The 2016 Edition of the ICSBEP Handbook

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Acknowledgments

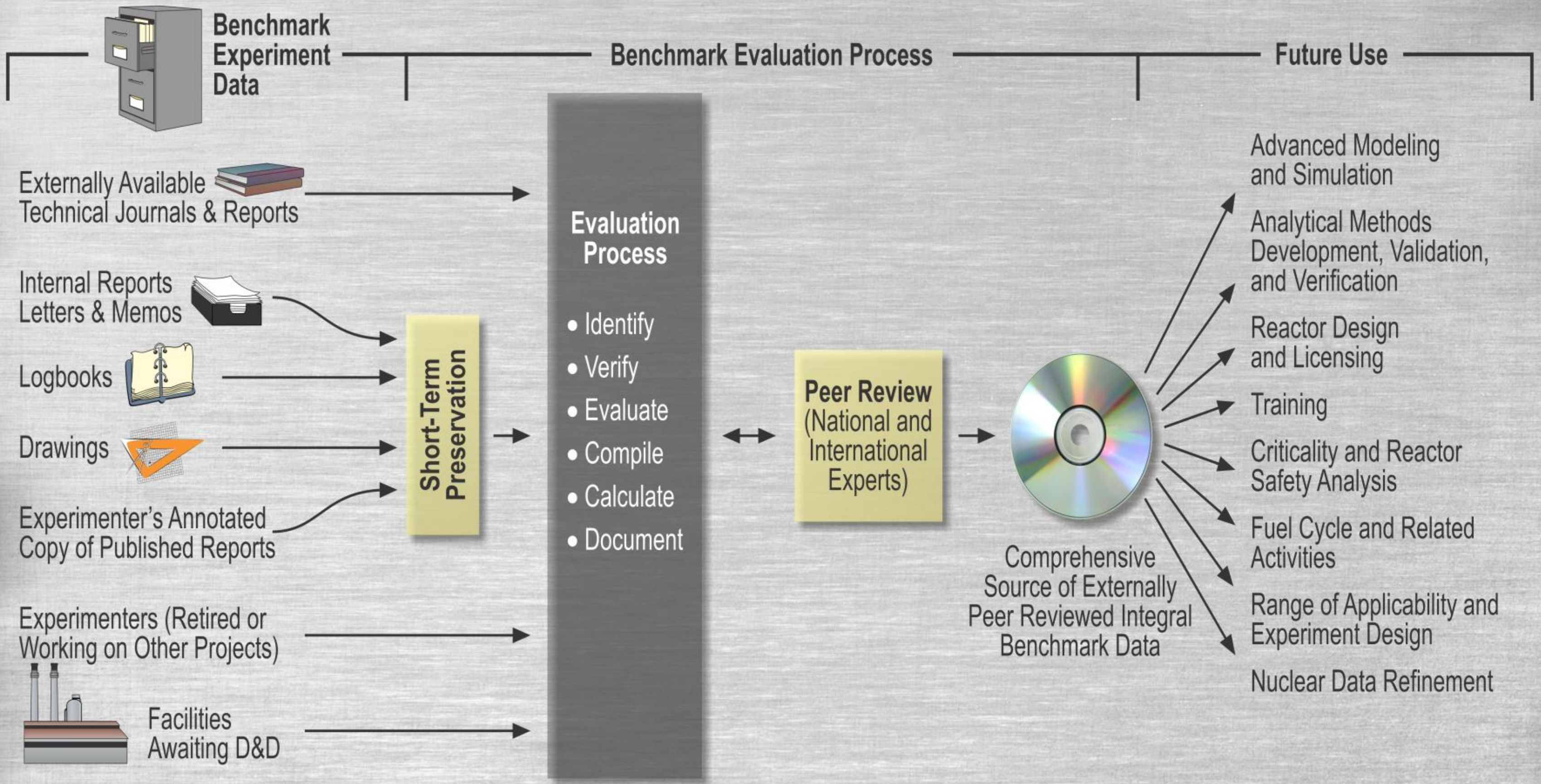
- The ICSBEP and IRPhEP are a collaborative effort
  - Scientists, engineers, administrative support, program sponsors
  - 25 different countries have participated
    - 22 in ICSBEP
    - 21 in IRPhEP
  - Without these dedicated individuals, these benchmark projects would not exist.

INTERNATIONAL BENCHMARK PROGRAMS

NEA NUCLEAR ENERGY AGENCY

OECD BETTER POLICIES FOR BETTER LIVES

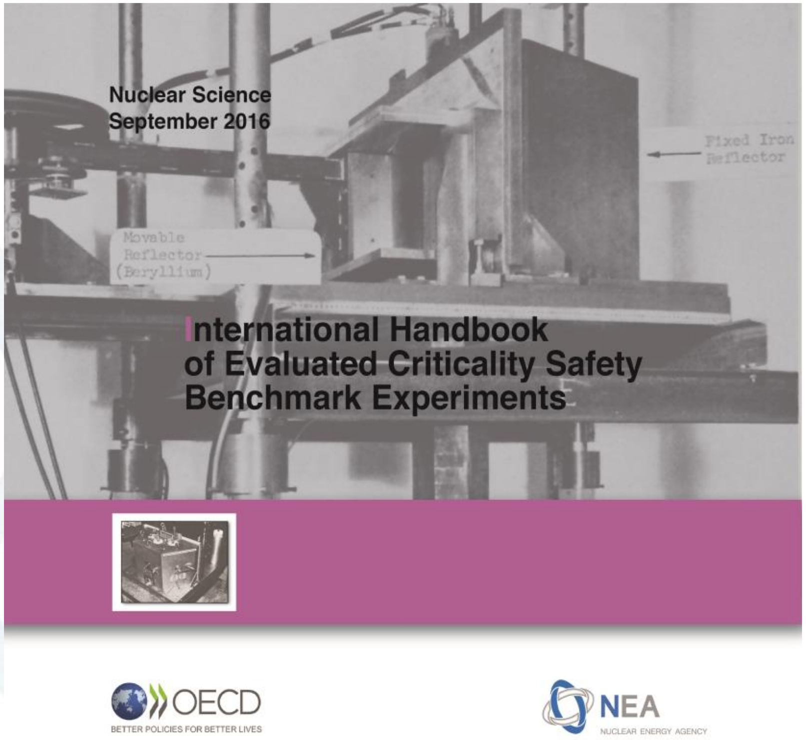
INL Idaho National Laboratory



International Handbook of Evaluated Criticality Safety Benchmark Experiments

September 2016 Edition

- **22 Contributing Countries**
- **~69,000 Pages**
- **570 Evaluations**
  - **4,913 Critical, Near-Critical, or Subcritical Configurations**
  - **45 Criticality-Alarm-Placement/Shielding Configurations**
  - **215 Configurations with Fundamental Physics Measurements**
  - **829 Unacceptable Experiment Configurations**



http://icsbep.inl.gov/

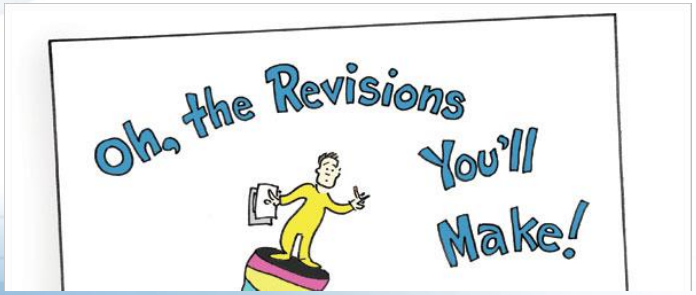
https://www.oecd-nea.org/science/wpncs/icsbep/

