Title
A MULTICHANNEL COINCIDENCE SYSTEM

Permalink
https://escholarship.org/uc/item/5b2495pk

Author
Kenney, Robert W.

Publication Date
1962-05-28

UCRL-10266

University of California

Ernest O. Lawrence Radiation Laboratory

Berkeley, California

DISCLAIMER

For Conference for
Instrumentation for High
Energy Physics, CERN

UCRL-10266

IVERSITY OF CALIFORNIA
wrence Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

A MULTICHANNEL COINCIDENCE SYSTEM

Robert W. Kenney

May 28, 1962

A MULTICHANNEL COINCIDENCE SYSTEM*

Robert W. Kenney

Lawrence Radiation Laboratory
University of California
Berkeley, California

May 28, 1962

Experimental requirements occasionally dictate that numerous coincidence channels be associated with an array of counters, any one channel perhaps requiring several counters to detect particles in time coincidence. In a recent Bevatron experiment on pion-nucleon scattering, for example, 50 counters were combined in various ways into 64 coincidence channels. The following description of the electronic system is somewhat oversimplified in the interests of brevity, and is intended to present only basic ideas. The electronics was designed and constructed by Messrs. Dick A. Mack, Frederick S. Goulding, Frederick A. Kirsten, Larry Scott, and Fong Gin. A simplified block diagram of their system is shown in Fig. 1. The principal features of the system were its economical use of fast circuitry, simplicity of multiple coincidence systems, and convenience of data readout.

The observation of an elastic pion-nucleon scattering event required that two charged particles emerge from the hydrogen target at the correct kinematic angles for pions and protons, within certain limits set by counter geometry. The full angular range of the scattered particles was divided into 21 intervals by choice of counter geometry, and each interval was independently observed to yield a complete angular distribution of 21 points taken simultaneously.

The system required that monitor counters and the auxiliary counter S_0, in fast (4-nsec) fourfold coincidence, provide a time reference for each

---

*Work done under the auspices of the U. S. Atomic Energy Commission.

event. The basic time resolution of the system was provided by placing the time reference signal in fast (35-nsec) double coincidence with the scintillation signal from each pion and proton counter in the array. The use of fast coincidence circuitry was minimized by employing only one such circuit for each of these counters. The output of each counter's coincidence circuit triggered an associated bistable element which provided a dc level, until reset 7 μsec thereafter, for feeding the remainder of the electronics. Dead-time corrections were avoided by providing a disabling gate for the monitors which, in effect, turned off the incident pion beam when the electronics was busy with the analysis and recording of an event. Two events separated by 7 μsec were accepted and stored even though the analysis and storing time was 20 μsec. The second event was temporarily stored in the bistable elements associated with the scintillators.

The second feature of the system rests upon the separation of the fast timing function from the slow coincidence circuits. Fast timing, outlined above, was satisfied first. Then the slow output pulses (dc levels) were subsequently fed to Rossi diode circuits to yield the required coincidence combinations. The slow coincidence circuitry was a "matrix" of the type shown in Fig. 2. All output channels were given convenient access to any input channel by circuit boards with input lines printed on one side and orthogonal output lines on the other and having connection holes at each junction for installation of connecting diodes. A given matrix output was obtained when simultaneous signals appeared on those input channels which were connected by simple diodes to the output line in question. For example, output channel No. 1 gave a coincidence signal only when signals appeared simultaneously on input channels π_1 and p_1. The multiplicity of the coincidence is limited by the paralleled capacity of the total number diodes, the rise time of the driven output channel being restricted to 2 μsec or less. This multiplicity is clearly very large, and there was no restriction even for ten fold coinc coincidences. Twenty-one output channels were devoted to elastic pion-proton events and the remaining channels measured the background of charged inelastic (pion-production) events recorded in the elastic channels. Double coincidences were required in all cases.

Each of the 64 matrix coincidences was scaled separately. The ferrite-core storage section of a pulse-height analyzer was utilized as a compact set of 64 scalers. This equipment was readily available and simply modified for our purposes, and the data were conveniently read out. The analyzer was modified by adding external circuitry (coder) for setting the address scalers, internal to the analyzer, to specific coordinates in the 8-by-8 core storage. A trigger on one of the coder's eight x inputs, x_i, and simultaneously on one of the eight y inputs, y_j, then resulted in storage of one count in the corresponding address (x_i, y_j) upon completion of the remainder of the normal "store" cycle in the analyzer. When an output was obtained from a given channel of the matrix described above, it was stored at its own address (x_i, y_j) in the core by splitting the matrix output signal and directing the two resulting pulses to the coder's x_i and y_j inputs for initiation of the modified storage cycle. Each of the sixteen coder inputs (eight x and eight y) was in reality a set of eight inputs that were mixed so that each of the eight addresses having a common x_i (or y_j) coordinate would receive its proper input signal. The average storage rate was limited by the pulse-height analyzer to one event per 20 μsec. The data analysis was greatly facilitated by punching IBM cards directly by the analyzer in a format suitable for computer input. Electric typewriter readout was also used. The complexity of such a scaling system is restricted principally by the analyzer storage.

