THE MMFL H$^-$ INJECTOR ION SOURCE CONTROL SYSTEM

E.S. Nikulin, V.P. Yakushev
INR RAS, Moscow, Russia
E-mail: nikulin@inr.ru

Technical solutions for the computer control system of the MMFL H$^-$ injector ion source are presented. The results are used for preliminary check tests of control system while monitoring the proton source parameters. Now the control of the parameters of the H$^-$ ion source power supply units and the beam characteristics is put into operation.

PACS: 41.75.Cn; 41.85.-p

Within the framework of construction of the H$^-$ injector a computer control system (CCS) project [1] has been developed using the National Instruments Corp (NI) modules.

The system is based on the LabVIEW software. The H$^-$ ion source (IS) control subsystems use a high-performance signal conditioning platform NI SCXI (Signal Conditioning eXtensions for Instrumentation).

The decisions for interference protection and power supply subsystems under high potential are structurally determined.

The workstation based on the P-IV/1800 processor provides the IS control and auxiliary technological systems (45 channels). The control of IS under high potential is realized using fiber optic cables. The basic IS parameters are operationally routed into the linac local network with carrying capacity of 100Mb/s. The protocol DataSocket and built-in Internet-server is used for the local network data transmission.

The main controlled IS devices are as follows: a discharge current generator; focusing and extracting voltage power supply; a magnet power supply and pulse valve units; caesium, cathode and anode heaters. The specialized code module (virtual instrument – VI) "Parameters of IS power supply.VI" has been developed for control of these units. The front panel (user interface) for this VI is shown in Fig.1.

Fig.1. "Parameters of IS power supply.VI" front panel

IS CCS is also intended for monitoring and control of measuring devices, complex of differential pumping and other auxiliary units. In Fig.2 the user interface of the code module for measurement of some basic and technological parameters of IS is shown. The code BlockDiagram of this VI is shown in Fig.4.

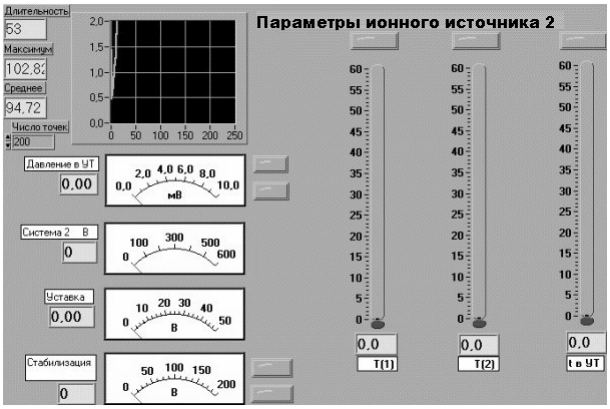

Fig.2. "Parameters of IS 2.VI" front panel

These model codes are hierarchical and modular VIs. They are used as independent applications (top-level programs) now. Further they will enter to the extended structure of CCS of the injector as virtual sub-instruments (subVI) according to the concept of modular programming accepted in LabVIEW. The hierarchical structure of the code is shown in Fig.3.

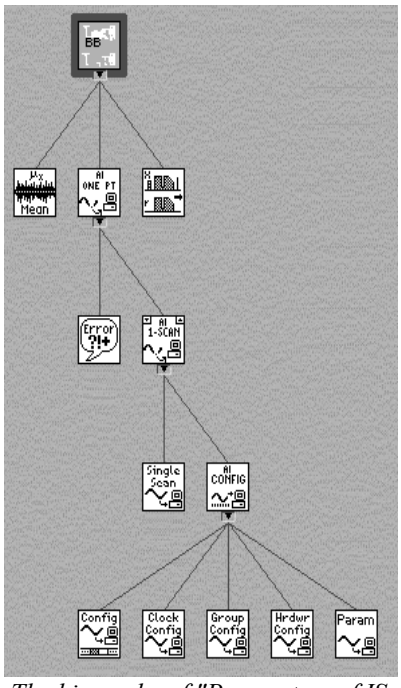

Fig.3. The hierarchy of "Parameters of IS power supply.VI"

