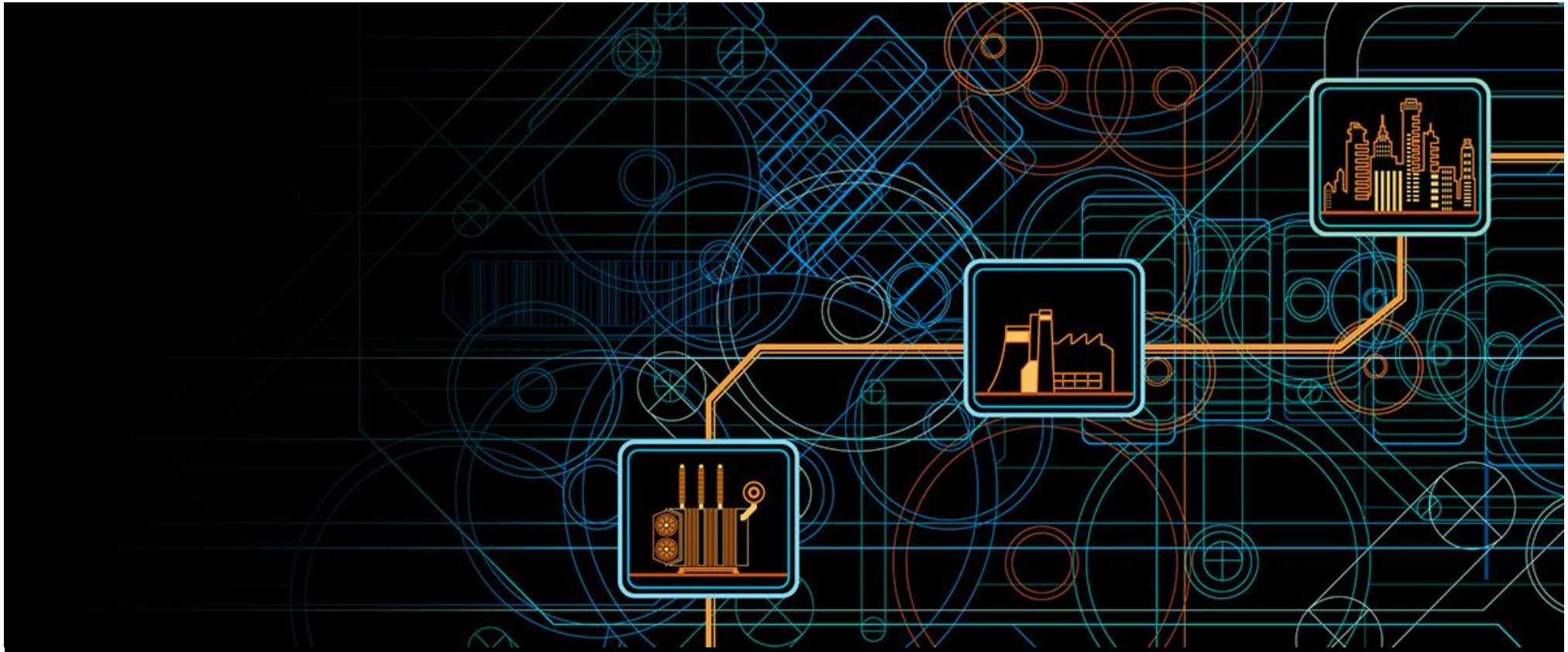
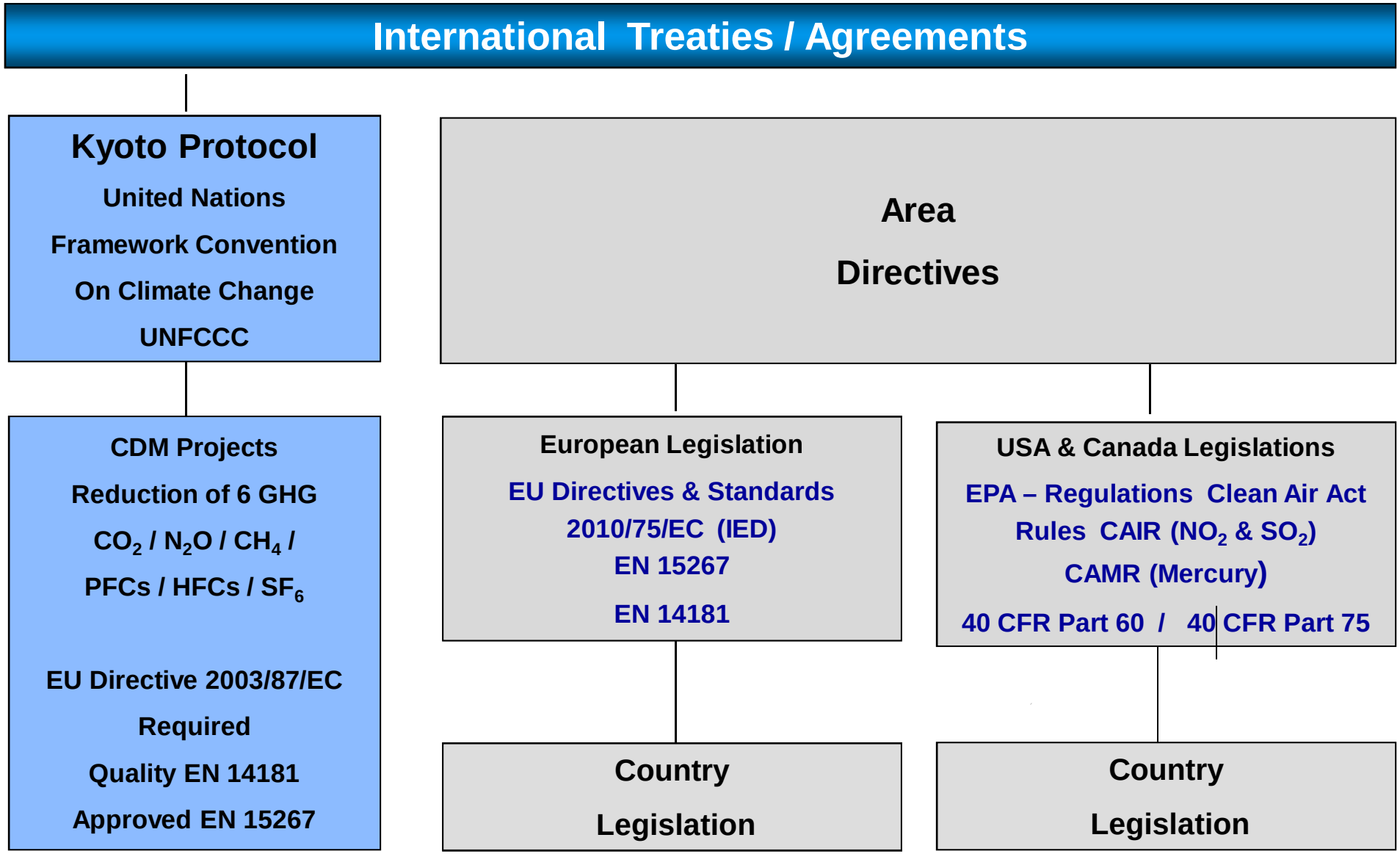


Tejbir Singh, MPPCB Regulator‘s Workshop 5.07.2017

Calibration of Gaseous CEMS

Regulators Perspective

Legislations
Air Pollution Control



EN 15267 • Type Approval for CEMS in Europe

Approval for **A**utomated **M**easuring **S**ystems (**AMS / CEMS**)

- Performance Tests
  - Laboratory tests
  - Field tests
- Requirements
  - 2 systems have to run in parallel
  - Must comply with the requirements of the EN 14181
  - Provides the basic data for the quality assurance standard EN 14181 (QAL1 / QAL3)
  - Comparison against Standard Reference Methods (SRM)

European Committee for Standadization

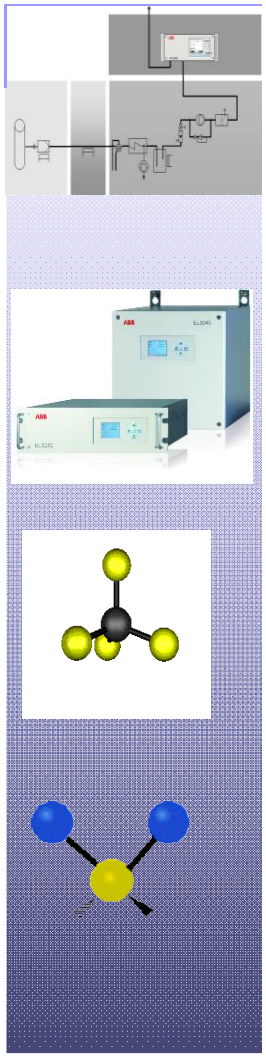
Characteristic	Performance criteria - Europe	
Test item	Field	
	Gaseous Pollutants	O_2
Response time	≤ 200 s ≤ 400 s for HCl, NH_3, HF	≤ 200 s
Linearity error (Lack of fit)	≤ 2 % of range	≤ 0,2 % Vol%
Zero drift & Span drift	≤ 3 % (maintenance interval)	≤ 0,2 Vol % (maintenance interval)
Reproducibility	≤ 3,3 % of range	≤ 0,2 Vol%
Availability	≥ 95 %	≥ 98 %
Min. maintenance interval	≥ 8 days	≥ 8 days
Cross - sensitivity (Interfer. gases)	≤ 4 % of range	≤ 0,4 % Vol%

