

## OKTAVIAN Activation Cross Sections in EXFOR (A37)

(N. Otsuka, 2015-08-25, Memo 4C-3/398)

**NRDC 2015 Action 37 (Otsuka):** Summarize the duplication pairs in the EXFOR entries listed in the item 3b of WP2013-17 (D-T neutron activation cross sections from OKTAVIAN, Osaka Univ.).

As I presented in the NRDC 2012 and 2013 meeting, neutron activation cross sections measured at the Osaka University OKTAVIAN facility have been often compiled from preliminary and final publications without assessment of their relations. Consequently both preliminary and final data sets of more than 100 reactions are active in EXFOR, and some EXFOR users plot them in their publications as if they are independent each other (e.g., Figs .4-7 of Junhua Luo et al., Phys. Rev. C89(2014)014604).

In order to solve this duplication and even *triplication* problems, these pairs were checked with the authors, and the final data set was identified for each case.

**Table 1** summarizes all relevant publications (including preliminary ones), **Table 2** summarizes all pairs with necessary actions, and **Table 3** summarizes flags used in Table 2. NEA Data Bank is invited to do necessary corrections. All corrections are also registered in the EXFOR Feedback List.

I am deeply grateful to Prof. Kiyoshi Kawade, Michihiro Shibata (Nagoya Univ.) and their colleagues for their cross-checking with patience over the last several years.

*Addition to Memo 4C-3/398: All necessary corrections have been already done by NEA DB. There are still some preliminary data, and an article for their final data is under preparation by Dr. N. Iwamoto (JAEA).*

**Table 1: Journal and report publications for the measurements (1984-1997)**

Ref.	EXFOR	Reference	INDC (JPN)	Lab.	standard <sup>+</sup>	Remark <sup>*</sup>
[1]	22089	Y.Ikeda+,R,JAERI-1312,1988	-	FNS	93a(B5)	
[2]	22637	C.Konno+, R,JAERI-1329.1993	-	FNS	93a(B5)	
[3]	22433	Y.Kasugai+, J,ANE,25,23,1997	-	OKT	B5*	(n,p)
[4]	22434	Y.Kasugai+, J,ANE,25,1485,1998	-	OKT	B5*	(n, $\alpha$ )
[5]	N/A	Y.Kasugai+, R,JAERI-R-2001-025,2001	-	FNS	93a(B5)	
[6]	22662	H.Sakane+, J,ANE,28,1175,2001	-	OKT	B5*	(n,2n)
[7]	22800	H.Sakane+, J,ANE,29,53,2002	-	OKT	B5*	(n,np)
[8]	22809	H.Sakane+, J,ANE,29,1209,2002	-	FNS	B6	
[9]	22827	H.Sakane+, J,ANE,30,1847,2003	-	FNS	B6	
[10]	23011	Y.Kasugai+, J,NST,31,1248,1994	-	OKT	93b	Ta,W (LL)
[11]	22860	K.Kawade+, J,NIM/A,496,183,2003	-	OKT	B5	no data
[12]	22156	T.Katoh+,R,JAERI-M-89-083,1989	124	OKT	B5	spsdd by [3,4,6,7]. 7 reactions are to be finalized.
[13]	22187	K.Kawade+,R,JAERI-M-90-171,1990	141	OKT	B5	spsdd by

							[3,4,6,7,18]
[14]	22215	T.Kobayashi+,S,JAERI-M-91-032,265,1991	148	OKT	B5	spsdd by [15]	
[15]	22281	K.Kawade+,R,JAERI-M-92-020,1992	154	OKT	B5	partly spsdd by [3,4,6,7], 1 reaction is to be finalized	
[16]	22351	Y.Kasugai+,S,JAERI-M-93-046,277,1993	163	OKT	B5	partly spsdd by [10,20], 4 reactions are to be finalized	
[17]	N/A	Y.Kasugai+,R,JAERI-M-93-124,1993	165	OKT	B5	spsdd by [3,4,6,7]	
[18]	22363	K.Yamauchi+,S,JAERI-M-94-019,253,1994	169	OKT	B5	partly spsdd by [3,7], 3 reactions are to be finalized	
[19]	22365	Y.Satoh+,S,JAERI-C-95-008,189,1995	173	OKT	B5	partly spsdd by [6,7,20], 3 reacts are to be finalized.	
[20]	22311	S.Murahira+,S,JAERI-C-96-008,171,1996	175	OKT	B5	Partly spsdd by [6,7]. 6 reactions are to be finalized	
[21]	22348	H.Sakane+, S,JAERI-C-97-004,193,1996	178	OKT	B5*	spsdd by [7,25]	
[22]	22340	H.Sakane+,S,JAERI-C-97-005,263,1996	179	OKT	B5*	spsdd by [6,25]	
[23]	22428	H.Sakane+,S,JAERI-C-98-003,318,1998	180	OKT	B5*		
[24]	22415	Y.Kasugai+,S,JAERI-M-92-027,268,1991	157	OKT	B5	spsdd by [17]	
[25]	22391	H.Sakane+,C.97TRIEST,1,619,1997	-	OKT	B5	To be finalized (all)	
[26]	22187	T. Yamada+,S,JAERI-M-90-025,251,1990	136	OKT	B5	spsdd by [3,4,6,7]	

