



Advances in the Gd-160 capture cross section data analysis

***M. Mastromarco, A. Mazzone, A. Manna, S. Amaducci, F.G. Infantes, A. Mengoni,
S. Cristallo, G. Tagliente, C. Massimi, U. Koester and N. Colonna***

Motivations

161Tb is a clinically interesting isotope for theranostics!!!

Dy 154 $3.0 \cdot 10^6$ a α 2.87	Dy 155 10.0 h ϵ β^+ ; 0.9; 1.1... γ 227...	Dy 156 0.056 σ 33 $\sigma_{n, \alpha} < 0.009$	Dy 157 8.1 h ϵ γ 326...	Dy 158 0.095 σ 33 $\sigma_{n, \alpha} < 0.006$	Dy 159 144.4 d ϵ γ 58; e^- σ 8000	Dy 160 2.329 σ 60 $\sigma_{n, \alpha} < 0.0003$	Dy 161 18.889 σ 600 $\sigma_{n, \alpha} < 1E-6$	Dy 162 25.475 σ 170	Dy 163 24.896 σ 120 $\sigma_{n, \alpha} < 2E-5$	Dy 164 28.260 σ 1610 + 1040	Dy 165 1.3 m ϵ β^- ; 0.9; 1.0... γ 95; 515... σ 2000 σ 3500
Tb 153 2.34 d ϵ β^+ ... γ 212; 170; 110; 102; 83...	Tb 154 23 h ϵ γ 248; 347; 1420; 123... β^+ ; 123; 1248; 1274; 540... 90.0 h γ 123; 123; 1248; 1274; 180; 262...	Tb 155 5.32 d ϵ γ 87; 105; 180; 262... $\beta^?$	Tb 156 24 h? ϵ γ 88; 150; 188; 199; 1222 β^+ ... $\beta^?$	Tb 157 99 a ϵ γ (54) e^-	Tb 158 10.5 s ϵ γ 534; 199; 1222 β^- ; 0.9 γ 944; 962; 80... 180 a γ (110) e^-	Tb 159 100 σ 23.2	Tb 160 72.3 d β^- ; 0.6; 1.7... γ 879; 299; 966... σ 570	Tb 161 6.90 d σ 1.5	Tb 162 7.76 m β^- ; 0.5; 0.6... γ 26; 49; 75... e^-	Tb 163 19.5 m β^- ; 1.4; 2.4... γ 260; 808; 888... σ 2000	Tb 164 3.0 m β^- ; 1.7; 3.0... γ 169; 755; 215; 688; 611...
Gd 152 0.20 $1.1 \cdot 10^{14}$ a α 2.14; σ 700 $\sigma_{n, \alpha} < 0.007$	Gd 153 239.47 d ϵ γ 97; 103; 70... σ 20000 $\sigma_{n, \alpha} 0.03$	Gd 154 2.18 σ 60	Gd 155 14.80 σ 61000 $\sigma_{n, \alpha} 0.00008$	Gd 156 20.47 σ ~2.0	Gd 157 15.65 σ 254000 $\sigma_{n, \alpha} < 0.05$	Gd 158 24.84 σ 2.3	Gd 159 18.48 h β^- ; 1.0... γ 364; 58...	Gd 160 21.86 σ 1.5	Gd 161 3.66 m β^- ; 0.5; 1.7... γ 361; 315; 102... σ 20000	Gd 162 8.2 m β^- ; 1.0... γ 442; 403...	Gd 163 68 s β^- γ 288; 214; 1562; 1685...
Eu 151 47.81 σ 4 + 3150 + 6000	Eu 152 96 m β^- ; 1.9... γ 541; 593; 344... σ 90 σ 68000 σ 11000	Eu 153 52.19 σ 300 $\sigma_{n, \alpha} 1E-6$	Eu 154 46.0 m β^- ; 0.6; 1.8... γ 123; 1274; 723; 1005... σ 68; 101... σ 1500	Eu 155 8.8 a β^- ; 0.17; 0.25... γ 87; 105... σ 3900	Eu 156 4.761 a β^- ; 0.5; 2.4... γ 812; 89; 1231... σ 3900	Eu 157 15.18 h β^- ; 0.5; 2.4... γ 87; 105... σ 3900	Eu 158 46 m β^- ; 2.4; 3.4... γ 64; 411; 371; 619... σ 3900	Eu 159 18.1 m β^- ; 2.6... γ 944; 977; 80; 898... σ 3900	Eu 160 42 s β^- ; 4.1... γ 68; 71; 79; 96; 103... σ 3900	Eu 161 26 s β^- γ 72 - 314	Eu 162 10.6 s β^- γ 71; 165
Sm 150 7.38 σ 102	Sm 151 93 a β^- ; 0.1... γ (22...) ; e^- σ 15200	Sm 152 26.75 σ 206	Sm 153 46.27 h β^- ; 0.7; 0.8... γ 103; 70... σ 420	Sm 154 22.75 σ 7.5	Sm 155 22.4 m β^- ; 1.5... γ 104; 246; 141...	Sm 156 9.4 h β^- ; 0.7... γ 204; 88; 166... e^-	Sm 157 8.11 m β^- ; 2.4... γ 198; 196; 394...	Sm 158 5.51 m β^- γ 189; 364; 325...	Sm 159 11.4 s β^- γ 190; 862; 254; 797; 179...	Sm 160 9.6 s β^- γ 110...	Sm 161 4.8 s β^- γ 264

(Medical Motivations: terbium-161 production)

- Chemically similar to lutetium-177 (used in theranostic as γ and β^- emitter)
 - Similar half-life $T_{1/2} = 6.9$ d (against 6.7 d of Lu-177)

In addition to being a γ and β^- emitter (like Lu-177), Tb-161 is also an emitter of Auger and conversion electrons;

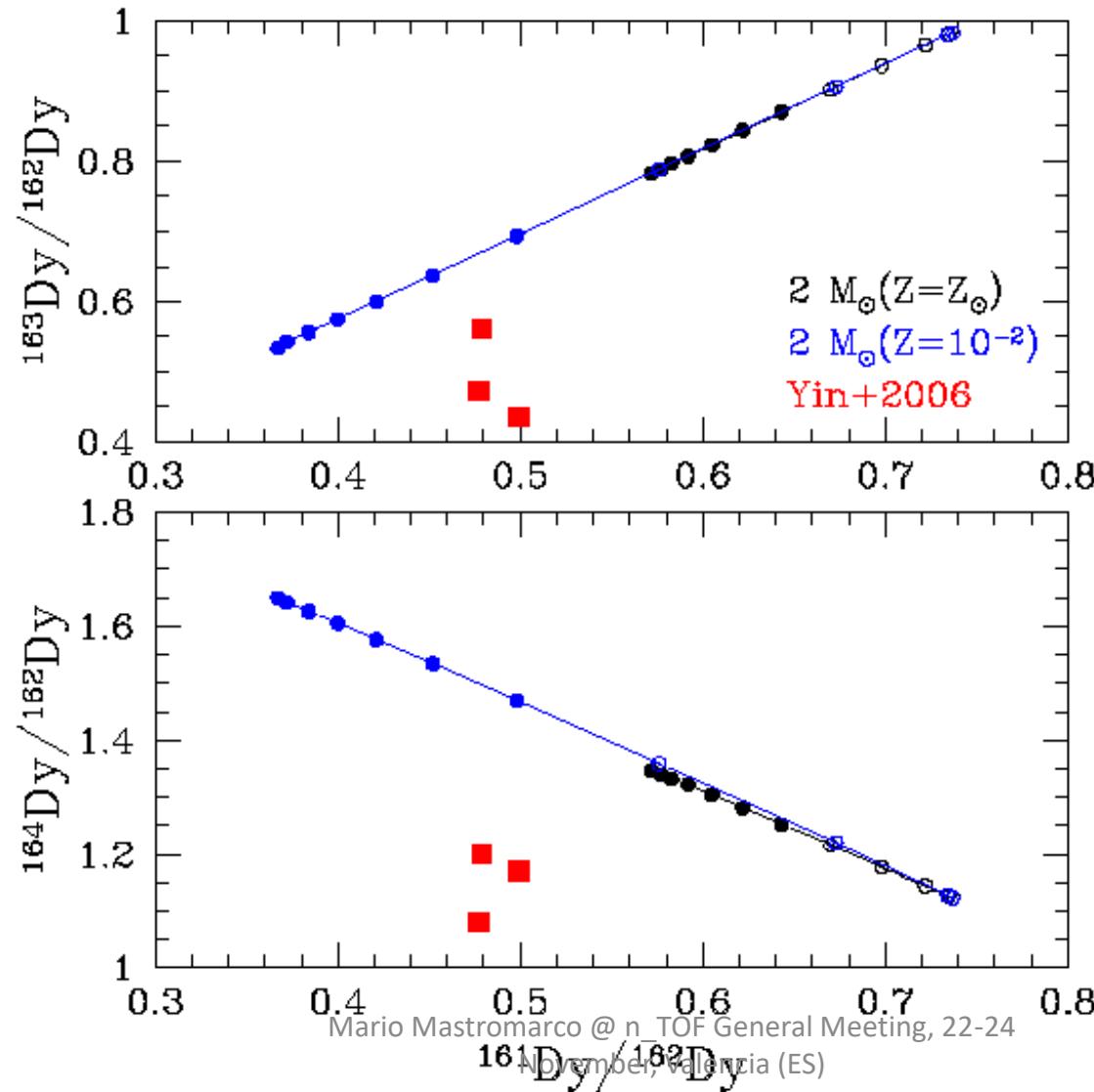
The higher LET (compared to Lu-177) can be effective in reducing the survival probability of tumors cells.

Motivations

...and influences the abundance of Dy in stars!!!

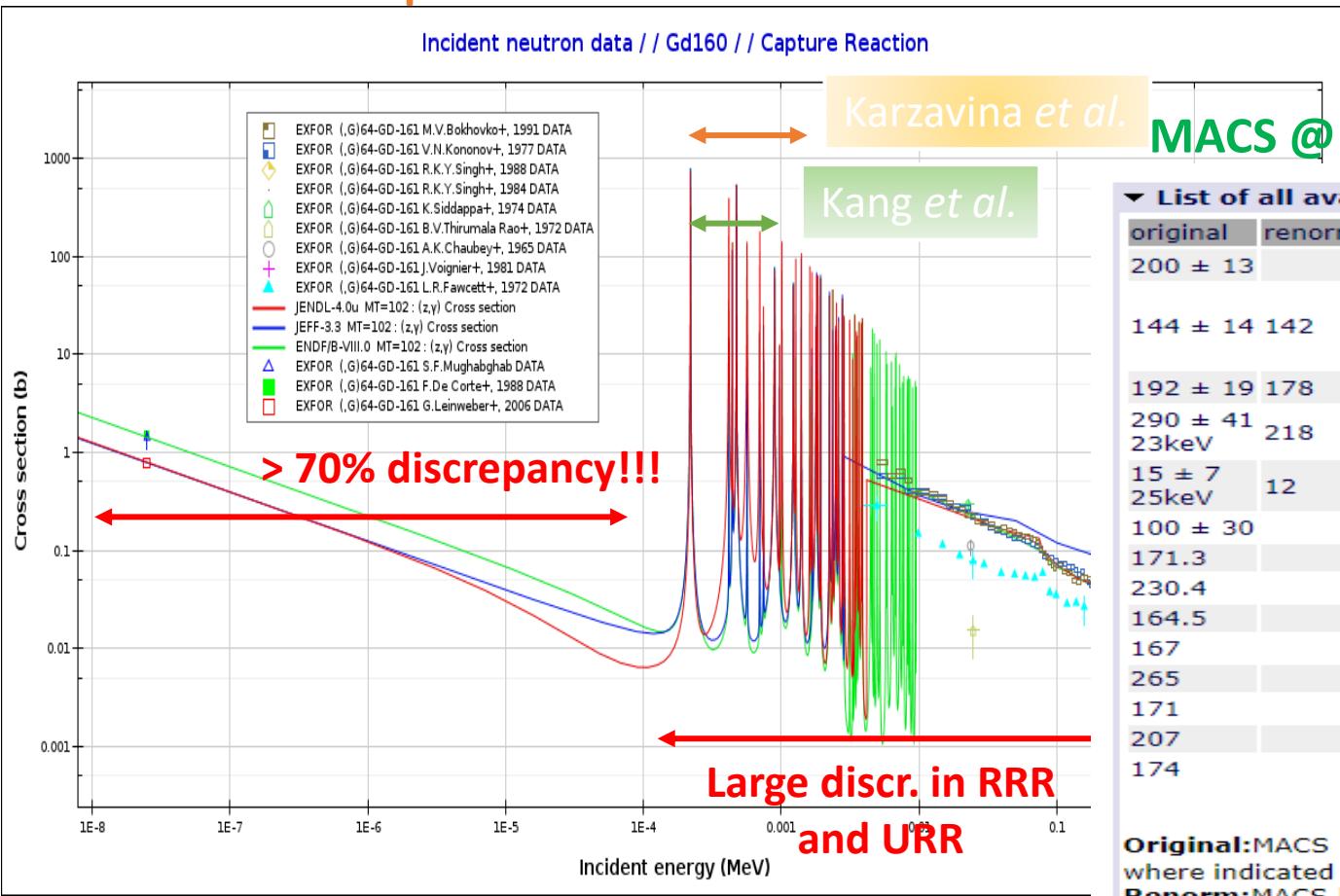
Dy 154 $3.0 \cdot 10^6$ a $\alpha 2.87$	Dy 155 10.0 h ϵ $\beta^+ 0.9; 1.1\dots$ $\gamma 227\dots$	Dy 156 0.056 $\sigma 33$ $\sigma_{n,\alpha} < 0.009$	Dy 157 8.1 h ϵ $\gamma 326\dots$	Dy 158 0.095 $\sigma 33$ $\sigma_{n,\alpha} < 0.006$	Dy 159 144.4 d ϵ $\gamma 58; e^-$ $\sigma 8000$	Dy 160 2.329 $\sigma 60$ $\sigma_{n,\alpha} < 0.0003$	Dy 161 18.889 $\sigma 600$ $\sigma_{n,\alpha} < 1E-6$	Dy 162 25.475 $\sigma 170$	Dy 163 24.896 $\sigma 120$ $\sigma_{n,\alpha} < 2E-5$	Dy 164 28.260 $\sigma 1610 + 1040$	Dy 165 1.3 m $\epsilon 108; e^-$ $\beta^- 0.9;$ $1.3\dots$ $\gamma 95;\dots$ $\gamma 515;\dots$ $\sigma 2000$ $\sigma 3500$
Tb 153 2.34 d ϵ β^+ $\gamma 212; 170;$ $110; 102; 83\dots$	Tb 154 23 h ϵ $\gamma 248;$ $347; 123;$ $1420; 248;$ $123; 540\dots$	Tb 155 5.32 d ϵ $\gamma 87; 105;$ $180; 262\dots$	Tb 156 24 h? ϵ $\gamma 88;$ $540;$ e^- $\beta^?$	Tb 157 99 a ϵ $\gamma (54)$	Tb 158 10.5 s ϵ $\gamma 534;$ $199;$ 1222	Tb 159 100 ϵ $\gamma (110)$	Tb 160 72.3 d $\beta^- 0.6; 1.7\dots$ $\gamma 879; 299;$ $966\dots$ $\sigma 570$	Tb 161 6.30 d $\beta^- 0.5; 0.6\dots$ $\gamma 26; 49; 75\dots$ e^-	Tb 162 7.76 m $\beta^- 1.4; 2.4\dots$ $\gamma 260; 808;$ $888\dots$	Tb 163 19.5 m $\beta^- 0.8; 1.3\dots$ $\gamma 351; 390;$ $494\dots$	Tb 164 3.0 m $\beta^- 1.7; 3.0\dots$ $\gamma 169; 755;$ $215; 688; 611\dots$
Gd 152 0.20 $1.1 \cdot 10^{14}$ a $\alpha 2.14; \sigma 700$ $\sigma_{n,\alpha} < 0.007$	Gd 153 239.47 d ϵ $\gamma 97; 103; 70\dots$	Gd 154 2.18 $\sigma 60$	Gd 155 14.80 $\sigma 61000$ $\sigma_{n,\alpha} 0.00008$	Gd 156 20.47 $\sigma \sim 2.0$	Gd 157 15.65 $\sigma 254000$ $\sigma_{n,\alpha} < 0.05$	Gd 158 24.84 $\sigma 2.3$	Gd 159 18.48 h $\beta^- 1.0\dots$ $\gamma 364; 58\dots$	Gd 160 21.86 $\beta^- 0.7\dots$ $\gamma 361; 315;$ $102\dots$ $\sigma 1.5$	Gd 161 3.66 m $\beta^- 1.7\dots$ $\gamma 361; 315;$ $102\dots$ $\sigma 20000$	Gd 162 8.2 m $\beta^- 1.0\dots$ $\gamma 442; 403\dots$	Gd 163 68 s β^- $\gamma 288; 214;$ $1562; 1685\dots$
Eu 151 47.81 $\sigma 4 + 3150 +$ 6000	Eu 152 96 m $\beta^- 1.9;$ $1.8\dots$ $\gamma 541;$ $953;$ $\beta^- 0.7; 1.5$	Eu 153 52.19 $\sigma 300$ $\sigma_{n,\alpha} 1E-6$	Eu 154 46.0 m $\beta^- 0.6; 1.8\dots$ $\gamma 123;$ $1274; 723;$ $1005\dots$ $\sigma 1500$	Eu 155 8.8 a $\beta^- 0.17; 0.25\dots$ $\gamma 87; 105\dots$	Eu 156 4.761 a $\beta^- 0.5; 2.4\dots$ $\gamma 812; 89;$ $1231\dots$	Eu 157 15.18 h $\beta^- 0.13\dots$ $\gamma 64; 411;$ $371; 619\dots$	Eu 158 46 m $\beta^- 2.4; 3.4\dots$ $\gamma 944; 977; 80;$ $898\dots$	Eu 159 18.1 m $\beta^- 2.6\dots$ $\gamma 68; 71; 79;$ $96; 103\dots$	Eu 160 42 s $\beta^- 4.1\dots$ $\gamma 173; 515;$ $412; 822\dots$	Eu 161 26 s β^- $\gamma 72-314$	Eu 162 10.6 s β^- $\gamma 71; 165$
Sm 150 7.38 $\sigma 102$	Sm 151 93 a $\beta^- 0.1\dots$ $\gamma (22\dots); e^-$ $\sigma 15200$	Sm 152 26.75 $\sigma 206$	Sm 153 46.27 h $\beta^- 0.7; 0.8\dots$ $\gamma 103; 70\dots$ $\sigma 420$	Sm 154 22.75 $\sigma 7.5$	Sm 155 22.4 m $\beta^- 1.5\dots$ $\gamma 104; 246;$ $141\dots$	Sm 156 9.4 h $\beta^- 0.7\dots$ $\gamma 204; 88; 166\dots$	Sm 157 8.11 m $\beta^- 2.4\dots$ $\gamma 198; 196;$ $394\dots$	Sm 158 5.51 m β^- $\gamma 189; 364;$ $325\dots$	Sm 159 11.4 s β^- $\gamma 190; 862;$ $254; 797;$ $179\dots$	Sm 160 9.6 s β^- $\gamma 110\dots$	Sm 161 4.8 s β^- $\gamma 264$

Motivations: Model Calculations against Observations



Motivations: State of the Art

Exp. Data and Main Evaluations



MACS @ kT=30 keV

source: <https://exp-astro.de/kadonis1.0/>

▼ List of all available values					Ref
original	renorm.	year	type	Comment	
200 ± 13		1992	c	VdG, TOF, ${}^6\text{Li}$, ${}^{10}\text{B}+\text{Au}$:B-V	BKP92
144 ± 14	142	1984	c	VdG, Act., 1/v(kT), Au:657mb(25keV) ${}^{160}\text{Gd}(n,\gamma){}^{161}\text{Tb}$ beta decay of	BKY84
192 ± 19	178	1978	b	VdG, TOF, ${}^{10}\text{B}$:Mag75, Au:628mb(kT=30keV)	KYP78
290 ± 41	218	1973	c	Sb-Be, Act., 1/v(E), ${}^{127}\text{I}$:836mb(23keV)	SSR73
15 ± 7	12	1972	c	Sb-Be, Act., 1/v(E), ${}^{127}\text{I}$:832mb(25keV)	TRK72
25keV					
100 ± 30		1971	e		AGM71
171.3		2006	e		endfb7
230.4		2004	e		jeff31
164.5		2002	e		jendl33
167		2000	t		RaT99
265		1981	t		Har81
171		1976	t		HWF76
207		2002	t	MOST 2002	Gor02
174		2005	t	MOST 2005	Gor05

> 30% discrepancy

Original: MACS [$\langle \sigma v \rangle / v_T$] (mb) for $kT=30$ keV, based on the published cross sections except where indicated otherwise.

Renorm: MACS [$\langle \sigma v \rangle / v_T$] (mb) for $kT=30$ keV for which the reference or standard cross section was meanwhile improved.

Type: The letters and numbers in the column labelled 'type' give information on how the cross section has been obtained:

a Directly quoted from the reference itself

b Calculated from smooth cross sections with model fit: $\ln(\sigma) = a + a_1 \ln(E) + a_2 \ln^2(E)$

e Evaluated value taken directly from the reference

t Theoretical value

Motivations:

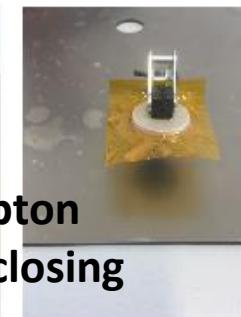
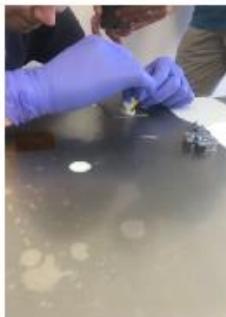
Unsatisfactory situation triggered the n_TOF Collaboration to perform a new measurement of the $^{160}\text{Gd}(n, \gamma)$ reaction from thermal up to 300 keV at n_TOF facility (CERN)

Samples: Gd sample and Dummy

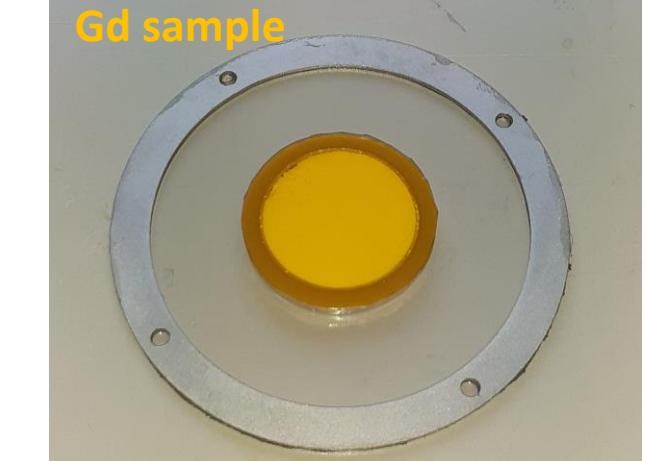
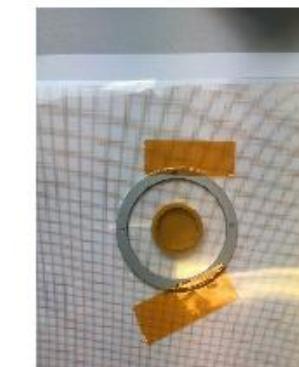
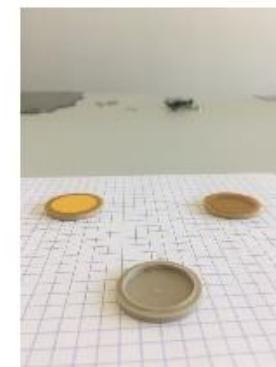
(Sample available in the form of powdered Gd oxide!!!!)

Step by step samples preparation...

START



END



Samples: Gd sample and Gd_2O_3 Composition

	mass [mg]
Gd oxide container total mass	1459
Gd oxide container after oxide removal	1141
Gd_2O_3	318
PEEK capsule	795
kapton	17
glue	114
dummy (capsule + glue + kapton)	926
Gd_2O_3	317
Gd oxide sample (oxide + PEEK)	1243
Gd mass (oxide is Gd_2O_3)	276
Gd-160 mass (98.1 % enrichment)	270

In the past the $^{160}Gd(n, \gamma)$ measurement was hampered by the natural isotopic presence of ^{155}Gd and ^{157}Gd

Samples: Gd sample and Gd_2O_3 Composition

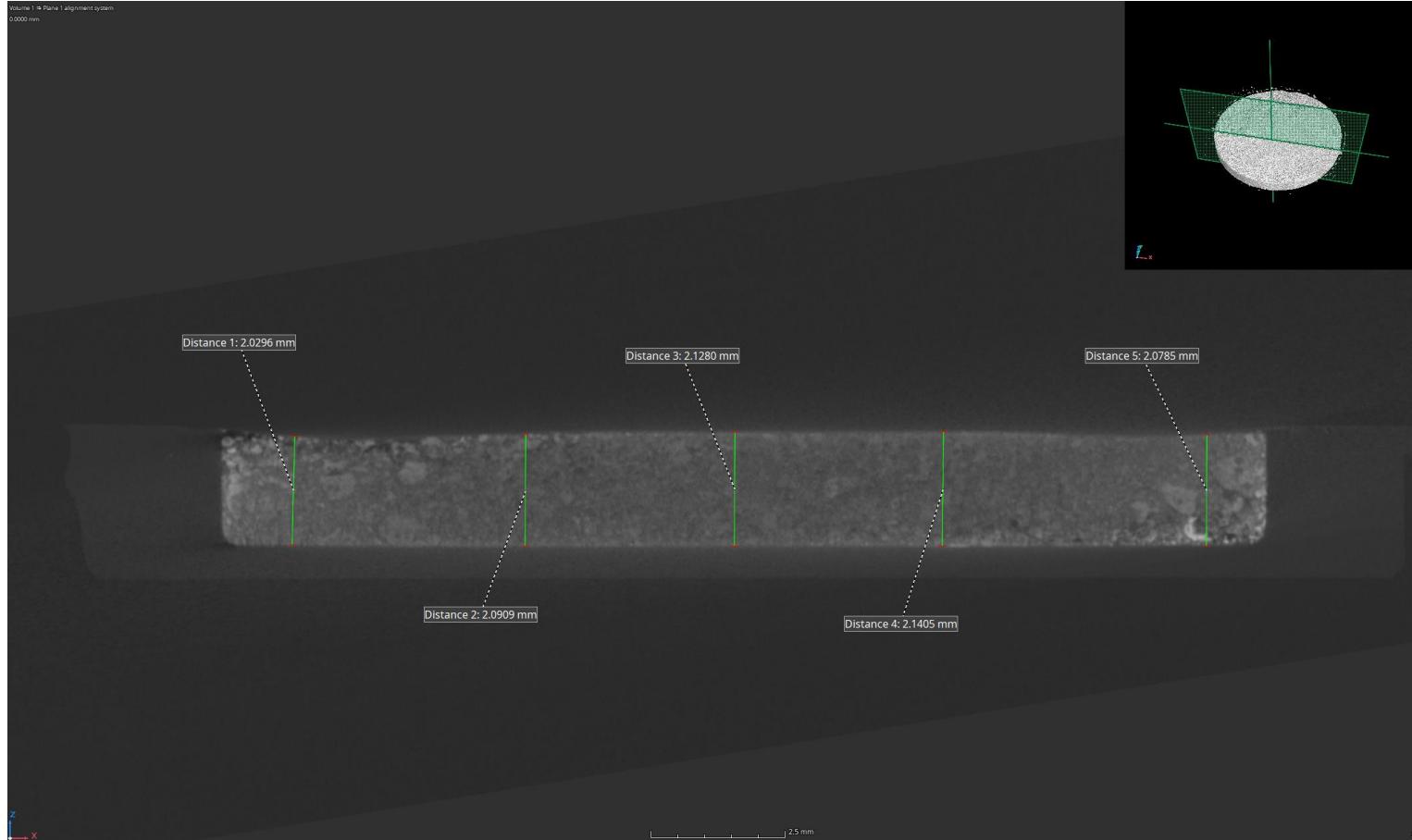
	mass [mg]
Gd oxide container total mass	1459
Gd oxide container after oxide removal	1141
Gd_2O_3	318
PEEK capsule	795
kapton	17
glue	114
dummy (capsule + glue + kapton)	926
Gd_2O_3	317
Gd oxide sample (oxide + PEEK)	1243
Gd mass (oxide is Gd_2O_3)	276
Gd-160 mass (98.1 % enrichment)	270

But this time...

