Slow Control System of the BM@N experiment

The 29th International Scientific Conference of Young Scientists and Specialists

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on behalf of Slow Control group:

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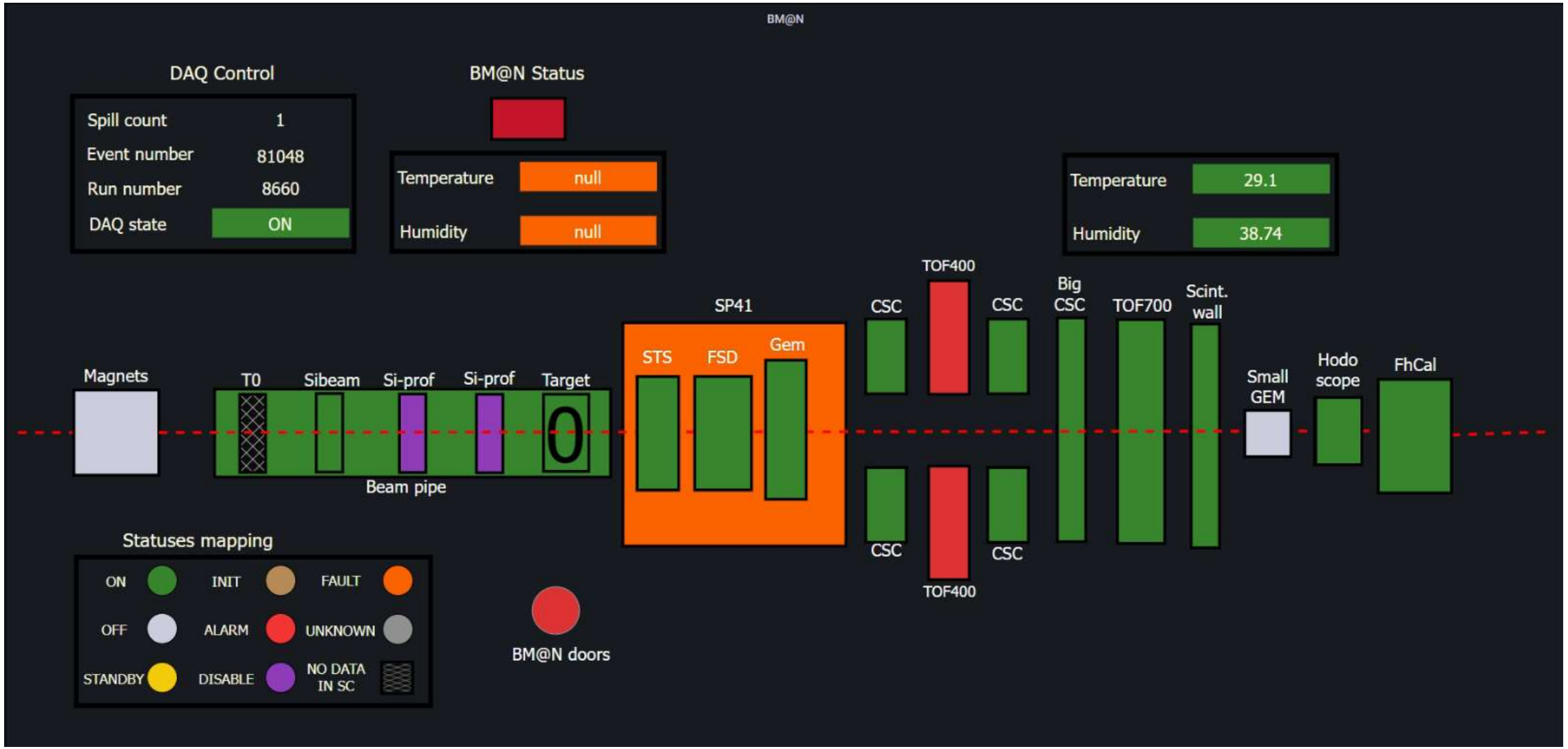
BM@N Experiment

BM@N building in NICA complex

BM@N experiential hall:

BM@N detectors



BM@N monitoring web-page

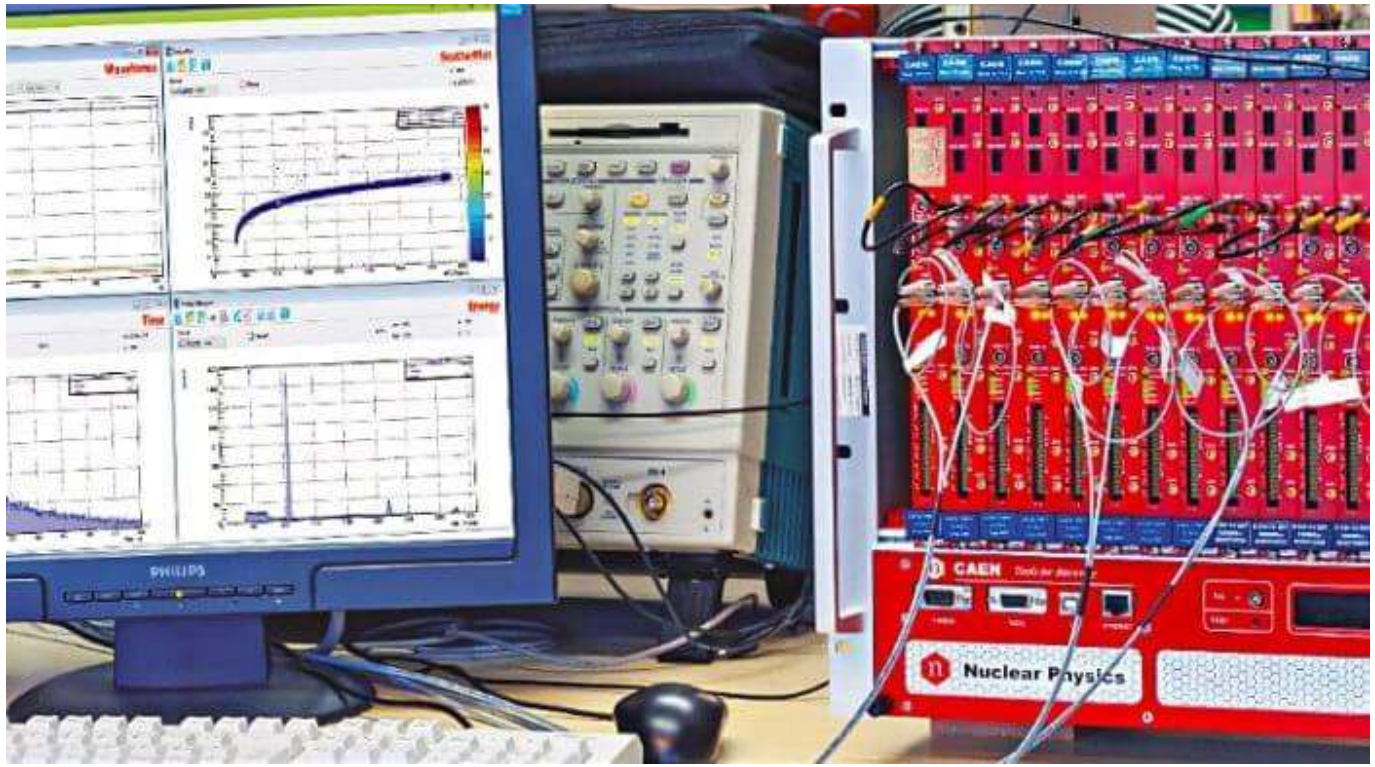
What is Slow Control?

