Sodium Nuclear Data Evaluation

for a better prediction of Na Void Reactivity Worth in Plutonium Burner Cores

and

for deep propagation of neutrons in sodium

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Outline of the Presentation

- Sodium void reactivity worth

- Core characteristics and measurements

- Sodium Nuclear Data Evaluations

- Calculation method and results
(for Non-leakage and Leakage terms)

- Recommendation for Plutonium Burner cores

- Analysis of Neutron propagation in JANUS2

- Conclusion and Recommendation for Sodium Nuclear Data

Sodium Void Reactivity Worth

- Non-leakage term
  - Scattering Matrix (>30keV : + , <30keV : -)
  - Absorption of Na (+)
  - Self-shielding of U-238 (+)
  - etc.

- Leakage term (-)
  - (Streaming effect should be considered)

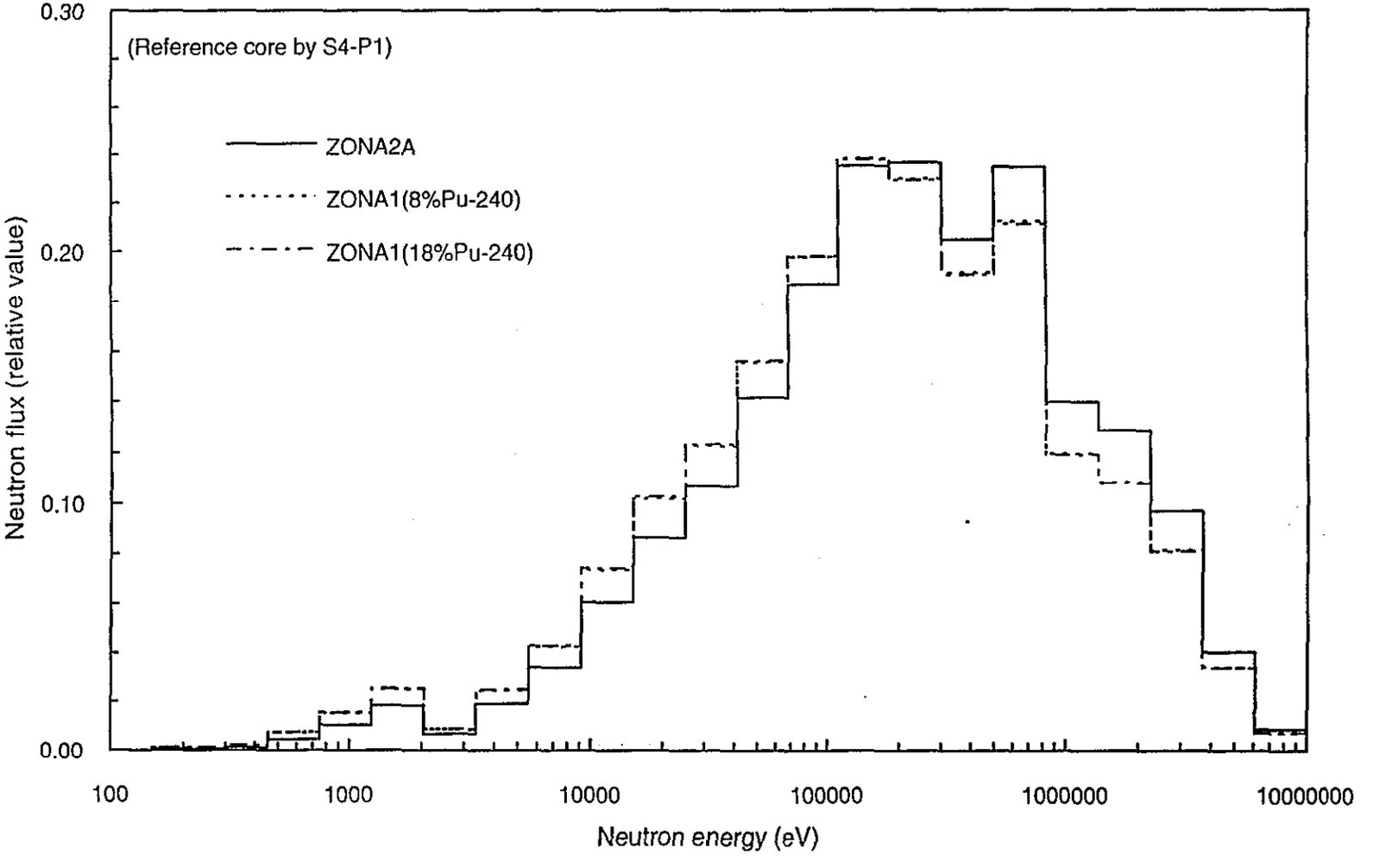
¤ It is necessary to evaluate the accuracy for each term, respectively

