DATA HANDLING IN MU MESON PAIR PRODUCTION AT CEA

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(presented by R. Weinstein)

SUMMARY

Mu pairs produced by the 5 GeV CEA bremstrahlung beam, were selected by requiring that they pass through 4 feet of iron, strike a trigger counter, and then continue on through another 3 inches of iron and strike a second trigger counter. In addition to the trigger counters there were 134 other scintillation counters for the measurement of angles and ranges. The output of each of the 134 counters was brought to a hodoscope electronic unit (similar to the units described by Fessel at this meeting) made by Space Sciences of Waltham, Mass. The design of our units is a slightly improved model of the one used by Fessel, and failure rates were negligible. Each unit amplified the signal and applied it to an AND circuit, the other input of which was the trigger caused by the mu pair. If both inputs occurred within 30 nsec, a flip-flop was put in a ONE state. The flip-flops were also connected in six shift registers, each 32 deep. After having received parallel read-in from the counter-trigger coincidence, these units were controlled as a shift register, by the "Interface and Command Unit". This latter unit performed the following functions:

a) set 3.5 inches at the start of a new tape roll;

b) start tape recorder when trigger is received; allow tape to reach speed;

c) send shift commands to all flip-flops of the six shift registers;

d) generate kill pulse to fast electronics;

e) compute transverse parity;

f) write LRCC with proper 0.02 inch gap;

g) write end-of-file mark every 64 events;

h) contain additional flip-flops into which manual information could be inserted;

i) contain additional flip-flops into which electronic information is inserted (beam intensity, file number, time of run, square of beam intensity, etc.);

j) send write commands to tape recorder at proper times;

k) keep tape going for 3/4 inch after an event;

l) reset all flip-flops to ZERO upon receipt of a CEA pre-spillout pulse;

m) stop all operations when an end of tape marker is passed;

n) no buffer was used because of the 60 cps repetition rate of CEA. This unit was composed of logic blocks made by Digital Equipment Corporation of Maynard, Mass.

The "Interface and Command Unit" writes on a slightly modified Potter 906 II tape recorder at 75 ips in low density format. The tape recorder was run in NRZ mode. It was started and stopped for each event, and after about 0.5×10^6 events, showed no wear. The only service to the recorder was a brief cleaning after every 16 hours of operation.

All data were read from the tape immediately after writing, and stored in flip-flops connected to lights. The lights were arranged in geometrical arrays similar to the counter geometry. Almost all counter failures were detected in this manner. The light board was made by Space Sciences and used both DEC and Space Sciences logic blocks.

Two quite different analyses of data were done off-line on an IBM 7090. A "quick" calculation was done of the single rates of every counter. This "bit count" occasionally indicated counter or electronic troubles. "Bit count" could be done in five minutes at the 7090 (after a three hour wait for the five minutes run). It would be a comfort and convenience to have this operation performed on-line.

The more complete calculations on the data took several hours of computer time, and the full memory of the 7094. A larger computer memory would be desirable. Since (a) backgrounds, and even some classes of background events, were unknown, (b) a knowledge of results had little or no bearing on data taking, and (c) about two man-years of programming would have had to be invested prior to a knowledge that the experiment would work, it is felt that on-line computation of results (as distinguished from on-line bit count) would have been a mistake in our original run.

DISCUSSION

LINDENBAUM: I would like to comment on Weinstein's question of whether the on-line operation of a computer to process the physics results during the run is necessary or desirable. In our elastic scattering experiments we found that the direct and continuous feedback of the results affected how we ran the programme to a great extent and was a great positive asset. On-line operation of the Merlin Computer was essential to ensure its efficient use during a run of our magnitude including debugging of equipment, debugging of programmes and efficient running of the experiment to ensure proper operation of the equipment and that the desired number of events were obtained. By on-line, I mean access to the computer for as long a period as necessary and as often as necessary. In practice, this means either continuously on-line or at least on-line cyclically with a very short period - a period of the order of a few minutes. This latter technique is only useable if the shared computer and intermediate storage are both adequate with regard to memory and speed of recording and their speed of transmission to the computer. Incidentally, we only calculated differential elastic cross-sections on the Merlin. We then ran tapes to the IBM 7090 for least-squares fitting of data, integration of curves, REGGE-pole analysis, etc. In this coming year's work we will only be able to evaluate about 10% of our data on-line to the Merlin (8 K memory about 1/7th the speed of the 7090). In the high rate cases tapes will be ferried to the IBM 7090 for the remainder of the work. One last point - in studying up to four prong events (for example, associated production etc.) the sophisticated programming required will lead to an almost insatiable demand for computer capacity and we will easily need the services of a CDC 3200 or equal, for more than the half time we shall be able to get on it.