PC MACT – CEM Solutions

Dan Kietzer
SICK Process Automation

Portland Cement MACT

Contents

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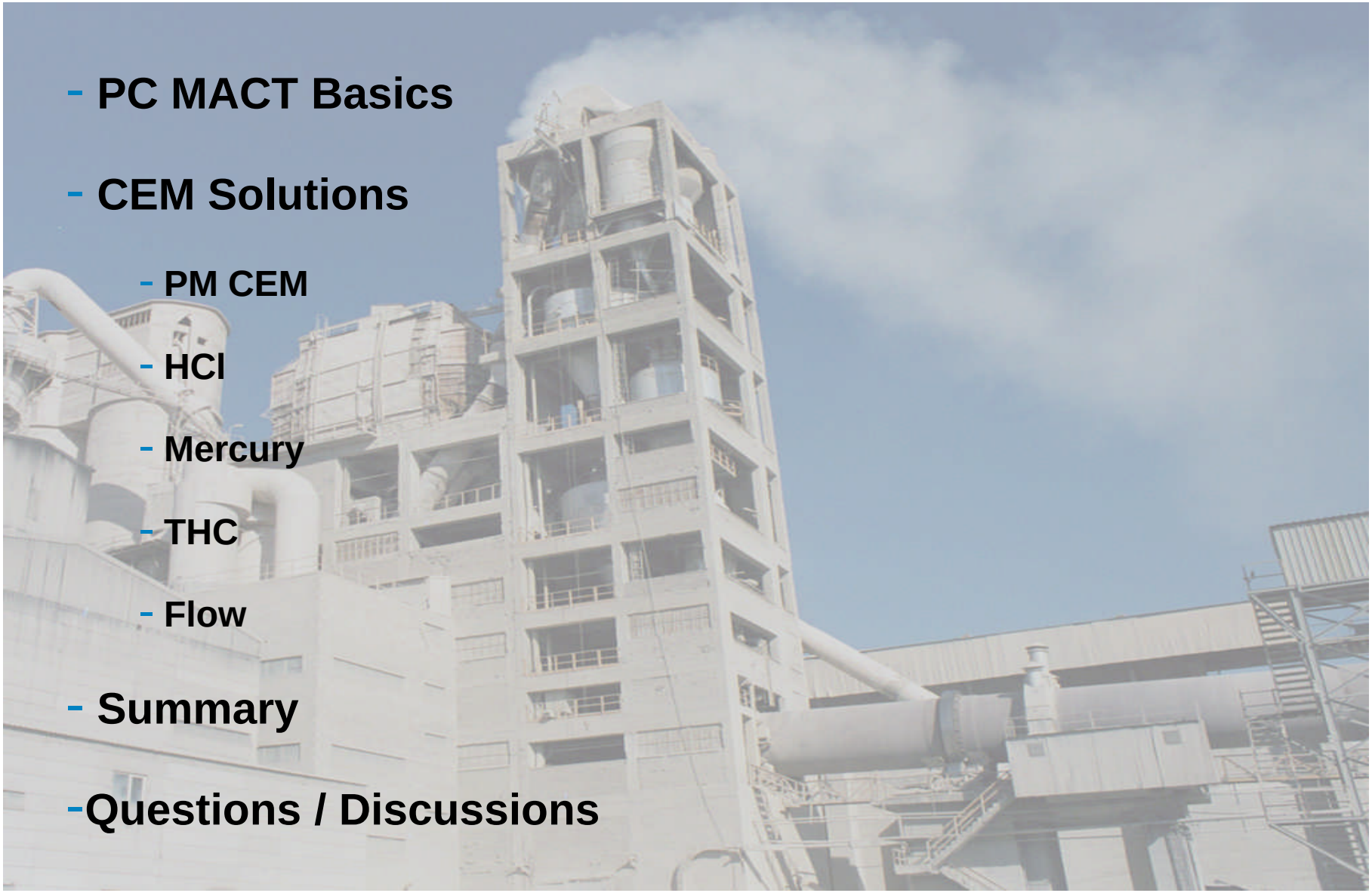

- PC MACT Basics
- CEM Solutions
  - PM CEM
  - HCl
  - Mercury
  - THC
  - Flow
- Summary
- Questions / Discussions

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: PC MACT Basics:

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Monitoring Requirements

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EPA Estimate: 158 sources will have to meet the new limits:

Pollutant	Unit	Emission Limit	
		Existing Kilns	New Kilns
Mercury	[µg/m^3]	12.5	4.8
Total Hydrocarbon	[mgC/m^3]	30.3	30.3
Particulate Matter	[mg/m^3]	10.0	2.5
Hydrochloric Acid	[mg/m^3]	3.8	3.8

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Monitoring Requirements

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- PM CEM
  - Applies to Kiln and Clinker Coolers as defined in Section 63.1343(b) of the PC MACT Rule
  - PM CEMs must comply with PS-11 and Procedure 2 of App. F, 40 CFR 60
    - Annual Relative Response Audits as defined in Procedure 2;
    - Response Correlation Audits every 3 years
  - Install and operate a flow monitor (continuous)
  - Measure clinker production or kiln feed rate to normalize mass concentration for comparison to the limit (hourly)

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Monitoring Requirements

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PS11 - Initial Correlation Audit (ICA)

- Pass the 7-day drift test
- PS-11 Correlation requirements
  - Conduct at least 15 reference method tests at 3 particulate mass concentrations that represent the range of unit operation – de-tune process to achieve higher mass loadings
  - Correlation coefficient must be >/= 0.85

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Monitoring Requirements

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PS11 - Absolute Correlation Audit (ACA)

- Quarterly filter audit of PM CEM (unless RRA or RCA is performed)
- 3 filter ranges tested 3 times each (similar to opacity filter audit)
- Filters not required to be NIST traceable. To manufacture standards.

PS11 - Relative Response Audit (RRA)

- Annual check of PM CEM response
- 3 simultaneous Reference Methods tests in comparison to PM CEM “as found” status.

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Monitoring Requirements

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Absolute Correlation Audit Testing Results

Date	Reference Filter	Reference Value (%)	Response Value (%)	Absolute Difference (%)
January	1	0.00	0.0	0.0
	2	37.9	37.8	0.1
	3	55.3	56.2	0.9
	4	92.6	92.8	0.2
April	1	0.00	0.0	0.0
	2	37.9	37.1	0.8
	3	55.3	56.0	0.7
	4	92.6	93.1	0.5
June	1	0.00	0.0	0.0
	2	37.9	37.9	0.0
	3	55.3	55.6	0.3
	4	92.6	93.2	0.6

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Monitoring Requirements

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PS11 - Response Correlation Audit (RCA)

- Verify curve stability over time – 3 year interval for PC MACT

- Requirements
  - Conduct at least 12 reference method tests at 3 particulate mass concentrations
  - Each of the 12 runs must be less than or equal to the highest value obtained during the PS-11 testing
  - Must have 9 out of 12 inside the range of values used to create the correlation curve
  - 75% of the 12 data points must fall within two parallel lines that represent +/- 25% of the equivalent emission limit from the correlation curve

