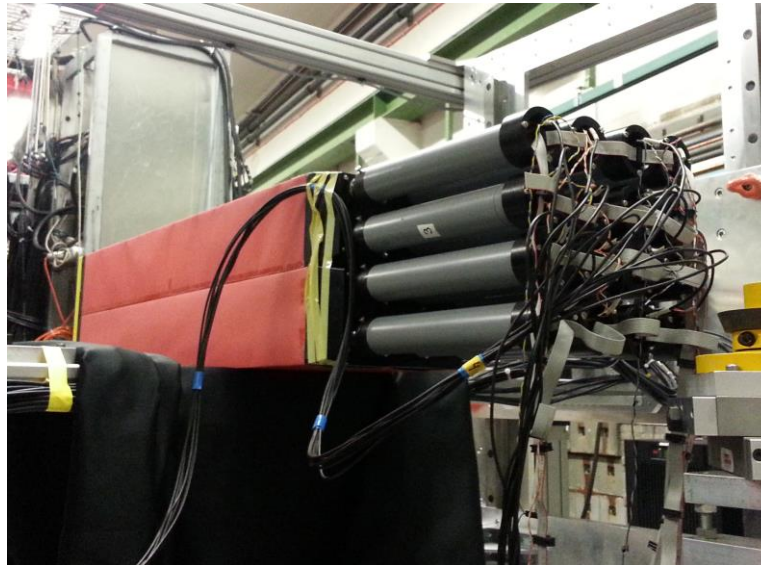


# Forward Spectrometer Calorimeter (FSC)

## Detector control system



Institute for High Energy Physics, Protvino, Russia

## DCS includes:

### 1. PMT power control (1512 PMTs):

- 1512 channels of ADC
- 1512 channels of DAC
- 1512 channels of EEPROM-codes
- few HV/LV-channels

[now 36-channel prototype in use]

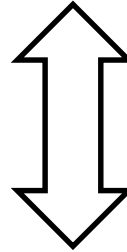
### 2. Monitoring systems control:

~ 400 channels of LED-pulses control & stability.

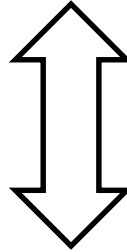
Total: up to 5000 channels (PVs in FSC DCS).

# FSC DCS: structure

Field layer: MCU boards (stm32f2xx, stm32f4xx) + Modbus RTU



Control layer: Raspberry Pi B+ with RS485/CAN-adapter



Supervisory layer: Control system studio (+ ArchiveEngine & AlarmHandler)

Forward Spectrometer Calorimeter slow control

Power Supplies Cockcroft-Walton control Temp. Humid. state Monitoring system

High and low voltages power supplies for CW-generators.

on/off	##	State	Volt +6.0	Volt -6.0	HV	Curr +6.0	Curr -6.0	Curr HV	Alarm
on/off	Group 280/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 560/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 840/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 1120/1512	0	5.118 V	-5.354 V	3.429 V	2.922 A	0.061 A	1.841 A	-
on/off	Group 1400/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 1512/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-

Alarm Table

ID	#	Mode	HV	HV-HV	HV	HV-HV	Cur	HV	Alarm
00001	1	1	1	1	1	1	1	1	1
00002	2	1	1	1	1	1	1	1	1
00003	3	1	1	1	1	1	1	1	1
00004	4	1	1	1	1	1	1	1	1
00005	5	1	1	1	1	1	1	1	1
00006	6	1	1	1	1	1	1	1	1
00007	7	1	1	1	1	1	1	1	1
00008	8	1	1	1	1	1	1	1	1
00009	9	1	1	1	1	1	1	1	1
00010	10	1	1	1	1	1	1	1	1
00011	11	1	1	1	1	1	1	1	1
00012	12	1	1	1	1	1	1	1	1
00013	13	1	1	1	1	1	1	1	1
00014	14	1	1	1	1	1	1	1	1
00015	15	1	1	1	1	1	1	1	1
00016	16	1	1	1	1	1	1	1	1
00017	17	1	1	1	1	1	1	1	1
00018	18	1	1	1	1	1	1	1	1
00019	19	1	1	1	1	1	1	1	1
00020	20	1	1	1	1	1	1	1	1
00021	21	1	1	1	1	1	1	1	1
00022	22	1	1	1	1	1	1	1	1
00023	23	1	1	1	1	1	1	1	1
00024	24	1	1	1	1	1	1	1	1
00025	25	1	1	1	1	1	1	1	1
00026	26	1	1	1	1	1	1	1	1
00027	27	1	1	1	1	1	1	1	1
00028	28	1	1	1	1	1	1	1	1
00029	29	1	1	1	1	1	1	1	1
00030	30	1	1	1	1	1	1	1	1
00031	31	1	1	1	1	1	1	1	1
00032	32	1	1	1	1	1	1	1	1
00033	33	1	1	1	1	1	1	1	1
00034	34	1	1	1	1	1	1	1	1
00035	35	1	1	1	1	1	1	1	1
00036	36	1	1	1	1	1	1	1	1

