Application Note AN M171

# Identification and Visualization of Natural Gas Emissions from a Small Smokestack by SIGIS 2 and HI 90

## Introduction

Global warming is one of the most critical and pressing global issues. The increasing concentrations of greenhouse gases (GHG) such as $CO_2$ and $CH_4$ in the atmosphere is the main driving force of global warming. Instruments that can identify the sources of both natural and human GHG emissions are therefore of great interest to environmental monitoring and protection agencies around the world.

## Identification and visualization of natural gas emissions

One of the most efficient methods to find the GHG sources are passive remote sensing systems based on FT-IR spectrometry. Such systems measure and analyze the spectra of IR emissions and absorptions from target gases from far distances. The identification is carried out by comparing the measured spectra containing gas specific information with the reference spectra of different gases in the library. Using different imaging methods, Bruker remote sensing systems SIGIS 2 (Figure 1) and HI 90 (Figure 2) can not only identify but also visualize natural gas clouds emitted from small rooftop smokestacks automatically and in real-time.

In this example, the same gas cloud with a width of only about 1.5 m is measured at the same time by both systems from about 100 m distance. Both systems can visualize the shape of the gas cloud and identify the two gas compounds methane ($CH_4$) and ethene ($C_2H_4$). Thanks to HI90's high spatial resolution (typically 128 x 128 pixels) combined with its high time resolution (< 3s per Frame) it can seamlessly follow the detailed evolution of the gas cloud even under windy conditions (Figure 2b).

| Keywords | Instrumentation and Software |
|---|---|
| Greenhouse Gas Emissions | SIGIS 2 |
| Remote Sensing | HI 90 |
| Hyperspectral Imaging | Software Package OPUS RS |
| Methane | |
| Natural Gas | |
| Smokestack | |

The measurement data shown below were automatically received during the measurement using our remote sensing software OPUS RS without any post-measurement data treatment.

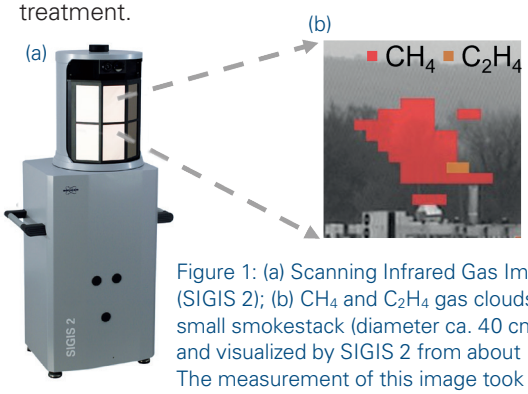


Figure 1: (a) Scanning Infrared Gas Imaging System (SIGIS 2); (b) $CH_4$ and $C_2H_4$ gas clouds emitted from a small smokestack (diameter ca. 40 cm) are identified and visualized by SIGIS 2 from about 100 m away. The measurement of this image took about 20s. For each pixel that is marked in red, methane was clearly identified. The orange marked pixels show the clear identification of ethene.

