Nuclear Data and Benchmarking Program

Presented by:
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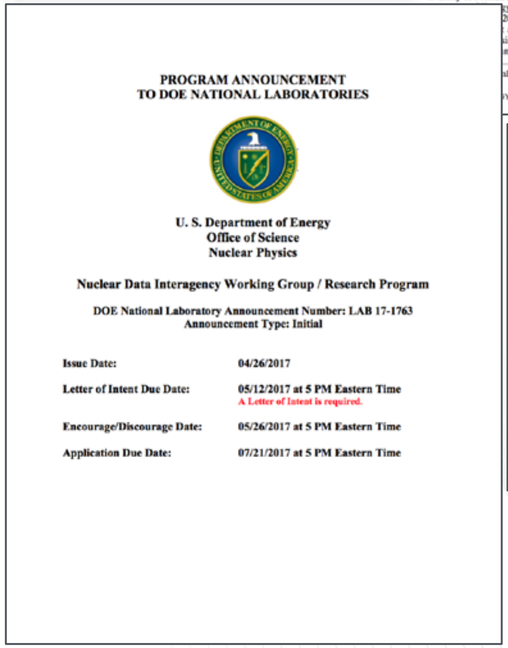
Nuclear Data and Benchmarking Program

Presented to:
SCALE Users' Group Workshop
Oak Ridge National Laboratory
August 28, 2018

Nuclear Data and Benchmarking Program

U.S. DEPARTMENT OF ENERGY | Office of Nuclear Energy

- New Nuclear Energy Enabling Technology (NEET) Crosscutting Program
- Partner with industry, NRC, and other programs to:
  - Identify priority needs for nuclear data and benchmarking
  - Perform new data measurements and evaluations
  - Support integral experiments and handbooks
  - Participate in application benchmark studies

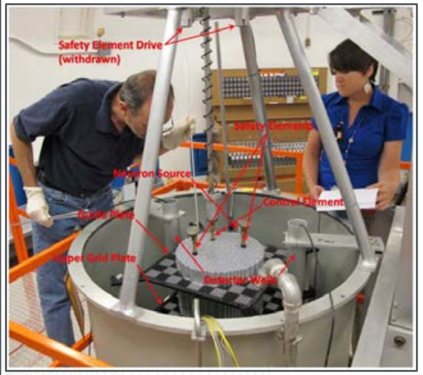

PROGRAM ANNOUNCEMENT
TO DOE NATIONAL LABORATORIES

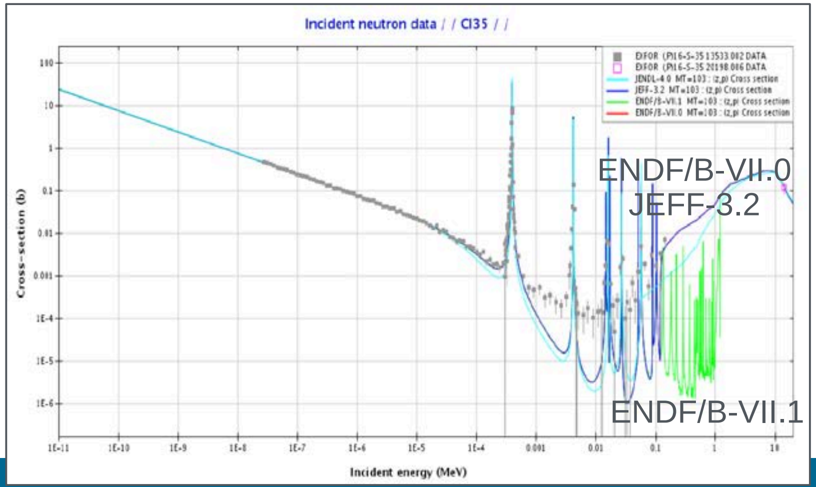
U. S. Department of Energy
Office of Science
Nuclear Physics

Nuclear Data Interagency Working Group / Research Program

DOE National Laboratory Announcement Number: LAB 17-1763
Announcement Type: Initial

Issue Date:	04/26/2017
Letter of Intent Due Date:	05/12/2017 at 5 PM Eastern Time A Letter of Intent is required.
Encourage/Discourage Date:	05/26/2017 at 5 PM Eastern Time
Application Due Date:	07/21/2017 at 5 PM Eastern Time





Abbreviated advanced reactor technology matrix (1/2)

Reactor Type	Companies Red = NRC Priority	Licensing action expected	Fuel / Enrichment	Thermal spectrum	Fast Spectrum	Coolant	Radial core expansion	Flowing Fuel	Fuel Form	Control elements
HPR	Oklo	2019	~20%		✓	Sodium heat pipes	✓		Metallic Castings	External drums
	Westinghouse (eVinci)	2019	19.75%	Thermal/ Epithermal		Sodium heat pipes (dual condenser)			Oxide	External drums
SFR	TerraPower (TWR)		~20%		✓	Sodium	✓		Metallic Rods	Internal rods
	GE PRISM		~20%		✓	Sodium	✓		Metallic Rods	Internal rods
LFR	Westinghouse		15-20%		✓	Lead	✓		Oxide/ Nitride	Internal rods
HTGR	X-energy (Xe-100)	2020s	15.5%	✓		Helium		Pebbles	TRISO	External rods
	Areva (SC-HTGR)		~20%	✓		Helium			TRISO	Internal rods
FHR	Kairos	2020s	~17%	✓		FLiBe		Pebbles	TRISO	External rods

Abbreviated advanced reactor technology matrix (2/2)

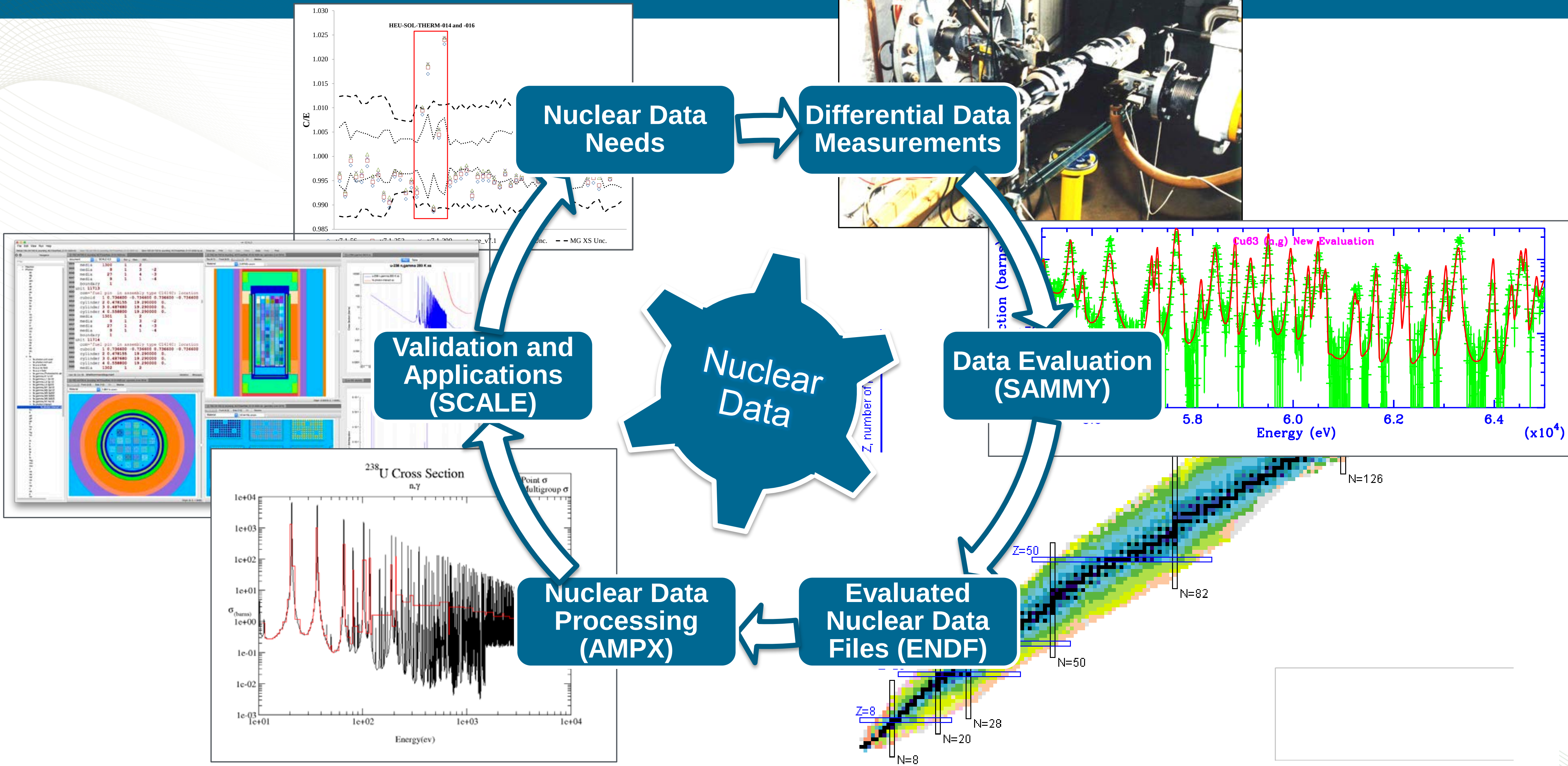
Reactor Type	Companies Red = NRC Priority	Licensing action expected	Fuel / Enrichment	Thermal spectrum	Fast Spectrum	Coolant	Radial core expansion	Flowing Fuel	Fuel Form	Control elements
MSR	Terrestrial Energy (IMSR)	2019	~5%	✓		Proprietary		Salt	Molten Salt	Internal rod
	Transatomic	2020s	~5%	Thermal/ Epithermal		FLiBe		Salt	Molten Salt	Internal ZrH moderating rods
	TerraPower (MCFR)	2020s	~20%		✓	Chloride salt		Salt	Molten Salt	External rods?
	Elysium		~20%		✓	Chloride salt		Salt	Molten Salt	
	FLiBe Energy		Thorium	✓		FLiBe		Salt	Molten Salt	Internal rods

Challenges for the advanced reactor community

- Unlike LWRs, advanced reactors do not have the benefit of decades of operational experience and supporting infrastructure
  - Unique materials and neutron spectra
  - Very high burnup possible
  - High assay LEU fuel may have insufficient integral experiments for validation
  - Nontraditional fuel forms
- General lack of experienced analysts who understand design and safety aspects of these systems

Where do nuclear data come from?

Nuclear Data Lifecycle

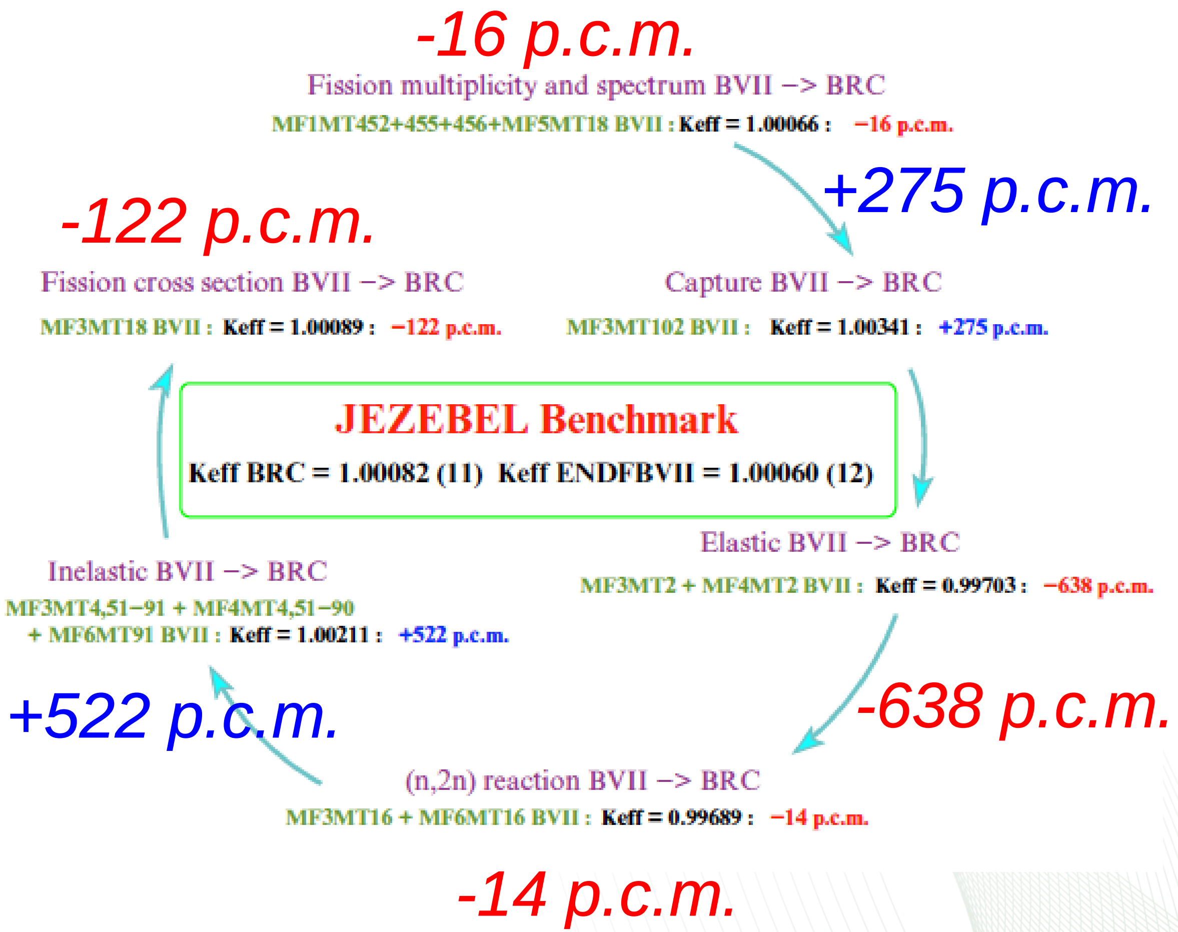


How are these “general purpose” libraries generated?

