^{241}Am cross section measurements at GELINA

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EC – JRC – IRMM

Standards for Nuclear Safety, Security and Safeguards (SN3S)

TOF - Facility GELINA

- **Pulsed white neutron source**

  (10 meV < E_n < 20 MeV)

- **Neutron energy : time-of-flight (TOF)**

- **Multi-user facility: 10 flight paths**

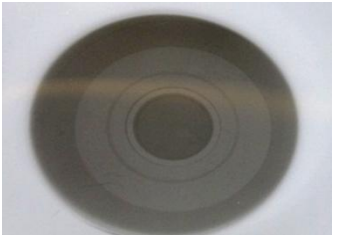
  (10 m - 400 m)

- **Measurement stations with special equipment to perform:**
  - **Total cross section measurements**
  - **Partial cross section measurements**

^{241}Am + n : TOF – experiments at GELINA

Sample

- Production (JRC – ITU)
  - AmO_2 homogeneously diluted in a Y_2O_3 matrix (solgel method)



- Characterization (JRC – IRMM & ITU)
  - Total amount : calorimetry (main uncertainty component : 114.20 ± 0.42 mW/g)
    324.6 ± 1.2 mg
  - Area : optical surface inspection of X-ray radiograph with microscope
    22.345 ± 10.030 cm^2

  ⇒ n = 2.068 ± 0.010 10^{-4} atom/barn

Experiments

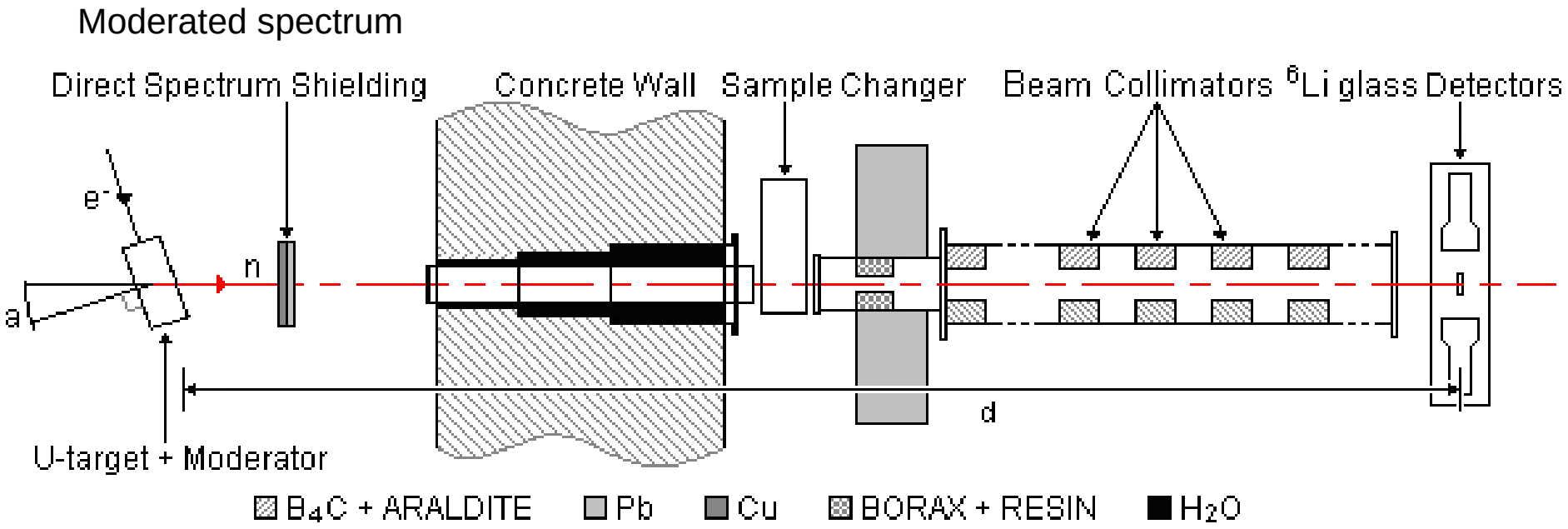
- Transmission at 25 m (^{6}Li-glass scintilllators)

- Capture at 12.5 m
  - Total energy detection using C_6D_6
  - Flux : $^{10}B(n,\alpha)$ using IC

  ⇒ Normalization : internal using transmission data

see also Fraval, ND2013, PA2 measurements at n_TOF

Transmission measurements at 25 m



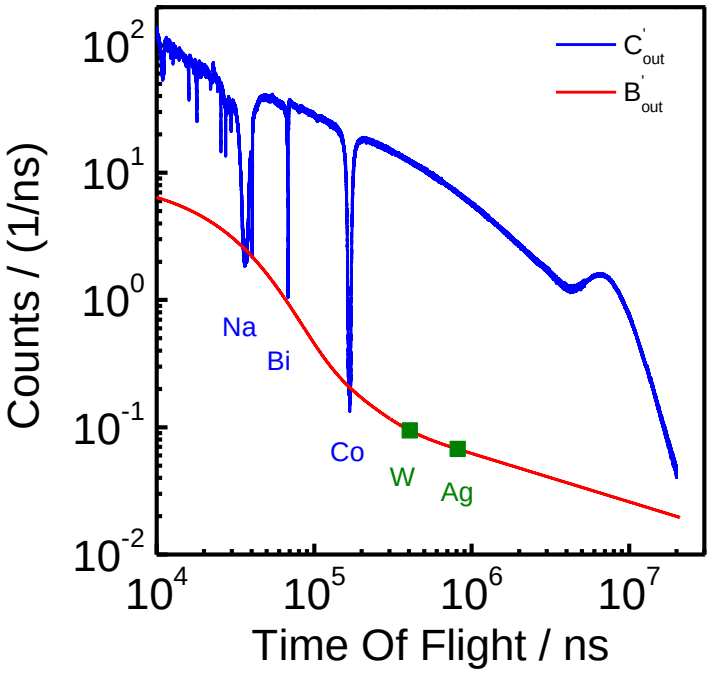
$$T_{exp} = \frac{C_{in} - B_{in}}{C_{out} - B_{out}} \leftrightarrow e^{-n\sigma_{tot}}$$

