

醫用迴旋加速器週邊輻射安全管制及中子劑量量測

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摘要

由實驗結果顯示慈濟醫院醫用迴旋加速器沿著加速器靶區屏蔽外圍包含迴廊走道，旋轉鉛門，機房，中子球偵測器監測、構台區人員管制區之中子劑量率分佈換算結果約為 16~706.19 $\mu\text{Sv/h}$ 。最大值為 706.19 $\mu\text{Sv/h}$ ，最小值為 16 $\mu\text{Sv/h}$ 。這些區域運轉時，實際上為人員禁止管制區且為連鎖自動裝置，故無輻射安全之虞，亦符合我國游離輻射防護法第三十條及游離輻射防護法施行細則第二條規定。距離加速器靶區及鉛門愈遠，中子劑量率愈低。加速器靶腔射程區及加速器區內不論氣泡式中子劑量是否先放於水中屏蔽，皆超過儀器偵測最大極限。品管室管制區、人員休息區皆為背景值，平均值約為 $0.16 \pm 0.05 \mu\text{Sv/hr}$ ，監測時間與實驗時程約三個月同步，實驗結果與地表輻射劑量背景曝露值約 0.1~0.2 $\mu\text{Sv/hr}$ 相似，可視為背景值。將運轉中加速器中子劑量率於加速器靶區、加速器室、迴旋走道以 colored MATLAB graphical 軟體代入換算並以顏色及 $\mu\text{Sv/yr}$ 表示三維中子劑量率分佈。可見加速器靶區最強，中子劑量率隨距離呈遞減。本研究所得數據在加速器靶區鉛門入口中子劑量率推估約達 500 $\mu\text{Sv/hr}$ ，顯見中子劑量率偏高，雖無影響外圍製藥區及非管制區劑量曝露，但建議此處鉛屏蔽或水泥混凝土可再加強修飾。整體而言，花蓮慈濟醫院迴旋加速器週邊輻射安全管制良好，中子劑量率符合我國現行游離輻射防護法及其施行細則等之地區及人員曝露劑量率規定。

關鍵字：迴旋加速器、微西弗、中子劑量率、游離輻射防護法、輻射安全

Radiation safety and neutron dose rate measurements in the control area of medical cyclotron

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Abstract

According to the research, the cyclotron in TZU CHI hospital for medical uses, along with its shielding of the cyclotron target area, including the mage pathway, the swing lead door, the utility room, BF3 fixed neutron counter, and the gantry, has the result of its neutron dosimetry rate, about 16~706.19 μ Sv/h. While machines running, these areas have a chain of automatic devices in which the members are forbidden the access. Those devices make no worry about the safety of radiation, and are in accordance with articles 30 and 2 in Ionizing Radiation Protection Act and its regulations. The more distance to keep from the accelerator and lead door, the less the neutron dosimetry rate could be. The range of the accelerator target unit and within the accelerator, whether the neutron bubble dosimeters were put in the water before or not, both exceed the maximum of what the instrument could detect. The areas of quality control and staff resting are background value, whose average is about 0.16 \pm 0.05 μ Sv/hr. The time of the detection synchronizes the time of the experiment for three months, and the result of the experiment and background exposure value of the radiation dose of the earth environmental surface are similar, which is about 0.1~0.2 μ Sv/hr and can be seen as the background value. Using the software of the colored MATLAB graphical to calculate the neutron dosimetry rate of the running cyclotron in the target area, cyclotron room, and the mage pathway, and using colors and μ Sv/hr to represent the neutron dosimetry rate distribution of the three dimensions.

The result shows that the neutron dosimetry rate distribution of the three dimensions in the cyclotron target area is the strongest, and the dose rate decreases progressively with increasing distance. The data of the neutron dosimetry rate in this work is estimated to be 500 μ Sv/hr near the entry of lead door within the cyclotron target area. It is obvious to see that the neutron dosimetry rate is slightly higher than the average. Even though it does not have the impact on the dose exposure of outside medicine manufactory and uncontrolled area, we suggest using concrete to strengthen the lead shielding in this area.

In sum, the radiation safety of the cyclotron in Hualien TZU CHI hospital is under control. The neutron dosimetry rate is in accordance with the rule of staff exposure dose and the regulations of Ionizing Radiation Protection Act in our country.

Key Words : target area , cyclotron ,mSv, Ionizing Radiation Protection Act, radiation safety