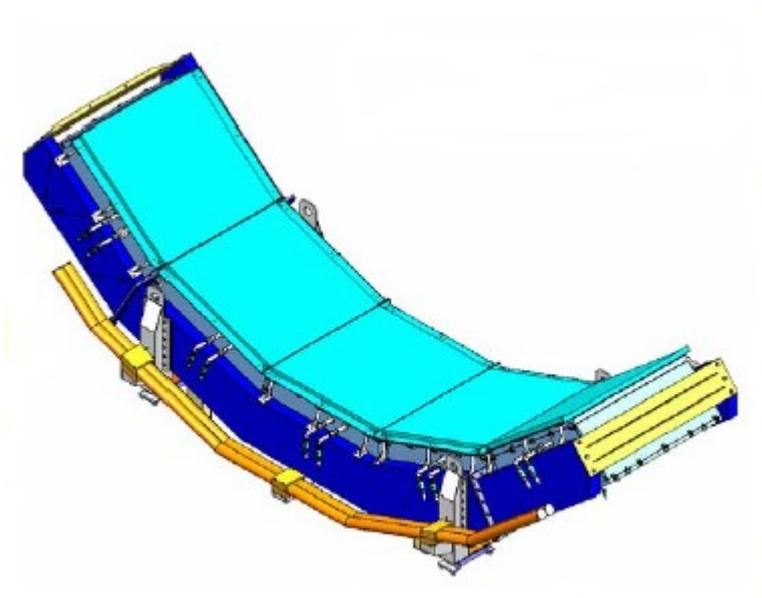




PHOS Detector Control System



Alexander Mamonov

Russian Federal Nuclear Center
All-Russia Scientific Research Institute of Experimental Physics
NRRI – Nuclear and Radiation Research Institute
2007

Table of contents

1 What is a system of slow control	3
2 Devices controlled by PHOS DCS	4
3 How to start and stop DCS system.....	6
3.1 Start of DCS system.....	6
3.2 Stop of DCS system.....	12
4 User interface of PHOS DCS	13
5 How the system works.....	20
5.1 System of finite states - Finite State Machine	20
5.2 Hierarchy of control system of PHOS detector.....	22
5.3 System of states and transitions of PHOS detector supply level.....	23
5.3.1 The circuit of states and transitions of the power supply crate.....	23
5.3.2 The circuit of states and transitions of the power supply channel.....	24
5.3.3 The circuit of states and transitions of control levels WIENER1 and WIENER2	26
5.3.4 The circuit of states and transitions of control level HV MODULE 1	27
5.3.5 The circuit of states and transitions of control levels LOW_VOLTAGE, HIGH_VOLTAGE	28
5.3.6 The circuit of states and transitions of control level POWER_SYSTEM	29
5.4 System of states and transitions of level MODULE 1 of PHOS detector.....	31
5.4.1 System of states and transitions of control level FEE	31
5.4.2 System of states and transitions of control level LED	32
5.4.3 System of states and transitions of control level MODULE 1	33
5.5 System of states and transitions of a PHOS detector level of crystal matrix cooling.....	34
5.6 System of states and transitions of the top level of PHOS detector.....	36
5.7 Integration of PHOS detector DCS system to ALICE experiment.....	38
5.8 Interlocks	39
5.9 Change of the rights of users	40
6 If something does not work... ..	42

1 What is a system of slow control

A detector control system (DCS) is created to automate PHOS detector control and is a part of DCS system of ALICE experiment, it allows to operate subsystems of detectors and react to arising mistakes, making it possible to avoid critical states of devices. Software of system engineering DCS includes a commercial system of control and data acquisition PVSS-2 of Austrian firm ETM and a superstructure JCOP Framework realized on its base and executed by CERN programmers. The system uses a principle of finite states (Finite State Machine) for synchronous PHOS detector control. The concept, consisting in the fact that any system can be broken into a quantity of states (States), the transition between them being strictly fixed and realized with the aid of strictly specified set of actions (Actions), form the basis of a principle of finite states.

2 Devices controlled by PHOS DCS

Into the list of devices comprised in a system of slow control (DCS - Detector Control System) of PHOS detector there are included:

1. Low-voltage power sources of WIENER PL512 mark;



Figure 1 - Low-voltage power sources WIENER PL512

2. Low-voltage power source WIENER VME UEP 6021;



Figure 2 - Low-voltage power source WIENER VME

3. High-voltage power source ISEG ECH 238-UPS as well as modules ISEG EHQ 8605p-F;



Figure 3 - High-voltage power source ISEG with 2 established modules

4. System of PHOS module matrix cooling.



Figure 4 - System of cooling a matrix of PHOS detector crystals

5. System of monitoring spectrometer channels on the basis of light-emitting diodes LED.
6. System of PHOS detector electronics consisting of RCU and FEE boards.

3 How to start and stop DCS system

3.1 Start of DCS system

Before start of project PVSS it is necessary to be convinced in the fact that all power devices of the detector are switched on (the crates are switched on). If necessary switch them on.

Switch-on of low-voltage crates WIENER PL512 can be realized only in a manual mode. For this purpose it is necessary to press the power supply button in the left top part of the crate front panel (figure 5).

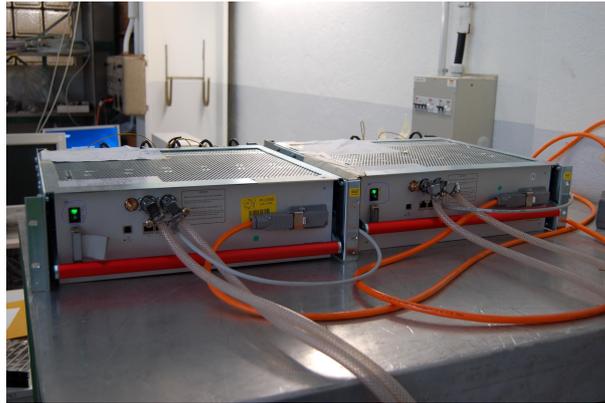


Figure 5 - The switched on low-voltage power sources WIENER

The switch-on of low-voltage crate WINER VME can be carried out only in a manual mode. For this purpose it is necessary to press the power-supply button in the left top part of the crate back panel (figure 6).

The requirement of controlling serviceability of the system of power supplies water cooling is obligatory for devices of WIENER mark (WIENER PL512 and WIENER VME). The temperature of water should be kept at such level that the temperature of the switched on power-supply channel is higher than 15°C, but lower than 70°C. Before the beginning of work it is necessary to check whether water delivery through sources is regular.



Figure 6 – Switched on low-voltage source WIENER VME

The switch-on of high-voltage crate ISEG can be carried out both in manual, and in an automatic mode. Before the beginning of work one should manually press the power supply

button in the right part of the crate front panel for correct start of an OPC-server of the device (figure 7).



Figure 7 – Switched on high-voltage source ISEG

In case of independent work before starting the system on a computer with a name pcvniief-dcs one should open DNS file which is in the root catalogue of the project (by default - D:\Users\Mamonov\Projects\Phos_PowerSupply_fwComponent\bin\DNS.exe).

After integration of the system of PHOS detector slow control into ALICE experiment the start of DNS file will not be required.

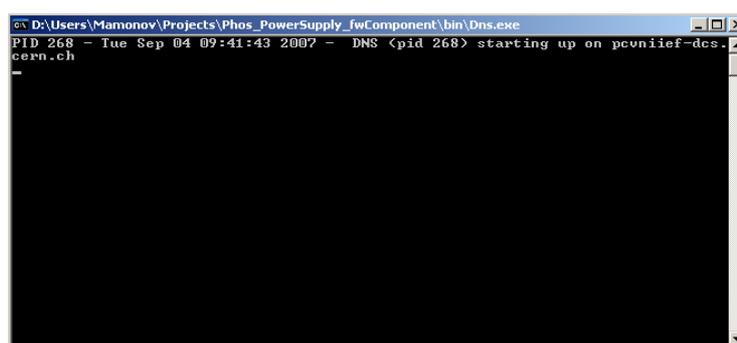


Figure 8 - DNS start

To receive the opportunity of operating ISEG device it is necessary to start manually its OPC-server (by default - Start\Programs\isegOPC\isegHVOPCServer). In case of successful start the user should see a window similar to figure 9. If the issued messages differ from those shown on the figure, it is necessary to check up whether the ISEG crate is switched on.

In case of problems with the source OPC-server start it is necessary to close ISEG OPC window to switch off ISEG device and repeat procedure of switch-on.

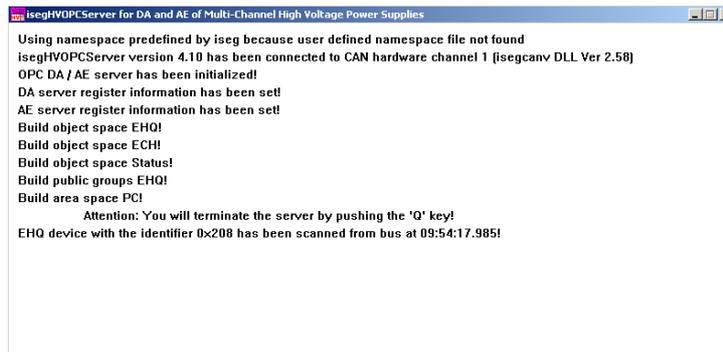


Figure 9 - Successful start of OPC-server ISEG

OPC-servers of Wiener mark devices are started automatically.

To start PVSS project it is necessary to start manually PVSS Control Panel (by default - Start\Programs\ETM PVSS II 3.6\PVSS II Console). In the opened window one should choose Phos_PowerSupply project and press the button of a green light signal for start (in the right top part of panel PVSS II Console).

