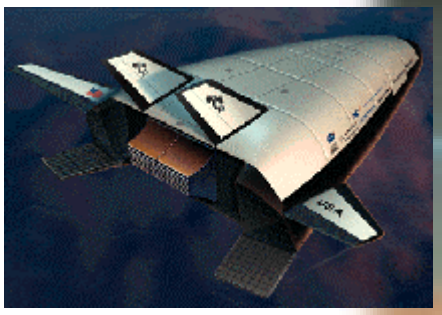
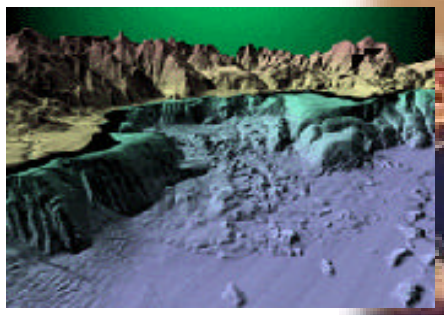
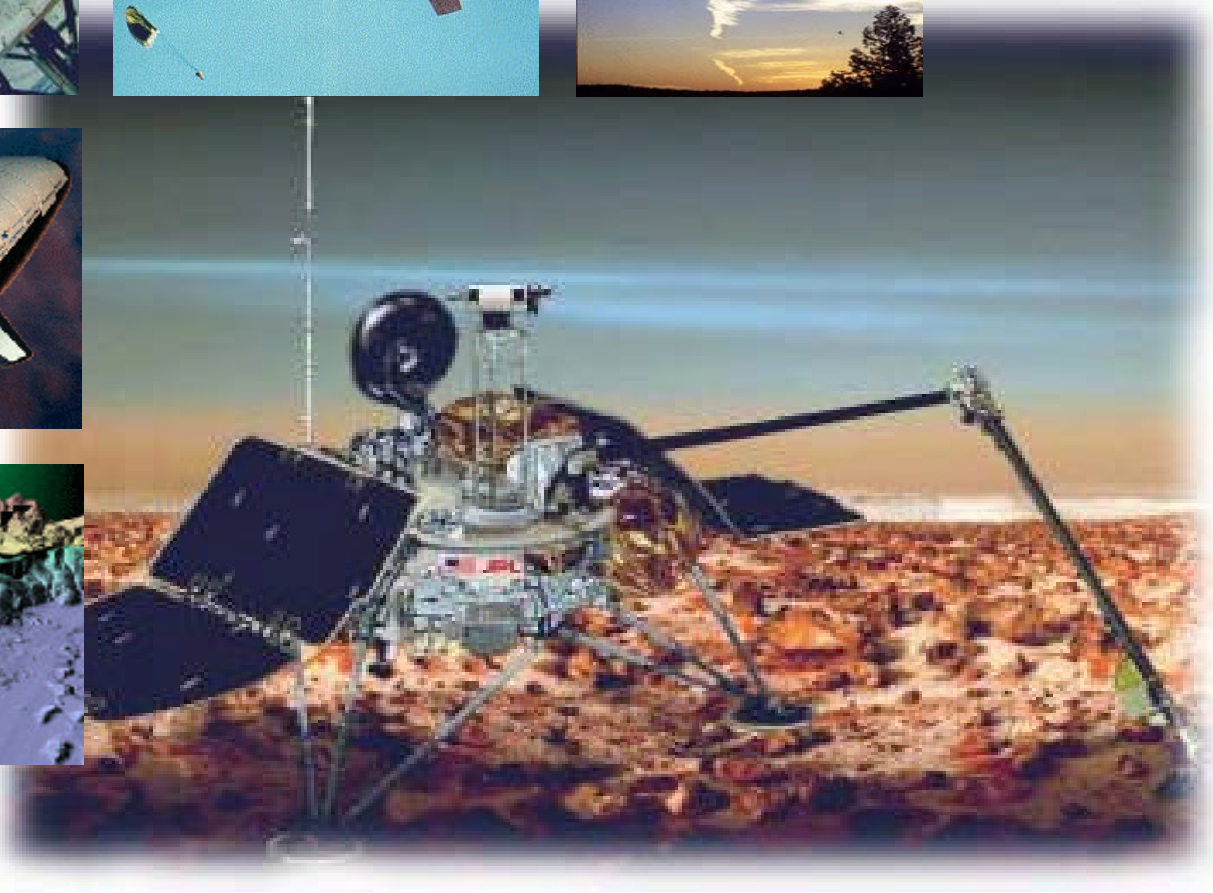
Lidar







