

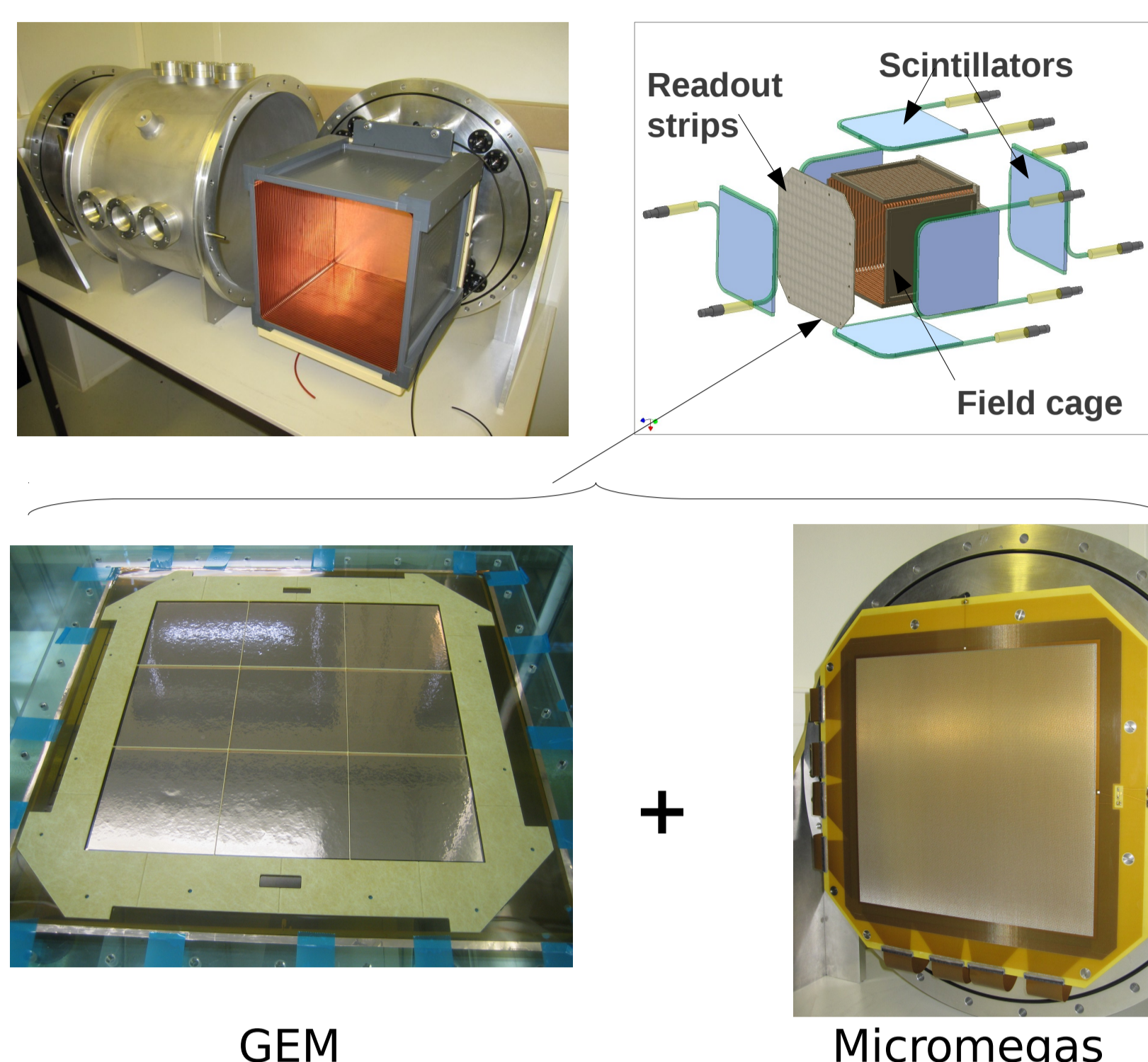


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The HARPO TPC

- 30 cm cubic TPC
- Electron amplification by Micromegas+2GEM
- Gas: Ar/iC₄H₁₀ 95/5% up to 5bar
- 2x288 strips readout (x&y), 1mm pitch
- Readout electronics based on AFTER chips (511 time bins up to 100 MHz)
- Trigger: 6 scintillators + micromegas signal and timing (+ laser pulse when available)



