



# ProCeas® & ambient air

## October 11<sup>th</sup>, 2016



# COMPANY OVERVIEW



- Company created in 2006
- Staff : about 25 collaborators, including 15 technicians, PhD's
- 3 R&D departments : mechanical, optical & chemistry, electronics & software
- About 25 gas measured
- Markets:
  - Environment
  - Quality control
  - Safety
  - Process optimization



## 3 B E – 1 P F I



3 R&D departments :

- Electronics & software
- Mechanical
- Optical & Chemical



1 PFI :

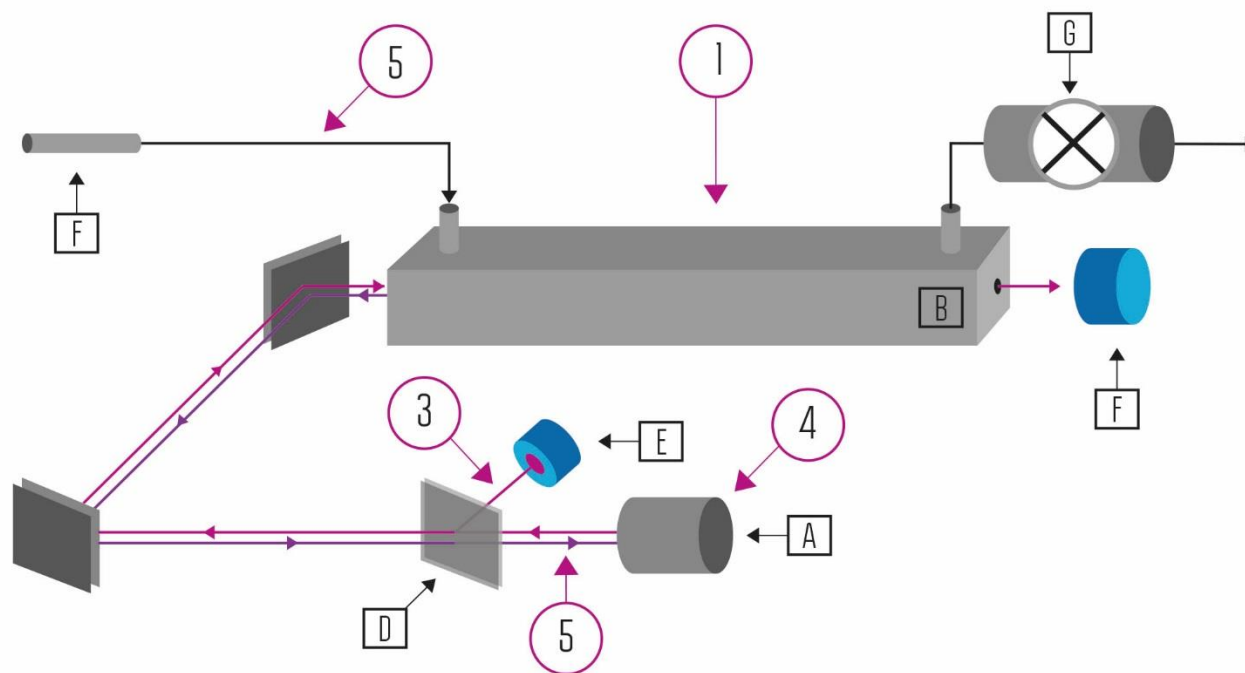
- Purchasing department
- Integration
- 300 analyzers/ yeat





# PROCEAS COMPONENTS

- ① Increasing sensitivity over standard gas cells by increasing pathlength to up to 20 km (a 1,000x improvement in signal intensity)
- ② Improve wavelength accuracy by 100x, reducing noise and increasing signal intensity by feeding back the laser beam onto itself
- ③ Self-stabilizing the spectrometer by monitoring (and compensating for) the variations of intensity of the laser IR source
- ④ Providing information at 200 different wavelengths every 100 milliseconds for multi-gas analysis and self-referencing capabilities
- ⑤ Reducing sample conditioning, and cleaning requirements, and accelerating response time by operating at low pressure



**A** Non-fibered scanning laser (200 wavelengths every 100 msec)

**B** Low volume (25 cc) hyper-reflective ( $R > 0.9999$ ) gas cell

**C** High-speed response, high sensitivity, high MTBF detector

**D** Beam-splitter & associated (non-hygroscopic) optics

**E** High MTBF stability detector for active stabilisation

**F** Sampling probe with sonic noise for low flow rate operation (3-9 Liter/hr)

**G** Sampling probe with sonic noise for low flow rate operation<sup>4</sup> (3-9 Liter/hr)



## 2 Patent

### OFCEAS



Improved Sensitivity



Increased Signal Intensity  
Reduced Signal Noise  
Improved Response Linearity



Self-Stabilization  
Self-Standardization



Direct Intensity Measurement  
Self Referencing Device

### Low Pressure Sampling



Absorption Bands Narrowing,  
Matching Spectral Information  
To Optical Resolution