$$\Rightarrow (E_r,\ g\Gamma_n,\ \Gamma)$$

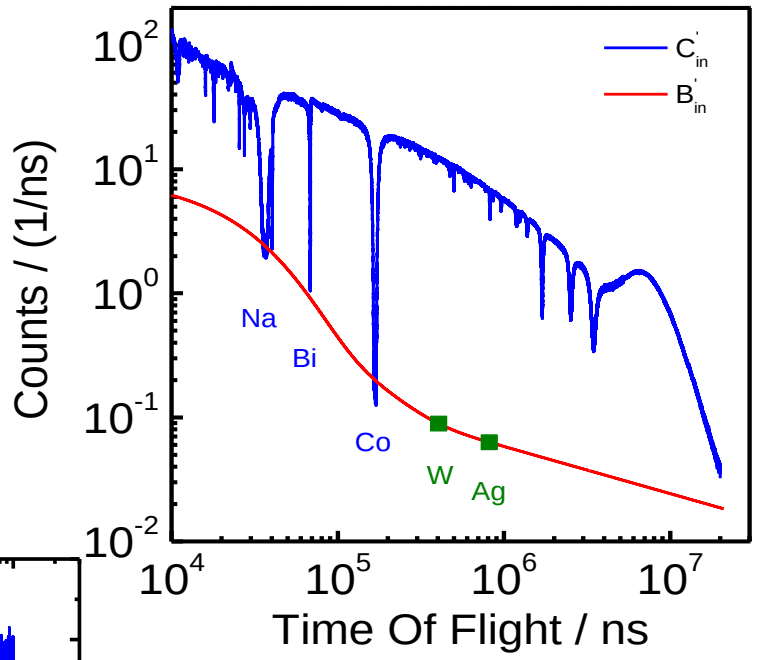
E_r = 6.6735 ± 0.0030 eV of ^{238}U+n

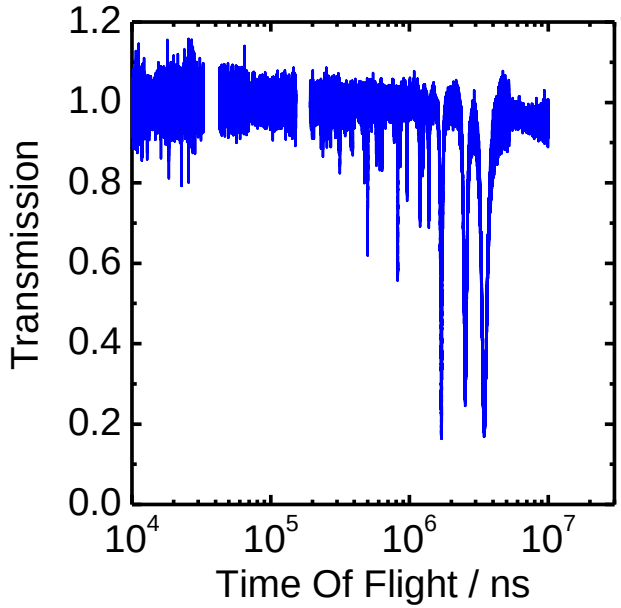
L = 26.444 ± 0.006 m

Transmission data



$$T_{exp} = \frac{C'_{in} - B'_{in}}{C'_{out} - B'_{out}}$$

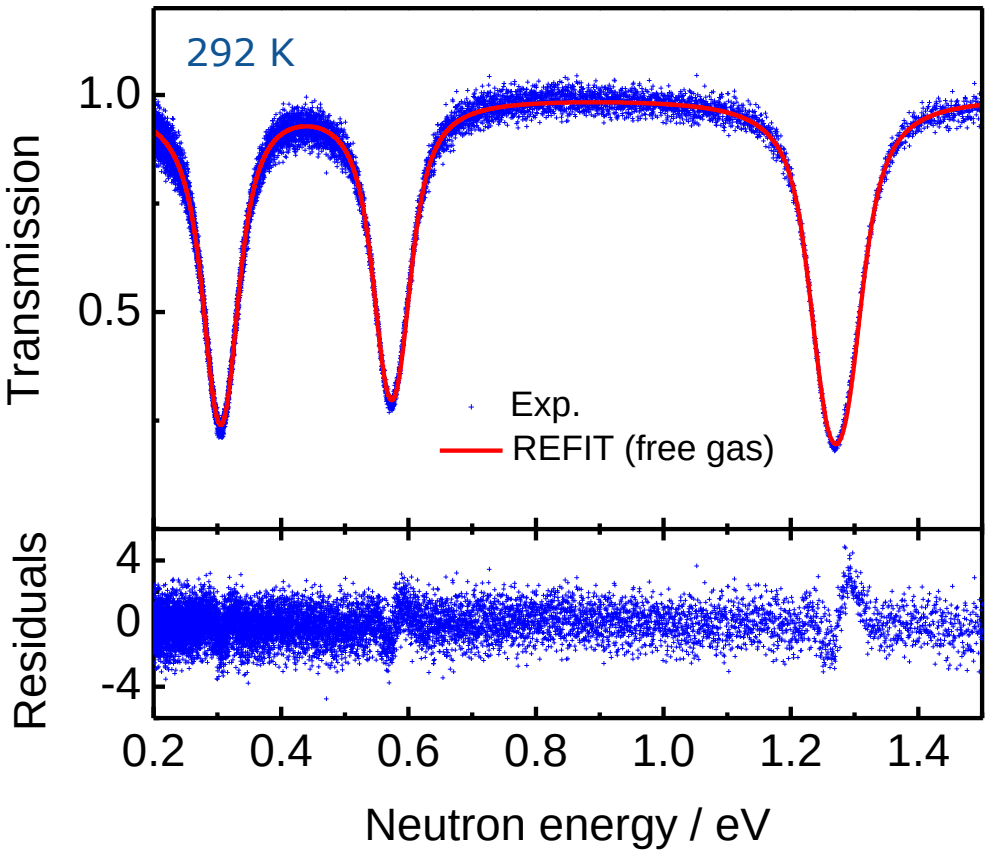




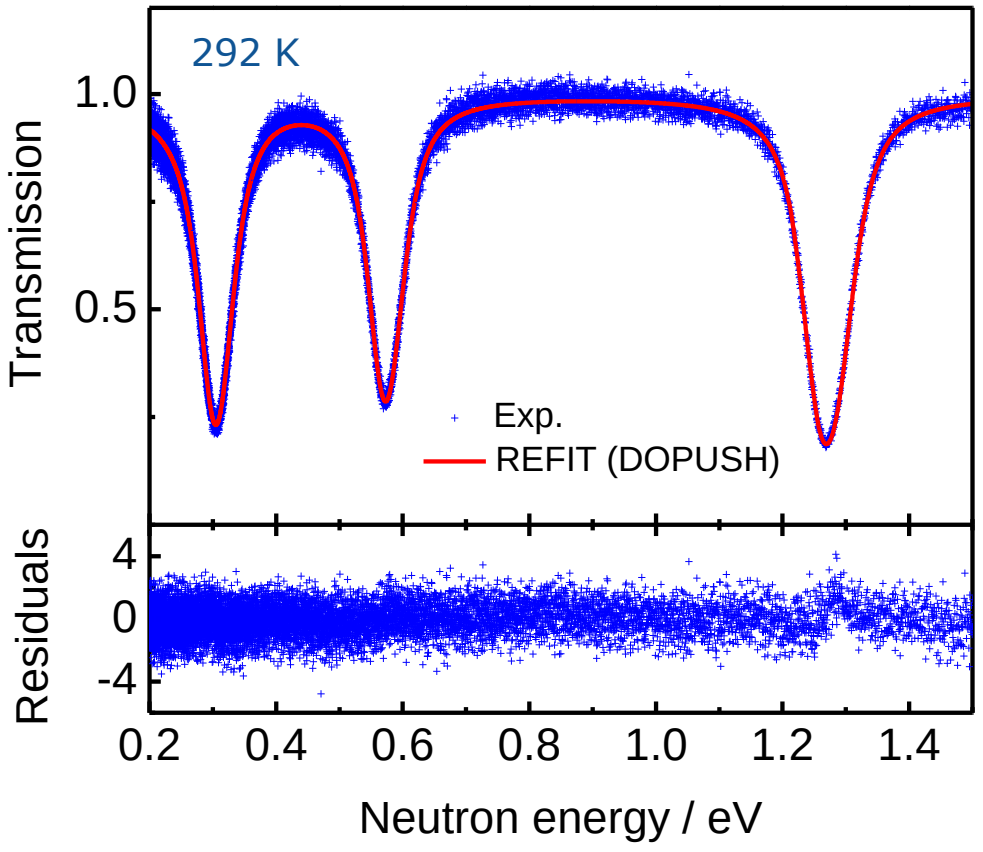
Fixed background filters : Na, Bi, Co

Transmission data
Resonance analysis with REFIT

Gas model



Crystal lattice



At the moment: E_r, $\mathbf{n}g\Gamma_n$, $\sim \Gamma_\gamma$

Comparison with LANSCE (Jandel et al.)
E_r and Γ_γ

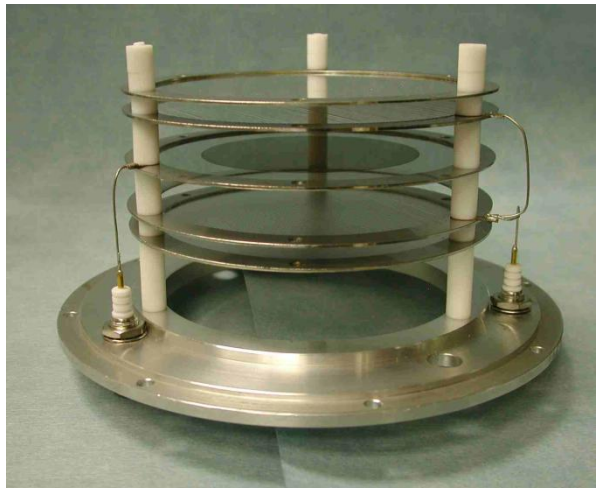
E_r / eV		Γ_γ / meV		
GELINA	LANSCE	GELINA	LANSCE	Weston and Todd
0.30605 ± 0.000014	0.3051 ± 0.0002	42.4	44.4 ± 0.3	46.9 ± 0.3
0.57387 ± 0.00026	0.5724 ± 0.0003	41.1	43.3 ± 0.5	47.3 ± 0.3
1.27106 ± 0.00058	1.2718 ± 0.0004	42.6	45.3 ± 0.7	49.2 ± 0.3

GELINA (# 1786) :

- **Flight path length traceable to E_r = 6.6735 ± 0.0030 eV eV of ^{238}U + n (ORELA)**
- **Response function of GELINA in REFIT includes neutron storage term (Ikeda and Carpenter) , (see # 1786)**

Capture measurements at 12.5 m

- **Total energy detection principle**
- **C6D6 liquid scintillators**
  - 125º
  - PHWT $\int R(E_d,E_\gamma)\, WF(E_d)\, dE_d = kE_\gamma$
- **Flux measurements (IC)**
  - $^{10}B(n,\alpha)$ < 150 keV

