

Study of the influence of construction materials on the ageing properties of high rate gas detectors

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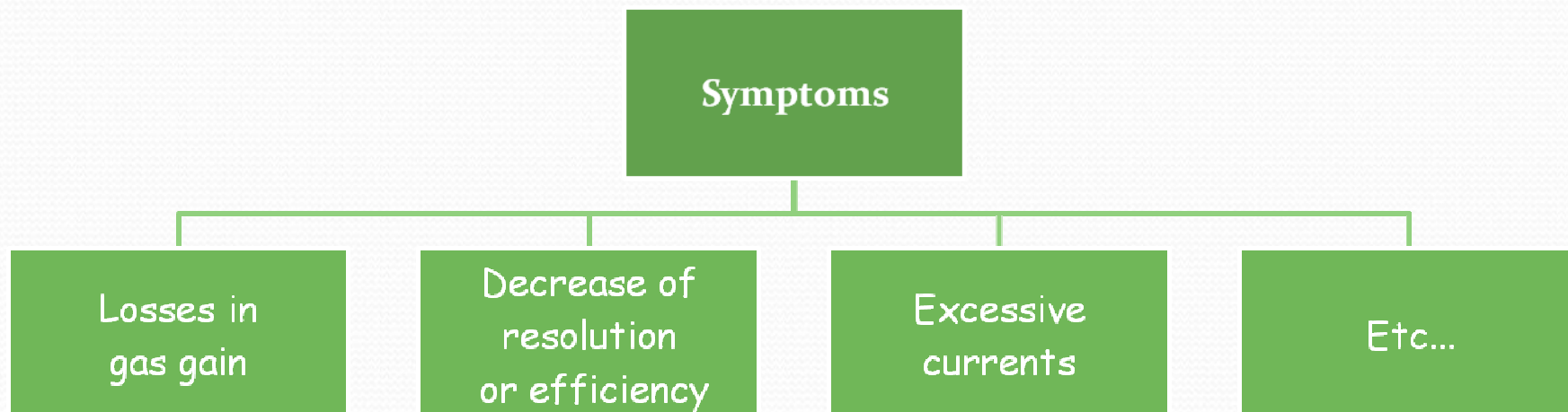
University of Tübingen, Germany

Plan

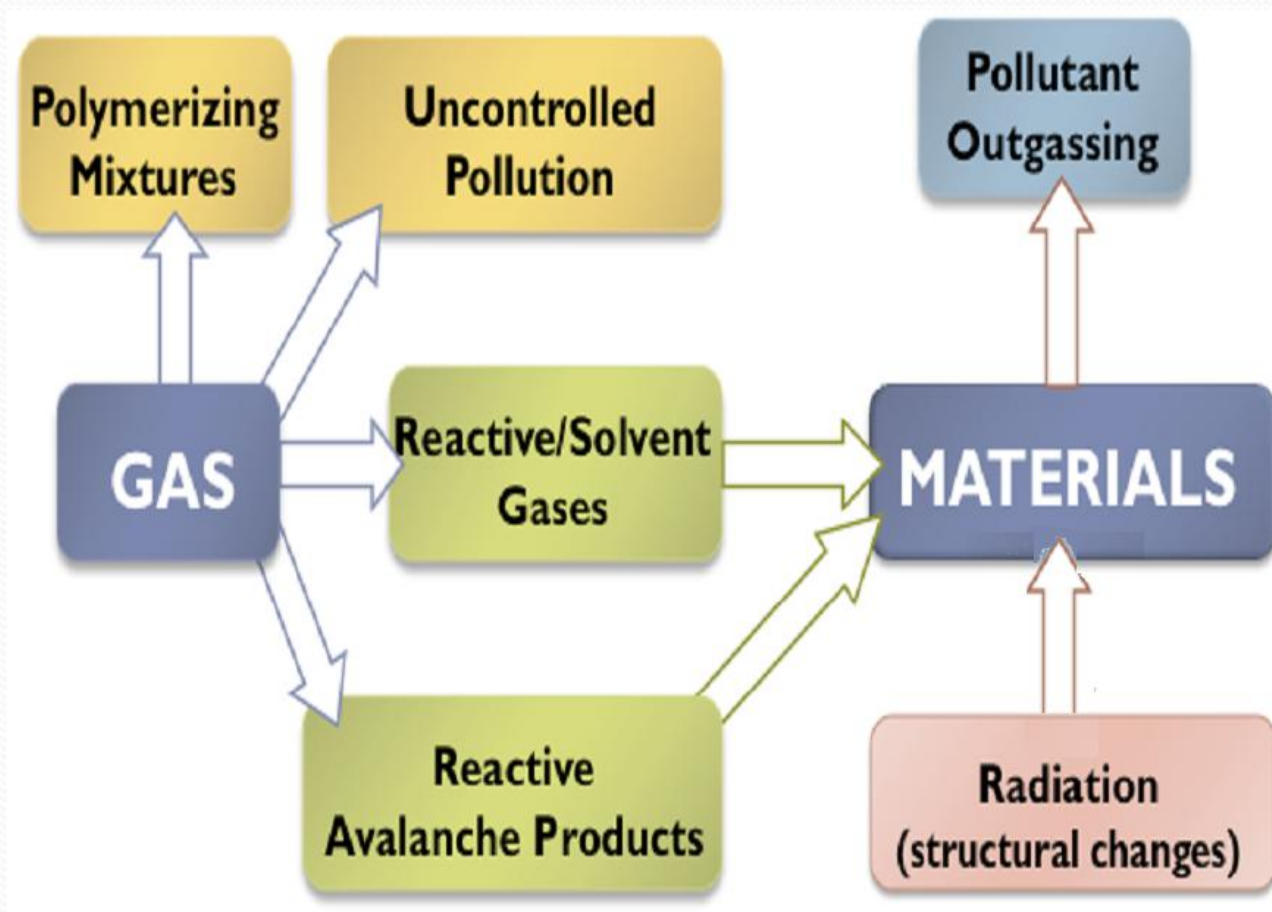
- Introduction
 - What is the detector ageing?
 - Why ageing studies?
- Experimental setup
- Results
- Summary and Outlook

What is the detector ageing?

