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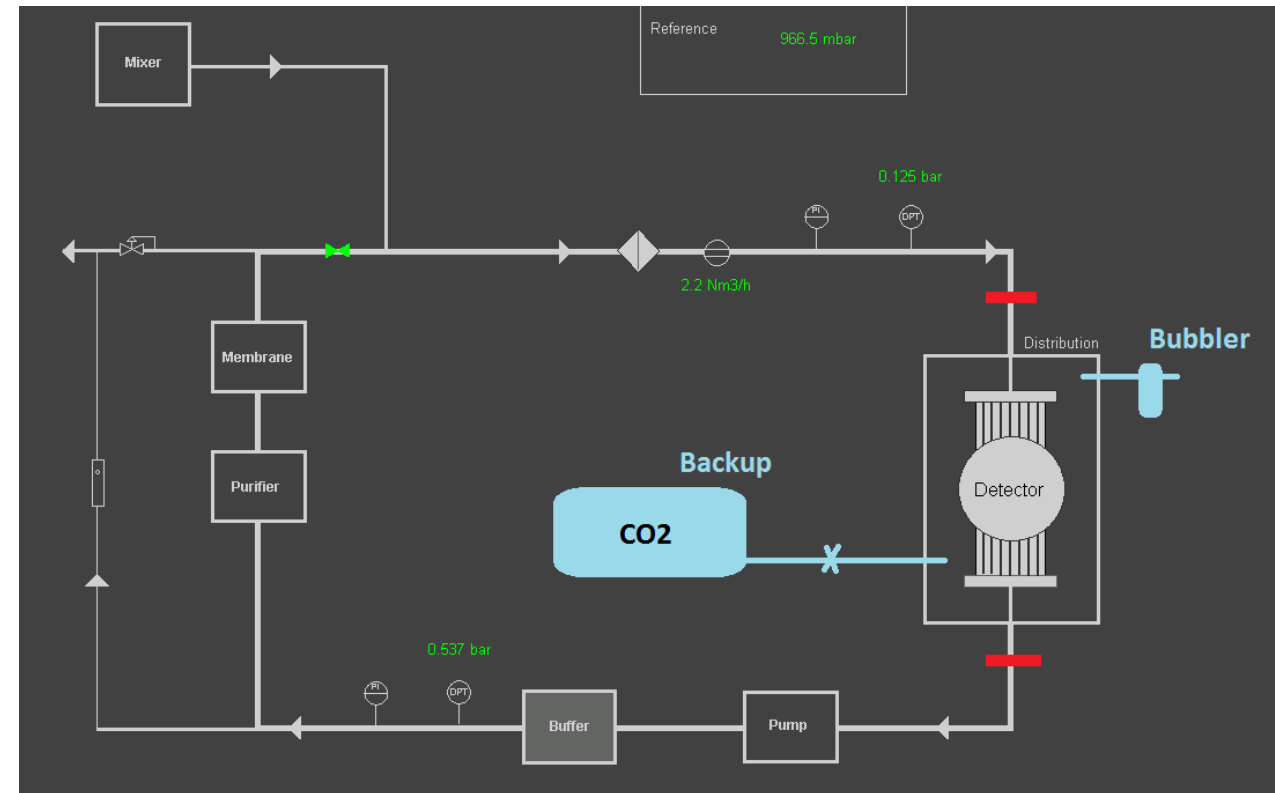
# **LHCB- RICH2 CF4 RECUPERATION**

Gas Mixture Status

# EFFECTS OF RUNNING WITH BACKUP

RICH2 gas system was stopped in Dec 2018, leaving as safety measure the bubbler and the CO2 backup line

- **Bubbler:**  
if  $P_{atm}$  decreases, the pressure inside the chamber increases, and gas mixture will exhaust from the bubbler to keep it stable
- **CO2 Backup:**  
if  $P_{atm}$  increases, the pressure inside the chamber decreases, CO2 will flow through the valve regulated by pressure difference, filling the the chamber up to stable pressure



# BACKUP INJECTION DEC2018-MAR2019

Looking at the Patm trend, we can estimate how much CO2 was injected from the backup, taking the positive pressure variations and converting the pressure difference in CO2 volume

Patm increase [mbar] = Injected CO2 [mbar]

Total System Volume = 100'000 liters

>> 1 mbar  $\Delta p$  = 100 liters CO2

Sum of positive  $\Delta p$  over the period  
Dec2018 - March2019 gives a total  
variation of about 400 mbar

= 40'000 liters of CO2 injected



# GAS MIXTURE AFTER SYSTEM STOP

40'000 liters of CO<sub>2</sub> injected in the system => 40'000 liters of Mixture went out from Bubbler

Total volume of RICH<sub>2</sub> = 100'000 liters => 40'000 l CO<sub>2</sub> / 100'000 l Volume = 40% Volume is CO<sub>2</sub>

40% CO<sub>2</sub> + 60% Mixture = 40% CO<sub>2</sub> + 60% (92% CF<sub>4</sub> + 8% CO<sub>2</sub>) = 40% CO<sub>2</sub> + 55.2% CF<sub>4</sub> + 4.8% CO<sub>2</sub>  
= **44.8% CO<sub>2</sub> + 55.2% CF<sub>4</sub>**

