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BEAM DIAGNOSTIC SYSTEM IN RIKEN RING CYCLOTRON

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SUMMARY

The beam diagnostic system in the Riken Ring Cyclotron is reported on a standpoint of its electronics and data processing. Two applications of the DIM-CIM data transfer system are described.

INTRODUCTION

The beam diagnostic system in the Riken Ring Cyclotron (RRC) and its beam line was reported in Ref.1, where the details of beam diagnostic probes were described. In this paper, the RRC beam diagnostic system will be reported on other view point, namely electronics and data processing system.

The total system of the beam diagnosis in RRC are shown in Fig.1. The beam diagnostic system, like other system in RRC such as magnet power supply and vacuum system, are connected to a CAMAC loop under the control of computer (Mitsubishi M60) in the Ring Cyclotron control system[2] through DIM-CIM (Device Interface Module and Communication Interface Module)[3].

DIM has 32-bit digital I/O and 16 ch analog inputs. The applications of DIM in the beam diagnostic system will be described.

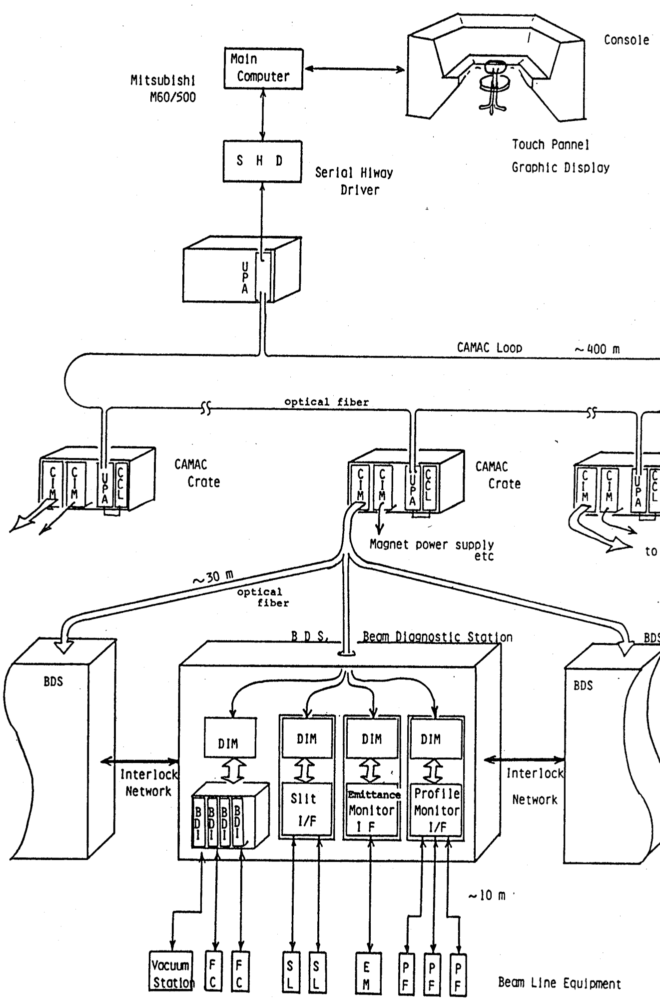

Fig. 1 Block diagram of the total beam diagnostic system.

BEAM DIAGNOSTIC STATION, BDS

In the beam diagnostic system, every DIM and additional circuits connecting the beam diagnostic equipment and DIM are mounted inside a 19" rack called as BDS (Beam Diagnostic Station). BDS's are located nearby the beam line and at every 10-15 m along the beam line. The distance between beam diagnostic devices and electronics can be short enough for the connection via hard cables. Each BDS is connected via several optical fiber cables (typically 30 m in length) to CIM inside a CAMAC crate. Five CAMAC crates are available in four different rooms in the RRC and linac building. They are linked by a CAMAC optical loop. The all BDS's are also linked in series via hard cables, which are mainly used as hardware interlock network for the radiation safety system for man and the protection system of instruments from beam irradiation. In the beam diagnostic system, DIM's are applied in two ways, BDI and BDA.