Core Characteristics

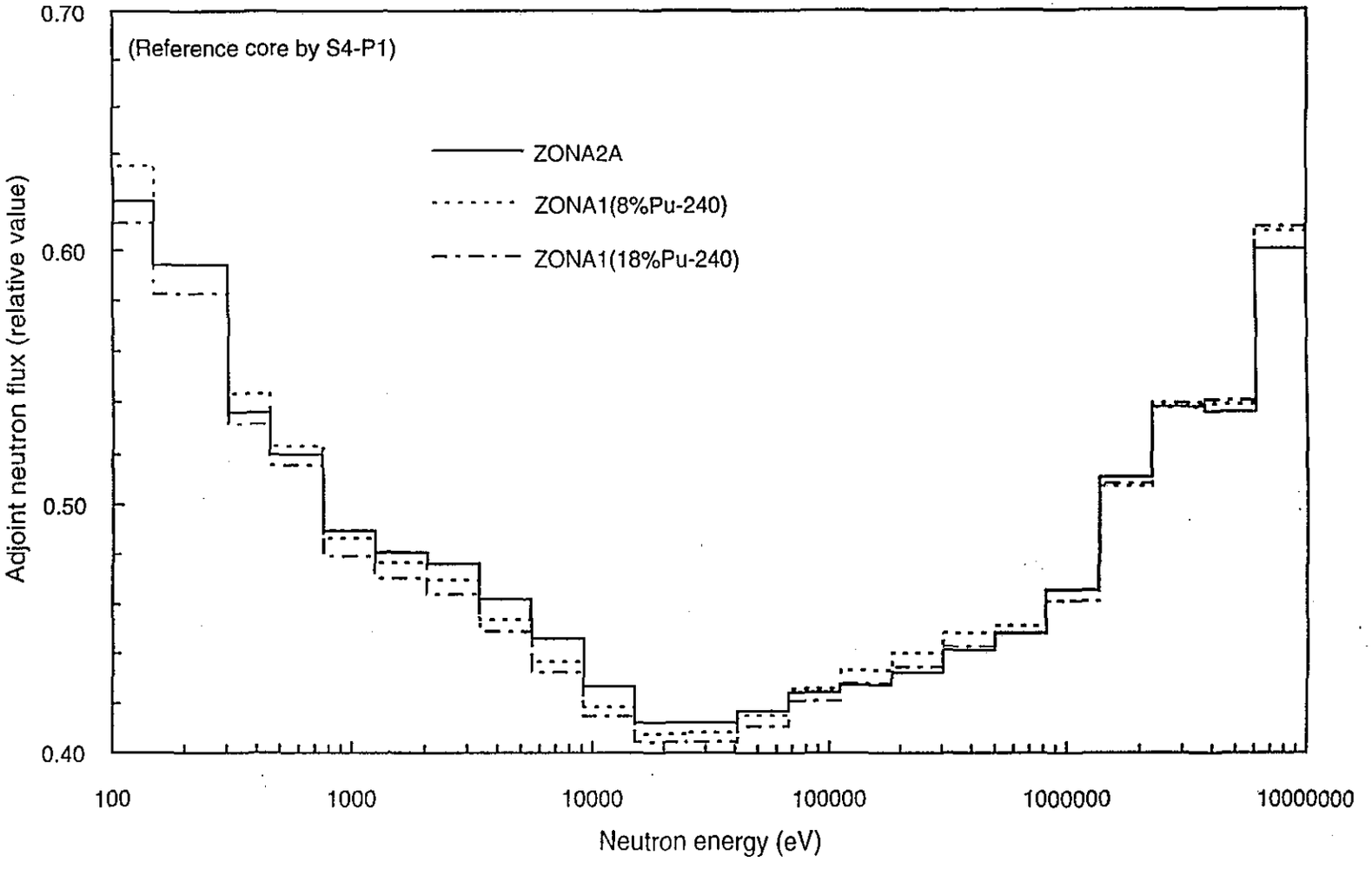
	ZONA2A	ZONAB	ZONA1/R1 8%Pu-240	ZONA1/R1 18%Pu-240
Pu fissile/H.M.	21.5%	21.5%	17.1%	16.3%
Pu-240/Pu	19.0%	19.0%	7.9%	18.9%
Core height	61cm	61cm	91cm	91cm
Blanket	Axial:20cm Radial:30cm	No No	Axial:20cm Radial:30cm	Axial:20cm Radial:30cm

