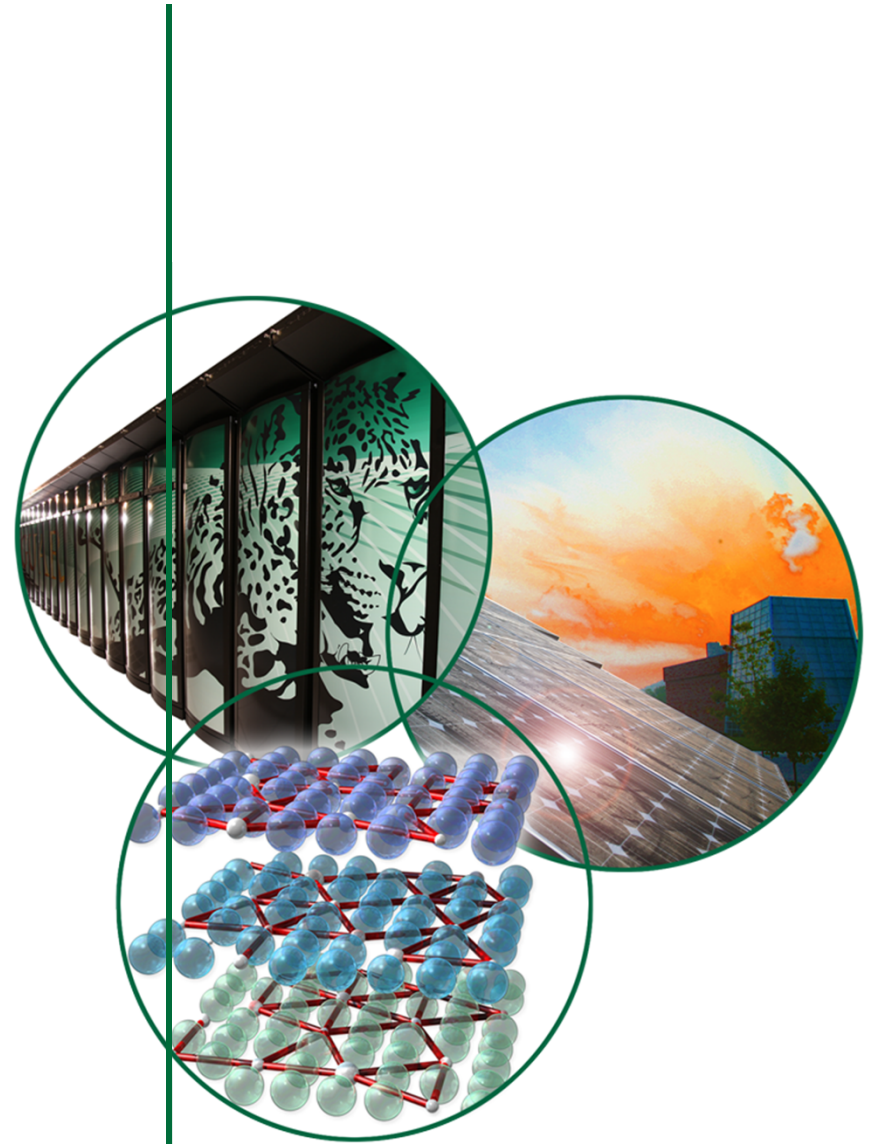


NSED Monthly Report

March 2012

Nuclear Science & Engineering
Directorate

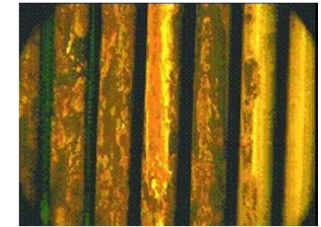


CASL Science Outcome

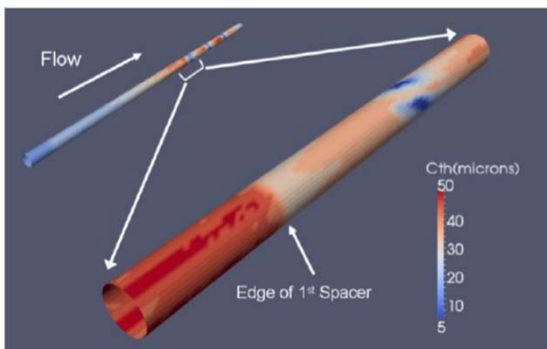
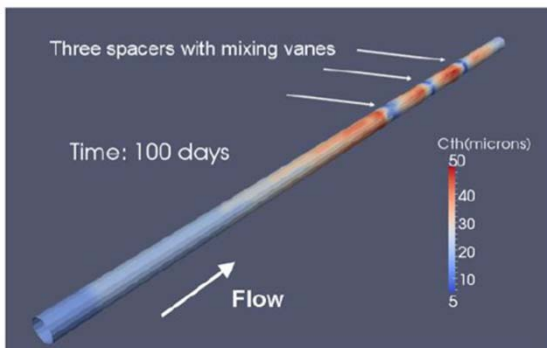
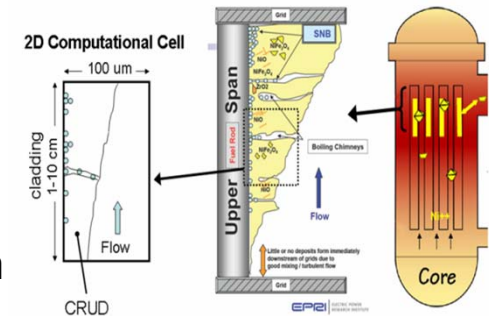
CASL is advancing the modeling and simulation of CRUD buildup in Pressurized Water Reactors (PWR)

A matrixed CASL team has developed an advanced (pin scale), coupled, multi-physics, 3D approach for simulating crud deposition and assessing the crud-induced power shift (CIPS) risk for a single fuel rod with three spacers and integral mixing vanes

- Boron containing crud buildup on PWR fuel pins has a detrimental effect on safety, operating costs, and allowable fuel burn-up



Typical crud loading in a PWR fuel assembly (NEI, 2012)



