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A COMPILATION OF $(n,2n)$ CROSS SECTIONS

MEASURED AT ABOUT 14 MeV

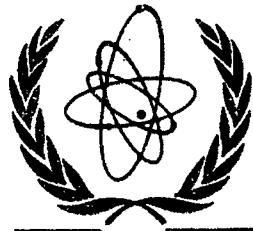
FOR NUCLIDES $6 < Z < 93$

Z.T. Bödy

Institute for Experimental Physics

Kossuth Lajos University

Debrecen, Hungary



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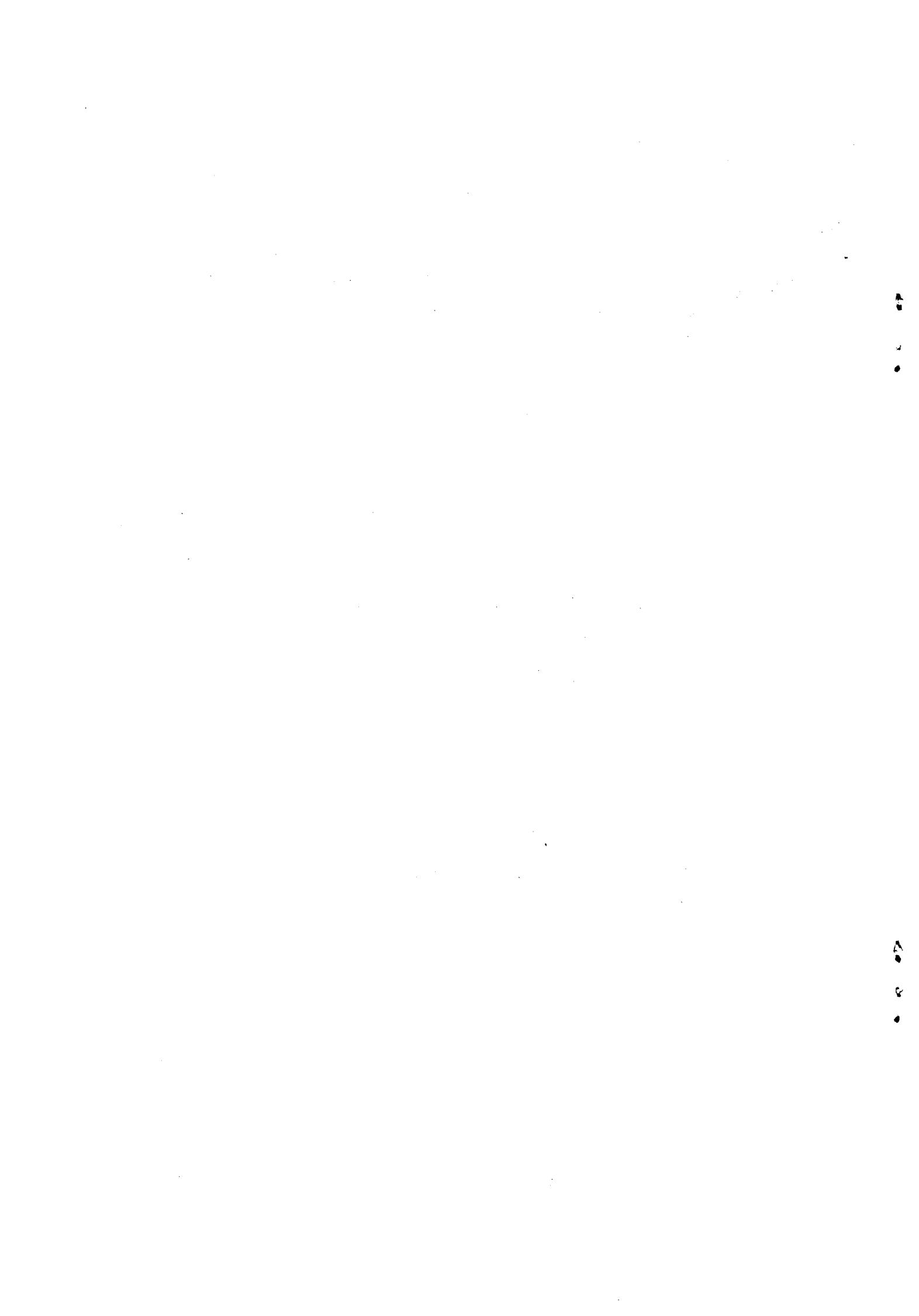
FOR NUCLIDES $6 < Z < 93$

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Note:

The main part of this document is a compilation of 14 MeV ($n,2n$) cross-sections prepared by Z.T. Bödy (Debrecen, Hungary) as a supplement to his thesis. This compilation, which had its closing date end of January 1972, formed the basis for an evaluation of recommended values of ($n,2n$) cross-sections at 14.7 MeV published by Z.T. Bödy and J.Csikai in Atomic Energy Review, vol.11, no.1, March 1973. For convenience a preprint of this evaluation is appended at the end of this document on pages 109 to 125. On page 126 a summary of the thesis by Z.T. Bödy is given.



A COMPILATION OF $/n,2n/$ CROSS SECTIONS
MEASURED AT ABOUT 14 MeV
FOR NUCLIDES $6 \leq Z \leq 93$

A supplement to the Thesis of
Z.T. Bődy

Institute for Experimental Physics in the Kossuth Lajos
University, Debrecen
1972



E X P L A N A T I O N S F O R T H E T A B L E S

The columns of the tables contain the following items:

1. reference number /"Ref."/,
2. neutron energy in MeV /"Energy/MeV"/,
3. /n,2n/ cross section in mb /"Cross Sec/mb"/,
4. an identifying symbol of the particular measurement composed from the name of the /first — if there are more/ author and the last two figures of the date /"Identif."/,
5. comments containing different available informations on the measurements and cross sections given. Usually these are:
 - a/ indication whether absolute or relative measurement was done, in the latter case the reference cross section was presented, for instance: " to Cu⁶³/n,2n/540 mb ",
 - b/ giving the types of the detected radiations and branching ratios if they were available,
 - c/ presentation occasionally informations on the cross section error.

All the cross sections were measured by activation methods unless otherwise stated /by writing the word "nonactivation!" in the comment/. Every element is on separate pages; generally the results of the measurements are in chronological order with some extra spaces reserved for possible future data. The results are given in the original form, no critical comments are attached to them. However, in some cases if it was suspected that a datum misprinted or that two apparently different results are essentially the same /e.g. one is the revised form of the other/ then this opinion is stated in the comment in a hypothetical way. After listing the cross sections arbitrarily normalized excitation functions are also given with a mark of exclamation /beside the word "arbitrarily normalized" /. Also an exclamation mark calls the attention /after the cross section value/ to other irregularities /e.g. the cross section contains some contributions from other processes/, so in such a case it is advisable to read the comment. The excitation functions are always given for the 14-15 MeV energy range ; sometimes data outside this interval are also given or it is noted that more points exist

for other energies. If the results were stored in non-digital form /e.g. graph/ in the reference then a remark "taken from curve" is written in the comment. For abbreviating the reaction $X^A/n, 2n/A-1m$ often the symbol X^{Am} was used. For example, Nb^{93m} means the $Nb^{93}/n, 2n/Nb^{92m}$ reaction; another way which is used to express this: "for the 10 d Nb^{92m} ", here also the half-life of the state is given for the sake of definiteness. Besides original papers also the compilations [5], [8], and [9] were used; if a datum was taken neither from a compilation nor from the original article generally the remark "quoted in" or "cited in" was written in the comment.

The most frequent abbreviations are the following:

abs.=absolute	fig.=figure
accord. or acc.=according	fnd.=/was/ found
act.=activity	f.=from
agreemt.=agreement	ICC.=internal conversion
annih. or ann.=annihilation	coefficient
auths.=authors	integr.=integral
assoc.=associated	identif.=identifying symbol
branch. or br.=branching	irrad.=irradiation
calibr.=calibration	max.=maximum
coinc.=coincidence	measd. or msd.=measured
comm.=comments	measmts. or measm.=measurements
com. or comm.=communication	meth.=method
compil.=compilation	multipl.=multiplication
cont.=contains	nat.=natural
countd. or cntd.=counted	neutr.=neutron
dec.=decay	obsd.=observed
det.=detected	priv.=privat
dev.=deviation	prob.=probable
disint.=disintegration	rad. or r.=radiation
elem.=element	rat. or r.=ratio
energ.=energies	renormd. or renormlzd.=
err. or e.=error	renormalized
est. or estim.=estimated	ref.=reference
exp.=experimental	sandw.=sandwich
E.C.=electron capture	scint.=scintillator

sect. or sec.=section
sngl.=single
spectr.=spectrum or spectra
stand. or st.=standard

st.=state
stat.or statist.=statistical
syst.=systematic
tot.=total

The collection of data was concluded at the end of January, 1972. However, those materials which appeared in the last months or published in reports may be missing.

Thanks are due to A. Demény who helped me in data collection in the first period of this work which results appeared in [128].

Two technical remarks: The references [72], [73] and [75] erroneously got into the list of literature, these contain no $/n, 2n/$ cross section data. The tables have not been paginated in order to make easy to complete them if necessary; atomic and mass numbers as well as identifying symbols can equivalently substitute the page numbers.

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Nitrogen
 $^{14}_{\text{N}}$
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Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[11] [9]	$14,5 \pm 0,35$	$5,67 \pm 0,85$	Paul53	abs.; stand.dev.; stat.e. only
[27]	14	$3,4 \pm 1,0$	Dudley54	abs.; hemisphere target
[9]	14	8,5	Rayburn58	to $\text{Cu}^{63}/n, 2n/500$ mb
[28]	14,1	19 ± 10	Ashby58	abs.; natural target/ 90° /
[26] [9]	$13,77 \pm 0,20$ $14,74 \pm 0,27$ $15,78 \pm 0,32$	$5,18 \pm 0,6$ $8,69 \pm 0,9$ $9,25 \pm 1,0$	Ferguson60	to $\text{Li}^6/n, t/28, 1$ mb total error
[9]	14,1	$4 \pm 1,2$	Brill'61	taken from curve; estim. total error
[25]	$14,4 \pm 0,3$	$7,41 \pm 0,59$	Rayburn61	to $\text{Cu}^{63}/n, 2n/503$ mb; tot. err., stand.dev./ 90° /
[5]	14,2	$8,7 \pm 0,7$	Bormann61	taken from curve
[14]	$14,13 \pm 0,1$	$5,4 \pm 0,46$	Cevolani62	abs.; tot. exp. err.
[71]	14,1	$7,19 \pm 2,25$	Golchert65	"precision $\pm 1,69$ mb"
[29]	$14,8 \pm 0,1$	$8,38 \pm 0,17$	Grimeland65	abs.; stand.dev.stat. err.only, syst.err. seems to be negligible
[7]	$14,6 \pm 0,1$	8 ± 1	Csikai65	to $\text{Cu}^{63}/n, 2n/ 540$ mb
[13]	$13,2 \pm 0,2$ $14,0 \pm 0,3$ $14,1 \pm 0,3$ $15,2 \pm 0,3$	$3,3 \pm 0,4$ $6,0 \pm 0,3$ $6,3 \pm 0,4$ $8,7 \pm 0,7$	Bormann65	abs.; natural target
[12]	$14,7 \pm 0,1$	$6,1 \pm 0,2$	Pasquarelli67	abs.; syst o,12 and stat err. o,15 mb

Fluorine
 $\frac{9}{19} F$

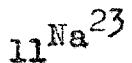
Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[11]	14,5 \pm 0,35	60,6 \pm 18,2	Paul53	abs.; stand.dev.stat.e.only
[8] [9]	14	51,3	Rayburn58	to Cu ⁶³ /n,2n/ 50omb
[28]	14,1	62 \pm 9	Ashby58	abs.; nonactivation tot.e.stand.dev./90°/
[5]	13,6 14,15 14,7 14,95 15,3	46 \pm 5 57 \pm 5 68 \pm 7 75 \pm 7 83 \pm 8	McCravy61	taken from curve
[8] [5]	14,1	73 \pm 4	Brill61	taken from curve
[25]	14,4 \pm 0,3	51,9 \pm 3,84	Rayburn61	to Cu ⁶³ /n,2n/ 503mb \pm 7,3% tot.e.stand.dev./90°/
[14]	14,13 \pm 0,1	38,9 \pm 2,3	Cevolani62	abs.; tot.exp.e.
[13]	13,2 \pm 0,2 14,1 \pm 0,3 15,2 \pm 0,3	25,7 \pm 2,2 41,2 \pm 2,2 60,2 \pm 5,2	Bormann65	abs.;
[18]	13,8 14,18 15,3	49,5 \pm 7 56,0 \pm 7,0 67,0 \pm 6,0	Picard65	stat. error only
[47]	14,2 \pm 0,2	42,6 \pm 3,8	Nagel65	to Fe ⁵⁶ /n,p/118 \pm 3 and Cu ⁶⁵ /n,2n/920 \pm 8omb
[12]	14,7 \pm 0,1	41 \pm 1,5	Pasquarelli67	abs.; from the 1,5syst.e. is 0,8 and stat.e. is 1,0mb
[1]	13,50 \pm 0,47 14,96 \pm 0,87 15,82 \pm 0,45	30,5 \pm 3,7 60,8 \pm 6,0 71,4 \pm 7,0	Menlove67	to U ²³⁵ /n,f/1950mb at 13,28MeV 2250mb at 14,96MeV 2330mb at 15,82MeV stand.dev.tot.error
[7]	14,7 \pm 0,3	53 \pm 4	Csikai68	to Cu ⁶³ /n,2n/ 54omb

Fluorine



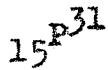
Ref.	Energy/MeV/	Cross.Sect./mb/	Identif.	Comments
[31]	14,0	33,5±1,5		
	14,1	34,6±1,5		to Al ²⁷ /n,d/ 111,5±2 mb
	14,2	36,6±1,5		at 14,7 MeV tot.error
	14,3	38,1±1,5	Vonach68	
	14,4	39,7±2,0		
	14,5	41,3±2,0		
	14,6	42,8±2,0		
	14,7	44,4±2,0		
.....				
[54]	13,54	43,6±2,1		to Cu ⁶³ /n,2n/ of Glover62;
	14,1	55,8±2,7		for Cu ⁶² 0,9782 branching
	14,56	65,9±3,2	Shiokawa68	was taken
	14,7	67,1±3,3		
	14,81	68,4±3,3		
.....				

Sodium



Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[30]	$14,1 \pm 0,2$	$13,78 \pm 1,1$	Prestwood55	abs.; stat.e.only, standard dev. /90/
[5]	14,9	38 ± 23	Picard63	taken from curve
[19]	$13,79 \pm 0,23$ $14,05 \pm 0,25$ $14,42 \pm 0,26$ $14,71 \pm 0,27$ $15,09 \pm 0,26$	$14,2 \pm 1,4$ $28,0 \pm 2,1$ $44,0 \pm 3,1$ $65,8 \pm 4,6$ $84,8 \pm 5,9$	Liskien65	abs.; the total e. is about 6-7% from which about 1% is stat.error
[18]	14,89	$38,5 \pm 23$	Picard65	stat.error only
[1]	$13,50 \pm 0,47$ $14,96 \pm 0,87$ $15,82 \pm 0,45$	$12,0 \pm 10,0$ $41,1 \pm 6,4$ $50,6 \pm 13,2$	Menlove67	to $\text{U}^{235}/n,f/$ 1950 mb at 13,28MeV; 2250 at 14,96; 2330 at 15,82 MeV. stand.dev.tot.error

Phosphorus



Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[8] [9]	14	11,9	Rayburn58	to Cu ⁶³ /n,2n/ 500mb
[26][9]	14,74±0,27	8,7±2,7	Ferguson60	to Li ⁶ /n,t/ He ⁴ 28,lmb
[25]	14,4±0,3	10,9±0,85	Rayburn61	to Cu ⁶³ /n,2n/ 503mb±7,3% tot.e.,stand.dev./90%
[5] [9]	14,8±0,4	8,9±1,2	Kantele62	to Cu ⁶³ /n,2n/ 507±45mb tot.e.,prob.e.
[14]	14,13±0,1	5,1±0,45	Cevolani62	abs.;tot. exp. error
[5] [8]	14,1	12,4±1,6	Bormann63	to Cu ⁶³ /n,2n/ 478±38mb
[5]	14,1	25 ± 5	Carles63	to Cu ⁶³ /n,2n/ 503±35mb taken from curve
[52]	14,8±0,1	8,5±1,2	Grimeland64	abs.; P ³¹ /n,2n/ / P ³¹ /n,d/ = = 0,087±0,006 and P ³¹ /n,d/ = = 98±12mb was used; annihil. measd.; red phosp.used; for Na ²² 89% β ⁺ assumed
[29]	14,8±0,1	11,2±0,4 11,7±0,3*	Grimeland65	abs.;stand.dev.;stat.e.only but syst.e.seems to be neg- ligible; * by other method
[37]	14,8	11 ± 3	Prasad66	to Fe ⁵⁶ /n,p/126mb /90°/tot.e.
[20]	14,8±0,1	16,0±1,6	Mitra 67	to Cu ⁶³ /n,2n/ 530±25mb at 14,8±0,1MeV
[12]	14,7±0,1	8,4±0,3	Pasquarelli67	abs.;from the o,3 syst.e. is 0,2 and stat.e. is 0,1 mb

Chlorine

 $\text{^{35}Cl}$

Ref.	Energy/Mev/	Cross Sect./mb/	Identif.	Comments
for the 3.2 m Cl^{34m}				
[11]	14.5 ± 0.35	3.47 ± 1.56	Paul53	abs.; stand. dev.; stat. err. only
.....				
[5][9][32]	14.8 ± 0.8	5.6 ± 2	Scalon58	to $\text{Cu}^{63}/n, 2n/556 \pm 28 \text{ mb}$ at 14.1 ± 0.15 Mev
.....				
[8][9]	14	5.3 ± 0.4	Rayburn59	to $\text{Cu}^{63}/n, 2n/500 \text{ mb}$. no syst.error included
.....				
[25]	14.4 ± 0.3	5.42 ± 0.41	Rayburn61	to $\text{Cu}^{63}/n, 2n/503 \text{ mb}$ 7.3%; tot.e. stand.dev. /90%
.....				
[5][8][9]	14.8 ± 0.5	12 ± 1.8	Khurana61	to $\text{Fe}^{56}/n, p/126 \text{ mb}$; tot.e.
.....				
[37][78]	14.8	7.3 ± 1	Prasad66	to $\text{Fe}^{56}/np/126 \text{ mb}$; tot.e.
.....				
[12]	14.7 ± 0.1	7 ± 0.2	Pasquarelli67	abs;err. contains o.15 syst., o.1 mb stat,err.
.....				
[32]	15 ± 0.5	7.6 ± 0.7	Pet68	to $\text{Pr}^{141}/n, 2n/2050 \pm 100$ and $\text{Cu}^{63}/n, 2n/560 \pm 30 \text{ mb}$
.....				

for the 1.5 s Cl^{34g}

[5][8][32]	14.8 ± 0.8	2.8 ± 0.5	Scalon58	see above at σ^m
.....				
[32]	15 ± 0.3	1.7 ± 0.3	Pet68	see above at σ^m

Potassium

 $^{19}K^{39}$

Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
for the 7,7 m K^{38g}				
[11]	$14,5 \pm 0,35$	$10,0 \pm 5,5$	Paul53	abs.; stand.dev.stat. err. only
.....				
[8][9]	14	3,8	Rayburn58	to $Cu^{63}/n, 2n/500$ mb.
.....				
[25]	$14,4 \pm 0,3$	$3,37 \pm 0,27$	Rayburn61	to $Cu^{63}/n, 2n/503$ mb \pm $7,3\%$; tot.e., stand.dev. /900/
.....				
[5][8][9]	$14,8 \pm 0,5$	$6 \pm 0,9$	Khurana61	to $Fe^{56}/n, p/126$ mb; tot.e.
.....				
[13]	$14,1 \pm 0,3$ $15,0 \pm 0,3$	$2,7 \pm 0,2$ $6,1 \pm 0,6$	Bormann65	abs.; natural target
.....				
[55]	$14,5 \pm 0,4$	$3,3 \pm 0,7$	Peil65	to $Fe^{56}/n, p/120$ mb \pm 45%/ monitor err. not included
.....				
[12]	$14,7 \pm 0,1$	$3,24 \pm 0,1$	Pasquarelli67	abs.; error contains 0,06 syst., 0,05 mb stat.e
.....				
[2]	$14,2 \pm 0,2$	$2,6 \pm 0,4$	Tiwari68	to $Al^{27}/n, p/115 \pm 5$ mb.
.....				
[32]	$13,6$ $14,1$ $14,5$ $15,0 \pm 0,3$	$0,6 \pm 0,1$ $1,7 \pm 0,2$ $4,1 \pm 0,4$ $5,1 \pm 0,5$	Pet68	to $Pr^{141}/n, 2n/2050 \pm 100$ and $Cu^{63}/n, 2n/560 \pm 30$ mb at 15 MeV
.....				

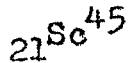
for the 0,95 s K^{38m}

[32]	$15 \pm 0,3$	$0,8 \pm 0,2$	Pet68	see above at σ^g
.....				

Calcium
 $^{48}_{20}\text{Ca}$

Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[5][8][9]	14,9	1070 ± 360	Hille62	to $\text{Al}^{27}/n,\alpha/116 \pm 5,3\text{mb}$ at $14,1 \pm 0,04$ MeV; stand. dev. tot. err.
[5][8]	14,5	920 ± 184	Hillmann62	to $\text{Al}^{27}/n,d/115\text{mb.}$; measd. 1,3 MeV γ with 0,71 abundance
[22]	14,7	611 ± 34	Minetti66	abs; error contains 30 syst., 14 mb stat.
[2]	$14,2 \pm 0,2$	900 ± 108	Tiwari68	to $\text{Al}^{27}/n,\alpha/115 \pm 5\text{mb}$ at $14,2 \pm 0,2$ MeV
[7]	13,1	860 ± 129	Csikai68	to $\text{Al}^{27}/n,d/117\text{mb}$ at 14,1 MeV.

Scandium

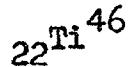


Ref.	Energy/MeV	Cross Sect/mb	Identif.	Comment
for the 4 h Sc^{44g}				
[9] [5]	14,3 ± 0,5	129 ± 9	Khurana59	to $\text{Fe}^{56}/n, p/110$ mb; stat.e.only, other err. ~10 %
[9] [5]	14,8 ± 0,5	148 ± 22	Khurana61	to $\text{Fe}^{56}/n, p/126$ mb; total error
[25]	14,4 ± 0,3	198 ± 15	Rayburn61	to $\text{Cu}^{63}/n, 2n/503$ mb ±7,3%; tot,err.
[9] [5]	14,8	179 ± 27	Mukherjee61	to $\text{Cu}^{63}/n, 2n/556$ and $\text{Al}^{27}/n, \alpha/117$ mb; mean dev.of singl.exp. data
[33] [9]	13,69 ± 0,10 14,01 ± 0,10 14,09 ± 0,10 14,31 ± 0,13 14,50 ± 0,20 14,68 ± 0,26	111,9 ± 4,2 138,5 ± 5,2 150,0 ± 5,7 169,0 ± 6,4 181,4 ± 6,9 204,3 ± 7,7	Prestwood61	to $\text{Al}^{27}/n, \alpha$ /see at Ti^{46} ; errors are stand. deviations in fitting data to a curve of prescri- bed form
[14]	14,13 ± 0,1	130 ± 7,8	Cevolani62	abs; tot.exp,err.
[34]	14,7 ± 0,2	204 ± 25	Bramlitt63	to $\text{Al}^{27}/n, \alpha/114$ mb; tot.e.; probable e.

for the 2,4 d Sc^{44m}

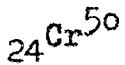
[25]	14,4 ± 0,5	149 ± 11	Rayburn61	see above at Sc^{44g}
[9] [5]	14,8	149 ± 22	Mukherjee61	see above at Sc^{44g}
[33]	13,69 ± 0,10 14,01 ± 0,10 14,09 ± 0,10 14,31 ± 0,13 14,50 ± 0,20 14,68 ± 0,26	91,9 ± 3,0 107,4 ± 3,5 116,2 ± 3,7 127,3 ± 4,1 134,3 ± 4,3 144,7 ± 4,7	Prestwood61	see above at Sc^{44g}
[5]	13,95 14,25 14,50 14,75 14,95	87 ± 5 97 ± 6 115 ± 6,5 126 ± 7,5 133 ± 8	Perkin61	taken from a curve; counted annihilation radiation

Titanium

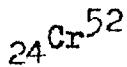


Ref.	Energy/MeV/	Cross Sect./mb/	Identif.	Comments
[8][9]	14	27,9	Rayburn58	to Cu ⁶³ /n, 2n/500 mb.
[5][8][9]	14,8±0,8	50,4±8,1	Poularikas59	to Cu ⁶³ /n, 2n/556±28mb, max. deviations of single exp. data from mean
[6]	13,88±0,10 14,09±0,10 14,58±0,20 14,93±0,36	7,0±1 13,0±3 28,0±3 44,5±3	Prestwood61	to Al ²⁷ /n,d/ 128±6,4; 127±6,4; 120±6,5; and 113±5,7 mb at the four respective energies; see comments at §
[9]	14,4±0,3	31,8±2,4	Rayburn61	to Cu ⁶³ /n, 2n/503mb. total error
[14]	14,13±0,1	13,3±1,1	Cevolani62	abs.; exp. error
[23]	13,6±0,2 14,8±0,1 16,0±0,5	1,6±0,2 44±3 100±10	Fai66	to Al ²⁷ /n,d/ or Butler63
[33]	14,1±0,3 15,0±0,3 16,0±0,3	16±2 69±9 138±18	Bormann65	taken from a curve, no other details given
[7]	14,7±0,3	56±5	Csikai68	to Cu ⁶³ /n, 2n/540 mb.

Chromium

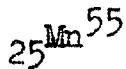


Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[8][9]	14	25,4	Rayburn58	to Cu ⁶³ /n, 2n/500 mb annihil. gamma
[8][9]	14,8	32 ± 3	Mukherjee61	to Cu ⁶³ /n, 2n/556 mb beta-activity
[8][9][25]	14,4 ± 0,3	26,4 ± 2,2	Rayburn61	to Cu ⁶³ /n, 2n/503 mb annihil. gamma
[39]	14,8 ± 0,5	27 ± 6,8	Khurana61	to Fe ⁵⁶ /n, p/126 mb sandwich meth.; beta act.; stat.e.: 2-8%; 0°
[33][5]	13,6 ± 0,2 14,1 ± 0,25 14,9 ± 0,3 15,8 ± 0,3	3 ± 1 10 ± 1,5 28,5 ± 2,5 47 ± 4	Bormann65	taken from a curve
[78]	14	27	Strain65	nat. elem. irrad.



