HIGH Q LASER®

Application Note

Satellite Laser Ranging (SLR)

In Satellite Laser Ranging (SLR) a global network of stations measures the instantaneous round trip time of flight of ultrashort laser pulses to satellites equipped with special reflectors. The few returning photons are detected at the SLR station and time tagged, allowing range measurements with millimeter precision, which can be accumulated to provide accurate orbits and a host of important science products.

SLR is the most accurate technique currently available to determine the geocentric position of an Earth satellite, allowing for the precise calibration of radar altimeters and separation of long-term instrumentation drift from secular changes in ocean topography.
SLR's ability to measure the temporal variations in the Earth's gravity field and to monitor motion of the station network with respect to the geocenter, together with the capability to monitor vertical motion in an absolute system, makes it unique for modeling and evaluating long-term climate changes.
Additional, SLR provides a unique capability for verification of the predictions of the Theory of General Relativity.
One of the SLR stations is located in Austria/Graz. It was the first station world wide using a 2 kHz ultrashort pulsed laser (High Q Laser); the Graz system allows additional side products: Satellite Spin Determination, Atmospheric Seeing measurements, Data Transmission etc.

Satellites used for SLR

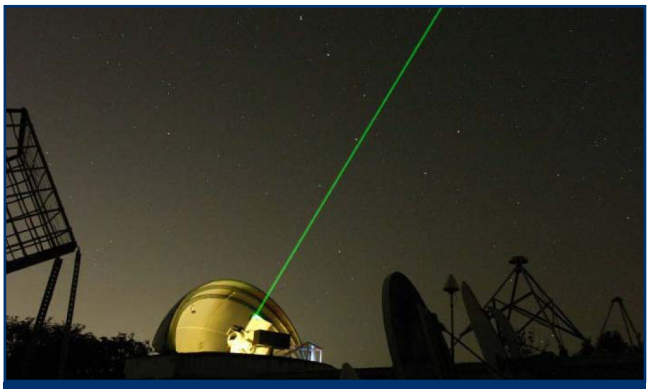
Image: NASA

Today there are more than 30 satellites used for SLR. The measurement precision from station to satellite is in the range of a few millimeters so even the shape of the satellite or its reflectors influence the measurement.

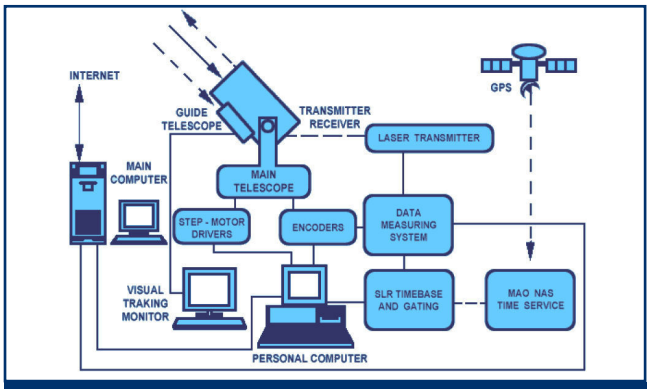
As an example LAGEOS (Laser Geodynamics Satellite, image) is an aluminium-covered brass sphere with a diameter of 60 cm and a mass of 411 kg, covered with retro-reflectors, giving it the appearance of a giant golf ball.

Active satellites used for: Altimetry, Gravitometry, Navigation
Passive satellites used for: Geodynamic

SLR station in Graz (Austria)



Station in Graz equipped with a 2 kHz *pico***REGEN**™ SLR laser system. Single shot accuracy: 2-3 mm



SLR setup for time-of-flight measurements of ps-laser pulses.

