

# A FOCUSING SYSTEM CONTROL UPGRADE OF MMF LINAC

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Being created in eightieth years, the linear accelerator control (LAC) system was founded upon a usage of SM4 computers with a RSX-11M operating system and interface devices with an object (IDO) designed by the Moscow Radio Technical Institute.

Since 2000, the operations on creation of a new linac control system are carried out in the Institute for Nuclear Research. Within the framework of this activity a focusing system control (FSC) upgrade is practically finished now, being carried out on the basis of a local network of computers with an operating system Windows 98. The software for the new control system was designed with the help of the graphic software package LabView.

In this report the main principles of upgrade of FSC are given, new programs of focusing element power sources control are described, block diagrams of programs are submitted and algorithms of their functioning are represented.

The control system of focusing devices of the accelerator consists of power sources, equipment of IDO and personal computers (PC), connected by means of a local Fast Ethernet (Fig. 1).

Structurally the linac is divided on five sectors by a function-territorial principle. On each sector there are up to 20-30 different power sources, which are the stabilized current sources. The range of maximum output currents values for different sources varies from  $\pm 1.5A$  to 1000A. The monitoring and control of current sources is carried out with the help of devices of IDO, consisting of interrogation blocks of both analog and discrete signals and of discrete and analog control blocks.

The IDO control is carried out by a National Instrument Digital input/output Card (DIO-96) installed in the computer-server of IDO. On this computer the programs of data gathering and control IDO run. Their composition is entered by programs of the server of IDO of data and commands organizing data transfer and control instructions to client programs. One of client programs is the program of management of focusing system.

The structure of the software package of management of focusing system (Fig. 2) includes two basic programs: the *Dispatcher of focusing* and *Sector focusing*.

The *Dispatcher of focusing* traces a state of programs and informs on an output of a current of power sources for a tolerance range.

The *Sector focusing* fulfils the basic functions of power source control. For each sector of the linac there is the program of focusing which takes into account the main features of power sources of this sector.

## 1 SECTOR FOCUSING PROGRAM

### 1.1 Program description

The program measures and controls of power source currents.

The program measures the value and polarity of a current of power sources. View of a window of the program is shown in figure 3. For results of measurements the absolute error (deviation from the mode) is calculated. For each power source the value of tolerance for an error figure is established. At exceeding this tolerance the signal "Attention" is displayed.

The program controls the value and polarity of a current. For control of power sources currents the automatic and step-by-step control is used. At *automatic control* value of a current which is necessary for establishing is set. After switch on of the adjustment installation of a current which switches off automatically, when the magnitude of a current equal to a preset value is set.

At *step-by-step* control the amount of steps (pulses) which is necessary dial pulsing for increment or decrement of a current magnitude is set.

As a rule, step-by-step control is used at adjustment of the accelerator. The automatic control will be used for installation beforehand of known values of a current, design modes or operating modes.

The program reads out modes saved as a text file on a hard disk of the computer. It allows to write the new mode and to edit the old list of modes.

The program measures a period of interrogation, delay and number of other technical parameters.

### 1.2 Structure of the program

In the program multiflowness LabView is used, consisting in that the structures While Loop can be run out independently of one another as separate subroutines, and to exchange the data with the help of local variables. Four While-Loop structures were created: the Menu, Display, Interrogation and Adjustment.

*The structure of the Menu* processes commands of the menu bar. In the menu bar the basic commands of management are collected by the work of the program. In particular, it makes stop of the program, select management mode (automatic or step-by-step), adjustment of tolerances etc.

*Structure Mapping:*

- Transforms of the data to visual sort, makes calculation and processing of the findings (data of measurement, error etc.);
- Handles actions of the operator, such as change of period of interrogation or choice of other mode;
- Informs on errors of equipment and output of signals for tolerance.

Structure Interrogation runs the subroutine of measurement of currents of power sources with the given period of interrogation.

### 1.3 Description of the structure of subroutines

The structure of subroutines is shown in figure 4.

The program *Focussing sector* includes the following basic subroutines:

- F TTO - subroutine of conversion of commands of management;
- IZM polling (opros) - subroutine of measurement;
- IZM - subroutine of measurement command;
- Reg+Pol - subroutine of current control and handle of polarity;
- Rezh - subroutine of operation with modes;
- Error?!+ - subroutine of error processing.