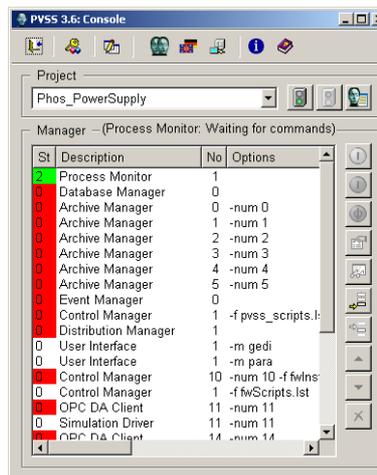


Figure 10 - Start of PVSS project

If all is made correctly the start of processes will begin and depending on a condition their color will change (green - successfully started, red - stopped). So, in figure 10 only the process responsible for PVSS Console display is started.

The detailed information on the PVSS system working process can always be received in automatically opening window PVSS Log Viewer.

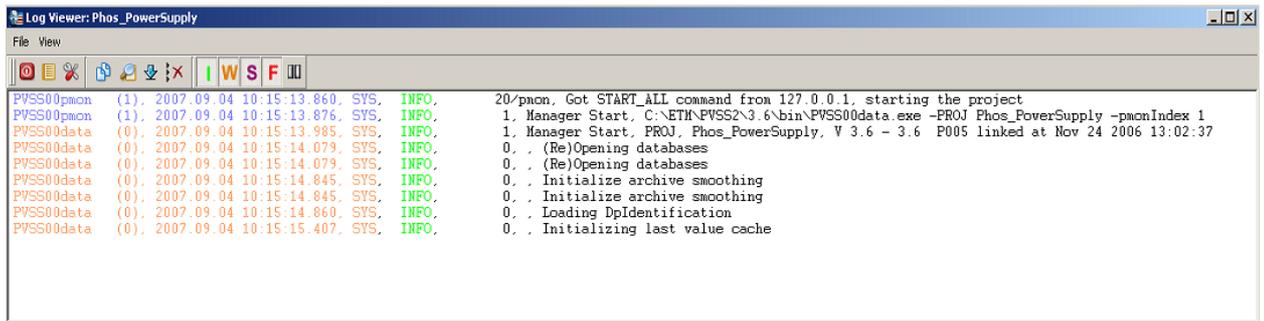


Figure 11 - PVSS Log Viewer

One of automatically opened windows is the window named as Device Editor & Navigator. It is required to check up in it the connection with a control system of crystal matrix cooling. If the connection is established, system dist_5 should be displayed on Hardware outlay of Device Editor & Navigator window.

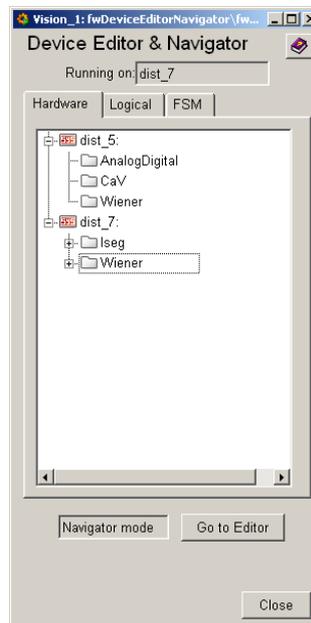


Figure 12 - Device Editor & Navigator, list of subsystems connected

If only dist_7 is present in the list of systems, it is necessary to restart the window having pressed button Close on panel Device Editor & Navigator. The new window will be started automatically right after the current one is closed. If in the list of systems of the new window there will be no system dist_5, the system PHOS_CoolingSystem 36 should be started on the pcvniief-dcs2 computer manually.

After the PHOS_PowerSupply project start one should make sure if the PHOS_CoolingSystem36 project is started on pcvniief-dcs2 computer. If necessary one is to start it having opened PVSS Control Panel (by default - Start\Programs\ETM PVSS II 3.6\PVSS II Console) and having pressed the green light signal button.

To establish connection with a control system of refrigerating machine in an automatically opened window PVSS DIM Client, one is to choose inlay Edit, press DIM Manager button and select DIM Manager in the appeared list. The configuration of connection

with CRW-DAQ is called DimDemoConfig. It should also be selected on the corresponding panel near the DIM Manager button. As a result there should appear the window as in figure 13. Having pressed the Start button the user arranges connection with the system of PHOS detector cooling.

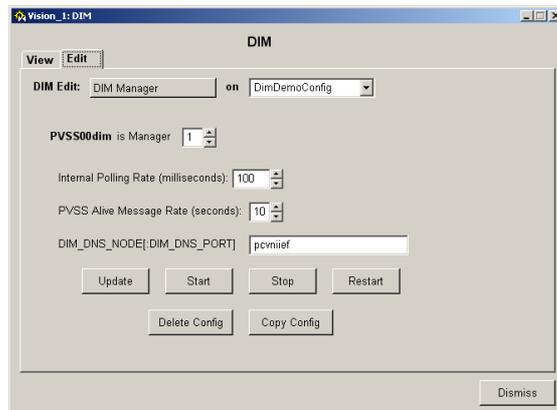


Figure 13 - DIM-client of PVSS

After successful start of subsystems and receipt of connection between them it is necessary to start the system of final states FSM on each of computers, having pressed button Start/Restart All in FSM inlay, Navigator mode of Device Editor & Navigator panel.

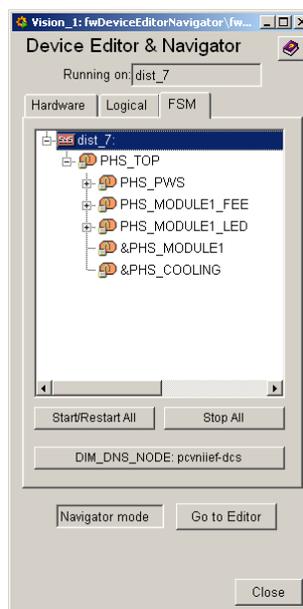


Figure 14 - Device Editor & Navigator, FSM stop

The start of the system of final conditions FSM can also be implemented (at presence of the rights of developer) from the basic user interface (figure 23).

In case of FEE of cards (maps) from PVSS program is supposed, it is necessary to start Phos_FEE project on computer aldc028 from the basic panel of PVSS Console.

Before the beginning of work on a computer alphspcdcs01 there should be started the InterComLayerPHOS.sh script in the following way:

InterComLayerPHOS.sh start - start of process
InterComLayerPHOS.sh stop - stop of process
InterComLayerPHOS.sh restart – restart of process
InterComLayerPHOS.sh status - check of the current status of process

At starting the project there should be selected in window DIM Client the PHOSDIMTEST configuration and pressed the Start in DIM Manager button (similarly to figure 13). In Device Editor & Navigator window, FSM inlay, Navigator mode, one should press button Start/Restart All to start FSM of the project.

On the basic machine pcvniiefdc there should be also checked up the connection to the system. To realize it one can turn to Device Editor & Navigator (figure 14), Hardware inlay. If systems are connected successfully, there should appear in the list the system with a name dist_2 (similarly to figure 12).

3.2 Stop of DCS system

To stop the project it is necessary to open Device Editor & Navigator window (figure 14), choose FSM inlay, Navigator mode, and press the Stop All button to stop FSM of the project (or at presence of the rights of the developer the user is to press STOP ALL from a window represented in figure 23).

Then, it is necessary to press the red light signal button in PVSS Control Panel (see figure 10) to close windows DNS.exe and OPC-server ISEG, switch off all power supplies by pressing the button of power supply switch-off on the panel of each device (by analogy to switch-on, see above) disconnect water delivery to cool WIENER devices.

PVSS project of PHOS_CoolingSystem36 can be left in working condition. In case its stop is necessary one should undertake similar steps on a computer controlling the system of cooling pcvnieef-dcs2.

The Phos_FEE project (if it has been started) can be left in working condition. In case its stop is necessary one should undertake similar steps on a computer controlling the system of cooling aldc028.

4 User interface of PHOS DCS

After the beginning of project PVSS and successful start of all processes on basic computer PHOS DCS with a name pcvniief-dcs the primary user window ALICE User Interface (figure 16) will be opened. Before the input to the system it is necessary to be authorized by entering the name and password in the corresponding window.



Figure 15 - Authorization of users

If one is a registered user of ALICE there will be opened the following window (more detailed information on the change of the user rights is available in section 5.9).

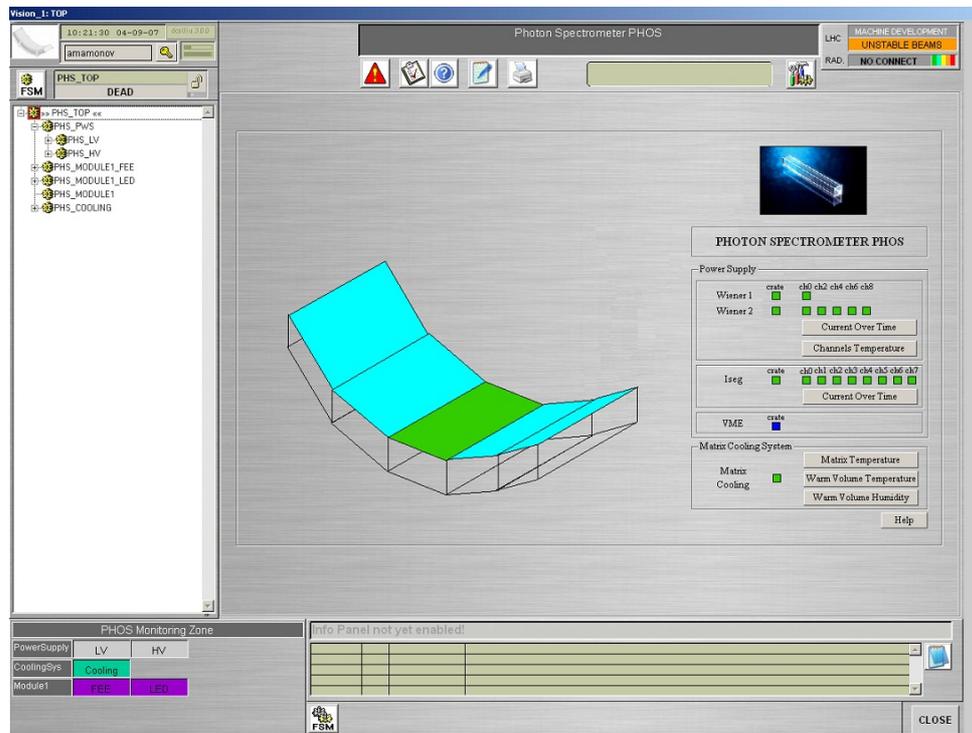


Figure 16 - Primary window of PHOS DCS system

The appeared window is the primary user window of DCS system (project PHOS). Besides system control buttons it contains indicators of all detector basic subsystems states.

