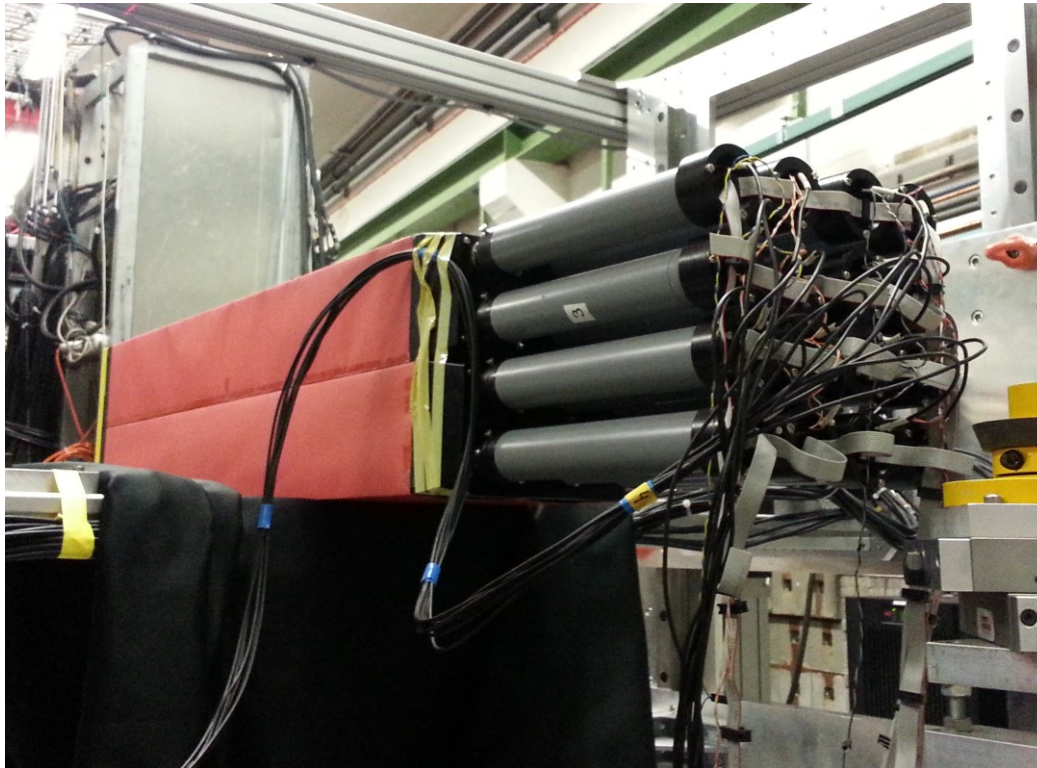# Forward Spectrometer Calorimeter
Detector control system
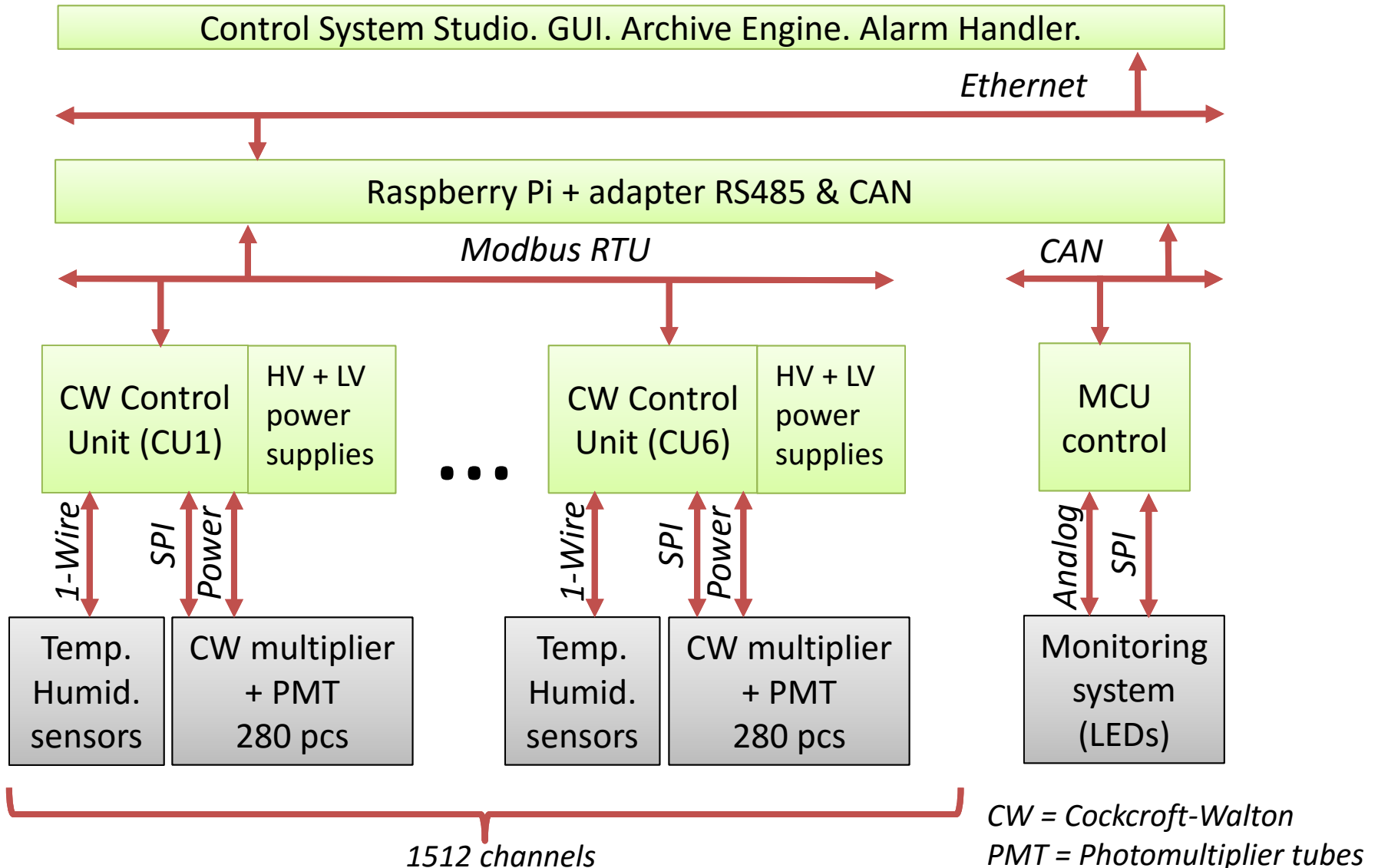
Sofia Bukreeva, Institute for High Energy Physics,
Institute for Theoretical and Experimental Physics, Russia