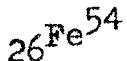
[9]	15,0	280 ± 50	Wenusch61	to Al ²⁷ /n, α/116 mb
[8]	14,9	280 ± 50	Wenusch61	probably these
[9]	14,9	280 ± 50	Hille62	are the variations
[5]	14	280 ± 60	Wenusch63	of the same measurem.
56	12,94 ± 0,20 13,51 ± 0,22 14,1 ± 0,27 14,88 ± 0,31 15,62 ± 0,33	64 ± 5 147 ± 12 276 ± 19 412 ± 29 476 ± 33	Bormann68	abs.; measd. integr. gamma spectr.; more points exist up to 19,56 MeV

Manganese



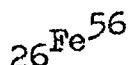
Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[5][8][9]	$14,5 \pm 0,5$	825 ± 190	Weigold60	to $\text{Cu}^{63}/n, 2n/522\text{mb}$ to $\text{Cu}^{65}/n, 2n/1030 \pm 95\text{mb}$ in ref.[5]; sandw.
[8]	14,1	600 ± 120	Wenusch61	to $\text{Al}^{27}/n, f/116\text{mb}$
[9]	14,1	600 ± 120	Hille62	probably is the same
[5]	14,0	900 ± 70	Benveniste58	liquid scint.tank
[8][5]	14,0	1310 ± 328	Granger63	counted 835 keV γ
[41]	$13,79 \pm 0,23$	828 ± 50		abs.;
	$14,05 \pm 0,25$	937 ± 56		835 keV gammas
	$14,42 \pm 0,26$	946 ± 57	Paulsen65	were counted
	$14,71 \pm 0,27$	945 ± 57		
	$15,09 \pm 0,26$	996 ± 60		
[1]	$1350 \pm 0,47$	613 ± 72		to $\text{U}^{235}/n, f/1950$ at
	$14,96 \pm 0,87$	854 ± 79	Menlove67	$13,28; 2250$ at 14,96
	$15,82 \pm 0,45$	890 ± 82		and 2330mb at 1582MeV
[65]	14,1	786 ± 60	Vonach67	priv. com. in [65]
[7]	13,65	750 ± 112	Csikai68	to $\text{Cu}^{65}/n, 2n/940\text{mb}$ at 14,1 MeV; 835keV gammas were counted
[62]	$14,8 \pm 0,20$	750 ± 30	Barrall69	abs.; 835keV gammas counted; 1,00 photon/ decay; given twice stand.dev./60mb/in- cluding all errors
[65]	$14,1 \pm 0,15$	798 ± 78	Bormann69	abs.; more points given by graph only; slope is same as that of Paulsen65

Iron



Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[5]	14	10 ± 4	Allan57	to Cu ⁶³ /n,2n/482±72 mb.; counted betas
[8] [9]	14	16,7	Rayburn58	to Cu ⁶³ /n,2n/500 mb. counted annihil. rad.
[5] [9]	15 ± 4	7	Depraz60	to Cu ⁶³ /n,2n/556±28mb
[3]	14,8	7,5± 1	Fry61	unpublished, cited in [3] on a figure
[5] [9]	14,4±0,3	15,0± 1,3	Rayburn61	to Cu ⁶³ /n,2n/503 mb. counted annihil. rad.
[9][8][5]	14,1±0,1	11 ± 2	Pollehn61	to Li ⁶ /n,t/25,8 mb. counted annihil. rad.
[5] [9]	14,8±0,9	7,9±0,8	Chittenden61	to Al ²⁷ /n,α/114 mb and Cu ⁶³ /n,2n/556 mb
[5]	14,1	10 ± 5,6	Carles63	to Cu ⁶³ /n,2n/503±35 mb; counted annih. rad.
[5]	14,5	8,5±0,8	Cross63	to Al ²⁷ /n,α/115 mb. counted gammas
[3]	14,5±0,105 1675±0,055	283± 0,5 50,4±5,0	Salisbury65	abs.; 90 % of neutrons are within these limits
[78]	14	21	Strain65	no details given
[7]	14,7±0,3	16 ± 3	Csikai68	to Cu ⁶³ /n,2n/540 mb at 14,7 ± 0,3 MeV
[57]	13,9±0,5 14,3±0,5 15,1±0,6 14,3±0,5 15,1±0,6	13 ± 7 10 ± 8 36 ± 17 15 ± 9 19 ± 10	Andreev68a Andreev68b	to Cu ⁶³ /n,2n/480 mb at 14,3 MeV; By two methods:a./annihil. gamma count.; b./co- inc between annihil. gammas.

Iron



Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[5]	14	440 ± 90	Wenusch62	to Al ²⁷ /n, α /116mb.
[8] [9]	14,9	440 ± 88	Hille62	probably the same
[28]	14,1	500 ± 40	Ashby58	nonactivation measurements, abs.; this is cross sect. of natural isotopic mixture

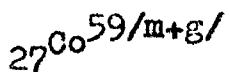
Cobalt

 $^{27}\text{Co}^{59/\text{m+g}/}$

Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[5] [9]	14,5 \pm 0,5	855 \pm 190 /473 \pm 120 for σ^m /	Weigold60	to Cu ⁶⁵ /n, 2n/1030 \pm 95mb; cont. 800keV γ
[8] [5]	14,5	149 \pm 5		
[9]	14,8 \pm 0,9	145 \pm 5 for σ^m	Preiss60	to Ni58/n, 2n/52 \pm 5mb; σ^m = 4 \pm 2 mb
[9] [41]	13,8 \pm 0,05 14,25 \pm 0,05 14,5 \pm 0,1 14,75 \pm 0,1 15,0 \pm 0,15 15,5 \pm 0,2	820 \pm 110 870 \pm 130 930 \pm 100 1020 \pm 120 970 \pm 100 970 \pm 130	Gabbard61	priv. comm. in [9] abs. according to [41]
[41] [33]	13,2 \pm 0,3 14,1 \pm 0,3 15,2 \pm 0,4 16,0	570 \pm 95 640 \pm 100 670 \pm 100 755 \pm 100	Bormann61	abs. according to [41]; Bormann62 in [33]
[9]	14,5 \pm 0,5	385 \pm 100 for σ^m	Bormann62	
[9] [5]	13,86 \pm 0,10 14,11 \pm 0,10 14,37 \pm 0,15 14,59 \pm 0,20 14,77 \pm 0,25	727 \pm 58 776 \pm 62 767 \pm 61 823 \pm 66 827 \pm 66	Weigold62	to Cu ⁶⁵ /n, 2n/G19- ver62 and to Cu ⁶⁵ /n, 2n/;
[43]	14,5 \pm 0,2	0,44 \pm 0,1 for σ^m/σ^g	Weigold62	taken from fig.
[5] [8]	14,1	630 \pm 126	Wenusch62	to Al ²⁷ /n, α /116mb
[9]			Hille62	count. gammas
[8] [5]	14	587 \pm 117	Granger63	count. 800keV γ
[8] [5]	14,1	640 \pm 70	Cabe63	to Cu ⁶⁵ /n, 2n/; ann. γ
[5] [41]	13,55 \pm 0,2 [33] 14,9 \pm 0,2 16,5 \pm 0,2	230 \pm 25 510 \pm 65 640 \pm 65	Jeronymo63	abs. acc. to [41]; counted 800 keV gammas
[5]	14,5	1,55 \pm 0,14 for σ^m/σ^g	Cross63	
[41]	13,79 \pm 0,23 14,05 \pm 0,25 14,42 \pm 0,26 14,71 \pm 0,27 15,09 \pm 0,26	613 \pm 37 650 \pm 39 677 \pm 41 686 \pm 41 704 \pm 42	Paulsen65	abs.; count. annih. gammas; flux measd. by proton rec. telsc and assoc. d., these agreed within 1,4%

Cobalt

27



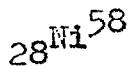
Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[5] [33]	12,55 \pm 0,15 14,1 \pm 0,3 15,2 \pm 0,3	125 \pm 55 /305 \pm 55/ 195 \pm 53 /447 \pm 42/ 182 \pm 100 /518 \pm 80/	Bormann65	for γ^{\pm} / and for σ^{\pm} in bracket/; counted annih. rad.; some taken f. curve
[60]	13,39 \pm 0,06 13,64 \pm 0,08 13,94 \pm 0,08 14,27 \pm 0,08 14,44 \pm 0,08 14,73 \pm 0,09 14,96 \pm 0,10	810 \pm 25 /0,546 \pm 0,025/ 914 \pm 27 /0,533 \pm 0,036/ 920 \pm 28 /0,572 \pm 0,035/ 1010 \pm 27 /0,526 \pm 0,025/Okumura67 996 \pm 12 /0,560 \pm 0,023/ 1030 \pm 17 /0,540 \pm 0,030/ 1105 \pm 30 /0,544 \pm 0,059/		abs.; counted 805 and 810 KeV gammas; /for $\sigma^{\gamma\gamma}$ in bracket/; beta branchings from Nucl. Data Sheets before 1966; flux measd. by assoc. alphas
[43]	13,57 \pm 0,12 14,12 \pm 0,14 14,50 \pm 0,15 14,80 \pm 0,16 15,04 \pm 0,17 15,25 \pm 0,22	600,5 \pm 28,0 /0,44 \pm 0,12/ 640,1 \pm 31,3 /0,56 \pm 0,07/ 683,3 \pm 63,7 669,6 \pm 34,2 /0,58 \pm 0,07/ 643,5 \pm 41,0 /0,45 \pm 0,07/ 626,6 \pm 36,0 /0,41 \pm 0,06/	Decowsky68	to Cu65/n,2n/ of Prest- wood and Bayhurst; /for $\gamma^{\pm}/\sigma^{\pm}$ ratio in the bracket/; see also [58], probably previous results

Nickel



Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[11]	14,5±0,35	40,6 ± 12,2	Paul53	abs.; st.dev.stat.e.
[5] [8] [9]	14,1	38,8 ± 8,2	Purser59	to Cu ⁶⁵ /n,2n/; ann.r.
[9] [8]	14	33,4 ± 2,7	Rayburn59	to Cu ⁶³ /n,2n/500 mb.
[8] [34]	14,8	52 ± 5	Preiss60	to Cu ⁶³ /n,2n/556,Cu ⁶⁵ /n,2n/1000,Al ²⁷ /n, α /11
[6] [9]	13,88±0,10 14,09±0,10 14,31±0,13 14,50±0,20 14,81±0,31	21,4 ± 1,1 23,5 ± 1,3 31,1 ± 1,6 34,3 ± 1,7 39,3 ± 2,0	Prestwood61	to Al ²⁷ /n, α / of Prestwood61 in [9], see also comment at Ti ⁴⁶ Prestwood61 value; see comm. at Sc ⁴⁵
[5] [8] [9]	14,4±0,3	34,2 ± 2,6	Rayburn61	to Cu ⁶³ /n,2n/503 mb.
[9]	14,8±0,8	52 ± 2,6	Cross62	to Al ²⁷ /n, α /115mb.; countd. gammas
[34]	14,7±0,2	31 ± 4	Bramlitt63	to Al ²⁷ /n, α /114 mb
[9] [5]	13,86±0,10 14,11±0,10 14,24±0,10 14,37±0,15 14,49±0,20 14,59±0,20 14,69±0,25 14,77±0,25 14,88±0,30	18,7 ± 1,5 22,9 ± 1,8 27,2 ± 2,2 29,3 ± 2,3 31,7 ± 2,5 33,5 ± 2,7 35,9 ± 2,9 36,2 ± 2,9 39,5 ± 3,2	Glover62	to Cu ⁶³ /n,2n/ of Glover62, see at Cu ⁶³ ; counted annihilation radiation
[5] [33]	12,53±0,2 13,53±0,2 14,9 ± 0,2 16,5 ± 0,2	2 ± 2 8 ± 2 19 ± 3 24 ± 3	Jeronymo63	abs.; counted 138, 1380 and 1910 keV gammas
[33]	13,5 ± 0,25	12 ± 1		taken from curve;
[5]	14,1 ± 0,25 14,9 ± 0,3 15,6 ± 0,3	22,7 ± 1,2 34,5 ± 2,5 40,5 ± 3	Bormann65	counted annihilation radiation
[24]	12,98±0,17 13,10±0,18 13,38±0,21 13,54±0,22 13,88±0,24 14,05±0,25 14,42±0,26 14,61±0,26 14,99±0,27 15,18±0,26 15,55±0,24 15,71±0,23 16,03±0,21	3,2 ± 0,3 4,6 ± 0,4 10,1 ± 0,7 11,9 ± 0,8 19,6 ± 1,4 22,0 ± 1,5 29,4 ± 2,1 33,4 ± 2,3 38,0 ± 2,7 39,5 ± 2,8 43,0 ± 3,0 44,5 ± 3,1 46,1 ± 3,2	Paulsen65	abs.; more points exist up to 19,58 MeV ; see also at Zn ⁶⁴

Nickel



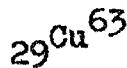
Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[21]	13,95±0,20	24,7 ± 2,5		
[81]	13,95±0,20	24,1 ± 2,4		
	14,20±0,25	25,5 ± 2,6		
	14,31±0,31	25,4 ± 2,5		
	14,31±0,31	30,8 ± 3,1	Temperley67	
	14,53±0,32	26,7 ± 2,7		
	14,53±0,32	27,9 ± 2,8		
	14,79±0,30	28,2 ± 2,8		
	14,79±0,30	31,0 ± 3,1		
[7]	14,7 ±0,3	37 ± 3	Csikai68	abs.; these data are from [21], [81] contains the means of the two independent measmts. listed here; countd. annih.rad., branch. ratio: 93,8 gamma per decays of reaction product was used
[62]	14,8 ±0,2	36 ± 1,5	Barrall69	to Cu ⁶³ /n,2n/540 mb abs.; cntd. 1,37 MeV γ; br.rat.: 0,86 γ/decays; twice stand.dev.given/3mb/including all the uncertainties
[127]	14,4	38 ± 4	Lu70	cited in [127]
[74]	13,56	0,62		
	13,61	0,63		
	13,66	0,64		
	13,71	0,69		
	13,76	0,71		
	13,81	0,74		
	13,86	0,75		
	13,91	0,73		
	13,96	0,69		
	14,01	0,80		
	14,06	0,80		
	14,11	0,79	/1/ Csikai66	
	14,16	0,88		
	14,21	0,80		
	14,26	0,81		
	14,31	0,88		
	14,36	0,93		
	14,41	0,88		
	14,46	0,98		
	14,51	0,93		
	14,56	0,98		
	14,61	0,99		
	14,66	1,00		
	14,71	0,96		

Copper



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[123]	14,0	580 ± 50	Phillips49	taken from curve
[123]	11,8±0,2	20 ± 40		abs.; irradiation with DD
	12,3±0,2	150 ± 50	Fowler50	neutrons; taken from curve
	12,5±0,2	220		
	12,7±0,2	250 ± 50		
[124]	13,0	360 ± 90	Wäffler50	taken from curve
[124][9]	13,25±0,4	270 ± 40		abs.; taken from curve;
	14,25±0,5	650 ± 80	Brolley52	up to 27 MeV;
	16,75±1,2	810 ± 100		
[11]	14,5 ± 0,35	482 ± 73	Paul53	abs.; stat.e. only;
[8][9][14]	14,1±0,15	556 ± 28	Yasumi57	abs.;
[5][8]	14,6	530 ± 25	De Juren60	counted betas;
[5]	13,20	500 ± 50		counted annihilation
	13,60	585 ± 60		radiation;
	13,85	685 ± 70		taken from curve
	14,15	645 ± 65		
	14,42	700 ± 70	McCravy60	
	14,70	770 ± 75		
	14,95	960 ± 95		
	15,35	945 ± 95		
[1][5]	12,4	185 ± 20		to Li ⁶ /n,t/; counted annih.
[14][8]	12,8	235 ± 20		radiation;
	13,77±0,2	378 ± 35	Ferguson60	taken from curve except the
	14,74±0,27	507 ± 45		13,77 and 14,74 MeV values;
	15,8	650 ± 60		up to 18 MeV;
[5][11][8]	14,1±0,2	458 ± 10	Sakisaka61	counted betas;
[11][5][8]	14,1±0,1	490 ± 45	Pollehn61	counted annih.rad.;
[14]	14,13±0,1	409 ± 25	Cevolani62	abs.; total experimental err.;
[5]	12,25	140 ± 13		normalized to 534 mb at 14,3
	14,25	535 ± 50	!// Koehler62	MeV; cntd. annih. rad.;
	16,45	705 ± 65		taken from curve; for 18 MeV, too
[5]	12,05	65		normalized to 503 mb at
	12,6	170 ± 15		14,4 MeV; taken from curve;
	13,0	250		also for higher energies;
	13,4	315	!// Rayburn62	
	15,25	525		
	15,9	600 ± 55		

Copper



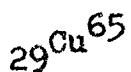
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[48]	13,86±o,1o 14,11±o,1o 14,37±o,15 14,59±o,20 14,77±o,25	424 ± 21 455 ± 23 488 ± 24 // Glover62 519 ± 26 550 ± 28		normalized to 550 mb at 14,77 MeV, this is the mean of Ferguson60 value and a 57o±4o mb value originally measured by Glover62; see also Cu ⁶⁷ ;
[8][9]	14,1	510 ± 36	Forbes52	abs.; counting betas;
[5][9]	13,2 14,1 ±o,1 15,2	320 ± 30 509 ± 56 627 ± 50	Bormann62	to Fe ⁵⁶ /n,p/112,5 mb at 14,1 MeV; taken from curve in [5] except the 14,1 MeV value;
[5]	14,1	478 ± 48	Ietessier64	cndt. annih. radiation;
[29]	14,8±o,1	548 ± 10 568 ± 16 *	Grimeland65	abs.; see P ³¹ ; cndt. betas; * by other method /ann.r./;
[5]	13,55 13,62 13,65 13,72 13,76 13,81 13,86 13,91 13,96 14,00 14,06 14,11 14,16 14,21 14,26 14,31 14,36 14,41 14,46 14,51 14,56 14,61 14,66 14,70	380 407 395 418 412 418 440 412 420 417 433 438 460 462 449 466 472 492 492 504 514 493 508 520		normalized to 541 mb at 14,6 MeV; taken from curve in [5]; counted gammas;
[42]	12,6o±o,11 12,76±o,14 12,98±o,17 13,1o±o,18 13,54±o,22 13,7o±o,23 14,05±o,25 14,24±o,26 14,42±o,26 14,8o±o,27 14,99±o,27 15,18±o,26 15,55±o,24 15,71±o,23	227 ± 14 264 ± 17 315 ± 21 340 ± 22 450 ± 30 479 ± 32 554 ± 38 575 ± 39 598 ± 41 619 ± 42 660 ± 44 715 ± 48 738 ± 49 762 ± 50	// Csikai65 Liskien65	abs.; also for higher energies up to 19,58 MeV

^{63}Cu

Ref.	Energy/MeV	Cross Sec/mb	Identif.	Comments
[12]	14,7 \pm 0,1	511 \pm 15	Pasquarelli67	abs.; cnd. betas;
[51]	13,700 \pm 0,040	389 \pm 12		normalized to 469 \pm 10 mb
	13,745 \pm 0,040	389 \pm 12		at 14,1 MeV, this value is
	13,770 \pm 0,040	420 \pm 13		the result of a compilation
	13,795 \pm 0,040	419 \pm 13		see ref. [77];
	13,820 \pm 0,040	423 \pm 13		
	13,845 \pm 0,040	443 \pm 13		
	13,870 \pm 0,040	431 \pm 13		
	13,895 \pm 0,040	418 \pm 13		
	13,920 \pm 0,040	436 \pm 13		
	13,950 \pm 0,040	441 \pm 13		
	13,975 \pm 0,040	455 \pm 14		
	14,000 \pm 0,040	459 \pm 14		
	14,025 \pm 0,040	463 \pm 14		
	14,055 \pm 0,040	451 \pm 13	/!/ Cuzzocrea68	
	14,075 \pm 0,040	467 \pm 14		
	14,110 \pm 0,040	469 \pm 14		
	14,135 \pm 0,040	462 \pm 14		
	14,160 \pm 0,040	473 \pm 14		
	14,210 \pm 0,040	497 \pm 15		
	14,260 \pm 0,040	479 \pm 14		
	14,300 \pm 0,040	506 \pm 15		
	14,360 \pm 0,045	503 \pm 15		
	14,405 \pm 0,050	517 \pm 16		
	14,445 \pm 0,055	522 \pm 16		
	14,525 \pm 0,060	526 \pm 16		
	14,585 \pm 0,065	517 \pm 16		
	14,670 \pm 0,090	568 \pm 17		
[15]	14,7 \pm 0,2	603 \pm 28	Crumpton69	abs.;
	14,8	615 \pm 28		
[65]	14,1 \pm 0,15	552 \pm 37	Bormann69	abs.;

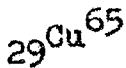
[12]	14,7 \pm 0,1	511 \pm 15	Pasquarelli67	abs.; cnd. betas;
[51]	13,700 \pm 0,040	389 \pm 12		normalized to 469 \pm 10 mb
	13,745 \pm 0,040	389 \pm 12		at 14,1 MeV, this value is
	13,770 \pm 0,040	420 \pm 13		the result of a compilation
	13,795 \pm 0,040	419 \pm 13		see ref. [77];
	13,820 \pm 0,040	423 \pm 13		
	13,845 \pm 0,040	443 \pm 13		
	13,870 \pm 0,040	431 \pm 13		
	13,895 \pm 0,040	418 \pm 13		
	13,920 \pm 0,040	436 \pm 13		
	13,950 \pm 0,040	441 \pm 13		
	13,975 \pm 0,040	455 \pm 14		
	14,000 \pm 0,040	459 \pm 14		
	14,025 \pm 0,040	463 \pm 14		
	14,055 \pm 0,040	451 \pm 13	/!/ Cuzzocrea68	
	14,075 \pm 0,040	467 \pm 14		
	14,110 \pm 0,040	469 \pm 14		
	14,135 \pm 0,040	462 \pm 14		
	14,160 \pm 0,040	473 \pm 14		
	14,210 \pm 0,040	497 \pm 15		
	14,260 \pm 0,040	479 \pm 14		
	14,300 \pm 0,040	506 \pm 15		
	14,360 \pm 0,045	503 \pm 15		
	14,405 \pm 0,050	517 \pm 16		
	14,445 \pm 0,055	522 \pm 16		
	14,525 \pm 0,060	526 \pm 16		
	14,585 \pm 0,065	517 \pm 16		
	14,670 \pm 0,090	568 \pm 17		
[15]	14,7 \pm 0,2	603 \pm 28	Crumpton69	abs.;
	14,8	615 \pm 28		
[65]	14,1 \pm 0,15	552 \pm 37	Bormann69	abs.;

Copper



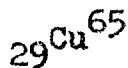
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[8][50]	14,1	970 ± 80	Forbes52	abs.;
[11]	14,5±0,35	1085 ± 175	Paul53	abs.;stat.e.;st.dev.;
[15]	14,1±0,2	1310 ± 200	Yasumi57	abs.;
[8]	14,0	935	Rayburn58	
[46]	14,8±0,9	954 ± 130*	Poularikas59	to Cu ⁶³ /n,2n/556±28 mb;cntd. 2β+KX-ray;br.r.=69,5±5 %; * probable error;
[5]	15	869 ± 104	Depraz60	to Cu ⁶³ /n,2n/556±28 mb;cntd./β;
[8][5]	14,5	1030 ± 95	Weigold60	to Cu ⁶³ /n,2n/522±20 mb;cntd. ann.rad.;in[5]it is for 14 MeV;
[5]	13,2	1250 ± 130		cntd. annihil. radiation;
	13,6	1360 ± 140		taken from curve;
	13,85	1420 ± 140		
	14,15	1340 ± 130		
	14,45	1500 ± 150	McCravy60	
	14,7	1710 ± 170		
	14,95	1620 ± 160		
	15,35	1760 ± 180		
[5]	14,4	959 ± 80	Rayburn61	to Cu ⁶³ /n,2n/503±37 mb;cntd. ann. rad.;
[5]	14,1	940 ± 85	Pollehn61	cntd. ann. rad.;
[9]	14,1±0,1	918 ± 80	Bormann61	
[6]	12,06±0,11	504 ± 25		to /see Ge ⁷⁰ ,Ti ⁴⁶ / for errors see Sc ⁴⁵ ;
	13,33±0,23	778 ± 31		
	13,40±0,20	771 ± 31		
	13,52±0,15	814 ± 33		
	13,69±0,10	830 ± 33		
	13,88±0,10	879 ± 35		
	14,01±0,10	879 ± 35	Prestwood61	
	14,09±0,10	906 ± 36		
	14,31±0,13	892 ± 36		
	14,50±0,20	937 ± 37		
	14,68±0,26	953 ± 38		
	14,81±0,31	968 ± 39		
	14,93±0,36	975 ± 39		
	16,50±0,30	997 ± 50		
[5]	12,55	625 ± 45		cntd.ann.rad.;
	13,4	775 ± 60		also for higher energies;
	14,25	930 ± 70	Rayburn62	
	15,2	1020 ± 80		
	15,9	1015 ± 80		

Copper



Ref.	Energy/MeV	Cross Sec/mb	Identif.	Comments
[48][5]	14,77±0,25	995 ± 70	Glover62	abs.; ctd. ann. rad.; br, r.=19 %; $\tilde{\rho}_{\text{Cs}}/\tilde{\rho}_{\text{Cu}}=2,03 \pm 0,08; 196 \pm 0,03; 1,86 \pm 0,08; 1,79 \pm 0,07$ and $1,75 \pm 0,02$ for $13,86 \pm 0,10; 14,11 \pm 0,10; 14,37 \pm 0,15; 14,59 \pm 0,20$ and $14,77 \pm 0,25$ MeV, respectively;
[5][8]	13,2 14,1 14,6 15,2 15,9	765 ± 70 920 ± 90 952 ± 86 935 ± 90 975 ± 90	Bormann63	to $\text{Al}^{27}/n,d/118 \pm 9$ mb at 14,1 MeV; taken from curve except the 14,6 MeV value; also for higher energies;
[50]	14,7 ± 0,3	1000 ± 25	Bonazzola64	abs.; $\beta^- = 38 \%$, $\beta^+ = 19 \%$;
[5]	13,65 13,8 13,95 14,05 14,15 14,25 14,45 14,55 14,6 14,65	850 860 925 965 935 890 930 995 1026 ± 50 995	Csikai65	to $\text{Cu}^{63}/n,2n/541$ mb at 14,6 MeV; counted gammas; taken from curve;
[47]	14,2 ± 0,2 14,6 ± 0,2	937 ± 84 878 ± 79	Nagel65	to $\text{Fe}^{56}/n,p/112 \pm 8$ mb;
[24]	12,60 ± 0,11 12,76 ± 0,14 12,98 ± 0,17 13,10 ± 0,18 13,38 ± 0,21 13,54 ± 0,22 13,88 ± 0,24 14,05 ± 0,25 14,42 ± 0,26 14,61 ± 0,26 14,99 ± 0,27 15,18 ± 0,26 15,55 ± 0,24 15,71 ± 0,23 16,03 ± 0,21	653 ± 46 672 ± 47 747 ± 52 753 ± 53 827 ± 58 855 ± 60 909 ± 64 893 ± 63 964 ± 68 988 ± 69 986 ± 69 1007 ± 70 1026 ± 72 1065 ± 75 1047 ± 73	Paulsen65	abs.; counted annihilation radiation; branching ratio = 19 %;
[45]	12,60 ± 0,12 13,08 ± 0,09 13,58 ± 0,08	651 ± 30 775 ± 50 863 ± 60	with DD neutrons] to $\text{S}^{32}/n,p/333; 305; 277$ and 226 mb at 12,60; 13,08; 13,58 and 14,50 MeV, respectively; corrected for $\text{Cu}^{63}/n,\gamma/$	interference: this means 6 mb subtraction at 14,50 MeV for natural copper; in [5] these values are under the name/s/ Butler/Santry/65;
	13,58 ± 0,06 13,89 ± 0,08 14,25 ± 0,08 14,50 ± 0,06 14,68 ± 0,06 14,74 ± 0,06	874 ± 26 909 ± 27 943 ± 28 973 ± 30 981 ± 30 1002 ± 30	with DT neutrons] subtraction at 14,50 MeV for natural copper; in [5] these values are under the name/s/ Butler/Santry/65;	Santry66

Copper



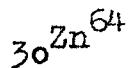
Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[17]	14,2	909 ± 70	Nagel66	to Fe ⁵⁶ /n,p/118±8 mb ; maybe the same as Nagel65
[7]	14,7 ± 0,3	970 ± 50	Csikai68	to Cu ⁶³ /n,2n/540 mb;
[51]	13,700±0,040	841 ± 55		normalized to 919±30 mb at 14,1 MeV following [77] /this is a compilated value /;
	13,745±0,040	827 ± 54		
	13,770±0,040	866 ± 56		
	13,795±0,040	924 ± 60		
	13,820±0,040	854 ± 56		
	13,845±0,040	891 ± 58		
	13,870±0,040	847 ± 55		
	13,895±0,040	863 ± 56		
	13,920±0,040	882 ± 57		
	13,950±0,040	906 ± 59		
	13,975±0,040	917 ± 60		
	14,000±0,040	895 ± 58		
	14,025±0,040	908 ± 59		
	14,055±0,040	882 ± 57	Cuzzocrea68	
	14,075±0,040	854 ± 55		
	14,110±0,040	919 ± 59		
	14,135±0,040	914 ± 59		
	14,160±0,040	916 ± 59		
	14,210±0,040	912 ± 59		
	14,260±0,040	959 ± 62		
	14,300±0,040	976 ± 63		
	14,360±0,045	907 ± 59		
	14,405±0,050	957 ± 62		
	14,445±0,055	997 ± 64		
	14,525±0,060	1055 ± 69		
	14,585±0,065	959 ± 62		
	14,670±0,090	991 ± 64		
[31]	14,7	874 ± 35		to Al ²⁷ /n,α/111,5±2 mb at 14,7 MeV;
	14,6	874 ± 0,990		for the other energies only relative values are given /see the comments at Ag ¹⁰⁷ /;
	14,5	• 0,980		
	14,4	• 0,969		
	14,3	• 0,958		
	14,2	• 0,945	Vonach68	
	14,1	• 0,932		
	14,0	• 0,918		
	13,9	• 0,907		
	13,8	• 0,887		
	13,7	• 0,871		
	13,6	• 0,856		
[15]	14,7±0,2	953 ± 54	Crumpton69	abs.;cntd. annih.rad.;br.r= 19,3±0,5 %;
[65]	14,1±0,15	906 ± 61	Bormann69	abs.;

