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Scattering Angular Distribution in the Fast Energy Range
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Benchmark of ENDF/B-VII.1 and JENDL-4.0 on Reflector Effects

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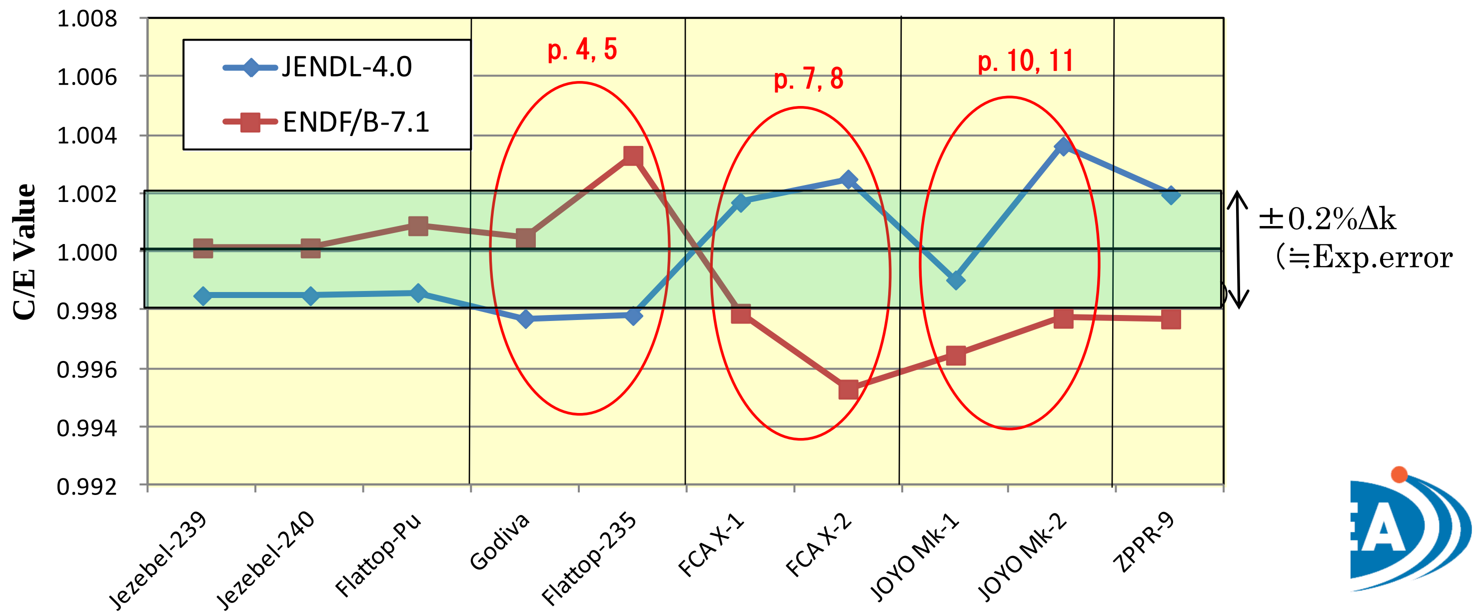
Summary of Benchmark

Criticality C/E values by Monte Carlo calculation

Exp.Core	JENDL-4.0	ENDF/B-7.1	Specification
Jezebel-239	0.9985	1.0001	(PMF001) Ultra-smal, Pu, Bare, Pu240: 4.5at%
Jezebel-240	0.9985	1.0001	(PMF002) Ultra-small, Pu, Bare, Pu240: 20at%
Flattop-Pu	0.9986	1.0009	(PMF006) Ultra-small, Pu, Nat. U reflector, Pu240: 4.8wt%
Godiva	0.9977	1.0005	(HMF001) Ultra-small, Uranium, Bare, U235: 94wt%
Flattop-235	0.9978	1.0033	(HMF028) Ultra-small, Uranium, Nat. U reflector, U235: 93wt%
FCA X-1	1.0017	0.9979	Small, Pu＋Enriched. Uranium, Dep. U blanket, Pu:28wt%, U235:12wt%
FCA X-2	1.0025	0.9953	Small, Pu＋Enriched. Uranium, SS reflector, Pu:28wt%、U235:12wt%
JOYO Mk-1	0.9990	0.9965	Small, Pu＋Enriched. Uranium, Dep. UO2 blanket, Pu:17wt%、U235:23wt%
JOYO Mk-2	1.0036	0.9977	Small, Pu＋Enriched. Uranium, SS reflector, Pu:28wt%、U235:12wt%
ZPPR-9	1.0020	0.9977	Large, Pu, Depleted U. blanket、Pu:13wt%



Method of Sensitivity Analysis

■ Cross-section sensitivity:

$$S_{m,x,g} = \frac{dR/R}{d\sigma_{m,x,g}/\sigma_{m,x,g}}$$

where,

R: core parameter,

m: nuclide,

x: reaction type,

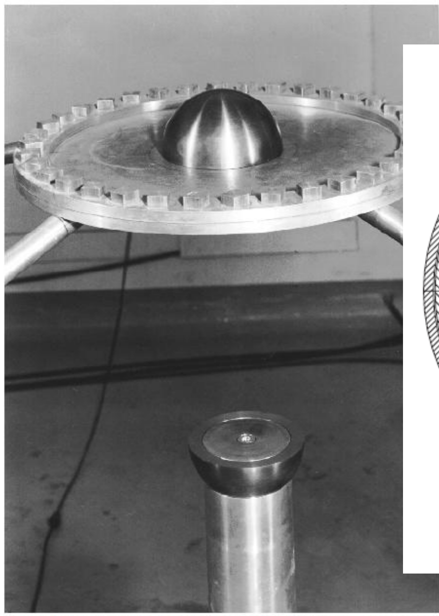
g: energy group number.