Forward Spectrometer Calorimeter DCS

- PMT power control

- Access to monitoring system

- Interface to sensors

- Control other detector parameters

- GUI, data archiving, alarm handler

FSC DCS: Structure

Control System Studio. GUI. Archive Engine. Alarm Handler.

Ethernet

Raspberry Pi + adapter RS485 & CAN

Modbus RTU

CAN

CW Control Unit (CU1) | HV + LV power supplies

...

CW Control Unit (CU6) | HV + LV power supplies

MCU control

1-Wire *SPI* *Power*

1-Wire *SPI* *Power*

Analog *SPI*

Temp. Humid. sensors

CW multiplier + PMT 280 pcs

Temp. Humid. sensors

CW multiplier + PMT 280 pcs

Monitoring system (LEDs)

1512 channels

CW = Cockcroft-Walton
PMT = Photomultiplier tubes

FSC control system: Components

- PMT Hamamatsu R7899 + CW multiplier with SPI (DAC & ADC on boards)
- Power Supplies: EPS-65-7.5, -48 (Meanwell)
- Temperature sensors: DS18B20
- Monitoring system:
  a) analog signal from LED generator
  b) LED system control(SPI?)

ADC on CW boards and temperature sensors were tested for radiation hardness to use it on the detector.
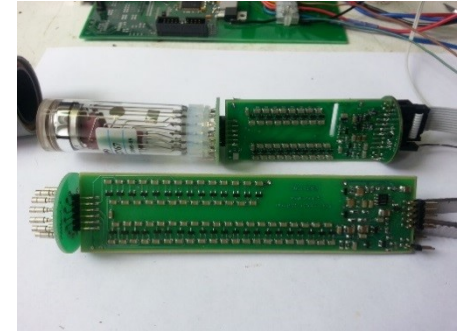
FSC control system: ADC and temperature sensors radiation tests

5 ADC chips: **AD7476ARTZ**, **AD7478AARMZ** (Analog Devices)

ADS7886SBDBVT, **ADC121S021CIMF** (Texas Instruments)

MAX11665AUT (Maxim Integrated)

2 temperature sensors: **DS18B20** (12-bit), **DS18S20** (8-bit)

Radiation tests:

1) cumulative dose 56krad (only ADC)

Up to 37krad: no changes.

From 37krad to 56krad: AD7476ARTZ, AD7478AARMZ were totally damaged and not recovered.

Conversion coefficient of MAX11665AUT, ADS7886SBDBVT, ADC121S021CIMF was changed not more than by ~10%. ADC started to recovery after the end of irradiation.

2) 10^{13} neutrons per $1cm^2$ (ADC and sensors)

Data analysis is in progress. Online analysis showed similar results.

ADS7886SBDBVT, ADC121S021CIMF showed the best results (ADC121S021CIMF cheaper).

More information in the next report.

MCU + Raspberry Pi + archiveengine were used for tests (RPi and MCU were put out of radiation area).
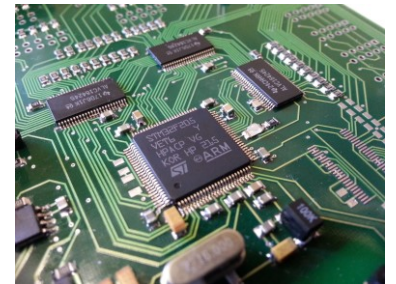
FSC control system: CW control units