$^{64}_{30}\text{Zn}$

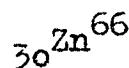
Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[11]	14,5 \pm 0,35	224 \pm 49	Paul53	abs.; st.dev.stat.e.
[34]	14,1 \pm 0,3	150 \pm 30	Cohen56	taken from a curve
[9] [34]	14,1 \pm 0,15	119 \pm 18	Yasumi57	abs.
[8]	14	159	Rayburn58	
[5] [9]	14,8 \pm 0,9	254 \pm 50	Preiss60	to/see Ni58/; cnd. β ;
[5] [61]	13,4 \pm 0,3 14,0 \pm 0,3 14,2 \pm 0,3 15,6 \pm 0,3	78 \pm 7 140 \pm 12 170 \pm 15 250 \pm 25	Koehler60	normalised to 167 \pm 11 mb at 14,4 MeV/Rayburn61/; taken from curve; cnd.betas;
[5] [8] [9]	14,4 \pm 0,3	167 \pm 13	Rayburn61	to Cu $^{63}/n, 2n/503 \pm 37$ mb.
[5] [9]	14,0 14,5 14,75 15,0 13,5	120 \pm 10 180 \pm 15 232 \pm 20 230 \pm 15 95 \pm 8	Gabbard61	taken from curve in [5]; small discrepancy between [5] and [9] values as in [5] the fourth energy is 15,3 instead of 15,0
[14]	14,13 \pm 0,1	105 \pm 7	Cevolani62	abs.tot.exp.e:annih. γ ;
[5]	13,86 \pm 0,10 14,11 \pm 0,10	97 \pm 7 107 \pm 9		to Cu $^{63}/n, 2n/$ and Cu $^{65}/n, 2n/$ of probably Glover62 in [48]; energy errors inferred from [48]; [5] data taken f.curv.
[8]	14,37 \pm 0,15 14,59 \pm 0,20	136 \pm 11 165 \pm 13	Weigold62	
[9]	14,77 \pm 0,25	182 \pm 15		
[34]	14,7 \pm 2	153 \pm 36	Bramlitt63	see comments at Sc 45
[49] [5]	13,2 \pm 0,3	45 \pm 5		taken from curves
[8]	14,1 \pm 0,4 15,2 \pm 0,4	102 \pm 13 184 \pm 20	Borrmann63	
[5]	14,6 \pm 0,1	200 \pm 13	Csikai65	to Cu $^{63}/n, 2n/541$ mb; ctd. γ ;
[4]	13,88 \pm 0,24 14,05 \pm 0,25 14,42 \pm 0,26 14,61 \pm 0,26 14,99 \pm 0,27 15,18 \pm 0,26	114 \pm 8 137 \pm 10 172 \pm 12 196 \pm 14 227 \pm 16 239 \pm 17	Paulsen65	abs.; from the 6-7% errors the statistical error is about 1 %.
[20]	14,8 \pm 0,1	102 \pm 10	Mitra67	to Cu $^{63}/n, 2n/530 \pm 25$ mb.
[10]	14,4 \pm 0,3	150 \pm 12	Ranakumar68	to Al $^{27}/n, p/68 \pm 8$ and Fe $^{56}/n, p/100 \pm 6$ mb.
[54]	13,5 14,6	65 \pm 20 150 \pm 20	Shiokawa68	taken f.curve; err:st.de of at least three measm

Zinc

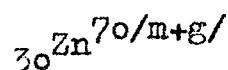
37



Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[7]	14,7 \pm 0,3	225 \pm 25	Csikai68	to Al ²⁷ /n, α /117mb; counted betas
[65]	14,1 \pm 0,15 14,8 \pm 0,15	131,1 \pm 8,2 208,1 \pm 10,8	Bormann69	abs.; more points exist in curve with slope similar to Paulsen65



[5]	14	530 \pm 100	Wenusch62	counted gammas
[9]	14,9	530 \pm 130	Hille62	the same as Wenusch62
[65]	14,9	744 \pm 60	Vonach68	priv.comm.in [65]
[10]	14,4 \pm 0,3	650 \pm 150	Ranakumar68	to Al ²⁷ /n, α /114 \pm 6mb
[7]	14,3	550 \pm 83	Csikai68	to Cu ⁶⁵ /n, 2n/940 mb at 14,1 MeV; cntd. γ ;
[65]	14,1 \pm 0,15 14,8 \pm 0,15 15,4 \pm 0,15	758 \pm 54 863 \pm 63 965 \pm 63	Bormann69	abs.; taken from curve except the 14,1 MeV value



[7]	14,7 \pm 0,3	1307 \pm 130	Csikai68	to Al ²⁷ /n, α /117mb. counted betas
[36]	14,7 \pm 0,3	574 \pm 60	Károlyi68	for $\sigma^{\gamma}/57$ m/
[10]	14,4 \pm 0,3	600 \pm 40	Ranakumar68	for $\sigma^{\gamma}/14$ h/; to Fe ⁵⁶ /n, p/100 \pm 6 and Al ²⁷ / n, α /114 \pm 6 mb.

$^{31}\text{Ga}^{69}$

Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[11]	14,5 ± 0,35	552 ± 166	Paul53	abs.; st.dev.stat.e.
[9]	14	1089	Rayburn58	
[5] [9]	14,4 ± 0,3	923 ± 70	Rayburn61	to Cu ⁶³ /n, 2n/503 ± 37 mb
[39]	14,8 ± 0,5	1070 ± 107	Khurana61	to Fe ⁵⁶ /n, p/see Cr ⁵⁸
[14]	14,13 ± 0,1	735 ± 44	Cevolani62	abs; tot.exp.e.
[13]	13,2 ± 0,2	688 ± 66		"abs."/ Zn ⁶⁶ /n, p/was
	14,1 ± 0,3	925 ± 75	Bormann65	absolutely measured
	14,8 ± 0,2	1057 ± 86		and used as a stand-
	15,2 ± 0,3	1004 ± 96		ard for this reaction,
[20]	14,8 ± 0,1	983 ± 150	Mitra67	to Cu ⁶³ /n, 2n/530 ± 25 mb
[78]	14	950 ± 95	Chatterjee67	
[7]	14,7 ± 0,3	1088 ± 100	Csikai68	to Al ²⁷ /n, p/73 mb; det. β

 $^{31}\text{Ga}^{71}$

[11]	14,5 ± 0,35	700 ± 105	Paul53	abs.; st.dev.stat.e.
[39]	14,8 ± 0,5	2180 ± 218	Khurana61	to Fe ⁵⁶ /n, p/see Cr ⁵⁸
[7]	14,7 ± 0,3	961 ± 100	Csikai68	to Al ²⁷ /n, p/73 mb; det. β

Germanium

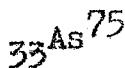
 $^{32}\text{Ge}^{70}$

Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comment
[11]	14,5 ± 0,35	666 ± 233	Paul53	abs.; st.dev.stat.e.
[9]	14	604 ± 48	Rayburn59	same as Rayburn61 ?
[9]	14,4 ± 0,3	598 ± 45	Rayburn61	to $\text{Cu}^{65}/n, 2n/503 \pm 37\text{mb}$.
[9] [6]	13,83 ± 0,10 14,01 ± 0,10 14,31 ± 0,13 14,50 ± 0,20 14,68 ± 0,26 14,83 ± 0,31 14,93 ± 0,36	509 ± 15 508 ± 15 607 ± 18 621 ± 19 664 ± 20 716 ± 21 681 ± 20	Prestwood61	to $\text{Al}^{27}/n, \alpha/118 \pm 5, 8\text{mb}$ at 14,68 MeV, values at other energies see in [9] and comments at Ti^{46} and Sc^{45}
[39]	14,8 ± 0,5	1600 ± 240	Khurana61	to $\text{Fe}^{56}/n, p$; see Cr^{50}
[63]	14,4 ± 0,3	448 ± 45		to $\text{Al}^{27}/n, \alpha/114 \pm 7$ and $\text{Fe}^{56}/n, p/100 \pm 6\text{mb}; E_\gamma = 574 \text{ keV}; o, 119 \pm /$ disint
	14,4 ± 0,3 - 1445 ± 45	Wood67		to $\text{Al}^{27}/n, \alpha$ and $\text{Cu}^{65}/n, 2n/94 \pm 8\text{mb}; E_\gamma = 574 \text{ keV}; o, 119 \pm /$ disintegr.
	14,4 ± 0,3 - 648 ± 100			to $\text{Al}^{27}/n, \alpha/7$ and $\text{Cu}^{65}/n, 2n/7; \text{cntd. annih. rad.}; \text{branch. r.} = 0,35$ for Ge^{69} and 0,19 for Cu^{64} ; finally presented, recommended: 447 ± 45 mb.

 $^{32}\text{Ge}^{76/m+g/}$

[11]	14,5 ± 0,35	1820 ± 546	Paul53	abs.; st.dev.stat.e.
[39]	14,8 ± 0,5	1200 ± 240	Khurana61	to $\text{Fe}^{56}/n, p$; see Cr^{50}
[5]	14,8	1171 ± 150	Mangal63	to $\text{Al}^{27}/n, p/83 \pm 6\text{mb}; 3^+ \pm 726 \pm 15\text{mb}; 5^- \pm 0,62$ to, 08 were given
[63]	14,4 ± 0,3	1236 ± 120		counting gamma, $E_\gamma = 265 \text{ keV}; o, 11$ photon/disintegration;
	14,4 ± 0,3 - 1444 ± 289	Wood67		counting beta; $1,00 \beta^-$ /disintegr.; for monitors see Ge^{70}
[60]	13,39 ± 0,06 13,64 ± 0,08 13,78 ± 0,08 14,11 ± 0,08 14,44 ± 0,08 14,59 ± 0,08 14,86 ± 0,09 14,96 ± 0,10	974 ± 39 /o, 839 ± 0,06/ 1024 ± 41 /o, 784 ± 0,056/ 1084 ± 43 /o, 810 ± 0,058/ 1154 ± 46 /o, 759 ± 0,055/ 1123 ± 45 /o, 808 ± 0,058/ 1178 ± 47 /o, 802 ± 0,058/ 1334 ± 53 /o, 736 ± 0,053/ 1438 ± 57 /o, 743 ± 0,053/	Okumura67	abs.; counted 265 keV gamma in the bracket: the $\sigma/\gamma/\gamma$ ratio; counted 139 keV gamma

Arsenia



Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
[11]	14,5 ± 0,35	545 ± 158	Paul53	abs.; st.dev.stat.e.
[9] [6]	14,01 ± 0,10	1070 ± 43		to Al ²⁷ /n,α/of Prest-
	14,31 ± 0,13	1113 ± 45		Prestwood61 wood61 in [9], see also
	14,68 ± 0,26	1149 ± 49		comments at Ti ⁴⁶ and
	14,93 ± 0,36	1123 ± 45		Sc ⁴⁵ ;
[5] [8]	14,1	843 ± 253	Granger63	cntd. 596 and 635 keV γ
[38]	14,05 ± 0,10	965 ± 68	Hille66	to Al ²⁷ /n,α/value=?
	14,75 ± 0,10	1038 ± 73		
[117]	14,4 ± 0,3	1016 ± 102	Cook67	cntd. 596 and 635 keV γ
[7]	14,7 ± 0,3	1092 ± 120	Csikai68	to Cu ⁶⁵ /n,2n/970 mb.
[56]	13,51 ± 0,22	825 ± 35		abs.; measured gammas;
	14,10 ± 0,27	1018 ± 65	Bormann68	data exist for more
	14,88 ± 0,31	1109 ± 71		energies
	15,62 ± 0,33	1123 ± 72		
[67]	14,2 ± 0,2	1170 ± 117	Prasad69	to Al ²⁷ /n,α/115 ± 5 mb; cntd. 596 keV γ; 0,61 γ/disintegration

Selenium

 $^{74}_{34}\text{Se}$

Ref.	Energy/MeV/	Cross Sect/mb/	Identif.	Comments
for the 7 h $\text{Se}^{73\text{g}}$				
[5]	14,4 ± 0,3	383 ± 30	Rayburn61	to $\text{Cu}^{63}/n, 2n/503 \pm 37$ mb
[68]	14,1	258 ± 21	Bormann66	cited in [68]; f.more energ.
[68]	14,4 ± 0,2	293 ± 29	Rao67	to $\text{Fe}^{56}/n, p/100 \pm 6$ mb with 0,989 γ /disint.; cntd. 360 keV γ with 0,99 γ /disintgr.
[40]	14,7	294 ± 20	Minetti67	abs/?/
[64]	13,71 ± 0,12	233,5 ± 7,9		to $\text{Cu}^{65}/n, 2n/$ of Santry66
	14,17 ± 0,15	331,9 ± 12,3	Aboud69	and Paulsen65
	15,02 ± 0,20	510,3 ± 11,5		
	15,22 ± 0,20	565,1 ± 9,0		
[102]	14,7	420 ± 44	Ivanenko69	

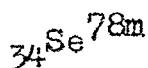
for the 42 m $\text{Se}^{73\text{m}}$

[5]	14,4 ± 0,3	48,7 ± 8,0	Rayburn61	to $\text{Cu}^{63}/n, 2n/503 \pm 37$ mb.
[68]	14,1	41,7 ± 4,6	Bormann66	see above
[68]	14,4 ± 0,2	65 ± 15	Rao67	to $\text{Fe}^{56}/n, p/$ see above; cntd. annih.r.l, 70 /disint
[40]	14,7	580 ± 60	Minetti67	abs/?/
[64]	13,71 ± 0,12	6,08 ± 0,52		see above
	14,17 ± 0,15	5,71 ± 0,78	Aboud69	
	15,02 ± 0,20	6,35 ± 0,56		
	15,22 ± 0,20	4,89 ± 0,23		

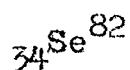
 $^{76}_{34}\text{Se}$

[38]	14,05 ± 0,10	845 ± 59	Hille66	to $\text{Al}^{27}/n, \alpha/$ value=?
	14,75 ± 0,10	944 ± 66		
[40]	14,7	1250 ± 80	Minetti67	abs/?/
[68]	14,4 ± 0,2	808 ± 81	Rao67	to / see at $\text{Se}^{74}/$; cntd. 280 and 401 keV γ with 0,25 and 0,12 γ /disintegration, respectively

Selenium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[40]	14,7	738 ± 40	Minetti67	abs/?; 18 s isomeric st,
<hr/>				
[5]	14,8	$125 \pm 12,5$	Mangal65	to Al ²⁷ /n,p/value=?; cntd. γ
[40]	14,7	255 ± 20	Minetti67	abs/?; 3,9 m isomeric st.
[68]	$14,4 \pm 0,2$	680 ± 100	Rao67	to /see at Se ⁷⁴ /; cntd. 96 keV γ with no, 078 γ /disint.
<hr/>				



for the 18 m Se^{81g}

[5]	14,8	< 100	Mangal65	to Al ²⁷ /n,p/
[40]	14,7	385 ± 20	Minetti67	abs/?/
[68]	$14,4 \pm 0,2$	225 ± 45	Rao67	to /see at Se ⁷⁴ /; cntd. 276+290 keV; o, 014 γ /decay
[126]	$14,8 \pm 0,5$	310 ± 25	Hasan72	to /see Mo ^{92m} /;

for the 57 m Se^{81m}

[11]	$14,5 \pm 0,35$	$\geq 1500 \pm 495$	Paul53	abs.; st.dev.stat.error
[5]	14,8	1600 ± 160	Mangal65	to Al ²⁷ /n,p/value=?; cntd. γ
[40]	14,7	1077 ± 30	Minetti67	abs/?/
[68]	$14,4 \pm 0,2$	894 ± 89	Rao67	to /see at Se ⁷⁴ /; cntd. 103 keV γ ; o, 119 γ /decay
[7]	12,5	1490 ± 224 for σ^{75-76} Csikai68	to Al ²⁷ /n, α /117 mb at 14,1 MeV; cntd. betas	
[102]	14,7	1870 ± 250	Ivanenko69	Se ⁸² /n,2n/+Se ⁸⁰ /n, γ /Se ^{81m}
[126]	$14,8 \pm 0,5$	850 ± 50	Hasan72	to /see Mo ^{92m} /;

Bromine

 $^{35}\text{Br}^{79}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[11]	14,5 ± 0,35	1141 ± 285	Paul53	abs.;st.dev.stat.e;cntd. β
[9]	14	788 ± 63	Rayburn59	
[5]	13,35 14,1 14,25 15,6	610 ± 50 815 ± 50 830 ± 70 895 ± 80	Alford60	normalized to 835 mb at 14,4 MeV ;taken from curve; counted beta
[9]	14,4 ± 0,3	835 ± 63	Rayburn61	to Cu ⁶³ /n,2n/503±37 mb
[14]	14,13± 0,1	793 ± 48	Cevolani62	abs.;cntd.annihilation r.
[5]	14,1	1330 ± 150	Carles63	to Cu ⁶³ /n,2n/503±35 mb taken from curve;cntd.ann.r.
[29] [5]	14,8 ± 0,1 14,8 ± 0,1	1060 ± 35 1141 ± 27	Grimeland65	abs.;two independent mea- smts.:first cntd.beta,se- cond cntd.annih.r.
[60]	13,39± 0,06 13,46± 0,08 13,86± 0,08 14,02± 0,08 14,16± 0,08 14,35± 0,08 14,59± 0,08 14,79± 0,09 14,96± 0,10	765 ± 18 821 ± 18 843 ± 36 868 ± 12 920 ± 30 933 ± 15 997 ± 14 1013 ± 14 1037 ± 20		abs.;flux measured by associated alphas
[117]	14,4 ± 0,2	741 ± 74	Rao68	cntd. 614 keV gammas

 $^{35}\text{Br}^{81}$ for the 18 m Br^{80g}

[9] [5]	14,2 ± 0,2	470 ± 50	Fukuzawa61
[9] [5]	14,6 ± 0,2	437 ± 29	Strohal62 to Al ²⁷ /n, α /115 and Fe ⁵⁶ /n,p/110 mb.
[29]	14,8 ± 0,1	464 ± 36	Grimeland65 abs.;st.dev.stat.e.only
[69]	14,7 ?	290 ± 25	Minetti67 abs/?; cited in [69]

Bromine



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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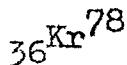
for the 18 m Br^{80g}

[60]	13,39±0,06 13,51±0,07 13,64±0,08 13,86±0,08 14,27±0,08 14,43±0,08 14,59±0,08 14,73±0,08 14,86±0,09 14,96±0,10	596 ± 21 648 ± 18 667 ± 19 704 ± 26 715 ± 27 723 ± 19 766 ± 24 762 ± 20 814 ± 22 806 ± 26		abs; flux measured by associated alphas
[117]	14,4 ± 0,2	391 ± 39	Rao68	cntd. 618 keV gammas

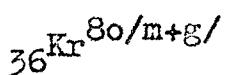
for the 4,4 h Br^{80m}

[11]	14,5 ± 0,35	828 ± 166	Paul53	abs.; stat.e., st.dev.; cntd. β
[9] [5]	14,4 ± 0,3	752 ± 72	Rayburn61 to Cu ⁶³ /n, 2n/503 ± 37 mb	
[9] [5]	14,2 ± 0,2	510 ± 56	Fukuzawa61	
[9] [5]	14,6 ± 0,2	610 ± 93	Strohal62 to /see at $\sigma^{\gamma\gamma}$ /	
[33] [5]	13,2 ± 0,3 14,1 ± 0,4 14,6 ± 0,3 15,4 ± 0,3	615 ± 80 720 ± 80 755 ± 90 800 ± 90	Bormann62	to Fe ⁵⁶ /n, p/ value=?; cntd. 620 keV gamma; taken from curve; for more energies up to 19,4 MeV
[29]	14,8 ± 0,1	760 ± 15	Grimeland65	abs; stat.e.; cntd. β
[69]	14,7?	740 ± 40	Minetti67	abs/?; cited in [69]
[60]	13,39±0,06 13,51±0,07 13,64±0,08 13,86±0,08 14,27±0,08 14,43±0,08 14,59±0,08 14,73±0,08 14,86±0,09 14,96±0,10	0,625±0,036 0,623±0,036 0,635±0,034 0,635±0,051 0,645±0,042 0,632±0,029 0,637±0,034 0,638±0,029 0,635±0,028 0,626±0,034		abs.; measured 620 keV gamma
[117]	14,4 ± 0,2	737 ± 74	Rao68	cntd. 618 keV gammas

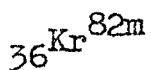
Krypton



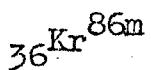
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[70]	14,4 ± 0,3	245 ± 20	Kondaiah68	to Fe ⁵⁶ /n,p/100±6mb for [847 keV with 0,9867 γ/decay]; cntd. 151 keV γ with 0,896γ/dec
[127]
[117]	14,4 ± 0,2	721 ± 50	Kondaiah68a	cites a paper of Kondaiah and Fink different from [70]



[70]	14,4 ± 0,3	810 ± 60	Kondaiah68	to /see at Kr ⁷⁸ /and to Al ²⁷ /n,d/114±6mb; cntd. 398 keV γ with 0,0772 γ/decay; [117] cites 809±40 mb/see also at Kr ⁷⁸ /
[127]
[70]	14,4 ± 0,3	415±50 for σ ^m	Kondaiah68	to Si ²⁸ /n,p/252±15mb for [1780 keVγ with 1,00γ/decay]; cntd. 127 keV γ; [117] cites 315±30mb



[70]	14,4 ± 0,3	160 ± 15	Kondaiah68	to Si ²⁸ /n,p/see above; 188 keVγ detected; [117] cites 158±3mb
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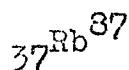
[70]	14,4 ± 0,3	350 ± 35	Kondaiah68	to Fe ⁵⁶ /n,p/see above; cntd. 150 keVγ with 0,77γ/decay; [117] cites 346 ± 25 mb.
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$^{37}\text{Rb}^{85}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
				for the 21 m $\text{Rb}^{84\text{m}}$ + 33 d $\text{Rb}^{84\text{g}}$
[5] [78]	13	1170 ± 230		taken from curve; the \pm
	13,9	1450 ± 290	Tewes60	20 % error given in [78]
	14,5	1870 ± 380		
[6] [9]	13,4 \pm 0,20	1099 ± 55		to /see at $\text{Ge}^{70}, \text{Ti}^{46}/$;
	13,69 \pm 0,10	1356 ± 68		σ does not contain the
	14,09 \pm 0,10	1447 ± 72	Prestwood61	decay of $\text{Rb}^{84\text{m}}$ by E.C.;
	14,50 \pm 0,20	1498 ± 75		counted betas; for
	14,68 \pm 0,26	1520 ± 76		errors see Sc^{45} ;
	14,81 \pm 0,31	1530 ± 77		
[5]	14,7	1420 ± 70	Rieder65	to $\text{Al}^{27}/n, \alpha/117\text{mb}; \text{cntd. } \gamma$
[69]	14,7	1682 ± 222	Minetti68	abs/?/
[7]	13,7	830 ± 125	Csikai68	to $\text{Al}^{27}/n, \alpha/117\text{mb}$ at 14,1 MeV; counted betas
[56]	13,51 \pm 0,22	887 ± 71		abs.; detected gammas
	14,10 \pm 0,27	937 ± 58		
	14,88 \pm 0,31	1174 ± 94	Bormann68	
	15,62 \pm 0,33	1170 ± 93		
[117]	14,4 \pm 0,2	478 ± 48 for γ^{∞}	Rao68	cntd. 250 and 464 keV γ ;

for the 33 d $\text{Rb}^{84\text{g}}$				
[9] [5] $14,6_{-0,3}^{+0,2}$	687 ± 74	Strohal62	to $\text{Al}^{27}/n, \alpha/115$ and $\text{Fe}^{56}/n, p/110\text{ mb}$; accord. to [69]	
			this is σ^{mag} ;	
[56]	13,51 \pm 0,22	610 ± 68		abs.; for $\sigma^{\infty}: 277 \pm 19$; 314 ± 21 ; 374 ± 28 ; 393 ± 29 at the
	14,10 \pm 0,27	623 ± 54	Bormann68	same energies mb
	14,88 \pm 0,31	800 ± 90		
	15,62 \pm 0,33	777 ± 89		
[69]	14,7	756 ± 161	Minetti68	abs/?/; $\sigma^{\infty} = 926 \pm 61 \text{ mb}$
[117]	14,4 \pm 0,2	414 ± 41	Rao68	cntd. 880 keV gammas
[125]	14,1	$1,07 \pm 0,05$ for σ^{∞}	Kneissl69	

Rubidium



Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

for the 1 m $\text{Rb}^{86m} + 19 \text{ d } \text{Rb}^{86g}$

[5] [78]	13	1760 ± 350		taken from curve; the \pm
	13,85	2080 ± 420	Tewes60	20 % error given in [78];
	14,5	2430 ± 490		counted gammas
[6] [9]	$13,40 \pm 0,20$	1056 ± 53		to /see at $\text{Ge}^{70}, \text{Ti}^{46}/$;
	$13,69 \pm 0,10$	1107 ± 55		σ does not contain the
	$14,09 \pm 0,10$	1170 ± 59	Prestwood61	decay of Rb^{86m} by E.
	$14,50 \pm 0,20$	1211 ± 61		C.; counted betas;
	$14,68 \pm 0,26$	1194 ± 60		for errors see Sc^{45} ;
	$14,81 \pm 0,31$	1191 ± 60		
[5]	$14,05$	1390 ± 140	Rieder65	to $\text{Al}^{27}/n, \alpha/127 \text{ mb}$ at
	$14,7$	1550 ± 150		$14,05 \text{ MeV}$ and 117 mb at
				$14,7 \text{ MeV}$; cndt. gammas
[7]	13,1	1290 ± 194	Csikai68	to $\text{Al}^{27}/n, \alpha/117 \text{ mb}$ at
				$14,1 \text{ MeV}$; cndt. betas
[69]	14,7	2551 ± 350	Minetti68	abs/?/
[117]	$14,4 \pm 0,2$	973 ± 97	Rao68	cndt. 1078 keV gammas

for the 19 d Rb^{86g}

[5] [9]	$14,6 \pm 0,2$	835 ± 136	Strohal62	to /see at $\text{Rb}^{85g}/$; accord to [69] this is σ^{mg} ;
[69]	14,7	1619 ± 250	Minetti68	abs/?/; $\sigma^{\text{mg}} = 932 \pm 150 \text{ mb}$;

Strontium

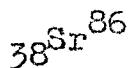
 $^{38}\text{Sr}^{84}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[39]	14,8 ± 5	1770 ± 180	Khurana61	to Fe ⁵⁶ /n,p/126 mb; tot.e.
[6] [9]	13,33 ± 0,23	71,7 ± 3,6		to /see at Ge ⁷⁶ ,Ti ⁴⁶ ;
	13,40 ± 0,20	84,3 ± 4,3		counted betas; for errors
	13,69 ± 0,10	111,1 ± 5,6		see Sc ⁴⁵ ;
	13,88 ± 0,10	115,9 ± 5,8		
	14,09 ± 0,10	142,4 ± 7,1	Prestwood61	
	14,31 ± 0,13	149,9 ± 7,5		
	14,50 ± 0,20	171,7 ± 8,6		
	14,68 ± 0,26	176,8 ± 8,8		
	14,93 ± 0,36	180,6 ± 9,0		
[9] [5]	14,6 ± 0,2	380 ± 50	Strohal62	to /see at Rb ⁸⁴ /; tot.e.
[9]	14,7	140 ± 80	Pouliakis62	priv.comm.in [9]

 $^{38}\text{Sr}^{86}$ for the 65 d Sr⁸⁵S

[9]	14,1	680 ± 109	Münzer61	to Al ²⁷ /n, α /116 mb.; cntd. gammas; tot.error
[9] [5]	14,6 ± 0,2	280 ± 10	Strohal62	to /see Rb ⁸⁵ /; cntd. γ ;
[5]	14,05	863 ± 43	Rieder65	to Al ²⁷ /n, α /117 at 14,7 and 127 mb at 14,05 MeV
	14,7	950 ± 50		
[7]	14,7	570 ± 86	Csikai68	to Cu ⁶⁵ /n,2n/940 at 14,1 MeV; cntd. annih. rad.
[69]	14,7	910 ± 80	Minetti68	abs/?/

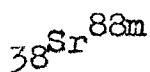
Strontium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
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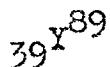
for the 70 m Sr^{85m}

[9]	14,1	21 ± 8	Münzer61	to /see at Sr ^{86S/}
[9] [5]	14,6 ^{+0,2} _{-0,3}	312 ± 50	Strohal62	to /see at Rb ^{85g/}
[5]	14,7	246 ± 12	Rieder65	to Al ^{27/n,d/117} mb.
[69]	14,7	222 ± 25	Minetti68	abs/?/



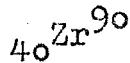
[5]	14,8	45	Bramlitt61	
[9] [5]	14,6 ^{+0,2} _{-0,3}	215 ± 24	Strohal62	to /see at Rb ^{85g/}
[13]	12,6 ^{+0,2} 13,2 ^{+0,2} 14,1 ^{+0,3} 15,2 ^{+0,3} 16,0 ^{+0,3}	106 ± 8 165 ± 12 213 ± 12 246 ± 19 248 ± 19	Bormann65	abs.; for more energies up to 19,6 MeV;
[69]	14,7	365 ± 30	Minetti68	abs/?/

Yttrium



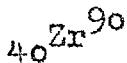
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[9] [5]	12,8	240 ± 48		taken from curve; the ±
	13,0	330 ± 66		20 % error given in [78];
	13,9	585 ± 117	Tewes60	counted gammas
	14,0	680 ± 136		
	14,6	685 ± 137		
	15,1	1005 ± 261		
[9]	14,1	540 ± 80	Münzer61	to Al ²⁷ /n, d/116 mb; cntd. γ
[9] [5]	14,6 ^{+0,2} _{-0,5}	542 ± 58	Strohal62	to / see at Rb ⁸⁵ ; cntd. γ
[5]	14,8	1130 ± 300	Hudson62	taken from curve
[8] [5]	14	1350 ± 338	Granger63	taken f. curve; cntd. 908 keV γ
[5]	14,05	915 ± 45	Rieder65	to / see at Sr ⁸⁶ ; taken
	14,7	1020 ± 50		from curve; cntd. gammas
[7] [36]	15,0	1010 ± 150	Csikai68	to Al ²⁷ /n, d/117 mb at 14,1 MeV; cntd. 899 keV γ
[6]	13,33 ^{+0,23}	8,20 ^{+0,41}		arbitrarily normalized!
	13,40 ^{+0,20}	8,74 ^{+0,44}		
	13,52 ^{+0,15}	8,63 ^{+0,43}		
	13,69 ^{+0,10}	10,54 ^{+0,69}		
	13,88 ^{+0,10}	10,70 ^{+0,54}		
	14,01 ^{+0,10}	12,01 ^{+0,60}		
	14,09 ^{+0,10}	11,96 ^{+0,60}	// Prestwood61	
	14,31 ^{+0,13}	13,17 ^{+0,66}		
	14,50 ^{+0,20}	13,46 ^{+1,35}		
	14,68 ^{+0,26}	13,74 ^{+0,69}		
	14,81 ^{+0,31}	14,16 ^{+0,71}		
	14,93 ^{+0,36}	13,89 ^{+0,70}		
[124]	14,1 to, 2	825 ± 32	Mather69	see at U ²³⁸ ; nonactivation!

