



***Monitoring and Control for MPD, Time Projection Chamber
LV, and HV Subsystems for Nuclotron-Based Ion Collider
Facility "NICA"***

Full name

Younna Ghoneim , Vlad Chepurnov



Let's move on to an abstract of Slow control for MPD TPC LV and HV systems based on CAEN Equipment

For the MPD detector control system, the Master SCADA and SCADA software were proposed. The TPC low-voltage and high-voltage systems concepts are presented. It is based on CAEN equipment and the OPC UA (OLE for Process Control) server protocol.

The status of interface design for CAEN equipment based on OPC UA, Master SCADA server, of HV and LV during the monitoring.

In our research work, we use Master Scada and Scada as visualizations instead of grafana, as they are more applicable according to the results.

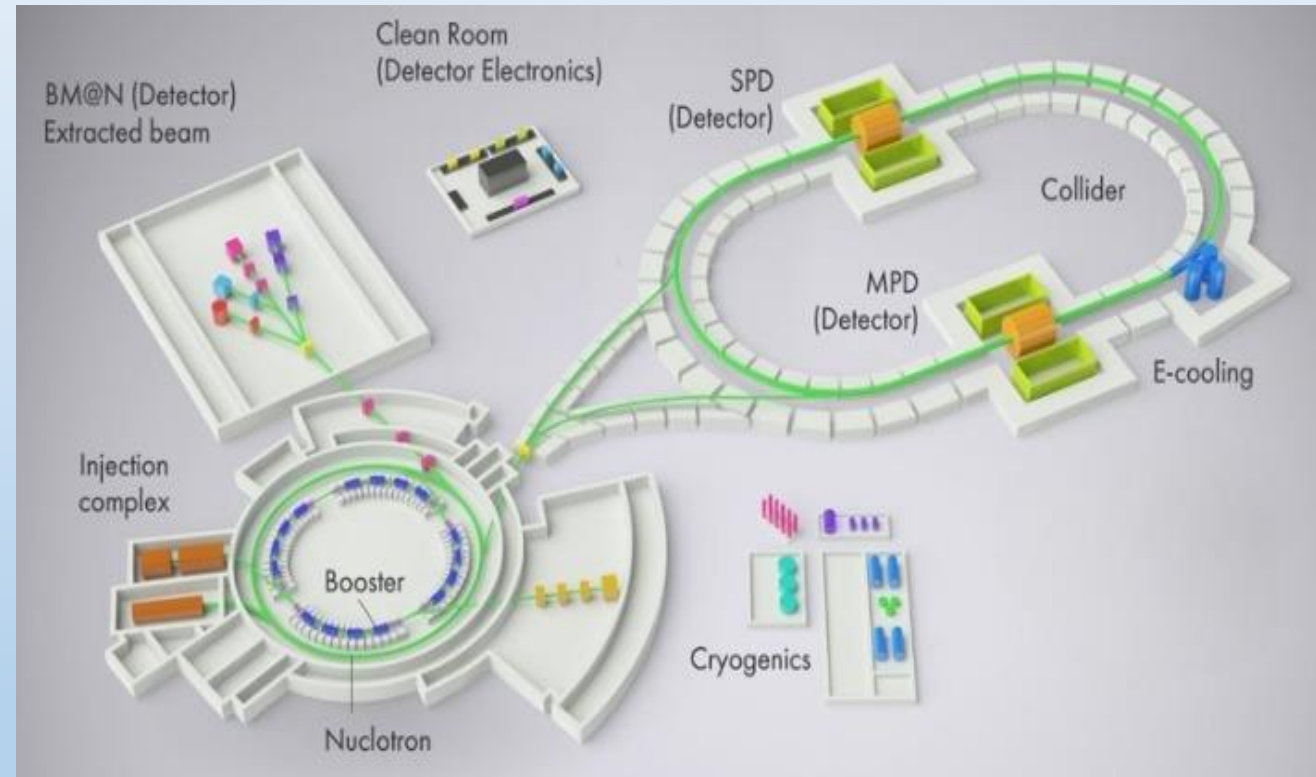


NICA collider

The NICA collider provides two beam intersection points, one of which will house the Multi-Purpose Detector (MPD) experimental setup.

The first phase will implement the following configuration of this setup: time-projection chamber (TPC), time-of-flight (TOF), zero-angle calorimeter (FHCAL), fast forward detector (FFD), and electromagnetic calorimeter (ECAL).

The TPC is the main track detector of the MPD installation.



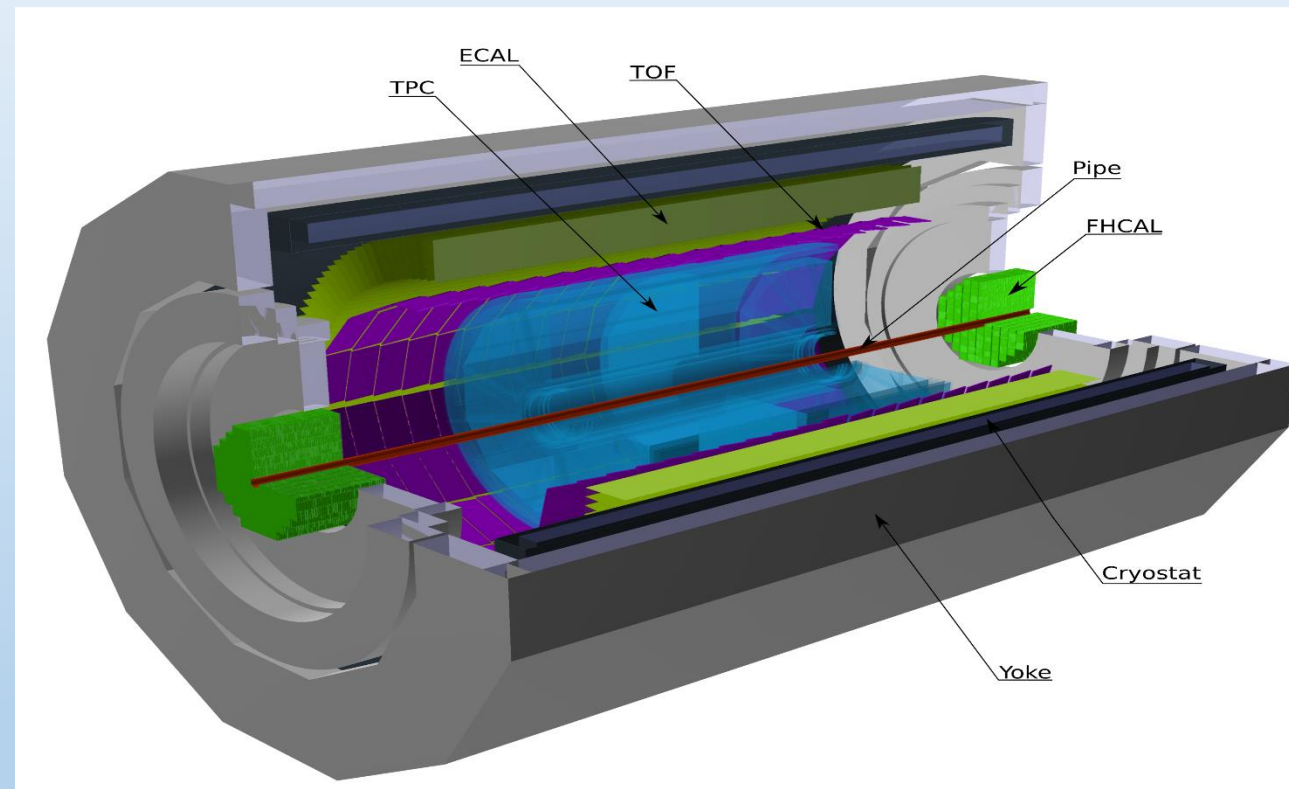
NICA Collider



MPD at NICA collider

The **Multi-Purpose Detector (MPD)** is a 4π spectrometer. It is designed to detect charged hadrons, electrons, and photons in high luminosity heavy-ion collisions within the energy range of the NICA collider.

