

# CONTROLLING OF BEAM LINE WITH PCs

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## Abstract

The beam-line control system was renewed with programmable logic controllers and personal computers. The new system comprises three subsystems. One part is control for the equipment using plural PLCs, which are connected with a network. The 2nd is acquisition of beam data from beam monitors. The last is a human interface of the control system using commercial-based graphical user interface tools that run under Windows NT. The control of equipment and the monitoring of beam are possible from console PCs on the control network.

## 1 INTRODUCTION

The Neutron and Meson Laboratory (NML) of the High Energy Accelerator Research Organization (KEK) utilizes a 500-MeV proton beam from the Booster Synchrotron of KEK-PS at 3 facilities: the Neutron Science Laboratory (KENS), the Meson Science Laboratory (KEK-MSL) and the Proton Medical Research Centre (PMRC), University of Tsukuba. A beam-line of the NML delivers a 500-MeV proton beam to four physical experimental rooms and a medical treatment room. The components of the beam line are listed in Table 1. In 1997 the beam-line control desks were moved from the local control room (LCR) of the NML to the PS central control room (CCR) to reduce the operation cost. With this movement of desks, we renewed the beam-line control system.

Along with an increase in the processing power of personal computers (PC) and progress concerning network environments, it has become possible to construct a more efficient system than previously constructed. The beam-line control system was replaced with programmable logic controllers (PLC) and PCs. In this paper we report on the new control system of the NML beam-line.

## 2 NEW BEAM-LINE CONTROL SYSTEM

To design the new beam-line control system, several conditions resulted concerning renewal of the beam-line control system:

- (1) The utility of the facility was allocated over 3800 hours per year. The renewal is, therefore, only during beam-shutdown time for maintenance.
- (2) The control desks have been moved to the CCR and the operation is performed in the CCR. The beam-

line equipment, however, still remain in the LCR. Concerning maintenance of that equipment, operation of the beam-line is possible not only from the CCR but also from the LCR.

- (3) Reliability of beam safety operation, such as interlock, must be kept the same as before the renewal.

Under these conditions, (1) makes the renewal difficult, because there is not enough time to modify interfaces of such beam-line equipment as the magnet power supplies. In addition, several improvements are planned as follows:

- (4) Fine beam tuning operation can be done from experimental rooms.
- (5) Information of monitoring beam can be obtained from the KEK network.

If condition (2) is satisfied, (4) is not difficult. (5) is required from facility users.

To satisfy the above conditions, the new control system is constructed with PLCs and PCs and comprises three subsystems:

Table 1. Components of the NML Beam-line

<b>Magnet</b>	
Pulsed Magnet	4
Bending Magnet	5
Quadrupole Magnet	36
Steering Magnet	24
<b>Power Supply</b>	
Pulsed Magnet PS	4
DC Magnet PS	16
Steering Magnet PS	24
<b>Vacuum</b>	
TMP	4
Ion Pump	3
<b>Beam Monitor</b>	
Intensity Monitor	11
Profile Monitor	22
Loss Monitor	13

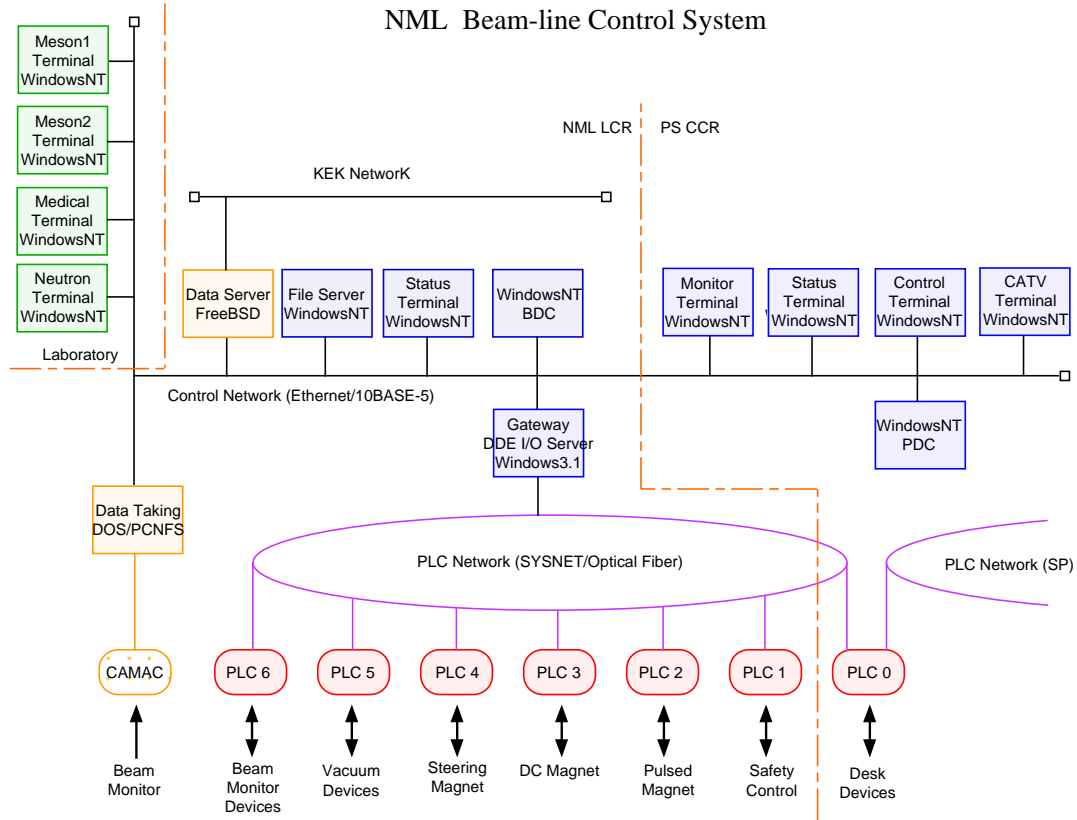


Figure 1. Diagram of the NML beam-line control system.

