Lidar application to environmental monitoring

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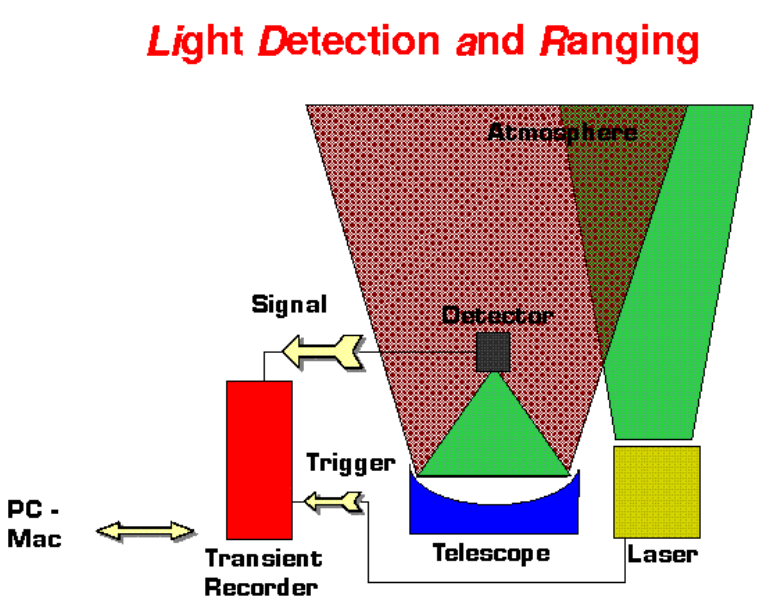
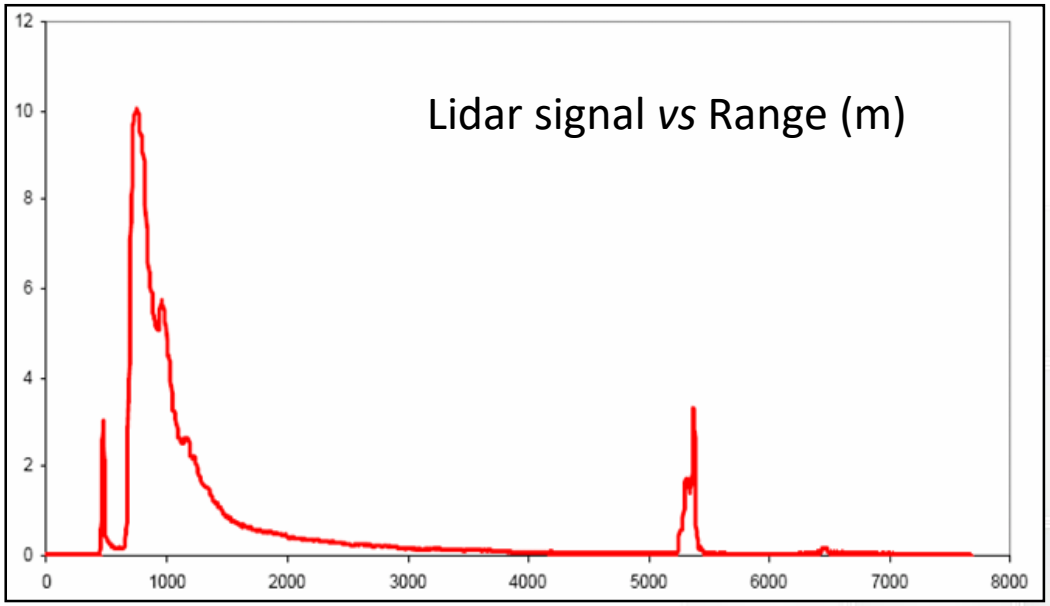
EPIC Online Technology Meeting on Photonics for Climate Change Monitoring, 24 April 2023

