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Cross Sections of Proton-Nucleus Interactions at High Energies

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The measured partial cross sections for high energy proton-nucleus interactions have been compiled from more than 200 publications. The targets range from lithium to uranium; the products considered have mass number $A \geqslant 6$. A comparison of cross sections induced by protons and ^{4}He is tabulated. Also a table of cross sections for (p, xn) reactions is given. These cross sections are useful for studies of interactions of cosmic rays and solar flare particles, as well as in radiation shielding and radiation therapy. These cross sections were used by the authors

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to develop semiempirical equations for calculating partial cross sections that have not yet been measured.

PREFACE

Experimental partial cross sections for high-energy proton-nucleus interactions (updated to June 1972) have been compiled in two parts for targets ranging from *Li* to *U* and for products with $A \geqslant 6$. Part I presents the cross sections for target nuclei with atomic numbers $Z_t \leqslant 28$, and Part II deals with heavier target nuclei. The data have been selectively used by the authors for developing semiempirical equations for a wide range of diverse high-energy nuclear reactions. These equations are discussed in detail in two papers published in the Astrophysics Journal Supplement (April 1973). They can be used to determine the transformations undergone by cosmic rays in interstellar space as well as the chemical changes induced in any materials with which the cosmic rays interacted.

The cross sections at energies exceeding 1 *GeV* reported in some earlier publications have been adjusted on the basis of the monitor reaction cross sections evaluated by Cumming [1]. The cross sections for the production of ^{9}Li, ^{16}C, and ^{17}N from ^{24}Mg, ^{28}Si, and ^{32}S are given as upper limits, because the targets were not isotopically pure; heavier isotopes of *Mg*, *Si*, and *S* contribute disproportionately to the production of ^{9}Li, ^{16}C, and ^{17}N. Upper limits for the production of the latter isotopes are also shown for ^{22}Ne and ^{26}Mg; they were calculated under the extreme assumption that the contribution of the lighter target isotopes is negligible. On the other hand, the yield of ^{16}C may have been underestimated—as it was assumed that all ^{16}C decays by neutron emission, while β decay was neglected. The tables are generally arranged in sequence of increasing target mass. For targets with $Z_t \leqslant 28$ the estimated statistical errors are given. Systematic errors may be large; in some cases the measured values of different authors differ by several standard deviations. Part III is a comparison of cross sections induced by protons and ^{4}He (α particles) respectively, and Part IV lists cross sections for (p, xn) reactions. In each part, the references are tabulated following the cross sections.

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CROSS SECTIONS OF PROTON-NUCLEUS INTERACTIONS AT HIGH ENERGIES

Part I — Proton Interactions for $3 \leqslant Z \leqslant 28$

The partial cross sections of nuclei with atomic numbers $3 \leqslant Z \leqslant 28$ are listed in Table 1, with the reference numbers being listed in Table 2. The estimated errors of the measured cross sections are also given in Table 1. The most abundant elements in nature (next to hydrogen and helium) have atomic numbers in this range.

Table 1
Partial Cross Sections of Nuclei with Atomic Numbers $3 \leqslant Z \leqslant 28$

Target	Product: $A \geqslant 6$	Proton Energy (MeV)	Partial Cross Section (mb)			Target	Product: $A \geqslant 6$	Proton Energy (MeV)	Partial Cross Section (mb)		
^{7}Li	^{6}Li	150	28			^{12}C	^{7}Be	50	22	±	1
^{9}Be	^{7}Be	150	8.8	±	0.5	^{12}C	^{7}Be	150	10	±	1
^{9}Be	^{7}Be	400	12	±	0.5	^{12}C	^{7}Be	250	9	±	1
^{9}Be	^{7}Be	$\geqslant$2000	12.5			^{12}C	^{7}Be	400	10	±	1
^{10}B	^{7}Be	150	8	±	1	^{12}C	^{7}Be	600	10	±	1
^{10}B	^{7}Be	600	5.4	±	1	^{12}C	^{7}Be	1000	10	±	1
^{11}B	^{10}Be	150	11	±	4	^{12}C	^{7}Be	$\geqslant$2000	9.5	±	0.5
^{11}B	^{10}Be	600	14	±	5	^{12}C	^{9}Li	150	0.017	±	0.003
^{11}B	^{7}Be	150	7	±	2	^{12}C	^{9}Li	1000	0.22	±	0.03
^{11}B	^{7}Be	600	4	±	1	^{12}C	^{9}Li	$\geqslant$2000	0.24	±	0.03
^{11}B	^{9}Li	150	0.29	±	0.04	^{12}C	^{8}Li	150	0.2		
^{11}B	^{9}Li	1000	1.2			^{12}C	^{8}Li	400	0.7	±	0.2
^{11}B	^{9}Li	$\geqslant$2000	1.1			^{12}C	^{7}Li	50	9	±	2
^{12}C	^{11}C	50	85	±	4	^{12}C	^{7}Li	150	9	±	2
^{12}C	^{11}C	150	50	±	2	^{12}C	^{7}Li	600	13	±	3
^{12}C	^{11}C	250	38	±	2	^{12}C	$^{6}Li + {}^{6}He$	50	10	±	2
^{12}C	^{11}C	400	31	±	2	^{12}C	$^{6}Li + {}^{6}He$	150	11	±	2
^{12}C	^{11}C	600	30	±	2	^{12}C	$^{6}Li + {}^{6}He$	600	15	±	3
^{12}C	^{11}C	1000	29	±	2	^{12}C	^{6}He	1000	0.5	±	0.2
^{12}C	^{11}C	$\geqslant$2000	27.5	±	2	^{12}C	^{6}He	$\geqslant$2000	0.5	±	0.3
^{12}C	^{10}C	150	2.6	±	0.3	^{14}N	^{13}N	50	23	±	3
^{12}C	^{10}C	400	3.6	±	0.3	^{14}N	^{13}N	150	8.3	±	0.5
^{12}C	^{10}C	600	3.2	±	0.3	^{14}N	^{13}N	400	5.1	±	0.5
^{12}C	^{10}C	1000	3.3	±	0.3	^{14}N	^{13}N	$\geqq$2000	4.5	±	0.5
^{12}C	^{11}B	150	16	±	4	^{14}N	^{13}C	150	15		
^{12}C	^{10}B	50	16	±	5	^{14}N	^{11}C	50	18.5	±	3
^{12}C	^{10}Be	150	1.1	±	0.2	^{14}N	^{11}C	150	15	±	1
^{12}C	^{10}Be	250	1.8	±	0.6	^{14}N	^{11}C	400	22	±	6
^{12}C	^{10}Be	600	2.8	±	0.6	^{14}N	^{11}C	600	20	±	5
^{12}C	^{9}Be	50	2.6	±	0.6	^{14}N	^{11}C	1000	25	±	6
^{12}C	^{9}Be	150	3.2	±	0.6	^{14}N	^{11}C	$\geqq$2000	11	±	4
^{12}C	^{9}Be	600	5.3	±	1	^{14}N	^{10}C	150	1.6	±	0.3

Table continues

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Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{14}N	^{7}Be	150	6 ± 1
^{14}N	^{7}Be	1000	12 ± 2
^{14}N	^{7}Be	≧2000	10.5 ± 2
^{14}N	^{9}Li	150	0.008 ± 0.001
^{14}N	^{9}Li	≧2000	0.28 ± 0.07
^{14}N	^{8}Li	400	0.6 ± 0.2
^{14}N	$^{6}Li + ^{6}He$	150	9.3 ± 3
^{15}N	^{7}Be	150	5.5 ± 1
^{15}N	^{9}Li	150	0.041 ± 0.006
^{15}N	^{9}Li	≧2000	0.53
^{16}O	^{15}O	50	68 ± 7
^{16}O	^{15}O	150	38 ± 4
^{16}O	^{15}O	400	31 ± 3
^{16}O	^{15}O	600	29 ± 3
^{16}O	^{15}O	≧2000	28 ± 5
^{16}O	^{14}O	150	0.9 ± 0.1
^{16}O	^{14}O	≧2000	9 ± 3
^{16}O	^{13}N	50	3.5 ± 0.4
^{16}O	^{13}N	150	4.5 ± 1
^{16}O	^{13}N	400	6.4 ± 2
^{16}O	^{13}N	600	6.7 ± 2
^{16}O	^{13}N	1000	9 ± 2
^{16}O	^{13}N	≧2000	5 ± 2
^{16}O	^{14}C	150	1.8 ± 0.5
^{16}O	^{14}C	≧2000	1.9 ± 0.5
^{16}O	^{11}C	50	10 ± 1
^{16}O	^{11}C	150	12 ± 1
^{16}O	^{11}C	400	8 ± 2
^{16}O	^{11}C	600	9 ± 1
^{16}O	^{11}C	1000	10 ± 1
^{16}O	^{10}C	150	1 ± 0.2
^{16}O	^{10}C	400	6 ± 2
^{16}O	^{10}C	1000	4 ± 0.5
^{16}O	$^{11}C + ^{11}B$	150	25 ± 8
^{16}O	$^{11}C + ^{11}B$	600	25 ± 12
^{16}O	$^{11}C + ^{11}B$	≧2000	~25
^{16}O	$^{10}C + ^{10}B$	150	10 ± 3
^{16}O	$^{10}C + ^{10}B$	600	12 ± 5
^{16}O	$^{10}C + ^{10}B$	≧2000	13 ± 7
^{16}O	^{10}Be	150	0.4 ± 0.1
^{16}O	^{10}Be	600	0.6 ± 0.2
^{16}O	^{10}Be	≧2000	0.9 ± 0.4
^{16}O	^{9}Be	150	1.7 ± 0.4
^{16}O	^{9}Be	600	2.4 ± 1.0
^{16}O	^{9}Be	≧2000	3.1 ± 0.8
^{16}O	^{7}Be	50	2 ± 0.5
^{16}O	^{7}Be	150	5.4 ± 1
^{16}O	^{7}Be	200	5.5 ± 1
^{16}O	^{7}Be	400	7 ± 2
^{16}O	^{7}Be	600	7 ± 1.5
^{16}O	^{7}Be	≧2000	9.3 ± 0.7
^{16}O	^{9}Li	150	0.006 ± 0.001
^{16}O	^{9}Li	1000	0.1 ± 0.01
^{16}O	^{9}Li	≧2000	0.13 ± 0.01
^{16}O	^{7}Li	150	8.5 ± 2
^{16}O	^{7}Li	600	11.3 ± 2
^{16}O	^{7}Li	≧2000	12.4 ± 2.2
^{16}O	$^{6}Li + ^{6}He$	150	10 ± 2
^{16}O	$^{6}Li + ^{6}He$	600	12.4 ± 2
^{16}O	$^{6}Li + ^{6}He$	≧2000	12.2 ± 2.3
^{18}O	^{17}N	150	14.5 ± 2
^{18}O	^{17}N	1000	30
^{18}O	^{17}N	⩾2000	25
^{18}O	^{16}C	150	0.2 ± 0.03
^{18}O	^{16}C	1000	1.1
^{18}O	^{16}C	⩾2000	0.9
^{18}O	^{11}C	150	2.5 ± 0.5
^{18}O	^{7}Be	150	1.2 ± 0.3
^{18}O	^{9}Li	150	0.11 ± 0.03
^{18}O	^{9}Li	1000	0.59
^{18}O	^{9}Li	⩾2000	0.58
^{19}F	^{18}F	50	86 ± 10
^{19}F	^{18}F	150	30 ± 1
^{19}F	^{18}F	250	24.5 ± 1
^{19}F	^{18}F	400	25 ± 5
^{19}F	^{18}F	600	24 ± 3
^{19}F	^{18}F	1000	24 ± 3
^{19}F	^{18}F	⩾2000	24 ± 3
^{19}F	^{17}F	150	6.5 ± 1
^{19}F	^{15}O	150	10.5 ± 2
^{19}F	^{15}O	400	10
^{19}F	^{15}O	600	9.5
^{19}F	^{15}O	1000	8
^{19}F	^{14}O	150	<0.05
^{19}F	^{14}O	1000	1.2
^{19}F	^{17}N	150	0.6 ± 0.1
^{19}F	^{17}N	1000	2.0
^{19}F	^{17}N	⩾2000	1.8
^{19}F	^{13}N	150	3 ± 1
^{19}F	^{13}N	400	1 ± 0.2
^{19}F	^{13}N	⩾2000	1.25 ± 0.5
^{19}F	^{16}C	150	0.011 ± 0.005
^{19}F	^{16}C	1000	0.10
^{19}F	^{16}C	⩾2000	0.07
^{19}F	^{11}C	150	4.5 ± 1
^{19}F	^{11}C	400	10
^{19}F	^{11}C	600	14
^{19}F	^{11}C	1000	14
^{19}F	^{11}C	⩾2000	4 ± 1
^{19}F	^{10}C	150	<0.1
^{19}F	^{10}C	400	5
^{19}F	^{10}C	1000	4
^{19}F	^{7}Be	150	2 ± 1
^{19}F	^{7}Be	⩾2000	7.6 ± 2
^{19}F	^{9}Li	150	0.023 ± 0.003
^{19}F	^{9}Li	1000	0.23
^{19}F	^{9}Li	⩾2000	0.28

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{20}Ne	^{17}N	150	<0.19 ± 0.05
^{20}Ne	^{16}C	150	<0.0068 ± 0.003
^{20}Ne	^{9}Li	150	<0.0066 ± 0.0014
^{20}Ne	^{8}Li	400	0.2 ± 0.06
^{22}Ne	^{17}N	150	≲2.5 ± 0.6
^{22}Ne	^{16}C	150	≲0.08 ± 0.03
^{23}Na	^{22}Na	50	94 ± 10
^{23}Na	^{22}Na	100	55 ± 2
^{23}Na	^{22}Na	150	46 ± 5
^{23}Na	^{22}Na	250	32 ± 2
^{23}Na	^{22}Na	400	37 ± 1
^{23}Na	^{22}Na	≳2000	26 ± 5
^{23}Na	^{18}F	50	30
^{23}Na	^{18}F	100	18
^{23}Na	^{18}F	150	10
^{23}Na	^{18}F	400	18 ± 0.6
^{23}Na	$^{18}F + ^{18}Ne$	≳2000	8.3 ± 1
^{23}Na	^{17}N	150	0.27 ± 0.04
^{23}Na	^{17}N	1000	1.1
^{23}Na	^{17}N	≳2000	1.2
^{23}Na	^{16}C	150	0.003 ± 0.002
^{23}Na	^{16}C	1000	0.08
^{23}Na	^{16}C	≳2000	0.10
^{23}Na	^{7}Be	≳2000	11 ± 2
^{23}Na	^{9}Li	150	0.011 ± 0.003
^{23}Na	^{9}Li	1000	0.18
^{23}Na	^{9}Li	≳2000	0.30
^{24}Mg	^{22}Na	50	52
^{24}Mg	^{22}Na	100	39 ± 3
^{24}Mg	^{22}Na	150	35 ± 8
^{24}Mg	^{22}Na	250	32 ± 9
^{24}Mg	^{22}Na	400	28 ± 6
^{24}Mg	^{22}Na	600	12 ± 2
^{24}Mg	^{22}Na	1000	12 ± 2
^{24}Mg	^{22}Na	≳2000	15 ± 2
Mg	^{22}Ne	600	10 ± 2
^{24}Mg	$^{21}Na + ^{21}Ne$	600	20 ± 3
^{24}Mg	$^{20}Ne + ^{20}F$	600	21 ± 3
^{24}Mg	^{18}F	50	7
^{24}Mg	^{18}F	100	12.5
^{24}Mg	^{18}F	150	12 ± 1
^{24}Mg	$^{18}F + ^{18}Ne$	400	18.2 ± 0.6
^{24}Mg	^{17}N	150	<0.08 ± 0.02
^{24}Mg	^{17}N	1000	<0.6
^{24}Mg	^{16}C	150	<0.0014
^{24}Mg	^{16}C	1000	<0.046
^{24}Mg	^{11}C	150	1.8
^{24}Mg	^{7}Be	150	2.5 ± 0.5
^{24}Mg	^{7}Be	250	2.5 ± 0.5
^{24}Mg	^{7}Be	400	3.2 ± 1
^{24}Mg	^{7}Be	600	8 ± 1
^{24}Mg	^{7}Be	1000	9 ± 1
^{24}Mg	^{7}Be	≳2000	12 ± 2
^{24}Mg	^{9}Li	1000	<0.13
^{25}Mg	^{24}Na	50	30
^{25}Mg	^{24}Na	100	31
^{25}Mg	^{24}Na	150	17 ± 1
^{25}Mg	^{24}Na	400	25 ± 2
^{25}Mg	^{24}Na	600	30 ± 1
^{25}Mg	^{24}Na	1000	32 ± 1
^{25}Mg	^{24}Na	≳2000	26 ± 1
^{25}Mg	^{22}Na	50	38
^{25}Mg	^{22}Na	100	30
^{25}Mg	^{22}Na	400	17.5
^{25}Mg	^{18}F	50	7
^{25}Mg	^{18}F	100	11
^{25}Mg	^{18}F	150	10
^{25}Mg	^{18}F	400	14 ± 0.6
^{26}Mg	^{24}Na	50	48
^{26}Mg	^{24}Na	100	38
^{26}Mg	^{24}Na	400	29 ± 2
^{26}Mg	^{22}Na	50	8
^{26}Mg	^{22}Na	100	9
^{26}Mg	^{22}Na	400	10 ± 1
^{26}Mg	^{18}F	50	5
^{26}Mg	^{18}F	100	5
^{26}Mg	^{18}F	150	5
^{26}Mg	^{18}F	400	9 ± 1
^{26}Mg	^{17}N	150	≲0.7 ± 0.2
^{26}Mg	^{16}C	150	≲0.013 ± 0.009
^{27}Al	^{24}Na	50	6.4 ± 0.3
^{27}Al	^{24}Na	150	10 ± 1
^{27}Al	^{24}Na	250	10.6 ± 1
^{27}Al	^{24}Na	400	10.5 ± 1
^{27}Al	^{24}Na	600	11 ± 1
^{27}Al	^{24}Na	1000	10 ± 0.6
^{27}Al	^{24}Na	≧2000	9.6 ± 0.6
^{27}Al	^{23}Na	150	23
^{27}Al	^{22}Na	50	38 ± 2
^{27}Al	^{22}Na	150	18 ± 1
^{27}Al	^{22}Na	250	15.5 ± 1
^{27}Al	^{22}Na	400	15.5 ± 1
^{27}Al	^{22}Na	≧2000	12.5 ± 1
^{27}Al	^{24}Ne	≧2000	1.3 ± 1
^{27}Al	^{22}Ne	600	11 ± 2
^{27}Al	^{22}Ne	≧2000	7 ± 1
^{27}Al	$^{21}Na + ^{21}Ne$	600	20 ± 3
^{27}Al	$^{21}Na + ^{21}Ne$	≧2000	17 ± 2
^{27}Al	$^{20}Ne + ^{20}F$	600	20 ± 3
^{27}Al	$^{20}Ne + ^{20}F$	≧2000	17 ± 2
^{27}Al	^{18}F	50	2 ± 1
^{27}Al	^{18}F	150	5.5 ± 1.1
^{27}Al	^{18}F	250	6 ± 1
^{27}Al	$^{18}F + ^{18}Ne$	400	7.7
^{27}Al	$^{18}F + ^{18}Ne$	600	9 ± 1
^{27}Al	$^{18}F + ^{18}Ne$	1000	7 ± 1
^{27}Al	$^{18}F + ^{18}Ne$	≧2000	6.5 ± 1
^{27}Al	^{17}N	150	0.08 ± 0.01

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{27}Al	^{17}N	1000	0.7
^{27}Al	^{17}N	≧2000	0.7
^{27}Al	^{15}O	600	6.6 ± 2
^{27}Al	^{15}O	≧2000	6 ± 2
^{27}Al	^{13}N	400	1.1 ± 0.1
^{27}Al	^{13}N	1000	1.4 ± 0.1
^{27}Al	^{13}N	≧2000	1.4 ± 0.1
^{27}Al	^{16}C	1000	0.05
^{27}Al	^{16}C	≧2000	0.065
^{27}Al	^{11}C	150	1.0
^{27}Al	^{11}C	400	2.3 ± 0.1
^{27}Al	^{11}C	1000	4.3 ± 0.2
^{27}Al	^{11}C	≧2000	5 ± 0.2
^{27}Al	^{7}Be	50	0.3 ± 0.03
^{27}Al	^{7}Be	150	1.0 ± 0.2
^{27}Al	^{7}Be	400	3.4 ± 0.5
^{27}Al	^{7}Be	600	4.9 ± 0.3
^{27}Al	^{7}Be	1000	7.6 ± 2
^{27}Al	^{7}Be	≧2000	9 ± 2
^{27}Al	^{9}Li	150	0.005
^{27}Al	^{9}Li	1000	0.13
^{27}Al	^{9}Li	≧2000	0.24
^{27}Al	^{6}He	1000	1.1 ± 0.5
^{27}Al	^{6}He	≧2000	1.1 ± 0.6
^{28}Si	^{25}Na	150	0.5
^{28}Si	^{24}Na	60	1.5 ± 0.3
^{28}Si	^{24}Na	150	3.5
^{28}Si	^{24}Na	250	4 ± 0.5
^{28}Si	^{24}Na	400	4.5 ± 0.5
^{28}Si	^{24}Na	600	5 ± 1
^{28}Si	^{24}Na	1000	5 ± 1
^{28}Si	^{24}Na	≧2000	5 ± 1
^{28}Si	^{23}Na	150	18
^{28}Si	^{22}Na	60	22 ± 4
^{28}Si	^{22}Na	150	14
^{28}Si	^{22}Na	250	15 ± 3
^{28}Si	^{22}Na	400	16 ± 2
^{28}Si	^{22}Na	600	8 ± 1
^{28}Si	^{22}Na	1000	8 ± 1
^{28}Si	^{22}Na	≧2000	9 ± 1
^{28}Si	^{21}Na	150	2.4
^{28}Si	^{20}Na	150	0.2
^{28}Si	^{22}Ne	600	8 ± 1
^{28}Si	^{22}Ne	≧2000	7 ± 1
^{28}Si	$^{21}Na + ^{21}Ne$	600	19 ± 3
^{28}Si	$^{21}Na + ^{21}Ne$	≧2000	15 ± 2
^{28}Si	$^{20}Ne + ^{20}F$	600	22 ± 3
^{28}Si	^{18}F	60	0.6 ± 0.1
^{28}Si	$^{18}F + ^{18}Ne$	400	11.2 ± 0.3
^{28}Si	^{17}N	150	<0.02 ± 0.005
^{28}Si	^{17}N	1000	<0.33
^{28}Si	^{16}C	1000	<0.023
^{28}Si	^{7}Be	60	0.7 ± 0.1
^{28}Si	^{7}Be	150	1.0 ± 0.3
^{28}Si	^{7}Be	250	1.2 ± 0.3
^{28}Si	^{7}Be	400	2 ± 0.4
^{28}Si	^{7}Be	600	2.5 ± 0.4
^{28}Si	^{7}Be	1000	3 ± 0.5
^{28}Si	^{7}Be	≧2000	4 ± 1
^{28}Si	^{9}Li	1000	<0.077
^{29}Si	^{24}Na	400	7.7 ± 0.2
^{29}Si	^{22}Na	400	10.8 ± 0.2
^{29}Si	^{18}F	400	7.3 ± 0.3
^{30}Si	^{29}Al	60	17 ± 5
^{30}Si	^{29}Al	150	10.5 ± 2
^{30}Si	^{29}Al	250	15 ± 4
^{30}Si	^{29}Al	400	19 ± 4
^{30}Si	^{28}Mg	150	2 ± 0.4
^{30}Si	^{28}Mg	250	2 ± 0.4
^{30}Si	^{28}Mg	400	3 ± 0.4
^{30}Si	^{24}Na	400	13.1 ± 0.1
^{30}Si	^{22}Na	400	8.4 ± 0.1
^{30}Si	^{18}F	400	7.5 ± 0.4
^{31}P	^{29}Al	150	5 ± 1
^{31}P	^{29}Al	250	5 ± 1
^{31}P	^{29}Al	400	8 ± 2
^{31}P	^{28}Mg	150	0.2 ± 0.03
^{31}P	^{28}Mg	250	0.3 ± 0.1
^{31}P	^{28}Mg	400	0.3 ± 0.1
^{31}P	^{24}Na	100	4.0
^{31}P	^{24}Na	200	4.9 ± 0.2
^{31}P	^{24}Na	300	5.5 ± 0.3
^{31}P	^{24}Na	400	6.4 ± 0.4
^{31}P	^{22}Na	100	4.9 ± 0.3
^{31}P	^{22}Na	200	8.0 ± 0.3
^{31}P	^{22}Na	300	8.4 ± 0.9
^{31}P	^{22}Na	400	9.4 ± 0.2
^{31}P	^{18}F	400	6.0 ± 1
^{32}S	^{29}Al	150	0.6 ± 0.2
^{32}S	^{29}Al	250	0.5 ± 0.2
^{32}S	^{29}Al	400	0.5 ± 0.2
^{32}S	^{24}Na	100	1.0 ± 0.1
^{32}S	^{24}Na	200	2.2 ± 0.1
^{32}S	^{24}Na	300	3.1 ± 0.1
^{32}S	^{24}Na	400	3.3 ± 0.6
^{32}S	^{22}Na	100	4.1 ± 0.3
^{32}S	^{22}Na	200	7.4 ± 0.2
^{32}S	^{22}Na	300	9.0 ± 0.1
^{32}S	^{22}Na	400	10 ± 1
^{32}S	$^{18}F + ^{18}Ne$	400	5 ± 1
^{32}S	^{17}N	1000	<0.26
^{32}S	^{16}C	1000	<0.017
^{32}S	^{9}Li	1000	<0.054
^{33}S	^{24}Na	400	5.1 ± 0.4
^{33}S	^{22}Na	400	4.9 ± 0.3
^{33}S	^{18}F	400	3.6 ± 0.4
^{34}S	^{24}Na	400	6.1 ± 0.2
^{34}S	^{22}Na	400	2.6 ± 0.3

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{34}S	^{18}F	400	3.4 ± 0.1
Cl	^{32}P	70	52 ± 13
Cl	^{32}P	150	34 ± 9
Cl	^{32}P	250	45 ± 11
Cl	^{32}P	400	40 ± 10
Cl	^{28}Mg	70	0.007 ± 0.002
Cl	^{28}Mg	150	0.06 ± 0.02
Cl	^{28}Mg	250	0.18 ± 0.05
Cl	^{28}Mg	400	0.20 ± 0.05
Cl	^{24}Na	100	0.67 ± 0.05
Cl	^{24}Na	200	2.1 ± 0.05
Cl	^{24}Na	300	3.0 ± 0.1
Cl	^{24}Na	400	4.1
Cl	^{22}Na	100	0.65 ± 0.08
Cl	^{22}Na	200	2.6 ± 0.1
Cl	^{22}Na	300	3.8 ± 0.03
Cl	^{22}Na	400	4.9
Cl	^{18}F	400	2.2 ± 0.5
^{37}Cl	^{35}S	70	44 ± 12
^{37}Cl	^{35}S	150	28 ± 8
^{37}Cl	^{35}S	250	24 ± 6
^{37}Cl	^{35}S	400	26 ± 6
^{40}Ar	^{8}Li	400	0.2 ± 0.07
K	^{24}Na	100	0.045 ± 0.007
K	^{24}Na	200	0.54 ± 0.01
K	^{24}Na	300	1.1 ± 0.1
K	^{24}Na	400	1.95
K	^{22}Na	100	0.084 ± 0.005
K	^{22}Na	200	0.69 ± 0.02
K	^{22}Na	300	1.4 ± 0.1
K	^{22}Na	400	2.5
Ca	^{24}Na	100	0.016 ± 0.008
Ca	^{24}Na	200	0.34 ± 0.01
Ca	^{24}Na	300	0.78 ± 0.01
Ca	^{24}Na	400	1.2
Ca	^{22}Na	200	0.61 ± 0.03
Ca	^{22}Na	300	1.6 ± 0.1
Ca	^{22}Na	400	2.6
Ca	^{17}N	⩾2000	0.29
Ca	^{16}C	⩾2000	0.025
Ca	^{9}Li	⩾2000	0.13
^{48}Ca	$^{47}Ca + ^{47}K$	100	118 ± 2
^{48}Ca	$^{47}Ca + ^{47}K$	200	106 ± 10
^{48}Ca	$^{47}Ca + ^{47}K$	300	106 ± 10
^{48}Ca	$^{47}Ca + ^{47}K$	400	101 ± 4
^{48}Ca	$^{47}Ca + ^{47}K$	600	110 ± 8
^{45}Sc	^{44}Sc	100	70 ± 10
^{45}Sc	^{44}Sc	200	50 ± 1
^{45}Sc	^{44}Sc	300	48 ± 1
^{45}Sc	^{44}Sc	400	42 ± 1
^{45}Sc	^{44}Sc	600	42 ± 1
^{45}Sc	^{24}Na	100	0.066 ± 0.003
^{45}Sc	^{24}Na	200	0.24
^{45}Sc	^{24}Na	300	0.60
^{45}Sc	^{24}Na	400	0.96
^{45}Sc	^{22}Na	100	0.073 ± 0.014
^{45}Sc	^{22}Na	200	0.17
^{45}Sc	^{22}Na	300	0.58
^{45}Sc	^{22}Na	400	0.79
Ti	^{44}Ti	300	1.5 ± 0.4
Ti	^{44}Ti	400	0.9 ± 0.2
Ti	^{44}Ti	600	0.6 ± 0.2
Ti	^{43}K	100	1.2 ± 0.2
Ti	^{43}K	300	2.0 ± 0.5
Ti	^{43}K	400	1.4 ± 0.3
Ti	^{43}K	600	2.1 ± 0.7
Ti	^{42}K	100	3.6 ± 0.6
Ti	^{42}K	300	6.4 ± 1.5
Ti	^{42}K	400	4.2 ± 0.8
Ti	^{42}K	600	6.0 ± 1.9
Ti	^{28}Mg	300	0.023 ± 0.01
Ti	^{28}Mg	600	0.10 ± 0.03
Ti	^{24}Na	100	0.010
Ti	^{24}Na	200	0.068
Ti	^{24}Na	300	0.24
Ti	^{24}Na	400	0.54
Ti	^{24}Na	>2000	4.2 ± 0.3
Ti	^{22}Na	100	0.015
Ti	^{22}Na	200	0.050
Ti	^{22}Na	300	0.15
Ti	^{22}Na	400	0.34
Ti	^{22}Na	>2000	3.7 ± 0.2
Ti	^{17}N	>2000	0.78
Ti	^{16}C	>2000	0.10
Ti	^{9}Li	>2000	0.41
^{51}V	^{48}V	60	32 ± 2
^{51}V	^{48}V	100	26 ± 5
^{51}V	^{48}V	170	18 ± 4
^{51}V	^{48}V	240	13 ± 4
^{51}V	^{47}V	170	4.6 ± 1
^{51}V	^{45}Ti	60	0.9 ± 0.2
^{51}V	^{45}Ti	100	4 ± 1
^{51}V	^{45}Ti	170	4 ± 1
^{51}V	^{45}Ti	240	8 ± 3
^{51}V	^{49}Sc	130	0.16 ± 0.04
^{51}V	^{49}Sc	210	0.23 ± 0.04
^{51}V	^{49}Sc	300	0.47 ± 0.08
^{51}V	^{49}Sc	400	0.39 ± 0.05
^{51}V	^{48}Sc	170	4 ± 1
^{51}V	^{47}Sc	60	1.2 ± 0.7
^{51}V	^{47}Sc	100	8 ± 1
^{51}V	^{47}Sc	170	5 ± 1
^{51}V	^{47}Sc	240	6 ± 2
^{51}V	^{46}Sc	60	4 ± 2
^{51}V	^{46}Sc	100	7 ± 1
^{51}V	^{46}Sc	170	8 ± 2
^{51}V	^{46}Sc	240	7 ± 2
^{51}V	$^{44}Sc + ^{43}Sc$	60	0.03

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{51}V	$^{44}Sc + ^{43}Sc$	100	21 ± 5
^{51}V	$^{44}Sc + ^{43}Sc$	170	12 ± 4
^{51}V	$^{44}Sc + ^{43}Sc$	240	17 ± 5
^{51}V	^{47}Ca	60	0.004
^{51}V	^{47}Ca	100	0.06 ± 0.01
^{51}V	^{47}Ca	170	0.07 ± 0.03
^{51}V	^{47}Ca	240	0.12 ± 0.04
^{51}V	^{45}Ca	60	0.12
^{51}V	^{45}Ca	100	0.7 ± 0.4
^{51}V	^{45}Ca	170	1.5 ± 0.8
^{51}V	^{45}Ca	240	1.4 ± 0.6
^{51}V	^{45}K	600	0.04 ± 0.004
^{51}V	^{45}K	⩾2000	0.04 ± 0.004
^{51}V	^{44}K	600	0.32 ± 0.03
^{51}V	^{44}K	⩾2000	0.40 ± 0.04
^{51}V	^{43}K	60	0.2 ± 0.08
^{51}V	^{43}K	100	0.5
^{51}V	^{43}K	170	1.5 ± 0.4
^{51}V	^{43}K	240	3.4 ± 0.8
^{51}V	^{43}K	600	1.87 ± 0.2
^{51}V	^{43}K	⩾2000	2.27 ± 0.2
^{51}V	^{42}K	60	0.07 ± 0.06
^{51}V	^{42}K	100	1.8
^{51}V	^{42}K	170	3 ± 1
^{51}V	^{42}K	240	5.9 ± 1
^{51}V	^{42}K	600	3.36 ± 0.3
^{51}V	^{42}K	⩾2000	4.05 ± 0.4
^{51}V	^{38}K	600	0.2 ± 0.04
^{51}V	^{39}Cl	60	0.0003
^{51}V	^{39}Cl	100	0.25
^{51}V	^{39}Cl	170	0.2 ± 0.05
^{51}V	^{39}Cl	240	1.3 ± 0.8
^{51}V	^{38}Cl	60	0.008 ± 0.004
^{51}V	^{38}Cl	100	0.13 ± 0.01
^{51}V	^{38}Cl	170	0.6 ± 0.1
^{51}V	^{38}Cl	240	2 ± 0.9
^{51}V	^{35}S	100	0.06
^{51}V	^{35}S	170	0.3 ± 0.1
^{51}V	^{35}S	240	0.3 ± 0.2
^{51}V	^{33}P	170	0.3 ± 0.1
^{51}V	^{33}P	240	0.3
^{51}V	^{32}P	170	0.2 ± 0.1
^{51}V	^{32}P	240	0.8 ± 0.4
^{51}V	^{31}Si	170	0.16 ± 0.04
^{51}V	^{28}Mg	170	0.001
^{51}V	^{28}Mg	240	0.008
^{51}V	^{27}Mg	170	0.023 ± 0.007
^{51}V	^{24}Na	100	0.006
^{51}V	^{24}Na	170	0.024 ± 0.06
^{51}V	^{24}Na	300	0.12
^{51}V	^{24}Na	400	0.31
^{51}V	^{22}Na	100	0.018
^{51}V	^{22}Na	300	0.07
^{51}V	^{22}Na	400	0.17
^{51}V	^{7}Be	170	0.23 ± 0.1
^{50}Cr	^{49}Cr	400	48 ± 3
^{50}Cr	^{48}Cr	400	5.4
^{50}Cr	^{49}V	400	22
^{50}Cr	^{48}V	400	30
^{50}Cr	^{47}V	400	18
^{52}Cr	^{51}Cr	400	59 ± 5
^{52}Cr	^{49}Cr	400	5.9 ± 0.6
^{55}Mn	^{54}Mn	50	265 ± 28
^{55}Mn	^{54}Mn	120	111 ± 12
^{55}Mn	^{54}Mn	150	89 ± 10
^{55}Mn	^{54}Mn	400	61 ± 2
^{55}Mn	^{52}Mn	170	16 ± 3
^{55}Mn	^{51}Mn	170	6 ± 2
^{55}Mn	^{49}Cr	170	6 ± 1
^{55}Mn	^{48}Cr	170	0.7 ± 0.14
^{55}Mn	^{48}V	170	13 ± 3
^{55}Mn	^{47}V	170	2.7 ± 0.6
^{55}Mn	^{45}Ti	170	5 ± 1
^{55}Mn	^{48}Sc	170	0.7 ± 0.3
^{55}Mn	^{47}Sc	170	2.5 ± 0.5
^{55}Mn	^{46}Sc	170	6 ± 1
^{55}Mn	$^{44}Sc + ^{43}Sc$	170	6 ± 1
^{55}Mn	^{47}Ca	170	0.03 ± 0.01
^{55}Mn	^{45}Ca	170	1.1 ± 0.3
^{55}Mn	^{43}K	170	0.5 ± 0.1
^{55}Mn	^{42}K	170	1.4 ± 0.2
^{55}Mn	^{39}Cl	170	0.03 ± 0.01
^{55}Mn	$^{38}Cl + ^{34}Cl$	170	0.06 ± 0.02
^{55}Mn	^{32}P	170	0.11 ± 0.04
^{55}Mn	^{31}Si	170	0.08 ± 0.02
^{54}Fe	^{53}Fe	400	37 ± 5
^{54}Fe	^{53}Fe	⩾2000	38 ± 5
^{56}Fe	^{55}Fe	150	110 ± 10
^{56}Fe	^{55}Fe	370	64 ± 4
^{56}Fe	^{55}Fe	700	60 ± 20
^{56}Fe	^{55}Fe	25000	36 ± 5
^{56}Fe	^{53}Fe	150	30 ± 2
^{56}Fe	^{53}Fe	700	31 ± 9
^{56}Fe	^{52}Fe	60	4
^{56}Fe	^{52}Fe	150	5.2 ± 1.4
^{56}Fe	^{52}Fe	700	1.8 ± 0.3
^{56}Fe	^{52}Fe	25000	0.82 ± 0.1
^{56}Fe	^{54}Mn	60	38
^{56}Fe	^{54}Mn	150	38 ± 8
^{56}Fe	^{54}Mn	370	19 ± 3
^{56}Fe	^{54}Mn	700	31 ± 5
^{56}Fe	^{54}Mn	2000	28 ± 5
^{56}Fe	^{54}Mn	25000	17 ± 2
^{56}Fe	^{52}Mn	60	20
^{56}Fe	^{52}Mn	150	14 ± 3
^{56}Fe	^{52}Mn	370	18
^{56}Fe	^{52}Mn	700	14.5 ± 2
^{56}Fe	^{52}Mn	2000	10 ± 2
^{56}Fe	^{52}Mn	25000	5.6 ± 0.8
^{56}Fe	^{51}Mn	150	5.8 ± 1.2

