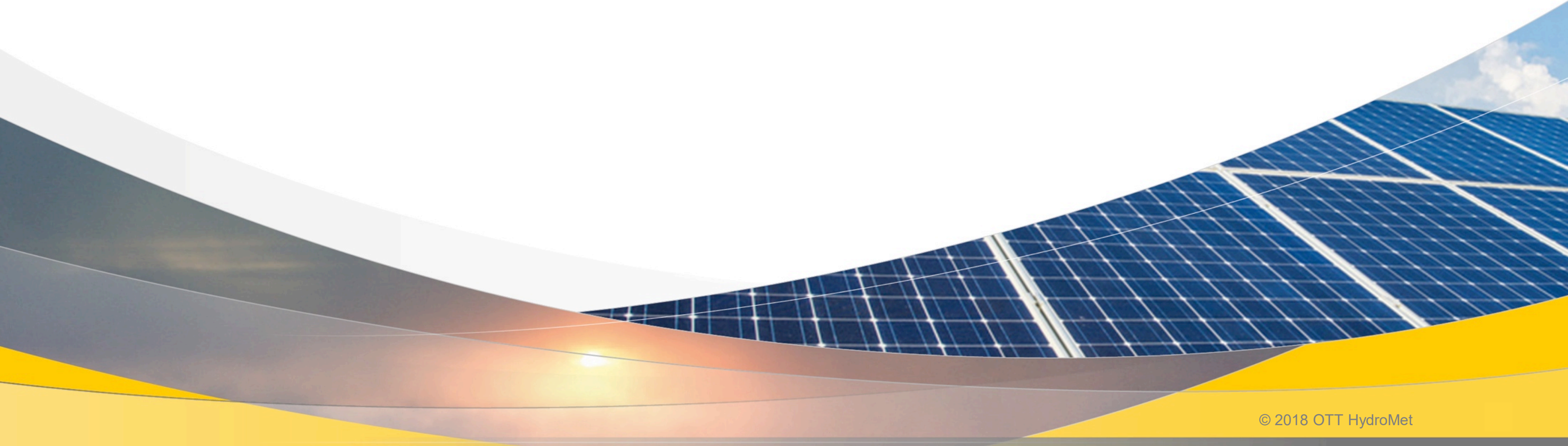
SNOW DEPTH DETECTION: COMPARISON BETWEEN LASER & ULTRASONIC SYSTEMS



SNOW DEPTH MEASUREMENTS

A snow depth sensor is an electrically powered active device with integrated data processing that measures the distance between the sensor and the underlying ground surface.

The two most common measurement principles to deliver snow depths are ultrasonic and laser ones.

The following paper provides a side-by-side comparison of the two principles to determine the best measurement methodology for snow depth detection.

THE **ULTRASONIC** MEASUREMENT PRINCIPLE

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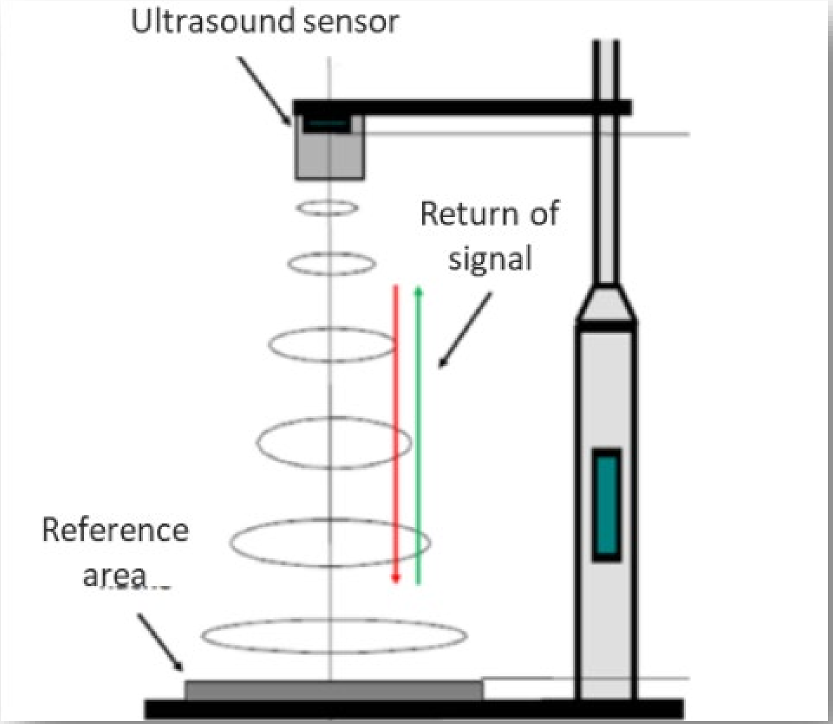
Snow depth measurements based on ultrasound are relatively affordable and come with a low power consumption. The technology behind is quite simple: It emits a sound wave at a specific frequency and listens for what echo bounces. The interval between the transmission of the sound wave and receipt of its answer informs on the distance to the next obstacle. This is possible due to the fact that sound travels with a velocity of 34 m/s (1129 ft/s).