Zirconium



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
for the $4,2 \text{ m Zr}^{89m} + 78 \text{ h Zr}^{89g}$				
[9] [5] [69]	14,1	544 \pm 22	Reed60	cntd. 588 and 915 keV gammas; $\sigma^2 = 470 \pm 22 \text{ mb}$;
[6]	13,40 \pm 0,20 13,51 \pm 0,15 13,69 \pm 0,10 13,88 \pm 0,10 14,01 \pm 0,10 14,09 \pm 0,10 14,31 \pm 0,13 14,50 \pm 0,20 14,68 \pm 0,26 14,81 \pm 0,31 14,93 \pm 0,36	398 \pm 12 457 \pm 14 527 \pm 16 585 \pm 18 604 \pm 18 623 \pm 19 for $\delta^4 93\% \sigma^{\infty}$ 716 \pm 21 768 \pm 23 822 \pm 25 838 \pm 25 856 \pm 26	Prestwood61	to /see at $\text{Ge}^{70}, \text{Ti}^{46}/$; counted betas; for errors see Sc^{45} ;
[9] [5]	14,4 \pm 0,3	677 \pm 51	Rayburn61	to $\text{Cu}^{63}/n, 2n/503 \pm 37 \text{ mb}$ cntd. annih. gammas
[69]	14,6 \pm 0,2 [9] [5]	502 \pm 36	Strohal62	to /see $\text{Rb}^{85g}/$; cntd. γ ; accord. to [9]: this is δ^4 and to [5]: $\delta^4 93\% \sigma^{\infty}$;
[5]	14,05 14,7	600 \pm 25 740 \pm 40 for $\delta^4 93\% \sigma^{\infty}$	Rieder65	to /see $\text{Sr}^{86}/$; counted gammas
[7]	15,1	800 \pm 60	Csikai68	to $\text{Cu}^{65}/n, 2n/940 \text{ mb}$ at 14,1 MeV; cntd. 511 and 915 keV gammas
[69]	14,7	953 \pm 97	Minetti68	abs/?; $\sigma^2 = 762 \pm 82 \text{ mb}$
[64]	13,57 \pm 0,12 14,20 \pm 0,20 14,56 \pm 0,11 14,86 \pm 0,14 15,14 \pm 0,13	596,5 \pm 4,4 677,9 \pm 28,5 759,2 \pm 5,8 815,7 \pm 15,5 885,5 \pm 4,0	Santry66 and Paulsen65; Aboud69	only statistical errors are given
[109]	14,4 \pm 0,3	652 \pm 31	Lu70	to $\text{Fe}^{56}/n, p/100 \pm 6 \text{ mb}$; err. con- tains $\sim 1\%$ stat.e. and does not cont. monitor err; for $\delta^4 910 \text{ keV}$ γ with 99% branch.r./o, ol T^{17+} / was used; see also at δ^4 ;
[109]		750 \pm 50		cited in [109] for the 14-15 MeV region without name

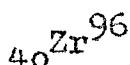
Zirconium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif-	Comments
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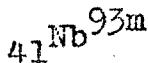
for the 4,2 m Zr^{89m}

[69]	[9]	14,1	74 ± 3	Reed60	cntd. 588 keV gammas
[5]					
[11]	[9]	$14,5 \pm 0,35$	$\geq 79,8 \pm 40$	Paul53	abs.; stat.e.
[9]		14,7	84	Pouliakis62	priv.comm. in [9]
[34]	[9]	$14,7 \pm 0,2$	84 ± 12	Bramlitt63	to $\text{Cu}^{63}/n,2n$ /value=?; cntd. beta and gamma
[5]		14,8	168 ± 12	Mangal63	to $\text{Al}^{27}/n,p/83 \pm 6$ mb; measd: $\sigma^2/\sigma^{meas} = 0,72 \pm 0,08$; cntd. γ ;
[5]		14,7	142 ± 21	Rieder65	to $\text{Al}^{27}/n,\alpha/117$ mb
[69]		14,7	191 ± 15	Minetti68	abs/?
[64]		$13,57 \pm 0,12$	$7,91 \pm 0,29$		to $\text{Cu}^{65}/n,2n$ of Santry66
		$14,20 \pm 0,20$	$4,48 \pm 0,15$		and Paulsen65; only
		$14,56 \pm 0,11$	$4,53 \pm 0,14$ for 5% γ^m	Aboud69	statistical errors are given
		$14,86 \pm 0,14$	$4,48 \pm 0,18$		
		$15,14 \pm 0,13$	$3,98 \pm 0,12$		
[109]		$14,4 \pm 0,3$	$79,5 \pm 5,6$	Lu70 to $\text{Fe}^{56}/n,p/100 \pm 6$ mb; cntd. 588 keV gammas with 94% branching rate $/ 0,08$ ICC./; see also at Zr^{90} ;	



[109]		$14,4 \pm 0,3$	1456 ± 80	Lu70 to $\text{Fe}^{56}/n,p/100 \pm 6$ mb; cntd. 724 and 756 keV gammas with branch. r. 43,1 and 55,5 %, respectively see also comment at Zr^{90}

Niobium



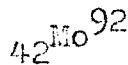
Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

[5]	[9]	13	365 ± 73		taken from curve; cntd. gamma;
		13,9	385 ± 77		the $\pm 20\%$ error is supposed
		14,0	395 ± 79	Tewes60	following other Tewes; re-
		14,6	410 ± 82		sults /see e.g. at Rb ^{85,87} ,
		15,1	420 ± 84		Y ⁸⁹ /
[9]	[5]	14,5	560 ± 62	Glagolev61	to Cu ^{63/n,2n/620} ± 40 mb; cntd.
					940 keV γ ; in [5] 14,7 MeV is
					written instead of 14,5
[9]		14,1	430 ± 70	Münzer61	to Al ^{27/n, \alpha/116} mb.; tot.e.e.
[78]		~ 15	360 ± 120	Alford62	to Cu ^{63/n,2n/586} mb.;
[9]	[5]	14,5 $\pm 0,9$	499 ± 91	Bramlitt62	to Cu ^{63/n,2n/556} ± 28 , Cu ^{65/n,2n/954} ± 130 and Al ^{27/n, \alpha/114} ± 7 mb; tot.e.e.; probable error!
[9]	[5]	14,6 $\pm 0,2$	318 ± 18	Strohal62	to /see at Rb ^{85S} /; in [9] this is assigned to a non-existing half-life
[5]		14,05	470 ± 25	Rieder65	to /see at Sr ^{86S} /; cntd. γ ;
		14,7	465 ± 25		
[78]		~ 15	400 ± 20	Western66	
[109]		14,4 $\pm 0,3$	578 ± 30	Iu70	to /see at Zr ⁹⁸ /; cntd. 934 keV γ with 99 % br.r.; see also Zr ⁹⁰
[116]		13,79 $\pm 0,23$	428 ± 22		abs.; time of flight; measd. from 12,62 to 19,59 MeV;
		14,05 $\pm 0,25$	423 ± 21		
		14,42 $\pm 0,26$	422 ± 21	Paulsen70	proton recoil telescope
		14,71 $\pm 0,27$	421 ± 21		
		15,09 $\pm 0,26$	420 ± 21		
[6]		13,40 $\pm 0,20$	$17,99 \pm 0,90$		arbitrarily normalized!
		13,69 $\pm 0,10$	$18,01 \pm 0,90$		
		14,01 $\pm 0,10$	$18,43 \pm 0,92$		
		14,31 $\pm 0,13$	$18,32 \pm 0,92$	Prestwood61	
		14,50 $\pm 0,20$	$18,46 \pm 0,92$		
		14,68 $\pm 0,26$	$18,20 \pm 0,91$		

Molybdenum
 ^{92}Mo /m+g/
 ^{42}Mo

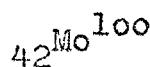
Ref.	Energy MeV/	Cross Sec/mb/	Identif.	Comments
[5] [9]	14,25±0,25	310 ± 87	Brolley52	counted betas; for 14,5 MeV in [5]
[11]	14,5 ±0,35	190 ± 29	Paul53	abs.; stat.e.; cntd. betas
[9] [5]	14,1 ±0,15	132 ± 21	Yasumi57	abs.; counted betas
[9]	14	188	Rayburn58	to $\text{Cu}^{63}/n, 2n/500$ mb; ann.rad.
[9] [5]	14,4 ±0,3	211 ± 16	Rayburn61	to $\text{Cu}^{63}/n, 2n/503 \pm 37$ mb; ann.r.
[9] [5]	14,6 ±0,2	315 ± 35	Strohal62	to /see at $\text{Rb}^{85}\beta$; cntd. β and γ
[9]	14,7	198 ± 40	Poularikas62	the same as Bramlitt63 ?
[14]	14,13±0,1	106 ± 7,5	Cevolani62	abs.; counted annih. rad.
[34]	14,7	198 ± 40	Bramlitt63	to $\text{Al}^{27}/n, \alpha/114$ mb;
[5] [36]	14,8	159 ± 16 for σ^3	Bacsó65	counted betas
[5] [7]	13,96	120		to $\text{Cu}^{63}/n, 2n/540$ mb at 14,7 MeV; cntd. beta and annihil.
	14,00	125		gamma ; in [5] this is assigned to σ^3 , while in [7] to σ^{ann} ;
	14,06	133		the errors are of the same magnitude as in the 14,60 MeV case
	14,11	130		
	14,16	127		
	14,21	138		
	14,26	146		
	14,31	151		
	14,36	153	Csikai65	
	14,41	157		
	14,46	155		
	14,51	161		
	14,56	166		
	14,60±0,1	175 ± 10		
	14,66	168		
	14,71	168		
[69]	14,8/?	256 ± 27	Prasad67	$\sigma^3 = 205 \pm 25$ mb;
[77]	14,1±0,2	158±5 for σ^3	Cuzzocrea67	to $\text{Cu}^{65}/n, 2n/919 \pm 30$ and $\text{Cu}^{63}/n, 2n/469 \pm 10$ mb; cntd. betas;
[69]	14,7	163±12 for σ^3	Minetti68	abs./?/; cntd. β^+ with b.r.=94%
[15]	14,7 ±0,2	222±10 for σ^3	Crumpton69	abs.; cntd. annih. rad. with br. r.=94%; metastable st. not obs.
	14,8 ±0,4	227±10		
[64]	13,56±0,13	102,0±2,0		to $\text{Cu}^{65}/n, 2n/$ of Santry66
	14,18±0,15	150,7±2,3		and Paulsen65; only statisti-
	14,53±0,11	156,3±1,5	Aboud69	cal errors are given
	14,85±0,13	201,5±2,6		
	15,05±0,20	232,2±3,3		
[109]	14,4 ±0,3	217 ± 18	Lu70	to /see Zr^{90} ; measd.: $\sigma^3 \text{ fm}^{-2} = 12,4 \pm 0,6$
[126]	14,8 ±0,5	232 ± 16	Hasan72	to /see Mo^{92m} ; $\sigma^3 = 112 \pm 14$ mb;

Molybdenum



Ref. Energy/MeV/ Cross Sec(mb/ Identif. Comments

for the 65 s Mo^{91m}				
[5] [36]	14,8	$15 \pm 1,5$	Bacs65	measd. $\sigma/\rho^2 = 10,6 \pm 0,3$
[69]	14,8/?	51 ± 10	Prasad67	
[69]	14,7	7 ± 2	Minetti68	abs./?/o,658 MeV γ was cntd. with br.r.=57 % /o,o55 ICC./
[64]	$13,72 \pm 0,10$	$68,92 \pm 7,06$		to /see at $\text{Mo}^{92m+g}/$; only statistical errors are
	$14,08 \pm 0,06$	$17,90 \pm 0,66$		
	$14,53 \pm 0,11$	$13,26 \pm 0,83$	for γ/ρ^2 Aboud69	given
	$14,78 \pm 0,16$	$9,73 \pm 0,36$		
	$15,05 \pm 0,20$	$8,20 \pm 0,38$		
[109]	$14,4 \pm 0,3$	$16,2 \pm 1,2$	Lu70	to $\text{Si}^{28}/n,p/252 \pm 15$ mb; cntd. 658 keV γ with br.r.=58 % /o,o55 ICC./; see also Zr^{90}
[126]	$14,8 \pm 0,5$	120 ± 12	Hassan72	to $\text{Al}^{27}/n,p/73 \pm 10$ or $\text{Al}^{27}/n,\alpha/$ 115 ± 8 mb; cntd. betas and gammas

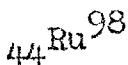


[11]	$14,5 \pm 0,35$	3790 ± 1895	Paul53	abs.; stat.e.; cntd.betas
[39]	$14,8 \pm 0,5$	1910 ± 191	Khurana61	to $\text{Fe}^{56}/n,p/115$ mb.;
[9] [5]	$14,6 \pm 0,2$	2039 ± 210	Strohal62	to /see $\text{Rb}^{87}/$; cntd. β and γ ;
[77]	$14,1 \pm 0,2$	1510 ± 180	Cuzzocrea67	to /see $\text{Mo}^{92m+g}/$;
[7]	$14,7 \pm 0,3$	1762 ± 200	Csikai68	to $\text{Al}^{27}/n,\alpha/117$ mb; cntd. β ;
[109]	$14,4 \pm 0,3$	1389 ± 84	Lu70	to /see $\text{Zr}^{90}/$; cntd. 740 keV γ with 12 % branch. ratio

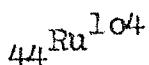
Ruthenium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[11]	14,5 ± 0,35	478 ± 91	Paul53	abs.; stat.e; cntd. betas
[9] [5]	14,4 ± 0,3	634 ± 55	Rayburn61	to Cu ⁶³ /n, 2n/503 ± 37 mb; ann.
[5]	14,7	860 ± 43	Rieder65	to Al ²⁷ /n, α/117 mb; cntd. γ;
[5]	14,7	2600 ± 300	Gray66	to Cu ⁶³ /n, 2n/507 and Al ²⁷ /n, p/82 mb; cntd. 768 keV γ of Tc ⁹⁵ ; cross section might contain 100-500 mb contribution from Ru ⁹⁶ /n, d/; cross sec. is larger than expected non-elastic cross section
[109]	14,4 ± 0,3	569 ± 30	Lu 70	to /see Zr ⁹⁰ /; cntd. 340 keV γ with 75 % br.r.;
[109]		616 ± 50		quoted in [109] for the 14- -15 MeV region without name

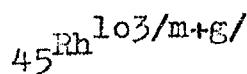


[109]	14,4 ± 0,3	1169 ± 96	Lu 70	to /see Zr ⁹⁰ /; cntd. 215 keV γ with br. r.=91 %;
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[5]	14,7	2500 ± 500	Gray66	to /see above/; cntd. 498 keV γ; cross sec. is larger than expected non-elastic cross section
[109]	14,4 ± 0,3	1440 ± 80	Lu 70	to /see Zr ⁹⁰ /; cntd. 497 keV γ with branch.r.=88 %;

Rhodium

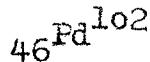


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[9] [5]	13	700 ± 80		counted gammas
	13,9	730 ± 80		
	14,0	740 ± 80	Tewes70	
	14,6	770 ± 80		
	15,1	790 ± 80		
[109]	14,4 ± 3	435 ± 35 for σ^m	Zr ⁹⁰	to /see Zr ⁹⁰ /; for σ^m : cntd.
	14,4 ± 3	522 ± 45 for $\gamma\gamma$	Lu ⁷⁰	698 keV /br.r.=42,2%/ , 768 /31,6%/ and 1050 keV χ /b.r.=31,6%/ for σ^m : cntd. 475 keV χ with branc ratio 57 %;/o ICC. in every case
		$\sigma^m \leftarrow \sigma^m$		
[116]	13,81±24	974±53 /390±31/		abs.; time of flight; both
	14,20±26	946±52 /383±30/		σ^m and σ^m are measured
	14,41±26	919±47 /379±26/	Paulsen70	from 10,63 to 19,59 MeV;
	15,03±27	984±50 /431±31/		in the bracket: $\sigma^m(1,1\gamma)$

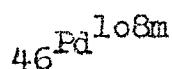

 919
 379

 540

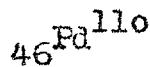
Palladium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[79][78]	14,4±0,3	569 ± 40	Fink68	to Fe ⁵⁶ /n,p/100±6 mb; the same as Lu70 ?532±71mb in [117]
[117]				
[109]	14,4±0,3	637 ± 45	Lu70	to /see Zr ⁹⁰ /; cntd. 298 keV γ with 30 % branching ratio



[79][78]	14,4±0,3	448 ± 32	Fink68	see comments at Pd ¹⁰²
[69]	14,7	517 ± 80	Minetti68	abs./?/; cntd. 220 keV with br.r.=100 % /0,4 ICC-/;



for the 13 h Pd^{109g}

[11]	14,5±0,35	1948 ± 974	Paul53	abs.; stat,err.; cntd.betas
[5]	14,8	0,33±0,05 for σ^{mfp}	Mangal63	to Al ²⁷ /n,p/83±6 mb;
[50]	14,7±0,2	2570 ± 160	Bonazzola64	abs.; cntd. 1,02 MeV beta with br.r.=100 %; systematic error is 159 and statist. e.is 22 mb; neutron spectrum given
[69]	14,7	1080 ± 110	Minetti67	abs./?/
[79]	14,4±0,3	1200±84 for σ^{mfp}	Fink68	see comm. at Pd ¹⁰² ; 1180±110 mb is given in [117]
[117]				
[109]	14,4±0,3	1416 ± 150	Lu70	to /see Zr ⁹⁰ /; cntd. 88 keV γ with br.r. 100 % /26,5 ICC/

for the 4,7 m Pd^{109m}

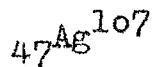
[5]	14,8	971 ± 12	Mangal63	to Al ²⁷ /n,p/83±6 mb;
[69]	14,7	510 ± 30	Minetti67	abs./?/
[79][117]	14,4±0,3	498 ± 33	Fink68	see comm. at Pd ¹⁰² ; 497±47 in [117]
[109]	14,4±0,3	510 ± 35	Lu70	to /see Zr ⁹⁰ /; cntd. 188 keV γ with br. ratio 58 % /0,72 ICC/;

$^{47}\text{Ag}^{107}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5] [9]	14,1	560 \pm 56	Forbes52	abs.; cntd. betas
[11]	14,5 \pm 0,35	519 \pm 260	Paul153	abs.; stat.e.; cntd. betas
[9] [5]	14,1 \pm 0,15	458 \pm 50	Yasumi57	abs.; counted betas
[9]	13,9 14,0 14,6 15,1	325 \pm 65 340 \pm 68 360 \pm 72 390 \pm 78	Tewes60	the \pm 20 % error is supposed following other Tewes' results /see e.g. at Rb ^{85,87,89/}
[39]	14,8 \pm 0,5	657 \pm 100	Khurana61	to Fe ⁵⁶ /n,p/126 mb; cndt. β ;
[9] [5]	14,8	662 \pm 66	Mukherjee61	to Al ²⁷ /n, α /117 and Cu ⁶³ /n ₂ n/556m
[9] [5]	14,1 \pm 0,2	537 \pm 15	Sakisaka61	abs.; counted betas
[5]	14,1	580 \pm 90	Langmann61	
[9] [5]	14,1	740 \pm 80	Vonach61	to Al ²⁷ /n, γ /116mb; in [5] err=120mb;
[5] [9] [69]	14,4 \pm 0,3	889 \pm 65	Rayburn61	to Cu ⁶³ /n, ₂ n/503 \pm 37mb; cndt. ann.rad
[24]	14,13 \pm 0,1	734 \pm 44	Cevolani62	abs.; cndt. annihilation rad.
[5]	14,1	818 \pm 75	Carles63	to Cu ⁶³ /n, ₂ n/503 \pm 35mb; ?no $T_{1/2}$ given
[5]	13,0 13,5 14,05 15,25	855 \pm 75 930 \pm 80 903 \pm 80 965 \pm 85	Rayburn63	to Cu ⁶³ /n, ₂ n/503 \pm 37 at 14,4 MeV; taken from curve
[80]	14,5	520	Chursin63	to Cu ⁶³ /n, ₂ n/552 mb
[20]	14,8 \pm 0,1	601 \pm 90	Mitra67	to Cu ⁶³ /n, ₂ n/530 \pm 25 mb
[69]	14,7	870 \pm 40	Minetti68	abs/?; cndt. 1,45/7% and 1,96/54%/ m
[51]	14,67 \pm 0,090 14,585 \pm 0,065 14,525 \pm 0,060 14,445 \pm 0,055 14,405 \pm 0,050 14,360 \pm 0,045 14,300 \pm 0,040 14,260 \pm 0,040 14,210 \pm 0,040 14,160 \pm 0,040 14,135 \pm 0,040 14,110 \pm 0,040 14,075 \pm 0,040 14,055 \pm 0,040 14,025 \pm 0,040 14,000 \pm 0,040 13,975 \pm 0,040 13,950 \pm 0,040	1096 \pm 101 1027 \pm 95 942 \pm 87 994 \pm 81 912 \pm 84 984 \pm 90 1025 \pm 94 1028 \pm 95 994 \pm 91 1048 \pm 96 1025 \pm 94 965 \pm 89 1111 \pm 102 1005 \pm 92 935 \pm 86 1000 \pm 92 1126 \pm 103 930 \pm 86	Cuzzocrea68	to Cu ⁶³ /n, ₂ n/469 \pm 10 mb at 14,1 MeV

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5] [9]	14,1	560 \pm 56	Forbes52	abs.; cndt. betas
[11]	14,5 \pm 0,35	519 \pm 260	Paul153	abs.; stat.e.; cndt. betas
[9] [5]	14,1 \pm 0,15	458 \pm 50	Yasumi57	abs.; counted betas
[9]	13,9 14,0 14,6 15,1	325 \pm 65 340 \pm 68 360 \pm 72 390 \pm 78	Tewes60	the \pm 20 % error is supposed following other Tewes' results /see e.g. at Rb ^{85,87,89/}
[39]	14,8 \pm 0,5	657 \pm 100	Khurana61	to Fe ⁵⁶ /n,p/126 mb; cndt. β ;
[9] [5]	14,8	662 \pm 66	Mukherjee61	to Al ²⁷ /n, α /117 and Cu ⁶³ /n ₂ n/556m
[9] [5]	14,1 \pm 0,2	537 \pm 15	Sakisaka61	abs.; counted betas
[5]	14,1	580 \pm 90	Langmann61	
[9] [5]	14,1	740 \pm 80	Vonach61	to Al ²⁷ /n, γ /116mb; in [5] err=120mb;
[5] [9] [69]	14,4 \pm 0,3	889 \pm 65	Rayburn61	to Cu ⁶³ /n, ₂ n/503 \pm 37mb; cndt. ann.rad
[24]	14,13 \pm 0,1	734 \pm 44	Cevolani62	abs.; cndt. annihilation rad.
[5]	14,1	818 \pm 75	Carles63	to Cu ⁶³ /n, ₂ n/503 \pm 35mb; ?no $T_{1/2}$ given
[5]	13,0 13,5 14,05 15,25	855 \pm 75 930 \pm 80 903 \pm 80 965 \pm 85	Rayburn63	to Cu ⁶³ /n, ₂ n/503 \pm 37 at 14,4 MeV; taken from curve
[80]	14,5	520	Chursin63	to Cu ⁶³ /n, ₂ n/552 mb
[20]	14,8 \pm 0,1	601 \pm 90	Mitra67	to Cu ⁶³ /n, ₂ n/530 \pm 25 mb
[69]	14,7	870 \pm 40	Minetti68	abs/?; cndt. 1,45/7% and 1,96/54%/ m
[51]	14,67 \pm 0,090 14,585 \pm 0,065 14,525 \pm 0,060 14,445 \pm 0,055 14,405 \pm 0,050 14,360 \pm 0,045 14,300 \pm 0,040 14,260 \pm 0,040 14,210 \pm 0,040 14,160 \pm 0,040 14,135 \pm 0,040 14,110 \pm 0,040 14,075 \pm 0,040 14,055 \pm 0,040 14,025 \pm 0,040 14,000 \pm 0,040 13,975 \pm 0,040 13,950 \pm 0,040	1096 \pm 101 1027 \pm 95 942 \pm 87 994 \pm 81 912 \pm 84 984 \pm 90 1025 \pm 94 1028 \pm 95 994 \pm 91 1048 \pm 96 1025 \pm 94 965 \pm 89 1111 \pm 102 1005 \pm 92 935 \pm 86 1000 \pm 92 1126 \pm 103 930 \pm 86	Cuzzocrea68	to Cu ⁶³ /n, ₂ n/469 \pm 10 mb at 14,1 MeV