Sample irradiated for 55 days at the thermal reactor of ILL: **^{155}Gd and ^{157}Gd burned out!!!**

Gd-160 enrichment:	
Isotope	[%]
Gd-152	3.80E-05
Gd-153	3.90E-10
Gd-154	0.02
Gd-155	3.30E-05
Gd-156	0.59
Gd-157	4.20E-06
Gd-158	1.29
Gd-160	98.1

Samples: Gd sample, X-ray Spectroscopy



Average thickness $\sim 2.10 \pm 0.01$ mm

Experimental Setup @ EAR1 and EAR2

Liquid scintillation detectors with **deuterated benzene:**
(C₆D₆ & sTED)

- Low neutron sensitivity
- Low γ -ray detection efficiency

EAR1

- Flight Path: **185 m**
- Flux: **10⁶/cm²/Proton Bunch**
- Very High Resolution: **< 10⁻³**

The **total energy detection principle** by combining the detection system with the so-called **Pulse Height Weighting Technique (PHWT)**.

For details see:

- P. Schillebeeckx et al., Nucl. Data Sheets **113**, 3054 (2012)
A. Borella, G. Aerts, F. Gunsing et al., Nucl. Instr. Meth. A **577**, 626 (2007)

Experimental Setup @ EAR1 and EAR2

Liquid scintillation detectors with **deuterated benzene**:
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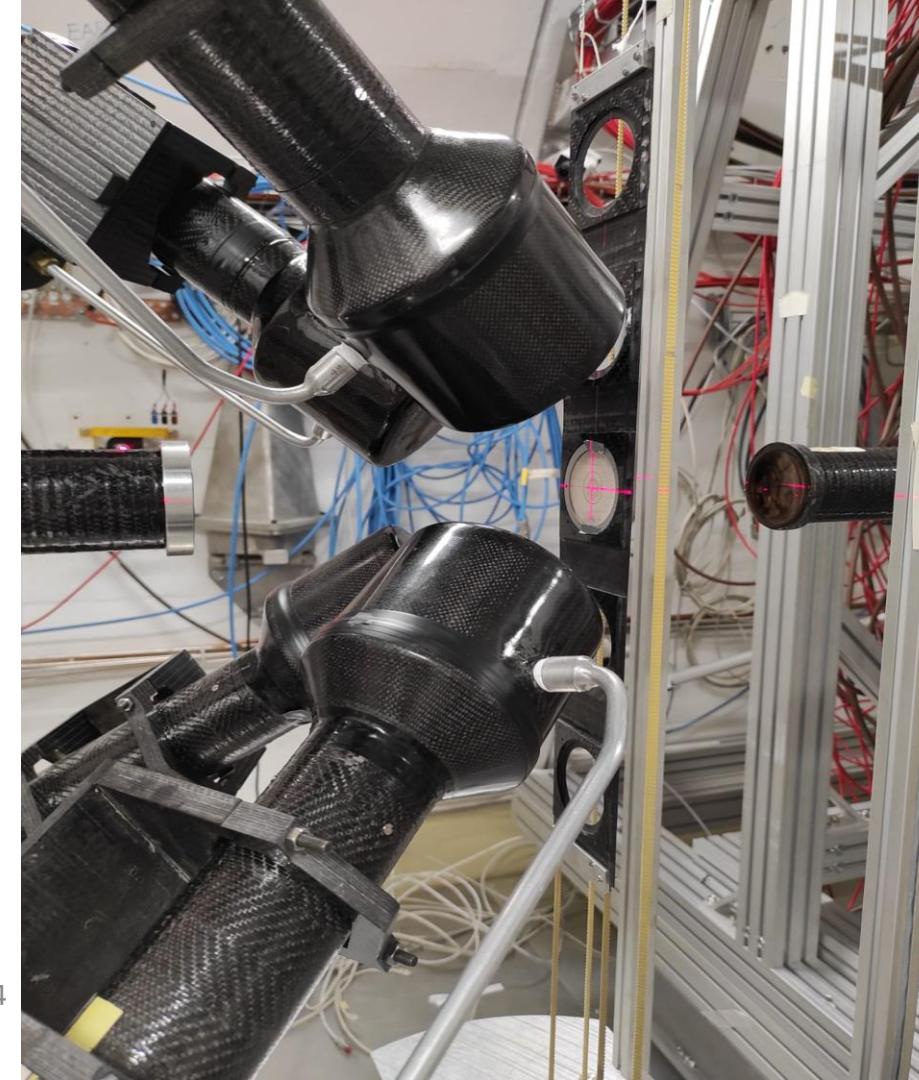
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EAR1: 4 C₆D₆



Experimental Setup @ EAR1 and EAR2

Liquid scintillation detectors with **deuterated benzene**:
(C₆D₆ & sTED)

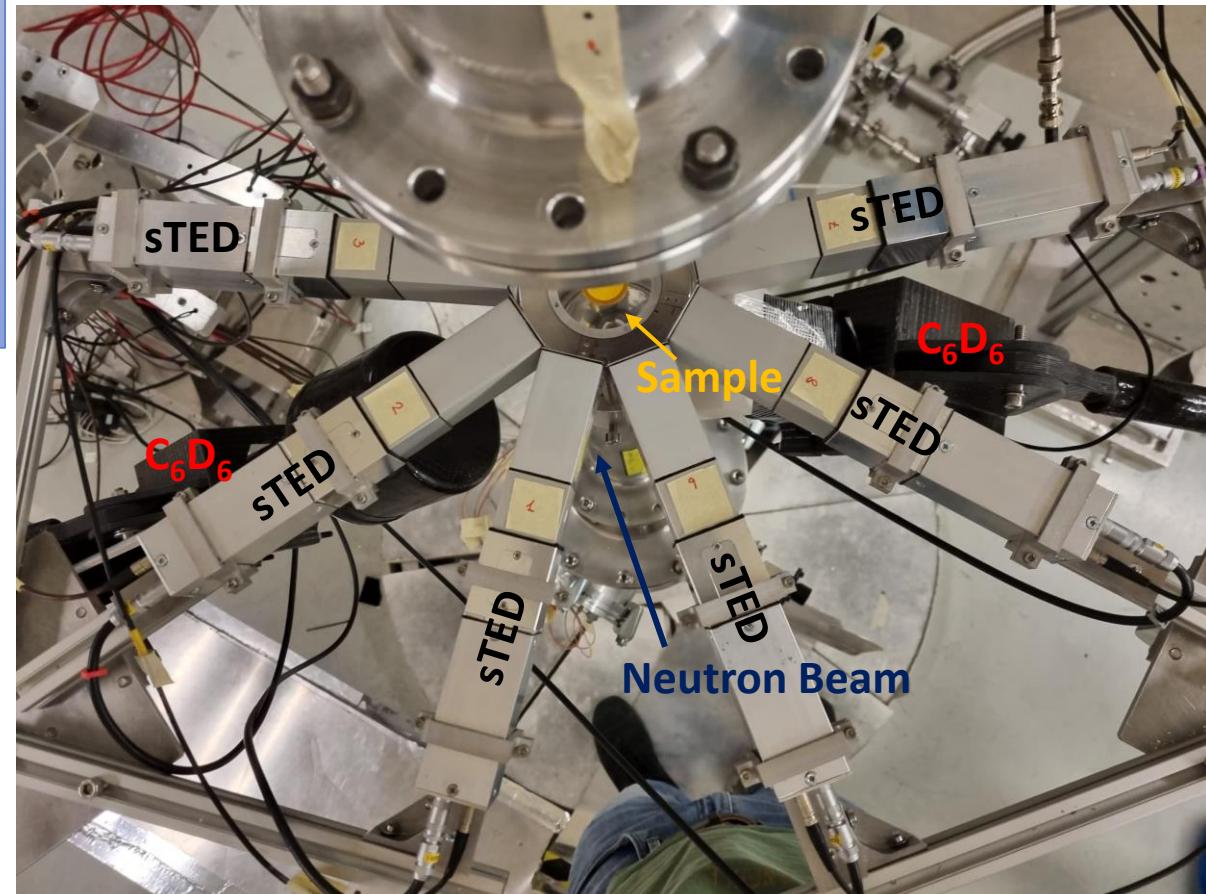
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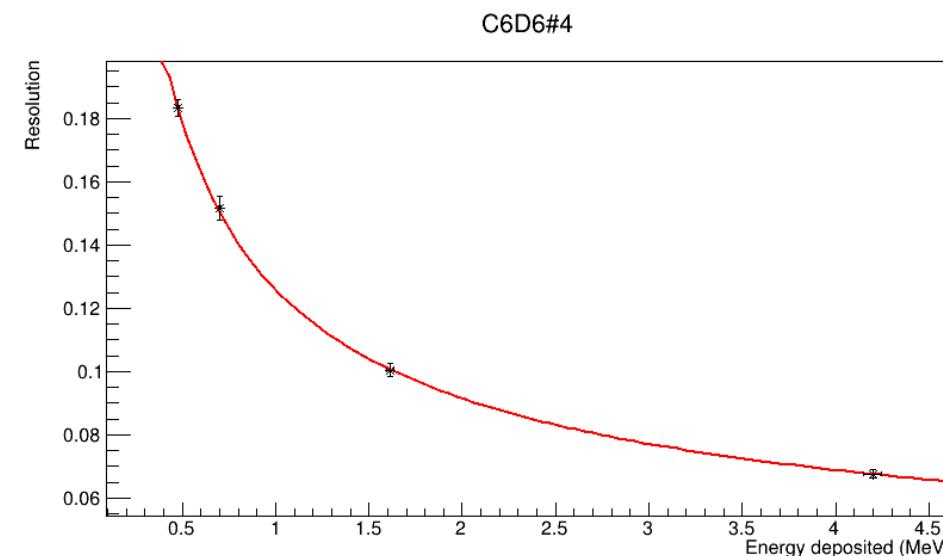
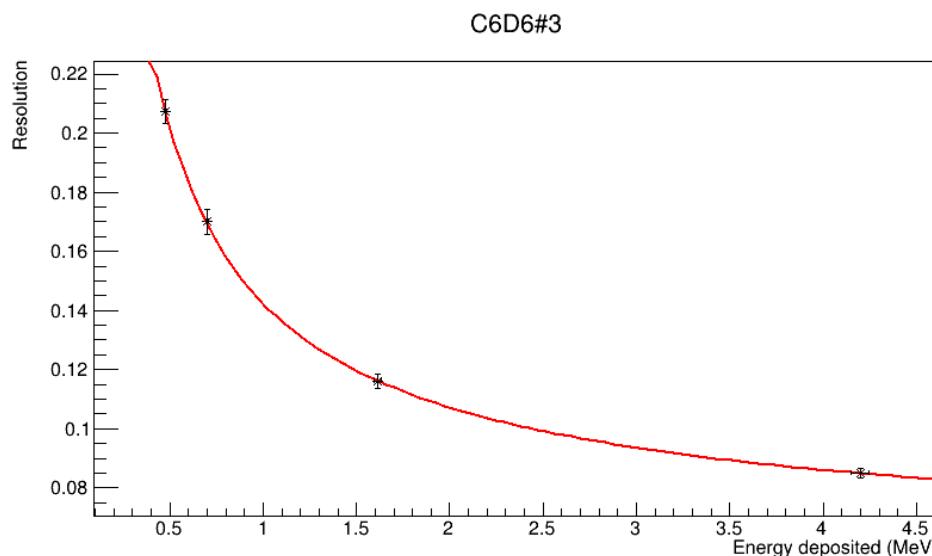
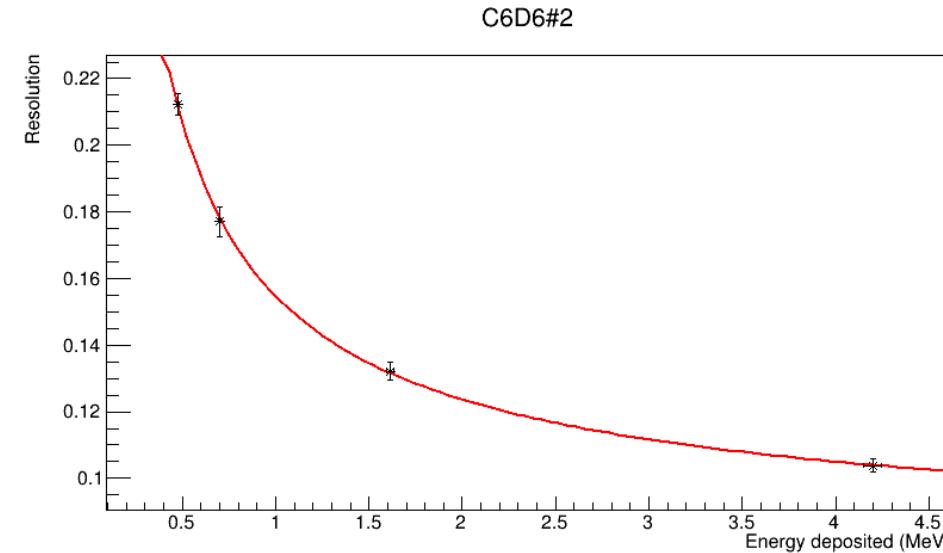
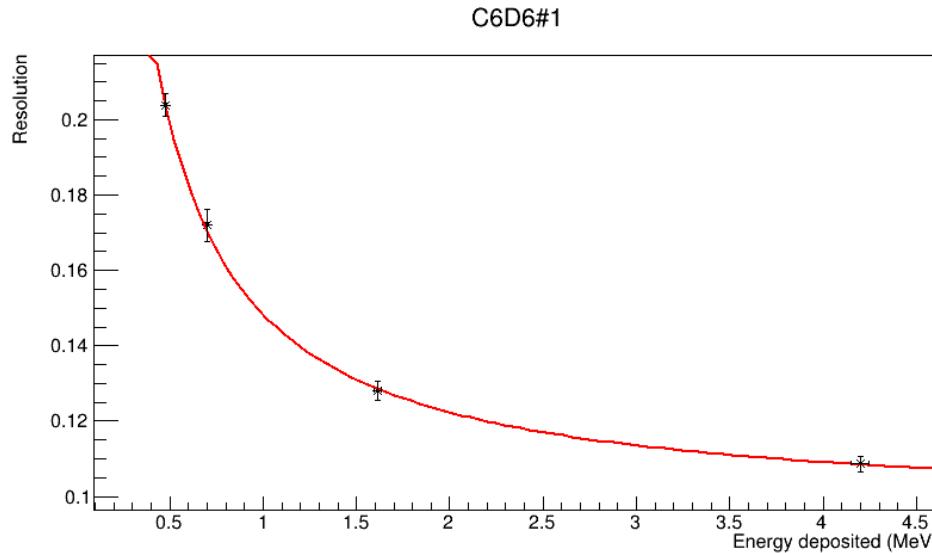
EAR2: 2 C₆D₆ + 9 sTED



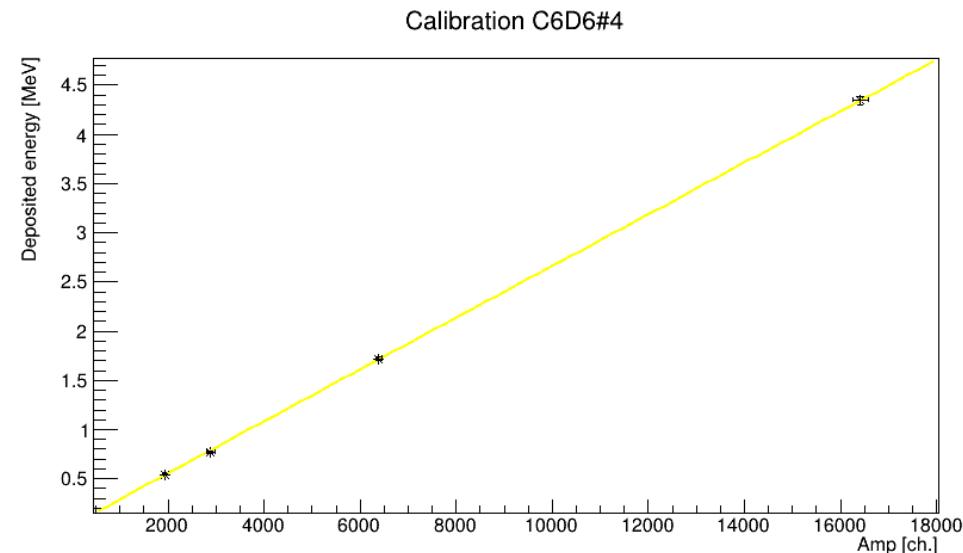
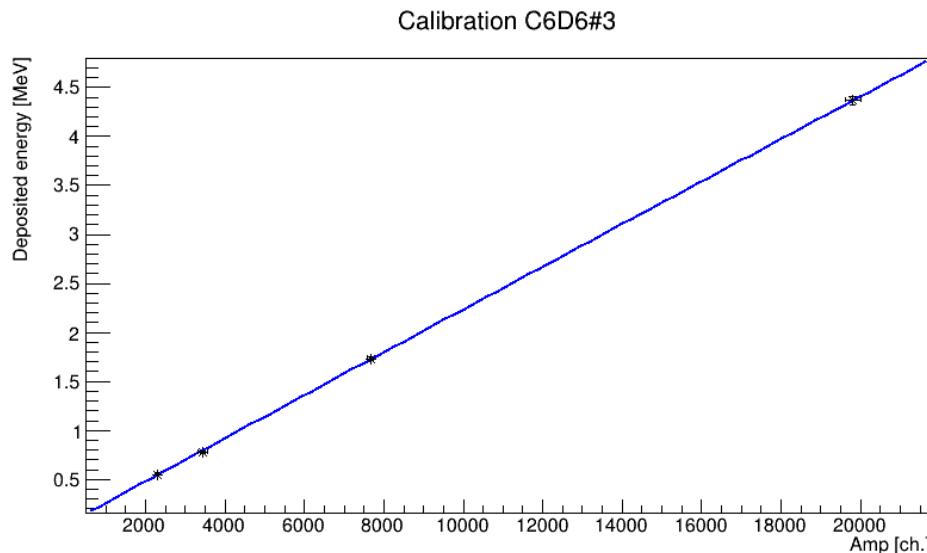
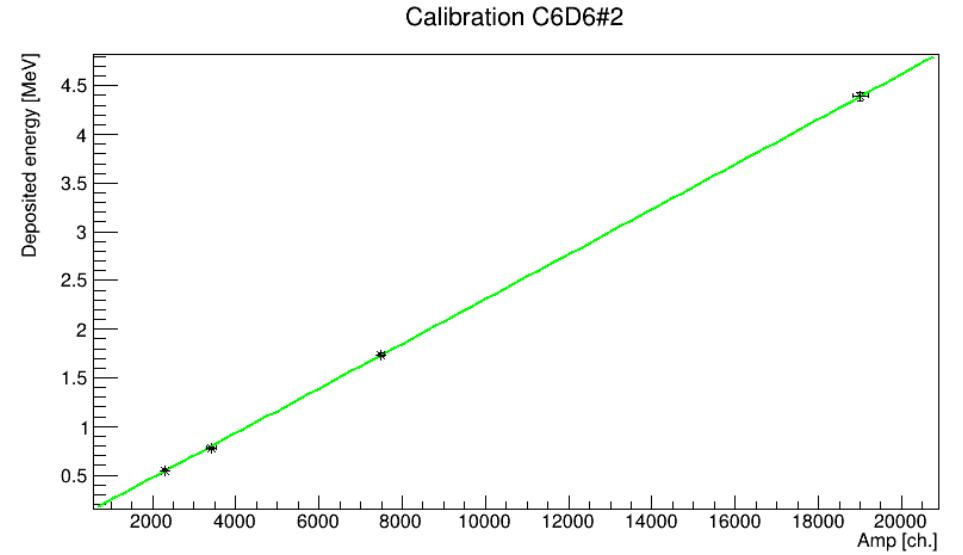
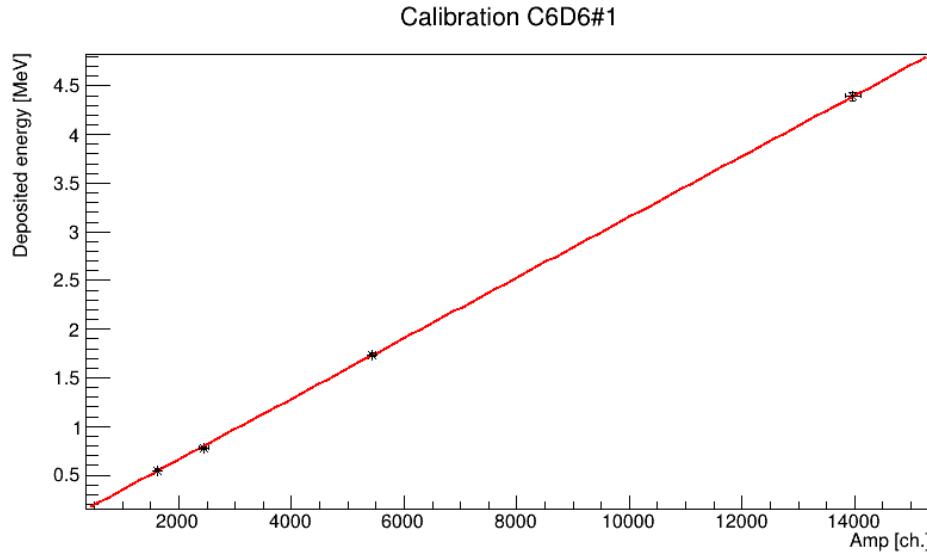
EAR1

(Resolved and Unresolved Resonances Region)

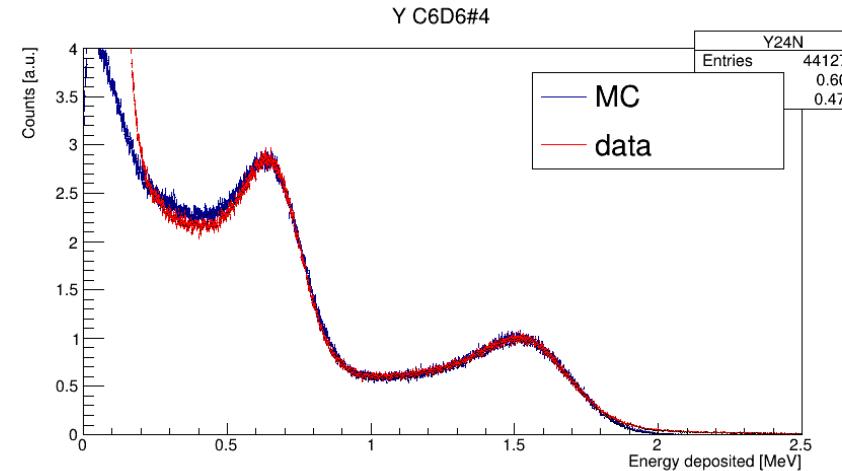
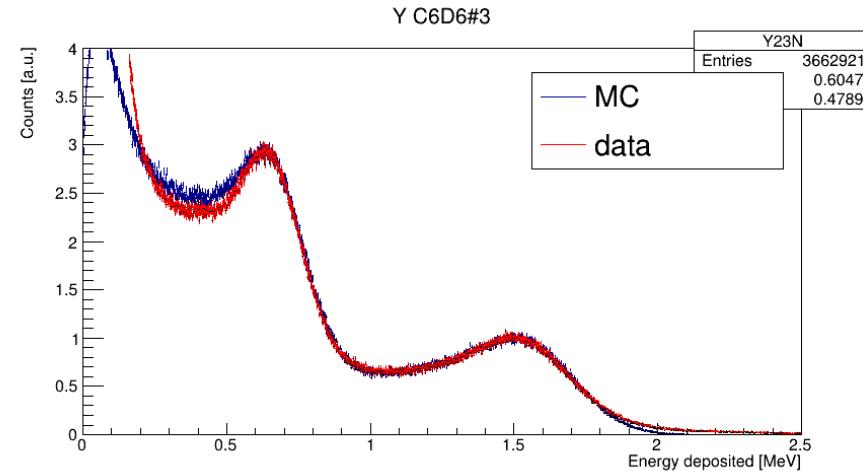
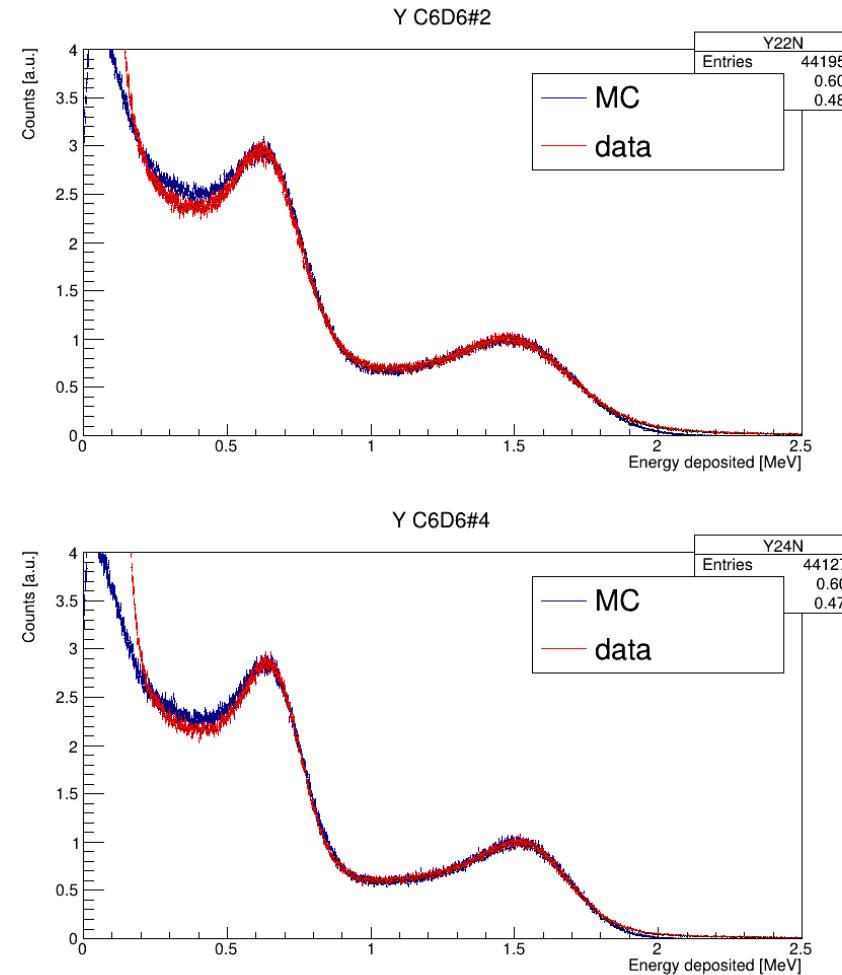
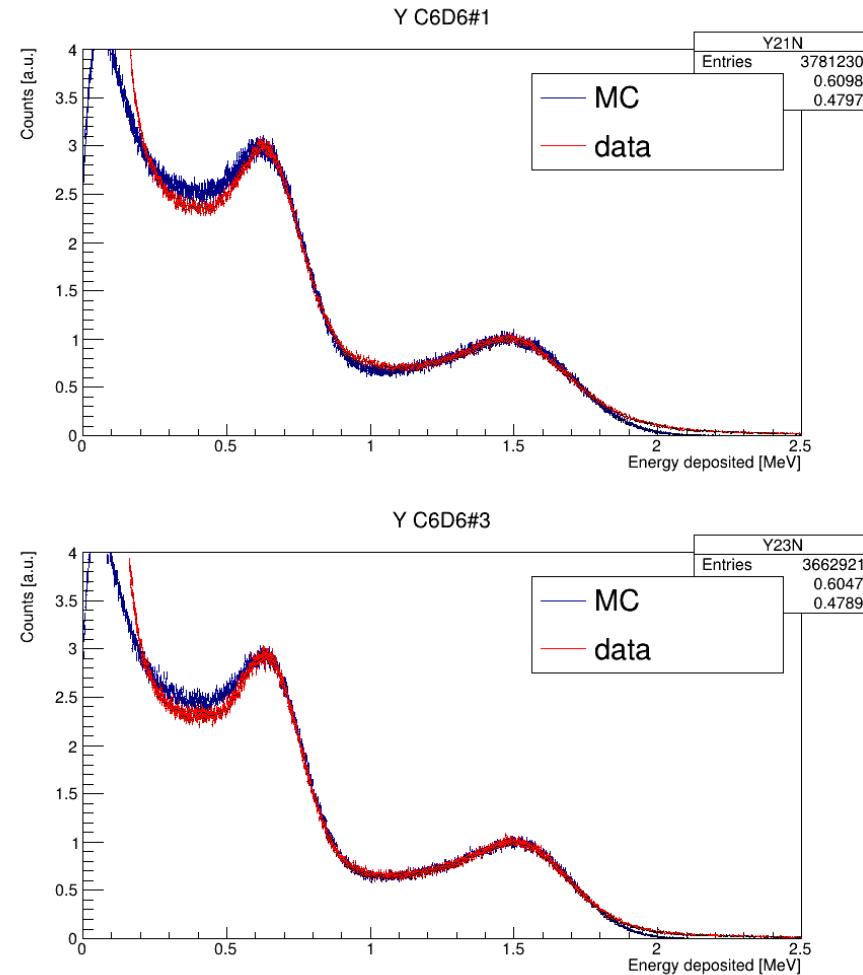
Resolution, calibration (+ MC)



