European Commission

Recent evaluations in the resolved and unresolved resonance region done at IRMM

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Joint Research Centre

- **Evaluation in RRR - Cd**
  - **Overview over literature**
  - **Measurements**
  - **results**
- **Evalution in URR -Au**
  - **Capture cross section**
  - **Total cross section**

Literature data

Liou et al. – Transmission and self-indication measurements at Columbia University

nat. Cd samples
enriched samples: ^{110}Cd, ^{112}Cd, ^{114}Cd and ^{116}Cd

Resonance parameters:
up to 10 keV for even isotopes
up to 2.3 keV for odd isotopes

Data in EXFOR – but not enough experimental information available for use in resonance shape analysis (RSA)

Literature data

Musgrove et al. – Capture measurements at 40m station of ORELA

enriched samples: ^{106}Cd, ^{108}Cd, ^{110}Cd, ^{112}Cd, ^{114}Cd and ^{116}Cd

Resonance energies and capture areas above 2.6 keV

Data not available in EXFOR

Literature data

Wasson and Allen - Capture measurements at 40m station of ORELA

enriched sample ^{111}Cd

Capture areas up to 2300 eV

spin assignment below 1300 eV

Data not available in EXFOR

Literature data

Frankle et al - Capture measurements at 40m station and transmission at 80m station ORELA

nat. sample and enriched sample ^{113}Cd

data used in RSA below 15 keV to determined $g\Gamma_n$

spin assignment applying approach Bollinger and Thomas

for p-waves data of Gunsing et al (capture 12 m GELINA)

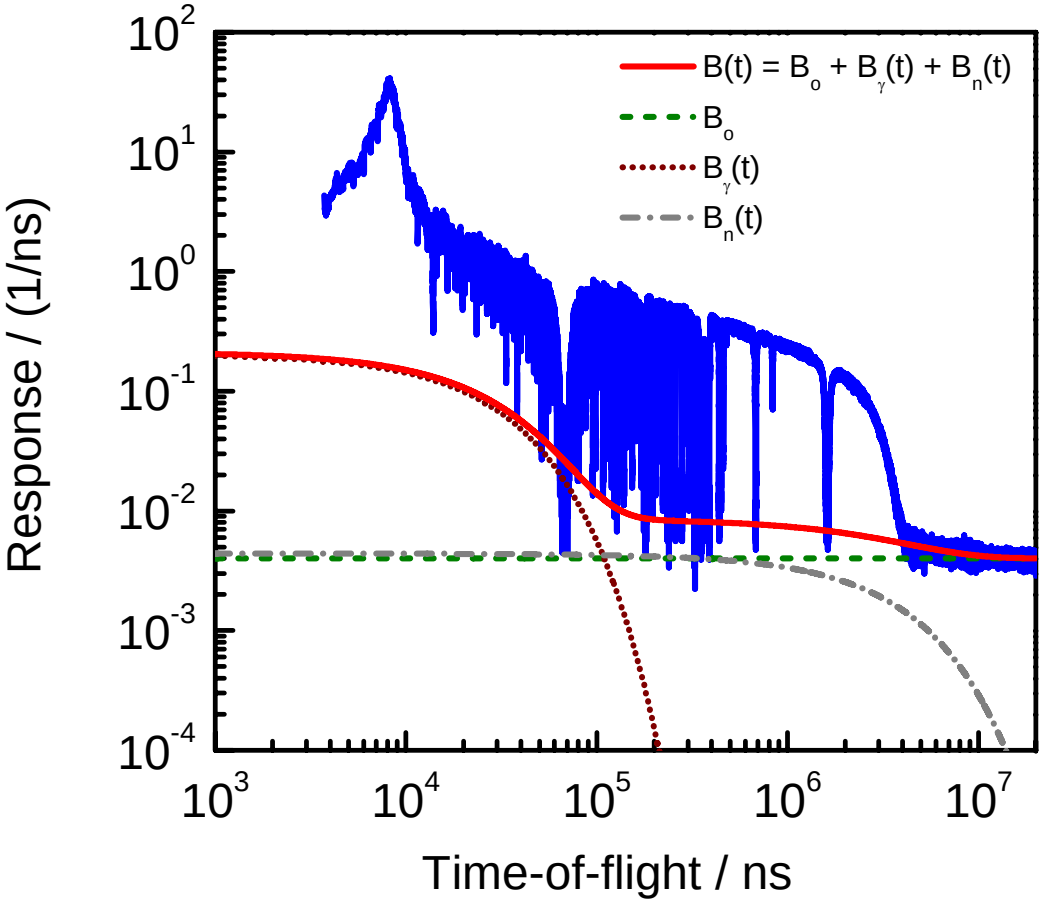
Data in EXFOR – can be used for RSA

European Commission

Experiments at GELINA with natural Cd samples

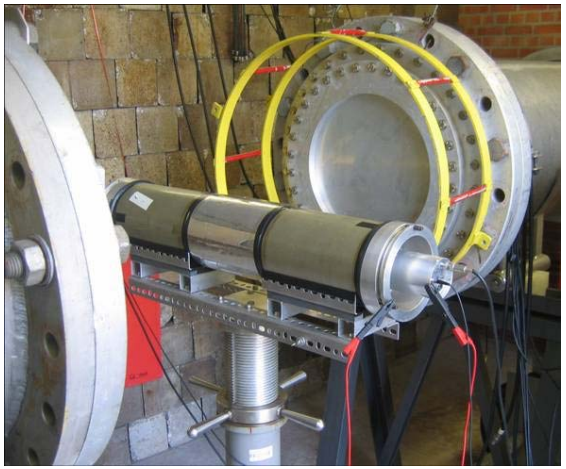
Weight g	Thickness mm	Areal density at/b	Trans. 25m	Trans 50m	Capt. 12.5m	Capt. 30m
1.281	0.03	$1.363\ 10^{-4}$	x		x	
3.184	0.08	$3.390\ 10^{-4}$	x			
87.460	2.06	$93.406\ 10^{-4}$		x	x	
1.979	0.12	$5.382\ 10^{-4}$		x		
17.1120	1.02	$46.698\ 10^{-4}$				x
414.646	25.00	$1205.\ 10^{-4}$		x		
447.216	5.09	$231.02\ 10^{-4}$		x		

Transmission

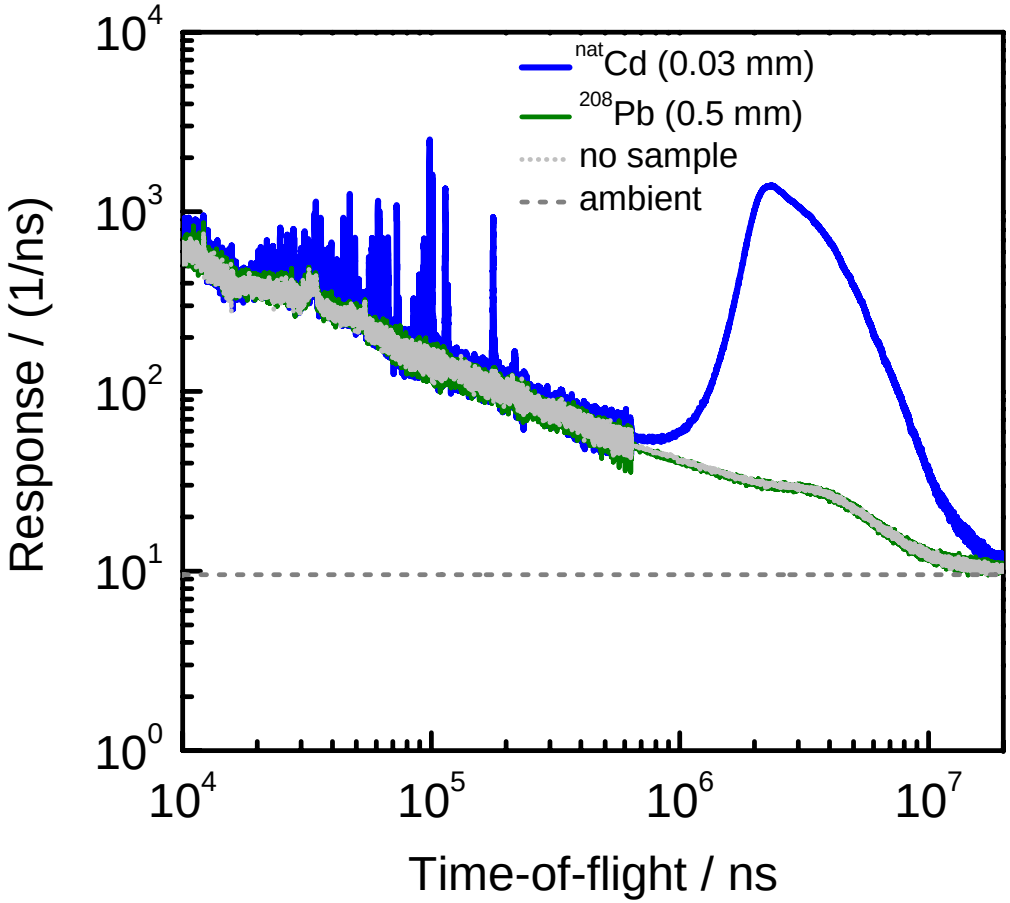


Sample and Bkg filters

Li-Glass scintillator



Capture



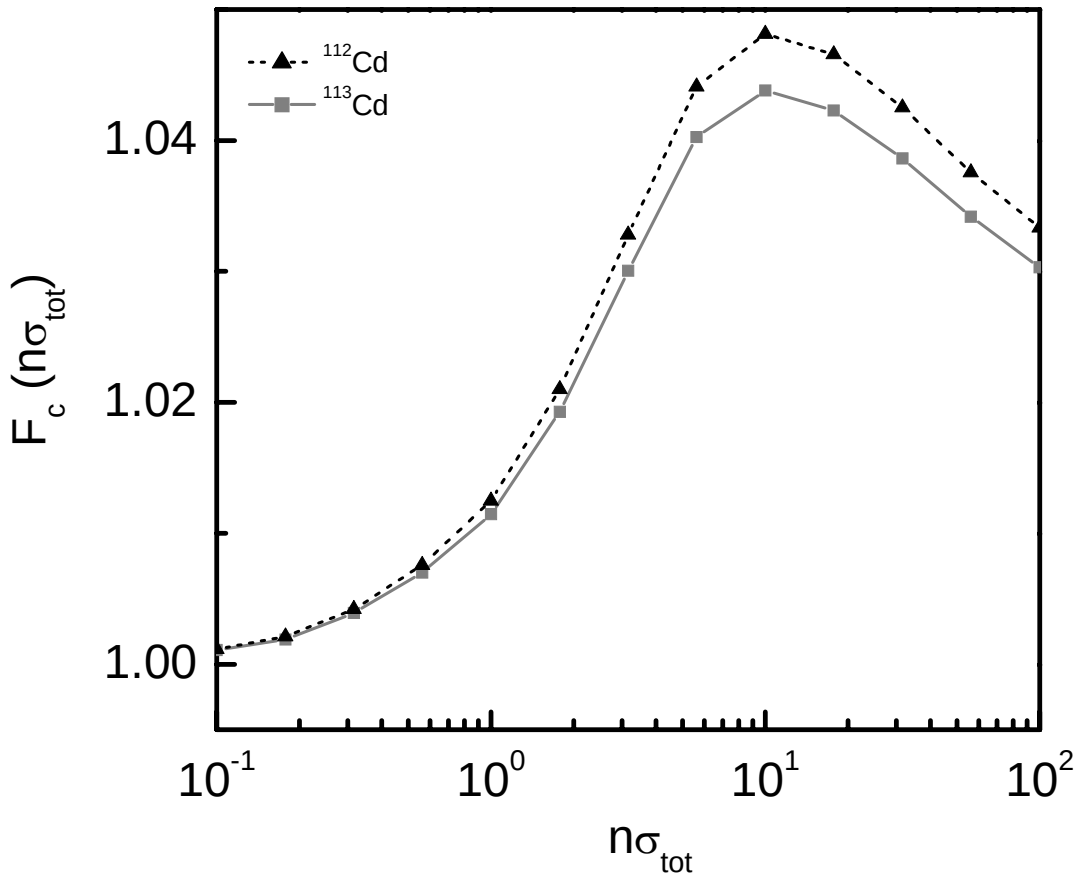
C_6D_6 liquid scintillators

- 125º
- Total energy detection + PHWT

Fluence measurements (IC)

