Development of Beamline Control System for RFT-30 Cyclotron

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1. Introduction

An RFT-30 cyclotron is a high energy proton accelerator for radioisotope development and fundamental researches. The RFT-30 cyclotron is currently improved since the system has the critical problems such as performance degradation and equipment aging. Therefore, the control system should be improved considering the user convenience, and efficiency of operation and maintenance. Especially, beamline system is critical part of the cyclotron system. We have developed the new beamline control system for the RFT-30 cyclotron. We have changed the beamline system into Experimental Physics and Industrial Control System (EPICS) base autonomous control system [1]. In this research, we developed the beamline control system for RFT-30 cyclotron. First, we have implemented the beamline system hardware for the RFT-30 cyclotron. Next, we developed the EPICS based beamline control system. The improved beamline control system can enhance the system stability and the provides the human operator with easy operation for the RFT-30 cyclotron.

2. Methods and Results

2.1 RFT-30 Cyclotron Beamline System Overview

The RFT-30 cyclotron is used for the radioisotope production and proton beam researches. Figure 1 shows the RFT-30 cyclotron and beamline system. The RFT-30 cyclotron is composed of ion source, radio frequency system, main magnet, beam injection/extraction system, and beamline system. The beamline system transports the high energy proton beam, which is extracted from the extraction system, into the target system. The RFT-30 cyclotron has four beamlines. The beamline system transports the accelerated high energy proton beam into the target system without beam loss. The beamline system consists of beamline vault faraday cup, drum collimator, beamline steering magnets, quadrupole magnets, target faraday cup, and AC magnets. The beamline faraday cup, drum collimator and quadrant is used for measuring the beam current and beam distribution. The steering magnets control the center position of the proton beam, and the quadrupole magnets are used for focusing the proton beam.

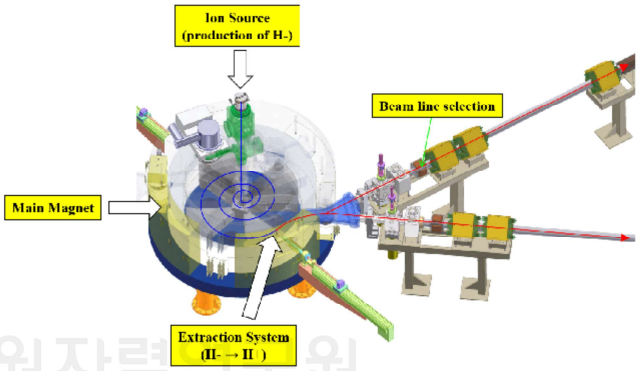

Fig. 1. RFT-30 Cyclotron Beamline System. The beamline system transports the proton beam extracted from the extraction system into the target system.

2.2 Beamline Control System Hardware

First, we have developed the beamline hardware system for the RFT-30 cyclotron control. The new developed beamline system is composed of beamline selector, power supplies, and PLC (Programmable Logic Controller) controller. The beamline power supplies are steering magnets (STX/STY), quadrupole magnet (QA, QB, QC), switching magnet (SM), AC magnet (ACX, ACY). Figure 2 shows the beamline selector. When the operator selects the beamline, the selector changes the beamline into the selected beamline and then sets the output of the beamline power supplies by using the control system.

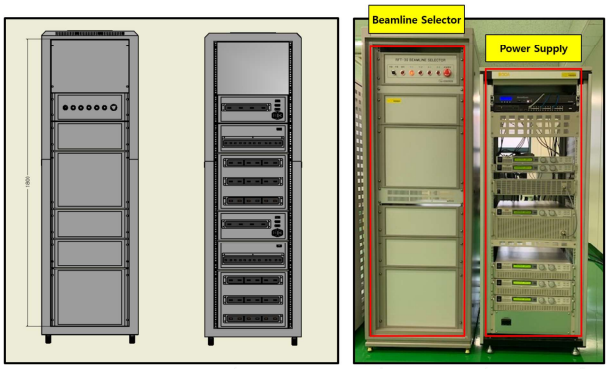

Fig. 2. RFT-30 Cyclotron Beamline Hardware. The beamline selector can control the setting value of the power supplies.

The PLC hardware is used for the control of the vacuum system. Figure 3 shows the new PLC hardware for the RFT-30 cyclotron. In order to meet the requirements of fast reliable control with PC based remote operation, we replaced the relay based compact filed-points (cFPs) system of the national instruments (NIs) into the Siemens S7 PLC based automated control system [2]. The S7 series PLC is widely used in industrial fields since they can provide a modular architecture and various products for many applications [3].

