Gas Quality Monitor for gaseous detectors

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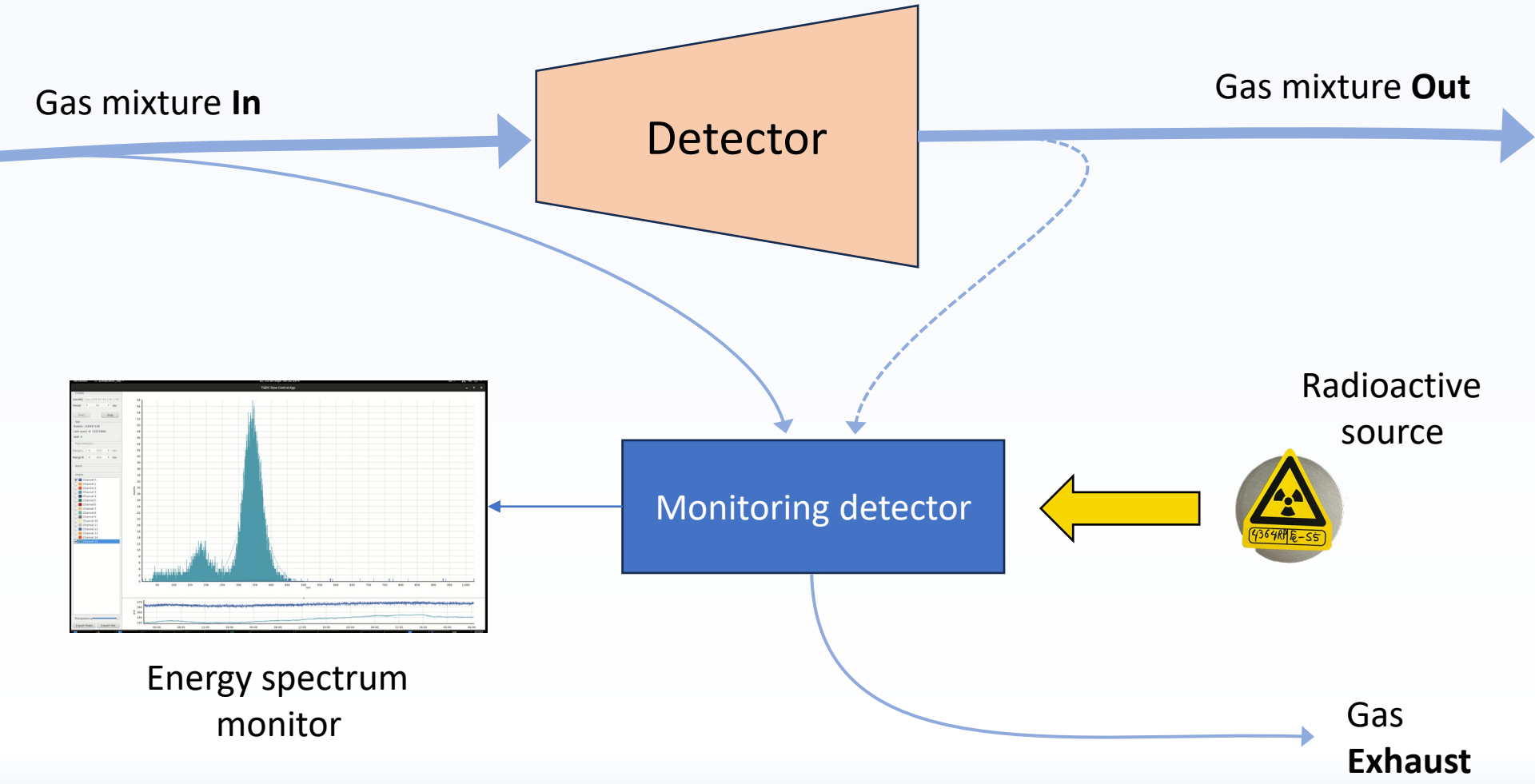
Behalf of Straw Tracker Team

Solution. Concept



Implementation. First prototype

Built for NA-62

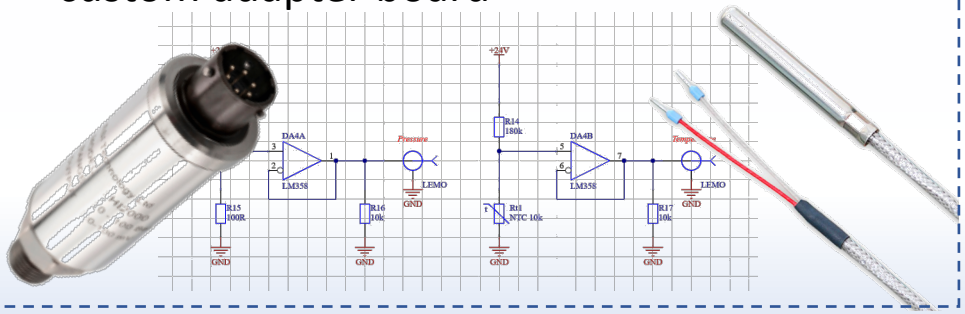
Straw chamber & ^{55}Fe

Integrating amplifier

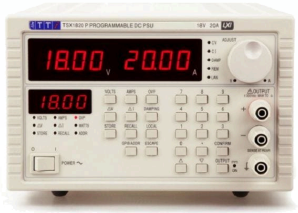
CAEN Digitizer

CAEN HV
(+ NIM crate)

