NESTOR FACILITY CONTROL SYSTEM

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Abstract

The NESTOR (New Electron STOrage Ring) is a X-ray generator based on compact storage ring and Compton back scattering in the National Science Centre "Kharkov Institute of Physics and Technology". It allows to carry out investigations in the wide range of fundamental and applied sciences such as physics, biology, medicine and etc.

In the paper the main fundamental problems and the philosophy of NESTOR facility control system are presented

INTRODUCTION

X-ray generator NESTOR [1,2] as an object of control is divided in several technological systems: electromagnetic elements, vacuum, RF, laser-optic, diagnostic of facility parameters, radiometric, etc. Each system is characterized with determined number of check and control points and also with character of checking signals (direct or alternating current, pulse, etc.). Table 1 shows the main NESTOR facility sub-systems as an objects of control and number of monitoring and control parameters and signals.

As any electro-physical facility NESTOR can be run in one of operation modes:

- preparation for facility "switch on";
- "switch on";
- putting in operation mode,
- keeping in operation mode;
- detuning of operation mode;
- putting out of operation mode;
- emergency mode.

Control system should provide uninterruptible, effective facility operation in each operation mode.

Table 1: Control System of NESTOR Facility

Subsystems	Signal Sources	Control parameters
Linear accelerator	40	15
Inflector	10	5
RF system	40	10
Vacuum system	14	10
EM system	110	110
Syst. of beam orbit correcting	40	16
Syst. of injection correction	14	8
Motor generator and PS	4	1
Cooling system	200	5
Temperature control	10	5
Beam diagnostic system	10	-
Blocking and video sensors	10	2
At all:	502	187

STRUCTURE OF THE CONTROL SYSTEM

A structure of automatic control system of NESTOR facility is built in accordance with classical, typical distributed scheme with set hierarchy of technical means and hardware [3-6]. In Fig. 1 a block scheme of NESTOR facility control system is presented.
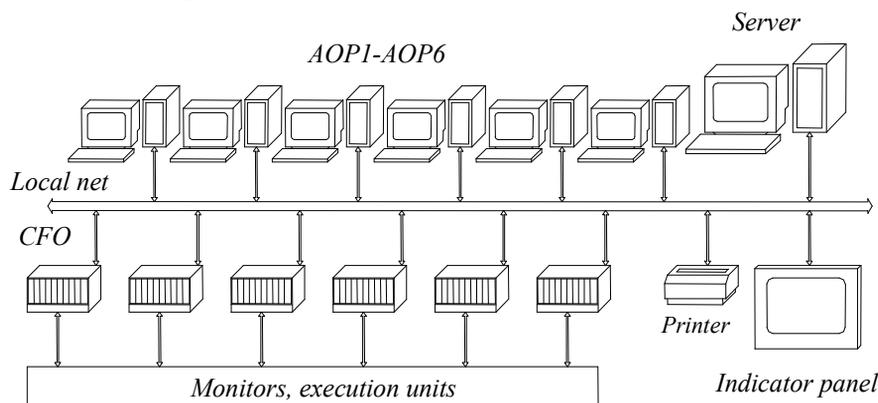

Figure 1: Block scheme of automatic control system of X-ray generator NESTOR.

Two levels of control are separated. Lower level is distributed and as a matter of fact is involved in compound of one or another facility system. It involved beam parameter instrumentation system units, execution units and communication facilities with object (CFO): controllers, converters, switches etc. The lower level is "all-sufficient". With local control panel (which could include not only controller but also computer) it is possible trough CFO to make all operations on the facility "switch-on", "switch-off" and detuning the facility systems, to collect and preliminary process information from detectors and monitors. Control can be automatic (with software without operator) or automatized. In the last case control can be made "manually".

The upper level involves server (main computer) and automatized operating places (AOP) of operators. Server is quite powerful computer for collecting, storing and processing of information data base, operating algorithms and code of whole facility control. All AOPs are completed with technical means and hardware for information display and computer control.

The connection between system levels is realized through local net.