Avoiding Condensates In  
The Sampling Line



Faster Sample Transfer Times



Self-Cleaning





# Optical Feedback Cavity Enhanced Absorption Spectroscopy



Increased Signal Intensity  
Improved Sensitivity  
Improved Response Linearity

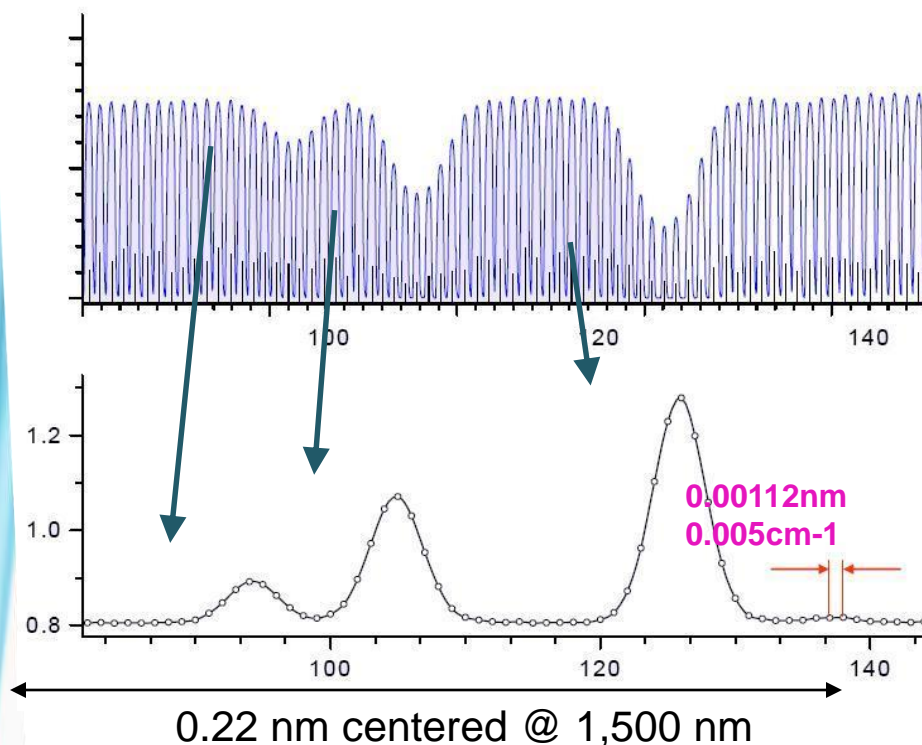


Direct Intensity Measurement  
Self Referencing Device



Self-Standardization

# FROM IR SPECTROMETERS TO OFCEAS



Increased Signal Intensity  
Improved Sensitivity  
Improved Response Linearity



Direct Intensity Measurement  
Self Referencing Device

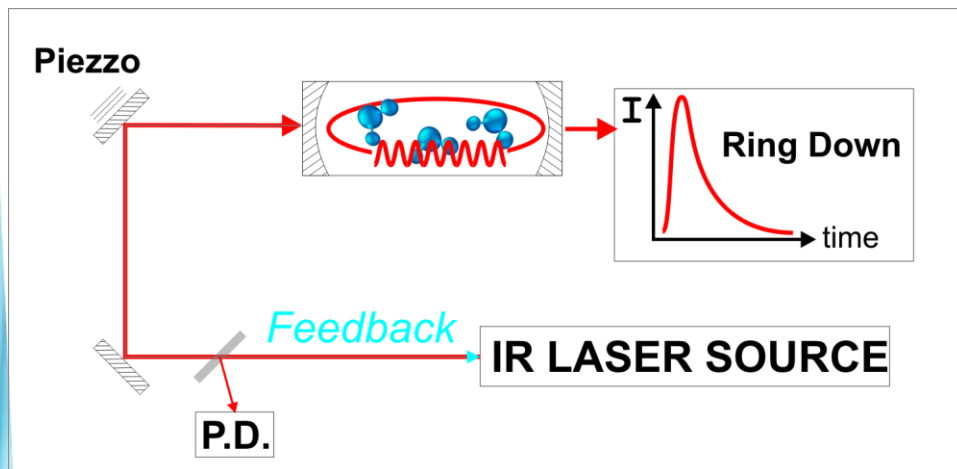


Self-Standardization

Injected Laser beam wavelength controlled  
by applying a current (0.002 nm / mA).

- Continuous intensity spectrum.
- 200 equidistant data points.
- 0.00112 nm optical resolution.

