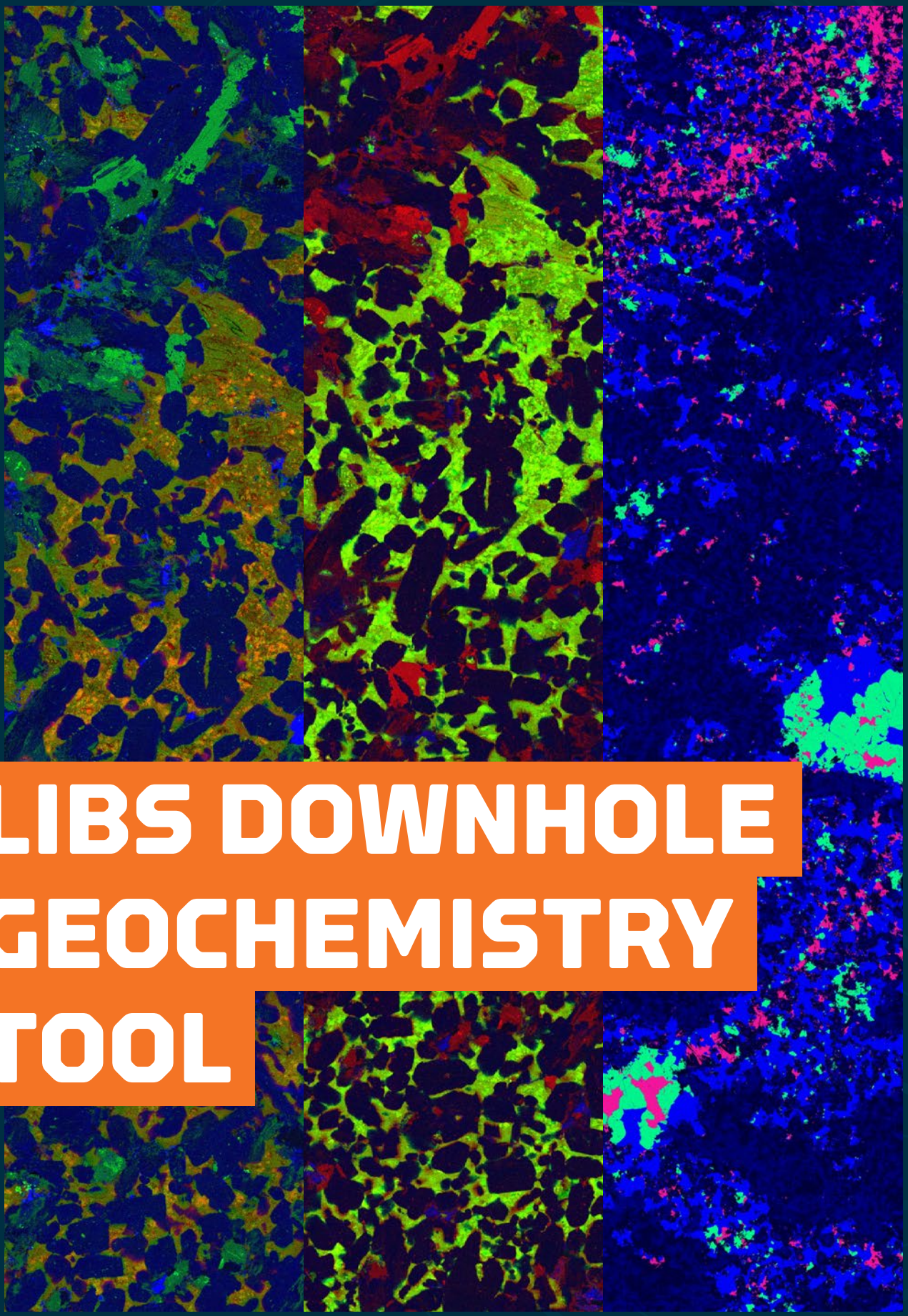
MinEx CRC

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program



LIBS DOWNHOLE GEOCHEMISTRY TOOL

CHEAPER, FASTER, SAFER, CLEANER MINING TECHNOLOGY

QUANTITATIVE, HIGH-RESOLUTION DOWNHOLE GEOCHEMISTRY FOR MINERAL EXPLORATION AND RESOURCE DRILLING

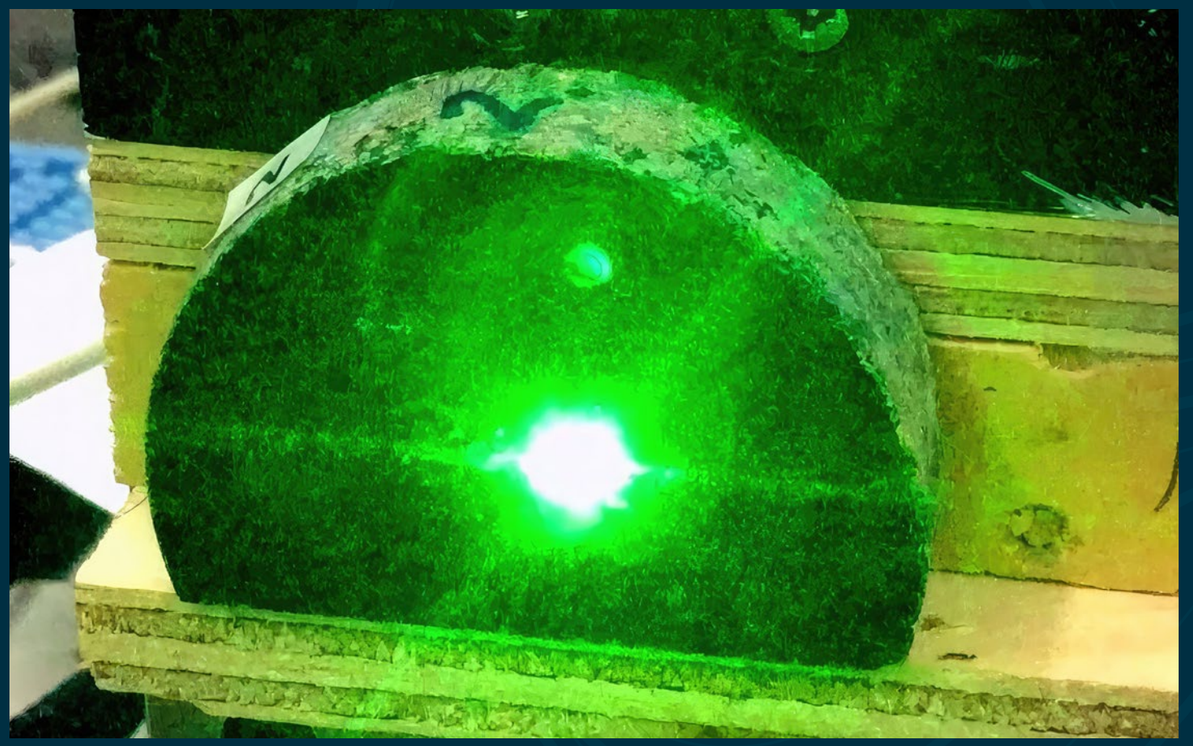
MinEx CRC is developing a downhole geochemical tool utilising Laser-induced Breakdown Spectroscopy (LIBS). The tool incorporates a high-powered, variable-focus laser and optics, and spectrometers capable of detecting all elements on the periodic table to part per million levels. The prototype tool fits within NQ diameter boreholes and can be deployed by wireline.

Introducing LIBS

Laser-induced Breakdown Spectroscopy utilises a rapid pulsed laser focussed on the analyte to generate a high-temperature plasma containing ionised material from the analyte. As the plasma cools all elements within it emit light at discrete, measurable wavelengths between ~200 and 900 nm (similar to the visible range for the human eye). The resulting spectral signature is a quantifiable fingerprint of the analyte composition.

