

File Revision Date:
September 22, 2025

Data Set Description:

PI: Hannes Vogelmann
1976-1999: Horst Jäger; 2000-2018: Thomas Trickl
Instrument: Lidar
Site(s): Garmisch-Partenkirchen, Germany, 1976 - 2015
Zugspitze / Schneefernerhaus, Germany, after 2015
Measurement Quantities: Aerosol
Vertical range: 3 km - 45 km a.s.l.

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Instrument Description:

Location:

Until 2015: IMK-IFU, Garmisch-Partenkirchen, Germany, 47.477° N, 11.064° E, elevation 730 m a.s.l.

After 2015: Schneefernerhaus, Garmisch-Partenkirchen, Germany, 47.417°, 10.979° E, elevation 2675 m a.s.l.

Transmitter:

Until 1989: ruby laser, 694.3 nm

1991–2015: Quanta-Ray GCR-4 Nd:YAG laser; 1064 (1.1 J), 532 (0.6 J), 355 nm (0.3 J); pulse repetition rate 10 Hz

After 2015: Innolas Spitlight DPSS 250 Nd:YAG laser, injection seeded, 150 mJ at 532 nm; pulse repetition rate 100 Hz

Receiver:

Until 2015: 52 cm diameter Cassegrain telescope; variable chopper; bandwidth 1 nm (1064 nm, 532 nm), 10 nm (355 nm);

After 2015: 65 cm Newton telescope, no chopper; near-field and far-field channel; 1-nm interference filter in far-field channel

Detectors:

Until 2015: 2 EMI 9128A analog PMTs; 1 EMI D341 photon counting PMT

After 2015: 2 Hamamatsu R7400U-03 PMTs (actively stabilized) plus high-speed discriminator junction (both from Romanski Sensors); see (Trickl et al. 2020; Klanner et al., 2021)

After March 2024: Hamamatsu R9880U-113 Mini and Licel transient digitizer (40MHz).

1991-2015: Depolarization at 532 nm; CCD camera with variable FOV (B/W) 4-channel frame grabber (8 bit)

Signal and data processing:

1976-1989: home-made photon counting system

1991-2015: 4-channel transient recorder (10 bit, 50 MHz); 2-channel photon counter (FastComtec, 200 MHz, 8K, 32 bit, operated with 75-m bins).

After 2015: 6-channel transient digitizer (Licel, 12 bit, 20 MHz); 5-channel photon counter (FastComtec, MCS6A, 5 GHz, operated with 7.68-m bins); performance: see (Trickl et al., 2020; Klanner et al., 2021)

January 2024: FasComTec MCS6A photon counters replaced by Licel photon counting.

April 2025: New Licel Transient Digitizer (40MHz + photon counting). Recording extended from 60km to 120km with binning (40MHz / 2).

Algorithm Description:

Until 2015: Rayleigh normalization in reference altitude range 25 km to 35 km, atmospheric density from Munich radiosonde and NCEP data. Algorithm intercomparison: see (Steinbrecht et al., 1997)

After 2015: Rayleigh normalization at reference altitude range 30 km to 48 km atmospheric density from Munich radiosonde and NCEP data

In 2012 iterative approach replaced by Klett solution; algorithm intercomparisons within EARLINET, passed within less than 1 % deviation.

Expected Precision/Accuracy of Instrument:

Uncertainty:

Until 2015 (possibly too optimistic):

Uncertainty of maximum backscatter coefficients: 1% to 5%;

Uncertainty of integrated backscatter: 8% (volcanic), 15% (aged), 60% (background)

After 2015:

Uncertainty of maximum backscatter coefficients: 10-15%;

Uncertainty of integrated backscatter: 10-15 %

Instrument History:

Mark 1 instrument built in 1973 as ruby lidar;

Mark 2 instrument built in 1991 as Nd:YAG lidar;

Mark 3 instrument built in 2016 as Nd:YAG lidar