RIKEN-RIBF CONTROL SYSTEM

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Abstract

Design issues on control system for the Radioactive Isotope Beam Factory (RIBF) project at RIKEN are discussed. They include a partial grade-up plan for the exisiting facility with EPICS, a R&D on CORBA/IIOP based system using VME/CPCI and future development plan for MUSES.

1 INTRODUCTION

RIKEN-RIBF project is an expansion of the exisitng RIKEN acclerator research facility (RARF). It is comprised of two major facilities. The first part consists of an intermediate ring cyclotron (IRC), a superconducting ring cyclotron (SRC) and two RI beam separators (Big RIPS). The second one is named Multi-Use Experimental Storage rings (MUSES) project, which contains an accumulator cooler ring (ACR), a booster synchrotron ring (BSR), a 300-MeV electron linac (e-linac) ans double storage ring (DSR). Figure 1 shows a bird's eye view of the RIBF facilities. The first phase will be completed by 2002 and MUSES is projected to be in operation in 2005 depending upon the budget approval.

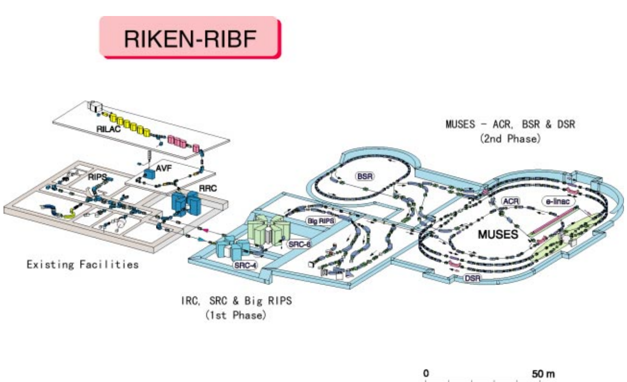

Fig. 1: Bird's eye view of RIBF facilities.

2 UPGRADE OF LEGACY SYSTEM

2.1 Facility Descriptions

The existing facility (RARF) has been in operation since 1986. In this heavy-ion (HI) accelerator complex, there are a K540-MeV RIKEN ring cyclotron (RRC) and two types of injectors: a frequency-variable Wideröe linac (RILAC) and a K70-MeV AVF cyclotron. A energy range of HI beam is from 0.6 MeV/nucleon to 135 MeV/nucleon and RI beam is produced by means of projectile-fragment separator (RIPS).

The RARF control system is centralised on a small main-frame (MF) computer (Melcom M60) which controls all the aspects of machine controls through CAMAC and proprietary field-bus (SUMITOMO CIM-DIM), MMI and DB. Similarly constructed injector controls are almost independent from those for the main ring.

2.2 Partial Upgrade with EPICS

There is an urgent need to quickly replace M60, due to its high annual operational expense, with something proven and reliable. EPICS was chosen because of its proven reliability and fast-development-feature with one CPU system. A high-end Power PC (MPC750-300MHz) based VME computer will entirely replace M60 while leaving all the CAMAC systems and below. This upgrade is planned to be completed by May 1999.

2.3 Future Major Upgrade and Integration with RIBF

This partial upgrade is considered the first step to undertake a major overhaul on the existing facility and its integration of RIBF control system. CIM-DIM interface was specifically designed for RARF and there are no more parts left for maintenance. Therefore, the replacement of CIM-DIM with a new fiber-linked field-bus used in RIBF is contemplated in the future with possible replacement of power-supplys themselves. In that case, it is likely that VME or CPCI controller will take the place of CAMAC. It is not certain at this moment whether EPICS will remain as RARF control system or a new system will take over it.

3 THE FIRST PHASE

3.1 Main Concepts

The first phase in RIKEN-RIBF project is an addition of two cyclotrons (IRC and SRC) and experimental beam lines (Big RIPS). It is qualitatively no different from RARF. However, it is not favorable now to use the same proprietary field-bus and CAMAC as RARF employs in terms of cost/performance efficiency, flexibility and scalability.

The followings are basic concepts for new control system:

- Vendor independent as much as possible
- Use of object-oriented (OO) technology

- Use of COTS as much as possible
- Portable source codes
- Software sharing with other labs
- Seamless integration with legacy systems
- Reliable hardware regardless of cost disadvantage.

Most of the concepts above expect the last one is recent trends in the industry. The last condition mainly comes from the peculiarity of Japanese government procurement which disfavors software expenses.

3.2 Use of CORBA Middileware

One of the strong candidates satisfying above conditions is a use of CORBA middleware for the communication layer. CORBA design priciples include:

- Separation of interface and implementations
- Heterogeneous distributed computing
- Location transparency
- Access transparency
- Support of multiple inheritance of interface.

RPC, RMI and DCOM may not completely satisfy our needs for the moment.

However, current standard CORBA (Ver. 2.2) does not address some key complexities of distributed computing for real-time embedded systems such as latency, fault tolerance, causal ordering, deadlock and QoS. There have been some CORBA benchmarking reported [1~4], but none in the context of embedded systems. We are going to conduct preliminary testing of various ORBs (VisiBroker, OmniBroker, etc.) and OS's (VxWorks and pSOS for controller, Windows-NT, Linux and Solaris for client) in the environment of accelerator control system using VME/CPCI as a field controller and some field-bus including a fibre-linked remote I/O and GPIB. The OPIs are most likely to be constructed by Tcl/Tk and Java. As far as the database is concerned, it is deemed to be still premature to abondon RDBMS such as Oracle because of its robustness and reliability. However, some trials of OODBMS such as Objectivity/DB is already started in RIKEN. Figure 2 shows a schematic diagram of the test system.

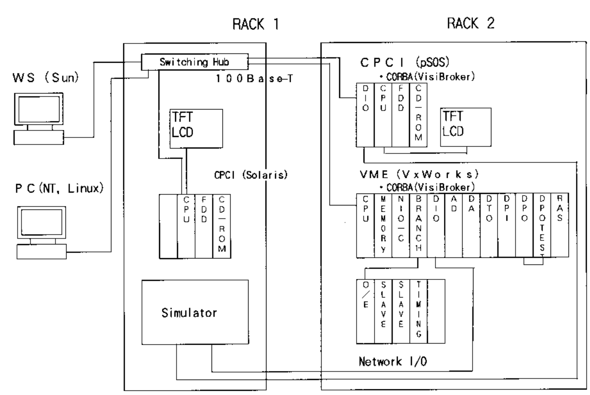

Fig. 2: A schematic diagram of CORBA test system

4 MUSES CONTROL PROSPECTS

4.1 Timing Issues

MUSES controls involve qualitatively different aspects from the first phase of the project that is essentially static machines. Its operation is inherently pulsed instead of DC for cyclotrons. Varieties of particles and their momentum require continuous tuning of timing signals. Therefore, one has to be careful to identify the level of timing requirement and accordingly choose the appropriate source of hardware or software timing system.

4.2 Cooler Controls

There will be a set of an electron cooler and a stochastic cooler for both ACR and DSR. These components directly affect the beam dynamics so that their operations cannot be totally independent from the lattice magnet controls. Introduction of a fast feed-back system is considered necessary and it is currently being investigated.

4.3 CORBA 3 and later

The next version of CORBA is supposed to address the problem of current version for embedded systems in the form of quality of service specifications (Minimum CORBA , Real-time CORBA, etc.)[5] We expect the future version of CORBA will be more suitable to MUSES controls.

REFERENCES

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