MPD MONITORING AND CONTROL SYSTEM – PRESENT STATUS AND PROSPECTS

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MAIN TASKS

- Monitoring of the diverse experimental hardware

(High Voltage, Low Voltage, Gas systems, Temperature,

Humidity, Pressure sensors, etc.)

- Alarm system
- Archiving data from devices
- Centralized control of the equipment

PECULIARITIES OF THE MPD SLOW CONTROL

- Long historical background of Slow Control hardware and software in subdetectors groups;
- Weak “connections” between subdetector groups concerning SC equipment/software;
- Extremely heterogeneous set of equipment to be monitored/controlled;
- Slow Control typically being developed later than major parts of all subdetectors -> requires easy scalability.

FFD - Fast Forward Detector

TOF - Time of Flight system

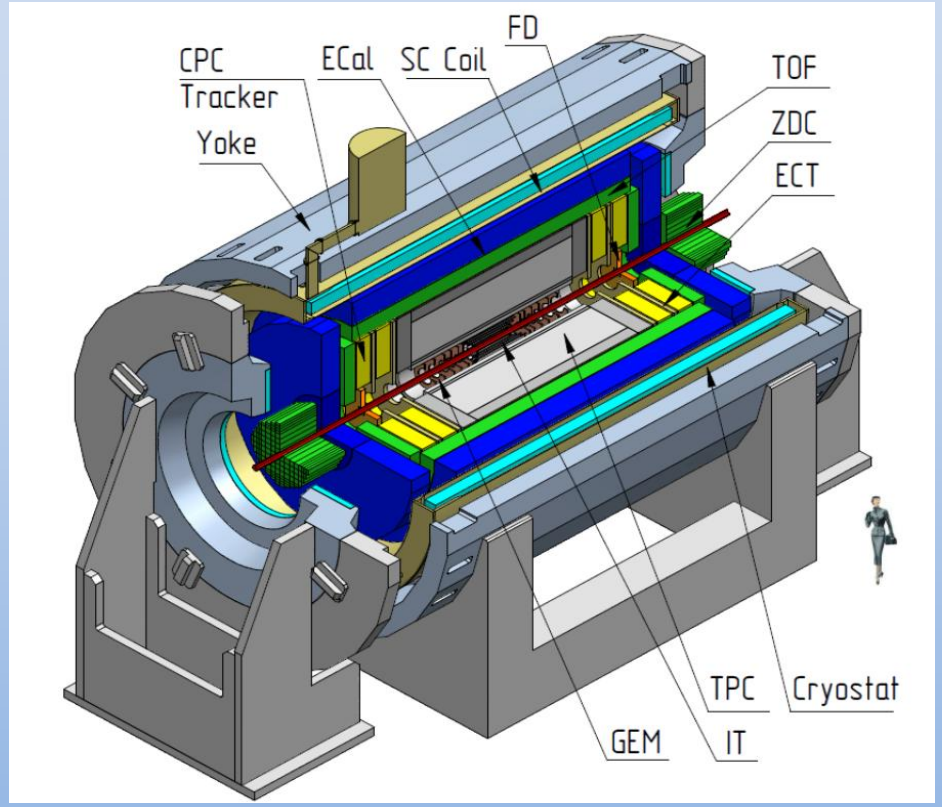
TPC - Time Projection Chamber

Ecal - Electromagnetic CALorimeter

CPC tracker - Cathode Pad Chamber

DCH -Drift CHambers

ZDC - Zero degree Calorimeter tracker



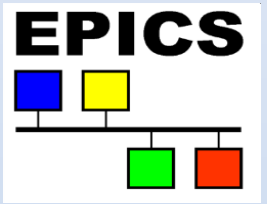
MAIN GOALS OF THE SYSTEM DEVELOPMENT

- Reliability – monitoring of hardware and software operation;
- Storage of Slow Control data in unified format;
- Common Slow Control configuration database for all subdetectors (HV, thresholds etc.);
- Easy incorporation of existing subsystems and new hardware;
- Modern and easily customizable user interface;
- Scalability;
- [Centralized as much as possible and reasonable] control of diverse hardware;
- Access control.

TANGO VS EPICS VS COMMERCIAL SCADA

Criteria:

- entry level complexity;
- existence of wide active collaboration;
- open source / price;
- support price;
- …



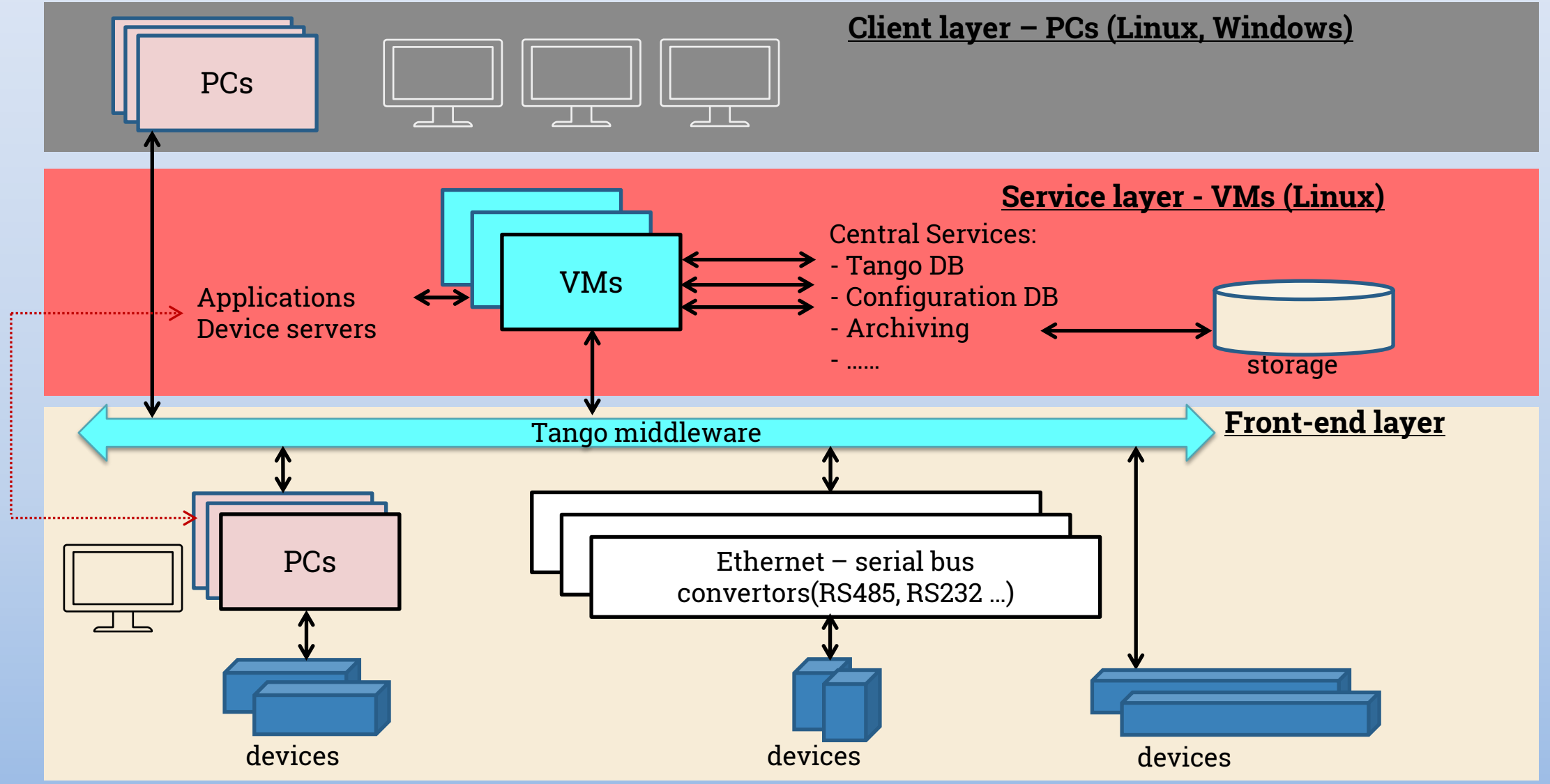
Tango:

- Already used LHEP accelerator complex;
- Open source;
- Competitive support price;
- JINR is a member of Tango Controls community.

All mentioned SCADA systems are mature and can fulfil requirements of large physical experiment.

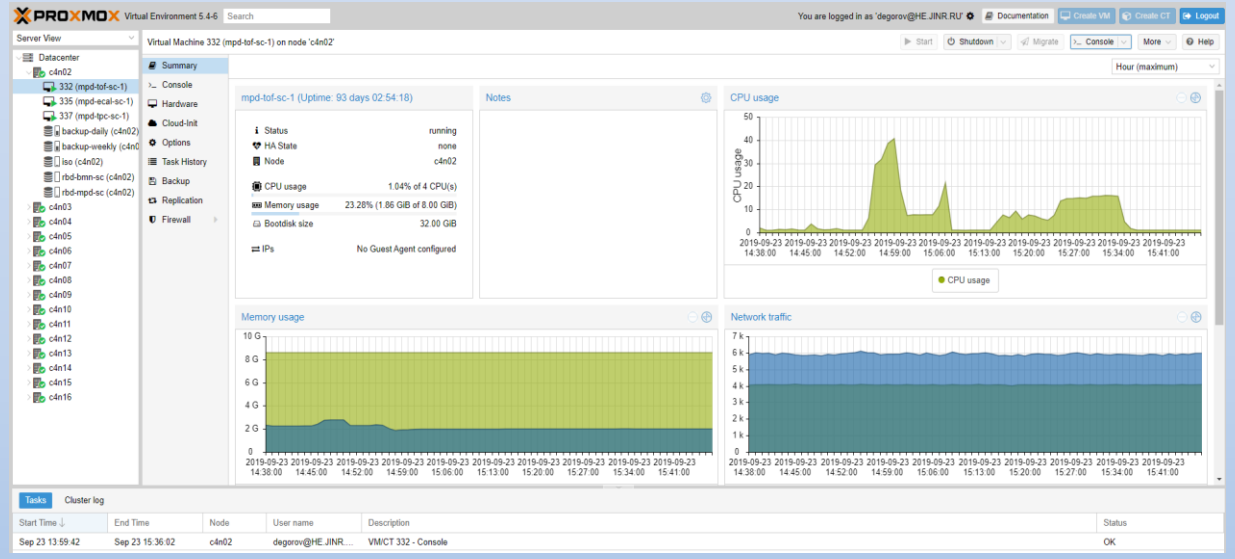
The most important point - team of people who can implement the system.

