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MEASUREMENT OF RADIOACTIVITY INDUCED BY GeV-PROTONS AND SPALLATION NEUTRONS USING AGS ACCELERATOR

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Measurement of radioactivity induced by high-energy protons with energy of 2.83 and 24 GeV and spallation neutrons produced by bombarding a mercury target with the high-energy protons were performed by using the AGS (Alternative Gradient Synchrotron) accelerator at Brookhaven National Laboratory. The samples of boron, carbon, aluminum, iron, copper, niobium, mercury-oxide, lead, bismuth, acrylic resin, SS-316, Inconel-625 and Inconel-718 were irradiated around the mercury target. After the irradiation, the radioactivity of each sample was measured by using HPGe detectors at the cooling time between 2 h and 200 d. In the processing of the measured γ-ray spectra, more than 90 radioactive nucleus were identified, and the radioactivity production data were obtained. This report gives the experimental procedure, the data processing and the experimental results.

Keywords: Induced Radioactivity, High Energy Proton, Spallation Neutron, Mercury Target, AGS, Boron, Carbon, Aluminum, Iron, Copper, Niobium, Mercury-Oxide, Lead, Bismuth, Acrylic Resin, SS-316, Inconel-625, Inconel-718, HPGe detector

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* High Energy Accelerator Research Organization

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AGS 加速器を使った GeV 領域の陽子と核破砕中性子による誘導放射能の測定

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ブルックヘブン国立研究所の AGS (Alternative Gradient Synchrotron) 加速器を使って、2.83 GeV 及び 24 GeV の陽子、及びそれら陽子が水銀ターゲットに入射して発生する核破砕中性子による誘導放射能の測定実験を行った。ホウ素、炭素、アルミ、鉄、銅、ニオブ、酸化水銀、鉛、ビスマス、アクリル、SUS316、Inconel-625 及び Inconel-718 の試料を水銀ターゲットの周りで照射した。照射後、冷却時間 2 時間から 200 日において、それぞれの試料の放射能を HPGe 検出器で測定した。測定したガンマ線スペクトルから 90 以上の放射性核種を同定し、それらの放射能データを得た。このレポートは、これらの実験手順、データ処理及び測定結果をまとめたものである。

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1. Introduction

Projects for intense spallation neutron sources driven by GeV-protons are proceeding recently in the world aiming at breakthroughs in the fundamental researches of life science, material science, and so on. In Japan, the spallation neutron source driven by 3 GeV protons with the intensity of 1 MW are being constructed under the Japan Proton Accelerator Complex (J-PARC) Project conduced by Japan Atomic Energy Research Institute (JAERI) and High Energy Accelerator Research Organization (KEK) [1]. For design the facility, safety handling of the radioactive materials is an important issue. A large amount of radioactive nuclides are to be produced by bombardment of GeV-protons and associated secondary particles to various target and surrounding materials. In order to create the maintenance scenario of the facility, the proper estimation of the induced radioactivity is indispensable.

In JAERI, a code system employing NMTC/JAM [2], MCNP [3] and DCHAIN-SP [4,5] has been developed to evaluate the induced radioactivity under the environment related to high-energy protons and neutrons. The calculation begins with the simulation of the transport phenomena of protons and high-energy neutrons (>20 MeV) using NMTC/JAM, which also simulate the nuclide production by the transported particles. Subsequently, the transport calculation for low-energy neutrons was performed using MCNP. Finally, using those calculation results as input, DCHAIN-SP computes time-development of radioactive products.

The reliability of the code system was checked by the analysis of the activation experiment with 14 MeV neutrons.[6] However, the whole system including the high-energy-part calculation by NMTC/JAM have not been validated because there was no adequate experimental data. Therefore the experiment of induced radioactivity measurement was carried out using a mercury (Hg) target and the AGS (Alternating Gradient Synchrotron) accelerator at Brookhaven National Laboratory.[7]

The series of the experiments using AGS accelerator has been performed since 1997 under an international collaboration among laboratories in Japan, U.S. and Europe, namely ASTE (AGS Spallation Target Experiment) collaboration. The main purpose of the experiment is to obtain experimental data on neutronic performances of the Hg target assembly [8, 9] and on shielding design parameters and to validate predictions from theoretical calculations on neutronics and shielding. In the series of the experiment, the induced radioactivity measurement was conducted in January 2001.

In the experiment, the samples of born, carbon, aluminum, iron, copper, niobium, mercury-oxide, lead, bismuth, acrylic resin, SS-316, Inconel-625 and Inconel-718 were irradiated around the mercury target, and the radioactivity was measured at the cooling time from 2 hours to 200 days. In this report, the experimental procedure and the measured data are presented.

2 Experiment

2.1 Mercury Target

A schematic plan view of the accelerator complex of Brookhaven National Laboratory is shown in Fig.1. The mercury target and shielding blocks were set in the area of SEB for nuclear physics experiment. The shielding configuration around the Hg target is shown in Fig. 2. The shielding, which is constructed by steel and concrete blocks, was specially designed for this shielding experiment. The slots for installing the activation detectors in the shields were prepared to measure the attenuation length for the spallation neutrons.

The schematic view of the Hg target is shown in Fig. 3. Hg was contained in a cylindrical target container made of stainless steel with 2.5 mm in thickness. The dimension of the target container was 200 mm in inner diameter and 1300 mm in inner length. The target container had a hemisphere beam incident surface on its top end. The target container was placed in the secondary container made of stainless steel. The secondary container was fixed on a platform that went up and down by remote control for the positioning. (During the beam tuning, the platform was moved to the off-axis position of the proton beam to aviod unnecessary activation.)

2.2 Samples

The materials of born (separated isotopes of ^{10}B and ^{11}B), carbon, aluminum, iron, niobium, mercury-oxide, lead, bismuth, acrylic resin[1], SS-316, Inconel-625 and Inconel-718 were used as irradiated samples for this experiment. The specifications of the samples were tabulated in Table 1. The samples were bunched as shown in Fig. 4. The bunch of samples was set at the on-beam and off-beam position as shown in Fig. 3. The on-beam samples were irradiated with the incident protons and the spallation neutrons, and off-beam samples were irradiated only with the neutrons.

For the on-beam samples, copper foils were inserted at the several positions in the bunch in order to measure the number of protons bombarding individual samples by referring the $^{nat}Cu(p, x)^{24}Na$ reaction. For the off-beam samples, niobium foils were inserted similarly in order to check the neutron flux by using the $^{93}Nb(n, 2n)^{92m}Nb$ reaction. (The threshold energy of the $^{93}Nb(n, 2n)^{92m}Nb$ reaction is about 11 MeV.)

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[1] The acrylic resin samples were irradiated to investigate the production of ^{7}Be from oxygen; that can be deduced by subtracting the contribution of the $C(n,x)^{7}Be$ reaction from the total production rate by using the carbon data obtained in this work.

2.3 Irradiation

The following four irradiation shown as indicated below denoting incident proton energy, and time length of irradiation were conducted:

- 24 GeV, Short (24-S),
- 24 GeV, Long (24-L),
- 2.83 GeV, Short (2.83-S),
- 2.83 GeV, Long (2.83-L).

The parameters of the irradiation are summarized in Table 2. (The abbreviations like "24-S" are used after this.) The short-irradiated samples were used mainly for measurements of short-lived radioactivities with the half-life ($T_{1/2}$) less than a few days, and the long-irradiated samples were used for measurement of long-lived products with $T_{1/2}$ longer than 10 d.

2.4 Proton Beam Monitor

The total number of the incident protons was measured with an integrating current transformer (ICT), a separated electron-chamber (SEC), and the activation method using a copper foil.[10] The configuration of the proton beam monitors in front of the mercury target is schematically shown in Fig. 5.

As for the activation method, the reaction of Cu(p, x)^{24}Na was adopted as a reference. Figure 6 shows the experimental values and the eye-guided curve for the production cross section. The experimental data were taken from Michel et al.[11], etc. Based on the eye-guide curve, the cross section values of the Cu(p, x)^{24}Na reaction were evaluated to be 3.5 ± 0.5 and 3.5 ± 0.2 mb for the incident proton energies of 2.83 and 24 GeV, respectively.

The comparisons of the experimental results among the different techniques are shown in Fig. 7. The results were consistent among them within the uncertainties. In this work, we decide to take the values of ICT measurement.

The imaging plate (IP) technique was employed for monitoring the incident proton beam profile. The thin aluminum foil was exposed to the proton beam. After the irradiation and cooling, the aluminum foil was attached to an IP to obtain the image of the distribution of activities induced by the incident protons. The center and full width at a half maximum, which was obtained by fitting the projection of the IP image, is summarized in Table 3.

The incident protons bombarded partially the on-beam samples because the dimension of

the sample was smaller than that of the proton beam expansion profile. To derive the number of protons bombarding the individual foils, several copper foils were irradiated simultaneously by inserting them in the bunch of foils, which has already mentioned in Sec. 2.2. The number of protons obtained by the activation of individual copper foils was tabulated in Table 4.

2.5 Reference Reaction for the Spallation Neutron Flux

The neutron flux at the off-beam position was checked experimentally using the ^{93}Nb(n, 2n)^{92m}Nb reaction as the reference. Figure 8 shows the cross section curve of the ^{93}Nb(n, 2n)^{92m}Nb reaction and the calculated neutron spectra at the beam-off position. (The neutron spectrum was calculated using the NMTC/JAM and MNCP.) As shown in Fig. 8, the ^{93}Nb(n, 2n)^{92m}Nb reaction is sensitive for neutrons between 11 and 20 MeV.

The measured reaction rate of the ^{93}Nb(n, 2n)^{92m}Nb reactions for the beam-off samples are tabulated in Table 5 along with the calculated reaction rates. (The calculated values were obtained by multiplying the calculated neutron flux spectrum and the cross section curve.) The calculated reaction rates are consistent with the experimental data within the accuracy of ±30% in almost all cases.

2.6 Activity Measurement

After the each irradiation, the γ-rays of activated samples were measure with three HPGe detectors at cooling times of 0.1~260 days.

The specifications of the detectors were tabulated in Table. 6. In Fig. 9, the configuration of the HPGe detector and the samples are shown. In order to keep the detector-to-sample geometry rigidly, the samples were mounted on the acrylic spacer. The γ-ray detection efficiencies were calibrated at the "standard position" shown in Fig. 9.

2.7 Data Processing

(1) Deduction of Radioactivities

Radioactivity for each product was deduced using the following equation:

$$A = \frac{\lambda N}{\left(1 - e^{-\lambda T_m}\right)\varepsilon_f I_\gamma}, \tag{2.1}$$

where

N : Count of the full-energy-peak of γ-ray,

λ : Decay constant (λ=ln2/ $T_{1/2}$, $T_{1/2}$ is the half-life of the product.),

T_m : Measurement Time,

ε_f: Gamma-ray detection efficiency,

I_γ : Gamma-ray emission probability per disintegration.

The γ-ray emission probabilities taken from Table of Isotopes[10)] were used to deduce the activities. The used decay data are tabulated in Table 7.

Special care was paid for the following four cases because two radioactive isotopes decay to a same nuclide via β^+ and β^--decay with emission of identical γ-rays. The detailed procedures of the data process are described below.

^{198g}Tl (Half life: 5.3 h) and ^{198g}Au (2.70 d)

Since the γ-ray of 411.8 keV is emitted by the decay of ^{198m,g}Tl and ^{198g}Au, it was possible that the disintegration curve of 411.8 keV γ-ray has three components with different half-lives. In Fig. 10, the counting rates of 411.8 keV γ-ray for the bismuth sample of 24-L-On were plotted as a function of cooling time. The data could be fitted well to a function consisting of the two decay-component of ^{198g}Tl and ^{198g}Au. Using the fitting result, the radioactivity of each product was deduced. The 675.7 keV γ-ray of from ^{198g}Tl were also checked to validate the fitting results if it was available. (The 675.9 keV γ-ray is not emitted from ^{198m}Tl and ^{198g}Au.) The contribution of ^{198m}Tl (1.87 h) was assumed to be less than 1% because the γ-ray peak of 282.8 keV with the isomeric transition was not seen in the γ-ray spectra.

^{199}Tl (7.42 h) and ^{199}Au (3.139 d)

The γ-rays of 158.4 keV and 208.2 keV are emitted from ^{199}Au and ^{199}Tl. The radioactivity of ^{199}Au was deduced by subtracting the contribution of ^{199}Tl, whose activity was deduced using 455.5 keV γ-ray which is not emitted from ^{199}Au.

^{200}Tl (26.1 h) and ^{200m}Au (18.7 h)

The γ-ray of 367.9 keV is emitted with the decays from ^{200}Tl and ^{200m}Au to ^{200}Pb. In this work, the contribution of ^{200m}Au was assumed to be less than 1% since the 497.8 keV γ-ray from ^{200m}Au was not observed.

^{203}Hg (46.61 d) and ^{203}Pb (51.9 h)

The radioactive products of ^{203}Hg and ^{203}Pb emit the identical γ-ray of 279.2 keV. Since the half-lives of those are completely different, it was easy to separate the disintegration rate for the 279.2 keV γ-ray into the two components. In Fig. 11, the counting rates of 279.2 keV for the bismuth sample irradiated at the on-beam position (2.83-L-On) are plotted with cooling time, which gives corresponding decay curve. By using the fitting results, the data at the short cooling time (< 10 d) were processed by assuming that the contribution of the ^{203}Hg was negligibly small, and it is considered that the data at 65 days cooling corresponded to the radioactivity of ^{203}Hg.

(2) Gamma-ray Detection Efficiency

The point source calibration of the γ-ray efficiency was carried out using standard γ-ray sources of ^{22}Na, ^{51}Cr, ^{54}Mn, ^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{113}Sn, ^{137}Cs, ^{139}Ce and ^{241}Am. The coincidence summing effect was considered for the sources of ^{22}Na, ^{60}Co and ^{88}Y. The measured full-energy-peak efficiencies at each γ-ray-energy point were fitted to a equation with 6 fitting parameters as follows:

$$\varepsilon = \sum_{i=1}^{3} a_{2i-1} \exp(-a_{2i}E) + a_7 E^{-a_8}, \tag{2.2}$$

where ε is the efficiency, E is the γ-ray energy and a_i's (i=1~8) are the fitting parameters. The efficiency curve of the detector #1 and #2 is shown in Fig. 12. For deducing the activities properly, the efficiency was corrected by considering the following items:

- Coincidence summing effect for cascade γ-rays,
- Pile-up effect for random coincidence,
- Geometric effect of the samples,
- γ-ray self-attenuation in the samples.

The relation between the efficiency curve calibrated using the standard sources and the corrected one could be shown by

$$\varepsilon_f = \varepsilon_f^{\,0} C_1 C_2 C_3 C_4, \tag{2.3}$$

where ε_f is a corrected efficiency, ε_f^0 is the efficiency calibrated using the standard sources and C_i are correction factors for the i'th items. The procedure for estimating the correction factors was described below.

The correction factor for item (1) was estimated by considering the decay-scheme of radioactive product, total and full-energy-peak efficiencies. The total efficiency was measured with the standard γ-ray sources, and the measured points were fitted to a fitting

function with 4 fitting parameters. The detail of the estimation of the correction factors was presented in Ref. (12).

For the item (2), the count loss for pile-up of pulses was estimated by assuming that the fraction of the count loss for the total counts is approximately proportional to a dead time. The correction factor C_2 was estimated using

$$C_2 = 1 - aD, \tag{2.4}$$

where D is a dead time in percentage and a is the constant which was determined from the experiment, in which the counting rate of 1369 keV γ-rays of ^{24}Na was investigated by changing total counting rate using other kinds of γ-ray sources. In Fig. 13, the measured counting loss was plotted as a function of a dead time. The constant a was determined from the fitting result. In this work, almost all the measurement was done with dead time less than 3%, so the contribution of the correction is less than 3% in most cases.

As for the item (3), the deviation of the efficiency for the volume-source geometry from a point source was estimated using point-detector concept, in which the efficiency is proportional to the inverse-square of the distance between the γ-ray source and the effective center of the detector. The correction factor C_3 was deduced by

$$C_3 = \frac{l + d}{l + d + t}, \tag{2.5}$$

where l is the distance from the surface of the aluminum cap of the detector to the sample, d is the distance from the surface of the detector to the effective center of the detector, and t is the thickness of the sample. The detailed procedure for deducing the formula is shown in Ref. 12. The contribution of this correction was estimated to be less than 3%.

The correction factor of C_4 was estimated by

$$C_4 = \frac{1 - e^{-\mu\rho t}}{\mu\rho t}, \tag{2.6}$$

where μ is the mass attenuation coefficient of γ-rays for a sample in cm^2/g, ρ is the density of the sample in g/cm^3, and t is the thickness of the sample in cm. In this work, the contribution of this correction was relatively high for low energy γ-rays. In case of maximum, the correction factor was estimated to be 5~6 for a 122 keV γ-ray of ^{57}Co. In most cases, the contribution was estimated to be less than 5%.

(3) Error Estimation

Experimental errors of the measured radioactivity are attributed to statistics of γ-ray counts, accuracy of the γ-ray detection efficiency, including the error of the correction factor, and the γ-ray emission probabilities. Estimated experimental errors are summarized in Table 8.

3. Results

Numerical data of the measured radioactivity are tabulated in Table 9. The data were plotted in Figs 14~19 as a function of cooling time for the major products. In the figures, the decay curves were drawn for each product by fitting the experimental data to the following equation:

$$A = A_0 \exp(-\lambda t), \tag{3.1}$$

where A is an activity [Bq/g], λ(=ln $2/T_{1/2}$; $T_{1/2}$ is the half-life of a product) is a decay constant, t is a cooling time and A_0, which corresponds to the activity at t=0, is a fitting parameter. The decay constants were taken from the reference[13], and those values were fixed in the fitting procedure. When there is a relatively long-lived parent nucleus in comparison with the daughter, like ^{203}Pb ($T_{1/2}$=51.873 h) with the parent of ^{203}Bi (11.76 h), the following expression was used:

$$A_2 = A_2^0 e^{-\lambda_2 t} + \frac{\lambda_2}{\lambda_2 - \lambda_1} A_1^0 \left(e^{-\lambda_1 t} - e^{-\lambda_2 t}\right). \tag{3.2}$$

In the expression, A_2 is the activity of the daughter, λ_1 and λ_2 are the decay constants of the parent and daughter, respectively, and A_1^0 and A_2^0 are the fitting parameters. If the experimental data for the parent activities were available, the parameter of A_1^0 was determined using the fitting result for the decay of the parent nucleus.

In the followings, we make a note about major radioactive products for the samples of iron, copper, niobium, mercury-oxide, lead and bismuth.

3.1 Iron (Figs. 14.1~14.2)

The experimental data of the iron samples for 2.83-L-On and 2.83-L-Off are plotted in Fig. 14.1, and that for 24-S-On and 24-L-Off are shown in Fig. 14.2. The major radioactive nuclides are ^{52g}Mn (5.591 d) and ^{51}Cr (27.702 d) at the cooling time of 2~50 days and ^{54}Mn after 100 days. The data ^{44g}Sc (3.927 h) were fitted to the Eq. (3.2) by considering the contribution of ^{44m}Sc (2.44 d) that decays to ^{44g}Sc in isomeric transition (transition probability: 98.80%). The short-lived component of ^{44g}Sc is clearly seen in the experimental data of 24-S-On (Fig. 14.2).

3.2 Copper (Figs. 15)

The copper samples were irradiated only at the on-beam position. The experimental data of 2.83-L-On and 24-L-On are shown in Fig. 15. The major radioactive products are

^{44m}Sc (58.6 h) before 3 days cooling, and ^{51}Cr (27.702 d) and ^{58g}Co (70.82 d) after a few days cooling. After ~300 days, the radioactivity of ^{54}Mn (312.3 d) becomes dominant.

3.3 Niobium (Figs. 16.1~16.2)

The experimental data of the niobium foils for 2.83-L-On and 2.83-L-Off are plotted in Fig. 16.1, and those for 24-S-On and 24-L-Off are plotted in Fig. 16.2. The dominant activities at 2~50 days cooling are ^{92m}Nb (14.60 h), ^{89g}Zr (3.27 d) and ^{87g}Y (3.33 d). At the short cooling time (<1 day), the activities of ^{90g}Nb (14.60 h) and ^{87m}Y (13.37 h) are also relatively intense. The activities of ^{88}Zr (83.4 d) and ^{88}Y (106.65 d), which are related by a parent-daughter relation, are dominant after 100 days cooling,.

3.4 Mercury-Oxide (Figs. 17.1~17.2)

The experimental data of the mercury-oxide samples for the irradiation of 2.83-L and 24-L are plotted in Fig. 17.1 and 17.2, respectively. (The experimental data for 2.83-S and 24-S were not presented in this report because the intensity of the induced activities was not sufficient.) The major radioactive nuclides are ^{197m}Hg (23.8 h), ^{198g}Au (2.70 d), ^{199}Au (3.14 d) and ^{203}Hg (46.6 d). In addition, for the on-beam samples, the activities of ^{185}Os (93.6 d) and ^{182m}Re (12.7 h) are relatively intense. In the following, some important products that could not be measured in this experiment are as follows:

- The radioactivity of ^{199m}Hg (42.6 min) was not observed since the half-life is short and we had no chance to measure the irradiated samples within a-few-hours cooling.
- The γ-ray peak of 77.4 keV from ^{197g}Hg (64.14 h) could not be separated from the X-ray peaks of mercury and gold.[2]
- The activities without the γ-ray emission like ^{194}Hg (520 y) and ^{195g}Au (186.1 d) could not be measured.

3.5 Lead (Figs. 18.1~18.3)

The radioactivity of the lead samples for the irradiation of 2.83-L, 24-L and 24-S are shown in Figs. 18.1~18.3. (The data for 2.83-S were not adopted because the intensity of induced radioactivity was not sufficient.) The radioactive nuclides of ^{203}Pb (51.9 h), ^{201}Tl (72.9 h) and ^{200}Tl (26.1 h) are dominant at the cooling time shorter than 10 days. At

[2] In order to separate the low energy γ-ray peak from the X-ray peaks, we need to employ a low-energy-photon-spectrometer (LEPS), which is specially designed for the detection of the low-energy γ-rays by mounting a Be window.

10~100 days cooling, the activity of ^{202}Tl (12.23 d) is the most intense. At the cooling longer than 100 days, ^{185}Os (93.6 d) and ^{183}Re (70.0 d) are the dominant nuclides. In addition, as for on-beam samples, the activity of ^{7}Be largely contributes to the total radioactivity at cooling longer than 200 d.

3.6 Bismuth (Figs. 19.1~19.3)

The radioactivity of the bismuth samples for 2.83-L, 2.83-S, 24-L and 24-S in Figs. 19.1~19.3. (The irradiation of 2.83-L-On and 2.83-S-On was not conducted.)

The dominant nuclides are ^{204}Bi (11.22 h) and ^{203}Bi (11.76 h) at cooling less than 2 days. In the period of cooling of 2~100 days, the nuclides of ^{206}Bi (6.24 d) and ^{205}Bi (15.31 d) were dominant. After 100 days cooling, almost all activity is attributed to ^{207}Bi (31.55 y). In addition, for the on-beam samples, the radioactivity of ^{185}Os (93.6 d), ^{183}Re (70.0 d) and ^{7}Be (53.29 d) are relatively intense.

4. Summary

Radioactivity of the samples irradiated around the mercury target bombarded with the incident proton energies of 24 and 2.83 GeV using the AGS accelerator were measured in the cooling time from 0.1 to 260 days. In the processing of the measured γ-ray spectra, more than 90 radioactive nuclides were identified. The experimental data for the radioactivity were tabulated, and the decay curves for the major radioactive nuclides were shown in the figures. Finally the dominant radioactive nuclides were noted for iron, copper, niobium, mercury-oxide, lead and bismuth samples.

On the basis of these experimental data, we will validate the DCHAIN-SP code system that has been employed for design of radiation safety on the J-PARC project.

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Table 1 List of the character of the irradiated samples.

Material	Chemical Form	Weight [g]	Size[mm]	Thickness[mm]
Boron-10 (99.82%) [a]	B [b]	0.5	25×25 [c]	
Boron-11 (99.50%) [a]	B [b]	0.6	25×25 [c]	
Carbon	C	2.8	25×25	2.5
Aluminum	Al	1.1	20×20	1
Iron	Fe	3.1	20×20	1
Copper	Cu	1.1	25×25	0.2
		0.7	20×20	0.2
		1.0	30×19	0.2
		0.6	20 (Diameter)	0.2
Niobium	Nb	3.4	20×20	1
Mercury-Oxide	HgO [b]	$5\sim9\times10^{-3}$	24×24 [c]	
Lead	Pb	0.91	20×20	0.2
		14	20×20	3
Bismuth	Bi	6	20 (Diameter)	2
Acrylic Resin	$\{-CH_2-C(CH_3)(COOH)-\}_n$	2.2	25×25	3
SS-316		1.3	20 (Diameter)	0.5
Inconel-625		0.38	20×20	0.1
Inconel-718		2.3	30×19	0.5

[a] Separated isotopes. The atomic percent of the enriched isotope is shown in parentheses.
[b] Powder samples packed with plastic sheet.
[c] Size of the package

Table 2 Summary of the irradiation parameters.

Irradiation code [a]	24-L	24-S	2.83-L	2.83-S
Proton energy [GeV]	24	24	2.83	2.83
Irradiation time [hh:mm:ss]	01:59:59	00:00:45	06:24:30	00:07:31
Total number of the incident protons [b]	1.48E+15	7.90E+12	2.19E+15	2.33E+13

[a] "24" and "2.83" show the incident proton energy in GeV, and "L" or "S" mean long or short irradiation, respectively.
[b] The detail of the measurement was described in the section 2.4. The errors were estimated to be ±10%.

Table 3 Shift of the center and full width at a half maximum for proton beam profile obtained by the imaging plate technique.

Irradiation	Beam Center [a]		FWHM	
	x[mm]	y[mm]	Δx[mm]	Δy[mm]
2.83-L	+1	-14	39.8	19.0
2.83-S	+0	-13	39.8	19.1
24-L	-4	-10	26.8	27.9
24-S	-2	-10	27.7	28.9

[a] The origin of the coordinate axes was set at the center of the Hg target. See Fig. 3.

Table 4 Number of protons that bombard each Cu-sample at the on-beam position.

Irradiation Code [a]	Sample	Size[mm]	Number of incident protons	%Err
2.83-L	Cu--4	20 (Diameter)	1.49E+04	15%
2.83-L	Cu-508	20×20	2.25E+14	15%
2.83-L	Cu-8	25×25	4.76E+14	15%
2.83-S	Cu-3	20 (Diameter)	4.36E+12	15%
2.83-S	Cu-503	20×20	6.22E+12	15%
2.83-S	Cu-1	30×19	6.41E+12	15%
2.83-S	Cu-7	25×25	7.30E+12	15%
24-L	Cu-6	20 (Diameter)	4.10E+14	6%
24-L	Cu-509	20×20	5.37E+14	6%
24-L	Cu-2	30×19	7.03E+14	6%
24-L	Cu-10	25×25	7.09E+14	6%
24-S	Cu-5	20 (Diameter)	2.66E+12	6%
24-S	Cu-506	20×20	3.54E+12	6%
24-S	Cu-9	25×25	4.75E+12	6%

[a] "24" and "2.83" show the incident proton energy in GeV, and "L" or "S" mean long or short irradiation, respectively.

Table 5 ^{93}Nb(n, 2n)^{92m}Nb reaction rate measured using the niobium samples at the off-beam position.

