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NEW ELECTRONICS FOR THE UNIVERSITY OF TENNESSEE SPIRAL READER MEASURING MACHINE

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NEW ELECTRONICS FOR THE UNIVERSITY OF TENNESSEE
SPIRAL READER MEASURING MACHINE

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July 7, 1970

Specifications and performance of an updated spiral reader at University of Tennessee are discussed.

The spiral reader measuring machines were developed by the Alvarez Physics Group, and began production measurement early in 1956.

Several papers and notes^{1,2} describe in detail the machines' spiraling slit technique of measuring particle tracks emanating from a vertex.

Obviously the slit light amplifier has to have a wide dynamic range, the radius and θ angle must be encoded, and the radius position must be servo-controlled, as must the x-y stage positioning. The film motion, clamping, and frame identification must work smoothly with the rest of the system. Typical production measurement rates of 100 events an hour, or 300 frames an hour, are logged by the Berkeley readers now.

In March 1969 the University of Tennessee funded the building of an updated spiral reader for their physics department.

This paper discusses the differences between the original system and the modernized system that was delivered June 21, 1970, and shown in Figs. 1 and 2.

The track positions are measured by the Tennessee spiral reader to an accuracy of 2μ , and when the points on a 100-point grid are measured by use of both the spiraling slit and the x-y coordinates, these measurements agree (after correction for distortion) with a rms deviation of approximately 3μ on the film. This is over an active measurement area of 3.5 by 9.0 cm. The x-y stage can move a total of 10 cm in x and 20 cm in y.

TTL integrated circuits were used instead of discrete component logic. This resulted in a space savings of four double electronics racks, 6 ft high, and reduced the power requirements. Seventy-five percent of the control logic was contained in six logic card bins of 40-card capacity, mounted in the main control rack; these are shown in Fig. 2.

A Digital Equipment Corp. PDP-9 computer was used instead of the older PDP-4. This allowed use of the existing control program, called Oak Tree. The PDP-9 logic levels had to be level-shifted to TTL logic levels, so the bidirectional bus was split to two buses before reaching the control logical rack, one bus for incoming data and one for outgoing data.

The noise-suppression techniques gained from working with spark chamber equipment were applied to the PDP-9.

Line filters were used on both the incoming power lines and the outgoing teletype lines. Line drivers and line receivers were used with twisted-pair cables 50 ft long to get data to and from the TTL control electronics. The outer cable shields of the data cables were tied to the outside skin of the computer and logic rack. The result of these and other precautions was that there were no cross-talk or noise problems.

IBM 7330 tape units were again used for input and output of data, but instead of building a controller for them, we used a PDP-8L minicomputer. The PDP-9 now outputs to the minicomputer via data break, then disconnects, and the PDP-8L gets the tape units up to speed and clocks the data to the tapes.

Similarly, when the PDP-9 wants to read tape, it tells the minicomputer; the 8L again gets the unit up to speed and reads and formats the data. When the reading is complete, the PDP-8L transfers the information via data break to the PDP-9.

This tape system allows the large computer more time for control and monitoring of the spiral reader.

Track-center finding on all machines is by detecting that the analog signal has risen by two to seven discrete voltage levels, then decreased by one level. When these conditions are met, the spiral angle, θ , $\Delta\theta$ of the pulse width, and the pulse height and radius are stored and then transferred to the PDP-9; θ and $\Delta\theta$ are used by the computer to determine the center of the track.

Instead of an up-down counter, digital-to-analog converter, and 5-MHz clock system to constantly track and null the incoming video film signal for this center-finding logic, a 32-comparator circuit was used, with each comparator set at a discrete reference level. These reference levels vary linearly from 0 to +5 volts. These $\mu\text{l}710$ comparators set or reset as the input signal rises or falls below their respective reference levels. The logic keeps track of how many up or down transitions have occurred, and uses this to determine when to store θ , $\Delta\theta$, and the pulse-height value. This new track-center logic can accurately

follow a $3\text{-V}/\mu\text{sec}$ slew-rate signal. This is four times as fast as required at present.

The servo amplifier was changed from a pulse-width-modulated system to a direct-coupled system because of now available inexpensive high-powered transistors.