# FROM IR SPECTROMETERS TO OFCEAS



Beamsplitter / PhotoDiode:

- **Continuous intensity standardization**

Ring Down Measurement (after each spectrum):

- **Check gas cell cleanliness**

Laser Feedback:

- **Laser Self-Stabilization**



## NO DRIFT



Increased Signal Intensity  
Improved Sensitivity  
Improved Response Linearity



Direct Intensity Measurement  
Self Referencing Device



Self-Standardization





# Low Pressure Sampling



Absorption Bands Narrowing,  
Matching Spectral Information  
To Optical Resolution



Avoiding Condensates In  
The Sampling Line



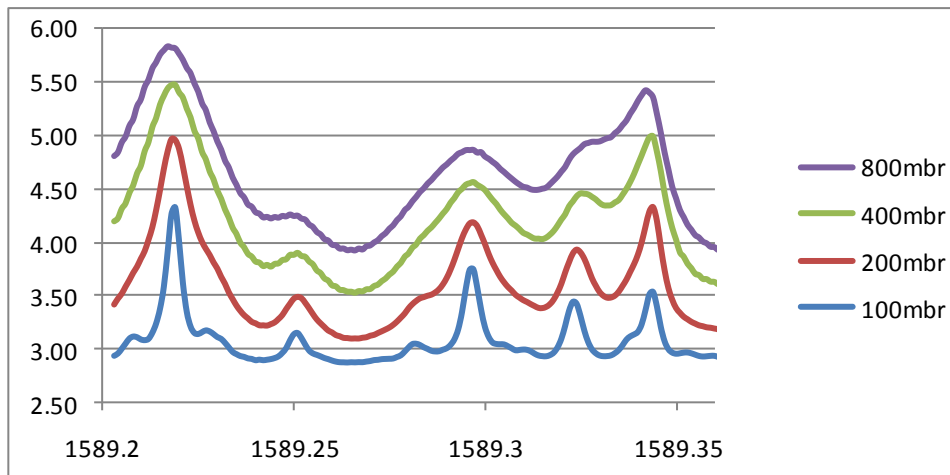
Faster Sample Transfer Times



Tangential filtration  
Low maintenance



# LOW PRESSURE (100mbr) SAMPLING

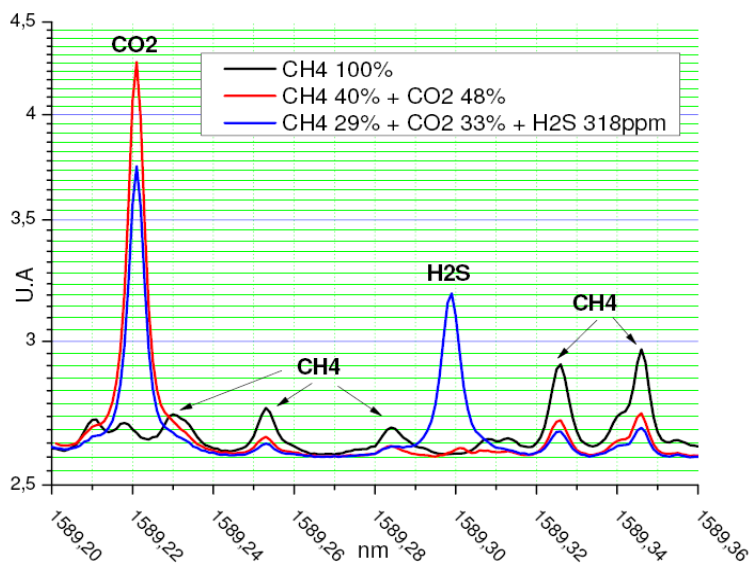


**CO<sub>2</sub> (30%) CH<sub>4</sub> (30%) H<sub>2</sub>S (300 ppm)**



Absorption Bands Narrowing,  
Matching Spectral Information  
To Optical Resolution

Narrows the bandwidth of the absorption bands Avoids.  
interferences and false positive response.