- A specific program (DOE-SC, NNSA/NCSP, NNSA/NA-22, DOD, international participant) funds an update in a nuclear data evaluation
  - New differential physics experiments
  - Data processing
  - Comparison to and **optimization with applications in their interest**
- National Nuclear Data Center - Cross Section Evaluation Working Group (CSEWG)
  - Updates are exchanged through a beta repository for ENDF and reviewed by a global team
  - Meets twice annually, with participation from IAEA, OECD/NEA, and others to review proposed updates
  - If changes benefit, or do not disrupt, applications of interest to these teams, the new evaluation is approved
- Until now, no official representation for Nuclear Energy applications

Compensating Errors in the Jezebel k_{eff}

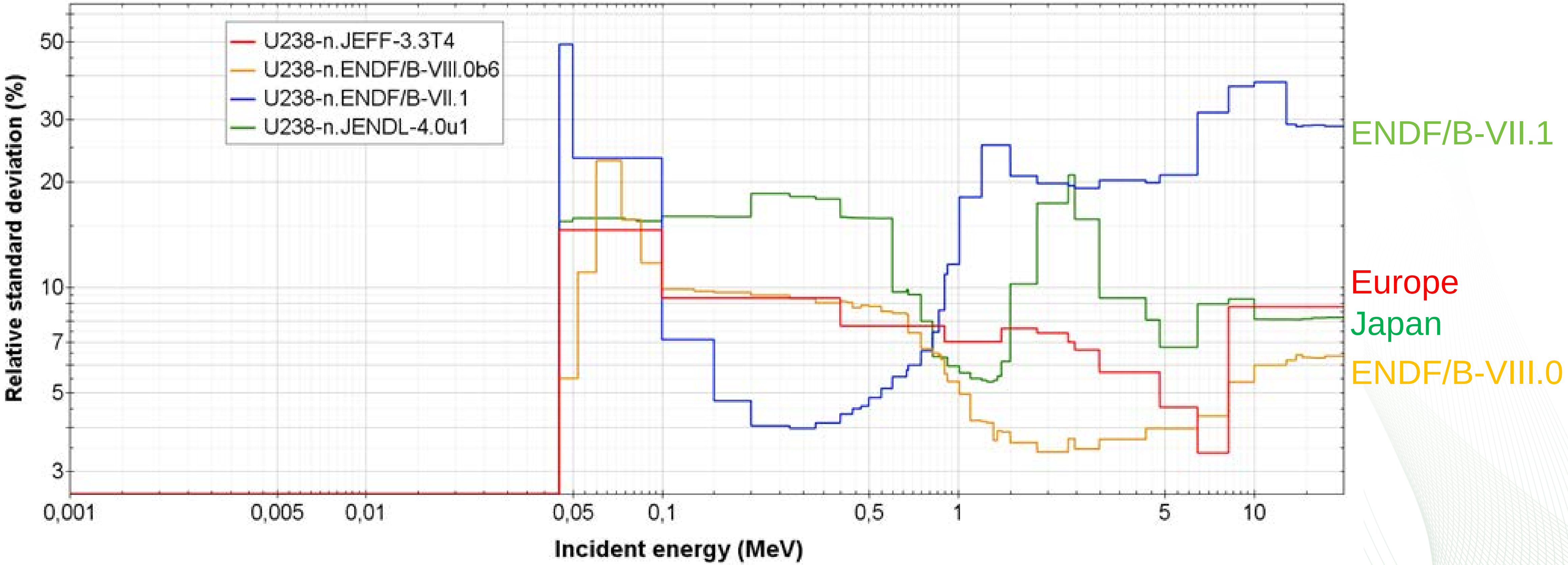
- Eric Bauge* reported on an analysis where components of the Bruyères-le-Châtel (BRC) ^{239}Pu evaluation were replaced with those from ENDF/B-VII.1. At each step in the replacement process, k_{eff} of the Jezebel critical assembly was computed. While both the BRC and ENDF/B-VII.1 give the same k_{eff} for Jezebel, they do so for very different reasons. This replacement study shows how different parts of the evaluation substantially shift the reactivity of Jezebel. We do not know if either evaluation is “correct” but both get the “correct” answer.



*E. Bauge *et al.*, Eur. Phys. J. A (2012) 48: 113

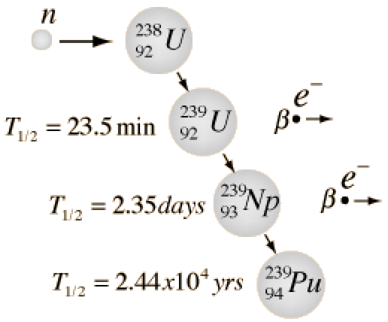
We do not know if either evaluation is “correct” but both get the “correct” answer.

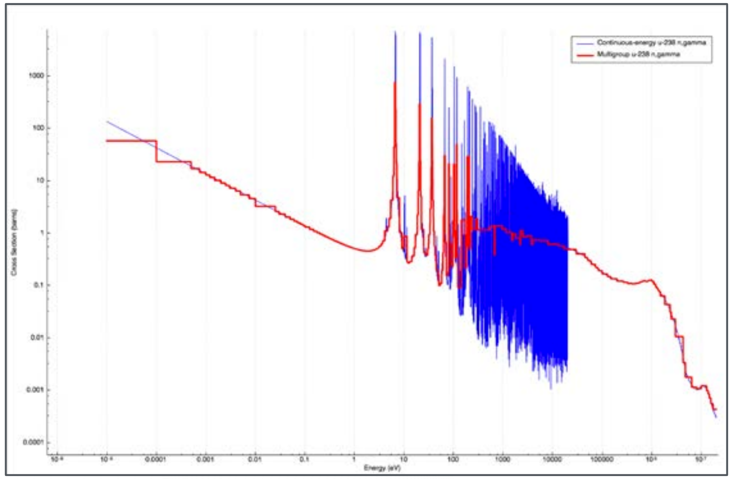
^{238}U inelastic scattering cross section uncertainty differences between international libraries

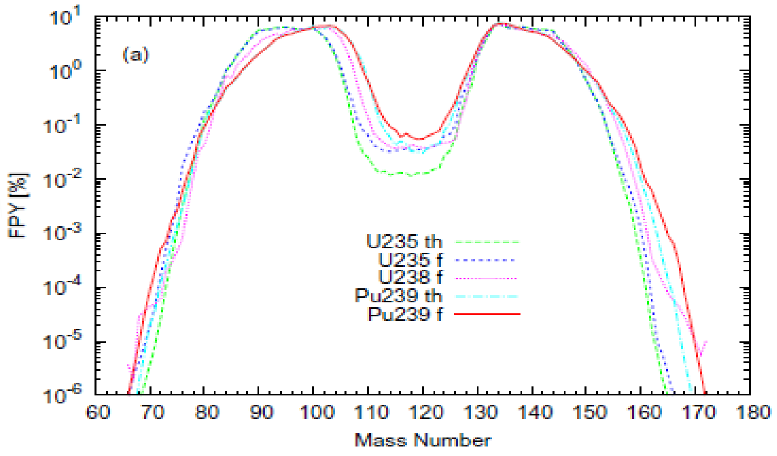


Nuclear data for activation, depletion, and decay

- **Decay data**
  - ENDF/B-VII.1
  - Natural isotopic abundances (NIST database)
  - ICRP 72 inhalation dose coefficients, EPA Report 12 on external exposure
- **Neutron reaction cross section data**
  - JEFF 3.1/A special purpose activation file
  - ENDF/B-VII.0, -VII.1
- **Fission product yields:** ENDF/B-VII.0
- **Photon emission line-energy data**
  - Evaluated Nuclear Structure Data Files (ENSDF)
  - ENDF/B-VII.1
- **Neutron emission libraries**
  - SOURCES 4C code
  - Spontaneous fission decay and delayed neutron data
  - Alpha stopping powers, (α,n) cross sections, excitation levels







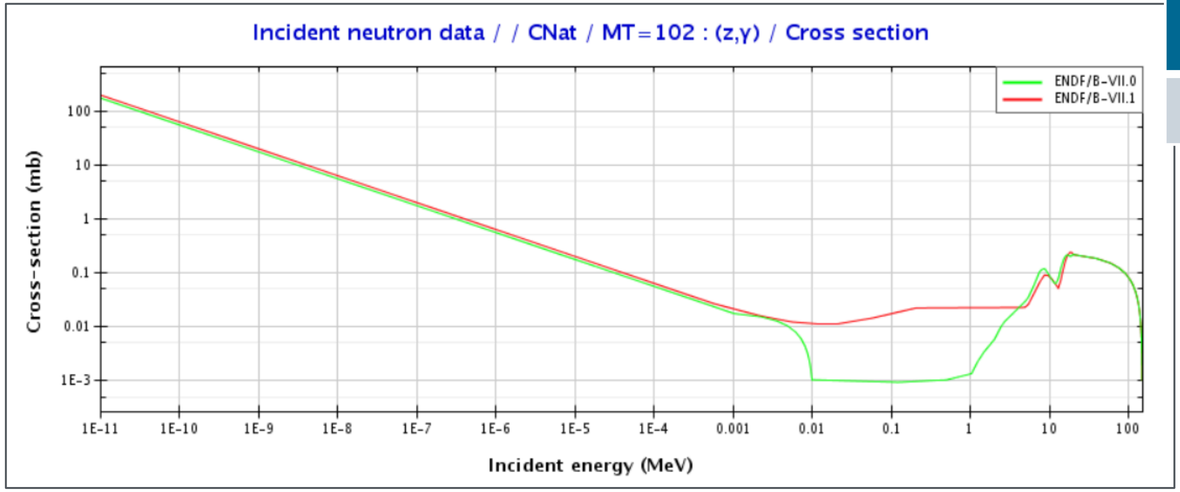
Recent nuclear data developments of interest to the advanced reactor community

Changes in graphite data

ENDF/B-VII.0 (2006) to ENDF/B-VII.1 (2011)

- Capture cross section increased from 3.36 mb to 3.86 mb: ~1,000 pcm

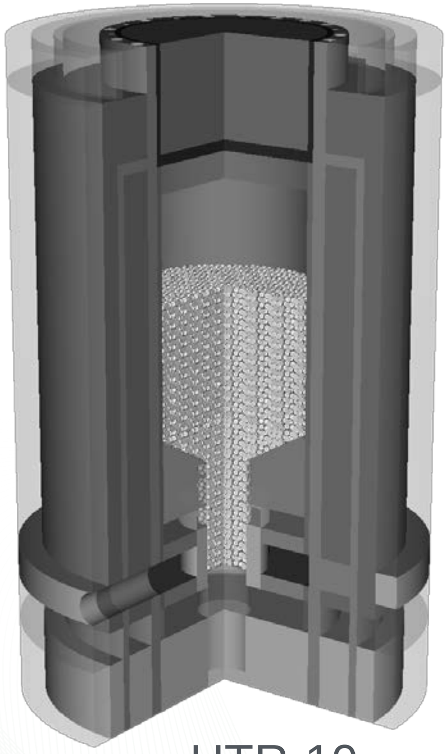
HTTR loading	ENDF-VII.0 C/E	ENDF-VII.1 C/E
Initial criticality	1.0165	1.0011
Full core	1.0097	1.0015



ENDF/B-VIII.0 (2018)

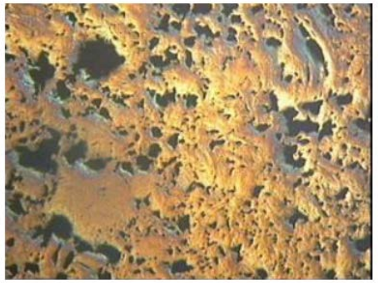
- New evaluations for thermal scatter based on molecular dynamics models from North Carolina State
- Includes data for crystalline and reactor-processed graphite

HTR-10 Configuration	ENDF-VII.1 C/E	ENDF-VIII.0 C/E
First core	1.00267	1.00582



HTR-10 Benchmark

Ideal Graphite
Density = 2.25 g/cm^3



Nuclear Graphite
Density = 1.5 – 1.8 g/cm^3

A. Hawari
NC State

HTR-10 pebble: KENO-VI eigenvalue comparison

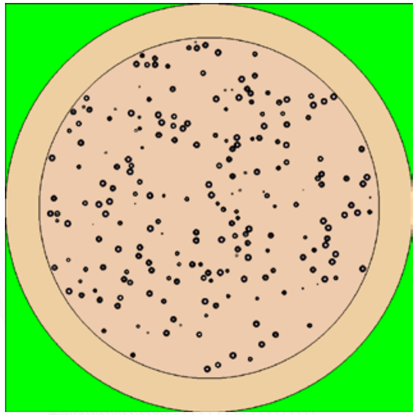
Library	Code	XS lib	k_∞	Δk (pcm)
ENDF/B-VII.1	KENO	CE	1.6770(4)	(ref)
ENDF/B-VIII.0	KENO	CE	1.6722(4)	−438(57)

Note: The 1σ statistical uncertainties are given in parentheses.

