Development and Test of the Three Threshold Discriminator

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The solution of a three-threshold discriminator using a two-point constant-level method has been presented in the IKP Annual Report 1996 [1]. A first discriminator of this type was realised as a hybrid on a printed-circuit board with the dimensions 25.5mm $\times$ 73.2mm. The unit, tested with pulses from a generator ($t_{rise} = 1$ns, $t_{width} = 3$ns), effectively reduced the time walk in a wide range of pulse amplitudes (± 50ps for a 300:1 dynamic range). However, when using this discriminator with (attenuated) pulses from a photomultiplier triggered by a light emitting diode (LED) system [2] (PM+LED) the results were not satisfactory anymore. The time walk reached values up to ± 200ps for a 10:1 dynamic range (with pulses of $t_{rise} = 3$ns, $t_{width} = 7$ns). It was found that the worsening of the timing characteristics was caused by the photoeffect from the first dynode of the photomultiplier which disturbed the leading edge of the output signals and thus did not allow to set a very low threshold value.

In order to still improve the characteristics of this discriminator, the input circuit was modified to enable constant-fraction shaping of the input pulses. The new printed-circuit board of the discriminator (model M$\wedge$M06) has the dimensions 24.8mm $\times$ 77.2mm. Test measurements with pulses of $t_{rise} = 3$ns and $t_{width} = 7$ns have shown an improvement of the timing characteristics of the discriminator after the modifications. Figure 1 presents timing characteristics of the modified discriminator for different settings of the three thresholds. The thresholds were chosen the following way: the highest threshold (THR3) was set to the minimum required signal amplitude (i.e. particle identification in the experiment), the lowest threshold (THR1) arbitrarily to the half of it. The middle threshold (THR2) was adjusted for minimum time walk over the whole possible amplitude range. The comparison of the THR1 timing, which acts as a leading edge discriminator, and the resulting output of the whole discriminator circuit shows the timing improvement. The time walk is about ± 100ps for a 120:1 dynamic range.

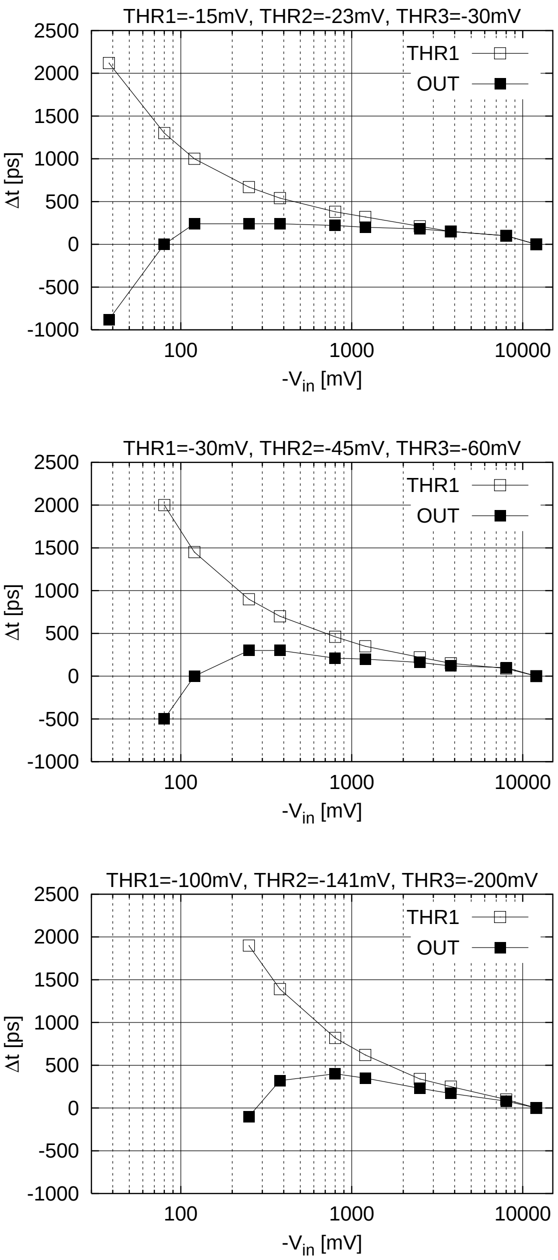

Fig. 1: Time walk measurements for different threshold settings with: input pulse source = PM+LED, t_{rise} = 3ns, t_{width} = 7ns, fraction = 0.2, delay = 2.5ns, clamping at +0.4V and –10V. The open squares show the timing characteristics of the lower threshold (THR1), the filled squares represent the time walk of the discriminator output.

References:

[1] J. Majewski, A. Misiak: "Multi-Point Methods for the Time Walk Reduction of Discriminators", IKP Annual Report 1996, p.39-41

[2] T. Sefzick et al.: "A System for Simulation of Scintillator Light Signals", Nucl. Inst. and Meth. A288 (1990) 571-573