- $^{10}B(n,\alpha)$ (back – to back)

Correction factor



Correction factor for γ attenuation in the sample for different isotopes

Starting file

Bound states initially adjust to match:

-thermal capture cross section from Mughabghab

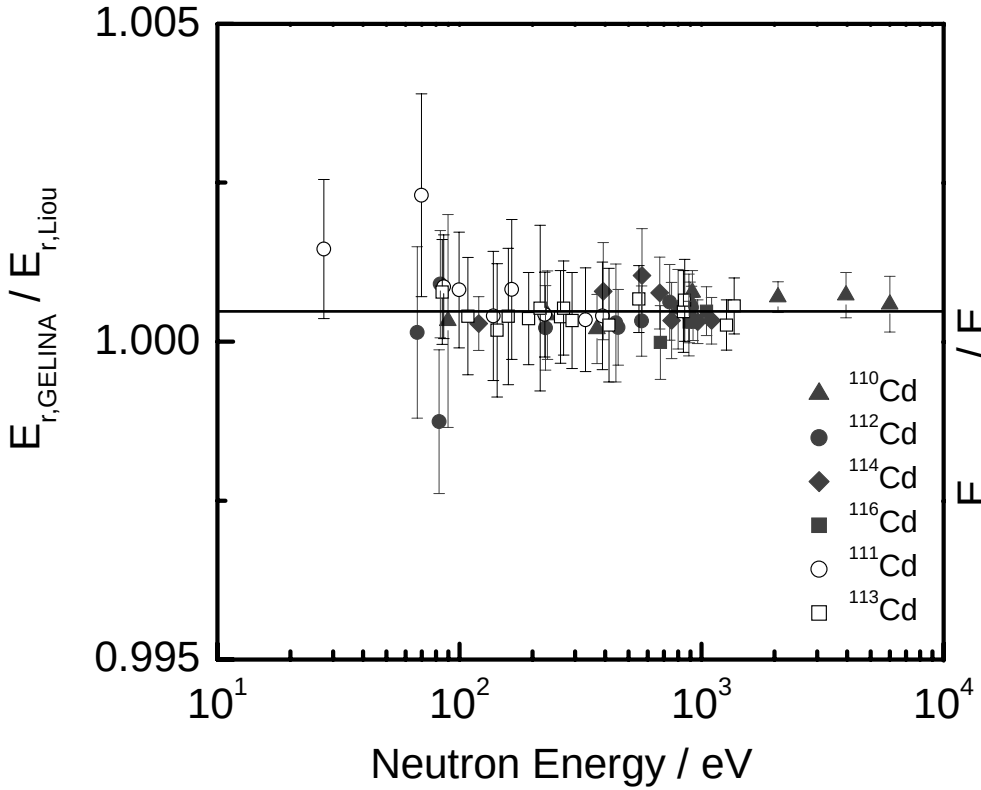
-Coherent scattering lengths from Knopf and Waschkowski

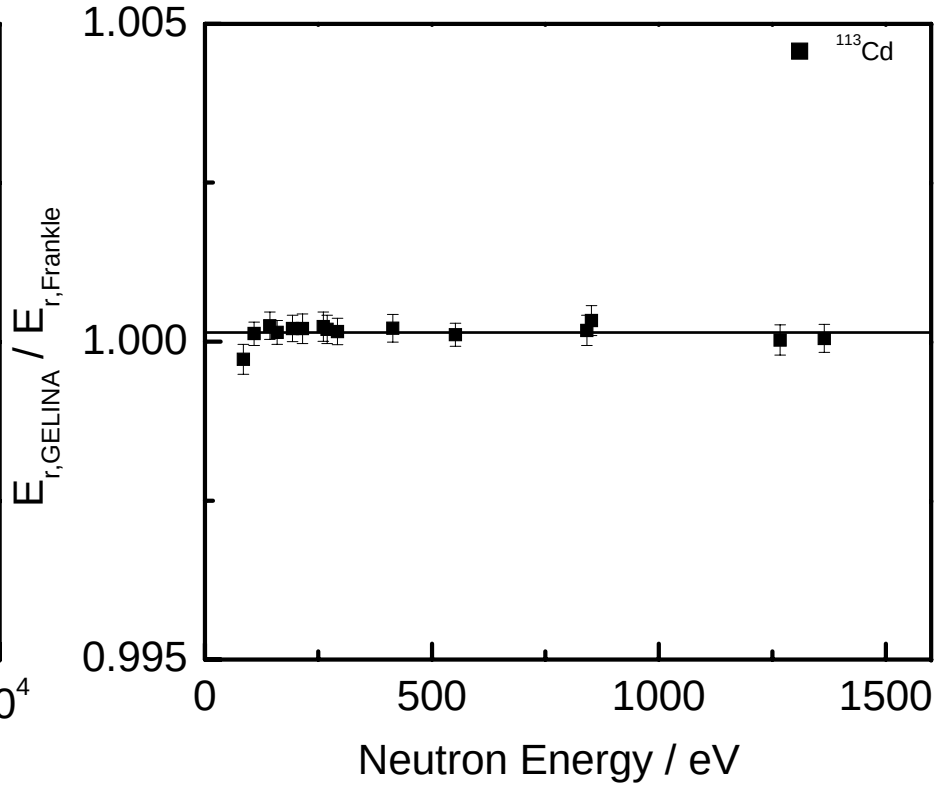
To avoid the use of very strong bound states R' was slightly adjusted

^{110}Cd and ^{112}Cd fitted to interference dips of s-wave resonances

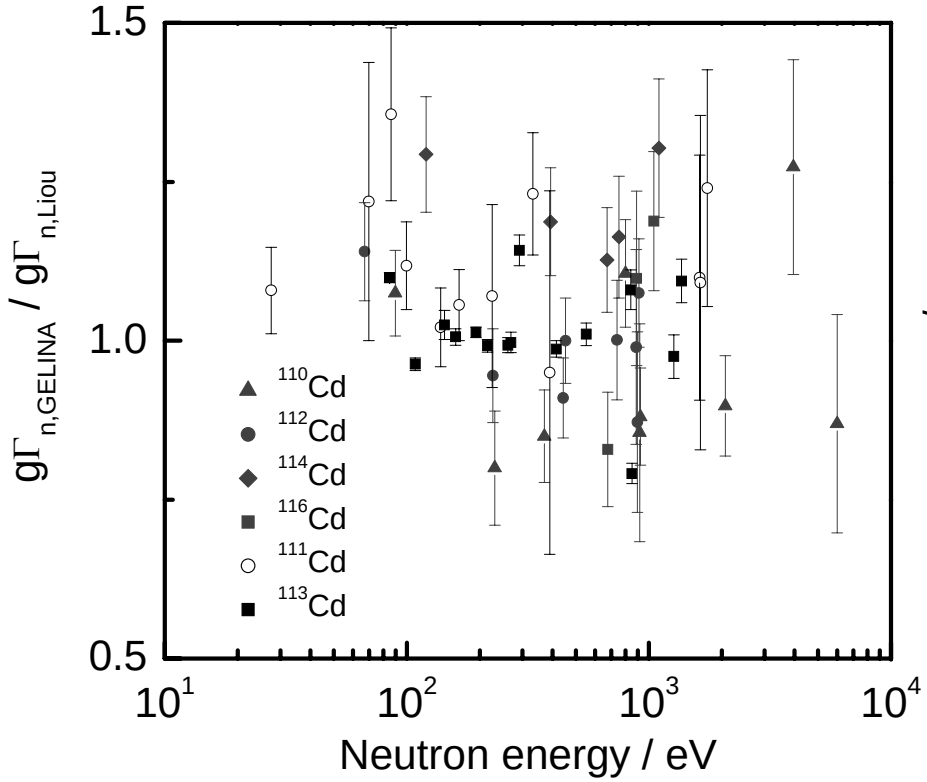
^{114}Cd was adjusted to thick transmission measurement