Influence on the Neutron spectrum and on the Adjoint flux

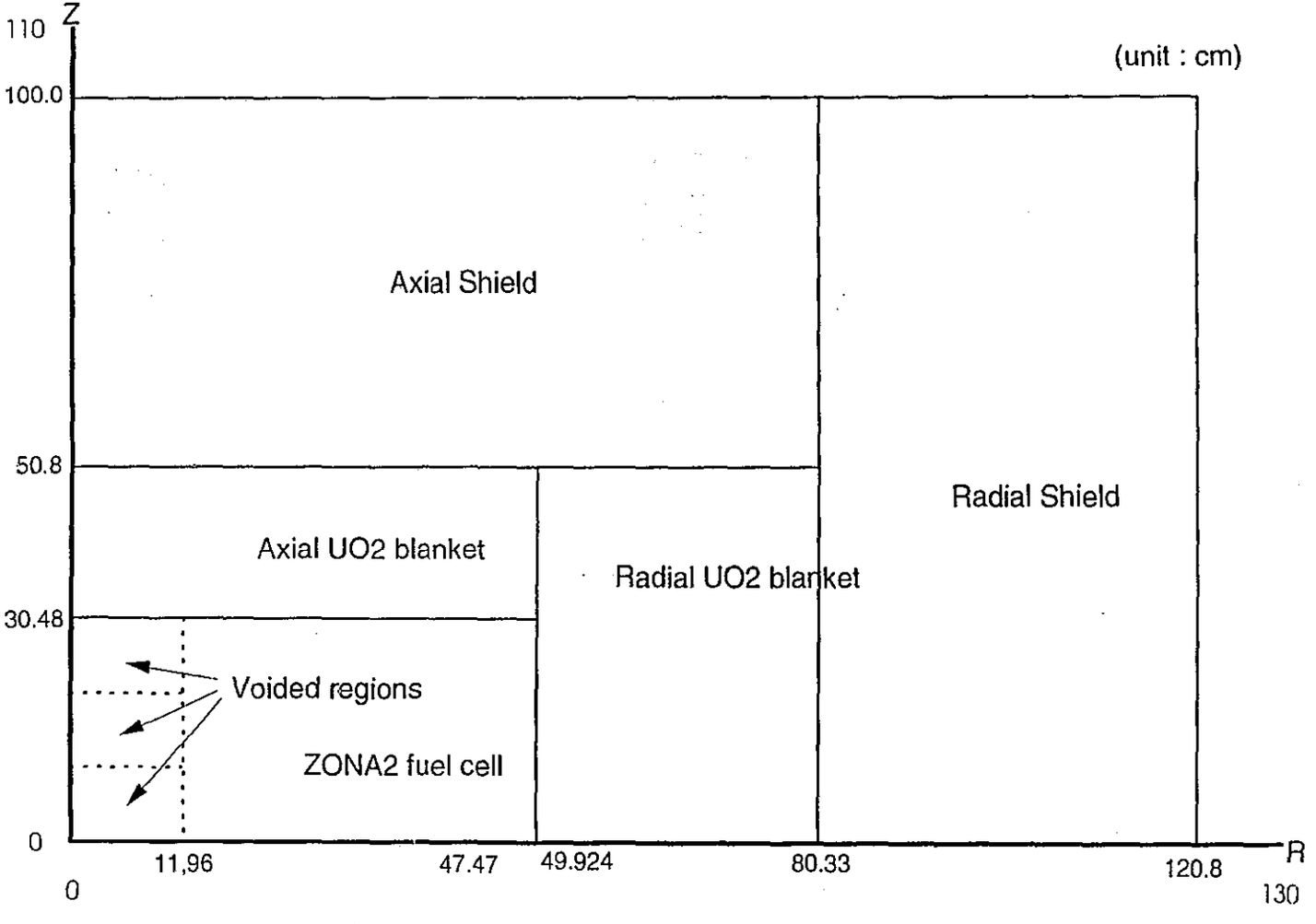
DIRECT FLUX for the DIFFERENT CORES



