Ceilometer

From
Atmos. Meas. Tech., 7, 1979–1997, 2014
www.atmos-meas-tech.net/7/1979/2014/
M. Wiegner et al.: The benefit of ceilometers 1981

We define ceilometers as single-wavelength backscatter lidars with the following characteristics:

- the emitted wavelength is in the near infrared between 900 and 1100 nm to avoid strong Rayleigh scattering,
- the pulse repetition rate is on the order of a few kilohertz, and the pulse energy of the laser is sufficiently low to allow eye-safe operation.
- Typically, a time resolution of better than 1 min and
- a spatial resolution on the order of 15m up to a height of 7.5 km or 15 km is available.
- Ceilometers can be operated continuously and unattended.

We choose this definition as such commercially available and widespread systems will most likely be used for purposes that are beyond their original intent.

Ceilometer: Vaisala CL51

Low power (1.6μJ/pulse), eye safe (905nm) laser backscatter at high repetition rate (~kHz)

- Second generation of advanced single lens optics provides excellent performance also at low altitudes
- Reliable operation in all weather: unsurpassed performance in vertical visibility and cloud detection during precipitation
- Cloud reporting range up to 13 km (43,000 ft)
- Backscatter profiling over full range up to 15 km (49,200 ft)
- Boundary layer profiling up to 4km
- Detection of Cirrus clouds
- Based on robust and affordable laser technology
- Modular design for easy installation and maintenance
- Extensive self-diagnostics with fault analysis
- Field proven, fully automatic 24/7 operation in all weather conditions
- Latest technology from the world leading manufacturer - installed base over 5000 ceilometers worldwide

Ceilometer: Jenoptik CHM 15k

Low power (1M class laser), eye safe (1064nm) laser backscatter at high repetition rate (~kHz)

- IP65 – reliable operation in all weather; heating & cooling system to prevent fogging and frosting
- Cloud height, boundary layer height and visibility
- Backscatter profiling over full range 30m – 15 km
- Detection of Cirrus clouds
- Based on robust and affordable laser technology
- Modular design for easy installation and maintenance
- Extensive self-diagnostics with fault analysis
- Field proven, fully automatic 24/7 operation in all weather conditions
- RS485 (standard + optional RS232, RS422, LAN)

Ceilometers in use:

Vaisala CT25k used to characterise increased aerosol optical depth during H.E.S.S. MWL observing campaign of PKS2155-304

APh 34, 304 (2010).

