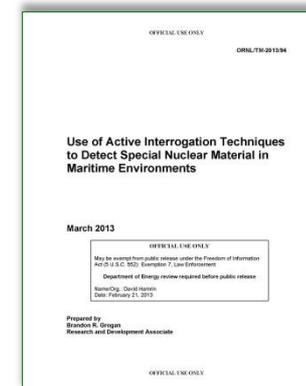
⇒ How to consider reduced capital outlay, factory fabrication of modules, and achieving “nth-of-a-kind” economies of production for standard designs.

Publications



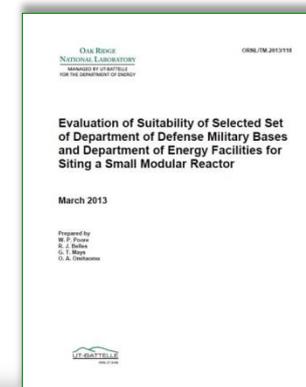
- ORNL/TM Report - 3
- Letter Reports – 1

Brandon R. Grogan, Jeffrey O. Johnson, John T. Mihalcz, James J. Henkel, Seth M. McConchie, Thomas M. Miller, and Bruce W. Patton, *Use of Active Interrogation Techniques to Detect Special Nuclear Material in Maritime Environments*, ORNL/TM-2013/94, Oak Ridge National Laboratory, UT-Battelle, LLC, March 2013.



R. J. Belles, D. A. Copinger, G. T. Mays, O. A. Omitaomu, and W. P. Poore, *Evaluation of Suitability of Selected Set of Coal Plant Sites for Repowering with Small Modular Reactors*, ORNL/TM-2013/109, Oak Ridge National Laboratory, UT-Battelle, LLC, March 2013.

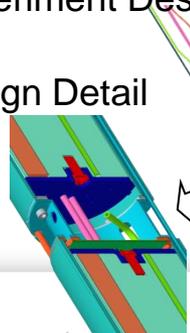
W. P. Poore, R. J. Belles, G. T. Mays, and O. A. Omitaomu, *Evaluation of Suitability of Selected Set of Department of Defense Military Bases and Department of Energy Facilities for Siting a Small Modular Reactor*, ORNL/TM-2013/118, Oak Ridge National Laboratory, UT-Battelle, LLC, March 2013.



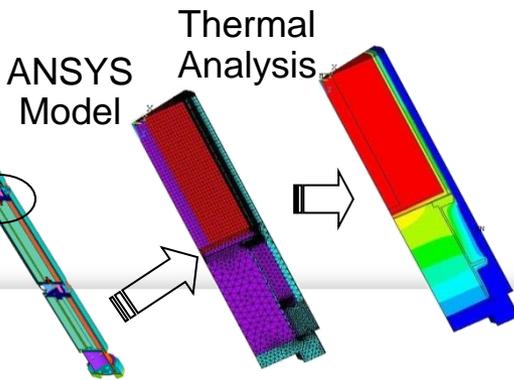
Project	Format	Sponsor	Stage					Notes
			Newly proposed	In Design	In Fabrication	In Reactor	Removed	
Titan Metal	Rabbit	DOE, FE US-Japan				8	12	Tungsten and steel
Composite Flexure	Rabbit	DOE, FE				8		SiC
Mini-Composite	Rabbit	DOE, FE			4	3Q 2013		SiC
Round-bar Tensile	Rabbit	DOE, FE		4+		2013		Steel
Hydrided Clad	Target	DOE, NE			2	2	2	Zircaloy
Ibiden	Rabbit	WFO, Ibiden				28 (10 waiting)	2	Graphite
Nippon	Rabbit	WFO, Nippon		31		3Q 2013		Graphite
UO2 TEM disks	Rabbit	Texas A&M				1		UO2
Titan Tensile	Rabbit	DOE				12	6	V-4Cr4Ti, SiC, Graphite, steel
EPRI	Large VXF	EPRI			3	3Q 2013		Steel, Inconel
Toyo Creep	Target	Toyo Tanso			3	3Q 2013		Graphite
PU238	Capsule	NASA			16			Partial length
Inconel springs	Rabbit	AECL		~40		2013		Inconel
Graphite Creep	Rabbit	EDF		5		3Q 2013		Irr. Graphite
SHINE	Rabbit	DOE		TBD				Mo-99
Exotic Ceramic	Rabbit	DOE, FE		9		2013		TiSiC Ceramic
SiC Joining tests	Rabbit	DOE, FE		21		3Q 2013		SiC
HTV Capsule	Target	DOE NE		1		4Q 2013		Graphite
FCR&D Rabbits	Rabbit	DOE NE		1		4Q 2013		DU fuel samples
General Atomics Rabbits	Rabbit	General Atomics		5		2013		SiC
FeCrAlY	Rabbit	Fusion		8+		2013		FeCrAlY
Metallic glass, High entropy alloys	Rabbit	Fusion		5		2013		Metallic glass, high entropy alloy

