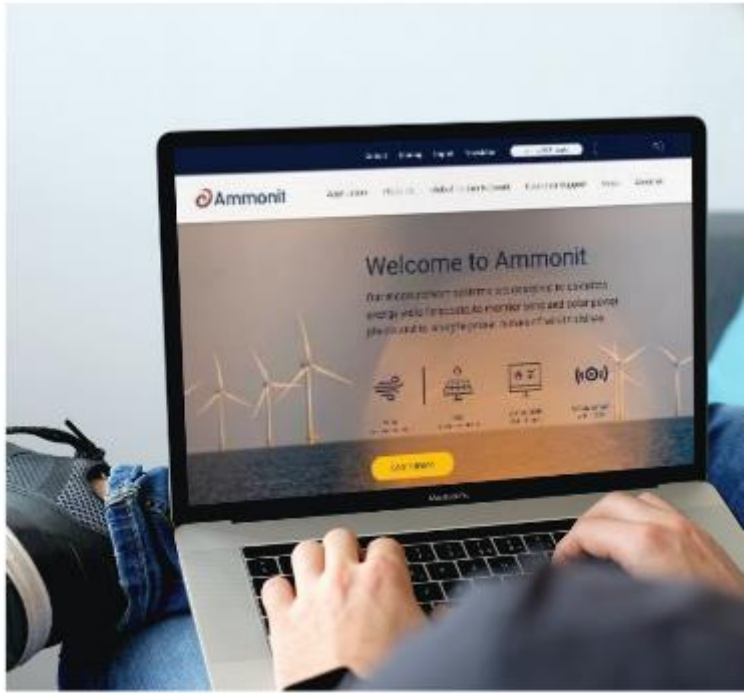


OUR MISSION

MEASURING WIND AND SOLAR POWER TO THE HIGHEST STANDARDS

History and Present

Ammonit was created in 1989 - More than 30 years of Know-How

In 1989 Ammonit developed the first wind computer, designed to record accurate measurement data for wind energy application.

We are Berliners

Ammonit is a German company, owned by the Managers.

We are international

Employees from all over the world

We are successful

Annual production: **1.000** System Data Logger

Annual Sales: **8 - 10 Mio. €**

We are certified

Since 2000 according to ISO 9001

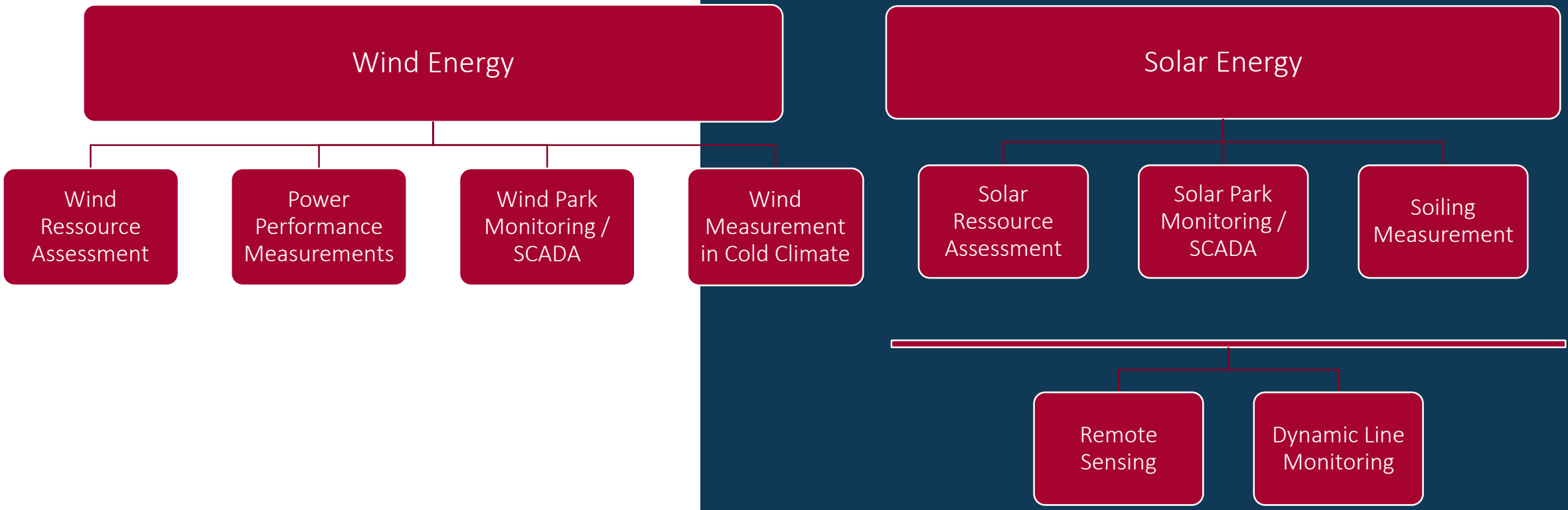
Global Partner Network

51 partners in 43 countries

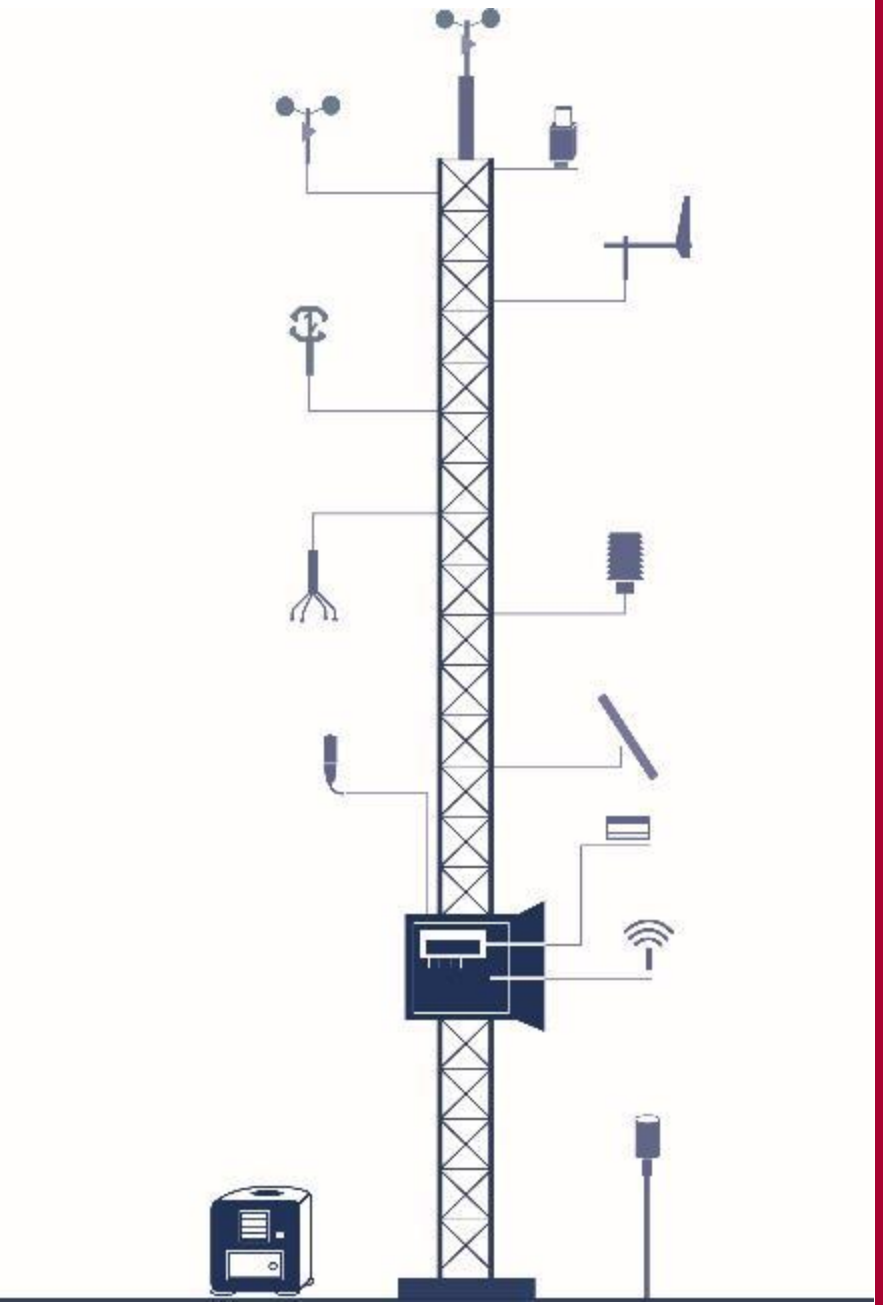
Applications

Before the construction of a Wind or Solar Power Plant

After the construction of a Wind or Solar Power Plant



Products



Data Loggers

- Meteo-42: S / M / L
- Meteo-42 A

Online Services

- AmmonitOR Data Cloud
- AmmonitConnect Remote Access
- AmmonitVerify

Data Logger Accessories

- Communication Systems
- Obstacle Lights
- Overvoltage Protection Modules
- Camera
- Bat Detection
- Power Supply
- Steel Cabinets
- Modules

Wind Sensors

- Anemometers
- Wind Vanes
- Temperature Humidity Sensors
- Air Pressure Sensors
- Precipitation Sensors
- Ultrasonic Anemometers
- Weather Stations

Solar Sensors

- Pyranometers
- Pyrheliometers
- Silicon Irradiance Sensors
- Sun Tracking Systems
- Soiling Sensors

https://www.ammonit.com/en/products/

Meteo**Laser**

Ammonit's Pulsed Doppler LiDAR.