CWCU – Cockcroft-Walton control unit
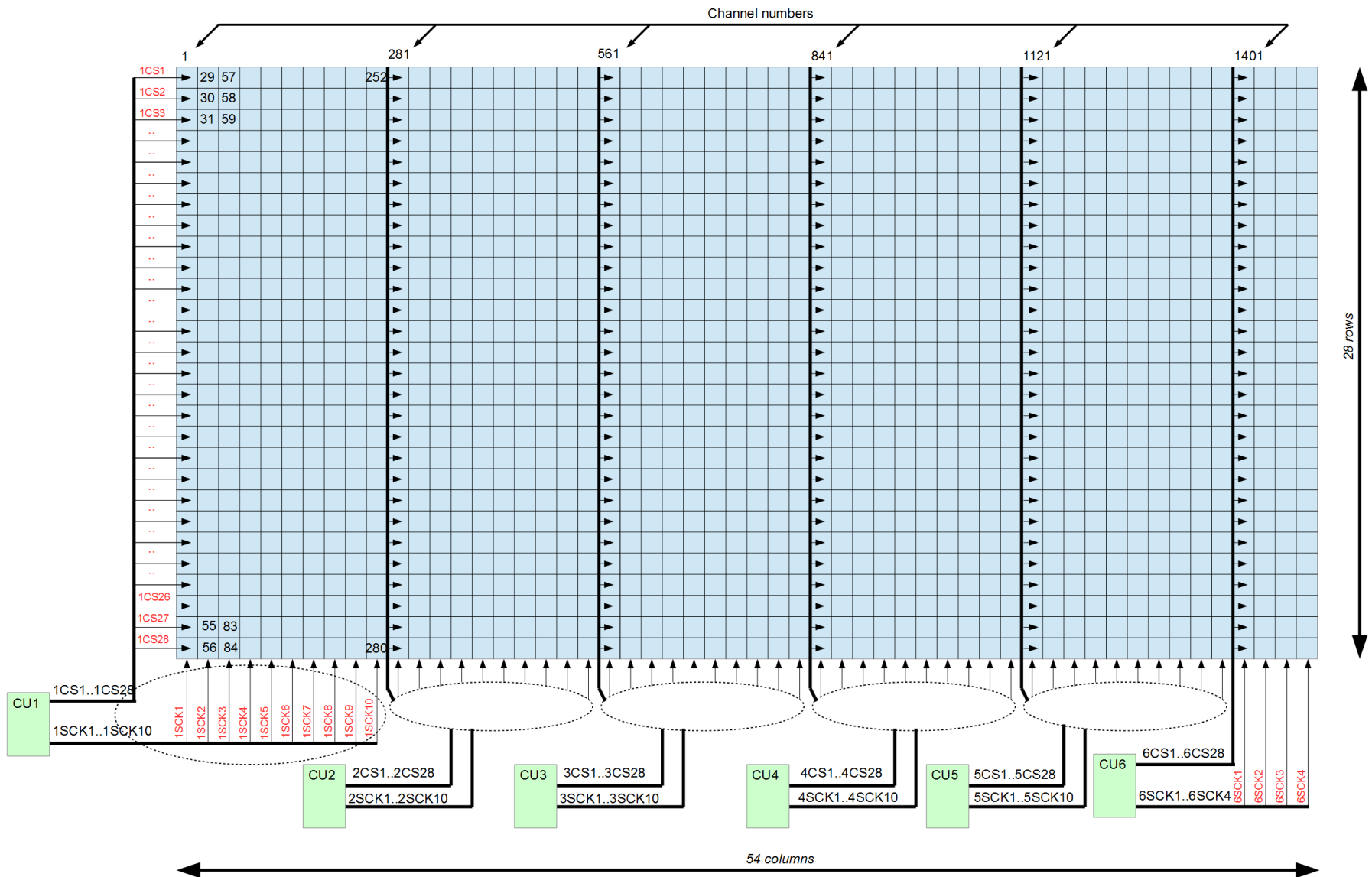based on stm32f205ve.
PCB with power supplies inside.

- Control LV & HV on CW multipliers
- Monitor currents
- Handle SPI: writing codes to DACs and reading ADCs
- Store codes in EEPROM
- Support Modbus RTU and CAN bus

To use in monitoring system and to read sensors:
- 1-wire interface
- analog input/output

FSC control system: Monitoring system

Monitoring systems:

1) LED pulse by fibers to all channels of "shashlyk".

Reading analog signal from photodiode in LED generator (for light pulse stabilization) .

- ADC in stm32f205: 6MSPS (~170ns),

12-bit, LSB = 8mV.

- Photodiode signal: width 400ns, period 2us.

is delayed, amplified and shaped up to a few us.

Not every signal will be catched by MCU.

- Trigger by external signal.

2) LED for every module.

Interface to fire LEDs in every module

independently.