TANGO-BASED SCS SCHEME



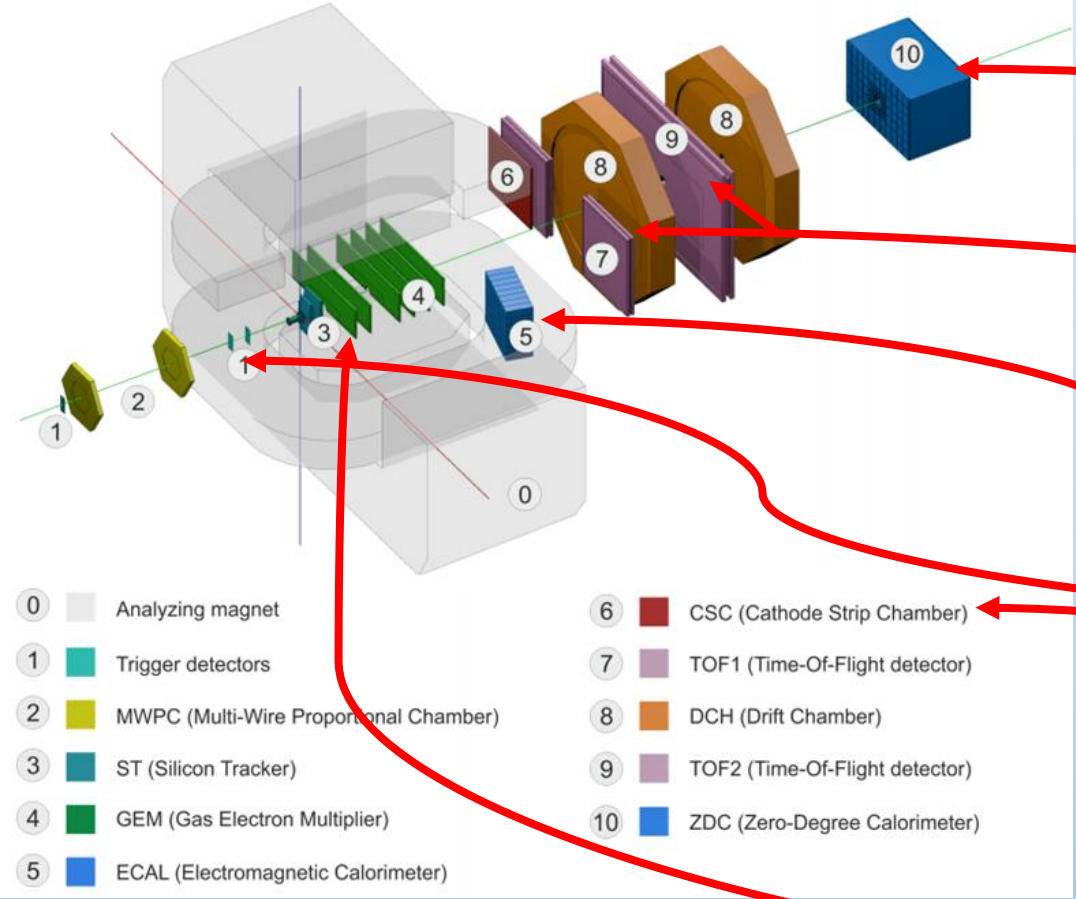
INFRASTRUCTURE – COMPUTING, DEVICES, INTERFACES

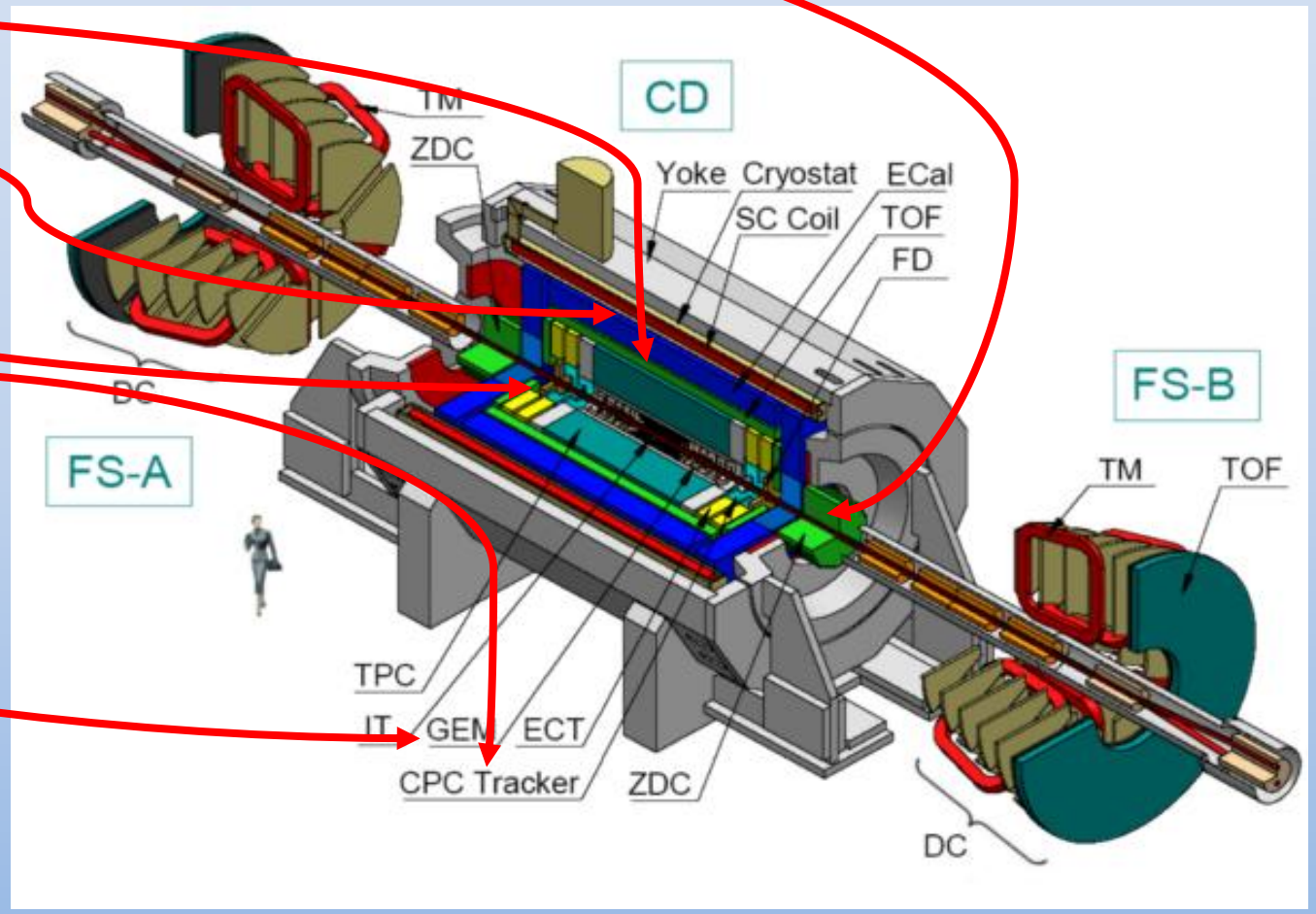
- Service layer tasks uses existing MPD computing farm.
- Virtualization is done using PROXMOX Virtual Environment.
- All centralized services are running on dedicated VM’s



Front-end layer includes a wide variety of devices which are uses different buses and protocols, such as Ethernet, RS-485, RS232 etc. etc.

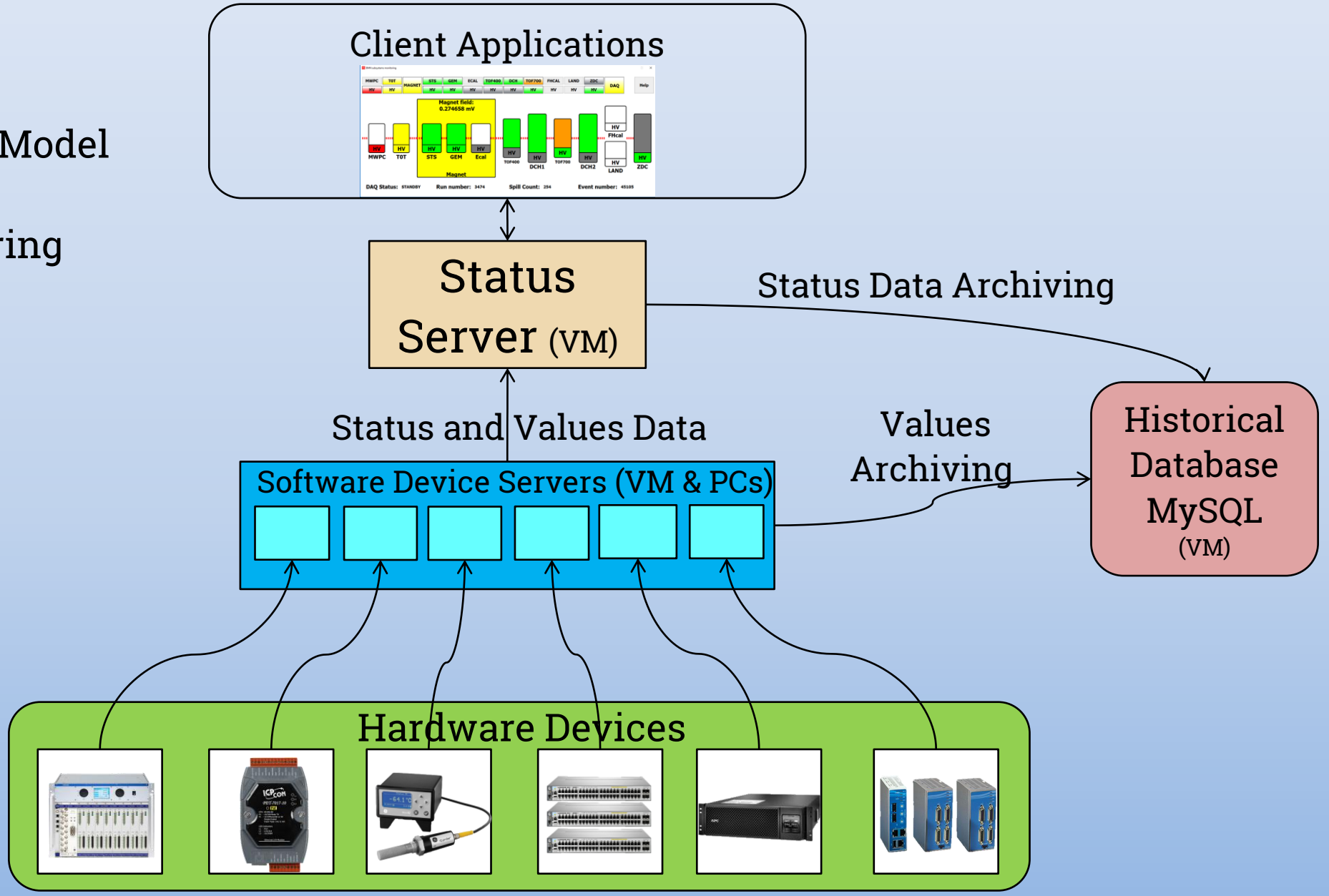
BM@N ↔ MPD


0 Analyzing magnet
1 Trigger detectors
2 MWPC (Multi-Wire Proportional Chamber)
3 ST (Silicon Tracker)
4 GEM (Gas Electron Multiplier)
5 ECAL (Electromagnetic Calorimeter)
6 CSC (Cathode Strip Chamber)
7 TOF1 (Time-Of-Flight detector)
8 DCH (Drift Chamber)
9 TOF2 (Time-Of-Flight detector)
10 ZDC (Zero-Degree Calorimeter)


CD
TM
ZDC
Yoke
Cryostat
ECal
SC Coil
TOF
FD
FS-A
FS-B
TM
TOF
TPC
IT
GEM
ECT
CPC Tracker
ZDC
DC

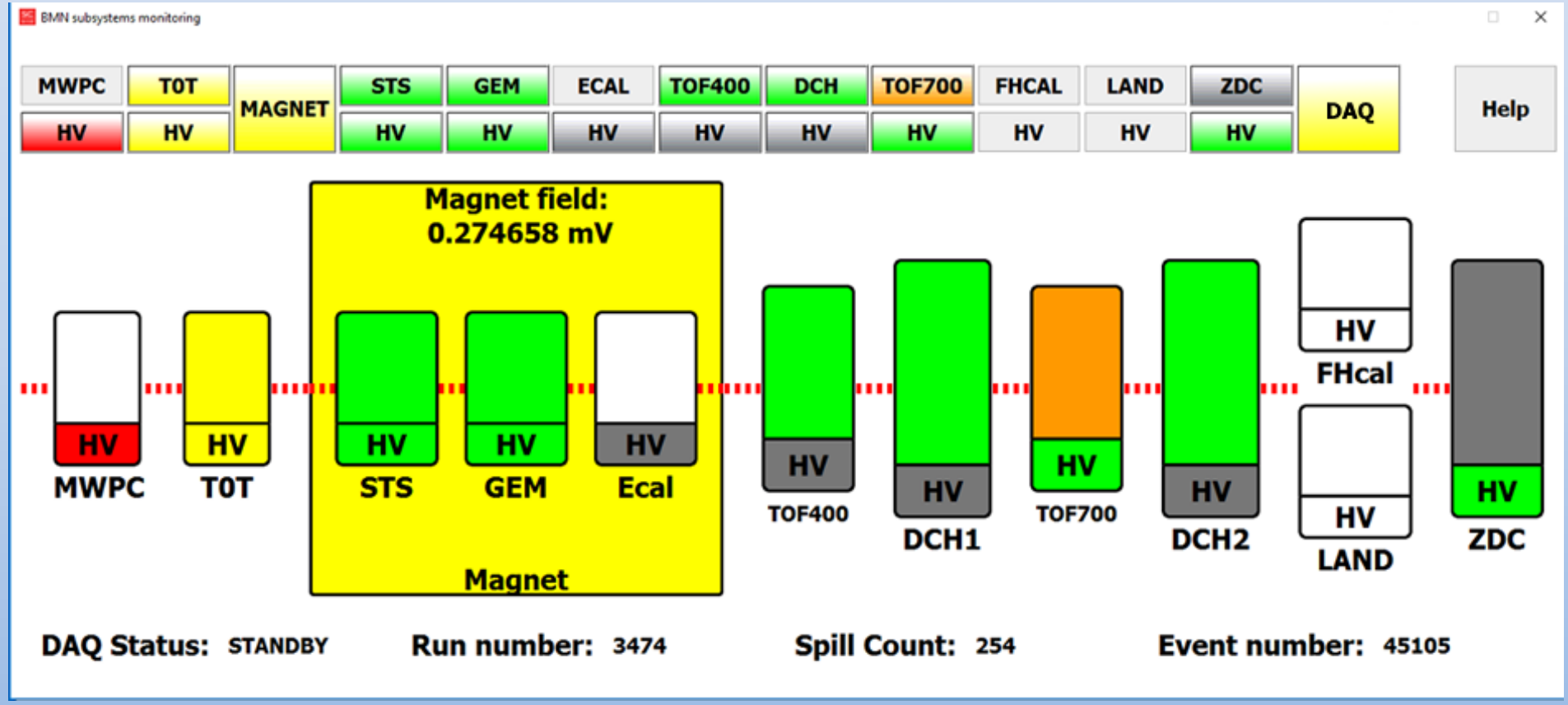
BM@N STATUS MONITORING SYSTEM

- Client - Server Model
- Event Based
- Online Monitoring
- Alarms
- Customizable
- Scalable



BM@N STATUS MONITORING SYSTEM

The Device Server and GUI application were developed to monitor the statuses of experiment subsystems.
Event-based system subscribes to “State” and “Status” attributes and sort information according to the device type and detector. Client is based on Python3 + PyQt4.