*Measurement* of value of a current and polarity of all power sources is carried out by the program IZM polling /opros/ which is started cyclically with the given period of interrogation. The data received by the client of interrogation (subroutine USO client polling /opros/) from a server of interrogation under report TCP/IP, are deciphered with the help of programs F USO and F TTO according to the table of process equipment TTO (see Fig. 5). With the help of this table transformation of commands of management by power sources (Current is augment!, Polarity + is include! etc.) in a format of commands IDO (№IDO, № the block etc.).

*Regulation* of a current of power supplies is carried out by a number of the pulses sent on the source of a basic voltage the ION. Each power supply is characterized by sensitivity expressed in change of the value of measured voltage (to a proportional current) on one pulse of control. The sensitivity of different variants of sources also can be in the range of 3÷20mV/pulses. Varied sensitivity and interferences, which can arise in long cables of communication from power sources up to case IDO (up to 30m), have imposed the particular requirements of algorithm of management. The algorithm of stepwise approximation was used. The count of steps is calculated under the formula:

$$N = \frac{I_L - I_T}{2K \cdot S};$$

where

- IL - current of a source,
- IT - current target,
- K - calibration factor,
- S - sensitivity.

When calculating the count of pulses at an initial stage of regulation the average sensitivity for sources, equal to 10 mV /imp is taken. But if after regulation the sign of an error changed, the sensitivity was incremented twice. It has allowed to reduce a control time and to magnify the accuracy of setting of value of a current.

The stopping of the program is carried out under four conditions:

- hand stopping;
- at excess of quantum of approaches > 50;
- at an error value < 0,1 %;
- If one pulse was moving, and previous one too

was, but in the other direction, (high sensitivity of the power source) stops on value the closest to established (installed) set.

In an operating time there is a necessity to look different modes and to compare them with current. During adjustment of the accelerator a more optimum mode of currents of power sources, which is necessary for remembering, can arise. For these purposes the programs of operation with modes (subroutine Modes, Reading of the Mode, Write of the Mode) will be used. With the help of these programs the reading, writing and editing of the list of modes which are stored as a text file on a hard disk of the computer are made. For each mode there is a name, which is expressed as date and time of record more often, the list of power sources with values of currents and the comment to it. The view of a window of the subroutine Modes is shown in figure 6.

In the program the special notice to errors is given, which can arise during execution of the program. The errors can be:

- Hardware, bound with the faulty equipment;
- Network, bound with data transfer on the network;
- Program, bound with a stopping of programs.

In the program the method used in LabView will be used where to each error the code is assigned, and the description of an error code can be read with the help of the special subroutine. It is possible to enter the error codes, as it was realized. It has allowed in time to diagnose errors, as in a time of debug, and a time of operation. For decode and storages of the information on errors the subroutine Error?!+ is used. At any moment it is possible to call this subroutine and to look information about the last errors which have occurred during operation.

## 2 PROGRAM THE MANAGER OF FOCUSING

At the on duty operator on the accelerator the information on all systems of the accelerator is collected. For convenience of processing, it should be in the form compressed and convenient for the operative management. At this the program *The Manager of Focusing* (see Fig. 7) was developed. The information on a displacement of currents, which values have left for limits allowable are given the operator and can affect work of the accelerator. For usability, the information is submitted as change of the colour of buttons.

The program maps a state of main sector programs (in operation, stopping, crash) and collects information about an output of currents for tolerance.

The colour of buttons displays a state of main programs and output of an error for tolerance.

At an output of a current for any of tolerances (Notice, the Crash) appears the window, with the information on a number of the power source and value of an error.

Use of the above-described programs has allowed to receive the information on a condition of system of focusing more operatively and to make management of its parameters. It has allowed essentially to improve and

simplify process of adjustment of the accelerator.