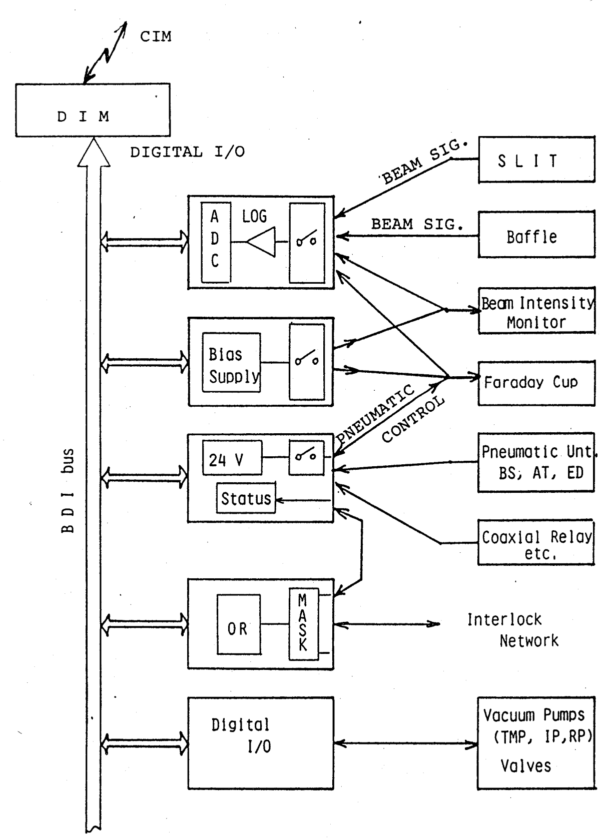

Fig. 2 BDI module circuits.

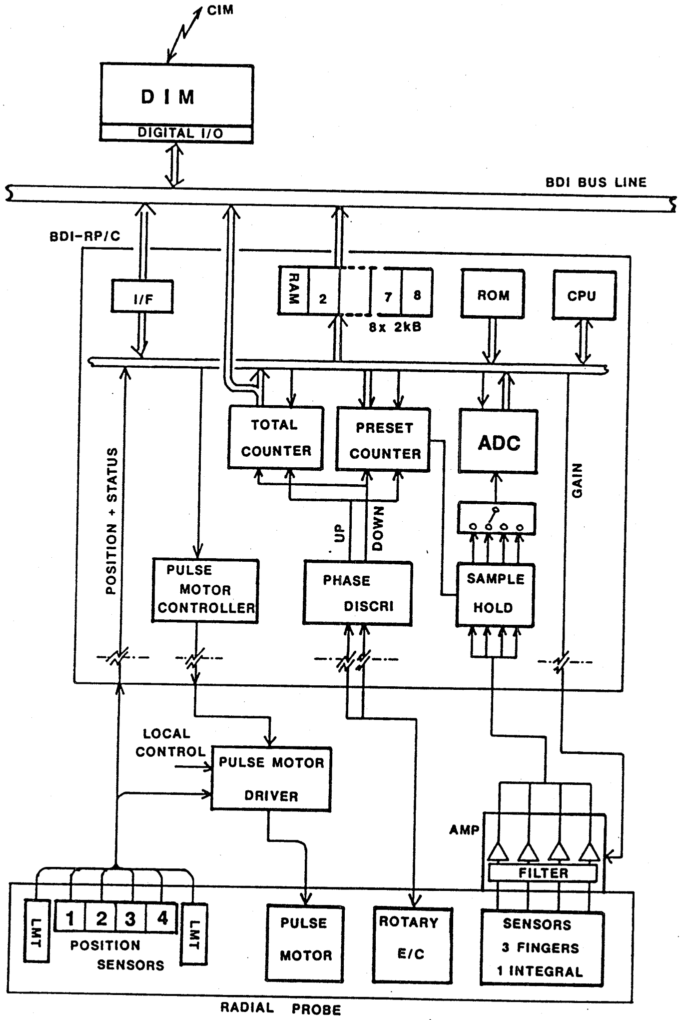

Fig. 3 Block diagram of radial probe system.

BDI CIRCUITS

In the beam diagnostic system, many kinds of probes are installed in one place according to local requirements. Also the different combinations of these probes can usually occur. Moreover, these arangement is not fixed for a long duration. A new device can be developped in the future. The BDI application of DIM has a large flexibility to respond these requirements in the beam diagnostic system.