State-of-the-Art Design

1. Pulsed doppler LiDAR - offering the highest possible accuracy
2. IEC classified with excellent accuracy results
3. IT communication tools of Ammonit:
    - AmmonitConnect (similar to VPN / SSH Reverse Tunnel) for live plots and configuration
    - AmmonitOR Data Cloud for Data Management

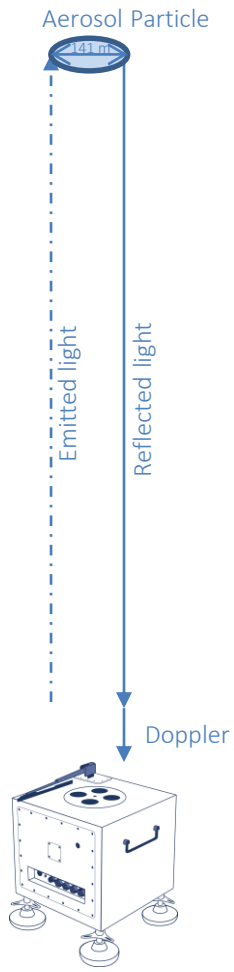
Compact

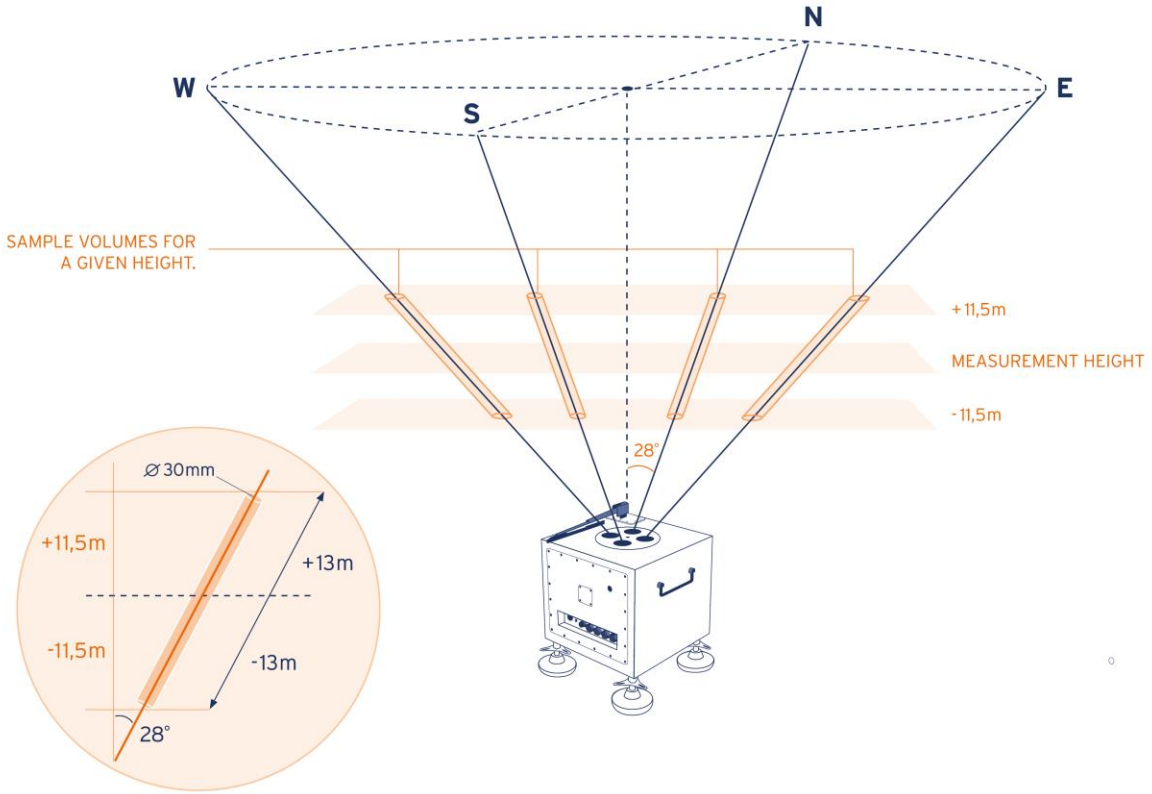
1. Compact price: lowest price for pulsed doppler LiDAR on the market
2. Compact dimensions: 39*39*34 cm, 32 kg without packaging
3. Low power consumption: < 35 W without heating or cooling

MeteoLaser: Physical principle

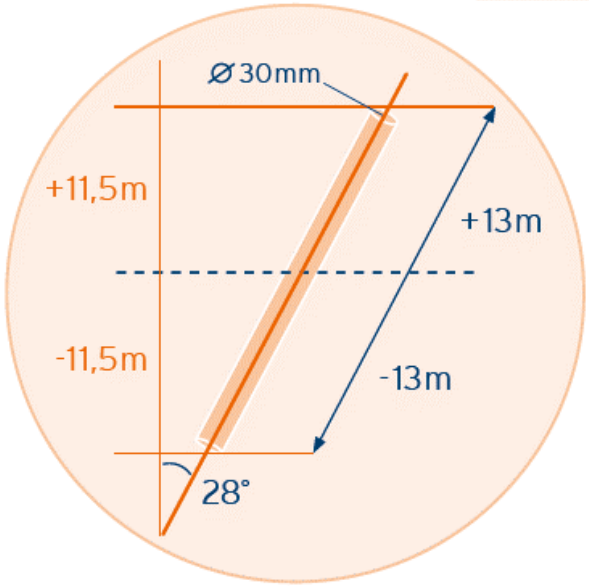
The MeteoLaser LiDAR is sending 4 beams every 0,8 second per beam, 3,2 second for the complete cycle.

From N-S and from E-W the LiDAR calculates the horizontal N-S/E-W wind speed and the vertical wind components.





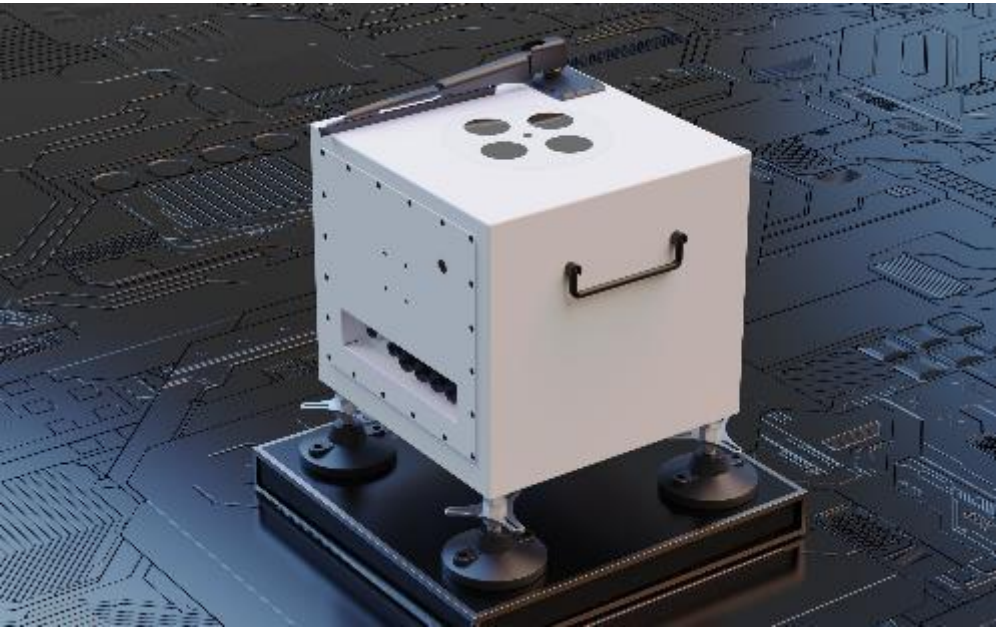
MeteoLaser: Probe length



Probe length: constant for all heights by MeteoLaser LiDAR

- Physically: The probe length is determined by the time duration of the pulse, and it is the same pulse for all heights.
- The pulse length is 175 ns.
- The probe length is for MeteoLaser:
  about ± 13 m along the line of sight
  which makes ± 11,5 m in height [13*cos(28)].
- The probe width is about 20 - 30 mm.
- The sensitivity is constant within the probe volume by pulsed LiDAR.

