Cerenkov Detectors
Gas tightness tests

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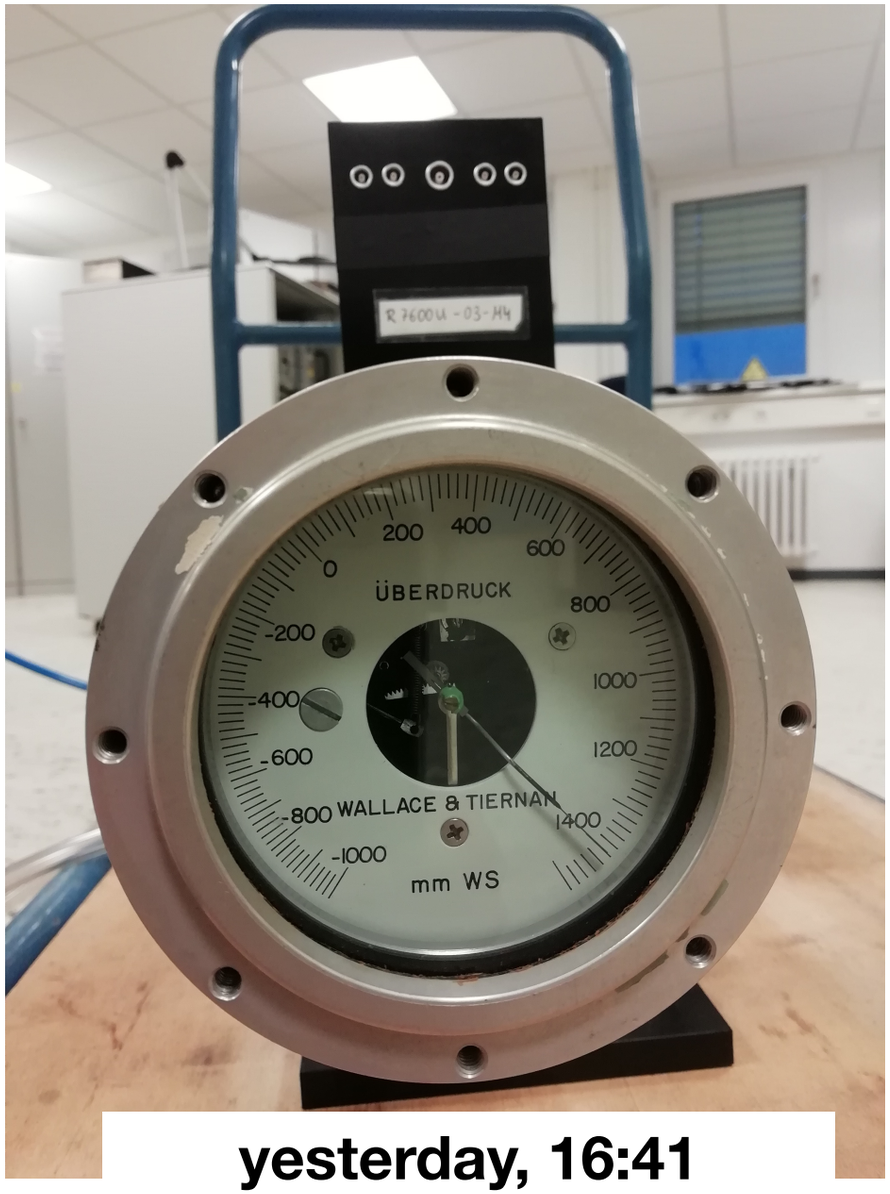
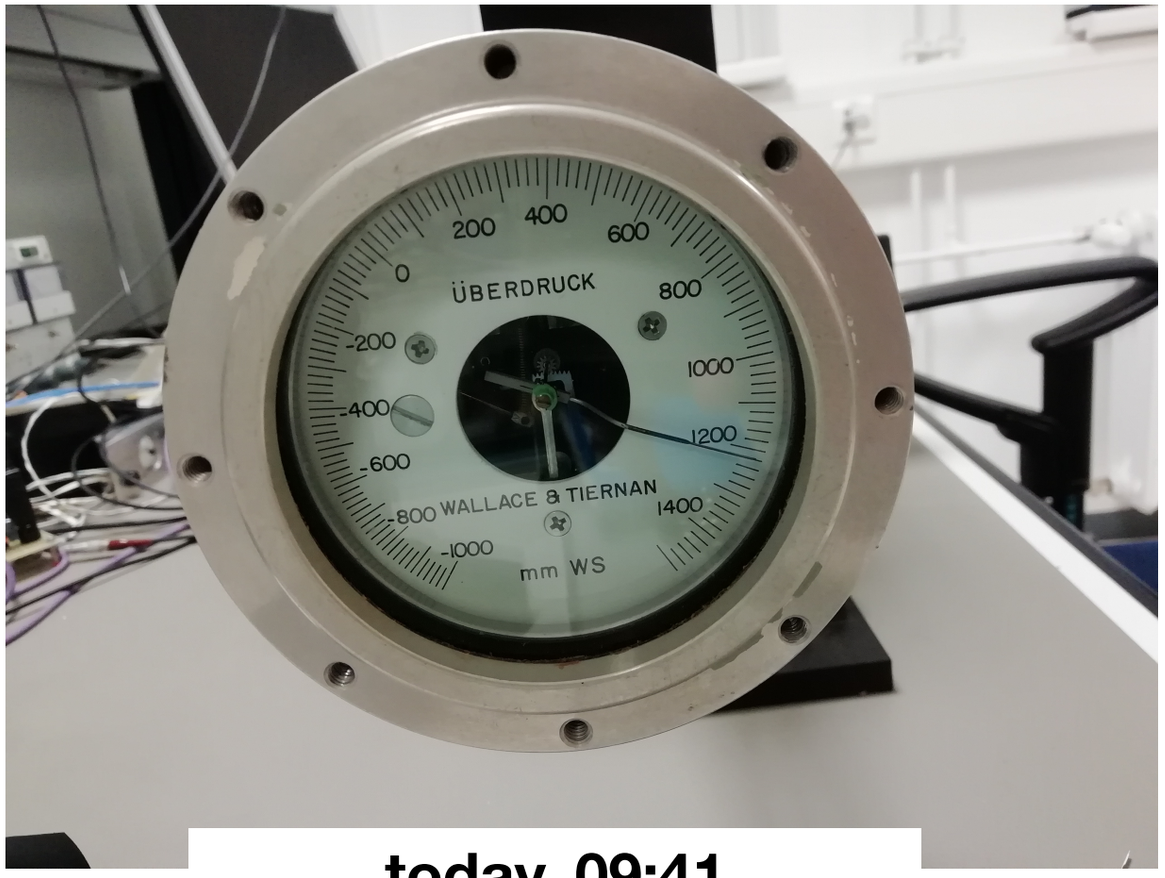
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