Performnce critera needs to be fulfilled in detail

EU CEMS Calibration - EN 14181
The three QALs and AST

QAL 1	Confirms the suitability of an CEMS for the measuring task according to EN 15267-3 and EN ISO 14956	**Manufacturer Declaration**
QAL 2	Calibration procedure of an CEMS after commissioning with **S**tandard **R**eference **M**ethods (**SRM**) Determination of variability & comparison with required *Uc*	**Certified Body EN ISO 17025**
QAL 3	**Ongoing quality assurance during operation.** **Regular control of Drift and Precision of the CEMS**	**Responsibility of Plant Owners**
AST	Annual Surveillance Test Yearly check of an CEMS	**Certified Body EN ISO 17025**

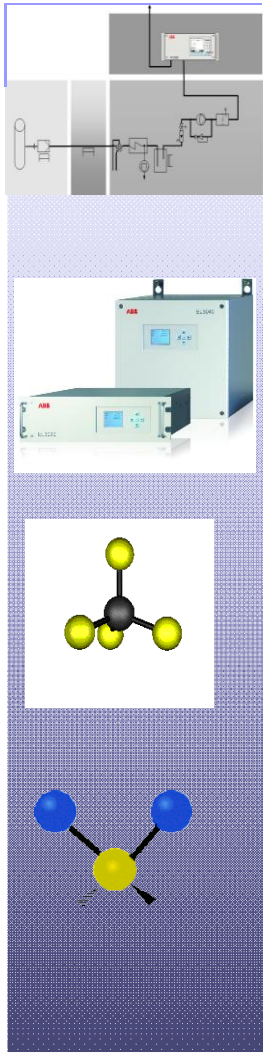
Continuous Gas Analysis – Extractive
Terminology - Adjustment



Adjustment

- Why – Aging, Dust, Moisture, etc numeration operation effects
- Compare the measuring values at the zero point and reference point against a reference material
  - Check during normal operation
  - Carrying out an adjustment of the analyzer / CEMS
    - For CEMS minimun 1 times the certifed maintenance interval
  - Take action if any deviation shown
  - Can be conducted
    - Manually by the operator
    - Running automatically

Continuous Gas Analysis – Extractive Operating Terminology - Validation



Validation

- Compare the measuring values at the zero point and reference point against a reference material
  - Check during normal operation
  - No adjustment of the analyzer / CEMS (Compare and record)
  - Take action only if out of the pre-set limits (e.g. QAL3)
  - Can be conducted
    - Manually by the operator
    - Running automatically

EN 14181
Calibration versus Adjustment

- European regulations strictly separates calibration from adjustment of a measuring system

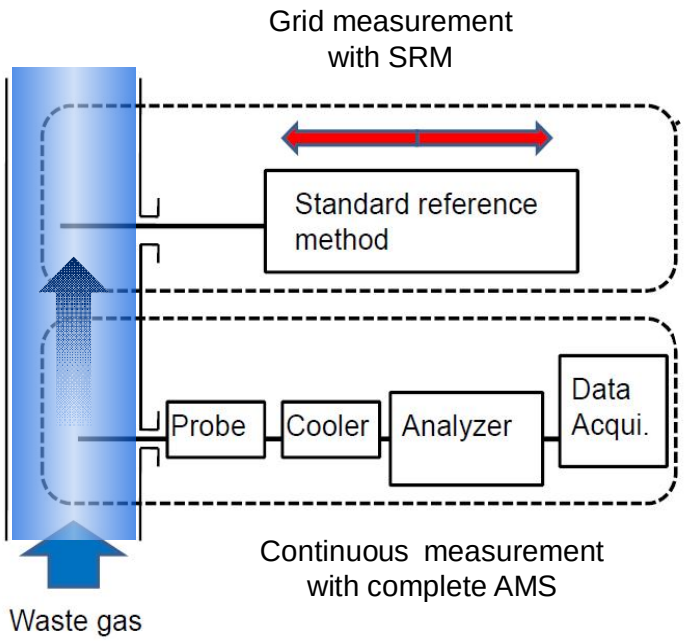
- Calibration

  of any CEMS by means of parallel measurement with a Standard Reference Method (SRM) by a test laboratory accredited according to EN ISO 17025

- Adjustment

  of an CEMS with reference material is done by the operator (or automatically by the CEMS)

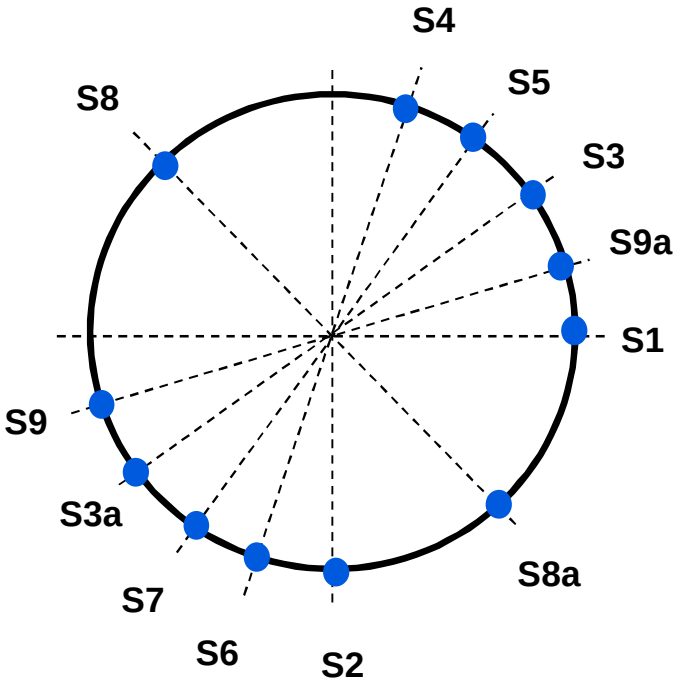
Continuous Gas Analysis – QAL2 as per EN 14181
Terminology – Calibration of CEMS



Calibration

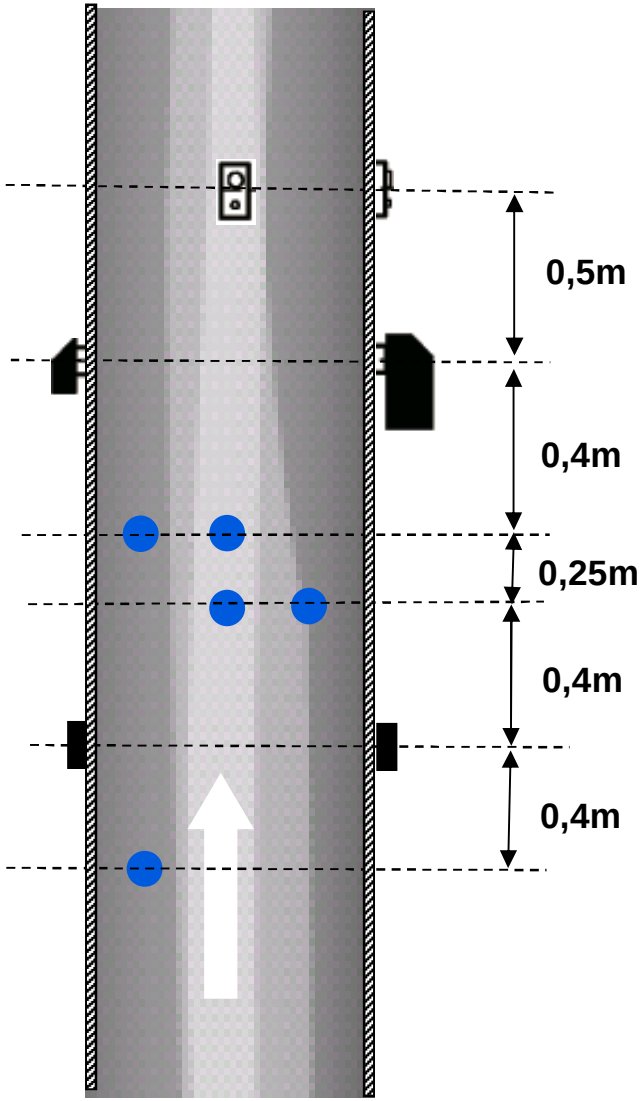
- Carrying out an parallel measurement with a Standard Reference Method (SRM) against the values obtained from an CEMS
- Conducted by an accredited test laboratory
- In Europe test laboratories needs to be accredited according to EN ISO 17025 when testing for CEMS)

Mounting Locations of Measuring Systems
Within a Measurement Section at a Stack



S1…9 Measurement Ports at 6 measurement planes

Top View



Front View

Reference Method (S1 / S2 / S5)

Dust (S3 / S3a)

AMS SO_2 / NO / O_2 / HCL / VOC (S4 / S6)

Volume Flow (S8 / S8a)

Temperature / Pressure (S9 / S9a)

