EARLINET:
A European Aerosol Research Lidar Network to Establish an Aerosol Climatology.

Contract EVR1-CT1999-40003

Handbook of Instrumentation.

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Compiled by:

Jens Bösenberg
Max-Planck-Institut für Meteorologie
Bundesstr. 55
D-20146 Hamburg

1 Introduction

EARLINET, the European Aerosol Research Lidar Network, uses a suite of laser remote sensing instruments to etablish a climatological data set for the vertical distribution of aerosol over Europe. Quantitative retrieval methods for aerosol optical properties are to be applied which poses strict requirements on the type of instruments that can be used. Because the lidars that are operated in EARLINET have not been especially designed for this purpose, but rather already existing instruments are used, they differ both in principle and in detail. This handbook describes the basic methodology, the common features of all systems, and the individual system properties. Additional instruments that are used for important ancillary measurements are also listed.

2 Lidar Methodology

For the purposes of this project the measurements have to be quantitative. Lidar methods are sufficiently mature now to provide reliable and quantitative aerosol measurements, but in order to come up with well defined physical parameters it is necessary to use a combination of several methods. The standard backscatter lidar is appropriate only to retrieve aerosol parameters for small optical depths, e.g. in clean areas, the upper troposphere, and the stratosphere. Since it is rather easy to operate and is at least a byproduct of any lidar measurement, this method is used to a large extent.

The limitations of the backscatter lidar method are due to the fact that only one set of signals is measured while two sets of parameters, backscatter and extinction, determine the signal. Additional problems arise because the signals have to be calibrated, and because the inversion is an ill-posed problem in a mathematical sense. Three methods have been demonstrated to overcome these problems: high spectral resolution lidar, Raman lidar and multiple zenith angle measurements.

The high spectral resolution lidar uses extremely narrow filters to separate the aerosol from the molecular return. Because of the rather demanding technology it is implemented at very few experimental sites only, and is presently not used in the frame of EARLINET.

The use of Raman scattering from nitrogen or oxygen in addition to measuring the elastic backscatter is a well established tool for determining the extinction profile separately from the backscatter profile. While the Raman and HSRL techniques are equivalent in performance, at least in principle, for reasons of comparability of data the preferred method within the network is the combination of Raman and elastic scattering at one UV wavelength around 355 nm. Of the 19 permanent stations of the network 17 will finally have capabilities to operate in this mode. Some flexibility in the choice of the actual wavelength is permitted to facilitate the use of different laser sources and existing instrumentation.

The third possibility to retrieve the extinction profile independently is to perform measurements at two or more different zenith angles simultaneously or at least alternating. When sufficient temporal averaging is applied it may be assumed under a broad range of conditions that the aerosol properties are the same for both directions. Then the set of two lidar equations can be solved directly to yield extinction and backscatter profiles. This method will also be used at some of the network stations, in particular for longer wavelengths where Raman scattering is too weak. Eight stations of the network can operate in this mode.

In order to get an estimate of the aerosol type additional measurements will be performed at wavelengths of approximately 532 and 1064 nm. At these wavelengths it is regarded sufficient to use elastic backscatter measurements only, because the wavelength dependence of backscatter can be used to characterise the aerosol type to the required extent, in particular when additional sunphotometer measurements will be used to estimate total optical depth.

3 Lidar Instruments, General Description

Lidar systems are generally built from three major building blocks: the transmitter system including the laser and transmitter optics, the receiver optics, and the detector and data acquisition system. Main common features of these systems are described in this section, while individual system data are provided in the following section.

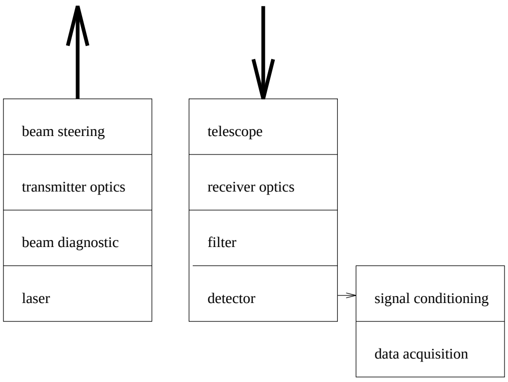

Figure 1: Block diagram of a lidar system.

3.1 Transmitter

A key component of any lidar system is the laser transmitter. For the purposes of this project the main requirements for the laser are: emission at suitable wavelengths (typically 1064, 532, and 355 nm), short pulse length (approx. 10 to 100 ns), sufficient pulse energy (some 10 mJ typically), moderate repition rate (some 10 Hz), and low divergence ($< 1mrad$, usually achieved through beam expanding optics). Requirements regarding spectral properties are not too demanding for this type of applications. The required wavelength stability, bandwidth, and spectral purity are usually met by standard lasers. The use of a Nd:YAG laser with primary emission at 1064 nm and subsequent frequency doubling and tripling is one of the standard solutions within EARLINET, but there are other excellent solutions. In particular for the UV-emission around 350 nm the choice of a XeF excimer laser provides high pulse energy and hence relatively strong return signals, which is an advantage in particular for the application of the Raman lidar technique. Other solutions exist operating even further in the UV reaching the solar blind region. This has the advantage that Raman measurements can be made even under daytime conditions, but at the expense of interference with ozone absorption. The use of different types of lasers within the network is not expected to cause real problems for the comparability of results, but certainly increases the necessity of making instrument intercomparisons.

In addition to the laser the transmitter system usually consists of beam expanding optics to decrease the beam divergence and the power density of the transmitted beam, and one or more steering mirrors to direct the beam into the atmosphere and into the receivers field of view. The pointing stability of the transmitted beam has to be much better than the field of view of the receiving telescope. Typical requirements are on the order of $10\mu rad$. In some cases the transmitter optics can be ommitted completely.

3.2 Receiving optics

The requirements for a receiving telescope for lidar applications are quite easy to meet. The most important parameter is the area of the primary mirror, and of course its reflectance. The requirements regarding resolution is rather poor even in comparison to simple telescopes used by hobby astronomers, in particular because the required image area is very small. Consequently it is not necessary to install elements for correcting aberrations. In principle one parabolic mirror is sufficient, e.g. mounted in Newton configuration. Even simpler is the direct coupling into an optical fiber in the focal plane of the primary (and only) mirror. The main point to observe in this design is that the f-number of the primary has to be adapted to the core diameter and the numerical aperture of the fiber and to the desired field of view. The fiber also determines the product of beam diameter and divergence , all following optics has to match that product in order to avoid transmission losses and shadowing effects. The stability of the mounting has to meet the same requirements as the transmitter optics.