A general view of the MPD detector with the end doors pulled back to see the internal parts of the detector. Drawn are the following subsystems: Forward Hadron Calorimeter (FHCAL), Time-Projection Chamber (TPC), Time-of-Flight System (TOF), Electromagnetic Calorimeter (ECAL).



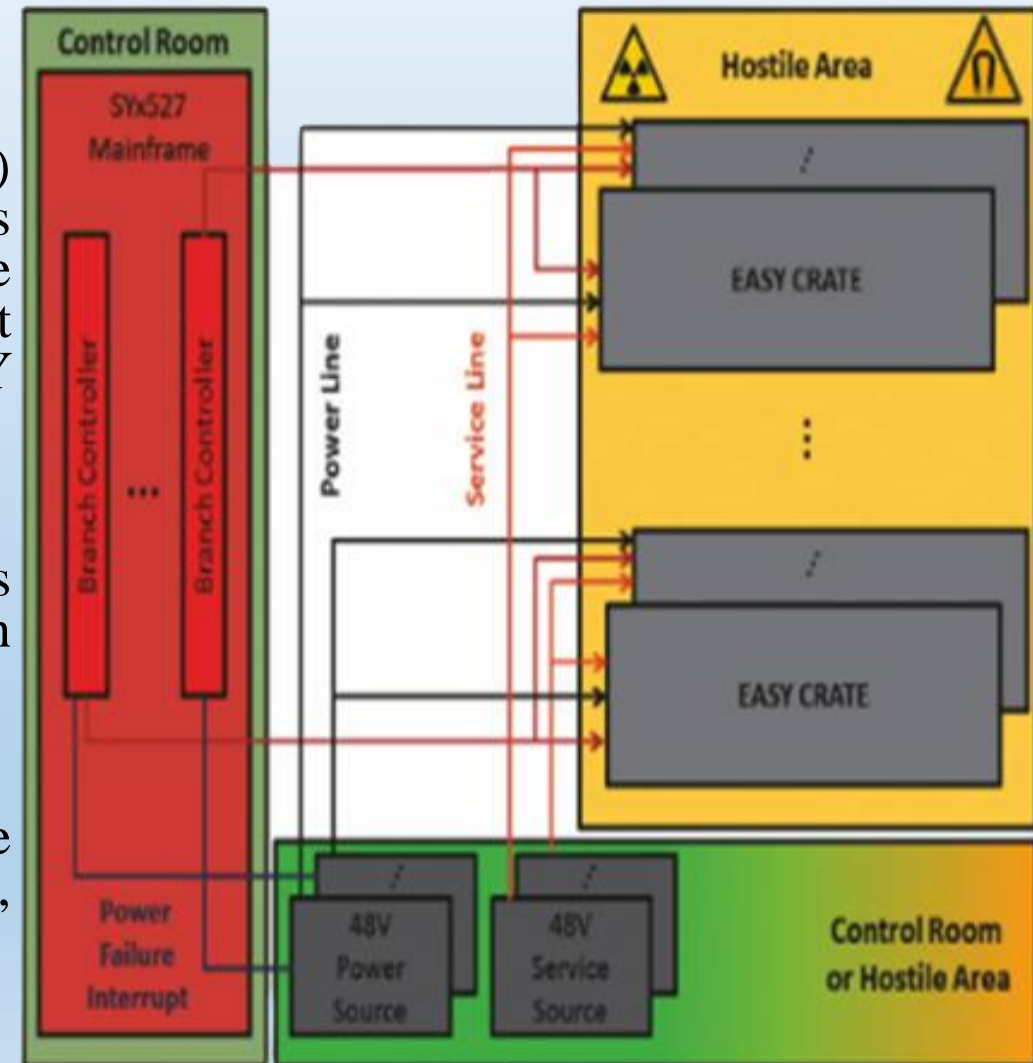
A general view of the MPD detector (stage 1)



EASY (Embedded Assembly System)

Architecture

- The EASY3000 (for boards up to 40 cm long, [A3XXX family](#)) can house up to 10 boards (depending on board width). As illustrated in the figure on the right, the branch controller is the EASY interface between the mainframe unit ([SY4527](#) or [SY5527](#)) and the remote boards in the EASY crate.
- The branch controller role is to configure the EASY channels as they belong to the supply unit slot in which the branch controller is placed.
- In this way, all channels of the EASY boards will be considered as channels of the branch controller board, increasing the number of channels the system can handle.





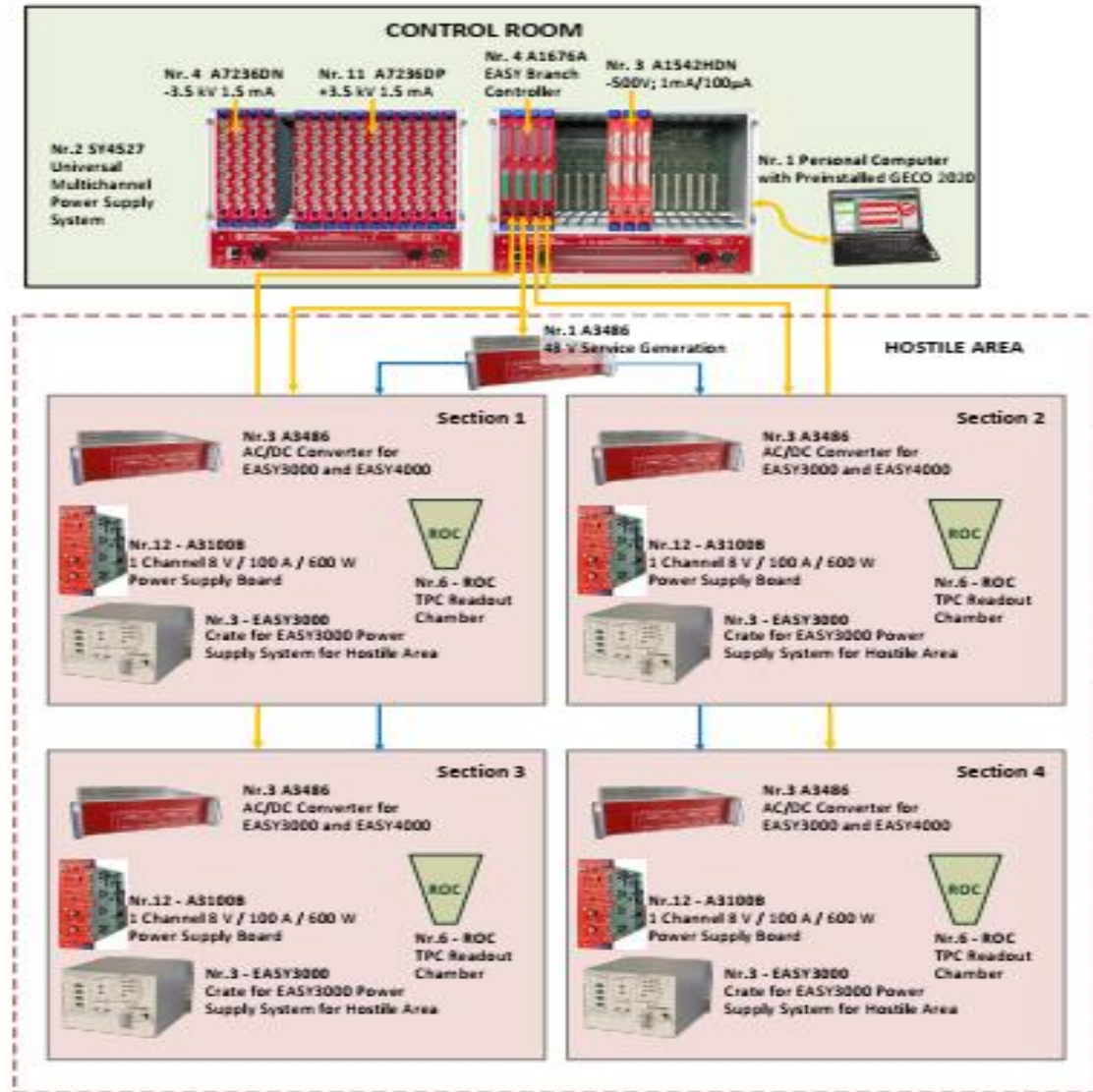
TPC HV+LV System

CONTROL ROOM (no radiation and magnetic field):

