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ELECTRONIC INSTRUMENTATION AT THE R.P.I. LINAC*

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The diversity of experiments which can be performed on a Linac poses special problems in the instrumentation of experiments. Experiments which have been performed in the past at R.P.I. are:

1. Reactor physics experiments using time analysers, neutron choppers phased to the Linac, automatic delay incrementing and automatic spatial position changing equipment.

2. Inelastic neutron scattering experiments using time analysers, neutron choppers phased to the Linac and multiple scattering angle detection.

3. Neutron total cross sections from thermal up to 20 mev, neutron capture cross sections up to 10 kev and measurements of α and η in fissile materials.

4. Photonuclear experiments up to 50 mev using time to pulse height converters.

5. Photo-fission using solid state detectors and 2 parameter pulse height analysis.

6. Neutron polarization experiments using a helium scintillator polarimeter counter and 8 scattering angles at photon energies up to 50 mev.

7. Ion recoil using a 2 stage 42 inch on-line mass spectrometer.

8. Radiation damage in semi-conductors.

The last class of experiments uses techniques not related to the other experiments and has been discussed elsewhere.[1,2] The sixth class was performed mostly utilizing instrumentation constructed elsewhere.[3] The first five classes of experiments all utilize the Technical Measurements Corporation's CN type of analysers. These are a type of wired program computer that uses a plug-in data logic unit to take pulse height information on three types of plug-in units and to take time of flight data in channels widths ranging from 31 ns to 2560 μsec. The analysers are also capable of external routing into memory sub-divisions; a feature which has been fully utilized in the above experiments.

An on-line computer has been purchased for May delivery which will improve the facility for taking accurate data in a form clearly interpretable by the experimenters. A T.M.C. 242 multi-parameter unit which accepts any of the above mentioned plug-in units in any combination is being interfaced to a Digital Equipment Corporation model PDP-7 computer. The interface design due to Mr. John Jones of D.E.C. is quite interesting (Figure 1). The data from the 242 unit is in the form of 2, 14 bit words or only a single word if the data is only single parameter. This data is presented to a matrix switch MAOS and also routing information if routing is being used. From this switch an 18 bit word is presented to the computer. This word can be directly deposited in the memory through the +1→MB hardware which is also the manner of operation of a wired program analyser; the time required for this operation is 1.75 μsec. If speed is not of the essence and more extensive mathematical operations are required, the data can enter the accumulator on a program break. The dead time in this case will depend upon the complexity of the program. The third mode of entry is through a list. The buffer address control, by means of switches, sets aside a certain region of the memory as a magnetic core buffer. Data is deposited into this region on the highest priority break. The program is written so that the location at which data was last retrieved is stored and the next place to find new data is addressed after completion of the calculational routine. This data is retrieved from this buffer memory,

*This work performed under AEC contract AT(30-3)-328.

processed and stored wherever it is desired.

The PDP-7 is capable of servicing many other input-output devices than just this mode. It is also being designed for acceptance of data from a high speed time of flight unit, from low speed devices, analogue to digital convertors, scope displays, etc. Figure 2 shows the extent of the present planning. All of it is not included in the equipment being supplied by D.E.C. However, most of the equipment is at hand but requires interfacing.

In the instrumentation at the Linac considerable difficulty has been experienced with electrical pick up due to ground loops. The use of distributed transformers has been the most effective way of overcoming this trouble. These are made by winding 50 - 100 turns of miniature 50 Ω coaxial cable on a permalloy core. This inductance effectively isolates one end of the cable from the other and of course is not seen by a signal propagating down the inside of the cable.

When using extensive amounts of equipment a need frequently arises for pulse shapers and inverters. One of the simplest and most effective circuits is shown in Figure 3. The tunnel diode can be triggered by a pulse of either sign. The bias is usually adjusted for about ± 1 volt triggering; the output is ± 6 volts and of whatever duration is set by the amount of inductance used.

Nuclear and atomic experiments are also performed using an on-line 2 stage mass spectrometer (Figure 4).* It is double focusing with 20" radius of curvature magnetic and electrostatic sectors using Einzel lenses in the vertical plane. There is also a 3.5 mtr drift pipe for ion selection by means of time of flight. Used for studying ion recoil, the ions are produced by the Linac electron beam traveling through a thin foil, these are detected either in the drift pipe leg or the spectrometer leg by a 24 stage electron multiplier. To date the device has been operated to within 12 μsec of the beam burst without gating of the multiplier.

References

1. Corelli, J. C., et al, J. Appl. Phys. 36, 5 (1965).
2. Fischer, J. E. and Corelli, J. C., J. Appl. Phys., 35, 12 (1964).
3. Bertozzi, W. et al, Phys. Rev. Ltrs., 10, 31 (1963).