Some important subsidiary circuits of the system prevented storage of extraneous information. A double-pulse rejection system gated the entire system off when two pions in the incident beam traversed the monitor telescope within the resolution time of the fast double-coincidence circuits associated with each pion and proton counter. False scattering events were rejected in this manner. If two or more of the 64 channels tried to store information simultaneously, the entire event was rejected, scaled, and recorded.

The data were analyzed by computer and the preliminary results were presented in the form of angular distributions plotted by the computer in its cathode-ray output format. Photographs of these plots were available within a few hours of the completion of any given run, and materially assisted the direction of the experiment. This work has been reported at the 1962 Conference on High-Energy Physics at CERN.[1]

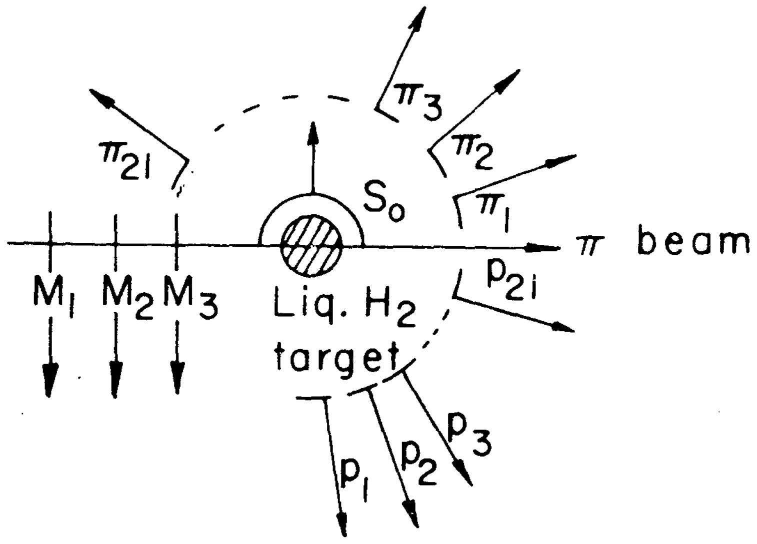
REFERENCE

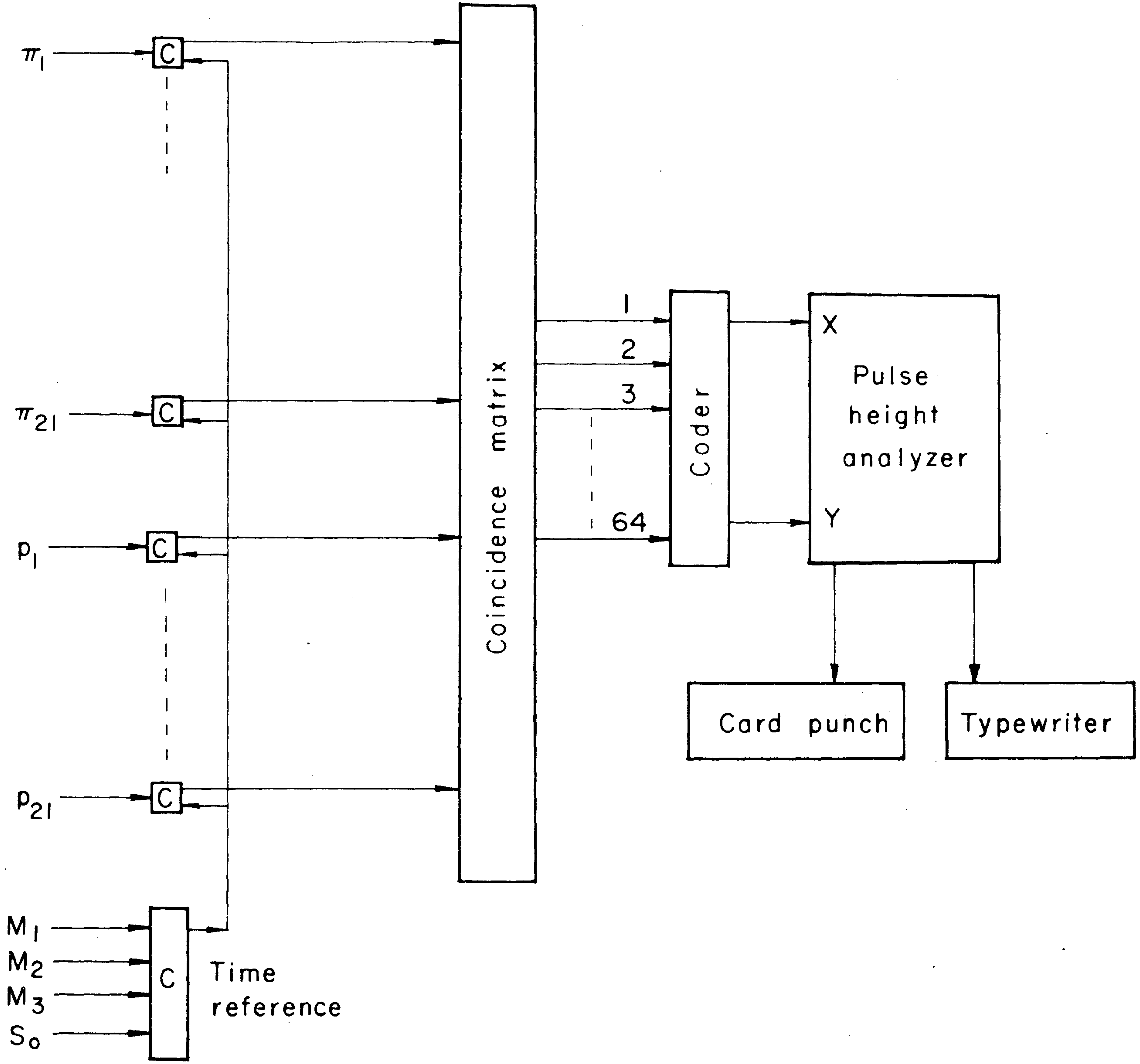
1. J. A. Helland, T. J. Devlin, D. E. Hagge, M. J. Longo, B. J. Moyer, and C. D. Wood, Angular Distributions in $\pi^{\pm}$-p Elastic Scattering in the Range 530 to 1550 MeV, UCRL-10263, May 1962.