Continuous Gas Analysis – Extractive Operating Terminology – Reference Materials

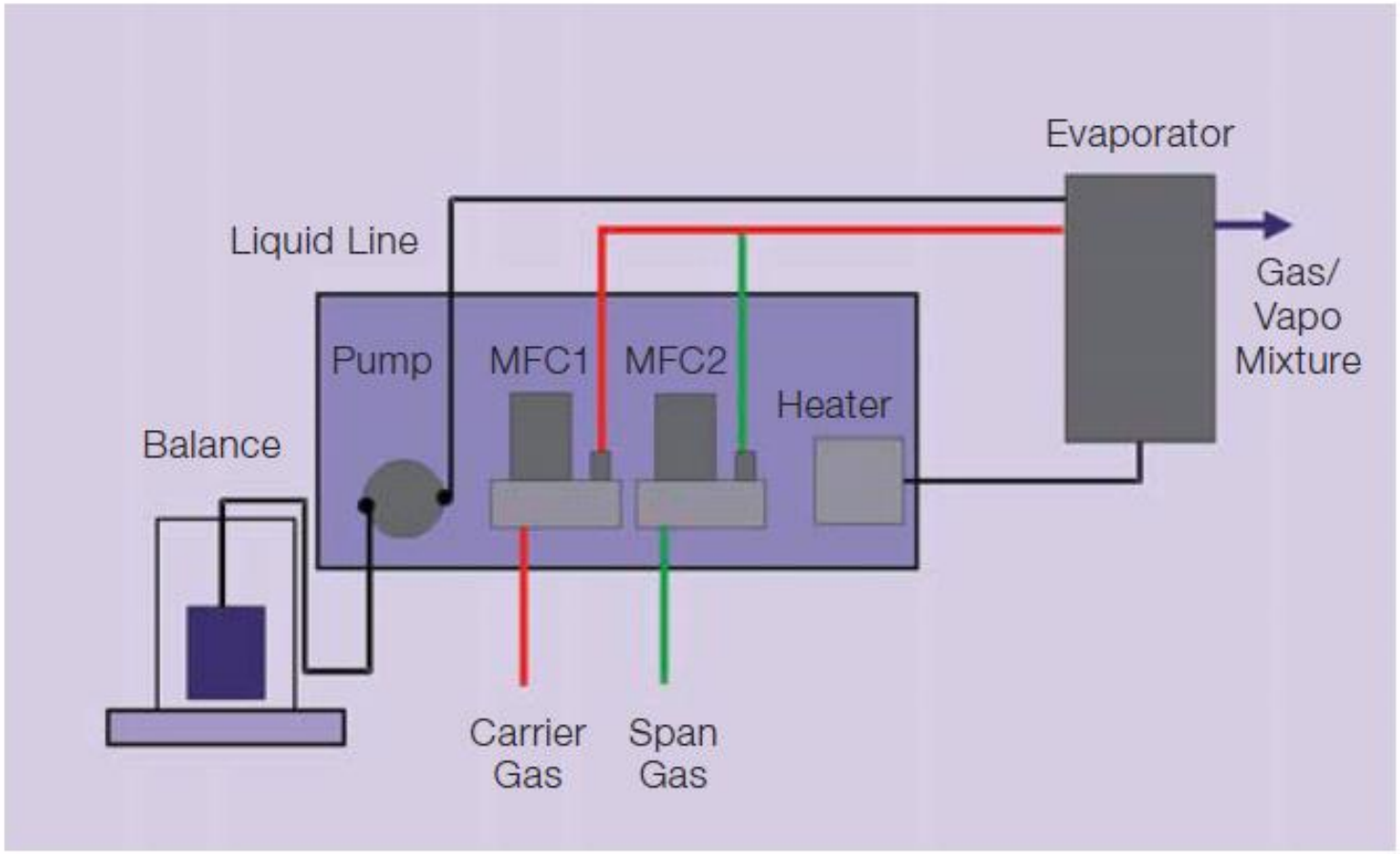
Adjustment cell IR-Anaylzer

Adjustment cell UV-Analyzer

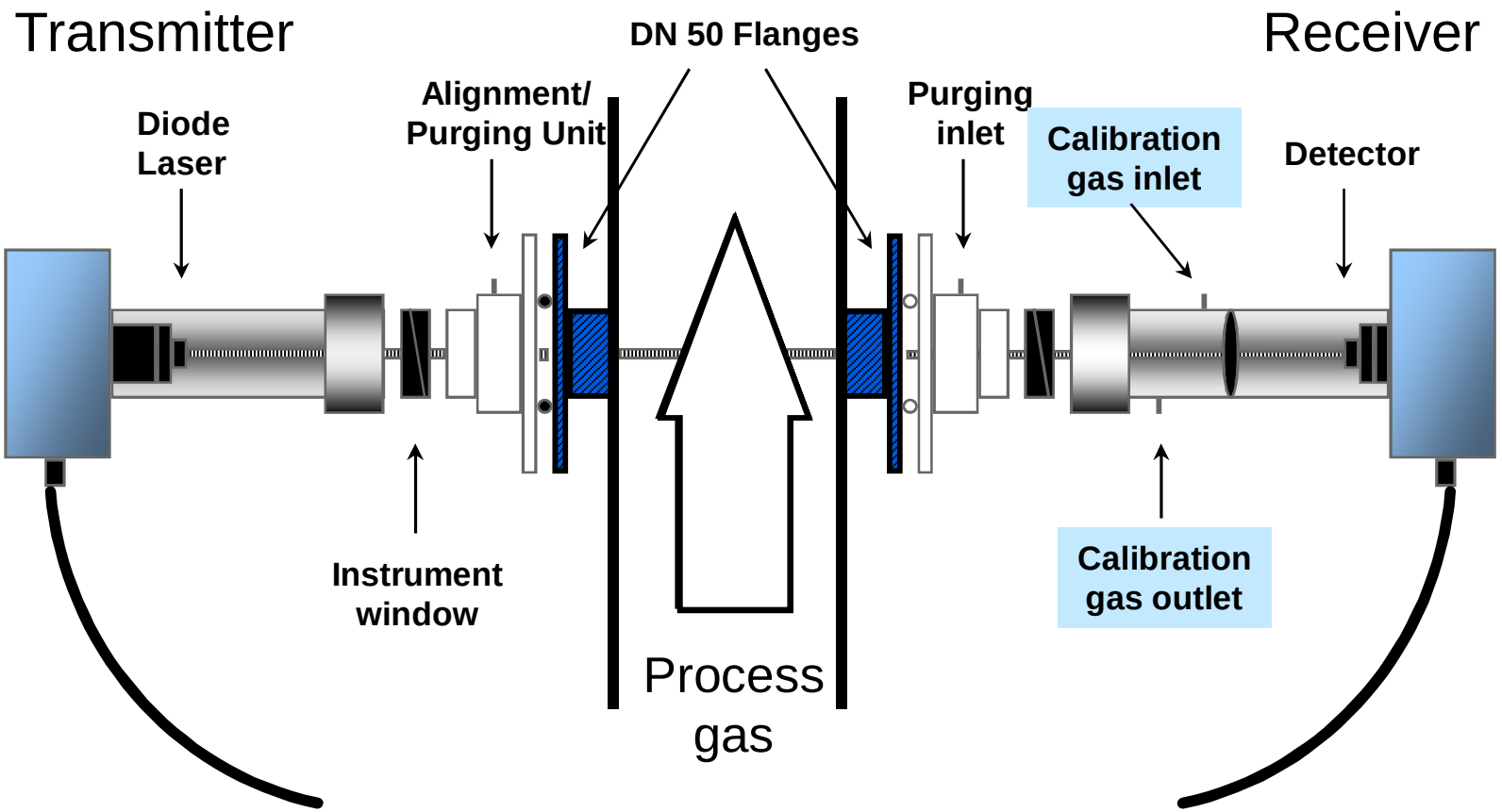
Suitable Reference Standards

- Analyzer internal facilities
  - Gas filled adjustment Cells / Cuvetts
  - Optical filters
- Following mediums
  - Cylinder Test Gases
  - Evaporization
    - Water measurements
    - Components not available in test gas cylinders

Hot / Wet Measurement • FTIR - Water Calibration
HovaCal Supply Unit eg. HCL, NH3, HF, etc

