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We have produced a dataset of the yields of radionuclides produced by the nuclear capture of negative muons applying Monte Carlo calculation due to scarce experimental data for the sake of radiation safety of experimental facilities which can provide negative muons. The dataset covers all the stable targets of natural elements. The use of the dataset is described in an example of radioactive estimation for a negative-muon-irradiated sample. The dataset reported is fundamental data expected to be utilized in experiments with negative muons of various fields including radiation safety.

Keywords: Nuclide Production, Negative Muon, Nuclear Capture, Monte Carlo Calculation, Radiation Safety

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モンテカルロ計算に基づく負ミュオン原子核捕獲反応による核種生成のデータ集

日本原子力研究開発機構　J-PARC センター
物質・生命科学ディビジョン

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負ミュオンを利用可能な実験施設における試料の放射化に伴う放射線安全の観点から、負ミュオンの原子核捕獲に伴う放射性核種生成量の評価が重要であるが、実験データの報告例が少ないのが現状である。そこでモンテカルロ計算によって、自然界に安定に存在する全元素に対して放射性核種生成量を求め、データ集を作成した。また、データの利用例として照射試料の放射化量を見積もった。本報告書は放射線安全をはじめ、様々な分野で負ミュオンを用いた実験を行う際の基礎データを提供するものである。

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1. Introduction

Muons are charged leptons and have positive or negative unit electric charge. The positively charged muon (μ^+) and negatively charged muon (μ^-) are utilized in experiments for materials science depending on analyzing methods because they exhibit different characteristics in matter.

When the negative muon μ^- is irradiated to and stopped in a sample, it either decays or is captured by a nucleus in a probability. The nuclear capture probability is known to be higher for the nucleus with higher atomic number Z and is about 60% even for ^{27}Al (Z = 13). After the nuclear capture, a nucleus (Z – 1) is produced in an excited state because a part of the μ^- mass of 106 MeV/c^2 is converted to the excitation energy, and is deexcited with emitting neutrons, γ-rays, and sometimes charged particles. As a result, radionuclides with relatively long lifetime can be left in the irradiated sample, which means that the irradiated sample can be activated.

It is important to handle properly the activated sample in terms of radiation safety of experimental facilities especially those providing intense beam. Materials and Life Science Experimental Facility (MLF) of Japan Proton Accelerator Research Complex (J-PARC)[1)] is one of the facilities where the intense beam is available and promotes experimental studies on materials science by providing intense pulsed muon and neutron beams from a muon source[2)] and a spallation neutron source[3)], respectively. The intensity of 3-GeV proton beam to produce muons and neutrons at MLF has been steadily increased and has reached about 95% of design value of 1 MW in user operation recently, which enables versatile μ^- application such as non-destructive elemental analysis[4), 5)] and muon spin rotation and relaxation[6)]. To promote intense-μ^--beam applications, it is required to ensure radiation safety by estimating radioactivity of samples used in not only neutron- but also μ^--irradiation experiments.

The radioactivity induced by neutron irradiation can be estimated using a user-friendly web interface system of SAmple Radioactivity Evaluation program, SARE-MLF. This program has been originally developed for neutron beam users in MLF and has been utilized by those from beginners to experts.

On the other hand, μ^--induced radioactivity cannot be estimated by SARE-MLF due to no numerical dataset of radionuclide production from nuclear capture of μ^-. Moreover, the radioactivity estimation based on experimental data is difficult for a wide range of target Z because experimental data of radionuclide production is limited for targets with $Z \leq 29$[7)]. To update SARE-MLF for enabling estimation of μ^--induced radioactivity for light to heavy targets, the numerical dataset covering a wide range of Z is demanded.

In this report, we aim to provide the dataset on μ^--induced radionuclide production covering a wide range of target $2 \leq Z \leq 92$ except for radioactive target. The dataset reported here includes also yields of stable nuclides produced by the nuclear capture and is obtained using Monte Carlo calculation code which is described in the next Chapter.

2. Monte Carlo calculation

2.1 Calculation code

The dataset of nuclide production from nuclear capture of μ^- was calculated using Particle and Heavy Ion Transport code System (PHITS)[8] version 3.20. The PHITS is a general-purpose Monte Carlo radiation transport code and can simulate behaviors of various kinds of particles including muons. Muon interactions such as bremsstrahlung and nuclear capture of μ^- were taken in the PHITS in stages of its update and were completely introduced to the PHITS version 2.86[9]. The model for nuclear capture of μ^- implemented in PHITS2.86 is detailed in Ref. 9) and is outlined here.

The nuclear capture probability mentioned in the previous chapter is obtained from nuclear capture rate Λ_c which is taken from Ref. 10). When the measured capture rate is not available, Λ_c is compensated by the following expression[11]:

$$\Lambda_c = Z_{eff}^4 G_1\{1 + G_2 A/(2Z) - G_3(A - 2Z)/(2Z) - G_4[(A - Z)/(2A) + (A - 2Z)/(8AZ)]\}, \quad (1)$$

where A is mass number of the target nucleus with Z, Z_{eff} is effective atomic number calculated by empirical formula given in Ref. 12), and G_i (i = 1, 2, 3, 4) is parameter set reported in Ref. 10). After the nuclear capture occurs according to the probability, the excitation energy determined by the distribution function deduced in Ref. 13) is given to a neutron in the produced nucleus and triggers deexcitation of the nucleus. The deexcitation process is described by JAERI quantum molecular dynamics (JQMD)[14] model plus generalized evaporation model (GEM)[15].

2.2 Calculation condition

The calculation was performed in a simple geometrical condition where a cubic target was placed in a vacuum. The target consisted of an element in natural isotope composition. The side length of the cubic target was set to 10 nm to avoid nuclide production from interactions between the target and secondary particles. Since the target was very thin, the incident energy of μ^- was set to 10 eV so that μ^- could be stopped in the target. The μ^- pencil beam flew the vacuum region and entered the target. The two-dimensional distribution of μ^- fluence is shown in Fig. 1 for aluminum target.

The input parameters used in the calculation were basically default setting of the PHITS. The number of events in the calculation for each target was adjusted to satisfy a criterion for statistical errors of nuclide yields. The criterion of the relative statistical error was set to be 10% or less for produced nuclide with (Z – 1) and (Z – 2) because it seems that those nuclides are mainly produced and that experimental data tend to include uncertainty of about 10% at least. The yield of the produced nuclide per incident μ^- was obtained using t-yield tally. A typical example of the output from the tally is shown in Fig. 2.

3. Results

The yields per incident μ^- of radionuclides as well as stable nuclides produced by the nuclear capture are summarized in Tables 1-74 with relative statistical errors. The calculation results with the relative error of 10% or less are listed in the tables. This dataset covers targets with $2 \leq Z \leq 92$ except for following nine radioactive targets: technetium (Z = 43), promethium (Z = 61), polonium (Z = 84), astatine (Z = 85), radon (Z = 86), francium (Z = 87), radium (Z = 88), actinium (Z = 89), and protactinium (Z = 91). Although bismuth (Z = 83), thorium (Z = 90) and uranium (Z = 92) are radioactive targets in the long term, they are considered stable targets based on the idea that the nuclide with half-life[16)] longer than 1×10^9 year is stable in this report.

To check reliability of calculated yields, calculation results are compared with experimental data[7)] of yields per captured μ^- for mainly produced nuclides in silicon and iron targets in Table 75. The calculated yields per incident μ^- was converted to those per captured μ^- using nuclear capture probability described below. It is confirmed that the calculation/experiment (C/E) value ranges from 0.6 to 2.4. This implies that additional experimental data especially for targets with high-Z is needed to clarify and improve the reliability of the calculated yields.

The sum of calculated yields per incident μ^- for a target with Z gives the nuclear capture probability for the target. Note that the probability for uranium (Z = 92) is obtained by summing total yield of nuclides with $Z > 87$ and half of that for produced nuclides with $Z \leq 58$ in Table 74 because the nuclides with $Z \leq 58$ are fission products. The probability obtained from the sum of yields for each target is shown in Fig. 3. This figure illustrates that the probability of nuclear capture is low for the target with low-Z while is almost 90% for that with $Z > 40$. It should be noted that the probabilities for light targets with $3 \leq Z \leq 6$ are overestimated due to double counting of reactions involving hydrogen- or helium-isotope production such as $^{12}C(\mu^-, {}^4He)^8Li$ and $^9Be(\mu^-, {}^3H)^6He$. Also, the probability for helium (Z = 2) is underestimated due to proton production.

4. Use of the dataset

An example of the dataset use for estimating μ^--induced radioactivity is described in this Chapter. The radioactivity of the radionuclide i produced from nuclear capture of μ^- during μ^- irradiation is written as

$$A_i(t) = p_i\{1 - (1/2)^{t/T_i}\} \qquad t \leq t_{\mathrm{irr}}, \tag{2}$$

where p_i and T_i is production rate and half-life of the radionuclide i, respectively, and t_{irr} is the irradiation time. The production rate p_i can be calculated by

$$p_i = I_{\mu\text{-}} Y_i, \tag{3}$$

where $I_{\mu\text{-}}$ is the number of μ^- stopped in matter per unit time and Y_i is the yield of the radionuclide i, which is obtained from Tables 1-74. Assuming that $I_{\mu\text{-}}$ is constant during irradiation, the radioactivity $A_i(t)$ increases along the saturation curve shown in Fig. 4 and almost reaches p_i when the irradiation time t_{irr} is much longer than T_i. After the irradiation, $A_i(t)$ decreases along the decay curve as shown in Fig. 4 and is expressed as

$$A_i(t) = A_i(t_{\mathrm{irr}})(1/2)^{(t - t_{\mathrm{irr}})/T_i} \qquad t > t_{\mathrm{irr}}. \tag{4}$$

Therefore, the radioactivity of irradiated matter A is obtained by summing over those of radionuclides produced in the matter:

$$A(t) = \sum_i A_i(t) \tag{5}$$

Let us consider an example of radioactivity estimation for the battery anode material of $Li_4Ti_5O_{12}$[6) irradiated by μ^-. In a compound, μ^- is captured by the nucleus of the constituent element, namely, Li, Ti, and O for the $Li_4Ti_5O_{12}$ example in a ratio. The ratio is known to be different from the atomic ratio in many cases[17) and is generally determined by experiments. Here, it is assumed that the ratio agrees with the atomic ratio for simplicity. In other words, $I_{\mu\text{-}}$ is assumed to be distributed to Li, Ti, and O with the ratio of 4:5:12.

If $I_{\mu\text{-}} = 1\times10^6$ s^{-1} and $t_{\mathrm{irr}} = 5$ h are selected, radioactivities of produced radionuclides at the end of irradiation can be calculated using equations (2) and (3) with Tables 1, 3, and 17 for Y_i paying attention to the assumption on $I_{\mu\text{-}}$ above. Then, the radioactivity of $Li_4Ti_5O_{12}$ at the end of irradiation can be obtained by using equation (5). The calculated results are listed in Table 76. The radioactivity of $Li_4Ti_5O_{12}$ is mainly contributed from scandium isotopes and decreases with ^{46}Sc decay over a long period. If the cooling period is 1 year, A = 4 Bq is obtained from equations (4) and (5).

5. Summary

We produced the dataset of the yields of nuclides produced by the nuclear capture of μ^- based on Monte Carlo calculation to provide the dataset covering all the stable natural elements. We also described an example of the dataset use for estimating radioactivity of a compound irradiated by μ^-. The use of the dataset enabled estimation of μ^--induced radioactivity for irradiated substances. The produced dataset is expected to contribute to various fields including radiation safety as fundamental data.

Acknowledgments

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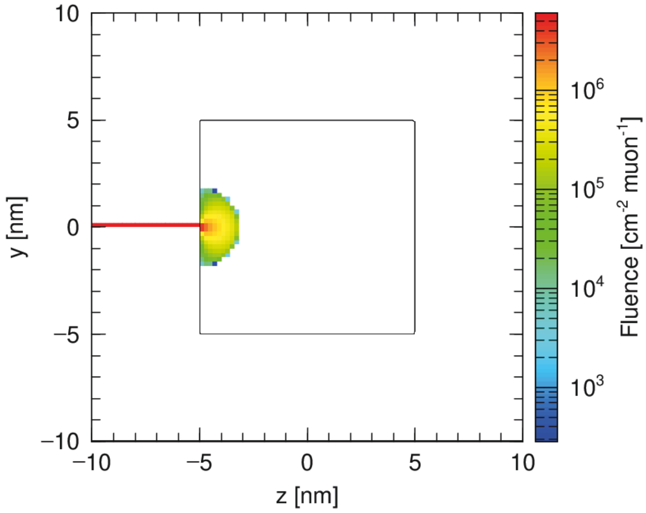

Fig.1 Two-dimensional distribution of μ^- fluence for Al target. The y is vertical direction. The μ^- beam comes from the negative z side and enters the cubic target with a side length of 10 nm located at the origin.

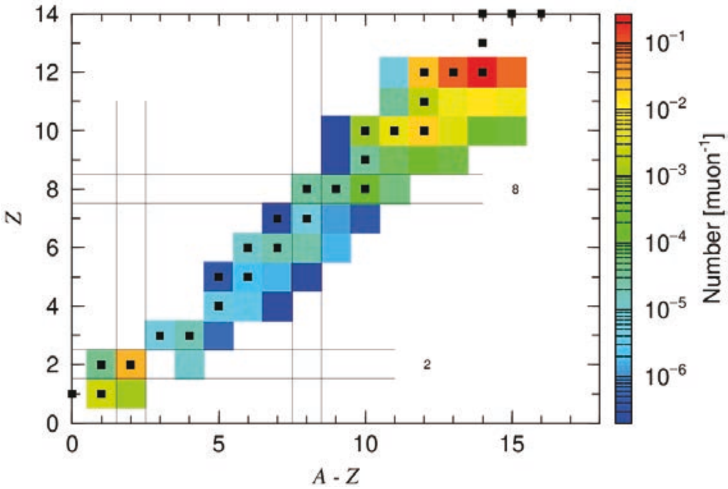

Fig. 2 Chart of nuclides produced by the nuclear capture for Al target. The horizontal and vertical axes indicate the number of neutrons and protons, respectively. Square dots show stable nuclides.

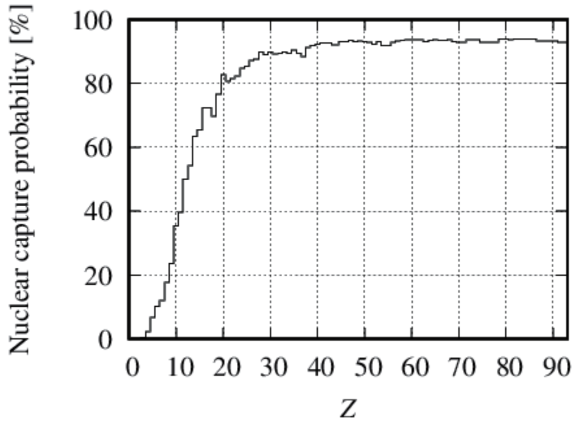

Fig. 3　Nuclear capture probability versus atomic number of target. The probability is obtained by summing yields of nuclides listed in tables of this report for a target.

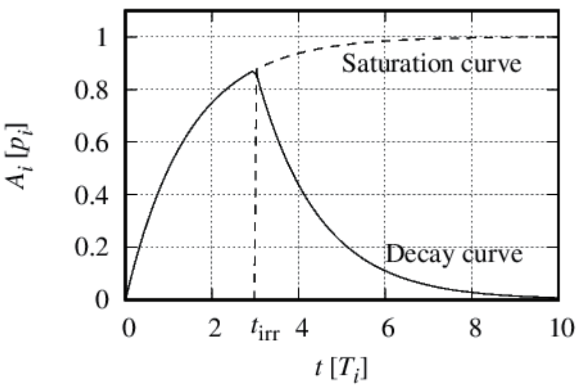

Fig. 4　Trend of radioactivity of produced radionuclide. The units of horizontal and vertical axes are half-life and production rate of the produced nuclide, respectively.

Table 1 Yields of nuclides produced by the nuclear capture of μ^- for targets with $2 \le Z \le 5$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
He (2)	^{2}H	Stable	1.372×10^{-4}	3.82
	^{3}H	12.32 y	4.620×10^{-5}	6.58
Li (3)	^{2}H	Stable	6.440×10^{-5}	4.04
	^{3}H	12.32 y	5.777×10^{-4}	1.81
	^{3}He	Stable	1.350×10^{-5}	8.61
	^{4}He	Stable	3.518×10^{-3}	0.532
	^{6}He	806.7 ms	3.816×10^{-4}	1.62
Be (4)	^{2}H	Stable	7.691×10^{-4}	0.658
	^{3}H	12.32 y	6.058×10^{-3}	0.236
	^{3}He	Stable	3.367×10^{-6}	9.95
	^{4}He	Stable	6.282×10^{-3}	0.230
	^{6}He	806.7 ms	7.355×10^{-4}	0.673
	^{8}He	119.1 ms	2.610×10^{-5}	3.57
	^{6}Li	Stable	8.933×10^{-5}	1.93
	^{7}Li	Stable	5.282×10^{-3}	0.251
	^{8}Li	839.9 ms	2.811×10^{-3}	0.344
	^{9}Li	178.3 ms	2.104×10^{-4}	1.26
B (5)	^{3}He	Stable	2.957×10^{-5}	3.11
	^{4}He	Stable	3.672×10^{-2}	0.119
	^{6}He	806.7 ms	4.339×10^{-3}	0.256
	^{6}Li	Stable	1.370×10^{-4}	1.45
	^{7}Li	Stable	1.074×10^{-3}	0.516
	^{8}Li	839.9 ms	3.765×10^{-4}	0.871
	^{9}Li	178.3 ms	2.329×10^{-4}	1.11
	^{7}Be	53.22 d	2.857×10^{-6}	10.0
	^{9}Be	Stable	7.910×10^{-3}	0.189
	^{10}Be	1.51×10^{6} y	1.601×10^{-2}	0.133

Table 2 Yields of nuclides produced by the nuclear capture of μ^- for targets with $6 \leq Z \leq 7$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
C (6)	^{3}He	Stable	2.080×10^{-5}	9.81
	^{4}He	Stable	3.585×10^{-2}	0.283
	^{6}He	806.7 ms	4.224×10^{-4}	2.18
	^{6}Li	Stable	1.893×10^{-3}	1.03
	^{7}Li	Stable	1.560×10^{-2}	0.355
	^{8}Li	839.9 ms	1.241×10^{-3}	1.27
	^{9}Be	Stable	1.172×10^{-3}	1.31
	^{10}Be	1.51×10^{6} y	2.460×10^{-3}	0.901
	^{11}Be	13.76 s	5.080×10^{-5}	6.27
	^{10}B	Stable	3.241×10^{-3}	0.784
	^{11}B	Stable	4.090×10^{-2}	0.217
	^{12}B	20.20 ms	5.326×10^{-4}	1.94
	^{13}B	17.36 ms	2.960×10^{-5}	8.22
N (7)	^{6}Li	Stable	1.522×10^{-4}	3.66
	^{7}Li	Stable	3.822×10^{-4}	2.40
	^{8}Li	839.9 ms	6.220×10^{-5}	5.67
	^{9}Be	Stable	4.616×10^{-3}	0.657
	^{10}Be	1.51×10^{6} y	3.283×10^{-3}	0.779
	^{10}B	Stable	1.398×10^{-4}	3.78
	^{11}B	Stable	1.901×10^{-3}	1.03
	^{12}B	20.20 ms	8.912×10^{-4}	1.50
	^{13}B	17.36 ms	4.866×10^{-4}	2.03
	^{11}C	1221.8 s	3.060×10^{-5}	8.08
	^{12}C	Stable	3.397×10^{-2}	0.239
	^{13}C	Stable	4.066×10^{-2}	0.217
	^{14}C	5700 y	3.302×10^{-2}	0.242

Table 3 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 8$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
O (8)	^{6}Li	Stable	2.842×10^{-4}	2.65
	^{7}Li	Stable	1.626×10^{-3}	1.11
	^{8}Li	839.9 ms	3.756×10^{-4}	2.31
	^{9}Be	Stable	2.816×10^{-4}	2.67
	^{10}Be	1.51×10^{6} y	4.112×10^{-4}	2.21
	^{11}Be	13.76 s	2.280×10^{-5}	9.37
	^{10}B	Stable	7.774×10^{-4}	1.60
	^{11}B	Stable	1.331×10^{-2}	0.385
	^{12}B	20.20 ms	2.322×10^{-3}	0.927
	^{12}C	Stable	4.915×10^{-3}	0.636
	^{13}C	Stable	7.968×10^{-3}	0.499
	^{14}C	5700 y	9.029×10^{-3}	0.469
	^{15}C	2.449 s	4.208×10^{-4}	2.18
	^{13}N	9.965 min	4.914×10^{-4}	2.02
	^{14}N	Stable	3.465×10^{-2}	0.236
	^{15}N	Stable	1.002×10^{-1}	0.134
	^{16}N	7.13 s	8.588×10^{-4}	1.53

Table 4 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 9$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
F (9)	^{6}Li	Stable	3.740×10^{-5}	7.31
	^{7}Li	Stable	2.544×10^{-4}	2.87
	^{8}Li	839.9 ms	6.680×10^{-5}	5.47
	^{9}Be	Stable	4.582×10^{-4}	2.26
	^{10}Be	1.51×10^{6} y	8.602×10^{-4}	1.52
	^{11}Be	13.76 s	1.248×10^{-4}	4.00
	^{11}B	Stable	2.964×10^{-4}	2.60
	^{12}B	20.20 ms	1.596×10^{-4}	3.54
	^{13}B	17.36 ms	5.860×10^{-5}	5.84
	^{12}C	Stable	2.388×10^{-3}	0.914
	^{13}C	Stable	8.697×10^{-3}	0.478
	^{14}C	5700 y	3.323×10^{-2}	0.241
	^{15}C	2.449 s	1.573×10^{-3}	1.13
	^{16}C	0.747 s	2.840×10^{-5}	8.39
	^{14}N	Stable	3.280×10^{-4}	2.47
	^{15}N	Stable	4.353×10^{-3}	0.676
	^{16}N	7.13 s	2.057×10^{-3}	0.985
	^{17}N	4.173 s	3.314×10^{-3}	0.776
	^{18}N	624 ms	7.722×10^{-4}	1.61
	^{16}O	Stable	1.582×10^{-2}	0.353
	^{17}O	Stable	3.524×10^{-2}	0.234
	^{18}O	Stable	1.084×10^{-1}	0.128
	^{19}O	26.88 s	1.791×10^{-2}	0.331

