"Raise a tower of light"

Windcube™

Wind Lidar system

Leosphere™


WIND CUBE

- Instant outdoor set up (15mn) : 45 kg – Plug and Play
- Silent and discreet, robust and unattended
- Steady high resolution throughout full range
- Self calibration
- As accurate as a cup anemometer
- Vertical component of the wind and turbulence data
- Ultra extensive range (2km), 2/3D capable
- 8 months outdoor extensive tests
- Data ready to use (real time filter)

Return On Innovation

The profitability of a wind farm project depends on two major challenges: reducing the uncertainty about the expected production and reducing the project risks and cost.

Then, every uncertainty regarding the forecasted wind resources becomes critical. So why estimate the wind data at 150m when you can measure it directly ? Why horizontally correlate and estimate the data when you can easily deploy and position your wind profiler anywhere throughout the site ? While requirements on data quality increase, the wind energy industry keeps looking for time and cost effective ways to realize initial assessments and due diligences. Easily deployable wind profilers reduce their risk by accelerating the process and simplifying procedures.

"Why estimate the data at 150m when you can measure it directly?"

Whether you are a turbine designer or an operator needing to enhance wind mill performances or a developer requiring to optimize the location of masts, you might need to remotely access to multiple wind measurements points: vertical profile and mapping of wind speed and direction, understanding of wind behaviour (turbulences and wind shears). Yet, until now, wind measurements were realized by various local or remote sensing techniques that made it difficult to collect 24/7 real-time, high-resolution wind data at any height up to 200m. Among these techniques, LIDARs were promising but their backtrack was not long enough.

"Don't raise mast, send the light."

The **Windcube**™ has brought an alternative to this situation by offering a compact, secured and easy to set up LIDAR with unmatched performances tested by independent organizations, ideally designed for wind measuring activities.
Co-developed with the French Aerospace Research Agency (ONERA), the **Windcube**™ opens the era of a new generation of LIDARs:
Operational? Easy to setup and re setup, autonomous (very light maintenance), the **Windcube**™ acts like any other meteorological sensor.
Cost and time effective? Save the time to request a construction permits or to raise a high mast and accelerate the assessment period. Not to mention the offshore situations.
Reduce risk? With easy and mobile wind measurements up to 200m, reduce the uncertainty on vertical and horizontal correlation of site assessments models. In complex sites, get real turbulences and wind shear measurements.

So why innovate? The **Windcube**™ will provide you the flexibility of a mobile sensor and the performances of a 200m met mast with cup anemometers.

KEY BENEFITS OF WINDCUBE™

- **Instant outdoor set up (15mn)** : 45 kg – Plug and Play
- **Silent and discreet, robust and self protecting, unattended**
- **Ultra extensive range** (2km)**, 2/3D capable**
- **Steady high resolution and availability throughout full range**
- **Both data storage** (> 1 year)**, Ethernet / GPRS data transfer**

Applications:
site assessment, farm operations, turbine optimization

Average size of windmills is growing fast, wind farm projects are becoming more and more complex and difficult to assess. Bigger, wider, higher, wind farms have new needs that will require a new way of measuring wind.

"Accuracy of the wind detection at 160m is getting critical"

Understanding the wind may be very difficult on complex sites. Relief components like trees or cliffs dramatically modify the distribution of the wind. In that perspective, measuring the wind, up to 160m, at several spots in the farm, becomes necessary to reliably predict the wind farm potential.
Get a 10 height wind profile in real time (1s data refreshment) up to 200m, that is the functionality that allows to use the **Windcube**™ for various applications

