NPL
National Physical Laboratory

Powering the R&D for UK-led, world-class airborne methane detection startup

Methane is responsible for around 30% of the rise in global temperatures since the Industrial Revolution, according to the International Energy Agency. The oil and gas industry, agriculture, and waste management all contribute to the total methane footprint, some planned and regulated (process emissions), others via ageing or defective infrastructure (fugitive emissions). Whilst large leaks or 'super-emitters' make the headlines, a staggering number of smaller fugitive emissions occur continually across the globe. Before repairs can begin, we first need to understand the emissions location, number and leak rate.

This is the goal of Big Sky Theory Limited, a start-up founded by drone experts, which aims to provide emissions intelligence from airborne platforms.

"Coming from an aviation background, I recognised that drones were a key emerging technology for methane detection, geolocation, and informing emissions management strategies," says its founder Ben Lunnon-Wood.

"The secret has been to develop a capability that offers confidence in airborne sensor technology and their deployment via Remotely Piloted Air Systems (RPAS), or drones. Industrial sites are often a large and complex network of gas infrastructure. Our underpinning aim is to quickly, effectively, and safely map the many small leaks in order to inform ground-based inspections and repairs. By documenting and prioritising fugitive emissions, Big Sky Theory hopes to inform both industry and the regulator, helping us all work collectively towards Net Zero targets."

"And on a personal note, I hope that in doing so, we will – in our small way – make the world a better place for generations to come".

Solution

Ben knew the direction he wanted to take for Big Sky Theory and saw collaboration as the key to success, ensuring scientific and aviation innovations were matched by rigorous validation of the hardware and deployment techniques. And so began a collaboration with the National Physical Laboratory (NPL).

The validation journey of discovery started with NPL's programme; Measurement for Business (M4B).

This involved a literature review of the different emissions sensing techniques that could achieve Big Sky Theory's desired levels of accuracy and assurance, helping Ben make an evidence-based decision on which sensor and configuration route to go. The result was Tuneable Diode Laser Absorption Spectroscopy (TDLAS). This approach fires a tuned laser to intersect a methane plume. The laser is reflected back off the ground and the returning laser energy is measured. This reading is used to calculate a parts-per-million-metre (ppm.m) figure that represents the concentration of methane directly beneath the drone. Multiple measurements taken this way can then visualise the plume and create an accurate 2D mapping of the search area.

Rather than attempt to design and build a TDLAS capability, the decision was made in collaboration with NPL to employ an off-the-shelf sensor, from a list of sensors provided by NPL that met the baseline requirements.

Having made his choice, NPL and Big Sky Theory moved to the laboratory to begin bench testing. "We knew the manufacturer's specifications would have limitations, so the aim of the first phase was to expand the operating threshold beyond the reported capability through controlled testing" says Ben.

They put it through its paces by investigating the sensor's strengths and weakness. The lab-based work included measuring calibrated closed gas samples to truly understand the reported measurements and to begin documenting background noise, a critically important figure in TDLAS data capture. The week spent in the laboratory provided essential know-how and familiarity of the laser sensor, helping Big Sky Theory to optimise the capability for the operational test and evaluation phase.

Next, they moved to outdoor controlled release trials, using NPL's facilities at Teddington. Accurately controlled gas releases were managed by NPL to simulate fugitive leak levels found in the oil and gas environments. Comparing sensor measurements to known gas parameters enabled the assessment of the accuracy of the TDLAS technique in near real-world conditions – leading to further optimisation. Performing these tests outdoors also introduced the meteorological variables which further enhanced the understanding of real-world performance and allowed further optimisation. The Teddington fieldwork concluded with a plethora of data sets ready for analysis and modelling that could be used for mission planning and to understand the impact of weather variables.

Impact

The M4B project laid the groundwork for building Big Sky Theory's business by identifying the initial sensing approach that they would take forward.

"We have since had other funded projects through the Innovate UK Analysis for Innovators (A4I) programme," says Ben "and this initial project allowed us to get the most from those, because we weren't going in blind."

Subsequent projects have investigated emission flow rates in industrial settings – the amount of methane escaping from a specific source over a given period – improving the intelligence Big Sky Theory can bring to its customers. Together, the work with NPL over multiple projects has enabled them to create their 'LaunCH4 and Locate™' service, which provides detection and geolocation of methane emissions sources to an accuracy of three metres.

And it doesn't stop there - subsequent projects are now investigating methane plume mapping in 3D using weather models and exploring using the technology for hydrogen detection.

"We have gone on through several R&D projects on our journey to provide the safest, fastest and most accurate methane detection and mapping service possible," says Ben. "It all started with an M4B project. Innovation, without validation, will always be challenged. M4B has allowed Big Sky Theory to meet this challenge head on and create confidence in the emerging world of drone-borne intelligence collection"

"NPL helped us identify and refine the right measurement technologies to offer the quality of methane measurements we were looking for, providing a tangible and trusted foundation to our business. Big Sky theory prides itself on being experts, and working with experts, to create the very best technological solutions. The relationship with NPL adds a huge amount of credibility in the eyes of our customers, since NPL's acumen in this space is well known across the world".

"I am sometimes asked if LaunCH4 and Locate™ would have been possible without NPL support via M4B. As our emissions programme continues to evolve, I'd have to say that without M4B, the capability would have fallen short of the standards we strive for every day. The direct support of the Environmental Emissions Metrology team at NPL has also been matched by the gravity and recognition the NPL relationship brings to business development engagement and the reputation we now hold within the industry. Good enough was never the aim. NPL and M4B facilitated the very best in scientific research and development."

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