[1] M. Foad, D. Jennings. Solid State Technology, 41(1998)43.

[2] S. M. Sze. Physics of Semiconductor Devices. Third edition. Hsinchu, Taiwan: A JOHN WILEY & SONS, inc, 1987, 95.

5 - 10 Investigation of the Digital Waveform Sample Techniques for the decetor

Chen Jinda, Du Chengming, Zhang Xiuling, Yang Haibo, Hu Zhengguo and Sun Zhiyu

In order to satisfy high precision requirement for the modern nuclear physics experiment detectors and radiologic imaging technology equipments, we do some researches in the $LaBr_3$ detector with digital waveform application research techniques. The DRS4 board and digital waveform methods substantially reduce the power consumption, which also are beneficial to the miniaturization of the data acquisition for large experiments, and to reduce the building cost.

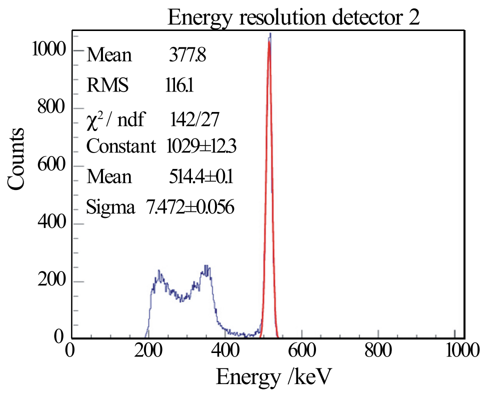

Fig. 1 (color online) The energy resolution obtained by DRS4 acquisition system.

In our study, the 8+1 channels DRS4 board was used to be as the data acquisition system. The system could process the digital sampling signals from the Detector consisting of PMT XP20D0 and $LaBr_3$ scintillator. The ^{22}Na source with 511 keV γ ray was used in the research. The energy resolution of 3.42% is obtained by DRS4 (as shown in Fig. 1), which was better than 4.2% obtained by CAMAC system for 511 keV γ rays. The results show that DRS4 system have good energy resolution, which can conform to the requirements of the new data acquisition system.

5 - 11 Incore Neutron Monitoring Techniques for Accelerator Driven Sub-critical Facility*

He Zhiyong, Zhao Qiang, Zhang Xueyin, Cui Wenjuan, Xu Hushan, Chen Zhiqiang and Luo Yuxi

In an accelerator driven sub-critical (ADS) facility, a sub-critical reactor is driven by an intense external neutron source provided by an accelerator coupled to a spallation target. The real-time measurement of incore neutron flux in an ADS facility is necessary for the commissioning measurements of the beams from the accelerator, for the routine verification of control rod positions, and for the calibration of the excore power range nuclear instruments. In a commercial reactor used in nuclear industry, several incore neutron detectors are used commonly to measure radial neutron flux profile at different radial locations within the reactor core. In an ADS facility, we propose that not only radial neutron flux profile but also vertical flux profile should be measured at different locations, because the incore neutron flux is affected dramatically by the neutrons from the spallation target.

To observe the vertical incore flux profile in the ADS facility, we have studied the neutron production from spallation targets with the Geant4-based Monte Carlo simulations. In the simulations, a heavy metal spallation target, located vertically at the centre of a sub-critical core, has a cylindrical shape with the radius of 10 cm and the length of 30 cm. The proton beam with the energy of 250 MeV and the current of 10 mA vertically impinges on the top of the cylindrical target. As shown in Fig. 1, the vertical coordinate is taken as z-axis and the centre of the target is taken as the coordinate origin. The neutron detector with a length of 10 cm moves vertically from the top to the bottom within the reactor core to measure the incore neutrons at seven locations from the top to the bottom, *i.e.* z= -90, -60, -30, 0, 30, 60, and 90 cm. The distance R between the detector and the z-axis is 20 cm. Although there may be some containers for the detector and the target, we do not consider any neutron absorption of these container materials.

