

Lidars gaz

Département "Optique et techniques Associées" / Unité "Sources Laser et Systèmes"

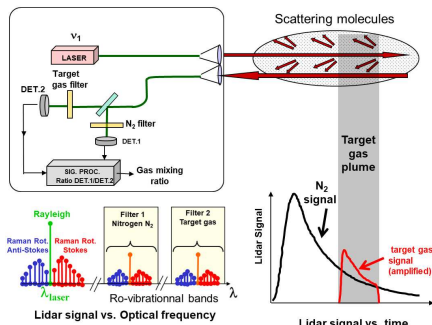
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Motivations

ENVIRONMENT	Greenhouse gas	CO ₂ , CH ₄ , H ₂ O
INDUSTRY	Flammable / Toxic gas	H ₂ , CH ₄
DEFENSE	Chemical Warfare Agents	Mustards, sulphurs...

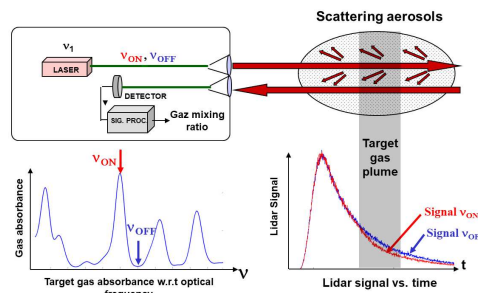
This poster

Raman Lidar Technique



- Direct view of target gas – no molecules, no signal
- Non-specific laser wavelength – works at 532,355,266...
- Very low signal – generally requires photon detection

Absorption Lidar Technique

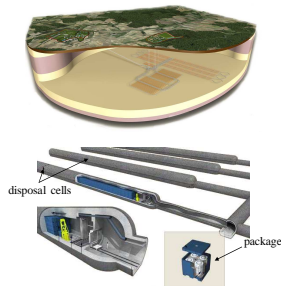


- Indirect view of target molecules – we see aerosols !
- The laser must be gas selective – can be difficult !
- Required energy alleviated - strong aerosols scattering

CALISTO Raman Lidar for H₂ monitoring

CIGEO Project

- Deep geological disposal facility for radioactive wastes (~ 500 m under)
- 500-meter-long waste disposal cells
- Slow hydrogen gas-release from waste packages
- Explosion/fire risks if H₂ > 4 %
- Non-intrusive H₂ monitoring is desired

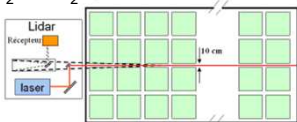


Lidar challenges

- H₂ can only be detected by Raman lidar (no absorption in Vis-IR)
- Very high sensitivity is required (1 photon/m/pulse)
- Interference between H₂O/H₂ Raman spectra
- Long range and high resolution are required

CALISTO Lidar objectives

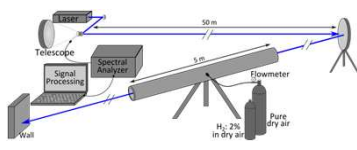
- Simultaneous measurement of H₂ + H₂O + N₂ as reference
- Maximum Range : 500 m
- Resolution : 3 m (package length)
- H₂ dynamic : 0 – 4 %
- H₂ precision : 500 ppm (0.05 %)



Results

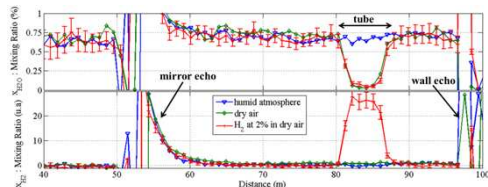
CALISTO Lidar demonstrator

- 355 nm Laser (5mJ, 5 ns, 20 Hz)
- 6 m gas cell for H₂-leak test
- Real time data processing
- Simultaneous measurement of H₂ and H₂O mixing ratios



H₂ and H₂O measurement tests at 85 m range

- 1 m resolution
- 1 min resolution
- 2% H₂ detected
- LOD : 0,06%



Partners : ANDRA & LATMOS

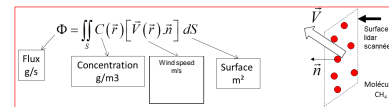
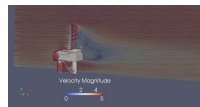
NAOMI DIAL/Doppler Lidar for CH₄ monitoring

NAOMI Project (with TOTAL E&P)

- CH₄ leaks in oil & gas exploration facilities
- Priority : improving CH₄ flux monitoring in major accidental scenarios to avoid human injuries, environmental pollution and financial losses

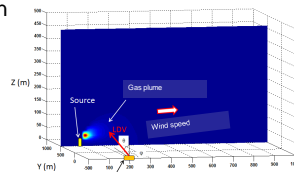
Flux : simultaneous measure of gas concentration / wind speed

- Gas concentration : DIAL CH₄
- Wind speed : Doppler



Objectives

- Dual-function Lidar : DIAL CH₄ + Doppler in a single instrument
- 1 km range with 15-50 m spatial resolution
- 10 % relative precision for 30 000 ppm.m
- Fiber Lidar architecture for robustness



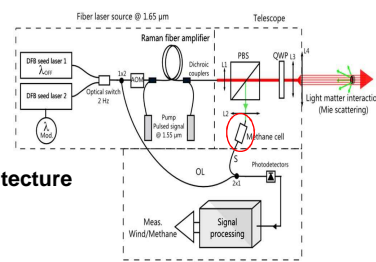
Challenges

- Laser source : no Erbium gain at 1645 nm
- Combined Lidar architecture for DIAL and wind operation

Results

A new fiber laser source

- 1645 nm, 20 μJ, 100 ns, 20 kHz
- Linearly polarized, monomode beam
- Two-stage Raman MOPFA amplifier
- Brillouin management for pump/signal

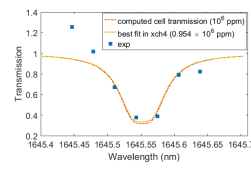


A combined DIAL/Doppler fiber architecture

- 2 lasers alternated λ_{ON}/λ_{OFF} for DIAL
- Coherent architecture for wind
- Monostatic design
- Few free-space optics
- Fiber gas cell emulates CH₄ plume

First tests

- Lidar signal up to 300 m with 10μJ
- Lidar measurement of CH₄ absorption cell



Partner : TOTAL E&P