CURRENT INCONSISTENCIES IN ^{238}Pu, ^{242,243} Am AND ^{242}Cm EVALUATIONS AND IMPACT ON UNCERTAINTIES

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- Improvements of the nuclear reaction modeling and nuclear parameter systematic for major actinides ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu
- Sound basis for critical assessment of $\sigma(n, F)$, $\sigma(n, \gamma)$, $\sigma(n, n')$, $\sigma(n,xn)$ of MA
- Essential «tweaking » of major actinides data files to yield K-eff ≈ 1
- A number of biases is imposed into capture, inelastic css, PFNS, etc.
- To avoid substituting model deficiency uncertainties for MA by enlarging the δx_i of x_i nuclear model parameters !!!
- Uncertainty estimation of CSS & PFNS of MA should be preceded by neutron data re-evaluation
- Otherwise, for MA(Np, Pu, Am, Cm) the artificially large $\Delta\sigma$ - unavoidable

“STRUCTURED” CORRELATIONS

- **Close interplay between EXP.(D$I)& MOD.**
- **Correlation of ARP &CSS**
- **Correlation of nuclear model parameters**
- **Correlation between reaction channels**
- **Correlation between (Z,A) &(Z±n,A±m)**
- **Correlation between σ(n, F)&ν_p & PFNS**

SCOPE

- **238-Pu**
- **ENDF/B-VII.0 (ENDF/B-VI)**
- **JENDL-3.3**
- **Maslov et al., 1998 (http://www-nds.iaea.org)**
- **241-Am [Maslov et al. 1998] in JENDL-3.3**
- **JEFF-3.1 , ENDF/B-VII.0**
- **242g-Am [Maslov et al. 1998] in JENDL-3.3, JEFF-3.1**
- **ENDF/B-VII.0**
- **242m-Am [Maslov et al. 1998] in JENDL-3.3, JEFF-3.1**
- **ENDF/B-VII.0**
- **243-Am- [Maslov et al. 1998] in JENDL-3.3, JEFF-3.1**
- **ENDF/B-VII.0**
- **242-Cm**
- **ENDF/B-VII.0 (ENDF/B-VII.0)**
- **JENDL-3.3**
- **BROND**
- **243-Cm- Maslov et al. 1998 in JEFF-3.1, JENDL-3.3,ENDF/B-VII**
- **245-Cm- Maslov et al. 1998 in JEFF-3.1, JENDL-3.3, ENDF/B-VII**
- **246-Cm- Maslov et al. 1998 in JEFF-3.1, JENDL-3.3, ENDF/B-VII**