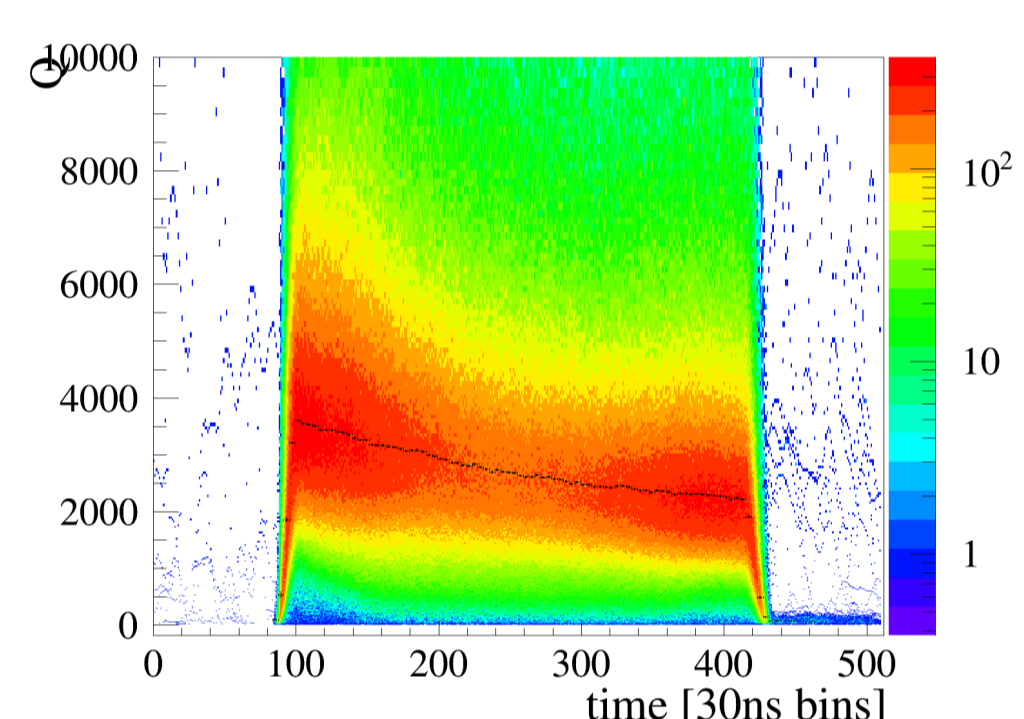
Characterization of the gas with cosmic ray data