Replace individual nuclides in ENDF/B-VII.1 calculation by ENDF/B-VIII.0 data:

Basis: ENDF 7.1	Δk to all ENDF 7.1 (pcm)
But: graphite from ENDF 8.0	**−7**
But: ^{235}U from ENDF 8.0	**−702**
But: ^{238}U from ENDF 8.0	**239**
All ENDF 8.0	**−438**

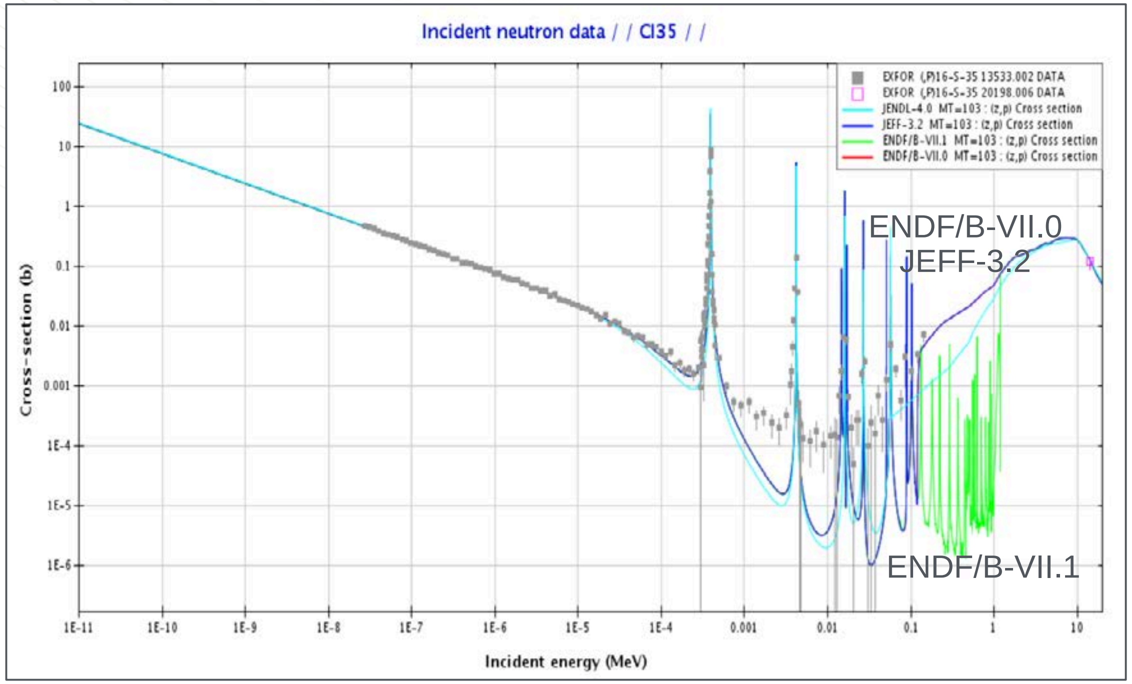
- Differences between ENDF/B-VII.0 and VII.1: carbon capture
- Differences between ENDF/B-VII.1 and VIII.0: ^{235}U and ^{238}U

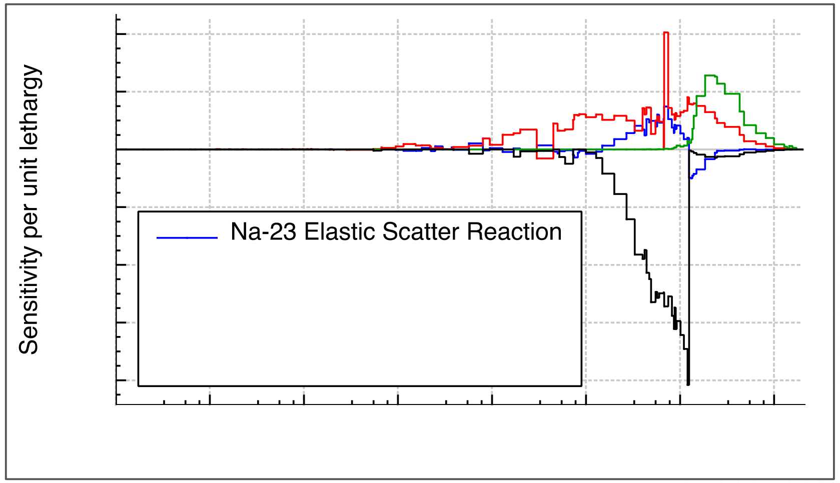


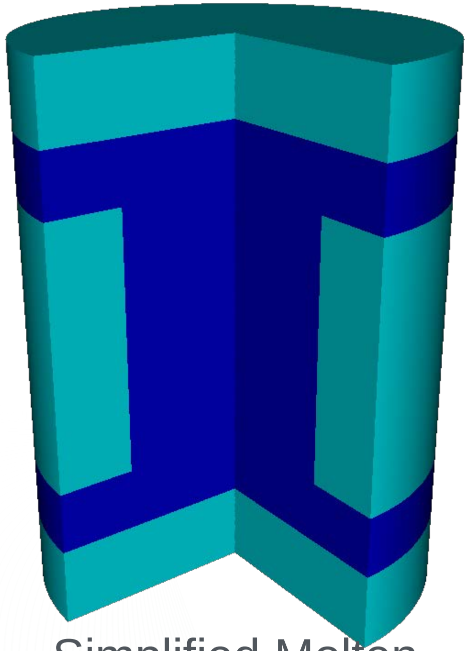
HTR-10 fuel pebble

Changes in ^{35}Cl(n,p) cross section from ENDF/B-VII.0 to VII.1

Data Library	k_{eff}
ENDF/B-VII.0	1.02993 ± 0.00002
ENDF/B-VII.1	1.04924 ± 0.00002







Simplified Molten Chloride Fast Reactor

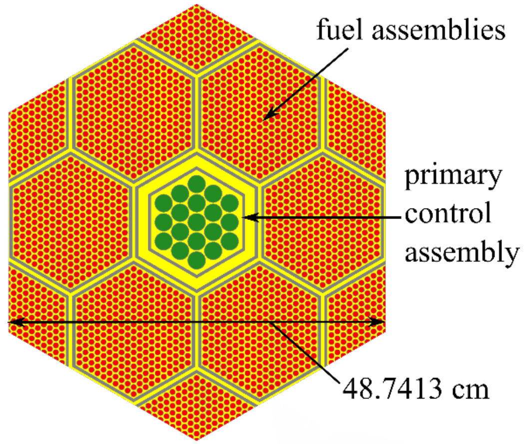
No data for FLiBe / FLiNaK thermal scattering

Reaction	Sensitivity
Cl-35 (n,p) Capture Reaction	-0.958
Pu-239 Nu-bar	0.603
U-238 Nu-bar	0.281
Na-23 Elastic Scatter Reaction	0.114

OECD Nuclear Energy Agency Uncertainty Analysis in Modeling Sodium Fast Reactor Study

CE TSUNAMI: nominal values and uncertainties

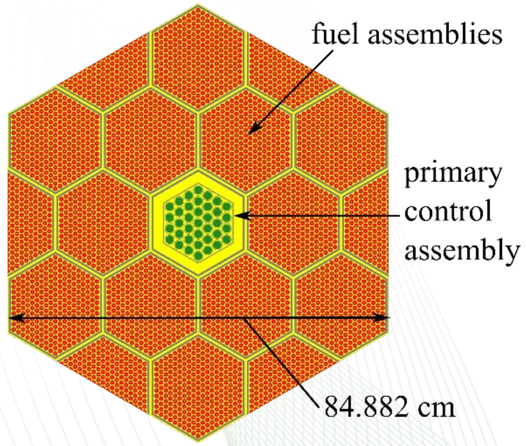
	MET1000		MOX3600	
	nominal	uncertainty	nominal	uncertainty
Eigenvalue	1.0841(1)	1.49(1)%	1.0771(1)	1.52(1)%
CR worth	12081(11) pcm	2.81(1)%	4973(11) pcm	2.67(1)%



MET1000

CE TSUNAMI: Top 3 contributors

MET1000		MOX3600	
Eigenvalue	CR worth	Eigenvalue	CR worth
U-238 inel.	U-238 inel.	U-238 inel.	U-238 inel.
Fe-56 inel.	Fe-56 inel.	U-238 cap.	Na-23 el.
Na-23 el.	Na-23 el.	Pu-239 cap.	U-238 chi

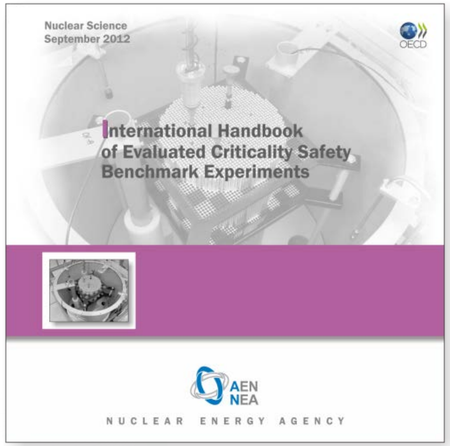


MOX3600

Validation of methods and nuclear data for advanced applications

International benchmark evaluation projects

- Programmatic support for US leadership of the following projects:
  - International Criticality Safety Benchmark Evaluation Project (ICSBEP)
  - International Reactor Physics Benchmark Evaluation Project (IRPhEP)
- Handbooks generated by these projects provide thousands of benchmark experiments from dozens of countries with an assessment of data integrity, quantification of experimental uncertainties, and thorough technical review with established deployment process
- Strong collaborations have been implemented with the Organisation for Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA)



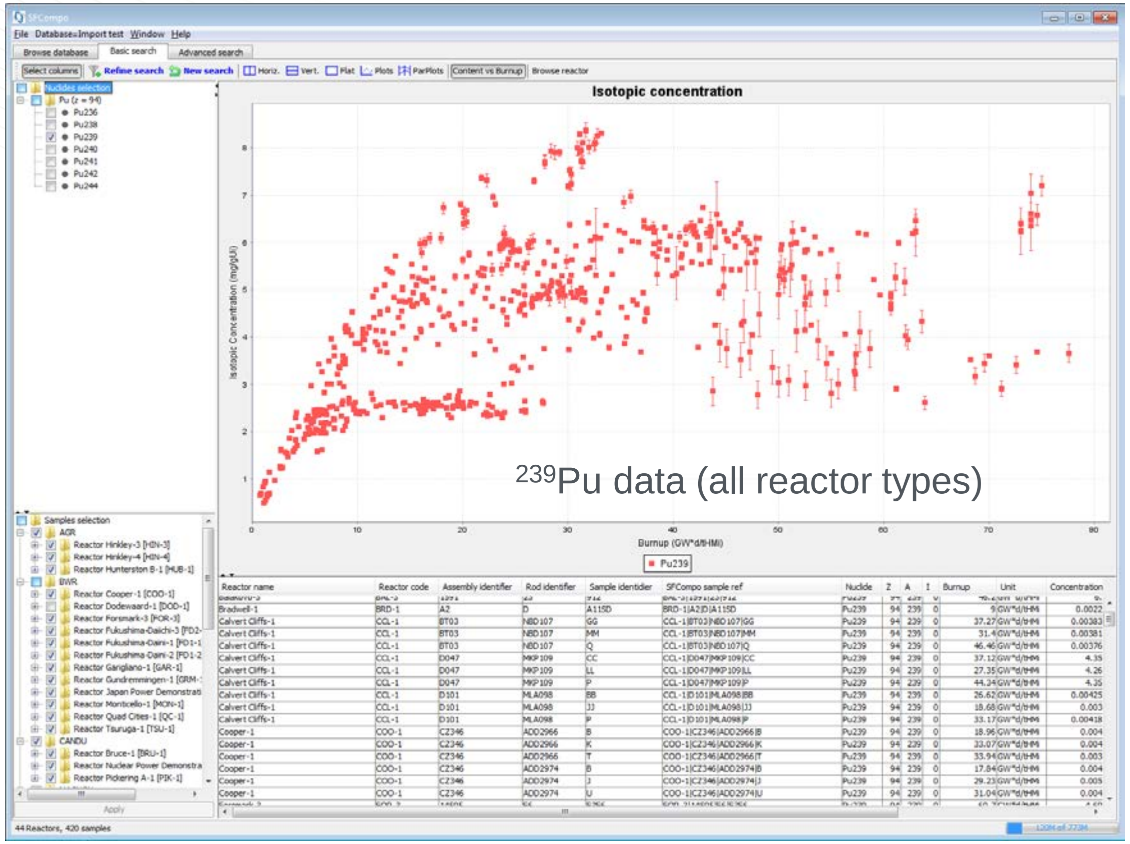
ICSBEP
- **22 contributing Countries**
- **~69,000 pages**
- **>5,000 approved benchmarks**

IRPhEP
- **21 contributing countries**
- **50 reactor facilities**
- **147 approved benchmarks**

International Spent Nuclear Fuel Database SFCOMPO 2.0 provides a central repository of destructive assay data

Modern database of measured fuel compositions was expanded as part of a multi-year international collaboration. ORNL has coordinated this effort through the OECD/NEA Expert Group on Assay Data for Spent Fuel since 2009.

http://www.oecd-nea.org/sfcompo/



^{239}Pu data (all reactor types)

- Databases maintained by OECD Nuclear Energy Agency Data Bank include:
  - ICSBEP (Criticality safety database)
  - IRPhEP (Reactor physics database)
  - SFCOMPO (Spent fuel composition and decay heat database)
- Data for PWR, BWR, AGR, MAGNOX, CANDU, RBMK, VVER-440, VVER-1000 fuels
- 44 reactors, 118 assemblies, 91 isotopes important to fuel cycle safety and WM
- 750 samples > 22,000 measurements
- Data essential for code validation and uncertainty analysis, integral nuclear data testing -- Energy and Security applications

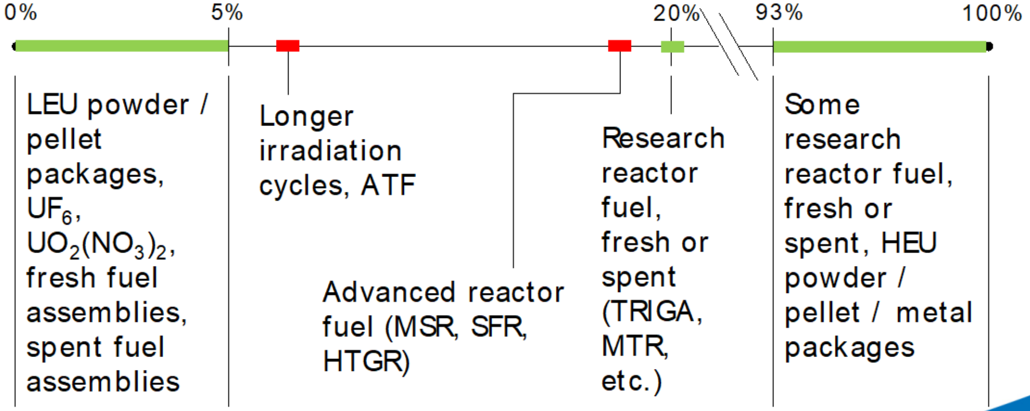
5% < Hi-assay LEU < 20%

NRC/NMSS perspectives on high assay fuel

> 5.0 Weight Percent

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Code Validation:



NMSS Division of Spent Fuel Management

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U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC Regulatory Perspective on Criticality Safety in Fissile Material Transportation and Spent Fuel Storage

Drew Barto
Criticality Shielding and Risk Assessment Branch
Division of Spent Fuel Management
US NRC

American Nuclear Society Winter Meeting
Washington, DC
October 30, 2017

NMSS Division of Spent Fuel Management

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Part 71/72 Interface

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

High-Capacity PWR Cask Criticality Safety Criteria:

Storage:

- < 5.0% Initial enrichment
- Minimum soluble boron during loading

Transportation:

- < 5.0% Initial enrichment
- > 45 GWd/MTU burnup
- Cooling time
- Limits on irradiation parameters:
  - Soluble boron
  - Specific power
  - Moderator temp.
  - Fuel temp.

