Preparation of the VANDLE array for beta decay studies at RIBF

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Owing to the recent developments of RIBF beams to produce neutron-rich nuclei, the frontier of decay spectroscopy reached nuclei far from stability where delayed neutron emission dominates beta decay. The energy measurements of neutrons provides the beta-decay strength distribution above the neutron separation energy. The strength distribution reflects the nuclear structure and allows to predict the decay properties of even more exotic nuclei. One of the experimental techniques to determine the energy of delayed neutrons is the neutron-time-of-flight measurement.

The Versatile Array of Neutron Detectors at Low Energy (VANDLE)[1)] has been constructed at the University of Tennessee. We recently reported strong beta-delayed neutron emissions in ^{83,84}Ga decay[2)] from Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory with the array. Part of the array is recently being moved to RIKEN RIBF. The modules of plastic scintillators with dimensions of $3 \times 6 \times 120$ cm^3. Both sides of the scintillator are made of Eljen EJ-200[3)] or Bicron BC408[4)] coupled with PMTs and the time for each left and right signal is averaged to get the position independent time. The detectors cover about 20% of the solid angle around the decay station with a 1 m TOF base. The use of digital data acquisition is essential to achieve good timing resolution. Pixie-16 digitizing modules from XIA LLC allow the digitizing of the signals from detectors sampled at 250 MS/s.

Fig. 1. Part of the VANDLE array setup at RIBF B3F. The delayed neutron will be detected by the array and the time-of-flight provides neutron energy.

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During the BRIKEN experiment[6)] in November 2017, we tested our data acquisition system, in particular, we tested the time stamping capability needed for synchronization with BigRIPS.

While the VANLDE array provides good timing resolution for neutron detection, it is also important to develop an implantation detector to give the start timing with good timing resolution. We developed a new, fast timing implantation detector that uses various types of inorganic scintillators and position-sensitive photomultiplier.[5)] The implantation detector which was developed for the experiment at RIBF consists of a segmented YSO scintillator coupled with position-sensitive PMT. The performance of the detector was confirmed during the BRIKEN experiment.[7)] Combining the fast-timing implantation detector and the VANDLE array will provide sufficient timing resolution for neutron-time-of flight measurement. The construction process for the full VANDLE array for experiments will be completed in the beginning of 2018.

References

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