Selection of high momentum cosmic tracks

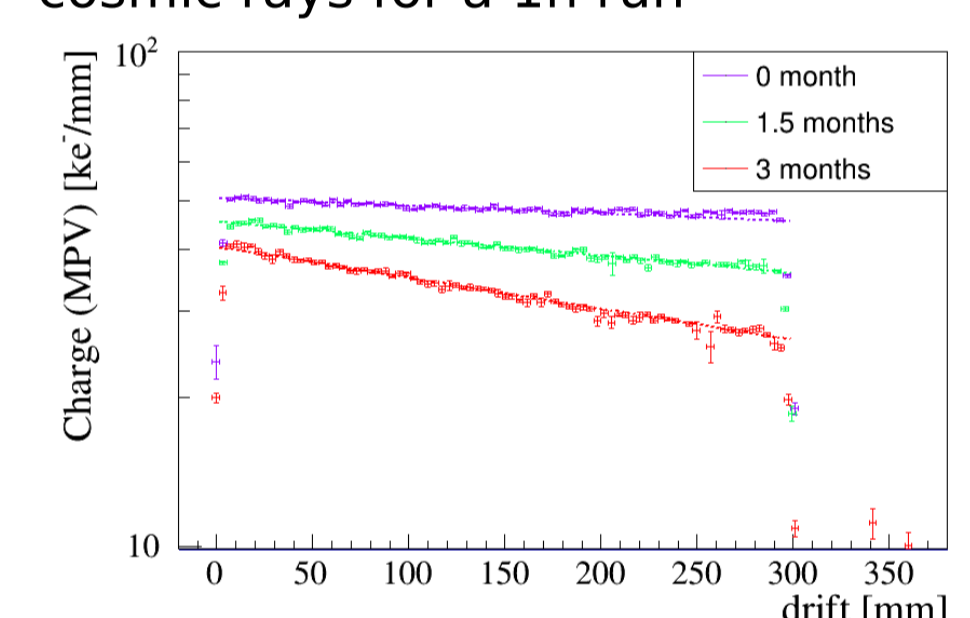
- straight tracks
- uniform $\langle dE/dx \rangle$

Distribution of charge vs drift time

- corrected for angular effect
- Gain from height
- Drift velocity from length
- Attenuation from slope
 - relative value
 - combined with threshold effects



