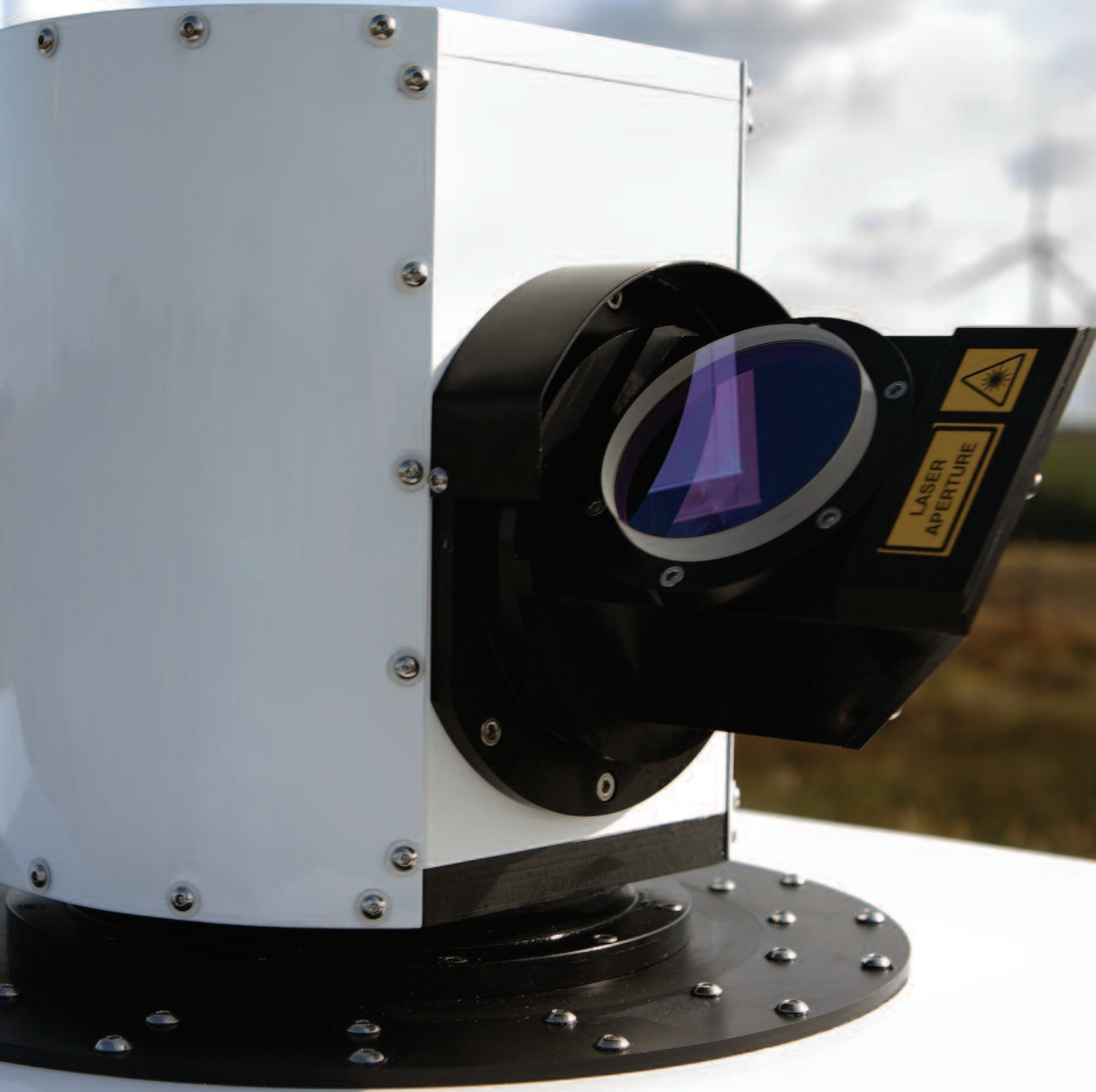


Galion™

2nd Generation Lidar



Sustainable Engineering Worldwide

Introduction

SgurrEnergy is a leading independent engineering consultancy headquartered in Scotland with a global network of offices located across Europe, the Americas and Asia. We offer expertise in onshore and offshore wind, wave and tidal, bio-energy, solar and hydro based energy technologies and provide a wider range of services including hybrid and hydrogen technologies. We are striving to innovate in order to continually enhance our product and service capabilities to the expanding renewables industry.