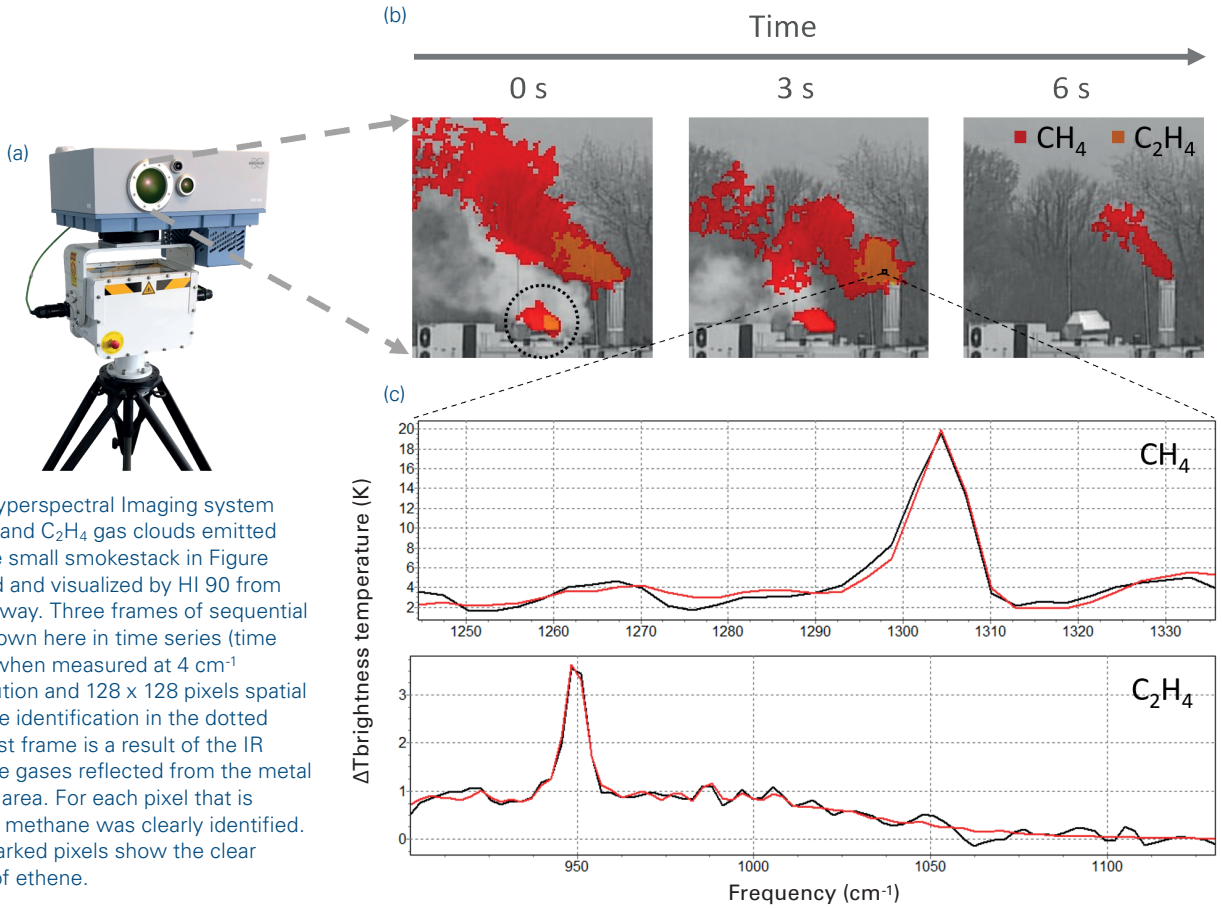


Figure 2: (a) Hyperspectral Imaging system HI 90; (b) $CH_4$ and $C_2H_4$ gas clouds emitted from the same small smokestack in Figure 1 are identified and visualized by HI 90 from about 100 m away. Three frames of sequential images are shown here in time series (time interval < 3 s when measured at 4 $cm^{-1}$ spectral resolution and 128 x 128 pixels spatial resolution). The identification in the dotted circle in the first frame is a result of the IR emission of the gases reflected from the metal surface in this area. For each pixel that is marked in red, methane was clearly identified. The orange marked pixels show the clear identification of ethene.

(c) Identification of $CH_4$ and $C_2H_4$ indicated by the good match between the measured (black) and reference (red) brightness-temperature spectra.

## Instrument Key Features

### Scanning Infrared Gas Imaging Systems (SIGIS 2)

- Unique system that combines performance of single detector FTIR with imaging by scanning
- Automatic real-time identification and visualization of target compounds
- Passive long-range detection (integrated telescope), no external light sources or reflection optics necessary
- Low detection limits due to highest optical throughput and lowest noise
- No calibration to target gas necessary
- Large library of reference spectra

### Hyperspectral Imaging system (HI 90)

- Actively aligned, friction free plane mirror interferometer
- High resolution focal plane array with 320 x 256 pixels
- Automatic ultra-fast real-time identification and visualization of target compounds
- Passive long-range detection
- Low detection limits due to high optical throughput, ultra-low noise and image processing algorithms
- No calibration to target gas necessary
- Large library of reference spectra

## Other typical applications of SIGIS 2 and HI 90

- Identification of hazardous clouds at accident sites by first responders around the world
- Monitoring of high-profile sport and political events, such as football World Cups, Olympic games and G20 meetings
- Monitoring of industrial facilities
- Identification of sources of air pollutions by environmental protection agencies
- Study of gases emitted from volcanos

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