Latest technology in Snow Depth Detection

Holger Wille

Source: Michiel Helsen, Utrecht University

Short Company Introduction – G.Lufft GmbH

Innovative Sensor Manufacturer with Experience of more than 135 years!

- **Founded** 1881 from Gotthilf Lufft
- **Long History** in environmental and climatological measurement equipment
- **Today** innovatve sensor manufacturer in the fields of Meteorology and Weather Critical Operations (WCO)

Fabrik Marke TRADE MARK

Trade LUFFT Mark

Lufft

Registrieren Regeln Messen Lufft

Lufft

1881 → 1900 → 1920 → 1950 → 1980 → 1990

Wind & Weather

- All in One Weather sensors
- Optical Sensors
  (Cloud Height & Snow Depth)

Traffic & Weather

- Mobile & stationary sensors for detection of road conditions.

Industrial Monitoring

- Handheld Devices
- Data loggers
- OEM products

Latest technology in Snow Depth Detection

Holger Wille

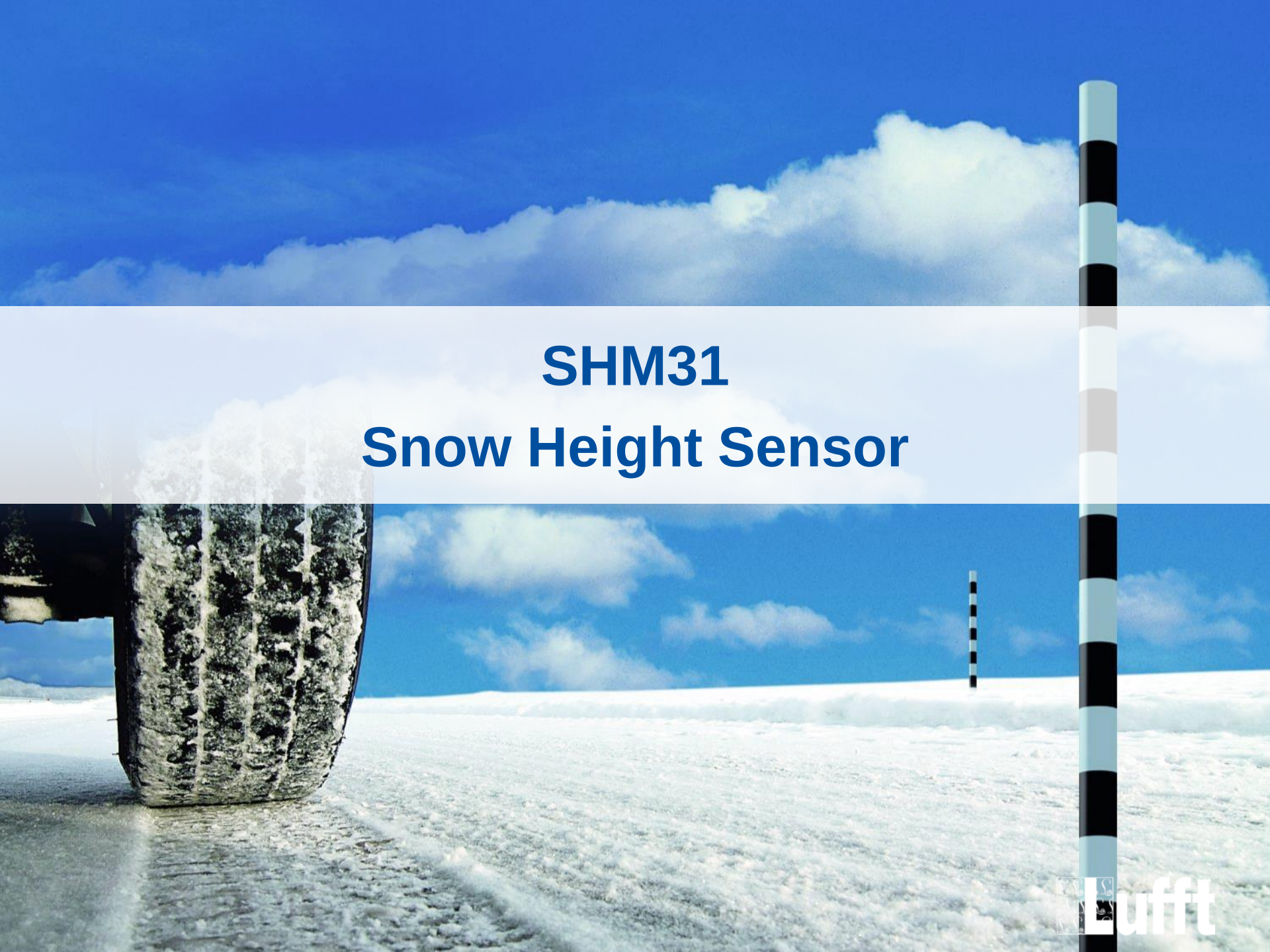
Source: Michiel Helsen, Utrecht University

Expert for Optics: Holger Wille

- Director Lufft Berlin - Office for Optical Sensors
- Expert for optical sensors, especially in the field of lidar ceilometers and laser-based snow depth sensors.
- Masters Degree in Physics from the Freie Universität in Berlin
- Worked in research in the fields of LIDAR and laser beam propagation in the atmosphere

SHM31

Snow Height Sensor



“Webinar snow depth sensors from Lufft”

1. Overview snow depth sensors
2. Best practise , installation and software
3. Examples meteorological measurement
4. Discussion, Questions & Answers
5. Live demonstration, configuration

Who needs snow depth measurements?