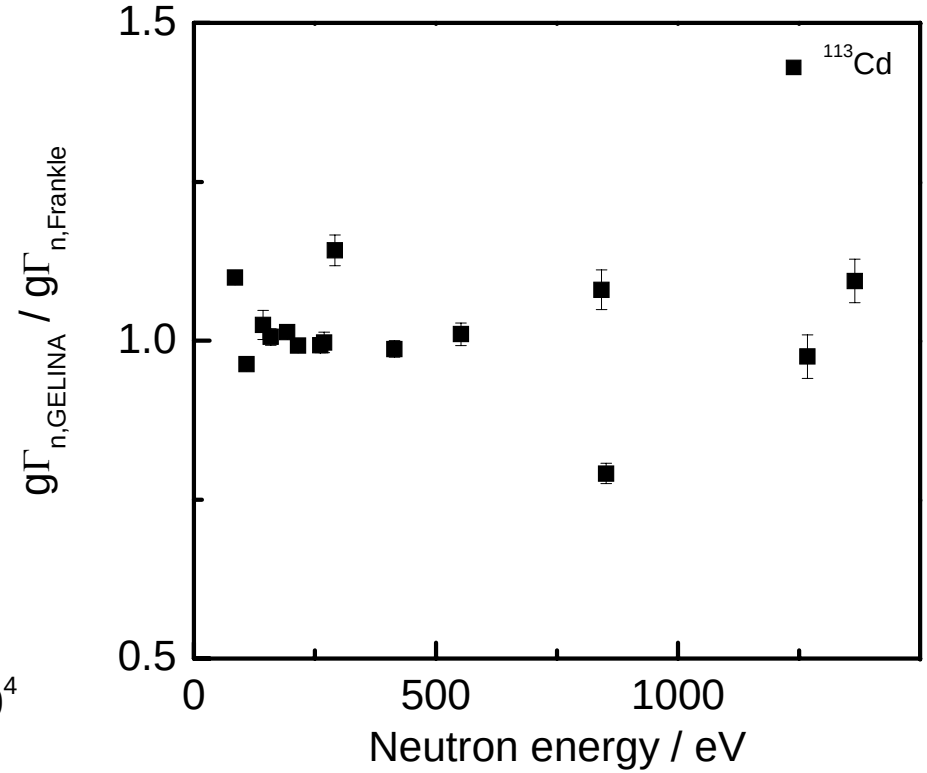
Comparison energies



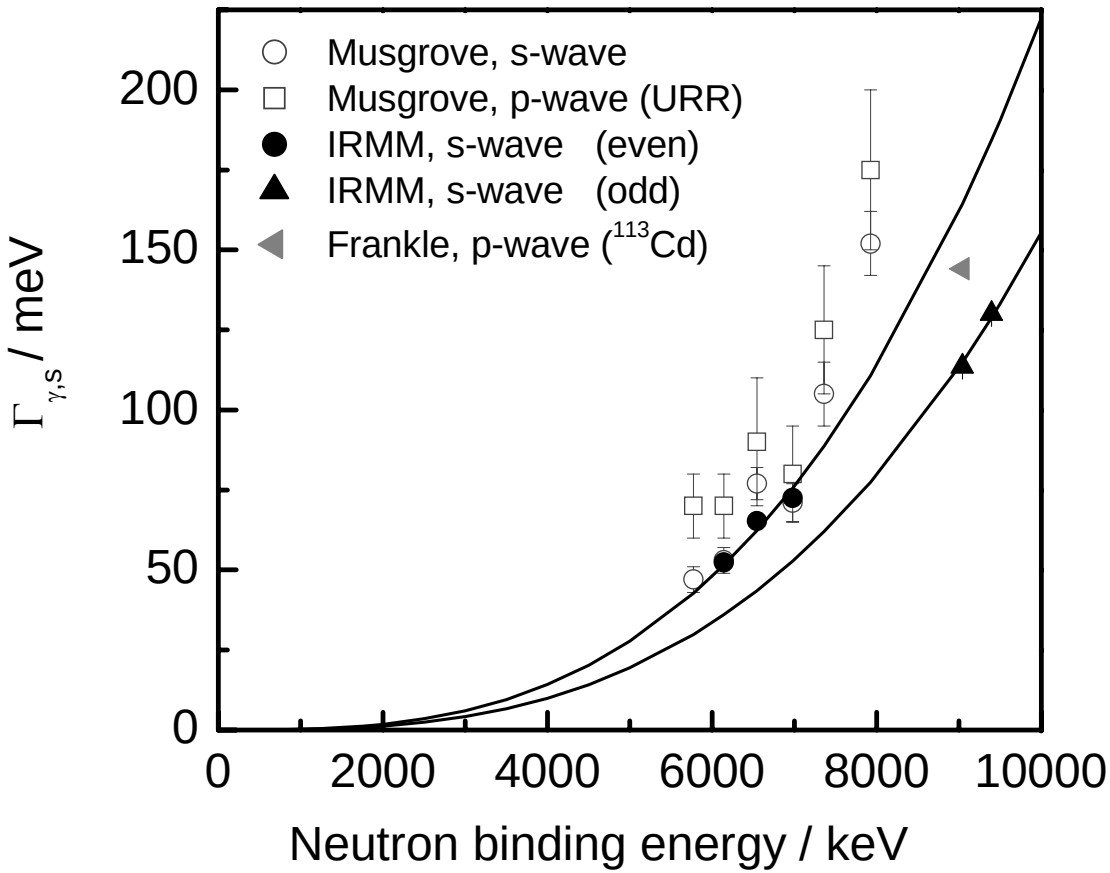


Comparison Γ_n

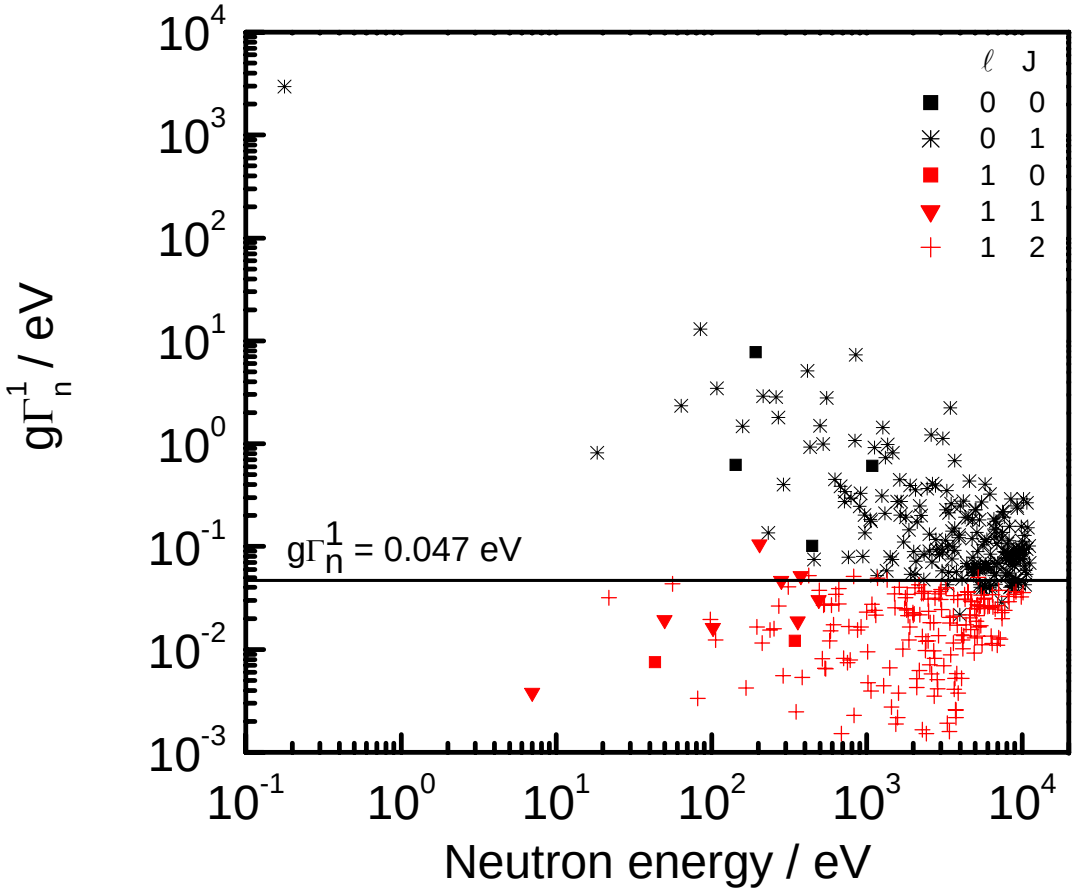




Average Γ_γ

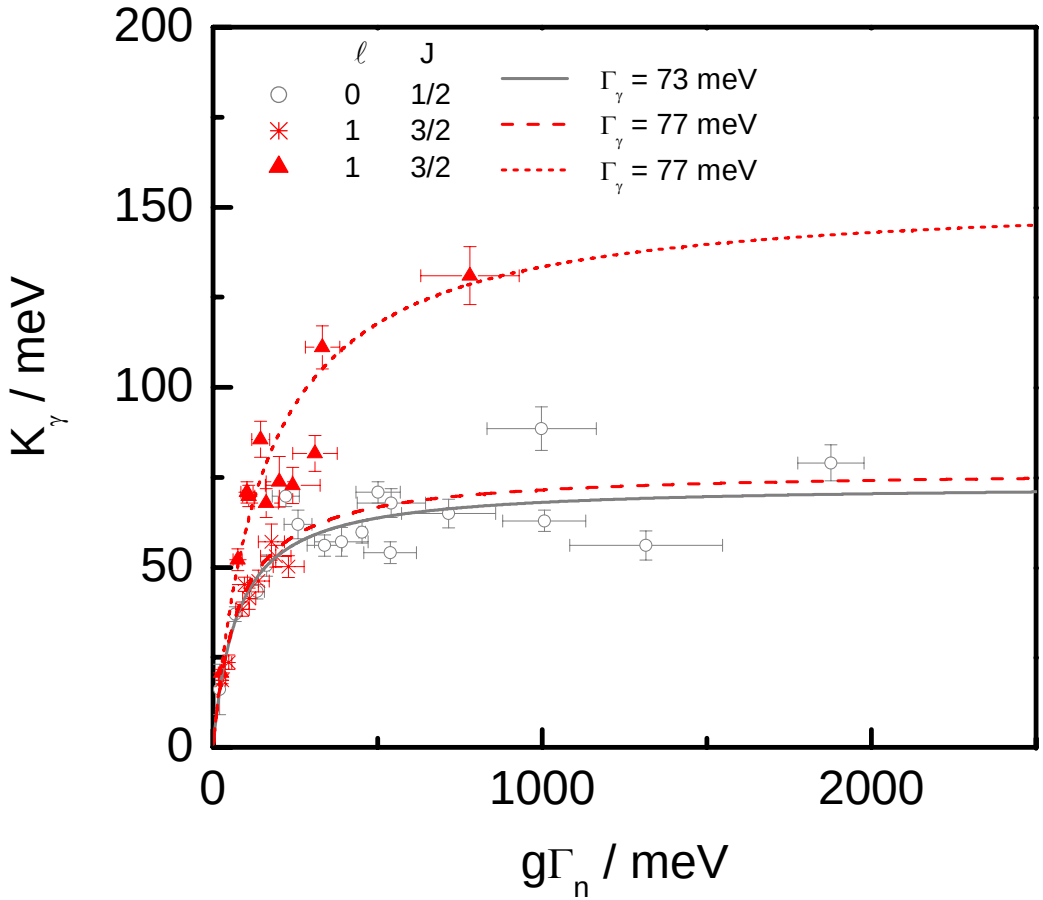


Spin assignment



Thomas –Bollinger approach of spin assignment compared to fixed cut-off in reduced neutron width

Spin assignment



transmission and capture

$$\Gamma_\gamma = \frac{1}{g_J}\frac{K_t K_\gamma}{K_t - K_\gamma}$$

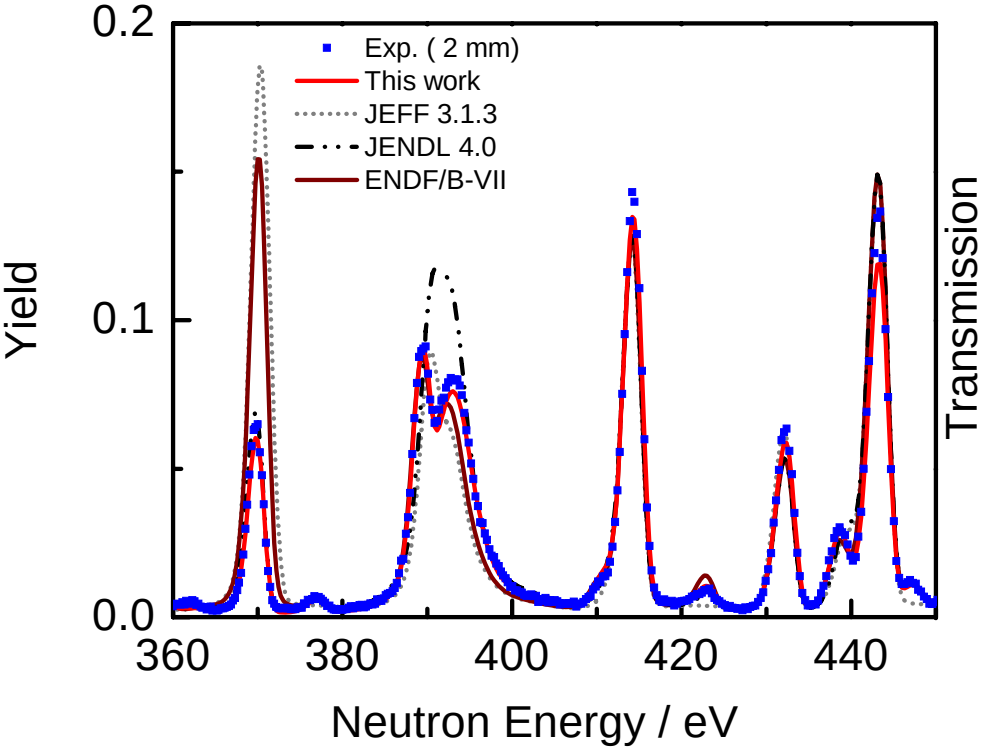
$$\Gamma_n = \frac{K_t}{g_J}$$

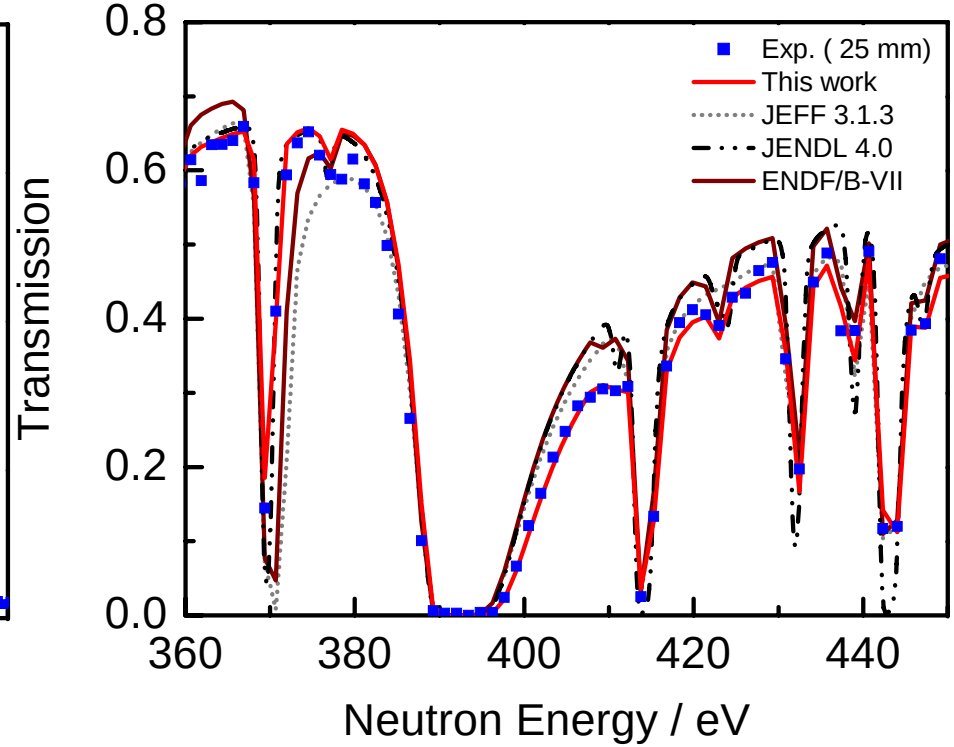
only capture

$$\Gamma_n = \frac{\overline{\Gamma}_\gamma K_\gamma}{g_J \overline{\Gamma}_\gamma - K_\gamma}$$