- Crud thickness and boron uptake within the 3-D crud layer along the entire surface of the pin was computed as a function of time by the new CASL corrosion chemistry & crud capability known as “MAMBA”
- The cladding surface heat flux, crud surface temperature, and the surface turbulent kinetic energy required by MAMBA were computed by a coupled neutronics and thermal-hydraulic calculation
- The resulting 3D boron distribution computed by MAMBA was used by the neutronics capability to assess the effects of the boron layer on the power distribution along the length of the pin (i.e. CIPS risk)
- The simulation produced findings useful to operating PWRs :
 - ✓ Significant azimuthal temperature variations on the cladding surface were observed
 - ✓ Varying crud deposition and erosion rates resulted in streak deposits (observed in operating PWRs)
 - ✓ Cladding “hot spots” were observed at thicker crud deposits which increases crud induced localized corrosion

CASL Science Outcome

Reactor Core Depletion of Watts Bar with Advanced M&S Tools

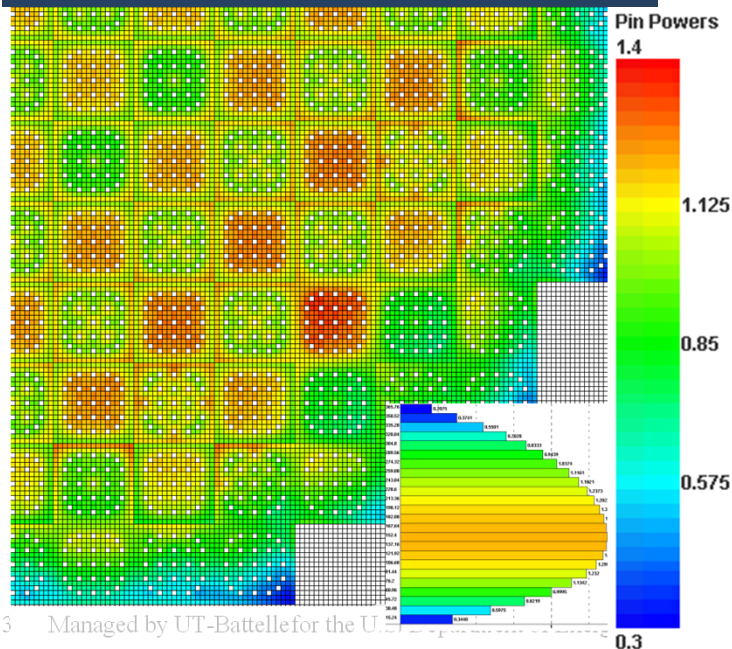


Objectives

- Demonstrate useable and accurate simulation of an operating nuclear power plant with high-fidelity R&D capabilities
- Provide analysis capability on a spatial scale never before available to reactor designers and operators
- Leverage leadership class computers to solve extremely large problems challenging the U.S. nuclear power industry
- Software validation against measured reactor data



Radial and Axial Power Distribution



Achievements – March 31, 2012

- Full reactor particle transport neutronics for 24 radial regions within each fuel rod in 47 energy groups
- Full reactor rod-by-rod thermal hydraulic conditions
- Over 7 million independent regions for power prediction and isotopic depletion
- Accurate prediction of initial criticality and excess reactivity throughout the entire first fuel cycle
- Explicit calculation of 3D fuel rod power peaking factors rather than reconstruction from 2D methods

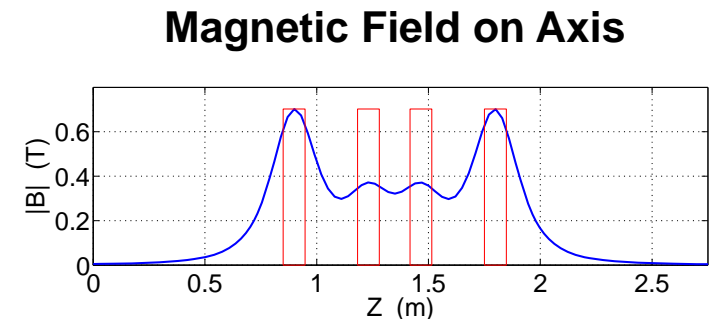
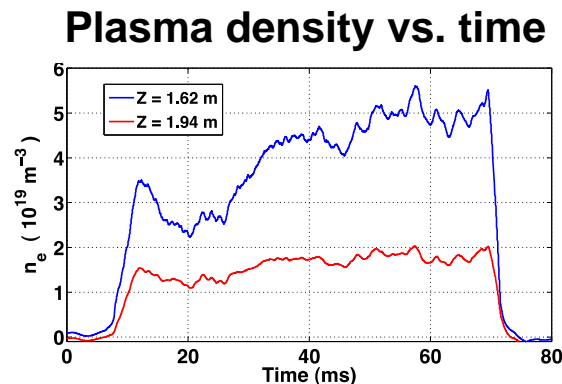
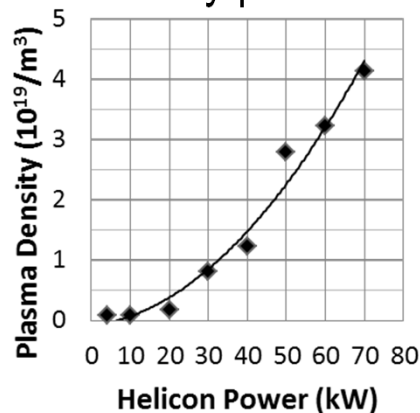
Fusion Energy Science Outcome

The LDRD Helicon wave experiment has fulfilled its mission

Plasma Materials Test Station (PMTS) Development

Produced plasma densities in the range needed for the PMTS high intensity plasma source

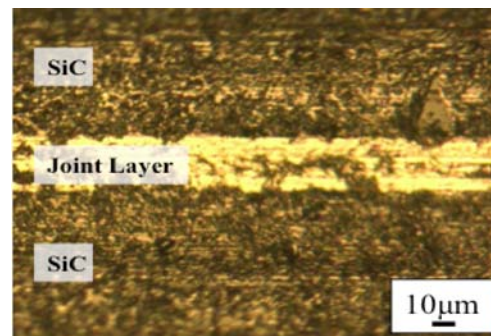
- A maximum plasma density of $4 \times 10^{19} \text{ m}^{-3}$ was produced using helium with a peak magnetic field strength $|B| > 0.7 \text{ T}$ (the highest achievable with present power supplies) at a measured input power of 70 kW
- Plasma density measured at the helicon exit was nearly $2 \times 10^{19} \text{ m}^{-3}$
- This operation represents, to our knowledge, the highest magnetic field achieved in a helicon plasma generator operating with light ions (H, D, or He)
- Similar densities have also been achieved with deuterium plasmas, but at a somewhat lower $|B|$ up to 0.4 T
- This helicon will supply the plasma for the PhIX (Physics Integration eXperiment) high intensity plasma source; the next step in PMTS development