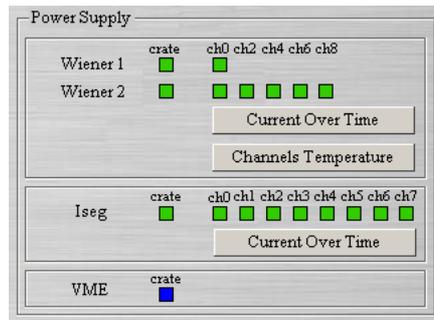


Figure 17 - Indicators of power supply system states of PHOS detector

Each color means a certain state of the device. So dark blue speaks for the fact that the system is not ready, switched off or is in a state of expectation. Yellow - the system is in an intermediate state at which, for example, there can be either growth of voltage on high-voltage source ISEG or cooling of PHOS module. Orange - no connection with one of devices is available. Green color - the system is ready to work. Red – error or incorrect operation of the device or system of devices. On the master panel there is available button Help by pressing which one can always get an instruction on what each color means.

Except for indicators of states there are available on the user's master panel the buttons after pressing which one can get the time schedule of the required value dependence on time. For example, figure 18 shows the schedule of temperature dependence in the detector « warm volume » on time for the last 8 hours (button Warm Volume Temperature).

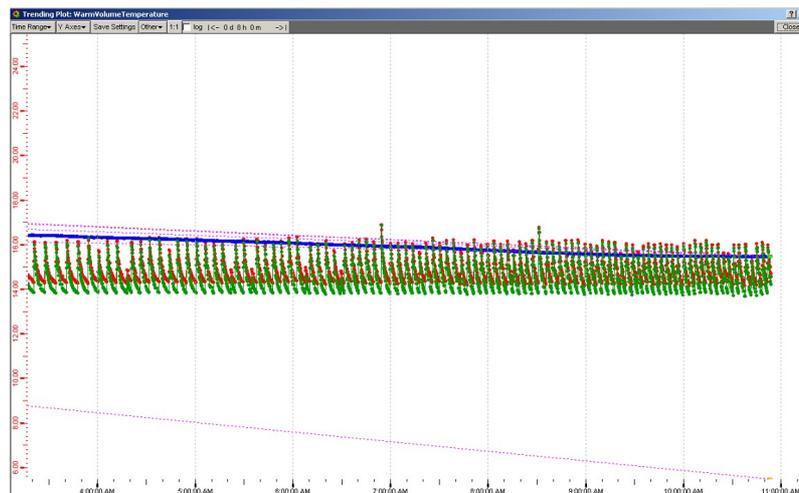


Figure 18 - The plot of temperature dependence in « warm volume » on time

To change the displayed time interval on axis x one should press button Time Range in a bar of the plot interface and select a new mode. There is an opportunity to examine the schedule for the last 10 minutes, 1 hour, 8 hours, 1 or 10 last days. There exists as well the opportunity itself to select time interval yourself (button User specified). By rotating a wheel of a mouse one can increase or reduce scale of the current plot.

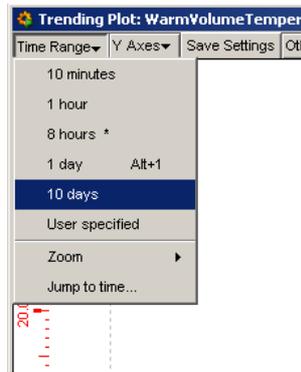


Figure 19 – Selection of time interval of the plot

One should realize the fact that the archiving of the obtained data occurs only when the project PVSS is started. The plots of the required values dependence on time serve only to monitor the current state of the system.

In the left top part of the user window there is a control panel FSM and the panel of the current user as well (figure 20). Having pressed the name of the system authorized user by right button one can replace his password, escape the mode of the current user or change his rights (the last action can only be performed if the system developer rights are available, more detailed information can be found in section 5.9).

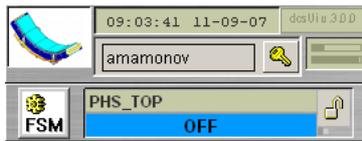


Figure 20 - Control panel FSM

Besides control panel FSM in the left part of the user interface there is a panel displaying a hierarchical tree of subsystems included in the project.

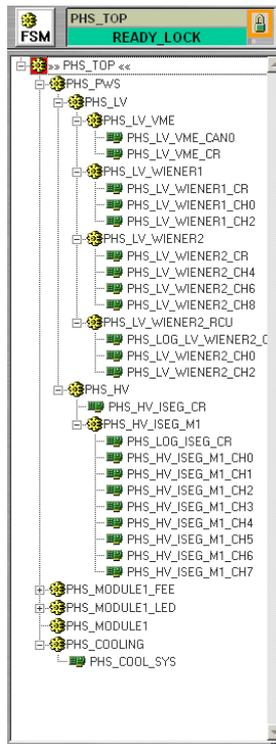


Figure 21 - The hierarchical tree of PHOS subsystems

By using the left button of the mouse one can open the subsystem of interest and to examine the list of devices included in it. Pressing by the right button of the mouse on the certain device one can get its user window.

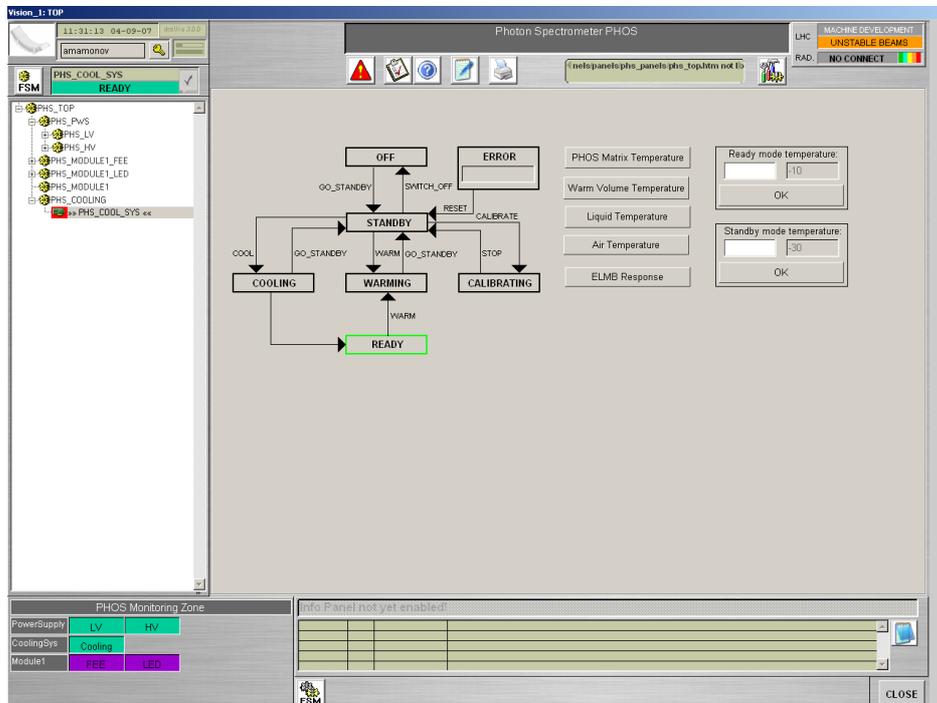


Figure 22 - User window of the system of crystals matrix cooling

Users who have status of developer have an opportunity to start and stop system DCS of the PHOS project. For these purposes there is a FSM button in the bottom part of the user interface primary window.

Figure 23 presents the window to control the DCS system including buttons Start/Restart All and Stop All allowing to start / restart or stop system. The system start and stop covers from 10 seconds to one minute. Besides there is an opportunity to observe from the given window the state of DNS, to change parameters of the received data archiving, to start the applications making it possible to receive a tree of current subsystems and to trace the change of selected devices states (it is not realized yet).



Figure 23 - Control Window of system PHOS DCS

After the system start the users who have the status of the operator and higher can start and a stop various subsystems of the detector. In figure 24 the window of control is represented by FSM system. One can get access to it by pressing FSM button on control panel available in figure 20.

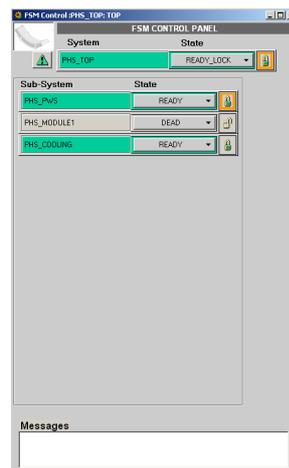


Figure 24-Control Window of system PHOS FSM

To get control over the system one should press a badge of the lock near the PHS_TOP level and take control upon oneself. At getting control over system the panel will change color according to the current state of the level (see the description of indicator colors of power supply system states).



