5 - 24 Research and Development on Nuclear Electronics in 2014 Nuclear Electronics Group

Su Hong

Nuclear electronics group in IMP is focused on researching and developing the instruments and the readout systems for the research of nuclear and particle physics, and the relevant interdisciplinary research. Some creative works have been done by the team in 2014.

First, a front-end electronics (FEE) for a plastic scintillation array detector has been developed successfully, which has been used in a scientific satellite (engineering model) for space dark matter explore. There are 360 channels included in the FEE, which can process the signals from dynodes of PMTs combined with the plastic scintillators in the detector. For each channel, the input dynamic range is from 120 fC to 12 pC, and the nonlinearity is better than 2%, the equivalent noise is less than 0.1 MIPs, and resolution is better than 0.8%. The dead time for read out the data in FEE is less than 1.5 ms. Meanwhile, a data acquisition system (DAQ) employed for test performance of the FEE in laboratory has been developed also.

Second, a new fast waveform sampling digitizing circuit has developed successfully by us. Different with the traditional waveform digitizing circuit constructed with analog to digital converter (ADC) or time to digital converter (TDC). It is developed based on domino ring sampler (DRS), a switched capacitor array (SCA) chip. The circuit linearity is better than 0.1%, the noise is less than 0.5 mV (root mean square, RMS), and its time resolution is about 50 ps. There are eight channels on each board, and several boards can be cascaded to construct a multi-board system.

Third, a new measuring system has been developed for scintillatorsilicon PIN photodiode (Si PIN), with very large input dynamic range from 4 MeV to 11.2 GeV. To meet such a large dynamic range, a doubleend readout mode for Si PIN is adopted for the first time, which using two low noise charge sensitivity amplifiers (CSAs) with different gain (1 V/pC, 0.1 V/pC). Also the shaping amplifiers with baseline restoration circuit have been designed to follow the CSAs, with an integral nonlinearity $< 0.5\%$. Testing has been done successfully with some source (^{60}Co, ^{137}Cs, ^{22}Na).

Fourth, a preliminary low noise charge readout circuit with a wide dynamic range from 100 fC to 100 pC has been developed. The circuit has been tested and evaluated, the linearity error is better than 3.6% for full-scale. This circuit will be used to measure the beam distribution in a new magnetic mass spectrometer facility.

Fifth, based on the test system developed by us for testing single event effect (SEE) appearing in logic devices under particle irradiation, and some experiments have been implemented in the beam irradiation terminal of the HIRFL, several FPGA chips are studied, a group of data has been acquired, which is very important for researching the single event effect in SRAM, FPGA devices.

Sixth, some modular instruments have been produced for physics experiments and testing system in Cancer therapy equipment, such as eight channel constant fraction discriminator in a single-width NIM module, multichannel current to voltage convertor, multichannel current integrator, charge to frequency convertor, fast logic level adapters, *etc.*

Other, five papers has been published in the domestic core journals, two papers among them have been included in SCI. Two PhD students and one Master student have graduated from group.