Silver



Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

for the 8,4 d Ag^{106m}			
[5]	13,9	470 ± 94	
	14,0	490 ± 98	Tewes60
	14,5	520 ± 104	
	15,1	570 ± 114	Tewes' results/see e.g. Rb ⁸⁵
[9]	14,1	600 ± 78	Vonach61 to Al ²⁷ /n, α /116mb; tot. err.
[9]	14,8	6500 /?/ Mukherjee61 to Al ²⁷ /n, α / and Cu ⁶³ /n, 2n/	
[69]	14,7	653 ± 30 Minetti68 abs?; cntd.o, 513 MeV γ / 86% δ ± 1523 ± 70 mb.;	
[31]	14,7	599 ± 20	
	14,6	599 ± 992	
	14,5	± 983	
	14,4	± 974	
	14,3	± 964	
	14,2	± 954	
	14,1	± 943	Vonach68 to Al ²⁷ /n, α /111, 5±2 mb at 14,7 MeV;
	14,0	± 931	only relative values are given for the most energ. e.g. for 14,1 MeV one ob- tains σ by multiplying 599 and ± 943 / = 565 mb /
	13,9	± 919	
	13,8	± 906	
	13,7	± 893	
	13,6	± 879	
[6]	13,40±0,2	$9,30 \pm 0,47$	arbitrarily normalized!
	13,52±0,15	$9,23 \pm 0,46$	
	13,69±0,10	$9,72 \pm 0,49$	
	13,88 ±0,10	$9,71 \pm 0,49$	
	14,09 ±0,10	$10,49 \pm 0,52$	
	14,31 ±0,13	$10,73 \pm 0,54$	/!/ Prestwood61
	14,50 ±0,20	$10,87 \pm 0,54$	
	14,68 ±0,26	$10,72 \pm 0,54$	
	14,81 ±0,31	$10,90 \pm 0,55$	
	14,93 ±0,36	$11,07 \pm 0,55$	
[74]	14,71	1,00	arbitrarily normalized!
	14,66	$0,99$	for more energies down to
	14,61	$0,97$	13,56 MeV;
	14,56	1,01	energy error is $\pm 0,05$ MeV -
	14,51	1,00	cross section error is
	14,46	$0,98$	about 1,5 %
	14,41	$0,99$	
	14,36	$0,98$	/!/ Csikai66
	14,31	$0,96$	
	14,26	$0,94$	
	14,21	$0,95$	
	14,16	$0,99$	
	14,11	$0,99$	
	14,06	$0,95$	
	14,01	$0,95$	
	13,96	$0,94$	

^{109}Ag

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[9] [5]	14,1	1000 ± 100	Forbes52	abs.; cntd. β ; total err.
[11]	14,5 ± 0,35	311 ± 156	Paul53	abs.; stat.e.; cntd. betas
[9] [5]	14,1 ± 0,15	604 ± 66	Yasumi57	abs.;
[9]	14	710 ± 110	Rayburn59	to Cu ⁶³ /n, 2n/500 mb
[9]	14,3 ± 0,5	619 ± 110	Khurana59	to Fe ⁵⁶ /n, p/110 mb; stat.e.;
[5] [8]	14,8	833 ± 83	Mukherjee61	to Al ²⁷ /n, α /117 and Cu ⁶³ /n, 2n/556 mb; in [9]: $\sigma = 883 \pm 88$ mb;
[9]	14,1	1080 ± 200	Langmann61	/abs?/; Thesis, priv. comm. in [5]
[9] [5]	14,1	840 ± 150	Vonach61	to Ag ¹⁰⁷ /n, 2n/8740 mb; tot.e.
[39]	14,8 ± 0,5	710 ± 107	Khurana61	to Fe ⁵⁶ /n, p/126 mb;
[80]	14,5	580	Chursin63	to Cu ⁶³ /n, 2n/552 mb;
[69]	14,7	797 ± 50	Minetti68	abs?/; cntd. 0,69 MeV β^+ / 0,2% 1,65/94% and 1,02 MeV / 1,9% / β^- ;
[51]	14,670 ± 0,090	770 ± 100		to Cu ⁶³ /n, 2n/469 ± 10 mb
	14,585 ± 0,065	776 ± 100		at 14,1 MeV; for more ener-
	14,525 ± 0,060	752 ± 100		gies down to 13,7 MeV;
	14,445 ± 0,055	741 ± 96		
	14,405 ± 0,050	767 ± 100		
	14,360 ± 0,045	665 ± 86		
	14,300 ± 0,040	672 ± 77		
	14,260 ± 0,040	625 ± 72		
	14,210 ± 0,040	689 ± 79		
	14,160 ± 0,040	729 ± 84	Cuzzocrea68	
	14,135 ± 0,040	708 ± 81		
	14,110 ± 0,040	768 ± 88		
	14,075 ± 0,040	749 ± 86		
	14,055 ± 0,040	815 ± 94		
	14,025 ± 0,040	745 ± 86		
	14,000 ± 0,040	750 ± 86		
	13,975 ± 0,040	817 ± 94		
	13,950 ± 0,040	812 ± 94		

$^{48}\text{Cd}^{106}$

Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[9] [5]	14,4 ± 0,3	827 ± 63	Rayburn61	to Cu ⁶³ /n, 2n/503 ± 37 mb; ann.r.
[5]	13,1 -	530 ± 50		taken from curve in [5];
	15,5	620 ± 60		counted annihilation
	14,0	640 ± 60		radiation
	14,3	820 ± 80	Rayburn63	
	14,6	950 ± 90		
	14,9	980 ± 100		
	15,2	950 ± 95		
[56]	13,44 ± 0,13	1072 ± 108		abs.;
[82]	14,11 ± 0,15	1358 ± 136		
	14,87 ± 0,17	1589 ± 159	Bormann68	
	15,52 ± 0,17	1614 ± 162		
[83]	14,4 ± 0,3	975 ± 86	Lu69	Two independent value; the first is abs.;
[109]	14,4 ± 0,3	966 ± 85		the second is independent of the decay scheme, to Cd ¹¹⁶ /n, 2n/8906 ± 60 mb, measd. σ of Cd ¹⁰⁶ /n, np+pn+d/divided by σ of Cd ¹⁰⁶ /n, 2n/ = 0,220 ± 0,023, and the sum of these is 1190 ± 105 mb;

 $^{48}\text{Cd}^{108}$

[84]	14,1	504 ± 75	Yu67 to Al ²⁷ /n, α/115 mb; [78] citing Thesis of Yu gives 252 ± 40 mb at 14 MeV
[79]	14,4 ± 0,3	964 ± 75	Fink68 to Fe ⁵⁶ /n, p/100 ± 6 mb; the same as Lu70?
[117]	14,4 ± 0,3	900 ± 135	Lu68 probably the same as Lu70
[109]	14,4 ± 0,3	865 ± 100	Lu70 to Fe ⁵⁶ /n, p/100 ± 6 mb; cntd. 93 keV with branch.r.=100% / ICC.=19,7%; see Zr ⁹⁰

 $^{48}\text{Cd}^{110}$

[79]	14,4 ± 0,3	998 ± 115	Fink68 to Fe ⁵⁶ /np/100 ± 6 mb; the same as Lu70?
[117]	14,4 ± 0,3	990 ± 208	Lu68 probably the same as Lu70
[109]	14,4 ± 0,3	1221 ± 150	Lu70 to Fe ⁵⁶ /n, p/100 ± 6 mb; cntd. with br. r.=100% / ICC.=26,5%; see also Zr ⁹⁰ ; 38 keV

$^{48}\text{Cd}^{112\text{m}}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[81]	13,72±0,13	666 ± 80		abs.; cntd. 245 keV γ with br.
	14,07±0,13	624 ± 75	Temperley68	r.=100 % /ICC.=0,062/;
	14,78±0,21	576 ± 69		Cd111/n,n;/also measd separately
[79]	14,4 ±0,3	781 ± 50	Fink68 to Fe ⁵⁶ /n,p/100±6 mb;	the same as Lu70?
[117]	14,4 ±0,3	744 ± 74	Lu68	probably the same as Lu70
[109]	14,4 ±0,3	725 ± 50	Lu70	to /see Zr ⁹⁰ /; cntd. 247 keV γ with br. r.=100 % /ICC.=0,065/; cross sect.con- tains σ of Cd111/n,n/

 $^{48}\text{Cd}^{116}$

for the 53 h Cd115 ^m and for the 43 d Cd ^{115m} /the latter is in bracket/				
[39]	14,8 ±0,5	690±104/490±74/	Khurana61	to Fe ⁵⁶ /n,p/126 mb;
[6]	13,40±0,20	821±82/780±78/		to /see Ge ⁷⁰ and Ti ⁴⁶ /;
[9]	13,69±0,10	830±83 /795±80/		counted betas; for errors
	14,01±0,10	850±85 /840±84/		see comments at Sc ⁴⁵
	14,09±0,10	835±84 /769±77/		
	14,31±0,13	863±86 /885±89/	Preswood61	
	14,50±0,20	826±83 /808±81/		
	14,68±0,26	817±82 /825±83/		
	14,81±0,31	781±78 /807±81/		
	14,93±0,36	798±80 /836±84/		
[5]	14,8	690±110/490±70/	Rayburn63	to Cu ⁶³ /n,2n/503±37 mb at 14,4 MeV; taken from curve; [78] does not mention this data, maybe a misprint in [5] because too si- milar to Khurana61 /??/
[84]	14,1	857±70 /730±60/	Yu67	to Al ²⁷ /n, α /115 mb
[79]	14,4 ±0,3	906±60 /615±45/	Fink68 to Fe ⁵⁶ /np/100±6 mb;	same as Lu70?
[117]	14,4 ±0,3	878±79	Lu68	probably the same as Lu70
[109]	14,4 ±0,3	820±50 /569±50/	Lu70	to Fe ⁵⁶ /n,p/100±6 mb; cntd. 335 keV γ with br.r.=96 % /ICC.=1,15/ for σ^{γ} and 934 keV γ with br.r.=2 % /ICC=0/ for $\sigma^{\gamma m}$; see also Zr ⁹⁰ ;

Indium

 $^{113}_{49}\text{In}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
				for the 14 m In^{112g} and for the 20 m In^{112m} /the latter is in bracket/
[86]	14,7	703 ± 102	$/837 \pm 98/$ Kozłowski68	abs.; cntd. 157 keV γ for σ^m
[35]	14,7 to,15	300 ± 30	$/1490 \pm 100/$ Rötzer68	to $\text{Al}^{27}/n\rho/115 \pm 5,9$ mb
[87]	14,7	340 ± 25	$/1413 \pm 85/$ Minetti68	abs/?/cntd. 155 keV γ for σ^m
[85]	13,9 to,2	376 ± 45	$/1073 \pm 160/$	to $\text{Zn}^{64}/n, 2n$ /values see in
	14,6 to,2	316 ± 40	$/1317 \pm 200/$ Károlyi70	[5]
	15,3 to,2	295 ± 35	$/1239 \pm 180/$	

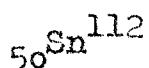
 $^{115}_{49}\text{In}$ for the 70 s In^{114g}

[37]	14,8	360 ± 40	Prasad66	to $\text{Fe}^{56}/n, p/126$ mb
[87]	14,7	269 ± 20	Minetti68	abs/?/counted betas
[35]	14,7 to,15	340 ± 70	Rötzer68	to $\text{Al}^{27}/n, d/115 \pm 5,9$ mb
[86]	14,7	164 ± 20	Kozłowski68	abs.; counted betas

for the 50 d In^{114m}

[6]	$13,33 \pm 0,23$	1471 ± 74		to /see Ge^{70} and $\text{Ti}^{46}/$;
[9]	$13,40 \pm 0,20$	1428 ± 71		counted betas; for errors
	$13,52 \pm 0,15$	1506 ± 75		see comments at Sc^{45}
	$13,69 \pm 0,10$	1468 ± 73		
	$13,88 \pm 0,10$	1523 ± 76	Prestwood61	
	$14,01 \pm 0,10$	1557 ± 78		
	$14,31 \pm 0,13$	1500 ± 75		
	$14,50 \pm 0,20$	1539 ± 77		
	$14,81 \pm 0,31$	1585 ± 79		
	$14,93 \pm 0,36$	1503 ± 75		
[1]	$13,50 \pm 0,47$	1007 ± 138		to /see $\text{F}^{19}/$;
	$14,96 \pm 0,87$	1264 ± 137	Menlove67	
	$15,82 \pm 0,45$	1325 ± 144		
[87]	14,7	1590 ± 90	Minetti68	abs/?/cntd. 192 keV γ , 96,5% [CC4,6]
[35]	14,7 to,15	1470 ± 120	Rötzer68	to $\text{Al}^{27}/n, d/115 \pm 5,9$ mb
[62]	14,8 to,2	1390 ± 55	Barrall69	abs.; cntd. 192 keV γ , br.r.=17 %, given twice stand. dev./110 mb/in- cluding all err.; irrad. with Mn^{55}

Tin



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[9]	14	1400 ± 110	Rayourn59	to Cu ⁶³ /n,2n/500 mb
[9]	12,9	500	Tewes60	counted gammas
[5]	13,9	725 ± 80		
[9]	14,4 ± 0,3	1508 ± 122	Rayburn61	to Cu ⁶³ /n,2n/503mb;cntd.ann.;
[5]	13,3	1070 ± 100		taken from curve
	13,8	1160 ± 100		
	14,1	1445 ± 150		
	14,9	1670 ± 170	Rayburn63	
	15,2	1635 ± 150		
	15,7	1800 ± 180		
[88]	14	1610 ± 320	Klucharev64	to Cu ⁶³ /n2n/552,Al ²⁷ /np/73mb
[7]	14,2	1530 ± 230	Csikai68	to Cu ⁶³ /n2n/448mb at 14,1 MeV;ann.
[56]	13,44 ± 0,13	998 ± 110		abs.;
	14,11 ± 0,15	1110 ± 127	Bormann68	
	14,87 ± 0,17	1217 ± 138		
	15,52 ± 0,17	1253 ± 141		
[89]	14,4	1300 ± 150	Lulie68	abs.?/;enriched target
[109]	14,4 ± 0,3	1275 ± 100	Lu70	to /see Zr ⁹⁰ /;measd.2,8 d.In ¹¹¹ 6so σ belongs to Sn ¹¹² /n2n/Sn ¹¹¹ /EC/In ¹¹¹ + +Sn ¹¹² /n,np/+...In ¹¹¹ ;cntd.173 keV γ with b.r.=99%/o,115ICC/and 247 keV γ with b.r.=99%/o,064ICC/
[6]	13,40 ± 0,20	3,67 ± 0,18		arbitrarily normalized!
	13,52 ± 0,15	3,91 ± 0,20		
	13,69 ± 0,10	4,03 ± 0,20		
	14,09 ± 0,10	4,72 ± 0,24		
	14,31 ± 0,13	5,07 ± 0,25	/!/Prestwood61	
	14,50 ± 0,20	5,16 ± 0,26		
	14,68 ± 0,26	5,36 ± 0,27		
	14,81 ± 0,31	5,34 ± 0,27		
	14,93 ± 0,36	5,65 ± 0,28		
[127]	14,4	1100 ± 100	Lu70/a	different from Lu70 in [109] as cited in [127];

$^{50}_{\text{Sn}}$ ^{114/m+g/}

Ref.	Energy/Mev/	Cross Sec/mb/	Identif.	Comments
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[89]	14,4	1800 ± 100	Lulić68	abs/?; enriched sample
[109]	14,4 ± 0,3	1239 ± 130 /!/ Lu70 to /see Zr ⁹⁰ /; includes only 91 % metastable state!; cntd. 393 keV γ with 100 % br.r./o,53 ICC/;		

 $^{50}_{\text{Sn}}$ ^{118m}

[90]	14,9	1230 ± 340	Brzosko63	to Fe ⁵⁶ /n,p/104±10 mb;
[89]	14,4	976 ± 120	Lulić68	abs/?; enriched sample
[109]	14,4 ± 0,3	957 ± 100	Lu70 to /see Zr ⁹⁰ /; includes 6% of Sn ¹¹⁷ /n, n;/; cntd. 158 keV γ, br.r.=100%/o,158	

 $^{50}_{\text{Sn}}$ ^{120m}

[89]	14,4	1444 ± 210	Lulić68	abs/?; enriched sample
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 $^{50}_{\text{Sn}}$ ^{122g}

[89]	14,4	875 ± 135	Lulić68	abs/?; enriched sample
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 $^{50}_{\text{Sn}}$ ¹²⁴

For the 125 d Sn ^{123g}				
[88]	14	900 ± 180	Klucharev64	to Cu ⁶³ /n,2n/552 and Al ²⁷ /n, p/73 mb; half-life not given
[5]				

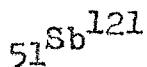
 $\text{For the 40 m Sn}^{123m}$

[89]	14,4 ± 0,3	547 ± 23	Lulić68	abs/?; enriched sample; half-life not indicated
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$^{121}_{51}\text{Sb}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
for the $^{16}\text{m Sb}^{120\gamma}$				
[11]	14,5 ± 0,35	$\geq 750 \pm 188$	Paul53	abs.; stat.e.; cntd.betas
[9]	14	1000	Rayburn58	to $\text{Cu}^{63}/n,2n/500$ mb;
[9]	14,3 ± 0,5	453 ± 41	Kern59	to $\text{Fe}^{56}/n,p/110$ mb;
[5]	13,2 13,6 13,85 14,1 14,4 14,7 15,0 15,35	1290 ± 130 1360 ± 140 1330 ± 130 1315 ± 130 1370 ± 140 1400 ± 140 1450 ± 150 1515 ± 150	McCravy60	taken from curve; counted annihilation radiation;
[39]	14,8 ± 0,5	1180 ± 180	Khurana61	to $\text{Fe}^{56}/n,p/126$ mb;
[9] [5]	14,4 ± 0,3	1056 ± 80	Rayburn61	to $\text{Cu}^{63}/n2n/503 \pm 37$ mb; ann.r.
[5]	12,9 14,1 14,3 15,5	1000 ± 100 1070 ± 100 1050 ± 90 1010 ± 90	/! Koehler62	normalized to 1056 mb at 14,4 MeV; taken from curve;
[5]	14,1	1450 ± 80	Carles63	to $\text{Cu}^{63}/n,2n/503 \pm 35$ mb; cntd. ann.rad;taken from curve;
[5]	13,5 14,1 15,2	930 ± 80 980 ± 90 1055 ± 100	Rayburn63	to $\text{Cu}^{63}/n,2n/503 \pm 37$ mb at 14,4 MeV;cntd. annihilation rad.;taken from curve
[91]	$13,20 \pm 0,10$ $13,60 \pm 0,16$ $13,70 \pm 0,20$ $14,05 \pm 0,21$ $14,72 \pm 0,26$ $15,16 \pm 0,24$	884 ± 75 878 ± 78 951 ± 81 1062 ± 82 998 ± 83 1120 ± 95	Kanda68	to $\text{Cu}^{63}/n,2n/\alpha$ Liskien65
[56]	$13,44 \pm 0,13$ $14,11 \pm 0,15$ $14,87 \pm 0,17$ $15,52 \pm 0,17$	919 ± 86 939 ± 90 1014 ± 96 1080 ± 101	Bormann68	abs/?; integr.gamma-spectr.
[87]	14,7	1244 ± 80	Minetti68	abs/?; annih.rad.counted
[109]	14,4 ± 0,3	1188 ± 60	Lu70	to /see $\text{Zr}^{90}/$;cntd. 1171 keV γ with br.rel. 32 % /ICC.=0/;

Antimony



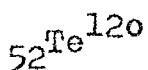
Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
for the 5,8 d Sb ^{120m}				
[91]	13,20 ^{+0,10} _{-0,06}	378 ± 98		to Cu ⁶³ /n,2n/of Liskien65
	13,60 ^{+0,16} _{-0,14}	397 ± 103		
	13,70 ^{+0,30} _{-0,20}	410 ± 100	Kanda68	
	14,05 ^{+0,21} _{-0,31}	432 ± 105		
	14,72 ^{+0,26} _{-0,36}	564 ± 132		
	15,16 ^{+0,87} _{-0,84}	704 ± 214		
[56]	13,44 ^{+0,13}	601 ± 55		abs/?;cntd. positrons
	14,11 ^{+0,15}	611 ± 58	Bormann68	
	14,87 ^{+0,17}	695 ± 64		
	15,52 ^{+0,17}	679 ± 64		
[87]	14,7	597 ± 35	Minetti68	abs/?;cntd.200keV gammas with branch.r.=100 %/ICCo,1
[109]	14,4 ± 3	427 ± 20	Lu70	to /see Zr90;/cntd.1030 keV /br.r.=99 %/and 1171 keV / br.r.=100 % / gammas
[6]	13,40 ^{+0,20}	1077 ± 54		arbitrarily normalized!
	13,52 ^{+0,15}	1098 ± 55		counted gammas
	13,69 ^{+0,10}	1114 ± 56		
	14,01 ^{+0,10}	1106 ± 55		
	14,09 ^{+0,10}	1272 ± 64	Prestwood61	
	14,31 ^{+0,13}	1128 ± 56		
	14,50 ^{+0,20}	1309 ± 65		
	14,68 ^{+0,26}	1260 ± 63		
	14,81 ^{+0,31}	1297 ± 65		
	14,93 ^{+0,36}	1214 ± 61		

Antimony

 $^{51}\text{Sb}^{123/\text{m+g}/}$

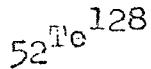
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[11]	14,5 ± 35	1245 ± 312	Paul53	abs.; stat.e.; counted betas
[9]	14,3 ± 5	1706 ± 100	Khurana59	to Fe ⁵⁶ /n,p/110 mb;
[39]	14,8 ± 5	1950 ± 200	Khurana61	to Fe ⁵⁶ /n,p/126 mb; accord.t
[5]	14,8	1013±12 for σ^m	Mangal63	[5]: it's renormd. Khurana59
				to Al ²⁷ /np/83±6 mb; measd. σ^m = 0,52±0,06 ,too.;
[6]	14,7 ± 3	1270 ± 50	Csikai68	to Cu ⁶³ /n2n/540 mb; cntd. β,γ
[56]	13,44±0,13	1247 ± 132		abs.; detected betas;
	14,11±0,15	1263 ± 135	Bormann68	for σ^m =547 ± 79 mb was foun
	14,87±0,17	1277 ± 137		at 14,11±0,15 MeV;
	15,52±0,17	1358 ± 149		
[87]	14,7	2280 ± 200	Minetti68	abs/?; detected 560 keV γ /br.r.=66,4%; for σ^m =686±60 mb fnd., cntd. 66keV γ /br.100%, ICC.=0,76/;
[109]	14,4 ± 3	1542 ± 80	Lu70 to /see Zr ⁹⁰ /	cntd. 564 keV γ , br.r.=66 % and 696 keV γ , br.r.=3,4 %;
[6]	13,40±0,20	1145 ± 57		arbitrarily normalized! thi
[9]	13,52±0,15	1161 ± 58		remark was not cited in [9],
	13,69±0,10	1269 ± 63		where the same values were
	14,01±0,10	1279 ± 64		found with slight rounding/
	14,09±0,10	1335 ± 67	/!/Prestwood61	
	14,31±0,13	1263 ± 63		
	14,50±0,20	1343 ± 67		
	14,68±0,26	1256 ± 63		
	14,81±0,31	1281 ± 64		
	14,93±0,36	1194 ± 60		

Tellurium

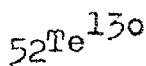


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
for the 16 h Te^{119g}				
[92]	14,8 ± 0,2	685 ± 100	Husain68	to $\text{Al}^{27}/n,\alpha/114$ mb;cntd. 645 keV γ with br.r.=85 % tot.e.except decay scheme e
for the 4,7 d Te^{119m}				
[92]	14,8 ± 0,2	535 ± 85	Husain68	to /see at $\text{Te}^{119g}/$;cntd. 1221 keV γ with br.r.=67 %;
for the 17 d Te^{121g}				
[92]	14,8 ± 0,2	750 ± 100	Husain68	to /see $\text{Te}^{120}/$;cntd.575 keV γ with br.r.=80 %;results with natural and enriched samples were in good agreem
[109]	14,4 ± 0,3	725 ± 40	Lu7o to /see $\text{Zr}^{90}/$;cntd.573 keV γ with br.r.=81 % /ICC=0 /;	
for the 150 d Te^{121m}				
[92]	14,8 ± 0,2	530 ± 80	Husain68 to /see $\text{Te}^{120}/$;cntd.212 keV γ , br.r=?/ICC=0,072;/see also 6%;	
[109]	14,4 ± 0,3	890 ± 100	Lu7o to /see $\text{Zr}^{90}/$;cntd.212 keV γ ,br. r=90 % /ICC.=0,084 /;	
Te^{124m}				
[109]	14,4 ± 0,3	980 ± 100	Lu7o to /see $\text{Zr}^{90}/$;cntd.159 keV γ ,br.r.= =100 %/ICC=0,19/;6' contains the $\text{Te}^{123}/n,n'$ /process,too;	

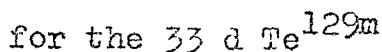
Tellurium



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
for the 9,3 h Te ¹²⁷ :				
[11]	14,5 ± 0,35	779 ± 234	Paul53	abs.;stat.e.;cntd.betas
[93]	14,8 ± 0,3	238 ± 36	Majumdar63 to Al ²⁷ /n,p/77±8 mb;cntd.695keV/br.r=99% and 270 keV/br.r=1% betas; runs with differently enriched samples: 224, 244, 260 and 221, 238 mb were obtained;	
[50]	14,7 ± 0,2	640 ± 23	Bonazzola64	abs.;cntd.695 keV β, br.r=100% from the 23,17syst., 16 mb stat.
[92]	14,8 ± 0,2	760 ± 100	Husain68 to /see Te ¹²⁸ /;cntd. 420 keV γ, br.r=0,83%;enriched sample;	
[109]	14,4 ± 0,3	712 ± 60	Lu70 to /see Zr ⁹⁰ /;cntd. 417 keV γ, br.r=0,83 % /ICC=0/;	
[109]	14,4 ± 0,3	949±150	for σ ^m Lu70 to /see Zr ⁹⁰ /;cntd.417keV γ, see 6 ^a	
126	14,8 ± 0,5	580 ± 45	Hasan72 to /see Mo ^{92m} /;	

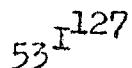


for the 67 m Te ^{129g}				
[11] [92]	14,5 ± 0,35	599 ± 120	Paul53	abs.;stat.e.;cntd. β ;σ ^{m+g} in ref. [9];
[93]	14,8 ± 0,3	225 ± 28	Majumdar63	to /see Te ¹²⁸ /;cntd.betas;
[90]	14,2 ± 0,2	210 ± 46	Brzosko65	to Fe ⁵⁶ /n,p/124±12 mb;
[50]	14,7 ± 0,2	580 ± 27	Bonazzola64	abs.;cntd.300keVβ/br.r=10%,700/4%,990/15% and 1453 keV/71% betas;14syst.,23mb stat.e.in 27%
[92]	14,8 ± 0,2	435 ± 50	Husain68	to /see Te ¹²⁸ /;cntd.460keVγ,br.r=16%
[109]	14,4 ± 0,3	570 ± 30	Lu70	to /see Zr ⁹⁰ /;cntd. 460 keV γ, br.r=8,3% and 487keV γ, br.r=1,53% /ICC=0/;
126	14,8 ± 0,5	660 ± 40	Hasan72	to /see above/;



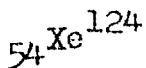
for the 33 d Te ^{129m}				
[93]	14,8 ± 0,3	528 ± 100	Majumdar63	to /see Te ¹²⁸ /;cntd.betas
[90]	14,2 ± 0,2	247 ± 74	Brzosko65	to Fe ⁵⁶ /n,p/124±12 mb;
[92]	14,8 ± 0,2	241 ± 30	Husain68	to /see Te ¹²⁸ /;cntd.106keVγ,br.r=64%;
[109]	14,4 ± 0,3	885 ± 45	Lu70	to /see Zr ⁹⁰ /;cntd.460/6%,487/1,12% and 696 keV gammas /branch.r=3,8% /ICC=0/;

Iodine



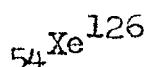
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[11]	14,5 ± 0,55	1120 ± 392	Paul53	abs.; stat.e.; cntd.betas
[5] [9]	13,1	1100		abs.; cntd.betas; estimated
[8]	14,1 15,6	1300 ± 80 1320	Martin53	tot.err.; the first and last values were taken from curve in [5]
[5] [9]	13,2 ± 0,3	1210 ± 130		to Al ²⁷ /n, α /107±5 mb at 15,21
[35]	14,1 ± 0,4 15,2 ± 0,4	1320 ± 110 1290 ± 120	Bormann62	MeV; cntd. 386 keV γ ; first and last data are from curve in [35]
[62]	14,8 ± 0,2	1660 ± 70	Barrall69	abs.; cntd. 386 keV γ with 34 γ /decay; twice stand.dev. /140 mb/given; see In115;
[109]	14,4 ± 0,3	1649 ± 80	Lu70	to /see Zr ⁹⁸ /; cntd. 386 keV γ ; br.r.=34 % /ICC=0,019/;

Xenon



Ref. Energy/Mev/ Cross Sec/mb/ Identif. Comments

[70]	$14,4 \pm 0,3$	1130 ± 110	Kondaiah68	to $\text{Xe}^{136}/n, 2n/1700 \pm 100$ mb; cntd. 149 keV γ with $0,6925(\gamma+e)/\text{decay}$, ICC. $=0,4643$; err. contains stat. and syst.e. except monitor cross sec., ICC., half-life, branching ratios;
.....				

