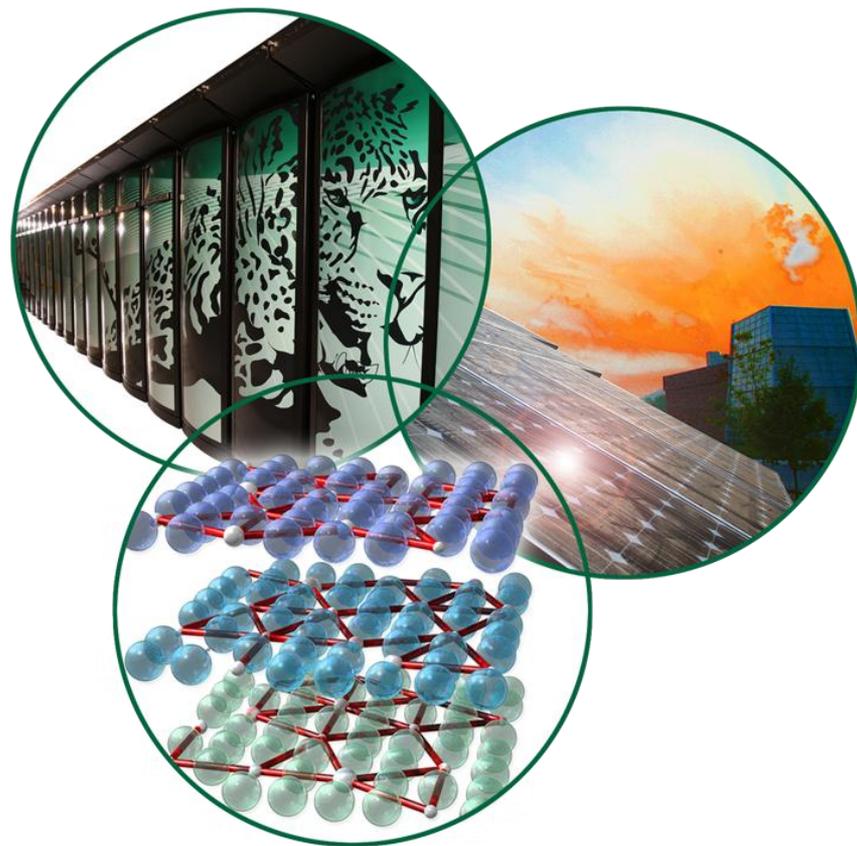


# NSED Monthly Report

## December 2012

### Nuclear Science & Engineering Directorate



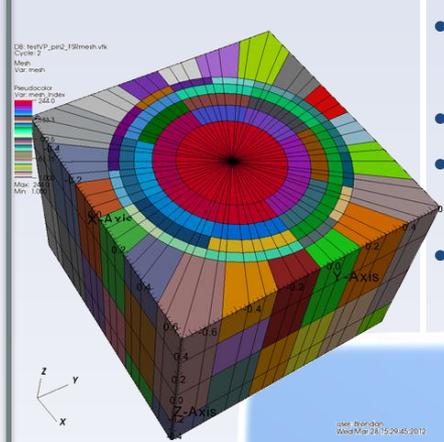
# Virtual Environment for Reactor Applications (VERA) milestone release (version 2.3; Rel. 12/19/12) provides significant additional capability

## A suite of tools for scalable simulation of nuclear reactor core behavior

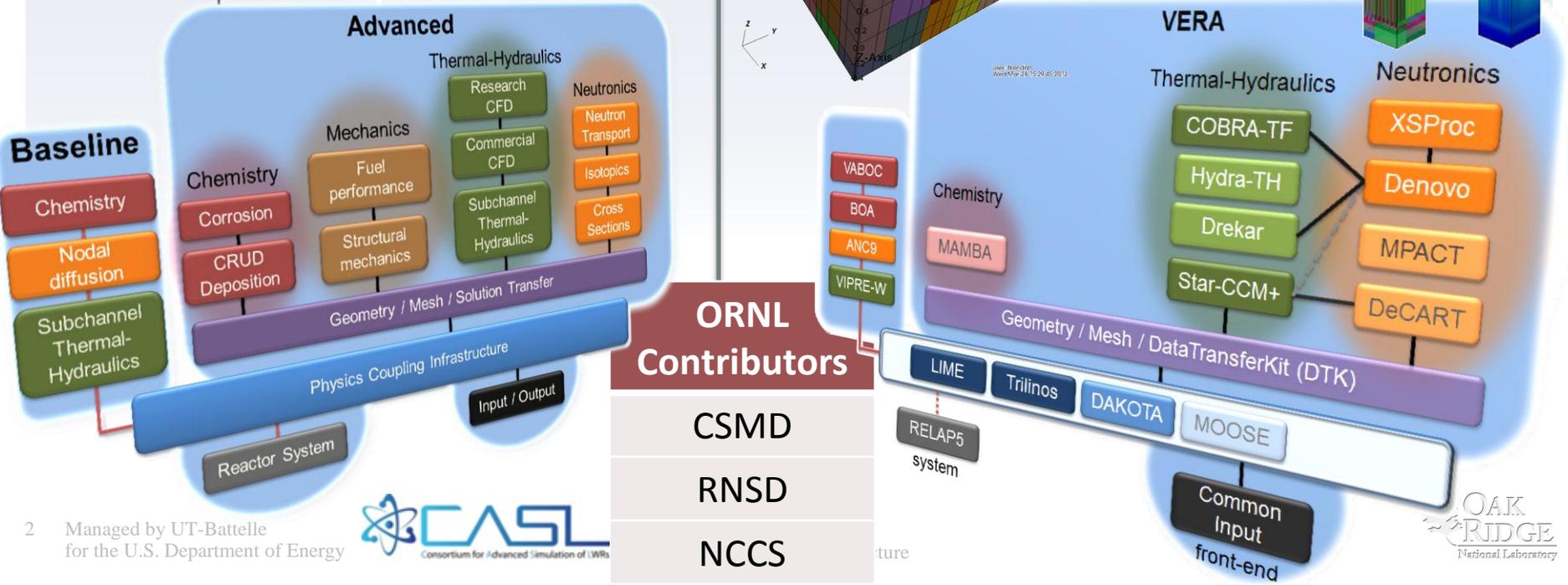
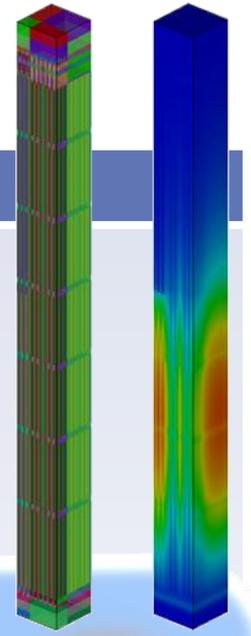
### Goals

- Flexible coupling of physics components
- Toolkit of components
- Rigorous software processes
- Scalable existing and future HPC platforms
- Attention to usability
- Development guided by relevant challenge problems
- Broad applicability
- Fundamental focus on V&V and UQ

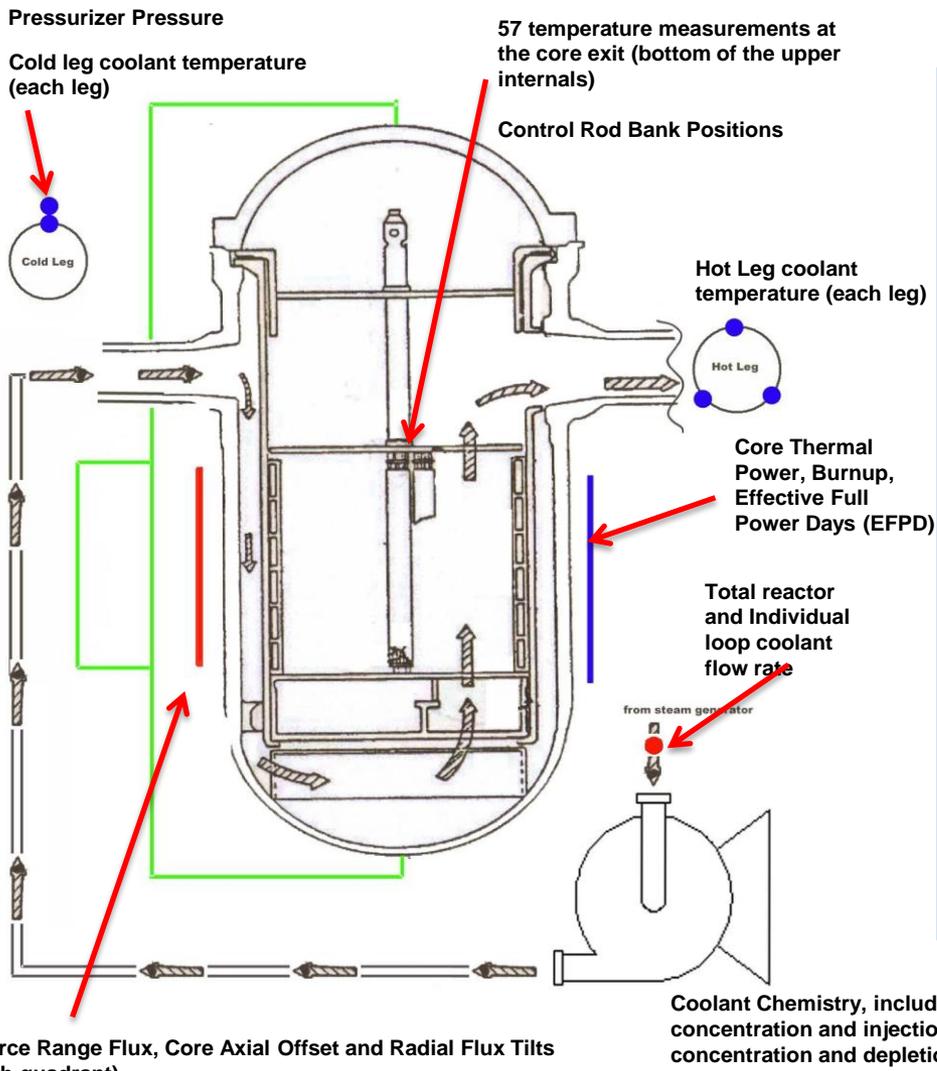
### VERA Snapshot 2.3



- Baseline industry capability
- Common input
- New pin-resolved transport
- Initial advanced physics coupling