Lidar

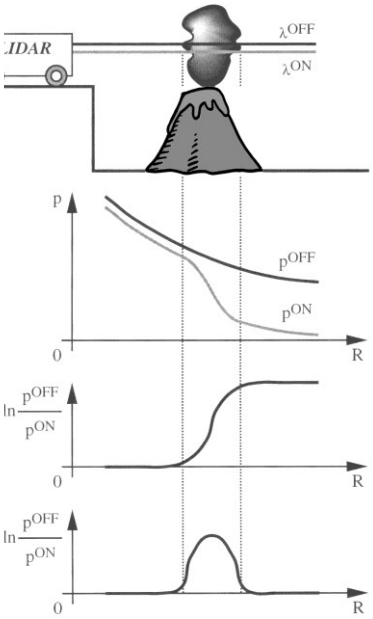
- Lidar (light detection and ranging) = laser radar
- A laser sends a light pulse to the atmosphere
- The atmosphere interacts with the laser beam
- A telescope detects the backscattered light
- R=ct/2 is the range (c is the speed of light, t is the time between transmission and detection)

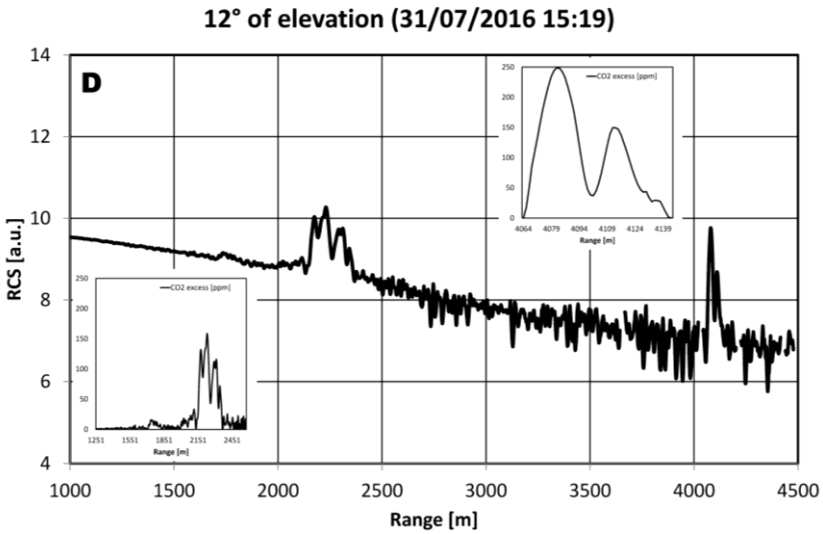


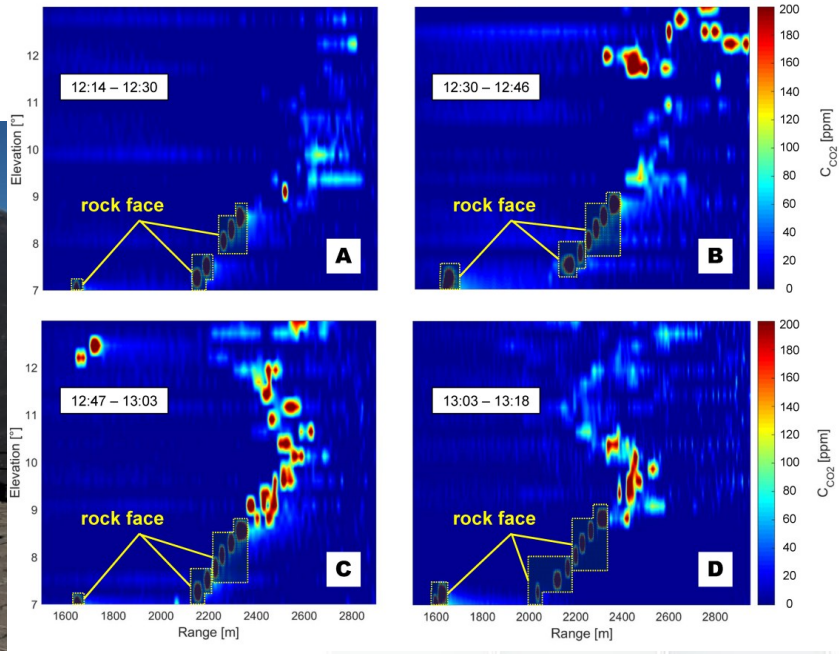


CO_2 in volcanic plumes