Irradiation Code [a]	Sample [b]	Reaction Rate[/target nucleus/proton] Experiment	%Err	Calculation [c]
2.83-L	Nb-10	3.24E-28	3.4%	3.2E-28
2.83-L	Nb-148	2.93E-28	3.1%	
2.83-L	Nb-9	2.96E-28	3.4%	
2.83-L	Nb-8	2.72E-28	3.4%	
2.83-S	Nb-7	4.78E-28	13%	
2.83-S	Nb-9	4.33E-28	15%	
2.83-S	Nb-8	3.32E-28	17%	
24-L	Nb-16	1.62E-27	3.3%	1.3E-27
24-L	Nb-4	1.33E-27	3.2%	
24-L	Nb-15	1.28E-27	3.5%	
24-L	Nb-14	1.24E-27	3.5%	
24-S	Nb-13	8.70E-27 [d]	4.2%	
24-S	Nb-11	6.97E-27 [d]	4.4%	

[a] "24" and "2.83" show the incident proton energy in GeV, and "L" or "S" mean long or short irradiation, respectively.

[b] The size of the Nb-foil is 20 mm × 20 mm and 1 mm in thickness.

[c] The values were obtained by multiplying the calculated neutron spectrum and the cross section curve.

[d] The experimental value is larger than the calculated value by a factor of 5~6 possibly due to the placement of the 24-S-Off samples at a wrong position.

Table 6 Specification of HPGe detectors.

Name	Efficiency [a]	FWHM[keV] [b]
JAERI-#1	55%	2.25
JAERI-#2	62%	2.30
KEK-#1	20%	1.84

[a] Relative to an efficiency of a 3-inch × 3-inch NaI(Tl) detector.

[b] Full width at half maximum for a 1332-keV γ-ray peak of ^{60}Co.

Table 7 Identified radioactive products and the associated decay data[a].

Product (←Parent)[b]	Half-life	Energy [keV]	Intensity per decay
^{7}Be	53.29 d	477.6	10.52(6)%
^{22}Na	2.6019 y	1274.5	99.944(14)%
^{24}Na	14.9590 h	1368.6	100.0%
^{42}K	12.360 h	1524.7	18.08(9)
^{43}K	22.3 h	617.5	79.2(6)
^{44m}Sc	58.6 h	271.1	86.8(3)
^{44g}Sc(←^{44m}Sc)	3.927 h	1157.0	99.9%
^{46g}Sc	83.79 d	889.3	99.9840(10)%
^{48}V	15.9735 d	983.5	99.98(28)%
^{48}Cr	21.56 h	308.3	100(2)%
^{51}Cr	27.702 d	320.8	9.86(5)%
^{52g}Mn	5.591 d	1434.1	100.0(6)%
^{54}Mn	312.3 d	834.8	99.9760(10)%
^{56}Mn	2.5785 h	846.8	98.9(3)%
^{52}Fe	8.275 h	168.7	99.18(28)%
^{59}Fe	44.503 d	1099.3	56.5(18)%
^{55}Co	17.53 h	931.3	75(5)%
^{56}Co	77.27 d	846.8	99.935(25)%
^{57}Co	271.79 d	122.1	85.60(17)%
^{58g}Co	70.82 d	810.8	94.48(8)%
^{60g}Co	5.2714 y	1173.2	99.9736(7)%
^{56}Ni	6.077 d	158.4	98.8(10)%
^{57}Ni	271.79 d	1377.6	81.7(24)%
^{67}Cu	2.58 d	184.6	48.7(3)%
^{65}Zn	244.26 d	1115.5	50.60(24)%
^{67}Ga	3.2612 d	184.6	21.2(3)%
^{69}Ge	1.63 d	1107.0	36(4)%
^{71}As	2.72 d	175.0	82.0(20)%
^{74}As	17.77 d	595.8	59.4(35)%
^{76}As	1.0788 d	657.0	6.2(4)%
^{75}Se	119.779 d	264.7	58.5(9)%
^{76g}Br	16.2 h	559.1	74(2)%
^{77g}Br	2.38 d	239.0	23.1(5)%
^{82g}Br	1.47 d	776.5	83.5(12)%
^{79g}Kr	1.46 d	261.4	12.7(4)%
^{83}Rb	86.2 d	520.4	45(3)%
^{84}Rb	32.77 d	881.6	69.1(16)%
^{86g}Rb	18.631 d	1076.6	8.64(4)%
^{83g}Sr	1.35 d	762.7	30(14)%
^{85g}Sr	64.84 d	514.0	96(4)%
^{87g}Y	3.33 d	484.8	89.7(6)%
^{87m}Y	13.37 h	380.8	78.05(8)%
^{88}Y(←^{88}Zr)	106.65 d	1836.1	99.2(3)%
^{86}Zr	16.5 h	242.8	95.84(20)%
^{88}Zr	83.4 d	392.9	100.0%
^{89g}Zr	3.27 d	909.0	99.871(3)%
^{95}Zr	64.02 d	756.8	54.46(10)%

a) Taken from Ref. (13).

b) A parent nucleus whose half-life is relatively long in comparison with the daughter is shown in parenthesis.

Product (←Parent Nucleus)	Half-life [keV]	Energy	Intensity per decay
^{90g}Nb	14.60 h	1129.2	92.7(5)%
^{91m}Nb	60.86 d	104.6	0.54(3)%
^{92m}Nb	10.15 d	934.5	99.07(4)%
^{95g}Nb (←^{95m}Nb ←^{95}Zr)	34.975 d	765.8	99.8(3)%
^{95m}Nb	86.6 h	235.7	24.9(8)%
^{103}Ru	39.26 d	497.1	90.9(10)%
^{110m}Ag	249.79 d	657.8	94.0(5)%
^{127g}Xe	36.4 d	202.9	68.3(5)%
^{139}Ce	137.640 d	165.9	79.8986(14)%
^{143}Pm	265 d	742.0	38.5(24)%
^{144}Pm	363 d	696.5	99.49(20)%
^{146}Eu(←^{146}Gd)	4.59 d	747.2	98.33(6)%
^{147}Eu	24.1 d	197.3	26.5(11)%
^{146}Gd	48.27 d	154.6	46.6(5)%
^{172g}Lu (←^{172}Hf)	6.70 d	1093.7	62.5(28)%
^{173}Lu	1.37 y	272.1	21.2(8)%
^{172}Hf	1.87 y	125.8	11.3(9)%
^{175}Hf	70 d	343.8	84(3)%
^{182m}Re(←^{182}Os)	12.7 h	1121.3	31.8(16)%
^{183}Re	70.0 d	162.3	23.3(7)%
^{182}Os	22.10 h	180.2	33.5(17)%
^{183g}Os	13.0 h	381.8	89.6(18)%
^{183m}Os	9.9 h	1101.9	49.0(13)%
^{185}Os	93.6 d	646.1	78(3)%
^{188}Pt	10.2 d	187.6	19.4(12)%
^{198g}Au(←^{198m}Au)	2.69517 d	411.8[c]	95.58(12)%
^{198m}Au	2.27 d	214.8	77.0(10)%
^{199}Au	3.139 d	158.4[d]	40.0(7)%
^{200m}Au	18.7 h	367.9	73(8)%
^{197m}Hg	23.8 h	134.0	33.50(40)%
^{203}Hg	46.612 d	279.2[e]	81.46(13)%
^{198g}Tl	5.3 h	411.8[f]	82(10)%
^{199}Tl	7.42 h	455.5	12.4(13)%
^{200}Tl	26.1 h	367.9	87.2(4)%
^{201}Tl	72.912 h	167.4	10.00(6)%
^{202}Tl	12.23 d	439.6	91.4(10)%
^{200}Pb	21.5 h	147.6	37.6(13)%
^{201}Pb	9.33 h	331.2	79(7)%
^{203}Pb(←^{203}Bi)	51.873 h	279.2[e]	81(12)%
^{203}Bi	11.76 h	820.3	29.6(15)%
^{204}Bi	11.22 h	899.2	99%
^{205}Bi	15.31 d	703.4	31.10(10)%
^{206}Bi	6.243 d	803.1	98.90%
^{207}Bi	31.55 y	1063.7[g]	74.5(2)%
^{206}Po	8.8 d	1032.3	33(4)%

c) The contribution of ^{198g}Tl was considered.

d) The contribution of ^{199}Tl was considered.

e) The 279 keV γ-ray peak are contributed by the decay of ^{203}Hg and ^{203}Pb. The long-lived component was considered to be that of ^{203}Hg. The activity of ^{203}Pb was deduced by subtracting the contribution of ^{203}Hg.

f) The γ-ray of 675.9 keV (I_γ=10.9±1.0%), which is not emitted from ^{198g}Au, were also processed.

g) The γ-ray peak of 1063.7 keV was processed instead of the most intense γ-ray of 569.7 keV because the γ-ray peak of 569.7 keV is a doublet at the cooling time of ~60 days.

Table 8 Estimated experimental errors in the radioactivity measurement.

Source of error	Error	
Statistics	< 60%	
Efficiency of the detectors	3%	
Efficiency curve for a point source	3%	
Correction		
Cascade coincidence sum	< 1%:	for ^{198m}Au
Random coincidence sum	< 1%:	for 20% dead time
Source geometry	< 0.5%:	for samples with 3 mm thickness
Self-attenuation	< 4%:	for 122 keV gamma-ray
Decay Data		
Gamma-ray Intensity	< 13%:	for ^{206}Po

Table 9.1 Format of the digital radioactivity data.

<<Table format>>

a) On-beam samples

Code [a]:	HgO-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) [b]:	2.19E+15
Irradiation time:	06'24"30
Sample:	HgO-2
Weight:	0.0059 g
Size:	24 mm×24 mm [c]
Position:	On-beam
N_p(Partial) [d]:	4.76E+14

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
59.91	1.35E+02	39%
63.30	1.11E+02	31%
262.67	3.33E+01	32%

. . . . . .

[a] The code is composed by symbols showing the sample, incident proton energy, irradiation time and sample position. The incident proton energy is shown in GeV. The irradiation time is shown by "L" and "S" that means "long" and "short", respectively, and the sample position is shown by "On" and "Off".

[b] Total number of the incident protons bombarded with the mercury target

[c] The sample thickness is shown as "2 mm^{t}". The diameter of the disk sample is shown as "20 mm$^{\phi}$".

[d] Number of the incident protons partially bombarded with the sample, which is measured with the activation of copper foils.

b) Off-beam samples

Code:	HgO-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	HgO-6
Weight:	0.0066 g
Size:	24 mm×24 mm
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m} [e]:	2.93~3.24E-28

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
2.49	5.28E+02	10%
3.53	5.52E+02	13%
3.99	4.01E+02	7.7%

. . . . . .

[e] Reaction rate of the ^{93}Nb(n,2n)^{92m}Nb reaction, [/target nucleus/proton], at the sample position

Table 9.2 Digital radioactivity data for the Boron-10 samples.

Code:	B10-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	B10-1
Weight:	0.451 g
Size:	25 mm×25 mm
Position:	On-beam
N_p(Partial) :	4.76E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.50	8.42E+03	5.2%

Code:	B10-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	B10-3
Weight:	0.574 g
Size:	25 mm×25 mm
Position:	On-beam
N_p(Partial) :	7.09E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.09	1.43E+04	5.3%

Code:	B10-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	B10-2
Weight:	0.503 g
Size:	25 mm×25 mm
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m} :	2.93~3.24E-28

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.52	1.87E+02	11%
4.72	1.37E+02	6.3%

Code:	B10-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	B10-4
Weight:	0.506g
Size:	25 mm×25 mm
Position:	On-beam
Reac. Rate of ^{93}Nb(n,2n)^{m}:	1.33~1.62E-27

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.20	6.10E+02	7.9%
4.13	4.93E+02	5.8%
58.97	2.50E+02	5.3%

Table 9.3 Digital radioactivity data for the Boron-11 samples.

Code:	B11-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	B11-1
Weight:	0.579 g
Size:	25 mm×25 mm
Position:	On-beam
N_p(Partial) :	4.76E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.55	4.53E+03	5.3%

Code:	B11-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	B11-3
Weight:	0.615 g
Size:	25 mm×25 mm
Position:	On-beam
N_p(Partial) :	7.09E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.10	7.94E+03	5.2%

Code:	B11-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	B11-2
Weight:	0.559 g
Size:	25 mm×25 mm
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m} :	2.93~3.24E-28

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.57	7.98E+01	24%
61.75	3.52E+01	12%

Code:	B11-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	B11-4
Weight:	0.689g
Size:	25 mm×25 mm
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^{m}:	1.28~1.33E-27

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
0.96	2.86E+02	6.0%

Table 9.4 Digital radioactivity data for the graphite samples.

Code:	C-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	C-2
Weight:	2.76 g
Size:	25 mm×25 mm, 2.5 mm^t
Position:	On-beam
N_p(Partial) :	4.76E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.48	7.61E+03	5.1%

Code:	C-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	C-4
Weight:	2.81 g
Size:	25 mm×25 mm, 2.5 mm^t
Position:	On-beam
N_p(Partial) :	7.09E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
0.912	1.32E+04	5.1%
1.09	1.27E+04	5.1%

Code:	C-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	C-1
Weight:	2.80 g
Size:	25 mm×25 mm, 2.5 mm^t
Position:	On-beam
N_p(Partial) :	7.30E+12

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
0.177	1.09E+02	13%

Code:	C-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	C-3
Weight:	2.78g
Size:	25 mm×25 mm, 2.5 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m:	1.33~1.62E-27

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.19	5.32E+02	5.5%

Table 9.5 Digital radioactivity data for the aluminum samples.

Code:	Al-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Al-171
Weight:	1.07 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
60.86	1.31E+03	5.1%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	1.22E+04	5.0%

Code:	Al-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	Al-170
Weight:	1.05 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	6.22E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.185	7.11E+03	5.1%
0.497	5.05E+03	5.1%

Code:	Al-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Al-175
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m :	2.96~2.93E-28

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
60.86	7.296E+00	16%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
1.48	1.00E+04	5.1%
4.54	3.06E+02	5.5%

Code:	Al-2.83-S-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	Al-174
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m :	4.33~4.78E-28

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.330	4.24E+02	5.5%

Table 9.5 Digital radioactivity data for the aluminum samples. (Continued)

Code:	Al-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Al-173
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
4.07	4.72E+03	5.6%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
4.07	1.47E+04	5.0%

Code:	Al-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Al-172
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	3.54E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.105	8.65E+03	5.2%
0.723	4.58E+03	5.2%

Code:	Al-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Al-177
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m :	1.28~1.33E-27

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
58.07	1.63E+01	15%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
58.07	2.38E+01	5.7%

Code:	Al-24-S-Off
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Al-176
Weight:	1.06 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m :	6.97~8.70E-27

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.152	1.01E+03	5.5%

Table 9.6 Digital radioactivity data for the iron samples.

Code:	Fe-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Fe-91
Weight:	3.11 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
4.51	1.82E+03	15%
6.63	1.30E+03	21%
60.67	6.78E+02	5.1%
263.50	4.85E+01	6.9%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
263.50	1.77E+01	5.1%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	8.82E+02	6.9%
4.51	2.49E+02	11%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	6.77E+02	8.7%
4.51	3.74E+02	11%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	7.59E+03	5.1%
4.51	5.57E+03	5.1%
6.63	3.06E+03	5.2%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	7.69E+03	8.7%
4.51	5.68E+03	11%
6.63	3.19E+03	5.3%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.49	7.97E+02	8.0%
4.51	7.28E+02	7.3%
6.63	7.62E+02	7.5%
263.50	8.52E+01	5.0%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
3.49	3.30E+03	5.3%
4.51	2.68E+03	5.3%
6.63	1.70E+03	5.6%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.49	7.74E+02	8.4%
4.51	4.94E+02	9.2%
6.63	2.00E+02	19%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.49	1.17E+04	5.9%
4.51	1.10E+04	5.8%
6.63	1.05E+04	6.1%
60.67	2.60E+03	5.0%
263.50	1.59E+01	12%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.49	1.02E+04	5.1%
4.51	8.99E+03	5.1%
6.63	6.92E+03	5.2%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
3.49	1.80E+03	5.8%
4.51	1.83E+03	5.5%
6.63	1.79E+03	5.7%
60.67	1.60E+03	5.0%
263.50	9.89E+02	5.0%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Fe-95
Weight:	3.10 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	2.93~2.96E-28

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.66	5.67E+01	5.8%
4.57	4.28E+01	7.0%
6.67	2.45E+01	11%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.66	5.54E+01	6.0%
4.57	4.18E+01	8.5%
6.67	2.36E+01	14%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.66	1.15E+01	15%
4.57	1.07E+01	20%
6.67	1.26E+01	22%
266.68	1.25E+00	5.6%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
3.66	5.23E+01	6.1%
4.57	4.04E+01	8.0%
6.67	2.81E+01	11%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.66	8.86E+00	18%
4.57	1.28E+01	19%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.66	4.15E+02	6.0%
4.57	4.17E+02	7.1%
6.67	3.57E+02	10%
59.71	1.06E+02	5.3%
266.68	7.95E-01	29%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.66	3.94E+02	5.1%
4.57	3.47E+02	5.3%
6.67	2.68E+02	5.7%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
3.66	1.28E+02	5.2%
4.57	1.22E+02	5.8%
6.67	1.24E+02	6.5%
59.71	1.18E+02	5.0%
266.68	7.50E+01	5.0%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	Fe-17
Weight:	3.10 g
Size:	20 mm×20 mm, 1mm^t
Position:	On-beam
N_p(Partial) :	6.22E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.123	5.05E+02	5.8%
0.406	4.15E+02	5.3%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.123	5.96E+02	11%
0.406	4.37E+02	7.6%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.123	1.31E+02	14%
0.406	1.13E+02	8.3%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.123	2.64E+03	5.1%
0.406	1.02E+03	5.1%

Product: ^{52}Fe, Half-life: 8.275 h

Cooling [d]	Activity [Bq/g]	%Error
0.123	1.07E+02	13%
0.406	6.54E+01	9.8%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-24-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Fe-93
Weight:	3.11 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
50.54	1.40E+03	5.2%
260.56	9.68E+01	6.0%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
50.54	3.84E+01	5.7%
260.56	2.93E+01	5.1%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
50.54	9.76E+02	5.0%
260.56	1.60E+02	5.0%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.54	6.23E+03	5.0%
260.56	4.33E+01	8.4%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.54	3.39E+03	5.0%
260.56	1.96E+03	5.0%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Fe-100
Weight:	3.10 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	1.28~1.33E-27

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	3.34E+01	10%
2.22	7.55E+00	55%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	2.33E+02	8.6%
2.22	5.12E+01	29%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	1.18E+02	6.7%
2.22	5.13E+01	17%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	1.18E+02	6.7%
2.22	5.13E+01	17%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	4.32E+02	5.2%
2.22	3.09E+02	5.5%
3.83	2.08E+02	5.9%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	5.04E+02	5.2%
2.22	3.23E+02	5.8%
3.83	2.04E+02	6.8%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	4.08E+01	13%
2.22	3.45E+01	21%
56.56	2.62E+01	5.2%
263.6	4.26E+00	6.0%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	3.13E+02	5.3%
2.22	2.49E+02	6.0%
3.83	1.87E+02	6.2%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	1.02E+02	7.0%
2.22	8.23E+01	9.3%
3.83	5.60E+01	14%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	1.62E+03	5.7%
2.22	1.50E+03	6.6%
3.83	1.46E+03	6.4%
56.56	4.02E+02	5.2%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	1.95E+03	5.1%
2.22	1.64E+03	5.1%
3.83	1.32E+03	5.2%
56.56	2.11E+00	8.5%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	4.47E+02	5.2%
2.22	4.35E+02	5.4%
3.83	4.49E+02	5.5%
56.56	4.16E+02	5.0%
263.6	2.56E+02	5.0%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Fe-92
Weight:	3.09 g
Size:	20 mm×20 mm, 1mm^t
Position:	On-beam
N_p(Partial) :	3.54E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.099	3.67E+02	13%
0.727	1.85E+02	6.0%
2.17	3.98E+01	7.4%
4.15	2.68E+00	48%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.727	2.03E+02	10%
2.17	2.16E+01	24%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.727	6.39E+01	10%
2.17	2.18E+01	14%
4.15	4.21E+00	60%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.727	1.64E+02	6.4%
2.17	1.01E+02	5.6%
4.15	6.16E+01	7.0%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.099	1.81E+03	6.3%
0.727	3.16E+02	5.6%
2.17	1.08E+02	6.0%
4.15	5.42E+01	8.7%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
0.727	6.28E+01	12%
2.17	4.99E+01	6.9%
4.15	3.50E+01	8.6%

Product: ^{48}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
0.727	3.38E+01	20%
2.17	1.43E+01	15%
4.15	9.12E+00	32%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
2.17	1.35E+02	13%
4.15	1.48E+02	14%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
0.099	7.41E+02	9.2%
0.73	2.20E+02	5.9%
2.17	1.41E+02	5.7%
4.15	1.13E+02	6.6%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
0.727	2.77E+01	16%
2.17	2.99E+01	9.0%
4.15	2.49E+01	12%

Product: ^{52}Fe, Half-life: 8.275 h

Cooling [d]	Activity [Bq/g]	%Error
0.099	6.01E+01	53%
0.727	3.38E+01	15%

Table 9.6 Digital radioactivity data for the iron samples. (Continued)

Code:	Fe-24-S-Off
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Fe-96
Weight:	3.08 g
Size:	20 mm×20 mm, 1mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	6.97~8.70E-27

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.658	3.69E+00	25%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.126	4.02E+01	9.3%
0.658	7.06E+00	17%

Table 9.7 Digital radioactivity data for the copper samples.

Code:	Cu-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Cu-508
Weight:	0.680 g
Size:	20 mm×20 mm, 0.2mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
4.51	1.23E+03	20%
6.64	1.29E+03	17%
60.52	6.10E+02	5.7%
263.50	3.39E+01	16%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
263.50	1.10E+01	6.7%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	1.81E+04	5.2%
3.52	5.06E+02	7.3%
4.51	1.63E+02	15%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	1.96E+04	6.6%
3.52	3.73E+02	26%

Product: ^{43}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	6.26E+03	6.3%
3.52	6.42E+02	9.1%
4.51	2.86E+02	13%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	1.11E+04	5.3%
3.52	4.39E+03	5.2%
4.51	3.29E+03	5.2%
6.64	1.79E+03	5.4%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	2.61E+04	5.1%
3.52	4.40E+03	5.2%
4.51	3.25E+03	5.5%
6.64	1.86E+03	5.6%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.52	5.00E+02	9.6%
4.51	4.96E+02	8.7%
6.64	4.22E+02	8.5%
263.50	5.38E+01	5.3%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
0.44	4.39E+03	6.6%
3.52	2.17E+03	5.6%
4.51	1.85E+03	5.6%
6.64	1.19E+03	5.8%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	1.99E+03	9.7%
3.52	5.56E+02	9.5%
4.51	4.06E+02	9.3%
6.64	2.43E+02	12%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.52	3.80E+03	9.4%
4.51	3.70E+03	8.5%
6.64	3.45E+03	8.5%
60.52	8.85E+02	5.3%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.52	4.20E+03	5.3%
4.51	3.75E+03	5.3%
6.64	2.94E+03	5.3%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
4.51	3.41E+02	9.9%
6.64	3.43E+02	9.9%
60.52	3.00E+02	5.1%
263.50	1.94E+02	5.1%

Product: ^{59}Fe, Half-life: 44.503 d

Cooling [d]	Activity [Bq/g]	%Error
3.52	3.75E+02	16%
4.51	3.55E+02	20%
6.64	3.61E+02	16%
263.50	5.31E+00	15%

Table 9.7 Digital radioactivity data for the copper samples. (Continued)

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	5.40E+03	8.3%
3.52	2.71E+02	20%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
60.52	3.19E+02	5.1%
263.50	5.16E+01	5.4%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.52	4.82E+02	7.4%
4.51	4.56E+02	7.7%
6.64	4.70E+02	7.1%
60.52	4.21E+02	5.0%
263.50	2.77E+02	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
0.44	2.27E+03	8.4%
3.52	2.66E+03	5.4%
4.51	2.67E+03	5.3%
6.64	2.62E+03	5.3%
60.52	1.55E+03	5.0%
263.50	2.18E+02	5.0%

Product: ^{60}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
263.50	5.27E+01	5.3%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.44	2.52E+03	8.9%
3.52	4.94E+02	8.4%
4.51	3.46E+02	9.2%
6.64	1.24E+02	17%

Table 9.7 Digital radioactivity data for the copper samples. (Continued)

Code:	Cu-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	Cu-1
Weight:	1.077 g
Size:	30 mm×19 mm, 0.2mm^t
Position:	On-beam
N_p(Partial) :	6.41E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.219	3.04E+02	5.9%
0.504	2.40E+02	5.8%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.219	3.92E+02	10%
0.504	2.55E+02	9.4%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.219	1.02E+02	11%
0.504	8.34E+01	9.0%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.219	1.63E+02	10%
0.504	1.48E+02	8.4%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.219	8.33E+02	5.4%
0.504	3.52E+02	5.7%

Table 9.7 Digital radioactivity data for the copper samples. (Continued)

Code:	Cu-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Cu-509
Weight:	0.690 g
Size:	20 mm×20 mm, 0.2mm^t
Position:	On-beam
N_p(Partial) :	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	3.08E+03	9.3%
55.54	1.60E+03	5.7%
57.73	1.48E+03	5.7%
260.56	1.07E+03	8.8%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.54	3.00E+01	8.7%
57.73	3.18E+01	8.8%
260.56	2.20E+01	6.1%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
4.10	7.12E+02	6.4%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
4.10	6.89E+03	5.1%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	7.75E+02	6.6%
55.54	5.38E+02	5.1%
57.73	5.13E+02	5.1%
260.56	9.81E+01	5.2%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	7.01E+03	6.5%
55.54	1.97E+03	5.4%
57.73	1.92E+03	5.3%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	7.76E+03	5.1%
55.54	1.45E+01	14%
57.73	1.44E+01	14%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	7.35E+02	6.9%
55.54	6.72E+02	5.1%
57.73	6.66E+02	5.1%
260.56	4.15E+02	5.0%

Product: ^{59}Fe, Half-life: 44.503 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	8.03E+02	9.3%
55.54	3.46E+02	6.3%
57.73	3.39E+02	6.6%
260.56	1.68E+01	11%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.54	7.57E+02	5.1%
57.73	7.36E+02	5.1%
260.56	1.15E+02	5.2%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	1.12E+03	5.6%
55.54	1.04E+03	5.0%
57.73	1.03E+03	5.0%
260.56	6.39E+02	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
4.10	6.37E+03	5.1%
55.54	4.02E+03	5.0%
57.73	3.92E+03	5.0%
260.56	5.31E+02	5.0%

Product: ^{60}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
55.54	1.31E+02	5.5%
57.73	1.27E+02	5.8%
260.56	1.24E+02	5.1%

Table 9.7 Digital radioactivity data for the copper samples. (Continued)

Code:	Cu-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Cu-506
Weight:	0.685 g
Size:	20 mm×20 mm, 0.2mm^t
Position:	On-beam
N_p(Partial) :	3.54E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	1.28E+02	6.2%
1.64	4.98E+01	7.1%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	1.47E+02	9.5%
1.64	3.85E+01	16%

Product: ^{43}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	4.64E+01	13%
1.64	2.48E+01	11%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	9.17E+01	8.1%
1.64	6.88E+01	6.5%
4.17	4.39E+01	10%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	1.34E+02	6.7%
1.64	7.39E+01	6.7%
4.17	3.59E+01	15%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
0.922	3.80E+01	19%
1.64	3.44E+01	9.5%
4.17	1.66E+01	23%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	1.74E+01	23%
1.64	1.18E+01	19%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
0.922	6.91E+01	8.3%
1.64	5.42E+01	7.5%
4.17	5.30E+01	13%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	4.37E+01	14%
1.64	2.00E+01	14%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.922	3.02E+01	13%
1.64	1.72E+01	11%

Table 9.8 Digital radioactivity data for the niobium samples.