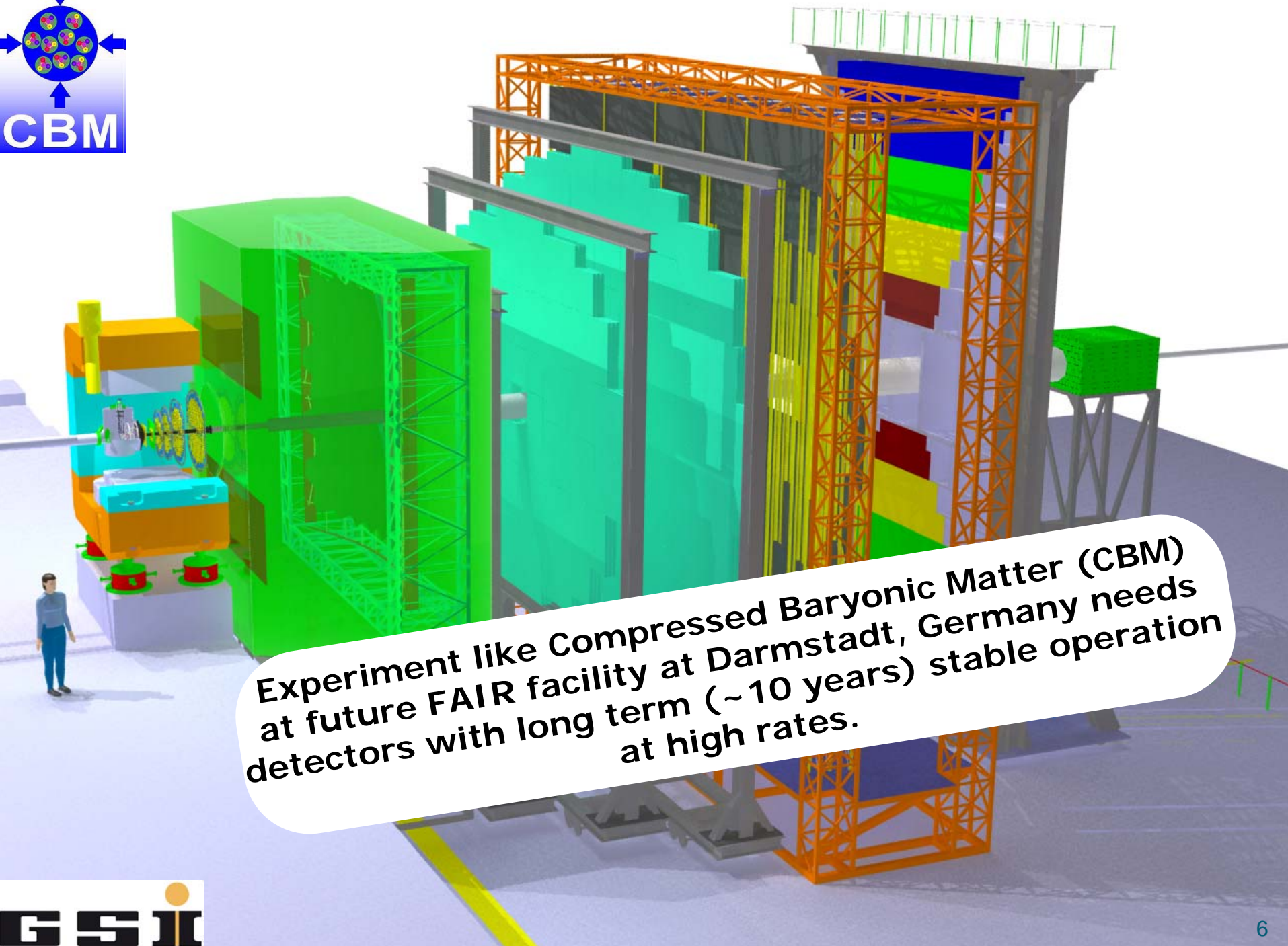
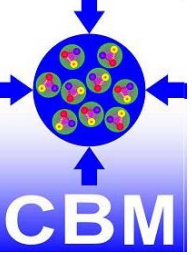
- ❖ It is the deterioration of the detector performance.