Breakdown of Current ICSBEP Benchmark Specifications

- 748 plutonium experiments
  - 36 compound
  - 123 metal
  - 589 solution
- 1435 highly enriched uranium experiments
  - 291 compound
  - 601 metal
  - 536 solution
  - 2 mixed compound/solution
  - 5 mixed metal/solution
- 268 intermediate- and mixed-enrichment uranium experiments
  - 156 compound
  - 47 metal
  - 65 solution
- 1662 low enriched uranium experiments
  - 1398 compound
  - 87 metal
  - 117 solution
  - 60 mixed compound/solution
- 244 ^{233}U experiments
  - 6 compound
  - 11 metal
  - 227 solution
- 536 mixed plutonium-uranium experiments
  - 301 compound
  - 52 metal
  - 86 solution
  - 76 mixed compound/solution
  - 21 mixed metal/compound
- 20 special isotope experiments
  - metal (^{237}Np, ^{238}Pu, ^{242}Pu, & ^{244}Cm)
- 9 criticality-alarm/shielding experiments
  - 45 unique configurations with numerous dose points
- 8 fundamental physics experiments
  - 215 unique measurements such as fission rates, transmission measurements, and subcritical neutron multiplication measurements

Recent Revisions to the Handbook

- 6 Revisions
  - PU-MET-FAST-001
    - Jezebel
    - Updated masses for components
  - PU-MET-INTER-002
    - ZPR-6/10
    - Improved uncertainty analysis
  - HEU-MET-FAST-028
    - Flattop
    - Updated sample calculations
  - LEU-COMP-THERM-061
    - VVER Lattice
    - Fixed Hf absorber rod diameter error in figure
  - LEU-COMP-THERM-071
    - UO2 Rod Arrays
    - Improved uncertainty analysis
  - FUND-NCERC-PU-HE3-MULT-001
    - Ni-Reflected Pu Sphere
    - Revised uncertainty analysis for leakage multiplication



Revision: PU-MET-FAST-001

- LANL – Jezebel
  - Pu Sphere
  - Jeff Favorite
- Discovered mass accountability statements, drawings, and logbooks

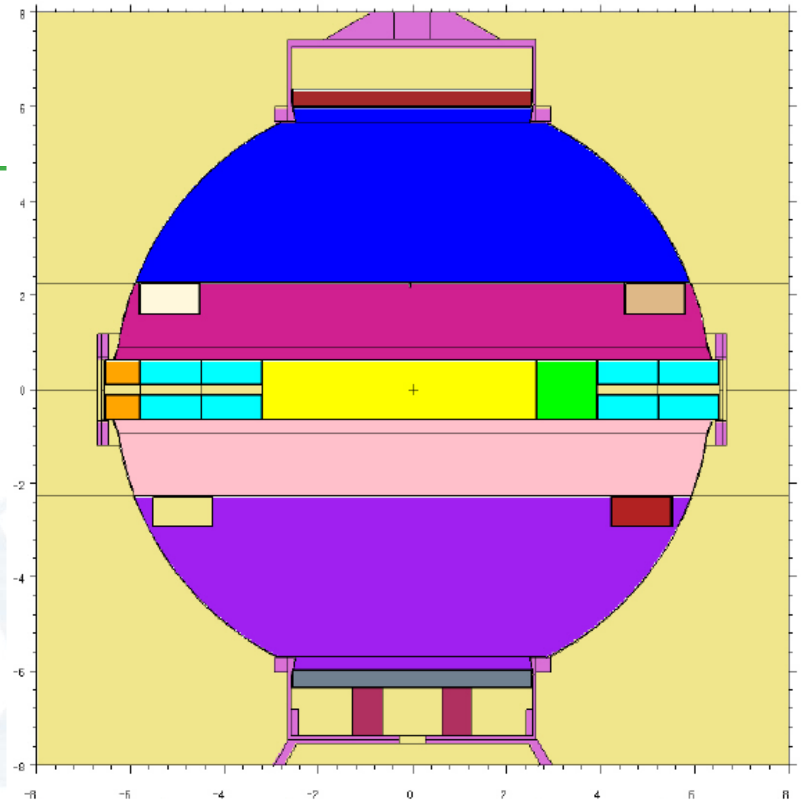


Table 51. Sample Calculation Results (Using MCNP6.1®, ENDF/B-VII.1) for the Detailed Models.

Case	Configuration	Calculated k_{eff}	Benchmark k_{eff}	Calc. – Bench. (pcm)	Calc. – Bench. (std. devs.)
1	A	1.00067 ± 0.00002	0.99999 ± 0.00110	68	0.61
2	B	1.00123 ± 0.00002	1.00016 ± 0.00110	107	0.96
3	C	1.00092 ± 0.00002	1.00020 ± 0.00110	72	0.64
4	D	1.00191 ± 0.00002	1.00128 ± 0.00110	63	0.56

Revision: PU-MET-INTER-002

- ANL – ZPR-6/10
  - Pu/C/SST Assembly Reflected by SS/Fe
  - Rich Lell
- Updated uncertainty analysis based on results from more recent ZPR/ZPPR benchmark evaluations

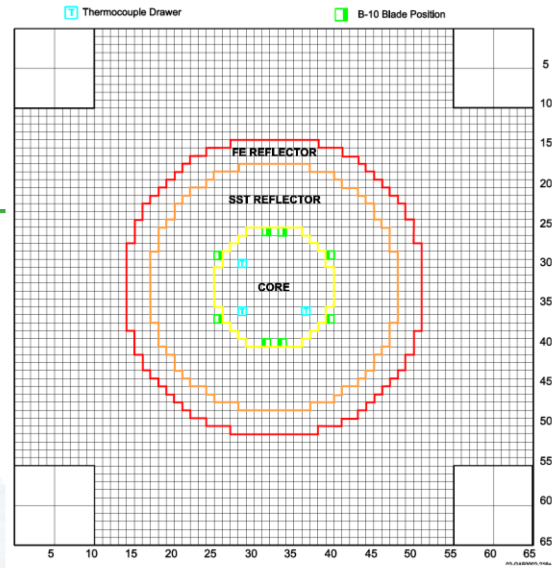


Table 4.1. Sample Calculation Results for Case 1, ZPR-6/10 Loading 24.

Code	Cross Sections	Calculation		C/E - 1	
		k_{eff}	σ	C/E-1, %	σ, %
KENO V.a	238-Group ENDF/B-V	1.0269	0.0009	3.96	0.26
KENO V.a	27-Group ENDF/B-IV	1.0262	0.0009	3.89	0.26
MCNP-4B	Cont. Energy ENDF/B-V	1.0038	0.0010	1.62	0.26
MCNP-4C	Cont. Energy ENDF/B-V	0.9945	0.0005	0.68	0.24
MCNP-4C	Cont- Energy ENDF/B-VI	1.0245	0.0005	3.72	0.25
VIM	Cont. Energy ENDF/B-V	0.9862	0.0005	-0.16	0.24
VIM	Cont. Energy ENDF/B-VI	1.0222	0.0006	3.48	0.25
MONK-8B[(a)]	8220-Group UKNDL	1.0444	0.0009	5.73	0.26
MONK-8B[(a)]	13193-Group JEF-2.2	1.0115	0.0009	2.40	0.26
MONK-8B[(a)]	13193-Group ENDF/B-VI	1.0324	0.0009	4.52	0.26
MCNP6	Cont. Energy ENDF/B-VII.1	1.0148	0.0001	2.73	0.24

(a) Results supplied by M. A. Smith (ANL)

Revision: HEU-MET-FAST-028

- LANL – Flattop
  - HEU Sphere Reflected by Nat-U
  - Roger Brewer
- Updated sample calculations from Jeff Favorite
  - Discrepancy noted in previously calculated results