What I showed you before



yesterday, 16:41
1400 mmH20 ≈ 140 mbar

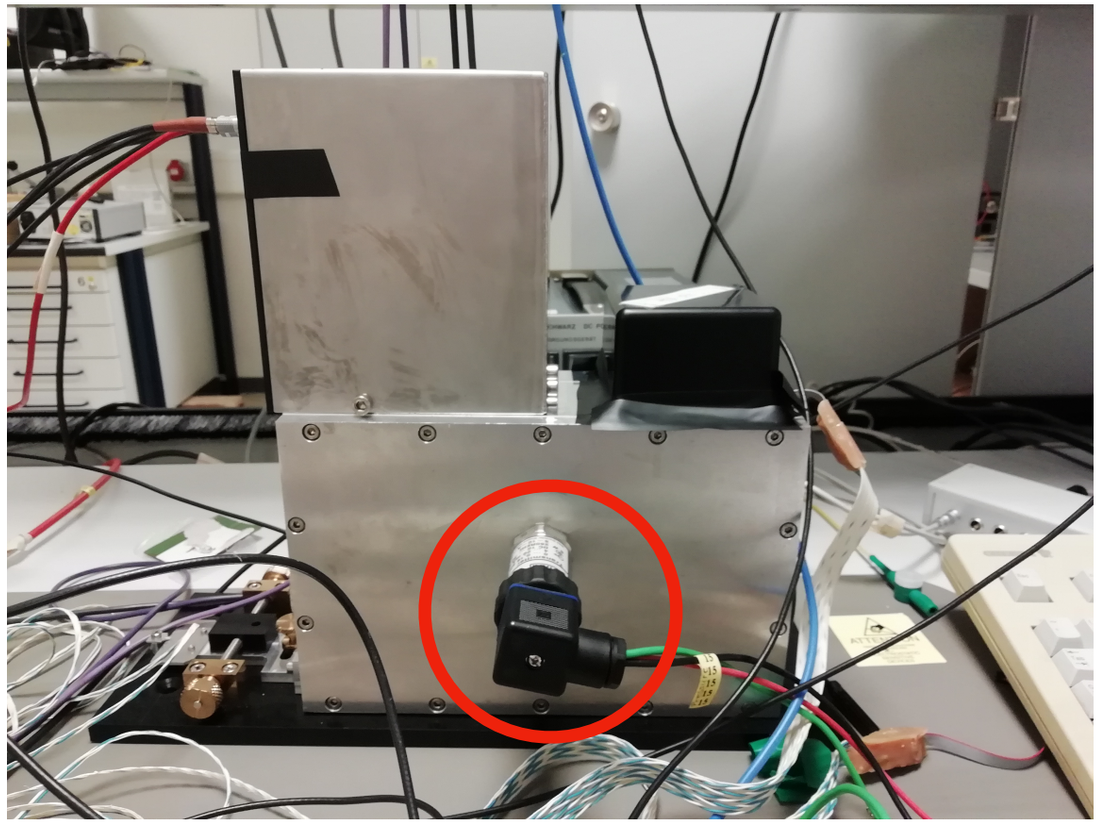


today, 09:41
1220 mmH20 ≈ 122 mbar

This test was not sufficient to make a statement about gas-tightness!

Reason 1: The mechanical manometer does not give reliable reading
Reason 2: Need to take external pressure & temperature changes into account

