

RPC Gas Mixture Purification

GIF Activity Update

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Purification studies

Observations

from previous studies

- GIF (source '00-'04)
 - Impurities
 - Recirculation fraction
- ISR (no source, '06 - '08)
 - Currents increase

Objectives

- Understand RPC irradiated gas mixture
- Systematic Understanding of purifiers
- Finding the optimal configuration of purifiers for LHC closed loop gas system operation

Current Status

- HF production
- Impurities Investigations
- Planning

Reference: [Studies of purification of the RPC gas mixture for the LHC experiments – Capeans et al., IEEE2008](#)

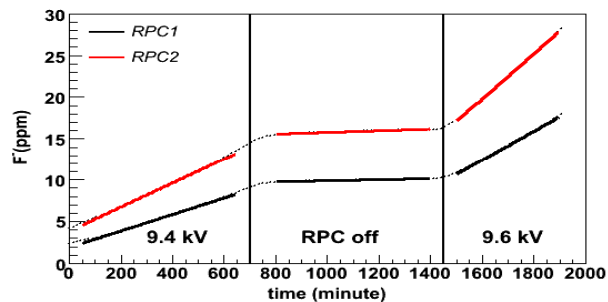
HF production



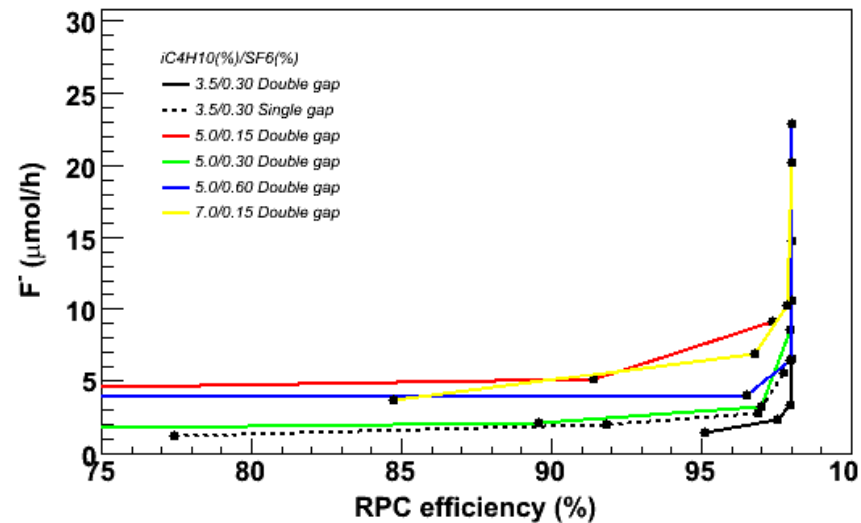
Technique:

For each gas mixture:

1. Measure the F^- concentration vs. time.
(using Ion Selective Electrode)
2. Estimate the F^- production rate.
(from the increase of the concentration)
3. Look at the effect on the chamber efficiency.



