Consilium

When Safety Matters

OPSIS M800 System

Continuos emission monitoring (CEM) for scrubber applications

Consilium

Consilium Opsis M800 System

Libery of the Seas
Owner: Royal Carribean Cruise Line
EGCS Maker: Yara Marine
Measuring points: 1
Class: DNV/GL

Grand Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Umm Bab
Owner: Maran Gas
EGCS Maker: Raw gas
Measuring points: 2
Class: Lloyds

Carnival Legend
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Freedom
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Linda
Owner: Langship
EGCS Maker: DeltaLangh
Measuring points: 1
Class: DNV/GL

Aila
Owner: Langship
EGCS Maker: DeltaLangh
Measuring points: 1
Class: DNV/GL

Carnival Elation
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 4
Class: Lloyds

Carnival Ecstasy
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring: 2
Class: Lloyds

Carnival Pride
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 6
Class: RINA

Normandie
Owner: Brittany Ferries
EGCS Maker: Yara Marine
Measuring points: 7
Class: BV

Cape Finistere
Owner: Brittany Ferries
EGCS Maker: Yara Marine
Measuring points: 7
Class: BV

NDA
Owner: NDA
EGCS Maker: NDA
Measuring points: 1
Class: DNV/GL

NDA
Owner: NDA
EGCS Maker: NDA
Measuring points: 1
Class: DNV/GL

Bore Song
Owner: Bore Shipping
EGCS Maker: DeltaLangh
Measuring points: 1
Class: Lloyds

Star Princess
Owner: Carnaval Corporation
EGCS Maker: Ecospray
Measuring points: 4
Class: Lloyds

Carnival Magic
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Paradise
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 4
Class: Lloyds

Carnival Miracle
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Victory
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Barfleur
Owner: Brittany Ferries
EGCS Maker: Yara Marine
Measuring points: 7
Class: BV

Island Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 1
Class: Lloyds

Golden Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Crown Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Consilium Opsis M800 System

Stena Transit
Owner: Stena Line
EGCS Maker: Wärtsilä
Measuring points: 2
Class: NDA

Stena Transporter
Owner: Stena Line
EGCS Maker: Wärtsilä
Measuring points: 2
Class: NDA

Waasmunster
Owner: Exmar
EGCS Maker: Wärtsilä
Measuring points: 1
Class: NDA

Carnival Breeze
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Norwegian Jewel
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 5
Class: DNV/GL

Norwegian Pearl
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 5
Class: DNV/GL

Norwegian Gem
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 5
Class: DNV/GL

Norwegian Escape
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 5
Class: DNV/GL

Norwegian Bliss
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 9
Class: DNV/GL

Newbuild HMD
Owner: NDA
EGCS Maker: Yara Marine
Measuring points: 2
Class: NDA

Newbuild HMD
Owner: NDA
EGCS Maker: Yara Marine
Measuring points: 2
Class: NDA

Newbuild HMD
Owner: NDA
EGCS Maker: Yara Marine
Measuring points: 2
Class: NDA

Carnival Dream
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Balticborg
Owner: Royal Wagenborg
EGCS Maker: Wärtsilä
Measuring points: 1
Class: BV

Bothniaborg
Owner: Royal Wagenborg
EGCS Maker: Wärtsilä
Measuring points: 1
Class: BV

Caribbean Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Ruby Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Emerald Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Carnival Sunshine
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Glory
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Conquest
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

NDA
Owner: NDA
EGCS Maker: Wärtsilä
Measuring points: 1
Class: NDA

NDA
Owner: NDA
EGCS Maker: Wärtsilä
Measuring points: 2
Class: NDA

NDA
Owner: NDA
EGCS Maker: Wärtsilä
Measuring points: 2
Class: NDA

Consilium Opsis M800 System

NDA
Owner: NDA
EGCS Maker: Wärtsilä
Measuring points: 2
Class: NDA

Coral Princess
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Finneagle
Owner: Finnlines
EGCS Maker: Wärtsilä
Measuring points: 4
Class: RINA

Finnclipper
Owner: Finnlines
EGCS Maker: Wärtsilä
Measuring points: 4
Class: RINA

Finnfellow
Owner: Finnlines
EGCS Maker: Wärtsilä
Measuring points: 4
Class: RINA

Samsung SN2130
Owner: Gaslog
EGCS Maker: Raw Gas
Measuring points: 9
Class: ABS

Samsung SN2131
Owner: Gaslog
EGCS Maker: Raw Gas
Measuring points: 9
Class: ABS

Hammerodde
Owner: Danske Faerger
EGCS Maker: PureTeq
Measuring points: 2
Class: BV

Norwegian Sun
Owner: Norwegian Cruise Line
EGCS Maker: Yara Marine
Measuring points: 5
Class: DNV

Carnival Fantasy
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 2
Class: Lloyds

Carnival Splendor
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 1
Class: Lloyds

Carnival Triumph
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Liberty
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

Carnival Valor
Owner: Carnival Corporation
EGCS Maker: Ecospray
Measuring points: 3
Class: Lloyds

H1711A Chemical Tanker
Owner: Stolt Tankers
EGCS Maker: Clean Marine
Measuring points: 1
Class: DNV

H1712A Chemical Tanker
Owner: Stolt Tankers
EGCS Maker: Clean Marine
Measuring points: 1
Class: DNV

Ark Dania
Owner: DFDS
EGCS Maker: ME Production
Measuring points: 2
Class: Lloyds

Ark Germania
Owner: DFDS
EGCS Maker: ME Production
Measuring points: 2
Class: Lloyds

Finlandia Seaway
Owner: DFDS
EGCS Maker: ME Production
Measuring points: 1
Class: Lloyds

Balanciaga 407
Owner: NDA
EGCS Maker: ME Production
Measuring points: 1
Class: Lloyds

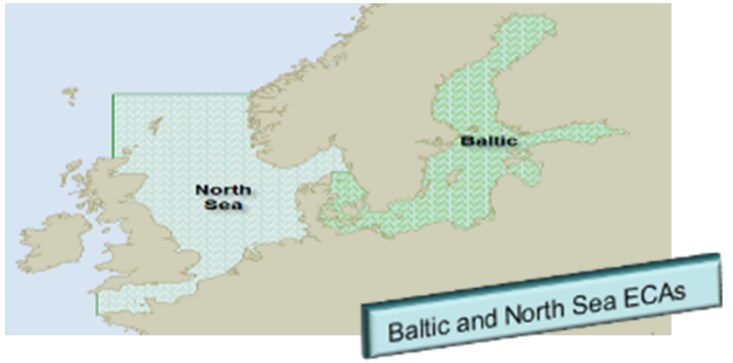
Balanciaga 408
Owner: NDA
EGCS Maker: ME Production
Measuring points: 1
Class: Lloyds

Stena Hollandica
Owner: Stena Line
EGCS Maker: Wärtsilä
Measuring points: 4
Class: Lloyds

Stena Brittanica
Owner: Stena Line
EGCS Maker: Wärtsilä
Measuring points: 4
Class: Lloyds

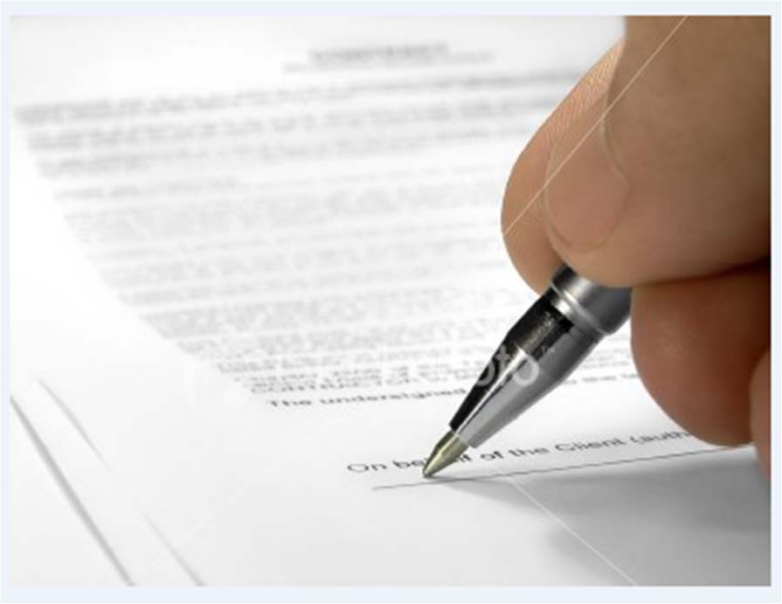
Upcoming regulations

- North Sea and English Channel
- 2012 North America (200nm off coast line)
- 2014 Puerto Rico and US Virgin Island
- .. More to come…..