Data acquisition is ready (not started)

BM@N STATUS MONITORING SYSTEM

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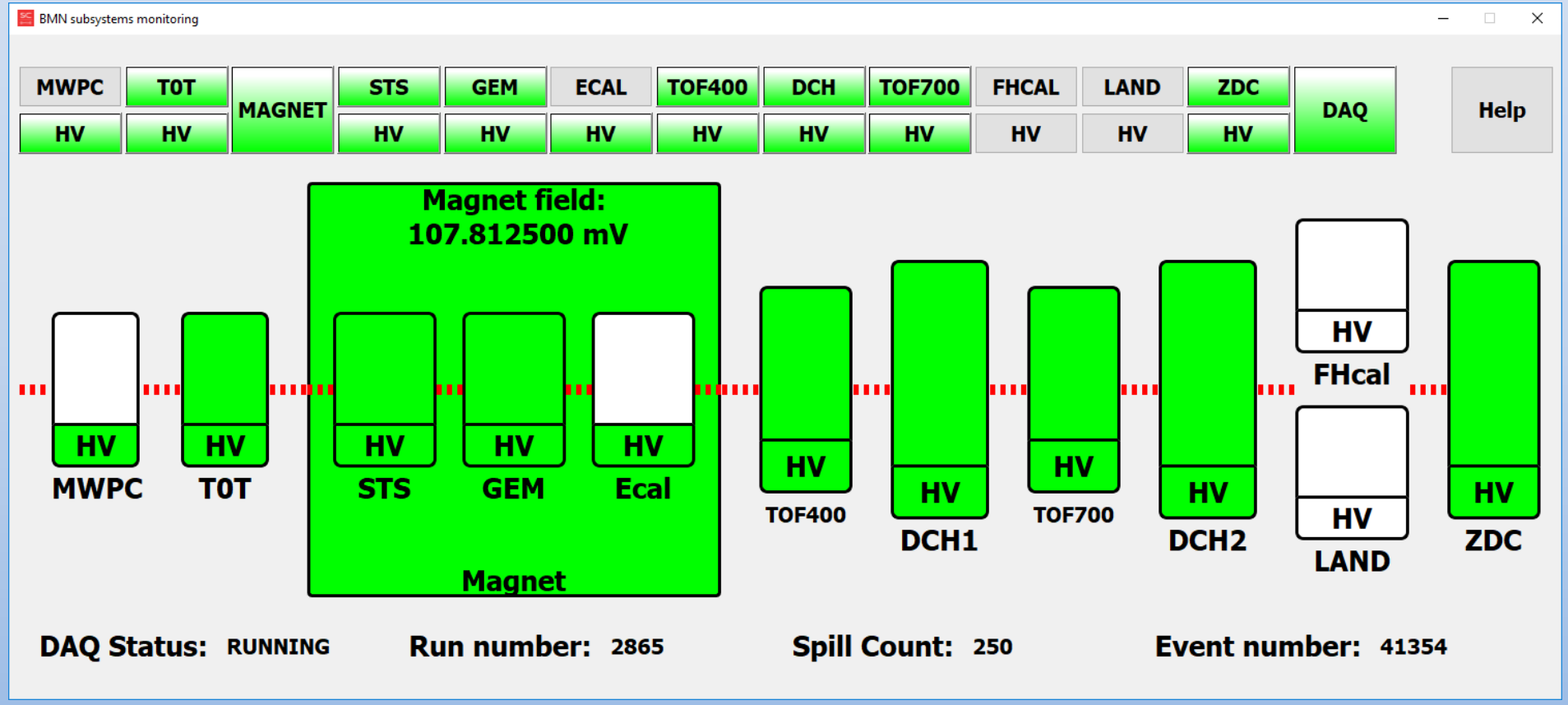
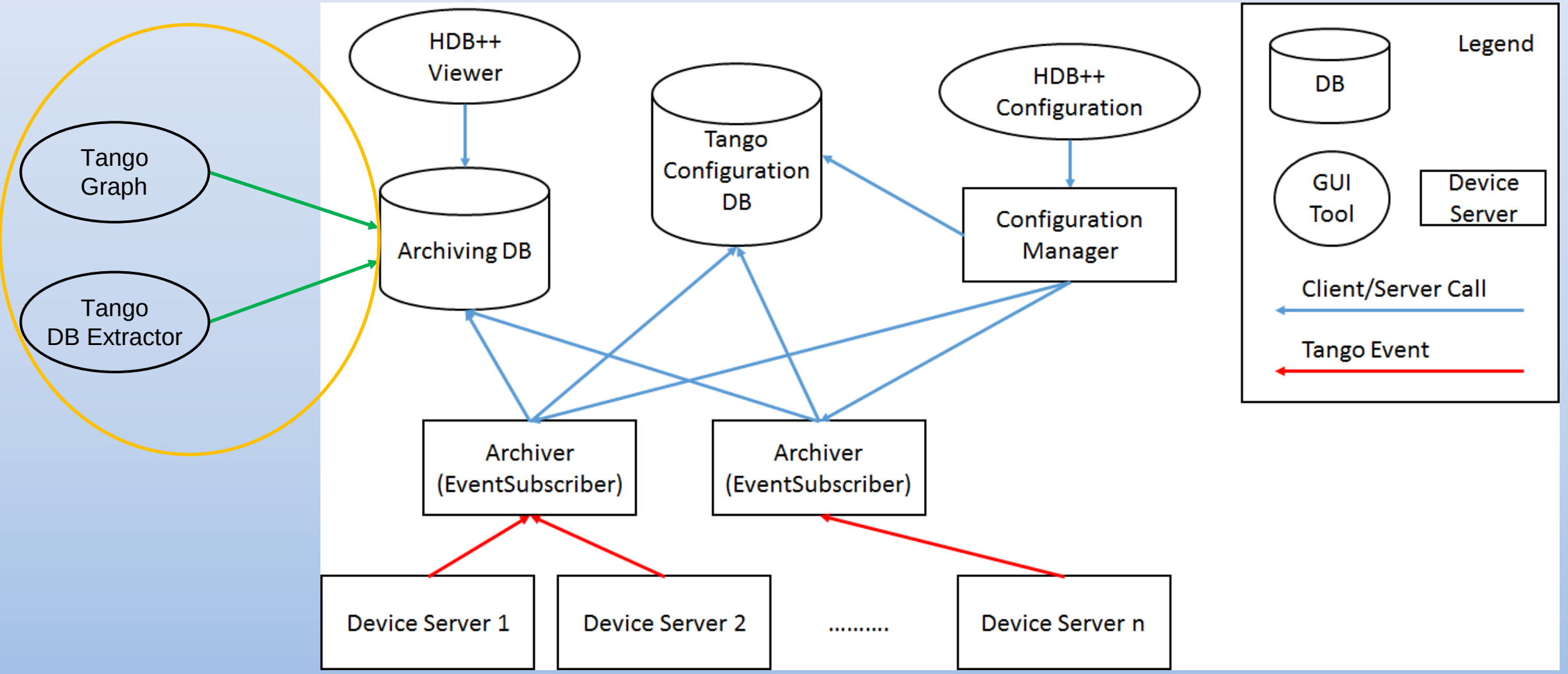
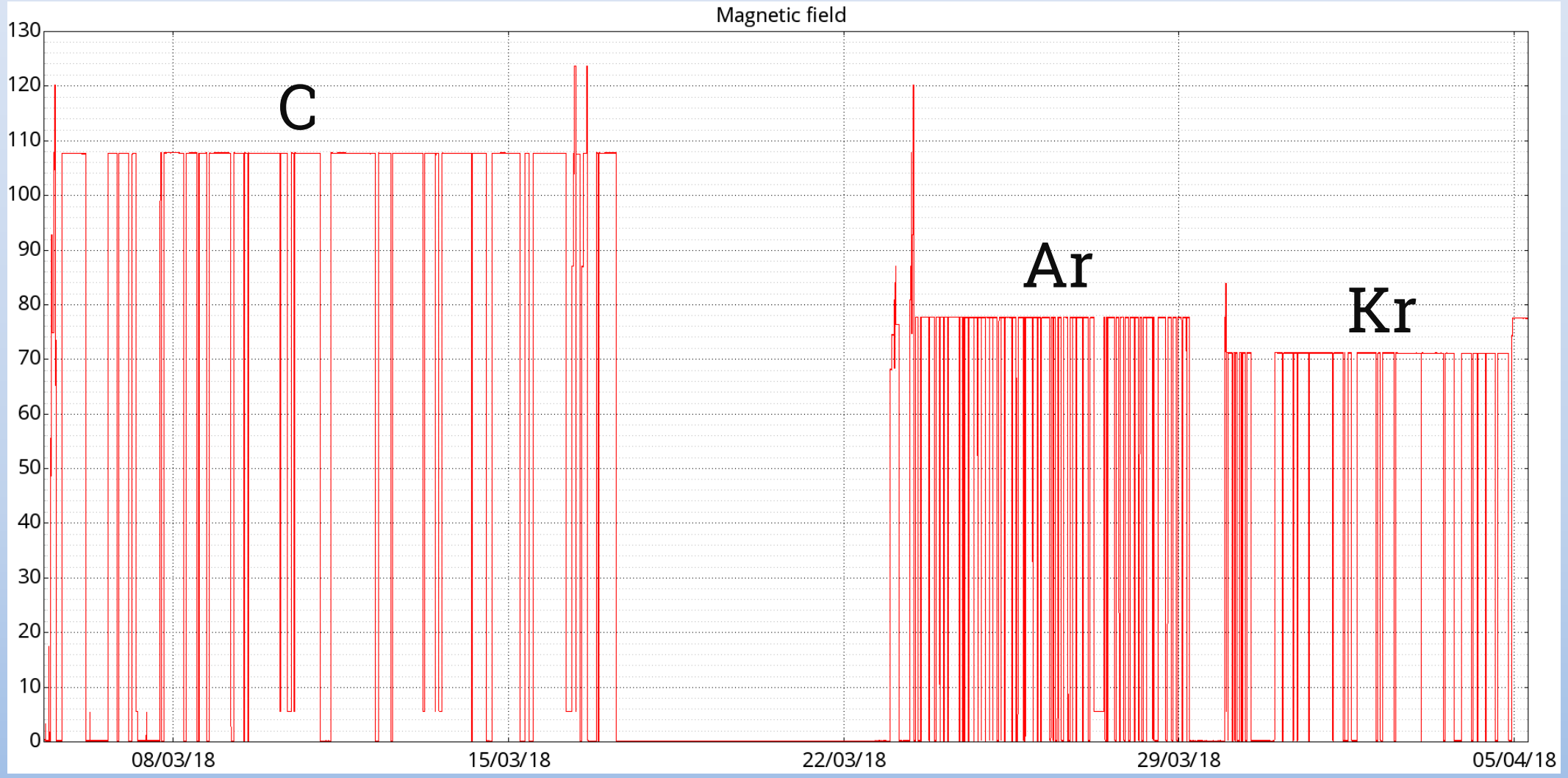