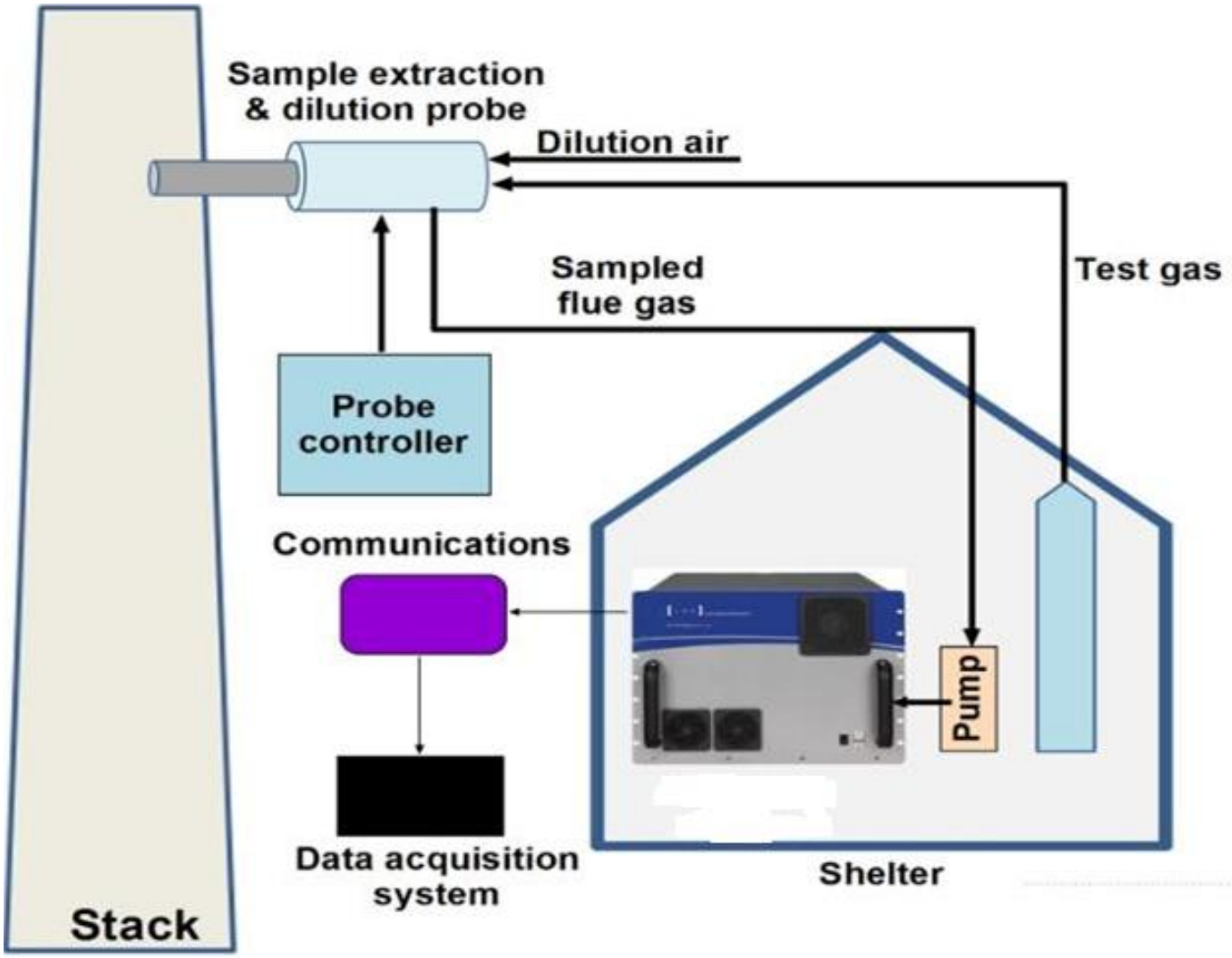


Lazer Analyzer Details
Calibration / Validation Check

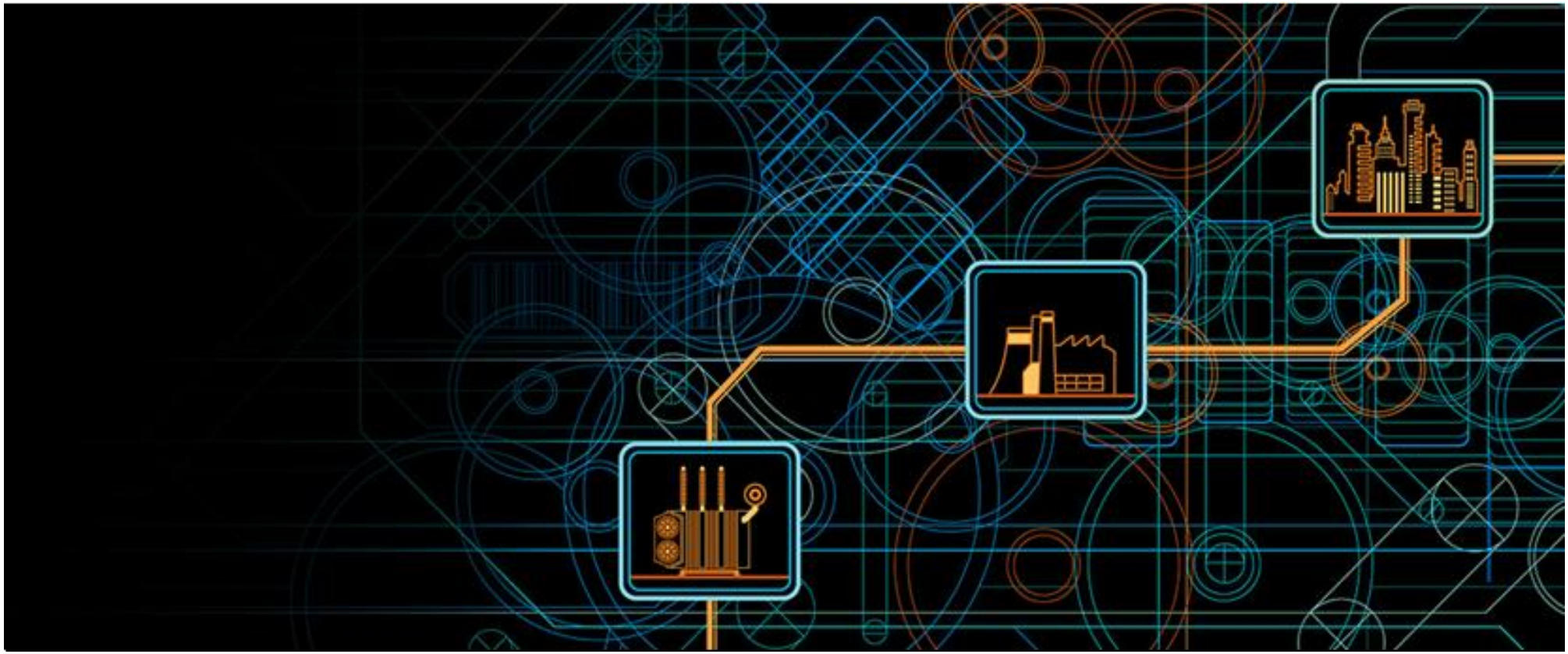


Calibration: Remove the Analyzer on to a Jig with Path length Cell to calibrate with Cal Gases annually.
However, Online Validation using built in Cell is done online