Table 5 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 10.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ne (10)	^{6}Li	Stable	2.470×10^{-4}	2.85
	^{7}Li	Stable	5.124×10^{-4}	1.98
	^{8}Li	839.9 ms	7.080×10^{-5}	5.32
	^{9}Be	Stable	1.086×10^{-4}	4.31
	^{10}Be	1.51×10^{6} y	3.780×10^{-5}	7.27
	^{10}B	Stable	9.920×10^{-5}	4.49
	^{11}B	Stable	7.226×10^{-4}	1.66
	^{12}B	20.20 ms	4.166×10^{-4}	2.19
	^{12}C	Stable	8.996×10^{-4}	1.49
	^{13}C	Stable	1.377×10^{-3}	1.21
	^{14}C	5700 y	2.106×10^{-3}	0.974
	^{15}C	2.449 s	1.446×10^{-4}	3.72
	^{13}N	9.965 min	1.128×10^{-4}	4.21
	^{14}N	Stable	1.553×10^{-2}	0.356
	^{15}N	Stable	8.558×10^{-2}	0.146
	^{16}N	7.13 s	4.921×10^{-3}	0.636
	^{17}N	4.173 s	1.054×10^{-4}	4.36
	^{18}N	624 ms	3.100×10^{-5}	8.03
	^{15}O	122.24 s	2.280×10^{-5}	9.37
	^{16}O	Stable	5.094×10^{-3}	0.625
	^{17}O	Stable	8.180×10^{-3}	0.492
	^{18}O	Stable	1.206×10^{-2}	0.405
	^{19}O	26.88 s	3.243×10^{-3}	0.784
	^{17}F	64.385 s	3.150×10^{-4}	2.52
	^{18}F	109.77 min	3.015×10^{-2}	0.254
	^{19}F	Stable	1.377×10^{-1}	0.112
	^{20}F	11.163 s	4.424×10^{-2}	0.208

Table 6 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 11.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Na (11)	^{7}Li	Stable	4.400×10^{-5}	6.74
	^{9}Be	Stable	4.760×10^{-5}	6.48
	^{10}Be	1.51×10^{6} y	3.280×10^{-5}	7.81
	^{12}C	Stable	8.700×10^{-5}	4.79
	^{13}C	Stable	1.112×10^{-4}	4.24
	^{14}C	5700 y	4.082×10^{-4}	2.21
	^{15}C	2.449 s	3.520×10^{-5}	7.54
	^{15}N	Stable	3.112×10^{-4}	2.54
	^{16}N	7.13 s	5.020×10^{-5}	6.31
	^{17}N	4.173 s	4.260×10^{-5}	6.85
	^{16}O	Stable	3.747×10^{-3}	0.729
	^{17}O	Stable	2.679×10^{-3}	0.863
	^{18}O	Stable	6.076×10^{-3}	0.572
	^{19}O	26.88 s	5.162×10^{-4}	1.97
	^{20}O	13.51 s	6.600×10^{-5}	5.51
	^{21}O	3.42 s	3.920×10^{-5}	7.14
	^{18}F	109.77 min	5.800×10^{-5}	5.87
	^{19}F	Stable	1.602×10^{-3}	1.12
	^{20}F	11.163 s	4.183×10^{-3}	0.690
	^{21}F	4.158 s	7.580×10^{-3}	0.512
	^{22}F	4.23 s	3.280×10^{-3}	0.780
	^{20}Ne	Stable	2.978×10^{-2}	0.255
	^{21}Ne	Stable	8.810×10^{-2}	0.144
	^{22}Ne	Stable	2.038×10^{-1}	0.0884
	^{23}Ne	37.25 s	4.389×10^{-2}	0.209

Table 7 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 12.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Mg (12)	^{7}Li	Stable	4.980×10^{-5}	6.34
	^{9}Be	Stable	3.740×10^{-5}	7.31
	^{11}B	Stable	6.300×10^{-5}	5.63
	^{12}C	Stable	6.620×10^{-5}	5.50
	^{13}C	Stable	3.740×10^{-5}	7.31
	^{14}C	5700 y	2.520×10^{-5}	8.91
	^{14}N	Stable	2.074×10^{-4}	3.11
	^{15}N	Stable	3.953×10^{-3}	0.710
	^{16}N	7.13 s	2.978×10^{-4}	2.59
	^{16}O	Stable	4.476×10^{-4}	2.11
	^{17}O	Stable	3.250×10^{-4}	2.48
	^{18}O	Stable	6.126×10^{-4}	1.81
	^{19}O	26.88 s	6.720×10^{-5}	5.46
	^{18}F	109.77 min	1.817×10^{-3}	1.05
	^{19}F	Stable	1.581×10^{-2}	0.353
	^{20}F	11.163 s	7.469×10^{-3}	0.516
	^{21}F	4.158 s	1.061×10^{-3}	1.37
	^{22}F	4.23 s	3.302×10^{-4}	2.46
	^{20}Ne	Stable	3.254×10^{-3}	0.783
	^{21}Ne	Stable	1.594×10^{-2}	0.351
	^{22}Ne	Stable	7.019×10^{-2}	0.163
	^{23}Ne	37.25 s	8.844×10^{-3}	0.473
	^{24}Ne	3.38 min	2.066×10^{-3}	0.983
	^{25}Ne	602 ms	3.268×10^{-4}	2.47
	^{21}Na	22.49 s	2.350×10^{-4}	2.92
	^{22}Na	2.6018 y	3.059×10^{-2}	0.252
	^{23}Na	Stable	2.166×10^{-1}	0.0851
	^{24}Na	14.956 h	8.626×10^{-2}	0.146
	^{25}Na	59.1 s	2.990×10^{-2}	0.255
	^{26}Na	1.07128 s	3.404×10^{-3}	0.765

Table 8 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 13.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Al (13)	^{14}C	5700 y	2.220×10^{-5}	9.49
	^{16}O	Stable	2.840×10^{-5}	8.39
	^{17}O	Stable	3.180×10^{-5}	7.93
	^{18}O	Stable	2.190×10^{-4}	3.02
	^{19}O	26.88 s	4.720×10^{-5}	6.51
	^{19}F	Stable	3.100×10^{-5}	8.03
	^{20}F	11.163 s	7.360×10^{-5}	5.21
	^{21}F	4.158 s	1.700×10^{-4}	3.43
	^{22}F	4.23 s	9.100×10^{-5}	4.69
	^{20}Ne	Stable	9.754×10^{-4}	1.43
	^{21}Ne	Stable	5.076×10^{-3}	0.626
	^{22}Ne	Stable	2.013×10^{-2}	0.312
	^{23}Ne	37.25 s	4.120×10^{-3}	0.695
	^{24}Ne	3.38 min	2.282×10^{-4}	2.96
	^{25}Ne	602 ms	1.046×10^{-4}	4.37
	^{22}Na	2.6018 y	3.260×10^{-5}	7.83
	^{23}Na	Stable	2.051×10^{-3}	0.986
	^{24}Na	14.956 h	6.040×10^{-3}	0.574
	^{25}Na	59.1 s	1.418×10^{-2}	0.373
	^{26}Na	1.07128 s	6.557×10^{-3}	0.551
	^{24}Mg	Stable	2.534×10^{-2}	0.277
	^{25}Mg	Stable	9.677×10^{-2}	0.137
	^{26}Mg	Stable	2.737×10^{-1}	0.0729
	^{27}Mg	9.458 min	8.591×10^{-2}	0.146

Table 9 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 14.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Si (14)	^{13}C	Stable	2.400×10^{-5}	9.20
	^{15}N	Stable	6.780×10^{-5}	5.43
	^{19}F	Stable	4.866×10^{-4}	2.03
	^{20}F	11.163 s	3.690×10^{-4}	2.33
	^{20}Ne	Stable	9.260×10^{-5}	4.65
	^{21}Ne	Stable	4.020×10^{-4}	2.23
	^{22}Ne	Stable	4.624×10^{-3}	0.656
	^{23}Ne	37.25 s	6.196×10^{-4}	1.80
	^{22}Na	2.6018 y	1.468×10^{-3}	1.17
	^{23}Na	Stable	3.053×10^{-2}	0.252
	^{24}Na	14.956 h	1.343×10^{-2}	0.383
	^{25}Na	59.1 s	8.858×10^{-4}	1.50
	^{26}Na	1.07128 s	4.222×10^{-4}	2.18
	^{24}Mg	Stable	3.150×10^{-3}	0.796
	^{25}Mg	Stable	1.847×10^{-2}	0.326
	^{26}Mg	Stable	1.051×10^{-1}	0.131
	^{27}Mg	9.458 min	2.129×10^{-2}	0.303
	^{28}Mg	20.915 h	1.041×10^{-3}	1.39
	^{29}Mg	1.30 s	1.056×10^{-4}	4.35
	^{25}Al	7.183 s	2.864×10^{-4}	2.64
	^{26}Al	7.17×10^{5} y	3.178×10^{-2}	0.247
	^{27}Al	Stable	2.694×10^{-1}	0.0737
	^{28}Al	2.245 min	1.147×10^{-1}	0.124
	^{29}Al	6.56 min	1.352×10^{-2}	0.382
	^{30}Al	3.62 s	1.287×10^{-3}	1.25

Table 10 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 15$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
P (15)	^{21}Ne	Stable	2.220×10^{-5}	9.49
	^{22}Ne	Stable	3.450×10^{-4}	2.41
	^{23}Ne	37.25 s	1.294×10^{-4}	3.93
	^{23}Na	Stable	2.640×10^{-5}	8.70
	^{24}Na	14.956 h	9.460×10^{-5}	4.60
	^{25}Na	59.1 s	2.612×10^{-4}	2.77
	^{26}Na	1.07128 s	1.542×10^{-4}	3.60
	^{24}Mg	Stable	4.458×10^{-4}	2.12
	^{25}Mg	Stable	3.296×10^{-3}	0.778
	^{26}Mg	Stable	1.373×10^{-2}	0.379
	^{27}Mg	9.458 min	5.118×10^{-3}	0.624
	^{28}Mg	20.915 h	3.558×10^{-4}	2.37
	^{29}Mg	1.30 s	1.272×10^{-4}	3.97
	^{27}Al	Stable	2.654×10^{-3}	0.867
	^{28}Al	2.245 min	1.111×10^{-2}	0.422
	^{29}Al	6.56 min	2.447×10^{-2}	0.282
	^{30}Al	3.62 s	9.645×10^{-3}	0.453
	^{28}Si	Stable	2.835×10^{-2}	0.262
	^{29}Si	Stable	1.322×10^{-1}	0.115
	^{30}Si	Stable	3.142×10^{-1}	0.0661
	^{31}Si	157.24 min	1.067×10^{-1}	0.129

Table 11 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 16.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
S (16)	^{22}Ne	Stable	3.000×10^{-5}	8.17
	^{23}Na	Stable	6.372×10^{-4}	1.77
	^{24}Na	14.956 h	5.858×10^{-4}	1.85
	^{24}Mg	Stable	5.060×10^{-5}	6.29
	^{25}Mg	Stable	3.650×10^{-4}	2.34
	^{26}Mg	Stable	4.638×10^{-3}	0.655
	^{27}Mg	9.458 min	1.325×10^{-3}	1.23
	^{26}Al	7.17×10^{5} y	1.007×10^{-3}	1.41
	^{27}Al	Stable	2.233×10^{-2}	0.296
	^{28}Al	2.245 min	1.575×10^{-2}	0.354
	^{29}Al	6.56 min	2.007×10^{-3}	0.997
	^{30}Al	3.62 s	8.212×10^{-4}	1.56
	^{28}Si	Stable	4.312×10^{-3}	0.680
	^{29}Si	Stable	3.374×10^{-2}	0.239
	^{30}Si	Stable	1.419×10^{-1}	0.110
	^{31}Si	157.24 min	3.051×10^{-2}	0.252
	^{32}Si	153 y	1.035×10^{-3}	1.39
	^{33}Si	6.11 s	2.602×10^{-4}	2.77
	^{29}P	4.142 s	2.948×10^{-4}	2.60
	^{30}P	2.498 min	3.464×10^{-2}	0.236
	^{31}P	Stable	2.711×10^{-1}	0.0733
	^{32}P	14.268 d	1.397×10^{-1}	0.111
	^{33}P	25.35 d	1.276×10^{-2}	0.393
	^{34}P	12.43 s	2.988×10^{-3}	0.817
	^{35}P	47.3 s	3.340×10^{-5}	7.74

Table 12 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 17.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Cl (17)	^{26}Mg	Stable	2.504×10^{-4}	2.83
	^{27}Mg	9.458 min	1.674×10^{-4}	3.46
	^{27}Al	Stable	2.520×10^{-5}	8.91
	^{28}Al	2.245 min	1.770×10^{-4}	3.36
	^{29}Al	6.56 min	6.668×10^{-4}	1.73
	^{30}Al	3.62 s	2.622×10^{-4}	2.76
	^{28}Si	Stable	5.322×10^{-4}	1.94
	^{29}Si	Stable	5.961×10^{-3}	0.578
	^{30}Si	Stable	2.492×10^{-2}	0.280
	^{31}Si	157.24 min	9.286×10^{-3}	0.462
	^{32}Si	153 y	2.434×10^{-3}	0.905
	^{33}Si	6.11 s	5.012×10^{-4}	2.00
	^{34}Si	2.77 s	4.360×10^{-5}	6.77
	^{30}P	2.498 min	2.360×10^{-5}	9.21
	^{31}P	Stable	3.145×10^{-3}	0.796
	^{32}P	14.268 d	1.659×10^{-2}	0.344
	^{33}P	25.35 d	4.586×10^{-2}	0.204
	^{34}P	12.43 s	1.923×10^{-2}	0.319
	^{35}P	47.3 s	3.521×10^{-3}	0.752
	^{36}P	5.6 s	9.480×10^{-4}	1.45
	^{32}S	Stable	1.137×10^{-2}	0.417
	^{33}S	Stable	7.581×10^{-2}	0.156
	^{34}S	Stable	2.837×10^{-1}	0.0711
	^{35}S	87.37 d	1.386×10^{-1}	0.112
	^{36}S	Stable	6.921×10^{-2}	0.164
	^{37}S	5.05 min	1.036×10^{-2}	0.437

Table 13 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 18.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ar (18)	^{34}Si	2.77 s	2.020×10^{-5}	9.95
	^{32}P	14.268 d	5.300×10^{-5}	6.14
	^{33}P	25.35 d	1.665×10^{-3}	1.10
	^{34}P	12.43 s	4.171×10^{-3}	0.691
	^{35}P	47.3 s	4.346×10^{-3}	0.677
	^{36}P	5.6 s	4.824×10^{-4}	2.04
	^{37}P	2.31 s	1.128×10^{-4}	4.21
	^{38}P	0.64 s	6.920×10^{-5}	5.38
	^{34}S	Stable	6.340×10^{-5}	5.62
	^{35}S	87.37 d	5.706×10^{-4}	1.87
	^{36}S	Stable	5.097×10^{-3}	0.625
	^{37}S	5.05 min	6.572×10^{-3}	0.550
	^{38}S	170.3 min	1.601×10^{-2}	0.351
	^{39}S	11.5 s	6.293×10^{-3}	0.562
	^{35}Cl	Stable	2.516×10^{-4}	2.82
	^{36}Cl	3.01×10^{5} y	8.103×10^{-3}	0.495
	^{37}Cl	Stable	9.887×10^{-2}	0.135
	^{38}Cl	37.230 min	1.811×10^{-1}	0.0951
	^{39}Cl	56.2 min	2.944×10^{-1}	0.0692
	^{40}Cl	1.35 min	6.954×10^{-2}	0.164

Table 14 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 19.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
K (19)	^{29}Si	Stable	6.980×10^{-5}	5.35
	^{30}Si	Stable	9.592×10^{-4}	1.44
	^{31}Si	157.24 min	5.272×10^{-4}	1.95
	^{32}Si	153 y	2.500×10^{-5}	8.94
	^{31}P	Stable	5.740×10^{-5}	5.90
	^{32}P	14.268 d	6.024×10^{-4}	1.82
	^{33}P	25.35 d	3.019×10^{-3}	0.813
	^{34}P	12.43 s	1.574×10^{-3}	1.13
	^{32}S	Stable	3.538×10^{-4}	2.38
	^{33}S	Stable	5.309×10^{-3}	0.612
	^{34}S	Stable	3.730×10^{-2}	0.227
	^{35}S	87.37 d	1.604×10^{-2}	0.350
	^{36}S	Stable	3.272×10^{-3}	0.781
	^{37}S	5.05 min	6.322×10^{-4}	1.78
	^{35}Cl	Stable	3.258×10^{-3}	0.782
	^{36}Cl	3.01×10^{5} y	2.484×10^{-2}	0.280
	^{37}Cl	Stable	7.170×10^{-2}	0.161
	^{38}Cl	37.230 min	2.457×10^{-2}	0.282
	^{39}Cl	56.2 min	1.115×10^{-3}	1.34
	^{40}Cl	1.35 min	5.696×10^{-4}	1.87
	^{36}Ar	Stable	1.018×10^{-2}	0.441
	^{37}Ar	35.011 d	7.570×10^{-2}	0.156
	^{38}Ar	Stable	3.407×10^{-1}	0.0622
	^{39}Ar	268 y	1.204×10^{-1}	0.121
	^{40}Ar	Stable	1.892×10^{-2}	0.322
	^{41}Ar	109.61 min	5.677×10^{-3}	0.592

Table 15 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 20$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ca (20)	^{30}Si	Stable	1.838×10^{-4}	3.30
	^{31}Si	157.24 min	1.244×10^{-4}	4.01
	^{31}P	Stable	1.505×10^{-3}	1.15
	^{32}P	14.268 d	2.498×10^{-3}	0.894
	^{33}P	25.35 d	1.972×10^{-4}	3.18
	^{34}P	12.43 s	1.604×10^{-4}	3.53
	^{32}S	Stable	4.060×10^{-5}	7.02
	^{33}S	Stable	9.500×10^{-3}	1.45
	^{34}S	Stable	1.517×10^{-2}	0.360
	^{35}S	87.37 d	7.279×10^{-3}	0.522
	^{36}S	Stable	1.462×10^{-4}	3.70
	^{37}S	5.05 min	2.540×10^{-5}	8.87
	^{34}Cl	1.5266 s	8.702×10^{-4}	1.52
	^{35}Cl	Stable	3.182×10^{-2}	0.247
	^{36}Cl	3.01×10^{5} y	3.778×10^{-2}	0.226
	^{37}Cl	Stable	1.113×10^{-2}	0.422
	^{38}Cl	37.230 min	3.907×10^{-3}	0.714
	^{39}Cl	56.2 min	5.880×10^{-5}	5.83
	^{36}Ar	Stable	2.174×10^{-3}	0.958
	^{37}Ar	35.011 d	2.707×10^{-2}	0.268
	^{38}Ar	Stable	1.935×10^{-1}	0.0913
	^{39}Ar	268 y	4.728×10^{-2}	0.201
	^{40}Ar	Stable	3.840×10^{-4}	2.28
	^{41}Ar	109.61 min	2.488×10^{-4}	2.84
	^{42}Ar	32.9 y	3.594×10^{-4}	2.36
	^{43}Ar	5.37 min	1.548×10^{-4}	3.59
	^{37}K	1.225 s	6.100×10^{-5}	5.73
	^{38}K	7.651 min	1.835×10^{-2}	0.327
	^{39}K	Stable	2.659×10^{-1}	0.0743
	^{40}K	Stable	1.421×10^{-1}	0.110
	^{41}K	Stable	2.975×10^{-3}	0.819
	^{42}K	12.355 h	3.555×10^{-3}	0.749
	^{43}K	22.3 h	5.336×10^{-3}	0.611
	^{44}K	22.13 min	1.738×10^{-3}	1.07
	^{45}K	17.81 min	8.680×10^{-5}	4.80

Table 15 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{46}K	105 s	1.808×10^{-4}	3.33
	^{47}K	17.50 s	2.704×10^{-4}	2.72
	^{48}K	6.8 s	2.760×10^{-5}	8.51

Table 16 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 21.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Sc (21)	^{35}S	87.37 d	4.100×10^{-5}	6.98
	^{36}S	Stable	2.114×10^{-4}	3.08
	^{37}Cl	Stable	3.320×10^{-5}	7.76
	^{38}Cl	37.230 min	1.086×10^{-4}	4.29
	^{39}Cl	56.2 min	1.904×10^{-4}	3.24
	^{40}Cl	1.35 min	5.800×10^{-5}	5.87
	^{38}Ar	Stable	1.163×10^{-3}	1.31
	^{39}Ar	268 y	3.923×10^{-3}	0.713
	^{40}Ar	Stable	7.151×10^{-3}	0.527
	^{41}Ar	109.61 min	1.105×10^{-3}	1.35
	^{42}Ar	32.9 y	5.922×10^{-4}	1.84
	^{43}Ar	5.37 min	4.114×10^{-4}	2.20
	^{40}K	Stable	1.538×10^{-4}	3.61
	^{41}K	Stable	3.674×10^{-3}	0.737
	^{42}K	12.355 h	1.408×10^{-2}	0.374
	^{43}K	22.3 h	3.252×10^{-2}	0.244
	^{44}K	22.13 min	1.817×10^{-2}	0.329
	^{40}Ca	Stable	2.560×10^{-5}	8.84
	^{41}Ca	9.94×10^{4} y	1.331×10^{-3}	1.23
	^{42}Ca	Stable	4.562×10^{-2}	0.205
	^{43}Ca	Stable	1.504×10^{-1}	0.106
	^{44}Ca	Stable	3.759×10^{-1}	0.0576
	^{45}Ca	162.61 d	1.507×10^{-1}	0.106