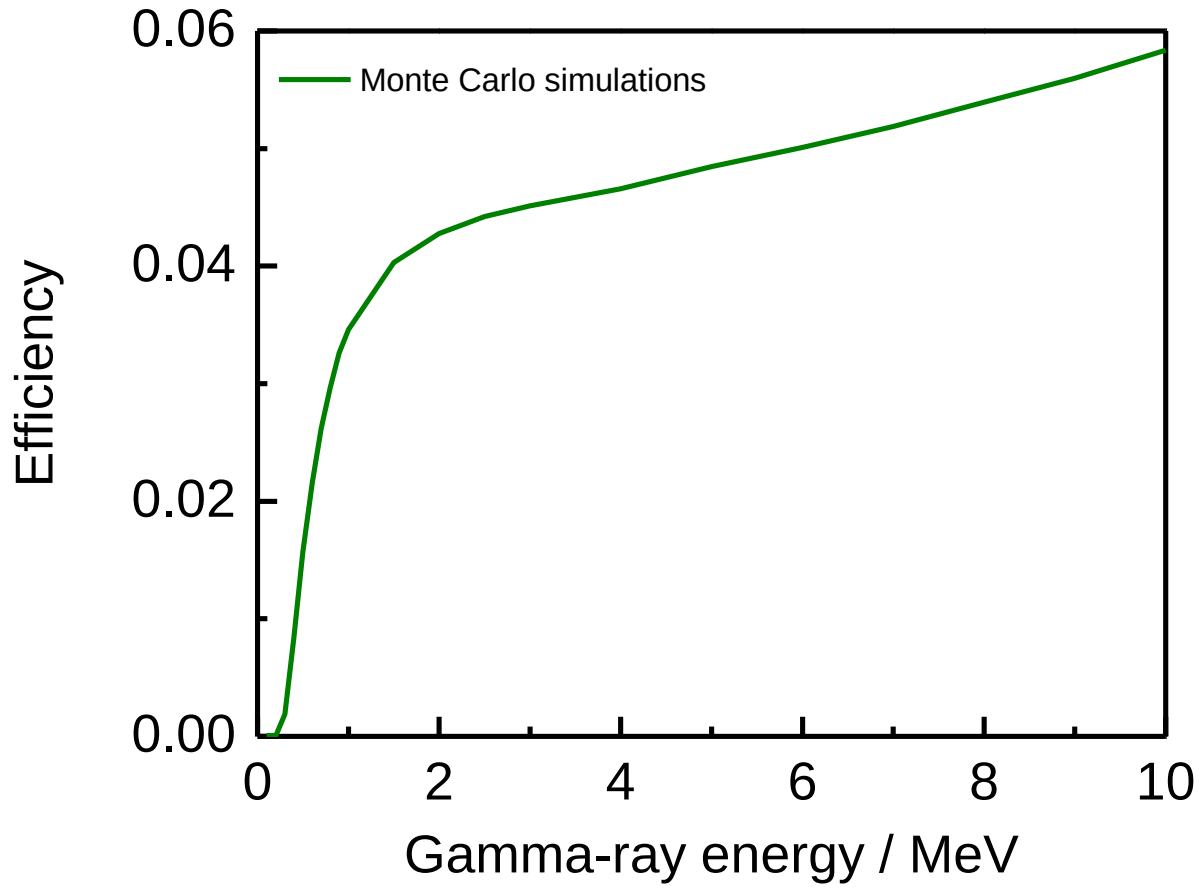


WF : from MC simulations

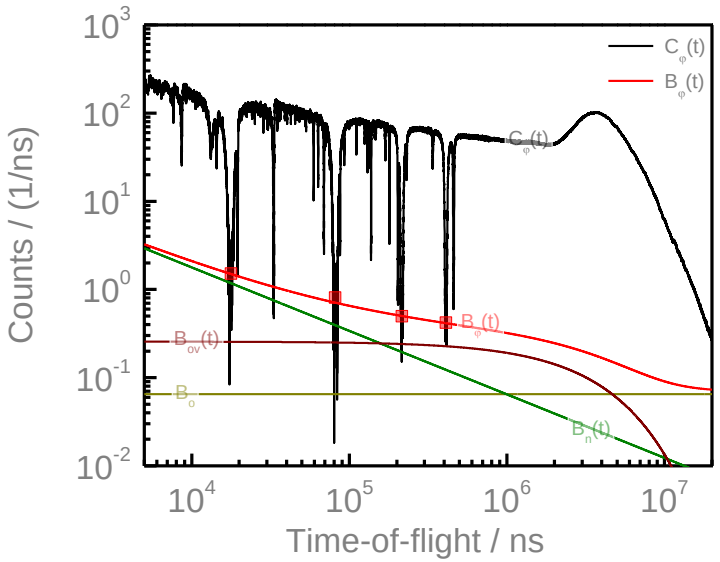
$$C_w(T_n) = \int C_c(T_n,E_d)\, WF(E_d)\, dE_d$$

