LA-UR-18-30577
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Title: Release Testing for MCNP 6.2.1

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Intended for: Report

Issued: 2018-11-02

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November 2, 2018

Contents

1 Summary

This document summarizes testing of MCNP® 6.2.1 for various benchmark validation and regression test suites. In particular, it depicts observed changes in results from the release of

MCNP 6.2.0. The results for MCNP 6.2.1 for each of the test suites is given in the following sections. More details for each suite and further analysis of the accuracy of MCNP 6.2.0 can be found in reference [4] (available in the MCNP references collection). Testing of the ACODE feature of MCNP has been included for the 6.2.1 release. As ACODE testing was not included in the 6.2.0 release, expanded detail is given in Section 8, with comparisons to a build of MCNP 6.2.0 and benchmark values.

Numerical results between version 6.2.0 and 6.2.1 agreed or were within expected statistics, indicating that MCNP 6.2.1 is accurate as MCNP 6.2.0 for the range of problems tested. Across all suites, differences in numerical quantities between the two versions is a result of the inclusion of the intel compiler flag option '`-fp-model consistent`', which is now included as a default build option for MCNP 6.2.1. This option changes floating-point arithmetic to produce consistent, reproducible results across different optimization levels, for equivalent architectures. This option allowed the code optimization to be increased to `O2` with minimal differences, improving performance in some cases. However, the change in arithmetic can lead to a change in random number usage, resulting in differences in integral quantities overall in certain cases. All these changes were found to be within expected statistics.

All results herein were generated on the LANL HPC machine Snow with Intel Xeon CPU E5-2695 v4 2.10GHz processors. MCNP was compiled with the default cmake build system options for Intel 18.0.2 as the c++ and Fortran compiler. Tests were performed in serial.

2 MCNP6 Analytical Criticality Verification Suite

The analytic criticality verification test suite (VERIFICATION_KEFF) consists of a variety of simplified test problems for which the exact k-effective of the system is known. Many of the test problems can be run in either multigroup (MG) or continuous-energy (CE) mode.

In Table 1 the test problems that can be executed in both MG and CE modes are shown, while the remaining test problems that can only be executed in MG mode are shown in Table 2. Because there are no differences in the results between the MCNP6.2 and MCNP6.2.1 releases, only the current release results are shown.

3 MCNP6 Criticality Validation Suite

The criticality validation test suite (VALIDATION_CRITICALITY) consists of 31 benchmark experiment test problems coming from the International Criticality Safety Benchmark Experiment Project (ICSBEP) handbook. These test problems cover a variety of fissile materials, configurations and energy spectra.

In Table 3, 6 of the 31 benchmarks, indicated with an asterisk, have differing results between the MCNP6.2 and the MCNP6.2.1 releases. Each of these differences were caused by the Intel Fortran compiler option (`-fp-model consistent`) that is now used by default in the MCNP6.2.1 release. Running the MCNP6.2 code with this compiler option gives the exact same results as the default MCNP6.2.1 release.

With respect to computational performance in running this entire suite of tests, the MCNP6.2.1 is ∼5.3% slower than MCNP6.2. The primary reason for this slowdown is the new mixed-material implementation in MCNP6.2.1 and not the `-fp-model consistent` flag, which only caused a ∼1.2% slowdown.

4 MCNP6 Extended Criticality Validation Suite

The extended criticality validation test suite (VALIDATION_CRIT_EXTENDED) consists of 119 benchmark experiment test problems coming from the International Criticality Safety Benchmark Experiment Project (ICSBEP) handbook. These test problems cover a wider variety of fissile materials, configurations and energy spectra as compared the original criticality validation test suite.

In Tables 4–8, 21 of the 119 benchmarks, indicated with an asterisk, have differing results between the MCNP6.2 and the MCNP6.2.1 releases. As before, each of these differences are caused by the `-fp-model consistent` compiler flag.

With respect to computational performance in running this entire suite of tests, the MCNP6.2.1 is ∼4.4% slower than MCNP6.2. The primary reason for this slowdown is again the new mixed-material implementation in MCNP6.2.1 and not the new `-fp-model consistent` flag, which causes a ∼1.4% slowdown.

5 Electron-Photon Validation Suites

5.1 Thin Foil Multiple-Elastic Scattering Suite

The tests in this suite study the angular distributions of electrons emerging from thin foils. Electron transport is the primary focus of these studies, but photon transport is verified to a lesser extent. Results were generated with MCNP 6.2.1 for each of the suites (labeled as Al, Pb, and Be Faddegon studies). There were no numerical differences in tallies from MCNP 6.2.0, except for the Be case. This difference was caused by `-fp-model consistent` compiler flag. This test suite contains templates giving differences from the 6.2.0 release. The following diffs were observed for the Be suite:

```
             OUTP      MCTAL      WWOUT      PTRAC     MESHTAL     EEOUT      GMV
__CASE________diff_____diff______diff______diff______diff______diff______diff__
  inp001     167133     20394         -          -          -          -         -
```

All templates in the suite were updated to the new outputs for MCNP 6.2.1 (with the `-fp-model consistent` flag) in this release.

5.2 Lockwood Validation Suite

This test suite studies electron energy deposition for a variety of absorber thicknesses and incident angles, for 0.05 and 1.0 MeV incident electrons. For this test suite, only the Ta,