## 2.1 PLC subsystem

- (1) Control for the equipment using plural PLCs, which are connected with a network.
- (2) Acquisition of beam data from beam monitors and data-server PC.
- (3) A human interface of the control system using graphical user interface (GUI) tools on the Windows NT.

Figure 1 shows a diagram of control system. The reasons to choose such a system are:

- (1) The change of the interface in controlled equipment is minimized because of the high connection ability of the PLC.
- (2) All of the necessary information can be communicated between each PLC via optical fiber links.
- (3) Terminal PCs in a control network are able to control all equipment under each PLC through a gateway PC.
- (4) Some equipment need local sequence control, such as vacuum pumps and gate valves.
- (5) Beam information is obtained from server PC which are linked to both the KEK network and the control network

All beam-line equipment are grouped in their function such as vacuum, beam-monitor controller, DC magnet power supply, pulsed magnet power supply, steering-magnet power supply, control-desk devices and safety-control devices. All equipment in each group are connected to the PLC, made of OMRON, with various interface modules of the PLC. The node number of each PLC is listed in Table 2. Local control in the each group is done by local PLC. Also global control between group, such as interlock, are done by the exchange of information through optical-fiber links, by which all PLCs are connected, by OMRON SYSNET. The gateway PC for the control network is also connected to the PLC optical fiber network.

Table 2. PLC I/O Node Number

PLC #	Part	I/O Node #
PLC 0	Desk Devices	238
PLC 1	Safety Devices	262
PLC 2	Pulsed Magnet PS	97
PLC 3	DC Magnet PS	526
PLC 4	Steering Magnet PS	324
PLC 5	Vacuum Devices	126
PLC 6	Beam Monitor	114

## 2.2 Data-acquisition subsystem

The signals from beam-intensity monitors, beam-profile monitors and beam-loss monitors are processed by CAMAC systems. Reading of the beam data from CAMAC is performed using a PC. The data is then stored to a data-server PC at every cycle. This beam data can be shown at all terminal PCs through the control network. In the data-taking PC, only a data-acquisition program is running under DOS. As an operating system of the data-server PC, the FreeBSD, an Unix-like operating system, was adopted. To access the server PC from the data-taking PC, the PC-NFS service is used.

## 2.3 Windows subsystem

Control of beam-line devices is done by a terminal PC, which is connected to the control network and is running Windows NT. For part of the human interface of equipment control, we used "InTouch", a commercial package, for constructing a GUI-based control panel on Windows NT. The InTouch is connected to the PLC via a gateway PC of control network and the PLC network using DDE communication and control all PLCs from an application window. Figure 2 shows the display of the NML operation window.

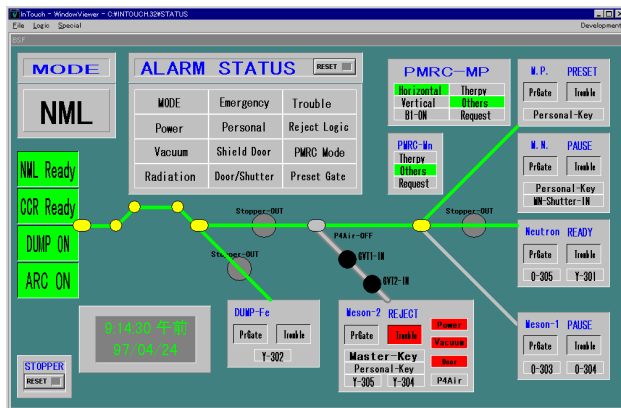


Figure 2. Display of the NML operation window.

Beam information is also displayed on these terminal PCs. Programs used to display beam information were made using rapid application development tool, Delphi. Programs access to the data-server PC and read beam data. Therefore, all PCs on the control network can operate the beam-line control. Figure 3 shows an example of the display of the fine-tuning operation windows on a PC in the experimental room.

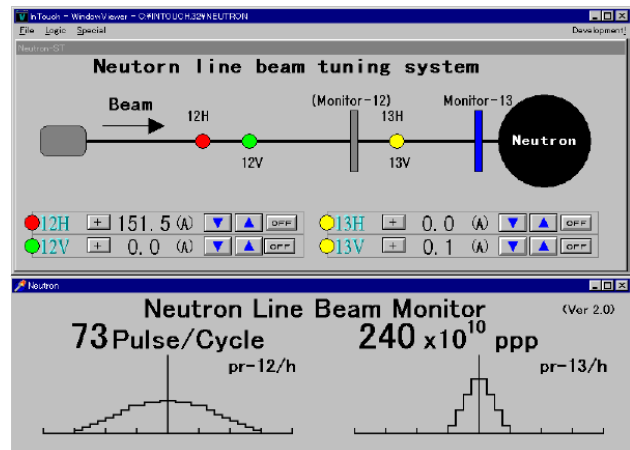


Figure 3. Display of the fine-tuning operation windows.

## 3. CONCRUSTION

Renewal of the beam-line control system was completed during in the beam-shutdown time. Also operation of the beam-line was successfully started on schedule. From all PCs on the control network, control of the beam-line equipment and monitoring of beam information could be achieved. The control system has been operating with no serious problems, though the response of the control operation from InTouch on Windows NT is slow, for some unknown reasons. Beam information is widely accessed form the KEK network. Improvements of the system, such as introduction of a database and/or web-based system, are in progress.

## ACKNOREGIMENTS

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