CAPTURE –model deficiency or ARR+OMP uncertainties

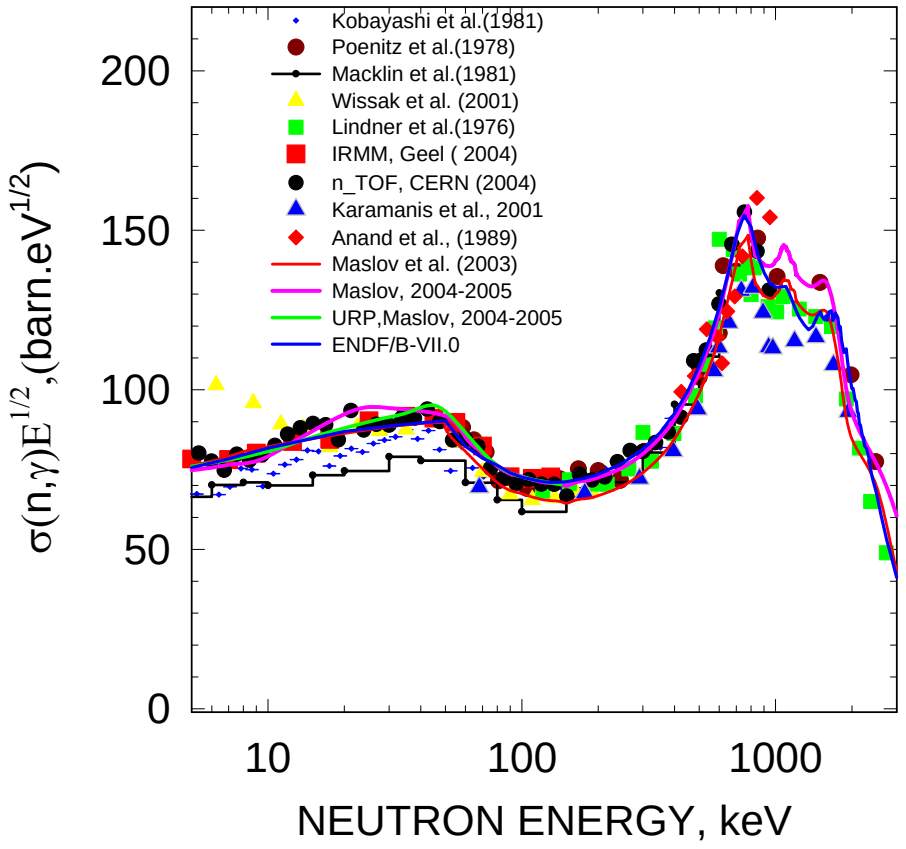
^{233}U, ^{235}U, ^{239}Pu

^{232}Th, ^{238}U

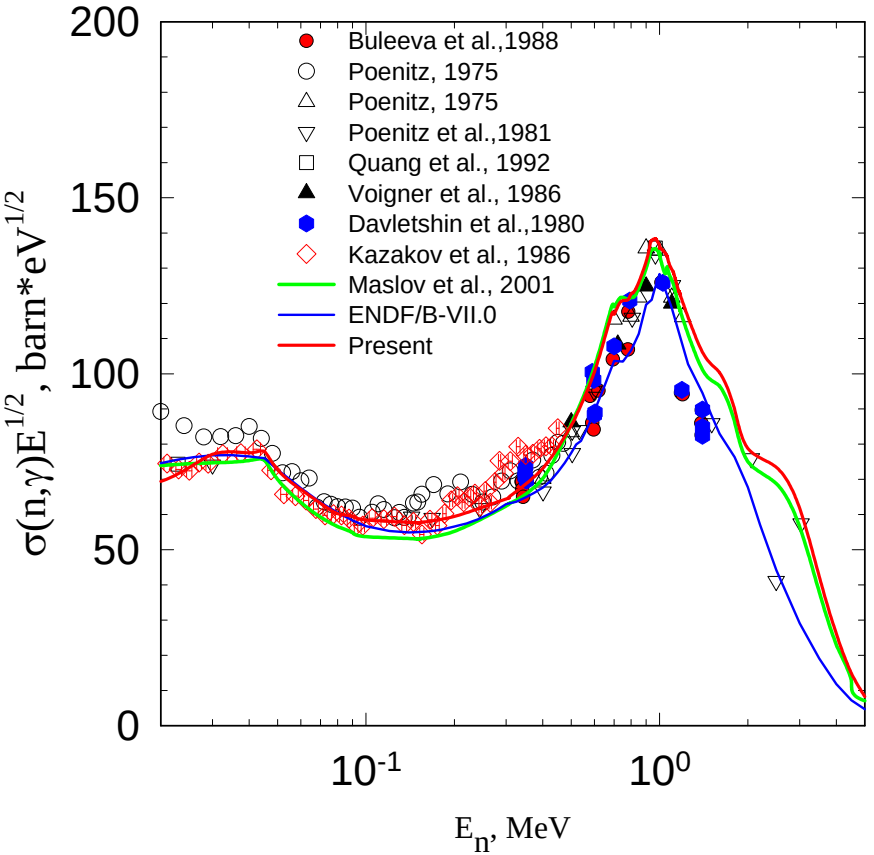
^{238}Pu, ^{242}Cm

“Tweaking “ consequences- “biases” revealed

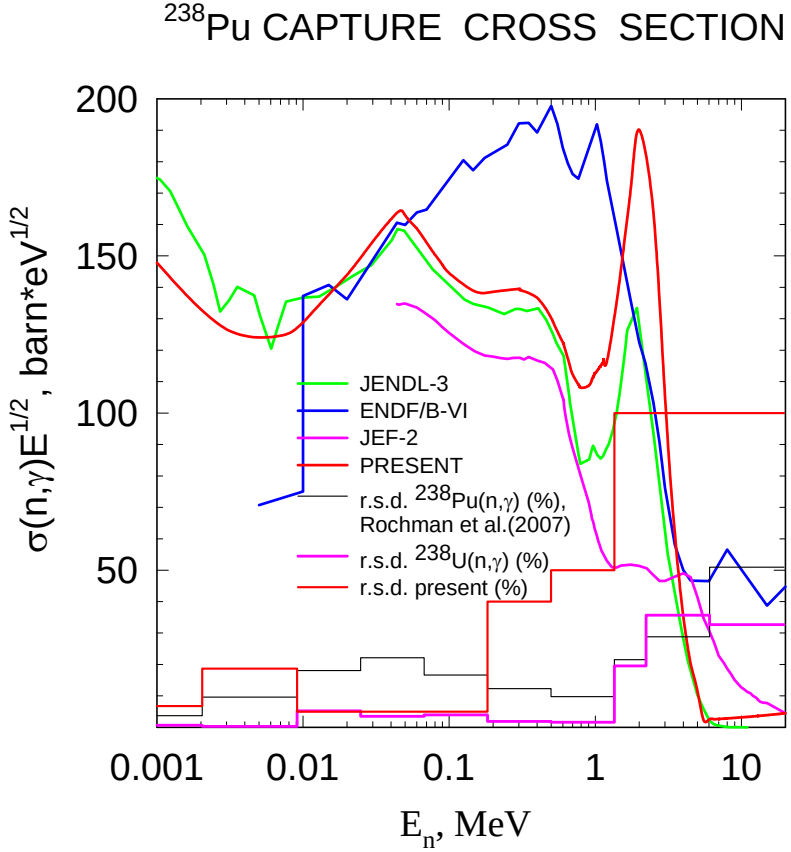
^{232}Th(n,γ) CROSS SECTION