- Important for
  - Meteorologists
  - Road, railway track, runway surveillance
  - Facility managers
  - Water ressource managers
  - Renewable energy, solar power plant operators
  - Climate modelers
  - Winter sports managers

SHM30 auf ICIMOD-Station, Nepal

Chinese railway track observation

Sensor comparison, ZAMG, Austria

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What do you expect from automatic snow depth sensors? - Challenges in snowy regions

“Precise and reliable measurements”

“Easy installation and operation”

“Robust”

“Can be powered by solar panel – autonomous operation possible”

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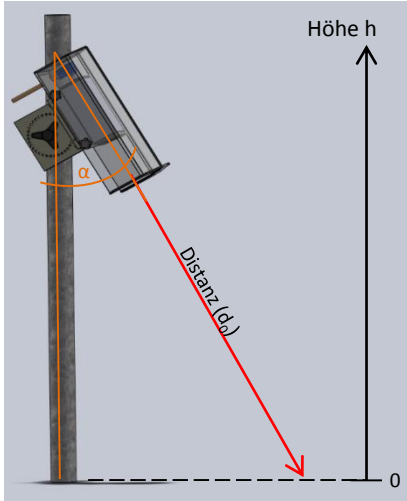
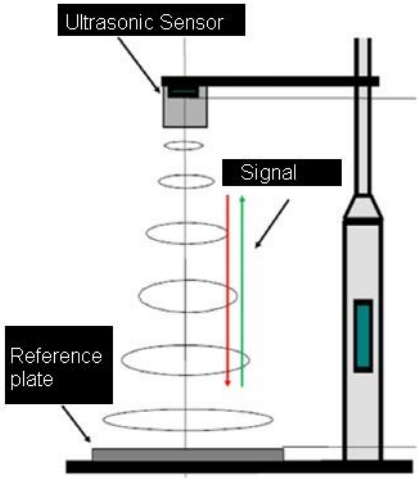
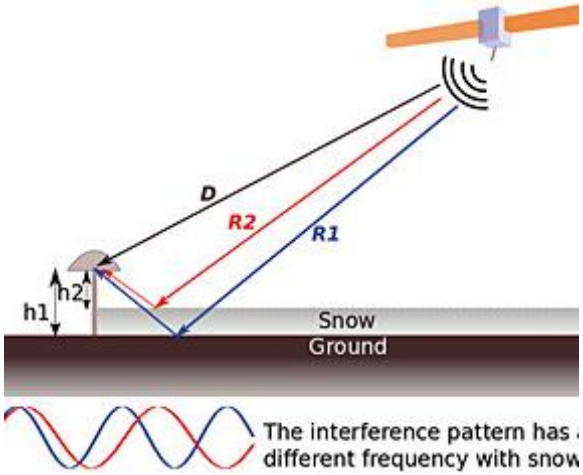
What do you know about measuring snow depth?

- Automatic methods:
  - laser snow depth sensors (commercial available)
    (< 0,5 cm accuracy, single beam → small probe area)
  - Ultrasonic snow depth sensors (commercial available)
    (2 cm accuracy, medium probe area)
  - GPS reflection techniques (scientific projects)
    (5 cm accuracy, wide probe area)







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Laser distance measuring vs Ultrasonic devices

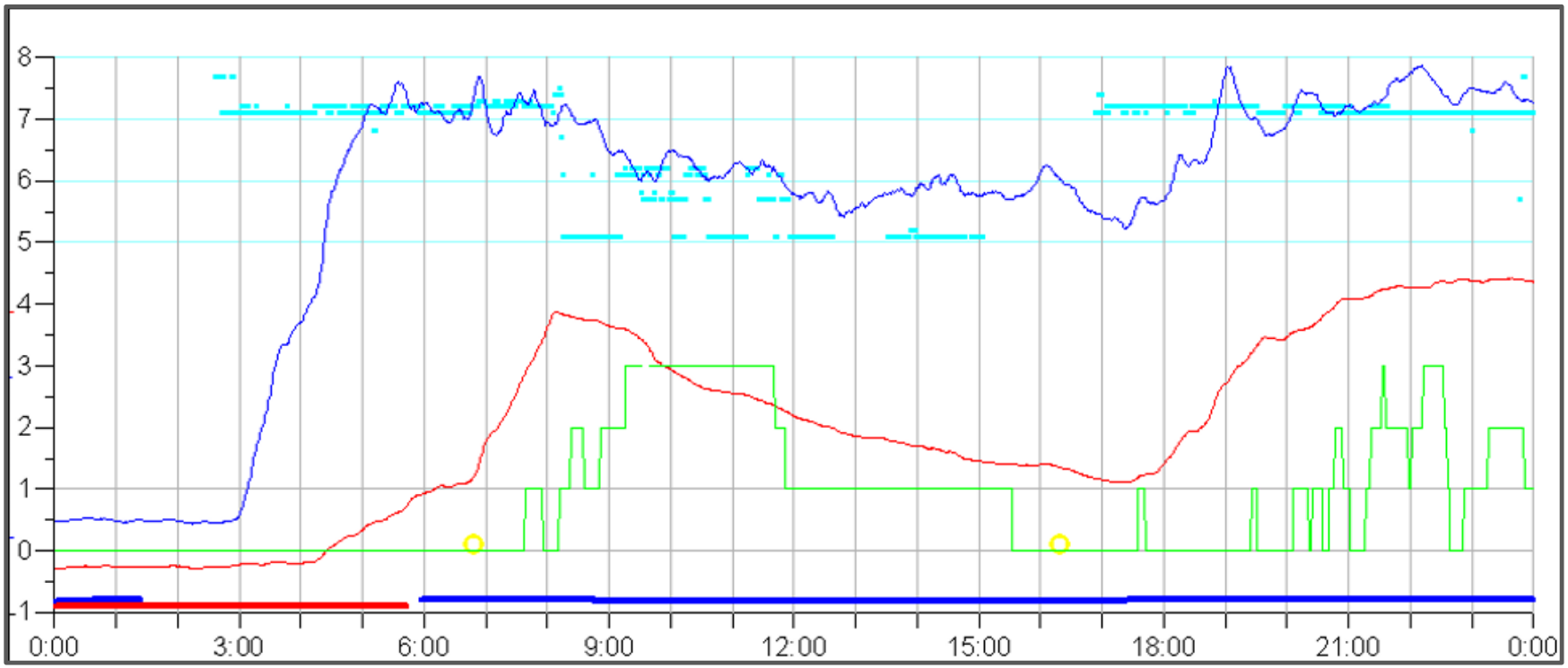
Benefits SHM30/ SHM31
+ Precision at 1mm, Accuracy, …
+ Compact measuring unit, easy handling, low life cycle costs
+ Very stable measuring method – very low false alarm rate
+ Independent from wind, temperature, humidity, mostly precipitaion
+ small laser spot allows precise distance tracking, e.g. on railway track

