DIAGNOSTICS AND PROTECTION CONTROL FOR IREN LINAC TEST FACILITY

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Abstract

The diagnostic and protection control systems for the full-scale test facility of the linear electron accelerator are constructed according to the project on pulsed neutron source IREN. Combined control schemes of timed diagnostics of a duty cycle and real-time protection control are created. Applicability of the diagnostics systems of cycle parameters and state transitions for control of the mode of protection is shown. Multichannel control modules of the protection system have been developed for logging and diagnostics of a status change, the alarms and control of a mode of operation. The applied multiway controllers for duty protection with fast locking of cycles of the IREN linac are presented.

INTRODUCTION

The IREN full-scale test facility (FSTF) is constructed at the JINR (Dubna) according to the project on a pulsed neutron source based on a 200 MeV electron accelerator (LUE-200) and a neutron multiplication target [1]. The examined equipment of the linac includes: a powerful klystron SLAC 5045 and RF (2856 MHz) power multiplier, a pulse modulator and power supply, a master synchronizer and an electron gun driver, as well as a cooling thermostat of the linac section, vacuum and other environment subsystems.

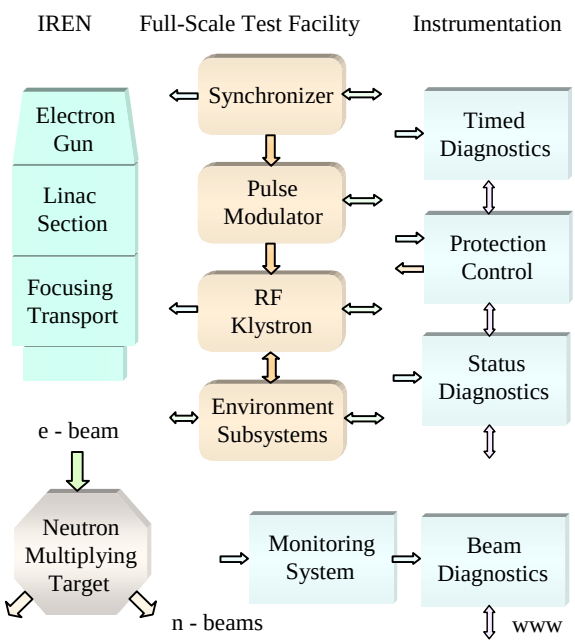

Figure 1: The first-stage instrumentation.

At the first stage of the instrumentation for the IREN full-scale test facility (fig. 1), the timed data taking system [2] for parameters monitoring and diagnostics of the duty cycle (from one beam impulse to the other) with a repetition rate of ~0–150 sec^{-1}, was constructed. A prototype of our monitoring system with on-line diagnostics of beam parameters was also tested on the pulsed neutron source IBR-30 with linac LUE-40. However, for a new source the neutron intensity, electron energy and beam power should be higher, but the pulse duration and repetition cycle values – lower. Some solvable problems of the timed data acquisition to control the pulsed facility were formulated in the reports [2, 3].

Adequate hardware for diagnostics of operation modes and state transitions, which cannot be timed with the IREN duty cycle, has been developed as well. Multichannel circuits of diagnostics for a fast duty control and an emergency protection of experimental test facilities were required, along with development of feedback systems for interactive control. The controllers of multiway protection systems are now developed for the real-time status diagnostics and an emergency control with a possible fast lock of the duty cycles.

COMBINED DIAGNOSTIC SCHEMES

The composed scheme (fig. 2) contains two parts including diagnostics systems of cycle parameters and of state transitions for duty protection and cycle control.

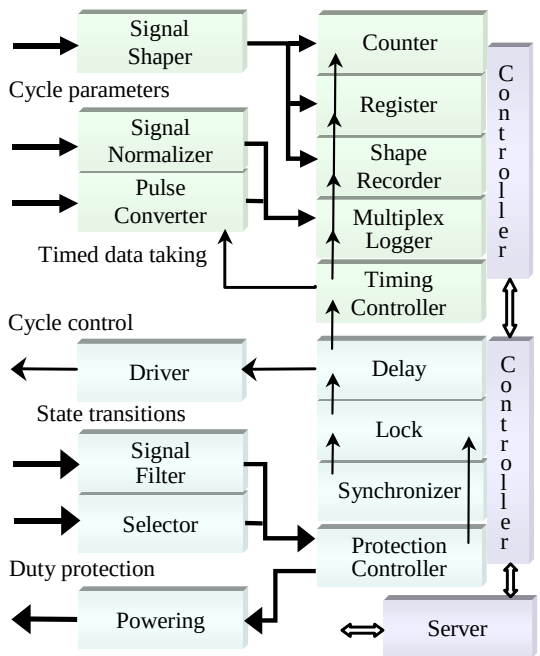

Figure 2: Diagnostic schemes and protection control.

The first system fulfils timed data taking of each cycle to diagnose parameters of the pulses, of the two-stage and analog signals. The modules of the timed converters of

pulse amplitude and hold time, and low-level signal normalizers, shapers of the signals, as well as the timing controller and data loggers with multichannel multiplexers, and also link controllers with a server are included in the diagnostics system.

