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Fast zero level trigger

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A fast zero level trigger T0 is aimed to provide the electronics of the ionization hodoscope with a gate of acceptable rate and as low as possible delay. At the August 1997 DIRAC meeting there was discussed the simplest scheme where T0 signal was arranged as a coincidence of the OR'd signals of the vertical hodoscopes $V1$ and $V2$. The scheme took only one additional module LeCroy OR unit 4564, the delay of T0 was around 35 ns.

Rough estimations of T0 rate without taking into account the secondary interactions in the channel and setup elements gave the number T0=$10^5\,s^{-1}$. This rate could be acceptable for the ionization detector electronics. But really the secondary interactions can add a lot to this number. Simulations of the Santiago group for the trigger rate T0=$V1 \cdot V2$ with account of secondary interactions give several times larger numbers.

To decrease the part of secondaries in T0 rate (apart from the exact numbers) it was suggested to include the preshower detectors to a trigger scheme. The preshower detectors $Pr1$ and $Pr2$ placed behind the Cherenkov counters were planned to be used at off-line data handling for additional suppression of electrons. So only recording of the amplitudes of these detectors was foreseen, without including them to trigger as really they could not improve the selection of useful events at the Trigger 1 stage. But in the preliminary trigger T0 the preshowers can be very useful decreasing T0 rate.

The logic formula for this new T0 is $(V1 \cdot Pr1) \cdot (V2 \cdot Pr2)$. A threshold in the preshower channels will be set at the level for detection of minimum ionizing particles. The rate decreases due to two reasons. The first, a solid angle for detection of background particles originating in the beam-pipe or other setup elements is much less than for the case of only the vertical hodoscopes as V and Pr are at 4 m distance. The second, there arises the energy threshold due to energy losses in the materials between V and Pr: the scintillators of the horizontal hodoscope, the input and output walls and the mirrors of the Cherenkov counter, 2 cm Pb in front of the preshower scintillator. Thus only particles with the energy over 60–70 MeV can be detected in the preshower. This removes a low energy background from T0 events.

The logic of T0 is very simple and can be assembled in slightly different ways dependent of available modules. One of the versions is shown in the Fig.1. The signals from the vertical hodoscope $V1$ (18 channels) through the discriminators CFD come to the LeCroy 4564 OR module. This module consists of 4 sections each by 16 inputs and is able to make OR of 16 channels within the section and different logical combinations of these OR. The signals from only one end of $V1$ scintillators are taken for this purpose (from

the lower ends or from the upper ones). The signals of the preshower $Pr1$ (8 channels) are linearly fan-out'ed and after discriminators D (LeCroy 3413) come to the second half of the same OR module. The module produces separate ORs of $V1$ and $Pr1$ signals and makes AND of these ORs. The same is done in another 4564 module for the $V2$ and $Pr2$ signals. Then a coincidence of signals from the outputs of two 4564 modules is made in any coincidence scheme with an output shaping of the T0 signal equal to the needed gate width for the ADC of the ionization detector. The third 4564 module can be used, for example, for this purpose. If the dedicated commutator unit (the prototype was produced by V.Karpukhin) is used at the input of the ionization detector electronics then the gate width is formed in this unit and the shaping in T0 scheme is not needed. In this case for coincidence of two 4564 OR/AND signals only one free section of 4516 module is sufficient which is available among the T1 modules.

The timing of the output signals in $V \cdot Pr$ coincidences should be defined by the V signal. The duration of signals at the AND outputs of 4564 modules (which is adjustable) should be tuned in accordance with the duration of the meantimer output signals in Trigger 1 scheme to have the same window for acception of accidentals. Really T0 will have a jitter of 3 ns (total width) with respect to T1 due to absence of meantimers in the T0 branch and hence to time dependence on the light propagation delay in the scintillators of V. So not to loose the "marginal" T1 events within the T0 sample, the V signals in T0 branch should have 3 ns more width.

The total delay of the above T0 scheme is 45–50 ns. The additional modules, compared to the T1 scheme, are: 4 linear fan-in/fan-out LeCroy 428F NIM modules and 1 discriminator LeCroy 3413 for the preshower detectors and 2 (3 if no commutator) LeCroy 4564 OR modules. The CFD in V channels should have 2 outputs per channel (the 2-nd outputs are connected to meantimers). This excludes the LeCroy 3420 option for CFD. The choice of the discriminator type for the preshowers is not strictly limited: they may be replaced by the similar types.