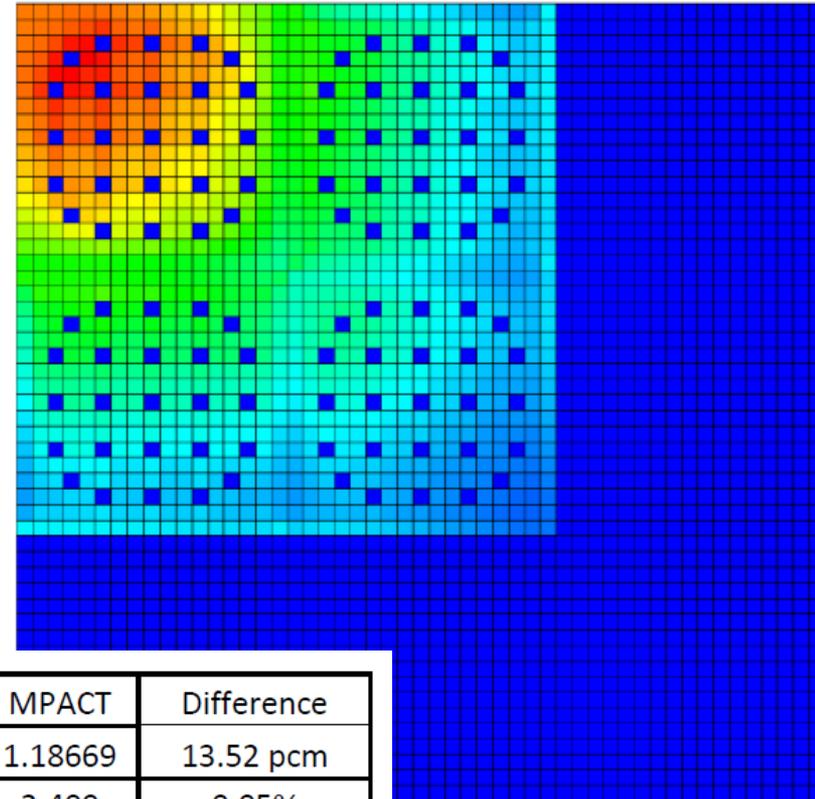
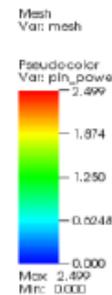
# TVA delivered detailed operational data from Watts Bar Unit 1 to support extensive validation of CASL's VERA



- TVA provided detailed information on Watts Bar Unit 1 Cycles 1 through 10
  - Core cycle design
  - Core performance observations
  - Measured operating data from various instrumented locations (see graphic) on a 5-day average basis for the complete cycle
  - Cycle 1 startup testing information
  - Applicable coolant chemistry information
- Zero power physics testing for all cycles to be provided in FY13, along with other supplementary data as needed

# Advanced pin-resolved method of characteristics (MOC) neutron transport code released through RSICC

- MPACT v1.0.0 released Nov 21, 2012
  - 2D and 3D MOC and CDP transport capability
  - CMFD Acceleration (for 2D lattice problems)
  - Cross-section shielding with Subgroup and ESSM
  - Scattering treatment up to P5 (removes dependency on transport corrected P0)
  - Visualization support with VISIT



	Reference	MPACT	Difference
keff	1.18655	1.18669	13.52 pcm
Max Power	2.498	2.499	0.05%
Min Power	0.23	0.236	2.65%
Inner UO2	492.8	491.69	-0.23%
MOX	211.7	212.13	0.20%
Outer UO2	139.8	140.06	0.18%



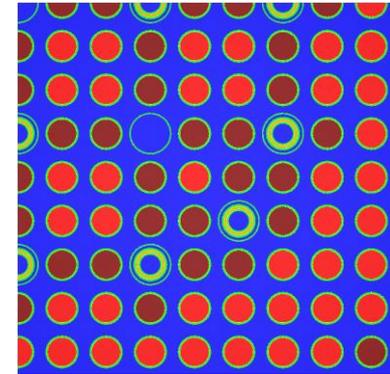
# Excellent results achieved with CASL neutronics lattice physics capability

## Purpose

- Verification of capability to model typical 2D PWR fuel lattices as is done in the nuclear industry
- Comparison of MPACT results to reference Monte Carlo results as well as industry codes
- Evaluation of lattice reactivity and normalized rod-by-rod fission reaction rate distribution

## Contributors

Andrew Godfrey  
Fausto Franceschini  
Scott Palmtag  
Julie Stout  
Ben Collins



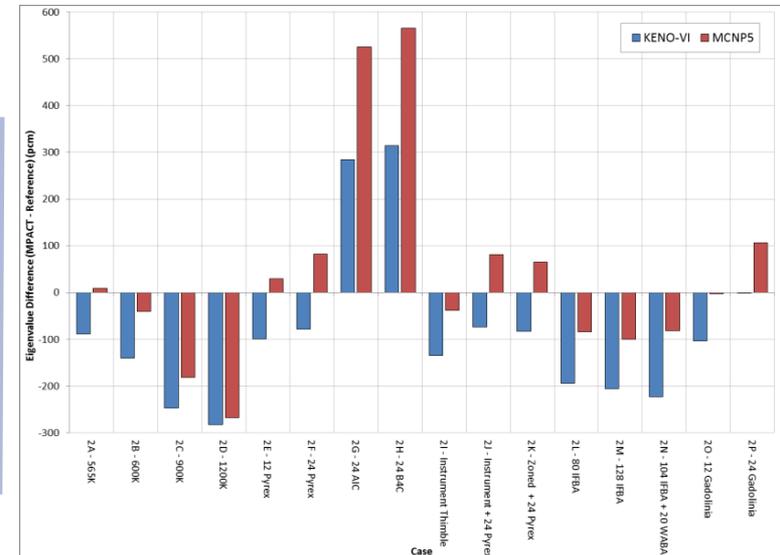
Problem 2N, IFBA/WABA

## Execution

- Completed specification for 2D problems
- Built and executed models for each problem with all codes (MPACT, KENO, MCNP, PARAGON)
- Performed comparisons between results using eigenvalue difference and pin power RMS difference

## Results

- Results from MPACT show excellent agreement with reference continuous energy Monte Carlo
  - 85 pcm ( $10^{-5}$ ) average eigenvalue difference
  - 0.15% pin power RMS difference over all cases
- MPACT performs very well based on comparisons to Industry design codes (PARAGON)



2D Lattice Eigenvalue Differences

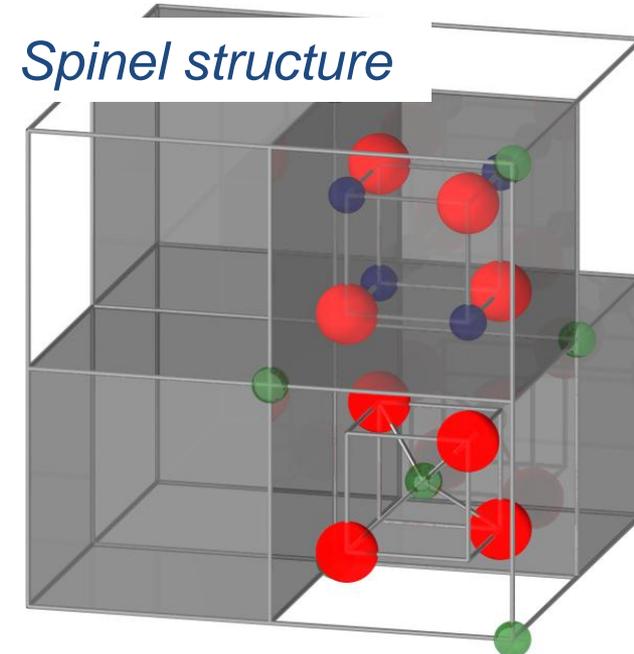
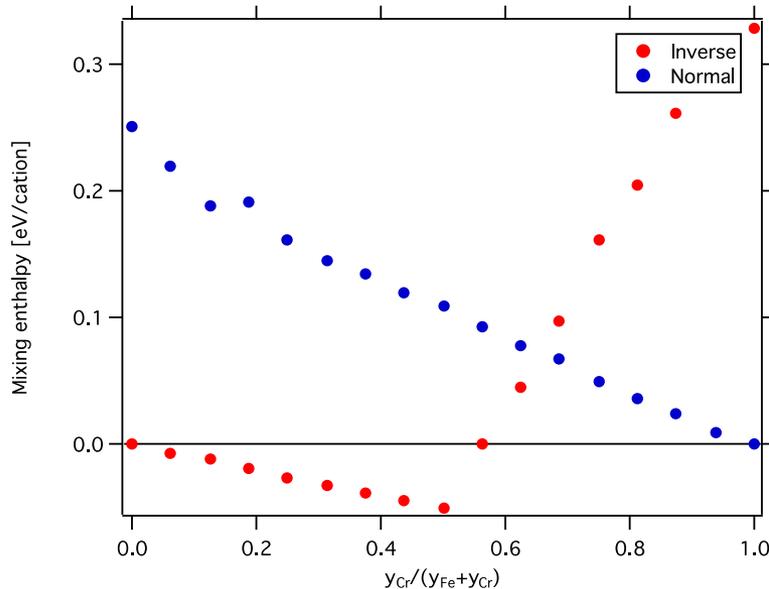
# Improvements in MAMBA and MAMBA-BDM allow CASL to enhance CRUD growth models

Completed density functional theory calculations that enable predictive CRUD growth models

The improved CRUD growth models being developed by CASL (in the MAMBA and MAMBA-BDM applications) require more accurate and flexible thermochemical models of CRUD phases (which are also relevant for source terms from corrosion sources)

- Effort led by D.A. Andersson and C.R. Stanek (LANL)

A manuscript has been prepared for *J. Am. Ceram. Soc.* that summarizes DFT results of formation energies, mixing enthalpies and non-stoichiometry of Ni-Fe-Cr-Zn spinels.