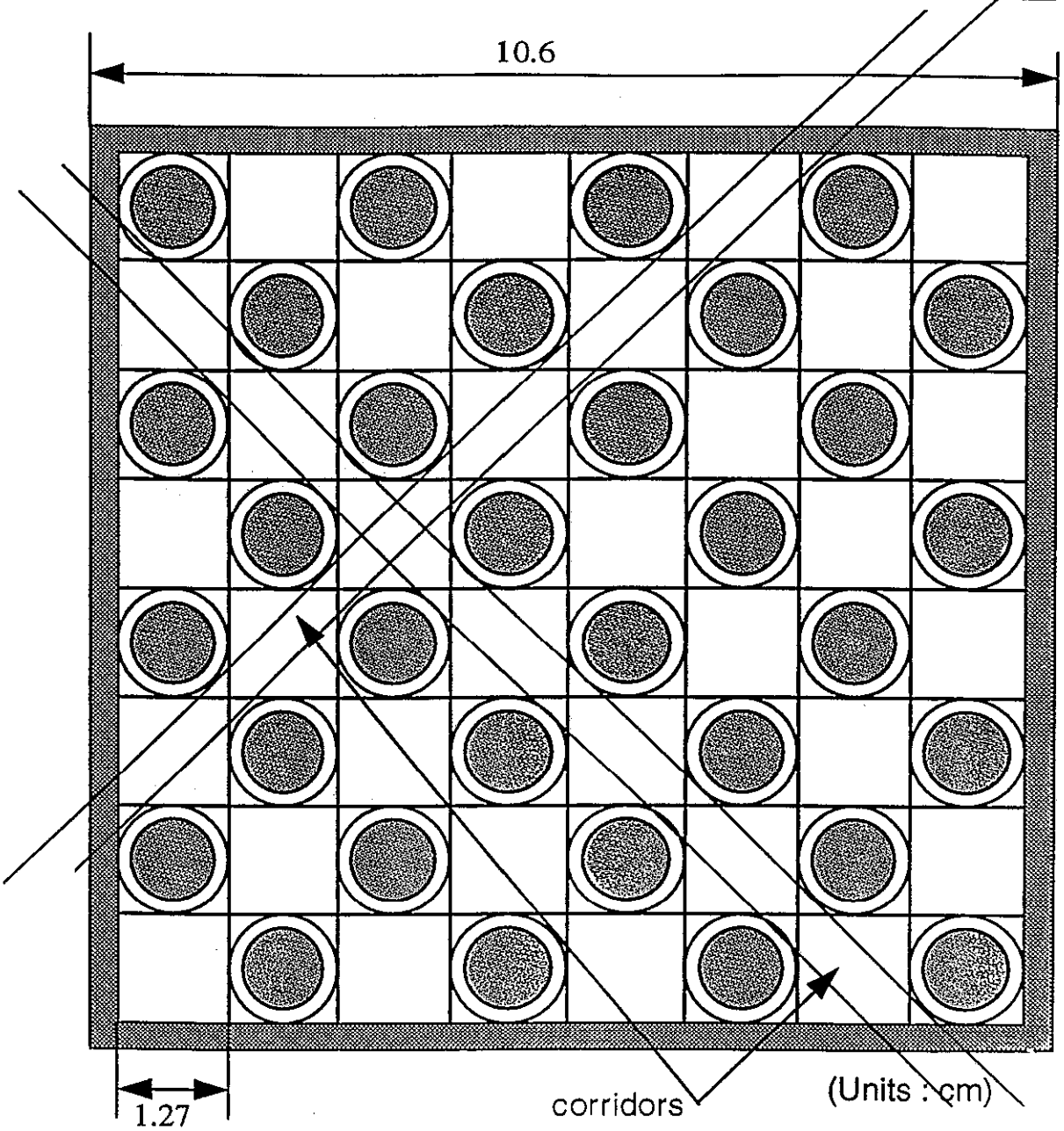
ADJOINT FLUX for the DIFFERENT CORES



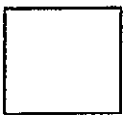
RZ Geometry of the ZONA2A core of the CIRANO programme