Code:	Nb-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Nb-2
Weight:	0.325 g
Size:	20 mm×20 mm, 0.1 mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.06E+03	25%
4.52	2.00E+03	30%
6.65	1.59E+03	28%
60.67	9.11E+02	7.2%
63.30	8.56E+02	5.5%
263.50	5.52E+01	24%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
60.67	1.03E+01	32%
63.30	6.61E+00	24%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.25E+02	23%
4.52	7.80E+01	37%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.83E+03	8.4%
4.52	1.37E+03	8.4%
6.65	7.92E+03	10%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.60E+03	7.7%
4.52	1.24E+03	7.2%
6.65	7.06E+02	7.4%

Product: ^{46}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
6.65	2.37E+02	14%
60.67	1.36E+02	6.2%
63.30	1.45E+02	5.2%
263.50	3.01E+01	8.1%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.09E+03	13%
4.52	8.29E+02	13%
6.65	4.97E+02	15%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	2.90E+02	29%
4.52	2.07E+02	31%
6.65	1.49E+02	27%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
6.65	1.02E+03	6.9%
60.67	9.37E+01	7.1%
63.30	7.85E+01	5.5%

Product: ^{51}Cr, Half-life: 27.70 d

Cooling [d]	Activity [Bq/g]	%Error
60.67	3.13E+02	13%
63.30	2.95E+02	7.0%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.61E+03	7.7%
4.52	1.49E+03	6.8%
6.65	1.09E+03	7.0%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
60.67	1.20E+02	6.9%
63.30	1.20E+02	5.3%
263.50	7.04E+01	5.9%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
60.67	9.70E+01	7.3%
63.30	9.40E+01	5.5%
263.50	1.74E+01	11%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
60.67	2.54E+02	5.3%
63.30	2.46E+02	5.1%
263.50	1.20E+02	5.2%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
4.52	6.92E+02	12%
6.65	6.36E+02	9.3%
60.67	3.75E+02	5.2%
63.30	3.70E+02	5.0%
263.50	5.35E+01	6.0%

Product: ^{60g}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
63.30	7.05E+00	21%
263.50	9.93E+00	17%

Product: ^{67}Cu, Half-life: 2.58 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	4.00E+03	7.7%
4.52	3.32E+03	7.0%
6.65	2.13E+03	7.8%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.23E+02	40%
4.52	2.94E+02	27%
6.65	3.39E+02	16%
60.67	2.37E+02	6.4%
63.30	2.43E+02	5.2%
263.50	1.44E+02	5.9%

Product: ^{67}Ga, Half-life: 3.2612 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	9.20E+03	7.8%
4.52	7.64E+03	7.1%
6.65	4.89E+03	7.9%

Product: ^{69}Ge, Half-life: 1.63 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	5.83E+03	13%
4.52	3.82E+03	13%
6.65	1.51E+03	14%

Product: ^{71}As, Half-life: 2.72 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	8.68E+03	5.9%
4.52	6.55E+03	5.9%
6.65	3.91E+03	6.0%

Product: ^{74}As, Half-life: 17.77 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.27E+03	18%
4.52	1.16E+03	13%
6.65	9.35E+02	13%
60.67	1.20E+02	11%
63.30	9.75E+01	8.4%

Product: ^{76}As, Half-life: 1.0788 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	8.51E+03	21%
4.52	2.98E+03	43%

Product: ^{75}Se, Half-life: 119.78 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	8.39E+02	20%
4.52	8.54E+02	15%
6.65	7.76E+02	12%
60.67	6.25E+02	5.3%
63.30	6.14E+02	5.1%
263.50	1.94E+02	5.3%

Product: ^{76g}Br, Half-life: 16.2 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.24E+03	7.7%
4.52	1.25E+03	10%
6.65	1.67E+02	34%

Product: ^{77g}Br, Half-life: 2.38 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.20E+04	6.5%
4.52	8.77E+03	6.7%
6.65	5.18E+03	7.4%

Product: ^{82g}Br, Half-life: 2.38 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.52E+03	7.6%
4.52	1.57E+03	9.2%
6.65	7.30E+02	13%

Product: ^{79g}Kr, Half-life: 1.46 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.03E+04	9.1%
4.52	6.76E+03	9.8%
6.65	2.43E+03	15%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
60.67	1.31E+03	8.9%
63.30	1.29E+03	8.9%
263.50	2.65E+02	9.1%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Product: ^{84g}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	8.03E+02	18%
4.52	5.63E+02	17%
6.65	6.63E+02	12%
60.67	2.32E+02	6.4%
63.30	2.11E+02	5.7%

Product: ^{86g}Rb, Half-life: 18.631 d

Cooling [d]	Activity [Bq/g]	%Error
63.30	6.08E+01	26%

Product: ^{83g}Sr, Half-life: 1.35 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.21E+04	48%
4.52	7.07E+03	47%
6.65	2.44E+03	48%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
6.65	3.05E+03	7.3%
60.67	1.62E+03	6.5%
63.30	1.58E+03	6.5%
263.496	1.95E+02	6.7%

Product: ^{87g}Y, Half-life: 3.33 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	4.34E+04	5.1%
4.52	3.59E+04	5.1%
6.65	2.31E+04	5.1%

Product: ^{87m}Y, Half-life: 13.37 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	7.56E+03	5.6%
4.52	3.06E+03	6.4%
6.65	6.39E+02	12%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.08E+03	8.8%
4.52	9.56E+02	7.4%
6.65	1.05E+03	6.4%
60.67	1.32E+03	5.1%
63.30	1.32E+03	5.0%
263.496	8.36E+02	5.1%

Product: ^{86}Zr, Half-life: 16.5 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.75E+03	7.4%
4.52	6.39E+02	12%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	2.85E+03	6.3%
4.52	2.72E+03	5.8%
6.65	2.60E+03	5.5%
60.67	1.57E+03	5.0%
63.30	1.53E+03	5.0%
263.496	2.97E+02	5.1%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	4.81E+04	5.0%
4.52	3.92E+04	5.0%
6.65	2.50E+04	5.0%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	5.82E+03	5.7%
4.52	2.06E+03	6.5%
6.65	1.75E+02	18%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.16E+04	5.1%
4.52	2.90E+04	5.0%
6.65	2.50E+04	5.0%
60.67	6.14E+02	5.2%
63.30	5.13E+02	5.0%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Code:	Nb-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Nb-148
Weight:	3.56 g
Size:	20 mm×20 mm, 1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	2.93E-28

Product: ^{46}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
4.64	9.03E+00	11%
6.67	9.73E+00	21%
60.34	6.65E+00	6.1%
266.68	1.49E+00	7.0%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
266.68	1.42E-01	21%

Product: ^{60g}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
266.68	2.17E-01	25%

Product: ^{71}As, Half-life: 2.72 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	3.58E+01	40%
4.64	1.09E+01	19%
6.67	8.78E+00	41%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
4.64	7.01E+00	45%
6.67	4.05E+00	5.1%
60.34	3.15E+00	13%
266.68	1.00E+00	7.5%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
60.34	2.15E+01	9.2%
266.68	4.12E+00	9.3%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
4.64	1.84E+01	18%
6.67	1.84E+01	26%
60.34	4.59E+00	8.8%

Product: ^{83g}Sr, Half-life: 1.35 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	3.71E+02	51%
4.64	1.13E+02	47%
6.67	5.85E+01	51%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
60.34	3.87E+01	6.6%
266.68	4.14E+00	6.7%

Product: ^{87g}Y, Half-life: 3.33 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	1.92E+03	5.3%
4.64	1.15E+03	5.1%
6.67	7.55E+02	5.2%

Product: ^{87m}Y, Half-life: 13.37 h

Cooling [d]	Activity [Bq/g]	%Error
1.64	1.60E+03	5.5%
4.64	6.02E+01	6.9%
6.67	8.51E+00	51%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
4.64	4.63E+01	6.2%
6.67	4.16E+01	8.4%
60.34	5.58E+01	5.1%
266.68	3.37E+01	5.0%

Product: ^{86}Zr, Half-life: 16.5 h

Cooling [d]	Activity [Bq/g]	%Error
1.64	1.78E+02	12%
4.64	1.02E+01	19%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	9.03E+01	20%
4.64	9.55E+01	5.4%
6.67	9.09E+01	6.3%
60.34	6.21E+01	5.0%
266.68	1.13E+01	5.0%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	3.61E+03	5.1%
4.64	1.98E+03	5.0%
6.67	1.31E+03	5.1%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.64	3.58E+03	5.2%
4.64	1.12E+02	5.4%
6.67	1.35E+01	15%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
1.64	2.82E+03	5.2%
4.64	2.30E+03	5.0%
6.67	2.05E+03	5.1%
60.34	5.42E+01	5.1%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Code:	Nb-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Nb-150
Weight:	3.56 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.09E+03	5.5%
58.79	1.05E+03	5.3%
260.56	7.65E+01	8.1%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.31E+01	18%
58.79	1.40E+01	14%
260.56	1.17E+01	9.0%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	2.14E+02	5.2%
58.79	2.07E+02	5.1%
260.56	4.19E+01	5.3%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.52E+02	5.4%
58.79	1.34E+02	5.3%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	4.51E+02	7.3%
58.79	4.37E+02	6.4%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.69E+02	5.3%
58.79	1.64E+02	5.2%
260.56	8.82E+01	5.1%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.20E+02	5.6%
58.79	1.16E+02	5.3%
260.56	1.80E+01	6.4%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	2.79E+02	5.1%
58.79	2.69E+02	5.0%
260.56	1.27E+02	5.0%

Product: ^{58}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	4.85E+02	5.0%
58.79	4.72E+02	5.0%
260.56	6.60E+01	5.1%

Product: ^{60}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
55.55	7.97E+00	27%
58.79	9.52E+00	16%
260.56	8.43E+00	11%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	3.06E+02	5.3%
58.79	3.08E+02	5.2%
260.56	1.77E+02	5.1%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	8.64E+02	5.1%
58.79	8.49E+02	5.1%
260.56	2.63E+02	5.1%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	2.39E+03	8.9%
58.79	2.34E+03	8.9%
260.56	4.76E+02	8.9%

Product: ^{84g}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	5.12E+02	5.6%
58.79	4.70E+02	5.6%
260.56	7.27E+00	13%

Product: ^{86g}Rb, Half-life: 18.631 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.26E+02	18%
58.79	8.95E+01	19%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	3.25E+03	6.5%
58.79	3.17E+03	6.5%
260.56	3.81E+02	6.5%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	2.84E+03	5.0%
58.79	2.84E+03	5.0%
260.56	1.79E+03	5.0%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	3.31E+03	5.0%
58.79	3.24E+03	5.0%
260.56	6.05E+02	5.0%

Product: ^{91m}Nb, Half-life: 60.86 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	7.30E+02	31%
58.79	8.45E+02	30%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
55.55	1.59E+03	5.0%
58.79	1.27E+03	5.0%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Code:	Nb-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Nb-4
Weight:	0.341 g
Size:	20 mm×20 mm, 0.1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	1.33E-27

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
56.56	2.99E+01	10%
263.78	6.32E+00	14%

Product: ^{71}As, Half-life: 2.72 d

Cooling [d]	Activity [Bq/g]	%Error
2.21	1.21E+02	24%
3.82	8.40E+01	31%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
56.56	1.10E+01	23%
263.78	4.43E+00	24%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
56.56	7.33E+01	11%
263.78	1.46E+01	14%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
56.56	2.37E+01	14%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
56.56	1.32E+02	6.8%
263.78	1.20E+01	11%

Product: ^{87g}Y, Half-life: 3.33 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	6.31E+03	5.3%
2.21	5.97E+03	5.1%
3.82	4.71E+03	5.2%

Product: ^{87m}Y, Half-life: 13.37 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.21E+04	5.1%
2.21	3.34E+03	5.3%
3.82	5.85E+02	8.8%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
2.21	1.51E+02	20%
3.82	1.54E+02	14%
56.56	1.87E+02	5.7%
263.78	1.12E+02	5.4%

Product: ^{86}Zr, Half-life: 16.5 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.18E+03	7.4%
2.21	5.10E+02	7.1%
3.82	9.57E+01	24%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
2.21	3.00E+02	8.8%
3.82	3.12E+02	8.1%
56.56	2.12E+02	5.2%
263.78	3.79E+01	5.7%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.45E+04	5.1%
2.21	1.11E+04	5.0%
3.82	7.84E+03	5.1%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.15	2.31E+04	5.1%
2.21	6.41E+03	5.1%
3.82	9.80E+02	6.1%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
1.15	9.63E+03	5.1%
2.21	8.83E+03	5.1%
3.82	7.87E+03	5.1%
56.56	2.33E+02	5.4%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Code:	Nb-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.9E+12
Irradiation time:	00'00"45
Sample:	N-149
Weight:	3.58 g
Size:	20 mm×20 mm, 1 mm^t
Position:	On-beam
N_p(Partial) :	3.54E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.101	1.83E+02	31%
0.719	1.19E+02	13%
2.16	1.72E+01	20%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.719	2.31E+01	55%
2.16	2.59E+01	22%
4.16	1.41E+01	26%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.101	5.91E+01	5.0%
2.16	2.80E+01	17%
4.16	1.54E+01	15%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	2.07E+01	52%
2.16	1.36E+01	25%
4.16	1.21E+01	16%

Product: ^{69}Ge, Half-life: 1.63 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	1.06E+02	31%
2.16	7.66E+01	18%
4.16	3.88E+01	20%

Product: ^{71}As, Half-life: 2.72 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	1.16E+02	17%
2.16	8.30E+01	11%
4.16	5.11E+01	9.6%

Product: ^{76}As, Half-life: 1.0778 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	1.40E+03	19%
2.16	3.69E+02	22%

Product: ^{76g}Br, Half-life: 16.2 h

Cooling [d]	Activity [Bq/g]	%Error
0.719	3.51E+01	8.7%
2.16	1.04E+02	8.5%
4.16	2.00E+01	20%

Product: ^{77g}Br, Half-life: 2.38 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	3.37E+02	24%
2.16	1.38E+02	13%
4.16	1.17E+02	15%

Product: ^{79g}Br, Half-life: 1.46 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	2.38E+02	37%
2.16	1.81E+02	20%
4.16	6.83E+01	32%

Product: ^{83g}Sr, Half-life: 1.35 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	5.01E+02	48%
2.16	3.00E+02	47%
4.16	1.15E+02	48%

Product: ^{87g}Y, Half-life: 3.33 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	5.99E+02	6.0%
2.16	7.24E+02	5.2%
4.16	5.35E+02	5.2%

Product: ^{87m}Y, Half-life: 13.37 h

Cooling [d]	Activity [Bq/g]	%Error
0.72	2.69E+03	5.2%
2.16	4.71E+02	5.4%
4.16	5.83E+01	9.5%

Product: ^{86}Zr, Half-life: 16.5 h

Cooling [d]	Activity [Bq/g]	%Error
0.72	2.96E+02	8.0%
2.16	8.12E+01	7.7%
4.16	1.20E+01	22%

Table 9.8 Digital radioactivity data for the niobium samples. (Continued)

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
0.101	7.80E+02	15%
0.719	1.27E+03	5.5%
2.16	9.53E+02	5.2%
4.16	6.25E+02	5.2%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.101	3.80E+03	6.9%
0.719	2.40E+03	5.2%
2.16	4.61E+02	5.4%
4.16	4.34E+01	9.2%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
0.719	5.17E+02	6.7%
2.16	5.00E+02	5.3%
4.16	4.08E+02	5.3%

Table 9.9 Digital radioactivity data for the mercury-oxide samples.

Code:	HgO-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	HgO-2
Weight:	0.0059 g
Size:	24 mm×24 mm
Position:	On-beam
N_p(Partial) :	4.76E+14

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
59.91	1.35E+02	39%
63.30	1.11E+02	31%
262.67	3.33E+01	32%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
1.67	1.30E+03	14%
3.52	1.03E+03	12%
4.00	9.15E+02	9.4%
6.80	9.36E+02	21%
59.91	4.01E+02	16%
63.30	3.63E+02	19%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
59.91	9.24E+02	20%
63.30	4.94E+02	21%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
59.91	5.31E+02	19%
63.30	3.30E+02	19%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
59.91	3.06E+02	19%
63.30	3.89E+02	12%
262.67	5.22E+01	24%

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
0.38	2.83E+04	10%
1.67	2.79E+04	7.5%
3.52	1.03E+04	8.4%
4.00	8.77E+03	8.0%
6.80	1.87E+03	27%

Product: ^{183g}Os, Half-life: 13.0 h

Cooling [d]	Activity [Bq/g]	%Error
0.38	3.34E+04	5.8%
1.67	9.72E+03	6.2%

Product: ^{183m}Os, Half-life: 9.9 h

Cooling [d]	Activity [Bq/g]	%Error
0.38	2.81E+04	7%
1.67	3.38E+03	14%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
6.80	9.70E+02	21%
59.91	4.84E+02	15%
63.30	4.24E+02	10%
262.67	9.33E+01	16%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
0.38	1.97E+04	6.6%
1.67	1.46E+04	5.3%
3.52	8.36E+03	5.4%
4.00	8.24E+03	5.2%
6.80	3.85E+03	7.8%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
1.67	1.29E+04	7.0%
3.52	7.71E+03	6.2%
4.00	6.84E+03	6.5%
6.80	3.41E+03	14%

Product: ^{197m}Hg, Half-life: 23.8 h

Cooling [d]	Activity [Bq/g]	%Error
0.38	1.13E+05	6.6%
1.67	4.59E+04	6.7%
3.52	1.20E+04	7.0%
4.00	8.25E+03	7.7%
6.80	1.27E+03	34%

Product: ^{203}Hg, Half-life: 46.612 h

Cooling [d]	Activity [Bq/g]	%Error
59.91	1.21E+03	8.3%
63.30	1.15E+03	6.5%
262.67	6.61E+01	22%

Table 9.9 Digital radioactivity data for the mercury-oxide samples. (Continued)

Code:	HgO-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	HgO-6
Weight:	0.0066 g
Size:	24 mm×24 mm
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	2.93~3.24E-28

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
2.49	5.28E+02	10%
3.53	5.52E+02	13%
3.99	4.01E+02	7.7%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
2.49	5.90E+02	16%
3.99	4.03E+02	11%

Product: ^{197m}Hg, Half-life: 23.8 h

Cooling [d]	Activity [Bq/g]	%Error
2.49	2.37E+03	8.5%
3.99	8.83E+02	9.6%

Product: ^{203}Hg, Half-life: 46.612 d

Cooling [d]	Activity [Bq/g]	%Error
61.75	1.93E+02	19%
65.49	2.61E+02	11%

Table 9.9 Digital radioactivity data for the mercury-oxide samples. (Continued)

Code:	HgO-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	HgO-4
Weight:	0.0067 g
Size:	24 mm×24 mm
Position:	On-beam
N_p(Partial) :	7.09E+14

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.25E+02	24%
57.13	1.52E+02	16%
59.73	1.37E+02	16%
259.88	3.05E+01	23%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
57.13	4.72E+01	47%
259.88	3.34E+01	23%

Product: ^{58}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
57.13	1.41E+02	17%
59.73	1.47E+02	16%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.99E+02	34%
259.88	3.84E+01	33%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
57.13	2.16E+02	25%
259.88	6.36E+01	27%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
57.13	1.04E+02	37%
59.73	1.79E+02	21%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.52E+02	22%
57.13	1.93E+02	15%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
59.73	1.65E+02	12%
259.88	5.28E+01	16%

Table 9.9 Digital radioactivity data for the mercury-oxide samples. (Continued)

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
59.73	8.99E+01	24%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
57.13	9.95E+01	27%

Product: ^{127g}Xe, Half-life: 36.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.54E+02	53%
57.13	1.43E+02	24%

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.30E+02	30%
57.13	1.56E+02	19%
59.73	1.59E+02	24%
259.88	7.52E+01	15%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
2.10	1.04E+03	25%
3.98	1.33E+03	18%
55.64	2.40E+02	11%
57.13	1.63E+02	8.2%
59.73	1.63E+02	11%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
2.10	7.59E+03	16%
3.98	5.11E+03	20%
55.64	8.58E+02	28%
57.13	8.16E+02	16%
59.73	1.05E+03	14%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	6.87E+02	23%
57.13	6.69E+02	13%
59.73	4.46E+02	17%

Product: ^{172g}Lu, Half-life: 6.7 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	6.38E+01	22%

Product: ^{173}Lu, Half-life: 1.37 y

Cooling [d]	Activity [Bq/g]	%Error
259.88	1.17E+02	34%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	7.40E+02	13%
57.13	6.75E+02	9.2%
59.73	6.56E+02	9.4%
259.88	8.93E+01	14%

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
0.92	6.83E+04	8.5%
2.10	3.97E+04	7.8%
3.98	1.45E+04	9.9%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	1.38E+02	20%

Product: ^{183g}Os, Half-life: 13.0 h

Cooling [d]	Activity [Bq/g]	%Error
0.92	4.79E+04	6.0%
2.10	1.25E+04	6.6%

Product: ^{183m}Os, Half-life: 9.9 h

Cooling [d]	Activity [Bq/g]	%Error
0.92	3.06E+04	7.9%
2.10	3.60E+03	16%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	8.40E+02	12%
57.13	8.42E+02	7.5%
59.73	9.42E+02	7.4%
259.88	1.75E+02	9.4%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
0.92	3.66E+04	6.5%
2.10	2.61E+04	5.2%
3.98	1.87E+04	5.5%

Product: ^{198m}Au, Half-life: 2.27 d

Cooling [d]	Activity [Bq/g]	%Error
2.10	7.69E+03	8.7%
3.98	4.30E+03	12%

Table 9.9 Digital radioactivity data for the mercury-oxide samples. (Continued)

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
0.92	3.58E+04	13%
2.10	3.01E+04	6.0%
3.98	1.72E+04	6.6%

Product: ^{197m}Hg, Half-life: 23.8 h

Cooling [d]	Activity [Bq/g]	%Error
0.92	1.81E+05	6.8%
2.10	8.17E+04	6.6%
3.98	2.12E+04	7.4%

Product: ^{203}Hg, Half-life: 46.612 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.67E+03	6.2%
57.13	2.59E+03	5.4%
59.73	2.59E+03	5.4%
259.88	1.57E+02	9.3%

Table 9.9 Digital radioactivity data for the mercury-oxide samples. (Continued)

Code:	HgO-24-L-Off
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	HgO-8
Weight:	0.0073 g
Size:	24 mm×24 mm
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	1.33~1.62E-27

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
1.09	2.71E+03	6.3%
2.23	1.80E+03	9.2%
4.04	1.46E+03	8.6%

Product: ^{198m}Au, Half-life: 2.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.09	3.54E+02	29%
2.23	2.40E+02	60%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
1.09	2.31E+03	14%
2.23	2.26E+03	12%
4.04	1.61E+03	17%

Product: ^{197m}Hg, Half-life: 23.8 h

Cooling [d]	Activity [Bq/g]	%Error
1.09	2.49E+04	6.7%
2.23	1.12E+04	7.4%
4.04	3.17E+03	11%

Product: ^{203}Hg, Half-life: 46.612 d

Cooling [d]	Activity [Bq/g]	%Error
56.55	9.54E+02	7.2%
57.13	9.35E+02	7.3%
61.88	8.49E+02	6.0%
263.89	7.51E+01	15%

Table 9.10 Digital radioactivity data for the lead samples.

Code:	Pb-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+15
Irradiation time:	06'24"30
Sample:	Pb-2
Weight:	0.916 g
Size:	20 mm×20 mm, 0.2 mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
266.39	2.10E+01	14%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
63.30	1.27E+00	16%
266.39	1.24E+00	18%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.21E+01	5.9%
63.30	3.33E+01	5.1%
266.39	6.17E+00	7.7%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	5.01E+00	17%
63.30	3.65E+00	8.9%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
63.30	4.80E+01	8.6%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	1.01E+01	9.6%
63.30	1.10E+01	5.7%
266.39	6.95E+00	8.1%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
63.30	2.67E+00	14%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
266.39	4.41E+00	11%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.23E+01	7.9%
63.30	3.31E+01	5.4%
266.39	1.01E+01	7.5%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	7.36E+01	9.6%
63.30	7.66E+01	8.9%
266.39	1.37E+01	11%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	7.27E+01	7.2%
63.30	7.37E+01	6.9%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	9.04E+01	6.8%
63.30	7.70E+01	6.6%
266.39	8.35E+00	42%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	5.14E+01	5.4%
63.30	5.26E+01	5.1%
266.39	2.56E+01	5.6%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	7.16E+01	5.4%
63.30	6.78E+01	5.1%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	2.32E+01	8.8%
63.30	2.27E+01	5.7%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	6.73E+01	7.0%
63.30	5.62E+01	6.6%

Product: ^{127g}Xe, Half-life: 36.4 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	1.49E+02	6.6%
63.30	1.44E+02	6.5%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	1.24E+02	5.2%
63.30	1.24E+02	5.0%
266.39	4.53E+01	5.1%

Product: ^{143}Pm, Half-life: 265 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	9.03E+01	8.7%
63.30	8.72E+01	8.1%
266.39	4.34E+01	8.4%

Product: ^{144}Pm, Half-life: 363 d

Cooling [d]	Activity [Bq/g]	%Error
63.30	5.83E+00	7.2%
266.39	4.47E+00	9.9%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	8.19E+02	11%
4.53	9.40E+02	8.6%
6.63	8.45E+02	7.0%
61.38	2.81E+02	5.1%
63.30	2.80E+02	5.1%
266.39	1.43E+01	5.9%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	6.44E+02	7.7%
63.30	6.00E+02	7.6%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.03E+02	5.2%
63.30	2.92E+02	5.1%

Product: ^{172g}Lu, Half-life: 6.70 d

Cooling [d]	Activity [Bq/g]	%Error
63.30	4.81E+01	6.8%
266.39	3.75E+01	7.0%

Product: ^{173}Lu, Half-life: 1.37 y

Cooling [d]	Activity [Bq/g]	%Error
63.30	8.47E+01	6.7%
266.39	5.21E+01	7.1%

Product: ^{172}Hf, Half-life: 1.87 y

Cooling [d]	Activity [Bq/g]	%Error
266.39	3.07E+01	14%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.37E+02	7.4%
63.30	3.06E+02	7.3%
266.39	3.92E+01	6.3%

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	7.05E+03	8.0%
4.53	3.34E+03	8.8%
6.63	1.07E+03	11%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
6.63	5.44E+02	20%
61.38	3.32E+02	6.1%
63.30	3.24E+02	5.8%
266.39	3.64E+01	7.0%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.20E+02	6.4%
63.30	2.97E+02	6.4%
266.39	6.59E+01	7.0%

Product: ^{188}Pt, Half-life: 10.2 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	5.47E+01	15%
63.30	4.05E+01	10%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	9.54E+02	12%
4.53	6.86E+02	8.4%
6.63	4.54E+02	7.9%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	9.69E+02	16%
4.53	6.83E+02	17%
6.63	5.34E+02	15%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.54E+04	5.1%
4.53	9.03E+03	5.1%
6.63	3.03E+03	5.2%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	1.86E+04	6.2%
4.53	1.58E+04	6.2%
6.63	8.74E+03	6.2%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
3.51	3.39E+03	5.6%
4.53	3.28E+03	5.4%
6.63	3.05E+03	5.2%
61.38	1.65E+02	5.2%
63.30	1.37E+02	5.1%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
3.51	2.30E+04	5.1%
4.53	1.60E+04	5.1%
6.63	8.95E+03	5.1%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Code:	Pb-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	Pb-6
Weight:	14.14 g
Size:	20mm × 20 mm, 3 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	2.93~3.24E-28

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
65.49	3.63E-02	32%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	2.13E-01	8.9%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	1.96E-01	9.7%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	7.16E-01	25%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	4.01E-01	6.2%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	2.31E-01	9.4%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	3.24E-01	13%
65.49	3.27E-01	10%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	3.33E-01	6.3%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	2.17E-01	10%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	6.89E-01	8.4.%
65.49	7.13E-01	7.1%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	8.09E-02	27%
65.49	9.63E-02	16%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	7.38E-01	25%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	5.47E-01	29%
65.19	3.85E-01	27%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	6.72E-01	10%
65.49	6.77E-01	8.6%
267.35	5.22E-02	29%

