Design of a Powerful Transversely Pumped Ti:Sapphire Laser for Near-Infrared Lidar Application

Johannes Speidel[1], Hannes Vogelmann[1], Matthias Perfahl[1], Thomas Trickl[1]

[1] Karlsruhe Institute of Technology, Campus-Alpin (KIT, IMK-IFU), *Garmisch-Partenkirchen, Germany, johannes.speidel@kit.edu*

Tropospheric water vapor is known to be one of the most important atmospheric constituents for many reasons, raising the need for precise remote sensing measurements. For water vapor lidar observations, the differential absorption lidar (DIAL) technique, operated within the near-infrared (NIR) spectrum, is predestinated, as it can deliver data at both high spatial and temporal resolution.
Successful lidar remote sensing of water vapor with the DIAL technique, however, is linked to powerful narrowband laser transmitters.

For water vapor DIAL purposes, up to now, the setup of a longitudinally pumped Ti:Sa laser, is often used. Injection seeding allows for the required changes between the online and offline wavelengths, providing at the very same time high spectral purity. However, operating this setup is challenging as its mechanical stability is poor. In addition laser pulses with high power are often achieved only with pumping near the Ti:Sa crystal damage threshold, asking for very delicate and experienced tuning at a high risk of crystal damage.

Within this contribution, we present a newly developed Ti:Sapphire (Ti:Sa) laser with high power NIR emission, suitable for lidar applications. In contrast to the described setup of longitudinally pumped Ti:Sa lasers, the new transverse pumping geometry stirs up hope for mechanically more stable NIR laser operation in a injection-seeded setup with the potential for a higher emission power. The core idea behind this novelty is, to maximize the pumped crystal volume. Consequently, the maximum output power is expected to increase with more crystal volume being pumped at constant radiances. As available pumping powers from commercial lasers constantly increase, we see high potential for further usage of the presented pumping geometry. The maximum capability of the theoretically estimated output power has not yet been fully exhausted as we focused on stable operation first.

Here, we demonstrate the general system performance that has been achieved so far. This includes the description of precursor experiments on the best geometrical pumping setup as well as the technical setup in which the laser is being operated. In addition, the specifications of the measured laser characteristics are presented.

The horizontal pumping geometry has been implemented into the mobile atmospheric monitoring system (ATMONSYS) lidar. By now, we were able to experience its operation during two field campaigns.