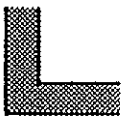
ZONA2PIT Two-Dimensional Cell Model of the CIRANO ZONA2A core



PuO_2-UO_2 Fuel Pin



Sodium Pin



Stainless Steel Tube

NA NUCLEAR DATA EVALUATION

UNIQUE evaluation performed in 1971

CARNAVAL IV not strictly based on this evaluation
(see comparison with ENDF BIV)
- (n,p) missing
- change of (n,γ) in the resonance region

Group	ENDF B IV- CARNAVAL IV / CARNAVAL IV
1	91.18
2	1.74
9	- 0.14
10	4.30
11	14.37

ENDF B IV
ENDF B V
ENDF B VI
JEF 1
JEF 2.2 — are the same evaluation
JENDL 3.2
BROND

change between JEF2 and CARNAVALIV due to heavy nuclide cross sections which modify the shape of the adjoint flux and then the slowing down component of the Na-Void

"Best Estimate" pour l'analyse des vidanges Na de ZONA2

avec JEF2

Transport P1 avec bouchons en place, cellule décrite à 2D et prise en compte de l'anisotrop

Composante	Centrale	Fuites Ax	Fuites Rad	Exp	Delta Exp	Total
V20	69.77	-5.71	-5.58	58.00	2.80	58.48
V40	131.30	-49.28	-11.05	62.50	2.90	70.98
V60	173.80	-154.59	-14.45	-11.00	3.50	4.76
V10	42.48	-100.05	-3.57	-74.10	4.60	-61.14
12V20	205.78	-17.01	-50.11	138.50	5.80	138.66
12V40	384.66	-130.55	-89.25	152.30	6.30	164.87
12V60	495.19	-403.60	-114.14	-81.30	6.00	-22.55
12V10	106.42	-258.32	-28.28	-215.90	9.70	-180.19

transport P1 direct
correction pour bouchons mélangés au combustible
correction 2D-1D avec anisotropie du streaming

"Best Estimate" pour l'analyse des vidanges Na de ZONA2

avec ERALIB1

Transport P1 avec bouchons en place, cellule décrite à 2D et prise en compte de l'anisotrop

Composante	Centrale	Fuites Ax	Fuites Rad	Exp	Delta Exp	Total
V20	65.34	-5.22	-5.08	58.00	2.80	55.04
V40	120.02	-45.07	-10.06	62.50	2.90	64.89
V60	162.75	-140.85	-13.11	-11.00	3.50	8.79
V10	39.83	-91.45	-3.25	-74.10	4.60	-54.88
12V20	192.99	-15.96	-46.72	138.50	5.80	130.32
12V40	360.81	-122.45	-83.23	152.30	6.30	155.13
12V60	464.23	-377.12	-106.07	-81.30	6.00	-18.96
12V10	100.13	-241.65	-26.32	-215.90	9.70	-167.85

transport P1 direct
correction pour bouchons mélangés au combustible
correction 2D-1D avec anisotropie du streaming

"Best Estimate" pour l'analyse des vidanges Na de ZONA2
avec JEF2.3 (nouvelle evaluation avec mesures récentes
d'OAK-RIDGE et de GEEL
Transport P1 avec bouchons en place, cellule décrite à 2D et prise en compte de l'anisotrop

Composante	Centrale	Fuites Ax	Fuites Rad	Exp	Delta Exp	Total
V20	66.10	-5.86	-5.73	58.00	2.80	54.50
V40	120.06	-49.96	-11.21	62.50	2.90	58.89
V60	161.62	-157.57	-14.74	-11.00	3.50	-10.69
V10	38.83	-102.22	-3.65	-74.10	4.60	-67.05
12V20	194.82	-17.84	-52.76	138.50	5.80	124.22
12V40	362.90	-137.06	-94.09	152.30	6.30	131.76
12V60	464.53	-425.52	-120.82	-81.30	6.00	-81.81
12V10	98.44	-272.71	-29.98	-215.90	9.70	-204.26

transport P1 direct
correction pour bouchons mélangés au combustible
correction 2D-1D avec anisotropie du streaming