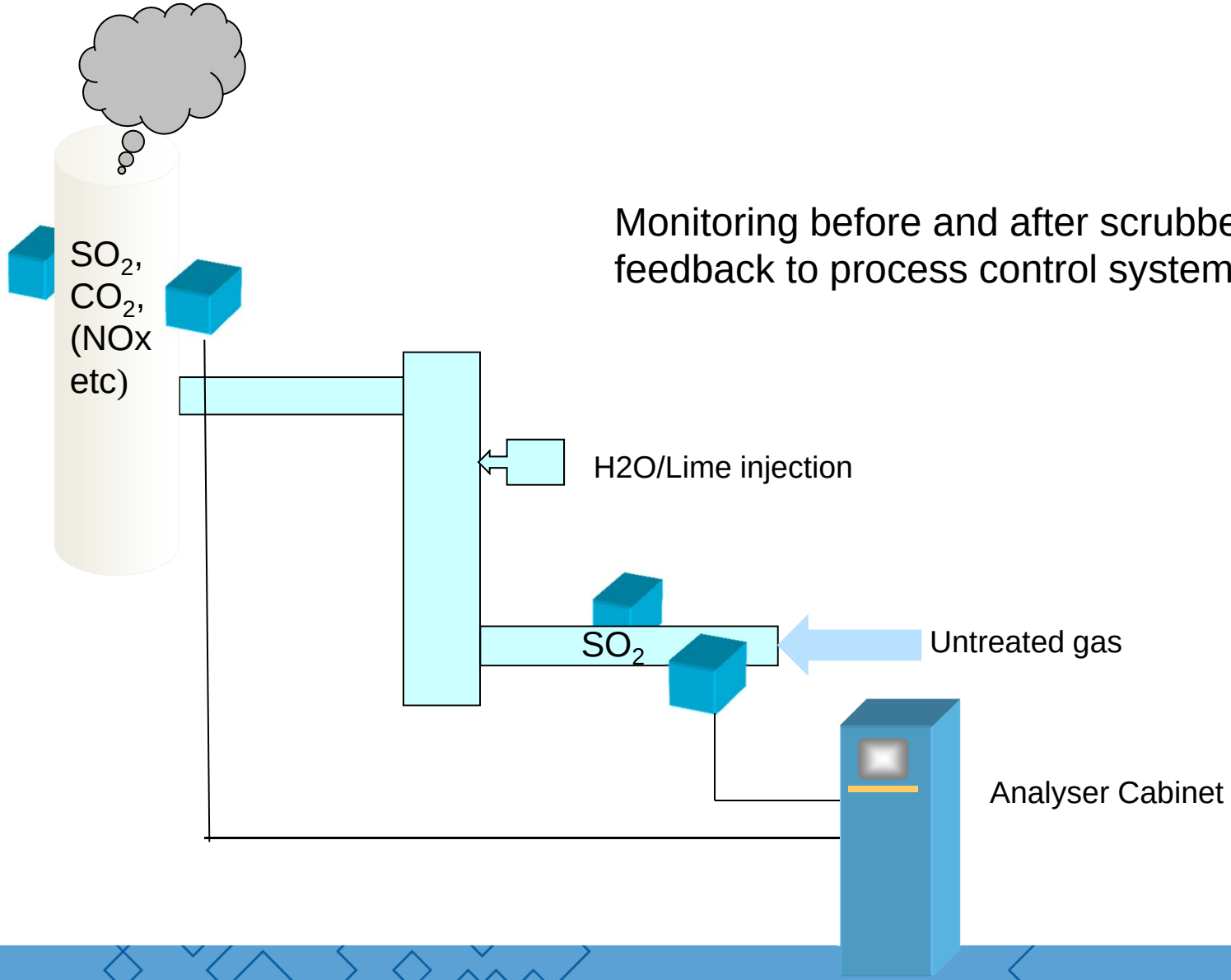


Certificates

- DNVGL
- RINA
- BV
- Lloyds



Scrubber/reactor control



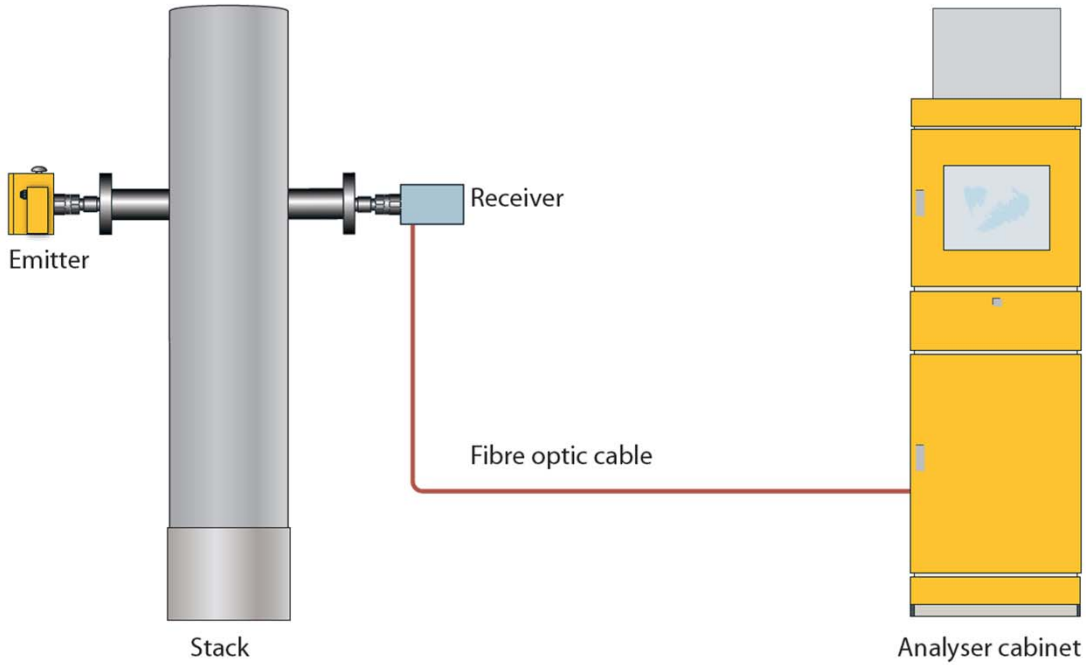
Monitoring before and after scrubber for feedback to process control system

- Difficult to measure after a wet scrubber
- 20 °C, condensing, wet
- Sulphuric acid – very corrosive
- Monitoring results must be accurate
- Application for non-contact method.