Borella et al., NIMA 577(2007) 626

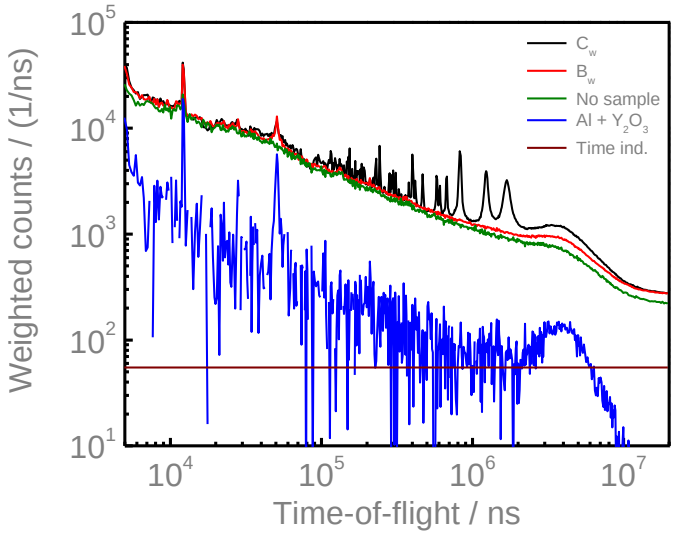
Effective detection efficiency



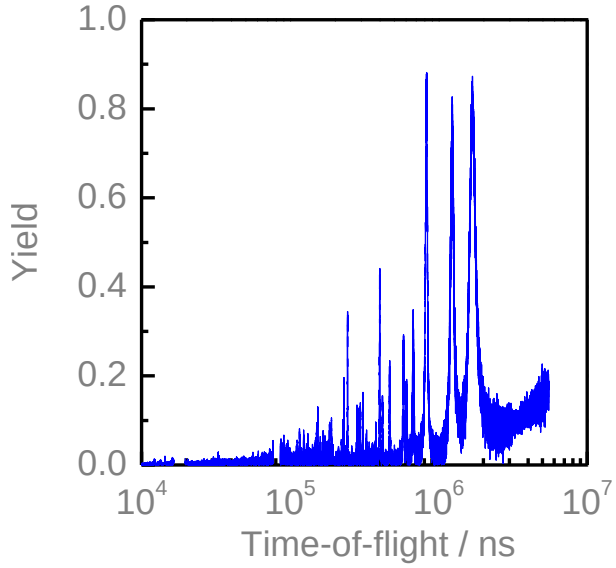
Capture data (counts) for E_d > 650 keV



$$Y_{exp} = N \frac{C'_w - B'_w}{C'_\varphi - B'_\varphi} Y_\varphi$$

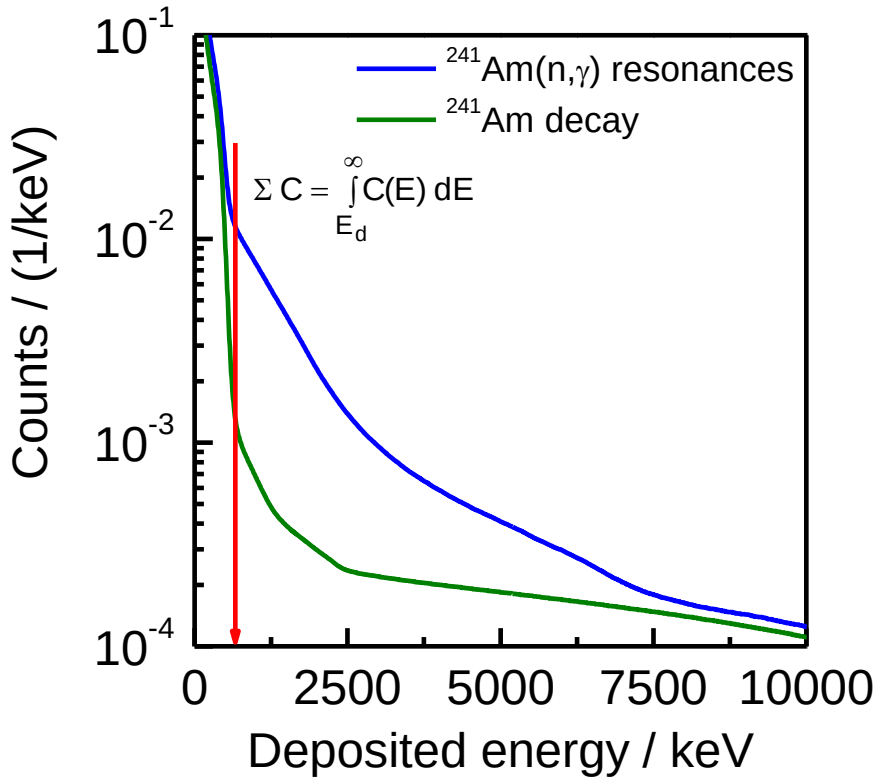


Fixed background filters



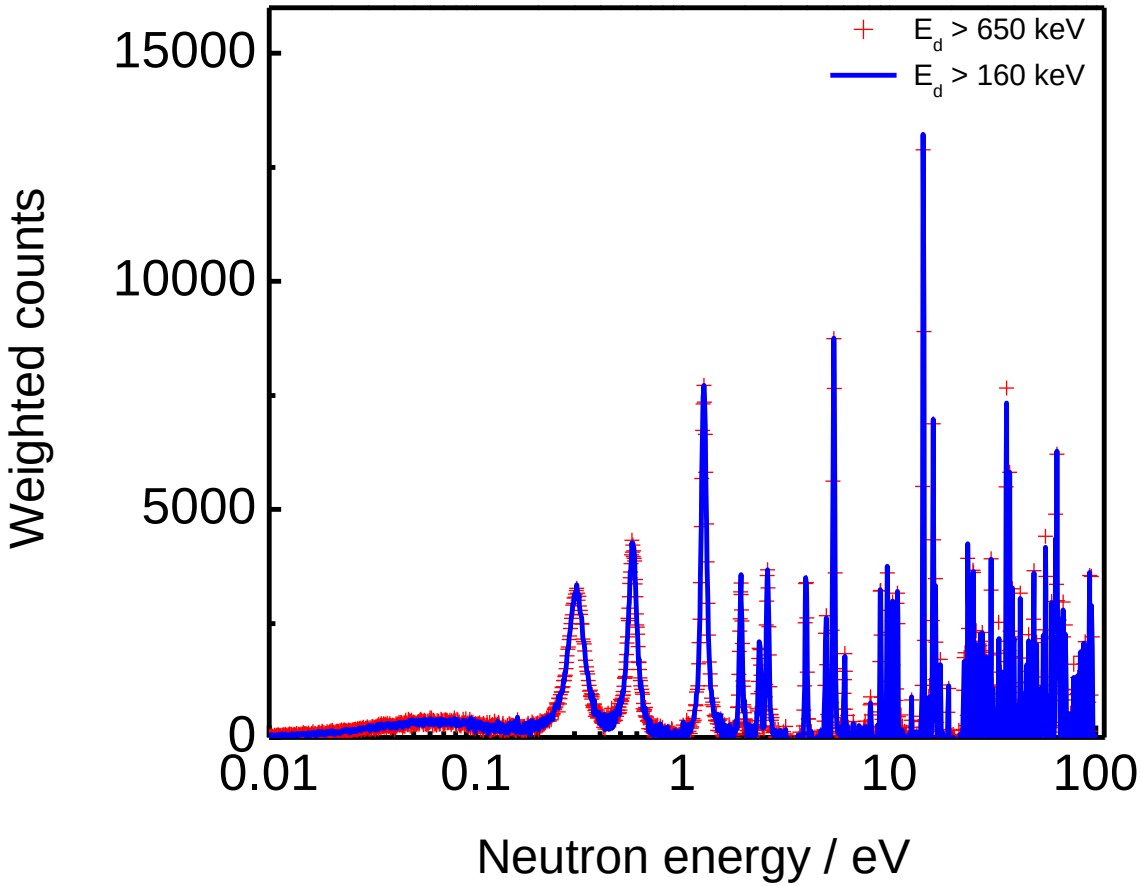
Time dependent background dominates

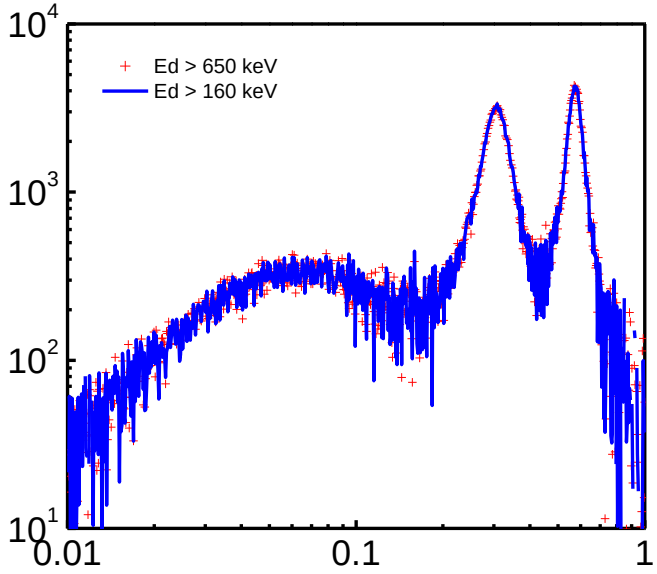