To separate the signal from unwanted background the field of view of the receiver can be made rather narrow, a little wider than the divergence of the tranmitted beam. Limits are posed by turbulent refraction effects that distort the beam, and by the range at which complete overlap between the transmitted beam and the receiver field of view is desired. A typical value used in many systems is $1mrad$ for the full angle.

Further reduction of the background is accomplished by spectral filtering. For elastic backscatter the bandwidth can be made quite narrow, and efficient filtering is easily achieved using standard components. For detection of Raman scattering the filter width should match the spectral width of the Raman band. The crucial parameter in this application is the blocking of the elastic signal, which has to be better than 10^8 to avoid crosstalk between the channels.

3.3 Detector and data acquisition

The main problems in the detection of lidar signals are the huge dynamic range which spans many orders of magnitude when no measures are taken to reduce it, and the weakness of the signals. The detector can be operated either in the photon-counting or in the analog detection mode. Both techniques are actually applied within EARLINET, often a combination is employed in a single system. In the UV wavelength region mostly photomultiplier tubes are used, in the visible and IR silicon avalanche photodiodes exhibit the same or better performance in the analog mode. For data acquisition special transient recorders are employed which can be operated repetitively, with sample frequencies of typically 10 MHz, corresponding to 15 m range resolution, and record length of about 1000 samples (15 km range). Many different variants are used. For the detectors operating in photon counting mode multichannel scalers are used for data acquisition. Count rate should be as high as possible, certainly > 100 MHz, dwell time and record length should be the same as for analog transient recorders. Special hard- or software is generally used to accumulate a larger number of shots.

4 Lidar Instruments, Individual Descriptions

The individual systems are described in tabular form, giving the main system characteristics as well as a list of planned upgrades that will be installed during the course of the project. A summarising table for all systems is also included at the end.

4.1 University of Wales, Aberystwyth (UCWA.DP)

Contractor	: UCWA.DP
Location	: Aberystwyth
Coordinates	: 52.4 N, 4.06 W
Laser type	: Spectron Lasers SLG805G Nd:YAG
Emitted wavelengths	: 355 nm
Pulse energy (typ)	: 200 mJ
Rep. Rate	: 15 Hz
Detected wavelengths	: 355, 387, 407 (Raman wavelengths night-time only)
Detectors	: PMT, EMI 9124A
Data acquisition	: Photon counting, Turbo-MCS
Filter bandwidth FWHM	: 5.8 nm (355), 2.8 nm (387), 1.7 nm (407)
Scanning capability	: no
Altitude range (typ.)	: 500-8000
Range resolution (raw)	: 30 m
Time resolution (raw)	: 5.5 mins
continuous acquisition	: Typical measurement will be 0.5 hr
Additional instruments	: boundary layer wind profiler

4.2 Ethnikon Polytechnion Athinon, Athens, (NTUA.DP.LLA)

Contractor	: NTUA.DP.LLA
Location	: Athens
Coordinates	: 37.9716 N, 23.7875 E
Laser type	: Nd:YAG, Continuum, Minilight I
Emitted wavelengths	: 532 nm
Pulse energy (typ.)	: 12 mJ
Repetition rate (typ.)	: 10 Hz
Detector Channels	
1.	
Wavelength	: 532 nm
Detector	: PMT, Hamamatsu, R928
Data acquisition mode	: 300 MHz, Photon counting
Filter bandwidth	: 1.0 nm Interference filter
Scanning capability	: no
Altitude range (typ.)	: 500-5000 m asl
Range resolution ph.c.(raw)	: 7.5-15 m
Time resolution ph.c. (raw)	: 6 min
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: Meteorological data (P,T,U) on a continuous basis, operated by NTUA, Department of Hydraulic

Planned upgrade

Contractor	: NTUA.DP.LLA
Location	: Athens
Coordinates	: 37.9716 N, 23.7875 E
Laser type	: Nd:YAG, QUANTEL, Brilliant
Emitted wavelengths	: 355 nm, 532 nm
Pulse energy (typ.)	: 65 mJ, 90 mJ
Repetition rate (typ.)	: 10 Hz
Detector Channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, Hamamatsu, R928
Data acquisition mode	: 300 MHz, Photon counting
Filter bandwidth	: 3 nm Interference filter
2.	
Wavelength	: 387 nm
Detector	: PMT, Hamamatsu, R5700-P06
Data acquisition mode	: 300 MHz, Photon counting (nighttime)
Filter bandwidth	: 3 nm Interference filter
3.	
Wavelength	: 532 nm
Detector	: PMT, Hamamatsu, R928
Data acquisition mode	: 300 MHz, Photon counting (daytime)
Filter bandwidth	: 1 nm Interference filter
Scanning capability	: no
Altitude range (typ.)	: 500-7000 m asl
Range resolution ph.c.(raw)	: 7.5-15 m
Time resolution ph.c. (raw)	: 60-90 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: Meteorological data (P,T,U) on a continuous basis, operated by NTUA, Department of Hydraulic

4.3 Universitat Polytécnica de Catalunya, Barcelona, (UPC.DTSC)

Contractor	: UPC.DTSC
Location	: Barcelona
Coordinates	: 41.393 N, 2.120 E
Laser type	: Nd:YAG, Quantel Brilliant
Emitted wavelengths	: 1064 nm
Detected wavelengths	: 1064 nm
Scanning capability	: yes. 300^o azimuth / 90^o elevation
Altitude range (typ.)	: 250 -10000 m
Range resolution (raw)	: 7.5 m
Time resolution (raw)	: 60 s
continuous acquisition	: yes
Transportable system	: yes
Additional instruments	: Portable aerosol spectrometer (mod. GRIMM 1158) pyranomenter (Kipp & Zonen)