- SY4527 - 2 pc
- controller A1676A - 4 pc
- HV modules –A72360P (+3.5kV/1.5mA) - 11 pc
- HV modules –A72360N (- 3.5kV/1.5mA) - 4 pc
- HV modules –A1542HDN (- 500V/1mA) - 3 pc

LV&HV system based on CAEN rad. hard design: (up to 2000 Gauss and 15 kRad)

- Power converters A3486 AC/DC (380 V -> 48 V) - 15 pc
- EASY3000 crates - 14 pc
- LV module - A3100B (8V/100A) - 48 pc
- LV module - A3100HBP (14V/50A) - 6 pc
- HV modules –A3540P (+4kV/1mA) - 8 pc
- HV modules –A3540N (- 4kV/1mA) - 2 pc





Crate SY4527 (Non Radiation Area)

The **SY4527** system is the fully equipped experimental version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying.

This system outlines a completely new approach to power generation and distribution by allowing the housing, in the same mainframe, of a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards (temperature, pressure monitors, etc.) and branch controllers, where the latter are used to control other remote generators and distributors.





Crate SY5527

The **CAEN Mod. SY5527** is the fully equipped experiment version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying. This system outlines a completely new approach to power generation and distribution by allowing the housing, in the same mainframe, of a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards.

- the **Board Section**, with 6 slots to house boards, distributors and branch controllers; "Low cost" version with 4 slots is available
- the **Fan Tray Section**, housing 3 fans arranged on two rows, with programmable rotation speed regulation;

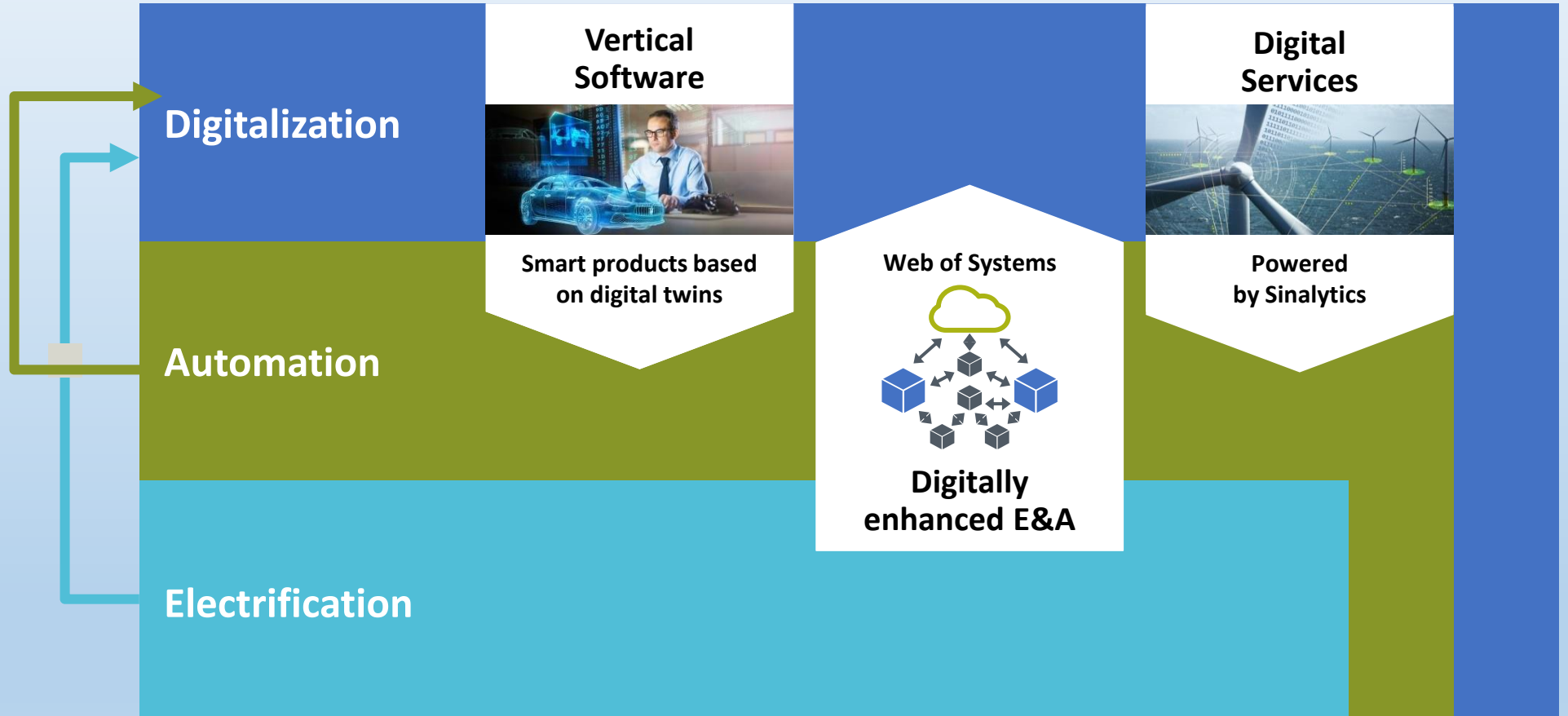




JINR

Scada solutions combine Digitalization with Automation and Electrification

SCADA is used to assist in automating and managing industrial processes that have become too complex or cumbersome for human monitoring and control. especially in cases where it is possible to improve efficiency.



Domain and product know-how for Digitalization



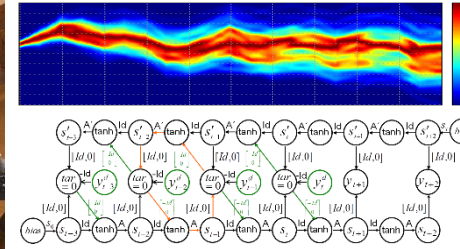
Areas of activity for SCADA: Technology and research Securing

Digitalization

Engineering & modeling & simulation & communication



Data analytics & monitoring



Security architectures

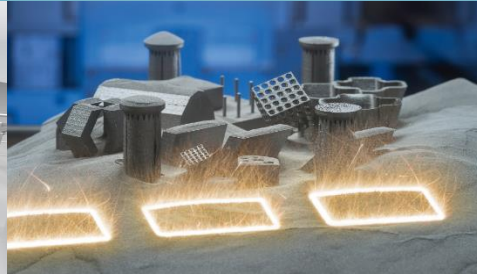


Automation

Future automation & sensors



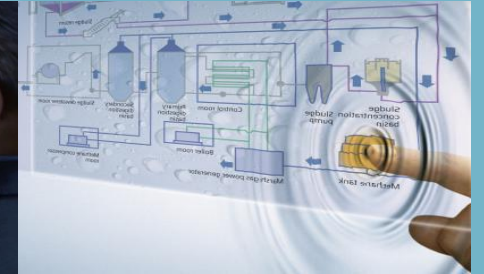
Additive manufacturing



Modern user interface design

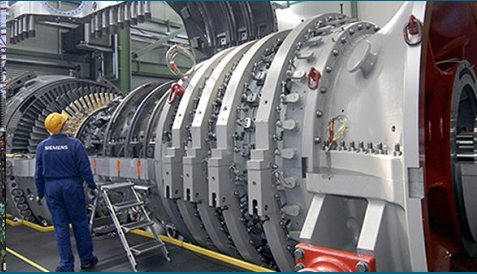


Enterprise IT

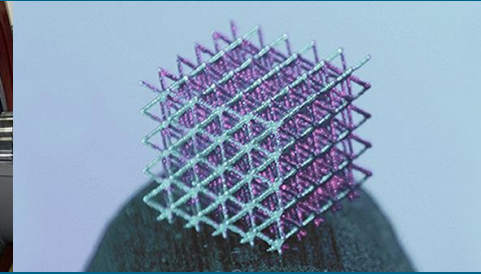


Electrification

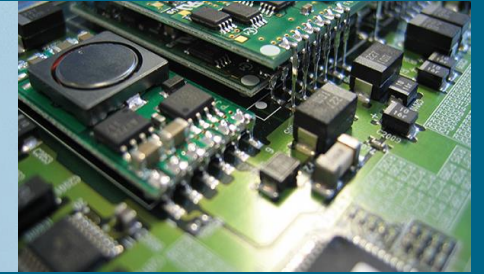
Smart grids & power electronics & switching technologies