Pulse height spectra : threshold



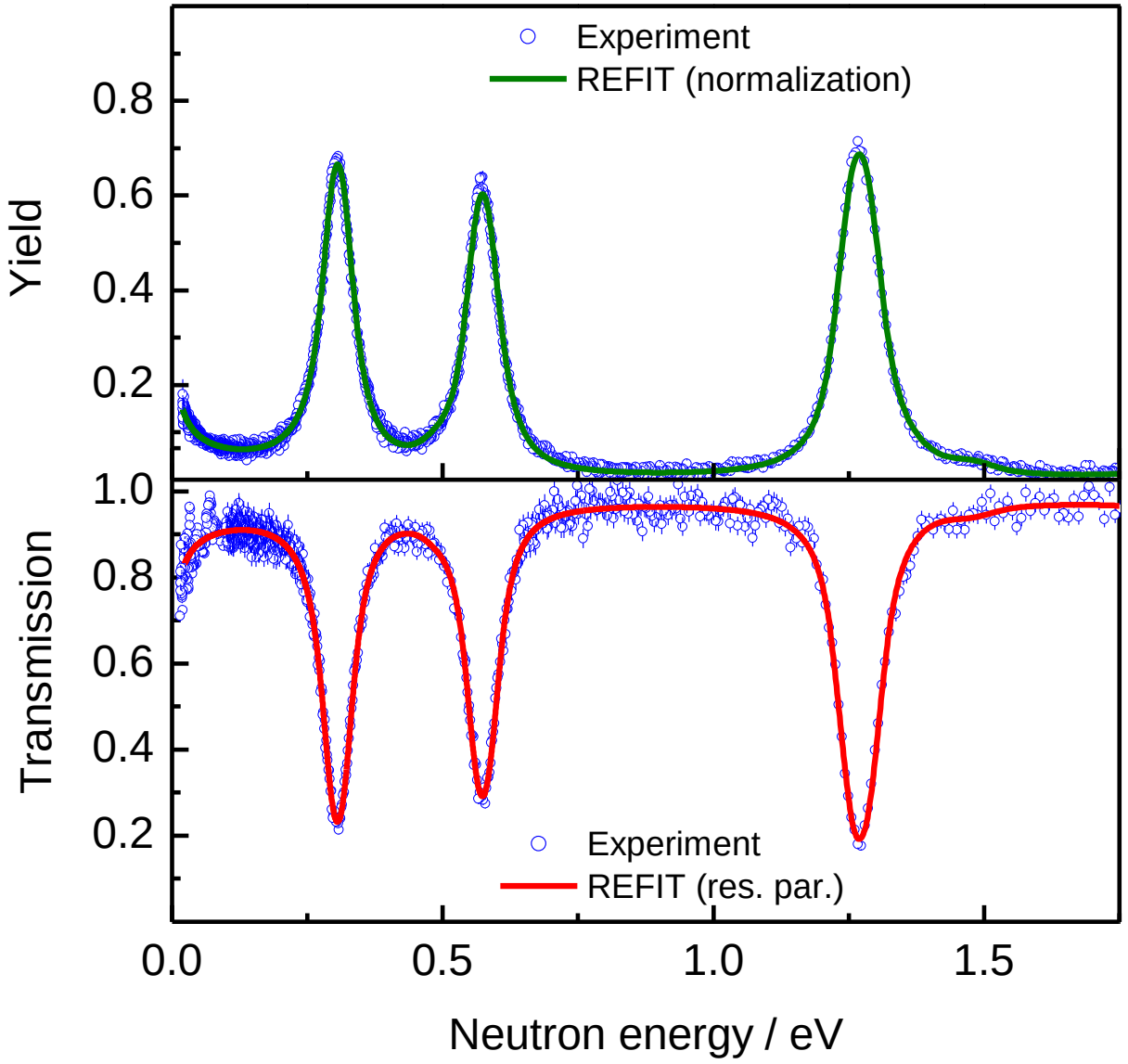
	Standard	^{241}Am
$E_d \approx$	160 keV	650 keV
$E_\gamma \approx$	300 keV	850 keV

Capture yield: impact of threshold
E_d > 160 and 650 keV





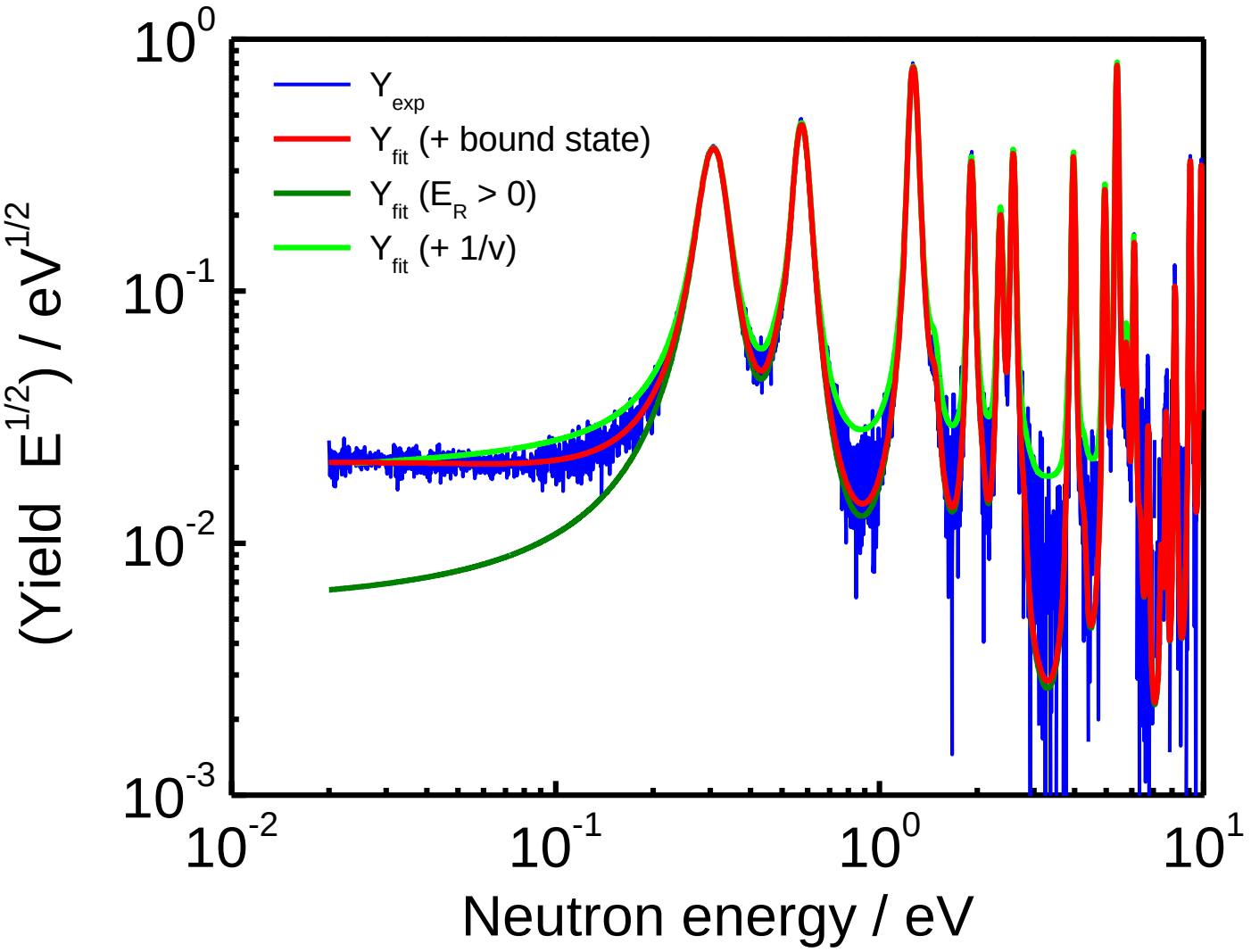
Transmission + capture at GELINA



$N_c = 1.00 \pm 0.02$

Energy / eV	Γ_n / meV		Γ_γ / meV	
0.306	0.064	(0.0004)	41.55	(0.39)
0.574	0.110	(0.0009)	42.11	(0.63)
1.272	0.373	(0.0035)	41.68	(0.79)

