New Lidar Systems at the German Aerospace Center

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Introduction

A new middle atmosphere group was started 2.5 years ago at the DLR Institute of Atmospheric Physics in Oberpfaffenhofen. Our main objective is to study **dynamical coupling processes** by gravity waves from the troposphere into the stratosphere and mesosphere by characterizing the complete life cycle of gravity waves employing observational and modelling tools. As LIDAR is currently the only available technique which allows continuous atmospheric observations from ground level to 100 km, we focus on development and installation of a new set of LIDAR systems.

Compact Rayleigh Autonomous Lidar (CORAL)

Motivation: **Daily soundings, statistical analysis of gravity waves**

- Temperature soundings 30-85 km, 10 min resolution
- Enhanced version of the TELMA Rayleigh lidar
- Improved container design
- Redundant sensors, electric systems, computers

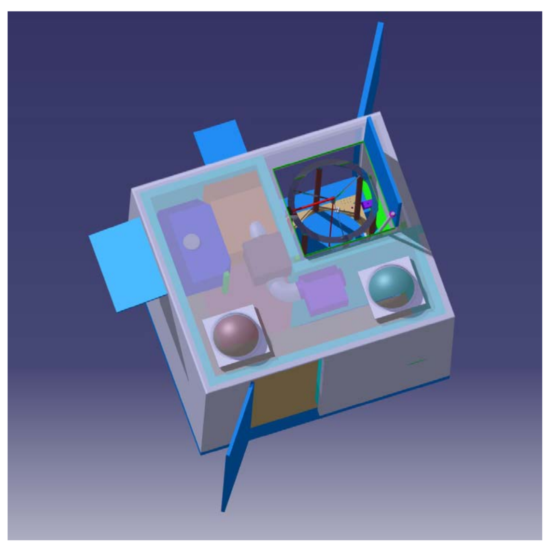

Fig. 6: CORAL container

Autonomous operation

- Client-/server software (C++) controls lidar operation & container systems
- Multi-threaded real-time system running on Linux computers
- Message-based data distribution system
- Uniform command language for hardware configuration & system parameter settings
- Self-monitoring and fault protection algorithms

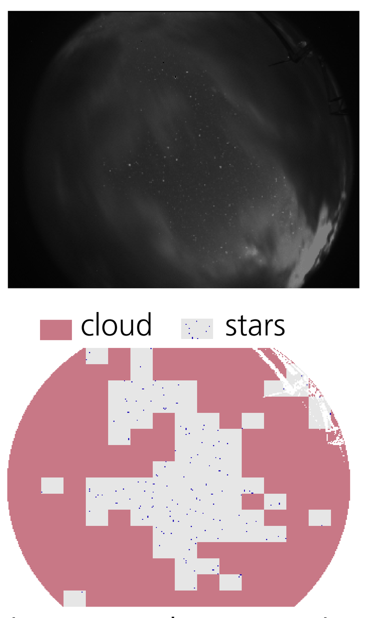

Fig. 7: All-sky image and automatic cloud detection

Temperature Lidar for Middle Atmosphere Research (TELMA)

Motivation: **Gravity wave parameters from ground to 100 km, Technology test bed**

- Temperature soundings 2-100 km, 10 min resolution
- Combined Rayleigh-/Raman-/Brillouin-/Sodium lidar
- Novel OPO-based laser system: 9 W at 532 nm, 0.8 W at 589 nm
- Mobile system integrated into 8 foot container
- Designed for remote operation

Fig. 1: TELMA operating during DEEPWAVE at Lauder, New Zealand, 2014

Fig. 2: Container with laser and receiver system (left) and telescope (right)