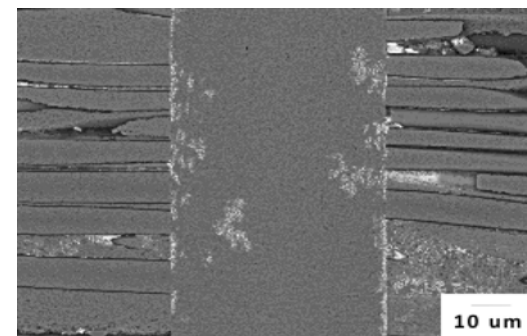
Fusion Energy Science Outcome

First Demonstration of Irradiation-Stable SiC Joining

- A collaboration of ORNL, Kyoto, PNNL, and Politecnico di Torino carried out a campaign to develop testing techniques, candidate materials, and proof-of-principle irradiations for joining silicon carbide
 - A number of joining methods were selected for development using materials that included various NITE based ceramic slurries and tapes, titanium enhanced metallic bonding, and glass ceramics.
 - Samples were irradiated in the High Flux Isotope Reactor at 500 and 800°C to ~4 dpa
 - The torsional shear strengths of all materials and joints studied were not affected by irradiation at 500°C



**Ti diffusion bonding
of CVD Si**



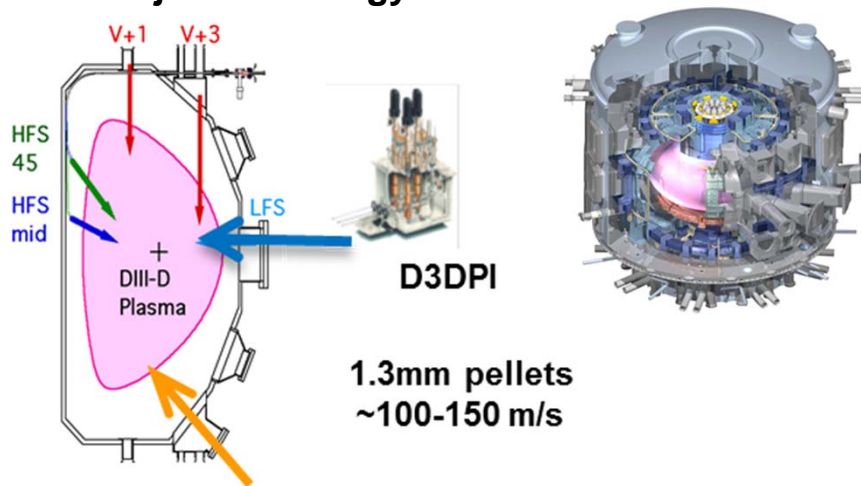
**NITE joining of
SiC/SiC composite**

Fusion Energy Science Outcome

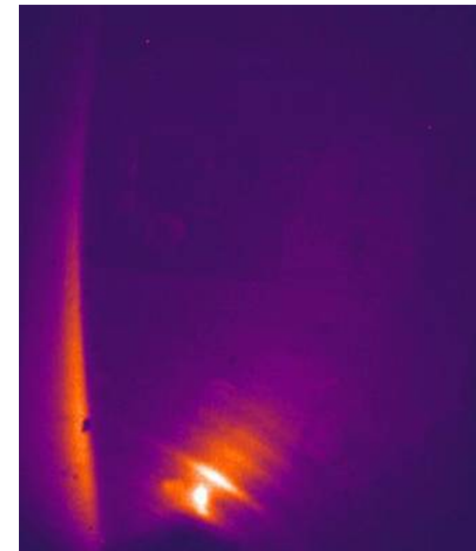
ORNL technique demonstrated to mitigate the effects of Edge Localized Mode (ELM) transients in ITER conditions

A DIII-D experiment demonstrated this pellet ELM pacing technique at 60 Hz with a **10x increase in natural ELM frequency**

- Reduced potential for damage to divertor plasma facing materials
- Reduced ELM Energy loss by 10x
- Minimal change in plasma confinement
- No density increase
- Viable ELM mitigation technique for ITER - solves a major technology hurdle



Fast Camera Images of Pellets Triggering ELMs Show Individual Filaments Being Perturbed



Next step – increase the pellet rate up to ~75 Hz to achieve ~15x increase in natural ELM frequency (closer to ITER needs)

- Smaller pellets to investigate minimum size for ELM triggering
- New IR periscope for improved divertor coverage
- Improved pellet mass diagnostics

Awards & Recognition



AMERICAN NUCLEAR SOCIETY

Lance Snead has been selected to receive the 2012 Mishima Award by the Honors and Awards Committee of the American Nuclear Society. The award recognizes outstanding contributions in research and development work on nuclear fuels and materials. Qualification is based on meritorious scientific and engineering achievements that have important implications to the science and technologies of nuclear fuels and materials development.



High level visits and events in NSED

Alice Caponiti of DOE visited on the 28th and 29th of this month to discuss Pu238. She was hosted by Tim Powers of the Nonreactor Nuclear Facilities Division and Bob Wham of Fuel Cycle and Isotopes Division. Alice met with Jeff Binder while she was here and she and her group toured REDC, HFIR and 3525.

On March 13, **John Marra, Bill Bates, Mike Chandler and Bob Pierce** from Savannah River National Laboratory were here hosted by Jeff Binder. They visited in order to explore possible areas of collaboration between Savannah River and ORNL.

Battelle corporate representatives **Paul Doucette and Mary Toler** were here from Washington, D.C. on March 5. This visit was hosted by Thom Mason and Jeff Binder met with them for NSED.

While in Washington, D.C., on March 12, Jeff Binder met with **Pete Lyons** to discuss Used Fuel Disposition.

