GAS ANALYZERS | MASS SPECTROMETERS | REMOTE SENSING SYSTEMS | MICROSCOPES

Air Quality Monitoring and Atmospheric Research

Your one-stop shop for environmental monitoring

Innovation with Integrity

Your Experts

for Air Quality Monitoring and Atmospheric Research

Air pollution and climate change are environmental issues which directly impact everyone. The first step in solving these issues is to identify and quantify air pollutants and greenhouse gas (GHG) emissions with dedicated instruments. For such applications, we all develop, manufacture, and offer a comprehensive portfolio of high-quality optical and mass spectrometers for gas analysis and air monitoring.

Bruker Optics is a renowned global supplier of FT-IR spectrometers. Its solar absorption spectrometers **EM 27/SUN** and **IFS 125HR** are used in global scientific networks to measure the concentration of GHGs and air pollutants in the atmosphere. Bruker's gas analyzers **MATRIX II-MG** series and **OMEGA 5** are used to quantify concentrations of multiple gases locally. The open path spectrometer **OPS** is used to quantify average gas concentrations in a several hundred meters long open path without the need for direct sampling of gases. The passive remote sensing systems (**EM 27**, **SIGIS 2**, and **HI 90**) from Bruker are used to identify gas clouds from long distances, with the latter two also capable of visualizing these clouds. With **LUMOS II** FT-IR microscopes, users can identify particulate matters in the atmosphere.

MIRO Analytical AG is an innovative provider of the fast, compact laser-based multi-gas analyzers **MGA** series for the simultaneous, high-precision monitoring of GHGs and air pollutants, in which Bruker holds a majority investment.

Bruker and TOFWERK form a strategic partnership to provide high-speed, ultra-sensitive solutions, including the **Vocus**, which is a compact and mobile mass spectrometer designed for real-time monitoring of hundreds of volatile organic compounds (VOCs).

Together we are your experts in monitoring greenhouse gases and air pollutants, supported by our intensive research and development efforts and our many years of experience in the field. We regularly work closely with our customers, including leading scientists and research networks, and are committed to providing the best optical and mass spectrometers to support the efforts against global warming and air pollution.

Measure throughout the Entire Atmosphere

Solar Absorption Spectrometers for Atmospheric Research

Precise and accurate quantification of various GHGs (mainly CO_2, CH_4 and CO) in the atmosphere are of fundamental importance to understand their impact on climate change.

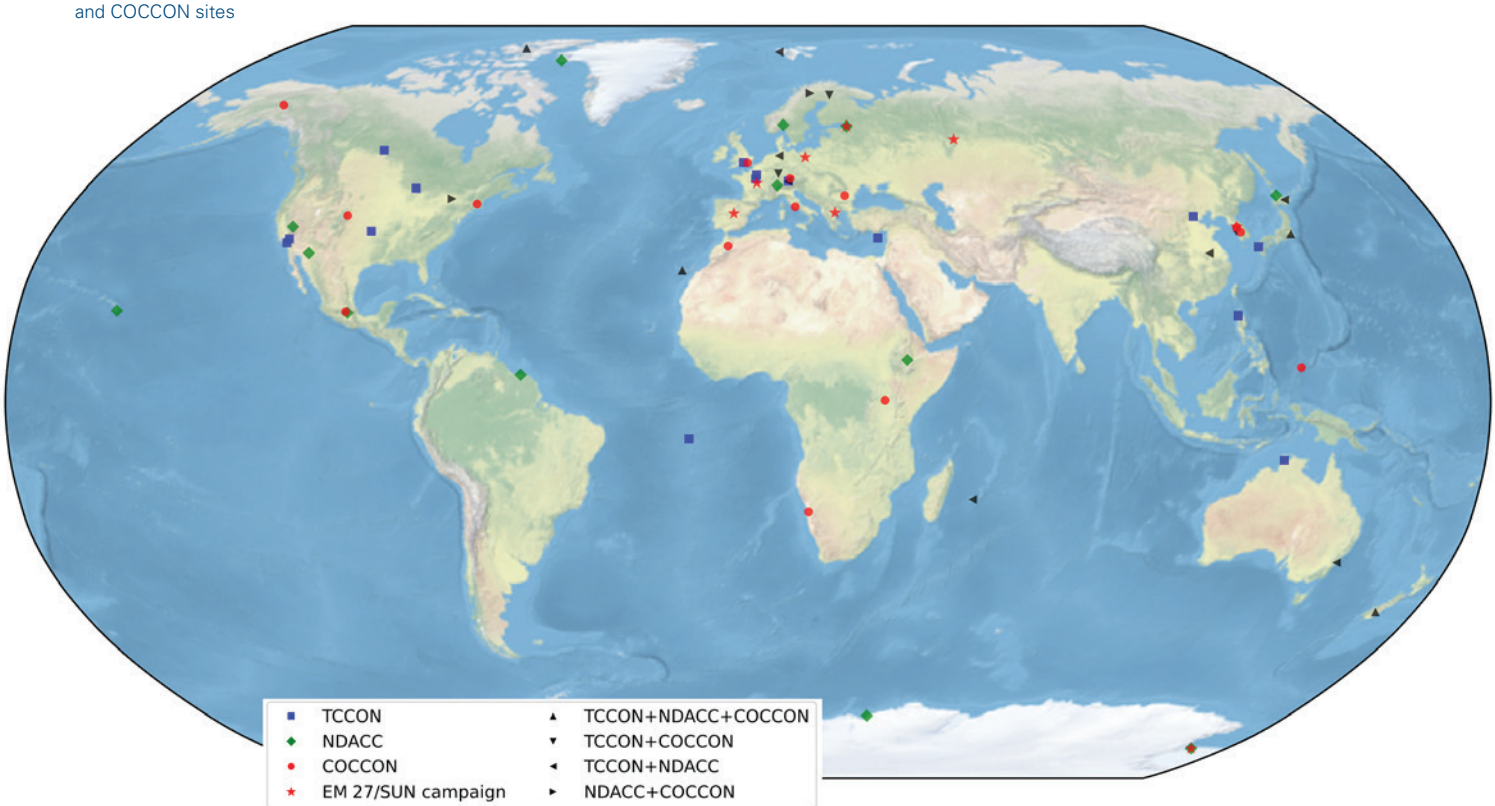
Bruker's high spectral resolution FT-IR spectrometer **IFS 125HR** and the portable FT-IR spectrometer **EM 27/SUN** use the sun as the light source to measure the column-averaged abundances of GHGs through the entire atmosphere. The movement of the sun is continuously followed by an accurate camera-based solar tracking system. The results of both instruments are often used to validate the data from satellite-based GHG measurements.