What is Slow Control?

- Monitoring of the experimental hardware.
- Centralized control of the Slow Control equipment (LV, HV, gas flow etc.)
- Archiving Slow Control data.
- Alarm system.
- SC Configuration database.

Not a Slow Control:

- Main data stream (DAQ).
- Event builder (reconstruction)/event display.
- Data quality.
- Run control.



What is Slow Control?

Monitoring and controls for users

Client Application

interface for operators to interact with the system

What and how read from server?

Data and command exchange

TANGO

Database

Device Server

archives all the operational data received from the device servers

direct communication with the experimental hardware

Tango-based Slow Control System has performed well in previous runs and will be used in the forthcoming run

CS analogs:

WinCC Professional

EPICS

Tango Controls System

Tango Controls is an object oriented, distributed control system. It is a framework for building custom SCADA systems. Tango defines communication protocol and API. It provides libraries, set of GUI tools and drivers (so called Device Servers)

- Multiplatform
- Archiving service
- Access control service
- Logging service
- Alarm service
- Configuration tool
- Administration tool
- Web interface
- Code generator for C++, Java, python
- GUI Toolkit for Java, QT, Python

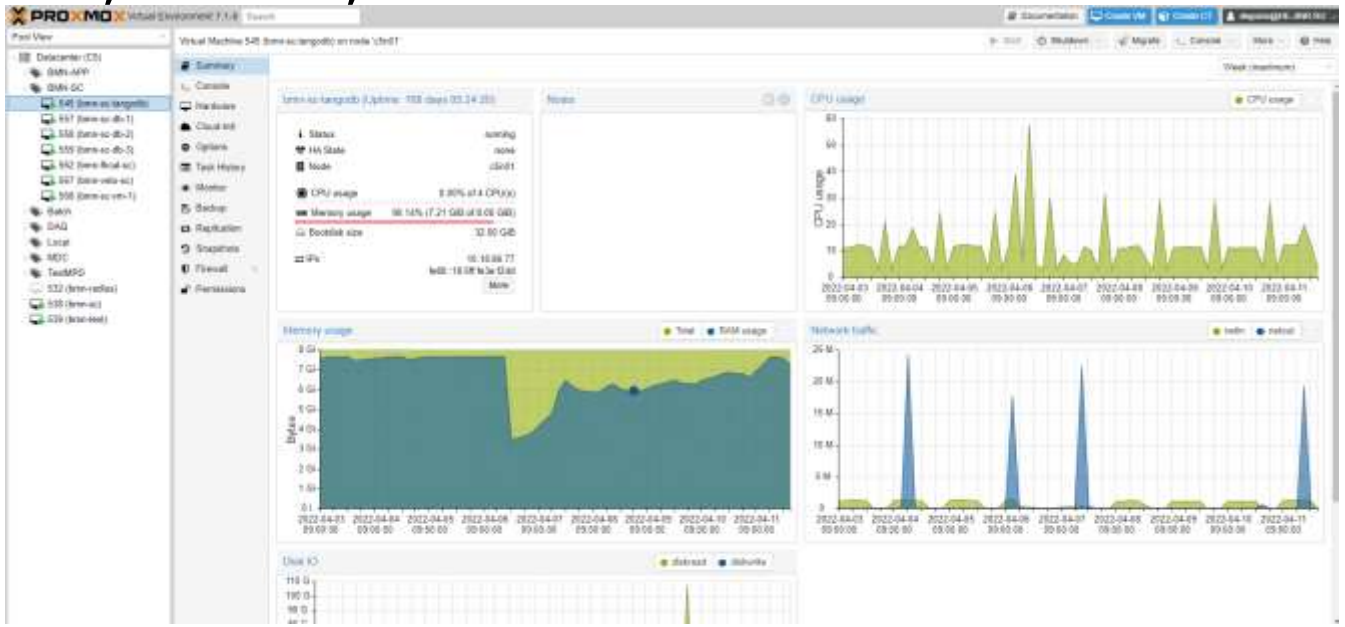
Infrastructure – computing, devices, interfaces

At present time the service layer tasks uses existing MPD/BM@N computing farm. Virtualization is done using PROXMOX Virtual Environment.

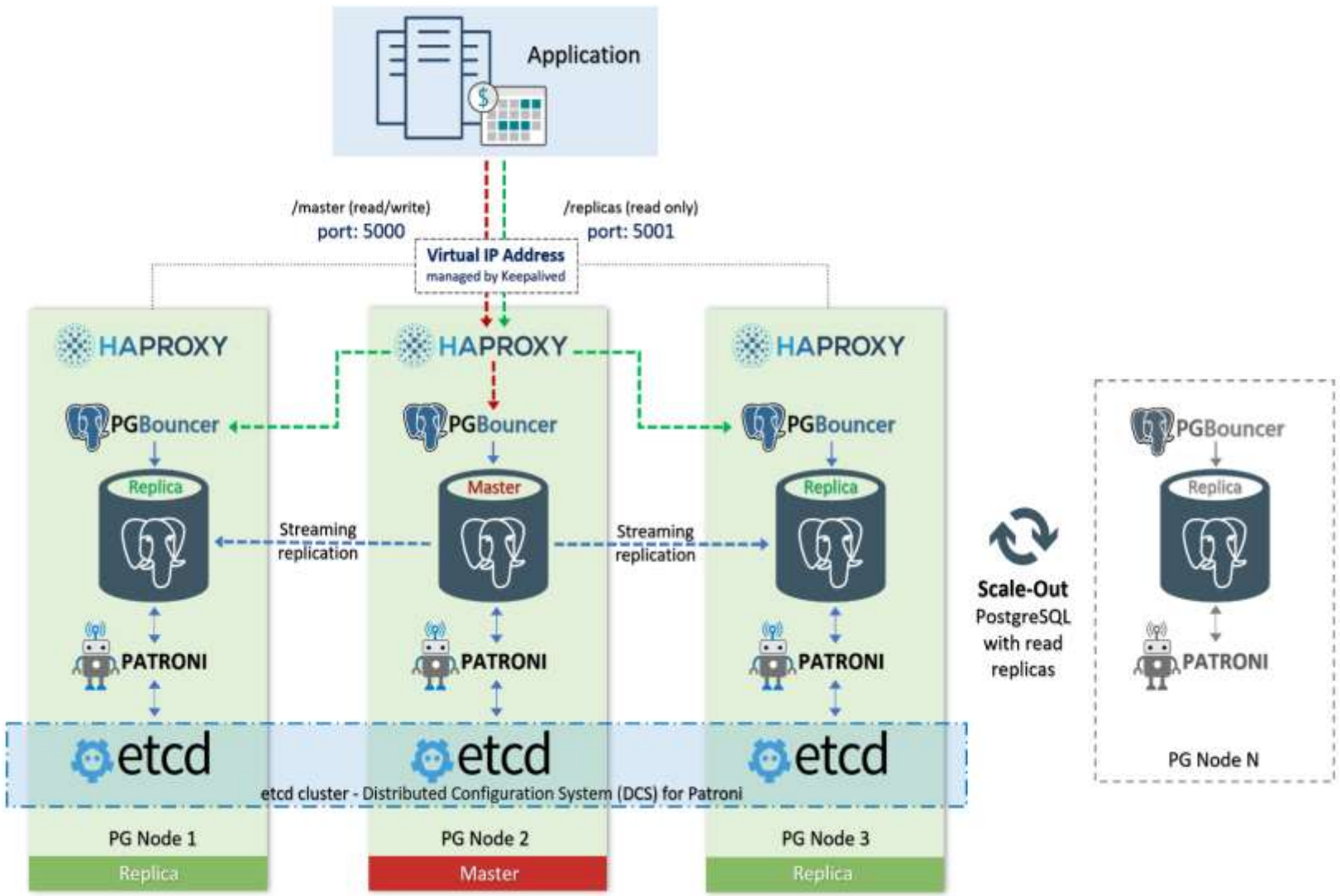
All centralized services are running on dedicated VM’s