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{56}Fe	^{51}Mn	370	4.0
^{56}Fe	^{51}Mn	700	6 ± 2
^{56}Fe	^{51}Cr	60	30
^{56}Fe	^{51}Cr	150	40 ± 10
^{56}Fe	^{51}Cr	370	25 ± 4
^{56}Fe	^{51}Cr	700	28 ± 5
^{56}Fe	^{51}Cr	2000	16 ± 2
^{56}Fe	^{51}Cr	25000	21 ± 3
^{56}Fe	^{49}Cr	150	6.1 ± 1.7
^{56}Fe	^{49}Cr	370	4.8
^{56}Fe	^{49}Cr	700	7 ± 1
^{56}Fe	^{48}Cr	150	0.5 ± 0.1
^{56}Fe	^{48}Cr	370	0.7
^{56}Fe	^{48}Cr	700	0.8 ± 0.2
^{56}Fe	^{48}Cr	2000	0.4 ± 0.1
^{56}Fe	^{48}Cr	25000	0.4 ± 0.1
^{56}Fe	^{49}V	150	33 ± 5
^{56}Fe	^{49}V	370	31
^{56}Fe	^{49}V	700	25 ± 4
^{56}Fe	^{49}V	25000	22 ± 3
^{56}Fe	^{48}V	60	5.5
^{56}Fe	^{48}V	150	15 ± 2
^{56}Fe	^{48}V	370	9
^{56}Fe	^{48}V	700	12 ± 3
^{56}Fe	^{48}V	2000	6 ± 1
^{56}Fe	^{48}V	25000	12 ± 2
^{56}Fe	^{47}V	150	5.9 ± 1.9
^{56}Fe	^{47}V	370	2.4
^{56}Fe	^{47}V	700	6.1 ± 0.7
^{56}Fe	^{45}Ti	150	4.5 ± 1.0
^{56}Fe	^{45}Ti	370	3.7
^{56}Fe	^{45}Ti	700	4.6 ± 0.3
^{56}Fe	^{45}Ti	25000	2.6 ± 0.4
^{56}Fe	^{48}Sc	370	0.35
^{56}Fe	^{48}Sc	25000	0.4 ± 0.1
^{56}Fe	^{47}Sc	150	0.7 ± 0.2
^{56}Fe	^{47}Sc	370	1.0
^{56}Fe	^{47}Sc	700	1.4 ± 0.2
^{56}Fe	^{47}Sc	2000	1.3 ± 0.3
^{56}Fe	^{47}Sc	25000	1.3 ± 0.2
^{56}Fe	^{46}Sc	150	3.0 ± 0.6
^{56}Fe	^{46}Sc	370	3.5
^{56}Fe	^{46}Sc	700	5.8 ± 0.9
^{56}Fe	^{46}Sc	25000	4 ± 0.6
^{56}Fe	^{44}Sc	150	5.9 ± 0.4
^{56}Fe	^{44}Sc	370	2.6
^{56}Fe	^{44}Sc	700	9 ± 2.6
^{56}Fe	^{44}Sc	25000	4.2 ± 0.6
^{56}Fe	^{43}Sc	150	2.5 ± 0.2
^{56}Fe	^{43}Sc	700	3 ± 1
^{56}Fe	^{43}Sc	25000	1.5 ± 0.2
^{56}Fe	^{47}Ca	150	0.007
^{56}Fe	^{47}Ca	370	0.007
^{56}Fe	^{47}Ca	700	0.07
^{56}Fe	^{47}Ca	25000	0.011 ± 0.002
^{56}Fe	^{45}Ca	150	0.36
^{56}Fe	^{45}Ca	370	0.56
^{56}Fe	^{45}Ca	700	1.3 ± 0.2
^{56}Fe	^{45}Ca	25000	0.67 ± 0.1
^{56}Fe	^{45}K	600	0.022 ± 0.002
^{56}Fe	^{44}K	600	0.12 ± 0.01
^{56}Fe	^{43}K	150	0.11
^{56}Fe	^{43}K	370	0.4
^{56}Fe	^{43}K	700	0.77 ± 0.1
^{56}Fe	^{43}K	25000	0.85 ± 0.1
^{56}Fe	^{42}K	150	0.25
^{56}Fe	^{42}K	370	0.7
^{56}Fe	^{42}K	700	2.7 ± 0.3
^{56}Fe	^{42}K	25000	2.2 ± 0.3
^{56}Fe	^{38}K	600	0.27 ± 0.05
^{56}Fe	^{39}A	370	4.1 ± 0.6
^{56}Fe	^{39}A	600	5.1 ± 1
^{56}Fe	^{39}A	2000	6.2 ± 1
^{56}Fe	^{39}A	25000	9.0 ± 1.5
^{56}Fe	^{38}Ar, ^{38}K, ^{38}Cl	150	0.45
^{56}Fe	^{38}Ar, ^{38}K, ^{38}Cl	370	8 ± 1.2
^{56}Fe	^{38}Ar, ^{38}K, ^{38}Cl	600	9.8 ± 2
^{56}Fe	^{38}Ar, ^{38}K, ^{38}Cl	2000	12.6 ± 2
^{56}Fe	^{38}Ar, ^{38}K, ^{38}Cl	25000	16.3 ± 2
^{56}Fe	^{37}Ar	150	0.19
^{56}Fe	^{37}Ar	370	3.3 ± 0.5
^{56}Fe	^{37}Ar	600	4.6 ± 1
^{56}Fe	^{37}Ar	25000	7.1 ± 1
^{56}Fe	^{36}Ar	370	1.0 ± 0.5
^{56}Fe	^{36}Ar	600	1.1 ± 0.2
^{56}Fe	^{36}Ar	2000	1.37 ± 0.2
^{56}Fe	^{36}Ar	25000	1.84 ± 0.3
^{56}Fe	^{39}Cl	150	0.024
^{56}Fe	^{39}Cl	370	0.045
^{56}Fe	^{39}Cl	700	0.25 ± 0.05
^{56}Fe	^{38}Cl	370	0.17
^{56}Fe	^{38}Cl	700	0.8 ± 0.1
^{56}Fe	^{34}Cl	150	0.11 ± 0.04
^{56}Fe	^{34}Cl	370	0.11
^{56}Fe	^{34}Cl	700	0.6 ± 0.1
^{56}Fe	^{38}S	700	0.05 ± 0.01
^{56}Fe	^{35}S	150	0.18 ± 0.09
^{56}Fe	^{35}S	370	0.23
^{56}Fe	^{35}S	700	1.7 ± 0.4
^{56}Fe	^{33}P	150	0.065 ± 0.03
^{56}Fe	^{33}P	700	1.2 ± 0.2
^{56}Fe	^{32}P	150	0.2 ± 0.1
^{56}Fe	^{32}P	370	0.5 ± 0.2
^{56}Fe	^{32}P	700	2.3 ± 0.2
^{56}Fe	^{32}P	2000	6 ± 1
^{56}Fe	^{31}Si	150	0.026 ± 0.013
^{56}Fe	^{31}Si	370	0.12
^{56}Fe	^{31}Si	700	0.9 ± 0.2

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{56}Fe	^{28}Mg	150	0.005 ± 0.001
^{56}Fe	^{28}Mg	700	0.08 ± 0.07
^{56}Fe	^{28}Mg	25000	0.47 ± 0.1
^{56}Fe	^{24}Na	150	0.065 ± 0.011*
^{56}Fe	^{24}Na	370	0.10
^{56}Fe	^{24}Na	700	1.2 ± 0.2
^{56}Fe	^{24}Na	2000	3.8 ± 0.6
^{56}Fe	^{24}Na	25000	3 ± 1
^{56}Fe	^{22}Na	150	0.03 ± 0.01*
^{56}Fe	^{22}Na	370	0.09
^{56}Fe	^{22}Na	700	0.36 ± 0.02
^{56}Fe	^{22}Na	25000	2.5 ± 1
^{56}Fe	^{22}Ne	600	0.40 ± 0.06
^{56}Fe	^{22}Ne	2000	1.2 ± 0.2
^{56}Fe	^{22}Ne	25000	3.4 ± 0.5
^{56}Fe	^{21}Na, ^{21}Ne	370	0.1 ± 0.015
^{56}Fe	^{21}Na, ^{21}Ne	600	0.71 ± 0.1
^{56}Fe	^{21}Na, ^{21}Ne	2000	2.4 ± 0.4
^{56}Fe	^{21}Na, ^{21}Ne	25000	6.9 ± 1
^{56}Fe	^{20}Ne, ^{20}F	600	0.75 ± 0.1
^{56}Fe	^{18}F	150	0.014 ± 0.003
^{56}Fe	^{18}F	700	0.2 ± 0.01
^{56}Fe	^{11}C	150	0.04 ± 0.01
^{56}Fe	^{11}C	700	0.15 ± 0.02
^{56}Fe	^{10}Be	700	0.8 ± 0.3
^{56}Fe	^{7}Be	150	0.23 ± 0.03
^{56}Fe	^{7}Be	370	0.5 ± 0.1
^{56}Fe	^{7}Be	700	2.5 ± 0.3
^{56}Fe	^{7}Be	2000	5 ± 1
^{56}Fe	^{7}Be	25000	7 ± 1
^{59}Co	^{58}Co	60	330 ± 150
^{59}Co	^{58}Co	100	250 ± 100
^{59}Co	^{58}Co	170	125 ± 60
^{59}Co	^{58}Co	240	100 ± 50
^{59}Co	^{58}Co	370	58 ± 3
^{59}Co	^{57}Co	370	38 ± 3
^{59}Co	^{56}Co	60	46 ± 20
^{59}Co	^{56}Co	100	62 ± 30
^{59}Co	^{56}Co	170	20 ± 10
^{59}Co	^{56}Co	240	19 ± 10
^{59}Co	^{56}Co	370	12 ± 1
^{59}Co	^{55}Co	60	2.2 ± 0.4
^{59}Co	^{55}Co	100	15 ± 3
^{59}Co	^{55}Co	170	6.3 ± 1.3
^{59}Co	^{55}Co	240	5.5 ± 1.1
^{59}Co	^{55}Co	370	3.7 ± 0.9
^{59}Co	^{55}Fe	170	270 ± 110
^{59}Co	^{55}Fe	370	26.5 ± 6
^{59}Co	^{53}Fe	370	1.2 ± 0.4
^{59}Co	^{52}Fe	100	0.4 ± 0.1
^{59}Co	^{52}Fe	170	0.45 ± 0.1
^{59}Co	^{52}Fe	240	0.5 ± 0.2
^{59}Co	^{52}Fe	370	0.2 ± 0.05
^{59}Co	^{56}Mn	60	4.5 ± 1.0
^{59}Co	^{56}Mn	100	10 ± 2
^{59}Co	^{56}Mn	170	9 ± 2
^{59}Co	^{56}Mn	240	11 ± 3
^{59}Co	^{56}Mn	370	2.7 ± 0.7
^{59}Co	^{54}Mn	370	18 ± 5
^{59}Co	^{52}Mn	170	36 ± 9
^{59}Co	^{52}Mn	370	14 ± 4
^{59}Co	^{51}Mn	100	4 ± 2
^{59}Co	^{51}Mn	170	4 ± 1
^{59}Co	^{51}Mn	240	13.5 ± 5
^{59}Co	^{51}Mn	370	3 ± 1
^{59}Co	^{51}Cr	370	20 ± 2
^{59}Co	^{49}Cr	170	4.7 ± 1.0
^{59}Co	^{49}Cr	370	2.9 ± 0.7
^{59}Co	^{48}Cr	170	0.35 ± 0.08
^{59}Co	^{49}V	370	22 ± 6
^{59}Co	^{48}V	170	10 ± 2
^{59}Co	^{48}V	370	7.6 ± 2
^{59}Co	^{47}V	170	1.5 ± 0.3
^{59}Co	^{47}V	370	1.5 ± 0.7
^{59}Co	^{45}Ti	170	1.8 ± 0.4
^{59}Co	^{45}Ti	370	2.5 ± 0.6
^{59}Co	^{48}Sc	170	0.25 ± 0.12
^{59}Co	^{47}Sc	170	1.2 ± 0.2
^{59}Co	^{46}Sc	170	2.5 ± 0.5
^{59}Co	^{44}Sc, ^{43}Sc	170	3 ± 0.6
^{59}Co	^{44}Sc, ^{43}Sc	370	6 ± 2
^{59}Co	^{47}Ca	370	0.04 ± 0.02
^{59}Co	^{45}Ca	370	0.5 ± 0.2
^{59}Co	^{45}K	600	0.017 ± 0.002
^{59}Co	^{45}K	⩾2500	0.025 ± 0.003
^{59}Co	^{44}K	600	0.097 ± 0.01
^{59}Co	^{44}K	⩾2500	0.14 ± 0.02
^{59}Co	^{43}K	170	0.11 ± 0.03
^{59}Co	^{43}K	370	0.36 ± 0.2
^{59}Co	^{43}K	600	0.57 ± 0.06
^{59}Co	^{43}K	⩾2500	0.69 ± 0.07
^{59}Co	^{42}K	170	0.46 ± 0.12
^{59}Co	^{42}K	370	0.6 ± 0.2
^{59}Co	^{42}K	600	1.35 ± 0.14
^{59}Co	^{42}K	⩾2500	1.74 ± 0.2
^{59}Co	^{38}K	370	0.22 ± 0.10
^{59}Co	^{38}K	600	0.18 ± 0.04
^{59}Co	^{38}K	⩾2500	0.25 ± 0.05
^{59}Co	^{39}Ar	600	3.94 ± 0.5
^{59}Co	^{38}Ar, ^{38}K, ^{38}Cl	600	6.85 ± 1
^{59}Co	^{37}Ar	600	2.9 ± 0.5
^{59}Co	^{36}Ar	600	0.54 ± 0.1
^{59}Co	^{39}Cl	170	0.003 ± 0.001
^{59}Co	^{39}Cl	240	0.1 ± 0.1
^{59}Co	^{39}Cl	370	0.4 ± 0.3
^{59}Co	^{38}Cl, ^{34}Cl	60	0.002 ± 0.001
^{59}Co	^{38}Cl, ^{34}Cl	100	0.04 ± 0.02

*Probably too high by an order of magnitude; see Ref. 65.

Table continues

Table 1 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{59}Co	^{38}Cl, ^{34}Cl	170	0.012 ± 0.006
^{59}Co	^{38}Cl, ^{34}Cl	240	0.15 ± 0.07
^{59}Co	^{38}Cl, ^{34}Cl	370	2 ± 1
^{59}Co	^{33}P	370	0.02 ± 0.01
^{59}Co	^{32}P	170	0.12 ± 0.03
^{59}Co	^{32}P	370	0.21 ± 0.07
^{59}Co	^{32}P	600	0.93 ± 0.14
^{59}Co	^{32}P	≧2500	4.2 ± 0.6
^{59}Co	^{31}Si	170	0.05 ± 0.02
^{59}Co	^{29}Al	370	≦0.21
^{59}Co	^{27}Mg	370	≦0.21
^{59}Co	^{24}Na	100	0.0015
^{59}Co	^{24}Na	370	0.07
^{59}Co	^{24}Na	600	0.42 ± 0.06
^{59}Co	^{22}Na	100	0.0050
^{59}Co	^{22}Na	370	0.06
^{59}Co	^{22}Ne	600	0.75 ± 0.1
^{59}Co	^{21}Ne, ^{21}Na	600	0.8 ± 0.12
^{59}Co	^{18}F	370	0.05 ± 0.02
^{59}Co	^{11}C	370	0.04
^{58}Ni	^{57}Ni	400	33 ± 3
^{58}Ni	^{57}Ni	≧2000	30 ± 4
^{58}Ni	^{56}Ni	400	3.5 ± 0.2
^{58}Ni	^{57}Co	400	29 ± 2
^{58}Ni	^{56}Co	400	35 ± 3
^{58}Ni	^{55}Co	400	12 ± 1
^{58}Ni	^{49}Cr	400	4.9 ± 0.5
^{58}Ni	^{48}Cr	400	1.4 ± 0.2
^{58}Ni	^{49}V	400	23 ± 3
^{58}Ni	^{48}V	400	17 ± 2
^{58}Ni	^{47}V	400	10 ± 1
Ni	^{56}Co	130	90
Ni	^{56}Co	200	59
Ni	^{56}Co	300	62
Ni	^{56}Co	400	45
Ni	^{56}Co	600	30 ± 5
Ni	^{56}Co	≧2000	25 ± 4
Ni	^{54}Mn	130	10.5 ± 2
Ni	^{54}Mn	200	8.5 ± 1
Ni	^{54}Mn	300	10 ± 2
Ni	^{54}Mn	400	7 ± 1
Ni	^{54}Mn	600	6 ± 1
Ni	^{54}Mn	≧2000	4.5 ± 1
Ni	^{52}Mn	130	39.5 ± 6
Ni	^{52}Mn	200	33.5 ± 6
Ni	^{52}Mn	300	38.5 ± 6
Ni	^{52}Mn	400	28 ± 4
Ni	^{52}Mn	600	16 ± 3
Ni	^{52}Mn	≧2000	10 ± 2
Ni	^{51}Cr	130	20 ± 4
Ni	^{51}Cr	200	19 ± 3
Ni	^{51}Cr	300	19 ± 3
Ni	^{51}Cr	400	18 ± 3
Ni	^{51}Cr	600	17 ± 3
Ni	^{51}Cr	≧2000	13 ± 2
Ni	^{48}V	130	3.5 ± 1
Ni	^{48}V	200	4.6 ± 1
Ni	^{48}V	300	6.5 ± 1
Ni	^{48}V	400	7.5 ± 1
Ni	^{48}V	600	6.5 ± 1
Ni	^{48}V	≧2000	9 ± 2
Ni	^{45}K	600	0.016 ± 0.002
Ni	^{44}K	600	0.05 ± 0.005
Ni	^{43}K	600	0.36 ± 0.04
Ni	^{43}K	≧2000	0.52 ± 0.05
Ni	^{42}K	600	1.2 ± 0.1
Ni	^{42}K	≧2000	1.8 ± 0.2
Ni	^{38}K	600	0.65 ± 0.1
Ni	^{39}Ar	600	3.9 ± 0.6
Ni	^{39}Ar	≧2000	3.0 ± 0.5
Ni	^{38}Ar + ^{38}K + ^{38}Cl	600	6.85 ± 0.5
Ni	"	≧2000	7.1 ± 1
Ni	^{37}Ar	600	3.9 ± 0.5
Ni	^{36}Ar	600	1.1 ± 0.2
Ni	^{36}Ar	≧2000	1.3 ± 0.2
Ni	^{32}P	130	0.007 ± 0.002
Ni	^{32}P	200	0.025 ± 0.004
Ni	^{32}P	300	0.13 ± 0.02
Ni	^{32}P	400	0.27 ± 0.04
Ni	^{32}P	600	1.3 ± 0.3
Ni	^{32}P	≧2000	4.5 ± 1
Ni	^{24}Na	200	0.0059
Ni	^{24}Na	300	0.025
Ni	^{24}Na	400	0.072
Ni	^{24}Na	600	0.3 ± 0.1
Ni	^{24}Na	≧2000	4 ± 1
Ni	^{22}Na	200	0.011
Ni	^{22}Na	300	0.045
Ni	^{22}Na	400	0.096
Ni	^{22}Ne	600	0.34 ± 0.05
Ni	^{21}Ne + ^{21}Na	600	0.67 ± 0.1
Ni	^{21}Ne + ^{21}Na	≧2000	1.9 ± 0.3
Ni	^{20}Ne + ^{20}F	600	0.72 ± 0.1
Ni	^{17}N	≧2000	0.40
Ni	^{16}C	≧2000	0.046
Ni	^{7}Be	130	0.21 ± 0.04
Ni	^{7}Be	200	0.38 ± 0.07
Ni	^{7}Be	300	0.59 ± 0.09
Ni	^{7}Be	400	0.81 ± 0.12
Ni	^{7}Be	600	2 ± 0.4
Ni	^{7}Be	≧2000	7 ± 1
Ni	^{9}Li	≧2000	0.25

Table 2
References for Target Nuclei with $3 \leqslant Z \leqslant 28$

Target	References
^{7}Li	2-4
^{9}Be	3, 5, 6
^{10}B	3, 7
^{11}B	3, 7-9, 39
^{12}C	1, 3, 5, 6, 10-44, 82
^{14}N	2, 3, 4, 6, 25, 28, 38, 39, 41, 45-50, 260
^{15}N	49
^{16}O	3, 6, 25, 29, 31, 38, 49, 51-59, 260
^{18}O	39, 49, 38
^{19}F	3, 5, 6, 7, 25, 38, 39, 45, 49, 60-62
^{20}Ne	39, 41
^{22}Ne	39
^{23}Na	4, 6, 38, 39, 60, 63-65
^{24}Mg	38, 39, 58, 63-65, 70
^{25}Mg	7, 39, 63-67
^{26}Mg	39, 63, 64
^{27}Al	1, 6, 10, 16, 20, 35, 37, 38, 39, 43, 44, 56, 62, 64, 65, 68-89
^{28}Si	38, 39, 58, 64, 65, 66, 90, 91, 70
^{29}Si	64
^{20}Si	64, 91, 92
^{31}P	64, 65, 92
^{32}S	38, 64, 65, 92
^{33}S	64
^{34}S	64
Cl	62, 65, 93
^{37}Cl	93
^{40}Ar	41
K	65
Ca	38, 65
^{48}Ca	61
^{45}Sc	65, 76, 94
Ti	38, 65, 95, 96
^{51}V	54, 65, 87, 92, 97-99
^{50}Cr	94, 100
^{52}Cr	94
^{55}Mn	60, 94, 98
^{54}Fe	45, 94
^{56}Fe	31, 36, 58, 69-71, 94, 95, 99, 101-110; additional data at other energies in Ref. 96 and on ^{22}Na and ^{24}Na in Ref. 65 at 100, 200, 300, and 400 MeV
^{59}Co	65, 70, 94, 98, 99, 108-110
^{58}Ni	45, 94, 100
Ni	38, 58, 65, 70, 99

Part II — Proton Interactions for $29 \leqslant Z \leqslant 92$

The partial cross sections of nuclei with atomic numbers $29 \leqslant Z \leqslant 92$ are listed in Table 3, with reference numbers being listed in Table 4. In case of cumulative cross sections, the principal contributing nuclei are listed. Some caution is needed in the use of the tabulated values; the radioactive life-times of some progenitors may be sufficiently long to preclude complete decay into the measured product. For products with mass numbers $150 \lesssim A \lesssim 155$, some of the neutron-deficient nuclei can decay by α emission; in these cases only a fraction of the principal progenitor nuclei listed contribute to the listed cross sections. Some old published values above 1 GeV have been adjusted on the basis of the monitor reaction cross sections of Cumming [1]. The values of Kurchatov et al. [150] have been renormalized on the basis of the work of Panontin et al. [148].

Table 3
Partial Cross Sections of Nuclei with Atomic Numbers $29 \leqslant Z \leqslant 92$

Target	Product: $A \geqslant 6$	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: $A \geqslant 6$	Proton Energy (MeV)	Partial Cross Section (mb)
Cu	^{24}Na	100	0.0005	Ge	^{22}Na	100	0.003
Cu	^{24}Na	200	0.0055	Ge	^{22}Na	200	0.049
Cu	^{24}Na	300	0.020	Ge	^{22}Na	300	0.070
Cu	^{24}Na	400	0.048	Ge	^{22}Na	400	0.047
Cu	^{22}Na	100	0.0014	As	^{24}Na	200	0.0076
Cu	^{22}Na	200	0.0052	As	^{24}Na	300	0.018
Cu	^{22}Na	300	0.015	As	^{24}Na	400	0.040
Cu	^{22}Na	400	0.038	As	^{22}Na	200	0.0095
Zn	^{24}Na	100	0.0004	As	^{22}Na	300	0.027
Zn	^{24}Na	200	0.0046	As	^{22}Na	400	0.040
Zn	^{24}Na	300	0.017	Se	^{24}Na	200	0.0017
Zn	^{24}Na	400	0.041	Se	^{24}Na	300	0.009
Zn	^{22}Na	100	0.0017	Se	^{24}Na	400	0.025
Zn	^{22}Na	200	0.0080	Se	^{22}Na	300	0.022
Ga	^{24}Na	100	0.0002	Se	^{22}Na	400	0.022
Ga	^{24}Na	200	0.0025	Sr	^{24}Na	400	0.009
Ga	^{24}Na	300	0.0094	Sr	^{22}Na	400	0.020
Ga	^{24}Na	400	0.030	Y	^{24}Na	400	0.010
Ga	^{22}Na	100	0.007	Y	^{22}Na	400	0.025
Ga	^{22}Na	200	0.060	Zr	^{24}Na	400	0.015
Ga	^{22}Na	300	0.026	Zr	^{22}Na	400	0.012
Ga	^{22}Na	400	0.035	Nb	^{24}Na	400	0.013
Ge	^{24}Na	100	0.0002	Nb	^{22}Na	400	0.013
Ge	^{24}Na	200	0.0056	Mo	^{24}Na	400	0.015
Ge	^{24}Na	300	0.017	Mo	^{22}Na	400	0.0135
Ge	^{24}Na	400	0.038	Pd	^{24}Na	400	0.019
				Pd	^{22}Na	400	0.016
				Ag	^{24}Na	400	0.016

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Ag	^{22}Na	400	0.010	Ta	^{48}Sc	18,000	1.4
Cd	^{24}Na	400	0.013	Ta	^{47}Sc	18,000	3.2
Cd	^{22}Na	400	0.0046	Ta	^{46}Sc	18,000	4.2
In	^{24}Na	400	0.013	Ta	^{44}Sc	18,000	2.5
In	^{22}Na	400	0.0054	Ta	^{43}Sc	18,000	0.7
Sn	^{24}Na	400	0.011	Au	^{48}Sc	18,000	1.5
Sn	^{22}Na	400	0.005	Au	^{47}Sc	18,000	3.2
Ta	^{24}Na	400	0.019	Au	^{46}Sc	18,000	4.2
Ta	^{22}Na	400	0.006	Au	^{44}Sc	18,000	2.4
Au	^{24}Na	400	0.022	Au	^{43}Sc	18,000	0.5
Au	^{22}Na	400	0.0036	U	^{49}Sc	18,000	1.8
Pb	^{24}Na	400	0.018	U	^{48}Sc	18,000	3.6
Pb	^{22}Na	400	0.005	U	^{47}Sc	18,000	6.2
U	^{24}Na	400	0.045	U	^{46}Sc	18,000	6.5
U	^{22}Na	400	0.0095	U	^{44}Sc	18,000	2.6
Cu	^{33}P	200	0.0058	U	^{43}Sc	18,000	0.5
Cu	^{33}P	550	0.58	Cu	^{57}Ni	90	0.9
Cu	^{32}P	200	0.013	Cu	^{57}Ni	190	1.3
Cu	^{32}P	550	0.83	Cu	^{57}Ni	340	1.8
Nb	^{33}P	550	0.060	Cu	^{57}Ni	680	0.7
Nb	^{32}P	550	0.054	Cu	^{60}Co	⩾3000	12
Mo	^{33}P	550	0.11	Cu	^{58}Co	340	58
Mo	^{32}P	550	0.048	Cu	^{58}Co	680	30
Pd	^{33}P	550	0.039	Cu	^{58}Co	⩾3000	18.5
Pd	^{32}P	550	0.039	Cu	^{57}Co	⩾3000	20
Ag	^{33}P	200	0.0018	Cu	^{56}Co	340	3.4
Ag	^{33}P	550	0.034	Cu	^{56}Co	680	9.5
Ag	^{32}P	200	0.003	Cu	^{56}Co	⩾3000	5.5
Ag	^{32}P	550	0.036	Cu	^{55}Co	190	1.4
Cd	^{33}P	550	0.025	Cu	^{55}Co	340	0.6
Cd	^{32}P	550	0.026	Cu	^{55}Co	680	3.1
In	^{33}P	550	0.016	Cu	^{55}Co	⩾3000	1.0
In	^{32}P	550	0.023	Cu	^{59}Fe	340	0.8
Ta	^{33}P	550	0.13	Cu	^{59}Fe	680	0.6
Ta	^{32}P	550	0.048	Cu	^{59}Fe	⩾3000	1.5
Au	^{33}P	550	0.073	Cu	^{55}Fe	340	11
Au	^{32}P	550	0.049	Cu	^{55}Fe	680	16
Pb	^{33}P	550	0.088	Cu	^{55}Fe	⩾3000	14
Pb	^{32}P	550	0.048	Cu	^{53}Fe	90	0.35
U	^{33}P	550	0.85	Cu	^{53}Fe	340	1.7
U	^{32}P	550	0.13	Cu	^{53}Fe	680	4.9
Y	^{48}Sc	18,000	1.1	Cu	^{53}Fe	⩾3000	1.1
Y	^{47}Sc	18,000	4.3	Cu	^{52}Fe	90	0.008
Y	^{46}Sc	18,000	8.4	Cu	^{52}Fe	190	0.10
Y	^{44}Sc	18,000	8.4	Cu	^{52}Fe	340	0.18
Y	^{43}Sc	18,000	2.5	Cu	^{52}Fe	680	0.21
La	^{48}Sc	18,000	1.2	Cu	^{52}Fe	⩾3000	0.13
La	^{47}Sc	18,000	2.7	Cu	^{57}Mn	680	0.43
La	^{46}Sc	18,000	4.2	Cu	^{56}Mn	90	0.9
La	^{44}Sc	18,000	3.3	Cu	^{56}Mn	190	1.6
La	^{43}Sc	18,000	0.7	Cu	^{56}Mn	340	2.5

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Cu	^{56}Mn	680	3.6	Cu	^{43}K	600	0.44
Cu	^{56}Mn	⩾3000	2.3	Cu	^{43}K	680	0.16
Cu	^{54}Mn	340	12	Cu	^{43}K	⩾3000	1.0
Cu	^{54}Mn	680	12.5	Cu	^{42}K	340	0.055
Cu	^{54}Mn	⩾3000	13	Cu	^{42}K	600	1.1
Cu	^{52}Mn	90	0.11	Cu	^{42}K	680	0.36
Cu	^{52}Mn	190	0.4	Cu	^{42}K	⩾3000	2.8
Cu	^{52}Mn	340	7.1	Cu	^{38}K	⩾3000	0.22
Cu	^{52}Mn	680	10	Cu	^{42}Ar	600	0.058
Cu	^{52}Mn	⩾3000	4.3	Cu	^{41}Ar	⩾3000	0.73
Cu	^{51}Mn	190	0.3	Cu	^{39}Ar	600	2.9
Cu	^{51}Mn	340	1.6	Cu	^{39}Ar	⩾3000	6
Cu	^{51}Mn	⩾3000	1.8	Cu	^{38}(Ar + K + Cl)	600	5.1
Cu	^{51}Cr	340	7.1	Cu	^{38}(Ar + K + Cl)	⩾3000	10.5
Cu	^{51}Cr	680	16	Cu	^{37}Ar	600	2.5
Cu	^{51}Cr	⩾3000	12	Cu	^{37}Ar	⩾3000	5.3
Cu	^{49}Cr	190	0.7	Cu	^{36}Ar	600	0.46
Cu	^{49}Cr	340	0.94	Cu	^{39}Cl	340	0.009
Cu	^{49}Cr	⩾3000	2.3	Cu	^{39}Cl	680	0.014
Cu	^{48}Cr	⩾3000	0.18	Cu	^{39}Cl	⩾3000	0.5
Cu	^{49}V	680	11	Cu	^{38}Cl	340	0.058
Cu	^{49}V	⩾3000	11	Cu	^{38}Cl	680	0.062
Cu	^{48}V	90	0.023	Cu	^{38}Cl	⩾3000	1.7
Cu	^{48}V	190	2.6	Cu	^{34}Cl	340	0.018
Cu	^{48}V	340	0.73	Cu	^{34}Cl	680	0.026
Cu	^{48}V	680	2.2	Cu	^{35}S	680	0.24
Cu	^{48}V	⩾3000	8	Cu	^{35}S	⩾3000	1.7
Cu	^{47}V	680	3.1	Cu	^{33}P	⩾3000	1.8
Cu	^{47}V	⩾3000	2.6	Cu	^{32}P	340	0.12
Cu	^{45}Ti	340	1.0	Cu	^{32}P	680	0.8
Cu	^{45}Ti	680	2.5	Cu	^{32}P	⩾3000	6.5
Cu	^{45}Ti	⩾3000	3.3	Cu	^{28}Mg	700	0.5
Cu	^{44}Ti	680	0.02	Cu	^{28}Mg	⩾3000	0.54
Cu	^{48}Sc	680	2.0	Cu	^{24}Na	340	0.031
Cu	^{48}Sc	⩾3000	0.32	Cu	^{24}Na	480	0.05
Cu	^{47}Sc	340	0.75	Cu	^{24}Na	700	0.3
Cu	^{47}Sc	680	4	Cu	^{24}Na	2000	3.3
Cu	^{47}Sc	⩾3000	2.5	Cu	^{24}Na	3000	3.0
Cu	^{46}Sc	340	1.7	Cu	^{24}Na	⩾5000	3.6
Cu	^{46}Sc	680	4	Cu	^{22}Na	340	0.036
Cu	^{46}Sc	⩾3000	6.5	Cu	^{22}Na	2000	2.3
Cu	^{44}Sc + ^{43}Sc	340	3.0	Cu	^{22}Na	⩾5000	2.4
Cu	^{44}Sc	⩾3000	3.8	Cu			
Cu	^{43}Sc + some ^{44}Sc	⩾3000	3.2	Cu	^{24}Ne	1000	0.03
Cu	^{47}Ca	340	0.009	Cu	^{24}Ne	2000	0.13
Cu	^{47}Ca	680	0.06	Cu	^{24}Ne	3000	0.11
Cu	^{47}Ca	⩾3000	0.071	Cu	^{22}Ne	600	0.28
Cu	^{45}Ca	340	0.16	Cu	^{22}Ne	3000	7
Cu	^{45}Ca	680	0.6	Cu	^{22}Ne	⩾5000	8
Cu	^{45}Ca	⩾3000	1.0	Cu	^{21}(Ne + Na)	600	0.48
Cu	^{45}K	600	0.0155	Cu	^{21}(Ne + Na)	2000	2.7
Cu	^{45}K	⩾3000	0.05	Cu	^{21}(Ne + Na)	⩾5000	7.3
Cu	^{44}K	600	0.09	Cu	^{20}(Ne + F)	600	0.50
Cu	^{44}K	⩾3000	0.21	Cu	^{18}F	340	0.033