Global User Networks and Key Applications

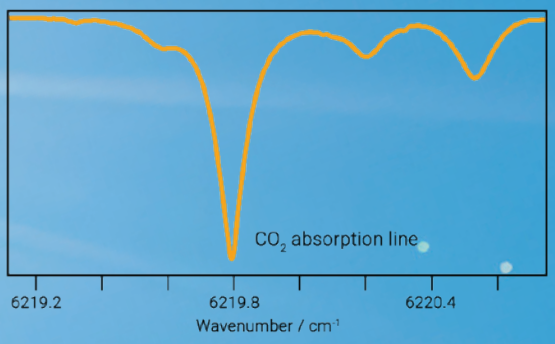
Bruker's solar absorption spectrometers are standard instruments in three global networks: **IFS 125HR** is used in TCCON (Total Column Carbon Observation Network) and Infrared Working Group (IRWG) of NDACC (Network for the Detection of Atmospheric Composition Change), whereas **EM 27/SUN** is used in COCCON (COllaborative Carbon Column Observing Network). TCCON is affiliated with the Global Atmosphere Watch (GAW) program. See the sites of all three networks in the map below.

TCCON uses **IFS 125HR** to measure GHGs in the near-infrared (NIR) spectral range with focus on CO_2, CH_4 and CO. In IRWG of NDACC, this instrument instead addresses trace gases such as O_3, N_2O, HCN, and $ClONO_2$ in addition to GHGs in the mid-infrared (MIR) spectral range. The **IFS 125HR** is the only instrument capable of meeting the accuracy requirements of these two networks due to its extremely high spectral resolution (up to 0.0015 cm^{-1}), which enables the quantification of gases with high accuracy to the point of describing how concentration changes with height in the atmospheric column.