Experiment Design

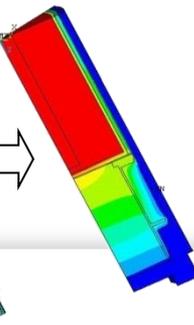
Design Detail



ANSYS Model



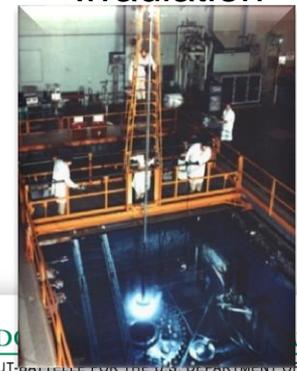
Thermal Analysis



Experiment Fabrication

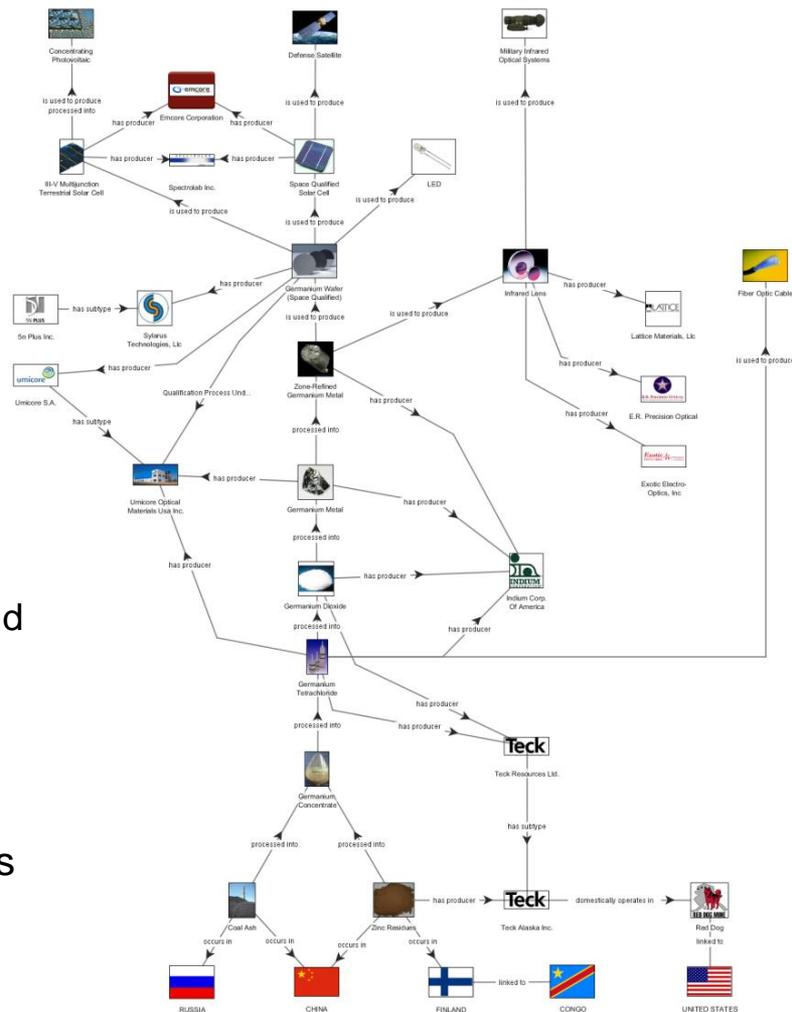


Irradiation



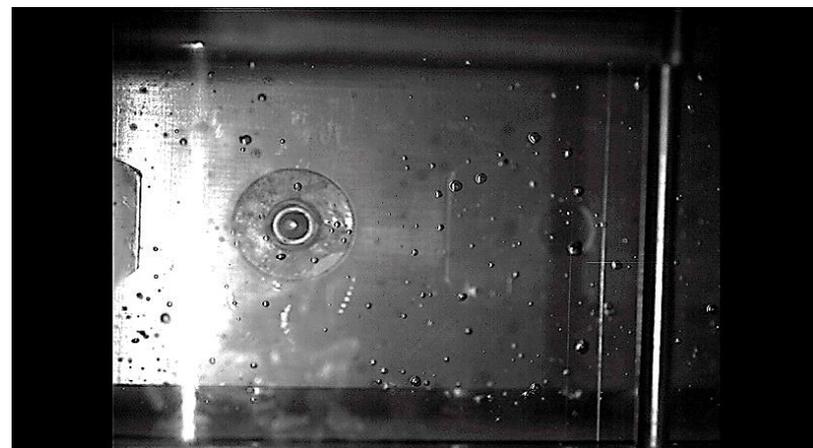
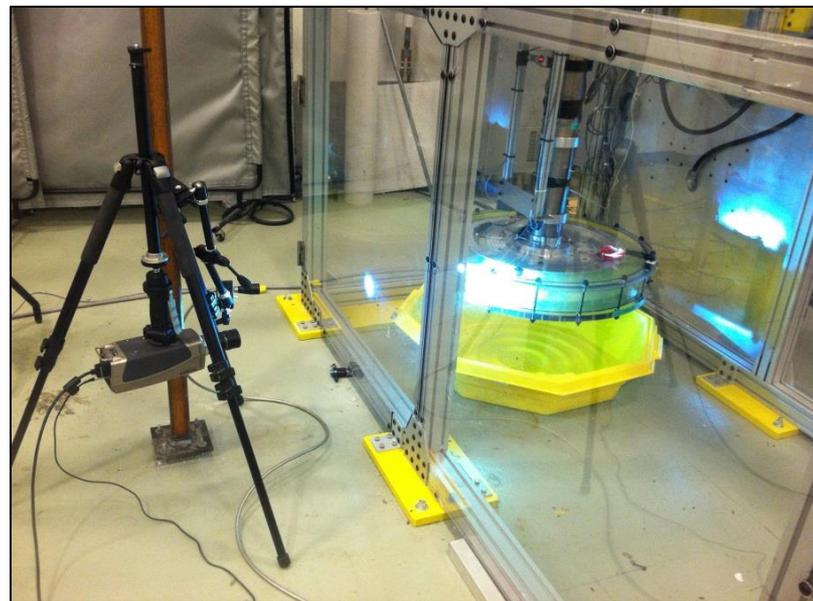
Defense Logistics Agency - Strategic Materials (DLA-SM) briefed

- ORNL briefed DLA-SM at Fort Belvoir on March 12 on the status of the Production and Research Informatics for Strategic Materials (PRISM) System
- PRISM's mission is to discover and track weaknesses in the supply chain of the defense industrial base