Innovative materials & coatings



Electronic design





CAEN Control Software Models

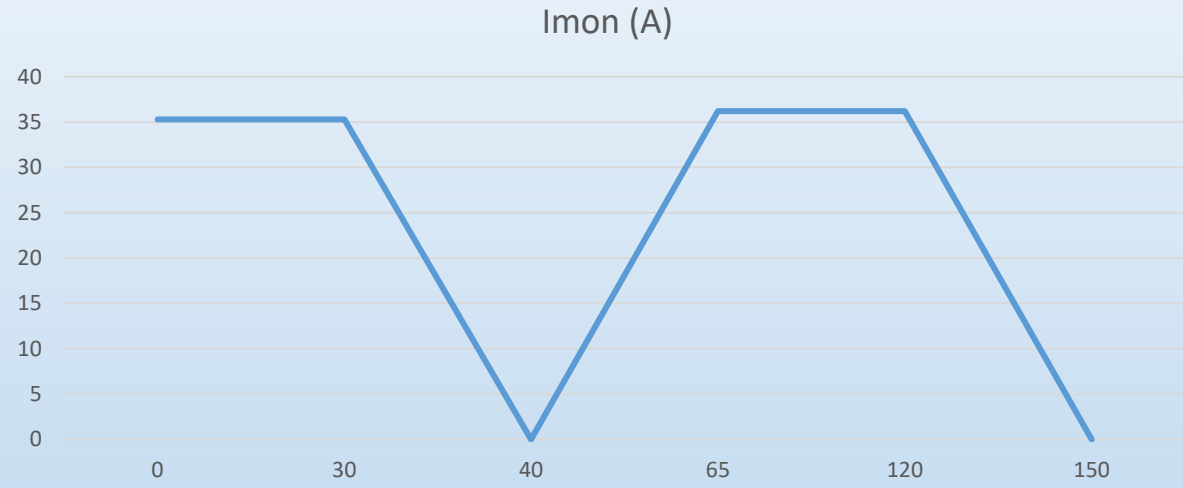
OPC Server for CAEN Power Supplies

- CAEN, in close collaboration with CERN, has developed an **OPC Server** which allows powerful, flexible and yet simple control of its power supply systems by any OPC compliant client application.
- OPC (OLE for Process Control) is an open interface based on the OLE/COM and DCOM technology; OPC offers “Plug & Play” connectivity between disparate hardware devices.





Relationship between Current and Time for Channel 3 Connected to Test Resistive Load





High Voltage Hardware SY4527





Results for HV and LV Control, Monitoring Using SCADA, GUI Interface for High Voltage

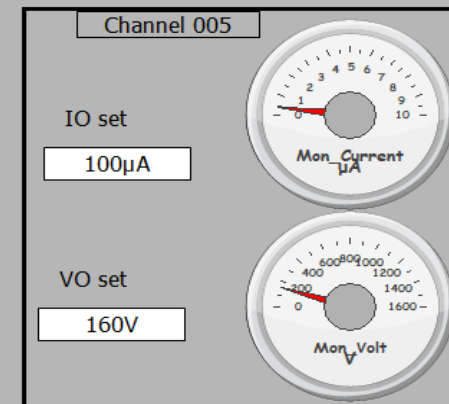
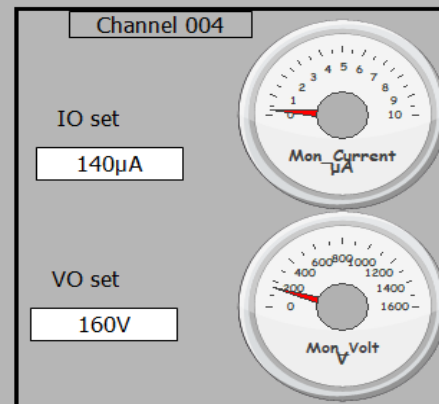
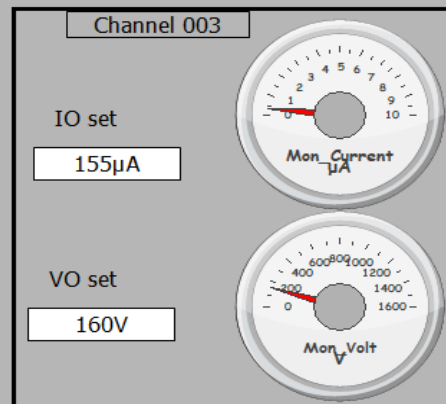
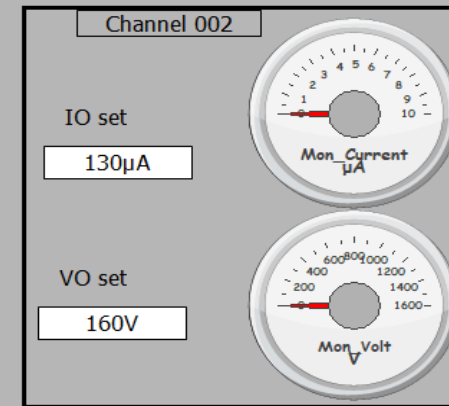
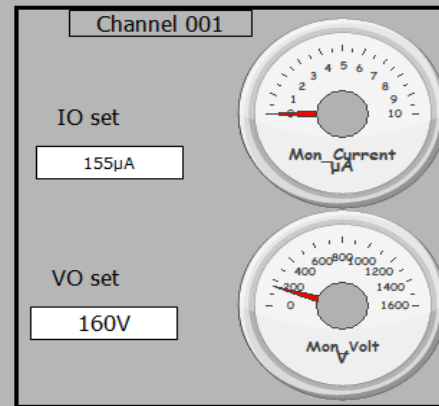
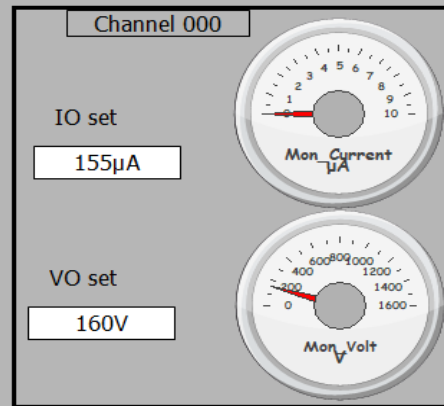