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
3.64	2.66E+01	13%
4.66	1.46E+01	15%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.61E+00	20%
65.49	1.27E+00	18%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.85E+00	6.8%
65.49	1.97+00	6.6%
267.35	4.31E-01	7.5%

Product: ^{188}Pt, Half-life: 10.2 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.78E+00	24%
65.49	1.46E+00	18%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
3.64	1.15E+01	31%
4.66	9.03E+00	9.4%
6.68	6.32E+00	13%

Product: ^{203}Hg, Half-life: 46.612 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	3.55E+00	5.4%
65.49	3.52E+00	5.2%
267.35	1.80E-01	13%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
3.64	1.11E+03	5.1%
4.66	6.62E+02	5.1%
6.68	2.22E+02	5.2%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
3.64	1.38E+03	5.8%
4.66	1.13E+03	5.7%
6.68	6.69E+02	7.0%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
3.64	1.99E+02	5.2%
4.66	1.87E+02	5.2%
6.68	1.69E+02	5.2%
60.33	8.56E+00	5.2%
65.49	7.00E+00	5.1%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
3.64	2.36E+03	5.0%
4.66	1.70E+03	5.0%
6.68	9.04E+02	5.1%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Code:	Pb-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Pb-4
Weight:	0.924 g
Size:	20 mm×20 mm, 0.2 mm^t
Position:	On-beam
N_p(Partial) :	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
259.76	5.93E+01	7.7%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.64	8.55E+00	19%
59.73	7.13E+00	7.6%
259.76	5.57E+00	8.5%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.05E+02	5.5%
59.73	1.10E+02	5.1%
259.76	2.10E+01	5.5%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.51E+01	9.1%
59.73	2.06E+01	6.7%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.29E+02	17%
59.73	1.22E+02	6.4%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	3.59E+01	7.0%
59.73	3.70E+01	5.2%
259.76	2.34E+01	5.5%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.10E+01	16%
59.73	8.42E+00	7.0%
259.76	1.97E+00	19%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
259.76	1.41E+01	6.2%

Product: ^{58}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.02E+02	5.7%
59.73	9.47E+01	5.1%

Product: ^{60}Co, Half-life: 5.2714 y

Cooling [d]	Activity [Bq/g]	%Error
55.64	6.31E+00	18%
59.73	5.40E+00	8.4%
259.76	4.86E+00	9.9%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.22E+01	9.1%
59.73	4.33E+01	5.4%
259.76	2.41E+01	6.6%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
59.73	8.49E+01	5.3%
259.76	2.88E+01	5.9%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.69E+02	9.4%
59.73	1.68E+02	8.9%
259.76	3.40E+01	9.4%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.50E+02	7.3%
59.73	1.34E+02	6.9%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.81E+02	6.7%
59.73	1.79E+02	6.6%
259.76	2.02E+01	42%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.07E+02	5.4%
59.73	1.03E+02	5.1%
259.76	5.89E+01	5.2%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.68E+02	5.4%
59.73	1.53E+02	5.0%
259.76	3.63E+01	4.2%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.37E+01	8.4%
59.73	4.79E+01	5.3%
259.76	5.10E+00	16%

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.09E+02	6.8%
59.73	9.92E+01	6.4%
259.76	1.34E+01	6.3%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.28E+02	7.0%
59.73	1.07E+02	6.6%

Product: ^{127g}Xe, Half-life: 36.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.34E+02	6.6%
59.73	2.16E+02	6.7%

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.56E+02	5.5%
59.73	1.55E+02	5.0%
259.76	5.73E+01	5.1%

Product: ^{143}Pm, Half-life: 265 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	5.40E+01	8.3%

Product: ^{144}Pm, Half-life: 363 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.03E+01	18%
59.73	8.35E+00	7.9%
259.76	7.41E+00	7.8%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	3.51E+02	5.1%
59.73	3.25E+02	5.0%
259.76	1.73E+01	5.7%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	9.00E+02	7.7%
59.73	7.58E+02	7.6%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.47E+02	5.4%
59.73	3.80E+02	5.1%

Product: ^{172g}Lu, Half-life: 6.70 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	6.36E+01	8.1%
59.73	6.72E+01	6.8%
259.76	5.24E+01	7.0%

Product: ^{173}Lu, Half-life: 1.37 y

Cooling [d]	Activity [Bq/g]	%Error
55.64	9.96E+01	12%
59.73	9.54E+01	6.8%
259.76	7.44E+01	6.9%

Product: ^{172}Hf, Half-life: 1.87 y

Cooling [d]	Activity [Bq/g]	%Error
259.76	4.94E+01	13%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.41E+02	7.4%
59.73	4.70E+02	7.3%
259.76	6.15E+01	6.2%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.43E+02	6.2%
59.73	5.58E+02	5.7%
259.76	6.54E+01	6.4%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.67E+02	6.5%
59.73	5.18E+02	6.4%
259.76	1.15E+02	6.4%

Product: ^{188}Pt, Half-life: 10.2 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.24E+02	13%
59.73	1.07E+02	9.3%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.90E+02	5.1%
59.73	4.40E+02	5.1%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.12E+02	5.4%
59.73	3.38E+02	5.1%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.93E+01	10%
59.73	1.01E+01	6.6%

Product: ^{207}Bi, Half-life: 31.55 y

Cooling [d]	Activity [Bq/g]	%Error
59.73	2.59E+00	16%
259.76	2.71E+00	14%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Code:	Pb-24-L-Off
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	Pb-8
Weight:	14.30 g
Size:	20mm × 20 mm, 3 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	1.33~1.62E-27

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	9.54E-01	14%
61.88	7.33E-01	11%

Product: ^{84}Rb, Half-life: 32.77 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.45E+00	8.4%
61.88	1.21E+00	7.4%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	4.45E-01	9.6%
61.88	3.87E-01	6.6%
263.78	1.09E-01	14%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
61.88	6.68E-02	40%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.98E+00	6.7%
61.88	1.60E+00	5.8%
263.78	2.15E-01	13%

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.64E+00	6.9%
61.88	2.59E+00	6.5%
263.78	4.14E-01	7.1%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.86E+00	7.1.%
61.88	2.54E+00	6.6%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.14E-01	19%
61.88	1.72E-01	13%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.43E+00	19%
61.88	1.68E+00	14%

Product: ^{173}Lu, Half-life: 1.37 y

Cooling [d]	Activity [Bq/g]	%Error
56.74	3.11E-01	30%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.79E+00	8.1%
61.88	2.74E+00	7.5%
263.78	3.48E-01	25%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	6.75E+00	12%
61.88	5.75E+00	8.4%
263.8	7.88E-01	18%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	8.06E+00	6.5%
61.88	7.83E+00	6.4%
263.78	1.71E+00	6.6%

Product: ^{203}Hg, Half-life: 46.612 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.52E+01	5.1%
61.88	1.37E+01	5.1%
263.78	7.36E-01	6.6%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
3.82	6.86E+02	5.2%
56.74	3.95E+01	5.1%
61.88	3.00E+01	5.1%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Code:	Pb-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Pb-3
Weight:	0.911 g
Size:	20 mm×20 mm, 0.2 mm^t
Position:	On-beam
N_p(Partial) :	3.54E+12

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
2.16	1.70E+02	13%
4.16	7.52E+01	19%

Product: ^{183g}Os, Half-life: 13.0 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	2.45E+02	9.0%
2.16	4.42E+01	13%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
0.73	7.27E+01	29%
2.16	1.48E+01	34%
4.16	2.13E+01	24%

Product: ^{198m}Au, Half-life: 2.27 d

Cooling [d]	Activity [Bq/g]	%Error
2.16	2.86E+01	25%
4.16	2.73E+01	36%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
2.16	5.14E+01	30%
4.16	1.94E+01	50%

Product: ^{198g}Tl, Half-life: 5.3 d

Cooling [d]	Activity [Bq/g]	%Error
0.10	4.65E+02	14%

Product: ^{199}Tl, Half-life: 7.42 h

Cooling [d]	Activity [Bq/g]	%Error
0.10	1.52E+04	23%
0.73	3.74E+03	16%
2.16	2.41E+02	63%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	9.49E+02	5.8%
2.16	5.89E+02	5.4%
4.16	2.24E+02	6.6%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	5.53E+02	27%
2.16	3.68E+02	19%
4.16	3.01E+02	16%

Product: ^{200}Pb, Half-life: 21.5 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	6.27E+02	12%
2.16	2.23E+02	12%
4.16	2.29E+01	78%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
0.10	2.19E+03	15%
0.73	1.07E+03	10%
2.15	5.67E+01	17%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	1.03E+03	5.5%
2.16	6.52E+02	5.3%
4.16	3.40E+02	5.9%

Product: ^{204}Bi, Half-life: 11.22 h

Cooling [d]	Activity [Bq/g]	%Error
0.73	2.79E+02	13%
2.16	3.02E+01	21%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
0.73	4.68E+01	30%
2.16	3.60E+01	18%
4.16	3.30E+01	16%

Table 9.10 Digital radioactivity data for the lead samples. (Continued)

Code:	Pb-24-S-Off
Incident proton energy:	24 GeV
N_p(Total):	7.90E+12
Irradiation time:	00'00"45
Sample:	Pb-7
Weight:	14.09 g
Size:	20mm × 20 mm, 3 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	6.97~8.70E-27

Product: ^{183g}Os, Half-life: 13.0 h

Cooling [d]	Activity [Bq/g]	%Error
0.69	2.78E+00	25%
2.41	4.52E-01	25%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
2.41	3.16E-01	31%

Product: ^{198g}Tl, Half-life: 5.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.13	2.17E+02	14%

Product: ^{199}Tl, Half-life: 7.42 h

Cooling [d]	Activity [Bq/g]	%Error
0.13	1.83E+02	16%
0.69	8.40E+01	14%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
0.69	6.01E+01	5.4%
2.41	3.63E+01	5.1%
4.20	1.61E+01	6.5%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
2.41	3.51E+01	10%
4.20	2.46E+01	32%

Product: ^{200}Pb, Half-life: 21.5 h

Cooling [d]	Activity [Bq/g]	%Error
0.69	5.86E+01	14%
2.41	1.45E+01	11%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
0.13	3.05E+02	10%
0.69	1.16E+02	10%
2.41	5.18E+00	11%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
0.13	1.53E+02	6.0%
0.69	1.27E+02	5.2%
2.41	6.97E+01	5.1%
4.20	4.01E+01	5.7%

Table 9.11 Digital radioactivity data for the bismuth samples.

Code:	Bi-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	Bi-53
Weight:	5.99 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	2.72~2.96E-28

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	1.27E-01	28%
267.35	4.01E-02	50%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
65.49	8.49E-01	13%

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.45E+00	16%
65.49	1.25E+00	8.4%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.75E+00	15%
65.49	1.83E+00	7.7%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	1.42E+00	16%
65.49	1.16E+00	7.7%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
60.33	7.08E-01	56%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
267.35	2.31E-01	14%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	6.85E+02	5.2%
4.56	4.36E+02	5.2%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	7.94E+02	13%
4.56	6.05E+02	13%
6.66	5.30E+02	16%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
3.65	4.32E+01	14%
4.56	3.98E+01	11%
6.66	3.86E+01	13%
60.33	1.85E+00	10%
65.49	1.31E+00	8.1%

Product: ^{200}Pb, Half-life: 21.5 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	1.85E+02	16%
4.56	1.07E+02	19%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	1.88E+01	30%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	1.65E+03	5.1%
4.56	1.25E+03	5.1%
6.66	6.36E+02	5.2%

Product: ^{203}Bi, Half-life: 11.76 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	8.12E+01	17%

Product: ^{204}Bi, Half-life: 11.22 h

Cooling [d]	Activity [Bq/g]	%Error
3.65	8.09E+01	12%
4.56	2.79E+01	17%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
3.65	8.98E+02	5.6%
4.56	8.40E+02	5.4%
6.66	7.52E+02	5.5%
60.33	6.41E+01	5.3%
65.49	5.11E+01	5.1%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
3.65	2.22E+03	5.1%
4.56	2.03E+03	5.0%
6.66	1.62E+03	5.1%
60.33	4.93E+00	7.1%
65.49	3.12E+00	6.2%

Product: ^{207}Bi, Half-life: 31.55 y

Cooling [d]	Activity [Bq/g]	%Error
60.33	3.26E+00	10%
65.49	3.20E+00	6.5%
267.35	3.07E+00	5.2%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Code:	Bi-2.83-S-Off
Incident proton energy:	2.83 GeV
Np(Total):	2.33E+13
Irradiation time:	00'07"31
Sample:	Bi-52
Weight:	6.37 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	3.32~4.33E-28

Product: ^{198g}Tl, Half-life: 5.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	5.68E+01	31%

Product: ^{199}Tl, Half-life: 7.42 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	5.32E+01	23%

Product: ^{200}Pb, Half-life: 21.5 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	3.06E+01	28%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	8.03E+01	11%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	1.68E+01	15%

Product: ^{203}Bi, Half-life: 11.76 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	8.70E+01	9.8%

Product: ^{204}Bi, Half-life: 11.22 h

Cooling [d]	Activity [Bq/g]	%Error
0.28	1.53E+02	10%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
0.28	3.32E+01	7.2%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Code:	Bi-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	Bi-51
Weight:	6.03 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	On-beam
N_p(Partial) :	4.10E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	5.01E+01	6.4%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
59.73	7.66E+00	5.1%
259.88	6.35E+00	5.8%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.29E+02	5.2%
59.73	1.28E+02	5.0%
259.88	2.30E+01	5.1%

Product: ^{48}V, Half-life: 15.9735 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	3.99E+01	8.1%
59.73	3.00E+01	6.7%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.79E+02	9.5%
59.73	1.62E+02	5.9%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.25E+01	6.0%
59.73	4.29E+01	6.0%
259.88	2.48E+01	5.1%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.06E+01	13%
59.73	1.04E+01	6.6%
259.88	1.65E+00	13%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	1.58E+01	8.1%

Product: ^{58}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.12E+02	5.2%
59.73	1.06E+02	5.0%

Product: ^{60}Co, Half-life: 5.2714 y

Cooling [d]	Activity [Bq/g]	%Error
259.88	5.17E+00	6.6%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	5.44E+01	7.4%
59.73	5.18E+01	5.3%
259.88	2.83E+01	5.3%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.23E+02	5.7%
59.73	1.12E+02	5.2%
259.88	3.41E+01	5.4%

Product: ^{83}Rb, Half-life: 86.2 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.01E+02	9.0%
59.73	1.98E+02	8.9%
259.88	3.83E+01	9.0%

Product: ^{85g}Sr, Half-life: 64.84 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.18E+02	6.6%
59.73	2.12E+02	6.5%
259.88	1.96E+01	42%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.25E+02	5.2%
59.73	1.23E+02	5.1%
259.88	6.78E+01	5.1%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.94E+02	5.1%
59.73	1.86E+02	5.0%
259.88	4.22E+01	5.1%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	7.67E+01	6.3%
59.73	7.70E+01	5.1%
259.88	7.74E+00	7.0%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.57E+02	6.4%
59.73	1.48E+02	6.5%
259.88	2.03E+01	5.2%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.37E+02	6.6%
59.73	2.10E+02	6.6%

Product: ^{127g}Xe, Half-life: 36.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.77E+02	6.6%
59.73	2.58E+02	6.5%

Product: ^{139}Ce, Half-life: 137.64 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.63E+02	5.2%
59.73	1.59E+02	5.0%
259.88	5.40E+01	5.1%

Product: ^{143}Pm, Half-life: 265 d

Cooling [d]	Activity [Bq/g]	%Error
259.88	5.44E+01	8.1%

Product: ^{144}Pm, Half-life: 363 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	8.88E+00	16%
59.73	8.61E+00	7.0%
259.88	6.89E+00	6.6%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	3.94E+02	5.1%
59.73	3.82E+02	5.0%
259.88	1.80E+01	5.2%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	9.63E+02	7.6%
59.73	9.26E+02	7.6%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.14E+02	5.3%
59.73	3.72E+02	5.1%

Product: ^{172g}Lu, Half-life: 6.70 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	6.28E+01	7.5%
59.73	6.40E+01	6.8%
259.88	4.77E+01	6.8%

Product: ^{173}Lu, Half-life: 1.37 y

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.03E+02	9.1%
59.73	1.03E+02	6.7%
259.88	7.15E+01	6.6%

Product: ^{172}Hf, Half-life: 1.87 y

Cooling [d]	Activity [Bq/g]	%Error
259.88	3.34E+01	18%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
259.76	5.85E+01	6.2%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.73E+02	7.2%
59.73	4.55E+02	7.0%
259.88	4.82E+01	8.1%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.60E+02	6.4%
59.73	4.41E+02	6.4%
259.88	9.28E+01	6.3%

Product: ^{188}Pt, Half-life: 10.2 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	1.28E+02	11%
59.73	1.11E+02	9%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.33E+02	5.2%
59.73	1.83E+02	5.1%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	2.02E+03	5.0%
59.73	1.68E+03	5.0%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	4.06E+02	5.0%
59.73	2.80E+02	5.0%

Product: ^{207}Bi, Half-life: 31.55 y

Cooling [d]	Activity [Bq/g]	%Error
55.64	7.31E+01	5.6%
59.73	7.18E+01	5.1%
259.88	6.63E+01	5.1%

Product: ^{206}Po, Half-life: 8.8 d

Cooling [d]	Activity [Bq/g]	%Error
55.64	9.92E+01	16%
59.73	6.95E+01	15%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Code:	Bi-24-L-Off
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	Bi-55
Weight:	5.99 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	1.24~1.28E-27

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.45E+00	13%
61.88	2.09E+00	11%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	6.56E-01	13%
61.88	6.47E-01	12%

Product: ^{95}Zr, Half-life: 64.02 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	3.62E+00	10%
61.88	4.04E+00	9.1%
263.78	2.18E-01	54%

Product: ^{95g}Nb, Half-life: 34.975 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	4.15E+00	7.4%
61.88	4.55E+00	7.1%
263.78	6.08E-01	13%

Product: ^{103}Ru, Half-life: 39.26 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	8.18E+00	6.9.%
61.88	6.76E+00	6.8%

Product: ^{146}Eu, Half-life: 4.59 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.24E+00	14%

Product: ^{147}Eu, Half-life: 24.1 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.20E+00	58%
61.88	9.95E-01	45%

Product: ^{146}Gd, Half-life: 48.27 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.86E+00	26%
61.88	1.18E+00	28%

Product: ^{175}Hf, Half-life: 70 d

Cooling [d]	Activity [Bq/g]	%Error
263.78	2.59E-01	25%

Product: ^{183}Re, Half-life: 70.0 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	3.77E+00	24%
61.88	4.01E+00	21%

Product: ^{185}Os, Half-life: 93.6 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	4.99E+00	7.6%
61.88	5.19E+00	7.2%

Product: ^{202}Tl, Half-life: 12.23 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	8.00E+00	5.8%
61.88	6.39E+00	5.7%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.40E+02	5.1%
61.88	1.97E+02	5.1%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	2.41E+01	5.1%
61.88	1.52E+01	5.1%

Product: ^{207}Bi, Half-life: 31.55 y

Cooling [d]	Activity [Bq/g]	%Error
61.88	1.07E+01	5.6%
263.78	1.03E+01	5.2%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Code:	Bi-24-S-On
Incident proton energy:	24 GeV
N_p(Total) :	7.90E+12
Irradiation time:	00'00"45
Sample:	Bi-50
Weight:	6.03 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	On-beam
N_p(Partial) :	2.66E+12

Product: ^{182m}Re, Half-life: 12.7 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	1.57E+02	22%
1.86	1.45E+02	8.2%
2.15	1.20E+02	9.8%
4.15	3.75E+01	22%

Product: ^{183g}Os, Half-life: 13.0 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	1.94E+02	9.1%
1.86	6.22E+01	6.7%
2.15	4.35E+01	9.6%

Product: ^{183m}Os, Half-life: 9.9 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	9.78E+01	20%
1.86	1.94E+01	17%

Product: ^{188}Pt, Half-life: 10.2 d

Cooling [d]	Activity [Bq/g]	%Error
1.86	9.95E+01	15%
2.15	1.01E+02	22%

Product: ^{198g}Au, Half-life: 2.69517 d

Cooling [d]	Activity [Bq/g]	%Error
1.86	1.92E+01	16%
2.15	2.01E+01	16%
4.15	9.95E+00	29%

Product: ^{198m}Au, Half-life: 2.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.86	2.61E+01	16%
2.15	2.81E+01	18%
4.15	1.84E+01	26%

Product: ^{199}Au, Half-life: 3.139 d

Cooling [d]	Activity [Bq/g]	%Error
1.86	5.97E+01	14%
2.15	5.13E+01	21%

Product: ^{198g}Tl, Half-life: 5.3 d

Cooling [d]	Activity [Bq/g]	%Error
0.74	6.50E+02	14%
1.86	1.98E+01	25%
2.15	8.00E+00	47%

Product: ^{199}Tl, Half-life: 7.42 d

Cooling [d]	Activity [Bq/g]	%Error
0.74	8.80E+02	17%
1.86	8.62E+01	20%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	6.34E+02	6.1%
1.86	5.50E+02	5.1%
2.15	5.05E+02	5.1%
4.15	2.23E+02	5.5%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
1.86	4.18E+02	9.8%
2.15	3.06E+02	17%
4.15	2.07E+02	25%

Product: ^{200}Pb, Half-life: 21.5 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	6.06E+02	16%
1.86	2.29E+02	8.3%
2.15	1.87E+02	13%
4.15	4.10E+02	37%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	1.18E+03	10%
1.86	1.49E+02	10%
2.15	9.08E+01	11%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	5.92E+02	6.4%
1.86	6.08E+02	5.1%
2.15	5.76E+02	5.1%
4.15	3.30E+02	5.4%

Product: ^{203}Bi, Half-life: 11.76 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	5.89E+02	11%
1.86	1.42E+02	8.3%
2.15	8.60E+01	13%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Product: ^{204}Bi, Half-life: 11.22 h

Cooling [d]	Activity [Bq/g]	%Error
0.74	1.17E+03	10%
1.86	2.18E+02	9.9%
2.15	1.43E+02	10%
4.15	8.40E+00	25%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
1.86	1.84E+02	6.6%
2.15	1.85E+02	7.9%
4.15	1.38E+02	8.3%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
0.74	3.72E+02	6.6%
1.86	3.64E+02	5.1%
2.15	3.53E+02	5.1%
4.15	2.98E+02	5.2%

Table 9.11 Digital radioactivity data for the bismuth samples. (Continued)

Code:	Bi-24-S-Off
Incident proton energy:	24 GeV
Np(Total):	7.90E+12
Irradiation time:	00'00"45
Sample:	Bi-54
Weight:	6.03 g
Size:	20 mm$^{\phi}$, 2 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	6.97~8.70E-27

Product: ^{198g}Tl, Half-life: 5.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	1.14E+02	21%

Product: ^{199}Tl, Half-life: 7.42 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	1.13E+02	19%
0.67	5.21E+01	27%

Product: ^{200}Tl, Half-life: 26.1 h

Cooling [d]	Activity [Bq/g]	%Error
0.67	2.87E+01	10%
2.39	2.41E+01	5.9%
4.19	1.18E+01	11%

Product: ^{201}Tl, Half-life: 72.912 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	9.36E+01	44%
2.39	2.45E+01	27%

Product: ^{201}Pb, Half-life: 9.33 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	1.85E+02	10%
0.67	9.05E+01	11%
2.39	4.04E+00	17%

Product: ^{203}Pb, Half-life: 51.873 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	2.85E+01	13%
0.67	5.39E+01	7.9%
2.39	4.83E+01	5.4%
4.19	2.75E+01	7.4%

Product: ^{203}Bi, Half-life: 11.76 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	1.93E+02	8.5%
0.67	1.04E+02	9.9%
2.39	6.09E+00	24%

Product: ^{204}Bi, Half-life: 11.22 h

Cooling [d]	Activity [Bq/g]	%Error
0.16	4.14E+02	9.8%
0.67	1.45E+02	10%
2.39	1.11E+01	11%

Product: ^{205}Bi, Half-life: 15.31 d

Cooling [d]	Activity [Bq/g]	%Error
2.39	1.74E+01	10%
4.19	1.95E+01	15%

Product: ^{206}Bi, Half-life: 6.243 d

Cooling [d]	Activity [Bq/g]	%Error
0.16	7.02E+01	6.6%
0.67	6.31E+01	6.3%
2.39	4.97E+01	5.2%
4.19	4.37E+01	6.2%

Table 9.12 Digital radioactivity data for the acrylic resin samples.

Code:	Ac-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.19E+12
Irradiation time:	06'24"30
Sample:	AC-2
Weight:	2.21 g
Size:	25 mm×25 mm, 3 mm^t
Position:	On-beam
N_p(Partial) :	4.76E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.49	6.38E+03	5.1%

Code:	Ac-24-L-On
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	AC-4
Weight:	2.27 g
Size:	25 mm×25 mm, 3 mm^t
Position:	On-beam
N_p(Partial) :	7.09E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
0.90	1.11E+04	5.1%
1.08	1.08E+04	5.2%

Code:	Ac-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total) :	2.33E+13
Irradiation time:	00'07"31
Sample:	AC-1
Weight:	2.22 g
Size:	25 mm×25 mm, 3 mm^t
Position:	On-beam
N_p(Partial) :	7.30E+12

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
0.191	9.79E+01	13%

Code:	Ac-24-L-Off
Incident proton energy:	24 GeV
N_p(Total) :	1.48E+15
Irradiation time:	01'59"59
Sample:	AC-4
Weight:	2.23g
Size:	25 mm×25 mm, 3 mm^t
Position:	Off-beam
Reac. Rate of ^{93}Nb(n,2n)^m:	1.33~1.62E-27

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
1.17	4.51E+02	5.7%

Table 9.13 Digital radioactivity data for the SS-316 samples.

