A CONTROL SYSTEM OF THE JHF ACCELERATOR COMPLEX

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Abstract

The current status of the control system for a new accelerator project (previously called JHF) is presented. We have started the construction of a part of the linac, although the project itself has not been approved yet. We have discussed intensively how the control system for the new accelerator should be and how we could accomplish our goal. We concluded that the EPICS is the most suitable as a framework of the control system because (1) it is well designed for a distributed system with VME, (2) has many nice tools to build a control system, (3) is well documented, and so on. We have recently installed the EPICS on a HP-UX server and PowerPC based VME controllers. One of the major R & D's we plan is to develop a network based EPICS device driver for PLC's and measurement stations.

1 NEW ACCELERATOR PROJECT

The Japan Hadron Facility (JHF), which consists of a 200-MeV Linac, a 3-GeV booster ring and a 50-GeV proton synchrotoron, would have been the next accelerator project at the High Energy Accelerator Research Organization (KEK) to promote various fields of science. Another big accelerator project called the Neutron Science Project (NSP), which consists of 1.5-GeV superconducting Linac and a storage ring, for neutron science and nuclear transmutation has been proposed by the Japan Atomic Energy Research Institution (JAERI) at Tokai, Ibaraki.

These two big accelerator projects have been merged and form a JAERI-KEK Joint Project [1]. The new accelerator will be constructed at Tokai-site. The Phase 1 of the new accelerator complex consists of

- 400-MeV normal-conducting Linac,

- 600-MeV superconducting Linac,

- 3-GeV rapid-cycling synchrotron, which provides the beam power of 1 MW and

- 50-GeV synchrotron ring which provides the beam current of 15 μA.

In addition, an upgrade towards 5-MW beam power in the few GeV energy region is proposed as a Phase 2. The JAERI-KEK Joint Team has very recently been formed by scientists, engineers and administrators from 2 institutions. (October 1st, 1999) However, we'd like to point out that this paper only covers the work done so for on the KEK-side.

2 CONTROL OF THE NEW ACCLERATOR

2.1 Introduction

Construction of a 60-MeV Linac as a part of the JHF accelerator complex started in 1998 though the whole of the project is not approved yet. A group for the accelerator control was formed in fall 1998. Since then, we have discussed intensively how the control system for the new accelerator should be and how we could accomplish our goals. Our conclusions are described in the following subsections.

2.2 Roles of Control system and Control group

First of all, we have to define ourselves, what we should be and what we have to do. The control group should:

- provide a common basis of control architecture and tools to all equipment groups — it is important not only for designing and producing control devices, but also for accelerator operations.

- provide bookkeeping tools for all components, devices and parts for steady operation of the accelerator complex.

The new accelerator is a very high-intensity machine and therefore the role of control is very important.

2.3 Primary Considerations

We think that the following points are very important in designing a control system for any accelerator.

- Ease of maintenance — In order to avoid unnecessary effort and extra cost in both manpower and money, maintainability is very important. To accomplish it, we use commercially available products in as many areas as possible and we also keep watching the market trends.

- Ease of upgrade — Since the operation of an accelerator usually lasts for a very long period, upgrades of the system often happen. It is ridiculous if we have to replace all parts of the system at the upgrade time. Therefore the system must be designed including the concept of layers or hierarchy, so that the replacement of limited layers would be enough for any upgrade.

- Common use — We should use the same products in networking, hardware and software in as many places as possible in order to reduce the overall cost.

2.4 EPICS

We decided to employ the EPICS in our control system, because;

- It is widely used in the field of accelerator control, and therefore many of the sharable software resources are available.

- It is scalable and also easy to integrate. For example, once we develop an EPICS based control system in a development stage of some device such as a magnet system, the system can be easily integrated into the total control system if we design it appropriately.

- It is very well documented.

2.5 PLC and Measurement Stations

When we started discussion on the global scheme of our control system with equipment groups working for the 60-MeV Linac, we found that many equipment groups preferred to use programable logic controllers (PLC's) to handle their devices locally. Some groups have already made a global design. We proposed an alternative method, namely, use of VME modules. However, we found that it costs additional effort in both equipment and control groups. Therefore, how those PLC's should be employed in the EPICS environment became one of our major concerns.

Another major concern was the waveform digitizer. Since the pulse width of the beam in the 60-MeV Linac is 200-300 nsec, the sampling rate of the waveform digitizer should be at least 100 MHz. Among various kinds of VME modules, such a waveform digitizer is available but it is very expensive. Digital oscilloscopes of various types may be used, but they are all expensive.

A measurement station called WE7000 from Yokogawa Co. became a good candidate. They have a 100-MHz sampling digitizer module. It is very cheap, however, there was one problem. The WE7000 was designed to be controlled by the Microsoft Windows operating system. We and Yokogawa Co. discussed the possibility of modifying the software so that the WE7000 can be handled by the UNIX operating system, and finally this has been done. We are proceeding further to make it work in the EPICS environment. The detailed story and a discussion are described in a separate paper at this Conference [2].

2.6 Present Status

The control group has two different kinds of responsibilities, which are of course very closely related; (1) to make a control system for the 60-MeV Linac at the KEK-site, which is a very short-term task, and (2) to design a control system for the JAERI-KEK Joint Project at the JAERI-site, which is a long-term task.

For the 60-MeV Linac which will be in operation in one year, the current situation is as follows;

- Most of the EPICS base programs and tools have been installed successfully in a HP-UX machine (HP 9000 model D380/2).

- VxWorks operating system has been installed for PowerPC based VME controllers (Forth PowerCore 6750).

- Some EPICS applications have been demonstrated with several VME modules.

- The measurement station WE7000 of Yokogawa, which was originally designed for Microsoft Windows, can now be controlled via UNIX, and will soon become available in the EPICS environment.

- Designs of control system for most of the equipment have been roughly made and detailed design is now ongoing.

For the JAERI-KEK Joint Project, we have just started discussions on several issues with the JAERI group. We have already agreed on the use of EPICS. The JAERI control group also agree to help us in the constuction of the 60-MeV Linac at KEK-site.

3 SUMMARY

Two big accelerator projects, namely, the JHF project at KEK and the NSP project at JAERI have recently merged to form a new JAERI-KEK Joint Project.

As a precursor of the Joint Project, a 60-MeV proton Linac is now under construction at KEK. We decided to use the EPICS in both the Linac and the Joint Project.

We are now developing network based EPICS drivers for PLC's and the WE7000 measurement station.

4 ACKNOWLEGMENTS

5 REFERENCES

[1] The Joint Project team of JAERI and KEK, "The Joint Project for High-Intensity Proton Accelerators", KEK Report 99-4, April, 1999.

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