LIDAR at the NSGF, Herstmonceux

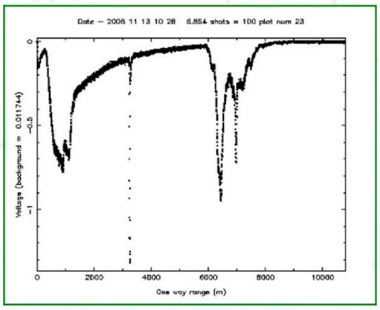
*The Satellite Laser Ranging (SLR) total laser light energy diminishes as it travels away from the facility due to absorption and scattering in the Earth's atmosphere. Some scattered light is directed straight back to the SLR station, where it can be detected in the telescope. This LIDAR (**Li**ght **D**etection **A**nd **R**anging) technique allows detection of variations in the density and the make-up of the atmosphere. Such variations include pressure, ions, cloud cover and pollution from human activity including aeroplane vapour trails. The LIDAR capability allowed measurement of the 2010 volcanic plume over the UK.*

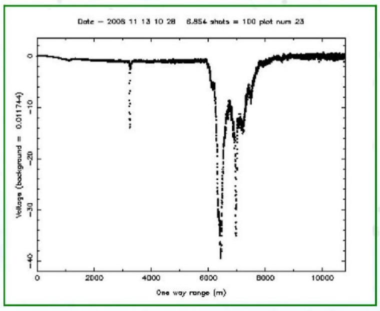
NERC Space Geodesy Facility Operations

The SGF contributes space geodetic observations which include:

- Two **GPS receivers** (named HERS and HERT) are in continuous and autonomous operation, providing hourly and daily and real-time GPS and GLONASS tracking data to the International GNSS Service (IGS).
- The **Satellite Laser Ranging** (SLR) facility is in operation, weather permitting, on a continuous basis. SLR is used to track those satellites that carry retro-reflector assemblies, and provides range measurements at mm-levels of precision. This technique is coordinated by the international Laser Ranging Service (ILRS).
- A permanent absolute gravimeter is producing a long-term series of high-accuracy gravity measurements to complement and enhance interpretation of the space geodesy results.

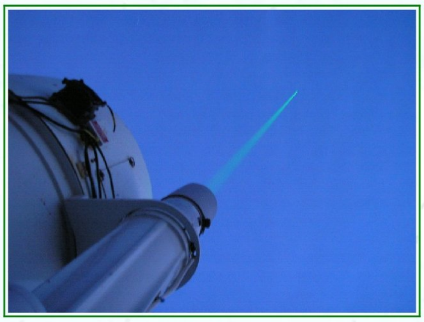
LIDAR at the NSGF





The Herstmonceux Elastic LIDAR Project (HELP) is a common example of a single wavelength elastic LIDAR system. The transmission stage of the HELP consists of a laser, mirrors and a beam expander. The laser is a flash lamp pumped, Q-switched System Nd:YAG laser which produces green light of wavelength 532 nm. The repetition rate for the laser is 12 Hz. The emitting telescope is mounted on the larger receive telescope.

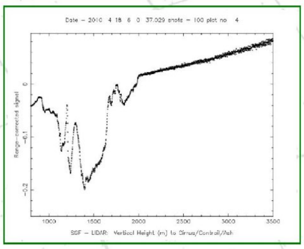
The backscattered laser light is collected in the receive telescope and detected by a photo-multiplying tube (PMT) detector. A lens is used in order to reduce the beam size so that it fill approximately 80% of the active area of the PMT. From the detector, the signal is then routed to a computer for analysis and display. A software program called LabView reads the incoming data from the detector each time the laser is fired. A single record consists of up to 30000 samples and a LIDAR measurement is made from an average of a number of these shot profiles.

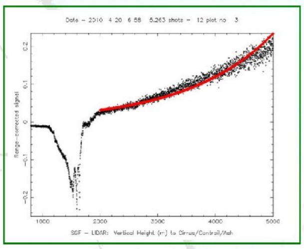


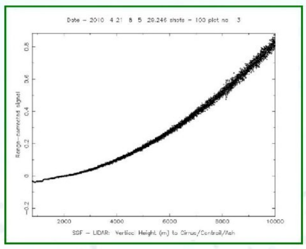
The raw LIDAR signal is background subtracted, to remove all ambient background light effects. This uses a pre-trigger method in which an average background value is taken microseconds before the laser fires. The LIDAR profile must then be range corrected for the fact that the energy of the laser pulse decreases with range from the telescope by R^2. Once this is done signal structure at the higher altitudes and atmospheric attenuation is more clearly visible. The plots above are of an averaged measurement before and after range correction.

The primary function of HELP is to study aerosols and clouds during laser ranging. Scattering can be observed from the laser probing of these atmospheric constituents and LIDAR makes a perfect instrument to perform detailed studies. Many successful aerosol and cloud studies have been done with elastic LIDAR.

Ash Cloud from Icelandic volcano

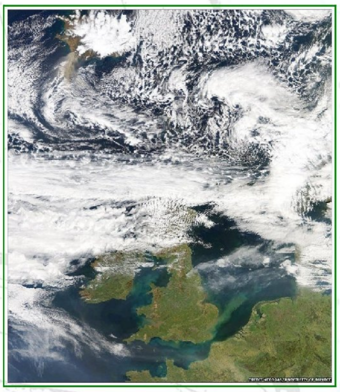






In April 2010 an Icelandic volcano called Eyjafjallajökull erupted, sending a plume of volcanic dust and ash up into the atmosphere over most of the European continent. The ash was considered to be a hazard to jet engines and the UK and European skies were closed to all such aircraft, causing great disruption to those planning to travel and who were overseas at the time.

The NSGF began LIDAR observations a day before the ash cloud was expected to arrive over the South East of England and then routinely every hour. Many observations showed increased backscatter due to the ash and dust particles at variable heights and thickness.



The first two plots above show that there are reflective layers of material, most likely ash particles from the volcano, at heights of from 1.1 to 1.6km above the Earth's surface. The smooth curve (in red) that has been fitted to the data from 2-5km shows that at those heights there are no further aerosol layers. The results from April 21 in the third plot shows that all the ash has disappeared from the low-atmosphere and a clear atmosphere is apparent up to a height of 10km.

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