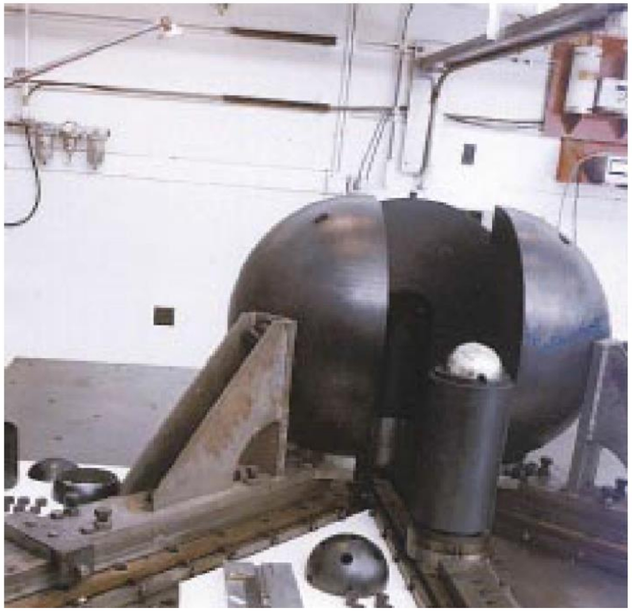


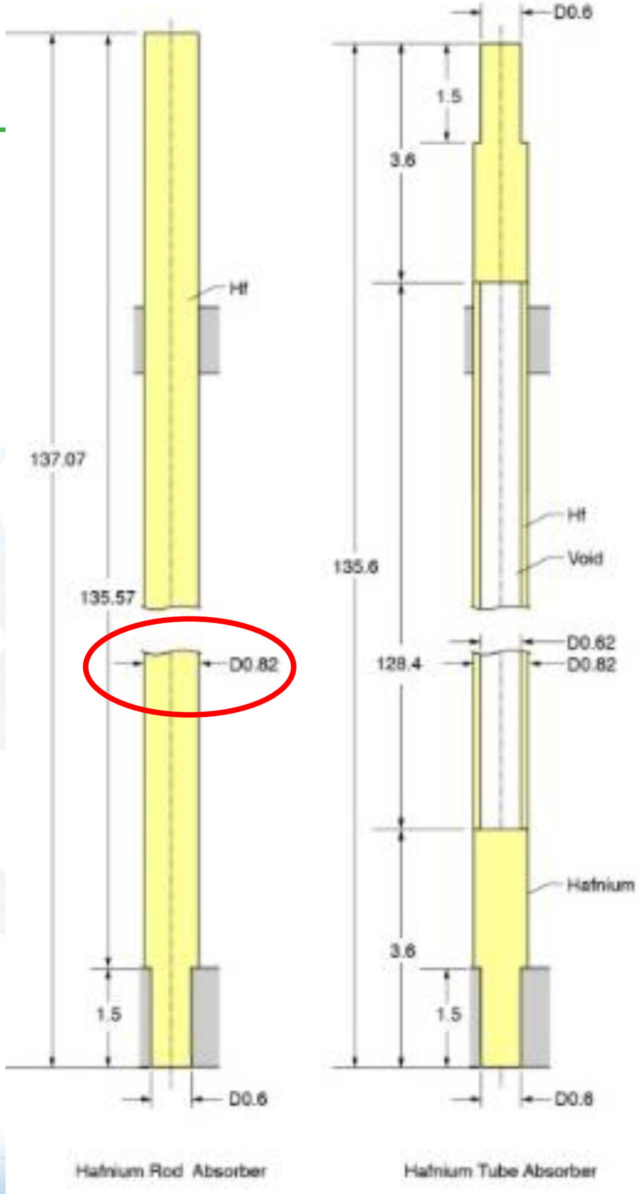
Table 3. Sample Calculation Results (United States).(a)

Code Name	Cross-Section Set	Calculated k_{eff}
KENO	Hansen-Roach (16 groups, no self-shielding)	0.9955 ± 0.0013
KENO	ENDF/B-IV (27 groups)	1.0050 ± 0.0012
MCNP6.1.1®	ENDF/B-V (Continuous-energy)	1.00422 ± 0.00001
MCNP6.1.1®	ENDF/B-VI.2 (Continuous-energy)	1.00248 ± 0.00001
MCNP6.1.1®	ENDF/B-VII.0 (Continuous-energy)	1.00288 ± 0.00001
MCNP6.1.1®	ENDF/B-VII.1 (Continuous-energy)	1.00284 ± 0.00001
ONEDANT	ENDF/B-IV (27 groups)	1.0076
PARTISN	ENDF/B-V (30 groups, no shelf-shielding)	0.99756
PARTISN	ENDF/B-VII.0 (30 groups, no self-shielding)	1.00262
PARTISN	ENDF/B-VII.0 (618 groups, no self-shielding)	1.00239

(a) Results reported with four decimal places appeared in Revision 1 of this evaluation (Sept. 1999). Results reported with five decimal places were calculated by Jeffrey A. Favorite, Los Alamos National Laboratory, in April 2016 for Revision 2 of this evaluation.

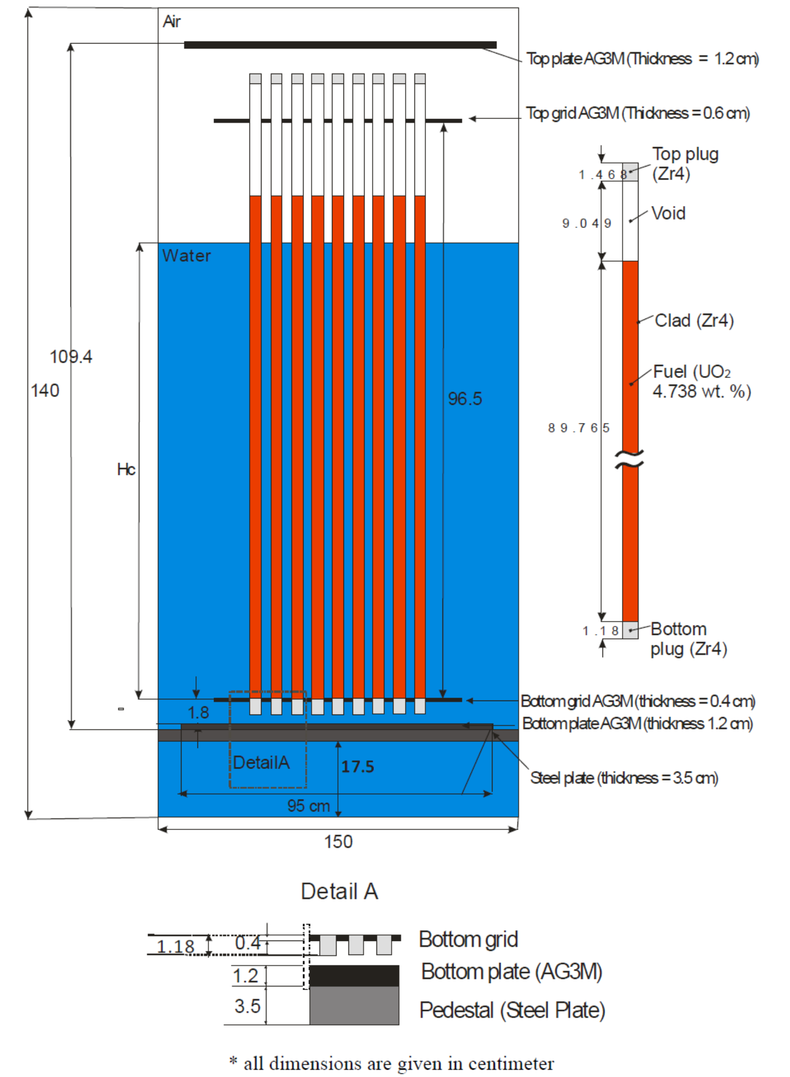
Revision: LEU-COMP-THERM-061

- **Kurchatov**
  - **VVER Physics Experiments**
  - **P-Facility**
- **Corrected error in benchmark diagram for absorber rod diameter**
  - **Figure 8**



Revision: LEU-COMP-THERM-071

- LEU O2 Fuel Rod Array (CEA, Valduc)
  - Nicolas Leclaire (IRSN)
- Updated uncertainty analysis, especially rod position uncertainty
- New photographs
- Updated sample calculations



Revision: FUND-NCERC-PU-HE3-MULT-001

- **NCERC – Ni-Reflected Pu Sphere**
  - **Benoit Richard**
  - **Jesson Hutchenson**
- **Revised uncertainty analysis for leakage multiplication, M_L**

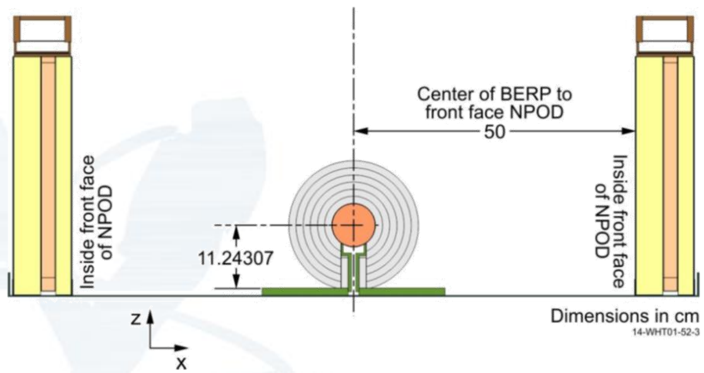


Figure 34. Overview of Full Setup, Cutout View in XZ Plane (Simplified Model).