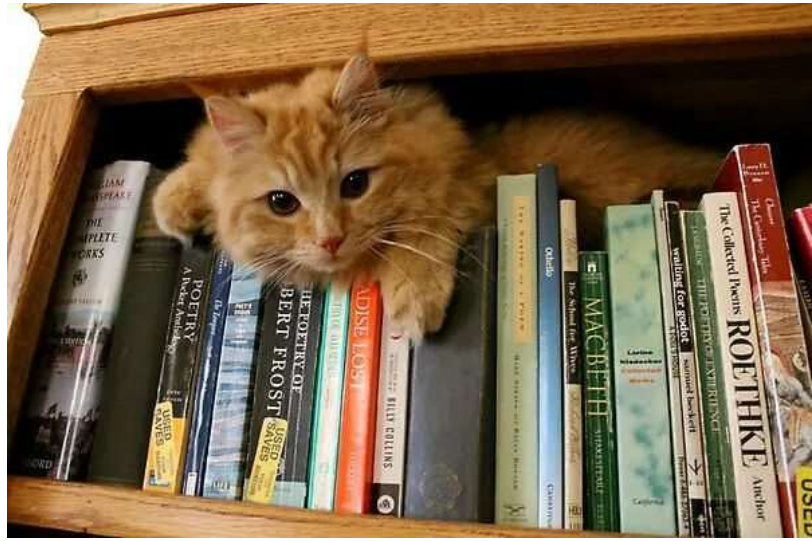
Front-end layer includes a wide variety of devices which are uses different buses and protocols, such as PXI, Ethernet, RS-485, RS232 etc.

PROXMOX



Database cluster



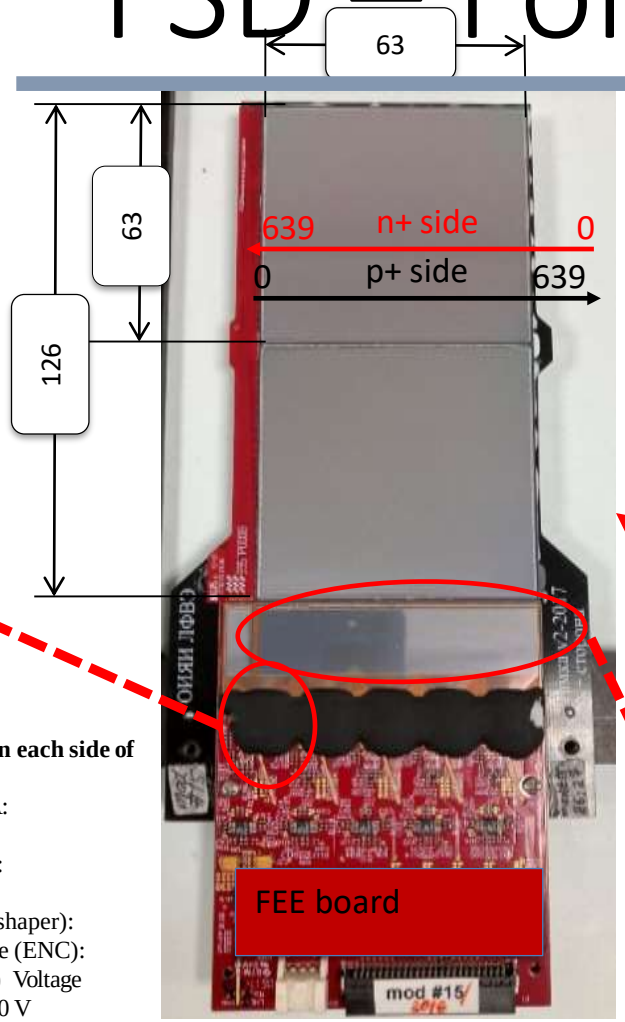


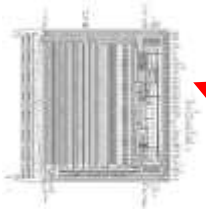
All BM@N data is archived in a PGSQL database deployed on a cluster consisting of three self-replicating virtual machines, which increases the system's reliability and fault tolerance.

Data visualization

Grafana is a free software data visualization system focused on IT monitoring systems data. It is implemented as a "dashboard" style web application with charts, graphs, tables, alerts.