MeteoLaser: Vectorial / Scalar averaging



1 second data

- Every 0,8 sec Line-of-sight data (raw data) and wind vector component for each height
- Every 3,2 second the complete wind vector for each height

10 minutes data

- Combination of vectorial and scalar averaging of 1 second data to obtain 10 minutes data

MeteoLaser: Requirements acc. to IEC

The MeteoLaser is a ground-based LiDAR. It has to fulfill:
Annex L of IEC 61400-12-1: 2017 (ed.2) / IEC 61400-50-2: 2022

The LiDAR has to be:

- verified/calibrated
- classified.

Note: IEC 61400-12-1 was getting too big (≥200 pages) and thus has been split in many parts:

- IEC 61400-12 -1 to -6 for measurement of wind turbine power
- IEC 61400-50-1 to -4 for the measurement of the wind speed

  but without content modification or addition for the 50-1 and the 50-2

IEC 61400-50-**1: 2022** Measuring wind speed with mast anemometry

IEC 61400-50-**2: 2022** Measuring wind speed with ground-based remote sensors (LiDARs)

Other relevant LiDAR norms:

IEC 61400-50-**3: 2022** Measuring wind speed with nacelle mounted LiDAR (new)

IEC 61400-50-**4:** Measuring wind speed with floating, buoy-mounted LiDAR (new), not yet available

MeteoLaser: IEC Verification / Calibration

Verification/Calibration according to IEC 61400-12-1 / IEC 61400-50-2

- What is a IEC verification/calibration?
  It is a calibration of the LiDAR against calibrated cup anemometers mounted on a meteorological mast.

- The IEC requires that each LiDAR has to be verified before and after being used in a measurement campaign (just like an anemometer).

The MeteoLaser has already been verified on several masts:

DTU	244 m Met mast	Denmark	
DNV	120 m Met mast	Germany	
UL	120 m Met Mast	Germany	
Pavana	200 m Met mast	Germany	
Geo-Net	200 m Met mast	Germany	Ongoing
Telener	210 m Met mast	Texas, USA	Beginning of 2023

MeteoLaser: IEC Verification / Calibration

Verification

- A non IEC conform golden LiDAR **factory report** is delivered for free.
  It is a measurement against a calibrated pulsed LiDAR (the golden LiDAR).
- The IEC conform verification is against a met mast, that should be at least 120 m.
- Ammonit offers **calibration** against 200 m met mast.
- The dotted lines are the limit of the uncertainty by the mast (about ± 1,5 to 2%).
- The target is to have the values in the middle of the uncertainty.

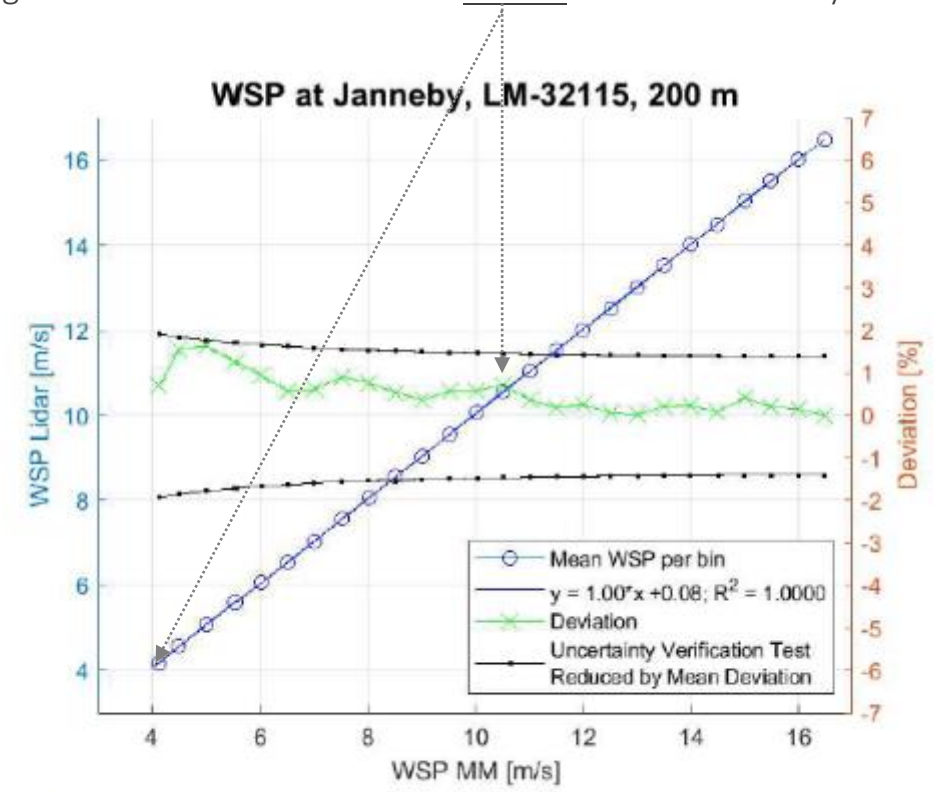


Figure 14: Scatterplot bin-wise wind speed and deviation at 200 m

MeteoLaser: IEC Classification

Height (m)	Pre-liminary Accuracy	Final Accuracy Class	Standard Uncertainty in %
135 m	3,46%	2,45%	1,41%
120 m	2,58%	1,83%	1,05%
100m	2,00%	1,41%	0,82%
80 m	1,79%	1,27%	0,73%
60 m	3,14%	2,22%	1,28%

IEC 61400-12-1 ed.2 (2017) / IEC 61400-50-2 Classification

performed by UL for LiDAR

- Objective:
  To identify and quantify sensitivities (accuracy impact)
  arising from various environmental conditions
  like, Wind Shear, TI, Temperature, Temperature gradient…
- Minimum of three classification tests of at least two devices for at least two locations
- Result of the classification tests is the Accuracy Class,
  which is linked to the measurement uncertainties.

We see

- good results with low measurement uncertainties
- with Final Accuracy Class in the range of 1,27% to 2,45%
- in line with what you can expect from a good pulsed LiDAR.

MeteoLaser: IEC Classification

IEC 61400-12-1 ed.2 (2017) Classification

performed by UL for LiDAR

The environmental parameters that most affect accuracy are:

- Turbulence Intensity (by all heights)
- Wind shear (especially by low heights)

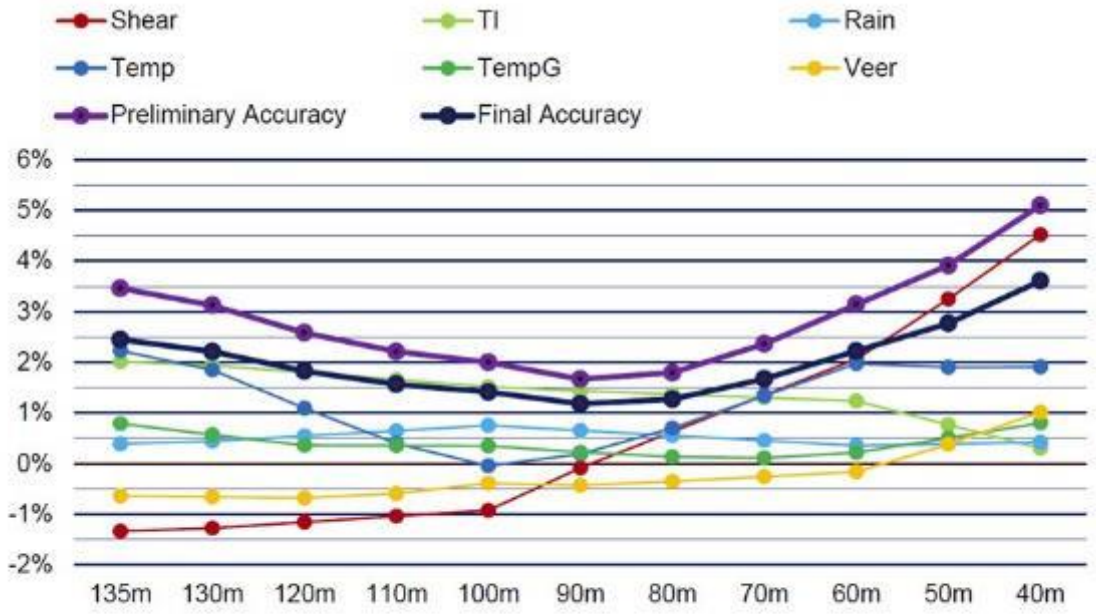


Figure 2.1: RSD Type-Specific Classification Result

MeteoLaser: typical 10 min CSV-file

Typical size of a 10 minutes CSV -file: Compressed: 30 KB, uncompressed 110 KB

Height(m)	40	50	60	80	100	120	140	160	180	200				
********** **********														
Timestamp	Int Temp (degree C)	Ext Temp (degree C)	Pressure (HPa)	Rel Humidity (%)	wiper count	40m Wind Speed Avg(m/s)	40m Wind Speed max (m/s)	40m Wind Speed min (m/s)	40m Wind Speed Std (m/s)	40m Wind Direction Avg (degree)	40m Z-wind Avg(m/s)	40m Z-wind Std (m/s)	40m CNR Avg(dB)	40m Data Availability (%)
28.03.22 00:10	24.80	6.22	1027.50	83.76	2	5.58	9.59	2.02	1.44	285.7	-0.11	0.32	9.08	97
28.03.22 00:20	24.80	6.16	1027.44	83.96	0	5.70	9.12	2.83	1.11	283.7	-0.07	0.28	10.09	100
28.03.22 00:30	24.80	6.16	1027.36	84.02	0	5.26	7.51	2.43	1.04	276.6	-0.08	0.29	10.55	100
28.03.22 00:40	24.80	6.00	1027.30	84.82	0	4.96	8.15	1.95	1.05	280.8	-0.14	0.31	10.84	100