Varying the concentration of SF_6 or iC_4H_{10} give
No clear benefits



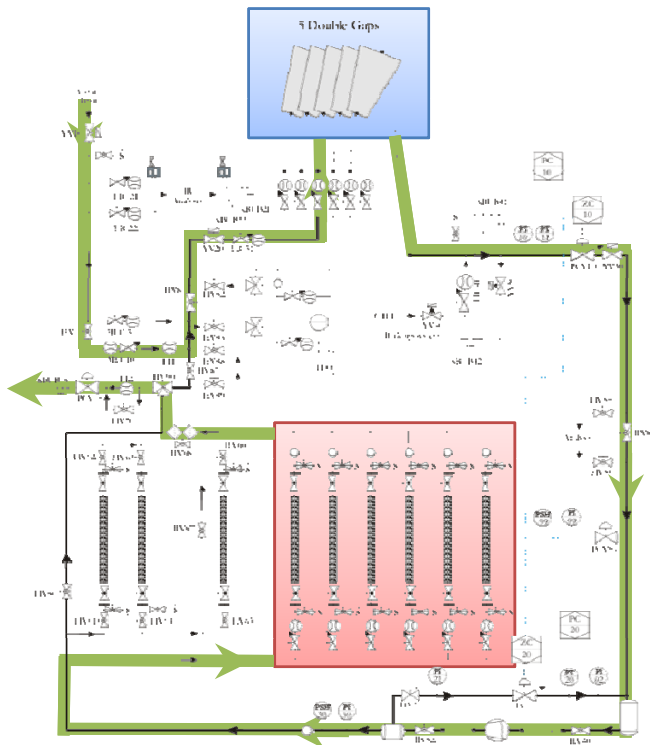
Impurities Investigation **Set-Up**

Hardware

- 5 CMS Double Gaps (HV, Gas etc.)
- Updated ATLAS GIF gas system
- Added **purifier rack**
- μ GC/MS used for gas composition analysis

Conditions:

- Open Mode
- HV = 9200 V
- Flow (RPC) = 1 vol/h
- Flow (Purifier) = 3 l/h/purifier
- Taken into account
 - Temperature
 - Humidity
 - Atm. Pressure
 - Radiation