NA-VOID

E/C values with different cross-sections sets
(2D cell model and transport S4-P1)
(with end-caps correction)

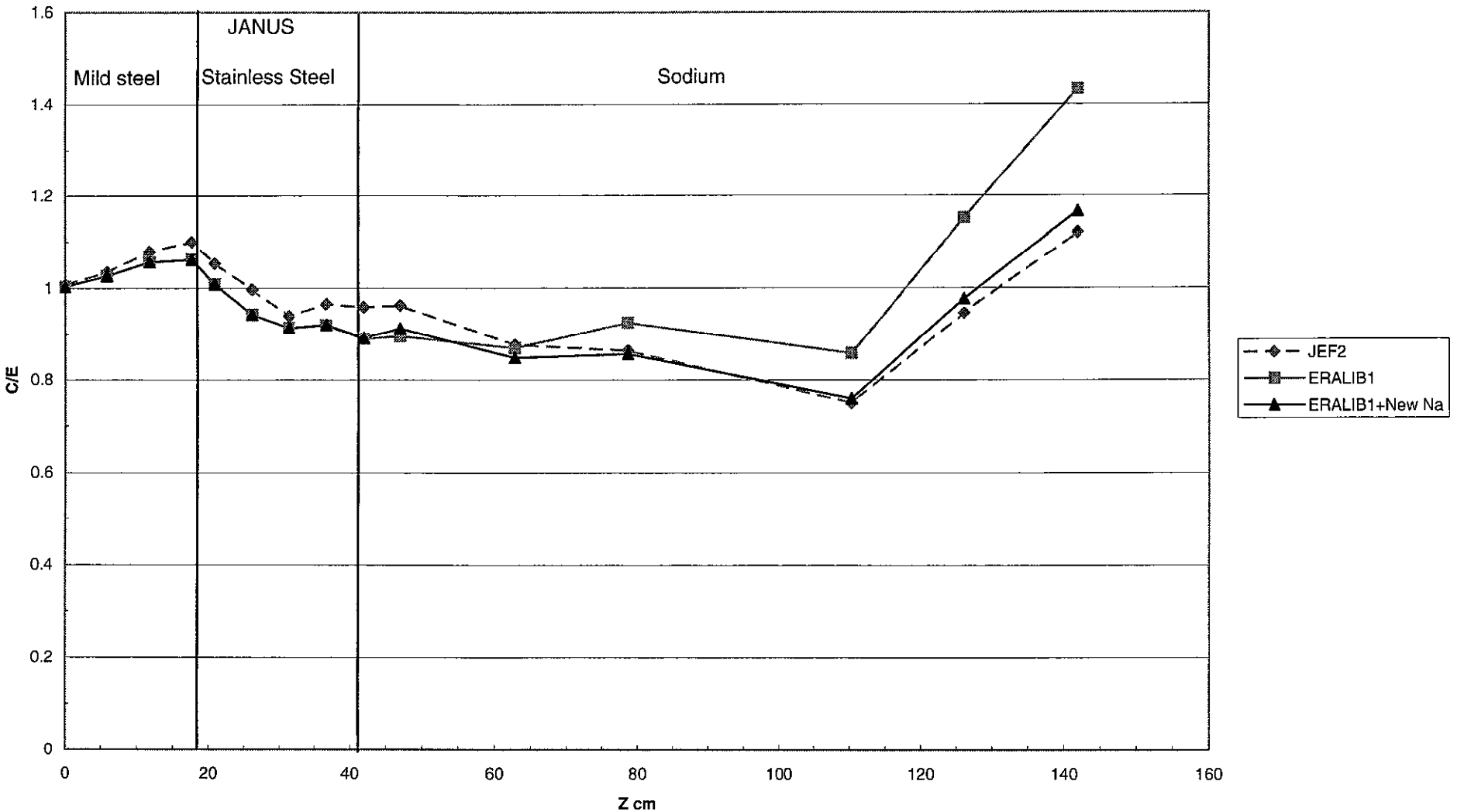
	Nuclear Data	ZONA2A	ZONA1/R1 8%Pu-240
KHI ** 2	CARNAVAL 4	7.43	2.02
	JEF2	4.60	4.30
	ERALIB1	6.40	2.92
	ERALIB1+ new Na Geel + Oak-Ridge	0.68	1.14