Presenter, Menq J Pan

University of New York at Buffalo • Electrical

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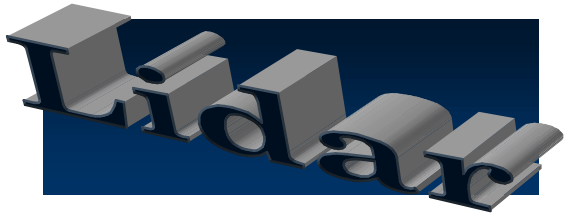
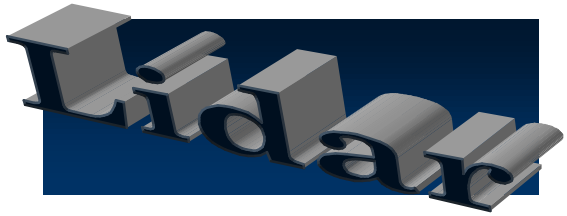


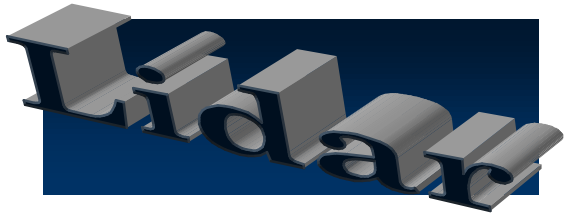
- What is L.I.D.A.R.?
- Motivation
- Varies Types/Techniques
- Other Applications
- Summary
- Reference

What is it?



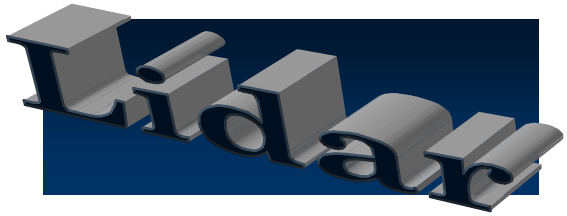
- LIDAR acronym for Light Detection and Ranging.
- Uses laser as light source.
- Remote sensing, to measure, observe, and monitor without making actual physical contact.
- Major techniques: Range finding, Differential Absorption (DIAL), and Doppler.

Motivation



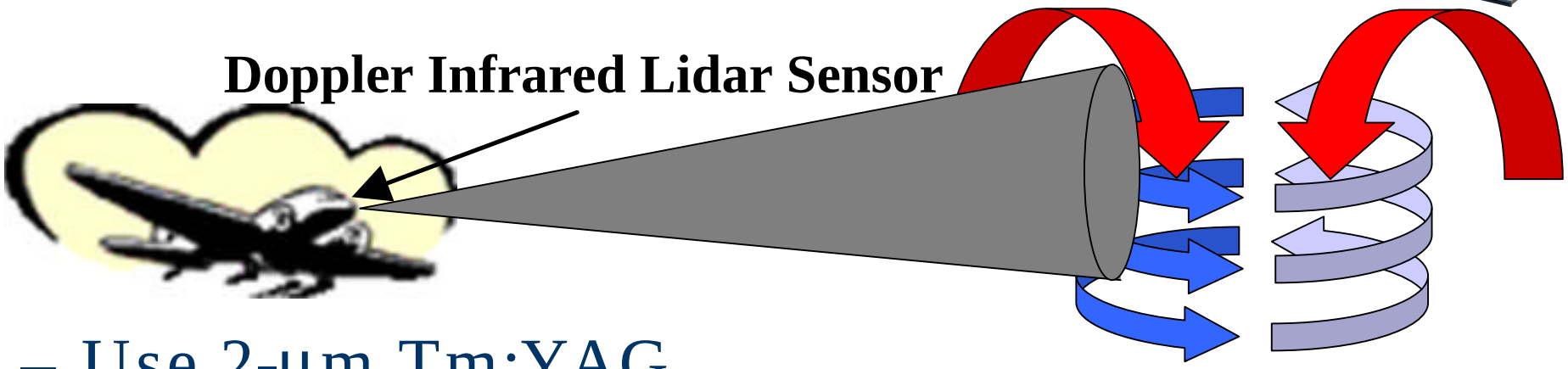
- The Clean Air Act Amendments.
- Capable of obtaining small particle in the air, such as aerosols.
- Obtain higher spatial resolution, thus better resolution in underwater imaging.
- Crosswind detection, turbulence sensor.

Backscattering Method



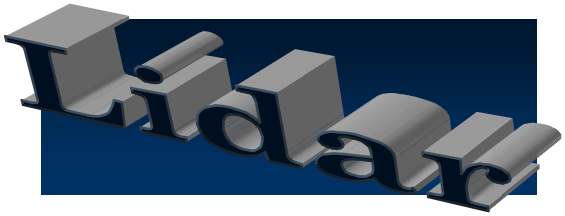
- Simplest Lidar techniques.
- Detects elastic scattering of laser pulses by aerosols or small particles suspended in the air.
- A laser pulse is transmitted to the atmosphere and scattered.
- Profiles of the aerosols can be visualized by collecting the backscattered light with high speed detectors.