Table 1: Analytic Criticality Verification Suite: MG and CE cases

Experiment	Analytic Results k-eff	MCNP6.2.1 MG Results k-eff	MCNP6.2.1 MG Results std	MCNP6.2.1 CE Results k-eff	MCNP6.2.1 CE Results std
PUa-1-0-IN	2.6129	2.6129	0.0000	2.6129	0.0000
PUa-1-0-SL	1.0000	0.9999	0.0001	1.0000	0.0001
PUa-H2O(1)-1-0-SL	1.0000	1.0001	0.0001	1.0001	0.0001
PUa-H2O(0.5)-1-0-SL	1.0000	1.0000	0.0001	1.0000	0.0001
PUb-1-0-IN	2.2903	2.2903	0.0000	2.2903	0.0000
PUb-1-0-SL	1.0000	1.0001	0.0001	1.0001	0.0001
PUb-1-0-CY	1.0000	1.0000	0.0001	1.0000	0.0001
PUb-1-0-SP	1.0000	1.0002	0.0001	1.0001	0.0001
PUb-H2O(1)-1-0-CY	1.0000	0.9999	0.0001	1.0001	0.0001
PUb-H2O(10)-1-0-CY	1.0000	1.0001	0.0001	1.0001	0.0001
Ua-1-0-IN	2.2500	2.2500	0.0000	2.2500	0.0000
Ua-1-0-SL	1.0000	1.0000	0.0001	1.0000	0.0001
Ua-1-0-CY	1.0000	1.0001	0.0001	1.0000	0.0001
Ua-1-0-SP	1.0000	0.9999	0.0001	1.0001	0.0001
Ub-1-0-IN	2.3309	2.3309	0.0000	2.3309	0.0000
Ub-H2O(1)-1-0-SP	1.0000	0.9999	0.0001	1.0001	0.0001
Uc-1-0-IN	2.2561	2.2561	0.0000	2.2561	0.0000
Uc-H2O(2)-1-0-SP	1.0000	1.0000	0.0001	1.0001	0.0001
Ud-1-0-IN	2.2327	2.2327	0.0000	2.2327	0.0000
Ud-H2O(3)-1-0-SP	1.0000	1.0000	0.0001	1.0000	0.0001
UD2O-1-0-IN	1.1333	1.1333	0.0000	1.1333	0.0000
UD2O-1-0-SL	1.0000	1.0000	0.0001	1.0000	0.0001
UD2O-1-0-CY	1.0000	1.0000	0.0001	0.9999	0.0001
UD2O-1-0-SP	1.0000	1.0000	0.0001	1.0000	0.0001
UD2O-H2O(1)-1-0-SL	1.0000	1.0000	0.0001	1.0001	0.0001
UD2O-H2O(10)-1-0-SL	1.0000	1.0000	0.0001	1.0000	0.0001
UD2O-H2O(1)-1-0-CY	1.0000	1.0001	0.0001	1.0000	0.0001
UD2O-H2O(10)-1-0-CY	1.0000	1.0000	0.0001	1.0001	0.0001
Ue-1-0-IN	2.1807	2.1807	0.0000	2.1807	0.0000
Ue-Fe-Na-1-0-SL	1.0000	1.0000	0.0001	1.0000	0.0001
PU-1-1-IN	2.5000	2.5000	0.0000	2.5000	0.0000
PUa-1-1-SL	1.0000	1.0000	0.0001	1.0000	0.0001
Ua-1-1-CY	1.0000	1.0000	0.0001	0.9999	0.0001
UD2Oa-1-1-IN	1.2056	1.2056	0.0000	1.2056	0.0000
UD2Oa-1-1-SP	1.0000	1.0000	0.0001	1.0001	0.0001
UD2Ob-1-1-IN	1.2274	1.2274	0.0000	1.2274	0.0000
UD2Ob-1-1-SP	1.0000	1.0000	0.0001	1.0001	0.0001

Table 2: Analytic Criticality Verification Suite: MG only cases

	Analytic Results	MCNP6.2.1 MG Results	
Experiment	k-eff	k-eff	std
PU-2-0-IN	2.6838	2.6837	0.0000
PU-2-0-SL	1.0000	0.9999	0.0001
PU-2-0-SP	1.0000	1.0001	0.0001
U-2-0-IN	2.2163	2.2163	0.0000
U-2-0-SL	1.0000	0.9999	0.0001
U-2-0-SP	1.0000	1.0000	0.0001
UAL-2-0-IN	2.6624	2.6624	0.0000
UAL-2-0-SL	1.0000	0.9998	0.0002
UAL-2-0-SP	1.0000	1.0002	0.0002
URRa-2-0-IN	1.6315	1.6315	0.0000
URRa-2-0-SL	1.0000	1.0001	0.0001
URRa-2-0-SP	1.0000	0.9999	0.0001
URRb-2-0-IN	1.3658	1.3658	0.0000
URRc-2-0-IN	1.6334	1.6334	0.0000
URRb-H2Oa(1)-2-0-SL	1.0000	1.0000	0.0001
URRb-H2Oa(5)-2-0-SL	1.0000	1.0001	0.0001
URRb-H2Oa(IN)-2-0-SL	1.0000	0.9999	0.0001
URRc-H2Oa(IN)-2-0-SL	1.0000	0.9999	0.0001
URRd-2-0-IN	1.0350	1.0350	0.0000
URRd-H2Ob(1)-2-0-ISLC	1.0000	0.9999	0.0001
URRd-H2Ob(10)-2-0-ISLC	1.0000	0.9999	0.0001
URRd-H2Oc(1)-2-0-ISLC	1.0000	1.0000	0.0001
URRd-H2Oc(10)-2-0-ISLC	1.0000	1.0000	0.0000
UD2O-2-0-IN	1.0002	1.0002	0.0001
UD2O-2-0-SL	1.0000	0.9998	0.0001
UD2O-2-0-SP	1.0000	0.9996	0.0001
URRa-2-1-IN	1.6315	1.6315	0.0000
UD2O-2-1-IN	1.0002	1.0002	0.0001
UD2O-2-1-SL	1.0000	0.9998	0.0001
URR-3-0-IN	1.6000	1.6000	0.0000
URR-6-0-IN	1.6000	1.6000	0.0000

Table 3: Criticality Validation Suite

	Experiment Results		MCNP6.2.0 Results		MCNP6.2.1 Results	
Experiment	k-eff	std	k-eff	std	k-eff	std
U233 Benchmarks						
JEZ233	1.0000	0.0010	1.0000	0.0006	1.0000	0.0006
FLAT23	1.0000	0.0014	0.9974	0.0007	0.9974	0.0007
UMF5C2	1.0000	0.0030	0.9960	0.0007	0.9960	0.0007
FLSTF1	1.0000	0.0083	0.9845	0.0011	0.9845	0.0011
*SB25	1.0000	0.0024	1.0007	0.0010	0.9998	0.0010
ORNL11	1.0006	0.0029	1.0018	0.0003	1.0018	0.0003
HEU Benchmarks						
GODIVA	1.0000	0.0010	0.9988	0.0006	0.9988	0.0006
*TT2C11	1.0000	0.0038	1.0009	0.0008	0.9997	0.0008
FLAT25	1.0000	0.0030	1.0034	0.0006	1.0034	0.0006
GODIVR	0.9985	0.0011	0.9989	0.0007	0.9989	0.0007
UH3C6	1.0000	0.0047	0.9957	0.0008	0.9957	0.0008
*ZEUS2	0.9997	0.0008	0.9976	0.0007	0.9955	0.0008
SB5RN3	1.0015	0.0028	0.9945	0.0013	0.9945	0.0013
ORNL10	1.0015	0.0026	1.0001	0.0004	1.0001	0.0004
IEU Benchmarks						
IMF03	1.0000	0.0017	1.0019	0.0006	1.0019	0.0006
BIGTEN	0.9948	0.0013	0.9952	0.0005	0.9952	0.0005
IMF04	1.0000	0.0030	1.0082	0.0006	1.0082	0.0006
*ZEBR8H	1.0300	0.0025	1.0186	0.0005	1.0187	0.0005
*ICT2C3	1.0017	0.0044	1.0035	0.0007	1.0040	0.0007
STACY36	0.9988	0.0013	0.9981	0.0006	0.9981	0.0006
LEU Benchmarks						
BAWXI2	1.0007	0.0012	1.0021	0.0006	1.0021	0.0006
LST2C2	1.0024	0.0037	0.9960	0.0006	0.9960	0.0006
Pu Benchmarks						
JEZPU	1.0000	0.0020	0.9990	0.0006	0.9990	0.0006
JEZ240	1.0000	0.0020	0.9999	0.0006	0.9999	0.0006
PUBTNS	1.0000	0.0030	0.9980	0.0007	0.9980	0.0007
FLATPU	1.0000	0.0030	1.0004	0.0007	1.0004	0.0007
THOR	1.0000	0.0006	0.9976	0.0006	0.9976	0.0006
PUSH2O	1.0000	0.0010	1.0013	0.0008	1.0013	0.0008
*HISHPG	1.0000	0.0110	1.0121	0.0006	1.0113	0.0006
PNL2	1.0000	0.0065	1.0050	0.0010	1.0050	0.0010