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* This work performed under NASA Grant NsG-371.

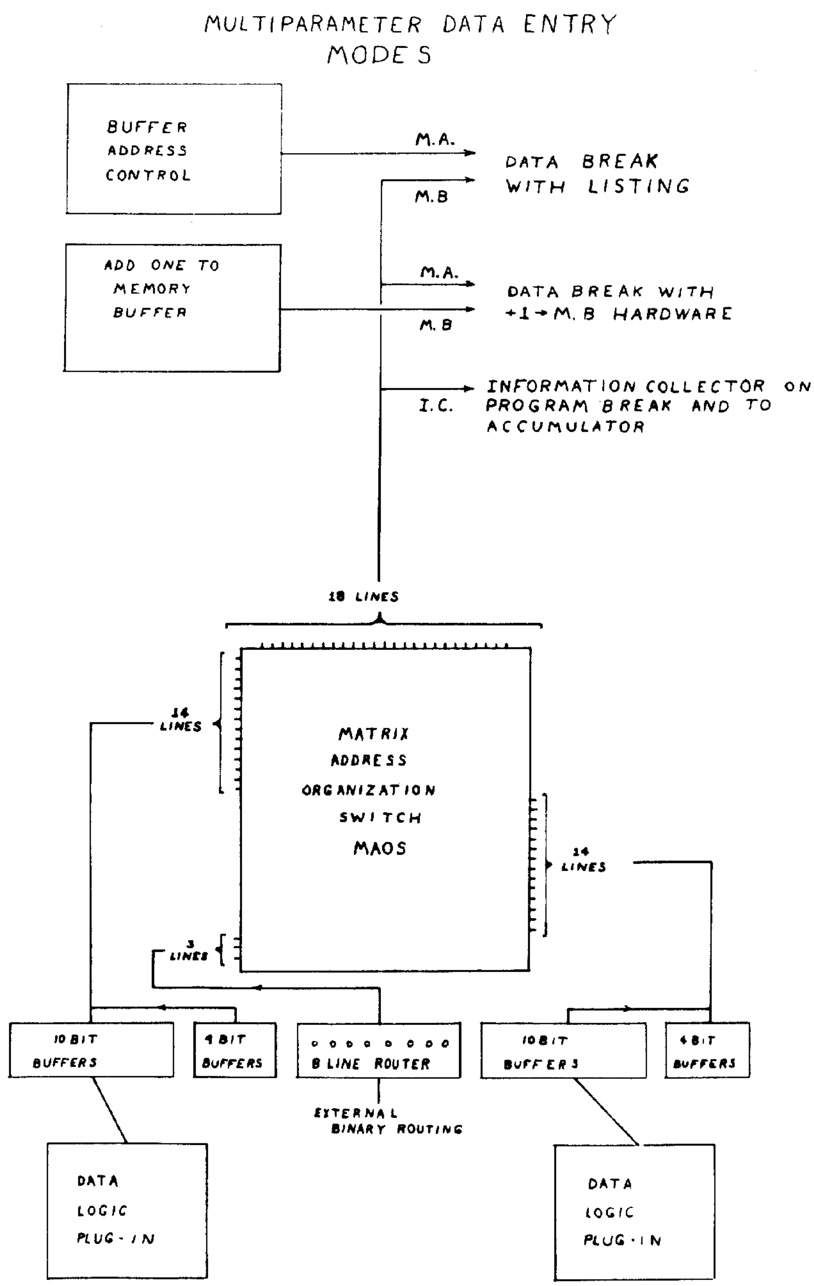

Fig. 1. Technique of Work Organization from T.M.C. 242 Unit and Manner of Computer Entry.

