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A New Data Acquisition System for TDPAC

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A new data acquisition system for TDPAC measurements with a 6 BaF_2-detectors spectrometer has been developed using multi-channel TDC and ADC. The major advantage of this system is that most of functions is implemented by the software instead of the hardware, so that the electronics of the system is rather simple and easily adjusted. Also, there is no limit on the numbers of energy windows, and it is easy to add more detectors.

1. Introduction

It is well known that the coincidence observation of two cascade radiations emitted by nucleus yields a correlation in their relative propagation directions. The spin of nucleus can be rotated by the hyperfine interaction between the nuclear moments and the magnetic field and/or electric field gradient (EFG), resulting in fluctuation of the coincidence spectrum. The time differential perturbed angular correlation (TDPAC) technique observes the spin rotation of nucleus that can provide specific information about both static and dynamic properties of local environment in materials.

The TDPAC technique is a valuable tool to investigate in an atomic scale the properties of condensed matter, such as point defects, atomic diffusion, phase transition, surface and interface, etc. It is well applicable at any temperature and pressure.

Usually, a 90° coplanar arrangement of 4 BaF_2-detectors is used to detect cascade γ radiations through the conventional fast-slow coincidence system[1] and maximum 12 ($P_4^2 = 4 \times 3 = 12$) coincidence spectra can be obtained. In recent years, the 6-detector TDPAC spectrometer[2,3] has been developed to expand the investigation fields to the samples with low-active or short-live probes. In conventional fast-slow coincidence system the signals from CFDs must be divided into the start and stop signals according to the gamma-ray energy by using single channels, and then generate 30 ($P_6^2 = 6 \times 5 = 30$) spectra for 6-detector TDPAC by using TAC, routing unit and MCA, so the electronics of 6-detector spectrometer would be very complex. To avoid this shortage a new data acquisition system for 6 BaF_2-detectors TDPAC spectrometer has been developed in the present work by using a multi-channel ADC and a multi-channel TDC, which directly records the energies of the signals and the time intervals between the input signals and a common stop (or start) signal.

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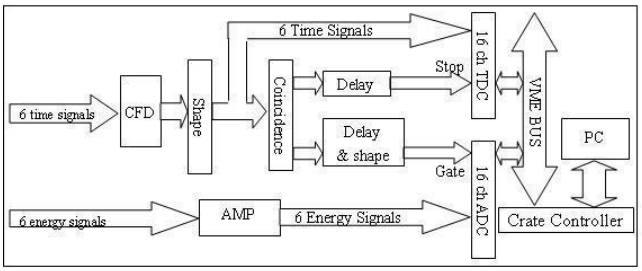

Figure 1. block diagram of data acquisition system

2. Description of the system

The schematic block diagram of the data acquisition system is shown in Fig.1. It comprises 6 CFDs, 6 amplifiers, a coincidence unit and a VME system including a 16-channel TDC, a 16-channel ADC, VME crate controller and PC. The 6 anode signals of BaF_2 detectors enter 6 CFDs to create time signals, which are shaped by the gate and delay generator to set the fast coincidence resolving width. The outputs of the generator enter the coincidence unit in 2 fold mode and the 16-channel TDC as the input signals. The 2 fold coincidence signal is delayed for about μs and then used as the common stop signal of TDC. In parallel, this coincidence signal is delayed and expanded in width, which then is used as the common gate of ADC. The amplified energy signals from 6 dynodes enter the inputs of 16-channel ADC.

In one data acquisition cycle the time intervals between the input time signals and the common stop signal are recorded by TDC, and the energy signals are recorded by ADC. The time intervals and energies of one data acquisition cycle are transmitted via VME bus and VME crate controller into PC and saved as one EVENT.

Usually, one EVENT datum is composed of two time intervals and two energies with the channel numbers. The software choose the EVENTs according to the cascade gamma-ray energies and calculate the difference of the two time intervals. The time difference could be positive or negative, so that 30 real TDPAC time spectra for 6-detector system are constructed. The off-line analysis can be performed to form TDPAC time spectra from the list data of event-by-event with various parameters. All the softwares are written in the c++ language.

3. Experimental examination

As a test of this new data acquisition system, we have measured the coincidence spectra of ^{181}Hf/^{181}Ta in Hf. Fig. 2 shows the screenshot of software interface in Chinese.

The present results show the proper working of this data acquisition system for TDPAC measurements with 6 BaF_2-detectors spectrometer.

4. Conclusion

A new digitalized data acquisition system using multi-channel TDC and ADC has been developed for TDPAC measurements with 6 BaF_2-detector spectrometer. The major advantage of this system is that most of functions are implemented by the software instead of the hardware,

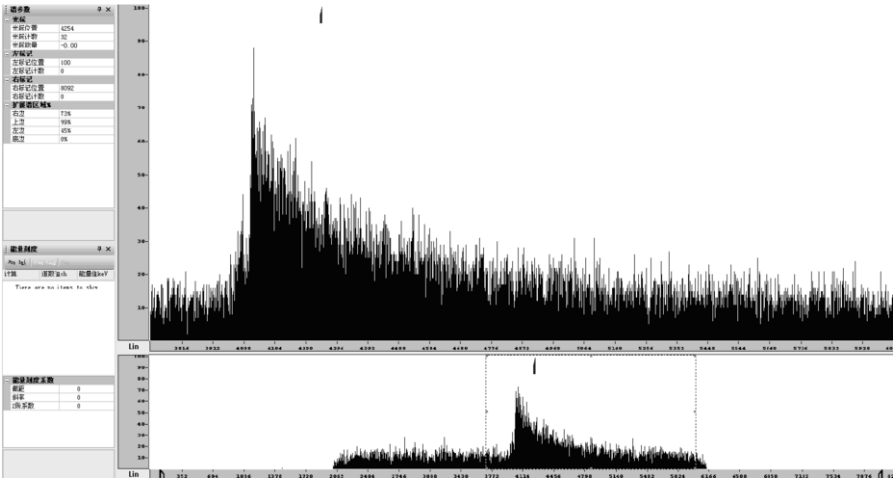

Figure 2. the screenshot of Chinese interface of software

so that the electronics of the system is rather simple and easily adjusted with a flexibility of adding more detectors and setting more energy windows. The measurements of the coincidence spectra for ^{181}Hf/^{181}Ta in Hf demonstrate the accurate working of the system.

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