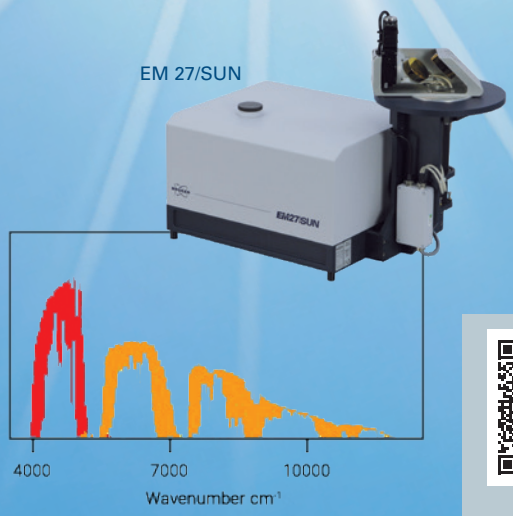
Global TCCON, NDACC and COCCON sites



Zoomed-in high-resolution solar absorption spectrum of IFS 125HR



EM 27/SUN



Solar absorption spectrum of EM 27/SUN

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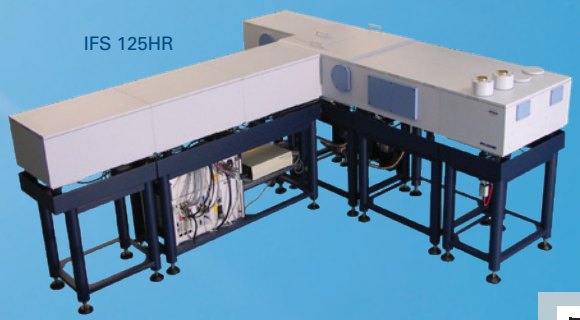
IFS 125HR



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COCCON uses **EM 27/SUN** to measure the concentration of CO_2, CH_4, and CO in the NIR range throughout the atmospheric column. **EM 27/SUN** can be installed for stationary measurements or can be made mobile for temporary measurement campaigns. **EM 27/SUN** is also used as the portable standardization method (travel standard) for calibration of **IFS 125HR** installations located at different sites globally.

One key application of **EM 27/SUN** is that multiple systems can be circled around a regional GHG source, such as a city, to deduce its GHG emission rate. City-level and national-level networks consisting of several **EM 27/SUN** are built to constantly monitor the change in GHG concentrations across a given area.

Solar tracker accessory for the IFS 125HR
The motorized mirrors of the solar tracker direct the solar radiation into the spectrometer. Using a camera-based feedback system, the mirrors automatically follow the position of the sun during its movement in the sky.
The smaller solar tracker of EM 27/SUN relies on the same principle.

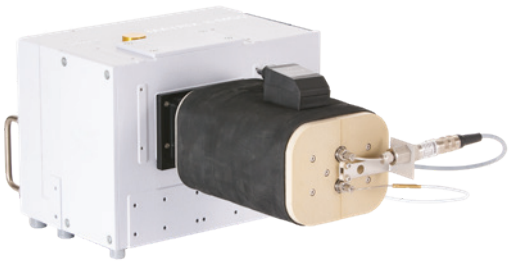
Quantify Local Gas Concentrations (I)

FT-IR-based Multi-Gas Analyzers

To quantify local concentrations of GHGs and air pollutants by direct sampling, Bruker Optics and MIRO Analytical offer the compact bench-top multigas analyzers **OMEGA 5**, **MATRIX II-MG** series, and **MGA** series. These systems can quantify gases precisely, accurately, and rapidly in real-time. **OMEGA 5** and **MATRIX II-MG** series are FT-IR-based gas analyzers which can cover a very large number of measurable gas species over a large concentration range. **MGA** series instruments are laser-based systems which are able to monitor GHGs and air pollutants with ppb to ppt precision.

