ON-LINE CHECKING OF BUBBLE CHAMBER MEASUREMENTS *

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(Presented by R. J. PLANO)

The On-Line system described here consists of standard precision digitized measuring projectors (DMP) connected to a small high speed digital computer. The encoders and parameter switches are read into the computer when requested by the operator depressing a push button to cause an interrupt. The parameter switches are used to transmit ID, comments, and questions to the computer. The computer communicates with the operator via a typewriter to signify and identify operator and machine errors, to answer questions, and to produce a permanent record of the operation.

I. CURRENT SYSTEM

Since October, 1963 we have been operating an on-line system composed of two DMP's manufactured by Vanguard Instrument Corp. connected to PDP-1 Computer with 4096 18-bit words.

Messages to the operators from the PDP-1 are typed on the standard on-line typewriter. Output of measurements and bookkeeping information for further analysis on the IBM 7040 at Rutgers is accomplished using a Kennedy Corp. incremental magnetic tape recorder which inexpensively writes IBM compatible tape at a maximum rate of 300 characters per second.

A considerable effort was made in designing and writing the program to make the system simple, convenient, and trouble-free for the operator. The program should discern and permit convenient correction of all detectable errors. Finally, the computer must, upon operator request, present sufficient information to allow quick recovery from any trouble that may arise.

In an attempt to attain these goals, the following operations were programmed:

1. On each entry of data or parameters, the switches are checked for correct parity and the encoder for illegal codes. If correct, the entire ID, including view and point number are tested for consistency with their expected values. Any discrepancy causes an immediate typeout describing the exact error. This avoids numerous operator errors such as incompletely measured tracks or events, accidental changes in event ID, as well as most breakdowns in the DMP and interface. Furthermore, the detailed description of the machine error allows malfunctions to be easily located.

2. By setting certain switches properly and depressing the entry button the operator can ascertain the current ID, the track numbers of those tracks successfully measured, or of those required. If an error is noticed before an event is completed, the operator can delete a track or an entire event. Finally, the operator must «sign in» before starting and «sign out» at the end of a shift. The «sign out» causes a print out of the number of events of each type successfully measured and a list of errors made.

3. Provision is made for a program to test the measurement of a straight line in order to check the overall operation of the equipment and operators. The immediate availability of the result is particularly valuable.

This program uses essentially all the core memory available and so does not permit reconstruction of tracks in space, which would provide continual checks on measurement accuracy in addition to the completeness checks now made.

II. FUTURE SYSTEM

By early 1965 we plan to replace the PDP-1 by a PDP-6 and add two rough measuring machines to the system. This PDP-6 will have 8192 words of 36 bit core memory. The additional memory will permit us to carry out reconstruction of all tracks as well as some simple kinematics. This facility should completely eliminate the need for remeasurements in most experiments.

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III. EVALUATION

The on-line system described here has a number of advantages over the usual system in which a card or paper tape punch is attached to each DMP. The advantages are of two general types:

1. The speed of measurement is increased. By comparison with rates attained using the usual system, we estimate an increase of 50—75% in the number of events measured per shift. This is due, we feel, to the ease of correcting logical errors, of ascertaining the status of a measurement, and the continual checking which serves to teach and reassure the operators. The typeout of the number of events measured at the end of each shift is also useful.

2. The quality and usefulness of the measurements are increased. This is due partly to the certainty that all events are measured completely and without obvious logical errors, but also to more subtle factors. One is the avoidance of occasional loss of large amounts of measurements due to subtle machine malfunction or operator misunderstanding. Another is due to the fact that all measurements from all machines come out on a single magnetic tape rather than groups of IBM cards. All bookkeeping is then carried out by programs on the IBM-7040, which gives much more rigorous, rapid, and precise knowledge of the current status of experiments.

Finally an on-line system with a sufficiently powerful computer allows further improvements as their desirability and feasibility becomes clear.

DISCUSSION

R. Birge

What did it cost to build and program the devices for on-line monitoring of bubble chamber measurements.

R. Plano

The list price of the basic PDP-1 computer with 4K memory is $ 100 000. The cost of the interface for two measuring machines is about $ 10 000. In addition, the incremental magnetic recorder cost about $ 6000 including interface. Programming the Rutgers system took about 6 man-months to produce the approximately 4000 word program.