The calculation is coherent with the data from the IR, that gives CO<sub>2</sub> > 35% (saturated)

GC analysis were performed to check the exact composition of the mixture

# GAS MIXTURE AFTER SYSTEM STOP

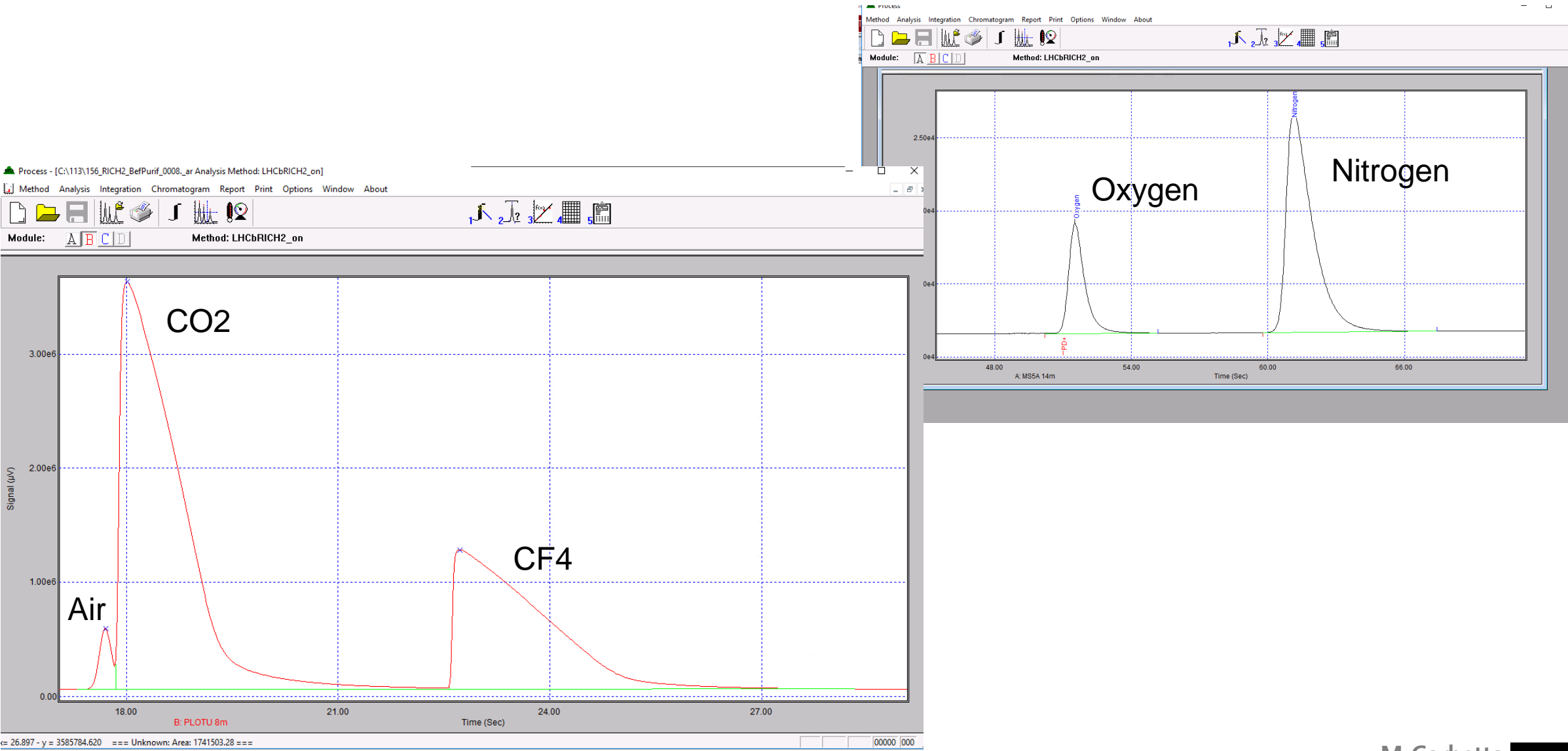
Results of GC Analysis on RICH2 Before Purifier

	area	% Sum	% Calib
Air	105097	0.02	
CF4	3358522	0.65	0.600763
CO2	1741503	0.33	0.37805
sum	5205122		
	area	ppm Calib	
O2	6139	3257.83026	
N2	20413	17959.3305	

Calibration	Reference	Factor
CO2	15%	2.17082E-05
CO2	10%	2.15285E-05
CF4	40%	1.78877E-05
CF4	90%	2.07212E-05
N2	1000ppm	0.879798684
O2	50 ppm	0.530677677
O2	10000ppm	1.138161356

	24/04/2019	27/11/2018
CF4 %	<b>0.600</b>	<b>0.953</b>
CO2 %	<b>0.378</b>	<b>0.084</b>
O2 [ppm]	3258	5186
N2 [ppm]	17959	15454
Air [ppm]	21217	20641
Air %	0.021	0.021
SUM	0.999	1.058

# GAS MIXTURE AFTER SYSTEM STOP



# CONCLUSION

Leaving the system in STOP with the Backup for four months  
cost the loss of about 35'000 liters of CF<sub>4</sub>!

Now the mixture composition is about 40%CO<sub>2</sub> and 60%CF<sub>4</sub>,  
with about 2% of Air (the same as it was during the Run)