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Atmospheric aerosol and gas sensing using Scheimpflug lidar

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This work presents a new lidar technique for atmospheric remote sensing based on Scheimpflug principle, which describes the relationship between nonparallel image- and object-planes[1]. When a laser beam is transmitted into the atmosphere, the implication is that the backscattering echo of the entire illuminated probe volume can be in focus simultaneously without diminishing the aperture. The range-resolved backscattering echo can be retrieved by using a tilted line scan or two-dimensional CCD/CMOS camera. Rather than employing nanosecond-pulsed lasers, cascade detectors, and MHz signal sampling, all of high cost and complexity, we have developed a robust and inexpensive atmospheric lidar system based on compact laser diodes and array detectors. We present initial applications of the Scheimpflug lidar for atmospheric aerosol monitoring in bright sunlight, with a 3 W, 808 nm CW laser diode. Kilohertz sampling rates are also achieved with applications for wind speed and entomology [2]. Further, a proof-of-principle demonstration of differential absorption lidar (DIAL) based on the Scheimpflug lidar technique is presented [3]. By utilizing a 30 mW narrow band CW laser diode emitting at around 760 nm, the detailed shape of an oxygen absorption line can be resolved remotely with an integration time of 6 s and measurement cycle of 1 minute during night time. The promising results demonstrated in this work show potential for the Scheimpflug lidar technique for remote atmospheric aerosol and gas sensing, and renews hope for robust and realistic instrumentation for atmospheric lidar sensing.

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