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Cu	^{18}F	420	0.08
Cu	^{18}F	660	0.1
Cu	^{18}F	980-1000	1.0
Cu	^{18}F	2000	1.2
Cu	^{18}F	3000	1.7
Cu	^{18}F	⩾5000	2.8
Cu	^{17}N	1000	0.15
Cu	^{17}N	2800	0.65
Cu	^{16}C	1000	0.018
Cu	^{16}C	2800	0.09
Cu	^{11}C	340	0.033
Cu	^{11}C	480	0.05
Cu	^{7}Be	660	1.6
Cu	^{7}Be	980-1000	4.4
Cu	^{7}Be	2000	11
Cu	^{7}Be	3000	10
Cu	^{7}Be	⩾5000	11.5
Cu	^{9}Li	1000	0.12
Cu	^{9}Li	2800	0.44
Cu	^{8}Li	2000	1.5
Cu	^{6}He	1000	2
Cu	^{6}He	2000	4
Cu	^{6}He	3000	4
^{63}Cu	^{62}Cu	60	156
^{63}Cu	^{62}Cu	370	55
^{63}Cu	^{62}Cu	680	70
^{63}Cu	^{62}Cu	⩾3000	56
^{63}Cu	^{61}Cu	60	100
^{63}Cu	^{61}Cu	100	93
^{63}Cu	^{61}Cu	200	43
^{63}Cu	^{61}Cu	370	33
^{63}Cu	^{61}Cu	680	55
^{63}Cu	^{61}Cu	⩾3000	16
^{63}Cu	^{60}Cu	60	22
^{63}Cu	^{60}Cu	100	10
^{63}Cu	^{60}Cu	200	12
^{63}Cu	^{60}Cu	680	3
^{63}Cu	^{60}Cu	⩾3000	3
^{65}Cu	^{64}Cu	100	94
^{65}Cu	^{64}Cu	200	64
^{65}Cu	^{64}Cu	300	56
^{65}Cu	^{64}Cu	370	59
^{65}Cu	^{64}Cu	⩾3000	55
^{65}Cu	^{61}Cu	60	90
^{65}Cu	^{61}Co	100	7
^{65}Cu	^{61}Co	200	6
^{65}Cu	^{61}Co	370	15
^{65}Cu	^{61}Co	⩾3000	14
^{65}Cu	^{57}Ni	100	1.3
^{65}Cu	^{57}Ni	200	1.8
^{65}Cu	^{57}Ni	300	1.4
^{65}Cu	^{57}Ni	370	1.4
^{64}Zn	^{63}Zn	370	55
^{64}Zn	^{63}Zn	⩾3000	56
^{64}Zn	^{62}Zn	370	17
^{66}Zn	^{65}Zn	⩾3000	50
^{68}Zn	^{67}Cu	130	18
^{68}Zn	^{67}Cu	200	15
^{68}Zn	^{67}Cu	300	21
^{68}Zn	^{67}Cu	370	21
^{68}Zn	^{66}Ni	370	1.2
^{68}Zn	^{65}Ni	370	2.5
Zn	^{61}Cu	340	38
Zn	^{57}Ni	340	2.0
Zn	^{56}Ni	340	0.10
Zn	^{61}Co	340	1.8
Zn	^{58}Co	340	53
Zn	^{56}Co	340	2.1
Zn	^{55}Co	340	1.7
Zn	^{59}Fe	340	0.8
Zn	^{52}Fe	340	0.25
Zn	^{56}Mn	340	2.2
Zn	^{54}Mn	340	21.8
Zn	^{52}Mn	340	11.5
Zn	^{51}Mn	340	2.3
Zn	^{51}Cr	340	17.2
Zn	^{49}Cr	340	2.3
Zn	^{48}Cr	340	0.23
Zn	^{48}V	340	5.5
Zn	^{47}V	340	0.92
Zn	^{45}Ti	340	1.06
Zn	^{47}Ca	340	0.006
Zn	^{45}Ca	340	0.25
Zn	^{43}K	340	0.22
Zn	^{43}K	600	0.32
Zn	^{43}K	3000	2.1
Zn	^{42}K	340	0.27
Zn	^{42}K	3000	0.87
Zn	^{35}S	340	0.07
Zn	^{32}P	340	0.023
Zn	^{24}Na	340	0.026
Zn	^{13}N	1000	0.13
Zn	^{13}N	1900	0.33
^{69}Ga	^{68}Ga	60	190
^{69}Ga	^{68}Ga	370	58
^{69}Ga	^{68}Ga	500	70
^{69}Ga	^{68}Ga	1500	60
^{69}Ga	^{68}Ga	3000	57
^{69}Ga	^{67}Ga	60	170
^{69}Ga	^{67}Ga	500	26
^{69}Ga	^{67}Ga	1500	20
^{69}Ga	^{67}Ga	3000	18

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{69}Ga	^{66}Ga	60	185
^{69}Ga	^{66}Ga	370	18
^{69}Ga	^{66}Ga	500	18
^{69}Ga	^{66}Ga	1500	12
^{69}Ga	^{66}Ga	3000	10
^{69}Ga	^{65}Ga	60	32
^{69}Ga	^{65}Ga	370	4.5
^{69}Ga	^{65}Ga	1500	1.7
^{69}Ga	^{65}Zn	60	124
^{69}Ga	^{63}Zn	60	29
^{69}Ga	^{62}Zn	60	0.62
^{69}Ga	^{67}Cu	60	0.34
^{69}Ga	^{67}Cu	500	1.4
^{69}Ga	^{67}Cu	1500	1.3
^{69}Ga	^{67}Cu	3000	1.3
^{69}Ga	^{64}Cu	60	21
^{71}Ga	^{70}Ga	60	190
^{71}Ga	^{70}Ga	370	58
^{71}Ga	^{70}Ga	500	69
^{71}Ga	^{70}Ga	1500	63
^{71}Ga	^{70}Ga	3000	58
^{71}Ga	^{68}Ga	60	230
^{71}Ga	^{68}Ga	370	38
^{71}Ga	^{68}Ga	500	36
^{71}Ga	^{68}Ga	1500	22
^{71}Ga	^{68}Ga	3000	22
^{71}Ga	^{67}Ga	60	86
^{71}Ga	^{67}Ga	500	16
^{71}Ga	^{67}Ga	1500	9
^{71}Ga	^{67}Ga	3000	8.4
^{71}Ga	^{66}Ga	60	3
^{71}Ga	^{66}Ga	370	10
^{71}Ga	^{66}Ga	500	10
^{71}Ga	^{66}Ga	1500	5
^{71}Ga	^{66}Ga	3000	4.8
^{71}Ga	^{69}Zn	60	9
^{71}Ga	^{65}Zn	60	70
^{71}Ga	^{67}Cu	60	2.1
^{71}Ga	^{64}Cu	60	14
^{70}Ge	^{69}Ge	3000	59
^{72}Ge	^{71}Ge	3000	70
^{75}As	^{74}As	100	70
^{75}As	^{74}As	170	90
^{75}As	^{74}As	380	64
^{75}As	^{74}As	2900	47
^{75}As	^{73}As	380	28
^{75}As	^{73}As	2900	17
^{75}As	^{72}As	100	41
^{75}As	^{72}As	170	58
^{75}As	^{72}As	380	67
^{75}As	^{72}As	2900	14
^{75}As	^{71}As	100	55
^{75}As	^{71}As	380	24
^{75}As	^{71}As	2900	7
^{75}As	^{70}As	170	7.4
^{75}As	^{71}Ge	100	12
^{75}As	^{71}Ge	170	70
^{75}As	^{69}Ge	100	11
^{75}As	^{69}Ge	170	50
^{75}As	^{68}Ge	100	4.1
^{75}As	^{68}Ge	170	25
^{75}As	^{67}Ge	100	0.6
^{75}As	^{67}Ge	170	3.0
^{75}As	^{73}Ga	100	0.22
^{75}As	^{73}Ga	170	0.43
^{75}As	^{73}Ga	380	0.9
^{75}As	^{73}Ga	2900	0.62
^{75}As	^{72}Ga	100	0.8
^{75}As	^{72}Ga	170	1.3
^{75}As	^{72}Ga	380	2.5
^{75}As	^{72}Ga	2900	2.3
^{75}As	^{70}Ga	100	5.7
^{75}As	^{70}Ga	170	16
^{75}As	^{70}Ga	380	20.4
^{75}As	^{68}Ga	100	17
^{75}As	^{68}Ga	170	29
^{75}As	^{68}Ga	380	23
^{75}As	^{67}Ga	100	25
^{75}As	^{67}Ga	170	52
^{75}As	^{67}Ga	380	30
^{75}As	^{67}Ga	2900	8
^{75}As	^{66}Ga	100	6.3
^{75}As	^{66}Ga	170	16
^{75}As	^{66}Ga	380	12
^{75}As	^{66}Ga	2900	5
^{75}As	^{72}Zn	380	0.004
^{75}As	^{72}Zn	.2900	0.025
^{75}As	$^{65}(Zn + Ga)$	100	6.6
^{75}As	$^{65}(Zn + Ga)$	380	30.4
^{75}As	^{62}Zn	380	1.1
^{75}As	^{67}Cu	100	0.22
^{75}As	^{67}Cu	170	0.55
^{75}As	^{67}Cu	380	0.79
^{75}As	^{66}Cu	380	5.2
^{75}As	^{64}Cu	100	2.3
^{75}As	^{64}Cu	170	7.2
^{75}As	^{64}Cu	380	14
^{75}As	^{62}Cu	380	18
^{75}As	$^{61}(Cu + Zn)$	100	0.14
^{75}As	$^{61}(Cu + Zn)$	170	1.5
^{75}As	$^{61}(Cu + Zn)$	380	8.1
^{75}As	^{60}Cu	170	0.34
^{75}As	^{60}Cu	380	1.4
^{75}As	^{66}Ni	100	0.004
^{75}As	^{66}Ni	170	0.024
^{75}As	^{66}Ni	380	0.051
^{75}As	^{65}Ni	100	0.019
^{75}As	^{65}Ni	170	0.13

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{75}As	^{65}Ni	380	0.57	^{89}Y	^{82}Y	240	0.07
^{75}As	^{57}Ni	380	0.16	^{89}Y	^{85}Sr	240	53
^{75}As	^{56}Ni	380	0.007	^{89}Y	^{83}Sr	240	24.5
^{75}As	^{61}Co	100	0.074	^{89}Y	^{82}Sr	240	8
^{75}As	^{61}Co	170	0.59	^{89}Y	^{86}Rb	240	4
^{75}As	^{61}Co	380	4.1	^{89}Y	^{84}Rb	240	64
^{75}As	^{57}Co	380	7.2	^{89}Y	$^{79}(Kr + Rb)$	240	21
^{75}As	^{56}Co	380	2.2	^{89}Y	^{77}Kr	240	10
^{75}As	^{55}Co	380	0.44	^{89}Y	^{76}Kr	240	3
^{75}As	^{59}Fe	170	0.10	^{89}Y	^{80}Br	240	2.4
^{75}As	"	380	0.44	^{89}Y	^{77}Br	240	3.8
^{75}As	^{55}Fe	380	3.53	^{89}Y	^{76}Br	240	3.9
^{75}As	^{53}Fe	380	0.155	^{89}Y	^{75}Br	240	3.4
^{75}As	^{52}Fe	380	0.008	^{89}Y	^{75}Se	240	0.85
^{75}As	^{56}Mn	170	0.12	^{89}Y	^{73}Se	240	3.1
^{75}As	^{56}Mn	380	1.15	^{89}Y	^{72}Se	240	0.85
^{75}As	^{54}Mn	380	5.05	^{89}Y	^{74}As	240	0.68
^{75}As	^{52}Mn	380	0.94	^{89}Y	^{72}As	240	2.0
^{75}As	^{51}Cr	380	1.0	^{89}Y	^{71}As	240	1.3
^{75}As	^{49}Cr	380	0.22	^{89}Y	^{77}Ge	240	0.006
^{75}As	^{48}Cr	380	0.010	^{89}Y	^{71}Ge	240	1.9
^{75}As	^{49}V	380	1.5	^{89}Y	^{67}Cu	450	0.068
^{75}As	^{48}V	380	0.26	^{89}Y	^{64}Cu	450	1.2
^{75}As	^{47}V	380	0.17	^{89}Y	^{66}Ni	450	0.015
^{75}As	^{45}Ti	380	0.047	^{89}Y	^{65}Ni	450	0.034
^{75}As	^{48}Sc	380	0.007	^{90}Zr	^{83}Y	60	0.002
^{75}As	^{47}Sc	380	0.092	^{90}Zr	^{83}Y	100	0.009
^{75}As	^{46}Sc	380	0.16	^{90}Zr	^{83}Y	240	0.008
^{75}As	$^{44}Sc + {}^{43}Sc$	380	0.30	^{90}Zr	^{83}Sr	60	0.03
^{75}As	^{47}Ca	380	0.002	^{90}Zr	^{83}Sr	100	12
^{75}As	^{45}Ca	380	0.022	^{90}Zr	^{83}Sr	240	17
^{75}As	^{43}K	380	0.031	^{96}Zr	^{95}Zr	240	70
^{75}As	^{42}K	380	0.057	^{96}Zr	^{95}Zr	450	61
^{76}Se	^{75}Se	250	66	^{96}Zr	^{95}Y	240	36
^{76}Se	^{75}Se	350	65	^{96}Zr	^{95}Y	450	38
^{79}Br	^{78}Br	3000	56	^{96}Ru	^{74}As	1800	1.1
^{79}Br	^{77}Br	3000	26	^{96}Ru	^{72}As	1800	7.0
^{79}Br	^{76}Br	3000	12	^{96}Ru	^{71}As	1800	9.7
^{79}Br	^{75}Br	3000	6	^{96}Ru	^{73}Ga	1800	0.007
^{81}Br	^{80}Br	450	62	^{96}Ru	^{72}Ga	1800	0.08
^{81}Br	^{80}Br	3000	59	^{96}Ru	^{67}Ga	1800	9.0
^{81}Br	^{78}Br	3000	14.5	^{96}Ru	^{66}Ga	1800	7.8
^{81}Br	^{77}Br	3000	10	^{96}Ru	^{72}Zn	1800	0.0016
^{81}Br	^{76}Br	3000	9	^{96}Mo	^{74}As	1800	3.3
^{81}Br	^{75}Br	3000	2.3	^{96}Mo	^{72}As	1800	9.5
^{89}Y	^{88}Y	50	215	^{96}Mo	^{71}As	1800	9.4
^{89}Y	^{88}Y	85	144	^{96}Mo	^{73}Ga	1800	0.04
^{89}Y	^{88}Y	100	143	^{96}Mo	^{72}Ga	1800	0.22
^{89}Y	^{88}Y	240	83	^{96}Mo	^{67}Ga	1800	9.6
^{89}Y	^{86}Y	48	126	^{96}Mo	^{66}Ga	1800	6.0
^{89}Y	^{86}Y	85	106	^{96}Mo	^{72}Zn	1800	0.006
^{89}Y	^{85}Y	85	118	^{96}Zr	^{74}As	1800	5.1
^{89}Y	^{85}Y	240	14	^{96}Zr	^{72}As	1800	9.0
^{89}Y	^{84}Y	85	24	^{96}Zr	^{71}As	1800	4.3

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{96}Zr	^{73}Ga	1800	0.3	^{93}Nb	^{24}Na	720	0.13
^{96}Zr	^{72}Ga	1800	0.9	^{93}Nb	^{22}Na	240	0.019
^{96}Zr	^{67}Ga	1800	6.3	^{93}Nb	^{22}Na	320	0.016
^{96}Zr	^{66}Ga	1800	2.0	^{93}Nb	^{22}Na	500	0.026
^{96}Zr	^{72}Zn	1800	0.1	^{93}Nb	^{22}Na	720	0.073
^{93}Nb	^{88}Y	50	11	^{93}Nb	^{17}N	2000	0.87
^{93}Nb	^{88}Y	100	13	^{93}Nb	^{16}C	2000	0.14
^{93}Nb	^{90}Nb	240	66	^{93}Nb	^{9}Li	2000	0.81
^{93}Nb	^{90}Nb	320	55	^{100}Mo	$^{99}(Mo + Nb)$	280	79
^{93}Nb	^{90}Nb	500	47	^{100}Mo	$^{99}(Mo + Nb)$	400	77
^{93}Nb	^{90}Nb	720	37	^{100}Mo	$^{99}(Mo + Nb)$	700	70
^{93}Nb	^{89}Nb	240	25	^{100}Mo	$^{99}(Mo + Nb)$	1000	67
^{93}Nb	^{89}Nb	320	22	^{100}Mo	$^{99}(Mo + Nb)$	⩾1800	75
^{93}Nb	^{89}Nb	500	18	^{103}Rh	^{100}Ru	56	159
^{93}Nb	^{89}Nb	720	14	^{103}Rh	^{99}Mo	450	0.038
^{93}Nb	^{89}Zr	240	63	^{103}Rh	^{67}Cu	450	0.0028
^{93}Nb	^{89}Zr	320	60	^{103}Rh	^{64}Cu	450	0.05
^{93}Nb	^{89}Zr	500	45	^{103}Rh	^{65}Ni	450	0.0008
^{93}Nb	^{89}Zr	720	38	^{109}Ag	^{103}Ru	340	0.5
^{93}Nb	^{88}Zr	240	81	^{109}Ag	^{103}Ru	3000	1.7
^{93}Nb	^{88}Zr	320	72	^{109}Ag	^{103}Ru	29,000	1.9
^{93}Nb	^{88}Zr	500	54	Ag	$^{97}(Ru + Rh)$	340	33
^{93}Nb	^{88}Zr	720	42	Ag	$^{97}(Ru + Rh)$	480	26
^{93}Nb	^{87}Zr	240	47	Ag	$^{97}(Ru + Rh)$	3000	19.5
^{93}Nb	^{87}Zr	320	42	Ag	$^{97}(Ru + Rh)$	29,000	19.1
^{93}Nb	^{87}Zr	500	33	Ag	$^{95}(Ru + Rh)$	340	22
^{93}Nb	^{87}Zr	720	26	Ag	$^{95}(Ru + Rh)$	480	11
^{93}Nb	^{67}Cu	240	0.0015	Ag	^{99}Mo	340	0.07
^{93}Nb	^{67}Cu	320	0.0052	Ag	^{99}Mo	480	0.095
^{93}Nb	^{67}Cu	500	0.029	Ag	$^{90}(Mo + Tc)$	340	19
^{93}Nb	^{67}Cu	720	0.12	Ag	$^{90}(Mo + Tc)$	480	5
^{93}Nb	^{64}Cu	240	0.021	Ag	^{92}Nb	340	7.3
^{93}Nb	^{64}Cu	320	0.10	Ag	^{90}Nb	340	7.9
^{93}Nb	^{64}Cu	500	0.73	Ag	^{90}Nb	480	12
^{93}Nb	^{64}Cu	720	2.8	Ag	$^{89}(Zr + Nb)$	340	5.6
^{93}Nb	^{61}Cu	240	0.0052	Ag	$^{89}(Zr + Nb)$	480	13.6
^{93}Nb	^{61}Cu	320	0.034	Ag	$^{89}(Zr + Nb)$	3000	22.6
^{93}Nb	^{61}Cu	500	0.42	Ag	$^{89}(Zr + Nb)$	29,000	17.5
^{93}Nb	^{61}Cu	720	1.7	Ag	$^{88}(Zr + Nb)$	480	16
^{93}Nb	^{66}Ni	240	0.0001	Ag	$^{88}(Zr + Nb)$	3000	20.1
^{93}Nb	^{66}Ni	320	0.00038	Ag	$^{88}(Zr + Nb)$	29,000	15.2
^{93}Nb	^{66}Ni	500	0.0029	Ag	$^{87}(Zr + Nb)$	340	7.9
^{93}Nb	^{66}Ni	720	0.008	Ag	^{86}Zr	340	2.5
^{93}Nb	^{65}Ni	240	0.00055	Ag	^{86}Zr	480	3.2
^{93}Nb	^{65}Ni	320	0.0032	Ag	^{91}Y	340	0.08
^{93}Nb	^{65}Ni	500	0.022	Ag	^{88}Y	340	2.6
^{93}Nb	^{65}Ni	720	0.063	Ag	^{88}Y	480	0.8
^{93}Nb	^{57}Ni	240	0.00035	Ag	$^{85}(Sr + Y)$	340	0.8
^{93}Nb	^{57}Ni	320	0.0018	Ag	$^{85}(Sr + Y)$	3000	19.5
^{93}Nb	^{57}Ni	500	0.018	Ag	$^{85}(Sr + Y)$	29,000	15.8
^{93}Nb	^{57}Ni	720	0.073	Ag	$^{83}(Sr + Y)$	480	4.7
^{93}Nb	^{24}Na	240	0.008	Ag	$^{83}(Sr + Y)$	3000	17.2
^{93}Nb	^{24}Na	320	0.015	Ag	$^{83}(Sr + Y)$	29,000	11.4
^{93}Nb	^{24}Na	500	0.043	Ag	$^{82}(Sr + Y)$	340	0.5

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Ag	^{82}(Sr + Y)	480	3.2	Ag	^{74}As	340	0.015
Ag	^{82}(Sr + Y)	3000	8.5	Ag	^{74}As	480	0.07
Ag	^{82}(Sr + Y)	29,000	6.4	Ag	^{74}As	3000	3.0
Ag	^{81}Sr	340	0.11	Ag	^{74}As	29,000	2.4
Ag	^{86}Rb	340	0.02	Ag	^{73}As	480	0.33
Ag	^{84}Rb	340	0.34	Ag	^{73}As	3000	16
Ag	^{84}Rb	480	0.6	Ag	^{73}As	29,000	13
Ag	^{84}Rb	3000	2.3	Ag	^{72}As	340	0.040
Ag	^{84}Rb	29,000	1.5	Ag	^{72}As	480	0.23
Ag	^{83}Rb	340	1.0	Ag	^{72}As	3000	8.3
Ag	^{83}Rb	3000	4.9	Ag	^{72}As	29,000	6.7
Ag	^{82}Rb	29,000	3.6	Ag	^{71}(As + Se)	340	0.034
Ag	^{82}Rb	340	1.3	Ag	^{71}(As + Se)	480	0.13
Ag	^{81}Rb	340	0.9	Ag	^{71}(As + Se)	3000	8.1
Ag	^{82}Rb + ^{81}Rb	480	6	Ag	^{71}(As + Se)	29,000	6.3
Ag	^{79}Rb	3000	1.14	Ag	^{70}As	340	0.0062
Ag	^{79}Rb	29,000	4.6	Ag	^{71}Ge	480	0.33
Ag	^{85}Kr	3000	0.035	Ag	^{69}(Ge + As)	340	0.020
Ag	^{85}Kr	29,000	0.023	Ag	^{69}(Ge + As)	480	0.11
Ag	^{84}(Kr + Rb)	3000	1.83	Ag	^{68}(Ge + As)	480	0.09
Ag	^{84}(Kr + Rb)	29,000	1.55	Ag	^{72}Ga	340	0.0011
Ag	^{83}(Kr + Rb + Sr + Y)	3000	17.9	Ag	^{72}Ga	3000	0.28
Ag	^{83}(Kr + Rb + Sr + Y)	29,000	14.3	Ag	^{72}Ga	29,000	0.26
Ag	^{82}(Kr + Rb + Sr)	3000	17.7	Ag	^{68}Ga	340	0.011
Ag	^{82}(Kr + Rb + Sr)	29,000	14.1	Ag	^{67}(Ga + Ge)	480	0.032
Ag	^{81}(Kr + Rb + Sr)	3000	17.0	Ag	^{67}(Ga + Ge)	3000	8.1
Ag	^{81}(Kr + Rb + Sr)	29,000	13.6	Ag	^{67}(Ga + Ge)	29,000	6.5
Ag	^{80}(Kr + Rb)	3000	16.6	Ag	^{66}(Ga + Ge)	340	0.0050
Ag	^{80}(Kr + Rb)	29,000	13.2	Ag	^{66}(Ga + Ge)	480	0.06
Ag	^{79}(Kr + Rb)	3000	12.6	Ag	^{65}(Zn + Ga)	3000	10.4
Ag	^{79}(Kr + Rb)	29,000	11.7	Ag	^{65}(Zn + Ga)	29,000	8.7
Ag	^{78}Kr	3000	11.1	Ag	^{63}(Zn + Ga)	340	0.0017
Ag	^{78}Kr	29,000	8.9	Ag	^{62}(Zn + Ga)	340	0.0011
Ag	^{77}Kr	3000	3.8	Ag	^{67}Cu	340	0.00038
Ag	^{77}Kr	29,000	3.4	Ag	^{67}Cu	480	0.009
Ag	^{76}Kr	3000	1.8	Ag	^{67}Cu	3000	0.22
Ag	^{76}Kr	29,000	1.4	Ag	^{67}Cu	29,000	0.19
Ag	^{82}Br	340	0.0068	Ag	^{64}Cu	340	0.0045
Ag	^{80}Br	340	0.011	Ag	^{64}Cu	480	0.024
Ag	^{77}(Br + Kr)	340	0.033	Ag	^{64}Cu	3000	4.1
Ag	^{77}(Br + Kr)	480	1.4	Ag	^{64}Cu	29,000	3.6
Ag	^{76}Br	340	0.070	Ag	^{61}Cu	340	0.0015
Ag	^{76}Br	480	1.1	Ag	^{61}Cu	480	0.013
Ag	^{75}(Br + Kr)	340	0.034	Ag	^{61}Cu	3000	3.2
Ag	^{75}(Br + Kr)	480	1.0	Ag	^{61}Cu	29,000	2.7
Ag	^{75}(Se + Br)	3000	19	Ag	^{66}Ni	480	0.0005
Ag	^{75}(Se + Br)	29,000	13.5	Ag	^{65}Ni	340	0.00015
Ag	^{73}(Se + Br)	340	0.055	Ag	^{65}Ni	480	0.0013
Ag	^{73}(Se + Br)	480	0.47	Ag	^{57}Ni	480	0.0011
Ag	^{72}Se	340	0.028	Ag	^{61}Co	340	0.0011
Ag	^{72}Se	480	0.18	Ag	^{61}Co	480	0.005
Ag	^{72}Se	3000	3.4	Ag	^{61}Co	3000	0.94
Ag	^{72}Se	29,000	2.5	Ag	"	29,000	0.9
Ag	^{76}As	340	0.0022	Ag	^{60}Co	3000	1.9

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Ag	^{60}Co	29,000	2.0	Ag	^{42}Ar	3000	0.12
Ag	^{58}Co	3000	5.8	Ag	^{42}Ar	29,000	0.19
Ag	^{58}Co	29,000	5.5	Ag	^{41}Ar	3000	0.41
Ag	^{57}Co	3000	4.35	Ag	^{41}Ar	29,000	0.63
Ag	^{57}Co	29,000	4.3	Ag	^{38}(Ar + Cl)	600	0.1
Ag	^{56}Co	3000	2.3	Ag	^{38}(Ar + Cl)	3000	4.7
Ag	^{56}Co	29,000	1.8	Ag	^{38}(Ar + Cl)	29,000	7.0
Ag	^{55}Co	480	0.0006	Ag	^{37}Ar	3000	1.2
Ag	^{55}Co	3000	0.24	Ag	^{37}Ar	29,000	2.15
Ag	^{55}Co	29,000	0.21	Ag	^{36}Ar	600	0.05
Ag	^{59}Fe	480	0.0024	Ag	^{36}Ar	3000	0.32
Ag	^{59}Fe	3000	0.52	Ag	^{36}Ar	29,000	0.47
Ag	^{59}Fe	29,000	0.63	Ag	^{39}Cl	340	0.0004
Ag	^{55}Fe	3000	4.5	Ag	^{38}Cl	340	0.0013
Ag	^{55}Fe	29,000	5.2	Ag	^{32}P	480	0.047
Ag	^{52}Fe	480	0.0015	Ag	^{32}P	600	0.031
Ag	^{56}Mn	340	0.0013	Ag	^{32}P	910	0.17
Ag	^{56}Mn	480	0.006	Ag	^{32}P	1800	1.1
Ag	^{54}Mn	3000	4.9	Ag	^{32}P	3000	2.1
Ag	^{54}Mn	29,000	5.5	Ag	^{31}Si	480	0.009
Ag	^{52}Mn	3000	2.5	Ag	^{28}Mg	340	0.001
Ag	^{51}Cr	3000	6.5	Ag	^{28}Mg	700	0.012
Ag	^{51}Cr	29,000	7.2	Ag			
Ag	^{49}Cr	3000	0.51	Ag	^{28}Mg	3000	0.33
Ag	^{48}Cr	3000	0.045	Ag	^{28}Mg	29,000	0.59
Ag	^{48}Cr	29,000	0.06	Ag	^{24}Na	340	0.010
Ag	^{49}V	3000	2.6	Ag	^{24}Na	480	0.047
Ag	^{49}V	29,000	6.3	Ag	^{24}Na	700	0.1
Ag	^{48}V	3000	2.0	Ag			
Ag	^{48}V	29,000	2.8	Ag	^{24}Na	1000	0.29
Ag	^{45}Ti	3000	0.66	Ag	^{24}Na	2000	1.2
Ag	^{45}Ti	29,000	1.0	Ag	^{24}Na	3000	2.2
Ag	^{49}Sc	3000	0.11	Ag	^{24}Na	29,000	4.1
Ag	^{49}Sc	29,000	0.14	Ag	^{22}Na	3000	1.14
Ag	^{48}Sc	3000	0.33	Ag	^{22}Na	29,000	2.35
Ag	^{48}Sc	29,000	0.47	Ag	^{24}Ne	1000	0.02
Ag	^{47}Sc	480	0.009	Ag	^{24}Ne	2000	0.09
Ag	^{47}Sc	3000	1.67	Ag	^{24}Ne	3000	0.21
Ag	^{47}Sc	29,000	1.7	Ag	^{22}Ne	600	0.07
Ag	^{46}Sc	3000	3.1	Ag	^{22}Ne	3000	6.1
Ag	^{46}Sc	29,000	3.4	Ag	^{22}Ne	29,000	13.7
Ag	^{44}Sc	3000	2.4	Ag	^{21}Ne	600	0.17
Ag	^{44}Sc	29,000	3.1	Ag	^{21}Ne	3000	6.5
Ag	^{43}Sc	3000	0.88	Ag	^{21}Ne	29,000	15
Ag	^{43}Sc	29,000	1.2	Ag	^{20}(Ne + F)	3000	6.5
Ag	^{47}Ca	480	0.0024	Ag	^{20}(Ne + F)	29,000	15
Ag	^{47}Ca	3000	0.052	Ag	^{18}F	340	0.007
Ag	^{47}Ca	29,000	0.090	Ag	^{18}F	1000	0.19
Ag	^{45}Ca	3000	0.73	Ag	^{18}F	2000	0.48
Ag	^{45}Ca	29,000	1.1	Ag	^{18}F	3000	1.4
Ag	^{43}K	3000	0.70	Ag	^{17}N	1000	0.16
Ag	^{43}K	29,000	0.46	Ag	^{17}N	2000	1.0
Ag	^{42}K	3000	1.7	Ag	^{13}N	3000	0.22
Ag	^{42}K	29,000	1.0	Ag	^{16}C	1000	0.028