Table 4: Extended Criticality Validation Suite: U233 cases only

Experiment	Experiment Results k-eff	std	MCNP6.2.0 Results k-eff	std	MCNP6.2.1 Results k-eff	std
U233 Benchmarks						
u233-met-fast-001	1.0000	0.0010	1.0000	0.0003	1.0000	0.0003
u233-met-fast-002-case-1	1.0000	0.0010	0.9983	0.0003	0.9983	0.0003
u233-met-fast-002-case-2	1.0000	0.0011	1.0003	0.0003	1.0003	0.0003
u233-met-fast-003-case-1	1.0000	0.0010	0.9995	0.0003	0.9995	0.0003
u233-met-fast-003-case-2	1.0000	0.0010	0.9995	0.0003	0.9995	0.0003
u233-met-fast-006	1.0000	0.0014	0.9984	0.0003	0.9984	0.0003
u233-met-fast-004-case-1	1.0000	0.0007	0.9988	0.0003	0.9988	0.0003
u233-met-fast-004-case-2	1.0000	0.0008	0.9956	0.0003	0.9956	0.0003
u233-met-fast-005-case-1	1.0000	0.0030	0.9959	0.0003	0.9959	0.0003
u233-met-fast-005-case-2	1.0000	0.0030	0.9952	0.0003	0.9952	0.0003
u233-sol-inter-001-case-1	1.0000	0.0083	0.9845	0.0005	0.9845	0.0005
*u233-comp-therm-001-case-3	1.0000	0.0024	1.0034	0.0004	1.0030	0.0004
u233-sol-therm-001-case-1	1.0000	0.0031	1.0010	0.0003	1.0010	0.0003
u233-sol-therm-001-case-2	1.0000	0.0033	1.0010	0.0003	1.0010	0.0003
u233-sol-therm-001-case-3	1.0000	0.0033	1.0007	0.0003	1.0007	0.0003
u233-sol-therm-001-case-4	1.0000	0.0033	1.0007	0.0003	1.0007	0.0003
u233-sol-therm-001-case-5	1.0000	0.0033	0.9996	0.0003	0.9996	0.0003
u233-sol-therm-008	1.0000	0.0029	1.0016	0.0002	1.0016	0.0002

Table 5: Extended Criticality Validation Suite: HEU cases only

	Experiment Results		MCNP6.2.0 Results		MCNP6.2.1 Results	
Experiment	k-eff	std	k-eff	std	k-eff	std
HEU Benchmarks						
heu-met-fast-001	1.0000	0.0010	0.9994	0.0003	0.9994	0.0003
heu-met-fast-008	0.9989	0.0016	0.9962	0.0003	0.9962	0.0003
heu-met-fast-018-case-2	1.0000	0.0014	0.9995	0.0003	0.9995	0.0003
heu-met-fast-003-case-1	1.0000	0.0050	0.9949	0.0003	0.9949	0.0003
heu-met-fast-003-case-2	1.0000	0.0050	0.9945	0.0003	0.9945	0.0003
heu-met-fast-003-case-3	1.0000	0.0050	0.9989	0.0003	0.9989	0.0003
heu-met-fast-003-case-4	1.0000	0.0030	0.9974	0.0003	0.9974	0.0003
heu-met-fast-003-case-5	1.0000	0.0030	1.0012	0.0003	1.0012	0.0003
heu-met-fast-003-case-6	1.0000	0.0030	1.0020	0.0003	1.0020	0.0003
heu-met-fast-003-case-7	1.0000	0.0030	1.0019	0.0003	1.0019	0.0003
heu-met-fast-028	1.0000	0.0030	1.0027	0.0003	1.0027	0.0003
*heu-met-fast-014	0.9989	0.0017	0.9977	0.0003	0.9975	0.0003
heu-met-fast-003-case-8	1.0000	0.0050	1.0023	0.0003	1.0023	0.0003
heu-met-fast-003-case-9	1.0000	0.0050	1.0023	0.0003	1.0023	0.0003
heu-met-fast-003-case-10	1.0000	0.0050	1.0052	0.0003	1.0052	0.0003
heu-met-fast-003-case-11	1.0000	0.0050	1.0094	0.0003	1.0094	0.0003
heu-met-fast-003-case-12	1.0000	0.0030	1.0087	0.0003	1.0087	0.0003
heu-met-fast-013	0.9990	0.0015	0.9975	0.0003	0.9975	0.0003
heu-met-fast-021-case-2	1.0000	0.0024	0.9979	0.0003	0.9979	0.0003
heu-met-fast-022-case-2	1.0000	0.0019	0.9976	0.0003	0.9976	0.0003
heu-met-fast-012	0.9992	0.0018	0.9984	0.0003	0.9984	0.0003
heu-met-fast-019-case-2	1.0000	0.0028	1.0069	0.0003	1.0069	0.0003
heu-met-fast-009-case-2	0.9992	0.0015	0.9966	0.0003	0.9966	0.0003
heu-met-fast-009-case-1	0.9992	0.0015	0.9977	0.0003	0.9977	0.0003
*heu-met-fast-011	0.9989	0.0015	0.9985	0.0003	0.9987	0.0004
heu-met-fast-020-case-2	1.0000	0.0028	1.0006	0.0003	1.0006	0.0003
heu-met-fast-004-case-1	1.0020	0.0010	1.0034	0.0003	1.0034	0.0003
heu-met-fast-015	0.9996	0.0017	0.9947	0.0003	0.9947	0.0003
*heu-met-fast-026-case-c-11	1.0000	0.0038	1.0032	0.0003	1.0036	0.0003
*heu-comp-inter-003-case-6	1.0000	0.0047	0.9948	0.0004	0.9950	0.0004
*heu-met-inter-006-case-1	0.9977	0.0008	0.9929	0.0003	0.9923	0.0003
*heu-met-inter-006-case-2	0.9997	0.0008	0.9965	0.0003	0.9970	0.0003
*heu-met-inter-006-case-3	1.0015	0.0009	1.0008	0.0003	1.0007	0.0003
*heu-met-inter-006-case-4	1.0016	0.0008	1.0072	0.0003	1.0071	0.0003
*u233-comp-therm-001-case-6	1.0015	0.0028	0.9987	0.0004	0.9983	0.0004
heu-sol-therm-013-case-1	1.0012	0.0026	0.9985	0.0003	0.9985	0.0003
heu-sol-therm-013-case-2	1.0007	0.0036	0.9969	0.0003	0.9969	0.0003
heu-sol-therm-013-case-3	1.0009	0.0036	0.9939	0.0003	0.9939	0.0003
heu-sol-therm-013-case-4	1.0003	0.0036	0.9953	0.0003	0.9953	0.0003
heu-sol-therm-032	1.0015	0.0026	0.9992	0.0002	0.9992	0.0002