Dilution CEMS
Basic Calibration arrangement

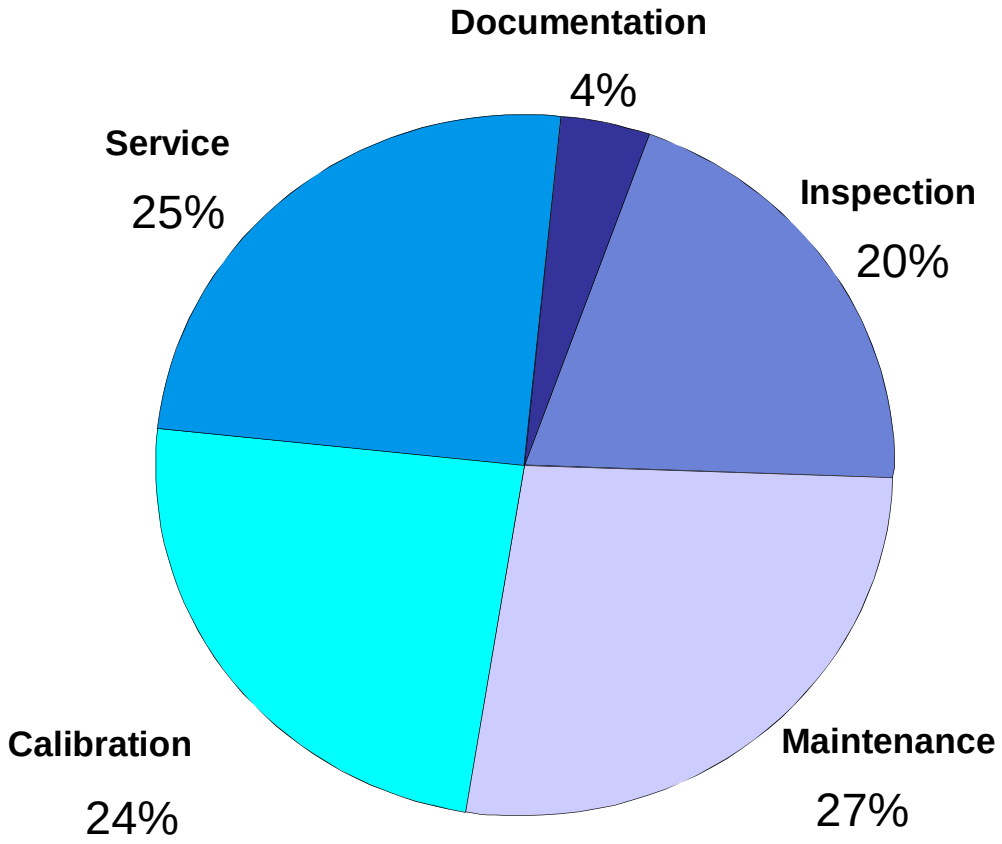


Calibration Gasses need to be passed all the way at the Probe



Calibration Concepts
Maintenance

Analyser Life Cycle
Cost Of Ownership

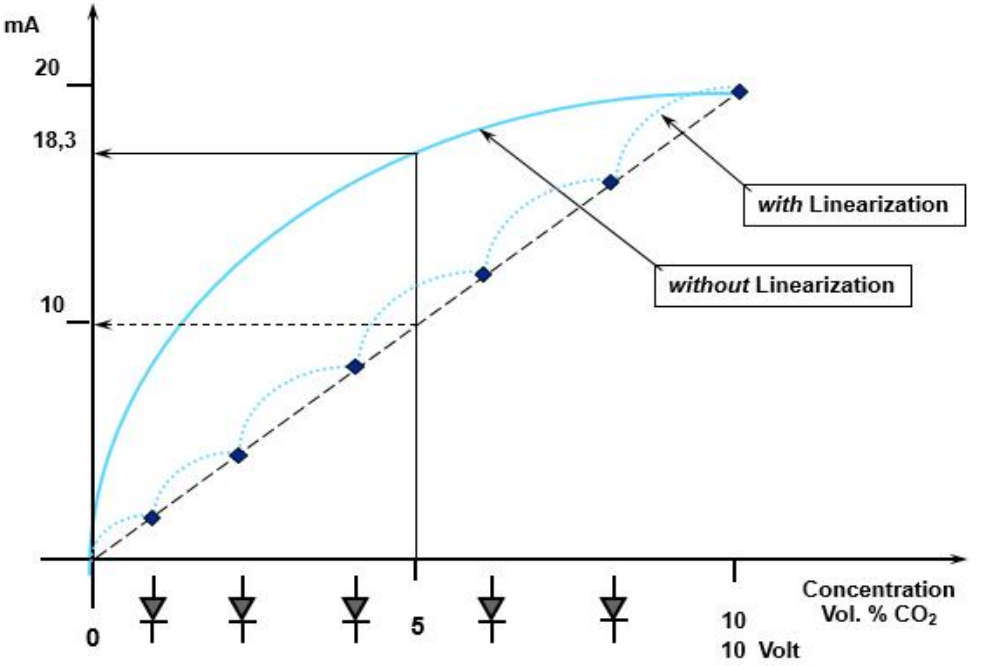


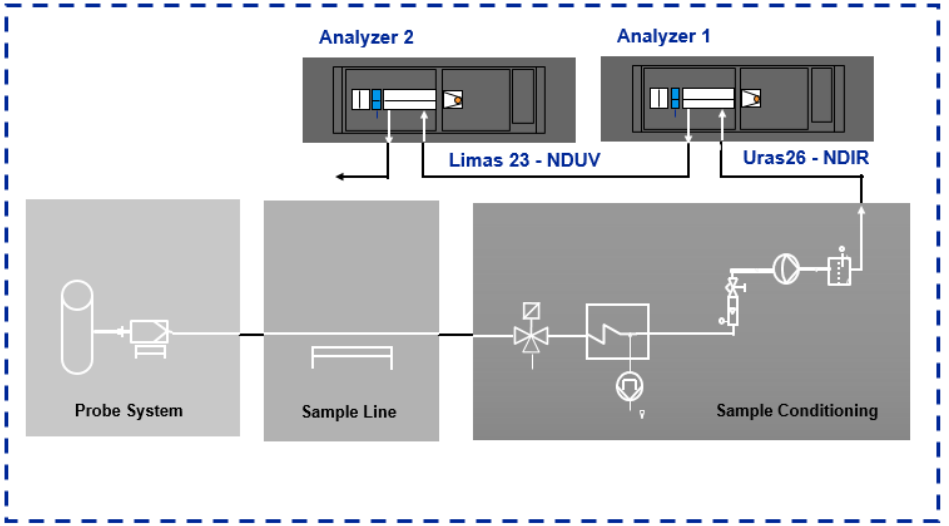
Lifetime consideration

- **1/3 = Device Costs**
  Purchase Price
- **2/3 = Operating Costs**

Source:atp

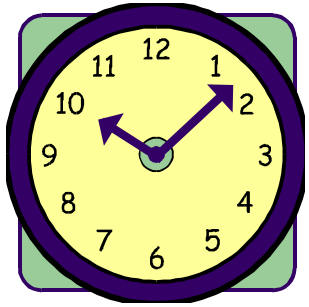
State of Art Analyser Calibration – Lab Calibration

