SOME RESULTS OF INTERFACING THE $\gamma - \gamma$ COINCIDENCE SPECTROMETER AND COMPUTER

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1. Introduction

The construction of the spectrometer based on SACP method (Summation of Amplitudes of coinciding of pulses) has lead to the need of the interface card to exchange data with computer. The interface card has been completed at the faculty of technology, Vietnam National University, Hanoi. With simple design, the card worked completely stability in the long work period. Many measuring experiments with this card have been done at Dalat nuclear research Institute. Processing independently, the results of experiments at Hanoi and Dubna pointed out the good operation of the spectrometer and the interface card.

2. Overview

The experimental research on the nuclear structure truthfully is measuring (by the different methods) some parameters such as cross-section, energy of the excited states, probability of the transitions between the excited states. From the measuring parameters it is possible calculate quantum parameters of the states. The experimental results are the bases to estimate, to correct and to complete the nuclear theory and the other applications of technology.

The studies can be carried out on the equipment such as the reactor, accelerator. Generally, the layout of the experiment is showed on Fig.1.

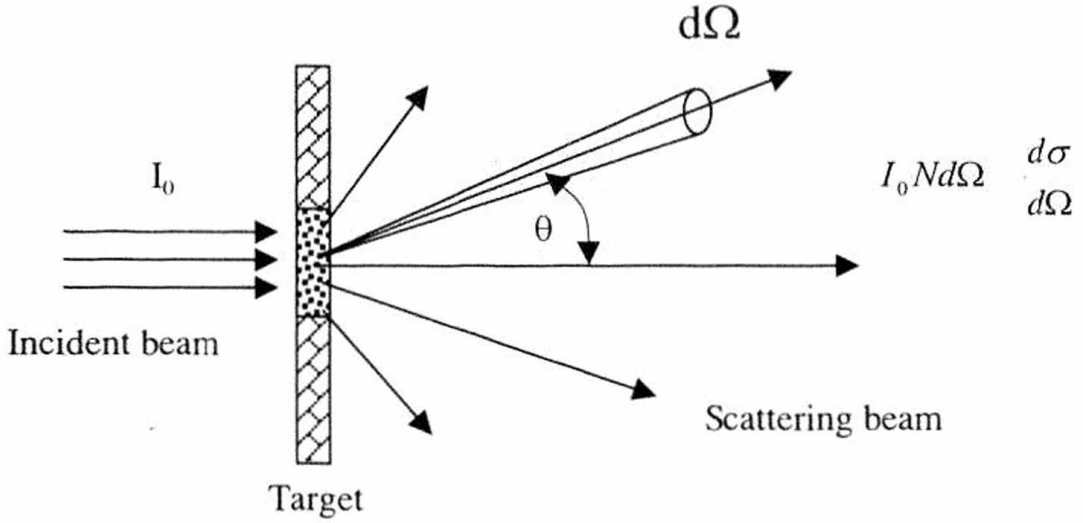

Fig.1. Studying nuclear structure by the nuclear reactions

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The possibility of the gamma-ray decay of the nuclei (being shot by particle beam of the accelerator or neutron beam of the reactor) is the highest. For the reason, the gamma spectrometer was used to obtain the most information of the studied nucleus. The use of the solid-state detectors with high-energy resolution and high speed enhanced the accuracy of the measuring.

However, the effects such as the Compton-scattering, election-position pair formation in the interaction of gamma ray with detector had a bad effect on the radiative spectrum and reduced the ability of obtaining information.

The use of the spectrometer with opposing Compton-scattering permit of reducing 30% of the background generated by the Compton-scattering. In order to reduce completely the Compton background, the method of summation of amplitudes of coincidence pulses must be used. Today, there is only such spectrometer at JINR (the Joint Institute for Nuclear Research, Dubna). From the results obtained by the use of the system, the quantity of the useful information increased many times. The results obtained by the other method are also the same in the energy region of 0 to 8 Mev.

In Vietnam

The nuclear reaction studies are carried out at two centers:

- On the accelerator of the nuclear center, physic institute, The National Science and Technology center.

- At the Dalat nuclear Research Institute with the tests on the neutron beam to define the reactive cross-section of the some nuclear isotopes. Now, the most modern gamma-ray spectrometers are the mono-crystal gamma-ray spectrometer. The reduction of the Compton-scattering background is not still optimal because of using the passive methods such as covering, making of collimation block or the active methods with using the anticoincidence system and detectors such as Geiger-Muller counter or scintillation detector.