Backscattering method

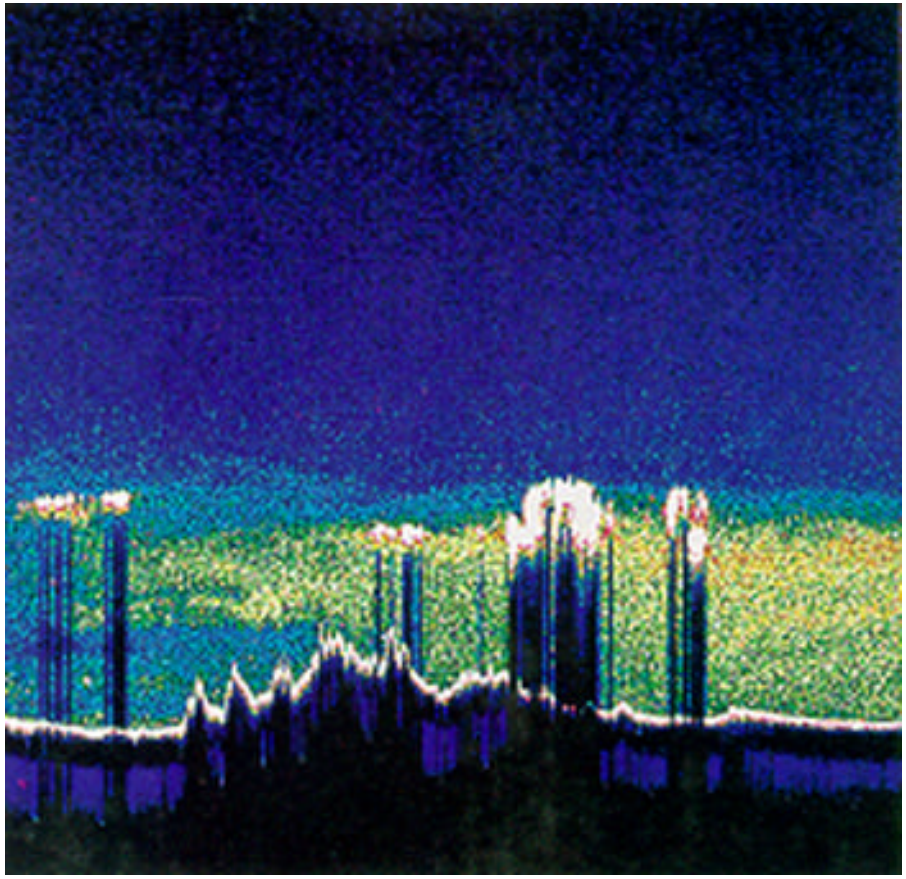


- Use 2-μm Tm:YAG
- Detect the shift in frequency of the back-scattered pulses due to the motion of aircraft.
- Highly variable velocities along the laser beam indicate the presence of clear-air turbulence.

Backscattering Method

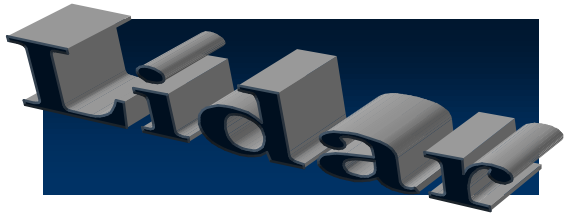


- Nd:YAG that can be frequency doubled and tripled, and Q-switched
- 160-mJ to 500-mJ per pulse.
- 10-Hz Rep Rate.
- Photomultiplier tubes and RCA avalanche photodiode.