Data acquisition is running

DATA ARCHIVING SYSTEM



EXAMPLE OF ARCHIVED DATA

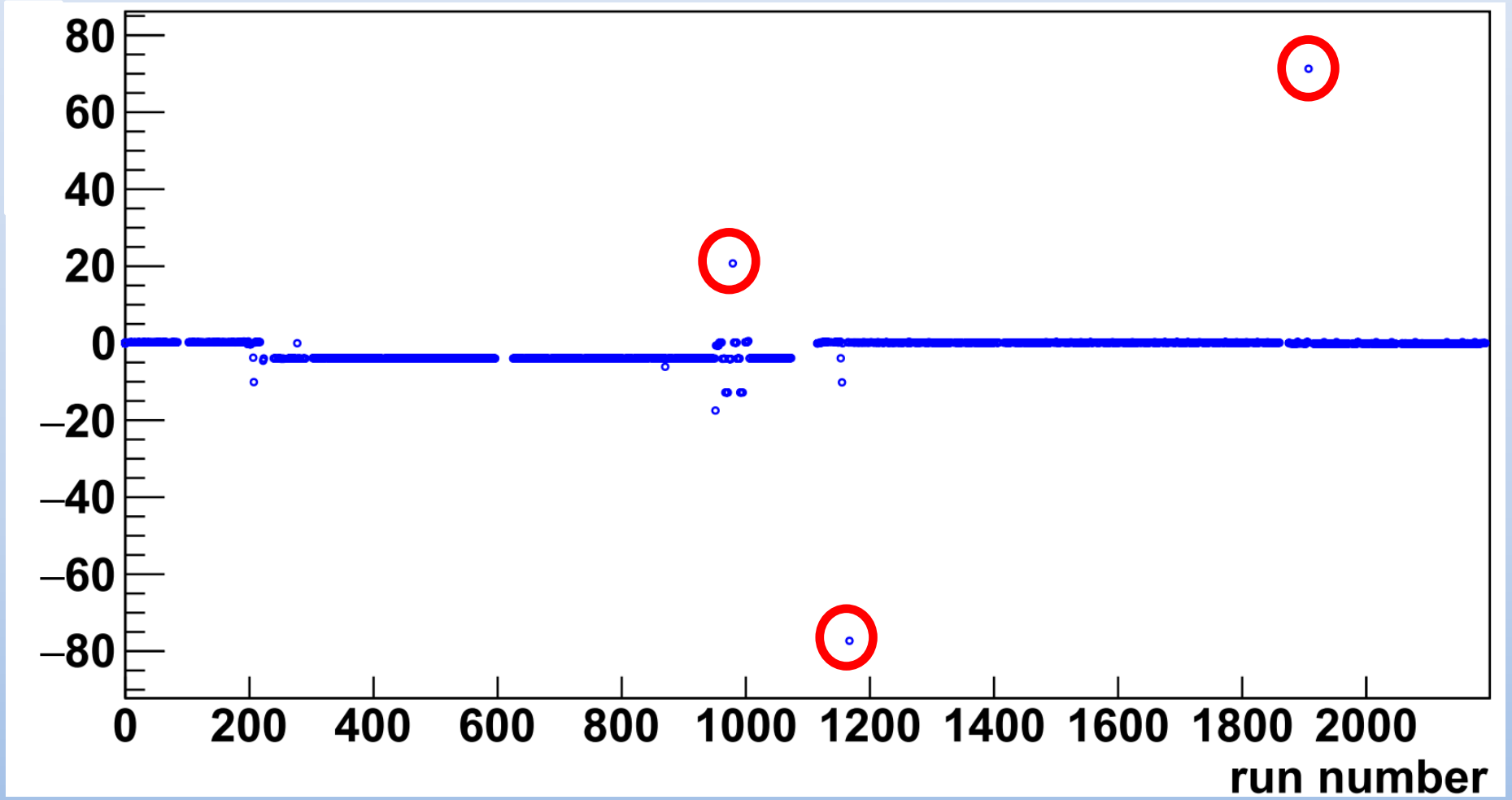


The Hall sensor's values are read via ADC ICP DAS PET-7017-10.

- Modbus TCP
- 16 bit

SP-41 magnetic field archived data in 55th Nuclotron run

MAGNETIC FIELD ARCHIVED DATA VS LOGBOOK



Difference between LogBook values and archived values

Data from devices is used in offline analysis.

This plot shows the delta between saved measurements and LogBook values, entered manually during the shift.

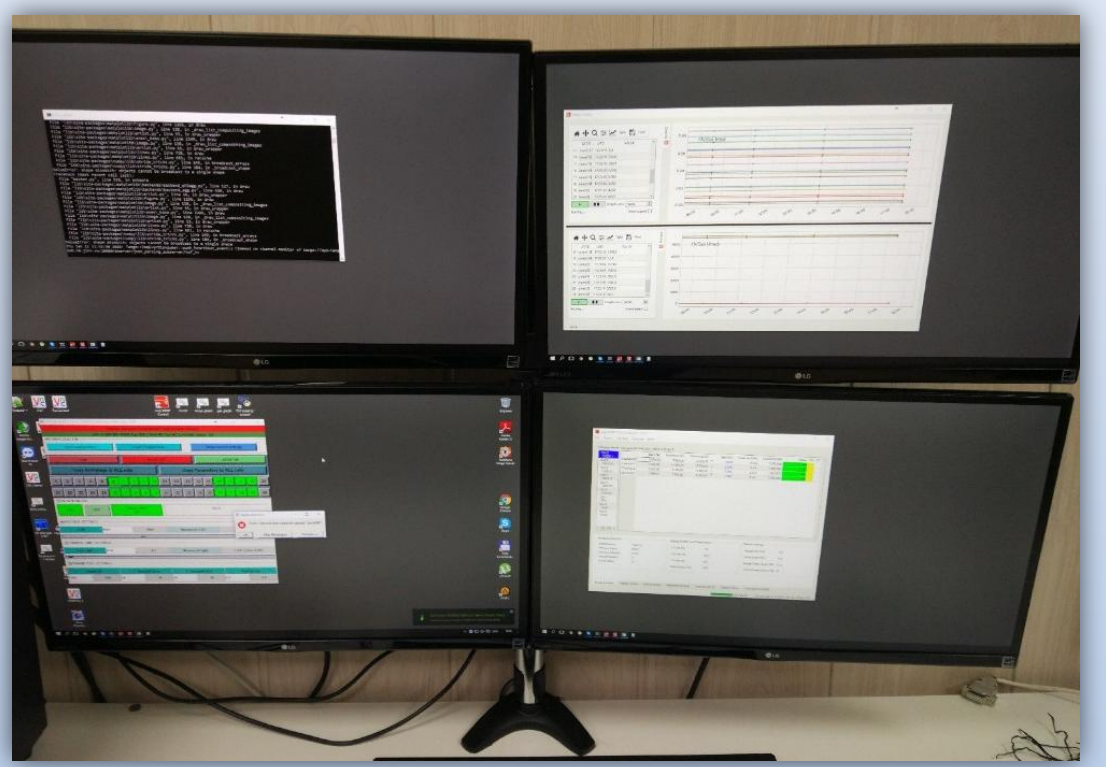
SC DATA PRESENTATION

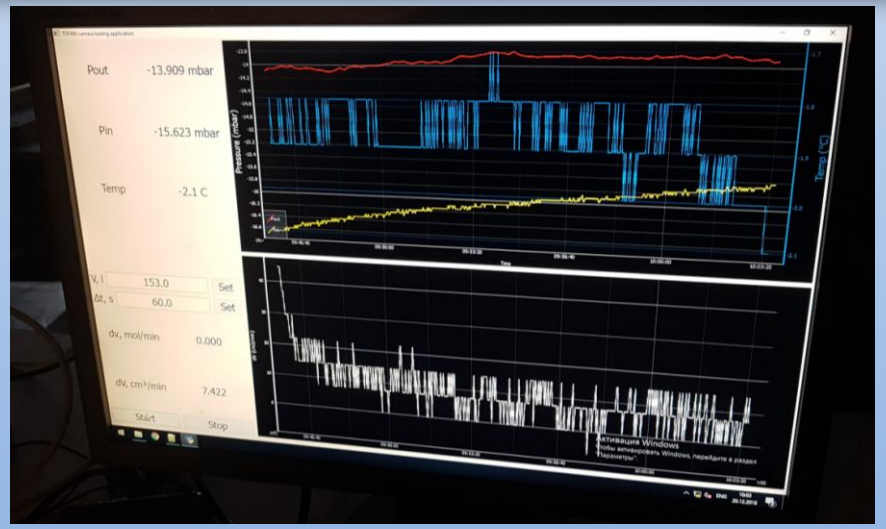
A number of applications was developed for data access and visualization:

Tango Graph, Tango DB Extractor, Tango Web View

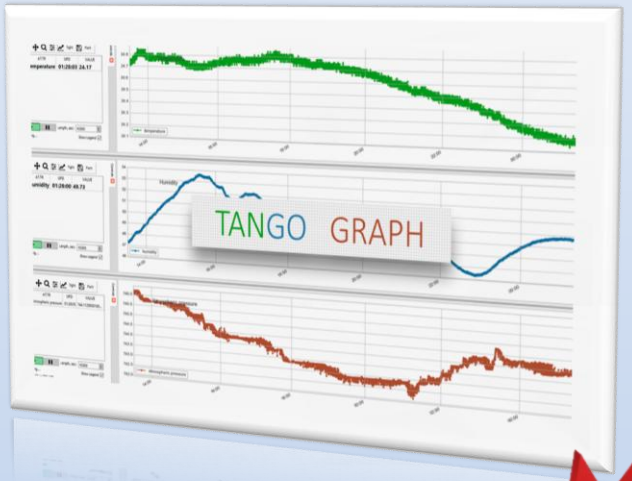
Intent to monitor, not to control or modify.

Our task is to create and provide tools for SC data presentation for BM@N and MPD experiments.





TANGO GRAPH



Powerful solution was created with python3 and pyqt for monitoring SC data.

FEATURES

- Flexible and highly configurable
- Load pre-history from DB
- Work with multiple plots in one window
- Annotations for data values
- Attributes alias and quality parameters support
- Event-driven
- Asynchronous access

DRAWBACKS

- Desktop application
- Requires special *.cfg* file
- Designed for live monitoring
- Requires direct DB connection