+ Parenthesized symbol gives the secondary reference. The abbreviations mean

Short-lived products

B5:  $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$  in ENDF/B-V (R. Kinsey)

B5\*:  $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$  in ENDF/B-V (ENDF/B-VI in literature is not correct.)

B6:  $^{27}\text{Al}(n,\alpha)^{24}\text{Na}$  in ENDF/B-VI (P.F. Rose)

Long-lived products

93a:  $^{93}\text{Nb}(n,2n)^{92}\text{Nb}$ , 464 mb $\pm$ 4.2% (constant between 13.3 to 15.0 MeV)

93b:  $^{93}\text{Nb}(n,2n)^{92}\text{Nb}$  in D.R. Nethaway, J. Inorg. Nucl. Chem. **40**(1978)1285

\* “spsdd” means superseded by the authors.

**Table 2. Latest data sets and corresponding superseded (or withdrawn) data sets**  
(See Table 3 for definitions of flags.)

Latest data	Flag	Previous data (1)	Flag	Previous data (2)	Flag
22156.005	*				
22156.012	*				
22156.017	*				
22156.018	*				

22156.019	*			
22156.020	*			
22281.003	*			
22311.002	*			
22311.011	*			
22311.013	*			
22311.005	*	22365.007	z	
22311.007	*	22365.009	z	
22311.014	*	22365.012	x	22351.008 x,g
22351.003	*			
22351.005	*			
22351.006	*			
22351.007	*			
22363.003	*,h	22187.007	w,e	
22363.004	*,i			
22363.005	*,j			
22365.002	*			
22365.003	*			
22365.013	*			
22391.002	*,l,m	22340.010	x	
22391.003	*,l,m	22340.003	x	
22391.004	*,m	22340.002	x	
22391.005	*,m	22348.002	x	
22391.006	*,m	22348.004	x	
22391.007	*,m	22348.003	x	
22391.008	*,m	22348.006	x	
22391.009	*,m	22340.004	x	22348.008 x
22391.010	*,m	22340.007	x	
22391.011	*,m	22348.007	x	
22391.012	*,m	22348.009	x	
22391.013	*,m	22340.008	x	
22433.002		22281.002	x	
22433.003	o	22187.004	y	
22433.004		22281.005	x	
22433.005	o	22187.008	y	
22433.006		22281.007	x	
22433.007	o	22187.009	y	
22433.008	o	22187.010	y	
22433.009		22281.008	x	
22433.010	o	22156.007	y,a	
22433.011	o	22156.008	y	
22433.012	o	22156.009	y	
22433.013	o	22187.012	y,c	
22433.014	o	22187.014	y,c	
22433.015		22281.015	x	

22433.016	o	22156.011	y	
22433.017	o	22156.014	y	
22433.018		22415.002	y	
22433.019		22415.003	y	
22433.020		22415.005	y	
22433.021		22415.007	y	
22433.022		22415.009	y	
22433.023		22415.012	y	
22433.024		22281.017	x	
22433.025		22415.014	y	
22433.026	p	22415.017	y	
22433.027	q	22415.018	x,n	22363.009 x,k
22433.028		22415.016	y	
22434.002	r,s	22281.004	x,f	22187.002 y
22434.003	r	22187.005	y	
22434.004	r	22156.004	y	
22434.005		22281.010	x	
22434.006	r	22156.010	y	
22434.007		22281.011	x	
22434.008		22281.012	x	
22434.009		22187.015	y	
22434.010		22281.014	x	
22434.011		22187.016	y	
22434.012		22415.006	y	
22434.013		22415.015	y	
22662.002	t	22156.002	y	
22662.003		22156.003	y	
22662.004		22156.006	y	
22662.006		22340.009	x	
22662.007		22281.013	x	
22662.008		22156.013	y	
22662.009		22415.013	x	
22662.010		22187.018	y,c	22156.016 y
22662.011		22187.017	y	
22662.012		22311.003	x	22365.005 x
22662.013		22311.004	x	22365.006 x
22662.014		22311.006	x	22365.008 x
22662.015		22311.008	x	
22662.016		22311.010	x	22365.010 x
22662.017		22311.009	x	22365.011 x
22662.018		22340.006	x	
22662.019		22340.005	x	
22800.002		22363.002	y	22187.003 x,c,d
22800.003		22281.006	x	
22800.004	u	22187.006	y	

