METHODS FOR ROOF-TOP MINI-ARRAYS

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1. Introduction. In order to test the idea of the Linsley effect mini array (1) for the study of giant air showers, it is desirable to have a trigger that exploits the Linsley effect itself. In addition to the trigger, it is necessary to have a method for measuring the relative arrival times of the particle swarm selected by the trigger. Since the idea of mini- arrays is likely to appeal to small research groups, it is desirable to try to design relatively simple and inexpensive methods, and methods that utilize existing detectors.

Thus far we have designed for clusters of small detectors where the operation is in the local particle density realm where the probability of ≥ 2 particles per detector is small. Consequently, we can discriminate pulses from each detector and thenceforth deal mainly with logic pulses.

This report describes the key circuits that have been built and the results of preliminary tests. Results from a preliminary run with a small shower array are presented in another conference paper (2). Expected rates of data collection are calculated in paper HE 4.7-8.

2. Method. Pulses from the photomultiplier (PM) of each detector are fed to discriminators (after preamplification if desirable). The discriminators can be single level or double level (CFD) if desirable enough to warrant the extra circuitry. The discriminator outputs are then "shaped" to 20 ns length and combined by an OR element. The OR'd output is fanned-out to the trigger circuit and to a 100 MHz time shift register.

For a study and utilization of the Linsley effect itself a time window of 2 μs is sufficient, but we can also provide an additional 2 μs of analog display (with lower time resolution) by means of a 30 MHz pulse form digitizer,[3] if we want to look for delayed pulses. Both of the above are also readily lengthened by adding more shift-register IC's.

(A) The trigger circuits are of two sorts. The first is digital and simply counts the number of pulses that arrive within a 2 μs gate that is opened by each pulse. (With the "singles" counting rates we need in order to have satisfactory particle detection efficiency, the accidental rates can be kept manageable.) If the number of pulses within the window satisfies the preset requirement, a trigger is generated at the end of the 2 μs gate. The circuit is shown in Fig. 1.

The above trigger has the advantage of simplicity, but it cannot count pulses that are closer together than 30 to 40 ns. There-

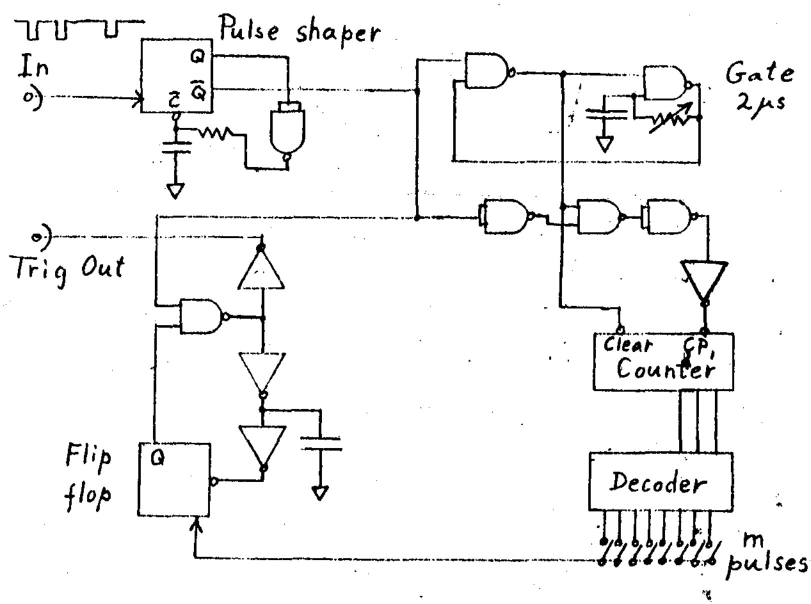

Fig. 1 Pulse-train trigger; digital.

fore, we have built a second type of trigger. Again, each arriving particle, i.e., pulse on the OR line, opens a 2 μs gate. But this time the gate is for an analog device that integrates the time occupied by following pulses (if any). This system has the advantage of partially "resolving" overlapping pulses. The circuit is shown in Fig. 2. Again, a trigger is generated at the end of the 2 μs gate if the preset requirement is met.