GUI

Exit

9:50:05 PM

2/7/2024





Interface for High Voltage Board 01 , Board 14



Hv_interface

Exit

9:34:41 PM

2/7/2024

Temperature of Board 1

32°C



Temperature of Board 14

10°C

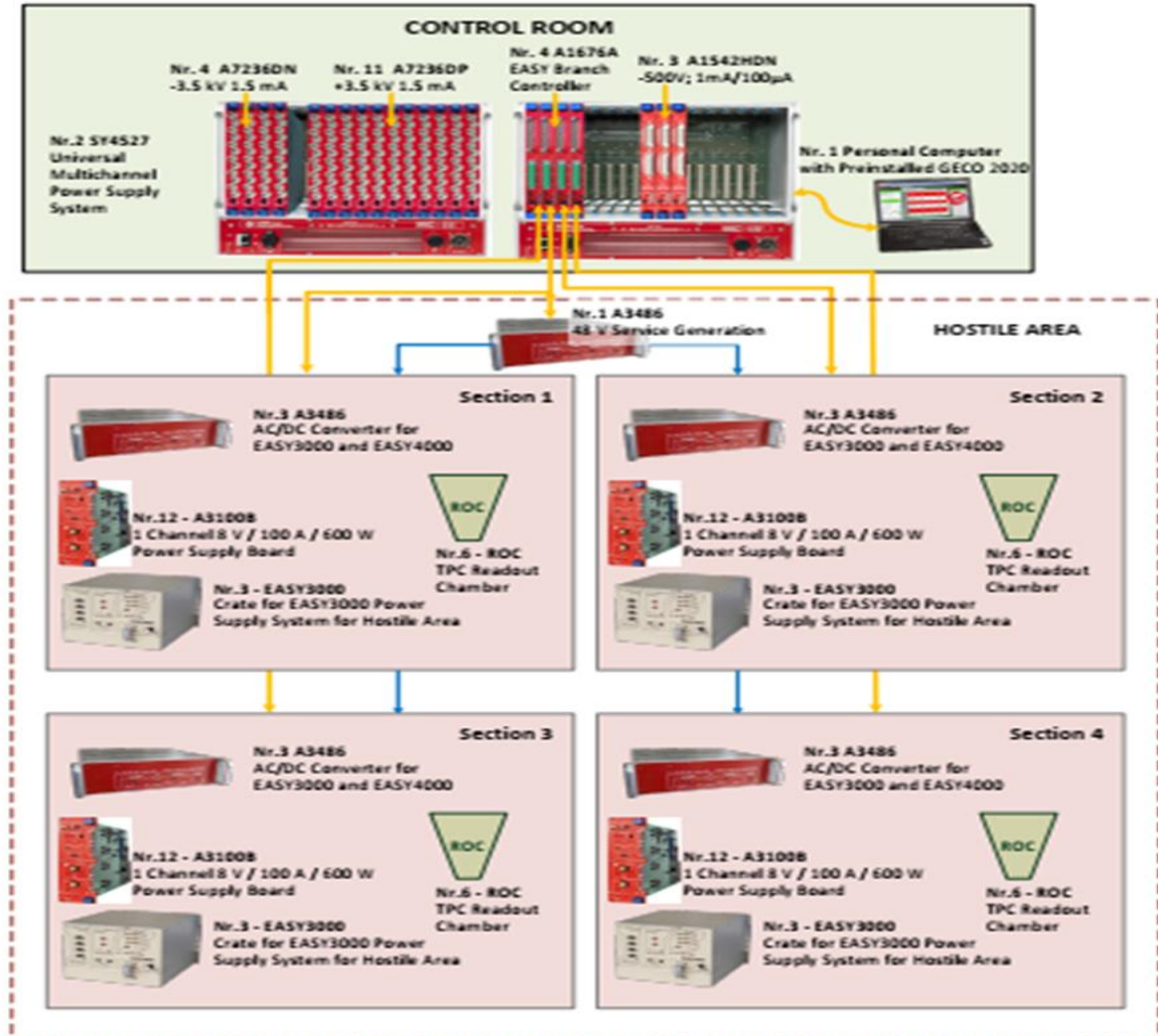


Clear Alarm

0000

Kill

0000





Interface for Low Voltage



lv_interface

Exit

7:46:07 PM
2/7/2024

Temperature of CH 00

32°C



Temperature of CH 02

37°C



Temperature of CH 04

31°C



Temperature of CH 06

32°C



12 PWS

48 PWS

CH00

0

0

CH02

0

0

CH04

0

0

CH06

0

0

CH08

0

Temperature of CH 09

31°C



Temperature of CH 10

33°C



Temperature of CH 11

0°C





High Voltage interface for Board _01

Project2 ▶ Advanced [SIMATIC PC station] ▶ HMI_RT_2 [WinCC RT Advanced] ▶ Screens ▶ High Voltage - B01

High Voltage _B01

HIGH VOLTAGE

Custom	Name	Power ON/OFF	Io set	Imon	Vo set	Vmon	Status	Rup	Rdn	Trip
B:01	CH000	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH001	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH002	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH003	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH004	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH005	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH006	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH007	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH008	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH009	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH010	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S
B:01	CH011	<input type="checkbox"/> OFF	+000μA	+000μA	+00000 V	+00000 V	0000	0000Vps	0000Vps	00S