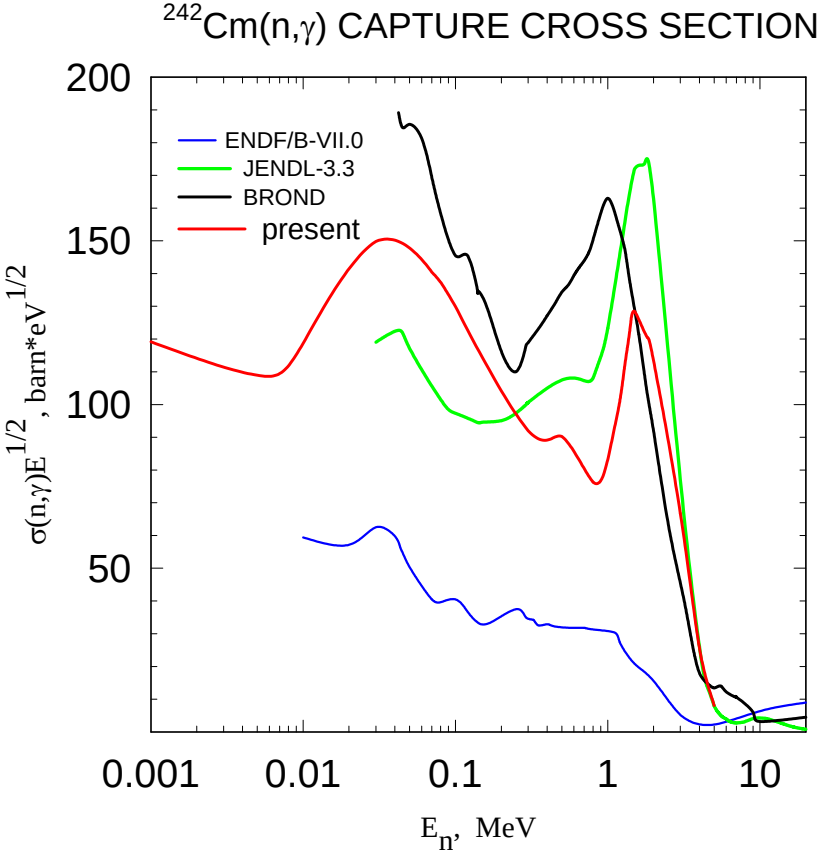


^{238}U CAPTURE CROSS SECTION

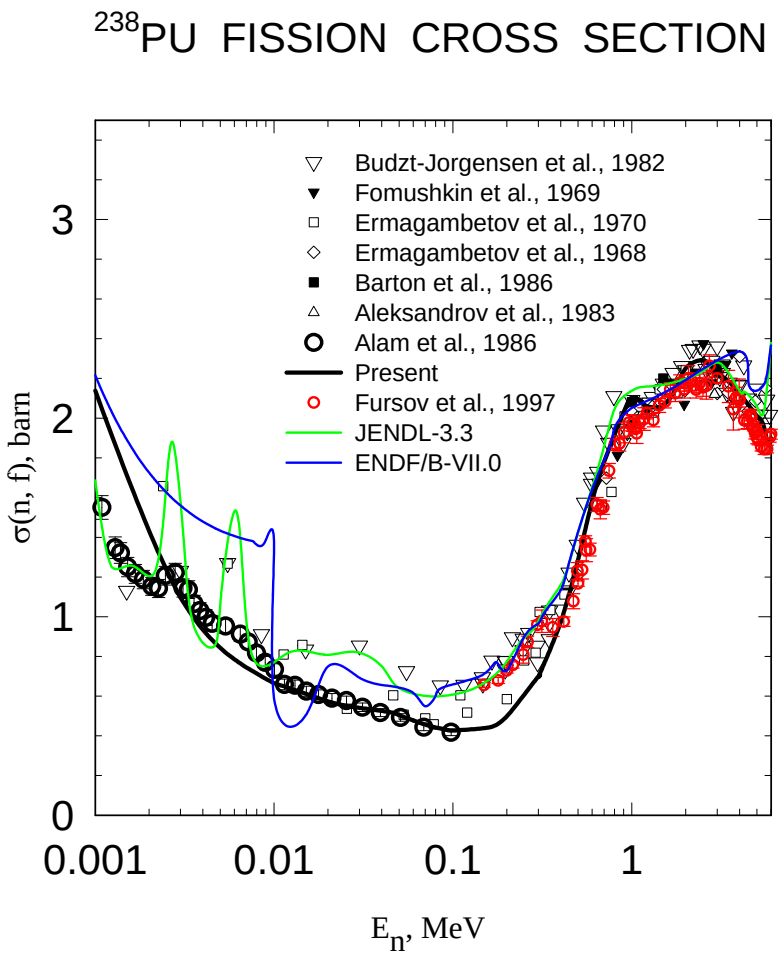


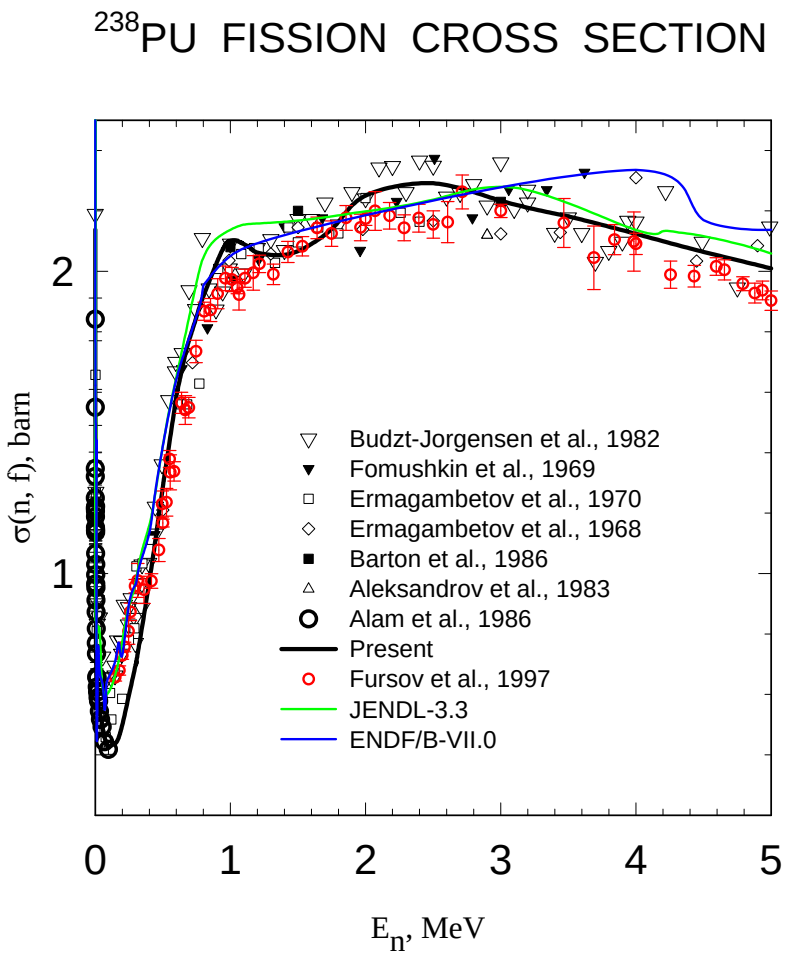
“Tweaking “ impossible- ARP+σ(n,f) fit

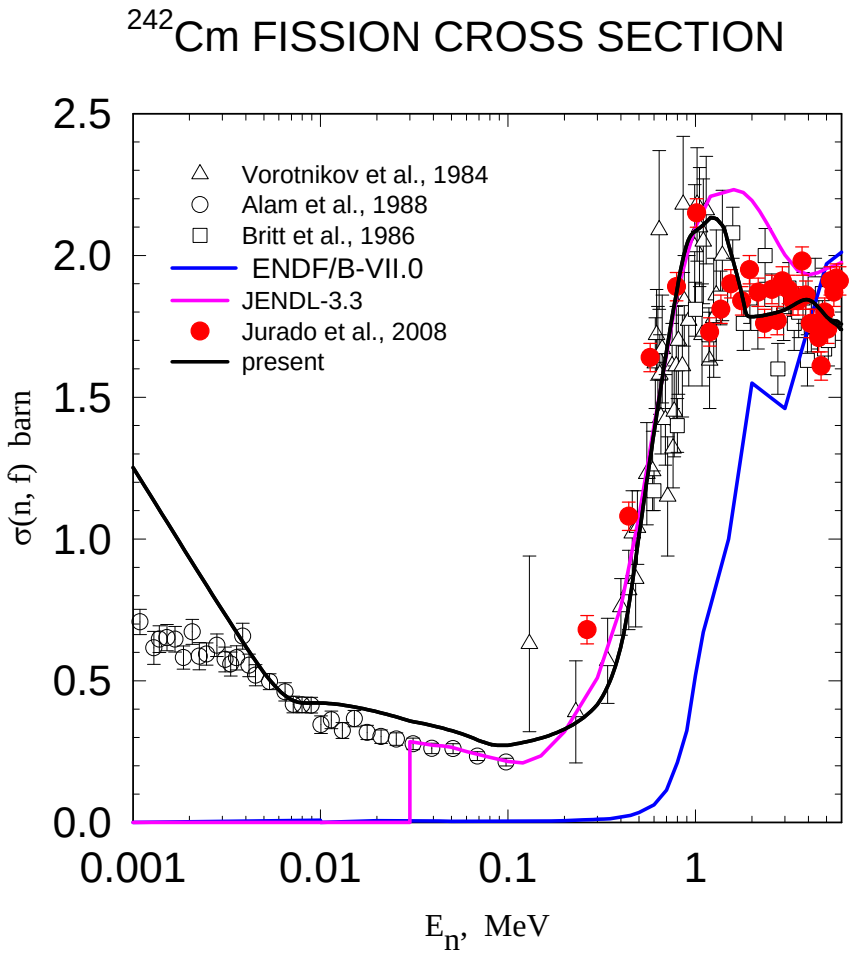


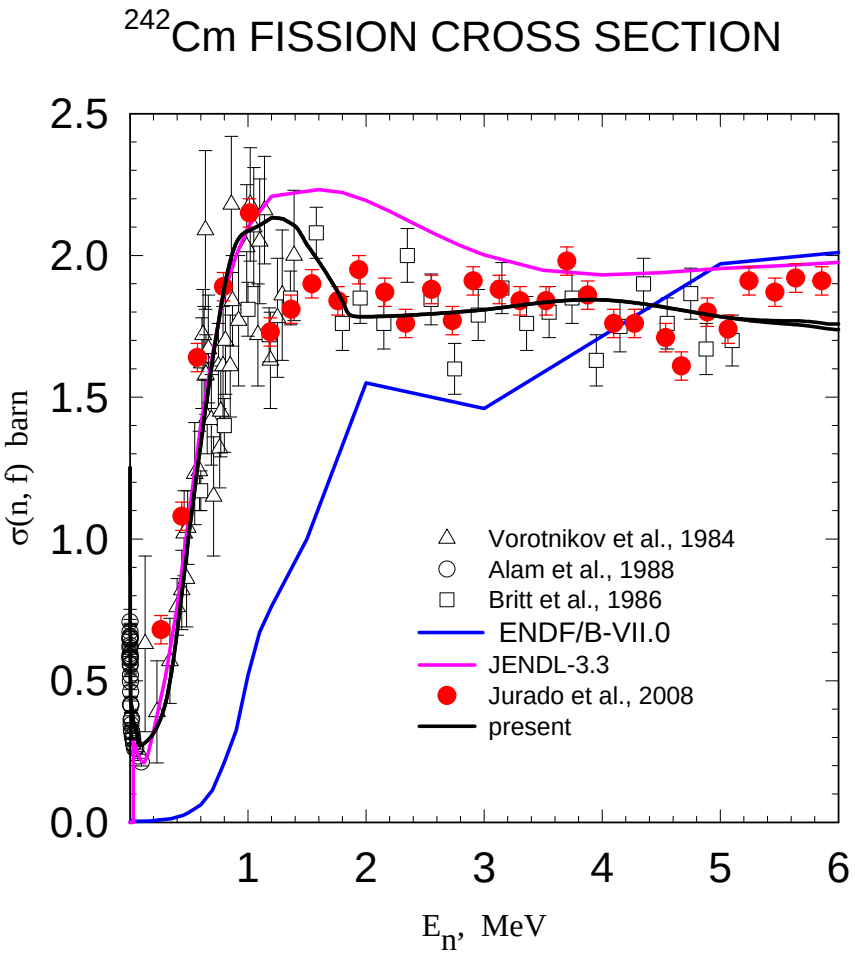


^{238}Pu(n, f)

