CONTROL SYSTEM OF THE RIKEN SSC (I)

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ABSTRACT

RIKEN SSC is controlled with a computer operating system. The control system consists of a computer network and a CAMAC serial loop. Micro processors are used for the interface between devices and the CAMAC system.

INTRODUCTION

RIKEN separated sector cyclotron (RIKEN SSC) consists of two injectors (RILAC and AVF cyclotron) and a separated sector cyclotron[1]. A large number of devices are distributed around them. There are thousands of parameters. In order to obtain a desired beam (particle and energy) and to transport it to a proper experimental area in a short time, complicated and fast control sequences are necessary. Because of this, computers are introduced.

The characteristics of the control system are as follows:

(1) A computer network consisting of distributed mini-computers is adopted;
(2) CAMAC crates are linked by a serial highway with optical fiber cables;
(3) Micro processors are used for the interface between CAMAC and devices;
(4) As many analog signals as possible are digitized and sent to the control room;
(5) Application programs are written in FORTRAN 77 language.

COMPUTER SYSTEM

Three mini-computer are linked using optical fiber cables. Each computer is of the same type, and is MELCOM 350-60/500 of Mitsubishi Electric Corp.(M-60). This is a new 32-bit industrial computer. The characteristics of the computer is listed in Table 1, where SHD is a bit serial highway driver. An intelligent system console includes two flexible disk drives. Many of the system subroutines required for real time operation have been converted to firmwares which allow faster execution of programs. The time critical part of operating system and application program can be made resident on the chache memory. Table 2 lists the configuration of each computer.

The network is that of duplex system. Even in the failure of one line or failure/power-off of any one computer, the computer link can be retained by adopting a loop back method automatically. The computer 1 and 2 are installed in the control room of SSC and the computer 3 is in the control room of RILAC.

The computer 1 controles the SSC through the CAMAC bit serial loop. The console devices such as touch panels, color displays and shaft encoders are installed in the control desk. These devices are linked to the computer 1 without a CAMAC system. The control desk consists of three parts (center, left and right parts). The left and right parts are equivalent. The devices which are linked to the computer 1 are installed in these areas. The minimum time of data refresh on a CRT is 280 msec. The center part is prepared for the devices such as ITV's and scopes which are not linked to the computer.

The computer 2 is used to store the data-base of the whole control system in large disk files. Most of the data are initial values, logging data and device name/link tables. The current values are stored mainly in the memory of the micro processors mentioned later.

Table 1
Characteristics of MELCOM 350-60/500

CPU	ECL LSI
memory	64Kbit LSI with ECC
word length	32 bit
max. memory	16 MB
max. address	4 GB
cycle time	250 ns/8 byte
chache memory	160 KB
register	24 (32 bit)
instruction	450
pipeline	5 steps
MIPS	3.7
computation time	ADD 0.095 μs
	FADD 0.3 μs
	FMULT 0.5 μs
	SIN(x) 5 μs
interrupt	8 levels
network	15.36 Mbps
CAMAC SHD	5 Mbps
GP-IB	250 KBps

Table 2
Comfiguration of each computer

Computer 1 (SSC)	
memory	3 MB
fixed disk	70 MB
CAMAC SHD	1
GP-IB	1
console devices	
Computer 2 (data base)	
memory	3 MB
fixed disk	70 MB x 2
magnetic tape	2 (1600/800 bpi)
line printer	1 (390 lpm)
TSS terminal	4
plotter	1 (10 pens)
communication port	11
20" graphic display	1 (7 colors)
hard copy	1
CAMAC SHD	1
Computer 3 (RINAC)	
memory	2 MB
fixed disk	70 MB
magnetic tape	1 (1600/800 bpi)
line printer	1 (390 lpm)
plotter	1 (10 pens)
20" graphic display	1 (7 colors)
hard copy	1
20" character display	1 (7 colors)
GP-IB	2

The source programs are also stored in the disk file. The machine codes of the control programs are stored in the disk files of control computers. The control computers pick up the necessary data or ask for remote batch jobs to this computer. This computer is also equipped with a CAMAC SHD and can be used as a back-up computer for the control computers. This computer is linked to the central computer of our institute.

The computer 3 controles the RILAC through the GP-IB using optical fiber links[2].

The first computer system (the computer 2 of Table 2) has been installed on October 1st, 1984. This is used for program development, for data base establishment and for the field measurement of the four sector magnet. On the first stage of the field measurement, a DEC LSI-11/02 computer is used for interfacing CAMAC and GP-IB devices such as DVM and scanner. The obtained data are transfered to M-60 computer and are displayed on a graphic CRT.

A CAMAC SHD will be installed in November. Because a GP-IB interface is not ready by this time, we use a personal computer (MULTI-16) as a makeshift. The other two computers, GP-IB interfaces and an operator console will be installed in October, 1985. Figure 1 is the photograph of the first computer which is installed in the SSC vault.

