

Fast clear technique for NEBULA data acquisition for SAMURAI17 experiment

Y. Togano,^{*1,*2} Y. Kubota,^{*2,*3} H. Baba,^{*2} and H. Otsu,^{*2} for the SAMURAI17 collaboration

A fast clear technique for NEBULA data acquisition (DAQ) was newly introduced for the $^{132}\text{Sn}(p, n)$ experiment at SAMURAI.¹⁾ The technique enabled the measurement of recoil neutrons and projectile-like neutrons in coincidence. NEBULA DAQ could not work with the main trigger for the (p, n) reaction measurement because the recoil neutrons were slow.

The incoming ^{132}Sn beams were detected by beam tagging detectors: SBT1 and SBT2. We define the signal from SBT1 as “Beam” in this report. Recoil neutrons from the (p, n) reaction were measured using WINDS²⁾ surrounding a liquid hydrogen target. The charged outgoing particles were analyzed by using the SAMURAI system. The outgoing neutrons from the breakup of reaction products were measured by using NEBULA. The main trigger of the experiment was a coincidence of Beam and WINDS. Because of the slow neutrons from the (p, n) reaction detected by using WINDS, the trigger decision of the experiment was ~ 300 ns slower than the that with the standard SAMURAI setup.³⁾

The main trigger for the experiment was controlled by using the GTO module.^{4,5)} The trigger for NEBULA DAQ was a coincidence of Beam and NEBULA signals ($\text{Beam} \times \text{NEBULA}$ trigger). The analog and time information of NEBULA was obtained by using CAEN V792 QDC and V775 TDC modules, respectively. The VME module used to interrupt NEBULA DAQ was RPV-130 by REPIC. The fast clear of V792 and V775 could be performed by inputting the fast clear signal to the modules during their data conversion. The dead time of the fast clear was 600 ns. Figure 1 shows the circuit diagram of NEBULA DAQ for the fast clear. The interrupt of

NEBULA DAQ was performed by using a $10 \mu\text{s}$ delayed main trigger signal to allow time for the data conversion of QDC and TDC. If the DAQ system was interrupted when NEBULA data were empty owing to no $\text{Beam} \times \text{NEBULA}$ trigger or the dead time of fast clear, the NEBULA data were recorded as an empty event. The fast clear signal was generated by anti-coincidence between $\text{Beam} \times \text{NEBULA}$ (synchronized with DAQ start/stop) and the main trigger. If the main trigger was fired to acquire data during the dead time of fast clear for NEBULA, a fast clear flag was stored by a coincidence register (coin. reg. 1). The NEBULA-accepted trigger was $\text{Beam} \times \text{NEBULA}$ vetoed by the dead time of NEBULA DAQ and the fast clear of V775/V792. A flag for $\text{Beam} \times \text{NEBULA}$ was stored by a coincidence register if it was coincident with the main trigger (coin reg. 2). NEBULA DAQ could be switched to the singles mode, in which the trigger was generated by NEBULA itself for calibrations, in B2F experimental area.

In the experiment, the typical rate of the main trigger and the $\text{Beam} \times \text{NEBULA}$ trigger were 2.4 kHz and 1.6 kHz, respectively. Owing to the dead time of the fast clear, $\sim 0.7\%$ of NEBULA data could not be collected. Fig. 2 shows the time versus crystal ID plot of NEBULA. The locus at approximately 60 ns corresponds to fast neutrons from the target region indicating that NEBULA DAQ functions effectively. This fast clear technique can be applied to other experiments by adjusting the delay for the $\text{Beam} \times \text{NEBULA}$ signal (300 ns in this experiment).

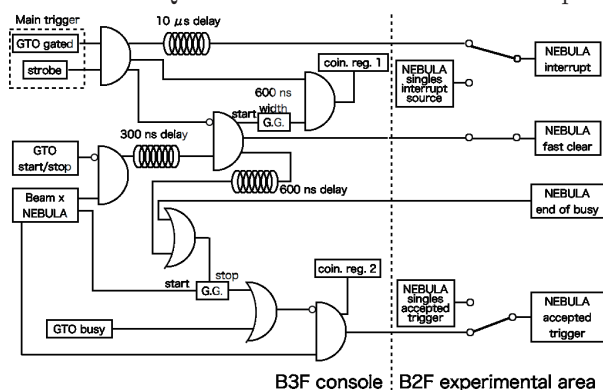


Fig. 1. Circuit diagram for NEBULA DAQ with fast clear.

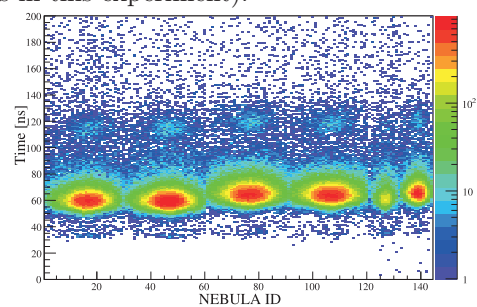


Fig. 2. Time versus crystal ID plot of NEBULA.

References

- 1) M. Sasano et al.: RIKEN Accel. Prog. Rep. **48** (2015).
- 2) K. Yako et al.: RIKEN Accel. Prog. Rep. **45**, 137 (2012).
- 3) T. Kobayashi et al.: Nucl. Instrum. Meth. B **317**, 294 (2013).
- 4) H. Otsu et al.: RIKEN Accel. Prog. Rep. **46**, 146 (2013).
- 5) H. Baba et al.: RIKEN Accel. Prog. Rep. **47**, 235 (2014).

*1 Department of Physics, Tokyo Institute of Technology

*2 RIKEN Nishina Center

*3 Center for Nuclear Study, University of Tokyo