Domestic Nuclear Detection Office Chief Scientist, Tom Albert, visited Oak Ridge National Laboratory and the Consortium for Advanced Simulation of Light Water Reactors on Wednesday, March 7. Dr. Albert received briefings on how teams in the Reactor and Nuclear Systems Division (RNSD) are developing and applying our signature computational methods and capabilities.

New DOE Sponsor **Pete Hanlon** visited ORNL on March 8 and met with Jeff Binder as well as GSD senior management and key staff. He was hosted by Bruce Bevard of the Reactors and Nuclear Systems Division.

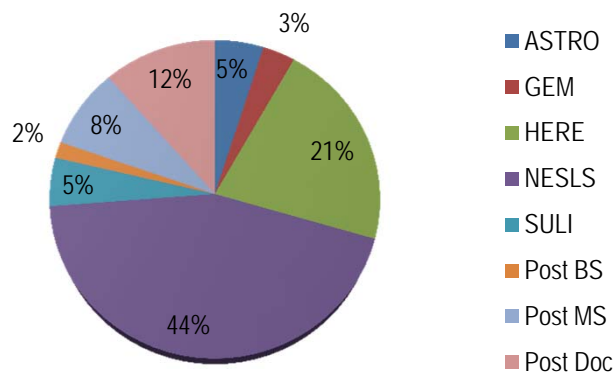
NSED education outreach committee

• Preparation for summer interns is in progress

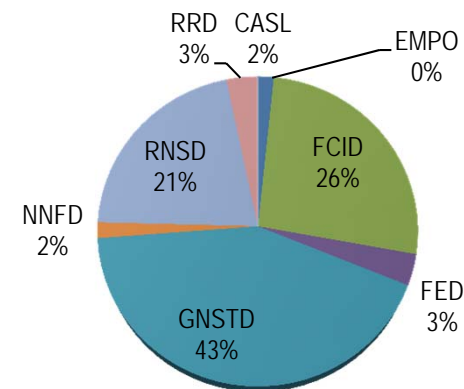
- Facility tours
- Seminar series
- Orientation

Student Program	Applications	Offers as of 3/30/12
ASTRO	69	3
GEM	24	2
HERE (UG+Grad)	524	13
NESLS	269	27
SULI	300	3

Intern Offers by Program



Intern Offers by Organization



NSED educational outreach: 2012 Uranium Bowl competition hosted by Governor's Chair Professor Howard Hall

The 2012 Uranium Bowl competition was conducted at the UT-Knoxville Student Center on March 6

- **More than 40 students from the UTK and North Carolina State University participated**
- **The competition involved a table top simulation exercise to blend the strengths of a physical protection system (a vital component of the nuclear safeguards field) with a highly interactive, real world, big picture application suited for the university environment**
- **The event was coordinated by Dawn Eipeldauer (ORNL) and developed by Dyrk Greenhalgh (ORNL/UTK), Steve Skutnik (ORNL/NCSU), and Michael Shannon (ORNL/GRA)**



NSED education outreach activities

Career Fairs:



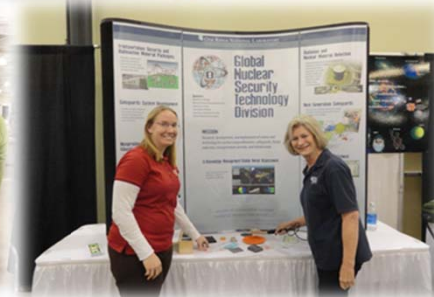
K-5 Science Expo at STEM Academy



Knox County Career Expo at Expo Center



Career Day at Anderson County Career & Technical Ctr



Hub Collocation at ORNL on March 12-15, 2012

- ❖ PoR-5 Planning Meeting for Milestone Development
- ❖ Product Integrator for CRUD Challenge Problem
- ❖ Crank-Nicholson Coupling Review for ANC/VIPRE/BOA and Fine Mesh Planning
- ❖ Validation Data Working Group
- ❖ CASL Data Center Collaboration
- ❖ VERA-CS Planning Meeting for MOC/ESSM/DEPLETION
- ❖ VERA-CS Planning Meeting for DENOVO/XSPROC/COBRA
- ❖ VERA Input and DAKOTA
- ❖ Reorganize Stories and Tasks in Epic 2428

❖ VOCC Tours 13 Tours for March 2012

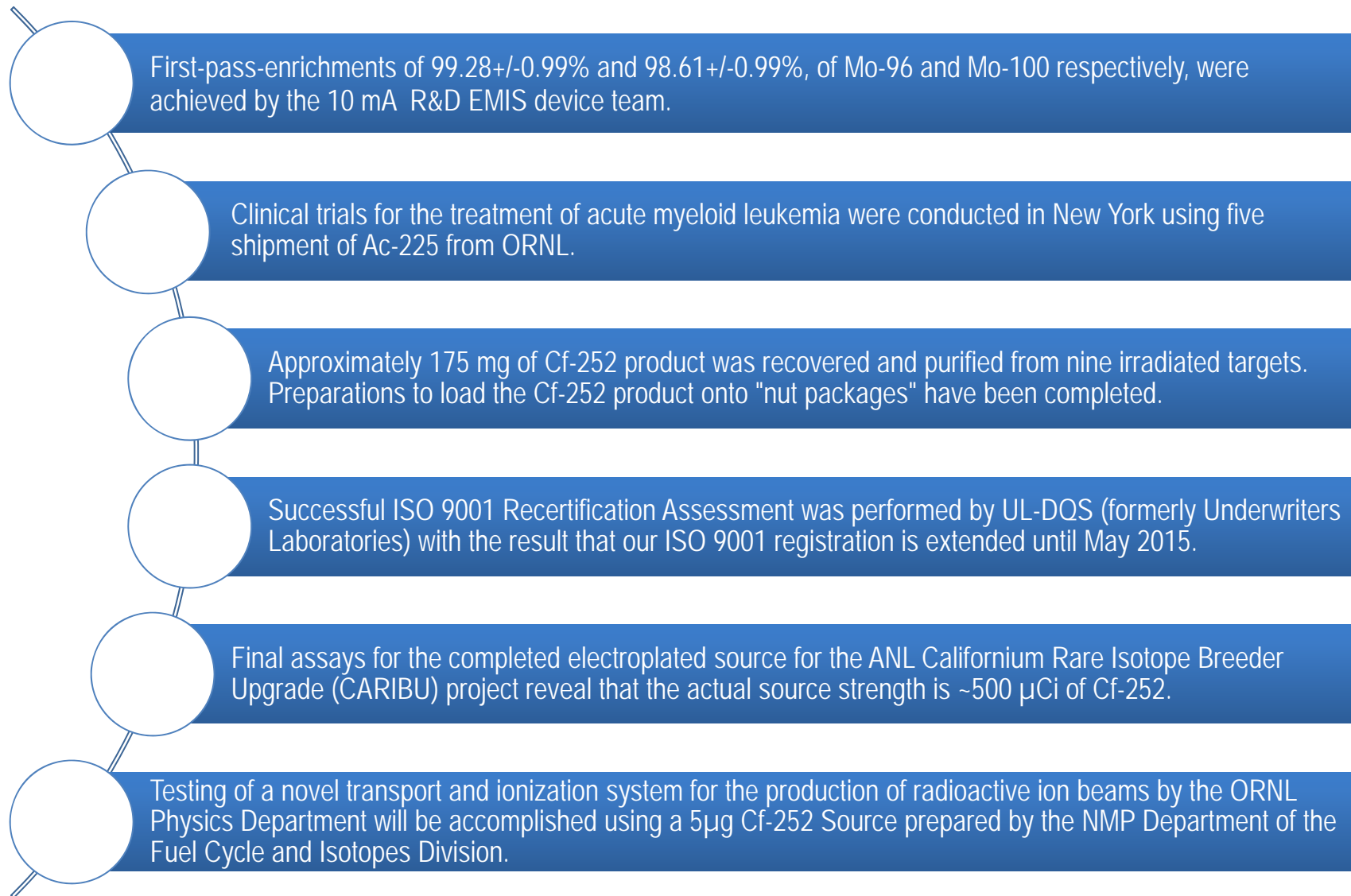
- ❖ Dr. Alvin Trivelpiece
- ❖ Korean Atomic Energy Research Institute
- ❖ NNSA Cyber
- ❖ Peter Hanlon, Assistant Deputy Administrator, NA26