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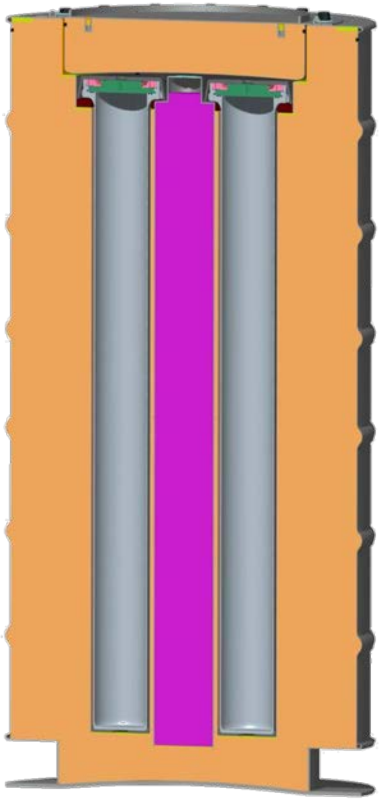
Example criticality validation process using the ES-4100 package

Photos Courtesy of Jeff Arbital

Y-12 National Security Complex

ES-4100 Design Features

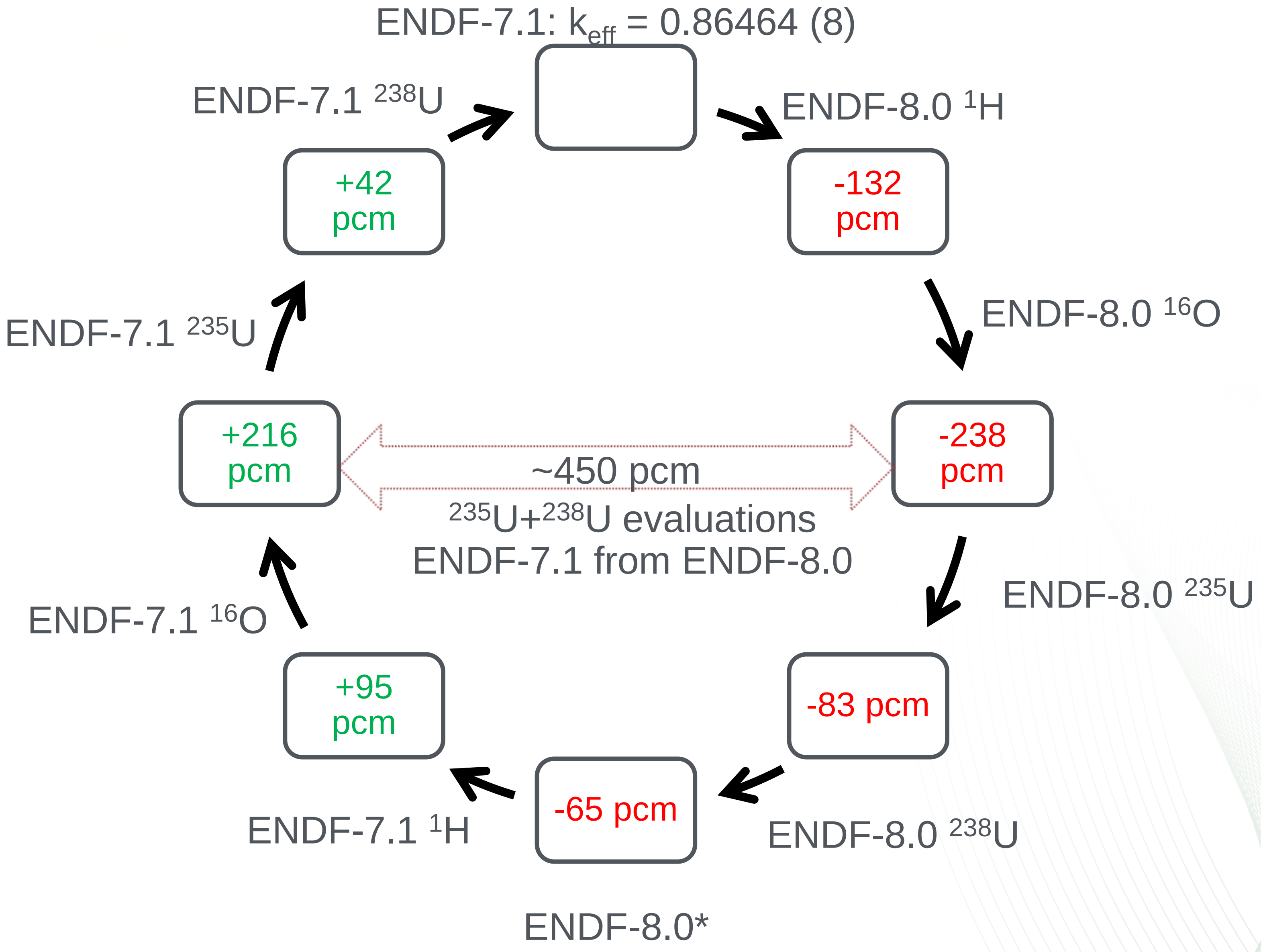
- Multi-pack – 4 containment vessels (CVs) per drum
- CV inner dimensions –
  - 5.0 in. dia by 58 in.
- Outer drum size –
  - 34.0 in. dia x 71 in.
- Insulation
  - Kaolite 1600
- Neutron absorber –
  - 277-4 cast ceramic w/B_4C
- Gross weight – approx 2000 lb.
  - Less than gross weight of four 6M-110's
- Content weight allowance – 4 X 88 lb
  - Over 350 lb of content weight



Allowable Contents:

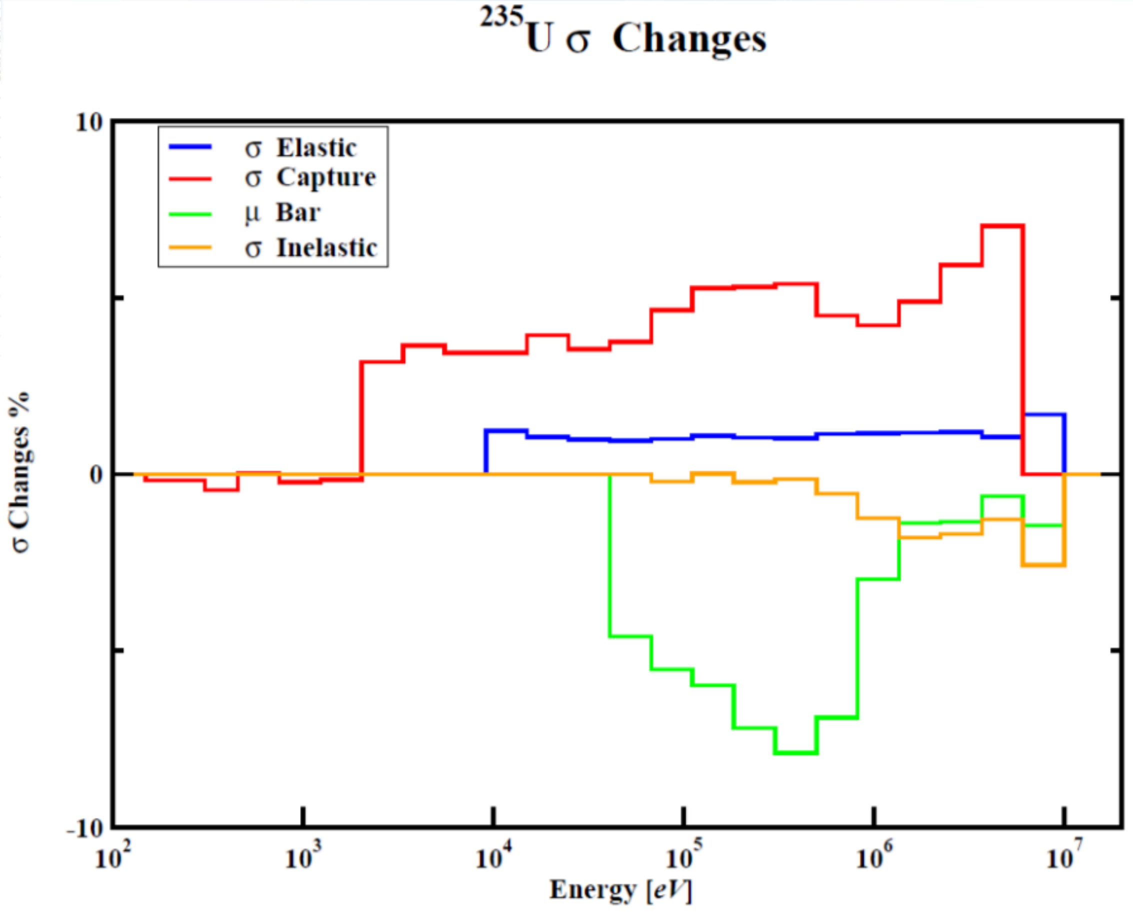
- Univ of Missouri Reactor Fuel – MURR
- Mass Inst of Tech Reactor Fuel - MIT
- ATR Fuel Rods
- MTR-type Fuel Elements and Components
- Foreign research reactor fuels
- Other fuels
- 1000 g U-235 per CV limit
  - (Typical US PWR fuel assembly has ~23,000 g U-235)

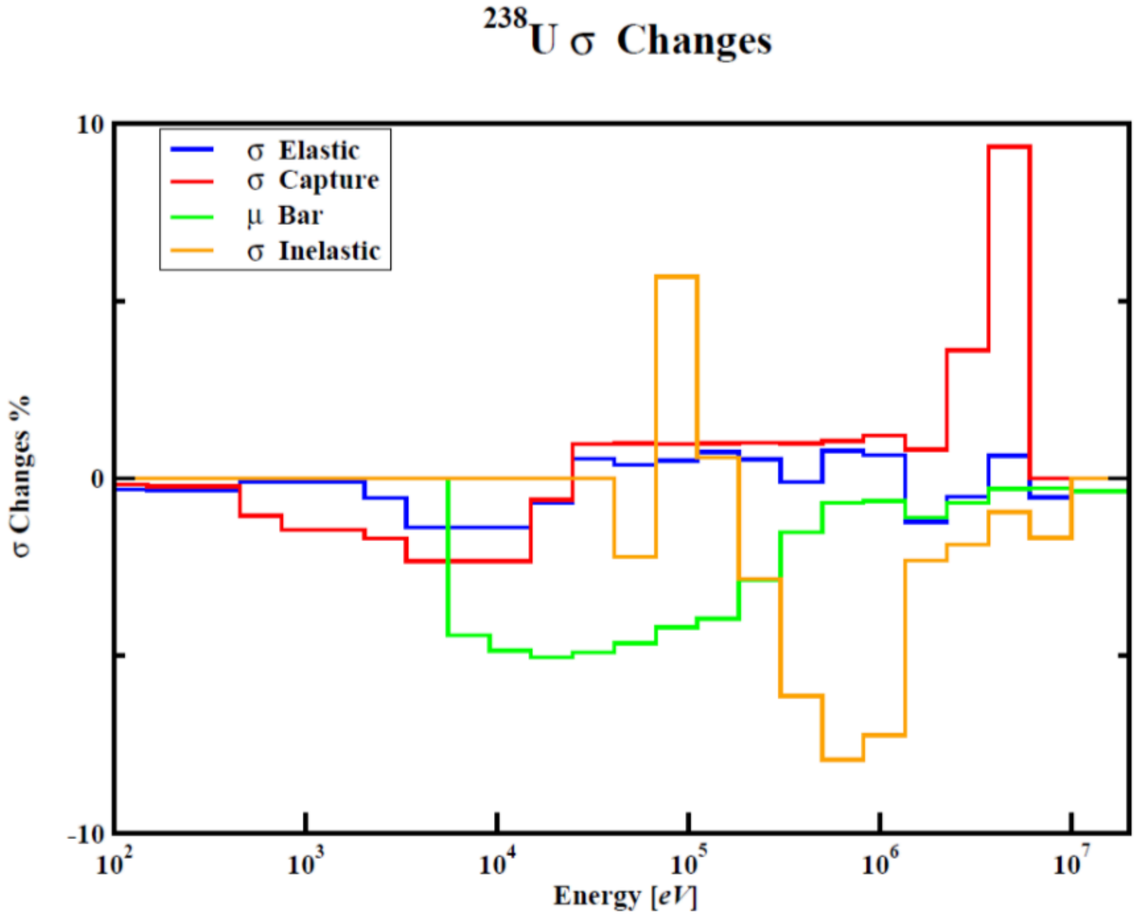
ES-4100 w/ 20 w/o UF_6 study on counteracting errors in ENDF/B-VII.1 – ENDF/B-VIII.0