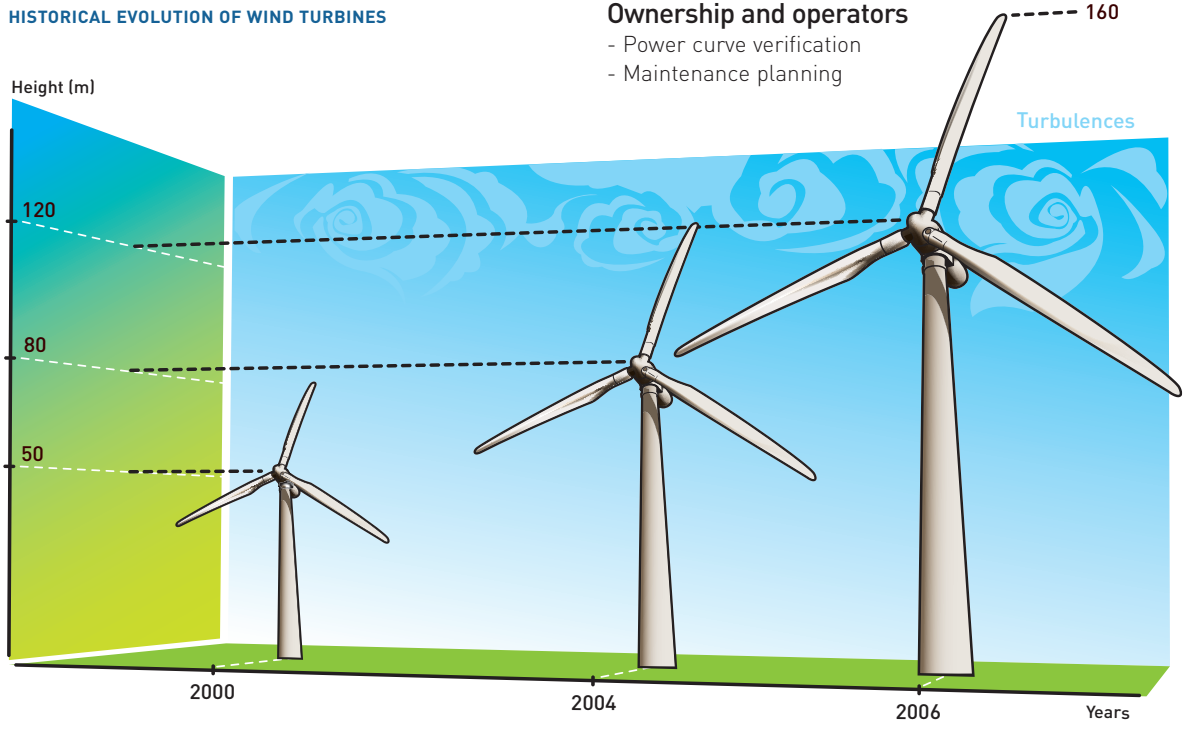
Developers
- Pre evaluation (optimization of mast location for site assessment)
- Initial site assessment
- Wind circulation for complex site evaluation
- Wind profiles and 3D mapping of wind
- Model calibration
- Micro sitting

Manufacturers and turbine designers
- Impact of vertical profile and turbulences on turbine efficiency
- Turbine optimization

Offshore project
- Initial site assessment without offshore metmast
- Offshore wind turbine production verification (lidar on the same platform as the turbine)

Ownership and operators
- Power curve verification
- Maintenance planning

HISTORICAL EVOLUTION OF WIND TURBINES

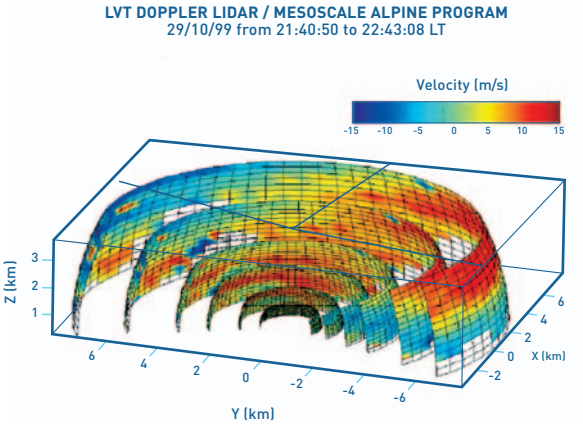


Functional Specifications & Performance

PERFORMANCES	
Range Min-Max[1]	40 to 200m
Accumulation Time	0.5s
Data Output Frequency	1Hz
Probed Length	20
Number Of Measurement Heights	10
Scanning Cone Angle	Dual 15° and 30°
Speed Accuracy	0.2m/s
Speed Range	0 to +60m/s
Direction Accuracy	1.5°
Data Availability	95%
Upgradability[2]	Extendable 400m (2007), 2km (2008) 3D Scanning
PARAMETERS	
Wind Profile	Yes
Turbulences	Advanced Analysis