Table 6: Extended Criticality Validation Suite: IEU cases only

Experiment	Experiment Results k-eff	Experiment Results std	MCNP6.2.0 Results k-eff	MCNP6.2.0 Results std	MCNP6.2.1 Results k-eff	MCNP6.2.1 Results std
IEU Benchmarks						
ieu-met-fast-003-case-2	1.0000	0.0017	1.0028	0.0003	1.0028	0.0003
ieu-met-fast-005-case-2	1.0000	0.0021	1.0024	0.0003	1.0024	0.0003
ieu-met-fast-006-case-2	1.0000	0.0023	0.9958	0.0003	0.9958	0.0003
*ieu-met-fast-004-case-2	1.0000	0.0030	1.0075	0.0003	1.0076	0.0003
ieu-met-fast-001-case-1	0.9989	0.0010	1.0009	0.0003	1.0009	0.0003
ieu-met-fast-001-case-2	0.9997	0.0010	0.9999	0.0003	0.9999	0.0003
ieu-met-fast-001-case-3	0.9993	0.0005	1.0011	0.0003	1.0011	0.0003
ieu-met-fast-001-case-4	1.0002	0.0005	1.0015	0.0003	1.0015	0.0003
ieu-met-fast-002	1.0000	0.0030	0.9991	0.0003	0.9991	0.0003
*ieu-met-fast-007-case-4	1.0049	0.0008	1.0045	0.0002	1.0048	0.0002
*mix-met-fast-008-case-7	1.0030	0.0025	1.0192	0.0002	1.0190	0.0002
*ieu-comp-therm-002-case-3	1.0017	0.0044	1.0038	0.0003	1.0035	0.0003
leu-sol-therm-007-case-14	0.9961	0.0009	0.9947	0.0003	0.9947	0.0003
leu-sol-therm-007-case-30	0.9973	0.0009	0.9971	0.0003	0.9971	0.0003
leu-sol-therm-007-case-32	0.9985	0.0010	0.9959	0.0003	0.9959	0.0003
leu-sol-therm-007-case-36	0.9988	0.0011	0.9990	0.0003	0.9990	0.0003
leu-sol-therm-007-case-49	0.9983	0.0011	0.9972	0.0003	0.9972	0.0003

Table 7: Extended Criticality Validation Suite: LEU cases only

Experiment	Experiment Results k-eff	Experiment Results std	MCNP6.2.0 Results k-eff	MCNP6.2.0 Results std	MCNP6.2.1 Results k-eff	MCNP6.2.1 Results std
LEU Benchmarks						
leu-comp-therm-008-case-1	1.0007	0.0016	1.0007	0.0003	1.0007	0.0003
leu-comp-therm-008-case-2	1.0007	0.0016	1.0007	0.0003	1.0007	0.0003
leu-comp-therm-008-case-5	1.0007	0.0016	1.0010	0.0003	1.0010	0.0003
leu-comp-therm-008-case-7	1.0007	0.0016	1.0003	0.0003	1.0003	0.0003
leu-comp-therm-008-case-8	1.0007	0.0016	0.9995	0.0003	0.9995	0.0003
leu-comp-therm-008-case-11	1.0007	0.0016	1.0012	0.0003	1.0012	0.0003
leu-sol-therm-002-case-1	1.0038	0.0040	0.9994	0.0003	0.9994	0.0003
leu-sol-therm-002-case-2	1.0024	0.0037	0.9964	0.0003	0.9964	0.0003

Table 8: Extended Criticality Validation Suite: Pu cases only

Experiment	Experiment Results k-eff	std	MCNP6.2.0 Results k-eff	std	MCNP6.2.1 Results k-eff	std
Pu Benchmarks						
pu-met-fast-001	1.0000	0.0020	0.9993	0.0003	0.9993	0.0003
pu-met-fast-002	1.0000	0.0020	1.0003	0.0003	1.0003	0.0003
pu-met-fast-022-case-2	1.0000	0.0021	0.9984	0.0003	0.9984	0.0003
mix-met-fast-001	1.0000	0.0016	0.9998	0.0003	0.9998	0.0003
mix-met-fast-003	0.9993	0.0016	1.0004	0.0003	1.0004	0.0003
pu-met-fast-006	1.0000	0.0030	1.0001	0.0003	1.0001	0.0003
pu-met-fast-010	1.0000	0.0018	0.9996	0.0003	0.9996	0.0003
*pu-met-fast-020	0.9993	0.0017	0.9983	0.0003	0.9979	0.0003
pu-met-fast-008-case-2	1.0000	0.0006	0.9977	0.0003	0.9977	0.0003
pu-met-fast-005	1.0000	0.0013	1.0019	0.0003	1.0019	0.0003
pu-met-fast-025-case-2	1.0000	0.0020	0.9991	0.0003	0.9991	0.0003
pu-met-fast-026-case-2	1.0000	0.0024	0.9987	0.0003	0.9987	0.0003
pu-met-fast-009	1.0000	0.0027	1.0048	0.0003	1.0048	0.0003
pu-met-fast-023-case-2	1.0000	0.0020	0.9994	0.0003	0.9994	0.0003
pu-met-fast-018	1.0000	0.0030	0.9993	0.0003	0.9993	0.0003
pu-met-fast-019	0.9992	0.0015	1.0004	0.0003	1.0004	0.0003
pu-met-fast-024-case-2	1.0000	0.0020	1.0025	0.0003	1.0025	0.0003
pu-met-fast-011	1.0000	0.0010	1.0000	0.0003	1.0000	0.0003
pu-met-fast-021-case-2	1.0000	0.0026	0.9935	0.0003	0.9935	0.0003
pu-met-fast-021-case-1	1.0000	0.0026	1.0047	0.0003	1.0047	0.0003
pu-met-fast-003-case-103	1.0000	0.0030	0.9990	0.0003	0.9990	0.0003
*pu-comp-inter-001	1.0000	0.0110	1.0116	0.0003	1.0120	0.0003
*mix-comp-therm-002-case-pnl30	1.0024	0.0060	1.0005	0.0003	1.0007	0.0003
*mix-comp-therm-002-case-pnl31	1.0009	0.0047	1.0012	0.0003	1.0019	0.0003
*mix-comp-therm-002-case-pnl32	1.0042	0.0031	1.0020	0.0003	1.0023	0.0003
mix-comp-therm-002-case-pnl33	1.0024	0.0021	1.0064	0.0003	1.0064	0.0003
*mix-comp-therm-002-case-pnl34	1.0038	0.0025	1.0046	0.0003	1.0037	0.0003
*mix-comp-therm-002-case-pnl35	1.0029	0.0027	1.0057	0.0003	1.0055	0.0003
pu-sol-therm-009-case-3a	1.0000	0.0033	1.0191	0.0002	1.0191	0.0002
pu-sol-therm-011-case-16-5	1.0000	0.0052	1.0054	0.0004	1.0054	0.0004
pu-sol-therm-011-case-18-1	1.0000	0.0052	0.9941	0.0003	0.9941	0.0003
pu-sol-therm-011-case-18-6	1.0000	0.0052	1.0005	0.0004	1.0005	0.0004
pu-sol-therm-021-case-1	1.0000	0.0032	1.0053	0.0004	1.0053	0.0004
pu-sol-therm-021-case-3	1.0000	0.0065	1.0043	0.0004	1.0043	0.0004
pu-sol-therm-018-case-9	1.0000	0.0034	1.0026	0.0003	1.0026	0.0003

