

A CONTROL SYSTEM FOR THE NEW AVF CYCLOTRON AT CYRIC

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Abstract

A control system for the new AVF cyclotron (K=110 MeV) at CYRIC is designed and constructed. The old AVF cyclotron, which had K=50 MeV and worked for 25 years, was manually controlled through the whole hard-wiring system. This system was difficult to reuse for the new cyclotron, since they were designed specially for the 680-type cyclotron and its associated devices. Therefore, we decided to dispose of the old control system, and to construct new system. In this report, we describe the characteristics of this new control system in addition to the beam current measurement system, which is also constructed for the new cyclotron.

1 THE FEATURES OF THE NEW CONTROL SYSTEM

On the occasion of design for the control system of new cyclotron, we have adopted the following guiding principles; 1) totally real-time computer control system, 2) robust networking among rooms and instruments for realize less wiring as possible, 3) only for human safety by hard wirings.

There are a large number of parameters or statuses to control and monitor of whole cyclotron system, such as vacuum valves, thermal switches, power supplies, motors and so on. The PLCs (Programmable Logic Controller), which are widely used for factory automation, is one of the best candidates for the purpose. The Ladder programs of PLC, which are described by relay-coil diagrams, are very powerful for the sequence control and are more efficient to develop the software. One PLC unit is consist of some CPU modules running the Ladder programs and some useful modules such as digital I/O, analog I/O, Ethernet and so on. With them, one can combine the suitable modules depend on the purpose. This has a flexibility to modify the system.

A PLC unit can be divided into a main block and sub blocks. The main block has CPU modules and it is connected to sub blocks through the optical fiber cable. Then these PLC blocks can work just like one long unit. Since most controlled devices need some hard-wirings to handle them, it is necessary to locate PLC units close to them to reduce wirings. On the other hand, it is convenient to set them far from objects in order to avoid from radiation damage in the cyclotron vaults and target rooms. Therefore, we have adopted to detach main block

having CPU modules from the devices, since a CPU module seems especially sensitive for radiation damage. However, sub blocks are still located near the devices, the length of wiring could be held to minimum.

Another remarkable feature of this system is that all PLC units can be fully handled through the network. Then TCP/IP protocols, which are the de-facto standard protocols in the world, are used to establish communication between PLC and PC. This means no special device drivers need to handle the PLC. While the Ladder Language is very suitable for the sequential control, it needs some interface programs to operate. Therefore human interface programs must be developed. In our cases, all man-machine interface programs have been developed by the software Labview from National Instrument Corporation because of the advantages as follows. The Labview has a programming environment like C or BASIC. While other programming environments use text-based languages, Labview uses a graphical programming language, named G, to create programs in block diagram form. In addition, Labview includes many libraries for data acquisition, GPIB and serial instrument control, data analysis, data presentation, and data storage. It is efficient to develop highly intelligent programs.

The whole control system have more than twenty PLC units and more than ten computers, so the heavy traffic jam will be expected. To prevent this network jam, a server-client system is constructed. All the communications between PLC and clients are made via the server machine. All information is stored in this server, and it is send to the client PCs as requested. A server machine can reply requests from many client machines, because the communication between PC and PC is about ten times faster than that between PC and PLC.

2 BEAM CURRENT MEASUREMENT SYSTEM

There are more than 50 points to measure the beam current such as probes, Faraday-cups and beam-stoppers, where we must measure beam current to operate the cyclotron and beam transport line. Those are distributed extending over seven rooms (Cyclotron vault and 6 target rooms). So far, we need analog ampere meter and long cables connected with them to measure beam current.

A new beam current measurement system, based on WE7000 from YOKOGAWA Electric Company, is constructed. The WE7000 is the computer based high speed measuring device, which has many useful performances as an oscilloscope module and a wave generator module and so on. In addition, a special module for current measurement is available. It has 4 CH input and has a wide input range from 1 nA to 10 mA full scale. At present, more than fifteen modules are available and located near the measuring points. No extra cables across the rooms are required to measure the beam current since

all stations with modules are connected through the exclusive optical fibers.

SUMMARY

The new control system for the new AVF cyclotron has been almost complete, and working without troubles. The first beam acceleration of α -50 MeV was succeeded and the new AVF cyclotron is now used for regular work.

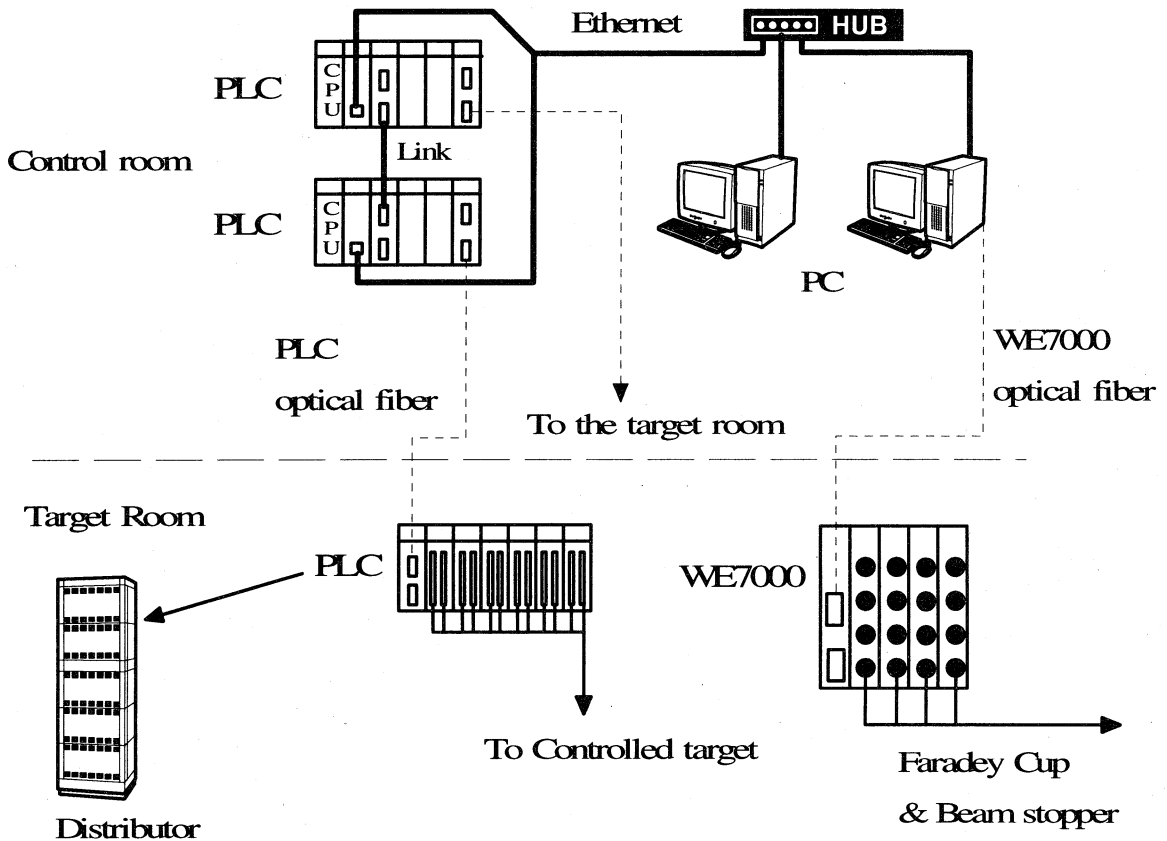


Figure 1: The diagram of the new control system.