Table 17 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 22.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ti (22)	^{37}Cl	Stable	4.380×10^{-5}	6.76
	^{38}Cl	37.230 min	3.360×10^{-5}	7.72
	^{39}Ar	268 y	3.180×10^{-5}	7.93
	^{40}Ar	Stable	1.420×10^{-4}	3.75
	^{41}Ar	109.61 min	6.320×10^{-5}	5.63
	^{42}Ar	32.9 y	6.140×10^{-5}	5.71
	^{39}K	Stable	4.540×10^{-5}	6.64
	^{40}K	Stable	4.420×10^{-4}	2.13
	^{41}K	Stable	1.738×10^{-3}	1.07
	^{42}K	12.355 h	2.233×10^{-3}	0.945
	^{43}K	22.3 h	2.909×10^{-3}	0.828
	^{44}K	22.13 min	1.066×10^{-3}	1.37
	^{45}K	17.81 min	3.854×10^{-4}	2.28
	^{46}K	105 s	3.016×10^{-4}	2.58
	^{42}Ca	Stable	5.752×10^{-4}	1.86
	^{43}Ca	Stable	3.931×10^{-3}	0.712
	^{44}Ca	Stable	2.158×10^{-2}	0.301
	^{45}Ca	162.61 d	1.719×10^{-2}	0.338
	^{46}Ca	Stable	3.219×10^{-2}	0.245
	^{47}Ca	4.536 d	1.688×10^{-2}	0.341
	^{48}Ca	Stable	2.155×10^{-3}	0.962
	^{49}Ca	8.718 min	3.982×10^{-4}	2.24
	^{43}Sc	3.891 h	5.984×10^{-4}	1.83
	^{44}Sc	4.0420 h	1.039×10^{-2}	0.436
	^{45}Sc	Stable	7.134×10^{-2}	0.161
	^{46}Sc	83.79 d	1.585×10^{-1}	0.103
	^{47}Sc	3.3492 d	3.052×10^{-1}	0.0675
	^{48}Sc	43.71 h	1.349×10^{-1}	0.113
	^{49}Sc	57.18 min	2.688×10^{-2}	0.269
	^{50}Sc	102.5 s	3.626×10^{-3}	0.741

Table 18 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 23.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
V (23)	^{45}K	17.81 min	2.700×10^{-5}	8.61
	^{44}Ca	Stable	2.966×10^{-4}	2.60
	^{45}Ca	162.61 d	1.271×10^{-3}	1.25
	^{46}Ca	Stable	2.372×10^{-3}	0.917
	^{47}Ca	4.536 d	5.666×10^{-4}	1.88
	^{48}Ca	Stable	4.724×10^{-4}	2.06
	^{49}Ca	8.718 min	3.212×10^{-4}	2.50
	^{46}Sc	83.79 d	1.072×10^{-4}	4.32
	^{47}Sc	3.3492 d	2.366×10^{-3}	0.918
	^{48}Sc	43.71 h	1.111×10^{-2}	0.422
	^{49}Sc	57.18 min	2.815×10^{-2}	0.263
	^{50}Sc	102.5 s	1.197×10^{-2}	0.406
	^{46}Ti	Stable	7.820×10^{-5}	5.06
	^{47}Ti	Stable	3.148×10^{-3}	0.796
	^{48}Ti	Stable	6.086×10^{-2}	0.176
	^{49}Ti	Stable	1.799×10^{-1}	0.0955
	^{50}Ti	Stable	4.031×10^{-1}	0.0544
	^{51}Ti	5.76 min	1.168×10^{-1}	0.123

Table 19 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 24.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Cr (24)	^{44}Ca	Stable	1.170×10^{-4}	4.13
	^{45}Ca	162.61 d	7.240×10^{-5}	5.26
	^{46}Ca	Stable	2.072×10^{-4}	3.11
	^{47}Ca	4.536 d	1.030×10^{-4}	4.41
	^{44}Sc	4.0420 h	5.660×10^{-5}	5.94
	^{45}Sc	Stable	4.824×10^{-4}	2.04
	^{46}Sc	83.79 d	1.686×10^{-3}	1.09
	^{47}Sc	3.3492 d	4.837×10^{-3}	0.641
	^{48}Sc	43.71 h	2.421×10^{-3}	0.908
	^{49}Sc	57.18 min	1.154×10^{-3}	1.32
	^{50}Sc	102.5 s	5.456×10^{-4}	1.91
	^{51}Sc	12.4 s	3.760×10^{-5}	7.29
	^{46}Ti	Stable	2.236×10^{-4}	2.99
	^{47}Ti	Stable	1.967×10^{-3}	1.01
	^{48}Ti	Stable	1.269×10^{-2}	0.395
	^{49}Ti	Stable	2.001×10^{-2}	0.313
	^{50}Ti	Stable	6.097×10^{-2}	0.176
	^{51}Ti	5.76 min	1.816×10^{-2}	0.329
	^{52}Ti	1.7 min	2.082×10^{-3}	0.979
	^{53}Ti	32.7 s	2.214×10^{-4}	3.01
	^{47}V	32.6 min	2.114×10^{-4}	3.08
	^{48}V	15.974 d	4.670×10^{-3}	0.653
	^{49}V	330 d	4.298×10^{-2}	0.211
	^{50}V	Stable	1.486×10^{-1}	0.107
	^{51}V	Stable	3.604×10^{-1}	0.0596
	^{52}V	3.743 min	1.391×10^{-1}	0.111
	^{53}V	1.543 min	2.147×10^{-2}	0.302
	^{54}V	49.8 s	1.728×10^{-3}	1.08

Table 20 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 25.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Mn (25)	^{48}Sc	43.71 h	4.300×10^{-5}	6.82
	^{49}Sc	57.18 min	1.796×10^{-4}	3.34
	^{50}Sc	102.5 s	6.260×10^{-5}	5.65
	^{48}Ti	Stable	4.062×10^{-4}	2.22
	^{49}Ti	Stable	2.040×10^{-3}	0.989
	^{50}Ti	Stable	3.912×10^{-3}	0.714
	^{51}Ti	5.76 min	6.906×10^{-4}	1.70
	^{52}Ti	1.7 min	4.290×10^{-4}	2.16
	^{53}Ti	32.7 s	3.642×10^{-4}	2.34
	^{50}V	Stable	1.244×10^{-4}	4.01
	^{51}V	Stable	3.735×10^{-3}	0.730
	^{52}V	3.743 min	1.120×10^{-2}	0.420
	^{53}V	1.543 min	2.168×10^{-2}	0.300
	^{54}V	49.8 s	1.227×10^{-2}	0.401
	^{50}Cr	Stable	7.040×10^{-5}	5.33
	^{51}Cr	27.704 d	3.748×10^{-3}	0.729
	^{52}Cr	Stable	8.176×10^{-2}	0.150
	^{53}Cr	Stable	2.103×10^{-1}	0.0867
	^{54}Cr	Stable	3.870×10^{-1}	0.0563
	^{55}Cr	3.497 min	1.125×10^{-1}	0.126

Table 21 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 26$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Fe (26)	^{47}Sc	3.3492 d	2.640×10^{-5}	8.70
	^{48}Sc	43.71 h	2.760×10^{-5}	8.51
	^{48}Ti	Stable	1.814×10^{-4}	3.32
	^{49}Ti	Stable	1.868×10^{-4}	3.27
	^{50}Ti	Stable	6.806×10^{-4}	1.71
	^{51}Ti	5.76 min	1.010×10^{-4}	4.45
	^{48}V	15.974 d	7.720×10^{-5}	5.09
	^{49}V	330 d	6.820×10^{-4}	1.71
	^{50}V	Stable	2.433×10^{-3}	0.906
	^{51}V	Stable	6.616×10^{-3}	0.548
	^{52}V	3.743 min	2.235×10^{-3}	0.945
	^{53}V	1.543 min	6.628×10^{-4}	1.74
	^{54}V	49.8 s	5.190×10^{-4}	1.96
	^{50}Cr	Stable	2.104×10^{-4}	3.08
	^{51}Cr	27.704 d	2.459×10^{-3}	0.901
	^{52}Cr	Stable	2.073×10^{-2}	0.307
	^{53}Cr	Stable	2.892×10^{-2}	0.259
	^{54}Cr	Stable	4.601×10^{-2}	0.204
	^{55}Cr	3.497 min	1.839×10^{-2}	0.327
	^{56}Cr	5.94 min	4.728×10^{-4}	2.06
	^{57}Cr	21.1 s	2.580×10^{-5}	8.80
	^{51}Mn	46.2 min	1.646×10^{-4}	3.49
	^{52}Mn	5.591 d	3.967×10^{-3}	0.709
	^{53}Mn	3.7×10^{6} y	5.578×10^{-2}	0.184
	^{54}Mn	312.20 d	1.828×10^{-1}	0.0946
	^{55}Mn	Stable	3.706×10^{-1}	0.0583
	^{56}Mn	2.5789 h	1.238×10^{-1}	0.119
	^{57}Mn	85.4 s	4.280×10^{-3}	0.682
	^{58}Mn	3.0 s	2.548×10^{-4}	2.80

Table 22 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 27$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Co (27)	^{50}Ti	Stable	2.560×10^{-5}	8.84
	^{52}V	3.743 min	3.800×10^{-5}	7.26
	^{53}V	1.543 min	9.840×10^{-5}	4.51
	^{54}V	49.8 s	2.960×10^{-5}	8.22
	^{52}Cr	Stable	6.624×10^{-4}	1.74
	^{53}Cr	Stable	2.770×10^{-3}	0.849
	^{54}Cr	Stable	3.926×10^{-3}	0.712
	^{55}Cr	3.497 min	6.452×10^{-4}	1.76
	^{56}Cr	5.94 min	5.156×10^{-4}	1.97
	^{57}Cr	21.1 s	4.066×10^{-4}	2.22
	^{54}Mn	312.20 d	2.166×10^{-4}	3.04
	^{55}Mn	Stable	4.422×10^{-3}	0.671
	^{56}Mn	2.5789 h	1.361×10^{-2}	0.381
	^{57}Mn	85.4 s	2.615×10^{-2}	0.273
	^{58}Mn	3.0 s	1.526×10^{-2}	0.359
	^{54}Fe	Stable	8.300×10^{-5}	4.91
	^{55}Fe	2.744 y	4.536×10^{-3}	0.663
	^{56}Fe	Stable	7.963×10^{-2}	0.152
	^{57}Fe	Stable	1.999×10^{-1}	0.0895
	^{58}Fe	Stable	3.973×10^{-1}	0.0551
	^{59}Fe	44.490 d	1.259×10^{-1}	0.118

Table 23 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 28.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ni (28)	^{49}V	330 d	5.300×10^{-5}	6.14
	^{50}V	Stable	1.060×10^{-4}	4.34
	^{51}V	Stable	5.200×10^{-5}	6.20
	^{52}V	3.743 min	4.100×10^{-5}	6.98
	^{51}Cr	27.704 d	2.220×10^{-4}	3.00
	^{52}Cr	Stable	3.296×10^{-3}	0.778
	^{53}Cr	Stable	1.726×10^{-3}	1.08
	^{54}Cr	Stable	2.166×10^{-4}	3.04
	^{55}Cr	3.497 min	6.620×10^{-5}	5.50
	^{52}Mn	5.591 d	6.004×10^{-4}	1.83
	^{53}Mn	3.7×10^{6} y	7.325×10^{-3}	0.521
	^{54}Mn	312.20 d	8.367×10^{-3}	0.487
	^{55}Mn	Stable	8.876×10^{-3}	0.473
	^{56}Mn	2.5789 h	3.953×10^{-3}	0.710
	^{57}Mn	85.4 s	3.358×10^{-4}	2.44
	^{58}Mn	3.0 s	2.382×10^{-4}	2.90
	^{54}Fe	Stable	2.699×10^{-3}	0.860
	^{55}Fe	2.744 y	3.184×10^{-2}	0.247
	^{56}Fe	Stable	1.470×10^{-1}	0.108
	^{57}Fe	Stable	5.398×10^{-2}	0.187
	^{58}Fe	Stable	1.611×10^{-2}	0.350
	^{59}Fe	44.490 d	6.409×10^{-3}	0.557
	^{60}Fe	2.62×10^{6} y	1.097×10^{-3}	1.35
	^{61}Fe	5.98 min	4.418×10^{-4}	2.13
	^{62}Fe	68 s	1.202×10^{-4}	4.08
	^{63}Fe	6.1 s	6.300×10^{-5}	5.63
	^{55}Co	17.53 h	1.758×10^{-3}	1.07
	^{56}Co	77.236 d	3.977×10^{-2}	0.220
	^{57}Co	271.74 d	2.318×10^{-1}	0.0814
	^{58}Co	70.86 d	1.650×10^{-1}	0.101
	^{59}Co	Stable	1.013×10^{-1}	0.133
	^{60}Co	1925.28 d	4.201×10^{-2}	0.214
	^{61}Co	1.649 h	1.384×10^{-2}	0.378
	^{62}Co	1.54 min	4.420×10^{-3}	0.671
	^{63}Co	27.4 s	2.281×10^{-3}	0.935

Table 23 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
	^{64}Co	0.30 s	5.248×10^{-4}	1.95

Table 24 Yields of nuclides produced by the nuclear capture of μ$^-$ for the target with $Z = 29$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
Cu (29)	^{54}Cr	Stable	2.560×10^{-5}	8.84
	^{56}Mn	2.5789 h	5.420×10^{-5}	6.07
	^{57}Mn	85.4 s	1.102×10^{-4}	4.26
	^{58}Mn	3.0 s	3.280×10^{-5}	7.81
	^{56}Fe	Stable	6.030×10^{-4}	1.82
	^{57}Fe	Stable	2.372×10^{-3}	0.917
	^{58}Fe	Stable	3.683×10^{-3}	0.736
	^{59}Fe	44.490 d	8.782×10^{-4}	1.51
	^{60}Fe	2.62×10^{6} y	8.448×10^{-4}	1.54
	^{61}Fe	5.98 min	4.694×10^{-4}	2.06
	^{62}Fe	68 s	9.560×10^{-5}	4.57
	^{63}Fe	6.1 s	8.420×10^{-5}	4.87
	^{58}Co	70.86 d	1.348×10^{-4}	3.85
	^{59}Co	Stable	3.757×10^{-3}	0.728
	^{60}Co	1925.28 d	1.305×10^{-2}	0.389
	^{61}Co	1.649 h	2.748×10^{-2}	0.266
	^{62}Co	1.54 min	1.559×10^{-2}	0.355
	^{63}Co	27.4 s	5.403×10^{-3}	0.607
	^{64}Co	0.30 s	3.351×10^{-3}	0.771
	^{58}Ni	Stable	3.320×10^{-5}	7.76
	^{59}Ni	7.6×10^{4} y	2.022×10^{-3}	0.994
	^{60}Ni	Stable	4.719×10^{-2}	0.201
	^{61}Ni	Stable	1.380×10^{-1}	0.112
	^{62}Ni	Stable	3.268×10^{-1}	0.0642
	^{63}Ni	101.2 y	1.569×10^{-1}	0.104
	^{64}Ni	Stable	1.094×10^{-1}	0.128
	^{65}Ni	2.51719 h	3.120×10^{-2}	0.249

Table 25 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 30$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Zn (30)	^{55}Mn	Stable	4.780×10^{-5}	6.47
	^{56}Mn	2.5789 h	2.820×10^{-5}	8.42
	^{56}Fe	Stable	2.020×10^{-5}	9.95
	^{57}Fe	Stable	1.824×10^{-4}	3.31
	^{58}Fe	Stable	6.360×10^{-4}	1.77
	^{59}Fe	44.490 d	1.178×10^{-4}	4.12
	^{60}Fe	2.62×10^{6} y	2.780×10^{-5}	8.48
	^{57}Co	271.74 d	2.436×10^{-4}	2.87
	^{58}Co	70.86 d	2.156×10^{-3}	0.962
	^{59}Co	Stable	6.487×10^{-3}	0.554
	^{60}Co	1925.28 d	3.067×10^{-3}	0.806
	^{61}Co	1.649 h	2.646×10^{-3}	0.868
	^{62}Co	1.54 min	1.281×10^{-3}	1.25
	^{63}Co	27.4 s	4.754×10^{-4}	2.05
	^{64}Co	0.30 s	2.246×10^{-4}	2.98
	^{65}Co	1.16 s	6.760×10^{-5}	5.44
	^{66}Co	0.20 s	4.560×10^{-5}	6.62
	^{59}Ni	7.6×10^{4} y	1.020×10^{-4}	4.43
	^{60}Ni	Stable	5.443×10^{-3}	0.605
	^{61}Ni	Stable	2.455×10^{-2}	0.282
	^{62}Ni	Stable	9.133×10^{-2}	0.141
	^{63}Ni	101.2 y	2.770×10^{-2}	0.265
	^{64}Ni	Stable	1.367×10^{-2}	0.380
	^{65}Ni	2.51719 h	8.359×10^{-3}	0.487
	^{66}Ni	54.6 h	6.239×10^{-3}	0.564
	^{67}Ni	21 s	2.482×10^{-3}	0.897
	^{68}Ni	29 s	6.780×10^{-5}	5.43
	^{69}Ni	11.4 s	2.940×10^{-5}	8.25
	^{60}Cu	23.7 min	4.100×10^{-5}	6.98
	^{61}Cu	3.336 h	8.050×10^{-3}	0.496
	^{62}Cu	9.67 min	5.199×10^{-2}	0.191
	^{63}Cu	Stable	2.056×10^{-1}	0.0879
	^{64}Cu	12.7006 h	1.409×10^{-1}	0.110
	^{65}Cu	Stable	1.297×10^{-1}	0.116
	^{66}Cu	5.120 min	7.794×10^{-2}	0.154

Table 25 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{67}Cu	61.83 h	6.713×10^{-2}	0.167
	^{68}Cu	30.9 s	1.690×10^{-2}	0.341
	^{69}Cu	2.85 min	1.537×10^{-3}	1.14
	^{70}Cu	44.5 s	3.140×10^{-4}	2.52

Table 26 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 31$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Ga (31)	^{62}Co	1.54 min	2.260×10^{-5}	9.41
	^{63}Co	27.4 s	7.160×10^{-5}	5.29
	^{64}Co	0.30 s	2.740×10^{-5}	8.54
	^{61}Ni	Stable	2.640×10^{-5}	8.70
	^{62}Ni	Stable	6.504×10^{-4}	1.75
	^{63}Ni	101.2 y	1.527×10^{-3}	1.14
	^{64}Ni	Stable	2.467×10^{-3}	0.899
	^{65}Ni	2.51719 h	9.282×10^{-4}	1.47
	^{66}Ni	54.6 h	1.094×10^{-3}	1.35
	^{67}Ni	21 s	5.662×10^{-4}	1.88
	^{68}Ni	29 s	1.004×10^{-4}	4.46
	^{69}Ni	11.4 s	9.040×10^{-5}	4.70
	^{64}Cu	12.7006 h	1.882×10^{-4}	3.26
	^{65}Cu	Stable	2.879×10^{-3}	0.832
	^{66}Cu	5.120 min	8.996×10^{-3}	0.469
	^{67}Cu	61.83 h	2.262×10^{-2}	0.294
	^{68}Cu	30.9 s	1.510×10^{-2}	0.361
	^{69}Cu	2.85 min	7.573×10^{-3}	0.512
	^{70}Cu	44.5 s	4.101×10^{-3}	0.697
	^{64}Zn	Stable	3.150×10^{-4}	2.52
	^{65}Zn	243.93 d	5.124×10^{-3}	0.623
	^{66}Zn	Stable	5.982×10^{-2}	0.177
	^{67}Zn	Stable	1.248×10^{-1}	0.118
	^{68}Zn	Stable	3.010×10^{-1}	0.0682
	^{69}Zn	56.4 min	1.549×10^{-1}	0.105
	^{70}Zn	Stable	1.394×10^{-1}	0.111
	^{71}Zn	2.42 min	3.715×10^{-2}	0.228

Table 27 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 32.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ge (32)	^{63}Ni	101.2 y	4.760×10^{-5}	6.48
	^{64}Ni	Stable	1.582×10^{-4}	3.56
	^{65}Ni	2.51719 h	5.880×10^{-5}	5.83
	^{66}Ni	54.6 h	3.660×10^{-5}	7.39
	^{63}Cu	Stable	1.704×10^{-4}	3.43
	^{64}Cu	12.7006 h	9.586×10^{-4}	1.44
	^{65}Cu	Stable	2.300×10^{-3}	0.932
	^{66}Cu	5.120 min	1.677×10^{-3}	1.09
	^{67}Cu	61.83 h	1.391×10^{-3}	1.20
	^{68}Cu	30.9 s	7.794×10^{-4}	1.60
	^{69}Cu	2.85 min	2.892×10^{-4}	2.63
	^{70}Cu	44.5 s	1.820×10^{-4}	3.32
	^{71}Cu	19.4 s	1.106×10^{-4}	4.25
	^{72}Cu	6.63 s	7.660×10^{-5}	5.11
	^{65}Zn	243.93 d	1.056×10^{-4}	4.35
	^{66}Zn	Stable	3.221×10^{-3}	0.787
	^{67}Zn	Stable	8.305×10^{-3}	0.489
	^{68}Zn	Stable	2.493×10^{-2}	0.280
	^{69}Zn	56.4 min	1.640×10^{-2}	0.346
	^{70}Zn	Stable	1.222×10^{-2}	0.402
	^{71}Zn	2.42 min	9.128×10^{-3}	0.466
	^{72}Zn	46.5 h	9.891×10^{-3}	0.448
	^{73}Zn	24.5 s	4.155×10^{-3}	0.692
	^{74}Zn	95.6 s	1.041×10^{-3}	1.39
	^{75}Zn	10.2 s	4.870×10^{-4}	2.03
	^{66}Ga	9.49 h	2.034×10^{-4}	3.14
	^{67}Ga	3.2617 d	1.033×10^{-2}	0.438
	^{68}Ga	67.71 min	4.058×10^{-2}	0.217
	^{69}Ga	Stable	1.220×10^{-1}	0.120
	^{70}Ga	21.14 min	1.126×10^{-1}	0.126
	^{71}Ga	Stable	1.682×10^{-1}	0.0994
	^{72}Ga	14.10 h	1.203×10^{-1}	0.121
	^{73}Ga	4.86 h	1.489×10^{-1}	0.107
	^{74}Ga	8.12 min	4.644×10^{-2}	0.203
	^{75}Ga	126 s	2.119×10^{-2}	0.304

Table 27 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{76}Ga	30.5 s	4.924×10^{-3}	0.636