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Ag	^{16}C	2000	0.18	In	^{112}Ag	200	1.17
Ag	^{11}C	340	0.013	In	^{112}Ag	400	1.81
Ag	^{11}C	480	0.047	In	^{111}Ag	200	2.33
Ag	^{11}C	3000	2.3	In	^{111}Ag	400	3.71
Ag	^{7}Be	85	0.03	In	^{105}Ag	200	22.5
Ag	^{7}Be	340	0.1	In	^{105}Ag	400	27
Ag	^{7}Be	1000	2.4	In	^{103}Ag	200	19
Ag	^{7}Be	2000	10	In	^{103}Ag	400	27
Ag	^{7}Be	3000	8	In	^{101}Ag	200	1.6
Ag	^{7}Be	29,000	18	In	^{101}Ag	400	3.7
Ag	^{9}Li	1000	0.22	In	^{103}Pd	200	4
Ag	^{9}Li	2000	1.05	In	^{103}Pd	400	10
Ag	^{8}Li	1000	0.6	In	^{101}Pd	200	8.6
Ag	^{8}Li	2000	5	In	^{101}Pd	400	16.5
Ag	^{8}Li	3000	4	In	^{100}Pd	200	2.9
Ag	^{6}He	1000	4	In	^{100}Pd	400	9
Ag	^{6}He	1900	6	In	^{99}Mo	400	0.11
Ag	^{6}He	3000	10	In	^{72}Se	3000	2.8
Ag	^{10}Be	>5000	10.1	In	^{74}As	3000	2.7
Ag	^{9}Be	>5000	15.4	In	^{72}As	3000	7.3
Ag	^{7}Be	>5000	17.4	In	$^{71}(As + Se)$	3000	5.7
Ag	^{9}Li	>5000	2.6	In	^{67}Ge	3000	0.7
Ag	^{8}Li	>5000	12.8	In	^{66}Ge	3000	0.16
Ag	^{7}Li	>5000	69	In	^{73}Ga	3000	0.087
Ag	^{6}Li	>5000	55	In	^{72}Ga	3000	0.23
^{106}Cd	^{105}Cd	400	30.4	In	^{67}Ga	3000	4.0
^{106}Cd	^{105}Ag	400	21	In	^{66}Ga	3000	3.5
^{108}Cd	^{107}Cd	400	102	In	^{72}Zn	3000	0.009
^{110}Cd	^{109}Cd	400	45	In	^{67}Cu	400	0.0007
^{112}Cd	^{111}Ag	400	16	In	^{67}Cu	3000	0.29
^{113}Cd	^{112}Ag	400	14	In	^{66}Ni	3000	0.052
^{114}Cd	^{113}Ag	400	14	In	^{65}Ni	3000	0.18
In	^{111}In	1000	16	In	^{13}N	1000	0.056
In	^{111}In	2000	19	In	^{13}N	1900	0.19
In	^{111}In	3000	14	In	^{13}N	2900	0.27
In	^{111}In	4000	15	In	^{7}Be	6000	11
In	^{111}In	6000	21	Sn	^{24}Na	660	0.045
In	^{111}In	30,000	13	Sn	^{18}F	660	0.017
In	^{109}In	1000	10	Sb	^{66}Ni	660	0.002
In	^{109}In	2000	10	Sb	^{65}Ni	660	0.006
In	^{109}In	3000	8	Sb	^{61}Co	660	0.005
In	^{109}In	30,000	7.4	Sb	^{59}Fe	660	0.008
In	^{109}Cd	1000	35	Sb	^{56}Mn	660	0.008
In	^{109}Cd	2000	46	Sb	^{48}Cr	660	0.004
In	^{109}Cd	4000	38	Sb	^{48}V	660	0.007
In	^{109}Cd	6000	43	Sb	^{45}Ti	660	0.006
In	^{107}Cd	1000	26	Sb	^{47}Ca	660	0.004
In	^{107}Cd	2000	29	Sb	^{43}K	660	0.008
In	^{107}Cd	4000	22	Sb	^{39}Cl	660	0.0012
In	^{107}Cd	6000	24	Sb	^{38}Cl	660	0.006
In	^{105}Cd	200	15.7	Sb	^{38}S	660	0.0007
In	^{105}Cd	400	13.5	Sb	^{32}P	660	0.006
In	^{113}Ag	200	0.076	Sb	^{31}Si	660	0.006
In	^{113}Ag	400	0.29	Sb	^{28}Mg	660	0.007

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Sb	^{24}Na	660	0.14	^{127}I	^{126}I	1000	68
Sb	^{18}F	660	0.028	^{127}I	^{126}I	2000	53
Sb	^{7}Be	660	2.5	^{127}I	^{126}I	4000	52
^{122}Te	^{121}Te	300	34	^{127}I	^{125}I	100	100
^{123}Te	^{122}Sb	300	12	^{127}I	^{125}I	170	44
^{124}Te	^{123}Te	300	41	^{127}I	^{125}I	250	50
^{125}Te	^{124}Sb	120	9.5	^{127}I	^{125}I	300	37
^{125}Te	^{124}Sb	300	6.4	^{127}I	^{125}I	500	26
^{125}Te	^{124}Sb	480	13	^{127}I	^{125}I	700	22
^{125}Te	^{124}Sb	660	20	^{127}I	^{125}I	1000	19
^{125}Te	^{122}Sb	120	20	^{127}I	^{125}I	2000	18
^{125}Te	^{122}Sb	300	18	^{127}I	^{125}I	4000	19
^{125}Te	^{122}Sb	480	15	^{127}I	^{124}I	100	50
^{125}Te	^{122}Sb	660	22	^{127}I	^{124}I	170	54
^{125}Te	^{120}Sb	120	10.6	^{127}I	^{124}I	250	50
^{125}Te	^{120}Sb	300	8	^{127}I	^{124}I	300	28
^{125}Te	^{120}Sb	480	7	^{127}I	^{124}I	500	22
^{125}Te	^{120}Sb	660	10	^{127}I	^{124}I	700	18
^{125}Te	^{119}Sb	120	9	^{127}I	^{124}I	1000	17
^{125}Te	^{119}Sb	300	7	^{127}I	^{124}I	2000	15
^{125}Te	^{119}Sb	480	5	^{127}I	^{124}I	4000	15
^{125}Te	^{119}Sb	660	7	^{127}I	^{123}I	100	44
^{126}Te	^{125}Te	300	40	^{127}I	^{123}I	170	13.5
^{126}Te	^{125}Sb	300	7.8	^{127}I	^{123}I	250	51
^{126}Te	^{124}Sb	120	12	^{127}I	^{123}I	300	12
^{126}Te	^{124}Sb	180	13	^{127}I	^{123}I	500	15
^{126}Te	^{124}Sb	300	15	^{127}I	^{123}I	700	14
^{126}Te	^{124}Sb	480	18	^{127}I	^{123}I	1000	22
^{126}Te	^{124}Sb	660	18	^{127}I	^{123}I	2000	14
^{126}Te	^{122}Sb	120	18	^{127}I	^{123}I	4000	14
^{126}Te	^{122}Sb	180	14	^{127}I	^{121}I	100	105
^{126}Te	^{122}Sb	300	21	^{127}I	^{121}I	170	20.5
^{126}Te	^{122}Sb	480	22	^{127}I	^{121}I	250	59
^{126}Te	^{122}Sb	660	22	^{127}I	^{121}I	300	50
^{126}Te	^{120}Sb	120	9	^{127}I	^{121}I	500	26
^{126}Te	^{120}Sb	180	12	^{127}I	^{121}I	700	14
^{126}Te	^{120}Sb	300	10	^{127}I	^{121}I	1000	17
^{126}Te	^{120}Sb	480	9	^{127}I	^{121}I	2000	10
^{126}Te	^{120}Sb	660	9	^{127}I	^{121}I	4000	9
^{126}Te	^{119}Sb	120	6	^{127}I	^{120}I	100	9
^{126}Te	^{119}Sb	180	6	^{127}I	^{120}I	170	7
^{126}Te	^{119}Sb	300	7	^{127}I	^{120}I	250	30
^{126}Te	^{119}Sb	480	7	^{127}I	^{120}I	300	8
^{126}Te	^{119}Sb	660	6	^{127}I	^{120}I	500	10
^{128}Te	^{127}Te	300	47	^{127}I	^{120}I	700	8
^{128}Te	^{127}Sb	300	5.4	^{127}I	^{120}I	1000	11
^{130}Te	^{129}Te	300	53	^{127}I	^{120}I	2000	6
^{130}Te	^{129}Sb	300	5.8	^{127}I	^{120}I	4000	5
^{127}I	^{126}I	100	126	^{127}I	^{118}Te	250	64
^{127}I	^{126}I	170	64	^{127}I	^{118}Te	500	39
^{127}I	^{126}I	250	62	^{127}I	^{118}Te	1000	28
^{127}I	^{126}I	300	56	^{127}I	^{118}Te	2000	16
^{127}I	^{126}I	500	67	^{127}I	^{118}Te	4000	11
^{127}I	^{126}I	700	53	^{127}I	^{66}Ni	450	0.00025

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{127}I	^{65}Ni	450	0.00033
Xe	^{8}Li	340	2.6
^{133}Cs	^{132}Cs	60	257
^{133}Cs	^{132}Cs	80	212
^{133}Cs	^{132}Cs	100	220
^{133}Cs	^{132}Cs	150	132
^{133}Cs	^{131}Cs	60	163
^{133}Cs	^{131}Cs	80	153
^{133}Cs	^{131}Cs	100	173
^{133}Cs	^{131}Cs	150	70
Ba	^{134}Xe	730	2.1
Ba	^{132}(Xe + Cs)	730	24
Ba	^{131}(Xe + Cs + Ba)	730	56
Ba	^{130}(Xe + Cs)	730	31
Ba	^{129}(Xe + Cs + Ba)	730	48
Ba	^{128}(Xe + Cs + Ba)	730	49
Ba	^{127}(Xe + Cs + Ba)	730	43
Ba	^{126}(Xe + Cs + Ba)	730	43
Ba	^{124}(Xe + Cs)	730	31
^{139}La	^{125}(Xe + Cs + Ba)	590	43
^{139}La	^{122}(Xe + Cs)	590	42
^{139}La	^{121}(Xe + Cs)	590	21
^{139}La	^{120}Xe	590	8.5
^{139}La	^{133}I	590	0.01
^{139}La	^{132}I	590	0.06
^{139}La	^{131}I	590	0.15
^{139}La	^{130}I	590	0.33
^{139}La	^{128}I	590	1.3
^{139}La	^{126}I	590	5.1
^{139}La	^{125}I	590	6.7
^{139}La	^{124}I	590	9.3
^{139}La	^{123}I	590	12
^{139}La	^{121}I	590	18
^{139}La	^{120}I	590	15
^{139}La	^{119}I	590	13
^{139}La	^{118}I	590	6
^{139}La	^{122}Sb	10,000	0.18
^{139}La	^{117}Sb	10,000	2.2
^{139}La	^{115}(Sb + Te)	10,000	4.9
^{139}La	^{72}Se	660	0.05
^{139}La	^{73}Ga	660	0.015
^{139}La	^{72}Zn	660	0.04
^{139}La	^{66}Ni	660	0.01
^{139}La	^{65}(Ni + Co)	660	0.1
^{139}La	^{61}(Co + Fe)	660	0.06
^{139}La	^{55}Co	660	0.03
^{139}La	^{51}Cr	660	0.1
^{139}La	^{48}Cr	660	0.01
^{139}La	^{47}Ca	660	0.02
^{139}La	^{32}P	340	0.0073
^{139}La	^{32}P	480	0.014
^{139}La	^{32}P	660	0.004
^{139}La	^{24}Na	120	0.0010
^{139}La	^{24}Na	240	0.003
^{139}La	^{24}Na	340	0.005
^{139}La	^{24}Na	480	0.02
^{139}La	^{24}Na	660	0.21
^{139}La	^{17}N	1000	0.39
^{139}La	^{17}N	3000	2.1
^{139}La	^{16}C	1000	0.07
^{139}La	^{16}C	3000	0.50
^{139}La	^{9}Li	1000	0.65
^{139}La	^{9}Li	3000	2.6
^{142}Ce	^{141}Ce	60	114
^{142}Ce	^{141}Ce	120	98
^{142}Ce	^{141}Ce	240	70
^{142}Ce	^{141}Ce	350	82
^{142}Ce	^{141}Ce	450	70
^{142}Ce	^{141}Ce	700	52
^{142}Ce	^{141}Ce	1000	54
^{142}Ce	^{141}Ce	2000	65
^{142}Ce	^{141}Ce	3000	46
^{142}Ce	^{141}Ce	10,000	52
^{142}Ce	^{141}La	60	9.2
^{142}Ce	^{141}La	120	12
^{142}Ce	^{141}La	240	22
^{142}Ce	^{141}La	350	20
^{142}Ce	^{141}La	450	16
^{142}Ce	^{141}La	700	20
^{142}Ce	^{141}La	1000	24
^{142}Ce	^{141}La	2000	14.5
^{142}Ce	^{141}La	3000	19
^{142}Ce	^{141}La	10,000	19
^{141}Pr	^{67}Cu	450	0.0013
^{141}Pr	^{64}Cu	450	0.0041
^{141}Pr	^{66}Ni	450	0.00057
^{141}Pr	^{65}(Ni + Co)	450	0.0011
^{141}Pr	^{17}N	1000	0.29
^{141}Pr	^{17}N	2000	2.1
^{141}Pr	^{16}C	1000	0.069
^{141}Pr	^{16}C	2000	0.41
^{141}Pr	^{9}Li	1000	0.39
^{141}Pr	^{9}Li	2000	2.25
^{144}Nd	^{17}N	2000	2.2
^{144}Nd	^{16}C	2000	0.48
^{144}Nd	^{9}Li	2000	2.75
^{165}Ho	^{115}Cd	450	0.022
^{165}Ho	^{109}(Pd + Rh)	450	0.028
^{165}Ho	^{99}(Mo + Nb)	450	0.027
^{165}Ho	^{89}(Sr + Rb)	450	0.029
^{165}Ho	^{82}Sr	450	0.0034
^{165}Ho	^{86}Rb	450	0.023
^{165}Ho	^{83}(Br + Se)	450	0.013
^{165}Ho	^{82}Br	450	0.019
^{165}Ho	^{76}Br	450	0.0082
^{165}Ho	^{77}As	450	0.10
^{165}Ho	^{76}As	450	0.059
^{165}Ho	^{74}As	450	0.064

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{165}Ho	^{72}(As + Se)	450	0.047
^{165}Ho	^{67}Cu	450	0.027
^{165}Ho	^{64}Cu	450	0.087
^{165}Ho	^{61}Cu	450	0.044
^{165}Ho	^{66}Ni	450	0.012
^{165}Ho	^{65}(Ni + Co)	450	0.021
^{165}Ho	^{59}(Fe + Mn)	450	0.032
^{165}Ho	^{32}P	600	0.0084
^{165}Ho	^{32}P	910	0.045
^{165}Ho	^{32}P	1800	0.24
^{165}Ho	^{32}P	2700	0.455
^{181}Ta	^{179}Ta	⩾6000	36
^{181}Ta	^{178}Ta	48	180
^{181}Ta	^{178}Ta	340	175
^{181}Ta	^{177}Ta	48	280
^{181}Ta	^{177}Ta	84	220
^{181}Ta	^{177}Ta	340	31
^{181}Ta	^{177}Ta	⩾6000	12
^{181}Ta	^{175}Ta	84	290
^{181}Ta	^{174}Ta	84	300
^{181}Ta	^{173}Ta	84	160
^{181}Ta	^{180}Hf	48	0.04
^{181}Ta	^{178}Hf	56	40
^{181}Ta	^{175}Hf	48	10
^{181}Ta	^{175}Hf	84	2
^{181}Ta	^{175}Hf	340	52
^{181}Ta	^{175}Hf	⩾6000	13
^{181}Ta	^{173}Hf	84	24
^{181}Ta	^{173}Hf	340	150
^{181}Ta	^{173}Hf	⩾6000	11
^{181}Ta	^{172}Hf	84	22
^{181}Ta	^{171}Hf	84	21
^{181}Ta	^{171}Hf	340	77
^{181}Ta	^{171}Hf	⩾6000	11
^{181}Ta	^{176}Lu	48	0.1
^{181}Ta	^{172}Lu	84	3.7
^{181}Ta	^{172}Lu	600	9.6
^{181}Ta	^{172}Lu	⩾6000	12
^{181}Ta	^{171}Lu	600	48
^{181}Ta	^{171}Lu	⩾6000	23
^{181}Ta	^{169}(Lu + Hf)	600	52
^{181}Ta	^{169}(Lu + Hf)	⩾6000	39
^{181}Ta	^{169}Yb	340	37.5
^{181}Ta	^{169}Yb	600	11
^{181}Ta	^{169}Yb	≈10,000	13
^{181}Ta	^{166}(Yb + Lu)	340	87
^{181}Ta	^{166}(Yb + Lu)	600	44
^{181}Ta	^{166}(Yb + Lu)	≈10,000	29
^{181}Ta	^{168}Tm	600	1.4
^{181}Ta	^{168}Tm	≈10,000	1.5
^{181}Ta	^{167}(Tm + Yb + Lu)	340	58
^{181}Ta	^{167}(Tm + Yb + Lu)	600	56
^{181}Ta	^{167}(Tm + Yb + Lu)	≈10,000	19
^{181}Ta	^{166}Tm	600	6
^{181}Ta	^{166}Tm	≈10,000	3.4
^{181}Ta	^{165}(Tm + Yb + Lu)	340	56
^{181}Ta	^{165}(Tm + Yb + Lu)	600	54
^{181}Ta	^{165}(Tm + Yb + Lu)	≈10,000	23
^{181}Ta	^{160}(Er + Tm)	340	36
^{181}Ta	^{160}(Er + Tm)	600	42
^{181}Ta	^{160}(Er + Tm)	≈10,000	18
^{181}Ta	^{155}Tb	≈10,000	5
^{181}Ta	^{153}(Tb + Dy + Ho)	600	16
^{181}Ta	^{153}(Tb + Dy + Ho)	≈10,000	15
^{181}Ta	^{152}(Tb + Dy)	600	17
^{181}Ta	^{152}(Tb + Dy)	≈10,000	10
^{181}Ta	^{151}(Tb + Dy)	600	12
^{181}Ta	^{151}(Tb + Dy)	≈10,000	16
^{181}Ta	^{149}Tb	600	9.5
^{181}Ta	^{149}Tb	≈10,000	8
^{181}Ta	^{153}Gd	≈10,000	0.8
^{181}Ta	^{151}Gd	≈10,000	1.2
^{181}Ta	^{149}(Gd + Tb)	600	7.7
^{181}Ta	^{149}(Gd + Tb)	≈10,000	15
^{181}Ta	^{147}(Gd + Tb)	600	7.3
^{181}Ta	^{147}(Gd + Tb)	≈10,000	12
^{181}Ta	^{146}(Gd + Tb)	600	6.5
^{181}Ta	^{146}(Gd + Tb)	≈10,000	15
^{181}Ta	^{149}Eu	≈10,000	1
^{181}Ta	^{148}Eu	600	0.76
^{181}Ta	^{147}Eu	600	2.5
^{181}Ta	^{147}Eu	≈10,000	3
^{181}Ta	^{146}Eu	600	2
^{181}Ta	^{146}Eu	≈10,000	3.4
^{181}Ta	^{145}(Eu + Gd)	600	6.6
^{181}Ta	^{145}(Eu + Gd)	≈10,000	10
^{181}Ta	^{140}(Nd + Pm + Sm)	600	2.2
^{181}Ta	^{140}(Nd + Pm + Sm)	≈10,000	15
^{181}Ta	^{143}Ce	≈10,000	3
^{181}Ta	^{139}(Ce + Pr + Nd + Pm)	600	1.8
^{181}Ta	^{139}(Ce + Pr + Nd + Pm)	≈10,000	17
^{181}Ta	^{135}(Ce + Pr + Nd)	340	0.25
^{181}Ta	^{134}(Ce + Pr + Nd)	340	0.022
^{181}Ta	^{134}(Ce + Pr + Nd)	600	0.4
^{181}Ta	^{134}(Ce + Pr + Nd)	≈10,000	13
^{181}Ta	^{131}(Ba + La + Ce)	340	0.015
^{181}Ta	^{131}(Ba + La + Ce)	≈10,000	11
^{181}Ta	^{129}(Ba + La)	340	0.0029
^{181}Ta	^{129}(Ba + La)	≈10,000	9
^{181}Ta	^{128}(Ba + La)	340	0.0047
^{181}Ta	^{128}(Ba + La)	≈10,000	6
^{181}Ta	^{126}Ba	≈10,000	5
^{181}Ta	^{129}Cs	340	0.0025
^{181}Ta	^{127}(Cs + Ba)	340	0.0054
^{181}Ta	^{126}I	≈10,000	0.09
^{181}Ta	^{124}I	≈10,000	0.34
^{181}Ta	^{123}I	≈10,000	0.51

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{181}Ta	^{121}I	≈10,000	2.0
^{181}Ta	^{120}I	≈10,000	1.6
^{181}Ta	^{119}I	≈10,000	0.49
^{181}Ta	^{118}I	≈10,000	0.1
^{181}Ta	^{121}Te	6000	11
^{181}Ta	^{118}Te	6000	7.5
^{181}Ta	^{117}Te	340	0.0052
^{181}Ta	^{117}Sb	20,000	1.6
^{181}Ta	$^{115}(Sb + Te)$	20,000	6.0
^{181}Ta	$^{111}(In + Sn)$	340	0.015
^{181}Ta	^{109}In	340	0.0071
^{181}Ta	^{115}Cd	340	0.0049
^{181}Ta	^{115}Cd	450	0.0060
^{181}Ta	$^{109}(Cd + In)$	6000	6.6
^{181}Ta	$^{107}(Cd + In)$	340	0.014
^{181}Ta	$^{107}(Cd + In)$	6000	5.3
^{181}Ta	^{113}Ag	340	0.0033
^{181}Ta	^{113}Ag	450	0.0037
^{181}Ta	$^{111}(Ag + Pd)$	340	0.020
^{181}Ta	$^{111}(Ag + Pd)$	450	0.024
^{181}Ta	$^{105}(Ag + Cd)$	340	0.031
^{181}Ta	$^{105}(Ag + Cd)$	6000	5.4
^{181}Ta	$^{109}(Pd + Rh)$	340	0.0059
^{181}Ta	$^{109}(Pd + Rh)$	450	0.021
^{181}Ta	$^{103}(Pd + Ag)$	6000	5.6
^{181}Ta	^{101}Pd	6000	4.2
^{181}Ta	^{100}Pd	6000	1.8
^{181}Ta	$^{105}(Rh + Ru)$	340	0.025
^{181}Ta	^{101}Rh	340	0.0026
^{181}Ta	^{105}Ru	340	0.0037
^{181}Ta	$^{103}(Ru + Tc)$	340	0.032
^{181}Ta	^{97}Ru	340	0.0017
^{181}Ta	$^{99}(Mo + Nb)$	340	0.053
^{181}Ta	$^{99}(Mo + Nb)$	450	0.056
^{181}Ta	$^{99}(Mo + Nb)$	6000	0.09
^{181}Ta	^{90}Mo	6000	1.25
^{181}Ta	^{97}Zr	340	0.0048
^{181}Ta	^{95}Zr	340	0.031
^{181}Ta	$^{89}(Zr + Nb)$	6000	6
^{181}Ta	^{88}Zr	6000	6
^{181}Ta	^{91}Sr	340	0.018
^{181}Ta	$^{89}(Sr + Rb)$	340	0.041
^{181}Ta	$^{89}(Sr + Rb)$	450	0.087
^{181}Ta	^{82}Sr	6000	2.65
^{181}Ta	^{87}Rb	20,000	0.26
^{181}Ta	^{86}Rb	340	0.054
^{181}Ta	^{86}Rb	450	0.076
^{181}Ta	^{86}Rb	20,000	0.7
^{181}Ta	^{85}Rb	20,000	1.0
^{181}Ta	^{84}Rb	340	0.089
^{181}Ta	^{84}Rb	20,000	3.2
^{181}Ta	^{83}Rb	20,000	4.9
^{181}Ta	^{82}Rb	20,000	6.3
^{181}Ta	^{81}Rb	20,000	6.7
^{181}Ta	^{80}Rb	20,000	4.2
^{181}Ta	^{79}Rb	20,000	1.7
^{181}Ta	^{78}Rb	20,000	0.4
^{181}Ta	^{77}Rb	20,000	0.05
^{181}Ta	^{83}Br	340	0.058
^{181}Ta	^{82}Br	340	0.092
^{181}Ta	^{72}Se	6000	0.61
^{181}Ta	$^{77}(As + Ge)$	340	0.035
^{181}Ta	$^{77}(As + Ge)$	450	0.062
^{181}Ta	^{76}As	340	0.064
^{181}Ta	^{76}As	450	0.056
^{181}Ta	^{74}As	340	0.024
^{181}Ta	^{74}As	450	0.055
^{181}Ta	^{72}As	450	0.044
^{181}Ta	^{73}Ga	340	0.051
^{181}Ta	^{72}Ga	340	0.074
^{181}Ta	^{62}Zn	6000	0.013
^{181}Ta	$^{67}(Cu + Ni)$	340	0.062
^{181}Ta	$^{67}(Cu + Ni)$	450	0.11
^{181}Ta	$^{67}(Cu + Ni)$	6000	0.53
^{181}Ta	^{64}Cu	340	0.075
^{181}Ta	^{64}Cu	450	0.11
^{181}Ta	^{64}Cu	6000	3.0
^{181}Ta	^{61}Cu	450	0.0047
^{181}Ta	^{61}Cu	6000	0.8
^{181}Ta	^{66}Ni	340	0.017
^{181}Ta	^{66}Ni	450	0.048
^{181}Ta	^{66}Ni	6000	0.10
^{181}Ta	$^{65}(Ni + Co)$	340	0.044
^{181}Ta	$^{65}(Ni + Co)$	450	0.088
^{181}Ta	$^{65}(Ni + Co)$	6000	0.33
^{181}Ta	$^{63}Co + {}^{61}(Co + Fe)$	6000	0.56
^{181}Ta	$^{61}(Co + Fe)$	340	0.062
^{181}Ta	$^{58}Co + {}^{56}Co$	6000	1.15
^{181}Ta	^{55}Co	6000	0.025
^{181}Ta	$^{59}(Fe + Mn)$	340	0.058
^{181}Ta	$^{59}(Fe + Mn)$	450	0.062
^{181}Ta	$^{56}(Mn + Cr)$	340	0.038
^{181}Ta	$^{56}(Mn + Cr)$	6000	1.65
^{181}Ta	^{54}Mn	6000	5.2
^{181}Ta	^{52}Mn	340	0.0021
^{181}Ta	^{47}Ca	6000	0.25
^{181}Ta	$^{45}(Ca + K)$	6000	1.25
^{181}Ta	^{43}K	340	0.020
^{181}Ta	^{42}K	340	0.0076
^{181}Ta	^{33}P	6000	2.9
^{181}Ta	^{32}P	6000	3.65
^{181}Ta	^{28}Mg	340	0.0040
^{181}Ta	^{28}Mg	6000	2.1
^{181}Ta	^{28}Na	20,000	0.07
^{181}Ta	^{27}Na	20,000	0.4
^{181}Ta	^{26}Na	20,000	1.1
^{181}Ta	^{25}Na	20,000	5.4
^{181}Ta	^{24}Na	340	0.007

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{181}Ta	^{24}Na	1000	0.2
^{181}Ta	^{24}Na	2000	0.75
^{181}Ta	^{24}Na	3000	2.1
^{181}Ta	^{24}Na	6000	7
^{181}Ta	^{24}Na	20,000	7
^{181}Ta	^{23}Na	20,000	11
^{181}Ta	^{22}Na	3000	0.3
^{181}Ta	^{22}Na	20,000	1.5
^{181}Ta	^{21}Na	20,000	0.125
^{181}Ta	^{17}N	1000	0.37
^{181}Ta	^{16}C	1000	0.10
^{181}Ta	^{7}Be	340	0.042
^{181}Ta	^{7}Be	3000	7.2
^{181}Ta	^{7}Be	20,000	20
^{181}Ta	^{9}Li	1000	0.59
^{186}W	^{185}W	300	70
^{186}W	^{185}W	400	69
^{186}W	^{185}Ta	130	3
^{186}W	^{185}Ta	210	5.6
^{186}W	^{185}Ta	300	5.5
^{186}W	^{185}Ta	400	7
^{186}W	^{184}Hf	130	0.2
^{186}W	^{184}Hf	210	0.14
^{186}W	^{184}Hf	300	0.3
^{186}W	^{184}Hf	400	0.3
^{186}W	^{17}N	1000	0.39
^{186}W	^{17}N	3000	3.4
^{186}W	^{16}C	1000	0.105
^{186}W	^{16}C	3000	0.89
^{186}W	^{9}Li	1000	0.82
^{186}W	^{9}Li	3000	3.9
^{187}Re	^{186}Re	300	68
^{187}Re	^{186}Re	400	67
^{187}Re	^{185}Ta	130	0.04
^{187}Re	^{185}Ta	210	0.07
^{187}Re	^{185}Ta	300	0.08
^{187}Re	^{185}Ta	400	0.11
^{187}Re	^{184}Hf	130	0.005
^{187}Re	^{184}Hf	210	0.003
^{187}Re	^{184}Hf	400	0.005
^{187}Re	^{115}Cd	450	0.016
^{187}Re	^{113}Ag	450	0.011
^{187}Re	^{112}Ag	450	0.022
^{187}Re	$^{111}(Ag + Pd)$	450	0.054
^{187}Re	$^{109}(Pd + Rh)$	450	0.061
^{187}Re	$^{99}(Mo + Rb)$	450	0.14
^{187}Re	$^{89}(Sr + Rb)$	450	0.22
^{187}Re	^{82}Sr	450	0.029
^{187}Re	^{86}Rb	450	0.37
^{187}Re	^{83}Br	450	0.15
^{187}Re	^{82}Br	450	0.21
^{187}Re	$^{77}(As + Ge)$	450	0.46
^{187}Re	^{76}As	450	0.38
^{187}Re	^{74}As	450	0.34
^{187}Re	^{72}As	450	0.20
^{187}Re	$^{67}(Cu + Ni)$	450	0.18
^{187}Re	^{64}Cu	450	0.15
^{187}Re	^{61}Cu	450	0.013
^{187}Re	^{66}Ni	450	0.081
^{187}Re	$^{65}(Ni + Co)$	450	0.14
^{187}Re	$^{59}(Fe + Mn)$	450	0.082
^{187}Re	^{32}P	600	0.027
^{193}Ir	^{192}Ir	47	160
^{193}Ir	^{192}Ir	84	120
^{197}Au	^{196}Au	50	180
^{197}Au	^{196}Au	86	155
^{197}Au	^{196}Au	100	127
^{197}Au	^{196}Au	150	76
^{197}Au	^{196}Au	200	74
^{197}Au	^{196}Au	450	70
^{197}Au	^{195}Au	50	146
^{197}Au	^{195}Au	86	120
^{197}Au	^{194}Au	50	125
^{197}Au	^{194}Au	86	137
^{197}Au	^{194}Pt	56	45
^{197}Au	^{192}Ir	50	0.05
^{197}Au	^{192}Ir	100	0.35
^{197}Au	$^{155}(Dy + Ho)$	⩾6000	12
^{197}Au	$^{153}(Dy + Ho)$	⩾6000	9
^{197}Au	$^{152}(Dy + Ho)$	⩾6000	6.4
^{197}Au	^{155}Tb	⩾6000	0.4
^{197}Au	^{153}Tb	⩾6000	3
^{197}Au	$^{153}(Tb + Dy + Ho)$	⩾6000	12
^{197}Au	^{152}Tb	⩾6000	2.3
^{197}Au	$^{151}(Tb + Dy)$	⩾6000	3.4
^{197}Au	^{149}Tb	700	1
^{197}Au	^{149}Tb	1000	6
^{197}Au	^{149}Tb	2000	11
^{197}Au	^{149}Tb	3000	9
^{197}Au	^{149}Tb	⩾6000	7
^{197}Au	^{149}Gd	⩾6000	1.8
^{197}Au	$^{148}(Gd + Tb)$	3000	5.3
^{197}Au	$^{147}(Gd + Tb)$	⩾6000	8.2
^{197}Au	^{146}Gd	⩾6000	7.4
^{197}Au	^{148}Eu	⩾6000	1.2
^{197}Au	^{147}Eu	⩾6000	2.6
^{197}Au	$^{147}(Eu + Gd + Tb)$	⩾6000	10.9
^{197}Au	^{146}Eu	⩾6000	1.7
^{197}Au	$^{146}(Eu + Gd)$	⩾6000	9.1
^{197}Au	$^{145}(Eu + Gd)$	⩾6000	6.6
^{197}Au	$^{140}(Nd + Pm)$	⩾6000	13
^{197}Au	$^{139}(Nd + Pm)$	⩾6000	7
^{197}Au	^{139}Pr	⩾6000	1.5
^{197}Au	^{139}Ce	⩾6000	1.3
^{197}Au	$^{139}(Ce+Pr+Nd+Pm)$	⩾6000	10
^{197}Au	$^{134}(Ce + Pr)$	⩾6000	12
^{197}Au	$^{131}(Ba + La + Ce)$	3000	5.3
^{197}Au	$^{129}(Ba + La)$	3000	4.4

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{197}Au	^{127}Cs	3000	4.3
^{197}Au	^{124}I	⩾6000	0.23
^{197}Au	^{123}I	⩾6000	0.56
^{197}Au	^{121}I	⩾6000	2.4
^{197}Au	^{120}I	⩾6000	1.9
^{197}Au	^{119}I	⩾6000	0.7
^{197}Au	^{118}I	⩾6000	0.1
^{197}Au	^{117}Sb	⩾6000	3.2
^{197}Au	^{115}(Sb + Te)	⩾6000	5.7
^{197}Au	^{115}(Cd + Ag)	450	0.15
^{197}Au	^{113}Ag	450	0.091
^{197}Au	^{112}Ag	450	0.21
^{197}Au	^{111}(Ag + Pd)	450	0.52
^{197}Au	^{109}(Pd + Rh)	450	0.34
^{197}Au	^{99}(Mo + Nb)	450	0.98
^{197}Au	^{90}(Sr + Rb)	450	0.73
^{197}Au	^{89}(Sr + Rb)	450	1.2
^{197}Au	^{82}Sr	450	0.068
^{197}Au	^{86}Rb	450	0.89
^{197}Au	^{84}Rb	3000	1.2
^{197}Au	^{83}Br	450	0.74
^{197}Au	^{82}Br	450	0.78
^{197}Au	^{72}Se	3000	0.37
^{197}Au	^{77}(As + Ge)	450	1.6
^{197}Au	^{76}As	450	1.4
^{197}Au	^{74}As	450	1.2
^{197}Au	^{74}As	3000	1.8
^{197}Au	^{72}As	450	0.35
^{197}Au	^{72}As	3000	1.8
^{197}Au	^{71}As	3000	0.9
^{197}Au	^{77}Ge	3000	0.075
^{197}Au	^{66}Ge	3000	0.015
^{197}Au	^{73}Ga	3000	0.19
^{197}Au	^{72}Ga	3000	0.57
^{197}Au	^{67}(Ga + Ge)	3000	0.88
^{197}Au	^{66}Ga	3000	0.49
^{197}Au	^{72}Zn	3000	0.066
^{197}Au	^{67}(Cu + Ni)	450	0.44
^{197}Au	^{67}(Cu + Ni)	3000	0.67
^{197}Au	^{64}Cu	450	0.28
^{197}Au	^{66}Ni	450	0.21
^{197}Au	^{66}Ni	3000	0.18
^{197}Au	^{65}(Ni + Co)	450	0.32
^{197}Au	^{65}(Ni + Co)	3000	0.53
^{197}Au	^{59}(Fe + Mn)	450	0.16
^{197}Au	^{32}P	340	0.003
^{197}Au	^{32}P	450	0.011
^{197}Au	^{32}P	660	0.027
^{197}Au	^{32}P	2000	0.9
^{197}Au	^{32}P	3000	1.7
^{197}Au	^{28}Mg	700	0.054
^{197}Au	^{24}Na	340	0.0013
^{197}Au	^{24}Na	480	0.037
^{197}Au	^{24}Na	700	0.13
^{197}Au	^{24}Na	1000	0.43
^{197}Au	^{24}Na	2000	2.0
^{197}Au	^{24}Na	3000	4.2
^{197}Au	^{24}Na	13,000	9
^{197}Au	^{22}Na	13,000	1.8
^{197}Au	^{24}Ne	1000	0.10
^{197}Au	^{24}Ne	2000	0.42
^{197}Au	^{24}Ne	3000	0.9
^{197}Au	^{18}F	420	0.0044
^{197}Au	^{18}F	1000	0.07
^{197}Au	^{18}F	2000	0.22
^{197}Au	^{18}F	3000	0.62
^{197}Au	^{18}F	13,000	2.1
^{197}Au	^{7}Be	150	0.033
^{197}Au	^{7}Be	660	0.4
^{197}Au	^{7}Be	1000	1.3
^{197}Au	^{7}Be	1900	5.3
^{197}Au	^{7}Be	3000	7.1
^{197}Au	^{7}Be	13,000	21.6
^{197}Au	^{8}Li	2000	7
^{197}Au	^{131}(Xe+Cs+Ba+La+Ce)	3000	9.9
^{197}Au	^{131}(Xe+Cs+Ba+La+Ce)	29,000	8.2
^{197}Au	^{130}(Xe + Cs)	3000	0.15
^{197}Au	^{130}(Xe + Cs)	29,000	0.1
^{197}Au	^{129}(Xe + Cs + Ba + La)	3000	9.9
^{197}Au	^{129}(Xe + Cs + Ba + La)	29,000	8.2
^{197}Au	^{128}(Xe + Cs + Ba)	3000	9.6
^{197}Au	^{128}(Xe + Cs + Ba)	29,000	8.0
^{197}Au	^{127}(Xe + Cs + Ba)	3000	9.6
^{197}Au	^{127}(Xe + Cs + Ba)	29,000	7.9
^{197}Au	^{126}(Xe + Cs + Ba)	3000	9.2
^{197}Au	^{126}(Xe + Ca + Ba)	29,000	8.2
^{197}Au	^{125}(Xe + Cs)	29,000	7.7
^{197}Au	^{124}(Xe + Cs)	3000	8.4
^{197}Au	^{124}(Xe + Cs)	29,000	7.9
^{197}Au	^{122}(Xe + Cs)	29,000	7.6
^{197}Au	^{86}Kr	3000	0.23
^{197}Au	^{86}Kr	29,000	0.1
^{197}Au	^{85}Kr	3000	0.34
^{197}Au	^{85}Kr	29,000	0.26
^{197}Au	^{84}(Br + Kr + Rb)	3000	2.4
^{197}Au	^{84}(Br + Kr + Rb)	29,000	2.7
^{197}Au	^{83}(Br+Kr+Rb+Sr+Y)	3000	5.9
^{197}Au	^{83}(Br+Kr+Rb+Sr+Y)	29,000	7.3
^{197}Au	^{82}(Br+Kr+Rb+Sr+Y)	3000	5.4
^{197}Au	^{82}(Br+Kr+Rb+Sr+Y)	29,000	7.1
^{197}Au	^{81}(Kr + Rb + Sr)	3000	4.4
^{197}Au	^{81}(Kr + Rb + Sr)	29,000	6.4
^{197}Au	^{80}(Kr + Rb)	3000	4.8
^{197}Au	^{80}(Kr + Rb)	29,000	6.8
^{197}Au	^{79}(Kr + Rb)	29,000	4.2
^{197}Au	^{78}Kr	3000	1.6
^{197}Au	^{78}Kr	29,000	2.8
^{197}Au	^{42}Ar	3000	0.4

