Quantum Diamond Microscope

State of the art, wide-field imaging of magnetic fields, with applications spanning geoscience, bio-imaging, electronics, materials characterization, and quantum research

Highlights

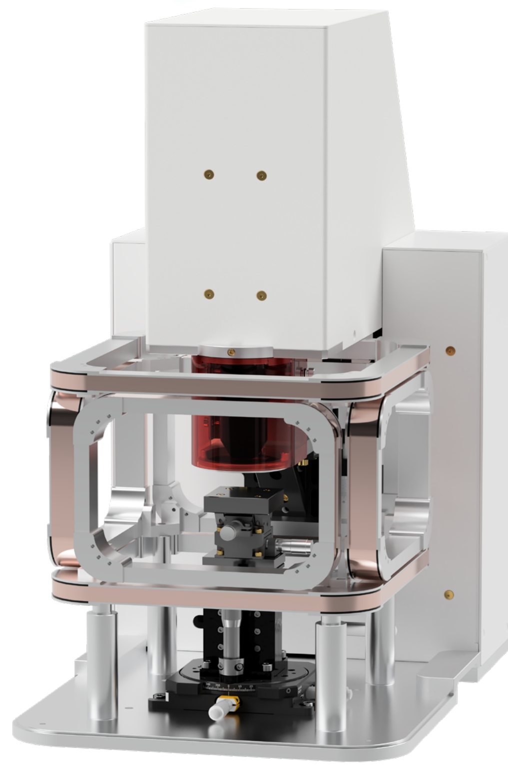
Image millitesla to nanotesla magnetic fields
Tunable spatial resolution down to less than one micron and field-of-view up to (4 × 4) mm².

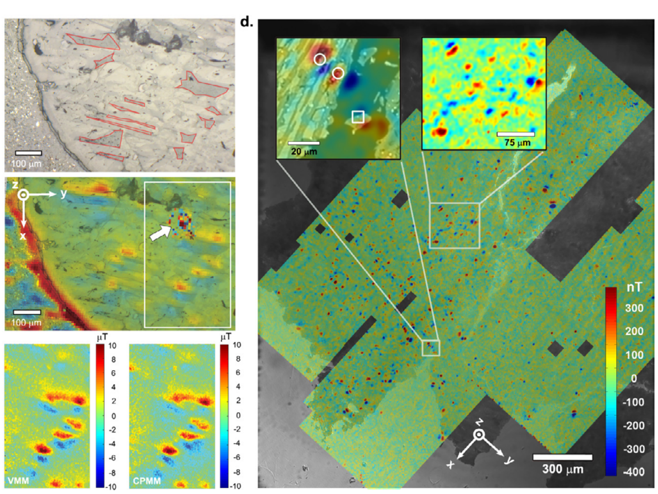
Correlate magnetic and optical images
Collect magnetic and optical images of samples using the same optical system for straightforward co-registration.

Vector measurements
The NV-diamond sensor enables reconstruction of the magnitude and direction of magnetic fields, providing superior reconstruction of magnetic source distributions.

Quantum-grade diamond
Manufactured by QDM.IO partner Element Six, with properties optimized for microscale magnetic field mapping applications.

Robust and easy to use
Operates under ambient room conditions, with no cryogenics, vacuum systems, or special power requirements.





Imaging of a geological sample using a quantum diamond microscope.
Reproduced from GGG, Vol. 18, Iss. 8, 3254-3267 (2017). DOI: 10.1002/2017GC006946

Operated using Ferrum

Easily configure measurements with Ferrum
Fully integrated software with an intuitive graphical user interface, including live visualization of data during acquisition.

Built from the ground up for wide-field magnetic imaging
Continuously updated with new features and supported by expert QDM.IO technical staff.

GPU-accelerated data analysis
Go from raw hyperspectral imaging data to magnetic field maps in seconds using a suite of GPU-based data analysis tools.

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Specifications

Microscope

PERFORMANCE (TYPICAL)

Metric	Value
Magnetic Sensitivity	< 5 μT/Hz½ (at 1 μm spatial resolution) , < 200 nT/Hz½ (at 10 μm spatial resolution)
Minimum Spatial Resolution	≤ 1 μm
Field of View (FoV)	Up to (4 × 4) mm² per FoV (larger samples can be imaged with tiling, motorized stages)
Operating Frequency	DC - 100 Hz
Dynamic Range	At least 0.2 mT

GENERAL

Dimensions (W x L x H)	330 mm x 493 mm x 564 mm
Cooling	Air-cooled
Vibration	Op. Theatre (ISO) or better
Weight	25 kg (approx.)
Environment	10 °C - 35 °C, <90% R.H. (non-condensing)

Controller

GENERAL

Cable Length (to microscope)	3 m (custom lengths available)
Operating Voltage	100-240 VAC, 50/60 Hz
Power Consumption	800 W max, 400 W typical
Cooling	Air-cooled
Weight	10 kg (approx.)
Environment	10 °C to 35 °C, <90% R.H. (non-condensing)
Dimensions (W x L x H)	450 mm x 450 mm x 180 mm (rack-mountable)

Publications

Examples of academic work using QDM technology.