Table 28 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 33.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
As (33)	^{67}Zn	Stable	3.560×10^{-5}	7.50
	^{68}Zn	Stable	5.088×10^{-4}	1.98
	^{69}Zn	56.4 min	8.222×10^{-4}	1.56
	^{70}Zn	Stable	6.960×10^{-4}	1.70
	^{71}Zn	2.42 min	1.606×10^{-4}	3.53
	^{72}Zn	46.5 h	5.114×10^{-4}	1.98
	^{73}Zn	24.5 s	4.218×10^{-4}	2.18
	^{70}Ga	21.14 min	2.682×10^{-4}	2.73
	^{71}Ga	Stable	2.792×10^{-3}	0.845
	^{72}Ga	14.10 h	8.063×10^{-3}	0.496
	^{73}Ga	4.86 h	2.332×10^{-2}	0.289
	^{74}Ga	8.12 min	1.508×10^{-2}	0.361
	^{70}Ge	Stable	1.160×10^{-3}	1.31
	^{71}Ge	11.43 d	1.219×10^{-2}	0.403
	^{72}Ge	Stable	1.084×10^{-1}	0.128
	^{73}Ge	Stable	1.892×10^{-1}	0.0926
	^{74}Ge	Stable	4.064×10^{-1}	0.0541
	^{75}Ge	82.78 min	1.281×10^{-1}	0.117

Table 29 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 34.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Se (34)	^{68}Ga	67.71 min	2.780×10^{-5}	8.48
	^{69}Ga	Stable	1.278×10^{-4}	3.96
	^{70}Ga	21.14 min	1.826×10^{-4}	3.31
	^{71}Ga	Stable	2.038×10^{-4}	3.13
	^{72}Ga	14.10 h	1.514×10^{-4}	3.63
	^{73}Ga	4.86 h	1.960×10^{-4}	3.19
	^{74}Ga	8.12 min	1.794×10^{-4}	3.34
	^{75}Ga	126 s	2.092×10^{-4}	3.09
	^{76}Ga	30.5 s	1.212×10^{-4}	4.06
	^{77}Ga	13.2 s	9.180×10^{-5}	4.67
	^{78}Ga	5.09 s	1.108×10^{-4}	4.25
	^{70}Ge	Stable	1.660×10^{-4}	3.47
	^{71}Ge	11.43 d	5.614×10^{-4}	1.89
	^{72}Ge	Stable	2.505×10^{-3}	0.892
	^{73}Ge	Stable	2.478×10^{-3}	0.897
	^{74}Ge	Stable	7.450×10^{-3}	0.516
	^{75}Ge	82.78 min	7.327×10^{-3}	0.521
	^{76}Ge	Stable	1.166×10^{-2}	0.412
	^{77}Ge	11.211 h	7.854×10^{-3}	0.503
	^{78}Ge	88 min	1.063×10^{-2}	0.431
	^{79}Ge	18.98 s	6.243×10^{-3}	0.564
	^{80}Ge	29.5 s	1.147×10^{-3}	1.32
	^{81}Ge	7.6 s	5.902×10^{-4}	1.84
	^{71}As	65.30 h	4.056×10^{-4}	2.22
	^{72}As	26.0 h	2.520×10^{-3}	0.890
	^{73}As	80.30 d	1.418×10^{-2}	0.373
	^{74}As	17.77 d	3.284×10^{-2}	0.243
	^{75}As	Stable	9.383×10^{-2}	0.139
	^{76}As	26.254 h	1.010×10^{-1}	0.133
	^{77}As	38.79 h	1.739×10^{-1}	0.0975
	^{78}As	90.7 min	1.334×10^{-1}	0.114
	^{79}As	9.01 min	1.848×10^{-1}	0.0939
	^{80}As	15.2 s	6.526×10^{-2}	0.169
	^{81}As	33.3 s	2.604×10^{-2}	0.274
	^{82}As	19.1 s	5.749×10^{-3}	0.588

Table 30 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 35.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Br (35)	^{72}Ge	Stable	2.484×10^{-4}	2.84
	^{73}Ge	Stable	4.906×10^{-4}	2.02
	^{74}Ge	Stable	6.070×10^{-4}	1.82
	^{75}Ge	82.78 min	2.532×10^{-4}	2.81
	^{76}Ge	Stable	5.230×10^{-4}	1.96
	^{77}Ge	11.211 h	4.134×10^{-4}	2.20
	^{78}Ge	88 min	1.802×10^{-4}	3.33
	^{79}Ge	18.98 s	1.800×10^{-4}	3.33
	^{74}As	17.77 d	1.104×10^{-4}	4.26
	^{75}As	Stable	1.926×10^{-3}	1.02
	^{76}As	26.254 h	6.009×10^{-3}	0.575
	^{77}As	38.79 h	1.705×10^{-2}	0.340
	^{78}As	90.7 min	1.369×10^{-2}	0.380
	^{79}As	9.01 min	9.554×10^{-3}	0.455
	^{80}As	15.2 s	6.537×10^{-3}	0.551
	^{74}Se	Stable	2.878×10^{-4}	2.64
	^{75}Se	119.78 d	4.531×10^{-3}	0.663
	^{76}Se	Stable	5.028×10^{-2}	0.194
	^{77}Se	Stable	1.083×10^{-1}	0.128
	^{78}Se	Stable	2.714×10^{-1}	0.0733
	^{79}Se	3.26×10^{5} y	1.673×10^{-1}	0.0998
	^{80}Se	Stable	1.839×10^{-1}	0.0942
	^{81}Se	18.45 min	6.124×10^{-2}	0.175

Table 31 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 36.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Kr (36)	^{73}As	80.30 d	3.200×10^{-5}	7.91
	^{74}As	17.77 d	5.180×10^{-5}	6.21
	^{75}As	Stable	1.030×10^{-4}	4.41
	^{76}As	26.254 h	1.092×10^{-4}	4.28
	^{77}As	38.79 h	2.058×10^{-4}	3.12
	^{78}As	90.7 min	2.068×10^{-4}	3.11
	^{79}As	9.01 min	2.588×10^{-4}	2.78
	^{80}As	15.2 s	1.648×10^{-4}	3.48
	^{81}As	33.3 s	2.374×10^{-4}	2.90
	^{82}As	19.1 s	1.590×10^{-4}	3.55
	^{74}Se	Stable	5.700×10^{-5}	5.92
	^{75}Se	119.78 d	1.904×10^{-4}	3.24
	^{76}Se	Stable	9.492×10^{-4}	1.45
	^{77}Se	Stable	7.000×10^{-4}	1.69
	^{78}Se	Stable	2.393×10^{-3}	0.913
	^{79}Se	3.26×10^{5} y	2.598×10^{-3}	0.876
	^{80}Se	Stable	7.585×10^{-3}	0.512
	^{81}Se	18.45 min	9.929×10^{-3}	0.447
	^{82}Se	Stable	1.796×10^{-2}	0.331
	^{83}Se	22.25 min	8.941×10^{-3}	0.471
	^{84}Se	3.26 min	2.973×10^{-3}	0.819
	^{85}Se	32.9 s	1.237×10^{-3}	1.27
	^{75}Br	96.7 min	1.374×10^{-4}	3.82
	^{76}Br	16.14 h	8.360×10^{-4}	1.55
	^{77}Br	57.04 h	3.558×10^{-3}	0.748
	^{78}Br	6.45 min	7.028×10^{-3}	0.532
	^{79}Br	Stable	2.389×10^{-2}	0.286
	^{80}Br	17.68 min	4.399×10^{-2}	0.209
	^{81}Br	Stable	1.360×10^{-1}	0.113
	^{82}Br	35.282 h	1.790×10^{-1}	0.0958
	^{83}Br	2.374 h	2.724×10^{-1}	0.0731
	^{84}Br	31.76 min	1.017×10^{-1}	0.133
	^{85}Br	2.90 min	5.927×10^{-2}	0.178
	^{86}Br	55.1 s	9.313×10^{-3}	0.461

Table 32 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 37.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Rb (37)	^{78}Se	Stable	8.760×10^{-5}	4.78
	^{79}Se	3.26×10^{5} y	1.872×10^{-4}	3.27
	^{80}Se	Stable	2.162×10^{-4}	3.04
	^{81}Se	18.45 min	1.034×10^{-4}	4.40
	^{82}Se	Stable	3.816×10^{-4}	2.29
	^{83}Se	22.25 min	3.678×10^{-4}	2.33
	^{84}Se	3.26 min	6.520×10^{-5}	5.54
	^{85}Se	32.9 s	4.860×10^{-5}	6.42
	^{80}Br	17.68 min	8.020×10^{-5}	4.99
	^{81}Br	Stable	1.479×10^{-3}	1.16
	^{82}Br	35.282 h	5.855×10^{-3}	0.583
	^{83}Br	2.374 h	1.814×10^{-2}	0.329
	^{84}Br	31.76 min	1.380×10^{-2}	0.378
	^{85}Br	2.90 min	4.675×10^{-3}	0.653
	^{86}Br	55.1 s	2.374×10^{-3}	0.917
	^{80}Kr	Stable	5.386×10^{-4}	1.93
	^{81}Kr	2.29×10^{5} y	6.697×10^{-3}	0.545
	^{82}Kr	Stable	6.694×10^{-2}	0.167
	^{83}Kr	Stable	1.425×10^{-1}	0.110
	^{84}Kr	Stable	3.316×10^{-1}	0.0635
	^{85}Kr	10.739 y	1.608×10^{-1}	0.102
	^{86}Kr	Stable	1.041×10^{-1}	0.131
	^{87}Kr	76.3 min	2.197×10^{-2}	0.298

Table 33 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 38$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Sr (38)	^{79}Br	Stable	2.640×10^{-5}	8.70
	^{80}Br	17.68 min	7.800×10^{-5}	5.06
	^{81}Br	Stable	2.098×10^{-4}	3.09
	^{82}Br	35.282 h	2.124×10^{-4}	3.07
	^{83}Br	2.374 h	2.588×10^{-4}	2.78
	^{84}Br	31.76 min	1.556×10^{-4}	3.59
	^{85}Br	2.90 min	3.300×10^{-4}	2.46
	^{86}Br	55.1 s	2.480×10^{-4}	2.84
	^{80}Kr	Stable	6.640×10^{-5}	5.49
	^{81}Kr	2.29×10^{5} y	2.060×10^{-4}	3.12
	^{82}Kr	Stable	1.342×10^{-3}	1.22
	^{83}Kr	Stable	1.888×10^{-3}	1.03
	^{84}Kr	Stable	7.219×10^{-3}	0.525
	^{85}Kr	10.739 y	1.164×10^{-2}	0.412
	^{86}Kr	Stable	2.619×10^{-2}	0.273
	^{87}Kr	76.3 min	1.134×10^{-2}	0.418
	^{81}Rb	4.572 h	2.798×10^{-4}	2.67
	^{82}Rb	1.2575 min	1.405×10^{-3}	1.19
	^{83}Rb	86.2 d	9.605×10^{-3}	0.454
	^{84}Rb	32.82 d	3.202×10^{-2}	0.246
	^{85}Rb	Stable	1.281×10^{-1}	0.117
	^{86}Rb	18.642 d	2.375×10^{-1}	0.0801
	^{87}Rb	Stable	3.672×10^{-1}	0.0587
	^{88}Rb	17.773 min	7.532×10^{-2}	0.157

Table 34 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 39.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Y (39)	^{82}Kr	Stable	9.780×10^{-5}	4.52
	^{83}Kr	Stable	2.524×10^{-4}	2.82
	^{84}Kr	Stable	2.772×10^{-4}	2.69
	^{85}Kr	10.739 y	1.160×10^{-4}	4.15
	^{86}Kr	Stable	5.966×10^{-4}	1.83
	^{87}Kr	76.3 min	5.202×10^{-4}	1.96
	^{84}Rb	32.82 d	6.620×10^{-5}	5.50
	^{85}Rb	Stable	1.744×10^{-3}	1.07
	^{86}Rb	18.642 d	9.559×10^{-3}	0.455
	^{87}Rb	Stable	2.748×10^{-2}	0.266
	^{88}Rb	17.773 min	1.531×10^{-2}	0.359
	^{84}Sr	Stable	2.844×10^{-4}	2.65
	^{85}Sr	64.849 d	5.834×10^{-3}	0.584
	^{86}Sr	Stable	7.796×10^{-2}	0.154
	^{87}Sr	Stable	2.056×10^{-1}	0.0879
	^{88}Sr	Stable	4.535×10^{-1}	0.0491
	^{89}Sr	50.563 d	1.198×10^{-1}	0.121

Table 35 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 40.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Zr (40)	^{83}Rb	86.2 d	6.120×10^{-5}	5.72
	^{84}Rb	32.82 d	3.672×10^{-4}	2.33
	^{85}Rb	Stable	7.136×10^{-4}	1.67
	^{86}Rb	18.642 d	4.024×10^{-4}	2.23
	^{87}Rb	Stable	6.860×10^{-4}	1.71
	^{88}Rb	17.773 min	5.822×10^{-4}	1.85
	^{89}Rb	15.32 min	2.458×10^{-4}	2.85
	^{90}Rb	158 s	1.054×10^{-4}	4.36
	^{91}Rb	58.2 s	4.180×10^{-5}	6.92
	^{92}Rb	4.48 s	4.300×10^{-5}	6.82
	^{85}Sr	64.849 d	6.860×10^{-5}	5.40
	^{86}Sr	Stable	3.342×10^{-3}	0.773
	^{87}Sr	Stable	1.137×10^{-2}	0.417
	^{88}Sr	Stable	3.550×10^{-2}	0.233
	^{89}Sr	50.563 d	1.812×10^{-2}	0.329
	^{90}Sr	28.91 y	8.830×10^{-3}	0.474
	^{91}Sr	9.65 h	4.466×10^{-3}	0.668
	^{92}Sr	2.611 h	3.520×10^{-3}	0.752
	^{93}Sr	7.43 min	2.078×10^{-3}	0.980
	^{94}Sr	75.3 s	3.686×10^{-4}	2.33
	^{95}Sr	23.90 s	1.828×10^{-4}	3.31
	^{86}Y	14.74 h	9.240×10^{-4}	1.47
	^{87}Y	79.8 h	2.700×10^{-2}	0.269
	^{88}Y	106.627 d	1.139×10^{-1}	0.125
	^{89}Y	Stable	3.109×10^{-1}	0.0666
	^{90}Y	64.05 h	1.460×10^{-1}	0.108
	^{91}Y	58.51 d	9.636×10^{-2}	0.137
	^{92}Y	3.54 h	5.463×10^{-2}	0.186
	^{93}Y	10.18 h	5.306×10^{-2}	0.189
	^{94}Y	18.7 min	1.976×10^{-2}	0.315
	^{95}Y	10.3 min	6.646×10^{-3}	0.547
	^{96}Y	5.34 s	1.327×10^{-3}	1.23

Table 36 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 41$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Nb (41)	^{87}Rb	Stable	2.700×10^{-5}	8.61
	^{86}Sr	Stable	2.306×10^{-4}	2.95
	^{87}Sr	Stable	8.312×10^{-4}	1.55
	^{88}Sr	Stable	1.072×10^{-3}	1.37
	^{89}Sr	50.563 d	3.412×10^{-4}	2.42
	^{90}Sr	28.91 y	8.862×10^{-4}	1.50
	^{91}Sr	9.65 h	7.988×10^{-4}	1.58
	^{88}Y	106.627 d	2.064×10^{-4}	3.11
	^{89}Y	Stable	5.593×10^{-3}	0.596
	^{90}Y	64.05 h	1.378×10^{-2}	0.378
	^{91}Y	58.51 d	2.913×10^{-2}	0.258
	^{92}Y	3.54 h	1.985×10^{-2}	0.314
	^{88}Zr	83.4 d	4.892×10^{-4}	2.02
	^{89}Zr	78.41 h	1.034×10^{-2}	0.438
	^{90}Zr	Stable	1.237×10^{-1}	0.119
	^{91}Zr	Stable	2.206×10^{-1}	0.0841
	^{92}Zr	Stable	3.645×10^{-1}	0.0591
	^{93}Zr	1.61×10^{6} y	1.332×10^{-1}	0.114

Table 37 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 42$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Mo (42)	^{86}Sr	Stable	1.014×10^{-4}	4.44
	^{87}Sr	Stable	4.000×10^{-5}	7.07
	^{88}Sr	Stable	4.160×10^{-5}	6.93
	^{86}Y	14.74 h	8.700×10^{-5}	4.80
	^{87}Y	79.8 h	3.392×10^{-4}	2.43
	^{88}Y	106.627 d	3.982×10^{-4}	2.24
	^{89}Y	Stable	1.506×10^{-3}	1.15
	^{90}Y	64.05 h	8.140×10^{-4}	1.57
	^{91}Y	58.51 d	6.288×10^{-4}	1.78
	^{92}Y	3.54 h	4.712×10^{-4}	2.06
	^{93}Y	10.18 h	3.794×10^{-4}	2.30
	^{94}Y	18.7 min	2.102×10^{-4}	3.08
	^{95}Y	10.3 min	1.596×10^{-4}	3.54
	^{96}Y	5.34 s	9.500×10^{-5}	4.59
	^{88}Zr	83.4 d	1.231×10^{-3}	1.27
	^{89}Zr	78.41 h	9.000×10^{-3}	0.469
	^{90}Zr	Stable	4.161×10^{-2}	0.215
	^{91}Zr	Stable	1.150×10^{-2}	0.415
	^{92}Zr	Stable	1.116×10^{-2}	0.421
	^{93}Zr	1.61×10^{6} y	1.221×10^{-2}	0.402
	^{94}Zr	Stable	1.478×10^{-2}	0.365
	^{95}Zr	64.032 d	9.807×10^{-3}	0.449
	^{96}Zr	Stable	9.621×10^{-3}	0.454
	^{97}Zr	16.749 h	4.461×10^{-3}	0.668
	^{98}Zr	30.7 s	1.602×10^{-3}	1.12
	^{99}Zr	2.1 s	7.972×10^{-4}	1.58
	^{89}Nb	2.03 h	1.161×10^{-3}	1.31
	^{90}Nb	14.60 h	1.453×10^{-2}	0.368
	^{91}Nb	6.8×10^{2} y	8.137×10^{-2}	0.150
	^{92}Nb	3.47×10^{7} y	6.663×10^{-2}	0.167
	^{93}Nb	Stable	1.001×10^{-1}	0.134
	^{94}Nb	2.03×10^{4} y	1.162×10^{-1}	0.123
	^{95}Nb	34.991 d	1.409×10^{-1}	0.110
	^{96}Nb	23.35 h	1.011×10^{-1}	0.133
	^{97}Nb	72.1 min	1.036×10^{-1}	0.132

Table 37 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
	^{98}Nb	2.86 s	3.784×10^{-2}	0.226
	^{99}Nb	15.0 s	2.394×10^{-2}	0.286
	^{100}Nb	1.4 s	5.795×10^{-3}	0.586

Table 38 Yields of nuclides produced by the nuclear capture of μ$^-$ for the target with Z = 44.

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
Ru (44)	^{90}Zr	Stable	1.686×10^{-4}	3.44
	^{91}Zr	Stable	2.320×10^{-5}	9.29
	^{92}Zr	Stable	3.560×10^{-5}	7.50
	^{93}Zr	1.61×10^{6} y	2.580×10^{-5}	8.80
	^{90}Nb	14.60 h	5.020×10^{-5}	6.31
	^{91}Nb	6.8×10^{2} y	3.436×10^{-4}	2.41
	^{92}Nb	3.47×10^{7} y	3.038×10^{-4}	2.57
	^{93}Nb	Stable	7.578×10^{-4}	1.62
	^{94}Nb	2.03×10^{4} y	6.250×10^{-4}	1.79
	^{95}Nb	34.991 d	4.424×10^{-4}	2.13
	^{96}Nb	23.35 h	4.730×10^{-4}	2.06
	^{97}Nb	72.1 min	5.544×10^{-4}	1.90
	^{98}Nb	2.86 s	2.694×10^{-4}	2.72
	^{99}Nb	15.0 s	2.574×10^{-4}	2.79
	^{100}Nb	1.4 s	1.470×10^{-4}	3.69
	^{101}Nb	7.1 s	3.680×10^{-5}	7.37
	^{102}Nb	4.3 s	5.000×10^{-5}	6.32
	^{92}Mo	Stable	1.035×10^{-3}	1.39
	^{93}Mo	4.0×10^{3} y	4.020×10^{-3}	0.704
	^{94}Mo	Stable	9.448×10^{-3}	0.458
	^{95}Mo	Stable	5.375×10^{-3}	0.608
	^{96}Mo	Stable	7.106×10^{-3}	0.529
	^{97}Mo	Stable	1.040×10^{-2}	0.436
	^{98}Mo	Stable	1.710×10^{-2}	0.339
	^{99}Mo	65.924 h	1.130×10^{-2}	0.418
	^{100}Mo	Stable	1.505×10^{-2}	0.362
	^{101}Mo	14.61 min	6.279×10^{-3}	0.563
	^{102}Mo	11.3 min	3.927×10^{-3}	0.712
	^{103}Mo	67.5 s	2.107×10^{-3}	0.973

Table 38 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{93}Tc	2.75 h	1.847×10^{-3}	1.04
	^{94}Tc	293 min	9.740×10^{-3}	0.451
	^{95}Tc	20.0 h	2.961×10^{-2}	0.256
	^{96}Tc	4.28 d	2.623×10^{-2}	0.273
	^{97}Tc	4.21×10^{6} y	6.051×10^{-2}	0.176
	^{98}Tc	4.2×10^{6} y	9.570×10^{-2}	0.138
	^{99}Tc	2.111×10^{5} y	1.613×10^{-1}	0.102
	^{100}Tc	15.65 s	1.386×10^{-1}	0.112
	^{101}Tc	14.2 min	1.626×10^{-1}	0.102
	^{102}Tc	5.28 s	6.547×10^{-2}	0.169
	^{103}Tc	54.2 s	5.734×10^{-2}	0.181
	^{104}Tc	18.3 min	1.380×10^{-2}	0.378

