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Methods and issues for the combined use of integral experiments and covariance data

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Needs to Adjust Mubar

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Meaning of Mubar Changes

Neutron Transport Equation: Diffusion Approximation

$$\nabla \cdot J(\vec{r},E) + \Sigma_t(\vec{r},E)\phi(\vec{r},E) = \int_0^\infty dE\Sigma_s(E' \to E)\phi(\vec{r},E') + S(\vec{r},E)$$

Neutron leakage

$$J(\vec{r},E) = -\frac{1}{3\Sigma_{tr}(\vec{r},E)}\nabla\phi(\vec{r},E) = -\frac{1}{3(\Sigma_t - \overline{\mu}_0\Sigma_s)}\nabla\phi$$

where,

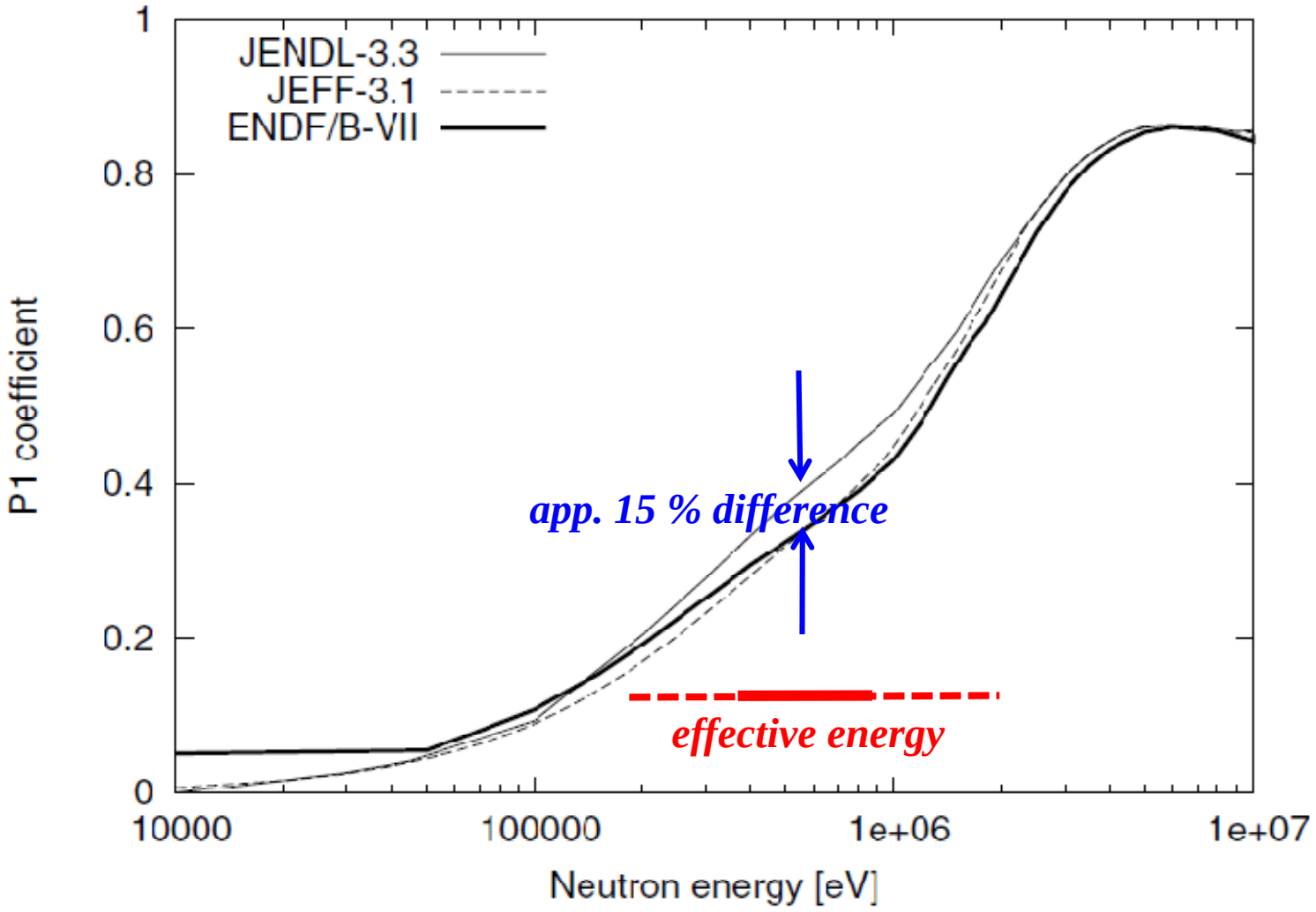
Average scattering angle cosine (i.e. mubar)

$$\overline{\mu}_0 \equiv \left\langle \hat{\Omega} \cdot \hat{\Omega}' \right\rangle = \frac{2\pi}{\Sigma_s}\int_{-1}^{+1} d\mu_0 \mu_0 \Sigma_s(\mu_0)$$