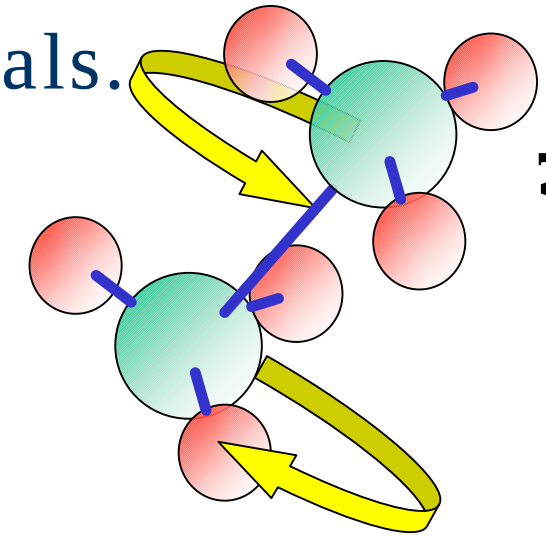


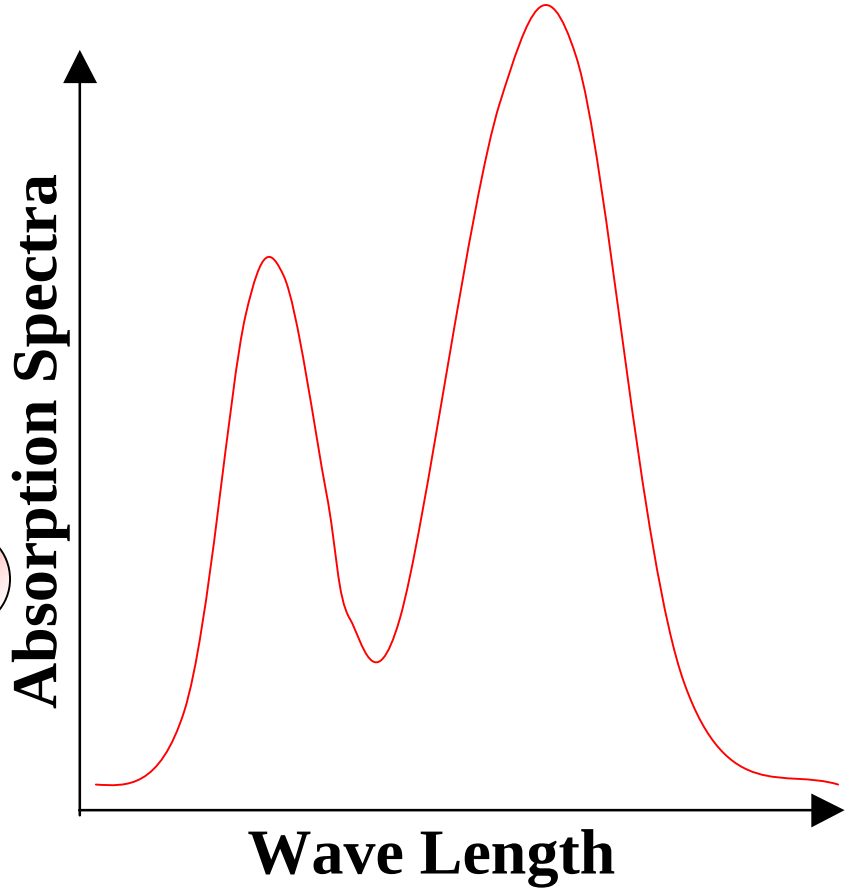
Altitude-time plot taken by Shuttle Discovery with LITE in a 1994 mission.

Differential Absorption



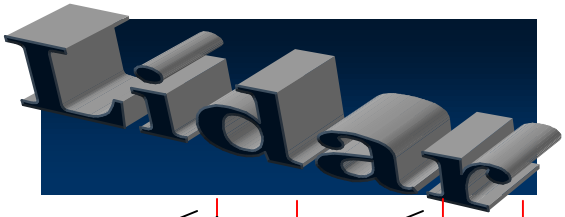
- Molecules vibrates, spins, and rotates differently.
- Distinct emission of light in different materials.