- PRISM is comprised of three components:
 - WebCrawler – gathers information from the internet, journals, industry reports, etc.
 - Analysts – personnel at ORNL and DLA-SM that review and filter the information provided by the WebCrawler and other sources
 - Palantir – visual database that stores all the high-value information inputted and organized by the analyst
- Noteworthy representatives from other interested agencies also in attendance at the briefing included:
 - DOE, Manufacture Industrial Base Policy (MIBP), Deloitte, US Geological Survey (USGS), DoD's WarStopper



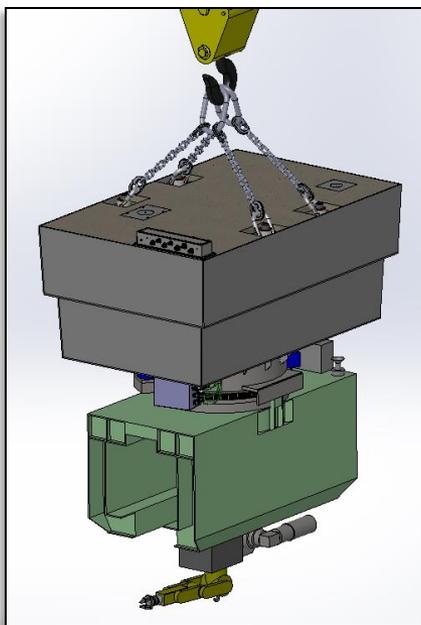
FRIB Beam Dump hydro-dynamic tests initiated