What we do now

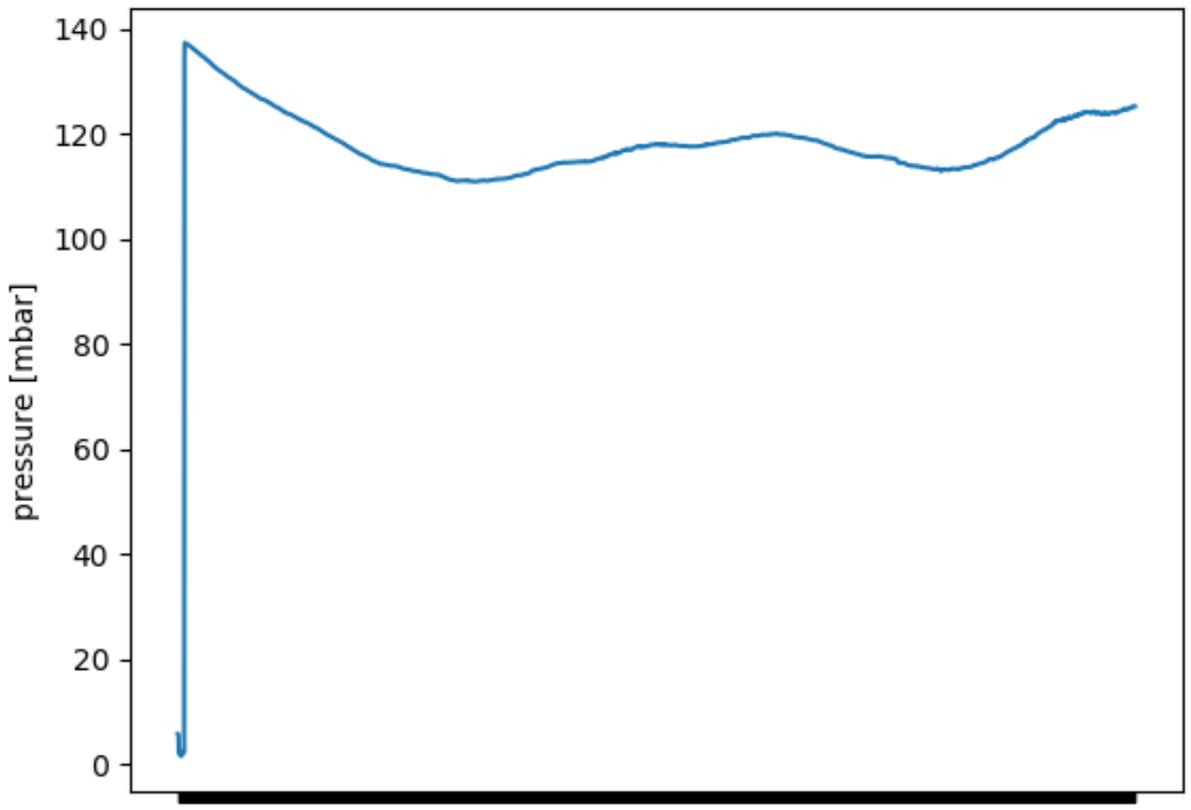


“Digital” pressure sensor attached to Cerenkov Box:

- monitor output (4-20 mA current for pressure range of 0-160 mbar) with Keithley 6514 Electrometer connected to serial port of PC

- precise pressure monitoring in real-time is possible!

Result:



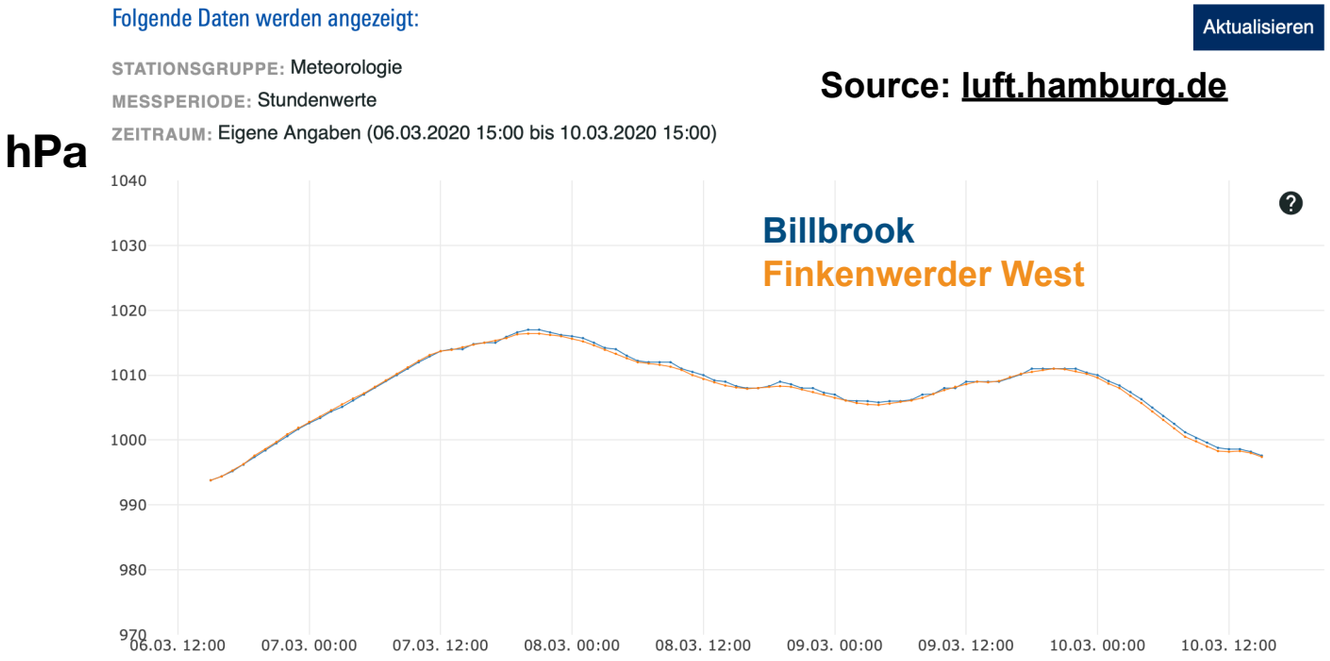
Fill with Argon
Fri 6.3. 15:00

Stop readout
Tue 10.3. 15:30

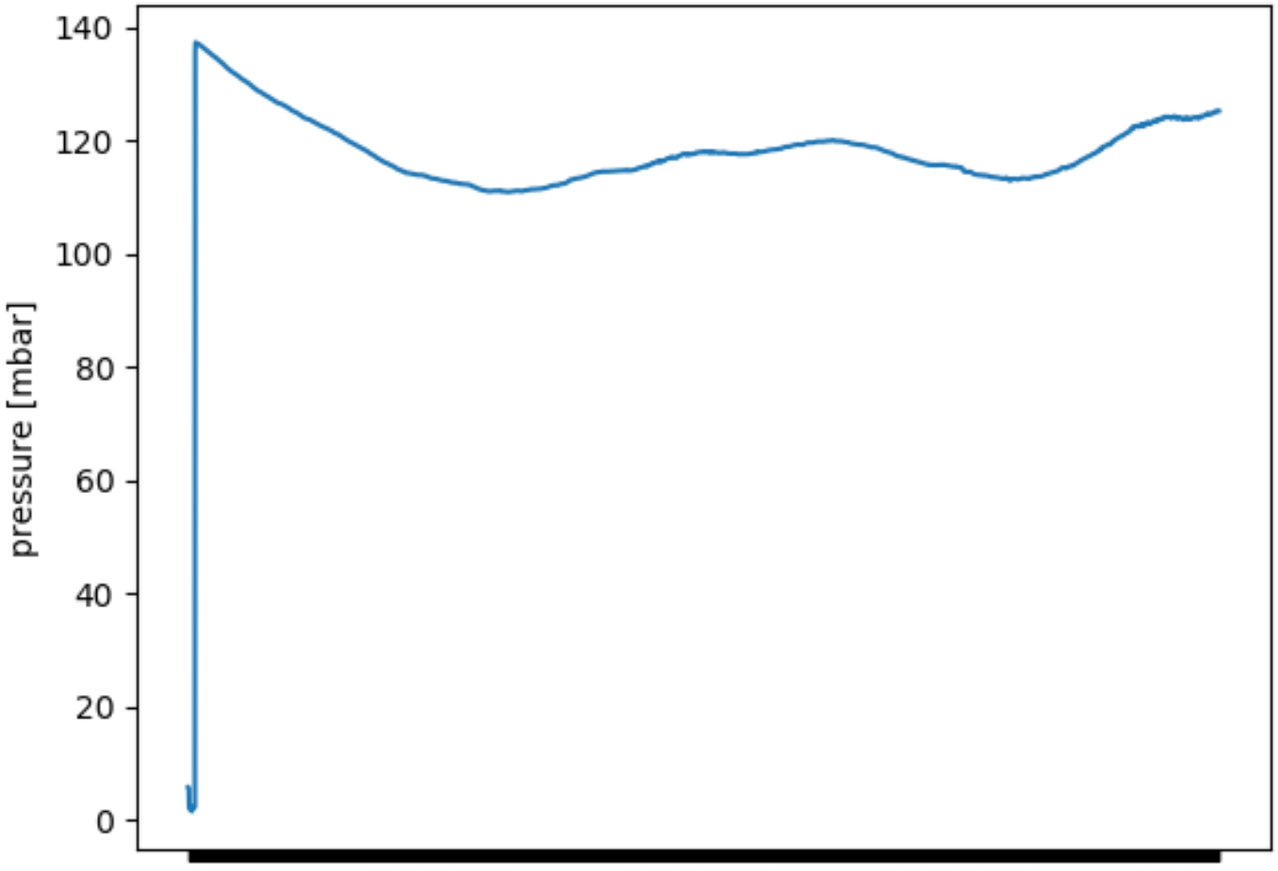
<u>Long-time monitoring in Hera West:</u>

- fill setup to ~140mbar (using mechanical manometer) with Argon (+2.3% Isobutane)
- take pressure reading from digital sensor every 2 minutes over the weekend
- observe modulations in pressure