❖ Meetings

- ❖ Industry Council Meeting: March 7-8, Raleigh, NC

- ❖ RTM.PRT.P4.02 - Demonstrate 3D full-core pin-homogenized transport with Watts Bars 1
- ❖ AMA.RX.P4.01 - Complete development of lattice model for the CASL physical reactor
- ❖ CASL.P4.02 - Conduct a CRUD investigation on representative clad surface regions within 3D subassembly using baseline VERA; compare results to higher resolution analysis using initial advanced and advanced VERA. Base analysis on relevant reactor environment and assess resulting CRUD Induced Power Shift (CIPS) risk
- ❖ VUQ.P4.01 - Validation data plan for CRUD Induced Power Shift (CIPS)
- ❖ THM.P4.01 - Drekar delivered to Virtual Reactor Integration (VRI)
- ❖ RTM.SUP.P4.01 - Deliver ENDF/B-VII cross-section library
- ❖ NFA.QA.P4.01 - CASL Quality Assurance Plan
- ❖ NFA.SLT.P4.01 - CASL Strategic Plan

Fuel Cycle and Isotopes Division



Radioisotope production and R&D

- Separation activities to recover Bk-249 and Cf-252 from HFIR irradiated target material at 7920
- Separation of the lanthanides, americium-curium, and transcurium elements using LiCl chromatographic anion exchange

Heavy Element Campaign C-75



- Berkex Extraction Process used to separate Bk-249 from Cf-252 at 7920; Cf-252 contamination was reduced from 1.23 milligrams to 65 nanograms
- ~25 mg Bk-249 product after transfer for final purification

Berkelium Purification



- Recovery of Cm-244 for future HFIR targets

Curium Recovery



- Resumed processing of Mk42 Am-Cm containers (mixer-settler runs)
- Performed calorimetry operations on 20 containers to be processed over next 3-4 months

Americium-Curium Processing



- Transferred remaining Campaign 74 Cf packages consisting of ~62 mg Cf-252 from 7920 to 7930
- Cf wire fabrication continuing

Californium Wire Production



- Completed Se-75 processing

Selenium Processing



- Ac-255 processing continuing
- Next campaign scheduled for week of April 2, 2012

Actinium Production



- Target design and fabrication underway
- Flux monitors installed in HFIR
- Np purification and pellet processing moving forward

Pu-238



Enriched stable isotopes chemical processing



A 99.32% Ag-109 research sample (valued at \$382K) was processed for return to the Stable Isotope Sales Inventory following analytical verification

A 92.70% Mo-97 research sample (valued at \$546K) was processed for return to the Stable Isotope Sales Inventory following analytical verification

A 69.02% Sr-84 research sample (valued at \$430K) was processed for return to the Stable Isotope Sales Inventory following analytical verification

Samples of 14 calutron-enriched isotopes from the Reserve Inventory were provided to the Chemical Sciences Division for the development of certified isotope standards

Support was provided to the electromagnetic isotope separation (EMIS) project by evaluating the quality of graphite used in the collectors and in the recovery of additional enriched Mo isotope samples

Enriched stable isotope fabrication and shipping

Twenty shipments of 40 enriched stable isotopes were made in March

- 71 shipments of 185 enriched stable isotopes has been made in FY12 to date

Eight Work Authorizations involving 10 technical services were completed in March

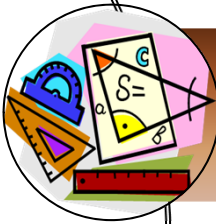
- 68 technical services have been completed in FY12 to date
- Included among these were Dy-161 and Dy-163 targets measuring 2.5 cm x 2.5 cm x 5 mg/cm² for a U.S. university



Global Nuclear Security Technology Division



Stand-off Radiation Detection System and Roadside Tracker highlighted by DHS in their annual document



Presented course to NNSA Policy-oriented personnel that exposed participants to the infrastructure, facilities, technologies and equipment used to develop a nuclear weapons program for proliferation significance



Successful Testing of Cesium Iodide Detectors from All-Russian Research Institute of Automatics



GNSTD personnel led a multi-lab training team for Commodity Identification training for 30 of Kenya's Front-line Border Security Enforcement Officials for counter terrorism operations on the Kenya-Somali border