■ Contribution of each cross-section

$$\frac{R_{ENDF} - R_{JENDL}}{R_{JENDL}} = \sum_{m,x} \sum_{g} \left[S_{m,x,g} \times \frac{\sigma_{m,x,g,ENDF} - \sigma_{m,x,g,JENDL}}{\sigma_{m,x,g,JENDL}} \right]$$

Reflector Effect : (Bare -> Nat. U)

Godiva



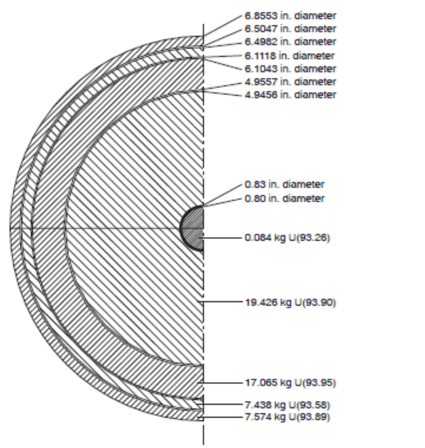


Figure 2. Idealized Final Configuration of Subcritical U Spherical Shells.

Figure 1. Experimental Setup for the Multiplication Measurements of Spherical Shell Configurations.

(HMF001)
Ultra-small, Uranium,
U235: 94wt%, Bare

Flattop-235

Figure 5. The Flattop Assembly.

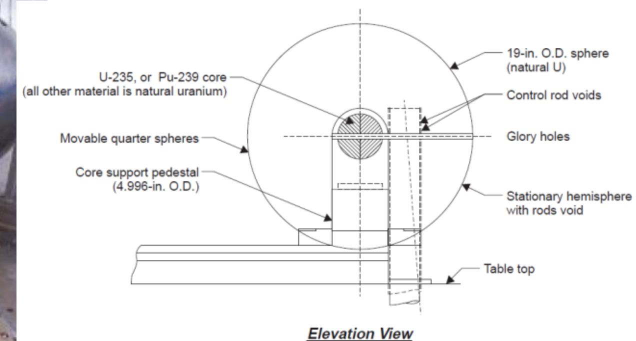
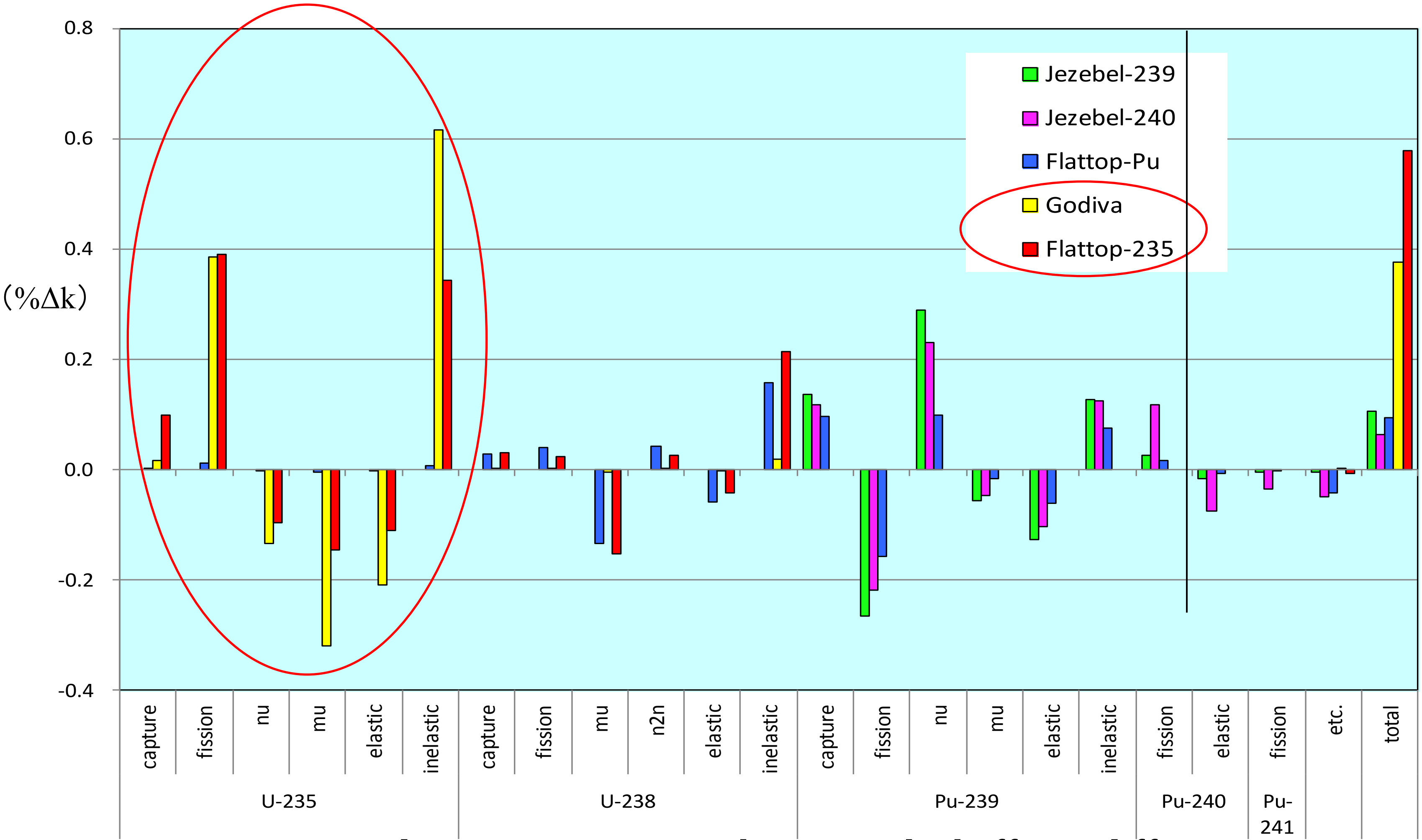


Figure 4. Schematic of the Flattop Assembly.