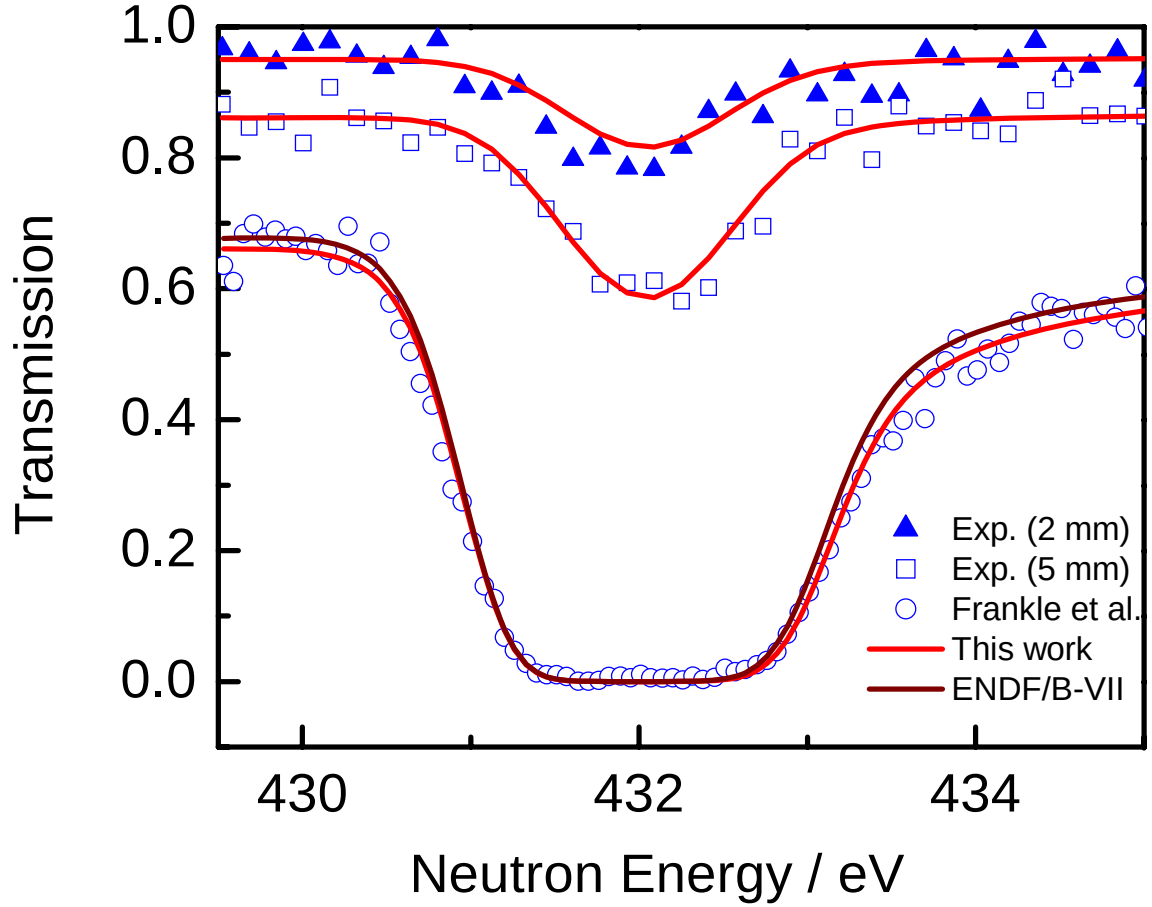
$$g_J > \frac{K_\gamma}{\overline{\Gamma}_\gamma}$$

Results

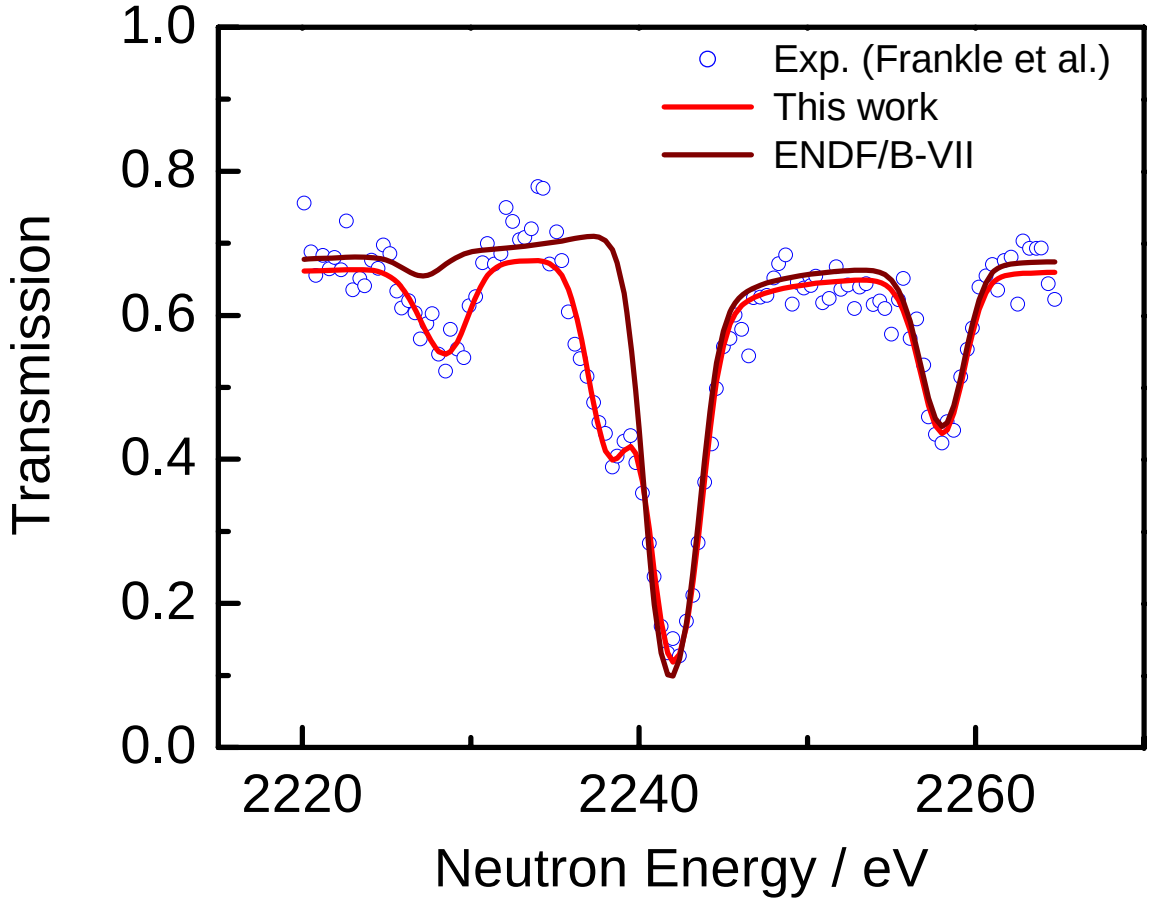

Exp. (2 mm)
This work
JEFF 3.1.3
JENDL 4.0
ENDF/B-VII
Yield
0.0
0.1
0.2
360
380
400
420
440
Neutron Energy / eV


Exp. (25 mm)
This work
JEFF 3.1.3
JENDL 4.0
ENDF/B-VII
Transmission
0.0
0.2
0.4
0.6
0.8
360
380
400
420
440
Neutron Energy / eV

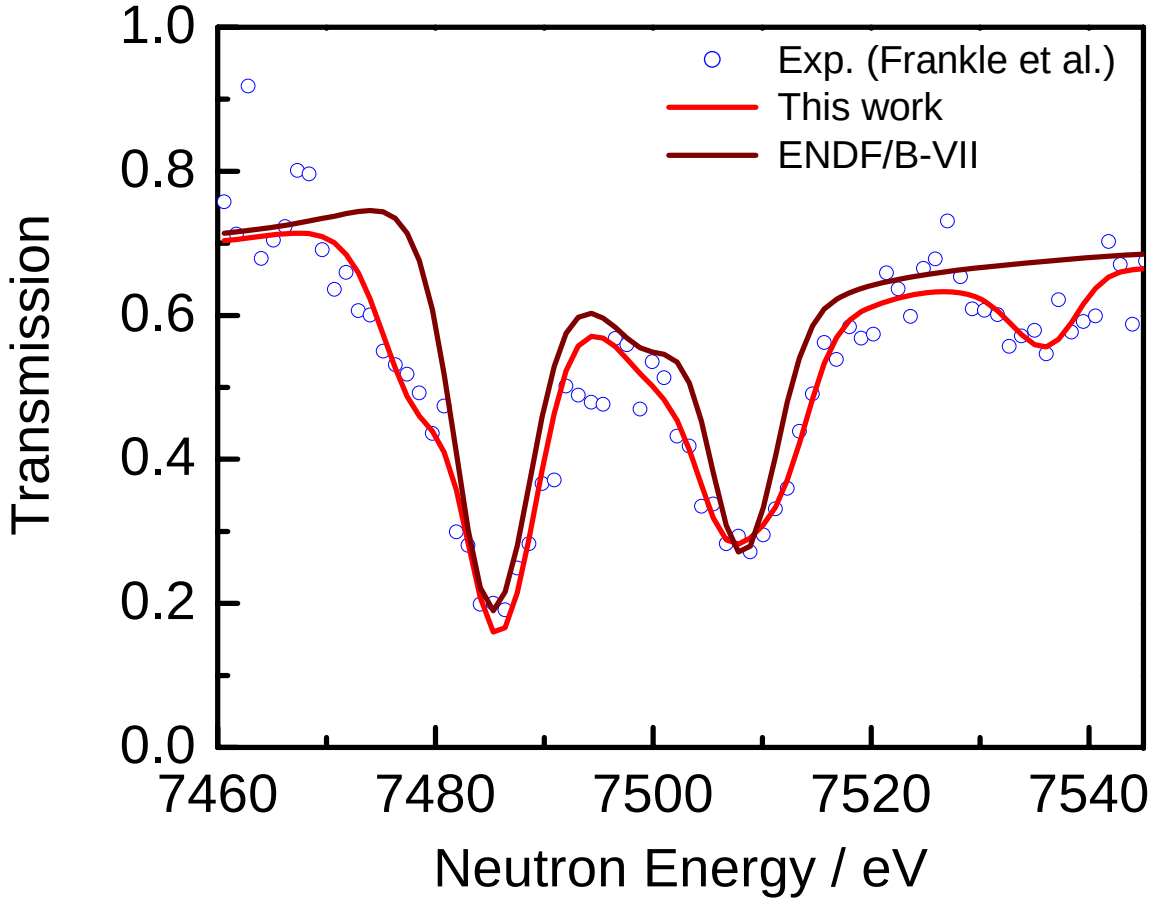
Results


1.0
0.8
0.6
0.4
0.2
0.0
Transmission
430
432
434
Neutron Energy / eV
Exp. (2 mm)
Exp. (5 mm)
Frankle et al.
This work
ENDF/B-VII