Tango Graph

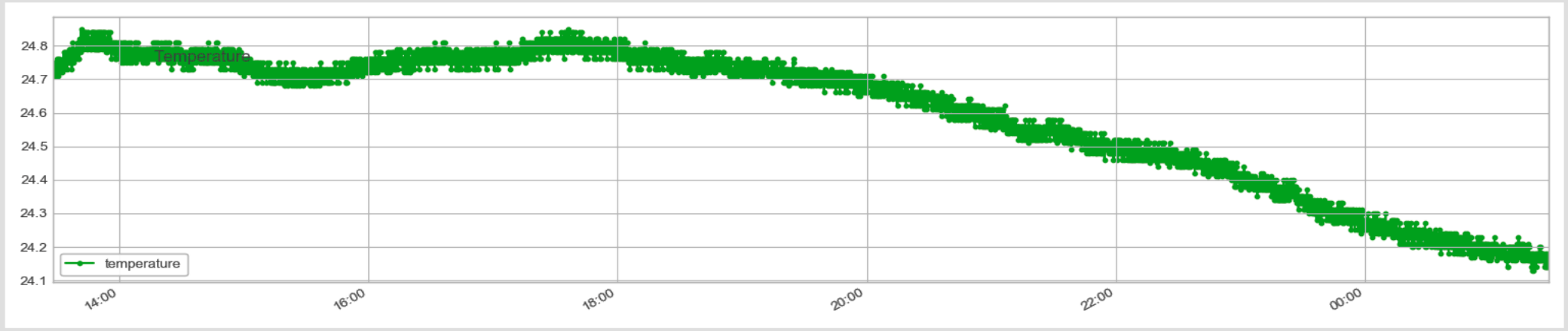
Tight Font

	ATTR	UPD	VALUE
1	temperature	01:28:03	24.17

Length, sec: 43200

Running... Show Legend

Controls



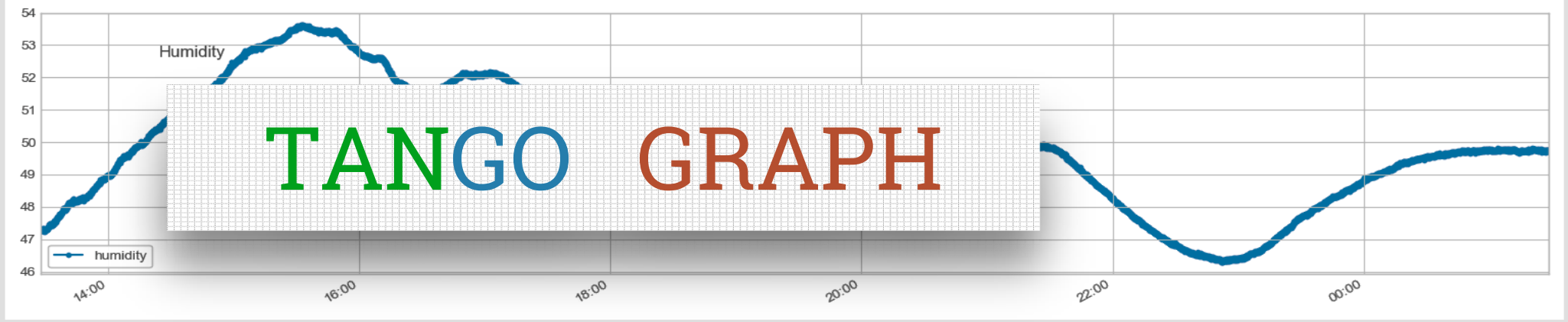
Tight Font

	ATTR	UPD	VALUE
1	humidity	01:28:00	49.73

Length, sec: 43200

Running... Show Legend

Controls



TANGO GRAPH

Tight Font

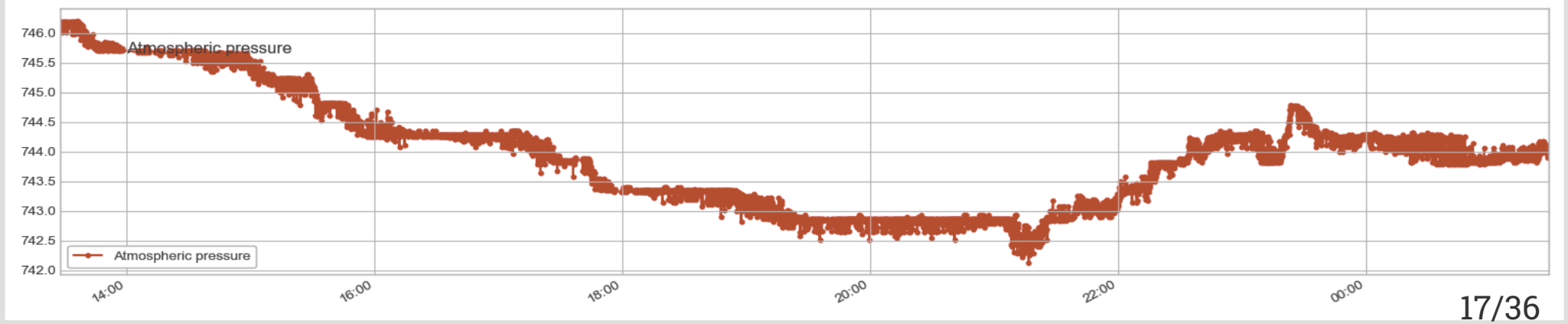
	ATTR	UPD	VALUE
1	Atmospheric pressure	01:28:05	744.1129930160...

Length, sec: 43200

Running... Show Legend

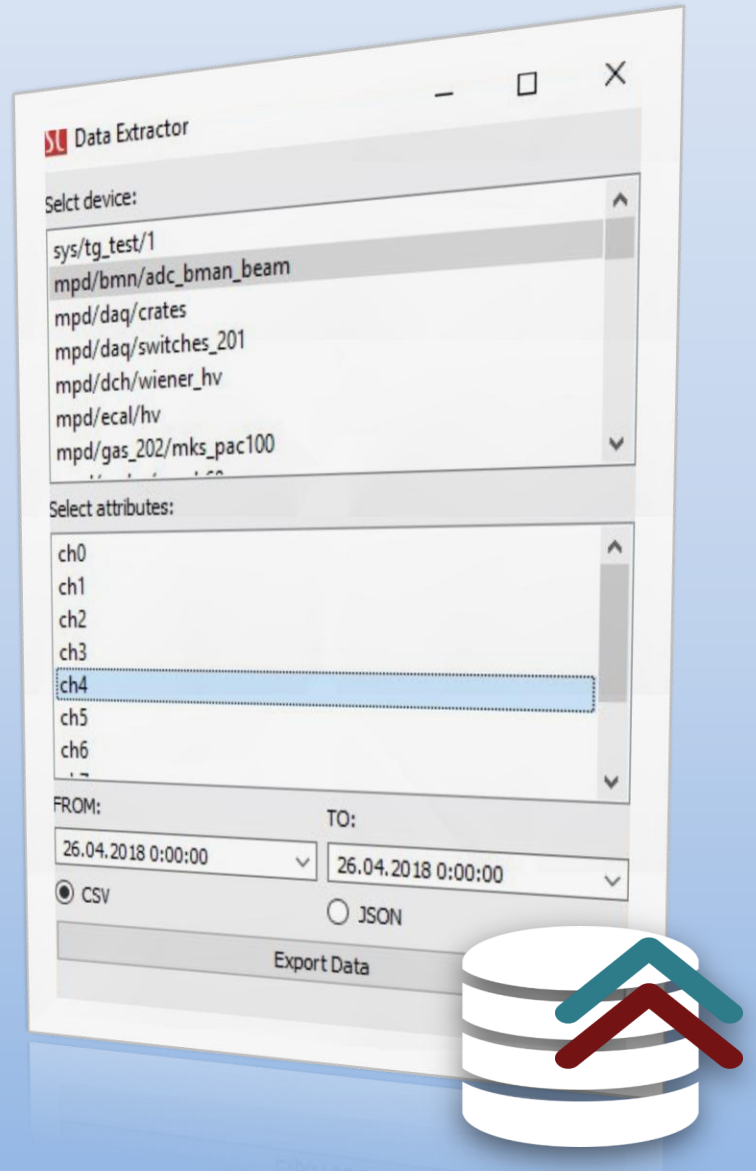
x=19:42 y=742.173

Controls



HELP

TANGO DB EXTRACTOR



Client solution for extracting archived data is developed in Python.

It allows users to access the MySQL database and download required data.

FEATURES

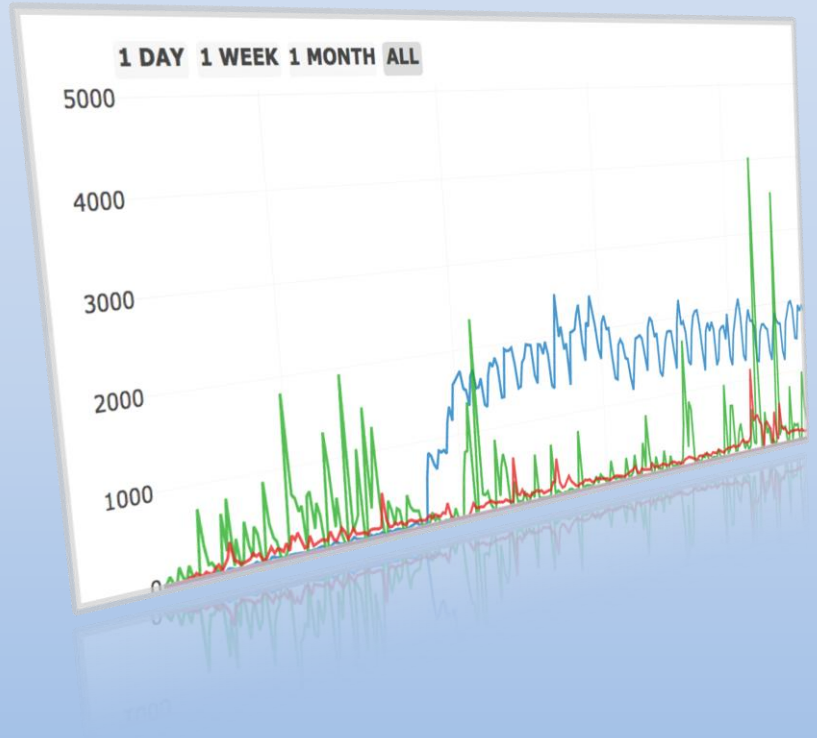
- Provides user-friendly interface
- Extracts data in both JSON and CSV format

DRAWBACKS

- Desktop application
- No visual preview for data
- Requires direct DB connection

TANGO WEB VIEW

It is possible to combine the features and get rid of drawbacks. This is contribution to modern approach of displaying data using web browser.



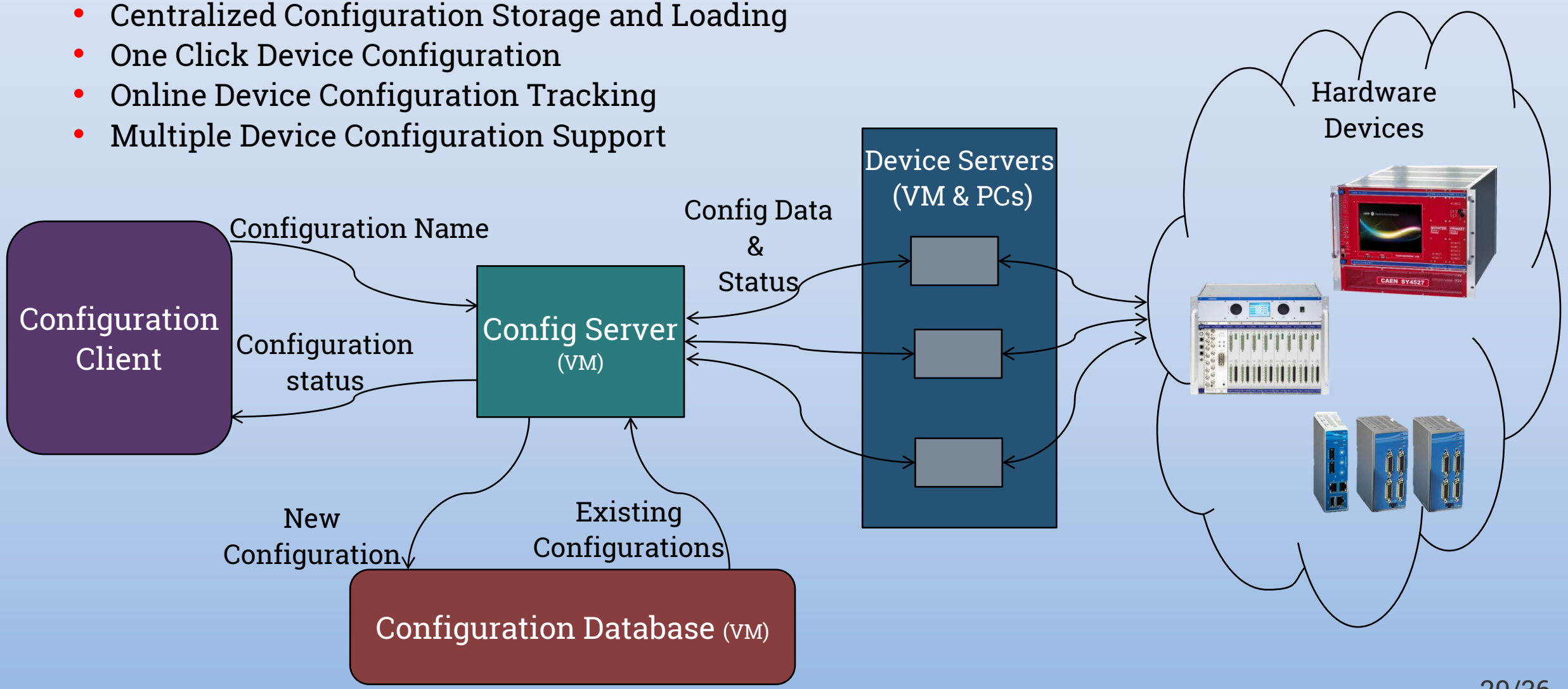
TANGO WEB VIEW is an application for displaying, monitoring and extracting values, that allows secure access to the database.

ADVANTAGES

- Direct DB connection is not required;
- No installation or any additional files required on client side, works in browser;
- Easier configuration process.

DEVICE CONFIGURATION SYSTEM (under development)

- Centralized Configuration Storage and Loading
- One Click Device Configuration
- Online Device Configuration Tracking
- Multiple Device Configuration Support



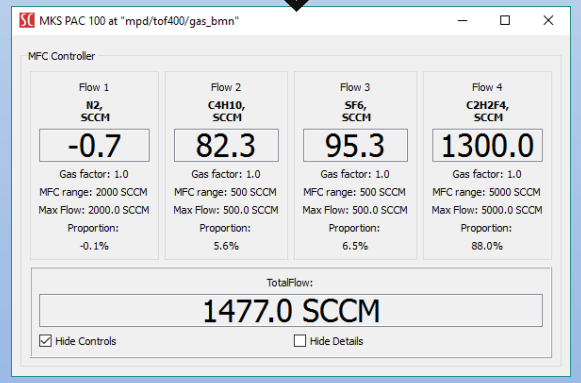
TOF400 HV AND LV MONITORING AND CONTROL

TOF detector uses Wiener MPOD crates for HV and LV systems. The crates communicate via SNMP protocol.