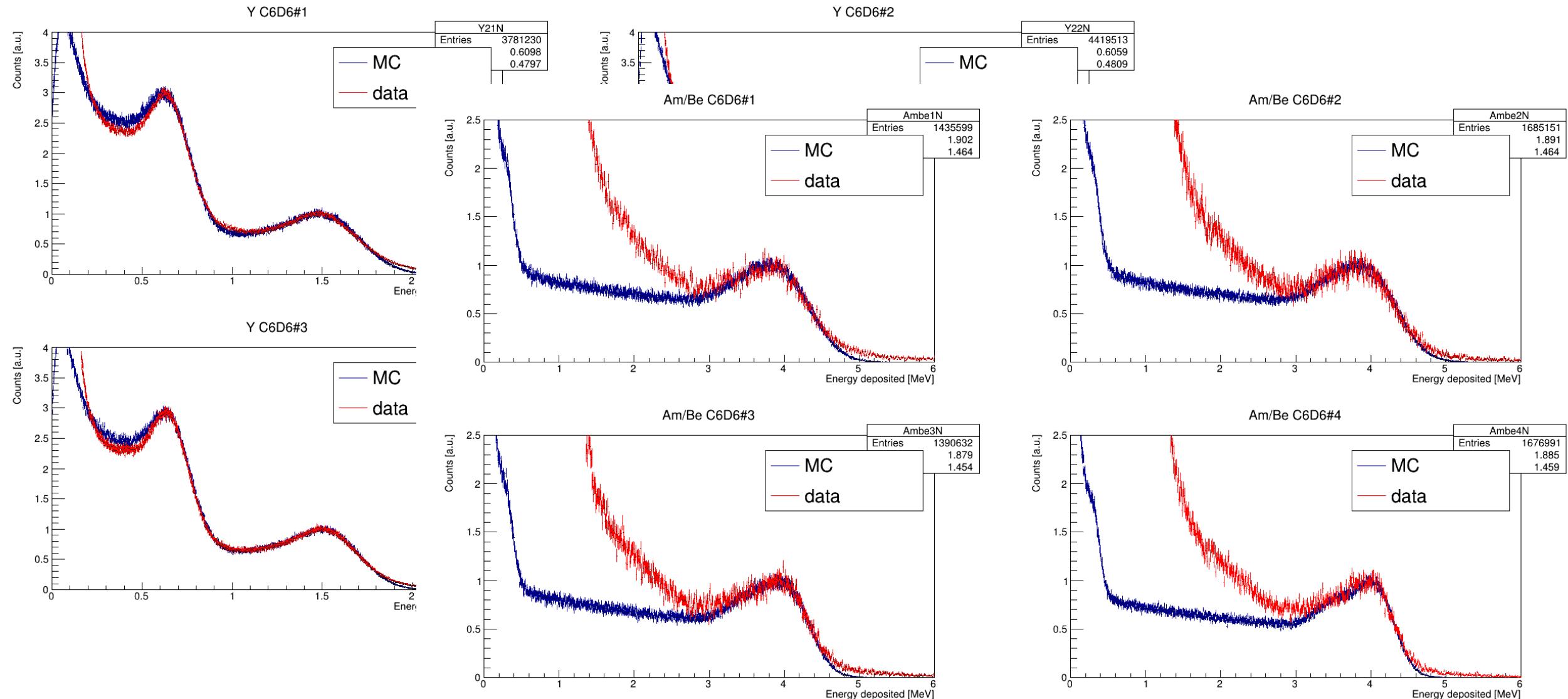
Resolution, calibration (+ MC)



Resolution, calibration (+ MC)

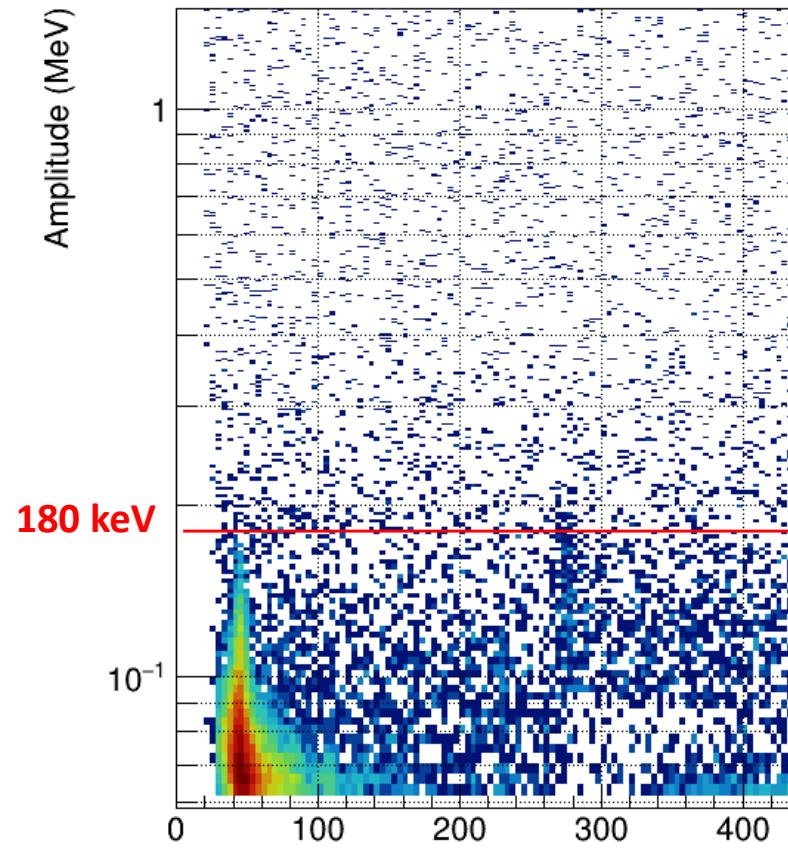


Resolution, calibration (+ MC)

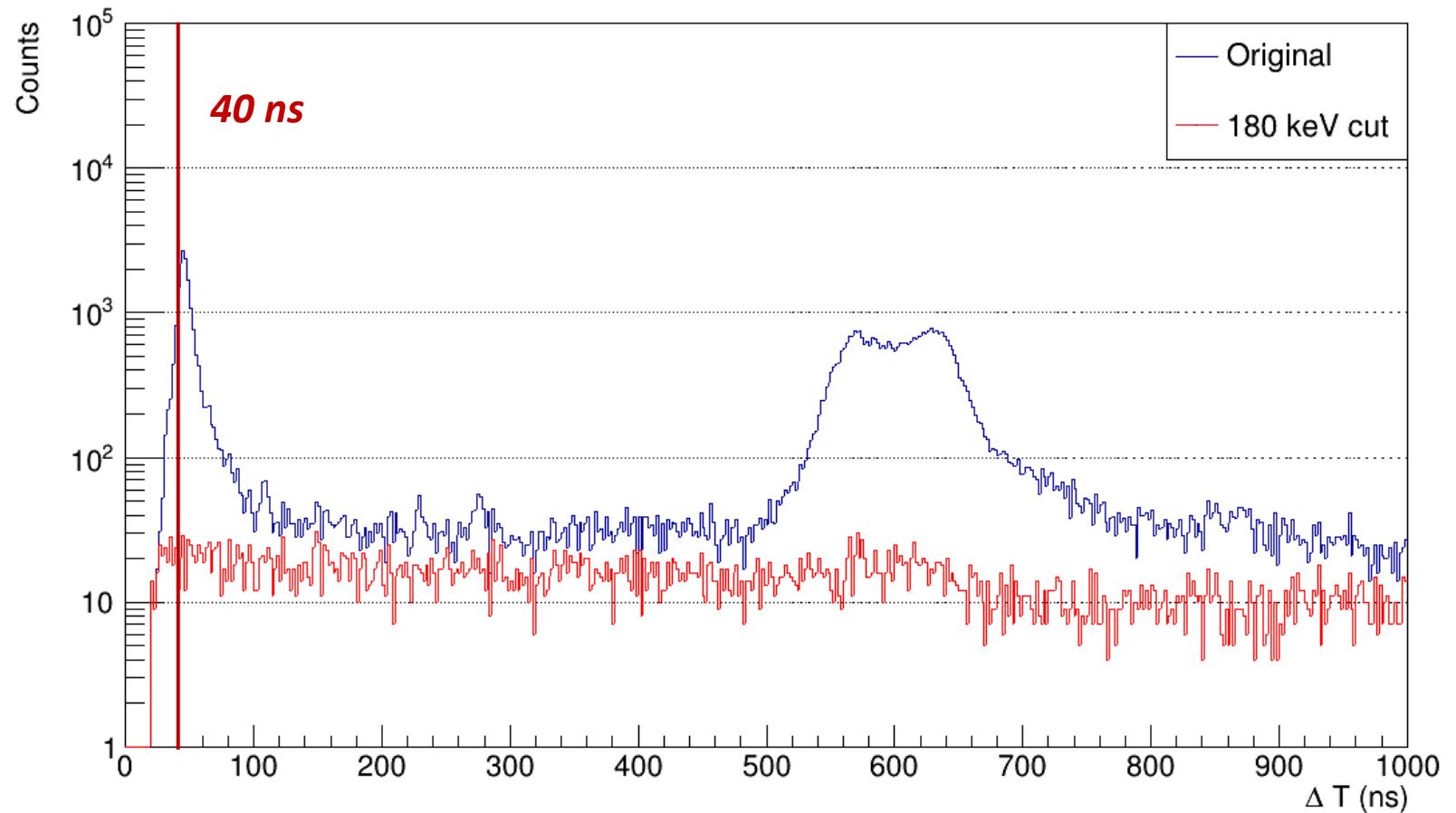


Low Thresholds: after pulse rejection and dead-time

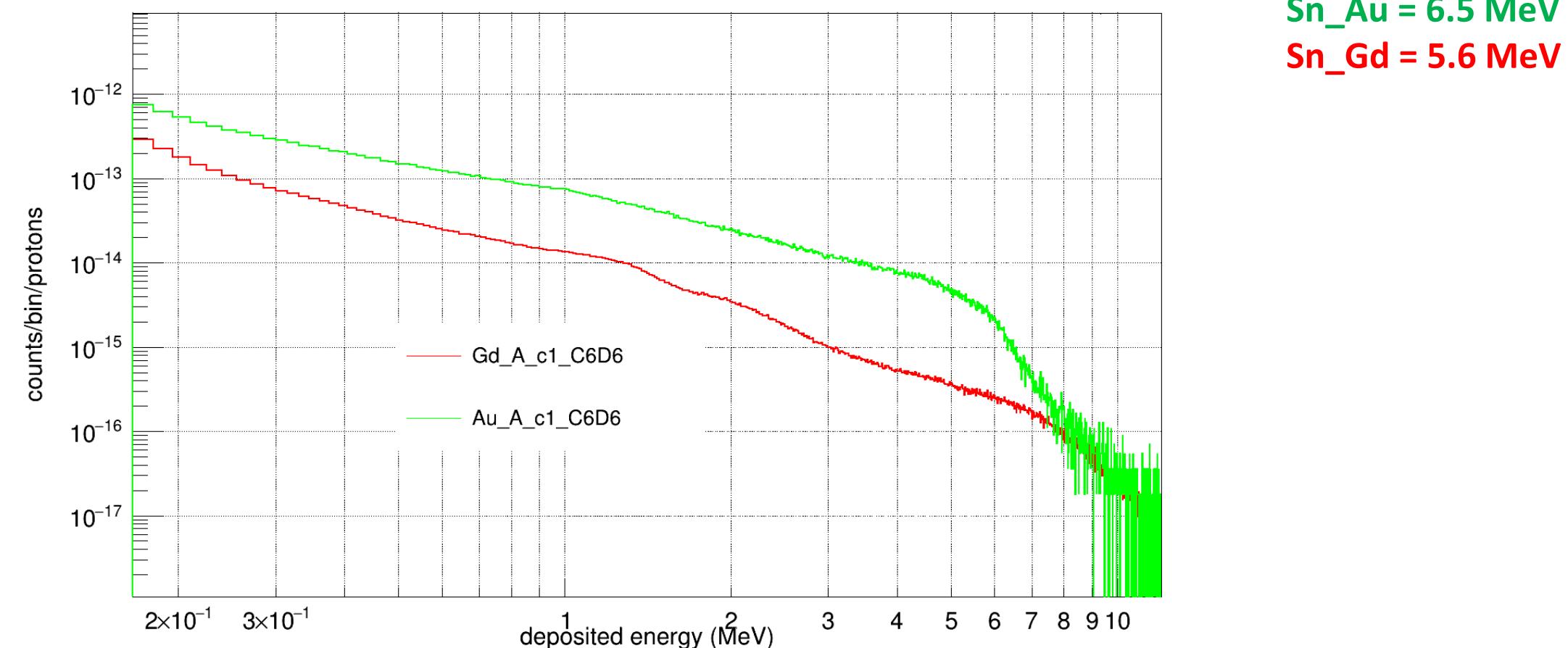
C6D61 2D



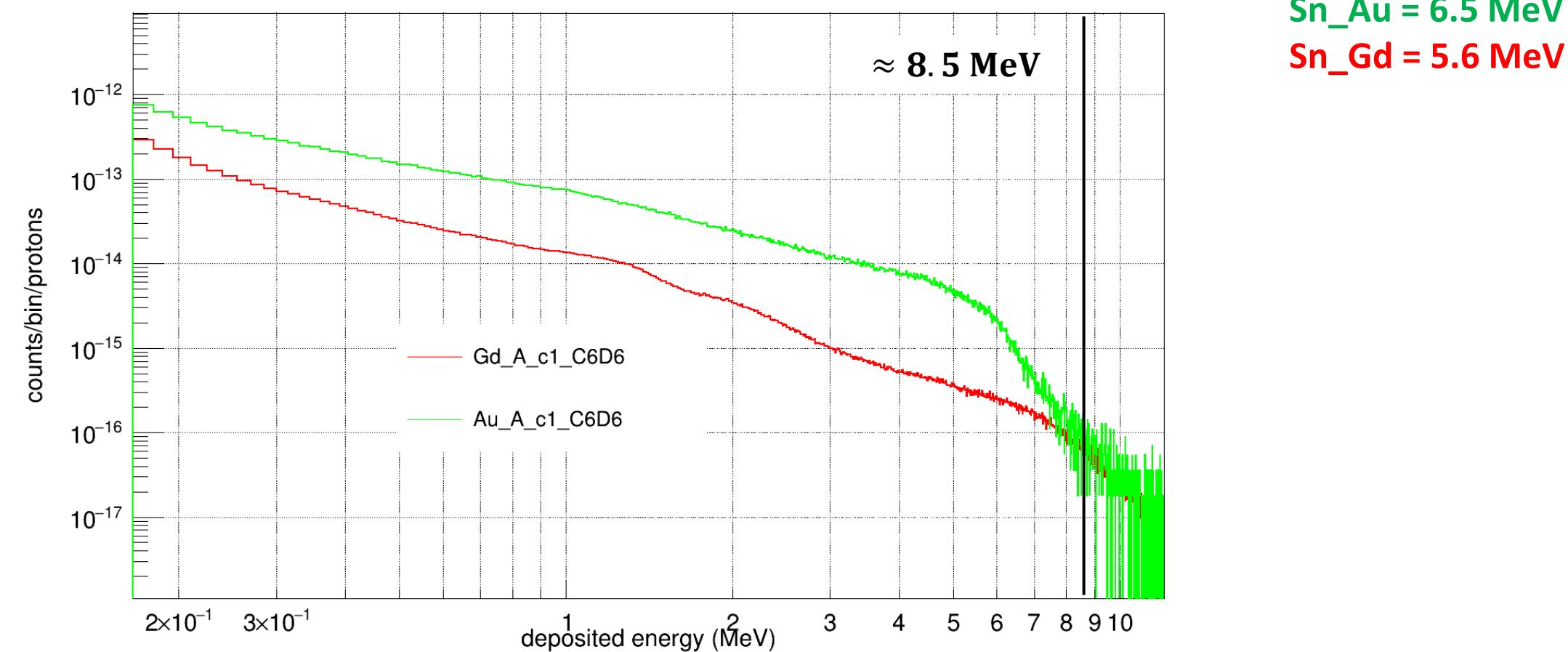
C6D61 1D



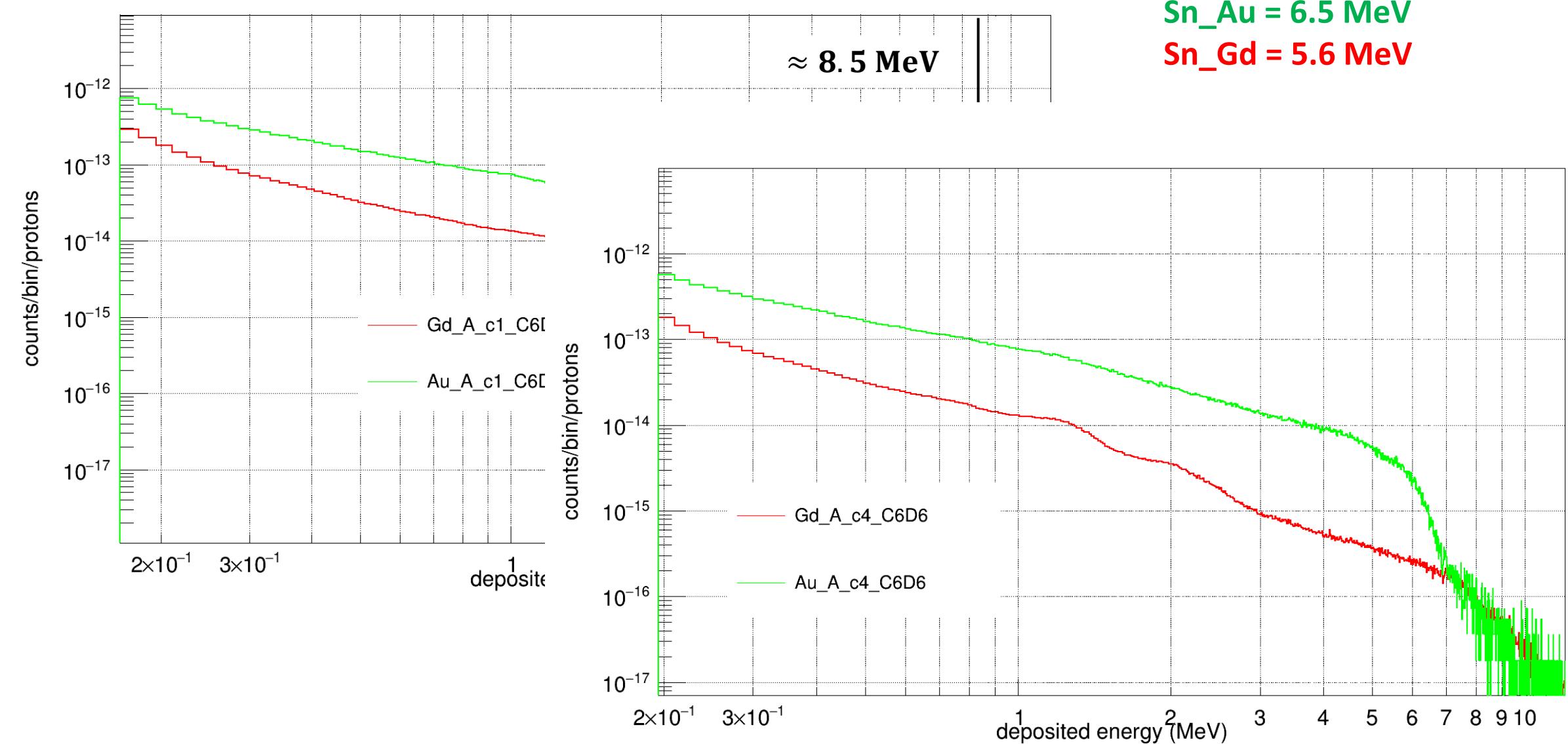
High Thresholds: HE background rejection



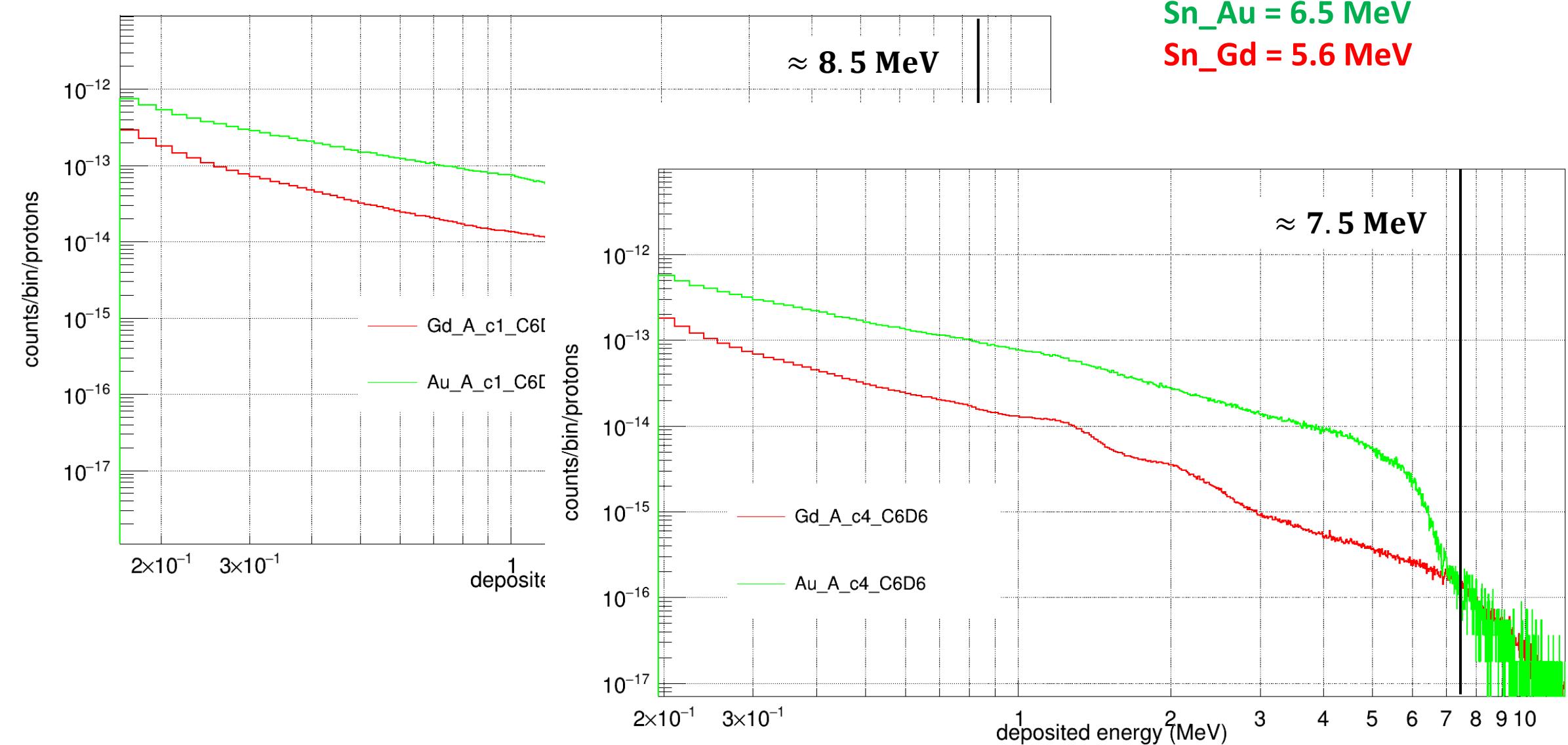
High Thresholds: HE background rejection