^{241}Am(n,γ) : experimental yield + fit



$\sigma(n_{th},\gamma) = 749 \pm 35$ b

$g_f = 1.00$

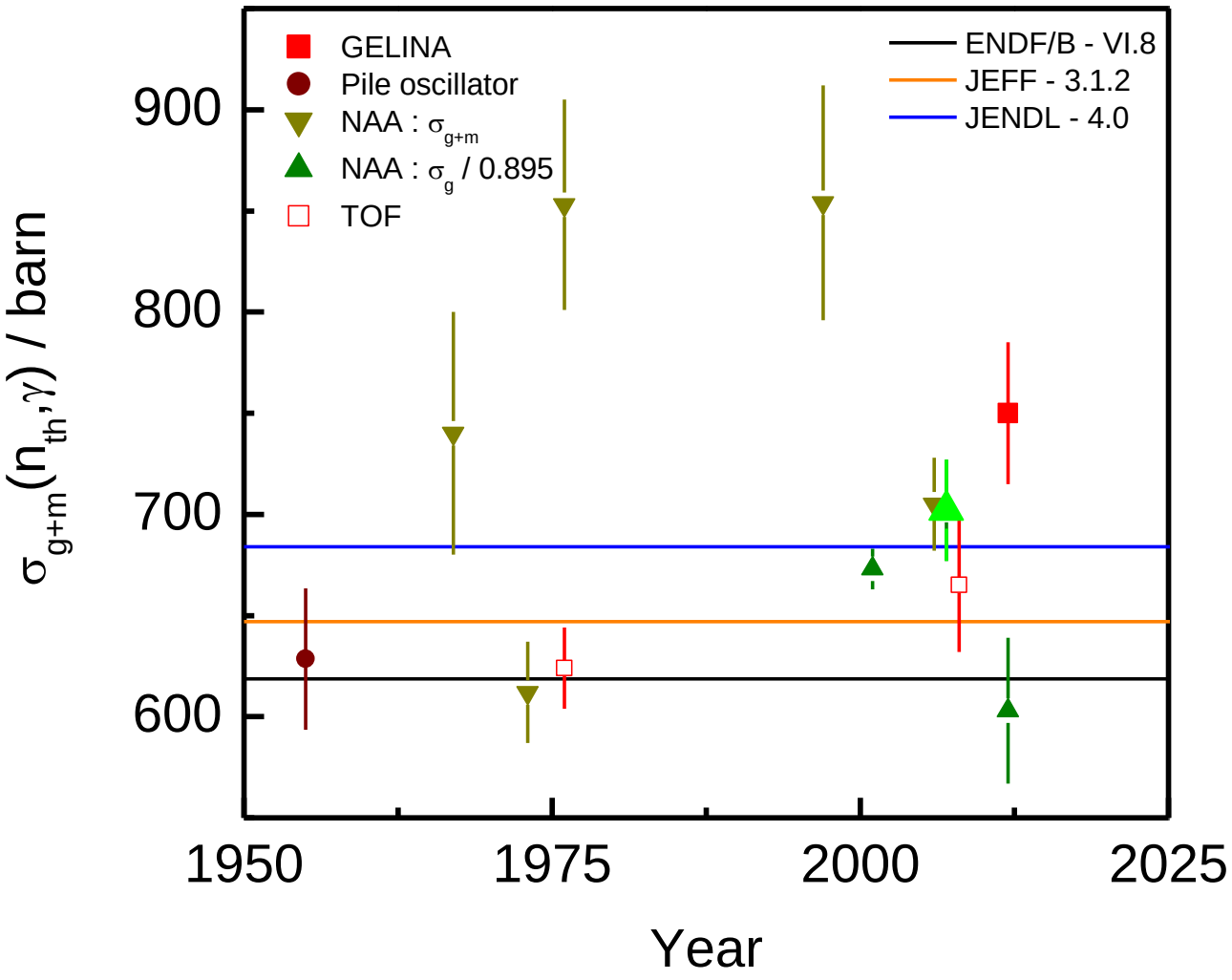
$\sigma(n_{th},\gamma) = 749$

$g_f = 1.04$

Mughabghab

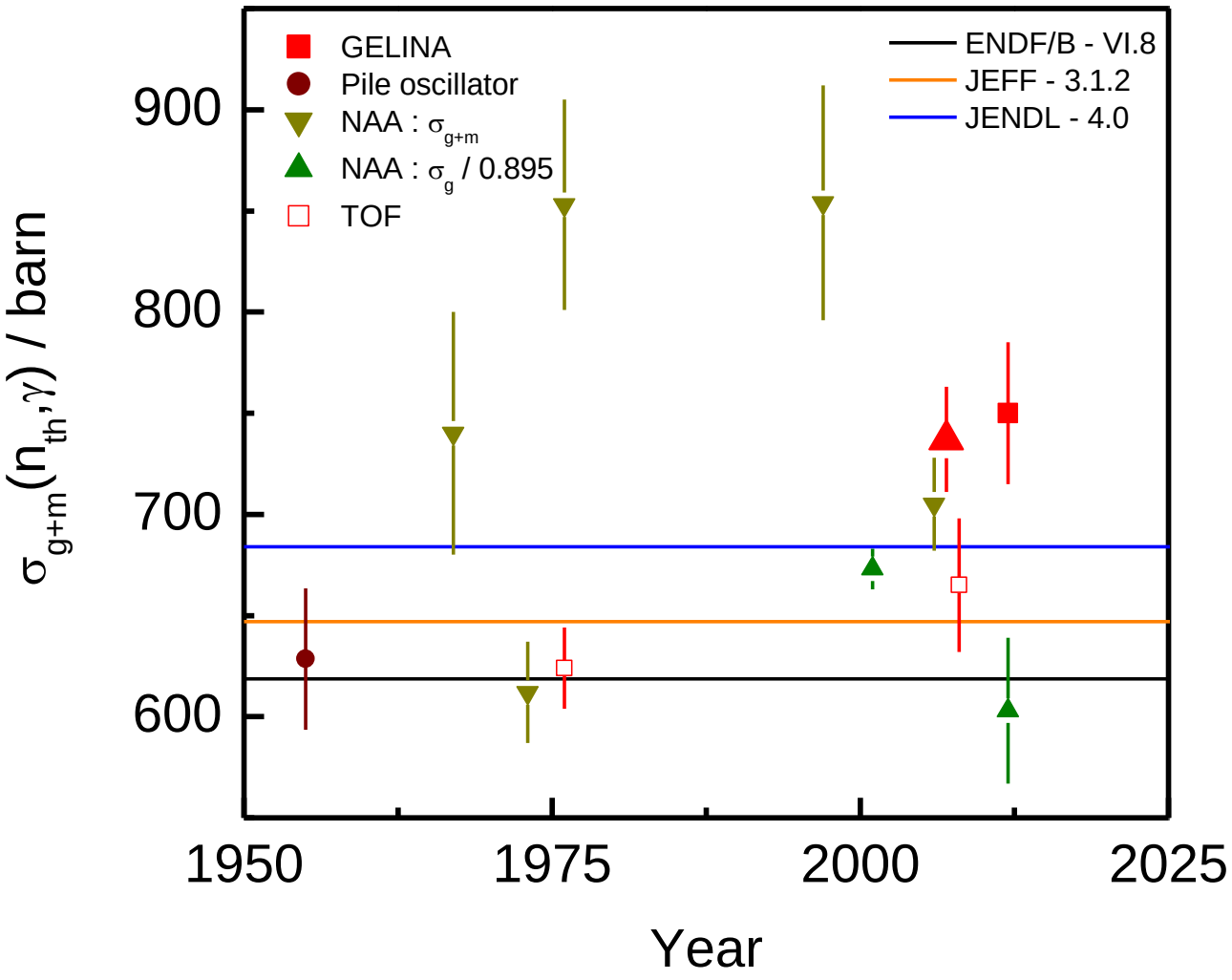
$g_f = 1.05$