OMEGA 5

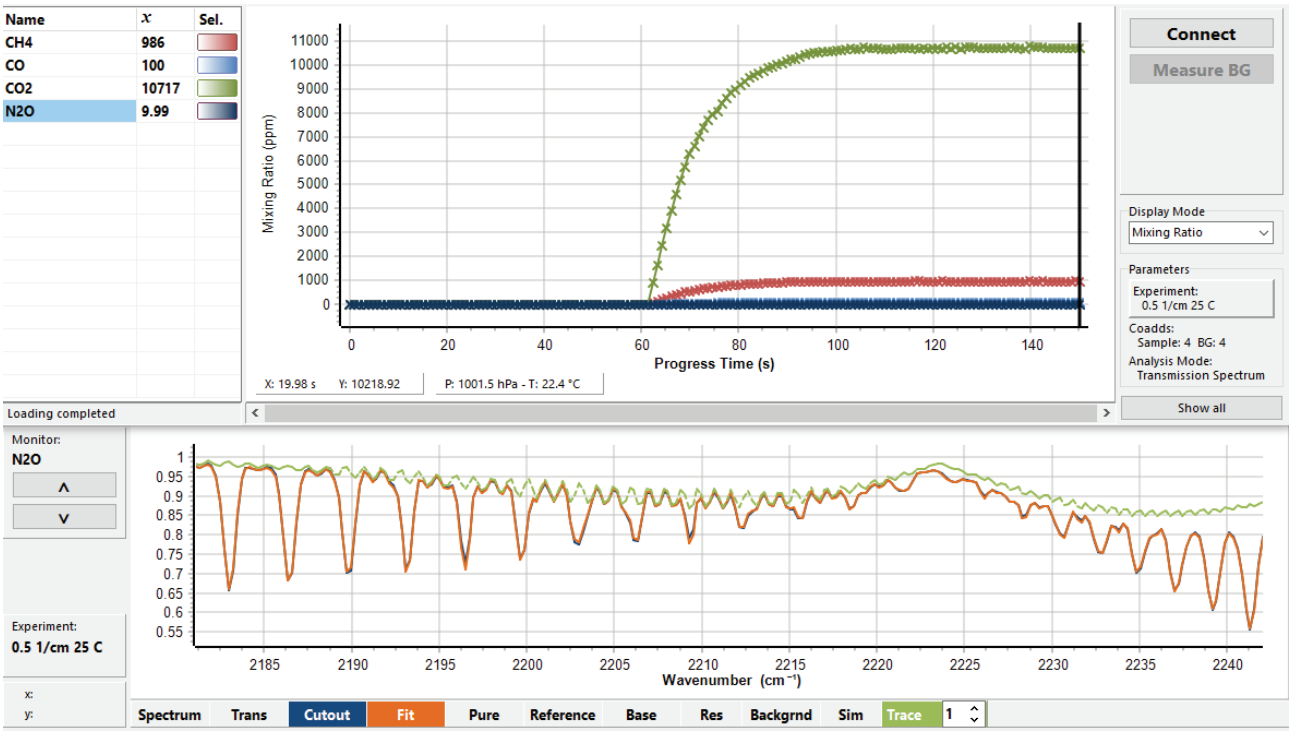
MATRIX II-MG



The FT-IR based gas analyzers **OMEGA 5** and **MATRIX II-MG** series enable the calibration-free analysis of a variety of gases simultaneously. By using the dedicated gas analysis software OPUS GA, close to 400 gases can be quantified without the need for extensive calibration measurements. The systems can quantify concentrations ranging from the ppb level even up to 100 %. Besides typical GHGs, also gases with high global warming potential (e.g., SF_6, CF_4 or freons) and air pollutants can be quantified in real-time and continuously.

Depending on the required detection limits and overall gas compositions, different detector types and gas cells with different optical lengths are available to precisely configure the system for individual applications. High scan rates of up to 5 Hz at 0.5 cm^{-1} spectral resolution can be achieved.

The well-sealed optics compartment of the instruments enables the quantification of low H_2O and CO_2 levels as the influence of the background is minimized. With the unique DryPath option for **OMEGA 5**, no external purge gas is required.



User interface of gas analysis software OPUS GA for the OMEGA 5 and MATRIX II-MG series

The Time Series window (top) displays the concentrations of individual compounds in a gas mixture as a function of time. In the Spectral Analysis window (bottom), the measured spectrum of the gas mixture (blue) shows an excellent agreement with the fit (orange). The contribution of the target gas N_2O (green) to the overall spectrum is also shown in a selected spectral range.

LEARN MORE

Quantify Local Gas Concentrations (II)

Laser-based High Precision GHG and Trace Gas Analyzers

The MIRO **MGA** series has revolutionized and simplified the in-situ monitoring of GHG and air pollutants by enabling simultaneous online measurements of up to 10 gases at high measurement rates, while offering excellent stability and precision. Because of this, one **MGA** can replace up to seven conventional gas analyzers.

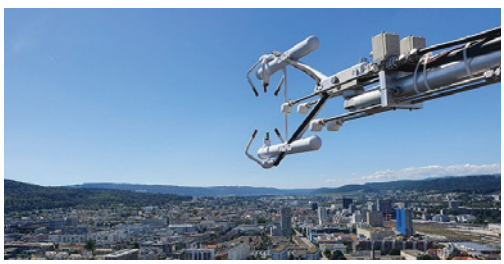
Multiple Conventional Analyzer

vs

MGA

Gas	Conventional Technology	MIRO Analytical´s Technology
CO_2, CH_4	CRDS NIR No. 1	one MGA with multiple lasers for 10 gases*
NH_3	CRDS NIR No. 2	
HCHO	CRDS NIR No. 3 or Hantzsch reaction	
N_2O, CO	CRDS MIR No. 4 or NDIR for CO	
NO, NO_2	CLD with NO_2 converter	
O_3	UV No. 1	
SO_2	UV No. 2	
HONO	MS or single QCL	
OCS	Single QCL	

Comparison of 9 conventional analyzers able to measure atmospheric gases in ppb or ppt range with one compact MGA multigas analyser.
* 10 gases maximum out of the 12 presented



