



Emission Monitoring Using Differential Absorption Lidar (DIAL)

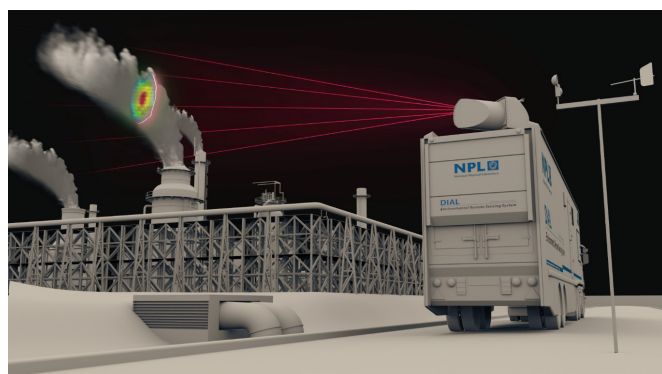
The NPL Differential Absorption Lidar (DIAL) is a sophisticated remote sensing system that provides rapid, accurate measurements of airborne pollutants and greenhouse gases (GHGs) following the protocol described in the European Standard EN 17628. The system is a completely self-contained mobile laboratory that provides 3D mapping of emission concentrations and, when combined with wind information, enables quantification of emission rates for a wide range of target species.



The DIAL system is able to monitor atmospheric pollutants remotely, at ranges of up to 1 km. DIAL measurements are real-time, directly traceable to primary standards of gas concentration and are free from interference and contamination. DIAL is particularly useful for measurements of emissions from process areas, tanks, flares and diffuse sources, e.g. landfill sites (Innocenti et al., Remote Sensing 2017, 9, 953; Innocenti et al., Remote Sensing 2022, 14, 4291).

The DIAL Technique

The DIAL technique uses a laser source of tuneable wavelength that is transmitted over the measurement region. A small fraction of this light is scattered back by the aerosols and particulates that are present in the atmosphere; this is collected with a telescope and a fast, sensitive detector. The concentration of the target species is derived from the differential absorption coefficient and the spatial distribution is obtained from the time delay between the laser pulse and detection. This data is combined with wind information to provide a direct measurement of the emission rate of the target species (Robinson et al., J. Environ. Monit. 2011, 13, 2213).



Applications

The DIAL technique can be used for a wide range of industries and emission scenarios, including:

- Remote measurements into inaccessible, hazardous or elevated areas
- Wide area surveys of diffuse sources, including methane from landfill sites
- Measurement of total industrial site emissions, including flares and tanks
- Boundary fence monitoring

- Identification and quantification of leaks and fugitive emissions
- Plume tracking and source identification from complex industrial plant
- Environmental impact assessment

Data Analysis and Interpretation

DIAL's unique software enables total site emissions to be visualised via a series of multi-dimensional concentration plots, in a way that highlights key emission points and their concentrations. A team of experts at NPL is available to give advice on data analysis and interpretation. The team has an in-depth technical knowledge of the operations of industrial plants, an awareness of potential emissions and extensive experience in solving complex atmospheric measurement problems.

Atmospheric Pollutants and GHGs

DIAL can collect real-time data for gaseous species with characteristic absorptions from the ultraviolet through to the mid-infrared spectral region including: methane, ethane, volatile organic compounds (VOCs) including petroleum and diesel vapours, HCl, NO, NO₂, SO₂ and benzene. Detection limits are shown in the following table:

Typical DIAL IR performance		
Species	Sensitivity (ppb)	Max Range (m)
Methane	92	500
Ethane	22	500
VOCs	37	500
HCl	13	700

Typical DIAL UV/Visible performance		
Species	Sensitivity (ppb)	Max Range (m)
NO	10	500
NO ₂	70	500
SO ₂	20	1000
Benzene	10	600

NB: The sensitivities apply to typical measurement conditions (a signal to noise of 500 for a 45 m wide plume), under typical meteorological conditions

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