The BDI-circuits, which are built in the plug-in modules (according with DIN 41494), use DIM digital input/output as a common bus line. The bus has 48 lines (high address is 6 bits, subaddress 8 bits, data in/out 8/8 bits, LAM(Look At Me) 8 bits, unit no. 8 bits and read/write strobes 1/1 bit) and power supplys (+5V, +15V, -15V, and +24V). The BDI circuit has two kinds of connectors at the rear end of board, the lower one (64pin) being connected to BDI bus and power supplys and the upper one is used as connection to probe or other circuits. The BDI circuit are divided into two groups, BDI module and BDI unit.

A BDI module circuit has simple function under control of DIM. A variety of BDI module circuits (up to 64) can be connected to one DIM module via the bus as shown in Fig.2. They include a pneumatic driver controller, a bias supply, a vacuum system controller, and an interlock circuit. Analog signals as beam currents from a Faraday cup or slit system are fed into a log-amplifier and converted into digital signals in one of the BDI-circuits.

The other is BDI unit, which is similar to a CAMAC module and has a micro processer in it and has more intelligent function. The BDI unit communicates with DIM using LAM and Unit no. lines. Maximum eight BDI units can be connected to one DIM. An example of BDI unit (BDI-RP/C, a radial probe control unit) is shown in Fig.3. A radial probe, which installed in the Ring Cyclotron, is moved in the radial direction by combination of a stepping motor and ball screw. The radial position of the probe head is detected by two limit switches at the both end of stroke and by four position sensors which are set along the stroke. A total counter in BDI-RP/C stored the number of pulses from the rotary encoder and its value shows the relative position from one of these position sensor. A preset counter make a trigger for data taking. A micro processer take the total counter value (that is, the position of probe) and four analog data and store them in RAM. Every when the one of 2k RAM is stored fully, BDI-RP/C can make LAM flag to DIM. The DIM can read directly the present position value and the DATA in RAM without disturbing the measurement or movement. Therefore an operator can take the radial probe data step by step without waiting for the whole measurement (it usually take several minutes).

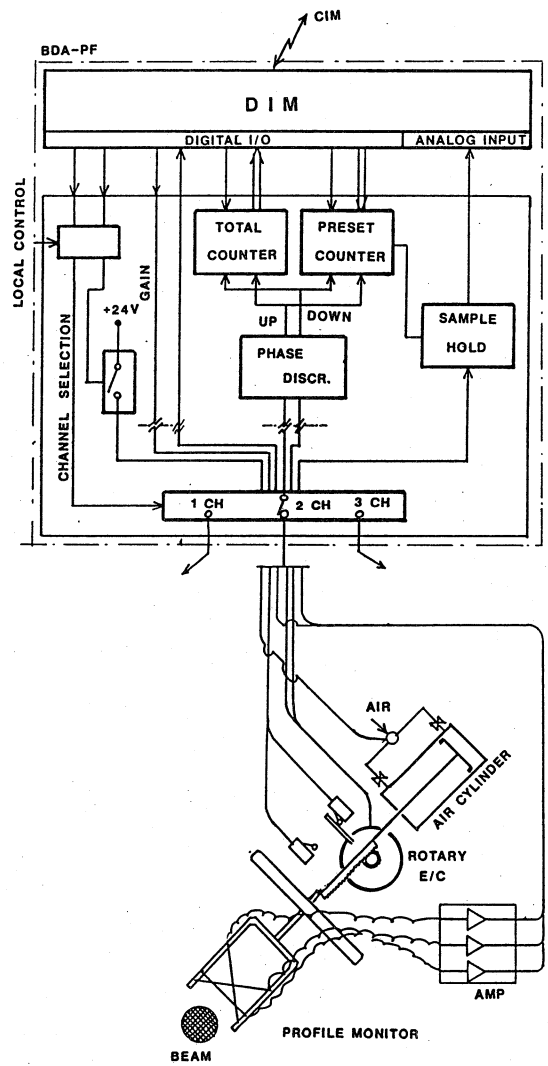

Fig. 4 Block diagram of beam profile measurement system.

BDA CIRCUIT

A BDA (Beam Diagnostic Application of DIM) circuit is used for a fixed purpose. Every BDA circuit has one DIM board inside and is mounted directly into the BDS 19" rack. The DIM digital I/O are used in a special way of each circuit. A beam profile monitor, a slit system and an emittance monitor are controlled with these BDA-circuits.