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{197}Au	^{42}Ar	29,000	0.8
^{197}Au	^{39}(Cl + Ar)	3000	3.5
^{197}Au	^{39}(Cl + Ar)	29,000	7.8
^{197}Au	^{38}(Cl + Ar + K)	3000	4.7
^{197}Au	^{38}(Cl + Ar + K)	29,000	9.4
^{197}Au	^{37}Ar	3000	0.5
^{197}Au	^{37}Ar	29,000	1.6
^{197}Au	^{36}Ar	3000	0.1
^{197}Au	^{36}Ar	29,000	0.28
^{197}Au	^{22}Ne	3000	12.5
^{197}Au	^{22}Ne	29,000	24
^{197}Au	^{21}(Ne + Na + F)	3000	10.3
^{197}Au	^{21}(Ne + Na + F)	29,000	26
^{197}Au	^{20}(F + Ne)	3000	10.7
^{197}Au	^{20}(F + Ne)	29,000	26
Pb	^{131}(Ba + La + Ce + Pr)	600	0.11
Pb	^{131}(Ba + La + Ce + Pr)	1000	0.96
Pb	^{131}(Ba + La + Ce + Pr)	1600	2.9
Pb	^{131}(Ba + La + Ce + Pr)	2000	6.6
Pb	^{131}(Ba + La + Ce + Pr)	3000	8.4
Pb	^{129}(Ba + La + Ce + Pr)	600	0.06
Pb	^{129}(Ba + La + Ce + Pr)	1000	0.32
Pb	^{129}(Ba + La + Ce + Pr)	1600	2.9
Pb	^{129}(Ba + La + Ce + Pr)	2000	6.2
Pb	^{129}(Ba + La + Ce + Pr)	3000	6.5
Pb	^{128}(Ba + La + Ce + Pr)	600	0.20
Pb	^{128}(Ba + La + Ce + Pr)	1000	0.46
Pb	^{128}(Ba + La + Ce + Pr)	1600	2.3
Pb	^{128}(Ba + La + Ce + Pr)	2000	5.8
Pb	^{128}(Ba + La + Ce + Pr)	3000	6.5
^{208}Pb	^{113}(Sn + Sb)	10,000	6.0
^{208}Pb	^{111}Sn	10,000	4.1
Pb	^{111}(In + Sn + Sb + Te)	450	0.45
Pb	^{111}(In + Sn + Sb + Te)	3000	3.4
^{208}Pb	^{111}(In + Sn + Sb + Te)	10,000	6.7
Pb	^{111}(In + Sn + Sb + Te)	28,000	3.9
Pb			
Pb	^{109}(In + Sn + Sb)	3000	2.3
^{208}Pb	^{109}(In + Sn + Sb)	10,000	6.1
Pb	^{109}(In + Sn + Sb)	28,000	3.5
Pb			
Pb	^{115}(Cd + Ag)	600	0.87
Pb	^{115}(Cd + Ag)	1000	0.75
Pb	^{115}(Cd + Ag)	1600	0.55
Pb	^{115}(Cd + Ag)	2000	0.53
Pb	^{115}(Cd + Ag)	3000	0.38
Pb	^{115}(Cd + Ag)	28,000	0.39
Pb			
Pb	^{109}Cd	3000	1.5
Pb	^{109}Cd	28,000	1.6
Pb			
Pb	^{107}(Cd + In + Sn)	600	0.13
Pb	^{107}(Cd + In + Sn)	1000	0.5
Pb	^{107}(Cd + In + Sn)	1600	0.59
Pb	^{107}(Ce + In + Sn)	2000	0.88
Pb	^{107}(Cd + In + Sn)	3000	0.9
^{208}Pb	^{113}Ag	450	1.3
^{208}Pb	^{113}Ag	10,000	0.4
^{208}Pb	^{112}Ag	450	2.1
^{208}Pb	^{112}Ag	10,000	0.6
^{208}Pb	^{111}(Ag + Pd)	450	3.3
^{208}Pb	^{111}(Ag + Pd)	10,000	0.9
^{208}Pb	^{105}(Ag + Cd)	10,000	6.1
^{208}Pb	^{103}Ag	10,000	2.7
^{208}Pb	^{112}Pd	450	0.3
^{208}Pb	^{112}Pd	10,000	0.09
^{208}Pb	^{111}Pd	450	0.6
^{208}Pb	^{109}(Pd + Rh)	450	2.2
Pb	^{109}(Pd + Rh)	3000	0.71
^{208}Pb	^{109}(Pd + Rh)	10,000	0.73
Pb	^{109}(Pd + Rh)	28,000	0.70
^{208}Pb	^{103}(Pd + Ag + Cd)	450	0.35
Pb	^{103}(Pd + Ag + Cd)	3000	2.2
^{208}Pb	^{103}(Pd + Ag + Cd)	10,000	4.6
Pb	^{103}(Pd + Ag + Cd)	28,000	3.5
Pb	^{101}(Pd + Ag + Cd)	3000	1.6
^{208}Pb	^{101}(Pd + Ag + Cd)	10,000	2.5
Pb	^{101}(Pd + Ag + Cd)	28,000	3.1
Pb	^{100}(Pd + Ag)	3000	1.0
^{208}Pb	^{100}(Pd + Ag)	10,000	1.0
Pb	^{100}(Pd + Ag)	28,000	1.9
Pb	^{99}(Mo + Nb)	600	3.5
Pb	^{99}(Mo + Nb)	1000	2.6
Pb	^{99}(Mo + Nb)	1600	2.1
Pb	^{99}(Mo + Nb)	2000	1.75
Pb	^{99}(Mo + Nb)	3000	1.2
Pb	^{73}Ga	400	1.2
Pb	^{73}Ga	600	1.3
Pb	^{73}Ga	1000	0.57
Pb	^{73}Ga	1600	0.95
Pb	^{73}Ga	2000	0.87
Pb	^{72}Ga	400	0.56
Pb	^{72}Ga	600	1.06
Pb	^{72}Ga	1000	0.68
Pb	^{72}Ga	1600	1.23
Pb	^{72}Ga	2000	0.94
Pb	^{67}(Ga + Ge)	400	0.013
Pb	^{67}(Ga + Ge)	600	0.43
Pb	^{67}(Ga + Ge)	1000	0.24
Pb	^{67}(Ga + Ge)	1600	0.64
Pb	^{67}(Ga + Ge)	2000	1.2
Pb	^{72}Zn	600	0.39
Pb	^{72}Zn	1000	0.37
Pb	^{72}Zn	1600	0.40

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
Pb	^{72}Zn	2000	0.30
Pb	^{72}Zn	3000	0.38
Pb	^{67}(Cu + Ni)	600	0.58
Pb	^{67}(Cu + Ni)	1000	0.74
Pb	^{67}(Cu + Ni)	1600	0.77
Pb	^{67}(Cu + Ni)	2000	0.69
Pb	^{67}(Cu + Ni)	3000	0.62
Pb	^{64}Cu	600	0.47
Pb	^{64}Cu	1000	0.71
Pb	^{64}Cu	1600	1.02
Pb	^{64}Cu	2000	1.2
Pb	^{64}Cu	3000	1.4
Pb	^{61}Cu	600	0.07
Pb	^{61}Cu	1000	0.08
Pb	^{61}Cu	1600	0.11
Pb	^{61}Cu	2000	0.23
Pb	^{61}Cu	3000	0.22
Pb	^{59}(Fe + Mn)	1000	0.5
Pb	^{59}(Fe + Mn)	1600	0.74
Pb	^{59}(Fe + Mn)	2000	0.87
Pb	^{59}(Fe + Mn)	3000	0.76
Pb	^{56}(Mn + Cr)	1000	1.3
Pb	^{56}(Mn + Cr)	1600	1.45
Pb	^{56}(Mn + Cr)	2000	1.2
Pb	^{56}(Mn + Cr)	3000	1.4
Pb	^{48}Sc	3000	0.9
Pb	^{47}Sc	3000	1.4
Pb	^{46}Sc	3000	1.9
Pb	^{43}Sc + ^{44}Sc	3000	1.9
Pb	^{47}Ca	1600	0.09
Pb	^{47}Ca	3000	0.29
Pb	^{45}(Ca + K)	3000	1.2
Pb	^{43}K	3000	1.7
Pb	^{42}K	3000	1.6
Pb	^{39}Cl	3000	0.71
Pb	^{38}(Cl + S)	3000	1.1
Pb	^{32}(P + Si)	1000	0.09
Pb	^{32}(P + Si)	1600	0.37
Pb	^{32}(P + Si)	2000	0.9
Pb	^{32}(P + Si)	3000	0.71
Pb	^{28}Mg	600	0.024
Pb	^{28}Mg	1000	0.075
Pb	^{28}Mg	1600	0.31
Pb	^{28}Mg	2000	0.52
Pb	^{28}Mg	3000	0.64
Pb	^{24}Mg	400	0.03
Pb	^{24}Na	1000	0.36
Pb	^{24}Na	1600	1.6
Pb	^{24}Na	2000	2.3
Pb	^{24}Na	3000	3.5
Pb	^{24}Na	4500	6.1
Pb	^{24}Na	15,000-20,000	11
Pb	^{22}Na	2000	1.6
Pb	^{21}Ne	600	0.1
Pb	^{18}F	600	0.005
Pb	^{18}F	1000	0.039
Pb	^{18}F	1600	0.20
Pb	^{18}F	2000	0.43
Pb	^{18}F	3000	0.61
Pb	^{18}F	4500	0.94
Pb	^{18}F	6000	1.2
Pb	^{17}N	3000	4.2
Pb	^{16}C	3000	1.16
Pb	^{7}Be	3000	6.2
Pb	^{7}Be	15,000-20,000	22
Pb	^{9}Li	3000	6.0
Pb	^{6}He	1000	10
Pb	^{6}He	1900	19
Pb	^{6}He	3000	26
^{209}Bi	^{207}Bi	50	196
^{209}Bi	^{207}Bi	380	55
	^{207}Bi	450	65
^{209}Bi	^{206}Bi	50	148
^{209}Bi	^{206}Bi	75	130
^{209}Bi	^{206}Bi	150	83
^{209}Bi	^{206}Bi	380	49.3
^{209}Bi	^{206}Bi	450	54
^{209}Bi	^{205}Bi	50	130
^{209}Bi	^{205}Bi	75	175
^{209}Bi	^{205}Bi	150	81
^{209}Bi	^{205}Bi	380	50
		450	50
^{209}Bi	^{204}Bi	75	138
^{209}Bi	^{204}Bi	380	37
^{209}Bi	^{203}Bi	75	76
^{209}Bi	^{203}Bi	110	116
^{209}Bi	^{203}Bi	150	75
^{209}Bi	^{203}Bi	380	47.6
^{209}Bi	^{202}Bi	120	95
^{209}Bi	^{202}Bi	150	71
^{209}Bi	^{202}Bi	380	56
^{209}Bi	^{201}Bi	120	63
^{209}Bi	^{201}Bi	150	57
^{209}Bi	^{201}Bi	380	50
^{209}Bi	^{200}Bi	120	25
^{209}Bi	^{200}Bi	150	44
^{209}Bi	^{200}Bi	380	64
^{209}Bi	^{199}Bi	120	13

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{209}Bi	^{199}Bi	150	42
^{209}Bi	^{199}Bi	380	69
^{209}Bi	^{199}Bi	380	60
^{209}Bi	^{206}Pb	56	27
^{209}Bi	^{203}Pb	380	14
^{209}Bi	^{203}(Pb + Bi)	2200	27
^{209}Bi	^{201}Pb	380	24.5
^{209}Bi	^{200}Pb	380	7.5
^{209}Bi	^{199}Pb	380	14
^{209}Bi	^{198}Pb	380	27
^{209}Bi	^{197}Pb	380	12.5
^{209}Bi	^{202}Tl	380	4.4
^{209}Bi	^{202}Tl	2200	3
^{209}Bi	^{201}Tl	380	15
^{209}Bi	^{201}(Tl + Pb + Bi)	2200	21
^{209}Bi	^{200}Ti	380	13.5
^{209}Bi	^{200}(Tl + some Pb)	2200	13
^{209}Bi	^{199}Tl	380	2.5
^{209}Bi	^{199}(Tl + Pb + Bi)	2200	28
^{209}Bi	^{198}Tl	380	26
^{209}Bi	^{198}(Tl + some Pb and Bi)	2200	16
^{209}Bi	^{197}Tl	380	≈0
^{209}Bi	^{196}(Tl + Pb)	380	62.5
^{209}Bi	^{195}Tl	380	62
^{209}Bi	^{197}Hg	380	4.6
^{209}Bi	^{195m}Hg	380	3.9
^{209}Bi	^{193}Hg	380	7
^{209}Bi	^{192}(Hg + Tl)	380	22
^{209}Bi	^{191}Hg	380	22
^{209}Bi	^{190}Hg	380	40
^{209}Bi	^{189}Hg	380	1
^{209}Bi	^{196}Au	380	0.46
^{209}Bi	^{195}Au	380	~0
^{209}Bi	^{194}Au	380	1.3
^{209}Bi	^{193}Au	380	0.6
^{209}Bi	^{192}Au	380	14
^{209}Bi	^{191}Au	380	17
^{209}Bi	^{189}Au	380	8
^{209}Bi	^{189}Pt	380	17
^{209}Bi	^{188}(Pt + Au)	380	21
^{209}Bi	^{186}Pt	380	28
^{209}Bi	^{153}(Dy + Ho)	⩾6000	12
^{209}Bi	^{156}Tb	⩾6000	0.4
^{209}Bi	^{155}Tb	⩾6000	0.6
^{209}Bi	^{153}Tb	⩾6000	2.1
^{209}Bi	^{153}(Tb + Dy + Ho)	⩾6000	14
^{209}Bi	^{152}Tb	⩾6000	2.1
^{209}Bi	^{151}(Tb + Dy)	⩾6000	2.3
^{209}Bi	^{149}Tb	1000	2.2
^{209}Bi	^{149}Tb	2000	10
^{209}Bi	^{149}Tb	4000	9
^{209}Bi	^{149}Tb	⩾6000	8.4
^{209}Bi	^{149}Gd	⩾6000	1.0
^{209}Bi	^{147}(Gd + Tb)	⩾6000	8.5
^{209}Bi	^{146}Gd	⩾6000	6.1
^{209}Bi	^{148}Eu	⩾6000	0.46
^{209}Bi	^{147}Eu	⩾6000	1.1
^{209}Bi	^{147}(Eu + Gd + Tb)	⩾6000	9.6
^{209}Bi	^{146}Eu	⩾6000	2.2
^{209}Bi	^{146}(Eu + Gd)	⩾6000	8.3
^{209}Bi	^{134}(Ce + Pr)	⩾6000	9.9
^{209}Bi	^{131}(Ba + La + Ce)	2000	6
^{209}Bi	^{129}(Ba + La)	2000	2
^{209}Bi	^{128}(Ba + La)	2000	5
^{209}Bi	^{131}(Cs + Ba, La, Ce, Pr)	75	0.002
^{209}Bi	^{131}(Cs + Ba, La, Ce, Pr)	190	0.003
^{209}Bi	^{131}(Cs + Ba, La, Ce, Pr)	300	0.012
^{209}Bi	^{131}(Cs + Ba, La, Ce, Pr)	450	0.004
^{209}Bi	^{129}(Cs + Ba, La, Ce)	75	0.0003
^{209}Bi	^{129}(Cs + Ba, La, Ce)	450	0.030
^{209}Bi	^{132}I	75	0.0006
^{209}Bi	^{132}I	120	0.0008
^{209}Bi	^{132}I	190	0.007
^{209}Bi	^{132}I	240	0.007
^{209}Bi	^{132}I	300	0.011
^{209}Bi	^{132}I	375	0.012
^{209}Bi	^{132}I	450	0.008
^{209}Bi	^{130}I	75	0.0008
^{209}Bi	^{130}I	120	0.0017
^{209}Bi	^{130}I	190	0.009
^{209}Bi	^{130}I	240	0.008
^{209}Bi	^{130}I	300	0.012
^{209}Bi	^{130}I	375	0.014
^{209}Bi	^{130}I	450	0.009
^{209}Bi	^{128}I	75	0.0012

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{209}Bi	^{128}I	120	0.0025	^{209}Bi	^{103}(Pd + Ag + Cd)	450	0.005
^{209}Bi	^{128}I	190	0.020	^{209}Bi	^{100}(Pd + Ag)	190	0.016
^{209}Bi	^{128}I	240	0.017	^{209}Bi	^{100}(Pd + Ag)	450	0.005
^{209}Bi	^{128}I	300	0.022	^{209}Bi	^{106}(Ru + Tc)	450	1.6
^{209}Bi	^{128}I	375	0.024	^{209}Bi	^{103}(Ru + Tc)	450	3.9
^{209}Bi	^{128}I	450	0.018	^{209}Bi	^{99}(Mo + Nb)	450	5.8
^{209}Bi	^{126}I	75	0.0012	^{209}Bi	^{99}(Mo + Nb)	660	5.4
^{209}Bi	^{126}I	120	0.0027	^{209}Bi	^{96}Nb	75	0.026
^{209}Bi	^{126}I	190	0.032	^{209}Bi	^{96}Nb	120	0.70
^{209}Bi	^{126}I	240	0.037	^{209}Bi	^{96}Nb	240	3.4
^{209}Bi	^{126}I	300	0.041	^{209}Bi	^{96}Nb	300	5.1
^{209}Bi	^{126}I	375	0.050	^{209}Bi	^{96}Nb	375	4.1
^{209}Bi	^{126}I	450	0.035	^{209}Bi	^{96}Nb	450	4.6
^{209}Bi	^{124}I	75	0.0003	^{209}Bi	^{95}Nb	75	0.017
^{209}Bi	^{124}I	120	0.0015	^{209}Bi	^{95}Nb	120	0.14
^{209}Bi	^{124}I	190	0.010	^{209}Bi	^{95}Nb	240	1.1
^{209}Bi	^{124}I	240	0.018	^{209}Bi	^{95}Nb	300	1.1
^{209}Bi	^{124}I	300	0.032	^{209}Bi	^{95}Nb	375	2.7
^{209}Bi	^{124}I	375	0.031	^{209}Bi	^{95}Nb	450	1.4
^{209}Bi	^{124}I	450	0.027	^{209}Bi	^{97}(Zr + Y)	450	0.5
^{209}Bi	^{121}(Te + I + Xe)	450	7.7	^{209}Bi	^{95}(Zr + Y)	450	1.8
^{209}Bi	^{118}Te	450	2.1	^{209}Bi	^{90}(Sr + Rb)	450	3.8
^{209}Bi	^{113}(Sn + Sb + Te)	450	2.7	^{209}Bi	^{89}(Sr + Rb)	450	5.4
^{209}Bi	^{111}(In + Sn + Sb)	75	0.12	^{209}Bi	^{89}(Sr + Rb)	660	6.4
^{209}Bi	^{111}(In + Sn + Sb)	190	1.2	^{209}Bi	^{82}Sr	450	0.16
^{209}Bi	^{111}(In + Sn + Sb)	450	4.7	^{209}Bi	^{86}Rb	190	0.05
^{209}Bi	^{115}(Cd + Ag)	450	1.6	^{209}Bi	^{86}Rb	240	0.05
^{209}Bi	^{113}Ag	75	0.28	^{209}Bi	^{86}Rb	450	4.1
^{209}Bi	^{113}Ag	120	1.5	^{209}Bi	^{84}Br	75	0.023
^{209}Bi	^{113}Ag	190	1.2	^{209}Bi	^{84}Br	120	0.19
^{209}Bi	^{113}Ag	240	1.9	^{209}Bi	^{83}(Br + Se)	75	0.034
^{209}Bi	^{113}Ag	300	0.9	^{209}Bi	^{83}(Br + Se)	120	0.45
^{209}Bi	^{113}Ag	375	1.1	^{209}Bi	^{83}(Br + Se)	190	0.63
^{209}Bi	^{113}Ag	450	1.5	^{209}Bi	^{83}(Br + Se)	240	1.6
^{209}Bi	^{112}Ag	75	0.12	^{209}Bi	^{83}(Br + Se)	300	2.1
^{209}Bi	^{112}Ag	120	0.7	^{209}Bi	^{83}(Br + Se)	375	1.6
^{209}Bi	^{112}Ag	190	1.2	^{209}Bi	^{83}(Br + Se)	450	1.3
^{209}Bi	^{112}Ag	240	1.4	^{209}Bi	^{82}Br	75	0.003
^{209}Bi	^{112}Ag	300	2.7	^{209}Bi	^{82}Br	120	0.13
^{209}Bi	^{112}Ag	375	1.9	^{209}Bi	^{82}Br	190	0.5
^{209}Bi	^{112}Ag	450	1.4	^{209}Bi	^{82}Br	240	1.2
^{209}Bi	^{111}(Ag + Pd)	75	0.35	^{209}Bi	^{82}Br	300	1.4
^{209}Bi	^{111}(Ag + Pd)	120	1.7	^{209}Bi	^{82}Br	375	1.5
^{209}Bi	^{111}(Ag + Pd)	190	2.5	^{209}Bi	^{82}Br	450	1.7
^{209}Bi	^{111}(Ag + Pd)	240	2.8	^{209}Bi	^{80m}Br	450	2.0
^{209}Bi	^{111}(Ag + Pd)	300	3.1	^{209}Bi	^{77}(As + Ge)	75	0.074
^{209}Bi	^{111}(Ag + Pd)	375	3.1	^{209}Bi	^{77}(As + Ge)	120	0.47
^{209}Bi	^{111}(Ag + Pd)	450	3.5	^{209}Bi	^{77}(As + Ge)	190	1.4
^{209}Bi	^{111}(Ag + Pd)	660	3.7	^{209}Bi	^{77}(As + Ge)	240	2.3
^{209}Bi	^{112}Pd	190	0.12	^{209}Bi	^{77}(As + Ge)	300	4.3
^{209}Bi	^{112}Pd	450	0.32	^{209}Bi	^{77}(As + Ge)	450	4.6
^{209}Bi	^{109}(Pd + Rh)	190	0.48	^{209}Bi	^{76}As	120	0.24
^{209}Bi	^{109}(Pd + Rh)	450	2.5	^{209}Bi	^{76}As	190	0.6
^{209}Bi	^{103}(Pd + Ag + Cd)	190	0.009	^{209}Bi	^{76}As	240	0.8

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{209}Bi	^{76}As	300	2.0
^{209}Bi	^{76}As	375	2.3
^{209}Bi	^{76}As	450	2.6
^{209}Bi	^{74}As	75	0.008
^{209}Bi	^{74}As	120	0.041
^{209}Bi	^{74}As	190	0.19
^{209}Bi	^{74}As	240	0.4
^{209}Bi	^{74}As	300	0.8
^{209}Bi	^{74}As	375	0.7
^{209}Bi	^{74}As	450	1.3
^{209}Bi	^{72}As	450	0.36
^{209}Bi	^{67}(Cu + Ni)	120	0.038
^{209}Bi	^{67}(Cu + Ni)	190	0.12
^{209}Bi	^{67}(Cu + Ni)	240	0.23
^{209}Bi	^{67}(Cu + Ni)	300	0.37
^{209}Bi	^{67}(Cu + Ni)	375	0.41
^{209}Bi	^{67}(Cu + Ni)	450	0.68
^{209}Bi	^{67}(Cu + Ni)	660	0.86
^{209}Bi	^{64}Cu	120	0.006
^{209}Bi	^{64}Cu	190	0.03
^{209}Bi	^{64}Cu	240	0.034
^{209}Bi	^{64}Cu	300	0.067
^{209}Bi	^{64}Cu	375	0.11
^{209}Bi	^{64}Cu	450	0.2
^{209}Bi	^{61}Cu	120	0.003
^{209}Bi	^{61}Cu	450	0.09
^{209}Bi	^{66}Ni	450	0.46
^{209}Bi	^{65}(Ni + Co)	450	0.60
^{209}Bi	^{59}(Fe + Mn)	450	0.23
^{209}Bi	^{59}(Fe + Mn)	660	0.36
^{209}Bi	^{38}(Ar + Cl + S)	600	0.05
^{209}Bi	^{32}P	660	0.046
^{209}Bi	^{28}Mg	660	0.03
^{209}Bi	^{24}Na	660	0.03
^{209}Bi	^{21}Ne	600	0.05
^{209}Bi	^{18}F	660	0.02
^{232}Th	^{231}Th	340	68
^{232}Th	^{231}Th	700	120
^{232}Th	^{231}Th	1800	100
^{232}Th	^{228}Th	340	30
^{232}Th	^{228}Th	700	25
^{232}Th	^{227}Th	340	22
^{232}Th	^{227}Th	700	15
^{232}Th	^{227}Th	1800	15
^{232}Th	^{226}Th	340	17
^{232}Th	^{226}Th	700	14
^{232}Th	^{226}Th	1800	9
^{232}Th	^{225}Th	700	12
^{232}Th	^{225}Th	1800	6.5
^{232}Th	^{228}Ac	50	2.6
^{232}Th	^{228}Ac	95	4.2
^{232}Th	^{228}Ac	340	28
^{232}Th	^{228}Ac	700	5.3
^{232}Th	^{228}Ac	1800	8.0
^{232}Th	^{227}Ac	50	2.8
^{232}Th	^{227}Ac	95	4.6
^{232}Th	^{227}Ac	340	14
^{232}Th	^{226}Ac	50	2.6
^{232}Th	^{226}Ac	95	3.15
^{232}Th	^{226}Ac	340	10
^{232}Th	^{226}Ac	700	5.5
^{232}Th	^{226}Ac	1800	7.3
^{232}Th	^{225}Ac	50	2.5
^{232}Th	^{225}Ac	95	3.2
^{232}Th	^{225}Ac	340	14
^{232}Th	^{225}Ac	700	5.0
^{232}Th	^{225}Ac	1800	8.2
^{232}Th	^{224}Ac	50	0.6
^{232}Th	^{224}Ac	95	1.6
^{232}Th	^{224}Ac	340	12.5
^{232}Th	^{224}Ac	700	5.4
^{232}Th	^{224}Ac	1800	5.4
^{232}Th	^{227}Ra	340	⩾0.7
^{232}Th	^{225}Ra	340	2.1
^{232}Th	^{224}Ra	340	8.0
^{232}Th	^{223}Ra	340	6.7
^{232}Th	^{211}Rn	150	1.1
^{232}Th	^{210}Rn	150	0.10
^{232}Th	^{211}At	150	2.5
^{232}Th	^{210}At	150	1.8
^{232}Th	^{209}At	150	1.4
^{232}Th	^{207}At	150	0.06
^{232}Th	^{206}At	150	0.05
^{232}Th	^{210}Po	150	5.4
^{232}Th	^{208}Po	150	1.5
^{232}Th	^{207}Po	150	0.05
^{232}Th	^{206}Po	150	0.003
^{232}Th	^{210}Bi + ^{214}Ac + ^{218}Fr + ^{222}Ac	150	4.9
^{232}Th	^{139}(Ba + Cs + Xe + I)	50	15
^{232}Th	^{139}(Ba + Cs + Xe + I)	85	18
^{232}Th	^{139}(Ba + Cs + Xe + I)	340	8
^{232}Th	^{131}Ba	85	0.1
^{232}Th	^{131}Ba	140	0.1
^{232}Th	^{131}Ba	190	0.6

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{232}Th	^{131}Ba	340	1.4	^{235}U	^{229}U	1800	0.06
^{232}Th	^{138}Cs	85	12	^{235}U	^{228}U	680	0.017
^{232}Th	^{138}Xe	85	6.6	^{235}U	^{235}Pa	680	⩽0.2
^{232}Th	^{137}(Cs + Xe + I)	85	17	^{235}U	^{235}Pa	1800	⩽0.2
^{232}Th	^{136}Cs	85	11	^{235}U	^{234}Pa	680	23
^{232}Th	^{136}Cs	450	1.3	^{235}U	^{234}Pa	1800	20
^{232}Th	^{134}Cs	85	8.8	^{235}U	^{233}Pa	680	23
^{232}Th	^{132}Cs	85	2.9	^{235}U	^{233}Pa	1800	18
^{232}Th	^{115}(Cd + Ag + Pd)	450	23	^{235}U	^{232}Pa	680	6.6
^{232}Th	^{113}(Ag + Pd + Rh)	450	16	^{235}U	^{232}Pa	1800	4.3
^{232}Th	^{112}Ag	450	5.1	^{235}U	^{229}Pa	680	4.2
^{232}Th	^{111}(Ag + Pd + Rh)	50	18	^{235}U	^{229}Pa	1800	1.4
^{232}Th	^{111}(Ag + Pd + Rh)	100	40	^{235}U	^{228}Pa	680	1.4
^{232}Th	^{111}(Ag + Pd + Rh)	340	45	^{235}U	^{228}Pa	1800	0.28
^{232}Th	^{111}(Ag + Pd + Rh)	450	26	^{235}U	^{227}Pa	680	0.42
^{232}Th	^{109}(Pd + Rh + Ru)	450	24	^{234}U	^{227}Pa	1800	0.05
^{232}Th	^{99}(Mo + Nb + Zr + Y)	450	27	^{235}U	^{233}Th	680	0.5
^{232}Th	^{96}Nb	450	3.7	^{235}U	^{233}Th	1800	0.3
^{232}Th	^{95}Nb	450	1.9	^{235}U	^{231}Th	680	8
^{232}Th	^{97}(Zr + Y + Sr)	50	20	^{235}U	^{231}Th	1800	10
^{232}Th	^{97}(Zr + Y + Sr)	100	35	^{235}U	^{228}Th	680	1.5
^{232}Th	^{97}(Zr + Y + Sr)	340	28	^{235}U	^{227}Th	680	1.7
^{232}Th	^{97}(Zr + Y + Sr)	450	19	^{235}U	^{227}Th	1800	1.9
^{232}Th	^{95}(Zr + Y + Sr + Rb)	450	14	^{235}U	^{226}Th	680	1.8
^{232}Th	^{90}(Sr + Rb + Kr)	450	7.2	^{235}U	^{226}Th	1800	2.2
^{232}Th	^{89}(Sr + Rb + Kr + Br)	450	15	^{235}U	^{225}Th	680	1.2
^{232}Th	^{86}Rb	85	1.1	^{235}U	^{225}Th	1800	1.8
^{232}Th	^{86}Rb	450	3.2	^{235}U	^{228}Ac	680	0.48
^{232}Th	^{83}(Br + Se)	450	4.4	^{235}U	^{228}Ac	1800	0.24
^{232}Th	^{82}Br	450	1.4	^{235}U	^{226}Ac	680	0.83
^{232}Th	^{80m}Br	450	0.97	^{235}U	^{226}Ac	1800	1.0
^{232}Th	^{77}(As + Ge)	450	5.2	^{235}U	^{225}Ac	680	1.1
^{232}Th	^{76}As	450	2.2	^{235}U	^{225}Ac	1800	1.1
^{232}Th	^{74}As	450	0.47	^{235}U	^{224}Ac	680	1.5
^{232}Th	^{72}As	450	0.13	^{235}U	^{224}Ac	1800	1.2
^{232}Th	^{67}(Cu + Ni)	450	0.89	^{235}U	^{48}Sc	3000	3.5
^{232}Th	^{64}Cu	450	0.11	^{235}U	^{47}Sc	3000	3.1
^{232}Th	^{66}(Ni + Co)	50	0.1	^{235}U	^{46}Sc	3000	2.7
^{232}Th	^{66}(Ni + Co)	95	0.2	^{235}U	^{47}Ca	3000	0.4
^{232}Th	^{66}(Ni + Co)	140	0.5	^{235}U	^{45}Ca	3000	3.2
^{232}Th	^{66}(Ni + Co)	190	1.0	^{235}U	^{43}K	3000	3.3
^{232}Th	^{66}(Ni + Co)	340	1.0	^{235}U	^{42}K	3000	2.9
^{232}Th	^{66}(Ni + Co)	450	0.63	^{238}U	^{237}U	100	93
^{232}Th	^{65}(Ni + Co)	450	0.59	^{238}U	^{237}U	150	73
^{232}Th	^{59}(Fe + Mn)	450	0.3	^{238}U	^{237}U	200	67.5
^{232}Th	^{32}P	450	0.03	^{238}U	^{237}U	340	85
^{232}Th	^{32}P	600	0.020	^{238}U	^{237}U	700	63
^{232}Th	^{32}P	900	0.09	^{238}U	^{237}U	2000	50
^{232}Th	^{32}P	1800	0.30	^{238}U	^{232}U	340	<4
^{232}Th	^{32}P	2800	0.63	^{238}U	^{232}U	700	4.7
^{235}U	^{232}U	680	25	^{238}U	^{232}U	2000	3
^{235}U	^{230}U	680	1.3	^{238}U	^{230}U	100	0.41
^{235}U	^{230}U	1800	6.3	^{238}U	^{230}U	150	0.67
^{235}U	^{229}U	680	0.10	^{238}U	^{230}U	170	0.57

