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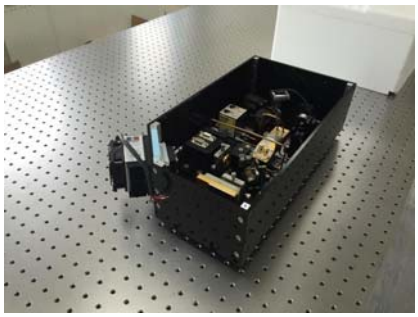
New Company Launched to Commercialize Portable Gas Monitoring Instruments

22 February 2016

Measuring carbon dioxide emissions from deep Earth is a complex and critically important challenge for the Deep Carbon Observatory (DCO). DCO convened a Gas Monitoring Workshop at Mt. Etna, Italy, in 2013, to identify and encourage the most promising technologies. As a result, Dr. Damien Weidmann (Rutherford Appleton Laboratory, UK) received DCO support to develop his team's prototype Laser Isotope Ratio-meter (LIR) into a field instrument capable of real time *in situ* measurement of $^{12}CO_2/^{13}CO_2$. Two years later, the LIR is the first product of **MIRICO Ltd.**, a company established by Weidmann and colleagues.

Volcanic degassing is the primary mechanism by which carbon is transferred from Earth's interior to the atmosphere—making extensive monitoring of Earth's volcanoes essential to understanding the planet's total carbon budget. Determining the $^{12}CO_2/^{13}CO_2$ ratio in emissions can reveal if the carbon was mantle or crust derived, allowing researchers to model carbon pathways among Earth's deep reservoirs. Developing autonomous and low-cost technology, which also can operate in harsh volcanic environments, is key to collecting the data the DCO scientific community needs to achieve its decadal goals.



The LIR employs high-resolution middle infrared (2-20 µm) laser spectroscopy to precisely fingerprint isotopologues, which vibrate at different frequencies. To better prepare for field deployment following the workshop, the development team made the 2013 LIR prototype smaller and more rugged without loss of sensitivity. Newly created field electronics allowed the instrument to operate using portable power sources. In addition, Weidmann's team added a gas handling system capable of preserving the unique chemical mixtures collected from different field sites.

For its first field test, the LIR monitored a fumarole at Solfatara, Campi Fleigrei, Italy, measuring *in situ,* real-time $^{12}CO_2/^{13}CO_2$ ratios. The development team declared success after comparing their data with data independently produced by scientists from INGV Napoli, led by Stefano Caliro, who analyzed isotopic ratios in the lab using mass spectrometry. Once validated, the LIR became the cornerstone of MIRICO Ltd., offering scientists a new option for monitoring volcanoes and other gas sources. According to Adrian Jones, University College London, an expert on the deep carbon cycle:

> "These novel laser instruments are attractive for monitoring of natural gas emissions, not only from volcanoes, where fast stable diagnostics for isotopic species of carbon can discriminate between different subsurface deep carbon reservoirs, but also they will provide new tools to assess human impact on climate change in the environment"

MIRICO—which stands for the Mid Infra-Red Instrumentation Company—is a UK-based laser spectroscopy instrumentation company formed in 2015 as a spin-out from the United Kingdom's Science and Technology Facilities Council (STFC), of which Rutherford Appleton Laboratory (RAL) is part. RAL's Space Laser Spectroscopy Team, led by Weidmann, developed the technology underpinning the new company. Its formation is the result of over ten years of cutting-edge research and development in the STFC/RAL Space division. The research focused on developing innovative spectroscopic techniques for Earth observation and planetary landers, which evolved into analytical instruments for trace gas analysis that deliver laboratory-standard performance in a compact and sturdy form.

The Space Laser Spectroscopy Team consists of eight senior scientists who have developed a range of techniques that overcome the drawbacks of other technologies. MIRICO Ltd., which was formed to commercialize and market these new technologies, also includes Mohammed Belal, MIRICO Director; Kate Ronayne, Non-Exec Director; Richard Brownsword, Senior Scientist and Johnny Chu, development scientist.