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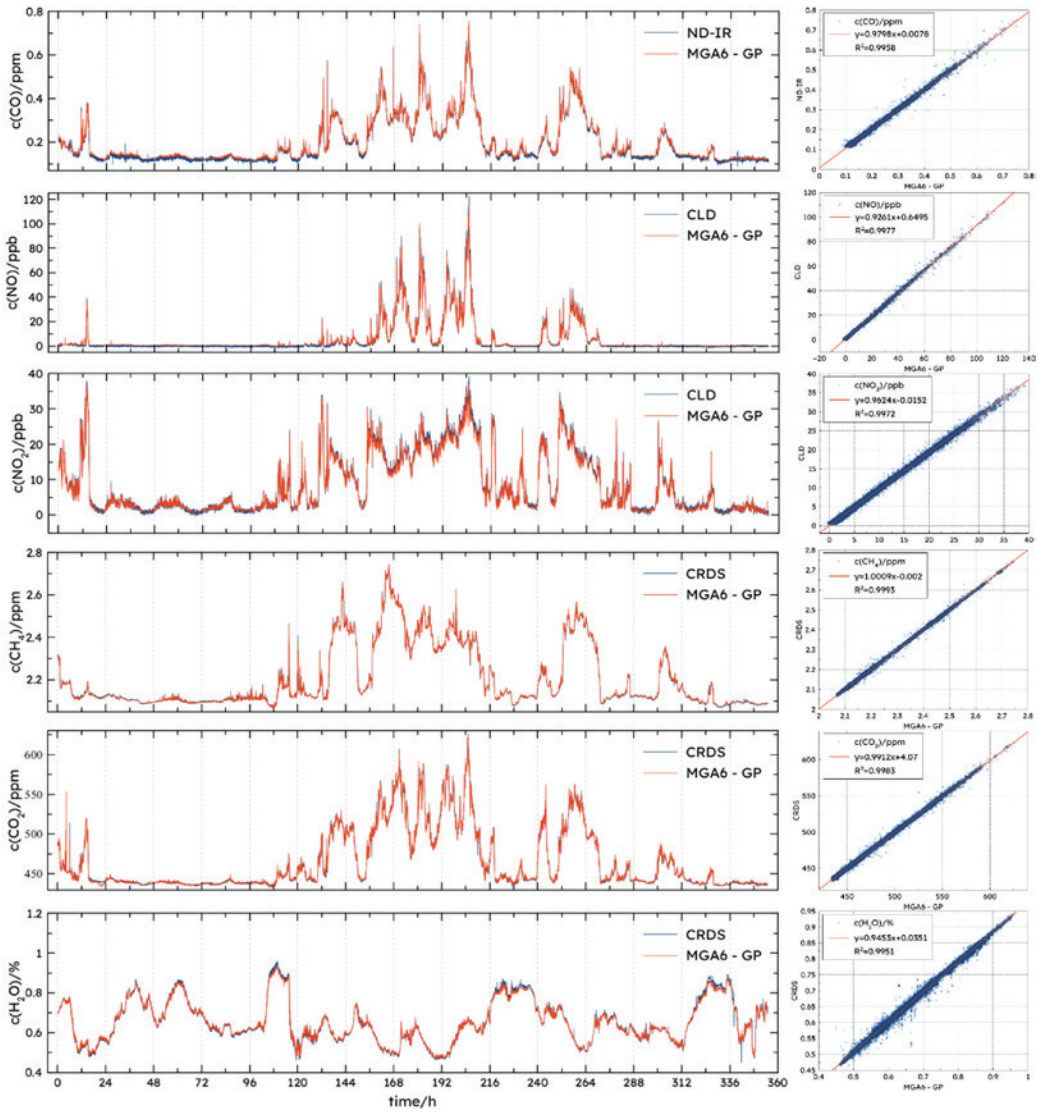
MIRO's mid-IR laser-based analyzers offer measurement precisions in the ppt range suitable for the most demanding applications in atmospheric monitoring of trace gases.

With their excellent precision, low drift and high time-resolution of up to 10Hz, **MGA** series are fitted for various field and laboratory applications such as **eddy covariance flux** measurements or mobile monitoring on cars and aircrafts.

The **MGA** series offers a variety of analyzers focused on different applications and use cases from MGA^3 for high precision GHG monitoring of CH_4, N_2O and H_2O to MGA^{10} for ten gases selectable from CO_2, CO, OCS, N_2O, H_2O, NO, NO_2, HONO, HCHO, SO_2, CH_4, O_3, NH_3.

Test for comparison of one MGA with other gas analyzers performed at an independent and reference Air Quality Monitoring Station in Switzerland.



Comparison of one MGA with four conventional analyzers over two weeks showing excellent performance in a single instrument for both air-qualtiy and greenhouse gas monitoring.

LEARN MORE

Quantify Local Gas Concentrations (III)

Compact and Ultra-sensitive Mass Spectrometer

The **Vocus** is a compact, mobile, ultra-sensitive monitor for hundreds of volatile organic compounds (VOCs). It is based on proton transfer reaction (PTR) time-of-flight (TOF) technology and fully optimized for applications that demand fast results with a small footprint.