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{230}U	200	0.42	^{238}U	^{228}Pa	340	1.7
^{238}U	^{230}U	250	0.40	^{238}U	^{228}Pa	700	1.0
^{238}U	^{230}U	340	0.35	^{238}U	^{228}Pa	2000	0.47
^{238}U	^{230}U	700	0.23	^{238}U	^{228}Pa	3000	0.56
^{238}U	^{230}U	2000	0.18	^{238}U	^{228}Pa	6000	0.5
^{238}U	^{229}U	100	0.046	^{238}U	^{227}Pa	100	0.086
^{238}U	^{229}U	150	0.11	^{238}U	^{227}Pa	150	0.30
^{238}U	^{229}U	170	0.09	^{238}U	^{227}Pa	170	0.46
^{238}U	^{229}U	200	0.09	^{238}U	^{227}Pa	200	0.60
^{238}U	^{229}U	250	0.07	^{238}U	^{227}Pa	300	0.71
^{238}U	^{229}U	340	0.060	^{238}U	^{227}Pa	340	0.71
^{238}U	^{229}U	700	0.05	^{238}U	^{227}Pa	700	0.39
^{238}U	^{229}U	2000	0.036	^{238}U	^{227}Pa	2000	0.18
^{238}U	^{228}U	100	0.012	^{238}U	^{227}Pa	3000	0.15
^{238}U	^{228}U	150	0.046	^{238}U	^{227}Pa	6000	0.12
^{238}U	^{228}U	170	0.038	^{238}U	^{234}Th	100	0.95
^{238}U	^{228}U	200	0.032	^{238}U	^{234}Th	150	1.8
^{238}U	^{228}U	250	0.037	^{238}U	^{234}Th	200	1.1
^{238}U	^{228}U	340	0.038	^{238}U	^{234}Th	340	1.8
^{238}U	^{228}U	700	0.024	^{238}U	^{234}Th	700	5
^{238}U	^{228}U	2000	0.015	^{238}U	^{234}Th	2000	18
^{238}U	^{237}Pa	700	13	^{238}U	^{234}Th	3000	5
^{238}U	^{237}Pa	2000	6	^{238}U	^{233}Th	700	7.5
^{238}U	^{237}Pa	3000	9	^{238}U	^{233}Th	2000	9
^{238}U	^{237}Pa	6000	6.6	^{238}U	^{233}Th	6000	7.5
^{238}U	^{235}Pa	100	5.7	^{238}U	^{231}Th	100	0.50
^{238}U	^{235}Pa	170	7.3	^{238}U	^{231}Th	150	1.0
^{238}U	^{235}Pa	250	15.1	^{238}U	^{231}Th	200	1.1
^{238}U	^{235}Pa	340	21	^{238}U	^{231}Th	270	1.7
^{238}U	^{235}Pa	700	17	^{238}U	^{231}Th	340	2.4
^{238}U	^{235}Pa	2000	7	^{238}U	^{231}Th	700	3
^{238}U	^{235}Pa	3000	7.6	^{238}U	^{231}Th	3000	6.6
^{238}U	^{235}Pa	6000	6.6	^{238}U	^{228}Th	100	0.85
^{238}U	^{234}Pa	700	22	^{238}U	^{228}Th	150	0.9
^{238}U	^{234}Pa	2000	11	^{238}U	^{228}Th	170	1.2
^{238}U	^{234}Pa	3000	11	^{238}U	^{228}Th	200	0.95
^{238}U	^{234}Pa	6000	10	^{238}U	^{228}Th	270	1.9
^{238}U	^{233}Pa	700	19	^{238}U	^{228}Th	340	2.9
^{238}U	^{233}Pa	2000	10	^{238}U	^{228}Th	700	2.7
^{238}U	^{233}Pa	3000	10	^{238}U	^{228}Th	2000	2.3
^{238}U	^{233}Pa	6000	11	^{238}U	^{228}Th	6000	2.1
^{238}U	^{232}Pa	340	8.7	^{238}U	^{227}Th	100	0.32
^{238}U	^{232}Pa	700	6.5	^{238}U	^{227}Th	150	0.9
^{238}U	^{232}Pa	2000	4.0	^{238}U	^{227}Th	170	1.2
^{238}U	^{232}Pa	3000	3	^{238}U	^{227}Th	200	1.3
^{238}U	^{232}Pa	6000	3.8	^{238}U	^{227}Th	270	2.3
^{238}U	^{230}Pa	100	1.5	^{238}U	^{227}Th	340	3.3
^{238}U	^{230}Pa	150	3.7	^{238}U	^{227}Th	700	2.3
^{238}U	^{230}Pa	200	3.6	^{238}U	^{227}Th	1000	2.2
^{238}U	^{230}Pa	270	4.8	^{238}U	^{227}Th	2000	1.6
^{238}U	^{229}Pa	700	4.9	^{238}U	^{227}Th	3000	1.7
^{238}U	^{229}Pa	2000	2.2	^{238}U	^{227}Th	6000	1.7
^{238}U	^{229}Pa	3000	2.1	^{238}U	^{226}Th	340	2.7
^{238}U	^{229}Pa	6000	2.5	^{238}U	^{226}Th	700	2.3

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{226}Th	1000	2.4
^{238}U	^{226}Th	2000	1.8
^{238}U	^{226}Th	6000	1.7
^{238}U	^{225}Th	700	1.5
^{238}U	^{225}Th	2000	1.4
^{238}U	^{228}Ac	340	0.62
^{238}U	^{228}Ac	700	1.1
^{238}U	^{228}Ac	2000	0.8
^{238}U	^{226}Ac	100	0.021
^{238}U	^{226}Ac	150	0.07
^{238}U	^{226}Ac	200	0.24
^{238}U	^{226}Ac	270	0.38
^{238}U	^{226}Ac	340	0.54
^{238}U	^{226}Ac	700	1.5
^{238}U	^{226}Ac	2000	1.3
^{238}U	^{225}Ac	100	0.011
^{238}U	^{225}Ac	150	0.009
^{238}U	^{225}Ac	200	0.26
^{238}U	^{225}Ac	270	0.41
^{238}U	^{225}Ac	340	0.62
^{238}U	^{225}Ac	700	1.6
^{238}U	^{225}Ac	2000	1.3
^{238}U	^{224}Ac	340	1.05
^{238}U	^{224}Ac	700	2.1
^{238}U	^{224}Ac	2000	1.4
^{238}U	^{228}Ra	340	0.43
^{238}U	^{225}Ra	340	0.26
^{238}U	^{225}Ra	700	7
^{238}U	^{224}Ra	100	0.017
^{238}U	^{224}Ra	150	0.09
^{238}U	^{224}Ra	200	0.26
^{238}U	^{224}Ra	270	0.44
^{238}U	^{224}Ra	340	0.58
^{238}U	^{223}Ra	340	0.48
^{238}U	$^{210}At + {}^{214}Fr + {}^{218}Ac$	200	0.08
^{238}U	$^{210}At + {}^{214}Fr + {}^{218}Ac$	340	1.2
^{238}U	$^{210}Po + {}^{214}Rn + {}^{218}Ra$	200	0.17
^{238}U	$^{210}Po + {}^{214}Rn + {}^{218}Ra$	340	1.7
^{238}U	$^{210}Bi + {}^{214}At + {}^{218}Fr + {}^{222}Ac + {}^{226}Pa$	200	1.1
238	$^{210}Bi + {}^{214}At + {}^{218}Fr + {}^{222}Ac + {}^{226}Pa$	340	1.6
238		6000	2.5
238	$^{212}Pb + {}^{216}Po + {}^{220}Rn$	6000	0.4
238	$^{209}Pb + {}^{213}Po + {}^{217}Rn + {}^{221}Ra + {}^{225}Th$	6000	3.2
238	^{193}Os	340	0.01
238	$^{171}(Hf + Ta)$	≈10,000	6.5
238	$^{170}(Hf + Ta)$	≈10,000	4.5
238	^{172}Lu	≈10,000	0.08
238	^{171}Lu	≈10,000	0.03
238	^{170}Lu	≈10,000	0.5
238	$^{169}(Lu + Hf)$	≈10,000	6.8
238	$^{169}(Yb + Lu + Hf)$	≈10,000	6.9
238	$^{166}(Yb + Lu)$	340	0.7
^{238}U	$^{166}(Yb + Lu)$	≈10,000	4.9
^{238}U	^{170}Tm	≈10,000	0.008
^{238}U	^{168}Tm	≈10,000	0.036
^{238}U	$^{167}(Tm + Yb + Lu)$	≈10,000	5.8
^{238}U	^{166}Tm	≈10,000	0.14
^{238}U	$^{165}(Tm + Yb + Lu)$	≈10,000	4.7
^{238}U	^{169}Er	≈10,000	0.004
^{238}U	^{165}Er	≈10,000	0.06
^{238}U	^{166}Ho	340	0.05
^{238}U	$^{155}(Dy + Ho)$	≈10,000	7
^{238}U	$^{153}(Dy + Ho)$	≈10,000	7
^{238}U	$^{152}(Dy + Ho)$	≈10,000	6
^{238}U	^{164}Tb	170	0.05
^{238}U	^{163}Tb	170	0.10
^{238}U	^{161}Tb	170	0.3
^{238}U	"	≈10,000	0.054
^{238}U	^{160}Tb	170	0.4
^{238}U	^{156}Tb	≈10,000	0.14
^{238}U	^{155}Tb	≈10,000	0.6
^{238}U	^{153}Tb	≈10,000	0.95
^{238}U	^{152}Tb	≈10,000	0.85
^{238}U	$^{151}(Tb + Dy)$	≈10,000	3.9
^{238}U	$^{149}(Tb + Dy)$	≈10,000	3.6
^{238}U	^{159}Gd	170	0.45
^{238}U	"	≈10,000	0.064
^{238}U	^{151}Gd	≈10,000	1.2
^{238}U	^{149}Gd	≈10,000	6.5
^{238}U	$^{148}(Gd + Tb)$	≈10,000	7.1
^{238}U	$^{147}(Gd + Tb)$	≈10,000	3.5
^{238}U	$^{146}(Gd + Tb)$	≈10,000	5.1
^{238}U	$^{157}(Eu + Sm)$	70	0.9
^{238}U	$^{157}(Eu + Sm)$	100	0.9
^{238}U	$^{157}(Eu + Sm)$	150	0.54
^{238}U	$^{157}(Eu + Sm)$	200	0.46
^{238}U	$^{157}(Eu + Sm)$	340	0.40
^{238}U	$^{157}(Eu + Sm)$	≈10,000	0.15
^{238}U	$^{156}(Eu + Sm)$	70	1.2
^{238}U	^{156}Eu	100	1.3
^{238}U	^{156}Eu	150	0.93
^{238}U	^{156}Eu	200	0.86
^{238}U	^{156}Eu	340	1.2
^{238}U	^{156}Eu	≈10,000	0.2
^{238}U	^{149}Eu	≈10,000	0.3
^{238}U	^{148}Eu	≈10,000	0.6
^{238}U	^{147}Eu	≈10,000	0.8
^{238}U	^{146}Eu	≈10,000	1.0
^{238}U	$^{145}(Eu + Gd)$	≈10,000	4.7
^{238}U	$^{156}(Sm + Pm)$	170	0.5
^{238}U	$^{153}(Sm + Pm)$	70	4.6
^{238}U	$^{153}(Sm + Pm)$	100	4.4
^{238}U	$^{153}(Sm + Pm)$	150	3.1
^{238}U	$^{153}(Sm + Pm)$	200	2.6
^{238}U	$^{153}(Sm + Pm)$	340	2.0
^{238}U	^{145}Sm	≈10,000	0.9

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{151}(Pm + Nd)	170	2.8
^{238}U	^{151}(Pm + Nd)	≈10,000	0.5
^{238}U	^{150}Pm	170	1.1
^{238}U	^{150}Pm	≈10,000	0.2
^{238}U	^{149}(Pm + Nd + Pr)	170	5.4
^{238}U	^{149}(Pm + Nd + Pr)	≈10,000	1
^{238}U	^{149}Pm	≈10,000	0.3
^{238}U	^{148}Pm	≈10,000	0.22
^{238}U	^{146}Pm	≈10,000	0.4
^{238}U	^{144}Pm	≈10,000	0.55
^{238}U	^{143}(Pm + Sm + Eu + Gd)	≈10,000	4.7
^{238}U	^{149}(Nd + Pr)	170	5.6
^{238}U	^{149}(Nd + Pr)	≈10,000	1.9
^{238}U	^{147}(Nd + Pr + Ce + La)	70	17
^{238}U	^{147}(Nd + Pr + Ce + La)	100	18
^{238}U	^{147}(Nd + Pr + Ce + La)	150	12
^{238}U	^{147}(Nd + Pr + Ce + La)	200	11
^{238}U	^{147}(Nd + Pr + Ce + La)	380	10
^{238}U	^{147}(Nd + Pr + Ce + La)	≈10,000	2.5
^{238}U	^{140}(Nd + Pm + Sm)	150	0.7
^{238}U	^{140}(Nd + Pm + Sm)	200	3.4
^{238}U	^{140}(Nd + Pm + Sm)	≈10,000	3.4
^{238}U	^{139}(Nd + Pm + Sm)	≈10,000	3.4
^{238}U	^{145}(Pr + Ce)	170	12
^{238}U	^{143}(Pr + Ce + La)	340	13
^{238}U	^{143}Pr	70	0.36
^{238}U	^{143}Pr	100	2.1
^{238}U	^{143}Pr	150	2.0
^{238}U	^{143}Pr	200	1.9
^{238}U	^{143}Pr	340	1.9
^{238}U	^{142}Pr	170	1.6
^{238}U	^{142}Pr	≈10,000	0.8
^{238}U	^{139}Pr	≈10,000	1.4
^{238}U	^{144}(Ce + La)	70	30
^{238}U	^{144}(Ce + La)	100	28
^{238}U	^{144}(Ce + La)	150	18
^{238}U	^{144}(Ce + La)	200	17
^{238}U	^{144}(Ce + La)	340	14
^{238}U	^{144}(Ce + La)	≈10,000	7.6
^{238}U	^{143}(Ce + La + Ba)	70	36
^{238}U	^{143}(Ce + La + Ba)	100	31
^{238}U	^{143}(Ce + La + Ba)	150	22
^{238}U	^{143}(Ce + La + Ba)	200	21
^{238}U	^{143}(Ce + La + Ba)	340	20
^{238}U	^{143}(Ce + La + Ba)	≈10,000	7
^{238}U	^{141}(Ce + La + Ba + Cs)	70	49
^{238}U	^{141}(Ce + La + Ba + Cs)	100	51
^{238}U	^{141}(Ce + La + Ba + Cs)	150	36
^{238}U	^{141}(Ce + La + Ba + Cs)	200	36
^{238}U	^{141}(Ce + La + Ba + Cs)	340	31
^{238}U	^{141}(Ce + La + Ba + Cs)	≈10,000	3.7
^{238}U	^{139}Ce	≈10,000	0.7
^{238}U	^{134}(Ce + Pr + Nd)	≈10,000	7.6
^{238}U	^{141}(La + Ba + Cs)	170	20
^{238}U	^{140}La	70	8.6
^{238}U	^{140}La	100	8.6
^{238}U	^{140}La	150	7.9
^{238}U	^{140}La	200	6.2
^{238}U	^{140}La	340	6
^{238}U	^{131}(La + Ce + Pr)	100	0.01
^{238}U	^{131}(La + Ce + Pr)	380	0.8
^{238}U	^{131}(La + Ce + Pr)	1000	2.4
^{238}U	^{131}(La + Ce + Pr)	3000	6.0
^{238}U	^{140}(Ba + Cs + Xe)	100	25
^{238}U	^{140}(Ba + Cs + Xe)	170	21
^{238}U	^{140}(Ba + Cs + Xe)	200	19
^{238}U	^{140}(Ba + Cs + Xe)	380	14.6
^{238}U	^{140}(Ba + Cs + Xe)	1000	9.3
^{238}U	^{140}(Ba + Cs + Xe)	3000	7.9
^{238}U	^{140}(Ba + Cs + Xe)	≈10,000	27
^{238}U	^{139}(Ba + Cs + Xe + I)	100	32
^{238}U	^{139}(Ba + Cs + Xe + I)	170	25
^{238}U	^{131}Ba	100	0.03
^{238}U	^{131}Ba	140	0.2
^{238}U	^{131}Ba	200	0.7
^{238}U	^{131}Ba	380	1.9
^{238}U	^{131}Ba	1000	5.8
^{238}U	^{131}Ba	≈10,000	6.6
^{238}U	^{129}(Ba + La + Ce + Pr)	100	0.002
^{238}U	^{129}(Ba + La + Ce + Pr)	200	0.12
^{238}U	^{129}(Ba + La + Ce + Pr)	1000	3.4
^{238}U	^{129}(Ba + La + Ce + Pr)	3000	2.5
^{238}U	^{128}(Ba + La + Ce)	≈10,000	17
^{238}U	^{127}(Ba + La + Ce)	1000	1.3
^{238}U	^{127}(Ba + La + Ce)	3000	4.7
^{238}U	^{143}Cs	150	3.2
^{238}U	^{142}Cs	150	6.5
^{238}U	^{142}Cs	≈10,000	0.9
^{238}U	^{141}Cs	150	9.3
^{238}U	^{141}Cs	≈10,000	1.4
^{238}U	^{140}Cs	150	12
^{238}U	^{140}Cs	≈10,000	2.2
^{238}U	^{139}Cs	150	12
^{238}U	^{139}(Cs + Xe)	1000	9.1
^{238}U	^{139}(Cs + Xe)	3000	7
^{238}U	^{139}Cs	≈10,000	3.5
^{238}U	^{138}Cs	150	13
^{238}U	^{137}(Cs + Xe + I)	100	37
^{238}U	^{137}Cs	150	22
^{238}U	^{137}(Cs + Xe + I)	200	23
^{238}U	^{137}(Cs + Xe + I)	380	16.7
^{238}U	^{137}(Cs + Xe + I)	680	11.9
^{238}U	^{137}(Cs + Xe + I)	1000	9.6
^{238}U	^{137}(Cs + Xe + I)	3000	8.8
^{238}U	^{137}(Cs + Xe + I)	≈10,000	9.4
^{238}U	^{136}Cs	100	14.7
^{238}U	^{136}Cs	170	12
^{238}U	^{136}Cs	200	9.9

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{136}Cs	380	7.2
^{238}U	^{136}Cs	680	4.8
^{238}U	^{136}Cs	1000	4.4
^{238}U	^{136}Cs	3000	3.2
^{238}U	^{136}Cs	≈10,000	2.9
^{238}U	^{135}(Cs + Xe + I + Te)	100	52
^{238}U	^{135}Cs	150	11
^{238}U	^{135}(Cs + Xe + I + Te)	200	34
^{238}U	^{135}(Cs + Xe + I + Te)	380	25
^{238}U	^{135}(Cs + Xe + I + Te)	680	18
^{238}U	^{135}(Cs + Xe + I + Te)	1000	13
^{238}U	^{135}Cs	3000	2.0
^{238}U	^{135}(Cs + Xe + I + Te)	≈10,000	15
^{238}U	^{134}Cs	100	11
^{238}U	^{134}Cs	150	8.3
^{238}U	^{134}Cs	200	8.6
^{238}U	^{134}Cs	380	6.9
^{238}U	^{134}Cs	680	5.5
^{238}U	^{134}Cs	1000	3.0
^{238}U	^{134}Cs	3000	2.8
^{238}U	^{133}Cs	150	7
^{238}U	^{132}Cs	100	3.7
^{238}U	^{132}Cs	150	4.3
^{238}U	^{132}Cs	200	5.0
^{238}U	^{132}Cs	380	6.2
^{238}U	^{132}Cs	680	5.9
^{238}U	^{132}Cs	1000	4.2
^{238}U	^{132}Cs	3000	3.3
^{238}U	^{132}Cs	≈10,000	2.4
^{238}U	^{131}Cs	100	1.5
^{238}U	^{131}Cs	150	2.6
^{238}U	^{131}Cs	200	3.8
^{238}U	^{131}Cs	380	6.7
^{238}U	^{131}Cs	680	5.8
^{238}U	^{131}Cs	1000	5.4
^{238}U	^{131}Cs	3000	3.7
^{238}U	^{131}Cs	≈10,000	2.4
^{238}U	^{130}Cs	100	0.58
^{238}U	^{130}Cs	150	1.2
^{238}U	^{130}Cs	200	2.2
^{238}U	^{130}Cs	380	5.1
^{238}U	^{130}Cs	1000	5.5
^{238}U	^{130}Cs	3000	4.3
^{238}U	^{130}Cs	≈10,000	2.5
^{238}U	^{129}(Cs + Ba + La + Ce)	100	0.05
^{238}U	^{129}Cs	150	0.55
^{238}U	^{129}Cs	200	1.55
^{238}U	^{129}Cs	380	3.9
^{238}U	^{129}Cs	1000	6.5
^{238}U	^{129}Cs	3000	5.0
^{238}U	^{129}Cs	≈10,000	3.1
^{238}U	^{128}Cs	150	0.25
^{238}U	^{128}Cs	≈10,000	3
^{238}U	^{127}(Cs + Ba + La + Ce)	200	0.3
^{238}U	^{127}(Cs + Ba + La + Ce)	380	1.21
^{238}U	^{127}Cs	1000	3.8
^{238}U	^{127}Cs	3000	3.0
^{238}U	^{127}Cs	≈10,000	3.8
^{238}U	^{126}Cs	≈10,000	4.1
^{238}U	^{125}(Cs + Ba + La)	1000	1.1
^{238}U	^{125}(Cs + Ba + La)	3000	3.9
^{238}U	^{125}Cs	≈10,000	4.8
^{238}U	^{124}Cs	≈10,000	4.5
^{238}U	^{123}Cs	≈10,000	4
^{238}U	^{122}Cs	≈10,000	2.5
^{238}U	^{121}Cs	≈10,000	1.2
^{238}U	^{120}Cs	≈10,000	0.4
^{238}U	^{138}(Xe + I)	600	2.6
^{238}U	^{138}(Xe + I)	≈10,000	2.2
^{238}U	^{135}Xe	600	4.5
^{238}U	^{135}Xe	≈10,000	2.5
^{238}U	^{125}(Xe + Cs + Ba)	600	3.6
^{238}U	^{125}(Xe + Cs + Ba)	≈10,000	9.5
^{238}U	^{122}(Xe + Cs)	600	0.26
^{238}U	^{122}(Xe + Cs)	≈10,000	3.6
^{238}U	^{121}(Xe + Cs)	600	0.12
^{238}U	^{121}(Xe + Cs)	≈10,000	2.2
^{238}U	^{120}(Xe + Cs)	600	0.02
^{238}U	^{120}(Xe + Cs)	≈10,000	1.6
^{238}U	^{135}(I + Te)	600	9
^{238}U	^{135}(I + Te)	3000	4.8
^{238}U	^{135}(I + Te)	≈10,000	6
^{238}U	^{134}I	170	11
^{238}U	^{134}I	600	7
^{238}U	^{134}I	1000	7.7
^{238}U	^{134}I	3000	4.0
^{238}U	^{134}I	≈10,000	5
^{238}U	^{133}(I + Te + Sb)	170	18
^{238}U	^{133}I	600	7
^{238}U	^{133}I	3000	4.9
^{238}U	^{133}I	≈10,000	5.1
^{238}U	^{132}I	170	16
^{238}U	^{132}I	600	13
^{238}U	^{132}I	1000	6
^{238}U	^{132}I	3000	4.9
^{238}U	^{132}I	≈10,000	5
^{238}U	^{131}(I + Te + Sb)	170	27
^{238}U	^{131}I	600	9.5
^{238}U	^{131}I	≈10,000	3.5
^{238}U	^{130}I	170	13
^{238}U	^{130}I	600	9.6
^{238}U	^{130}I	3000	2.4
^{238}U	^{130}I	≈10,000	3.6
^{238}U	^{128}I	170	9.4
^{238}U	^{128}I	600	10
^{238}U	^{128}I	≈10,000	3.2
^{238}U	^{126}I	170	5.2
^{238}U	^{126}I	600	10

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{126}I	≈10,000	3.6
^{238}U	^{125}I	600	6.5
^{238}U	^{125}I	3000	2.6
^{238}U	^{125}I	≈10,000	2.5
^{238}U	^{124}I	170	1.1
^{238}U	^{124}I	600	5
^{238}U	^{124}I	3000	4.7
^{238}U	^{124}I	≈10,000	3.2
^{238}U	^{123}I	600	3.8
^{238}U	^{123}I	3000	2.9
^{238}U	^{123}I	≈10,000	2.5
^{238}U	^{122}I	600	2.0
^{238}U	^{122}I	≈10,000	2.8
^{238}U	^{121}I	600	1.1
^{238}U	^{121}I	≈10,000	3.2
^{238}U	^{120}I	600	0.43
^{238}U	^{120}I	≈10,000	1.7
^{238}U	^{119}I	600	0.20
^{238}U	^{119}I	≈10,000	1.2
^{238}U	^{118}I	600	0.06
^{238}U	^{118}I	≈10,000	0.4
^{238}U	^{134}Te	170	9
^{238}U	^{134}Te	600	7.2
^{238}U	^{134}Te	1000	5.6
^{238}U	^{134}Te	3000	4.5
^{238}U	^{134}Te	≈10,000	3.3
^{238}U	$^{132}(Te + Sb)$	170	14
^{238}U	$^{132}(Te + Sb)$	600	7.5
^{238}U	$^{132}(Te + Sb)$	1000	7
^{238}U	$^{132}(Te + Sb)$	3000	7
^{238}U	$^{132}(Te + Sb)$	≈10,000	7.6
^{238}U	$^{131}(Te + Sb + Sn)$	150	11
^{238}U	^{129}Te	170	17
^{238}U	$^{127}(Te + Sb + Sn + In)$	600	11
^{238}U	$^{127}(Te + Sb + Sn + In)$	≈10,000	5.5
^{238}U	^{127}Te	170	14
^{238}U	$^{118}(Te + I)$	600	0.8
^{238}U	$^{118}(Te + I)$	≈10,000	4.2
^{238}U	$^{131}(Sb + Sn)$	170	7.9
^{238}U	$^{131}(Sb + Sn)$	570	3.9
^{238}U	$^{131}(Sb + Sn)$	≈10,000	2.4
^{238}U	$^{129}(Sb + Sn)$	170	11
^{238}U	$^{129}(Sb + Sn)$	450	3.7
^{238}U	$^{129}(Sb + Sn)$	570	3.0
^{238}U	$^{129}(Sb + Sn)$	≈10,000	1.5
^{238}U	^{129}Sb	450	2.9
^{238}U	^{128}Sb	450	6
^{238}U	$^{127}(Sb + Sn)$	170	19
^{238}U	$^{127}(Sb + Sn)$	450	12.5
^{238}U	^{127}Sb	450	8.7
^{238}U	^{126}Sb	450	10.5
^{238}U	^{126}Sb	570	10
^{238}U	^{126}Sb	≈10,000	3
^{238}U	$^{125}(Sb + Sn + In)$	450	24
^{238}U	^{125}Sb	450	12
^{238}U	^{124}Sb	450	14.7
^{238}U	^{124}Sb	570	14.4
^{238}U	^{124}Sb	≈10,000	3.8
^{238}U	^{122}Sb	450	12.7
^{238}U	^{122}Sb	570	12.3
^{238}U	^{122}Sb	≈10,000	2.8
^{238}U	^{120}Sb	570	9.5
^{238}U	^{120}Sb	≈10,000	3.0
^{238}U	^{119}Sb	570	9.2
^{238}U	^{117}Sb	450	1.8
^{238}U	^{117}Sb	570	2.9
^{238}U	^{117}Sb	≈10,000	2.8
^{238}U	^{116}Sb	450	0.8
^{238}U	^{116}Sb	570	1.3
^{238}U	^{116}Sb	≈10,000	2.2
^{238}U	$^{115}(Sb + Te)$	450	0.3
^{238}U	$^{115}(Sb + Te)$	570	0.7
^{238}U	$^{115}(Sb + Te)$	≈10,000	4
^{238}U	^{129}Sn	≈10,000	1.5
^{238}U	^{128}Sn	450	1.7
^{238}U	^{128}Sn	≈10,000	2.5
^{238}U	^{127}Sn	≈10,000	3.8
^{238}U	$^{123}(Sn + Cd + In)$	450	25
^{238}U	$^{113}(Sn + Sb)$	450	0.48
^{238}U	^{111}Sn	≈10,000	2.2
^{238}U	^{119}In	570	4.8
^{238}U	^{119}In	≈10,000	1.6
^{238}U	^{117}In	450	14.7
^{238}U	^{117}In	570	19
^{238}U	^{117}In	3000	11
^{238}U	^{117}In	≈10,000	6
^{238}U	$^{111}(In + Sn)$	380	0.6
^{238}U	$^{111}(In + Sn)$	570	1.6
^{238}U	$^{111}(In + Sn)$	3000	4.6
^{238}U	$^{111}(In + Sn)$	≈10,000	5.7
^{238}U	^{110}In	450	0.27
^{238}U	$^{109}(In + Sn)$	570	0.11
^{238}U	$^{109}(In + Sn)$	3000	1.9
^{238}U	$^{109}(In + Sn)$	≈10,000	2.6
^{238}U	^{107}In	≈10,000	1.2
^{238}U	^{119}Cd	570	0.7
^{238}U	^{119}Cd	≈10,000	0.7
^{238}U	$^{117}(Cd + Ag)$	450	41
^{238}U	$^{117}(Cd + Ag)$	570	41
^{238}U	$^{117}(Cd + Ag)$	≈10,000	8.8
^{238}U	$^{115}(Cd + Ag + Pd)$	100	28
^{238}U	$^{115}(Cd + Ag + Pd)$	150	31
^{238}U	$^{115}(Cd + Ag + Pd)$	200	34
^{238}U	$^{115}(Cd + Ag + Pd)$	340	34
^{238}U	$^{115}(Cd + Ag + Pd)$	450	49
^{238}U	$^{115}(Cd + Ag + Pd)$	3000	21
^{238}U	$^{115}(Cd + Ag + Pd)$	≈10,000	20
^{238}U	^{109}Cd	3000	3.6

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{109}Cd	≈10,000	3.4
^{238}U	^{107}Cd	≈10,000	5.3
^{238}U	$^{115}(Ag + Pd)$	100	20
^{238}U	$^{115}(Ag + Pd)$	150	20
^{238}U	$^{115}(Ag + Pd)$	200	20
^{238}U	$^{115}(Ag + Pd)$	340	20
^{238}U	$^{115}(Ag + Pd)$	450	20
^{238}U	$^{113}(Ag + Pd + Rh)$	100	32
^{238}U	$^{113}(Ag + Pd + Rh)$	150	32
^{238}U	$^{113}(Ag + Pd + Rh)$	200	32
^{238}U	$^{113}(Ag + Pd + Rh)$	340	32
^{238}U	$^{113}(Ag + Pd + Rh)$	≈10,000	14
^{238}U	^{112}Ag	100	1
^{238}U	^{112}Ag	200	5
^{238}U	^{112}Ag	340	9
^{238}U	^{112}Ag	≈10,000	9.4
^{238}U	$^{111}(Ag + Pd + Rh + Ru)$	100	50
^{238}U	$^{111}(Ag + Pd + Rh + Ru)$	170	53
^{238}U	$^{111}(Ag + Pd + Rh + Ru)$	190	53
^{238}U	$^{111}(Ag + Pd + Rh + Ru)$	340	48.5
^{238}U	$^{111}(Ag + Pd + Rh + Ru)$	≈10,000	24
^{238}U	^{105}Ag	450	0.22
^{238}U	^{105}Ag	≈10,000	5.3
^{238}U	^{103}Ag	≈10,000	1.9
^{238}U	$^{112}(Pd + Rh + Ru)$	450	38
^{238}U	$^{112}(Pd + Rh + Ru)$	720	29
^{238}U	$^{112}(Pd + Rh + Ru)$	3000	16.9
^{238}U	$^{112}(Pd + Rh + Ru)$	≈10,000	14
^{238}U	$^{111}(Pd + Rh + Ru)$	340	39
^{238}U	$^{111}(Pd + Rh + Ru)$	≈10,000	17
^{238}U	$^{109}(Pd + Rh + Ru)$	450	60
^{238}U	$^{109}(Pd + Rh + Ru)$	3000	21.4
^{238}U	$^{109}(Pd + Rh + Ru)$	≈10,000	20
^{238}U	$^{103}(Pd + Ag)$	450	0.4
^{238}U	$^{103}(Pd + Ag)$	3000	3.6
^{238}U	$^{103}(Pd + Ag)$	≈10,000	4.6
^{238}U	^{101}Pd	3000	2.0
^{238}U	^{101}Pd	≈10,000	2.7
^{238}U	^{100}Pd	3000	0.88
^{238}U	^{100}Pd	≈10,000	1.0
^{238}U	^{105}Rh	170	7.5
^{238}U	$^{106}(Ru + Tc + Mo)$	170	50
^{238}U	$^{106}(Ru + Tc + Mo)$	340	52
^{238}U	$^{106}(Ru + Tc + Mo)$	≈10,000	21
^{238}U	$^{105}(Ru + Tc + Mo)$	170	56
^{238}U	$^{105}(Ru + Tc + Mo)$	≈10,000	23
^{238}U	$^{103}(Ru + Tc + Mo + Nb)$	170	43
^{238}U	$^{103}(Ru + Tc + Mo + Nb)$	340	42
^{238}U	$^{103}(Ru + Tc + Mo + Nb)$	≈10,000	23
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	100	69
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	170	55
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	200	53
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	340	59
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	720	49
^{238}U	$^{99}(Mo + Nb + Zr + Y)$	≈10,000	27
^{238}U	$^{98}(Nb + Zr + Y)$	170	7.8
^{238}U	^{97}Nb	170	9.0
^{238}U	^{96}Nb	100	2
^{238}U	^{96}Nb	170	3.8
^{238}U	^{96}Nb	200	4
^{238}U	^{96}Nb	340	7
^{238}U	^{95}Nb	170	2.7
^{238}U	$^{97}(Zr + Y + Sr)$	100	50
^{238}U	$^{97}(Zr + Y + Sr)$	170	32
^{238}U	$^{97}(Zr + Y + Sr)$	200	50
^{238}U	$^{97}(Zr + Y + Sr)$	340	42
^{238}U	$^{95}(Zr + Y + Sr + Rb)$	170	33
^{238}U	$^{93}(Y + Sr + Rb + Kr)$	100	49
^{238}U	$^{93}(Y + Sr + Rb + Kr)$	170	40
^{238}U	$^{93}(Y + Sr + Rb + Kr)$	200	38
^{238}U	$^{93}(Y + Sr + Rb + Kr)$	340	38
^{238}U	$^{92}(Y + Sr + Rb + Kr)$	170	12
^{238}U	^{91}Y	170	10
^{238}U	^{90}Y	100	0.11
^{238}U	^{90}Y	170	2.0
^{238}U	^{90}Y	200	3.7
^{238}U	^{90}Y	340	7.2
^{238}U	$^{92}(Sr + Rb + Kr)$	170	6.2
^{238}U	$^{92}(Sr + Rb + Kr)$	340	40
^{238}U	$^{91}(Sr + Rb + Kr)$	170	35
^{238}U	$^{91}(Sr + Rb + Kr)$	340	38
^{238}U	$^{90}(Sr + Rb + Kr)$	170	27
^{238}U	$^{89}(Sr + Rb + Kr + Br)$	100	30
^{238}U	$^{89}(Sr + Rb + Kr + Br)$	170	31
^{238}U	$^{89}(Sr + Rb + Kr + Br)$	200	30
^{238}U	$^{89}(Sr + Rb + Kr + Br)$	340	33
^{238}U	^{95}Rb	≈10,000	0.6
^{238}U	^{94}Rb	≈10,000	1.3
^{238}U	^{93}Rb	≈10,000	1.9
^{238}U	^{92}Rb	≈10,000	2.9
^{238}U	^{91}Rb	≈10,000	3.2
^{238}U	^{90}Rb	≈10,000	3.3
^{238}U	^{89}Rb	≈10,000	4.2
^{238}U	^{88}Rb	≈10,000	4.7
^{238}U	^{87}Rb	≈10,000	5.8
^{238}U	^{86}Rb	100	0.6
^{238}U	^{86}Rb	170	2.3
^{238}U	^{86}Rb	200	2.3
^{238}U	^{86}Rb	380	5.6
^{238}U	^{86}Rb	680	8.3
^{238}U	^{86}Rb	1000	10.8
^{238}U	^{86}Rb	3000	8.5
^{238}U	^{86}Rb	≈10,000	6.4
^{238}U	^{85}Rb	≈10,000	7.0
^{238}U	^{84}Rb	200	0.8
^{238}U	^{84}Rb	380	1.7
^{238}U	^{84}Rb	680	3.6
^{238}U	^{84}Rb	1000	6.9