The system timer launches multiplex data logging, fulfilled after the cycle start. The remaining cycle time is intended for data transfer into the system server and for programmed diagnostics to control of the next cycles. The pulse parameters are also logged after triggering of the shape recorders. The pulse rate counters register a gated train of sensor signals of a chilling expenditure rate. The status registers write changes of on-off signals also synchronously with the beginning of the cycle.

The earlier applied system admits execution of data diagnostics with noticeable delays, sometimes exceeding several milliseconds. Periodic diagnostics timed with trigger pulses is bound to the repetition rate of the IREN cycles. It can be essential in the mode of one-time cycle, and at possible state transitions during the time prior to the beginning or between infrequent starts. The relative durations of cycle periods and the delay times of the diagnostics systems are still more important, when a fast lock control and duty protection are required.

STATUS DIAGNOSTICS AND CONTROL

The system of status diagnostics and duty control supplements the first considered scheme. Diagnostic instruments of continuous tracking are advanced for the multiway duty control with a possibility of the fast cycle blocking and the status data acquisition for the operational control protocol.

The composed control scheme (fig. 2) contains input pulse selectors and filters of the status signals for control assemblies, such as the protection controller and powering switches, and the pulse lock gate of the master synchronizer with the trigger delay and the cycle driver.

The control modules can fulfil a check of the input signals with logging and diagnostics of state transitions. There are control modules for the multiway diagnostics of pulse parameters, the on-off and analog signals. That is why various signal filters, conditioners, detectors, threshold circuits of sampling, and also multichannel logics of data logging and duty control are offered.

The control modules register the state transitions at once, when the alarm levels or closings of contacts are defined. The protection control and alarming, and the computer link are initialized after logging of new statuses. The modules permit to select modes of protection and link control. The control channels are intended to switch the powerful RF and high-voltage devices and a locking of operation cycles.

The module of a lock permits the synchronizer pulses. Selected gates can be locked by the signal of the protection controller or by the program command. The signal for a pulse lock has a higher priority. The delayed pulses start the equipment drivers and the system timing.

The fast lock of a trigger pulse and also disconnection of high-voltage devices or RF-power lowering are usable at electric breakdowns and violation of vacuum conditions, cooling, etc. Thus, the required maintaining conditions of the RF-pulse parameters define assigned thresholds for duty protection control of the test facility.

MULTIWAY PROTECTION CONTROL

The controllers allow us to register state transitions for the selected sensor contacts or two-stage signals, and deviations of analog signals or pulse amplitudes. The shown single-unit module (Fig. 3) registers a state change of 16 contacts and 8 analog signals or pulses of different polarity. Besides there is a lock control and four protection channels selected from possible 16.

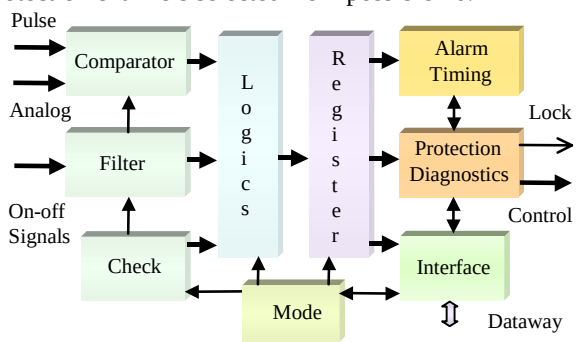

Figure 3: Multiway diagnostic and protection control.

The input conditioners include protective and noise filters and signal comparators, and threshold logics. Abnormal signal fluctuations or the contact closures found by threshold devices, at once are written into the register. The register signal act simultaneously on the lock logics and protection control, as well as on the alarm monitor and the link interface. Thus, the lock switching becomes possible at the lag is less than 1 microsecond.

The channel of common protection is connected to the fast locking and with a control of the main high-voltage source. The sealed cutout switches are applied for a power control with millisecond delays. The control channel of the tube cathode and the timed channels for the klystron pulser can be powered up after reset of the register. The delaying channels are switched on, and the lock is stopped after the timer operation is over.

The record of alarm signals in the register is allowed, but reset of the signals is permitted after removal of reason of the alarm. Here the priority of the protection turn-on is provided towards the turn-off of the operation.

There is a possibility to disable registration or reset of the data, or operations of the timer, and to check the control channels, selecting modes of the controller.

The reset of the register and link permission are fulfilled at a power-up of the controller. Commands of data read-out and the allowed reset, and also permission of link can be fulfilled according to the program.

Operations of the controllers in the system, as well as autonomous operation of each controller, are possible without an interference of external actions.

THE CONCLUSION

The designed diagnostics systems of cycle parameters and state transitions are complementary and applicable on pulsed test facilities. The timed diagnostic scheme is optimized for data acquisition during each cycle but can bring essential lags for online control and fast protection.

The designed multiway controllers of status diagnostic systems fulfil an emergency control at once after detection of parameter deviations. Thus, the fast lock of the linac cycles, alarm and a duty control are provided.

The diagnostic systems have been examined to control a functional mode of the linear accelerator. Multiway protection control with possible a fast lock of the linac cycles is used for the IREN test facility.

REFERENCES

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