The drawbacks of this measurement principle are, that it has a wide beam angle of 30 °. Thus, it's prone to be interfered by obstacles with-
in the measurement field, which also affects the accuracy. An accuracy
of 1 - 2 cm was observed in the field in good conditions in terms of stable temperature and no precipitation. Moreover, the accuracy of Ultrasonic sensors can be further influenced by air temperature, wind gusts and humidity.

A further negative point is the high maintenance effort, since the desiccant needs to be checked regularly and the transducer needs to be exchanged every 6, 12 or 36 months depending on the environment.



THE **LASER** MEASUREMENT PRINCIPLE

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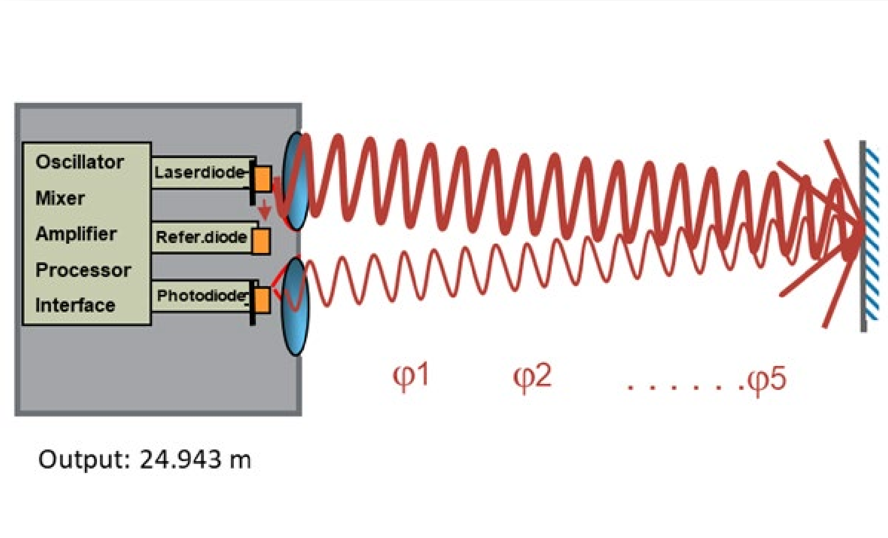

A laser snow depth sensor, such as the Lufft SHM31, is a well-established technology in the industrial field. It transmits high frequency modulated light and compares the reflected light with the reference signal by means of a microprocessor, which calculates the phase shift and the distance. With modulation frequencies of f1 to f5 resulting in phase shifts of φ1 to φ5, a laser sensor enables unique distance measurements.

The Lufft snow depth sensors are compact, easy to handle and have low life cycle costs. Furthermore the measuring method is very stable, precise to the millimeter and has a very low false alarm rate. Also, it's not interfered by wind gusts, temperature changes, rain or extreme humidity events.

However, it also has a quite high power consumption, a very small measurement spot diameter, which might be too small for some applications and the initial costs are higher initial investments than for Ultrasonic systems.