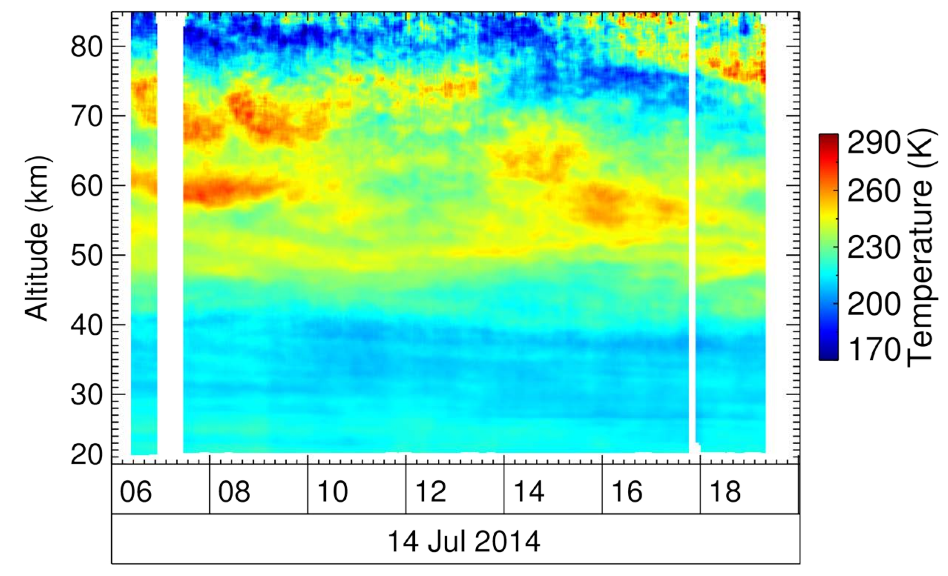

Fig. 3: Example: 13 hours of temperature measurements

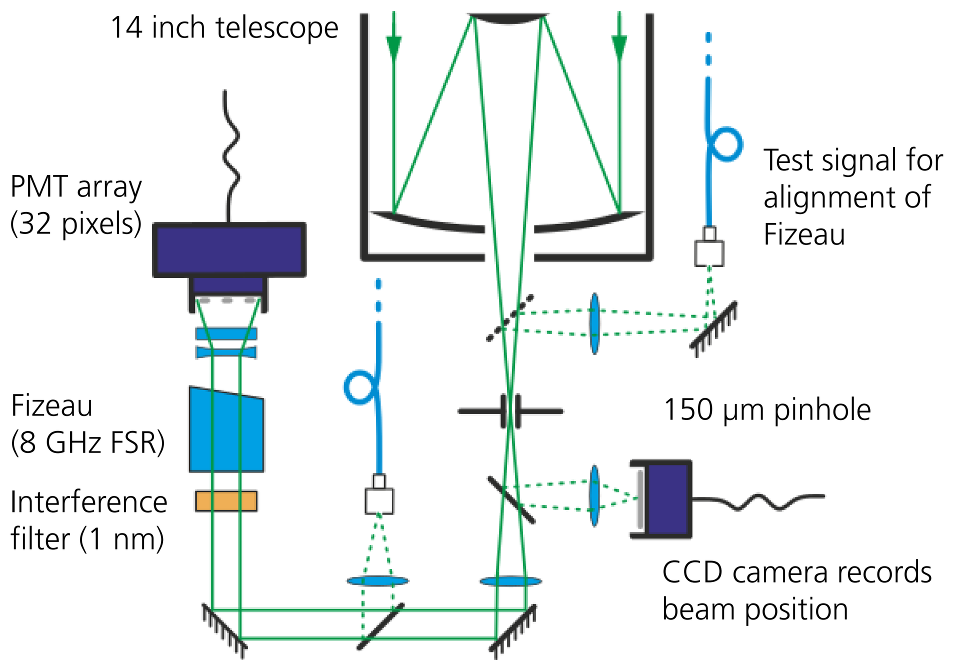

Fig. 4: Sketch of the Rayleigh-Brillouin receiver for TELMA

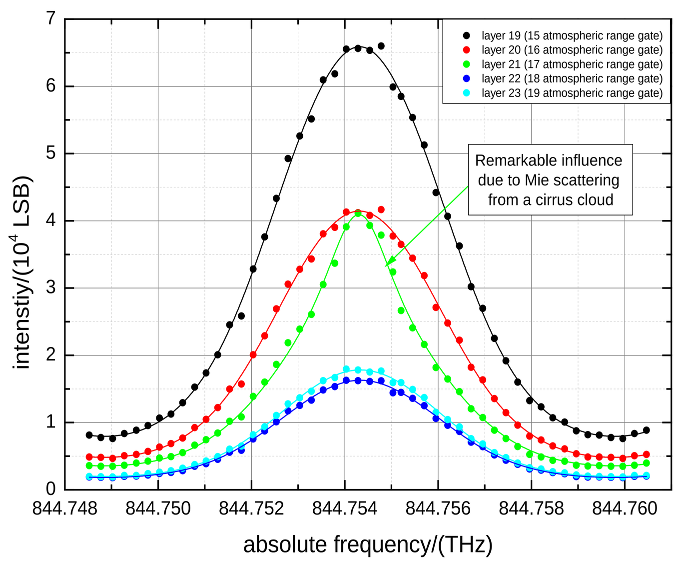

Fig. 5: Measured Rayleigh–Brillouin line shapes for different distances from the A2D lidar. Witschas et al., Opt. Lett. (2014).

Airborne Lidar for Studying the Middle Atmosphere (ALIMA)