Vocus

The **Vocus** is the perfect choice for long-term industrial, fenceline or stack emission monitoring targeting air toxics such as aromatic hydrocarbons, small, oxidized organics or CFCs (chlorofluorocarbons). Utilizing advanced TOF technology coupled to a medium pressure chemical ionization source based on PTR technology, the **Vocus** provides detection limits in the single-digit parts-per-trillion range in just one second. It delivers fast, sensitive and reliable measurements without the need for chromatography, handling complex mixtures in challenging conditions with ease. GPS integration is a standard for mobile deployments enabling source identification or leak detection in real time. Its humidity-independent response ensures reliable results in all conditions and together with its compact, durable design making it the ideal tool for mobile labs and fieldwork.

User interface of Vocus software

The Vocus is supported by software with an intuitive interface with integrated customizable dashboard, alarm thresholds and automatic performance checks providing real-time concentration data streams with instant data export options.

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Quantify Gas Compounds in Open Path

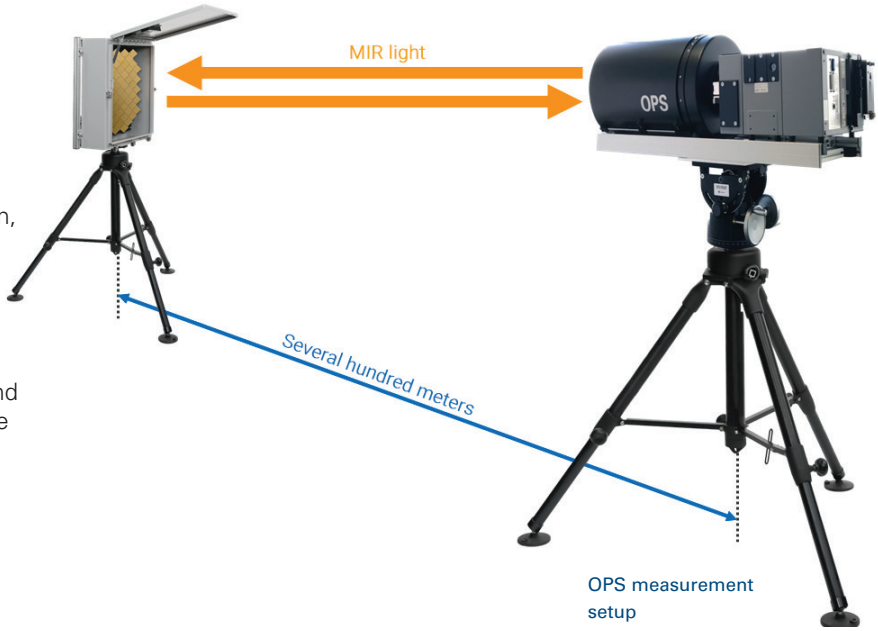
Calibration-free Open Path Spectrometer

If the gas cannot be directly sampled locally, or the average gas concentrations along a fenceline are of interest, Bruker's Open Path Spectrometer (**OPS**) is the perfect solution to quantify the gases along a path in real-time.

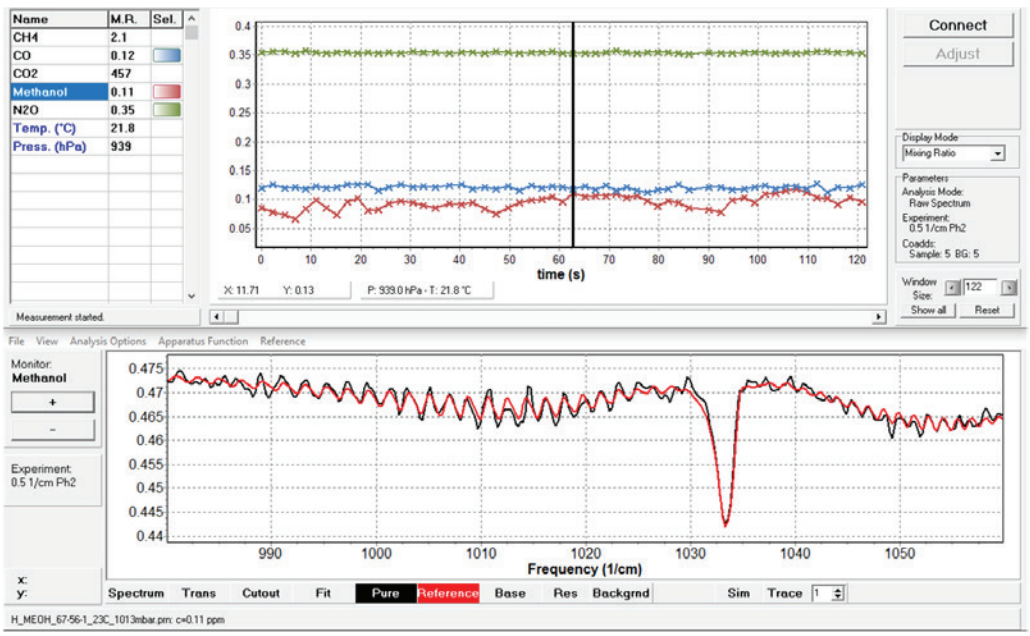
OPS is an active remote sensing system. Radiation from an MIR light source in the spectrometer is transmitted through a telescope to a retroreflector array which typically is positioned at a location several hundreds of meters from the spectrometer. From the retroreflector array the light is reflected back to the spectrometer along the same path. The gases along this optical path are quantified in real-time. As an option, a motorized pan-tilt-head can be used to automatically orient the spectrometer to individual retroreflector arrays in different directions.