A chopper-stabilized FET input preamplifier followed by a power amplifier feeds a PMI U-12 motor which drives an axis of the measuring stage. The power amplifier can swing ± 20 volts at 20A, and moves the measuring engine smoothly at speeds of up to 5 in./sec. Three of these servo systems are required for the spiral reader.

The film platen and film supply system on the University of Tennessee spiral reader is designed to handle three-reel 35-mm film of up to 1200 ft per reel.

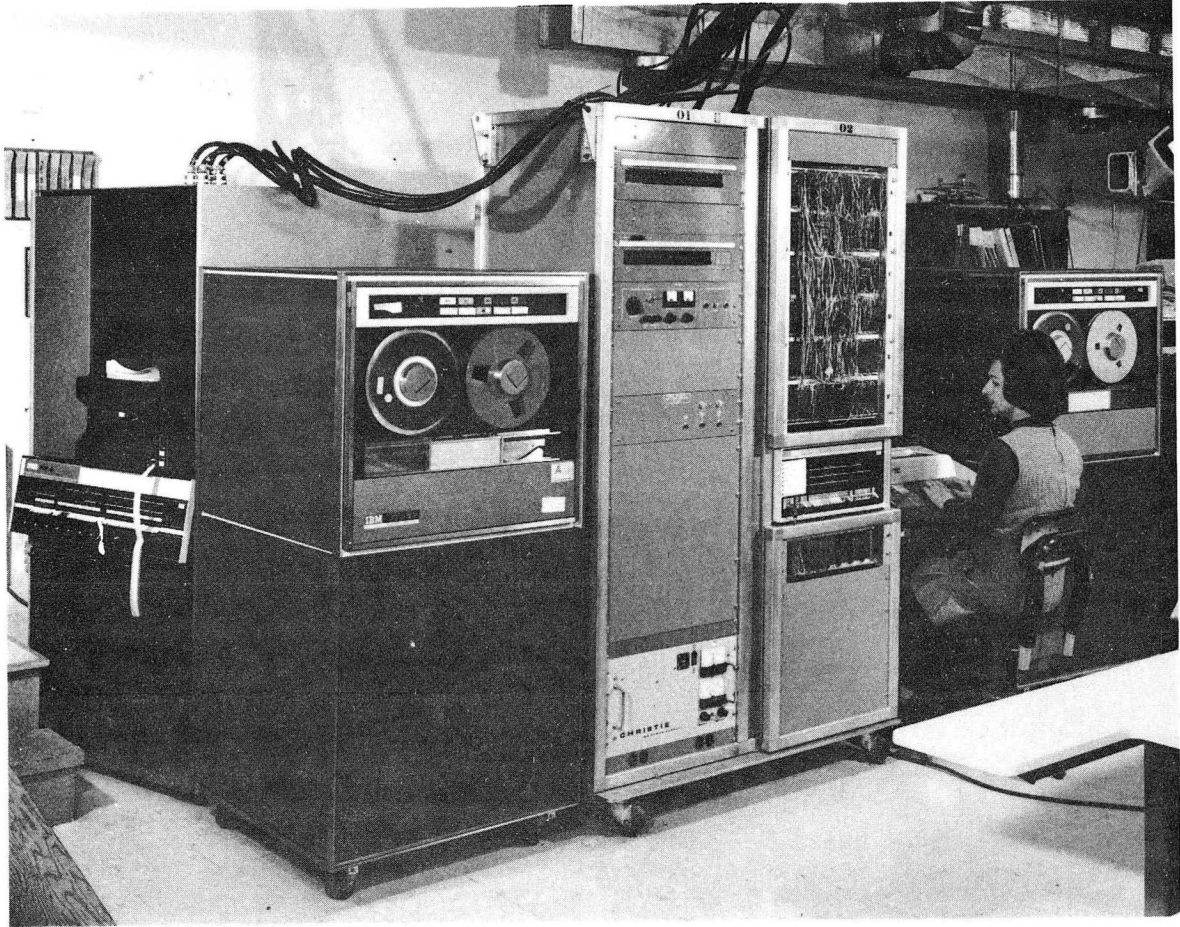
References

1. Gerald R. Lynch, Remarks on Use of the Spiral Reader, Lawrence Radiation Laboratory Report UCRL-17328, Jan. 1967.
2. Gerald V. Bulter, Spiral Reader System Electronics, Lawrence Radiation Laboratory Internal Report UCID-2842, Nov. 1966.

