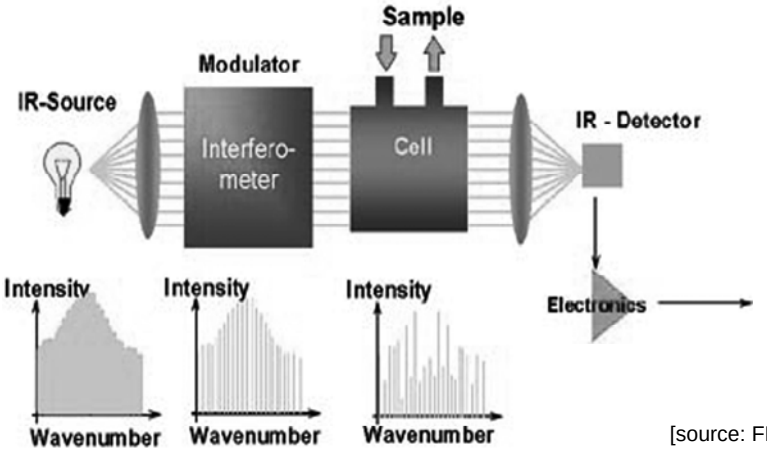
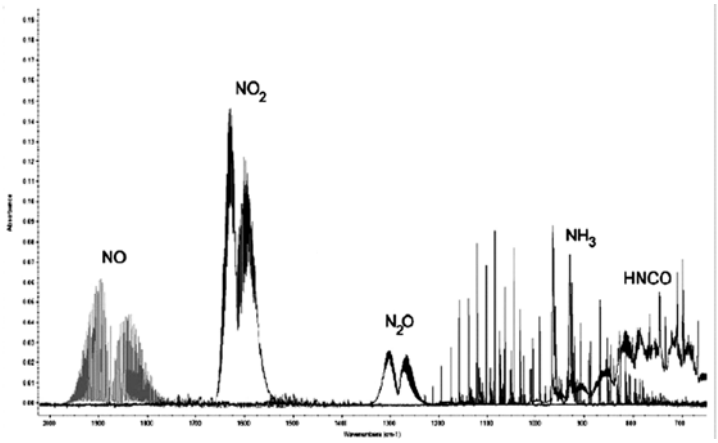
Measurement Principle using an FTIR (Fourrier Transform Infra Red) Spectrometer (AVL SESAM FTIR)

The FTIR measuring principle is a measurement with IR light. Contrary to NDIR with a narrow wave length area by means of an optical filter, the scan area of the IR wave length by use of the FTIR measuring principle is large. The principle of FTIR is that the gas to be analysed is led through a cuvette with an IR light source at one end that is sending out scattered IR light, and a modulator that "cuts" the infra red light into different wave lengths. At the other end of the cuvette a detector is measuring the amount of IR light to pass through the cuvette. Like the NDIR measuring principle it is the absorption of light at different wave lengths that is an expression of the concentration of gases to be analysed. By data processing, Fourier Transformation mathematics is used to turn the measured absorption values into gas concentrations for the analysed gases. As the light, when using the FTIR measuring principle, is modulated into many different wave lengths, it is possible to analyse many different gases in the same instrument; such as CO, H2O, SO2, NO, NO2, HCl, HF, NH3. Using the below measuring principle also produces a much larger data material (as compared to the conventional NDIR principle), from where the concentrations of the different gases can be measured. The large data material supply excellent calibration curves and correlation values, thus providing very reliable analysis results.



[source: FLSmidth/Airloq]