Wind monitoring services

SgurrEnergy provides a variety of wind monitoring solutions to evaluate the wind resource potential at your prospective wind farm site, offering a one stop shop for all mast and Lidar services from planning applications, installation, data collection and mast decommissioning to wind analysis services for energy yield prediction, project layout and optimal design. We also offer technical advisor support during project construction phase. The Galion is an advanced wind data acquisition Lidar exclusively available for sale or rental from SgurrEnergy.



Galion at a glance


More than just a virtual met mast, the feature-set below defines the 2nd generation capabilities of the Galion Lidar

Features

- Pulsed laser device for wind speed and direction measurement
- High resolution data capture
- 4 km range
- Remote access to real time data
- Steerable beam
- Environmentally tested from -15°C to +35°C
- Independently validated by Risø DTU

Benefits

- Highly portable
- No planning permission required
- 1 year warranty as standard
- No cloud correction required
- Multiple turbine location survey from a single deployment
- Accurate measurements in complex terrain and forestry
- Acquire direct measurements where previously only model approximations have been available



Galion has been deployed internationally – supported by SgurrEnergy’s global network.

Lidar

Lidar is a mature remote sensing technology that is now successfully being used in wind power applications. Galion is based on pedigree Lidar technology proven in the atmospheric science industry. Contact us to receive a copy of the full track record.

How does it work?

Galion Lidar operates by emitting a pulsed laser beam and measuring the Doppler shift of the light back scattered by microscopic airborne particulates carried by the wind. This indicates the wind velocity in the line of sight. Combining these measurements in multiple directions gives the ambient wind velocity vector.

Galion can capture the following wind data using its steerable beam:

- speed
- direction
- flow inclination
- turbulence
- shear
- veer

This is particularly useful for measurements across the entire rotor diameter of a wind turbine and at multiple locations including ridges and forestry.

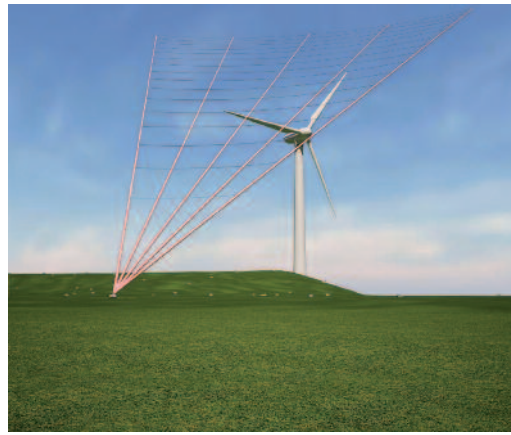
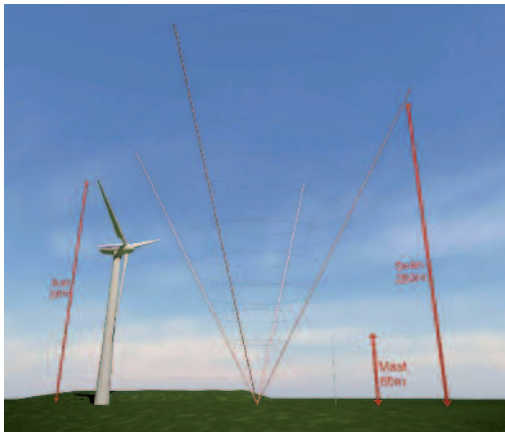


Galion 

Applications

Site and resource assessment

As technology develops and wind turbines get taller, mast height can no longer reach the full height of turbine blades. As a result, wind farm projects are becoming more difficult to reliably assess. However, new innovative techniques such as Galion Lidar which do not have the same restrictions as met masts, allow full measurement across the turbine span, covering the shortfall created by mast height measurement.