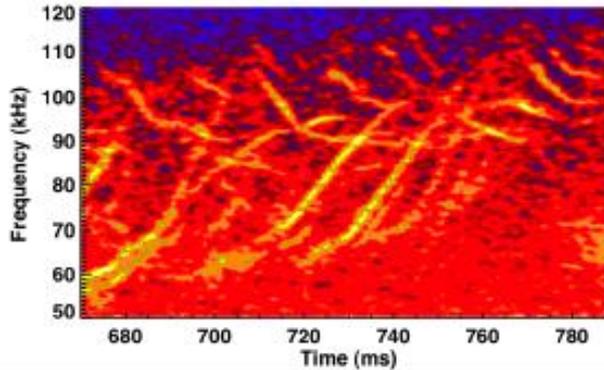


**Key results:** Limited solubility for  $NiFe_2O_4$ - $ZnFe_2O_4$ ; Cr soluble in  $NiFe_2O_4$  up to  $Ni(Fe_1, Cr_1)O_4$  after which a miscibility gap emerges (see left); oxygen excess reactions are in many cases spontaneous and involves metal vacancies.

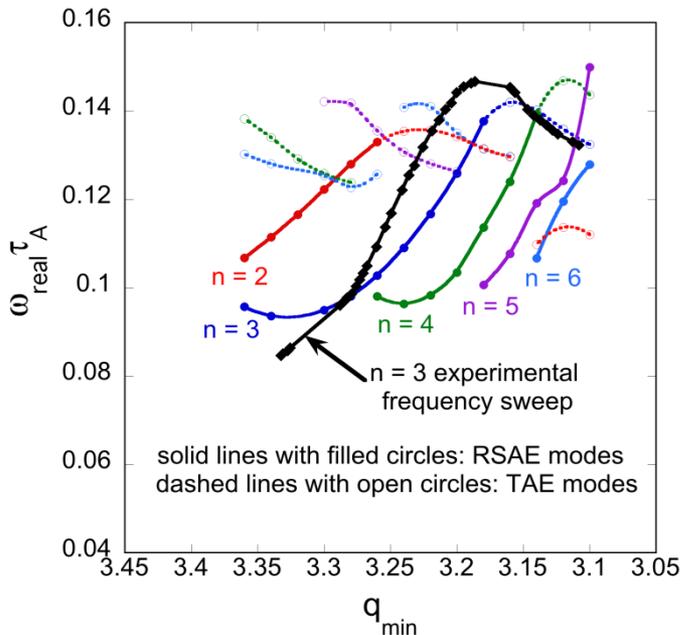
# Improved DIII-D Alfvén cascade simulation leads to better models for ITER advanced tokamak burning plasma scenarios

Reversed shear safety factor ( $q$ ) profiles are a central element in ITER advanced tokamak scenarios due to their good alignment with bootstrap current, stabilization of neoclassical tearing and kink instabilities and generation of internal transport barriers. This regime also produces a rich spectrum of Alfvén frequency phenomena due to the time-variation of the  $q$ -profile as the current profile evolves. These instabilities can lower fast ion confinement, leading to less ignition margin in ITER and localized wall heating. As the minimum of  $q$  passes through various rational values, a range of Alfvén instabilities will appear, sweep up or down in frequency and then disappear. This sequence of Alfvén instabilities is known as an Alfvén cascade due to the interplay of up- and down-sweeping coherent frequency peaks that are evident in spectrograms of the internal fluctuations. These cascades have been simulated with a new computationally efficient Landau-closure model<sup>1</sup> (TAEFL) that includes coupling to geodesic-acoustic wave dynamics and closure relations optimized for energetic particle/Alfvén wave resonances. This model has also been part of a verification/validation study<sup>2</sup> with two gyrokinetic codes (GTC, GYRO) for an  $n = 3$  frequency up-sweeping Alfvén instability.

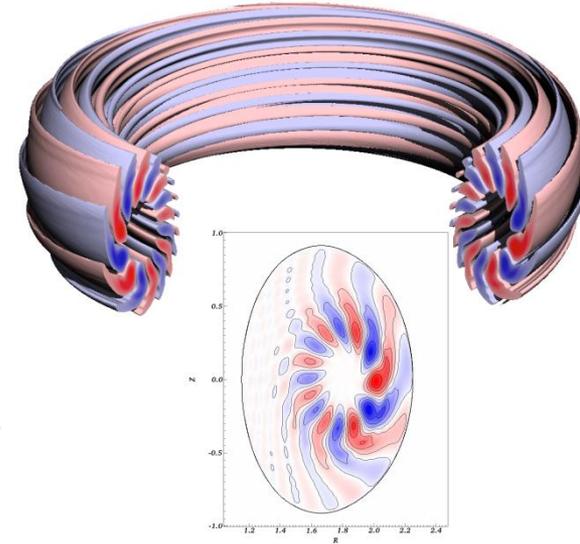
DIII-D experimental spectrogram



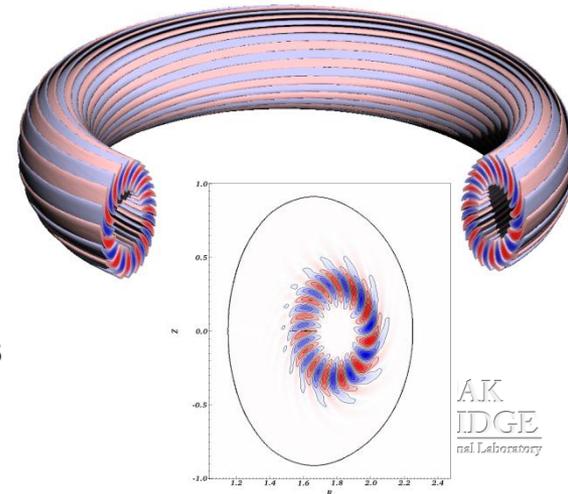
Frequency sweeps from TAEFL



$n = 2$  RSAE mode structure for  $q_{\min} = 3.36$



$n = 4$  RSAE mode structure for  $q_{\min} = 3.24$

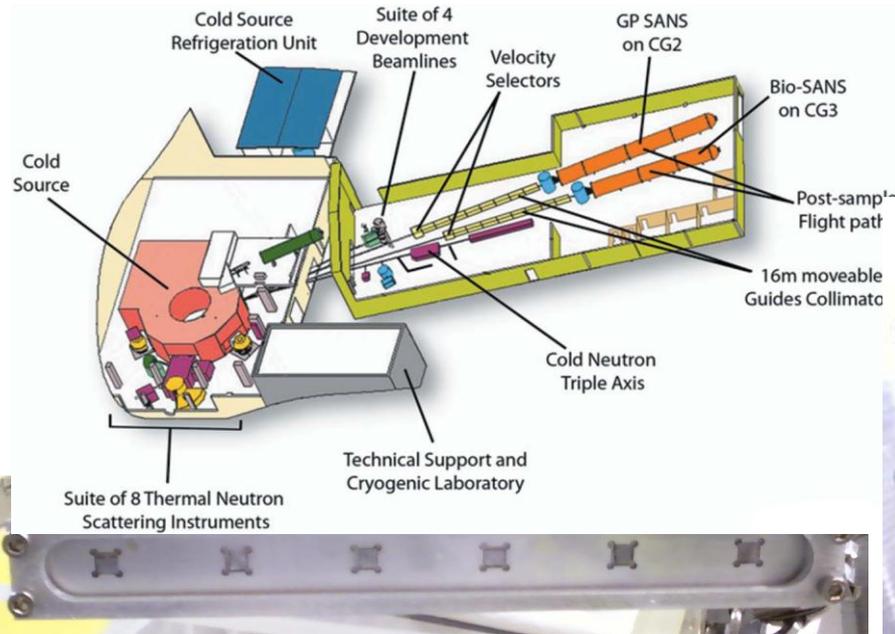


<sup>1</sup>D. A. Spong, submitted to Nuclear Fusion (2013)

<sup>2</sup>D. Spong, E. Bass, et al., Physics of Plasmas, **19** 082511-1, Sept.(2012).

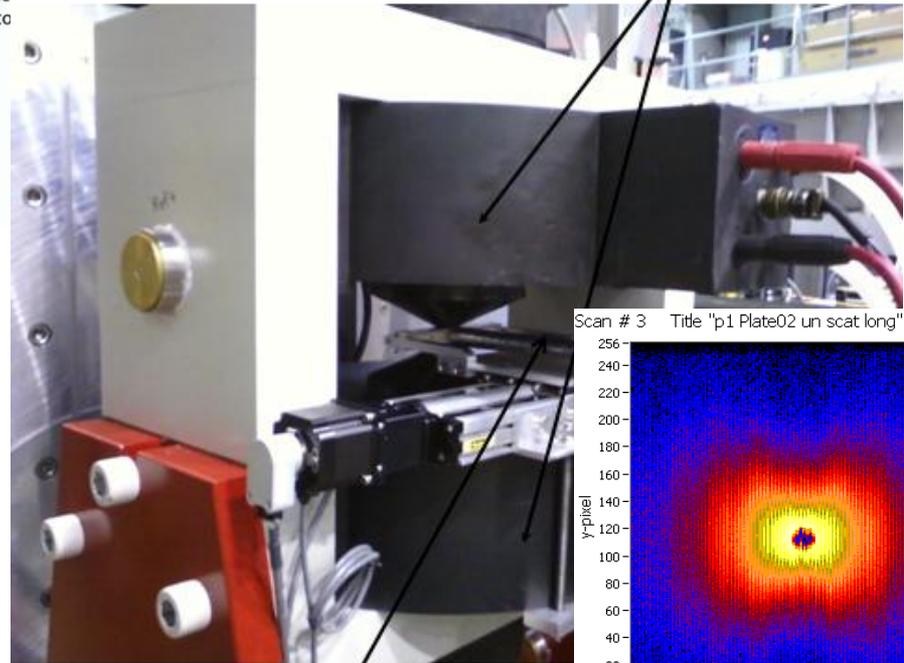
# A new neutron scattering facility at HFIR allows unique insight into fundamentals of radiation damage in nuclear reactor components at very long lifetimes