Figure Legends

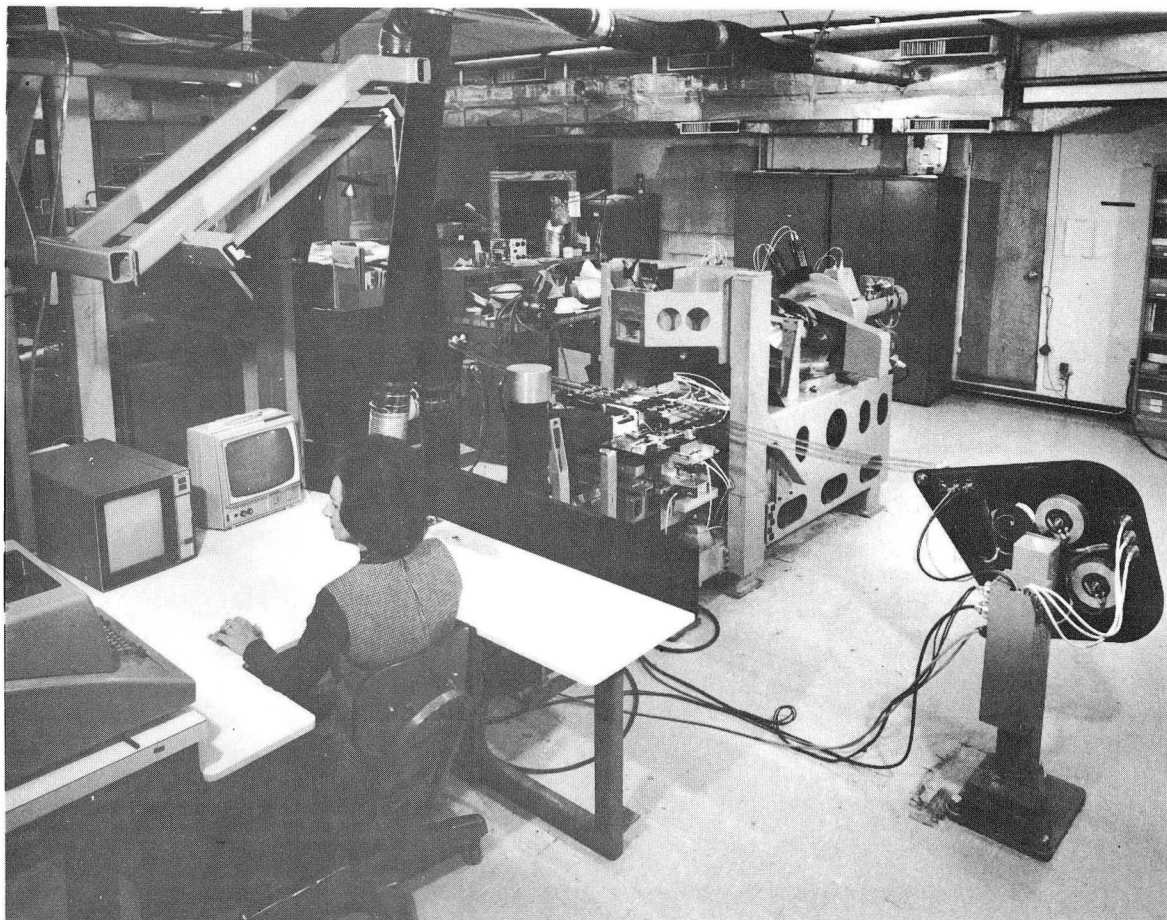
Fig. 1. Operator console and precision mechanical portion of the spiral reader measuring system. From left to right: the teletype for operator-machine communication, the flat table area for viewing the film image, display scope for presenting radius and θ value of digitized tracks, closed-circuit TV monitor for vertex centering, operator, high-intensity lamp housing, platen on x-y stage with three films in place, and at the far end of the stable frame the rotating-slit mechanism, or cone assembly.

Fig. 2. Majority of electronics of the spiral reader measuring system. Left to right: the D. E. C. PDP-9 computer, with data cables connected at the top, an IBM 7330 tape unit, power and control electronics rack with six bins on T. T. L. logic and a PDP-8L computer, teletype for the 8L, and a second IBM 7330 tape unit.



XBB 705-2377

Fig. 1



CBB 705-2378

Fig. 2

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