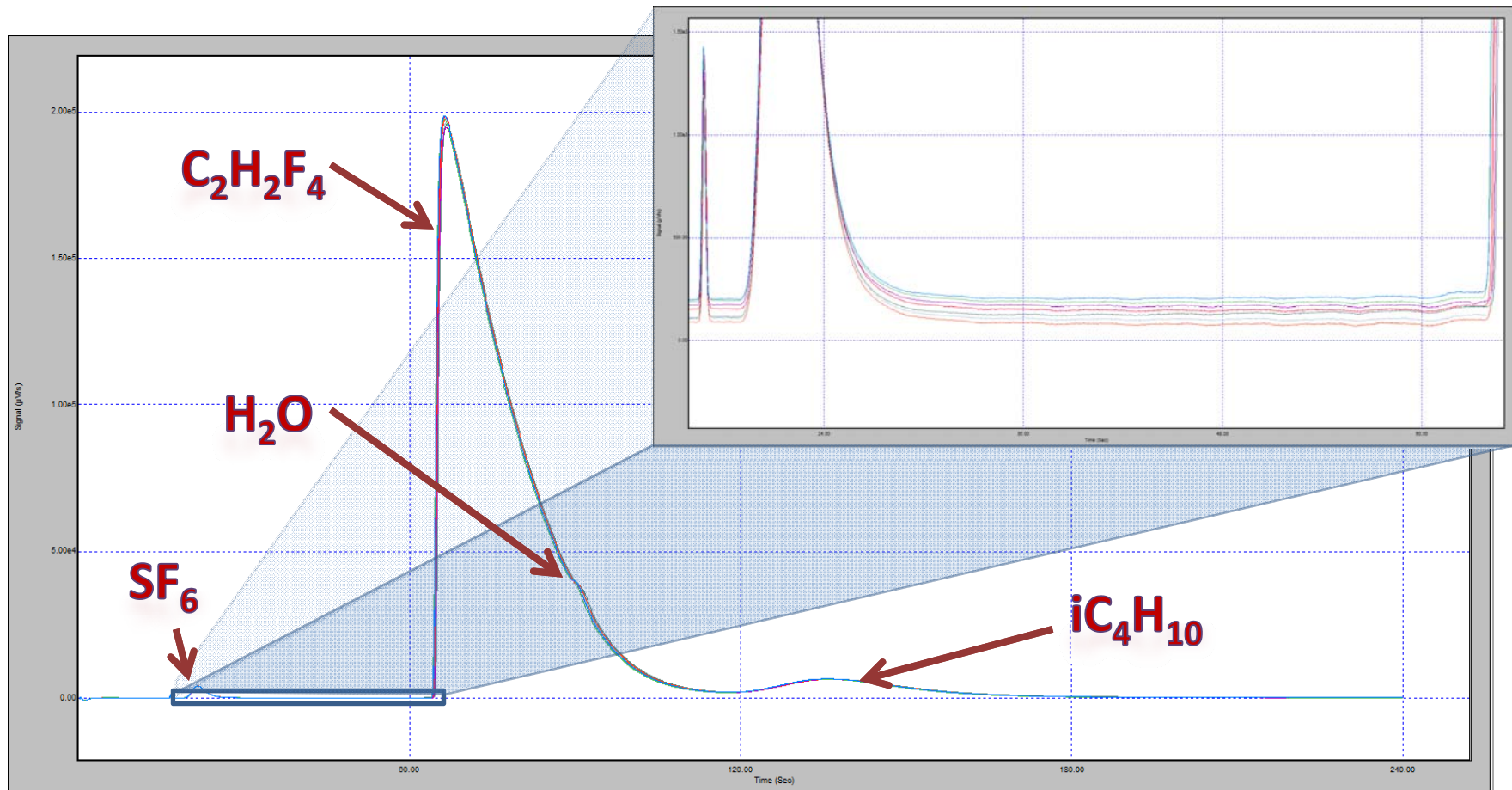


Purifiers Tested:

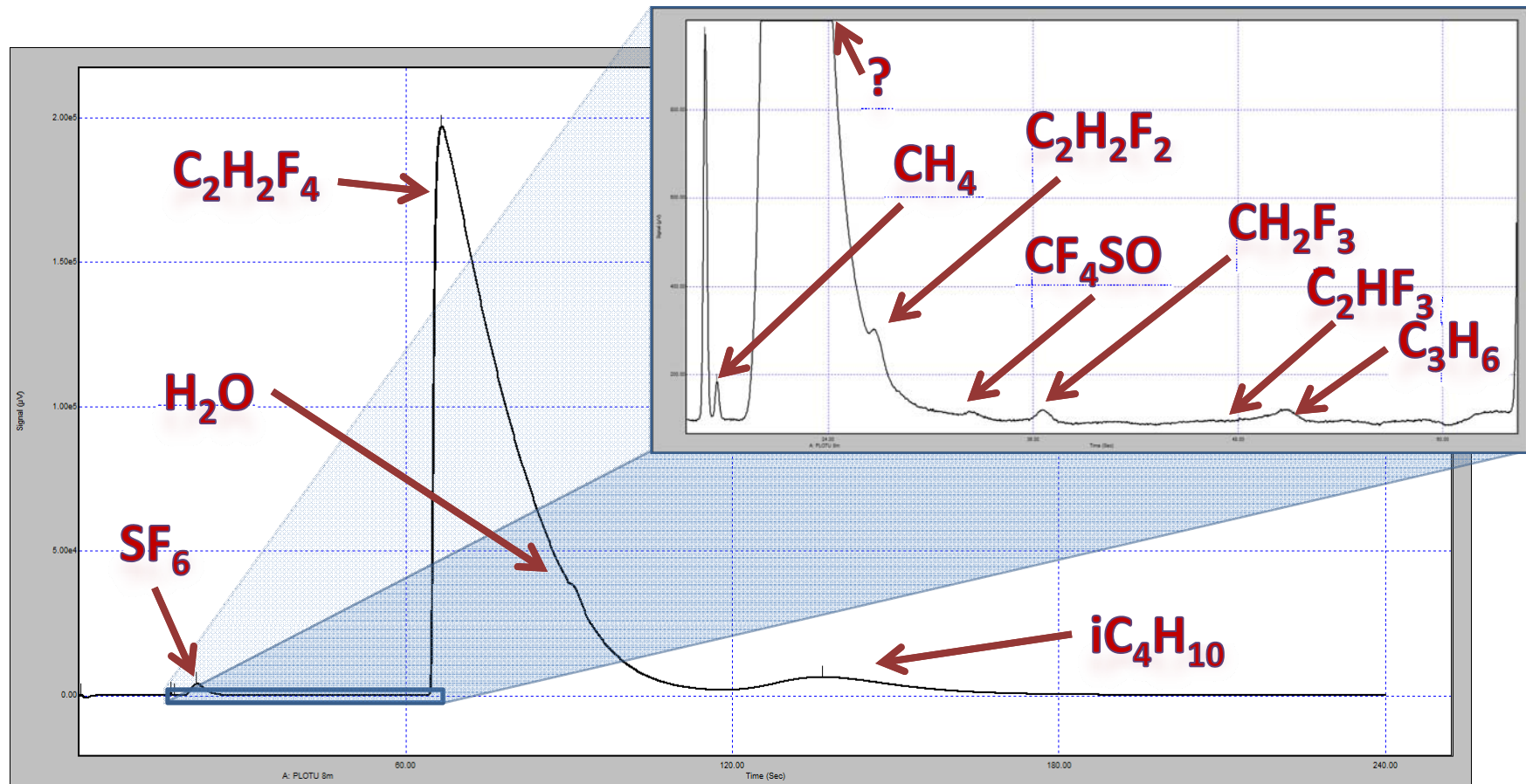
- Molecular Sieve 3A
- Molecular Sieve 4A
- Molecular Sieve 5A
- CuO (BASF R11)
- CuO/ZnO (BASF R12)
- Ni/Al₂O₃ (Leuna 6525)
- Ni/SiO₂ (Leuna 6503)