- Rotating Beam Dump Hydraulic Mockup at ORNL
 - Unique and unprecedented rotating water cooled beam dump with very high power density beam dissipation
 - Hardware attached to water loop in Bldg. 5800, D-111 Thermal Hydraulics laboratory
 - Phase 1 testing with transparent drum underway, flow characterized to pressure limits of drum
 - High-speed video shows flow characterized using induced air bubbles



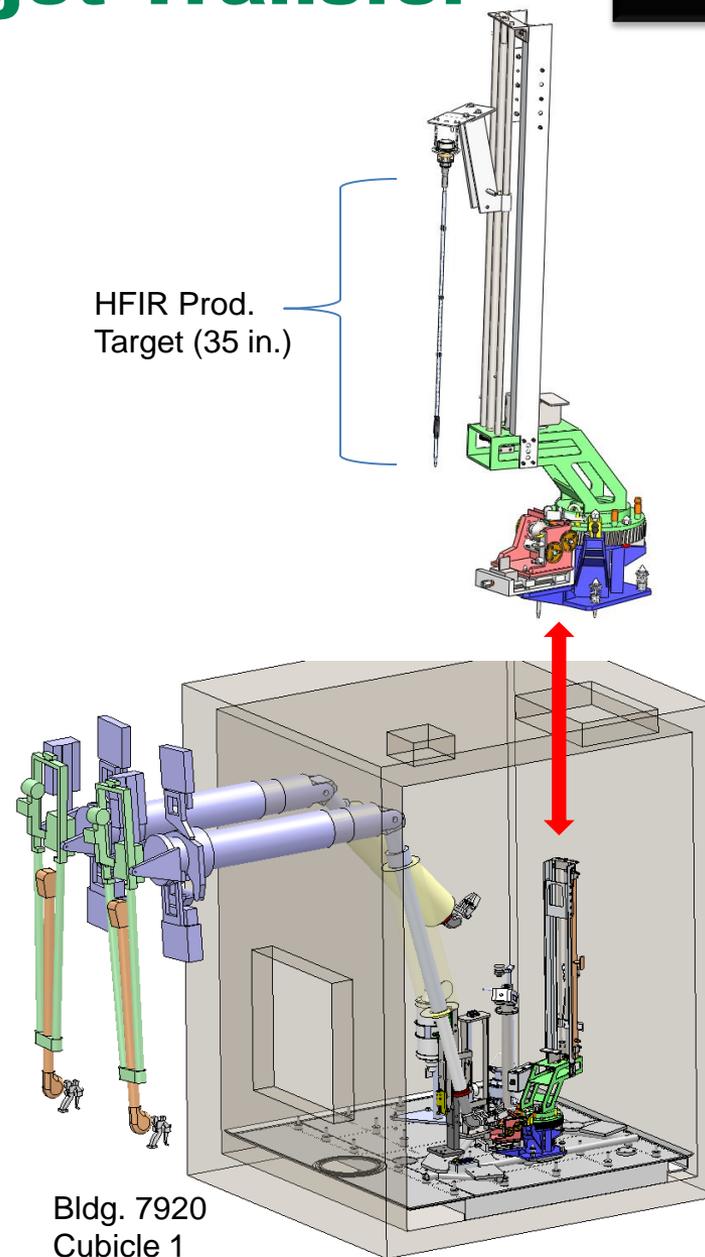
Bldg. 7930 manipulator system replacement progressing

- Remote Systems (RS) personnel are assisting with the design and replacement of the Bldg. 7930 Cell-G failed manipulator system
 - The unique new system design is shown below (CAD image)
 - Fabrication of the shield plug weldment was completed at the ORNL fab shop in March (photos below)
 - RS personnel are continuing to work on the detail design of related equipment required for installation in Bldg. 7930, the shield plug overall assembly, and the maintenance stand detail design drawings



Bldg. 7920 Hot Cell Target Transfer Arm Replacement

- Remote Systems staff are designing and fabricating a new Target Transfer Arm (TTA) for Cubicle 1
 - Used to precisely handle and position new HFIR targets between multiple manufacturing and inspection stations
 - TTA is a critical device needed in the production of valuable radioisotopes such as Cf and Bk
- Detailed design was completed in March, and parts procurement and fabrication has started



Bldg. 7920
Cubicle 1

Reactor pressure vessel specimens from industry are providing new opportunities to support possible life extension decisions

- Within the Light Water Reactor and Sustainability Program (LWRS) examination of irradiation effects in reactor pressure vessel steels has a high priority due to the potential safety impact of degradation in this important component



In recent weeks, samples for atom probe tomography (APT) of irradiated reactor pressure vessel surveillance specimens from the R. E. Ginna nuclear plant have been prepared and experiments have been performed by M. K. Miller of ORNL.

