Multichannel gated-neutron-detector with low afterpulse rate for neutron spectroscopy in ultra-intense laser-plasma interaction experiments

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Gated-photomultiplier-tubes (gated-PMT's) with increased robustness against background noises due to the hard x-ray incidence have been implemented on the 600-channel neutron time-of-flight (nTOF) detector at Institute of Laser Engineering (ILE), Osaka University. This diagnostic uses 600 individual neutron detectors consisting of a plastic scintillator and a liner-focused PMT, allowing to obtain a large detection area with long flight path (13.5 m). A very simple gating circuit has been developed to gate out the primary x-ray peak and measure the subsequent neutron signals without causing the anode current saturation. By applying a reverse potential between the cathode and first dynode (d1), we succeeded in suppressing subsidiary signals called "after pulse" produced after the main pulse (see Fig. 1), mainly due to ionic feedback to the photocathode. Cathode-d1 voltages of all the PMT's are simultaneously switched by only one switching circuit module coupled with a digital delay pulse generator (e.g. DG645) and a DC power supply. The switching circuit provides + 200-V precisely defined squire pulse with a reasonably steep front of 80 ns. A high cut-off ratio of anode current of more than 10^3 can be obtained under constant illumination in the 'on' and 'off' conditions. Our design doesn't request either switching groups of dynodes or adding a gating electrode inside the tube, and thus allows to be applied to the hundreds of neutron detectors at low price.

In our presentation, we will show the design and response of the multichannel gating system and discuss future prospects of neutron diagnostics in the superintense laser plasma interaction experiments on the field of research including fast ignition ICF and laser-driven neutron sources.

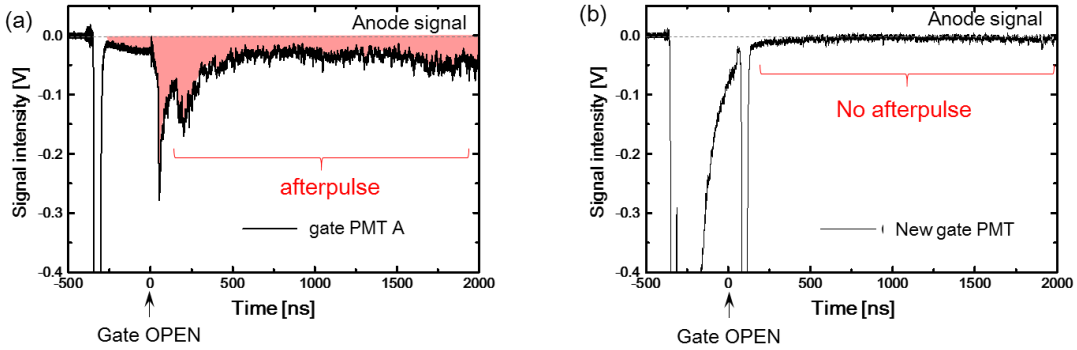

Figure 1: Anode signal response of (a) conventional gated PMT and (b) new gated PMT to the strong light incidence at t = -300 ns. Each one switches the gain on at t = 0 ns by applying the potential between the first and second dynode and between the cathode and first dynode respectively.