Survey multiple potential turbine positions from a single deployment

Galion can be deployed for wind farm development and on operational wind farms with the following applications:

- Site prospecting (pre-evaluation of wind potential before investing in a long term measurement campaign)
- Reliable meteorological measurements for noise impact assessments
- Site and resource assessment (wind speed, direction, flow inclination, turbulence, shear, and veer)
- Model validation and verification by comparison with direct measurements
- Measurements at proposed turbine locations and across entire site
- Verification of modelled vertical profile extrapolation (WAsP, CFD)
- Micro-siting
- Direct measurement and visualisation of non-linear features
- Wind turbine wakes
- Flow separation and recirculation at forest edges, slopes and in complex terrain
- Sector management
- Post investment appraisals
- Reconciliation of revenues with observed resource
- Wind turbine power performance monitoring, assessment, and auditing
- Operations and maintenance
- Reduce project uncertainty
- Power curve verification
- Site repowering
- Refinancing

**Reduce project risk
Acquire direct
measurements at
multiple points across
your site from a single
deployment and reduce
modelling uncertainty.**

For manufactures and turbine designers

- Impact of vertical profile and turbulence on turbine performance
- Power curve verification
- Wind shear, veer, turbulence and flow inclination across the rotor area

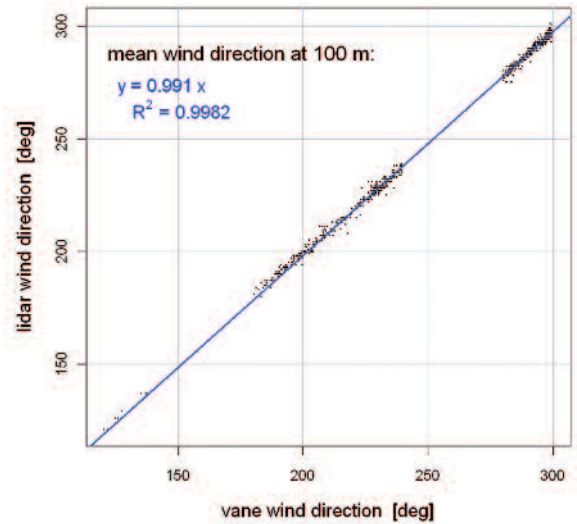
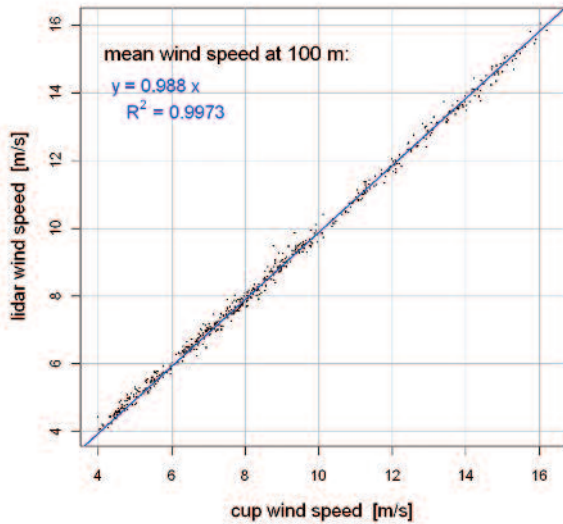
Validation

Independent verification testing has been carried out by Risø DTU at their Høvsøre facility in Denmark. The Galion has been verified under a conventional VAD scan regime against their 116m instrumented mast.

