VACUUM AUTOMATIC CONTROL SYSTEM (ACS) FOR NICA PROJECT

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Abstract

Upgrade of the Nuclotron [1] is the first step in the Nuclotron-based Ion Collider fAcility [2] project. A modernization of the Nuclotron vacuum system leads to decreasing of the heavy ion losses due to scattering on the rest gas. The successful realization of the modernization takes possibility to use Nuclotron as a part of NICA project. It's impossible to image the modern vacuum system without the automation control system (ACS). The goal of ACS at Nuclotron is to manage about 70 units of the vacuum system and the data acquisition.

VACUUM SYSTEM MODERNIZATION

Modernization of the Nuclotron high vacuum system had the aim to increase the beam lifetime which is the necessary condition for the using of Nuclotron for the NICA project. For this work it was chosen non-oil pumps such as ion pump, turbo pump and forvacuum pump "Pfeiffer Vacuum" company (Figure 1). It allowed to reach the pressure about 10^{-10} Torr. Mass-spectrometer PrismaPlus were installed to rest gas composition definition.

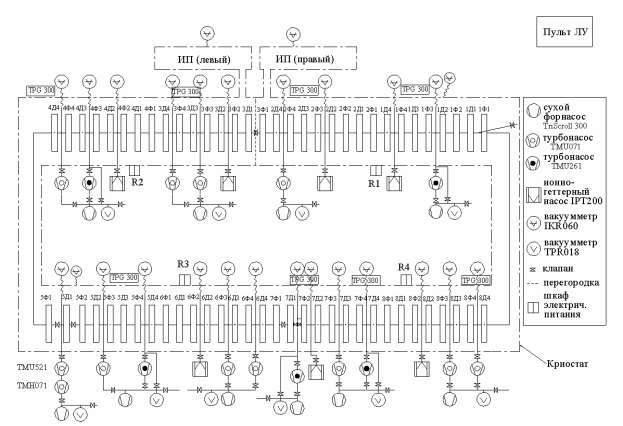

Figure 1. The scheme of the Nuclotron high vacuum system.

First step of the modernization includes the mounting of new turbo pumps. It permits to decrease a vacuum pressure about ten times. Problem vacuum parts also were reconstructed, measurement units were added.

Second step includes the installation of the tandem with two turbo pumps at each parts of the ring (22 points) and scrappers which are used for the lost ions absorption.

THE CONTROL SYSTEM FOR THE VACUUM OPERATION

Structure

ACS system consists of two main parts:

- Master controller (PLC), touch-panel and PC in the control room;
- Four Racks in the center of Nuclotron and units at the experimental hall.

PLC (Figure 2) works at the main controller and defines system logic. RS485 protocol is used for communication between units.

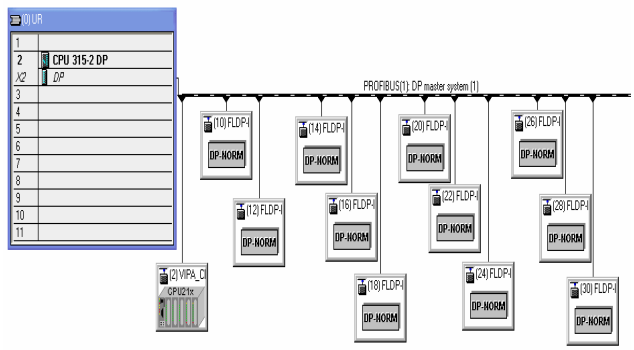

Figure 2. PLC controller with Profibus protocol.

The touch-panel (Figure 3) is placed on the central rack, creates visual interface for vacuum system components and hand mode provides.

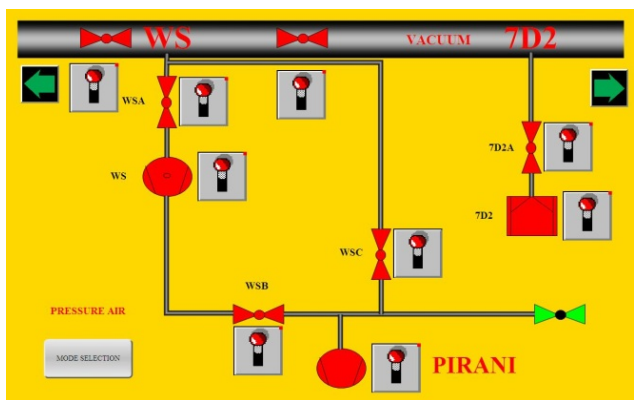

Figure 3. Touch-panel of control system.

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ISBN 978-3-95450-125-0

PC allows to display vacuum units parameters like speed, current and vacuum values (Figure 4). The program creates graphics and collects information in the database.

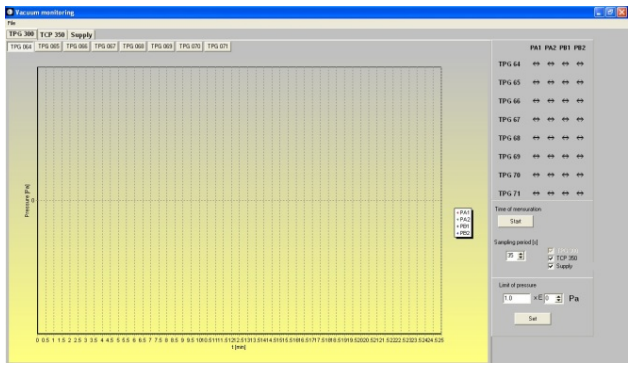

Figure 4. Window of the vacuum monitoring program.