Planned upgrade

Contractor	: UPC
Location	: Barcelona
Coordinates	: 41.393 N, 2.120 E
Laser type	: Nd:YAG, Quantel Brilliant
Emitted wavelengths	: 532 nm, 1064 nm
Typ. energy per pulse	: 150 mJ, 150 mJ
Repetition rate	: 20 Hz
Detector channels	
1.	
Wavelength	: 532 nm
Detector	: APD, EG&G C30956E
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 10 nm
2.	
Wavelength	: 1064 nm
Detector	: APD, EG&G C30956E
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 10 nm
3.	
Wavelength	: 607.4 nm
Detector	: PMT, Hamamatsu (model TBD)
Data acquisition mode	: Photon counting
Filter bandwidth	: 3 nm
Scanning capability	: no
Altitude range	: 250 - 10000 m
Range resolution anal. (raw)	: 15 m
Range resolution ph. c. (raw)	: TBD
Time resolution anal. (raw)	: 60 s
Time resolution ph. c. (raw)	: TBD
Continuous acquisition	: yes
Transportable system	: yes
Additional instruments	: Portable aerosol spectrometer (GRIMM 1158) Pyranometer (Kipp & Zonen)

4.4 Fraunhofer Institut für Umweltforschung, Garmisch-Partenkirchen (FHG.IFU)

Contractor	: FHG.IFU
Location	: Garmisch-Partenkirchen
Coordinates	: 47.476 N, 11.063 E, 730 m a.s.l.
Laser type	: Nd:YAG, QuantaRay DCR-11
Emitted wavelengths	: 355 nm, 532 nm, 1064 nm
Pulse energy (typ.)	: 400 mJ (total)
Repetition rate (typ.)	: 10 Hz
Detector channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, RSV GmbH
Data acquisition mode	: 12 bit, 10 MHz analog
Filter bandwidth	: 0.5 nm interference filter
2.	
Wavelength	: 532 nm
Detector	: PMT, RSV GmbH
Data acquisition mode	: 12 bit, 10 MHz analog
Filter bandwidth	: 0.5 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: Pin Photodiode, RSV GmbH
Data acquisition mode	: 12 bit, 10 MHz analog
Filter bandwidth	: 0.5 nm interference filter
Scanning capability	: 0 to 90 degr. in elevation, -90 degr. to +90 degr. in azimuth
Altitude range (typ.)	: approx. 0.2 - 10 km
Range resolution anal. (raw)	: 15 m
Time resolution anal. (raw)	: 30 s (between measurements)
Continuous acquisition	: possible with minor modifications
Transportable system	: yes
Additional instruments	: visibility meter at Zugspitze summit (2960 m a.s.l.) pyranomenter (Kipp & Zonen)

Planned upgrade

Contractor	: FHG.IFU
Location	: Garmisch-Partenkirchen
Coordinates	: 47.476 N, 11.063 E, 730 m a.s.l.
Laser type	: Nd:YAG, QuantaRay DCR-11
Emitted wavelengths	: 355 nm, 532 nm, 1064 nm
Typ. energy	: 400 mJ (total)
Repetition rate (typ.)	: 10 Hz
Detector channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, RSV GmbH
Data acquisition mode	: 12 bit, 40 MHz analog
Filter bandwidth	: 0.5 nm interference filter
2.	
Wavelength	: 532 nm
Detector	: PMT, RSV GmbH
Data acquisition mode	: 12 bit, 40 MHz analog
Filter bandwidth	: 0.5 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: Pin Photodiode, RSV GmbH
Data acquisition mode	: 12 bit, 40 MHz analog
Filter bandwidth	: 0.5 nm interference filter
Scanning capability	: 0 to 90 degr. in elevation, -90 degr. to +90 degr. in azimuth
Altitude range (typ.)	: 0.2 - 10 km
Range resolution anal. (raw)	: 3.75 m
Time resolution anal. (raw)	: 30 s (between measurements)
Continuous acquisition	: possible with minor modifications
Transportable system	: yes
Additional instruments	: visibility meter at Zugspitze summit (2960 m a.s.l.)

4.5 Max-Planck-Institut für Meteorologie, Hamburg, (MPG.IMET)

Contractor	: MPG.IMET
Location	: Hamburg
Coordinates	: 53.568 N, 9.973 E
Laser type	: XeF-Excimer, Lambda Physik EMG 201 EMG
Emitted wavelengths	: 351 nm
Pulse energy (typ.)	: 40 mJ
Repetition rate (typ.)	: 20 Hz
Detector channels	
1.	
Wavelength	: 351 nm
Detector	: PMT, EMI 9883 QB
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 5 nm interference filter
2.	
Wavelength	: 387 nm
Detector	: PMT, EMI 9893 QB 350
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 1.5 nm interference filter
Scanning capability	: no
Altitude range (typ.)	: 300 - 9000 m asl
Range resolution anal. (raw)	: 15 m
Range resolution ph.c. (raw)	: 30 m
Time resolution anal. (raw)	: 10 s
Time resolution ph.c. (raw)	: 30 s
Continuous acquisition	: yes
Transportable system	: yes
Additional instruments	: ceilometer (continuous measurement) sunphotometer (in the frame of AERONET)

Planned upgrade

Contractor	: MPG.IMET
Location	: Hamburg
Coordinates	: 53.568 N, 9.973 E
Laser type	: Nd:YAG, Continuum Powerlite 7030
Emitted wavelengths	: 355 nm, 532 nm, 1064 nm
Typ. energy	: 110 mJ, 60 mJ, 200 mJ
Repetition rate (typ.)	: 30 Hz
Detector channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, EMI 9883 QB
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 10 nm interference filter
2.	
Wavelength	: 532 nm
Detector	: APD, Advanced Photonics
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 3 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: APD, Advanced Photonics
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 10 nm interference filter
4.	
Wavelength	: 387 nm
Detector	: PMT, EMI 9893 QB 350
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 3 nm
5.	
Wavelength	: 402 nm
Detector	: PMT, EMI 9893 QB 350
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 3 nm interference filter
Scanning capability	: no
Altitude range (typ.)	: 300 - 9000 m asl
Range resolution anal. (raw)	: 15 m
Range resolution ph.c. (raw)	: 30 m
Time resolution anal. (raw)	: 10 s
Time resolution ph.c. (raw)	: 30 s
Continuous acquisition	: yes
Transportable system	: yes
Additional instruments	: ceilometer (continuous measurement)
	sunphotometer (in the frame of AERONET)