Figure 35. Overview of Full setup, Cutout View in YZ Plane (Simplified Model).

Recent Additions to the Handbook

- 6 New
  - HEU-MET-FAST-083
    - Complex HEU Annuli
  - HEU-MET-FAST-096
    - Critical Experiments for SORA Reactor
  - LEU-COMP-THERM-097
    - 7uPCX Al/Ti Rod Experiments
  - ALARM-TRAN-PB-SHIELD-001
    - Fissile Solution Critical Excursion
  - ALARM-TRAN-CH2-SHIELD-001
    - Fissile Solution Critical Excursion
  - FUND-NCERC-PU-HE3-MULT-002
    - W-Reflected Pu Sphere

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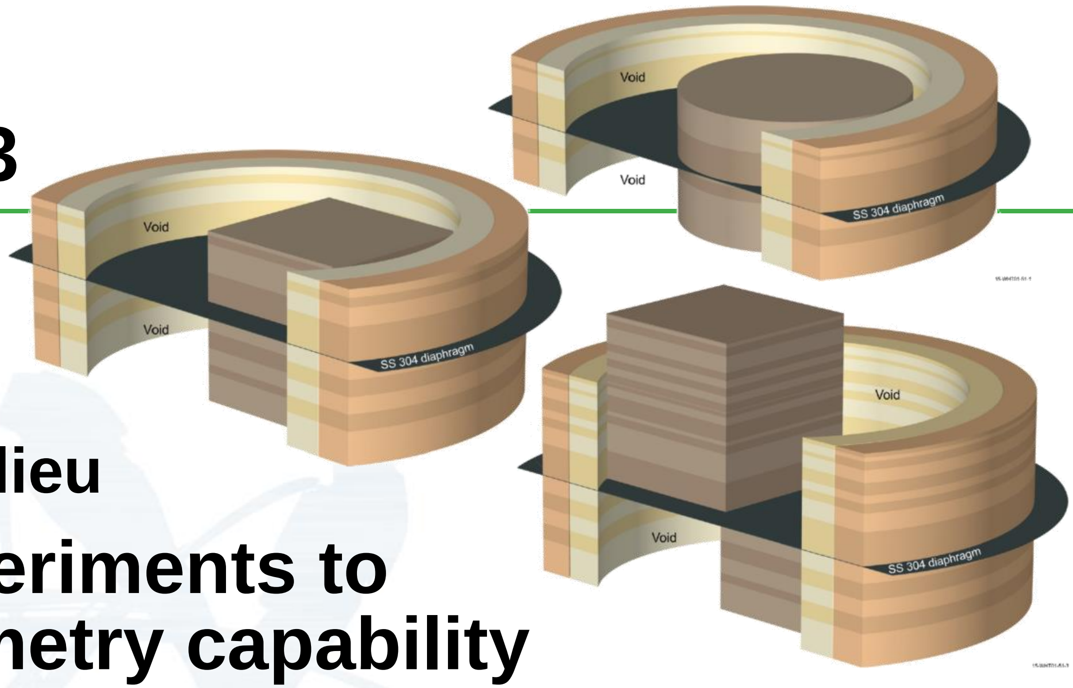
New:
HEU-MET-FAST-083

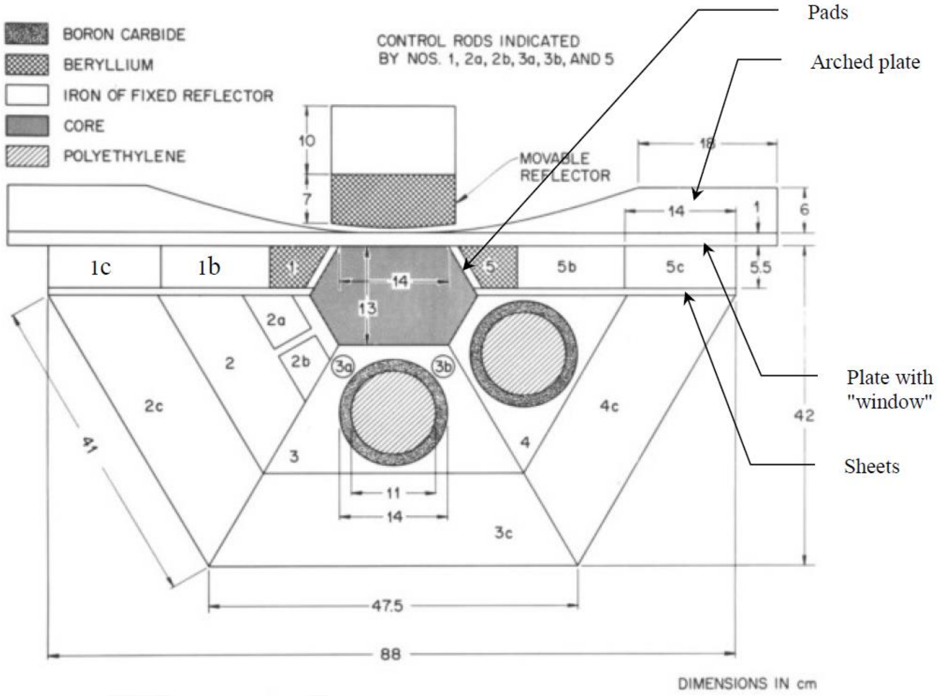
- **Complex HEU Annuli (ORCEF)**
  - ❖ **ISU – Quinton Bealieu**
- **J. T. Mihalczo experiments to test complex geometry capability of early Monte Carlo codes with off-centered geometries**

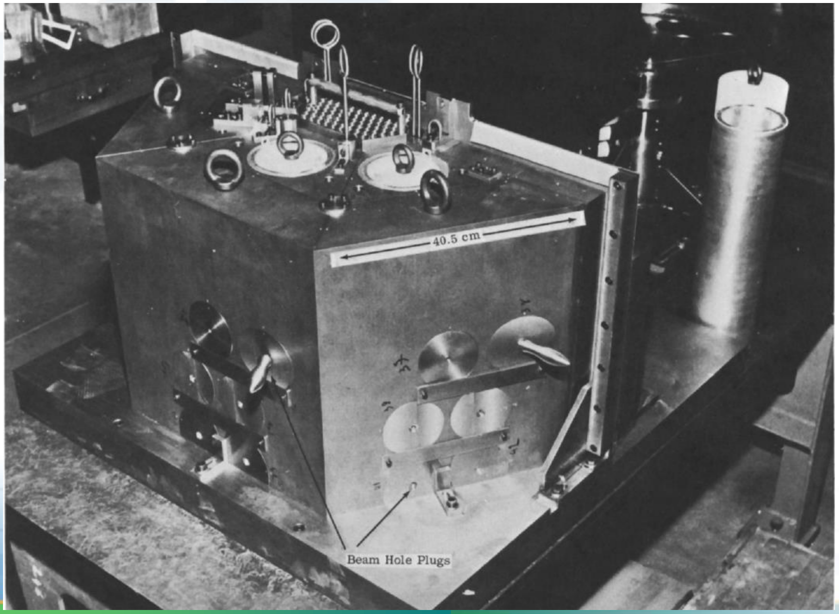


Case	Calculated			Benchmark Experiment			$\frac{C-E}{E}(\%)$
	k_{eff}	±	σ	k_{eff}	±	σ	
1 – Annulus with Cylinder	0.99693	±	0.00002	1.0001	±	0.0006	-0.31
2 – Annulus with Parallelepiped	0.99842	±	0.00002	0.9993	±	0.0012	-0.09
3 – Annulus with Split Parallelepiped	0.99616	±	0.00002	0.9984	±	0.0009	-0.22

