

HF study for RPC's ECOGAS

Ecogas meeting
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HF measurements set up

GOAL:

Study the **HF production rate** as a function of the **background rate** using an ECOGAS mixture:
50% CO₂, 45% HFO, 4% isobutane, 1% SF₆

RPC CHAMBER:

- CMS-RPC GT
- 2mm electrodes and gas gap thickness
- Total gaps surface 14000 cm² →
- ≈ 3 L/h == 1 gas vol change/h
- 2 gaps connected in series in the gas line

ELECTRODES & STATION:

- Reference electrode HANNA HI-5313
- Fluoride ion probe HANNA FC301
- Station: HANNA HI-5222 (resolution 0.1 mV)

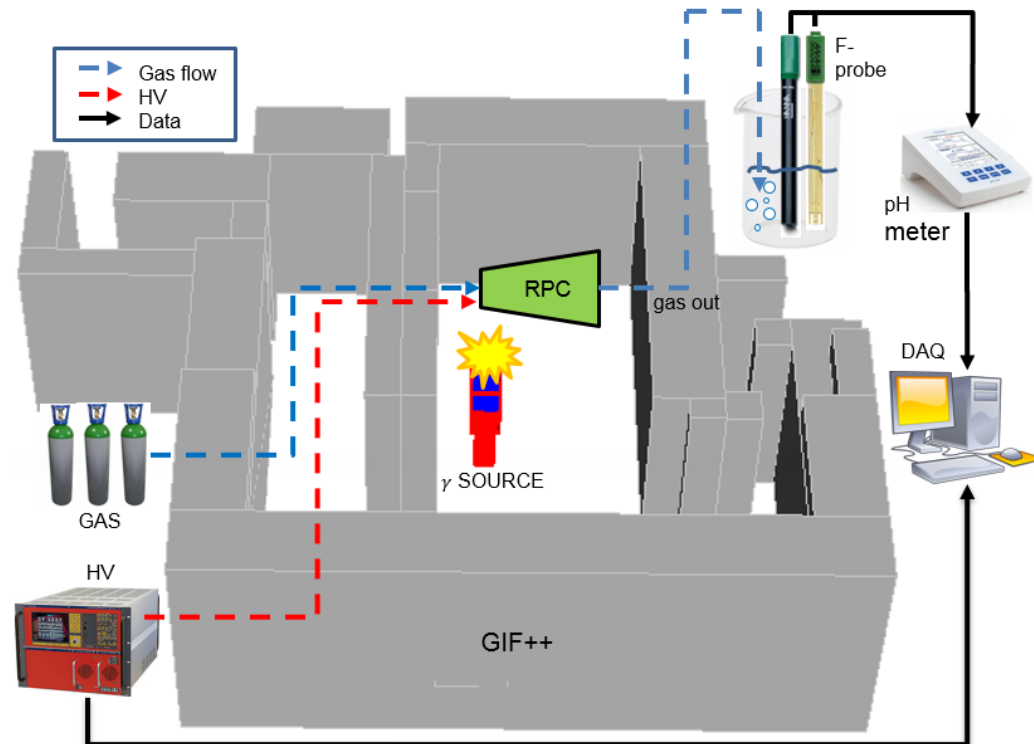
SOLUTION:

Solution: 50% H₂O+ 50% TISAB*
(Total Ionic Strength Adjusting Buffer) + 1ppm F⁻

METHOD:

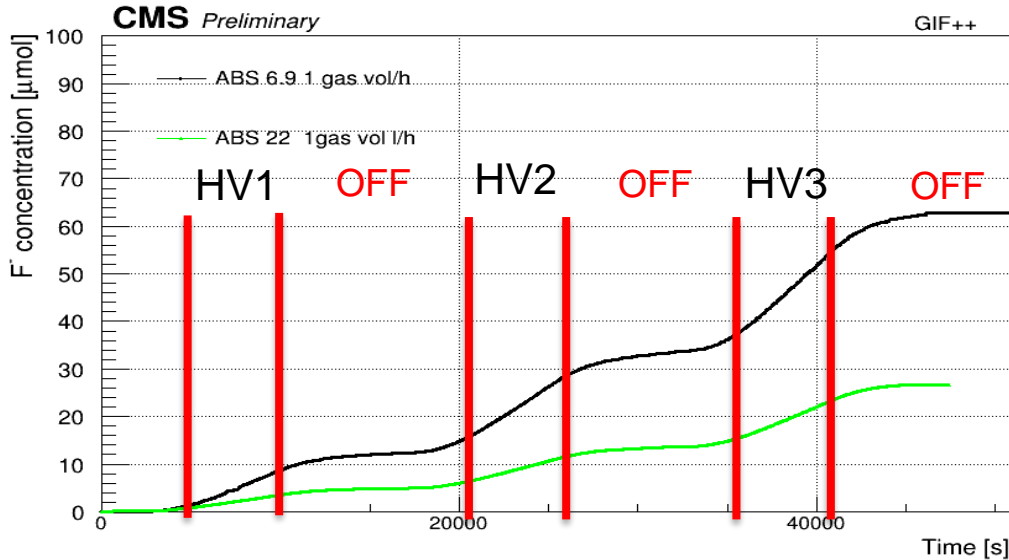
Probe continuously immersed in the solution and connected to the acquisition system which monitors the probe output voltage as a function of time.