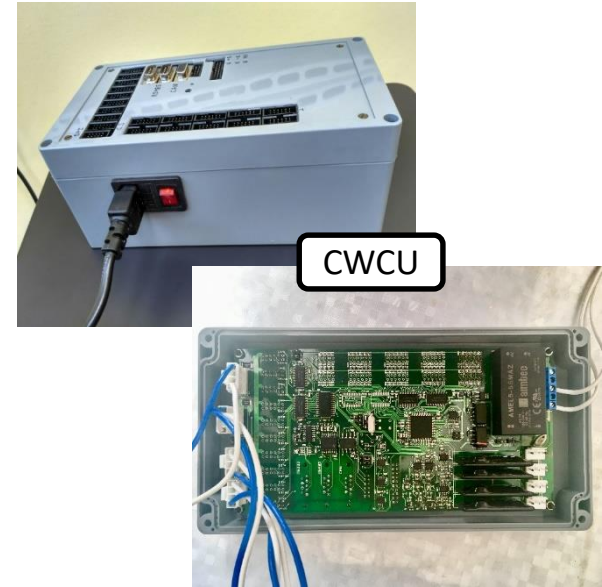
**This was tested 2 years ago for the 36-channel prototype. Nothing new.**

# FSC DCS: field layer

Field layer: MCU boards (stm32f2xx, stm32f4xx) + Modbus RTU

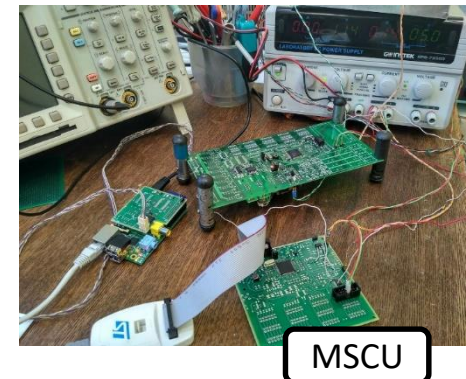
CWCU (Cockcroft-Walton Control Unit):

- HV & LV control
- Voltage reference codes for up to 280 PMTs
- Temperature sensors interface (Dallas, 1-Wire)
- Modbus RTU/CAN-bus



MSCU (Monitoring System Control Unit)

- LED control in both monitoring systems
- Temperature sensors interface (Dallas, 1-Wire)
- Modbus RTU



# FSC DCS: control layer

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## Control layer: Raspberry Pi B+ with RS485/CAN-adapter

Adapter for Raspberry Pi:

- ISO3086T for Modbus/RS485 (main interface in FSC DCS)
- SJA1000T for CAN-bus (used for few custom-made power supplies)



# FSC DCS: supervisory layer

## Supervisory layer: Control system studio (+ ArchiveEngine & AlarmHandler)

Control system studio:

- GUI (test version)
- ArchiveEngine (works fine)
- AlarmHandler (some difficulties, but basically it works)

Forward Spectrometer Calorimeter slow control

Power Supplies Cockcroft-Walton control Temp. Humid. state Monitoring system

High and low voltages power supplies for CW-generators.

on/off	##	State	Volt +6.0	Volt -6.0	HV	Curr +6.0	Curr -6.0	Curr HV	Alarm
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on/off	Group 1512/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-

The screenshot displays the control system studio interface. On the left, there are two alarm panels: 'High Voltage 100V' (red) and 'Low Voltage +/-6V' (green). Below them is an 'Alarm Tree' showing a hierarchy of alarms, with 'Area: High Voltage 100V (MAJOR/LOW\_ALARM)' highlighted in red. The main window shows the 'Forward Spectrometer Calorimeter slow control' interface, which includes a table of power supplies (identical to the one above) and an 'Alarm Table' at the bottom. The 'Alarm Table' shows current alarms with columns for PV, Description, Alarm Time, Current Sev., Current Stat., Alarm, and Alarm Value. A tooltip is visible over the 'Alarm Table' showing details for a 'MAJOR alarm: HV voltage'.

