HARDWARE FOR A COMPUTER CONTROL SYSTEM FOR THE 1.5m BUBBLE CHAMBER BEAMLINE AT NIMROD

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Abstract

A control and acquisition system based on a PDP-8 and Camac has been provided for the K9 separated bubble chamber beam. Multiplexed control of magnets and collimators is included.

Introduction

A PDP-8 computer with 12K of core, high speed reader, 32K disk and DEC tape forms the basis of a computer data handling and control system for the K9 bubble chamber beam at Nimrod; operation of K9 with the new system commenced in mid-1971. Operator control is by means of a teletype and a small supplementary panel of program control keys. The major interfacing is by means of a 2-crate Camac system, and there are separately interfaced 1 second clock-pulses, typewriter, digital voltmeter and synchronising information about Nimrod pulse cycle. A block diagram of the system appears in Figure 1. The associated software is described in a separate paper[1].

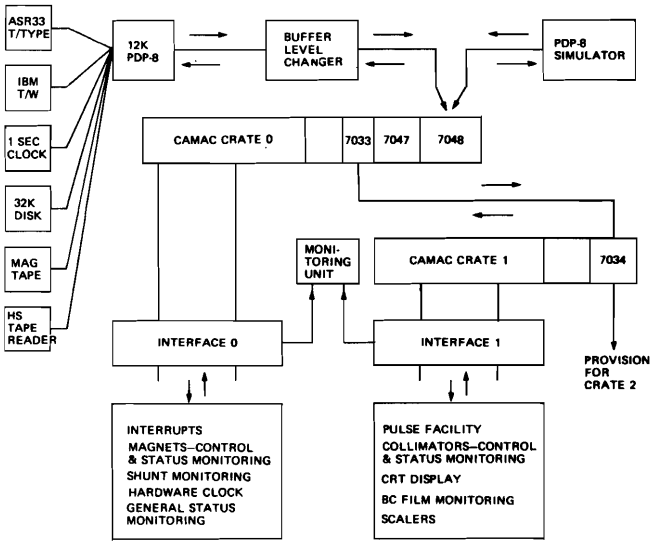

Figure 1: Block diagram of complete system

Camac System

The system hardware includes the 2 Camac crates (containing some 38 modules), a PDP-8 simulator, a master monitor unit and a power unit. The philosophy has been to retain, as far as possible, the facility to regain manual control of the beamline should this be necessary (excluding both the computer and Camac) and to be able to drive the full system, including Camac, step-by-step, using the PDP-8 simulator in place of the computer.

Harwell 7000 series modules 7033 and 7034 link the 2 crates, the master controller being the 7048. A 12-bit register-module type 7047 is used as a word-length converter, permitting full 24-bit transfers in and out.

The monitor unit has three 24-bit display channels and may be connected into any user module inputs or outputs without affecting operation. It may also monitor the Camac dataways via dataway buffer modules, using the simulator to provide single step operation.

Each Camac crate has an interface unit mounted immediately beneath it to deal with connector and cabling sorting problems, to provide monitoring outlets, and to deal with individual user hardware requirements. By containing the 'non-standard' hardware within these two units, the system hardware generally is made simpler and easier to monitor.

Incoming data includes the digital voltmeter output, several groups of status bits, the settings of the program control switches, a minute-count from a hardware clock, multiplexed data concerning collimator jaws, bubble chamber roll and film numbers and serial pulse trains from various beam detectors.

Camac soak-testing routines have been written and run on the computer and have proved invaluable in showing up various mechanical and electrical faults in the crates and in the system modules.

Magnet Current Control and Measurement

A total of 23 power supplies powering 17 beamline elements and 2 separators are computer controlled in a multiplexed system using two 24-bit Camac driver modules. A common data word from one module is multiplexed into the required magnet power supply (MPS) by a 'select' word from the other, each bit in the select word being unique to a particular MPS. Currents of up to 500 A may be set, with 0.5 A accuracy.

The DAC relays in the MPS are driven directly by the free collector outputs of the driver modules, using the DAC supply rail of + 24 volts.

The magnet current shunt voltages are fed to the DVM via a low-level scanner (LLS), a 50-channel motor-driven scanning switch fitted with special contacts for handling low level signals. It selects a channel by comparing the incoming command word from the Camac driver with the word from its own encoder. When they match the motor homes, the homing time being about 1 s in the worst case. A DVM 'read' trigger is then generated once only during the next Nimrod cycle and the DVM raises an interrupt when its read conversion is complete.

