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EXTENDED-CAPACITY HIGH-SPEED-DISK RECORDING SYSTEM FOR TREAT HODOSCOPE*

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New requirements for time resolution, test duration, field of view, and recording redundancy in dynamic digital radiographic imaging of fuel motion in TREAT and TREAT-Upgrade (TU) in-pile experiments have been formulated. This has necessitated the design and fabrication of a new hodoscope[1] high-speed data acquisition system. Recently an array of proportional counters[2] was installed to operate in tandem with the Hornyak-button array. The full implementation of this new array, together with the increased field-of-view needed for future TU 37-pin experiments, required a separate recording system operating in parallel with that for the Hornyak buttons. The new recording system was required to have substantially higher capacity than the earlier recording system in use[3], in order to record sufficient data channels and samples with adequately small collection intervals, for some new types of experiments.

The hodoscope[1] is a digital cine-radiographic device that monitors fuel motion within thick opaque capsules during experiments at the TREAT reactor. A test-fuel configuration in a capsule, positioned at the center of the reactor, is subjected to a destructive radiation transient simulating LMFBR accident conditions. Fast fission neutrons emitted by the test fuel are sampled by two-dimensional detector arrays, each detector counting up to the range of a million cps. The detectors are located behind slots in an ex-core collimator aimed at elements of a rectangular grid at the capsule. The proportional-counter and Hornyak-button arrays each are set up for 352 channels, to be expanded to 484 channels for TU. A 352-channel sampling interval of 6 ms for 170 s duration is desired for some new transition-series integral experiments, and an 88-channel interval of 0.15 ms for 13 s is needed for some new phenomenological tests.

For design and fabrication economy, most of the basic architecture of the earlier data recording system[3] was maintained. However major components of that system were no longer available, particularly the expensive limited-capacity head-per-track disk drive. To provide the necessary extended capacity, a more reliable but less expensive state-of-the-art Winchester disk drive has been installed. This disk drive yields 82 Mbytes (unformatted), has 10 moving heads ganged together and 96 fixed heads, and is dual-ported to two disk controllers. Development effort has been minimized and functionality increased by use of the two disk controllers.

A commercially available read/write disk controller on the minicomputer bus transfers data between the disk and minicomputer under software control. This special controller allows the transient data portion of the disk to have a format compatible with efficient high-speed data transfer from the scaler channels, while the format for the remainder of the disk is compatible with operating system software. This controller can read the transient data from the disk, but it cannot do so without interlacing (skipping) sectors. Because of bus and controller bandwidth limitations and bus protocol overhead, no disk controller for the mincomputer could be found that could write the transient data into consecutive sectors at the necessary speed.

To write transient data on the disk, a relatively simple write-only disk controller has been designed and constructed. It executes high-speed continuous data transfer directly from the scaler controller to the disk under hardware control, by sending data to the fixed heads when the moving-head assembly seeks the next cylinder position. This provides 1066 continuous data tracks and a sample capacity 248% larger than available with the older recording system, but still leaves 75% of the new disk drive's capacity unused. The remainder of the disk, accessible by the read/write controller, is available for data transfer operations, scan data, operating system software, and programming. Thus procurement of a separate disk drive for these functions was avoided.

At the end of every sampling interval, the scaler controller simultaneously latches and resets all scalers designated for readout and transfers data serially to the write-only disk controller at the 9.6-Mbit/s disk clock rate. The scalers can be read in 88-channel segments. Recording duration is extended by interlacing sectors written by the write-only disk controller. After the transient, disk data is read by the read/write controller and transferred to tape by the minicomputer. The minicomputer, with attached video terminal, printer-plotter, and tape drive, provides program control and output for system checkouts, scans, transients, and software development.

At a recording duration of 17.8 s, the new recording system yields a 0.62-ms transient sampling interval for 352 channels, 0.16 ms for 88 channels, and 0.93 ms for 528 channels. At a 178-s duration, a 6.23-ms interval is obtained for 352 channels, 1.56 ms for 88 channels, and 9.35 ms for 528 channels. Recording duration can be closely tailored to transient duration over a wide range. Options (not yet exercised) for further extending transient recording duration are to use a portion of the remaining disk capacity and/or the tape drive to record transient data under software control, in time regions for which very small collection intervals are unnecessary. The new recording system meets sampling-rate and duration requirements for all anticipated experiments and has been successfully operated during a number of transients, without failure. Its design may be of interest in other real-time digital radiographic applications.

References

1. A. DeVolpi, C. L. Fink, G. E. Marsh, E. A. Rhodes, and G. S. Stanford, "Fast-Neutron Hodoscope at TREAT: Methods for Quantitative Determination of Fuel Dispersal", Nucl. Tech. 56, 141 (1982).

2. C. L. Fink, J. J. Eichholz, D. R. Burrows, and A. DeVolpi, "Proton-Recoil Proportional Counter Tests at TREAT", IEEE Trans. Nucl. Sci. NS-27, 833 (1980).

3. E. Rhodes, A. DeVolpi, C. Fink, G. Stanford, R. Pecina, D. Travis, and R. Kash, "TREAT Fast-Neutron Hodoscope: Improvements in Time and Mass Resolution of Fuel Motion", IEEE Trans. Nucl. Sci. NS-26, 809 (1979).