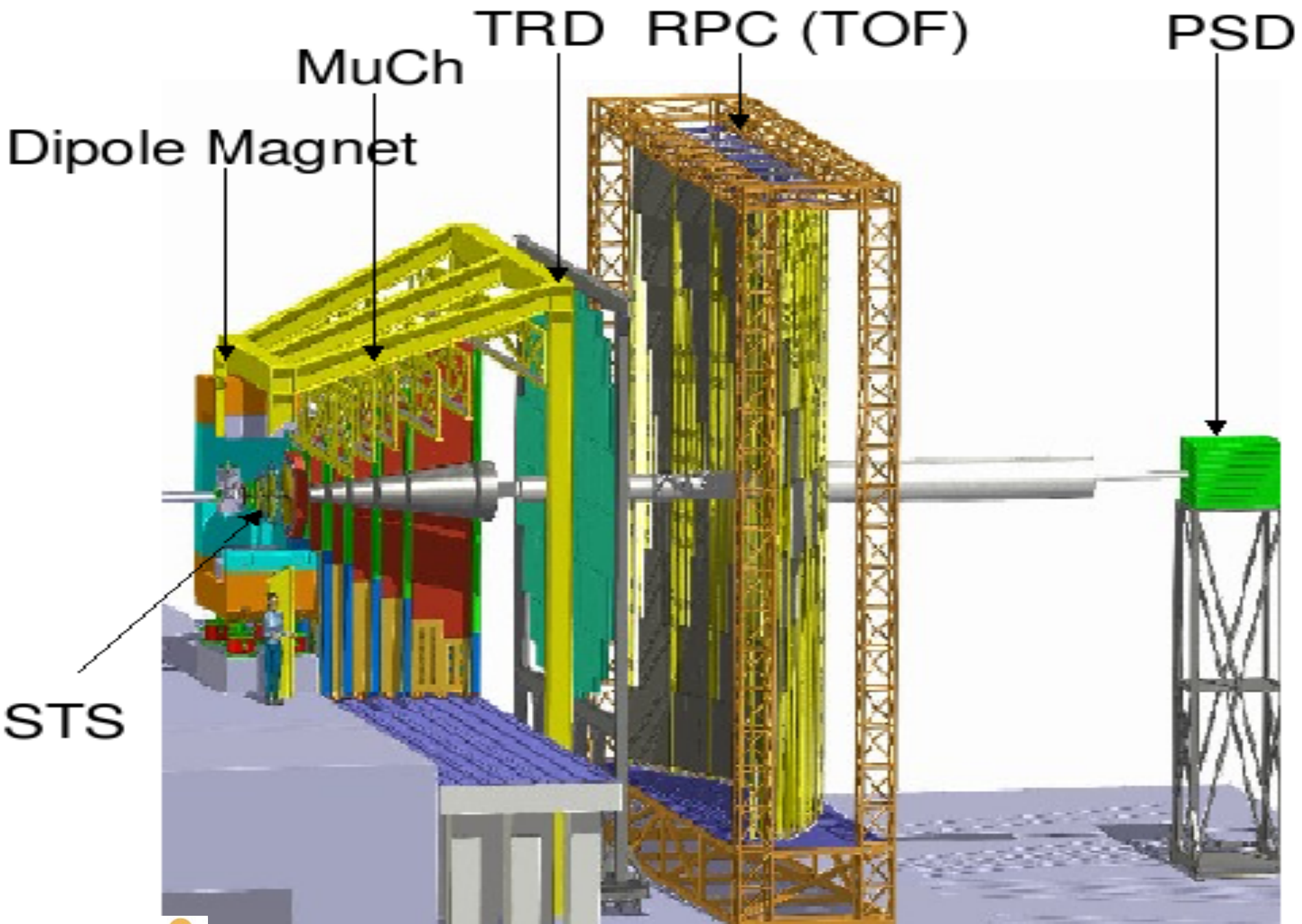
Sources of ageing

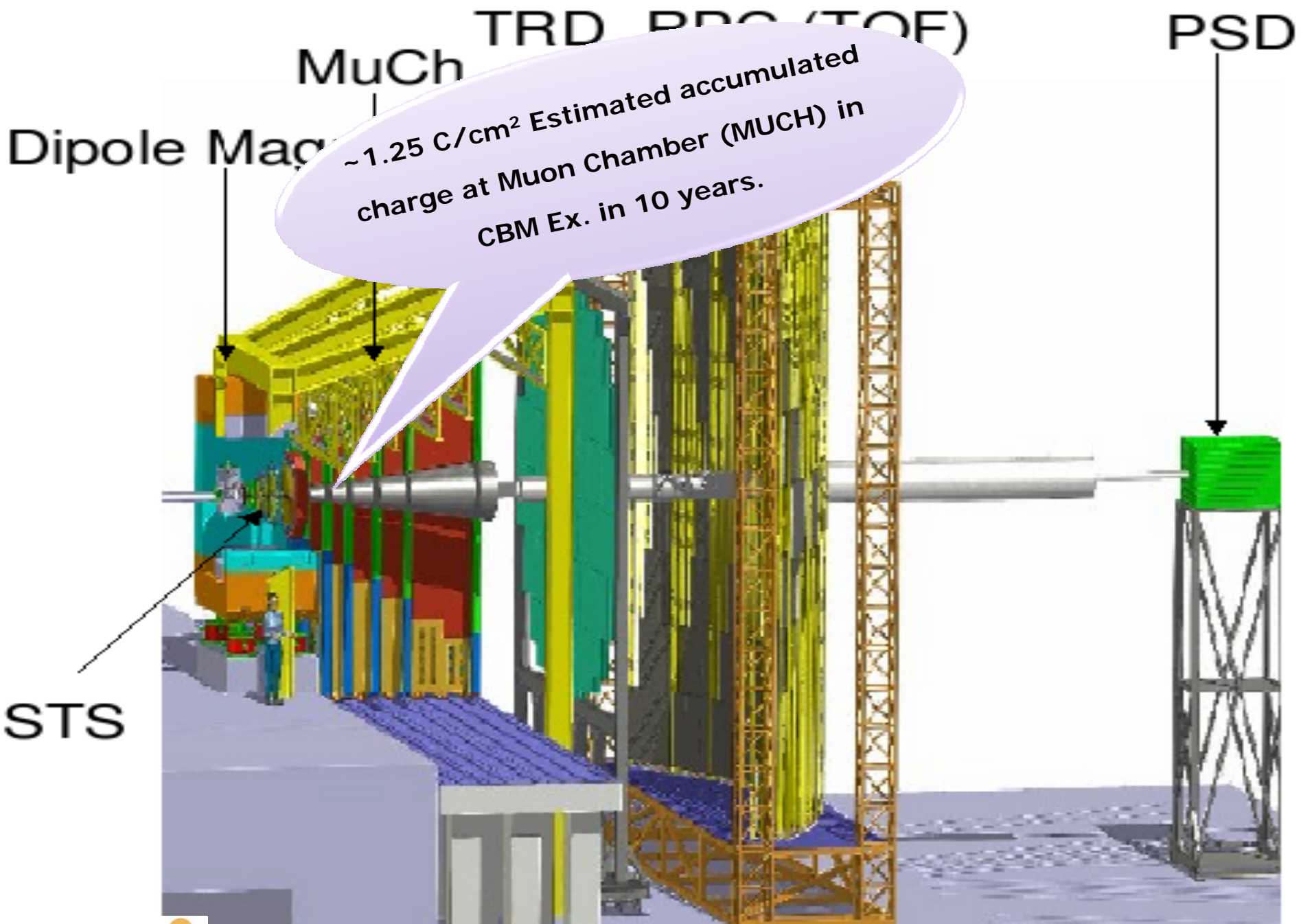


Why ageing studies?



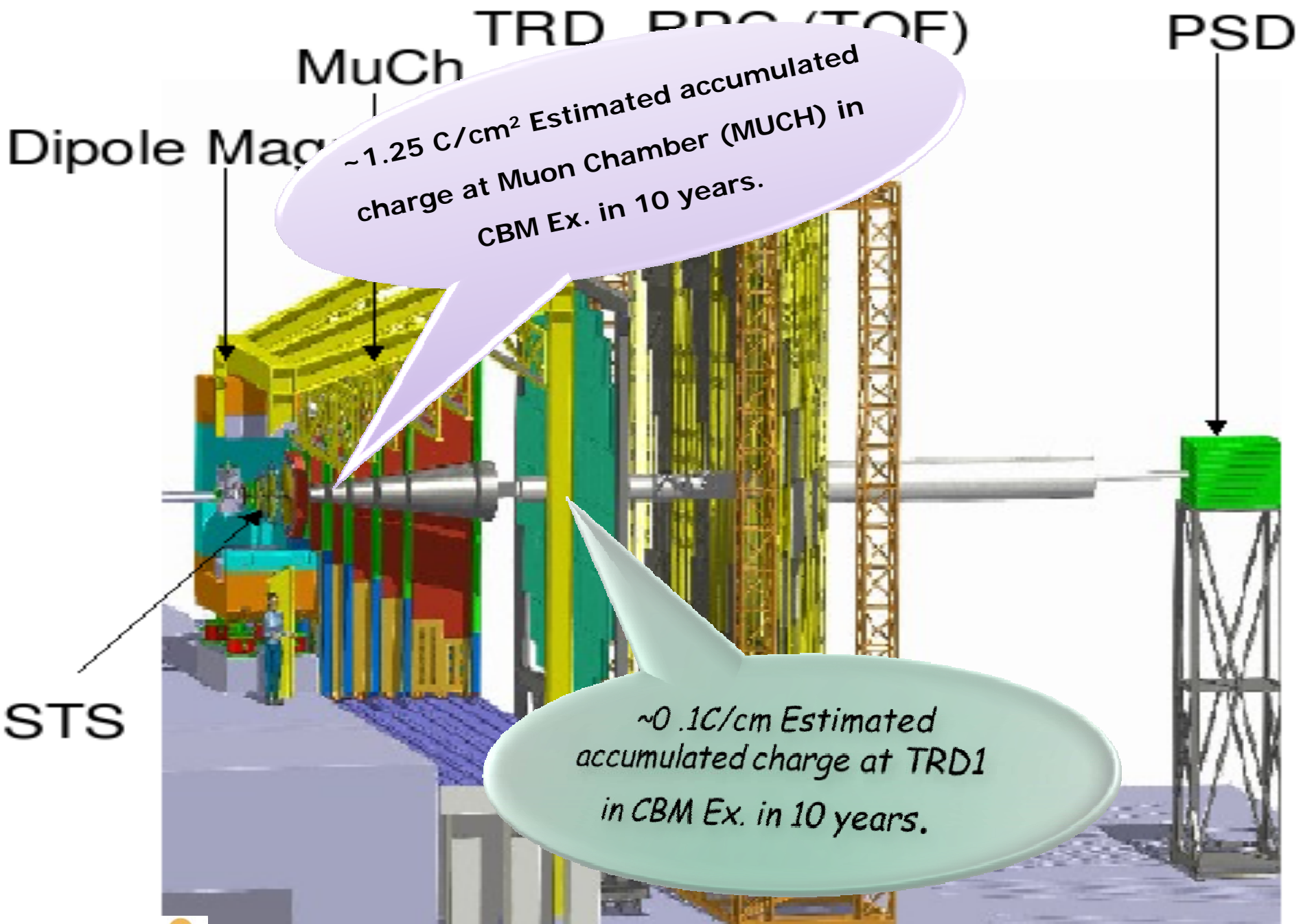
Experiment like Compressed Baryonic Matter (CBM) at future FAIR facility at Darmstadt, Germany needs detectors with long term (~10 years) stable operation at high rates.





~1.25 C/cm² Estimated accumulated charge at Muon Chamber (MUCH) in CBM Ex. in 10 years.

STS



~1.25 C/cm² Estimated accumulated charge at Muon Chamber (MUCH) in CBM Ex. in 10 years.

~0.1C/cm Estimated accumulated charge at TRD1 in CBM Ex. in 10 years.

Dipole Magnet

MuCh

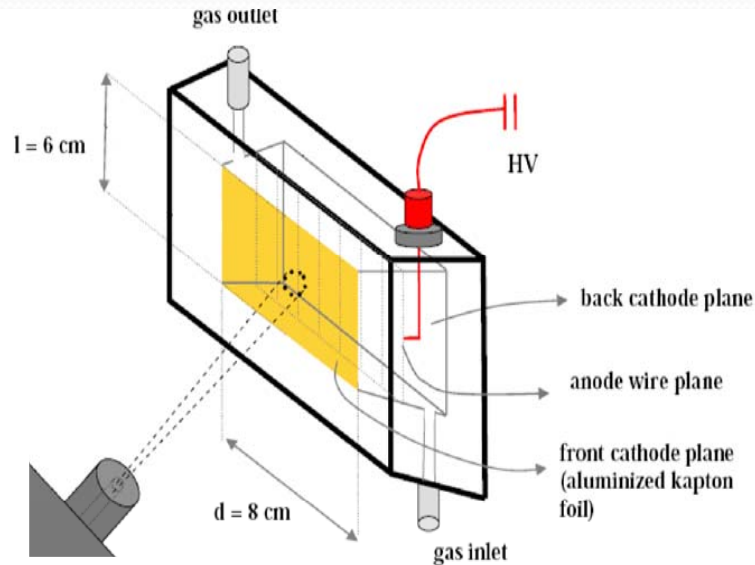
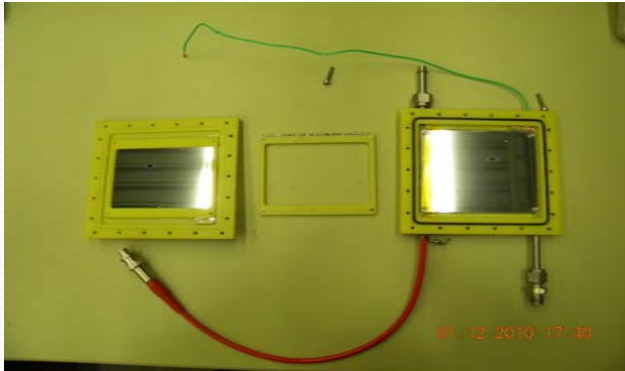
TRD PDC (TOF)