MeteoLaser: typical 1 second CSV-file

Typical size of a 1 second CSV-file: Compressed: 18 MB, uncompressed 75 MB, memory for 5 years of 1 second data: Download over AmmonitConnect or locally

Doppler Measurement

Calculation out of measurement

Timestamp	Position	Temperature	40m CNR (dB)	40m Radial Wind Speed (m/s)	40m Wind Speed (m/s)	40m Wind Direction (degree)	40m X-wind (m/s)	40m Y-wind (m/s)	40m Z-wind (m/s)
00:00:20.201	90	5.10	14.73	-2.76	5.52	280.9	-5.42	1.04	-0.42
00:00:21.107	180	5.10	15.92	-1.38	5.60	284.5	-5.42	1.40	-0.52
00:00:21.940	270	5.10	14.64	2.85	6.10	283.3	-5.94	1.40	-0.38
00:00:22.650	0	5.10	15.04	1.15	6.51	294.3	-5.94	2.68	-0.04
00:00:23.455	90	5.10	15.32	-3.23	6.97	292.7	-6.43	2.68	-0.17
00:00:24.260	180	5.10	16.10	-1.39	6.98	292.8	-6.43	2.69	-0.17
00:00:24.965	270	5.10	15.32	2.46	6.59	294.2	-6.02	2.69	-0.29
00:00:25.770	0	5.10	15.14	1.27	6.64	295.1	-6.02	2.82	-0.25

MeteoLaser: Power Consumption

Best in class power consumption: **30 W** (5°C to 30°C).
We have actually consumed 28 W in North Germany in Winter.

In most tropical countries, it is possible to have a only solar power supply.
→ 900 W - 1000 W Solar Module and 440 Ah 24V System

Information on solar ressources:

https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

https://globalsolaratlas.info/map?c=11.523088,8.349609,4

MeteoLaser: Power Supply

Solar only without trailer	Fuel cell + Solar without trailer
Solar only with trailer	Fuel cell + Solar with trailer

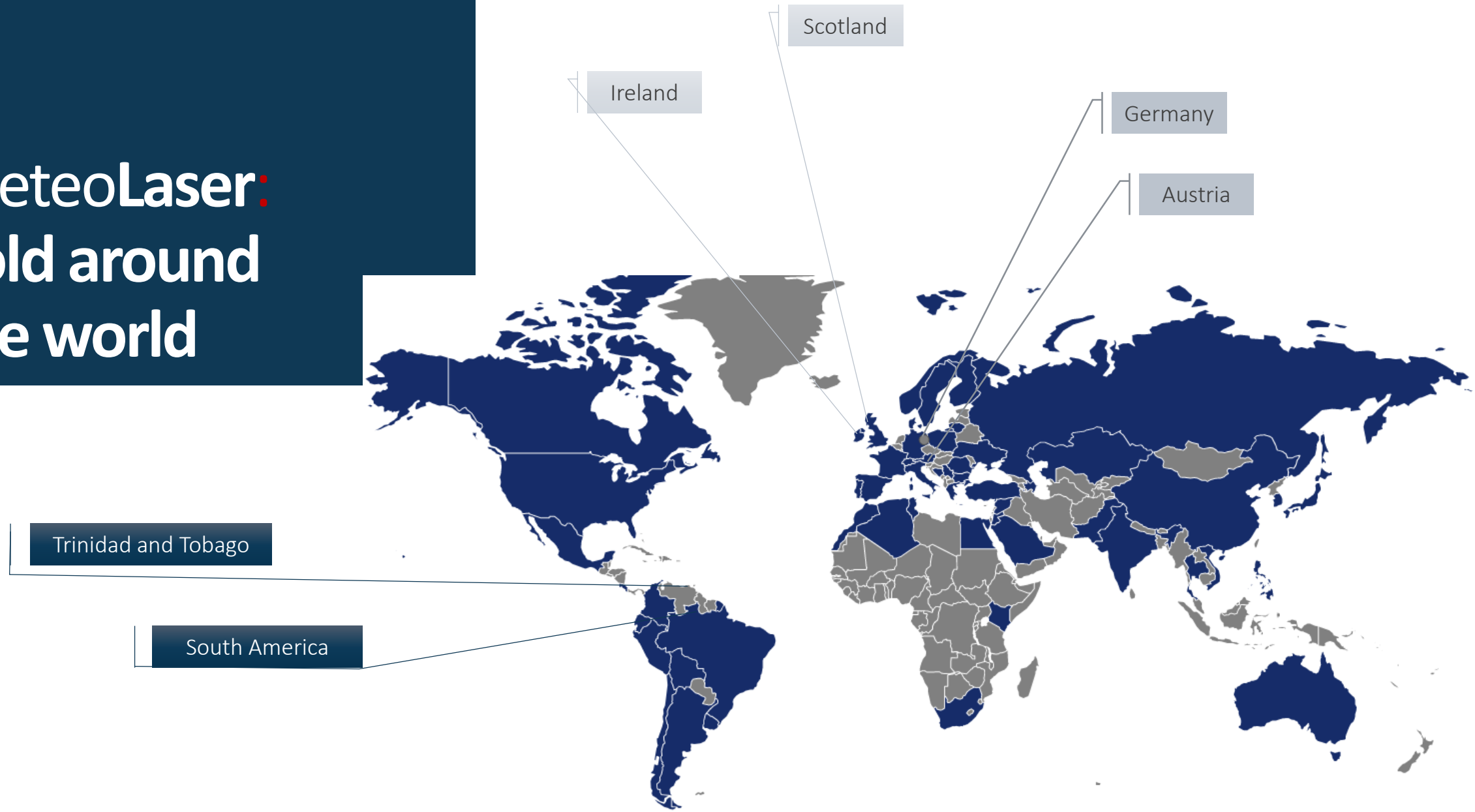
Solar only

- For tropical countries without dark season
- Factor 20-30 for dimensioning solar module to power consumption
- 1200 W are enough for LiDAR with 35 - 45 W consumption

Fuel cell + Solar for cold climate

- 1215 W Solar Module / 85 W Fuel Cell / 260 Ah 24 V Battery
- Monitoring system with cloud, simple maintenance
- Difficult to import fuel cell outside Europe and USA

MeteoLaser: Sold around the world



MeteoLaser project of University of Rostock and IWEN Energy Institute:

Analysis of vertical wind shear up to 300 m and fatigue loading of wind turbines

Prof. Dr. Uwe Ritschel

University of Rostock

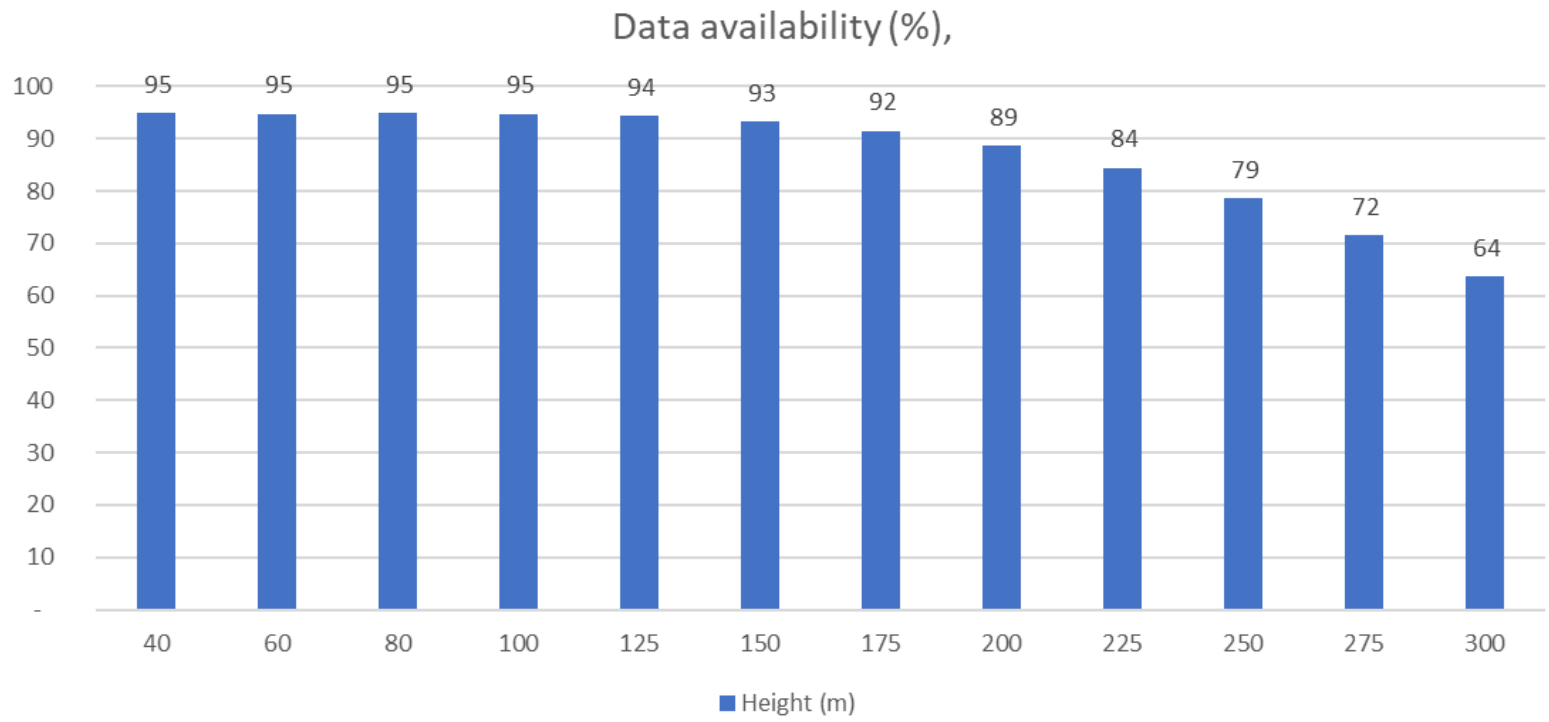
Faculty of Mechanical Engineering and Marine Technology

