LIDAR

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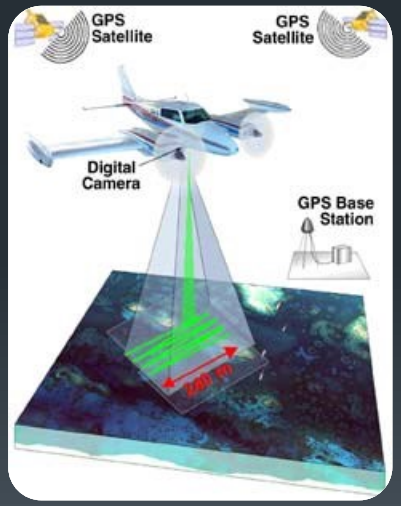
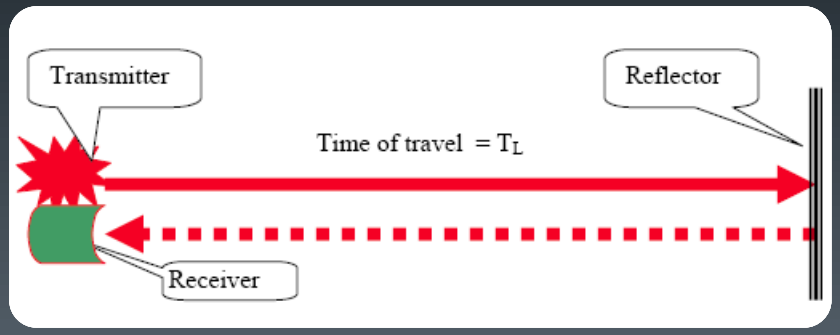
What is LIDAR?

- Lidar (Light Detection And Ranging) is an optical remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.
- Lidar is popularly used as a technology to make high-resolution maps, with applications in applications:
  - ✓Agriculture;
  - ✓Architecture;
  - ✓Archaeology;
  - ✓Geography;
  - ✓Geology;
  - ✓Seismology;
  - ✓Atmospheric remote sensing;
  - ✓Physics and astronomy;

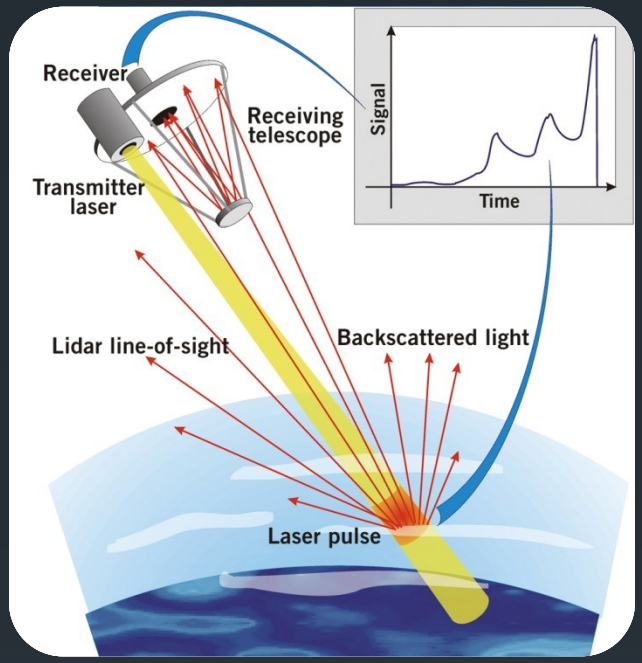


General description

- Lidar uses ultraviolet, visible, or near infrared light to image objects;
- It can target a wide range of materials, including non-metallic objects, rocks, rain, chemical compounds, aerosols, clouds and even single molecules. A narrow laser-beam can map physical features with very high resolutions of up to 30 cm/px;
- Typically light is reflected via backscattering;
- Different types of scattering are used for different lidar applications: most commonly Rayleigh scattering, Mie scattering, Raman scattering and fluorescence. Based on different kinds of backscattering, the LIDAR can be accordingly called Rayleigh Lidar, Mie Lidar, Raman Lidar, Na/Fe/K Fluorescence Lidar.