- Previously Westinghouse provided tested Charpy impact specimens representing a forging and a weld metal to ORNL.
 - The forging (SA508 class 2, Heat 125P666) contains about 0.05 wt% copper and 0.69 wt% nickel, while the weld metal (weld wire heat 61782 with a Linde 80 welding flux, designated SA-847) contains about 0.23 wt% copper and 0.53 wt% nickel.
 - For each material, the available surveillance specimens have been irradiated to three different fluences: 1.69, 3.64, and $5.80 \times 10^{19} \text{ n/cm}^2$ (>1 MeV). The highest Charpy impact 41-J shifts and corresponding fluences are 217F (192°C) at $5.80 \times 10^{19} \text{ n/cm}^2$ (>1 MeV) for the weld metal, and 91F (162°C) at $5.80 \times 10^{19} \text{ n/cm}^2$ (>1 MeV) for the forging. The APT measurements are currently being analyzed and additional experiments are underway.

Predictive Modeling of potential life-limiting swelling in PWR core internal components is being developed.

- Swelling may be an important form of degradation for some pressurized water reactor core internals later in life. LWRS has been performing both experimental and modeling research to help predict potential levels of swelling for extended service conditions. During recent months, a more detailed description of the helium and dpa generation rates has been obtained that reaches to the high doses associated with LWR life extension.
- The non-linear increase of helium and dpa generation rates as a function of fluence based on creation of Ni-59 has been accounted for. An example is shown in the figure of the He/dpa ratio as a function of the dose in dpa.
 - Note that for a neutron energy spectrum typical of LWR internal components, 1 dpa is obtained at a fluence of $\sim 7.2 \times 10^{22}$ n/cm² (E>0.1 MeV) or 1.5×10^{21} n/cm² (E>1.0 MeV).
 - The dpa-per-unit-fluence ratio increases by about 25% between 1 and 200 dpa.

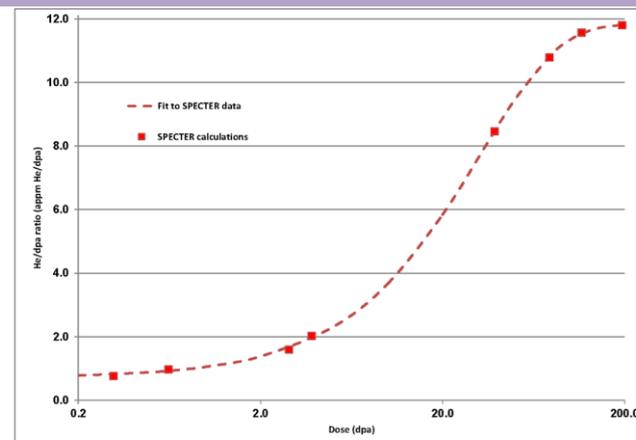


Figure 1: The impact of this dose-dependent He generation rate is being assessed in the cavity nucleation code. (Roger Stoller)

Publications

New Plasma-Antennas Interactions (PMI) papers now online

- C. C. Klepper participated in the *20th International Conference on Plasma Wall Interactions in Controlled Fusion Devices*, May 21–25, 2012, in Aachen, Germany, with two contributed papers. Both papers were accepted for publication in a special issue of the *Journal of Nuclear Materials*. Both of these papers are now available online.
 - *Direct, Spectroscopic Measurement of Electric Fields in a Plasma-RF Antenna Interaction Region in Tore Supra*, with R. C. Isler, E. H. Martin, D. L. Hillis, and J. H. Harris as additional FMNSD co-authors.
<http://www.sciencedirect.com/science/article/pii/S002231151300281X>
 - *RF Sheath-Enhanced Beryllium Sources at JET's ICRH Antennas*, with contributors from seven international research organizations, including ORNL/FMNSD's T. M. Biewer.
<http://www.sciencedirect.com/science/article/pii/S0022311513001323>
- Each paper represents a significant contribution to the understanding of plasma-antenna interactions in fusion energy devices in the presence of high power RF antenna heating and/or current drive. These accomplishments are the result of long-term investment by DOE and FMNSD in long-standing collaborations at large international fusion energy facilities.