Contact us for latest details on further validation of remote arc scans, the fully steerable beam and multiple surveying from a single deployment. Email galion@sgurrenergy.com

The executive summary of the Risø report is available online at www.sgurrenergy.com

Contact us for a copy of the full Risø report and track record.



Comparison of the wind speeds measured by Galion at a height of 100m with measurements acquired using conventional cup anemometry at Risø DTU's Høvsøre test facility show excellent agreement

Galion's accuracy when measuring wind direction is demonstrated by comparing measurements at 100m with conventional instrumentation

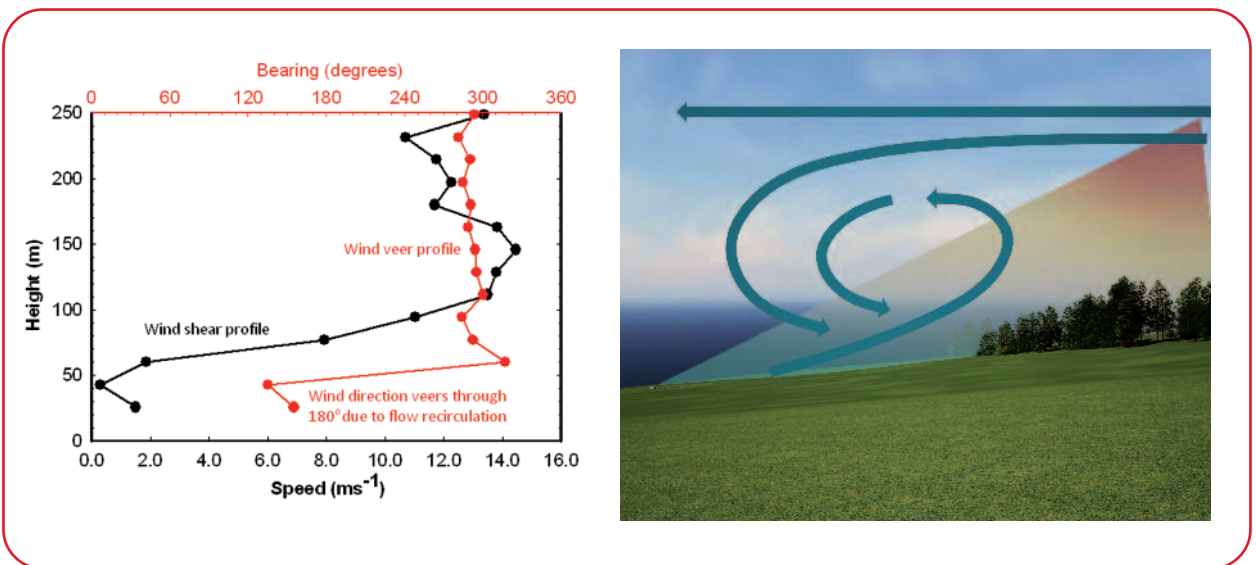


Complex terrain and forestry

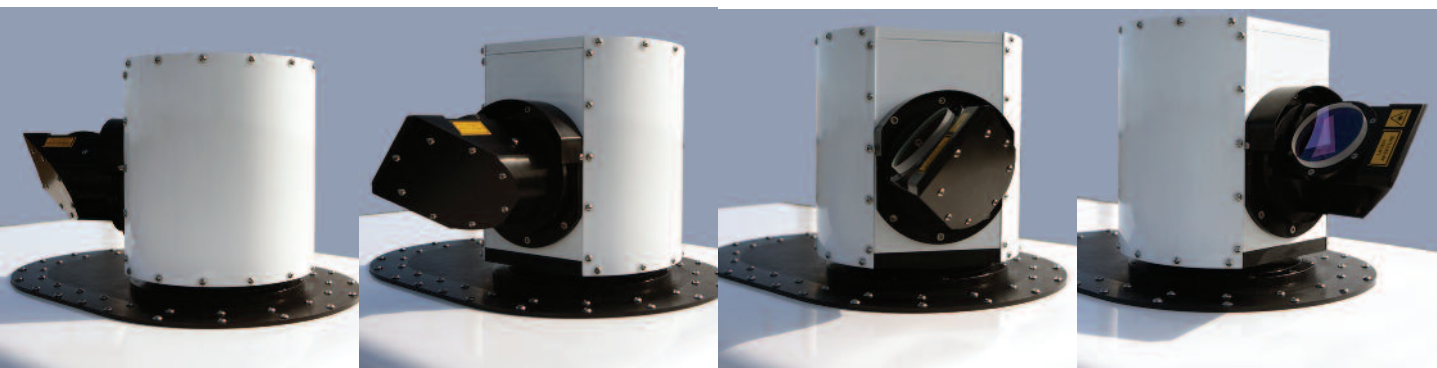
Forestry flow

Understanding the influence of forestry and complex terrain on wind flow is crucial when selecting turbine locations and identifying sites with highly adverse conditions. Modelling often inadequately characterises flow under these circumstances as the codes may be operating outwith their envelope of validity and are unable to predict serious nonlinear effects such as flow recirculation. The consequences of inadequately characterising flow can be severe, resulting in the imposition of extreme fatigue loads on poorly producing turbines. The Galion addresses the urgent need to be able to directly measure and image wind flow structures that would otherwise have eluded detection.