3. Spectrometer of Summation of amplitudes of coincidence pulses

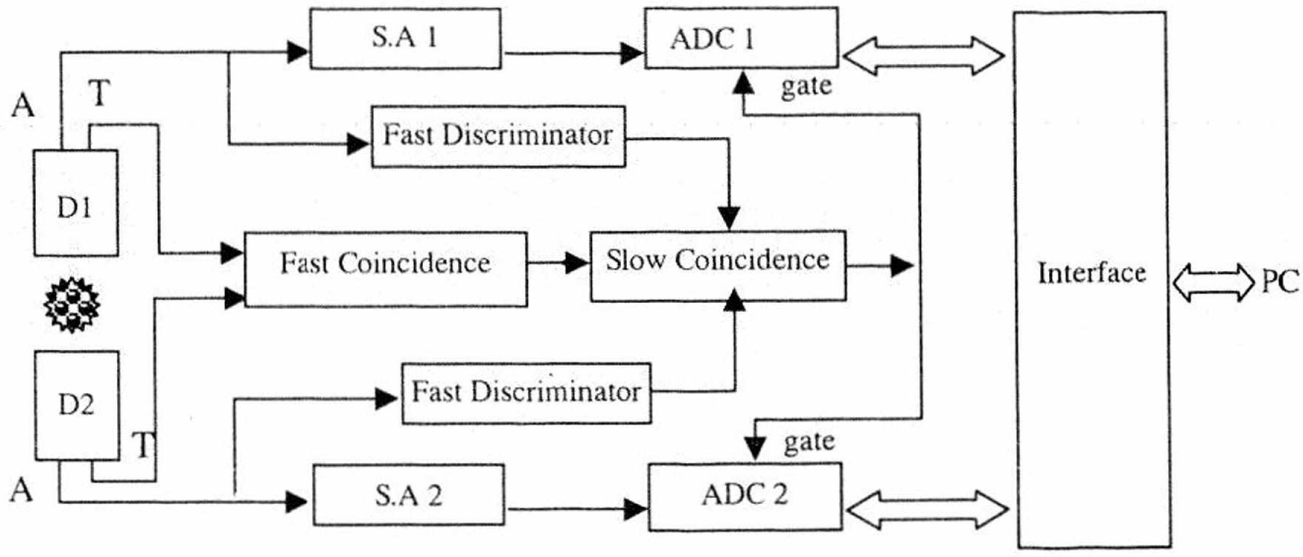

Fig. 2. The schema of the selected system at Dalat after many of different tests.

D1 and D2 are semiconductor detectors. SA1 and SA2 are spectrum amplifiers; ADC1 and ADC2 are the 4K analog to digital converters of successive approximation. They were manufactured at Dalat nuclear Research Institute.

From 1996, the ideas of examining and constructing the system of SACP to use the neutron beam at the Dalat nuclear reactor has been carried out. Up to now, after many of testing and examining the first period of building system has been completed. The second period of using the system to research the nuclear structure on the neutron beam has been started. The schema of the system is on Fig.2

The fast and slow coincidence blocks were made at physic Faculty, Natural Sciences Institute. The interface card was made at Faculty of Technology, Vietnam National University, Hanoi.

Operational principle of the system is followed

The target nuclei captured thermal neutron lives in the excited state shortly ($10^{-17} - 10^{-14}$s) and it will decay by cascade. Two solid-state detectors capture pairs of gamma. The signals from the time outputs of the detectors are led to the fast amplifiers and the discriminator and then to the inputs of the coincidence block. At that time, the signals from the amplitude outputs of the two detectors are also led to the spectrum amplifiers. In the case of two time signals being coincident, there is a pulse at output of the coincidence block. The pulse will enable the ADCs to operate.

Rise slope of the pulses also have duty of erasing the data of the last conversion if the computer did not take them. After converting two pulses to digital form, the ADCs will generate the signal of "Data ready" to computer to send data.

After receiving data, PC will generate a command to erase the data in two ADCs and continues the new cycle.

The information was stored in PC under form of a two-dimension matrix $E_1(n)$ and $E_2(n)$. $E_1(n)$ and $E_2(n)$ are the digital amplitude of the pulses of detector 1 and detector 2. n is the ordinal number of the coincident fact counted from the start time. Thus, the interface card has duty of informing two ADC's data ready, taking data to PC and generating the command to erase data in two ADC's buffer.

The interface card is completed from ICs-8255. The measuring results with source Co60 are showed in Fig. 3.