$\sigma(n_{th}, \gamma)$: GELINA ⇔ experimental data



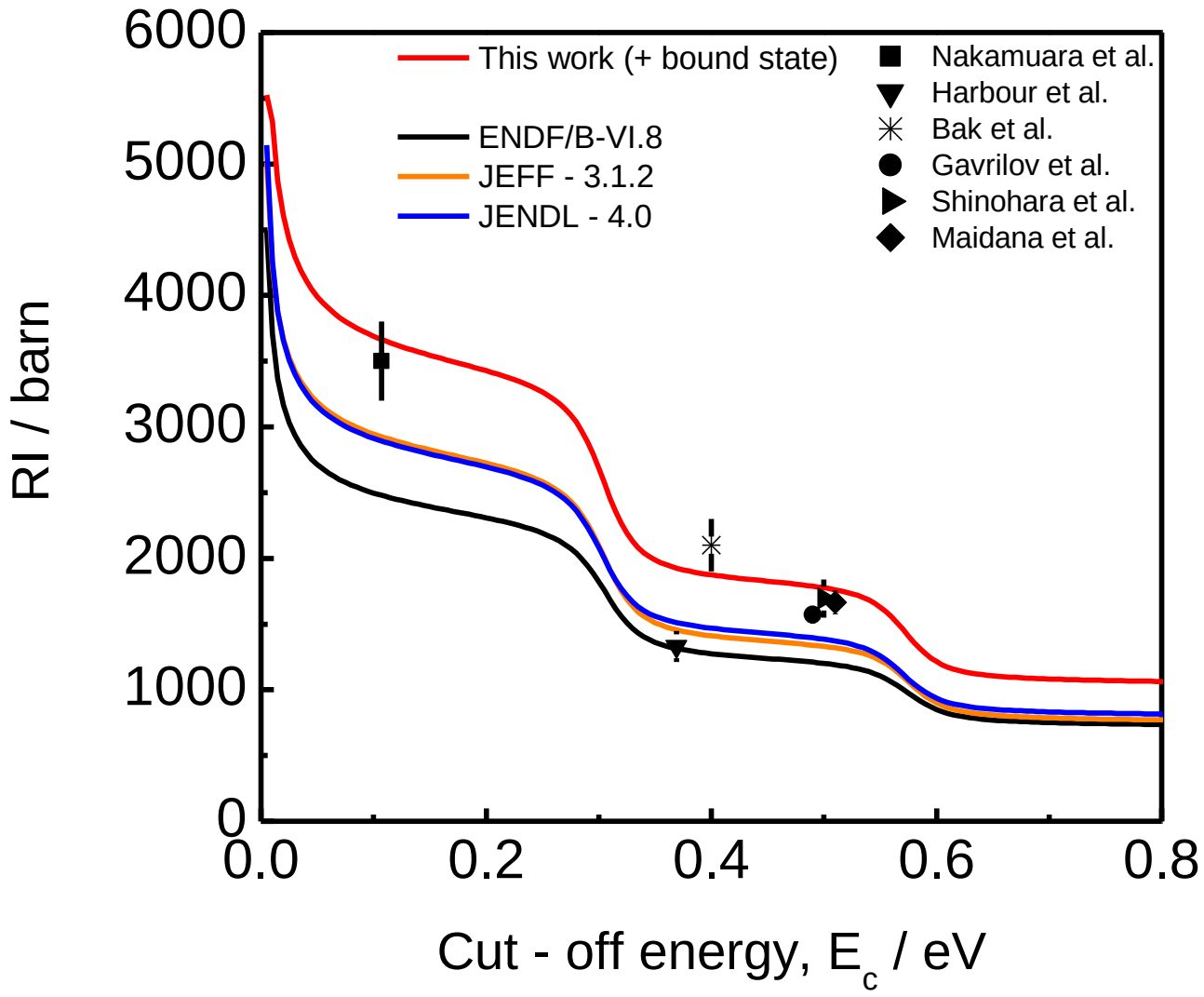
$g_f = 1.05$

$\sigma(n_{th}, \gamma)$: GELINA ⇔ experimental data



$g_f = 1.00$

RI : GELINA ⇔ evaluated data



$$RI = \int_{E_c} \sigma(E) \frac{1}{E} dE$$