Drawbacks
- Higher power consumption
- Laser spot might be too small in some applications (large field studies for climate modelers)
- Higher initial investment

Benefits ultrasonic
+ delivers average snow depth value on probe area due to wide beam angle
+ relative affordable, production costs lower than for laser sensors
+ lower power consumption without heating mode possible

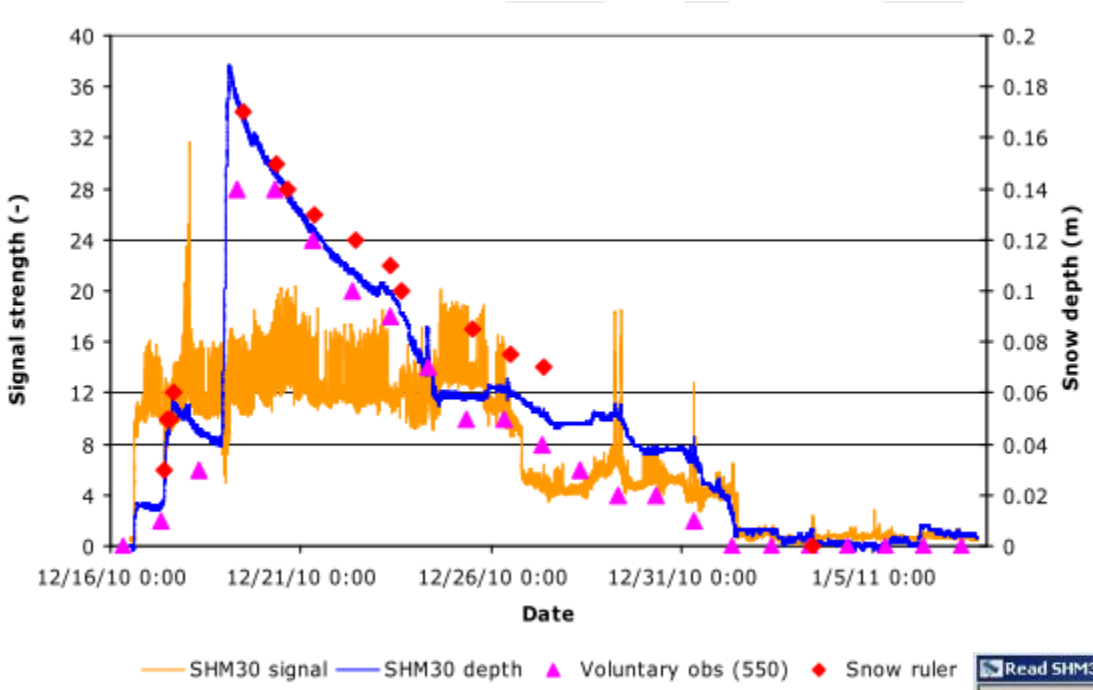
Drawbacks
- wide beam angle of 30°- large → obstacles may interfere → High false alarm rate during precipitation events
- real measuring precision in the field: >1 cm
- temperature & wind dependent
- desiccant in the transducer housing has to be checked regulary
- transducer has to be regularly changed every 6 months/ 12 months or 36 months depending on the environment

SHM - ultrasonic comparison (© 2009, DWD)



- x-axis: day time UTC
- y-axis:
  - SHM30 snow depth in cm, SHM30 signal strength
  - Ultrasonic snow depth sensor SR50
  - Wawa code (table 4680) (present weather code)
  - Sun rise, sun set
  - Line marker: Hoarfrost possible, formation of dew

Comparison SHM30 vs snow ruler vs observations



Major Reports/ publications

- WMO SPICE campaign (additional publications will follow in 2017)
  - https://www.wmocimo.net/eventpapers/session3/O3(4)_Smith%20et%20al_SPICE_SoG.pdf

- Comparison, evaluation report DWD (German Met Service)
  - https://www.wmo.int/pages/prog/www/IMOP/publications/IOM-104_TECO-2010/3_3_Lanzinger_%20Germany.doc