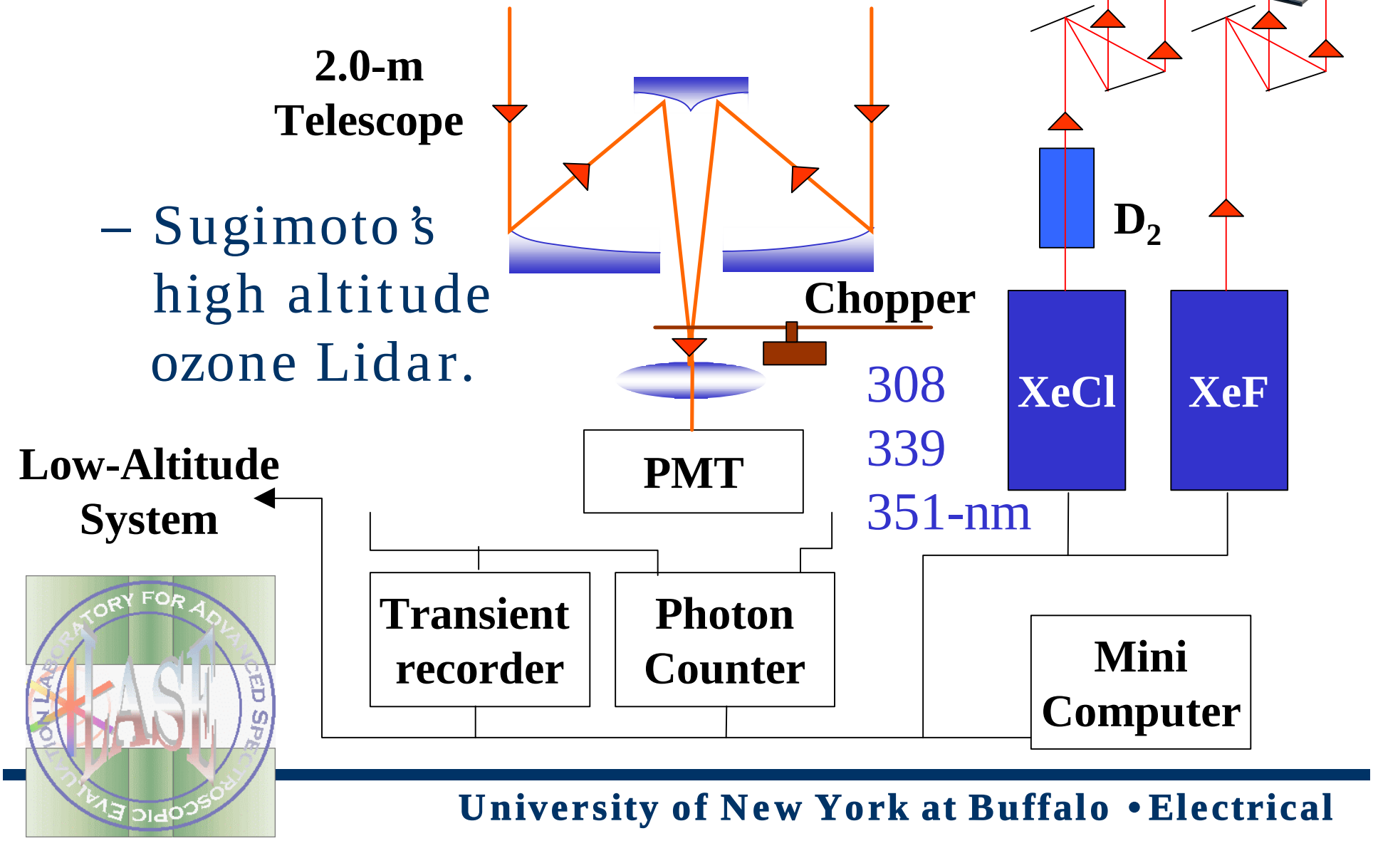


Resonant losses

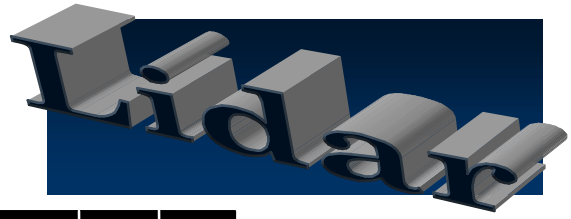
Differential Absorption



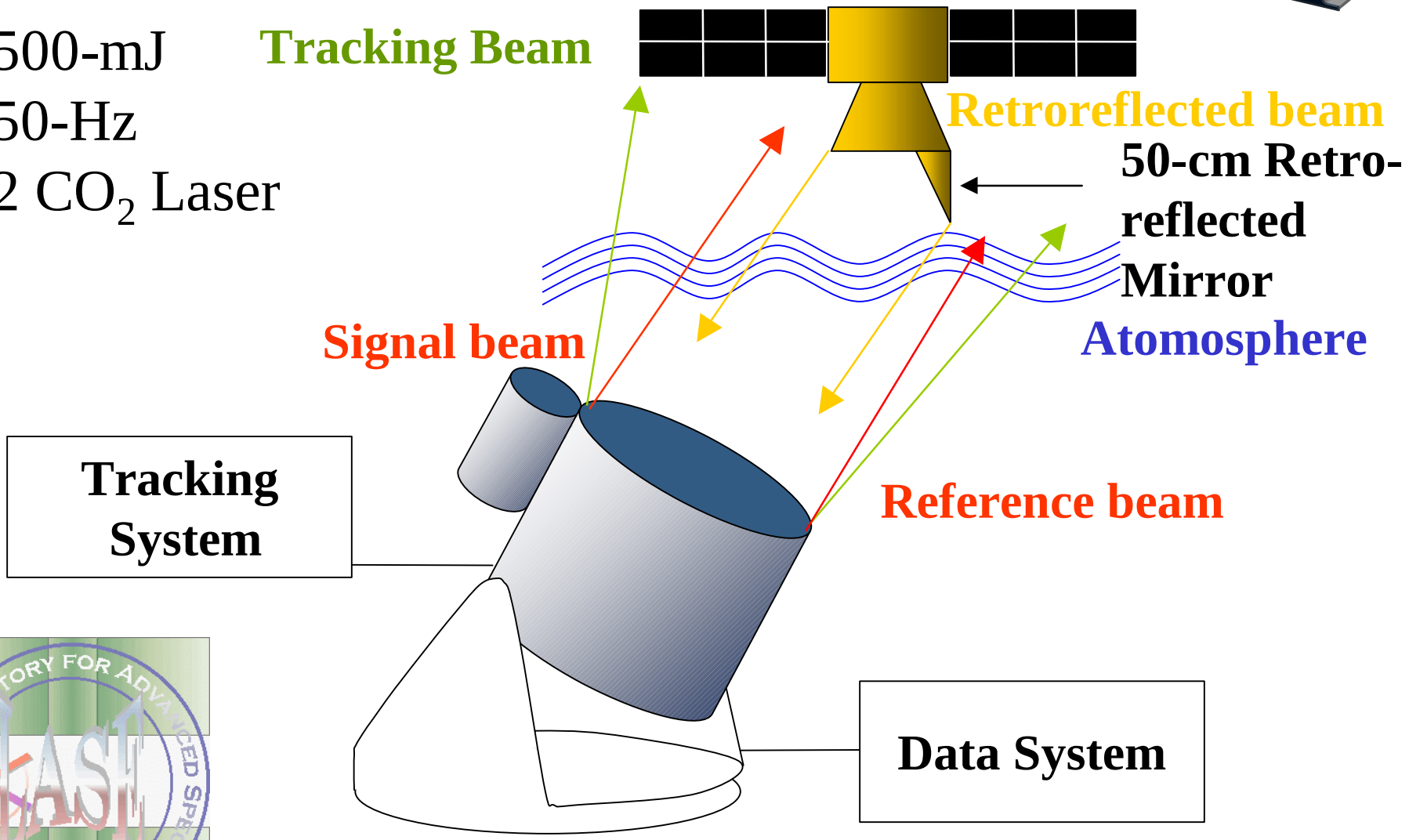
– Sugimoto's high altitude ozone Lidar.