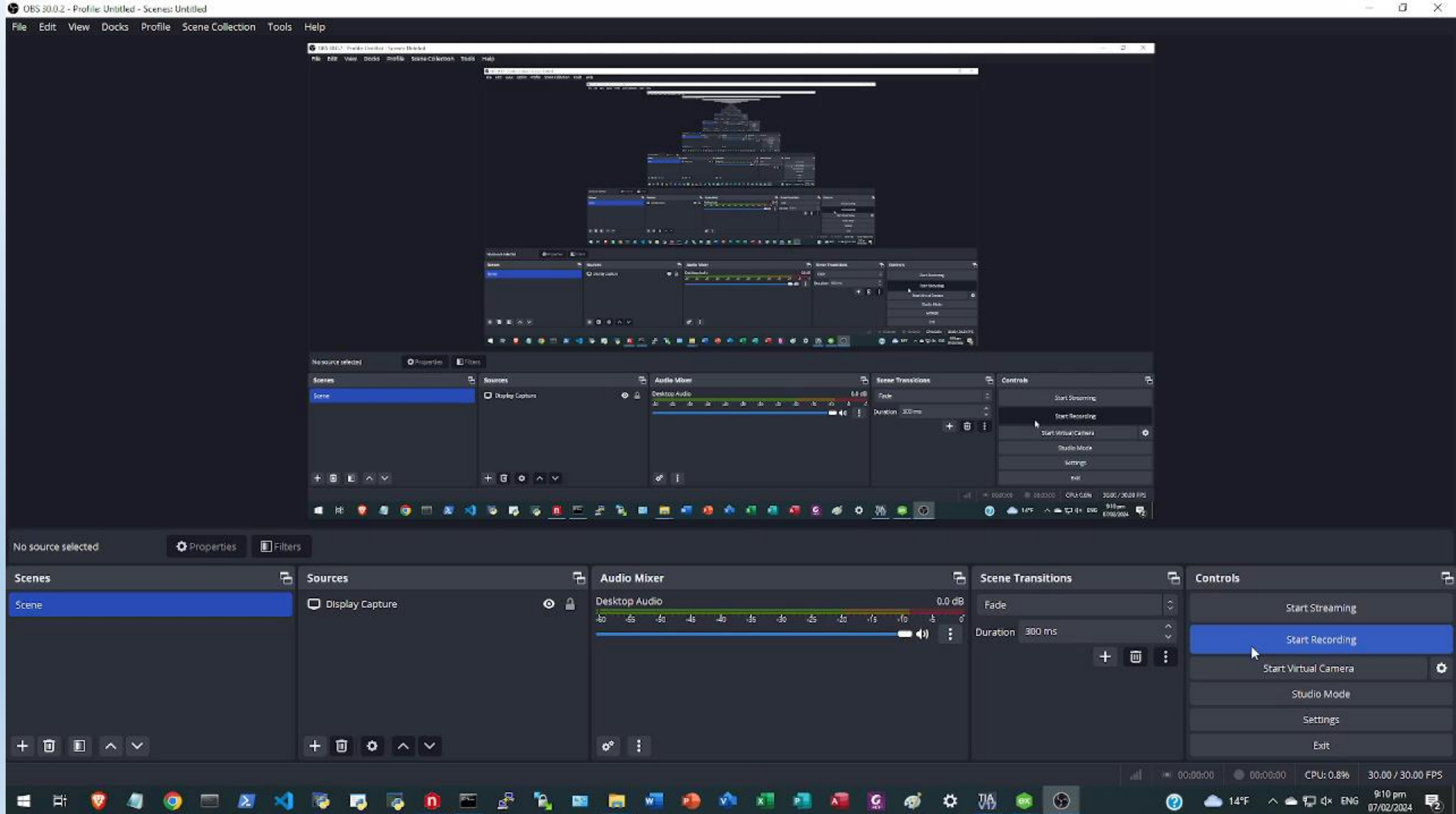


GUI interface for High Voltage, Board 01, Board 14

The screenshot displays the OBS Studio 30.0.2 interface. The main preview window shows a complex scene with multiple overlapping windows, including a terminal window at the top and several smaller application windows below. The interface is dark-themed. At the bottom, there are several docked panels: 'Scenes' (showing 'Scene' selected), 'Sources' (showing 'Display Capture'), 'Audio Mixer' (showing 'Desktop Audio' at 0.0 dB), 'Scene Transitions' (showing 'Fade' with a 300 ms duration), and 'Controls' (showing buttons for 'Start Streaming', 'Start Recording', 'Start Virtual Camera', 'Studio Mode', 'Settings', and 'Exit'). The Windows taskbar is visible at the very bottom, showing various application icons and system information like CPU usage (0.4%), FPS (30.00 / 30.00), and the date/time (10:03 pm, 07/02/2024).



GUI interface for Low Voltage





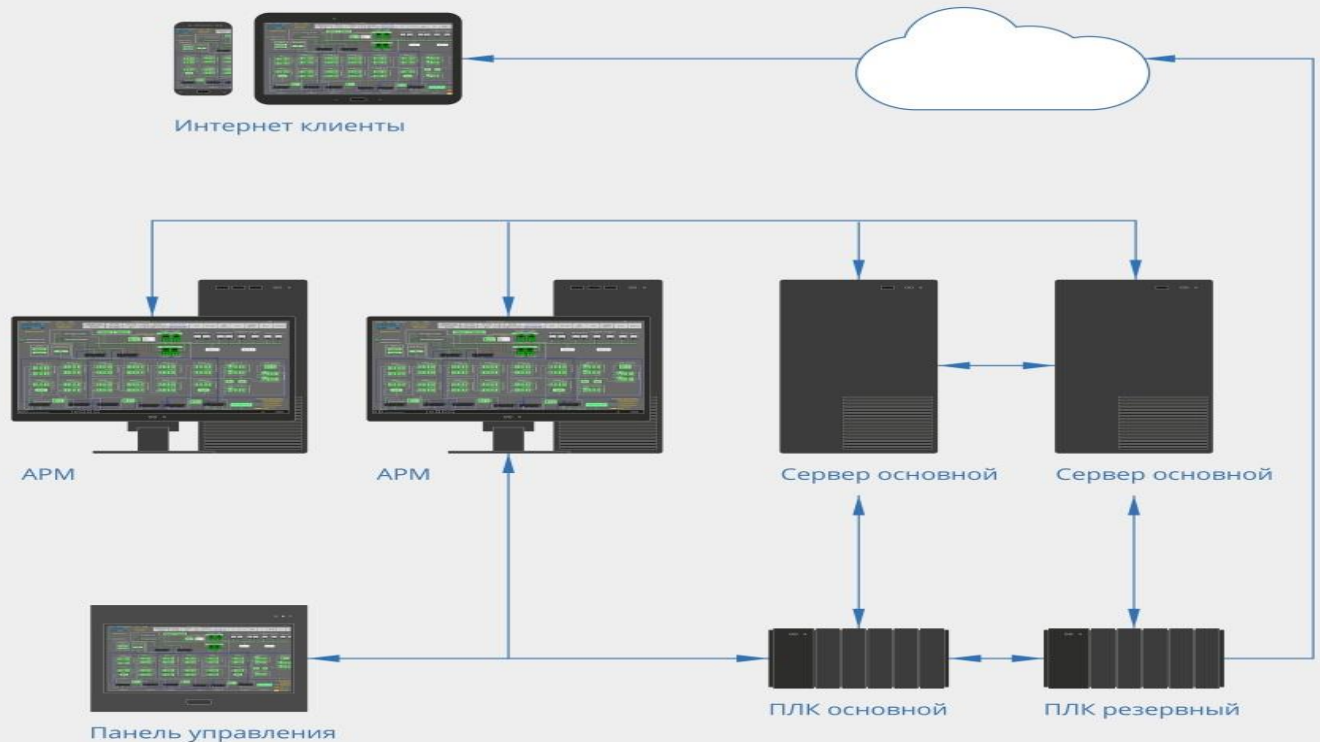
Master SCADA 4D – New Generation of SCADA

Master SCADA 4D is a product of a new generation of SCADA systems developed by MPS software. In it, compared to the previous version, the tools for creating large distributed systems with the ability to use Internet of Things technologies are significantly expanded.

Such integration assumes that all levels of the management system are included in the project.

These are levels like:

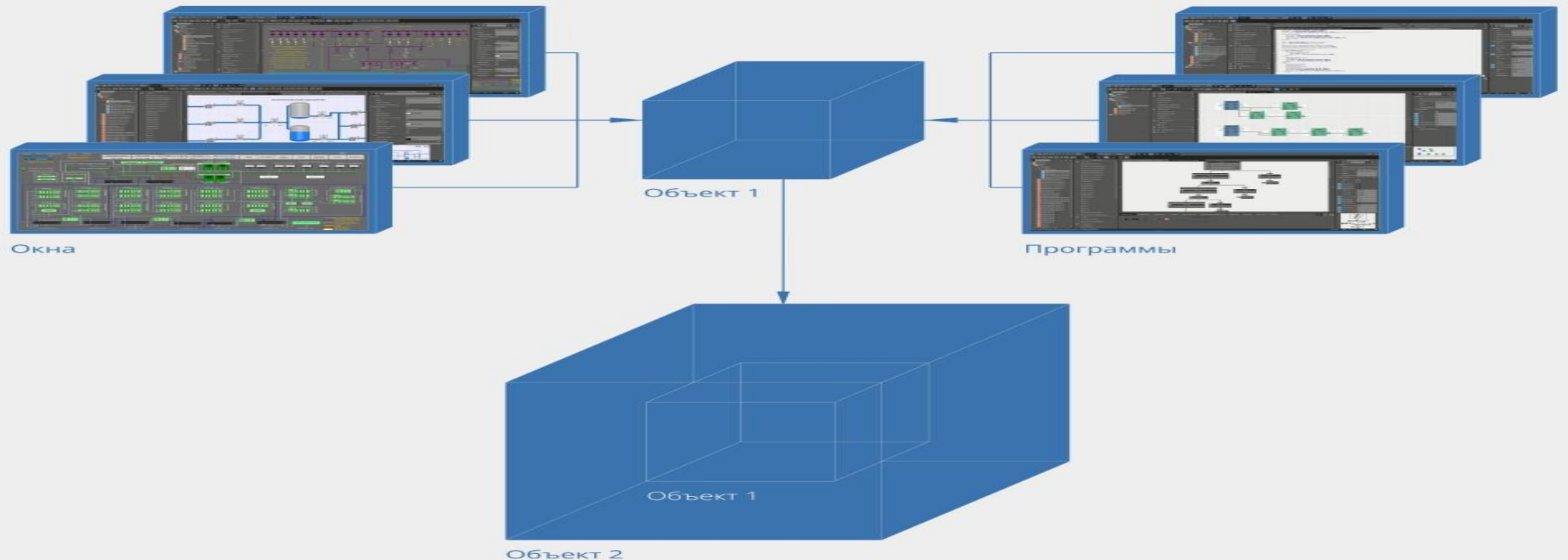
- programmable controllers;
- local HMI panels;
- Operators' workstations;
- Servers
- Cloud services.