Fusion Energy Division

- Diego Del-Castillo-Negrete was awarded a Visiting Scientist Scholarship by the European organization Erasmus Mundus
- Don Spong participated in the Energetic Particle Topical Group (ITPA-EP) meeting in Japan
 - This is the primary international group working out ITER physics issues
 - Meeting topics focused on energetic particle and magnetohydrodynamics (MHD) physics in ITER
 - Don presented results from ongoing nonlinear simulation of energetic particle driven Alfvén instabilities
- Nicholas Commaux presented a talk, “ORNL Disruption Mitigation Activity on DIII D” at the Joint US-Japan MHD Workshop and ITPA MHD Stability/Energetic Particle Topical Group meeting held at the National Institute for Fusion Science in Toki, Japan
- Larry Baylor, Stan Milora, Dave Rasmussen, and Nermin Uckan attended a U.S. Disruption Mitigation Workshop, March 12-13, San Diego, California, sponsored by the US Burning Plasma Organization, US Virtual Laboratory for Technology, and the US ITER Project Office
 - The US ITER Project Office has been given the responsibility of providing ITER's Disruption Mitigation System (DMS)
 - This meeting was called to review the DMS definition, refine technology concepts to help meet schedule constraints, and inform the physics community on what is realizable in the ITER environment
- Robert Pearce and Matthias Dremel from the ITER Organization in France visited ORNL to discuss vacuum issues with the US-ITER project office
 - FED is involved in the design and testing of the specialized tritium compatible cryopumps that will be used as part of the roughing pump system

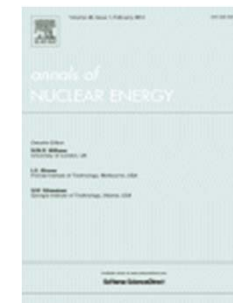


Key Highlights and Activities

- **Planning leadership provided to the Department of Energy, Office of Nuclear Energy (DOE-NE) Used Fuel Disposition Campaign**
 - **Draft Implementation plans prepared and delivered for future utilization of standardized canisters and handling of existing dual purpose cask systems**
 - **\$5.7M project for Integrated Data, Experiments, and Analysis System proposed and accepted by DOE-NE (project start in May)**
- **Hosted DOE-NE Advanced Reactor Concepts Program working meeting**
- **At request of IBM, initiated discussions to support the University of Tennessee on establishing a Center for Advanced Digital Nuclear I&C Systems**
- **Provided software and data to DOE's National Atmospheric Release Advisory Center**
 - **Improved model for source terms from initial stabilized weapons detonation cloud**
- **Provided NRC with decay heat and radionuclide data for their evaluation of consequences from a severe accident in a spent fuel pool**

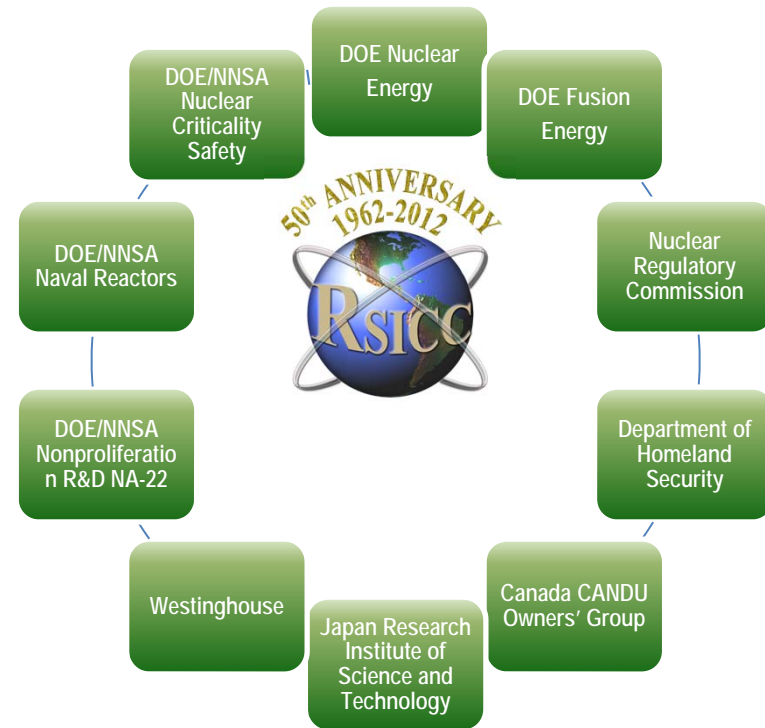
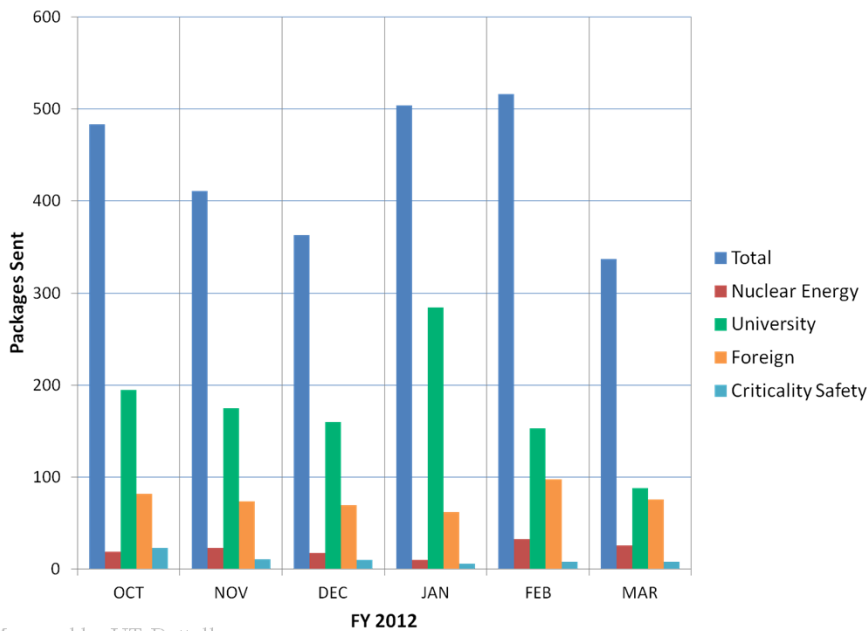
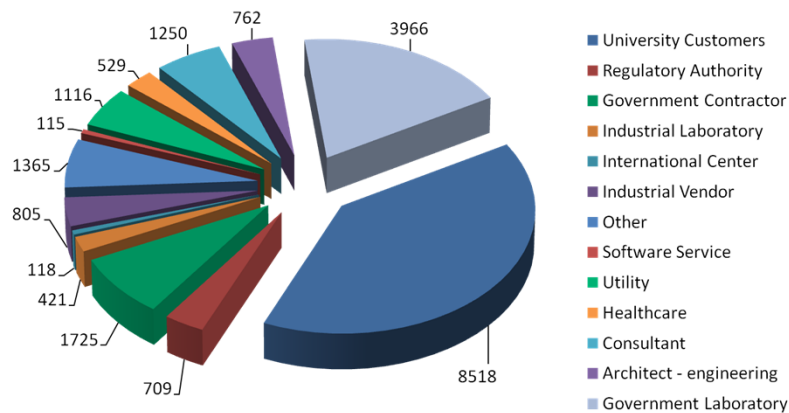
PUBLICATION