PSD

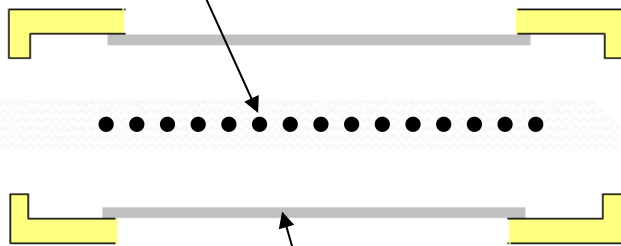
STS

Experimental setup

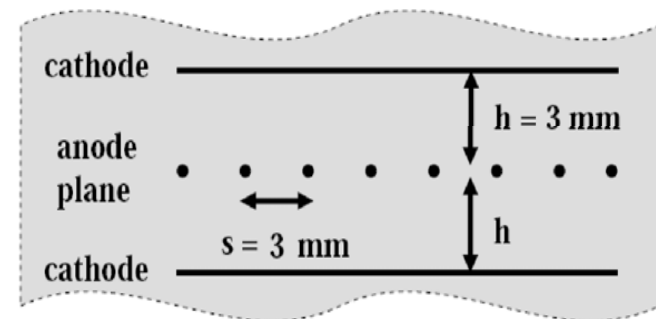
Fabrication and Operation of MWPC for Ageing test



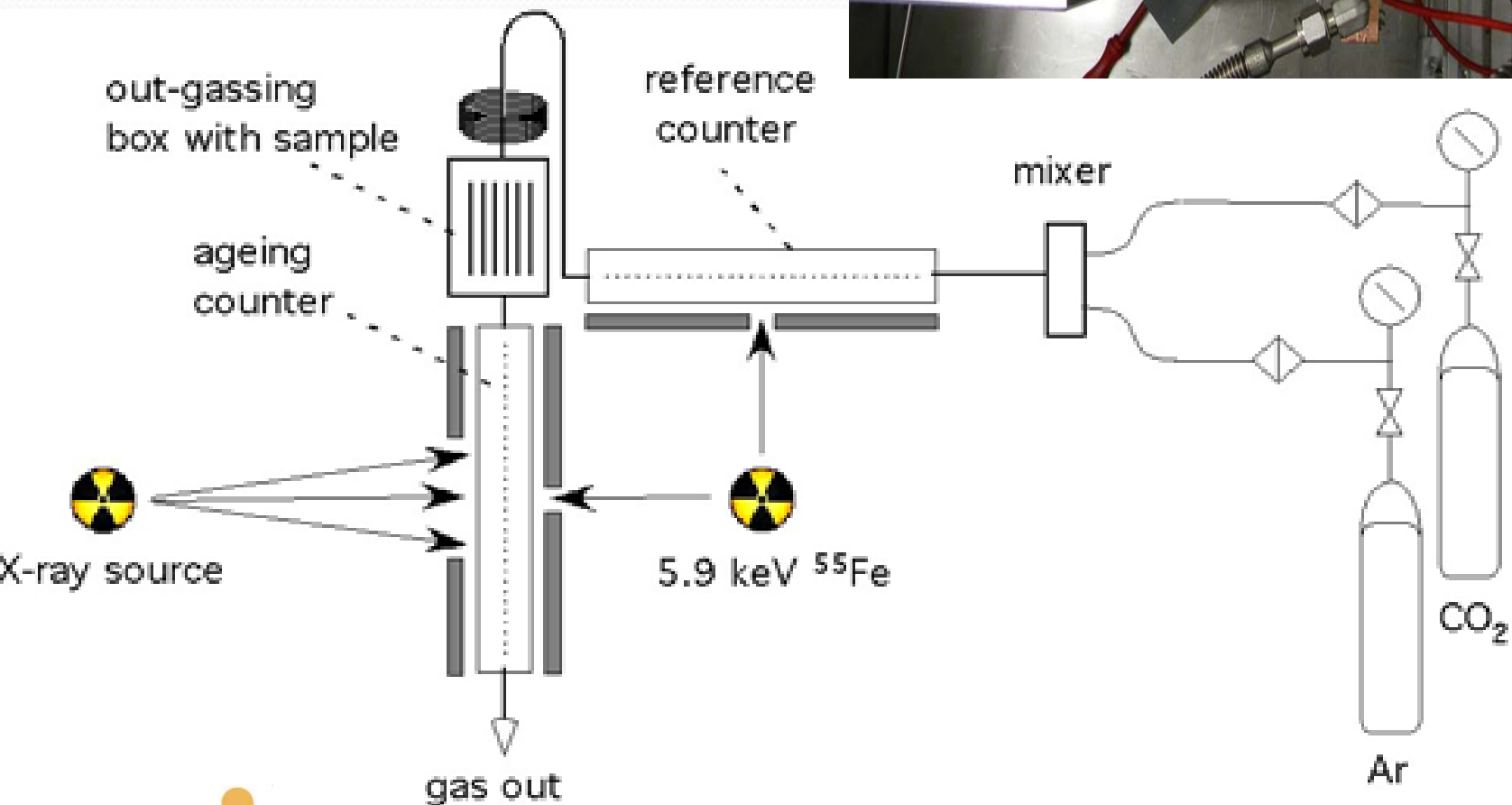
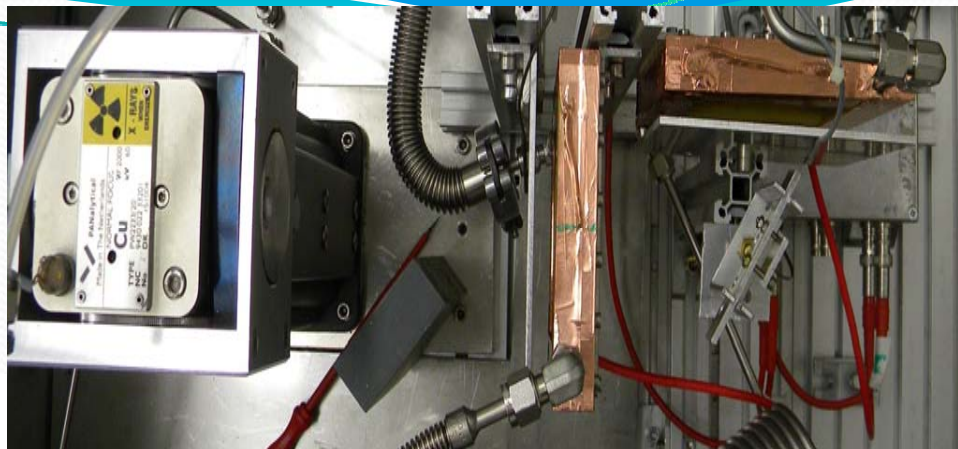
20 μm W-Au wires