The probe output voltage is proportional to the F⁻ activity, and represent the F⁻ integrated in time.

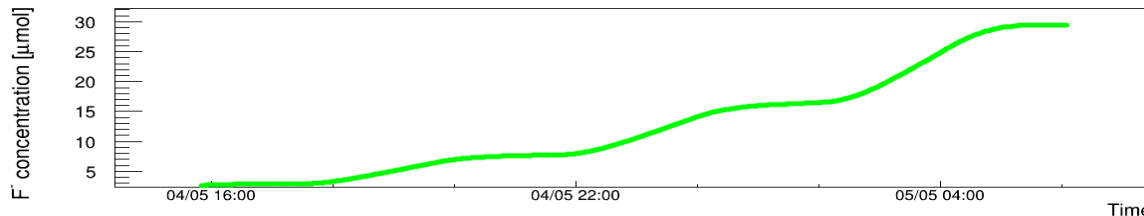
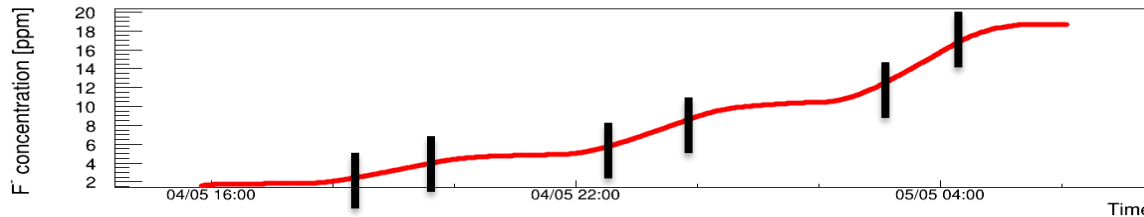
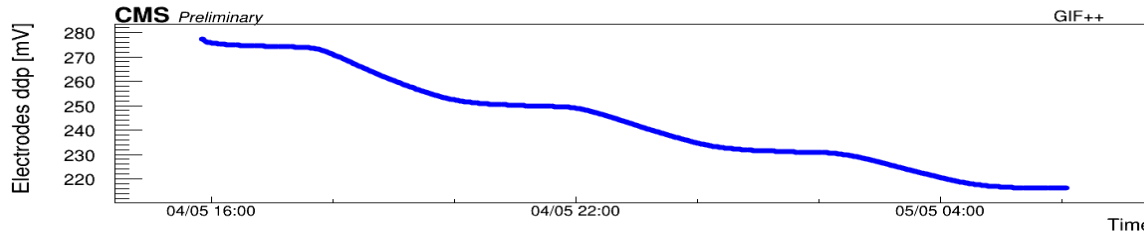


* TISAB neutralizes the effect of electrode interfering substances that could bias the measurement, keeping the solution at a pH of 5.5.