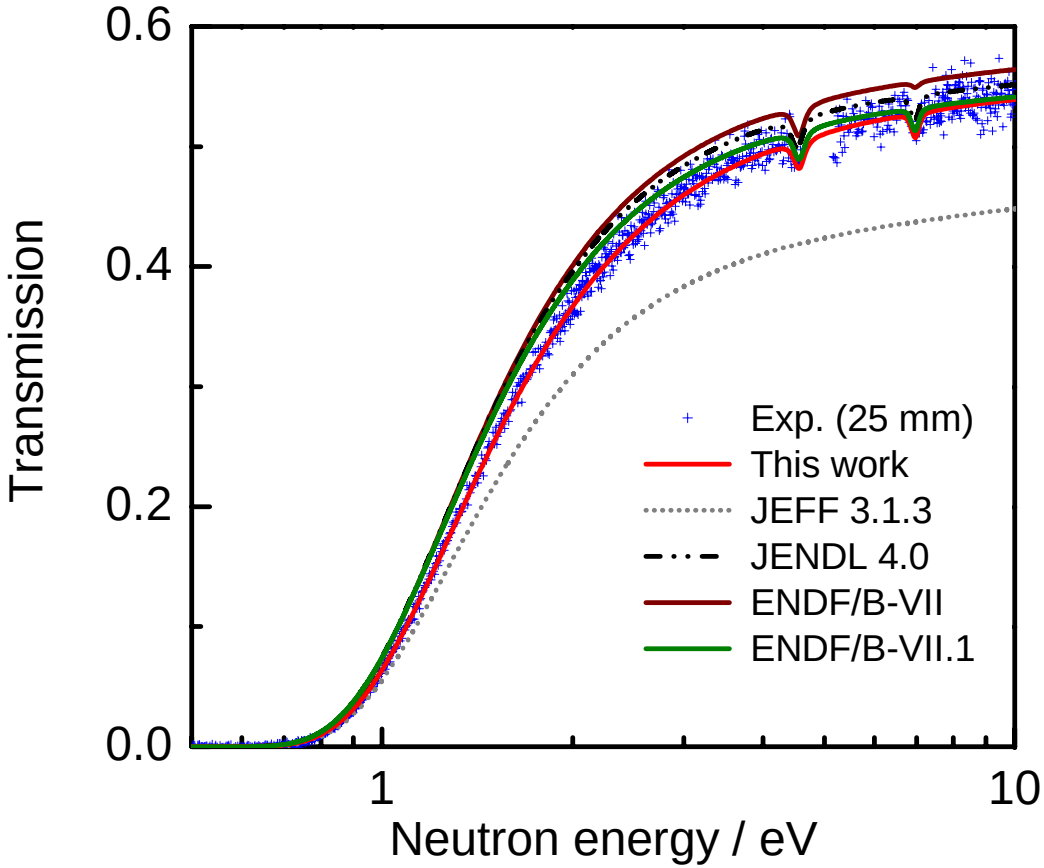
Results


Exp. (Frankle et al.)
This work
ENDF/B-VII
Transmission
1.0
0.8
0.6
0.4
0.2
0.0
2220
2240
2260
Neutron Energy / eV

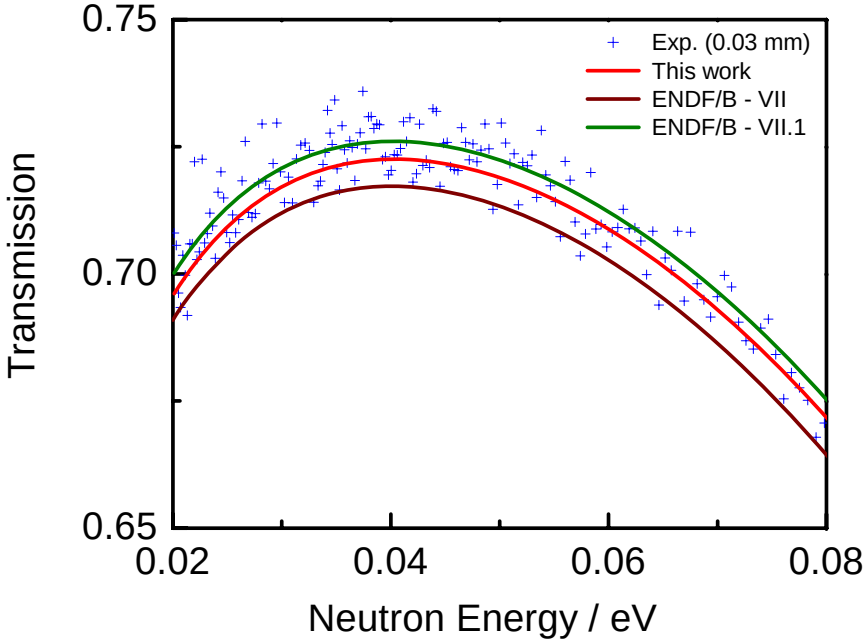
Results

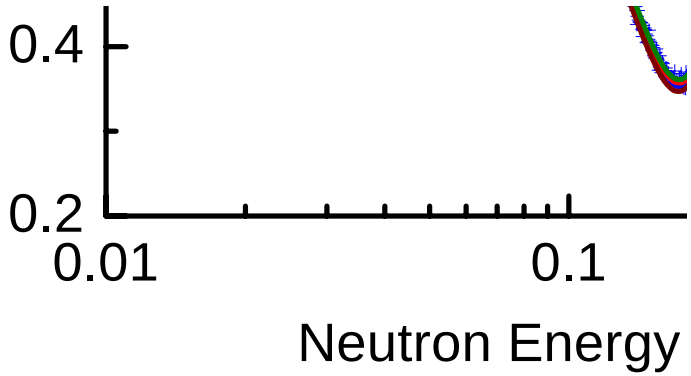

Exp. (Frankle et al.)
This work
ENDF/B-VII
Transmission
1.0
0.8
0.6
0.4
0.2
0.0
7460
7480
7500
7520
7540
Neutron Energy / eV

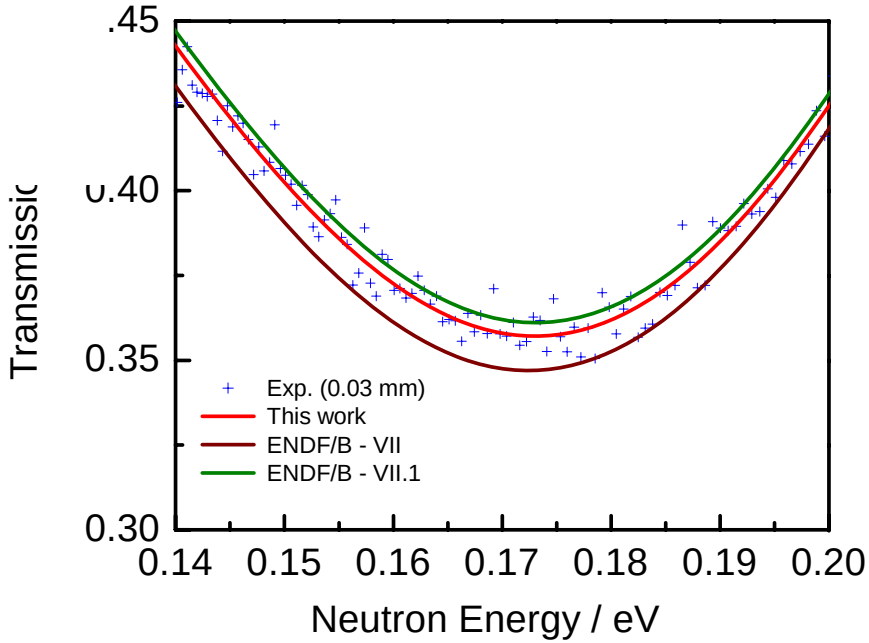
Results


0.6
0.4
0.2
0.0
Transmission
1
10
Neutron energy / eV
Exp. (25 mm)
This work
JEFF 3.1.3
JENDL 4.0
ENDF/B-VII
ENDF/B-VII.1

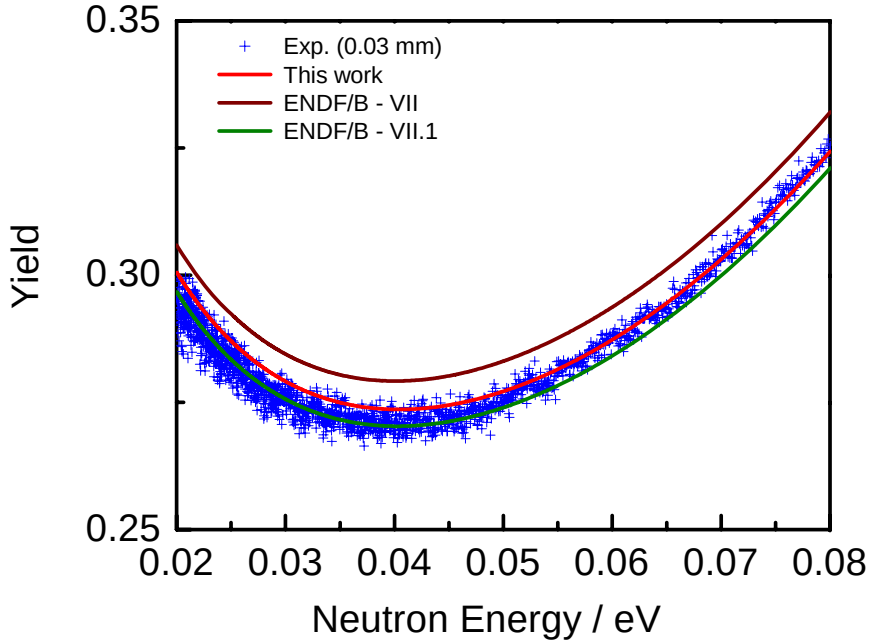
Results

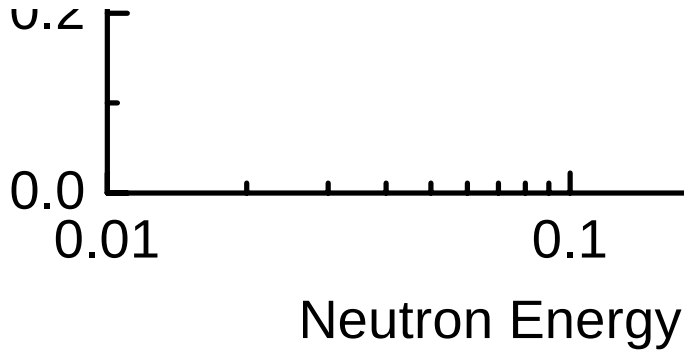

Exp. (0.03 mm)
This work
ENDF/B - VII
ENDF/B - VII.1
Transmission
0.75
0.70
0.65
0.02
0.04
0.06
0.08
Neutron Energy / eV

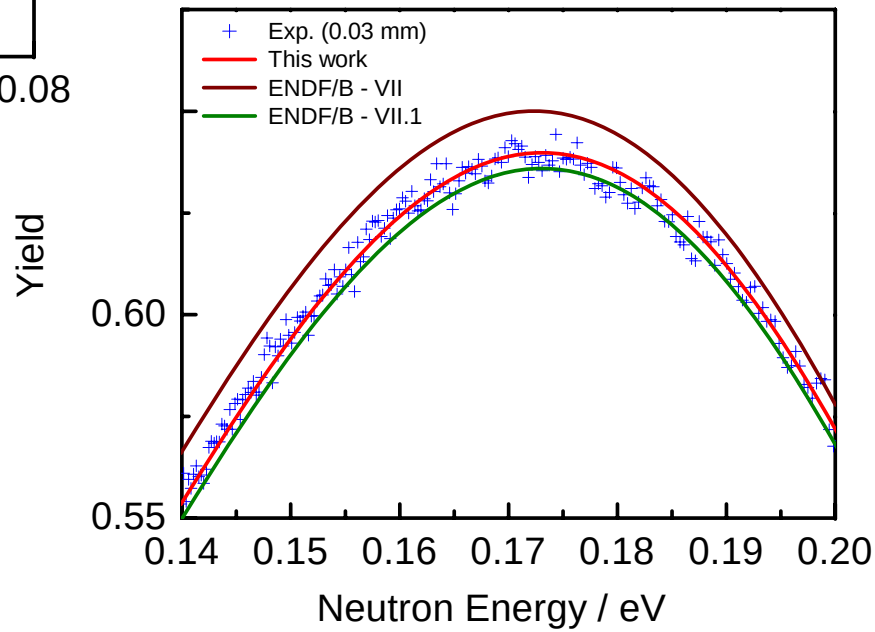

0.4
0.2
0.01
0.1
Neutron Energy


Transmissic
.45
0.40
0.35
0.30
Exp. (0.03 mm)
This work
ENDF/B - VII
ENDF/B - VII.1
0.14
0.15
0.16
0.17
0.18
0.19
0.20
Neutron Energy / eV