[1] According to atmospheric conditions
[2] By embedding a new laser source

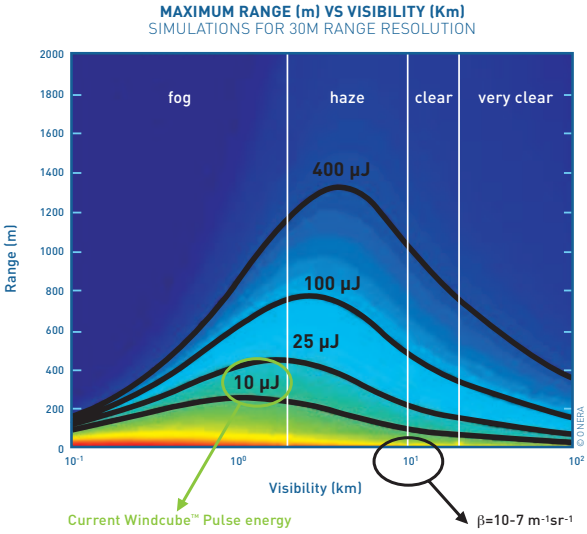
The **Windcube**™ technology allows the user to get many components of the wind:
- Real-time (1Hz) Wind coordinates u, v, w
- Radial wind speed variance
- Signal-to-Noise Ratio
- 1s/10min horizontal wind speed + direction average
- Turbulence and wind shear data (cross-products)
- More than 10 user-defined heights (correlated or not)



"Steady performances whatever the height"

Upgrades

The **Windcube**™ can be easily upgraded by adding or switching some components. Such plug-in will enhance the detection range or add new features like 2D/3D windflow detection capability. The extended range will be a key specification in a near future to better understand the wind flow at the higher heights (200 to 400m).



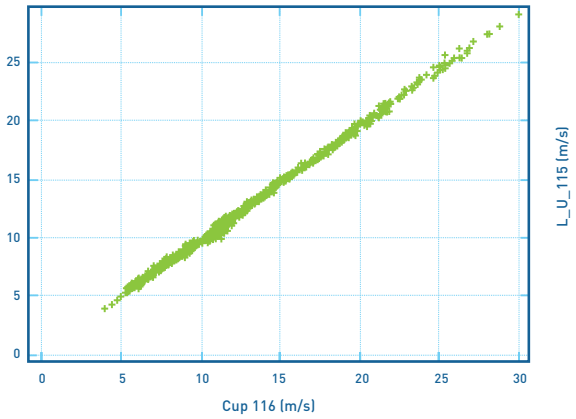
10µJ Pulse energy → >150m range in most weather conditions

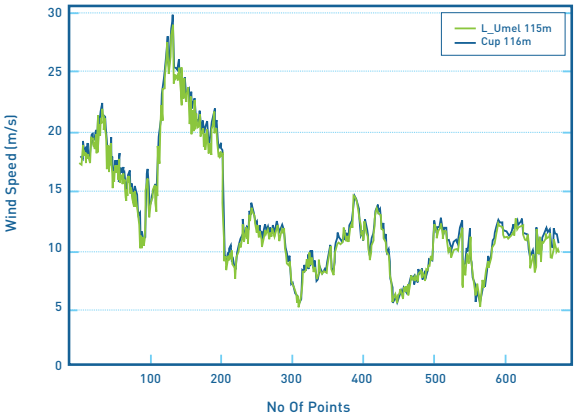
KEY SPECIFICATIONS

- 10 height profile in 1 second
- maximum height up to 200m

External validation test

10MIN AVERAGE LIDAR HORIZONTAL WIND SPEED (H_WS) COMPARED WITH RISØ CUP ANEMOMETER AT 116M. H_WS(WINDCUBE™) = 0.975 H_WS(CUP) + 0.003





676 data points over March 2007 at Høvsøre test site (Denmark): dry weather data, wind direction between 240°-300° and 70°-110° (free sector), wind speeds above 4m/s.

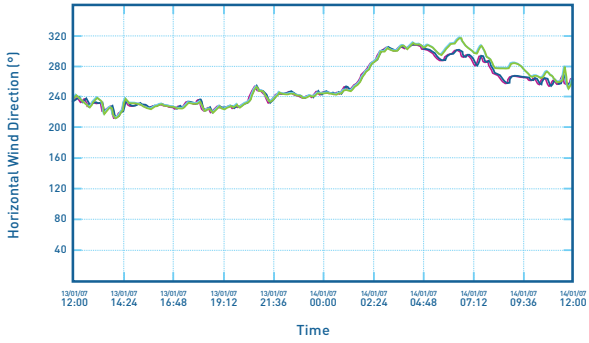
"8 months of outdoor extensive operation since october 2006"

WINDCUBE™ DATA AVAILABILITY OVER MARCH AT RISØ HØVSØRE TEST SITE

ALTITUDE (m)	**MARCH DATA AVAILABILITY** (1Hz DATA, %)
60	99.1
100	98.2
150	95.9
200	87.7

Site weather statistics: T° min : 0°C, T° max : 16°C, precipitation 50mm, wind speed between 1 and 30 m/s

10MIN AVERAGE LIDAR HORIZONTAL WIND DIRECTION COMPARED WITH CEA-SACLAY (FRANCE). USA-1 SONIC ANEMOMETER AT 60M & 100M.