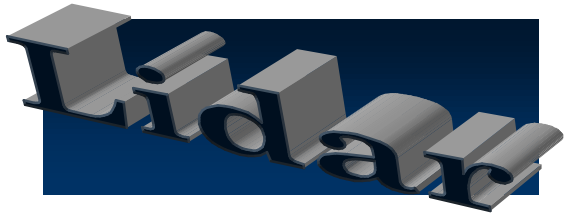
Differential Absorption



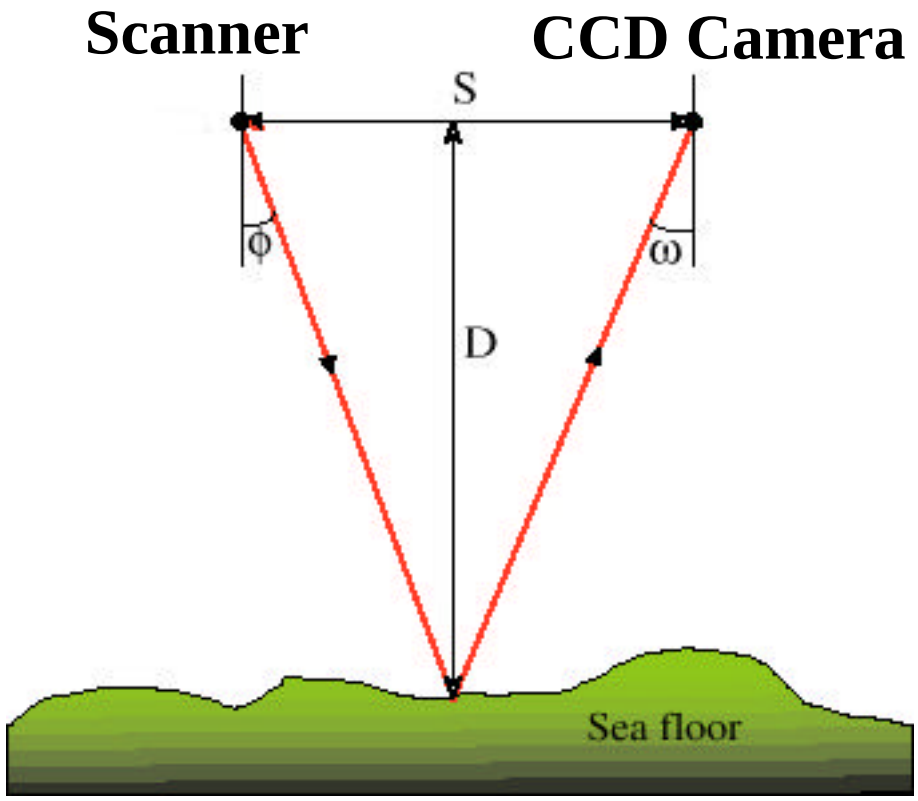
- 500-mJ
- 50-Hz
- 2 CO_2 Laser



Bathymetry

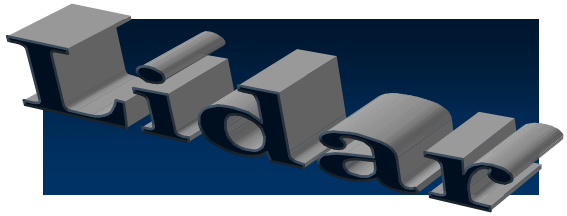


– Triangulate the target by illuminating it with a laser, then capture the reflection with a CCD Camera.

