

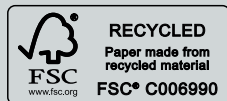


CHARM[®] – LASER-BASED SYSTEM FOR REMOTE GAS DETECTION

Efficient and reliable airborne
pipeline inspection

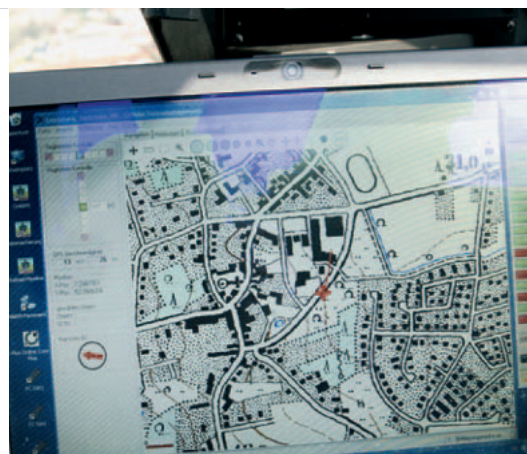
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Open Grid Europe GmbH
Kallenbergstraße 5 | 45141 Essen
T +49 201 3642-0 | F +49 201 3642-13900
info@open-grid-europe.com
www.open-grid-europe.com





CHARM® operator's laptop
CHARM® includes a specially developed software package allowing inspection flights to be scheduled and analysed within a short space of time. All coordinates, measuring points and events are accurately recorded, with photographs taken for additional documentation.



A high-performance combination for inspecting natural gas transmission systems

Laser technology and helicopter

Natural gas pipeline inspections are mainly carried out on the ground by walking surveys using mobile gas detectors to check for leakages. This method is very time-consuming and labour-intensive. The CHARM® remote gas detection system (CH₄ Airborne Remote Monitoring) developed and supplied by Open Grid Europe is the state-of-the-art inspection system for natural gas transport pipelines. CHARM® can be used for inspecting pipelines under a soil cover or under sealed surfaces.

systems containing details of the pipeline route. Any questionable pipeline section identified by CHARM® can be fully examined and evaluated on site by technical teams. This approach makes it easier and less costly for gas suppliers to comply with their inspection obligations and to maintain high safety standards for their gas supply infrastructure.

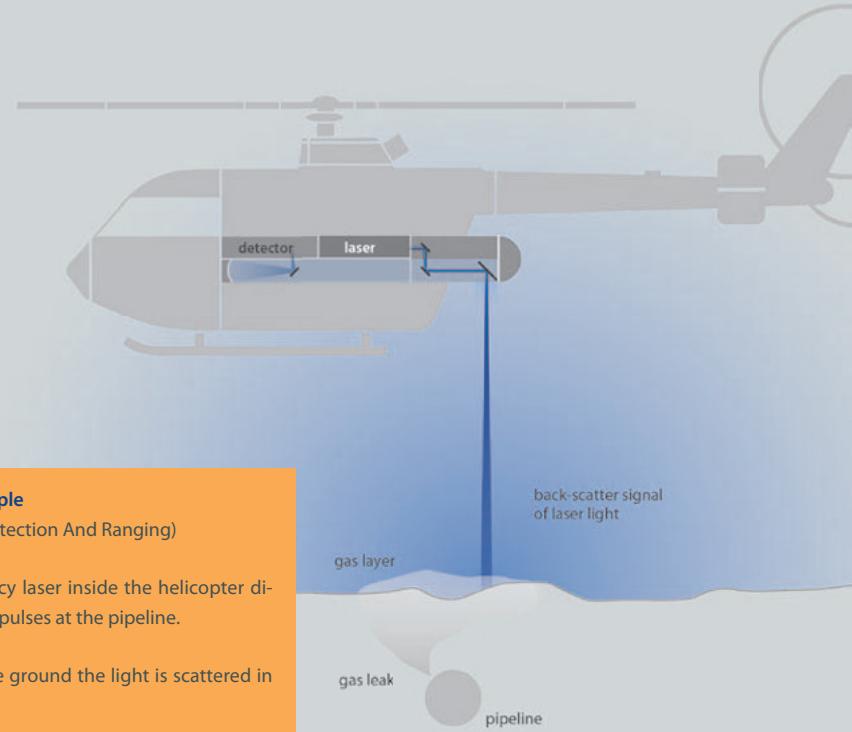
The method is based on an infrared laser system installed on board a helicopter and is capable of precisely detecting even very low methane concentrations. Open Grid Europe offers this highly efficient and flexible way of natural gas pipeline tightness checking to gas transport companies all over Europe. Accurate methane level measurements require the use of satellite navigation systems to determine the precise location of the helicopter in combination with geographic information

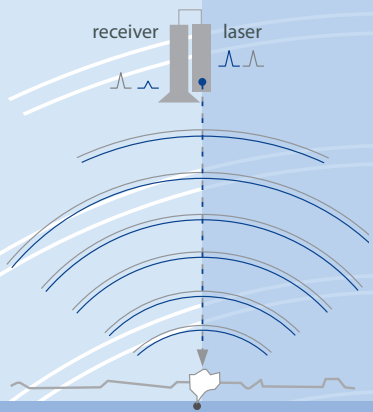
CHARM® principle LIDAR (Light Detection And Ranging)

A high frequency laser inside the helicopter directs laser light pulses at the pipeline.