Under development…

Signal waveform

Waveform integral

ADC integral	
Entries	50
Mean	2.74e+04
RMS	546.9
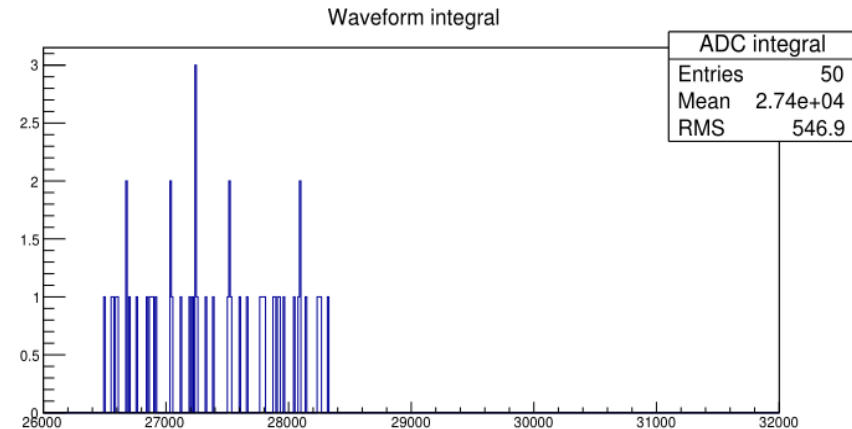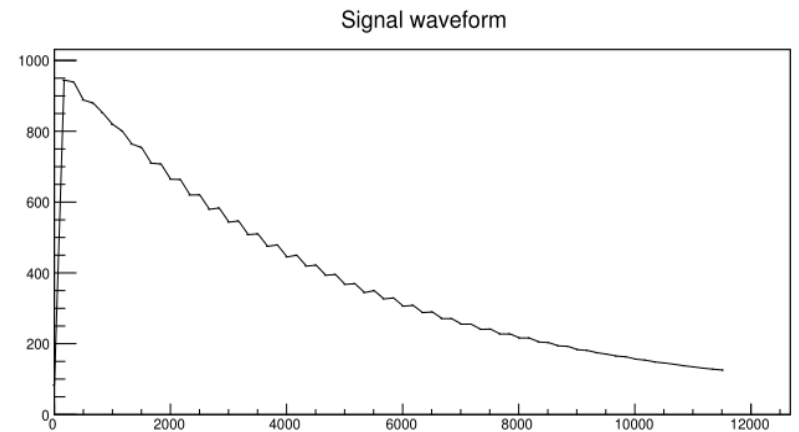
FSC control system: Raspberry Pi + adapter

Adapter RS485 and CAN for RPi model B:
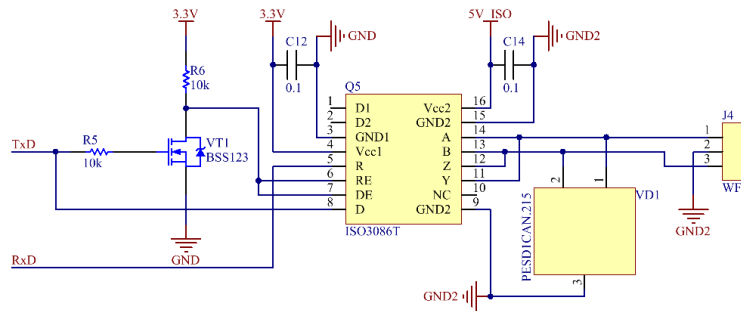
Modbus RTU:

ISO3086T

Baud rate 19200/9600

CAN:

SJA1000T, used on 50 kbit/s

Adapter can be used for Raspberry Pi model B+, model 2B and other (it is suitable for 40-pin connector).

IOCs for Raspbian with Modbus and CAN support are tested with CWCU.

FSC control system: Slow control architecture

CSS PANDA

Databases

Supervisory Layer

EPICS

Gateway [Channel Access Server/Client]

