Total α, β radioactivity in soil, water, plant samples from environment around HIRFL and soil, plant samples from Radioactive Waste Storeroom (RWS) are measured with BH1216 low background α, β easuring instrument, the results are shown in Table 3, and compared with the background level of China[2].

References

[1] Chunting Liu, Shuming Bai, Xiuying Ren, et al., Radiation Protection, 1 (1996)121. (in Chinese)

[2] Lianmao Sha, Hennan Zhu, Shi Chen, Radiation Protection, 12(1996)122. (in Chinese)

6 - 44 Studying of Residual Activity Induced by 300 MeV/u Carbon Ion in Copper Target

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Activation of accelerator components due to beam losses is an important issue for a high-energy heavy ion accelerator. The induced components may become a main source of exposure to maintenance workers and a serious access-restriction for “hand-on” maintenance, and also have a certain radiation influence over the environment. In this work, experimental of residual activation induced by 300 MeV/u carbon ions was studied at the deep-therapy terminal of HIRFL.

Carbon ions with energy of 300 MeV/u were accelerated by HIRFL and delivered to the deep tumor therapy room, and the target was irradiated by 6.97×10^{10} carbon ions. The ion counts were measured by a plate ionization chamber which located behind the beam extraction windows. The ionization chamber is filled with the nitrogen gas with 1 atm pressure. The copper target consisted of 15 foils (7 thick targets and 8 thin target), and the thick and thin targets are alternating arranged. The overall thickness is 60 mm. The thin foil is a cylinder of 50 mm in diameter and 0.5 mm in thickness, used for gamma spectrum measurements to sample the depth-profiled of residual activity; and the thick foil is a cylinder of 50 mm in diameter and 8 mm in thickness, used for defining the distance between sampling-points. The configuration of the copper target is shown in Fig. 1. The experiment is carried out at the deep-therapy terminal of HIRFL, and the experimental layout as shown in Fig. 2.

Fig. 1 (color online) The copper target for experiment.

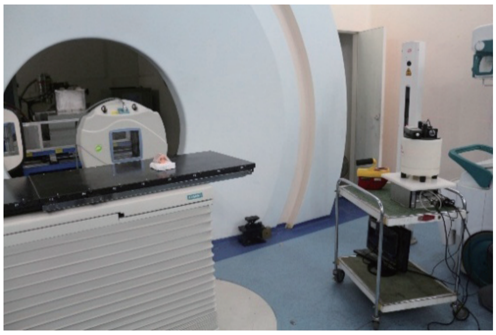

Fig. 2 (color online) The experiment layout.

The gamma-ray spectroscopy measurements were carried out with HPGe detector. Fig. 3 shows the time evolution of the total dose rate after the irradiation, it shows that the total activity will decrease rapidly just after the accelerator is shut down. The total dose rate in the copper target will reduce to about 54% of its original value after 11 min, and the dose rate reduce to about 39% of its original date after the accelerator shut down 30 min. As time goes on, total activity of the target decays more slowly. Table 1 shows the activity of the radionuclides in the first thin foil target. Fig. 4 shows the depth-profiling of the residual activity. It can be seen that the produced radionuclides have the largest activity at the end range of the carbon in copper target (the range of 300 MeV/u carbon ion in copper target is about 2.7 cm)，and there is also produced radionuclides in the target out of the carbon ion’s range.。This is because a large number of carbon ions stopped near the end of range, and secondary particles have a larger range than the primary ions.

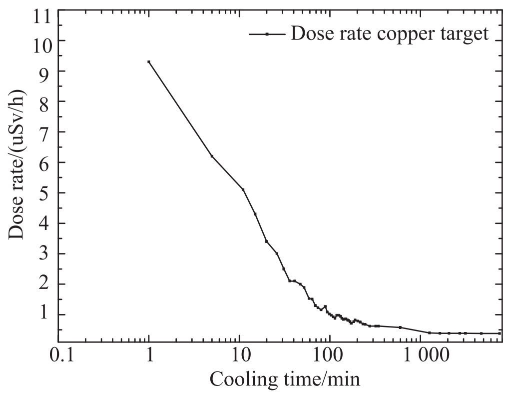

Fig. 3 Dose rate changes with the cooling time.

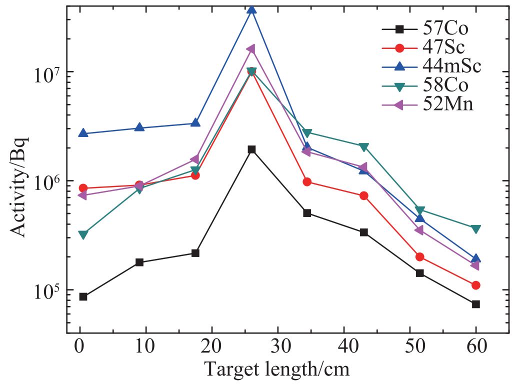

Fig. 4 (color online) Activity depth profiles of radionuclides.

Table 1 Identified isotopes and their activities in the first thin copper foil.

Nuclide	Energy/keV	Half-life/min	Branching ratio	Activity of removal time/Bq
^{48}Cr	112.36	1 293.6	0.960	3.0×10^5
^{57}Co	122.5	391 536.0	0.856	8.6×10^4
^{47}Sc	159.45	4 823.0	0.683	8.5×10^5
^{44m}Sc	271.42	3 516.0	0.867	2.7×10^7
^{43}Kr	372.76	1 338.0	0.870	1.4×10^6
^{43}K	617.49	1 338.0	0.870	1.2×10^6
^{52}Mn	744.6	8 051.0	0.900	9.4×10^5
^{58}Co	810.775	102 038.0	0.990	3.2×10^5
^{55}Co	931.3	1 051.8	0.750	1.0×10^6
^{52}Mn	936.25	8 051.0	0.945	7.3×10^5
^{44}Sc	1 157.031	238.3	0.999	1.3×10^8
^{48}Sc	1 312.096	2 620.2	1.001	6.2×10^5
^{24}Na	1 370.92	897.5	1.000	5.9×10^6
^{52}Mn	1 434.068	805	1.000	5.8×10^5
^{62}Zn	1 527.9	551.6	0.005 7	4.8×10^8