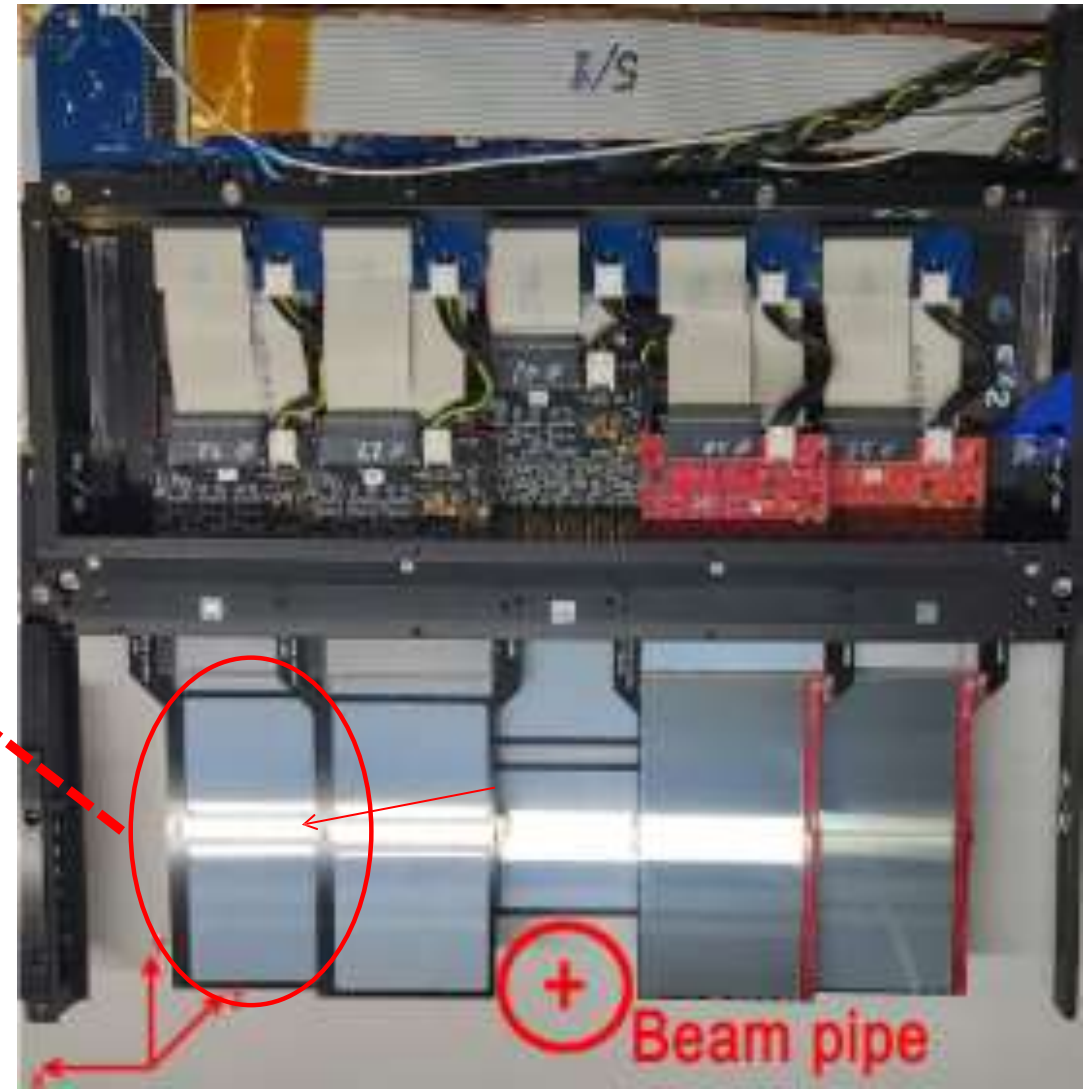
FSD – Forward Silicon Detector





ASIC VATAGP7.2 (5 chips on each side of module)
Number of CSA:
128 channels
Dynamic range:
±30 fC
Peaking time (slow/fast shaper):
500 ns/ 50ns Noise (ENC):
70e +12e/pF (typ.) Voltage
supply: +1,5 V, -2,0 V
Gain from input to output buffer: 16,5 µA/fC Output Serial analog multiplexer clock speed: 3,9 MHz
Power dissipation per channel: 2,2 mW

Pitch Adapter (n+) side
Number of channels: 640
Value of poly-Si resistors: ≈ 1 MΩ
Value of integrated capacitors: ≈ 120 pF
Capacitor working voltage: 100 V
Capacitor breakdown voltage: >150 V
Manufactured by ZNTC (Zelenograd)