High Thresholds: HE background rejection

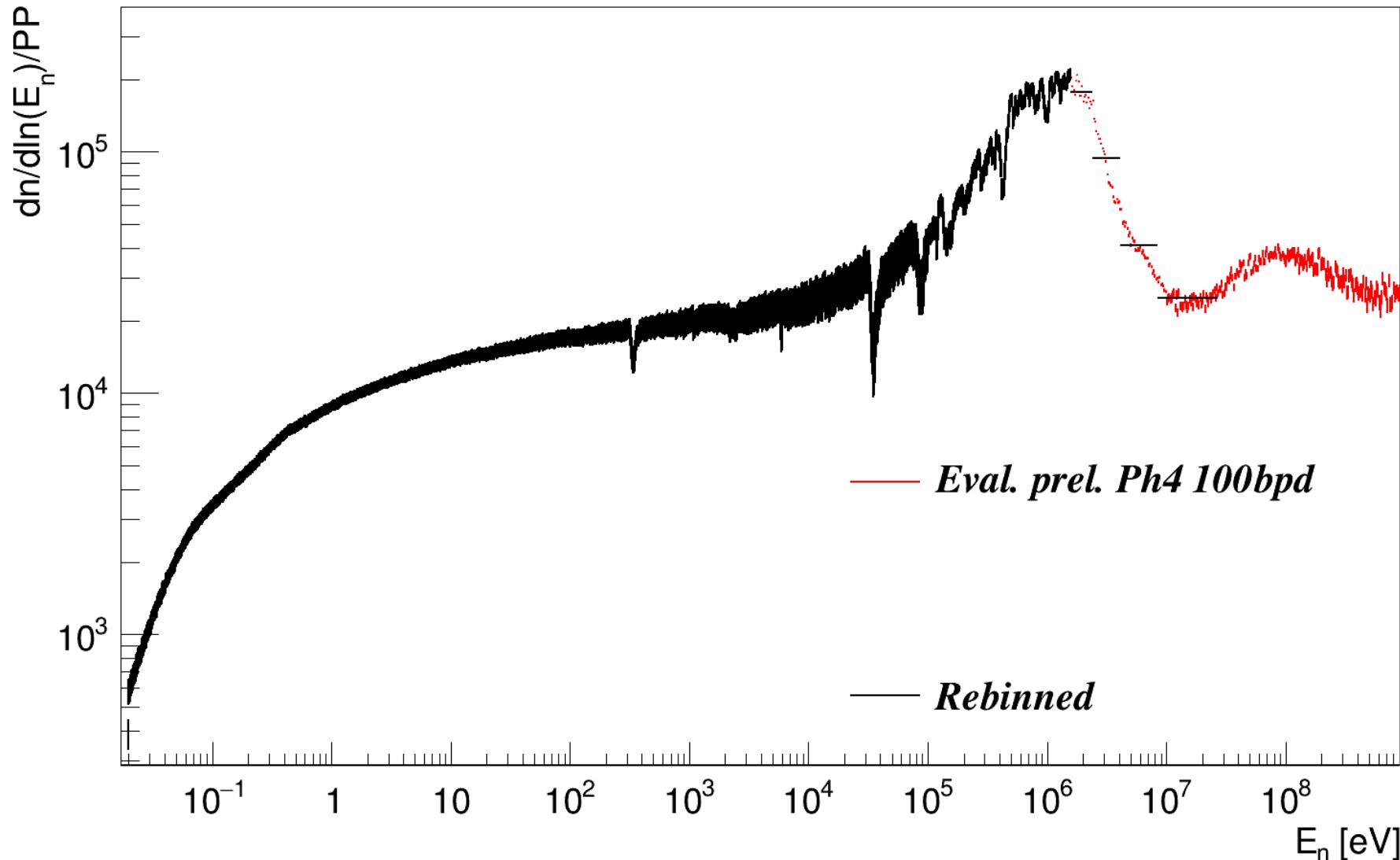


High Thresholds: HE background rejection

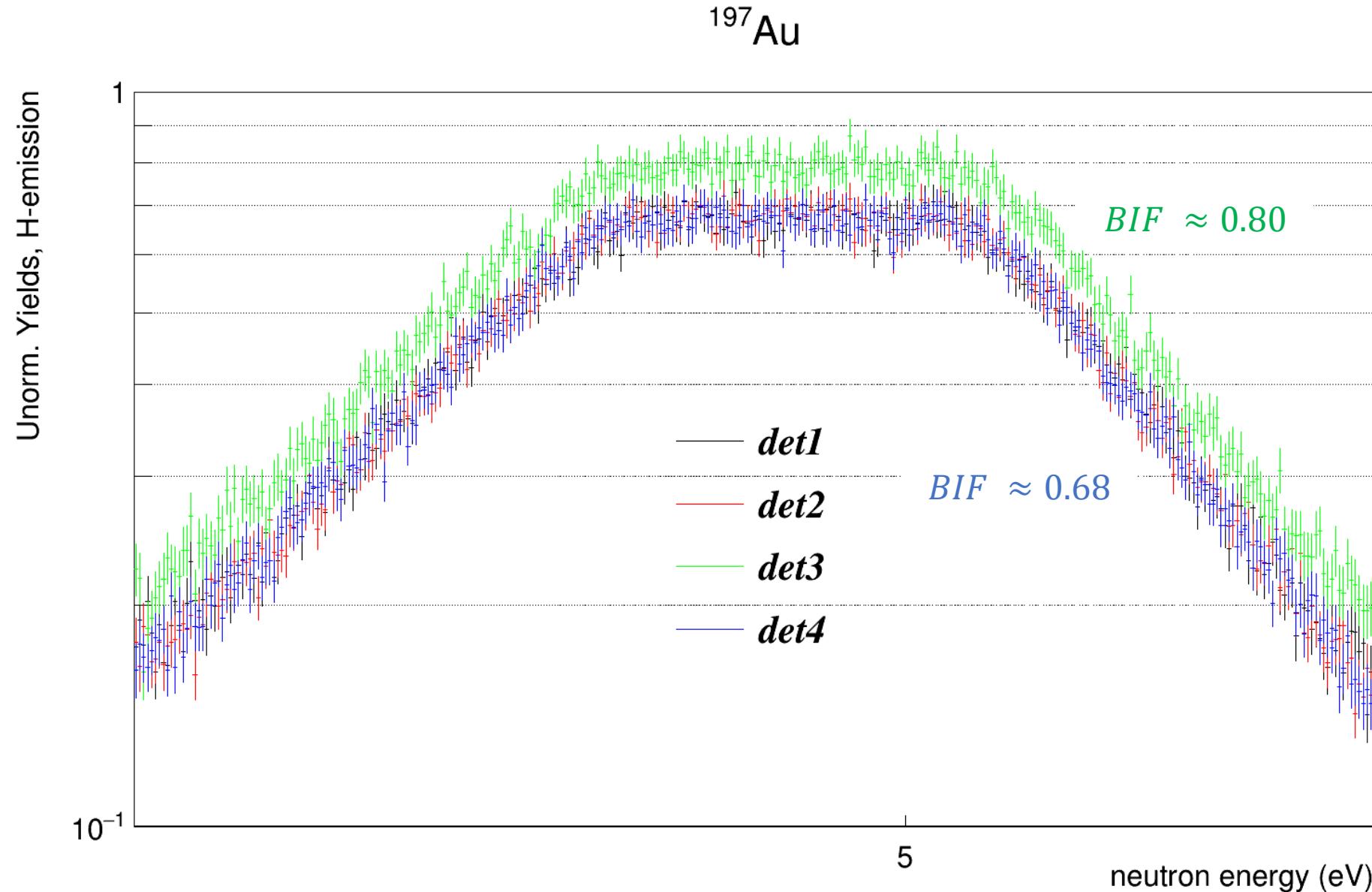


Evaluated Flux

Flux EAR1

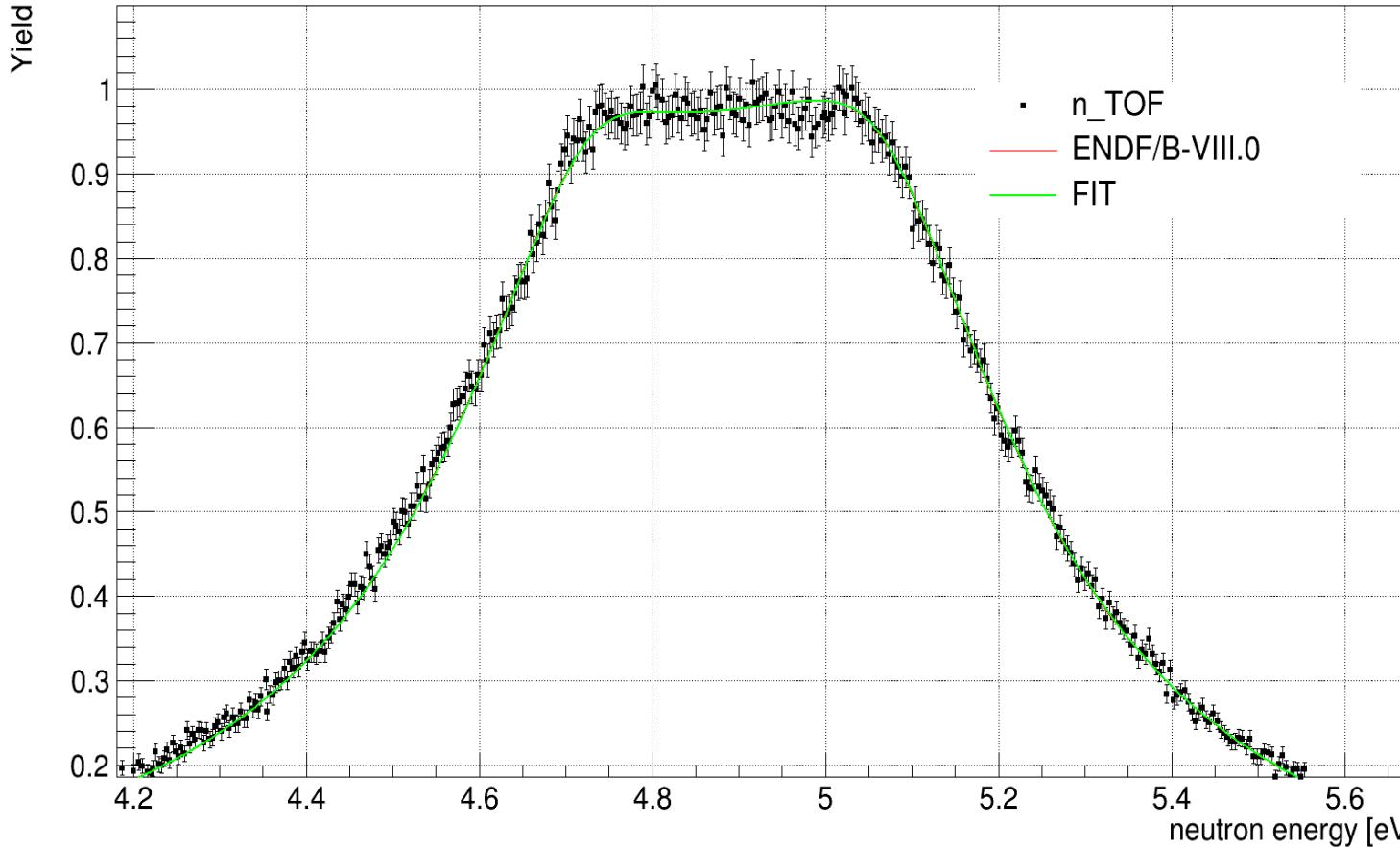


Au-197: normalization factors



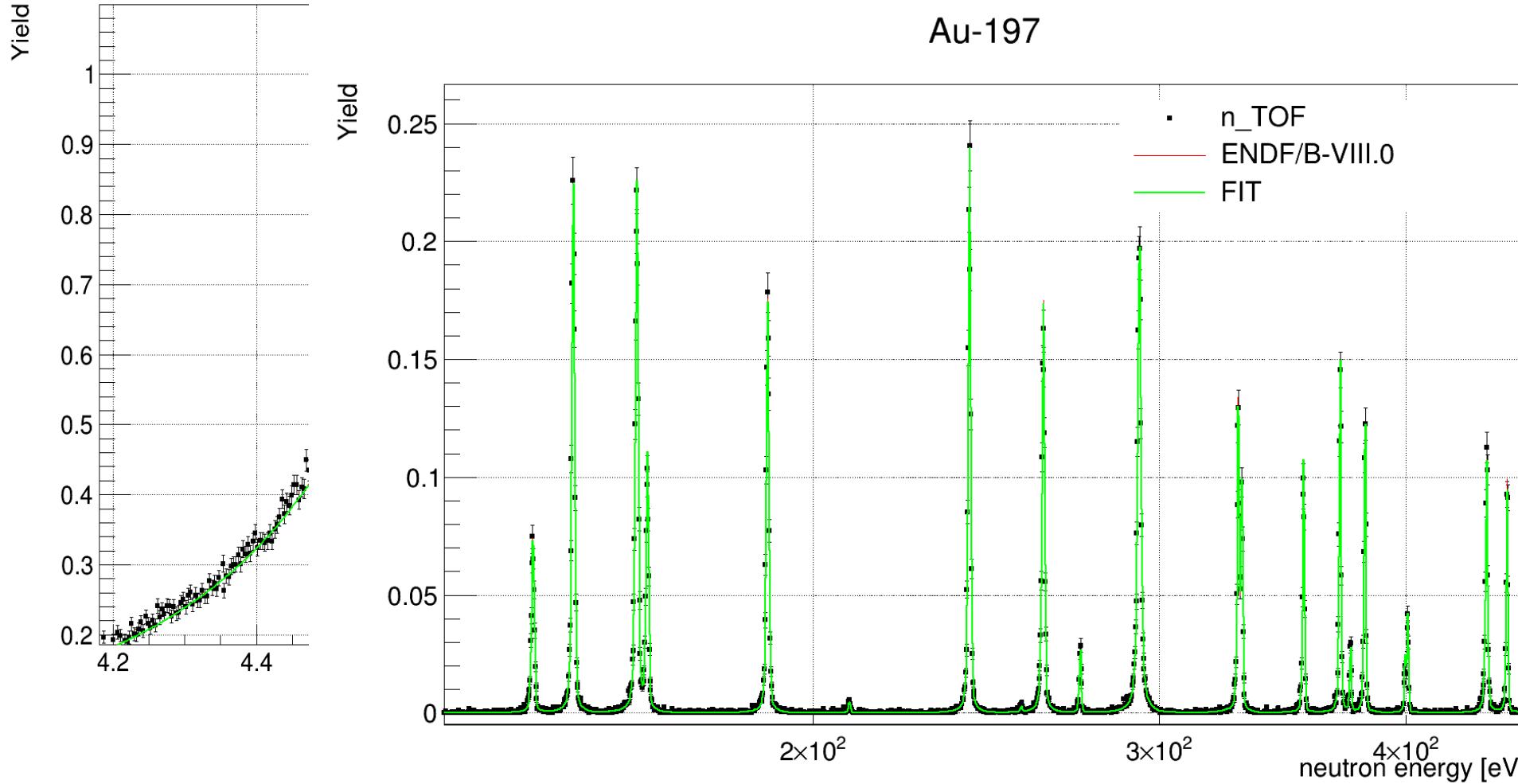
Au-197: TOF – neutron energy check (transport code and SAMMY)

Au-197



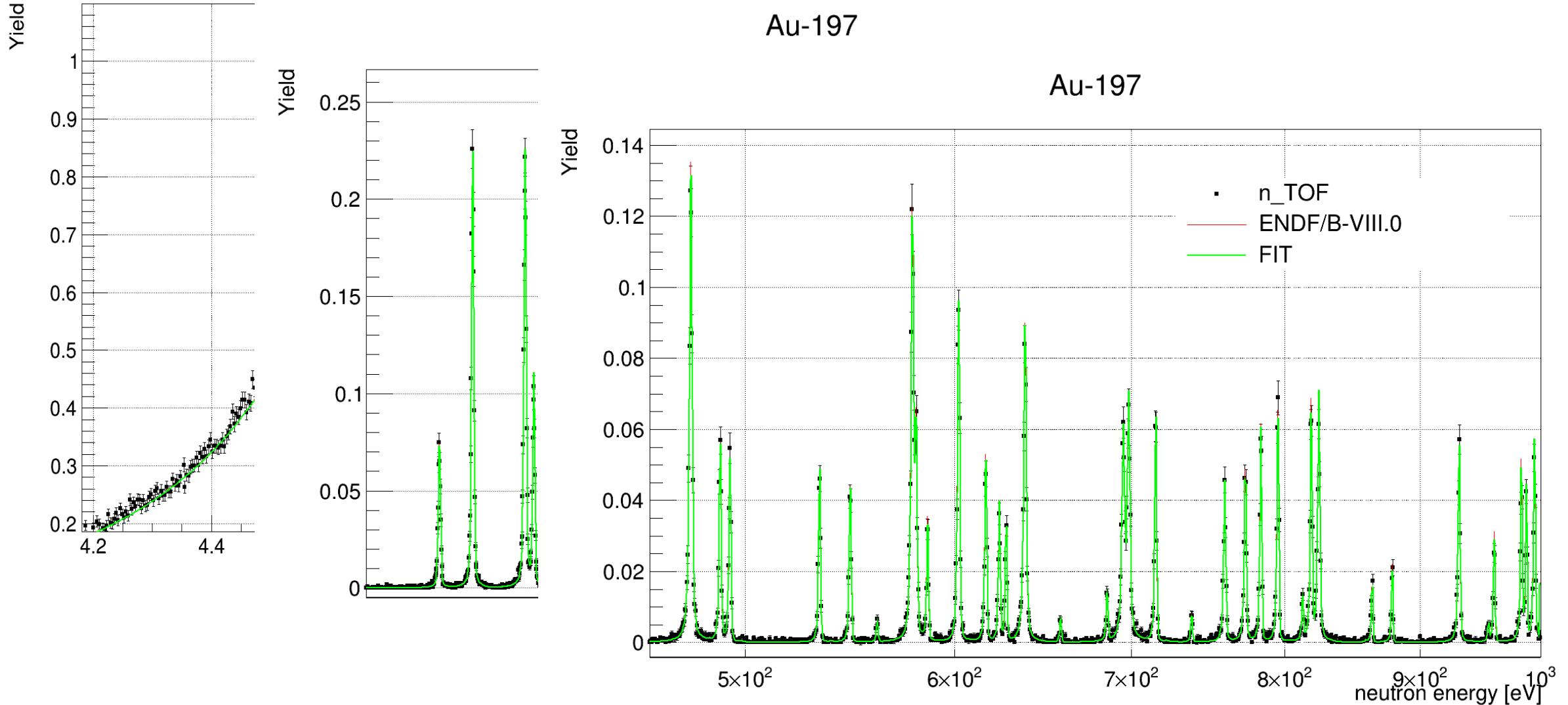
Au-197: TOF – neutron energy check (transport code and SAMMY)

Au-197

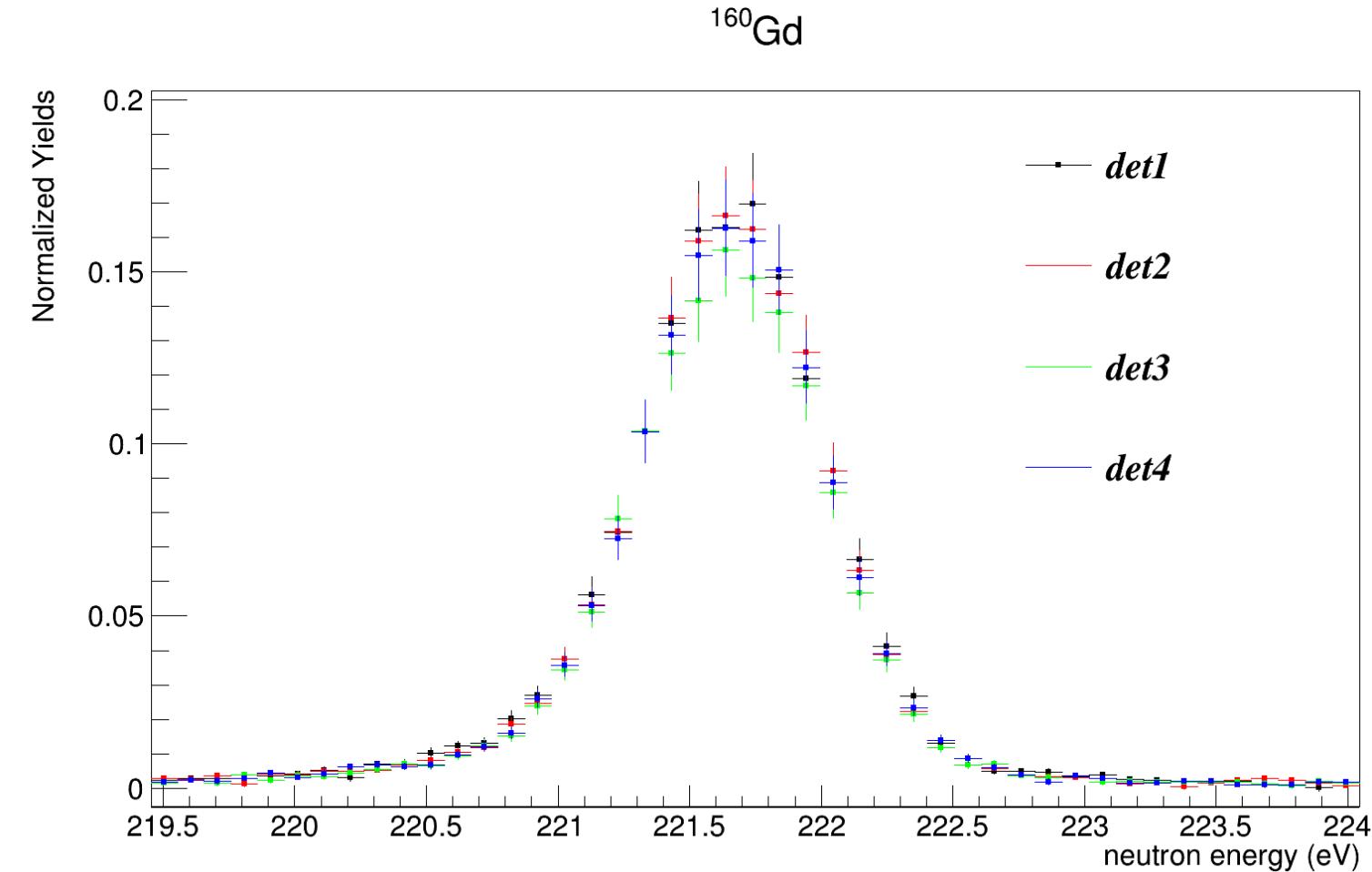


Au-197: TOF – neutron energy check (transport code and SAMMY)