Figure 25 – Getting of control over the system

It should be noted that if someone has already got control over the system it is impossible to intercept him. Control can be "kept" either a user at ALICE level or another user of PHOS (such situation is probable when the user "has not returned" control to the system at the termination of the session).

In case when it is of crucial importance to get control over the system one can restart system from a window of PHOS DCS system control (figure 23) if he has the rights of developer.

There is an opportunity of operative monitoring over the basic subsystems of the detector from primary user window of PHOS DCS.

PHOS Monitoring Zone		
PowerSupply	LV	HV
CoolingSys	Cooling	
Module1	FEE	LED

Figure 26 - Monitoring of PHOS DCS system

By pressing each subsystem one can immediately get its user window. Moreover, the color of each zone speaks on the current state of the subsystem. Colors of states fully comply with colors of indicators. Violet color means that there is no connection with the system (probably, the project on the other machine it is not started), grey – the FSM system is not started or the user has not taken control on himself.

In the top part of the user interface there is a panel from which the access to Alarm Panel is possible, where there are instructions on work with system as well as the timeout keys of the current window and options (not realized yet).

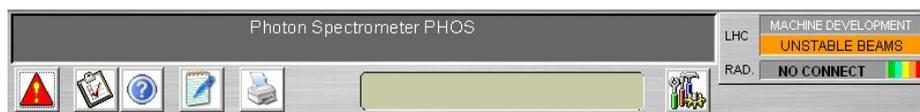


Figure 27 - User interface panel

In the left part of the panel available in figure 27 there is a button calling the alarm panel (figure 28). In the given panel one can always find the current mistakes and warnings of incorrect system operation. The generation of messages is carried out by program PVSS II, that is why it does not carry information on mistakes of the system of final states - Finite State Machine.

ALICE-Alarm: XOP Alarm Screen

Alarm Screen Acknowledgement: Acknowledge* Unacknowledged Mode: Current Alarms Historical Alarms Select Time Range: []

Print alarms: [] Acknowledge* [] Individual/Group acknowledged []

Alarm Filters: Systems: [] Device Name: [] Logical Name: [] Alarm Text: [] Alarm State: []
 dist_5 Device Type: [] Device Description: [] W E F [] [] []
 dist_7 [] [] [] [] [] []

Shd	Device ID element	Logical name	Alarm text	Dir	Value	Ask	Time	Col
	dist_7_EventLicenseRemainingTime		License expires	WENT	21474836		2007/05/02 11:39:35.855	
	dist_5_EventLicenseRemainingTime		License expires	WENT	21474836		2007/05/04 14:53:04.996	
	dist_7_MemmonCheckFreekB		Memory full	WENT	2096748		2007/08/20 17:20:51.3	
	dist_7_MemmonCheckFreekB		Memory almost full	WENT	2096748		2007/08/20 17:20:51.3	
	dist_5_MemmonCheckFreekB		Memory full	WENT	9711776		2007/08/27 11:38:38.880	
	dist_7_ArchivCliskFreekB		Disc full	WENT	1000728		2007/08/04 09:53:02.857	
	dist_7_ArchivCliskFreekB		Disc almost full	WENT	1000728		2007/08/04 09:53:02.857	

Alarms Displayed: [7] Unacknowledged: [7] Manage Display... Close

Figure 28 – Alarm panel of PVSS

5 How the system works

5.1 System of finite states - Finite State Machine

The entire chain of detectors control in ALICE experiment is constructed on a simple but effective principle of final states (Finite State Machine).

The principle of final states is the abstraction making it possible to present arbitrary complex system in the form of a set of less complex subsystems. For such subsystems the discrete set of conditions is characteristic the transition between them being carried out with the help of specific actions or processes. The number of the system states is limited; the transition between them can be implemented only in a certain prescribed direction.

The strict hierarchical treelike structure in which the concept "parent - child" is introduced is characteristic for the principle of final states. "Parent" is the specific level which makes it possible to supervise "children". Moreover, "children" cannot directly affect the state of each other - they only transfer the data on their state to the "parent" and receive commands from it. The state of "parent" always depends on the state of its "children". Each "child" can have only one "parent" but "parents" can have a set of "children".

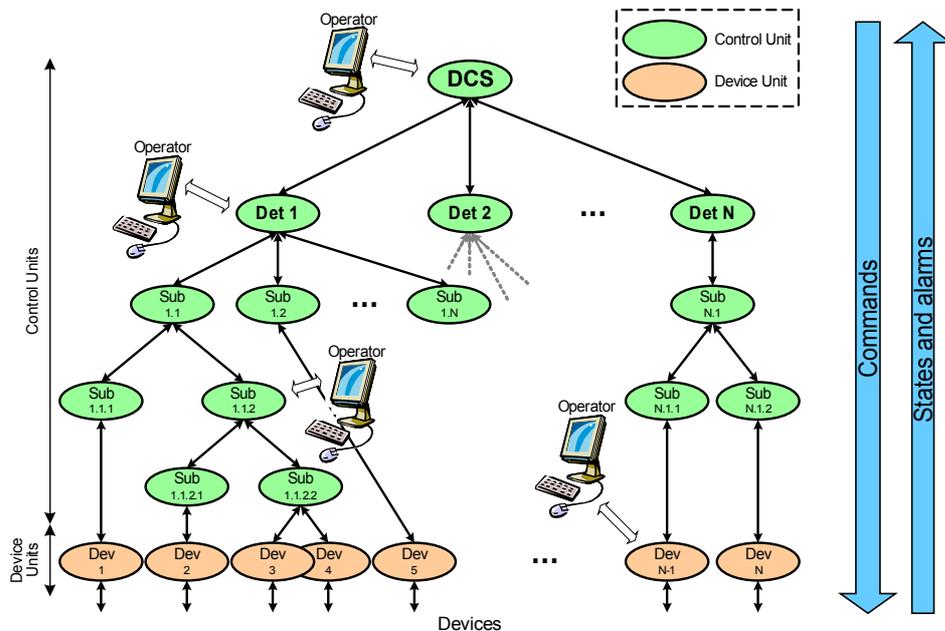


Figure 29 - Representation of a system using a "parent - child" principle

When representing each subsystem using the "parent - child" principle the concept of a logic level (Logical Unit), a managing level (Control Unit) and the final device (Device Unit) is introduced.

The final device is a real-life device (a pump, cooling machine, power supply channel). There can be a set of such devices but the unique connection for them is a connection with a control level and is exclusively in form of "child". The principle of final states assumes that at the very bottom of hierarchical structure there is a real device, and it cannot represent itself as "parent" any more.

A control level is an abstract concept. Typically this is the "parent" who supervises final devices. Control levels can simultaneously play a part of "parent" (when they are connected to final devices (terminations)) and "child" (being a "child" for another control level).

A logic level is an abstract concept as well. It is introduced not to duplicate the final device (termination) or control level. For example, the final device in the system is a low-voltage power supply source and it is connected to one of control levels. To connect this very power supply source as a final device to another control level seems to be impossible because to each "child" there can correspond only one "parent". The creation of a logic level instead of the final device can be a solution of such dilemma. It will make it possible for each control level to supervise the final device.

Both for the "parent" and its "children" a strictly certain set of states and the allowed transitions between them is characteristic. For example, the states and transitions between them all of one and the same power supply source can be presented in the form of elementary system of final states (figure 30).

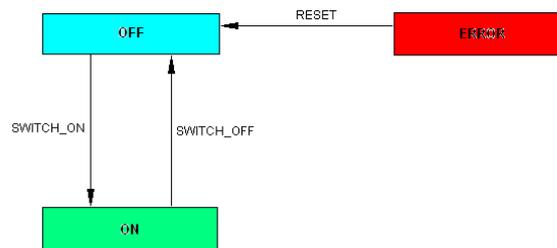


Figure 30 - Elementary system of final states

Here the OFF state (switched off) corresponds to the switched off power supply source when the voltage on the output is equal to zero. ON (switched on) is an operating mode of the source when it generates the voltage on the load, ERROR (mistake) is a mode when any problems lead to incorrect mode of operation, for example, exposed voltage is higher than the maximum possible one for the given source or the voltage on the load is lower than the specific threshold established by the user. It follows from figure 30 that transition from each state is possible only in one direction. So, it is impossible to get directly to the ON state from the ERROR state missing the OFF state.

From the point of view of the end user such transitions are carried out exclusively on pressing the button to which one or several actions are connected. So, having pressed button RESET (dump) in the ERROR state the system will come to the OFF state, whence, pressing the SWITCH_ON button (switch on) we shall pass to the working system. It is clear that the user cannot pass to the ERROR state on his own will, therefore, one can leave the ERROR state by pressing the button but such state can be set only by the device misoperation or by discrepancy between the output (or set) parameters and real potentialities of the system.

5.2 Hierarchy of PHOS detector control system

The hierarchy of PHOS detector control system is presented in figure 31.