Cross section changes ENDF/B-VII.1 – ENDF/B-VIII.0

OECD/NEA SG-46

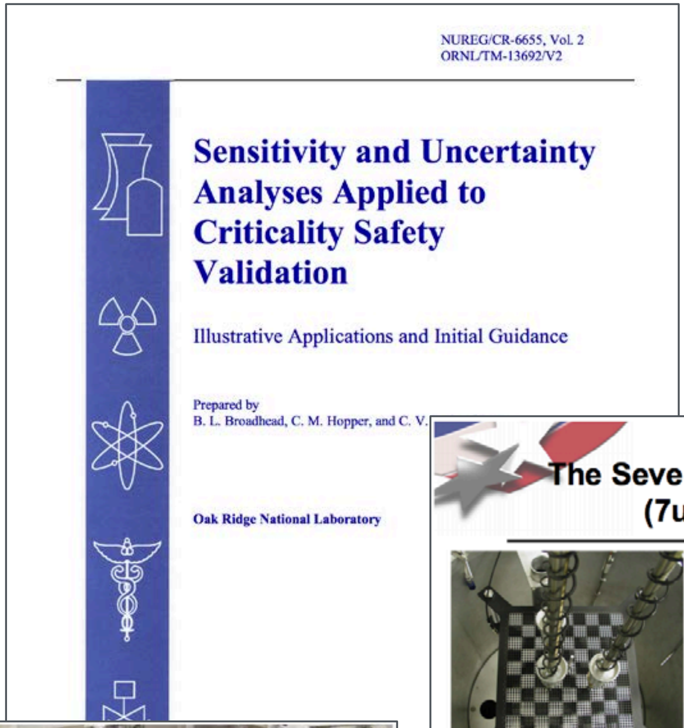




Previous activities on fuel cycle analysis for high-burnup fuel

- S/U methods applied for investigation and design of experimental benchmarks and for safety margin assessment
- Need to move beyond 5% regulatory limit

The 30B cylinder: . . . *can contain 2270 kilograms of low-enriched uranium in the form of uranium hexafluoride. IAEA regulations include requirements for packages to meet the following test requirements: withstand a pressure test of at least 1.4 MPa; withstand a free drop test; withstand a thermal test at a temperature of 800 °C for 30 minutes* (World Nuclear News).



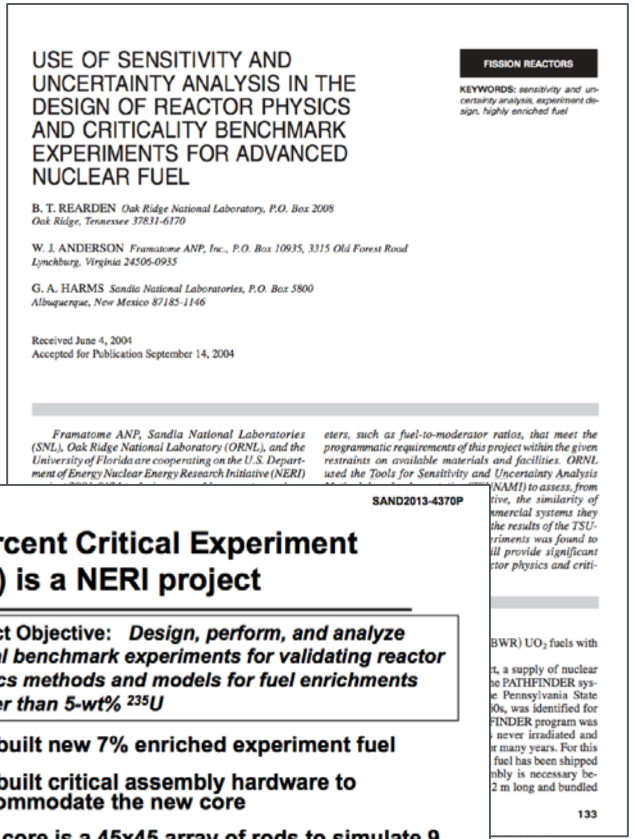
NUREG/CR-6655, Vol. 2
ORNL/TM-13692/V2

Sensitivity and Uncertainty Analyses Applied to Criticality Safety Validation

Illustrative Applications and Initial Guidance

Prepared by
B. L. Broadhead, C. M. Hopper, and C. V.

Oak Ridge National Laboratory



USE OF SENSITIVITY AND UNCERTAINTY ANALYSIS IN THE DESIGN OF REACTOR PHYSICS AND CRITICALITY BENCHMARK EXPERIMENTS FOR ADVANCED NUCLEAR FUEL

FISSION REACTORS

KEYWORDS: sensitivity and uncertainty analysis, experiment design, highly enriched fuel

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W. J. ANDERSON Framatome ANP, Inc., P.O. Box 10935, 3315 Old Forest Road Lynchburg, Virginia 24506-0935

G. A. HARMS Sandia National Laboratories, P.O. Box 5800 Albuquerque, New Mexico 87185-1146

Received June 4, 2004
Accepted for Publication September 14, 2004

Framatome ANP, Sandia National Laboratories (SNL), Oak Ridge National Laboratory (ORNL), and the University of Florida are cooperating on the U.S. Department of Energy Nuclear Energy Research Initiative (NERI) ...

... eters, such as fuel-to-moderator ratios, that meet the programmatic requirements of this project within the given restraints on available materials and facilities. ORNL used the Tools for Sensitivity and Uncertainty Analysis ...

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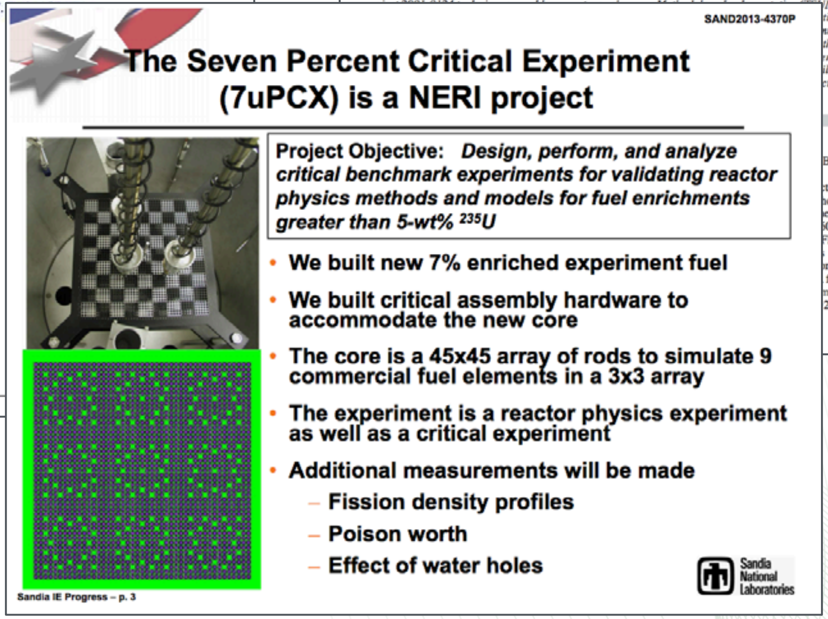


SAND2013-4370P

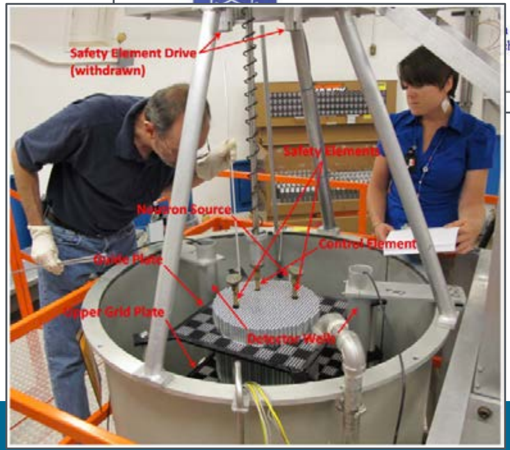
The Seven Percent Critical Experiment (7uPCX) is a NERI project

Project Objective: *Design, perform, and analyze critical benchmark experiments for validating reactor physics methods and models for fuel enrichments greater than 5-wt% ^{235}U*

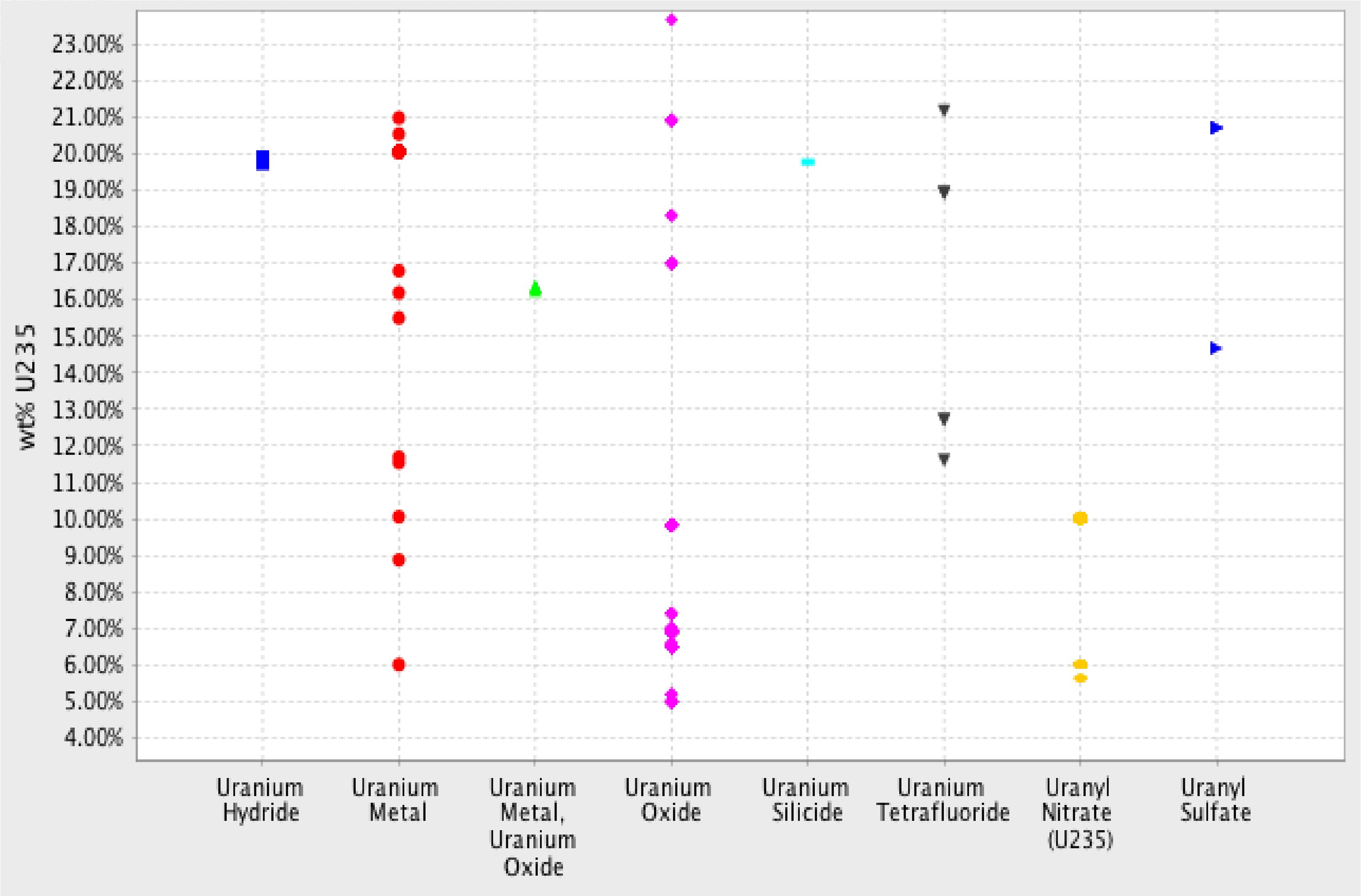
- We built new 7% enriched experiment fuel
- We built critical assembly hardware to accommodate the new core
- The core is a 45x45 array of rods to simulate 9 commercial fuel elements in a 3x3 array
- The experiment is a reactor physics experiment as well as a critical experiment
- Additional measurements will be made
  - Fission density profiles
  - Poison worth
  - Effect of water holes

Sandia National Laboratories

Sandia IE Progress – p. 3



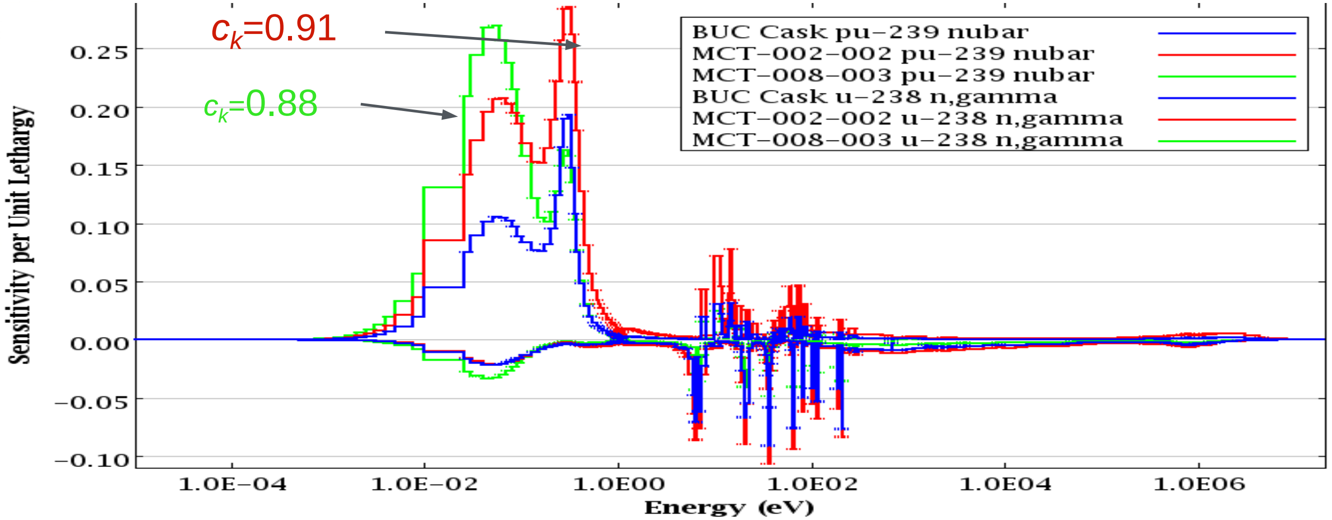
376 ICSBEP experiments with 5% < ^{235}U wt% < 25%