## Magnet and Automated Motor to Handle Specimen Holder with Irradiated Specimens

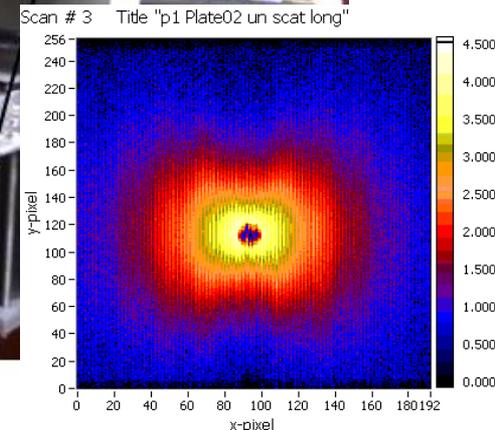


Specimen holder

Magnet poles



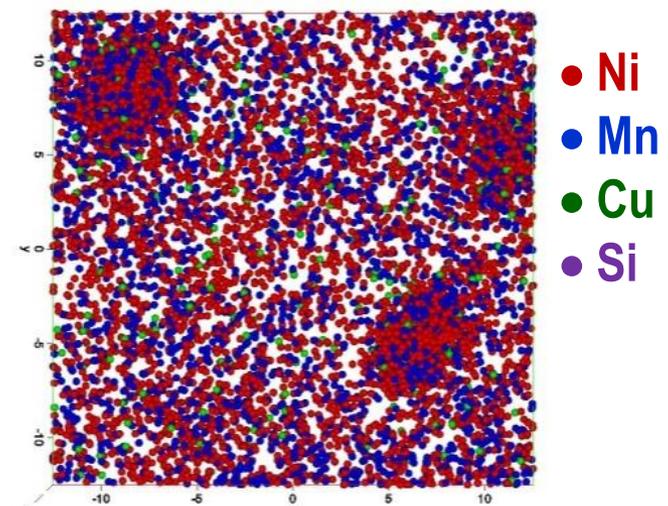
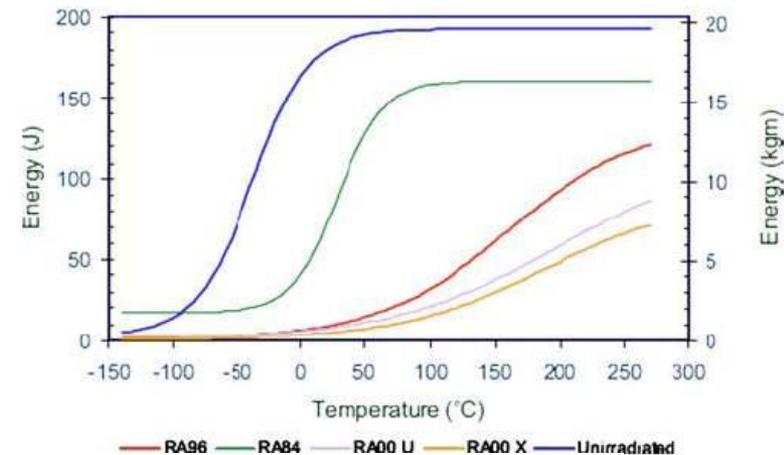
air-scattering guard tube



- SANS is being used to study high-dose radiation effects on RPV steels.
- First experiment was performed in October 2012, results are under evaluation.
- Next measurement is scheduled for April and will include surveillance specimens from Ginna and ATR with UCSB

# New research has confirmed the presence of new irradiation-driven processes in commercial nuclear power plant materials under extended service conditions

- Classical embrittlement of the reactor pressure vessel has been driven by rapid Cu-rich precipitate hardening
- Modern RPV steels have low-residual Cu-levels to mitigate this concern
- However, early models (Odette et al.) predicted that irradiation may drive phase transformations in even low Cu alloys
  - Mn-Ni(-Si-Cu) LBP that can reach large volume fractions (f)
  - Could lead to large embrittlement in low Cu steels previously thought to have little sensitivity to embrittlement
- RPV materials and surveillance specimens from the Ginna Nuclear Plant and from the Zion Nuclear Plants (both PWRs) for material examination, APT, SANS, PAS



Low-copper (0.05 wt%) weld shifts 162°C at  $6 \times 10^{19}$ , clusters primarily of Ni-Mn-Si, very little copper.

# Ultra-Trace Forensic Science Center



In late November, **Joseph E. Macmanus**, Nominee for United States Representative to the Vienna Office of the United Nations, was toured through the Ultra-Trace Forensic Science Center and briefed on ORNL efforts supporting the IAEA

- The Ultra Trace Forensic Science Center Phase IIa trace sample preparation, sampler science, and magnetic resonance force microscopy laboratories were completed and ready for occupation in October 2012
- The new facilities feature class 100 through class 10,000 hardwall clean room laboratory space housing metal free benches and hoods (including a perchloric acid chemical fume hood) with secure access.



Kathy Gibson, Michelle Flanagan, Gordon Bjorkman, Patrick Raynaud and Robert Einziger of the US NRC visited ORNL on December 3. *Hosted by Bruce Bevard*

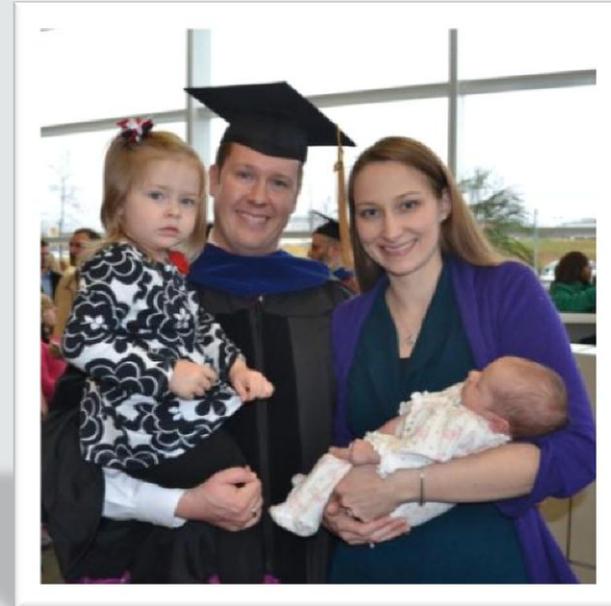


Eben Mulder, Trevor Blench and Martin van Staden of Steenkampskraal Thorium Ltd. on December 12. They provided an overview of their company's activities and their reactor design status. *Hosted by Jess Gehin*



# Completion of PhD

**Dr. Erik D. Kabela**, a forensic meteorologist in the Global Nuclear Security Technology Division, earned his Doctor of Philosophy degree in Geography with emphasis in Applied Climatology from the University of South Carolina on December 17, 2012. Erik joined ORNL in December, 2011 and has been actively engaged in micro-scale climate research and application of micro-scale meteorological tools to forensics research efforts within the division and the Global Security Directorate.



***Dissertation title:***

NARCCAP Model Assessment and Future Projections for the Southeast United States

# CONGRATULATIONS !

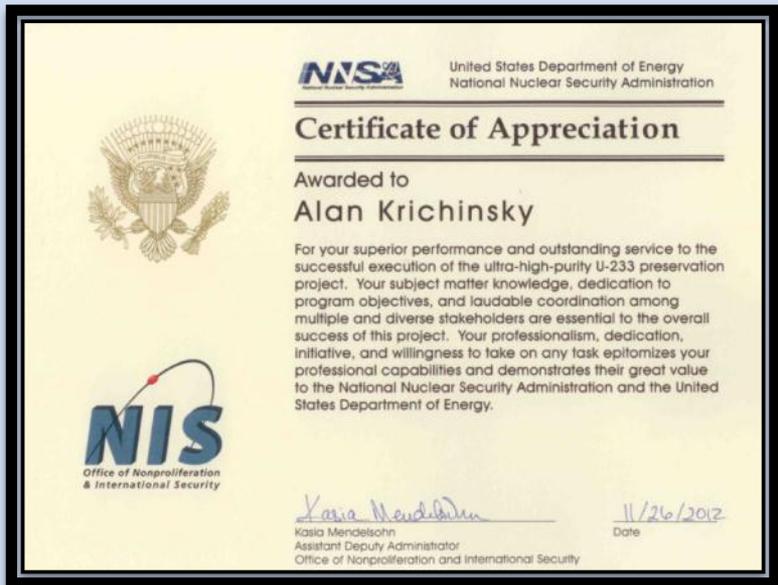
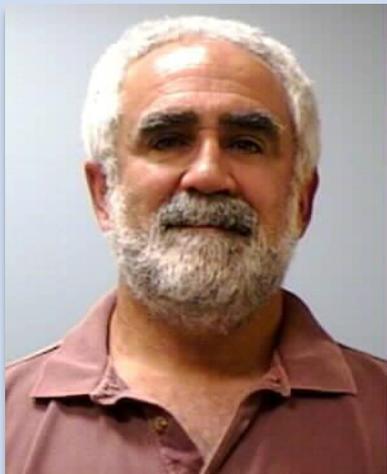
# IAEA Division Director Appointment



**Ana Raffo-Caiado** has accepted an appointment at the IAEA as the Director of the Division of Programme Support and Coordination in the Department of Technical Cooperation (TC). The IAEA TC Department helps countries to improve their scientific and technological capabilities in the peaceful applications of nuclear technology, thus contributing to sustainable development. A division-level position is the highest ever offered to an ORNL employee. Ana will be taking a leave of absence in March 2013 to start this new position.