DOAS CEM for scrubbers

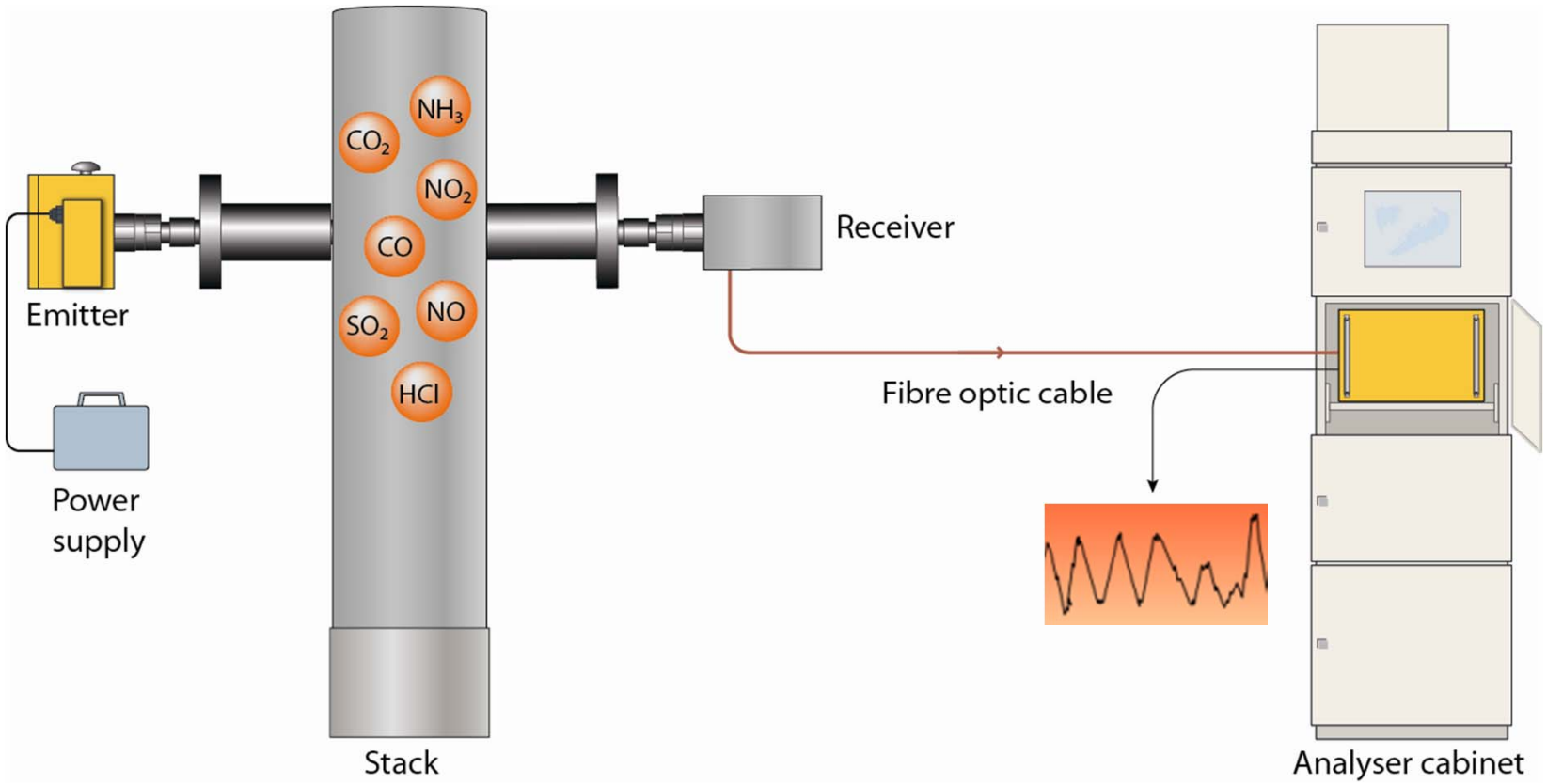
Dual Optical Absorption Spectroscopy

- No contact with gases (sample free)
- Long life time
- Low maintenance
- Easy installation



OPSIS M800 System

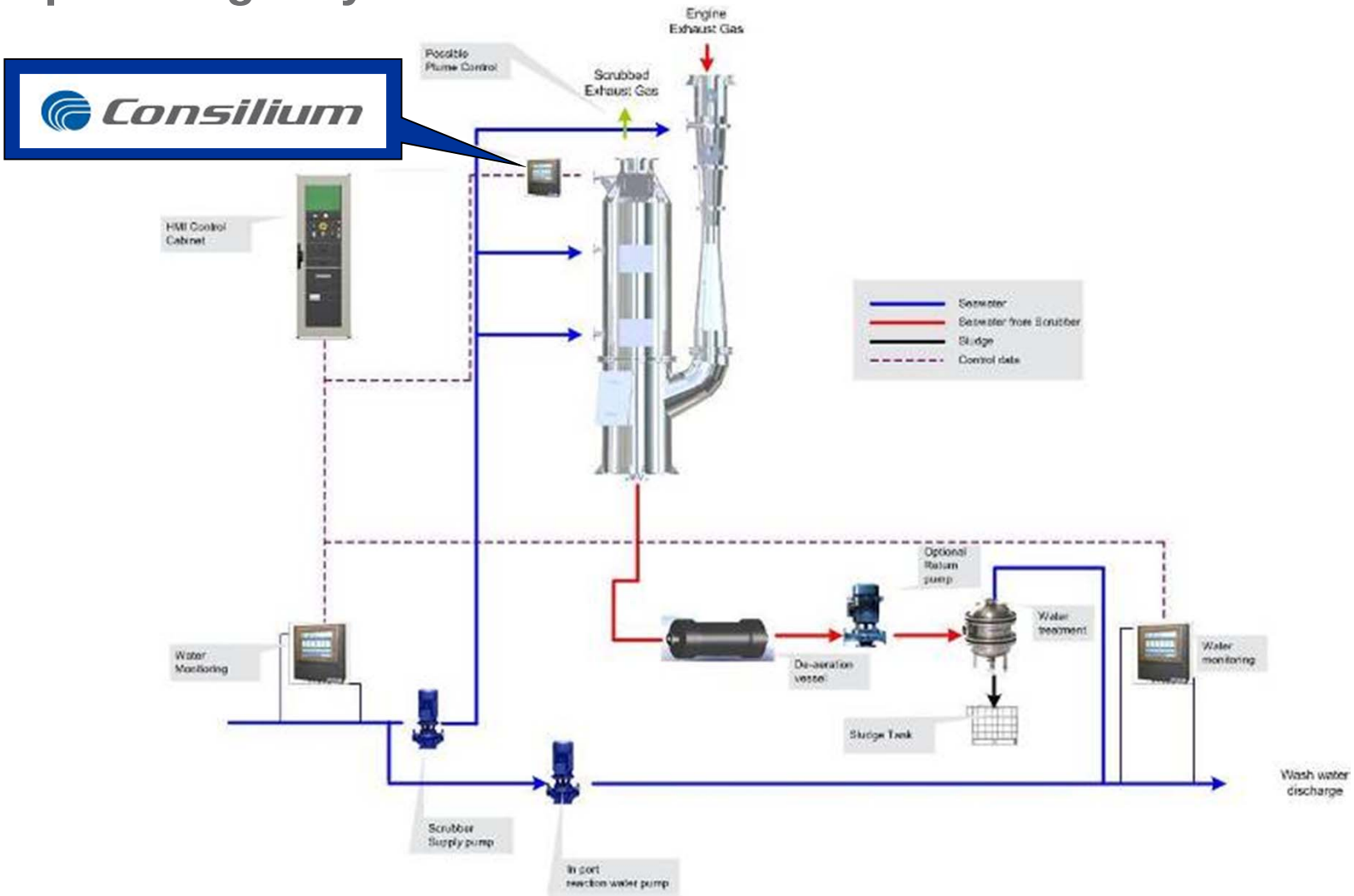
Non contact gas monitoring solution



Opsis **DOAS** **(D**ifferential **O**ptical **A**bsorption **S**pectroscopy)
Used for monitoring industrial emissions for more than 25 years !

