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LONG-TERM STABLE INTERNAL CALIBRATION CHAIN FOR A SPACE-BORNE INTEGRATED PATH DIFFERENTIAL ABSORPTION LIDAR SYSTEM.

Abstract

In February 2010, the Franco-German Council of Ministers decided to start a microsatellite mission monitoring the greenhouse gas methane in the atmosphere, MERLIN (Methane Remote Sensing LIDAR Mission) was born. The measuring instrument is an Integrated Path Differential Absorption LIDAR which depends on the intensity of the optical ground return signals having two different wavelengths. The principle is based on the relation of two independent return signals, which are recorded as associated pulse pairs consecutively.

However, even the pulse energies of highly-sophisticated lasers vary by a few per cent, and hence influence the recorded ground return signals. Thus the energy of every pulse needs to be normalised in order to eliminate the disturbing effect. To normalise the signals, the energy of each emitted pulse has to be monitored with high accuracy. Due to the uncertainty of different detectors, an internal calibration chain is necessary to measure the reference signal with the same detector. Since the internal reference signal needs to be of the same strength as the very weak ground return signal, an internal attenuation of 14 magnitudes is required. In additional, potentially occurring energy inhomogeneities within the laser beam have to be removed. Furthermore, the calibration chain must have long-term stability and be independent of environmental influences in space.

In order to monitor the energy of each emitted pulse a small fraction is extracted by a holographic grating. The diffracted beam points into an integrating sphere and the remaining beams in nadir direction towards ground. Through this integrating sphere, the light becomes homogenised. A minor part is collected by multimode fibre optics. In order to detect the reference signal after parasitic light has vanished, the fibre optics have a certain length to delay the signal. A second integrating sphere is connected to the end with a pinhole at the exit. The light shining through the pinhole is collimated onto a beam splitter by a lens. This beam splitter combines the reference and the terrestrial return signal to then project both onto the instrument detector consecutively.

Because of the internal calibration chain, a normalisation of the pulse energies - and hence an accurate measurement of the methane content of the atmosphere - is possible. This calibration chain has an attenuation of 14 magnitudes and supplies homogenously distributed light to the detector. Furthermore, the reference signal has a high degree of long-term stability and is independent of the space environment.