Name of research institute or organization:

École Polytechnique Fédérale de Lausanne (EPFL)

Title of project:

Study of the atmospheric aerosols, water vapor, ozone and temperature by LIDAR

Project leader and team:

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Prof. Hubert van den Bergh, head of the Laboratory for Air and Soil Pollution
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Project description:

In 2006, the EPFL lidar group continued the work on the upgrade of the multi-wavelength elastic-Raman scattering lidar with an ozone channel. The transmitter part of the lidar was completed with a system protecting the laser of the lidar from freezing in a case of power breakdown. The DIAL spectral separation unit of the receiver was designed built and installed. The first signals were acquired.

The freezing protection system (Fig.1) consists of a heating cable wrapped around the water cooled oscillator and amplifier laser heads. The heater is powered from the main power supply and in case of emergency from a battery when the temperature of the heads drops below 10°C. The battery ensures 48 h autonomous operation without external power supply. The battery charge is maintained by special circuit during normal operation. In order to improve the laser security an additional protection system was employed. It consists of an air pump, which drains the cooling water from the laser head after the laser is being stopped.

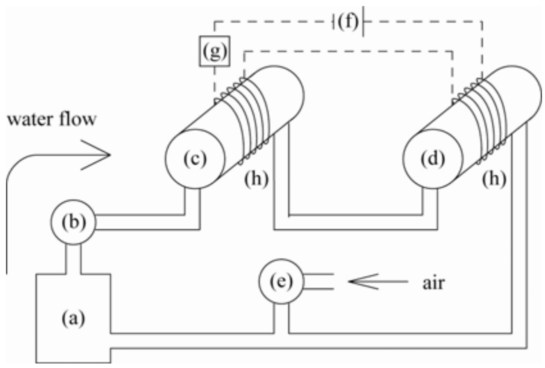

Fig. 1: Freezing protection system: (a) cooling water reservoir; (b) pump; (c) laser oscillator; (d) laser amplifier; (e) additional air pump to empty the cooling circuit; (f) 12 V battery (120 Ah), (g) thermostat; (h) heating cable (15 W).

The long-range receiver of the lidar has been redesigned and upgraded with an ozone channel. The receiver separates the backscattered radiation, collected by the astronomical telescope, by wavelength and directs the radiation to the detecting photosensors. The UV radiation used for ozone detection is first taken out from the backscatterd light by means of dichroic mirrors and directed to the ozone channel. This channel (Fig. 2) is based on a UV-enhanced, flat-field, imaging grating (Zeis

GmbH) and has a resolution of 1 nm/mm, sufficient for separating the three closely spaced DIAL wavelengths.

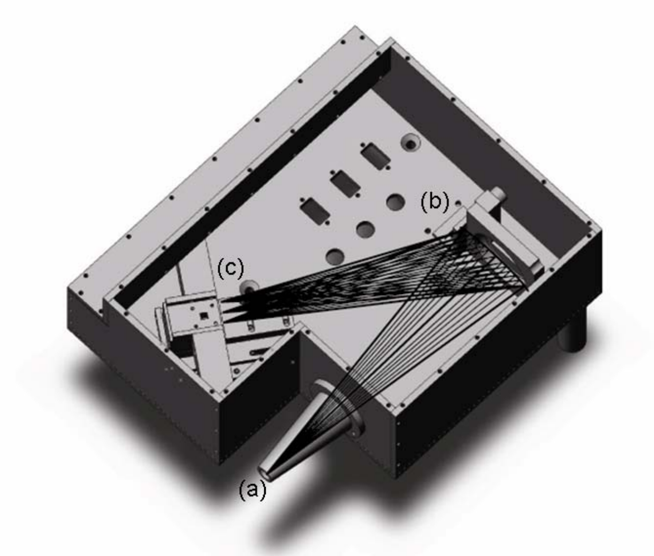

Fig. 2: ozone DIAL detection box: (a) entrance diaphragm, (b) diffraction grating, (c) PMTs block

The remaining backscattered radiation is separated in three elastic (355, 532 and 1064 nm) and two Raman (384 and 604 nm) channels by interference filter polychromator and used for aerosol measurements. The Raman signals at 404 nm and 384 nm are used for water vapour measurements. A 3D plot of the long-range receiving box is shown in Fig. 3.

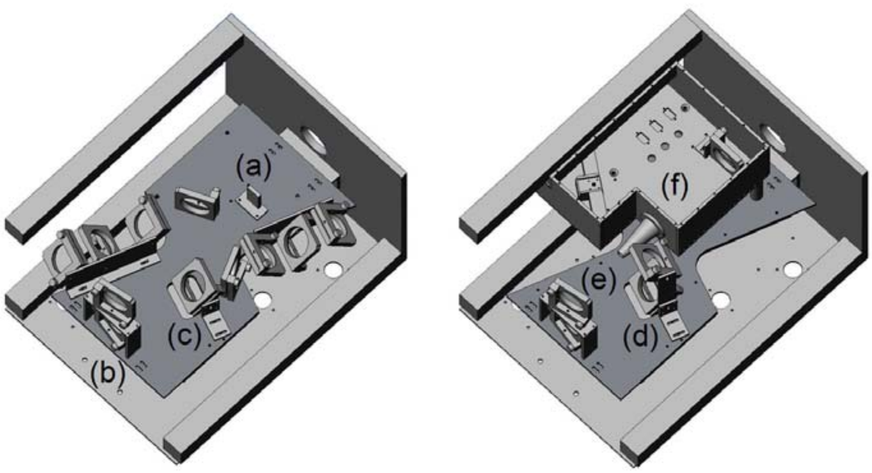

Fig. 3: Long-range detection box. (left): (a) entrance diaphragm, (b) collimating spherical mirror (c) UV beam-splitter, separates the UV DIAL from the other wavelengths. The residual long-wavelength light is distributed by dichroic mirrors on the detectors. (right): (d) UV-reflector above (c), (e) focusing spherical mirror, (f) UV DIAL detection box (Fig.2).

