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THE SELECTIVE TRIGGERING SYSTEM WITH PROPORTIONAL CHAMBERS FOR THE SMALL ANGLE Π -p SCATTERING EXPERIMENT AT 40 AND 50 GeV

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In the small angle π-p scattering experiment only such particles should be selected from the beam the scattering angles of which are greater than a definite one. The proportional chambers (three of each plane X and Y) were used as detectors for a decision making system. The information from the proportional chambers was processed by an analog device giving permission for triggering the magnetic spectrometer with 18 magnetostrictive spark chambers.

The readout electronics [1] digitizes data from the spectrometer and transfers them to the computer.

The general view of the experimental setup in the beam of the Serpukhov accelerator is shown in Fig. 1.

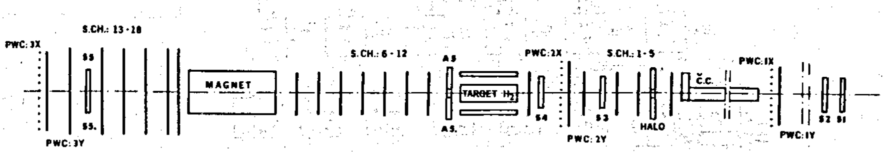

Fig. 1. General view of the spectrometer.

The straight line in the coordinate system of three proportional chambers is presented by the equation:

$$AX1 - BX2 + X3 - C = 0, \qquad (1)$$

where $A = \frac{\ell_2}{\ell_1}$; $B = \frac{\ell_1 + \ell_2}{\ell_1}$; $C = \frac{c}{a}$; $X1$, $X2$, $X3$, are the numbers of the wires in the proportional chambers; ℓ_1 is the distance between the first and the second blocks of the chambers; ℓ_2 is the distance between the second and the third blocks of the chambers; a is the wire spacing of the proportional chambers; c is the constant depending on the transverse shifts of the chambers relatively the coordinate axis.

From the mathematical point of view, the electronics problem can be determined as follows:

$$|AX1 - BX2 + X3 - C| > K , \qquad (2)$$

where K is a value proportional to the scattering angle.

The spectrometer could be triggered when the scattering angle of a particle was greater than that specified by constant K .

Figure 2 presents the block diagram of the analog electronics resolving the inequality (2).

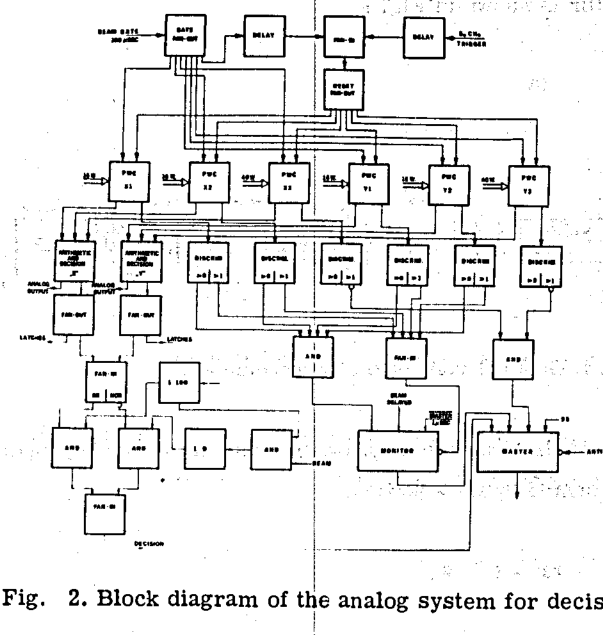

Fig. 2. Block diagram of the analog system for decision making.

Principle of Operation of the Selective Triggering System

Signals from the wires of the proportional chambers were amplified, shaped and passed the gates which were opened for ~100 nsec and next were stored in the flip-flop memory (see Fig. 4). The GATE pulse came from the fast electronics circuits presented in Fig. 3.