Be, and Mo material suites with the condensed history eleectron treatment were run [2]. The number of histories in these tests is sufficient to produce low statistical error, on the order of 0.1%. The cell-averaged energy deposition tallies were compared between MCNP 6.2.1 and 6.2.0, for each test case. Differences in cell-averaged energy depositions were negligible, below 1.0×10^{-4} standard deviations in all cases. The difference resulted from the `-fp-model consistent` compiler flag leading to minor differences in random number usage.

6 Shielding Verification Suite

The Shielding Verification Test Suite contains 78 shielding inputs. This test suite is located in the Testing/VERIFICATION_SHLD_SVDM directory. See the file `About_the_tests` for more information regarding the tests. The ensemble test suite is used as a verification suite in the sense of version-to-version comparison. The purpose is to determine how the test results compare with various versions of MCNP, starting with MCNP5 1.60. It is also used to compare results from different cross section data sets. The original baseline results were created by running MCNP5 1.60 with the ENDF/B VII.0 cross section data (`xsdir=xsdir_2012-01-06`)

To perform the verification of MCNP 6.2.1 the test suite was run using the default ENDF/B-VII.1 cross section data. These results were then plotted and compared to the MCNP 6.2.0 results, found in the subdirectory 'Results_ENDF7.1_MCNP_6.2'. There were no observable differences between MCNP 6.2.1 and MCNP 6.2.0 results. A review of the mctal files showed that the only differences were in the figures of merit. MCNP 6.2.1 is verified that it provides the same results and MCNP 6.2.0.

7 Shielding Validation Suite

The MCNP Shielding Validation Suite contains models of 18 benchmark experiments. The suite consists of 11 cases of the Livermore Pulsed Spheres, five cases of the Fusion Shielding experiments, and two photon experiments. The photon experiments are a skyshine experiment and an air-over-ground experiment. All of the benchmarks were run with MCNP 6.2.1 and compared to both the experimental and the MCNP 6.2.0 results. The MCNP 6.2.0 and MCNP 6.2.1 tally results matched exactly.

8 ACODE Verification

There are two test suites in the MCNP test library involving α: the α-eigenvalue set (`VERIFICATION_ACODE`), and the Rossi α set (`VERIFICATION_ROSSI_ALPHA`). The sections below examine how the results changed between MCNP version 6.2 and 6.2.1 for a wide variety of data libraries (starting with ENDF/B-VI.8 onward to ENDF/B-VIII).

When MCNP 6.2 and 6.2.1 are compiled with the fp-consistent flag, they precisely agree for the α-eigenvalue test suites. When they are not, of the 92 simulations run, 64 simulations diverged. Of these, 45 were within one standard deviation, or 70.3%. This is close to the 68.2% one would expect from two identical simulations diverging by random number sequence.

For many of the tests, experimental reference values are also shown. For k-eigenvalues, the values are adjusted experimental values. These are tuned to correspond with the simplified models used in the simulation. For α, the values are unadjusted experimental Rossi αs. Due to possible issues with nuclear data, the models, and the experiments themselves, these experimental values do not always match simulation, but are reported here.

8.1 `VERIFICATION_ACODE`

In the `VERIFICATION_ACODE` suite, there are nine benchmarks from the ICSBEP handbook [1]. The nine benchmarks are listed in Table 9. All of these have k-eigenvalues of approximately unity. However, a few diverge due to model and temperature corrections.

Table 9: Models Used

Benchmark	Short Name	Notes
IEU-MET-FAST-007	BIGTEN	Uses the two region homogenized model
U233-MET-FAST-006	Flattop-23	
HEU-MET-FAST-028	Flattop-25	
PU-MET-FAST-006	Flattop-Pu	
HEU-MET-FAST-001	Godiva	
U233-MET-FAST-001	Jezebel-233	
PU-MET-FAST-001	Jezebel-Pu	Uses improved simplified model
PU-MET-FAST-008	Thor	
HEU-MET-INTER-006	Zeus-1	Case 1

The goal of this test suite is to compute α at approximately delay critical. This is done by computing k with delayed neutrons, and setting `KTARG` to this value of k. Then, `ACODE` is run to compute α. The resulting α is approximately equal to the Rossi α, so the experimental value is tabulated alongside.

To improve comparison quality, all simulations for this suite were run with 100 thousand particles per batch, with 600 total batches and 100 inactive batches. α, in the α calculations, was allowed to vary after batch 50. Due to a known stability issue with the `ACODE` algorithm in which negative eigenvalues can overflow the fission bank, simulations in which this occur are noted with a (*) and were repeated with a different random number seed. Said seed was kept consistent between the 6.2 and 6.2.1 runs.

8.1.1 k-Eigenvalue Comparisons

First, the k-eigenvalue was computed in order to set `KTARG`. The k-eigenvalues as compared between MCNP 6.2 and 6.2.1 are shown in the following tables.

Table 10: k-Eigenvalue Comparison, ENDF/B-VI.8

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta k/\sigma$ 6.2 v. 6.2.1	$\delta k/\sigma$ 6.2.1 v. Exp.
BIGTEN	0.9948(11)	1.00703(7)	1.00703(7)	—	11.11
Flattop-23	1.0000(14)	1.00034(10)	1.00034(10)	—	0.24
Flattop-25	1.0000(30)	0.99690(9)	0.99690(9)	—	1.03
Flattop-Pu	1.0000(30)	1.00154(10)	1.00154(10)	—	0.51
Godiva	1.0000(10)	0.99640(9)	0.99640(9)	—	3.59
Jezebel-233	1.0000(10)	0.99278(8)	0.99278(8)	—	7.20
Jezebel-Pu	1.00000(129)	0.99733(9)	0.99733(9)	—	2.06
Thor	1.0000(6)	1.00554(9)	1.00554(9)	—	9.13
Zeus-1	0.9977(8)	0.99190(11)	0.99201(11)	0.71	7.04