LEOSPHERE thanks CEA for **Windcube**™ evaluation campaign performed in January-February 2007 and RISØ for **Windcube**™ evaluation campaign performed in March-April 2007.
More test site weather statistics available at: http://veaonline.risoe.dk/rodeo/ProjectOverview.aspx?&Project=4&Rnd=147049

Technical Specifications

PARAMETERS	
Wind Profile	Yes
Turbulences	Advanced Analysis

ELECTRICAL	
Power Supply	24V DC or 100/240V AC 50-60Hz[1]
Power Consumption	120W
ENVIRONMENTAL	
Temperature Range	-10 to +40°C
Operating Humidity	IP65
Rain Protection	Wiper
Compacity	Portable (2 persons)
OPTICS & ELECTRONICS	
Laser	1.54 µm
Eyesafety[2]	IEC 60825-1
DIMENSIONS	
Size	800x550x550mm
Weight	45Kg
DATA	
Data Format	ASCII/Binary
Data Transfert	GSM/LAN/TCP-IP

[1] Autonomous power supply solution under development
[2] Currently under certification

Casing

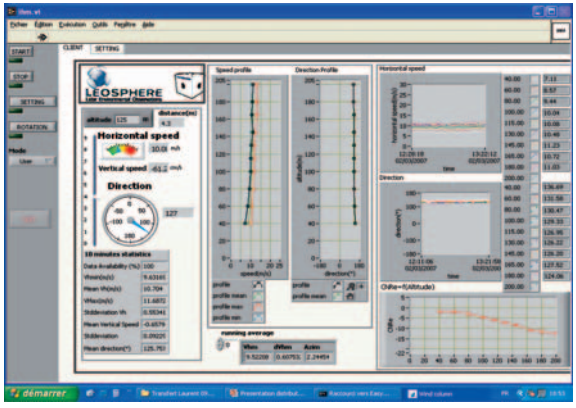
We have been carrying out several environmental long term tests on the **Windcube**™ system. The **Windcube**™ is enclosed in an IP65 waterproof and dustproof housing, which protects the system from all weather conditions. The system is also equipped with a window de-icing system and an automatic wiper system that allows the system to operate in cold, rainy and snowy conditions.

"Either Offshore or onshore operating conditions"

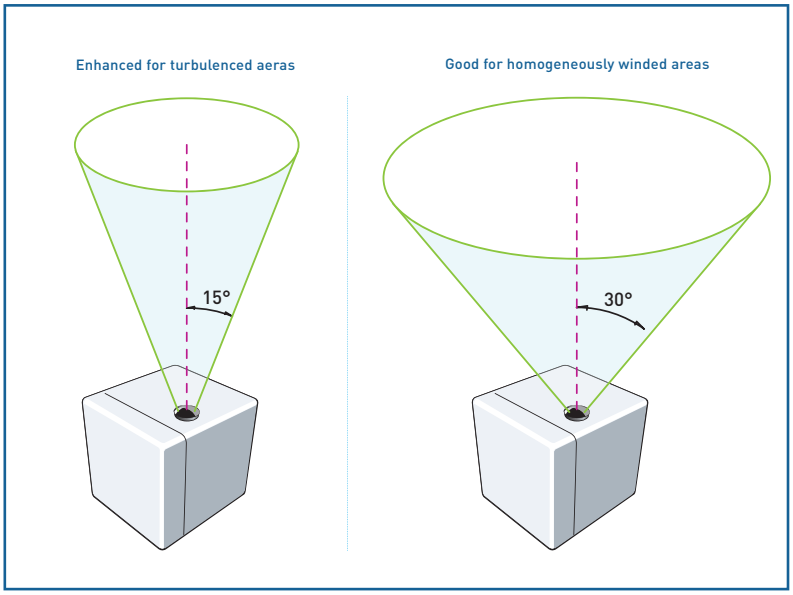
Light maintenance

The only maintenance tasks to perform are to fill the wiper container when it is empty (every 3 months) and make sure the **Windcube**™ window is not obstructed by dirt and dust particles that could not be removed by the wiper.

