DIFFERENT THINKING.
BETTER MEASURING.

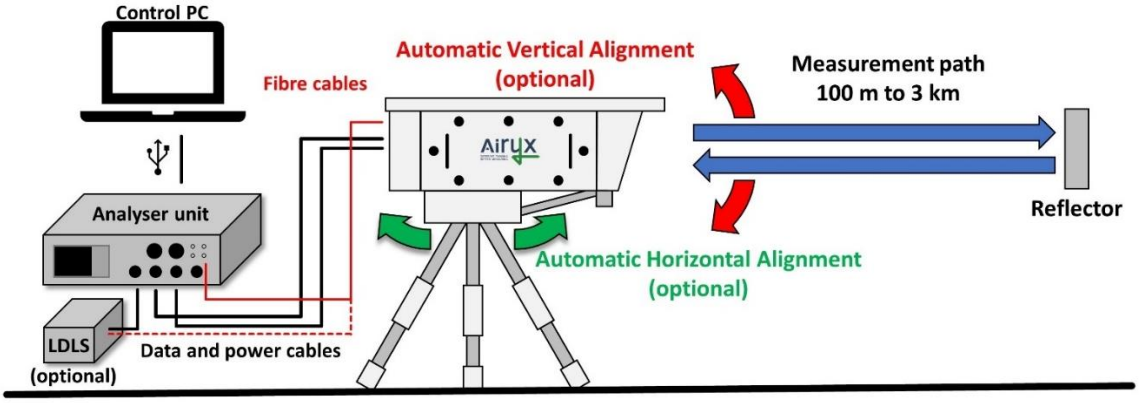
A SPIN-OFF FROM THE UNIVERSITY OF HEIDELBERG
INSTITUTE OF ENVIRONMENTAL PHYSICS

Open-path active remote sensing instrument

FAST AND ACCURATE SPECTRAL TRACE GAS MEASUREMENTS USING ACTIVE SPECTROSCOPY

Left: Telescope unit of the Airyx Open Path system. Right: Retro reflector array.

The Airyx open-path remote sensing instrument allows to monitor a wide range of atmospheric trace gases (NO_2, SO_2, O_3, HCHO, HONO, H_2O, BrO, OClO) based on the method of Differential Optical Absorption Spectroscopy (DOAS). Light emitted by High Power LEDs (centered at 280, 325, and 365 nm wavelength) covering the UV/vis range from 280 to 380 nm are coupled into a telescope and sent through the atmosphere along light paths of lengths between several 100 m and several km. Optionally, a high-power broadband light source (LDLS) is available extending the spectral range and the maximum measurement path length. The instrument measures the average concentration along the path with high precision (sub ppb range, depending on path length) and high time resolution (few seconds, depending on visibility).



Scheme of the Open path instrument setup. Besides standard high Power LEDS, a broadband Laser Driven Light Source (Xe-lamp) is available.

Although the complex setup, the instrument is very easy to operate: Initial light path alignment is performed by the help of an internal field of view camera combined with precise motors. During operation, the software automatically monitors and optimizes the alignment ensuring constant high-quality measurement without relying on user input. The optional motorized telescope base enables automatized measurements on multiple light paths in different directions and/or heights. Calibration gases are not needed since trace gases are quantified along well-defined light paths using literature absorption data. Automated, frequent lamp reference measurements ensure drift-free, long-term operation at highest precision.

APPLICATIONS

- Spatially averaged trace gas measurement along light paths from several hundred meters to several kilometers
- Emission monitoring (e.g., SO_2, NO_2, HCHO) / Air quality monitoring
- Studies of atmospheric trace gas chemistry (e.g., O_3, BrO, OClO), volcanic plume chemistry or polar halogen chemistry
- Traffic emission monitoring (SO_2, NO_2) at time resolution of few seconds
- Validation studies for satellite data, passive remote sensing, in situ and spatially high resolved chemistry modelling

PROPERTIES (TYPICALLY)

Typical limit of detection at 1000m path (one way), 10 second data averaging[*1]	NO_2	1.5 ppb	**Achievable path lengths**	100 m to 3000m (one way). 500 m to 1500 m recommended.
	SO_2	0.3 ppb		
	O_3	15 ppb	**Time resolution / data averaging**	Down to 3 seconds; adjustable temporal averaging improves sensitivity
	HCHO	4.5 ppb		
	HONO	0.8 ppb		
Spectrometer specifications[*2]	Range:	270-380 nm	**Measurement software**	Included; Customizable measurement routine (time resolution, spectral averaging, multiple measurement paths)
	FWHM:	typ. 0.45 nm		
	Ultra-low straylight configuration			
Detector Quantum efficiency	~60% (back UV thinned detector)		**Power consumption**	< 70 W, 12 V
Noise	10^{-4} at 1000 scans (~60 s int. time)		**Additional sensors**	Temperature, Pressure, Humidity
Detectable gas species	NO_2, SO_2, O_3, HCHO, HONO, H_2O, BrO, OClO		**Data analysis**	Data analysis package provided for standard trace gases
Light sources	High power LEDs centered at 280, 325 and 365 nm, optionally high-power broad band Xe lamp		**Data communication**	USB 2.0, Measurement PC (Notebook) included
Temperature stabilization	Spectrometer and light sources are temperature stabilized		**Retro reflectors**[*4]	20 x 1” fused silica corner cube reflector array; IP64 housing
Telescope specifications	Focal length:	800 mm	**Weight & Dimension**	
	Mirror diameter:	200 mm	Telescope	ca. 20 kg; ca. 100 x 35 x 32 cm3
	Field of view:	ca. 0.05°	Analyzer	ca. 14 kg; ca. 40 x 44 x 13 cm3
Path alignment	Camera + fiber bundle motors		**Operation temperature range for telescope unit**	-20°C to 40°C
	Optional multi-path motors[*3]			
Fiber configuration	Sending	6 mono fibers	**Telescope mounting options**	Aluminum rail system or tripod
	Receiving	1 mono fiber		
	UV fused silica multi-fiber bundle			
Lamp reference measurement	Automatic; Reference plate in front of fiber bundle		**Mechanical stability**	Robust for harsh environmental conditions (IP64)

COMMENTS:
[*1] Limit of detection depends on path length, data averaging and visibility conditions.
[*2] Typical specifications. Spectrometers are equipped with color filters to reduce stray light.
[*3] Extension of OP-telescope for motorized elevation change (0 to 30°) and azimuth rotation (-130° to 130°) for application of several vertical light paths.
[*4] Number of required arrays depends on application and desired length of light path.

ADVANTAGES

BENEFITS	INNOVATION
High measurement accuracy	• Ultra-low stray light spectrometers • Stable spectrometer temperatures, low noise • Non-linear spectrometer characterization included • Continuous measurement and automatic reference measurement • Measurement routine adaptable
Simple setup & operation	• Simple instrument setup and start up • Automated path alignment and measurement routine incl. adjustment • Low maintenance, easy cleaning of optics • No calibration required; gas quantification based on spectral absorption data
Long lifetime	• Water proof with IP64, snow resistant • Designed for long term operation • Water proof retro reflector array with changeable desiccant