## A.7: Control system for 10 MeV industrial linac

A linac based Agricultural Radiation Processing Facility (ARPF) is being setup by RRCAT for irradiation of agricultural products. An electron RF linac of 10 MeV, 5 kW is being developed indigenously for the same at RRCAT. The linac system consists of a linac and subsystems like RF system, magnet power supplies, vacuum pumps and gauges, radiation monitoring systems, interlocks, personnel safety system and the support systems. A supervisory control system for the linac and associated subsystems is developed by Accelerator Control Section (ACS).

The control system features monitoring and controls of diversified subsystems, timing trigger system, frequency synthesizer, oscilloscopes, and machine interlocks. Scheme of the control system is shown in Fig. A.7.1. The control system is distributed over the hardware and software layers namely Equipment Interface (EI) layer and User Interface (UI) layer and Network (NW) layer. Subsystems and interlocks are supervised directly in hardware in the EI layer. The UI layer offers Supervisory Control And Data Acquisition (SCADA) implemented in LabVIEW. Communication and data exchanges between instruments and programs are managed by the NW layer.

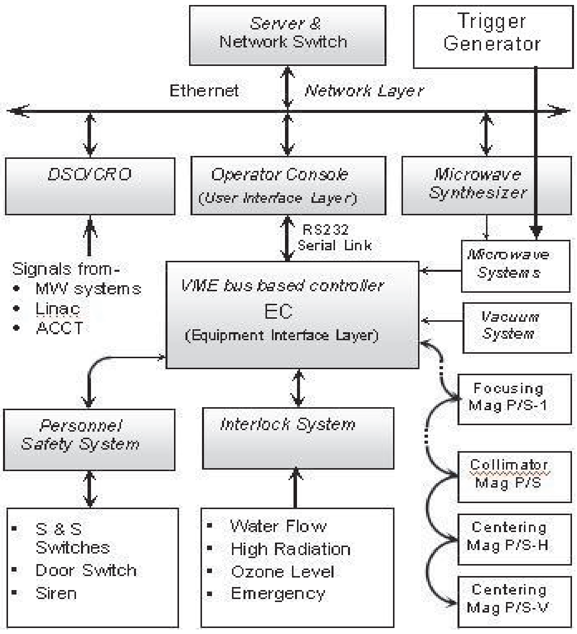


*Fig. A.7.1: Scheme of the linac control system*

The heart of the control system is VME bus based controller referred to as the Equipment controller (EC). All the subsystems are interfaced to the EC. The control system supervises the subsystems using digital inputs for reading status like On/Off, Local/Remote etc., digital outputs for controls like On/Off, Reset etc, analog inputs for readbacks, and analog outputs for settings. All the magnet power supplies are connected to the VME CPU over RS485 serial interface. Machine safety interlocks are supervised directly in hardware. All interlock inputs are taken in fail-safe mode. If any of the interlocks fail, necessary control action is taken in the hardware itself. This ensures safety of the Linac and subsystems in any case. Personnel safety is ensured by a dedicated "Area Search" interlock module. The status of the personnel safety interlocks is read by the EC and displayed on the console panel as well. Isolation is provided in each of the interface signals for better performance in the electrically noisy environment. Digital I/O signals are isolated using opto-isolators and relays. Analog isolation amplifiers are used for all analog I/O channels. Both RS232 and RS485 interfaces are also of isolated type. Isolation is provided on channel to channel basis to avoid formation of ground loops between the subsystems. The chances of EMI and common mode interference are thus reduced.

Main control software running in EC is developed in assembly language of MC68000. The software is modular. The software layer of the control system consists of SCADA system developed in LabVIEW. In addition to main GUI, an operators' panel is also developed to facilitate parallel operation of devices. Latest set points and readbacks are updated on both the panels simultaneously. The SCADA program interacts with EC over RS232 link. Software system also includes dedicated software developed to control the frequency synthesizer and the oscilloscope connected over Ethernet. An RF power measurement module is developed which measures reflected power from the waveform acquired on the oscilloscope and displays it online. Logging of GUI events, VME commands and responses, errors and data is also done. A web site is developed to display the historical data of beam current and energy and facilitates the retrieval of various parameters logged in the database. Fig. A.7.2 shows the online display of a recent beam trial.

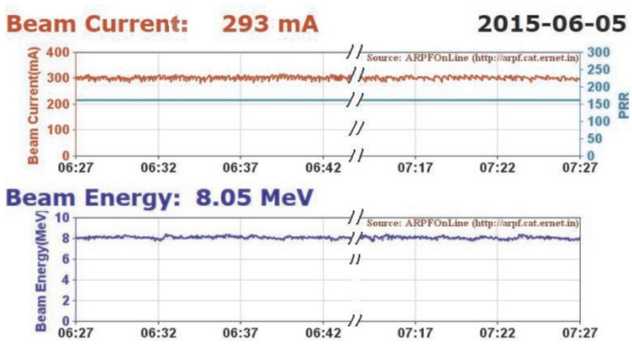


*Fig. A.7.2: Operation of linac on June 5, 2015*

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