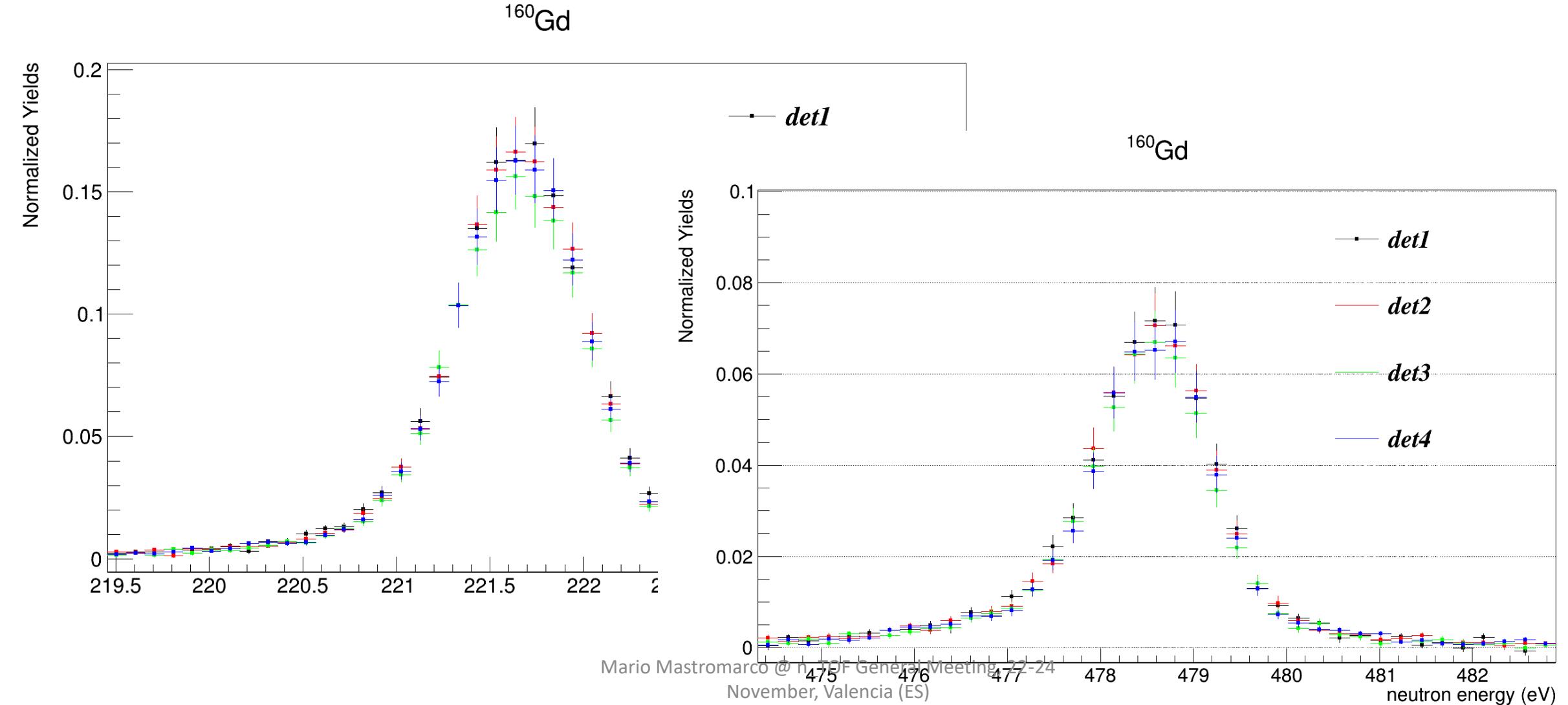
Au-197



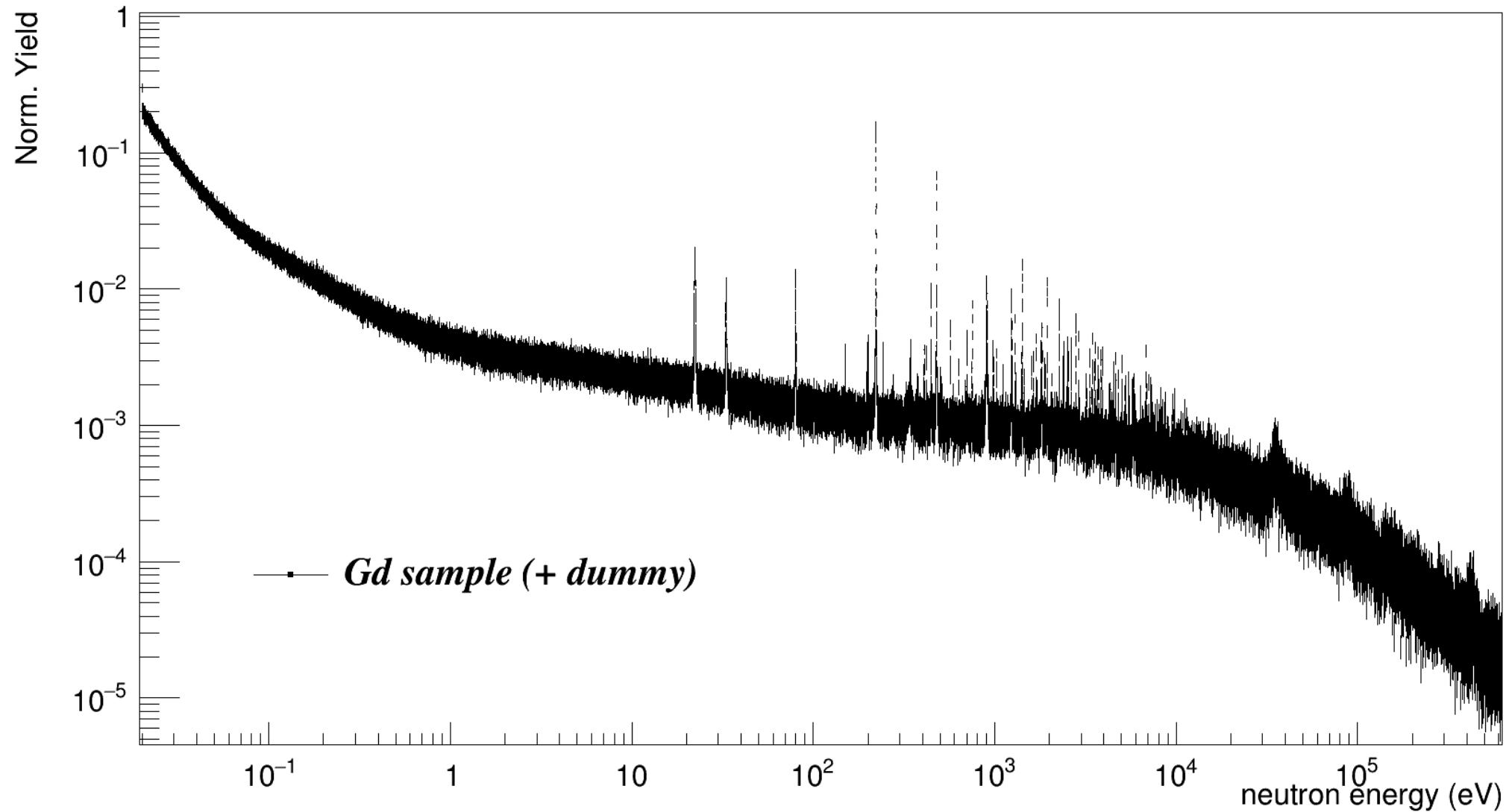
Gd-160: normalization factors



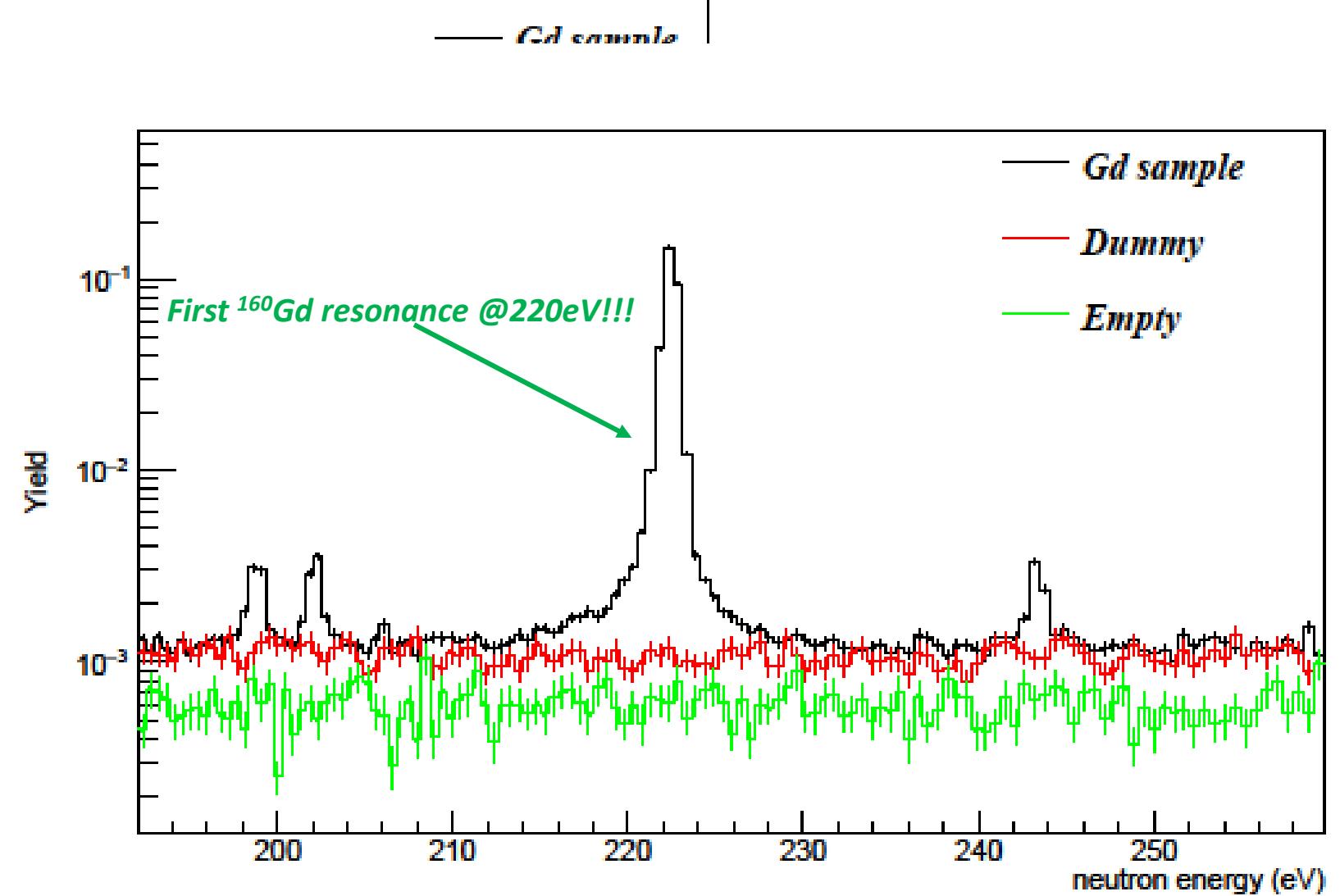
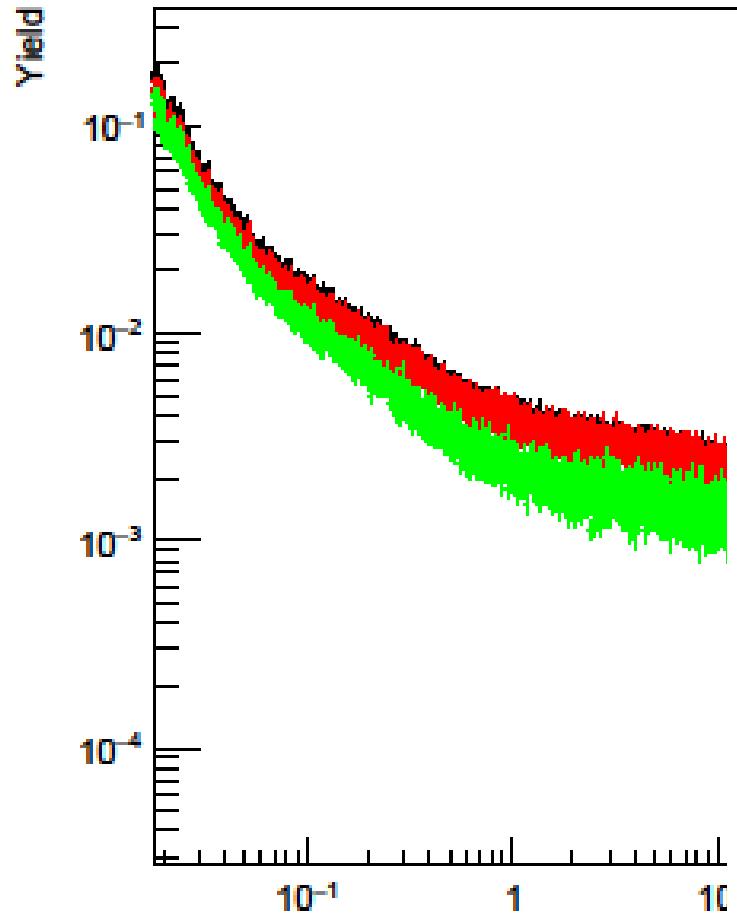
Gd-160: normalization factors



Yields...



Yields...



RSA by SAMMY code

```

1 Gd160 dummy case
2 Gd 160      151.920066
3 TWENTY
4 USE NEW SPIN GROUP FORMAT NUMBER
5 REICH-MOORE FORMALISM IS WANTED
6 PRINT ALL INPUT PARAmeters
7 BROADENING IS WANTED
8 USE FREE GAS MODEL OF DOPPLER BROADENING
9 DOUBLE
10 NORMALIZE AS YIELD Rather than cross section
11 eV
12 PUBLISH
13
14 294.15      183.9252          0.007
15 7.4763380   3.3109e-4        0.00000
16 CAPTURE
17   1   1   0   0.5   1.0   0.0          #gd160
18   1   1   0   0     0.5
19   2   1   0   -0.5  1.0   0.0
20   1   1   0   1     0.5
21   3   1   0   -1.5  1.0   0.0
22   1   1   0   1     0.5
23   4   1   0   0.5   1.0   0.0          #gd158
24   1   1   0   0     0.5
25   5   1   0   -0.5  1.0   0.0
26   1   1   0   1     0.5
27   6   1   0   -1.5  1.0   0.0
28   1   1   0   1     0.5
29   9   1   0   0.5   1.0   0.0          #gd156
30   1   1   0   0     0.5
31   10  1   0   -0.5  1.0   0.0
32   1   1   0   1     0.5
33   11  1   0   -1.5  1.0   0.0
34   1   1   0   1     0.5
35   14  1   0   0.5   1.0   0.0          #gd154
36   1   1   0   0     0.5
37
38   2.100e-1    1.00    0.0    0.0
39
40 USER-DEFINED RESOLUTION FUNCTION
41 FILE=RF EAR1 v2 CORR.txt

```

5

0.9
RADIUS PARAMETERS FOLLOW

7.4763380	7.4763380	0	0	1	
7.4763380	7.4763380	0	0	2	3
7.8000000	7.8000000	0	0	4	
7.8000000	7.8000000	0	0	5	6
7.9000000	7.9000000	0	0	7	8
7.9000000	7.9000000	0	0	9	
7.9000000	7.9000000	0	0	10	11
7.9000000	7.9000000	0	0	12	13
7.4000000	7.4000000	0	0	14	
8.5000000	8.5000000	0	0	15	16
8.0000000	8.0000000	0	0	17	

NUCLIDE MASSES AND ABUNDANCES FOLLOW

159.926848	.98086900	0.	0	1	2	3
157.923640	1.290E-02	0.	0	4	5	6
156.924053	4.200E-08	0.	0	7	8	
155.922449	5.900E-03	0.	0	9	10	11
154.922862	3.300E-07	0.	0	12	13	
153.921257	3.3025E-4	0.	0	14		
152.921671	3.900E-12	0.	0	15	16	
151.920066	3.800E-07	0.	0	17		

BROADENING PARAMETERS FOLLOW

7.4763800	294.15000	.0003309	0.	0.	0.	0	0	0	0	0	0
-----------	-----------	----------	----	----	----	---	---	---	---	---	---

MISCELLaneous parameters follow

TZERO	0	0	.00000000	.00000000	.99999999	.00000000	183.9252
-------	---	---	-----------	-----------	-----------	-----------	----------

NORMALization and "constant" background follow

1.0000000	1.89773-8	0.	0.	0.	0.	0.	0	1	0	0	0
.005000000	1.00000-9	1.00000-8	0.	0.	0.	0.	0.				

RSA by SAMMY code

```

1 Gd160 dummy case
2 Gd 160      151.920066
3 TWENTY
4 USE NEW SPIN GROUP FORMAT NUMBER
5 REICH MOORE FORMALISM IS WANTED
6 PRINT ALL INPUT PARAmeters
7 BROADENING IS WANTED
8 USE FREE GAS MODEL OF DOPPLER BROADENING
9 DOUBLE
10 NORMALIZE AS YIELD Rather than cross section
11 eV
12 PUBLISH
13
14 294.15      183.9252          0.007
15 7.4763380  3.3109e-4        0.00000
16 CAPTURE
17   1   1   0   0.5   1.0   0.0          #gd160
18   1   1   0   0     0.5
19   2   1   0  -0.5   1.0   0.0
20   1   1   0   1     0.5
21   3   1   0  -1.5   1.0   0.0
22   1   1   0   1     0.5
23   4   1   0   0.5   1.0   0.0          #gd158
24   1   1   0   0     0.5
25   5   1   0  -0.5   1.0   0.0
26   1   1   0   1     0.5
27   6   1   0  -1.5   1.0   0.0
28   1   1   0   1     0.5
29   9   1   0   0.5   1.0   0.0          #gd156
30   1   1   0   0     0.5
31  10   1   0  -0.5   1.0   0.0
32   1   1   0   1     0.5
33  11   1   0  -1.5   1.0   0.0
34   1   1   0   1     0.5
35  14   1   0   0.5   1.0   0.0          #gd154
36   1   1   0   0     0.5
37
38  2.100e-1    1.00    0.0    0.0
39
40 USER-DEFINED RESOLUTION FUNCTION
41 FILE=RF EAR1 v2 CORR.txt

```

5

0.9
RADIUS PARAMETERS FOLLOW

7.4763380	7.4763380	0	0	1	
7.4763380	7.4763380	0	0	2	3
7.8000000	7.8000000	0	0	4	
7.8000000	7.8000000	0	0	5	6
7.9000000	7.9000000	0	0	7	8
7.9000000	7.9000000	0	0	9	
7.9000000	7.9000000	0	0	10	11
7.9000000	7.9000000	0	0	12	13
7.4000000	7.4000000	0	0	14	
8.5000000	8.5000000	0	0	15	16
8.0000000	8.0000000	0	0	17	

NUCLIDE MASSES AND ABUNDANCES FOLLOW

159.926848	.98086900	0.	0	1	2	3
157.923640	1.290E-02	0.	0	4	5	6
156.924053	4.200E-08	0.	0	7	8	
155.922449	5.900E-03	0.	0	9	10	11
154.922862	3.300E-07	0.	0	12	13	
153.921257	3.3025E-4	0.	0	14		
152.921671	3.900E-12	0.	0	15	16	
151.920066	3.800E-07	0.	0	17		

BROADENING PARAMETERS FOLLOW

7.4763800	294.15000	.0003309	0.	0.	0.	0	0	0	0	0	0
-----------	-----------	----------	----	----	----	---	---	---	---	---	---

MISCELLaneous parameters follow

TZERO	0	0	.00000000	.00000000	.99999999	.00000000	183.9252
-------	---	---	-----------	-----------	-----------	-----------	----------

NORMALization and "constant" background follow

1.0000000	1.89773-8	0.	0.	0.	0.	0.	0	1	0	0	0
.005000000	1.00000-9	1.00000-8	0.	0.	0.	0.	0				

RSA by SAMMY code

```

1 Gd160 dummy case
2 Gd 160      151.920066
3 TWENTY
4 USE NEW SPIN GROUP FORMAT NUMBER
5 REICH MOORE FORMALISM IS WANTED
6 PRINT ALL INPUT PARAMeters
7 BROADENING IS WANTED
8 USE FREE GAS MODEL OF DOPPLER BROADENING
9 DOUBLE
10 NORMALIZE AS YIELD Rather than cross section
11 eV
12 PUBLISH
13
14 294.15      183.9252          0.007
15 7.4763380  3.3109e-4        0.00000
16 CAPTURE
17   1   1   0   0.5   1.0   0.0          #gd160
18   1   1   0   0     0.5
19   2   1   0  -0.5   1.0   0.0
20   1   1   0   1     0.5
21   3   1   0  -1.5   1.0   0.0
22   1   1   0   1     0.5
23   4   1   0   0.5   1.0   0.0          #gd158
24   1   1   0   0     0.5
25   5   1   0  -0.5   1.0   0.0
26   1   1   0   1     0.5
27   6   1   0  -1.5   1.0   0.0
28   1   1   0   1     0.5
29   9   1   0   0.5   1.0   0.0          #gd156
30   1   1   0   0     0.5
31   10  1   0  -0.5   1.0   0.0
32   1   1   0   1     0.5
33   11  1   0  -1.5   1.0   0.0
34   1   1   0   1     0.5
35   14  1   0   0.5   1.0   0.0          #gd154
36   1   1   0   0     0.5
37   2.100e-1    1.00    0.0    0.0
38   USER-DEFINED RESOLUTION FUNCTION
39   FILE=RF EAR1 v2 CORR.txt
40
41

```

5

0.9
RADIUS PARAMETERS FOLLOW

7.4763380	7.4763380	0	0	1	
7.4763380	7.4763380	0	0	2	3
7.8000000	7.8000000	0	0	4	
7.8000000	7.8000000	0	0	5	6
7.9000000	7.9000000	0	0	7	8
7.9000000	7.9000000	0	0	9	
7.9000000	7.9000000	0	1	0111	
7.9000000	7.9000000	0	1	213	
7.4000000	7.4000000	0	1	4	
8.5000000	8.5000000	0	1	516	
8.0000000	8.0000000	0	1	7	

NUCLIDE MASSES AND ABUNDANCES FOLLOW

159.926848	.98086900	0.	0	1	2	3
157.923640	1.290E-02	0.	0	4	5	6
156.924053	4.200E-08	0.	0	7	8	
155.922449	5.900E-03	0.	0	9	1011	
154.922862	3.300E-07	0.	0	1213		
153.921257	3.3025E-4	0.	0	14		
152.921671	3.900E-12	0.	0	1516		
151.920066	3.800E-07	0.	0	17		

BROADENING PARAMETERS FOLLOW

7.4763800	294.15000	.0003309	0.	0.	0.	0	0	0	0	0	0
-----------	-----------	----------	----	----	----	---	---	---	---	---	---

MISCELLaneous parameters follow

TZERO	0	0	.00000000	.00000000	.99999999	.00000000	183.9252
-------	---	---	-----------	-----------	-----------	-----------	----------

NORMALization and "constant" background follow

1.0000000	1.89773-8	0.	0.	0.	0.	0.	0	1	0	0	0
.005000000	1.00000-9	1.00000-8	0.	0.	0.	0.	0	0	0	0	0

RSA by SAMMY code

```

1 Gd160 dummy case
2 Gd 160      151.920066
3 TWENTY
4 USE NEW SPIN GROUP FORMAT NUMBER
5 REICH MOORE FORMALISM IS WANTED
6 PRINT ALL INPUT PARAmeters
7 BROADENING IS WANTED
8 USE FREE GAS MODEL OF DOPPLER BROADENING
9 DOUBLE
10 NORMALIZE AS YIELD Rather than cross section
11 eV
12 PUBLISH
13
14 294.15      183.9252          0.007
15 7.4763380   3.3109e-4        0.00000
16 CAPTURE
17   1   1   0   0.5   1.0   0.0          #gd160
18   1   1   0   0     0.5
19   2   1   0   -0.5  1.0   0.0
20   1   1   0   1     0.5
21   3   1   0   -1.5  1.0   0.0
22   1   1   0   1     0.5
23   4   1   0   0.5   1.0   0.0          #gd158
24   1   1   0   0     0.5
25   5   1   0   -0.5  1.0   0.0
26   1   1   0   1     0.5
27   6   1   0   -1.5  1.0   0.0
28   1   1   0   1     0.5
29   9   1   0   0.5   1.0   0.0          #gd156
30   1   1   0   0     0.5
31   10  1   0   -0.5  1.0   0.0
32   1   1   0   1     0.5
33   11  1   0   -1.5  1.0   0.0
34   1   1   0   1     0.5
35   14  1   0   0.5   1.0   0.0          #gd154
36   1   1   0   0     0.5
37
38   2.100e-1   1.00   0.0   0.0
39
40 USER-DEFINED RESOLUTION FUNCTION
FILE=RF EAR1 v2 CORR.txt
41

```

5

#gd160

#gd158

#gd156

#gd154

```

0.9
RADIUS PARAMETERS FOLLOW
7.4763380  7.4763380 0 0 1
7.4763380  7.4763380 0 0 2 3
7.8000000  7.8000000 0 0 4
7.8000000  7.8000000 0 0 5 6
7.9000000  7.9000000 0 0 7 8
7.9000000  7.9000000 0 0 9
7.9000000  7.9000000 0 01011
7.9000000  7.9000000 0 01213
7.4000000  7.4000000 0 014
8.5000000  8.5000000 0 01516
8.0000000  8.0000000 0 017

NUCLIDE MASSES AND ABUNDANCES FOLLOW
159.926848 .98086900 0.          0 1 2 3
157.923640 1.290E-02 0.          0 4 5 6
156.924053 4.200E-08 0.          0 7 8
155.922449 5.900E-03 0.          0 9011
154.922862 3.300E-07 0.          01213
153.921257 3.3025E-4 0.          014
152.921671 3.900E-12 0.          01516
151.920066 3.800E-07 0.          017

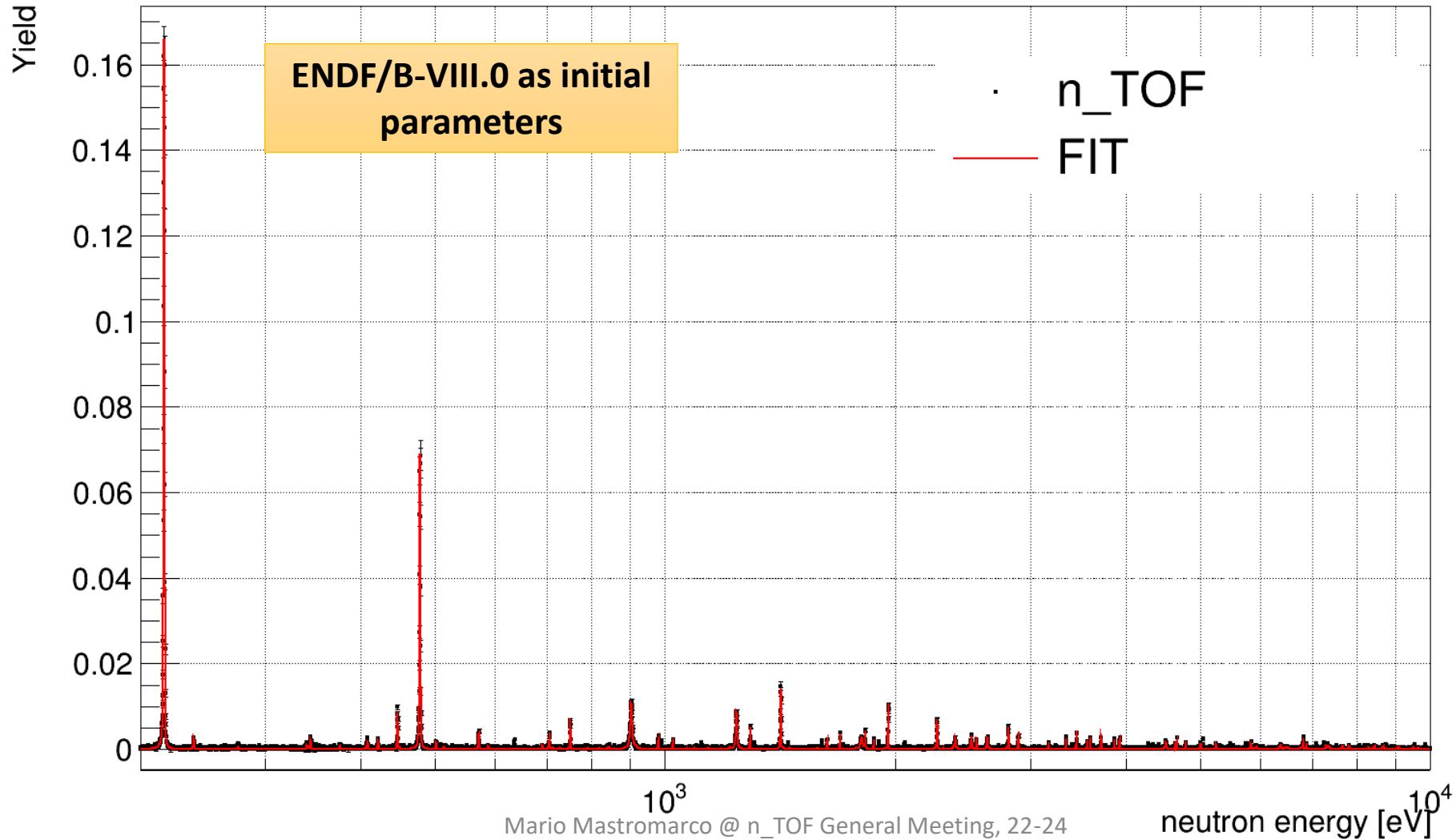
BROADENING PARAMETERS FOLLOW
7.4763800  294.15000 .0003309 0.          0.          0.          0 0 0 0 0 0

MISCELLaneous parameters follow
TZERO 0 0 .00000000 .00000000 .99999999 .00000000 183.9252

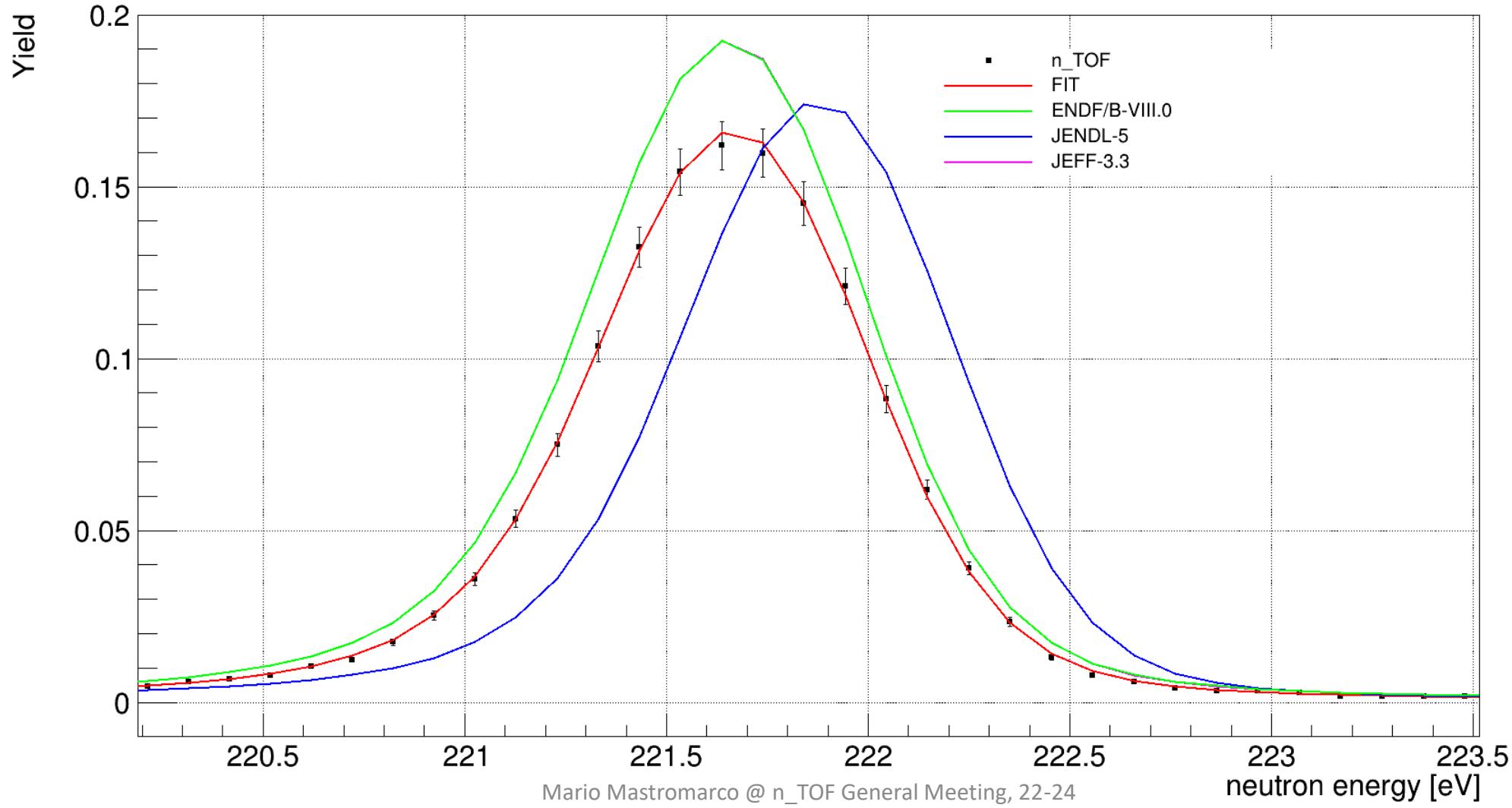
NORMALization and "constant" background follow
1.00000000 1.89773-8 0.          0.          0.          0.          0 1 0 0 0 0
.005000000 1.00000-9 1.00000-8 0.          0.          0.