SNMP
Simple Network Management Protocol

TOF400 GAS SYSTEM

- Monitoring and control of gas system based on MKS Instruments PAC-100 modules;
- Scales with RS-232 interface to control the weight of gas bottle;
- Oxygen and humidity sensors made by GE Measurement to control the quality of gas mixture.



TOF400 GAS SYSTEM

TOF400 Gas System flows, gas bottle weight, water and oxygen level in gas mixture

TOF400 FRONT-END ELECTRONICS MONITORING AND CONTROL

GUI application that allows to monitor FEE parameters and temperature and set DAC values. Uses Socket protocol.

X 20

python

box1 box2

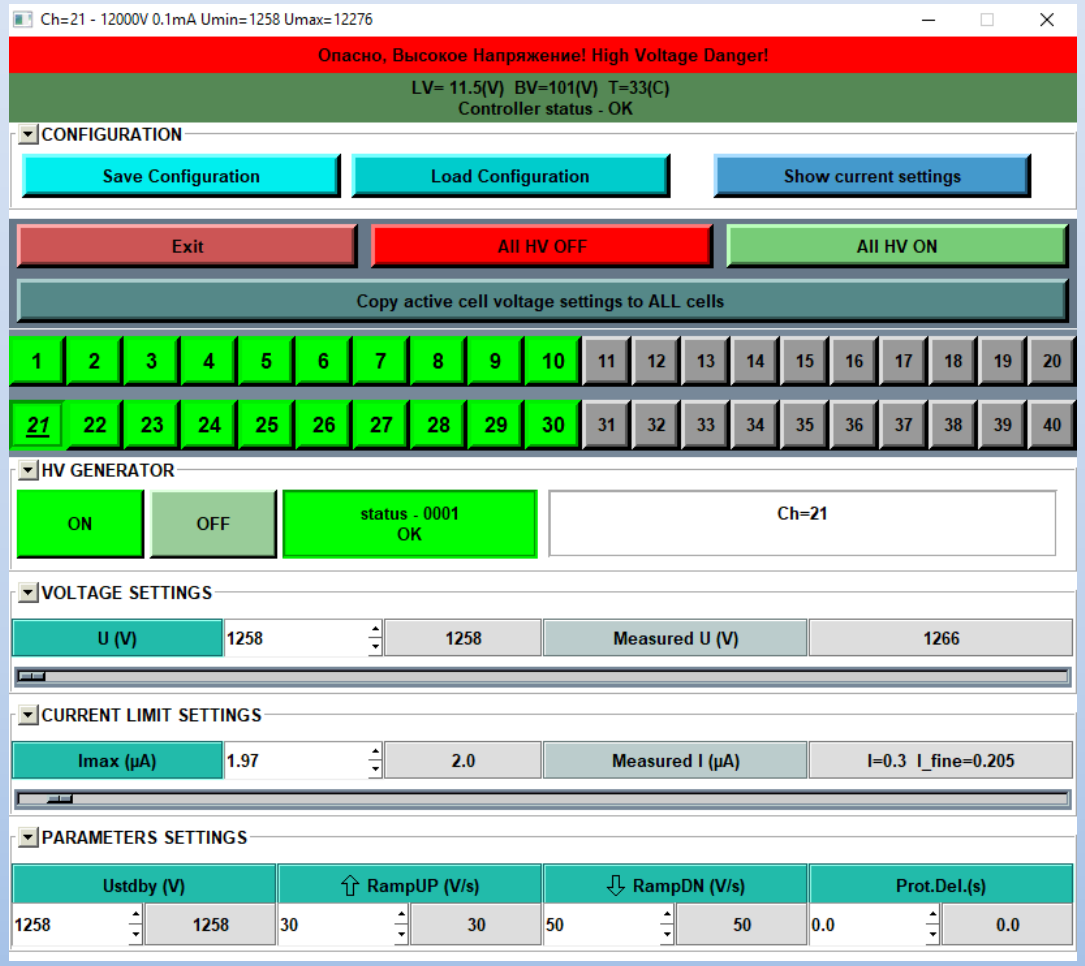
	V+, mV	V-, mV	Vdelta, mV	Vpower, mV	DAC, mV	Tboard, °C	Tgas, °C
1	1946	1741	1624	3248	2775	45	44
2	1693	1637	1544	3287	0	41	36
3	1687	1737	1735	3293	0	43	43
4	1940	1649	1627	3220	0	48	46
5	1914	1588	1615	3265	0	46	38
6	1993	1985	1741	3235	0	50	44
7	1754	1906	1731	3204	0	40	47
8	1777	1836	1860	3272	0	38	48
9	1915	1909	1655	3222	0	37	37
10	1864	1969	1703	3295	0	46	49
11	1855	1578	1841	3268	0	50	46
12	1610	1751	1908	3206	0	49	49
13	1976	1686	1611	3286	0	39	48
14	1693	1898	1787	3250	0	44	47
15	1788	1847	1517	3252	0	49	44
16	1503	1645	1761	3207	0	46	36
17	1711	1785	1990	3268	0	42	35
18	1746	1559	1676	3256	0	38	47
19	1788	1579	1829	3256	0	40	36
20	1514	1566	1641	3296	0	49	46

TOF700, ZDC AND ECAL HV

TOF700, Ecal and ZDC detectors are using HVSys modules for HV systems, which are made by small company in JINR.

These devices has its own software, written on TCL, and communicates via Socket protocol with only one active connection.

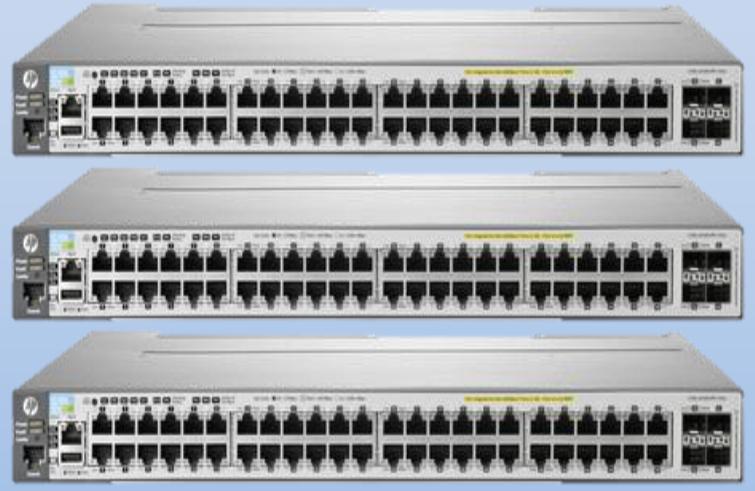
TCP-server was implemented to the existing software in order to acquire data from the equipment. It sends data on request in JSON format.

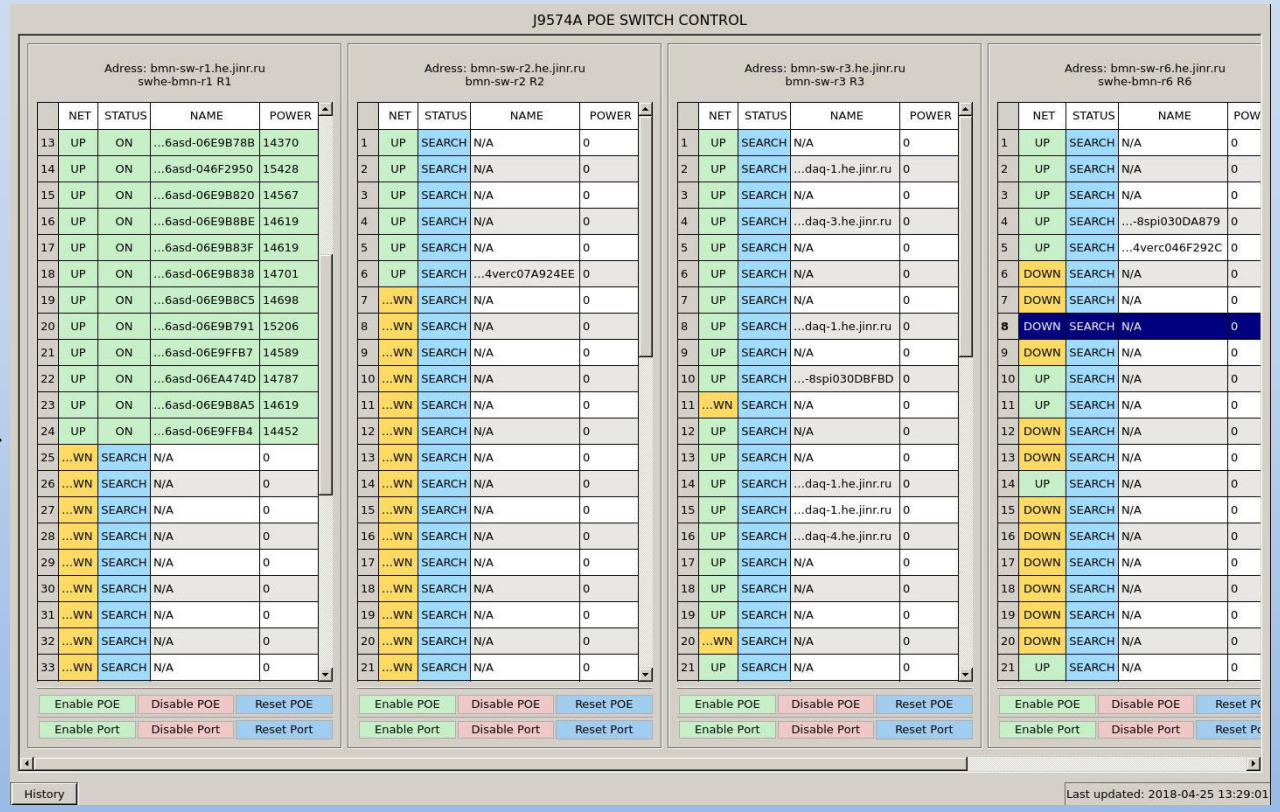


NETWORK SWITCH MONITORING AND CONTROL

Application for HP Aruba switches control. Uses SNMP protocol.

- Multidevice support;
- Power consumption and status for every connected device;
- Allows to switch on/off network and/or power for every port.



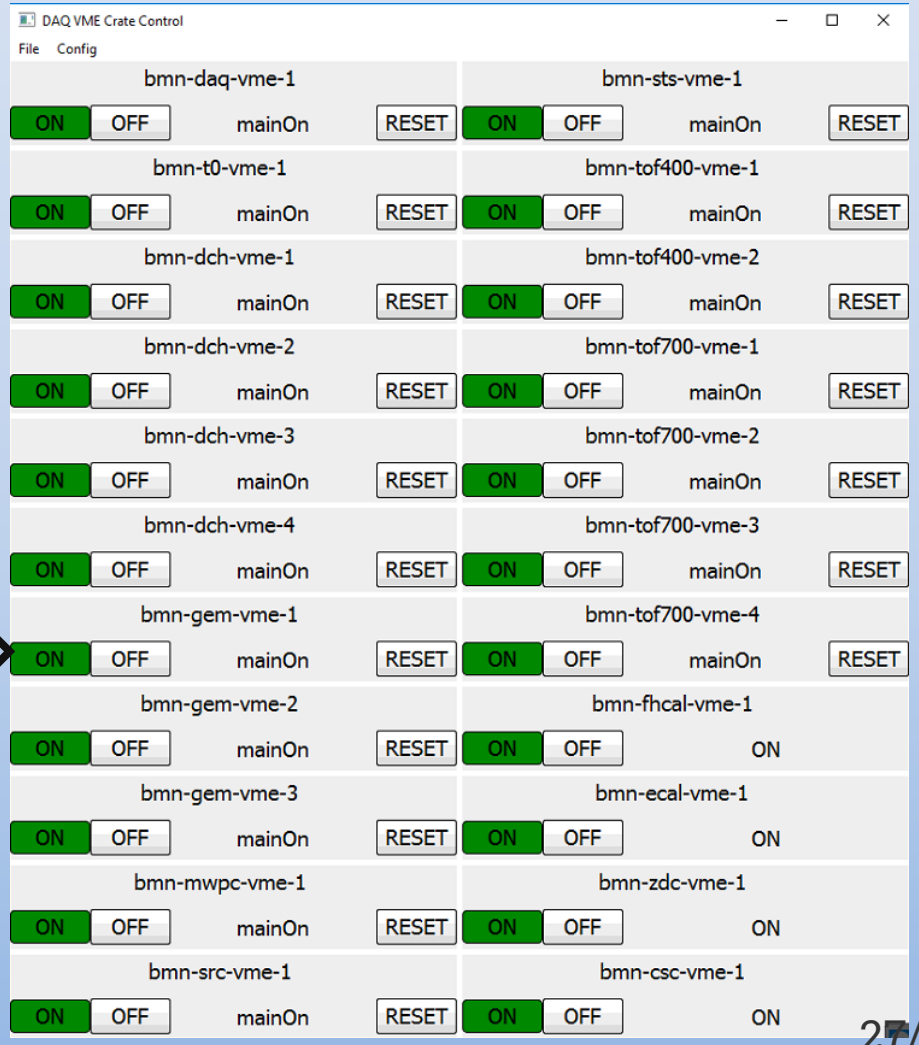


DAQ VME CRATES MONITORING AND CONTROL

Monitoring and control for Wiener and ELMA VME crates

- Multidevice support;
- Displays state and status for every crate;
- On/off/reset buttons for crates.