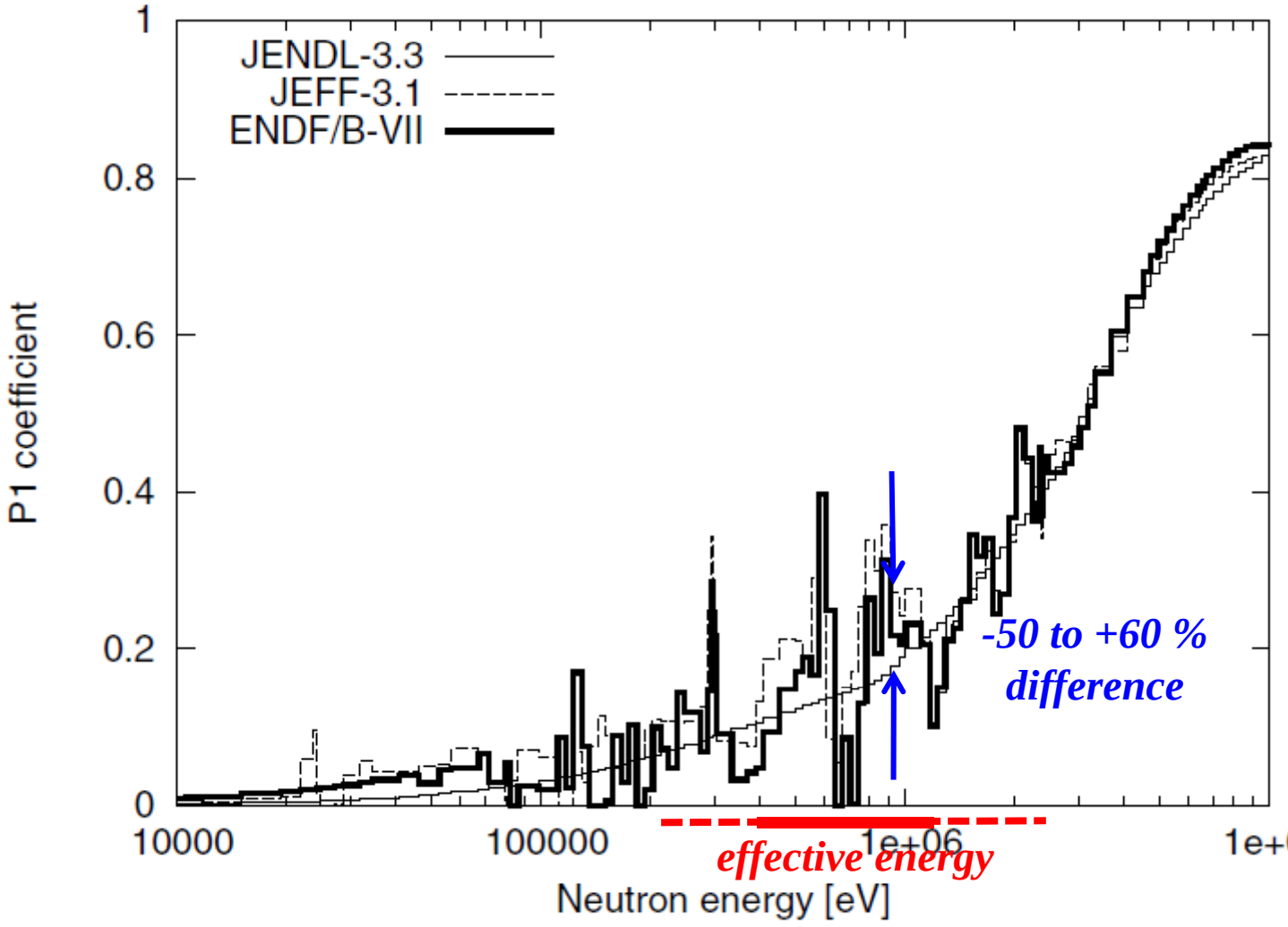
➔ When ***mubar*** increases, ***neutron leakage*** will increase,

, that is, ***keff*** and/or ***positive sodim void reactivity*** will decrease.