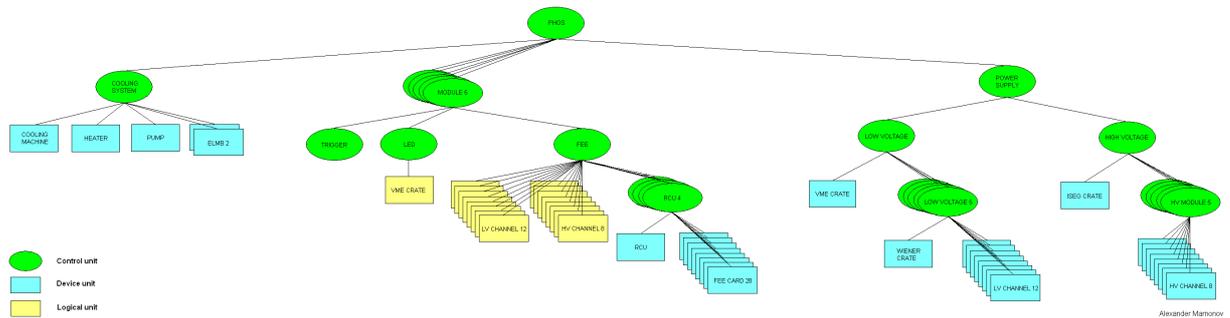


Figure 31 - Hierarchy of PHOS detector control system

Such structure includes three basic branches - system of cooling, five spectrometer modules, system of detector power supply provision. The system of cooling will consist of ELMB boards, a pump, cooling machine, heaters of warm volume. Each spectrometer module will consist of LED system which is connected to power supply source of VME and FEE systems into which structure there are included RCU cards (maps) and 28 FEE cards (maps). Besides, FEE system requires the possibility of some high- and low-voltage channels switch-off. The power supply system of the detector consists of high- and low-voltage branches. The low-voltage branch includes VME power supply source, a level for WIENER and each of its 12 channels control. The high-voltage branch includes the power supply device of ISEG firm into which 5 modules are included, 8 independent channels being available for each of them.

It follows from figure 31 that all real power supply devices are in the "power supply system" branch while in the module part of hierarchy all control levels are connected to logic levels. Such arrangement makes it possible to conduct - in case of mistakes or other problems occurrence - debugging of only one branch while the other always remains unchanged and will not need any interference.

5.3 System of states and transitions of PHOS detector power supply level

5.3.1 The circuit of power supply crate states and transitions

Figure 32 presents the circuit of states and transitions of power supply crates of WIENER and ISEG marks. It should be noted that for WIENER PL512 power supply sources the switch-on of crates can be carried out only in a manual mode by pressing the corresponding button on the device front panel (see paragraph 2.1). For WIENER VME sources the switch-on of power supply delivery to the channels is carried out by a program method (however, for total delivery of power supply one should manually press the button on the back panel of the device). The power supply of ISEG mark is switched on both by program method and manually.

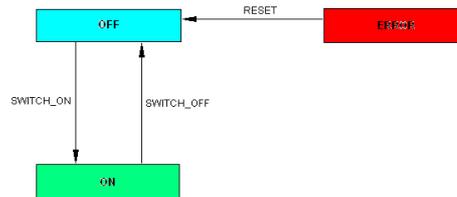


Figure 32 - System of states and transitions of WIENER PL512, ISEG, WIENER VME power supply crates

State OFF means that power supply on crate is absent or the crate itself is switched off. In this state the crate will pass to state ON - that is it will be switched on - by pressing the SWITCH_ON button.

State ON assumes that the crate is switched on and ready for work. At pressing the SWITCH_OFF button the system passes to state OFF.

State ERROR arises only at occurrence of problems with switch-on or unstable work in the course of operation. After pressing the RESET button the crate will return to position OFF.

5.3.2 The circuit of states and transitions of power supply source channel

Figure 33 describes the circuit of states and transitions for WIENER PL512 and ISEG power supply source channels.

Voltage supply to the channels of WIENER VME source is carried out automatically after the crate is switched on.

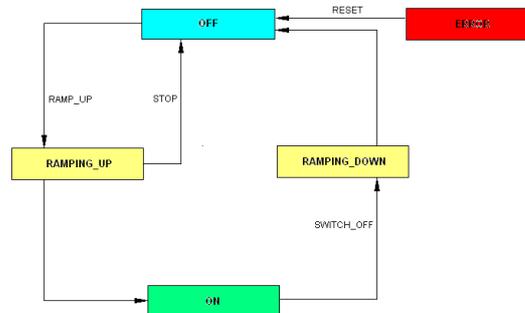


Figure 33 - System of states and transitions of WIENER PL512, ISEG, WIENER VME power supply source channels

State OFF means that power supply is missing on the source on the channel. In this state the channel will pass to state RAMPING_UP at pressing the RAMP_UP button.

States RAMPING_UP and RAMPING_DOWN describe processes of voltage rise and fall on the power supply source channels. In state RAMPING_UP there is an opportunity of power emergency switch-off on the channel by pressing the STOP button.

State ON assumes that the channel is switched on and generates the required voltage. At pressing the SWITCH_OFF button the system will pass to state OFF.

State ERROR arises only at occurrence of problems with switch-on or unstable work in the course of operation. After pressing the RESET button the channel will return to position OFF.

The current state of each device can be always checked up by clicking on the channel of the power supply source in the primary window of the user interface specified in figure 21 by the right button of the mouse. Any user can always check up in this window the status and parameters of the specific channel.

Figure 34 - The channel of WIENER PL512 power supply source in the primary window of user interface

An alternative method of learning the status of WIENER PL512 low-voltage power supply sources can be their check in a browser window of any computer available in the internal network of CERN. For this purpose one should type lvphoswiener or lvphoswiener2 in the browser window (for example, Microsoft Internet Explorer).

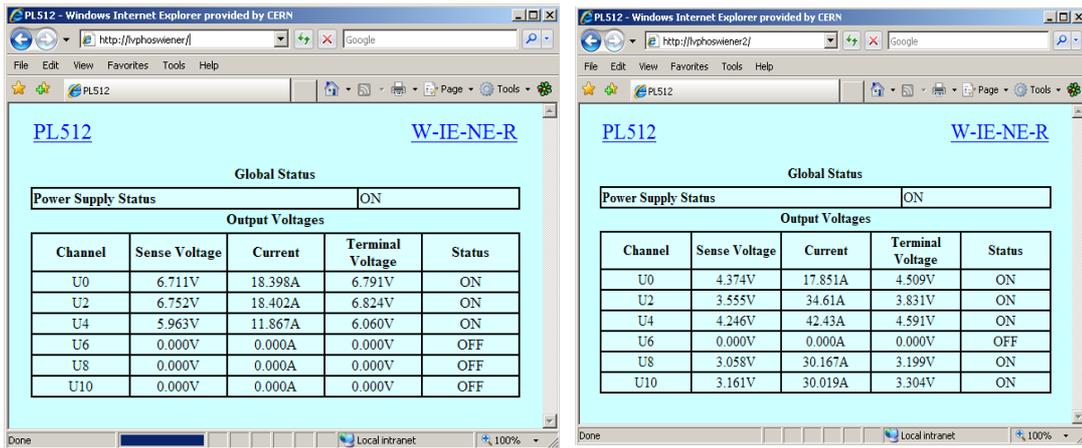


Figure 35 - Check of the status of WIENER PL512 sources in a browser window

The voltage preset by the user is generated by the channels of power supply sources. To change options of maximal current, power, generated voltage, maximal working temperature of the channel, voltage rise and fall rate one should pass prior to the final device to the required power supply channel by the system tree in the same window of user interface (figure 34), set new values in a white field and press the ENTER button. If new installations are accepted by the device the new options will be displayed in a grey field. If new options are not accepted check up whether all processes in PVSS II Console panel represented in figure 10 are started and whether OPC server of ISEG device has successfully started. If nothing helps address to developers (more detailed information is available in chapter 6).

5.3.3 The circuit of states and transitions of WIENER1 and WIENER2 control levels

Figure 36 presents the general circuit of states and transitions of WIENER1 and WIENER2 level controlling low-voltage WIENER PL512 power supply sources.

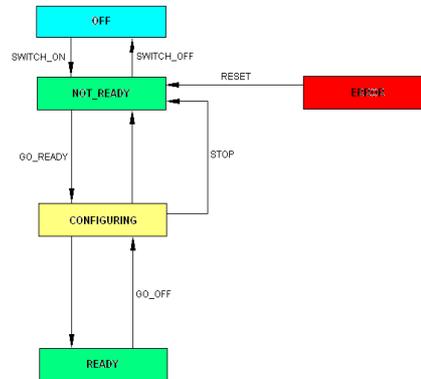


Figure 36 - System of states and transitions of low-voltage power supply source control levels

State OFF means that both crates of WIENER 1 and WIENER 2 power supply sources are switched off (state OFF). One can switch on the sources only manually. If at least one of crates is switched on (state ON) the system will pass to state NOT_READY.

NOT_READY is a state at which at least one of WIENER crates is switched on. The switch-off of crates can be carried out only manually. At pressing the GO_READY button the system will pass to state CONFIGURING.

CONFIGURING is a state at which there occurs a process of switch-on (RAMPING_UP) or switch-off (RAMPING_DOWN) of power supply low-voltage channels. At pressing the STOP button the emergency switch-off of all power supply source channels will be carried out. After the voltage established by the user is achieved for all channels used the system passes to state READY.

READY is a state when all channels of both WIENER power supply sources are switched on and generate voltage (state ON). To switch off the channels one should press button GO_OFF.

ERROR is such condition that arises if at least one of channels was spontaneously disconnected (is in state ERROR) or the crate is in state ERROR.

5.3.4 The circuit of states and transitions of HV MODULE 1 control level

The circuit of states and transitions for control level HV MODULE 1 is presented in figure 36. The HV MODULE 1 level controls the ISEG high-voltage power supply source.

Below is given the description of each state and transition for the HV MODULE 1 level.

OFF is a state when the crate of the ISEG power supply source is in state OFF, i.e. it is switched off. To switch the crate on one should press the SWITCH_ON button. The system will pass to state NOT_READY.