Input to the RPC



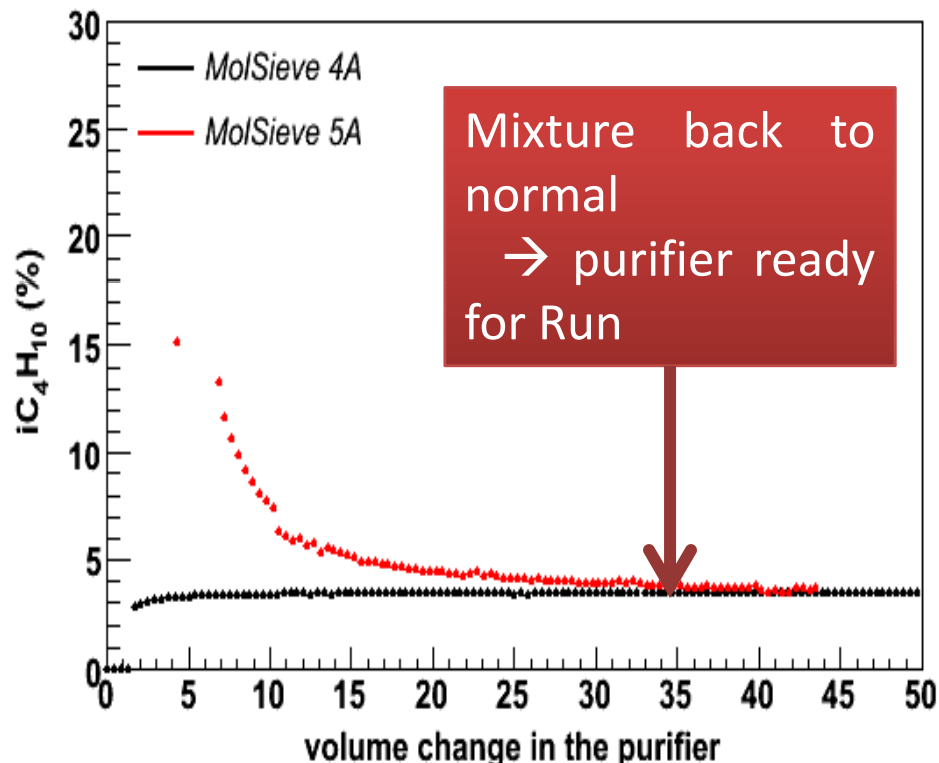
Return from the RPC



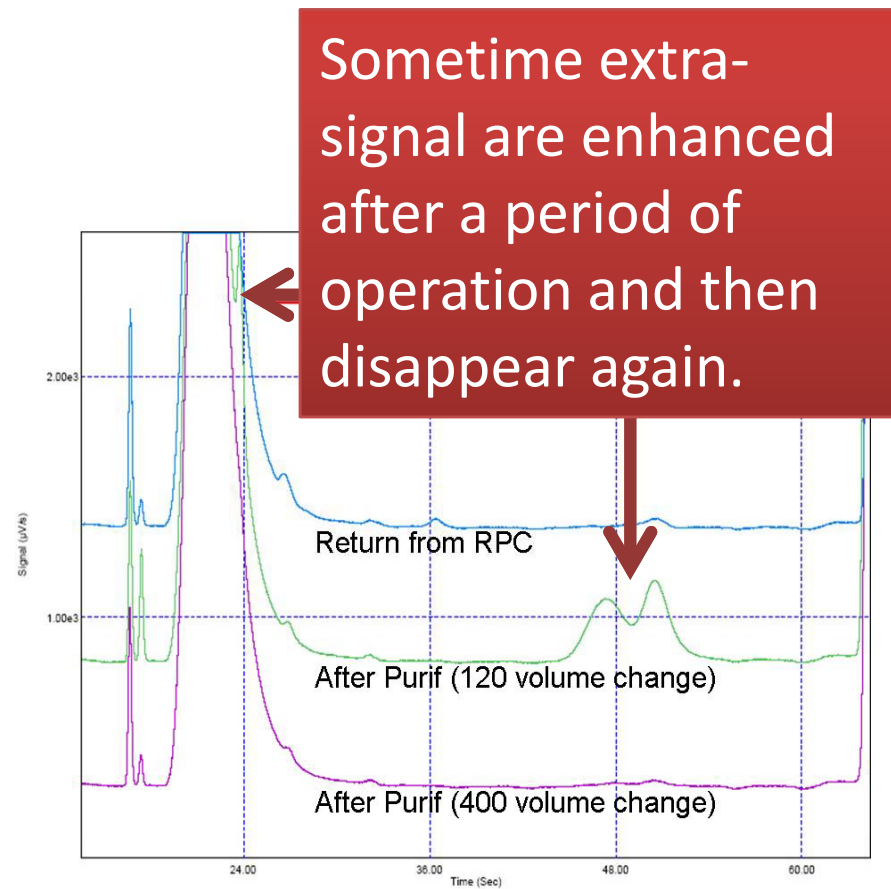
Purifiers: Conditioning

In the first hours of operation many purifiers affect also the main components of the mixture. The result is a change of the mixture composition.

Problem solved with a **conditioning phase** before being used in the loop.



Filtering capacity for Ni/Al_2O_3



Purifiers: Performance

	Conditioning (Purifier volume change)	Main component filtered	CH ₄	?	C ₂ H ₂ F ₂	CF ₄ SO	CH ₂ F ₂	C ₂ HF ₃	C ₂ H ₃ F ₃	C ₃ H ₆
MS3A	3	H ₂ O	Unchanged	Not present	Unchanged	Removed	Unchanged	Unchanged	Unchanged	Unchanged
MS4A	10	H ₂ O	Unchanged	Not present	Unchanged	Removed	Removed	Unchanged	Removed	Removed
MS5A	50	H ₂ O	Unchanged	Not present	Back after 1000 vol change	Removed	Removed	Removed	Removed	Removed
Cu (Basf R11)	20	O ₂	Unchanged	Not present	Unchanged	Removed	Unchanged	Removed	Removed	~Removed
Cu/Zn (Basf R12)	20	O ₂	Unchanged	Present up to 400 vol change	Enhanced after 900 vol change	Removed	Unchanged	Removed	Removed	Present up to 450 vol change
Ni Al ₂ O ₃ (Leuna)	15	O ₂	Unchanged	Not present	Unchanged	Removed	Unchanged	Removed	Present up to 150 vol change	Present up to 150 vol change
Ni SiO ₂ (Leuna)	15	O ₂	Unchanged	Present up to 400 vol change	Unchanged	Removed	Unchanged	Removed	Unchanged	Unchanged

Summary

- Chamber performance verification with radiation ✓
- Reference bakelite resistivity measurement ✓
- Assembly and calibration of F⁻ measurement setup ✓
- HF concentrations for different iC₄H₁₀ and SF₆ concentrations ✓
- Detailed analysis of the standard LHC purifiers' effect on the RPC gas mixture. ✓

Problems:

- ✓ μGC precision
- ✓ Pump break down
- ✓ Gas leak
- ✓ Several power cuts
- ✓ GIF maintenance stop

Mostly **solved**, ✓
but caused **delay** 😞

Short-Term Plan

- Move GC/MS, install it and test it (IG)
- Characterize again purifiers (IG)
- Get Si-gel cartridge and install it (RG)
- Test Si-Gel (IG)
- Set-up the long-term test with selected purifiers (Cu, Ni, MS4A)

Long-Term Plan

- Running on the current configuration to complete measurements for one or two months more.
- Update the purifiers' table and choose the "best" configuration.
- Add a new double gap after the filters (without radiation) and check the stability for a few months.
- Switch to close loop and try to reach the 10 ATLAS/CMS equivalent years.