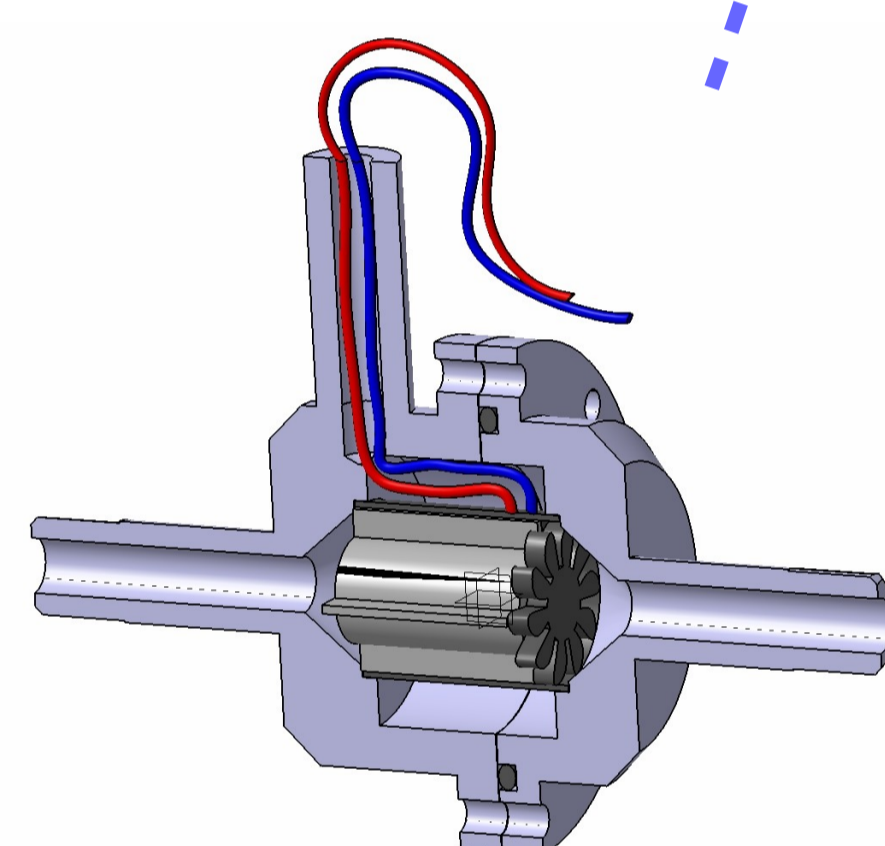
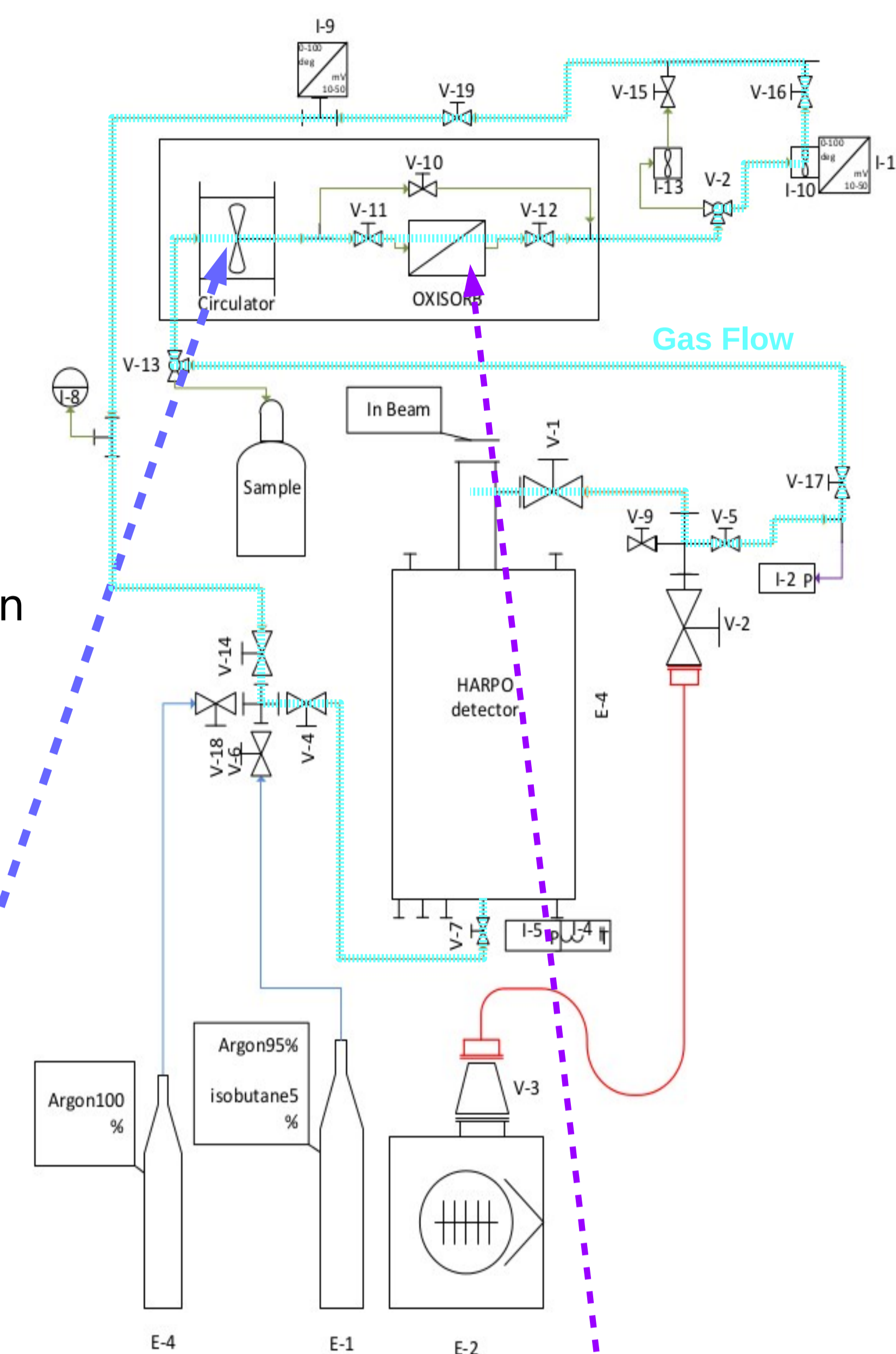
Charge vs drift time distribution of cosmic rays for a 1h run