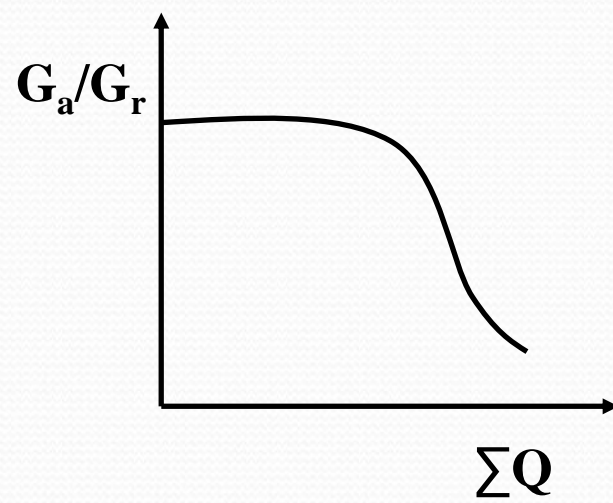
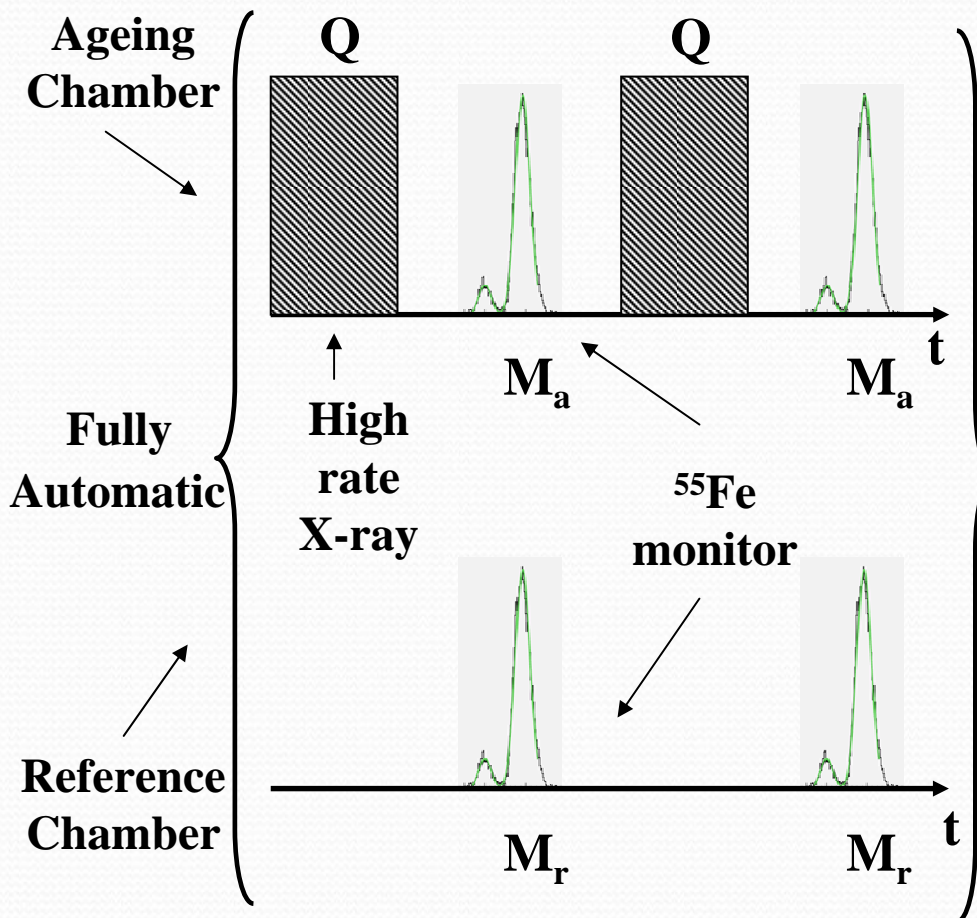


Al cathode



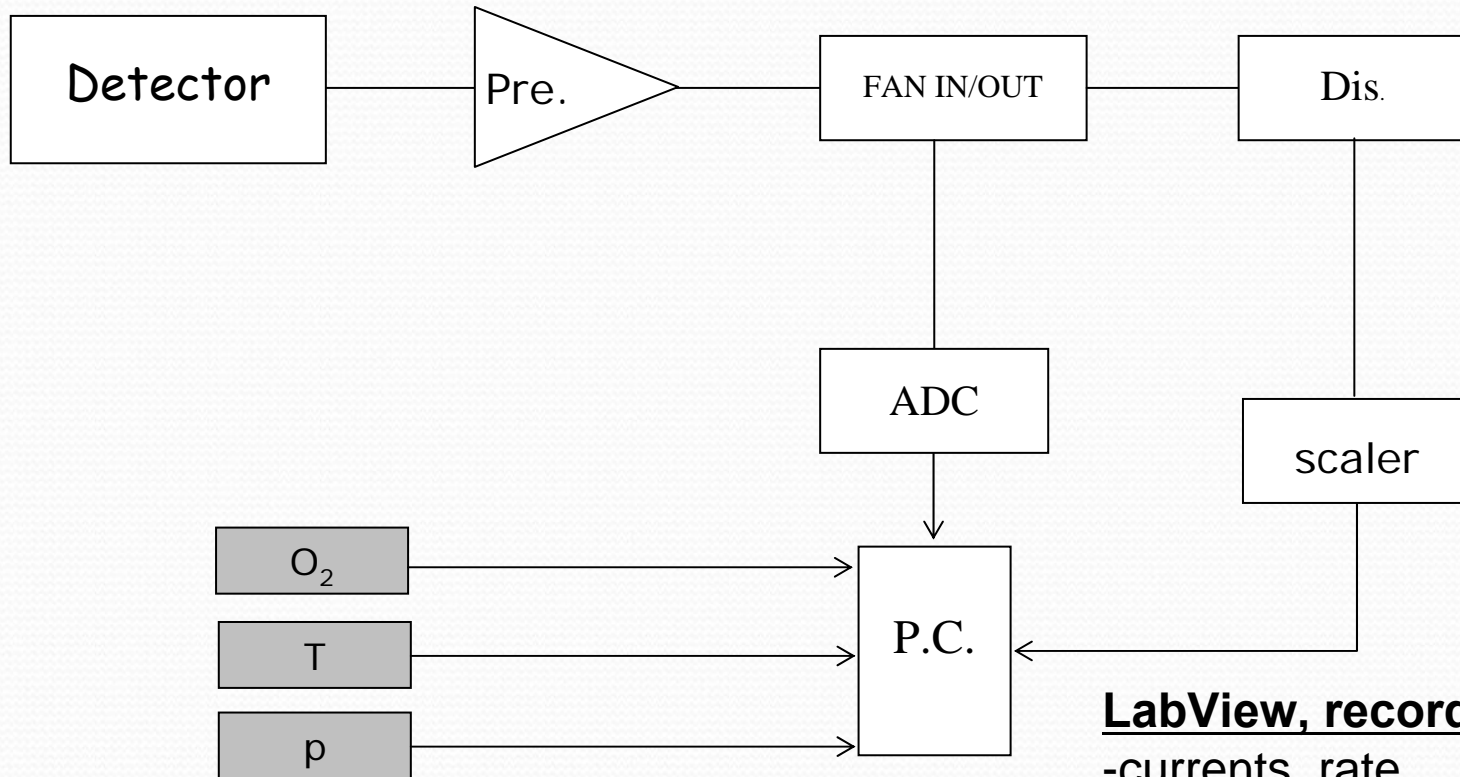
The setup





- Fully automatic
- Correction for Environmental parameters (e.g. T, P, RH, gas composition) are done taking the ratio of gain for ageing chamber and reference chamber
- Required precision should be < 1%

