# Multiwavelength Ozone DIAL for automated unattended Outdoor Operation

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## The Ozone Profiler:

The Ozone Profiler is a compact stand-alone Differential Absorption Lidar (DIAL) system for the continuous measurement of the vertical distribution and concentration of Ozone as well as for the determination of the qualitative vertical distribution of aerosols. The operation is fully automatic and can be carried out on a remote basis, e.g. Allowing the system control and the data evaluation from a remote location via modem or Ethernet connection.

The system has a weatherproof enclosure for outdoor operation and is installed together with the laser cooling unit on a trailer of 2000 kg total weight allowing an easy change of the measuring site and reducing the preparation effort for the measurements to a minimum. With the mobile diesel generator on ist own chassis the system is self-contained and independent from any el. power and water supply.

## Applications:

- Analysis of the information and development of ozone episodes
- Detection of pollutant storage layers
- Detection of inversion layers
- Investigation of pollution transport
- Valuable input data for forecasting models

## The Concept:

For the LIDAR - DIAL measurement of Ozone five wavelengths are available:266, 289, 299, 316 and 355 nm. The first and the last are the FHG and THG of a Nd:YAG Laser, the others are generated inDeuterium and Hydrogen Raman cells[1]. The specialty of the presented concept is that the different wavelengths are emitted sequentially. The advantages compared to simultaneous emission are:

a) There is only one detection channel, using only one AD-converter for all of the wavelengths (and a second for the near field detection). This way, the possibility of a differential non-linearity, that could result in a systematic error, is avoided.

b) Each of the Raman cell's filling can be optimized for one of the wavelengths, thus leading to highest efficiencies of the Raman conversion.

c) Differences in beam divergence between FHG / THG and Raman shifted radiation can individually be treated and compensated.

The sequential operation of three Raman cells and two bypass lines requires a electro-mechanical multiplexer, steering the Nd:YAG output radiation at a repetition rate of 20 Hz into the respective paths. The mechanics of this multiplexer bases on long-term experience with similar precision mechanics in other unattended Lidars and has proven its stability over a testing period of several months. After passing the Raman cells and individual beam shaping optics, the different beams are collected in a common transmitter path via a passive wavelength-selective optics. The co-axial transmitter mirror is motor-controlled. An automatic alignment algorithm optimizes its position individually for each of the wavelengths.

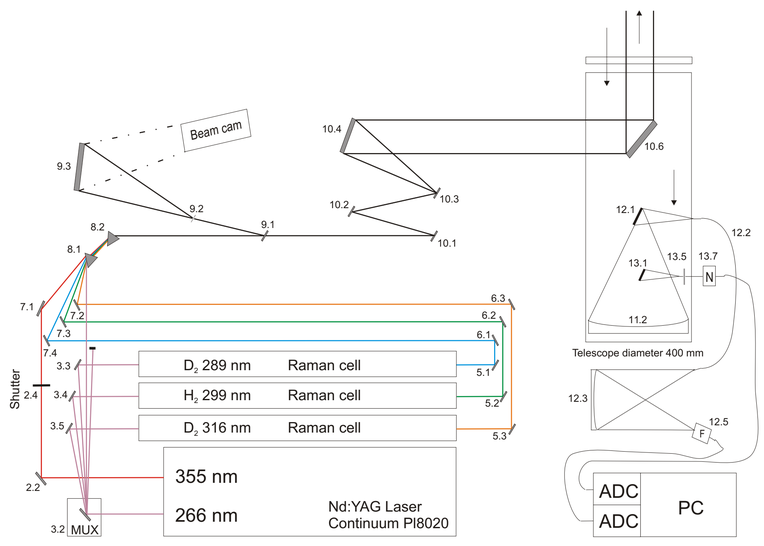
The safety concept of the system features:

a) A pressure control and Hydrogen leak detection with external power-off and ventilation system, and

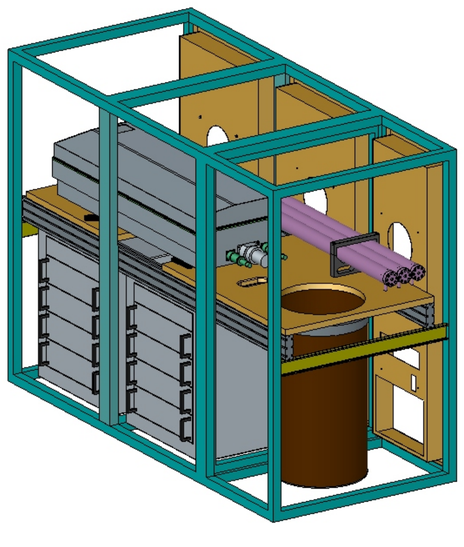
b) And eye-safety electronics that checks the Lidar returns with respect to obstacles and, in case of any indication, instantaneously cuts of the laser beam path.

## Ozone Profiler:


## Principle diagramm:




## 3D-View:



## Specifications (Operation):

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|---|---|
| Measurement principle: | DIAL (Differential Absorption LIDAR) |
| Parameters: | Ozone<br>Aerosols (as extinction) |
| Altitude Range: | 200m - 5000m |
| Altitude resolution: | 200m or better below 2000m<br>600m or better above 2000m |
| Accuracy of measurement: | 3 ppbv or better in moderately polluted environments<br>1 ppbv in clean environment |
| Precision of measurement: | 2 ppbv or better (simple standard deviation, 1 sigma) |
| Operational point: | 100m - 200m |
| Best spatial resolution: | 7,5m |
| Integration time: | 1min- 24h (30min recommended for the specified accuracy and precision) |
| Operating temperature (external): | -10°C to +30°C at relative humidity up to 95%<br>-10°C to +40°C together with laser cooling unit |
| Operating winds: | up to 20m/s average, 40m/s gust |

## Technical Specifications:

Laser and Optics: Continuum Precision II 8020, 80mJ @266nm, rep.Rate 20Hz
3x D2 - H2 Raman Cells, approx 2m length
Multiplexer technique to couple inside

Detection: Telescope area: 40cm Diameter,
Spectrometer
Photomultiplier and Transient Recorder
Hamamatsu/ Licel, 12Bit
Software modul and driver for automatic operation in Labview

Chassis Dimensions: 2.26 x 1.00 x 1.75 m
Weight: Approx.1t

Power supply: 1 x 230V/25A, 1-phase, 50Hz (Ozone Profiler)
1 x 230V/16A, 1-phase, 50Hz (cooling unit) or
1 x 400V/15A, 3-phase, 50Hz

## References:

[1] M.J.T. Milton et. Al. , Raman-shifted laser sources suitable for differential-absorption lidar measurements of ozone in the troposphere. Apl. Phys. B, 66, 105-113 (1998)

[2] J. Bösenberg et. Al., Troposperic Ozone Lidar Intercomparison Experiment, TROLIX ‘91, MPI for Meteorology, Report No 102, April 1993, Hamburg

[3] P. Brenner et. Al., A Novel Mobile Vertical-sounding System for Ozone Studies in the Lower Troposphere, in: Advances in Atmospheric Remote Sensing with Lidar, A. Ansmann et. Al (Eds.), 383-386, July 1996, Berlin

## Acknowledgements:

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