DISTRIBUTED CONTROL SYSTEM IN RTC – AN EXPERIENCE WITH EPICS

Tanushyam Bhattacharjee, R B Bhole, N Chaddha, Sarbajit Pal and D Sarkar
Variable Energy Cyclotron Centre, Kolkata - 7000 064

Abstract

The revamping of the Room Temperature Cyclotron (RTC) is completed. This paper is aimed to describe the part by part implementation details and experience of using Experimental Physics and Industrial control System (EPICS) distributed architecture in RTC. The supervisory controls of internal and external magnet power supplies, ion source power supplies, ion source gas flow have been done and the systems are running round the clock very reliably.

INTRODUCTION

The room temperature cyclotron (K-130) has been operated at VECC without comprehensive computerization of its control system. During the modernization project of this cyclotron, a programme has been undertaken to computerize the control systems of power supplies (main magnet, trim coils, beam line magnets, deflector, ion source etc.)[1], the vacuum system, LCW system and other subsystems of the cyclotron in view of the higher stability of the beam in the experimental target. The stringent requirements for the control of these power supplies for the beam tuning pose many challenges during the development of the control. The control has been designed by keeping in mind the following user elicited requirements.

Fast response

The setting and monitoring of the beam tuning parameters need fast response during tuning to judge the proper beam acceleration, extraction and optics. While choosing the control system, it is necessary to know the latency of the system. The determinism like the hard/firm real time system is not an important criteria in accelerator control if not concerned about the beam loss, however, the setting and monitoring of parameters during beam tuning need soft real time response in order of hundreds of milliseconds including network delay, device and application-software processing time.

Unification

The computer control facility has to be unified for easy inter-and intra- subsystems integration and it should not pose any complexity during development. Hence, a unified architecture for the whole computer control has to be defined without compromising the necessary beam tuning requirements.

Modularity

The software and the system architecture have to be modular in nature for easy diagnostic and upgradation during development and maintenance. The development of the OPerator Interface (OPI), device driver and application software has to be done in a modular way.

Easy Upgradation

It is necessary to design the control system for effortless upgradation/addition of new devices. Any addition, extension and upgradation of the control system should be done without complete re-modification of the whole system.

Ease of Operation

The facility for console-independent-OPIs has to be implemented. Any subsystems under this control have to be available from any console to provide the ease of operation during beam tuning.

WHY EPICS?

The distributed accelerator control architecture to be adopted for achieving such requirements should cover the full range of a control system starting from device driver, middleware to client development tools. EPICS provides such facilities to work with the full range of distributed control system architecture in multiple platforms. However, most of the other accelerator control systems available worldwide suffer either from providing the full range of a control system or from providing multi-platform support. In addition, EPICS is open source, reliable and easy to use. Most of the EPICS modules for accelerator control are freely available and hence, it is not required any additional effort for development.

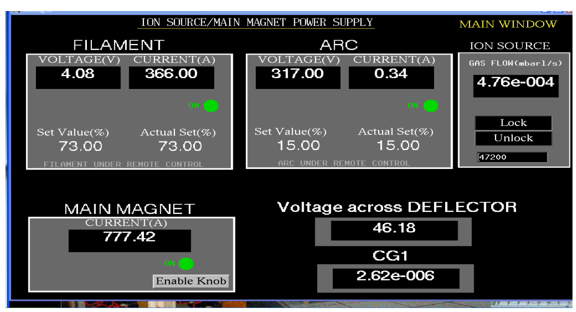

Figure 1: Main magnet, Ion source Graphical Interface.

MAJOR SYSTEMS

The computer interface cards in the power supplies, having RS232 interfaces, have been connected to multi-port serial to Ethernet converters. The supervisory controls of the following subsystems are developed in EPICS by accessing the power supplies over control LAN for room temperature cyclotron.

Main Magnet and Ion Source

The main magnet is required to be energized by a high current power supply to achieve the required magnetic field for acceleration. Since the tuning value of the main magnet power supply varies for the same accelerated ion species with same energy due to the hysterisis of the main magnet, precise and accurate tuning of the main magnet is required after each shutdown. The touch sensitive panel with optical encoder based knobs have been used for the manual beam tuning.

The controls of filament and arc power supplies for hot cathode Penning Ionization Gauge (PIG) type ion source are also incorporated with the main magnet along with the gas flow control and monitoring facility as shown in Figure 1.

Figure 2: Trim Coil Power Supplies Interface.

Trim Coils

The trim coil power supplies are required to tune the magnetic field for achieving isochronisms required for proper acceleration of the ion species. The tuning and setting of multiple power supplies can be done simultaneously either by using soft knobs or by retrieving the stored tuning data. The trim coil interface is shown in Figure 2.

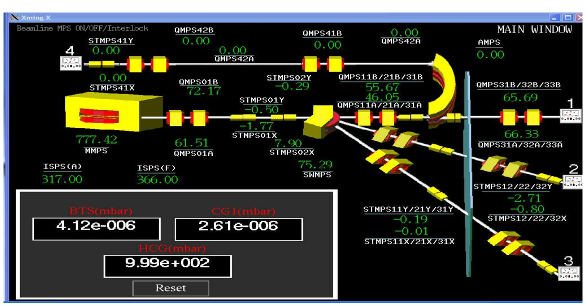

Figure 3: BTS Power Supplies Interface.

Beam Transport System

The Beam Transport System (BTS) consists of quadrupole doublets, steering magnets, switching magnet, analyzing magnet to transport the beam in the experimental area by successive focusing of beam. Beam line OPI at control console as shown in Figure 3 is used for tuning the power supplies for beam transport.

Deflector

A high voltage deflector power supply is used for extracting the beam from the outer orbit of the cyclotron. The main challenge of this deflector is to provide intelligent control for holding very high voltage between electrode and septum with a gap of a few mm. The deflector conditioning and operation logic have been developed. Figure 4 shows the operator interface available at control console.

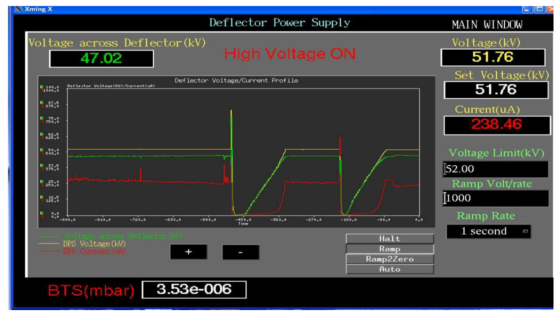

Figure 4: Deflector Power Supply Interface.

ADVANTAGES

The low retentivity of the magnets facilitates the reproducibility of the beam by setting the current of all magnets, trim coils and ion source power supplies from the archived tuning parameters. Any subsystems under this control can be operated from any console, provides the ease of operation during the tuning. Diagnosis and fault finding are easier as the whole system is unified under single architecture. The configurable graphical comparison of subsystem parameters can be done online as per the requirements. As the hardware and software architecture are defined, it supports effortless upgradation and addition of new devices in the control system.

CONCLUSION

The complete upgradation of the accelerator with computer control and the implementation of an expert system with the knowledge base of beam dynamics can be envisaged for auto/fine beam tuning which will lead to reduce beam development time. In this view, the main magnet automatic tuning is being developed and the facility will be available at the console very soon.

REFERENCES

[1] Tanushyam Bhattacharjee et al, “Rejuvenated Magnet Power Supply Control for K-130 Cyclotron”, in Proceedings of SACET-2009, VECC, Kolkata