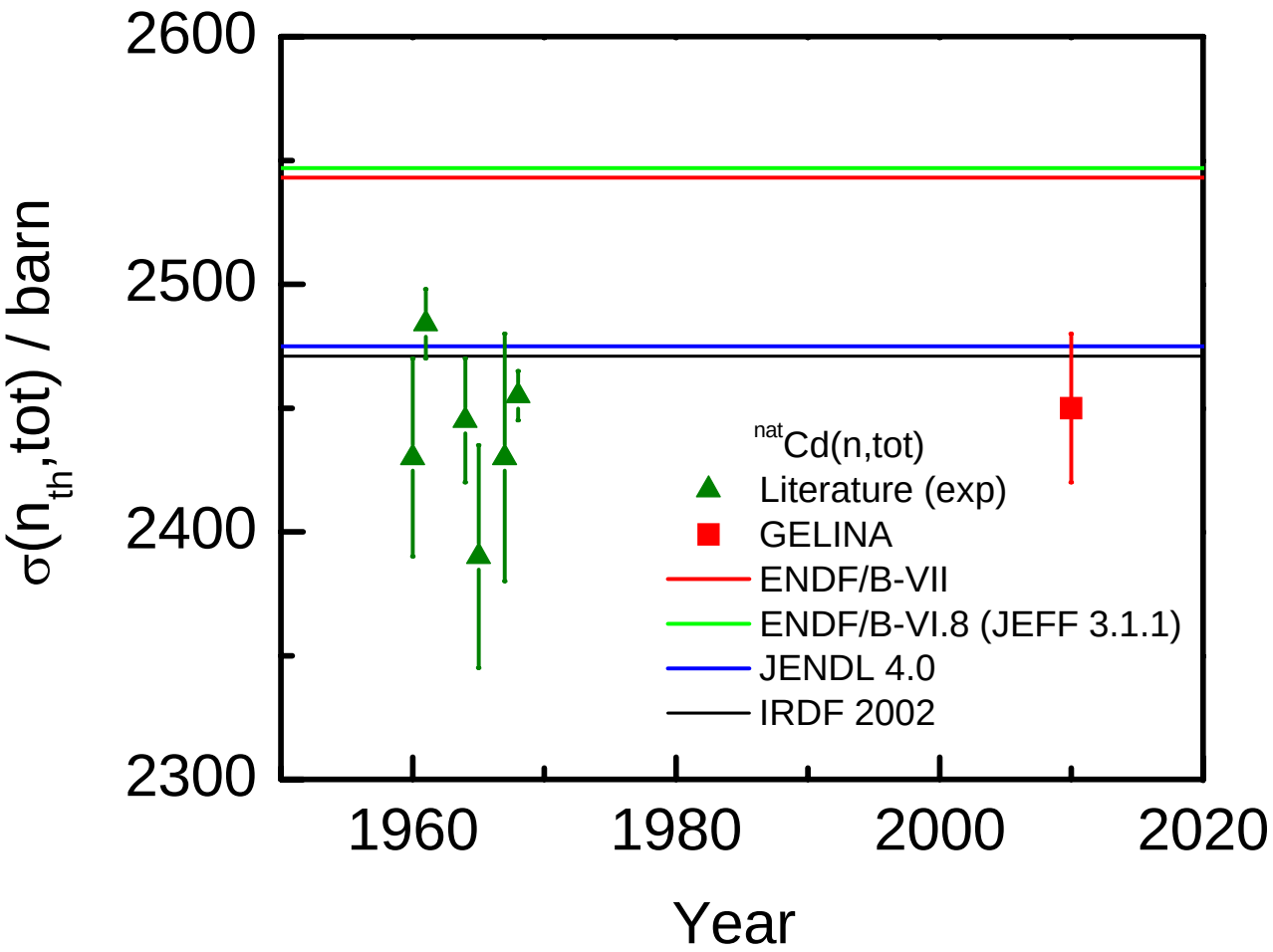
Results


Exp. (0.03 mm)
This work
ENDF/B - VII
ENDF/B - VII.1
Yield
0.35
0.30
0.25
0.02
0.03
0.04
0.05
0.06
0.07
0.08
Neutron Energy / eV


0.0
0.01
0.1
Neutron Energy


Exp. (0.03 mm)
This work
ENDF/B - VII
ENDF/B - VII.1
Yield
0.60
0.55
0.14
0.15
0.16
0.17
0.18
0.19
0.20
Neutron Energy / eV

Thermal cross section



Summary Cd

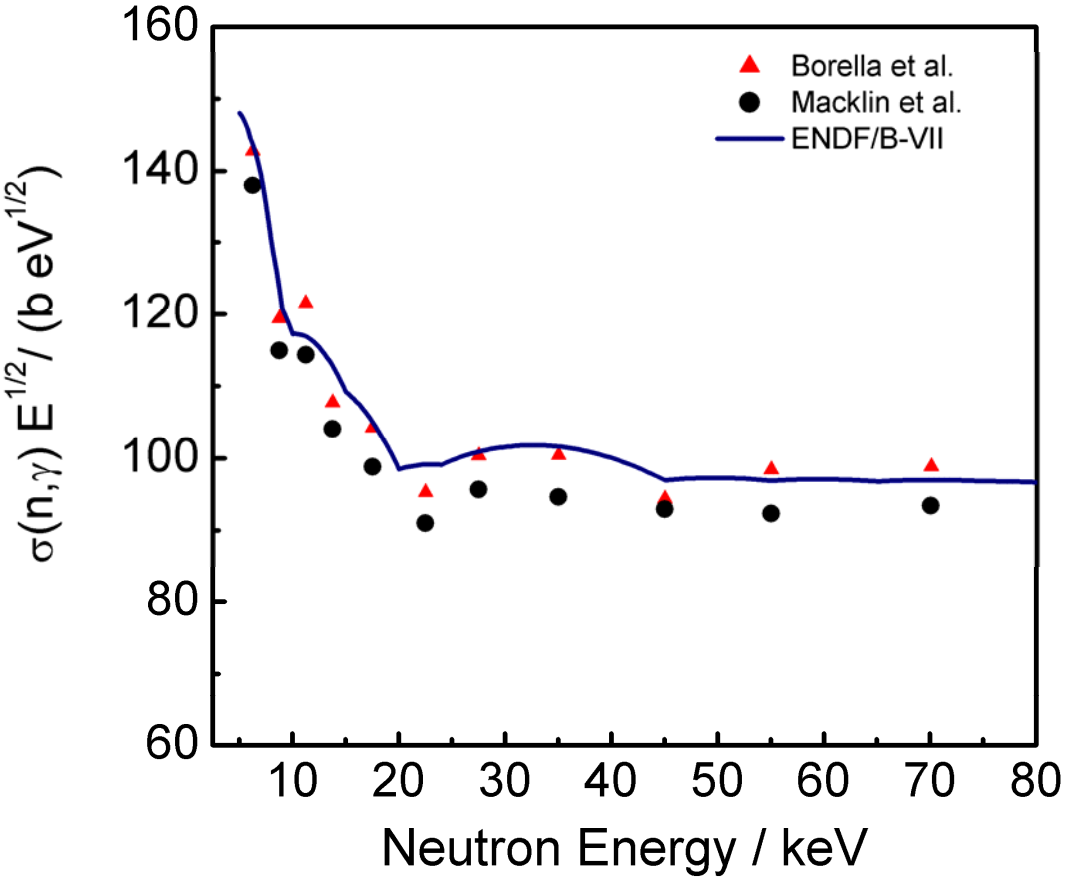
- ^{113}Cd Improved resonance parameter from thermal up to 10 keV
- Impossible to describe thermal cross section and first resonance

  This file puts higher importance on the shape of first resonance (Cd cut-off) than on thermal cross section

- Low abundant isotopes ^{106,108,116}Cd – quality files adequate
- ^{114}Cd measurements with enriched sample might give improvement

Covariance will be provided by CEA Cadarache

Au- capture URR Status

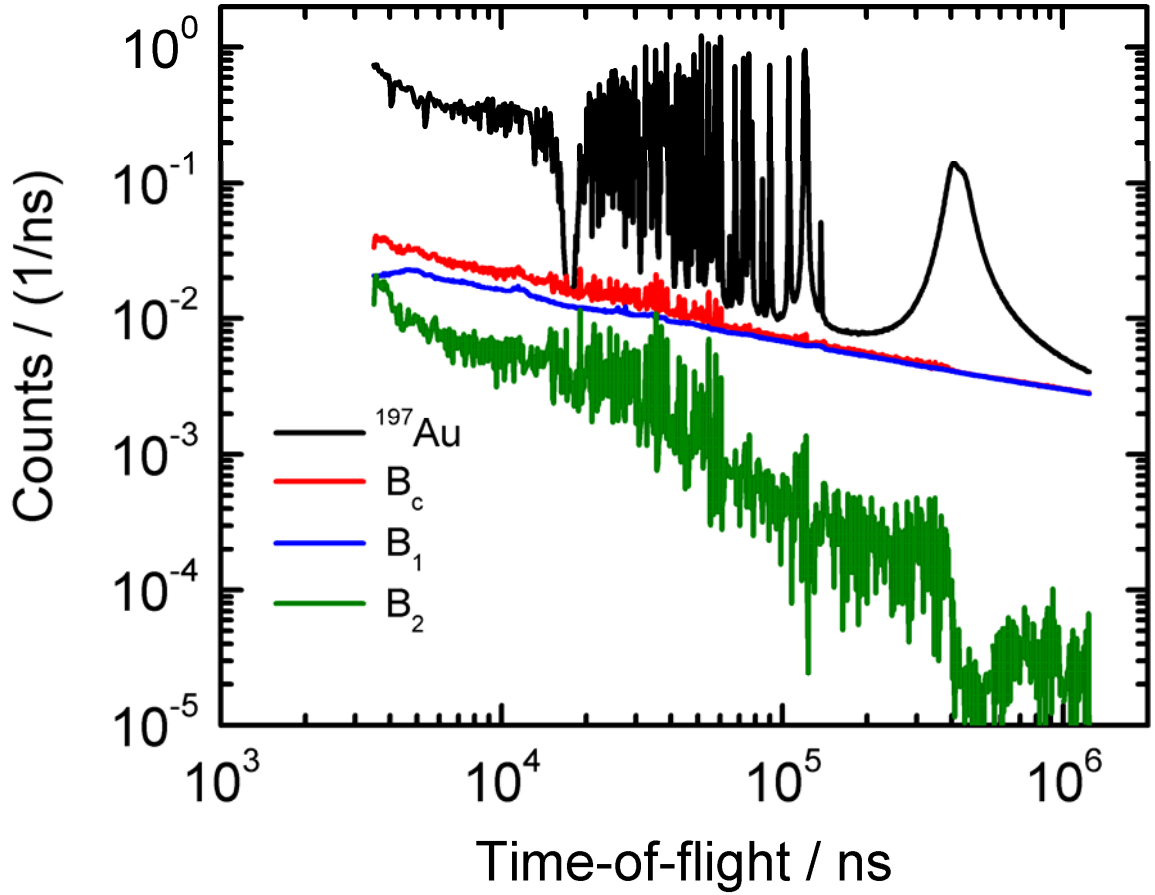


Discrepancy between Standard file for neutron reaction cross section and “astrophysical” Standard