Code:	SS316-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	SS316-2
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	On-beam
N_p(Partial) :	1.49E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	6.11E+02	5.3%
266.39	4.47E+01	9.4%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
266.39	1.64E+01	5.3%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	7.08E+02	6.7%
4.53	2.28E+02	8.8%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.25E+02	8.9%
4.53	2.93E+02	9.7%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.00E+03	5.1%
4.53	4.47E+03	5.1%
6.64	2.52E+03	5.3%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.13E+03	5.1%
4.53	4.48E+03	5.1%
6.64	2.45E+03	5.6%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.50E+02	8.0%
4.53	6.23E+02	6.3%
6.64	6.90E+02	8.8%
266.39	7.41E+01	5.1%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	3.39E+03	5.3%
4.53	2.70E+03	5.2%
6.64	1.88E+03	5.7%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.70E+02	8.6%
4.53	5.07E+02	7.2%
6.64	2.50E+02	17%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.96E+02	11%
4.53	1.64E+02	12%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.07E+04	6.0%
4.53	1.03E+04	5.4%
6.64	1.02E+04	6.3%
61.38	2.60E+03	5.1%
266.39	1.53E+01	18%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.35E+03	5.2%
4.53	5.56E+03	5.1%
6.64	4.46E+03	5.3%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.12E+03	6.1%
4.53	1.09E+03	5.5%
6.64	1.06E+03	6.6%
61.38	9.22E+02	5.0%
266.39	5.83E+02	5.0%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.09E+02	5.0%
266.39	4.88E+01	5.1%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	3.38E+02	9.2%
4.53	3.60E+02	6.9%
6.64	3.87E+02	8.7%
61.38	3.24E+02	5.0%
266.39	2.10E+02	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.38E+03	5.5%
4.53	2.20E+03	5.2%
6.64	2.23E+03	5.5%
61.38	1.22E+03	5.0%
266.39	1.64E+02	5.0%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.51E+03	5.3%
4.53	2.00E+03	5.2%
6.64	1.40E+03	5.7%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.66E+03	6.1%
4.53	1.63E+03	6.0%
6.64	6.88E+02	8.0%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	8.49E+00	15%
266.39	2.36E+00	24%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
266.39	1.02E+01	5.8%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	1.84E+01	6.8%
266.39	3.96E+00	9.8%

Product: ^{89g}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	5.47E+02	8.7%
4.53	4.77E+02	7.4%
6.64	2.82E+02	13%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Code:	SS316-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	SS316-6
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	2.72~2.96E-28

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.68	6.45E+01	5.3%
4.62	4.75E+01	7.5%
6.68	2.25E+01	21%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.68	8.72E+01	5.3%
4.62	5.33E+01	8.0%
6.68	2.57E+01	22%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	9.16E+01	5.2%
4.62	8.49E+01	6.8%
6.68	5.08E+01	12%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.68	2.46E+01	6.1%
4.62	2.26E+01	15%
6.68	8.12E+00	54%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	7.97E+02	5.1%
4.62	7.87E+02	6.4%
6.68	8.15E+02	8.2%
60.67	2.05E+02	6.0%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	3.00E+02	5.1%
4.62	2.65E+02	5.5%
6.68	2.25E+02	6.6%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	9.19E+01	5.1%
4.62	9.61E+01	6.4%
6.68	9.77E+01	8.0%
60.67	8.61E+01	5.1%

Product: ^{58g}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	2.56E+02	5.0%
4.62	2.56E+02	5.5%
6.68	2.68E+02	6.1%
60.67	1.57E+02	5.1%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	6.71E+01	5.2%
4.62	6.27E+01	6.8%
6.68	3.76E+01	12%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.68	1.18E+02	5.9%
4.62	7.85E+01	7.6%
6.68	3.35E+01	13%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
3.68	2.65E+01	5.9%
4.62	2.42E+01	13%
6.68	2.14E+01	23%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.68	4.58E+00	17%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Code:	SS316-24-L-On
Incident proton energy:	24 GeV
N_p(Total):	2.19E+15
Irradiation time:	01'59"59
Sample:	SS316-4
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	On-beam
N_p(Partial) :	4.10E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.60E+03	5.5%
259.76	1.23E+02	8.8%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.75	4.00E+01	6.9%
259.76	3.28E+01	5.6%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	8.59E+02	5.0%
259.76	1.61E+02	5.1%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	6.48E+03	5.1%
259.76	6.31E+01	13%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.95E+03	5.0%
259.76	1.24E+03	5.0%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	7.29E+02	5.0%
259.76	1.15E+02	5.1%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	6.95E+02	5.0%
259.76	4.40E+02	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.24E+03	5.0%
259.76	3.02E+02	5.0%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	7.75E+00	38%
259.76	4.48E+00	21%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.89E+01	6.9%
259.76	2.11E+01	6.2%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	4.34E+01	8.0%
259.76	7.59E+00	11%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Code:	SS316-24-L-Off
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	SS316-8
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	1.24~1.28E-27

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	6.91E+01	11%
2.20	2.53E+01	20%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	2.93E+02	12%
2.20	7.71E+01	32%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	4.81E+02	5.4%
2.20	3.56E+02	5.6%
3.84	2.44E+02	6.9%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	5.01E+02	5.7%
2.20	3.69E+02	6.0%
3.84	2.38E+02	8.4%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	5.66E+01	14%
2.20	5.18E+01	19%
3.84	4.76E+01	27%
56.74	3.65E+01	6.0%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	5.57E+02	5.4%
2.20	4.48E+02	5.6%
3.84	3.26E+02	6.2%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	2.07E+02	7.0%
2.20	1.43E+02	8.5%
3.84	8.15E+01	17%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.25E+02	8.1%
2.20	4.79E+01	14%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	2.62E+03	5.8%
2.20	2.74E+03	5.9%
3.84	2.77E+03	6.5%
56.74	7.46E+02	5.2%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.43E+03	5.2%
2.20	1.20E+03	5.2%
3.84	9.81E+02	5.5%
56.74	2.02E+00	31%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	3.06E+02	5.8%
2.20	3.00E+02	5.7%
3.84	2.98E+02	6.9%
56.74	2.79E+02	5.1%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	4.68E+02	7.8%
2.20	1.80E+02	9.1%
3.84	3.29E+01	22%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	6.08E+01	5.4%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.17E+02	7.7%
2.20	1.00E+02	8.0%
3.84	1.27E+02	8.6%
56.74	1.01E+02	5.1%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	8.10E+02	5.3%
2.20	8.28E+02	5.2%
3.84	8.22E+02	5.4%
56.74	5.12E+02	5.0%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	4.12E+02	5.5%
2.20	3.31E+02	5.6%
3.84	2.41E+02	6.3%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.26E+03	5.9%
2.20	7.82E+02	6.0%
3.84	3.74E+02	7.3%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	1.52E+00	31%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
56.74	3.46E+00	20%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.16	1.50E+02	7.5%
2.20	1.19E+02	7.8%
3.84	9.27E+01	13%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.16	3.11E+02	6.3%
2.20	9.76E+01	11%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Code:	SS316-24-S-On
Incident proton energy:	24 GeV
N_p(Total):	7.90E+12
Irradiation time:	00'00"45
Sample:	SS316-3
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	On-beam
N_p(Partial) :	2.66E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	3.84E+02	6.7%
0.746	1.86E+02	6.3%
2.12	3.77E+01	8.4%
4.14	5.48E+00	26%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	4.00E+02	18%
0.746	2.31E+02	9.2%
2.12	3.39E+01	20%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	1.07E+02	19%
0.746	5.66E+01	14%
2.12	2.15E+01	15%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	1.84E+02	13%
0.746	1.43E+02	6.8%
2.12	8.82E+01	6.1%
4.14	4.76E+01	10%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	1.83E+03	5.2%
0.746	2.61E+02	6.0%
2.12	9.66E+01	6.6%
4.14	5.60E+01	9.9%

Product: ^{47}Sc, Half-life: 3.3492 h

Cooling [d]	Activity [Bq/g]	%Error
0.746	7.55E+01	11%
2.12	5.08E+01	7.4%
4.14	4.34E+01	10%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
0.746	2.56E+01	19%
2.12	1.68E+01	17%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
0.746	4.02E+01	15%
2.12	9.78E+00	19%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
2.12	9.26E+01	6.4%
4.14	6.61E+01	10%

Product: ^{56}Mn, Half-life: 2.5785 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	6.65E+03	5.1%
0.746	1.16E+02	7.7%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	1.47E+02	16%
0.746	9.46E+01	11%
2.12	2.33E+01	14%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
0.746	2.95E+01	17%
2.12	3.03E+01	9.9%
4.14	3.24E+01	12%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
0.746	5.43E+01	11%
2.12	3.75E+01	7.4%
4.14	3.21E+01	10%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	1.96E+02	10%
0.746	1.15E+02	8.4%
2.12	6.35E+01	7.8%
4.14	2.76E+01	14%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
0.746	1.26E+01	33%
2.12	1.38E+01	17%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.090	4.67E+01	30%
0.746	2.22E+01	26%
2.12	7.64E+00	25%

Table 9.13 Digital radioactivity data for the SS-316 samples. (Continued)

Code:	SS316-24-S-Off
Incident proton energy:	24 GeV
N_p(Total):	7.90E+12
Irradiation time:	00'00"45
Sample:	SS316-7
Weight:	1.30 g
Size:	20 mm$^{\phi}$, 0.5 mm^{t}
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^{m}:	6.97~8.70E-27

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.118	5.50E+01	13%
0.681	8.48E+00	22%

Product: ^{56}Mn, Half-life: 2.5785 h

Cooling [d]	Activity [Bq/g]	%Error
0.118	2.00E+03	5.1%
0.681	5.57E+01	7.6%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.118	1.98E+01	36%
0.681	1.30E+01	15%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.681	3.39E+00	43%

Table 9.14 Digital radioactivity data for the Inconel-625 samples.

Code:	IC625-2.83-L-On
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	Inc625-2
Weight:	0.377 g
Size:	20× 20 mm, 0.1 mm^t
Position:	On-beam
N_p(Partial) :	2.25E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	9.61E+02	7.6%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
61.38	2.91E+01	13%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	8.67E+02	9.8%
4.52	3.10E+02	17%

Product: ^{43}K, Half-life: 22.3 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	5.65E+02	16%
4.52	3.29E+02	27%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	7.04E+03	5.3%
4.52	5.17E+03	5.4%
6.64	3.03E+03	5.6%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.19E+03	5.5%
4.52	4.75E+03	5.7%
6.64	2.98E+03	5.8%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	5.96E+02	15%
4.52	5.85E+02	14%
6.64	5.64E+02	11%
61.38	3.81E+02	5.2%

Product: ^{47}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	4.67E+03	5.6%
4.52	3.67E+03	5.8%
6.64	2.66E+03	6.0%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.13E+03	12%
4.52	7.63E+02	13%
6.64	5.95E+02	13%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	5.23E+02	15%
4.52	2.52E+02	21%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.13E+04	8.7%
4.52	1.25E+04	8.0%
6.64	1.21E+04	6.85
61.38	3.02E+03	5.3%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	7.83E+03	5.3%
4.52	6.62E+03	5.4%
6.64	5.44E+03	5.3%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.02E+03	10%
4.52	7.74E+02	14%
6.64	5.11E+02	11%
61.38	3.46E+02	5.4%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.15E+03	9.4%
4.52	9.49E+02	16%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.46E+03	6.1%
4.52	2.69E+03	6.7%
6.64	2.73E+03	6.0%
61.38	1.62E+03	5.0%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Continued)

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	2.19E+03	6.2%
4.52	2.29E+03	6.0%
6.64	2.42E+03	5.7%
61.38	2.16E+03	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.40E+04	5.1%
4.52	1.38E+04	5.1%
6.64	1.36E+04	5.1%
61.38	7.75E+03	5.0%

Product: ^{60g}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
3.50	3.99E+02	15%
4.52	2.93E+02	23%
6.64	2.89E+02	17%
61.38	2.58E+01	12%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	3.46E+03	5.6%
4.52	2.71E+03	5.9%
6.64	1.96E+03	6.0%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.63E+04	5.9%
4.52	9.86E+03	6.0%
6.64	3.74E+03	6.3%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	3.60E+01	19%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	5.29E+01	12%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
6.64	9.36E+01	23%
61.38	1.08E+02	6.7%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
3.50	1.53E+02	38%
4.52	2.53E+02	19%
6.64	1.81E+02	21%
61.38	1.50E+02	5.9%

Product: ^{89g}Zr, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	4.13E+03	5.7%
4.52	3.36E+03	5.8%
6.64	2.24E+03	6.1%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
3.50	6.28E+02	14%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
61.38	4.28E+01	13%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Continud)

Code:	IC625-2.83-L-Off
Incident proton energy:	2.83 GeV
N_p(Total):	2.19E+15
Irradiation time:	06'24"30
Sample:	Inc625-6
Weight:	0.370 g
Size:	20× 20 mm, 0.1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	2.96~2.93E-28

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.45E+02	14%
4.58	4.91E+01	11%
6.67	4.30E+01	29%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
1.66	8.73E+01	21%
4.58	4.87E+01	11%
6.67	2.60E+01	39%

Product: ^{46g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
60.52	1.82E+01	11%
61.58	1.67E+01	8.9%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.42E+02	14%
4.58	1.05E+02	7.1%
6.67	7.48E+01	19%

Product: ^{48}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
4.58	3.35E+01	14%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	7.53E+02	18%
4.58	7.11E+02	7.2%
6.67	7.91E+02	14%
60.52	1.88E+02	12%
61.58	1.83E+02	8.1%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	3.23E+02	6.6%
4.58	2.03E+02	5.8%
6.67	1.48E+02	14%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	3.99E+01	34%
4.58	2.43E+01	14%
6.67	3.03E+01	28%
60.52	2.10E+01	10%
61.58	1.88E+01	7.5%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
1.66	4.55E+02	8.7%
4.58	2.56E+01	17%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.69E+02	11%
4.58	1.43E+02	6.1%
6.67	1.67E+02	10%
60.52	8.94E+01	5.6%
61.58	8.40E+01	5.4%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	2.27E+02	8.8%
4.58	1.81E+02	5.4%
6.67	1.93E+02	8.2%
60.52	1.69E+02	5.4%
61.58	1.55E+02	5.1%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.47E+03	5.3%
4.58	1.34E+03	5.1%
6.67	1.30E+03	5.7%
60.52	8.29E+02	5.0%
61.58	7.64E+02	5.0%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.02E+02	14%
4.58	7.74E+01	7.1%
6.67	5.53E+01	19%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.66	1.69E+03	6.1%
4.58	4.19E+02	6.1%
6.67	1.55E+02	12%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Continued)

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
60.52	5.63E+00	24%
61.58	6.56E+00	16%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.66	3.16E+02	7.0%
4.58	1.59E+02	6.0%
6.67	9.99E+01	15%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.66	3.22E+02	8.1%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
60.52	5.01E+00	28%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Contined)

Code:	IC625-24-L-On
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	Inc625-4
Weight:	0.373 g
Size:	20× 20 mm, 0.1 mm^t
Position:	On-beam
N_p(Prtical):	5.37E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.05E+03	6.2%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.75	4.00E+01	11%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	1.09E+03	11%
55.75	7.84E+02	5.1%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	2.50E+04	6.4%
55.75	6.67E+03	5.2%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	1.45E+04	5.2%
55.75	2.59E+01	22%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	1.72E+03	9.9%
55.75	7.22E+02	5.1%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	6.21E+03	5.6%
55.75	3.45E+03	5.0%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	4.44E+03	5.4%
55.75	4.02E+03	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	2.37E+04	5.1%
55.75	1.35E+04	5.0%

Product: ^{60g}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
55.75	6.56E+01	9.3%

Product: ^{65}Zn, Half-life: 244.26 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	3.57E+01	26%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	8.32E+01	11%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.273E+02	5.7%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
4.08	5.91E+02	13%
55.75	3.10E+02	5.5%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.06E+02	8.0%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Continued)

Code:	IC625-24-L-Off
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	Inc625-8
Weight:	0.363 g
Size:	20× 20 mm, 0.1 mm^t
Position:	Off-beam
Reac. Rate for ^{93}Nb(n,2n)^m:	1.28~1.33E-27

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	5.04E+02	7.6%
2.23	3.62E+02	11%
3.94	1.80E+02	15%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	4.65E+02	7.3%
2.23	2.00E+02	22%
3.94	1.68E+02	17%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
56.92	4.19E+01	6.9%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	6.65E+02	6.7%
2.23	6.06E+02	7.7%
3.94	3.99E+02	10%

Product: ^{48}Sc, Half-life: 43.67 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	2.76E+02	10%
2.23	1.83E+02	16%
3.94	1.18E+02	26%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	1.61E+02	15%
2.23	7.06E+01	28%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	2.80E+03	8.6%
2.23	2.68E+03	11%
3.94	2.77E+03	11%
56.92	7.35E+02	6.1%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	1.16E+03	5.7%
2.23	9.18E+02	6.3%
3.94	7.49E+02	7.2%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
56.92	6.54E+01	5.9%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	2.27E+03	7.5%
2.23	7.90E+02	8.6%
3.94	2.14E+02	17%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	4.90E+03	6.9%
2.23	4.64E+02	7.4%
3.94	4.04E+02	11%
56.92	3.03E+02	5.1%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	5.99E+02	6.4%
2.23	6.08E+02	7.1%
3.94	5.87E+02	7.2%
56.92	5.62E+02	5.1%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	4.52E+03	5.1%
2.23	4.56E+03	5.1%
3.94	4.54E+03	5.2%
56.92	2.82E+03	5.0%

Product: ^{60g}Co, Half-life: 5.271 y

Cooling [d]	Activity [Bq/g]	%Error
56.92	1.61E+01	9.1%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	4.91E+02	6.7%
2.23	4.48E+02	7.7%
3.94	2.95E+02	10%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Contined)

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	6.96E+03	5.8%
2.23	4.12E+03	6.0%
3.94	2.09E+03	6.6%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
56.92	1.34E+01	9.8%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
56.92	2.09E+01	11%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
1.13	1.17E+03	5.6%
2.23	9.41E+02	6.2%
3.84	5.84E+02	8.0%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
1.13	2.06E+03	5.5%
2.23	6.17E+02	7.2%
3.84	8.79E+01	38%

Product: ^{92g}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
56.92	1.68E+01	11%

Table 9.14 Digital radioactivity data for the Inconel-625 samples. (Contined)

Code:	IC625-24-S-On
Incident proton energy:	24 GeV
N_p(Total):	7.90E+12
Irradiation time:	00'00"45
Sample:	Inc625-3
Weight:	0.376 g
Size:	20× 20 mm, 0.1 mm^t
Position:	On-beam
N_p(Prtical):	3.54E+12

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.083	3.29E+02	11%
0.71	1.82E+02	9.3%
2.31	3.20E+01	13%

Product: ^{52}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.083	3.85E+02	42%
0.71	2.00E+02	26%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.71	1.48E+02	13%
2.31	1.08E+02	7.4%
4.15	4.92E+01	20%

Product: ^{44g}Sc, Half-life: 83.79 h

Cooling [d]	Activity [Bq/g]	%Error
0.083	2.11E+03	5.9%
0.71	2.83E+02	8.8%
2.31	9.46E+01	7.7%
4.15	5.51E+01	19%

Product: ^{47}Sc, Half-life: 3.3492 d

Cooling [d]	Activity [Bq/g]	%Error
0.71	1.12E+02	18%
2.31	7.66E+01	9.4%
4.15	6.98E+01	18%

Product: ^{48}Cr, Half-life: 21.56 h

Cooling [d]	Activity [Bq/g]	%Error
0.71	6.45E+01	26%
2.31	1.51E+01	24%

Product: ^{52g}Mn, Half-life: 5.591 d

Cooling [d]	Activity [Bq/g]	%Error
0.71	1.83E+02	10%
2.31	1.23E+02	7.0%
4.15	9.35E+01	13%

Product: ^{55}Co, Half-life: 17.53 h

Cooling [d]	Activity [Bq/g]	%Error
0.083	8.64E+02	9.7%
0.71	4.38E+02	9.2%
2.31	9.69E+01	9.7%

Product: ^{56}Ni, Half-life: 6.077 d

Cooling [d]	Activity [Bq/g]	%Error
0.71	8.04E+01	18%
2.31	5.66E+01	9.4%
4.15	5.16E+01	18%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.083	1.11E+03	7.4%
0.71	8.85E+02	6.6%
2.31	3.90E+02	6.3%
4.15	1.71E+02	11%

Product: ^{89g}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
0.71	1.19E+02	14%
2.31	8.44E+01	8.1%
4.15	5.36E+01	19%

Product: ^{90g}Nb, Half-life: 14.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.71	6.02E+02	10%
2.31	2.50E+02	9.1%
4.15	4.04E+01	16%

Table 9.15 Digital radioactivity data for the Inconel-718 samples.

Code:	IC718-2.83-S-On
Incident proton energy:	2.83 GeV
N_p(Total):	2.33E+13
Irradiation time:	00'07"31
Sample:	Inc718-1
Weight:	2.27 g
Size:	30× 19 mm, 0.5 mm^t
Position:	On-beam
N_p(Prtical):	6.41E+12

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
61.98	6.05E+00	43%

Product: ^{24}Na, Half-life: 14.9590 h

Cooling [d]	Activity [Bq/g]	%Error
0.150	4.01E+02	5.9%
0.464	3.07E+02	5.5%

Product: ^{42}K, Half-life: 12.360 h

Cooling [d]	Activity [Bq/g]	%Error
0.150	4.39E+02	13%
0.464	3.10E+02	9.8%

Product: ^{44m}Sc, Half-life: 58.6 h

Cooling [d]	Activity [Bq/g]	%Error
0.150	2.30E+02	9.0%
0.464	2.15E+02	6.4%
7.06	3.05E+01	8.8%

Product: ^{44g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
0.150	1.75E+03	5.2%
0.464	6.48E+02	5.3%
7.06	2.97E+01	9.5%

Product: ^{46g}Sc, Half-life: 3.927 h

Cooling [d]	Activity [Bq/g]	%Error
7.06	7.45E+00	21%
61.98	6.50E+00	7.1%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
7.06	1.39E+02	14%
61.98	3.68E+01	9.5%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
7.06	8.93E+00	19%
61.98	6.24E+00	7.1%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
7.06	2.56E+01	10%
61.98	1.61E+01	5.6%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
0.46	2.88E+01	17%
7.06	2.23E+01	8.4%
61.98	2.08E+01	5.5%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
0.15	1.24E+02	11%
0.46	1.30E+02	7.1%
7.06	1.31E+02	5.6%
61.98	7.76E+01	5.1%

Product: ^{57}Ni, Half-life: 35.60 h

Cooling [d]	Activity [Bq/g]	%Error
0.15	8.51E+02	6.2%
0.46	7.49E+02	5.9%
7.06	3.22E+01	9.5%

Product: ^{89}Zr, Half-life: 3.27 d

Cooling [d]	Activity [Bq/g]	%Error
0.15	5.59E+01	19%
0.46	7.62E+01	9.3%
7.06	1.70E+01	14%

Table 9.15 Digital radioactivity data for the Inconel-718 samples. (Continued)

Code:	IC718-24-L-On
Incident proton energy:	24 GeV
N_p(Total):	1.48E+15
Irradiation time:	01'59"59
Sample:	Inc718-2
Weight:	2.38 g
Size:	30×19 mm, 0.5 mm^t
Position:	On-beam
N_p(Prtical):	7.03E+14

Product: ^{7}Be, Half-life: 53.29 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.45E+03	5.8%

Product: ^{22}Na, Half-life: 2.6019 y

Cooling [d]	Activity [Bq/g]	%Error
55.75	3.64E+01	9.5%

Product: ^{46g}Sc, Half-life: 83.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	7.80E+02	5.1%

Product: ^{51}Cr, Half-life: 27.702 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	6.51E+03	5.1%

Product: ^{54}Mn, Half-life: 312.3 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.08E+03	5.0%

Product: ^{56}Co, Half-life: 77.27 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.96E+03	5.0%

Product: ^{57}Co, Half-life: 271.79 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	3.50E+03	5.0%

Product: ^{58g}Co, Half-life: 70.82 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.23E+04	5.0%

Product: ^{75}Se, Half-life: 119.779 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	6.23E+01	8.8%

Product: ^{88}Y, Half-life: 106.65 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.63E+02	5.6%

Product: ^{88}Zr, Half-life: 83.4 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	2.16E+02	5.3%

Product: ^{92m}Nb, Half-life: 10.15 d

Cooling [d]	Activity [Bq/g]	%Error
55.75	1.11E+02	6.5%

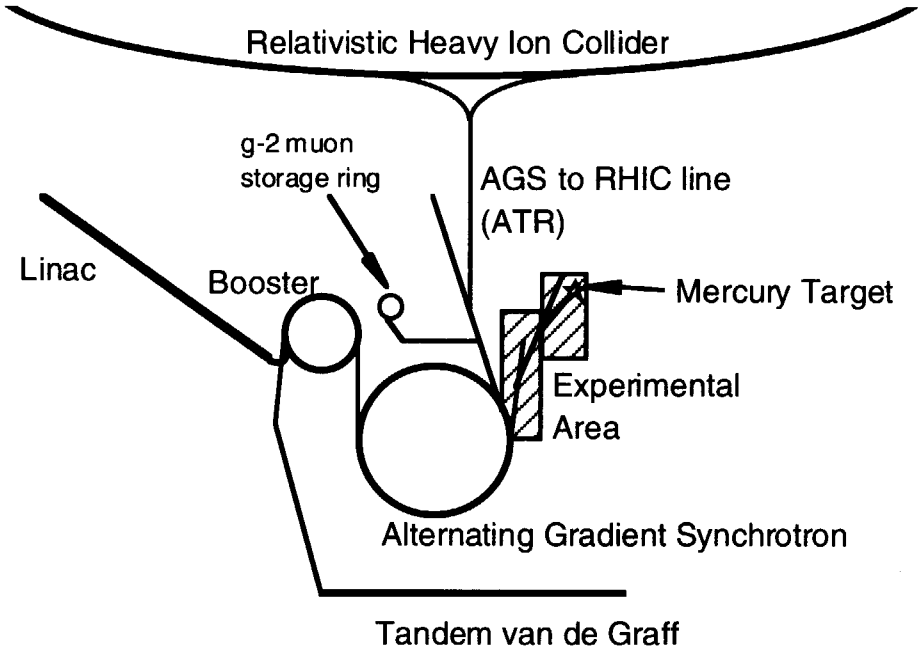


Fig. 1 A schematic drawing of the AGS accelerator complex.

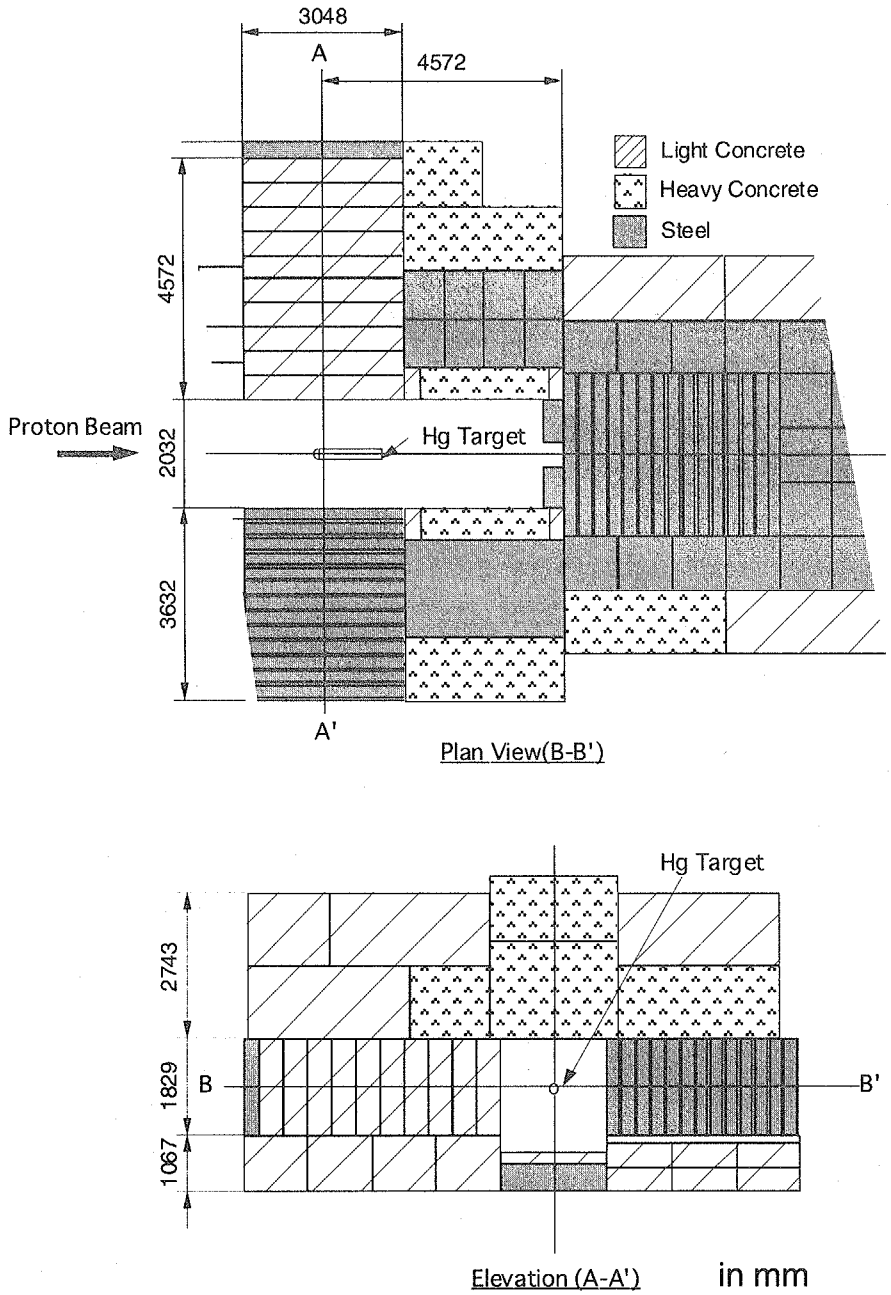


Fig. 2 Shield configuration around the mercury target.