Pressure & Temperature sensors
+ custom adapter board

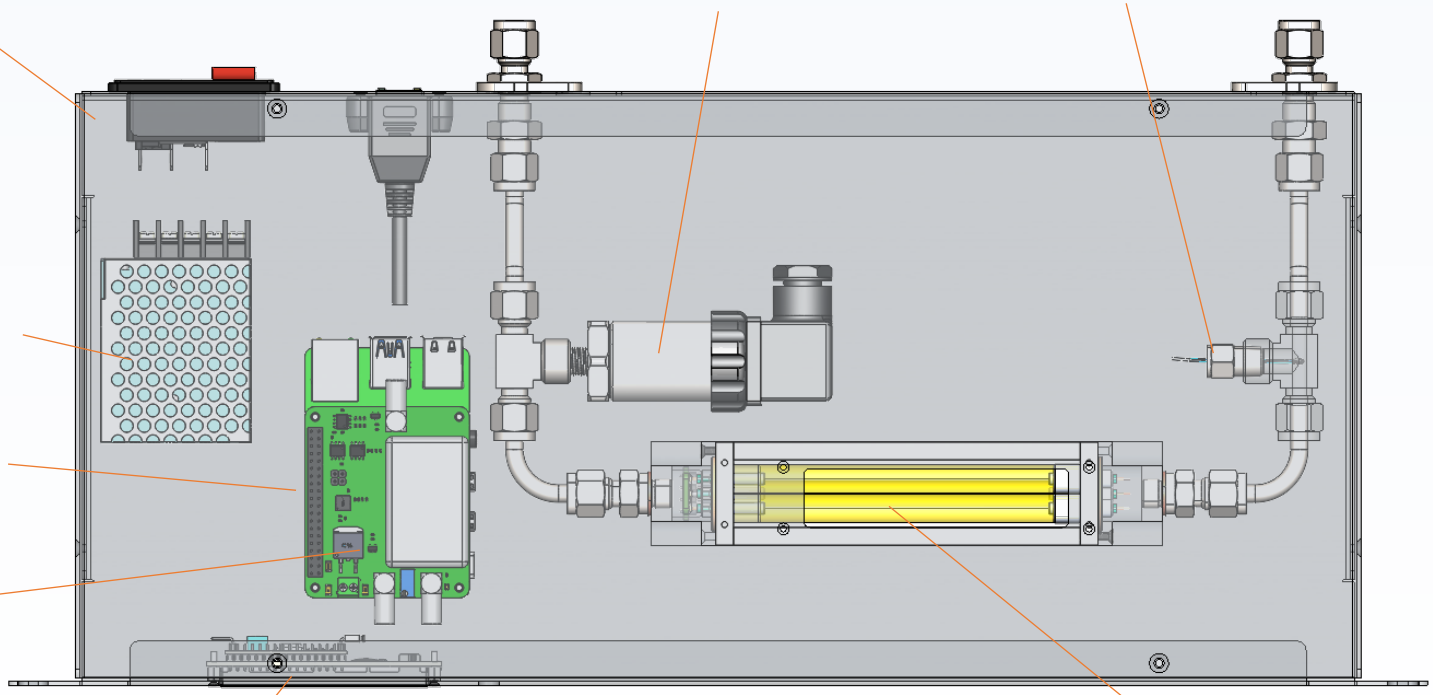


LV PS (4 ch.)



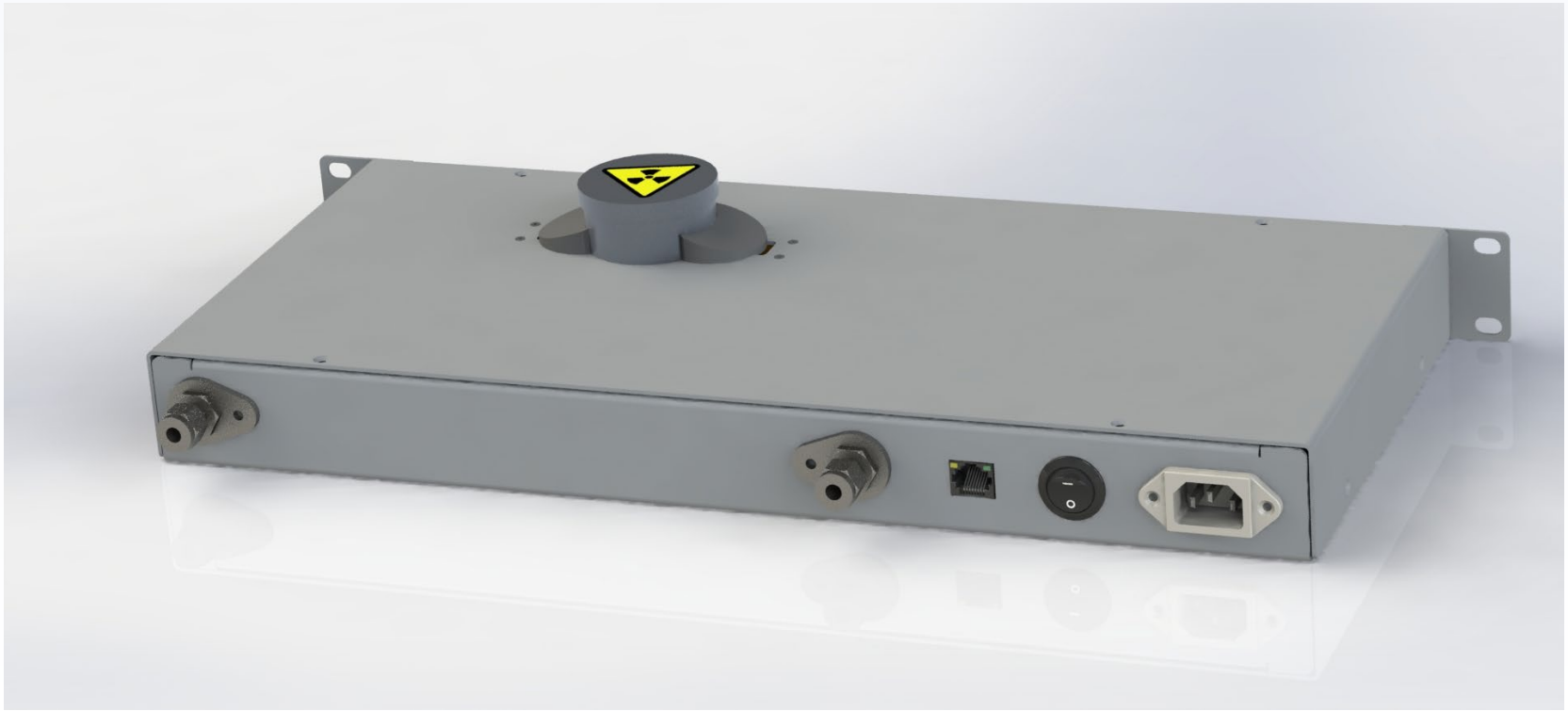
Computer

Implementation. Black box



Physical interfaces

- Swagelok 6mm (In & Out)
- Ethernet (+ Wi-Fi antenna)
- 220V (C13)
- Socket for environment sensor (front panel)



Control interfaces

GasMonPi Configuration

High Voltage:

1850

power state

Threshold:

250

Exposition:

60

Pulser:

