Memo

Electronics DeadTime (Gen)

~cdaq/gen/Documents/n-detector/n-el_deadtime.ps

Marko Zeier & Thomas Petitjean

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Intention

In order to learn about the eN-coincidence deadtime of the Gen-electronics due to the high rate of the nucleons, we did set up a system that simulates a random rate of $4MHz$ of nucleon signals and an eN-coincidence rate of $400Hz$, as the experiment was running before its shutdown.

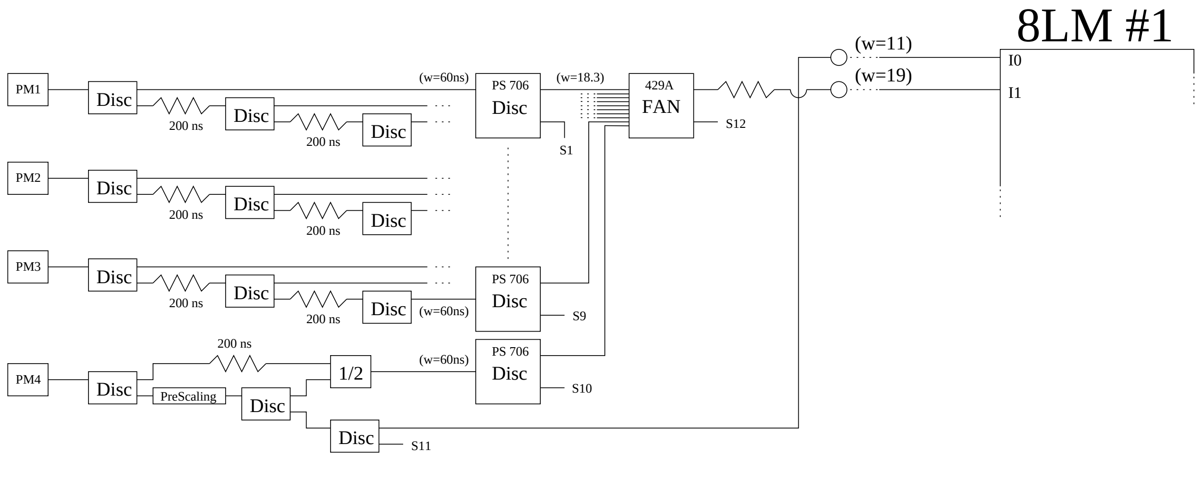
We mesured the electronics deadtime varying the eN-coincidence-rate, the nucleon-rate, the nucleon-gate-width before going into the PS706-Discriminators (nominally $60ns$) and the nucleon-gate-width at the 8LM, where the eN-coincidence is formed (nominally $19ns$).

Setup

The nucleon-rate of $4MHz$ is formed by 10 independent channels of $400MHz$ of random pulses. These 10 channels are fed into the PS706 discriminators and replace the 10 lines coming from the left-right coincidence units used during the experiment (check `~cdaq/gen/Documents/n-detector/n_logic_eoe.ps`).

To get random pulses we used 4 photomultipliers (PMs) operated with a small light leek. The PMs were setup to procude a rate of $400kHz$. Each PM channel is splitted up into 3 channels, each delayed by $200ns$. With this delay we have each PM deliver 3 independent $400kHz$ of random signals.

The much lower eN-coincidence rate is taken out of the last PM by prescaling the signal-rate down to $400Hz$.



The deadtime of the electronics can now be calculated out of the information of scaler S11, which contains all the eN-coincidences sent through the electronics, and content of the eN-Pretrigger scaler, that counts all the eN-coincidences that are formed at 8LM.