Electronics setup



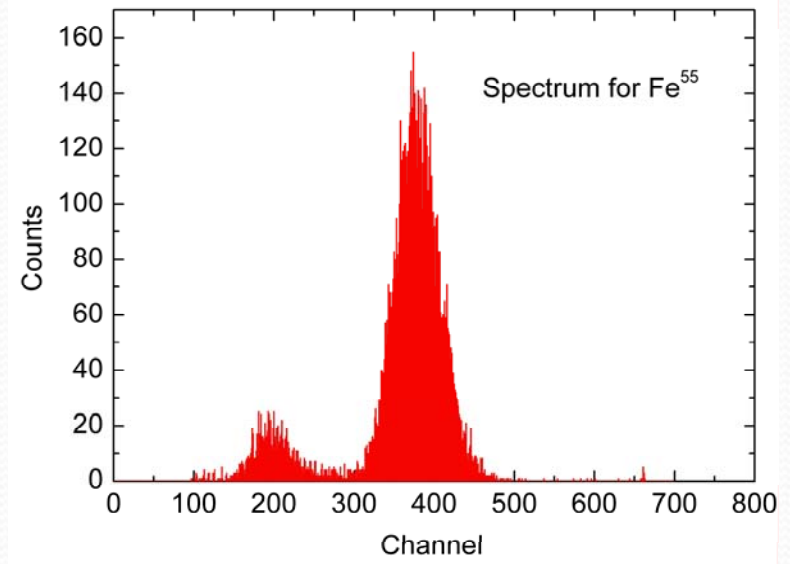
LabView, recording of:

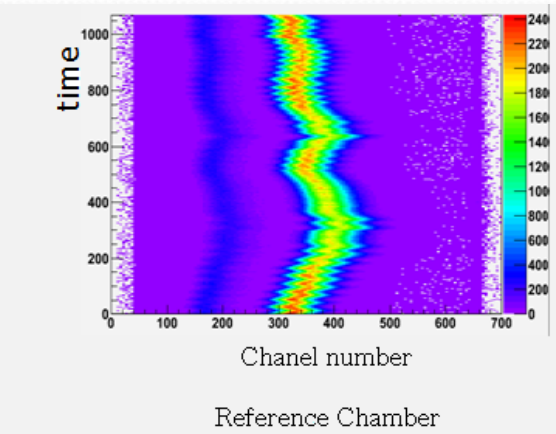
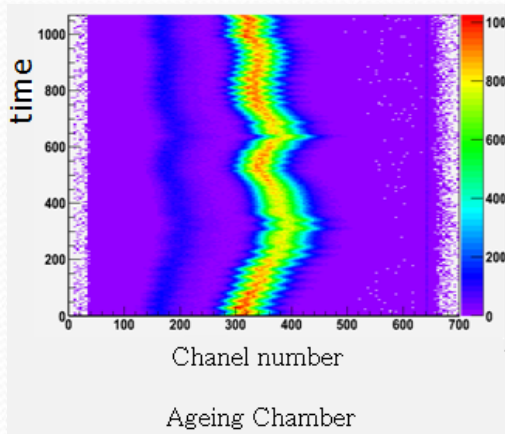
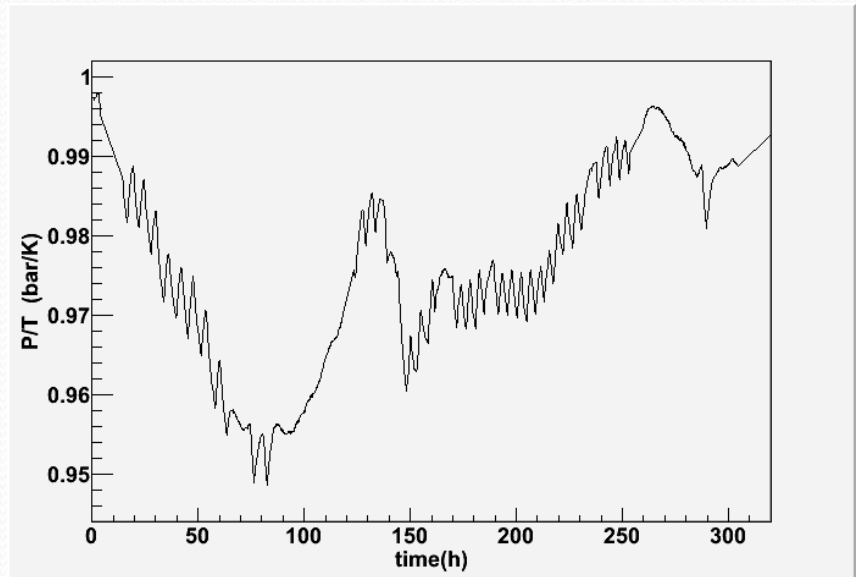
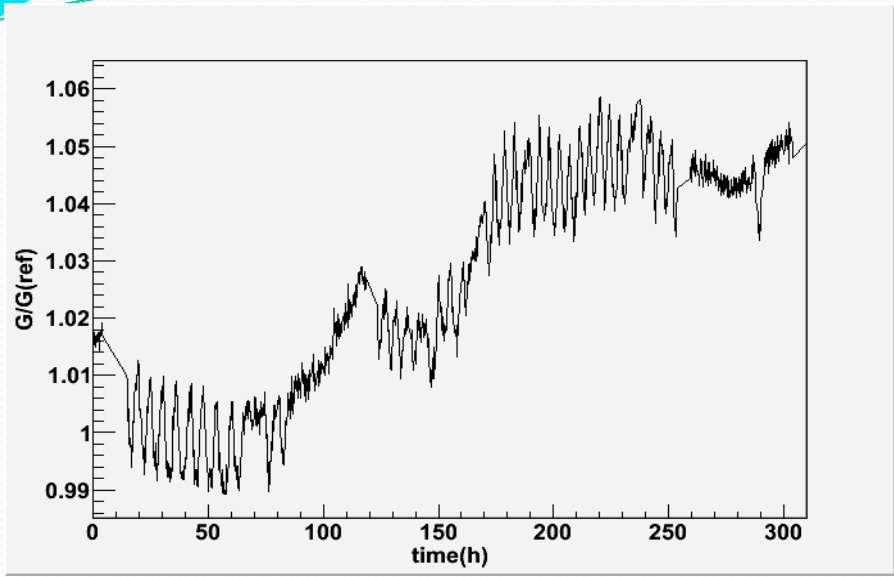
- currents, rate
- T, p, O₂
- spectra

Results

Stability test of the setup

- Spectrum of Fe^{55} x-ray source are observed for both the ageing and reference chambers with Ar/Co_2 : 80/20
- The gain of both the chambers are measured
- Temperature and pressure are monitored

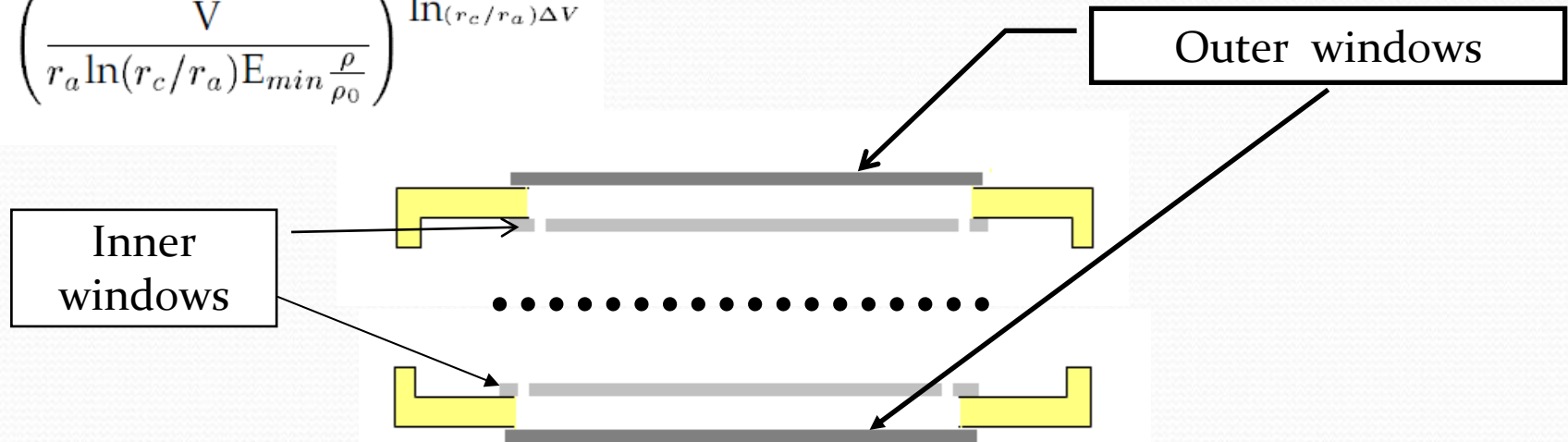




Residual instability has been observed due to change in the gas density and detector geometry resulting from the change of ambient parameters (T, P etc.)