Table 39 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 45.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Rh (45)	^{97}Nb	72.1 min	2.040×10^{-5}	9.90
	^{95}Mo	Stable	2.540×10^{-5}	8.88
	^{96}Mo	Stable	2.362×10^{-4}	2.91
	^{97}Mo	Stable	3.626×10^{-4}	2.35
	^{98}Mo	Stable	3.012×10^{-4}	2.58
	^{99}Mo	65.924 h	2.062×10^{-4}	3.11
	^{100}Mo	Stable	7.772×10^{-4}	1.60
	^{101}Mo	14.61 min	6.642×10^{-4}	1.74
	^{98}Tc	4.2×10^{6} y	3.250×10^{-4}	2.48
	^{99}Tc	2.111×10^{5} y	3.760×10^{-3}	0.728
	^{100}Tc	15.65 s	1.101×10^{-2}	0.424
	^{101}Tc	14.2 min	2.747×10^{-2}	0.266
	^{102}Tc	5.28 s	1.845×10^{-2}	0.326
	^{97}Ru	2.83 d	2.740×10^{-5}	8.54
	^{98}Ru	Stable	2.470×10^{-3}	0.899
	^{99}Ru	Stable	2.056×10^{-2}	0.309
	^{100}Ru	Stable	1.248×10^{-1}	0.118
	^{101}Ru	Stable	2.131×10^{-1}	0.0860
	^{102}Ru	Stable	3.918×10^{-1}	0.0557
	^{103}Ru	39.247 d	1.148×10^{-1}	0.124

Table 40 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 46.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Pd (46)	^{97}Tc	4.21×10^{6} y	2.420×10^{-5}	9.09
	^{98}Tc	4.2×10^{6} y	6.780×10^{-5}	5.43
	^{99}Tc	2.111×10^{5} y	1.712×10^{-4}	3.42
	^{100}Tc	15.65 s	1.278×10^{-4}	3.96
	^{101}Tc	14.2 min	1.978×10^{-4}	3.18
	^{102}Tc	5.28 s	3.024×10^{-4}	2.57
	^{103}Tc	54.2 s	4.502×10^{-4}	2.11
	^{104}Tc	18.3 min	2.018×10^{-4}	3.15
	^{105}Tc	7.64 min	9.737×10^{-5}	4.53
	^{106}Tc	35.6 s	1.034×10^{-4}	4.40
	^{107}Tc	21.2 s	2.300×10^{-5}	9.32
	^{108}Tc	5.17 s	2.360×10^{-5}	9.21
	^{98}Ru	Stable	1.606×10^{-4}	3.53
	^{99}Ru	Stable	5.226×10^{-4}	1.96
	^{100}Ru	Stable	2.134×10^{-3}	0.967
	^{101}Ru	Stable	4.015×10^{-3}	0.704
	^{102}Ru	Stable	1.241×10^{-2}	0.399
	^{103}Ru	39.247 d	1.408×10^{-2}	0.374
	^{104}Ru	Stable	2.004×10^{-2}	0.313
	^{105}Ru	4.439 h	8.267×10^{-3}	0.490
	^{106}Ru	371.8 d	7.659×10^{-3}	0.509
	^{107}Ru	3.75 min	4.911×10^{-3}	0.637
	^{108}Ru	4.55 min	2.320×10^{-3}	0.927
	^{109}Ru	34.4 s	1.270×10^{-3}	1.25
	^{98}Rh	8.72 min	4.560×10^{-5}	6.62
	^{99}Rh	16.1 d	8.748×10^{-4}	1.51
	^{100}Rh	20.5 h	4.045×10^{-3}	0.702
	^{101}Rh	3.3 y	2.277×10^{-2}	0.293
	^{102}Rh	207.3 d	5.344×10^{-2}	0.188
	^{103}Rh	Stable	1.447×10^{-1}	0.109
	^{104}Rh	42.3 s	1.545×10^{-1}	0.105
	^{105}Rh	35.341 h	1.875×10^{-1}	0.0931
	^{106}Rh	30.07 s	8.812×10^{-2}	0.144
	^{107}Rh	21.7 min	1.063×10^{-1}	0.130
	^{108}Rh	16.8 s	4.520×10^{-2}	0.206

Table 40 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
	^{109}Rh	80.8 s	3.494×10^{-2}	0.235
	^{110}Rh	3.35 s	8.506×10^{-3}	0.483

Table 41 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 47$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ag (47)	^{100}Ru	Stable	1.284×10^{-4}	3.95
	^{101}Ru	Stable	2.042×10^{-4}	3.13
	^{102}Ru	Stable	2.148×10^{-4}	3.05
	^{103}Ru	39.247 d	2.516×10^{-4}	2.82
	^{104}Ru	Stable	6.616×10^{-4}	1.74
	^{105}Ru	4.439 h	5.818×10^{-4}	1.85
	^{106}Ru	371.8 d	3.178×10^{-4}	2.51
	^{107}Ru	3.75 min	2.882×10^{-4}	2.63
	^{102}Rh	207.3 d	2.174×10^{-4}	3.03
	^{103}Rh	Stable	2.700×10^{-3}	0.859
	^{104}Rh	42.3 s	8.120×10^{-3}	0.494
	^{105}Rh	35.341 h	2.089×10^{-2}	0.306
	^{106}Rh	30.07 s	1.693×10^{-2}	0.341
	^{107}Rh	21.7 min	1.276×10^{-2}	0.393
	^{108}Rh	16.8 s	8.225×10^{-3}	0.491
	^{102}Pd	Stable	8.520×10^{-4}	1.53
	^{103}Pd	16.991 d	8.337×10^{-3}	0.488
	^{104}Pd	Stable	6.225×10^{-2}	0.174
	^{105}Pd	Stable	1.231×10^{-1}	0.119
	^{106}Pd	Stable	2.750×10^{-1}	0.0726
	^{107}Pd	6.5×10^{6} y	1.625×10^{-1}	0.102
	^{108}Pd	Stable	1.783×10^{-1}	0.0960
	^{109}Pd	13.59 h	5.072×10^{-2}	0.194

Table 42 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 48.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Cd (48)	^{100}Rh	20.5 h	2.860×10^{-5}	8.36
	^{101}Rh	3.3 y	6.840×10^{-5}	5.41
	^{102}Rh	207.3 d	4.020×10^{-5}	7.05
	^{103}Rh	Stable	9.300×10^{-5}	4.64
	^{104}Rh	42.3 s	1.668×10^{-4}	3.46
	^{105}Rh	35.341 h	2.660×10^{-4}	2.74
	^{106}Rh	30.07 s	2.030×10^{-4}	3.14
	^{107}Rh	21.7 min	3.322×10^{-4}	2.45
	^{108}Rh	16.8 s	2.882×10^{-4}	2.63
	^{109}Rh	80.8 s	3.176×10^{-4}	2.51
	^{110}Rh	3.35 s	2.124×10^{-4}	3.07
	^{111}Rh	11 s	1.702×10^{-4}	3.43
	^{112}Rh	3.6 s	9.760×10^{-5}	4.53
	^{102}Pd	Stable	2.546×10^{-4}	2.80
	^{103}Pd	16.991 d	7.450×10^{-4}	1.64
	^{104}Pd	Stable	1.385×10^{-3}	1.20
	^{105}Pd	Stable	1.027×10^{-3}	1.40
	^{106}Pd	Stable	1.841×10^{-3}	1.04
	^{107}Pd	6.5×10^{6} y	3.456×10^{-3}	0.759
	^{108}Pd	Stable	1.048×10^{-2}	0.435
	^{109}Pd	13.59 h	1.071×10^{-2}	0.430
	^{110}Pd	Stable	1.677×10^{-2}	0.342
	^{111}Pd	23.4 min	1.019×10^{-2}	0.441
	^{112}Pd	21.04 h	1.113×10^{-2}	0.422
	^{113}Pd	93 s	4.392×10^{-3}	0.673
	^{114}Pd	2.42 min	1.216×10^{-3}	1.28
	^{115}Pd	25 s	6.436×10^{-4}	1.76
	^{103}Ag	65.7 min	7.372×10^{-4}	1.65
	^{104}Ag	69.2 min	3.293×10^{-3}	0.778
	^{105}Ag	41.29 d	7.742×10^{-3}	0.506
	^{106}Ag	23.96 min	7.169×10^{-3}	0.526
	^{107}Ag	Stable	2.267×10^{-2}	0.294
	^{108}Ag	2.382 min	4.938×10^{-2}	0.196
	^{109}Ag	Stable	1.260×10^{-1}	0.118
	^{110}Ag	24.56 s	1.295×10^{-1}	0.116

Table 42 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{111}Ag	7.45 d	1.902×10^{-1}	0.0923
	^{112}Ag	3.130 h	1.216×10^{-1}	0.120
	^{113}Ag	5.37 h	1.306×10^{-1}	0.115
	^{114}Ag	4.6 s	3.776×10^{-2}	0.226
	^{115}Ag	20.0 min	2.287×10^{-2}	0.292
	^{116}Ag	237 s	4.712×10^{-3}	0.650

Table 43 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 49$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
In (49)	^{108}Pd	Stable	5.800×10^{-5}	5.87
	^{109}Pd	13.59 h	6.000×10^{-5}	5.77
	^{110}Pd	Stable	9.920×10^{-5}	4.49
	^{111}Pd	23.4 min	1.530×10^{-4}	3.62
	^{112}Pd	21.04 h	5.738×10^{-4}	1.87
	^{113}Pd	93 s	5.094×10^{-4}	1.98
	^{109}Ag	Stable	1.684×10^{-4}	3.45
	^{110}Ag	24.56 s	7.424×10^{-4}	1.64
	^{111}Ag	7.45 d	4.455×10^{-3}	0.669
	^{112}Ag	3.130 h	1.007×10^{-2}	0.444
	^{113}Ag	5.37 h	2.465×10^{-2}	0.281
	^{114}Ag	4.6 s	1.582×10^{-2}	0.353
	^{108}Cd	Stable	1.146×10^{-4}	4.18
	^{109}Cd	461.9 d	9.482×10^{-4}	1.45
	^{110}Cd	Stable	9.418×10^{-3}	0.459
	^{111}Cd	Stable	3.317×10^{-2}	0.241
	^{112}Cd	Stable	1.463×10^{-1}	0.108
	^{113}Cd	Stable	2.084×10^{-1}	0.0872
	^{114}Cd	Stable	3.712×10^{-1}	0.0582
	^{115}Cd	53.46 h	1.050×10^{-1}	0.131

Table 44 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 50.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Sn (50)	^{109}Ag	Stable	3.800×10^{-5}	7.25
	^{110}Ag	24.56 s	5.100×10^{-5}	6.26
	^{111}Ag	7.45 d	4.500×10^{-5}	6.67
	^{112}Ag	3.130 h	5.000×10^{-5}	6.32
	^{113}Ag	5.37 h	1.482×10^{-4}	3.67
	^{114}Ag	4.6 s	1.804×10^{-4}	3.33
	^{115}Ag	20.0 min	1.862×10^{-4}	3.28
	^{116}Ag	237 s	1.562×10^{-4}	3.58
	^{117}Ag	72.8 s	1.174×10^{-4}	4.13
	^{118}Ag	3.76 s	7.500×10^{-5}	5.16
	^{108}Cd	Stable	1.864×10^{-4}	3.28
	^{109}Cd	461.9 d	4.916×10^{-4}	2.02
	^{110}Cd	Stable	1.095×10^{-3}	1.35
	^{111}Cd	Stable	7.462×10^{-4}	1.64
	^{112}Cd	Stable	1.618×10^{-3}	1.11
	^{113}Cd	Stable	3.483×10^{-3}	0.756
	^{114}Cd	Stable	9.899×10^{-3}	0.447
	^{115}Cd	53.46 h	9.360×10^{-3}	0.460
	^{116}Cd	Stable	1.372×10^{-2}	0.379
	^{117}Cd	2.49 h	9.468×10^{-3}	0.458
	^{118}Cd	50.3 min	1.091×10^{-2}	0.426
	^{119}Cd	2.69 min	4.589×10^{-3}	0.659
	^{120}Cd	50.80 s	6.674×10^{-4}	1.73
	^{121}Cd	13.5 s	3.834×10^{-4}	2.28
	^{122}Cd	5.24 s	2.984×10^{-4}	2.59
	^{123}Cd	2.10 s	2.106×10^{-4}	3.08
	^{108}In	58.0 min	3.620×10^{-5}	7.43
	^{109}In	4.159 h	7.988×10^{-4}	1.58
	^{110}In	4.92 h	2.595×10^{-3}	0.877
	^{111}In	2.8047 d	6.401×10^{-3}	0.557
	^{112}In	14.88 min	6.756×10^{-3}	0.542
	^{113}In	Stable	2.501×10^{-2}	0.279
	^{114}In	71.9 s	5.271×10^{-2}	0.190
	^{115}In	Stable	1.233×10^{-1}	0.119
	^{116}In	14.10 s	1.163×10^{-1}	0.123

Table 44 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{117}In	43.2 min	1.780×10^{-1}	0.0961
	^{118}In	5.0 s	1.196×10^{-1}	0.121
	^{119}In	2.4 min	1.388×10^{-1}	0.111
	^{120}In	3.08 s	3.765×10^{-2}	0.226
	^{121}In	23.1 s	2.144×10^{-2}	0.302
	^{122}In	1.5 s	1.318×10^{-2}	0.387
	^{123}In	6.15 s	1.633×10^{-2}	0.347
	^{124}In	3.12 s	3.053×10^{-3}	0.808

Table 45 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 51$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Sb (51)	^{114}Cd	Stable	4.880×10^{-5}	6.40
	^{115}Cd	53.46 h	5.700×10^{-5}	5.92
	^{116}Cd	Stable	5.380×10^{-5}	6.10
	^{117}Cd	2.49 h	7.640×10^{-5}	5.12
	^{118}Cd	50.3 min	3.274×10^{-4}	2.47
	^{119}Cd	2.69 min	3.014×10^{-4}	2.58
	^{120}Cd	50.80 s	7.760×10^{-5}	5.08
	^{121}Cd	13.5 s	5.800×10^{-5}	5.87
	^{116}In	14.10 s	1.572×10^{-4}	3.57
	^{117}In	43.2 min	1.763×10^{-3}	1.07
	^{118}In	5.0 s	5.342×10^{-3}	0.610
	^{119}In	2.4 min	1.604×10^{-2}	0.350
	^{120}In	3.08 s	1.296×10^{-2}	0.390
	^{121}In	23.1 s	8.427×10^{-3}	0.485
	^{122}In	1.5 s	5.452×10^{-3}	0.604
	^{115}Sn	Stable	5.080×10^{-5}	6.27
	^{116}Sn	Stable	2.450×10^{-3}	0.902
	^{117}Sn	Stable	1.471×10^{-2}	0.366
	^{118}Sn	Stable	8.067×10^{-2}	0.151
	^{119}Sn	Stable	1.362×10^{-1}	0.113
	^{120}Sn	Stable	2.908×10^{-1}	0.0698
	^{121}Sn	27.03 h	1.547×10^{-1}	0.105
	^{122}Sn	Stable	1.550×10^{-1}	0.104
	^{123}Sn	129.2 d	4.370×10^{-2}	0.209

Table 46 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 52.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Te (52)	^{119}In	2.4 min	3.180×10^{-5}	7.93
	^{120}In	3.08 s	4.160×10^{-5}	6.93
	^{121}In	23.1 s	6.040×10^{-5}	5.75
	^{122}In	1.5 s	6.620×10^{-5}	5.50
	^{123}In	6.15 s	1.270×10^{-4}	3.97
	^{124}In	3.12 s	8.800×10^{-5}	4.77
	^{125}In	2.36 s	7.440×10^{-5}	5.18
	^{126}In	1.53 s	7.600×10^{-5}	5.13
	^{127}In	1.09 s	4.220×10^{-5}	6.88
	^{128}In	0.84 s	5.220×10^{-5}	6.19
	^{117}Sn	Stable	4.980×10^{-5}	6.34
	^{118}Sn	Stable	3.202×10^{-4}	2.50
	^{119}Sn	Stable	7.124×10^{-4}	1.68
	^{120}Sn	Stable	2.264×10^{-3}	0.939
	^{121}Sn	27.03 h	2.439×10^{-3}	0.905
	^{122}Sn	Stable	5.321×10^{-3}	0.612
	^{123}Sn	129.2 d	6.086×10^{-3}	0.572
	^{124}Sn	Stable	1.096×10^{-2}	0.425
	^{125}Sn	9.64 d	7.258×10^{-3}	0.523
	^{126}Sn	2.18×10^{5} y	1.010×10^{-2}	0.443
	^{127}Sn	2.10 h	7.605×10^{-3}	0.511
	^{128}Sn	59.07 min	7.282×10^{-3}	0.522
	^{129}Sn	2.23 min	3.911×10^{-3}	0.714
	^{117}Sb	2.80 h	2.054×10^{-4}	3.12
	^{118}Sb	3.6 min	8.860×10^{-4}	1.50
	^{119}Sb	38.19 h	4.915×10^{-3}	0.636
	^{120}Sb	15.89 min	9.914×10^{-3}	0.447
	^{121}Sb	Stable	2.676×10^{-2}	0.270
	^{122}Sb	2.7238 d	3.232×10^{-2}	0.245
	^{123}Sb	Stable	7.520×10^{-2}	0.157
	^{124}Sb	60.20 d	8.332×10^{-2}	0.148
	^{125}Sb	2.75856 y	1.399×10^{-1}	0.111
	^{126}Sb	12.35 d	9.796×10^{-2}	0.136
	^{127}Sb	3.85 d	1.583×10^{-1}	0.103
	^{128}Sb	9.05 h	9.452×10^{-2}	0.138

Table 46 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
	^{129}Sb	4.366 h	1.081×10^{-1}	0.129
	^{130}Sb	39.5 min	2.596×10^{-2}	0.274

Table 47 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 53$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
I (53)	^{120}Sn	Stable	2.580×10^{-5}	8.81
	^{121}Sn	27.03 h	3.600×10^{-5}	7.45
	^{122}Sn	Stable	5.680×10^{-5}	5.93
	^{123}Sn	129.2 d	1.636×10^{-4}	3.50
	^{124}Sn	Stable	8.010×10^{-4}	1.58
	^{125}Sn	9.64 d	7.206×10^{-4}	1.67
	^{122}Sb	2.7238 d	2.812×10^{-4}	2.67
	^{123}Sb	Stable	3.594×10^{-3}	0.745
	^{124}Sb	60.20 d	1.082×10^{-2}	0.428
	^{125}Sb	2.75856 y	3.094×10^{-2}	0.250
	^{126}Sb	12.35 d	1.942×10^{-2}	0.318
	^{121}Te	19.17 d	6.460×10^{-5}	5.56
	^{122}Te	Stable	3.547×10^{-3}	0.750
	^{123}Te	Stable	2.190×10^{-2}	0.299
	^{124}Te	Stable	1.254×10^{-1}	0.118
	^{125}Te	Stable	2.080×10^{-1}	0.0873
	^{126}Te	Stable	3.878×10^{-1}	0.0562
	^{127}Te	9.35 h	1.177×10^{-1}	0.123

Table 48 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 54.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Xe (54)	^{125}Sb	2.75856 y	9.060×10^{-5}	4.70
	^{126}Sb	12.35 d	2.172×10^{-4}	3.03
	^{127}Sb	3.85 d	4.016×10^{-4}	2.23
	^{128}Sb	9.05 h	1.438×10^{-4}	3.73
	^{129}Sb	4.366 h	3.114×10^{-4}	2.53
	^{130}Sb	39.5 min	1.254×10^{-4}	3.99
	^{131}Sb	23.03 min	3.140×10^{-5}	7.98
	^{132}Sb	2.79 min	3.220×10^{-5}	7.88
	^{121}Te	19.17 d	2.940×10^{-5}	8.25
	^{122}Te	Stable	9.060×10^{-5}	4.70
	^{123}Te	Stable	8.060×10^{-5}	4.98
	^{124}Te	Stable	3.804×10^{-4}	2.29
	^{125}Te	Stable	1.506×10^{-3}	1.15
	^{126}Te	Stable	7.194×10^{-3}	0.525
	^{127}Te	9.35 h	1.070×10^{-2}	0.430
	^{128}Te	Stable	1.732×10^{-2}	0.337
	^{129}Te	69.6 min	9.691×10^{-3}	0.452
	^{130}Te	Stable	1.541×10^{-2}	0.357
	^{131}Te	25.0 min	5.765×10^{-3}	0.587
	^{132}Te	3.204 d	2.816×10^{-3}	0.842
	^{133}Te	12.5 min	2.231×10^{-3}	0.946
	^{134}Te	41.8 min	1.656×10^{-3}	1.10
	^{135}Te	19.0 s	4.986×10^{-4}	2.00
	^{121}I	2.12 h	1.206×10^{-4}	4.07
	^{122}I	3.63 min	2.970×10^{-4}	2.60
	^{123}I	13.2230 h	7.270×10^{-4}	1.66
	^{124}I	4.1760 d	1.249×10^{-3}	1.27
	^{125}I	59.400 d	9.763×10^{-3}	0.450
	^{126}I	12.93 d	3.045×10^{-2}	0.252
	^{127}I	Stable	9.672×10^{-2}	0.137
	^{128}I	24.99 min	1.223×10^{-1}	0.120
	^{129}I	1.57×10^{7} y	1.624×10^{-1}	0.102
	^{130}I	12.36 h	1.238×10^{-1}	0.119
	^{131}I	8.0252 d	1.493×10^{-1}	0.107
	^{132}I	2.295 h	4.905×10^{-2}	0.197

Table 48 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{133}I	20.83 h	4.377×10^{-2}	0.209
	^{134}I	52.5 min	2.610×10^{-2}	0.273
	^{135}I	6.58 h	2.442×10^{-2}	0.283
	^{136}I	83.4 s	2.007×10^{-3}	0.998

Table 49 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 55.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Cs (55)	^{126}Te	Stable	8.980×10^{-5}	4.72
	^{127}Te	9.35 h	1.438×10^{-4}	3.73
	^{128}Te	Stable	1.382×10^{-4}	3.80
	^{129}Te	69.6 min	1.546×10^{-4}	3.60
	^{130}Te	Stable	7.308×10^{-4}	1.65
	^{131}Te	25.0 min	7.284×10^{-4}	1.66
	^{127}I	Stable	2.800×10^{-5}	8.45
	^{128}I	24.99 min	3.276×10^{-4}	2.47
	^{129}I	1.57×10^{7} y	3.689×10^{-3}	0.735
	^{130}I	12.36 h	1.101×10^{-2}	0.424
	^{131}I	8.0252 d	3.033×10^{-2}	0.253
	^{132}I	2.295 h	1.968×10^{-2}	0.316
	^{127}Xe	36.4 d	5.340×10^{-5}	6.12
	^{128}Xe	Stable	3.014×10^{-3}	0.813
	^{129}Xe	Stable	2.044×10^{-2}	0.310
	^{130}Xe	Stable	1.196×10^{-1}	0.121
	^{131}Xe	Stable	2.068×10^{-1}	0.0876
	^{132}Xe	Stable	3.791×10^{-1}	0.0572
	^{133}Xe	5.2475 d	1.220×10^{-1}	0.120