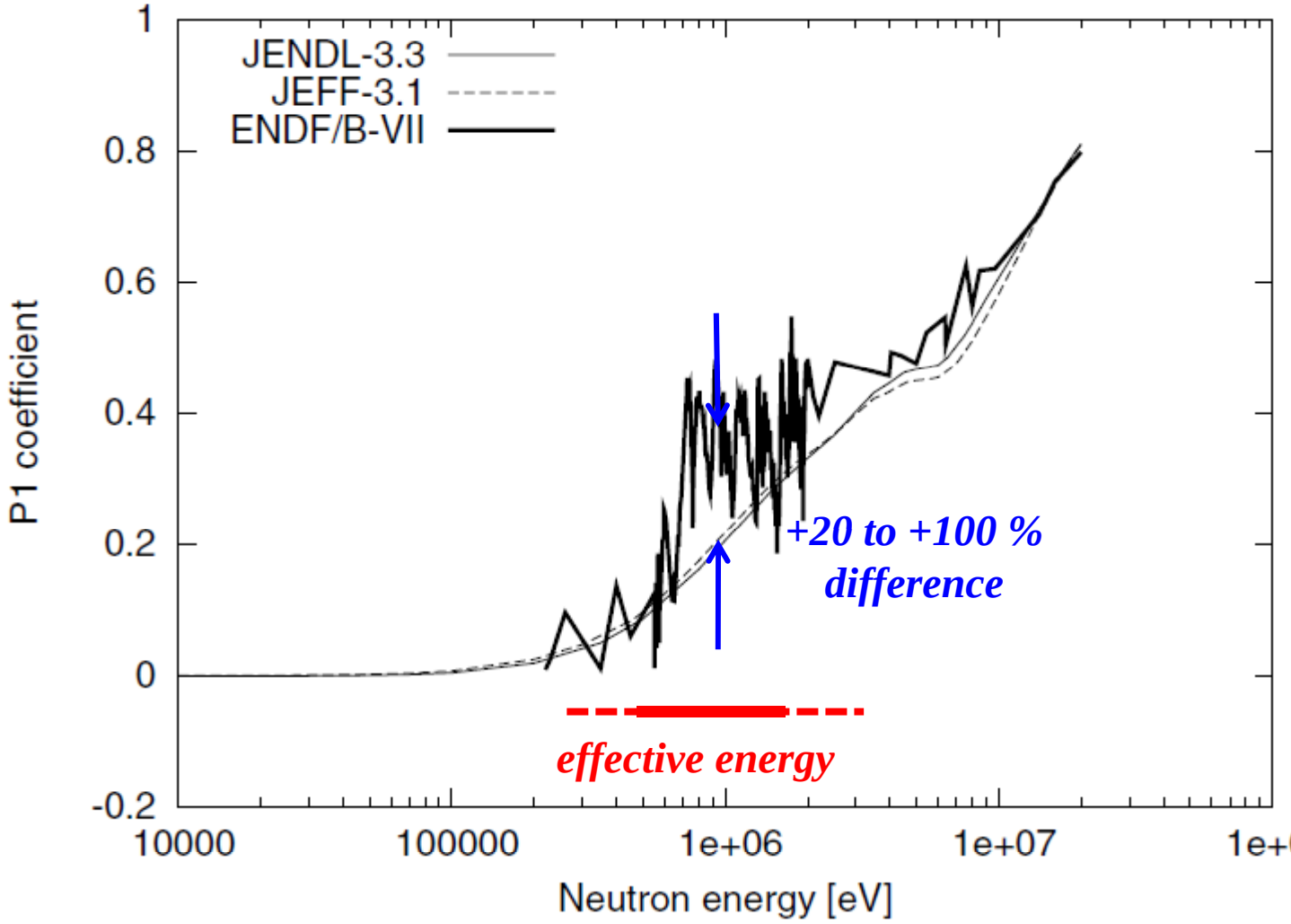
P1 Coefficients in Various Libraries (1/3)
- U-238, Elastic scattering -