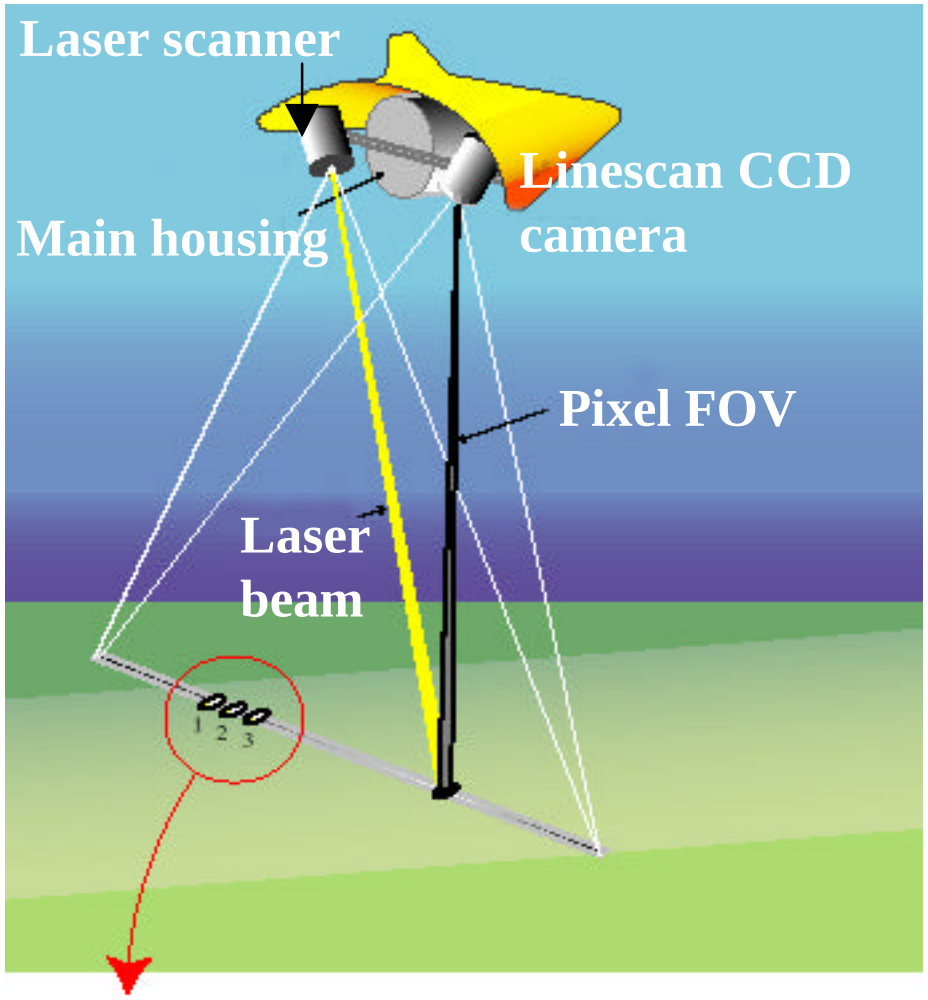


$$D = \frac{S}{\tan \phi - \tan \omega}$$

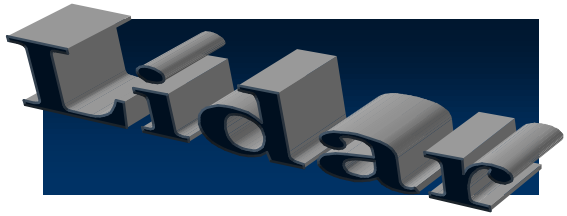
Bathymetry



- Airborne or underwater.
- Utilized frequency doubled pulse Nd:YAG (532nm).
- Blue-green laser minimizes water absorption.