NNFD FY2013 Cumulative Facility Metrics

Hot Cell Availability

Facility Upgrades and Maintenance Activities

91.7% Bldg. 7920

91.8% Bldg. 7930

100% Bldg. 3525

100% Bldg. 3025E

7920

- Programmed maintenance operations.
- Completed conversion of AmCm solution to oxide, working on consolidation of rework material.
- Continuing work on preparation for receiving the next PuBe source.
- Removed several bags of RHTRU waste from Cub 9.
- Oxide dissolved in prep for Protactinium prior to being converted back to oxide for Np Pellet Production.



7930

- Programmed maintenance operations.
- Eckert & Ziegler Isotopes Production Cermet Wire completed & shipped on schedule, 3/5.
- QSA Global Inc. Go/No Go gauge wire completed & shipped one week early, 3/13.



- Shield Plug Frame Assembly for PaR nearing completion at ORNL's Fabrication Shop.
- Annual Fan Motor Control System and Backdraft Dampers Functional Test Completed 3/7

3525

- Programmed maintenance operations.
- Completed annual calibration of TSR instruments
- Completed removal and repair of SEM cell manipulator



- Began site preparation for Chillwater Expansion Tank replacement

3025E

- Programmed maintenance operations.
- CAA Exhaust HEPA leak testing
- Completed rebuild of first Welch vacuum pump and staged second pump for rebuild in the CAA



- Replaced Cell 6 door operating system shear pins

4500 Area Gaseous Waste Reconfiguration and Stabilization Project

NNFD

- Final three trains of roughing filters removed from the 3106 Filter Pit and placed in waste containers (200 filters total removed)
- Collected samples from six roughing filters
- Work Plan to create access openings in vent duct for application of foam issued for review
- Erected enclosure at 4500 Area Hot Off Gas header isolation point
- Initiated procurement of vent duct foaming and labor/material handling support subcontractors
- Shipped sealand of 4556 Filter Pit demolition debris to Energy Solutions - Clive



Roughing Filters Loaded in Intermodal Container



Placing a Roughing Filter into a Bag



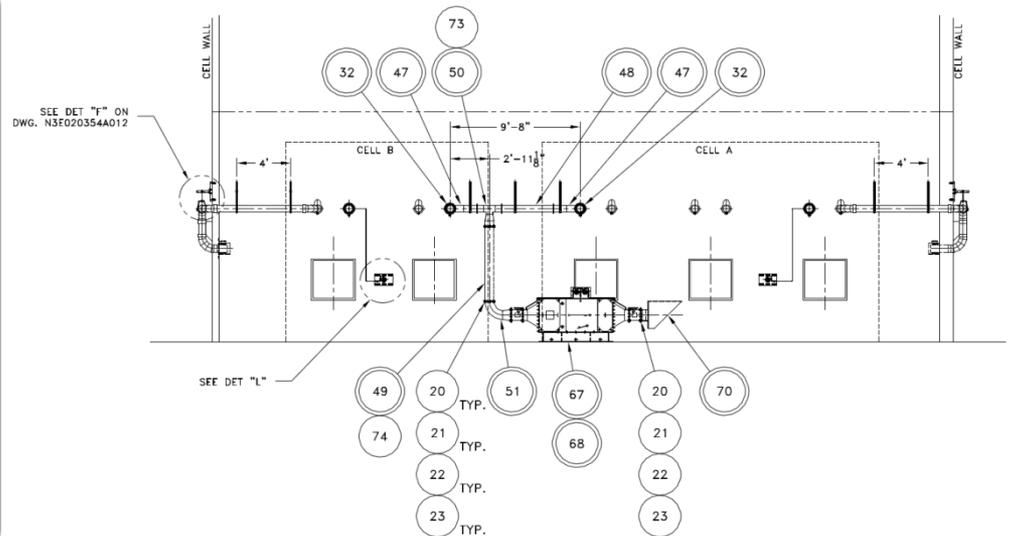
Hot Off Gas Isolation Point in Enclosure

EM project integration support

- EM Contractor SEC continued to work with NNSS for possible shipment of the one remaining RTG at 3517 (BUP-500). UT-B has sufficient funding remaining in MPO to support shipment logistics. SEC received contract extension/clarification. The MPO to support this shipment is in the approval cycle.
- At UCOR request UT-B is preparing an estimate and work plan to install 2 manipulators into Cell A and B of Building 3026D. Manipulators maybe relocated at cell face and will be retrieved by UT-B post project. UT-B has also been asked to prepare an estimate to provide long term ventilation for these hot cells.
- At UCOR request, UT-B is preparing a MOU and a work plan to remove the 6 manipulators from the cells in the Alpha Handling Area of Building 3038.