GEOSCIENCE

Paleomagnetic evidence for a long-lived, potentially reversing martian dynamo at ~3.9 Ga
SC Steele, RR Fu, MWR Volk, TL North, AR Brenner, AR Muxworthy, GS Collins, and TM Davison
Science Advances 9, eade9071 (2023).
DOI: https://doi.org/10.1126/sciadv.ade9071

Plate motion and a dipolar geomagnetic field at 3.25 Ga
AR Brenner, RR Fu, ARC Kylander-Clarkb, GJ Hudak , and BJ Foley
PNAS 119 (42), e2210258119 (2022).
DOI: https://doi.org/10.1073/pnas.2210258119

Micrometer-scale magnetic imaging of geological samples using a quantum diamond microscope
DR Glenn, RR Fu, P Kehayias, D Le Sage, EA Lima, and BP Weiss
Geochemistry, Geophysics, Geosystems 18 (8), 3254-3267 (2017).
DOI: https://doi.org/10.1002/2017GC006946

Solar nebula magnetic fields recorded in the Semarkona meteorite
RR Fu , BP Weiss, EA Lima R. J Harrison, X-N Bai, SJ Desch, DS EbelL, C Suavet, H Wang, DR Glenn, D Le Sage, T Kasama, RL Walsworth, and AT Kuan
Science 346,1089-1092 (2014).
DOI: https://doi.org/10.1126/science.1258022

LIFE SCIENCES

Single-cell magnetic imaging using a quantum diamond microscope
DR Glenn, K Lee, H Park, R Weissleder, A Yacoby, MD Lukin, H Lee, RL Walsworth, and CB Connolly
Nature Methods 12, 736–738 (2015).
DOI: https://doi.org/10.1038/nmeth.3449

Optical magnetic imaging of living cells
D Le Sage, K Arai, DR Glenn, SJ DeVience, LM Pham, L. Rahn-Lee, M. D. Lukin, A.Yacoby, A Komeili, and RL Walsworth
Nature 496, 486–489 (2013).
DOI: https://doi.org/10.1038/nature12072

Mapping the microscale origins of magnetic resonance image contrast with subcellular diamond magnetometry
HC Davis, P Ramesh, A Bhatnagar, A Lee-Gosselin, JF Barry, DR Glenn, RL Walsworth, and MG Shapiro
Nature Communications, 9(1): 131 (2018).
DOI: https://doi.org/10.1038/s41467-017-02471-7

CONDENSED MATTER, MATERIALS SCIENCE, AND ELECTRONICS

Imaging Viscous Flow of the Dirac Fluid in Graphene Using a Quantum Spin Magnetometer
MJH Ku, TX Zhou, Q Li, YJ Shin, JK Shi, C Burch, H Zhang, F Casola, T Taniguchi, K Watanabe, P Kim, A Yacoby, and RL Walsworth
Nature 583, 537–541 (2020).
DOI: https://doi.org/10.1038/s41586-020-2507-2

Magnetic Field Fingerprinting of Integrated-Circuit Activity with a Quantum Diamond Microscope
MJ Turner, N Langellier, R Bainbridge, D Walters, S Meesala, TM Babinec, P Kehayias, A Yacoby, E Hu, M Lončar, RL Walsworth, and EV Levine
Physical Review Applied 14, 014097 (2020).
DOI: https://doi.org/10.1103/PhysRevApplied.14.014097

QUANTUM RESEARCH

High-Precision Mapping of Diamond Crystal Strain Using Quantum Interferometry
MC Marshall, R Ebadi, C Hart, MJ Turner, MJH Ku, DF Phillips, and RL Walsworth
Phys. Rev. Applied 17, 024041(2022)
DOI: https://doi.org/10.1103/PhysRevApplied.17.024041

Characterisation of CVD diamond with high concentrations of nitrogen for magnetic-field sensing applications
AM Edmonds, CA Hart, MJ Turner, PO Colard, JM Schloss, KS Olsson, R Trubko, ML Markham, A Rathmill, B Horne-Smith
Mater. Quantum. Technol. 1 025001(2021)
DOI: https://doi.org/10.1088/2633-4356/abd88a