...



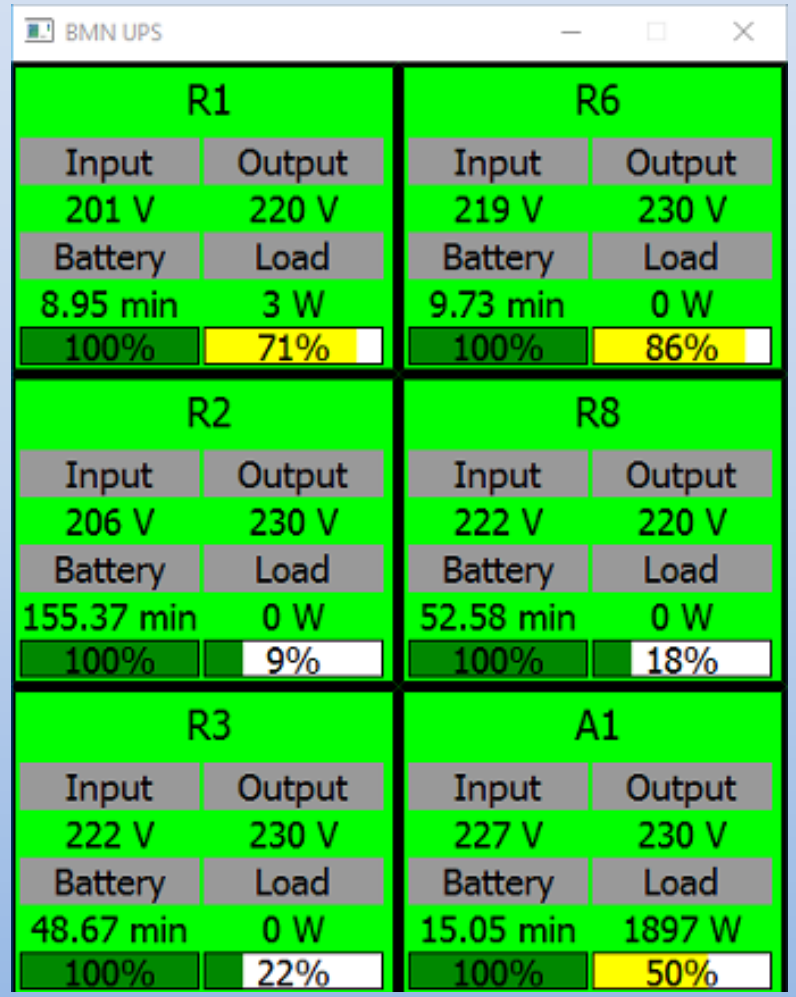
UPS MONITORING

The application that allows to monitor status of the UPSes in BMN racks.

The Device Server communicates via SNMP protocol. Multidevice support.

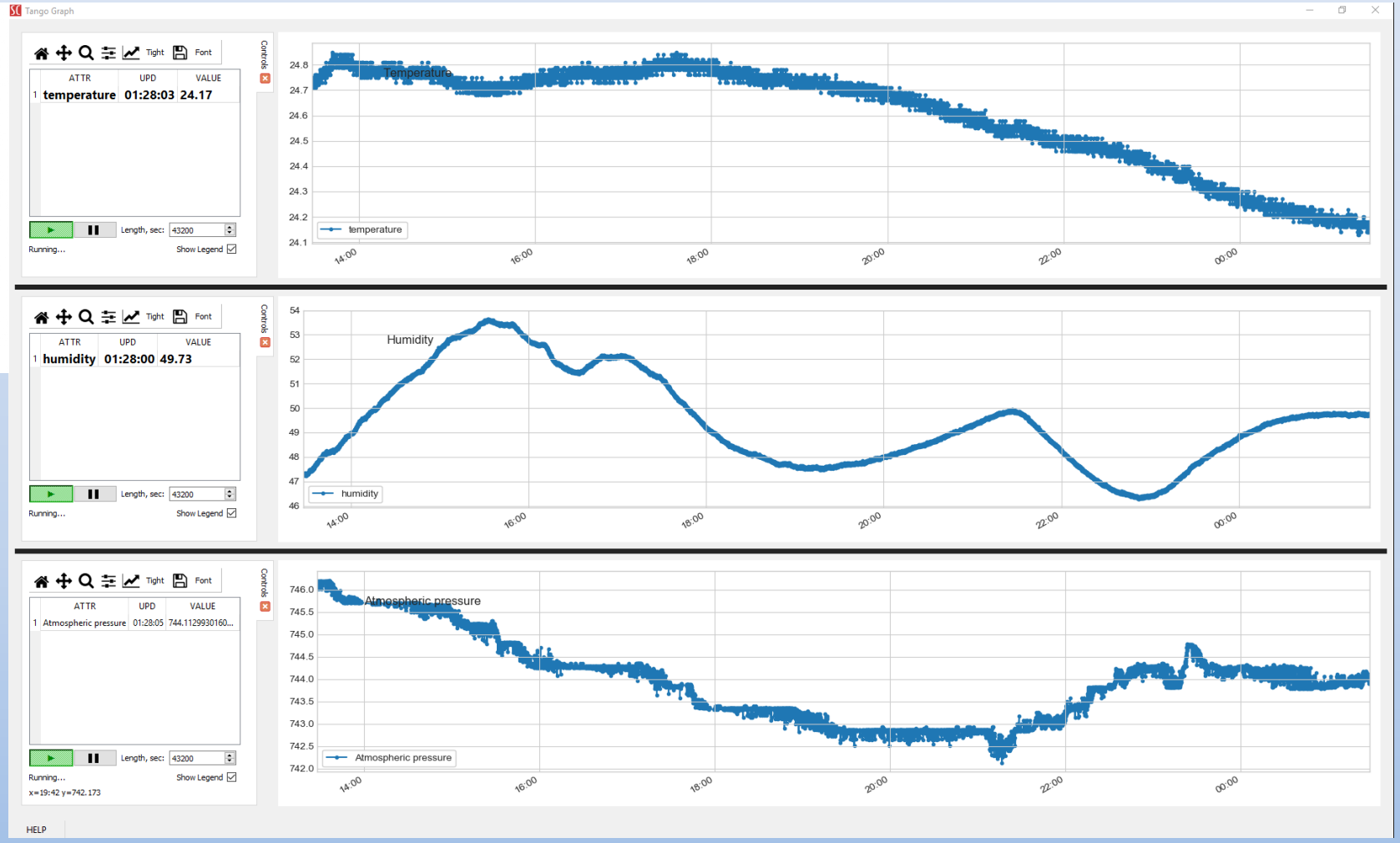
Displays:

- Input/Output voltage;
- Load;
- Battery status.



TEMPERATURE, HUMIDITY, ATMOSPHERIC PRESSURE MONITORING

The module PIR-230-E contain a temperature and humidity sensor for measuring indoor temperature and humidity

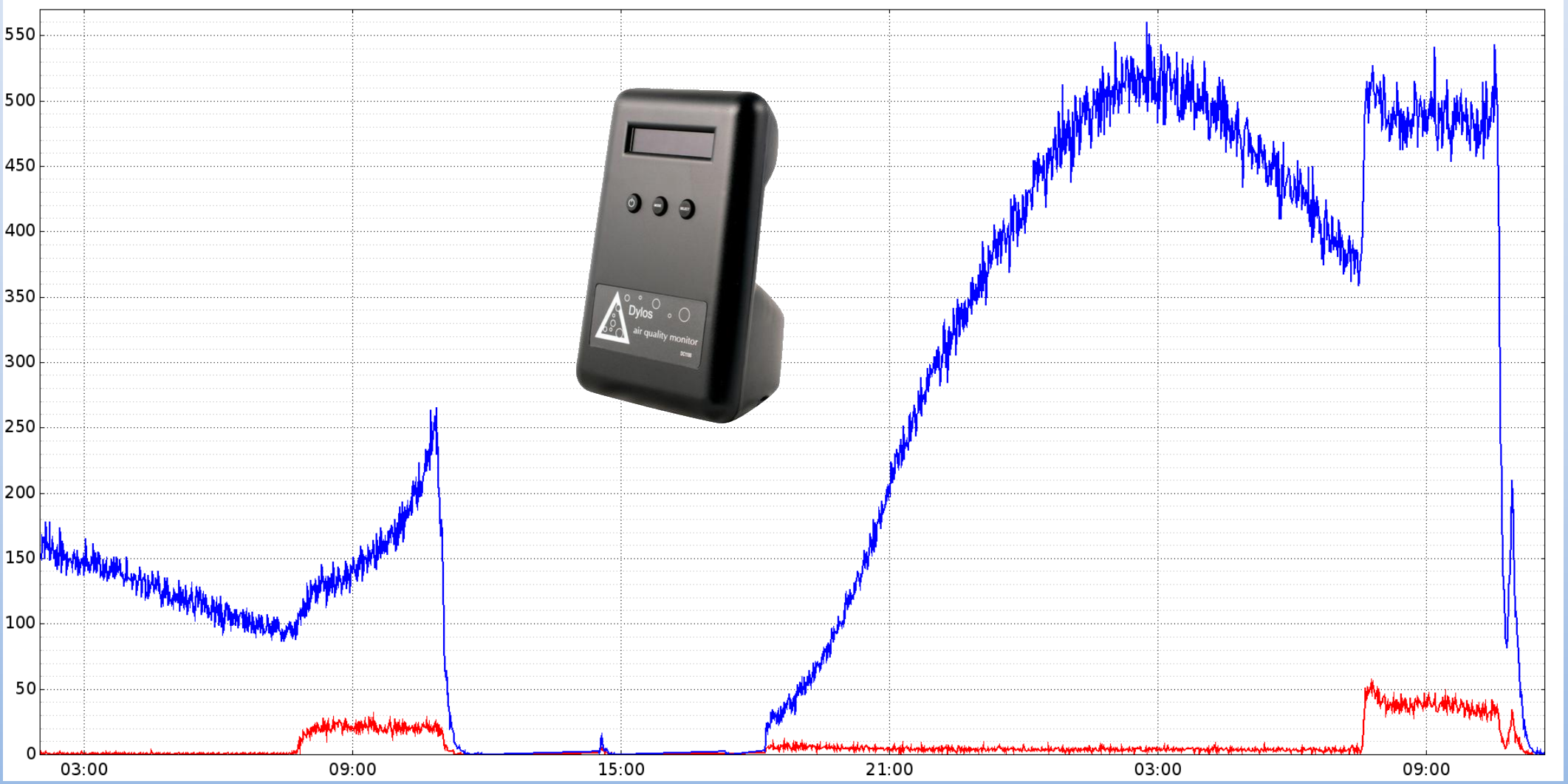


Temperature, humidity and atmospheric pressure plots
12 hours, TOF detectors assembling area