Motivation: **Very high-resolution gravity wave measurements**

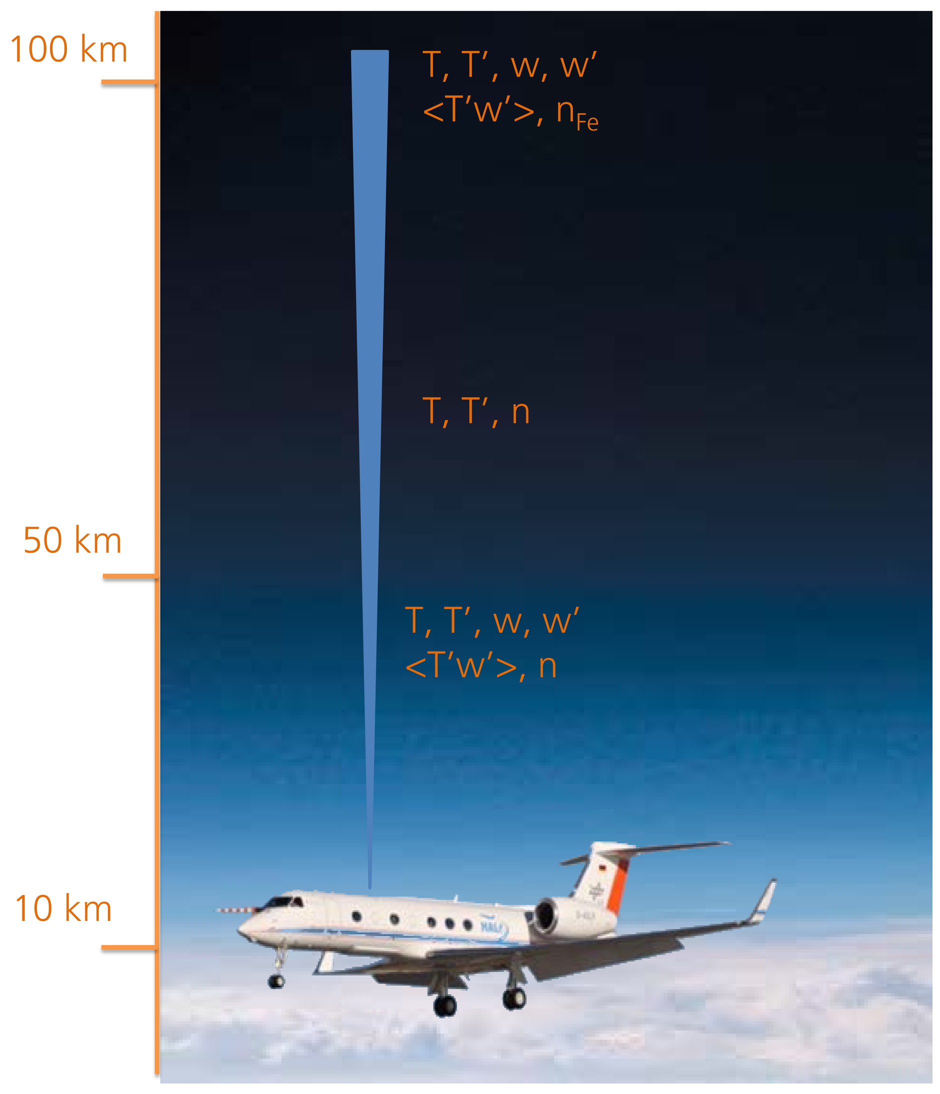

Fig. 8: ALIMA onboard the research aircraft HALO

- Temperature and vertical wind 15-100 km, 30 seconds resolution
- Doppler iron lidar (372 nm)
- High-power laser: 9 W at 372 nm, 6 W at 558 nm
- 18 inch telescope
- Narrow-band daylight filters
- Momentum flux measurements in ground-based configuration (two co-planar beams)
- First airborne measurement in 2018