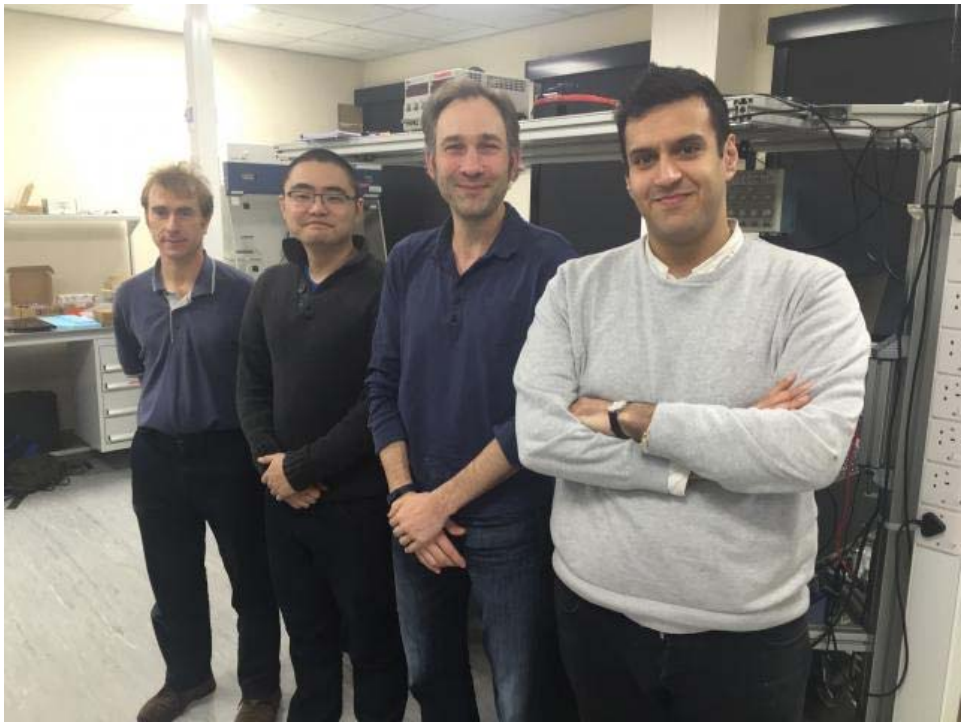
Although the LIR inspired the founding of MIRICO Ltd., the instrument is in a final development and trial phase. The company is actively seeking collaborators and opportunities within the scientific community to further test and demonstrate the instrument's performance. MIRICO wishes to further improve the LIR's electronics, fit the instrument into an even more rugged package, and collect feedback from additional field trials before calling the product complete. In addition, although the base instrument is designed for stable isotope analysis, MIRICO is very

open to customizing development to meet the application requirements of various users.

Currently two complete LIR instruments exist; one is used as a research and development instrument and the second is on trial at a customer site. A third instrument is planned for additional trials in collaboration with MIRICO partners and customers. According to MIRICO Director, Mohammed Belal, “We are always open to collaboration and our aim is to test with customers even at this stage of our development so that we can implement feedback from customers into our instrument design.” MIRICO would like to produce on the order of ten instruments by the end of 2016. However, they’d like to ramp that number up once instrument design is final and with established manufacturing procedures.

The LIR has a range of potential applications for gas analysis beyond volcano monitoring, including high-precision measurement for the healthcare (e.g., breath, urine, blood samples) and energy industries. Chief Scientific Officer Weidman (RAL/STFC/MIRICO Ltd.) says:

> “Because of its highly demanding requirements, space science research efforts nurture new technologies widely applicable to terrestrial challenges. MIRICO fully exploits that in a creative way. We are planning to explore many sectors with our first product and are looking forward to collaborating with various industries and stakeholders to pioneer the next generation of laser analyzers.”



Images: Top left: Richard Brownsord and Johnny Chu from MIRICO. *Middle right:* The Laser Isotope Ratiometer beta prototype. *Lower left:* Johnny Chu, Richard Brownsword, and Damien Weidmann working on the instrument. *Lower center:* MIRICO's Richard Brownsword, Johnny Chu, Damien Weidmann, and Mohammed Belal. All photos courtesy of Mohammed Belal.