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BEAM DIAGNOSTICS AND CONTROL AT S.A.R.A.

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Abstract. - *Control of beam diagnostics and read out of beam currents at S.A.R.A. is done by microprocessor systems. A new system for control of power supplies has been done and the first step for data logging of machine parameters is described.*

1. Introduction

Beam diagnostics and control of power supplies at S.A.R.A. [1] have been designed in the aim of reducing their cost but however in the prospect of a later computer control. Rather than buying ready to use units and modules, home - made systems have been developped for specific purposes, with a decentralized structure using microprocessors, instead of a computer that would concentrate all the tasks. Data acquisition will start with operation of S.A.R.A., but setting and control of the accelerator will be planned in a second step.

2. Control of intercepting probes and movements

This system has been designed to control movements and positions of all intercepting probes and mechanisms of the new S.A.R.A. accelerator, including transfer beam lines. It is able to drive 36 IN/OUT probes and 16 continuous movements from a single pannel.

IN/OUT probes include Faraday cups, viewing quartz and later, beam profile monitors on transfer beam lines. They are actuated by pneumatic jacks driven by solenoïd valves. Their position is simply detected by limit switches which status are displayed by red or green LED, intermediate positions and defects are shown by flashing of both LED's.

Continuous movements controlled by this system are essentially the three main intercepting probes, extraction probes and movements of electrostatic and magnetic inflectors. They are actuated by AC motors except the 3 main probes that are driven by DC motors. Their positions are read by potentiometers which output voltage is displayed on individual numerical displays.

The first diagnostic element on the beam path, either IN/OUT or continuous movement is signaled by LED flashing at a specific rate.

The whole system is based on two 6 800 microprocessors. In the control room, the first system (1 KRAM, 2 KROM) scans the keyboard, codes and sends orders to the second microprocessor, it is interfaced with the 16 channel analog to digital converter used for position measurements. Each numerical value is then converted by a linear law (ax + b) so as to give directly the results on alphanumeric displays with the right scale factor. The microprocessor displays status of the limit switches, it also identifies the first probe on the beam path by comparing status of IN/OUT probes and positions of the continuous displacement probes.

In the cyclotron room, the second microprocessor (1 KRAM, 2 KROM) scans the status of the limit switches and sends them to the first micro. It receives orders from the control room and activates TTL to AC solid state relays. It also switches the speed of the motors of the main probes.

The two processors are serially linked through ACIA'S by two telephonic pairs and three interrupt lines.

During development, a third microprocessor (32 KROM, 16 KRAM) was linked to the first one, it was interfaced with diskettes, teletype and magnetic cassettes.

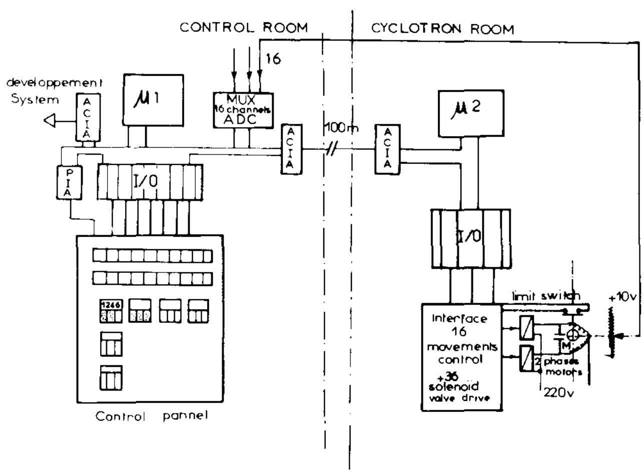

Figure 1 : Control system of intercepting probes and movements

3. Acquisition of beam currents

The acquisition of beam currents is built around a Z 80 microprocessor, the purpose of the system being to display any set of analogic values in the most convenient way for the operator, all editing work and modifications are done by software.