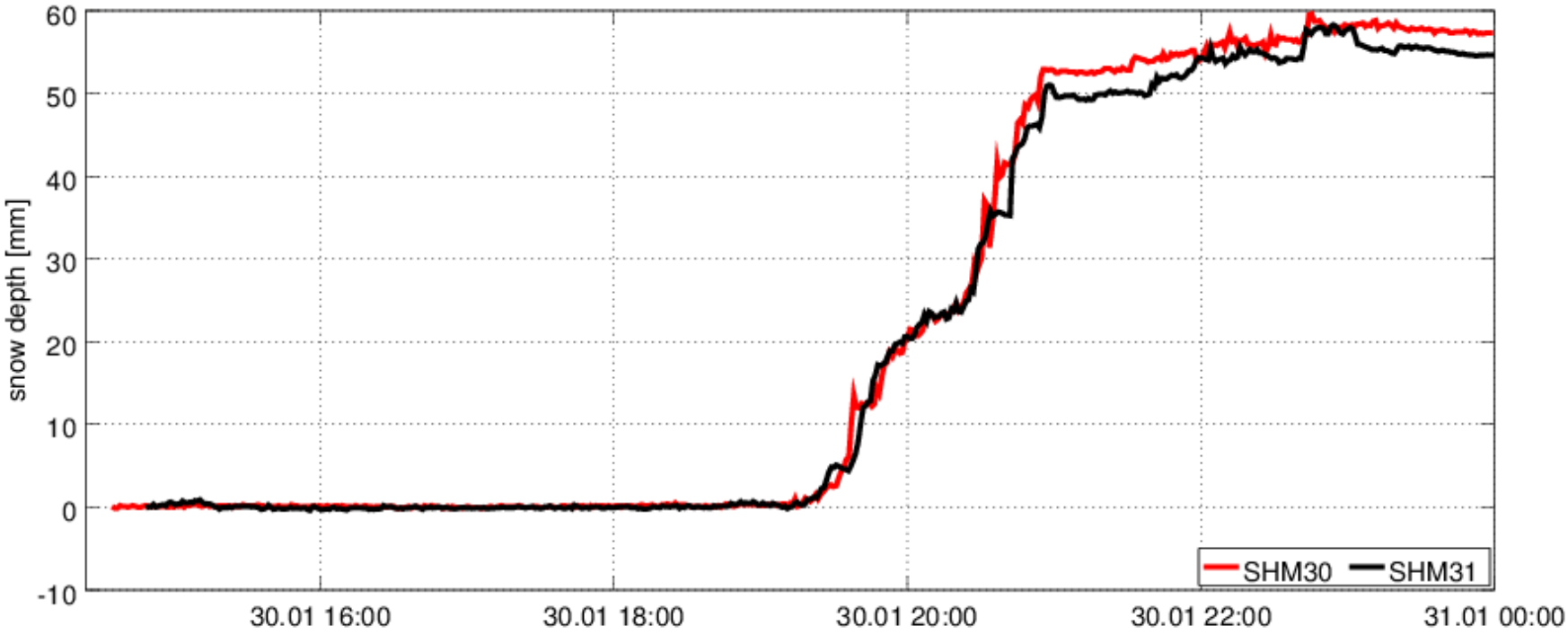
- Evaluation report KNMI (Dutch Met Service)
  - http://bibliotheek.knmi.nl/knmipubTR/TR325.pdf

Comparison SHM30 and SHM31

	SHM31 – 8365.30	SHM30 – 8365.xx
Interfaces	One device includes all: • RS232 • RS485 • SDI-12 in einem Sensor	Different sensors for • RS232 • RS422 • RS232 with external heater
Protocol	• UMB-ASCII 2.0 • UMB - Binary • SDI-12 • Modbus (in future)	• ASCII
Heater	• Window and laser diode heater, external heater mode integrated	• Laser diode heater
Inclination angle	• Integrated sensor	• Manual setup of angle
Opto-Mechanics	• Easy cleaning of window	• Stray light protection required, more time consuming cleaning
Protection class	• IP-68	• IP-65
Firmware	• Update by customer (ConfigTool.NET)	• Update by Jenoptik only

Snow depth comparison SHM30 / SHM31

- sensors deliver comparable results
- Looking at slightly different plates

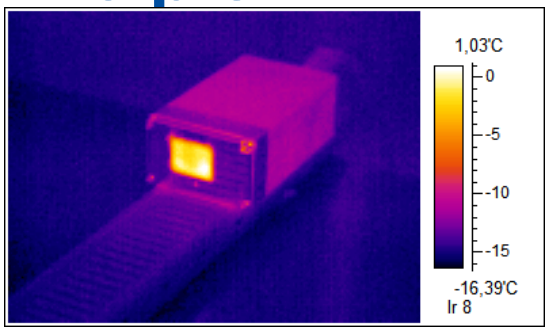


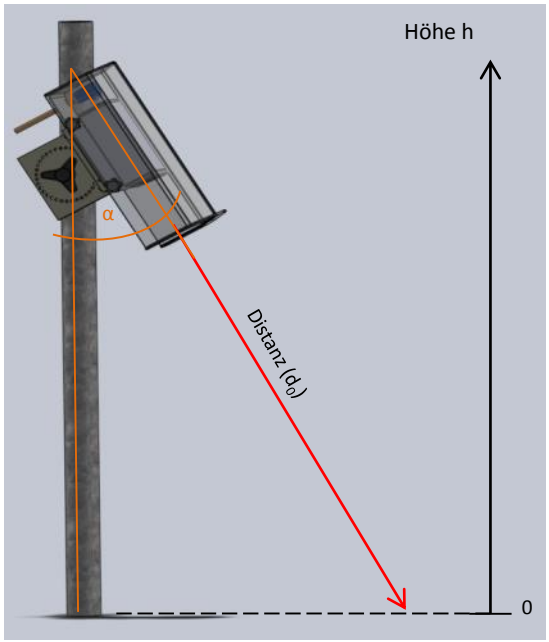
SHM31 basic measuring principle (laser module)

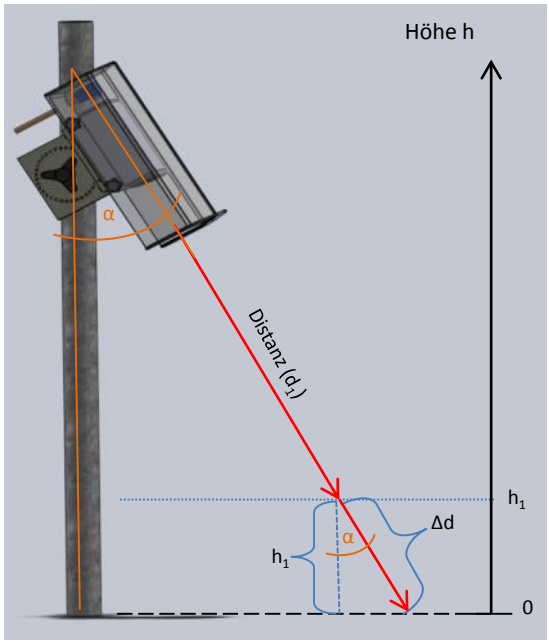
- Intensity modulated laser pulse group is transmitted
- Backscattered pulse group is compared with transmitted pulse and analyzed (phase, TOF and intensity)
- Distance is calculated
- Signal strength is calculated from intensity