LIDAR's components



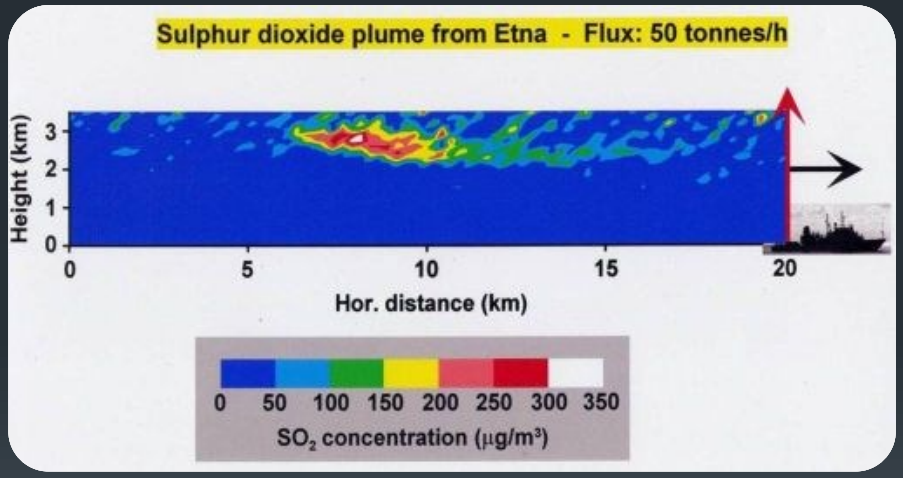
There are several major components to a LIDAR system:

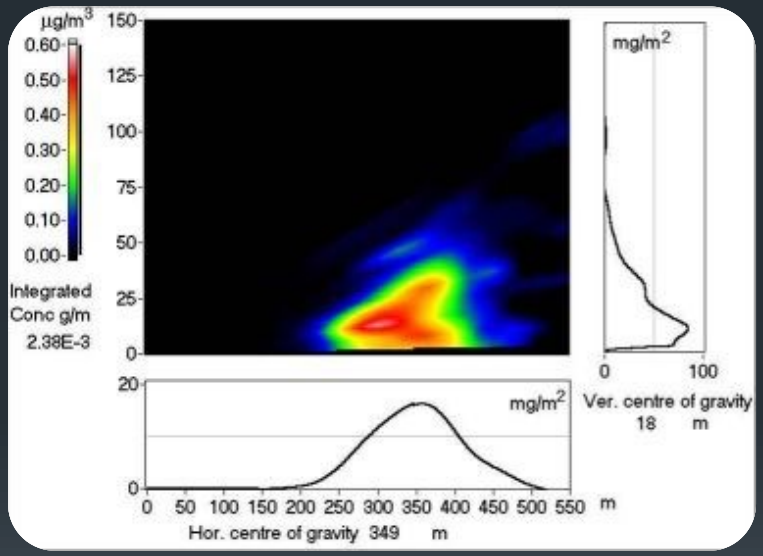
- Laser: 600–1000 nm lasers;
- Photodetector and receiver electronic: two main photodetector technologies are used in lidars: solid state photodetectors, such as silicon avalanche photodiodes, or photomultipliers;
- Position and navigation systems: lidar sensors that are mounted on mobile platforms such as airplanes or satellites require instrumentation to determine the absolute position and orientation of the sensor. Such devices generally include a Global Positioning System (GPS) receiver and an Inertial Measurement Unit (IMU);
- 3D imaging can be achieved using both scanning and non-scanning systems. High resolution 3D lidar cameras use homodyne detection with an electronic CCD or CMOS shutter.

https://www.youtube.com/watch?v=eBUCGxZq_xg

Atmospheric lidar

1. In atmospheric LIDAR applications it is used the DIfferential Absorption Lidar technique to measure concentrations and fluxes of pollutants. Pulsed laser radiation on, and slightly off an absorption peak of the molecule under study is generated using an Optical Parametric Oscillator and the backscattered radiation is detected with time resolution. The light on the absorption peak will be attenuated due to absorption and thus the concentration can be evaluated.





Volcanic sulphur dioxide:

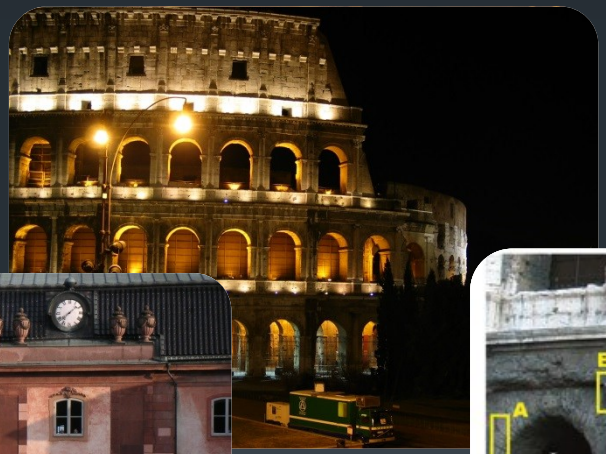
The laser radiation was sent upwards while boat traversed the plume and thus sulphur dioxide flux from different volcanoes in the Mediterranean Sea could be determined.