(HMF028)
Ultra-small, Uranium,
U235: 93wt%, Nat. U reflector

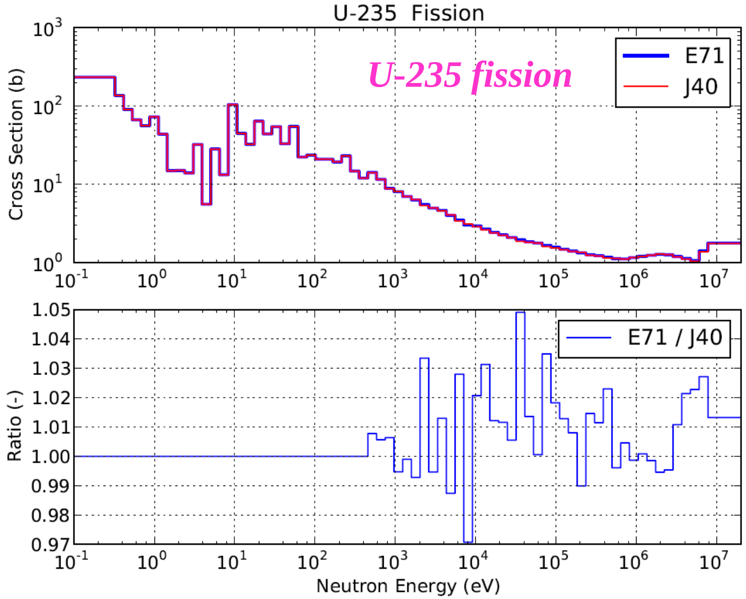
Reflector Effect :   (Bare -> Nat. U)

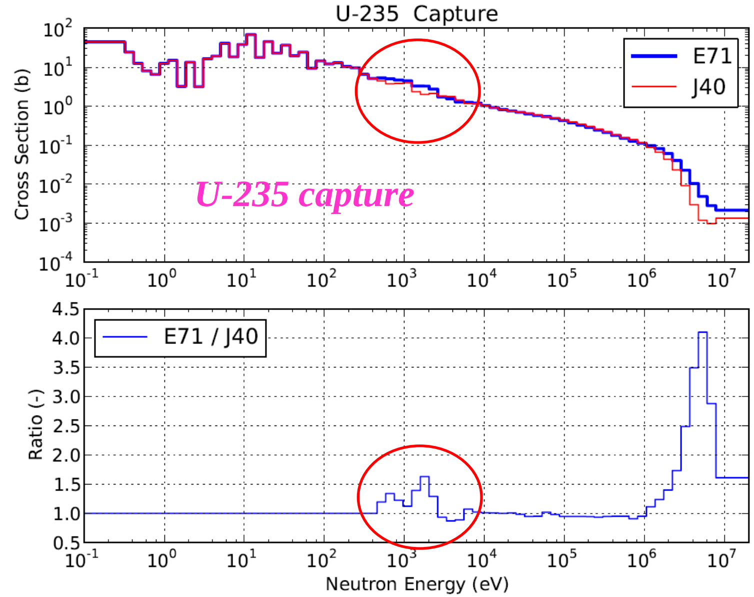


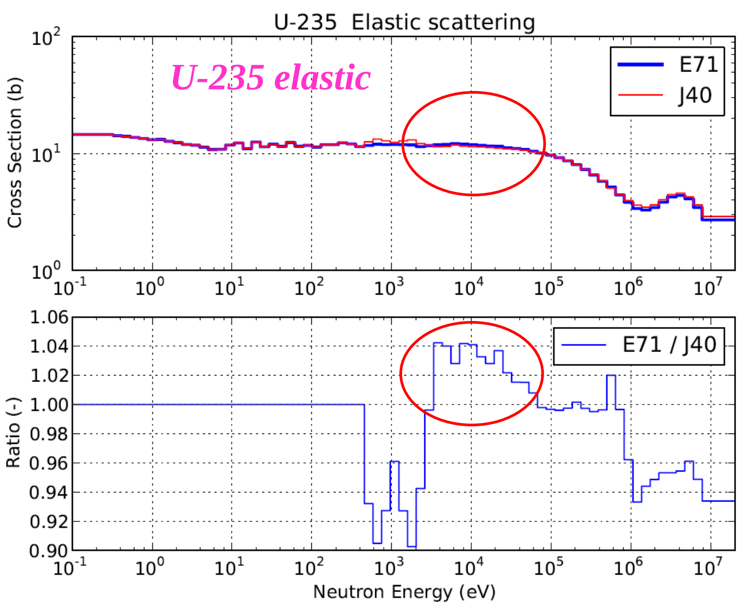
Isotope- and reaction-wise contribution to the keff C/E difference between ENDF-7.1 and JENDL-4.0