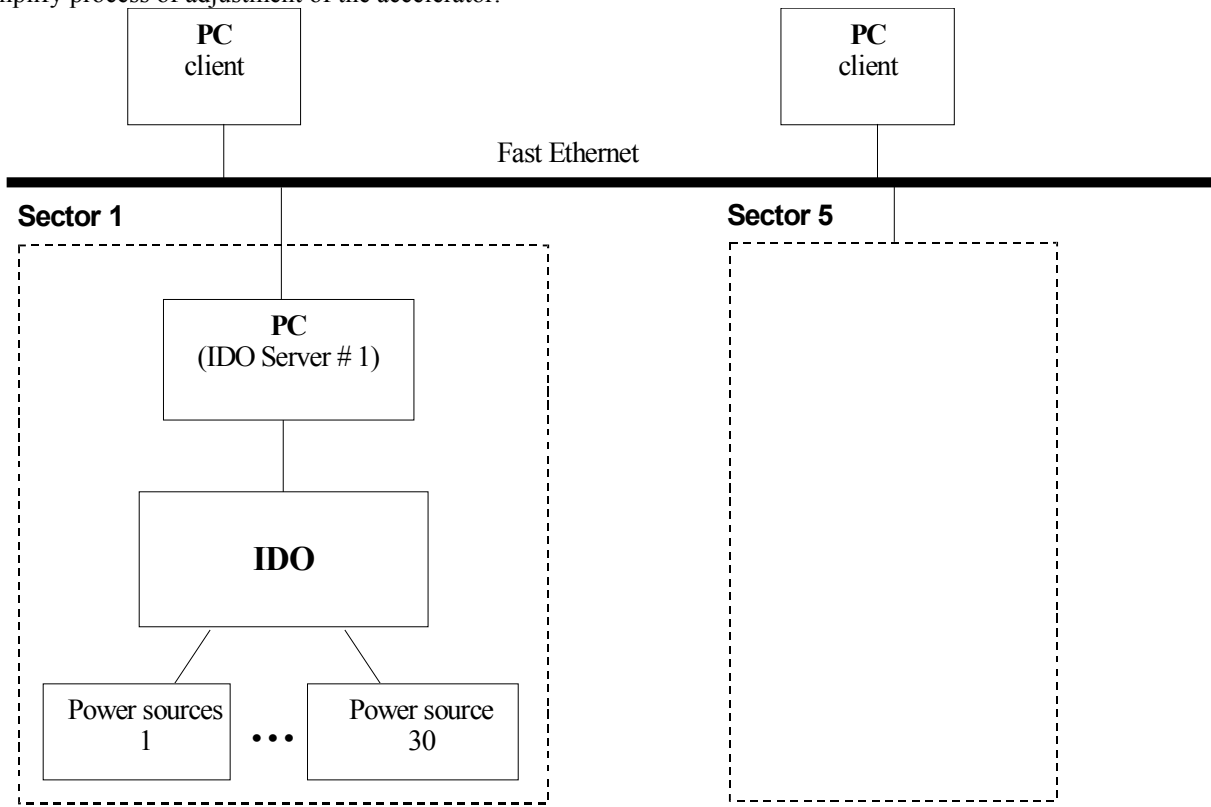


Fig. 1.