The plots below were captured from a scan of a managed forest edge and its downwind clear farmland.



In the graph above the black profile shows how wind speed changes with height. The red profile shows how wind direction changes with height. The dramatic 180° flip in wind direction around hub height is suggestive of flow separation and recirculation. This is confirmed by an RHI scan whose implementation relies on the Galion's fully steerable beam. The result: a site which may have seemed promising is definitively ruled out as a potential turbine location.

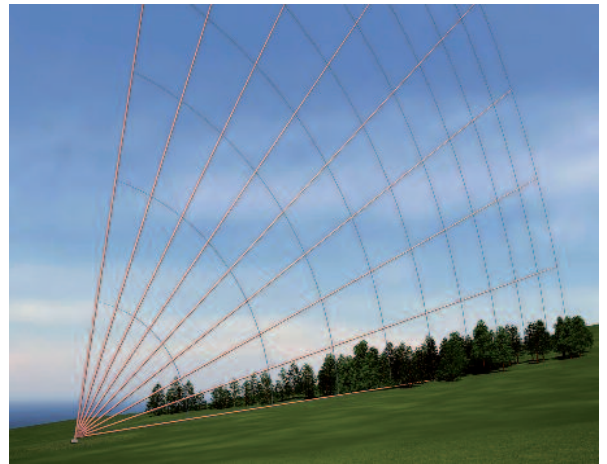
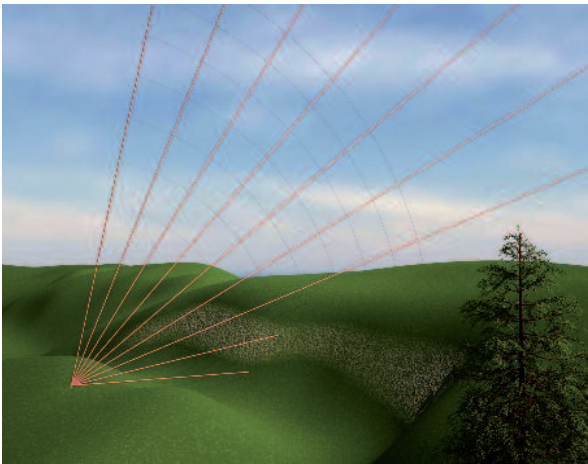


No bias in complex terrain

Deployed in complex upland terrain typical of many wind farm sites, Galion's fully steerable beam overcomes issues of bias and measurement ambiguity.

Custom scan regimes are possible, including those that eliminate ambiguity and bias in complex terrain, for example arc scans and bistatic "dual Doppler" configurations. The Galion is uniquely able to implement the most suitable scan geometry for any application.