Coordinate plane from double side Si-modules

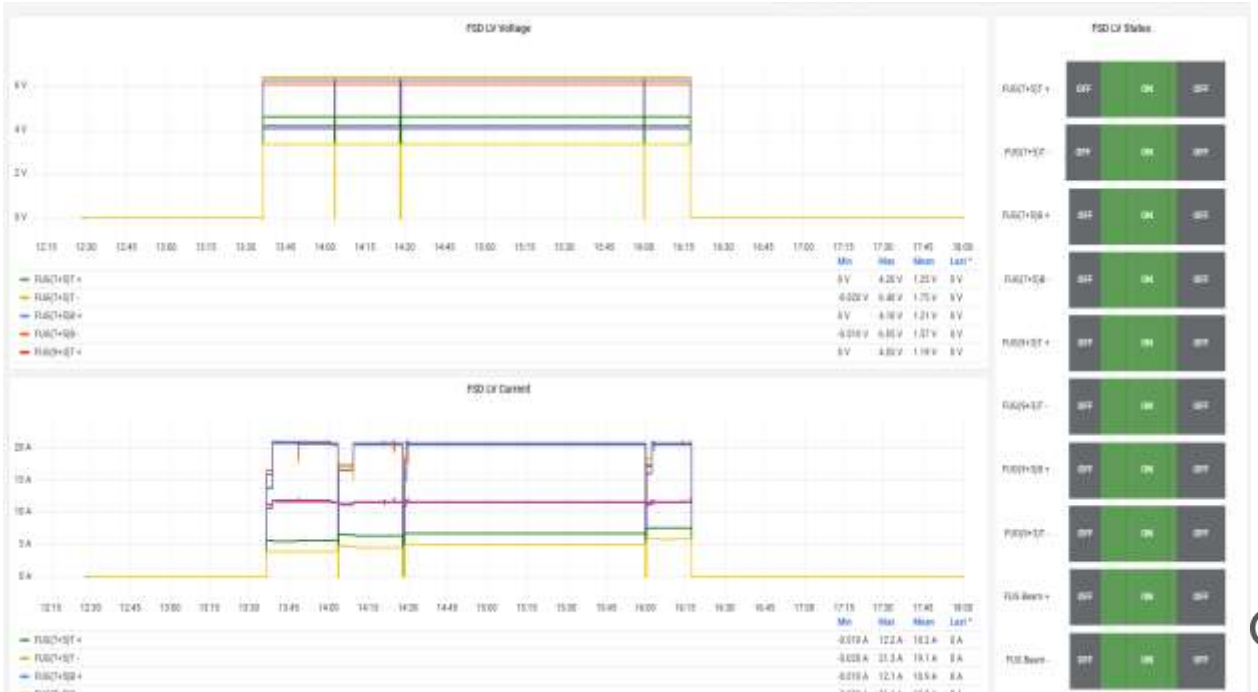
LV system of FSD, GEM, BT

TANGO device server

Historical DataBase

LV GUI

TCP/IP



Grafana

FSD FEE temperature

TCP/IP

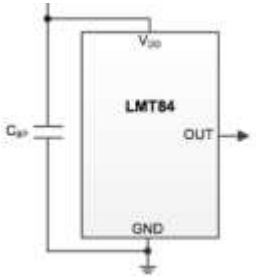
Modbus

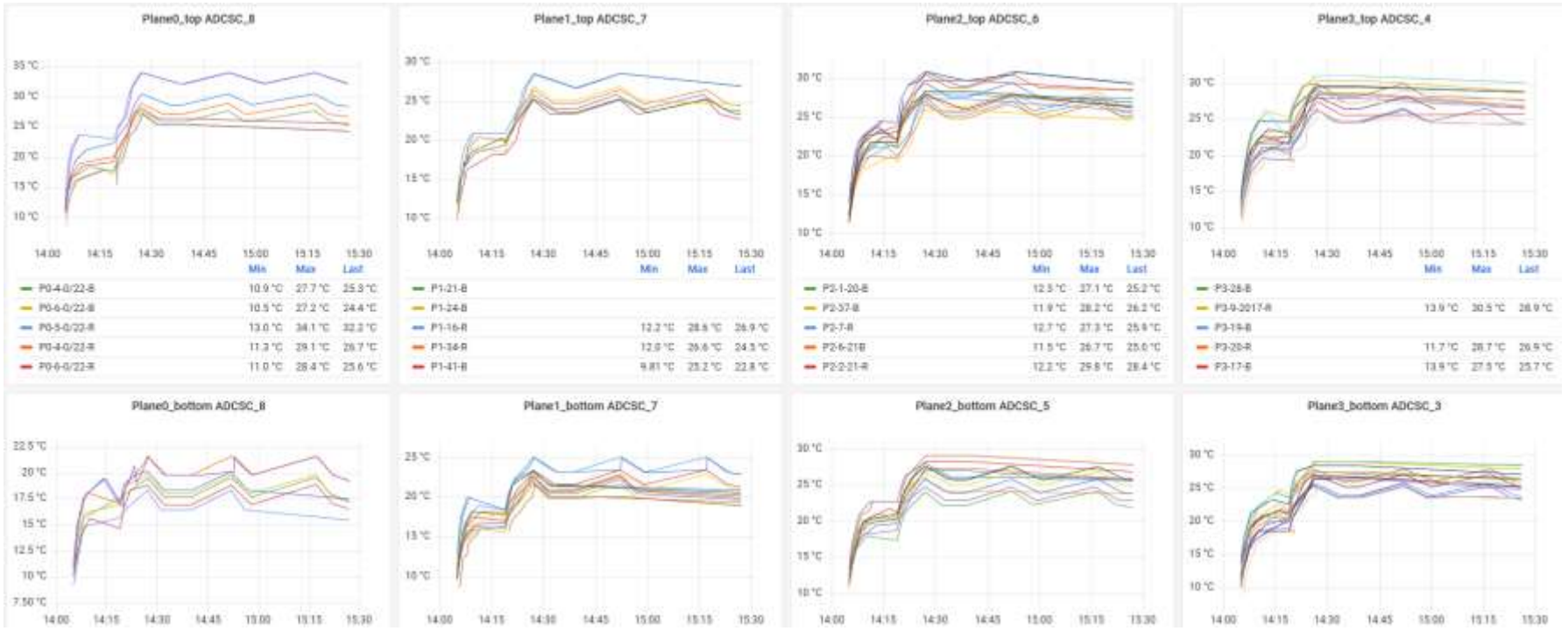