4.6 Ecole Polytechnique Fédérale de Lausanne, (EPFL.DGR.PAS)

Contractor	: EPFL.DGR.PAS
Location	: Jungfraujoch
Coordinates	: 46.5481 N 7.9839 E, 3580 m altitude
Laser type	: Nd:YAG, Coherent Infinity 40-100
Emitted wavelengths	: 1064 nm, 532 nm, 355 nm
Pulse energy (typ.)	: 400 mJ
Repetition rate (typ.)	: 40 Hz
Telescope diameter	: 20 cm
Detector channels	
1.	
Wavelength	: 1064 nm
Detector	: Cooled Avalanche Photodiode EG&G C30955
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 1 nm interference filter
2.	
Wavelength	: 532 nm parallel polarisation
Detector	: PMT, Hamamatsu H6780-06
Data acquisition mode	: 12 bit analog and 250 MHz photon counting
Filter bandwidth	: 1 nm interference filter
3.	
Wavelength	: 532 nm cross polarisation
Detector	: PMT, Hamamatsu H6780-06
Data acquisition mode	: 12 bit analog and 250 MHz photon counting
Filter bandwidth	: 1 nm interference filter
3.	
Wavelength	: 387 nm
Detector	: PMT, Thorn Emi 9829 QA
Data acquisition mode	: 12 bit analog and 250 MHz photon counting
Filter bandwidth	: 5 nm interference filter
4.	
Wavelength	: 355 nm
Detector	: PMT, Hamamatsu H6780-06
Data acquisition mode	: 12 bit analog and 250 MHz photon counting
Filter bandwidth	: 1 nm interference filter
Scanning capability	: no
Altitude range (typ.)	: 4000 - 11000 m asl
Range resolution anal. (raw)	: 7.5 m
Range resolution ph.c. (raw)	: 7.5 m
Time resolution anal. (raw, typ.)	: 100 s
Time resolution ph.c. (raw, typ.)	: 100 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: sunphotometer (operated by Swiss Meteo, needs agrement before using the data)

Planned upgrade

Contractor	: EPFL.DGR.PAS
Location	: Jungfraujoch
Coordinates	: 46.5481 N 7.9839 E, 3580 m altitude
Duplication of the system with a 76 cm telescope	
Altitude range with both telescopes (typ.)	: 4000 - 80000 m asl

4.7 Institut für Atmosphärenphysik, Kühlungsborn, (IATPH)

Contractor	: IATPH
Location	: Kühlungsborn, Germany
Coordinates	: 54.1167N, 11.7667E
Laser type	: Nd:YAG, Spectra Physics GCR 290
Emitted wavelengths	: 355, 532, 1064 nm
Pulse energy	: 200, 400, 500 mJ
Repetition rate	: 30 Hz
Detector channels	:
1.	
Wavelength	: 354.7 nm
Detector	: PMT, Hamamatsu 4220P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 0.92 nm interference filter
2.	
Wavelength	: 386.7 nm
Detector	: PMT, Hamamatsu 4220P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 1.0 nm interference filter
3.	
Wavelength	: 532.1 nm
Detector	: PMT, Hamamatsu 4632P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 0.35 nm interference filter
4.	
Wavelength	: 607.4 nm
Detector	: PMT, Hamamatsu 4632P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 0.36 nm interference filter
5.	
Wavelength	: 1064.1 nm
Detector	: PMT, Hamamatsu R3236 (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 1.0 nm interference filter
6.	
Wavelength	: 529.1, 530.4, 532.1 nm (Rotating Filter Wheel)
Detector	: PMT, Hamamatsu 4632P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: interference filters: 0.5 nm (529.1), 0.47 nm (530.4), 0.36 nm (532.1)
Polarization filter	: possible settings: vertical, parallel, neutral
Scanning capability	: no
Altitude range (typ.)	: 1000 - 12000 m, 10000 - 35000 m
Range resolution (raw)	: 50 m
Time resolution (raw)	: 8 s, 33 s, 133 s (typical)
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: multi-metal resonance lidar (2 dye lasers, 1 alexandrite laser, 3 wavelengths for altitudes $>$ 30 km, 1 in troposphere (423 nm)), ozone lidar (308 nm excimer laser), Vaisala balloon launch facility

Planned upgrade

Contractor	: IAP
Location	: Kühlungsborn, Germany
Coordinates	: 54.1167N, 11.7667E
1.) Detector channels	
Wavelength	: 407.5 nm (H_2O Raman)
Detector	: PMT, Hamamatsu 4220P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 0.5 nm interference filter
Wavelength	: 913 nm (O_2 Raman)
Detector	: Avalanche Photodiode
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 0.5 nm (?) (not yet specified)
2.) ”Low Raman” Telescope	:
Altitude range	: 200 - 3000
Wavelength	: 387 nm
Detector	: PMT, Hamamatsu 4220P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 10 nm interference filter
Wavelength	: 608 nm
Detector	: PMT, Hamamatsu 4632P (selected)
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 10 nm interference filter

4.8 Dipartimento di Fisica - Universit Degli Studi-L’Aquila, (ULAQ.DF)

Contractor	: ULAQ.DF
Location	: L’Aquila - Italy
Coordinates	: 42.344N - 13.327E - 683m asl
Transmitter	
Laser type	: XeF-Excimer, Lambda Physik EMG 150 MSC
Emitted wavelengths	: 351 nm
Pulse energy (typ.)	: 60 mJ
Repetition rate (typ.)	: 30-80Hz
Receiver	
Cassegrain 1m primary mirror, f10 telescope	
Detector channels	
1.	
Wavelength	: 351 nm
Detector	: PMT, EMI 9214 QA
Data acquisition mode	: 100Mhz photon counting
Filter bandwidth	: 7 nm interference filter + 351nm notch
2.	
Wavelength	: 382 nm
Detector	: PMT, EMI 9214 QA
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter + 351nm notch
3.	
Wavelength	: 403 nm
Detector	: PMT, EMI 9214 A
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 3 nm interference filter + 351nm notch
Scanning capability	: no
Altitude range (typ.)	: 1000 - 12000 m asl
Range resolution photon counting (raw)	: 300 m
Time resolution photon counting (raw)	: 300 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: PTU balloon sounding, SODAR

Planned upgrade

Contractor	: ULAQ.DF
Location	: L'Aquila - Italy
Coordinates	: 42.344N - 13.327E - 683m asl

Addition of "liquid water" channel:
4.