Product description – measuring principle

Main measured values:
distance, signal strength, temperatures and tilt angle







$$\Delta d = d_0 - d_1$$

$$h_1 = (d_0 - d_1)\cos\alpha$$

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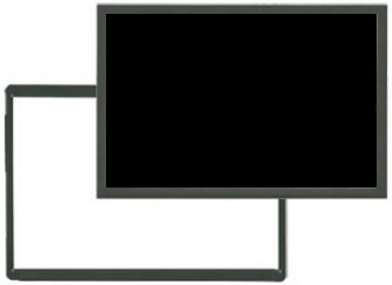
Scope of delivery (SHM31)

Article No.	Description
8365.30	Snow depth sensor SHM31-UMB
8365.KAB015	Connection cable SHM 31; 15 m
8365.610-11	Mast clamp, pre-assembled, steel, up to 72 mm
8365.609-11	Mast clamp, steel, up to 300 mm
8365.608-11	Mast clamp, steel, up to 80 mm
8365.KWK-SET	Target boards set (sw & ws)



Target boards

Product description - Installation

Auto angle correction

Easy pole mounting

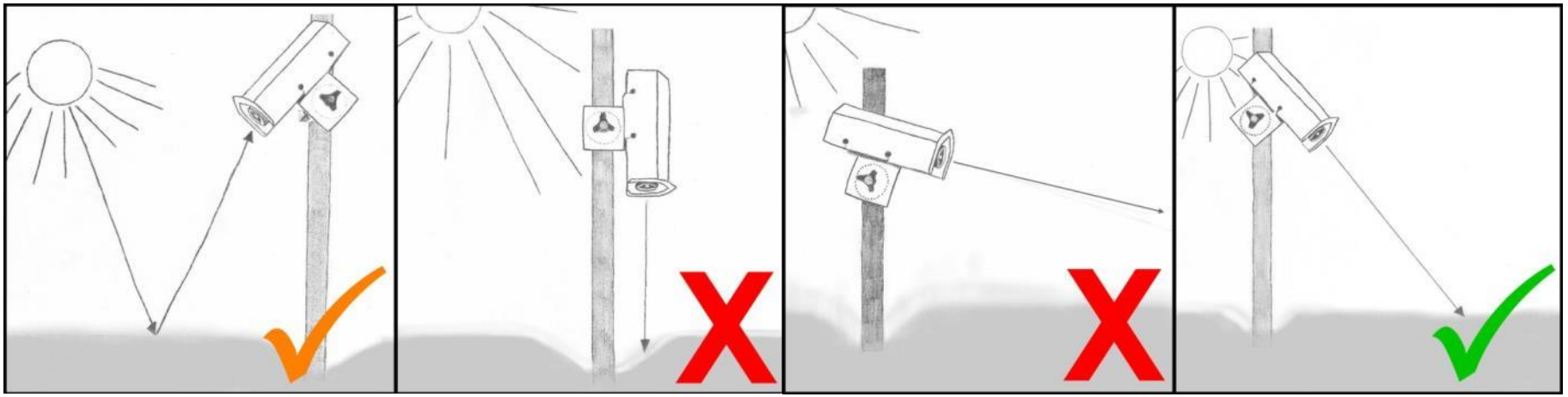
Cable mount

Mounted with protection grommet in place.

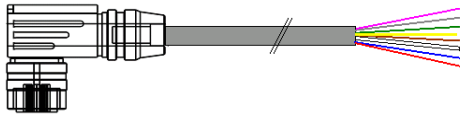
Product description - installation

Easy installation at pole:

- Installation angle: 10° – 30°
- Installation height: up to 16 m



SHM31 interface cable / connectors



Cable connectors / wires	SHM 31	Description	Plug Pin #
green	A_RS485	RS485 A	5
yellow	B_RS485/SDI12	RS485 B / SDI-12 Data Line	2
rose	RS232_TX	RS232 Transmit	1
blue	RS232_RX	RS232 Receive	6
grey	GND	Ground RS232/ RS485	4
red	EXT_TRIG_IN	Heater on/off +	3
brown	V_IN_+	Power supply (+)	8
white	V_IN_-	Power supply (–), Ground SDI-12	7

Product description – technical data

Technical Data		
Dimensions & weight	Dimensions (LxWxH)	302 mm × 130 mm × 234 mm
	Weight	2.35 kg
Operating parameters	Temperature range	-40…50 °C
	Relative humidity	0...100%
Measuring parameters	Snow Depth	0 … 15 m
	Mounting distance to surface	0.1…16 m
	Accuracy (snow depth)[2]	± (5 mm + 0.06 %)
	Repeatability	0.6 mm
Data-interfaces	Protocols	UMB, UMB-ASCII 2.0, SDI-12
	Interfaces	RS485, RS232, SDI-12
	Data transfer mode	Polling (UMB, UMB-ASCII 2.0, SDI-12); Auto telegram output (UMB-ASCII 2.0)
Electrical parameters	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 safety / Electrical safety	Laser classification	Laser class 2 (IEC 60825-1:2014)
	Protection class	IP68
	EMC	EN 61326-1:2012 (industrial standard)
	EC	2014/30/EU & RoHS 2011/65/EU