In our case, up to 100 currents from Faraday cups, differential probes and slits are read with full scales down to 1 nA.

Sixteen beam currents are fed to current to voltage converters which gain are controlled either manually or by software. Then selection is done by a 16 channel multiplexer. Outputs from six such units are fed to a 12 bit analog to digital converter.

For the read out, a number of relevant parameters (up to 20) related to a specific part of the accelerator (i. e. first part of the injection line, extraction, etc...) are displayed on fixed patterns called "menus" on a CRT video display. Currents are seen both as indexes on fixed scales and as numerical values in real time.

Slits are grouped by pairs to make beam alignment easier ; in the case of differential probes each current is displayed individually together with the total current on the three differential fingers and on the whole probe.

Full scales extend from 16 μA with 1 out of 128 resolution down to 1 nA with 1 out of 16 resolution. Range selection is made by changing the gain of current to voltage converters in three 1/10 ranges and by masking data after digital conversion.

The menus are selected by conversationnal software and one of them will be used to monitor machine operation when the beam is on the target.

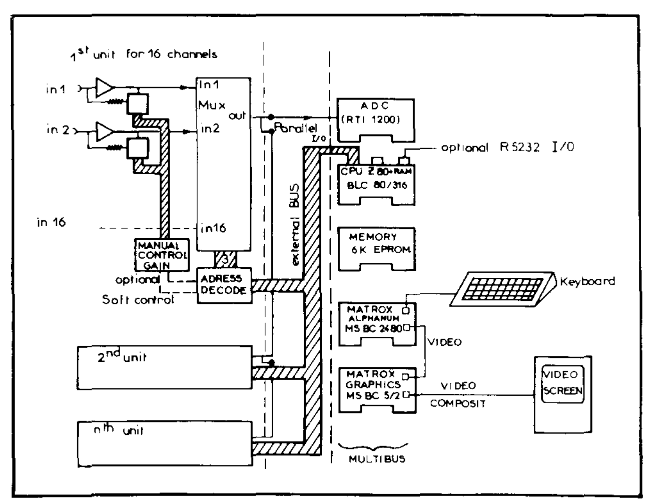

Figure 2 : Acquisition of beam currents on intercepting probes at S.A.R.A. (developpement system is not shown).

Provision has been made to read analog values coming from other diagnostics and the system will also be used for a vectorial representation of the 10 phase probes located inside the machine. Outputs of two analogic values may also be delivered for another use such as a strip chart recorder.

4. Control of power supplies

The 50 power supplies of the post-accelerator (cyclotron and beam lines) are of different manufacturers, some of them being rather old fashionned. It was decided, as a first step to computer control, to normalize their commands and make them compatible with logical levels. They are now controlled by means of 4 keyboards of 16 power supplies capacity. Orders to and status from the supplies are scanned, multiplexed and displayed on the keyboards. Mnemonic name of the selected element under control is displayed on four alphanumeric characters displays (for instance EDE1, HE4, etc...) together with its current or voltage. For trim coils, we have however kept individual control by means of multiturn potentiometers.

All the system is controlled by three state logic, so as to be easily switched to computer control.

5. Data acquisition

Data acquisition of the two cyclotrons has been undertaken in a rather modest way.

At first, a single CAMAC crate will be used to connect 10 multiplexers (16 channels) to a numerical voltmeter. A few digital data, for instance polarities of power supplies, are also fed to CAMAC modules. The CAMAC system is connected to a PDP 11/10.

As a first step to computer control, only data logging and supervision of the two cyclotrons has been considered. Routines for these goals have been done and also for sorting previously recorded beams, according to a set of parameters i.e. Q/A, E/A, etc...

Since a few parameters will have to be still manually entered, some effort has been done to make a conversationnal system easily understandable by operators not very familiar with computers.

Recorded beams data will be printed and logged on diskettes, and later on discs.

Reference

1. See other papers on S.A.R.A. this Conference.