PROJECT OF CONTROL SYSTEM FOR ACCELERATOR SILUND-21

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Abstract

The paper presents a project of control system for SILUND-21 linear induction accelerator (energy 6 - 10 MeV, peak current 1 kA, pulse duration 50 ns, repetition rate up to 50 pps) which is under construction at JINR.

The proposed control system is a UNIX-based workstation with distributed interface on the VME standard. Three VME crates are used to control the following subsystems: synchronization, accelerator monitoring and beam diagnostics.

1 ACCELERATOR

Linear induction accelerator SILUND-21 [1] will provide the electron beam with the following parameters: energy of about 10 MeV, peak current $\sim$ 1 kA, pulse duration $\sim$ 50 ns and repetition rate up to 50 pulses per second. SILUND-21 will serve as a base of experimental facility to study microwave electronics, FEL technique and two-beam acceleration. It is assumed also to perform experiments to adopt the FEL bunching technique to generate the CLIC driving beam.

SILUND-21 accelerator consists of seven accelerating modules. Each module includes induction section, focusing solenoid, modulator and power supply for solenoid. The modulator scheme is based on the application of the nonlinear power compression technique and includes a number of pulsed elements with severe requirements to the amplitude stability and to the triggering time . The accuracy of synchronization of accelerating high-voltage pulses should be about of 1 ns during operation.

2 CONTROL SYSTEM

The project of the control system for SILUND-21 has been developed on the base of the experience obtained during design and operation of linear induction accelerators SILUND, SILUND-II, SILUND-20 and LUEK-20 [2] - [5].

Peculiar features of a linear induction accelerator define the requirements to the control system:

- Jitter of triggering pulses for modulators, the beam and modulator diagnostic devices should be less or about of 1 ns.
- Control system should provide a possibility to measure parameters of analog signals with duration from several nanoseconds up to several tens of nanoseconds with a high accuracy.
- Present design of accelerator does not provide a possibility to operate in CW mode at maximal repetition rate due to the problems of high heat and radiation load. So, the mode of operation should be foreseen when the accelerator produces series of pulses with prescribed repetition rate and given delay time between series.
- The control system should be stable to a high level of electromagnetic disturbances induced by pulsed systems of linear induction accelerator.

The control system for SILUND-21 is designed on a Unix-based workstation and front-end computers with a VME-bus. All these computers communicate with each other using the TCP/IP protocol through Ethernet connection. Ethernet establishes links between the operator workstation and the crates containing the interface for equipment.

The typical interface crate is based on the VME standard with a 680X0 CPU and variable number of VME modules for connection with the accelerator equipment.

3 VME SYSTEMS

Three VME crates are used in the control system:

- Crate for the synchronization system to provide triggering pulsed elements with prescribed time diagram of operation.
- Crate for the accelerator monitoring system.
- Crate for the beam diagnostic system.

3.1 Synchronization system

Synchronization system provides triggering pulsed elements (modulators, focusing elements, high-voltage power supplies for modulators, accelerator and beam diagnostics) with prescribed time diagram of operation. Operation of synchronization system is matched with the zero phase of the net AC voltage. Number of independent channels of the system is about 80. Apparatus of synchronization system provide the following characteristics:

- High stability of triggering pulses (jitter less than 1 ns).

- Wide band (0 – 20 ms) of individual control of time delay for triggering each channel.
- Step of time delay for modulators and “fast” diagnostic devices is equal to 1 ns.
- Step of time delay for “slow” elements is equal to 100 ns.
- Repetition rate of the accelerator is changed in the limits from 0.1 to 100 pulses per second. The mode of operation is used when the accelerator produces series of pulses with the prescribed repetition rate and delay time between series.

3.2 Accelerator monitoring system

Accelerator monitoring system consists of more than 100 monitoring and control channels and performs the following functions:

- Instant monitoring of pulsed parameters. When a value of monitoring parameter falls out of beyond given amplitude and time range, the operator is given a message or set up is switched off.
- Stabilization of charging voltage of modulators [6].
- Control of analog multiplexers to connect the required channels (analog or digital) with oscilloscopes at the operator console.
- Digital registration of pulsed signals.

3.3 Beam diagnostics system

Beam diagnostics system performs monitoring the parameters of the electron beam in the accelerator. It includes the following apparatus:

- Rogowsky coils with fast A/D board.
- Induction beam position monitors with fast A/D board for nondestructive beam monitoring.
- Sensor monitors with fast A/D board to measure the beam emittance at the accelerator exit.
- Screen and transition radiation monitors combined with video camera and digital processing electronics.

4 SOFTWARE ARCHITECTURE

Front-end VME-stations are based on MC680x0 processors. Each VME-station controls specific accelerator hardware and carry out data acquisition and low-level analysis for alarm system. Front-end stations operate under Real Time Operational System OS-9. There is a possibility for the direct interchange of data between stations. UNIX host is a resource server for processing and visualizing the data received from VME subsystems on high speed TCP/IP communication network. Accelerator status display is realize on UNIX host via XMOTIF (Open View).

The control software uses table files as a parameter database containing relations between the object to be controlled and the corresponding hardware parameters (for example, the board addresses, the port names, the nodenames of the VME system, etc.). The control software produces several kinds of history records to be archived onto log files for subsequent analysis. The UNIX host and front-end stations perform access to the table and log files via NFS file-sharing technique.

The communication software of the control system rely on the TCP/IP socket library and TCP/IP communication tools (telnet, etc.). The table and log files, message distributors and user interfaces independently exist for each control equipment with different socket servicenames. The control messages forwarded to a specific equipment do not have any interference with those for other equipment.

5 REFERENCES

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