- **DIAL (differential absorption lidar)**
- **λ^{ON} (λ^{OFF}) is the more (less) absorbed wavelength**
- **p^{ON} (p^{OFF}) is the signal at λ^{ON} (λ^{OFF})**
- **σ^{ON} (σ^{OFF}) is the cross section of the molecule at λ^{ON} (λ^{OFF})**







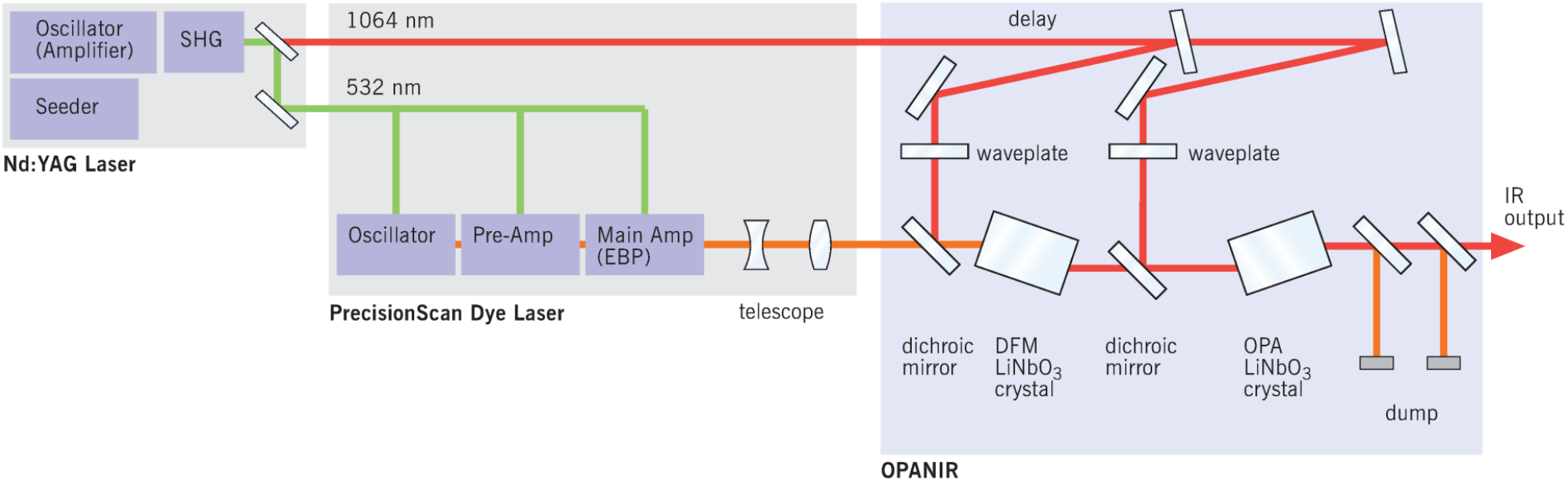
Geosciences (2016) DOI doi:10.3390/geosciences7010009

Volcanic lidar projects

- CO2VOLC (ERC), PI: M Burton, INGV Pisa
- BRIDGE (ERC), PI: A Aiuppa, Palermo University
- VULCAMED (ERDF), PI: L Fiorani