# CONGRATULATIONS!

# Certificate of Appreciation



**Alan Krichinsky** received special recognition from NA-24 for his outstanding support and efforts to preserve ultra-pure U233 for future uses. This work represents a multi-year effort that involves coordination with multiple stakeholders, multiple funding sources, and the installation and preparation of a clean area for processing and packaging the samples.

# CONGRATULATIONS !

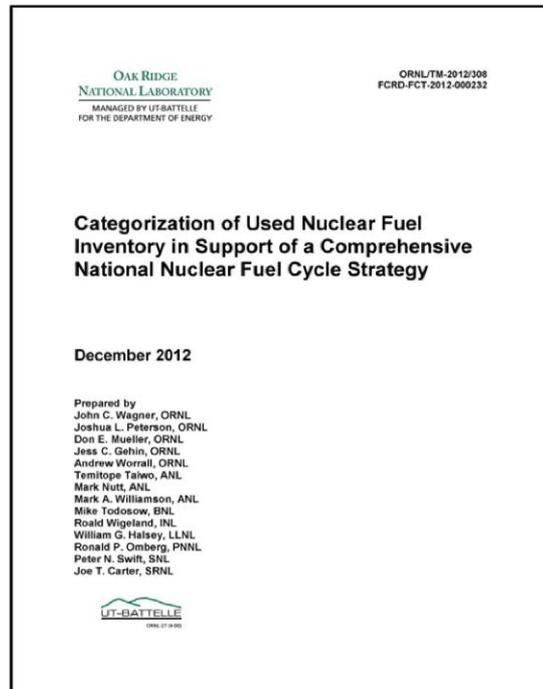
# Graduate Student Successfully Defends Master's Thesis

- Spenser Walsh, a graduate student at the University of Tennessee, Chemical Engineering Department, successfully defended her Master's thesis titled "The Effect of Pellet Geometry on The Specific Activity of  $^{63}\text{Ni}$ ". The experimental part of the thesis was performed at ORNL under the guidance of Julie Ezold and Saed Mirzadeh and supported by DOE-NP.



View of irradiated Ni-63 samples through the glovebox preparing for pellet dissolution

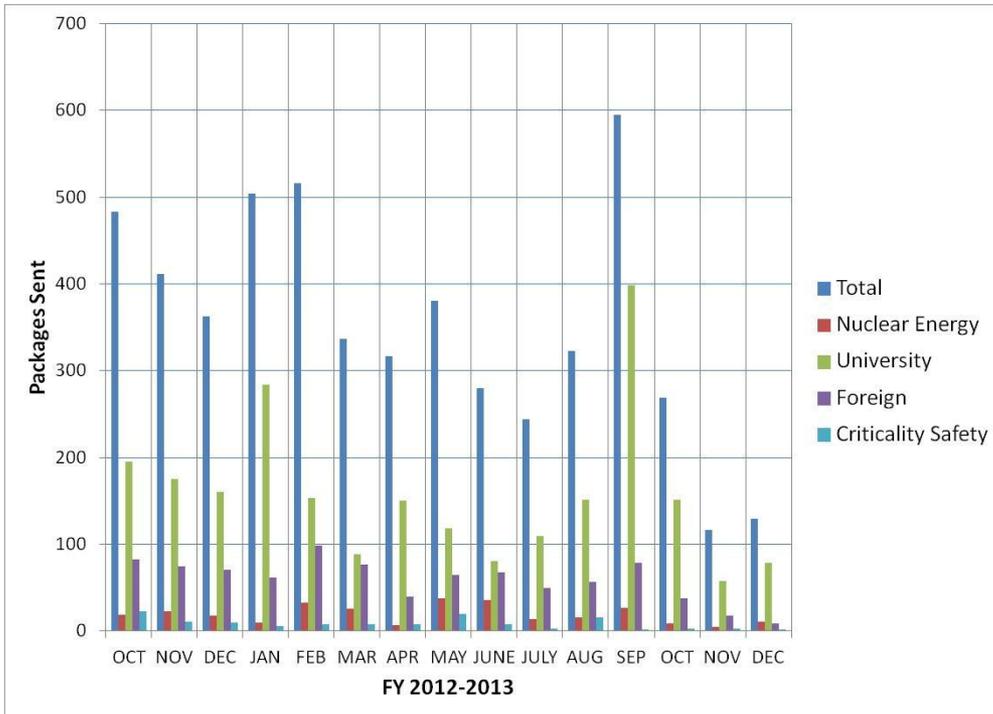
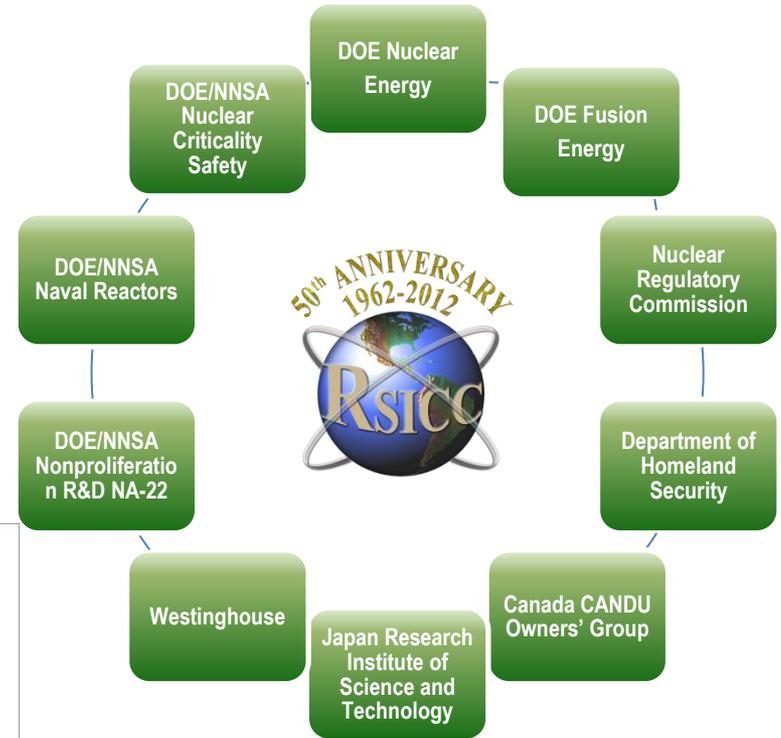
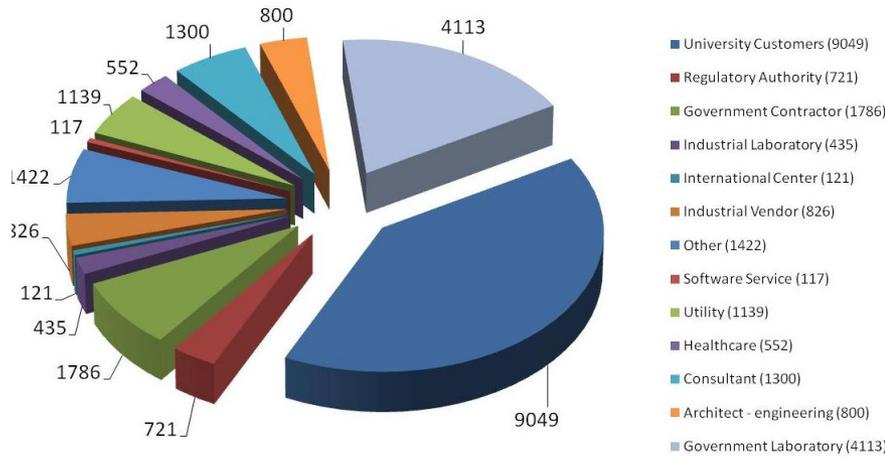
- ORNL/TM Report - 1
- Letter Reports - 5



John C. Wagner, Joshua L. Peterson, Don E. Mueller, Jess C. Gehin, Andrew Worrall, Temitope Taiwo (ANL), Mark Nutt (ANL), Mark A. Williamson (ANL), Mike Todosow (BNL), Roald Wigeland (INL), William G. Halsey (LLNL), Ronald P. Omberg (PNNL), Peter N. Swift (SNL), and Joe T. Carter (SRNL), ***Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy, ORNL/TM-2012/308*** (FCRD-FCT-2012-000232), UT-Battelle, LLC, Oak Ridge National Laboratory, December 2012.

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

RSICC Customer Base



- **Software and data packages distributed FY2013: 514**
- **5 package updates and revisions December 2012**

# A batch of MSRE coolant salt is prepared for shipment to the Czech Nuclear Institute for use in collaborative research

- A Memorandum of Understanding (MOU) between the U.S. Department of Energy and the Czech Republic Ministry of Industry and Trade was signed in Prague on December 12, 2012, which provides authorization for transfer of a 75-kg batch of fluoride coolant salt removed from the Molten Salt Reactor Experiment (MSRE) to the Czech Nuclear Institute
- The salt was originally removed from the MSRE in 1999, and was subdivided into smaller lots in May 2012
- The transfer system was then dismantled and the transfer tanks were decontaminated and packaged for shipment, which will take place as soon as the documentation is finalized



MOU Signatures



Salt Transfer Underway



Ready to Ship

# Mercury process and handling hardware built and tested for defense logistics agency

- ❖ Designed and fabrication of a modified shaker tray
  - For use as a back-up to the unit being fabricated for the defense national stockpile transfer project in the event solids collection in the vibration tray causes a need for more frequent cleaning than expected
  - A test plan was developed and initial testing completed January 3, 2013
- ❖ Designed and fabrication of a Flask lifting device
  - New flask lifting device improves performance and safety for future operations
  - Is independent of the use of the stopper
  - Was tested in the mock-up facility and improvements identified for operational use

*Shaker tray with six inverted flasks*



*New mercury flask lifting fixture*



# Phase II of building 4501 hot cell D clean-out was initiated (EM-funded)

- Cell has been in idle standby from the MSRE project for ~10 years
- Clean-out will enable reuse of this hot cell to support the Isotope Program's accelerator-produced Ac-225 R&D collaboration with BNL and LANL
- Development, review and approval of Work Plan for Phase II was completed
- Several hot cell entries to assess scope of work were conducted
- Phase II of project covers disassembly and removal of in-cell equipment, vessels, plumbing from previous project



An extensive amount of process equipment for MSRE U-233 trap venting is in place and must be removed

John Cosgrove and Ron Boyd entering Cell D to prepare for equipment removal



# A collaborative study of LWR materials degradation begins

*The study focusses on high fluence phase transformations and swelling in reactor components*

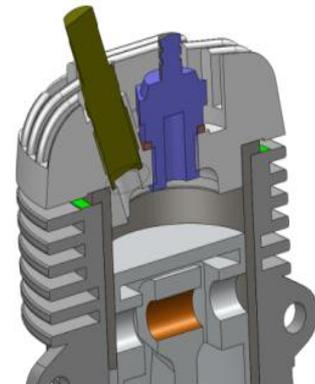
During December, a failed LWR component was received at ORNL for examination. This component will be characterized as part of a partnership between LWRs, Areva, and EPRI.