Modulation source 1: The weather



Source: luft.hamburg.de



Fill with Argon
Fri 6.3. 15:00

Stop readout
Tue 10.3. 15:30

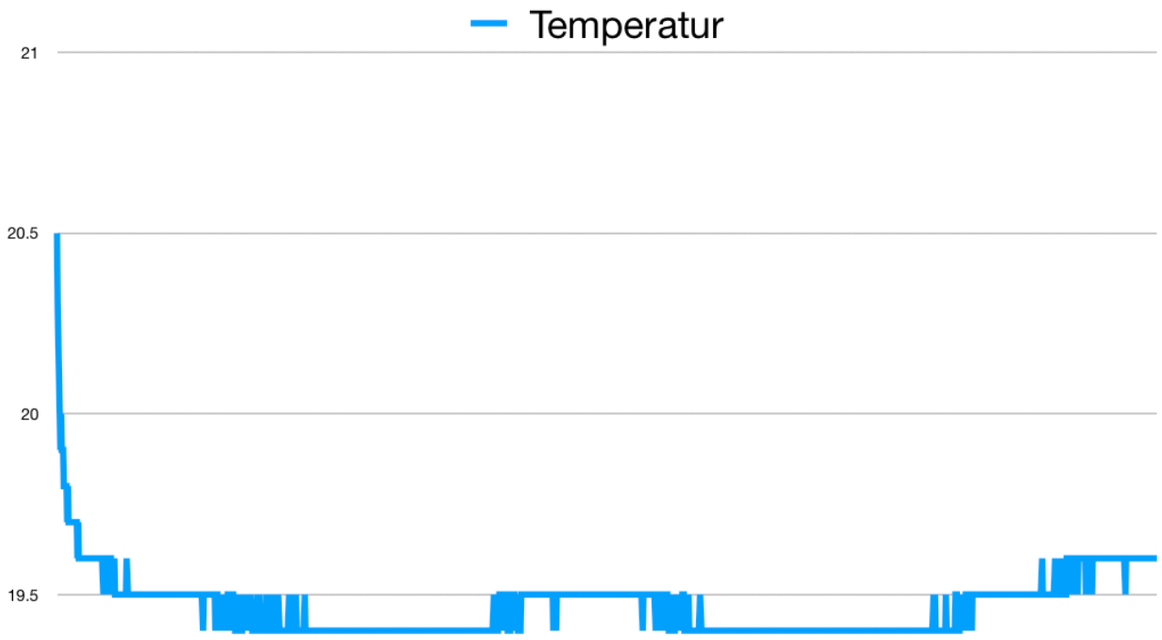
Cerenkov box is a barometer:

- digital sensor measures pressure difference inside/outside the box
- pressure outside going up → measured pressure difference going down

Correct:

- can extract pressure measurement from website for every hour (csv file)
- extrapolate linearly in between readings
- use to correct our measured pressure (additive)
- max difference between Billbrook & Finkenwerder 0.7mbar (~ Error)

Modulation source 2: Temperature in the lab



- Monitor temperature using Fluke Airmeter
- Not 100% precise, because the airmeter is next to the box so there can be a delay of change in temperature
- Measure for 54h over the weekend