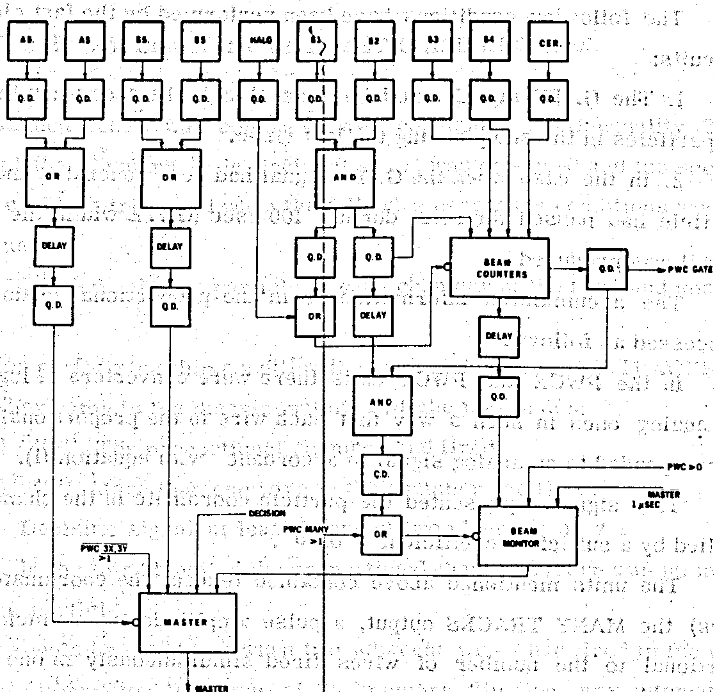

Fig. 3. Fast electronics circuit.

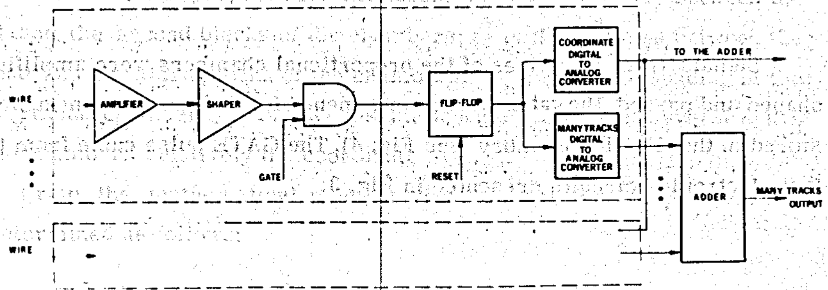

Fig. 4. Block diagram of the electronics for the proportional chambers.

The following conditions have been performed by the fast electronics circuits:

1. The GATE signal could be generated in the case when there were no particles in the setup during the last 1μsec.

2. In the case when the GATE signal had been generated and the next particle had passed the setup during 100 nsec (GATE width) the inhibition signal was produced.

The accumulated information from the proportional chambers was processed as follows.

In the PWCX and PWCY units there were converters of logic pulses to analog ones in such a way that each wire in the proportional chamber corresponded to an analog signal in accordanc with equation (1).

This signal represented the particle coordinate in the chamber multiplied by a sufficient coefficient A or B.

The units mentioned above contained (except the coordinate converters) the MANY TRACKS output, a pulse amplitude from which was proportional to the number of wires fired simultaneously in one chamber.

The analog signals of coordinates $AX1$, $BX2$ and $X3$ were added with constant C in the ARITHMETIC AND DECISION unit shown in Fig. 5.

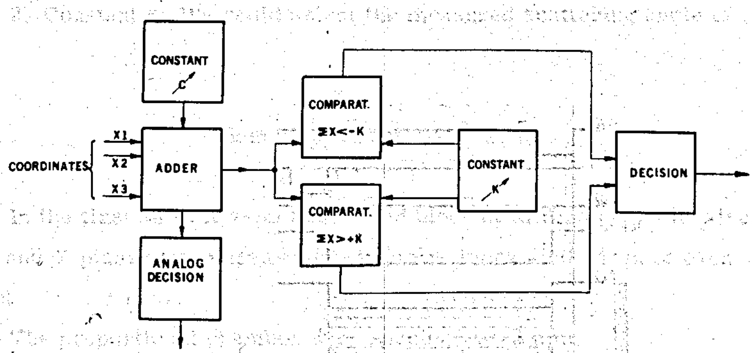

Fig. 5. Unit of the ARITHMETIC AND DECISION.

The obtained result was compared with constant K. If inequality (2) was satisfied the standard logic decision signal was produced and the spectrometer could be triggered when the following necessary conditions would be performed:

1. One and only one particle in each chamber of the first and second blocks.

For performing this condition the analog signals MANY TRACKS were used. They came to the discriminators with the thresholds:

a) > "0". The proportional chamber had fired.

b) > "1". More than one wire in the chamber had fired.