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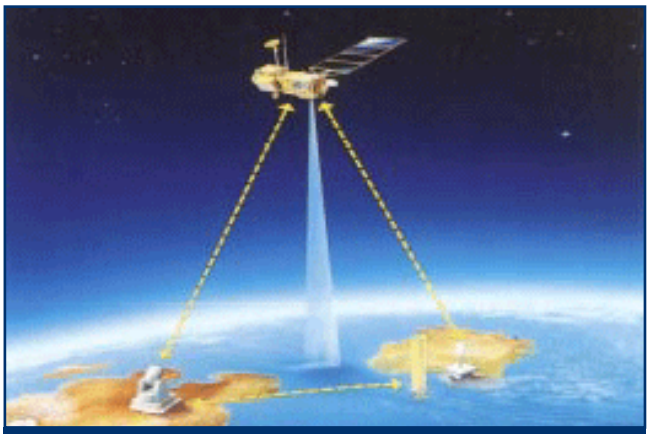
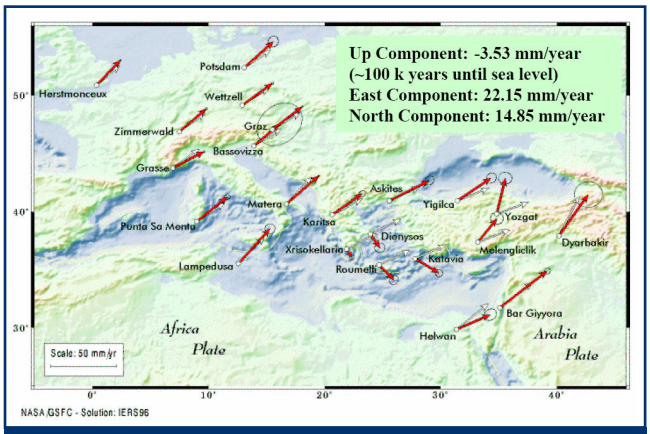
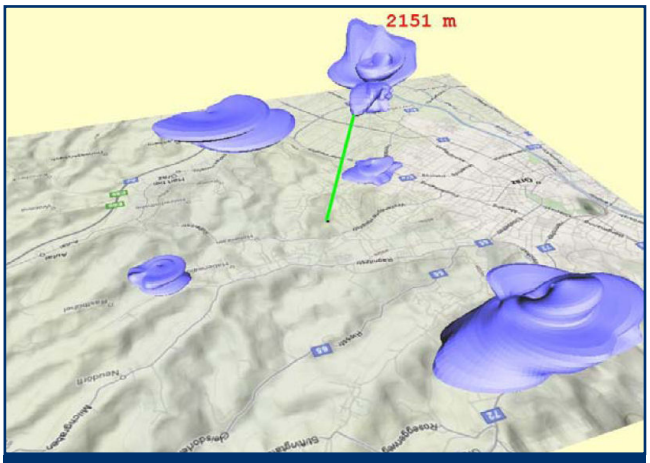
Research areas of SLR



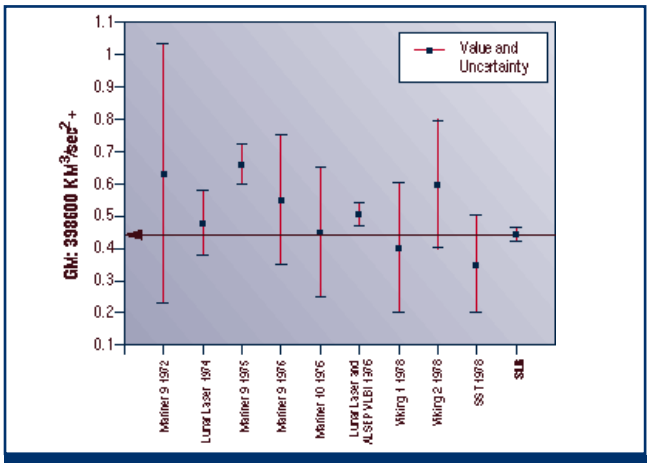
SLR Supports **Sensing of Surface Elevations**: Satellite Laser Ranging (SLR) provides direct, clear measurements of surface heights of sea level and land surfaces, using satellites and SLR stations on the ground that cross-check each other. Accurate SLR measurements provide changes in the global mean sea level to a few millimeters per year. (Source: NASA)



Tectonic Motion: SLR provides mm/yr accurate determinations of station motion on a global scale in a geocentric reference frame. Combined with gravity models and decadal changes in Earth rotation, these results contribute to modeling of convection in the Earths mantle by providing constraints on related earth interior processes.

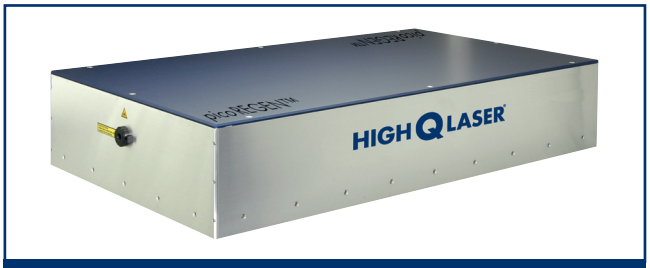


SLR LIDAR: Photons of each laser pulse are backscattered from clouds, atmospheric layers, aircraft vapour trails etc.
A single-Photon Counting Module (SPCM), installed in the main receiver telescope, detects these photons.
Any reflection point is determined with 3D coordinates.



Fundamental physics: SLR measurements of Lageos have provided the most accurate measurement of GM, the product of the gravitational constant and the mass of the Earth, and have confirmed that it does not change secularly.

SLR Laser from High Q Laser



*pico***REGEN**™ SC-532-800 HE SLR: Wavelength 532 nm, Pulse duration 10 ps, pulse energy 0.4 mJ @ 2 kHz

References

Austrian Academy of Sciences - Space Research Institute
SLR station Graz
www.iwf.oeaw.ac.at

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Additional source:
International Laser Ranging Service
http://ilrs.gsfc.nasa.gov