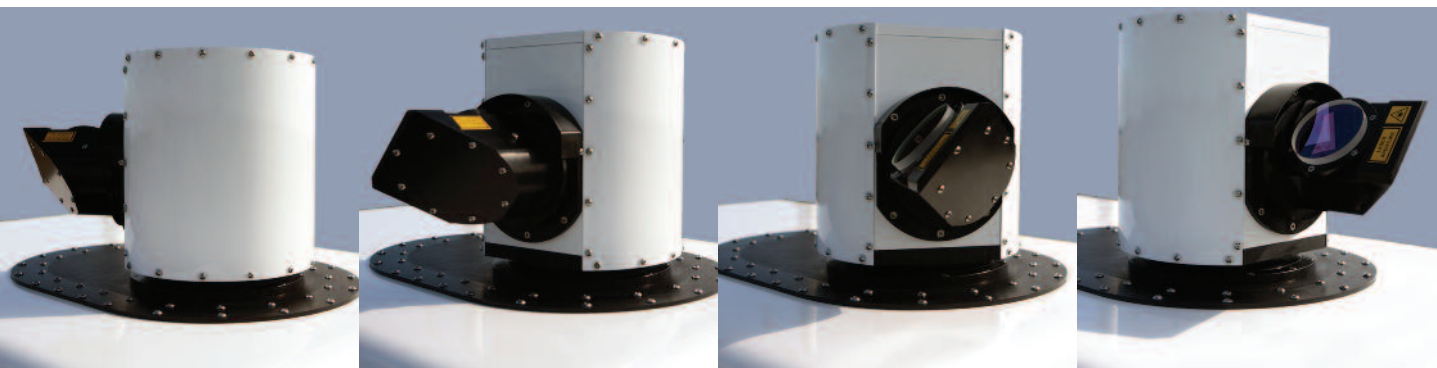
SgurrEnergy can provide full training and support to assist the operator in better understanding the scan regime required for specific site characteristics.



Scan over complex terrain to visualise its effects on wind flow

No need for cloud correction

Continuous wave Lidar systems are susceptible to errors arising from clouds and mist. In comparison to continuous wave devices, Galion's time-of-flight pulsed laser provides distance discrimination with no cloud or mist ambiguities. An added benefit is that data are effectively acquired from all distances simultaneously. This enables the measurement of instantaneous wind shear profiles.