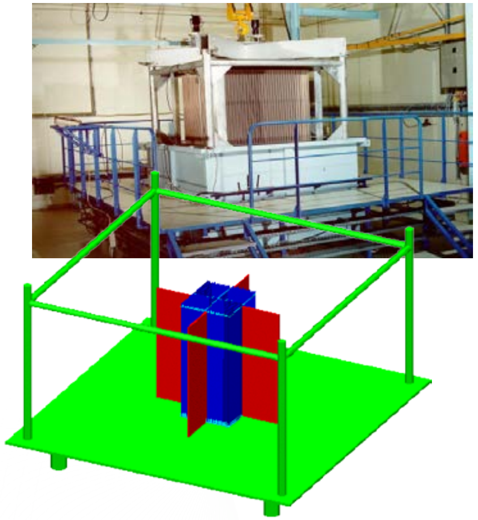


- Many legacy experiments for metallic cores
- IRPhEP has a few experiments for HTGR (HTR-10, HTTR)
- No experiments for molten salt (limited new measurements in Czech republic for non-fueled FLiBe)
- No data for FHR

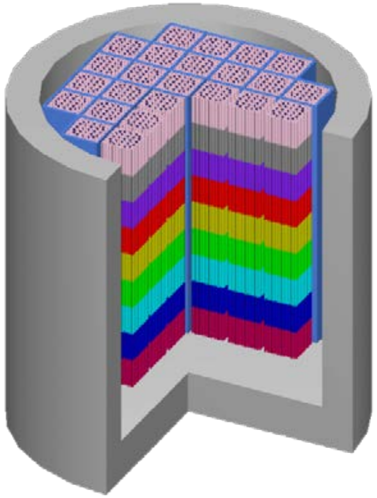
SCALE/TSUNAMI similarity analysis for validation: Identifying experiments representative of targeted application

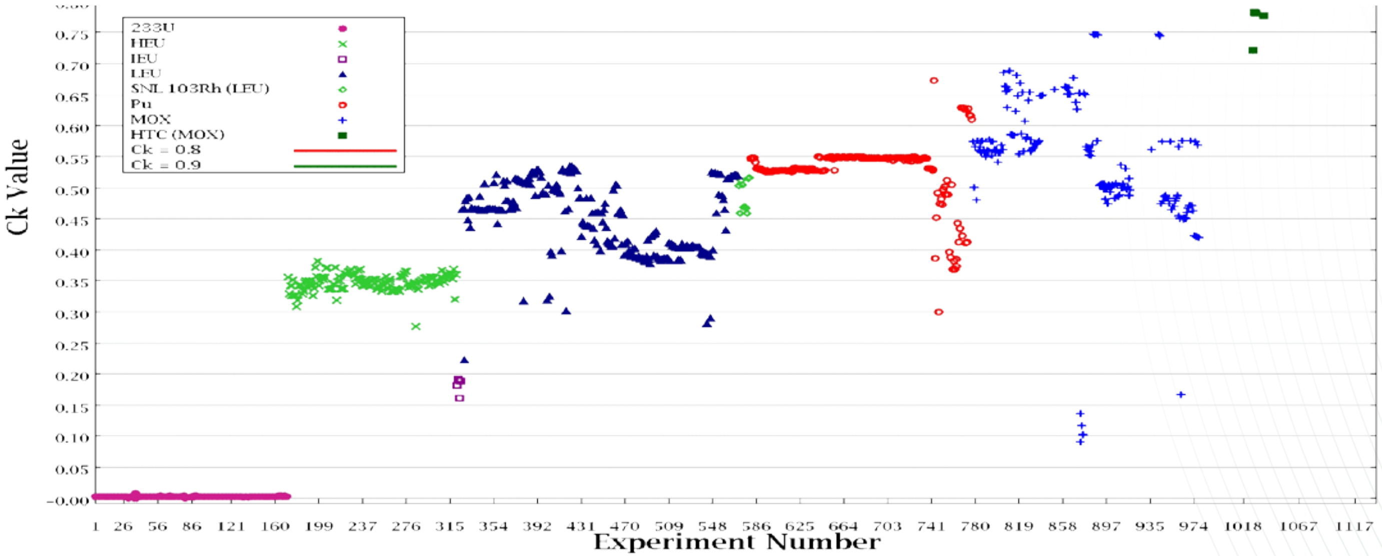
$$c_k^{(m,n)} = \frac{\mathbf{S}_{k_m}^{\mathbf{T}} \mathbf{C}_{\alpha\alpha} \mathbf{S}_{k_n}}{\sqrt{Var(k_m)Var(k_m)}}$$