```

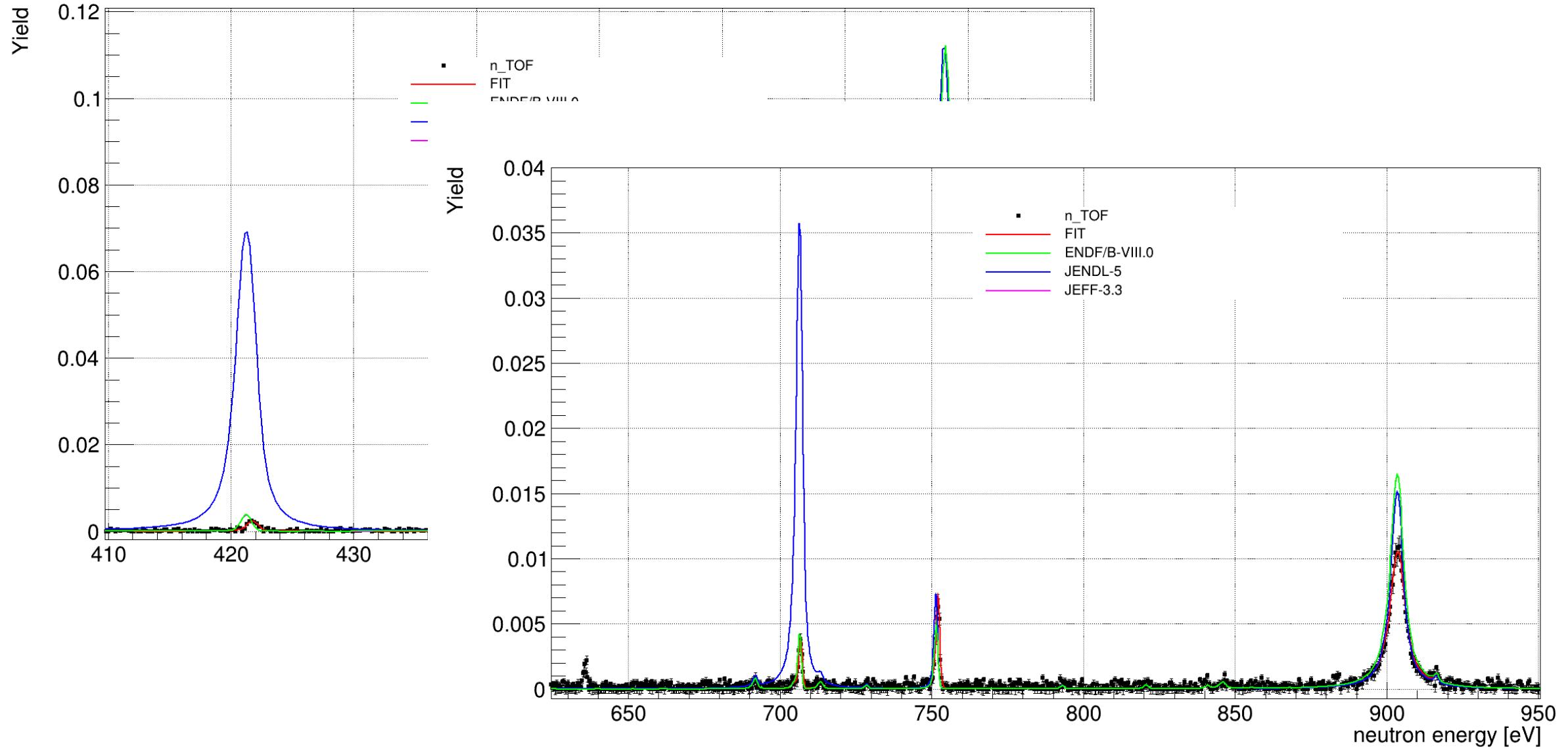
RSA up to 10 keV



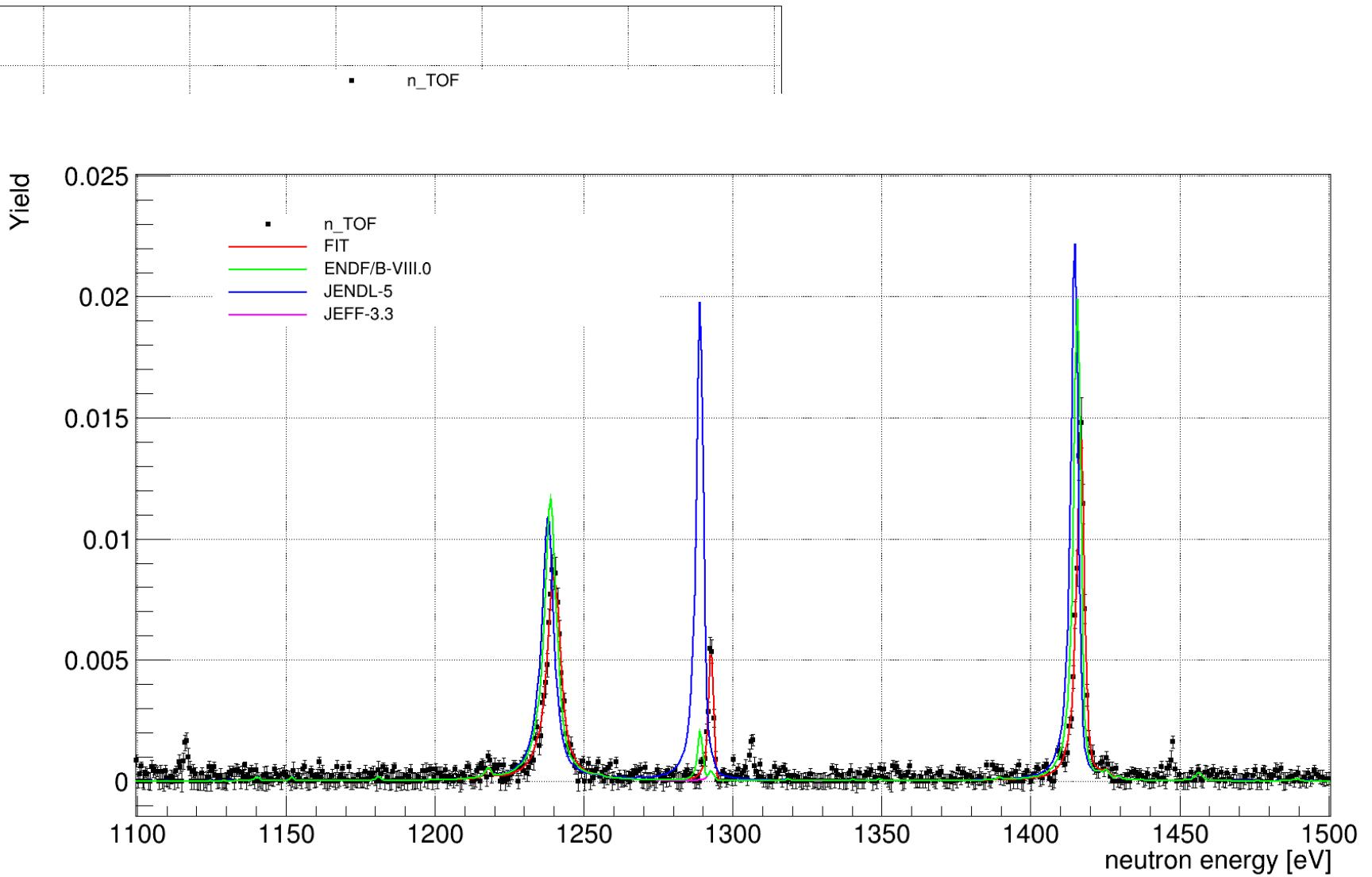
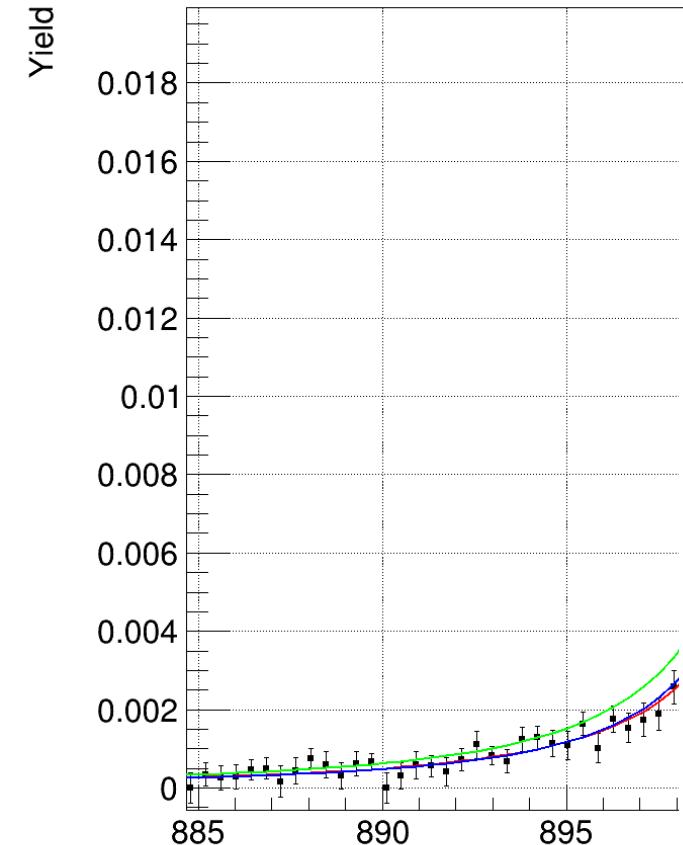
Main ^{160}Gd capture resonance



RSA...

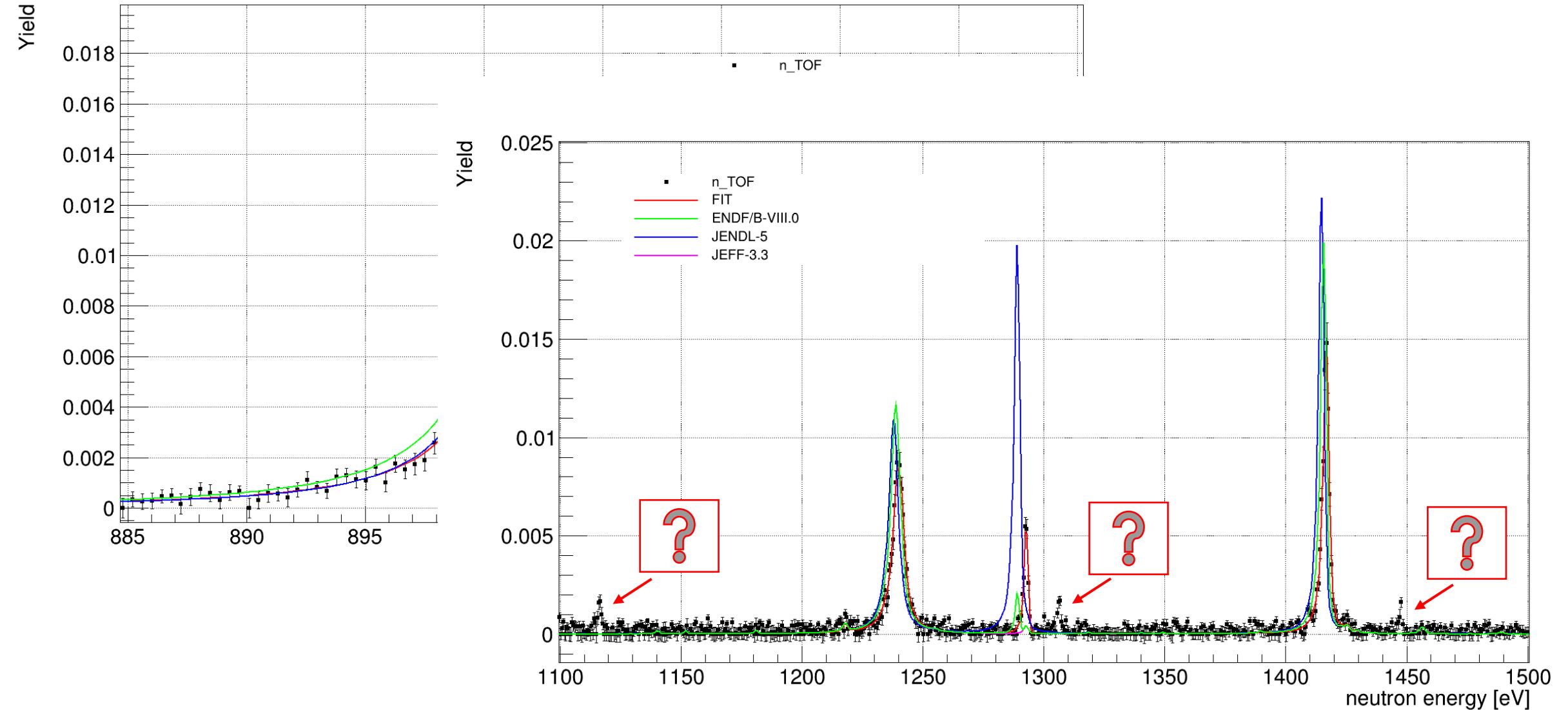


RSA...



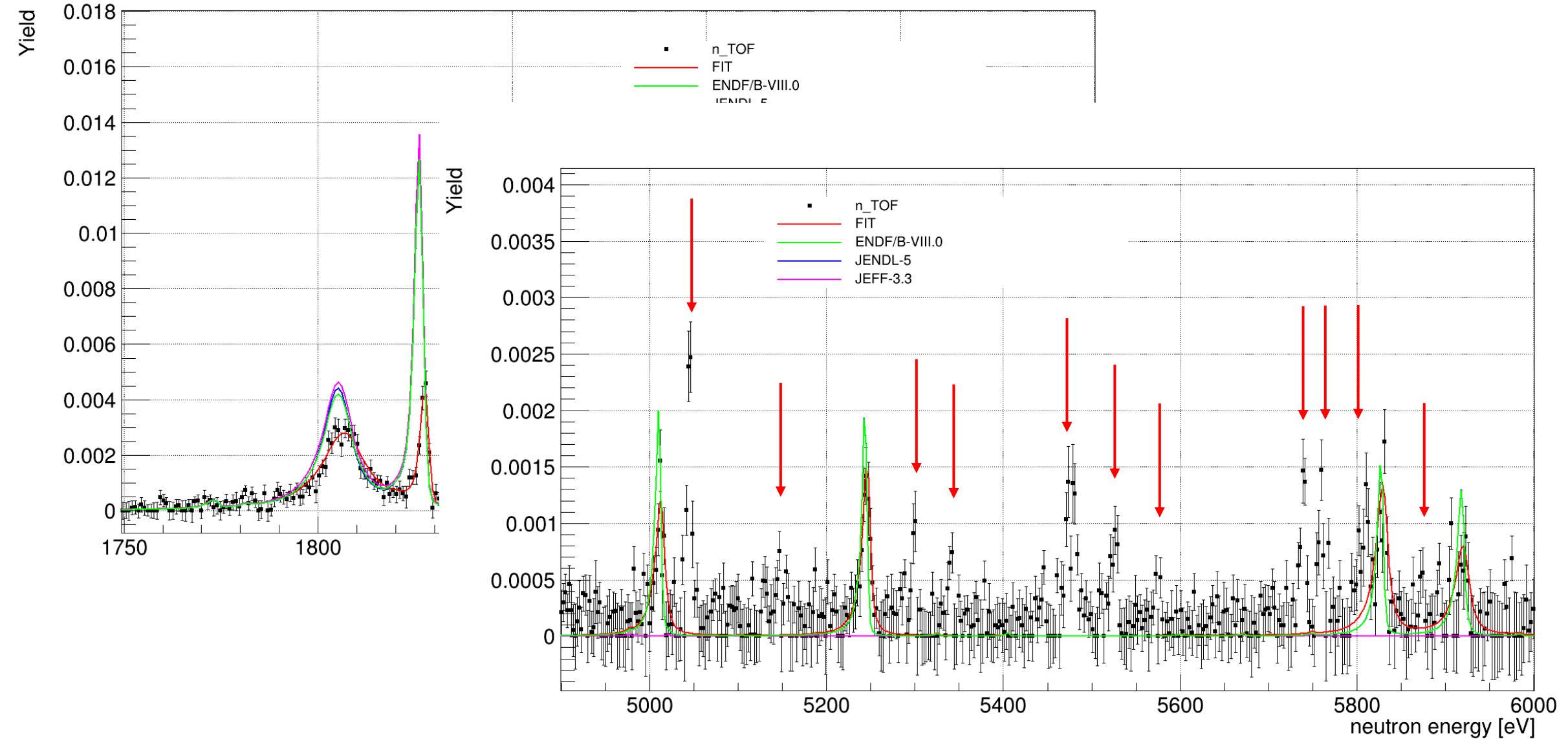
RSA...

unrecognized structures



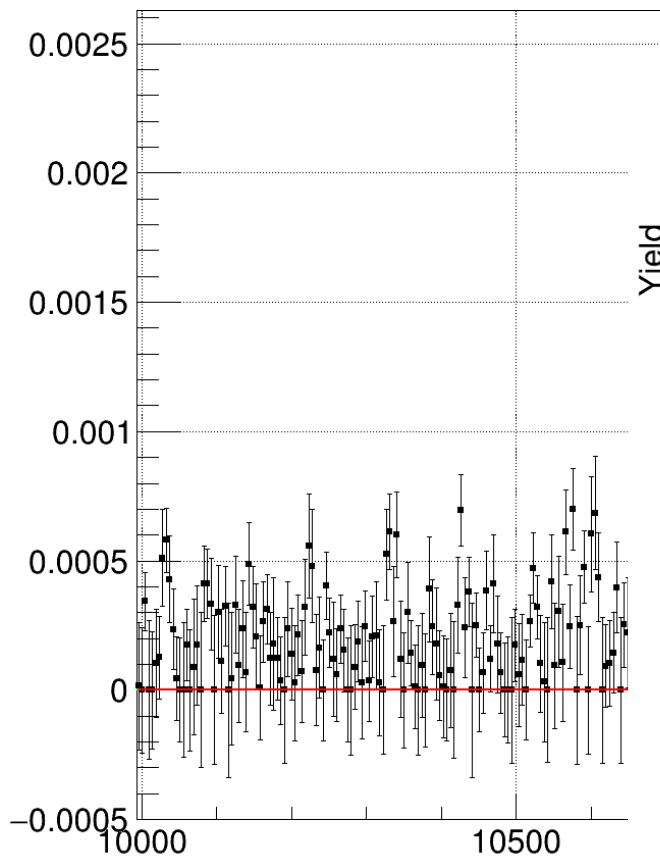
RSA...

unrecognized structures

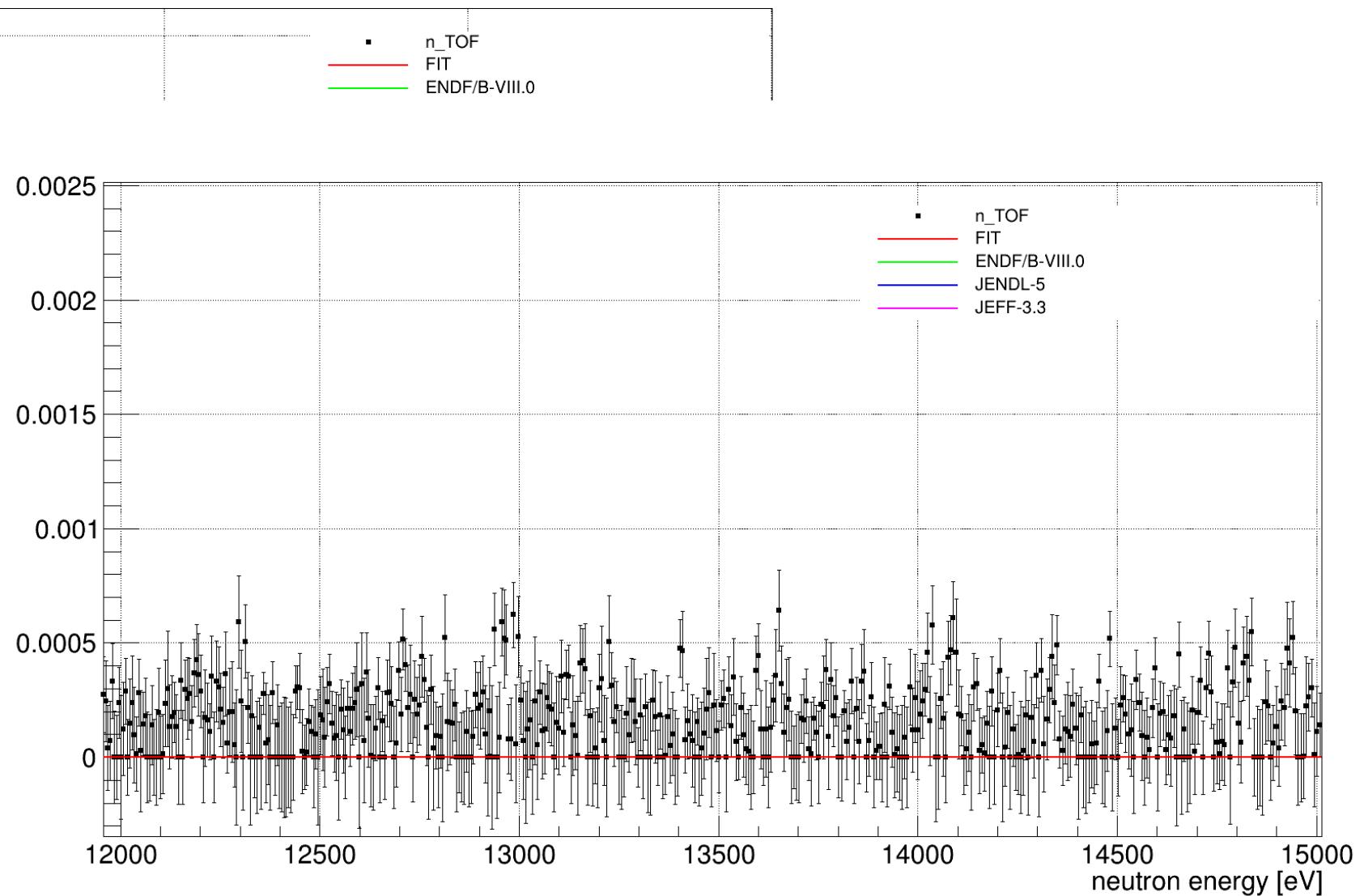


Unsigned structures above 10 keV

Yield

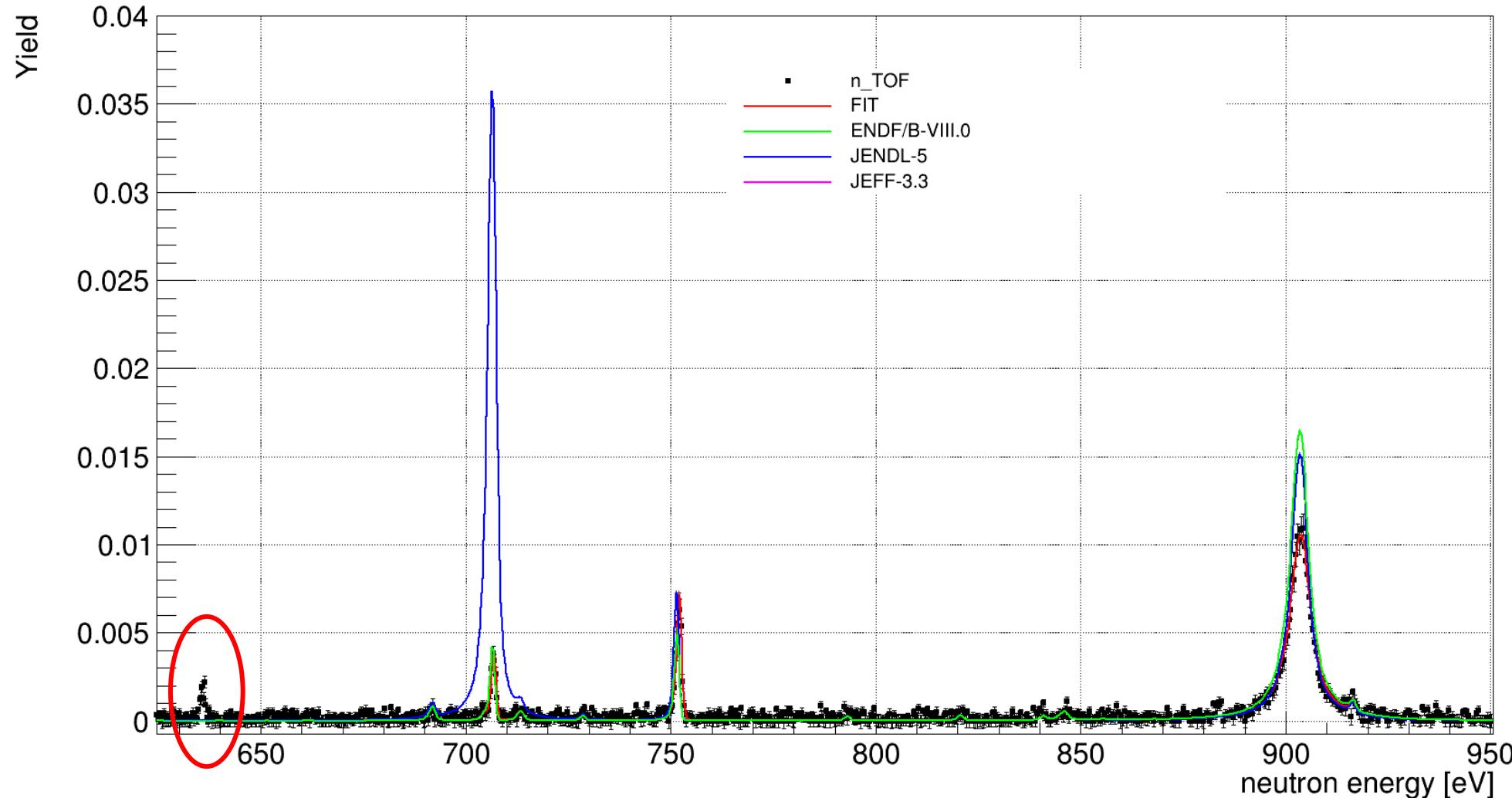


Yield



neutron energy [eV]