NOT_READY is a state at which the crate of the ISEG power supply source is switched on but the channels are not switched on or not all channels generate voltage. If at least one high-voltage channel is switched on, then, at pressing the SWITCH_OFF button it will be switched off. At repeated pressing the ISEG crate will be switched off and the system will pass to state OFF. The GO_READY button will lead the system to state CONFIGURING.

CONFIGURING is a state at which there occurs the process of voltage rise and fall on channels of the ISEG power supply source. There is a button STOP to stop such process urgently. At achievement of the prescribed by the user voltage on the channels the system will pass to state READY.

READY is a state at which all channels of the source give out the required voltage. After pressing the GO_OFF button the voltage on channels will start falling down and the system will pass to state CONFIGURING.

ERROR is a state of a mistake at one of channels or the ISEG crate. At pressing the RESET button the system will return to state NOT_READY.

5.3.5 The circuit of states and transitions of LOW_VOLTAGE, HIGH_VOLTAGE control levels

The circuit of states and transitions for the LOW_VOLTAGE level controlling the WIENER1 and WIENER2 levels as well as the final WIENER VME device is similar to the circuit given in figure 36. They differ only in descriptions and functions of states and transitions.

The system can be in state OFF only at the switched off power supply sources. If one of the sources is switched on the transition to state NOT_READY is carried out. At pressing the SWITCH_ON button there will be implemented the switch-on of all power supply sources.

State NOT_READY means that not all power supply channels or neither of them generates voltage. At pressing the SWITCH_OFF button all power supply channels will be switched off. If all channels are switched off the power supply source crate is switched off. After the GO_READY button is pressed the system passes to state CONFIGURING.

State CONFIGURING occurs when in one (or in all) power supply channels there takes place the voltage rise (at switch-on) or fall (at switch-off). The STOP button pressing leads to the switch-off of power supply channels. After the voltage achieves the prescribed value the system automatically passes to state READY.

In state READY all channels of power supply sources are switched on and generate voltage. At pressing the GO_OFF button the system passes to state NOT_READY through intermediate state CONFIGURING.

In case of mistake on one of the power supply sources the system passes to state ERROR. To dump this state one should press the RESET button.

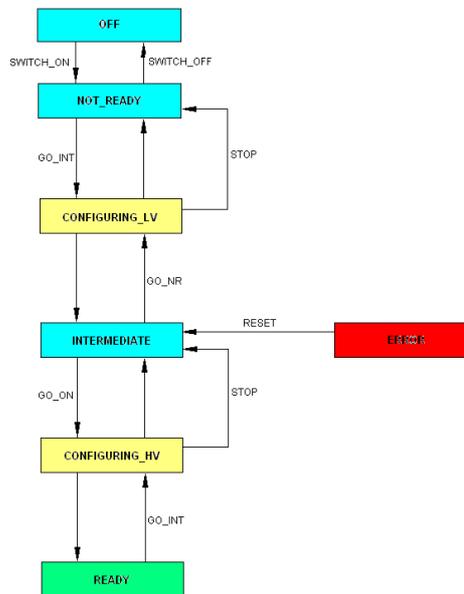
Figure 37 - User window of the level controlling WIENER PL512 power supply sources

The HIGH_VOLTAGE control level of high-voltage power supply source ISEG is fully identical to the circuit of the level presented in figure 36. Figure 38 demonstrates the user window of the level controlling the ISEG device.

Figure 38 - User window of the level controlling the ISEG power supply source

5.3.6 The circuit of states and transitions of POWER_SYSTEM control level

Figure 39 displays the circuit of states and transitions of Power System level controlling two WIENER PL512 low-voltage power supply sources, one WIENER VME source and high-voltage ISEG source.



Alexander Mamonov

Figure 39 - System of states and transitions of PHOS detector power supply levels Low Voltage, High Voltage, Power System

Such circuit makes it possible to synchronize switch-on of low- and high-voltage power supply sources in the required order. Thus, the switch-on of high-voltage power supply system should occur only after the low-voltage one.

Let us consider each state of the circuit in detail.

OFF - all power supply sources are in the switched off condition. At pressing the SWITCH_ON button the transition to state NOT_READY and the switch-on of crates is realized. OFF state is possible only when all channels of the device are switched off. If at least one channel is alive or the voltage is not equal to zero the transition to state OFF is not executed.

NOT_READY - in this condition at least one of WIENER crates is switched on. ISEG modules go on being in state OFF.

CONFIGURING_LV is a state describing the process of switch-on or switch-off of WIENER low-voltage power supply channels.

INTERMEDIATE – the low-voltage component of the detector is switched on and ready for operation, the high-voltage modules are switched on but the channels of each module are in the switched off condition and do not generate voltage.

CONFIGURING_HV - there takes place switch-on or switch off of the detector high-voltage channels. The channels of WIENER source remain switched off.

READY is a working mode at which all devices are switched on and generate the required voltage.

ERROR is a state of mistake. In case of mistake occurrence (depending on its type) the system passes to INTERMEDIATE or NOT_READY state at pressing the RESET button.

In figure 40 there is available the window representing to the user the data about current states of ISEG, WIENER PL512, WIENER VME devices.

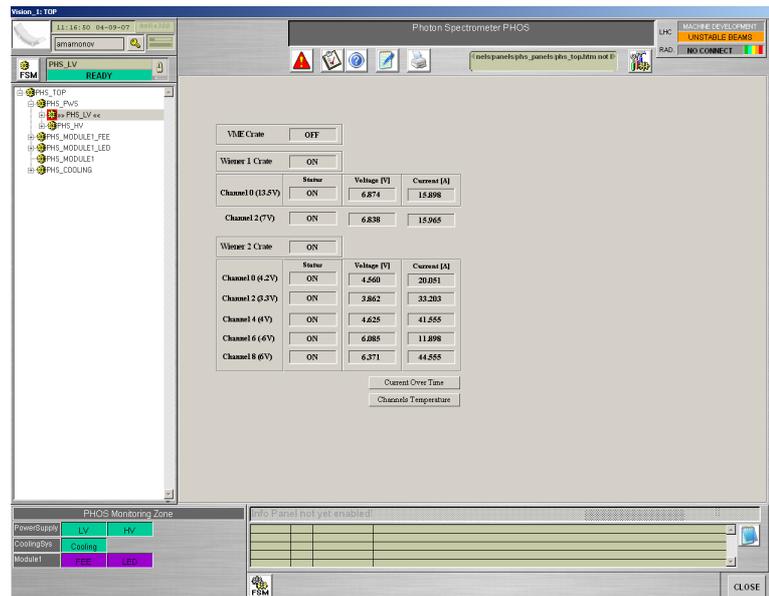
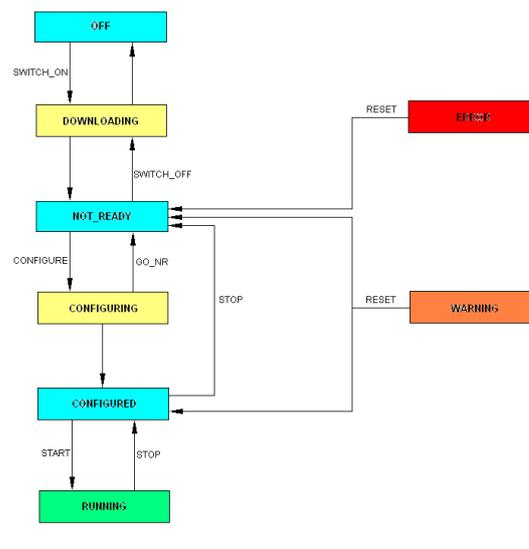


Figure 40 - User window of the level controlling WIENER PL512, WIENER VME, ISEG devices

5.4 System of states and transitions of PHOS detector MODULE 1 level

5.4.1 System of states and transitions of FEE control level

In figure 42 the system of states and transitions of FEE level is available. At the given stage it is realized not completely.



Alexander Mamonov
Per Thomas Hill

Figure 42 - System of states and transitions of PHOS detector FEE level

Before you start working on computer alphspcdcs01 you should first start a script InterComLayerPHOS.sh the following way:

InterComLayerPHOS.sh start - start of process

InterComLayerPHOS.sh stop - stop of process

InterComLayerPHOS.sh restart – restart of process

InterComLayerPHOS.sh status - check of the process current status

Below is given the brief description of each state and transition of the system.

OFF - all FEE and RCU cards (maps) are switched off. Transition in the DOWNLOADING state is carried out by pressing the SWITCH_ON button in terms of the detector low-voltage power supply system switch-on.

DOWNLOADING is a state characterizing the process of FEE cards (maps) connection. After all cards (maps) are connected the system passes to state NOT_READY.

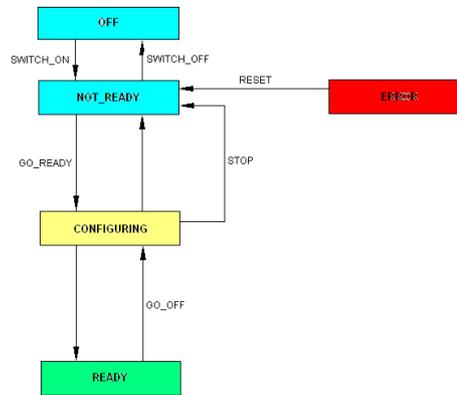
NOT_READY is a state in which the low-voltage component of the detector power supply works and the cards (maps) of the system electronics are connected. At pressing GO_STANDBY there will begin disconnection of FEE cards (maps) and the system will pass to state DOWNLOADING.

ERROR - the system does not answer the user commands. At pressing the RESET button the system returns to state NOT_READY.