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{84}Rb	3000	5.4
^{238}U	^{84}Rb	≈10,000	6.8
^{238}U	^{83}Rb	680	3.6
^{238}U	^{83}Rb	≈10,000	6.7
^{238}U	^{82}Rb	≈10,000	5.6
^{238}U	^{81}Rb	≈10,000	4.6
^{238}U	^{80}Rb	≈10,000	3.5
^{238}U	^{79}Rb	≈10,000	1.8
^{238}U	^{78}Rb	≈10,000	0.56
^{238}U	$^{84}(Br + Se)$	170	2.7
^{238}U	$^{84}(Br + Se)$	340	3.3
^{238}U	$^{83}(Br + Se)$	100	1.5
^{238}U	$^{83}(Br + Se)$	150	1.5
^{238}U	$^{83}(Br + Se)$	200	1.5
^{238}U	$^{83}(Br + Se)$	340	3
^{238}U	^{82}Br	100	0.8
^{238}U	^{82}Br	150	1.0
^{238}U	^{82}Br	200	1.5
^{238}U	^{82}Br	340	2
^{238}U	^{80m}Br	100	0.4
^{238}U	^{80m}Br	170	0.35
^{238}U	^{80m}Br	200	0.9
^{238}U	^{80m}Br	340	2
^{238}U	^{72}Se	3000	0.19
^{238}U	^{78}As	170	2.5
^{238}U	$^{77}As + ^{77}Ge$	170	4.8
^{238}U	^{76}As	150	0.8
^{238}U	^{76}As	340	0.21
^{238}U	^{74}As	170	0.034
^{238}U	^{74}As	3000	5.1
^{238}U	^{72}As	3000	2.4
^{238}U	^{71}As	3000	0.92
^{238}U	$^{78}Ge + ^{78}Ga$	150	6.7
^{238}U	$^{77}Ge + ^{77}Ga$	170	2.9
^{238}U	^{67}Ge	3000	0.033
^{238}U	^{66}Ge	3000	0.004
^{238}U	$^{73}(Ga + Zn)$	170	1.95
^{238}U	$^{73}(Ga + Zn)$	3000	2.3
^{238}U	$^{73}(Ga + Zn)$	≈10,000	5.2
^{238}U	^{72}Ga	170	0.53
^{238}U	^{72}Ga	3000	4.2
^{238}U	^{72}Ga	≈10,000	4.6
^{238}U	^{68}Ga	≈10,000	6.0
^{238}U	^{67}Ga	3000	1.3
^{238}U	^{66}Ga	3000	0.49
^{238}U	^{72}Zn	340	2.1
^{238}U	^{72}Zn	3000	1.3
^{238}U	^{72}Zn	≈10,000	0.58
^{238}U	$^{67}Cu + ^{67}Ni$	100	0.2
^{238}U	$^{67}Cu + ^{67}Ni$	150	0.4
^{238}U	$^{67}Cu + ^{67}Ni$	200	0.7
^{238}U	$^{67}Cu + ^{67}Ni$	340	2.1
^{238}U	$^{67}Cu + ^{67}Ni$	720	3.1
^{238}U	$^{67}Cu + ^{67}Ni$	3000	4.7
^{238}U	$^{67}Cu + ^{67}Ni$	≈10,000	3.4
^{238}U	^{64}Cu	170	0.026
^{238}U	^{64}Cu	≈10,000	4.6
^{238}U	^{61}Cu	≈10,000	0.45
^{238}U	$^{66}Ni + ^{66}Co$	100	0.3
^{238}U	$^{66}Ni + ^{66}Co$	140	0.5
^{238}U	$^{66}Ni + ^{66}Co$	190	1.2
^{238}U	$^{66}Ni + ^{66}Co$	340	0.9
^{238}U	$^{66}Ni + ^{66}Co$	3000	1.8
^{238}U	$^{66}Ni + ^{66}Co$	≈10,000	1.2
^{238}U	$^{65}Ni + ^{65}Co$	3000	3.6
^{238}U	$^{65}Ni + ^{65}Co$	≈10,000	2.4
^{238}U	$^{61}Co + ^{61}Fe$	≈10,000	5.5
^{238}U	$^{59}Fe + ^{59}Mn$	340	0.18
^{238}U	$^{59}Fe + ^{59}Mn$	≈10,000	2.6
^{238}U	^{52}Fe	≈10,000	0.038
^{238}U	$^{56}Mn + ^{56}Cr$	≈10,000	5.7
^{238}U	^{52}Mn	≈10,000	0.85
^{238}U	^{49}Sc	590	0.37
^{238}U	^{49}Sc	≈10,000	1.8
^{238}U	^{48}Sc	590	0.37
^{238}U	^{48}Sc	3000	4.2
^{238}U	^{48}Sc	≈10,000	3
^{238}U	^{47}Sc	590	0.36
^{238}U	^{47}Sc	3000	3.0
^{238}U	^{47}Sc	≈10,000	6.0
^{238}U	^{46}Sc	590	0.20
^{238}U	^{46}Sc	3000	2.2
^{238}U	^{46}Sc	≈10,000	6.7
^{238}U	^{44}Sc	590	0.046
^{238}U	^{44}Sc	≈10,000	2.2
^{238}U	^{43}Sc	590	0.012
^{238}U	^{43}Sc	≈10,000	0.7
^{238}U	$^{47}Ca + ^{47}K$	3000	1.0
^{238}U	$^{47}Ca + ^{47}K$	≈10,000	1.4
^{238}U	$^{45}Ca + ^{45}K$	3000	3.2
^{238}U	$^{45}Ca + ^{45}K$	≈10,000	4.8
^{238}U	$^{44}K + ^{45}K$	≈10,000	2.5
^{238}U	$^{43}K + ^{43}Ar$	3000	3.5
^{238}U	$^{43}K + ^{43}Ar$	≈10,000	3.8
^{238}U	^{42}K	3000	3.5
^{238}U	^{42}K	≈10,000	6.2
^{238}U	^{39}Cl	≈10,000	2.1
^{238}U	^{38}Cl	≈10,000	3.8
^{238}U	^{38}S	≈10,000	0.65
^{238}U	$^{35}S + ^{35}P$	≈10,000	3.0
^{238}U	$^{33}P + ^{33}Si$	≈10,000	0.74
^{238}U	$^{32}P + ^{32}Si$	600	0.025
^{238}U	$^{32}P + ^{32}Si$	≈10,000	1.5
^{238}U	$^{31}Si + ^{31}Al$	≈10,000	2.0
^{238}U	^{28}Mg	700	0.115
^{238}U	^{28}Mg	≈10,000	3.2
^{238}U	^{29}Na	≈10,000	0.05
^{238}U	^{28}Na	≈10,000	0.1

Table continues

Table 3 (Continued)

Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)	Target	Product: A ⩾ 6	Proton Energy (MeV)	Partial Cross Section (mb)
^{238}U	^{27}Na	≈10,000	3	^{238}U	^{36}Ar	29,000	0.2
^{238}U	^{26}Na	≈10,000	6	^{238}U	^{37}Ar	3000	0.4
^{238}U	^{25}Na	≈10,000	13	^{238}U	^{37}Ar	29,000	1.6
^{238}U	$^{24}Na + ^{24}Ne$	340	0.05	^{238}U	$^{38}(Cl + Ar + K)$	3000	11
^{238}U	$^{24}Na + ^{24}Ne$	600	0.15	^{238}U	$^{38}(Cl + Ar + K)$	29,000	15
^{238}U	$^{24}Na + ^{24}Ne$	1000	0.63	^{238}U	$^{39}(Cl + Ar)$	3000	7.0
^{238}U	$^{24}Na + ^{24}Ne$	3000	6	^{238}U	$^{39}(Cl + Ar)$	29,000	13
^{238}U	$^{24}Na + ^{24}Ne$	≈10,000	14	^{238}U	^{42}Ar	3000	1.2
^{238}U	^{23}Na	≈10,000	15	^{238}U	^{42}Ar	29,000	2.0
^{238}U	^{22}Na	3000	0.8	^{238}U	^{78}Kr	3000	1.0
^{238}U	^{22}Na	≈10,000	2.4	^{238}U	^{78}Kr	29,000	2.7
^{238}U	^{21}Na	≈10,000	0.1	^{238}U	$^{79}(Kr + Rb)$	29,000	5.3
^{238}U	^{24}Ne	1000	0.23	^{238}U	$^{80}(Kr + Rb)$	3000	14
^{238}U	^{24}Ne	3000	1.7	^{238}U	$^{80}(Kr + Rb)$	29,000	14
^{238}U	^{18}F	660	0.03	^{238}U	$^{81}(Kr + Rb)$	3000	10
^{238}U	^{18}F	1000	0.13	^{238}U	$^{81}(Kr + Rb)$	29,000	11
^{238}U	^{18}F	3000	1.2	^{238}U	$^{82}(Br + Kr + Rb + Sr)$	3000	20
^{238}U	^{18}F	≈10,000	2.6	^{238}U	$^{82}(Br + Kr + Rb + Sr)$	29,000	20
^{238}U	^{17}N	1000	1.1	^{238}U	$^{83}(Br + Kr + Rb + Sr + Y)$	3000	30
^{238}U	^{17}N	3000	6.3	^{238}U	$^{83}(Br + Kr + Rb + Sr + Y)$	29,000	28
^{238}U	^{13}N	1000	0.025	^{238}U	$^{84}(Br + Kr + Rb)$	3000	26
^{238}U	^{13}N	2900	0.105	^{238}U	$^{84}(Br + Kr + Rb)$	29,000	23
^{238}U	^{17}C	≈10,000	0.3	^{238}U	$^{85}(Br + Kr)$	3000	8
^{238}U	^{16}C	1000	0.31	^{238}U	$^{85}(Br + Kr)$	29,000	8
^{238}U	^{16}C	3000	1.8	^{238}U	^{86}Kr	3000	12
^{238}U	^{16}C	≈10,000	2.0	^{238}U	^{86}Kr	29,000	13
^{238}U	^{15}C	≈10,000	4	^{238}U	^{122}Xe	29,000	5
^{238}U	^{14}C	≈10,000	22	^{238}U	$^{124}(Xe + Cs)$	3000	4.5
^{238}U	^{13}C	≈10,000	37	^{238}U	$^{124}(Xe + Cs)$	29,000	6.6
^{238}U	^{12}C	≈10,000	25	^{238}U	$^{125}(Xe + Cs + Ba)$	3000	6.0
^{238}U	^{13}B	≈10,000	9	^{238}U	$^{125}(Xe + Cs + Ba)$	29,000	6.4
^{238}U	^{12}B	≈10,000	21	^{238}U	$^{126}(Xe + Cs + Ba)$	3000	8.2
^{238}U	^{11}B	≈10,000	69	^{238}U	$^{126}(Xe + Cs + Ba)$	29,000	10
^{238}U	^{10}B	≈10,000	16	^{238}U	$^{127}(Xe + Cs + Ba + La)$	3000	7.5
^{238}U	^{12}Be	≈10,000	2.5	^{238}U	$^{127}(Xe + Cs + Ba + La)$	29,000	9.4
^{238}U	^{11}Be	≈10,000	4.8	^{238}U	$^{128}(I + Xe + Cs + Ba + La)$	3000	9.3
^{238}U	^{10}Be	≈10,000	55	^{238}U	$^{128}(I + Xe + Cs + Ba + La)$	29,000	12.9
^{238}U	^{9}Be	≈10,000	48	^{238}U	$^{129}(Xe + Cs + Ba + La)$	3000	8.8
^{238}U	^{7}Be	100	0.02	^{238}U	$^{129}(Xe + Cs + Ba + La)$	29,000	10.4
^{238}U	^{7}Be	3000	7	^{238}U	$^{130}(I + Xe + Cs)$	3000	8.1
^{238}U	^{7}Be	≈10,000	18	^{238}U	$^{130}(I + Xe + Cs)$	29,000	8.2
^{238}U	^{9}Li	1000	1.7	^{238}U	$^{131}(Te + I + Xe + Cs$		
^{238}U	^{9}Li	3000	7.5	^{238}U	$+ Ba + La + Ce + Sb)$	3000	16
^{238}U	^{9}Li	≈10,000	15	^{238}U	$^{131}(Te + I + Xe + Cs$		
^{238}U	^{8}Li	≈10,000	49	^{238}U	$+ Ba + La + Ce + Sb)$	29,000	23.5
^{238}U	^{7}Li	≈10,000	164	^{238}U	$^{132}(Te + I + Xe + Cs + Sb)$	3000	13
^{238}U	^{6}Li	≈10,000	73	^{238}U	$^{132}(Te + I + Xe + Cs + Sb)$	29,000	16
^{238}U	^{6}He	≈10,000	87	^{238}U	$^{133}(I + Xe + Te)$	3000	13
^{238}U	$^{20}(F + Ne)$	3000	10	^{238}U	$^{133}(I + Xe + Te)$	29,000	26
^{238}U	$^{20}(F + Ne)$	29,000	38	^{238}U	$^{134}(I + Xe + Te)$	3000	10.7
^{238}U	$^{21}(F + Ne + Na)$	3000	10	^{238}U	$^{134}(I + Xe + Te)$	29,000	14.5
^{238}U	$^{21}(F + Ne + Na)$	29,000	38	^{238}U	$^{135}(Xe + I + Te)$	3000	15
^{238}U	^{22}Ne	3000	10	^{238}U	$^{136}(Xe + I + Te)$	3000	8.4
^{238}U	^{22}Ne	29,000	37	^{238}U	$^{136}(Xe + I + Te)$	29,000	12

Table continues

Table 4
References for Target Nuclei with Z ⩾ 29

Target	References
^{63}Cu	45, 71
^{65}Cu	45, 60, 71, 73, 94, 111, 112
Cu	38, 44, 62, 65, 69-71, 88, 89, 95, 99, 106, 111, 113-127
^{64}Zn	45
^{66}Zn	112
^{68}Zn	92
Zn	65, 99, 128, 129
^{69}Ga	94
^{71}Ga	94
Ga	65
^{70}Ge	112
^{72}Ge	112
Ge	65
^{75}As	65, 92, 98, 132-136
^{76}Se	112
Se	65, 137
^{79}Br	112, 135, 138
^{81}Br	112, 135, 138
Kr	41
Sr	137
^{89}Y	60, 132, 137, 139-141, 210
^{90}Zr	142
^{96}Zr	135, 143
Zr	137
^{93}Nb	38, 127, 137, 144, 145
^{96}Mo	143
^{100}Mo	45
Mo	127, 137
^{96}Ru	143
^{103}Rh	132, 146
Pd	127, 137
Ag	38, 44, 62, 70, 88, 110, 118, 123, 124, 129, 132, 147-156, 259
In	127, 129, 132, 137, 148, 157-159
Cd	250
Sn	89, 137
Sb	89, 161
Te	162-164
^{127}I	132, 135, 165, 166
Xe	41
^{133}Cs	60, 167
Ba	168
^{139}La	38, 141, 169-171
^{142}Ce	135, 172, 173, 210
^{141}Pr	38, 132
Nd	38
^{165}Ho	110, 132
^{170}Er	174
Er	174
^{181}Ta	38, 45, 87, 118, 127, 132, 137, 141, 146, 156, 171, 175-181, 210
^{186}W	92, 135
W	38
^{187}Re	92, 135
Re	110, 132
^{193}Ir	182
Ir	182

Table continues

Table 4 (Continued)

Target	References
^{197}Au	60, 62, 73, 87, 88, 110, 118, 123, 124, 126, 127, 132, 137, 141, 146, 147, 154, 156, 159, 169, 171, 176, 183-189, 210
Pb	38, 44, 70, 118, 127, 137, 156, 190-194, 228
^{209}Bi	70, 89, 132, 146, 176, 189, 195-200
^{232}Th	110, 132, 197, 201-207
^{235}U	191, 206
^{238}U	38, 89, 90, 110, 123, 124; 127, 129, 137, 141, 147, 154, 156, 159, 171, 177, 178, 189, 191 192, 202, 203, 206, 208-227, 229-231

Part III—α-Nucleus Interactions

Table 5 is a comparison of cross sections induced by α particles and protons with heavy target nuclei. The reference numbers are listed in Table 6. Some cross sections are cumulative; see Table 3.

Table 5
Partial Cross Sections for α-Particle Projectiles as Well as Protons

Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)	
			α	p
^{12}C	^{11}C	22	0.5	50
^{12}C	^{11}C	27	4	80
^{12}C	^{11}C	31	12	90
^{12}C	^{11}C	35	20	91
^{12}C	^{11}C	40	24	90
^{12}C	^{11}C	50	43	85
^{12}C	^{11}C	100	38	63
^{12}C	^{11}C	150	44	50
^{12}C	^{11}C	200	48	38
^{12}C	^{11}C	300	52	35
^{12}C	^{11}C	380	57	33
^{12}C	^{11}C	900	49	29
^{16}O	^{15}O	900	47	28
^{16}O	^{13}N	900	7	5
^{16}O	^{11}C	900	18.5	10
^{16}O	^{7}Be	900	18.5	8.5
^{27}Al	^{24}Na	40	0.3	1.6
^{27}Al	^{24}Na	60	11	8.6
^{27}Al	^{24}Na	80	32	10
^{27}Al	^{24}Na	100	33	10
^{27}Al	^{24}Na	120	30	10
^{27}Al	^{24}Na	200	28	9.5
^{27}Al	^{24}Na	300	25	10.5
^{27}Al	^{24}Na	380	24	11
^{27}Al	^{22}Na	60	34	28
^{27}Al	^{22}Na	80	18	23
^{27}Al	^{22}Na	100	25	20
^{27}Al	^{22}Na	120	27	19
^{27}Al	^{18}F	920	12.5	8
^{51}V	^{48}Sc	60	1.5	—
^{51}V	^{48}Sc	80	4	—
^{51}V	^{48}Sc	100	3	—
^{51}V	^{48}Sc	120	4	—
^{51}V	^{47}Sc	60	2	1.2
^{51}V	^{47}Sc	80	9	—
^{51}V	^{47}Sc	100	17	8
^{51}V	^{47}Sc	120	17	—
^{51}V	^{46}Sc	60	18	4
^{51}V	^{46}Sc	80	12	—
^{51}V	^{46}Sc	100	46	7
^{51}V	^{46}Sc	120	52	—
^{12}C	^{10}Be	100	5	—
^{12}C	^{10}Be	140	6	1.1
^{12}C	^{9}Be	100	20	—
^{12}C	^{9}Be	140	20	3.2
^{12}C	^{7}Be	100	27	—
^{12}C	^{7}Be	140	30	10
^{12}C	^{7}Be	920	20	10
^{12}C	^{7}Li	100	60	—
^{12}C	^{7}Li	140	55	8
^{12}C	^{6}Li	100	51	—
^{12}C	^{6}Li	140	55	10
Cu	^{64}Cu	380	34.3	22.5
Cu	^{62}Cu	380	83.2	48
Cu	^{61}Cu	380	52	23
Cu	^{60}Cu	380	6.2	—
Cu	^{65}Ni	380	1.9	—
Cu	^{57}Ni	380	3.4	1.8
Cu	^{59}Fe	380	1.8	0.8
Cu	^{56}Mn	380	2.6	2.5
Cu	^{52}Mn	380	4.2	7.1
Cu	^{51}Mn	380	1.3	1.6
Cu	^{51}Cr	380	0.8	7.1
Cu	^{49}Cr	380	0.3	0.9
Cu	^{38}Cl	380	0.1	0.06
Cu	^{28}Mg	320	0.012	—
Cu	^{28}Mg	500	0.037	—
Cu	^{28}Mg	700	0.091	0.049
Cu	^{28}Mg	880	0.19	—
Cu	^{24}Na	320	0.083	0.031

Table continues

Table 5 (Continued)

Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)	
			α	p
Cu	^{24}Na	500	0.28	—
Cu	^{24}Na	720	0.70	0.37
Cu	^{24}Na	880	1.4	—
^{93}Nb	^{90}Nb	320	129	55
^{93}Nb	^{90}Nb	500	97	47
^{93}Nb	^{90}Nb	720	84	37
^{93}Nb	^{90}Nb	880	72	—
^{93}Nb	^{89}Nb	320	47	22
^{93}Nb	^{89}Nb	500	36	18
^{93}Nb	^{89}Nb	720	28	14
^{93}Nb	^{89}Nb	880	27	—
^{93}Nb	^{89}Zr	320	111	60
^{93}Nb	^{89}Zr	500	81	45
^{93}Nb	^{89}Zr	720	74	38
^{93}Nb	^{89}Zr	880	63	—
^{93}Nb	^{88}Zr	320	145	72
^{93}Nb	^{88}Zr	500	105	54
^{93}Nb	^{88}Zr	720	93	42
^{93}Nb	^{88}Zr	880	80	—
^{93}Nb	^{87}Zr	320	92	42
^{93}Nb	^{87}Zr	500	66	33
^{93}Nb	^{87}Zr	720	56	26
^{93}Nb	^{87}Zr	880	48	—
^{93}Nb	^{67}Cu	320	0.011	0.005
^{93}Nb	^{67}Cu	500	0.072	0.029
^{93}Nb	^{67}Cu	720	0.17	0.12
^{93}Nb	^{67}Cu	880	0.26	—
^{93}Nb	^{64}Cu	320	0.17	0.10
^{93}Nb	^{64}Cu	500	1.4	0.73
^{93}Nb	^{64}Cu	720	4.3	2.8
^{93}Nb	^{64}Cu	880	6.3	—
^{93}Nb	^{61}Cu	320	0.044	0.034
^{93}Nb	^{61}Cu	500	0.65	0.42
^{93}Nb	^{61}Cu	720	2.6	1.7
^{93}Nb	^{61}Cu	880	4.8	—
^{93}Nb	^{66}Ni	320	0.0011	0.0004
^{93}Nb	^{66}Ni	500	0.007	0.003
^{93}Nb	^{66}Ni	720	0.019	0.008
^{93}Nb	^{66}Ni	880	0.03	—
^{93}Nb	^{65}Ni	320	0.0061	0.0032
^{93}Nb	^{65}Ni	500	0.041	0.022
^{93}Nb	^{65}Ni	720	0.12	0.063
^{93}Nb	^{65}Ni	880	0.17	—
^{93}Nb	^{57}Ni	320	0.0054	0.0018
^{93}Nb	^{57}Ni	500	0.036	0.018
^{93}Nb	^{57}Ni	720	0.14	0.073
^{93}Nb	^{57}Ni	880	0.24	—
^{93}Nb	^{24}Na	320	0.043	0.015
^{93}Nb	^{24}Na	500	0.113	0.043
^{93}Nb	^{24}Na	720	0.30	0.13
^{93}Nb	^{24}Na	880	0.53	—
^{93}Nb	^{22}Na	320	0.047	0.016
^{93}Nb	^{22}Na	500	0.086	0.026
^{93}Nb	^{22}Na	720	0.20	0.073
^{93}Nb	^{22}Na	880	0.25	—
Ag	^{28}Mg	320	0.004	0.001
Ag	^{28}Mg	500	0.011	
Ag	^{28}Mg	700	0.026	0.012
Ag	^{28}Mg	880	0.049	—
Ag	^{24}Na	320	0.032	0.010

Table continues

Table 5 (Continued)

Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)	
			α	p
Ag	^{24}Na	500	0.095	0.047
Ag	^{24}Na	700	0.23	0.10
Ag	^{24}Na	880	0.45	—
Sb	^{121}Te	380	18	—
Sb	^{119}Te	380	67	—
Sb	^{118}Te	380	29	—
Sb	^{124}Sb	380	15	—
Sb	^{122}Sb	380	72	—
Sb	^{119}Sb	380	180	—
Sb	^{118}Sb	380	100	—
Sb	^{121}Sn	380	2.2	—
Sb	^{117m}Sn	380	28	—
Sb	^{113}Sn	380	30	—
Sb	^{108}Sn	380	8	—
Sb	^{114m}In	380	23	—
Sb	^{111}In	380	160	—
Sb	^{115m}Cd	380	0.35	—
Sb	^{115}Cd	380	1.1	—
Sb	^{109}Cd	380	14	—
Sb	^{107}Cd	380	43	—
Sb	^{112}Ag	380	0.57	—
Sb	^{111}Ag	380	2.3	—
Sb	^{106}Ag	380	3.5	—
Sb	^{105}Ag	380	1.7	—
Sb	^{112}Pd	380	0.004	—
Sb	^{109}Pd	380	0.12	—
Sb	^{103}Pd	380	4.7	—
Sb	^{101}Pd	380	1.1	—
Sb	^{100}Pd	380	1.0	—
Sb	^{97}Ru	380	0.32	—
^{127}I	^{126}I	250	84 ± 21	81 ± 20
^{127}I	^{126}I	500	70 ± 18	63 ± 16
^{127}I	^{126}I	700-750	48 ± 12	55 ± 14
^{127}I	^{125}I	250	39 ± 10	50 ± 12
^{127}I	^{125}I	500	32 ± 8	21 ± 5
^{127}I	^{125}I	700-750	20 ± 5	15 ± 6
^{127}I	^{124}I	250	37 ± 9	50 ± 12
^{127}I	^{124}I	500	32 ± 8	25 ± 6
^{127}I	^{124}I	700-750	21 ± 5	19 ± 5
^{127}I	^{123}I	250	75 ± 20	51 ± 13
^{127}I	^{123}I	500	47 ± 12	27 ± 7
^{127}I	^{123}I	700-750	31 ± 7	17 ± 4
^{127}I	^{121}I	250	26 ± 5	59 ± 15
^{127}I	^{121}I	500	41 ± 10	25 ± 6
^{127}I	^{121}I	700-750	32 ± 7	13 ± 4
^{127}I	^{120}I	250	16 ± 4	30 ± 8
^{127}I	^{120}I	500	23 ± 6	15 ± 4
^{127}I	^{120}I	700-750	14 ± 4	11 ± 3
^{181}Ta	^{149g}Tb	500	5.7	—
^{181}Ta	^{149g}Tb	700	16.5	14.5
^{181}Ta	^{149g}Tb	880	20.0	—
^{197}Au	^{149g}Tb	500	0.06	—
^{197}Au	^{149g}Tb	700	0.93	1.2
^{197}Au	^{149g}Tb	880	3.9	—
^{197}Au	^{28}Mg	320	0.021	—
^{197}Au	^{28}Mg	500	0.062	—
^{197}Au	^{28}Mg	700	0.10	0.054
^{197}Au	^{28}Mg	880	0.20	—
^{197}Au	^{24}Na	320	0.032	—
^{197}Au	^{24}Na	500	0.11	—
^{197}Au	^{24}Na	700	0.31	0.14
^{197}Au	^{24}Na	880	0.59	—
^{232}Th	^{139}Ba	100	26	16
^{232}Th	^{139}Ba	140	20	—
^{232}Th	^{139}Ba	190-200	17	12
^{232}Th	^{139}Ba	270	—	12
^{232}Th	^{139}Ba	310	30	—
^{232}Th	^{139}Ba	350	—	12
^{232}Th	^{139}Ba	380	10	—
^{232}Th	^{131}Ba	140	0.6	0.1
^{232}Th	^{131}Ba	190	1.0	0.6
^{232}Th	^{131}Ba	270	4.0	1.1
^{232}Th	^{131}Ba	300	—	1.4
^{232}Th	^{131}Ba	350	—	1.3
^{232}Th	^{131}Ba	380	5.9	—
^{232}Th	^{111}Ag	100	60	39
^{232}Th	^{111}Ag	140	76	—
^{232}Th	^{111}Ag	190-200	82	53
^{232}Th	^{111}Ag	270-280	76	49
^{232}Th	^{111}Ag	310	78	—
^{232}Th	^{111}Ag	350	—	45

Table continues

Table 5 (Continued)

Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)	
			α	p
^{232}Th	^{111}Ag	380	72	—
^{232}Th	^{97}Zr	100	46	33
^{232}Th	^{97}Zr	140	54	—
^{232}Tn	^{97}Zr	190-200	51	36
^{232}Th	^{97}Zr	270-280	52	36
^{232}Th	^{97}Zr	350	—	26
^{232}Th	^{97}Zr	380	36	—
^{232}Th	^{66}Ni	100	0.3	0.2
^{232}Th	^{66}Ni	140	1.2	0.5
^{232}Th	^{66}Ni	190	1.6	0.9
^{232}Th	^{66}Ni	270	2.3	1.1
^{232}Th	^{66}Ni	300	—	1.1
^{232}Th	^{66}Ni	350	—	1.2
^{232}Th	^{66}Ni	380	2.7	—
^{238}U	^{139}Ba	100	55	32
^{238}U	^{139}Ba	140	45	—
^{238}U	^{139}Ba	190-200	45	20
^{238}U	^{139}Ba	270	50	23
^{238}U	^{139}Ba	310	30	—
^{238}U	^{139}Ba	350	—	20
^{238}U	^{139}Ba	380	38	—
^{238}U	^{131}Ba	100	0.2	—
^{238}U	^{131}Ba	140	0.8	0.2
^{238}U	^{131}Ba	190	1.8	0.7
^{238}U	^{131}Ba	270	4	1.3
^{238}U	^{131}Ba	300	—	2.1
^{238}U	^{131}Ba	350	—	2.4
^{238}U	^{131}Ba	380	6.7	—
^{238}U	^{136}Cs	50	6	—
^{238}U	^{136}Cs	100	23	12
^{238}U	^{136}Cs	150	17	—
^{238}U	^{136}Cs	200	18	11
^{238}U	^{136}Cs	250	19	10
^{238}U	^{136}Cs	300	14	—
^{238}U	^{136}Cs	350	13	9
^{238}U	^{136}Cs	380	15	—
^{238}U	^{111}Ag	100	72	52
^{238}U	^{111}Ag	140	85	—
^{238}U	^{111}Ag	190-200	86	53
^{238}U	^{111}Ag	270	83	51
^{238}U	^{111}Ag	310	85	—
^{238}U	^{111}Ag	350	—	52
^{238}U	^{111}Ag	380	77	—
^{238}U	^{96}Nb	100	5.5	2
^{238}U	^{96}Nb	150	8	3
^{238}U	^{96}Nb	200	10	4
^{238}U	^{96}Nb	250	15	5
^{238}U	^{96}Nb	300	15	7
^{238}U	^{96}Nb	350	15	8
^{238}U	^{96}Nb	380	15	—
^{238}U	^{97}Zr	100	72	47
^{238}U	^{97}Zr	140	68	—
^{238}U	^{97}Zr	190-200	55	53
^{238}U	^{97}Zr	270	56	50
^{238}U	^{97}Zr	310	66	—
^{238}U	^{97}Zr	350	—	41
^{238}U	^{97}Zr	380	56	—
^{238}U	^{66}Ni	100	0.4	0.3
^{238}U	^{66}Ni	140	1.2	0.5
^{238}U	^{66}Ni	190	1.8	1.1
^{238}U	^{66}Ni	270	2.3	1.2
^{238}U	^{66}Ni	300	—	1.2
^{238}U	^{66}Ni	350	—	1.25
^{238}U	^{66}Ni	380	2.6	—
^{238}U	^{28}Mg	320	0.064	—
^{238}U	^{28}Mg	500	0.12	—
^{238}U	^{28}Mg	700	0.24	0.12
^{238}U	^{28}Mg	880	0.45	—
^{238}U	^{24}Na	320	0.094	—

Table continues

Table 5 (Continued)

Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)		Target	Product: A ⩾ 6	Total Kinetic Energy (MeV)	Partial Cross Section (mb)	
			α	p				α	p
^{238}U	^{24}Na	380	—	0.05	^{238}U	^{24}Na	700	0.50	0.23
^{238}U	^{24}Na	500	0.21	—	^{238}U	^{24}Na	880	0.88	—

Table 6
References for α-Nucleus Interactions

Target	References	Target	References
C	16, 32, 232-234	Nb	145
N	234	Ag	124
O	233	Sb	240
Al	16, 228, 235, 236	I	72
V	236	Ta	176
Ni	237, 238	Au	124, 176
Cu	114, 124	Th	203
Zr	239	U	124, 203, 215

Part IV—(p, xn) Reactions

Table 7 is a list of partial cross sections for (p, xn) reactions. The reference numbers are listed in Table 8.