FIGURE LEGENDS

Fig. 1. Simplified block diagram of electronics.

Fig. 2. Coincidence matrix. Circled intersections are connected by diodes.


π21
π3
π2
π1
S0
π beam
p21
M1 M2 M3
Liq. H2 target
p1
p2
p3


π1
C
π21
C
p1
C
p21
C
M1
M2
M3
S0
C
Time reference
Coincidence matrix
1
2
3
64
Coder
X
Y
Pulse height analyzer
Card punch
Typewriter

62700-2

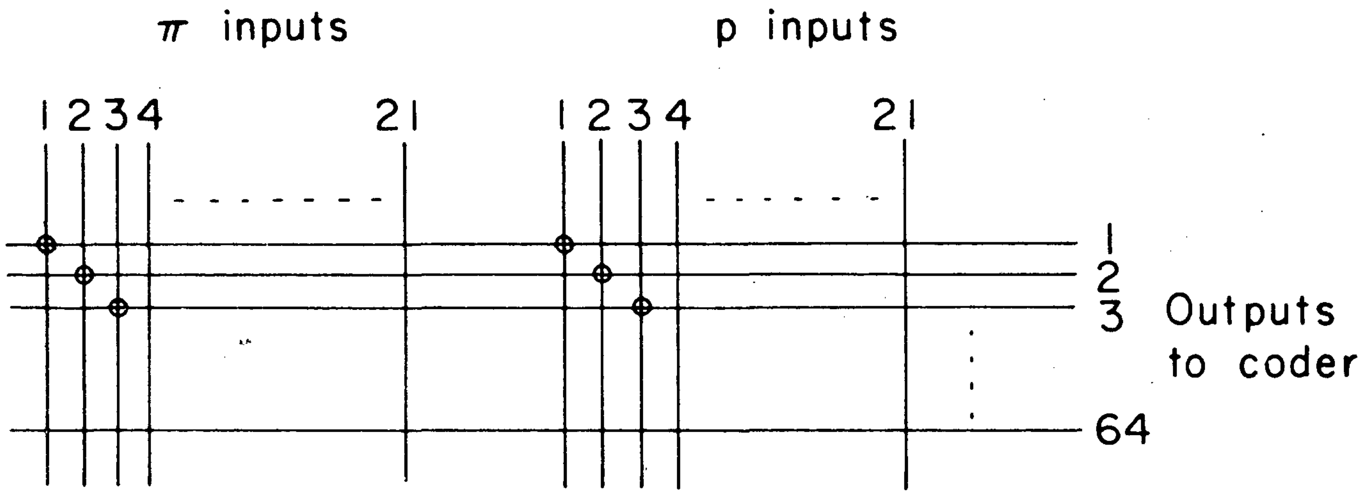


Fig 2

62701-1