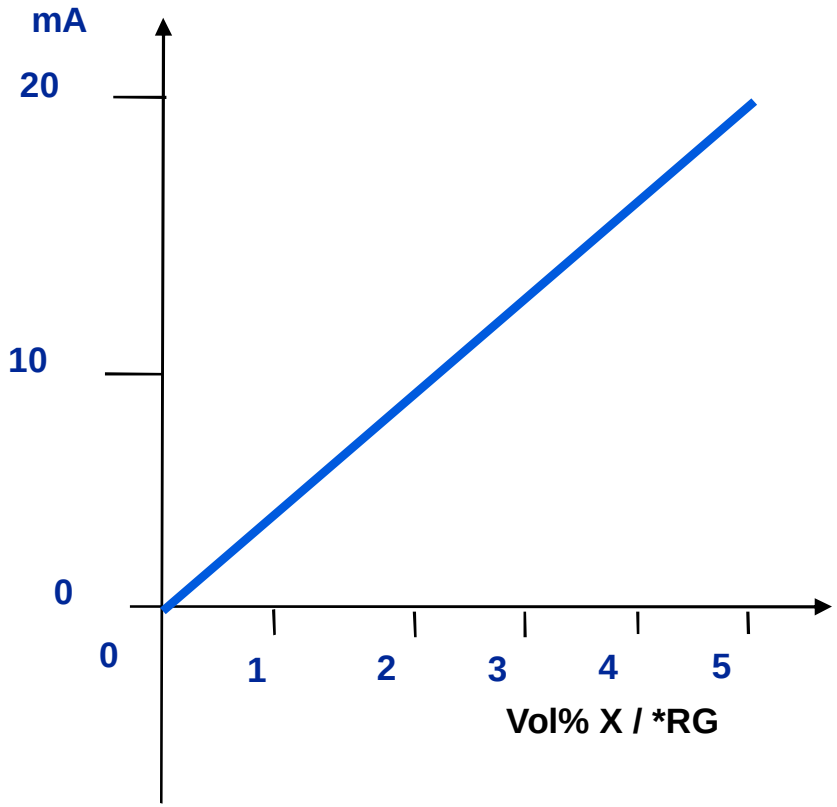


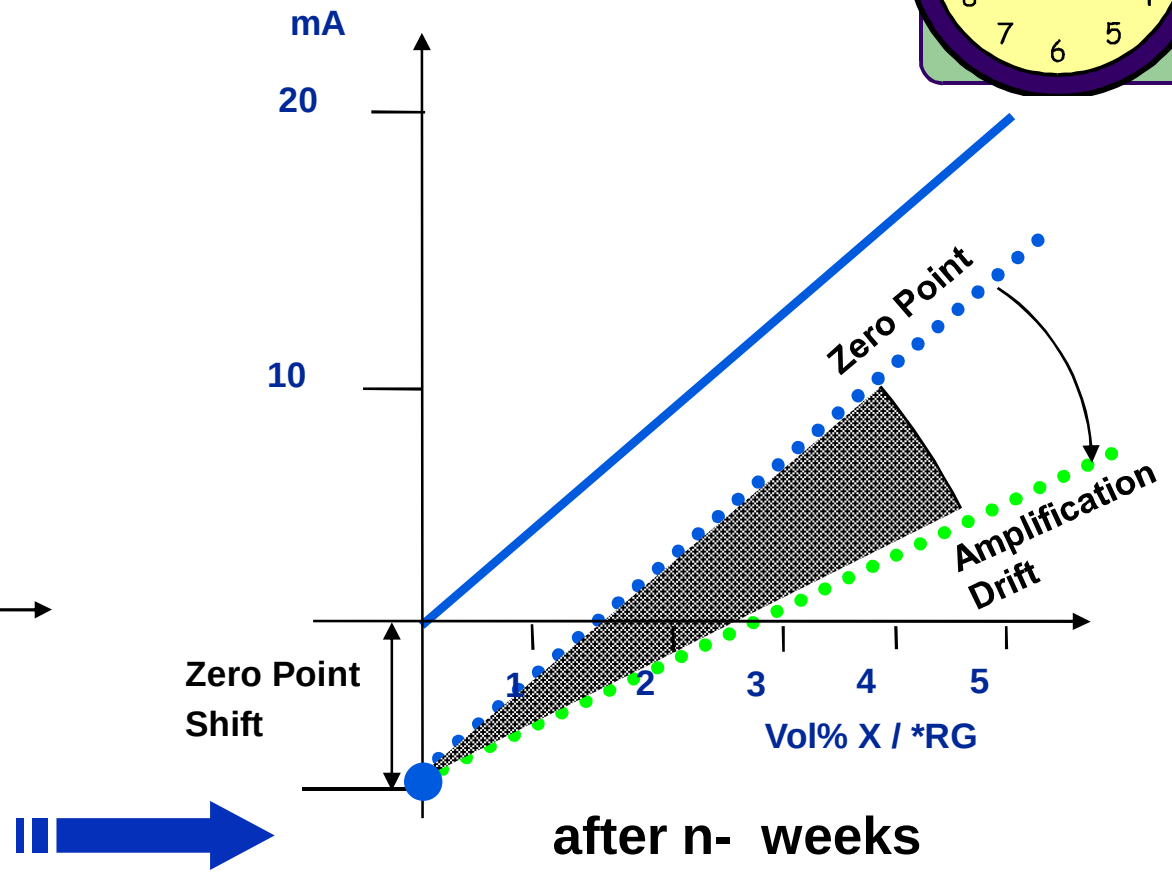


Calibration

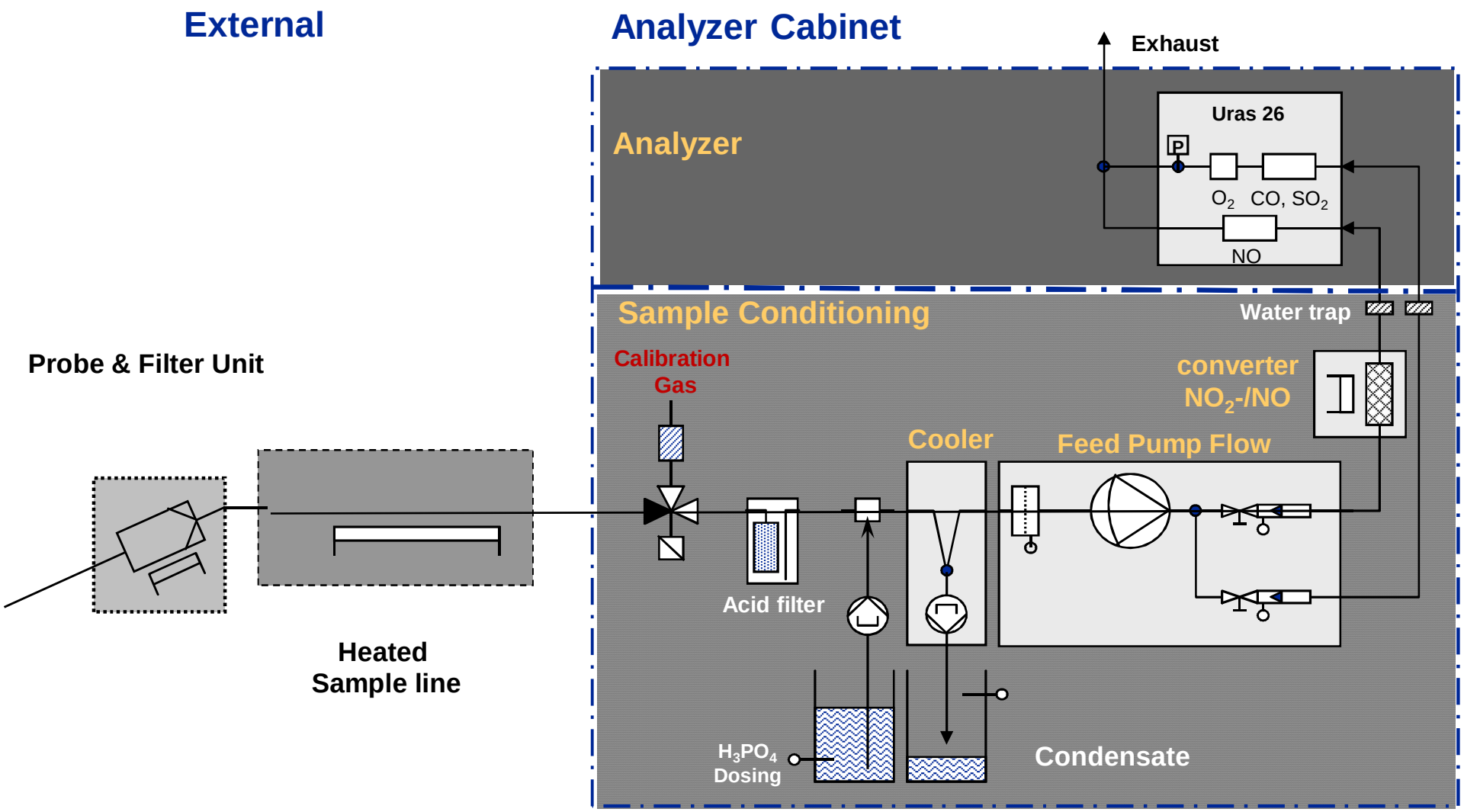
Read out after n- weeks
Typical Analyser







Automated CEMS
Cold dry extractive



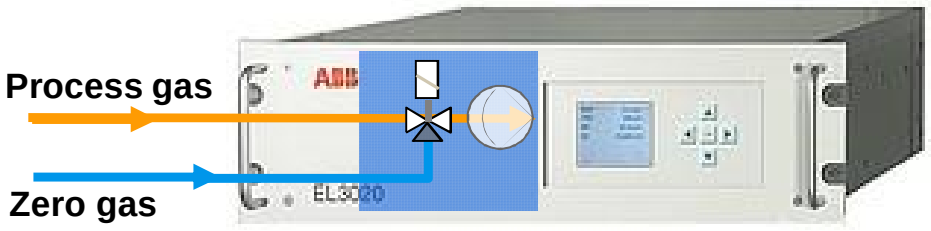
Auto Calibration
Solutions with test gases

Internal Auto-Adjustment

without test gases

- Paramagnetic
- NDIR with calibration Cells
- NDUV with Calibration Cells

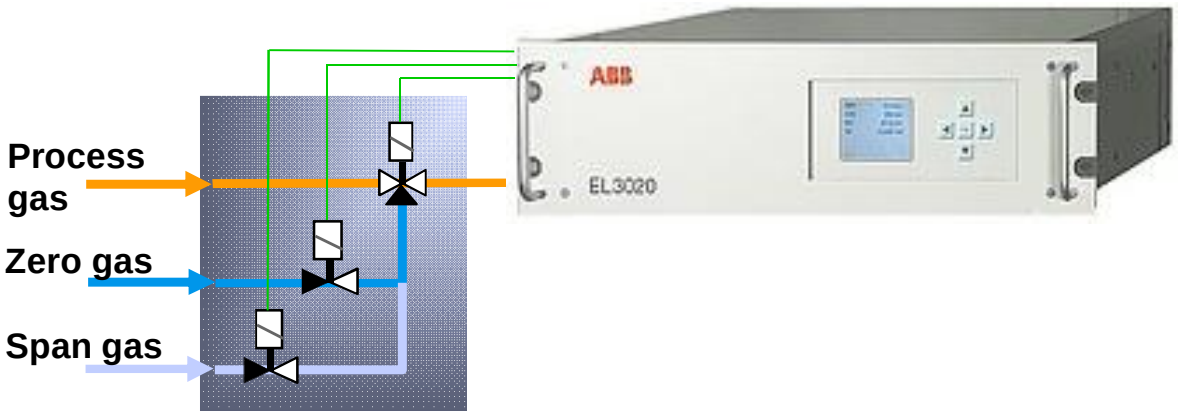
Internal gas feed with 1 solenoid and pump



Extenal Auto-Adjustment

- Para / NDIR / NDUV
- 3 solenoids for adjustment with test gases
- 1 solenoid for analyzer check without test gases

Up to 3 external solenoids, internally controlled



Cold / Dry extractive operating AMS
Span check with test gases

Medium

§ Set of span gases CO / CO_2 / SO_2 / NO	4 test gas cylinders

Procedure

§ Frequency (Automatically controlled)	1 time / week
§ Quantity of test gas required for 1 check	~ 20 l / component

Test gas comsumption per year

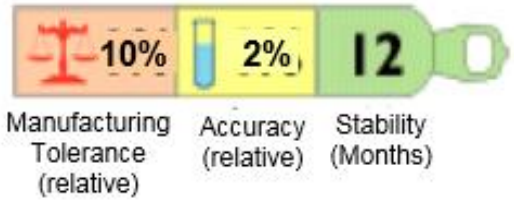
§ 20 l x 50 weeks = 1000 l / component	4 cylinders / year
§ Consider : Stability of test gases are limited	