Evolution of the distribution for 3 runs, at 1.5 month interval. The increasing exponential attenuation is clearly visible

Circulation And Purification System (CAPS)

- Sealed TPC
 - 100 litres vessel
- Closed circulation circuit
 - Small turbine for gas circulation
 - Oxisorb® filter for O₂ and H₂O removal
 - Flowmeter
- All parts of the circuit can be isolated
 - Testing for leaks
 - Sample extraction
- Thoroughly tested for leaks
 - in vacuum
 - under pressure



Light and sealed turbine for circulation with flows of about one litre per hour
Patent FR 15 50987 (2015/02/09)

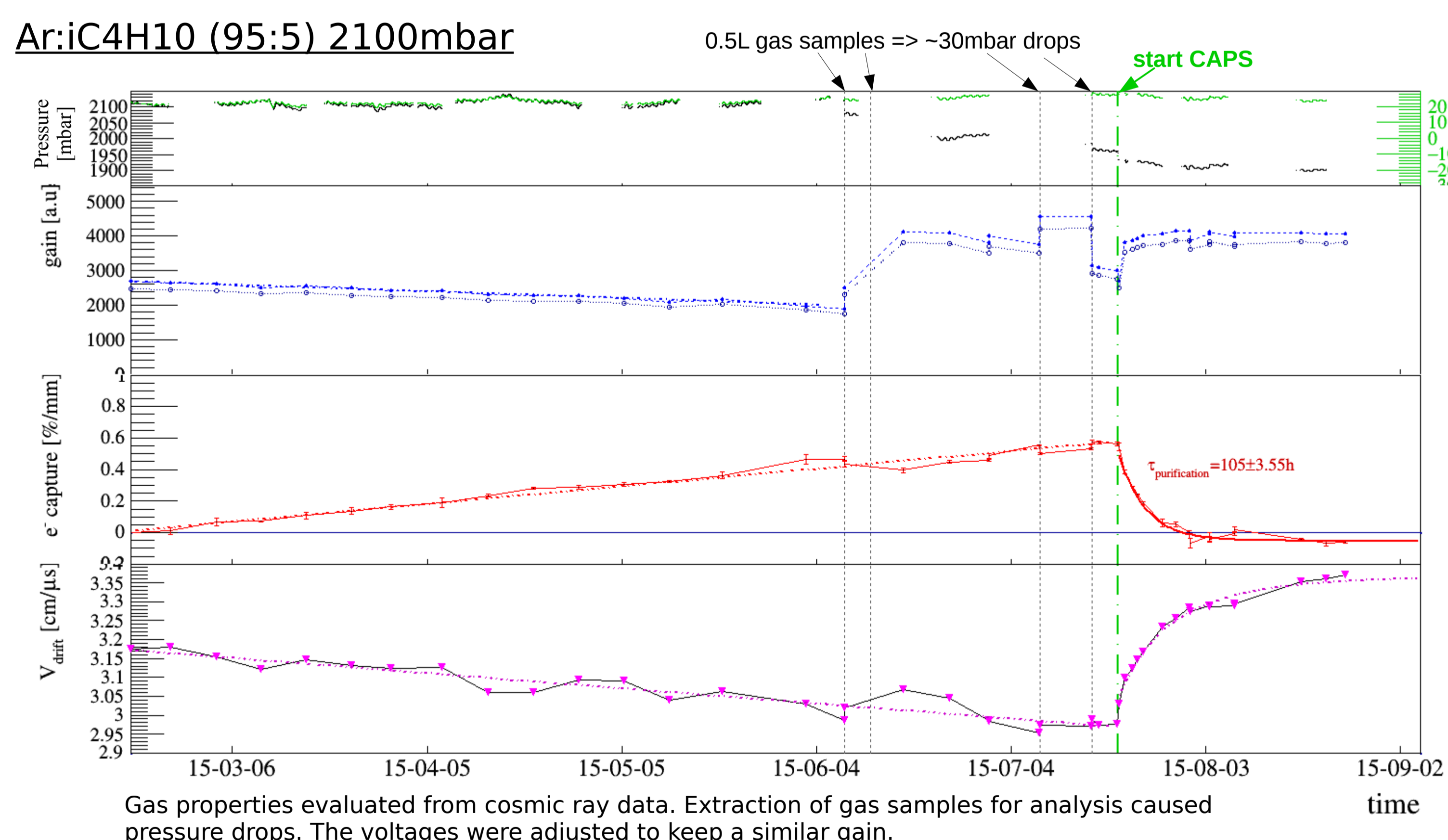


Oxisorb® filter for O₂ and H₂O

Immediately after opening CAPS
After one week of circulation

Measurement Results

Gas evolution from cosmic ray data



- Unchanged gas in sealed vessel for 5 month: February to July 2015
- CAPS started after 5 month (July 2015)
- The attenuation increases due to electron capture
 - probably O₂ from leaks
- The drift velocity decreases
 - probably H₂O from outgassing
- The original properties are recovered after a couple of weeks of circulation