NA VOID FOR CAPRA 4/94 -COEUR PROPRE

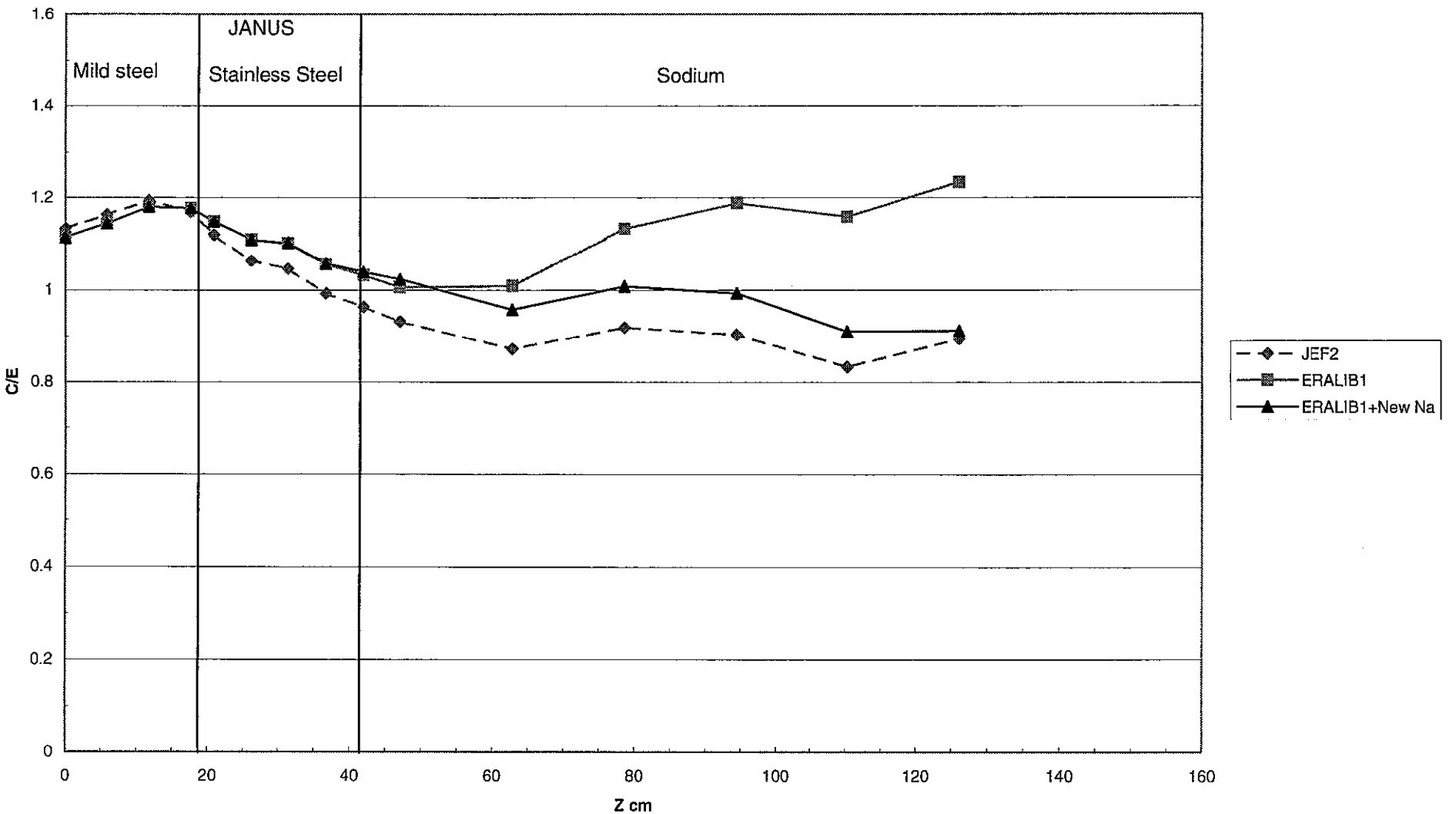
Values with different cross-sections sets
(2D cell model and diffusion theory)

Component	Non-leakage	Axial Leakage	Radial Leakage	Total (pcm)
Nuclear Data				
CARNAVAL 4	1689	-562	-274	853
JEF2	1758	-514	-252	992
ERALIB1	1671	-479	-237	955
ERALIB1+ new Na Geel + Oak-Ridge	1680	-534	-266	880