Atomic mercury:

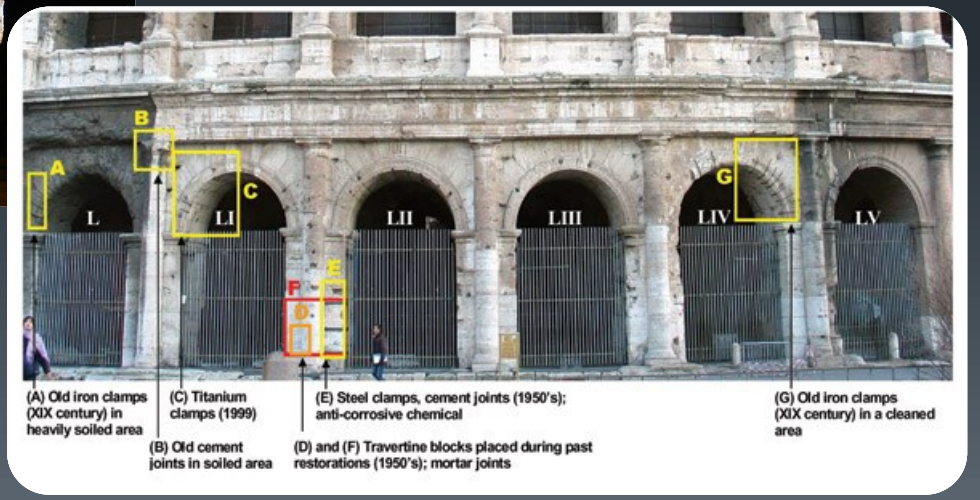
Mercury is a severe pollutant and is often emitted as atoms. The mercury absorption line at 254 nm it is used to measure elemental mercury fluxes from factories, geothermal fields, etc.

Fluorescence lidar

2. With fluorescence lidar, ultraviolet laser pulses are directed towards a solid target where fluorescence is induced. The fluorescence light is detected and the full spectrum is obtained using a spectrometer. The laser beam is then scanned over an area to gather the entire spectrum in each point. When analyzing the spectral shapes, a function can be applied that yields a value in each point, which can be displayed in a false-color coded picture. In this manner different features of the spectra can be focused on and this may represent different characteristics of the target.

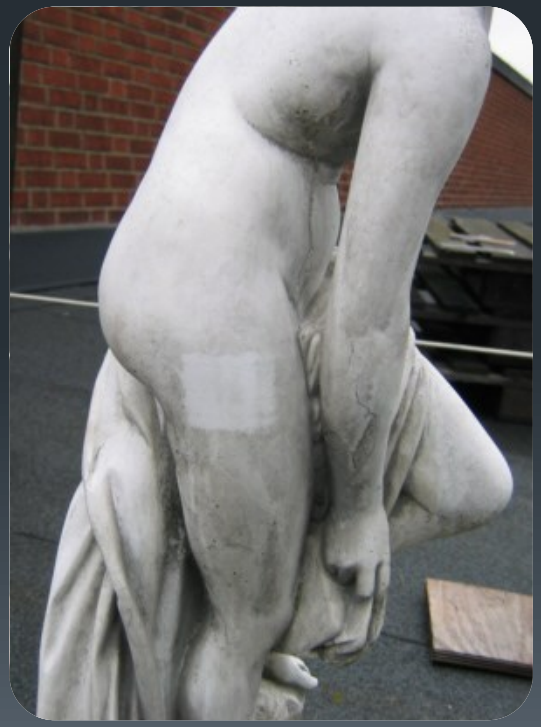


Lund fluorescence LIDAR at the Coliseum



Laser-induced break-down spectroscopy lidar

3. Breakdown can be induced in a material by focusing an intense laser onto a small spot. This induces a plasma that contains ablated material and thereby free atoms and ions that are excited. When de-exciting, characteristic spectral lines are sent out, which can be detected and analyzed in a spectrometer and thus the chemical content of the target can be measured. This has been performed using the lidar system with a target distance of 60 m. The same setup can be used for remote laser cleaning of facades and statues.



A cleaned area on a garden statue

A laser spark on Aluminium at 60 m distance