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Low Deadtime Delay Line Readout for Position-Sensitive Proportional Counters

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ABSTRACT

A method is presented for circumventing the long deadtimes (25 μ sec) which usually accompany the readout of helical proportional chambers and other position-sensitive detectors with delay line readout.

I. INTRODUCTION

High resolution timing methods have been employed in recent years to obtain positional information from multiwire proportional chambers. Most notable among such efforts are the helical chambers of Lee et al.¹ and Gilland et al.,² and the capacitively coupled delay line readout of Grove et al.³ In both types of chambers, the positional information is obtained by recording the time difference in the arrival of a pulse at the two ends of a delay line. Unfortunately, the digitizing of these time differences introduces deadtimes of the order of $T = 25 \mu$ sec due to the inherent requirements of an ADC. We present here a method of reducing the deadtime of the readout to a level where the deadtime of the detector ($\sim 1 \mu$ sec) dominates.

II. BUFFERING

The probability for multiple events occurring within a time T is given by a Poisson distribution:

$$P(n) = \frac{\lambda^n e^{-\lambda}}{n!}$$

where $P(n)$ is the probability that n events occur within time $T = \lambda/R$ (R is the event rate). If T represents the deadtime of the system then all but the first event are discarded, and the average number of events lost is

$$\langle N_L \rangle = \sum_{n=2}^{\infty} (n-1) P(n) = \lambda - 1 + e^{-\lambda}$$

Now, suppose a buffer is installed such that a second event can be processed by an alternate ADC. Then only the third and subsequent events are discarded, and the average number of events lost becomes

$$\langle N_L \rangle = \sum_{n=3}^{\infty} (n-2) P(n) = \lambda(1 + e^{-\lambda}) + 2(e^{-\lambda} - 1)$$

This can mean a significantly smaller fractional loss of data than one would experience without the alternate ADC. In Table I, we present a comparison of the count rates attainable with and without the buffer, assuming $T = 25 \mu$ sec. For a desired fractional loss (column 1), we list the count rate attainable without buffering (column 2) and with buffering (column 3) and the ratio of those count rates (column 4). Since a typical detector has a 1- μ sec deadtime, we also state (column 5) the limit on count rate due to the deadtime of the proportional counter itself. Note that for a fractional loss of 0.001, the count rate (2000/sec) is limited by the deadtime of the proportional counter, whereas for a fractional loss of 0.100, it is the readout which limits the count rate (39 200/sec).

TABLE I

F.L.	Event Rate		Ratio	Event Rate Detector
	Nonbuffered	Buffered		
0.001	80/sec	3 200/sec	40	2 000/sec
0.005	400	7 200	18	10 000
0.010	800	10 400	13	20 000
0.050	4 000	25 600	6.4	103 000
0.100	8 400	39 200	4.7	215 000
0.500	64 000	148 000	2.3	1 600 000

III. ELECTRONICS

The readout depicted in Fig. 1 is designed for, but not limited to, helical delay line chambers. An anode pulse (the helix is the cathode), possibly gated by other logic signals, toggles a flip-flop which alternately activates the "start" input of two time-to-digital converters (TDC). Using two TDC's in the manner shown in Fig. 1 provides the buffering. The pulses from the two ends of the helix provide the two stop signals and the difference between these two elapsed times is used to calculate the position of a particle's trajectory through the chamber.

Fig. 1. Schematic for buffered delay line readout for an X-Y pair of helical chambers.

Since the total propagation delay for a pulse on the helix is a constant, one may sum the two elapsed times to discriminate against multitrack events. For this reason, the anode pulse is split,

with one signal to the trigger logic and the other directly to the AND gate, thus maintaining the necessary time resolution.

TDC's generally have at least four stop inputs, making it possible to monitor both X- and Y-coordinate information. This is shown in the figure. The two anode pulses are ORed together so that the system will trigger on either chamber and statistics can be kept on the efficiencies of the detectors.

The DATA1 and DATA2 busy signals prevent the flip-flop from being triggered when both TDC's are busy, thereby keeping the proper synchronization between the flip-flop and the readout.

IV. CONCLUSION

This simple circuit reduces the deadtime of a delay line readout to a level comparable with the deadtime of the proportional counter. There is little to be gained by the addition of a third TDC unless the deadtime of the proportional counters can be significantly reduced. The circuit requires twice as many TDC's as one would normally need, but quite often the experimental geometry is such that only one or two chambers experience count rates high enough to warrant the use of this system.

References

1. D. M. Lee, S. E. Sobottka, and H. A. Thiessen, Nucl. Instr. and Meth. 104 (1972) 179.
2. J. R. Gilland and J. C. Emming, Nucl. Instr. and Meth. 104 (1972) 241.
3. R. Grove, I. Ko, B. Leskovar, and V. Perez-Mendez, Nucl. Instr. and Meth. 99(1972) 381; A. Rindi, V. Perez-Mendez, and R. Wallace, Nucl. Instr. and Meth. 77(1970) 325.

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