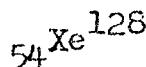


for the 17 h Xe^{125}g + the 55 s Xe^{125}m

[70]	$14,4 \pm 0,3$	1355 ± 165	Kondaiah68	to /see $\text{Xe}^{124}/$; cntd. 187 keV γ with $0,625(\gamma+e)/\text{decay}$, ICC. $=0,137$; for errors see Xe^{124} ;
.....				

for the 55 s Xe^{125}m

[70]	$14,4 \pm 0,3$	700 ± 200	Kondaiah68	to $\text{Xe}^{128}/n, 2n/840 \pm 65$ mb; cntd. 111 keV γ with $1,00(\gamma+e)/\text{decay}$, ICC. $=0,645$ for errors see Xe^{124} ;
.....				

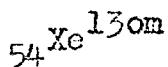


for the 36 d Xe^{127}g + the 75 s Xe^{127}m

[70]	$14,4 \pm 0,3$	1530 ± 170	Kondaiah68	to /see $\text{Xe}^{124}/$; cntd. 203 keV γ with $0,7473(\gamma+e)/\text{decay}$, ICC. $=0,093$ and 375 keV γ with $0,2209(\gamma+e)/\text{decay}$, ICC. $=0,014$; for errors see Xe^{124} ;
.....				

for the 75 s Xe^{127}m

[70]	$14,4 \pm 0,3$	840 ± 65	Kondaiah68	to $\text{Si}^{28}/n, p/252 \pm 15$ mb; cntd. 125 keV γ with $1,00(\gamma+e)/\text{decay}$, ICC. $=0,4456$ and 175 keV γ , $1,00(\gamma+e)/\text{decay}$, ICC. $=153$;
.....				



[70]	$14,4 \pm 0,3$	1435 ± 130	Kondaiah68	to /see $\text{Xe}^{124}/$; cntd. 197 keV γ with $1,0(\gamma+e)/\text{decay}$, ICC. $=16,24$;
.....				

$^{54}\text{Xe}^{132m}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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- [70] $14,4 \pm 0,3$ 775 ± 65 Kondaiah68 to Xe^{136} /see Xe^{124} /and to Xe^{128}
 $/n, 2n, ^{m+8}1530 \pm 170$ mb; cntd. 164 keV
 γ with 1,00 ($\gamma + e$)/decay, ICC=46,81;

 $^{54}\text{Xe}^{134}$

for the 5,3 d Xe^{133g} + the 2,3 d Xe^{133m}

- [70] $14,4 \pm 0,3$ 2360 ± 240 Kondaiah68 to Xe^{128} / $n, 2n, ^{m+8}1530 \pm 170$ mb; cnt
 81 keV, with 0,999 ($\gamma + e$)/decay, Xe^{126} ,
 ICC=41,8; for errors see [109];

- [109] $14,4 \pm 0,3$ 1698 ± 170 Lu70 probably a revised value of Kondaiah68
 [109] and [70] were written by /partially/
 the same authors, [109] presents the sam
 values as [70] except Xe^{134} ;

for the 2,3 d Xe^{133m}

- [70] $14,4 \pm 0,3$ 665 ± 80 Kondaiah68 to /see Xe^{124} /, cntd. 233 keV γ
 with 1,0 ($\gamma + e$)/decay, ICC=6,38;

 $^{54}\text{Xe}^{136}$

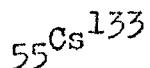
for the 9,1 h Xe^{135g} + the 16 m Xe^{135m}

- [70] $14,4 \pm 0,3$ 1700 ± 100 Kondaiah68 to $\text{Al}^{27}/n, \alpha/114 \pm 6$ mb; cntd. 250 keV
 γ with 0,97 ($\gamma + e$)/decay, ICC=0,062;

for the 16 m Xe^{135m}

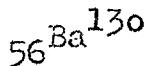
- [70] $14,4 \pm 0,3$ 750 ± 50 Kondaiah68 to $\text{Al}^{27}/n, p/68 \pm 8$ mb; cntd. 527 keV
 γ with 1,00 ($\gamma + e$)/decay, ICC=0,25;

Cesium



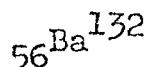
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[8][9][47]	14,1	1550 ± 250	Münzer61	to Al ²⁷ /n, α /116 mb; tot. err.
[78][9]	14,1±0,1	704 ± 140	Pollehn61	to Li ⁶ /n,t/25,8 mb; error estimated here after [9]
[5][9]	13,2±0,3	1200 ± 110		to Al ²⁷ /n, α /118 mb at 14,1
[33]	14,1±0,1	1289 ± 130	Bormann62	MeV; first and last data from curves [5][3]; cntd. 670 keV γ ;
	16,0±0,4	1140 ± 100		
[47]	14,2±0,2	2018 ± 182	Nagel65	to Fe ⁵⁶ /n,p/118±8 and Cu ⁶⁵ /n,2n/920±80 mb at 14,2 MeV; to Fe ⁵⁶ /np/112±8 and Cu ⁶⁵ /n2n/970±80 mb at 14,5 MeV
14,6±0,2	1598 ± 160			
[109]	14,4±0,3	1542 ± 75	Lu70	to /see Zr ⁹⁸ /; cntd. 668 keV γ , br.r=97,8 % /ICC=0/;
[109]		1625 ± 135		cited in [109] for the 14-15 MeV region without name

Barium

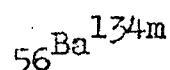


Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

- [109] $14,4 \pm 0,3$ 1371 ± 70 /!/ Lu70 together with the Ba¹³⁰/n,np/process! to /see Zr⁹⁰/;measd.Cs¹²⁹decay;cntd. 372 keV γ , br.r=36 %/ICC=0,05/ and 411 keV γ , br.r.=24 %/ICC.=0,02/;
-

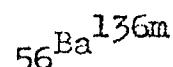


- [109] $14,4 \pm 0,3$ 1574 ± 100 Lu70 to /see Zr⁹⁰/;cntd. 496 keV γ , br.r.=48,6 % /ICC.=0,013/;
-



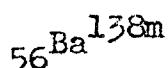
- [95] $14,8 \pm 0,8$ 940 ± 80 Wille60 to Cu⁶³/n,2n/519 and Cu⁶⁵/n,2n/1020 mb; counted betas;
-

- [109] $14,4 \pm 0,3$ 783 ± 56 Lu70 to /see Zr⁹⁰/; cntd. 276 keV γ , br.r.=100 % /ICC.=4,7/;
-



- [95] $14,8 \pm 0,8$ 700 ± 80 Wille60 to /see Ba^{134m}/;counted betas;
-

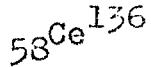
- [109] $14,4 \pm 0,3$ 1149 ± 80 /!/ Lu70 together with the Ba¹³⁵/n,n'/process!to /see Zr⁹⁰/;cntd.268 keV , br.r.=100 % /ICC.=5,25 /;
-



- [95] $14,8 \pm 0,8$ 1250 ± 100 Wille60 to /see Ba^{134m}/;counted betas;
-

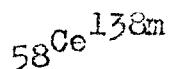
- [94] $14,0 \pm 0,2$ 1620 ± 70 Cuzzocrea67 to Cu⁶³/n,2n/469±10 and Cu⁶⁵/n,2n/919±30 mb;cntd. betas;
-

Cerium



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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[109] $14,4 \pm 0,3$ 1318 ± 90 Lu70 to /see Zr⁹⁰/; cntd. 265 keV γ , br.r.=47,4 % /ICC.=0,069 /;



[109] $14,4 \pm 0,3$ 958 ± 100 Lu70 to /see Zr⁹⁰/; cntd. 255 keV γ , br.r.=99,4 % /ICC.=8,1 /;



for the 140 d Ce¹³⁹ + the 55 s Ce^{139m}

[95][9] $14,8 \pm 0,8$ 3000 ± 400 Wille60 to /see Ba^{134m}/;

[8] $14,7$ 1880 Anonymus62 cited in [8] without name

[96] $14,8$ 1600 ± 140 Csikai67 to Pr¹⁴¹/n,p/11,4 mb; cntd. 166 keV gamma;

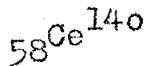
[94] $14,0 \pm 0,2$ 3220 ± 320 Cuzzocrea67 to /see Ba^{138m}/; given $\sigma \approx 2280 \pm 200$ mb; this is $\sigma_{\gamma\gamma}$ in fact!

[97] $14,7 \pm 0,15$ 1740 ± 100 Dilg68 to Al²⁷/n, α /111,5±2 mb;

[56] $13,51 \pm 0,22$ 1743 ± 122 abs.; cntd. integr. gamma spectr.
 $14,10 \pm 0,27$ 1804 ± 105 from 12,94 up to 19,56 MeV;
 $14,88 \pm 0,31$ 1823 ± 128 Bormann68
 $15,62 \pm 0,33$ 1982 ± 139

[109] $14,4 \pm 0,3$ 1593 ± 130 Lu70 to /see Zr⁹⁰/; cntd. 165 keV γ , br.r.=100 % /ICC.=0,24 /;

Cerium



Ref. Energy/MeV/ Cross Sec(mb/ Identif. Comments

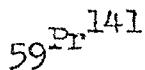
for the 55 s Ce^{139m}

[95]	$14,8 \pm 0,8$	1200 ± 400	Wille60	to /see $\text{Ba}^{134m}/;$
[98]	[9] $14,1 \pm 0,1$	1440 ± 166	Pollehn61	to $\text{Li}^6/n, t/25, 8 \pm 1,5 \text{ mb};$
[37]	$14,8$	1130 ± 120	Prasad66	to $\text{Fe}^{56}/n, p/126 \text{ mb}; \text{tot.e.};$
[99]	$14,5 \pm 0,3$	870 ± 134	Menon67	to $\text{Cu}^{63}/n, 2n/497 \pm 41 \text{ mb}; \text{cntd.}$ $760 \text{ keV gamma} / \text{ICC}=0,08/;$
[94]	$14,0 \pm 0,2$	940 ± 250	Cuzzocrea67	to /see $\text{Ba}^{138m}/;$
[109]	$14,4 \pm 0,3$	621 ± 70	Lu70	to $\text{Si}^{28}/n, p/252 \pm 15 \text{ mb}; \text{cntd.}$ $746 \text{ keV } \gamma, \text{br.r.}=100\% / \text{ICC}=0,08/$



[95]	$14,8 \pm 0,8$	1600 ± 300	Wille60	to /see $\text{Ba}^{134m}/;$
[96]	[7] $14,8$	1960 ± 170	Csikai67	to /see $\text{Ce}^{140m+8}/; \text{cntd.} 145$ keV gamma;
[97]	$14,7 \pm 0,15$	1860 ± 170	Dilg68	to /see $\text{Ce}^{140m+87}/;$
[56]	$13,51 \pm 0,22$	1778 ± 164		abs.; counted integr. gamma-
	$14,10 \pm 0,27$	1695 ± 102	Bormann68	-spectr.; from 12,94 up to
	$14,88 \pm 0,31$	1802 ± 160		19,56 MeV;
	$15,62 \pm 0,33$	1581 ± 142		
[109]	$14,4 \pm 0,3$	1730 ± 170	Lu70	to /see $\text{Zr}^{98}/; \text{cntd.} 145 \text{ keV } \gamma,$ $\text{br.r.}=70 \% / \text{ICC} \approx 0,45/;$

Praseodymium



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[11]	14,5 ± 0,35	2060 ± 721	Paul53	abs.; stat.e.; cntd. betas;
[9]	14	1763	Rayburn58	to Cu ⁶³ /n, 2n/500 mb;
[99]	13,77 ± 0,20	1386 ± 125		to Li ⁶ /n, t/28, 1 mb;
[26] [9]	14,74 ± 0,27	1591 ± 143	Ferguson60	
	15,78 ± 0,32	1737 ± 156		
[95]	14,8 ± 0,8	2100 ± 300	Willie60	to /see Ba ^{134m} /; cntd. betas;
[9][5]	14,4 ± 0,3	1801 ± 135	Rayburn61	to Cu ⁶³ /n, 2n/503 ± 37 mb; annih.;
[39]	14,8 ± 0,5	1378 ± 206	Khurana61	to Fe ⁵⁶ /n, p/126 mb;
[14]	14,13 ± 0,1	1240 ± 74	Cevolani62	abs.; cntd. annihilation rad.;
[5]	12,5	1570 ± 150		normalized to 1591 mb at 14,4
	13,7	1690 ± 160		/?/MeV; counted betas; taken
	14,05	1750 ± 150	Koehler62	from curve;
	14,3	1780 ± 160		
	15,95	1770 ± 140		
[5]	13,5	1700 ± 170		counted annihilation radiation
	13,8	1750 ± 170		taken from curve;
	14,0	1900 ± 190		
	14,3	2020 ± 200		
	14,6	1900 ± 190	Rayburn63	
	14,9	1930 ± 190		
	15,2	1880 ± 190		
	15,4	1780 ± 180		
[99]	14,5 ± 0,3	1082 ± 130	Menon67	to /see Ce ^{140m} /; β ⁺ /total=0,53;
[94]	14,0 ± 0,2	2002 ± 225	Cuzzocrea67	to /see Ba ^{138m} /; cntd. betas;
[56]	13,44 ± 0,13	1485 ± 143		abs.; counted positrons; from
	14,11 ± 0,15	1614 ± 159	Bormann68	12,78 up to 19,42 MeV;
	14,87 ± 0,17	1700 ± 164		
	15,52 ± 0,17	1787 ± 172		
[32]	15,0 ± 0,3	2050 ± 100	Pet68	to Cu ⁶³ /n, 2n/560 ± 30 mb; cntd.
[100]				annih. rad.; the ± 10 mb error in [32] is a misprint;

Neodymium

80

 $^{142}_{60}\text{Nd}$

Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

for the 2,5 h Nd^{141}g + the 64 s Nd^{141}m

- [9] [8] 14 2480 ± 200 Rayburn59 to $\text{Cu}^{63}/\text{n},2\text{n}/500$ mb;
- [95] $14,8 \pm 0,8$ 2060 ± 200 Wille60 to /see $\text{Ba}^{134}\text{m}/$; counted betas;
- [9] [5] $14,4 \pm 0,3$ 2411 ± 200 Rayburn61 to $\text{Cu}^{63}/\text{n},2\text{n}/503 \pm 37$ mb; cntd. ann.
- [5] 14,7 1650 ± 165 Grissom66 to $\text{Cu}^{63}/\text{n},2\text{n}/610$ mb; cntd. 760 keV γ , K-capture X-rays and ann. rad.
- [94] $14,0 \pm 0,2$ 1530 ± 190 for $\sigma^*\gamma$ Cuzzocrea67 to /see $\text{Ba}^{138}\text{m}/$;
- [97] $14,7 \pm 0,15$ 1640 ± 120 Dilg68 to $\text{Al}^{27}/\text{n},\alpha/111,5 \pm 2$ mb;
- [4] $14,2 \pm 0,2$ 1447 ± 210 for $\sigma^*\gamma$ Prasad69 to $\text{Al}^{27}/\text{n},\alpha/115 \pm 5$ mb;

for the 64 s Nd^{141}m

- [99] 14,5 755 Kotajima60
- [5] 14,6 545 ± 60 Broadhead65 to $\text{Si}^{28}/\text{n},\text{p}/243 \pm 22$ mb;
- [5] $14,7 0,689 \pm 0,069$ for $\sigma^*\gamma$ Grissom66 to /see above/;
- [99] $14,5 \pm 0,3$ 673 ± 66 Menon67 to $\text{Cu}^{63}/\text{n},2\text{n}/497 \pm 41$ mb;
- [94] $14,0 \pm 0,2$ 709 ± 64 Cuzzocrea67 to /see $\text{Ba}^{138}\text{m}/$;
- [4] $14,2 \pm 0,2$ 628 ± 63 Prasad69 to /see above/;

 $^{148}_{60}\text{Nd}$

- [95] $14,8 \pm 0,8$ 2160 ± 200 Wille60 to /see $\text{Ba}^{134}\text{m}/$; cntd. betas;
- [4] $14,2 \pm 0,2$ 1626 ± 200 Prasad69 to $\text{Al}^{27}/\text{n},\alpha/115 \pm 5$ mb;

 $^{150}_{60}\text{Nd}$

- [95] $14,8 \pm 0,8$ 2200 ± 300 Wille60 to /see $\text{Ba}^{134}\text{m}/$; cntd. betas;
- [99] $14,5 \pm 0,3$ 1728 ± 276 Menon67 to /see $\text{Nd}^{142}\text{m}/$;

Samarium

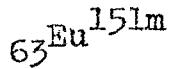
 $^{144}_{62}\text{Sm}/\text{n+g/}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[lol]	14,8 ± 0,9	1200 ± 300	Wille60	to $\text{Cu}^{63}/\text{n}, 2n/519$ mb;
[99]	14	748	for σ^{m} Kotajima60	
[9] [5]	14,4 ± 0,3	1484 ± 120	Rayburn61	to $\text{Cu}^{63}/\text{n}, 2n/503$ mb; cndtd. ann.r.;
[8][5]	14,7	1670 ± 400	Alford63	to $\text{Cu}^{63}/\text{n}, 2n/610$ mb; cndtd. ann.r. $\sigma^{\text{m}} = 0,5$ by 700 keV γ of Sm^{143}m ;
[5]	13,8 14,1 14,4 14,9 15,2	1260 ± 130 1540 ± 150 1510 ± 150 1570 ± 170 1670 ± 170	Rayburn63	taken from curve in [5]; counted annihilation radiation;
[5]	14,6	400 ± 44	for σ^{m} Broadhead65	to/see $\text{Nd}^{142}\text{m}/$; cndtd. 700 keV γ ;
[99]	14,5 ± 0,3	765 ± 150	for σ^{g} Menon67	to /sec $\text{Nd}^{142}\text{m}/$; $\beta^*/\text{total} = 0,467$, $e/\gamma = 0$; $\sigma^{\text{m}} = 687 ± 71$ mb, $e/\gamma = 0,091$;
[94]	14,0 ± 0,2	1055 ± 130	for σ^{g} Cuzzocrea67	to/see $\text{Ba}^{138}\text{m}/$; $\sigma^{\text{m}} = 285 ± 155$ mb;
[7]	13,8	1600 ± 240	Csikai68	to $\text{Cu}^{63}/\text{n}, 2n/488$ mb at 14,1 MeV;
[56]	13,44 ± 0,13 14,11 ± 0,15 14,87 ± 0,17 15,52 ± 0,17	1081 ± 106 1371 ± 137 1629 ± 160 1637 ± 160	Bormann68	abs.; from 12,78 to 19,42 MeV ;
[4]	14,2 ± 0,2	761 ± 107	for σ^{g} Prasad69	to/see $\text{Nd}^{148}/$; $\sigma^{\text{m}} = 554 ± 55$ mb;

 $^{154}_{62}\text{Sm}/\text{154}$

[11]	14,5 ± 0,35	≥ 225 ± 90	Paul53	abs.; counted betas; maybe this value is a misprint as remarked in [lol], and the correct value is 2250 mb, which is in [9], too;
[lol]	14,8 ± 0,9	1500 ± 300	Wille58	to $\text{Cu}^{63}/\text{n}, 2n/519$ mb;

Europium



Ref.	Energy/Mev/	Cross Sec/mb/	Identif.	Comments
[95]	14,8±0,8	500 ± 200	Willie60	to /see Ba ^{134m} /;
[39]	14,8±0,5	640 ± 64	Khurana61	to Fe ⁵⁶ /n,p/126 mb;
[53]	14,8±0,2	480 ± 63	Spenke64	to Al ²⁷ /n, α /116 mb ± 7 %;err
[5]				does not include monitor err.



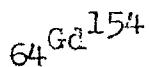
for the 9,3 h Eu^{152m1}

[95]	14,8±0,8	750 ± 200	Willie60	to/see Ba ^{134m} /; perhaps 5 ^m +6 ^m ?
[39]	14,8±0,5	164 ± 25	Khurana61	to Fe ⁵⁶ /n,p/126 mb;
[4]	14,2±0,2	652 ± 90	Prasad69	to Al ²⁷ /n, α /115±5 mb;

for the 96 m Eu^{152m2}

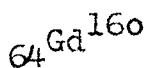
[4]	14,2±0,2	91 ± 12	Prasad69	to Al ²⁷ /n, α /115±5 mb;
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Gadolinium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
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[97]	$14,7 \pm 0,15$	1855 ± 140	Dilg68	to Al ²⁷ /n, α /111,5±2 mb;
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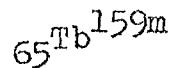
[11]	$14,5 \pm 0,35$	1470 ± 809	Paul53	abs.; stat.e.; cntd. betas;
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[95]	$14,8 \pm 0,8$	1450 ± 300	Wille60	to /see Ba ^{134m} /;
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[39]	$14,8 \pm 0,5$	1725 ± 172	Khurana61	to Fe ⁵⁶ /n,p/126 mb;
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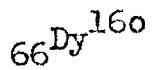
[4]	$14,2 \pm 0,2$	1675 ± 160	Prasad69	to Al ²⁷ /n,2n/115±5 mb;
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Terbium



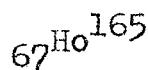
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5]	14,6	160 ± 19	Broadhead65	to Si ²⁸ /n,p/243±22 mb;cntd. 111 keV γ and 44 keV X-ray;
[37]	14,8	1250 ± 300	Prasad66	to Fe ⁵⁶ /n,p/126 mb;
[4]	14,2±0,2	524 ± 70	Prasad69	to Al ²⁷ /n, α /115±5 mb;

Dysprosium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[97]	14,7 ± 0,15	2015 ± 120	Dilg68	to Al ²⁷ /n, α/111,5±2 mb; counted K X-rays after electron capture;

Holmium

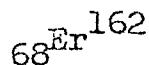


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
for the 24 m Ho ¹⁶⁴ S + the 39 m Ho ¹⁶⁴ m				
[39]	14,8 ± 0,5	2100 ± 210	Khurana61	to Fe ⁵⁶ /n,p/126 mb;cntd.betas;
[50]	14,7 ± 0,2	2760 ± 55	Bonazzola64	abs.;cntd. 0,9 /15 %/and 0,99 MeV /25 %/betas;44 mb statistical and 33 mb systematic error from the total/55/
[97][1]	14,0	1780 ± 140	Sethi66	energy taken from curve in [1]
[97]	14,7 ± 0,15	2110 ± 300	Dilg68	to /see Dy ¹⁶⁰ /;cntd.X-rays;

for the 39 m Ho¹⁶⁴m

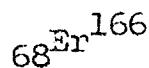
[97][1]	14,0	1050 ± 100	Sethi66	energy taken from curve in [1]
[1]	13,5 ± 0,47	1005 ± 142		to /see Na ²³ /;
	14,96 ± 0,87	1050 ± 117	Menlove67	
	15,82 ± 0,45	1047 ± 117		
[97]	14,7 ± 0,15	1180 ± 170	Dilg68	to /see Dy ¹⁶⁰ /;cntd.X-rays;
[56]	13,42 ± 0,16	1701 ± 192		abs.;counted betas;from 12,75
	14,10 ± 0,18	1782 ± 204	Bormann68	up to 19,47 MeV;perhaps with contribution of σ?
	15,52 ± 0,21	1599 ± 180		

Erbium



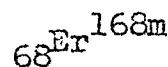
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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[4]	14,2±0,2	1870 ± 300	Prasad69	to Al ²⁷ /n, ~115±5 mb;
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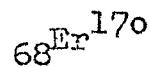
[95]	14,8±0,8	1000 ± 400	Wille60	to /see Ba ^{134m} /;
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[97]	14,7±0,15	1965 ± 115	Dilg68	to /see Dy ¹⁶⁰ /; cntd. X-rays;
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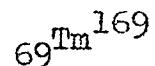
[5]	14,6	190 ± 24	Broadhead65	to /see Tb ^{159m} /; cntd. 208 keV and 44 keV X-rays;
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[37]	14,8	690 ± 110	Prasad66	to Fe ⁵⁶ /n,p/126 mb;
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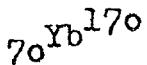
[95]	14,8±0,8	1200 ± 500	Wille60	to /see Ba ^{134m} /;
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[53]	14,8±0,2	1895 ± 133	Spenke64	to Al ²⁷ /n, ~116±8 mb; monitor error is not included in the 133 mb error;
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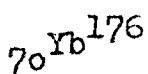


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5]	12,3	930 ± 350		counted gammas; taken from
	13,0	920 ± 370		curve in [5];
	13,85	970 ± 400	Tewes60	from 9,9 MeV;
	14,5	1030 ± 400		
[97]	14,7 ± 0,15	2000 ± 115	Dilg68	Al ²⁷ /n, α/111,5 ± 2 mb; counted K X-rays after electron capture;

Ytterbium

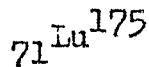


Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[97]	14,7±0,15	2080 ± 110	Dilg68	to Al ²⁷ /n,α/111,5±2 mb; counted K X-rays after electron capture



[95]	14,8±0,8	430 ± 100	Wille60	to /see Ba ^{134m} /;cntd. betas;
[39]	14,8±0,5	786 ± 80	Khurana61	to Fe ⁵⁶ /n,p/126 mb;cntd.β;
[53]	14,8±0,2	1810 ± 130	Spenke64	to Al ²⁷ /n,α/116±8 mb;the err. does not include the 7 % monitor error;cntd. betas;

Lutecium



Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
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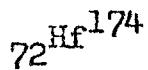
for the 3,6 y Lu^{174g}

[97]	14,7 ± 0,15	1285 ± 140	Dilg68	to Al ²⁷ /n,α/111,5 mb ± 1,5 %; cntd. X-rays;
.....				

for the 165 d Lu^{174m}

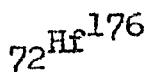
[95]	14,8 ± 0,8	1600 ± 300	Wille60	to /see Ba ^{134m} /; cntd. betas;
[97]	14,7 ± 0,15	655 ± 55	Dilg68	to Al ²⁷ /n,α/111,5 ± 2 mb; see comments at Yb ¹⁷⁰ ;
.....				