SNOW DEPTH MEASUREMENT TECHNOLOGY: LASER VS. ULTRASONIC AT A GLANCE

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ULTRASONIC	LASER
+ Simple technology + Affordable + Low power consumption	+ The eye-safe laser technology is well-established in industrial fields + Compact measuring unit in weather-proof housing, easy handling, low life cycle costs + Very stable, reliable and cost-effective measuring method – very low FAR + Independent from wind gusts, temperature changes, precipitation or extreme humidity + Determines snow depths up to 10 meter reliably within seconds and with millimeter precision + Efficient background light suppression + Allows differentiation between snow and grass
– Wide beam angle of 30°: the large measuring field could be interfered by obstacles – Real measuring precision in the field: > 1cm – Not temperature & wind independent – Desiccant in the transducer housing has to be checked regularly – Transducer has to be changed regularly every 6 months, 12 months or 36 months depending on the environment	– Higher power consumption – Laser spot might be too small for some applications – Higher initial investment

SNOW DEPTH MEASUREMENT TECHNOLOGY: COMPARISON OF TECHNICAL DATA

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Laser (Lufft SHM31)

Dimensions (LxWxH)	302mm × 130mm × 234mm
Weight	2.35 kg
Temperature range	-40 ... +50 °C
Relative humidity	0%...100%
Measurement principle	opto-electronic (rangefinder; laser distance sensor) with eye-safe laser
Measurement range	0 ... 15 m
Mounting distance to surface	0.1 ... 16 m
Accuracy (snow depth)	± (5 mm + 0.06 %)
Repeatability	0.6 mm
Intermediate precision/ reproducibility	5 mm
RS485, RS232, SDI-12	ASCII, UMB protocol/ ASCII protocol/ SDI-12 protocol
Data transfer mode	Polling (UMB, ASCII, SDI-12); Auto telegram output (ASCII)
Typ. power consumption at 24 VDC and 10 s laser measurement interval	without heater: approx. 0.7 W; with window heating: approx. 3.4 W
Power supply	12, 24 VDC
Maximum power consumption (connecting power with heater on)	18 W
Laser classification	Laser class 2 (IEC 60825-1:2014)
Protection class housing	IP68
EMC	EN 61326-1:2012 (industrial standard)
EC	2014/30/EU & RoHS 2011/65/EU

Ultrasonic (Sommer USH-8)

Dimensions	Ø 110 mm, length 350 mm
Weight	1.6 kg
Operating temperature	-40 … +60 °C
Measurement principle	Ultrasonic (frequency 50 kHz; angle of reflected beam 12°)
Measurement range	0 ... 10 m
Accuracy (snow depth)	0.1 % (FS)
Resolution	1 mm
Analogue (snow depth)	Snow depth measurement; 4 - 20 mA signal; Resolution: 12 Bit; Max. load: 300 Ω
Digital	Snow depth measurement, air temperature, quality flag; RS 232; serial interface. Protocol: various ASCII formats
Power supply	Supply voltage: 10.5 ... 15 VDC Power input: max. 200 mA (Measuring phase about 3 sec); <1 mA (Standby) Power consumption: 0.5 Ah / day (with measuring interval of 1min)
Protection class housing	IP66
Lightning protection	Integrated lightning protection (discharge capacity 0.6 kW)
Temperature sensor	Integrated air-temperature sensor in self-venting radiation shield
Measurement range	-40 … +60 °C
Resolution	0.1 °C
Non-linearity	≤ 0.15 %

LASER SNOW DEPTH SENSOR
FIELDS OF APPLICATION

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- Weather Services
- Traffic weather
- Aviation
- Winter sports
- Water and energy management

AWS at Yala Base Camp, Himalaya. Source: ICIMOD

AWS at Ackernalm, AT. Source:Tiroler Landesregierung

AWS „Compedal". Source: Amt der Tiroler Landesregierung

Source: Zentralanstalt f. Meteorologie u. Geodynamik (ZAMG), Vienna, Austria

AWS at Connyalm in Obertilliach. Source: Amt der Tiroler Landesregierung Innsbruck, AT

Antartica, Neumayer Station. Source: Alfred Wegener Institut

Railway in Shanghai, CN. Source: Shanghai Demu

Solar powered SHM30 snow depth station.

