Rutherford Laboratory

Technical Leaflet

B.11

ELECTRONICS GROUP

As in most sciences the final measurements and recording of results in high energy physics experiments rely largely on electronic equipment. In many parts of the experimental area such equipment can be seen ranging from small units performing simple functions to large pieces of equipment which simplify the recording and understanding of the experimental results. Much of this equipment has been designed and developed by the Electronics Group of the Rutherford Laboratory, or the Atomic Energy Research Establishment.

Typical examples of equipment which may be seen are:-

(i) Scaler Print Out Equipment - P.L.A. and N.1.

In most of the experiments the results are obtained by counting the number of events in given categories. This counting is performed by units known as scalers and in some experiments there can be as many as fifty scalers. The contents of these have to be recorded at frequent intervals and to do this by eye and hand is not only time consuming but is also liable to human errors. The scaler print out equipment enables the contents of a bank of scalers to be printed out automatically at a preselected time. Not only can the results be printed in the normal numerical form but also in the form of punched paper coded suitably for direct input to a digital computer.

(ii) Spark Position Indicator - N.1.

In some experiments the position of a spark in a spark chamber is used to give information about the position of a particle. The position of the spark is recorded accurately by a digital method often using scalers and a print out system such as described above. The recorded numbers have to be processed before a picture of the progress of the experiment can be built up, so this information is not immediately available.

The spark position indicator produces analogue information in parallel with the digital record. This analogue information is not so accurate as the digital information but it can be displayed on cathode ray tubes to give an immediate picture of an event. ' Individual sparks are represented by small spots of light and the track of the particle represented by the pattern of these spots on two cathode ray tube screens.

(iii) Co-ordinator for Scattering Experiments - π 1

In many experiments the events are divided into categories and the

number of events in each category is recorded. Each of the categories can be given an address corresponding to a position in a store such as is used in a digital computer. The coordinator accepts information from approximately 50 counters, classifies an event as belonging to one of 512 categories and generates the signals necessary to address a store.

(iv) A more detailed exhibit is shown demonstrating some of the uses of the smaller units.

In general there are two quantities which have to be measured in experiments using high energy accelerators. The first relates to the direction of motion of one particle relative to another and the second relates to the time of occurrence of one event relative to another. Typical methods of measuring the first quantity are by spark chambers, bubble chambers, or by counter arrays, examples of which can be seen in the experimental area. The exhibit arranged by the electronics group demonstrates methods of measurement relating to the timing of events.

It is interesting first to consider the actual scale in which these measurements are made. The electronic engineer is well accustomed to measurements made in microseconds, i.e. millionths of a second; the unit of time most used in high energy physics is the nanosecond, one thousandth of one millionth of a second. Probably this unit can best be comprehended by remembering that light will travel one foot in one nanosecond so, since the particles which we are measuring are often travelling at speeds near to that of light, the nanosecond is a most appropriate unit.

The methods shown are those by which the following questions may be answered.

1) Do two events occur at the same time? (measured say to within one nanosecond). This information tells the experimenter that the two events probably have a common origin.

2) Is a particle travelling faster than some preselected value? This knowledge can help determine what type of particle is being measured.

3) How fast is a particle travelling? This can give information which will determine the energy of the particle.

In the demonstration pulses of electromagnetic radiation are used to simulate high energy particles. The demonstration is thus rather akin to radar but the important point is the time scale in which the results are measured.