P1 Coefficients in Various Libraries (2/3)
- Fe-56, Elastic scattering -



P1 Coefficients in Various Libraries (3/3)
- Na-23, Elastic scattering -



Influence of Mubar Differences to keff (1/2)
- between ENDF/B-7 and JENDL-3.3 -

(*Base: JENDL-3.3)

	ZPPR-9	MZA	MZB	MONJU	JOYO-I	JOYO-II
U-235, Cap.					+0.28	+0.12
U-235, ν					+0.10	
U-238, $\bar{\mu}$	+0.09	+0.17	+0.11	+0.08	+0.20	+0.08
Pu-239, Cap.	+0.20	+0.22	+0.20	+0.18	+0.13	+0.19
Pu-239, ν	-0.17	-0.10	-0.15	-0.13		
Pu-240, Cap.		+0.08	+0.07	+0.12		+0.08
Pu-241, Cap.				+0.05		
Pu-241, Fis.				-0.09		
Na, Ela.				+0.06		+0.05
Na, Inela.	+0.06			+0.06		
Na, $\bar{\mu}$	-0.10	-0.26	-0.17	-0.16	-0.39	-0.46
Cr, Ela.		+0.06			+0.06	+0.16
Cr, Inela.	-0.06		-0.06	-0.07		
Cr, $\bar{\mu}$						+0.08
Fe, Ela.		-0.07	-0.05		-0.07	-0.17
Fe, Inela.	+0.07		+0.06	+0.06		

Influence of Mubar Differences to keff (2/2)
- between JEFF-3.1 and JENDL-3.3 -

(*Base: JENDL-3.3)

	ZPPR-9	MZA	MZB	MONJU	JOYO-I	JOYO-II
U-235, Cap.					+0.27	+0.12
U-238, Fis.	-0.12	-0.09	-0.10	-0.08	-0.08	-0.06
U-238, Inela.		-0.06			-0.07	-0.07
U-238, Nu	+0.15	+0.11	+0.12	+0.10	+0.10	+0.08
U-238, Ela.	+0.07	+0.16	+0.11	+0.07	+0.18	+0.07
U-238, $\bar{\mu}$	+0.10	+0.19	+0.13	+0.09	+0.21	+0.08
Pu-239, Cap.	+0.09	+0.09	+0.09	+0.08	+0.05	+0.08
Pu-239, Fis.	-0.31	-0.21	-0.26	-0.22	-0.06	-0.08
Pu-239, Inela.	+0.09		+0.06	+0.06		-0.07
Pu-239, ν	-0.24	-0.15	-0.22	-0.19		-0.05
Pu-240, Cap.	+0.06	+0.11	+0.10	+0.16	+0.07	+0.11
Pu-240, Fis.		+0.05		+0.06		+0.06
Pu-240, ν		+0.10	+0.08	+0.12	+0.06	+0.11
Na, Ela.		+0.16	+0.08	+0.08	+0.30	+0.34
Na, Inela.	+0.25	+0.07	+0.18	+0.17	-0.09	-0.12
Na, $\bar{\mu}$						-0.06
Cr, $\bar{\mu}$						+0.08
Fe, Ela.						+0.10
Fe, Cap.	+0.07	+0.07	+0.08	+0.08	+0.06	+0.09
Fe, Inela.	+0.11	+0.06	+0.09	+0.09		
Fe, $\bar{\mu}$	-0.08	-0.19	-0.13	-0.11	-0.19	-0.49

Influence of Mubar Differences to Leakage term of Sodium Void Reactivity

(*Base: JENDL-3.3)

	ZPPR-9, step 2		MZB, step 7	
	JEFF-3.1	ENDF/B-VII.0	JEFF-3.1	ENDF/B-VII.0
U-238, Ela.	-1.4			
U-238, μ	-1.8	-1.7	-1.1	-1.0
Na, Ela.	+3.5		+4.4	
Na, Inela.	-2.8		-3.1	
Na, $\bar{\mu}$		-3.7		-4.8
Fe, $\bar{\mu}$	+1.4		+1.2	

Concluding Remarks

- The differences of ***mubar evaluation among various libraries*** seem rather large in the sensitive energy region to the FBR core parameters.

- The effect of mubar differences would be ***100 to 400 pcm for the criticality***, and ***2 to 5 % to the leakage term of sodium void reactivity***.

We might need to **adjust the mubar values**, if our target accuracy would be **300 pcm for criticality**, and/or **7 % for sodium void reactivity** in 1 σ, according to the SG26 conclusion.