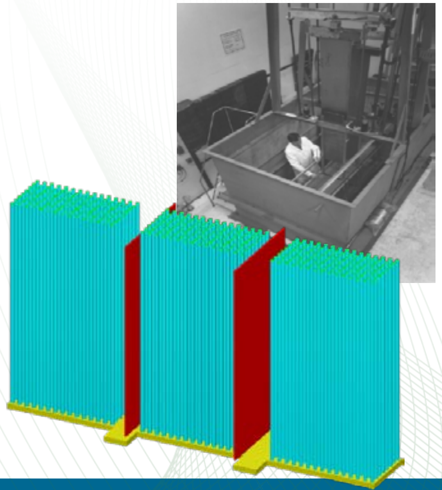


APPLICATION



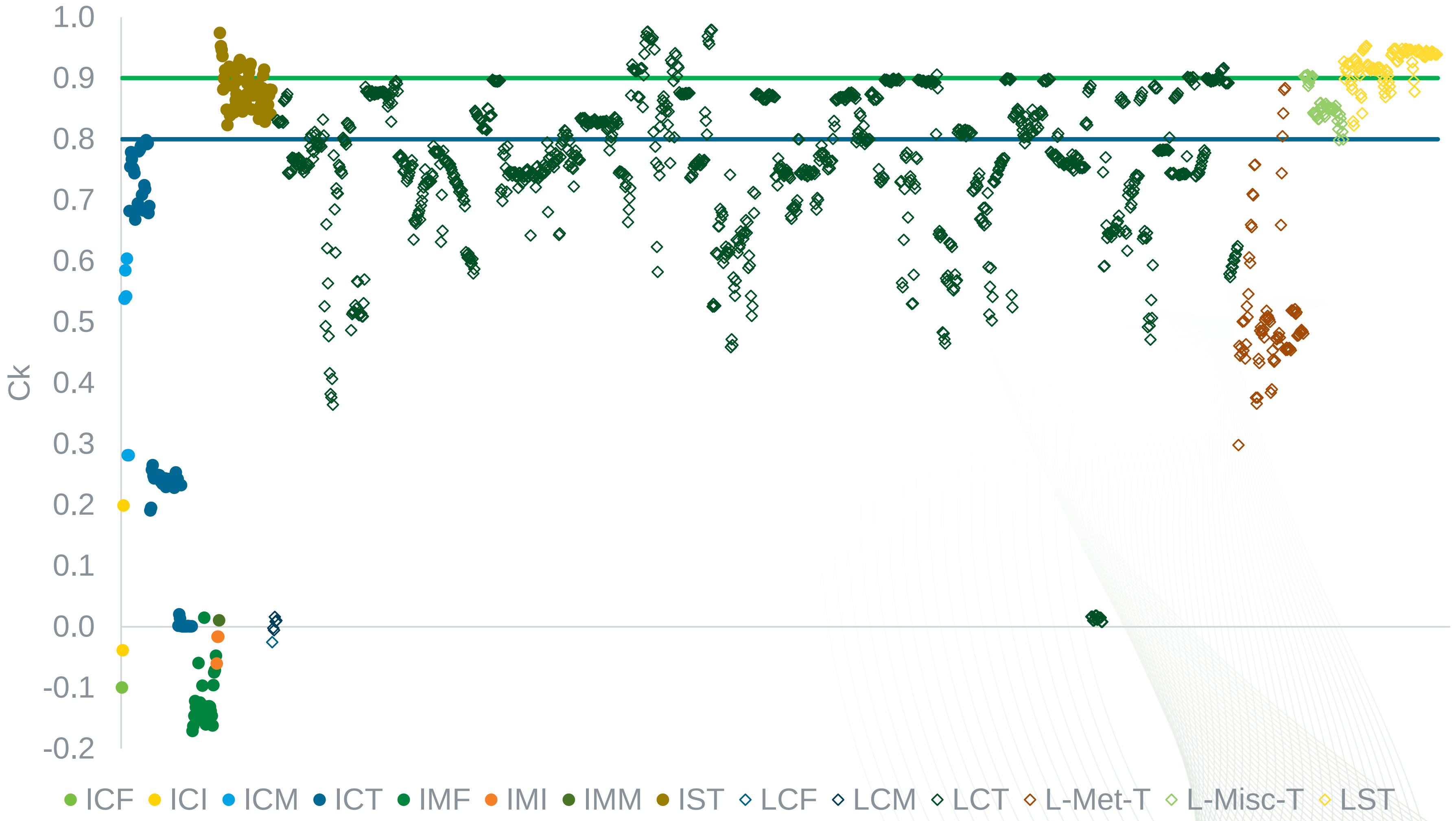


NUCLEAR CRITICALITY EXPERIMENTS

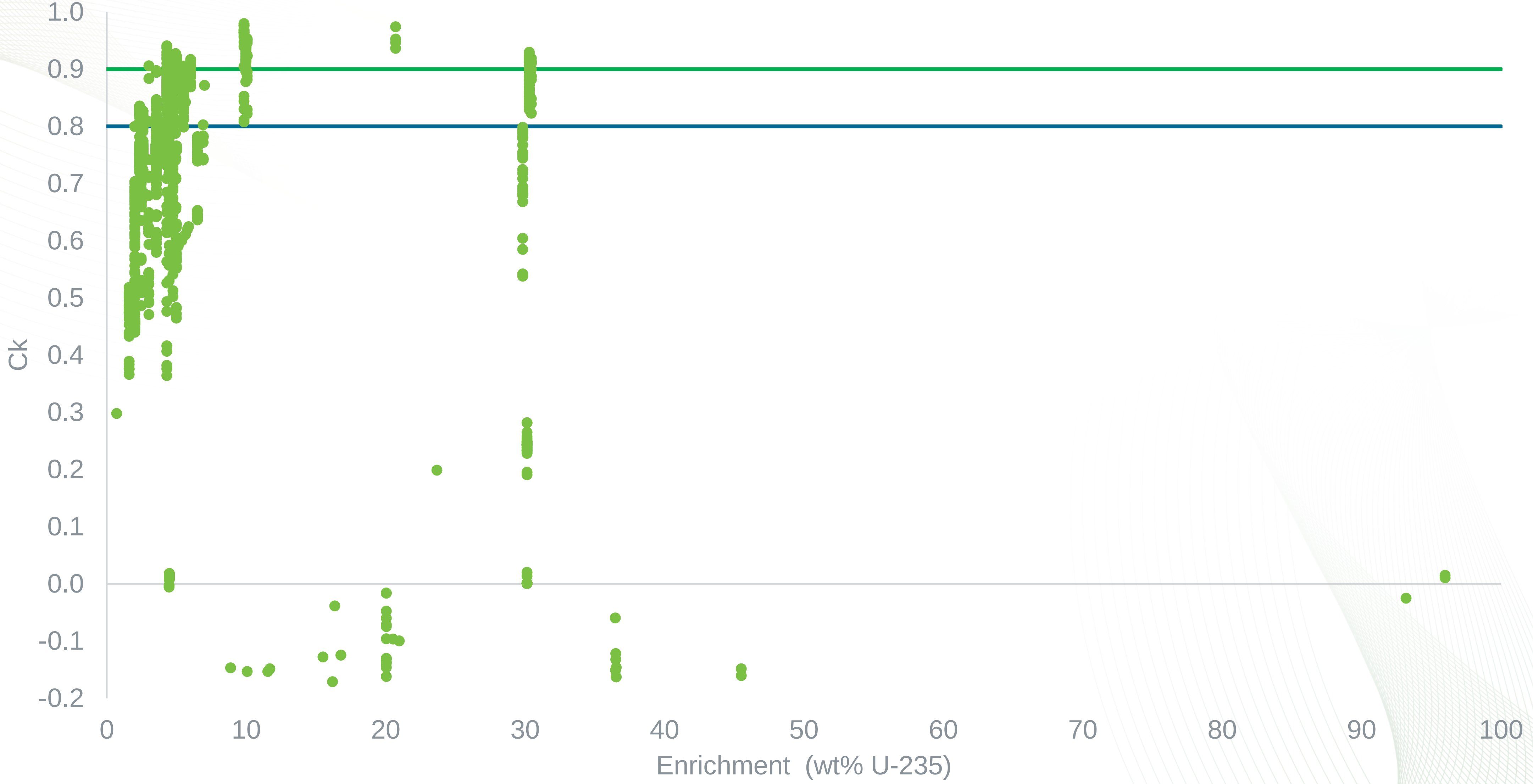


Selection of applicable critical experiments using similarity assessment

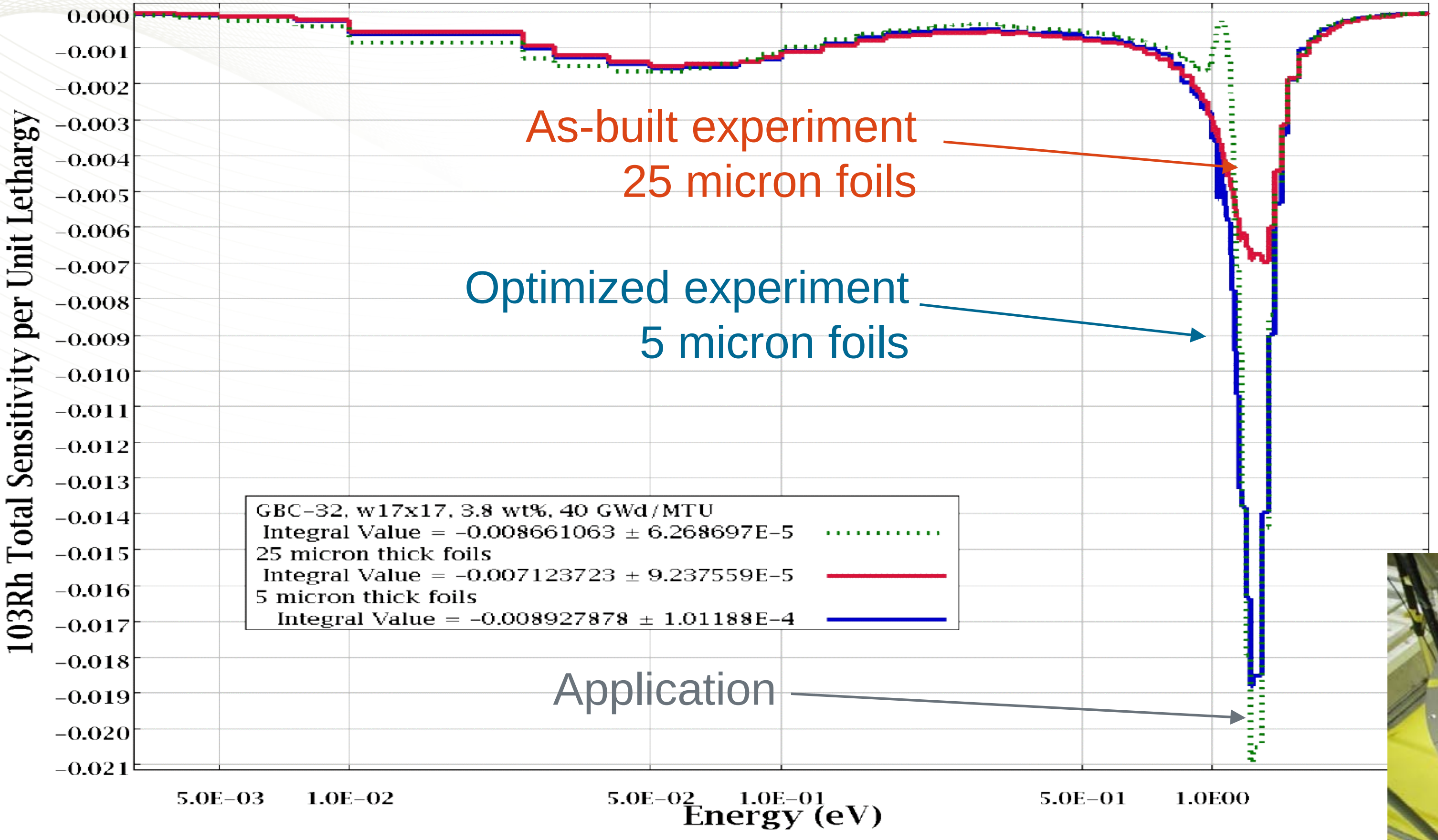
- Plot of c_k by LCE group
- c_k is a correlation coefficient indicating how similar an experiment is to an application model

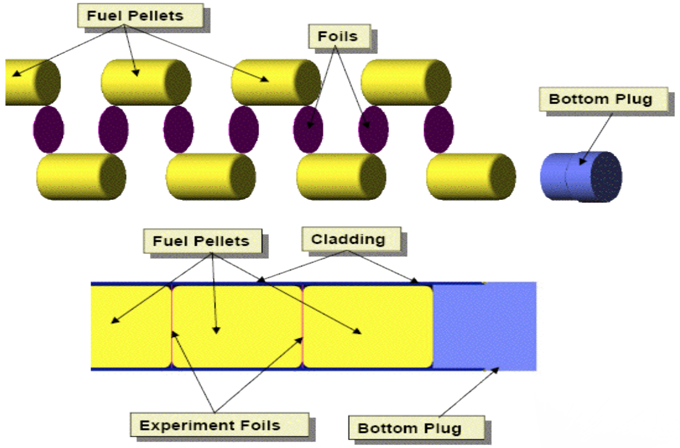


c_k sorted by enrichment

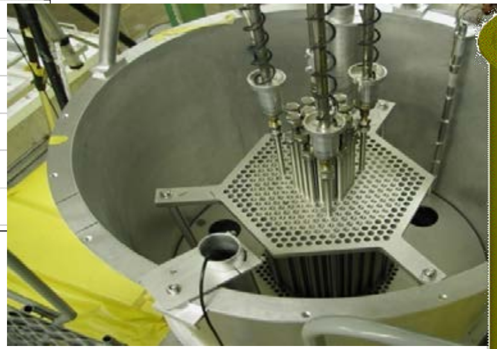


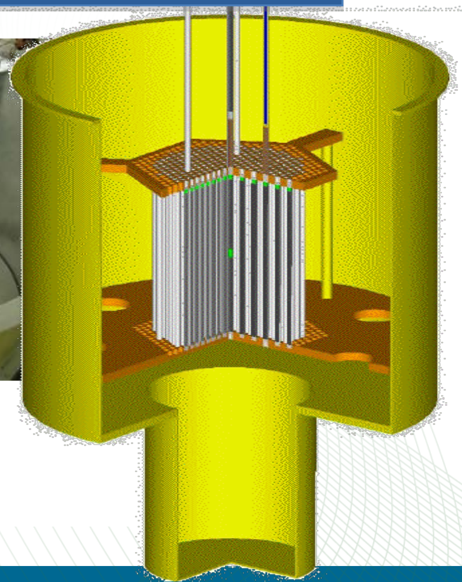
Design of optimized experiments





Rh-103 Critical Experiment Design for Burnup Credit





- Experiment designs optimized to meet application needs
- Required analysis in DOE Nuclear Criticality Safety Program

National Criticality Experiments Research Center

- NCERC is located within the Device Assembly Facility at the Nevada National Security Site
- NA-10 Approved Security Category I / Hazard Category 2 Nuclear Operations on May 8, 2011
- DOE Nuclear Criticality Safety Program (NCSP), NA-511, is the principal programmatic sponsor
  - NCERC also supports NA-20, NA-40, NA-80, DTRA, DHS, NASA and a variety of other WFO customers

What is NCERC?

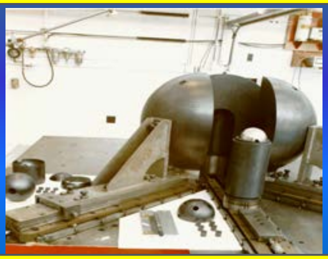
A collection of general purpose laboratories capable of subcritical, delayed, and super-prompt critical operations using large quantities special nuclear material (metallic HEU and WG Pu)

Critical Assemblies

Comet General-Purpose Vertical Critical Assembly

Godiva IV Fast Burst Assembly

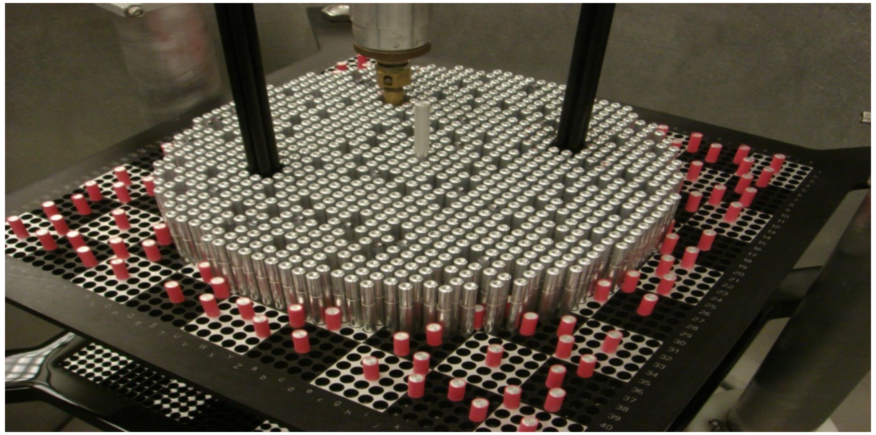
Planet General-Purpose Vertical Critical Assembly



Flattop Fast Benchmark Critical Assembly

Critical Experiments at Sandia National Laboratories

- Maintain the capability to perform water moderated low-enriched lattice critical experiments in the Sandia Critical Experiments Facility.
- Two enrichments available: 4.3% and 6.9% Enriched in U-235.
- Primary Mission is to provide hands-on criticality safety training to cleared and uncleared personnel.



U.S. DEPARTMENT OF ENERGY

Fission nuclear data programs and prioritization

Previous DOE-NE activities in nuclear data

Nuclear data cross-cut activity in Fuel Cycle R&D Program

- c. 2008–2013
- ~$5M/yr FCR&D and ARC
  - Nuclear theory and nuclear data
  - Nuclear data sensitivity studies
  - measurement program and challenges
  - Advanced detector development effort

U.S. DEPARTMENT OF ENERGY
Nuclear Energy

The need for new data have been identified in fast reactor sensitivity calculations

- **Fission Cross Section Measurements**
  - U233, U234, Np237, Pu238, Pu239, Pu240, Pu241, Pu242, Am241, Am242m, Am243, Cm242, Cm243, Cm244, Cm245, Cm246
- **Capture Cross Section Measurements**
  - Si28, O16, Fe56, B10, Na23, Ni58, Pb206
  - U234, U235, U238, Np237, Pu238, Pu239, Pu240, Pu241, Pu242, Am241, Am242, Am243, Cm242, Cm244, Cm245
- **Elastic/Inelastic Cross Section Measurements**
  - C12, N15, O16, Cr52, Fe56, Pb207, Pb208, U238
  - C12, N15, O16, Na23, Cr-52, Fe56, Pb207, Pb208
- **Fission neutron spectrum and multiplicity**
  - Pu238, Pu239, Pu240, Pu242, Am241, Am243, Cm244, Cm245

Previously completed

Completed 2008

Completed 2009

Completed 2010

Underway

The measurements and required accuracies are EXTREMELY challenging

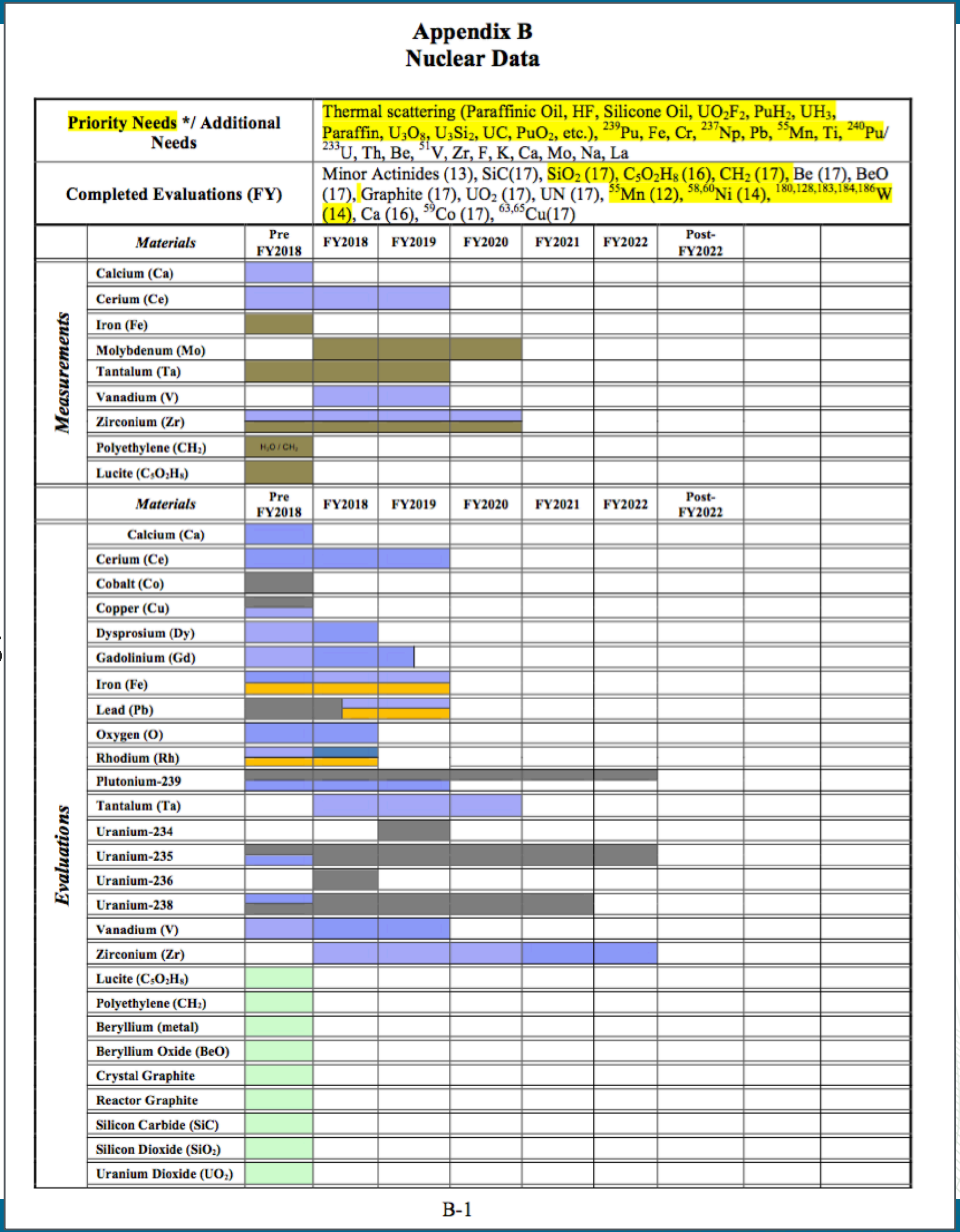
November 17, 2010 | Fuel Cycle R&D Nuclear Data Deep Dive, Washington, D.C. | 22