Start
Fri 6.3. 15:00

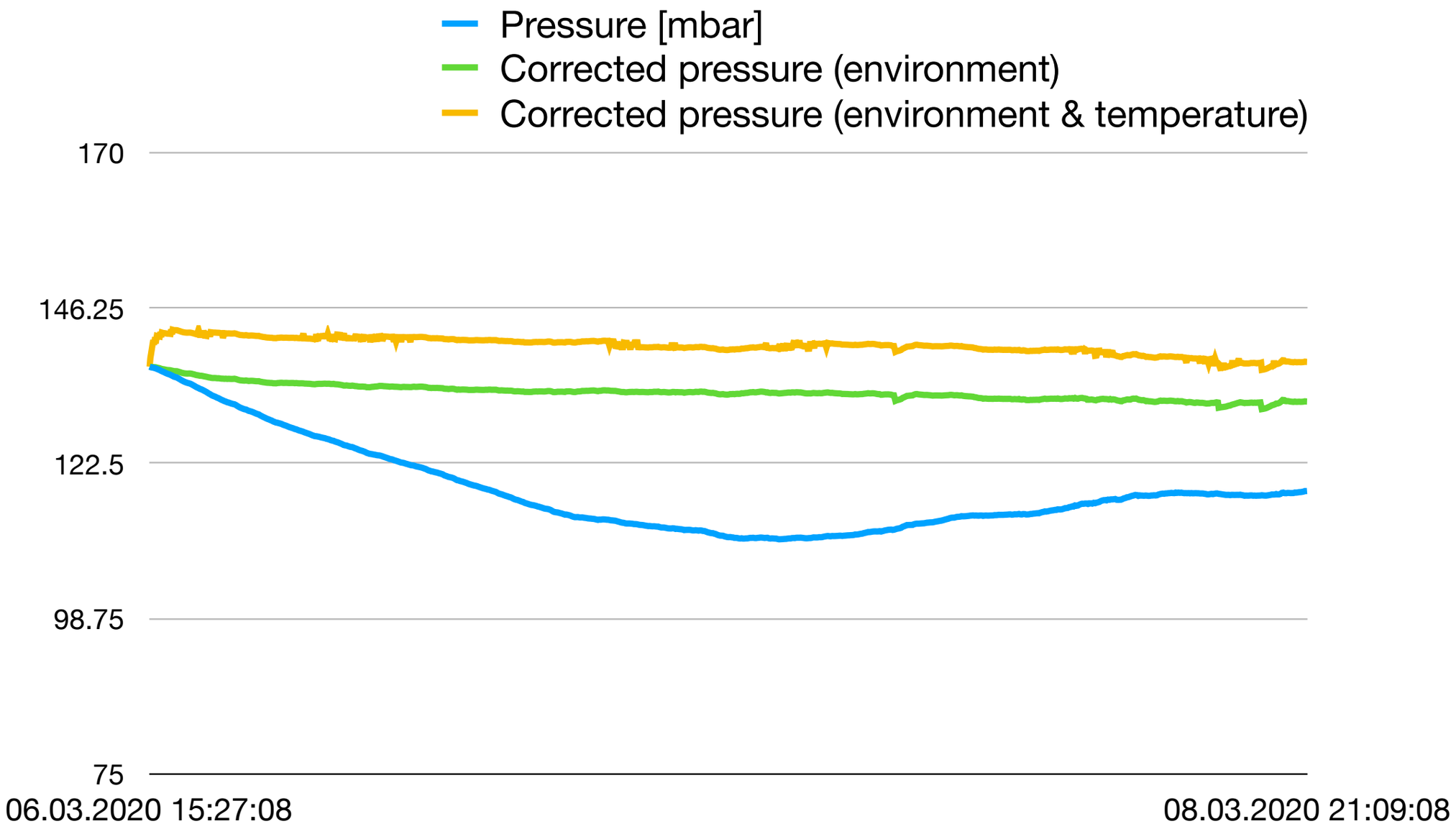
Stop
Sun 9.3. 21:00

Decrease in temperature then relatively stable.
Could be effect of our body temperature or cooling down, so not super reliable.

Ideal Gas Law:

$$p \cdot V = N k_B T \xrightarrow{V = \text{const.}} \frac{p_1}{p_2} = \frac{T_1}{T_2}$$

Corrected result:



Take-aways:

- Green cuve (correct external pressure only): Lose 5.3±0.7 mbar over 54 h
- I wouldn't trust the temperature correction, but 1°C change in temperature corresponds to ~5mbar pressure change
- **It's safe to say our gas loss is < 0.1 mbar/h**

This corresponds to 0.3 ml loss of Gas per hour for our whole 3 litre box.

Summary

1) Long-time pressure monitoring in Hera West:

- digital pressure sensor works now, can monitor the pressure in our detector in real time
- need to correct for external pressure variations and temperature
- from pressure logging: Our gas loss is < 0.1mbar/h
  → **Pressure logging: Gas volume loss < 0.3ml/h for the whole Cerenkov Box**

2) Gas Leakage detection system (sniffer):

- TPC group has a highly sensitive gas leakage detector
- can measure differences between gas sample and surrounding air by measuring temperature conductance
- checked this during Argon fill at 140mbar over-pressure fill
  → **We checked all valves, gaps, and openings around the box, not a single leak was detected!**

I think its valid to state that the Cerenkov Prototype is gas tight!