Avoiding Condensates In  
The Sampling Line



Faster Sample Transfer Times

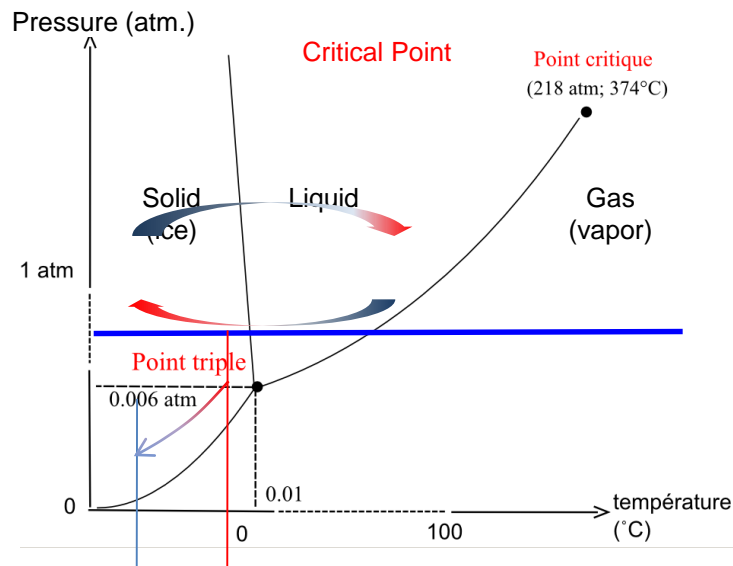


Tangential filtration  
Low maintenance



# LOW PRESSURE (100 mbr) SAMPLING

## Avoiding Condensates in the Sampling Line



As pressure goes down ...



... so does the boiling point ...



... and so does the dew point..



Absorption Bands Narrowing,  
Matching Spectral Information  
To Optical Resolution



Avoiding Condensates In  
The Sampling Line



Faster Sample Transfer Times



Tangential filtration  
Low maintenance

# PROCEAS ADVANTAGES FOR INDOOR AIR & AMBIENT AIR MEASUREMENT



- LOD : ppb and sub-ppb level
- High response time
- No interference
- LPS : Avoiding Condensates In the Sampling Line
- Transportable
- Stability



# TARGET APPLICATIONS

## – Ambient Air

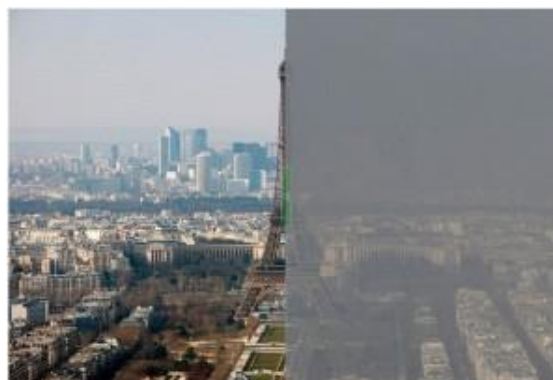
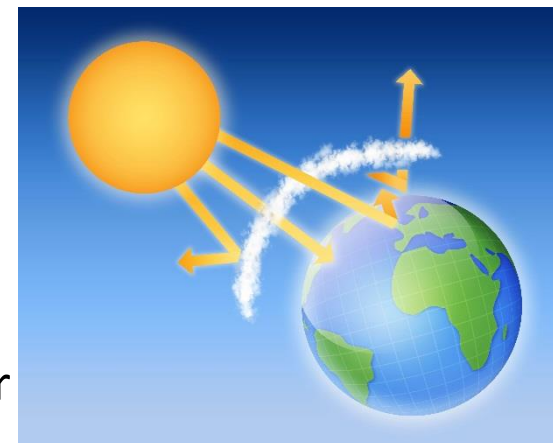
- Formaldehyde (ppb) security, supervision
- Odour control :  $\text{NH}_3$ ,  $\text{H}_2\text{S}$  (ppb)
- HF, HCN, (<ppb) : security

## – Green House Gases

- R&D : CO,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ ,  $\text{NH}_3$  (ppb)

## – Monitoring

- $\text{NH}_3$  (<ppb) : fine particule emissions tracer



# CASE STUDY



## HUTCHINSON

Formaldehyde (ppb) : fast loop, 3 measurement points :

- Laboratory
- Hall
- Offices

## MINES DE DOUAI

NH<sub>3</sub> (<ppb)

- European measurement campaign
- AASQA associations





# GASES



## GASES MEASURED

Diatomic	$H_2$	$O_2$			
Nitrogen	$NH_3$	$NO$	$N_2O$	$NO_2$	$HCN$
Sulfur	$H_2S$	$COS$	$CS_2$		
Oxides	$SO_2$	$SO_3$	$CO$	$CO_2$	$H_2O$
Halogenides	$HF$	$HBr$	$HCl$		
Alcohols	$CH_3OH$	$C_2H_5OH$			
Aldehydes	$CH_2O$	$C_2H_4O$			
Hydrocarbons	$CH_4$	$C_2H_2$	$C_2H_4$	$C_2H_6$	

# SOME OF OUR REFERENCES



**DGA**  
Institute for Energy Technology



**SIEMENS**



**ELEKTRONIK-KONTOR**  
Messtechnik



*Creative Oxygen*

**ARKEMA**  
INNOVATIVE CHEMISTRY



**GDF SUEZ**



university of  
 groningen



**ARTELIA**



**NOVA ARB**



**MIDREX**



Centre de Recherche Public  
Gabriel Lippmann



**hobré instruments bv**



TERRABON