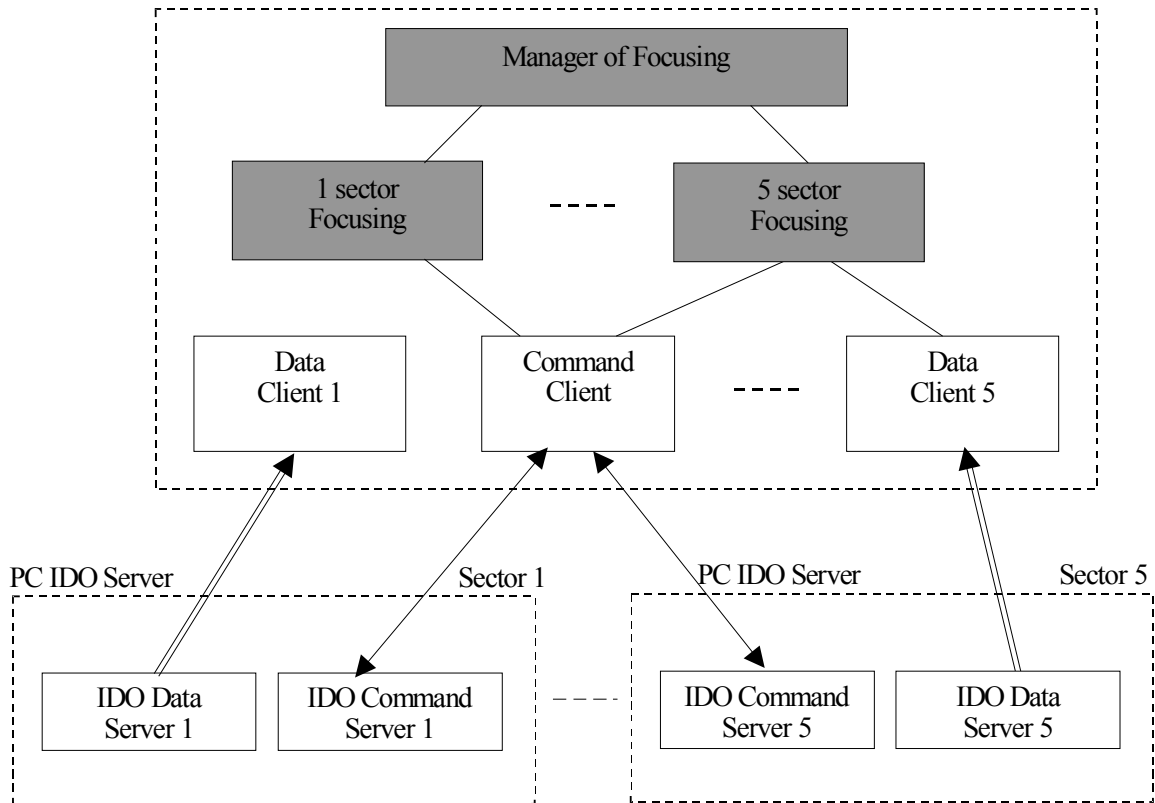


Fig. 2.

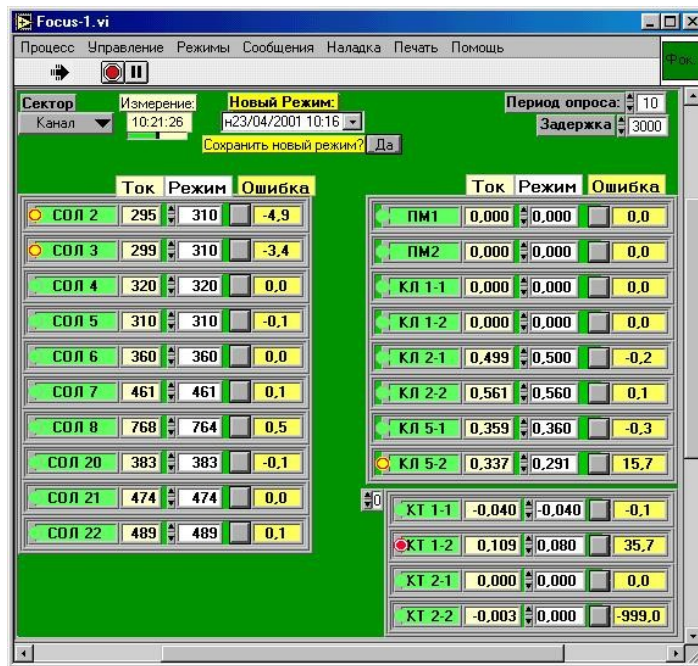


Fig. 3.