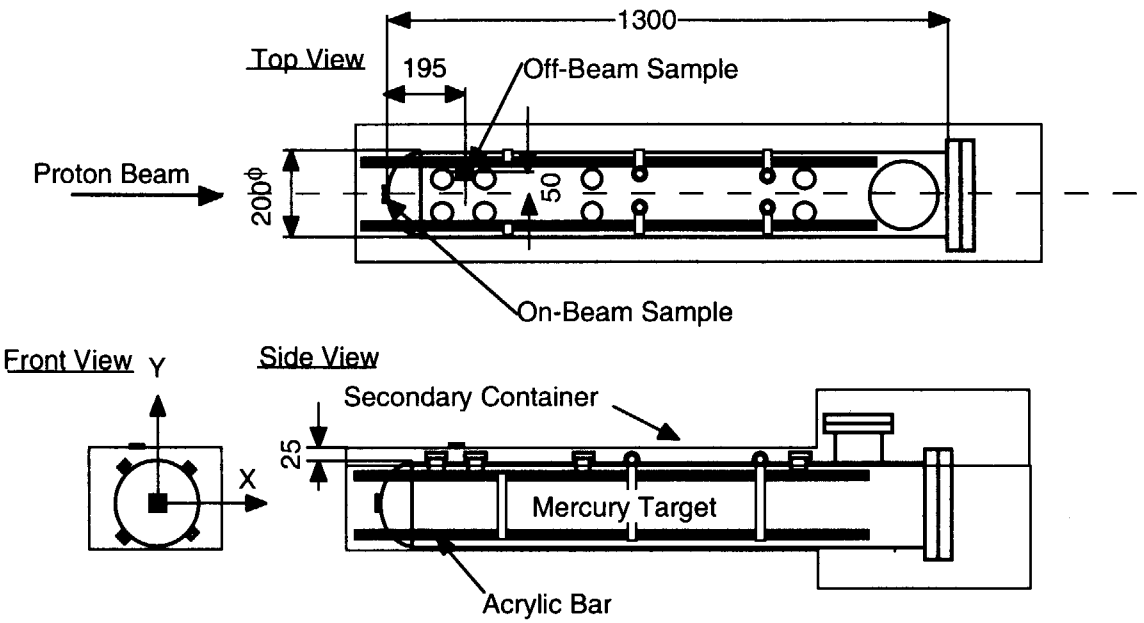


Fig. 3 Side, top and front view of the mercury target. The target container was made of stainless steel with 2.5 mm in thickness. The acrylic bar was used to set the activation detectors for measurement of neutronics performance of the mercury target. The xy-axes in the front view are used to show the shift of the proton beam center and the FWHM in Table 3. The origin of the coordinate axes was set at the center of the circles with 200 mm in diameter.

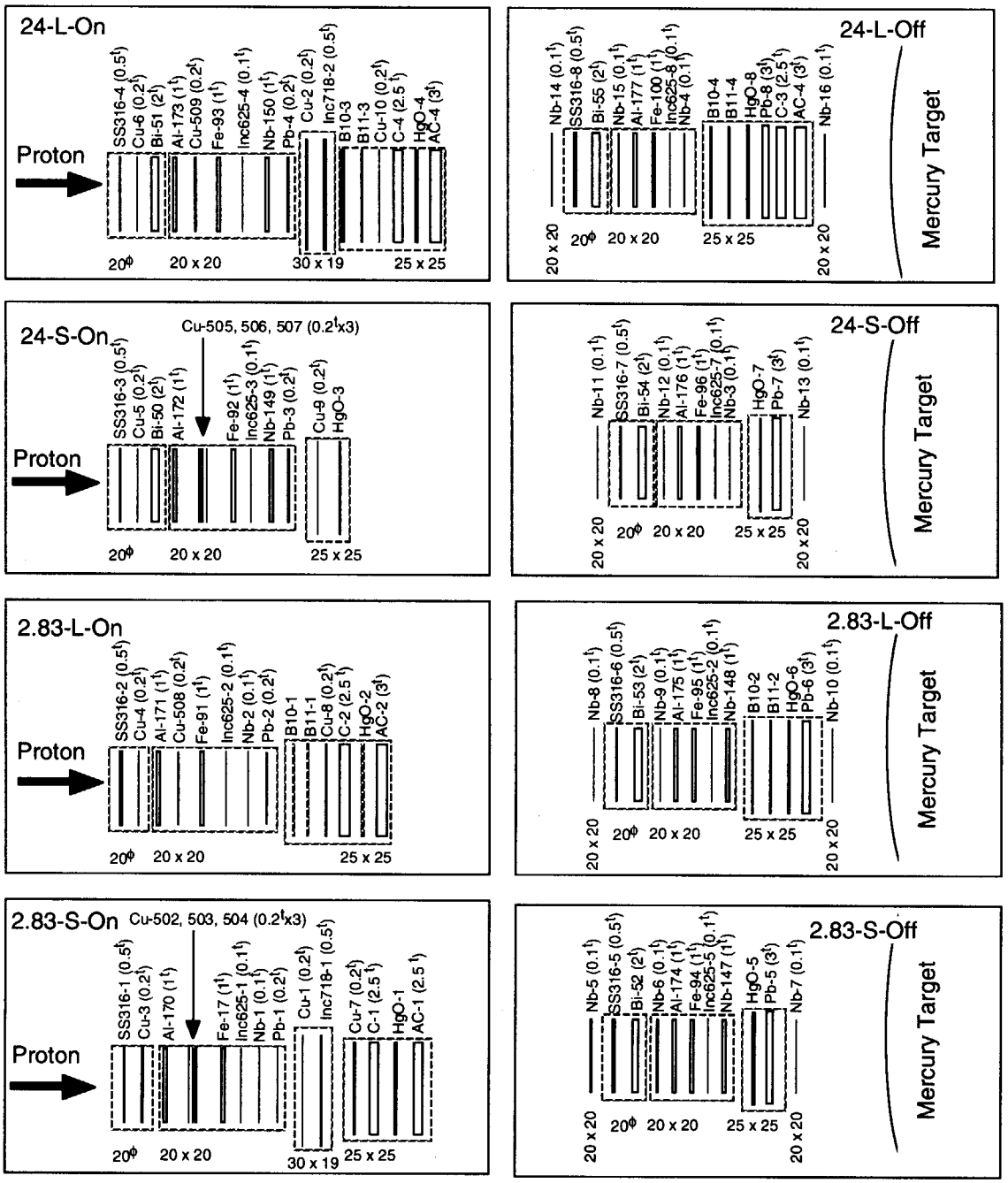


Fig. 4 Arrangement of the samples in each bunch. The total thickness of each bunch is 1~2 cm. The irradiation code like "24-L-On" means incident proton energy, irradiation time-length and sample position. The incident proton energy is shown in GeV. The symbols of "L" or "S" show long or short-irradiation, respectively. (The parameter for each irradiation are tabulated in Table 2.) "On" and "Off" show the on- and off-beam position, respectively. The sample code like Bi-51(2^t) shows abbreviation of material name, ID number and the thickness in mm. The size of each sample is shown like "20×20" and "20^ϕ", where "20^ϕ" means 20 mm diameter.

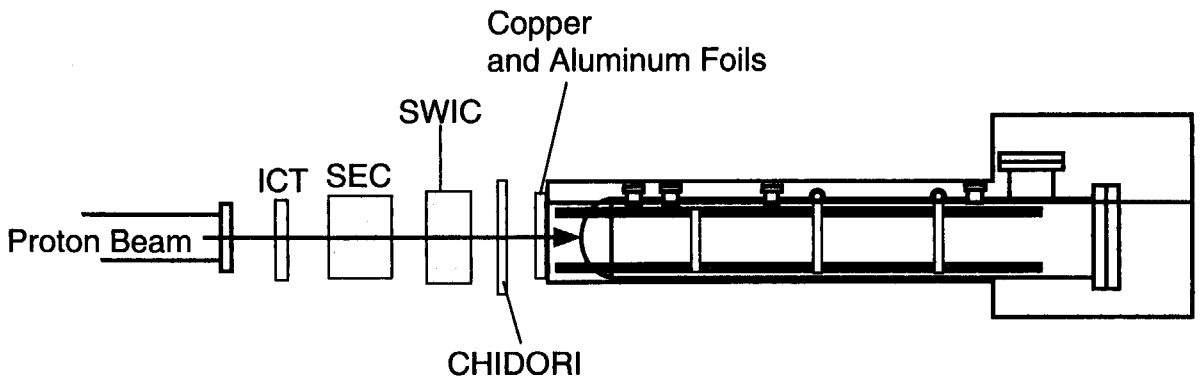


Fig. 5 Configuration of the proton beam monitors. The size of the copper and aluminum foil was 220 mm × 200 mm, and 0.2 mm and 25 μm in thickness, respectively. "SWIC" and "CHIDORI" are beam-profile monitors [10].

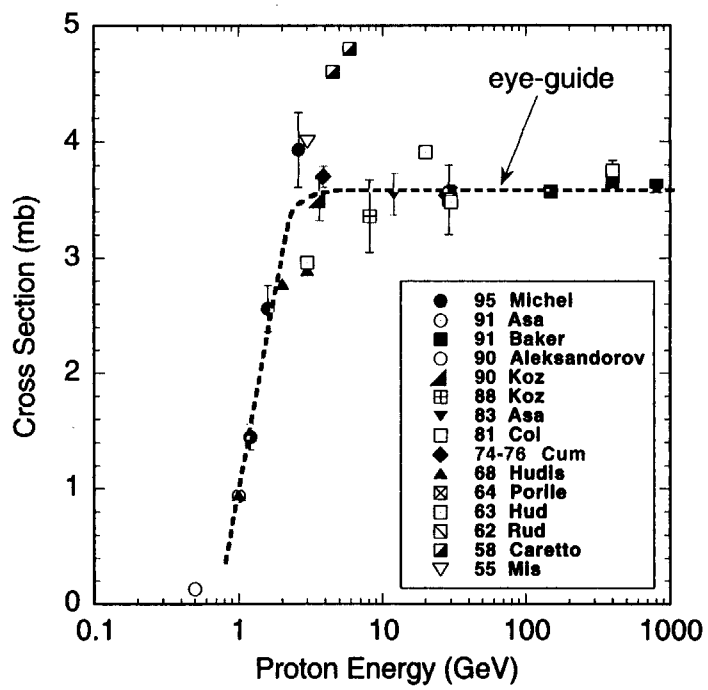


Fig. 6 Experimental cross section data for the $^{nat}Cu(p, x)^{24}Na$ reaction. The line shows the eye-guided curve. The cross sections were evaluated to be 3.5 ± 0.5 and 3.5 ± 0.2 mb at 2.83 and 24 GeV, respectively.

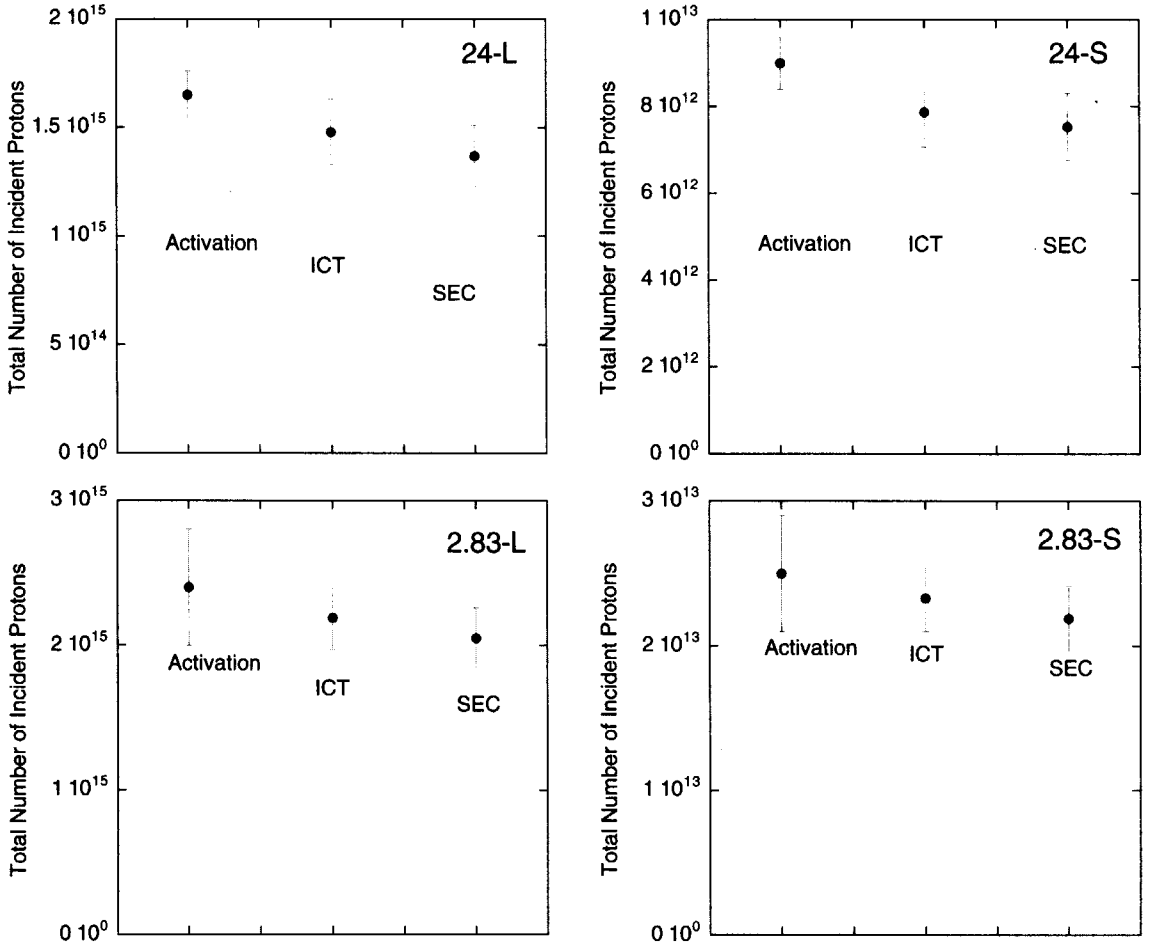


Fig. 7 Comparison of the experimental results for the different technique: ITC, SEC and activation technique using copper foils.

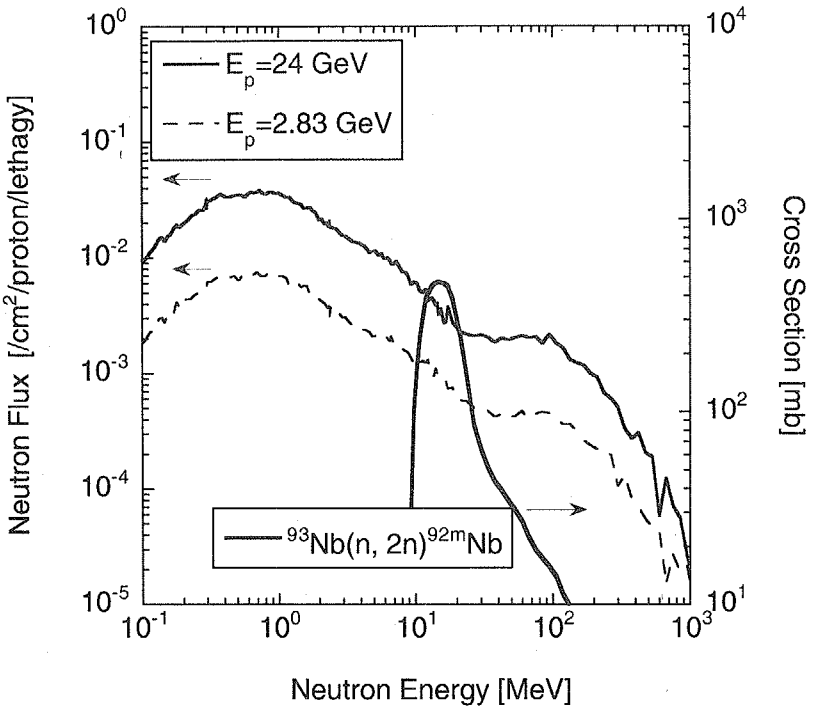


Fig. 8 Cross section curve of FENDL/A-2 evaluation for the ^{93}Nb(n, 2n)^{92m}Nb reaction and the calculated neutron spectrum at the off-beam position. The neutron spectrum was calculated using NMTC/JAM and MCNP.

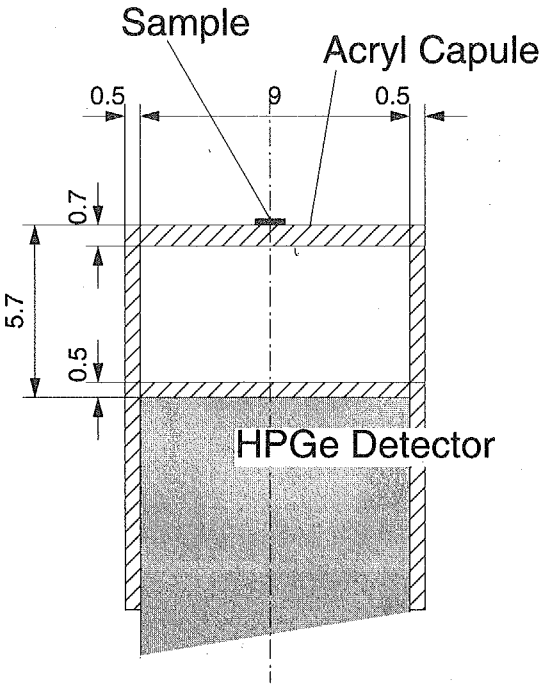


Fig. 9 Configuration of the HPGe detector and the sample

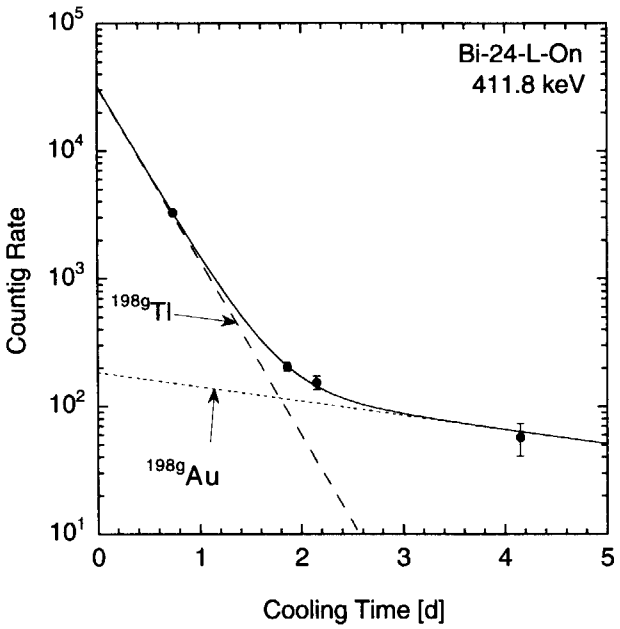


Fig. 10 Variation of counting rates of 411.8 keV gamma-ray for the bismuth sample irradiated at on-beam position (E_p=24 GeV) as a function of cooling time. The solid line shows the decay curve fitted to the experimental data, and the two dotted lines show the components of ^{198g}Tl and ^{198g}Au.

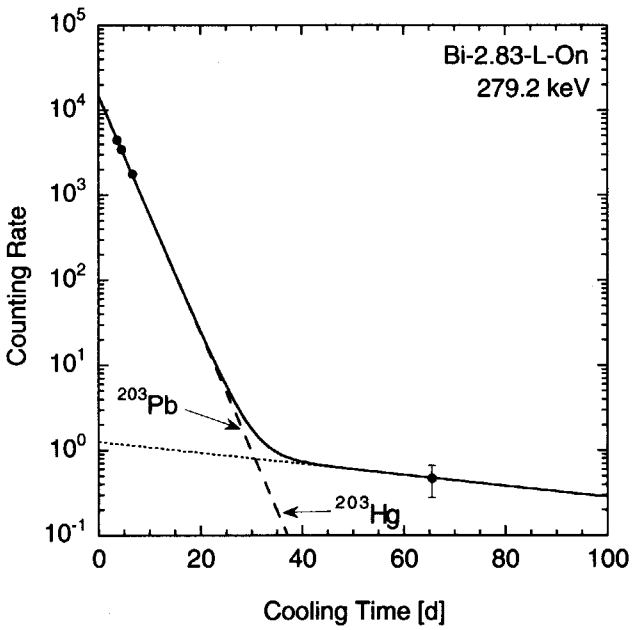
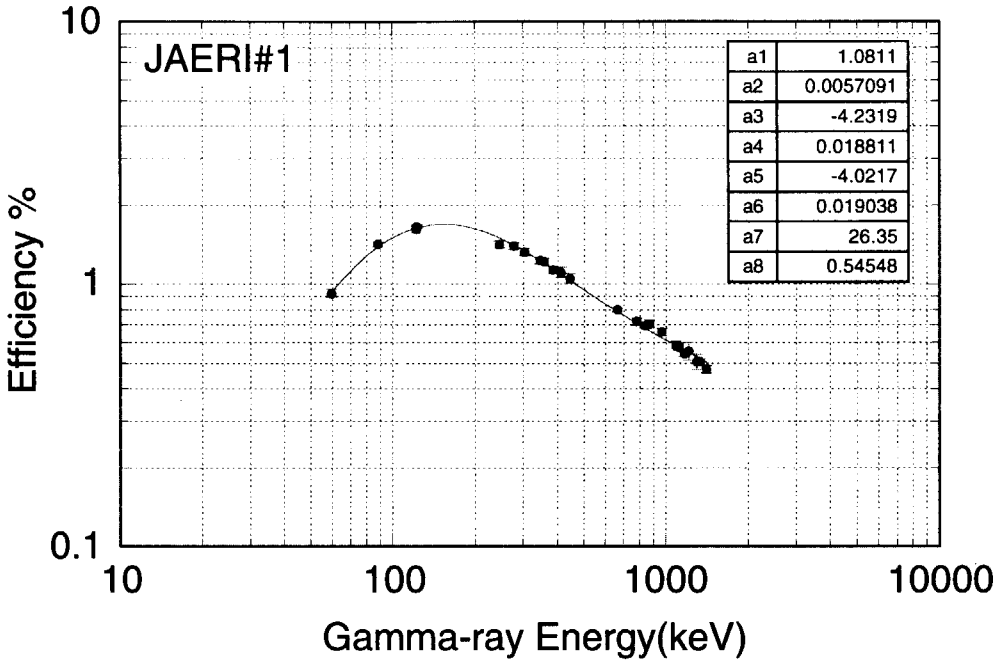


Fig. 11 Variation of counting rates of 279.2 keV for the bismuth sample irradiated at on-beam position (E_p=2.83 GeV) as a function of cooling time. The solid line shows the decay curve fitted to the experimental data, and the two dotted lines show the components of ^{203}Pb and ^{203}Hg.



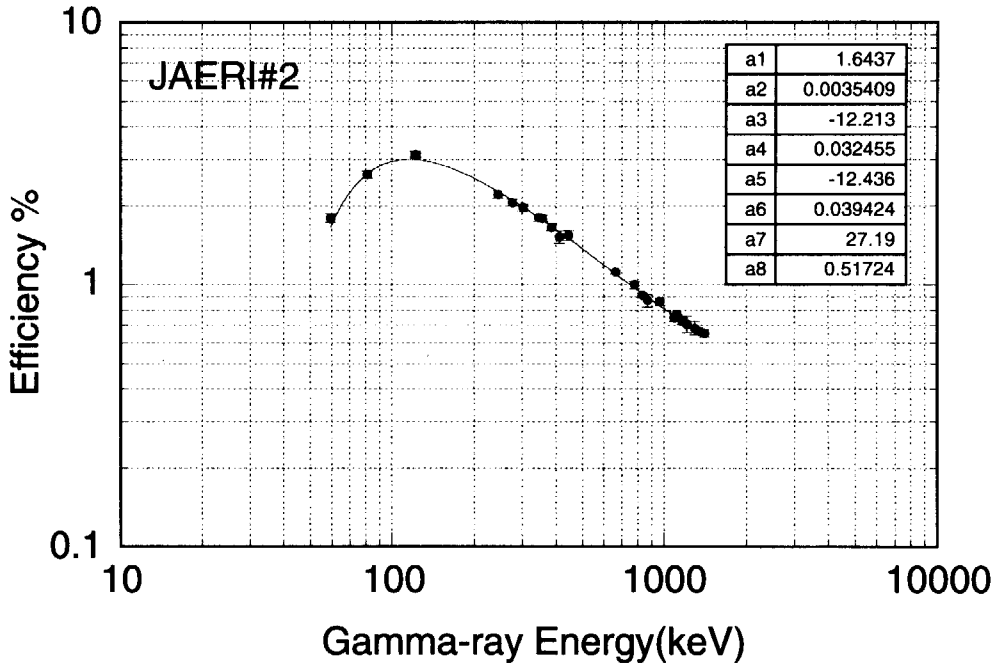


Fig. 12 Full-energy-peak efficiency curves of the HPGe detectors of JAERI #1 and #2. The closed circles show the experimental results measured with standard sources, and the lines show the fitting curves. The Eq. (2.2) was used for the fitting function. The fitting parameters are also tabulated in the figures.

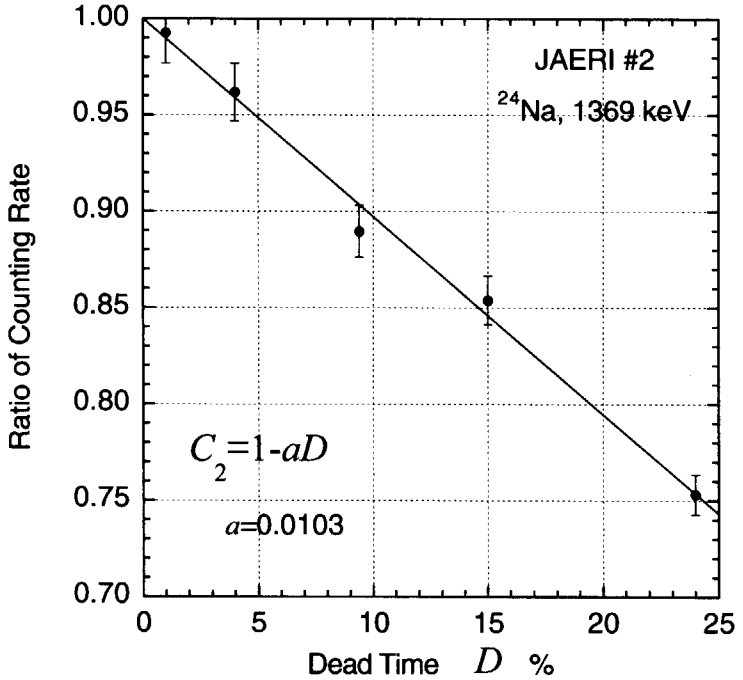
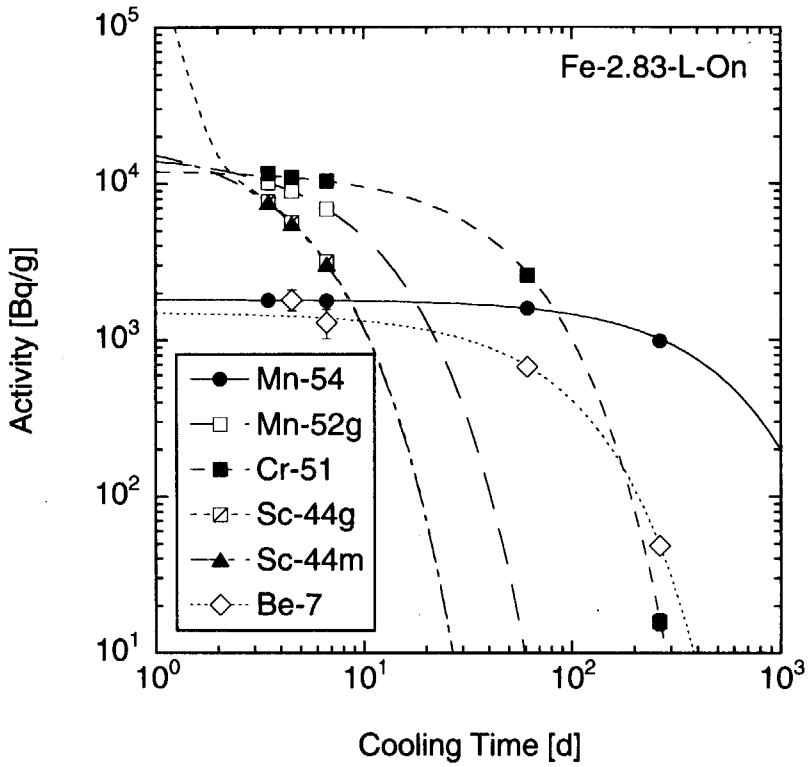


Fig. 13 Variation of the counting rate of 1369-keV γ-rays of ^{24}Na as a function of a dead time for the detector of JAERI #2. The shaping time constant of the spectroscopy amplifier was 3 μsec. In this measurement, other standard sources, ^{133}Ba, ^{152}Eu, etc., were used to increase the dead time. The data were normalized to the values extrapolated to D = 0%. The line shows the fitting curve; the fitting function and parameters are shown in the figure.