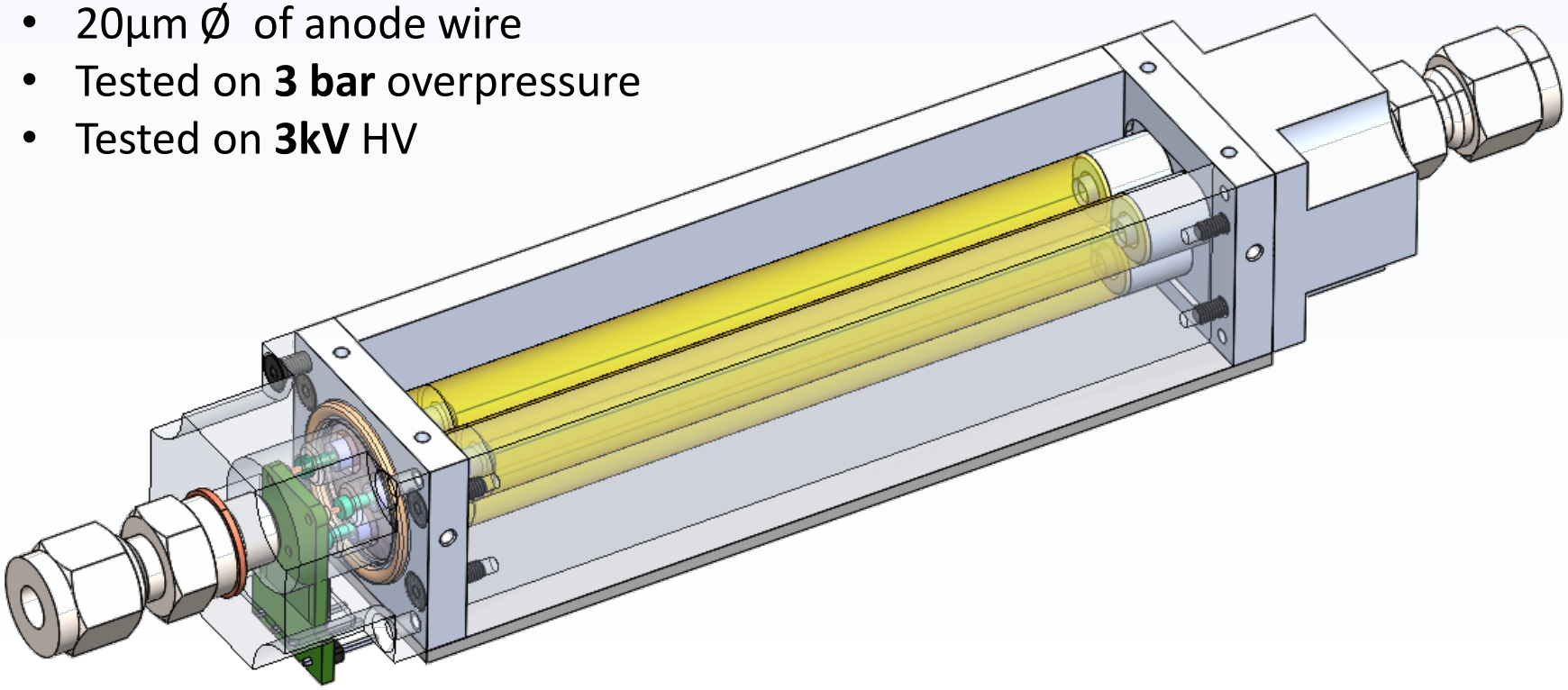
1500

600

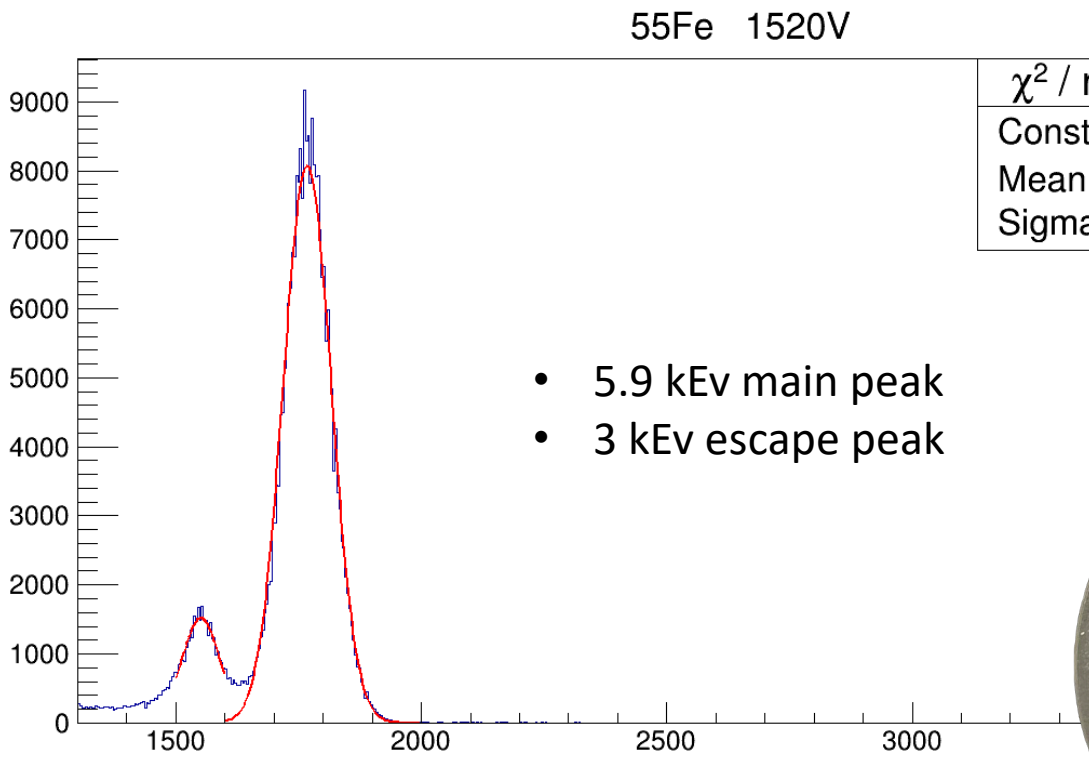
Configure

Straw chamber

- 3x straw tubes
- Ø 10mm, 120mm length
- 20µm Ø of anode wire
- Tested on **3 bar** overpressure
- Tested on **3kV** HV



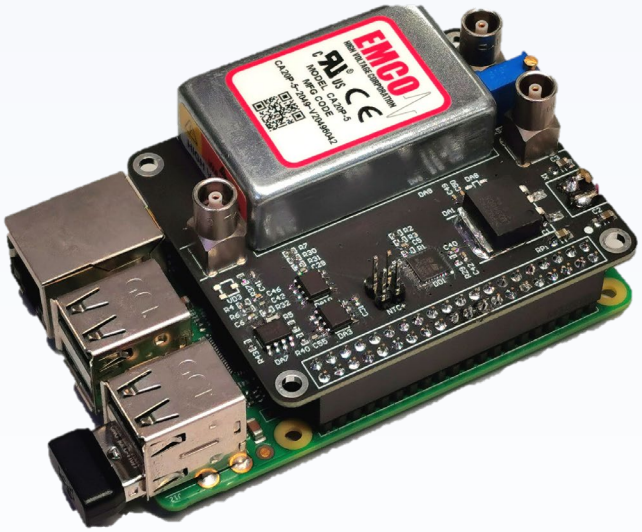
Radioactive source. Iron-55 (55Fe)