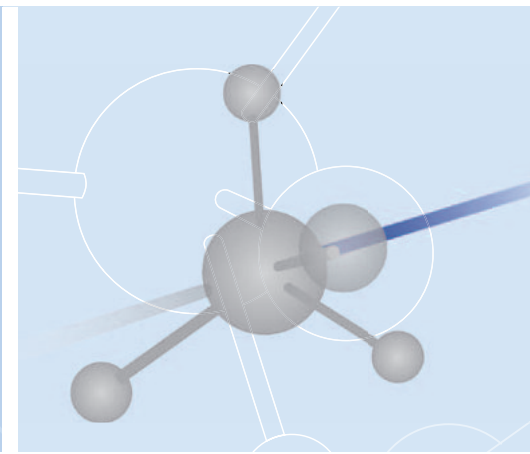
When it hits the ground the light is scattered in all directions.

The small fraction of the emitted light that is scattered back to the system on board of the helicopter is focussed and fed to a detector for analysis.





In order to eliminate the atmospheric influences and ground surface backscatter effects on the measurement signal, the DIAL technique uses light pulses of two different wavelengths. Pulses of the measurement wavelength (λ_{on}) are absorbed by methane while pulses of the second wavelength (λ_{off}) are not absorbed and serve as a reference. Differences in back-scattered signals are converted to integrated concentration-length-values.

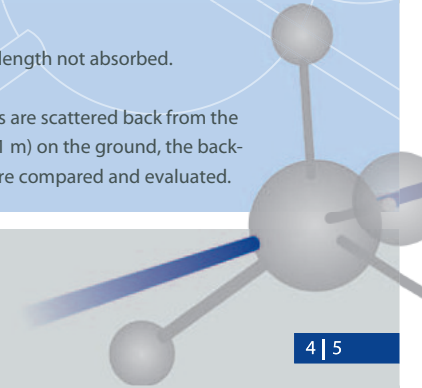


DIAL principle at molecular level

λ_{on}
Measurement wavelength absorbed by methane.

λ_{off}
Reference wavelength not absorbed.

Both laser pulses are scattered back from the same spot (dia. 1 m) on the ground, the back-scatter signals are compared and evaluated.



Detection of very low methane concentrations

Natural gas detection systems used for monitoring the tightness of buried pipelines must be capable of identifying even the smallest traces of methane. The CHARM® technology is based on the Differential Absorption Lidar (DIAL) measurement principle, an established active remote sensing method for detecting different gases in the atmosphere. The LIDAR (Light Detection And Ranging) technique involves transmitting laser light and detecting

and analysing the light back-scattered by the atmosphere or a solid target object like the ground. Trace gas concentrations can be determined by tuning the laser wavelength to the spectral signature and absorption characteristics of the gas to be measured.

Natural gas traces made visible

CHARM® is securely installed on a helicopter and protected from vibrations. Control systems ensuring spatial stabilisation of the laser beam compensate for the effects of movement and direct the measurement beam precisely towards the pipeline's centreline. Differential GPS (Global Positioning System) allows highly accurate localisation of the helicopter. The system is combined with an inertial measurement system (IMS) for accurate helicopter positioning in order to target the measurement beam automatically and precisely onto the pipeline corridor (CHARM®-Auto-Tracking, CAT). When operating at an altitude of around 120 m, the CHARM® system generates laser spots of about 1 m diame-

tre on the ground. Using a scanner, the laser spots cover a corridor along the pipeline route which can be as wide as 30 m.

CHARM® certified by DVGW

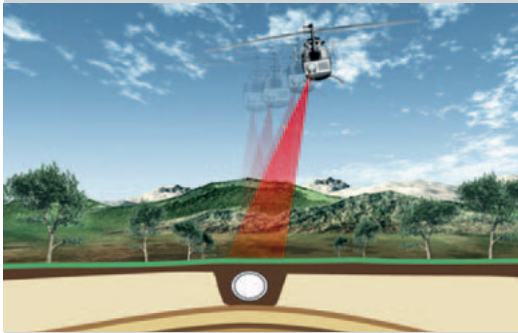
DVGW, the German Technical and Scientific Association for Gas and Water, has published a technical rule (guideline G 501) for airborne remote gas detection defining the functional and procedural requirements for these methods. CHARM® is the only system to meet these requirements and has been certified by DVGW. It has been shown to be capable of checking buried pipelines in built-up areas as well as in open country for tightness and detecting even the smallest leakages with gas flows as low as 100 l/h. In cooperation with energy companies and gas network operators, a comprehensive programme of tests to determine the system's fitness for purpose was conducted under the responsibility of the DVGW research unit at the Engler-Bunte Institute of Karlsruhe Technical University. As part of these tests, different parameters such as