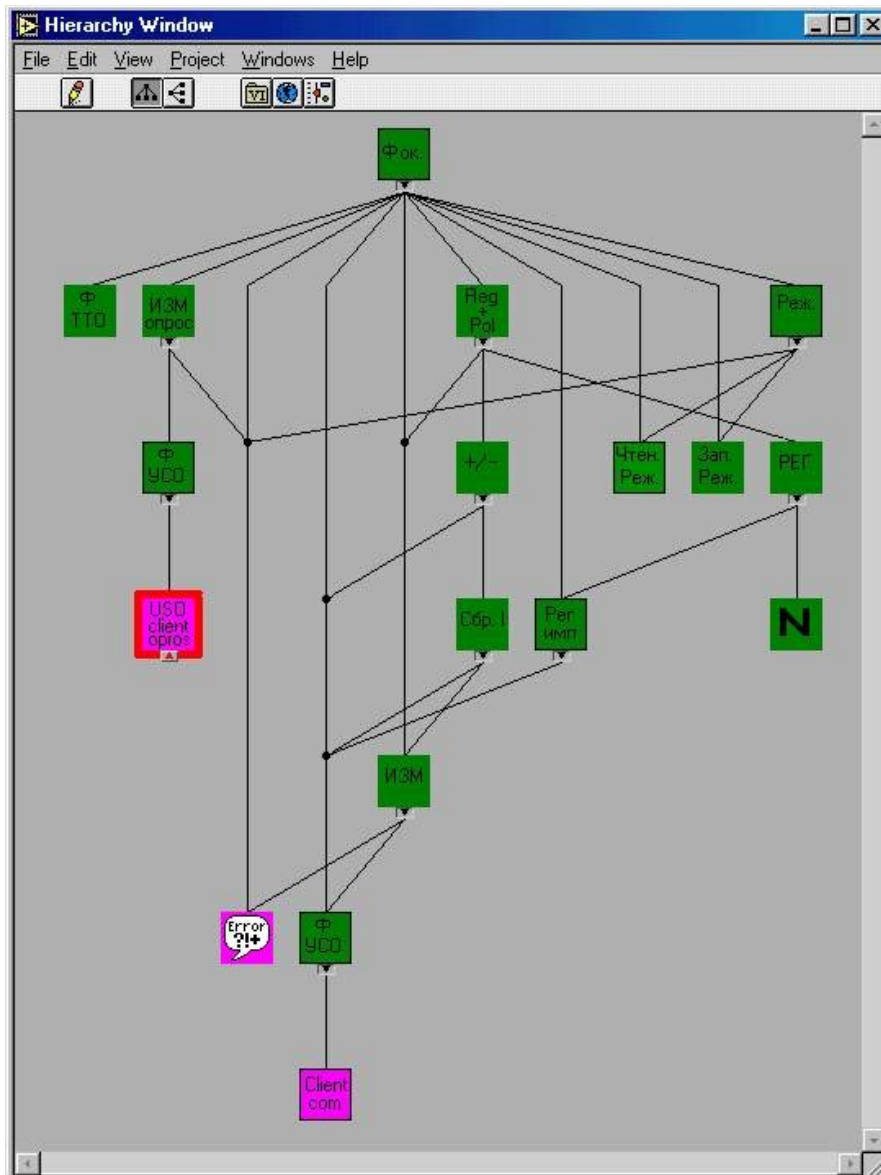


Fig. 4.



Fig. 5.

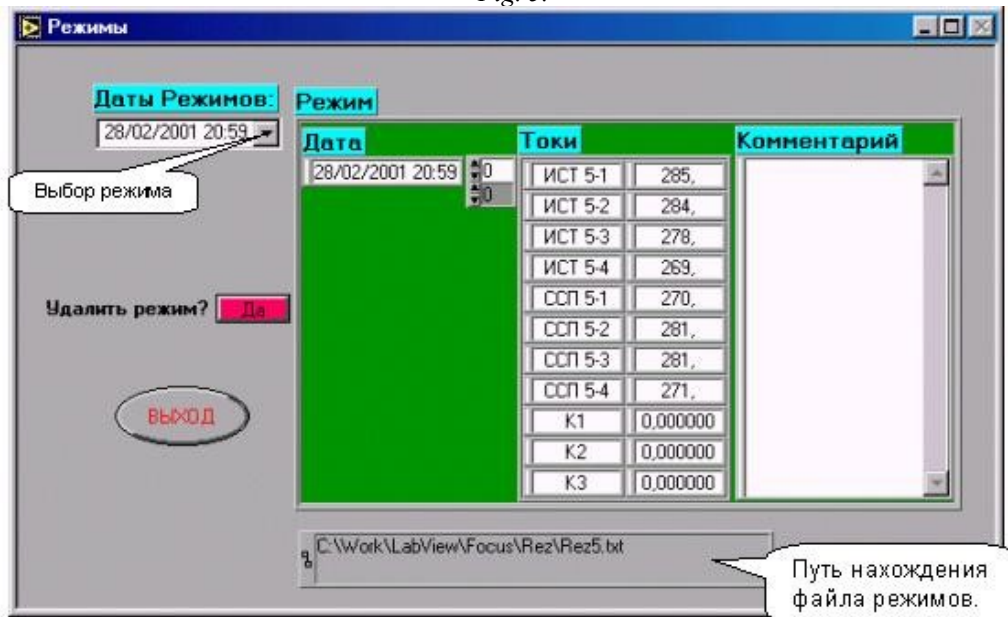


Fig. 6.

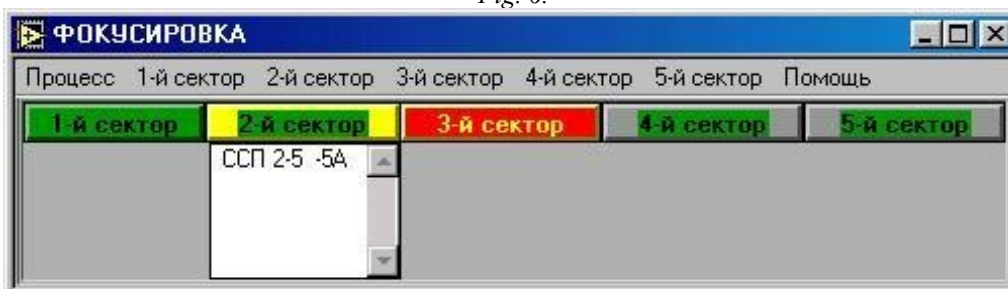


Fig. 7.