Development of Distributed Data Acquisition and Control System for Radioactive Ion Beam Facility at Variable Energy Cyclotron Centre, Kolkata

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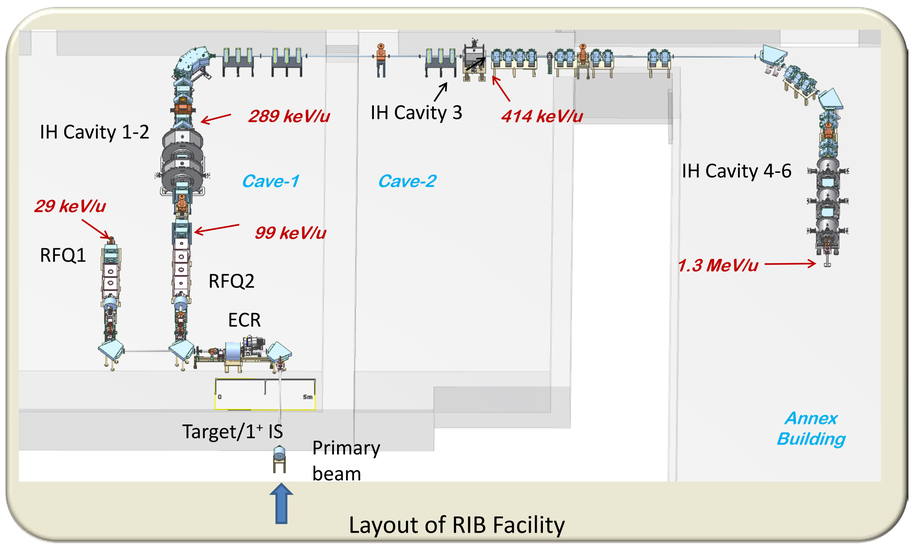
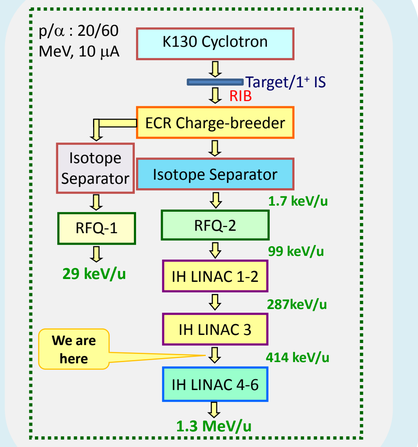
Overview of RIB Facility Project



Layout of RIB Facility

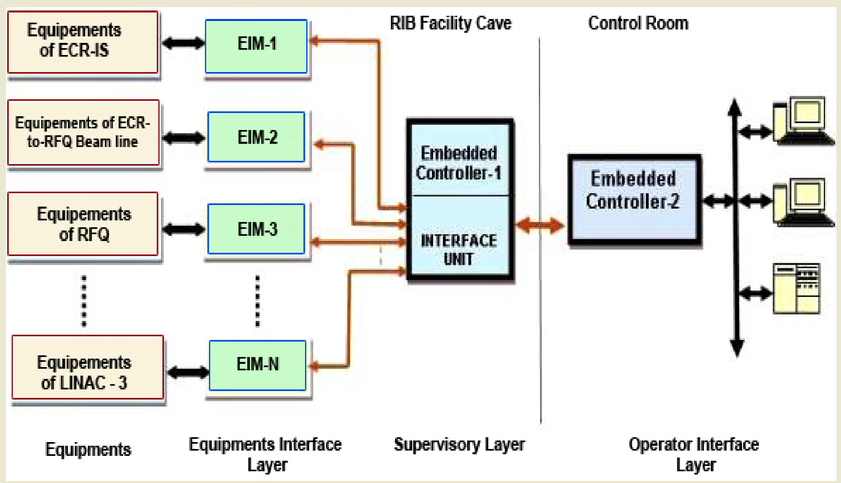
- An Isotope Separator On Line (ISOL) type Radioactive Ion Beam (RIB) Facility is being developed around the VECC K=130 cyclotron.
- Final Beam Energy: **1.3 Mev/u.**
- Main Subsystems:
  - **6.4 GHz Electron Cyclotron Resonance (ECR) Ion source.**
  - **Heavy Ion Radio Frequency Quadrupole Linear Accelerator (RFQ Linac).**
  - **Rebunchers.**
  - **Inter-digital H-mode Linear Accelerator (IH Linacs)** etc.
- **"Distributed Data Acquisition and Control System (DDACS)"** is being developed for monitoring, supervision and control of all the important parameters associated with its various sub-systems.
- Equipments to be controlled & monitored:
  High Current Magnet Power Supplies, High Voltage Power Supplies, Klystron High Power Amplifier (KHPA), RF Transmitters, Vacuum Pump Controllers, Vacuum Gauges, Gate Valves, Faraday Cups etc.



Features of DDACS

- Multi-layered architecture i.e entire task of data acquisition and control is shared by different control modules distributed in all layers.
- Modular, incrementally upgradeable and extendable to fulfil the future requirements as machine grows in scale.
- Module wise usable in case of testing, installation and commissioning of a subsystem.
- Provision to accommodate various kinds of heterogeneous equipments manufactured by different companies and hence characterised by different operational requirements.
- Use of state-of-the-art technology.
- Expandable in terms of addition of similar modules for similar subsystems.