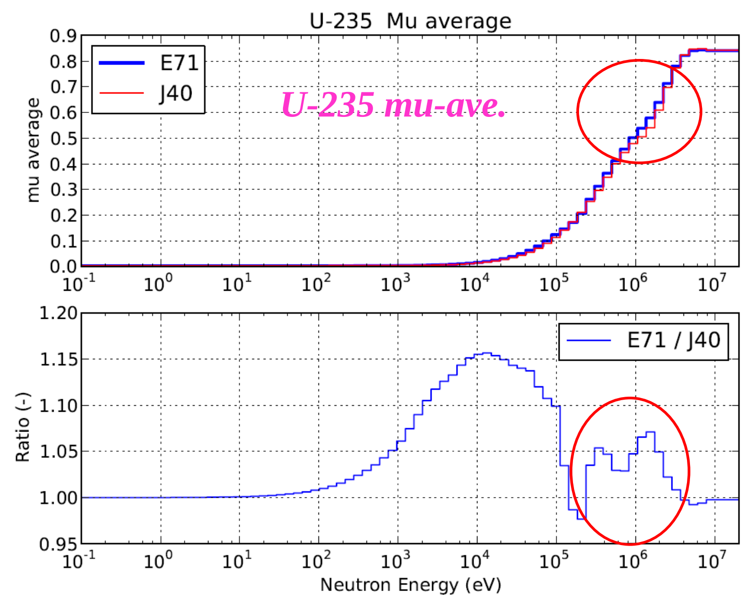
=> The cancellation among inelastic, capture (+) and mu-ave., elastic (-) of U-235 seems to make the reflector effect by ENDF-7.1 worse than JENDL-4.0 by 300pcm.

ENDF/B-7.1 vs. JENDL-4.0 ： U-235



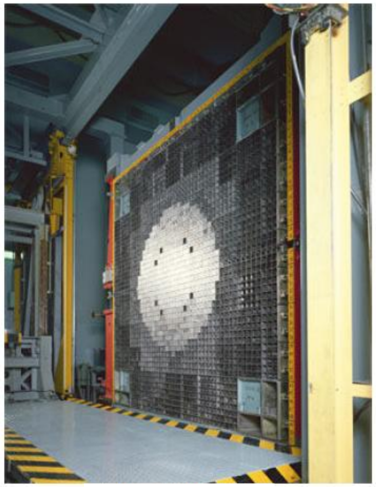




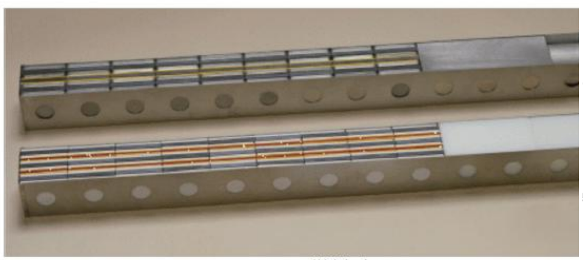


Reflector Effect : (Dep.U blanket -> SS reflector)