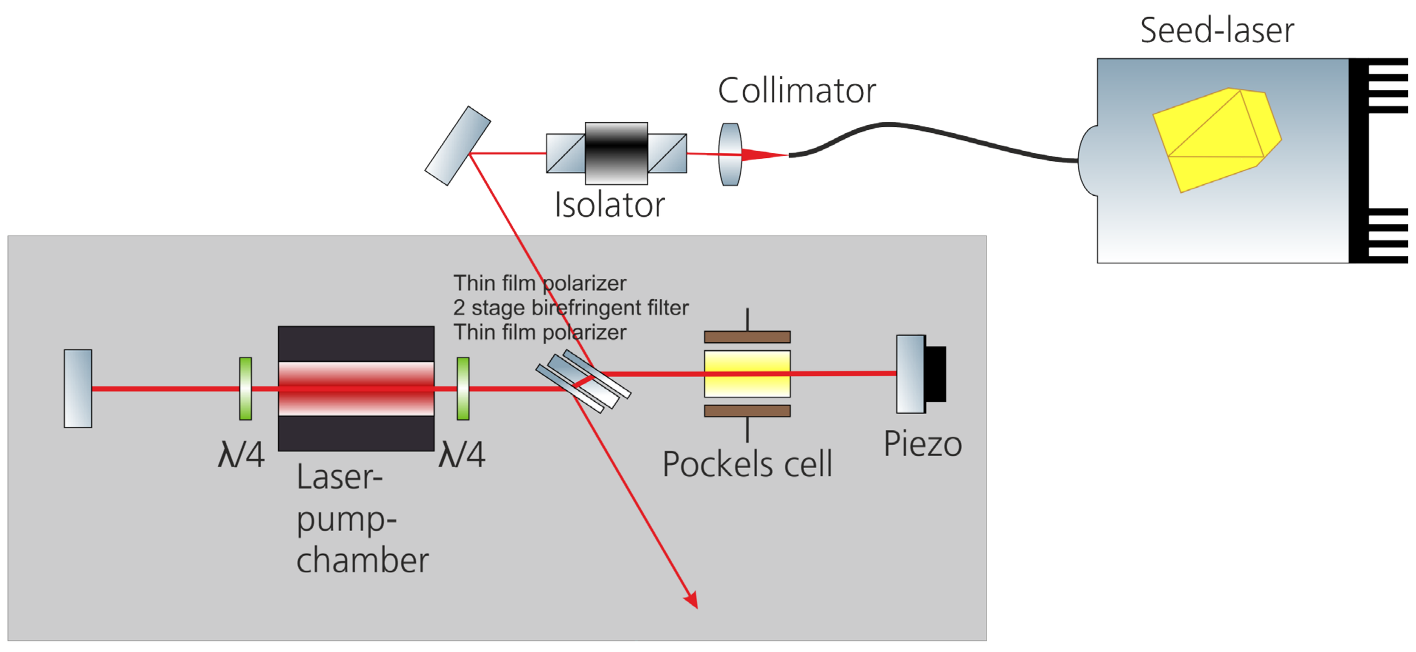

Fig. 9: Prototype of linear Nd:YAG oscillator operating at 1116 nm wavelength

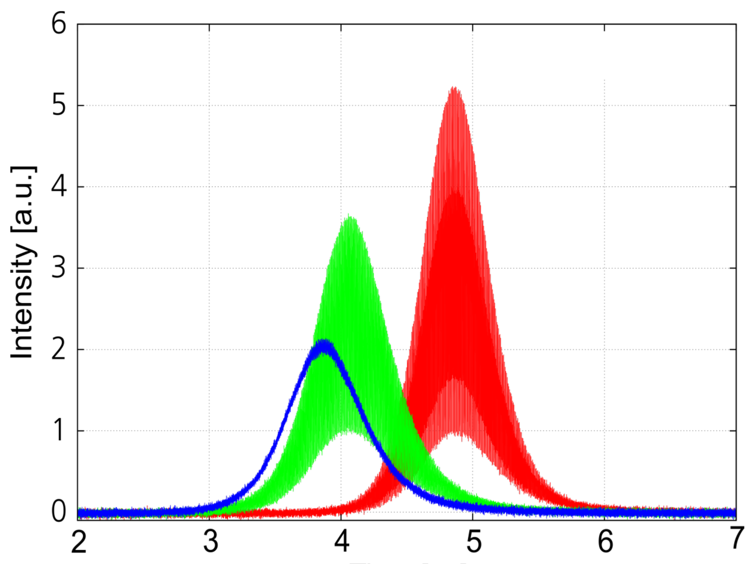