Borella et al agree with standard

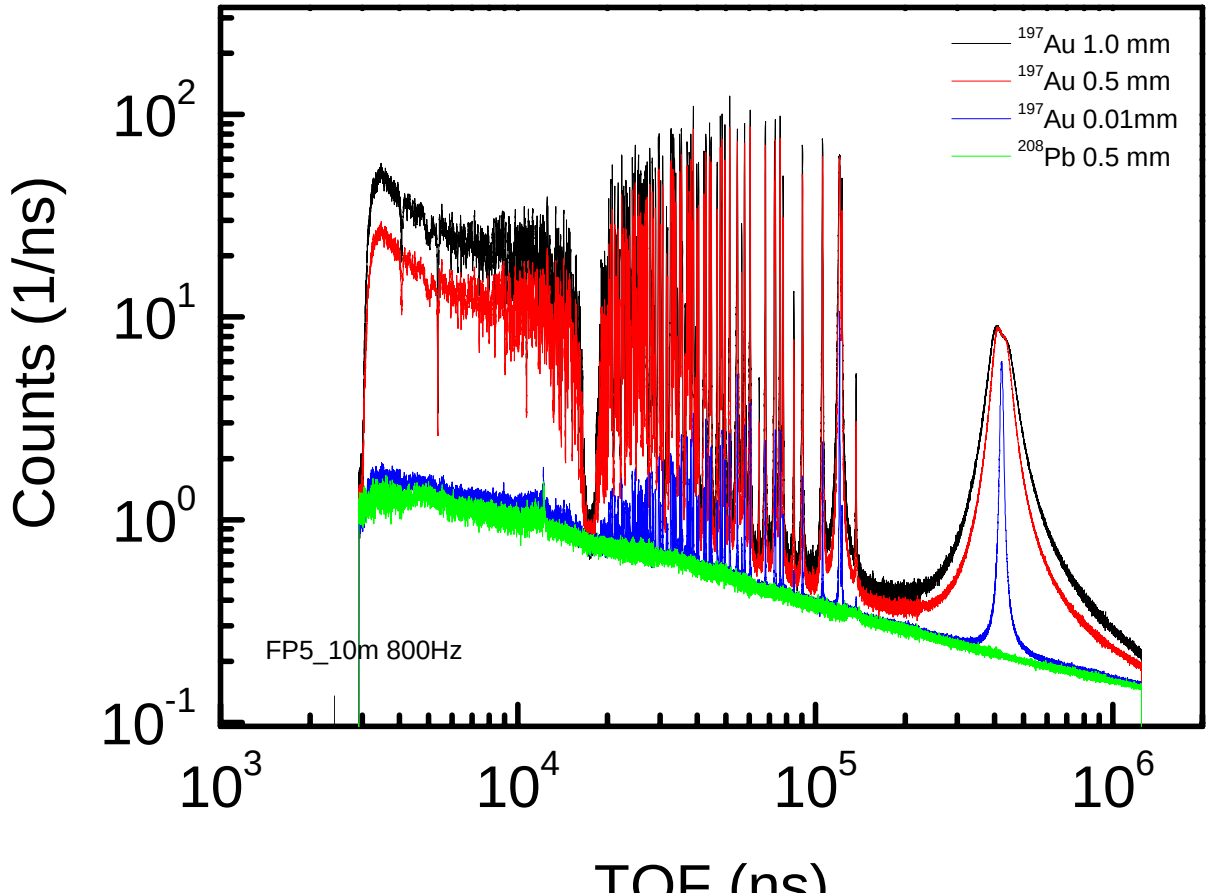
Trend confirmed by Feinberg et al
Lederer et al