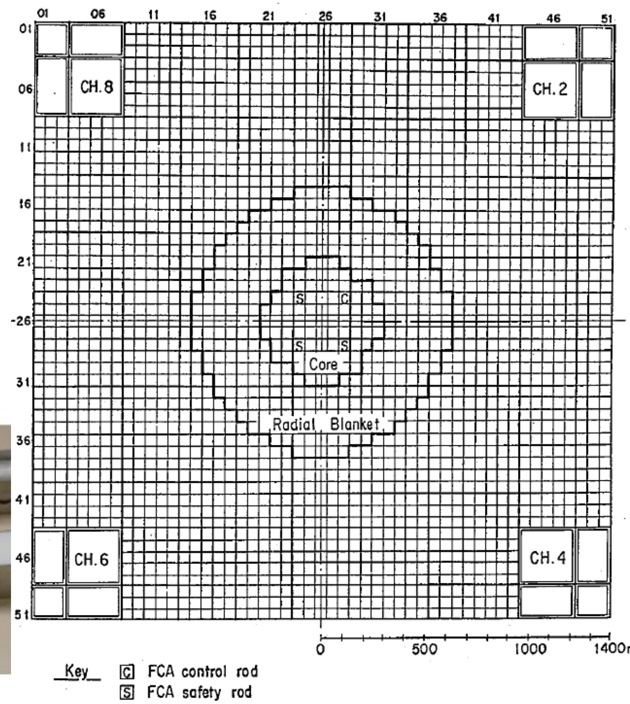
FCA



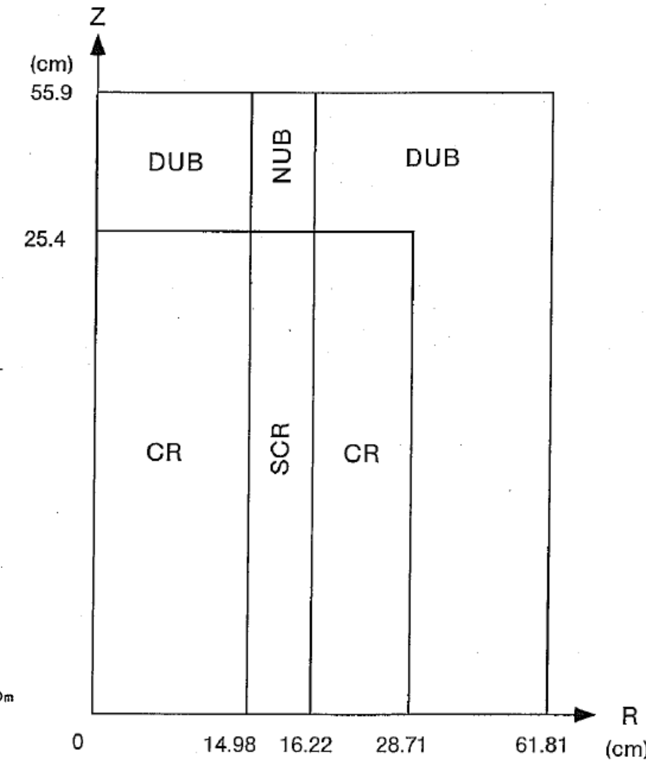
FCA facility



Fuel drawer and plates of FCA



Cross-cut view of FCA X-1



Two-dimensional RZ model of FCA X-1

Small core, Pu＋Enriched. Uranium,

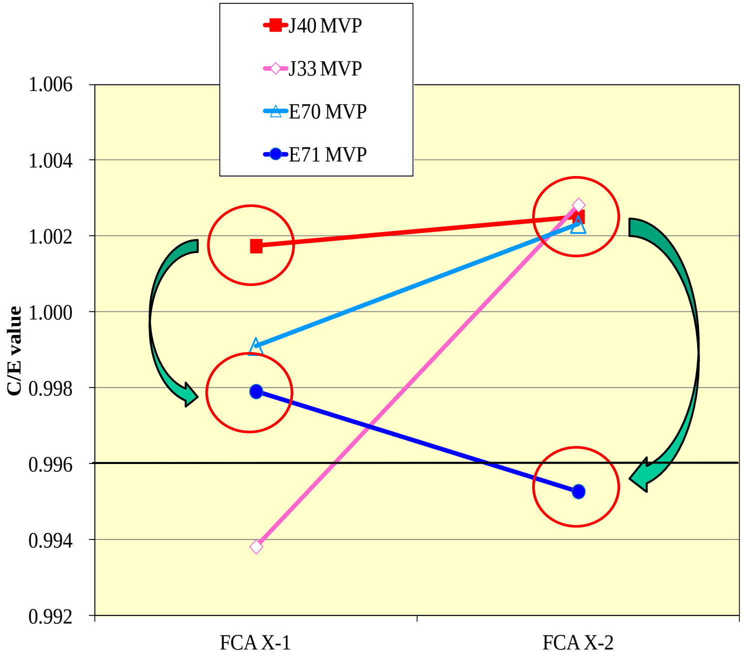
Pu:28wt%, U235:12wt%

FCA X-1: Dep. U blanket

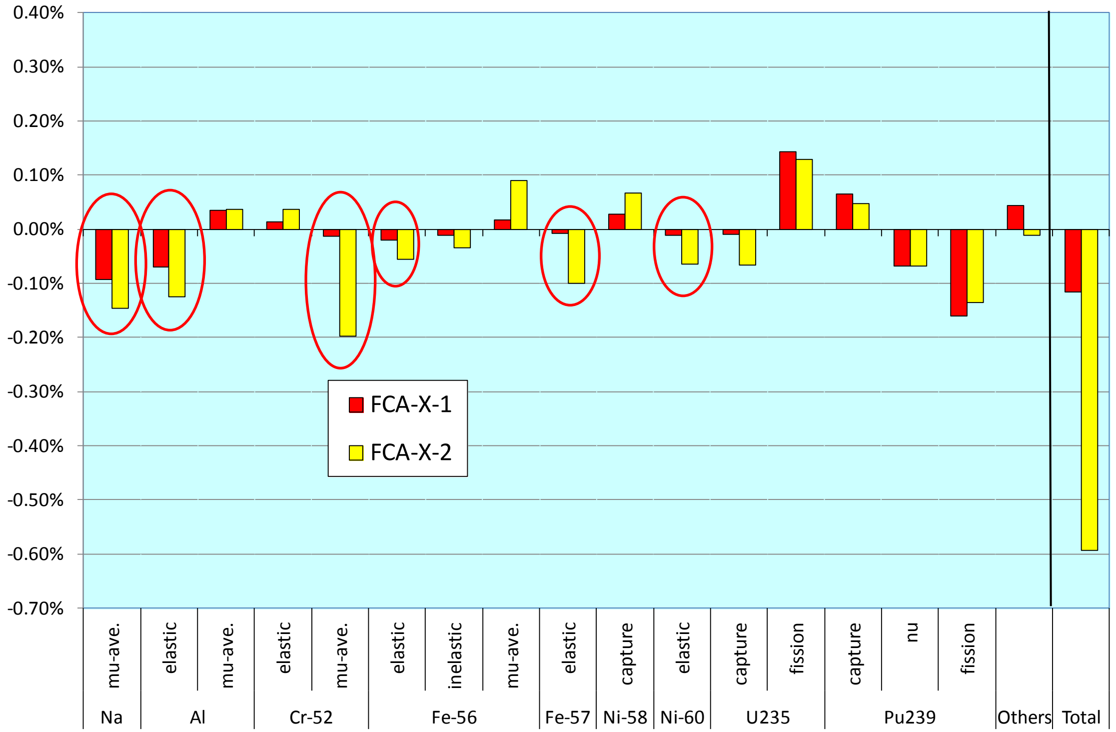
FCA X-2: SS reflector

Reflector Effect : (Dep.U blanket -> SS reflector)