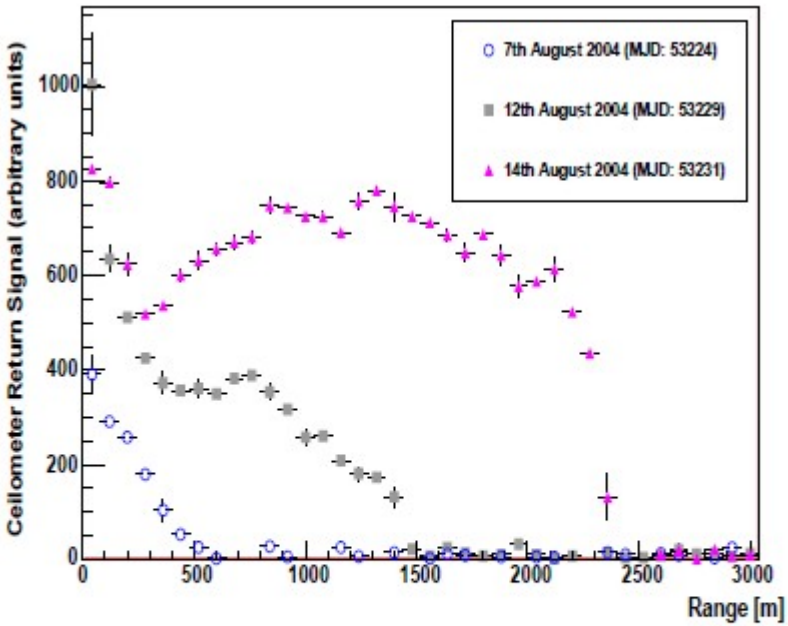


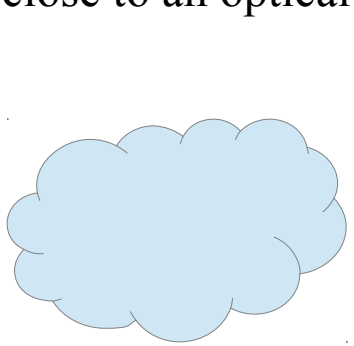
Figure 2: The derived return signal as seen by the CT25K ceilometer for several nights in August 2004. The 7th August shows the normal clear-sky behaviour, whereas the other nights show increasing low-level aerosol density. The return signal here is a derived quantity (proportional to extinction), produced by closed source software.

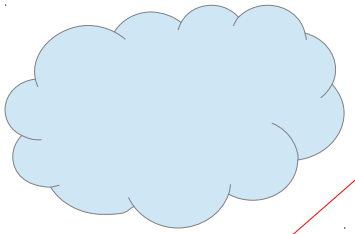
Vaisala CT51 at VERITAS site for environmental monitoring

Automatic monitoring of boundary layer structures with ceilometers
http://www.vaisala.com/Vaisala%20Documents/Vaisala%20News%20Articles/VN184/vn184_07_AutomaticMonitoringofBoundaryLayerStructureswithCeilometers.pdf

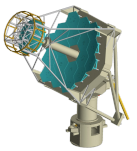
Ceilometer use in CTA: pointing forecast

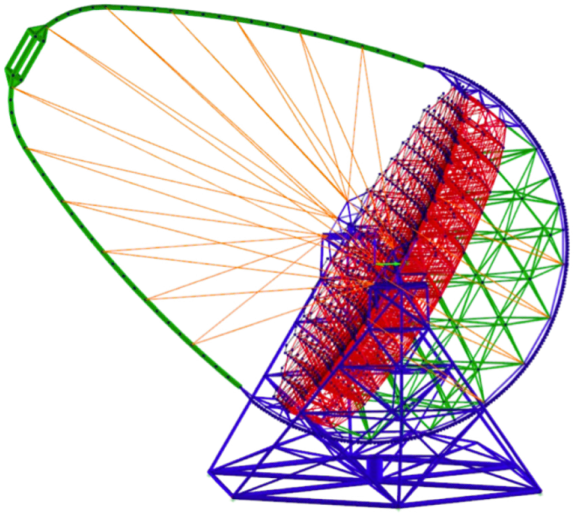
Can determine presence/height of cloud, without disrupting observations (for us, may need adding to queueing system if site close to an optical observatory)