Hafnium



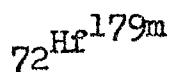
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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[5]	14	860 ± 60	Hillmann66 priv. comm.	in [5];
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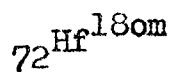


[5]	14	2000 ± 1000	Hillmann66	see above
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[97]	$14,7 \pm 0,15$	2220 ± 115	Dilg68	to $\text{Al}^{27}/\text{n}, \alpha/\text{l}11,5 \pm 2$ mb; see comments at Yb^{170} ;
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[37]	14,8	880 ± 100	Prasad66	to $\text{Fe}^{56}/\text{n}, \text{p}/\text{l}26$ mb; half life = = 15 s was given;
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[37]	14,8	570 ± 50	Prasad66	to $\text{Fe}^{56}/\text{n}, \text{p}/\text{l}26$ mb;
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Tantalum
 $^{181}_{73}\text{Ta}$

92

Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

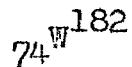
$\sigma^{\text{m+g}}$ /nonactivation methods/

- [9][5] 14,1 1800 ± 300 Rosen57 nuclear emulsion; $E_n > 0,5$ MeV; $d\Omega = 4\pi$;
 [5][28] 14,1 2560 ± 190 Ashby58 liquid scint.tank; first 264 of 200 mb was given, renormlzd. later by auths [5];

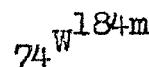
for the 8,1 h Ta^{180m}

- [11] $14,5 \pm 0,35$ 867 ± 217 Paul53 abs.; stat.e.; counted betas
 [5][9] $14,8 \pm 0,8$ 2740 ± 30 Poularikas60 to $\text{Cu}^{63}/n, 2n/556$ mb;
 [6] $13,52 \pm 0,15$ 1126 ± 56 to /see Ge^{70} and Ti^{46} /; counted
 $13,88 \pm 0,10$ 1118 ± 56 betas; for errors see comments
 $14,09 \pm 0,10$ 1132 ± 57 at Sc^{45} ;
 $14,31 \pm 0,13$ 1115 ± 56 Prestwood61
 $14,50 \pm 0,20$ 1116 ± 56
 $14,68 \pm 0,26$ 1087 ± 54
 [56] $13,57 \pm 0,14$ 1125 ± 90 abs.; from 12,96 up to 18,25
 $14,10 \pm 0,15$ 1146 ± 93 MeV;
 $14,60 \pm 0,16$ 1157 ± 94 Bormann68
 $15,09 \pm 0,17$ 1065 ± 85
 $15,64 \pm 0,17$ 916 ± 74
 [74] $13,96$ $1,01$ arbitrarily normalized!
 $14,01$ $1,03$ energy errors are $\sim 0,05$ MeV,
 $14,06$ $1,00$ cross section errors are $\sim 1,5\%$;
 $14,11$ $1,00$ down to 13,56 MeV;
 $14,16$ $0,95$
 $14,21$ $0,92$
 $14,26$ $0,97$
 $14,31$ $1,01$ /!/ Csikai66
 $14,36$ $0,97$
 $14,41$ $0,99$
 $14,46$ $0,97$
 $14,51$ $0,98$
 $14,56$ $0,98$
 $14,61$ $1,03$
 $14,66$ $1,00$
 $14,71$ $0,96$
 [31] $13,6$ $1,014$ arbitrarily normalized!
 $13,7$ $1,013$ the cross sections are accurate
 $13,8$ $1,011$ to $\pm 1\%$;
 $13,9$ $1,010$
 $14,0$ $1,009$
 $14,1$ $1,008$ /!/ Vonach68
 $14,2$ $1,006$
 $14,3$ $1,005$
 $14,4$ $1,004$
 $14,5$ $1,003$
 $14,6$ $1,001$
 $14,7$ $1,000$

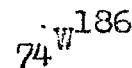
Wolfram



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[103]	14,8	2300 ± 200	Druzhinin66	abs. and to $\text{Al}^{27}/n,\alpha/$; cntd. 136 and 152 keV γ ; individual runs: 2400 ± 300 and 2160 ± 200 mb abs., 2380 ± 230 mb to $\text{Al}^{27}/n,\alpha/$ of Gordeev63 compilation;
[97]	$14,7 \pm 0,15$	2160 ± 120	Dilg68	to $\text{Al}^{27}/n,\alpha/$; $111,5 \pm 2$ mb; see comments at Yb170;



[37]	14,8	790 ± 90	Prasad66	to $\text{Fe}^{56}/n,p/$ 126 mb;
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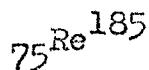


for the 76 d W^{185}g and the 1,6 m $\text{W}^{185\text{m}}$				
[103]	14,8	2290 ± 230	Druzhinin66	see above; cntd. 440 keV beta individual runs: 2600 ± 380 and 2520 ± 240 and 1980 ± 170 abs., 2410 ± 220 and 2350 ± 230 mb to $\text{Al}^{27}/n,\alpha/$ of Gordeev63 compil.

for the 1,6 m $\text{W}^{185\text{m}}$

[5]	14,8	> 470	Poularikas60	
[37]	14,8	540 ± 80	Prasad66	to $\text{Fe}^{56}/n,p/$ 126 mb;

Rhenium



Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

for the 38 d $\text{Re}^{184\text{g}}$

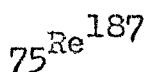
- [5] 14,1 1910 ± 600 Karam62 to $\text{Au}^{197}/n, 2n/\gamma$ 1722 ± 465 mb; cntd. γ

 [104] 14,8 1430 ± 220 Druzhinin67 individual runs: 1520 ± 230 and
 1300 ± 200 abs., 1430 ± 220 and 1450 ± 220 to $\text{Al}^{27}/n, \alpha/\gamma$ 117 ± 10 mb; cntd.
 $895/14,8\%$ and $904\text{keV}/44,5\%$; γ

for the 165 d $\text{Re}^{184\text{m}}$

- [5] 14,1 1120 ± 400 /!/Karam62 to /see above/; 2,2 d half life
 was measured /!/

 [104] 14,8 260 ± 100 Druzhinin67 individual runs: 270 ± 110 and
 240 ± 110 abs., 250 ± 100 and 270 ± 100 mb to $\text{Al}^{27}/n, \gamma$ 117 ± 10 mb; cntd.
 γ see above; 15 % br.r. to W^{184}

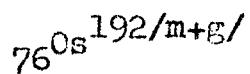


- [39] $14,8 \pm 0,5$ 1675 ± 168 Khurana61 to $\text{Fe}^{56}/n, p/$ 126 mb;

 [5] 14,1 1440 ± 410 Karam62 to /see $\text{Re}^{185\text{g}}/\gamma$; cntd. gammas;

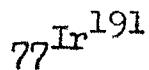
 [104] 14,8 1490 ± 160 Druzhinin67 individual runs: 1480 ± 150 and
 1420 ± 130 and 1620 ± 170 mb abs.,
 1440 ± 140 and 1540 ± 140 mb to
 $\text{Al}^{27}/n, \alpha/\gamma$ 117 ± 10 mb;

Osmium



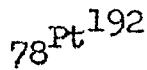
Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
[118]	14.4 ± 0.4	1993 ± 200	Hankla72	to Fe ⁵⁶ /n, p/see Rao67 Se ^{74g} and Al ²⁷ /n, α/114±6 mb; cntd. 129 keV γ, 0, 258 γ/decay;

Iridium

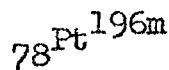


Ref.	Energy/MeV/	Cross Sec(mb/	Identif.	Comments
for the 11 d Ir^{190g}				
[97]	$14,7 \pm 0,15$	1730 ± 135	Dilg68	to $\text{Al}^{27}/n,\alpha/111,5\text{mb} \pm 1,5\%$; see comments at Yb^{178} ;
.....				
for the 3,1 h Ir^{190m_1}				
[39]	$14,8 \pm 0,5$	367 ± 55	Khurana61	to $\text{Fe}^{56}/n,p/ 126\text{ mb}; \text{cntd.} \beta$;
.....				

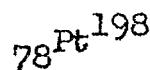
Platinum



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[118]	14,4 ± 0,4	2035 ± 150	Hankla72	to /see Os ¹⁹² /; cntd. 457 keV gamma /0,021 γ per decay/;



[118]	14,4 ± 0,4	460 ± 55	Hankla72	to /see Os ¹⁹² /; cntd. 99 keV γ, 0,113 γ/decay; together with the Pt ¹⁹⁵ /n,n,/process;
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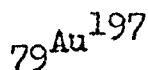
for the 20 h Pt^{197g} + the 1,5 h Pt^{197m}

[1][5]	14,5 ± 0,35	277 ± 1524	for 0%/?/ Paul53	abs.; counted betas
[5][118]	14,8	3430 ± 343	Mangal65	to Al ²⁷ /n,p/; cntd. gammas;
[118]	14,4 ± 0,4	1716 ± 170	Hankla72	to /see Os ¹⁹² /; cntd. 191 keV γ, 0,050 γ/decay;

for the 1,5 h Pt^{197m}

[5][118]	14,8	1130 ± 113	Mangal65	to Al ²⁷ /n,p/; cntd. gammas;
[118]	14,4 ± 0,4	1009 ± 100	Hankla72	to /see Os ¹⁹² /; cntd. 297 keV /0,027 γ per decay/ and 346 keV /0,124 γ per decay/ gammas;

Gold



Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

	for the 6,2 d Au^{196g} + the 9,7 h Au^{196m}			
[11]	$14,5 \pm 0,35$	1722 ± 465	Paul53	abs.; counted betas;
[5][28]	$14,1$	2520 ± 190	Ashby58	abs.; nonactivation!; renormalized in [5] by the authors;
[105]	14	1800 ± 500	Bak60	abs/?/;
[9] [5]	$13,9$ $14,0$ $14,1$ $14,6$ $15,1$	1960 1900 ± 400 2110 2090 2110 ± 400	Tewes60	counted gammas; the errors are taken from curve in [5];
[106]	$14,1 \pm 0,6$	$1220 \pm 20 \leq 1830 \pm 30$	Graves55	abs.; nonactivation!; multiplication of neutrons in a thin spherical shell;
[6]	$13,40 \pm 0,20$ $13,69 \pm 0,10$ $14,01 \pm 0,10$ $14,31 \pm 0,13$ $14,50 \pm 0,20$ $14,81 \pm 0,31$	2330 ± 117 2369 ± 118 2403 ± 120 2420 ± 121 2403 ± 120 2356 ± 118	Prestwood61	to /see Ge^{76} , Ti^{46} /; for errors see Sc^{45} ;
[5]	14,8	1700 ± 150	Mangal65	to $\text{Al}^{27}/n,p/$; counted gammas; taken from curve; 1950 ± 25 mb was given in [118] for this value
[97]	$14,7 \pm 0,15$	2320 ± 180	Dilg68	to $\text{Al}^{27}/n,\alpha/l11,5 \pm 2$ mb; see also comments at Yb^{170} ;
[31]	$14,7$ $14,6$ $14,5$ $14,4$ $14,3$ $14,2$ $14,1$ $14,0$ $13,9$ $13,8$ $13,7$ $13,6$	2100 ± 140 $2100 \pm 0,999$ $0,998$ $0,997$ $0,996$ $0,995$ $0,995$ $0,994$ $0,993$ $0,992$ $0,991$ $0,990$	Vonach68	to $\text{Al}^{27}/n,\alpha/l11,5 \pm 2$ mb; see comments at Ag^{107} ; maybe this value is not independent from Dilg68
[107]	$14,4 \pm 0,3$	1986 ± 200	Hankla68	to $\text{Fe}^{56}/n,p/l00 \pm 6$ mb and $\text{Al}^{27}/n,\alpha/l14 \pm 6$ mb; it's same as:
[118]	$14,4 \pm 0,4$	1986 ± 150	Hankla72	to /see $\text{Os}^{192}/$; cntd. 356 keV $/0,870 \pm$ per decay/ and 425 keV $/0,068 \pm$ per decay/ gammas;

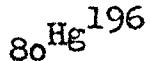
Gold



Ref.	Energy/MeV	Cross Sec/mb	Identif.	Comments
				for the 9,7 h Au^{196m}
[9][5]	13,9	165		counted gammas; the errors are taken from curve in [5] ;
	14,0	165 ± 40		
	14,1	195	Tewes60	
	14,6	210		
	15,1	195 ± 40		
[6]	13,4 \pm 10,20	$118,8 \pm 5,9$		to /see $\text{Ge}^{70}, \text{Tl}^{46}$ /; for errors see Sc^{45} ;
	13,69 \pm 10,10	$128,1 \pm 6,4$		
	14,0 \pm 10,10	$134,3 \pm 6,7$	Prestwood61	
	14,31 \pm 10,13	$137,1 \pm 6,9$		
	14,50 \pm 10,20	$142,1 \pm 7,1$		
	14,81 \pm 10,31	$145,1 \pm 7,3$		
[5][97]	14,8	230 ± 35	Mangal65	to $\text{Al}^{27}/n, p/$; counted gammas; [118] cites ± 15 mb for error;
[97]	14,7 \pm 15	148 ± 15	Dilg68	to /see Yb^{170} /;
[107]	14,4 \pm 3	151 ± 18	Hankla68	to /see $\text{Au}^{197}/m+g//$; same as:
[118]	14,4 \pm 4	151 ± 18	Hankla72	to /see Os^{192} /; cntd. 148 keV γ with $\text{o}, 437 \gamma$ /decay;

Mercury

100



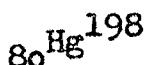
Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

for the 9,5 h $\text{Hg}^{195\text{g}}$

[119]	$14,1 \pm 0,5$	≤ 1100	Temperley69 to $\text{Fe}^{56}/n, p/106 \pm 7$ mb/845 keV γ ; br.r.=98,8 %/; cntd.262 keV γ , branching ratio=2,2 %;
[118]	$14,4 \pm 0,4$	363 ± 54	Hankla72 to /see $\text{Os}^{192}/$; cntd.585 keV $/0,070 \gamma$ per decay/ and 600 keV/ $0,058 \gamma$ per decay/gammas;

for the 40 h $\text{Hg}^{195\text{m}}$

[119]	$14,1 \pm 0,5$	1060 ± 70	Temperley69 to /see above/; cntd.262 keV gamma, br.r.=31,2 %;
[107]	$14,4 \pm 0,3$	1446 ± 174	Hankla68 to /see $\text{Au}^{197}/$; it's same as:
[118]	$14,4 \pm 0,4$	1617 ± 160	Hankla72 to /see $\text{Os}^{192}/$; cntd.261 keV gamma with $0,198 \gamma$ /decay;



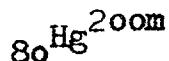
for the 64 h $\text{Hg}^{197\text{g}}$

[97]	$14,7 \pm 0,15$	2340 ± 220 for δ^{170} Dilg68	to /see $\text{Yb}^{170}/$;
[119]	$14,1 \pm 0,5$	940 ± 100	Temperley69 to /see above/; cntd.191 keV γ , br.r.=2 %, ICC=0,82 to ,08 ;
[118]	$14,4 \pm 0,4$	1125 ± 100	Hankla72 to /see $\text{Os}^{192}/$; cntd.191 keV gamma with $0,0995 \gamma$ /decay;

for the 24 h $\text{Hg}^{197\text{m}}$

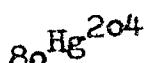
[119]	$14,1 \pm 0,5$	900 ± 70	Temperley69 to /see above/; cntd.134 keV γ br.r.=93,5 $\pm 1,0$ %, ICC=1,61 ;
[107]	$14,4 \pm 0,3$	885 ± 106	Hankla68 to /see $\text{Au}^{197}/$; it's same as:
[118]	$14,4 \pm 0,4$	885 ± 80	Hankla72 to /see $\text{Os}^{192}/$; cntd. 134 keV $/0,356 \gamma$ per decay/ and 279 keV/ $0,045 \gamma$ per decay/ gammas;

Mercury



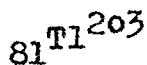
Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
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[119]	$14,1 \pm 0,5$	880 ± 60	Temperley69	to /see Hg^{196g} /; cntd. 158 keV /br.r=100 %, ICC=0, 9 to, 1/ and 375 keV /br.r=100 %, ICC= = 5,45 to, 25 / gammas;
[107]	$14,4 \pm 0,3$	128 ± 20	Hankla68	to /see Au^{197} /; maybe same as:
[118]	$14,4 \pm 0,4$	789 ± 120	Hankla72	to /see Os^{192} /; cntd. 158 keV gamma with 0,585 γ /decay;

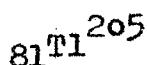


[97]	$14,7 \pm 0,15$	2300 ± 160	Dilg68	to /see Yb^{170} /;
[108]	$15,0 \pm 0,3$	2230 ± 300	Petõ68	to $\text{Y}^{89}/n, 2n/$ 10 to 80 mb; cntd. 279 keV gammas
[119]	$14,1 \pm 0,5$	2060 ± 190	Temperley69	to /see Hg^{196g} /; cntd. 279 keV γ , br.r=100 %, ICC=0, 2262 \pm 0019
[107]	$14,4 \pm 0,3$	2077 ± 250	Hankla68	to /see Au^{197} /; it's same as:
[118]	$14,4 \pm 0,4$	2077 ± 166	Hankla72	to /see Os^{192} /; cntd. 279 keV gamma with 0,82 γ /decay;

Thallium

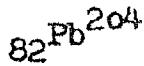


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5]	14,8	>680	Poularikas60	
[5] [9]	13,0 13,9 14,6 15,1	1420 ± 280 1450 ± 290 1560 ± 290 1650 ± 330	Tewes60	counted gammas; the 13 MeV value is taken from curve in [5]; there are more points down to the threshold;
[6] [9]	13,52±0,15 13,88±0,10 14,09±0,10 14,31±0,13 14,50±0,20 14,68±0,26	1268 ± 63 1302 ± 65 1302 ± 65 1329 ± 66 1321 ± 66 1305 ± 65	Prestwood61	to /see Ge^{76} , Ti^{46} /; for errors see Sc^{45} ;
[108]	15,0 ±0,3	1680 ± 210	Pető68	to $\gamma^{89}/n, 2n/1010 \pm 80$ mb; cntd. 440 keV gamma;
[97]	14,7 ±0,15	2185 ± 120	Dilg68	to /see Yb^{170} /;
[120]	14,8	1700 ± 170	Druzhinin71	abs.; cntd. 439 /95 %/ and 522 /0,1 %/ keV gammas;
[107]	14,4 ±0,3	1784 ± 214	Hankla68	to /see Au^{197} /; maybe same as:
[118]	14,4 ±0,4	1950 ± 200	Hankla72	to /see Os^{192} /; cntd. 440 keV gamma with 0,908 γ/decay;

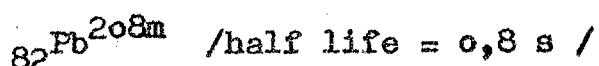


[53]	14,8 ±0,2	1990 ± 280	Spenke64	to $\text{Al}^{27}/n, \alpha/116$ mb ± 7 %; cntd. betas /98 %/; error is the sum of 7 % monitor err. and 7 % other errors ;
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Lead

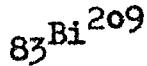


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5]	12,3	1250 ± 500		taken from curve; counted
	12,8	1330 ± 500	Tewes60	gammas; also for smaller
	13,0	1540 ± 600		energies;
[5]	12,1	1580 ± 80		taken from curve; errors are
	12,3	1630 ± 100		statistical only;
	12,4	1520 ± 120	Vaughn63	
	13,0	1680 ± 80		
	14,0	1750 ± 50		
	15,4	1900 ± 220		
[7] 108	14,7 ± 0,3	1575 ± 160	Csikai67	to Cu ⁶⁵ /n, 2n/97 mb; cndt. 279 keV gamma;
[97]	14,7 ± 0,15	2110 ± 110	Dilg68	to /see Yb ¹⁷⁰ /;
[118]	14,1	1936 ± 98	Mather69	cited in [118] for isotopic mix ture! acc. to [124]
[85]	13,5 ± 0,2	1970 ± 300		to Fe ⁵⁶ /n, p/105 ± 5 mb at
	14,2 ± 0,2	1780 ± 270	Károlyi70	14,7 MeV;
	15,0 ± 0,2	1740 ± 260		
	15,5 ± 0,2	1630 ± 250		
[120]	14,8	2200 ± 200	Druzhinin71	abs.; cndt. 279 keV γ/81 %/;
[118]	14,4 ± 0,4	1737 ± 140	Hankla72	to /see Os ¹⁹² /; cndt. 279 keV gamma with 0,665 γ/decay;
[108]	15,0 ± 0,3	860 ± 180 for σ [~]	Pető68	to Pr ¹⁴¹ /n, 2n/2050 ± 180 mb; cndt. 825 keV γ; half life = 6 s



[5]	[9]	14,7	1700 ± 300	Glagolev61	to Cu ⁶³ /n, 2n/620 ± 400 mb; cndt. 1,06 MeV gammas;
[5]		11,0	504,2 ± 40	Shunk62	cndt. 1,06 MeV γ; for 10,0
		14,0	1313,5 ± 100		MeV also given: 173,7 ± 14 mb;
[37]		14,8	990 ± 120	Prasad66	to Fe ⁵⁶ /n, p/126 mb;
[108]		15,0 ± 0,3	1340 ± 174	Pető68	to /see Pb ²⁰⁴ /; cndt. 0,57 and 1,06 MeV γ; with Pb ²⁰⁷ n, n ⁺ /Pb ²⁰⁷

Bismuth

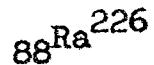


Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
				$\delta \sim m^+ q$, from nonactivation measurements
[106]	14,1 \pm 0,6	1860 \pm 200 \pm 6 \pm 200	Graves55	neutron multiplication in a spherical shell;
[5]	14,1	2300 \pm 300	Rosen57	nuclear emulsion
[5]	14,5	2420 \pm 200	Flerov58	neutr. multipl.; graphite
[112]				prism detector; in [5] this is attached to 14 MeV
[28]	14,1	2600 \pm 190	Ashby58	liquid scintillator tank;
[112]	14	2180 \pm 200	Lebedev59	neutron multiplication;
[5][112]	14,1	1950 \pm 80	Adam63	angular correlation of emitted neutrons;
[112]	14,1 \pm 0,7	2250 \pm 250	Feicht67	Fermi's watertank-method;

for the 2,6 ms state of Bi²⁰⁸

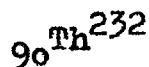
[5][9]	14,7	660 \pm 120	Glagolev61 to Cu ⁶³ /n, 2n/620 \pm 400 mb; cntd. 880 keV gamma;
[113]	14,3	290 \pm 30	Monnand66 to Cu ⁶³ /n, 2n/500 mb; 900 keV γ /100 % were cntd. with 500 and 630 keV gammas;

Radium



Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[5]	14.5	1600 ± 200	O'Conner60	after chemical separation 3.3 h Pb ²⁰⁹ betas were counted in the Ra ²²⁵ decay chain;

Thorium



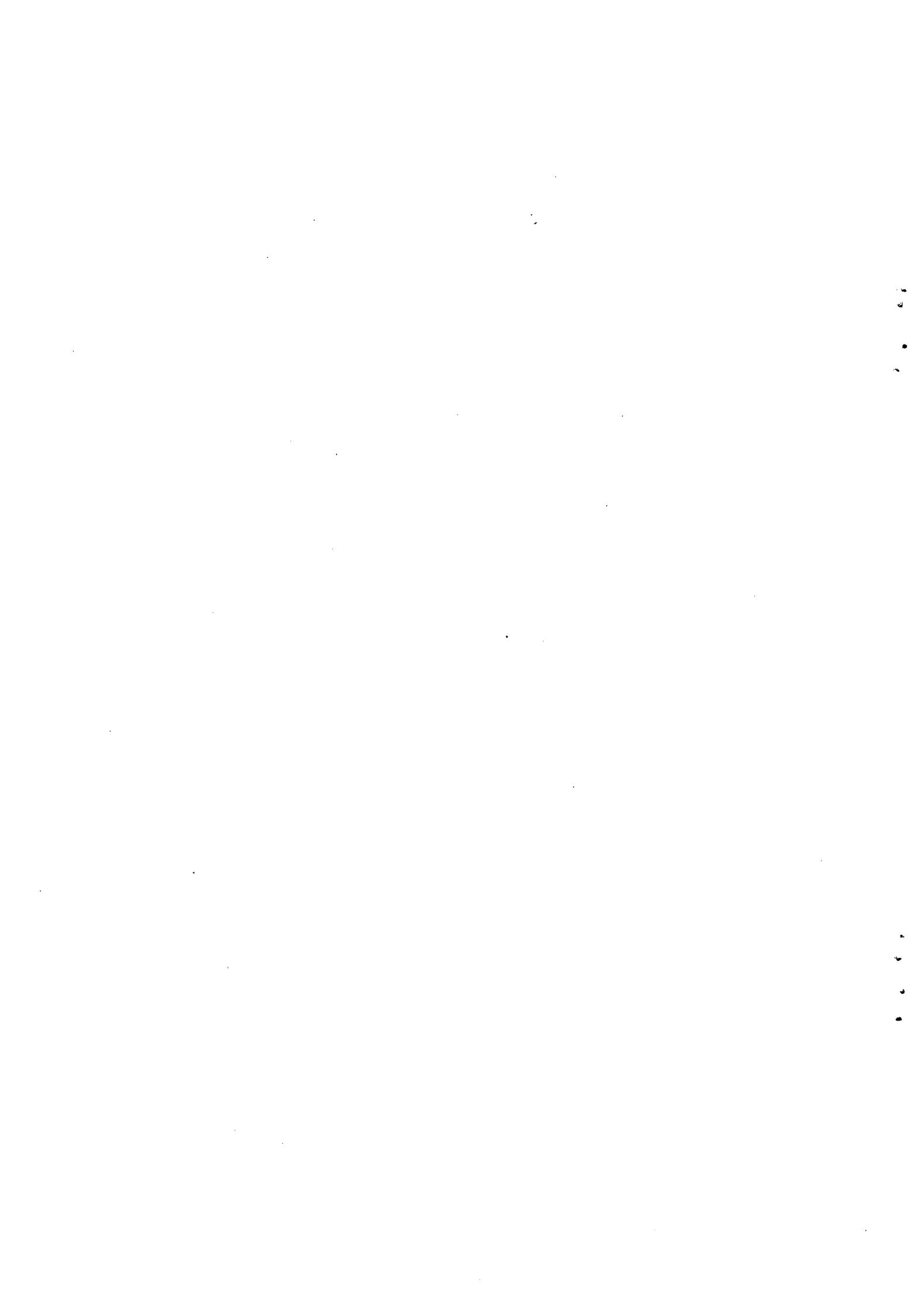
Ref. Energy/MeV/ Cross Sec/mb/ Identif. Comments

[5][122]	15,0	1100 ± 100	Phillips56	cntd. 25,6 keV gammas;
[5]	16,0	480 ± 60	Cochran58	taken from curve
[5] [9]	13,0	1750 ± 350		also down to 8,4 MeV in 5 ;
[114]	13,9	1490 ± 300		an error ± 20 % was supposed
[122]	14,0	1330 ± 270	Tewes60	following[78];
[78]	14,47	1148 ± 220		
	14,6	1400 ± 280		
	15,1	980 ± 200		
[9] [5]	14,7	650 ± 150	Zislin60	to Mo ⁹⁹ and Ba ¹⁴⁰ yields in U ²³⁸ fission of 1160 mb;
[5] [9]	14,1±0,3	1200 ± 50	Perkin61	to Al ²⁷ /n, &/; counted 58,5
[122]				and 85 keV gammas;
[9] [5]	14,45±0,2	1230 ± 60	Butler61	to S ³² /n, p/229 mb; cntd. betas; also for 6,5-12,5 and 18,5- -20,5 MeV; err.: stat. and calibr
[6]	13,33±0,23	1610 ± 161		to / see Ge ⁷⁰ , Ti ⁴⁶ ; for errors
	13,40±0,20	1680 ± 168		see Sc ⁴⁵ ;
	13,52±0,15	1635 ± 164		
	13,69±0,10	1630 ± 163		
	13,88±0,10	1580 ± 158		
	14,09±0,10	1560 ± 156	Prestwood61	
	14,31±0,13	1520 ± 152		
	14,50±0,20	1440 ± 144		
	14,68±0,26	1400 ± 140		
	14,81±0,31	1280 ± 128		
	14,93±0,36	1255 ± 126		

Uranium

 $^{238}_{92}\text{U}$

Ref.	Energy/MeV/	Cross Sec/mb/	Identif.	Comments
[122]	14.	400 ± 300	Graves51	also cited in [123];
[122]	14.	650 ± 50	Pool54	in [123] 720 mb is given;
[5][123]	14,1	650 ± 50	Phillips56	cntd. gamma from U^{237} ;
[5][123]	15	900 ± 150	Antropov58	to U^{238} fission; cntd. U^{237} ;
[115]	16,00±0,3	320 ± 50	Knight58	measd. σ_{abs} = 0,23 ± 0,02 and multiplied by $\sigma_{\text{f.n.}} = 1380$ mb of Smith57; abs.; cntd. U^{237}/β ; 30 mb stat.e. from 50; also for 5,98-9,97 MeV energies;
[115]	13,2	1060		unpublished data cited in [115] and [123]; taken from curves;
[123]	13,4	1040		
	13,6	950		
	13,8	910		
	14,1	810	Graves58	
	14,4	790		
	14,7	730		
	14,8	620		
	15,1	510		
	15,2	500		
[122]	14,5±0,4	690 ± 40	Perkin61	to $\text{Cu}^{63}/n, 2n/$; cntd. 59 and 203 keV γ from U^{237} and 100 keV X-ray from IC. of 203 keV γ ;
[124]	14,1±0,2	822 ± 30	Mather69	to U^{238} fission; nonactivation! liquid scint. counter; total correction applied for different effects is + 19 mb;
[121]	14,4±0,2	528 ± 58	Daróczy71	to $\text{Al}^{27}/n, \gamma/117±4$ mb; 208 keV γ counted ref. to the 205 keV γ of U^{235} ;



Preprint of a paper published in Atomic Energy Review vol. 11, nr.1 (1973):

Recommended values of $(n,2n)$ cross-sections at 14.7 MeV

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Abstract. A survey is given on the present knowledge of $(n,2n)$ cross-sections at 14.7 MeV. Recommended values are tabulated for elements and isotopes. These were obtained on the basis of experimental data supplemented by N-Z systematics and are compared with values resulting from empirical formulae.