Table 50 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 56.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ba (56)	^{128}I	24.99 min	2.620×10^{-5}	8.74
	^{129}I	1.57×10^{7} y	5.880×10^{-5}	5.83
	^{130}I	12.36 h	8.180×10^{-5}	4.95
	^{131}I	8.0252 d	1.788×10^{-4}	3.34
	^{132}I	2.295 h	1.906×10^{-4}	3.24
	^{133}I	20.83 h	2.764×10^{-4}	2.69
	^{134}I	52.5 min	1.886×10^{-4}	3.26
	^{135}I	6.58 h	4.530×10^{-4}	2.10
	^{136}I	83.4 s	1.926×10^{-4}	3.22
	^{127}Xe	36.4 d	3.940×10^{-5}	7.13
	^{128}Xe	Stable	9.600×10^{-5}	4.56
	^{129}Xe	Stable	9.600×10^{-5}	4.57
	^{130}Xe	Stable	2.678×10^{-4}	2.73
	^{131}Xe	Stable	7.852×10^{-4}	1.60
	^{132}Xe	Stable	3.197×10^{-3}	0.790
	^{133}Xe	5.2475 d	4.953×10^{-3}	0.634
	^{134}Xe	Stable	1.123×10^{-2}	0.420
	^{135}Xe	9.14 h	1.532×10^{-2}	0.359
	^{136}Xe	Stable	2.672×10^{-2}	0.270
	^{137}Xe	3.818 min	7.547×10^{-3}	0.513
	^{127}Cs	6.25 h	1.236×10^{-4}	4.02
	^{128}Cs	3.66 min	3.250×10^{-4}	2.48
	^{129}Cs	32.06 h	7.696×10^{-4}	1.61
	^{130}Cs	29.21 min	1.071×10^{-3}	1.37
	^{131}Cs	9.689 d	5.236×10^{-3}	0.616
	^{132}Cs	6.480 d	1.410×10^{-2}	0.374
	^{133}Cs	Stable	4.424×10^{-2}	0.208
	^{134}Cs	2.0652 y	7.080×10^{-2}	0.162
	^{135}Cs	2.3×10^{6} y	1.732×10^{-1}	0.0977
	^{136}Cs	13.01 d	2.276×10^{-1}	0.0824
	^{137}Cs	30.08 y	2.881×10^{-1}	0.0703
	^{138}Cs	32.5 min	3.142×10^{-2}	0.248

Table 51 Yields of nuclides produced by the nuclear capture of μ^- for targets with $57 \leq Z \leq 58$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
La (57)	^{133}Xe	5.2475 d	2.160×10^{-5}	9.62
	^{134}Xe	Stable	5.520×10^{-5}	6.02
	^{135}Xe	9.14 h	1.864×10^{-4}	3.28
	^{136}Xe	Stable	7.772×10^{-4}	1.60
	^{137}Xe	3.818 min	4.508×10^{-4}	2.11
	^{134}Cs	2.0652 y	2.548×10^{-4}	2.80
	^{135}Cs	2.3×10^{6} y	3.478×10^{-3}	0.757
	^{136}Cs	13.01 d	1.256×10^{-2}	0.397
	^{137}Cs	30.08 y	3.142×10^{-2}	0.248
	^{138}Cs	32.5 min	1.239×10^{-2}	0.399
	^{133}Ba	10.551 y	7.340×10^{-5}	5.22
	^{134}Ba	Stable	3.684×10^{-3}	0.736
	^{135}Ba	Stable	2.456×10^{-2}	0.282
	^{136}Ba	Stable	1.372×10^{-1}	0.112
	^{137}Ba	Stable	2.465×10^{-1}	0.0782
	^{138}Ba	Stable	3.912×10^{-1}	0.0558
	^{139}Ba	82.93 min	6.681×10^{-2}	0.167
Ce (58)	^{136}Cs	13.01 d	2.140×10^{-4}	9.67
	^{137}Cs	30.08 y	8.040×10^{-4}	4.99
	^{138}Cs	32.5 min	4.820×10^{-4}	6.44
	^{135}Ba	Stable	5.100×10^{-4}	6.26
	^{136}Ba	Stable	5.284×10^{-3}	1.94
	^{137}Ba	Stable	1.648×10^{-2}	1.09
	^{138}Ba	Stable	3.974×10^{-2}	0.695
	^{139}Ba	82.93 min	1.601×10^{-2}	1.11
	^{140}Ba	12.751 d	3.180×10^{-3}	2.50
	^{141}Ba	18.27 min	1.462×10^{-3}	3.70
	^{135}La	19.5 h	2.196×10^{-3}	3.02
	^{136}La	9.87 min	1.683×10^{-2}	1.08
	^{137}La	6×10^{4} y	1.061×10^{-1}	0.411
	^{138}La	Stable	2.298×10^{-1}	0.259
	^{139}La	Stable	3.734×10^{-1}	0.183
	^{140}La	1.67858 d	8.301×10^{-2}	0.470
	^{141}La	3.92 h	3.198×10^{-2}	0.778
	^{142}La	91.1 min	6.520×10^{-3}	1.75

Table 52 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 59$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Pr (59)	^{134}Ba	Stable	5.160×10^{-5}	6.23
	^{135}Ba	Stable	9.040×10^{-5}	4.70
	^{136}Ba	Stable	1.382×10^{-4}	3.80
	^{137}Ba	Stable	3.322×10^{-4}	2.45
	^{138}Ba	Stable	1.334×10^{-3}	1.22
	^{139}Ba	82.93 min	8.320×10^{-4}	1.55
	^{136}La	9.87 min	2.918×10^{-4}	2.62
	^{137}La	6×10^{4} y	3.953×10^{-3}	0.710
	^{138}La	Stable	1.534×10^{-2}	0.358
	^{139}La	Stable	3.934×10^{-2}	0.221
	^{140}La	1.67858 d	1.809×10^{-2}	0.330
	^{135}Ce	17.7 h	2.060×10^{-5}	9.86
	^{136}Ce	Stable	1.898×10^{-3}	1.03
	^{137}Ce	9.0 h	1.699×10^{-2}	0.340
	^{138}Ce	Stable	1.161×10^{-1}	0.124
	^{139}Ce	137.641 d	2.340×10^{-1}	0.0809
	^{140}Ce	Stable	4.004×10^{-1}	0.0547
	^{141}Ce	32.504 d	8.845×10^{-2}	0.144

Table 53 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 60.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Nd (60)	^{135}La	19.5 h	3.580×10^{-5}	7.47
	^{136}La	9.87 min	1.068×10^{-4}	4.33
	^{137}La	6×10^{4} y	2.050×10^{-4}	3.12
	^{138}La	Stable	3.109×10^{-4}	2.54
	^{139}La	Stable	7.650×10^{-4}	1.62
	^{140}La	1.67858 d	5.324×10^{-4}	1.94
	^{141}La	3.92 h	4.319×10^{-4}	2.15
	^{142}La	91.1 min	2.554×10^{-4}	2.80
	^{143}La	14.2 min	1.860×10^{-4}	3.28
	^{144}La	40.8 s	8.900×10^{-5}	4.74
	^{137}Ce	9.0 h	1.470×10^{-4}	3.69
	^{138}Ce	Stable	2.466×10^{-3}	0.899
	^{139}Ce	137.641 d	8.641×10^{-3}	0.479
	^{140}Ce	Stable	2.438×10^{-2}	0.283
	^{141}Ce	32.504 d	1.751×10^{-2}	0.335
	^{142}Ce	Stable	1.756×10^{-2}	0.335
	^{143}Ce	33.039 h	9.894×10^{-3}	0.447
	^{144}Ce	284.91 d	8.164×10^{-3}	0.493
	^{145}Ce	3.01 min	3.292×10^{-3}	0.778
	^{146}Ce	13.49 min	1.766×10^{-3}	1.06
	^{147}Ce	56.4 s	1.163×10^{-3}	1.31
	^{148}Ce	56.8 s	1.068×10^{-3}	1.37
	^{149}Ce	5.12 s	5.084×10^{-4}	1.98
	^{137}Pr	1.28 h	2.214×10^{-4}	3.01
	^{138}Pr	1.45 min	3.412×10^{-3}	0.764
	^{139}Pr	4.41 h	3.148×10^{-2}	0.248
	^{140}Pr	3.39 min	8.975×10^{-2}	0.142
	^{141}Pr	Stable	2.071×10^{-1}	0.0875
	^{142}Pr	19.12 h	1.327×10^{-1}	0.114
	^{143}Pr	13.57 d	1.467×10^{-1}	0.108
	^{144}Pr	17.28 min	8.209×10^{-2}	0.150
	^{145}Pr	5.984 h	6.969×10^{-2}	0.163
	^{146}Pr	24.09 min	2.376×10^{-2}	0.287
	^{147}Pr	13.44 min	2.242×10^{-2}	0.295
	^{148}Pr	2.29 min	1.238×10^{-2}	0.399

Table 53 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{149}Pr	2.26 min	1.297×10^{-2}	0.390
	^{150}Pr	6.19 s	2.656×10^{-3}	0.867

Table 54 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 62.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Sm (62)	^{140}Pr	3.39 min	2.240×10^{-5}	9.44
	^{141}Pr	Stable	1.144×10^{-4}	4.18
	^{142}Pr	19.12 h	8.500×10^{-5}	4.85
	^{143}Pr	13.57 d	9.940×10^{-5}	4.49
	^{144}Pr	17.28 min	2.408×10^{-4}	2.88
	^{145}Pr	5.984 h	4.455×10^{-4}	2.12
	^{146}Pr	24.09 min	2.337×10^{-4}	2.92
	^{147}Pr	13.44 min	2.234×10^{-4}	2.99
	^{148}Pr	2.29 min	8.700×10^{-5}	4.79
	^{149}Pr	2.26 min	1.428×10^{-4}	3.74
	^{150}Pr	6.19 s	1.424×10^{-4}	3.75
	^{151}Pr	18.90 s	5.220×10^{-5}	6.19
	^{152}Pr	3.57 s	5.020×10^{-5}	6.31
	^{140}Nd	3.37 d	3.766×10^{-4}	2.30
	^{141}Nd	2.49 h	1.169×10^{-3}	1.31
	^{142}Nd	Stable	3.259×10^{-3}	0.782
	^{143}Nd	Stable	2.978×10^{-3}	0.818
	^{144}Nd	Stable	6.927×10^{-3}	0.536
	^{145}Nd	Stable	1.060×10^{-2}	0.432
	^{146}Nd	Stable	1.692×10^{-2}	0.341
	^{147}Nd	11.03 d	9.213×10^{-3}	0.464
	^{148}Nd	Stable	9.595×10^{-3}	0.454
	^{149}Nd	1.726 h	5.095×10^{-3}	0.625
	^{150}Nd	Stable	9.520×10^{-3}	0.456
	^{151}Nd	12.44 min	6.863×10^{-3}	0.538
	^{152}Nd	11.4 min	5.507×10^{-3}	0.601
	^{153}Nd	31.6 s	2.971×10^{-3}	0.819
	^{140}Pm	9.2 s	2.728×10^{-4}	2.71
	^{141}Pm	20.90 min	2.972×10^{-3}	0.819
	^{142}Pm	40.5 s	9.308×10^{-3}	0.461
	^{143}Pm	265 d	2.386×10^{-2}	0.286
	^{144}Pm	363 d	2.786×10^{-2}	0.264
	^{145}Pm	17.7 y	7.035×10^{-2}	0.163
	^{146}Pm	5.53 y	9.757×10^{-2}	0.136
	^{147}Pm	2.6234 y	1.226×10^{-1}	0.120

Table 54 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{148}Pm	5.368 d	7.778×10^{-2}	0.154
	^{149}Pm	53.08 h	8.147×10^{-2}	0.150
	^{150}Pm	2.698 h	6.519×10^{-2}	0.169
	^{151}Pm	28.40 h	1.167×10^{-1}	0.123
	^{152}Pm	4.12 min	6.585×10^{-2}	0.168
	^{153}Pm	5.25 min	6.574×10^{-2}	0.169
	^{154}Pm	2.68 min	1.599×10^{-2}	0.351

Table 55 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 63.

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
Eu (63)	^{144}Nd	Stable	3.296×10^{-5}	9.85
	^{145}Nd	Stable	3.680×10^{-5}	9.32
	^{146}Nd	Stable	8.416×10^{-5}	6.17
	^{147}Nd	11.03 d	1.978×10^{-4}	4.02
	^{148}Nd	Stable	6.586×10^{-4}	2.20
	^{149}Nd	1.726 h	5.821×10^{-4}	2.34
	^{150}Nd	Stable	4.045×10^{-4}	2.81
	^{151}Nd	12.44 min	3.878×10^{-4}	2.87
	^{145}Pm	17.7 y	5.664×10^{-5}	7.52
	^{146}Pm	5.53 y	4.954×10^{-4}	2.54
	^{147}Pm	2.6234 y	3.522×10^{-3}	0.952
	^{148}Pm	5.368 d	8.692×10^{-3}	0.604
	^{149}Pm	53.08 h	1.996×10^{-2}	0.396
	^{150}Pm	2.698 h	1.676×10^{-2}	0.433
	^{151}Pm	28.40 h	1.643×10^{-2}	0.438
	^{152}Pm	4.12 min	1.028×10^{-2}	0.555
	^{145}Sm	340 d	2.038×10^{-4}	3.96
	^{146}Sm	10.3×10^{7} y	4.284×10^{-3}	0.862
	^{147}Sm	Stable	1.924×10^{-2}	0.404
	^{148}Sm	Stable	8.025×10^{-2}	0.192
	^{149}Sm	Stable	1.248×10^{-1}	0.150
	^{150}Sm	Stable	2.476×10^{-1}	0.0986
	^{151}Sm	90 y	1.466×10^{-1}	0.137
	^{152}Sm	Stable	1.798×10^{-1}	0.121
	^{153}Sm	46.284 h	4.924×10^{-2}	0.249

Table 56 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 64$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Gd (64)	^{149}Pm	53.08 h	2.060×10^{-5}	9.86
	^{150}Pm	2.698 h	2.580×10^{-5}	8.80
	^{151}Pm	28.40 h	8.661×10^{-5}	4.81
	^{152}Pm	4.12 min	1.935×10^{-4}	3.22
	^{153}Pm	5.25 min	3.908×10^{-4}	2.26
	^{154}Pm	2.68 min	2.711×10^{-4}	2.72
	^{155}Pm	41.5 s	2.184×10^{-4}	3.03
	^{156}Pm	26.70 s	1.048×10^{-4}	4.37
	^{157}Pm	10.56 s	3.480×10^{-5}	7.58
	^{158}Pm	4.8 s	3.460×10^{-5}	7.61
	^{148}Sm	Stable	3.319×10^{-5}	7.76
	^{149}Sm	Stable	9.824×10^{-5}	4.51
	^{150}Sm	Stable	5.574×10^{-4}	1.89
	^{151}Sm	90 y	1.478×10^{-3}	1.16
	^{152}Sm	Stable	6.567×10^{-3}	0.550
	^{153}Sm	46.284 h	1.021×10^{-2}	0.440
	^{154}Sm	Stable	1.910×10^{-2}	0.321
	^{155}Sm	22.18 min	1.301×10^{-2}	0.390
	^{156}Sm	9.4 h	1.312×10^{-2}	0.388
	^{157}Sm	8.03 min	6.040×10^{-3}	0.574
	^{158}Sm	5.30 min	3.489×10^{-3}	0.756
	^{159}Sm	11.37 s	2.207×10^{-3}	0.951
	^{148}Eu	54.5 d	8.060×10^{-5}	4.98
	^{149}Eu	93.1 d	4.958×10^{-4}	2.01
	^{150}Eu	36.9 y	1.922×10^{-3}	1.02
	^{151}Eu	Stable	1.024×10^{-2}	0.440
	^{152}Eu	13.517 y	2.668×10^{-2}	0.270
	^{153}Eu	Stable	8.922×10^{-2}	0.143
	^{154}Eu	8.601 y	1.230×10^{-1}	0.120
	^{155}Eu	4.753 y	1.877×10^{-1}	0.0930
	^{156}Eu	15.19 d	1.351×10^{-1}	0.113
	^{157}Eu	15.18 h	1.370×10^{-1}	0.112
	^{158}Eu	45.9 min	6.819×10^{-2}	0.165
	^{159}Eu	18.1 min	6.406×10^{-2}	0.171
	^{160}Eu	42.6 s	1.393×10^{-2}	0.376

Table 57 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 65$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Tb (65)	^{152}Sm	Stable	2.299×10^{-5}	9.33
	^{153}Sm	46.284 h	2.301×10^{-5}	9.33
	^{154}Sm	Stable	5.600×10^{-5}	5.98
	^{155}Sm	22.18 min	2.112×10^{-4}	3.08
	^{156}Sm	9.4 h	7.788×10^{-4}	1.60
	^{157}Sm	8.03 min	7.144×10^{-4}	1.67
	^{153}Eu	Stable	4.360×10^{-5}	6.77
	^{154}Eu	8.601 y	5.083×10^{-4}	1.98
	^{155}Eu	4.753 y	4.945×10^{-3}	0.635
	^{156}Eu	15.19 d	1.434×10^{-2}	0.371
	^{157}Eu	15.18 h	3.208×10^{-2}	0.246
	^{158}Eu	45.9 min	2.015×10^{-2}	0.312
	^{153}Gd	240.4 d	1.869×10^{-4}	3.27
	^{154}Gd	Stable	5.965×10^{-3}	0.577
	^{155}Gd	Stable	3.006×10^{-2}	0.254
	^{156}Gd	Stable	1.422×10^{-1}	0.110
	^{157}Gd	Stable	2.282×10^{-1}	0.0822
	^{158}Gd	Stable	3.556×10^{-1}	0.0602
	^{159}Gd	18.479 h	1.006×10^{-1}	0.134

Table 58 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 66.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Dy (66)	^{157}Eu	15.18 h	8.160×10^{-5}	9.90
	^{158}Eu	45.9 min	2.248×10^{-4}	5.97
	^{159}Eu	18.1 min	4.152×10^{-4}	4.39
	^{160}Eu	42.6 s	2.504×10^{-4}	5.65
	^{161}Eu	26 s	1.552×10^{-4}	7.18
	^{155}Gd	Stable	8.480×10^{-5}	9.71
	^{156}Gd	Stable	4.792×10^{-4}	4.09
	^{157}Gd	Stable	1.832×10^{-3}	2.09
	^{158}Gd	Stable	7.614×10^{-3}	1.02
	^{159}Gd	18.479 h	1.269×10^{-2}	0.789
	^{160}Gd	Stable	2.216×10^{-2}	0.594
	^{161}Gd	3.66 min	1.512×10^{-2}	0.722
	^{162}Gd	8.4 min	1.281×10^{-2}	0.785
	^{163}Gd	68 s	3.562×10^{-3}	1.50
	^{153}Tb	2.34 d	8.800×10^{-5}	9.53
	^{154}Tb	21.5 h	2.032×10^{-4}	6.27
	^{155}Tb	5.32 d	5.656×10^{-4}	3.76
	^{156}Tb	5.35 d	1.579×10^{-3}	2.25
	^{157}Tb	71 y	1.162×10^{-2}	0.825
	^{158}Tb	180 y	3.574×10^{-2}	0.465
	^{159}Tb	Stable	1.110×10^{-1}	0.253
	^{160}Tb	72.3 d	1.596×10^{-1}	0.205
	^{161}Tb	6.89 d	2.312×10^{-1}	0.163
	^{162}Tb	7.74 min	1.670×10^{-1}	0.200
	^{163}Tb	19.5 min	1.188×10^{-1}	0.244
	^{164}Tb	3.0 min	2.029×10^{-2}	0.622

Table 59 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 67.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ho (67)	^{162}Gd	8.4 min	5.160×10^{-4}	6.22
	^{163}Gd	68 s	4.120×10^{-4}	6.97
	^{160}Tb	72.3 d	5.860×10^{-4}	5.84
	^{161}Tb	6.89 d	5.092×10^{-3}	1.98
	^{162}Tb	7.74 min	1.506×10^{-2}	1.14
	^{163}Tb	19.5 min	3.057×10^{-2}	0.797
	^{164}Tb	3.0 min	1.850×10^{-2}	1.03
	^{159}Dy	144.4 d	2.740×10^{-4}	8.54
	^{160}Dy	Stable	6.526×10^{-3}	1.75
	^{161}Dy	Stable	3.327×10^{-2}	0.762
	^{162}Dy	Stable	1.471×10^{-1}	0.341
	^{163}Dy	Stable	2.366×10^{-1}	0.254
	^{164}Dy	Stable	3.485×10^{-1}	0.193
	^{165}Dy	2.331 h	9.231×10^{-2}	0.444

Table 60 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 68.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Er (68)	^{161}Tb	6.89 d	4.920×10^{-5}	9.02
	^{162}Tb	7.74 min	1.152×10^{-4}	5.89
	^{163}Tb	19.5 min	3.452×10^{-4}	3.40
	^{164}Tb	3.0 min	4.012×10^{-4}	3.16
	^{165}Tb	2.11 min	2.480×10^{-4}	4.02
	^{166}Tb	25.1 s	1.115×10^{-4}	5.99
	^{167}Tb	18.9 s	4.120×10^{-5}	9.85
	^{168}Tb	8.2 s	4.320×10^{-5}	9.62
	^{159}Dy	144.4 d	5.760×10^{-5}	8.33
	^{160}Dy	Stable	2.472×10^{-4}	4.02
	^{161}Dy	Stable	7.044×10^{-4}	2.38
	^{162}Dy	Stable	3.708×10^{-3}	1.04
	^{163}Dy	Stable	8.749×10^{-3}	0.673
	^{164}Dy	Stable	2.139×10^{-2}	0.428
	^{165}Dy	2.331 h	1.876×10^{-2}	0.458
	^{166}Dy	81.6 h	1.475×10^{-2}	0.517
	^{167}Dy	6.20 min	5.317×10^{-3}	0.865
	^{168}Dy	8.7 min	2.672×10^{-3}	1.22
	^{169}Dy	39 s	1.700×10^{-3}	1.53
	^{159}Ho	33.05 min	2.228×10^{-4}	4.24
	^{160}Ho	25.6 min	7.424×10^{-4}	2.32
	^{161}Ho	2.48 h	4.176×10^{-3}	0.977
	^{162}Ho	15.0 min	1.417×10^{-2}	0.528
	^{163}Ho	4570 y	6.144×10^{-2}	0.247
	^{164}Ho	28.8 min	1.190×10^{-1}	0.172
	^{165}Ho	Stable	2.328×10^{-1}	0.115
	^{166}Ho	26.824 h	1.721×10^{-1}	0.139
	^{167}Ho	2.98 h	1.430×10^{-1}	0.155
	^{168}Ho	2.99 min	5.673×10^{-2}	0.258
	^{169}Ho	4.72 min	4.336×10^{-2}	0.297
	^{170}Ho	2.76 min	9.670×10^{-3}	0.640