Master SCADA 4D – New Generation of SCADA

Objects in Master SCADA 4D are understood as a named set of graphical representation of a technological object, its parameters, monitoring and control algorithms, control windows and other available project elements (including other objects).





Results for HV and LV Control, Monitoring Using Master SCADA, Main window Interface.

The screenshot displays the MasterSCADA 4D 1.3 software interface. The main window shows a circular control panel with two sections: "West Side" and "East Side". Each side contains 12 ROCs (Remote Operation Control) labeled W ROC1 through W ROC12 and E ROC1 through E ROC12. The ROCs are arranged in a circle, with each ROC having a central indicator light. Below the ROCs, there are control buttons for "Power All", "VOSet All Positive", "SVmax All Positive", "VOSet All-Negat...", and "SVmax All Negative". A legend on the right side of the interface shows four indicator lights: red for "Error", yellow for "Ramp Up Down", green for "All ON", and white for "All OFF". The interface also includes a menu bar, a toolbar, and a project tree on the left side.

Objects: MainControl, Главное окно

Power All	VOSet All Positive	SVmax All Positive	VOSet All-Negat...	SVmax All Negative
On All	Off All	text in... Set All	text in... Set All	text in... Set All

Палитра
Палитра Легенда



High Voltage interface

W ROC 1

Name	Power	VOSet	IOSet	Vmon	Imon	Status	Trip	SVmax
	On All Off All	text in... Set All P				Help		text in... Set All P
A1.CH000.Block1 (PID:27072)	PowerOn/Off	0 V	0 uA	0	0 uA	Up Down 0	0	0 edit
A2.CH001.Block1 (PID:27072)	PowerOn/Off	0 V	0 uA	0	0 uA	Up Down 0	0	0 edit
A3.CH002.Block1 (PID:27072)	PowerOn/Off	0 V	0 uA	0	0 uA	Up Down 0	0	0 edit
A4.CH003.Block1 (PID:27072)	PowerOn/Off	0 V	0 uA	0	0 uA	Up Down 0	0	1420 edit
- CE.CH000.Block14 (PID:20698)	PowerOn/Off	0 V	0 uA	0	0 uA	Up Down 0	0	0 edit



Low Voltage interface

Low Voltage

ROC1 A Graph

Name	PowerON/OFF	IOSet	Imon	VOSet	Vmon	Status	Temp	Trip	SerNum	RemBdName
CH000	OnAll OffAll	Amper	Amper	Voltage	Voltage		C	sec		
CH001	ON	0 A	0	0 V	0	Unlodge OVC Tripped		0		
CH002										
CH003	ON	0 A	0	0 V	0	Unlodge OVC Tripped		0		
CH004										
CH005	ON	0 A	0	0 V	0	Unlodge OVC Tripped		0		
CH006										
CH007	ON	0 A	0	0 V	0	Unlodge OVC Tripped		0		
CH008										
CH009	Main PowerON/OFF	0 A	0 A	0 V	0 V	Unlodge OVC Tripped	0 C	0 sec		
CH010	Power	0 A	0 A	0 V	0 V	Unlodge OVC Tripped	0 C	0 sec		



Data Transfer from Master Scada to the database of PostgreSQL16

The screenshot displays the pgAdmin 4 interface for a PostgreSQL 16 database. The left-hand Object Explorer shows the database structure, with the 'public' schema and its tables expanded. The main query window contains the following SQL query:

```
1 select value,name from data_raw,items
```

The bottom pane shows the 'Data Output' tab with the following results:

	value double precision	name character varying (2000)
1	0	Объекты.MainControl.HighVoltage.SY4527.IOSet.Block01000.Channel00.IOSetChannel00Re...
2	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.Vmon 1
3	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.Imon 1
4	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan000.Imon
5	0	Объекты.MainControl.HighVoltage.SY4527.IOSet.Block01000.Channel01.IOSetChannel01Re...
6	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.V0Set 1
7	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan000.Vmon
8	0	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan000.V0Set 1
9	155	Объекты.MainControl.HighVoltage.SY4527.IOSet.Block01000.Channel00.IOSetChannel00Re...
10	155	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.Vmon 1
11	155	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.Imon 1
12	155	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan000.Imon
13	155	Объекты.MainControl.HighVoltage.SY4527.IOSet.Block01000.Channel01.IOSetChannel01Re...
14	155	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan001.V0Set 1
15	155	Объекты.MainControl.HighVoltage.SY4527.Board01.Chan000.Vmon



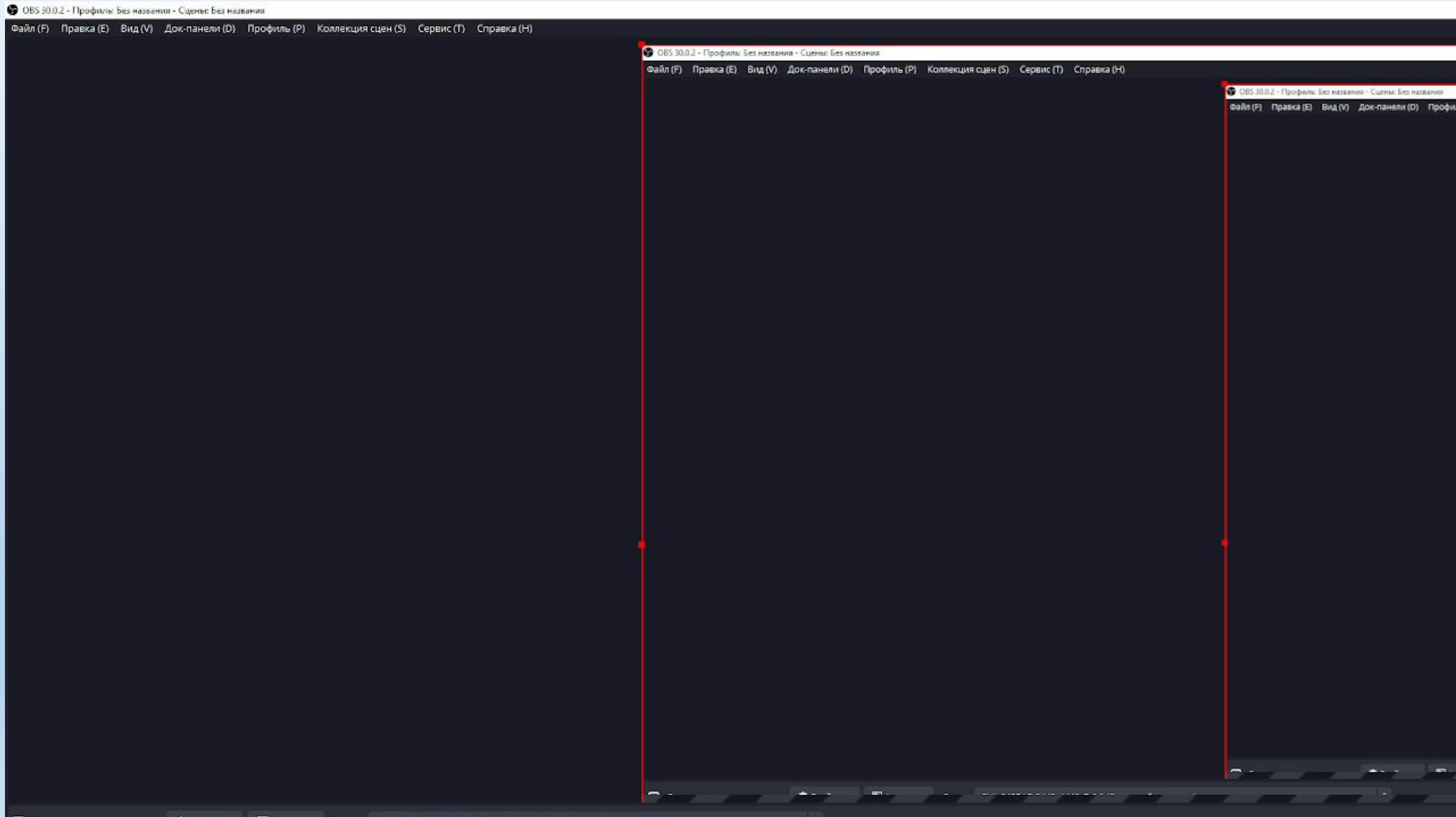
Roc 1 HV Monitoring for Current, Temperature, Voltage, Versus Time