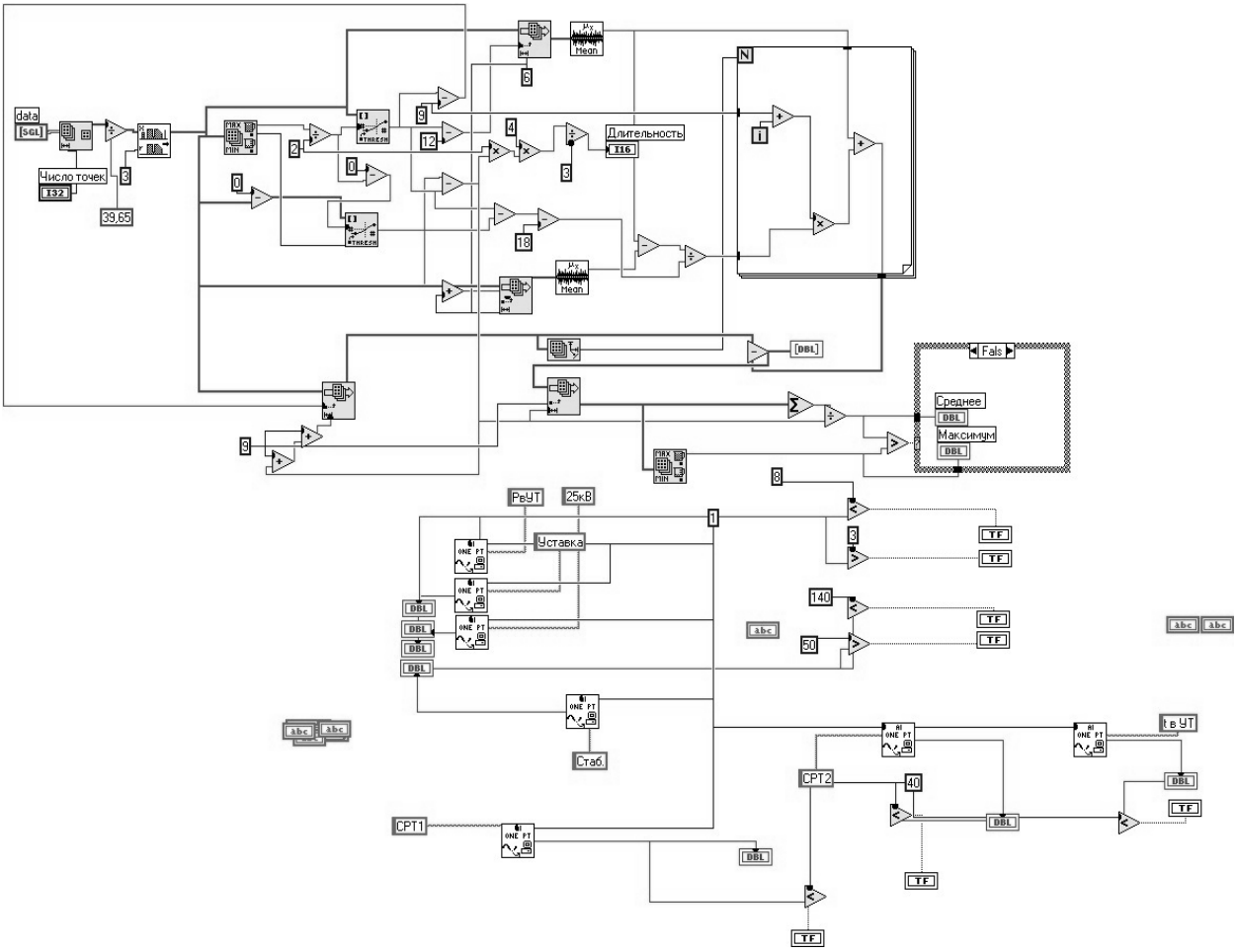

Fig.4. The block diagram of "Parameters of IS 2.VI"

The "Parameters of IS 2.VI" code previously has been adjusted and tested during operation of the proton injector. The tests results have appeared more than satisfying.

Model tests for the "Parameters of IS power supply.VI" code and the appropriate hardware with the use of data transmission optical cables have gone off successfully. The hardware located inside the IS shield is based on the SCXI-1001 microprocessor chassis [3]. The SCXI-bus transmits timer and trigger signals between modules in real time ensuring thus synchronization of operations. The SCXI chassis architecture allows scanning the input channels from several modules at rates up to 333 kS/s for every data acquisition device.