FCA X-1,2



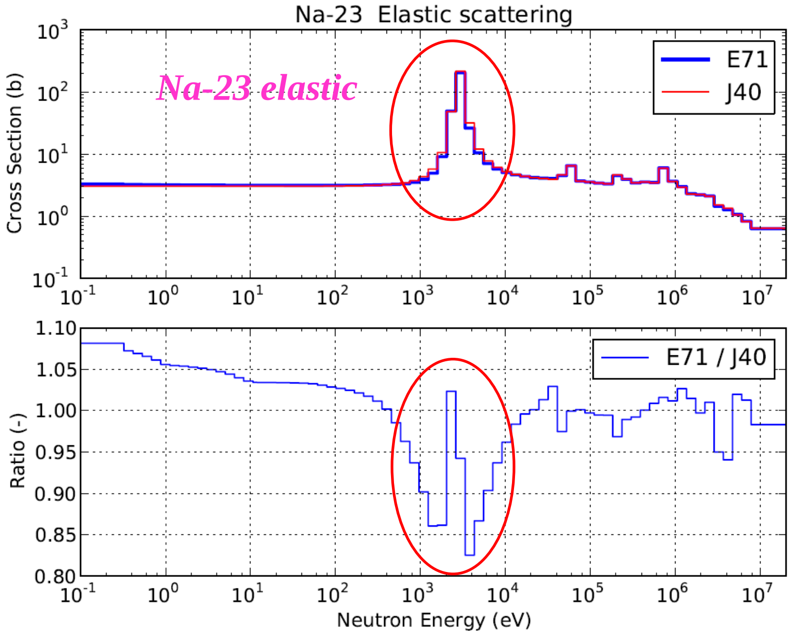
keff C/Es of FCA X-1 and X-2

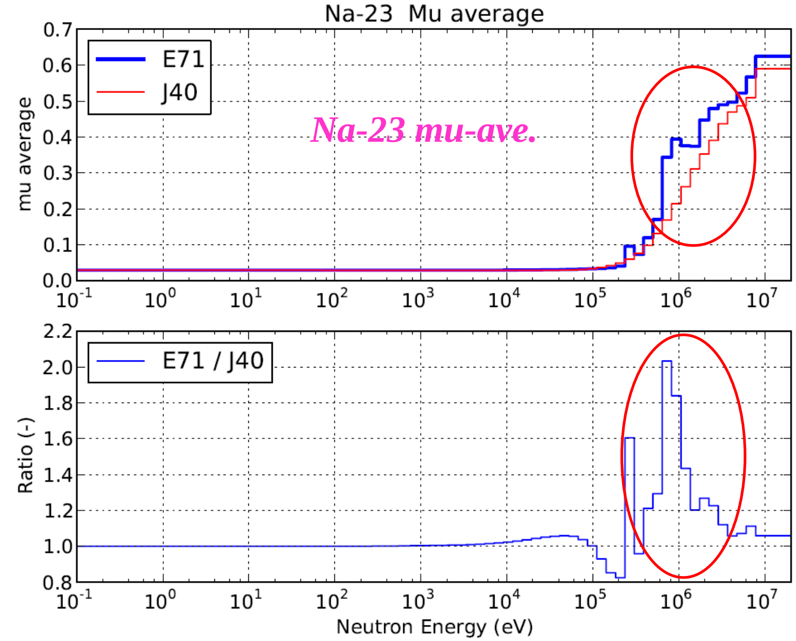


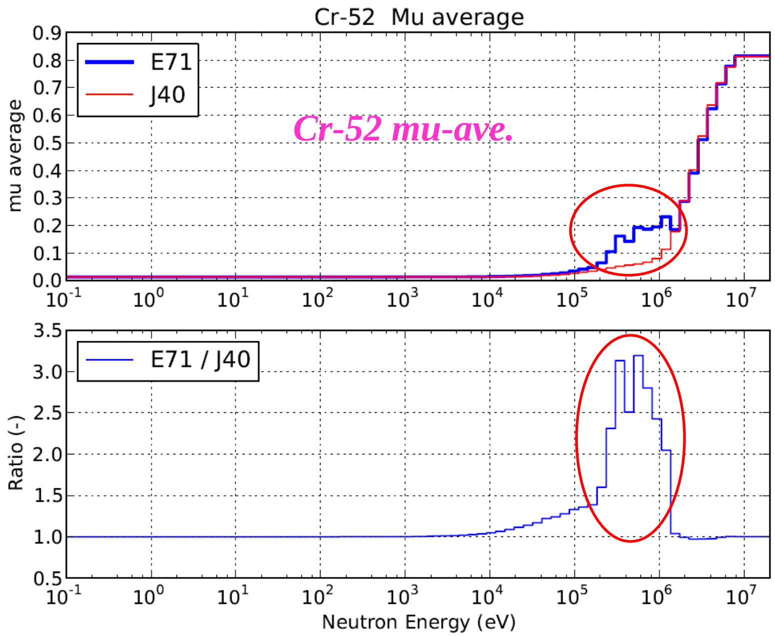
Isotope- and reaction-wise contribution to the keff C/E difference between ENDF-7.1 and JENDL-4.0

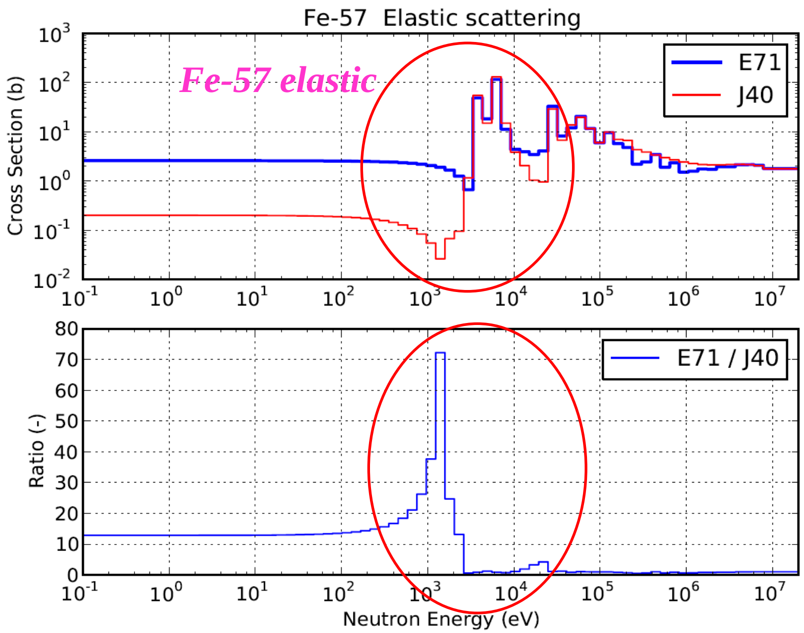
=> **The replacement reactivity from U-238 blanket to SS reflector seems better evaluated by JENDL-4.0 than by ENDF-7.1 by 300pcm. This difference is caused by the negative reactivity from mu-ave. of Cr-52 and Na, and elastic of Fe-57, Ni-60, Al.**

