TUM School of Natural Sciences
Dense and strange hadronic matter group
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Studying the impact of humidity on the performance of MPGDs

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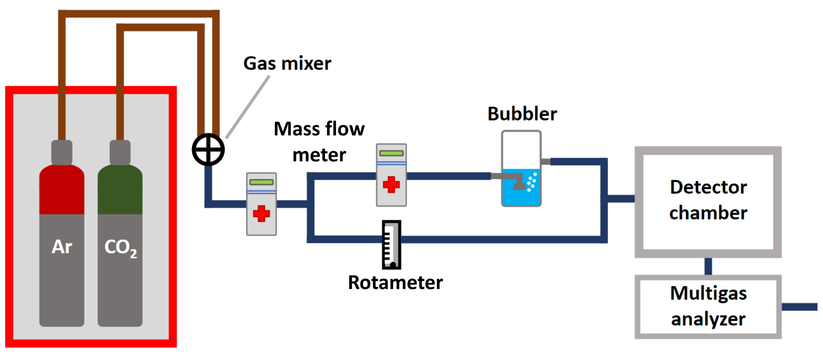
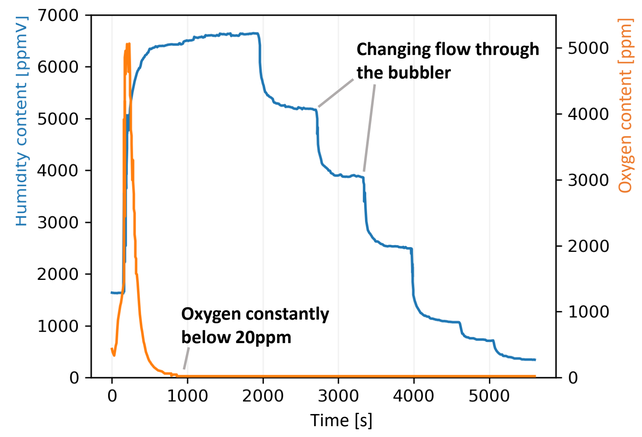
Despite long experience in the production and successful operation of MPGDs, the effect of water contamination of the gas composition on their performance is still a subject of debate [1, 2]. Therefore, we study various performance criteria while varying the humidity of the gas mixture in a range of 0-5000 ppmV.

The setup

- MPGDs:
  - GEM (holes: 50/70 µm, pitch: 140 µm)
  - Micromegas (LPI: 730, wire thickness: 13 µm)
  - THGEM (holes: 400 µm, pitch: 800 µm, thickness: 470 µm)
- Gas-tight vessel filled with Ar-CO_2 (90-10)



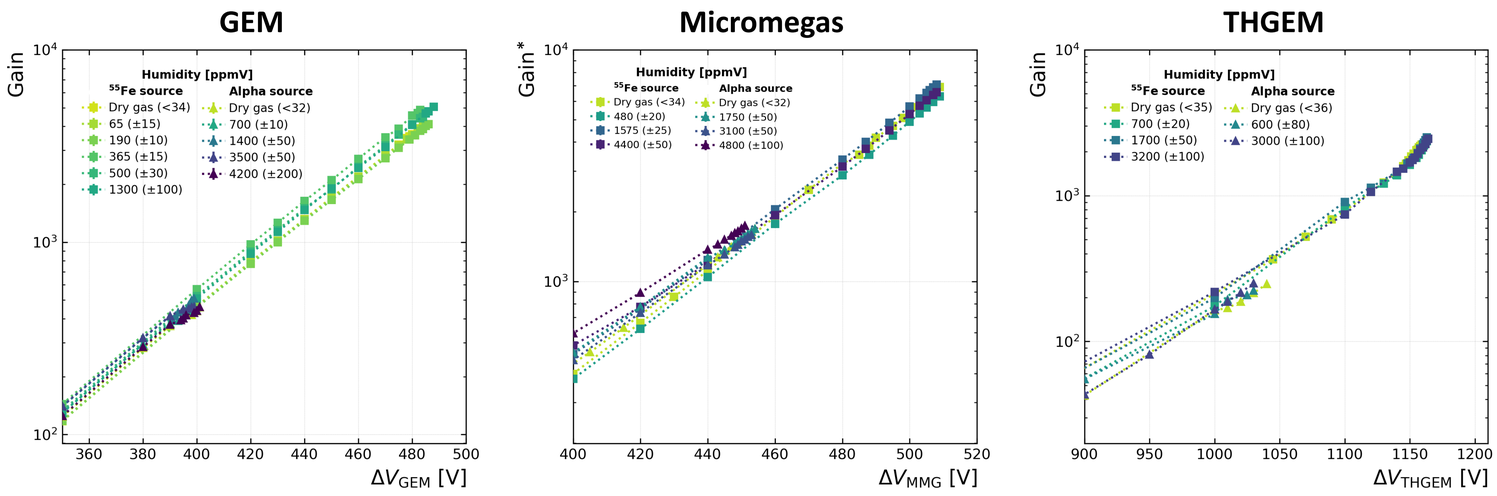


- Used sources: alpha emitter (^{239}Pu- ^{241}Am- ^{244}Cm), ^{55}Fe X-ray source
- Humidity is introduced to the gas by incorporating a bubbler in the gas system through which gas can be flushed at different rates