Table 61 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 69.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Tm (69)	^{165}Dy	2.331 h	1.830×10^{-4}	7.39
	^{166}Dy	81.6 h	6.570×10^{-4}	3.90
	^{167}Dy	6.20 min	5.850×10^{-4}	4.13
	^{164}Ho	28.8 min	6.300×10^{-4}	3.98
	^{165}Ho	Stable	5.795×10^{-3}	1.31
	^{166}Ho	26.824 h	1.621×10^{-2}	0.779
	^{167}Ho	2.98 h	3.505×10^{-2}	0.525
	^{168}Ho	2.99 min	2.224×10^{-2}	0.663
	^{163}Er	75.0 min	1.420×10^{-4}	8.39
	^{164}Er	Stable	5.081×10^{-3}	1.40
	^{165}Er	10.36 h	2.905×10^{-2}	0.578
	^{166}Er	Stable	1.379×10^{-1}	0.250
	^{167}Er	Stable	2.286×10^{-1}	0.184
	^{168}Er	Stable	3.471×10^{-1}	0.137
	^{169}Er	9.392 d	1.015×10^{-1}	0.297

Table 62 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 70.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Yb (70)	^{167}Ho	2.98 h	9.700×10^{-5}	7.18
	^{168}Ho	2.99 min	2.240×10^{-4}	4.73
	^{169}Ho	4.72 min	3.690×10^{-4}	3.68
	^{170}Ho	2.76 min	2.790×10^{-4}	4.23
	^{171}Ho	53 s	1.970×10^{-4}	5.04
	^{172}Ho	25 s	1.235×10^{-4}	6.36
	^{165}Er	10.36 h	6.100×10^{-5}	9.06
	^{166}Er	Stable	5.430×10^{-4}	3.03
	^{167}Er	Stable	1.897×10^{-3}	1.62
	^{168}Er	Stable	7.269×10^{-3}	0.826
	^{169}Er	9.392 d	1.197×10^{-2}	0.643
	^{170}Er	Stable	1.967×10^{-2}	0.499
	^{171}Er	7.516 h	1.528×10^{-2}	0.568
	^{172}Er	49.3 h	1.507×10^{-2}	0.572
	^{173}Er	1.4 min	6.597×10^{-3}	0.867
	^{174}Er	3.2 min	2.125×10^{-3}	1.53
	^{175}Er	1.2 min	1.235×10^{-3}	2.01
	^{165}Tm	30.06 h	2.790×10^{-4}	4.23
	^{166}Tm	7.70 h	1.464×10^{-3}	1.85
	^{167}Tm	9.25 d	1.058×10^{-2}	0.684
	^{168}Tm	93.1 d	3.127×10^{-2}	0.394
	^{169}Tm	Stable	9.174×10^{-2}	0.223
	^{170}Tm	128.6 d	1.354×10^{-1}	0.179
	^{171}Tm	1.92 y	1.914×10^{-1}	0.145
	^{172}Tm	63.6 h	1.512×10^{-1}	0.168
	^{173}Tm	8.24 h	1.380×10^{-1}	0.177
	^{174}Tm	5.4 min	5.245×10^{-2}	0.301
	^{175}Tm	15.2 min	3.508×10^{-2}	0.371
	^{176}Tm	1.9 min	7.373×10^{-3}	0.820

Table 63 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 71.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Lu (71)	^{172}Er	49.3 h	8.600×10^{-4}	5.39
	^{173}Er	1.4 min	7.475×10^{-4}	5.78
	^{170}Tm	128.6 d	6.850×10^{-4}	6.04
	^{171}Tm	1.92 y	5.788×10^{-3}	2.07
	^{172}Tm	63.6 h	1.646×10^{-2}	1.22
	^{173}Tm	8.24 h	3.349×10^{-2}	0.849
	^{174}Tm	5.4 min	2.147×10^{-2}	1.07
	^{170}Yb	Stable	6.188×10^{-3}	2.00
	^{171}Yb	Stable	3.299×10^{-2}	0.856
	^{172}Yb	Stable	1.413×10^{-1}	0.390
	^{173}Yb	Stable	2.352×10^{-1}	0.285
	^{174}Yb	Stable	3.378×10^{-1}	0.221
	^{175}Yb	4.185 d	9.635×10^{-2}	0.484

Table 64 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 72$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Hf (72)	^{173}Tm	8.24 h	1.525×10^{-4}	5.73
	^{174}Tm	5.4 min	2.660×10^{-4}	4.34
	^{175}Tm	15.2 min	4.580×10^{-4}	3.30
	^{176}Tm	1.9 min	2.805×10^{-4}	4.22
	^{177}Tm	95 s	1.905×10^{-4}	5.12
	^{171}Yb	Stable	1.160×10^{-4}	6.56
	^{172}Yb	Stable	8.705×10^{-4}	2.40
	^{173}Yb	Stable	3.015×10^{-3}	1.29
	^{174}Yb	Stable	1.031×10^{-2}	0.693
	^{175}Yb	4.185 d	1.543×10^{-2}	0.565
	^{176}Yb	Stable	2.196×10^{-2}	0.472
	^{177}Yb	1.911 h	1.495×10^{-2}	0.574
	^{178}Yb	74 min	1.317×10^{-2}	0.612
	^{179}Yb	8.0 min	4.445×10^{-3}	1.06
	^{171}Lu	8.247 d	4.596×10^{-4}	3.30
	^{172}Lu	6.70 d	2.663×10^{-3}	1.37
	^{173}Lu	1.37 y	1.659×10^{-2}	0.544
	^{174}Lu	3.31 y	4.691×10^{-2}	0.319
	^{175}Lu	Stable	1.219×10^{-1}	0.190
	^{176}Lu	Stable	1.616×10^{-1}	0.161
	^{177}Lu	6.6443 d	2.038×10^{-1}	0.140
	^{178}Lu	28.4 min	1.470×10^{-1}	0.170
	^{179}Lu	4.59 h	1.236×10^{-1}	0.188
	^{180}Lu	5.7 min	2.698×10^{-2}	0.425

Table 65 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 73$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ta (73)	^{176}Yb	Stable	4.441×10^{-5}	6.71
	^{177}Yb	1.911 h	1.793×10^{-4}	3.34
	^{178}Yb	74 min	6.296×10^{-4}	1.78
	^{179}Yb	8.0 min	4.699×10^{-4}	2.06
	^{175}Lu	Stable	6.420×10^{-5}	5.58
	^{176}Lu	Stable	7.956×10^{-4}	1.58
	^{177}Lu	6.6443 d	5.741×10^{-3}	0.589
	^{178}Lu	28.4 min	1.646×10^{-2}	0.346
	^{179}Lu	4.59 h	3.289×10^{-2}	0.243
	^{180}Lu	5.7 min	2.084×10^{-2}	0.307
	^{175}Hf	70 d	2.932×10^{-4}	2.61
	^{176}Hf	Stable	7.227×10^{-3}	0.524
	^{177}Hf	Stable	3.696×10^{-2}	0.228
	^{178}Hf	Stable	1.461×10^{-1}	0.108
	^{179}Hf	Stable	2.363×10^{-1}	0.0804
	^{180}Hf	Stable	3.428×10^{-1}	0.0619
	^{181}Hf	42.39 d	9.046×10^{-2}	0.142

Table 66 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 74.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
W (74)	^{179}Lu	4.59 h	3.187×10^{-4}	6.47
	^{180}Lu	5.7 min	3.933×10^{-4}	5.82
	^{181}Lu	3.5 min	2.653×10^{-4}	7.09
	^{182}Lu	2.0 min	1.507×10^{-4}	9.41
	^{177}Hf	Stable	2.827×10^{-4}	6.87
	^{178}Hf	Stable	2.403×10^{-3}	2.35
	^{179}Hf	Stable	7.069×10^{-3}	1.37
	^{180}Hf	Stable	1.813×10^{-2}	0.849
	^{181}Hf	42.39 d	1.769×10^{-2}	0.861
	^{182}Hf	8.90×10^{6} y	1.685×10^{-2}	0.882
	^{183}Hf	1.018 h	9.637×10^{-3}	1.17
	^{184}Hf	4.12 h	6.765×10^{-3}	1.40
	^{185}Hf	3.5 min	3.576×10^{-3}	1.93
	^{177}Ta	56.36 h	1.236×10^{-3}	3.28
	^{178}Ta	2.36 h	8.908×10^{-3}	1.22
	^{179}Ta	1.82 y	4.436×10^{-2}	0.536
	^{180}Ta	8.154 h	9.839×10^{-2}	0.350
	^{181}Ta	Stable	1.911×10^{-1}	0.238
	^{182}Ta	114.74 d	1.584×10^{-1}	0.266
	^{183}Ta	5.1 d	1.623×10^{-1}	0.262
	^{184}Ta	8.7 h	8.839×10^{-2}	0.371
	^{185}Ta	49.4 min	8.341×10^{-2}	0.383
	^{186}Ta	10.39 min	1.735×10^{-2}	0.869

Table 67 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 75.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Re (75)	^{182}Hf	8.90×10^{6} y	4.160×10^{-4}	9.80
	^{183}Hf	1.018 h	4.160×10^{-4}	9.80
	^{181}Ta	Stable	2.428×10^{-3}	4.05
	^{182}Ta	114.74 d	6.940×10^{-3}	2.39
	^{183}Ta	5.1 d	1.696×10^{-2}	1.52
	^{184}Ta	8.7 h	1.722×10^{-2}	1.51
	^{185}Ta	49.4 min	1.788×10^{-2}	1.48
	^{186}Ta	10.39 min	1.070×10^{-2}	1.92
	^{180}W	Stable	2.124×10^{-3}	4.34
	^{181}W	121.2 d	1.286×10^{-2}	1.75
	^{182}W	Stable	6.270×10^{-2}	0.773
	^{183}W	Stable	1.161×10^{-1}	0.552
	^{184}W	Stable	2.295×10^{-1}	0.367
	^{185}W	75.1 d	1.788×10^{-1}	0.429
	^{186}W	Stable	2.035×10^{-1}	0.396
	^{187}W	24.000 h	5.035×10^{-2}	0.869

Table 68 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 76.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Os (76)	^{184}Ta	8.7 h	7.733×10^{-5}	9.29
	^{185}Ta	49.4 min	1.654×10^{-4}	6.35
	^{186}Ta	10.39 min	2.100×10^{-4}	5.63
	^{187}Ta	283 s	2.247×10^{-4}	5.45
	^{188}Ta	19.6 s	1.407×10^{-4}	6.88
	^{190}Ta	5.3 s	1.033×10^{-4}	8.04
	^{182}W	Stable	1.887×10^{-4}	5.94
	^{183}W	Stable	7.053×10^{-4}	3.07
	^{184}W	Stable	2.749×10^{-3}	1.56
	^{185}W	75.1 d	5.260×10^{-3}	1.12
	^{186}W	Stable	1.259×10^{-2}	0.723
	^{187}W	24.000 h	1.349×10^{-2}	0.698
	^{188}W	69.78 d	1.615×10^{-2}	0.637
	^{189}W	11.6 min	9.146×10^{-3}	0.850
	^{190}W	30.0 min	1.029×10^{-2}	0.801
	^{181}Re	19.9 h	9.600×10^{-5}	8.32
	^{182}Re	64.2 h	5.647×10^{-4}	3.44
	^{183}Re	70.0 d	3.984×10^{-3}	1.29
	^{184}Re	35.4 d	1.181×10^{-2}	0.747
	^{185}Re	Stable	4.074×10^{-2}	0.396
	^{186}Re	3.7185 d	7.139×10^{-2}	0.294
	^{187}Re	Stable	1.429×10^{-1}	0.200
	^{188}Re	17.005 h	1.414×10^{-1}	0.201
	^{189}Re	24.3 h	1.736×10^{-1}	0.178
	^{190}Re	3.0 min	1.190×10^{-1}	0.222
	^{191}Re	9.8 min	1.259×10^{-1}	0.215
	^{192}Re	16 s	2.009×10^{-2}	0.570

Table 69 Yields of nuclides produced by the nuclear capture of μ^- for targets with $77 \leq Z \leq 78$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Ir (77)	^{187}Re	Stable	2.132×10^{-3}	4.33
	^{188}Re	17.005 h	5.936×10^{-3}	2.59
	^{189}Re	24.3 h	1.561×10^{-2}	1.59
	^{190}Re	3.0 min	1.434×10^{-2}	1.66
	^{191}Re	9.8 min	1.475×10^{-2}	1.63
	^{192}Re	16 s	8.860×10^{-3}	2.12
	^{186}Os	Stable	2.196×10^{-3}	4.26
	^{187}Os	Stable	1.224×10^{-2}	1.80
	^{188}Os	Stable	5.981×10^{-2}	0.793
	^{189}Os	Stable	1.076×10^{-1}	0.576
	^{190}Os	Stable	2.348×10^{-1}	0.361
	^{191}Os	14.99 d	1.764×10^{-1}	0.432
	^{192}Os	Stable	2.205×10^{-1}	0.376
	^{193}Os	29.830 h	5.293×10^{-2}	0.846
Pt (78)	^{190}Os	Stable	3.080×10^{-3}	4.02
	^{191}Os	14.99 d	7.635×10^{-3}	2.55
	^{192}Os	Stable	2.322×10^{-2}	1.45
	^{193}Os	29.830 h	2.264×10^{-2}	1.47
	^{194}Os	6.0 y	1.926×10^{-2}	1.60
	^{195}Os	6.5 min	5.140×10^{-3}	3.11
	^{196}Os	34.9 min	1.020×10^{-3}	7.00
	^{197}Os	2.8 min	6.300×10^{-4}	8.91
	^{189}Ir	13.2 d	2.165×10^{-3}	4.80
	^{190}Ir	11.78 d	1.105×10^{-2}	2.12
	^{191}Ir	Stable	6.108×10^{-2}	0.877
	^{192}Ir	73.829 d	1.209×10^{-1}	0.603
	^{193}Ir	Stable	2.538×10^{-1}	0.383
	^{194}Ir	19.18 h	1.920×10^{-1}	0.459
	^{195}Ir	2.29 h	1.409×10^{-1}	0.552
	^{196}Ir	52 s	3.614×10^{-2}	1.16
	^{197}Ir	5.8 min	2.249×10^{-2}	1.47
	^{198}Ir	8 s	4.585×10^{-3}	3.30

Table 70 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 79.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Au (79)	^{194}Os	6.0 y	7.480×10^{-4}	5.17
	^{195}Os	6.5 min	6.600×10^{-4}	5.50
	^{192}Ir	73.829 d	3.640×10^{-4}	7.41
	^{193}Ir	Stable	4.278×10^{-3}	2.16
	^{194}Ir	19.18 h	1.372×10^{-2}	1.20
	^{195}Ir	2.29 h	3.279×10^{-2}	0.768
	^{196}Ir	52 s	2.143×10^{-2}	0.956
	^{192}Pt	Stable	3.928×10^{-3}	2.25
	^{193}Pt	50 y	2.402×10^{-2}	0.902
	^{194}Pt	Stable	1.345×10^{-1}	0.359
	^{195}Pt	Stable	2.301×10^{-1}	0.259
	^{196}Pt	Stable	3.769×10^{-1}	0.182
	^{197}Pt	19.8915 h	9.595×10^{-2}	0.434

Table 71 Yields of nuclides produced by the nuclear capture of μ^- for the target with $Z = 80$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Hg (80)	^{195}Ir	2.29 h	1.394×10^{-4}	9.05
	^{196}Ir	52 s	2.526×10^{-4}	6.73
	^{197}Ir	5.8 min	3.086×10^{-4}	6.09
	^{198}Ir	8 s	1.509×10^{-4}	8.70
	^{194}Pt	Stable	7.863×10^{-4}	3.81
	^{195}Pt	Stable	2.716×10^{-3}	2.05
	^{196}Pt	Stable	1.003×10^{-2}	1.06
	^{197}Pt	19.8915 h	1.317×10^{-2}	0.925
	^{198}Pt	Stable	1.931×10^{-2}	0.762
	^{199}Pt	30.8 min	1.263×10^{-2}	0.946
	^{200}Pt	12.6 h	1.376×10^{-2}	0.906
	^{201}Pt	2.46 min	5.104×10^{-3}	1.49
	^{202}Pt	44 h	3.691×10^{-4}	5.56
	^{203}Pt	22 s	3.760×10^{-4}	5.51
	^{193}Au	17.65 h	3.189×10^{-4}	5.99
	^{194}Au	38.02 h	2.519×10^{-3}	2.13
	^{195}Au	186.01 d	1.776×10^{-2}	0.795
	^{196}Au	6.1669 d	4.695×10^{-2}	0.482
	^{197}Au	Stable	1.247×10^{-1}	0.283
	^{198}Au	2.6941 d	1.466×10^{-1}	0.258
	^{199}Au	3.139 d	1.873×10^{-1}	0.223
	^{200}Au	48.4 min	1.381×10^{-1}	0.267
	^{201}Au	26.0 min	1.285×10^{-1}	0.278
	^{202}Au	28.4 s	4.134×10^{-2}	0.515
	^{203}Au	60 s	2.180×10^{-2}	0.716
	^{204}Au	39.8 s	4.560×10^{-3}	1.58

Table 72 Yields of nuclides produced by the nuclear capture of μ^- for targets with $81 \leq Z \leq 82$.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Tl (81)	^{199}Au	3.139 d	1.048×10^{-3}	8.73
	^{200}Au	48.4 min	3.928×10^{-3}	4.50
	^{201}Au	26.0 min	1.242×10^{-2}	2.52
	^{202}Au	28.4 s	1.440×10^{-2}	2.34
	^{203}Au	60 s	1.851×10^{-2}	2.06
	^{204}Au	39.8 s	1.214×10^{-2}	2.55
	^{199}Hg	Stable	7.400×10^{-3}	3.28
	^{200}Hg	Stable	4.102×10^{-2}	1.37
	^{201}Hg	Stable	9.182×10^{-2}	0.890
	^{202}Hg	Stable	2.149×10^{-1}	0.541
	^{203}Hg	46.610 d	1.999×10^{-1}	0.566
	^{204}Hg	Stable	2.572×10^{-1}	0.481
	^{205}Hg	5.14 min	6.151×10^{-2}	1.11
Pb (82)	^{202}Au	28.4 s	4.302×10^{-5}	8.81
	^{203}Au	60 s	1.274×10^{-4}	5.12
	^{204}Au	39.8 s	1.634×10^{-4}	4.52
	^{205}Au	32.0 s	3.801×10^{-5}	9.36
	^{200}Hg	Stable	7.667×10^{-5}	6.59
	^{201}Hg	Stable	3.748×10^{-4}	2.98
	^{202}Hg	Stable	1.993×10^{-3}	1.29
	^{203}Hg	46.610 d	5.071×10^{-3}	0.809
	^{204}Hg	Stable	1.504×10^{-2}	0.467
	^{205}Hg	5.14 min	1.601×10^{-2}	0.453
	^{206}Hg	8.32 min	1.402×10^{-2}	0.484
	^{207}Hg	2.9 min	1.660×10^{-3}	1.42
	^{200}Tl	26.1 h	2.424×10^{-4}	3.71
	^{201}Tl	3.0420 d	2.042×10^{-3}	1.28
	^{202}Tl	12.31 d	8.632×10^{-3}	0.619
	^{203}Tl	Stable	4.107×10^{-2}	0.279
	^{204}Tl	3.783 y	1.019×10^{-1}	0.171
	^{205}Tl	Stable	2.395×10^{-1}	0.103
	^{206}Tl	4.202 min	2.655×10^{-1}	0.0959
	^{207}Tl	4.77 min	2.115×10^{-1}	0.111
	^{208}Tl	3.053 min	1.381×10^{-2}	0.488

Table 73 Yields of nuclides produced by the nuclear capture of μ^- for targets with Z = 83, 90.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
Bi (83)	^{205}Hg	5.14 min	9.240×10^{-5}	5.34
	^{206}Hg	8.32 min	3.005×10^{-4}	2.96
	^{207}Hg	2.9 min	7.026×10^{-5}	6.12
	^{204}Tl	3.783 y	4.093×10^{-4}	2.54
	^{205}Tl	Stable	4.738×10^{-3}	0.744
	^{206}Tl	4.202 min	1.781×10^{-2}	0.381
	^{207}Tl	4.77 min	3.602×10^{-2}	0.265
	^{208}Tl	3.053 min	1.288×10^{-2}	0.449
	^{203}Pb	51.92 h	5.343×10^{-5}	7.02
	^{204}Pb	Stable	3.206×10^{-3}	0.905
	^{205}Pb	1.70×10^{7} y	2.614×10^{-2}	0.313
	^{206}Pb	Stable	1.422×10^{-1}	0.126
	^{207}Pb	Stable	2.839×10^{-1}	0.0814
	^{208}Pb	Stable	3.664×10^{-1}	0.0674
	^{209}Pb	3.234 h	4.524×10^{-2}	0.236
Th (90)	^{228}Fr	38 s	4.233×10^{-4}	6.27
	^{229}Fr	50.2 s	1.055×10^{-3}	3.97
	^{230}Fr	19.1 s	7.233×10^{-4}	4.80
	^{226}Ra	1603 y	6.767×10^{-4}	4.96
	^{227}Ra	42.2 min	3.073×10^{-3}	2.33
	^{228}Ra	5.75 y	1.589×10^{-2}	1.02
	^{229}Ra	4.0 min	2.596×10^{-2}	0.791
	^{230}Ra	93 min	4.335×10^{-2}	0.607
	^{231}Ra	103.9 s	1.683×10^{-2}	0.987
	^{226}Ac	29.37 h	8.883×10^{-4}	4.33
	^{227}Ac	21.772 y	1.303×10^{-2}	1.12
	^{228}Ac	6.15 h	4.982×10^{-2}	0.564
	^{229}Ac	62.7 min	1.714×10^{-1}	0.284
	^{230}Ac	122 s	2.521×10^{-1}	0.223
	^{231}Ac	7.5 min	2.847×10^{-1}	0.205
	^{232}Ac	119 s	5.262×10^{-2}	0.548

Table 74 Yields of nuclides produced by the nuclear capture of μ^- for the target with Z = 92. Produced nuclides from ^{83}As to ^{150}Ce are fission products.