22800.005	u	22187.011	y	
22800.006		22281.009	x	
22800.007	u	22187.013	y	
22800.008		22281.016	x	
22800.009		22363.006	y	22156.015 w,b
22800.010		22363.007	y	
22800.012		22415.008	x	
22800.013		22363.008	y	22415.010 x
22800.014		22415.011	x	
22800.015		22365.004	x	
22800.016		22348.005	x	
22800.017		22311.012	x	
22800.018		22365.014	x	
23011.002		22351.002	x	
23011.003		22351.004	x	
23011.004		22351.009	x	
23011.006		22351.010	x	

**Table 3. Explanation of Flags in Table 2.**

#	EXFOR #	Remarks
a	22156.007 [12]	(SPSDD,22433011) → (SPSDD,22433010)
b	22156.015 [12]	It is superseded by 22800.009 [7]. They are from two independent measurements, but (1) their results agree within the error bars, and (2) the contribution of [12] to the weighted mean is small.
c	22187.012,014,018 [13]	En=14.02 MeV → 14.01 MeV
d	22187.003 [13]	3 data points (14.02, 14.35 and 14.64 MeV) are tabulated in Table 3 of [26] but they have no relation with this reaction, and should be deleted.
e	22187.007 [13] (1 pt)	This data point is withdrawn due to poor statistics.
f	22281.004 [15]	En is not correct. The correct value is given in Table 5 of [4]. Consequently 22281.004 becomes perfect duplication of 22434.002, and must be deleted.
g	22351.008 [16] (6 pts)	The final publication is under preparation.
h	22363.003 [18] (5 pts)	The final publication is under preparation.
i	22363.004 [18] (6 pts)	The final publication is under preparation.
j	22363.005 [18] (6 pts)	The final publication is under preparation.
k	22363.009 [18]	All data points are withdrawn except for 3.51 mb at 14.87 MeV.
l	22391.002-003 [25]	1 data point at 13.88 MeV in [22] is missing due to mistake.
m	22391.002-013 [25]	The final publication is under preparation.
n	22415.018 [24]	All data points are withdrawn except for 5.4 mb at 14.87 MeV.
o	22433 003,005, 007-008, 010-014, 016-017 [3]	En=14.02 MeV → 14.01 MeV
p	22433.026 [3]	Add one data point (13.65 MeV $\sigma=3.50$ mb, $\delta_e=6.4\%$ , $\delta_r=5.1\%$ , $\delta_t=8.0\%$ )
q	22433.027 [3]	Weighted mean of two data points at 14.87 MeV in 22363.009 and 22415.018. Note that $I_\gamma$ (311 keV) in the EXFOR entry must be changed from 97.95% to 0.99% (See the errata). It is now 1.716% (NDS110(2009)2945).
r	22434 002-004,006 [4]	En=14.02 MeV → 14.01 MeV
s	22434.002 [4]	Table 5 of [4] is not correct for this reaction except for the En values. The final values of ( $\sigma$ , $\delta_e$ , $\delta_r$ ) must be copied from Table 9(a) of [15] (=22281.004). Note that En of Table 9(a) is not correct. En “Set 2” is wrongly printed instead of En “Set 1”. (See Fig.1 of [4] for Set 1 and Set 2).
t	22662.002 [6]	$\sigma=5.48$ mb → 5.84 mb at 14.01 MeV (=22156.002)
u	22800 004-005,007 [7]	En=14.02 MeV → 14.01 MeV
w	22156.015 [12] 22187.007 [13]	withdrawn
x	many	superseded (SPSDD must be added)
y	many	superseded (SPSDD already coded)
z	22365.007, 009 [19]	duplication (must be deleted)
*	many	to be finalized in journal publications