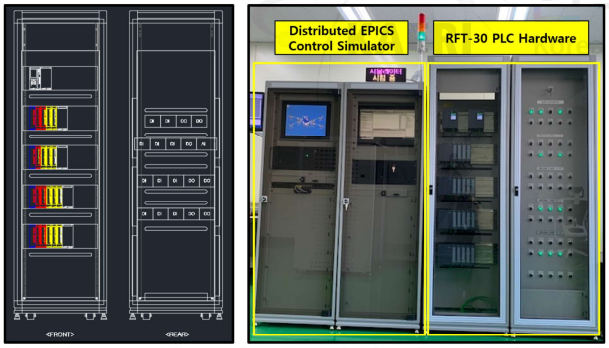

Fig. 3. RFT-30 PLC control hardware. The PLC hardware is used for the beamline vacuum control.

2.3 Beamline Control System

The original control system used the LabView program of NI [8]. The LabView control system of the RFT-30 cyclotron is currently facing the critical problems such as performance degradation and equipment aging. We developed the EPICS beamline control system for the RFT-30 cyclotron. The EPICS based control network is based on LAN and the input output controller (IOC) server is constructed using the Linux CentOS.

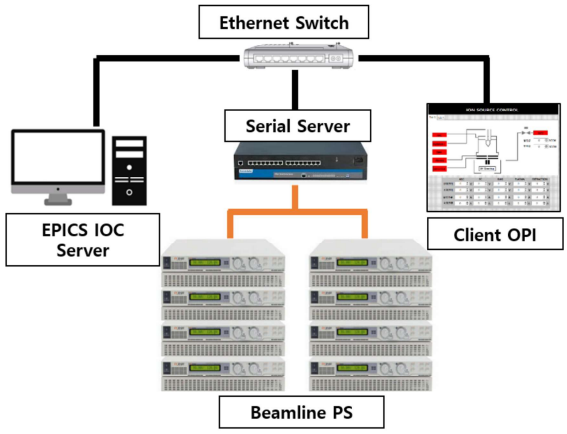

Fig. 4. Beamline Control System Overview. The EPICS control system consists of EPICS IOC server, CSS Client OPI, and Beamline devices

The EPICS base module, ASYN, and STREAM programs for EPICS are installed at the Linux server [4, 5]. The EPICS IOC server is used for the PLC and the beamline power supply, and vacuum control. As shown in Fig. 3, the power supplies are connected to the serial server and ASYN driver and Stream Device module is used for the control of power supplies. A new EPICS device support for the PLC is based on s7nodave, which allows for a simple integration of S7 PLC into EPICs control system. Moreover, we have developed the EPICS sequencer based autonomous control program for the beamline PS control [6]. The sequence control program can automatically start and stop the beamline PS setting. The autonomous control system can enhance the system stability and the provides the human operator with easy operation. For the EPICS client control program, we constructed the client operator interface (OPI) by using the control system studio(CSS) [7]. The CSS based client program can control the beamline devices using the process variable(PV) of the OPI.

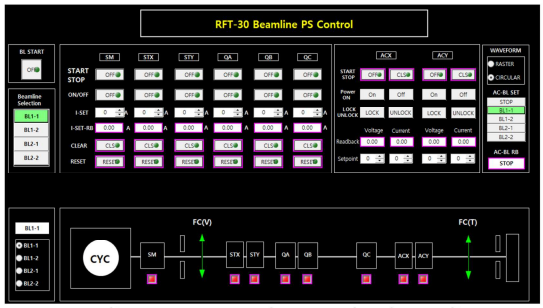

Fig. 5. Beamline PS Control OPI. The beamline PS OPI is used for the control of SM, STX/STY, QA/QB/QC, and ACX/ACY.

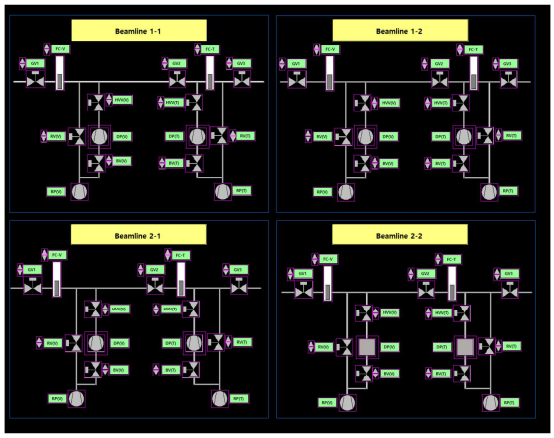

Fig. 6. Beamline PLC Control OPI. The PLC OPI controls the beamline vacuum system, such as valve, pump, faraday cup.

3. Conclusions

The RFT-30 cyclotron is facing the critical problems such as performance degradation and equipment aging. We have developed the new beamline control system for the RFT-30 cyclotron. We have changed the beamline system into the EPICS base autonomous control system. The improved beamline control system can enhance the system stability and provide the human operator with easy operation for the RFT-30 cyclotron system.

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