HF vs time

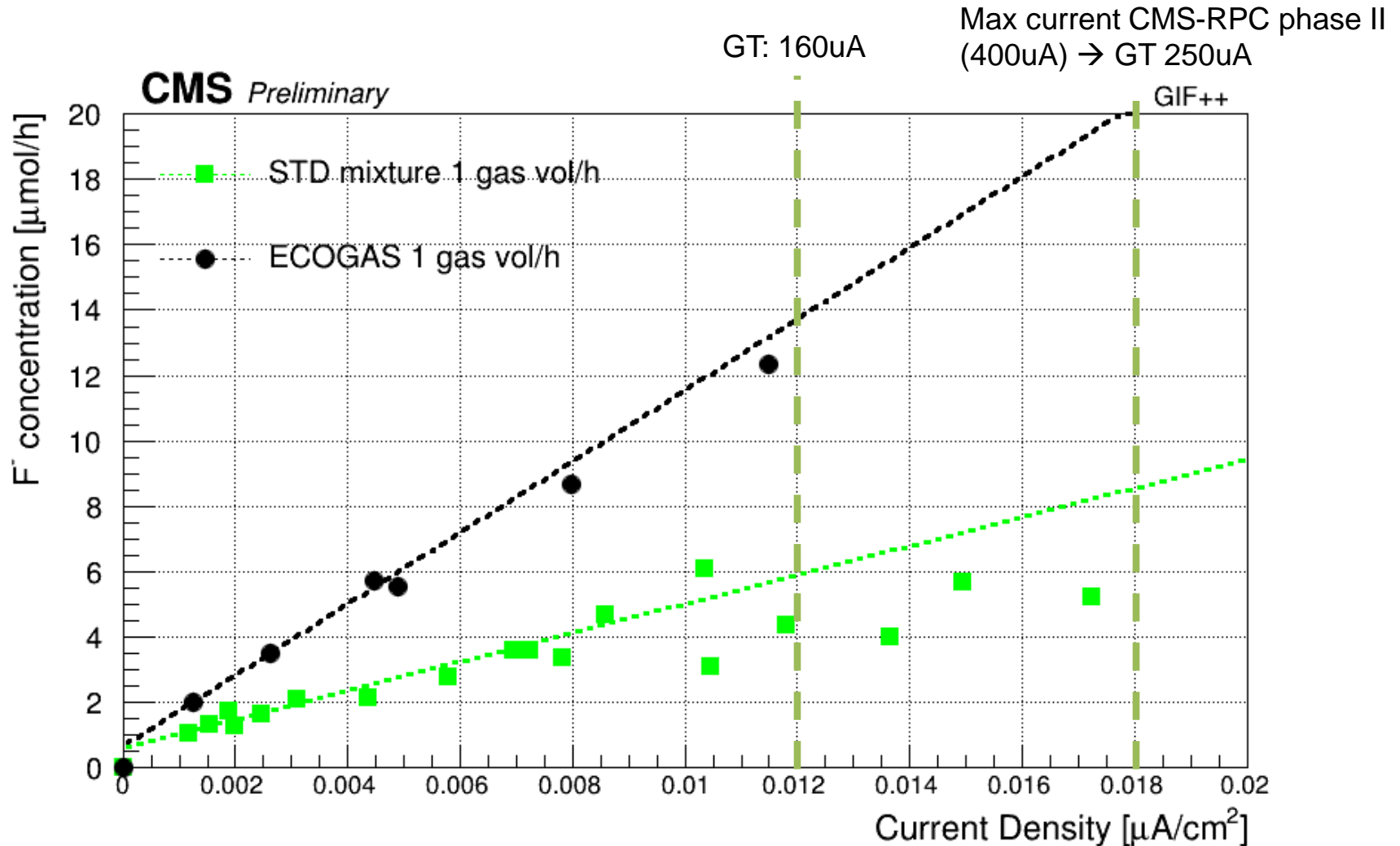


- ✓ HF concentration increase with background rate (ABS)
- ✓ HF increase with the current (HV)



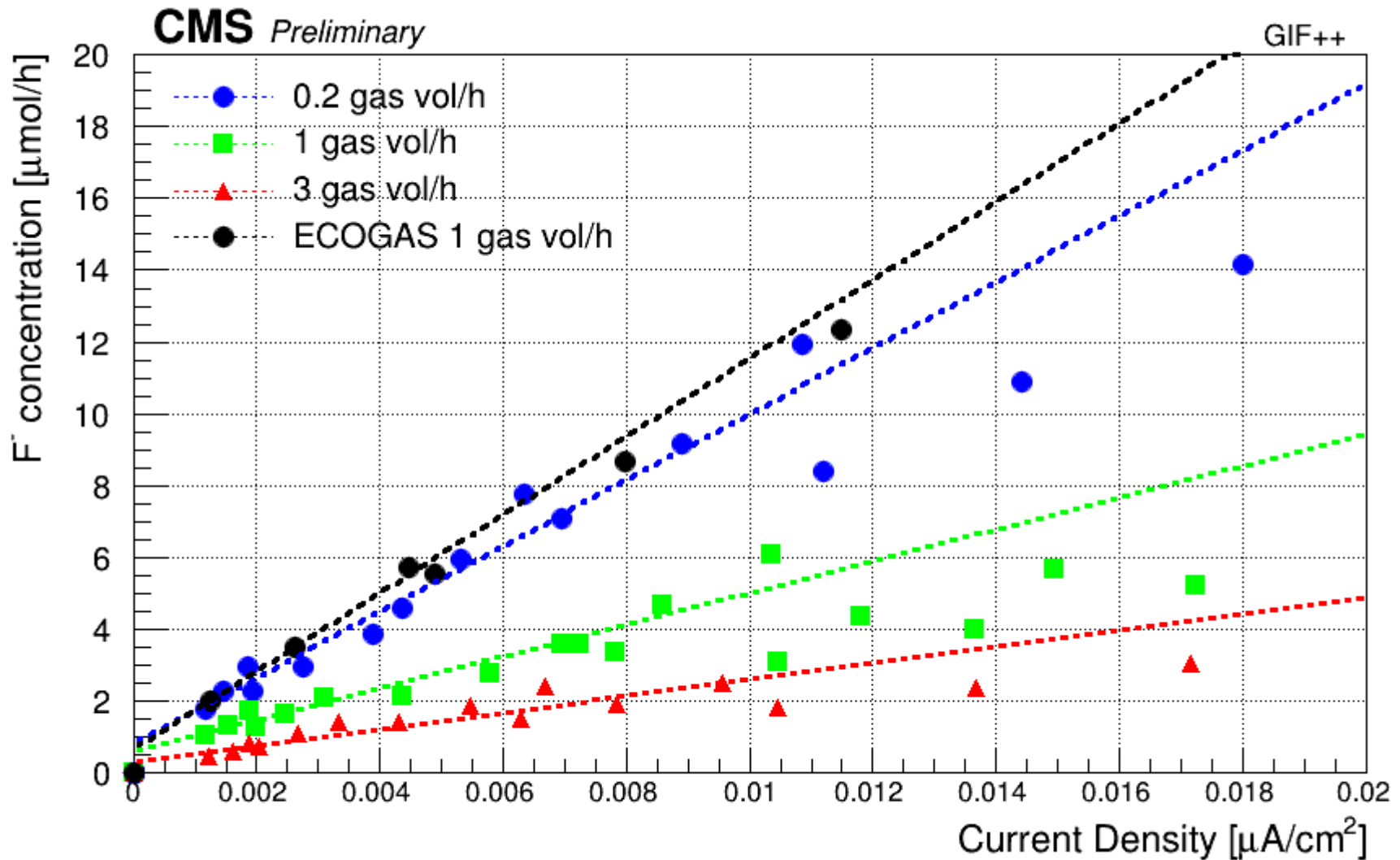
1. Conversion from mV to ppm
2. Linear trend fit to estimate the hourly concentration
3. Conversion from ppm to $\mu\text{mol/h}$