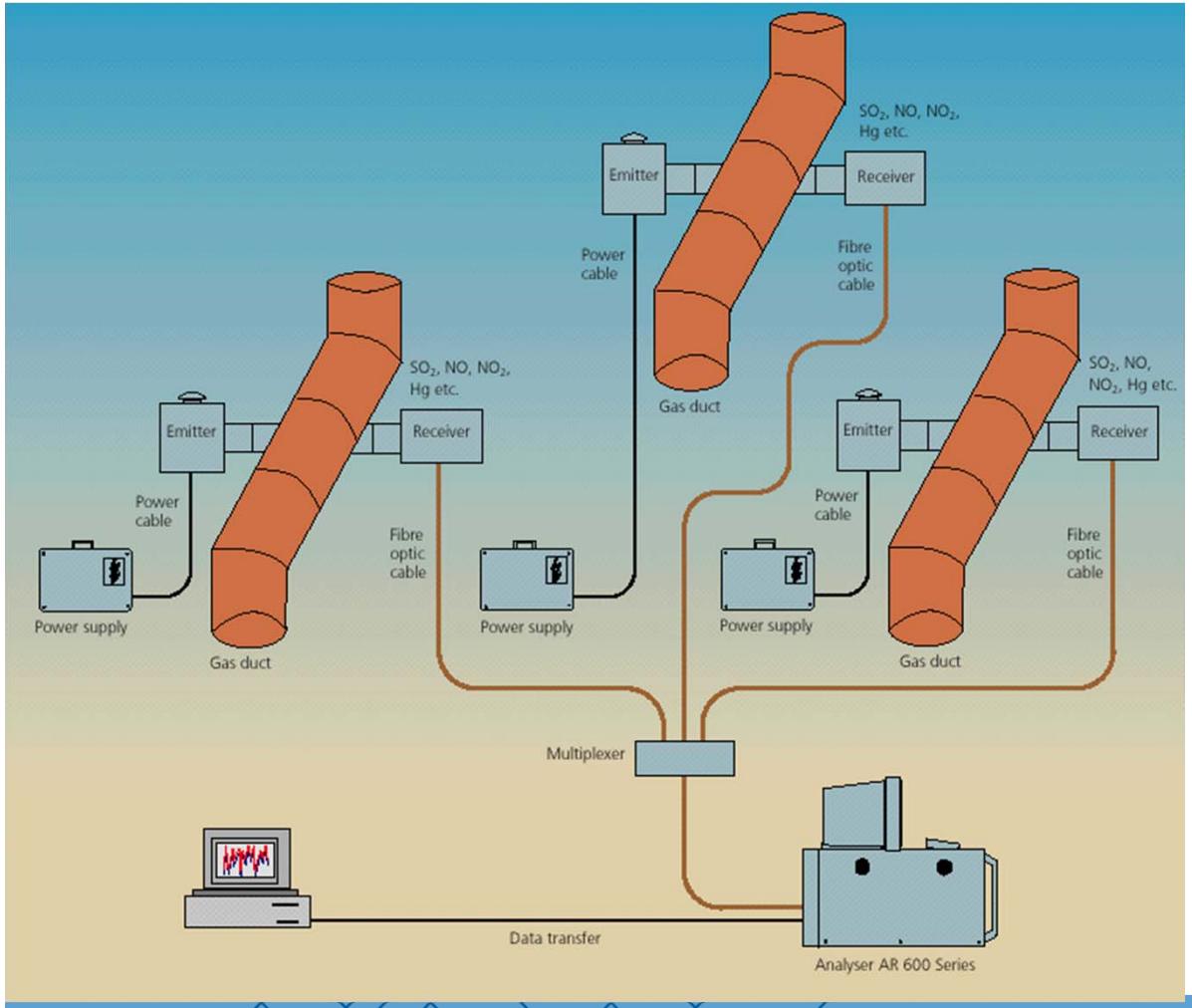
Seawater scrubbing

Example design layout



- Monitor SO_2, NO_x and CO_2
- Monitor up to 10 locations simultaneously
- Non-contact method
- Simple and reliable