Wavelength	: 398-400 nm
Detector	: PMT, EMI 9214 A
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 1-3 nm interference filter + 351nm notch
	Improvement of the range resolution photon counting to 30 m

4.9 Istituto Nazionale per la Fisica della Materia, Lecce (INFM)

Contractor	: INFM-Lecce
Location	: Lecce - Italy
Coordinates	: 40.33N, 18.10E
Laser type	: XeF-Excimer, Lambda Physik LPX210i
Emitted wavelengths	: 351 nm
Pulse energy (typ.)	: 50 mJ
Repetition rate (typ.)	: 80 Hz
Detector channels	
1.	
Wavelength	: 351 nm
Detector	: PMT, Hamamatsu R212UH
Data acquisition mode	: 8 bit analog, 150 MHz photon counting
Filter bandwidth	: 2-4 nm double monochromator
2.	
Wavelength	: 382 nm
Detector	: PMT, Hamamatsu R1527
Data acquisition mode	: 150 MHz photon counting
Filter bandwidth	: 2-4 nm double monochrometer
Scanning capability	: no
Altitude range (typ.)	: 400 - 7000 m a.s.l.
Range resolution analog	: 1.5 m
Range resolution photon counting	: 15 m
Time resolution (raw)	: 3 minutes
continuous acquisition	: yes
Transportable system	: no
Additional instruments	: no

Planned upgrade

Contractor	: INFM-Lecce
Location	: Lecce, Italy
Coordinates	: 40.33N, 18.10E
Detector channels	
1.	
Wavelength	: 351 nm
Detector	: PMT, EMI 9893B/350
Data acquisition mode	: 8 bit analog, 150 MHz photon counting
Filter bandwidth	: 10 nm interference filter
2.	
Wavelength	: 382 nm
Detector	: PMT, EMI 9893B/350
Data acquisition mode	: 8 bit analog, 150 MHz photon counting
Filter bandwidth	: 3 nm interference filter
3.	
Wavelength	: 403 nm
Detector	: PMT, EMI 9893B/350
Data acquisition mode	: 8 bit analog, 150 MHz photon counting
Filter bandwidth	: 3 nm interference filter
Scanning capability	: yes

4.10 Institut für Troposphärenforschung, Leipzig, (IFT)

Contractor	: IfT
Location	: Leipzig
Coordinates	: 51.35 N, 12.43 E
Laser type	: Nd:YAG, Spectra Physics GCR-290-30
Emitted wavelengths	: 1064, 532, 355 nm
Pulse energy (typ.)	: 1.6 J
Repetition rate	: 30 Hz

Detector channels

1. Wavelength	: 355 nm (elastic)
Detector	: PMT, EMI 9893Q/350B
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 5 nm interference filter
2. Wavelength	: 387 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 3 nm interference filter
3. Wavelength	: 408 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 3 nm interference filter
4. Wavelength	: 532 nm (elastic, parallel polarized)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 5 nm interference filter
5. Wavelength	: 532 nm (elastic, cross polarized)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 5 nm interference filter
6. Wavelength	: 607 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 3 nm interference filter
7. Wavelength	: 1064 nm (elastic)
Detector	: PMT, Hamamatsu R3236
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 5 nm interference filter
8. Wavelengths	: 530.3+533.7 nm (rot. Raman (J=6), nitrogen)
Detector	: PMT, EMI 9893Q/350B
Data acquisition mode	: 300 MHz photon counting
Wavelength separation	: double grating monochromator
9. Wavelengths	: 529.0+535.0 nm (rot. Raman (J=12), nitrogen)
Detector	: PMT, EMI 9893Q/350B
Data acquisition mode	: 300 MHz photon counting
Wavelength separation	: double grating monochromator

Scanning capability	: no
Altitude range (typ.)	: extinction + Klett: 3 km - tropopause
	: (with corrections for overlap: 0.5 km - tropopause)
	: backscatter (Raman) : 100 m - tropopause
Range resolution (raw)	: 60 m
Time resolution (raw)	: 30 s
continuous acquisition	: yes
Transportable system	: no
Additional instruments	: sun photometer (regular measurements)
	radio sonde (under special conditions and for calibration)

Planned upgrade

Contractor	: IfT
Location	: Leipzig
Coordinates	: 51.35 N, 12.43 E
2. Wavelength	: 387 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 0.5 nm interference filter
3. Wavelength	: 408 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 0.5 nm interference filter
6. Wavelength	: 607 nm (vibr. Raman, nitrogen)
Detector	: PMT, EMI 9893Q/350A
Data acquisition mode	: 300 MHz photon counting
Filter bandwidth	: 0.5 nm interference filter
8. Wavelengths	: 530.3+533.7 nm (rot. Raman (J=6), nitrogen)
Detector	: PMT, EMI 9893Q/350B
Data acquisition mode	: 300 MHz photon counting
Wavelength separation	: single grating monochromator
Background suppression	: Fabry-Perot interferometer
9. Wavelengths	: 529.0+535.0 nm (rot. Raman (J=12), nitrogen)
Detector	: PMT, EMI 9893Q/350B
Data acquisition mode	: 300 MHz photon counting
Wavelength separation	: single grating monochromator
Background suppression	: Fabry-Perot interferometer
Scanning capability	: no
Altitude range (typ.)	: extinction + Klett: 0.5 km - tropopause
	: backscatter (Raman) : 0 m - tropopause
Range resolution (raw)	: 60 m
Time resolution (raw)	: 30 s
continuous acquisition	: yes
Transportable system	: no
Additional instruments	: sun photometer (continuous measurement)
	radio sonde (under special conditions and for calibration)

4.11 Instituto Superior Técnico, Lisbon, (IST.CFP)

Contractor	: IST.CFP
Location	: LISBON
Coordinates	: 37 N, 8.5 W
Laser type	: Nd-Yag
Emitted wavelengths	: 1064 nm (plus 532 nm in progress)
Detected wavelengths	:
	1064 nm (elastic)
	(532 nm elastic in progress)
Scanning capability	: yes
Altitude range (typ.)	: 300 - 5000 m asl, (extension to higher ranges in progress)
Range resolution (raw)	: 1.5 m
Time resolution (raw)	: 1 s
continuous acquisition	: yes
Additional instruments	: none