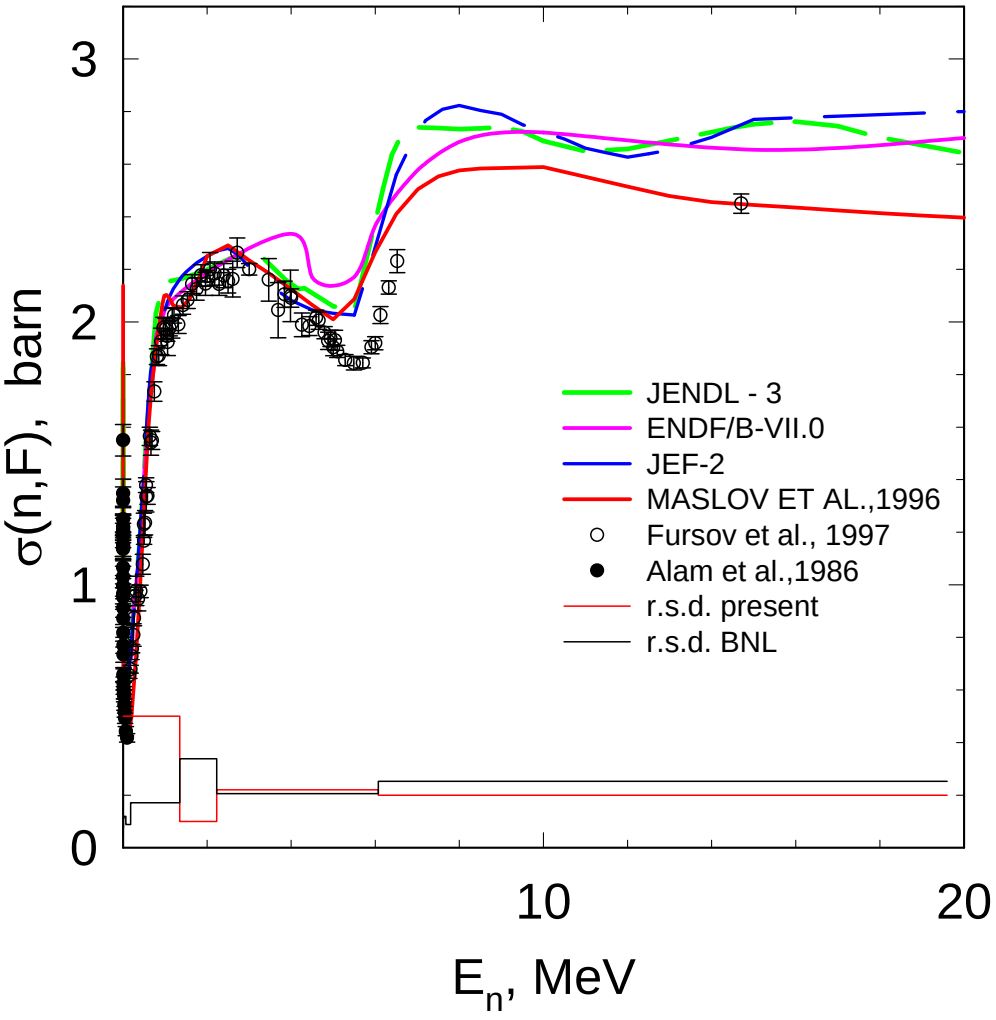

238PU FISSION CROSS SECTION
Budzt-Jorgensen et al., 1982
Fomushkin et al., 1969
Ermagambetov et al., 1970
Ermagambetov et al., 1968
Barton et al., 1986
Aleksandrov et al., 1983
Alam et al., 1986
Present
Fursov et al., 1997
JENDL-3.3
ENDF/B-VII.0
σ(n, f), barn
E_n, MeV
0
1
2
3
0.001
0.01
0.1
1


238PU FISSION CROSS SECTION
Budzt-Jorgensen et al., 1982
Fomushkin et al., 1969
Ermagambetov et al., 1970
Ermagambetov et al., 1968
Barton et al., 1986
Aleksandrov et al., 1983
Alam et al., 1986
Present
Fursov et al., 1997
JENDL-3.3
ENDF/B-VII.0
σ(n, f), barn
E_n, MeV
0
1
2
3
4
5


242Cm FISSION CROSS SECTION
Vorotnikov et al., 1984
Alam et al., 1988
Britt et al., 1986
ENDF/B-VII.0
JENDL-3.3
Jurado et al., 2008
present
σ(n, f) barn
E_n, MeV


242Cm FISSION CROSS SECTION
Vorotnikov et al., 1984
Alam et al., 1988
Britt et al., 1986
ENDF/B-VII.0
JENDL-3.3
Jurado et al., 2008
present
σ(n, f) barn
E_n, MeV

^{238}Pu FISSION CROSS SECTION



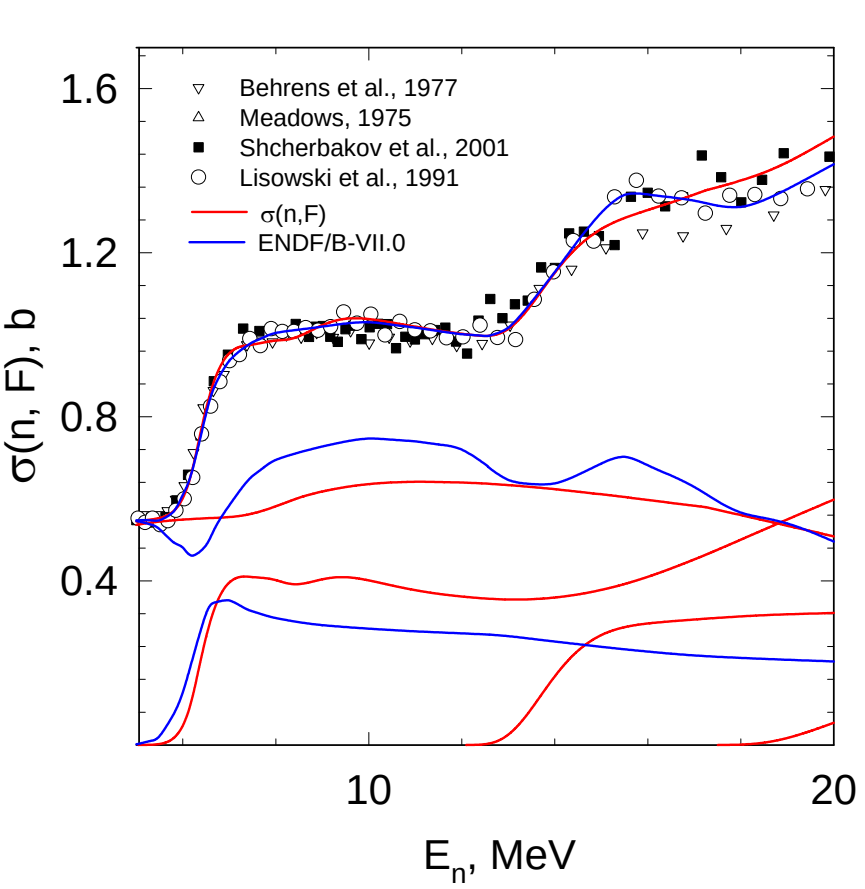
FISSION -model deficiency or Fiss.param. uncertainties

^{235}U, ^{238}U, ^{232}Th

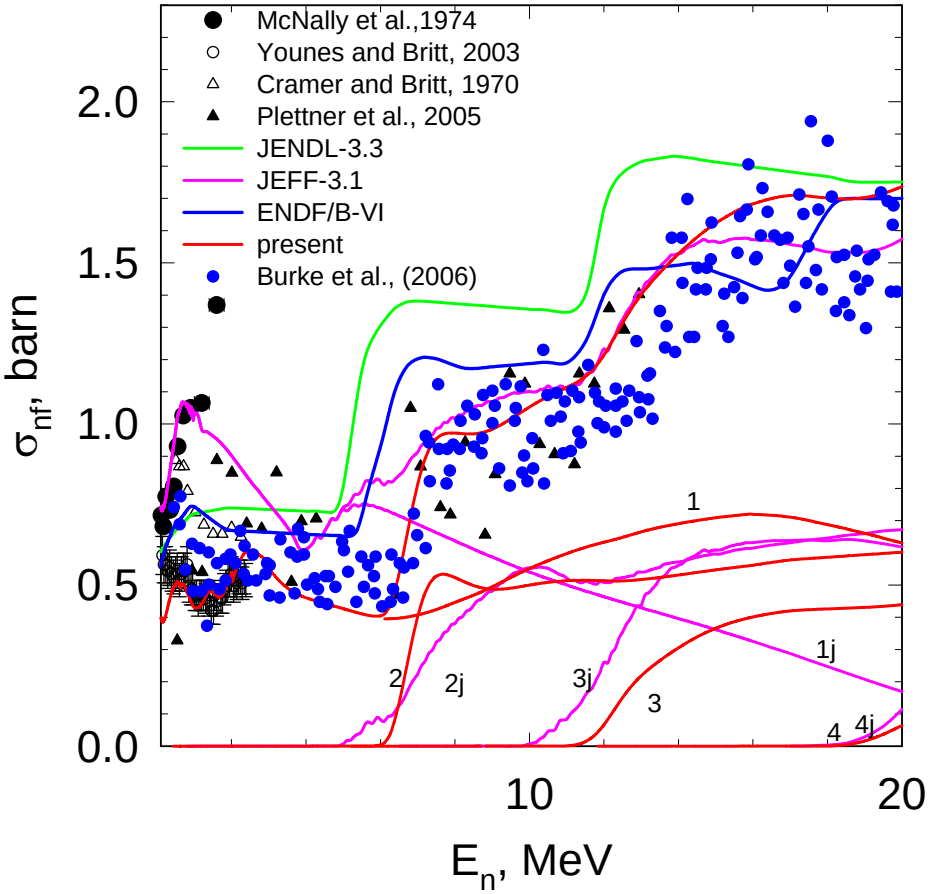
^{237}U

^{238}Pu, ^{242}Cm, ^{241}Am, ^{243}Am

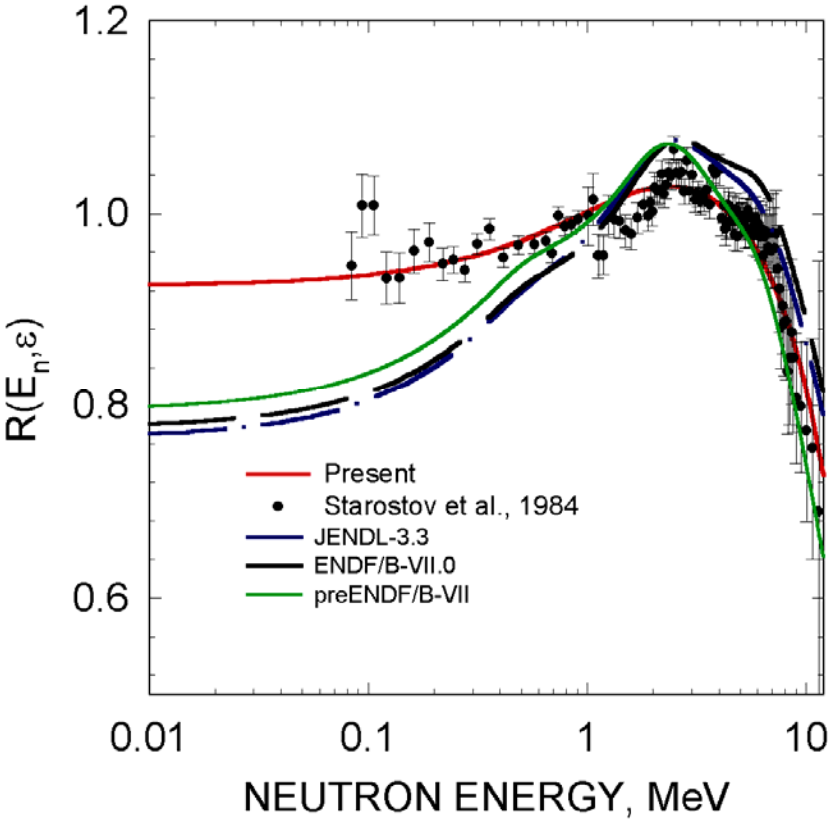
^{238}U(n,F)