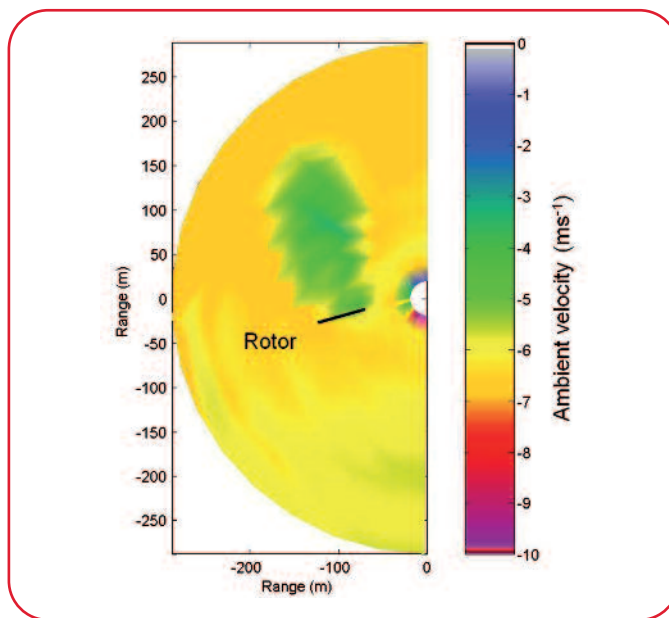


Understanding wind flow in operational wind farms

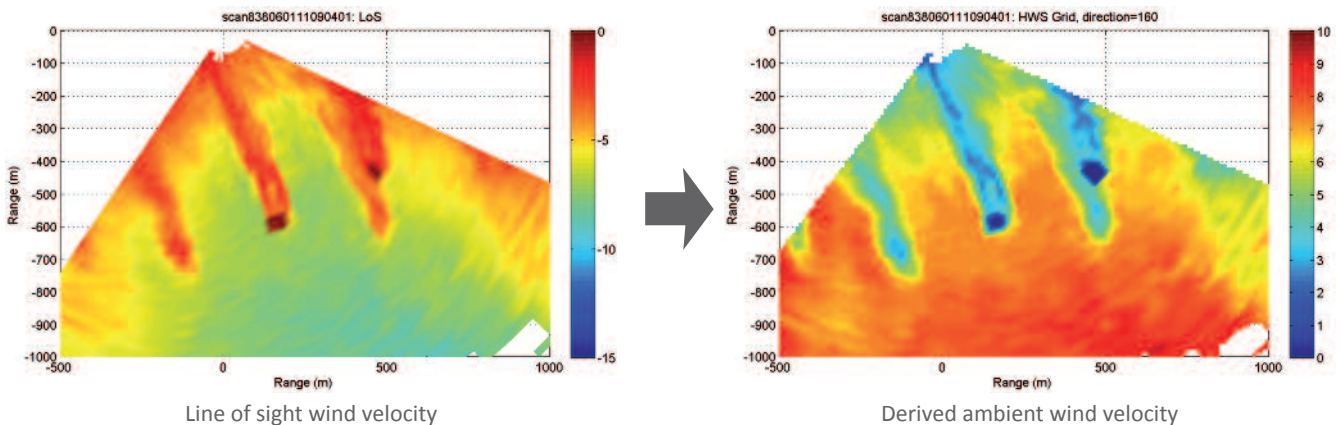
Wake capture

The propagation of wind turbine wakes has been a subject of intense study due to their implications for turbulence, fatigue loading and power production in arrays of turbines, particularly offshore. The Galion allows us to directly measure and dramatically image wind turbine wakes with previously unattainable degrees of precision and detail, allowing us to understand their formation and propagation and mitigate their impact on other turbines as never before. The 2nd generation Galion Lidar introduces a step change in wake studies.

Bird's eye views of wakes produced by wind turbines.



The wake imagery shown above was captured over a period of 1 hour from a Galion deployment 100m from the turbine.



Operational assets

Whether repowering a site, refinancing a project or simply reconciling the available resources with the revenues generated exploiting them, a detailed understanding of the wind flow features influencing wind turbine productivity and longevity is critical. No other device offers the level of detail and accuracy across the entire wind farm site. Galion enables characterisation of wind turbine inflow to drive down project uncertainty and inform

- Post investment appraisal and due diligence
- Effective O&M strategies delivering focused investigation, inspection and intervention to optimise asset productivity
- Power performance assessment that fully captures inflow across the whole rotor
- Performance monitoring, assessment, optimisation and auditing
- Sector management to minimise the effects of wake induced turbulence
- Power curve verification

Visit sgurrenergy.com to view Galion in action. Contact us for a field demo.



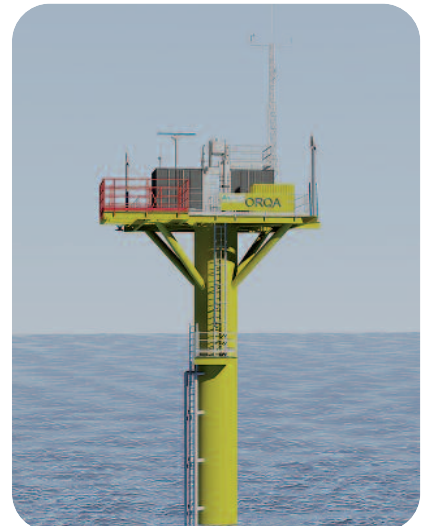
Use Galion onshore and scan up to 4km out over the sea

Offshore resource assessment

Offshore developments present a set of challenges which the Galion is uniquely equipped to meet. Its 4km range enables measurements to be acquired whether the device is installed onshore or on an offshore platform. Galion deployment significantly reduces the costs associated with offshore measurement by met mast methods.