Local CSS:
Archive Engine/
Alarm Server/
GUI

Local Database.
FSC

Channel Access. FSC PVs

IOC Application.
Sensors

IOC Application.
CW-control

IOC Application.
Monitoring system
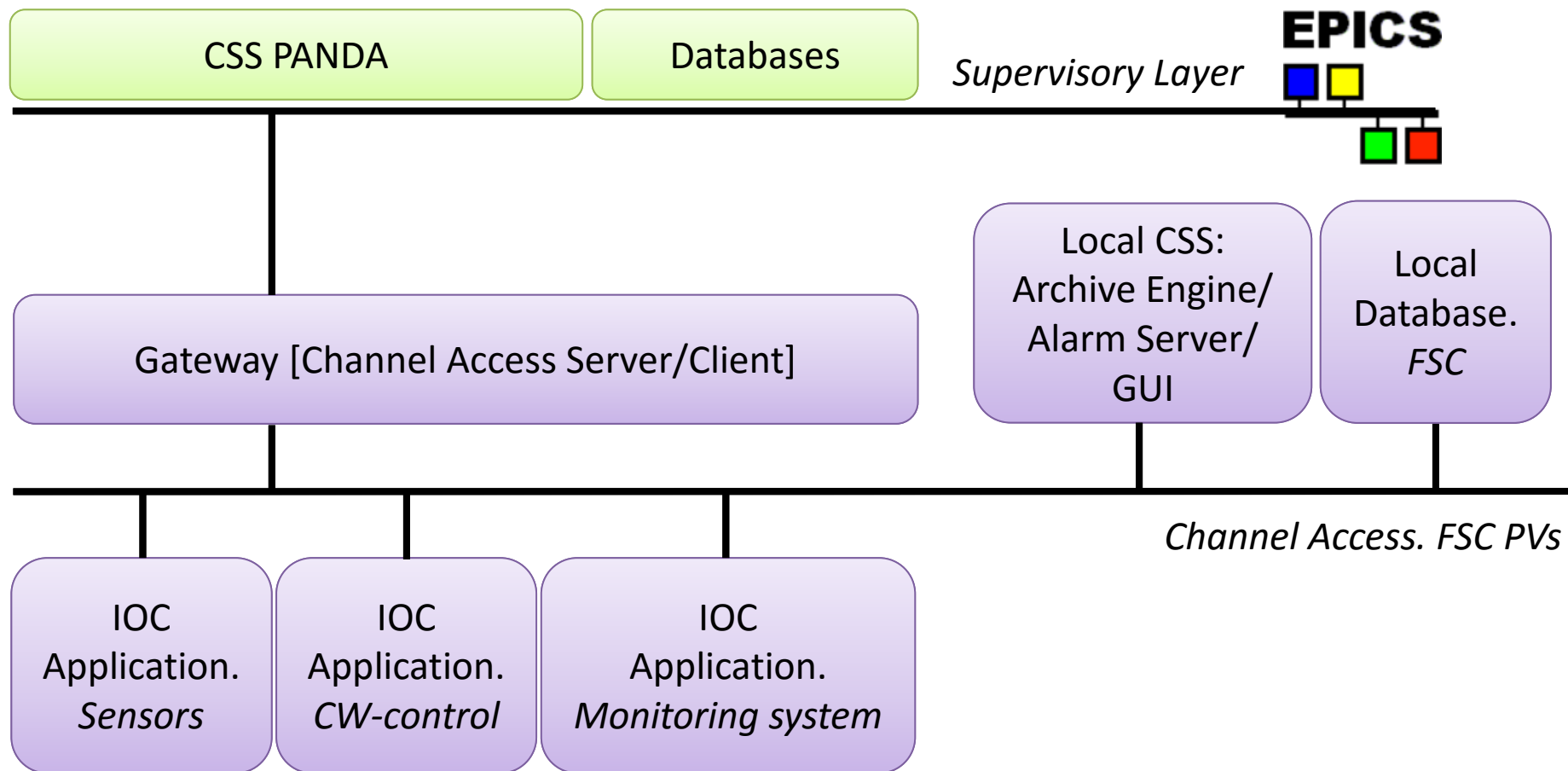
FSC control system: CSS

GUI in developing.

ArchiveEngine was used in radiation tests.

AlarmHandler is not used yet.