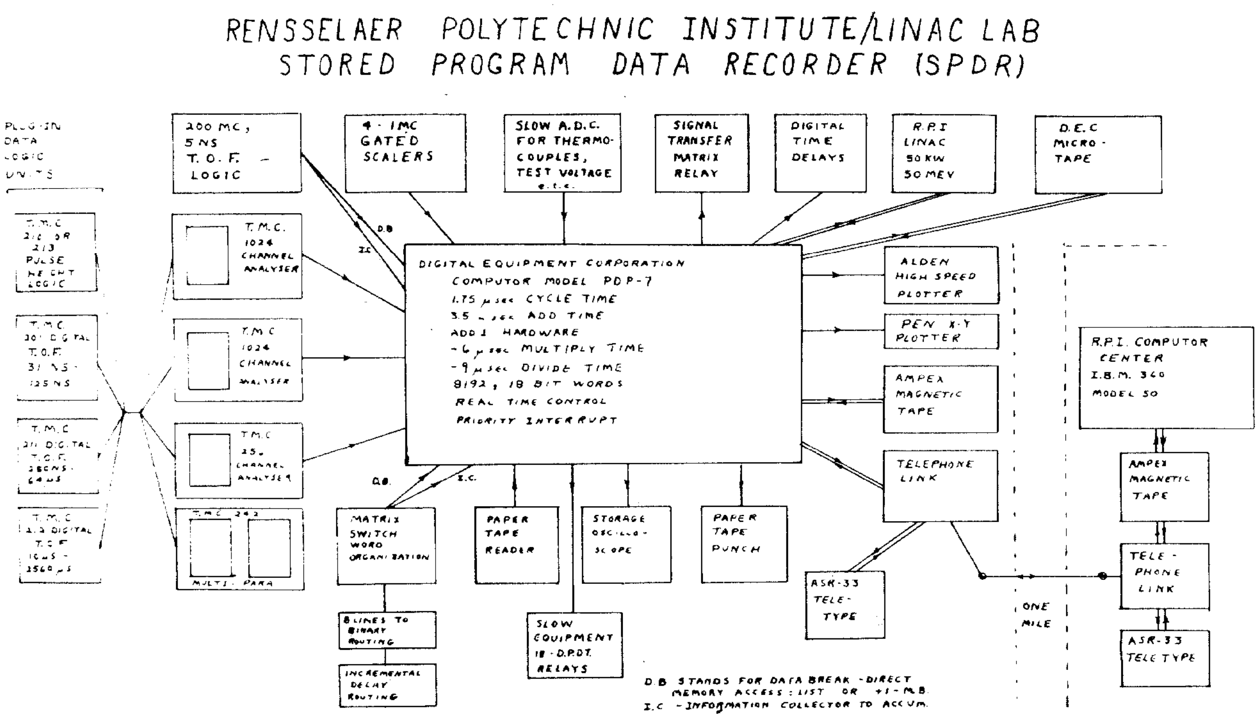

Fig. 2. The Stored Program Data Recorder.

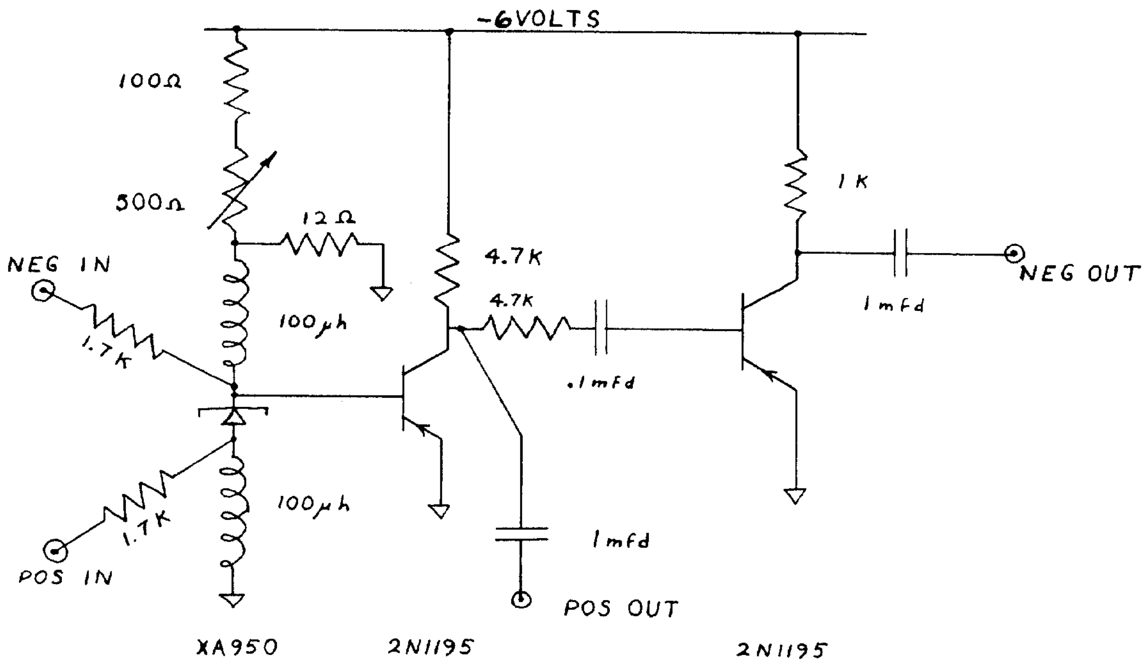

Fig. 3. Bipolar Input Pulse Shaper, Bipolar Output. (Usually built 4 to a panel with power supply.)

Fig. 4. The On-Line Ion-Recoil Mass-Charge Spectrometer.