Architecture of DDACS



Schematic Diagram of DDACS

Three-layer architecture ,

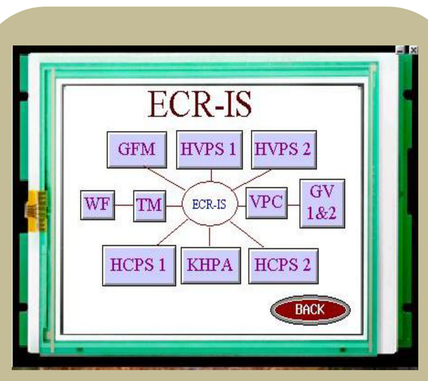
a) Equipment Interface Layer
b) Supervisory Control Layer
c) Operator Interface Layer

The control system is composed of a number of functional modules distributed over these layers which are connected through suitable communication network and protocol.

Equipment Interface Layer (Layer-1)

- Comprises of multiple microcomputer based modules named as "Equipment Interface Module" (EIM).
- Multiple equipments associated with each subsystem are physically connected to their respective EIM module through a variety of interfaces.
- EIMs are indigenously developed around 32-bit ARM controller with analog/digital front-end electronics (ADCs, DACs, Opto Isolators, Multiplexers etc.) and RS232/RS-485 level translator.
- Touch-screen display for local control and monitor.
- EIMs are individually connected to the Supervisory Layer computer through fiber optic link in a star topology.
- EIM periodically scans all equipments, connected to it, to read the status of their parameters and finally sends the status information to the upper layer on demand.
- EIM issues required control commands to the individual equipment for changing value of their parameters as desired by the operators.


EIM Modules



Touch Screen Panel

Supervisory Layer (Layer-2):


Embedded Controller-1 Module

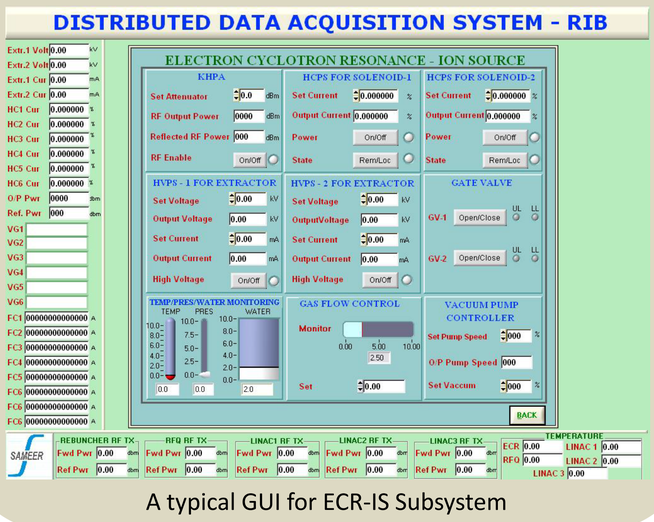

Controller Unit


Data Interface Unit

- Realised by a system (**Embedded Controller-1** or **EC-1**) developed using Single Board Computer (SBC) with Embedded XP operating system.
- The EC-1 is built around a VIA processor operating at 800 MHz. The OS, drivers and application software are embedded in a Flash memory.
- Acquire data from EIMs (Layer-1), process the same and communicate the relevant data to control console at Layer-3.
- Receive the control messages from the control console, parse the same and distribute those to related EIMs to make effective on the equipments.
- Customised command-response based protocol with 16 bit Cyclic Redundancy Check (CRC) has been adopted for reliable data communication between EC-1 and EIMs.
- *"Instrument Id"* along with specific *"Function Code"* in a command message uniquely define a particular operation on a piece of equipment connected to a particular EIM.
- The application software, running in EC-1, is developed using Labwindows CVI.
- The EC-1 is connected upward to an Operator Interface Layer controller, named as Embedded Controller-2 (EC-2) through a pair of optical link.

Operator Interface Layer (Layer-3):

- Handles data representation and operator interaction.
- Consists of **Embedded Controller (EC-2)** and multiple PCs/ Workstations located in the RIB control room.
- EC-2 is interconnected with different monitoring units (PCs/ Workstations) through UDP protocol on an Ethernet LAN.
- Status information of different equipments received from all EIMs by EC-1 are sent to EC-2 and finally displayed in user friendly Graphical User Interface (GUI) at PC/ Workstations.
- Any control action (for changing status of equipments) initiated at this layer finally reaches to the intended equipment through EC-1 and respective EIM.
- The response to user interaction has been kept within the human acceptable limits (500 milliseconds to 1 second).



A typical GUI for ECR-IS Subsystem

Present Status

- Functional performance of the modules has been checked using a simulator system developed indigenously.
- EMI/EMC qualification tests are done as per IEC 61000 standards on the modules to qualify them to be used in an accelerator environment.
- DDACS is being installed and integrated to the RIB facility phase by phase through rigorous field testing.

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