Table 11: k-Eigenvalue Comparison, ENDF/B-VII.0

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta k/\sigma$ 6.2 v. 6.2.1	$\delta k/\sigma$ 6.2.1 v. Exp.
BIGTEN	0.9948(11)	0.99495(8)	0.99495(8)	—	0.14
Flattop-23	1.0000(14)	0.99944(10)	0.99944(10)	—	0.40
Flattop-25	1.0000(30)	0.99793(9)	0.99800(9)	0.55	0.67
Flattop-Pu	1.0000(30)	0.99991(10)	0.99991(10)	—	0.03
Godiva	1.0000(10)	0.99999(9)	0.99999(9)	—	0.01
Jezebel-233	1.0000(10)	0.99970(8)	0.99970(8)	—	0.30
Jezebel-Pu	1.00000(129)	0.99986(8)	0.99986(8)	—	0.11
Thor	1.0000(6)	0.99814(9)	0.99814(9)	—	3.07
Zeus-1	0.9977(8)	0.99357(11)	0.99349(11)	0.51	5.11

Table 12: k-Eigenvalue Comparison, ENDF/B-VII.1

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta k/\sigma$ 6.2 v. 6.2.1	$\delta k/\sigma$ 6.2.1 v. Exp.
BIGTEN	0.9948(11)	0.99483(7)	0.99483(7)	—	0.03
Flattop-23	1.0000(14)	0.99883(9)	0.99886(9)	0.24	0.81
Flattop-25	1.0000(30)	0.99807(9)	0.99809(9)	0.16	0.64
Flattop-Pu	1.0000(30)	0.99990(10)	0.99990(10)	—	0.03
Godiva	1.0000(10)	1.00007(8)	1.00007(8)	—	0.07
Jezebel-233	1.0000(10)	0.99989(8)	0.99989(8)	—	0.11
Jezebel-Pu	1.00000(129)	0.99991(8)	0.99991(8)	—	0.07
Thor	1.0000(6)	0.99761(8)	0.99761(8)	—	3.95
Zeus-1	0.9977(8)	0.99345(11)	0.99337(11)	0.51	5.36

Table 13: k-Eigenvalue Comparison, ENDF/B-VIII

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta k/\sigma$ 6.2 v. 6.2.1	$\delta k/\sigma$ 6.2.1 v. Exp.
BIGTEN	0.9948(11)	0.99449(7)	0.99449(7)	—	0.28
Flattop-23	1.0000(14)	1.00007(9)	1.00007(9)	—	0.05
Flattop-25	1.0000(30)	0.99608(9)	0.99608(9)	—	1.31
Flattop-Pu	1.0000(30)	0.99867(10)	0.99867(10)	—	0.44
Godiva	1.0000(10)	0.99994(9)	0.99994(9)	—	0.06
Jezebel-233	1.0000(10)	1.00064(8)	1.00064(8)	—	0.64
Jezebel-Pu	1.00000(129)	0.99996(8)	0.99996(8)	—	0.03
Thor	1.0000(6)	0.99749(9)	0.99749(9)	—	4.14
Zeus-1	0.9977(8)	0.99633(11)	0.99621(11)	0.77	1.85

Overall, the majority of simulations precisely matched one another. Only 7 simulations diverged, none of which diverged by more than one standard deviation. Runtime performance was also tabulated for all simulations. 6.2.1 is on average 5% slower than 6.2 on these tests.

8.1.2 α-Eigenvalue Comparisons

Next, the `VERIFICATION_ACODE` suite was run. The target k was set to the 6.2.1 value from the previous section and ν was set to the prompt value. As mentioned earlier, "*" marks simulations for which the random number seed was changed in order to avoid overflowing the fission bank.

Table 14: α-Eigenvalue Comparison, ENDF/B-VI.8

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$	
				6.2 v. 6.2.1	6.2.1 v. Exp.
BIGTEN	$-1.17(1)\times 10^5$	$-1.218(13)\times 10^5$	$-1.216(13)\times 10^5$	0.11	2.87
Flattop-23	$-2.71(3)\times 10^5$	$-2.96(7)\times 10^5$	$-3.00(7)\times 10^5$	0.45	3.71
Flattop-25	$-3.82(2)\times 10^5$	$-4.05(5)\times 10^5$*	$-4.07(5)\times 10^5$*	0.28	4.62
Flattop-Pu	$-2.14(5)\times 10^5$	$-1.97(7)\times 10^5$	$-1.96(7)\times 10^5$	0.04	2.10
Godiva	$-1.11(2)\times 10^6$	$-1.132(16)\times 10^6$	$-1.132(16)\times 10^6$	—	0.86
Jezebel-233	$-1.00(1)\times 10^6$	$-1.064(30)\times 10^6$	$-1.064(30)\times 10^6$	—	2.04
Jezebel-Pu	$-6.4(1)\times 10^5$	$-6.15(29)\times 10^5$	$-6.15(29)\times 10^5$	—	0.81
Thor	$-1.9(1)\times 10^5$	$-1.71(8)\times 10^5$	$-1.82(8)\times 10^5$	0.99	0.65
Zeus-1	$-3.38(7)\times 10^3$	$-3.63(6)\times 10^3$	$-3.69(6)\times 10^3$	0.72	3.36

Table 15: α-Eigenvalue Comparison, ENDF/B-VII.0

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$	
				6.2 v. 6.2.1	6.2.1 v. Exp.
BIGTEN	$-1.17(1)\times 10^5$	$-1.166(12)\times 10^5$	$-1.150(13)\times 10^5$	0.87	1.22
Flattop-23	$-2.71(3)\times 10^5$	$-2.90(7)\times 10^5$	$-3.03(7)\times 10^5$	1.35	4.13
Flattop-25	$-3.82(2)\times 10^5$	$-3.76(5)\times 10^5$	$-3.71(5)\times 10^5$	0.75	2.06
Flattop-Pu	$-2.14(5)\times 10^5$	$-1.93(6)\times 10^5$	$-1.89(7)\times 10^5$	0.43	2.98
Godiva	$-1.11(2)\times 10^6$	$-1.190(15)\times 10^6$	$-1.190(15)\times 10^6$	—	3.21
Jezebel-233	$-1.00(1)\times 10^6$	$-1.134(31)\times 10^6$	$-1.134(31)\times 10^6$	—	4.11
Jezebel-Pu	$-6.4(1)\times 10^5$	$-6.93(29)\times 10^5$	$-6.93(29)\times 10^5$	—	1.72
Thor	$-1.9(1)\times 10^5$	$-2.27(9)\times 10^5$	$-2.20(9)\times 10^5$	0.53	2.26
Zeus-1	$-3.38(7)\times 10^3$	$-3.52(6)\times 10^3$	$-3.41(6)\times 10^3$	1.31	0.27