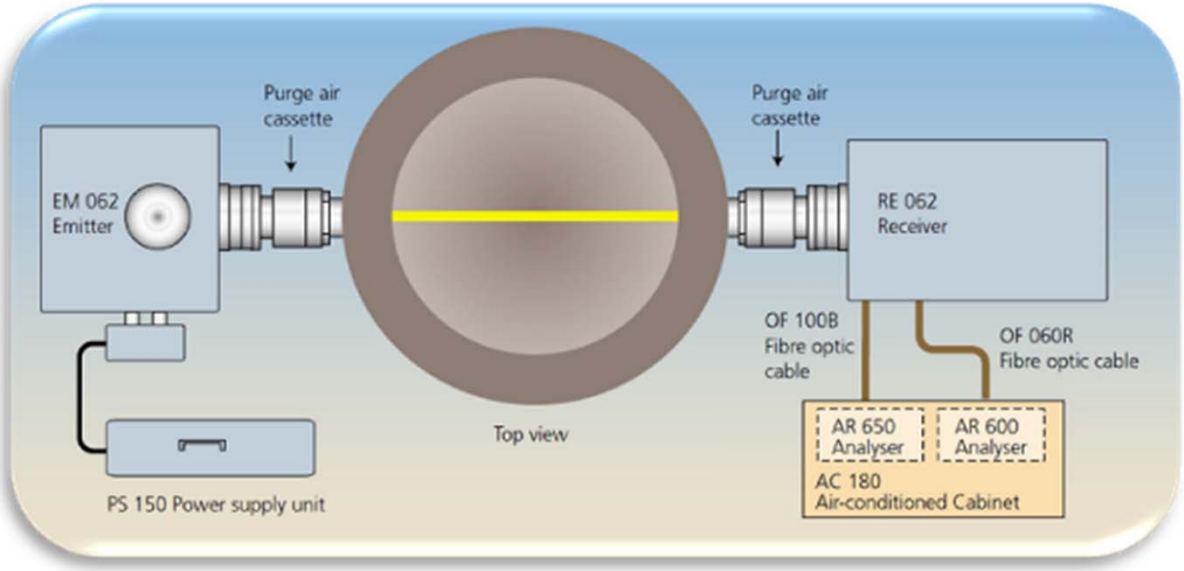
Scalable - Multiple ducts



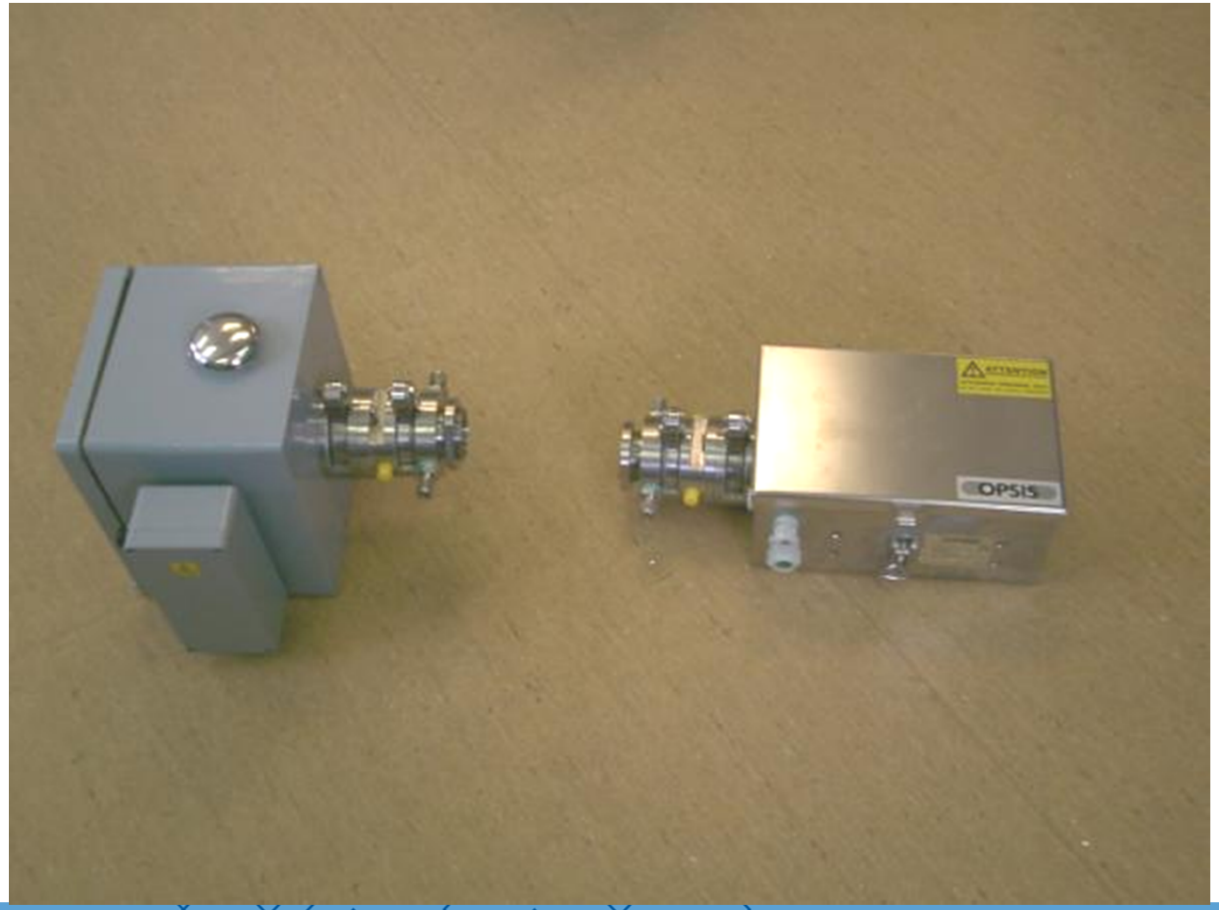
- One analyser
- Fast response
- No heated cable
- No cooling
- Only fiber optic cable needed

Solution

- In-situ installation (no contact with the highly corrosive smoke)
- Slight overpressure to protect lenses
- One analyzer for all gases

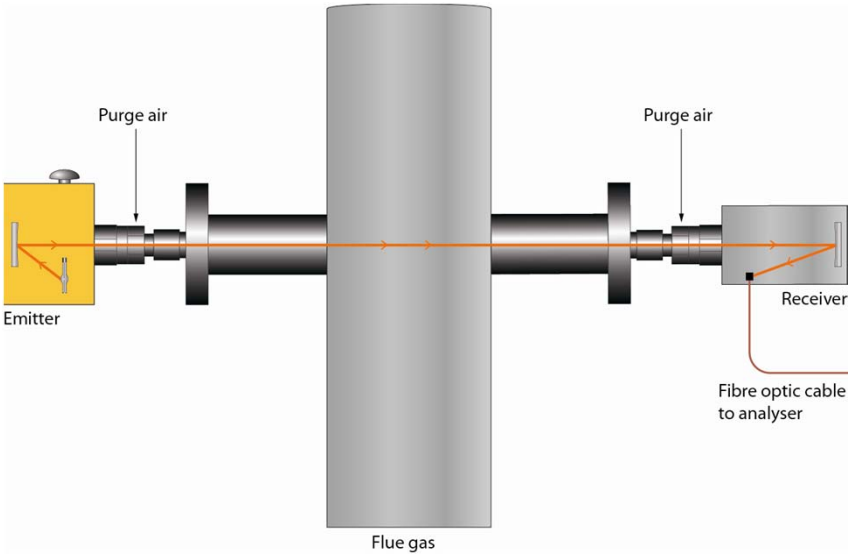


Emitter/receiver



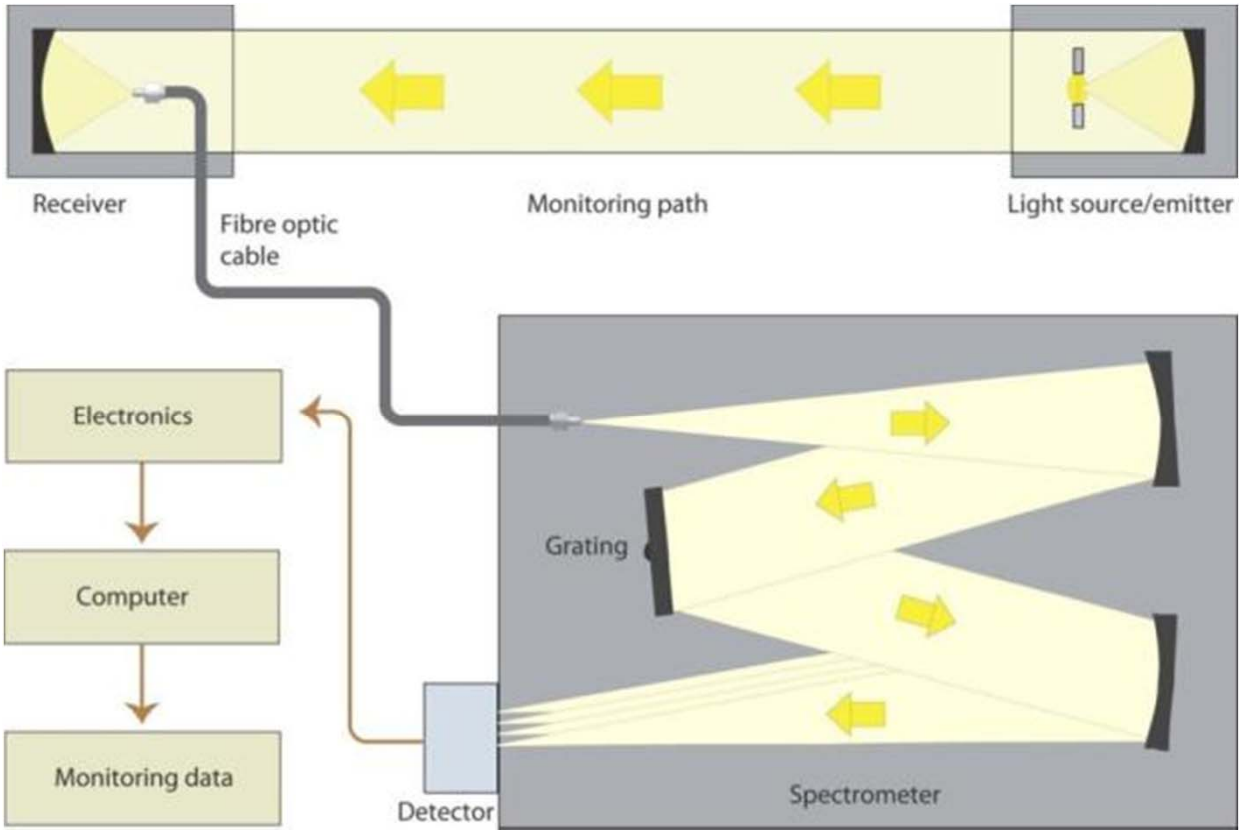
- 1.5“ pipe sockets
- Compact size
- No electronic parts
- Industrial design