Device Server

Properties
Attributes
Commands

TCP/IP

HDB

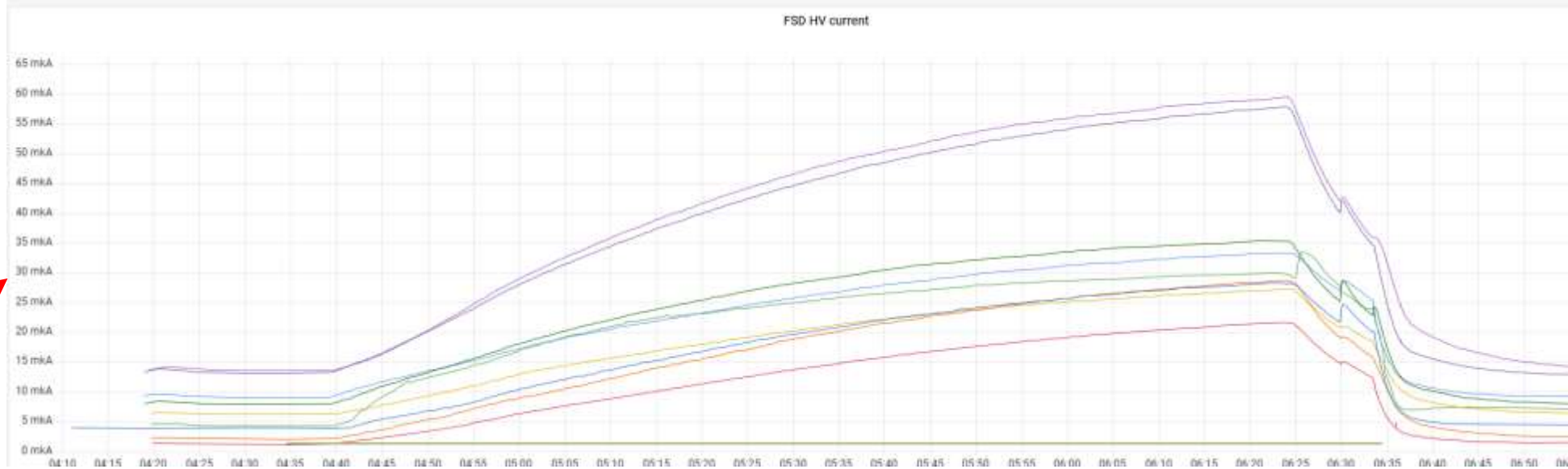




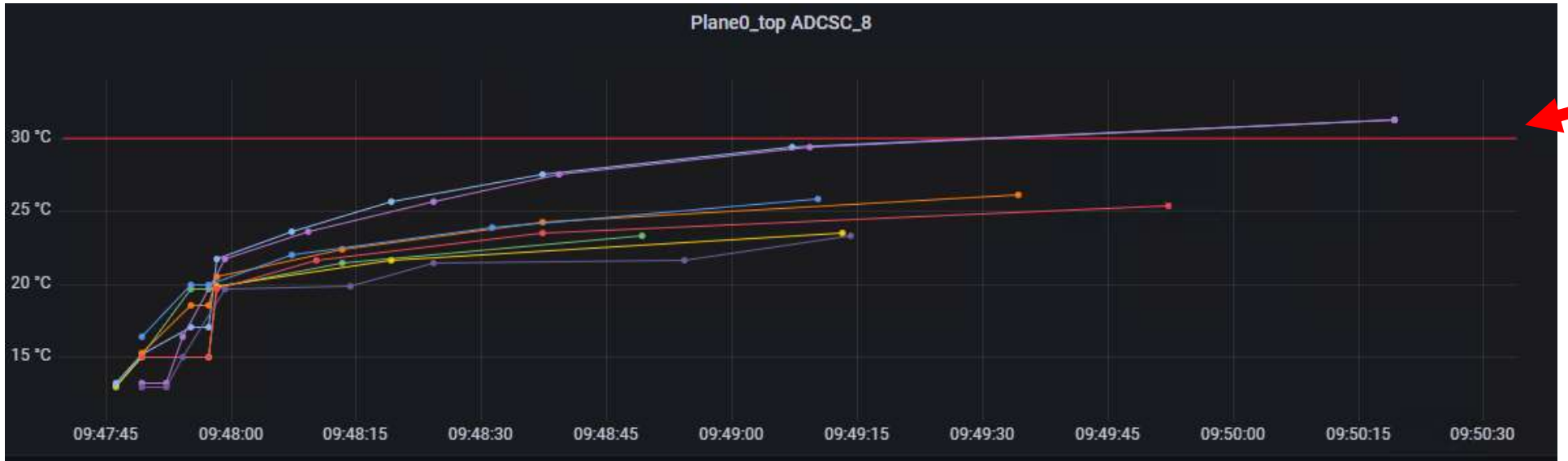
FSD FEE temperature

Temperature heating over 80˚C

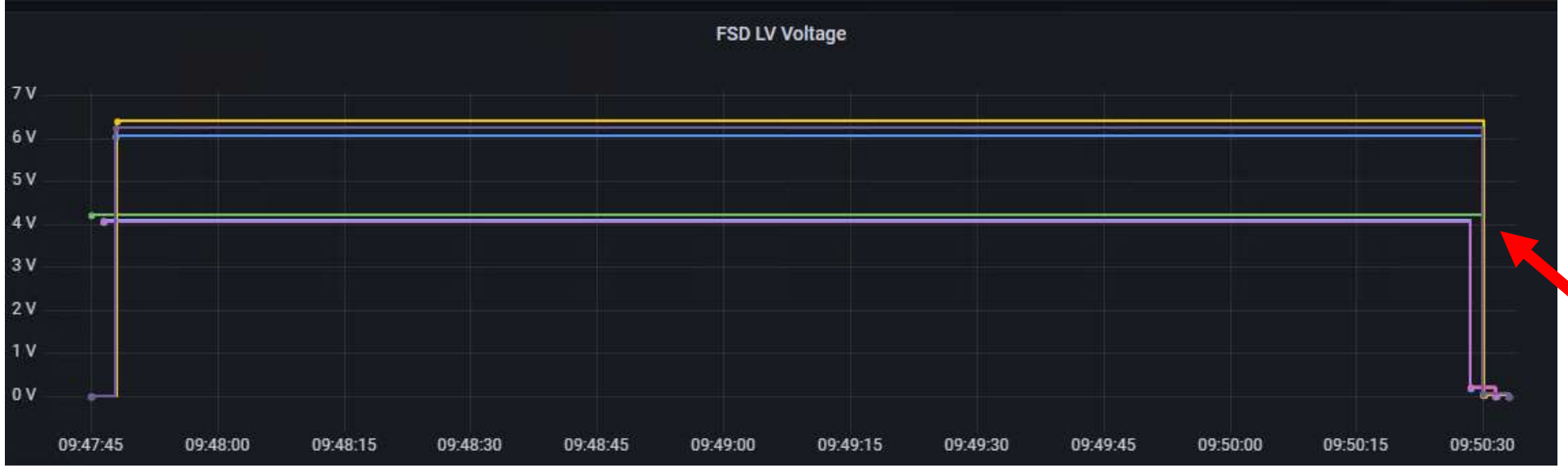
Increasing dark currents of silicon detectors