Figure 1: Measuring principle of an FTIR

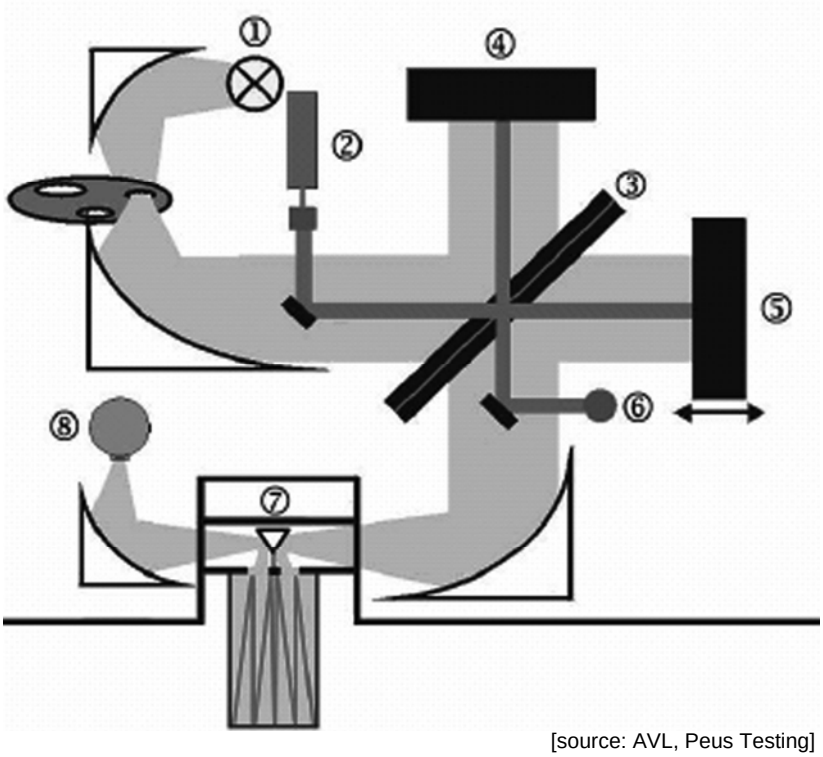


[source: AVL, Peus Testing]

Figure 2: FTIR Infrared Spectrum

The AVL SESAM-FTIR uses a Michelson Interferometer with two mirrors, a fixed one and a movable one. The wideband infrared radiation of the light source is splitted into two beams by a beamsplitter. One of the beams hits the fixed mirror the other one hits the movable mirror. They are subsequently added to one beam. With the interference effects varying erasement and amplification of single wavelengths occur depending on the position of the movable mirror. This modified infrared light is transferred into the gas cell. At each movement of the mirror (scan) an interferogram (intensity over time) is enregistred by the infrared detector.

1	**IR-Source**
2	**Laser**
3	**Beamsplitter**
4	**Fixed mirror**
5	**Movable mirror**
6	**Laser detection**
7	**Heated Gas Cell**
8	**MCT IR Detector**



[source: AVL, Peus Testing]

Figure 3: Spectrometer optical bench setup

[source: AFHB]

Figure 4: FTIR (arrow) and sampling line in the IC- engines laboratory in Biel

AVL SESAM-FTIR : measured values

AFHB 2008

Conventional Components:			Range	[ppm]
✓ CO	Carbon monoxide		0	8000
✓ CO2	Carbon dioxide		0	200'000
✓ NO	Nitrogen monoxide		0	10'000
✓ NO2	Nitrogen dioxide		0	1'000
✓ NOx	Total Nitrogen oxides	calulated	0	10'000
HC	Hydrocarbons			

Non Regulated Components :				
✓ H2O	Water		0	250'000
✓ CH4	Methane		0	1'000
✓ SO2	Sulphur dioxide		0	1'000
✓ N2O	Nitrous oxide		0	1'000
✓ NH3	Ammonia		0	1000
✓ COS	Carbonoxidsulfid		0	200

Differentiated Hydrocarbons :				
✓ C2H2	Acetylene		0	1'000
✓ C2H4	Ethene		0	1'000
✓ C2H6	Ethane		0	1'000
✓ C3H6	Propene		0	1'000
✓ C4H6	1,3 butadiene		0	1'000
NC5	n-Pentane			
IC5	iso-Pentane			
✓ NC8	n-Octane		0	1'000
AHC	Aromatic hydrocarbons			

Optional Components:				
✓ C3H8	Propane			
✓ HCHO	Formaldehyde		0	1'000
CH3OH	Methanol			
CH3CHO	Acetaldehyde			
C2H5OH	Ethanol		0	1'000
✓ HCOOH	Formic Acid		0	1'000
✓ HCN	Hydrocyanic Acid		0	1'000
✓ HNCO	Isocyanic Acid			
✓ THCD	Total Hydrocarbon Diesel	calculated	0	30'000
✓ NMHC	Non Methanic Hydrocarbons	calculated		

sources: AVL, technical data sheet