THE CONTROL SYSTEM FOR CAEP FEL

Demin Zhang, Hanbin Wang, Ming Li , Xingfan Yang
Institute of Applied Electronics, CAEP

Abstract

It describes a control system of CAEP Free Electron Laser (FEL), which is a distributed control system based on EPICS and Visual C++6.0. EPICS is popular in large accelerator laboratories in the world. It is a software toolkit for building process control system for a wide variety of experiment and industrial applications. The software tools in the kit provide independent and expandable modules for system configuration, distributed process control, run-time database, alarm manager, etc. It gives detailed description of the magnet power supply system , beam diagnostic system, including the hardware structure and software design. Other subsystems are also described in the paper. The control system has standard module, interoperability, and repeatability are available. The control system is simple direct, and stable.

INTRODUCTION

CAEP FEL facility is based on RF linac, which consists of an RF-gun, an accelerator, a beam transport line, a wiggler, an optical cavity and a measurement system. The facility started operation in 2000, and the first lasing of the FEL was observed in March 2005[1]. The FEL light wave length is 115 micron, but the saturation of the FEL can not be achieved , mainly because of the low electron current and the instability of the facility. The members of the group have strived to upgrade the machine, which remains for physics and the THz source research. We decided to develop a high performance photo-cathode RF-gun injector to generate high current and low emittance beam[2]. In order to get the high peak current, the magnetic bunch compressor was used .The beam position monitor(BPM), the dipole bending magnet, the achromatic section and other auxiliary components are also included in the beam line. The design of the control system was done in 2000 with Microsoft Visual C++ 6.0. With the purchasing of the new equipment, the control system will be updated, with EPICS toolkit adopted.

SYSTEM OVERVIEW

According to some new devices applied in the FEL system, the existing control system has to be upgraded. EPICS toolkit will be used to build a prototype for upgrading CAEP FEL control system. The purpose is to study some front-end control technology and merge the existing control system which is written with C++ 6.0 into EPICS. We will try our best to make the control system being a distributed system using the “standard mode” which is adopted by EPICS[3](Experiment Physics and Industrial Control System), a set of open source software tools, libraries and applications developed collaboratively and used worldwide[4]. We apply the EPICS toolkit to design the magnet power control system, and the other subsystems are developed with C++ language. Figure 1 shows the architecture of the control system.

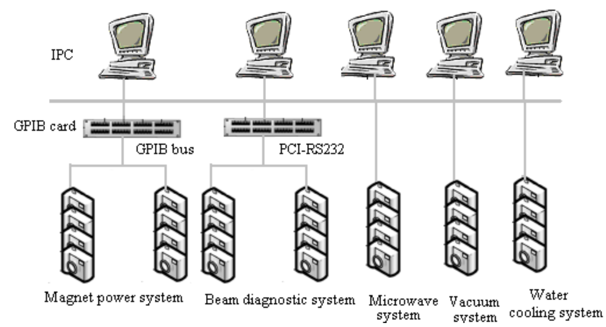

Figure 1: Architecture of the FEL control system

Industrial computer based hardware is widely used as the operator interface at the center control room. It is used as not oily front-end controller but also IOC. And it takes care of monitoring and archiving of selected signals, and displays the running status of control system. Important information is displayed on the big screen.

MAGNET POWER SUPPLY SYSTEM

The magnet power supply control system is used for setting and reading back current of the power supplies, which are programmable power supplies. There are 14 instruments, 8 for beam focusing and transporting, 6 for beam center correction, and the control accuracy is 2%+10mA. The Programmable Power Supply are controlled by Micro Processor Unit with extremely high accuracy of 200W maximum, and the single output with double range that can easily connect communication interface RS-232 or GPIB to computer in order to satisfy our demand for auto-control. The software commands are fully complied with the SCPI format, it is convenient to proceed auto-controlled application program. A GPIB bus connects the power supplies and the GPIB card in the IPC crates exchanging data. Using conducting wire to transfer current to magnet. Figure 2 shows the hardware architecture of the system.

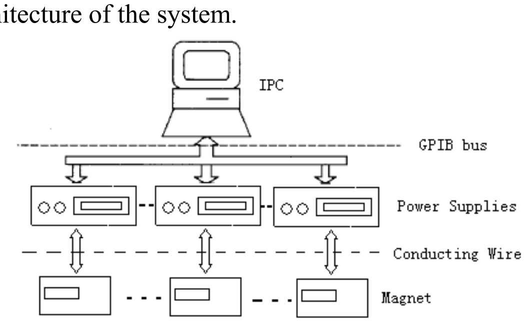

Figure 2: Architecture of the power supply system

ISBN 978-3-95450-117-5

One IPC is used for the operator console computer running EPICS base R3.14.9 under Red Hat Enterprise Linux WS 4.0. ASYN4-7 and StreamDevice2-3 are applied for building GPIB device support module. We adopt Extensions toolkits to design software, such as MEDM for man-machine operation interface, Alarm Handle for monitoring alarm state of the channels, Channel Archiver for archiving data, BURT for backup and recovery data, VDCT for developing runtime database. There are two records types, AI and AO.