Manipulators in AHA of Building 3038



View of Possible Ventilation Configuration at 3026

Central campus legacy material removal project

2026 Activities

- Phase I cleanup completed
- Defined Phase II project work with Isotek and DOE EM
- 2792ft³ of waste removed and packaged to date



Post Cleanup Painting at Cell Access Area in 2026

4501 D Cell Activities

- Debris removal complete/painting remains
- 335ft³ of waste removed and packaged



Final Vessel Removal via Top Plug from 4501 D Cell

4501 D Cell Post Cleanup



Soil and slab characterization and removal in the southeast quadrant

- BCP approved for characterization and remediation of former Building 3550 slab and potentially contaminated underlying soil (ARRA funded).
- Initiated procurements for site characterization subcontractor (BOA task release); data evaluation (SAIC PO); and DOE-EM Sample Management Office support (UCOR MPO).
- Initiated supporting documents and preparations for sampling slab and underlying soil.



Wide-angle view of 3550 from southeast



View of 3550 from northwest

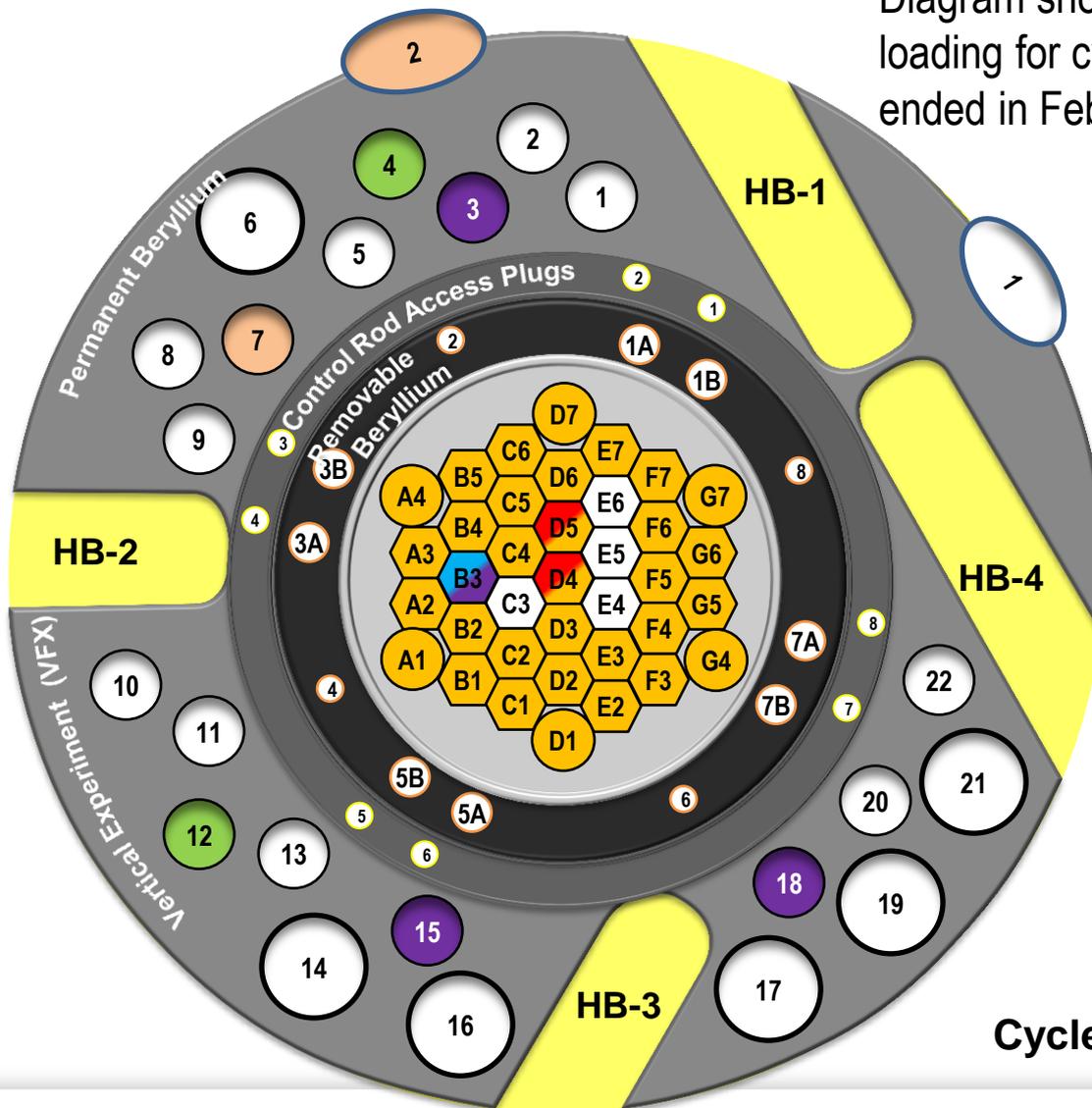
HFIR in routine end of cycle 446 outage during month of March