PV	Description	Alarm Time	Current Sev.	Current Stat.	Alarm	Alarm Value
PANDA:FSC:HV:WCUCU1:sta	MAJOR alarm: HV state	2017/10/30 12:47:33	MAJ_OR	LOW_ALARM	MAJ_OR	LOW_0
PANDA:FSC:HV:WCUCU1:V	MAJOR alarm: HV voltage	2017/10/30 12:47:27	MAJ_OR	LOW_ALARM	MAJ_OR	LOW_17
PANDA:FSC:HV:WCUCU1:1	MAJOR alarm: HV curr	2017/10/30 15:47:11	MAJ_OR	LOW_ALARM	MAJ_OR	LOW_-274

# FSC DCS: monitoring systems

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## Monitoring systems:

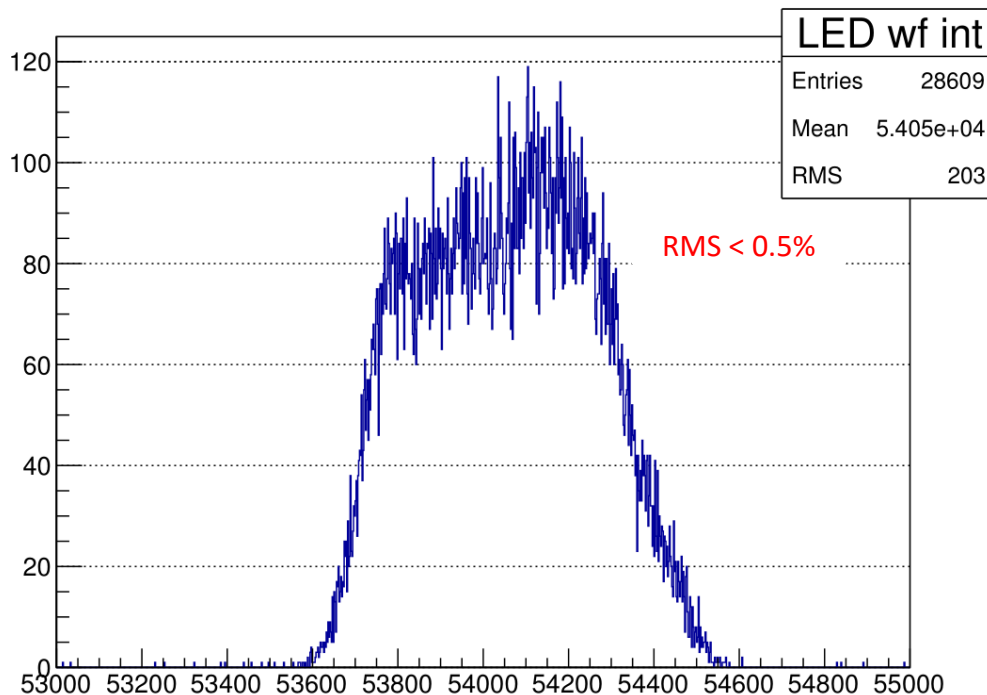
- 1) Front-side system for quick and simple checking of the detector channels (independently) and the readout electronics circuits. 378 LEDs – each in 4-channel module of FSC. [*Under the development*]
- 2) Back-side system for precise monitoring of the PMT gain in each channel of the detector. Two light pulsers for the whole detector, LED pulse in each channel by optical fiber. [*Prototyping*]

# FSC DCS: back-side monitoring system

Back-side system is based on light pulser (1 for half of the detector):

- Powerfull blue LED, LED-driver
- Light mixer
- Reference photodiode (for LED-pulse stability measurement)
- Temperature heater (for thermal stabilization)

Photodiode signal (received by MSCU in DCS):