HF vs current: STD vs ECO mix



- ✓ The HF concentration depends linearly by the current
- ✓ Ecogas slope: $1.09137\text{e}+03$ STD mix slope: $4.42870\text{e}+02$
- ✓ HF concentration: factor 2.5 higher with ecogas

HF vs current: STD vs ECO mix

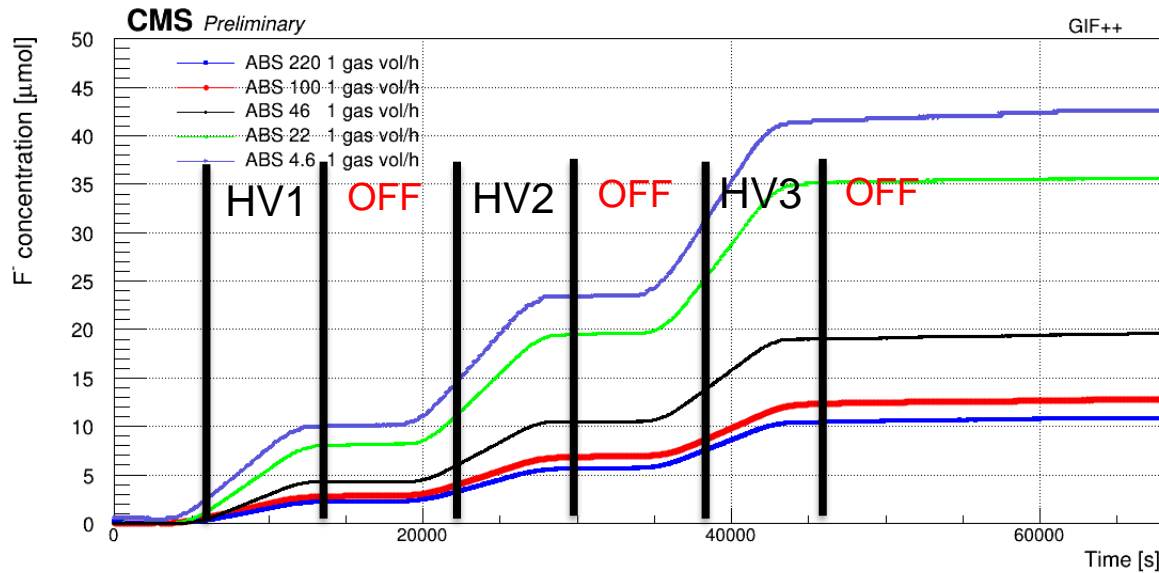


Ecogas HF concentration with 1 gas vol/h similar to the STD mix HF concentration with 0.2 gas vol/h