G. Ilas, I. C. Gauld, and G. Radulescu, "Validation of new depletion capabilities and ENDF/B-VII data libraries in SCALE," Annals of Nuclear Energy, vol. 46, p.43-55 (2012).



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

RSICC Customer Base



- Software and data packages distributed FY 2012: 2,614
- 7 package updates and revisions March 2012

NNFD FY 2012 cumulative facility metrics

Hot Cell Availability

96.9% REDC 7920

95.0% REDC 7930

85.0% Irradiated Fuels Examination Laboratory (3525)

90.0% Irradiated Material Examination and Testing Laboratory (3025E)

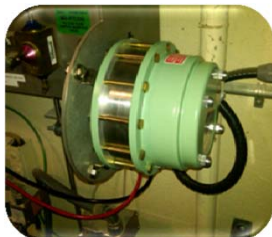
Facility Upgrades and Maintenance Activities

7920

- Lab 211 glove box installation for Np-237 Pellet Pressing Operations



- Lab 108 glove box installation for Analytical Science Group
- New COG Flow Interlock Switch installation



7930

- Review of Cell G PaR System replacement (failure could impact Cf source production)
- Programmed maintenance operations

3525

- CCCTF SEM/Furnace exchange



- K-15 housing replaced



- 2.5 Level crane replaced



3025E

- Cell 6 door hydraulic system repairs



- Steam line upgrade project

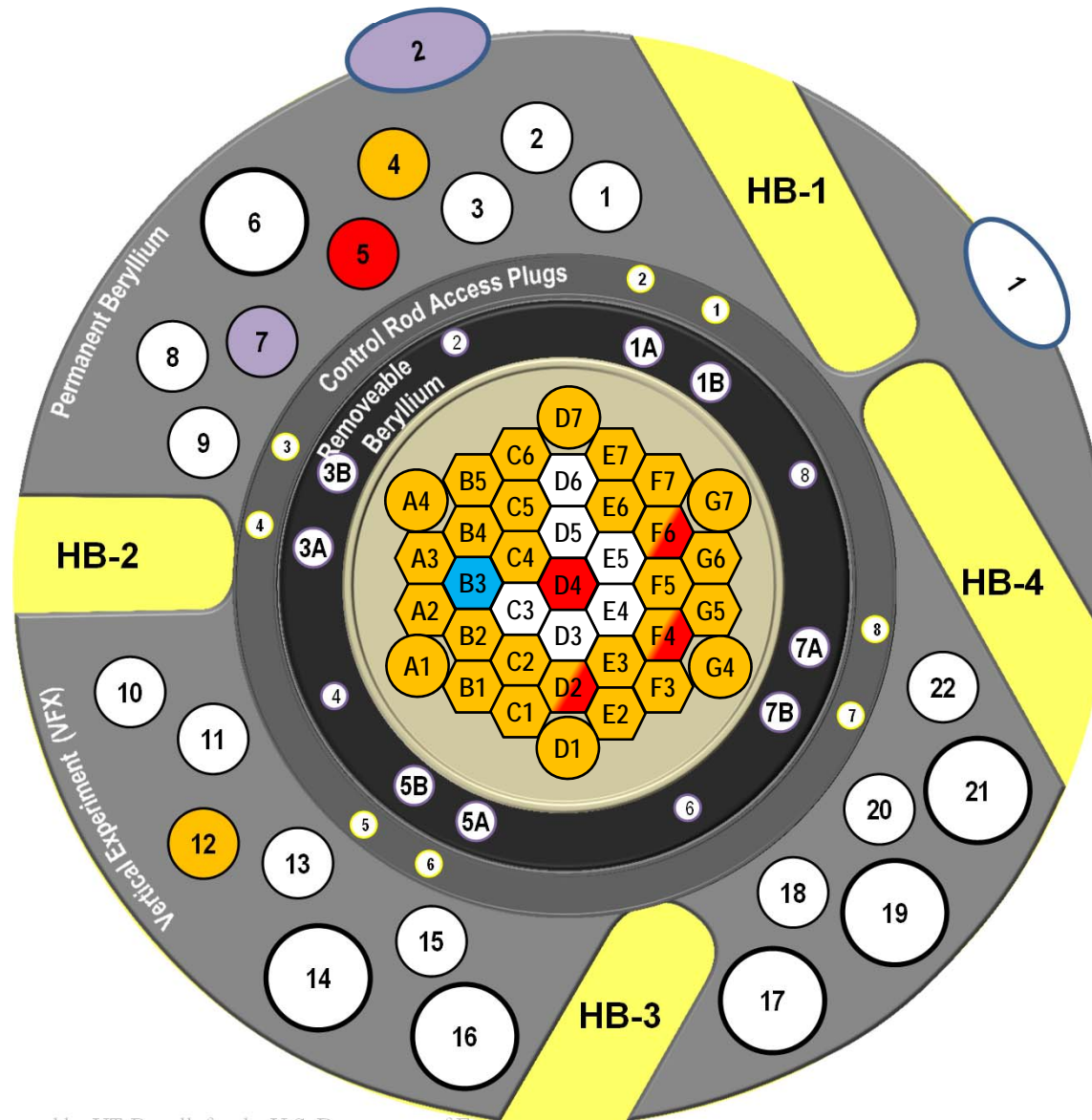


- Carrier magnet repair

HFIR cycle 440 resumed as cycle 440B on March 26 and continues into April

March 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

Cycle 440B began
3/26/12



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

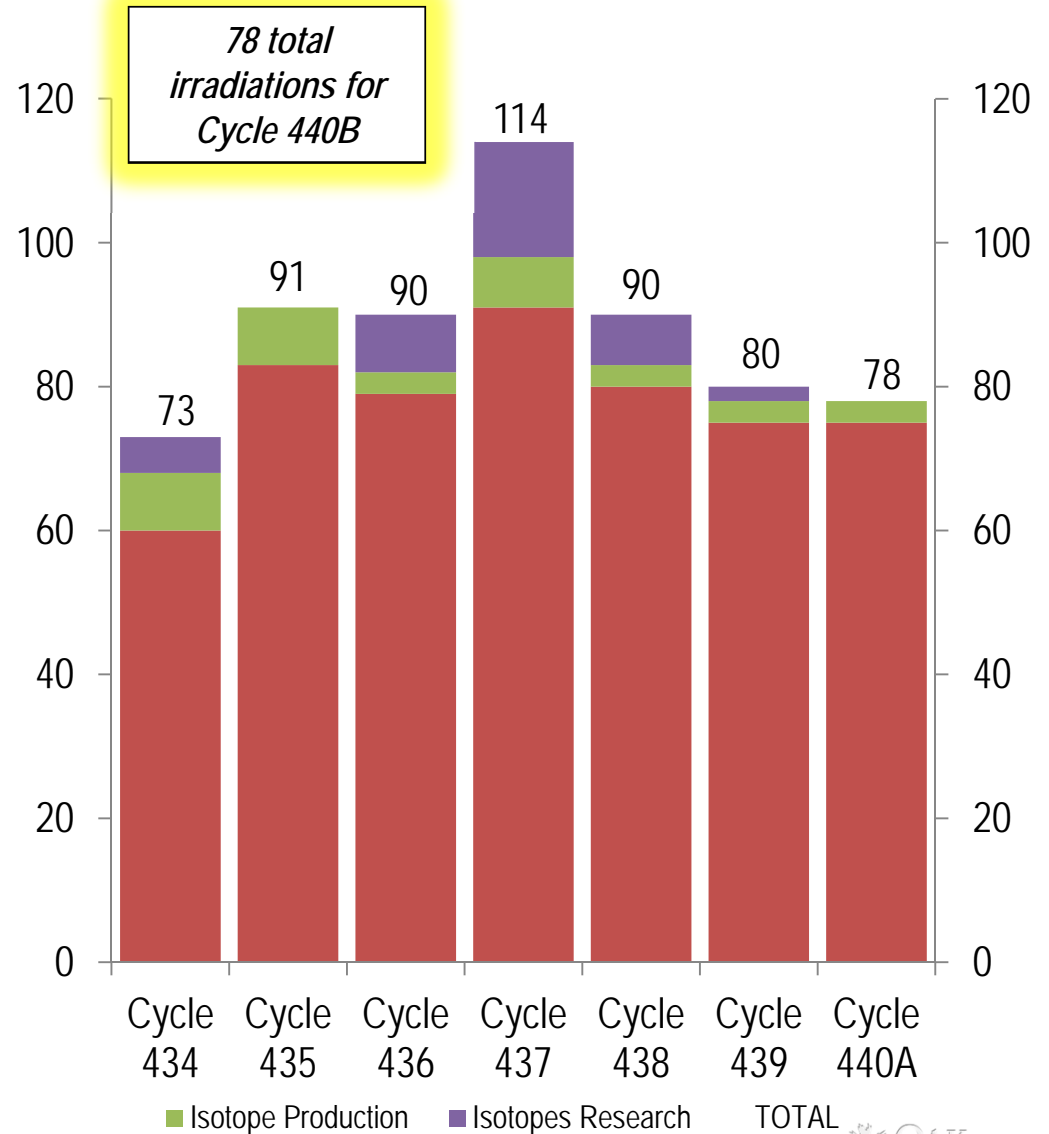
HFIR materials and isotope irradiation capsules loaded for cycle 440A remain for cycle 440B

75 Materials and Fuels Experiments

• Silicon Carbide	• Graphite
• V, Mo, & Cu alloys	• Uranium
• Zircaloy	• Steels
• UO2 Fuels	• UCN Fuels

3 Commercial Isotope

3 Selenium (Se-75) - production



Environmental Management Program Office