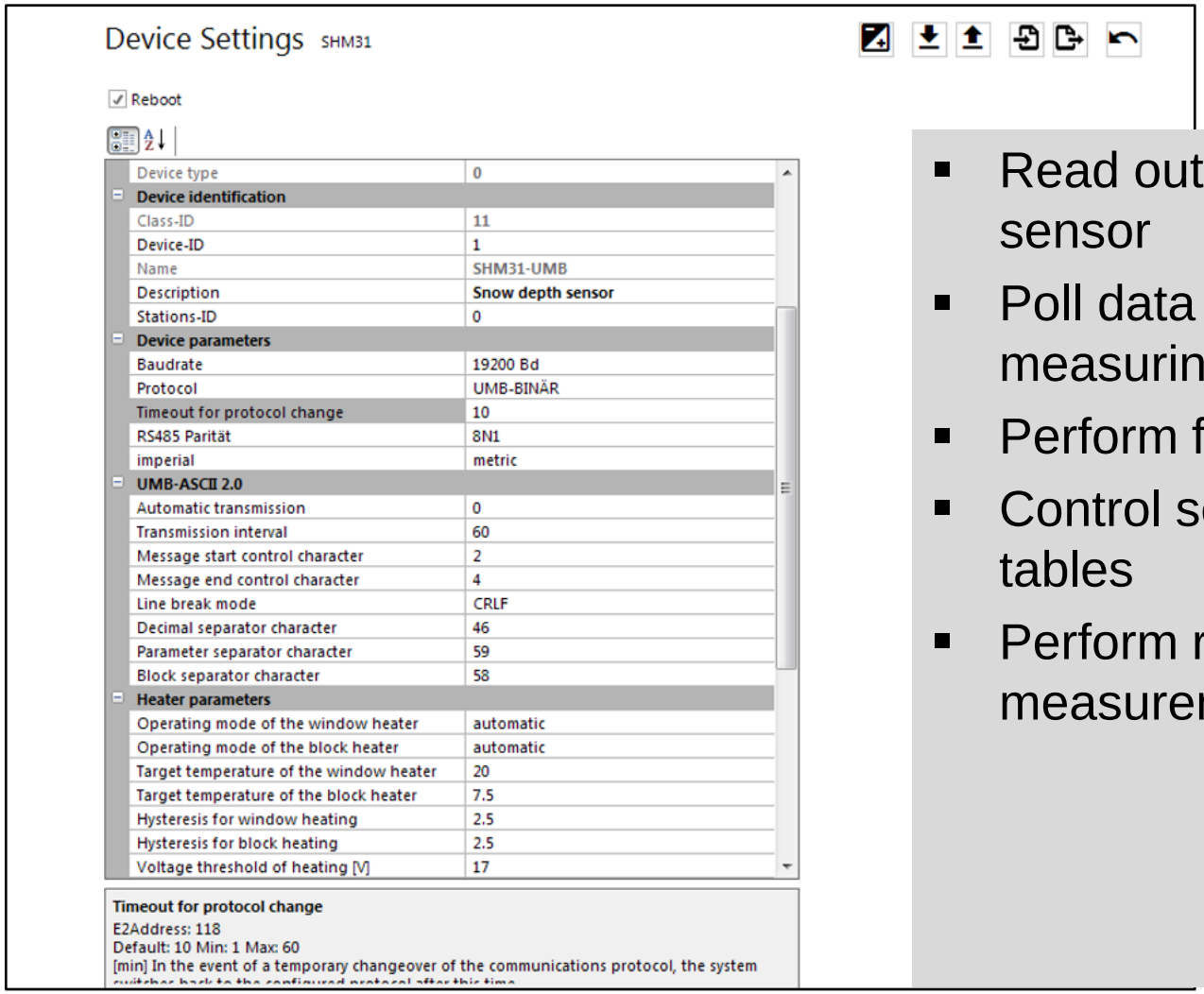
Communication

There are 3 different communication interfaces implemented:

1. UMB standard (RS 485 interface)
2. UMB-ASCII 2.0 (RS485 + RS232 interface)
3. SDI-12

I will focus here on UMB and UMB-ASCII 2.0 interface. In the manual you find a precise description for all 3 interfaces.

1) ConfigTool.net



- Read out UMB channels from sensor
- Poll data , display and store measuring data
- Perform firmware updates
- Control sensor using parameter tables
- Perform reference measurements, defrost mode,...

UMB Channel list (example)
(see user manual for a full list)

UMB- Channel					
act	**min**	**max**	**avg**	**Measured value (format float32)**	**unit**
600	601	602	603	snow depth	mm
604	605	606	607	snow depth	cm
608	609	610	611	snow depth	m
612	613	614	615	snow depth	inch
650				distance	mm
651				distance	inch
660				distance raw	mm
661				distance raw	inch
690				sensor altitude	mm