New:
HEU-MET-FAST-096

- **SORA Critical Experiments (ORCEF)**
  - **Liu Xiaobo (China)**
- **J. T. Mihalczo experiments to mockup iron matrix and reflected pulse reactor**





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HEU-MET-FAST-096 Results

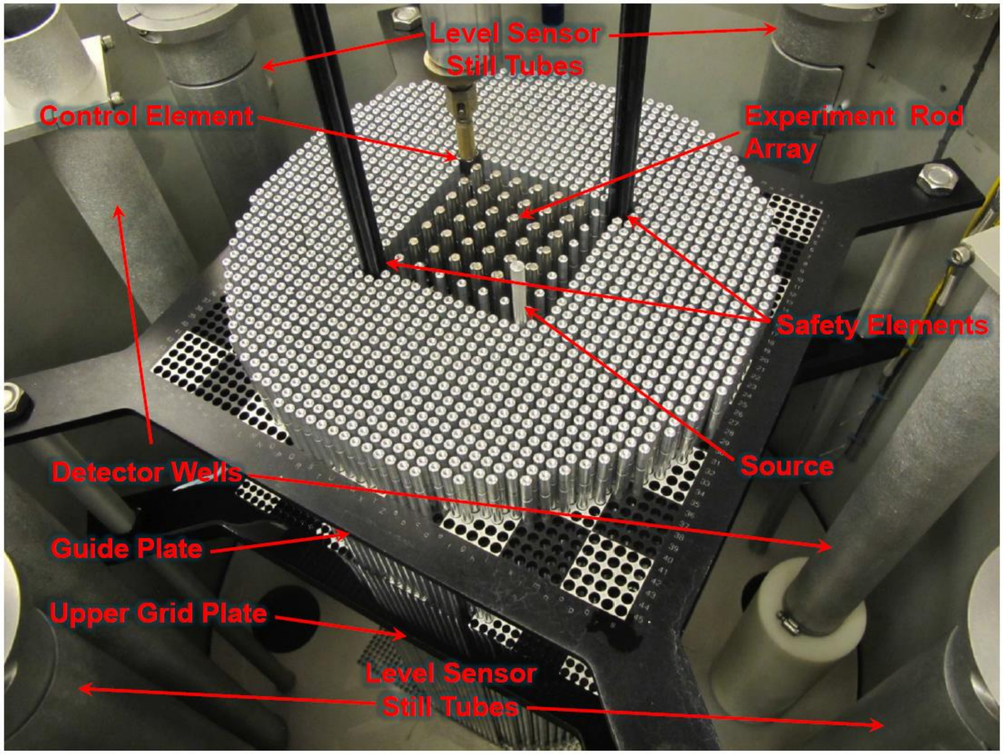
Be "Pulse" Reflector (Cases 1–9)

Fe "Pulse" Reflector (Cases 10–15)

Case	Calculated			Benchmark Experiment			$\frac{C-E}{E}\%$		
	Δk_{eff}	±	σ_{MC}	Δk_{eff}	±	σ			
1	0.99777	±	0.00004	1.0022	±	0.0024	-0.45	±	0.24
2	0.99845	±	0.00004	1.0021	±	0.0024	-0.37	±	0.24
3	1.00050	±	0.00004	1.0014	±	0.0025	-0.09	±	0.24
4	0.99883	±	0.00004	1.0020	±	0.0025	-0.32	±	0.24
5	1.00066	±	0.00004	1.0023	±	0.0026	-0.17	±	0.24
6	1.00009	±	0.00004	1.0017	±	0.0026	-0.16	±	0.24
7	0.99637	±	0.00004	1.0007	±	0.0026	-0.43	±	0.25
8	0.99722	±	0.00004	1.0019	±	0.0025	-0.46	±	0.24
9	0.99960	±	0.00004	1.0017	±	0.0025	-0.21	±	0.24
10	0.99582	±	0.00004	1.0014	±	0.0025	-0.55	±	0.25
11	0.99451	±	0.00004	1.0013	±	0.0023	-0.68	±	0.25
12	0.99390	±	0.00004	1.0013	±	0.0024	-0.74	±	0.25
13	1.00106	±	0.00004	1.0032	±	0.0023	-0.21	±	0.24
14	0.99299	±	0.00004	1.0008	±	0.0024	-0.78	±	0.25
15	0.99815	±	0.00004	1.0017	±	0.0024	-0.35	±	0.24

New: LEU-COMP-THERM-097

- Ti/Al Rods in 6.9% Enriched UO2 Lattices
  - Gary Harms – SNL
- 21 experiments designed to test titanium nuclear data



LEU-COMP-THERM-097 Results

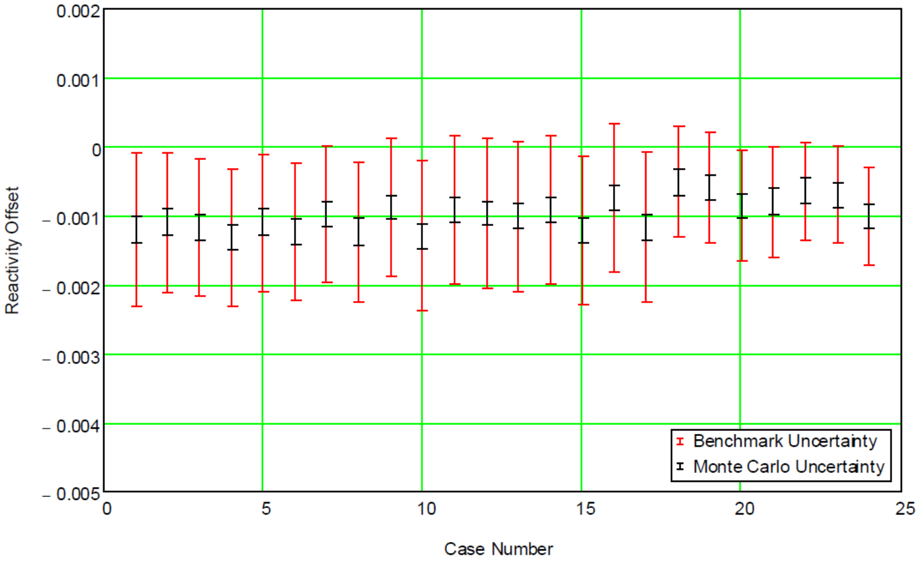


Figure 73. Reactivity Offset for MCNP6.1.1 Calculations using Continuous-Energy Cross Sections from the ENDF/B-VII.1 Library.

