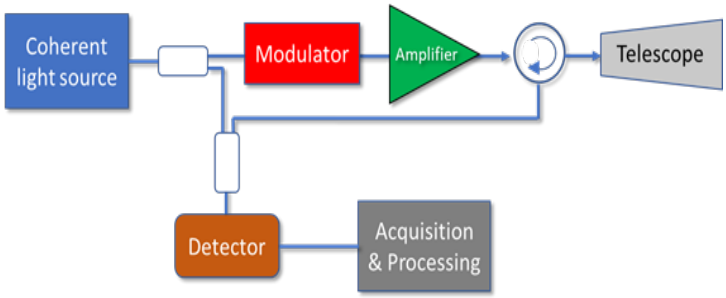
App Note: DLS-05

Narrow Linewidth Laser for Wind Lidar

1. Introduction to Light source solutions for Wind Lidar

1.1 LiDAR (Light Detection and Ranging) is a technique for measuring distances and doing mappings. Traditional Lidar are essentially distance ranging sensors where the ***distance*** is determined by the time of flight of a pulse of light reflecting back from an object. By firing several pulses consecutively, the ***velocity*** of that object can also be derived.

1.2 Wind Lidar sensor are not based upon this principle but rather on the Doppler frequency shift which affects waves reflecting from a moving object. In Wind Lidar systems, a coherent Frequency Modulated Continuous Wave (FMCW) beam of light is sent through the atmosphere. As the light propagates, it interacts with the aerosols and a small portion of it is backscattered towards the instrument where it mixed with a local reference oscillator (heterodyne scheme) and measured by a photodetector.



1.3 FMCW lidars give access to the ***distance***, the wind ***velocity*** and can even yield aerosol ***composition*** if the polarization can be extracted.

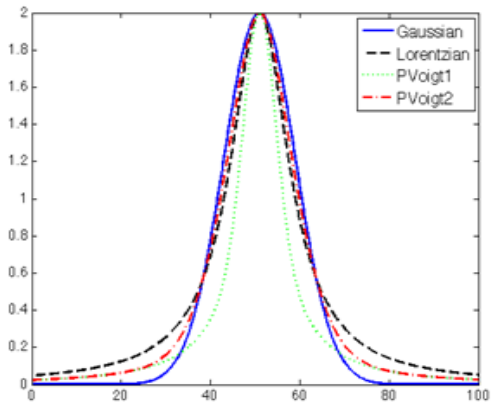
2. Wind Lidar Laser source requirements

2.1 Wavelength selection: When it comes to choosing the wavelength of an Wind Lidar system, the main things to be considered are *Atmospheric transmission*, *Eye safety* and *Component availability*.

Atmospheric absorption depends on aerosol concentration and contents. Two atmospheric windows are of interest, Band I (0.9-2.5um) in the near infrared and band II (3-5.5um) in the intermediate infrared regions.

Eye safety is determined by the maximum permitted exposure (MPE expressed in J/m2) at a given wavelength. For example the MPE is 1000 times higher in the 1.5-1.8µm band compared to the 0.8-1.2µm band making the 1.55µm Telecom wavelength a candidate of choice since all the components required for a Lidar system are readily available at low cost for this wavelength.

2.2 Spectral quality: In a coherent Lidar system, a beat signal is obtained by mixing a local oscillator with a back scatted signal. The quality of this beat signal and the ability of extracting meaningful information from it depends on the temporal phase matching between the mixed signals which depends on the intrinsic local oscillator coherence and the propagation time of the sensing signal. Hence there is a direct correlation between a Wind Lidar system Range requirements and the laser source (seed) linewidth.



Typical linewidth of Denselight 1550nm EC laser

2.3 Relative Intensity Noise (RIN): The detection performances of a Wind Lidar is affected by the system overall carrier to noise ratio (CNR). The laser seed relative intensity noise (RIN) is one noise source and must be as low as possible for high sensitivity. The RIN of Denselight EC laser can be 20 to 40 dB lower the RIN of typical C-band fiber lasers.

2.4 Polarization: To avoid what is called signal fading, the local oscillator and the measured signal must have the same polarization state. Denselight External cavity laser diodes are polarized source by design making them suitable for Wind Lidar applications.

2.5 Reliability and Robustness: Wind Lidar systems are installed outdoors (either at floor level or on masts) and therefore must withstand vibrations and large temperature swings. Denselight products operate from 0 to 50° C and are qualified against Telcordia GR-460-CORE standards.

3. DenseLight NLW light source

3.1 DenseLight offers a wide range of narrow linewidth laser designed for applications requiring narrow spectral linewidth, excellent SMSR, power stability, and a very highly wavelength stable laser output such as Wind Lidar sensing.

Products	Product Code	Specification
NLW laser	DL-CLS101B-FP-S1550	Strained InGaAsP/InP MQW gain chip coupled with built-in fiber Bragg grating Lasing wavelength of 1550nm Typical ultra-narrow linewidth < 50-200KHz Minimum 10mW CW operation Excellent Minimum SMSR of 45dB Internal thermoelectric cooler and thermistor SMF/PMF
ILM	BF series	Typical ultra-narrow linewidth < 10-200KHz Typically 10mW (Up to 20mW) CW Power Excellent RIN < -140dB/Hz (for power > 10mW) Excellent minimum SMSR > 45dB Wavelength stability: +/- 1pm @ 25 Deg C. Integrated laser driver and temperature controller