BKG Au- capture

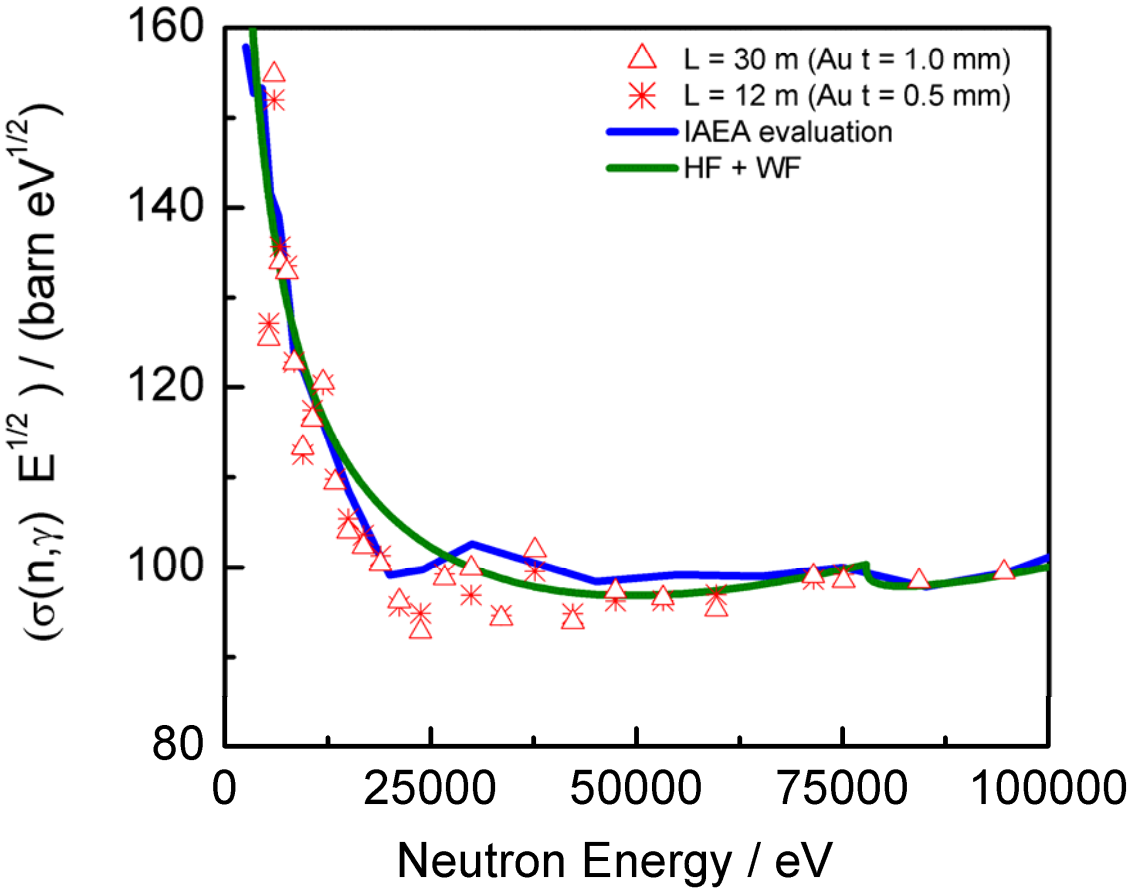


$$B(t) = B_0 + B_1(t) + B_2(t)$$

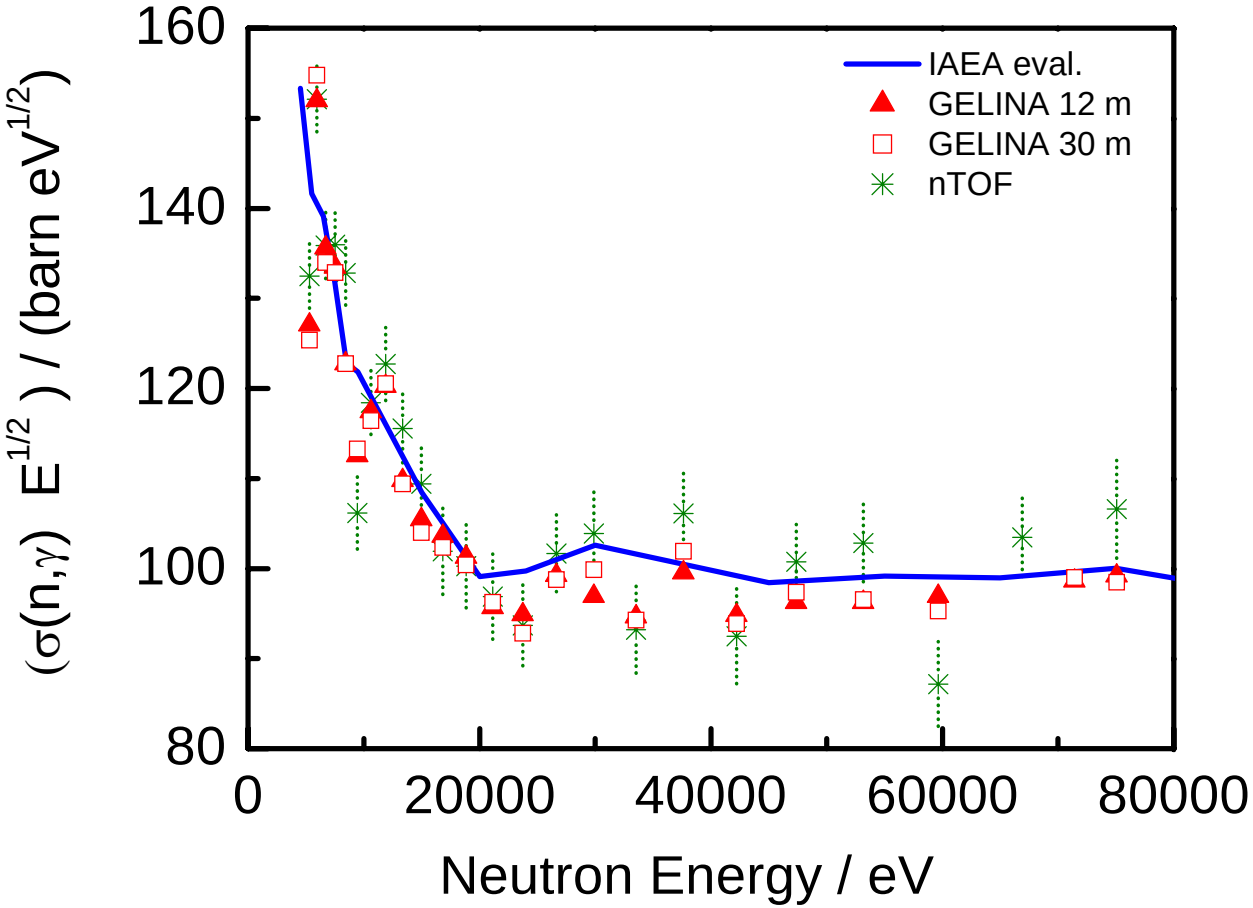
BKG Au- capture



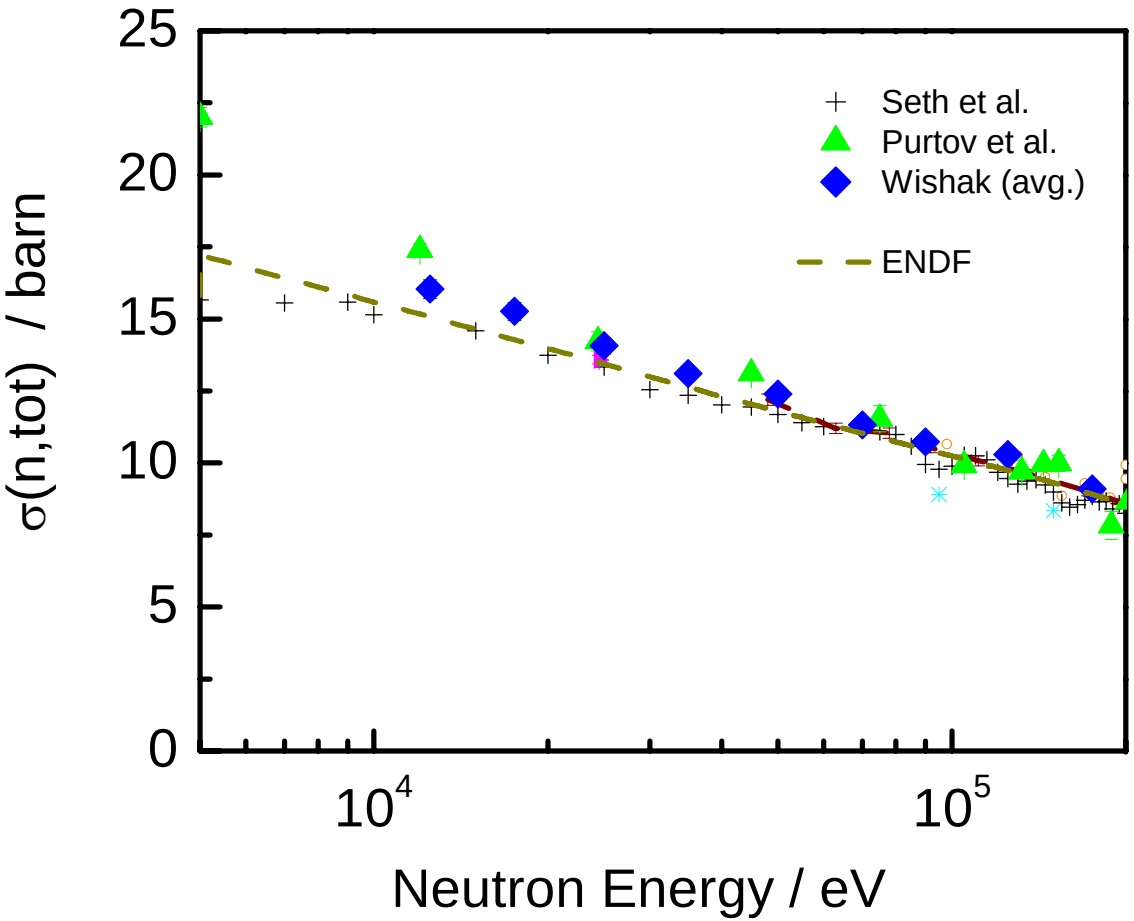
Au- capture URR Results



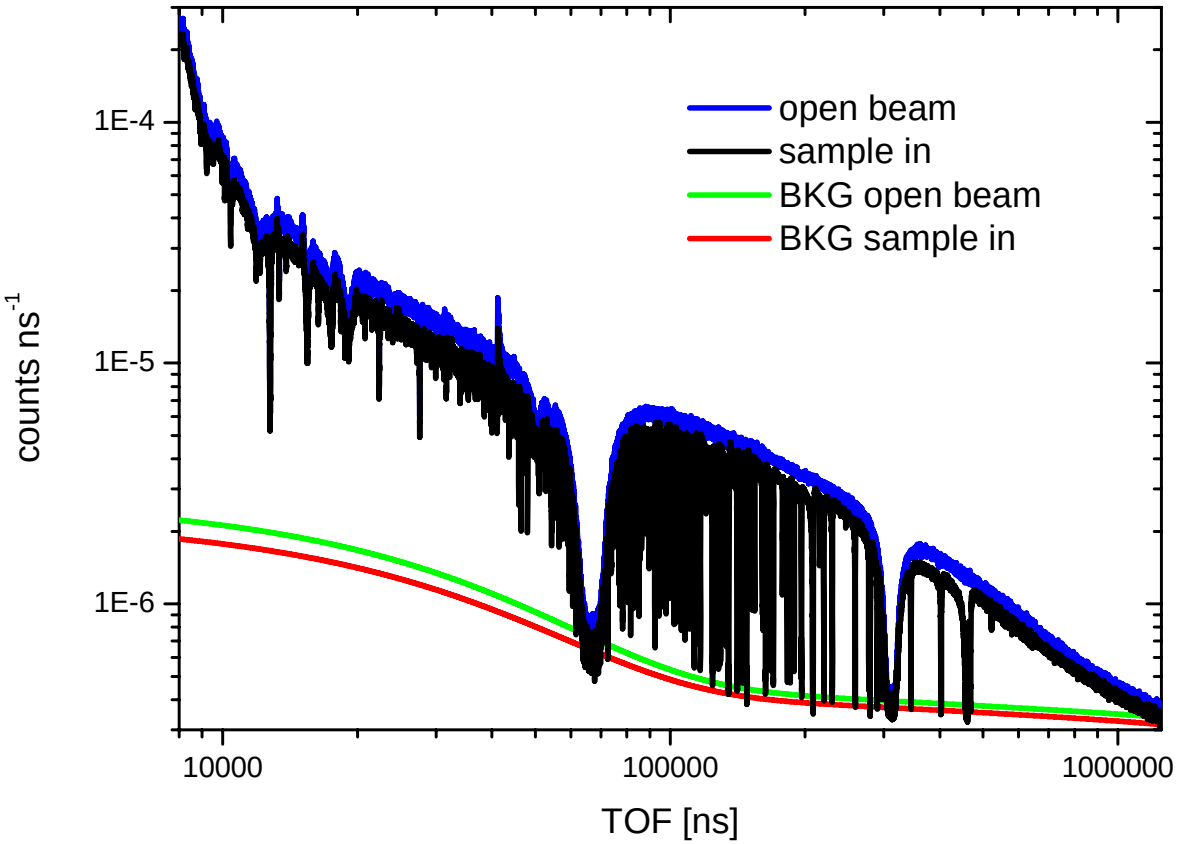
Gold URR Capture



Gold URR Total Status

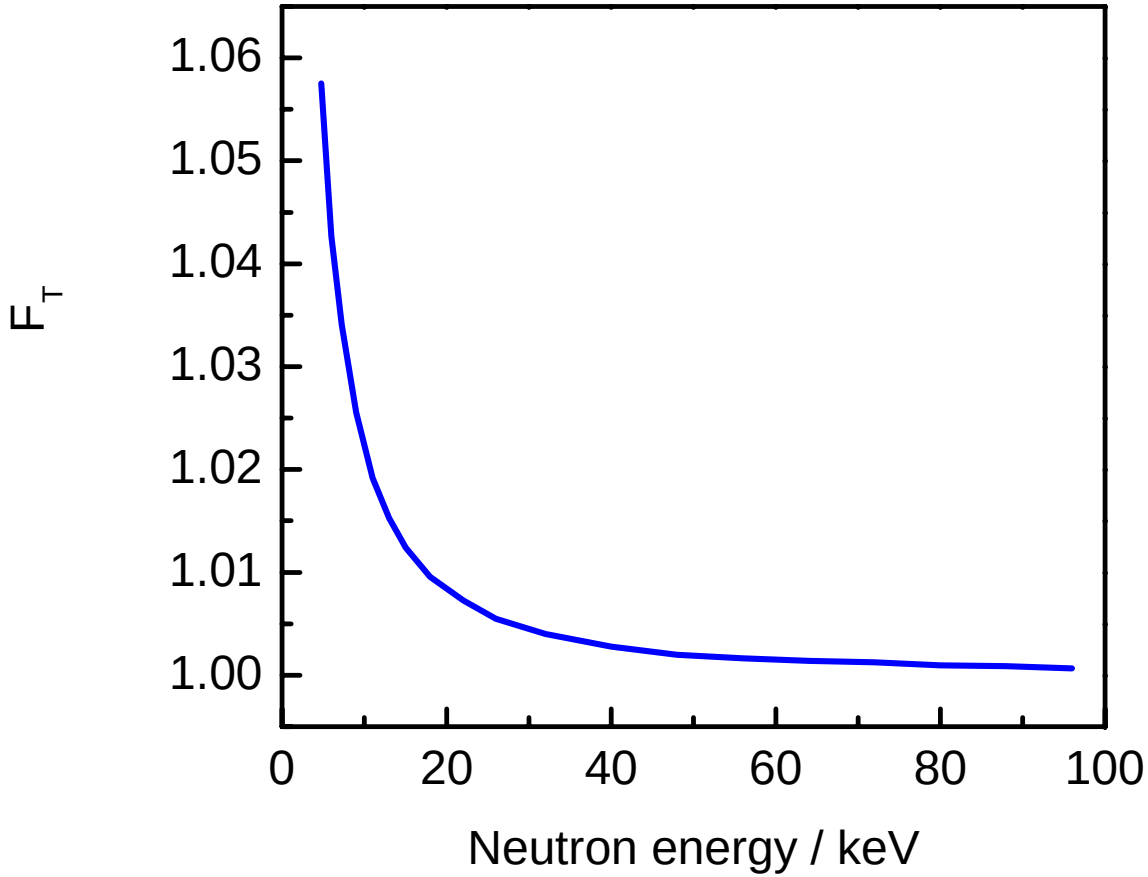


BKG Gold URR Total



$$B(t) = B_0 + B_1(t) + B_2(t)$$

Self Shielding

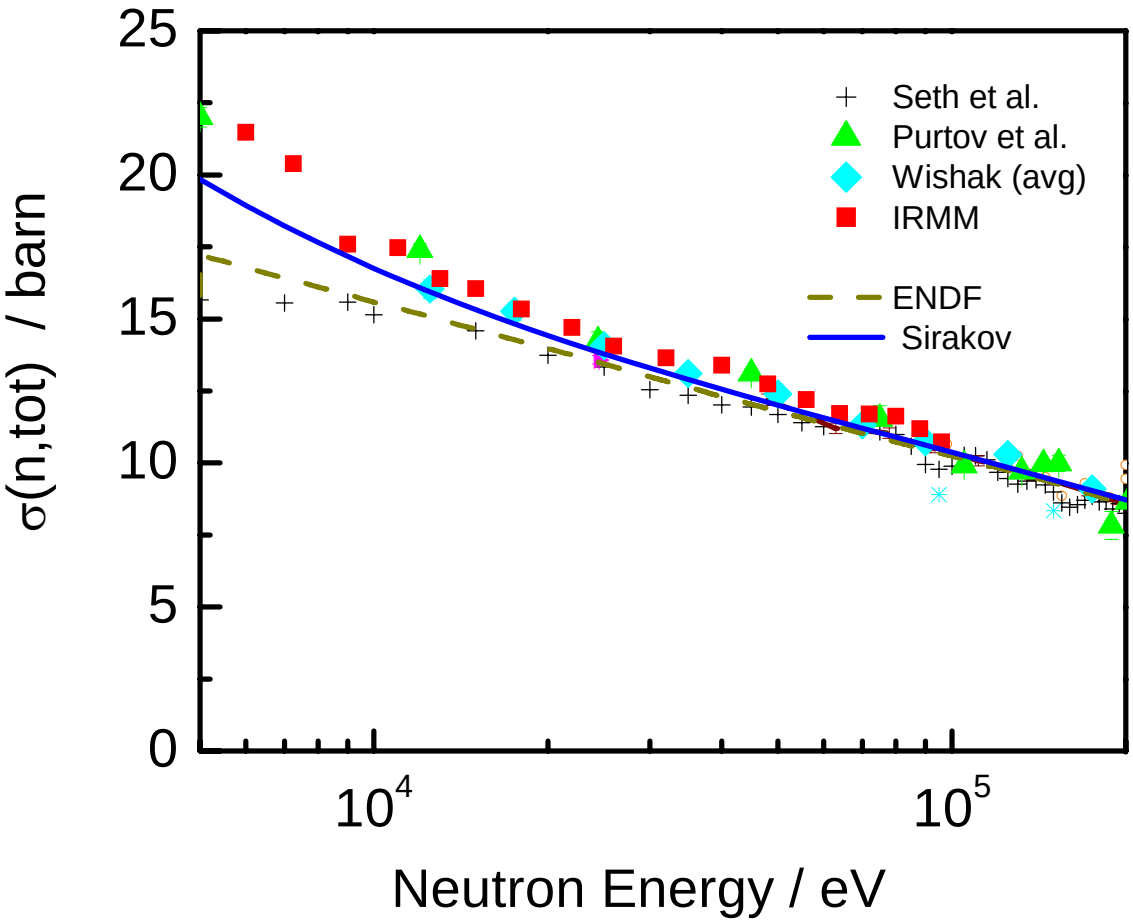


Self Shielding correction calculated with MCNP

Still to be done:

SESH

Gold URR Total Results



Comparison with literature data and OM calculation

Summary Au

•Capture measurements with two thicknesses agree with standard evaluation

• Only small data base for URR total cross section
  -Later measurements seem to disagree with evaluation

• Transmission measurements with 3mm sample
  -Agreement with data of Purtov et al.