Fig. 10: Time traces of seeded (blue) and unseeded laser pulses (red)

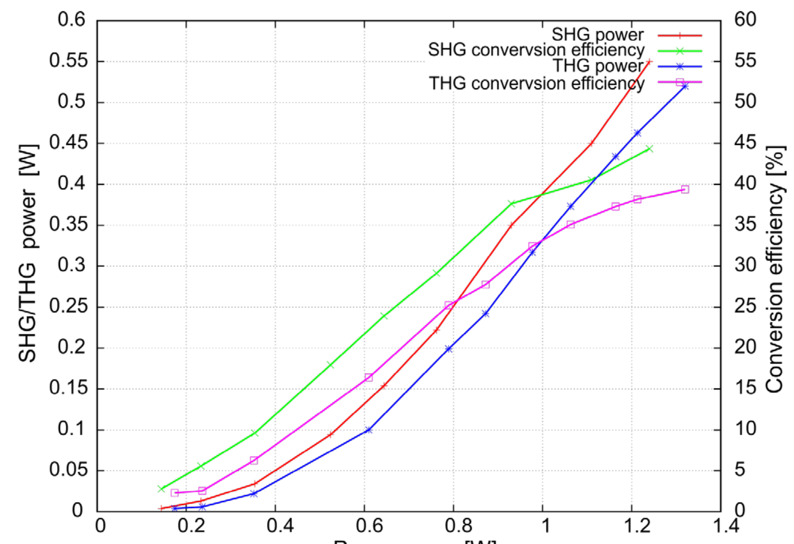

Fig. 11: Conversion efficiencies (preliminary results)