First DIAL signals were acquired at the end of the year and are shown in Fig. 4.

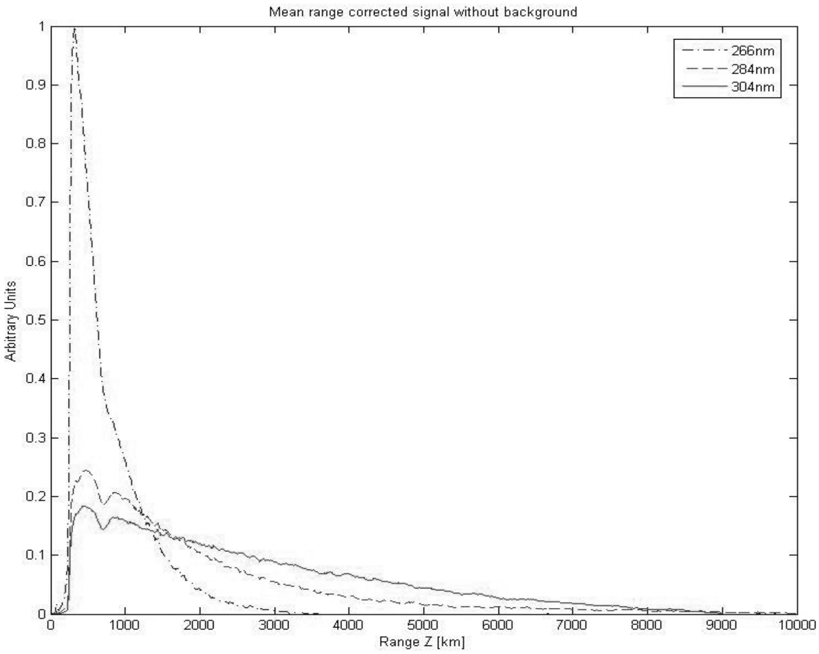

Fig. 4 First DIAL signals.

The vertical ozone profile will be calculated with a MATLab based routine developed in the laboratory.

The ozone data together with the data from the water vapour and temperature channels will be used to study troposphere-stratosphere exchange (STE).

Key words:

Multi-wavelength lidar, Raman lidar, pure rotational Raman scattering, aerosols, backscatter and extinction coefficients, troposphere, water-vapor mixing ratio, temperature, ozone, STE.

Internet data bases:

http://lpas.epfl.ch/lidar/research/LidarJungfrau/Jungfrau.html

Collaborating partners/networks:

EARLINET -**E**uropean **A**erosol **R**esearch **LI**dar **NET**work
ISM: Payerne station
Institute of Atmospheric Optics-Tomsk, Russia

Scientific publications and public outreach 2006:

Refereed journal articles

Marcel Bartlome, Valentin Simeonov, Hubert Van den Bergh, "Upgrade of the EPFL multiwavelength lidar with an ozone channel" submitted to Science of the Total Environment.

Valentin Simeonov, Marian Taslakov, and Hubert van den Bergh, “Sensitivity enhancement of open-path trace gas measurements by a multi-pass approach” submitted to Optics letters.

Conference papers

V. B. Simeonov, I. Serikov, P. R. Ristori, M. M. Froidevaux, T. Dinoev, M.Parlange, H. van den Bergh, “High spatial and temporal resolution measurements of water vapor, temperature, and aerosol with by Raman LIDAR for turbulent observations” in Proc. of SPIE 6367 (13th International Symposium on Remote Sensing, 2006, 11-14 September 2006, Stockholm, Sweden), SPIE Paper number: 6367- 12, in print.

T. Dinoev, Y.Arshinov, S. M. Bobrovnikov, I.Serikov, P. R. Ristori, B. Calpini,; H. van den Bergh, and V. B. Simeonov “"Water vapor Raman lidar for meteorology - advances", in Proc. of SPIE 6367 (13th International Symposium on Remote Sensing 2006, 11-14 September 2006, Stockholm, Sweden), SPIE Paper number: 6367- 11, in print.

M. Taslakov, V. Simeonov, H. van den Bergh, and J. Feist, “Open Path Measurements of Ozone water vapour CO_2 and atmospheric temperature Using intrapulse tuning method of Quantum Cascade Laser”, SPIE “ Lasers Physics and Applications “, in print.

Taslakov M., Simeonov V, van den Bergh H, “Open Path Space resolved measurements of atmospheric compounds using pulsed Quantum Cascade Laser spectroscopy”, SPIE “ Lasers Physics and Applications “, in print.

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