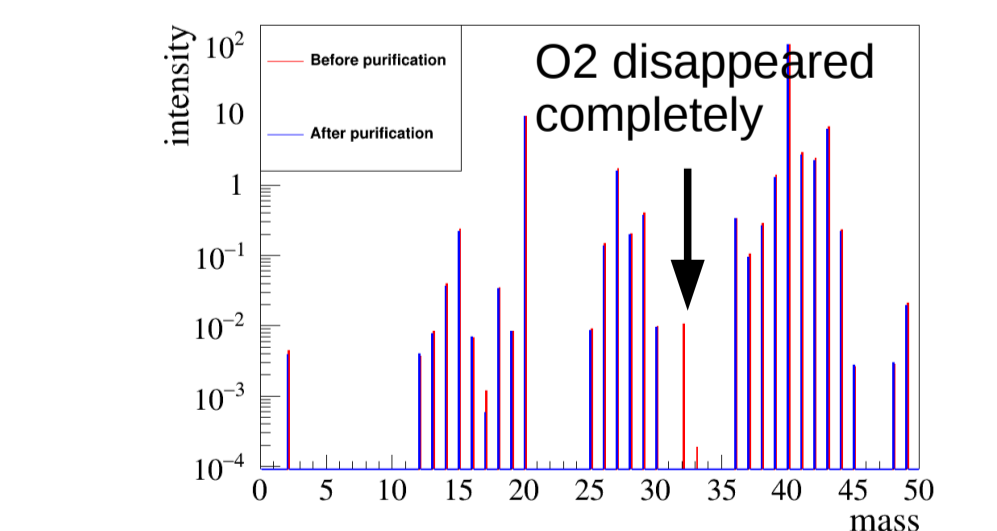
Gas contamination analysis and discussion

Gas samples were analysed in a high resolution (R=2800) direct injection mass spectrometer (THERMO MAT 271) at LRMO

- Before starting of CAPS:
620ppm N₂, 180ppm O₂, 190ppm CO
120ppm CO₂, 5.10% isobutane
 - After one month running
890ppm N₂, <20ppm O₂, 250ppm CO
160ppm CO₂, 4.42% isobutane
 - The H₂O content cannot be measured in samples (needs online device)
- After 1 month of purification, no oxygen is left in the gas.



Example of high resolution mass spectrum. ¹²C¹⁶O, ¹⁴N and ¹²C¹⁴H₂ can be separated



Full spectrum from the mass spectrometer before and after purification

Conclusions and discussion

- The HARPO TPC provided good cosmic data for several month in fully sealed mode
- Equipped with a simple lightweight purification system, the full performance was recovered in only a few weeks
 - => Could run continuously without degradation
- A loss of isobutane during purification was observed and needs further investigation
- Further long time study (>1year) should be done in continuous running mode (CAPS and HV on)