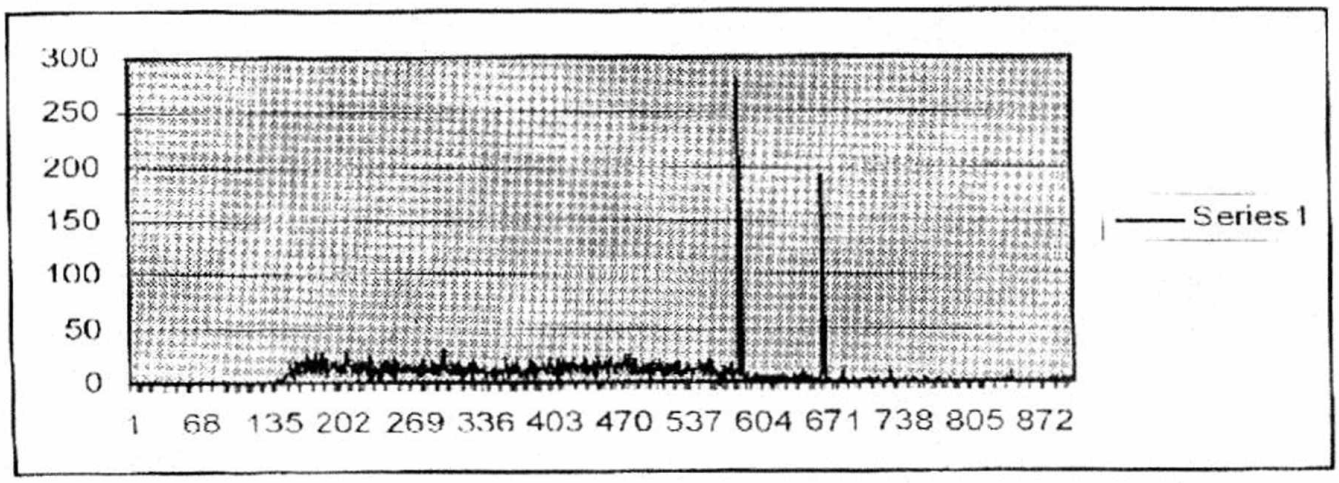

Fig.3. The pattern of spectra C_o^{60} obtained by the interface

From Fig.3, it is possible to say that the system operates very well; the Co^{60} gamma spectrum of each detector is completely like with that of mono-crystal gamma ray spectrometer. The above results mean that the address decode, the data transmission are good and stability. Some calculates of the energy and time resolution has been carried out and the obtained results are very good.

With the obtained database and after the processing, the summation and differential spectra of source Co^{60} are given in Fig.4.

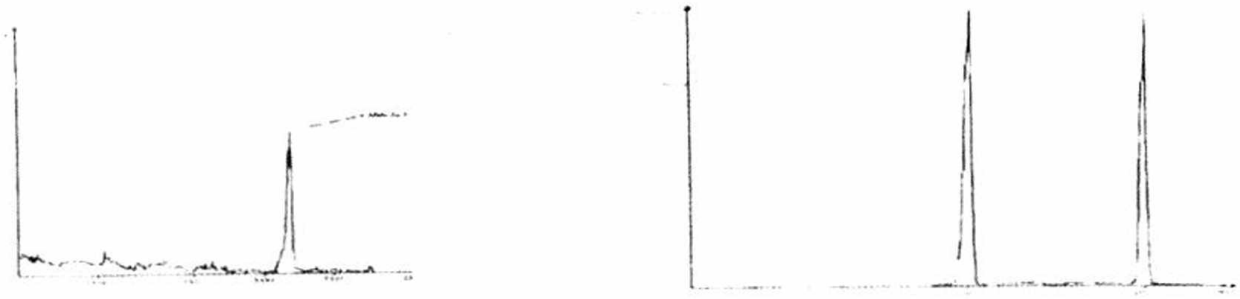

Fig. 4. The summation and differential spectra of source Co^{60}

From the differential spectrum, it is possible to say that the Compton-scattering background has been erased completely.

4. Estimation of the interface operation

From the obtained results, it is clear that the system of SACP operates very well and can be used to study the nuclear structure on the neutron channel of the reactor. The system operates effectively like the system of JINR (the Joint Institute for Nuclear Research, Dubna) although it is simple.

Interface card has good ability of the information transmission. Although the number of the measuring fact in a time unit is not much (about 100 counts per second) but the time of one conversion is very short about 25 μs and the transmission rate is about $1\mu s$.

In the near future, besides using the system to study the nuclear structure the system will be enhanced with four analog inputs.

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