Table 16: α-Eigenvalue Comparison, ENDF/B-VII.1

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$ 6.2 v. 6.2.1	$\delta\alpha/\sigma$ 6.2.1 v. Exp.
BIGTEN	$-1.17(1)\times 10^5$	$-1.168(12)\times 10^5$	$-1.186(12)\times 10^5$	1.04	1.04
Flattop-23	$-2.71(3)\times 10^5$	$-2.91(7)\times 10^5$	$-2.93(7)\times 10^5$	0.24	3.03
Flattop-25	$-3.82(2)\times 10^5$	$-3.90(5)\times 10^5$*	$-4.01(5)\times 10^5$*	1.58	3.65
Flattop-Pu	$-2.14(5)\times 10^5$	$-2.05(7)\times 10^5$	$-1.99(6)\times 10^5$	0.65	1.93
Godiva	$-1.11(2)\times 10^6$	$-1.195(15)\times 10^6$	$-1.195(15)\times 10^6$	—	3.40
Jezebel-233	$-1.00(1)\times 10^6$	$-1.036(31)\times 10^6$	$-1.036(31)\times 10^6$	—	1.12
Jezebel-Pu	$-6.4(1)\times 10^5$	$-6.29(30)\times 10^5$	$-6.29(30)\times 10^5$	—	0.35
Thor	$-1.9(1)\times 10^5$	$-2.08(9)\times 10^5$	$-2.11(9)\times 10^5$	0.22	1.57
Zeus-1	$-3.38(7)\times 10^3$	$-3.45(6)\times 10^3$	$-3.50(6)\times 10^3$	0.55	1.26

Table 17: α-Eigenvalue Comparison, ENDF/B-VIII

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$ 6.2 v. 6.2.1	$\delta\alpha/\sigma$ 6.2.1 v. Exp.
BIGTEN	$-1.17(1)\times 10^5$	$-1.151(13)\times 10^5$	$-1.154(13)\times 10^5$	0.19	0.93
Flattop-23	$-2.71(3)\times 10^5$	$-3.01(7)\times 10^5$*	$-3.07(7)\times 10^5$*	0.56	4.80
Flattop-25	$-3.82(2)\times 10^5$	$-4.07(5)\times 10^5$	$-4.12(5)\times 10^5$	0.68	5.65
Flattop-Pu	$-2.14(5)\times 10^5$	$-2.08(7)\times 10^5$	$-2.22(7)\times 10^5$	1.44	0.93
Godiva	$-1.11(2)\times 10^6$	$-1.138(15)\times 10^6$	$-1.138(15)\times 10^6$	—	1.11
Jezebel-233	$-1.00(1)\times 10^6$	$-1.120(28)\times 10^6$	$-1.120(28)\times 10^6$	—	3.99
Jezebel-Pu	$-6.4(1)\times 10^5$	$-7.06(28)\times 10^5$	$-7.06(28)\times 10^5$	—	2.24
Thor	$-1.9(1)\times 10^5$	$-2.06(9)\times 10^5$	$-2.16(9)\times 10^5$	0.77	1.95
Zeus-1	$-3.38(7)\times 10^3$	$-3.51(6)\times 10^3$	$-3.49(6)\times 10^3$	0.27	1.08

Overall, the Godiva, Jezebel-233, and Jezebel-Pu runs all exactly match between 6.2 and 6.2.1. The remaining 24 simulations yielded differing solutions. Of these, 19 (79%) were within one standard deviation, and the remainder were within two.

8.2 `VERIFICATION_ROSSI_ALPHA`

This suite has a slightly different set of benchmarks. These are listed in Table 18. All simulations were run exactly as specified in their source files with no modification other than with regard to cross sections, as these were already run with a sufficient number of neutrons.

Table 18: Models Used

Benchmark	Short Name	Notes
HEU-MET-FAST-001	Godiva	
HEU-MET-FAST-028	Flattop-25	
HEU-MET-FAST-072	Zeus-6	Case 1
HEU-MET-FAST-073	Zeus-5	
HEU-MET-INTER-006	Zeus-1	Case 1, 4
IEU-MET-FAST-007	BIG TEN	Case 4, Improved Benchmark
IEU-SOL-THERM-004	STACY-46	Case 46
IEU-SOL-THERM-007	STACY-30	Case 30
PU-MET-FAST-001	Jezebel-Pu	
PU-MET-FAST-006	Flattop-Pu	
PU-MET-FAST-008	Thor	
U233-MET-FAST-001	Jezebel-233	
U233-MET-FAST-006	Flattop-23	

For each model, the Rossi α was computed and compared between MCNP 6.2 and 6.2.1. They are also compared against the experimental Rossi α. A number of these values are not published in the 2015 ICSBEP handbook, so those that are not available were taken from [3]. The results for ENDF/B-VI.8 through ENDF/B-VIII are shown in the following 4 tables.

Table 19: Rossi α Comparison, ENDF/B-VI.8

Short Name	Ref	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$	
				6.2 v. 6.2.1	6.2.1 v. Ref.
Godiva	$-1.11(2)\times10^6$	$-1.139(12)\times10^6$	$-1.139(12)\times10^6$	—	1.24
Flattop-25	$-3.82(2)\times10^5$	$-4.094(19)\times10^5$	$-4.112(19)\times10^5$	0.65	10.59
Zeus-6	$-3.73(5)\times10^4$	$-4.092(26)\times10^4$	$-4.139(26)\times10^4$	1.32	7.28
Zeus-5	$-7.96(8)\times10^5$	$-1.095(7)\times10^5$	$-1.080(7)\times10^5$	1.57	26.81
Zeus-1 Case 1	$-3.38(7)\times10^3$	$-3.734(16)\times10^3$	$-3.778(16)\times10^3$	1.92	5.20
Zeus-1 Case 4	$-2.619(18)\times10^4$	$-3.267(14)\times10^4$	$-3.293(14)\times10^4$	1.30	28.98
BIG TEN	$-1.17(1)\times10^5$	$-1.263(8)\times10^5$	$-1.256(8)\times10^5$	0.61	6.91
STACY-46	$-1.06(4)\times10^2$	$-1.100(25)\times10^2$	$-1.100(25)\times10^2$	—	0.85
STACY-30	$-1.27(3)\times10^2$	$-1.325(32)\times10^2$	$-1.325(32)\times10^2$	—	1.26
Jezebel-Pu	$-6.4(1)\times10^5$	$-6.39(7)\times10^5$	$-6.39(7)\times10^5$	—	0.12
Flattop-Pu	$-2.14(5)\times10^5$	$-2.164(35)\times10^5$	$-2.164(35)\times10^5$	—	0.40
Thor	$-1.9(1)\times10^5$	$-1.97(7)\times10^5$	$-1.97(7)\times10^5$	—	0.62
Jezebel-233	$-1.00(1)\times10^6$	$-1.094(7)\times10^6$	$-1.094(7)\times10^6$	—	7.64
Flattop-23	$-2.71(3)\times10^5$	$-3.09(4)\times10^5$	$-3.09(4)\times10^5$	—	7.32