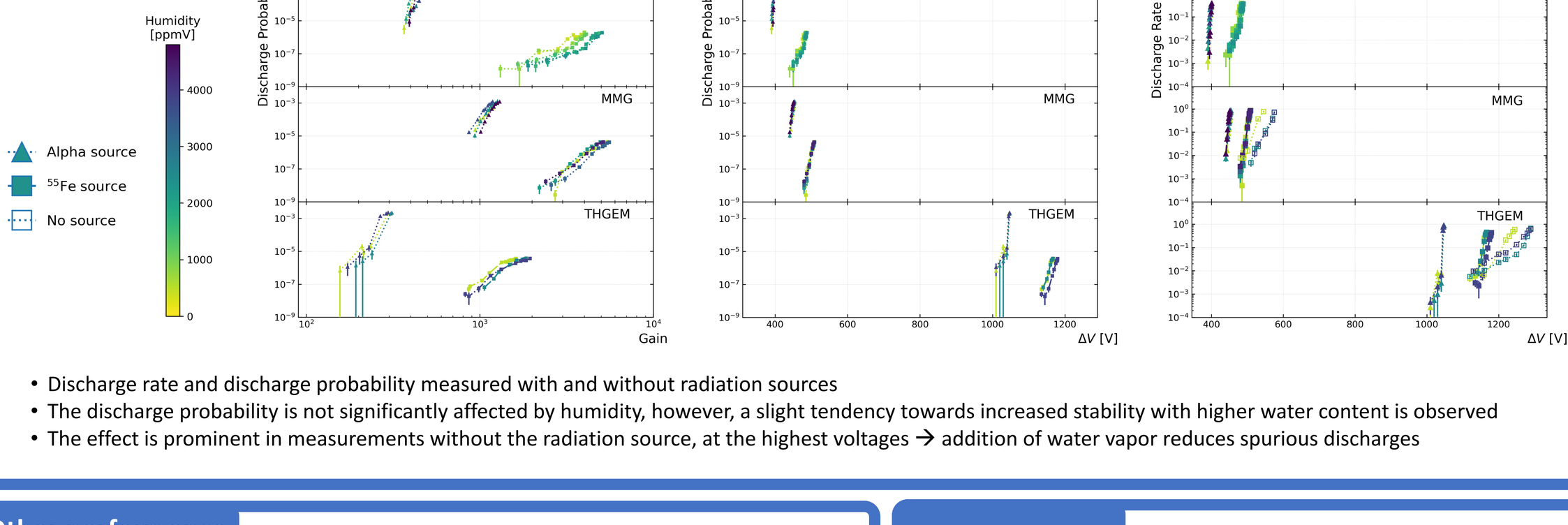
Impact on gain

- Gain is studied as a function of the amplification voltage at a drift field of 400 V/cm
- No impact of humidity on the gain of a structure is distinguished at operational gains and voltages
- The results meet expectations: Townsend coefficient is not affected by water content in the given range

* Gain curve for micromegas corrected for electron collection efficiency



Impact on discharge stability



- Discharge rate and discharge probability measured with and without radiation sources
- The discharge probability is not significantly affected by humidity, however, a slight tendency towards increased stability with higher water content is observed
- The effect is prominent in measurements without the radiation source, at the highest voltages → addition of water vapor reduces spurious discharges

Other performance criteria

Energy resolution:

- No significant effect of humidity on the energy resolution is observed within the given humidity range

Charging-up effects:

- No significant impact on characteristic time constants is observed for different humidity levels (similar results obtained in [3])

Conclusion

- Adding water to the gas mixture increases the discharge stability at the highest voltages
- We conclude, that low humidity levels do not influence the discharge formation process. However, they reduce the rate of spurious discharges related to electrode defects or charging-up of the insulating layers.

References: [1] F. Sauli, C. Altunbas, M. Capéans et al. “Construction, test and commissioning of the triple-gem tracking detector for compass“, NIM-A 490(1-2) (2002), pp. 177-203
[2] D. Xiao. Gas Discharge and Gas Insulation. (2016)
[3] M. Shirajum, “Charging-up Behaviour of MicroPattern Gaseous Detectors”, Master’s thesis, University of Helsinki, 2020

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