The modules, built-in in the chassis are:

- DAC NI SCXI-1124 – 6-channel isolated analog output conditioning module. It is a source for DC voltage (unipolar and bipolar) or current signals. Each output channel is independently optically isolated. So we can operate with up to 250 V_{rms} of common-mode voltage between any two channels or between any channel and earth ground.

- ADC NI SCXI-1140 – 8-channel simultaneous-sampling differential amplifier module. Each channel contains a high-input impedance instrumentation differential amplifier with switch-selectable gain followed by track-and-hold (T/H) amplifier. The T/H amplifiers track simultaneously, which is useful to preserving phase relationships between the channels.

- NI SCXI-1160 – 16-line general purpose electromechanical relay module. It offers 16 independent single-pole double-throw latching relays and switches up to 2 A at 250 V_{rms} or 30 VDC.

- two multifunctional devices NI SCXI-1200 [4]. There are 2×8 analog input and 2×2 analog output 12-bit channels, 2×24 TTL-compatible digital I/O and 2 counter/timer channels.

The analog transmission channels have a bandwidth of 1.6MHz. The accuracy of A/D and D/A conversions is ±0.025%. A proportion of the channels is reserved.

If necessary, it is possible to insert into the chassis up to six additional modules.

The SCXI system with the help of sampling-storage buffer device stores the information during the injector pulse (200 μs) and dumps it at the workstation during 10 ms before the beginning of the next pulse.

The SCXI-1001 microprocessor chassis is connected with the workstation RS232 port by fiber optic cables. Summary length of the cables is 600 m. As optic/RS232 modems the ROM-210 converters are applied [5]. The information is transmitted in both directions through the multiplexer and the SCXI-2400 connection module. The workstation RAM stores a previous injector operation history for the subsequent analysis. System dumps the accumulated information in archive periodically.

The SCXI chassis is in unfavorable operating conditions: on the one hand near there are IS powerful high-voltage pulsed devices and, on the other hand, a boosted

ionizing radiation. System stability and protection are provided at different levels with a particular circuit and constructive solutions set. Among them, except for the mentioned above fiber optics, it is possible to mark specially designed buffer devices. This ensures the signals normalization and coordination, channels protection against overloads and noise filtration at the system inputs. The chassis exterior shielding is used. The input/output module channels stand overloads up to 42 V on their inputs, and if equipped by terminal blocks – up to 250 V_{rms}. Also in special cases it is possible to use module channels with optical isolation. The uninterrupted power supplies (UPS) are applied for system viability maintenance in long-lived operation sessions and additional filtration from interference, which is induced in a power supply circuits.

REFERENCES

1. V.I. Derbilov et al. The computer control systems of H^+ and H^- injectors of the Moscow meson facility linac // *Problems of Atomic Science and Technology. Series: Nuclear Physics Investigations.* 2001, №5(39), p.128-130.
2. V.I. Derbilov et al. *Avtomatizirovannie sistemi upravleniya injektorov ionov H^+ i H^- lineinogo uskoritelya Moskovskoi mezonnoi fabriki*. Proc. of the XIV International Conference on Electrostatic Accelerator Beam Technology. 2002, Obninsk, p.249-255 (in Russian).
3. *The Measurement and Automation Catalog.* «National Instruments», 2002, p.445, 434, 428, 443.
4. *The Measurement and Automation Catalog.* «National Instruments», 2000, p.389.
5. http: // www.nnz-ipc.ru

АСУ ИОННОГО ИСТОЧНИКА ИНЖЕКТОРА H^- ЛУ ММФ

Е.С.Никулин, В.П.Якушев

Рассматриваются технические решения АСУ источника ионов H^- инжектора линейного ускорителя Московской мезонной фабрики. К настоящему времени введена в действие система контроля, управления и измерения параметров узлов системы питания источника ионов и характеристик пучка, частично – параметров технологических систем источника ионов. Использованы результаты первых контрольных испытаний АСУ в процессе мониторинга источника протонов.

АСУ ІОННОГО ДЖЕРЕЛА ІНЖЕКТОРА H^- ЛУ ММФ

Е.С.Нікулін, В.П.Якушев

Розглядаються технічні рішення АСК джерела іонів H^- інжектора лінійного прискорювача Московської мезонної фабрики. До теперішнього часу уведена в дію система контролю, керування й виміру параметрів вузлів системи живлення джерела іонів і характеристик пучка, частково – параметрів технологічних систем джерела іонів. Використано результати перших контрольних випробувань АСК в процесі моніторингу джерела протонів