BACKUP:
Results from CMS-RPC HF study using STD mixture

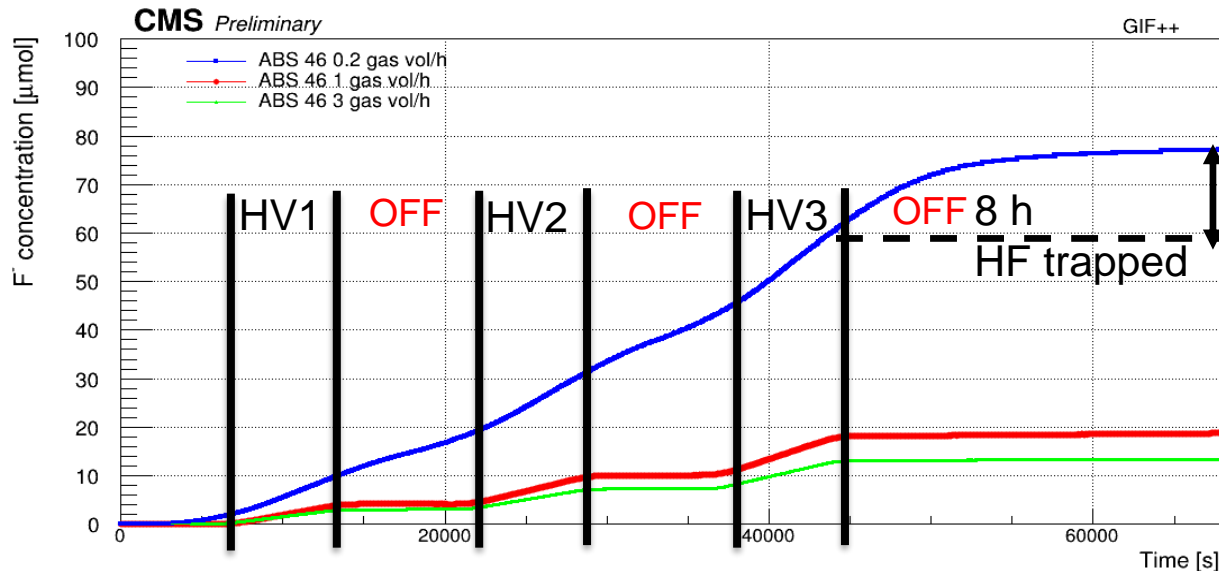
HF vs time

HF concentration at different background & fix gas flow



- ✓ HF concentration increase with background rate (ABS)
- ✓ HF increase with the current (HV)

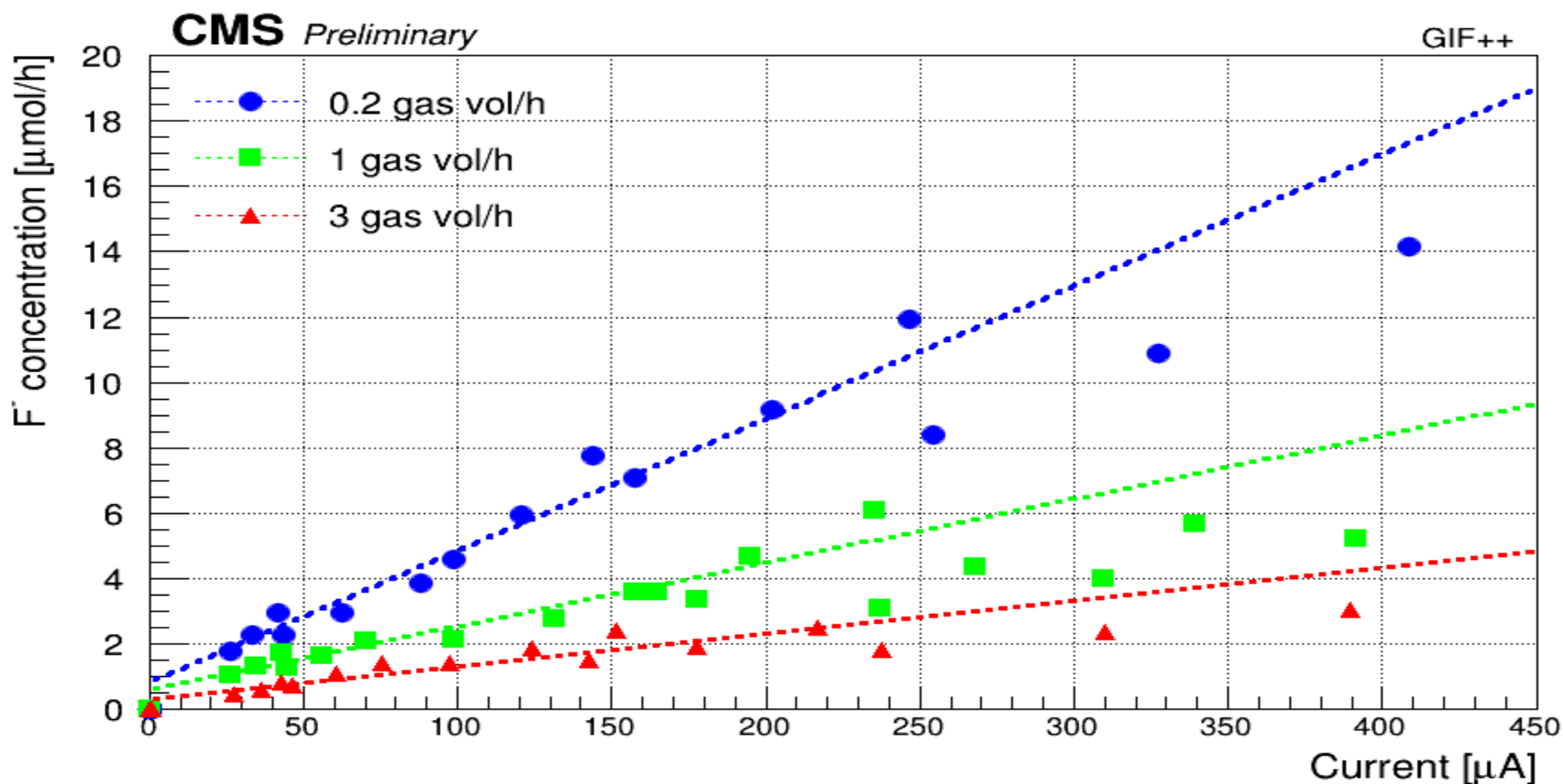
HF concentration at different gas flow & fix background