Specifications

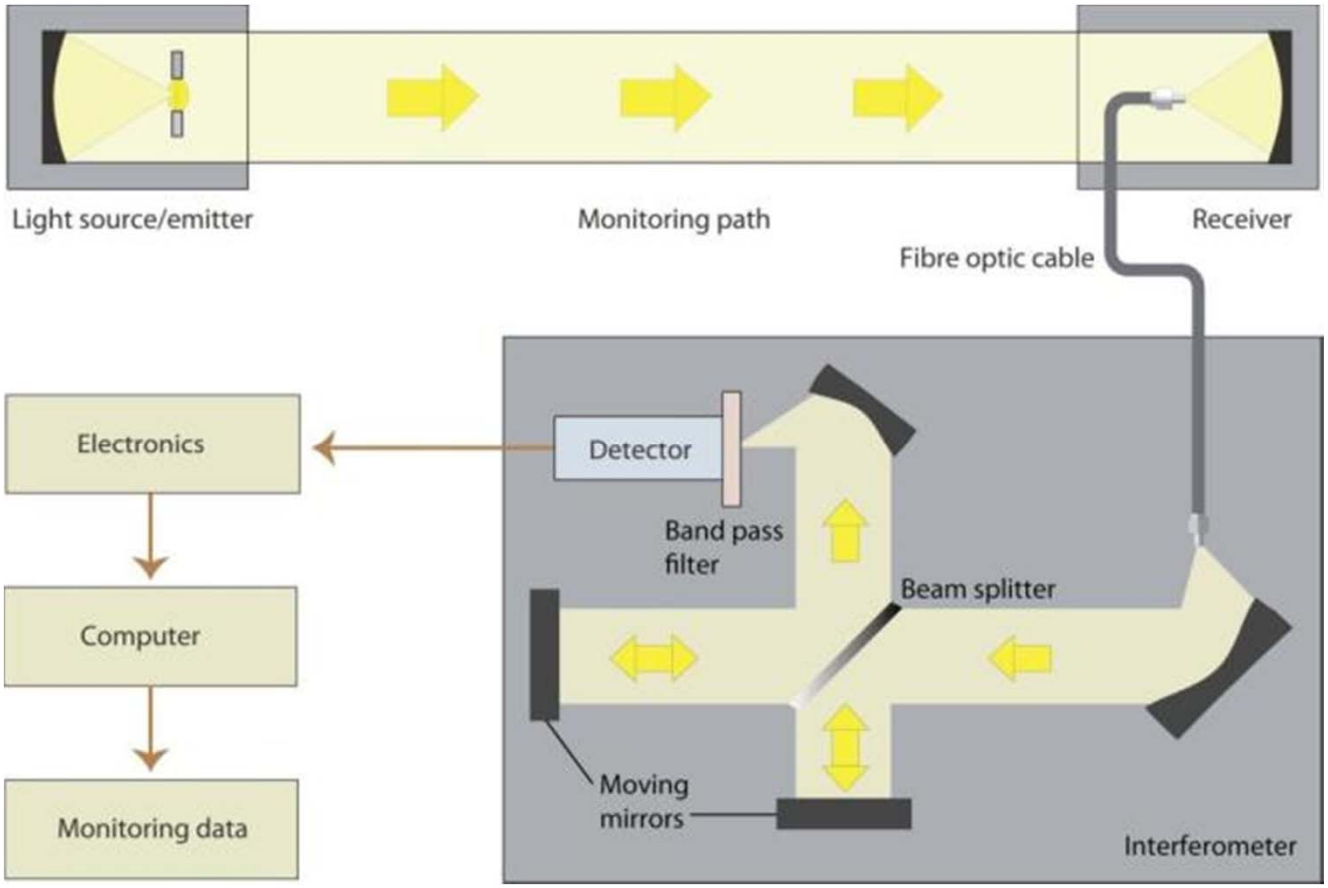


- Dimensions (W x D x L): 600 x 800 x 2140 mm
- Weight: 250 kg
- Power consumption: 1,5 kW (standard setup)
- Voltage supply 230 V (+6%-10%) / 115 V (10%) 50/60Hz
- Ambient temperature: 0 to +55 C