Control and Operation

ACS has 3 modes:

Ad 1 –this mode is for the manual control of all elements;

Ad 2 – this mode correspond to the required automatic mode. If the current running operation is indicated then the local position of this operation is indicated too (e.g. forvacuum pumping in the section 2D4);

Ad 3 – this mode of the operation defines the hardware components (stages) which are used (it enables/disables several posts identified by their position).

The parameters of TPG300 (Pfeiffer Vacuum company) are monitored by means of the RS485 interface. All TPG300 devices are equipped with the Data convertor (FOTON company). This data convertor has a form of a small-case electronic device which converts not only the electric level of IO signals, but it also establishes the Pfeiffer Vacuum Protocol. Thus, in spite of the original RS232 interface of TPG300 (point-to-point communication only), these convertors make the TPG 300 Pfeiffer Vacuum Protocol compatible. The alarm signals are connected directly to IO modules inside the racks. The data are monitored via RS485 interface.

The PC handles the line of TCP350 and power supplies for ion pumps and the line of TPG300. Each device is identified by its address. The data are presented in the graphs (max and actual rotation and the pump current for the turbo pumps, the pressure of gauges for the TPG300. Moreover, the progress of the pressure is simply summarized and presented in the table form (see right part of the screen). The colours indicate the pressure trends: green = the pressure becomes lower, yellow = the pressure becomes higher, red = the pressure is higher than the preset threshold. These limits are simply preset; the scan period is also modifiable (sampling period).

The measurement starts after <START> button is pressed. The data are stored in the separated files; the filenames contain the data and time of starting measurement. Each file has the same structure: 1st row is the head, following lines represent the measured data. All the information is in ASCII-character forms and separated by <;> sign. Thus, the work with datafile outside the ACS is simple (Excel etc.).

Blocking and Protection

Summary of blocking events :

- All gate valves are closing in case of emergency signal coming from any IKR gauges; also malfunction or switch-off of TPG300 instrument causes closing of all gate valves;
- Each gate valve cannot be opened if the corresponding turbo pump is not running;
- The gate valve can be opened in the case of the running of the corresponding turbo pump (for ESS – higher pump) and
  - the good high vacuum inside chamber, or
  - the key-operated switch on ASU is in the Pos I, i.e. left (=High Vacuum Disabled Mode);
- The gate valves B1WS and B2WS are not blocked through the turbo pumps;
- Turbo pump can start if the forvacuum valve is opened;
- The forvacuum valve can be opened if the corresponding forvacuum pressure is good (Pirani signal);
- All gate valves are closing in case of decreasing of air pressure in pneumatic system;
- Low forvacuum (higher pressure) implies closing of corresponding gate valve;
- Key –operated switch on ASU = selection of protection mode (Table 1).

Table 1: Protection modes of ASC

Pos 0 (central) *Standard Mode*	*Pos I (left)* *High Vacuum Disabled Mode*	*Pos II (right)* *No Protection Mode*
All protection is applied, including high vacuum check	The protection through the high vacuum detection inside the chamber is blocked. This mode is needed if the manual control of chamber-valves is required, it must be operated with qualified persons only. The risk of damages!	No protection is implemented. This mode is useful for extraordinary situation and must be operated with qualified persons only. The risk of damages!

ISBN 978-3-95450-125-0

Indications

- The state of the high vacuum is indicated on the touch panel by means of the colour of the word VACUUM located in the picture of chamber tube (usually top-left position on the screens):
  - green VACUUM ..... low pressure = good high vacuum inside the chamber;
  - red VACUUM ..... higher pressure = bad high vacuum inside the chamber; alarm signal from any gauges IKR implies this red stage;
- The state of the vacuum inside the chamber (see above) is forwarded to the main control room through DWDT relay contacts:
  - Closed contacts ..... good high vacuum;
  - Open contacts ..... bad high vacuum;
- The event of the bad high vacuum signal is latched and indicated by means of the yellow indicator on the front panel on ASU; this alarm signal can be reset only manually by pushing the black button on the front panel of ASU (if the vacuum is good inside the chamber);
- The state of the forvacuum (primary vacuum) is indicated by means of the colour of PIRANI word located in the picture near the forvacuum pump (bottom position):
  - green PIRANI ..... low pressure = good forvacuum;
  - red PIRANI ..... higher pressure = bad forvacuum.

Software

The system is under the control of three software packages :

- PLC software. This is the standard PLC program written in STL form of Siemens STEP7 language;
- Touch panel software. This is the application build up in the ZenOn Editor 6.21 (COPA-DATA GmbH);
- PC program. This is the Delphi based PC application.

REFERENCES

[1] A.Sidorin, G.Trubnikov, V.Kekelidze, et.al. Status of the Nuclotron. These proceedings.
[2] I.Meshkov. NICA Project at JINR. These proceedings.

ISBN 978-3-95450-125-0