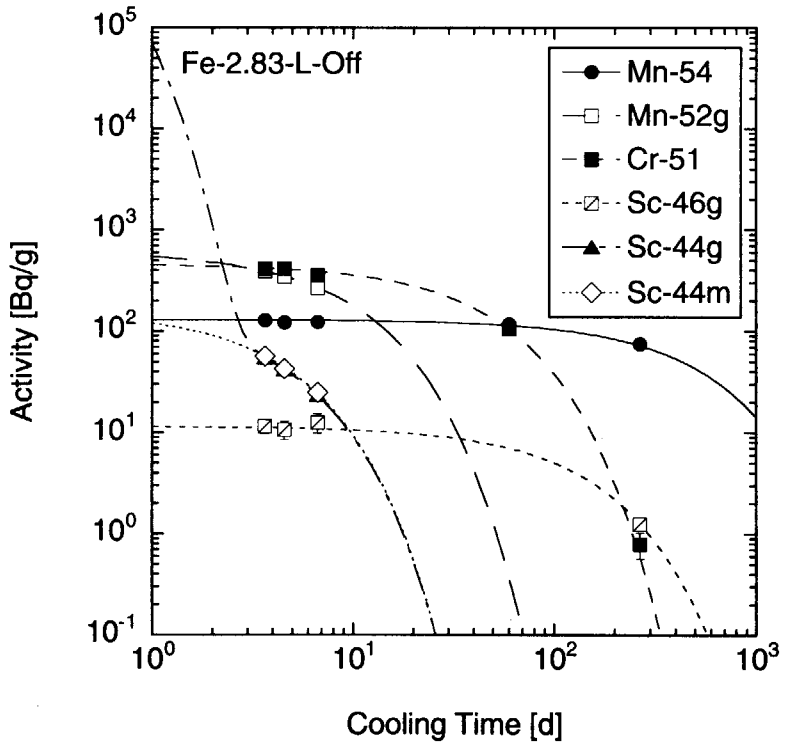


Fig. 14.1 Radioactivity of the iron samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 2.83 GeV. The experimental data for the major products are shown with the fitting curves.

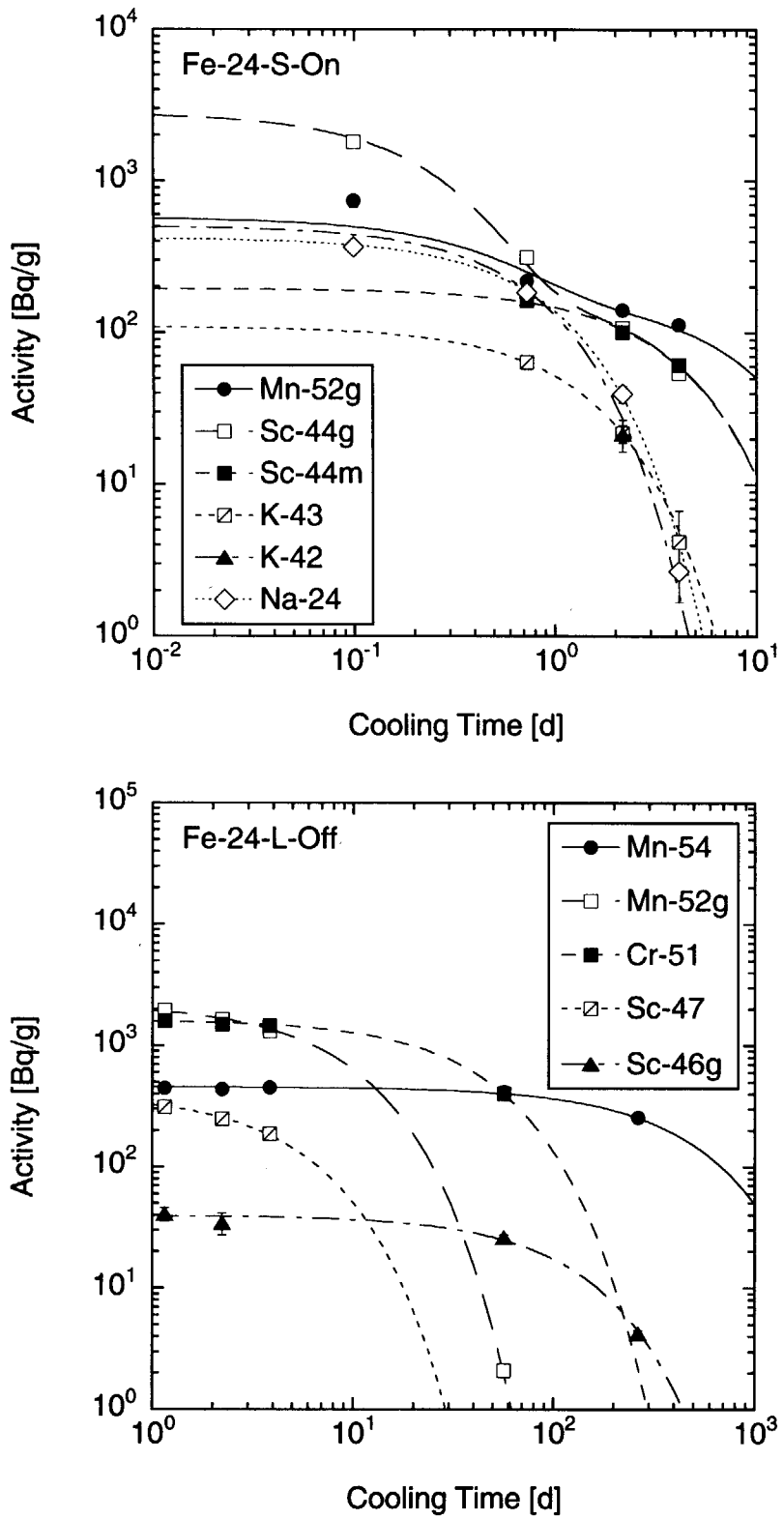


Fig. 14.2 Radioactivity of the iron sample for the short irradiation at the on-beam position and that for the long irradiation at the off-beam position with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

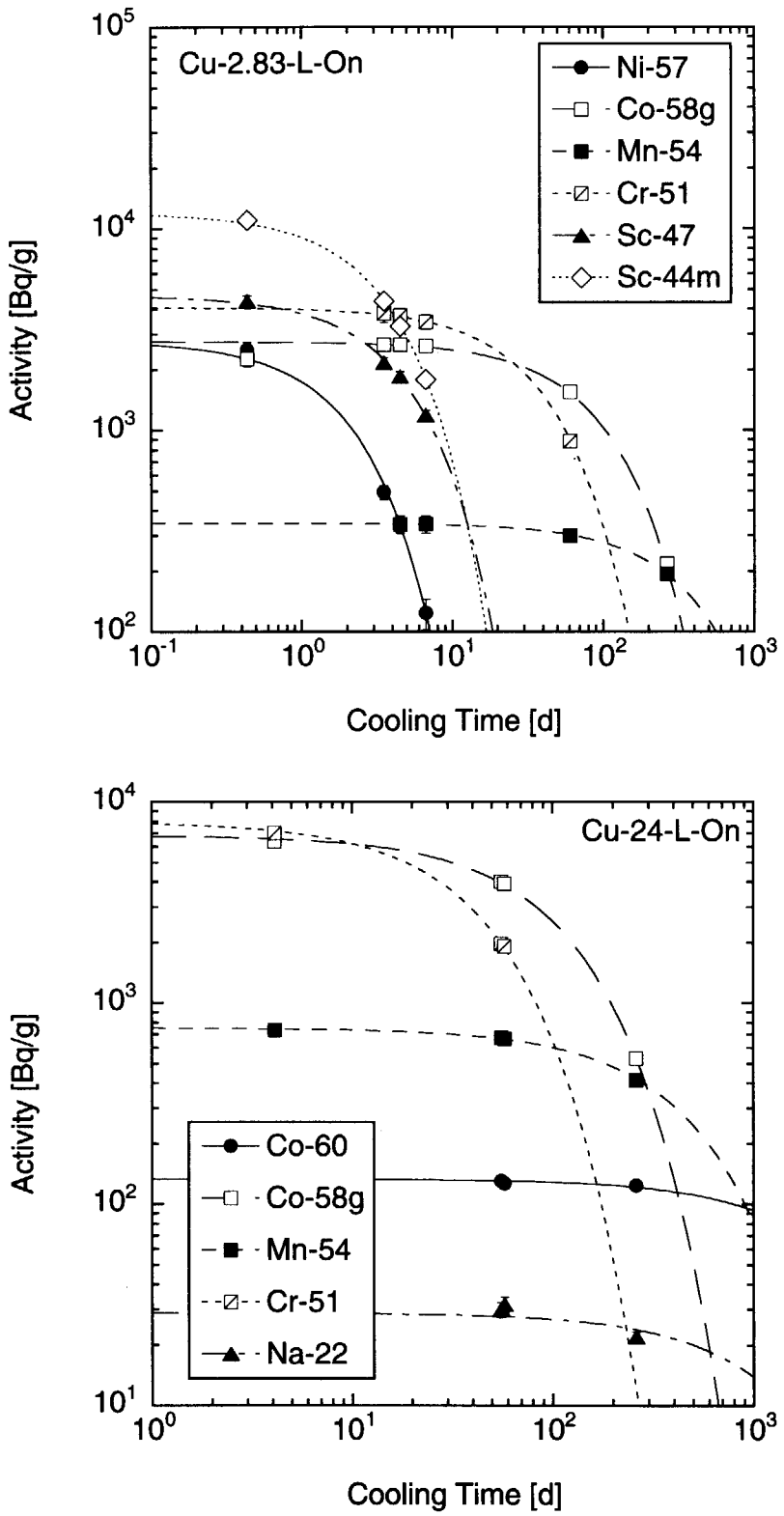


Fig. 15 Radioactivity of the copper samples for the long irradiation at the on-beam position with the incident proton energy of 2.83 and 24 GeV. The experimental data for the major products are shown with the fitting curves.

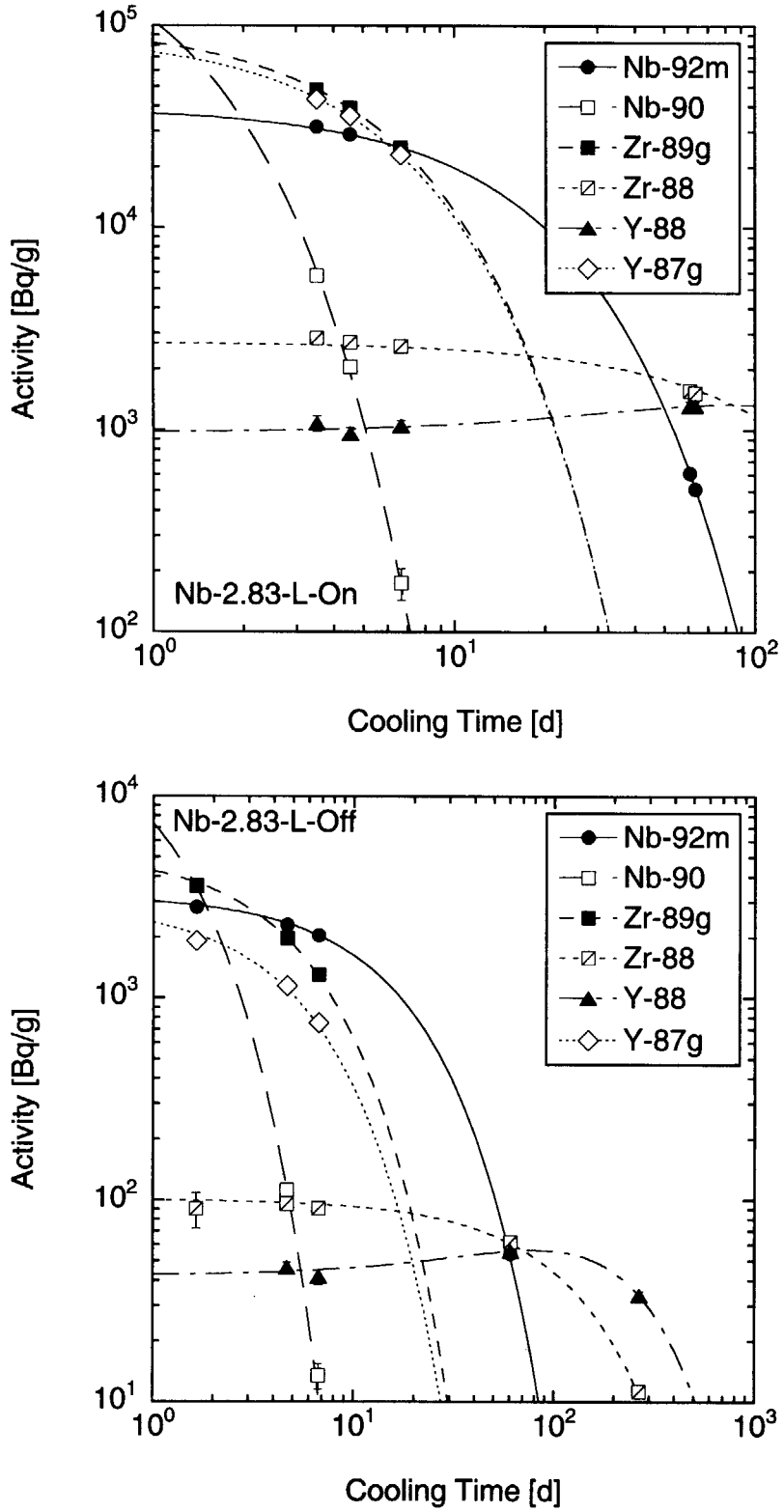


Fig. 16.1 Radioactivity of the niobium samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 2.83 GeV. The experimental data for the major products are shown with the fitting curves.

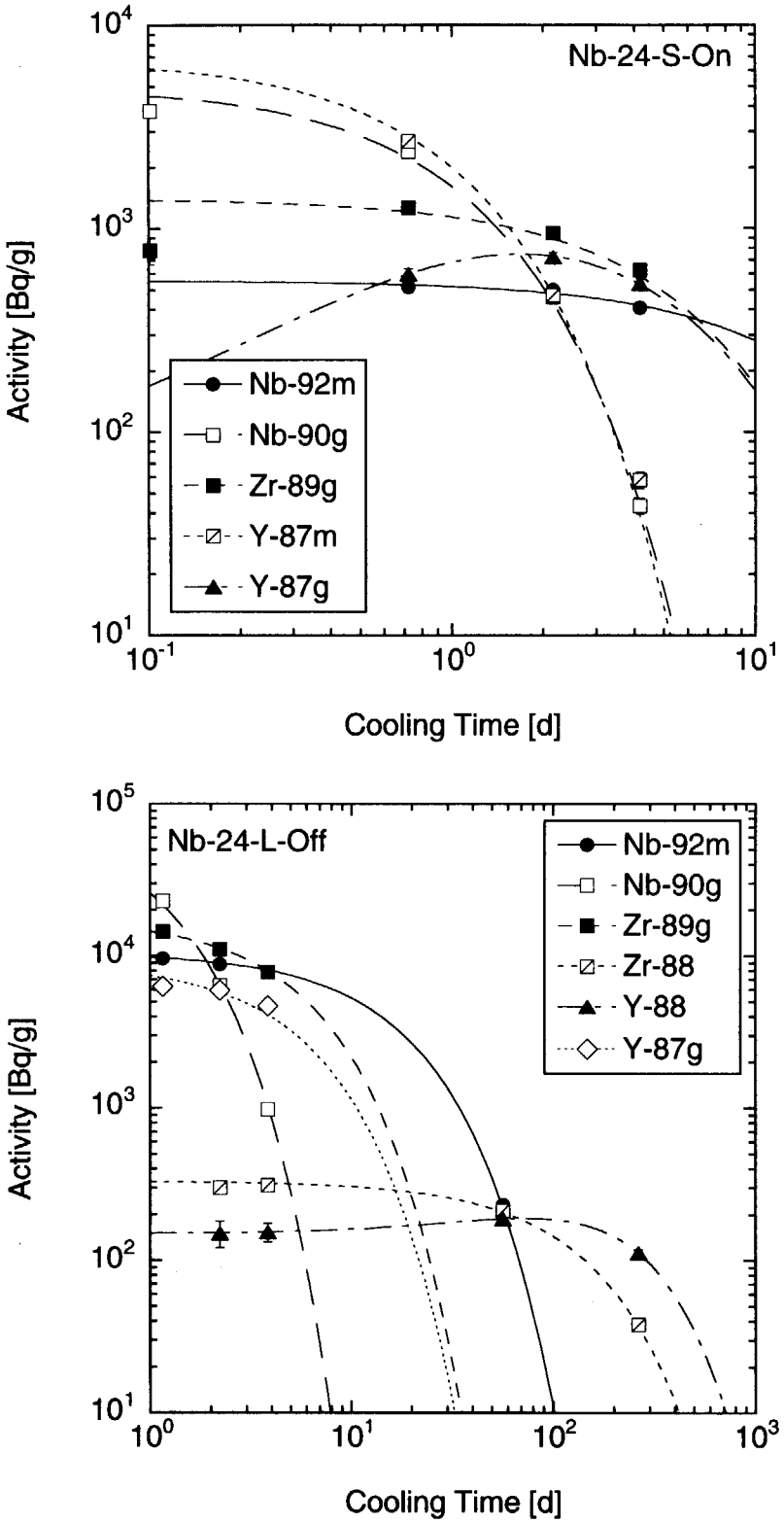


Fig. 16.2 Radioactivity of the niobium samples for the short irradiation at the on-beam position and that for the long irradiation at the off-beam position with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

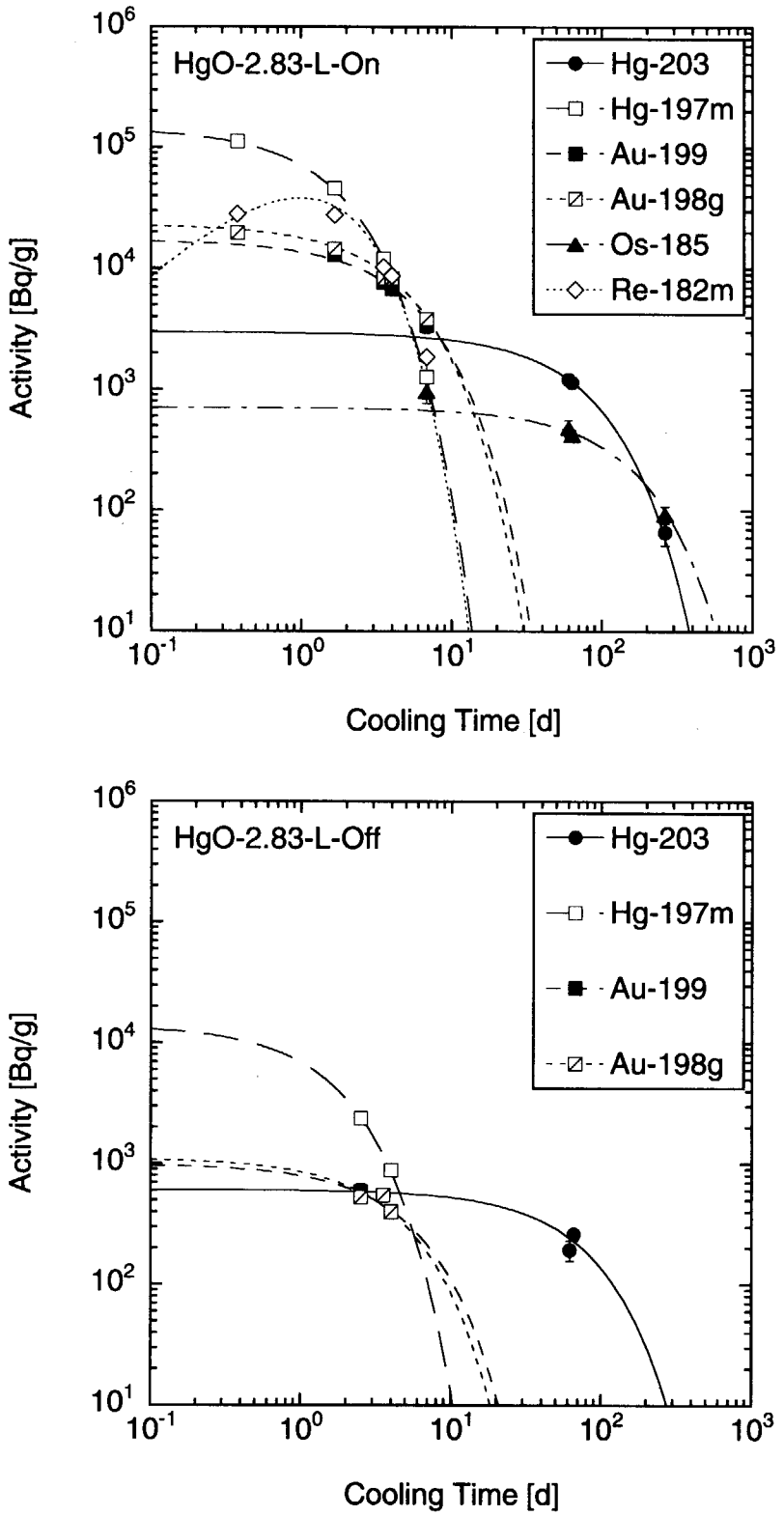


Fig. 17.1 Radioactivity of the mercury-oxide samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 2.83 GeV. The experimental data for the major products are shown with the fitting curves.

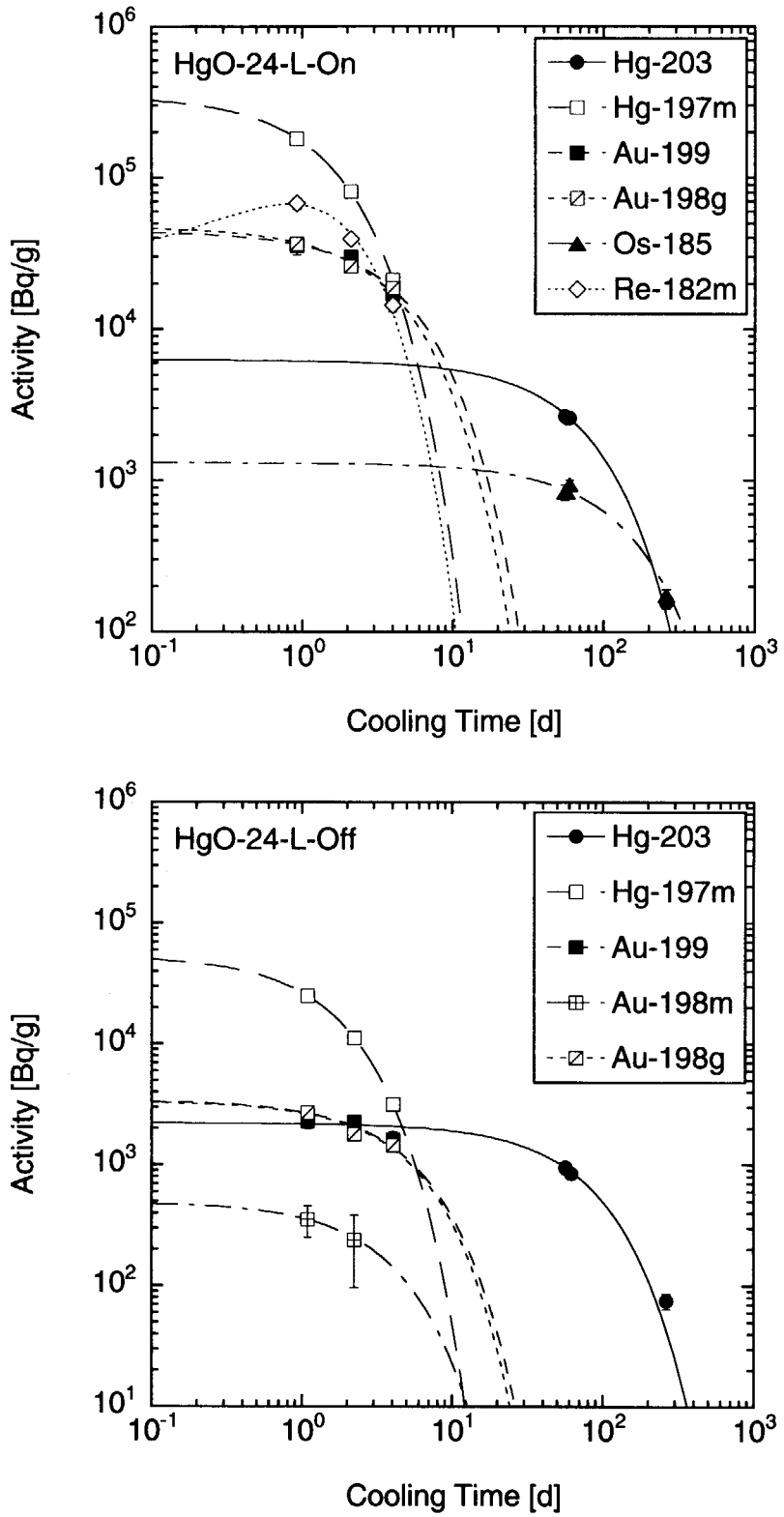


Fig. 17.2 Radioactivity of the mercury-oxide samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

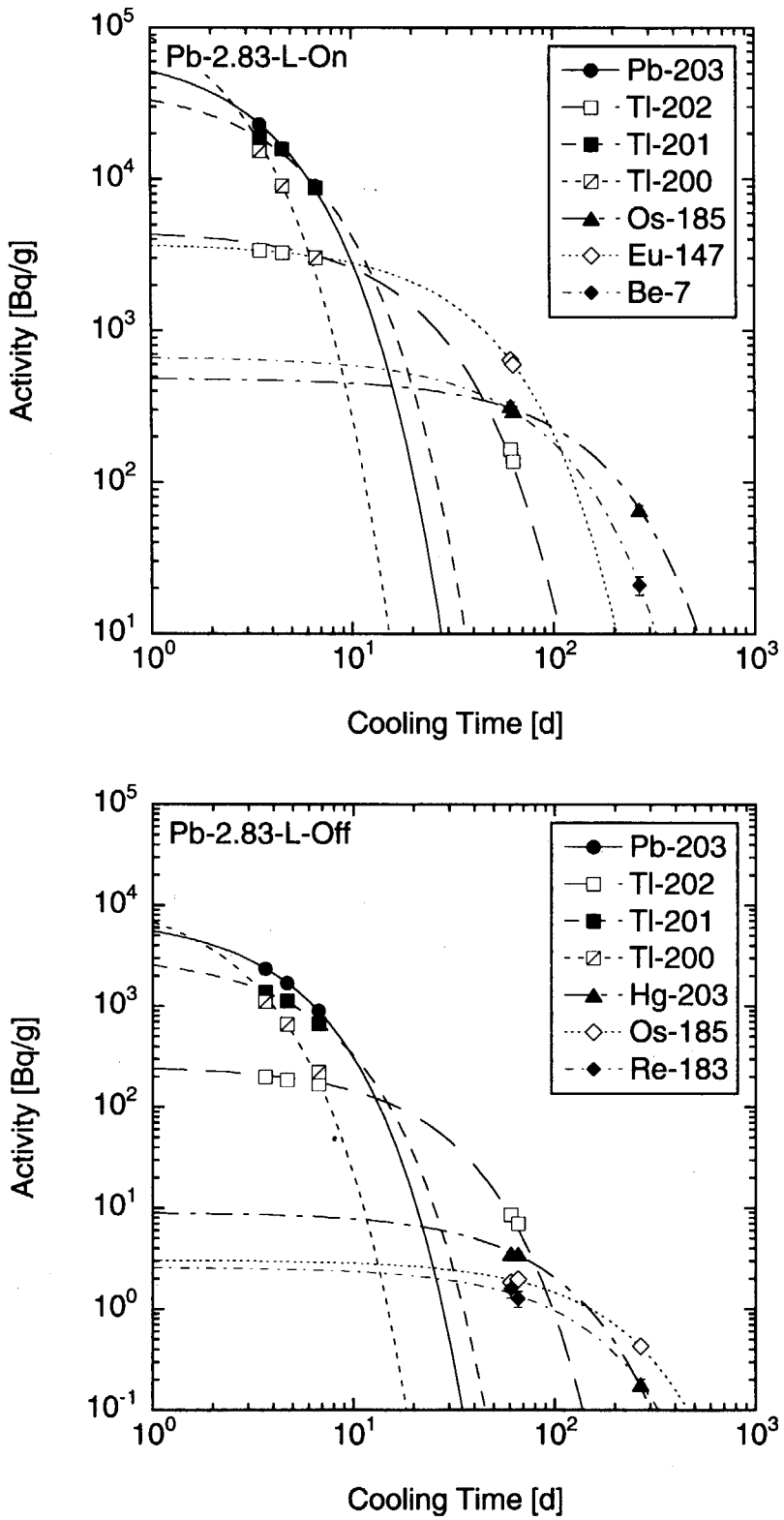


Fig. 18.1 Radioactivity of the lead samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 2.83 GeV. The experimental data for the major products are shown with the fitting curves.