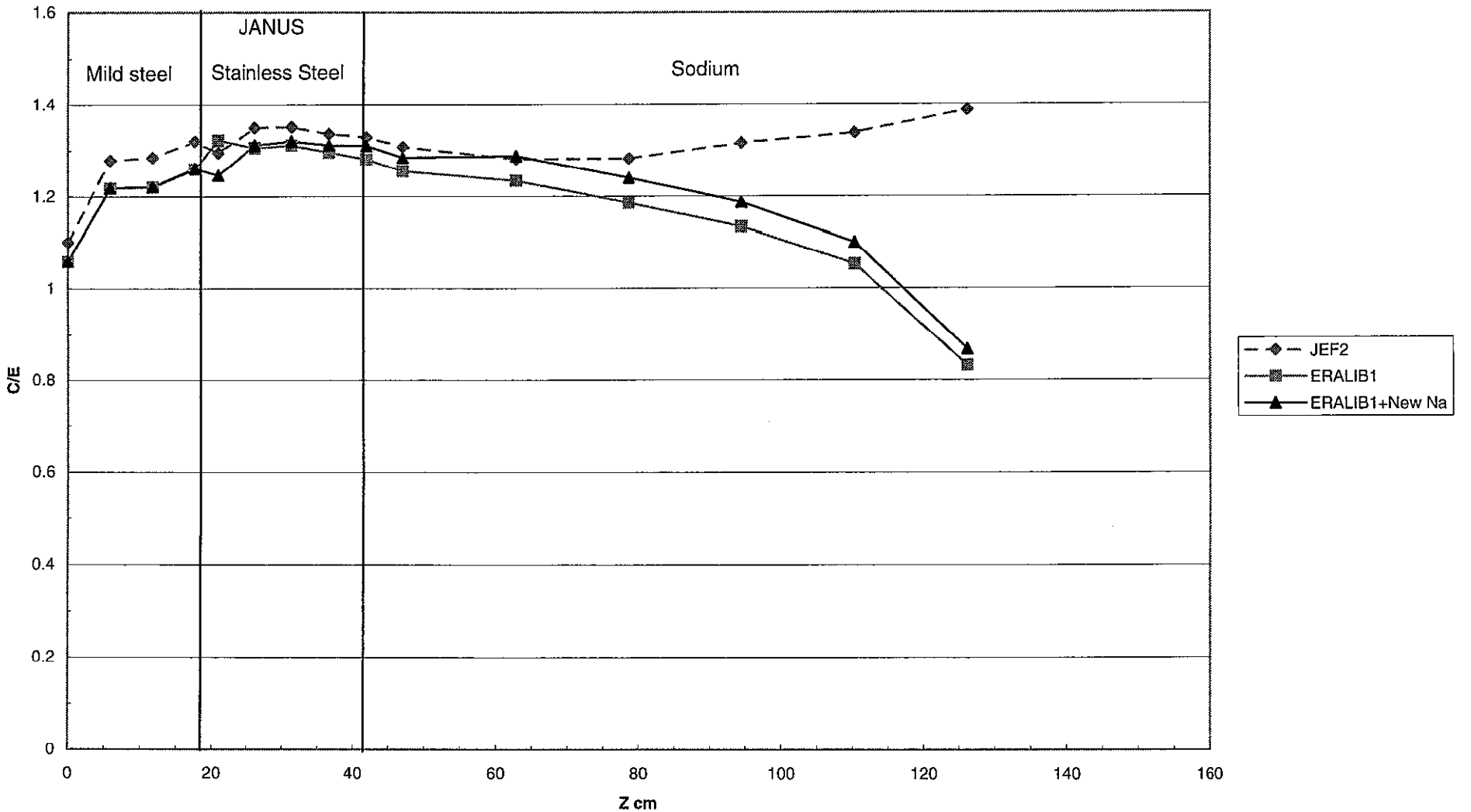
JANUS2 Réponse Soufre S32(n,p)P32



JANUS2 Réponse Rhodium Rh103(n,n') Rh103m



JANUS2 Réponse Manganèse Mn55(n,gamma)Mn56 Fer



JANUS2 Réponse Or Au197(n,gamma) Au198