structure @ 635 eV

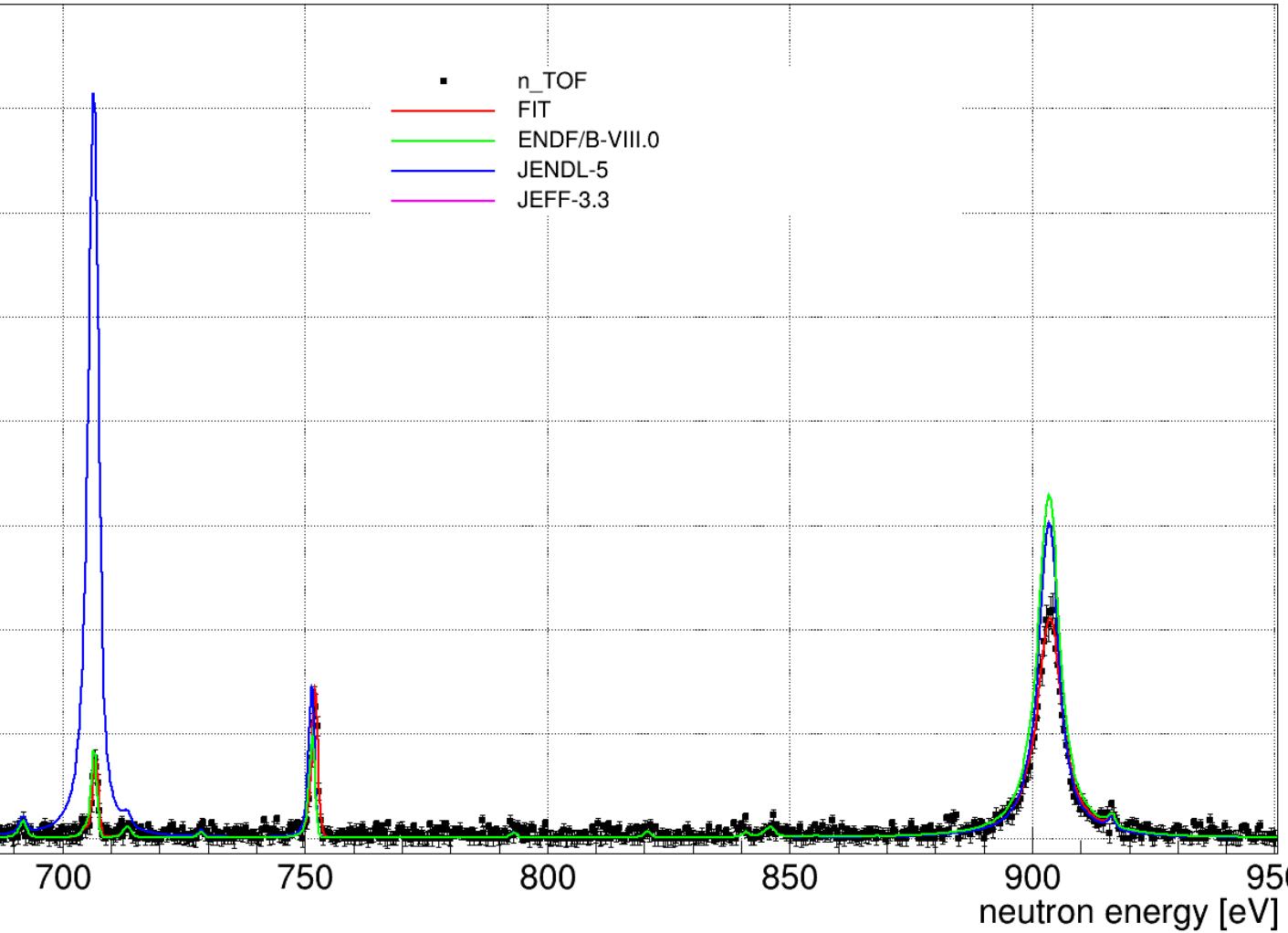


48 rows

JEFF

Search	Incident particle	Evaluation	Material	E
NEA	Incident neutron data	JEFF-3.3	As72	635.0613
NEA	Incident neutron data	JEFF-3.3	As74	637.2687
NEA	Incident neutron data	JEFF-3.3	As74	637.3422
NEA	Incident neutron data	JEFF-3.3	Sr84	635
NEA	Incident neutron data	JEFF-3.3	Sr89	636.8112
NEA	Incident neutron data	JEFF-3.3	Ru99	636.2
NEA	Incident neutron data	JEFF-3.3	Pd108	636.2
NEA	Incident neutron data	JEFF-3.3	Pd110	636.5
NEA	Incident neutron data	JEFF-3.3	Ag108	635.36
NEA	Incident neutron data	JEFF-3.3	Ag109	634.5
NEA	Incident neutron data	JEFF-3.3	Ag110	637.1204
NEA	Incident neutron data	JEFF-3.3	Ag110	637.4988
NEA	Incident neutron data	JEFF-3.3	Cd106	635.087
NEA	Incident neutron data	JEFF-3.3	In114	634.3417
NEA	Incident neutron data	JEFF-3.3	In114	637.0182
NEA	Incident neutron data	JEFF-3.3	Sb126	634.5823
NEA	Incident neutron data	JEFF-3.3	Te121	635.9277
NEA	Incident neutron data	JEFF-3.3	I127	635.75
NEA	Incident neutron data	JEFF-3.3	Xe127	637.111
NEA	Incident neutron data	JEFF-3.3	Xe129	636.8
NEA	Incident neutron data	JEFF-3.3	Ba131	634.9718
NEA	Incident neutron data	JEFF-3.3	Ba131	635.5911
NEA	Incident neutron data	JEFF-3.3	La138	635.7065
NEA	Incident neutron data	JEFF-3.3	Ce137	636.527
NEA	Incident neutron data	JEFF-3.3	Ce143	636.832
NEA	Incident neutron data	JEFF-3.3	Pr141	635.8
NEA	Incident neutron data	JEFF-3.3	Nd142	636.4
NEA	Incident neutron data	JEFF-3.3	Gd149	635.845
NEA	Incident neutron data	JEFF-3.3	Tb159	637.6
NEA	Incident neutron data	JEFF-3.3	Dy161	635.3
NEA	Incident neutron data	JEFF-3.3	Dy163	637.17
NEA	Incident neutron data	JEFF-3.3	Ho165	634.8
NEA	Incident neutron data	JEFF-3.3	Er167	636.9
NEA	Incident neutron data	JEFF-3.3	Tm170	635.7607
NEA	Incident neutron data	JEFF-3.3	Yb168	636.2426
NEA	Incident neutron data	JEFF-3.3	Hf177	634.32
NEA	Incident neutron data	JEFF-3.3	Ta181	636.29
NEA	Incident neutron data	JEFF-3.3	Re187	636
NEA	Incident neutron data	JEFF-3.3	Re188	635.007
NEA	Incident neutron data	JEFF-3.3	Re188	637.4905
NEA	Incident neutron data	JEFF-3.3	Os187	636.5
NEA	Incident neutron data	JEFF-3.3	U234	637
NEA	Incident neutron data	JEFF-3.3	U235	635.3746
NEA	Incident neutron data	JEFF-3.3	U235	635.9864
NEA	Incident neutron data	JEFF-3.3	U235	636.5639
NEA	Incident neutron data	JEFF-3.3	U238	636.5637
NEA	Incident neutron data	JEFF-3.3	Pu239	637.2519
NEA	Incident neutron data	JEFF-3.3	Pu240	637.56

535 eV



48 rows

JEFF

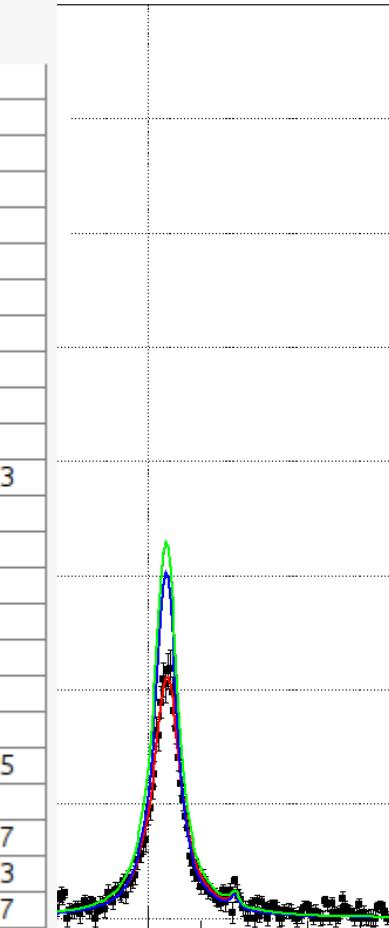
Search	Incident particle	Evaluation	Material	E
NEA	Incident neutron data	JEFF-3.3	As72	635.0613
NEA	Incident neutron data	JEFF-3.3	As74	637.2687
NEA	Incident neutron data	JEFF-3.3	As74	637.3422
NEA	Incident neutron data	JEFF-3.3	Sr84	635
NEA	Incident neutron data	JEFF-3.3	Sr89	636.8112
NEA	Incident neutron data	JEFF-3.3	Ru99	636.2
NEA	Incident neutron data	JEFF-3.3	Pd108	636.2
NEA	Incident neutron data	JEFF-3.3	Pd110	636.5
NEA	Incident neutron data	JEFF-3.3	Ag108	635.36
NEA	Incident neutron data	JEFF-3.3	Ag109	634.5
NEA	Incident neutron data	JEFF-3.3	Ag110	637.1204
NEA	Incident neutron data	JEFF-3.3	Ag110	637.4988
NEA	Incident neutron data	JEFF-3.3	Cd106	635.087
NEA	Incident neutron data	JEFF-3.3	In114	634.3417
NEA	Incident neutron data	JEFF-3.3	In114	637.0182
NEA	Incident neutron data	JEFF-3.3	Sb126	634.5823
NEA	Incident neutron data	JEFF-3.3	Te121	635.9277
NEA	Incident neutron data	JEFF-3.3	I127	635.75
NEA	Incident neutron data	JEFF-3.3	Xe127	637.111
NEA	Incident neutron data	JEFF-3.3	Xe129	636.8
NEA	Incident neutron data	JEFF-3.3	Ba131	634.9718
NEA	Incident neutron data	JEFF-3.3	Ba131	635.5911
NEA	Incident neutron data	JEFF-3.3	La138	635.7065
NEA	Incident neutron data	JEFF-3.3	Ce137	636.527
NEA	Incident neutron data	JEFF-3.3	Ce143	636.832
NEA	Incident neutron data	JEFF-3.3	Pr141	635.8
NEA	Incident neutron data	JEFF-3.3	Nd142	636.4
NEA	Incident neutron data	JEFF-3.3	Gd149	635.845
NEA	Incident neutron data	JEFF-3.3	Tb159	637.6
NEA	Incident neutron data	JEFF-3.3	Dy161	635.3
NEA	Incident neutron data	JEFF-3.3	Dy163	637.17
NEA	Incident neutron data	JEFF-3.3	Ho165	634.8
NEA	Incident neutron data	JEFF-3.3	Er167	636.9
NEA	Incident neutron data	JEFF-3.3	Tm170	635.7607
NEA	Incident neutron data	JEFF-3.3	Yb168	636.2426
NEA	Incident neutron data	JEFF-3.3	Hf177	634.32
NEA	Incident neutron data	JEFF-3.3	Ta181	636.29
NEA	Incident neutron data	JEFF-3.3	Re187	636
NEA	Incident neutron data	JEFF-3.3	Re188	635.007
NEA	Incident neutron data	JEFF-3.3	Re188	637.4905
NEA	Incident neutron data	JEFF-3.3	Os187	636.5
NEA	Incident neutron data	JEFF-3.3	U234	637
NEA	Incident neutron data	JEFF-3.3	U235	635.3746
NEA	Incident neutron data	JEFF-3.3	U235	635.9864
NEA	Incident neutron data	JEFF-3.3	U235	636.5639
NEA	Incident neutron data	JEFF-3.3	U238	636.5637
NEA	Incident neutron data	JEFF-3.3	Pu239	637.2519
NEA	Incident neutron data	JEFF-3.3	Pu240	637.56

535 eV

27 rows

ENDF

Search	Incident particle	Evaluation	Material	E
NEA	Incident neutron data	ENDF/B-VIII.0	As73	637.6
NEA	Incident neutron data	ENDF/B-VIII.0	Rb86	636
NEA	Incident neutron data	ENDF/B-VIII.0	Sr84	635
NEA	Incident neutron data	ENDF/B-VIII.0	Ru99	636.2
NEA	Incident neutron data	ENDF/B-VIII.0	Pd108	636.2
NEA	Incident neutron data	ENDF/B-VIII.0	Pd110	636.5
NEA	Incident neutron data	ENDF/B-VIII.0	Ag111	634.5
NEA	Incident neutron data	ENDF/B-VIII.0	Cd106	635.087
NEA	Incident neutron data	ENDF/B-VIII.0	Xe129	636.8
NEA	Incident neutron data	ENDF/B-VIII.0	Pr141	635.8
NEA	Incident neutron data	ENDF/B-VIII.0	Nd142	636.4
NEA	Incident neutron data	ENDF/B-VIII.0	Pm145	634.7093
NEA	Incident neutron data	ENDF/B-VIII.0	Dy161	635.3
NEA	Incident neutron data	ENDF/B-VIII.0	Dy163	637.17
NEA	Incident neutron data	ENDF/B-VIII.0	Ho165	634.8
NEA	Incident neutron data	ENDF/B-VIII.0	Er167	636.9
NEA	Incident neutron data	ENDF/B-VIII.0	Re187	636
NEA	Incident neutron data	ENDF/B-VIII.0	Os186	634.7
NEA	Incident neutron data	ENDF/B-VIII.0	Os187	636.5
NEA	Incident neutron data	ENDF/B-VIII.0	Ir194m	634.3605
NEA	Incident neutron data	ENDF/B-VIII.0	U234	637
NEA	Incident neutron data	ENDF/B-VIII.0	U235	635.3727
NEA	Incident neutron data	ENDF/B-VIII.0	U235	635.9863
NEA	Incident neutron data	ENDF/B-VIII.0	U235	636.5657
NEA	Incident neutron data	ENDF/B-VIII.0	U238	636.5637
NEA	Incident neutron data	ENDF/B-VIII.0	Pu239	637.2534
NEA	Incident neutron data	ENDF/B-VIII.0	Pu240	637.4241

900 950
neutron energy [eV]

48 rows

JEFF

Search NEA	Incident particle	Evaluation	Material	E
NEA	Incident neutron data	JEFF-3.3	As72	635.0613
NEA	Incident neutron data	JEFF-3.3	As74	637.2687
NEA	Incident neutron data	JEFF-3.3	As74	637.3422
NEA	Incident neutron data	JEFF-3.3	Sr84	635
NEA	Incident neutron data	JEFF-3.3	Sr89	636.8112
NEA	Incident neutron data	JEFF-3.3	Ru99	636.2
NEA	Incident neutron data	JEFF-3.3	Pd108	636.2
NEA	Incident neutron data	JEFF-3.3	Pd110	636.5
NEA	Incident neutron data	JEFF-3.3	Ag108	635.36
NEA	Incident neutron data	JEFF-3.3	Ag109	634.5
NEA	Incident neutron data	JEFF-3.3	Ag110	637.1204
NEA	Incident neutron data	JEFF-3.3	Ag110	637.4988
NEA	Incident neutron data	JEFF-3.3	Cd106	635.087
NEA	Incident neutron data	JEFF-3.3	In114	634.3417
NEA	Incident neutron data	JEFF-3.3	In114	637.0182
NEA	Incident neutron data	JEFF-3.3	Sb126	634.5823
NEA	Incident neutron data	JEFF-3.3	Te121	635.9277
NEA	Incident neutron data	JEFF-3.3	I127	635.75
NEA	Incident neutron data	JEFF-3.3	Xe127	637.111
NEA	Incident neutron data	JEFF-3.3	Xe129	636.8
NEA	Incident neutron data	JEFF-3.3	Ba131	634.9718
NEA	Incident neutron data	JEFF-3.3	Ba131	635.5911
NEA	Incident neutron data	JEFF-3.3	La138	635.7065
NEA	Incident neutron data	JEFF-3.3	Ce137	636.527
NEA	Incident neutron data	JEFF-3.3	Ce143	636.832
NEA	Incident neutron data	JEFF-3.3	Pr141	635.8
NEA	Incident neutron data	JEFF-3.3	Nd142	636.4
NEA	Incident neutron data	JEFF-3.3	Gd149	635.845
NEA	Incident neutron data	JEFF-3.3	Tb159	637.6
NEA	Incident neutron data	JEFF-3.3	Dy161	635.3
NEA	Incident neutron data	JEFF-3.3	Dy163	637.17
NEA	Incident neutron data	JEFF-3.3	Ho165	634.8
NEA	Incident neutron data	JEFF-3.3	Er167	636.9
NEA	Incident neutron data	JEFF-3.3	Tm170	635.7607
NEA	Incident neutron data	JEFF-3.3	Yb168	636.2426
NEA	Incident neutron data	JEFF-3.3	Hf177	634.32
NEA	Incident neutron data	JEFF-3.3	Ta181	636.29
NEA	Incident neutron data	JEFF-3.3	Re187	636
NEA	Incident neutron data	JEFF-3.3	Re188	635.007
NEA	Incident neutron data	JEFF-3.3	Re188	637.4905
NEA	Incident neutron data	JEFF-3.3	Os187	636.5
NEA	Incident neutron data	JEFF-3.3	U234	637
NEA	Incident neutron data	JEFF-3.3	U235	635.3746
NEA	Incident neutron data	JEFF-3.3	U235	635.9864
NEA	Incident neutron data	JEFF-3.3	U235	636.5639
NEA	Incident neutron data	JEFF-3.3	U238	636.5637
NEA	Incident neutron data	JEFF-3.3	Pu239	637.2519
NEA	Incident neutron data	JEFF-3.3	Pu240	637.56

535 eV

27 rows

ENDF

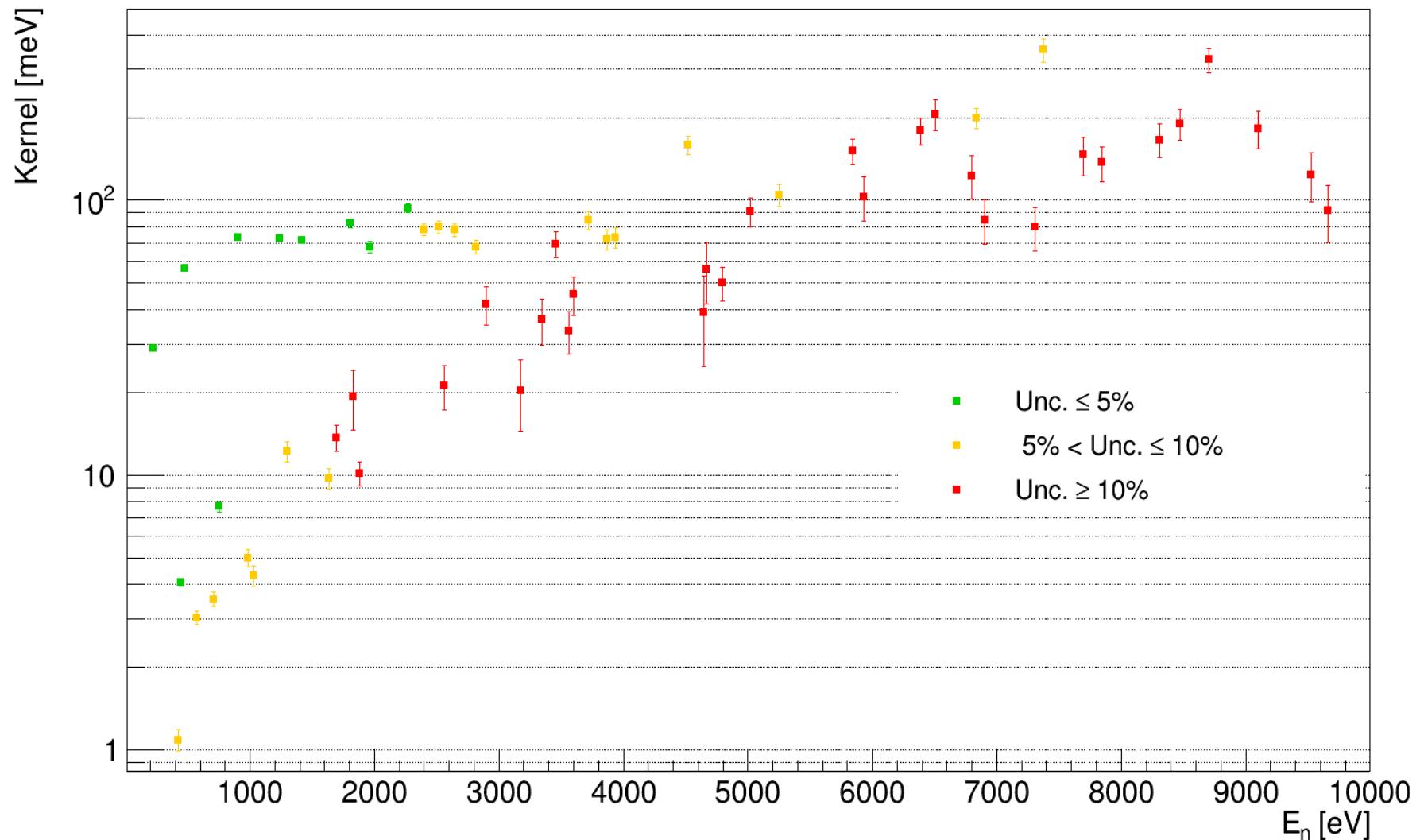
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NEA	Incident neutron data	ENDF/B-VIII.0	Rb86	636
NEA	Incident neutron data	ENDF/B-VIII.0	Sr84	635
NEA	Incident neutron data	ENDF/B-VIII.0	Ru99	636.2
NEA	Incident neutron data	ENDF/B-VIII.0	Pd108	636.2
NEA	Incident neutron data	ENDF/B-VIII.0	Pd110	636.5
NEA	Incident neutron data	ENDF/B-VIII.0	Ag111	634.5
NEA	Incident neutron data	ENDF/B-VIII.0	Cd106	635.087
NEA	Incident neutron data	ENDF/B-VIII.0	Xe129	636.8
NEA	Incident neutron data	ENDF/B-VIII.0	Pr141	635.8
NEA	Incident neutron data	ENDF/B-VIII.0	Nd142	636.4
NEA	Incident neutron data	ENDF/B-VIII.0	Pm145	634.7093
NEA	Incident neutron data	ENDF/B-VIII.0	Dy161	635.3
NEA	Incident neutron data	ENDF/B-VIII.0	Dy163	637.17
NEA	Incident neutron data	ENDF/B-VIII.0	Ho165	634.8
NEA	Incident neutron data	ENDF/B-VIII.0	Er167	636.9
NEA	Incident neutron data	ENDF/B-VIII.0	Re187	636
NEA	Incident neutron data	ENDF/B-VIII.0	Os186	634.7
NEA	Incident neutron data	ENDF/B-VIII.0	Os187	636.5
NEA	Incident neutron data	ENDF/B-VIII.0	Ir194m	634.3605
NEA	Incident neutron data	ENDF/B-VIII.0	U234	637
NEA	Incident neutron data	ENDF/B-VIII.0	U235	635.3727
NEA	Incident neutron data	ENDF/B-VIII.0	U235	635.9863
NEA	Incident neutron data	ENDF/B-VIII.0	U235	636.5657
NEA	Incident neutron data	ENDF/B-VIII.0	U238	636.5637
NEA	Incident neutron data	ENDF/B-VIII.0	Pu239	637.2534
NEA	Incident neutron data	ENDF/B-VIII.0	Pu240	637.4241

117 rows

TENDL

Search NEA	Incident particle	Evaluation	Material	E
NEA	Incident neutron data	TENDL-2019	Mn50m	634.465
NEA	Incident neutron data	TENDL-2019	Co62	634.6249
NEA	Incident neutron data	TENDL-2019	Cu76m	634.6431
NEA	Incident neutron data	TENDL-2019	Ga65	637.5577
NEA	Incident neutron data	TENDL-2019	As73	637.4963
NEA	Incident neutron data	TENDL-2019	Br79m	636.5836
NEA	Incident neutron data	TENDL-2019	Rb86	635.5952
NEA	Incident neutron data	TENDL-2019	Sr84	635
NEA	Incident neutron data	TENDL-2019	Nb102m	637.2151
NEA	Incident neutron data	TENDL-2019	Nb106	635.9606
NEA	Incident neutron data	TENDL-2019	Nb94	635.6213
NEA	Incident neutron data	TENDL-2019	Nb95	636.027
NEA	Incident neutron data	TENDL-2019	Nb98	637.4332
NEA	Incident neutron data	TENDL-2019	Nb98m	635.5377
NEA	Incident neutron data	TENDL-2019	Mo103	635.8959
NEA	Incident neutron data	TENDL-2019	Tc95	637.2974
NEA	Incident neutron data	TENDL-2019	Tc95m	637.5628
NEA	Incident neutron data	TENDL-2019	Ru99	635.7896
NEA	Incident neutron data	TENDL-2019	Ru99	636.2
NEA	Incident neutron data	TENDL-2019	Rh101	634.4981
NEA	Incident neutron data	TENDL-2019	Rh101	635.4865
NEA	Incident neutron data	TENDL-2019	Rh111	635.7004
NEA	Incident neutron data	TENDL-2019	Rh98m	636.0915
NEA	Incident neutron data	TENDL-2019	Rh99	636.2984
NEA	Incident neutron data	TENDL-2019	Pd108	636.2
NEA	Incident neutron data	TENDL-2019	Pd110	636.5
NEA	Incident neutron data	TENDL-2019	Ag105	634.7806
NEA	Incident neutron data	TENDL-2019	Ag105	635.3285
NEA	Incident neutron data	TENDL-2019	Ag116	634.3221
NEA	Incident neutron data	TENDL-2019	Cd99	635.2761
NEA	Incident neutron data	TENDL-2019	Cd99	637.3324
NEA	Incident neutron data	TENDL-2019	In122	636.9546
NEA	Incident neutron data	TENDL-2019	In122	637.2724
NEA	Incident neutron data	TENDL-2019	In124	637.0118
NEA	Incident neutron data	TENDL-2019	In124m	635.2783
NEA	Incident neutron data	TENDL-2019	In124m	636.6797
NEA	Incident neutron data	TENDL-2019	Sn110	636.6528
NEA	Incident neutron data	TENDL-2019	Sn113	637.2378
NEA	Incident neutron data	TENDL-2019	In127	635.75
NEA	Incident neutron data	TENDL-2019	Xe124	637.1186
NEA	Incident neutron data	TENDL-2019	Xe129	636.8
NEA	Incident neutron data	TENDL-2019	Cs135	636.1415
NEA	Incident neutron data	TENDL-2019	La146	637.5143
NEA	Incident neutron data	TENDL-2019	Ce138	635.8478
NEA	Incident neutron data	TENDL-2019	Ce141	635.3785
NEA	Incident neutron data	TENDL-2019	Ce141	636.4137
NEA	Incident neutron data	TENDL-2019	Pr141	635.8
NEA	Incident neutron data	TENDL-2019	Pr143	635.162
NEA	Incident neutron data	TENDL-2019	Pr147	636.7186
NEA	Incident neutron data	TENDL-2019	Pr154	635.4293