Modification in the design

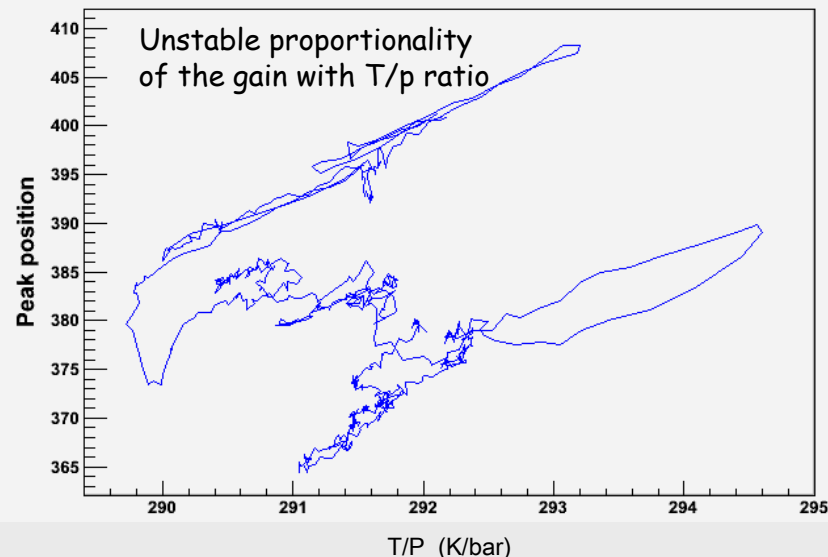
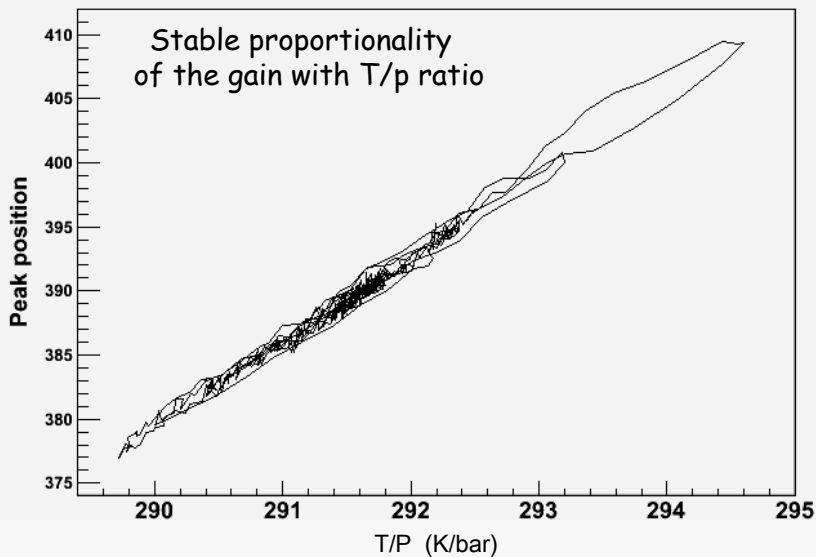
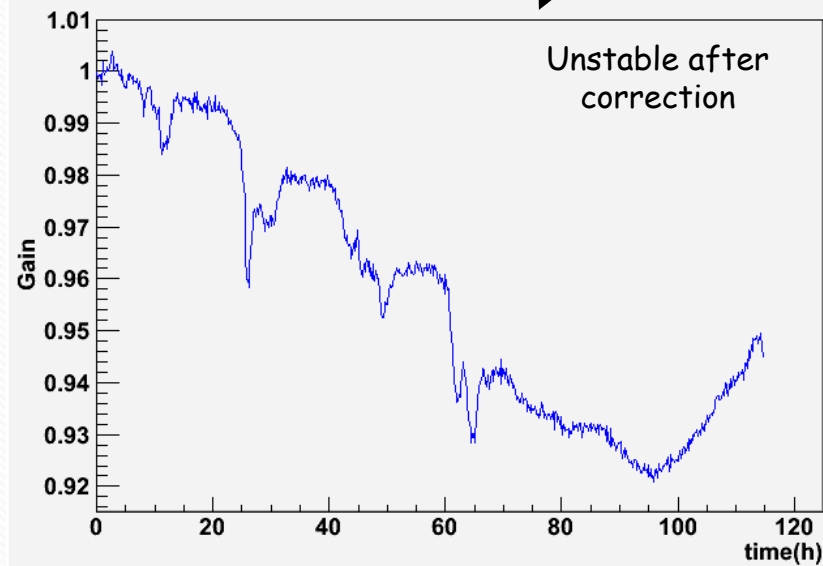
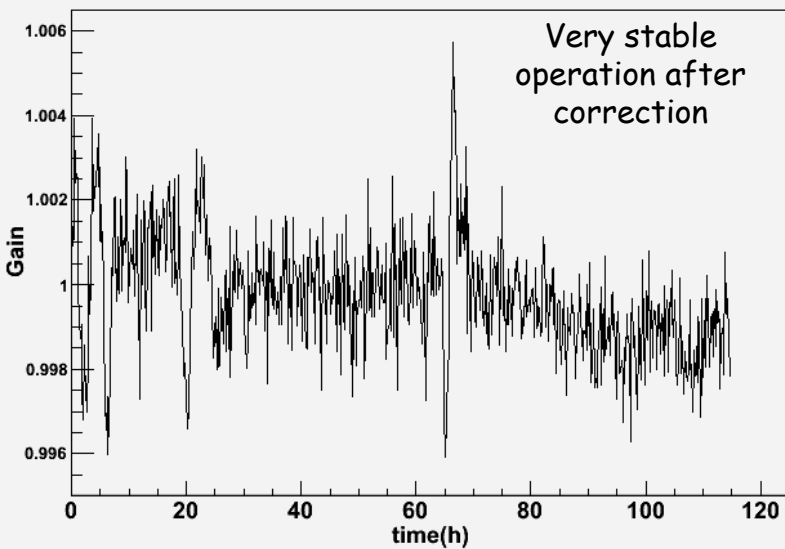
$$G = \left(\frac{V}{r_a \ln(r_c/r_a) E_{min} \frac{\rho}{\rho_0}} \right) \frac{V \ln 2}{\ln(r_c/r_a) \Delta V}$$