2. Decision signal at least in one of two planes X or Y.

3. In the third block of the proportional chambers there was no more than one particle.

It should be noted that when two adjacent wires had fired in the chamber the information from one of the memory flip-flops was automatically suppressed.

The system required about 300 nsec for analysing one event. After a while the RESET signal (delayed signal GATE) cleared all flip-flops and the electronics was ready to accept the next event. The time diagram of one event is given in Fig. 6.

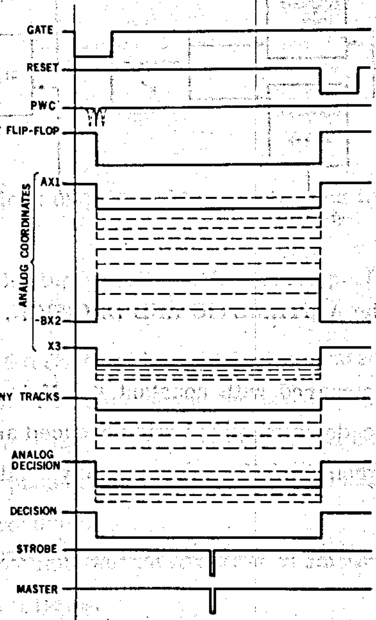

Fig. 6. Timing of one event.

In the case when the spectrometer was triggered the analog decision signals were transferred to the computer. It gave possibility to check the operation of the system during the experiment.

In the selective triggering system there were possibilities to change some constants:

1. Constant c. We could correct the geometrical transverse shifts of the chambers.

2. Constant κ. We could select the measured scattering angle of the pion.

Some Technical Data

In the first as well as in the second block of the chambers 16 wires of X and Y planes were used and in the third block - 40 wires of each plane.

The proportional chamber wire spacing was 3 mm.

The constant κ made it possible to select the scattering angle up to ± 2 mrd.

The following results have been obtained:

The trigger rate determined as a ratio of the analysed event number to the number of triggers was on an average about 15 when detecting the particles scattered for the angles greater than 0.5 mrd in X plane and greater than 0.4 mrd in Y plane.

In photo 7 the profile of the beam in the third chamber is presented. The photo was done using the coordinate output and analyser.

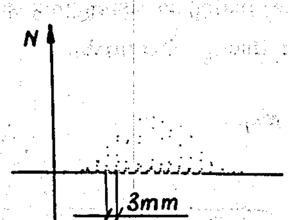

Fig. 7. Profile of the beam in the third chamber.

The analog decision without any additional conditions is given in Fig.8.

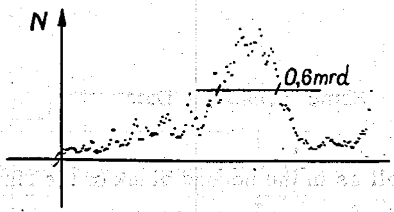

Fig. 8. Analog decision without any additional conditions.

The same decision but under the condition that in each chamber of the first and second blocks one and only one wire has fired is presented in Fig. 9.

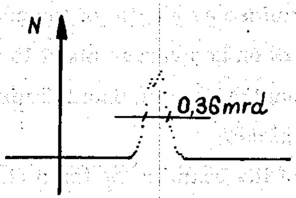

Fig. 9. Analog decision under the condition: ''one and only one''.

In these both cases the analog decision signals passed through the linear gate.

Fig. 10 shows the analog decision in x plane for particles with the scattering angle greater than $\pm$ 0.5 mrd.

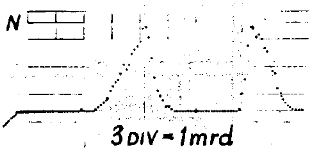

Fig. 10. Analog decision for the particles scattered at the angle more than $\pm$ 0.5 mrd.

In Figs. 8 and 9 it is easy to observe a discrete structure of the analog decision the reason of which is the discrete information from the wires of the proportional chambers.

The resolution of the selective triggering system found from this picture is equal to ± 0.18 mrd (± one wire spacing of the proportional chamber).

References

1. M. Turala et al. JINR,Preprint, E1-5818, Dubna (1971).
2. L.J. Koester et al. Wire Proportional Counter Arrays with Fast Digital Arithmetic for Decision Making. Ispra Conf. Nucl.Electron.,1969.

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