THE SSC-LINAC CONTROL SYSTEM

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Abstract

This article gives a brief description of the SSC-Linac control system for Heavy Ion Research Facility of Lanzhou (HIRFL) [1]. It describes in detail mainly of the overall system architecture, hardware and software. The overall system architecture is the distributed control system. We have adopted the EPICS system as the system integration tools to develop the control system of the SSC-Linac. We use the NI PXIe chassis and PXIe bus master as a front-end control system hardware. Device controllers for each subsystem were composed of the commercial products or components designed by subsystems. The operating system in OPI and IOC of the SSC-Linac control system will use Linux.

INTRODUCTION

Heavy Ion Research Facility in Lanzhou is component by the SFC, SSC, CSRm and CSRe.The HIRFL is currently operating in series. As the sole HIRFL injector, SFC running time over 7000 hours per year. It not only to work alone, but also provide SSC and CSR beam.

When the SFC working alone, SSC and CSR are in the stopped state; When the SFC + SSC for beam time, CSR is in shutdown state; When the SFC + CSR for beam time, SSC is in shutdown state. This situation makes the whole accelerator performance of the device cannot be fully exploited for beam time has been greatly hampered. Build a platform for the SSC linear injector - SSC-LINAC is for Heavy Ion Research Facility in Lanzhou platform upgrade is an important content. Additional injector combined with time-sharing method for beam can ease the pressure of SFC , but also can achieve SFC, SSC, CSR independent work in parallel, effectively improve the system for the accelerator beam capacity, increasing the actual time for the beam , the beam to meet growing customer demand.

SSC-LINAC is the injector of separated sector cyclotron (SSC). SSC-LINAC mainly is composed by the ion source, low energy beam transport line (LEBT), RFQ accelerator , Medium energy beam line (MEBT), IH -type DTL linear accelerator and high-energy beam injection line (HEBT). Overall Layout of SSC-LINAC shows in Fig. 1.

SSC-LINAC control system has nine major categories. They are the power supply control system, RF control system, vacuum control system, beam diagnostic control systems, magnet field control system, the ECR control systems, Basic conditions control systems, safety interlock protection control system and radiation safety and protection control system.

Figure 1: Overall Layout of SSC-LINAC.

SYSTEM INTRODUCTION

The SSC-LINAC uses a distributed control system, also called the "standard model." It is divided into the operator interface layer, the front-end layer and the device control layer. Different levels between devices us the network and field bus for data communication. The new control system requires the improvements based on the HIRFL-CSR control system. Combining with the current international LINAC device control system status and development trend, we use EPICS [2] system as system integration tools to develop SSC-LINAC control system. It includes some front-end computers installed real-time operating system. The Front-end computer communicates with field I/O devices through different fieldbus. The operator interface achieves communication with the front end computer through the Internet. In addition to the three-tier structure, there is a gateway used to isolate control network and devices network. At same times, it provides all control system parameters for computer of external control network. The structure shows in Fig. 2.
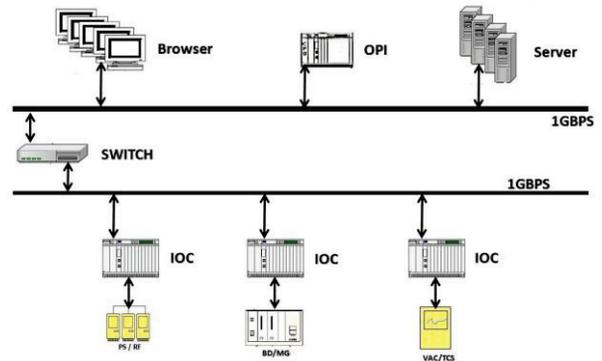

Figure 2: System structure of SSC-LINAC.

HARDWARE

SSC-LINAC control system hardware consists of three parts: the operator console devices, the front-end control equipment and the network and database devices. The front-end computer generated real-time database systems,

real-time operation, data acquisition, device control and fault alarm and responded the request of console control through the LAN. The operator console device uses the PC. Network and database devices use H3C switches and servers. The front-end control system includes the device control and sub- level processing stage. It used to control various subsystems of the accelerator, such as the power supply system, beam diagnostic system, an ion source system, vacuum system, cooling system, etc. The front-end control system hardware uses PXIe Chassis and PXIe bus master of NI Company. In PXIe chassis, we installed various control components, provided a variety of software channel signalling protocol, analog signal output, analog signals detect, digital signals input and so on. The hardware architecture Shows in Fig. 3. Device controller is the underlying distributed control system, and connected directly with the controlled device to complete analog signal and digital signal input / output and signal processing functions. Each subsystem device controller uses a commercial product or design of each subsystem respective components. Such as PXIe boards, interface cards, fieldbus modules, FPGA controller, RF controller.
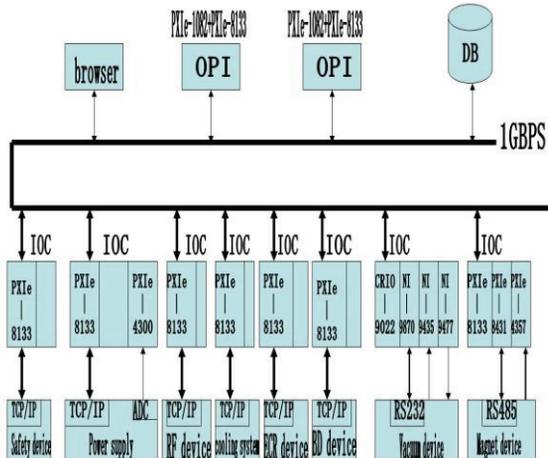
OPI and IOC exchange data with channel access. OPI - side application software includes system configuration software tools that edit system configuration files or application and run tools that visit the database of the IOC and achieve real-time monitoring, control, data storage and other functions. Its structure is shown in Fig. 4.