ENDF/B-7.1 vs. JENDL-4.0：Structure material









Reflector Effect : (Dep.UO_2 blanket -> SS reflector)

JOYO

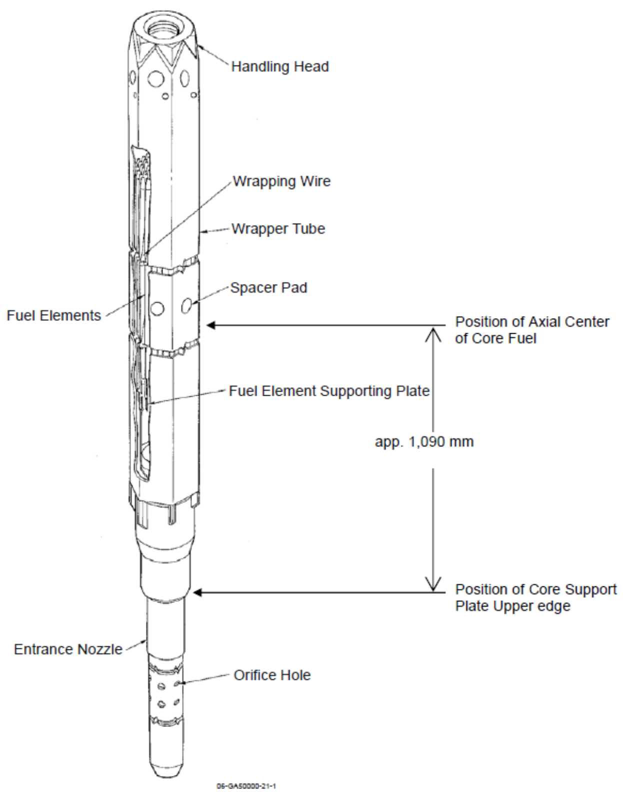


Figure 1.6. Schematic View of Core Fuel Subassembly.

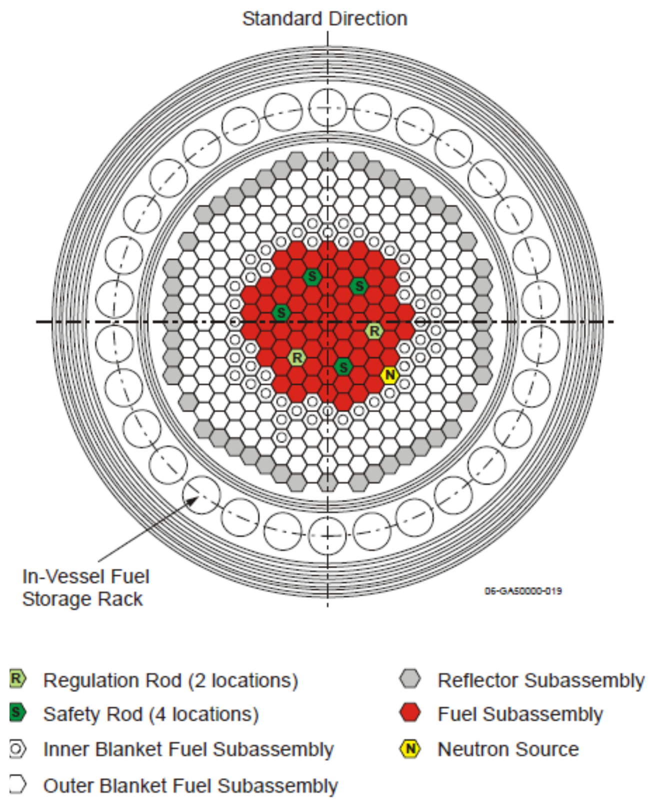


Figure 1.4. Horizontal Cross-section of JOYO MK-I Core.

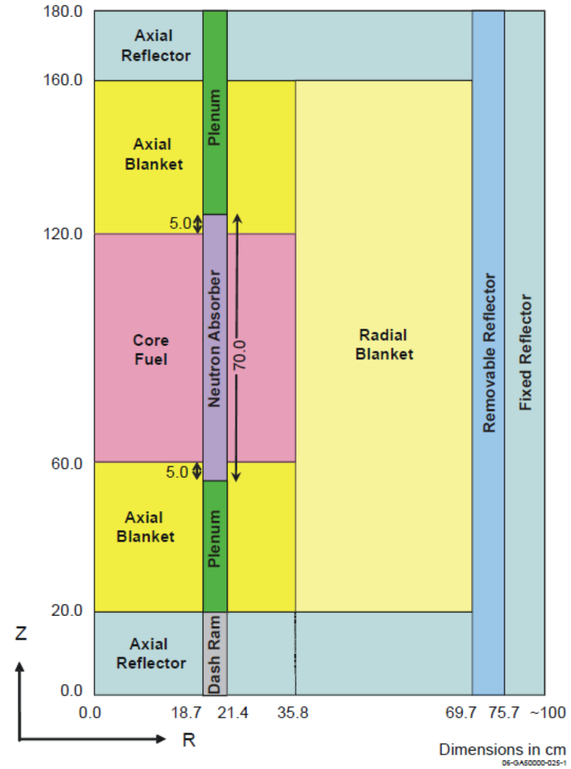


Figure 1.13. Rough Layout of JOYO MK-I Core in RZ Geometry. (with full insertion of control rods)