FSD Autoswitch system

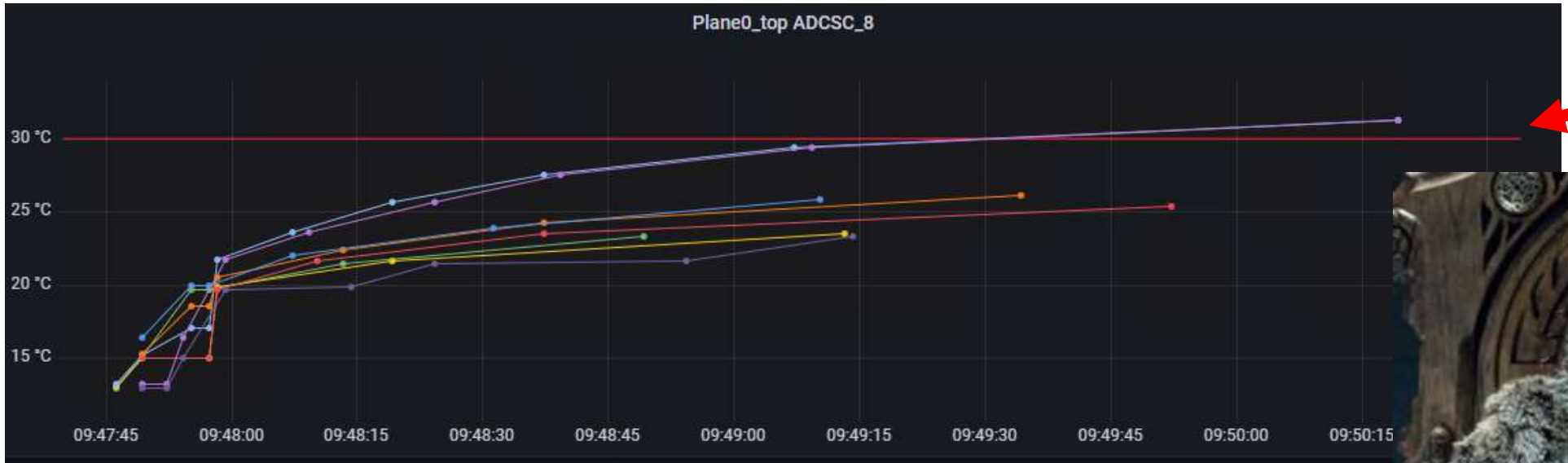


Temperature threshold

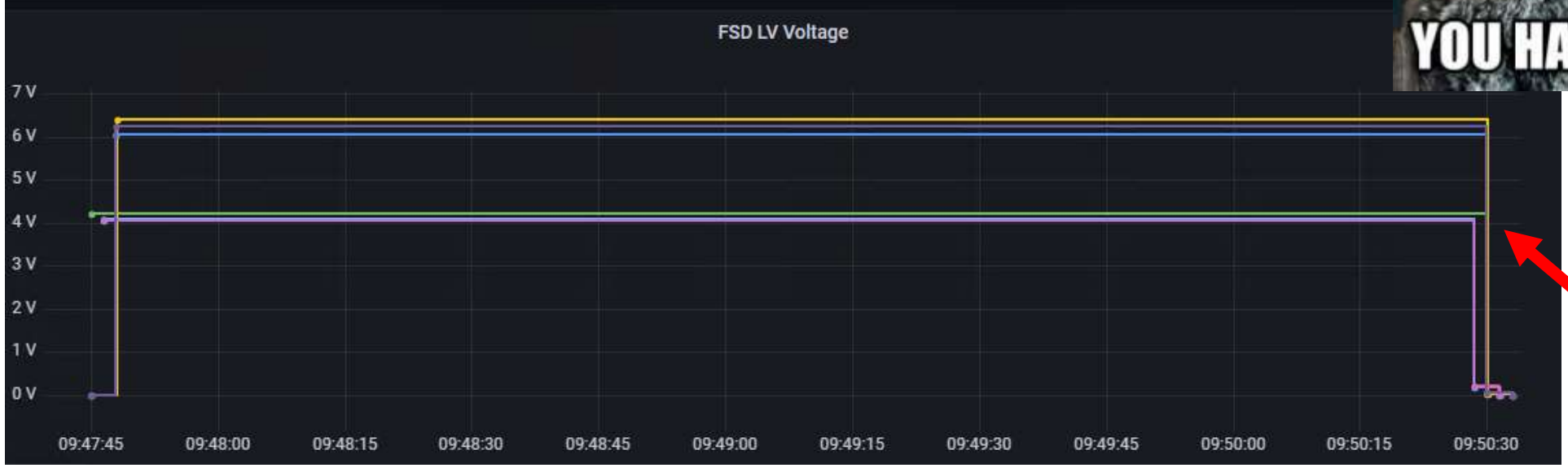


Delayed automatic LV shutdown

FSD Autoswitch system

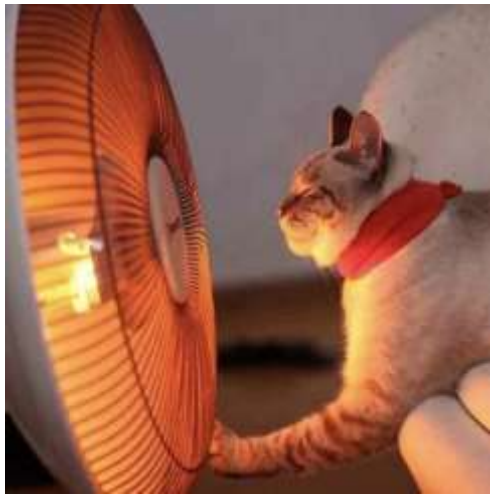


Temperature threshold



Delayed automatic LV shutdown

FSD Conditioner monitoring



TCP/IP

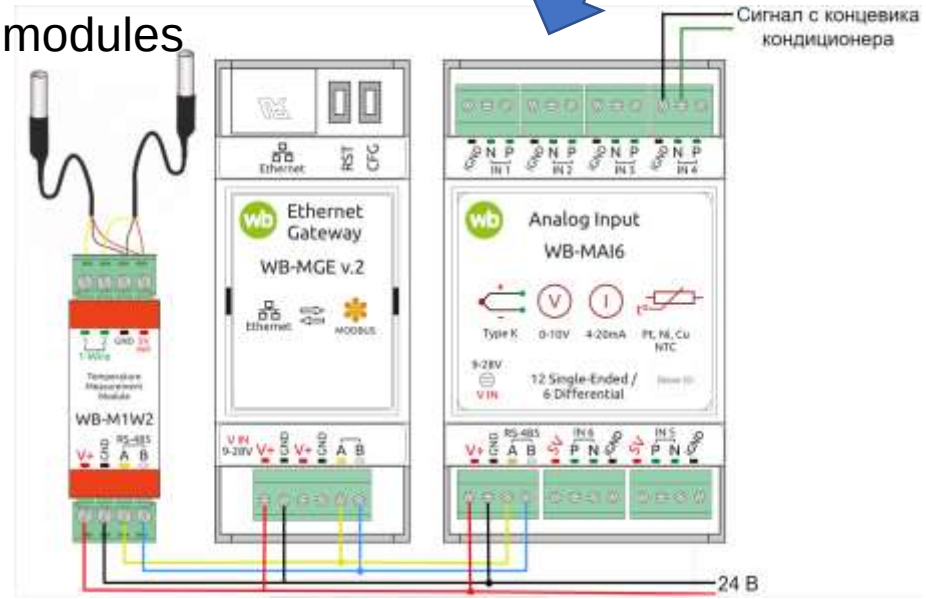
TANGO

TANGO device server

Historical DataBase

MAI6 & WB M1W2 Measurement modules

Modbus RTU



HV system of FSD, GEM, BT

TCP/IP

CAEN HV Wrapper

CAEN HV Wrapper Library

TANGO

TANGO device server

Historical DataBase

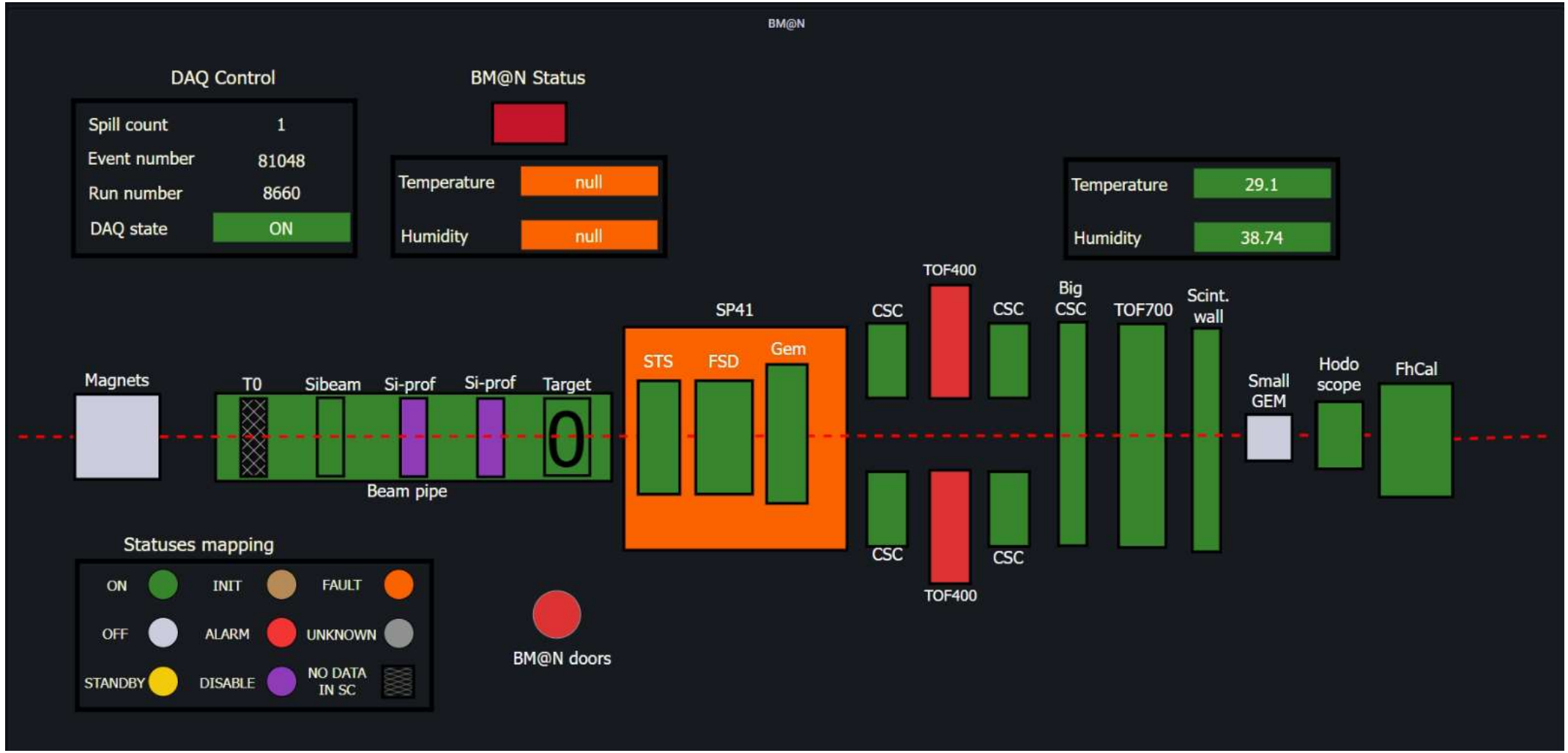
Grafana

HV system of FSD, GEM, BT

The change in detector currents at three beam tracker stations during the BM@N SRS 2022-2023 session is shown.

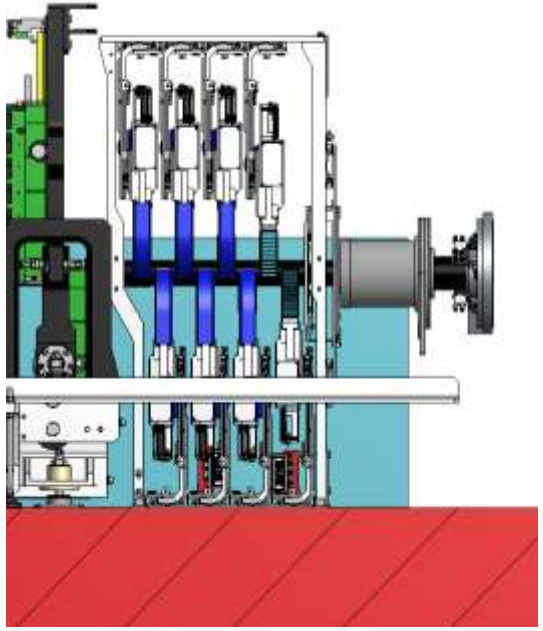
The average value of the dark current at the beginning of the session is 0.761 μA, measured at a temperature of +22.5°C; the average value of the dark current at the end of the session, for a reason radiation damage, is 12.7 μA,

Conclusions

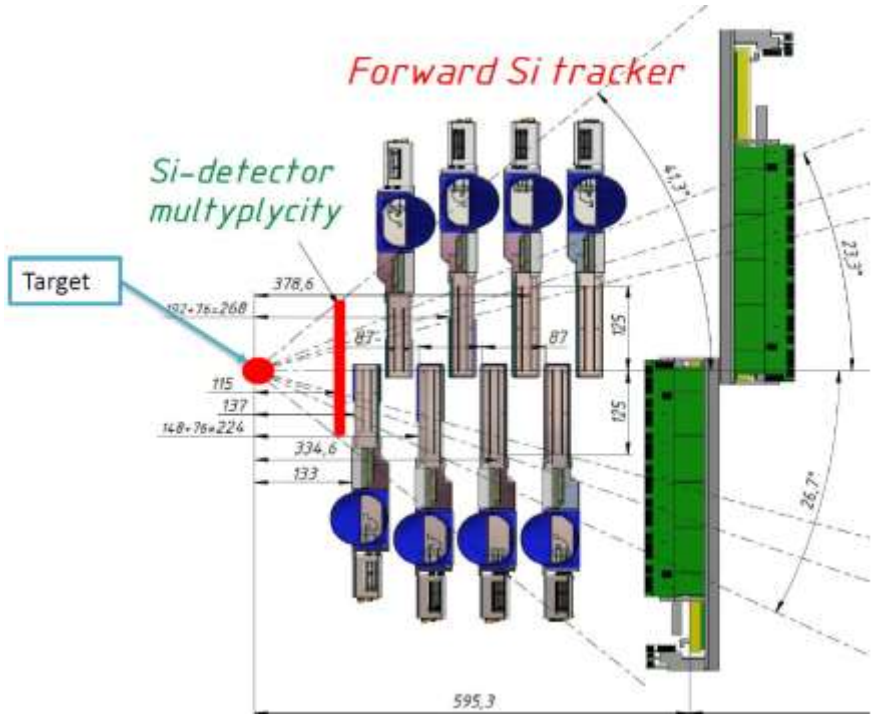


Thank You for attention!