4.12 Försvarets Forskningsanstalt, Linköping, (FOA)

Contractor	: FOA
Location	: Linköping
Coordinates	: 58.392 N, 15.575 E
Laser type	: Nd:YAG, Quantel Brilliant B
Emitted wavelength	: 355 nm, third harmonic
Pulse energy at 355	: 170 mJ
Pulse length	: 5 ns
Pulse repetition rate	: 10 Hz
Beam divergence	: $<$ 0.3 mrad
Receiver	: Cassegrain telescope with photomultiplier detector
Detected radiation	: Elastic scattering at 355 nm
Telescope diameter	: 30 cm
Field of view	: 0.4 mrad or wider
Filter bandwidth	: 12 nm
Detector	: PMT, Hamamatsu H6780-03
Data acquisition	: Transient recorder, Licel TR40-160 and PC
Sampling rate	: 40 MHz
Acquisition mode	: 12 bit analog, photon counting is available
Scanning capability	: no
Altitude range	: 100 - 10000 meters
Range resolution	: 7.5 m
Time resolution	: 0.1 s - 300 s, 300 s is normal
Continous acquisition	: possible
Addition. instruments	: Nephelometer for visibility and pyranometer

Comment: The lidar at FOA is designed to be eyesafe with emission at wavelengths, where the human eye is nontransparent. The configuration is coaxial, which means that the laser beam is emitted along the optical axis of the receiver.

Planned upgrade

Contractor	: FOA
Location	: Linköping

1. Detector for Raman scattering from N_2

Detection wavelength	: 386.7 nm
Filter bandwidth	: 3 nm
Detector	: PMT, Hamamatsu H5783-03 or H6780-03
Data acquisition	: 250 MHz photon counting

2. IR-lidar

Source	: Raman cell with Methane, pumped by the YAG-laser
Emitted wavelength	: 1540 nm
Pulse energy	: about 80 mJ
Detected radiatio	: elastic scattering
Telescope and acquis.	: as with UV-lidar
Filter bandwidth	: 31 nm
Detector	: InGaAs-diode

4.13 Institute of Physics - Academy of Sciences of Belarus, Minsk, (IAP.LSMO)

System 1

Contractor	: BISIP.SMO
Location	: Minsk, Belarus
Coordinates	: 53.917 N, 27.383 E
Laser type	: Excimer-XeCl and Raman cell; YAG
Emitted wavelengths	: 353; 532
Pulse energy (typ.)	: 20 mJ;
Repetition rate (typ.)	: 10-20 Hz

Detector channels:

1.

Wavelength	: 353 nm
Detector	: PMT 175
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter

2.

Wavelength	: 532 nm, p and s- components
Detector	: PMT 140; PMT 140
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter

Scanning capability	: no
Altitude range (typ.)	: 2000 - 30000 m
Range resolution (raw)	: 64 m
Time resolution (raw)	: 600 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: ozone and CO2 lidars

Planned upgrade

Contractor	: BISIP.SMO
Location	: Minsk, Belarus
Coordinates	: 53.917 N, 27.383 E
Laser type	: Excimer-XeCl and Raman cell; YAG
Emitted wavelengths	: 353; 532
Pulse energy (typ.)	: 20 mJ;
Repetition rate (typ.)	: 10-20 Hz
Detector channels:	
1.	
Wavelength	: 353 nm
Detector	: PMT 175
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter
2.	
Wavelength	: 384 nm
Detector	: PMT 175
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter
3.	
Wavelength	: 532 nm, p and s- components
Detector	: PMT 140; PMT 140
Data acquisition mode	: 100 MHz photon counting
Filter bandwidth	: 5 nm interference filter
Scanning capability	: no
Altitude range (typ.)	: 2000 - 30000 m
Range resolution (raw)	: 64 m
Time resolution (raw)	: 600 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: ozone and CO_2 lidars; Operated by other groups spectral UV measurements, sunphotometer, Radiosonde, general meteorological measurements

System 2

Contractor	: BISIP.SMO
Location	: Minsk, Belarus
Coordinates	: 53.917 N, 27.383 E
Laser type	: YAG and Ruby
Emitted wavelengths	:1064, 532; 694
Pulse energy (typ.)	: 100mJ, 20 mJ; 500mJ
Repetition rate (typ.)	: 10 Hz; 0.1 Hz
Detector channels	
1.	
Wavelength	: 532 nm
Detector	: PMT 84
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 4 nm interference filter
2.	
Wavelength	: 694 nm
Detector	: PMT 84
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 5 nm interference filter
Scanning capability	: yes
Altitude range (typ.)	: 500 - 10000 m
Range resolution (raw)	: 15 m
Time resolution (raw)	: 200 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: ozone and CO2 lidars

Planned upgrade

Contractor	: BISIP.SMO
Location	: Minsk, Belarus
Coordinates	: 53.917 N, 27.383 E
Laser type	: YAG and Ruby
Emitted wavelengths	:1064, 532; 694, 347
Pulse energy (typ.)	: 100mJ, 20 mJ; 500mJ, 25mJ
Repetition rate (typ.)	: 10 Hz; 0.1 Hz
Detector channels	
1.	
Wavelength	: 532 nm
Detector	: PMT 84
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 4 nm interference filter
2.	
Wavelength	: 694 nm
Detector	: PMT 84
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 5 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: ADP
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 5 nm interference filter
4.	
Wavelength	: 347 nm
Detector	: PMT 175
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 5 nm interference filter
Scanning capability	: yes
Altitude range (typ.)	: 500 - 10000 m
Range resolution (raw)	: 15 m
Time resolution (raw)	: 200 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: ozone and CO2 lidars; Operated by other groups spectral UV measurements, sunphotometer, Radiosonde, general meteorological measurements

4.14 Ludwig-Maximilians-Universität, München, (UMUEN.MI)

Contractor	: UMUEN.MI
Location	: Munich
Coordinates	: 48.15 N, 11.57 E
Laser type	: Nd:YAG, Continuum Surelite II
Emitted wavelengths	: 355 nm, 532 nm, 1064 nm
Typ. energy	: 175 mJ, 50 mJ, 175 mJ
Repetition rate (typ.)	: 10 Hz
Detector channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, Hamamatsu R5600
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 1.0 nm interference filter
2.	
Wavelength	: 532 nm
Detector	: PMT, Hamamatsu R5600
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 1.1 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: PIN
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 2.7 nm interference filter
Scanning capability	: yes
Altitude range (typ.)	: 200 m - 5000 m
Range resolution (raw)	: 3.75 m
Time resolution (raw)	: 0.1 s
continuous acquisition	: yes
Additional instruments	: none