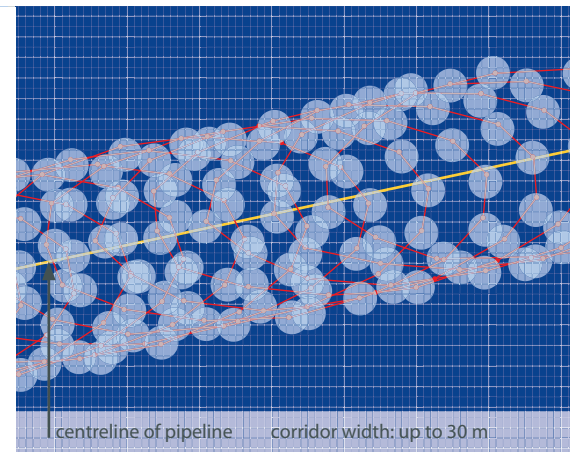
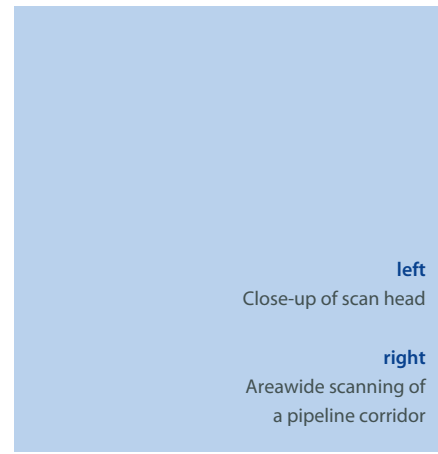
the quantity of the released gas, the climatic conditions as well as the altitude and speed of the helicopter were repeatedly modified. The tests confirmed that CHARM® is capable of reliably inspecting high-pressure pipelines to a high standard in accordance with the applicable codes of practice.

Development partners

Apart from Open Grid Europe, the following organisations were involved in the development of CHARM®:

- Adlares GmbH
- Air Lloyd Deutsche Helicopter Flugservice GmbH
- Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)
- PLEdoc Gesellschaft für Dokumentations-erstellung und -pflege mbH





left
Close-up of scan head

right
Areawide scanning of
a pipeline corridor

centreline of pipeline corridor width: up to 30 m

Open Grid Europe | The Gas Wheel

Open Grid Europe is one of the leading transmission system operators in Europe. We provide secure gas transmission in line with our customers' needs and are a partner you can rely on for all grid-related services – 24 hours a day, 7 days a week.

The Facts

Our customers: more than 450 national and European TSOs, municipal utilities, industrial customers and gas traders | Our staff: around 1,650 across Germany | Our transmission system: around 12,000 km long, with 30 compressor stations, 100 machine units, 17 border crossing points. Around 1,100 entry points, 679 bn kWh exit volume in 2014. Around 137 mn kW peak load in 2014.

Maximum safety standards

When gas escapes from a buried natural gas pipeline, it is dispersed in layers near to ground level. It is not possible to predict the dispersal path, so in some cases the gas may not emerge directly above the leak but several metres away from the pipeline.

CHARM® scans a corridor with a width of up to 30 m along the pipeline route. The generous width of the corridor significantly increases the probability of detecting any leaks. The system's highly automated mode of operation and regular in-flight checks ensure that all components are fully functional and available for use. All flights are automatically and extensively documented to provide evidence that the required pipeline inspections were carried out appropriately.

CHARM® at a glance

- Airborne infrared laser-based remote gas detection system
- Even smallest traces of natural gas are safely identified from altitudes of 80 to 140 m
- High methane sensitivity allowing detection at levels of 5 ppm · m and over during operation
- Full coverage of pipeline route over widths of up to 30 m
- Accurate geographic positioning of measurement beam with CHARM®-Auto-Tracking (CAT)
- High detection frequency, 1,000 double pulse measurements per second
- High patrol speed during inspection (50–150 km/h)
- Automatic function checks ensure that all system components are working properly
- Automated documentation of pipeline inspection and real-time reporting of indications
- High-tech method to supplement conventional pipeline inspection procedures
- Certified to DVGW Guideline G 501: "Airborne Remote Gas Detection Methods"
- Photographic documentation of inspection flights provides knowledge of the general condition of the pipeline route

Your contact

Dr.-Ing. Axel Scherello | T +49 201 3642-18704 | axel.scherello@open-grid-europe.com

For further details on CHARM®, go to www.open-grid-europe.com/charm-en
Further information on leak testing of gas installations and above-ground piping is provided in a brochure with the same title.