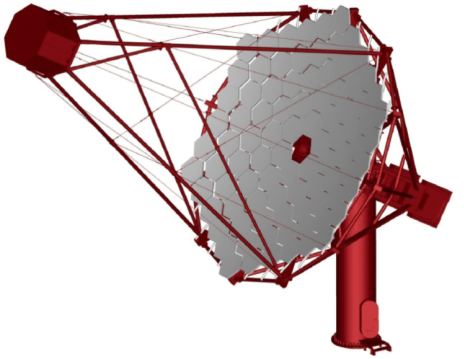




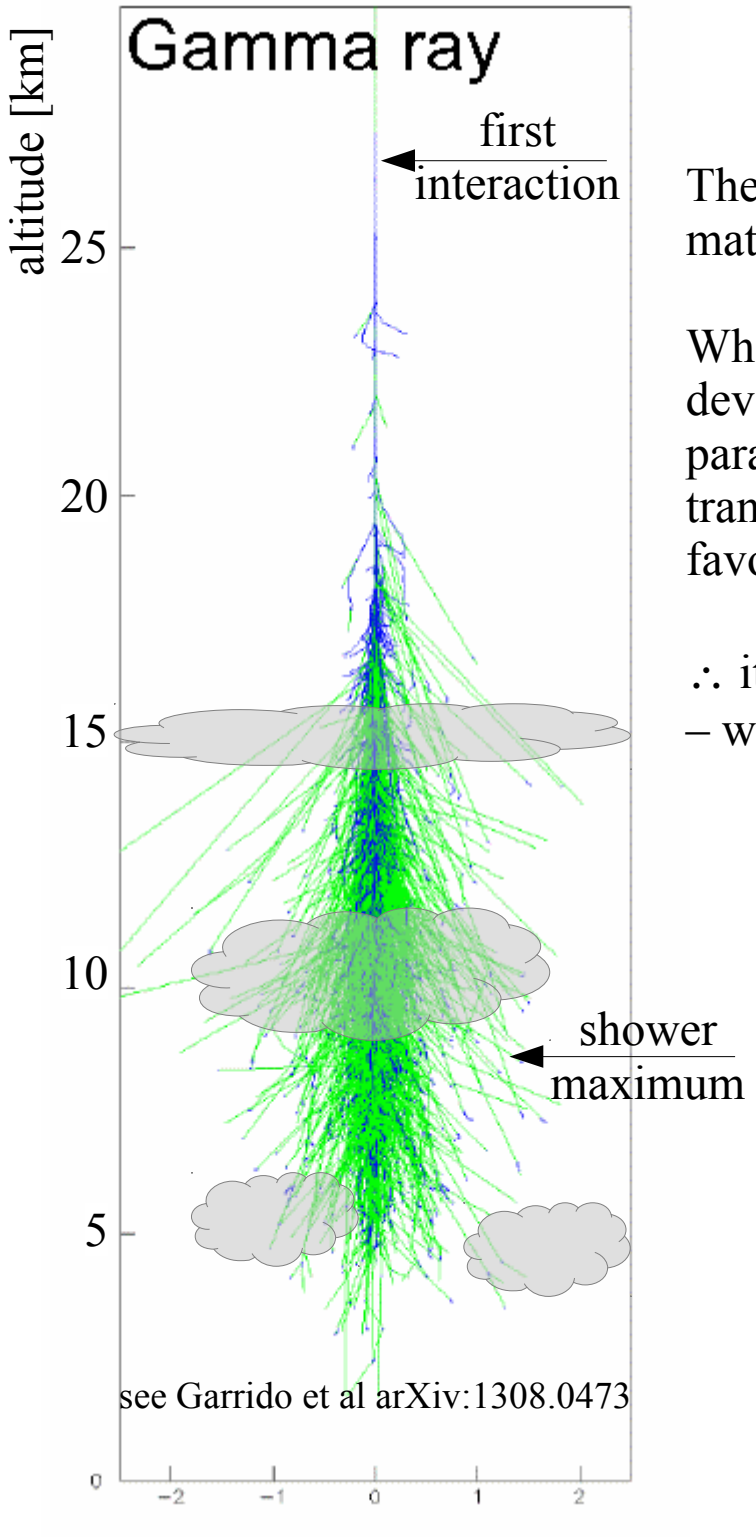
steerable ceilometer







oblivious telescopes



The altitude of the aerosol overburden (here I include clouds) matters!

When the clouds or aerosol layer is at or above the shower development region then the total extinction is no longer a useful parameter to measure as it is has a diminishing effect on the transmission. (but it means we can still detect sources under favourable cloud conditions!)

∴ it is important to know the differential atmospheric transmission – we need instruments with height resolution.

Data Selection – Passive Instrumentation

The Cherenkov telescope becomes the best monitor of its own performance

Data Correction – Active Instrumentation

A ceilometer will detect cloud height up to 13km above the site. In clear skies this can even give some information on the boundary layer.
A Raman lidar will disentangle the molecular and aerosol components.

Cost/benefit Analysis

CTA Operations Costs :- ~5.3M€/year South ~3.7M€/year North ~ 9M€/year
Construction Costs :- 200M€/20 years ~10M€/year

Duty Cycle ~ 1000 hrs/yr → 19M€/1000 ~ 19k€/hour

Ceilometer ~34k€, PTU ~ 10k€, 300W power + 0.1TB/year data storage → ~90k€ total

~5 hours of recovered data would recoup costs of ceilometer (4.4h in South;6.9h in North)