UV DOAS Technique

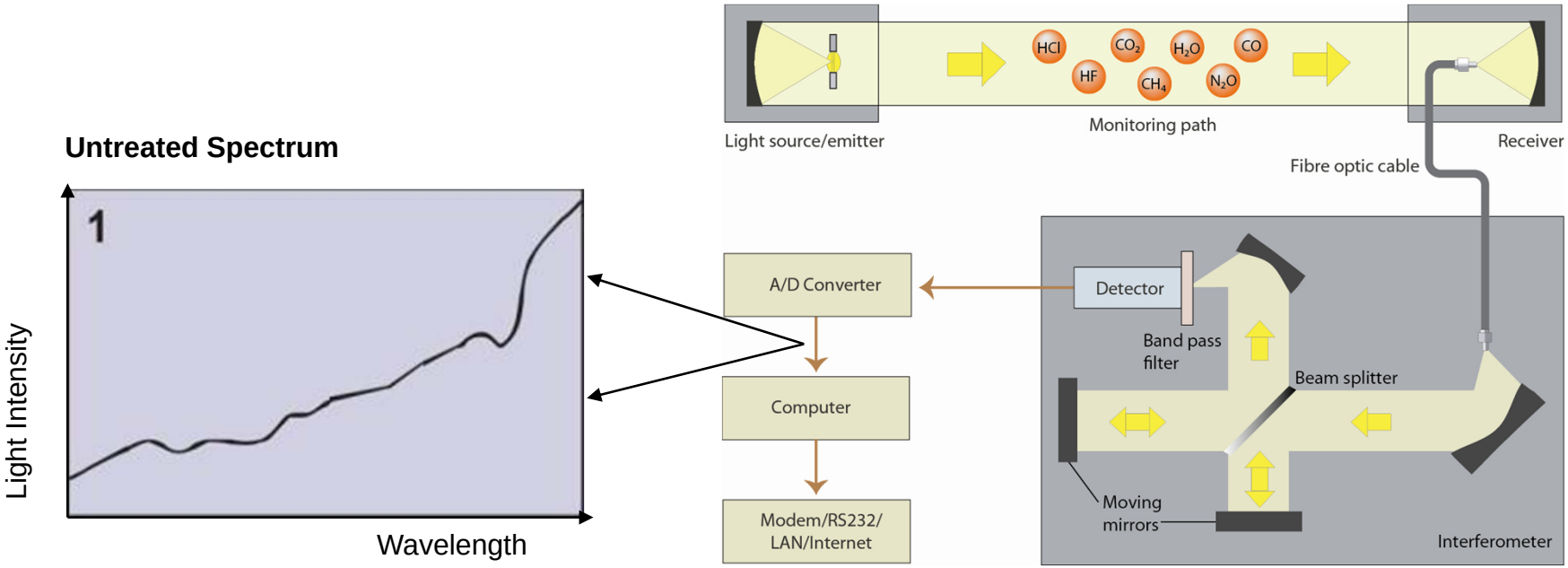


IR DOAS Technique



DOAS Technique

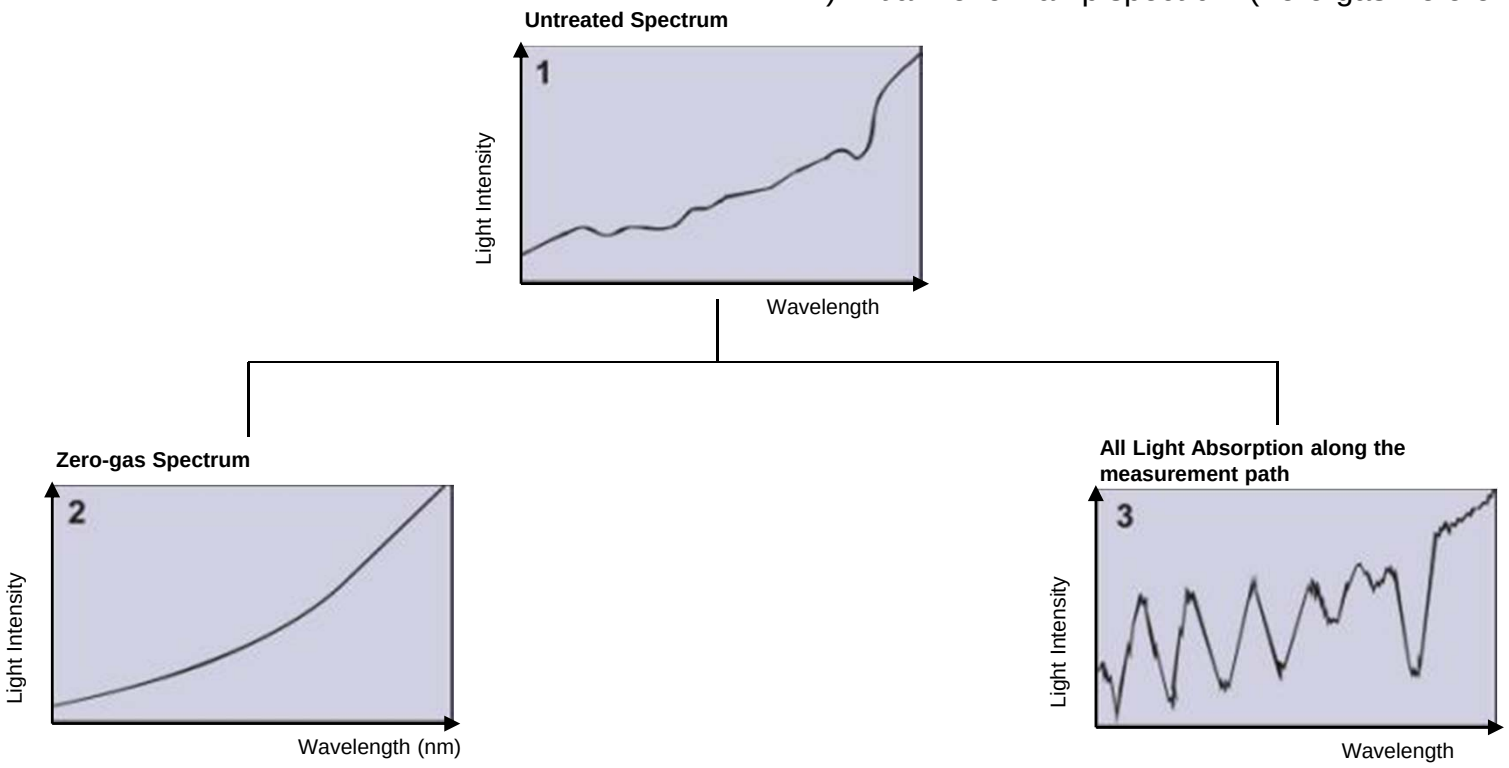
Once the light signal is converted into digital signal, it is stored as the **Untreated Spectrum**.



DOAS Technique

The Untreated Spectrum is made of 2 factors:

1) All light absorption along the measurement path.
2) Initial Xenon lamp spectrum (Zero-gas Reference Spectrum).

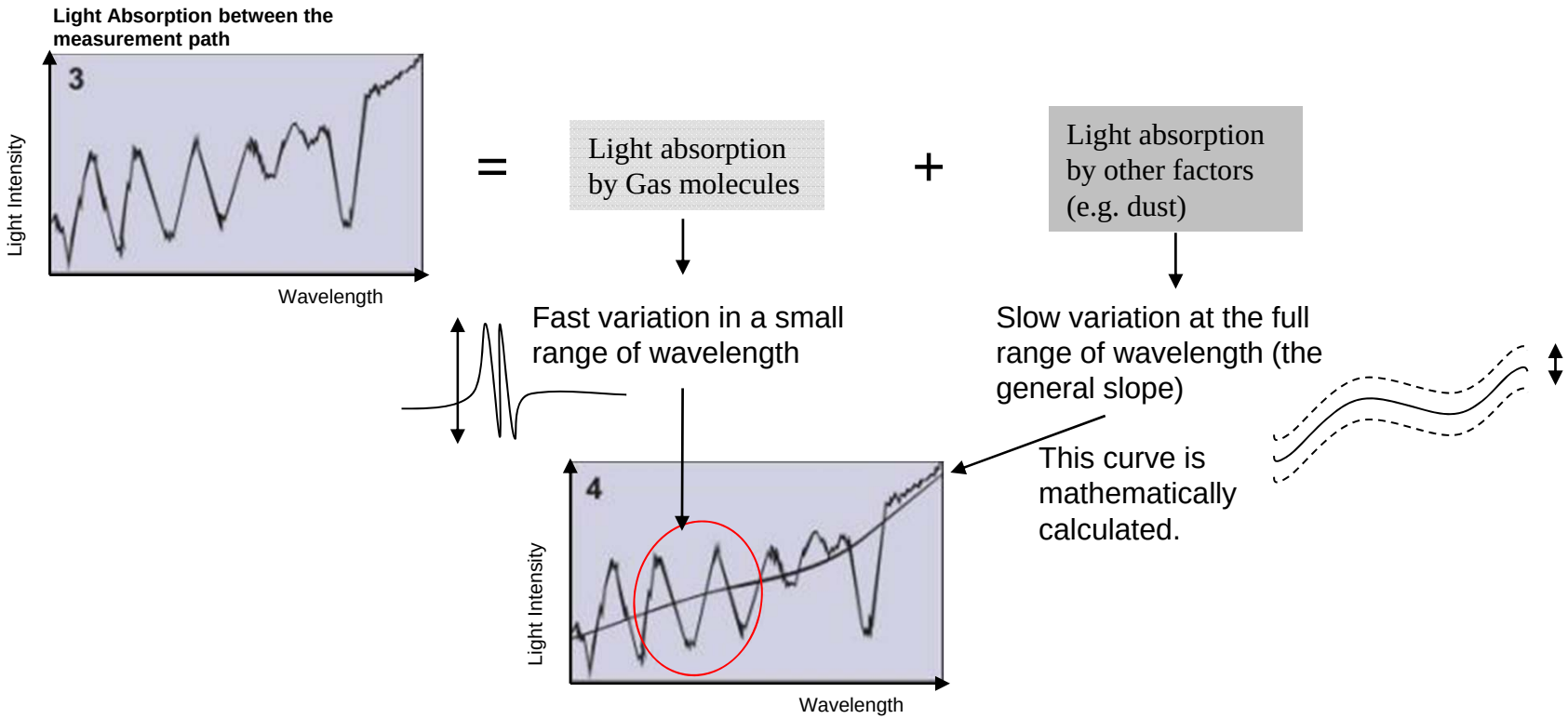


Zero-gas reference spectrum is previously recorded with no absorption gases presented.