HFIR

March 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
31						

Reactor OFF

Diagram shows experiment loading for cycle 446 which ended in February

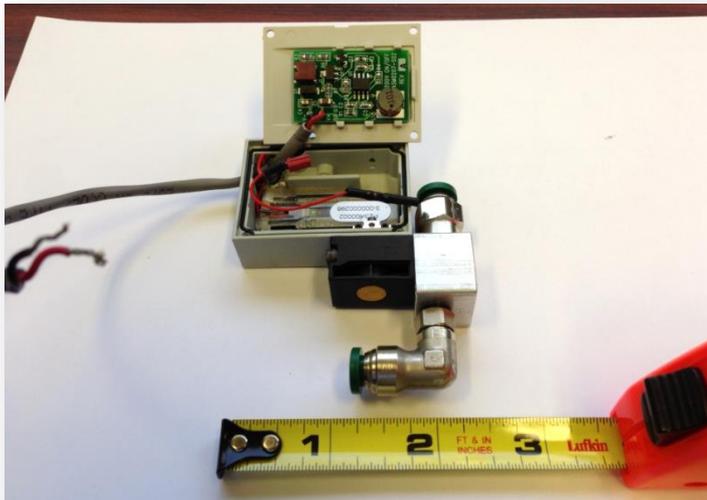
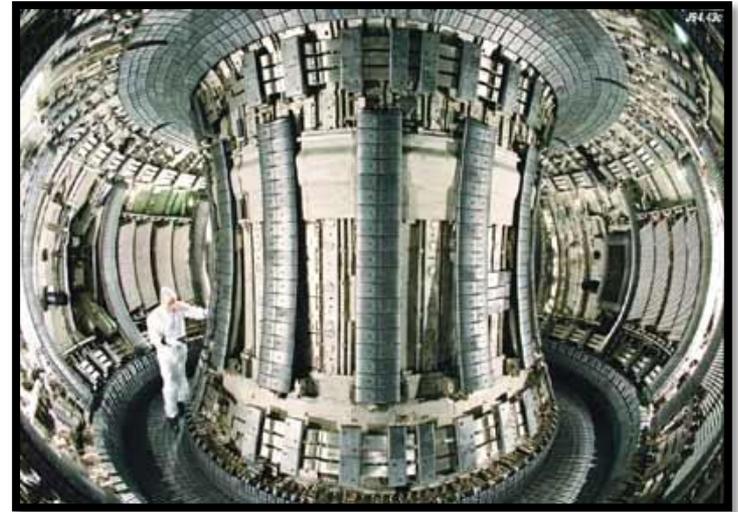


- Isotope Production
- Isotopes for Research
- Materials Experiment
- Fuels Experiment
- Pneumatic Facility NAA
- Hydraulic Facility
- Neutron Scattering
- Available Positions

Cycle 446 graphical summary

HFIR gamma irradiation supports ITER component selection and qualification

- Evaluation of a piezoelectric operator valve to replace a coil-solenoid operator valve
- 3 irradiations (1 valve in each)
- 5 KGray total dose each
- Results are being analyzed
- More irradiations upcoming to support additional components/materials



Piezoelectric valve and the electronics required to operate it (electronics were not irradiated)

Sample support canister and the piezoelectric valve