Table 7
Partial Cross Sections for (p, xn) Reactions

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{7}Li	(p, n)	155	3.6
^{10}B	(p, n)	155	0.65
^{11}B	(p, n)	40	31
^{11}B	(p, n)	53	24
^{11}B	(p, n)	90	8
^{11}B	(p, n)	103	9
^{11}B	(p, n)	155	3.5
^{11}B	(p, 2n)	155	0.55
^{13}C	(p, n)	155	1.9
^{14}N	(p, n)	155	0.075
^{18}O	(p, n)	155	4.9
^{19}F	(p, n)	155	4
^{44}Ca	(p, n)	370	2
^{48}Ca	(p, n)	370	2.3
^{48}Ca	(p, 2n)	370	5.5
^{48}Ca	(p, 3n)	370	5.6
^{48}Ca	(p, 5n)	370	2.0
^{45}Sc	(p, n)	10	450
^{45}Sc	(p, n)	15	200
^{45}Sc	(p, n)	20	71
^{45}Sc	(p, n)	25	37
^{45}Sc	(p, n)	30	28
^{45}Sc	(p, n)	35	22
^{45}Sc	(p, n)	40	11
^{45}Sc	(p, n)	48	8.5
^{45}Sc	(p, n)	56	8.5
^{45}Sc	(p, n)	64	6
^{45}Sc	(p, n)	85	6
^{45}Sc	(p, n)	130	5
^{45}Sc	(p, n)	205	2.3
^{45}Sc	(p, n)	298	1.4
^{45}Sc	(p, n)	363	1.2
^{45}Sc	(p, 2n)	15	12
^{45}Sc	(p, 2n)	20	16
^{45}Sc	(p, 2n)	25	47
^{45}Sc	(p, 2n)	30	63
^{45}Sc	(p, 2n)	35	54
^{45}Sc	(p, 2n)	40	50
^{45}Sc	(p, 2n)	48	33
^{45}Sc	(p, 2n)	56	20
^{45}Sc	(p, 2n)	64	16
^{45}Sc	(p, 2n)	85	12
^{48}Ti	(p, n)	15	408
^{48}Ti	(p, n)	30	29
^{48}Ti	(p, n)	45	25
^{48}Ti	(p, n)	118	5.1
^{48}Ti	(p, n)	155	3.2
^{48}Ti	(p, n)	319	1.9
^{48}Ti	(p, n)	433	0.8
^{48}Ti	(p, n)	584	1.0
^{51}V	(p, n)	30	78
^{51}V	(p, n)	55	33
^{51}V	(p, n)	95	16
^{51}V	(p, n)	155	5
^{51}V	(p, 3n)	60	31
^{51}V	(p, 3n)	100	12
^{51}V	(p, 3n)	175	4.8
^{51}V	(p, 3n)	240	2.2
^{51}V	(p, 4n)	60	1.2
^{51}V	(p, 4n)	100	1.5
^{51}V	(p, 4n)	170	0.2
^{51}V	(p, 4n)	240	0.18
^{52}Cr	(p, n)	155	3.9
^{52}Cr	(p, n)	370	1.45
^{52}Cr	(p, n)	400	0.8
^{52}Cr	(p, 2n)	370	0.83
^{52}Cr	(p, 2n)	400	0.9
^{54}Cr	(p, n)	370	0.72
^{56}Fe	(p, n)	4.8	0.8
^{56}Fe	(p, n)	6.7	89
^{56}Fe	(p, n)	8.0	171
^{56}Fe	(p, n)	8.1	200
^{56}Fe	(p, n)	9.3	240
^{56}Fe	(p, n)	10.2	340
^{56}Fe	(p, n)	11.2	320
^{56}Fe	(p, n)	13.2	389
^{56}Fe	(p, n)	14.1	398
^{56}Fe	(p, n)	15	300
^{56}Fe	(p, n)	15.6	180
^{56}Fe	(p, n)	17.5	130

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)	Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{56}Fe	(p, n)	18.0	90	^{64}Ni	(p, n)	298	2.4
^{56}Fe	(p, n)	18.9	75	^{64}Ni	(p, n)	370	1.0
^{56}Fe	(p, n)	21.6	49	^{64}Ni	(p, n)	396	1.8
^{56}Fe	(p, n)	22.2	45	^{63}Cu	(p, n)	5	43
^{56}Fe	(p, n)	23.5	30	^{63}Cu	(p, n)	8.5	359
^{56}Fe	(p, n)	24.6	28	^{63}Cu	(p, n)	12	513
^{56}Fe	(p, n)	25.5	24	^{63}Cu	(p, n)	15	470
^{56}Fe	(p, n)	26.3	25	^{63}Cu	(p, n)	400	0.9
^{56}Fe	(p, n)	27.7	19	^{63}Cu	(p, 2n)	400	0.8
^{56}Fe	(p, n)	30.8	18	^{65}Cu	(p, n)	370	0.7
^{56}Fe	(p, n)	31.0	20	^{68}Zn	(p, n)	10	380
^{56}Fe	(p, n)	33.2	16	^{68}Zn	(p, n)	15	590
^{56}Fe	(p, n)	34.4	18	^{68}Zn	(p, n)	20	82
^{56}Fe	(p, n)	36.0	18	^{68}Zn	(p, n)	25	39
^{56}Fe	(p, n)	39.0	16	^{68}Zn	(p, n)	30	31
^{56}Fe	(p, n)	130	4.2	^{68}Zn	(p, n)	48	13
^{56}Fe	(p, n)	208	2.3	^{68}Zn	(p, n)	56	13
^{56}Fe	(p, n)	297	1.5	^{68}Zn	(p, n)	64	10
^{56}Fe	(p, n)	370	0.96	^{68}Zn	(p, n)	75	8
^{56}Fe	(p, n)	396	0.89	^{68}Zn	(p, n)	85	7
^{56}Fe	(p, n)	500	0.94	^{68}Zn	(p, n)	400	1.4
^{56}Fe	(p, n)	800	0.81	^{68}Zn	(p, 2n)	15	410
^{56}Fe	(p, n)	1500	0.82	^{68}Zn	(p, 2n)	20	430
^{56}Fe	(p, n)	2200	0.67	^{68}Zn	(p, 2n)	25	400
^{56}Fe	(p, n)	2900	0.71	^{68}Zn	(p, 2n)	30	290
^{56}Fe	(p, 2n)	15.6	3	^{68}Zn	(p, 2n)	35	120
^{56}Fe	(p, 2n)	18.0	30	^{68}Zn	(p, 2n)	40	59
^{56}Fe	(p, 2n)	18.9	32	^{68}Zn	(p, 2n)	48	39
^{56}Fe	(p, 2n)	22.2	54	^{68}Zn	(p, 2n)	56	33
^{56}Fe	(p, 2n)	23.5	65	^{68}Zn	(p, 2n)	64	26
^{56}Fe	(p, 2n)	25.5	62	^{68}Zn	(p, 2n)	75	19
^{56}Fe	(p, 2n)	26.3	59	^{68}Zn	(p, 2n)	85	15
^{56}Fe	(p, 2n)	29.5	66	^{68}Zn	(p, 2n)	400	2.3
^{56}Fe	(p, 2n)	30	58	^{68}Zn	(p, 3n)	30	61
^{56}Fe	(p, 2n)	31.0	55	^{68}Zn	(p, 3n)	35	120
^{56}Fe	(p, 2n)	34.4	33	^{68}Zn	(p, 3n)	40	91
^{56}Fe	(p, 2n)	36.0	27	^{68}Zn	(p, 3n)	48	36
^{56}Fe	(p, 2n)	39.0	18	^{68}Zn	(p, 3n)	56	23
^{56}Fe	(p, 2n)	44.6	10	^{68}Zn	(p, 3n)	64	16
^{56}Fe	(p, 2n)	45	11.5	^{68}Zn	(p, 3n)	75	12
^{56}Fe	(p, 2n)	370	0.74	^{68}Zn	(p, 3n)	85	9
^{57}Fe	(p, n)	370	1.1	^{68}Zn	(p, 3n)	400	2.3
^{57}Fe	(p, 2n)	370	1.1	^{69}Ga	(p, n)	56	20
^{57}Fe	(p, 3n)	370	0.26	^{69}Ga	(p, n)	500	1.8
^{58}Fe	(p, n)	370	2.1	^{69}Ga	(p, n)	1500	0.5
^{58}Fe	(p, 2n)	370	3.2	^{69}Ga	(p, n)	3000	0.5
^{58}Fe	(p, 3n)	370	2.2	^{69}Ga	(p, 2n)	56	34
^{58}Fe	(p, 4n)	370	0.6	^{69}Ga	(p, 2n)	500	2.3
^{59}Co	(p, 3n)	170	1.1	^{69}Ga	(p, 2n)	1500	0.7
^{59}Co	(p, 3n)	370	0.24	^{69}Ga	(p, 2n)	3000	0.6
^{59}Co	(p, 3n)	400	0.46	^{69}Ga	(p, 3n)	56	21
^{59}Co	(p, 4n)	400	0.0065	^{69}Ga	(p, 3n)	500	1.0
^{64}Ni	(p, n)	130	6.1	^{69}Ga	(p, 3n)	1500	0.3
^{64}Ni	(p, n)	205	3.0	^{69}Ga	(p, 3n)	3000	0.3

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{69}Ga	(p, 4n)	56	5.8
^{69}Ga	(p, 4n)	500	0.14
^{69}Ga	(p, 4n)	1500	0.04
^{69}Ga	(p, 4n)	3000	0.04
^{71}Ga	(p, 3n)	56	106
^{71}Ga	(p, 4n)	56	72
^{71}Ga	(p, 5n)	56	8
^{71}Ga	(p, 6n)	56	0.2
^{72}Ge	(p, n)	100	10.3
^{72}Ge	(p, n)	200	5.0
^{72}Ge	(p, n)	300	3.1
^{72}Ge	(p, n)	400	2.5
^{72}Ge	(p, 2n)	100	18.8
^{72}Ge	(p, 2n)	200	8.6
^{72}Ge	(p, 2n)	300	5.6
^{72}Ge	(p, 2n)	400	3.8
^{72}Ge	(p, 3n)	100	10.2
^{72}Ge	(p, 3n)	200	5.0
^{72}Ge	(p, 3n)	300	2.8
^{72}Ge	(p, 3n)	400	2.0
^{75}As	(p, n)	380	5.8
^{75}As	(p, n)	400	1.4
^{75}As	(p, 3n)	103	11
^{75}As	(p, 3n)	170	8.4
^{75}As	(p, 3n)	380	4.7
^{75}As	(p, 3n)	400	4.3
^{75}As	(p, 4n)	103	13
^{75}As	(p, 4n)	170	10
^{75}As	(p, 4n)	380	5.7
^{75}As	(p, 4n)	400	1.8
^{75}As	(p, 6n)	380	0.5
^{77}Se	(p, n)	400	2.0
^{77}Se	(p, 2n)	400	4.2
^{88}Sr	(p, n)	68	36
^{88}Sr	(p, n)	110	17
^{88}Sr	(p, n)	143	17.5
^{89}Y	(p, n)	5	50
^{89}Y	(p, n)	8.5	352
^{89}Y	(p, n)	12	720
^{89}Y	(p, n)	15	712
^{89}Y	(p, n)	18.5	552
^{89}Y	(p, n)	21.5	395
^{89}Y	(p, n)	24.8	194
^{89}Y	(p, n)	27.5	103
^{89}Y	(p, n)	30.5	61.4
^{89}Y	(p, n)	33.5	43
^{89}Y	(p, n)	36.8	45
^{89}Y	(p, n)	42	37
^{89}Y	(p, n)	48	29
^{89}Y	(p, n)	54	30
^{89}Y	(p, n)	60	23
^{89}Y	(p, n)	66	20
^{89}Y	(p, n)	72	17
^{89}Y	(p, n)	78	14
^{89}Y	(p, n)	85	12
^{89}Y	(p, n)	400	1.85
^{89}Y	(p, 2n)	15	68
^{89}Y	(p, 2n)	18.5	352
^{89}Y	(p, 2n)	21.5	495
^{89}Y	(p, 2n)	24.8	1252
^{89}Y	(p, 2n)	27.5	1318
^{89}Y	(p, 2n)	30.5	862
^{89}Y	(p, 2n)	33.5	506
^{89}Y	(p, 2n)	36.8	329
^{89}Y	(p, 2n)	42	172
^{89}Y	(p, 2n)	48	112
^{89}Y	(p, 2n)	54	82.5
^{89}Y	(p, 2n)	60	73
^{89}Y	(p, 2n)	66	60
^{89}Y	(p, 2n)	72	54
^{89}Y	(p, 2n)	78	46
^{89}Y	(p, 2n)	85	41
^{89}Y	(p, 2n)	400	4.5
^{89}Y	(p, 3n)	30.5	55
^{89}Y	(p, 3n)	33.5	118
^{89}Y	(p, 3n)	36.8	313
^{89}Y	(p, 3n)	40	385
^{89}Y	(p, 3n)	42	341
^{89}Y	(p, 3n)	45	299
^{89}Y	(p, 3n)	48	168
^{89}Y	(p, 3n)	54	91
^{89}Y	(p, 3n)	60	55
^{89}Y	(p, 3n)	66	54
^{89}Y	(p, 3n)	72	48
^{89}Y	(p, 3n)	78	36
^{89}Y	(p, 3n)	85	32
^{89}Y	(p, 3n)	400	3.8
^{89}Y	(p, 4n)	45	27
^{89}Y	(p, 4n)	48	57
^{89}Y	(p, 4n)	54	78
^{89}Y	(p, 4n)	57	81.5
^{89}Y	(p, 4n)	60	63
^{89}Y	(p, 4n)	66	42
^{89}Y	(p, 4n)	72	32
^{89}Y	(p, 4n)	78	28
^{89}Y	(p, 4n)	85	22
^{89}Y	(p, 4n)	400	2.4
^{90}Zr	(p, n)	400	2.2
^{90}Zr	(p, 2n)	400	3.5
^{90}Zr	(p, 3n)	400	3.8
^{96}Zr	(p, n)	400	0.76
^{96}Zr	(p, 2n)	400	4.4
^{103}Rh	(p, n)	130	6.1
^{103}Rh	(p, n)	205	3.5
^{103}Rh	(p, n)	298	3.0
^{103}Rh	(p, n)	396	2.3
^{109}Ag	(p, n)	140	3.2
^{109}Ag	(p, n)	210	3.0

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)	Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{109}Ag	(p, n)	290	1.7	^{127}I	(p, n)	11	240
^{109}Ag	(p, n)	380	1.4	^{127}I	(p, n)	16	420
^{108}Cd	(p, 2n)	400	6.2	^{127}I	(p, n)	21	24
^{110}Cd	(p, 2n)	400	3.6	^{127}I	(p, n)	42	9
^{111}Cd	(p, n)	70	6.6	^{127}I	(p, n)	49	8
^{111}Cd	(p, n)	100	6.0	^{127}I	(p, n)	56	10
^{111}Cd	(p, n)	150	3.1	^{127}I	(p, n)	63	5
^{111}Cd	(p, n)	200	2.0	^{141}Pr	(p, n)	9	309
^{111}Cd	(p, n)	300	1.3	^{141}Pr	(p, n)	12	887
^{111}Cd	(p, n)	400	0.9	^{141}Pr	(p, n)	15	707
^{112}Cd	(p, 2n)	50	78	^{141}Pr	(p, n)	20	309
^{112}Cd	(p, 2n)	70	30	^{141}Pr	(p, n)	25	66
^{112}Cd	(p, 2n)	100	20	^{141}Pr	(p, n)	38	29
^{112}Cd	(p, 2n)	150	10.8	^{141}Pr	(p, 2n)	9	0.2
^{112}Cd	(p, 2n)	200	8.8	^{141}Pr	(p, 2n)	12	236
^{112}Cd	(p, 2n)	300	5.9	^{141}Pr	(p, 2n)	15	617
^{112}Cd	(p, 2n)	400	4.1	^{141}Pr	(p, 2n)	20	1894
^{113}Cd	(p, 3n)	70	40	^{141}Pr	(p, 2n)	25	1646
^{113}Cd	(p, 3n)	100	27	^{141}Pr	(p, 2n)	28	1208
^{113}Cd	(p, 3n)	150	16.7	^{141}Pr	(p, 2n)	33	534
^{113}Cd	(p, 3n)	200	12.3	^{141}Pr	(p, 2n)	38	210
^{113}Cd	(p, 3n)	300	8.2	^{141}Pr	(p, 2n)	45	98
^{113}Cd	(p, 3n)	400	5.8	^{141}Pr	(p, 2n)	50	97
^{114}Cd	(p, 4n)	70	74	^{141}Pr	(p, 2n)	55	99
^{114}Cd	(p, 4n)	100	44	^{141}Pr	(p, 2n)	65	98
^{114}Cd	(p, 4n)	150	21	^{141}Pr	(p, 2n)	85	89
^{114}Cd	(p, 4n)	200	14.5	^{141}Pr	(p, 3n)	25	114
^{114}Cd	(p, 4n)	300	10	^{141}Pr	(p, 3n)	28	427
^{114}Cd	(p, 4n)	400	7	^{141}Pr	(p, 3n)	33	950
^{116}Cd	(p, 6n)	70	129	^{141}Pr	(p, 3n)	38	1185
^{116}Cd	(p, 6n)	100	45	^{141}Pr	(p, 3n)	45	270
^{116}Cd	(p, 6n)	150	15	^{141}Pr	(p, 3n)	50	136
^{116}Cd	(p, 6n)	200	11.6	^{141}Pr	(p, 3n)	55	88
^{116}Cd	(p, 6n)	300	7.4	^{141}Pr	(p, 3n)	65	70
^{116}Cd	(p, 6n)	400	6	^{141}Pr	(p, 3n)	85	59
^{122}Te	(p, 2n)	300	3.7	^{141}Pr	(p, 4n)	38	222
^{124}Te	(p, n)	400	1.3	^{141}Pr	(p, 4n)	45	454
^{124}Te	(p, 2n)	300	5.3	^{141}Pr	(p, 4n)	50	360
^{124}Te	(p, 2n)	400	3.6	^{141}Pr	(p, 4n)	55	169
^{125}Te	(p, n)	400	1.2	^{141}Pr	(p, 4n)	65	77
^{125}Te	(p, 2n)	300	4.4	^{141}Pr	(p, 4n)	85	60
^{125}Te	(p, 2n)	400	3.1	^{170}Er	(p, 3n)	22	520
^{125}Te	(p, 3n)	400	2.1	^{170}Er	(p, 3n)	28	620
^{126}Te	(p, n)	400	0.9	^{170}Er	(p, 3n)	34	260
^{126}Te	(p, 2n)	300	6.3	^{181}Ta	(p, n)	24	47
^{126}Te	(p, 2n)	400	3.3	^{181}Ta	(p, n)	30	44
^{126}Te	(p, 3n)	400	3.5	^{181}Ta	(p, 3n)	24	1200
^{126}Te	(p, 4n)	400	2.5	^{181}Ta	(p, 3n)	30	920
^{130}Te	(p, n)	130	7.7	^{181}Ta	(p, 3n)	36	280
^{130}Te	(p, n)	205	4.1	^{181}Ta	(p, 4n)	30	240
^{130}Te	(p, n)	270	3.3	^{181}Ta	(p, 4n)	36	760
^{130}Te	(p, n)	396	3.3	^{181}Ta	(p, 4n)	42	430
^{130}Te	(p, n)	423	2.3	^{181}Ta	(p, 4n)	48	200
^{127}I	(p, n)	7	17	^{181}Ta	(p, 4n)	54	130

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{181}Ta	(p, 4n)	64	120
^{181}Ta	(p, 4n)	74	62
^{181}Ta	(p, 4n)	84	64
^{181}Ta	(p, 4n)	5700	1.8
^{181}Ta	(p, 5n)	36	130
^{181}Ta	(p, 5n)	42	550
^{181}Ta	(p, 5n)	48	830
^{181}Ta	(p, 5n)	54	650
^{181}Ta	(p, 5n)	64	200
^{181}Ta	(p, 5n)	74	110
^{181}Ta	(p, 5n)	84	98
^{181}Ta	(p, 5n)	5700	1.2
^{181}Ta	(p, 6n)	48	87
^{181}Ta	(p, 6n)	54	420
^{181}Ta	(p, 6n)	64	320
^{181}Ta	(p, 6n)	74	170
^{181}Ta	(p, 6n)	84	73
^{186}W	(p, n)	130	14
^{186}W	(p, n)	205	6.2
^{186}W	(p, n)	298	5.1
^{186}W	(p, n)	396	4.4
^{197}Au	(p, n)	20	18
^{197}Au	(p, 3n)	50	250
^{197}Au	(p, 3n)	100	60
^{197}Au	(p, 3n)	140	27
^{197}Au	(p, 5n)	50	900
^{197}Au	(p, 5n)	100	250
^{197}Au	(p, 5n)	140	78
^{197}Au	(p, 6n)	50	90
^{197}Au	(p, 6n)	100	200
^{197}Au	(p, 6n)	140	90
^{197}Au	(p, 7n)	100	300
^{197}Au	(p, 7n)	140	82
^{197}Au	(p, 8n)	100	260
^{197}Au	(p, 8n)	140	75
^{202}Hg	(p, n)	400	1.1
^{202}Hg	(p, 2n)	400	3.8
^{206}Pb	(p, n)	12.7	230
^{206}Pb	(p, n)	16.3	60
^{206}Pb	(p, 2n)	12.7	60
^{206}Pb	(p, 2n)	16.3	530
^{206}Pb	(p, 2n)	20.7	1050
^{206}Pb	(p, 2n)	24.6	980
^{206}Pb	(p, 2n)	25.0	760
^{206}Pb	(p, 2n)	27.8	530
^{206}Pb	(p, 2n)	28.0	540
^{206}Pb	(p, 2n)	30	360
^{206}Pb	(p, 2n)	35.9	150
^{206}Pb	(p, 2n)	39.2	120
^{206}Pb	(p, 2n)	42.4	130
^{206}Pb	(p, 2n)	45.4	160
^{206}Pb	(p, 2n)	49.0	130
^{206}Pb	(p, 2n)	52.5	150
^{206}Pb	(p, 2n)	56.3	110
^{206}Pb	(p, 2n)	63.8	90
^{206}Pb	(p, 3n)	20.7	20
^{206}Pb	(p, 3n)	24.6	520
^{206}Pb	(p, 3n)	25.0	540
^{206}Pb	(p, 3n)	27.8	880
^{206}Pb	(p, 3n)	27.9	730
^{206}Pb	(p, 3n)	30	890
^{206}Pb	(p, 3n)	31	770
^{206}Pb	(p, 3n)	34	730
^{206}Pb	(p, 3n)	35.9	570
^{206}Pb	(p, 3n)	36.6	400
^{206}Pb	(p, 3n)	41.2	150
^{206}Pb	(p, 3n)	42.4	180
^{206}Pb	(p, 3n)	45.4	190
^{206}Pb	(p, 3n)	49.0	140
^{206}Pb	(p, 4n)		
^{206}Pb	+ (p, p3n)	31	60
^{206}Pb	+ (p, p3n)	34	370
^{206}Pb	+ (p, p3n)	35.9	490
^{206}Pb	+ (p, p3n)	36.6	620
^{206}Pb	+ (p, p3n)	39.8	910
^{206}Pb	+ (p, p3n)	41.2	1100
^{206}Pb	+ (p, p3n)	45.4	1030
^{206}Pb	+ (p, p3n)	45.8	970
^{206}Pb	+ (p, p3n)	49.0	520
^{206}Pb	+ (p, p3n)	52.5	470
^{206}Pb	+ (p, p3n)	56.3	300
	+ (p, p3n)	63.8	210
^{206}Pb			
^{206}Pb	(p, 5n)	39.2	20
^{206}Pb	(p, 5n)	42.4	140
^{206}Pb	(p, 5n)	45.8	360
^{206}Pb	(p, 5n)	49.0	570
^{206}Pb	(p, 5n)	52.5	590
^{206}Pb	(p, 5n)	56.3	380
^{206}Pb	(p, 5n)	63.8	210
^{206}Pb	(p, 6n)	49.0	50
^{206}Pb	(p, 6n)	52.5	260
^{206}Pb	(p, 6n)	56.3	400
^{206}Pb	(p, 6n)	63.8	550
^{206}Pb	(p, 7n)	63.8	180
^{207}Pb	(p, 2n)	13	80
^{207}Pb	(p, 2n)	15.2	360
^{207}Pb	(p, 2n)	17.5	580
^{207}Pb	(p, 2n)	17.8	620
^{207}Pb	(p, 2n)	18.4	700
^{207}Pb	(p, 2n)	19.3	890
^{207}Pb	(p, 2n)	20.1	820
^{207}Pb	(p, 2n)	20.9	960
^{207}Pb	(p, 2n)	24.5	560
^{207}Pb	(p, 2n)	26.9	340
^{207}Pb	(p, 2n)	30.7	90
^{207}Pb	(p, 2n)	33.9	20
^{207}Pb	(p, 3n)	24.5	460

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{207}Pb	(p, 3n)	26.9	700
^{207}Pb	(p, 3n)	30.7	940
^{207}Pb	(p, 3n)	33.9	790
^{207}Pb	(p, 4n)	33.9	170
^{207}Pb	(p, 4n)	37.1	600
^{207}Pb	(p, 4n)	39.9	810
^{207}Pb	(p, 4n)	43.2	840
^{207}Pb	(p, 4n)	46.4	690
^{207}Pb	(p, 5n)	43.2	80
^{207}Pb	(p, 5n)	46.4	390
^{208}Pb	(p, 3n)	24.5	480
^{208}Pb	(p, 3n)	26.9	740
^{208}Pb	(p, 3n)	30.7	980
^{208}Pb	(p, 3n)	33.8	730
^{208}Pb	(p, 3n)	37.1	520
^{208}Pb	(p, 3n)	39.9	270
^{208}Pb	(p, 3n)	43.2	220
^{208}Pb	(p, 3n)	46.4	170
^{208}Pb	(p, 4n)	33.8	280
^{208}Pb	(p, 4n)	37.1	720
^{208}Pb	(p, 4n)	39.9	930
^{208}Pb	(p, 4n)	43.2	840
^{208}Pb	(p, 4n)	46.4	560
^{208}Pb	(p, 5n)	43.2	200
^{208}Pb	(p, 5n)	46.4	450
^{209}Bi	(p, 2n)	12	90
^{209}Bi	(p, 2n)	18	530
^{209}Bi	(p, 2n)	23	937
^{209}Bi	(p, 2n)	29	422
^{209}Bi	(p, 2n)	54	74
^{209}Bi	(p, 2n)	84	41.5
^{209}Bi	(p, 2n)	90	31.6
^{209}Bi	(p, 3n)	21.9	370
^{209}Bi	(p, 3n)	24.8	570
^{209}Bi	(p, 3n)	27.7	790
^{209}Bi	(p, 3n)	30.7	820
^{209}Bi	(p, 3n)	33.7	560
^{209}Bi	(p, 3n)	36.6	340
^{209}Bi	(p, 3n)	39.8	220
^{209}Bi	(p, 3n)	46.4	110
^{209}Bi	(p, 3n)	50.4	80
^{209}Bi	(p, 3n)	54	94
^{209}Bi	(p, 3n)	380	15
^{209}Bi	(p, 4n)	29.6	120
^{209}Bi	(p, 4n)	35.5	890
^{209}Bi	(p, 4n)	36	495
^{209}Bi	(p, 4n)	38.8	1220
^{209}Bi	(p, 4n)	41	780
^{209}Bi	(p, 4n)	42	960
^{209}Bi	(p, 4n)	44	710
^{209}Bi	(p, 4n)	45.2	710
^{209}Bi	(p, 4n)	47	530
^{209}Bi	(p, 4n)	52	325
^{209}Bi	(p, 4n)	56.5	240
^{209}Bi	(p, 4n)	63	152
^{209}Bi	(p, 4n)	72	102
^{209}Bi	(p, 4n)	76	109
^{209}Bi	(p, 4n)	81	106
^{209}Bi	(p, 4n)	90	64
^{209}Bi	(p, 4n)	104	47
^{209}Bi	(p, 4n)	110	45
^{209}Bi	(p, 4n)	116	49
^{209}Bi	(p, 4n)	128.8	36.5
^{209}Bi	(p, 4n)	144	34
^{209}Bi	(p, 4n)	380	11
^{209}Bi	(p, 5n)	39.8	100
^{209}Bi	(p, 5n)	41	58
^{209}Bi	(p, 5n)	43	510
^{209}Bi	(p, 5n)	44	330
^{209}Bi	(p, 5n)	46.4	630
^{209}Bi	(p, 5n)	47	550
^{209}Bi	(p, 5n)	50.4	800
^{209}Bi	(p, 5n)	52	615
^{209}Bi	(p, 5n)	55	680
^{209}Bi	(p, 5n)	59.7	450
^{209}Bi	(p, 5n)	63	270
^{209}Bi	(p, 5n)	76	120
^{209}Bi	(p, 5n)	81	134
^{209}Bi	(p, 5n)	110	62
^{209}Bi	(p, 5n)	380	16
^{209}Bi	(p, 6n)	46.4	60
^{209}Bi	(p, 6n)	50.4	210
^{209}Bi	(p, 6n)	55	400
^{209}Bi	(p, 6n)	63	550
^{209}Bi	(p, 6n)	72	250
^{209}Bi	(p, 6n)	76	185
^{209}Bi	(p, 6n)	81	190
^{209}Bi	(p, 6n)	380	8.9
^{209}Bi	(p, 7n)	59.7	90
^{209}Bi	(p, 7n)	66	167
^{209}Bi	(p, 7n)	72	280
^{209}Bi	(p, 7n)	76	312
^{209}Bi	(p, 7n)	81	200
^{209}Bi	(p, 7n)	92	130
^{209}Bi	(p, 7n)	110	74
^{209}Bi	(p, 7n)	380	12.5
^{209}Bi	(p, 8n)	75	62
^{209}Bi	(p, 8n)	80	175
^{209}Bi	(p, 8n)	85	220
^{209}Bi	(p, 8n)	90	180
^{209}Bi	(p, 8n)	95	137
^{209}Bi	(p, 8n)	104	85
^{209}Bi	(p, 8n)	106	82
^{209}Bi	(p, 8n)	110	71
^{209}Bi	(p, 8n)	116	71
^{209}Bi	(p, 8n)	120	57.5
^{209}Bi	(p, 8n)	133	53
^{209}Bi	(p, 8n)	144	50

Table continues

Table 7 (Continued)

Target	Reaction	Energy (MeV)	Partial Cross Section (mb)
^{209}Bi	(p, 8n)	157	52
^{209}Bi	(p, 8n)	380	5.2
^{209}Bi	(p, 9n)	85	24
^{209}Bi	(p, 9n)	90	62
^{209}Bi	(p, 9n)	95	80
^{209}Bi	(p, 9n)	97	85
^{209}Bi	(p, 9n)	104	84
^{209}Bi	(p, 9n)	106	73
^{209}Bi	(p, 9n)	110	72
^{209}Bi	(p, 9n)	116	53
^{209}Bi	(p, 9n)	128.8	45.5
^{209}Bi	(p, 9n)	133	40
^{209}Bi	(p, 9n)	144	36
^{209}Bi	(p, 9n)	380	13
^{209}Bi	(p, 10n)	97	8
^{209}Bi	(p, 10n)	104	32
^{209}Bi	(p, 10n)	106	35
^{209}Bi	(p, 10n)	110	63
^{209}Bi	(p, 10n)	116	57
^{209}Bi	(p, 10n)	120	48
^{209}Bi	(p, 10n)	128.8	43
^{209}Bi	(p, 10n)	133	44
^{209}Bi	(p, 10n)	144	39
^{209}Bi	(p, 10n)	157	42
^{209}Bi	(p, 10n)	380	10
^{209}Bi	(p, 11n)	106	1.5
^{209}Bi	(p, 11n)	110	8.6
^{209}Bi	(p, 11n)	120	20.6
^{209}Bi	(p, 11n)	125	23.2
^{209}Bi	(p, 11n)	129	19
^{209}Bi	(p, 11n)	133	25
^{209}Bi	(p, 11n)	144	28
^{209}Bi	(p, 11n)	157	28
^{209}Bi	(p, 12n)	125	3
^{209}Bi	(p, 12n)	129	6
^{209}Bi	(p, 12n)	133	10
^{209}Bi	(p, 12n)	144	17
^{209}Bi	(p, 12n)	157	20
^{209}Bi	(p, 13n)	144	3
^{209}Bi	(p, 13n)	157	5
^{232}Th	(p, n)	28	24
^{232}Th	(p, n)	36	15
^{232}Th	(p, n)	50	10
^{232}Th	(p, n)	82	9
^{232}Th	(p, n)	150	8
^{232}Th	(p, n)	340	2.6
^{232}Th	(p, 3n)	24	167
^{232}Th	(p, 3n)	25.6	246
^{232}Th	(p, 3n)	27.3	272
^{232}Th	(p, 3n)	28.8	250
^{232}Th	(p, 3n)	32.8	103
^{232}Th	(p, 3n)	36.7	66
^{232}Th	(p, 3n)	36.8	62
^{232}Th	(p, 3n)	40	49
^{232}Th	(p, 3n)	50	31
^{232}Th	(p, 3n)	54	27
^{232}Th	(p, 3n)	57	26
^{232}Th	(p, 3n)	60	25
^{232}Th	(p, 3n)	62.7	22
^{232}Th	(p, 3n)	65	22
^{232}Th	(p, 3n)	66	21
^{232}Th	(p, 3n)	80	16
^{232}Th	(p, 3n)	150	7.5
^{232}Th	(p, 3n)	340	4.2
^{232}Th	(p, 4n)	680	2.3
^{232}Th	(p, 4n)	1800	2.2
^{232}Th	(p, 5n)	40	55
^{232}Th	(p, 5n)	50	39
^{232}Th	(p, 5n)	54	21
^{232}Th	(p, 5n)	57	16
^{232}Th	(p, 5n)	60	14
^{232}Th	(p, 5n)	62.7	12
^{232}Th	(p, 5n)	66	11.4
^{232}Th	(p, 5n)	80	6.7
^{232}Th	(p, 5n)	150	3.2
^{232}Th	(p, 5n)	340	1.7
^{232}Th	(p, 5n)	680	0.8
^{232}Th	(p, 5n)	1800	0.6
^{232}Th	(p, 6n)	40	0.18
^{232}Th	(p, 6n)	50	12.4
^{232}Th	(p, 6n)	54	15
^{232}Th	(p, 6n)	57	12
^{232}Th	(p, 6n)	60	10
^{232}Th	(p, 6n)	62.7	7.5
^{232}Th	(p, 6n)	66	6.2
^{232}Th	(p, 6n)	80	4.1
^{232}Th	(p, 6n)	150	1.5
^{232}Th	(p, 6n)	340	1.0
^{232}Th	(p, 6n)	680	0.26
^{232}Th	(p, 6n)	1800	0.20
^{232}Th	(p, 7n)	150	1
^{238}U	(p, n)	340	0.46
^{238}U	(p, n)	680	0.25
^{238}U	(p, 3n)	32	30
^{238}U	(p, 3n)	38	9
^{238}U	(p, 3n)	55	5
^{238}U	(p, 3n)	65	5
^{238}U	(p, 3n)	70	6
^{238}U	(p, 3n)	80	4
^{238}U	(p, 3n)	120	2.5
^{238}U	(p, 3n)	150	2.6
^{238}U	(p, 3n)	340	1.7
^{238}U	(p, 3n)	680	0.26

Table 8
References for (p, xn) Reactions

Target	References	Target	References
^{7}Li	3	^{71}Ga	130
^{10}B	3	^{72}Ge	248
^{11}B	3. 4, 9	^{75}As	98, 136, 248
^{13}C	4	^{77}Se	245
^{14}N	3	^{88}Sr	9
^{18}O	241	^{89}Y	140, 248
^{19}F	3	^{90}Zr	248
^{44}Ca	242	^{96}Zr	248
^{48}Ca	242	^{103}Rh	244
^{45}Sc	243, 244	^{109}Ag	242
^{48}Ti	4, 96	$^{108-116}Cd$	160, 250
^{51}V	4, 8, 97, 242	$^{122-130}Te$	164, 244, 245, 248
^{52}Cr	4, 94, 245	^{127}I	251
^{54}Cr	242	^{141}Pr	252
^{56}Fe	58, 94, 96, 242, 246, 247	^{170}Er	174
^{57}Fe	242, 247	^{181}Ta	175, 180
^{58}Fe	242, 247	^{186}W	244
^{59}Co	98, 109, 248	^{197}Au	185, 186, 253
^{64}Ni	242, 244	^{202}Hg	248
^{63}Cu	245, 249	$^{206-208}Pb$	254
^{65}Cu	242	^{209}Bi	196, 198, 199, 254
^{68}Zn	243, 248	^{232}Th	202, 206, 255-258
^{69}Ga	130, 131	^{238}U	202, 206

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