

CONTROL SYSTEM USER INTERFACE FOR THE CYCLOTRON DC-280

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Abstract

At the end of 2018 new isochronous cyclotron DC-280 will be put into operation at the FLNR, JINR. The distributed control system consists of about 10000 process variables and has developed using LabVIEW DSC module. Based on our experience of many similar projects it was developed the technology to build interface for effective operation and control of the machine. This paper describes basic principles and functions that we applied for user interface.

INTRODUCTION

To simplify design and ease of maintenance the control system was divided into three subsystems: **Injection** (ECR source, axial injector), **Accelerator** (cyclotron, extraction, transport) and **Low level RF**. Each of them describes certain tasks. They are simply as follow: produce, inject, accelerate, extract and transport the beam to the target. The distribution of tasks between several computers gives fast response and allows debugging and running the subsystems independently of each other.

Every subsystem has unique human to machine interface (HMI) that can be executed on any project node.

TECHNOLOGY

All control signals are described by process variables. The variables of each subsystem are deployed on a dedicated host. LabVIEW provides fast and reliable data transmission for large and small applications, called Publish-Subscribe Protocol (PSP). It manages **shared variables** (See Fig. 1) that publish data over a network through a software component called the Shared Variable Engine (SVE).

INTERFACE LAYOUT

The user interface screen is divided into several functional areas (See Fig. 2). The top part contains information about the name of the accelerator, the version of the program, general parameters and the date and time. The central part of the screen is occupied by the front panel, which is divided into two main parts: a smaller left and a large right one, each of which has several tabs. Switch between tabs by using the buttons on the left side of the user interface screen. They switch the tab or combination of tabs of several panels. When the object under the mouse cursor next to it pops up a line with the name of the operating variable and the context information window that located at the bottom of the screen displays the name of the control and the path to the associated hardware variable. The lower part of the screen is reserved for system events and alarms.

Each control object image is represented in accordance with the actual device. The state of the object is displayed

by color: black means that the device is off, green that it is on, grey means the device goes from one state to another and red indicates an alarm. And in some cases object state is displayed by shape of the its image. The user interface was developed taking into account the possibility of using a computer with two screens and works regardless of the position of the program window.

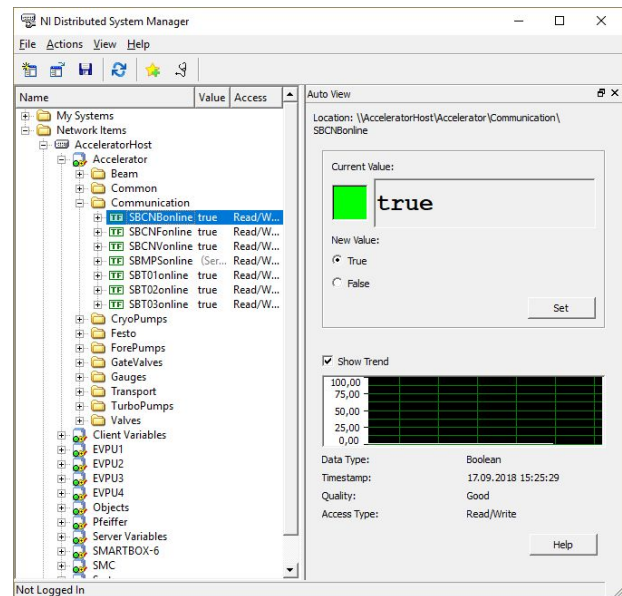


Figure 1: Shared variables.

To exchange data on the network HMI uses shared variables. All user interfaces are clients or subscribers to the SVE [1,2].

TOOLTIPS

For safety reason the interlocking system has a lot of signals blocking the operation of object. To simplify troubleshooting and identifying the causes of malfunctioning of the device, operator can view the list of all interlocks using the context menu on the selected object. Popup window that appears next to the object provides information about all interlocks that can affect the operation of the object. It contains information about the name of the interlock and the path to it. The triggered interlocks are indicates by red color (See Fig. 3). The number of popup windows is unlimited and there is a possibility to move them on the screen of the interface. When a driver loses connection to its device, all controls and indicators that represent this device become disabled and its image greyed out (See Fig. 4).