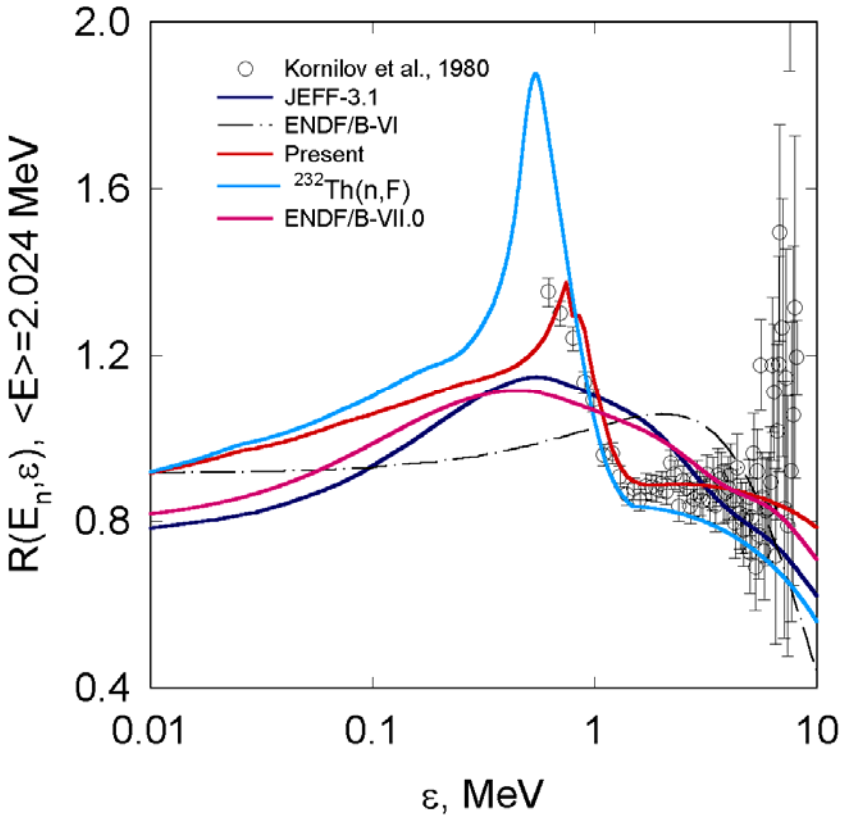


^{237}U(n,F)

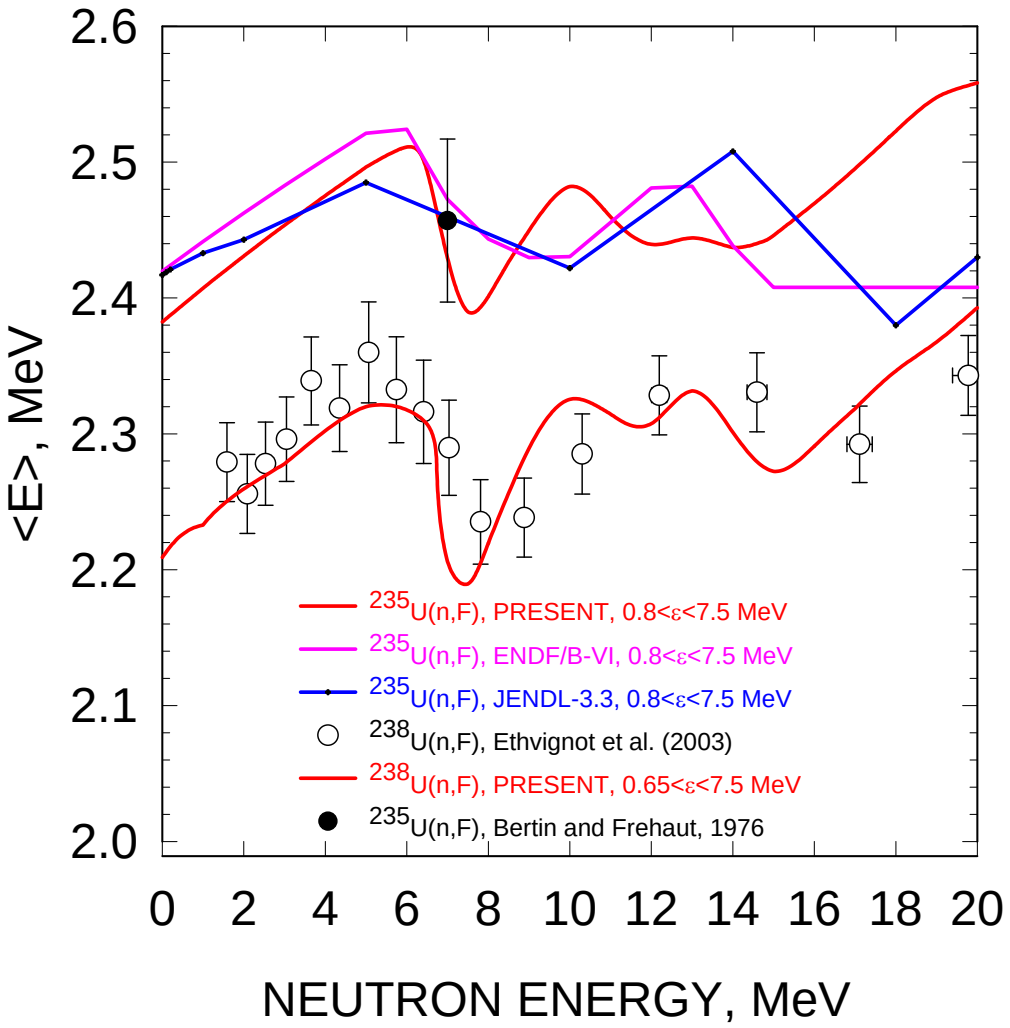


E_n=thermal, 238_U(n, f),PFNS, E_n=7 MeV

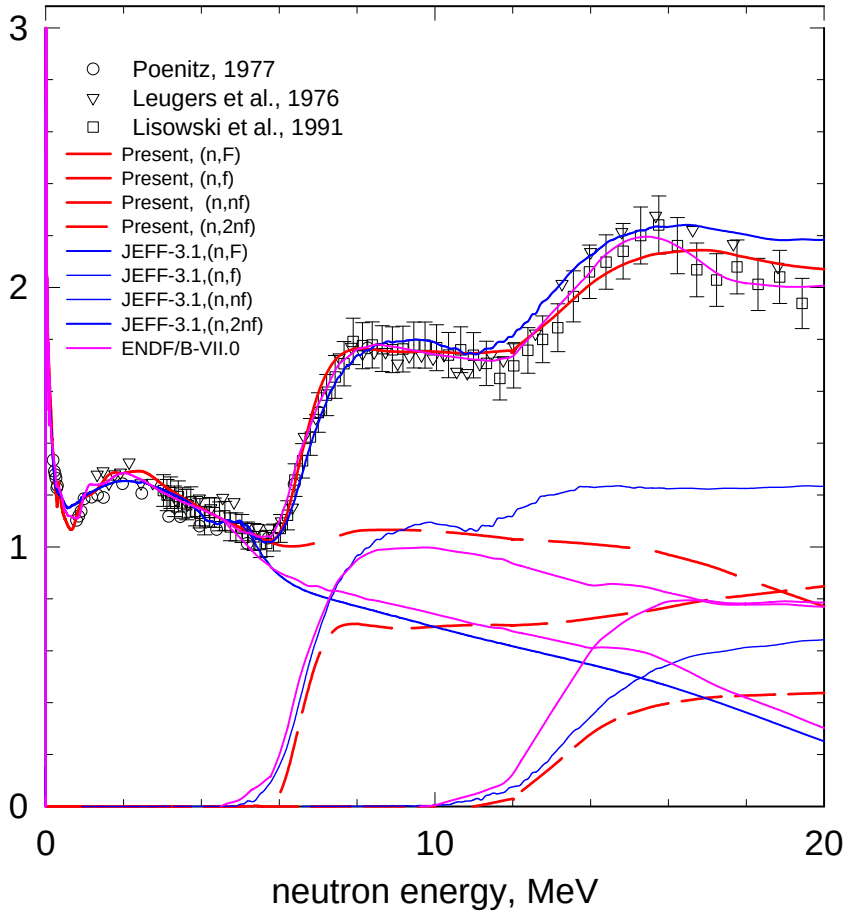


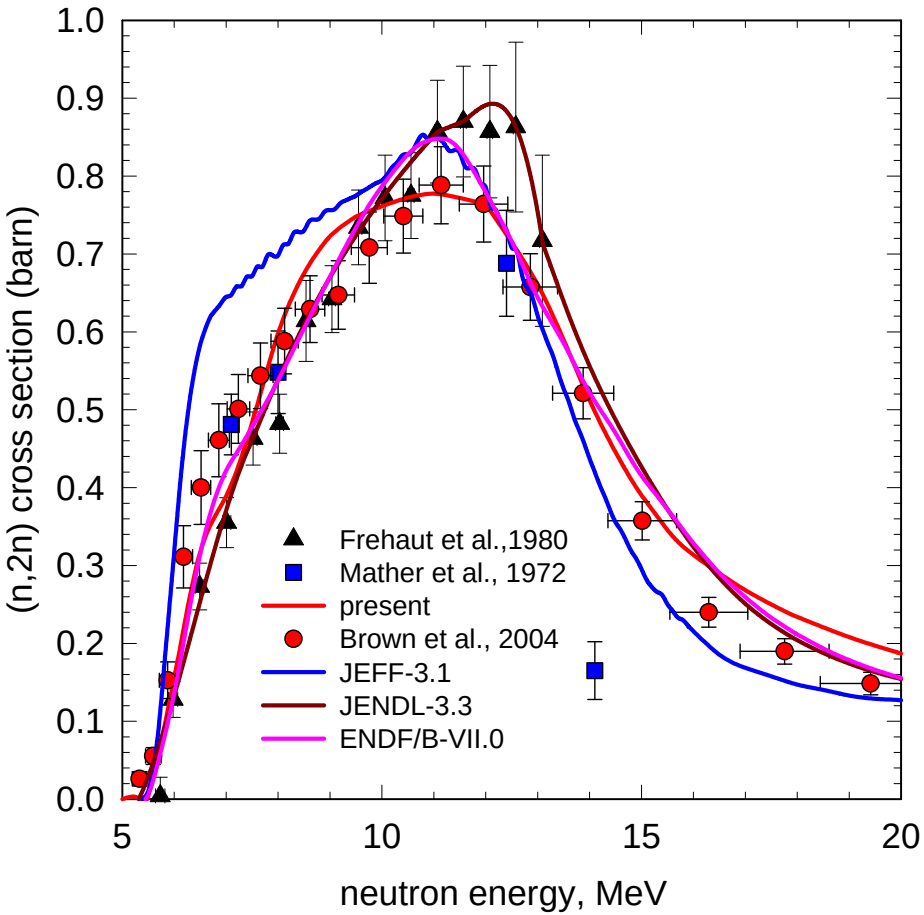


^{235}U&^{238}U: AVERAGE ENERGY OF PFNS



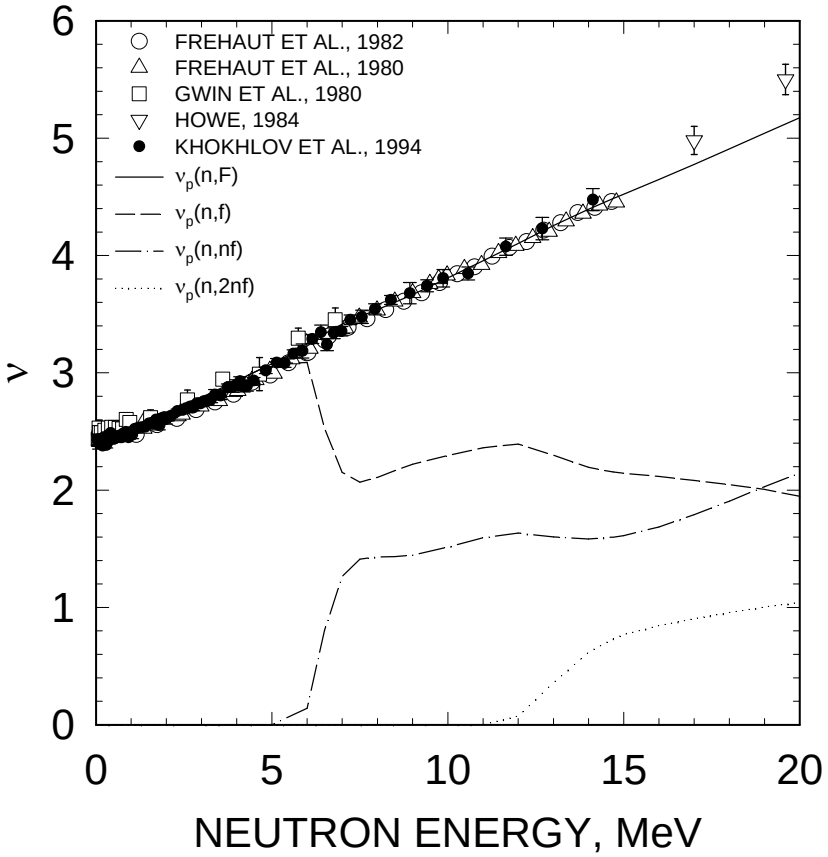
^{235}U(n,F) & 235u(n,2n)