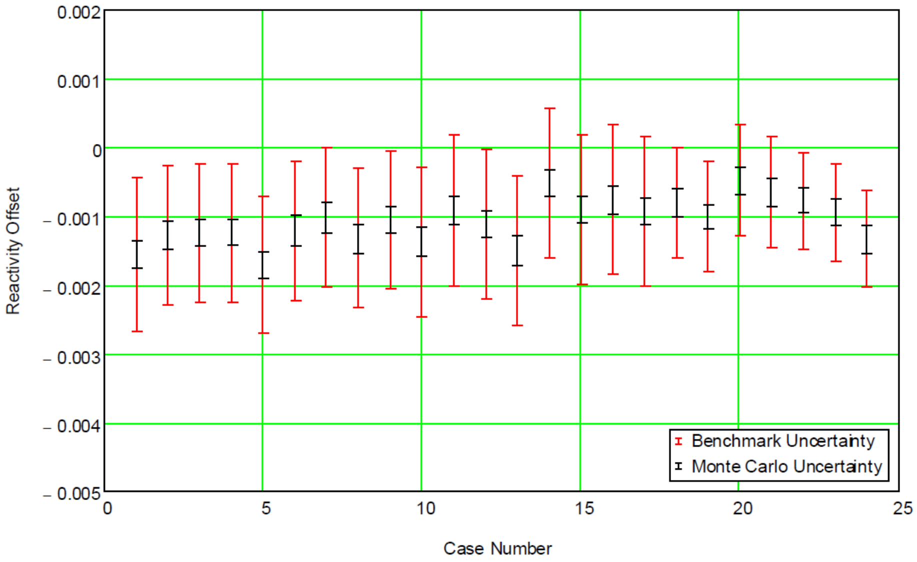


Figure 72. Reactivity Offset for KENO V.a Calculations using Continuous-Energy Cross Sections from the ENDF/B-VII.1 SCALE6.2 Library.

New: ALARM-TRAN -PB-SHIELD-001

- **Valduc SILENE with Pb Reflector**
  - **Thomas Miller (ORNL)**
- **Neutron activation and thermoluminescent dosimeter responses**

ALARM-TRAN-PB -SHIELD-001 Results

Table 4-10. Sample neutron activation calculation results with SCALE 6.2 ENDF/B-VII.1 (US)

Position	Reaction	Activity (Bq/g)	Monte Carlo relative uncertainty	C/E	C/E relative uncertainty
Case 1 collimator A	$^{59}Co(n,\gamma)^{60}Co$	7.001E+01	0.0458	1.15	0.0841
	$^{197}Au(n,\gamma)^{198}Au$	8.206E+04	0.0333	1.19	0.0758
	$^{115}In(n,\gamma)^{116}In$	9.615E+06	0.0481	1.21	0.0886
	$^{115}In(n,n'\gamma)^{115m}In$	5.761E+03	0.0188	0.94	0.0661
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	2.297E+03	0.0317	1.14	0.0759
	$^{24}Mg(n,p)^{24}Na$	3.367E+01	0.0229	1.36	0.0686
	$^{58}Ni(n,p)^{58}Co$	7.818E+00	0.0166	1.14	0.0657
Case 2 collimator B	$^{59}Co(n,\gamma)^{60}Co$	3.883E+01	0.0033	1.20	0.0784
	$^{197}Au(n,\gamma)^{198}Au$	3.883E+04	0.0041	1.25	0.0831
	$^{115}In(n,\gamma)^{116}In$	4.690E+06	0.0035	1.22	0.0842
	$^{115}In(n,n'\gamma)^{115m}In$	9.600E+02	0.0071	1.02	0.1076
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	1.257E+03	0.0033	1.21	0.0741
	$^{24}Mg(n,p)^{24}Na$	6.949E+00	0.0151	1.26	0.1196
	$^{58}Ni(n,p)^{58}Co$	1.475E+00	0.0077	1.16	0.1120
Case 3 free field	$^{59}Co(n,\gamma)^{60}Co$	7.641E+01	0.0409	1.22	0.0812
	$^{197}Au(n,\gamma)^{198}Au$	7.825E+04	0.0507	1.22	0.0832
	$^{115}In(n,\gamma)^{116}In$	8.874E+06	0.0414	1.13	0.0822
	$^{115}In(n,n'\gamma)^{115m}In$	5.176E+03	0.0297	0.99	0.0698
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	2.560E+03	0.0383	1.23	0.0749
	$^{24}Mg(n,p)^{24}Na$	3.091E+01	0.0277	1.17	0.0760
	$^{58}Ni(n,p)^{58}Co$	7.235E+00	0.0209	1.14	0.0667
Case 4 scattering box 1	$^{59}Co(n,\gamma)^{60}Co$	3.026E+01	0.0376	1.24	0.0828
	$^{197}Au(n,\gamma)^{198}Au$	2.987E+04	0.0314	1.24	0.0776
	$^{115}In(n,\gamma)^{116}In$	3.653E+06	0.0341	1.26	0.0852
	$^{115}In(n,n'\gamma)^{115m}In$	3.429E+02	0.0368	1.06	0.1113
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	1.151E+03	0.0470	1.31	0.0820
	$^{24}Mg(n,p)^{24}Na$	1.451E+00	0.0143	1.20	0.1358
	$^{58}Ni(n,p)^{58}Co$	4.076E-01	0.0152	1.26	0.1323
Case 5 scattering box 2	$^{59}Co(n,\gamma)^{60}Co$	3.521E+01	0.0161	1.25	0.0749
	$^{197}Au(n,\gamma)^{198}Au$	3.285E+04	0.0163	1.27	0.0717
	$^{58}Ni(n,p)^{58}Co$	2.128E-01	0.0318	1.12	0.1170
Case 6 scattering box 3	$^{59}Co(n,\gamma)^{60}Co$	5.479E+01	0.0287	1.20	0.0774
	$^{197}Au(n,\gamma)^{198}Au$	5.436E+04	0.0309	1.24	0.0753
	$^{58}Ni(n,p)^{58}Co$	1.767E+00	0.0301	1.01	0.0776
Case 7 scattering box 4	$^{59}Co(n,\gamma)^{60}Co$	4.946E+01	0.0270	1.20	0.0776
	$^{197}Au(n,\gamma)^{198}Au$	4.889E+04	0.0357	1.25	0.0779
	$^{58}Ni(n,p)^{58}Co$	1.787E+00	0.0426	0.98	0.0839

Table 4-11. Sample TLD dose calculation results with SCALE 6.2 ENDF/B-VII.1 (US)

Position	TLD Type	Dose (Gy)	Monte Carlo relative uncertainty	C/E	C/E relative uncertainty
Case 1 collimator A	Al_2O_3	6.909E-01	0.0837	0.84	0.1164
Case 2 collimator B	Al_2O_3	4.264E-01	0.0270	0.78	0.1217
Case 3 free field	Al_2O_3	3.101E-01	0.1289	0.55	0.1509
Case 6 scattering box 3	Al_2O_3	3.178E-01	0.0885	0.76	0.1183