This higher fluence component will undergo visual inspection, sectioning, and detailed electron microscopy studies to provide insights into degradation at high fluences on plant relevant materials.



# Printed engines development

- Remote System Group staff members are working with members of several ORNL groups to develop the capability of printing small-scale internal combustion engine components for portable power and small Unmanned Aerial Vehicles (UAV) applications.
- The primary science aspect of the study is to use additive manufacturing to embed sensors into small single cylinder engines to collect data on small scale combustion to better understand how engine efficiency of small engines may be improved.
- Most major parts have been printed in prototype form but need to be sent out for post-processing (cleanup machining).
- It is anticipated that a custom-printed, instrumented head will be running on an otherwise commercial engine by mid January and that a complete printed engine will be available by the end of January



# ORNL working with BNL and LANL to produce Ac-225 from proton-irradiated Thorium-232

**Actinium-225 production from proton-irradiated Thorium-232** - Continued analysis of data and preparation of draft report for Actinium-225 production from Proton-Irradiated Thorium-232. Currently working on additional data for both [p,xn] reactions (protactinium isotopes) and [p,pxn] reactions thorium isotopes. The 2013 goal is to produce 60-70 mCi of Actinium in a single batch and manufacture at least two 20-mCi generators for both internal and external evaluation. This will be coordinated closely with BNL and LANL.



John Cosgrove working in Cell C in 4501 where the R&D-scale, proton-irradiated Th-232 targets from BNL are processed.

# Radioisotope production

- Completed consolidation of Campaign 75 rework material which will be stored until Heavy Element Campaign 76.

Heavy Element Campaign C-75



- Performed CLEANEX MXS Runs to clean up material in preparation for Oxalate Precipitation/Oxide Conversion.



Americium-Curium Processing



- QSA Order No. 66-0029-1: SR-CF-1406 is in QSA 3009/02; shipped on time December 3, 2012.



- Campaign 74 Rework: Ongoing for upcoming Eckert & Ziegler and QSA Global Cf-252 orders.

Cf-252 Production



- Conducted analysis of the gap between the tube and pellets after hydrostatic compression using surrogate materials.
- Placed six tensile targets into HFIR

Pu-238 Operations



- Shipments: Two Ac-225 Shipments with a total of 14.5 mCi shipped
- ORNL will host the 8th International Symposium on Targeted Alpha Therapy (TAT) during June 2013 at ORNL. Planning is underway.

Actinium Production



- The Remote Hot-Cell Target Fabrication Equipment Upgrade Project is in progress at REDC - Continued design of the transfer arm for Cubicle 1; initiated solicitation of vendor concepts and budgetary proposals for replacing the Cubicle 2 target assembly machine; and, continued troubleshooting of the Cubicle 3 pellet fabrication systems with initial emphasis on hoist repair.

Target Fabrication Equipment Upgrade



- Received and processed 3 Selenium capsules (5400Ci Se-75 ) at IMET Bldg. 3025E.

Se-75 Production



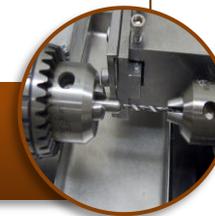
- Performed IX Column Separation Runs to separate Pu and Be.

PuBe Operations



- The leach solution underwent an Ion-Exchange Separation to separate out decayed Cm-248.
- The main Cf-251 fractions underwent Concentration Run to reduce volumes. Fractions were sampled and submitted to Analytical to determine contents and run yields.
- Analytical data reveals minimal Cf-252 contamination during Cell G processing operations.

LDRD Cf-251 Separations



# Enriched stable isotope technical services and shipping

Four shipments of 15 enriched stable isotopes were made in December

- 30 shipments of 91 enriched stable isotopes have been made in FY13 to date

Three custom technical services were completed in December

- 33 technical services have been completed in FY13 to date

Reprocessing of six stable isotope lease returns was completed

- Mo-95
- Mo-96
- Mo-98
- Mo-98
- Zr-92
- Mg-25



Mo-95 lease return



Mg-25 lease return



Zr-92 lease return

These items will be returned to the Isotope Sales inventory

# Radiation monitor research team meeting with Homeland Security DND Office and SNRL



## Domestic Nuclear Detection Office

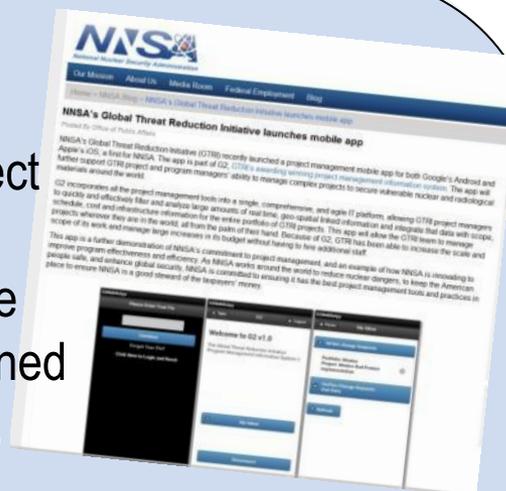
**Advanced Radiation Monitoring Devices Characterization Team Meeting:** ORNL's Characterization Team met with representatives from the Domestic Nuclear Detection Office and Savannah River National Laboratory to walk-through, finalize, and begin preparations for the Low Level Irradiator characterization measurement plan campaign scheduled to begin in February. (Funding level: \$1.7M)

The Advanced Radiation Monitoring Devices program aims to research, characterize, and develop recently introduced scintillation materials and associated technologies to develop instrumentation that provides improved capabilities in personal spectroscopic radiation detection applications.

# G2 Mobile - project management app successfully launched

ORNL successfully launched G2 Mobile, an iOS and Android module of GTRI's awarding winning project management information system. The app will further support the GTRI project and program managers' ability to manage complex projects to secure vulnerable nuclear and radiological materials around the world. The app also represents NNSA's first enterprise-sanctioned mobile deployment as described in a recent NNSA Blog article.

<http://www.nnsa.energy.gov/blog/nnsa%E2%80%99s-global-threat-reduction-initiative-launches-mobile-app>



# Russian Scientific Research Institute gets Personnel Reliability Program upgrade

**RUSSIAN FEDERAL NUCLEAR CENTER**  
All-Russian Research Institute of Experimental Physics

A SC «ROSATOM» COMPANY

**Material Protection, Control & Accounting Upgrades at All of Experimental Physics (VNIIEF) Sites** The U.S. Project Team is working with VNIIEF to upgrade the Personnel Reliability Program at the site. Under the current contract, VNIIEF will implement drug testing, alcohol testing, and psychological testing at one guarded area as part of trial operation. During the December 2012 meeting in Moscow, the U.S. Project Team was given a demonstration of Russian developed software called “Prognoz” (used to determine fitness for duty) which is deployed at the nuclear power plants in Russia.



# ORNL participation helps facilitate agreements between the Russian Federation Ministry of Defense and DTRA



ORNL participated in the 21st DOE Office of Nuclear Warhead Protection Joint Coordination Group meeting in December 2012 in Moscow, Russia. The purpose of the semi-annual meeting between the DOE, the Defense Threat Reduction Agency (DTRA), the National Laboratories, the Russian Federation (RF) Ministry of Defense (MOD), and multiple Russian Integrating contractors was to facilitate the implementation of the joint agreements between the DOE and RF MOD and status works in progress.

ORNL participated in a sustainably assurance activity to a 12th MOD site to ensure the systems and facilities supported by DOE are being maintained and utilized in accordance with the agreements between DOE and RF MOD. ORNL also supported meetings with DOE and DTRA to evaluate and comment training developed for new self-assessment activities for the MOD. This training will be implemented in early 2013 with US comments incorporated.

# Subject matter expert support to IAEA

Matt Feldman has been invited by the IAEA to a meeting in Brazil as a subject matter expert on Type B cask developed through IAEA Project RLA 3008. The objective of this project is to engineer casks for the safe and secure transport of spent nuclear fuel. This trip is in support of EM-33, DOE Packaging Certification Program.



# CASL collocation - December

## RTM R&D Activities, Closed Meeting

- CASL Code Verification – AMA, Hydra, COBRA, MPO, VRI, Denovo & MPACT
- Hydra-TH Development Meeting
- VERA Developers Workshop
- COBRA-TF Assessment
- VERA Input Demonstration
- Milestone Review
- GTRF Meeting
- DNB-CP Working Group Meeting
- Hydra-TH Meeting
- Crud code interface and data flow meeting
- VERA RSICC Release Plan Review

# CASL partner review conducted in December

<b>North Carolina State University</b>	<b>December 4</b>
<b>University of Michigan</b>	<b>December 6</b>
<b>Tennessee Valley Authority</b>	<b>December 11</b>
<b>Electric Power Research Institute</b>	<b>December 12</b>
<b>Sandia National Laboratory</b>	<b>December 17</b>
<b>Los Alamos National Laboratory</b>	<b>December 18</b>
<b>Idaho National Laboratory</b>	<b>December 19</b>

# Modeling and Simulation (M&S)

*SCALE used with PNNL and UM code for successful nuclear safety initiatives*

System functionality has been established for the initial version of a computational framework to automate as-loaded, cask-specific safety evaluations for used nuclear fuel using SCALE and Pacific Northwest National Laboratory's COBRA-SFS software. This is an important step in assessing realistic safety margins for used fuel storage and transport cask systems.