It is possible to make more compact scheme with only one 4564 module instead of 2–3 if CFD of the vertical hodoscopes have the OR output. In LeCroy 3420 CFD, for example, this option is realized: there is a separate OR output of all 16 channels which exceed the set threshold. Then T0 scheme can be made as shown in Fig.2.

There were five 3420 CFD modules proposed for the vertical hodoscopes. Each hodoscope occupied by 2 modules completely and by 4 channels in the 5-th module. For the present scheme the signals of two hodoscopes should not be put in the same module, so there will be 6 CFD in total, by 3 per each hodoscope. We connect the OR outputs of three $V1$ discriminators to the 1-st section of the 4564 module. The same is done for $V2$ connected with the 2-nd section. The 3-d and 4-th sections receive by 8 signals from the discriminators of $Pr1$ and $Pr2$, respectively. Then the module makes OR for each section and AND of these OR thus realizing the logic formula T0=$V1 \cdot V2 \cdot Pr1 \cdot Pr2$. The outputs $V1 \cdot Pr1$ and $V2 \cdot Pr2$ are also available for the control of counting rates in separate arms. Note that the signals of all PMs of the vertical hodoscopes are OR'd here (i.e. from both ends of the scintillators) but it does not affect negatively the trigger quality. The delay of this T0 scheme is around 35–40 ns.

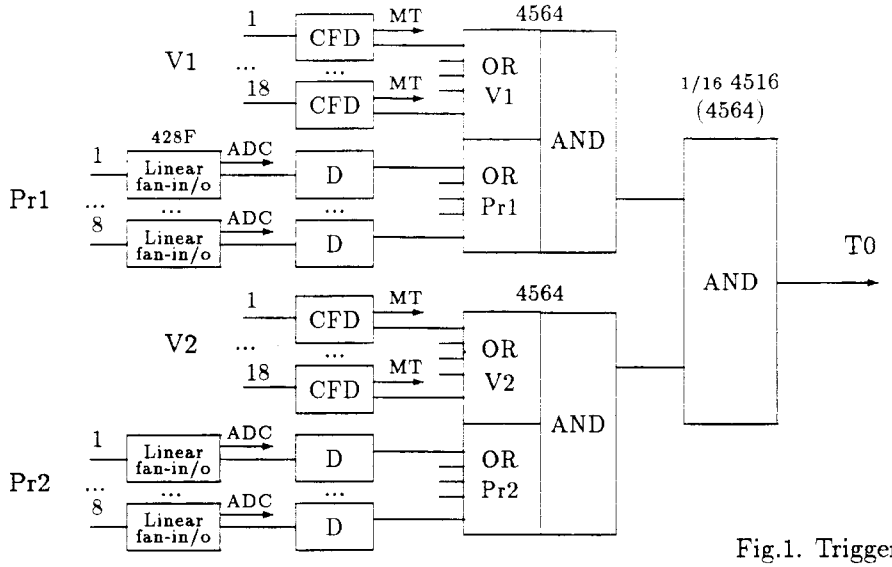

Fig.1. Trigger 0 scheme.

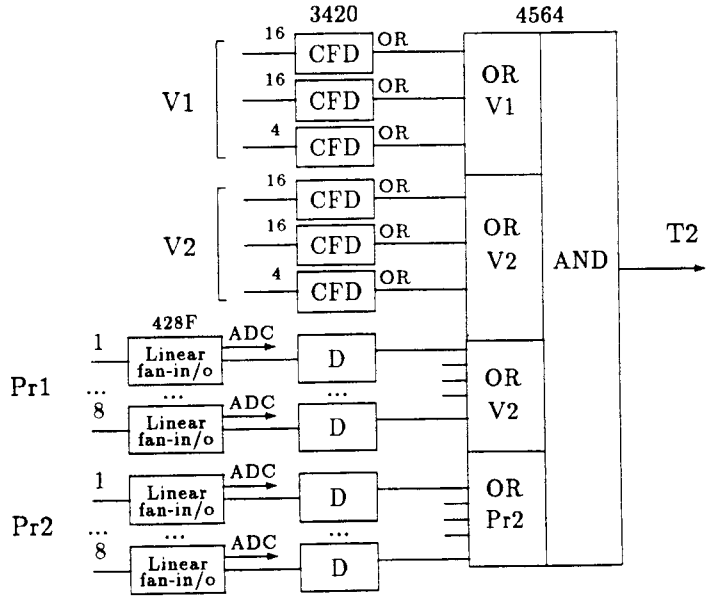

Fig.2. Trigger 0 scheme.
OR outputs of CFD are used.