MEASUREMENT EXAMPLE – HINTERWILDALPEN

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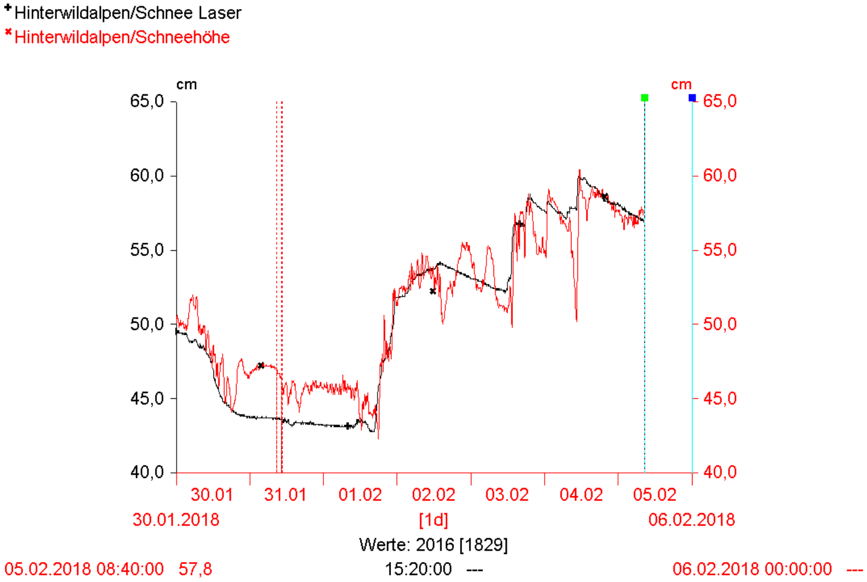
Comparison of Lufft SHM31 and Ultrasonic sensor. Copyright: Wiener Wasser, AT (2018)



Red: Ultrasonic sensor, black: Lufft SHM31. The influence of air on the Ultrasonic sensor is obvious (low peaks). Copyright: Wiener Wasser, AT (2018)

CONCLUSION

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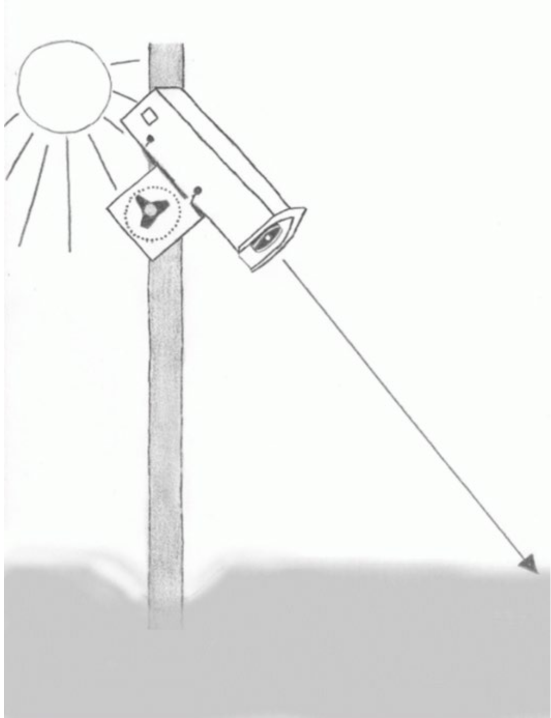
Although Ultrasonic snow depth sensors cause lower initial costs, the benefits of opting for a more expensive laser-based product are obvious:

1. **The operation of laser snow depth sensors is more reliable than Ultrasonic ones**
   Due to the very high precision, the stable measurement principle, the resistance against any environmental interferences as well as the maintenance-free operation, laser based systems are more reliable than ultrasound ones.
2. **Laser snow depth sensors are more cost-effective than Ultrasound ones**
   In the end, laser based snow depth sensors pay off, as the recurrent maintenance-efforts of Ultrasonic systems at large are more costly than the total cost of ownership of a laser system. On the contrary, the laser sensor is maintenance-free.
3. **Laser-based snow depth sensors have more features than Ultrasonic ones**
   Due to the fact, that lasers work optically, they offer more functions than Ultrasound ones, e.g. the differentiation of material such as grass and snow.



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