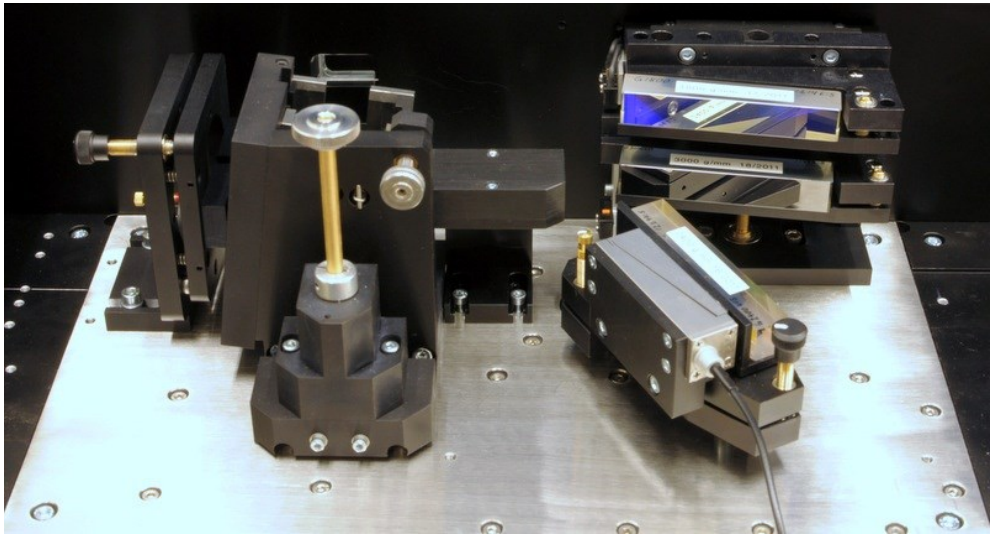
BRIDGE laser source

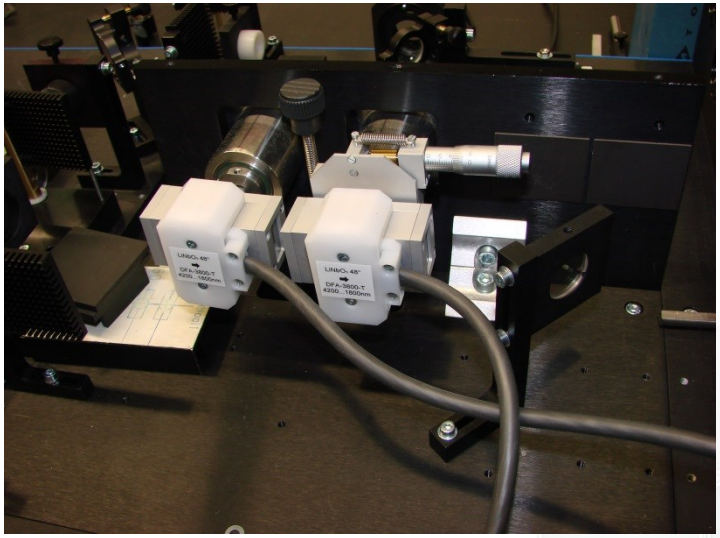
- Based on Nd:YAG pumped dye laser, difference frequency mixing, optical parametric amplifier
- Operation at 1.57, 2.01 and 2.06 µm (nearly two orders of magnitude of CO_2 absorption coefficient)