T. Hill, "Nuclear Data Deep Dive," Fuel Cycle R&D Program, Washington, D.C., November 17, 2010

NNSA Nuclear Criticality Safety Program

- Federal manger:
  - Angela Chambers
  - NA-511, Office of Defense Nuclear Safety
- http://ncsp.llnl.gov
- ~$4M/year invested in nuclear data measurement and evaluation
- Needs-driven rolling 5-year plan
- Nuclear Data Advisory Group drives needs

- Similar OUO plan for integral benchmark experiments ~$6M/year



Appendix B
Nuclear Data

Priority Needs */ Additional Needs	Thermal scattering (Paraffinic Oil, HF, Silicone Oil, UO_2F_2, PuH_2, UH_3, Paraffin, U_3O_8, U_3Si_2, UC, PuO_2, etc.), ^{239}Pu, Fe, Cr, ^{237}Np, Pb, ^{55}Mn, Ti, ^{240}Pu/ ^{233}U, Th, Be, ^{51}V, Zr, F, K, Ca, Mo, Na, La
Completed Evaluations (FY)	Minor Actinides (13), SiC(17), SiO_2 (17), $C_5O_2H_8$ (16), CH_2 (17), Be (17), BeO (17), Graphite (17), UO_2 (17), UN (17), ^{55}Mn (12), $^{58,60}Ni$ (14), $^{180,128,183,184,186}W$ (14), Ca (16), ^{59}Co (17), $^{63,65}Cu$(17)

	Materials	Pre FY2018	FY2018	FY2019	FY2020	FY2021	FY2022	Post-FY2022
Measurements	Calcium (Ca)							
	Cerium (Ce)							
	Iron (Fe)							
	Molybdenum (Mo)							
	Tantalum (Ta)							
	Vanadium (V)							
	Zirconium (Zr)							
	Polyethylene (CH_2)	H_2O / CH_2						
	Lucite ($C_5O_2H_8$)							

	Materials	Pre FY2018	FY2018	FY2019	FY2020	FY2021	FY2022	Post-FY2022
Evaluations	Calcium (Ca)							
	Cerium (Ce)							
	Cobalt (Co)							
	Copper (Cu)							
	Dysprosium (Dy)							
	Gadolinium (Gd)							
	Iron (Fe)							
	Lead (Pb)							
	Oxygen (O)							
	Rhodium (Rh)							
	Plutonium-239							
	Tantalum (Ta)							
	Uranium-234							
	Uranium-235							
	Uranium-236							
	Uranium-238							
	Vanadium (V)							
	Zirconium (Zr)							
	Lucite ($C_5O_2H_8$)							
	Polyethylene (CH_2)							
	Beryllium (metal)							
	Beryllium Oxide (BeO)							
	Crystal Graphite							
	Reactor Graphite							
	Silicon Carbide (SiC)							
	Silicon Dioxide (SiO_2)							
	Uranium Dioxide (UO_2)							

B-1

OECD Nuclear Energy Agency high priority request list

NEA Nuclear Data High Priority Request List

HPRL Main	High Priority Requests (HPR)	General Requests (GR)	Special Purpose Quantities (SPQ)	New Request	SGC/HPRL Documents

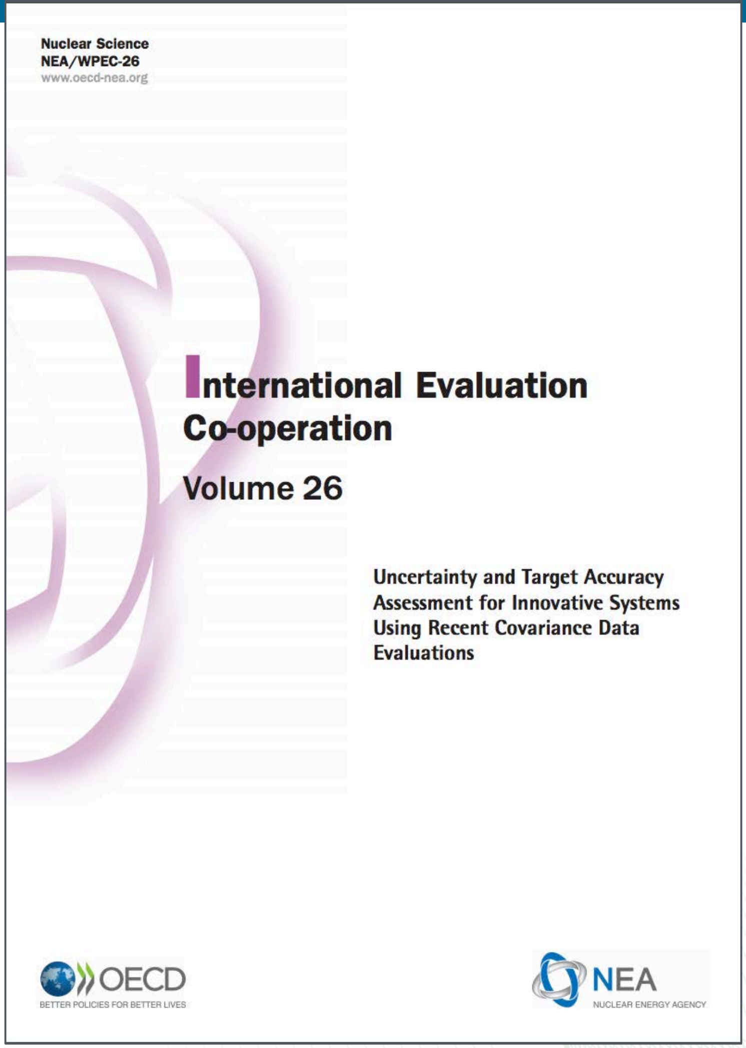
Results of your search in the request list

Requests are shown from the following list(s):
High Priority (H)

Explanations of each column can be found in the table heads. To view the details of a request, please click on the **link symbol** after the request ID.
To send a comment on a particular entry, please view the request, and click on the **'letter'** symbol there.

ID	View	Target	Reaction	Quantity	Energy range	Sec.E/Angle	Accuracy	Cov	Field	Date
2H		8-O-16	(n,a),(n,abs)	SIG	2 MeV-20 MeV		See details	Y	Fission	12-SEP-08
3H		94-PU-239	(n,f)	prompt g	Thermal-Fast	Eg=0-10MeV	7.5	Y	Fission	12-MAY-06
4H		92-U-235	(n,f)	prompt g	Thermal-Fast	Eg=0-10MeV	7.5	Y	Fission	12-MAY-06
5H		72-HF-0	(n,g)	SIG	0.5-5.0 keV		4	Y	Fission	16-APR-07
8H		1-H-2	(n,el)	DA/DE	0.1 MeV-1 MeV	0-180 Deg	5	Y	Fission	16-APR-07
12H		92-U-235	(n,g)	SIG,RP	100 eV-1 MeV		3	Y	Fission	06-NOV-07
15H		95-AM-241	(n,g),(n,tot)	SIG	Thermal		See details		Fission	10-SEP-08
18H		92-U-238	(n,inl)	SIG	65 keV-20 MeV	Emis spec.	See details	Y	Fission	11-SEP-08
19H		94-PU-238	(n,f)	SIG	9 keV-6 MeV		See details	Y	Fission	11-SEP-08
21H		95-AM-241	(n,f)	SIG	180 keV-20 MeV		See details	Y	Fission	11-SEP-08
22H		95-AM-242	(n,f)	SIG	0.5 keV-6 MeV		See details	Y	Fission	11-SEP-08
25H		96-CM-244	(n,f)	SIG	65 keV-6 MeV		See details	Y	Fission	12-SEP-08
27H		96-CM-245	(n,f)	SIG	0.5 keV-6 MeV		See details	Y	Fission	12-SEP-08
29H		11-NA-23	(n,inl)	SIG	0.5 MeV-1.3 MeV	Emis spec.	See details	Y	Fission	12-SEP-08
32H		94-PU-239	(n,g)	SIG	0.1 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
33H		94-PU-241	(n,g)	SIG	0.1 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
34H		26-FE-56	(n,inl)	SIG	0.5 MeV-20 MeV	Emis spec.	See details	Y	Fission	12-SEP-08
35H		94-PU-241	(n,f)	SIG	0.5 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
36H		92-U-238	(n,g)	SIG	20 eV-25 keV		See details	Y	Fission	15-SEP-08
37H		94-PU-240	(n,f)	SIG	0.5 keV-5 MeV		See details	Y	Fission	15-SEP-08
38H		94-PU-240	(n,f)	nubar	200 keV-2 MeV		See details	Y	Fission	15-SEP-08
39H		94-PU-242	(n,f)	SIG	200 keV-20 MeV		See details	Y	Fission	15-SEP-08
40H		14-SI-28	(n,inl)	SIG	1.4 MeV-6 MeV		See details	Y	Fission	15-SEP-08
41H		82-PB-206	(n,inl)	SIG	0.5 MeV-6 MeV		See details	Y	Fission	15-SEP-08
42H		82-PB-207	(n,inl)	SIG	0.5 MeV-6 MeV		See details	Y	Fission	15-SEP-08
43H		1-H-1	(n,el)	SIG,DA	10 MeV-20 MeV	4 pi	1-2	Y	Standard	13-MAY-11
44H		93-NP-237	(n,f)	SIG,DE	200 keV-20 MeV			Y	Fission	18-MAY-15
45H		19-K-39	(n,p),(n,np)	SIG	10 MeV-20 MeV		10	Y	Fusion	11-JUL-17

Number of requests found: 28 (out of a total of 89 requests).
Download consolidated output report



https://www.oecd-nea.org/dbdata/hprl/

Nuclear Data Interagency Working Group

March 2018 FOA –
NP, ASCR, NE, NA-22

Department of Energy
Office of Science
Nuclear Physics

Nuclear Data Interagency Working Group / Research Program

DOE National Laboratory Announcement Number: LAB 18-1903

Announcement Type: Initial

Announcement Issue Date:	March 26, 2018
Submission Deadline for Letter of Intent:	April 13, 2018, at 5 PM Eastern A Letter of Intent is required
Proposal Encourage/Discourage Date:	April 29, 2018, at 5 PM Easterm
Submission Deadline for Pre-Applications:	N/A
Submission Deadline for Applications:	June 15, 2018, at 5 PM Eastern

Partners	Program Managers	Program Area	NDWG Member	Organization
NNSA/DNN R&D	Donny Hornback	Proliferation Detection	Catherine Romano (Chair) Candido Pereira	ORNL ANL
DOE/SC/Nuclear Physics	Tim Hallman Ted Barnes	Nuclear Physics/Nuclear Data	Lee Bernstein Dave Brown	LLNL BNL
NNSA/DNN R&D	Donna Wilt	Forensics / Post Detonation	Todd Bredeweg Jason Burke	LANL LLNL
DNDO/ Transformational & Applied Research	Namdoo Moon	Nuclear Detection		LANL
NNSA/NCSP	Angela Chambers	Criticality Safety	Mike Zerkle	NNL
NNSA/Defense Prog.	Ralph Schneider Staci Brown	Research and Development	Teresa Bailey	LLNL
NNSA/Defense Prog.	Douglas Wade Adam Boyd	Physics and Engineering Models	Bob Little	LANL
DOE/Nuclear Energy	Dan Funk Dave Henderson	Nuclear Energy	Brad Rearden	ORNL
DNDO /Forensics	William Ulicny Jeff Morrison	Forensics	Richard Essex	NIST
NNSA /Forensics	Tom Black Steve Goldberg	Nuclear Technical Forensics	Bob Rundberg	LANL
DOE/SC/ Isotope Office	Jehanne Gillo Dennis Phillips	Isotope Production	Meiring Nortier	LANL
NNSA/Nuclear Safeguards and Security	Arden Dougan	Safeguards Technology	Sean Stave	ORNL
NNSA/DNN R&D	Chris Ramos	Safeguards	Chris Pickett	ORNL
		Additional Expert Contributors	Mark Chadwick Patrick Talou Alejandro Sonzogni	LANL LANL BNL

Nuclear Data and Benchmarking Program
Initial Activities

- Nuclear data and validation studies:
  - Gap analysis for nonLWR (ORNL – Sobes/Bostelmann)
  - Investigation of HA-LEU transportation validation basis (ORNL – Rearden/Scaglione/Marshall/Clarity/Holcomb)
- Nuclear data generation:
  - Investigation and generation of application driven covariance data (ORNL – Sobes)
  - Improvements of nuclear data for depletion, activation, and decay (ORNL – Wieselquist)
  - New measurement of ^{238}U (n,n’) with associated uncertainties (LBNL – Bernstein)
- International benchmarking activities:
  - Multi-Physics Experimental Data, Benchmark, and Validation (ORNL - Valentine)
  - International Physics Benchmark Programs: ICSBEP and IRPhEP (INL - Bess)
- University projects:
  - Generation of thermal scattering data for graphite (N.C. State, X-energy, ORNL)
  - Generation of thermal scattering sensitivity/uncertainty capabilities (U. Michigan, ORNL)