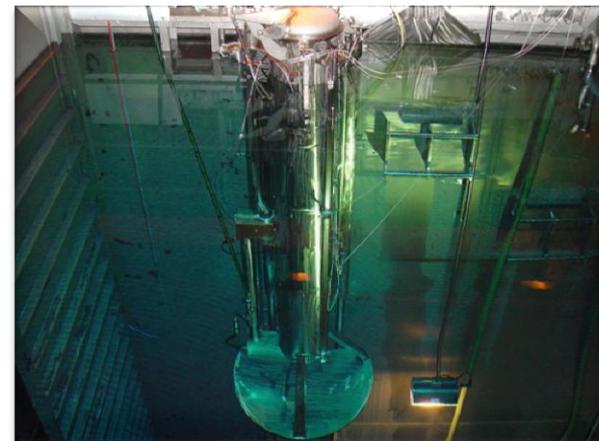


RNSD and the University of Michigan (UM) completed an integrated regression test suite for the U.S. Nuclear Regulatory Commission (NRC) that will help verify reliable operations in the link between ORNL's SCALE system and UM's PARCS nodal code.

# Modeling and Simulation (M&S)

*SCALE consultation and computational analysis support for Swedish used fuel facility*

- Under a collaborative arrangement, RNSD is providing consultation and computational analysis support to the CLAB used fuel storage facility in Sweden as they plan and perform a full assembly decay heat measurement program that will provide valuable validation data for the SCALE code system.
- New models are being investigated to develop improved detector response functions for the Euratom unattended data acquisition and analysis system for used fuel assembly safeguards.



Spent fuel assembly calorimeter at the Swedish CLAB facility



Fork detector measurements during CASTOR cask loading



# Reactor Technology Activities



Richard Wood participated in an International Atomic Energy Agency Independent Engineering Review of Russian nuclear I&C systems at the Novovoronezh Nuclear Power Plant.



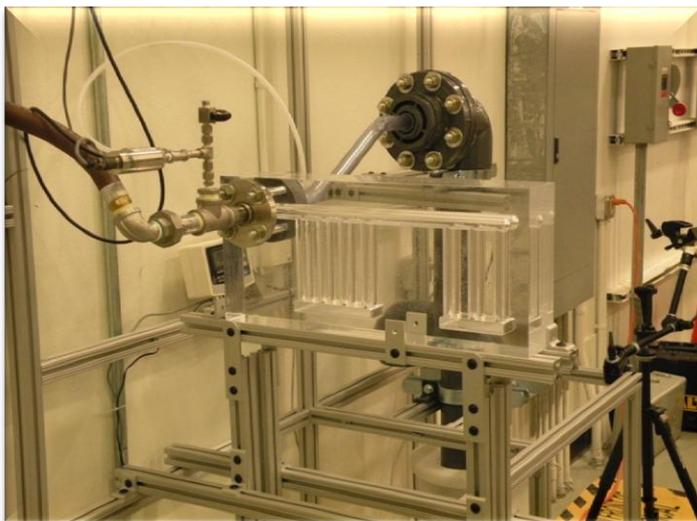
Igor Remec participated with Randy Nanstand and Mikhail Sokolov of MSTD in an independent review of the reactor pressure vessel neutron embrittlement program at the Beznau-1 reactor in Switzerland.



Staff participated in the Department of Energy Office of Nuclear Energy Advanced Reactor Concepts Working Group Meeting at Argonne National Laboratory with presentations on I&C, small modular reactor (SMR) economics analysis, SMR site screening capabilities, and fluoride salt-cooled high-temperature reactor technology developments.

## Cooling system drainage experiments obtain benchmark-quality data for reactor technology

Experiments were completed to obtain benchmark-quality data on air-water flow in geometries representative of specific portions of the cooling channels of the US ITER First Wall/ Blanket Systems. These experiments support investigations of using pressurized air as a means for draining the First Wall/ Blanket cooling system.

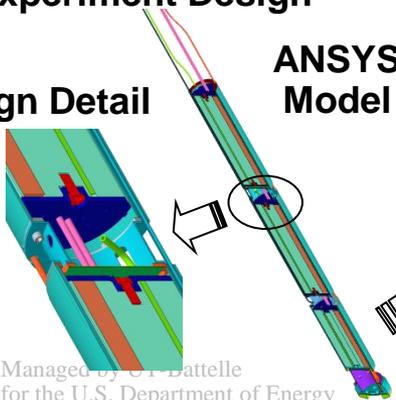


# Materials irradiation – December

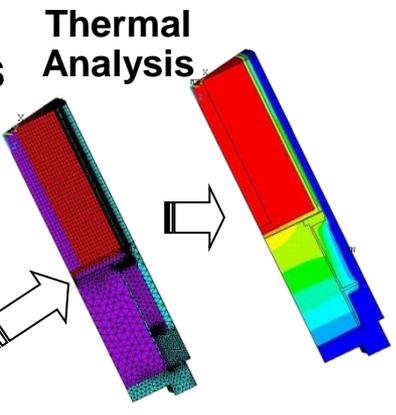
Project	Format	Sponsor	Stage					Notes
			Newly proposed	In Design	In Fabrication	In Reactor	Removed	
Titan Metal	Rabbit	DOE, FE US-Japan				20		Tungsten and steel
Composite Flexure	Rabbit	DOE, FE				8		SiC
Mini-Composite	Rabbit	DOE, FE			4	3Q 2013		SiC
Round-bar Tensile	Rabbit	DOE, FE		4+		2013		Steel
Hydrided Clad	Target	DOE, NE			2	2	2	Zircaloy
Ibiden	Rabbit	WFO, Ibiden				26 (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				9		Single pellet
Inconel springs	Rabbit	AECL		~40		2013		Inconel
Graphite Creep	Rabbit	EDF		5		4Q 2013		Irr. Graphite
SHINE	Rabbit	DOE		TBD				Mo-99
Exotic Ceramic	Rabbit	DOE, FE		10		2013		TiSiC Ceramic
SiC Joining tests	Rabbit	DOE, FE		21		2013		SiC

## Experiment Design

### Design Detail



### ANSYS Model



### Thermal Analysis

## Experiment Fabrication

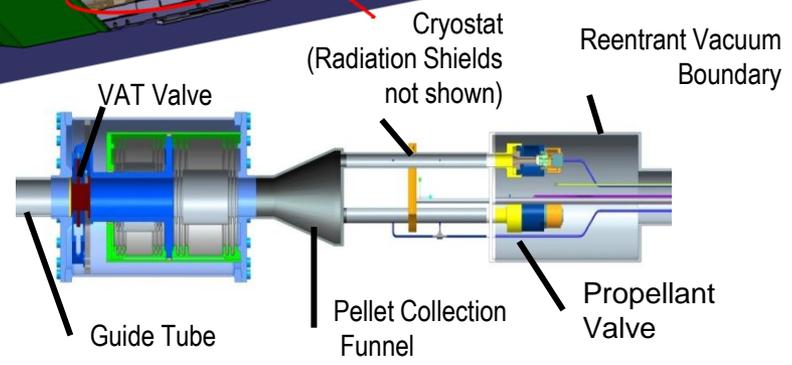
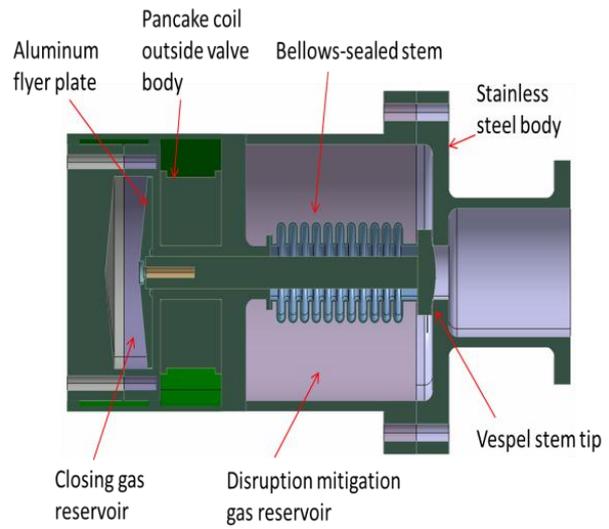
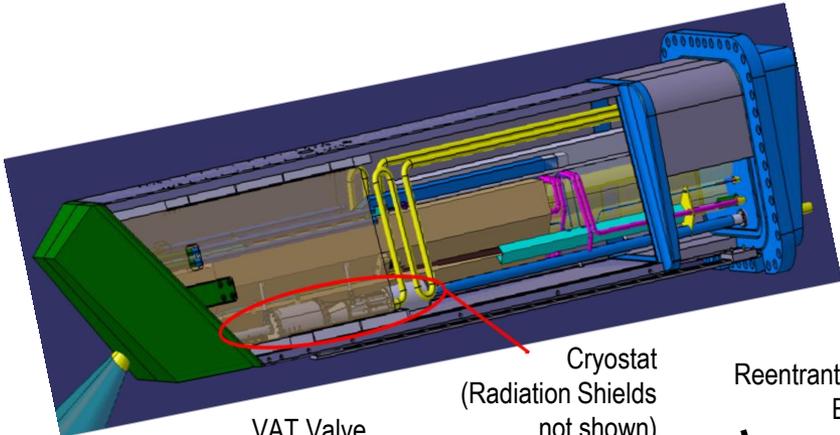
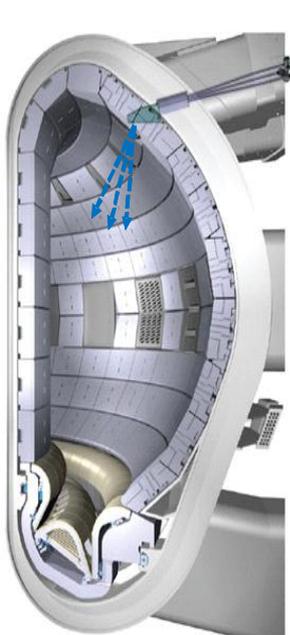


## Irradiation



# Disruption mitigation system for ITER

ORNL designs for ITER disruption mitigation were proposed at a conceptual design review



## Hot Cell Availability

## Facility Upgrades and Maintenance Activities

100.0% Bldg 7920

98.6% Bldg 7930

99.0% Bldg 3525

100.0% Bldg 3025E

### 7920

- Programmed maintenance operations.
- Continued with J113A Recirculating Cooling Water Pump / Motor Replacement
- Completed installation of Ethernet Cables for ICAM Remote Monitoring Capability
- Programmed Maintenance Operations

### 7930

- Programmed maintenance operations.