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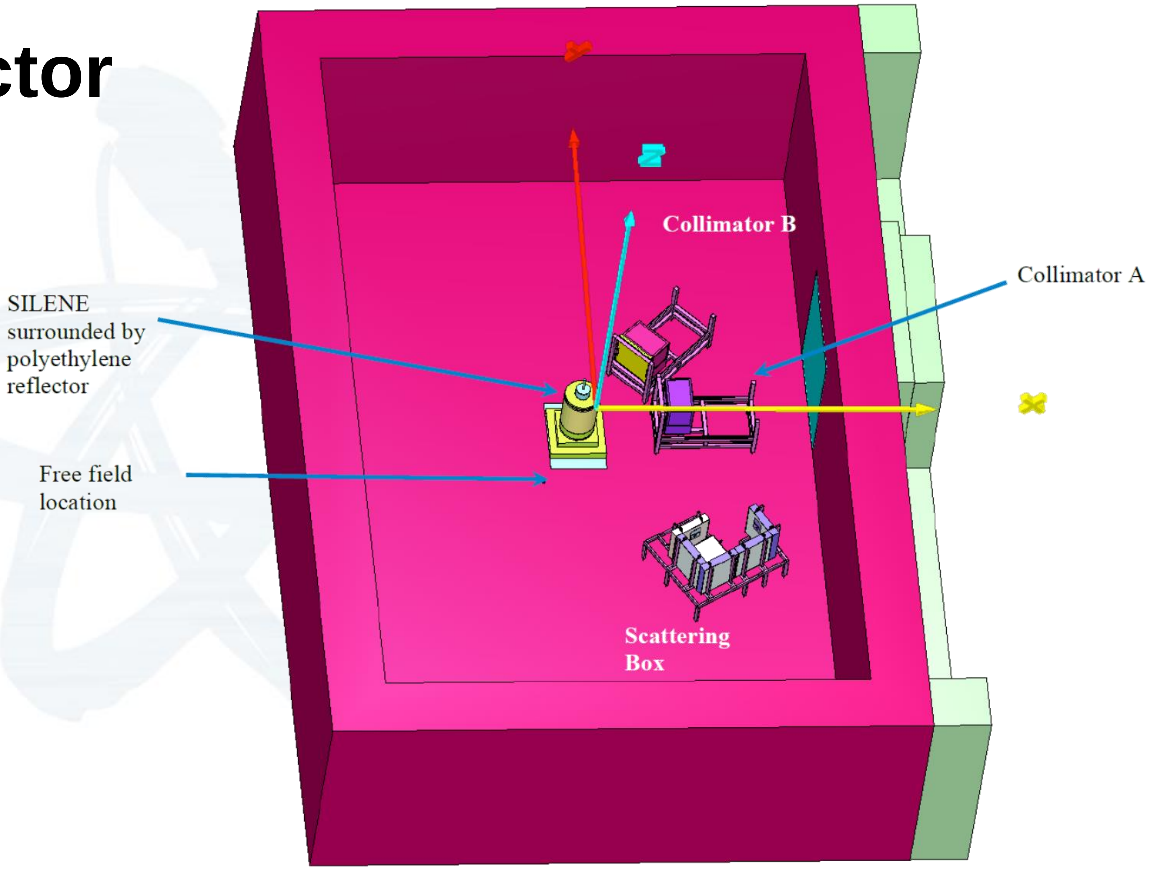
New: ALARM-TRAN-CH2-SHIELD-001

- **Valduc SILENE with CH2 Reflector**
  - **Thomas Miller (ORNL)**
- **Neutron activation and thermo-luminescent dosimeter responses**



ALARM-TRAN-CH2 -SHIELD-001 Results

Table 4-8. Sample Neutron Activation Calculation Results with MCNP6 ENDF/B-VII.1 (US).

Position	Reaction	Activity (Bq/g)	Monte Carlo relative uncertainty	C/E	C/E relative uncertainty
Case 1 collimator A	$^{59}Co(n,\gamma)^{60}Co$	4.644E+00	0.0024	1.0206	0.0683
	$^{197}Au(n,\gamma)^{198}Au$	5.801E+03	0.0030	0.8911	0.0716
	$^{115}In(n,\gamma)^{116}In$	6.407E+05	0.0032	0.9591	0.0691
	$^{115}In(n,n'\gamma)^{115m}In$	8.269E+02	0.0020	0.8327	0.0630
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	1.722E+02	0.0029	0.9165	0.0638
	$^{24}Mg(n,p)^{24}Na$	1.608E+01	0.0036	0.9928	0.0747
	$^{58}Ni(n,p)^{58}Co$	1.939E+00	0.0018	0.9005	0.0654
Case 2 collimator B	$^{59}Co(n,\gamma)^{60}Co$	7.427E-01	0.0024	1.1253	0.0855
	$^{197}Au(n,\gamma)^{198}Au$	1.091E+03	0.0033	0.9314	0.0798
	$^{115}In(n,\gamma)^{116}In$	9.983E+04	0.0033	0.9092	0.0825
	$^{115}In(n,n'\gamma)^{115m}In$	3.595E+02	0.0019	0.8746	0.0722
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	3.775E+01	0.0022	0.9075	0.0749
	$^{24}Mg(n,p)^{24}Na$	8.019E+00	0.0034	1.0428	0.0774
Case 3 free field	$^{59}Co(n,\gamma)^{60}Co$	5.448E+00	0.0033	1.0896	0.0692
	$^{197}Au(n,\gamma)^{198}Au$	5.860E+03	0.0043	1.0559	0.0648
	$^{115}In(n,\gamma)^{116}In$	6.648E+05	0.0035	1.1326	0.0725
	$^{115}In(n,n'\gamma)^{115m}In$	7.067E+02	0.0021	0.8403	0.0683
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	2.110E+02	0.0037	0.9859	0.0671
	$^{24}Mg(n,p)^{24}Na$	1.575E+01	0.0044	1.0712	0.0801
	$^{58}Ni(n,p)^{58}Co$	1.800E+00	0.0025	1.0033	0.0634
Case 4 scattering box 1	$^{59}Co(n,\gamma)^{60}Co$	2.577E+00	0.0016	1.1894	0.0729
	$^{197}Au(n,\gamma)^{198}Au$	2.548E+03	0.0020	1.0798	0.0739
	$^{115}In(n,\gamma)^{116}In$	3.034E+05	0.0019	1.1448	0.0743
	$^{115}In(n,n'\gamma)^{115m}In$	5.681E+01	0.0034	0.9661	0.0994
	$^{56}Fe(n,p)^{56}Mn$ + $^{55}Mn(n,\gamma)^{56}Mn$	9.111E+01	0.0021	1.1636	0.0685
Case 5 scattering box 2	$^{59}Co(n,\gamma)^{60}Co$	3.040E+00	0.0013	1.2078	0.0709
	$^{197}Au(n,\gamma)^{198}Au$	2.951E+03	0.0018	1.1763	0.0688
Case 6 scattering box 3	$^{59}Co(n,\gamma)^{60}Co$	4.327E+00	0.0014	1.1065	0.0717
	$^{197}Au(n,\gamma)^{198}Au$	4.336E+03	0.0018	1.1089	0.0681
Case 7 scattering box 4	$^{59}Co(n,\gamma)^{60}Co$	3.953E+00	0.0013	1.1388	0.0696
	$^{197}Au(n,\gamma)^{198}Au$	3.888E+03	0.0017	1.0595	0.0730

Table 4-9. Sample TLD Dose Calculation Results with MCNP6 ENDF/B-VII.1 (US).

Position	TLD Type	Dose (Gy)	Monte Carlo relative uncertainty	C/E	C/E relative uncertainty
Case 1 collimator A	Al_2O_3	3.314E+00	0.0071	0.6265	0.0787
Case 2 collimator B	Al_2O_3	1.902E+00	0.0044	0.6040	0.0832
Case 3 free field	Al_2O_3	3.130E+00	0.0041	0.6535	0.0917
Case 6 scattering box 3	Al_2O_3	6.628E-01	0.0034	0.6563	0.0846
Case 7 scattering box 4	Al_2O_3	7.478E-01	0.0058	0.6560	0.0784

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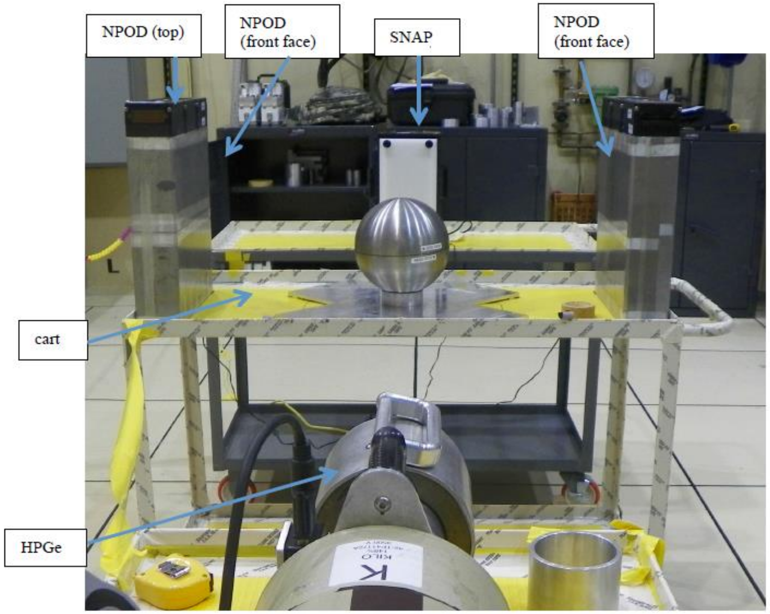
New: FUND-NCERC-PU-HE3-MULT-002