Chair of Wind Energy Technology

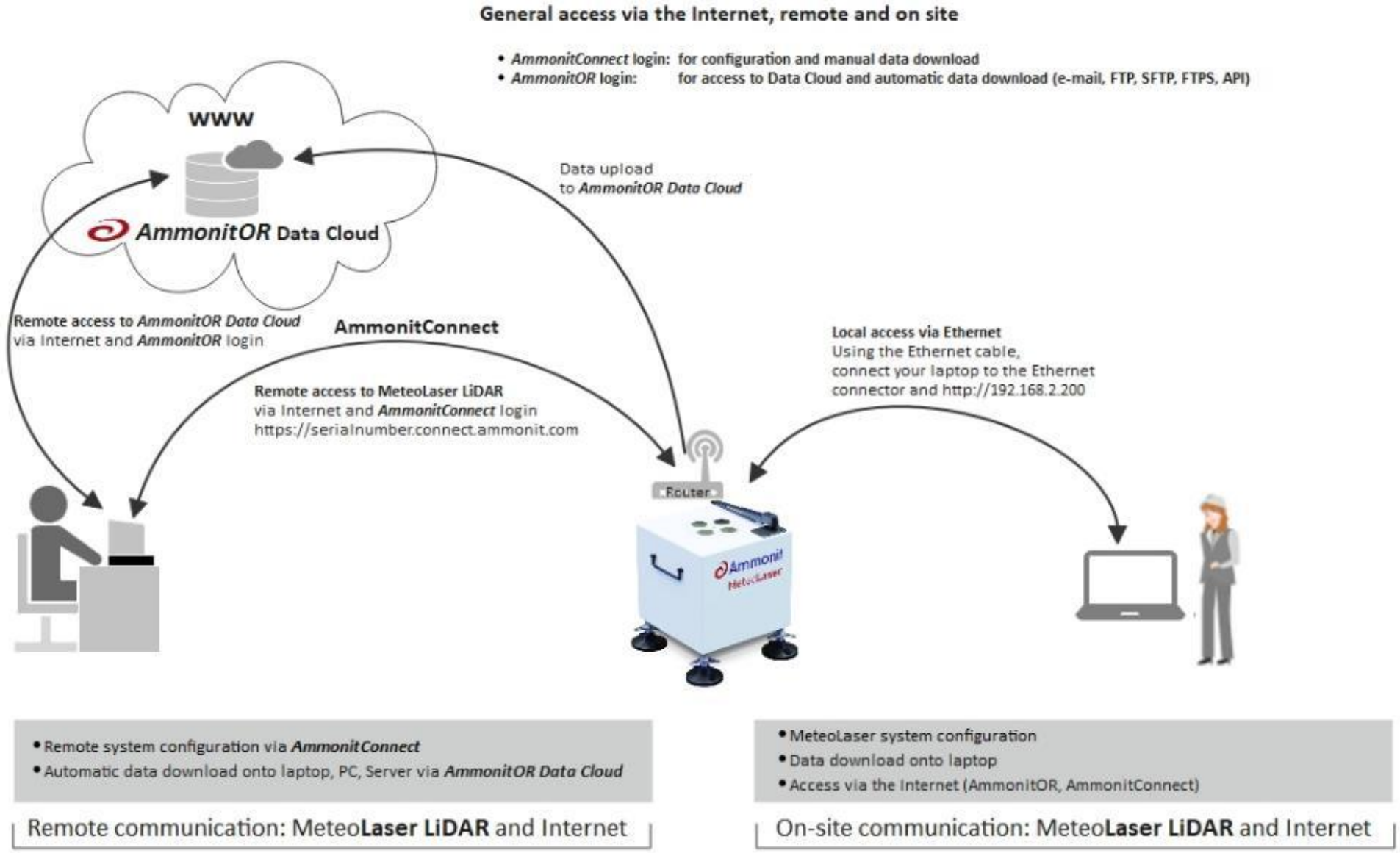
MeteoLaser: Data availability

Project IWEN, Rostock, North Germany, 1 Year measurement period

1- Second data availability



MeteoLaser on AmmonitOR Data Cloud and AmmonitConnect



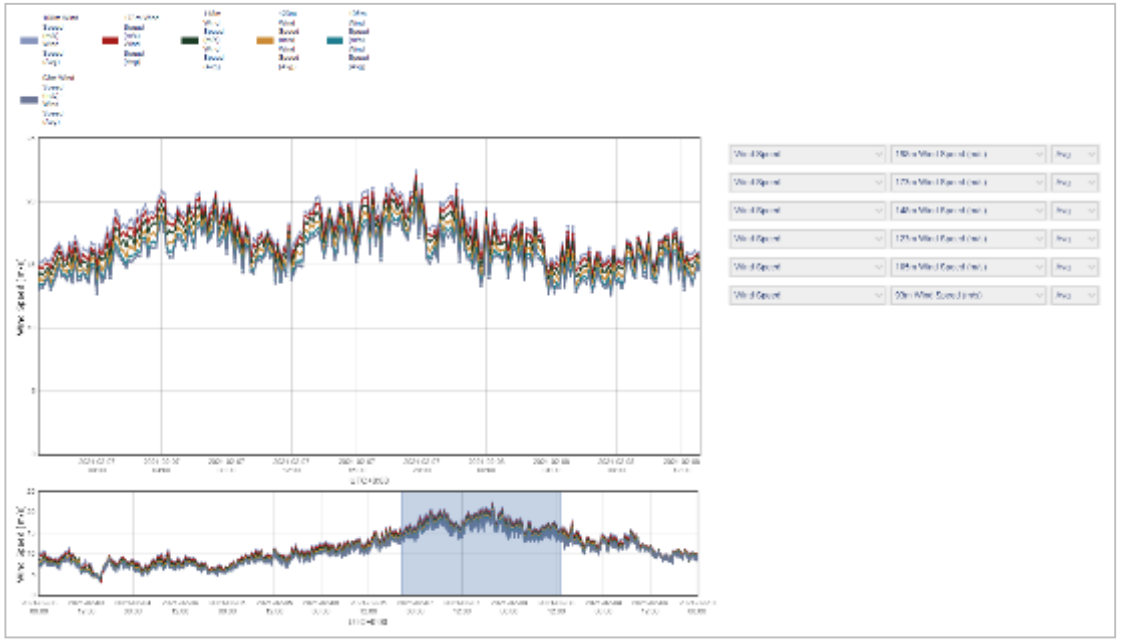
MeteoLaser on AmmonitOR Data Cloud.

Campaign Monitoring via AmmonitOR cloud

10 minutes data are transferred to AmmonitOR cloud via SCP:

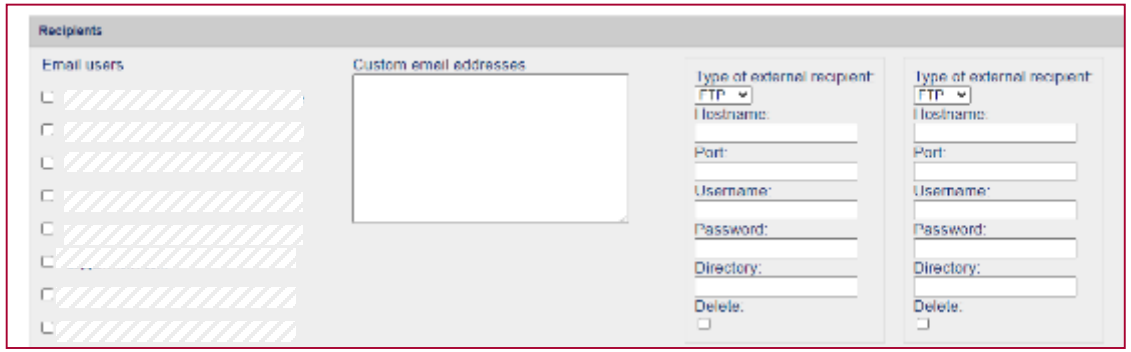
- Secure access with access right management
- Plots for campaign monitoring
- Campaign monitoring and reporting tools
- Data Export

AmmonitOR Data Cloud



AmmonitOR offers **exports** per Email, FTP, SCP, FTPS, SFTP and **API**.