Introduction

In addition to the checking of nuclear theories and cross-section systematics the knowledge of $(n,2n)$ data at 14.7 MeV is also important for practical applications, especially for planning thermonuclear devices and for activation analysis. According to the recent survey by Bödy [1,2] $(n,2n)$ cross-sections have been measured at 14.7 MeV for about 30 per cent of the stable nuclei. The great number of the unknown data can be explained by the limits of the activation method and the unfavourable decay schemes [3]. The experimental values show large discrepancies; therefore more accurate trends can be revealed from the data measured by the same author where the relative accuracy is higher. More reliable data can be obtained by appropriate averaging of the available values [4]. The observed N-Z dependence in the $(n,2n)$ cross-sections [5] gives a possibility to estimate unknown values for isotopes and elements. Tables 1, 2, 3, give recommended values obtained on the basis of experimental data and N-Z systematics.

Summary of the procedure for obtaining recommended values

Recommended $(n,2n)$ cross-sections at 14.7 MeV are determined by the following procedure (details of which are given in the Appendix):

- 1.a. The recent compilation of experimental data by Bödy, which is available as a separate report [2], is taken as the basis for the present survey.
- b. The experimental data are re-normalized to up-to-date standard values given in table 4.
- c. Most probable values are estimated by appropriate averaging. Table 1 gives recommended values for those nuclides for which experimental data exist.
- 2.a. The values of table 1 are converted to constant excess energy above threshold by means of the Weisskopf formula.
- b. The resulting values are extra- and interpolated by N-Z systematics to obtain unmeasured values at constant excess energy.
- c. These are converted to 14.7 MeV using the Weisskopf formula. The resulting table 2 gives recommended values for those nuclides for which no experimental data exist.
3. Values from tables 1 and 2 are used for averaging over isotopic abundances. Table 3 gives recommended values for elements in natural isotopic composition.

Table 1. Recommended values of $(n, 2n)$ cross-sections at 14.7 MeV for nuclides where experimental data exist. The errors given are standard deviations.

* = Values which are strongly energy dependent around 14.7 MeV are marked (see text, appendix).

	$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$		$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$
N-14	7,52*	0,63	Sr-84	227	70
F-19	54,1	5,4	Sr-86	971	194
Na-23	43,3	9	Y-89	1064	52
P-31	10,7	0,96	Zr-90	798*	18
Cl-35	9,2	0,7	Zr-96	1456	80
K-39	4,36	0,28	Mo-92	200*	11
Ca-48	940	74	Mo-100	1700	137
Sc-45	311	24	Ru-96	638	75
Ti-46	50,8*	4,1	Ru-98	1169	91
Cr-50	29,4	1,9	Ru-104	1440	80
Cr-52	352	66	Rh-103	917	60
Mn-55	837	57	Pd-102	637	45
Fe-54	14,3	7	Pd-110	2050	470
Fe-56	490	36	Ag-107	1488	130
Co-59	838	77	Cd-106	885	42
Ni-58	33,7*	4,3	Cd-108	865	100
Cu-63	558*	11	Cd-110	1221	150
Cu-65	965*	5	Cd-116	1535	90
Zn-64	190,5	14,3	In-113	1721	67
Zn-66	742,4	82	In-145	1721	67
Zn-70	1273	130	Sn-112	1489	55
Ga-69	1007	63	Sn-114	1550	250
Ga-71	1085	280	Sn-124	1425	180
Ge-70	646	50	Sb-121	1655	90
Ge-76	1151	137	Sb-123	1602	190
As-75	1111	34	Te-120	1220	131
Se-74	442*	10	Te-122	1444	170
Se-76	937	70	Te-128	1594	150
Se-82	1258	112	Te-130	1455	55
Br-79	1069	39	I-127	1655	55
Br-81	1136	45	Xe-124	1377	110
Kr-78	245	20	Xe-126	1402	165
Kr-80	810	60	Xe-128	1583	170
Rb-85	1411	86	Xe-134	1698	170
Rb-87	1817	343	Xe-136	1760	100
			Cs-133	1567	82

TABLE I. /cont./

Ba-130	1371	70	Hf-176	2270	115
Ba-132	1574	100	Ta-181	2220	370
Ce-135	1318	90	W-182	2232	100
Ce-140	1730	70	W-185	2290	230
Ce-142	1820	80	Re-185	2020	620
Pr-141	1744	174	Re-187	1428	111
Nd-142	1738	167	Ir-191	2050	140
Nd-143	1954	250	Os-192	2028	200
Nd-150	2014	300	Pt-192	2070	150
Sm-144	1557	105	Pt-198	2000	250
Sm-154	1633	300	Au-197	2109	110
Gd-154	1897	140	Hg-196	2015	160
Gd-160	1532	145	Hg-198	2043	167
Dy-160	2060	120	Hg-204	2183	94
Ho-165	2096	273	Tl-203	1750	185
Er-162	1951	300	Tl-205	1930	288
Er-166	2009	115	Pb-204	1881	133
Er-170	1862	133	Bi-209	2214	100
Tm-169	2045	115	Ra-226	1600	200
Yb-170	2126	110	Th-232	1156	178
Yb-176	1779	130	U-238	703	50
Lu-175	1983	150			

Table 2. Recommended values of $(n,2n)$ cross-sections at 14.7 MeV obtained from N-Z systematics. The errors are standard deviations.

	$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$		$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$
Ca-42	290	60	Mo-94	865	80
Ca-43	595	90	Mo-95	980	100
Ca-44	470	40	Mo-96	1125	120
Ca-46	740	80	Mo-97	1295	170
Ti-47	380	60	Mo-98	1370	180
Ti-48	320	50	Ru-99	940	90
Ti-49	660	70	Ru-100	960	100
Ti-50	655	60	Ru-101	1120	110
V-51	565	60	Ru-102	1225	70
Cr-53	890	140	Pd-104	945	120
Cr-54	1120	130	Pd-105	1275	140
Fe-57	900	140	Pd-106	1430	170
Fe-58	1060	190	Pd-108	1740	200
Ni-60	408	30	Ag-109	1440	170
Ni-61	780	55	Cd-111	1260	170
Ni-62	900	60	Cd-112	1590	230
Ni-64	1095	90	Cd-113	1370	230
Zn-67	1000	80	Cd-114	1450	170
Zn-68	1120	85	Sn-115	1565	120
Ge-72	788	30	Sn-116	1560	120
Ge-73	1010	40	Sn-117	1530	110
Ge-74	1100	60	Sn-118	1465	120
Se-77	1135	50	Sn-119	1480	110
Se-78	1085	35	Sn-120	1495	120
Se-80	1200	120	Sn-122	1470	120
Kr-82	795	80	Te-123	1290	80
Kr-83	1130	130	Te-124	1345	80
Kr-84	1280	150	Te-125	1340	80
Kr-86	2010	200	Te-126	1495	120
Sr-87	1525	130	Te-130	1590	110
Sr-88	1465	110	Xe-129	1525	110
Zr-91	1160	50	Xe-130	1580	120
Zr-92	1235	50	Xe-131	1565	110
Zr-94	1350	60	Xe-132	1630	120
Nb-93	1080	80	Ba-134	1550	90

TABLE II./cont./

	$\sigma/\text{mb}/$	$d\sigma/\text{mb}/$		$\sigma/\text{mb}/$	$d\sigma/\text{mb}/$
Ba-135	1570	110	Yb-174	1890	130
Ba-136	1660	90	Hf-174	2040	130
Ba-137	1655	110	Hf-177	1950	130
Ba-138	1720	120	Hf-178	1975	140
La-139	1730	100	Hf-179	2075	160
Ce-138	1520	90	Hf-180	2235	160
Nd-143	1720	110	W-180	2130	160
Nd-144	1800	110	W-183	2180	160
Nd-145	1775	110	W-184	2230	160
Nd-146	1845	110	Os-184	2170	170
Sm-147	1580	150	Os-186	2175	170
Sm-148	1625	160	Os-187	2130	160
Sm-149	1585	150	Os-188	2175	170
Sm-150	1645	160	Os-189	2125	170
Sm-152	1790	170	Os-190	2185	160
Eu-151	1675	170	Os-192	(2190)	(160)
Eu-153	1885	190	Ir-193	2130	160
Gd-152	1790	220	Pt-190	2045	170
Gd-155	1785	130	Pt-192	(2030)	(160)
Gd-156	1800	130	Pt-194	2010	150
Gd-157	1725	130	Pt-195	1960	140
Gd-158	1740	130	Pt-196	1990	140
Tb-159	1875	140	Hg-196	(2060)	(160)
Dy-156	1790	190	Hg-198	(2010)	(160)
Dy-158	1910	190	Hg-199	2020	160
Dy-161	2050	130	Hg-200	2090	160
Dy-162	2160	130	Hg-201	2085	160
Dy-163	2180	130	Hg-202	2160	160
Dy-164	2350	170	Pb-206	1915	150
Er-164	1995	180	Pb-207	1930	160
Er-167	1910	120	Pb-208	1985	160
Er-168	1930	120			
Yb-168	1850	280			
Yb-171	1970	130			
Yb-172	1970	130			
Yb-173	1900	150			

Table 3. Recommended values of $(n, 2n)$ cross-sections at 14.7 MeV for elements. The errors are standard deviations.
 (Data for H, Li and Be were taken from BNL-325 [9].)

Z		$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$	Z		$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$
1	H	0.026	0.003	50	Sn	1494	115
3	Li	60	10	51	Sb	1632	120
4	Be	500	100	52	Te	1482	90
7	N	7,52	0,63	53	I	1655	55
9	F	54,1	5,4	54	Xe	1604	120
11	Na	43,3	9	55	Cs	1567	82
15	P	10,7	0,96	56	Ba	1694	110
20	Ca	15	1.5	57	La	1732	103
21	Sc	311	21	58	Ce	1739	72
22	Ti	341	45	59	Pr	1744	174
23	V	565	55	60	Nd	1800	130
24	Cr	407	70	62	Sm	1660	196
25	Mn	837	57	63	Eu	1784	180
26	Fe	474	35	64	Gd	1714	120
27	Co	838	77	65	Tb	1875	144
28	Ni	183	15	66	Dy	2194	124
29	Cu	684	10	67	Ho	2096	273
30	Zn	565	48	68	Er	1943	120
31	Ga	1038	200	69	Tm	2045	115
32	Ge	918	40	70	Yb	1912	130
33	As	1111	34	71	Lu	1983	150
34	Se	1143	100	72	Hf	2093	144
35	Br	1102	45	73	Ta	2220	370
36	Kr	1320	145	74	W	2240	164
37	Rb	1524	160	75	Re	1647	120
38	Sr	1414	120	76	Os	2110	160
39	Y	1064	52	77	Ir	2100	153
40	Zr	1030	33	78	Pt	1988	160
41	Nb	1080	80	79	Au	2109	110
42	Mo	1062	110	80	Hg	2100	160
44	Ru	1144	90	81	Tl	1877	250
45	Rh	917	60	82	Pb	1953	157
46	Pd	1491	200	83	Bi	2214	100
47	Ag	1465	160	90	Th	1156	178
48	Cd	1412	130	92	U	703	50
49	In	1722	70				

Fig.1.: $\langle n, 2n \rangle$ cross sections for elements at 14.7 MeV.
Points represent pure experimental values
Table I./ crosses contain data also from
Table II.

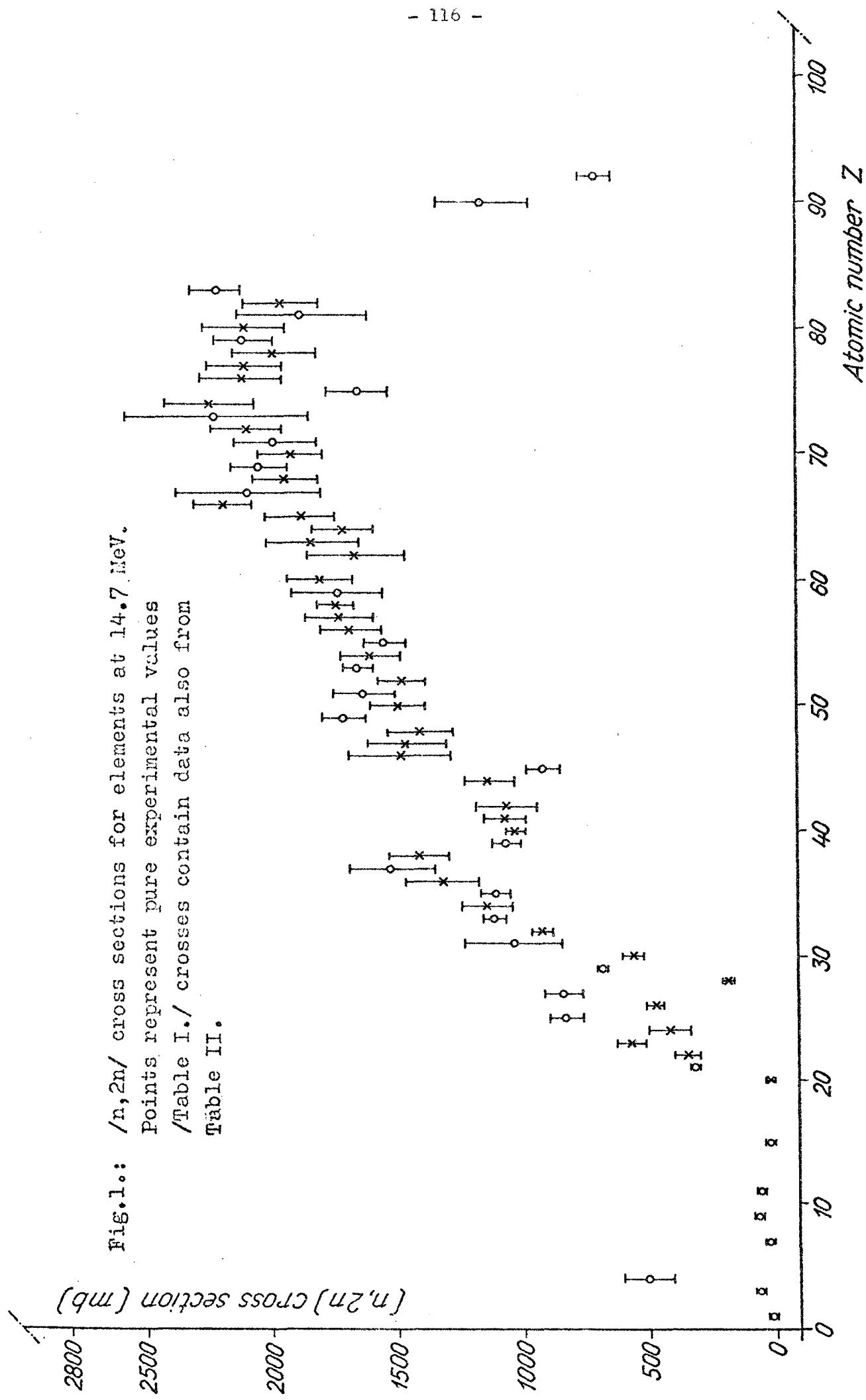


Table 4. Standard cross-sections for 14.7 MeV neutrons accepted for the renormalization of experimental data.

Isotope	Reaction	Cross-section /mb/	Reference
Al-27	n,p	73	(9)*
Al-27	n, α	114	(10)
Cu-65	n,2n	971	present **
Cu-63	n,2n	558	present
S-32	n,p	223	(10)
Li-6	n,t	26	(9)
Fe-56	n,p	98	(11),(12)
Pr-141	n,p	11.4	(14)
P-31	n, α	110	(9)
U-235	n,f	2250	(9)
Pr-141	n,2n	1750	present
Au-197	n,2n	2110	present
Y-89	n,2n	1060	present

* Estimated from data in (9).

** 965 mb from Table I. + 6 mb from Cu⁶³/n, γ /contribution which was subtracted when estimating the value in Table I; this is because the standards used were made of natural copper. For the 6 mb value of the reaction Cu⁶³/n, γ / see ref. (13).

Treatment of experimental data

The compilation used [2] includes data up to the end of January 1972.

The experimental $(n, 2n)$ cross-sections show frequently large inaccuracies and discrepancies, possible sources of which have been discussed earlier [3].

In this situation, where standard averaging methods fail, the generalized averaging procedure by Bödy and Dede [4] was applied, where systematic and statistical errors are treated separately. This procedure is expressed by the formulae

$$m = \sum_{i=1}^N \frac{x_i}{s_i^2 + y^2} \cdot \left[\sum_{i=1}^N \frac{1}{s_i^2 + y^2} \right]^{-1} \quad /1/$$

and

$$\sum_{i=1}^N \left(\frac{x_i - m}{s_i^2 + y^2} \right)^2 = \sum_{i=1}^N \frac{1}{s_i^2 + y^2} - \sum_{i=1}^N \left(\frac{1}{s_i^2 + y^2} \right)^2 \cdot \left[\sum_{i=1}^N \frac{1}{s_i^2 + y^2} \right]^{-1} \quad /2/$$

Here x_i and s_i are the experimental value and the error of the i^{th} author, respectively. ($i = 1, 2, \dots, N$). y^2 is the variance of the distribution attributed to the systematic error.

The root mean square error Δm of the most probable value m is

$$\Delta m = \left[\sum_{i=1}^N \frac{1}{s_i^2 + y^2} \right]^{-1/2} \quad /3/$$

If Eqs. /1/ and /2/ have no solution with $y^2 \geq 0$ then

Eqs. /1/ and /3/ give the results with $y^2 = 0$. One can see that when systematic errors are negligible compared to the statistical errors ($y^2/s_i^2 \rightarrow 0$), the present method reduces

to the well known expressions giving the weighted mean using reciprocal square of the errors:

$$m \rightarrow \sum_{i=1}^N \frac{x_i}{s_i^2} \cdot \left[\sum_{i=1}^N \frac{1}{s_i^2} \right]^{-1} \quad /4/$$

If the statistical errors are negligible compared with the systematic errors ($s_i^2 / y^2 \rightarrow 0$), the present method reduces to the simple arithmetic mean:

$$m \rightarrow \frac{1}{N} \sum_{i=1}^N x_i \quad /5/$$

The experimental data were re-normalized to up-to-date standard values, which are compiled in table 4. The uncertainties of the standards were not included in the errors of the experimental input data. No corrections have been done concerning the decay schemes. In many cases no reliable information is available which scheme has been assumed by the author; often the 'Nuclear Data Sheets' are quoted without stating the year of publication.

The authors do generally not give errors in a unique way. Where possible, some corrections were applied according to the available information; for example, stated probable errors were converted into Gaussian ones. In other cases it had to be assumed that errors quoted by the authors are of the same type.

If an author measured different values using different methods then the average of them was used as a single input. This is however not an infallible solution since the systematic errors have both common and non-common parts in such cases. But there are only a few such data.

The most probable values for $(n,2n)$ cross-sections at 14.7 MeV obtained by this averaging procedure are presented in Table I. The errors listed are Gaussian standard deviations as obtained from /3/.

In about 60 cases also energy dependent estimations were performed (see 17) by supposing a linear energy dependence in the 14-15 MeV region. In general, these results were used only for checking the energy independent results, where data around 14.7 MeV were used only. Some nuclei in Table I have a strongly energy dependent cross-section such that the cross-section variation for 0.1 MeV is equal or greater than the cross-section error given. These nuclides (N-14, Ti-46, Ni-58, Cu-63, Cu-65, Se-74, Zr-90 and Mo-92) are marked in table I.

N-Z systematics

For those nuclei where measurements are difficult to perform the cross-sections were estimated using N-Z systematics. The resulting recommended values are given in table 2.

It has been observed 15 that the $(n,2n)$ cross-sections at a constant excess energy above the threshold varies linearly with (N-Z) if either N or Z is constant. This N-Z dependence makes it possible to inter- or extrapolate new values linearly. For converting cross-sections to constant excess energy and re-converting new cross-sections to 14.7 MeV the Weisskopf formula was used. Owing to the fact that the linear N-Z dependence holds either for constant N or for constant Z, there are cases where the systematics gave the same cross-sections in two independent ways. In order to show the inner consistency of the systematics such examples are given in table 5.

Table 5. Data obtained from the N-Z trend both for constant N and Z at 3 MeV excess energy above threshold. Independent estimates from using isotonic and isotopic lines agree well.

Nuclide	N = constant		Z = constant	
	$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}/$	$\sigma/\text{mb}/$	$\Delta\sigma/\text{mb}$
Cr-54	870	70	830	130
Zn-68	985	80	845	60
Ge-72	730	40	750	30
Mo-94	720	70	670	70
Mo-96	900	60	950	100
Mo-98	1030	100	1220	130
Se-78	930	40	915	40
Se-80	1160	180	960	60
Sr-88	1400	130	1320	130
Ru-102	1010	70	1020	90
Te-130	1470	120	1310	90
Er-162	2020	200	1820	140
Sn-118	1190	80	1310	80
Hf-176	1820	120	1840	120
Sm-152	1710	170	1490	140

Another test for the reliability of the N-Z systematics can be seen from the cross-section values of Cs-192, Pt-192, Hg-196 and Hg-198. The experimental values of these nuclides given in table 1 have become available only after the values in table 2 had been deduced from systematics. Both agree well within their errors. For these nuclides the values in table 1 are preferred as recommended values; the values in table 2 are therefore enclosed in parentheses.

The errors listed in table 2 are meant as Gaussian standard deviations. They originate from the errors of those nuclides in table 1, on which the extra- or interpolation is based in each case. No additional uncertainty was assigned to the N-Z systematics.

Elements with natural isotopic composition

The cross-sections for elements at 14.7 MeV have been calculated from tables 1 and 2 by averaging over isotopic abundances. The resulting recommended values are given in table 3 and figure 1. As it can be seen in the Fig. 1. the tendency of the original experimental data is fairly well followed by the values for which the N-Z systematics was taken into account. In the case of light nuclei the odd-even effect can be well observed; this - similarly to the shell effect - is probably caused by the variation in the threshold energies. The errors given are Gaussian standard deviations originating from the errors in tables 1 and 2.

Comparison with empirical formulae

There are semi-empirical and empirical formulae for $(n,2n)$ cross-sections given by Pearlstein [6], Adám-Jéki [7] and Chatterjee [8].

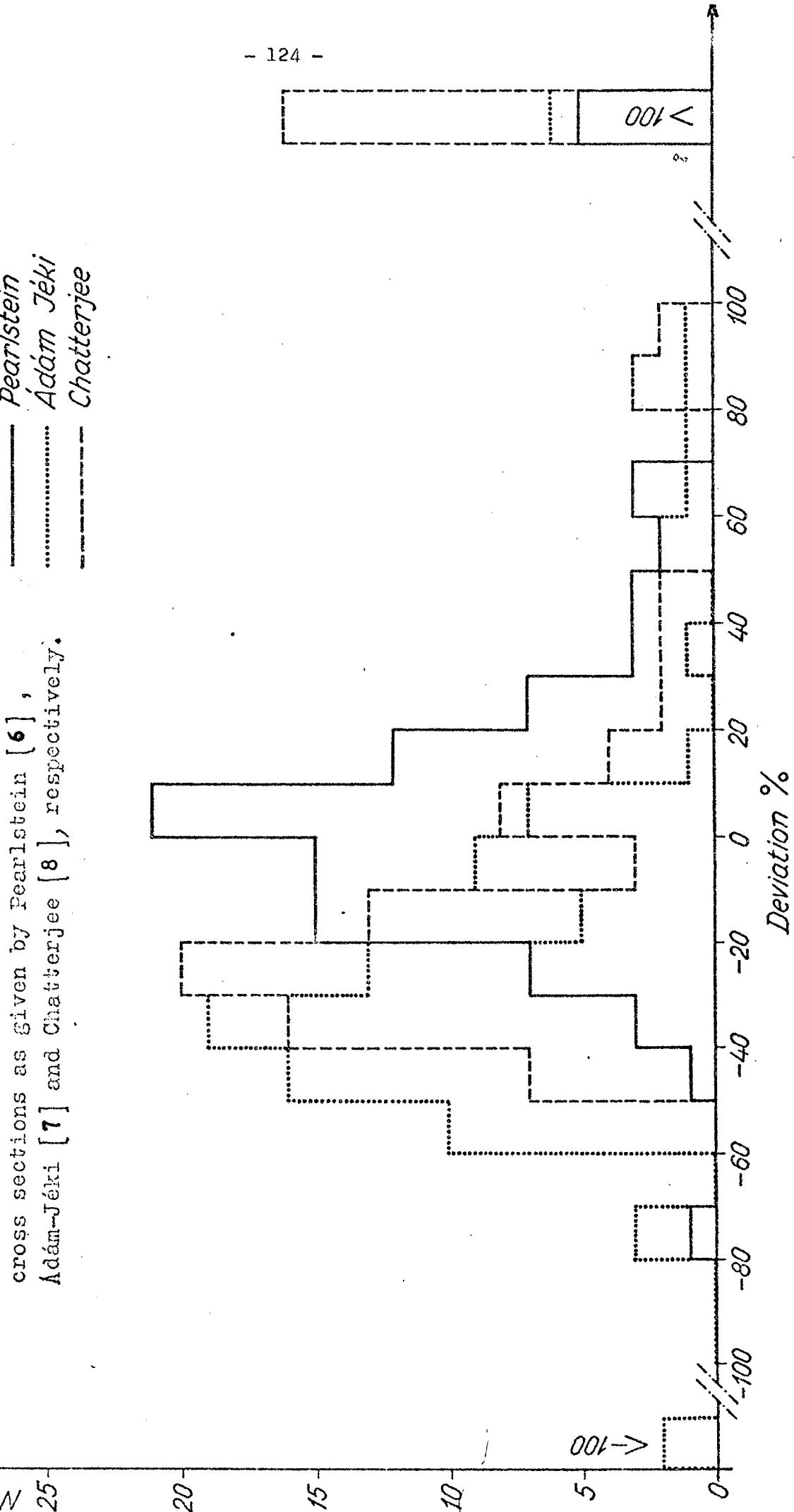
The relative differences between the experimental values from table 1 and those obtained from the empirical formulae have been calculated. The comparison shows that in 59 per cent of all cases Pearlstein's formula gives the best approximation; Adám-Jéki and Chatterjee obtain the best approximation in 22 and 19 per cent of the cases, respectively. In Fig. 2. histograms are presented in order to visualize the distributions of the deviations; the histogramme is nearly symmetric and centered to zero for the cross-sections given by Pearlstein, while this is not so in the other two cases.

For mass number $A < 80$ the cross-sections are under-estimated and for $A > 100$ are over-estimated by Pearlstein's formula; the trend is opposite for the other two expressions. All the three formulae give unreliable results for neutron deficient isotopes far from the stability line.

Fig.2.: Distribution of the relative differences between experimental /Table I./ and theoretical cross sections as given by Pearlstein [6], Ádám-Jéki [7] and Chatterjee [8], respectively.

25

Number of data



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Summary of the Thesis

by Z.T.Bödy

The following items are contained in this thesis:

A treatise of activation cross section measurements in order to establish the explicite dependence of experimental cross sections on the different quantities influencing the evaluation /as flux, decay scheme, etc./

Classification of errors to make data-handling easier.

Discussion of some possible averageing procedures including new ones.

An explicit formula is given for d,d and d,t neutron spectra considering both energy loss and angular scattering of deuterons in the target.

As a first application, the Cu⁶⁵/n,2n/Cu⁶⁴ cross section measurements are analysed and corrected for averageing, to have most probable value. The analysis shows that only a part of the data allows complete correction, because of lack of relevant informations /branching ratios, etc./.

As a major application the most probable values of /n,2n/ cross sections have been calculated for every nuclide where data are available at all, using all these data, without corrections. The averageing procedure was the one which allows the presence of systematic errors restricted by some general assumptions. After having calculated the averaged /experimental/ cross sections further cross sections were obtained from N-Z systematics. In such a way we have /n,2n/ cross sections of either experimental or semi-empirical nature for almost every nuclide. Finally, /n,2n/ cross sections for elements have also been calculated /at 14.7 MeV/ viewing possible technical needs for different applications of /d,t/ neutrons in sciences and technology, especially for fusion reactors in the future.