- ✓ HF concentration increase with lower gas volume changes
- ✓ HF trapped increase with lower gas volume changes

HF vs current for CMS-RPC @ STD mixture

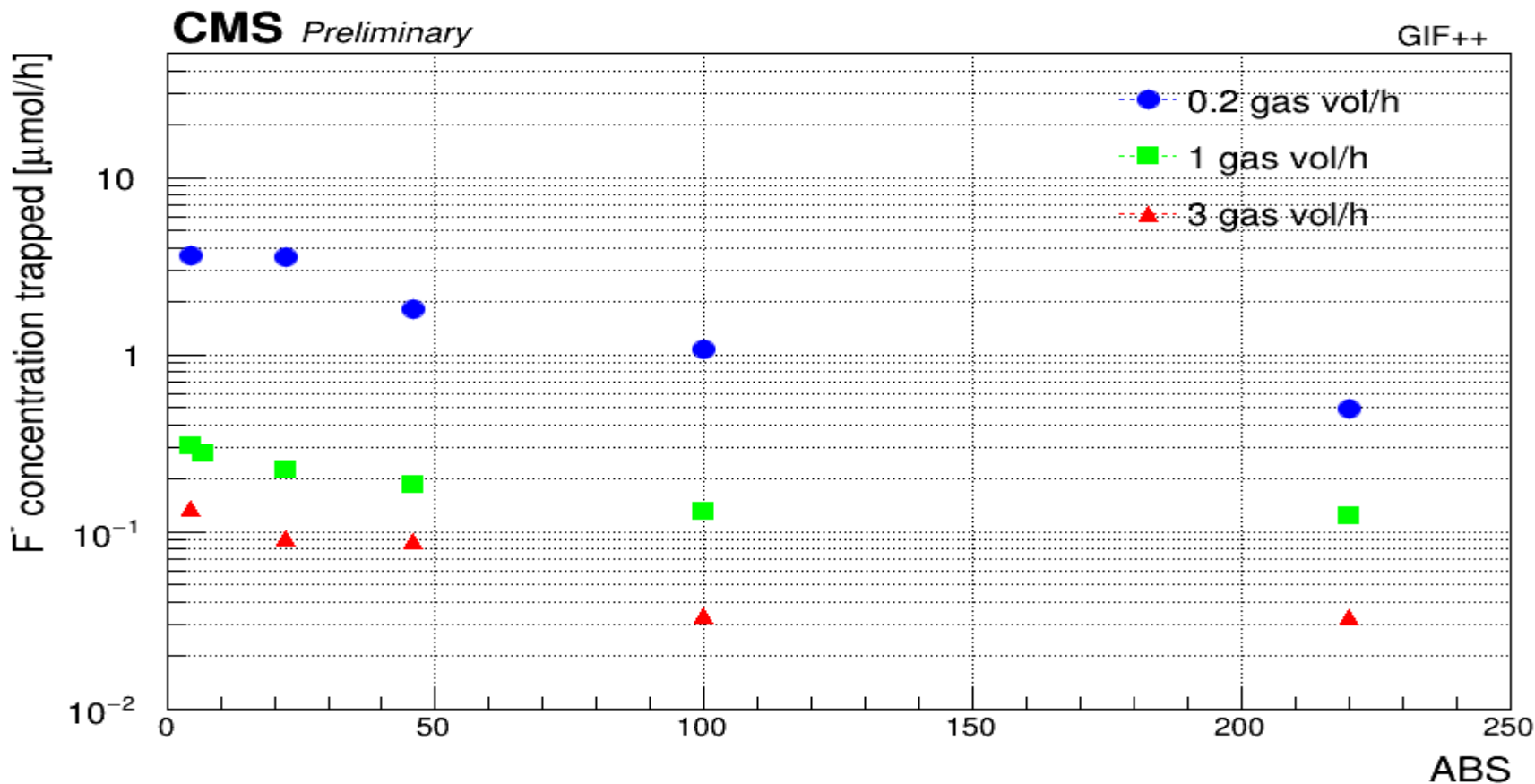
Fit and normalization in time of the **linear trend @ different currents @ different background (ABS)**