OPS allows for a calibration-free analysis and quantification of concentrations down to the ppb range.

The main applications include fenceline monitoring at industrial sites, agriculture gas measurements over farmland, and air pollution monitoring in the city.



OPS measurement setup



User interface of OPUS RS/OPS software
In this example, the temporal behavior of the average methanol concentration in an industrial area (upper window, red datapoints) quantified by OPS clearly shows values fluctuating from 60 to 120 ppb. The lower window shows the measured spectrum (black) in the spectral range where methanol is quantified. This spectrum is already automatically corrected for the baseline and the absorptions of interfering compounds. The reference spectrum of methanol (red) agrees well with the measured one.

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Identify and Visualize Gases Remotely

Passive Remote Sensing Systems

Passive remote sensing systems are ideal instruments to identify which GHGs and air pollutants are emitted, and from where, even from a distance. Passive systems use the thermal radiation emitted from background objects behind the gas clouds or from gases themselves as the light source for measuring the absorption or emission spectra of target gases.

Bruker's FT-IR based passive systems **EM 27**, **SIGIS 2**, and **HI 90** can automatically identify multiple gases in real-time. **SIGIS 2** and **HI 90** can even visualize the gas clouds to directly reveal the locations of emission sources. All three systems have high optical throughputs and low noise, which is essential for the accurate identification of gas clouds with weak signals, like gas clouds with low concentration or small size. The remote sensing software OPUS RS is easy-to-use and includes large reference libraries of common hazardous compounds.

Compact and Highly Sensitive

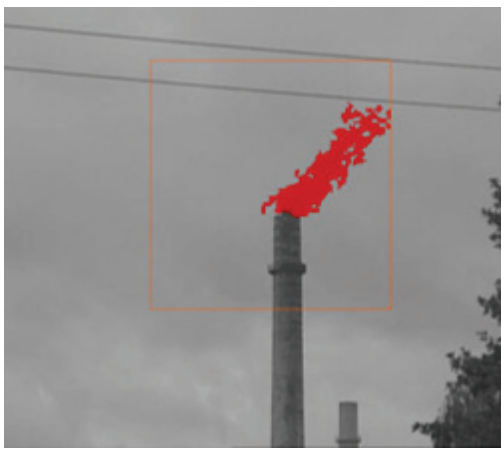
EM 27 is a compact, robust, and highly sensitive passive remote sensing system using a single element detector. It identifies gas clouds along the line of sight by simply pointing the system in a given direction.

Imaging Large Areas by Scanning

SIGIS 2 (scanning infrared gas imaging system) uses a single element detector and generates chemical images by using a fast-scanning mirror. Its head can automatically rotate ±180° to monitor large areas.

Ultra-fast Imaging

Hyperspectral Imager **HI 90** is equipped with a high spatial resolution cryocooled focal plane array (FPA) detector. It can identify and visualize small gas clouds rapidly (one frame of hyperspectral image in less than 3s).



Left: SIGIS 2 for 24/7 industrial monitoring
Right: HI 90 identifies and visualizes SO_2 emission from about 600 m distance.

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Suspended Dust and Particle Monitoring
FT-IR Microscopes

LUMOS II

FT-IR microscopy is a proven tool for particle analysis. It allows routine identification of dust particles collected on a substrate. Each particle is individually measured and characterized in terms of its chemical composition and dimensions. Statistical evaluation gives thorough quantitative information on the level of particle contamination and helps to identify its origin.