Planned upgrade

Contractor	: UMUEN.MI
Location	: Munich
Coordinates	: 48.15 N, 11.57 E
Laser type	: Nd:YAG, Continuum Surelite II
Emitted wavelengths	: 355 nm, 532 nm, 1064 nm
Typ. energy	: 175 mJ, 50 mJ, 175 mJ
Repetition rate (typ.)	: 10 Hz
Detector channels	
1.	
Wavelength	: 355 nm
Detector	: PMT, Hamamatsu R5600
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 1.0 nm interference filter
2.	
Wavelength	: 532 nm
Detector	: PMT, Hamamatsu R5600
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 1.1 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: PIN
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 2.7 nm interference filter
4.	
Wavelength	: 387 nm
Detector	: PMT, Hamamatsu R7400
Data acquisition mode	: 250 MHz photon counting
Filter bandwidth	: 0.5/3 nm interference filter
5.	
Wavelength	: 607 nm
Detector	: PMT, Hamamatsu R7400
Data acquisition mode	: 250 MHz photon counting
Filter bandwidth	: 0.5/3 nm interference filter

Scanning capability	: yes
Altitude range (typ.)	: 200 m - 8000 m
Range resolution anal. (raw)	: 3.75 m
Range resolution ph.c. (raw)	: up to 3.75 m
Time resolution anal. (raw)	: 0.1 s
Time resolution ph.c. (raw)	: 40 s
continuous acquisition	: yes

Additional instruments	: none

4.15 Istituto Nazionale per la Fisica della Materia, Napoli, (INFM)

Contractor	: INFM
Location	: Napoli
Coordinates	: 40.833 N, 14.183 E
Altitude	: 0 m a.s.l.
Laser type	: XeF excimer
Emitted wavelengths	: 351 nm
Detected wavelengths	: 351 nm (elastic)
	382 nm (vibr. Raman, nitrogen)
Scanning capability	: no
Altitude range (typ.)	: 250 - 3000 m a.s.l.
Range resolution (raw)	: 15 m
Time resolution (raw)	: 1 minute
continuous acquisition	: yes
Additional instruments	: ground level measurements of: pressure, temperature, R.H.

4.16 Observatoire Cantonal, Neuchâtel, (OCN.LG)

Contractor	: OCN.LG
Location	: Neuchâtel, Switzerland
Coordinates	: 47.001 N, 6.955 E (geographical), 487 m asl
Laser type	: Nd:YAG, Quanta System HYL102
Emitted wavelengths	: 1064nm. 532nm, 355nm
Pulse energy (typ.)	: 110 mJ, 60 mJ, 50 mJ
Repetition rate	: 20 Hz
Detector channels	
1.	
Wavelength	: 355 nm, total
Detector	: PMT, EMI 9829 QB
Data acquisition mode	: analog, 8 bit single shot
Filter bandwidth	: 2 nm interference filter
2.	
Wavelength	: 532 nm, P-polarised
Detector	: PMT, EMI 9829 QB
Data acquisition mode	: analog, 8 bit single shot
Filter bandwidth	: 0.25 nm interference filter
3.	
Wavelength	: 532 nm, S-polarised
Detector	: PMT, EMI 9829 QB
Data acquisition mode	: analog, 8 bit single shot
Filter bandwidth	: 0.25 nm interference filter
4.	
Wavelength	: 1064 nm, total
Detector	: APD, EG&G C30955E
Data acquisition mode	: analog, 8 bit single shot
Filter bandwidth	: 2 nm interference filter

Scanning capability	: no
Altitude range (typ.)	: 987 - 11000 m asl (500m-10500m agl)
Range resolution (raw)	: 15 m
Time resolution (raw)	: 200 s
continuous acquisition	: yes
Transportable system	: no

Additional instruments	: general meteorological instruments (ground based) compact transportable depolarisation-backscatter lidar at 532nm

Planned upgrade

Contractor : OCN.LG
Location : Neuchâtel, Switzerland
Coordinates : 47.001 N, 6.955 E (geographical), 487 m asl
Detector channels
1.
Wavelength : 355 nm, total
Detector : PMT, EMI 9829 QB
Data acquisition mode : analog, 8 bit single shot; 100 MHz photon counting
Filter bandwidth : 2 nm interference filter
2.
Wavelength : 532 nm, P-polarised
Detector : PMT, EMI 9829 QB
Data acquisition mode : analog, 8 bit single shot; 100 MHz photon counting
Filter bandwidth : 0.25 nm interference filter
3.
Wavelength : 532 nm, S-polarised
Detector : PMT, EMI 9829 QB
Data acquisition mode : analog, 8 bit single shot; 100 MHz photon counting
Filter bandwidth : 0.25 nm interference filter
4.
Wavelength : 1064 nm, total
Detector : APD, EG&G C30955E
Data acquisition mode : analog, 8 bit single shot
Filter bandwidth : 2 nm interference filter
5.
Wavelength : 387 nm, Raman N2
Detector : PMT, EMI 9829 QB
Data acquisition mode : 100 MHz photon counting
Filter bandwidth : 0.5 nm interference filter

Range resolution anal. (raw) : 15 m
Range resolution ph.c. (raw) : 37.5 m
Time resolution (raw) : 200 s
Continuous acquisition : yes
Transportable system : no

Additional instruments : general meteorological instruments (ground-based);
compact transportable depolarisation-backscatter lidar at 532nm

4.17 Ecole Normale Supérieure, Palaiseau, (ENSUP.LMD)

Contractor	: IPSL
Location	: Ecole Polytechnique, Palaiseau, France
Coordinates	: 48.42 N - 2.16 E
Laser type	: Surelite II Continuum
Emitted wavelengths	: 532 nm, 1064 nm
Pulse energy (typ.)	: 100 mJ, 200 mJ
Repetition rate (typ.)	: 20 Hz
Detector channels	
1.	
Wavelength	: 532 nm (parallel polarized)
Detector	: PM, Hamamatsu, R268
Data acquisition mode	: 8 bit analog
Filter bandwidth	: 3 nm interference filter
2.	
Wavelength	: 532 nm (cross polarized)
Detector	: PM, Hamamatsu,R268
Data acquisition mode	: 8 bit analog
Filter bandwidth	: 3 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: PM, Hamamatsu, R31602
Data acquisition mode	: 8 bit analog
Filter bandwidth	: 3 nm interference filter
Scanning capability	: no
Altitude range (typ.)	: 500 - 15000 m
Range resolution anal. (raw)	: 15 m
Time resolution anal. (raw)	: 10 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: pyranometer, pyrgeometer, (continuous measurement) sunphotometer (in the frame of AERONET)