Forward Spectrometer Calorimeter slow control

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

High and low voltages power supplies for CW-genereators.
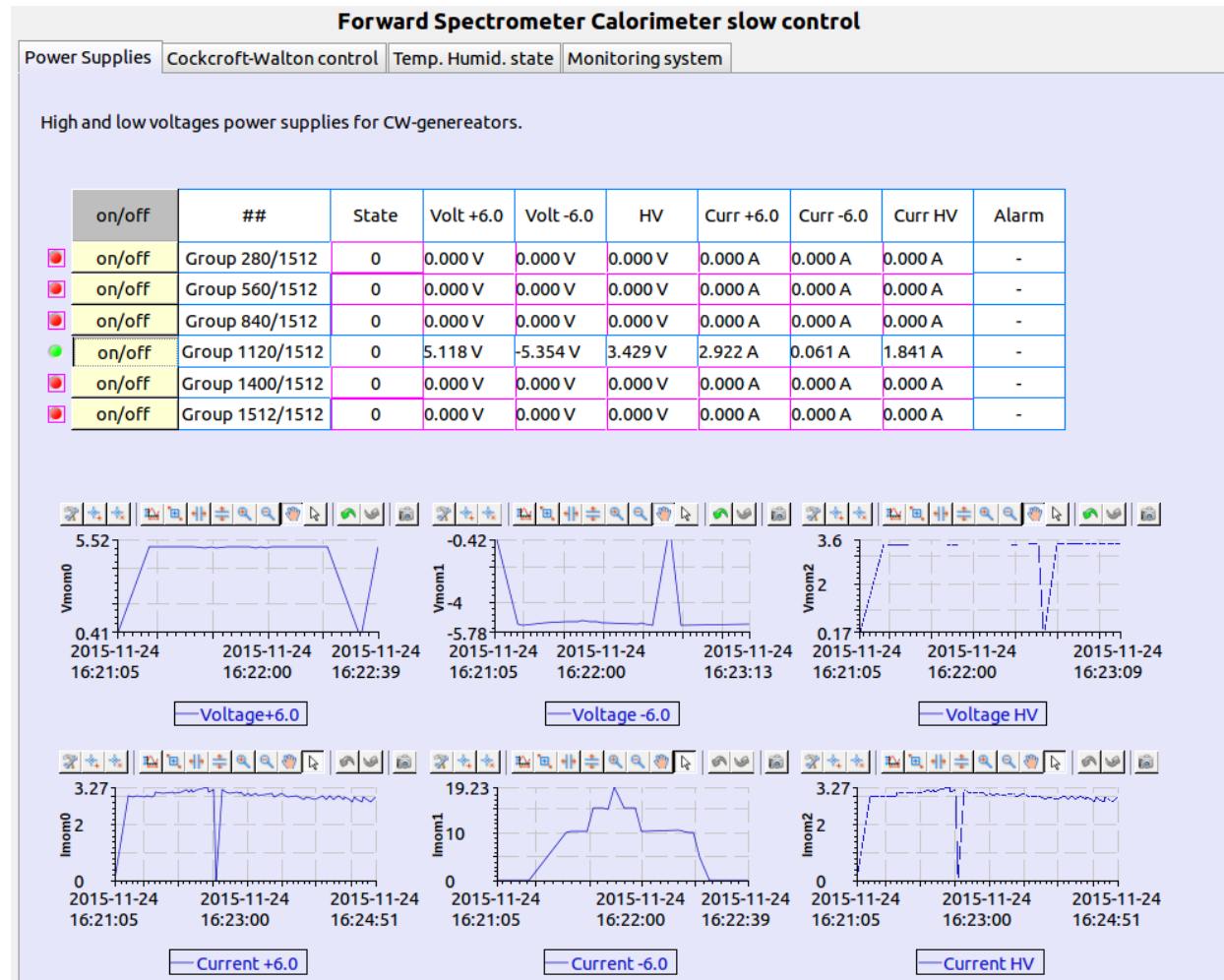
on/off	##	State	Volt +6.0	Volt -6.0	HV	Curr +6.0	Curr -6.0	Curr HV	Alarm
on/off	Group 280/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 560/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	Group 840/1512	0	0.000 V	0.000 V	0.000 V	0.000 A	0.000 A	0.000 A	-
on/off	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	-

FSC control system: Summary

FSC DCS:

CWCU is generally prepared. Used for different DCS subsystems (CW control, monitoring system, sensors).

5 different ADC and 2 temperature sensors (Dallas) were successfully tested for radiation hardness. ADC121S021CIMF and DS18B20 were preliminarily chosen to use in detector.

Raspberry Pi: model B is not for sale anymore (at least in Russia).

Should be replaced with another models or another computers.

CSS: easy to use, convenient to edit GUI.

Archive Engine was helpful for radiation tests.

Alarm Handler is not required right now.