- User management
- Float management



MeteoLaser on AmmonitOR Data Cloud.

AmmonitOR Data Cloud

Completeness

Device IWEN (LM32109)

Display percent
Display number of entries

Total completeness: 96.54 %

2022

2022

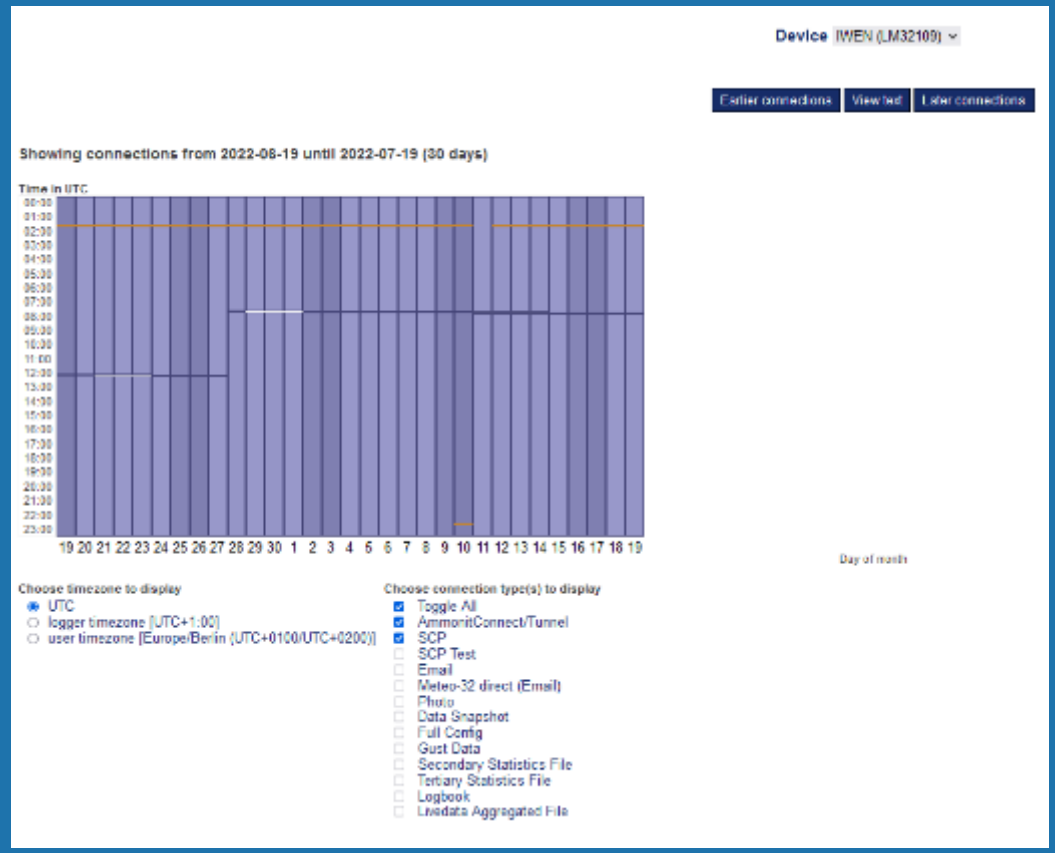
Month\Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2022-11	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1															
2022-10	100	100	100	100	61	78	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100
2022-09	100	100	100	100	100	100	100	100	100	100	100	100	100	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
2022-08	99	24	43	45	52	69	72	81	90	92	199	101	99	99	100	100	100	100	100	100	100	100	50	100	100	100	100	100	100	100	100
2022-07	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
2022-06	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1	
2022-05	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	83	1
2022-04	99	100	100	100	100	100	100	100	100	100	100	100	100	100	96	100	100	100	100	100	100	100	100	100	99	100	100	100	100	1	
2022-03	99	100	100	99	100	100	100	99	100	99	97	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99
2022-02	99	100	100	100	100	100	100	100	100	100	100	99	99	100	99	98	100	97	100	98	100	99	100	99	99	100	100	40			
2022-01	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	100	100	100	100	100	100	1

2021

2021

Month\Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2021-12	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	97	100	1
2021-11																														47	