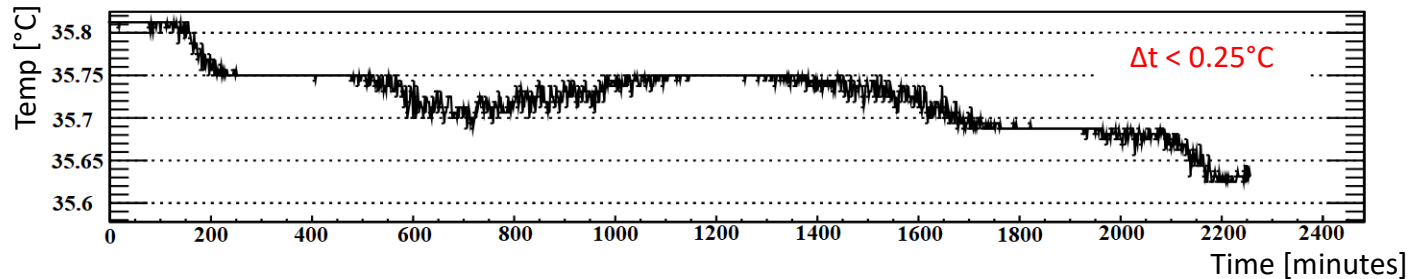




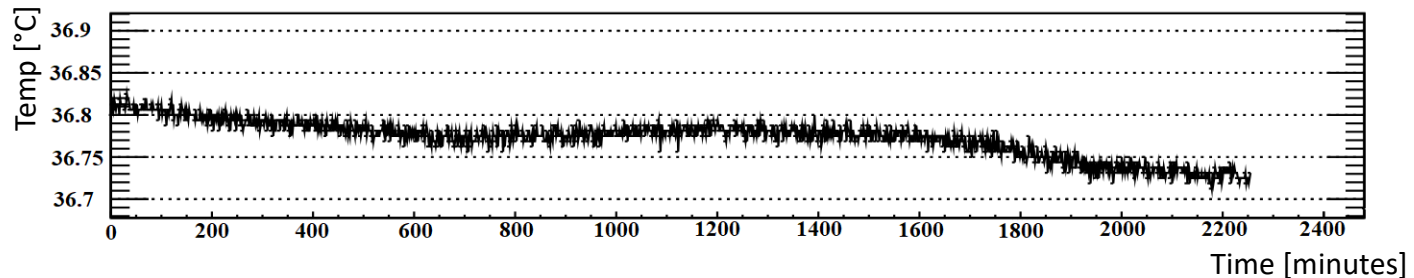
# FSC DCS: back-side monitoring system

## Temperature stability (received by MSCU in DCS):

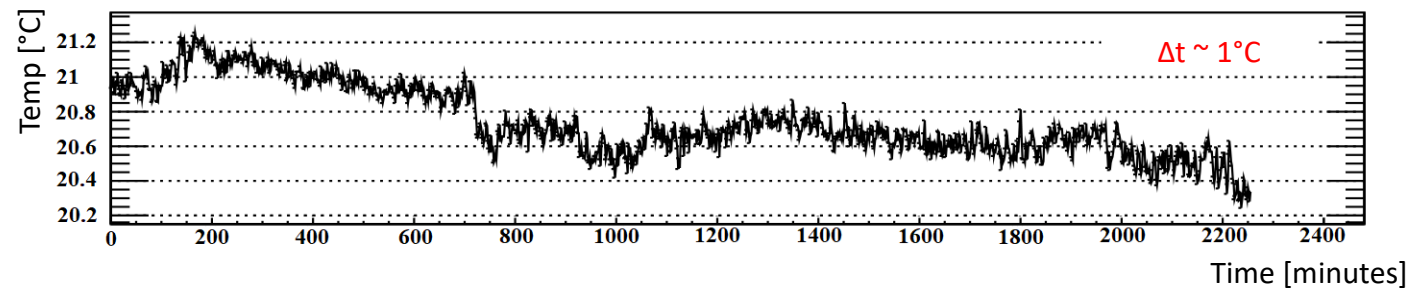
*Temperature near LED*



*Temperature near the heater*



*Temperature outside*



# FSC DCS: summary

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DCS was tested with 36-channel prototype, but not in beam time.

DCS-chain (MCU + Raspberry/IOC + CSS/Archiver) was successfully applied also in other tasks (for radiation hardness tests of DCS components).

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