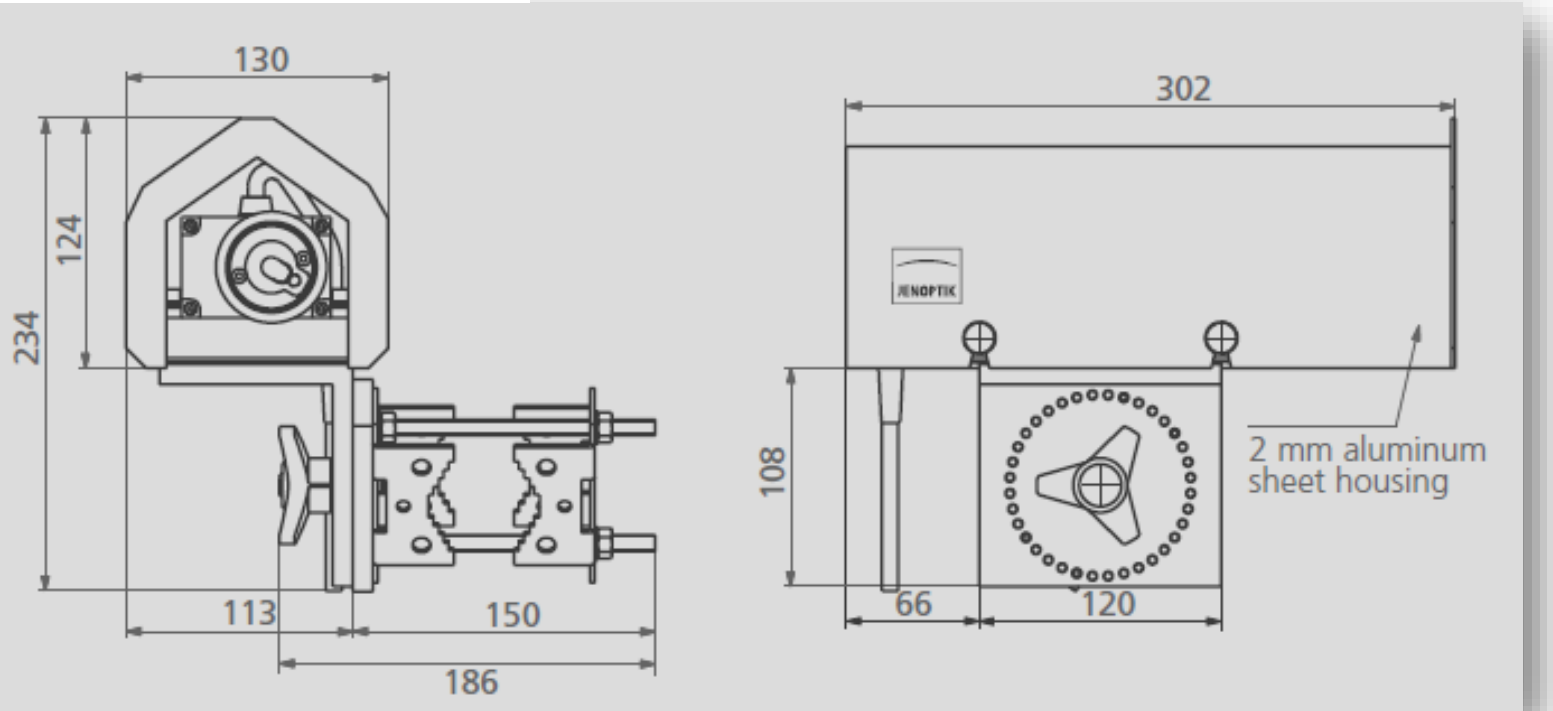
2) UMB ASCII 2.0

- Terminal program required
- General syntax: Query <Add>:<Nr>:<Payload><CR><LF>
- Example:
  - **Polling (Request of the data telegram):**
  - B001:4E SS;1<CR><LF>
  - <STX>B001:4E:SS;1=085;003.0117;+02.1253;185;+15;17.8;00:00:94 <CR><LF><EOT>

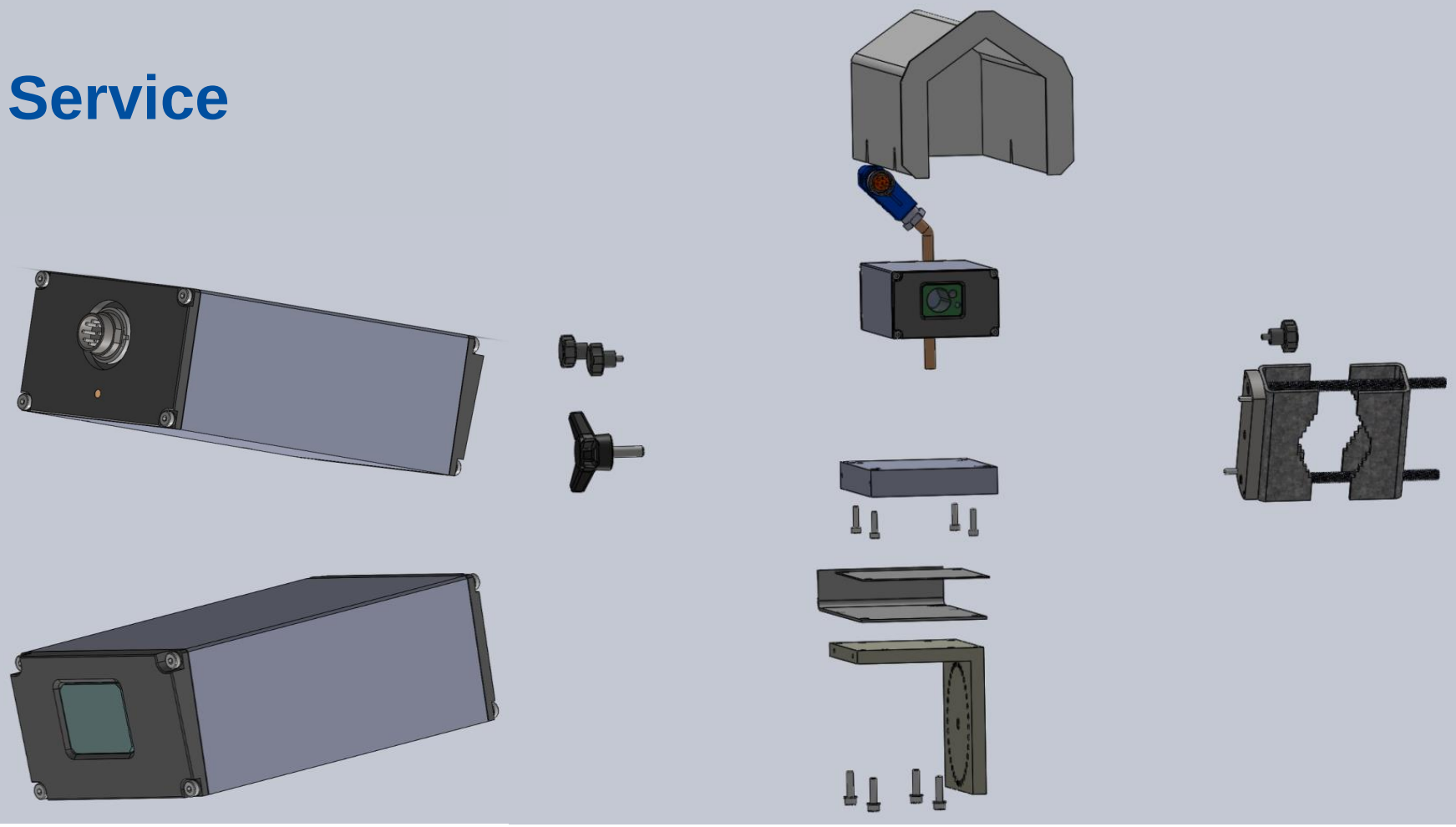
+02.1253	8	Snow depth
185	3	Signal strength [0;255]
+15	3	Window temperature
17.8	4	Tilt angle
15:	3	Error code (E15)