Considering the facility layout and general algorithm of facility control number and allocation of points of each system are determined (Table 1). At that, as a rule, generalized parameters are used. In the whole system the number of checkpoints can be larger then it is determined with global control algorithm. It depends on intrinsic needs of a system. For example, vacuum system has a row of "intrinsic" check and control points (forevacuum, valves, shutters, power supply etc.) but to the upper level only information about system readiness and main system parameters are passed. From the algorithm and hardware properties the requirements to signal parameters, speed of response, signals matching and their sequences etc. are followed

THE ALGORITHM OF THE FACILITY OPERATION

In "switch-on" operation mode all subsystems of the lower level of Automatic Control System (ACS) function separately in autonomous regime and when all devices are ready the signal of readiness is transmitted to upper level. Then controllers (computers) of the lower level implement tasks produced by the main computer.

A program based on a global algorithm accomplishes control of the facility as a whole complex. The algorithm is a detail description of main computer operations and their sequence for each operation mode mentioned above. In the description the purposes, ways of fulfillment and list of check and control parameters are pointed in details with real address and value of each parameter.

As it seems the algorithm of rising of the storage ring operating energy is the most difficult task. All elements of electromagnetic system, power supply system, RF system and electron beam instrumentation system operate in this mode as a single system.

The separate object for control algorithm is emergency situations. The general algorithm includes all emergency situations that are possible during the facility operation in one or another operation mode. Ways of emergency situations solutions are also included in the general algorithm. Especially important is emergency regime produced with unauthorized power supply interruption or vacuum failure in the facility. In this regime ACS has to provide immediate facility switch-off with minimal damages for equipment and environment.

The detail description of the control algorithm is not the subject for this paper and is the point for separate report. Now this work is in progress and will be completed with put in operation of NESTOR facility.

HARDWARE AND SOFTWARE

Choice of hardware for NESTOR facility ACS is dictated by financial abilities of the project and will be done as will be the progress of projects of separate systems and the general control algorithm as a whole. It is concerned first of all computers and operation systems. It is possible to use the items from Advantech production row (IBM- compatible computers, working stations, control panels, controllers etc). The widely known devices of CAMAC standard are also used. As supported means of the local net the Ethernet and multi point nets on the base of RS-480 connection interface are used. Partly devices are manufactured in NSC KIPT or according to our technical proposition in other organizations. We are trying to make our devices unified in maximal degree (portability and maintainability are required).

Software is built on the base of object-oriented programming language like C^{++} and lower lever programming language like assembler language. Software is built on block-module principle with specified module for each class of the operation.

In time the realization of the upper level of ACS can be shifted to the last stages of the project realization. Such approach allows to take into account all current improvement raised during design, development and commissioning of NESTOR facility systems.

CURRENT CONTROL SYSTEM STATUS

Till now the lower level control systems were designed and partly developed and put into operation. During the commissioning of the NESTOR facility [7] the following control systems were used:
- linear accelerator control system with monitoring and control of RF voltage, RF faze, magnetic focusing elements and so on;
- storage ring magnetic element power supply control system;
- beam diagnostic system at the NESTOR transportation channel;
- cooling system of the electron accelerator;
- cooling system of the storage ring;
- video monitoring system of the facility.

The control is made from remote control room (Fig. 2). Fig. 3 shows a screen short of the linear accelerator control system. The control system of the storage ring magnetic elements power supply system is shown in Fig. 4-5. Elements of the video monitoring system are shown in Fig. 6.

At the moment the control systems of the RF, LLRF, vacuum, storage ring beam diagnostics systems are under design and development.
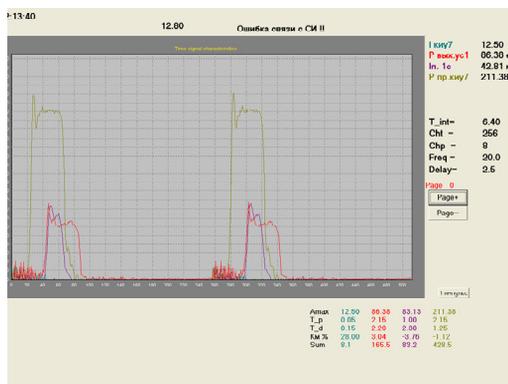

Figure 2: NESTOR facility control room.

Figure 3: NESTOR facility linear accelerator control system screen short.

Figure 4: NESTOR facility storage ring magnetic elements power supply control system.

Figure 5: Programmed power supply sources of storage ring magnetic elements power supply control system.

Figure 6: Elements of video monitoring system.

CONCLUSION

The general principles of the NESTOR facility control system architecture were formulated. The control system is under design and development. The current status of the control system allows to carry out the first facility commissioning, to pass electron beam through transportation channel in bring beam to the injection azimuth. The development of the control system is in progress.

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