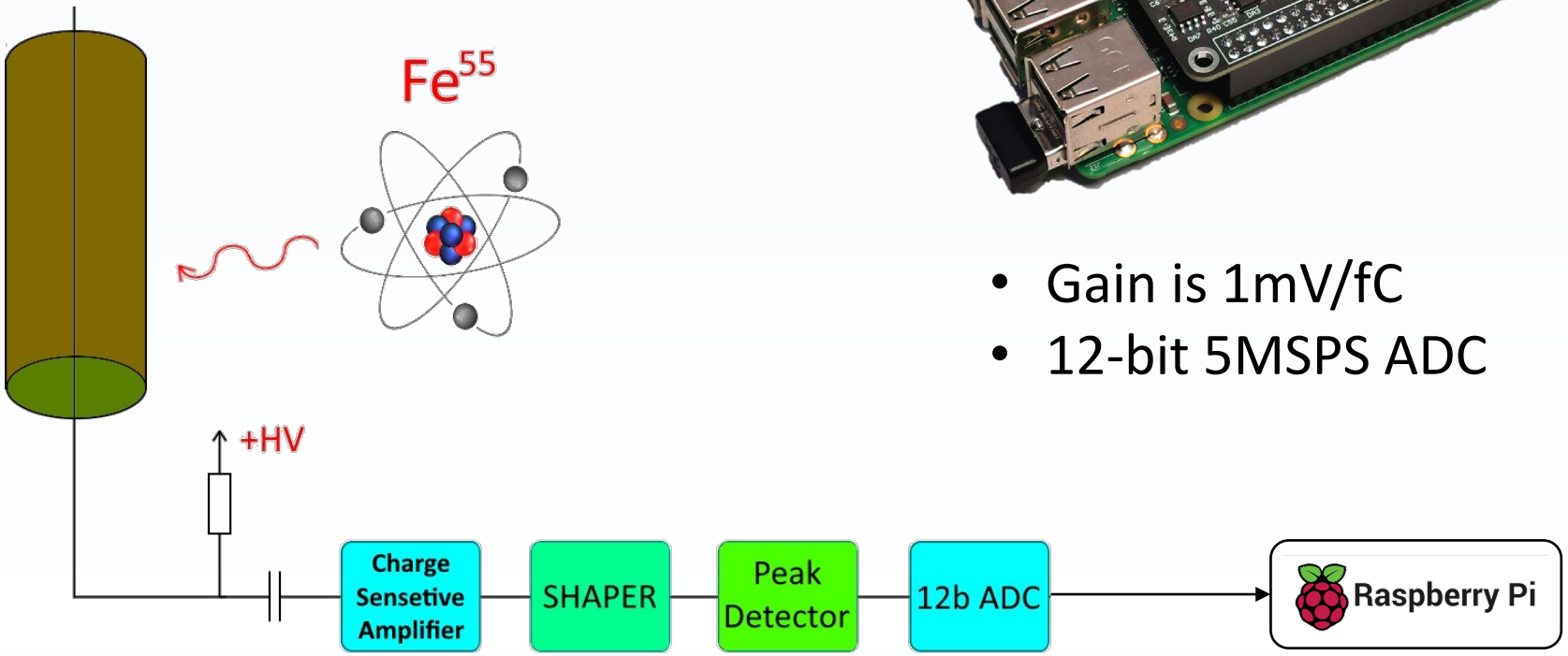
- 5.9 kEv main peak
- 3 kEv escape peak

Digitizer unit

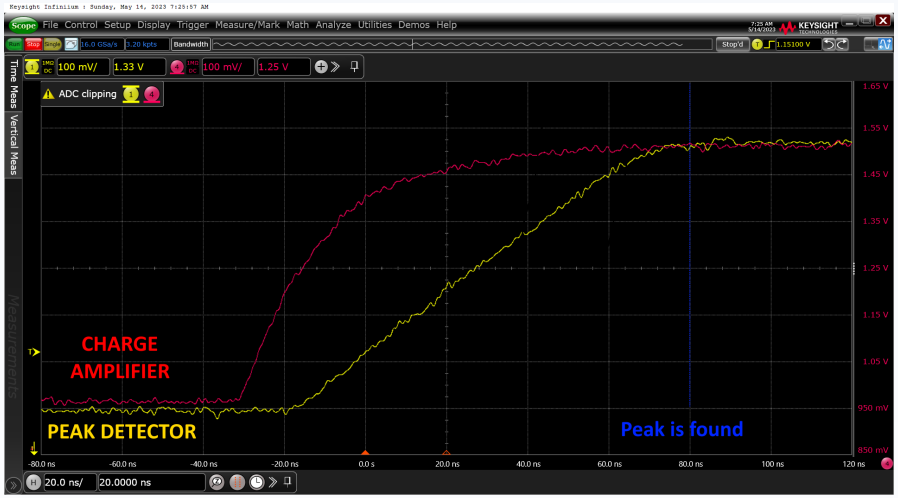
Form factor: Raspberry Pi **shield board**
* In next version it is planned to change the design to a Raspberry Pi compute module use.