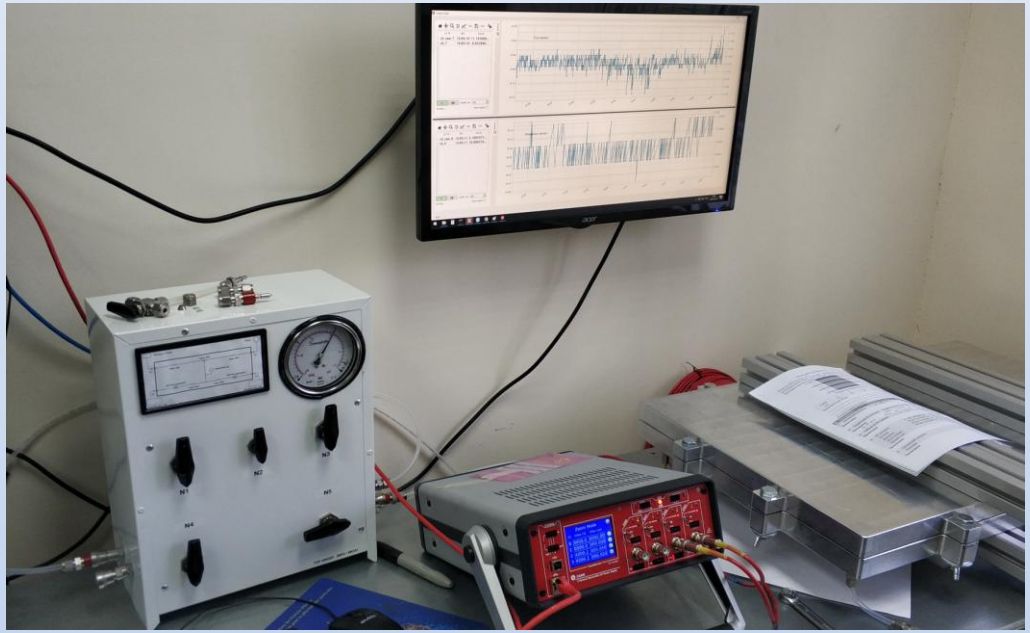
Honeywell Heavy Duty Pressure Transducer 15 psi range, 0.25% accuracy

AIR QUALITY MONITORING

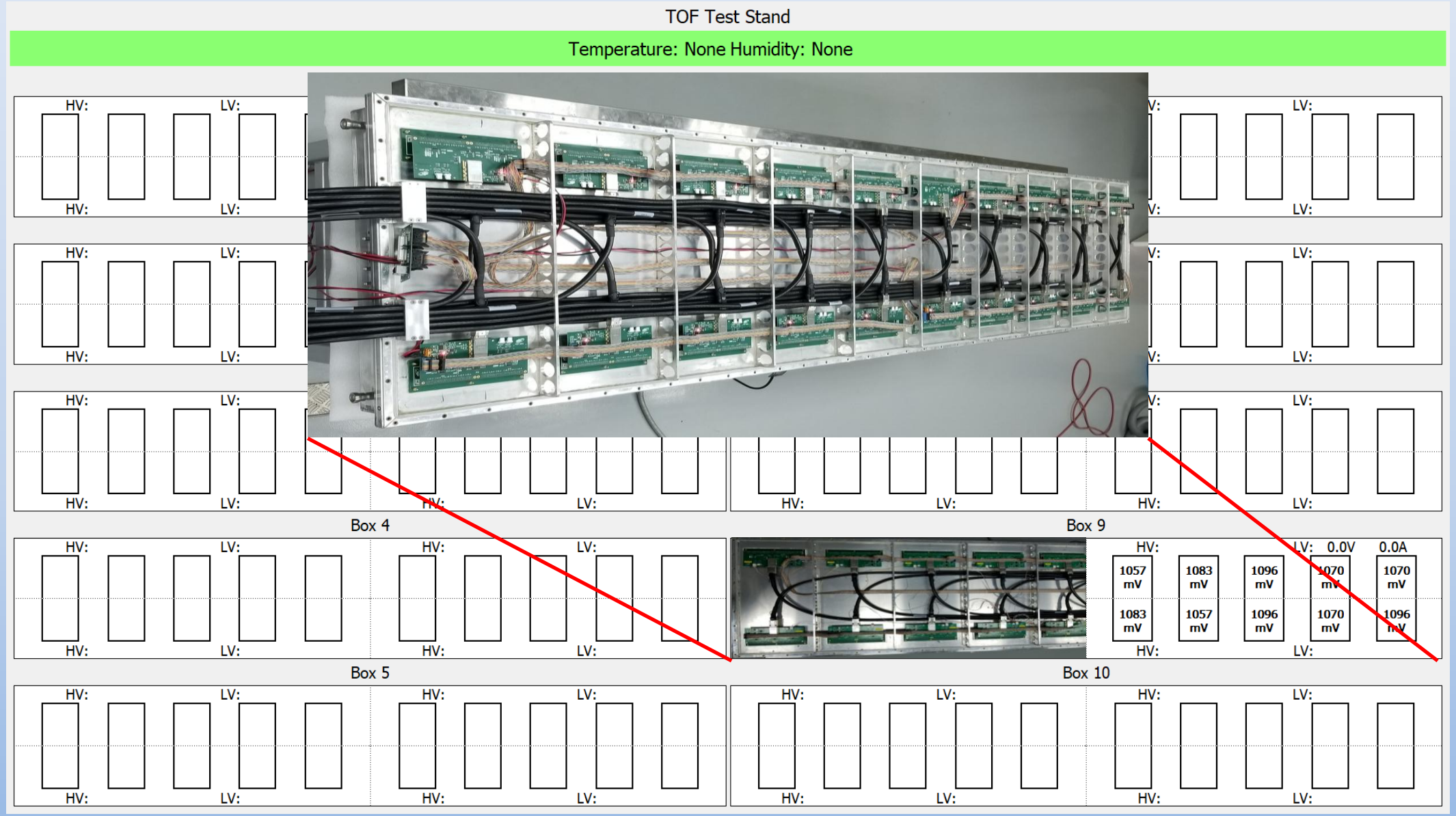
MPD TOF assembling and testing stand requires clean room.
We use Dylos DC1100 Pro Air Quality Monitor to control number of dust particles.



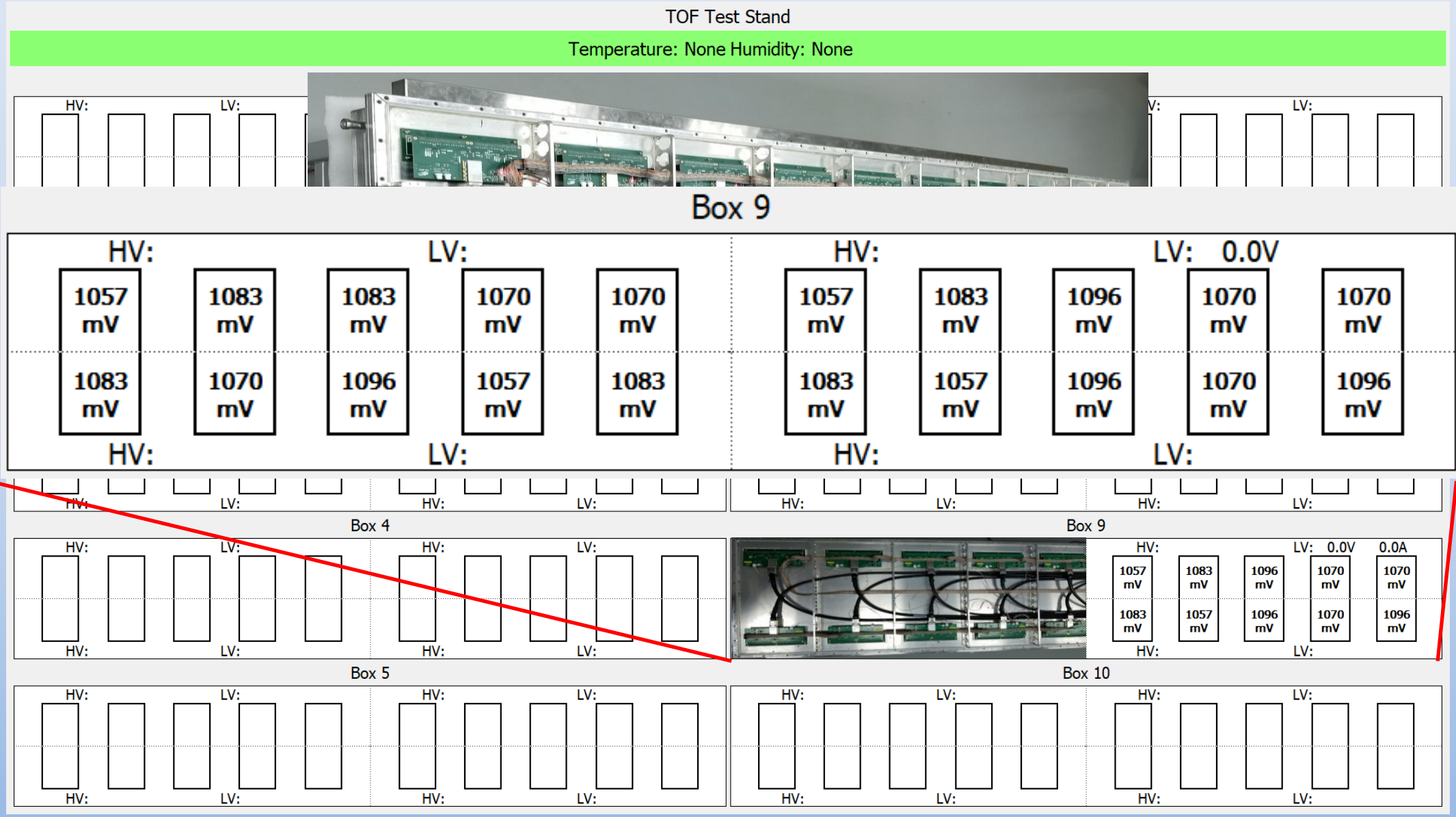
MPD TOF TEST STAND



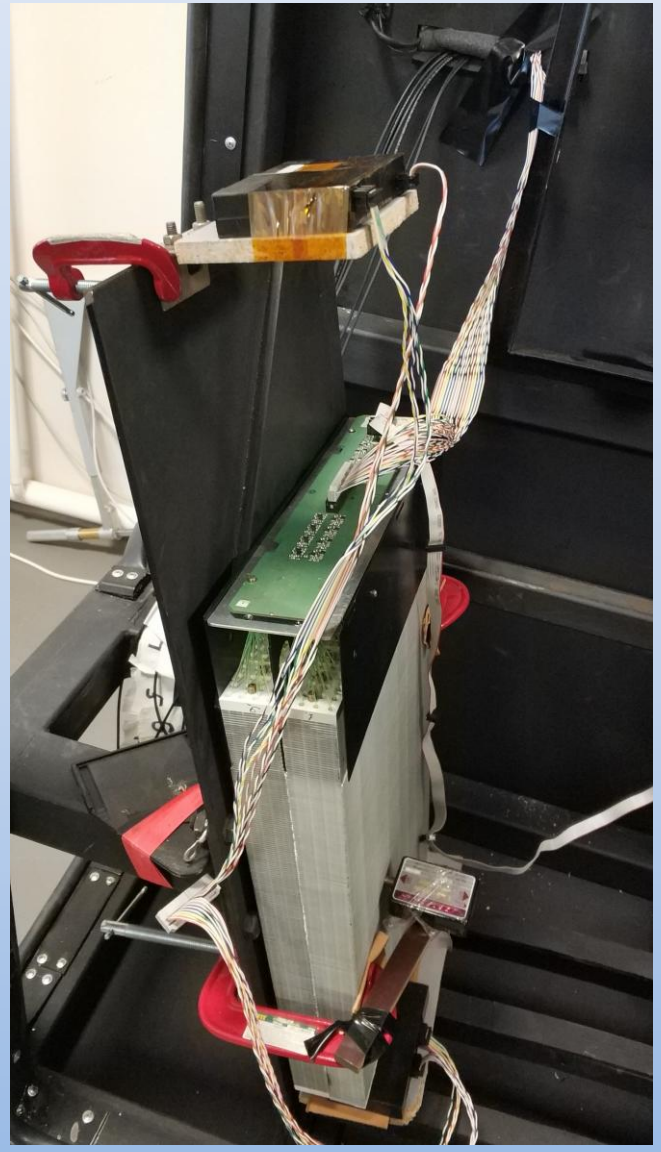
MPD TOF TEST STAND



MPD TOF TEST STAND



DEVELOPMENT OF MPD ECAL TEST STAND



CONCLUSION

- Created base structure of Slow Control for MPD including databases, archiving system, alarms system, etc.
- Developed software specific for MPD experiment (status monitoring system, applications for data access and visualization, device configuration system);
- Developed software for various hardware used in MPD subdetectors Slow Control;
- Essential part of MPD Slow Control system was tested during several BM@N runs at Nuclotron.

THANK YOU FOR YOUR ATTENTION