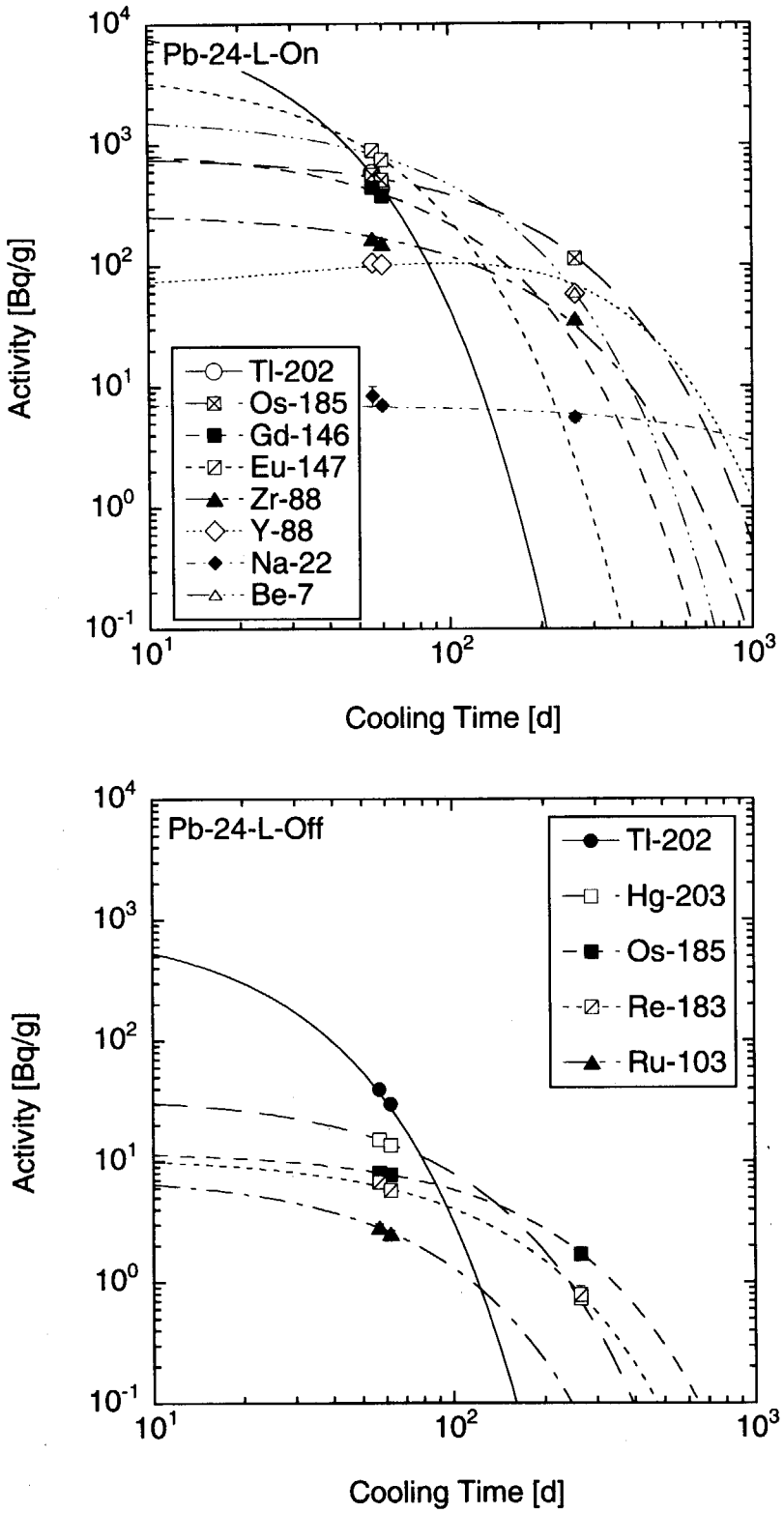


Fig. 18.2 Radioactivity of the lead samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

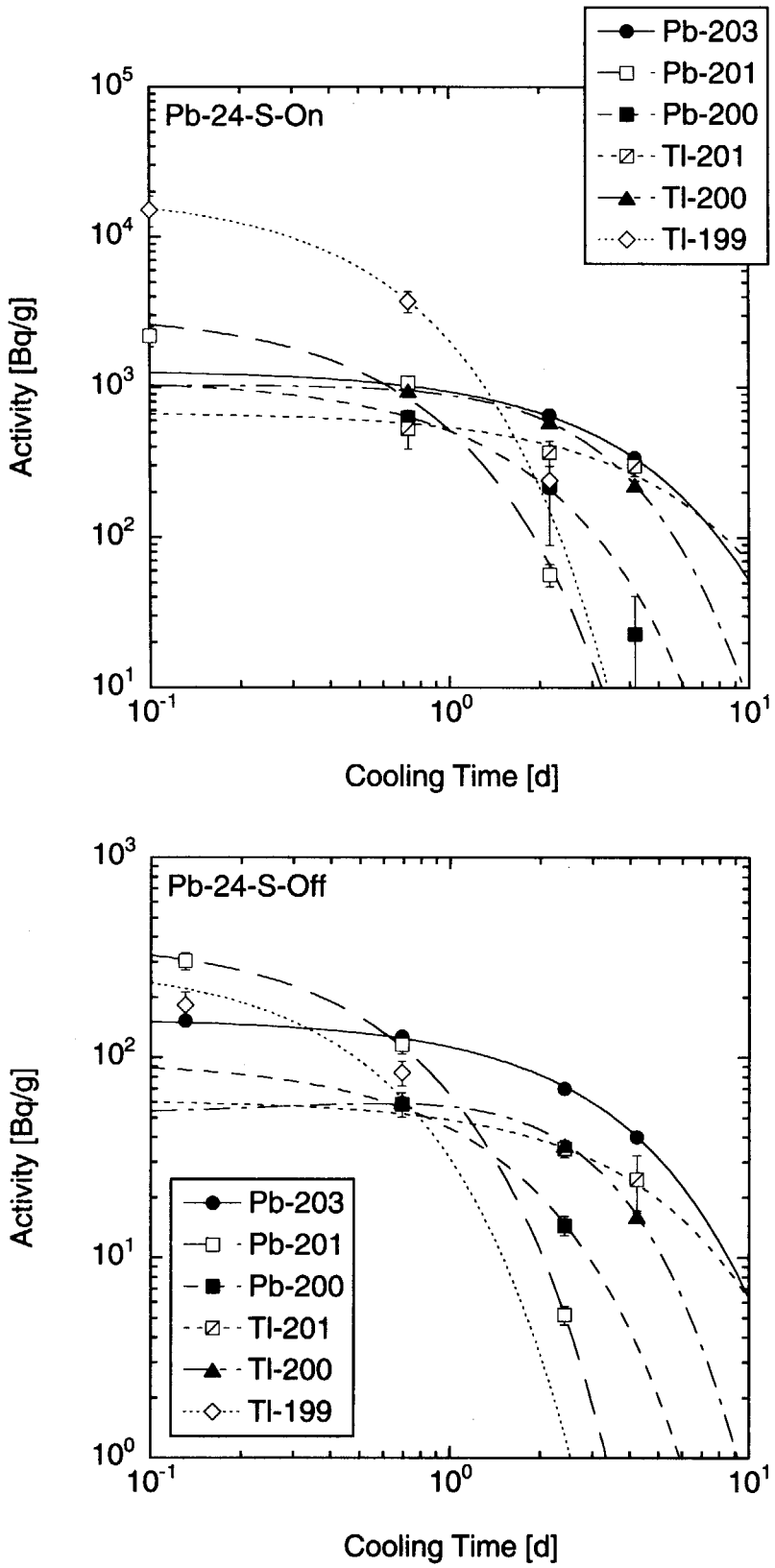


Fig. 18.3 Radioactivity of the lead samples for the short irradiation at the on- and off-beam positions with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

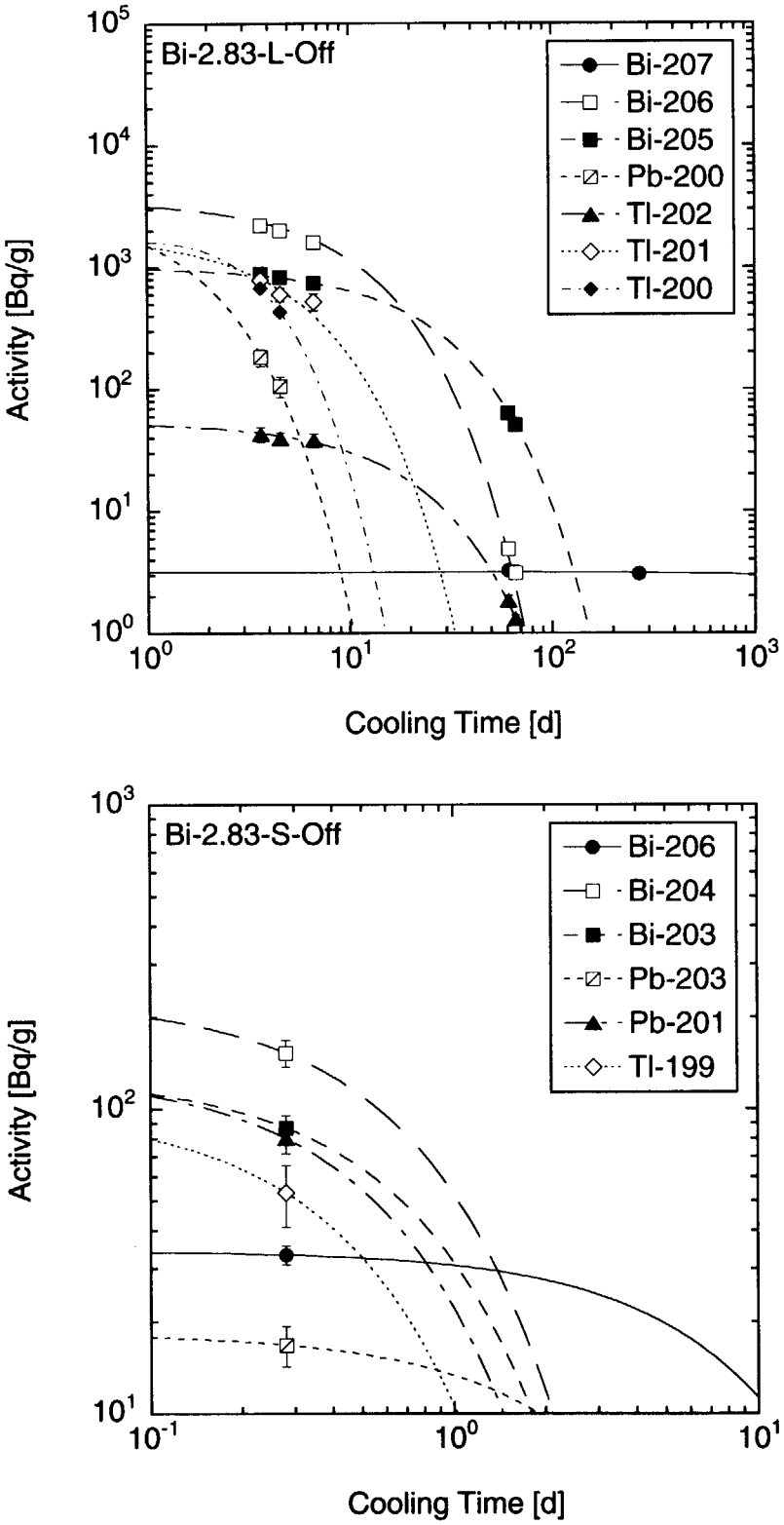


Fig. 19.1 Radioactivity of the bismuth samples for the long and short irradiation at the off-beam positions with the incident proton energy of 2.83 GeV. The experimental data for the major products are shown with the fitting curves.

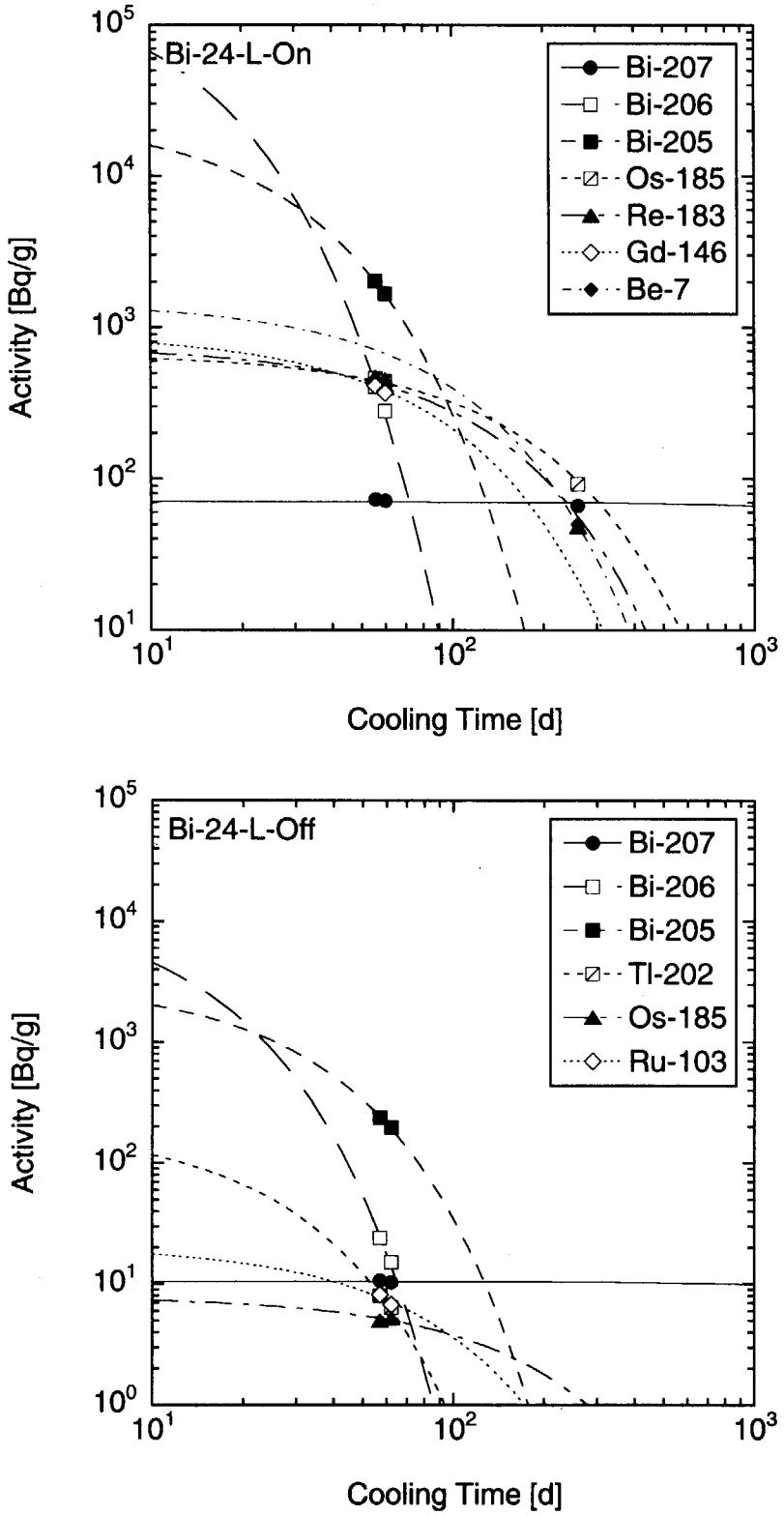


Fig. 19.2 Radioactivity of the bismuth samples for the long irradiation at the on- and off-beam positions with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

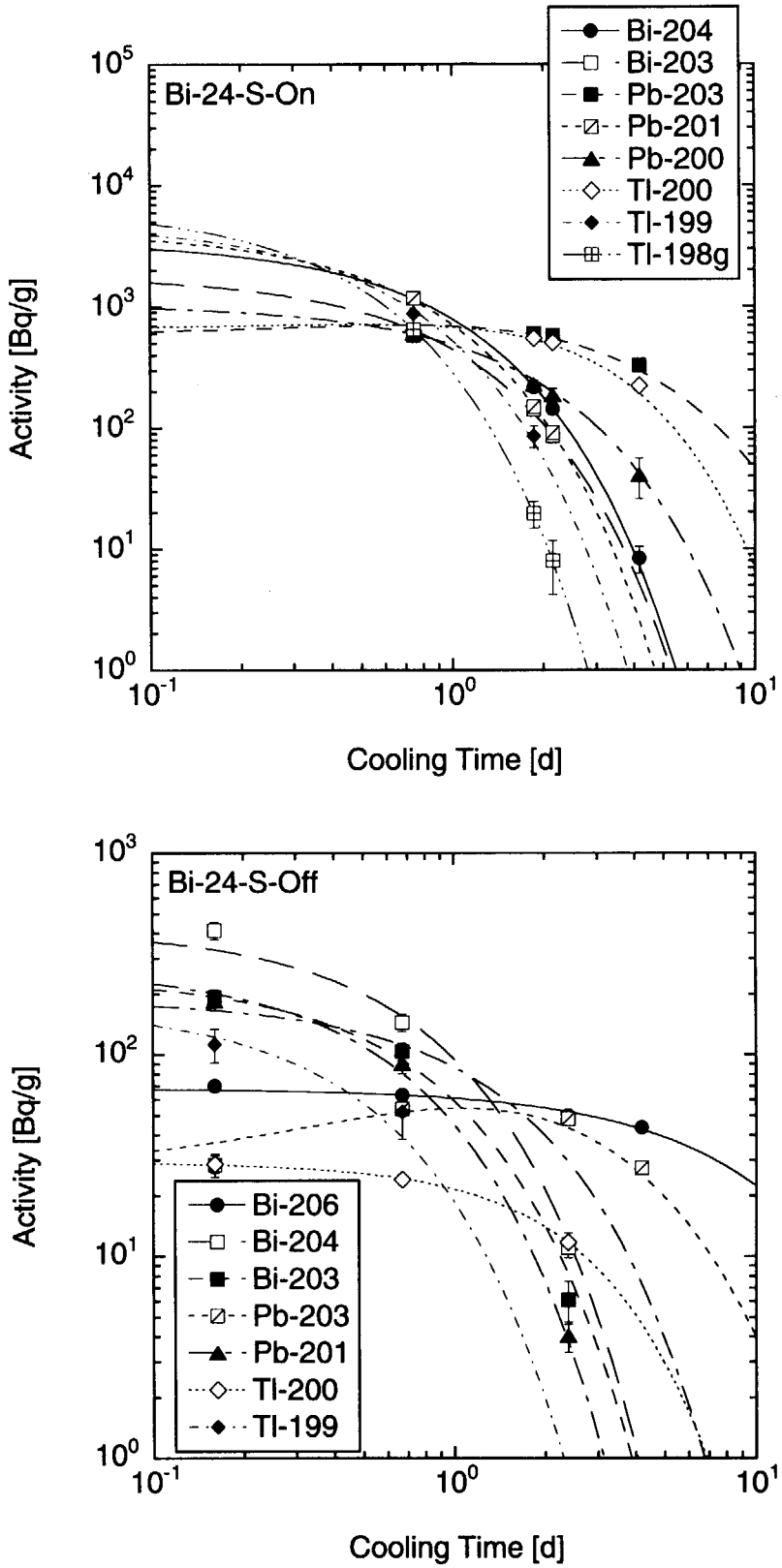


Fig. 19.3 Radioactivity of the bismuth samples for the short irradiation at the on- and off-beam positions with the incident proton energy of 24 GeV. The experimental data for the major products are shown with the fitting curves.

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国際単位系（SI）と換算表

表1　SI基本単位および補助単位

量	名称	記号
長さ	メートル	m
質量	キログラム	kg
時間	秒	s
電流	アンペア	A
熱力学温度	ケルビン	K
物質量	モル	mol
光度	カンデラ	cd
平面角	ラジアン	rad
立体角	ステラジアン	sr

表2　SIと併用される単位

名称	記号
分，時，日	min，h，d
度，分，秒	°，′，″
リットル	l，L
トン	t
電子ボルト	eV
原子質量単位	u

1 eV=1.60218×10^{-19}J

1 u=1.66054×10^{-27}kg

表5　SI接頭語

倍数	接頭語	記号
10^{18}	エクサ	E
10^{15}	ペタ	P
10^{12}	テラ	T
10^{9}	ギガ	G
10^{6}	メガ	M
10^{3}	キロ	k
10^{2}	ヘクト	h
10^{1}	デカ	da
10^{-1}	デシ	d
10^{-2}	センチ	c
10^{-3}	ミリ	m
10^{-6}	マイクロ	μ
10^{-9}	ナノ	n
10^{-12}	ピコ	p
10^{-15}	フェムト	f
10^{-18}	アト	a

表3　固有の名称をもつSI組立単位

量	名称	記号	他のSI単位による表現
周波数	ヘルツ	Hz	s^{-1}
力	ニュートン	N	m·kg/s^2
圧力，応力	パスカル	Pa	N/m^2
エネルギー,仕事,熱量	ジュール	J	N·m
工率，放射束	ワット	W	J/s
電気量，電荷	クーロン	C	A·s
電位，電圧，起電力	ボルト	V	W/A
静電容量	ファラド	F	C/V
電気抵抗	オーム	Ω	V/A
コンダクタンス	ジーメンス	S	A/V
磁束	ウェーバ	Wb	V·s
磁束密度	テスラ	T	Wb/m^2
インダクタンス	ヘンリー	H	Wb/A
セルシウス温度	セルシウス度	℃	
光束	ルーメン	lm	cd·sr
照度	ルクス	lx	lm/m^2
放射能	ベクレル	Bq	s^{-1}
吸収線量	グレイ	Gy	J/kg
線量等量	シーベルト	Sv	J/kg

表4　SIと共に暫定的に維持される単位

名称	記号
オングストローム	Å
バーン	b
バール	bar
ガル	Gal
キュリー	Ci
レントゲン	R
ラド	rad
レム	rem

1 Å=0.1nm=10^{-10}m

1 b=100fm^2=10^{-28}m^2

1 bar=0.1MPa=10^5Pa

1 Gal=1cm/s^2=10^{-2}m/s^2

1 Ci=3.7×10^{10}Bq

1 R=2.58×10^{-4}C/kg

1 rad=1cGy=10^{-2}Gy

1 rem=1cSv=10^{-2}Sv

(注)

1．表1－5は「国際単位系」第5版，国際度量衡局1985年刊行による。ただし，1 eVおよび1 uの値はCODATAの1986年推奨値によった。

2．表4には海里，ノット，アール，ヘクタールも含まれているが日常の単位なのでここでは省略した。

3．barは，JISでは流体の圧力を表わす場合に限り表2のカテゴリーに分類されている。

4．EC閣僚理事会指令ではbar，barnおよび「血圧の単位」mmHgを表2のカテゴリーに入れている。

換　算　表

力	N(=10^5dyn)	kgf	lbf
	1	0.101972	0.224809
	9.80665	1	2.20462
	4.44822	0.453592	1

粘　度　1 Pa·s(N·s/m^2)=10 P(ポアズ)(g/(cm·s))

動粘度　1m^2/s=10^4St(ストークス)(cm^2/s)

圧力	MPa(=10bar)	kgf/cm^2	atm	mmHg(Torr)	lbf/in^2(psi)
	1	10.1972	9.86923	7.50062×10^3	145.038
	0.0980665	1	0.967841	735.559	14.2233
	0.101325	1.03323	1	760	14.6959
	1.33322×10^{-4}	1.35951×10^{-3}	1.31579×10^{-3}	1	1.93368×10^{-2}
	6.89476×10^{-3}	7.03070×10^{-2}	6.80460×10^{-2}	51.7149	1

エネルギー・仕事・熱量	J(=10^7 erg)	kgf·m	kW·h	cal(計量法)	Btu	ft·lbf	eV
	1	0.101972	2.77778×10^{-7}	0.238889	9.47813×10^{-4}	0.737562	6.24150×10^{18}
	9.80665	1	2.72407×10^{-6}	2.34270	9.29487×10^{-3}	7.23301	6.12082×10^{19}
	3.6×10^6	3.67098×10^5	1	8.59999×10^5	3412.13	2.65522×10^6	2.24694×10^{25}
	4.18605	0.426858	1.16279×10^{-6}	1	3.96759×10^{-3}	3.08747	2.61272×10^{19}
	1055.06	107.586	2.93072×10^{-4}	252.042	1	778.172	6.58515×10^{21}
	1.35582	0.138255	3.76616×10^{-7}	0.323890	1.28506×10^{-3}	1	8.46233×10^{18}
	1.60218×10^{-19}	1.63377×10^{-20}	4.45050×10^{-26}	3.82743×10^{-20}	1.51857×10^{-22}	1.18171×10^{-19}	1

1 cal= 4.18605J（計量法）

= 4.184J（熱化学）

= 4.1855J（15℃）

= 4.1868J（国際蒸気表）

仕事率　1 PS(仏馬力)

= 75 kgf·m/s

= 735.499W

放射能	Bq	Ci
	1	2.70270×10^{-11}
	3.7×10^{10}	1

吸収線量	Gy	rad
	1	100
	0.01	1

照射線量	C/kg	R
	1	3876
	2.58×10^{-4}	1

線量当量	Sv	rem
	1	100
	0.01	1

(86年12月26日現在)

Measurement of Radioactivity Induced by GeV-Protons and Spallation Neutrons Using AGS Accelerator