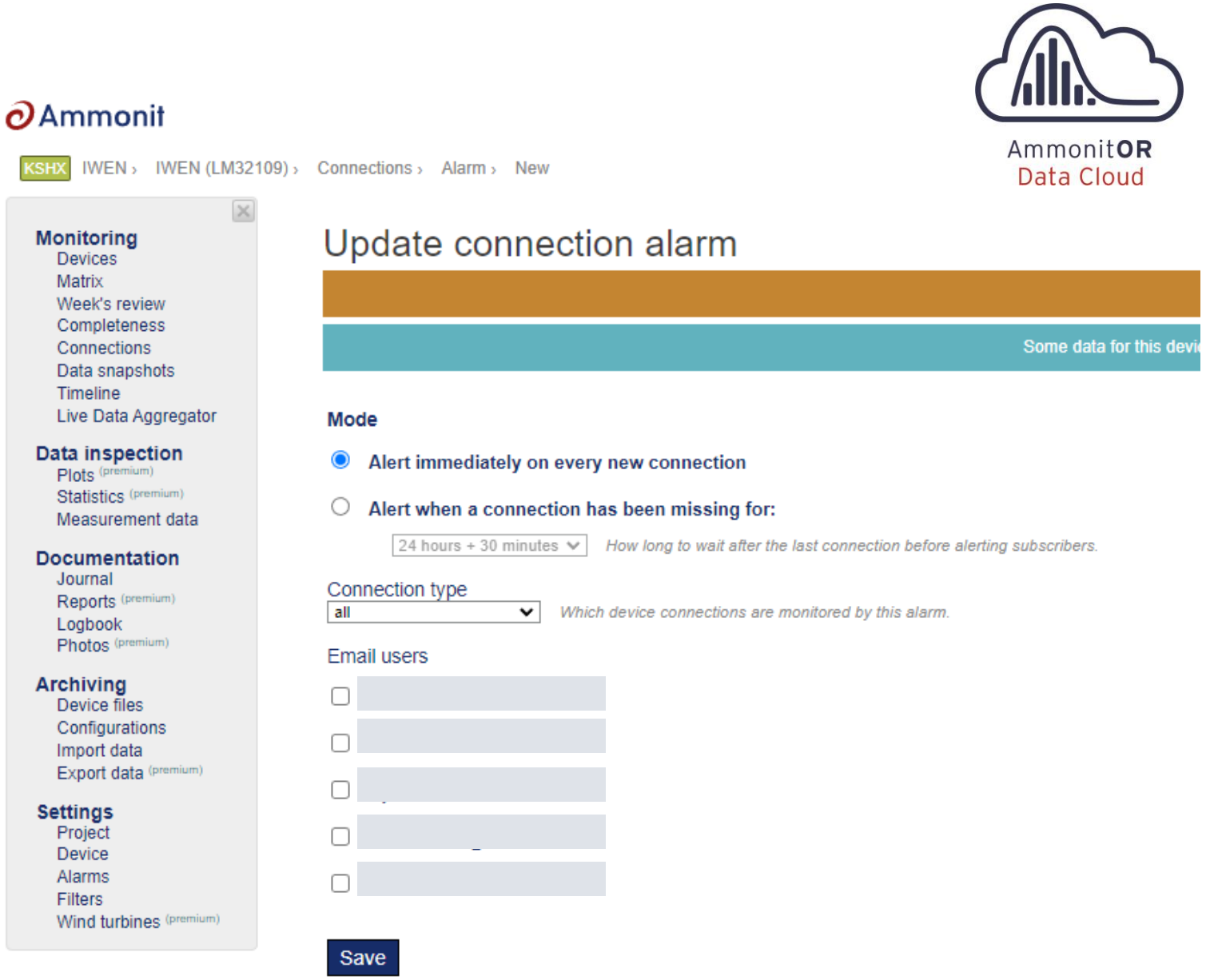
Connections



Bonus

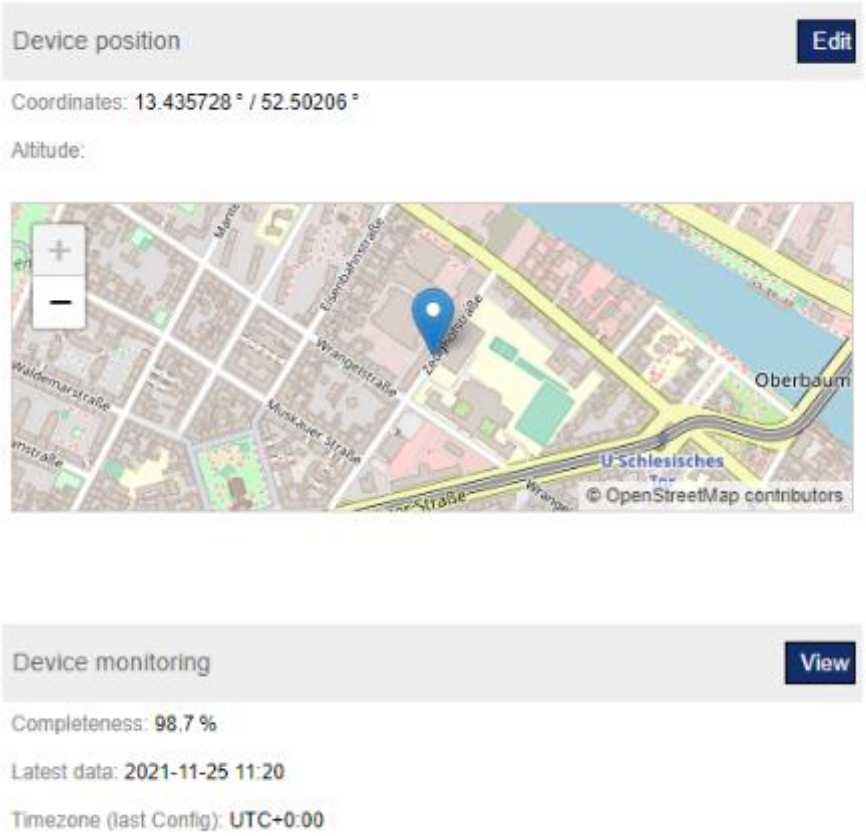
MeteoLaser on AmmonitOR Data Cloud.

As shown here on example of the IWEN project, there is the possibility to set up an alarm to track the connections of the MeteoLaser LiDAR.



MeteoLaser on AmmonitOR Data Cloud.

AmmonitOR Data Cloud



All registered AmmonitOR users have access to some **example projects** in order to test AmmonitOR's features.

By clicking on https://or.ammonit.com/examples/ you can view“LM21901 Roof Measurement” https://or.ammonit.com/FXQR/LM21901/plot/dynamic-xy/

That’s our measurement test campaign with the MeteoLaser LiDAR on Ammonit roof from September to November 2021.

Please note that if you do not yet have an AmmonitOR account, you are welcome to register for free on AmmonitOR here: https://or.ammonit.com/access/login/

MeteoLaser through AmmonitConnect.

Direct access through AmmonitConnect (SSH Reverse Tunnel)

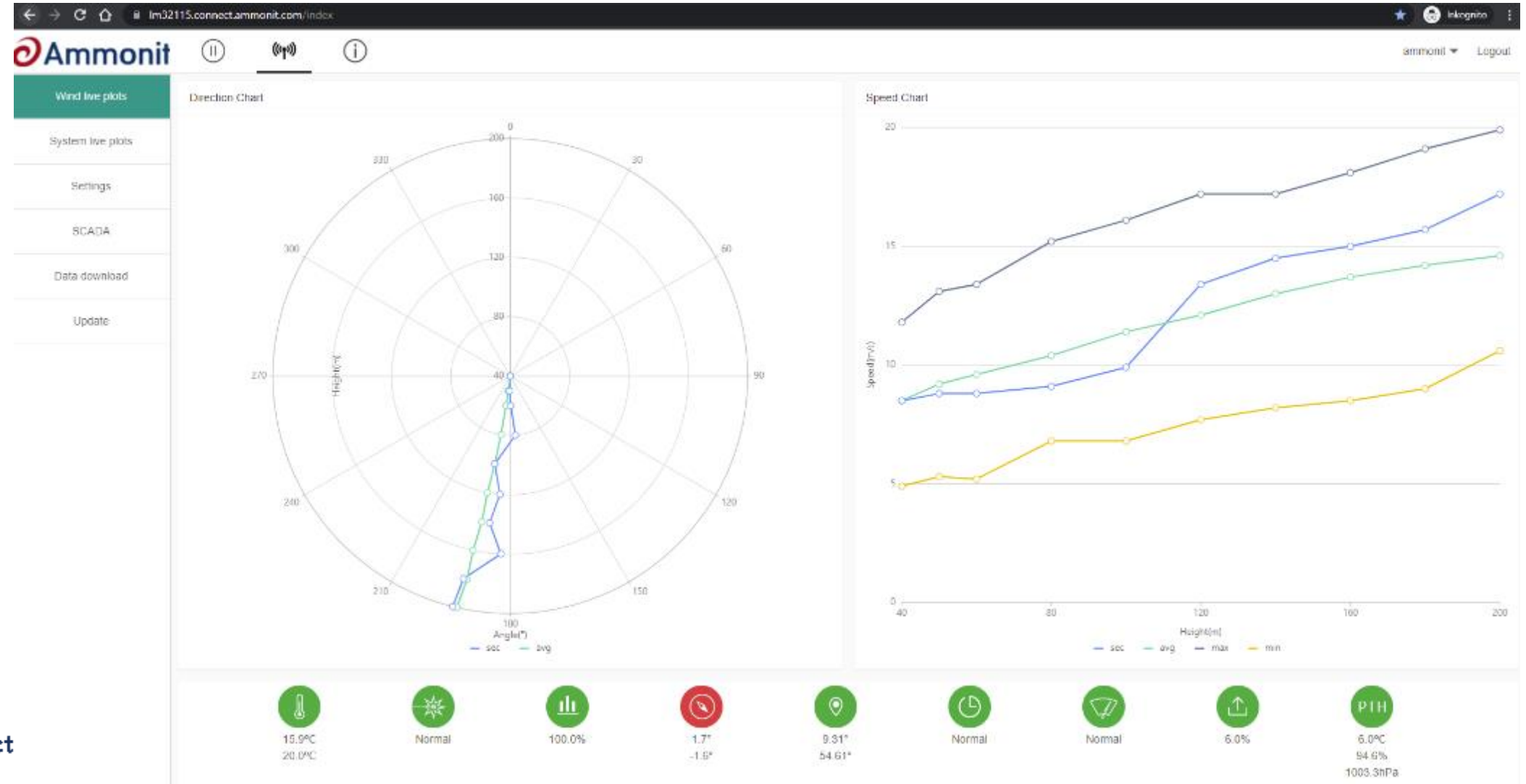
https://lmXXXXX.connect.ammonit.com

- For realtime plots and system data
- For configuration
- For manual download of 10-minutes or 1-second data

AmmonitConnect Remote Access

MeteoLaser through AmmonitConnect.