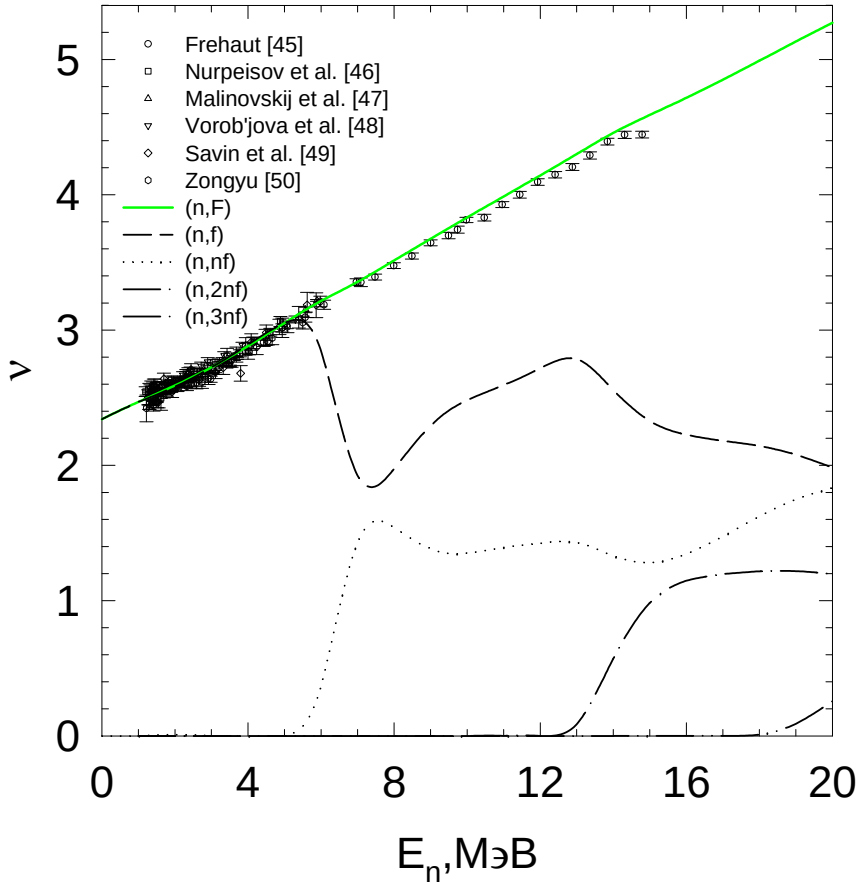




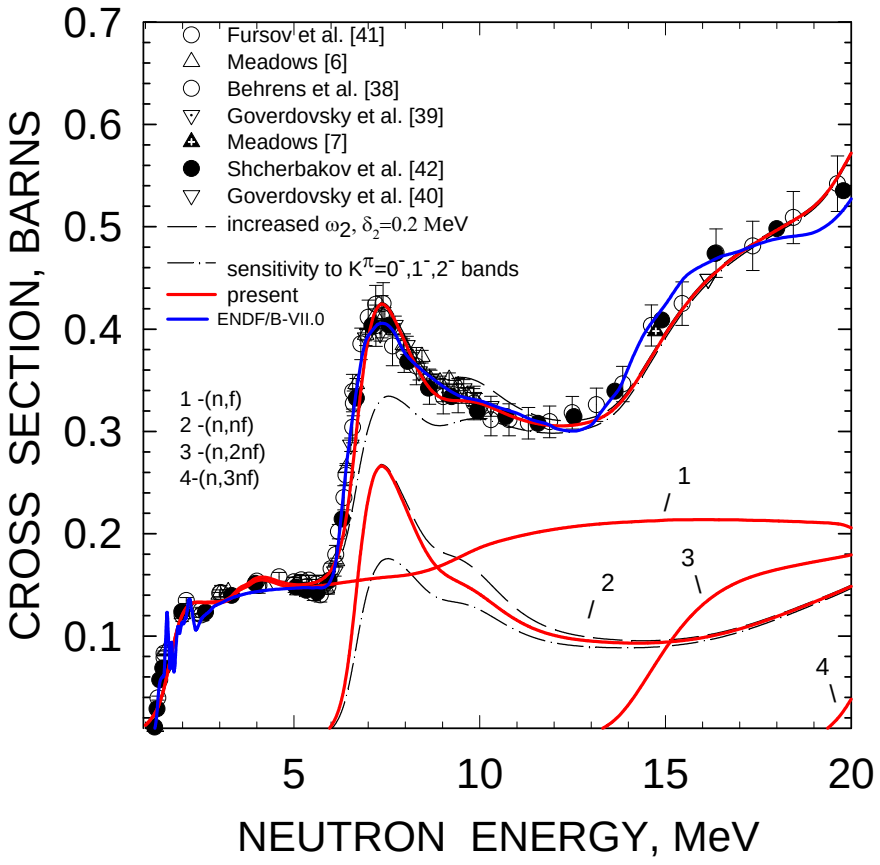
$^{235}U(n,F)$ ν of PFN $^{238}U(n,F)$

$^{235}U(n,F)$, NEUTRON MULTIPLICIY

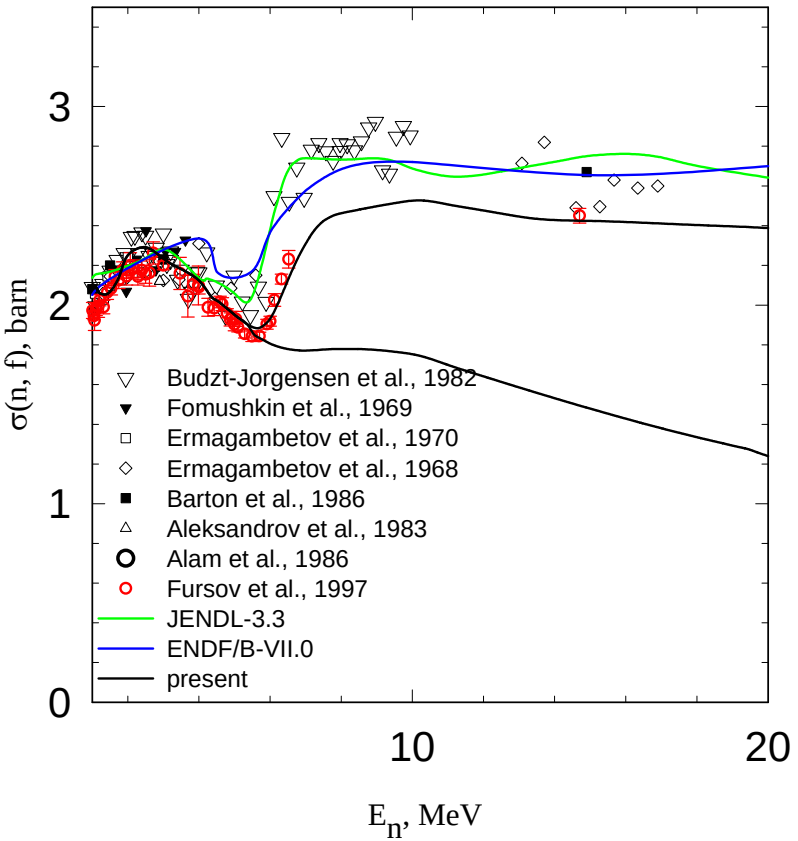




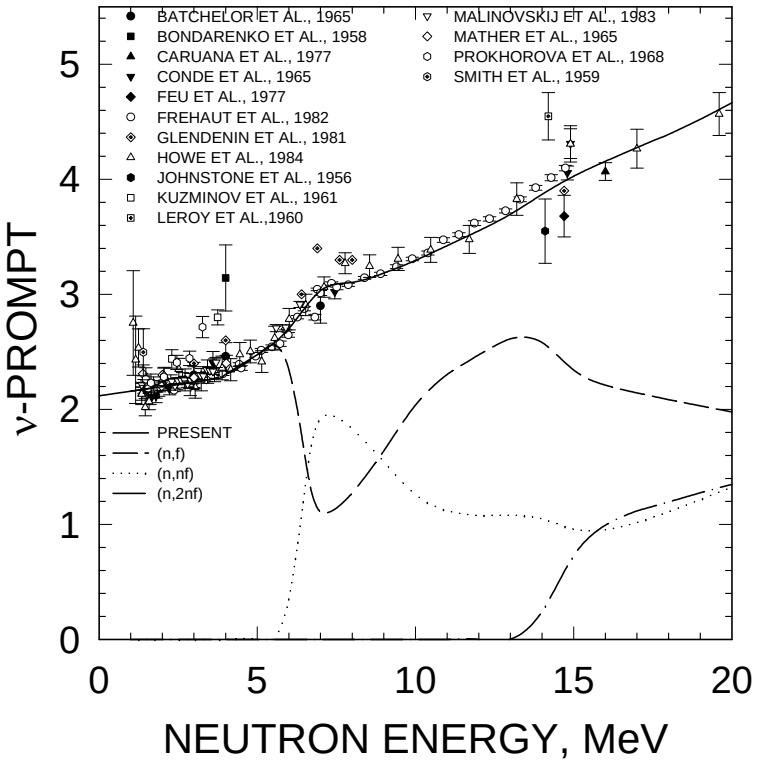
^{232}Th FISSION CROSS SECTION



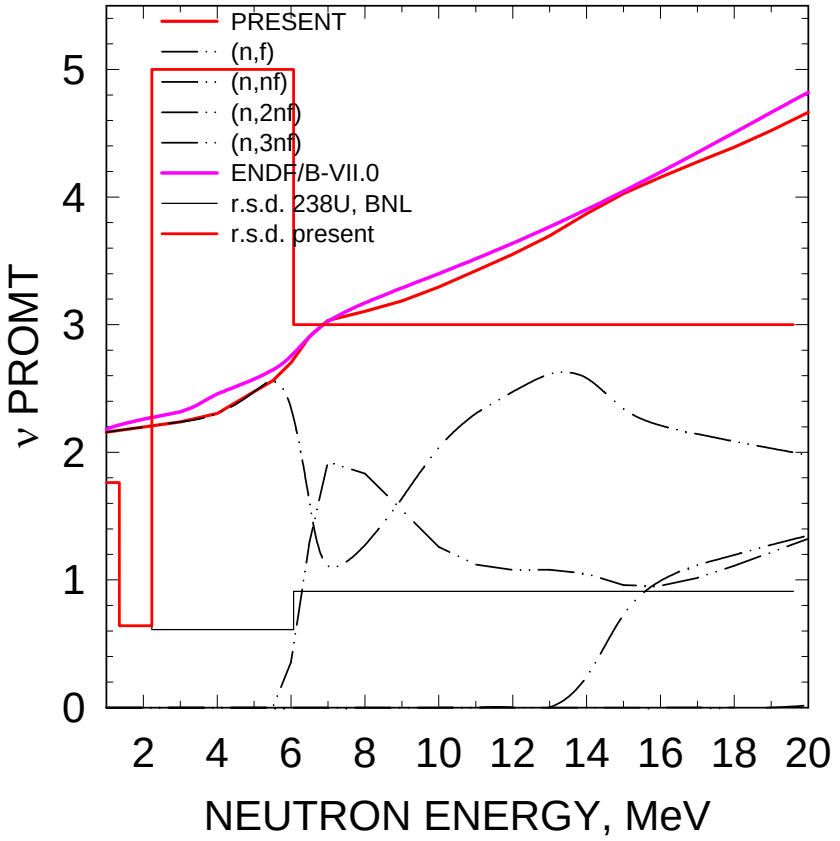
^{238}PU FISSION CROSS SECTION



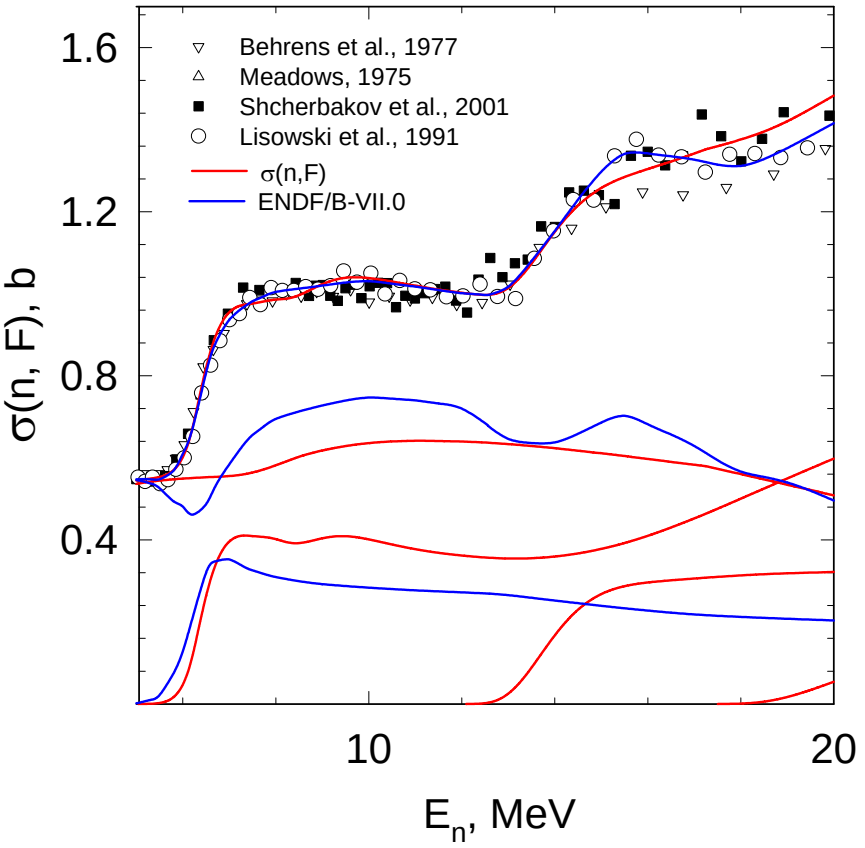
^{232}Th, NEUTRON MULTIPLICIY



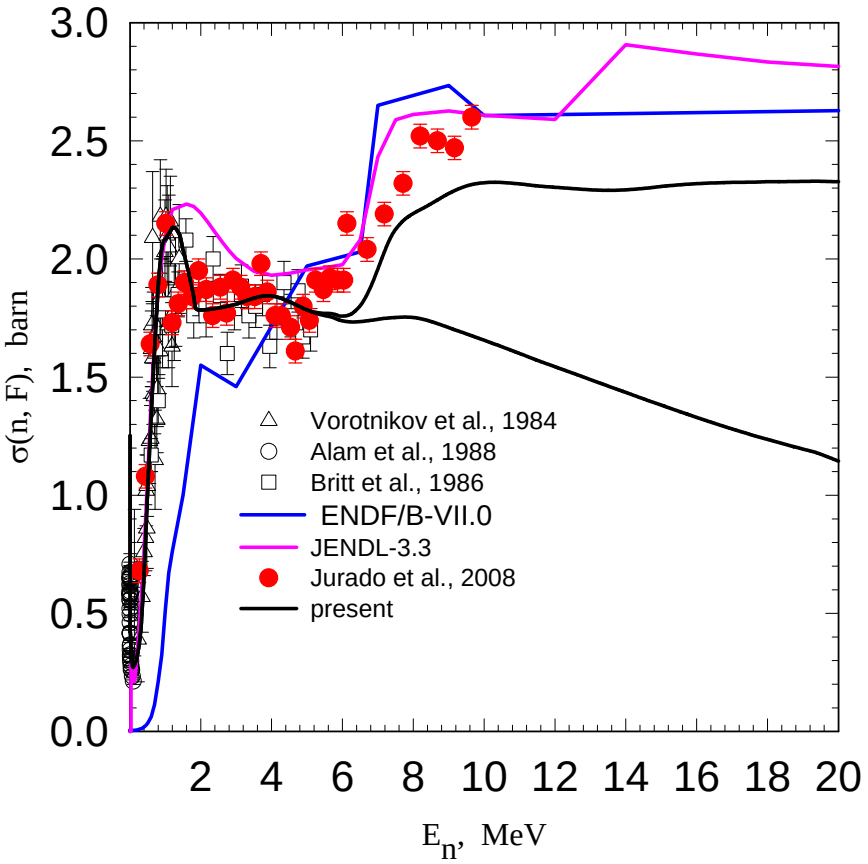
^{232}Th(n,F) PROMPT NEUTRON MULTIPLICITY