Costs

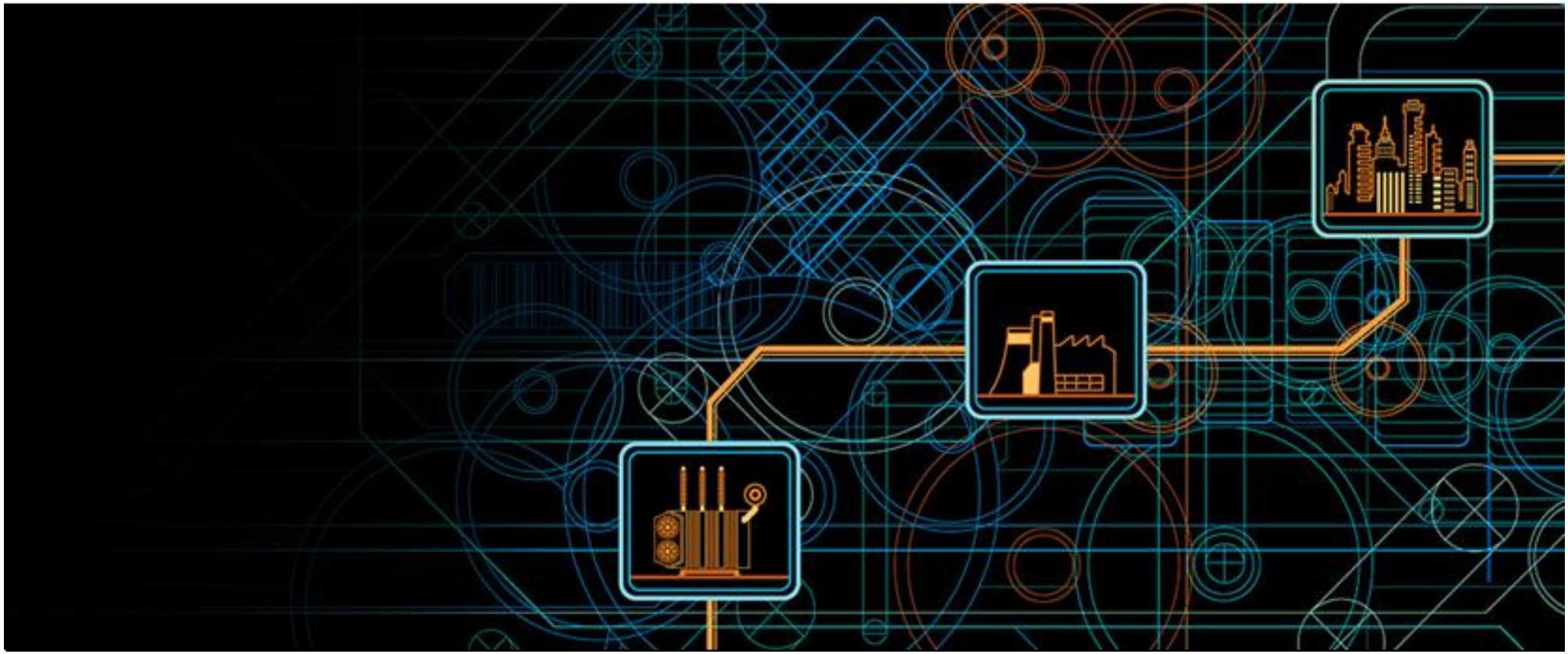
§ Test gas cylinders for 1 year operation	**2.000 € / year**
§ Labour for 1 year (if not running automatically)	**2.000 € / year**

Working with Cylinder Test Gases
General

- Stability - impacts
  - Cylinder material
  - Duration how long the gas mixture is stable
  - Storage temperature (e.g. decomposition)
  - Reaction of components with the internal wall of the cylinder
  - Adsorption with the internal wall
  - Instability of molcules under pressure (e.g. Nitrogen oxides)



- Accuracy classes
  - < 2% Definition scales
  - Class 1 Relative Uc 1 - 5% (gravimetric method)
  - Class 2 Relative Uc 2 - 5 %
  - Class 3 Relative UC 5 - 10 %



Calibration Concept using Cells / Cuvetts
QAL3

Adjustment without cylinder test gases
NDIR / NDUV Photometer

- **12 months maintenance interval certified by using internal adjustment cells**
- **Adjustment cells are standard**
  - IR Photometer
  - UV Photometer
- **Zero - point adjustment with N2 / Air**
  - IR Photometer
  - UV Photometer
- **No test gases required between two AST**

Unique QAL3 Functionality

- **Integrated QAL3 functionality according EN 14181 possible~**

- **Internal QAL3 - calculation**
- **Internal data storage for more than 1 year**
- **Comfortable operating and configuration via Web Browser**
- **Print-out of tables for reporting**
- **No loss of stored values in case of power supply failure**

- **Status information at the analyzer display in case QAL3 fails**
  - **QAL3 Limit** **“The calibration drift exceed the QAL3 limits“**
  - **QAL3 memory** **“The QAL3 memory is full. Please read out“**
- **Downloading of all stored data for further evaluation in spreadsheet tools like Excel**

Cold / Dry extractive operating AMS
QAL 3 span check with gas filled adjustment cells

Adjustment cell IR-Analyzer

Adjustment cell UV-Analyzer

Technology

- Gas filled adjustment cells with high tightness
- 1 cell for each measuring component
- High stability also for critical gases like NO and NO_2

Application

- State of the art technology for span point checks used for
  - IR & UV Photometers

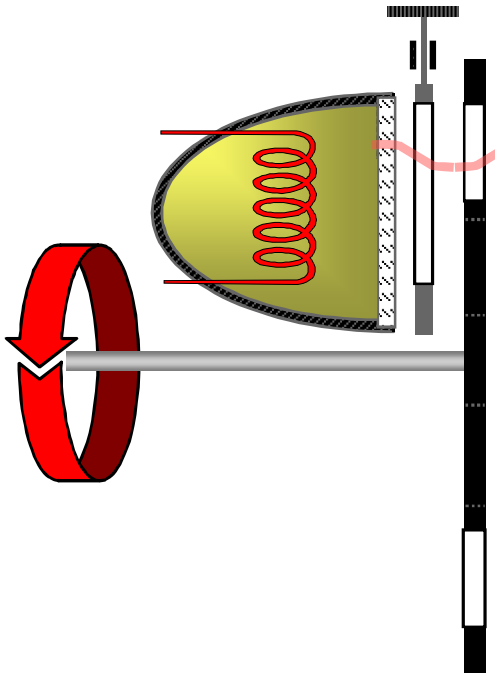
Savings

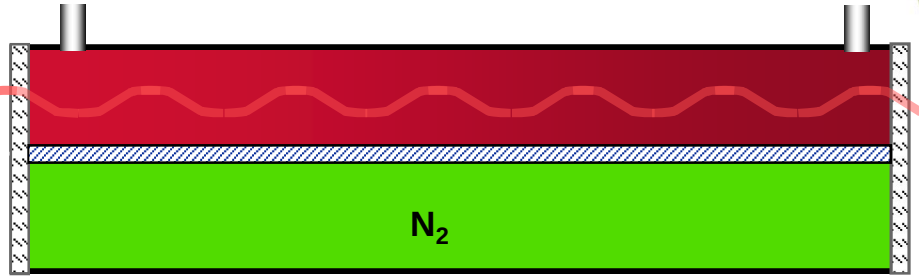
- Think above the life cycle of an AMS
- 10 year operation a` 2.000 €/y **20.000 € Cost savings**