Other conditions are not realized yet (nevertheless one can work with them though no actions with FEE electronics will occur). The User interface for the level controlling FEE electronics is missing.

5.4.2 System of states and transitions of LED control level

Figure 43 presents the circuit of states and transitions of the future LED system of PHOS detector spectrometer channels monitoring. It is based on VME crate operation and is not realized yet.



Alexander Mamonov

Figure 43 - System of states and transitions of PHOS detector LED level

The user interface for the level controlling LED system is not realized yet.

5.4.3 System of states and transitions of MODULE 1 control level

The MODULE1 level of PHOS detector verifies control levels of LED and FEE systems and is shown in figure 41.

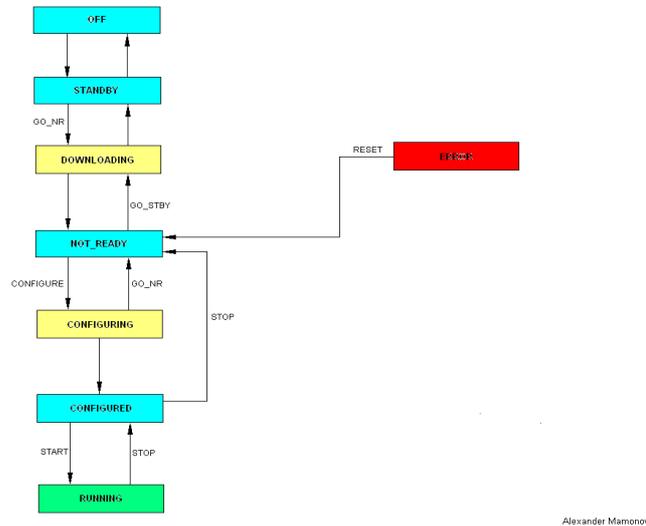


Figure 41 - System of states and transitions of MODULE1level

Brief description of each system state and transition is given below.

OFF - all FEE and RCU cards (maps) are connected; all system power supply sources are disconnected. Transition to state STANDBY is carried out automatically in terms of the detector power supply system switch-on (at least one of crates is switched on).

STANDBY is a state at which at least one of crates of the detector power supply system is switched on. If the entire power supply low-voltage component is switched on (all channels generate voltage), then, after pressing the GO_NR button the system passes to state DOWNLOADING. Transition to state OFF is carried out automatically if all crates of power supply systems are switched off.

DOWNLOADING is a state describing the process of FEE cards (maps) connection. After all cards (maps) are connected the system passes to state NOT_READY.

NOT_READY is a state in which the low-voltage component of detector power supply works and the cards (maps) of the system electronics are connected. At pressing GO_STANDBY there will start the disconnections of FEE cards (maps) and the system will pass to state DOWNLOADING.

ERROR – there is a mistake in one of subsystems. Depending on where there was a mistake, the system itself will choose - at pressing the RESET button - the order of operation to eliminate it.

Other states are not realized yet.

The user interface of MODULE1level is not realized yet.

5.5 System of states and transitions of PHOS detector level of crystal matrix cooling

In figure 44 the general circuit of states of the cooling system (it is developed together with Alexey Kurjakin) is presented. It includes the fixed states (OFF, STANDBY, READY) in which the system can stay for a long time, and a set of temporary states (COOLING, READY, CALIBRATING) in which the system cannot stay constantly. It should be noted that the cooling system control is a process requiring special attentiveness. Sharp difference of temperatures can damage crystals in the matrix because of their high fragility.

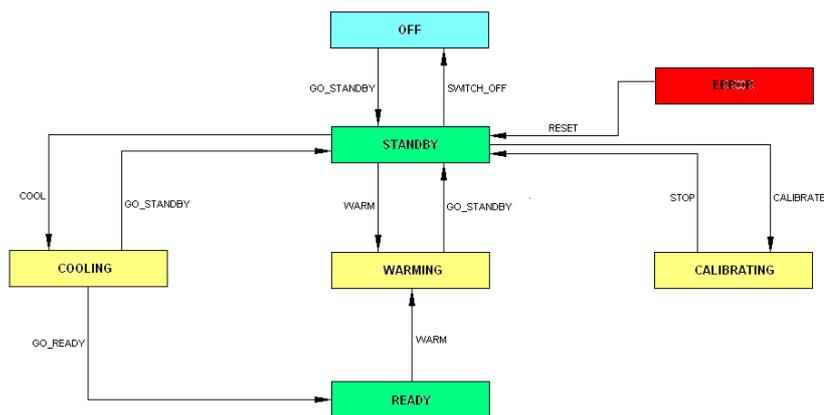


Figure 44 - System of states and transitions of PHOS detector level of crystal matrix cooling

Let us consider in detail each possible state of the cooling system.

In state OFF all devices of the cooling system are switched off and do not function. It is supposed that in this state the temperature inside the matrix of crystals is equal to the environment temperature. By pressing the GO_STANDBY button the system passes to state STANDBY.

In the STANDBY state cooling does not occur as well – there work only pumps due to which there occurs circulation of cooling liquid in the volume. At cooling or warming the detector the user must in no circumstances pass to state OFF but he is to remain in STANDBY constantly. The stop of the entire system can lead to essential temperature jumps of the cooling liquid and, as consequence, to high temperature gradients in the crystal matrix. At passing to state OFF the detector volume heating to the temperature close to the temperature of environment is obligatory. Transition to state OFF is carried out by the SWITCH_OFF button, in state COOLING – by the COOL button, in state CALIBRATING – by the CALIBRATE button, in state WARMING – by the WARM button.

State COOLING assumes work of the cooling machine to cool a matrix of crystals and work of heaters for warm volume of the detector. From this state the transition to mode READY is possible at achievement of necessary temperature. Such transition on the part of PVSS is carried out automatically. In case of need of the cooling system stop it is necessary to press button GO_STANDBY.

State READY differs from the state COOLING only by the fact that the temperature is kept at a constant level instead of being reduced. From state READY the only possible transition is to state WARMING, it can be realized by pressing the WARM button as it is assumed that the

escape from this state is undertaken in order to switch off the system of cooling. The temperature of warm volume is also kept at a constant level.

State WARMING is characterized by regular heating of the detector volume with its transition to the state when the temperature of the crystal matrix is equal to the temperature of environment. In case we do not need to warm the detector completely the transition to state STANDBY by pressing the GO_STANDBY button is possible. It is obvious that in this case one should return to state WARMING prior to complete switch-off of the cooling system (transition of the system to state OFF).

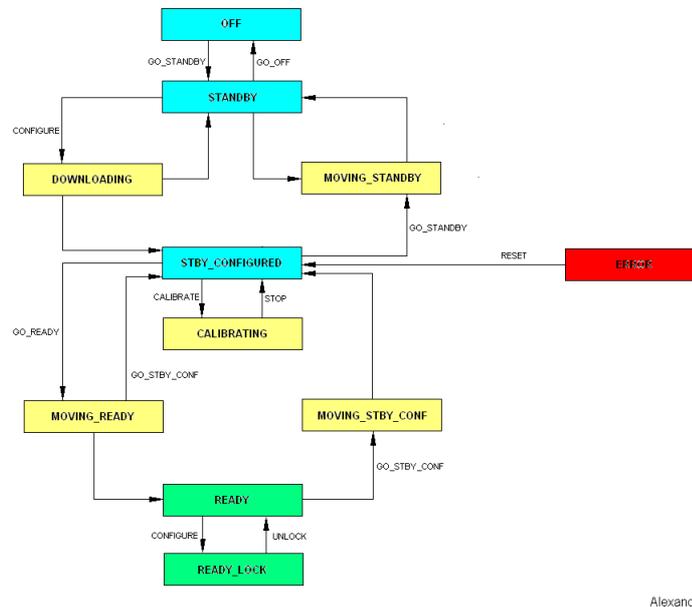
The system passes to state CALIBRATING on a user command. This state is chiefly required to describe behavior of a subsystem during calibration of temperature gauges. By using the STOP button one makes the system pass to state NOT_READY.

In state ERROR the system can pass from any state described above depending on the type of the error. By pressing RESET the user passes in state STANDBY.

The graphic interface of the system of crystal matrix cooling is presented in figure 22. It includes buttons of plots of temperature variation dependence in « cold volume », in « warm volume », in environment, humidity - time dependence. In the right part of the panel presented in figure 22 the buttons of temperature thresholds setting are located, at achieving them the system passes to states READY and STANDBY. At error occurrence in the cooling system field located above the buttons of temperature thresholds the name of a subsystem in which there was the error is displayed

5.6 System of states and transitions of the PHOS detector top level

The circuit of all possible states of a photon spectrometer can be found in figure 45.



Alexander Mamonov

Figure 45 - System of states and transitions of the PHOS detector top level

In ALICE community it is accepted that the initial state of any system is OFF. This is the state in which all devices are in the switched off condition. Simultaneously with it the OFF state is also a final state to which the system sooner or later should come. From the OFF state one can pass to state STANDBY by pressing the GO_STANDBY button.

State STANDBY is characterized by transition of the detector cooling system to as well as of power supply system of WIENER detector state STANDBY. A high-voltage component is in state OFF. By pressing the GO_OFF button one can make the system pass to state OFF. After pressing the CONFIGURE button the system passes to state DOWNLOADING.

State DOWNLOADING leads to the switch-on of the low-voltage branch of the power supply system (the channels are in state RAMPING_UP) as well as to the switch-on of high-voltage modules of ISEG device. The cooling system still remains in STANDBY. After transition of the low-voltage subsystem to state READY and switch-on of high-voltage modules (state INTERMEDIATE) the system automatically passes to state STBY_CONFIGURED.