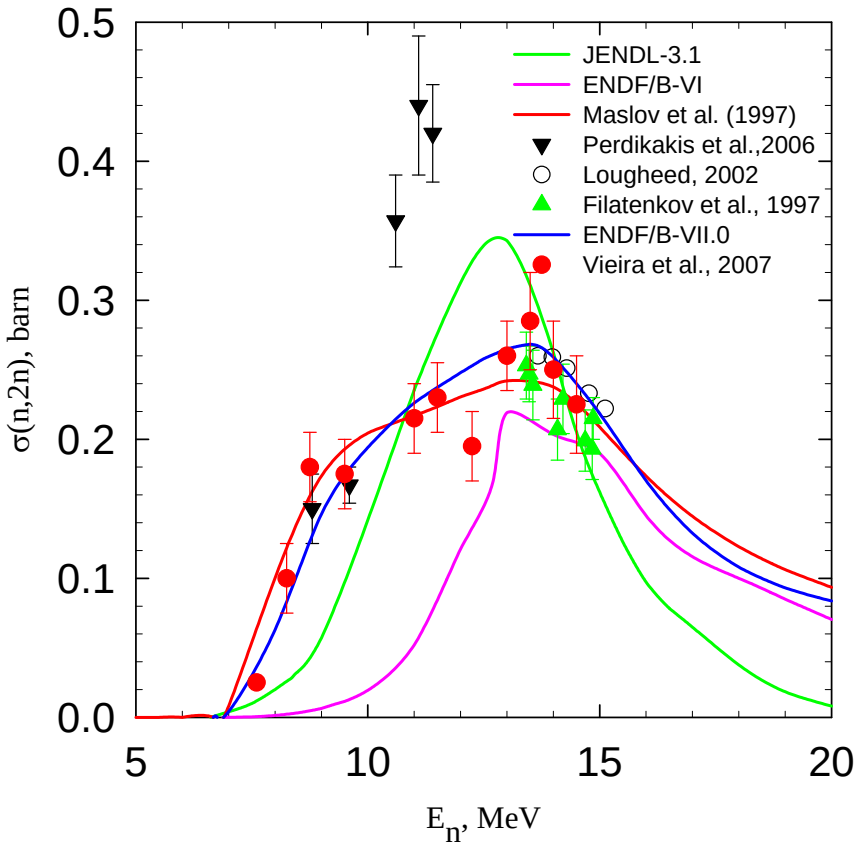
^{238}U FISSION CROSS SECTION



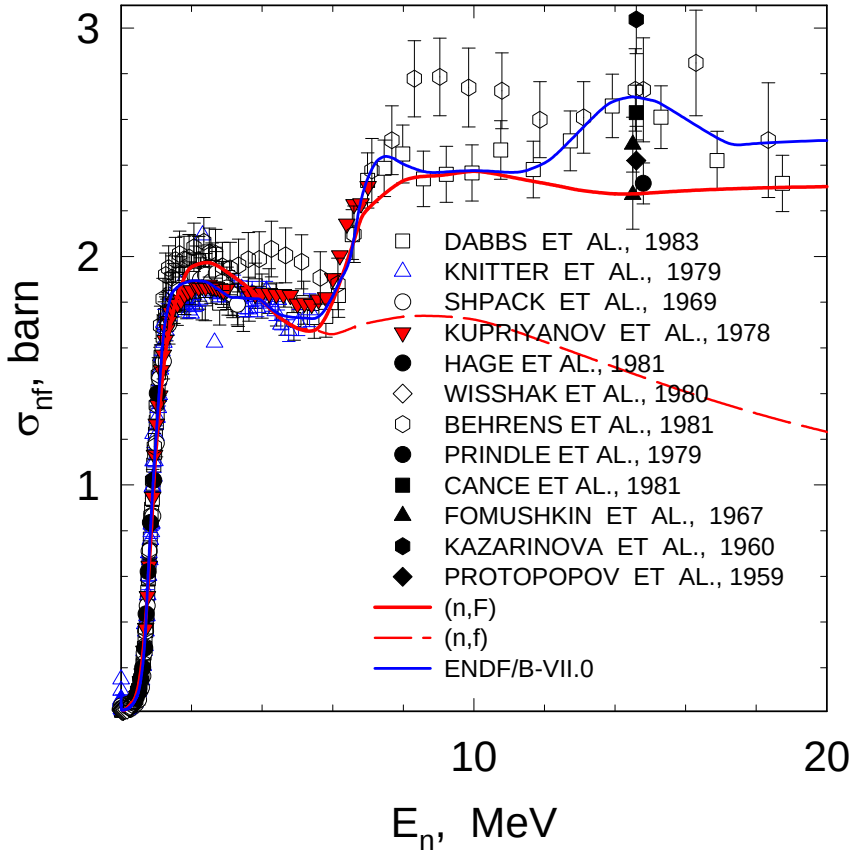
^{242}Cm FISSION CROSS SECTION



^{241}Am(n,2n) CROSS SECTION

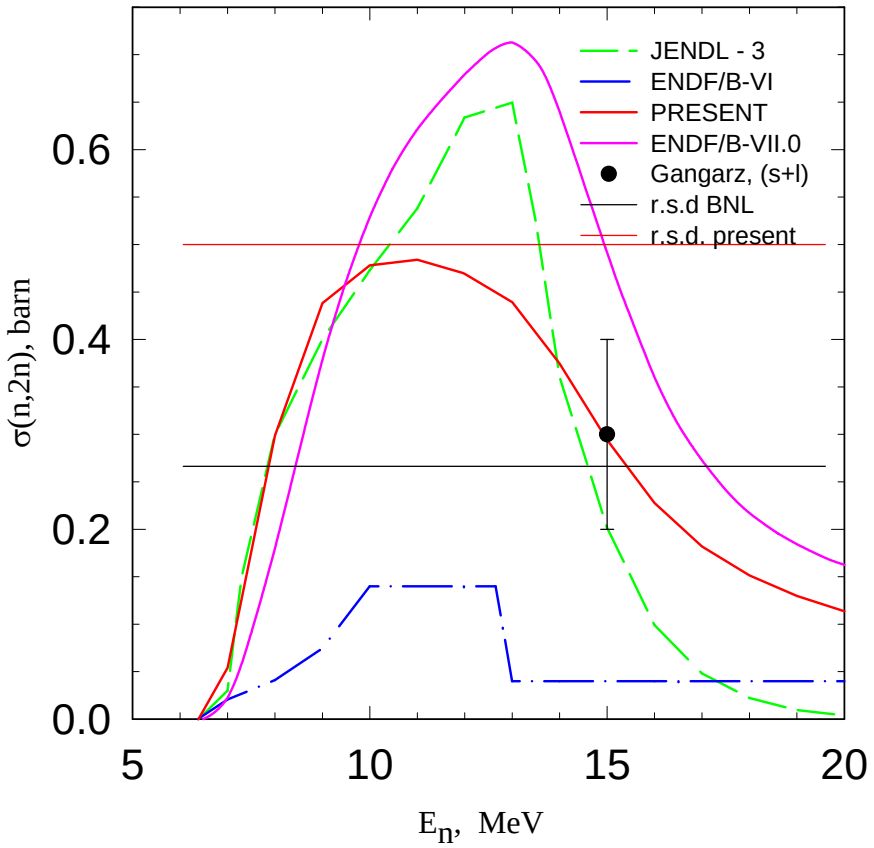


^{241}Am FISSION CROSS SECTION

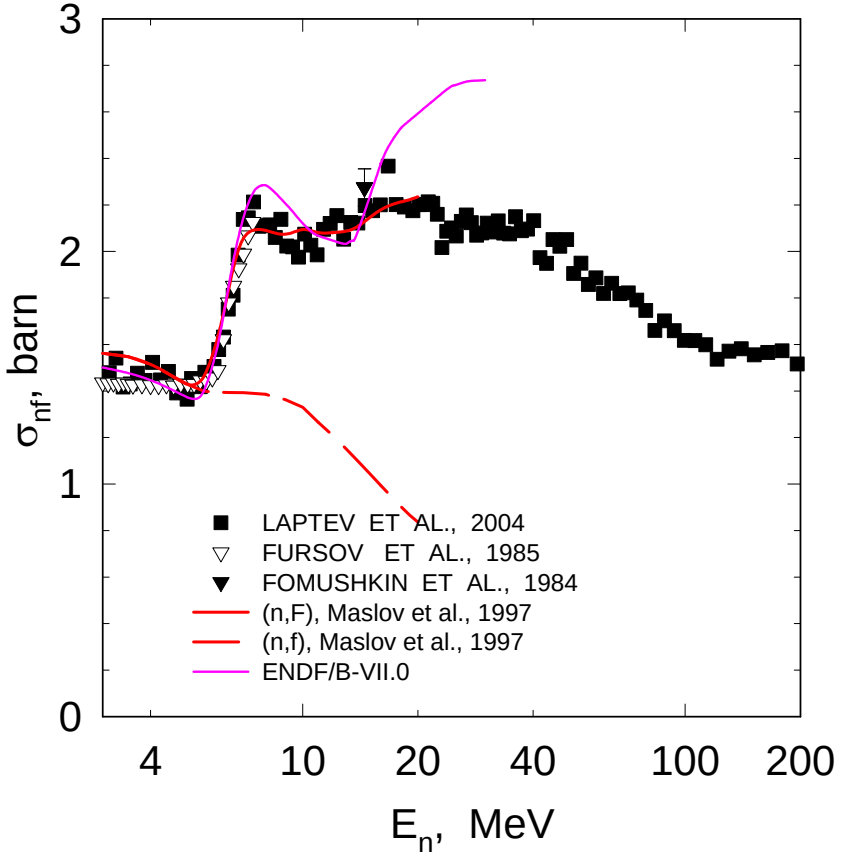


$^{242g}Am/^{242m}Am \approx ^{236s}Np/^{236l}Np \approx 0.35$, Gancartz - $^{242g}Am = ^{242s}Am$

^{243}Am (n,2n) CROSS SECTION



^{243}Am FISSION CROSS SECTION

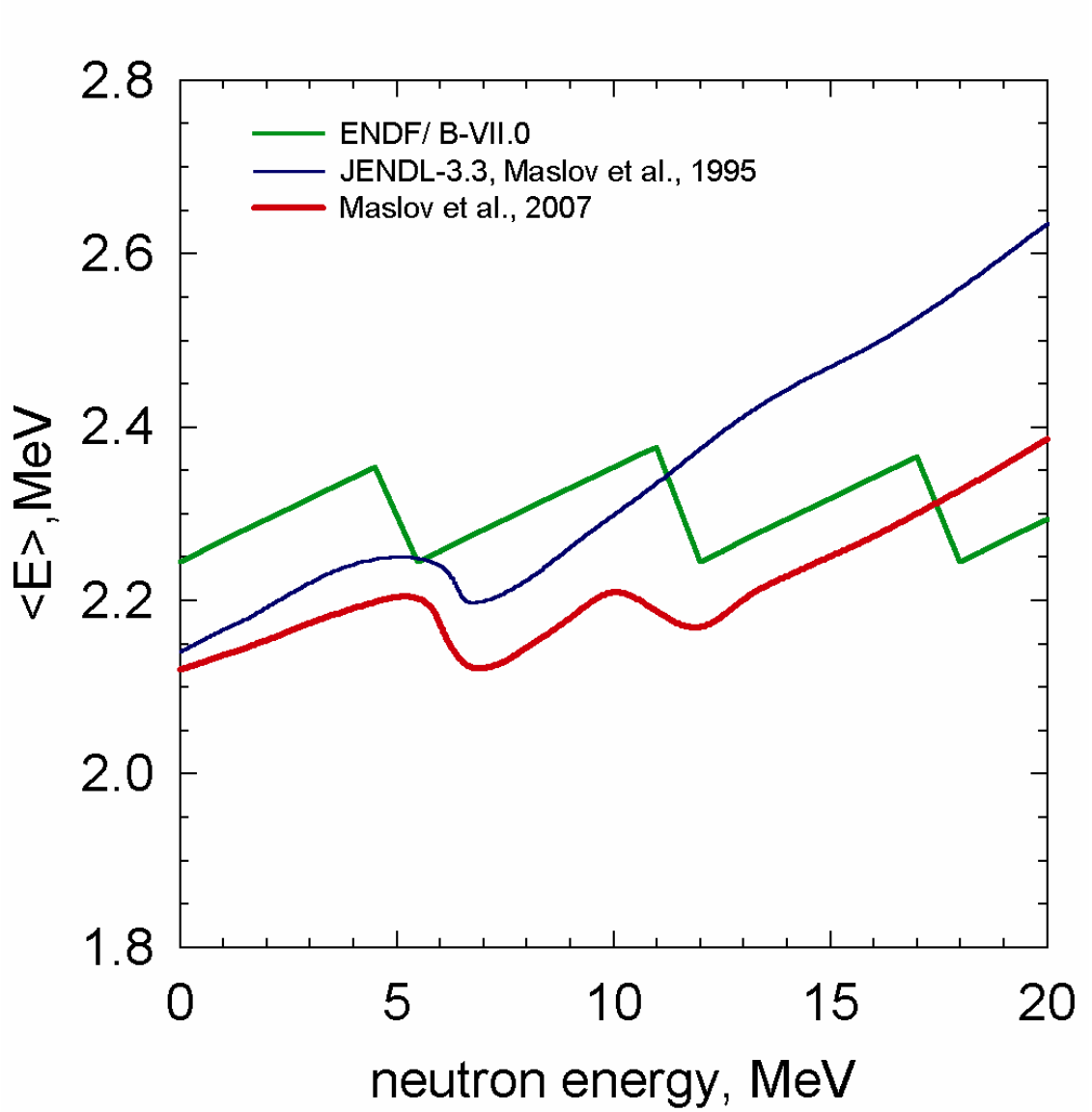


Prompt-fission neutron spectra

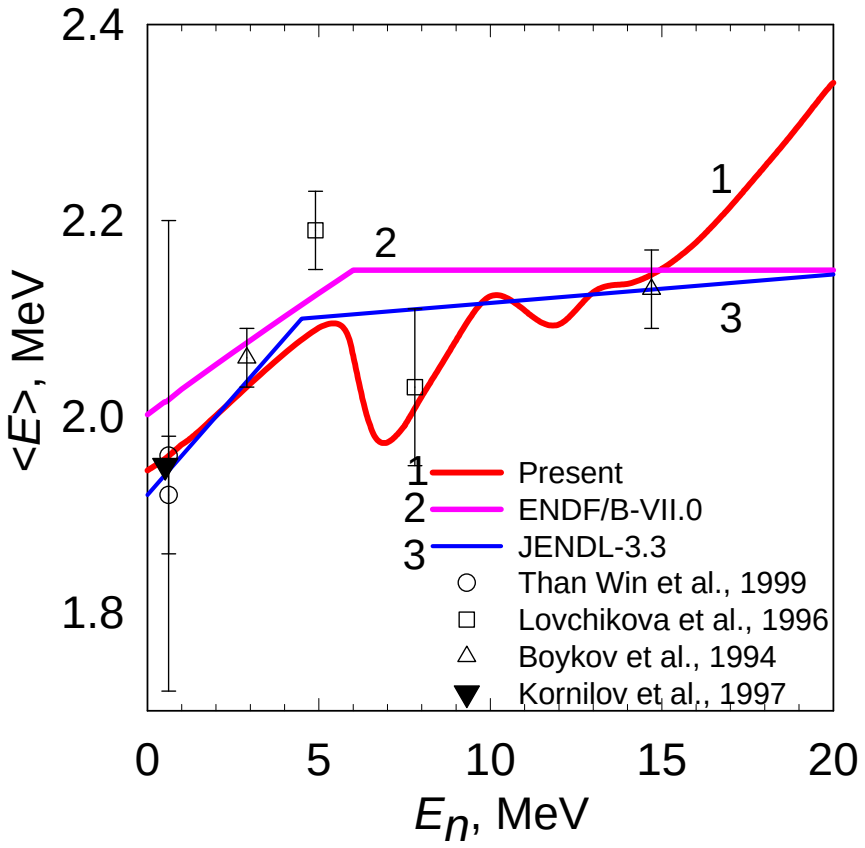
superposition of exclusive pre-fission (n,xnf) spectra and post-fission spectra
$S_{A+2-x}(\varepsilon, E_n)$

$$\mathrm{S}(\varepsilon, \mathrm{E_n}) = \nu^{-1}(E_n)\{\nu_1(E_n)\beta_1(E_n)\mathrm{S}_{\mathrm{A+1}}(\varepsilon, \mathrm{E_n}) +$$
$$\beta_2(E_n)[\nu_2(E_n)\mathrm{S}_A(\varepsilon, \mathrm{E_n}) + \frac{d\sigma^1_{\mathrm{nnnf}}(E_n)}{d\varepsilon}] +$$
$$\beta_3(E_n)[\nu_3(E_n)\mathrm{S}_{A-1}(\varepsilon, \mathrm{E_n}) + (\frac{d\sigma^1_{\mathrm{n2nnf}}(E_n)}{d\varepsilon} + \frac{d\sigma^2_{\mathrm{n2nnf}}(E_n)}{d\varepsilon})] +$$
$$\beta_4(E_n)[\nu_4(E_n)\mathrm{S}_{A-2}(\varepsilon, \mathrm{E_n}) + (\frac{d\sigma^1_{\mathrm{n3nnf}}(E_n)}{d\varepsilon} + \frac{d\sigma^2_{\mathrm{n3nnf}}(E_n)}{d\varepsilon} + \frac{d\sigma^3_{\mathrm{n3nnf}}(E_n)}{d\varepsilon})]\}$$