Service, maintenance

Technical drawing



Service



Using target boards for data verification

8365.KWK-SET

2x SHM 31 / SHM 30

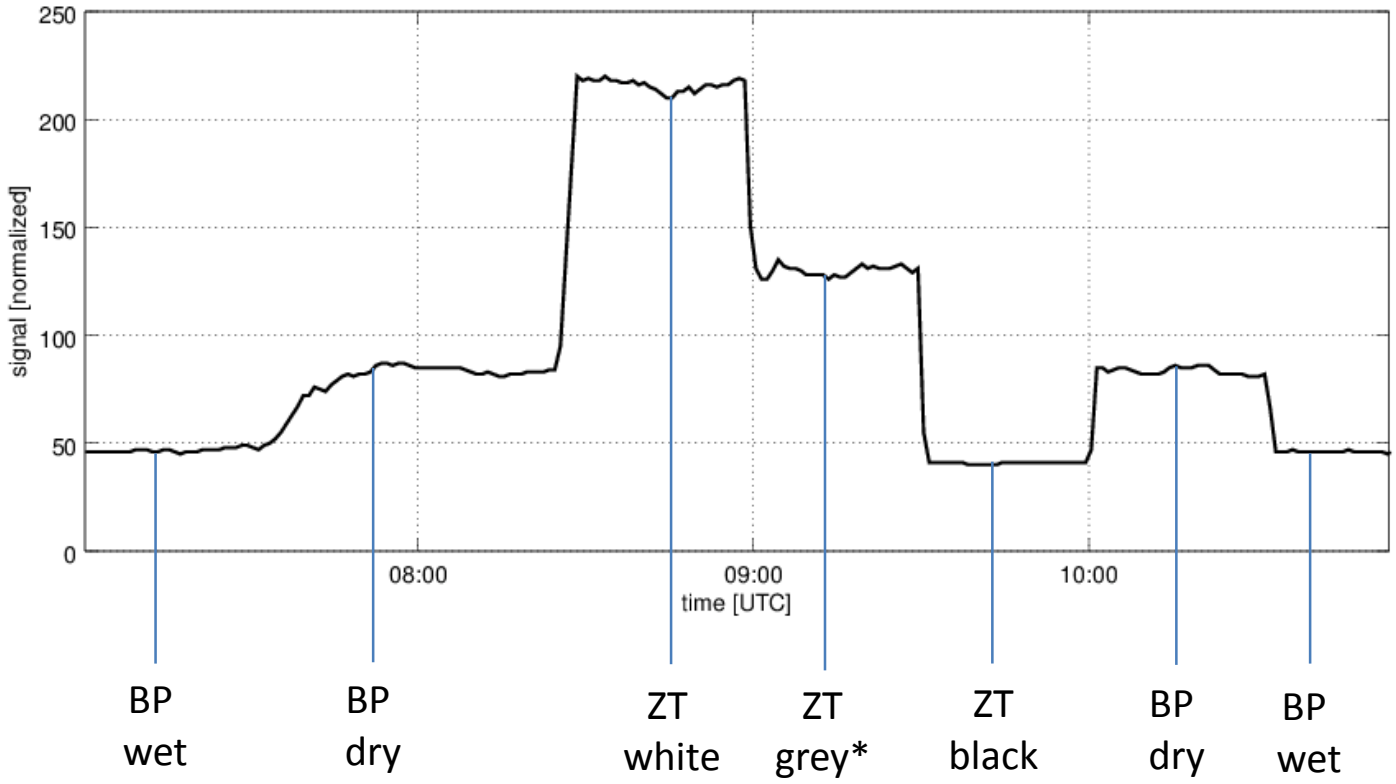
Concrete panel

Black board

White board

Verification of signal strength

Installation height: 2998mm
Tilt angle: 27.9°



BP = concrete panel
ZT = boards

Application fields - examples

Weather forecast/ monitoring

Traffic and aviation safety/ surveillance

Avalanche warnings and winter sport weather

Solar tracker monitoring

Application fields - images

SHM30 @ AWI Neumayer Station in Antarctica

How to overcome challenges with SHM31

- ✓ Extended heating function/ window heater
- ✓ Higher resistance and performance (IP68, all weather operation mode)
- ✓ Energy saving with variuos heating modes: 0.7 W without heater and 3.4 W with window heater enabled, 18 W max. all heaters enabled
- ✓ Built-in auto inclination sensor
- ✓ Up to 15 m snow depths and 16 m installation height
- ✓ Robust, maintenance-free
- ✓ Differentiation between snow and other natural surfaces

Lufft

More SHM31 details

Click here to visit SHM31 product site for more info

Snow Depth Sensor SHM 31

SHARE PRINT

The laser-based snow depth sensor Lufft SHM 31 stands for millimeter-accurate snow level detection over long distances in all weather conditions without any maintenance, due to opto-electronic/laser based rangefinder technology.

Millimeter-accurate snow levels in all weather conditions: The SHM 31 operates with a visible, easy-to-measure measuring beam. The snow depth is given up to 15 meters within seconds, millimeter-accurate and reliable. Various heating functions significantly extends the lifetime of the laser diode and allows high-quality measurement data in all weather conditions. Regular maintenance becomes redundant with the SHM 31. A very robust housing and an arduous operation principle allows almost no maintenance work throughout the lifetime of the sensor. No special interventions like frequent replacements of desiccant or regular calibration are needed.

Parameters measured:	Snow depth
Measurement technology:	opto-electronic measuring technique (rangefinder) with eye-safe laser sensor
Product highlights:	Determination of snow depth over long distances, heating options allow high quality measurements in all weather conditions, simplified installation due to automatic inclination angle compensation
Interfaces:	RS485 & RS232 with UMB, ASCII & SDI12 protocol
Article number:	8365.30

Request a quote or advice

Extract of our valued customers …

Thank you for your attention!

More on www.Lufft.com

Contact: Holger Wille

Holger.wille@lufft.de

Live demo

UMB ConfigTool.NET
UMB ASCII 2.0