In the control system, OPI and IOC are installed Red Hat Enterprise Linux 5.5 operating system. EPICS software architecture of Linux platform shows in Fig. 5 [3]. OPI application software user interface use mainly CSS (control system studio) editing tools for interactive interface edit. It can create graphical interface unit and the control channel of the correspondence.CSS establish a connection with the control channel, achieve the control channel monitoring through the man-machine interface operation; CSS achieve the working state of the channel alarm application alarm processing software tools ALH (Alarm Handier) and design the configuration file; CSS archive some control channel data application data archiving tools (Channel Archive) for offline analysis; CSS Backup & Restore the value of IOC each channel application BURT tools.

Figure 3: Hardware architecture.

SOFTWARE DESIGN

Corresponds with EPICS architecture, the software can be divided into two parts: OPI application software and IOC application software.
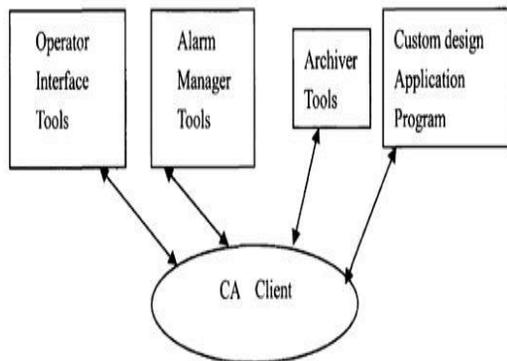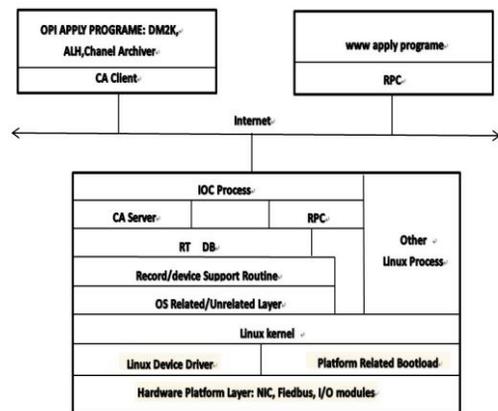

Figure 4: OPI software architecture.

Figure 5: EPICS software architecture of Linux platform.

IOC dynamic database design of accelerator uses graphical design software tool VDCT. It can be clearly reaction process of the database record (such as scan trigger mode, data conversion, alarm threshold, etc.), and the relationship between records. Control system software architecture shown in Fig. 6. Software process is below: Before starting Accelerator, the first step is checking whether the various subsystems are ready, and operating the subsystems unready. The second step is running the system equipment and starting experiment.
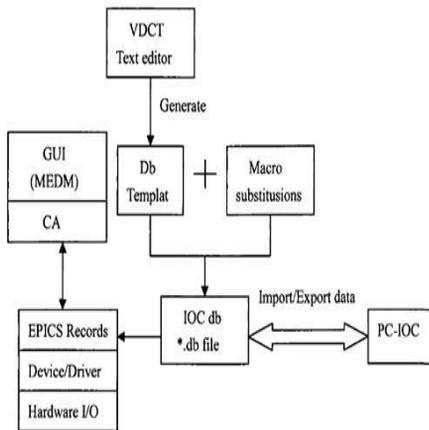
Figure 6: Control system software architecture.

SUMMARY

From September 2012, we built a test platform in the laboratory, and the related technologies were tested. We achieved EPICS system architecture, IOC function, OPI functionality and network devices and NI -board operations. The basic hardware and software platforms for EPICS were built up. In November 2012, we achieved the operation of PXIe bus board, the operation of the network interface device, the operation of large data packets equipment operation, the operation of equipment on the serial port. A hardware platform based on NI PXIe chassis, controller and card was finished. We achieved the IOC package for the controller used in the field. In December 2012, we achieved the operation of Oracle database on EPICS system, packet transmission capabilities between different IOC.

Through the platform testing, we verified the SSC-LINAC control system hardware and software, solved practical problems, and demonstrated the feasibility of the control system design.

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