(B) The relative time record is obtained from a 100 MHz time shift register that holds 2 μs of information. The register is stopped and read out when a trigger is received from (A). The register is composed of four 25 MHz elements with a 50 ns multitap TTL delay IC to phase shift among the registers. The circuit is shown in Fig. 3.

3. Applications. The above circuit elements are being used by the cosmic ray group of L.K. Ng at Hong Kong (2) in conjunction with a cluster of eight 1/4 m^2 scintillators. There are plans underway to use this method in parallel with the main shower experiment of the Cosmic Ray Group of the Institute of High Energy Physics at Beijing. We also hope to use it for calibrations at some of the existing large shower arrays.

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References

[1]Linsley, J (1983) Research Report UNML 6/83.
[2]Ng, LK et al., Paper at this conference.
[3]Crosby, DA and MacAdam KB (1981), Rev. Sci. Inst. 52(2) 297.

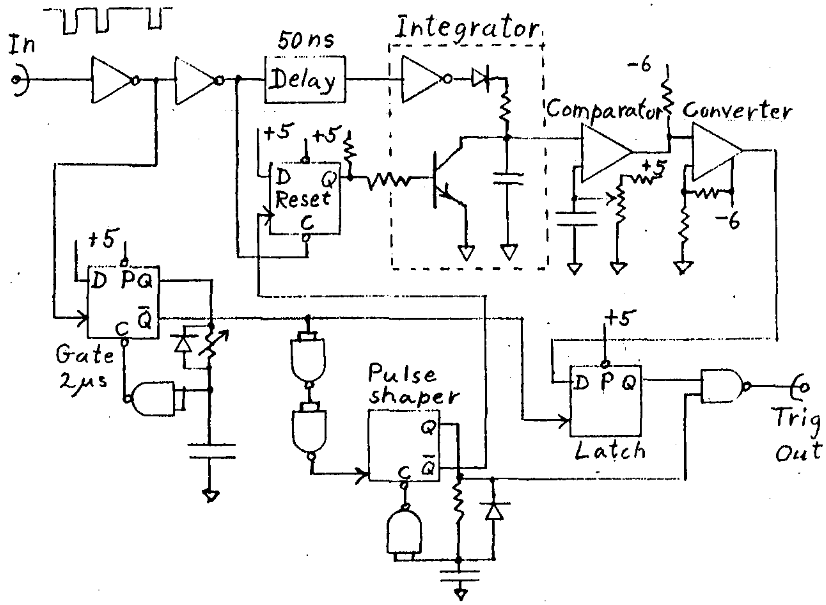

Fig. 2 Pulse-train trigger; integrated width.

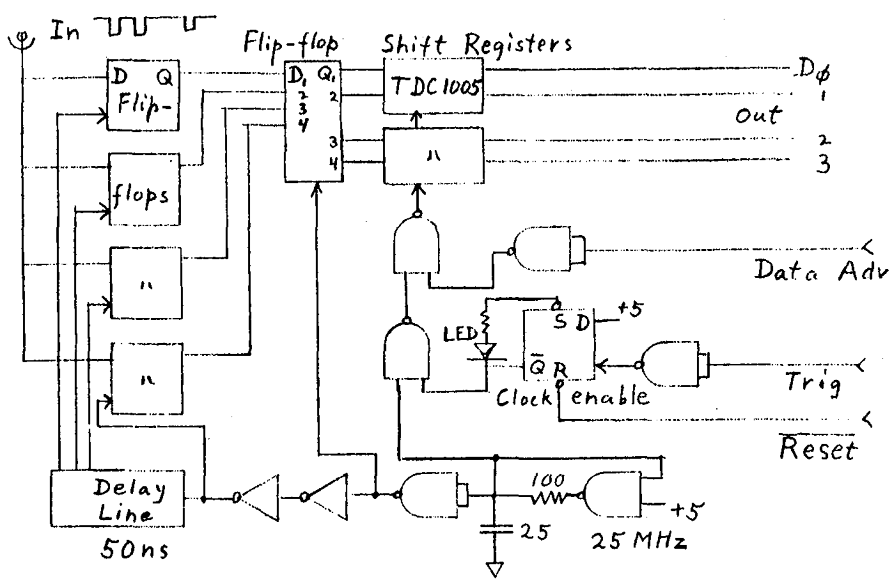

Fig. 3 100 MHz shift register.