State STBY_CONFIGURED assumes switch-on of all low-voltage power supply channels and of the switched already on high-voltage modules of ISEG. The cooling system is in state STANDBY. By pressing the CALIBRATE button one can make the system pass to state CALIBRATING. The GO_READY button will lead the system to state MOVING_READY, while the GO_STANDBY button - to state MOVING_STANDBY.

State CALIBRATING is required exclusively to describe the state of the system of photon spectrometer cooling. All other subsystems are in the same states as at STBY_CONFIGURED. To return to state STBY_CONFIGURED one should press the STOP button.

In state MOVING_READY the cooling system passes to state COOLING and there starts the reduction of temperature of the crystal matrix. It is clear that the prompt decrease of temperature from +25 to -25°C is impossible. Therefore the given process at the first switch-on occupies no less than two days. The low-voltage power supply system is in state READY, the

high-voltage one - in state RAMPING_UP (switch-on of high-voltage channels). After achievement of the required temperature and switch-on of the system high-voltage component there goes a transition to state READY. It is possible to stop cooling by pressing the GO_STBY_CONF button and making the system pass to state STBY_CONFIGURED.

State READY is characterized by completely efficient system at which all necessary conditions for the experiment performance are created. The pressing of the GO_STBY_CONF button leads to the system transition to state MOVING_STBY_CONF. The CONFIGURE button is required to realize transition to state READY_LOCK.

State READY_LOCK is created especially for FEE FSM but now it does not differ from READY at all. The pressing of UNLOCK will return the system to state READY.

In state MOVING_STBY_CONF there takes place the switch-off of the detector high-voltage component (state RAMPING_DW_INT), the low-voltage power supply sources are in state READY as well as the system of cooling. After transition of the high-voltage system to state INTERMEDIATE there takes place an automatic transition to state STBY_CONFIGURED. It should be noted that the switch-off of high-voltage power supply sources at the time when the system of cooling is in state READY is possible and the required temperature of the crystal matrix is established. At the following transition of the system of photon spectrometer top level control the cooling system does not pass to state COOLING and the transition of the entire system to state READY does not occupy a lot of time.

State MOVING_STANDBY assumes switch-off of ISEG high-voltage modules (state RAMPING_DOWN_NR) and low-voltage WIENER channels (state RAMPING_DOWN). The cooling system passes to state WARMING before the crystal matrix achieves the temperature of environment. It is clear that such transition will occupy no less than two days. At achievement of the required temperature the system automatically passes to state STANDBY and is ready to complete switch-off (to transition in state OFF).

State ERROR means incorrect operation in any device or mistake in the order of devices switch-on. To correct the mistake one should press the RESET button. In case of any device malfunction it seems impossible to put the system to the normal state using the program method. In this case the switch-off of the detector subsystems should be executed manually.

The graphic interface of the system of crystal matrix cooling is described in detail in chapter 4.

5.7 Integration of PHOS detector DCS system to ALICE experiment

The system of slow control will be integrated to DCS system of ALICE experiment. The circuit of the top level states and transitions of ALICE experiment used in DCS system of PHOS detector can be found in figure 46. A single unique state MOVING_STANDBY (between the STANDBY and STBY_CONFIGURED states) is added by PHOS project to describe the process crystal matrix warming up to the temperature of environment.

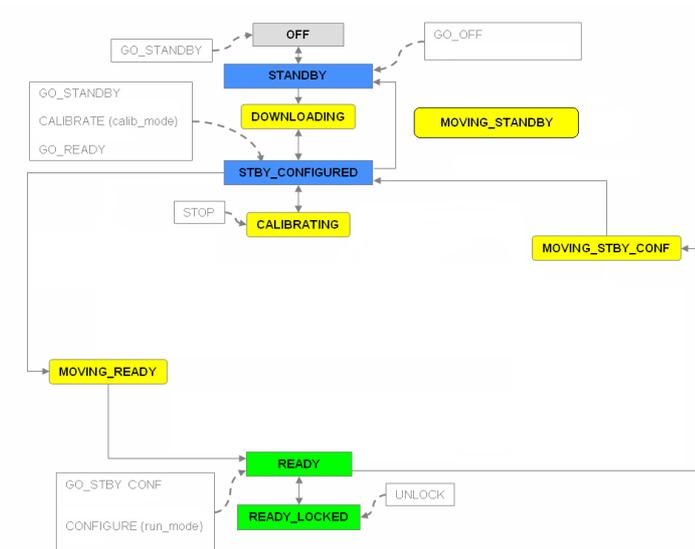


Figure 46 - States and transitions of the PHOS detector top level in system DCS ALICE

5.8 Interlocks

Besides states ERROR there exist between subsystems of PHOS detector such connections whose inadmissible combination can also bring to state ERROR.

So in case of detector high-voltage power supply switch on at a Power Supply level there will be deduced an error if the low-voltage system is switched off or switched on not completely. The result of RESET action will consist in immediate switch-off of ISEG high-voltage crate and switch-off of the low-voltage power supply system.

In case of error in the cooling system the operator will get the state of error at a level of the cooling system. Now the system itself switches off in such situation the entire detector power supply. In future no spontaneous actions will be performed by the system; it will only inform the operator on critical temperature achievement inside the warm volume of the detector and on the error of the system of cooling. The operator should solve himself whether it is necessary to switch off the power supply system of the detector to decrease the temperature of the warm volume or not.

5.9 Change of the rights of users

In figure 20 there is presented the window which -at presence of the manager rights - allows addition or deletion of users changing their rights and passwords of log-in to the system. When the current user name is pressed by the right button of the mouse there will be opened a window including Log Out, Log In, Tools, Change Password, Administration, Help possibilities. Let us consider each of them in detail:

1. Log Out - an output from the current user mode
2. Log In - an input to the new user system. In this case the mode of the current user will be closed.
3. Tools – makes it possible to find the certain user or to see the current users of subsystems.
4. Change Password - change of the password of the current user.
5. Administration - has a property page Users, Groups, Domains, Setup.

The Setup property page it is not realized yet. The Domains property page makes it possible to create and change system domains. Today there is created especially for PHOS project users a domain with a name phs to which the following groups of users (Groups) are included:

- phs_developer are users having full access to all components of the system. Such users can change somehow an existing code, add and delete detector subsystems, start FSM, change states of system components.
- phs_expert are users having the right to change the states of system components if the developer has enabled them to make it.
- phs_operator has the same rights as phs_expert today.
- phs_observer is an observer having the right only to trace the current state of the system though not having an opportunity to somehow change its state. By default all members of ALICE collaboration have the status of observer relatively to all detectors.

6. Help means the help by component Framework Access Control.

The user having the rights of the system developer and manager can add and delete users at the desire and change their rights. For this purpose the user is to press button Add for addition of the new user or choose current double pressing of the mouse left button on the user of interest (figure 47) in the Administration/Users property page.



Figure 47 - The window of user addition and deletion

In the opened window one can change the user name and his description. It should be taken into account that the name of the user must coincide with a name of CERN NICE user (figure 48).



Figure 48 – Alteration of the user rights

By pressing the Edit button one can change the rights of the user. For this purpose he is to add or delete the existing status of the user in the opened window (figure 49).

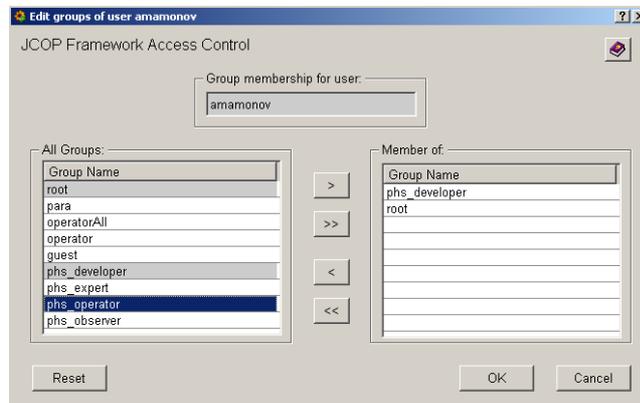


Figure 49 - The window of the user status alteration

6 If something does not work...

The key rule which is necessary to adhere in case of problems occurrence is to be calm and not to undertake hasty steps the consequences of which are not known to the user.

At first he is to find out what exactly works incorrectly. Does the problem consist in wrong display of the device state in the user interface or it really works incorrectly.

In some cases one should try to stop system completely to reload the machine and start the project anew.

One should also understand that the stop of OPC-server of one of the devices automatically leads to the effect of uncontrollability of the device. In order to avoid it you are to check up whether all steps described in item 2 of the manual are undertaken correctly.

If nothing helps address to following people:

- 1 General problems with the interface, FSM system and PVSS:
Alexander Mamonov alexander.mamonov@cern.ch
- 2 Problems with low-voltage power supply sources WIENER and WIENER VME,
ISEG high-voltage source:
Lionel Wallet lionel.wallet@cern.ch
- 3 Problems with the system of crystal matrix cooling:
Alexey Kurjakin alexei.kuryakin@cern.ch
Sergey Filchagi sergey.filchagin@cern.ch
- 4 Problems with the system of electronics water cooling:
Dmitry Budnikov dmitry.budnikov@cern.ch
- 5 Problems with LED-system:
Michael Bogolyubsky mikhail.bogolioubski@cern.ch
Sergey Sadovsky serguei.sadovski@cern.ch
- 6 Problems with FEE-system:
Per Thomas Hille perthi@fys.uio.no
Hisayuki Torii hisayuki.torii@cern.ch
- 7 Problems with integration in DCS of ALICE system:
Lennart Jirden lennart.jirden@cern.ch
Marco Boccioli marco.boccioli@cern.ch