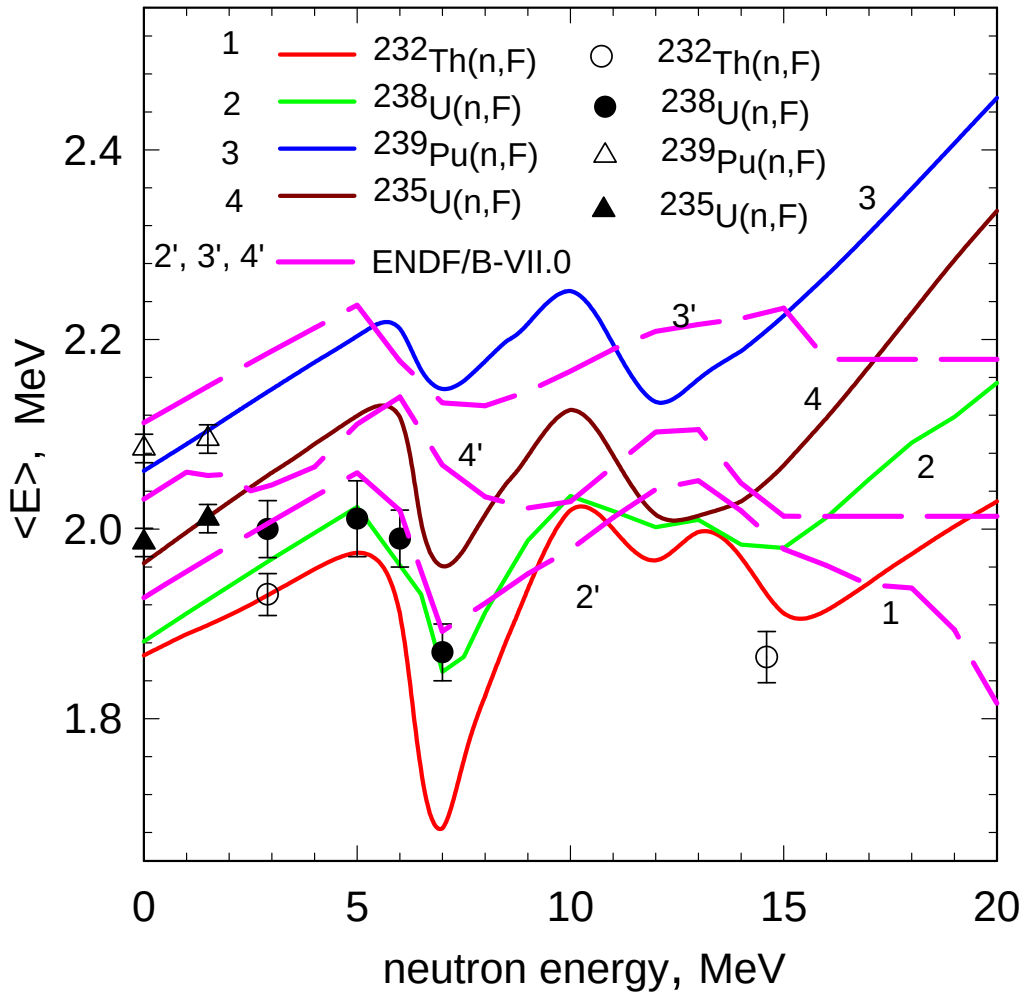
241_Am(n, F),<E>


ENDF/ B-VII.0
JENDL-3.3, Maslov et al., 1995
Maslov et al., 2007
<E>,MeV
2.8
2.6
2.4
2.2
2.0
1.8
0
5
10
15
20
neutron energy, MeV

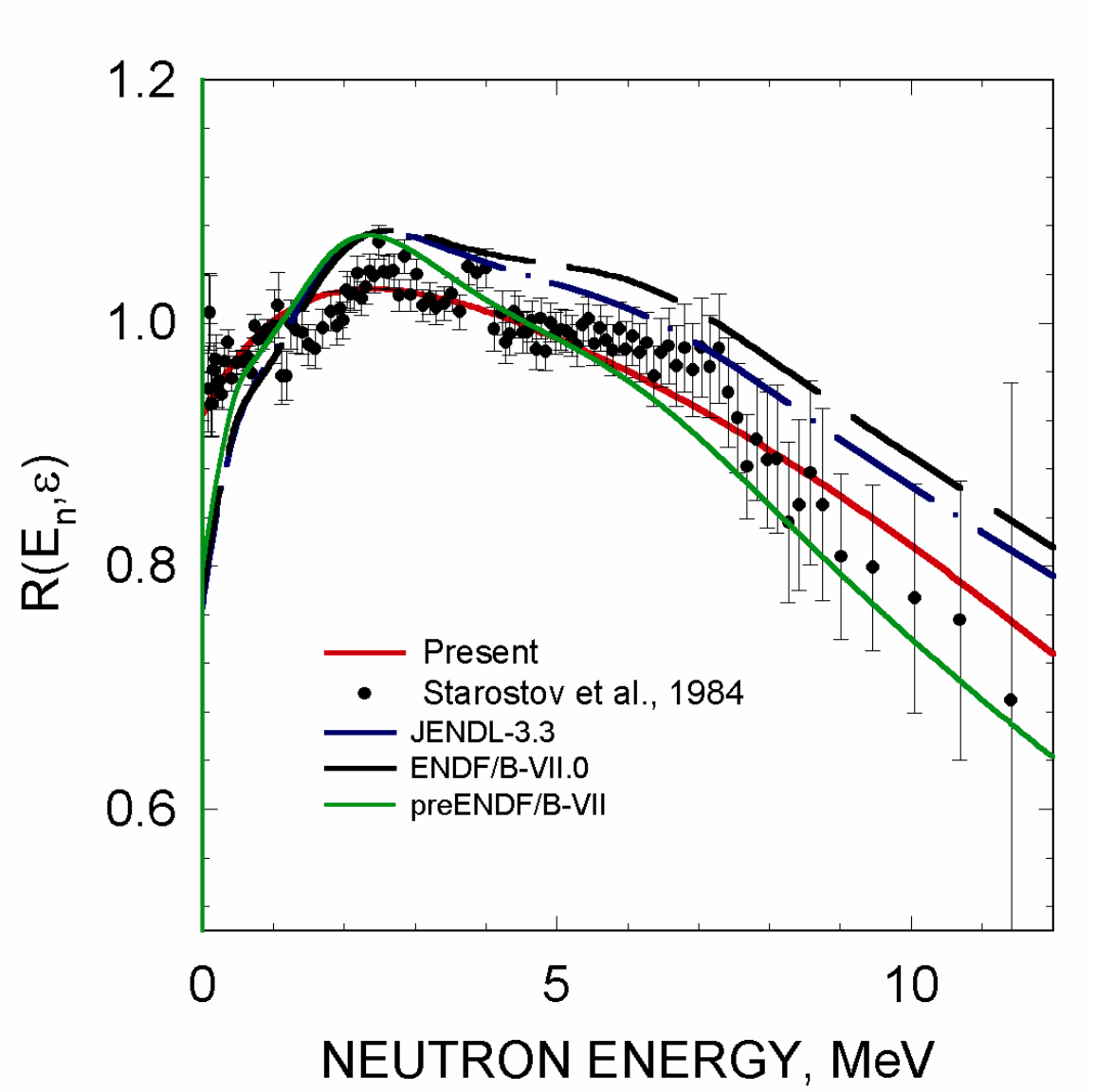
^{237}Np(n,F) AVERAGE ENERGY OF PFNS



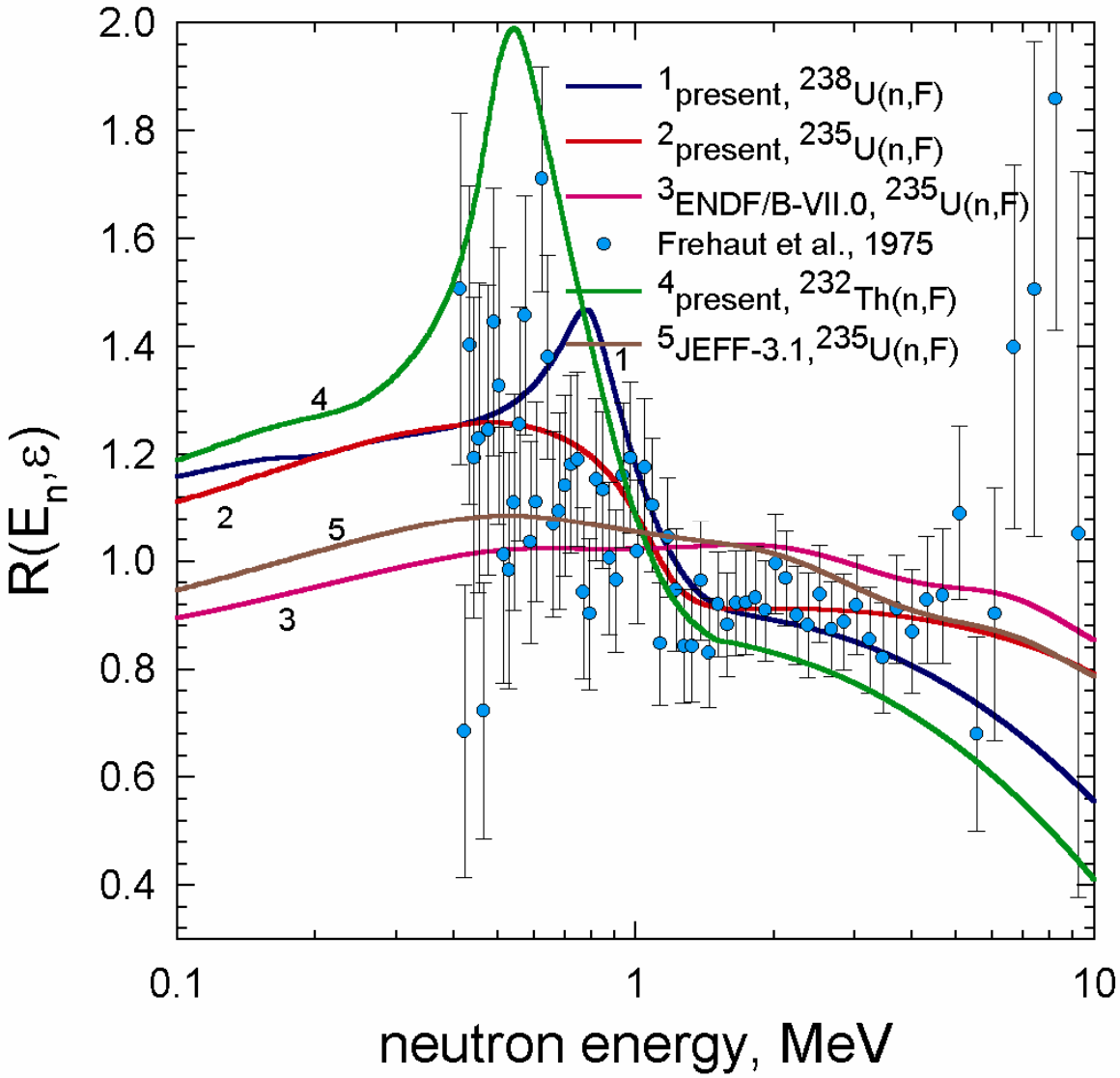
AVERAGE ENERGY OF PFNS



235_U(n, f), thermal



235_U(n, f),E_n=7 MeV



Conclusions

1. **In a few examples of Pu, Am, Cm nuclides it is shown that substituting model deficiency uncertainties by enlarging the uncertainties of conventional nuclear model parameters could be avoided.**
2. **In a number of MA the uncertainty estimation of CSS, PFNS should be preceded with the robust neutron data re-evaluation.**

   Otherwise, in case of poorly investigated Np, Pu, Am, Cm targets the artificially large cross section uncertainty estimates will be unavoidable.
3. **Correlated evaluation of fission CSS and PFNS for MA, as for ^{237}Np(n, F) and ^{241}Am(n, F), supported by the PFNS measurement for ^{237}Np(n, F) by Taieb et al. [39].**