Fig. 2 shows the neutron flux in 7 locations for 250 MeV proton beam with the current of 10 mA on lead and bismuth targets. The numbers from no. 1 to 7 in the x-axis correspond to the seven locations from the bottom to the top in Fig. 1. The decrease of neutron flux from location 4 to location 7 is due to the increasing distance between the target and the detector, while the steep decrease of neutron flux from location 5 to location 1 is due to both the neutron absorption of target and the increasing distance from the target to the detector. It is noteworthy to mention that the difference of neutron flux between the central location, *i.e.* location 4, and the lower location, *e.g.* location 1, attains more than two orders of magnitude for 250 MeV proton beam on lead or bismuth target. The neutron flux at the central location attains 2×10^{13} n/cm^2/s with the beam current of 10 mA. Given as the designed flux of 2×10^{14} n/cm^2/s for C-ADS facility, it should be very fast to attain the designed flux at the central location. On the other hand, it will take more time to attain the designed flux at the lower or upper locations which are far from the target.

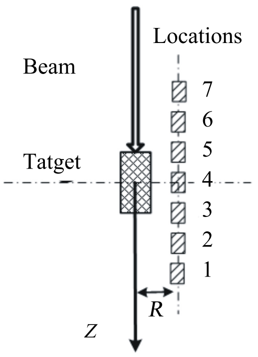

Fig. 1 Incore neutron flux monitoring techniques in an ADS facility where the spallation target located vertically at the centre of the core is bombarded vertically by a proton beam. The neutron flux is measured at seven locations from the top to the bottom.

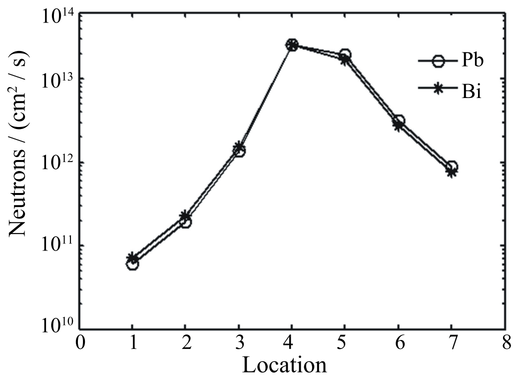

Fig. 2 Neutron flux spectrum of the spallation reactions for 250 MeV proton beam with the current of 10 mA impinging on lead and bismuth targets.

Finally, we propose incore monitoring technique for an ADS facility as follows. During the operation of the reactor, the incore neutron flux should be measured at multiple vertical locations. The detectors for the measurements of incore neutron flux may either be left in a fixed location or provided with a motorized drive to allow move vertically within the reactor core. During the reactor startup, as the neutrons from the spallation target dominate, the incore neutron detectors should be put at the central location which is close to the target for the commissioning measurements of the proton accelerator.

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5 - 12 New Research on Accelerator Driven Subcritical System Spallation Target

Wang Huiqiao and Yang Lei

Nuclear power is a mature technology of clean energy, with the incomparable advantage of other energy sources to resolve conflicts in the fast-growing energy needs and environmental protection. A major issue of the development of nuclear energy facing is the spent fuel deposal, especially the safe disposal of long-lived high-level radioactive waste. At present, accelerator-driven subcritical system (ADS), composed of a high energy proton accelerator, a spallation target and a subcritical reactor, is recognized as the most promising nuclear waste transmutation technology for its excellent safety, powerful transmutation ability and good neutron economy. Therefore, ADS is the most promising tool transmuting large quantities of radioactive waste to reduce the risk of deep storage[1].

As one of the ADS subsystems, spallation target consists of the target body, the beam-target coupling system, the heat exchange system, drive system, *etc.* Its main function is to generate neutron through spallation reactions caused by high energy protons bombarding on heavy nuclei in the target for maintaining the subcritical fission reaction[2], so as to achieve the purpose of transmutation of nuclear waste. Meanwhile, the spallation reaction energy deposed in the system is transferred out to maintain the normal operation of the system.

By researching on domestic and foreign spallation target programs, to avoid high radiotoxicity temperatures-corrosion effects and other serious flaw of liquid metal targets, we proposed a new target concept: the gravity-driven