Amortization time

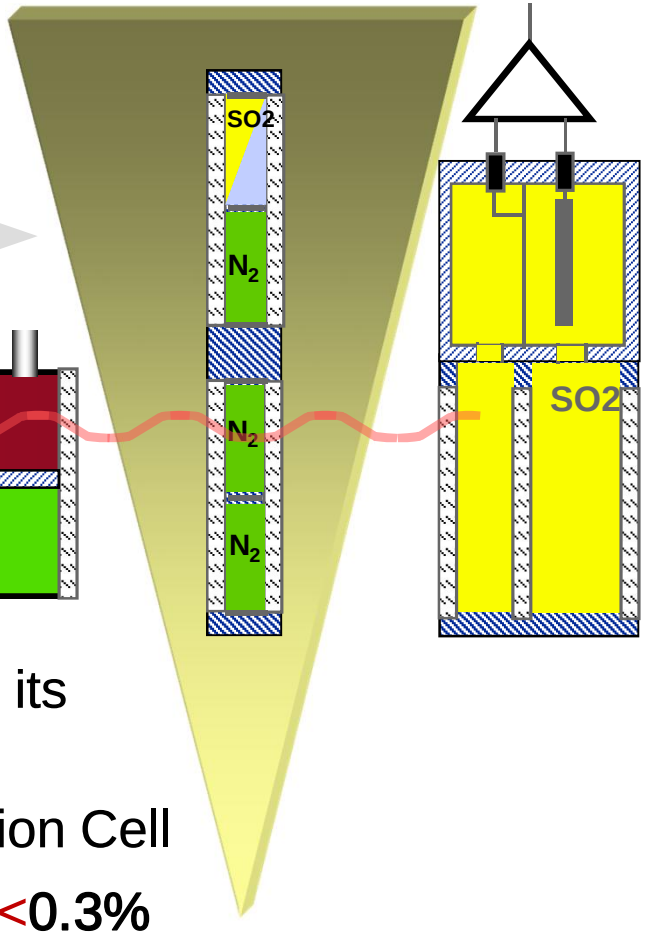
- 1 year

Calibration using Cells / Cuvetts



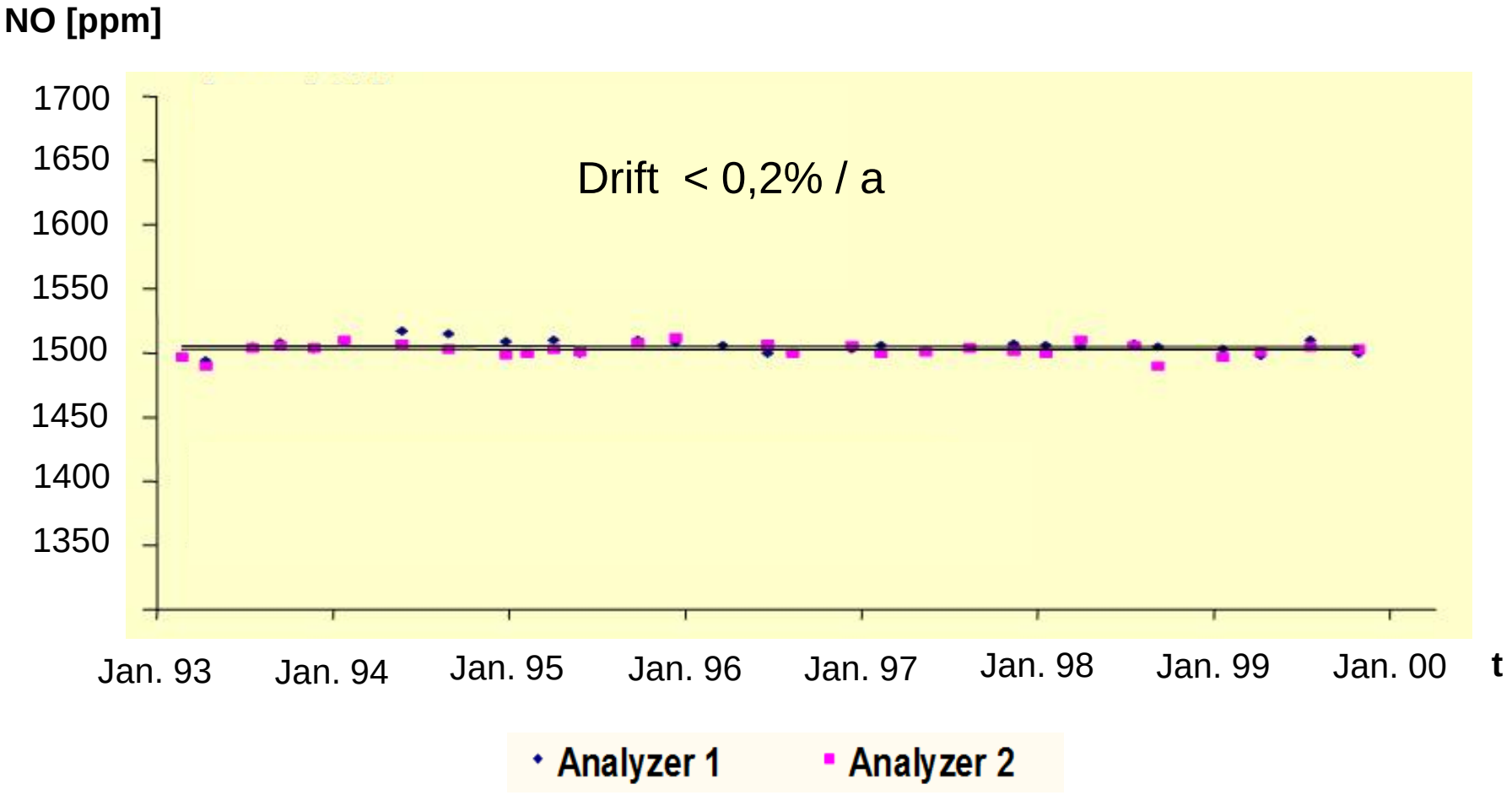


Calibration cell



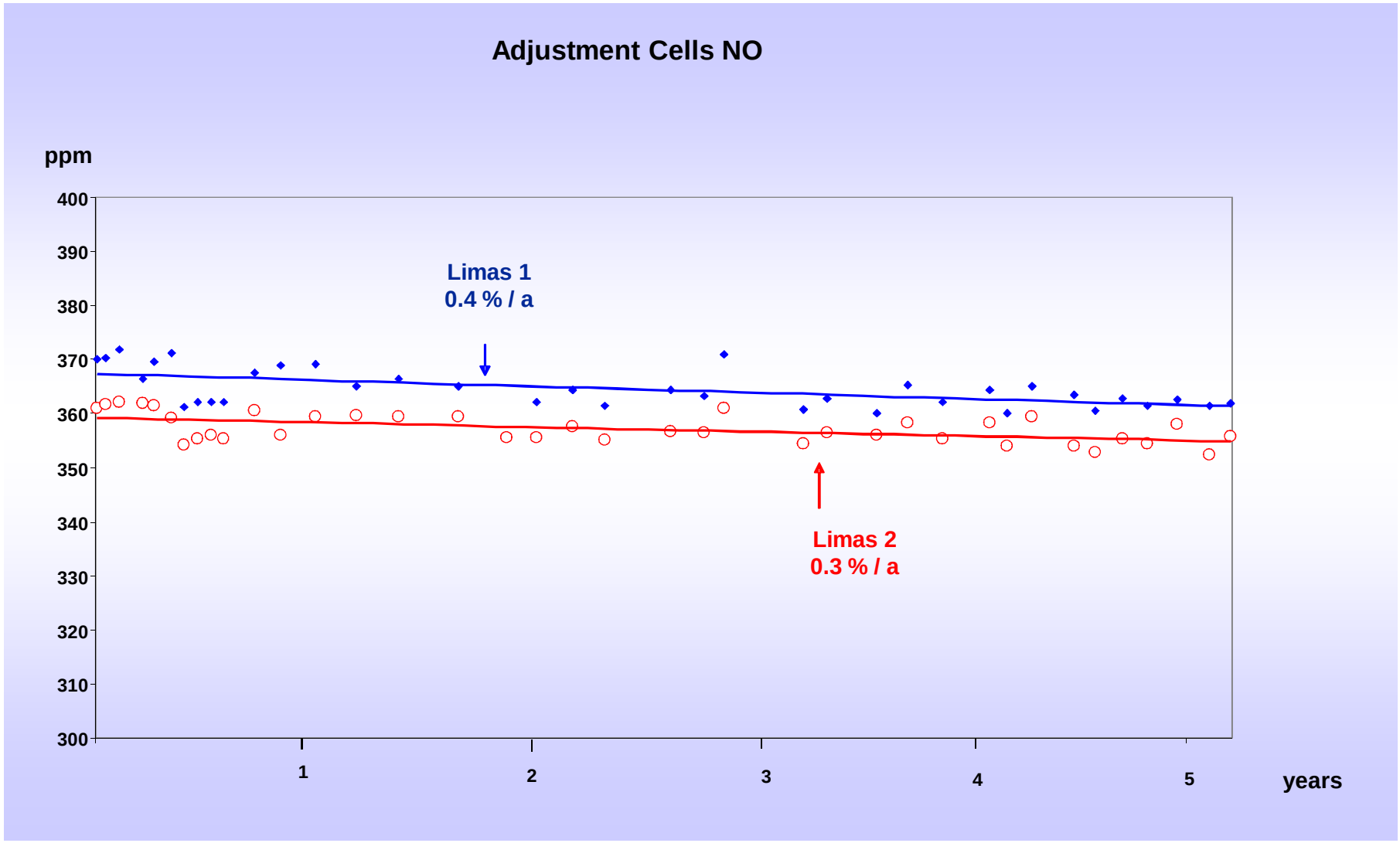
- Any Analyser is as accurate as its Calibration Reference !!
- TUV /MCERT Certified Calibration Cell
- Gas Filled Cell not Ambient Air <**0.3% drift per Year**
- Lower Cost of Ownership
- Exists Since 1979 by H&B now ABB

Stability of gas filled adjustment cells
NDIR – Analyzer with NO - Cells



Test carried out by TUEV Süd, Germany

Stability of adjustment cells
NDUV – Analyzer



Field Report

Application:

Iron & Steel Plant - BF emissions monitoring

Notes:

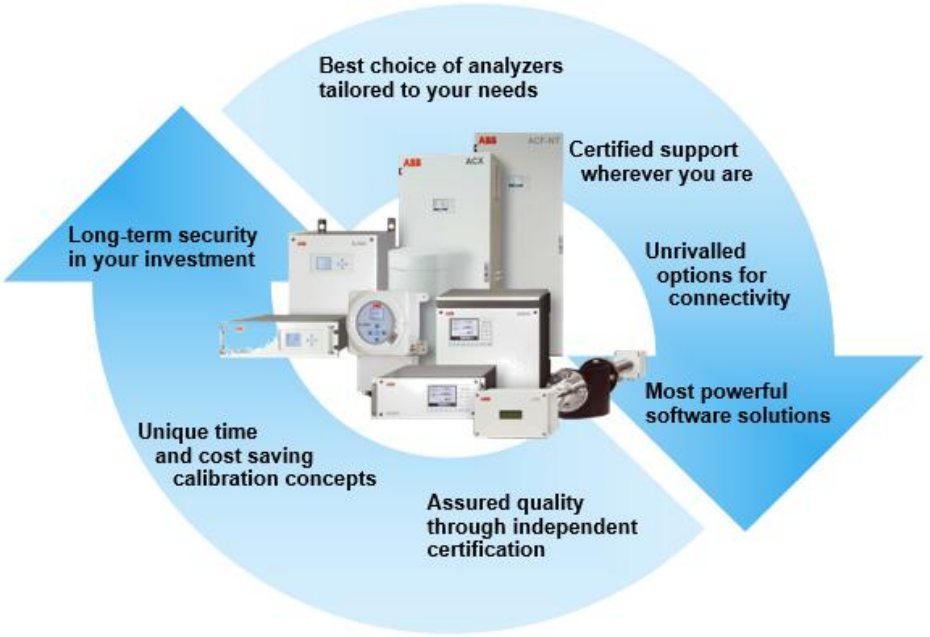
Benefits:

- Emissions regulation Compliance
- Calibration Concepts – Life Cycle Cost

Q & A
CEMS – Continuous Emission Monitoring

Contact Information

Any Questions ?



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