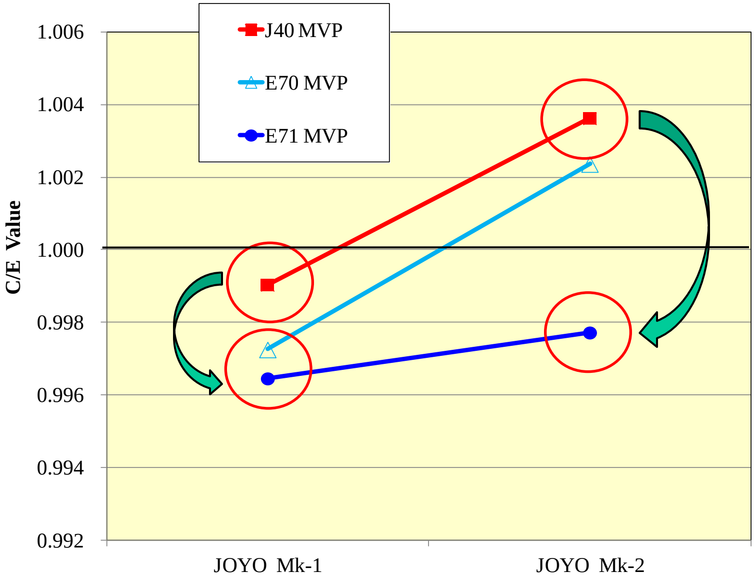
Small core, Pu＋Enriched. Uranium

JOYO Mk-I: Pu=17wt%、U235=23wt% , Nat. U blanket

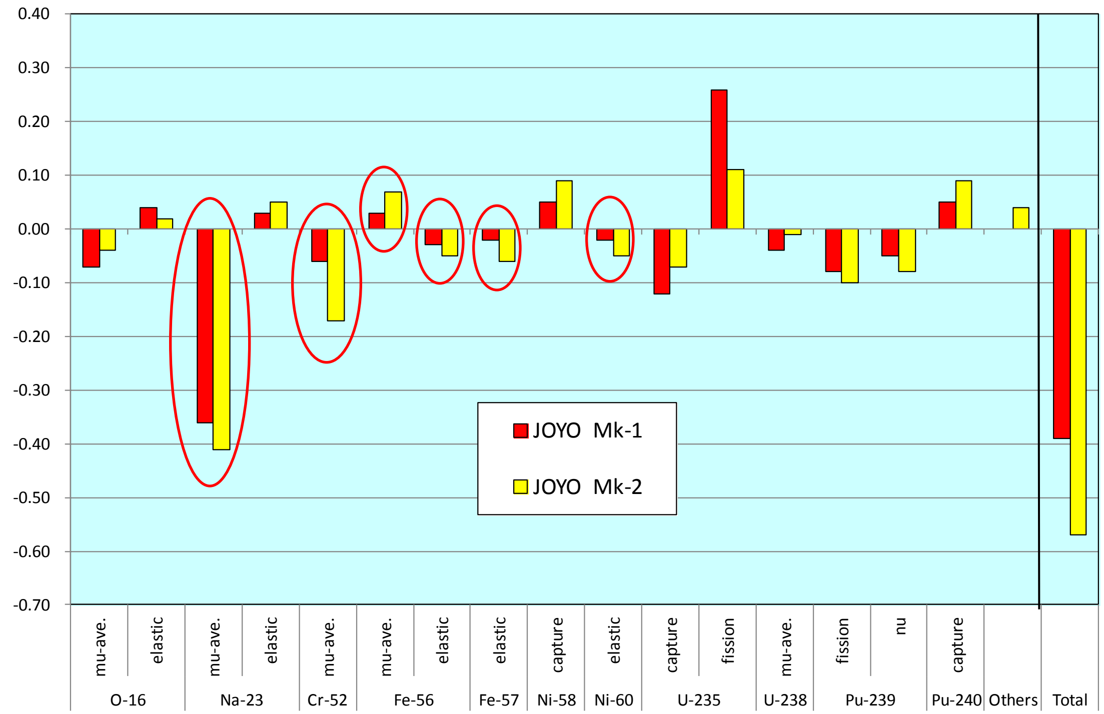
JOYO Mk-II: Pu=28wt%、U235=12wt% , SS reflector

Reflector Effect : (Dep.UO_2 blanket -> SS reflector)

JOYO Mk-I, II



keff C/Es of JOYO Mk-I and Mk-II



Isotope- and reaction-wise contribution to the keff C/E difference between ENDF-7.1 and JENDL-4.0

=> **The replacement reactivity from U-238 blanket to SS reflector resulted in the positive change of keff for JENDL-4.0, which is larger than that of ENDF-7.1. This difference is caused by the negative reactivity from mu-ave. of Cr-52 and Na, and elastic of Fe-57, Ni-60, Fe-56. However, we cannot judge which library is favorable, since the fuel compositions of the two cores are quite different, unlike the FCA case.**

Concluding Remarks

1. **From Los Alamos data, JENDL-4.0 seems better than ENDF-7.1 about the summation of reflector reactivity effect from inelastic, capture (+) and mu-ave., elastic (-) of U-235.**

   → ***Note that we cannot find which library is better for individual reaction from this benchmark.***

2. **From FCA data, the replacement reactivity from U-238 blanket to SS reflector seems better evaluated by JENDL-4.0 than by ENDF-7.1, which is caused by the negative reactivity from mu-ave. of Cr-52 and Na, and elastic of Fe-57, Ni-60, Al.**

   → ***JOYO data shows similar trends for reflector effects, but we cannot guess which library is favorable from JOYO, because of the influence from core fuel compositions.***