Development of a Fast-Scanning LiDAR System with High Spatial Resolution

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Regulatory measurement [1] of atmospheric particulate matter (PM) relies on a small number of fixed-point detectors [2] around locations of interest, at close to ground level. A fast-scanning LiDAR system has been developed to measure dust plume presence over a much greater atmospheric volume. The system incorporates a < 1 ns pulsed 355 nm UV source laser and a 355 mm aperture receiver telescope with sensitive detection to provide three-dimensional visualisation of PM plumes with a range resolution of 1.5 m and an acquisition time per single direction of less than 1 second. The design avoids the shortcomings of current commercial LiDAR systems with 10-30 s single direction acquisition times, slow mechanical movement of the turret and a 25-40 m range resolution.

The system has been field tested overlooking a chemical manufacturing plant in Newcastle, NSW known to have water vapour and smokestack plume emissions [3] with results shown in Figure 1. Each horizontal line of this scan represents the signal acquired in 0.7 s, averaging ~700 laser pulses. Hard target returns are circled in yellow while diffuse plume media returns from a range of 1.12 km - 1.17 km are circled in red. The new LiDAR is the only means of measuring the presence of particulate matter with this definition at distance and elevation.

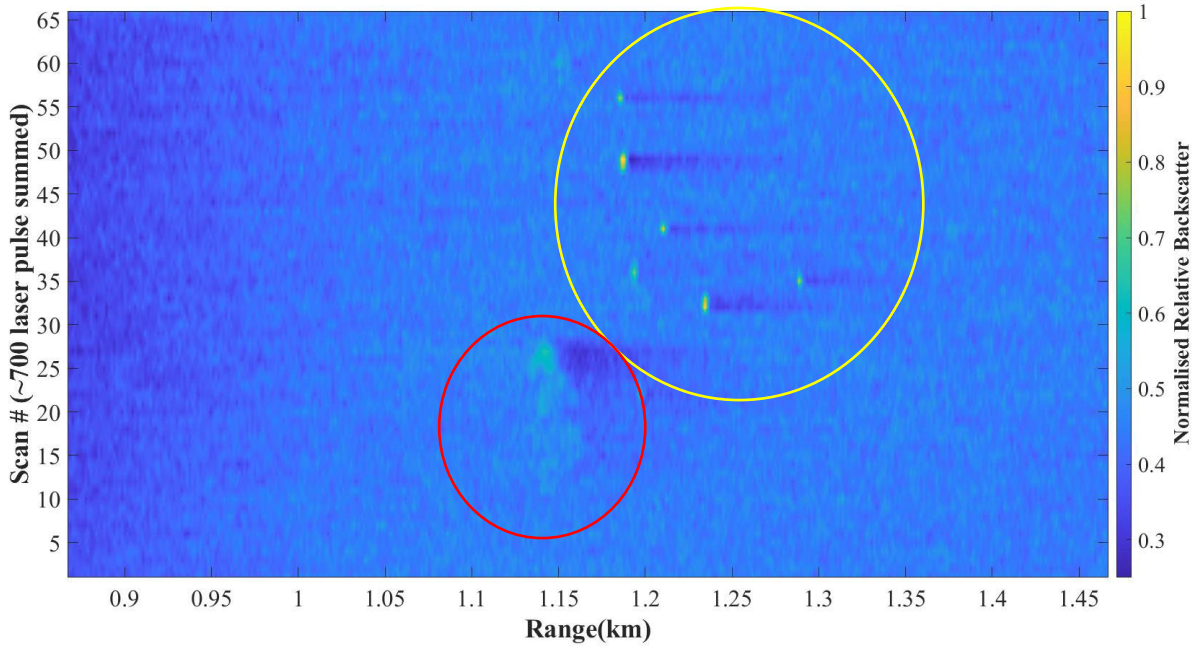

Figure 1 Contour map of LiDAR data showing hard targets in yellow circle and a water vapour plume in the red circle. Scan (y-axis) consisting of ~700 laser pulses and range (x-axis) ranging from 1-1.45km.

[1] M. Riley, J. Kirkwood and N. Jiang, "Air quality monitoring in NSW: From long term trend monitoring to integrated urban services,," *Air Quality & Climate Change,* pp. 44-51, 2020.

[2] Department of Water and Environmental Regulation, "Mapping Dust Plumes at Port Hedland using a LiDAR," State Government of W.A., Perth, 2018.

[3] Roddis, Damon, "Open Path Boundary Monitoring, ACARP," Pacific Environment Limited, 2017.