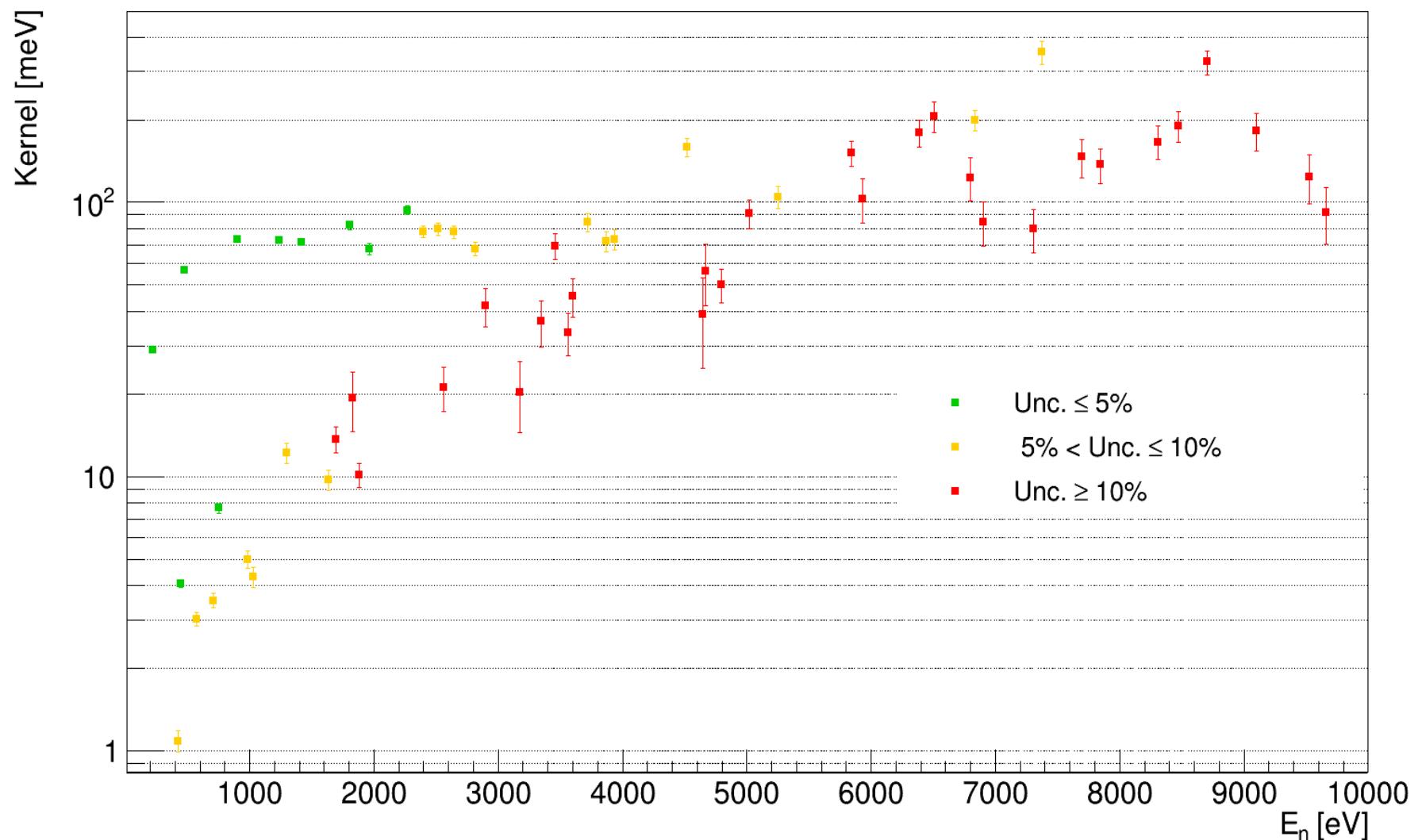
Extracted kernels



Extracted kernels

$$\Gamma_{\gamma 0} = 74.99 \pm 0.62 \text{ meV}$$

$$\Gamma_{n 0} = 4.73 \pm 0.12 \text{ meV}$$



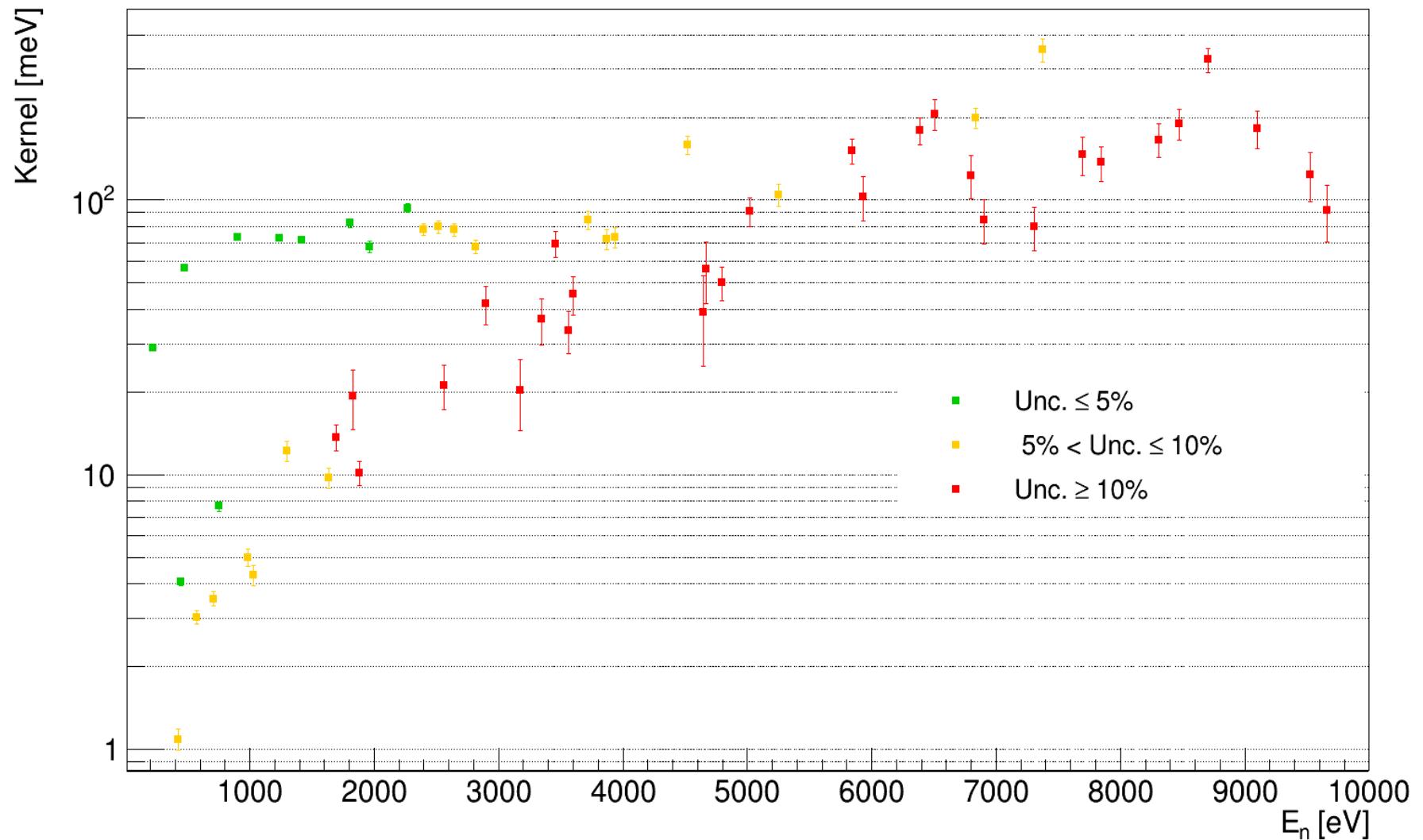
Extracted kernels

$$\Gamma_{\gamma 0} = 74.99 \pm 0.62 \text{ meV}$$

$$\Gamma_{n0} = 4.73 \pm 0.12 \text{ meV}$$

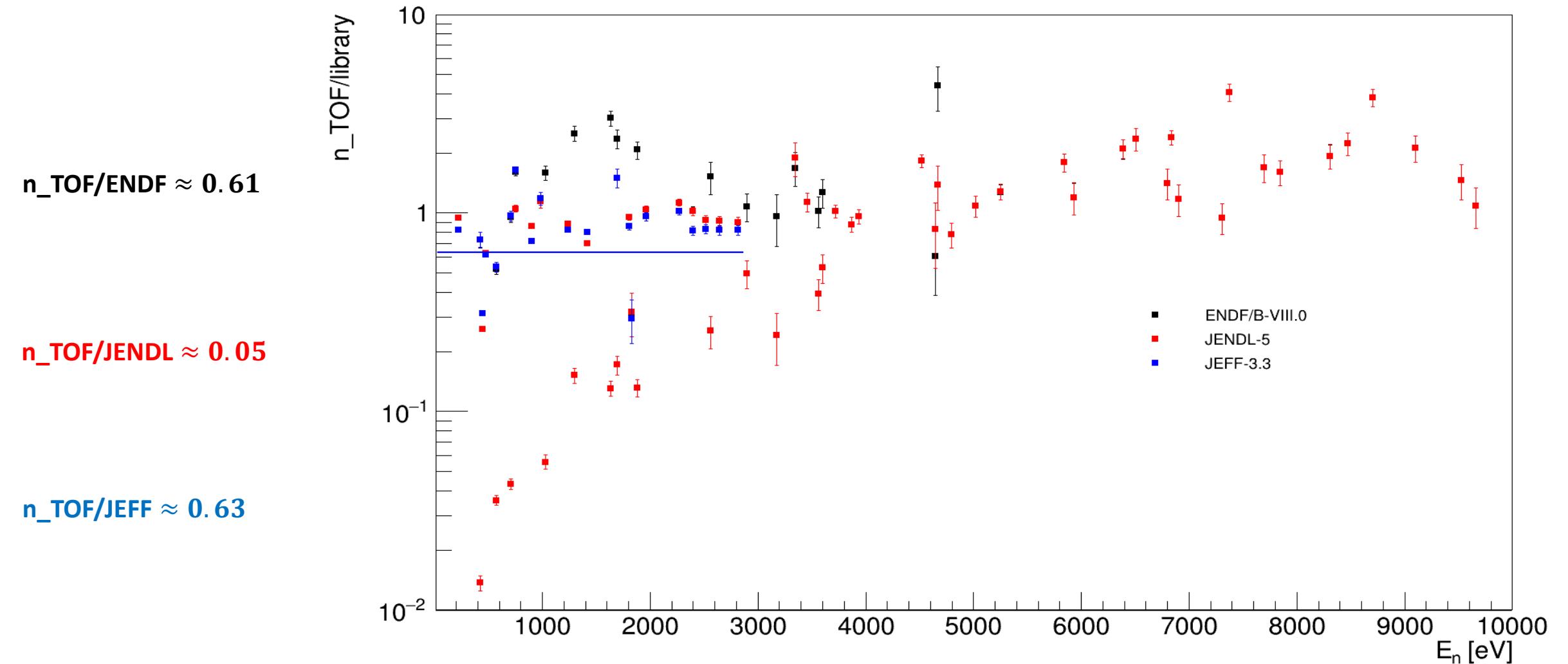
$$\Gamma_{\gamma 1} = 84.16 \pm 5.72 \text{ meV}$$

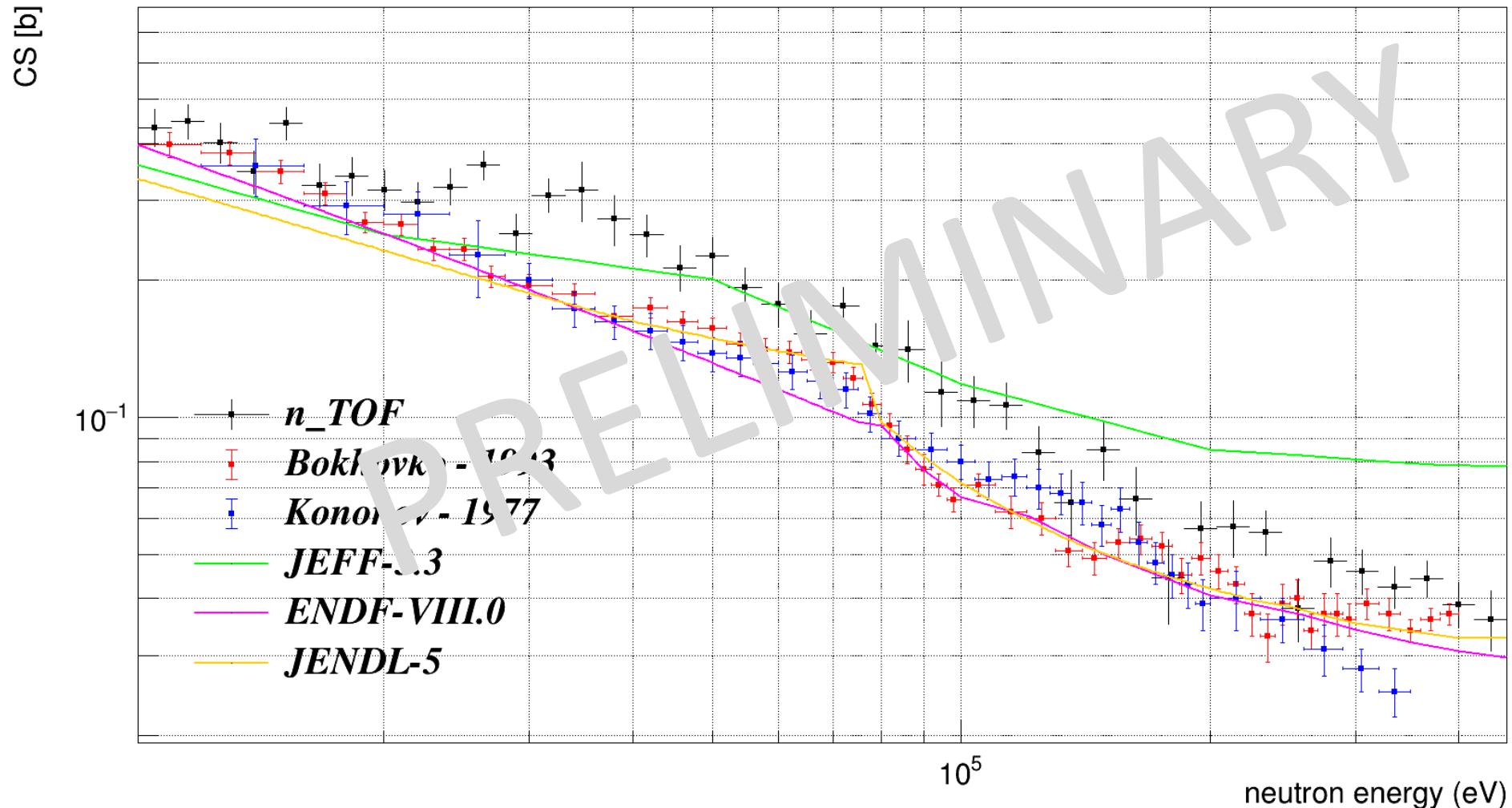
$$\Gamma_{n1} = 5.72 \pm 0.03 \text{ meV}$$

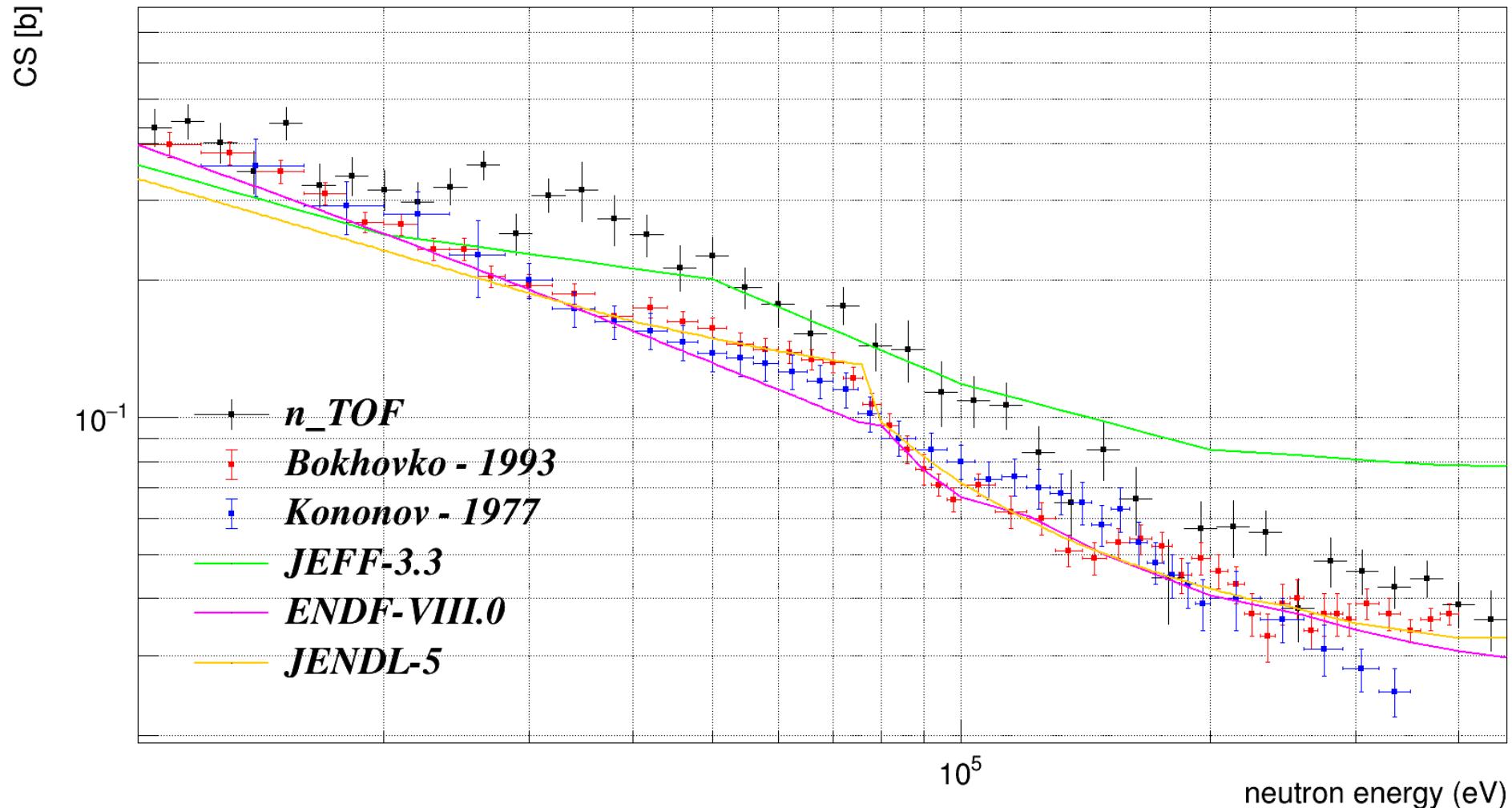


Kernels comparison

kernel ratio





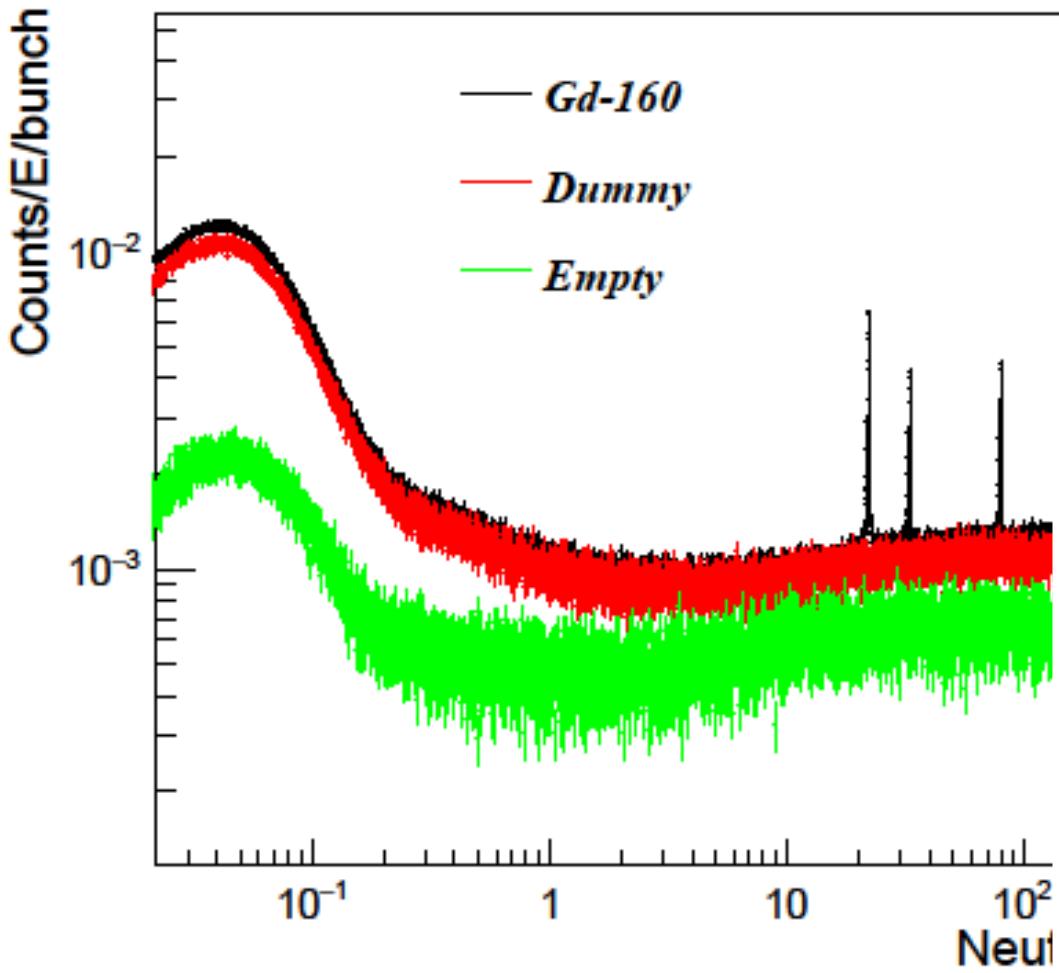


EAR2

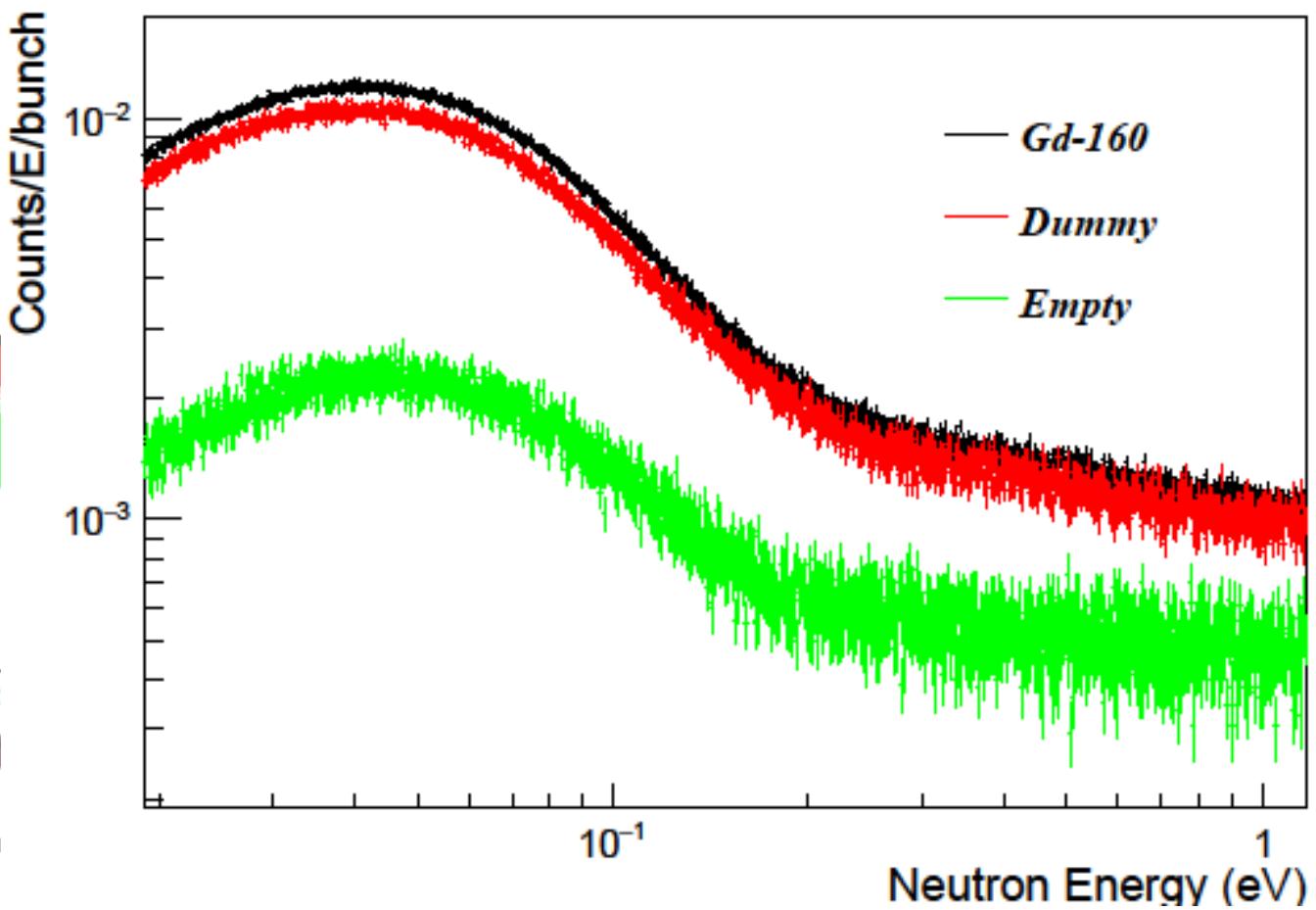
(Thermal and Resolved Resonances Region)

sTED scintillators

Whole Energy Range



Thermal Region



Conclusions

STEPS DONE & TO DO (EAR1)

- *Kernel average uncertainty $\leq 12.0\%$*
- *Dummy background subtracted + in beam γ -rays*
- *RRR analized by R-matrix SAMMY Code + unsigned structures + URR*

TO DO (EAR2)

- *Implementation of the Setup geometry and energy loss (MC code) to get the WF for the PHWT*
- *Extract the Yield from Weighted Counts and normalize at @4.9 eV of Au*
- *Study of the reaction at low neutron energies and the RRR*

Thank You

Conclusions (EAR2)

- *The $^{160}\text{Gd}(n,\gamma)$ has been measured from thermal to a few hundreds of keV in both n_TOF experimental area*
- *The preliminary results have a good S/B ratio in the thermal and in RRR*

TO DO

- *Implementation of the Setup geometry and energy loss (MC code) to get the WF for the PHWT*
- *Extract the Yield from Weighted Counts and normalize at @4.9 eV of Au*
- *Study of the reaction at low neutron energies and the RRR*