LIBS analysers comprise a laser responsible for generating the plasma, optics for capturing and delivering the light signal, spectrometers for detecting the spectra, and back-end processing (e.g. deconvolution, multivariate analyses, calibration) for elemental identification and quantification.

The LIBS technique has had wide application in materials classification and quantification including in deep sea and extra-terrestrial settings. In the last decade handheld LIBS analysers have been commercially available to the mineral exploration community and more recently 2D LIBS scanning tools for detailed chemical and textural mapping have entered the market.



LIBS plasma

Advantages of the LIBS technique

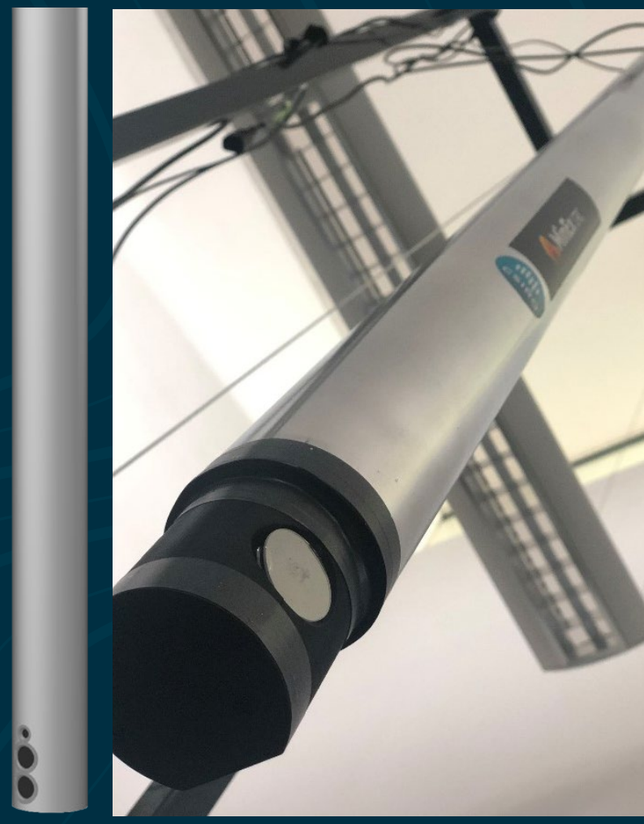
LIBS has a number of advantages over other potential in-field, real-time analytical techniques including:

- It can be applied to solids, liquids or gasses
- Little or no sample preparation is required
- It can detect all elements in every pulse, including light elements (e.g. helium, lithium, nitrogen, oxygen, carbon) that are not easy to measure with other in-field techniques
- It is effectively non-destructive due to the very small analytical area

MinEx CRC Downhole LIBS tool

MinEx CRC are developing a first-of-a-kind downhole LIBS tool intended to leverage the benefits of the LIBS technique to solve the challenge of obtaining real-time, in-hole geochemistry during a drilling campaign.

The all-in-one prototype tool has been fabricated and successfully trialled in simulated borehole conditions in the laboratory. Field trials are scheduled in 2024.



Prototype downhole tool

Safe

The downhole LIBS tool does not contain a permanent source of harmful radiation.

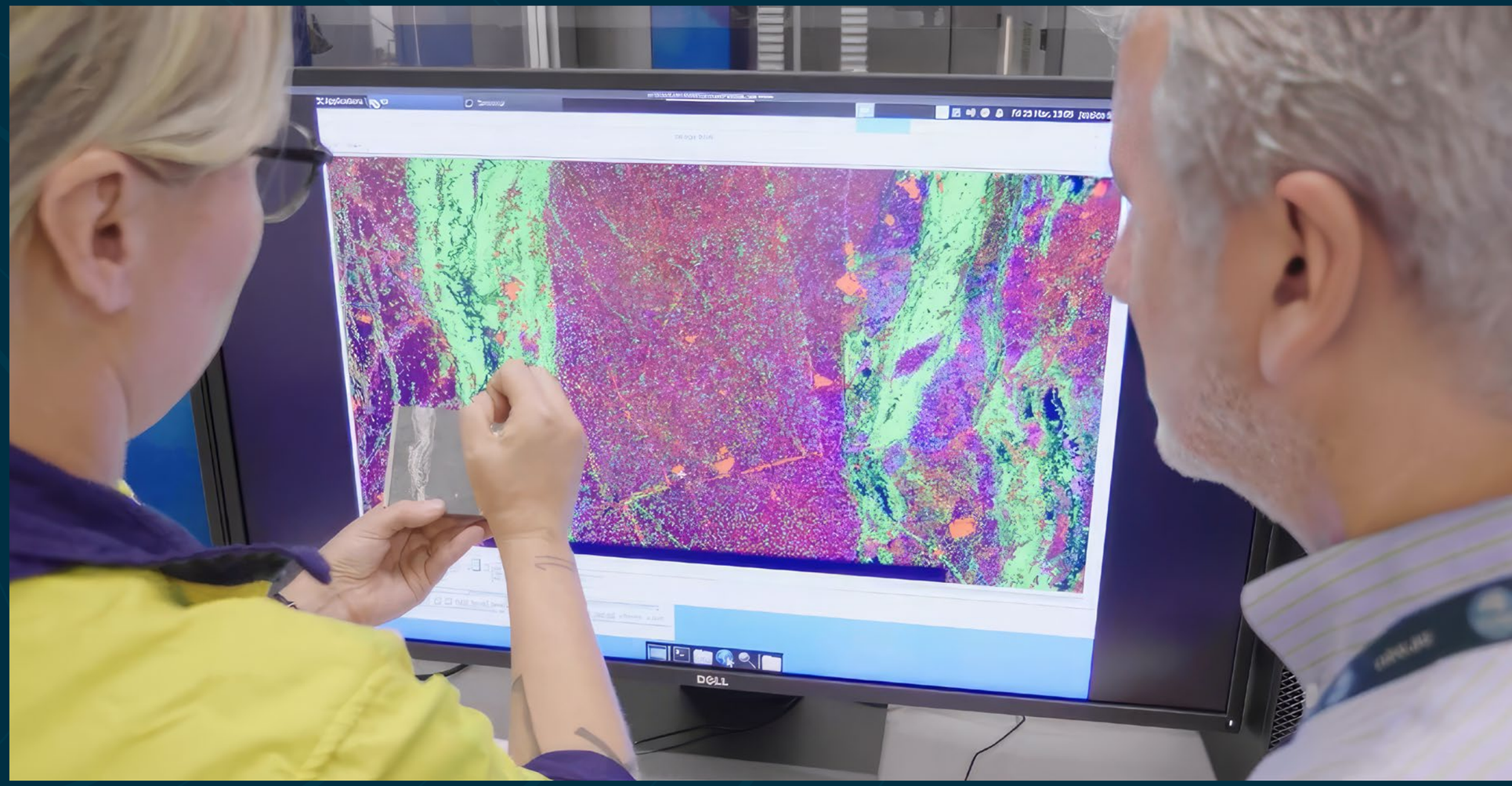
The in-built laser is switchable and can be configured to operate only when deployed in the borehole.