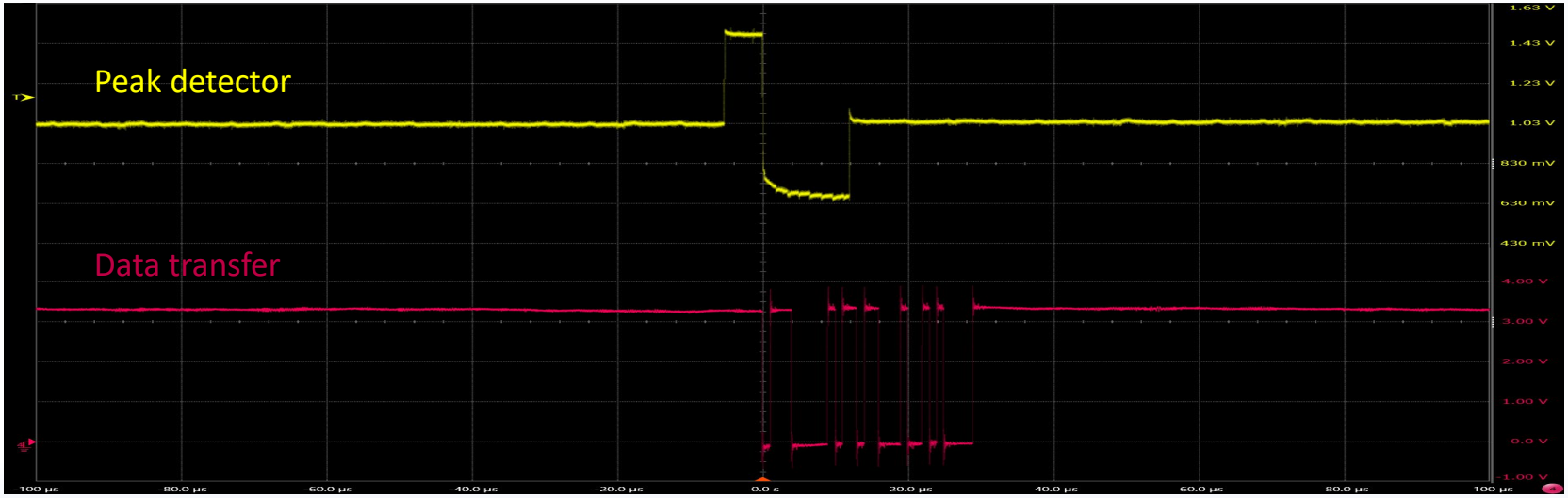
- Gain is 1mV/fC
- 12-bit 5MSPS ADC



Peak detector



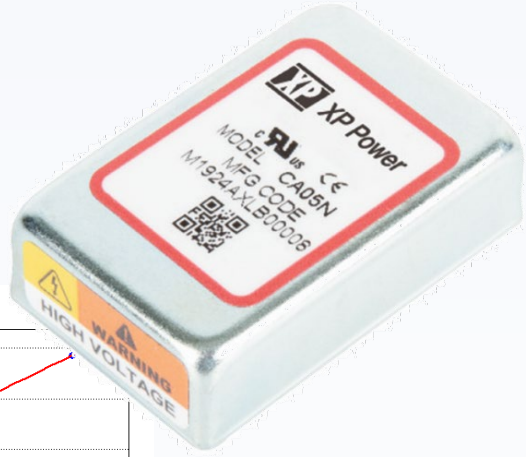
- < 100ns full drift time
- ~ 7us digitization
- ~ 30us data transmission
- ~ 33kHz maximum hit rate