- Beta 3 (9204-3) Project at Y-12

- Completed shipment of all waste from Beta 3 including the >Cat 3 shipment
- Completed and submitted to DOE the D0 HAD categorizing the building as “rad”



- ORNL North-West Quad Soils and Slabs D&D and Remediation

- Completed demolition of 2010, 2011, 2017, and 2018 slabs
- Completed site restoration at 2010 and 2018
- Demolition currently underway at 2009 and 2013 slabs
- Waste shipments to date total 337 loads to EMWMF and 45 loads to the Y-12 landfill



Environmental Management Program Office

- **4500 Area Gaseous Stabilization Project**

- Completed required D&D work at 4507 penthouse
- Loaded out all staged 4507 waste
- Installed vent duct sections into hot cell manipulator ports
- Received bids for 4556 Filter Pit cleanout
- Commenced installation of power distribution panel and power feed to new HEPA ventilation skid



- **Isotopes Area Legacy Material Removal**

- Completed removal of ~50,000lbs of lead from Buildings 3030 and 3031
- 25,000lbs of lead shipped to SNS for reuse, balance staged in shipping containers
- Subcontractor demobilized and D0 PCCR transmitted to DOE



Radioactive waste strategic development

Kathy Carney has been appointed to develop a radioactive waste management strategy that will identify the long range system and infrastructure requirements necessary to support ORNL's future nuclear and operational mission needs.



- **Within the context of this radioactive waste management strategy, a plan for the “Continuity of Transuranic (TRU) Waste Operations” was developed in March to prepare ORNL for the self-performance of TRU waste management as EM completes its legacy TRU mission in Oak Ridge.**
- **The concepts of the plan were successfully presented to the ORNL Site Office on March 27.**