Other LLS channels read separator voltages and currents, photomultiplier EHT voltages, and standard cell voltages for DVM calibration checks.

A hand-held control panel, consisting in effect of 3 switch registers is able to replace the 3 Camac drivers involved in selecting, setting and reading a magnet. This provides a useful alternative manual control.

Control and Readout of Collimator Jaw Positions

Due to the slowness with which the collimator jaws move, a system capable of simultaneous control of any number of jaws was developed.

Each jaw position is indicated with a resolution of 0.1 mm by a shaft-encoder with a 4-decade readout. These readouts are fed to a multiplexer (Figure 2) where they are switched onto a common dataway running back to a decoding unit in the K9 control room. This inputs position data for any selected jaw to a Camac module.

To adjust the position of a jaw, Camac drivers supply a data word containing the required direction and amount of movement, and a 'jaw select' word to the collimator control unit. The data is switched on to a common control data highway and it is strobed into a 16-bit store associated with the selected jaw. As the jaw moves, serial pulses from the shaft-encoder are clocked into the store until an overflow is attained, when either one or both jaws of the pair stop. (Counts are subtracted from the bussed control data word to reduce overshoot; if this condition still occurs, the jaw is reversed to take up backlash and the jaw is set again). By repeated loading of stores any number of jaws can be set in motion simultaneously and independently.

Status bits are available through the Camac to monitor the condition of the jaws. These may be examined at any time, but generally are included in a checking routine initiated by a Camac interrupt, when a jaw stops.

Status Signals

Signals indicating magnet polarities, interlock and on-off status of all MPS sets, separator status, beamline vacuum, overall Nimrod status, details of the bubble chamber photographic sequence and several other relevant conditions are fed into the Camac system through interface units known as 'status boxes'. The signals mostly originate as either mains signals, d.c. levels or pulses; the main function of the status boxes is to affect a conversion of these to Camac logical levels. Each unit has 24 inputs and provides illuminated indication of the data output to Camac. Suitable grouping builds up distinctive 24-bit patterns relating to particular beamline conditions. An over-ride switch is provided for each bit, whereby it may be manually set to either of its logical levels. This enables modification of the behaviour of the fault-analysis software to deal with unusual beamline situations, and is also of use in developing and testing such software.

Reference

1) Initial experience of the use of interpretive software for beamline control. P Adams. Ibid.

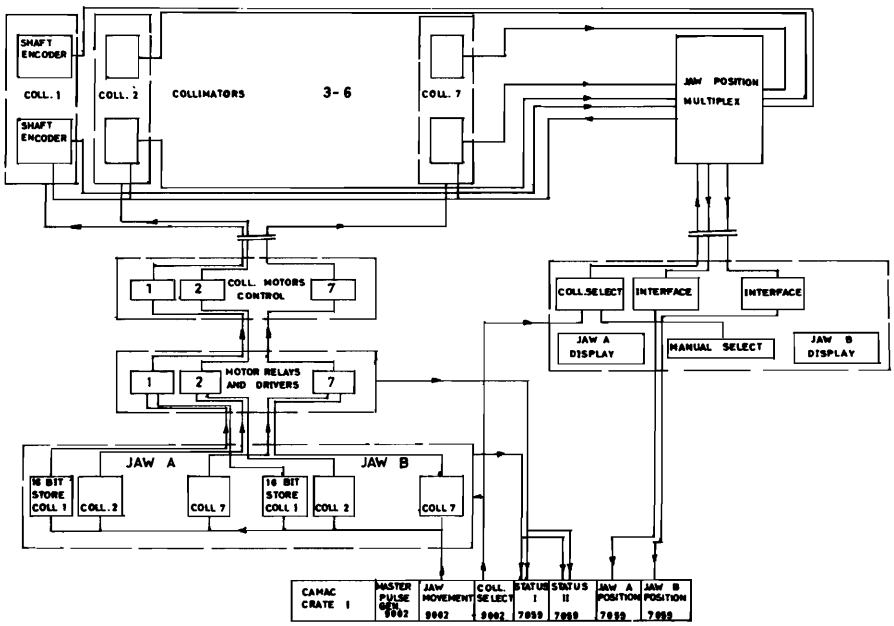

Figure 2: The collimator control system