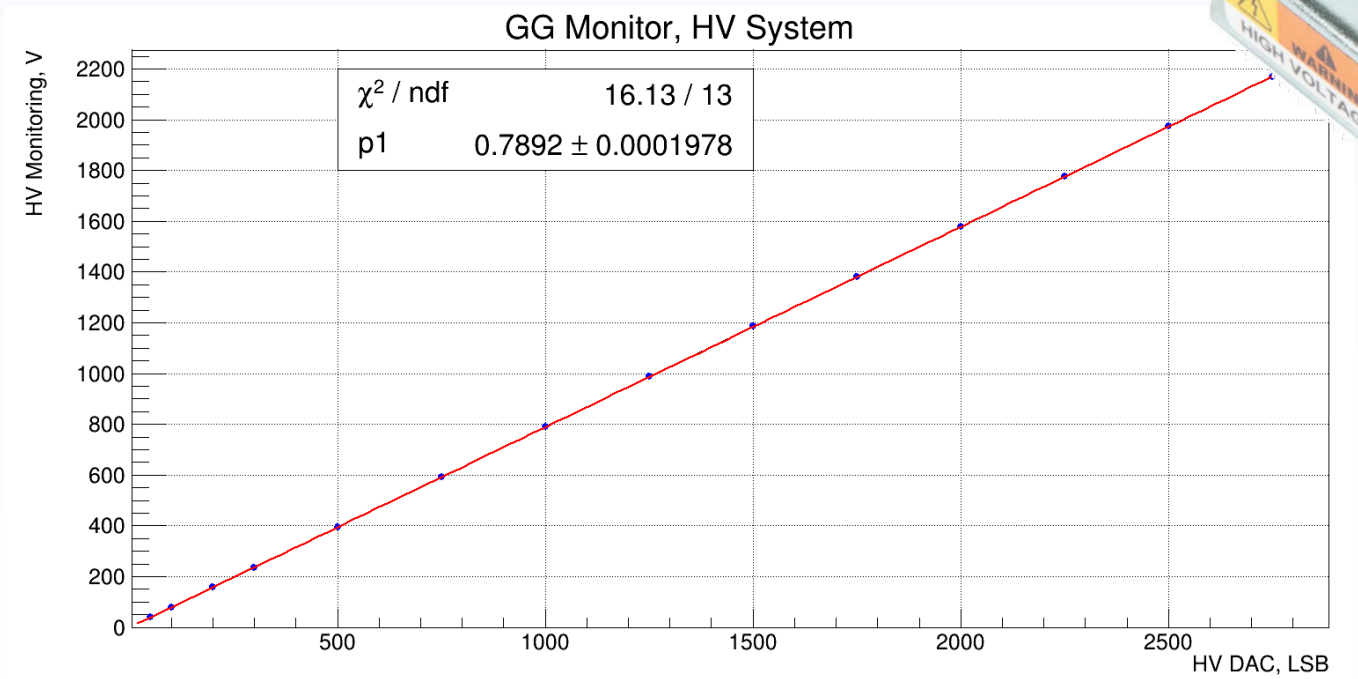


Onboard HV system

Non-Isolated **DC-HVDC Converter**

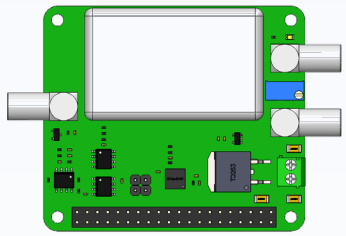
SINGLE O/P, 1W,+0...2kV





Good and linear HV system. **0.8 V/LSB** resolution

Software



SciPy

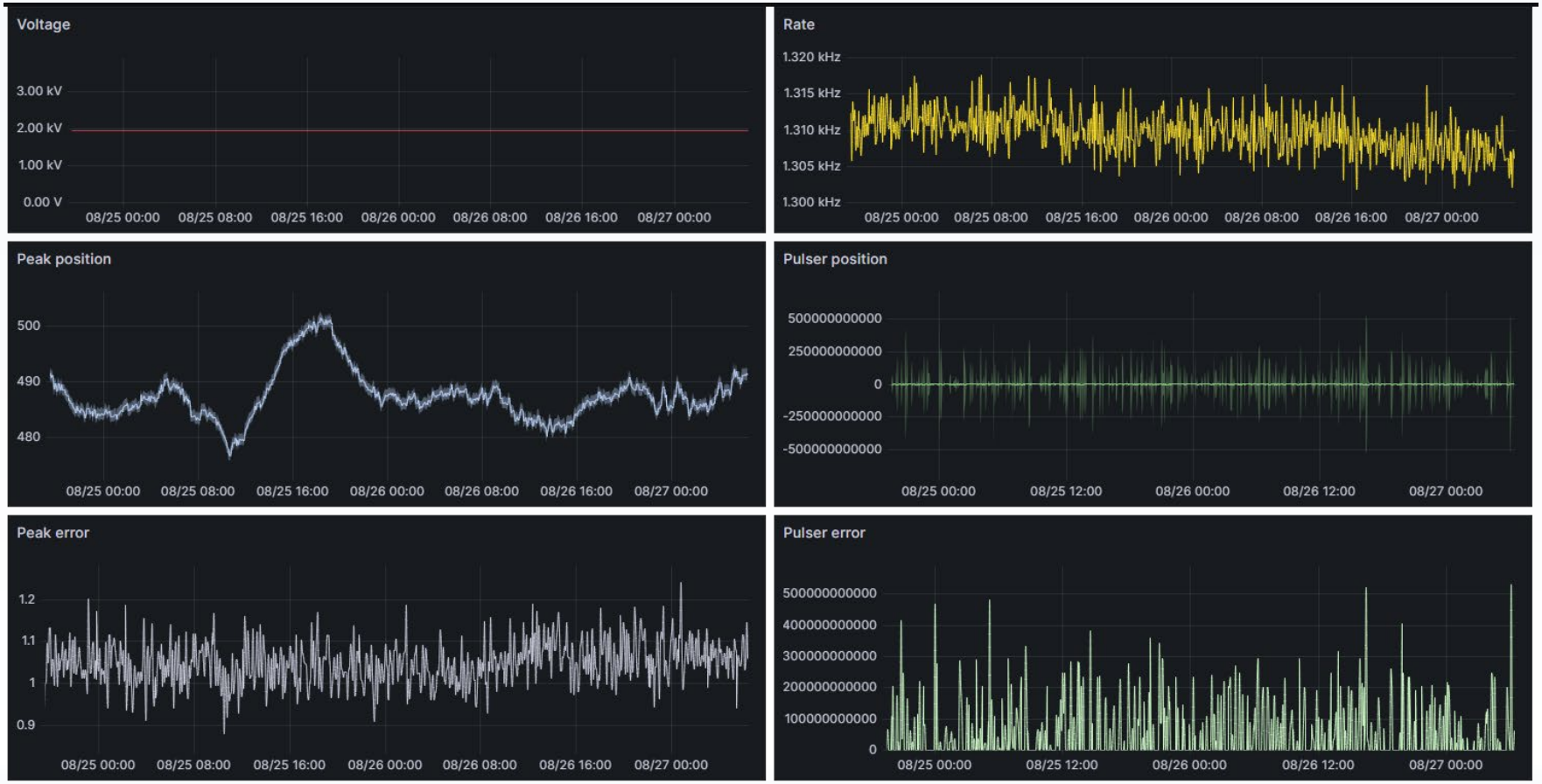
PostgreSQL + Timescale

Database

ORACLE

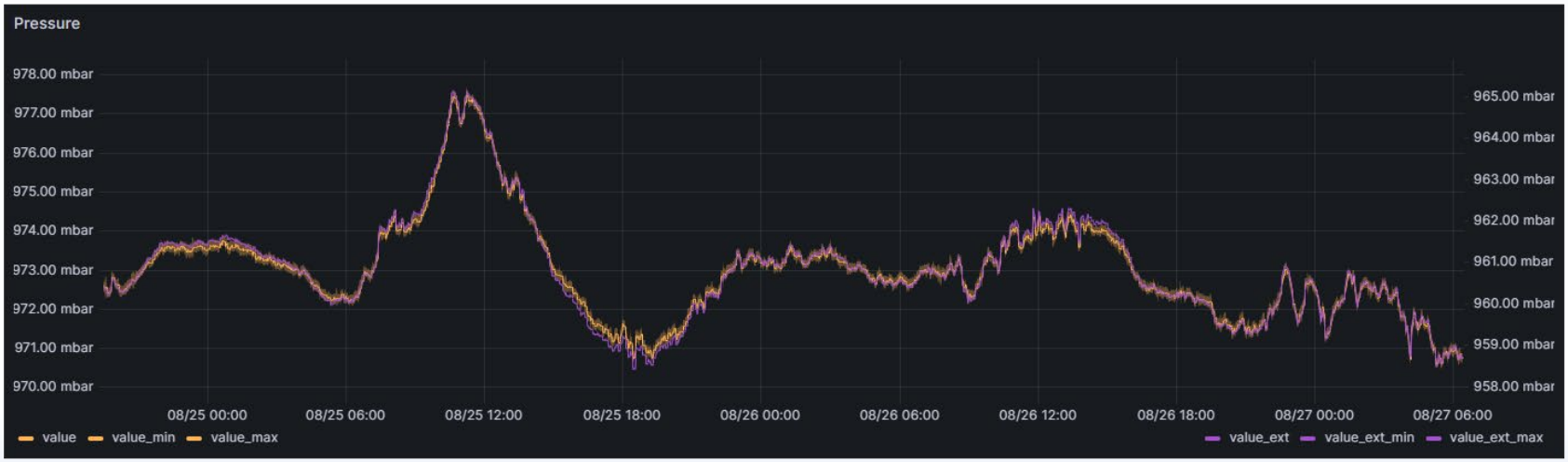
Grafana +

What we have in Grafana?
Gas monitor conditions

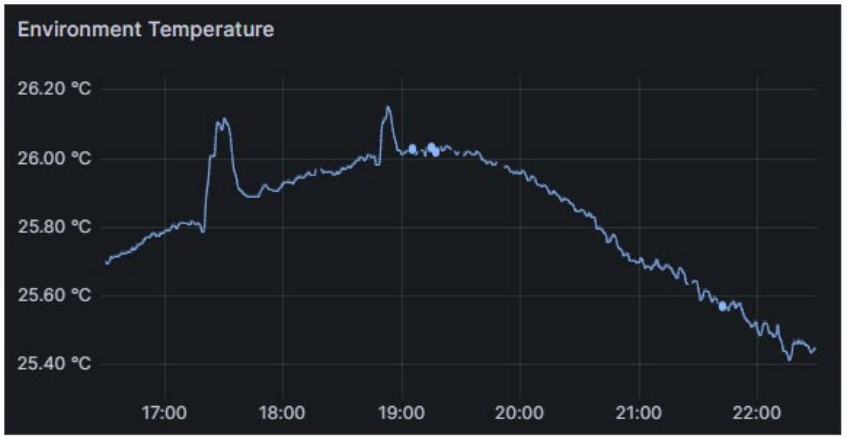


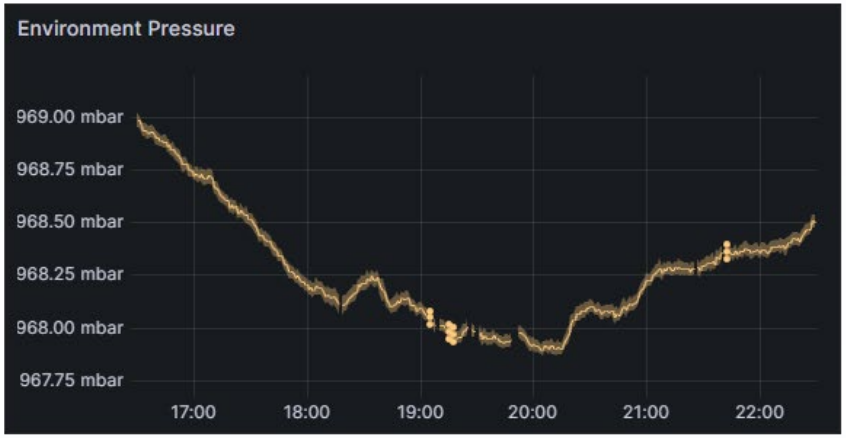
What we have in Grafana?
Last accumulated spectrum