- ✓ The HF concentration depends linearly by the current
- ✓ The slope depends by the gas volumes exchanges

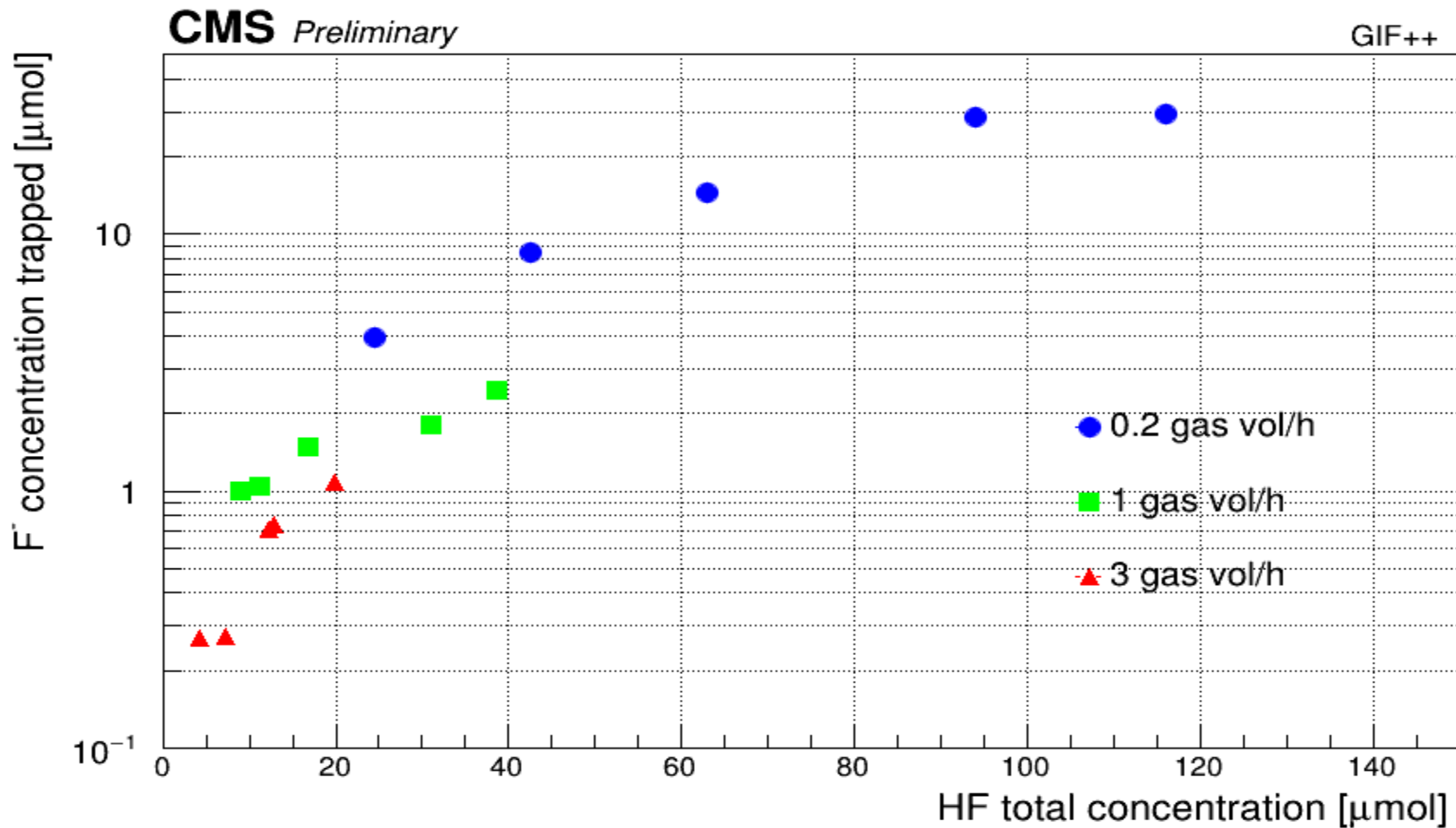
HF trapped

For each ABS the data taking continued after the HV3 → detector OFF for 8 hours to estimate the **HF trapped** in the chamber