Planned upgrade

Contractor	: IPSL
Location	: Ecole Polytechnique, Palaiseau, France
Coordinates	: 48.42 N - 2.16 E
Laser type	: Surelite II Continuum
Emitted wavelengths	: 532 nm, 1064 nm
Pulse energy (typ.)	: 100 mJ, 200 mJ
Repetition rate (typ.)	: 20 Hz
Detector channels	
1.	
Wavelength	: 532 nm (parallel polarized)
Detector	: PM, Hamamatsu R268
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 3 nm interference filter
2.	
Wavelength	: 532 nm (cross polarized)
Detector	: PM, Hamamatsu R268
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 3 nm interference filter
3.	
Wavelength	: 1064 nm
Detector	: PM, Hamamatsu R31602
Data acquisition mode	: 12 bit analog
Filter bandwidth	: 3 nm interference filter
4.	
Wavelength	: 607 nm (vibr. Raman)
Scanning capability	: no
Altitude range (typ.)	: 500 - 15000 m
Range resolution anal. (raw)	: 15 m
Time resolution anal. (raw)	: 10 s
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: pyranometer, pyrgeometer, (continuous measurement) sunphotometer (in the frame of AERONET)

4.18 Istituto Nazionale per la Fisica della Materia, Potenza, (INFM)

Contractor	: INFM
Location	: Potenza - Italy
Coordinates	: 40.6 N, 15.733 E
Altitude	: 820 m a.s.l.
Laser type	: Nd-YAG
Emitted wavelengths	: 355 , 532 nm
Detected wavelengths	: 355, 532 nm (elastic)
	387 nm (vibr. Raman, nitrogen)
Scanning capability	: no
Altitude range (typ.)	: 1200 - 8000 m a.s.l.
Range resolution (raw)	: 15 m
Time resolution (raw)	: 1 minute
continuous acquisition	: yes
Additional instruments	: ground level measurements of:
	pressure, temperature, R.H., wind speed and direction

4.19 Aristoteleio Panepistimio Thessalonikis, (UTHESS.PD.AP)

Contractor	: LAP-AUTH
Location	: Thessaloniki
Coordinates	: 40.5 N, 22.9 E
Laser type	: Nd:Yag, Quanta-Ray GCR-150
Emitted wavelengths	: 266, 289, 316 nm
Pulse energy (typ.)	: 8-25 mJ
Repetition rate (typ.)	: 10 Hz
Detector channels	
Wavelengths	: 266 nm, 289 nm, 316 nm
Detector	: PMT, Hamamatsu 5600P-06
Data acquisition mode	: 12 bit analog, 250 MHz photon counting
Wavelength separation	: Czerny-Turner spectrometer
Scanning capability	: no
Altitude range (typ.)	: 700 - 8000 m asl
Range resolution anal. (raw)	: 7.5 m
Range resolution ph.c. (raw)	: 30 m
Time resolution anal. (raw)	: 4 min
Time resolution ph.c. (raw)	: 4 min
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: spectral UV-B measurements (continuous measurement)
	: meteorological measurements (continuous measurement)

Planned upgrade

Contractor	: LAP-AUTH
Location	: Thessaloniki
Coordinates	: 40.5 N, 22.9 E
Laser type	: Nd:Yag, Quanta-Ray GCR-150
Emitted wavelengths	: 532, 355 nm
Pulse energy (typ.)	: 300-120 mJ
Repetition rate (typ.)	: 10 Hz
Detector channels	
Wavelengths	: 532 nm, 355 nm, 387 nm
Detector	: PMT, Hamamatsu 5600P-06
Filter bandwidth	:
Data acquisition mode	: 12 bit analog, 250 MHz photon counting
Scanning capability	: no
Altitude range (typ.)	: 700 - 8000 m asl
Range resolution anal. (raw)	: 7.5 m
Range resolution ph.c. (raw)	: 30 m
Time resolution anal. (raw)	: 1 min
Time resolution ph.c. (raw)	: 1 min (387 nm 30 min)
Continuous acquisition	: yes
Transportable system	: no
Additional instruments	: spectral UV-B measurements (continuous measurement)
	: meteorological measurements (continuous measurement)

Station no.	1	2	3	4	5	6	7	8	9	10	11	12	13	13.2	14	15	16	17	18	19
Detection channels																				
elastic backscatter																				
solar blind UV					u															x
UV	x	u		x	x	x	x	x	x	x		x	x	u	x	x	x		x	u
VIS		x	u	x	x	x	x			x	u		x	x	x		x	x	x	u
IR			x	x	x	x	x			x	x	u	x	x	x		x	x		
N_2 Raman scattering																				
solar blind UV					u															
UV	x	u			x	x	x	x	x	x		u		u	u	x	u		x	u
VIS			u				x			x					u			u		
water vapor channel	x				u		u	x	u	x										
temperature channel							x			x										
depolarisation channel					u	x	x			x							x	x		
scanning capability			x	x					u		x	x	x	x	x					x
system transportable			x	x	x						x	x			x		x			x
altitude limit low	0.5	0.5	.25	0.2	0.3	4.0	1.0	0.3	0.4	0.3	0.3	0.1	0.1	0.5	0.2	.25	1.0	0.5	1.2	0.7
altitude limit high	8.0	5.0	10.	10.	9.0	11.	35.	12.	7.0	12.	5.0	10.	30.	10.	5.0	3.0	10.	15.	8.0	8.0
range resolution (raw)	30	7.5	7.5	15	15	7.5	50	300	15	60	1.5	7.5	15	15	3.75	15	30	15	15	7.5
time resolution (raw)	330	360	1800	10	10	100	33	300	180	30	1	.1	10	200	0.1	60	200	10	60	240

Table 1: Overview over main system characteristics

1	Aberystwyth	2	Athens	3	Barcelona	4	Garmisch-Partenkirchen	5	Hamburg
6	Jungfraujoch	7	Kühlungsborn	8	L'Aquila	9	Lecce	10	Leipzig
11	Lisboa	12	Linköping	13	Minsk	14	München	15	Napoli
16	Neuchâtel	17	Palaiseau	18	Potenza	19	Thessaloniki		