To quickly launch all control system software, a Program Manager was developed. With its help, operator can run and stop the entire software package with just one click.

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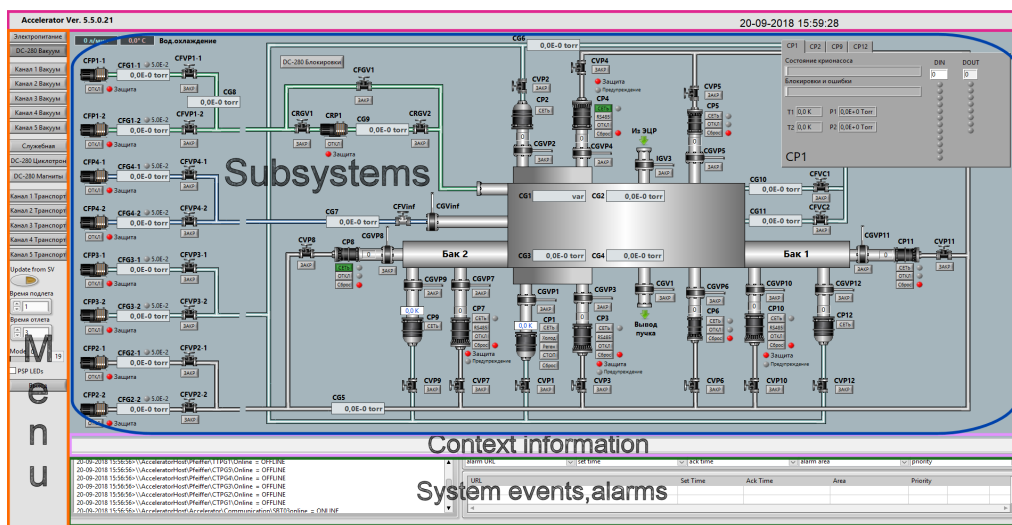


Figure 2: The user interface layout.

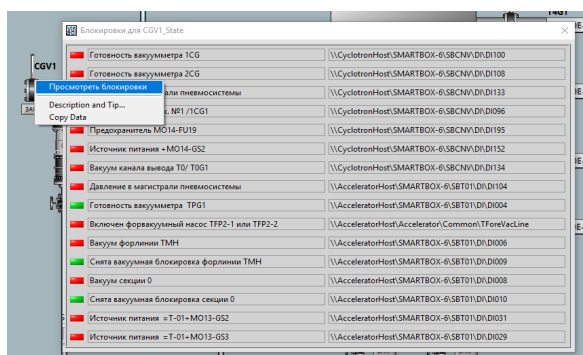


Figure 3: Popup window with the list of interlocks.

If the operator position mouse cursor over an object, the context string displays actual values of raw variables on which that object depends, for example, ADC code.

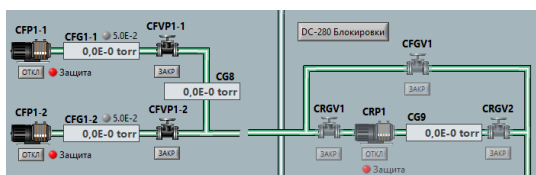


Figure 4: Online and offline states of objects.

CONCLUSION

The control system of DC-280 cyclotron is already in operation and is used in commissioning of the cyclotron. The user interface window can be viewed in the monitoring mode from anywhere in the world.

In addition to the standard services offered by the user interface for the operator (visualization of the control process, printing of reports, alarms, etc.) we have implemented useful functions for servicing and repairing the system in the event of a malfunction.

These functions were obtained thanks to our experience in the development of visualization programs for control systems of operated cyclotrons. They greatly simplify the work of engineers to find and eliminate any hardware problems.

REFERENCES

- [1] National Instruments. *Network Variable Technical Overview*, <http://www.ni.com/white-paper/5484/en/>.
- [2] V. Aleinikov, I. Borina, A. Krylov, S. Pachtchenko, K. Sychev, "Using LABVIEW to build distributed control system of a particle accelerator." ICALEPCS 2017. Barcelona, Spain.