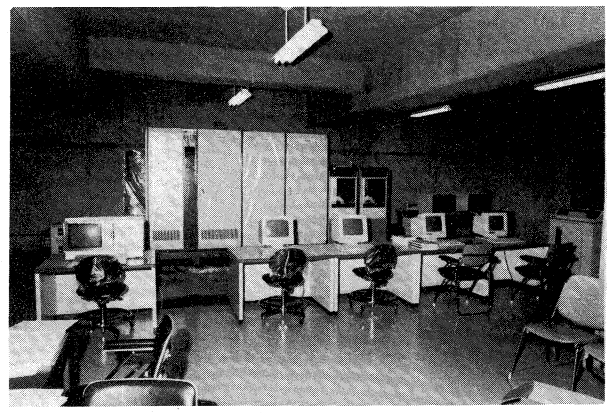

Fig. 1. MELCOM 350-60/500 computer.

INTERFACE SYSTEM

The computer network and CAMAC system are shown in Fig. 2. Seven CAMAC crates are distributed in four power supply rooms. Because the distance between these rooms and the control computer is very long (90 m max.), these CAMAC crates are connected by a bit serial CAMAC loop using optical fiber cables.

Two types of modules which include micro processors and memory are developed for the interface between controlled devices and the CAMAC system. One is a CAMAC module which has 12 pairs of serial I/O ports. The other is an interface module to each controlled device and is installed at a place close to the devices. The information are transfered serially between these two modules. The details of these modules are given in the other report on this symposium[3].

DIAGNOSTIC NETWORK

For the local diagnostics, it is convenient to use movable consoles[4]. However, we make another decision in order to lower the cost and to have more flexibility. A simple network is adopted and only the ports for CRT display are prepared at necessary places. In making diagnosis, a CRT display unit is carried and plugged into the nearest port. These ports are also used for the display of machine operations at operator room or counting rooms by selecting desired part of the machine from a keyboard.

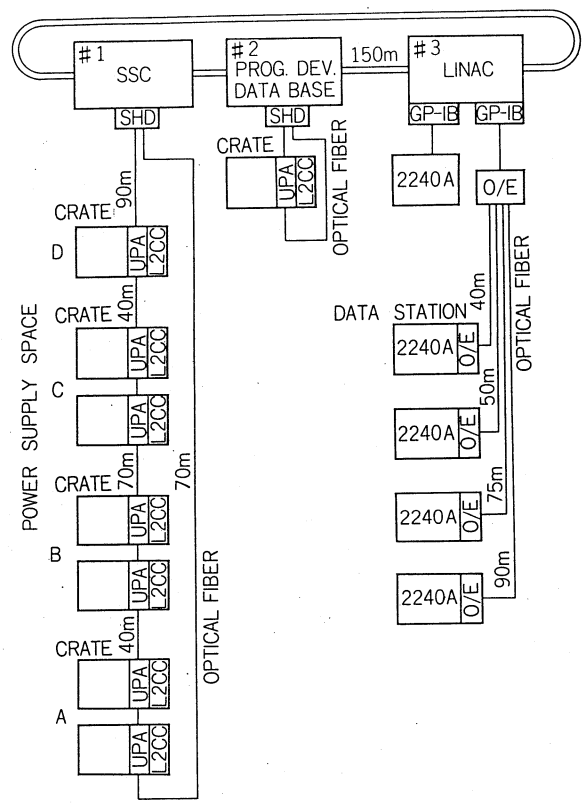

Fig. 2. Computer network and CAMAC system.

ANALOG SYSTEM

As many analog signals as possible are digitized and sent to the control room through the CAMAC loop. It is often necessary to observe wave forms of the signals from some beam detectors such as coaxial Faraday cups and phase probes. For these signals a sampling method is adopted and the band width is reduced. The results are sent by coaxial cables and displayed on the scoped on the control desk. The contents of the display memory are read into the control computer through a GP-IB for numerical analysis.

SOFTWARE

The operating system OS60/UMX is a combination of real time and UNIX system. It consists of kernel, OS60 and UNIX parts. The programs are first developed under UNIX system and finally transfered to the disk area of OS60 system which can be started (FORKed) on real time. The source programs are developed by a screen editor (vi) of the UNIX system.

The application programs are written in FORTRAN 77 language which includes real time functions. A FORTRAN 77 debugger is incorporated for the interactive debugging of the programs.

This operating system has powerful functions for network support. It is possible to transfer messages and the contents of disk file to other computer. Another function is the starting of tasks in other computer by sending parameter value.

Many software packages for graphic display, network and data base are prepared. CAMAC subroutines are developed following the IEEE standard[5]. The program for the data link between a personal computer or LSI-11 are developed.

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