Table 20: Rossi α Comparison, ENDF/B-VII.0

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$ 6.2 v. 6.2.1	$\delta\alpha/\sigma$ 6.2.1 v. Exp.
Godiva	$-1.11(2)\times 10^6$	$-1.129(12)\times 10^6$	$-1.129(12)\times 10^6$	—	0.84
Flattop-25	$-3.82(2)\times 10^5$	$-3.952(18)\times 10^5$	$-3.957(18)\times 10^5$	0.21	5.08
Zeus-6	$-3.73(5)\times 10^4$	$-4.134(26)\times 10^4$	$-4.091(26)\times 10^4$	1.17	6.43
Zeus-5	$-7.96(8)\times 10^5$	$-1.078(7)\times 10^5$	$-1.066(7)\times 10^5$	1.27	25.62
Zeus-1 Case 1	$-3.38(7)\times 10^3$	$-3.582(16)\times 10^3$	$-3.611(16)\times 10^3$	1.30	3.02
Zeus-1 Case 4	$-2.619(18)\times 10^4$	$-3.199(14)\times 10^4$	$-3.234(14)\times 10^4$	1.72	26.52
BIG TEN	$-1.17(1)\times 10^5$	$-1.179(7)\times 10^5$	$-1.183(7)\times 10^5$	0.33	1.03
STACY-46	$-1.06(4)\times 10^2$	$-1.043(25)\times 10^2$	$-1.043(25)\times 10^2$	—	0.35
STACY-30	$-1.27(3)\times 10^2$	$-1.328(33)\times 10^2$	$-1.328(33)\times 10^2$	—	1.31
Jezebel-Pu	$-6.4(1)\times 10^5$	$-6.52(8)\times 10^5$	$-6.52(8)\times 10^5$	—	0.92
Flattop-Pu	$-2.14(5)\times 10^5$	$-2.102(34)\times 10^5$	$-2.045(33)\times 10^5$	1.21	1.58
Thor	$-1.9(1)\times 10^5$	$-1.96(7)\times 10^5$	$-1.96(7)\times 10^5$	—	0.53
Jezebel-233	$-1.00(1)\times 10^6$	$-1.078(7)\times 10^6$	$-1.078(7)\times 10^6$	—	6.40
Flattop-23	$-2.71(3)\times 10^5$	$-3.02(4)\times 10^5$	$-3.01(4)\times 10^5$	0.22	5.84

Table 21: Rossi α Comparison, ENDF/B-VII.1

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$ 6.2 v. 6.2.1	$\delta\alpha/\sigma$ 6.2.1 v. Exp.
Godiva	$-1.11(2)\times 10^6$	$-1.132(12)\times 10^6$	$-1.132(12)\times 10^6$	—	0.94
Flattop-25	$-3.82(2)\times 10^5$	$-3.957(18)\times 10^5$	$-3.960(18)\times 10^5$	0.12	5.17
Zeus-6	$-3.73(5)\times 10^4$	$-4.167(26)\times 10^4$	$-4.105(26)\times 10^4$	1.72	6.67
Zeus-5	$-7.96(8)\times 10^5$	$-1.076(7)\times 10^5$	$-1.089(7)\times 10^5$	1.30	27.63
Zeus-1 Case 1	$-3.38(7)\times 10^3$	$-3.592(16)\times 10^3$	$-3.609(16)\times 10^3$	0.74	2.99
Zeus-1 Case 4	$-2.619(18)\times 10^4$	$-3.224(14)\times 10^4$	$-3.235(14)\times 10^4$	0.55	26.54
BIG TEN	$-1.17(1)\times 10^5$	$-1.181(7)\times 10^5$	$-1.180(7)\times 10^5$	0.04	0.83
STACY-46	$-1.06(4)\times 10^2$	$-1.059(25)\times 10^2$	$-1.059(25)\times 10^2$	—	0.03
STACY-30	$-1.27(3)\times 10^2$	$-1.205(30)\times 10^2$	$-1.205(30)\times 10^2$	—	1.54
Jezebel-Pu	$-6.4(1)\times 10^5$	$-6.32(7)\times 10^5$	$-6.32(7)\times 10^5$	—	0.64
Flattop-Pu	$-2.14(5)\times 10^5$	$-2.020(33)\times 10^5$	$-2.048(33)\times 10^5$	0.59	1.53
Thor	$-1.9(1)\times 10^5$	$-2.06(7)\times 10^5$	$-2.03(7)\times 10^5$	0.33	1.01
Jezebel-233	$-1.00(1)\times 10^6$	$-1.066(7)\times 10^6$	$-1.066(7)\times 10^6$	—	5.36
Flattop-23	$-2.71(3)\times 10^5$	$-2.98(4)\times 10^5$	$-2.94(4)\times 10^5$	0.60	4.57

Table 22: Rossi α Comparison, ENDF/B-VIII

Short Name	Experiment	MCNP 6.2	MCNP 6.2.1	$\delta\alpha/\sigma$ 6.2 v. 6.2.1	$\delta\alpha/\sigma$ 6.2.1 v. Exp.
Godiva	-1.11(2)$\times 10^6$	-1.143(12)$\times 10^6$	-1.143(12)$\times 10^6$	—	1.43
Flattop-25	-3.82(2)$\times 10^5$	-4.027(19)$\times 10^5$	-4.009(18)$\times 10^5$	0.70	6.95
Zeus-6	-3.73(5)$\times 10^4$	-4.124(26)$\times 10^4$	-4.120(26)$\times 10^4$	0.13	6.94
Zeus-5	-7.96(8)$\times 10^5$	-1.047(7)$\times 10^5$	-1.055(7)$\times 10^5$	0.89	24.70
Zeus-1 Case 1	-3.38(7)$\times 10^3$	-3.684(16)$\times 10^3$	-3.654(16)$\times 10^3$	1.30	3.58
Zeus-1 Case 4	-2.619(18)$\times 10^4$	-3.206(14)$\times 10^4$	-3.198(14)$\times 10^4$	0.44	25.07
BIG TEN	-1.17(1)$\times 10^5$	-1.194(7)$\times 10^5$	-1.194(7)$\times 10^5$	0.05	1.97
STACY-46	-1.06(4)$\times 10^2$	-1.113(26)$\times 10^2$	-1.051(25)$\times 10^2$	1.70	0.18
STACY-30	-1.27(3)$\times 10^2$	-1.286(31)$\times 10^2$	-1.217(30)$\times 10^2$	1.59	1.24
Jezebel-Pu	-6.4(1)$\times 10^5$	-6.56(8)$\times 10^5$	-6.56(8)$\times 10^5$	—	1.29
Flattop-Pu	-2.14(5)$\times 10^5$	-2.103(34)$\times 10^5$	-2.113(34)$\times 10^5$	0.21	0.45
Thor	-1.9(1)$\times 10^5$	-2.11(7)$\times 10^5$	-2.11(7)$\times 10^5$	—	1.65
Jezebel-233	-1.00(1)$\times 10^6$	-1.088(7)$\times 10^6$	-1.088(7)$\times 10^6$	—	7.19
Flattop-23	-2.71(3)$\times 10^5$	-2.97(4)$\times 10^5$	-2.94(4)$\times 10^5$	0.62	4.49

Of the 56 simulations run, 23 yield Rossi αs that are precisely equal. An additional 19 are within one standard deviation. The remaining 14 are within two. Those that matched are predominantly simple geometries.

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