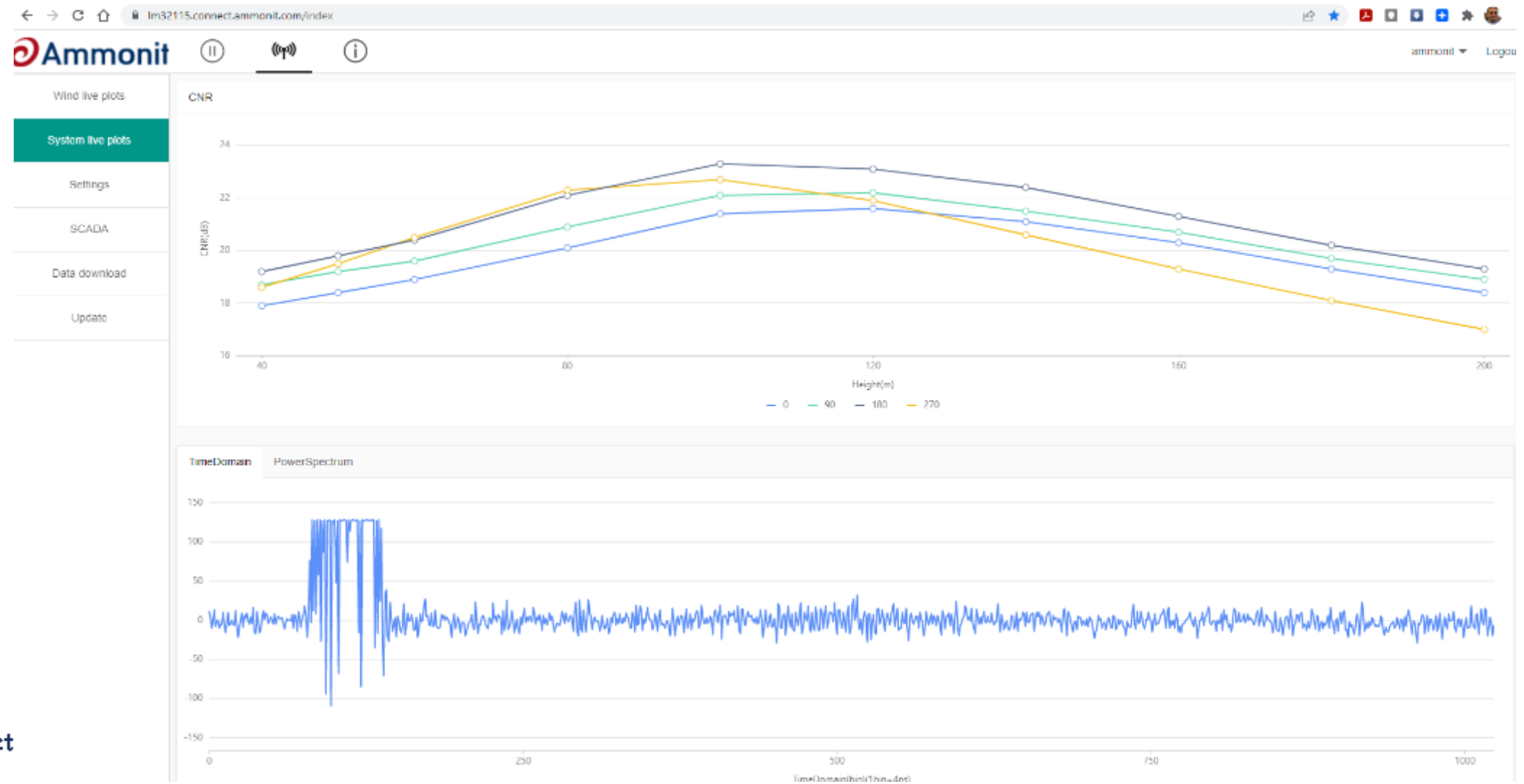
Live Plots



AmmonitConnect
Remote Access

MeteoLaser through AmmonitConnect.

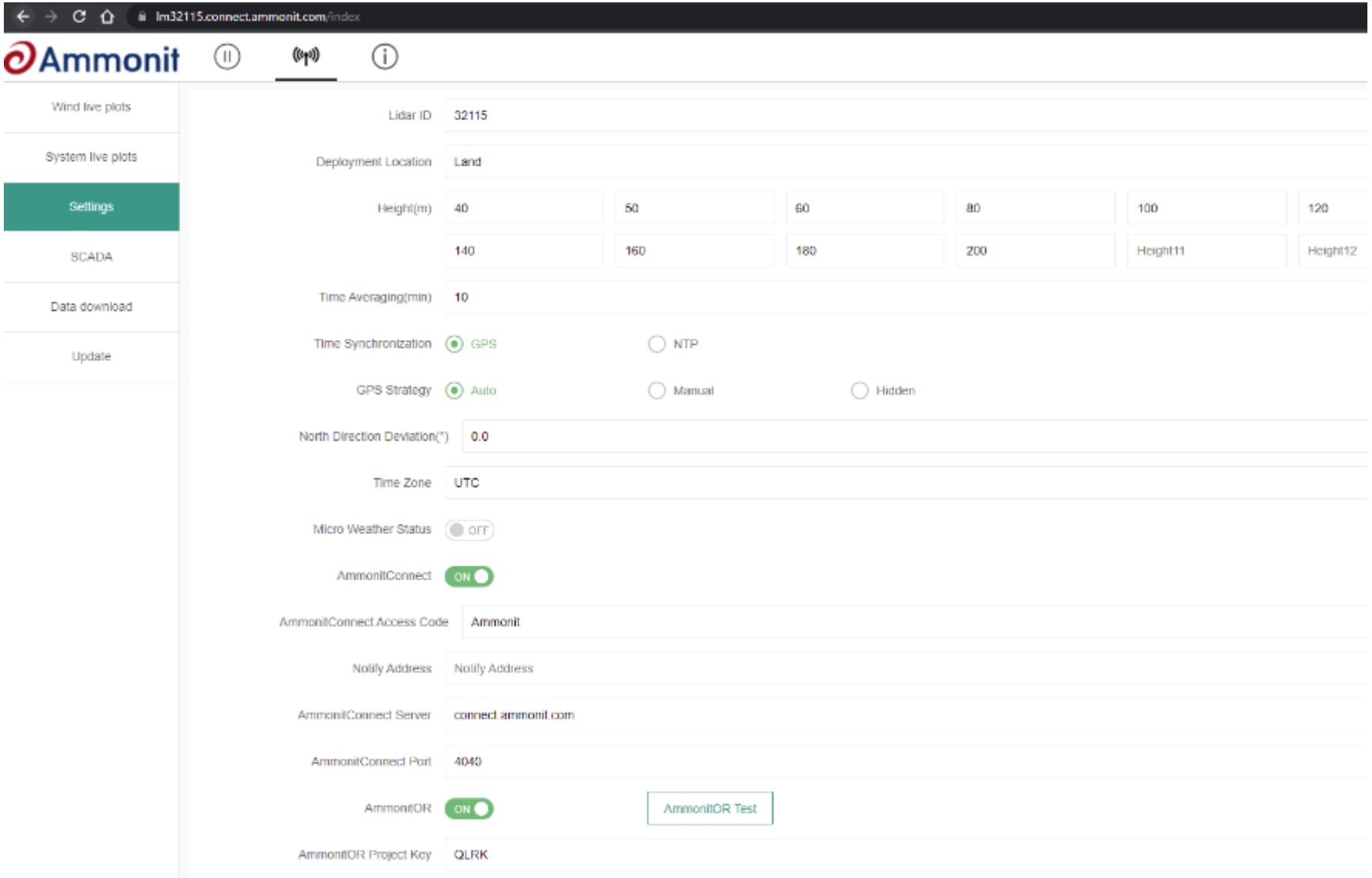
System
Live Plots



AmmonitConnect
Remote Access

MeteoLaser through AmmonitConnect.

Settings



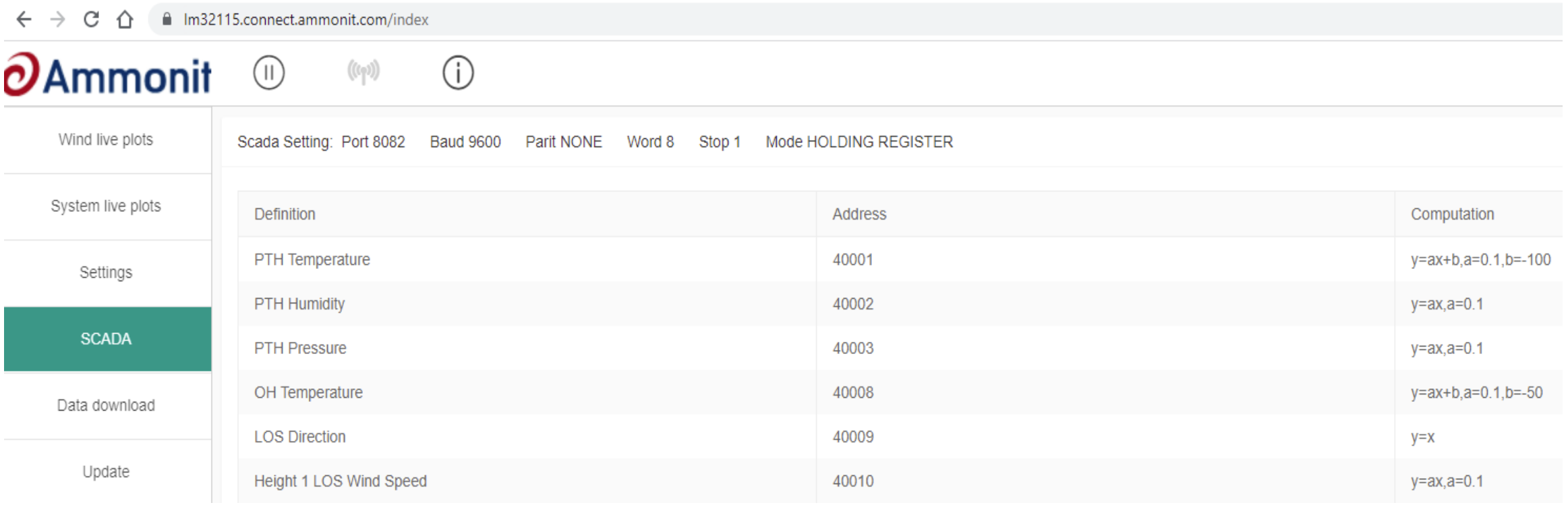
AmmonitConnect
Remote Access

MeteoLaser through AmmonitConnect.

SCADA Modbus TCP

MeteoLaser LiDAR offers SCADA output with Modbus TCP

Interesting for wind park monitoring application + for forecasting applications



Definition	Address	Computation
PTH Temperature	40001	y=ax+b,a=0.1,b=-100
PTH Humidity	40002	y=ax,a=0.1
PTH Pressure	40003	y=ax,a=0.1
OH Temperature	40008	y=ax+b,a=0.1,b=-50
LOS Direction	40009	y=x
Height 1 LOS Wind Speed	40010	y=ax,a=0.1

Interested in an offer for MeteoLaser?

Ammonit

Our Sales Team
Email: sales@ammonit.com
Phone: +49-30-6003188-0

eTraining@ammonit

Our new Data Logger **Meteo-42**

Spring 2023

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or follow us on **LinkedIn**