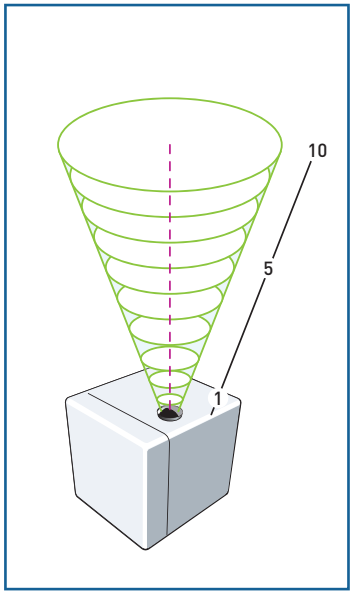
"Take your Windcube™ and deploy it anywhere you need, plug it, it's already measuring"



What does Windcube™ brings to existing Wind Lidar technologies?



SCANNING CONE ANGLE CHOICE



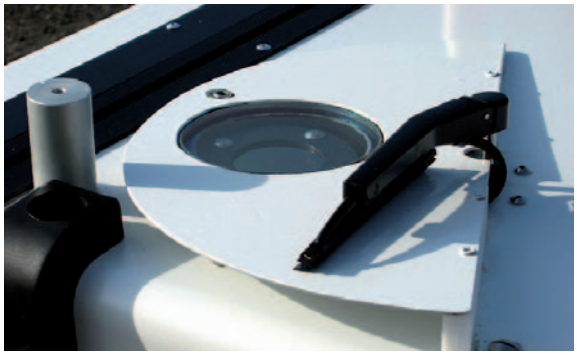
10 HEIGHT WIND PROFILE IN 1 SECOND

Wind circulation can be homogeneous or considerably complex according to the relief and roughness of the assessed site. Because many sites are subject to turbulences, the **Windcube**™ technology entails two measurement modes (15° or 30° scanning cone angle) to be able to better retrieve wind profiles according to complexity of the wind structures. Then choose the mode which fits the best to your operational constraints !

"10 height wind profile in 1 second"

Pulsed laser benefits: simultaneous & steady measurements

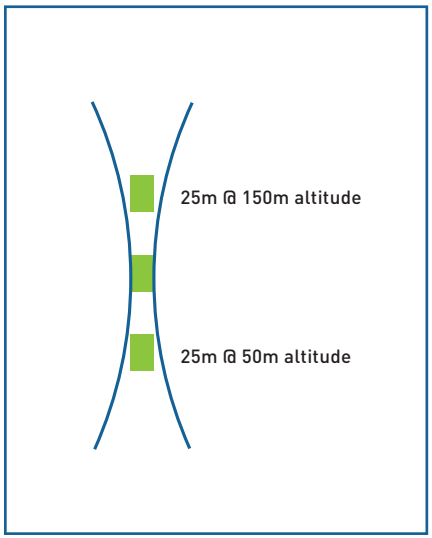
Thanks to its pulsed laser source, the resolution and accuracy of the **Windcube**™ remain the same at any height. The **Windcube**™ optics don't have to focus at each chosen height. The other benefit of the pulsed source is the simultaneous measurements at any height : the **Windcube**™ can retrieve up to 10 measurement heights in 1 second.



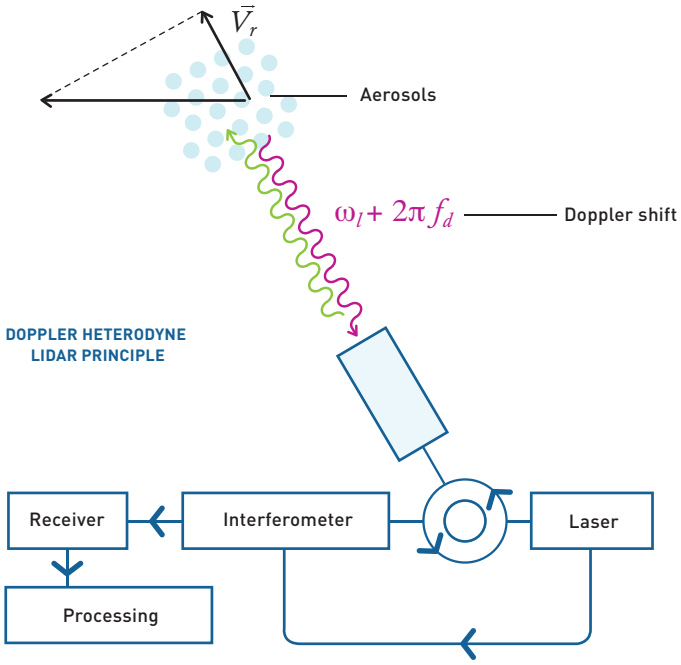
KEY SPECIFICATIONS

- Autonomous
- Portable (45 kg)