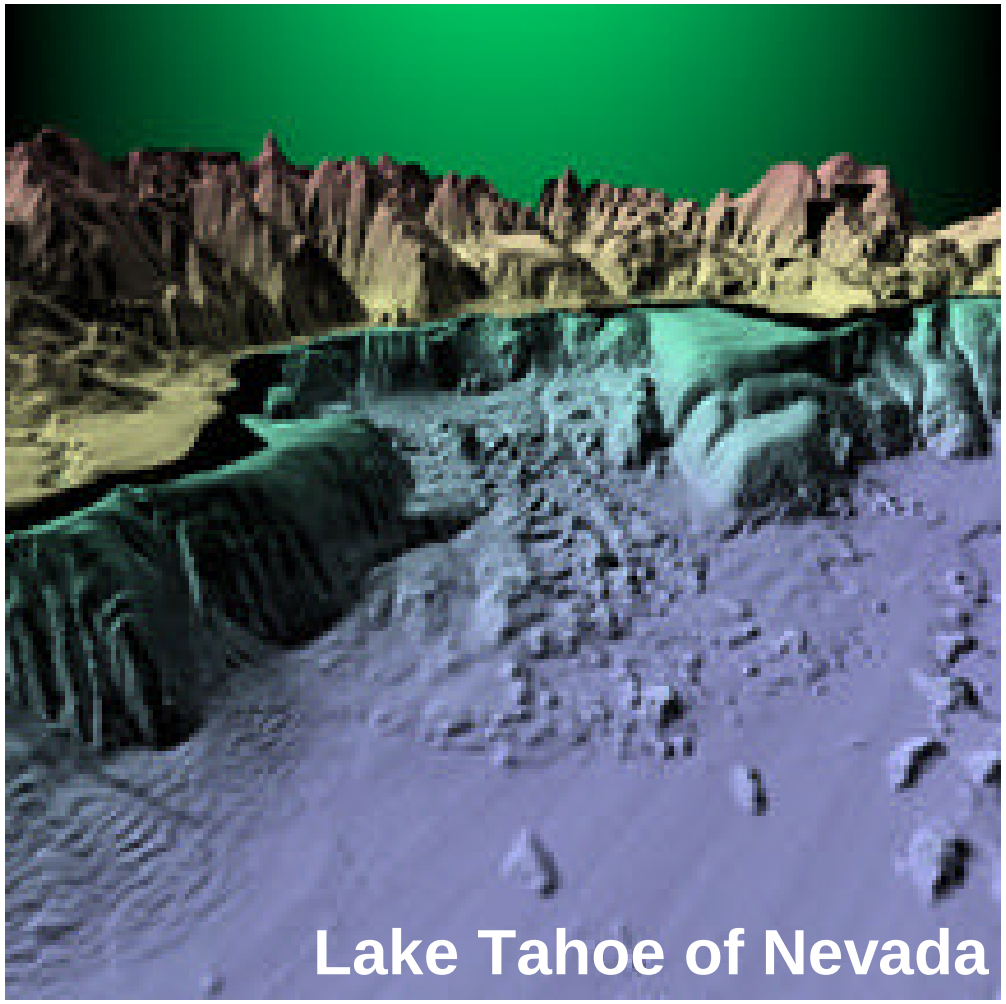


Bathymetry



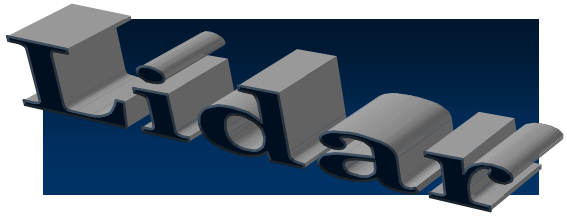
- Each pulse generates a pixel.
- Operating at repetition rate of several kilohertz.

Bathymetry



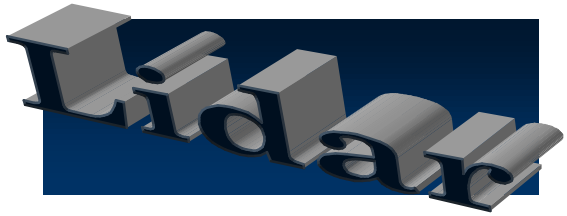
Above taken by US Army Corps of Engineers

Other Applications



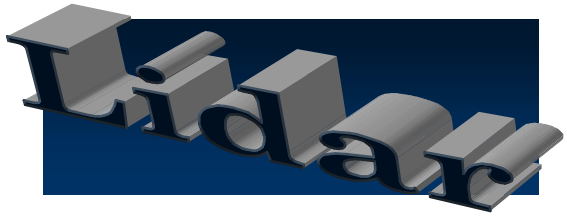
- Airborne mapping of beach erosion.
  - › Fly over beach at 135-mph with GPS.
  - › High rep rate needed.
- Protects against biological warfare agents
  - › Consist of a infrared transmitter, receiving telescope, and a detector with an information processor integrated into the frame.
    - **Air cool laser with high energy-per-pulse mounted on helicopters.**

Other Applications



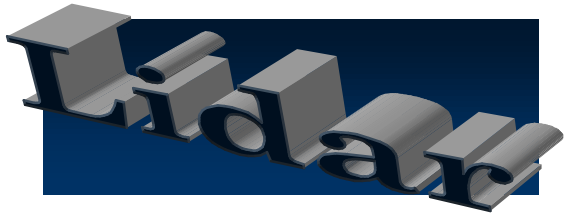
- Wind profiling Lidar for Air Drops
  - Mounted on C-130 transport.
  - Provide 3-D maps of wind from altitude to ground.
  - Eye-safe Tm:YAG, 2-μm, 12-mJ/pulse at 100Hz.
  - Weight 600-lbs and occupies 45-ft^2.

Summary



- Capable of real-time data analysis, wide-area surveillance and multi-material measurement analysis.
- Good tool for understanding the environmental changes.
- Room for improvement.
- Potential for image recognition.

Reference



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