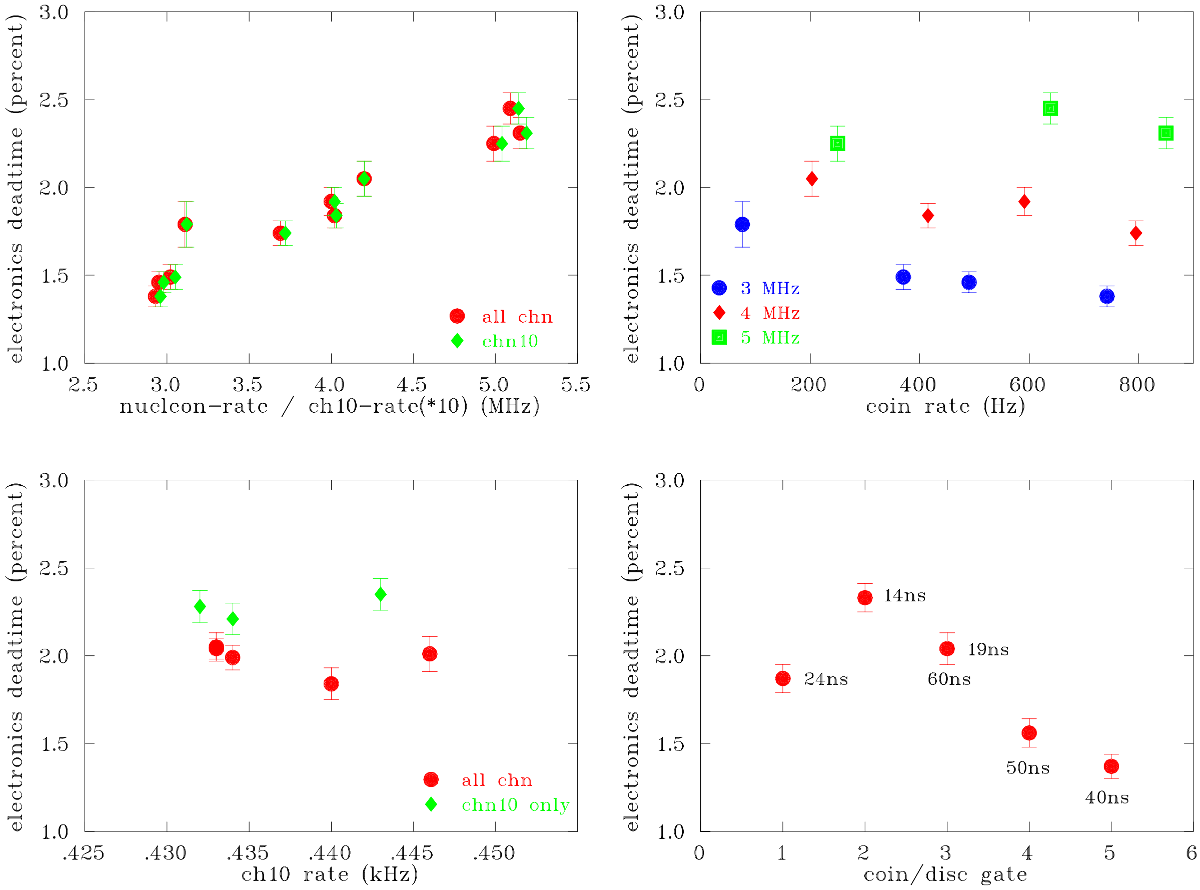
Conclusions

- The top left plot shows the electronic deadtime as a function of the random nucleon rate. The nucleon rate was varied from $3Mhz$ up to $5MHz$. At the nominal nucleon rate of $4MHz$, at which the experiment was running, we do have an electronics deadtime of roughly 2%. The dependence on the rate can be expressed as $edt[\%] \simeq 0.5 * Rate[MHz]$. This is in rough agreement with the expectation that electronic deadtime occurs exclusively on the $400kHz$ lines, when a coincidence pulse is "eliminated" by a preceeding random pulse. Thus the output pulse of the PS706 discriminator comes to early to make the coincidence at the 8LM. With $60ns$ pulse width and a rate of $400kHz$ this situation occurs with 2.4% probability.

- The top right plot shows the electronic deadtime as a function of the eN-coincidence rate. There are 3 samples of data on that plot taken at nucleon rates of 3, 4 and $5MHz$. The electronic deadtime is independent of the eN-coincidence rate.

- The bottom left plot shows the electronics deadtime as a function of the nucleon rate of channel 10, which is the channel we feed the eN-coincidences in. There are two samples of data on that plot. One having only channel 10 fed with $400kHz$ of nucleon-signals and the other one where all the 10 channels are fed with $400kHz$ of nucleon-signals.

  This again is in agreement with the expectations. The higher deadtime for chn10-only is due to the absence of accidental coincidences caused by the other channels.



- The bottom right plot shows the simple checks that we did on the setup by varying the gate-lengths. The central point corresponds to the the nominal gate settings of $60ns$ at the entrance of the PS706-discriminators and $19ns$ at the 8LM, where the coincidences are formed.

  The left two points show what happens to the deadtime by varying the $19ns$ gate by $\pm 5ns$. A longer gate corresponds to a smaller electronics deadtime which is what one expects.

The right two points show what happens to the deadtime by varying the $60ns$ gate to $50ns$ or $40ns$. The $60ns$ were chosen because of the flaky digital delayunits (PEC) that produce double pulses having signals shorter than $60ns$. This test as well shows the expected behavior of a smaller electronics deadtime with smaller widths of the signal.

Continuation of Gen

A helicity dependent electronic deadtime caused by varying bar-rates related to a beam current asymmetry could introduce a false asymmetry into the data.

During Gen the beam current asymmetry was $\leq 10^{-3}$ and the bar-rate was typically $4MHz$. Assuming that the bar rate is proportional to the beam current, the effect on the electronics deadtime must be in the same order. However for the lifetime, which is the essential quantity, the asymmetry dilutes to $\leq 10^{-5}$ and is thus negligible.

For the continuation of the E93026 one could think about the replacement of the logical delay units (PEC) with units, that allow smaller signal lengths, or the use of updating discriminators.