BEAM DIAGNOSTIC SYSTEM

Beam diagnostic system is important to detect the beam performance in the transfer line. There are many parameters to be monitored, such as beam intensity, beam position, beam profile, energy divergence, micropulse width etc. There are 3 ICT for bunch intensity measurement, and a field bus connects the device and oscilloscope. 5 BPM are used for beam position measurement. The signals which are collected by BPMs are transferred to the computer to correct beam position. Beam profile diagnostics includes image acquisition, pneumatic control and electric operated control. There are 5 profile detectors , 2 slit, and 7 cameras which collect signals from the detectors. The cameras transfer the position and shape information to video signals which are displayed on the screen in the center control room. Figure 3 shows the architecture of the system. The IPC collects data from oscilloscopes and the beam profile monitor by PCI-RS232 interface. The control software is developed with C++ 6.0 and LabView toolkit.

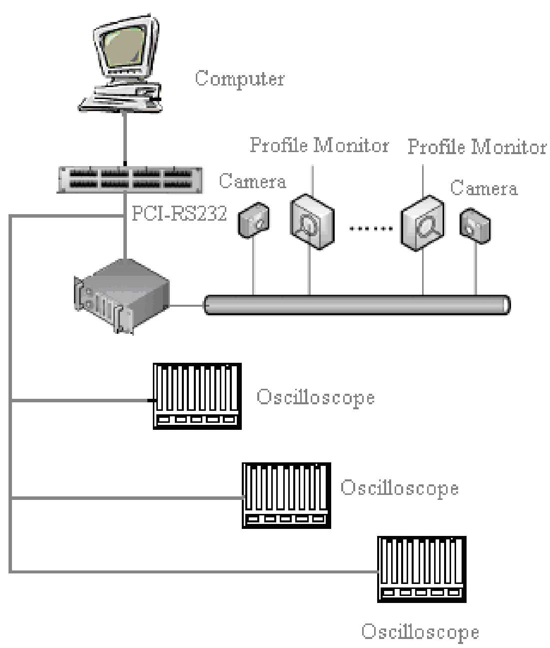

Figure 3: Architecture of Beam diagnostic system

OTHER SUBSYSTEMS

Vacuum system is used for establishing and maintaining the vacuum level of the accelerating cavity, beam transfer lines and other facilities. A high vacuum level is beneficial to get steady beam intensity, dimension and position. Vacuum system includes the control of vacuometers and vacuum-pump power supply.

The interlock system is independent of the control system, which consists of the machine protection system and the personal safety system. The machine protection system can be divided into two levels, the subsystem level and the device level. At the device level, there are magnet power supply interlock system, vacuum interlock system, microwave interlock system and so on. The personal safety system mainly deals with the occurrence when someone stays at the experiment hall, then he could knob down the danger button to cut off the high voltage power. When the hall door is not closed, the high voltage power doesn't work.

Water cooling system places in a room near the experiment hall. It is used for cooling accelerating cavity and keeping temperature steady. The control system includes power supply, setting and detecting the temperature.

Wiggler control system includes the control of grating and stepper motor. The control system is expected to run continuously and steadily, so it is very important to design the control logic, control PID loop. The software is written with C++ language. There is no modification in the control system.

CONCLUSION

The control system of the FEL-THz was designed, updated and is under commissioning. EPICS is adopted in the magnet power supply control system and works well. The interlock system has been under construction, and we will build the third level which is called center interlock. It can accept necessary information from subsystem level and make interlock between subsystems. The next step we will setup a network based on distributed control system with EPICS, and merge the existing control system into EPICS.

The authors wish to express their gratitude to ZHAO Ji-Jiu, LI Gang, ZHAO Zhuo from IHEP, who have given them a lot of valuable advice and help. The authors would also like to thank the FEL group at CAEP for their skillful work and assistance during the constructing of the control system.

REFERENCES

[1] Xiao Jin etc. “Experiment Study on the CAEP FIR-FEL”, HIGH ENERGY PHISICS AND NUCLEAR PHISICS, Vol.30, Supp.1 , Feb,2006,96-98

[2] Xing-Fan Yang etc. “The FEL-THz facility driven by a photo-cathode injector”, FEL2009

[3] Kraimer MR. EPICS IOC Application Developer's Guide, ANL/APS Report.1998,5-11

[4] Ji-Jiu ZHAO, Chun-Hong WANG etc. BEPC II Control System, HIGH ENERGY PHISICS AND NUCLEAR PHISICS, Vol.30, No.11, Nov. 2006, 1100-1106

ISBN 978-3-95450-117-5