### 3525

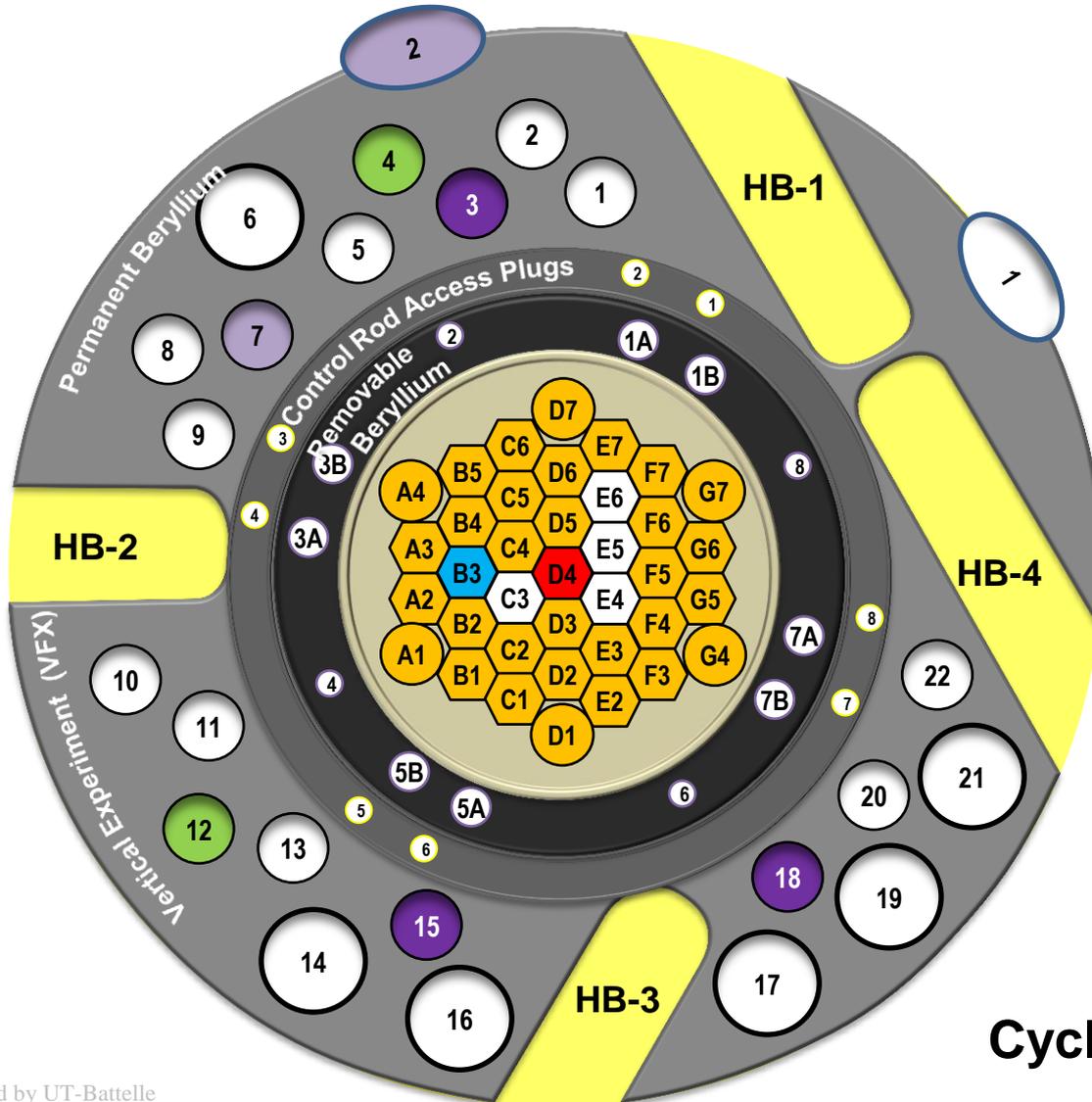
- Programmed maintenance operations
  - Completed final performance and acceptance testing for standby diesel generator
- 
- Completed changeout of System K-14 Building exhaust HEPA Filters
- 

### 3025E

- Programmed maintenance operations
- Monthly fire protection inspection completed
- Trouble shooting Cell 2 INSTRON turbo pump
- Replaced roughing pump supporting INSTRON Test frame vacuum system
- Troubleshooting of CAA crane remote control completed

# Materials irradiations at HFIR remain near record levels in cycle 445 during December

December 2012						
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 ON						



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

Cycle 445 summary

# The number of HFIR Cycle 445 irradiations being driven by materials research and Pu-238 research

## Materials and Fuels Experiments

- Silicon Carbide
- V, Mo, & Cu alloys
- Zircaloy
- UO<sub>2</sub> Fuels
- UCN Fuels
- Graphite
- Steels

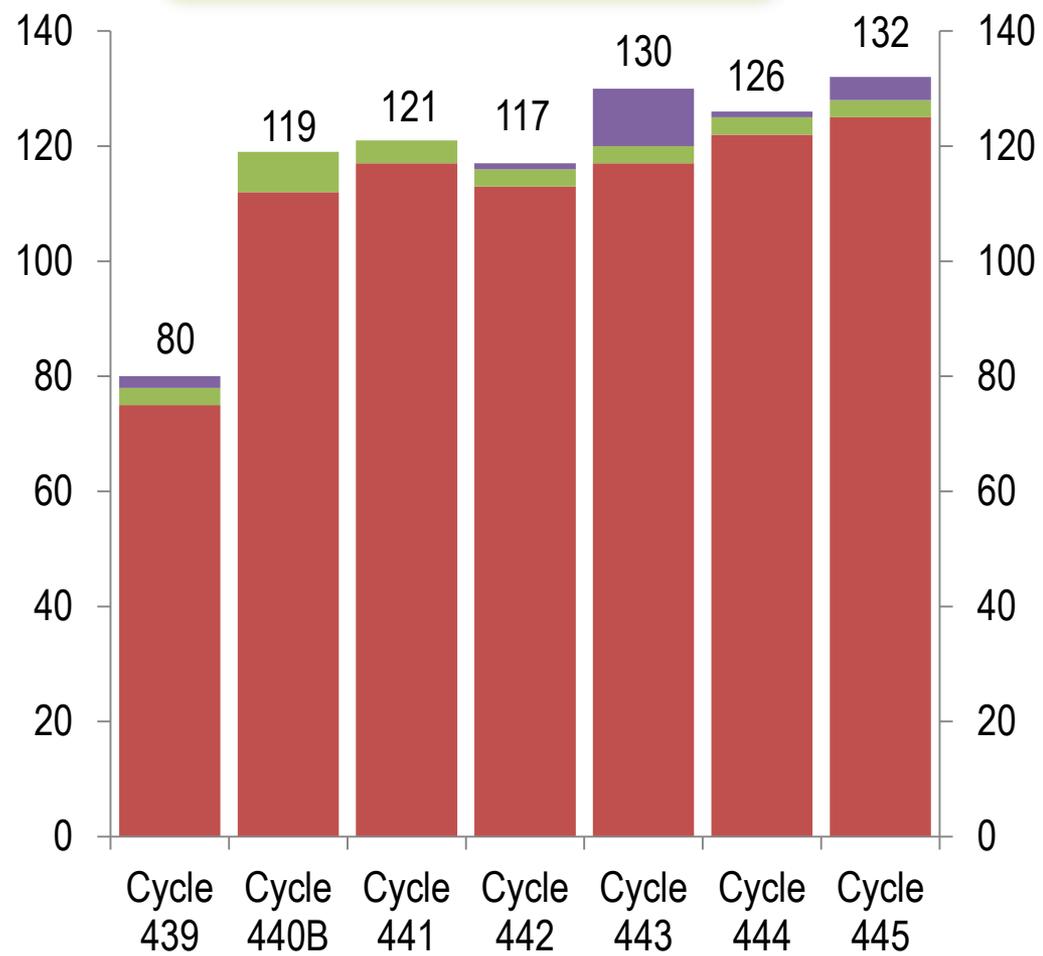
## Commercial Isotope Production Capsules

- Selenium (Se-75) - production

## Isotopes for Research

- Pu-238 Tensile specimen samples
- Pneumatic Tube irradiations

132 total irradiations for Cycle 445



# Significant number of NAA irradiations at HFIR during Cycle 445

## NAA irradiations during Cycle 445 include

- 72 IAEA Pre-inspection checks
- 74 Trace element analysis for Ionomics project to determine how trees will behave during climate change
- 12 Flux monitors both shielded and unshielded at 10% and 100% power
- 34 Trace elements in hair
- 4 Plant spores for Mutagenics Project to determine how moderate neutron doses affect the germination of these organisms
- 2 Thorium targets for investigation of the burnup and yield of Protactinium-233
- 1 Diamond detectors for CERN experiments on the LHC
- 1 Graduate student research at Virginia Tech on radiation effects on graphene and carbon nanotubes
- 1 Enriched Samarium-102 for tracer production of Samarium-103 for separations research from Eu

**Total 201**

