A New Constant Fraction Discriminator for μSR Spectrometers

R. Scheuermann [1], T. Prokscha [1], U. Hartmann [2], U. Zimmermann [1], C. Buehler [2], A. Dijksman [2], D. Imboden [2], U. Greuter [2], N. Schlumpf [2], A. Suter [1], A. Amato [1]

[1] *Laboratory for Muon Spin Spectroscopy, CH-5232 Villigen PSI, Switzerland*

[2] *Laboratory for Particle Physics, CH-5232 Villigen PSI, Switzerland*

A new 8–channel constant fraction discriminator (CFD) especially designed to satisfy the needs of future μSR spectrometers has been developed. The device is fully programmable via VME or RS485 bus and has an automatic walk adjust implemented. First tests of the prototype in a standard μSR electronic set–up show a performance comparable to the currently used commercial CFD935 (ORTEC).

The data acquisition (DAQ) systems of the present μSR facility spectrometers are based on the ORTEC picosecond time analyzer pTA 9308 and on CAMAC TDC's (LRS 2228A, LRS 4208) for event–by–event readout (LEM apparatus and spectrometer). Best timing properties are obtained by using an ORTEC CFD935 constant fraction discriminator, where the timing of the output signal is independent of the input signal height within a certain dynamic range. In a CFD the original input signal is attenuated and superimposed with its delayed complementary signal in which the trigger point is given by the zero crossing of this signal.

The disadvantage of the present system is the limitation to a maximum of 14 histograms and the requirement of quite old hardware coincidence units for vetoing purposes. A new generation of μSR spectrometers will require a much larger number of channels to be recorded, e.g., if detectors with a small active area such as APDs will be used, or in order to allow event–by–event data acquisition and to put all the required logics into software. On the CAMAC side the modules have reached their end of product life and they are limiting – due to slow readout speed – the event rate at the new high intensity LEM-μE4 beamline currently being under construction at PSI.

To overcome the present limitations a new DAQ system is being developed focusing on the use of the CAEN V1190B 64–channel multistop TDC with VME bus. A set–up with commercially available CFDs like the ORTEC CFD935 with only 4 channels per module would be extremely expensive. In order to reduce the number of required hardware components the development of a new, VME based and programmable CFD with specifications to optimally suit μSR needs was launched. Its design makes it useful for other particle physics experiments as well.

Specifications of the model PSI CFD105:

– comparator: ADCMP 565
– 8 channels per single–slot VME module
– input: -5..-5000 mV at 50 Ω
– threshold: 0..-1023 mV (adjustable via 10 bit DAC)
– output: 2× ECL + NIM OUT, $\overline{\text{OUT}}$
– updating mode (output pulse width as long as input signal above threshold) or blocking mode (single shot with fixed (variable) output pulse width 5..50 ns (adjustable via 10 bit DAC)
– fully programmable via VME or RS485 bus
– automatic walk adjust
– constant fraction: 20%
– delay time 1..8.5 ns, adjustable in 500 ps steps

The block diagram of the analog section is shown in Fig. 1. The prototype (non–programmable) has been tested at the GPD spectrometer. When used as a pulse former for a positron counter the contribution of photodetector and CFD105 to the time resolution is 110 ps, as determined from the width of the zero crossing of the CFD monitor signal (Fig. 2). Comparison with the Ortec CFD935 was done by splitting the analog signal with a LeCroy Linear FIFO 428F and routing the two signals into different histograms. The widths of the prompt peak in both histograms are the same: the HWHM obtained by a fit of a Gaussian is 1.30 ns for CFD105 and 1.33 ns for CFD935.

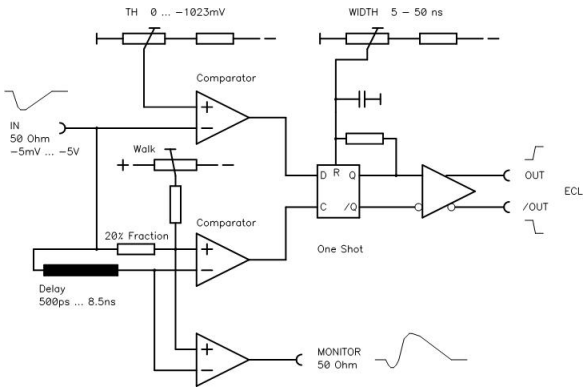

Figure 1: Block diagram of the analog section.

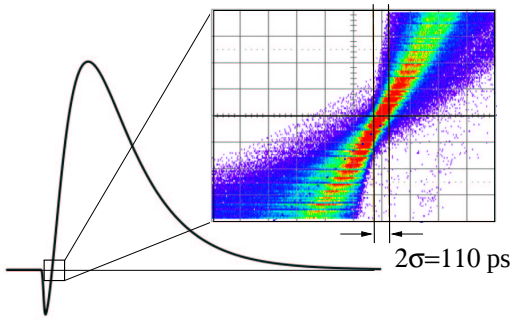

Figure 2: Monitor signal (superposition of original input signal and attenuated reversal) of the CFD105 when fed with signals from a positron counter. From the width of the zero crossing the time resolution is about 110 ps.