ROC1 A Graph



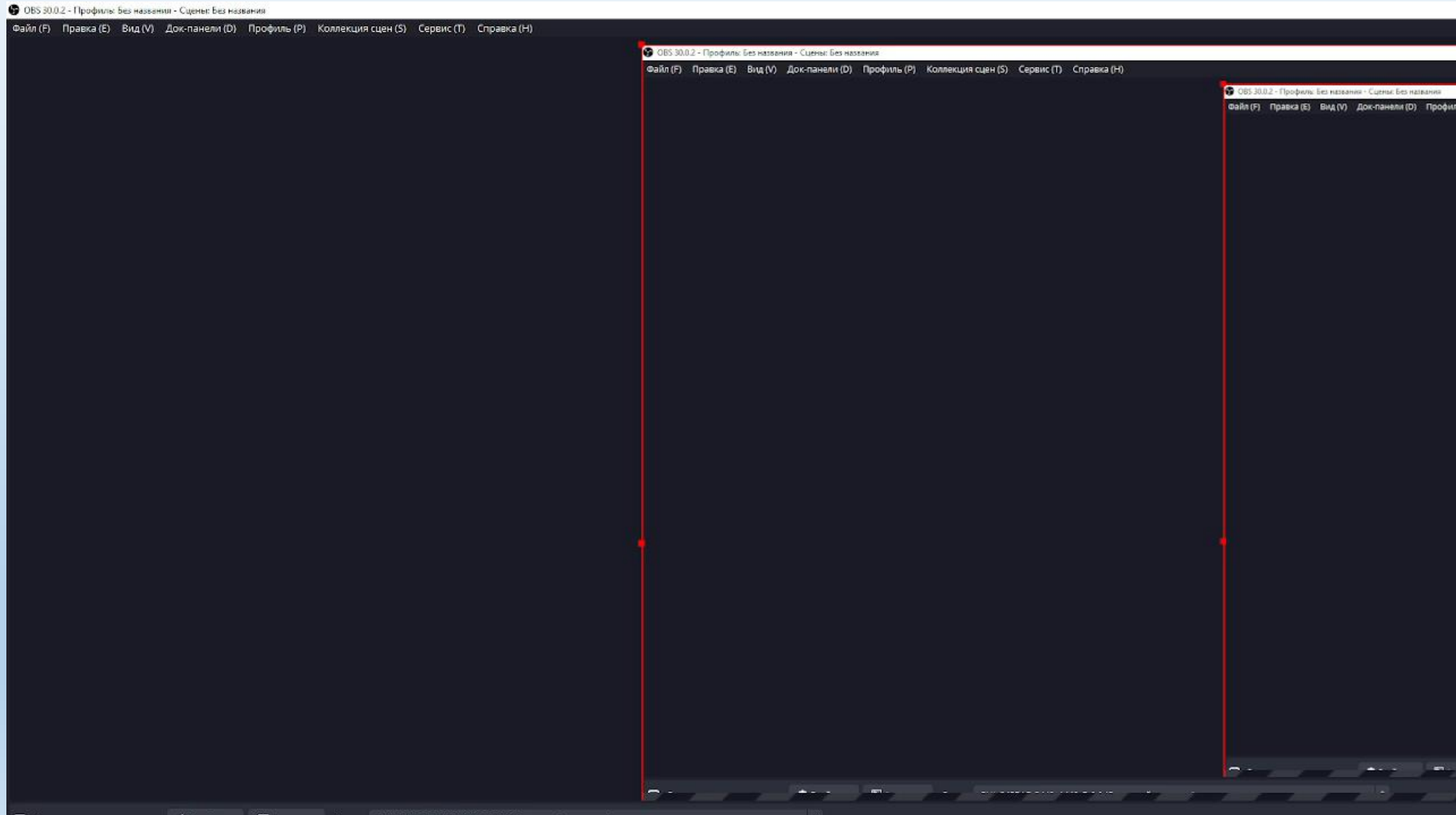


Low Voltage GUI interface





High Voltage GUI interface



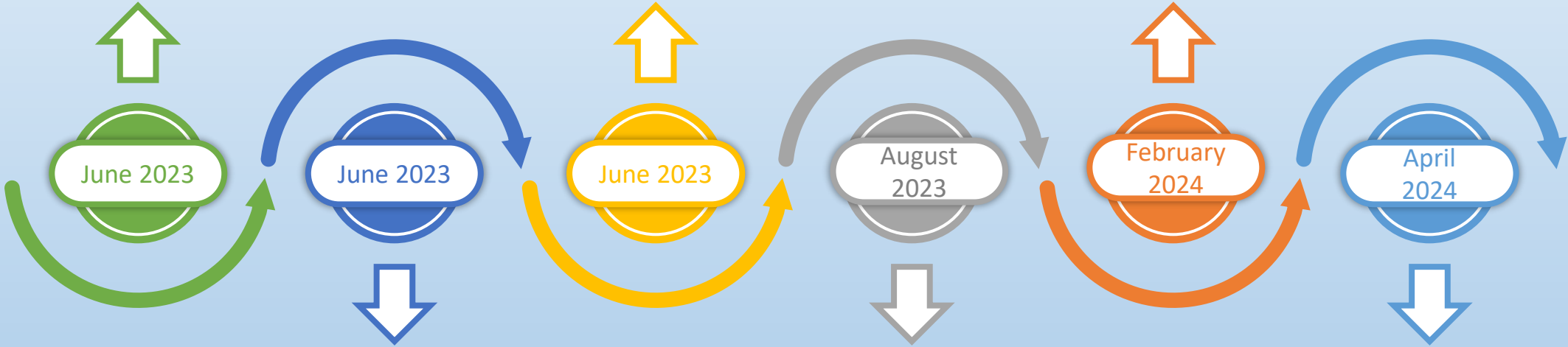


Time Frame

1. Connect between Server, Client to our Mainframe.

3. Read Data from modules through the Mainframe.

5. Create a graphic user interface (GUI) for TPC LV+HV subsystem



2. Install software tools used for control and monitoring variety of parameters.

4. Control and read data using Tango and OPC Server Tools.

6. Test and improve GUI



Conclusion

- Our main goal is to create software using the tools of Master Scada ,Scada software and the CAEN OPC server for control and monitoring of all the parameters of high- and low-voltage TPC subsystem.
 1. Connect the server, client, and CAEN Mainframe.
 2. Install software tools used for controlling and monitoring a variety of parameters.
 3. Control and read data using SCADA and OPC Server Tools.
 4. Create a graphic user interface (GUI) for the TPC LV+HV subsystem.
- Create, test and optimize a graphic user interface (GUI) for TPC LV+HV subsystem. To do GUI for each TPC subsystem. combine the GUIs for each TPC subsystem to control and monitoring TPC detector (TPC DCS).

Acknowledgement

I am grateful to everyone who helped me with this research.

I would like to convey my heartfelt gratitude to Dr. Sergey Movchan, Dr.Alexander Pillar, and Vlad Chepurnov for their tremendous support and assistance in the completion of our Research work and Poster.

Stay Tuned!
More Details Coming Soon...



Thanks for your Attention

Full Name

Youmna Ghoneim

Tel.: +7 (923) 40 80 895

E-mail: yumnasami24@gmail.com, Ghoneim@jinr.ru

08.02.2024

Scan here for PPT



Telegram Contact

