

QUANTUM SOLUTIONS

for gravity measurement



exail

Free-fall absolute gravimeters using quantum technologies and laser-cooled atoms

Exail pioneered the commercial deployment of quantum sensors based on laser-cooled atoms, a breakthrough enabling continuous, absolute gravity measurements over timescales ranging from seconds to years. Designed for field use, these compact and transportable industry-grade sensors operate reliably in both indoor and outdoor environments.

With an outstanding precision of 10^{-8} m/s² (1 μ Gal), Exail Absolute Quantum Gravimeters (AQQ) accurately capture small variations in gravity caused by subsurface mass distribution or density inhomogeneities at a given location, both in space and over time.

Such a unique scientific and technological know-how was developed for more than 15 years of academic research by partners (LP2N and LTE laboratories). Exail actively collaborates with leading academic players, conducting field tests, instrument comparisons, and operational optimizations to further enhance its sensors capabilities.

HIGH-PRECISION GRAVITY MEASUREMENTS FOR SUBSURFACE CHARACTERIZATION

Exail's Absolute Quantum Gravimeter enables precise and long-term monitoring of gravity variations for a wide range of geophysical and environmental applications. From active volcano surveillance and groundwater reservoir monitoring to subsurface mapping in civil engineering and archaeology,

it delivers accurate data without requiring complex optical alignment. Its robust, fibered design ensures stable operation over 50,000 hours, making it suitable for demanding field deployments, geodetic networks, and international metrology collaborations.



AQG-A: COMPACT SOLUTION FOR LABORATORY OBSERVATIONS

The AQG-A is specifically designed for installation in laboratories and temperature-controlled environments. Lightweight and compact, it is equipped with wheels to facilitate mobility.

Operating temperature	[18°C ; 24°C]
Power consumption	< 350 W (AC and DC)
Total mass	< 100 Kg Each module < 45 Kg



AQG-B: ROBUST AND THERMALIZED FOR FIELD APPLICATIONS

The AQG-B version is designed to support larger temperature range thanks to a thermalization module. The electronics is protected in rugged cases with handles which can be assembled together.

Operating temperature	[0°C ; 40°C]
Power consumption	< 500 W (AC and DC)
Total mass	< 140 Kg Each module < 45 Kg

APPLICATIONS FROM VOLCANOLOGY TO CIVIL ENGINEERING

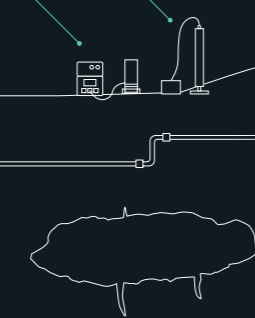
Metrology and geodesy

AQG-A
Indoor Absolute Quantum Gravimeter for absolute referencing and geodesy



Near surface detection

AQG-B
Outdoor Absolute Quantum Gravimeter for civil engineering large cavity detection and archeology
+
DQG
Differential Quantum Gravimeter for the detection of smaller objects, at closer vicinity



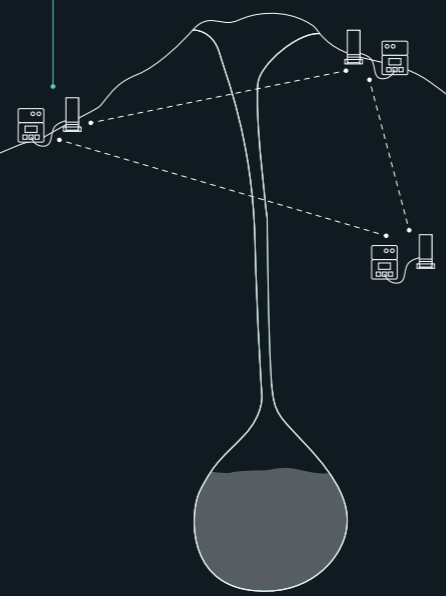
Natural resources

AQG-B
Outdoor Absolute Quantum Gravimeter for reservoir monitoring
+
DQG
Differential Quantum Gravimeter for enhanced reservoir monitoring



Volcanology

AQG-B
Outdoor Absolute Quantum Gravimeter for volcano monitoring and gravity imaging



Hydrology

DQG
Differential Quantum Gravimeter for hydrodynamics with an immunity to vibrations
+
AQG-B
Outdoor Absolute Quantum Gravimeter for hydrodynamics



Mass balance assesment



COMPACT FIELD-READY GRAVIMETRY WITH RAPID SETUP AND VERSATILE DEPLOYMENT

- **Modular architecture:** The sensor head is separate from the laser and control system, reducing the footprint and easing integration.
- **Tailored transport cases:** Secure, compact packing solutions ensure safe mobility.
- **Flexible installation:** A 15-meter cable allows optimal placement of the sensor head.
- **Fast setup:** Dedicated software, leveling tools, and a Linux control laptop enable quick start-up. The AQQ supports full shutdown during transport and rapid reactivation on site.
- **Streamlined connections:** Minimal connectors and a single optical interface simplify setup and packaging.

Performances

Precision (@ quiet site)	500 nm/s ² Sqrt (t)
	50 nm/s ² in 1.5 min
	20 nm/s ² in 10 min
	10 nm/s ² in 40 min
Cycling frequency	1.85 Hz
Long-term stability	< 20nm/s ²
Repeatability	< 50 nm/s ²
Trueness	< 150 nm/s ²

A TURN-KEY TRANSPORTABLE AND EASY-TO OPERATE QUANTUM SENSOR

Exail's AQQ are free fall gravity meters with no moving parts. Their design is based on a patented optomechanical pyramidal retro-reflector.

Such a simple and compact architecture allows a single laser beam operation. This unique configuration simplifies the setup and enhances robustness, as there is no need for multiple beams alignment.



Check AQQ's full
bibliography



AQQ-B is robust and thermalized for field applications, with custom transport cases and low footprint.

EXAIL QUANTUM GRAVIMETERS ACROSS THE WORLD



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