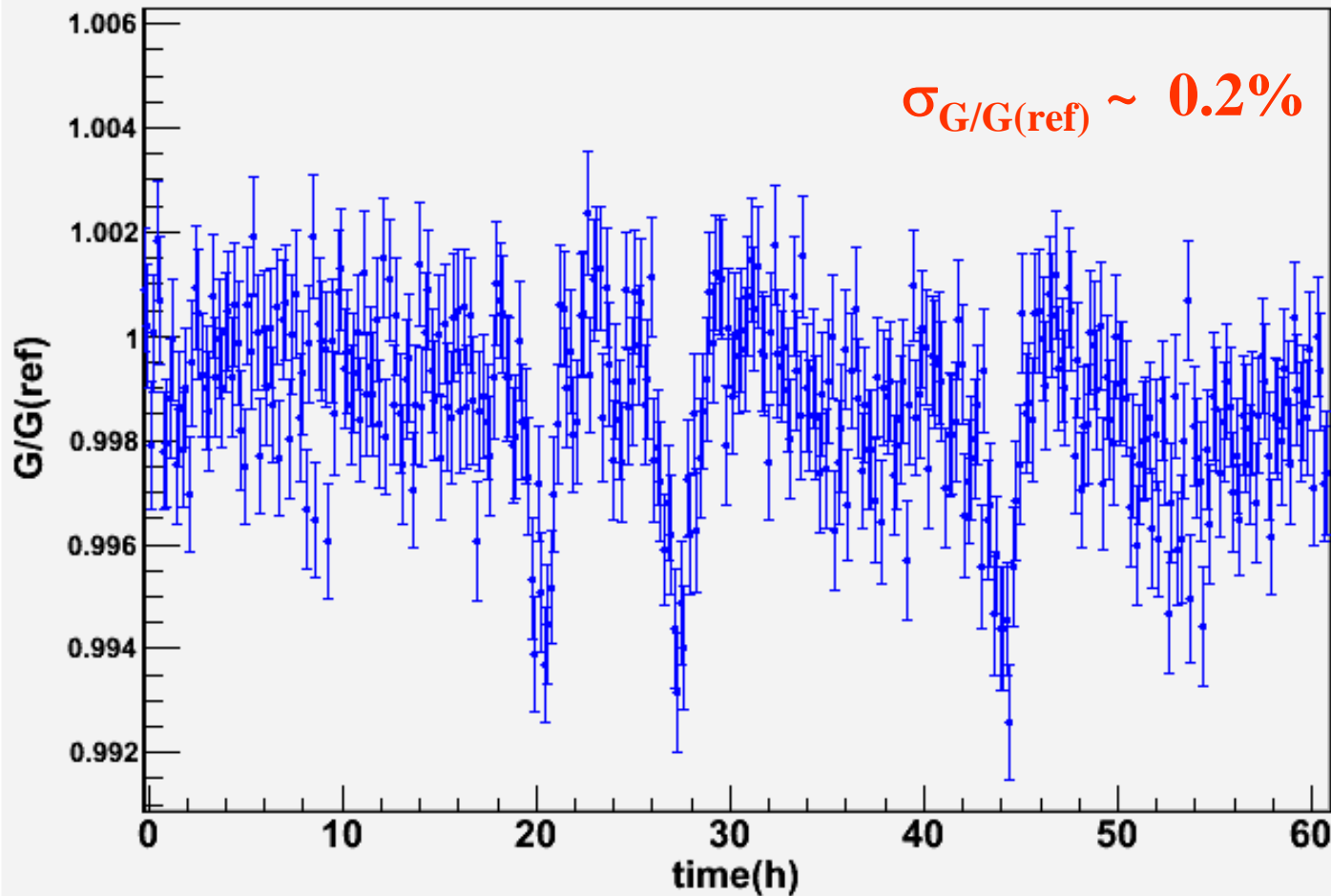


To avoid the residual fluctuation of the gain resulting from the change of geometry of the chamber, extra outer windows have been added with two holes in inner windows

With outer windows

Without outer windows

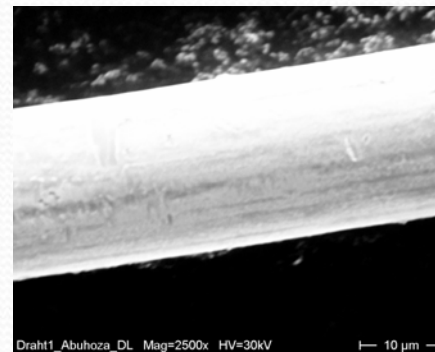
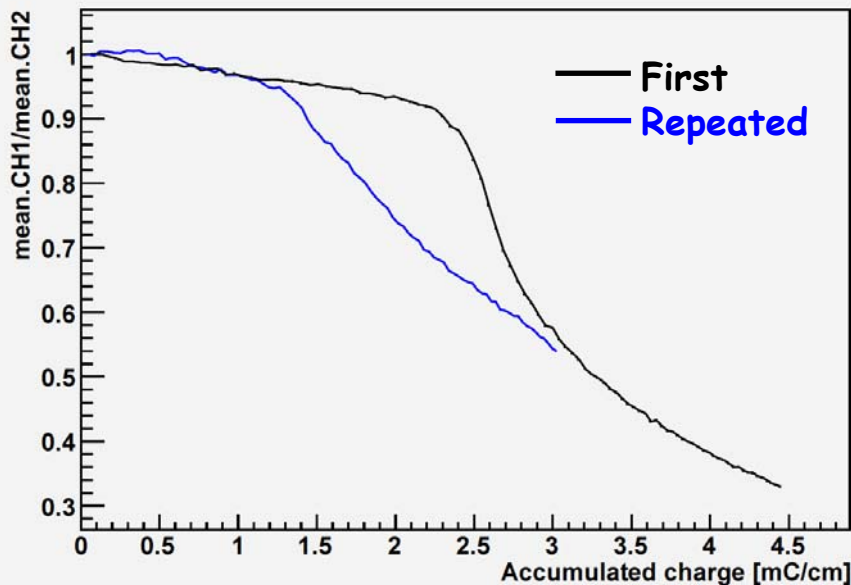
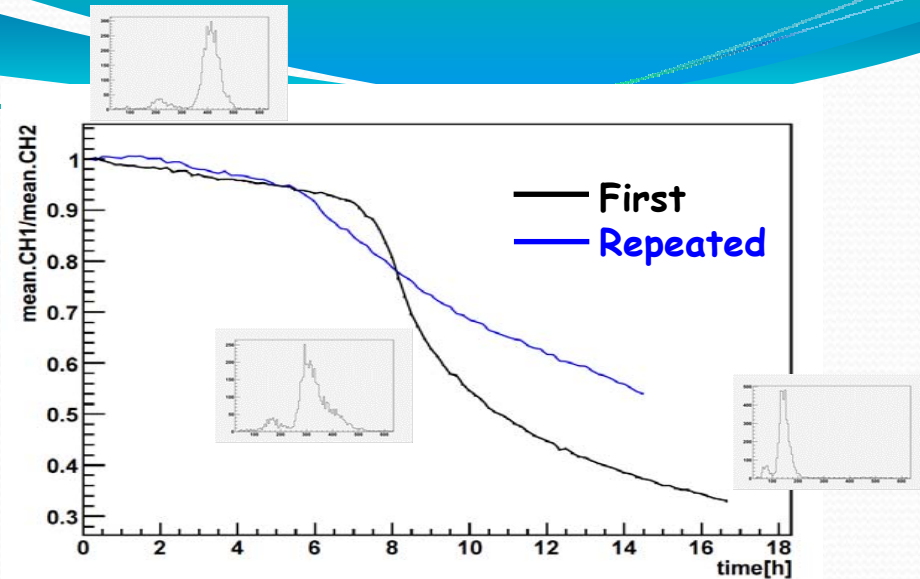




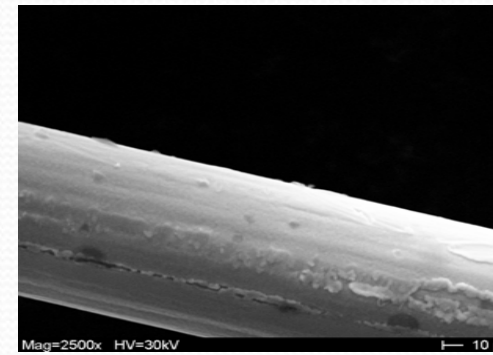
With the modified design the maximum variation of the gain ratio can be measured <1%

Ageing test of silicone-based glue (RTV-3145) with Ar/CO₂: 80/20

The ratio of the gain decreased drastically down to about 30%



Non-irradiated wires



Irradiated wires

Electron microscope images of the irradiated and non-irradiated anode wires

Summary and Outlook

- ◆ Studies of the influence of construction materials on the ageing properties of the high rate gas detectors are necessary
- ◆ A dedicated ageing test stand is operational in GSI DetLab
- ◆ High stability of the electric field in the detector must be achieved for the ageing test
- ◆ The ambient parameters (e.g. temperature, pressure etc.) should be kept constant during the test as much as possible and the residual should be corrected with the reference chamber
- ◆ Ageing test is performed on RTV-3145
- ◆ Strong decrease of gain observed in RTV-3145 test
- ◆ For accelerated ageing test the optimization of gas flow rate, intensity of radiation, gas mixing ratio are in progress

Thank you!