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
U (92)	^{83}As	13.4 s	2.683×10^{-4}	7.88
	^{84}As	4.02 s	1.767×10^{-4}	9.71
	^{85}As	2.021 s	2.150×10^{-4}	8.80
	^{84}Se	3.26 min	2.983×10^{-4}	7.47
	^{85}Se	32.9 s	3.017×10^{-4}	7.43
	^{86}Se	14.3 s	5.167×10^{-4}	5.68
	^{87}Se	5.50 s	3.200×10^{-4}	7.22
	^{88}Se	1.53 s	3.733×10^{-4}	6.68
	^{89}Se	0.43 s	1.800×10^{-4}	9.63
	^{90}Se	195 ms	1.883×10^{-4}	9.40
	^{85}Br	2.90 min	2.183×10^{-4}	8.73
	^{86}Br	55.1 s	2.850×10^{-4}	7.65
	^{87}Br	55.65 s	5.683×10^{-4}	5.41
	^{88}Br	16.34 s	6.250×10^{-4}	5.16
	^{89}Br	4.357 s	7.667×10^{-4}	4.66
	^{90}Br	1.91 s	5.533×10^{-4}	5.49
	^{91}Br	0.543 s	5.017×10^{-4}	5.76
	^{92}Br	0.314 s	1.983×10^{-4}	9.17
	^{93}Br	102 ms	2.183×10^{-4}	8.74
	^{88}Kr	2.825 h	4.733×10^{-4}	5.93
	^{89}Kr	3.15 min	6.350×10^{-4}	5.12
	^{90}Kr	32.32 s	1.062×10^{-3}	3.96
	^{91}Kr	8.57 s	9.050×10^{-4}	4.29
	^{92}Kr	1.840 s	1.055×10^{-3}	3.97
	^{93}Kr	1.286 s	4.917×10^{-4}	5.82
	^{94}Kr	212 ms	5.467×10^{-4}	5.52
	^{95}Kr	0.114 s	2.033×10^{-4}	9.05
	^{96}Kr	80 ms	1.967×10^{-4}	9.21
	^{90}Rb	158 s	3.600×10^{-4}	6.80
	^{91}Rb	58.2 s	7.767×10^{-4}	4.63
	^{92}Rb	4.48 s	1.043×10^{-3}	4.00
	^{93}Rb	5.84 s	1.525×10^{-3}	3.30
	^{94}Rb	2.702 s	1.012×10^{-3}	4.06
	^{95}Rb	377.7 ms	1.053×10^{-3}	3.98

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
	^{96}Rb	203 ms	5.700×10^{-4}	5.41
	^{97}Rb	169.1 ms	5.300×10^{-4}	5.61
	^{98}Rb	115 ms	3.117×10^{-4}	7.31
	^{99}Rb	54 ms	2.050×10^{-4}	9.02
	^{92}Sr	2.611 h	4.100×10^{-4}	6.38
	^{93}Sr	7.43 min	6.417×10^{-4}	5.10
	^{94}Sr	75.3 s	1.378×10^{-3}	3.47
	^{95}Sr	23.90 s	1.210×10^{-3}	3.71
	^{96}Sr	1.07 s	1.622×10^{-3}	3.20
	^{97}Sr	429 ms	9.433×10^{-4}	4.20
	^{98}Sr	0.653 s	1.148×10^{-3}	3.81
	^{99}Sr	269 ms	6.167×10^{-4}	5.20
	^{100}Sr	200 ms	6.200×10^{-4}	5.18
	^{101}Sr	118 ms	2.233×10^{-4}	8.64
	^{102}Sr	69 ms	1.883×10^{-4}	9.41
	^{94}Y	18.7 min	2.533×10^{-4}	8.11
	^{95}Y	10.3 min	6.333×10^{-4}	5.13
	^{96}Y	5.34 s	9.468×10^{-4}	4.19
	^{97}Y	3.75 s	1.522×10^{-3}	3.31
	^{98}Y	0.548 s	1.272×10^{-3}	3.62
	^{99}Y	1.484 s	1.618×10^{-3}	3.21
	^{100}Y	732 ms	1.292×10^{-3}	3.59
	^{101}Y	0.45 s	1.058×10^{-3}	3.97
	^{102}Y	0.36 s	7.433×10^{-4}	4.73
	^{103}Y	0.23 s	4.333×10^{-4}	6.20
	^{104}Y	197 ms	2.250×10^{-4}	8.61
	^{96}Zr	Stable	1.917×10^{-4}	9.33
	^{97}Zr	16.749 h	3.900×10^{-4}	6.54
	^{98}Zr	30.7 s	8.200×10^{-4}	4.51
	^{99}Zr	2.1 s	9.700×10^{-4}	4.14
	^{100}Zr	7.1 s	1.765×10^{-3}	3.07
	^{101}Zr	2.3 s	1.350×10^{-3}	3.51
	^{102}Zr	2.9 s	1.658×10^{-3}	3.17
	^{103}Zr	1.3 s	1.192×10^{-3}	3.74
	^{104}Zr	1.2 s	1.147×10^{-3}	3.81

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
	^{105}Zr	0.66 s	5.900×10^{-4}	5.31
	^{106}Zr	180 ms	4.600×10^{-4}	6.02
	^{107}Zr	146 ms	1.767×10^{-4}	9.72
	^{99}Nb	15.0 s	2.650×10^{-4}	7.93
	^{100}Nb	1.4 s	4.467×10^{-4}	6.11
	^{101}Nb	7.1 s	9.483×10^{-4}	4.19
	^{102}Nb	4.3 s	1.242×10^{-3}	3.66
	^{103}Nb	1.5 s	1.923×10^{-3}	2.94
	^{104}Nb	4.8 s	1.490×10^{-3}	3.34
	^{105}Nb	2.91 s	1.728×10^{-3}	3.10
	^{106}Nb	0.93 s	1.027×10^{-3}	4.03
	^{107}Nb	300 ms	1.208×10^{-3}	3.71
	^{108}Nb	0.193 s	5.333×10^{-4}	5.59
	^{109}Nb	108 ms	4.250×10^{-4}	6.26
	^{102}Mo	11.3 min	3.667×10^{-4}	6.74
	^{103}Mo	67.5 s	5.050×10^{-4}	5.74
	^{104}Mo	60 s	1.195×10^{-3}	3.73
	^{105}Mo	36.3 s	1.277×10^{-3}	3.61
	^{106}Mo	8.73 s	1.958×10^{-3}	2.92
	^{107}Mo	3.5 s	1.540×10^{-3}	3.29
	^{108}Mo	1.09 s	1.858×10^{-3}	2.99
	^{109}Mo	0.61 s	1.145×10^{-3}	3.81
	^{110}Mo	0.296 s	1.238×10^{-3}	3.67
	^{111}Mo	186 ms	4.983×10^{-4}	5.78
	^{112}Mo	120 ms	4.383×10^{-4}	6.17
	^{105}Tc	7.64 min	3.533×10^{-4}	6.87
	^{106}Tc	35.6 s	6.433×10^{-4}	5.09
	^{107}Tc	21.2 s	1.463×10^{-3}	3.37
	^{108}Tc	5.17 s	1.310×10^{-3}	3.57
	^{109}Tc	0.91 s	2.387×10^{-3}	2.64
	^{110}Tc	0.900 s	1.597×10^{-3}	3.23
	^{111}Tc	290 ms	2.167×10^{-3}	2.77
	^{112}Tc	271 ms	1.270×10^{-3}	3.62
	^{113}Tc	160 ms	1.232×10^{-3}	3.68
	^{114}Tc	100 ms	5.067×10^{-4}	5.74

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ⁻]	Relative error [%]
	^{115}Tc	78 ms	3.283×10^{-4}	7.13
	^{108}Ru	4.55 min	4.883×10^{-4}	5.84
	^{109}Ru	34.4 s	7.967×10^{-4}	4.57
	^{110}Ru	12.04 s	1.728×10^{-3}	3.10
	^{111}Ru	2.12 s	1.590×10^{-3}	3.24
	^{112}Ru	1.75 s	2.587×10^{-3}	2.54
	^{113}Ru	0.80 s	1.742×10^{-3}	3.09
	^{114}Ru	0.52 s	2.183×10^{-3}	2.76
	^{115}Ru	318 ms	1.123×10^{-3}	3.85
	^{116}Ru	204 ms	1.035×10^{-3}	4.01
	^{117}Ru	151 ms	3.567×10^{-4}	6.83
	^{118}Ru	99 ms	2.950×10^{-4}	7.52
	^{110}Rh	3.35 s	2.117×10^{-4}	8.88
	^{111}Rh	11 s	7.067×10^{-4}	4.86
	^{112}Rh	3.6 s	1.050×10^{-3}	3.98
	^{113}Rh	2.80 s	1.958×10^{-3}	2.92
	^{114}Rh	1.85 s	1.830×10^{-3}	3.02
	^{115}Rh	0.99 s	2.778×10^{-3}	2.45
	^{116}Rh	0.68 s	1.848×10^{-3}	3.00
	^{117}Rh	0.44 s	1.967×10^{-3}	2.91
	^{118}Rh	286 ms	1.037×10^{-3}	4.01
	^{119}Rh	171 ms	8.350×10^{-4}	4.47
	^{120}Rh	132 ms	3.183×10^{-4}	7.23
	^{121}Rh	151 ms	2.500×10^{-4}	8.16
	^{113}Pd	93 s	3.200×10^{-4}	7.22
	^{114}Pd	2.42 min	1.033×10^{-3}	4.01
	^{115}Pd	25 s	1.185×10^{-3}	3.75
	^{116}Pd	11.8 s	2.412×10^{-3}	2.63
	^{117}Pd	4.3 s	1.783×10^{-3}	3.05
	^{118}Pd	1.9 s	2.670×10^{-3}	2.50
	^{119}Pd	0.92 s	1.725×10^{-3}	3.11
	^{120}Pd	0.5 s	1.792×10^{-3}	3.05
	^{121}Pd	285 ms	7.933×10^{-4}	4.58
	^{122}Pd	175 ms	6.550×10^{-4}	5.04
	^{123}Pd	109 ms	2.367×10^{-4}	8.39

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ$^-$]	Relative error [%]
	^{115}Ag	20.0 min	2.267×10^{-4}	8.58
	^{116}Ag	237 s	4.167×10^{-4}	6.32
	^{117}Ag	72.8 s	1.228×10^{-3}	3.68
	^{118}Ag	3.76 s	1.388×10^{-3}	3.46
	^{119}Ag	2.1 s	2.203×10^{-3}	2.75
	^{120}Ag	1.23 s	2.127×10^{-3}	2.80
	^{121}Ag	0.78 s	2.562×10^{-3}	2.55
	^{122}Ag	0.529 s	1.417×10^{-3}	3.43
	^{123}Ag	0.299 s	1.328×10^{-3}	3.54
	^{124}Ag	0.172 s	6.400×10^{-4}	5.10
	^{125}Ag	159 ms	4.200×10^{-4}	6.30
	^{118}Cd	50.3 min	3.167×10^{-4}	7.25
	^{119}Cd	2.69 min	5.033×10^{-4}	5.75
	^{120}Cd	50.80 s	1.542×10^{-3}	3.29
	^{121}Cd	13.5 s	1.458×10^{-3}	3.38
	^{122}Cd	5.24 s	2.437×10^{-3}	2.61
	^{123}Cd	2.10 s	1.793×10^{-3}	3.05
	^{124}Cd	1.25 s	2.292×10^{-3}	2.69
	^{125}Cd	0.68 s	1.212×10^{-3}	3.71
	^{126}Cd	0.514 s	1.062×10^{-3}	3.96
	^{127}Cd	0.37 s	4.167×10^{-4}	6.32
	^{128}Cd	0.28 s	2.867×10^{-4}	7.63
	^{121}In	23.1 s	3.833×10^{-4}	6.59
	^{122}In	1.5 s	6.717×10^{-4}	4.98
	^{123}In	6.15 s	1.510×10^{-3}	3.32
	^{124}In	3.12 s	1.515×10^{-3}	3.31
	^{125}In	2.36 s	2.227×10^{-3}	2.73
	^{126}In	1.53 s	1.628×10^{-3}	3.20
	^{127}In	1.09 s	1.835×10^{-3}	3.01
	^{128}In	0.84 s	1.035×10^{-3}	4.01
	^{129}In	611 ms	8.450×10^{-4}	4.44
	^{130}In	0.29 s	3.183×10^{-4}	7.23
	^{124}Sn	Stable	5.767×10^{-4}	5.38
	^{125}Sn	9.64 d	7.467×10^{-4}	4.72
	^{126}Sn	2.18×10^{5} y	1.637×10^{-3}	3.19

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
	^{127}Sn	2.10 h	1.510×10^{-3}	3.32
	^{128}Sn	59.07 min	2.248×10^{-3}	2.72
	^{129}Sn	2.23 min	1.552×10^{-3}	3.27
	^{130}Sn	3.72 min	1.693×10^{-3}	3.13
	^{131}Sn	56.0 s	8.067×10^{-4}	4.54
	^{132}Sn	39.7 s	4.733×10^{-4}	5.93
	^{126}Sb	12.35 d	2.100×10^{-4}	8.91
	^{127}Sb	3.85 d	6.817×10^{-4}	4.94
	^{128}Sb	9.05 h	8.667×10^{-4}	4.38
	^{129}Sb	4.366 h	1.640×10^{-3}	3.19
	^{130}Sb	39.5 min	1.643×10^{-3}	3.18
	^{131}Sb	23.03 min	2.180×10^{-3}	2.76
	^{132}Sb	2.79 min	1.522×10^{-3}	3.31
	^{133}Sb	2.34 min	1.278×10^{-3}	3.61
	^{134}Sb	0.78 s	3.700×10^{-4}	6.71
	^{135}Sb	1.679 s	2.683×10^{-4}	7.88
	^{129}Te	69.6 min	2.367×10^{-4}	8.39
	^{130}Te	Stable	6.667×10^{-4}	5.00
	^{131}Te	25.0 min	9.800×10^{-4}	4.12
	^{132}Te	3.204 d	1.783×10^{-3}	3.05
	^{133}Te	12.5 min	1.777×10^{-3}	3.06
	^{134}Te	41.8 min	2.207×10^{-3}	2.75
	^{135}Te	19.0 s	9.433×10^{-4}	4.20
	^{136}Te	17.63 s	7.683×10^{-4}	4.66
	^{137}Te	2.49 s	3.633×10^{-4}	6.77
	^{138}Te	1.4 s	2.300×10^{-4}	8.51
	^{132}I	2.295 h	2.700×10^{-4}	7.86
	^{133}I	20.83 h	7.900×10^{-4}	4.59
	^{134}I	52.5 min	1.230×10^{-3}	3.68
	^{135}I	6.58 h	2.107×10^{-3}	2.81
	^{136}I	83.4 s	1.165×10^{-3}	3.78
	^{137}I	24.5 s	1.343×10^{-3}	3.52
	^{138}I	6.26 s	8.617×10^{-4}	4.40
	^{139}I	2.280 s	6.700×10^{-4}	4.99
	^{140}I	0.86 s	3.050×10^{-4}	7.39

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
	^{141}I	0.418 s	2.150×10^{-4}	8.80
	^{134}Xe	Stable	1.717×10^{-4}	9.85
	^{135}Xe	9.14 h	3.767×10^{-4}	6.65
	^{136}Xe	Stable	1.017×10^{-3}	4.05
	^{137}Xe	3.818 min	9.615×10^{-4}	4.16
	^{138}Xe	14.14 min	1.440×10^{-3}	3.40
	^{139}Xe	39.68 s	1.000×10^{-3}	4.08
	^{140}Xe	13.60 s	1.200×10^{-3}	3.73
	^{141}Xe	1.73 s	6.067×10^{-4}	5.24
	^{142}Xe	1.23 s	5.050×10^{-4}	5.74
	^{143}Xe	0.511 s	1.917×10^{-4}	9.33
	^{137}Cs	30.08 y	2.083×10^{-4}	8.94
	^{138}Cs	32.5 min	3.733×10^{-4}	6.68
	^{139}Cs	9.27 min	6.717×10^{-4}	4.98
	^{140}Cs	63.7 s	8.350×10^{-4}	4.47
	^{141}Cs	24.84 s	1.105×10^{-3}	3.88
	^{142}Cs	1.684 s	8.683×10^{-4}	4.38
	^{143}Cs	1.791 s	8.783×10^{-4}	4.36
	^{144}Cs	0.994 s	3.833×10^{-4}	6.59
	^{145}Cs	0.587 s	3.233×10^{-4}	7.18
	^{140}Ba	12.751 d	2.017×10^{-4}	9.09
	^{141}Ba	18.27 min	2.867×10^{-4}	7.63
	^{142}Ba	10.6 min	6.033×10^{-4}	5.25
	^{143}Ba	14.5 s	6.200×10^{-4}	5.18
	^{144}Ba	11.5 s	7.433×10^{-4}	4.73
	^{145}Ba	4.31 s	5.650×10^{-4}	5.43
	^{146}Ba	2.21 s	4.733×10^{-4}	5.93
	^{147}Ba	0.894 s	2.767×10^{-4}	7.76
	^{144}La	40.8 s	2.133×10^{-4}	8.84
	^{145}La	24.8 s	3.917×10^{-4}	6.52
	^{146}La	6.1 s	3.467×10^{-4}	6.93
	^{147}La	4.06 s	4.583×10^{-4}	6.03
	^{148}La	1.26 s	2.567×10^{-4}	8.06
	^{149}La	1.091 s	2.817×10^{-4}	7.69
	^{148}Ce	56.8 s	2.433×10^{-4}	8.27

Table 74 (Continued).

Target (Z)	Produced nuclide	Half-life	Yield [/μ^-]	Relative error [%]
	^{149}Ce	5.12 s	1.933×10^{-4}	9.29
	^{150}Ce	4.0 s	2.450×10^{-4}	8.25
	^{234}Ac	44 s	4.150×10^{-4}	6.34
	^{235}Ac	62 s	1.053×10^{-3}	3.98
	^{236}Ac	1.2 min	6.583×10^{-4}	5.03
	^{232}Th	Stable	8.467×10^{-4}	4.44
	^{233}Th	21.83 min	3.947×10^{-3}	2.05
	^{234}Th	24.10 d	1.866×10^{-2}	0.937
	^{235}Th	7.1 min	2.922×10^{-2}	0.744
	^{236}Th	37.5 min	4.930×10^{-2}	0.567
	^{237}Th	4.8 min	1.577×10^{-2}	1.02
	^{232}Pa	1.32 d	8.117×10^{-4}	4.53
	^{233}Pa	26.975 d	7.478×10^{-3}	1.49
	^{234}Pa	6.70 h	3.104×10^{-2}	0.721
	^{235}Pa	24.4 min	1.245×10^{-1}	0.342
	^{236}Pa	9.1 min	2.073×10^{-1}	0.253
	^{237}Pa	8.7 min	2.722×10^{-1}	0.211
	^{238}Pa	2.28 min	5.180×10^{-2}	0.552

Table 75 Comparison between calculated yields per captured μ^- and experimental data for silicon and iron targets.

Target (Z)	Produced nuclide	Calculation (C)	Experiment (E)	C/E
Si (14)	^{24}Na	2.118±0.008	3.4±0.2	0.62±0.04
	^{26}Al	5.013±0.012	2.1±0.2	2.4±0.2
	^{28}Al	18.09±0.02	22.8±2.5	0.793±0.087
Fe (26)	^{53}Mn	6.389±0.012	8.3±1.0	0.77±0.09
	^{54}Mn	20.94±0.02	18.7±1.1	1.12±0.07
	^{56}Mn	12.38±0.01	17.4±1.0	0.711±0.041

Table 76 Estimated radioactivities of $Li_4Ti_5O_{12}$ irradiated by μ^-.

Target (Z)	Radionuclide	Half-life	$A(t_{irr})$ [Bq]
Li (3)	^{3}H	12.32 y	3.53×10^{-3}
	^{6}He	806.7 ms	7.27×10^{1}
Ti (22)	^{38}Cl	37.230 min	7.97
	^{39}Ar	268 y	1.12×10^{-5}
	^{41}Ar	109.61 min	1.28×10^{1}
	^{42}Ar	32.9 y	1.76×10^{-4}
	^{42}K	12.355 h	1.30×10^{2}
	^{43}K	22.3 h	2.91×10^{-3}
	^{44}K	22.13 min	9.97×10^{1}
	^{45}K	17.81 min	9.18×10^{1}
	^{46}K	105 s	7.18×10^{1}
	^{45}Ca	162.61 d	3.63
	^{47}Ca	4.536 d	1.26×10^{2}
	^{49}Ca	8.718 min	9.48×10^{1}
	^{43}Sc	3.891 h	8.40×10^{1}
	^{44}Sc	4.0420 h	1.42×10^{3}
	^{46}Sc	83.79 d	6.50×10^{1}
	^{47}Sc	3.3492 d	3.07×10^{3}
	^{48}Sc	43.71 h	2.45×10^{3}
	^{49}Sc	57.18 min	6.23×10^{3}
	^{50}Sc	102.5 s	8.63×10^{2}
O (8)	^{8}Li	839.9 ms	2.15×10^{2}
	^{10}Be	1.51×10^{6} y	6.18×10^{-8}
	^{11}Be	13.76 s	1.30×10^{1}
	^{12}B	20.20 ms	1.33×10^{3}
	^{14}C	5700 y	3.58×10^{-4}
	^{15}C	2.449 s	2.40×10^{2}
	^{13}N	9.965 min	2.81×10^{2}
	^{16}N	7.13 s	4.91×10^{2}
Total	—	—	1.77×10^{4}

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