In addition the Galion is able to acquire measurements inaccessible to other devices, whether in terms of vertical profiling immediately above the platform or acquisition of hub height wind speed data at multiple proposed turbine locations within the Galion's range.

Galion can be deployed for offshore measurement campaigns through the SgurrEnergy Offshore Risk Quantification Analysis platform. ORQA is a versatile solution which provides developers with a single turn-key option for advanced data collection and consequently risk quantification for offshore development. For more information contact SgurrEnergy on **0141 227 1700** or email info@sgurrenergy.com



Technical and performance specifications

Technical specifications

Size	84x66x66cm (nominal height does not include met mast)
Weight	85kg
Power requirements	24V DC
Power consumption	150W
Temperature	-15°C to +35°C (extreme temperature option available)
Relative Humidity	0% to 100%
Altitude	Sea level to 2000m ASL
Ingress protection	IP65
Laser	Class 1M
Eye safety	IEC 60825 - 1
Data format	ASCII
Data transfer	3G/GPRS/GSM or Ethernet

No need for planning permission

Operates effectively in all weather conditions

Easy deployment; Galion comes in a wheeled flight case and is highly portable

For a demonstration view the short deployment clip at sgurrenergy.com

Performance specifications

	Standard range	Long range
Range (distance)	40 to 250m	80 to 4,000m
Range (height)	0 to 250m	0 to top of atmospheric boundary layer
Number of measurement heights	15+ (User programmable)	100+ (User programmable)
Scanning cone angle	User programmable	User programmable
Speed range (VAD mode)	0 to 70m/s	0 to 70m/s

Parameters

Output Data	Horizontal and vertical wind speed and direction
	Back-scatter intensity
	Local temperature
	Pressure
	Relative humidity
	GPS co-ordinates and compass bearing of instrument axis
	All data are time-stamped



Global Galion customer support, wherever you need it

Support services

Training

Upon commissioning, one day of training will be given on the deployment and programming of the unit. SgurrEnergy is an established, independent consultancy with an experienced team of wind analysts. If the Galion is used as a virtual mast (performing conventional VAD scans) data will be presented in a manner similar to mast output. It is recommended that the data captured using the more advanced scan geometries is analysed by a specialist wind energy consultant.

Maintenance

The Galion is a low maintenance device. The only tasks required are to refill the wiper fluid (approximately once every 3 months dependent on conditions). A 6 monthly remote health check will be provided if the Galion can be taken somewhere with an internet connection. Note that this does not allow access to clients' confidential wind data due to the strictly partitioned nature of the product architecture.



Warranty

The Galion is covered by a 12 month warranty valid from date of delivery. The full scope is outlined in the terms and conditions provided with a formal quotation. There is no specific requirement for periodic maintenance. Rental devices are operated and maintained by SgurrEnergy personnel, and warranty therefore only relates to units that have been purchased.

Power Pack

Based on methanol fuel cell technology a fully autonomous power pack has been developed for Galion which delivers power with proven reliability. With similar weight and dimensions to the Galion, the power supply can be transported and deployed in much the same way.

Purchase

Purchase Galion with full warranty package and comprehensive training to deploy and manage the device on site.

Purchase with SgurrEnergy operation

Purchase Galion with full warranty package and let our engineers deploy, operate and maintain the device on your behalf.

Rent with SgurrEnergy operation

Rent Galion and let our engineers deploy, operate and maintain the device on your behalf.

Contact us today to find out more about Galion deployment for site development or operational wind farms. To request a field demo or formal quotation.

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