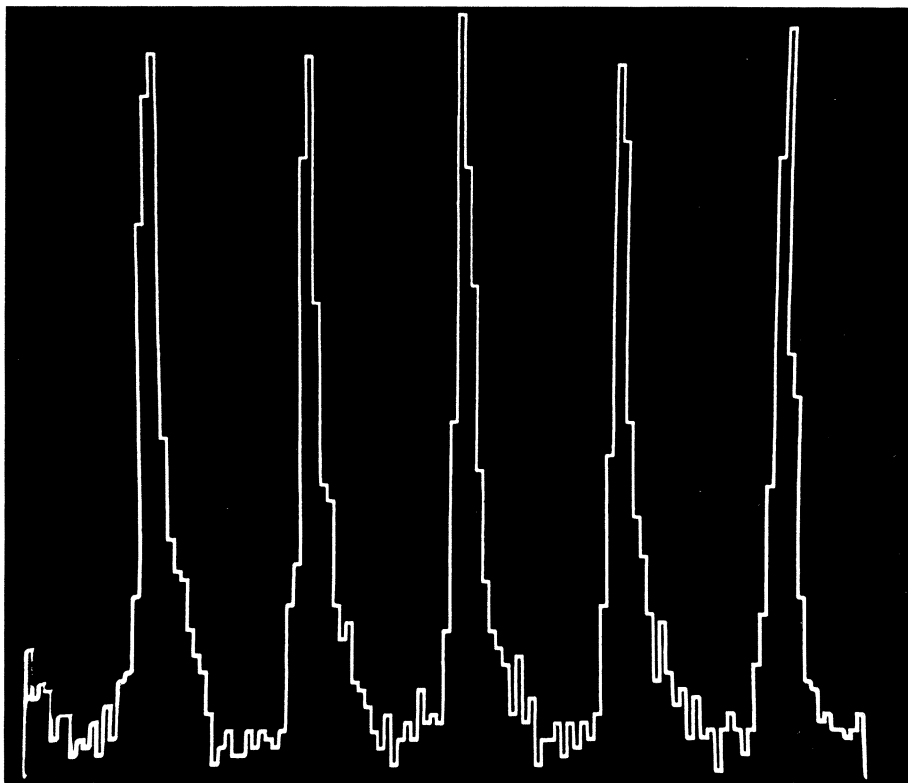




Distribution of arrival times of charged particles at counters, relative to the phase of a signal from a resonant cavity in the Daresbury 5 GeV electron synchrotron. The timing system is being used in a study of the charge exchange reaction $K_L^0 + p \rightarrow K^+ + n$. The Figure shows the resolution of the detection system with several peaks at 5 ns intervals corresponding to bunch separation in the synchrotron. The full width at half height of the peaks is 600 ps.

the lower intensity of kaon beams compared with pion beams and the difficulty of separating isospin states in positive strangeness kaon-nucleon scattering. K^+p scattering presents information on the positive strangeness isotopic spin 1 state. In order to get the corresponding isospin 0 state it is necessary to study either K^+n or K^0p scattering. K^+n involves the use of deuterium which introduces further difficulties. K^0p also presents difficulties because of the neutron background in the K^0 beam and lack of knowledge of the K^0 momentum. The Daresbury experiment has a beam with a low neutron background, the momentum spectrum spans the region where structure is expected and, thanks to the efforts of the accelerator team, the beam is time resolved which allows the incident kaon velocity to be measured.

The group use wire spark chambers on either side of a wide aperture magnet to measure the direction and momentum of the K^+ produced in the charge exchange reaction. The neutron direction and time of flight are measured using an array of neutron counters. The velocity of the incident K^0 is found from the recorded time of arrival of the kaon relative to a pulse generated by the accelerator r.f.

These measurements ensure that each event is 'over-determined' but the group found that more was required to distinguish the reaction of

interest from elastic neutron-proton scattering. Also the cross-section for this background reaction is many times greater than for charge exchange. This difficulty was overcome by measuring the K^+ time of flight through the magnet and the pulse height it produced in a thick scintillation counter which picked out the kaon as opposed to a proton.

The r.f. structure of the beam in the synchrotron is used to time the flight of the neutral kaon. Normally the r.f. structure is a 1 ns bunch of electrons every 2.5 ns. However, modulation of the injector electron gun at 204 MHz alters this to a bunch every 5 ns. The timing method depends upon an oscillator (again 204 MHz) phase locked to the bunches; phase locking is done in two independent ways. The first method uses a signal from an idler cavity in the synchrotron to phase lock the oscillator to the circulating bunches. However, this signal dies away during extraction.

The second method uses a signal from the Cherenkov light of relativistic electrons in the bremsstrahlung beam that produces the neutral kaon beam. Conveniently, the bremsstrahlung beam has a 0.1 % contamination due to pair production in the air. Changes in phase between the oscillator (phase locked to the idler cavity) and the Cherenkov signal are measured. This is very sensitive — a change in phase equivalent to 50 ps is easily seen —

and when the two signals agree to this accuracy both are almost certainly correct because they are obtained in such different ways.

Time of flight information on the neutral kaon is obtained in the following way; the positive kaon generates a start pulse for a time to digital converter. The output from the oscillator, which is in phase with the circulating bunches, is converted to a pulse train and the next pulse after the start pulse is used to stop the time to digital converter. As the bunch which produced the K^0 is not identified, the measured time interval yields a series of possible K^0 times of flight at 5 ns intervals. The actual time of flight can be any one of this series and the kinematics of the event is then invoked to select the correct time. (A bunch separation of 5 ns, instead of the usual 2.5 ns, is used because the kinematics is not sufficiently accurate to distinguish between bunches 2.5 ns apart.) The momentum of the incident neutral is determined to about 50 MeV/c (at 1 GeV/c) which has proved invaluable to tie down the kinematics properly and thus to reduce the background of unwanted neutron induced events.

Summer School

The Canadian Institute of Particle Physics Summer School will be held from 27 August to 1 September at McGill University, Montreal. Further information may be obtained from Miss C. Bridgman, Department of Physics, McGill University, P.O. Box 6070, Montreal 101, Quebec, Canada.

The Proceedings of the 1972 School, edited by R. Henzi and B. Margolis are now available at a cost of \$ 10 Canadian from the same address.