Technology



PULSED LASER OPTICAL VISION



DOPPLER HETERODYNE LIDAR PRINCIPLE

Lidar principle

Leosphere **Windcube**™ is an active remote sensor based on Laser Detection and Ranging technique. The heterodyne Lidar principle relies on the measurement of the Doppler shift of laser radiation backscattered by the particles in the air (dust, water droplets from clouds and fog, pollution aerosols, salt crystals, biomass burning aerosols...).

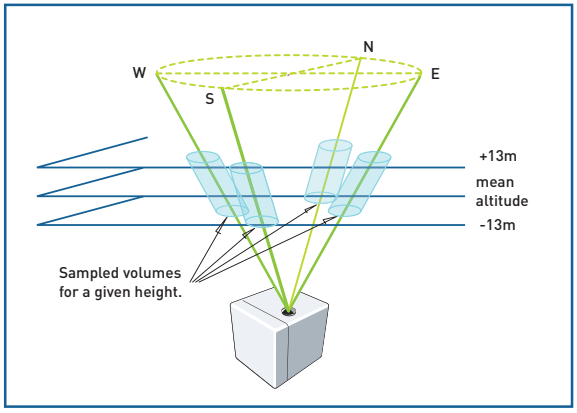
Technological breakthrough

Leosphere holds a complete Lidar product range (aerosol, wind and humidity Lidar) and key expertises in Lidar systems development and industrialization. Developed in cooperation with the French Aerospace agency (ONERA), the **Windcube**™ is the result of 20 years of research and development. Its inventors have overcome major technological challenges to give birth to the new generation of wind Lidar system.

3D wind vector retrieval

4 lines of sight are sequentially scanned to perform geometrical computation of 3D wind vector components (horizontal and vertical wind speeds, and direction).

Retrieved wind field corresponds to an average of ~25m thick atmosphere layer centered on up to 10 user defined altitudes. Classical scanning cone angle is 30°; the **Windcube**™ offers an additional 15° scanning angle for accurate wind profiling in complex terrain.



SAMPLE VOLUME DOPPLER LIDAR RETRIEVAL

Leosphere & Easy Services

Leosphere is 100% specialized in LIDAR remote atmospheric observations. Its corporate mission is to provide clients with a high-end and differentiated range of products and services based upon 3 dimensions : The **EZ LIDAR**™ concept, an exclusive dual range of aerosol LIDAR and wind LIDAR systems.

Because the **Windcube**™ is much more than a simple sensor, becoming one of our client grants you free services and options that will never make it difficult to use your system.

Bottom-line

All our systems are guaranteed 1 year (parts, software, and manpower). Wherever you are our engineers will conduct a diagnostic within 48 hours and propose a solution.

Hotline

Because you might have some questions or comments, our engineers are available 8 hours a day to help you, debug your software, or help interpreting your data.

Quickstart set

Whether you acquire or rent a system, our teams will come on location to help you set up, and make sure your technicians, engineers are fully trained before they leave.

Maintenance

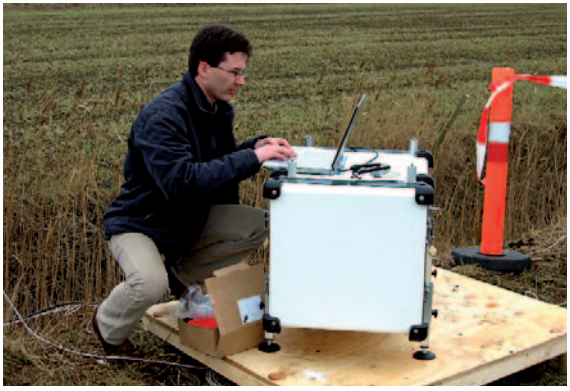
A multiple-level maintenance program is proposed by Leosphere from basic annual check to a full warranty including the loan of a spare system in case yours is broken down.

Rental

You need a **Windcube**™ for 10 days or more ? Why don't you just rent one, it is transportable and easily deployable, this is the perfect solution for short term campaigns.

WARRANTY

- 1 year full warranty
- 48 hour diagnostic



Want to know more about Windcube™ or EZ LIDAR range?

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Scientific Partnership

Leosphere is a 62139€ equity corporation registered in Paris (SIRET 452 972 649)