Name of research institute or organization:

École Polytechnique Fédérale de Lausanne (EPFL)

Title of project:

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

Project leader and team:

Dr. Valentin Simeonov, project leader
Prof. Hubert van den Bergh, head of the Laboratory for Air and Soil Pollution
Dr. Marian Taslakov, Marcel Bartolome, Pablo Ristori, Todor Dinoev

Project description:

In 2005, the EPFL lidar group continued the work on the upgrade of the multi-wavelength elastic-Raman scattering lidar with an ozone channel. The work was interrupted for more than 6 months because of a serious damage to the laser. The damage was caused by frozen cooling water due to below zero temperatures in the Coude room. Because of difficulties with repairing the original laser (discontinued from production by Coherent) a new laser was installed. The new laser is Continuum 8000 Powerlite with 1.2 J energy per pulse and repetition rate of 10 Hz. To allow ozone and aerosol measurements, the laser was modified at the EPFL so as to produce four wavelengths simultaneously (1064, 532, 355 and 266 nm).To achieve this, to the original configuration producing fundamental (1064 nm), second (532 nm) and fourth (266 nm) harmonics, a third harmonic (355 nm) crystal was added. The third harmonic is produced from the residual (after producing fourth harmonic) fundamental and second harmonics generation. The additional nonlinear crystal is a KDP type and to attain maximum conversion efficiency, a special phase adjusting device was designed and built at the EPFL.

After the installation at Jungfraujoch, it became obvious that the laser could not be operated at high altitudes because of the high-voltage arching due to the low atmospheric pressure. When consulted the producer acknowledged that their lasers were not designed and tested for such operational conditions. Because of luck of experience, the producer could not assist us in any way and we had to redesign the laser heads. At the end of September, the laser was successfully put in operation.

To complete the transmission part of the lidar, a special Raman converter for producing two additional wavelengths (284 and 304 nm) from the 266 nm radiation was designed, built and installed on the lidar. The two additional wavelengths, together with the 266 nm, are needed for ozone measurements since they will be performed by the DIAL method.

In its final configuration the new transmitting part of the lidar consists of two separate lines (see Fig. 1). In the first line the three wavelengths (1064, 532, and 355 nm) are transmitted coaxially to the 20 cm (short range) receiving telescope after passing through a five-times multi-wavelength beam expander. These wavelengths are used in the aerosol, temperature and water vapour observations. The UV wavelengths used for ozone measurements are transmitted into the atmosphere directly after the Raman converter and off-axis to the receiving telescopes.

The lidar will be put in operation at the end of March after solving the problems related to the protection of the laser from a possible freezing of the cooling water.

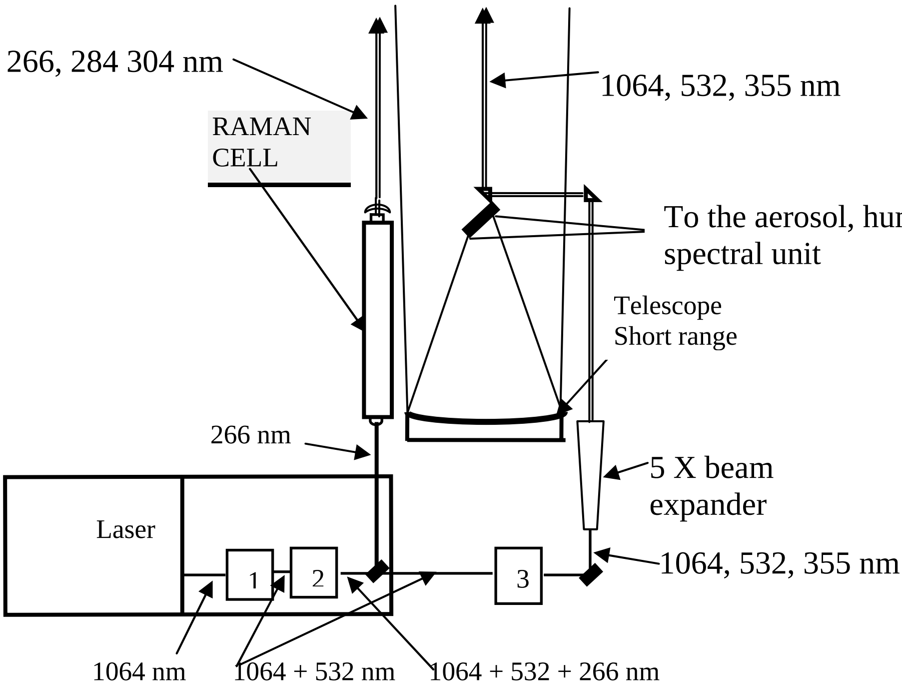

Figure 1. Schematic of the new transmitting part of the EPFL lidar, 1-second harmonic generator, 2-fourth harmonic generator, 3-third harmonic generator.

Key words:

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

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
Paul-Scherrer Institute
ISM: Payerne station
Institute of Atmospheric Optics-Tomsk, Russia

Scientific publications and public outreach 2005:

Refereed journal articles

M. Taslakov, V. Simeonov, and H. van den Bergh, "Open-path ozone detection by Quantum Cascade Laser", Applied Physics B, **82,** 501-506, (2006).

M.Taslakov, V.Simeonov, and H.van den Bergh, "Open path atmospheric spectroscopy using room temperature operated pulsed quantum cascade laser", accepted for publishing in Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, SAA-D-05-00145R1.

Book section

B. Calpini, V. Simeonov, “Trace gas species detection in the lower atmosphere by lidar from remote sensing of atmospheric pollutants to possible air pollution abatement strategies”, Chapter 4 in “Laser Remote Sensing” Optical Engineering series Volume: 97, T. Fuji and T. Fukuchi eds., Taylor and Francis/CRC Press, 2005.

Conference papers

V. Simeonov,P. Ristori, M. Taslakov,T. Dinoev, L. T. Molina, M. J.Molina, and H. van den Bergh, “Ozone and aerosol distribution above Mexico City measured with a DIAL/elastic lidar system during the Mexico City Metropolitan Area (MCMA) 2003 field campaign”, in Proc. of SPIE Vol. 5984 59840O-1, Remote Sensing 2005,19–22 September 2005 Bruges, Belgium, in print.

P Ristori, M. Froidevaux, T. Dinoev, I. Serikov, V. Simeonov, M. Parlange, H. Van den Bergh, “Development of a temperature and water vapor Raman LIDAR for turbulent observations, in Proc. of SPIE Vol. 5984 59840F-1, Remote Sensing-2005,19–22 September 2005 Bruges, Belgium, in print.

M. Taslakov, V. Simeonov, H. van den Bergh, and J. Feist, “Ammonia and Ozone Open Path.Measurements Using Quantum Cascade Laser Technology”, in the proceedings of The First International Conference on Environmental Science and Technology January 23-26, 2005, New Orleans, Louisiana, USA, in print.

Taslakov M., Simeonov V, van den Bergh H, “System for a Remote Read out of Multiple Passive Sensors Using 28 THz Quantum Cascade Laser”, in the proceedings 2005 Joint IEEE International Frequency Control Symposium and Precise Time and Time Interval (PTTI) 29-31 August 2005, Vancouver, BC, Canada, in print.

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