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5 - 17 Study of CsI(Tl) Scintillation Detector's Properties for Gamma-ray Measurement

Jin Zengxue, Chen Zhiqiang, Han Rui, Lin Weiping, Liu Xingquan
Zhang Suyalatu, Liu Jianli and Shi Fudong

Spallation reaction produced numerous light charged particles. Light charged particles were detected by using light charged particle flight time spectrometer, which is a complete set of system from different angle d*E*-*E* telescope system structure and a beam counter. The energy loss d*E* of charged particles was measured by a plastic scintillator detector. The total energy *E* of charged particles was measured by stopping the particles in a CsI(Tl) scintillation detector.

In this study, we systematically tested CsI(Tl) scintillation detector that consists of a CsI(Tl) crystal (diameter of 5 cm, length of 15 cm) coupling a Hamamatsu H7195 PMT. Other electronics conditions(the Gain is 20, the Threshold is 20 mV) being equal, we measured pulse height spectrum of CsI(Tl) detector at the different bias voltage and shaping time(1, 2, 3, 6 μs), respectively. Gamma-ray spectrum measurements were performed by using ^{137}Cs and ^{60}Co radio isotopes.

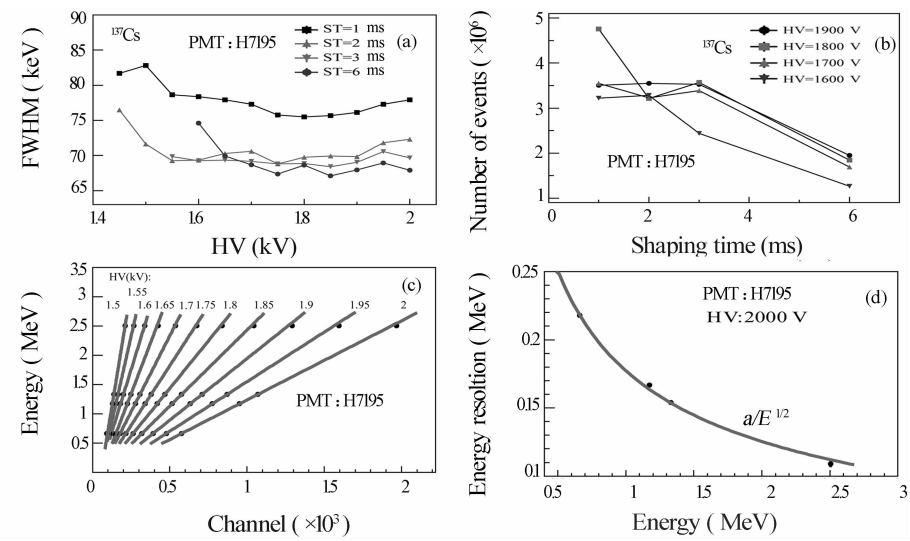

Fig. 1 (a) Energy resolution as a function of bias voltage. (b) Data acquisition count rate as a function of the shaping time. (c) Energy calibration curve in different bias voltage. (d) Energy resolution as a function of source energy.

Fig. 1(a) shows the energy resolution of CsI(Tl) detector as a function of bias voltage at different shaping time. The result shows that energy resolution tends to be stable with the increase of the bias voltage. And in the same bias voltage, the energy resolution tends to be better with the increase of the shaping time. Data acquisition count rate of CsI(Tl) detector at different bias voltage as a function of the shaping time is plotted in Fig. 1(b). With the increase of shaping time, data acquisition count rate gradually drops. Especially, it has the fastest decline as shaping time from 3 to 6 μs. To take into account the energy resolution and data acquisition count rate, 3 μs of shaping time is the best measurement condition for CsI(Tl) detector. Fig. 1(c) shows energy calibration curve of CsI(Tl) detector at the different bias voltage by using ^{137}Cs and ^{60}Co. We can found that energy calibration curves are linear at different bias voltage. Meanwhile,

energy resolution as a function of source energy had been investigated. The result is shown in Fig. 1(d). The curve is fitting result for $a/E^{1/2}$ formula[1-3]. It shows better for the result.

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5 - 18 Measurement of ΔE-E Telescope Detector for Light Charged Particles

Jin Zengxue, Chen Zhiqiang, Han Rui, Lin Weiping, Liu Xingquan
Zhang Suyalatu, Liu Jianli and Shi Fudong

Spallation reaction which is high energy proton after accelerated bombard heavy metal target play an important role in application of the accelerator driven subcritical reactors (ADS) for nuclear waste transmutation. Not only the strong neutron shower but also large number of LCPs would be produced in the reaction. It is very useful for spallation reaction to study produced LCPs[1-3].

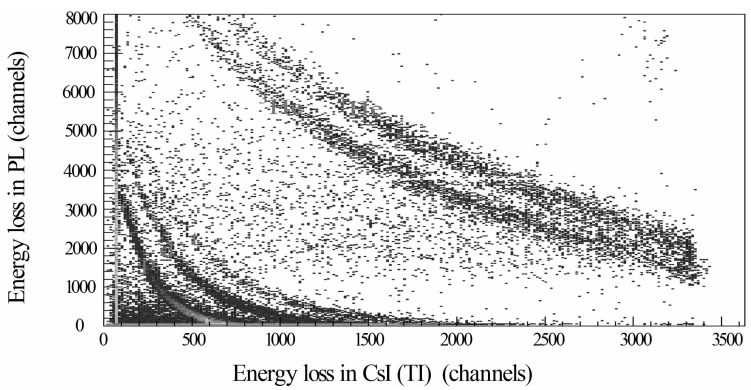

Fig. 1 Correlation of energy loss and residual energy measured with the ΔE-E telescope detector{350 MeV/u ^{12}C + (18 cm thickness) H_2O}. Hydrogen and helium isotopes can be well separated.

In this study, we had measured LCPs by using ΔE-E telescope detector. The telescope consisted of two different scintillation detectors. The energy loss ΔE of charged particles was measured by the $10\times10\times0.5$ cm^3 plastic scintillator. It was coupled through a light guide to the HAMAMATSU H7195 PMT. The total energy E of charged particles was measured by stopping the particles in the $\phi5\times15$ cm^3 CsI(Tl) crystal. The CsI(Tl) crystal was directly coupled to the HAMAMATSU H7195 PMT. Beam ^{12}C at 350 MeV was incident on 18 cm thick water target.

The measured spectrum has been shown in Fig. 1. In the diagram, it is seen that light charged particles (p, d, t, ^{3}He, ^{4}He) are very clearly separated. These results provide the effective foundation for studying spallation reaction.

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