FSD – Forward Silicon Detector



3D view of forward Si



Forward SI installed in BM@N

HV system of TOF(Right) BM@N

TCP/IP
Socket

Socket Manager

TCP/IP
Socket

Device Server

Properties
Attributes
Commands

Historical DataBase

TCP/IP
Socket

HV/LV system of TOF(Left) BM@N

TCP/IP

SNNP

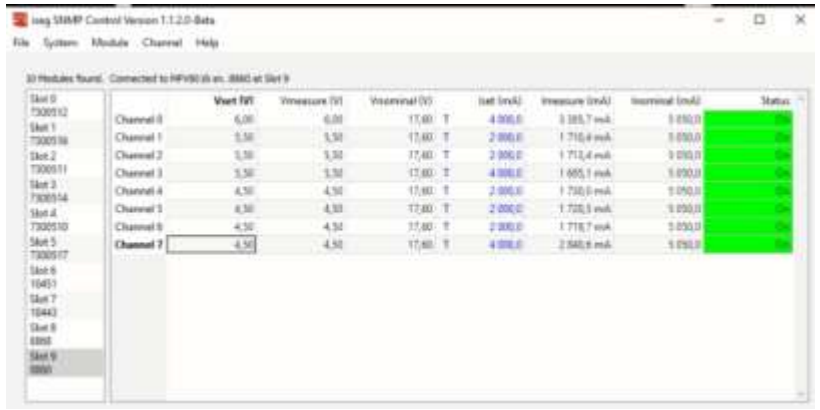
Device Server

Properties
Attributes
Commands

Historical DataBase

TCP/IP

SNNP



HV system of TOF BM@N

HV current during the BM@N SRS 2022-2023 session is shown.

TOF Preamplifiers

x20 Preamps per each detector

RS - 485

TCP/IP

Socket

TCP/IP

Socket

Device Server

Properties
Attributes
Commands

HDB

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	1989	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	33
18	1748	1559	1676	3256	0	38	47
19	1788	1579	1829	3256	0	40	36
20	1514	1566	1641	3296	0	49	45

Grafana

Gas system of TOF400/TOF700 BM@N

TCP/IP

Modbus

Device Server

Properties
Attributes
Commands

HDB

Device Server

Properties
Attributes
Commands

TCP/IP

TCP/IP

Socket

Gas system of TOF400/TOF700 BM@N

TOF Gas system during the BM@N SRS 2022-2023 session is shown.