Fit for purpose

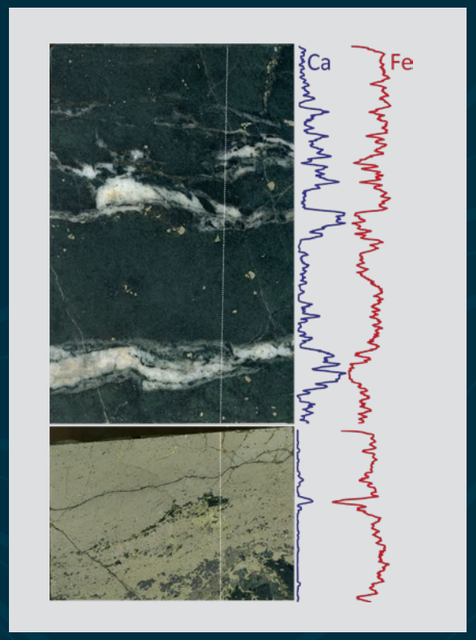
With a length of ~1.7 m and weight of <5 kgs the LIBS prototype tool is lightweight and easy to transport.

The prototype tool has outer diameter of 75 mm, designed to fit within NQ boreholes. Further miniaturisation will be explored in future versions of the tool.

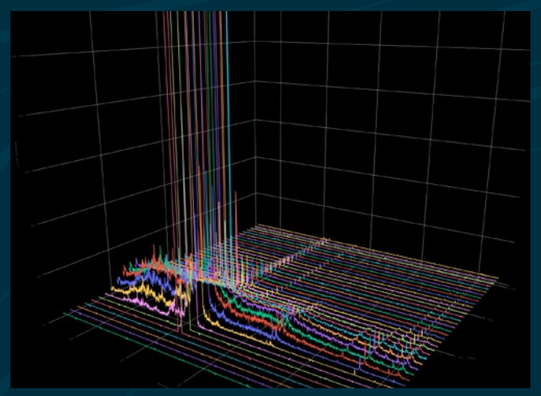
The tool will be driller deployable by wireline and geochemical logging can be conducted in parallel with complimentary survey and geophysical logging techniques with little to no additional time penalty.



Calibration against real rocks



Grain-scale analytical signal



High quality spectra

Scalable data

At logging rates of 2 to 10 m/min and typical sampling rates of 10 Hz the LIBS tool will deliver 60 to 300 individual analyses per meter.

Each LIBS analysis represents an area of <100 µm – at mineral grain-scale for most geological materials. As a result, the output from a LIBS traverse of the borehole wall is highly scalable. It can be broken down into individual mineral (and mixed mineral) observations or bulked out over hand-specimen (decimeter) or mining-scales (meter) depending on geological or engineering parameters.

Reliable, quantified analyses

Preliminary results from the prototype MinEx CRC LIBS downhole tool indicate that analytical precision and detection limits will be comparable to commercially available hand-held LIBS analysers. Detection limits are expected to be at part per million levels for most elements.

Standardised calibration procedures and analytical standards will be provided to users in order to ensure accurate and precise analyses.

DOWNHOLE PROTOTYPE SPECIFICATIONS

Physical	
Length	1.7 m
Diameter	75 mm
Weight	~4 kg
Power	24 V

Technique	Laser Induced Breakdown Spectroscopy (LIBS)
Focal length	Active focus system 20-150 mm
Deployment type	Wireline
Deployment speed	10 m/min
Deployment conditions	Dry and open borehole

Data	
Spectral resolution	<0.2 nm
Data processing	Physics-Informed Machine Learning Model
Elements	All of them

TRL	
Focal length	4 – Component validation in laboratory environment. Preparing for validation in relevant environment/field trial (TRL 5)
Software	2-3 – Technology concept formulated TO Analytical and experimental critical function proof-of-concept

PROJECT PARTICIPANTS

Project Industry Participants

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Project Research Participants

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