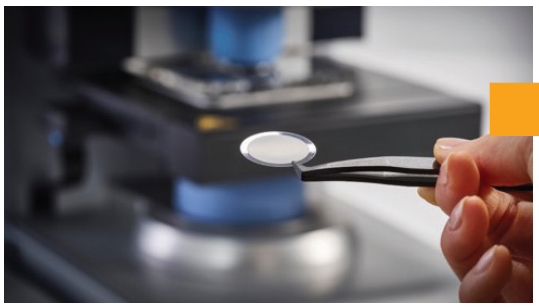
Use ATR FT-IR for Analysis on Any Filter Material

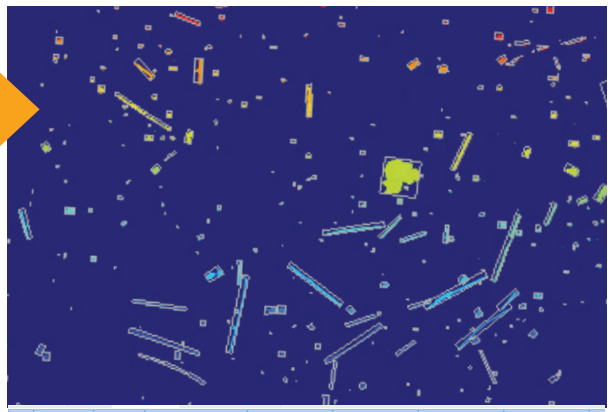
Using attenuated total reflectance (ATR) in FT-IR microscopy allows for the analysis and identification of dust and particles on any air filter.

Use IR Imaging for High-throughput Particle Analysis

IR imaging has the power to assess particles only by their chemical information. This hugely improves the reliability and speed of detection.

Workflow





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1 Place Filter Loaded with Particles

IR microscopic analysis of particles works on virtually any filter material. Metal coated polycarbonate, silicon, and aluminum oxide can be imaged.

2 Navigate OPUS Workflow

Choosing the method of analysis is very simple. OPUS even allows beginners to quickly select and start IR analysis of samples.

3 Obtain Optimal Results

AI-based evaluation methods simplify analysis to a one-click solution. Highest analytical confidence guaranteed.

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Numerous Instruments for a Variety of Applications

1. Measuring GHGs at remote locations (**IFS 125HR**, **EM 27/SUN**, **MGA** series, and **Vocus**)
2. Measuring GHGs and air pollutants from aircraft (**MGA** series and **Vocus**)
3. Measuring GHGs emitted from wildfires (**EM 27/SUN**, **OPS**, and **Vocus**)
4. Measuring GHGs during a campaign in remote areas for validating data measured from GHG-monitoring satellites (**EM 27/SUN**)
5. Measuring the GHGs and air pollutants emitted from landfills (**EM 27/SUN**, **OPS**, and **Vocus**)
6. Measuring agricultural gases (e.g., NO_x, NH_3) and GHGs (**MGA** series, **OPS**, **EM 27/SUN**, **MATRIX II-MG** series, **OMEGA 5** and **Vocus**)
7. Measuring exhaust gases from cars on the highway (**OPS** and **Vocus**)
8. Measuring atmospheric particles close to the road or in cities (**LUMOS II**)
9. Measuring exhaust gases from car tailpipes directly while driving (**MATRIX II-MG5**)
10. Environmental and industrial monitoring with passive remote sensing systems (**EM 27**, **SIGIS 2**, and **HI 90**)
11. Fenceline monitoring at the border of a factory (**OPS** and **Vocus**)
12. Gas analysis in the lab of a factory (**MATRIX II-MG** series, **OMEGA 5**, and **Vocus**)
13. Measuring air pollutants in mobile labs in cities (**MGA** series, **OMEGA 5**, **MATRIX II-MG** series, and **Vocus**)
14. Several **EM 27/SUN** stationed around a city to quantify the GHG-emission rate of this city
15. Measuring fluxes of GHGs and air pollutants with the eddy covariance technique (**MGA** series)
16. Multiple **MGA** series and **Vocus** systems deployed throughout a city to quantify GHGs and air pollutants locally

Environmental, Social, and Governance

As a forward-thinking, innovative company, Bruker has a rich legacy of protecting the environment, treating others with dignity and respect, and following the highest standards of ethical compliance and governance. These principles more recently characterized as Environmental, Social, Governance (ESG), have been an integral part of our DNA for over 60 years.

Bruker´s innovative technologies and solutions support scientists and businesses around the world to explore, understand, and improve the world in which we live. Our innovative spirit drives solutions intended to address environmental challenges, improve recycling, advance research discovery, identify hazardous and harmful materials in the environment, and keep our foods and environment safe. We are proud to support a more sustainable future.

As a global innovation leader in developing and marketing advanced analytical technologies and solutions, our scientists and engineers support businesses and scientists around the world to better understand environmental hazards, protect our essential food supply, research clean, sustainable energy, and search for new ways to improve the quality of life. We are especially proud to collaborate closely with many of our customers on ways to ensure a more sustainable future.

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Bruker Optics is ISO 9001, ISO 13485, ISO 14001 and ISO 50001 certified.

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