- NCERC – W-Reflected Pu Sphere
  - Benoit Richard
  - Jesson Hutchenson



- Subcritical measurements with varying reflector thickness

Case	Tungsten Thickness (in.)	R_1 (cts/s)	σ	(C-E)/E (%)	R_2 (cts/s)	σ	(C-E)/E (%)	M_L	σ	(C-E)/E (%)
1	0.0	9387.38	3.14	4.06	1752.88	9.65	6.64	3.545	0.023	5.16
2	0.5	13402.94	4.10	1.83	4810.58	17.46	0.38	4.473	0.022	-0.71
3	1.0	17273.83	5.12	0.84	10174.02	29.20	-2.40	5.514	0.024	-4.43
4	1.5	21518.23	6.36	0.04	19521.57	49.74	-3.38	6.644	0.026	-5.66
5	2.0	26082.81	7.81	-0.15	34258.82	79.50	-4.05	7.865	0.029	-6.28
6	2.5	30718.62	9.44	-0.46	55664.39	122.18	-4.33	9.137	0.029	-7.08
7	2.75	32958.73	10.29	-0.57	68657.54	146.86	-4.49	9.834	0.035	-6.20
8	3.0	35236.45	11.16	-1.00	83636.32	175.06	-5.42	10.442	0.032	-7.29

Evaluations Planned for Future Publication

- Bettis TRX Critical Experiments
- INL/NASA UF6 Spherical Gas-Core Reactor
- IRSN/Valduc H2O-Moderated LEUO2 Rods with CH2 Core
- IPEN/MB-01 Subcritical Experiments
- NCERC Cu-Reflected Pu Sphere
- SNL Ti Experiments in BUCCX
- JAEA TRACY Critical and Supercritical Experiments
- Westinghouse Saxton Plutonium Project
- Transient Reactor Test (TREAT)
- GODIVA-IV Revision

Conclusions

- The ICSBEP and IRPhEP continue to provide high-quality integral benchmark data
- Valuable for nuclear data testing, uncertainty reduction, criticality safety, reactor physics, advanced modeling and simulation
- Data contributed from 25 countries
- Enable current and future activities supported by experimental validation

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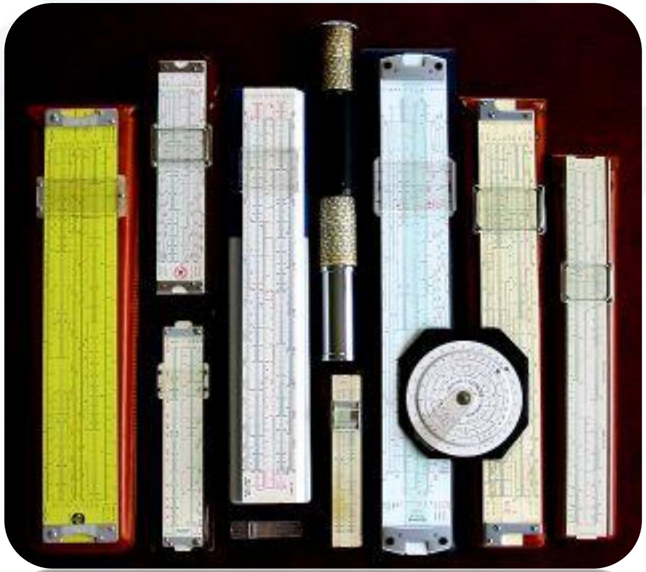
Questions?

Extra Slides



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- Argentina
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- Canada
- People's Republic of China
- Czech Republic
- France
- Germany
- Hungary
- India
- Israel
- Italy
- Japan

- Kazakhstan
- Poland
- Republic of Korea
- Russian Federation
- Serbia
- Slovenia
- South Africa
- Spain
- Sweden
- Switzerland
- United Kingdom
- United States of America

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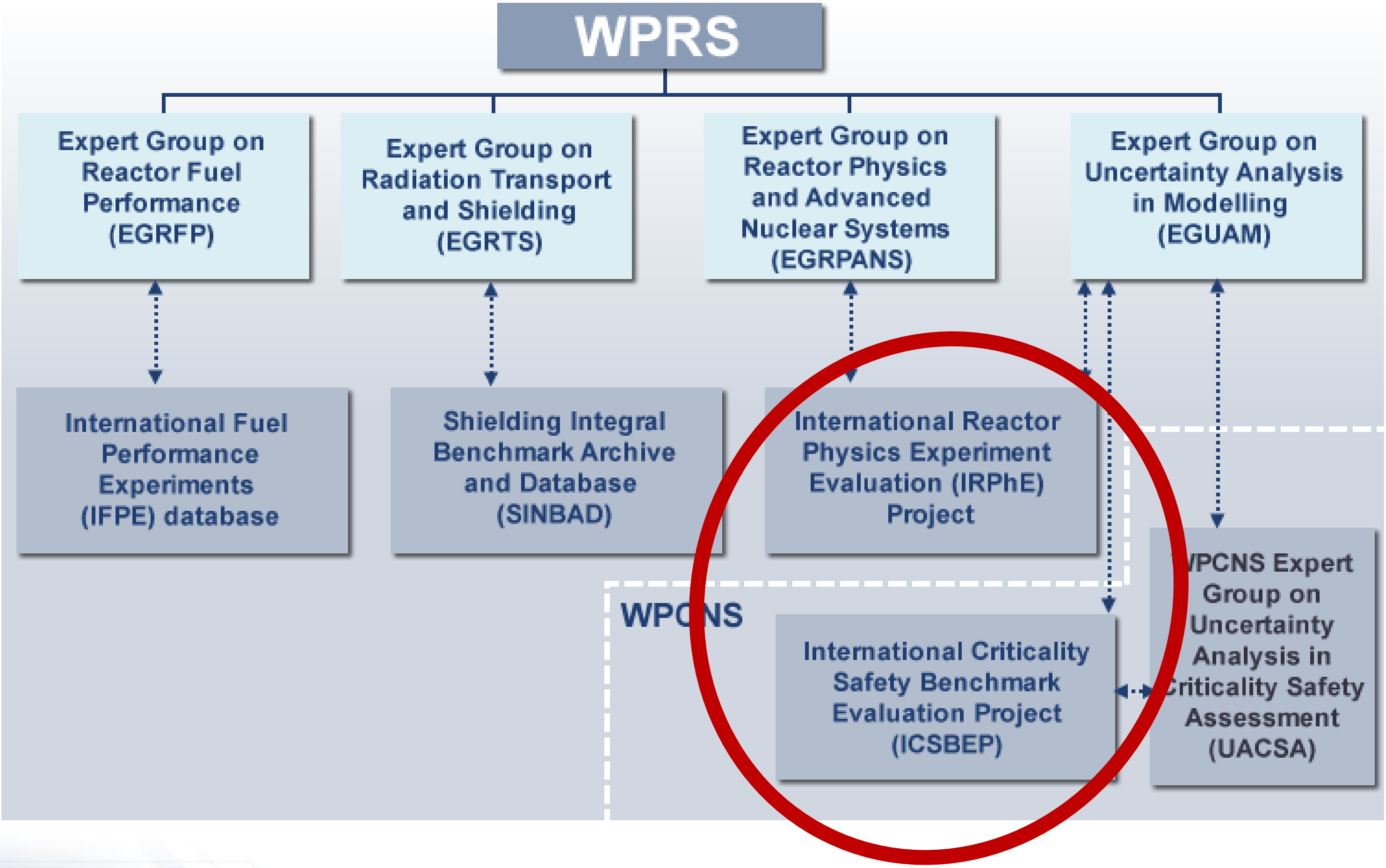

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