BRIDGE laser source

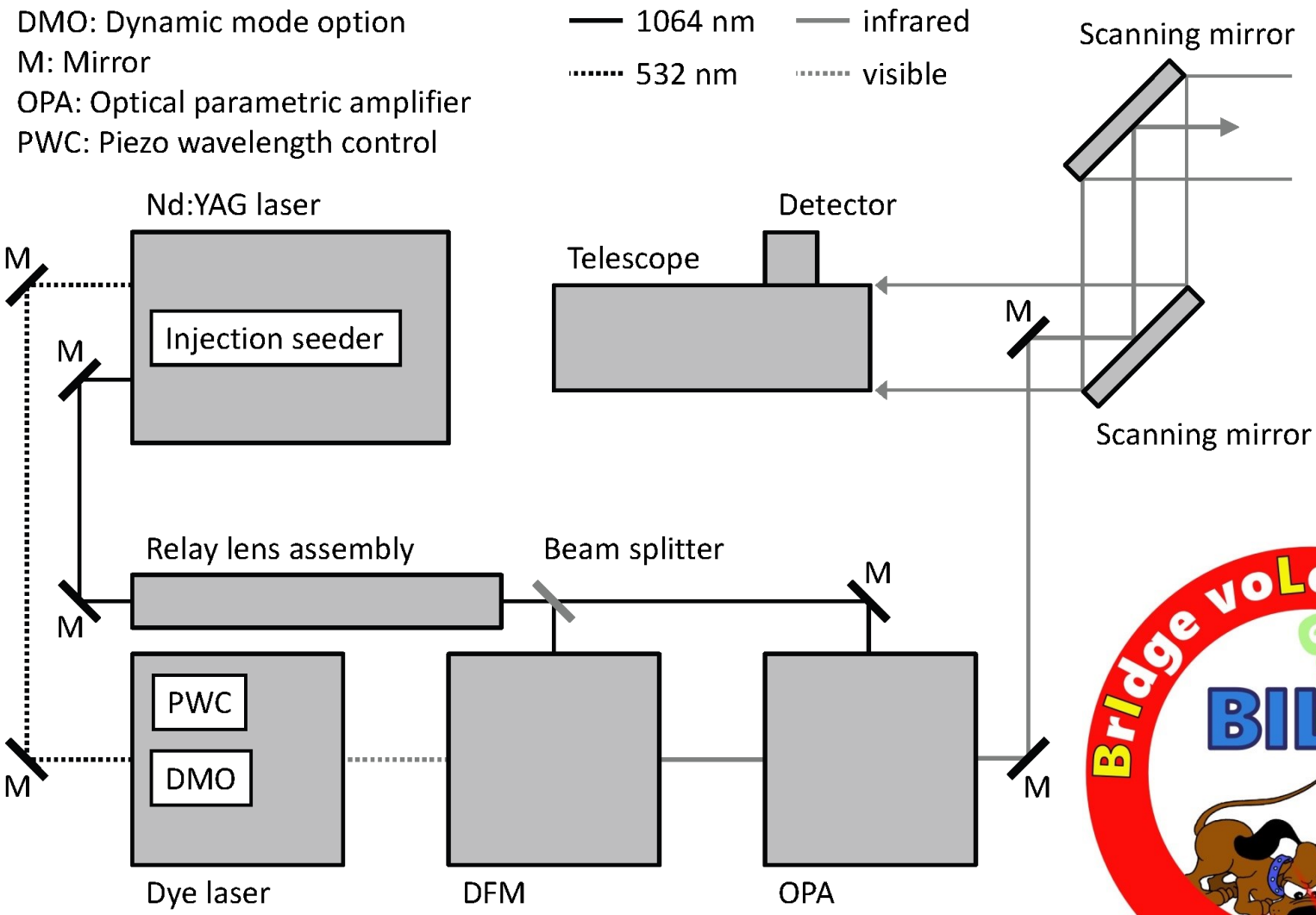
- **Special features**
  - **enhanced beam profile amplifier** (beam size/divergence)
  - **dynamic mode option** (spectral stability)
  - **piezo wavelength control** (ON-OFF transition)
  - **double crystals** (ON-OFF generation/amplification)





BrIdge voLcanic LIdar

DFM: Difference frequency mixing
DMO: Dynamic mode option
M: Mirror
OPA: Optical parametric amplifier
PWC: Piezo wavelength control



BrIdge voLcanic LIdar

Transmitter	Pulse energy	25 mJ
	Pulse duration	8 ns
	Repetition rate	10 Hz
	Transmitted wavelength	2.01 µm
	Linewidth	0.04 cm^{-1}
	Beam divergence	0.5 mrad (full angle)
Receiver	Mirror coating	Al
	Diameter	310 mm
	Focal length	900 mm
Detector	Diameter	1 mm
	Photosensitivity	1.2 A W^{-1}
	Bandwidth	0 ÷ 10 MHz
	Specific detectivity	3.5×10^{11} cm $Hz^{1/2}$ W^{-1}
Analog-to-digital converter	Dynamic range	14 bit
	Sampling rate	100 Ms s^{-1}

Thank you for your attention!