What we have in Grafana?
Gas conditions

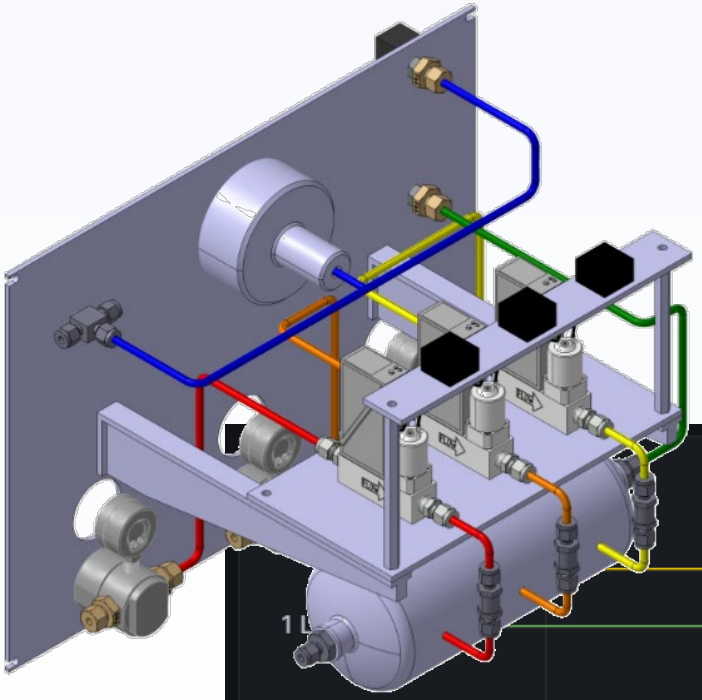


What we have in Grafana? Environment conditions



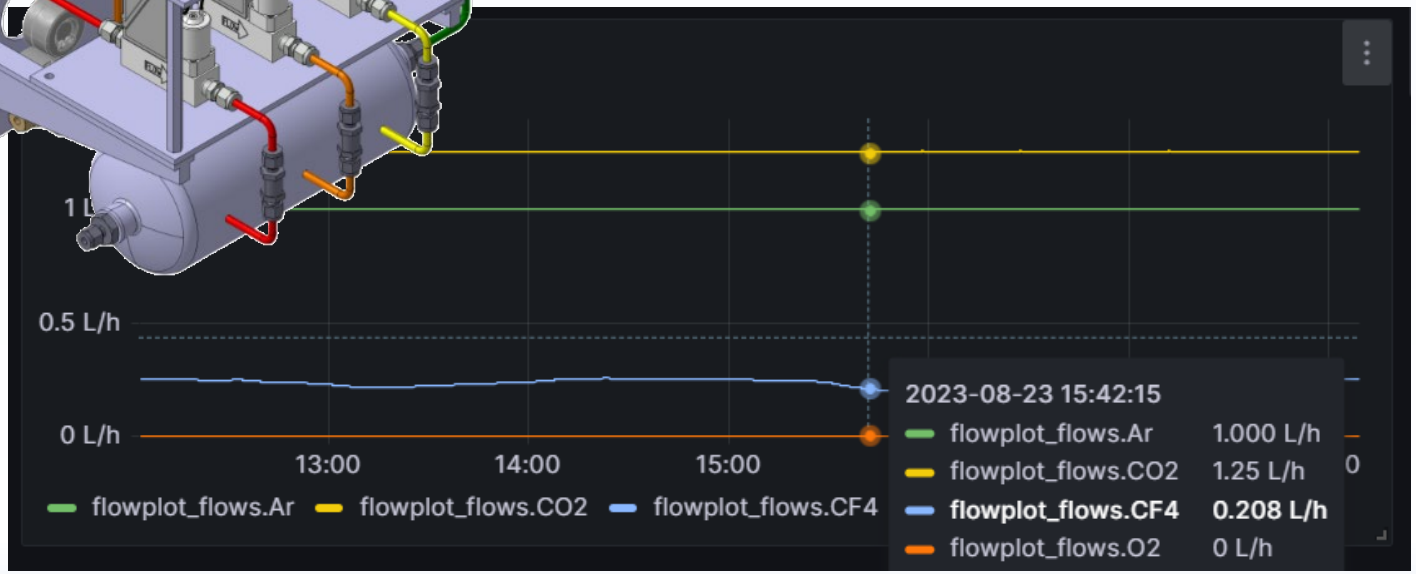


Testing stand



Bronkhorst MFC’s:

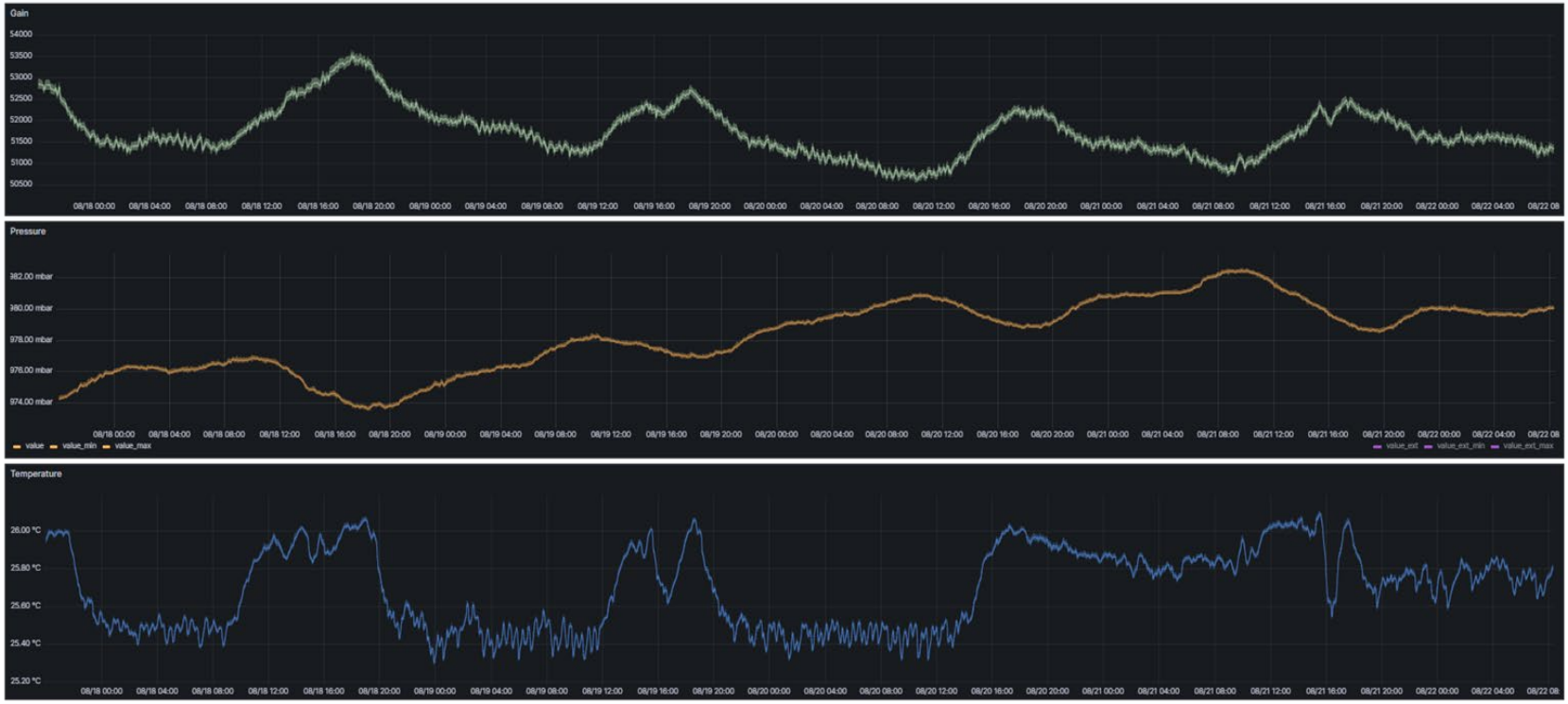
- Argon
- CO2
- CF4
- O2



Influence of temperature and pressure

$$G = \left(\frac{V}{r_a \ln(r_c/r_a) E_{min} \frac{\rho}{\rho_0}} \right)^{\frac{V \ln 2}{\ln(r_c/r_a)\Delta V}}$$

** Diethorn's formula*

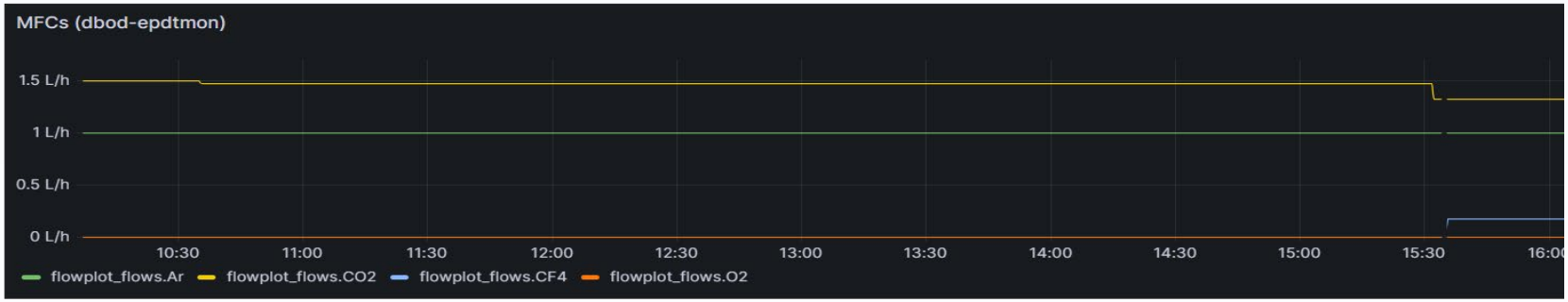


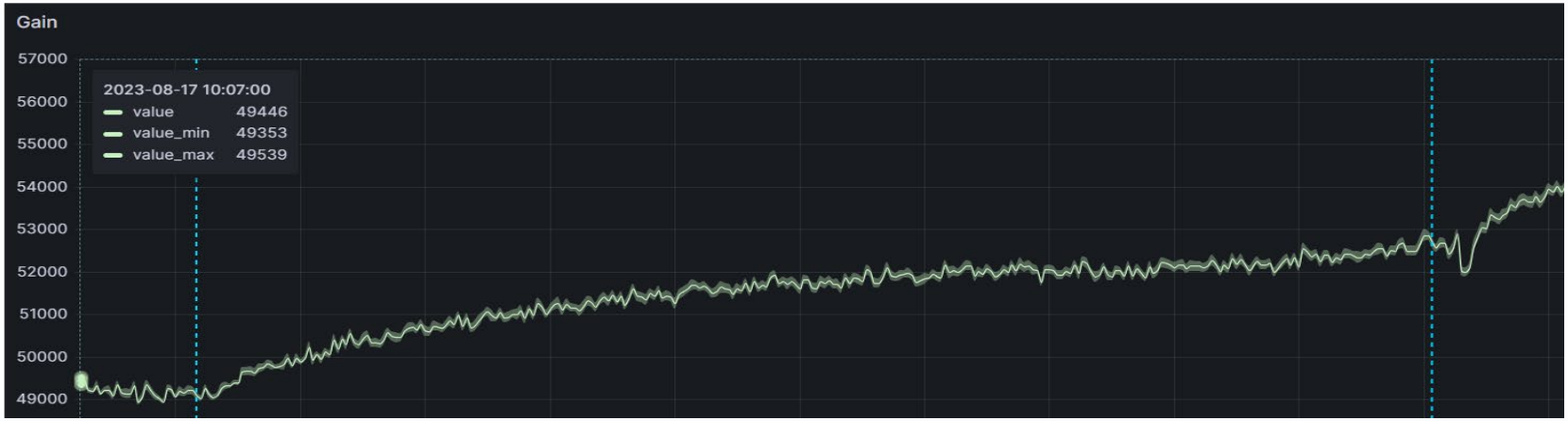
Temperature and pressure effect

Gas monitor sensitivity

Pressure accuracy: 0.2 mbar
Temperature accuracy: 0.01 °C
Gain error: ±1.2 times

Sensitivity to Ar percentage (preliminary): better than 0.05%





Example: +0.5% of Ar

Thanks!