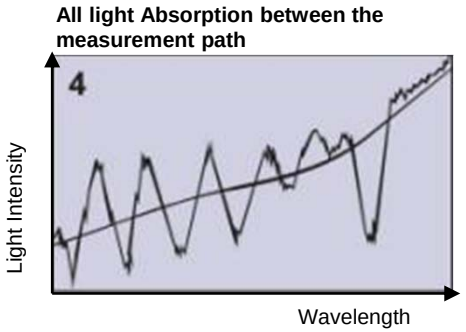
All light absorption along the measurement path is obtained after the Untreated Spectrum is divided by the Zero-gas reference spectrum mathematically.

DOAS Technique

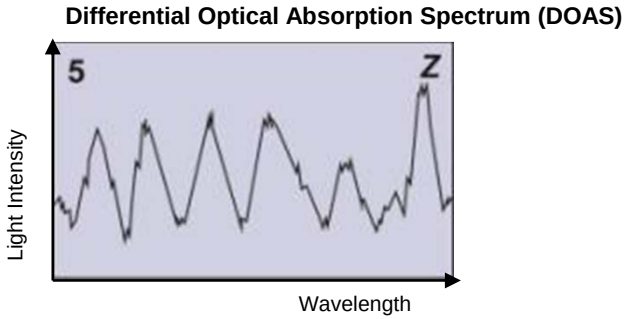
However, this result is caused not just by the gases that are present, but also by other factors such as dust, water vapour, etc.



DOAS Technique



By Calculation



By dividing the spectrum with the calculated slow variation curve, the effect of the non-gas molecule absorption can be eliminated completely.

The resulting curve is known as the Differential Optical Absorption Spectrum (DOAS), which represent absorption from all gases.

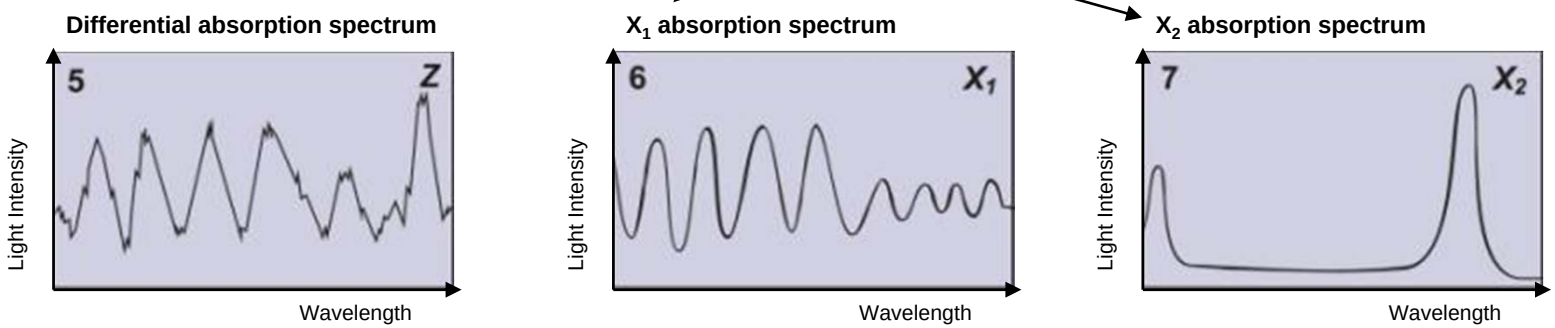
The task now is to identify the concentration of different gases present.

DOAS Technique

By the experience of OPSIS, the number of gases that absorb light in this wavelength range are already known.

The pre-recorded reference spectrum for each gas is also stored in the computer's memory.

In this example there are only two gases, called X_1 and X_2.

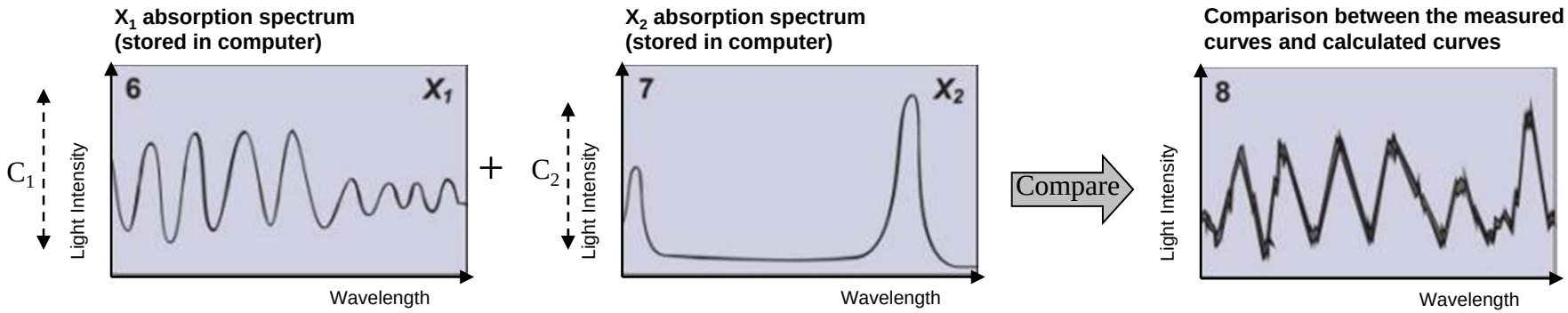


The task now is to determine the proportions of X_1 and X_2 that combine to give the best match for curve Z.

DOAS Technique

The computer uses a equation as equivalent as:

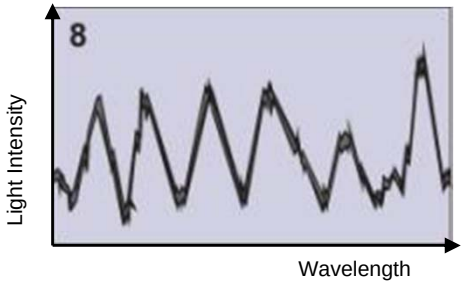
$C_1 X_1 + C_2 X_2 = Z$, where C_1 and C_2 are the proportions of each gas.



C_1 and C_2 are varied until the best correspondence is achieved, then it is possible to calculate the concentrations of X_1 and X_2.

DOAS Technique

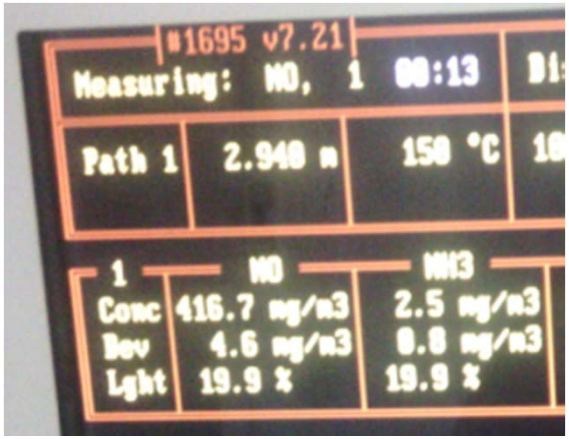
Comparison between the measured curves and calculated curves



C_1, C_2

Calculations

Dev 1, Dev 2



The result of C1 and C2 are mathematically converted to their corresponding gas concentration.

The accuracy of this result can be checked by calculating the deviation of each gas, which is the difference between the measured curves and the calculated curves (the grey area in the above spectrum).

The less deviation, the more accurate result is.

In general, the more reference spectrum stored in the computer's memory, the more accurate the result of the calculation will be.

Consilium

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