The profile monitor controller (BDA-PF) is shown in Fig. 4. The three-wire scanning method is employed for the beam profile measurement in beam line. The sensor is moved in a linear action by a pneumatic air cylinder. The wire position relative to the beam axis is known with a position sensor at the both ends of stroke and combination of a rotary encoder and a total counter. The total counter (16bits) is reset at the begining of movements in the both directions. A preset counter (8bits) makes a trigger to sample hold and data taking. The measurement is made in the similar way as the radial prove controller but, in this case, a micro processer in the DIM take the position and three analog data and store them in 8k RAM in the DIM.

It takes about 2 sec. to make the profile measurement from time when a operator makes a command at a console desk to when the data (in normal case, 1.3kB in amount) are displayed on a graphic screen . It is spent mainly for scanning period of probe (about 1.3 sec) and for the data transfer from CAMAC to host computer (0.5 sec).

Fig.5 shows another example of BDA-circuit, the emittance monitor controller (BDA-EM). The two actuators, slit system and multi-wire profile monitor, have to be driven synchronously. So the ciruit has two pulse motor drivers which are controlled directly by DIM. The controller has 32 sets of amplifier which convert beam currents signal from wires to voltage signal.

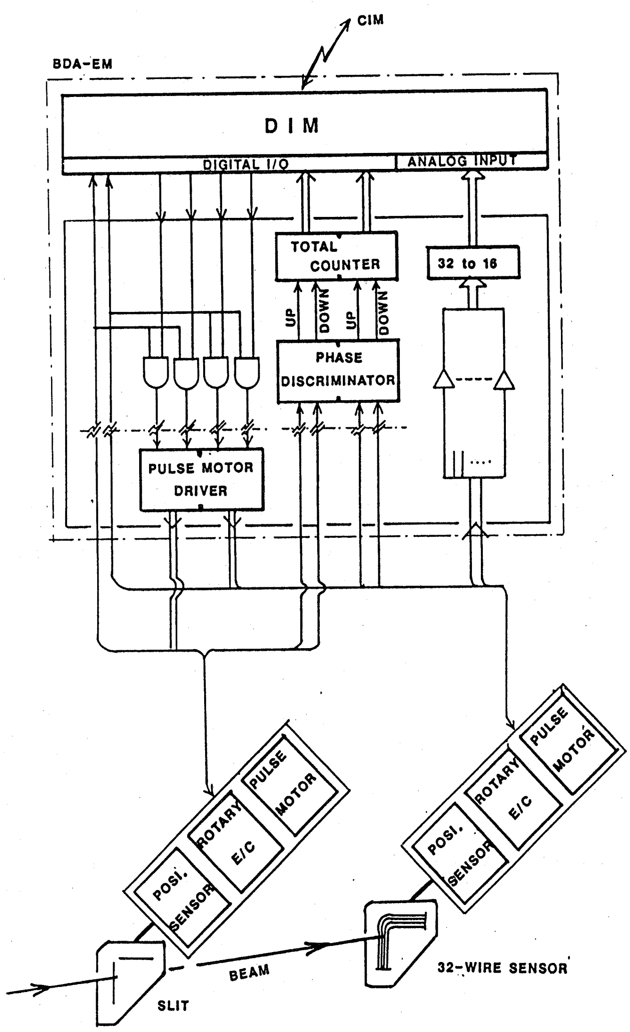

Fig. 5 Block diagram of emittance measurement system.

SOFTWARE

Every program of micro processer in DIM and CIM is directly written into an 8kB ROM in them.

A program in CIM is identical for any DIM's used in the beam diagnostic system. A CIM communicates with DIM's (up to 12) and also with CAMAC. So, the CIM program converts the data transfer format between 8-bit serial data (CIM-DIM) and 24-bit parallel data (CIM-CAMAC).

Every DIM has a common program concerning the communication with CIM. Each time the command from CIM reaches to one DIM, the DIM is interrupted and this program is started. In this routine the DIM checks the priority of the command, interplets the command, and finally send the response (3B) back to CIM. During the period (about 30 msec), CIM waits for the response. The response has information about whether the command is acceptable or not, and also error message, when the command is rejected. After sending the response, the DIM start to perform the command.

The other area of ROM in DIM is used for a special program for each kinds of DIM. Four kinds of programs are developped. One is for DIM used in the BDI bus. This program can be is used for any BDI modules and BID units and also available when new BDI circuits are developped. Other three programs are for BDA circuits, BDA-PF, BDA-SL and BDA-EM.

References

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