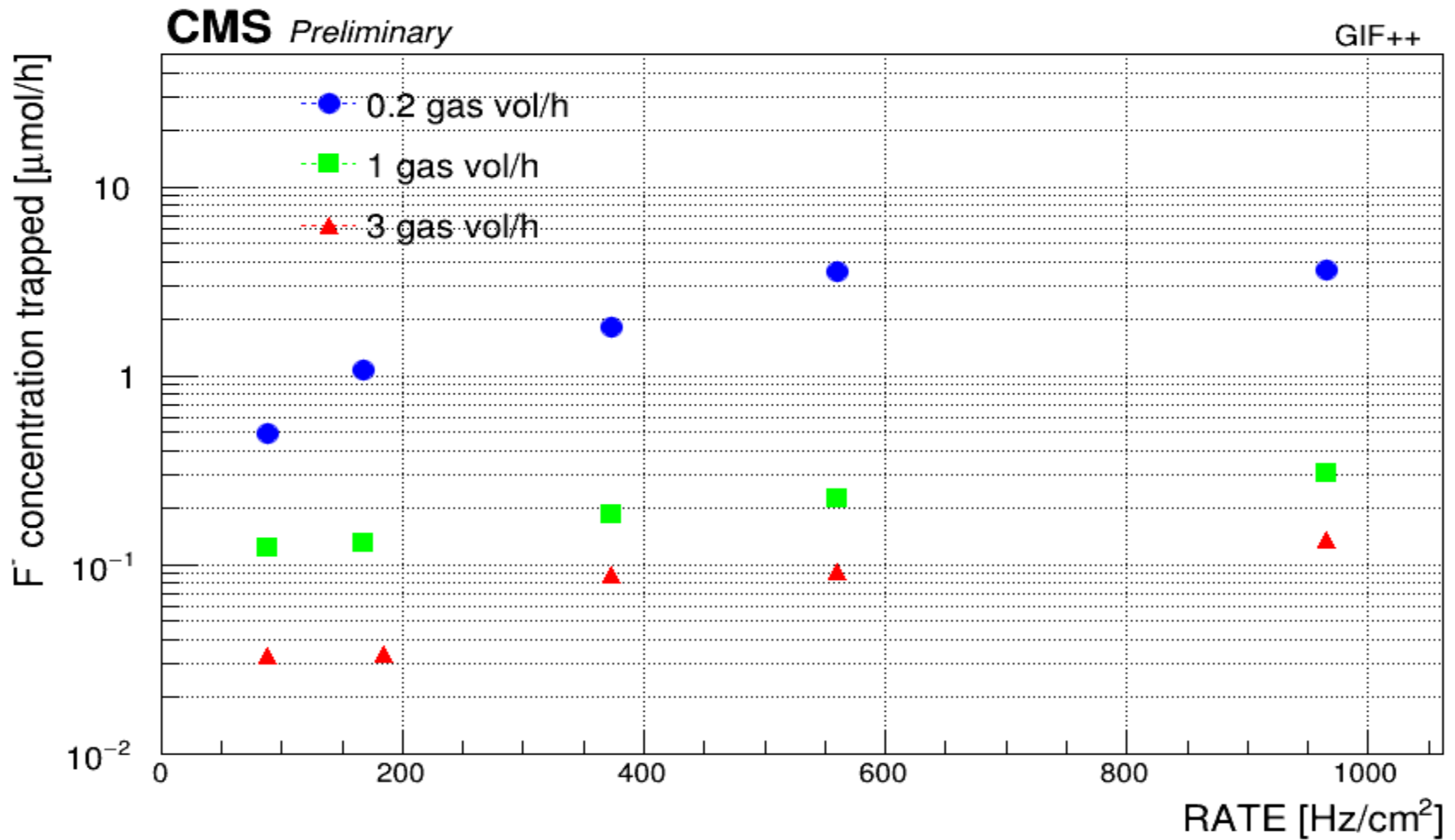


- ✓ HF trapped increase with the background rate
- ✓ HF trapped increase with lower gas flow

HF trapped vs HF tot accumulated



HF trapped vs rate



HF deposited on BAKELITE

Test to verify the HF concentration 'deposited' on the bakelite surface, which the gas flow is not able to remove, operating the detector with high electric field using pure Argon.

At the last HF measurement the HF concentration have reached the plateau.

After 20 days with the detector OFF:

- the detector has been flushed with argon 1 gas vol/h (5 L/h) for 18h
- 30h of HV scan with argon → 3HV scan from 500V up to 2400V ($\approx 200\mu\text{A}$)
- exhaust gas flushing in the solution (TISAB+ H₂O)

HF concentration measurement result:

5.39 ± 0.03 ppm → 14.18 ± 0.08 μmol