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Monitoring Requirements

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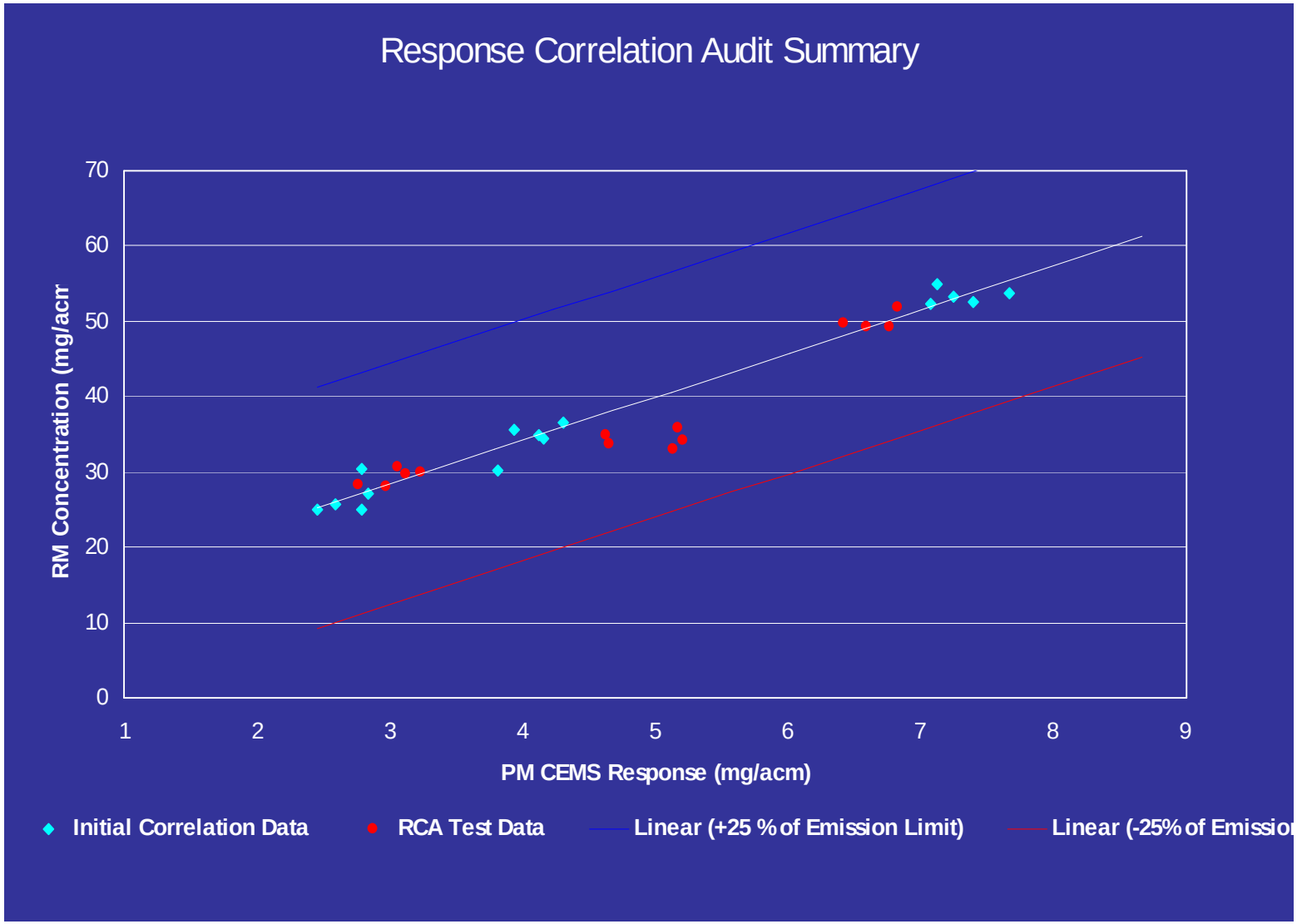

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Monitoring Requirements

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- Total Hydrocarbon
  - Install and operate a CEM in accordance with Performance Spec 8, App. B, 40 CFR 60
  - For sources equipped with alkali bypass stack, you may use performance tests
  - Optional total organic HAP limit… CEM installed in accordance with PS 8, App. B, 40 CFR 60
  - Emission limits corrected to 7% O2, expect during start-up and shutdown

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Monitoring Requirements

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- HCl
  - If the affected facility is equipped with a wet scrubber or tray tower, compliance can be shown through compliance testing and a continuous parameter monitoring system (CPMS); otherwise
  - Install and operate a CEM in accordance to PS15, App. B and Procedure 1 of App. F.
    - In absence of a traditional Performance Spec for HCl, EPA allows use of alternative monitoring techniques
    - EPA in process of developing PS specific to HCl
  - Emission limits corrected to 7% O2, expect during start-up and shutdown

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Monitoring Requirements

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- Mercury
  - Install and maintain a Mercury CEM in accordance with PS-12A, App. B, 40 CRF 60.
  - Optional: Sorbent trap according to PS-12B
  - Must also install and operate a flow monitor

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: CEM Solutions:

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PC MACT CEM Solutions

- **PM CEM**
  - Dry Stack – Scatter Light Probe (SP100)
  - Wet Stack – Scatter Light Probe w/ heated bypass (FWE200)
- **HCl**
  - Hot/Wet IR Photometer (MCS100E)
  - Hot/Wet Tunable Diode Laser (GME700)
- **Mercury**
  - Atomic Absorption Spectrometer (MERCEM300Z)
- **Volume Flow**
  - Ultrasonic Flow Monitor (Flowsic 100)
- **THC**
  - Flame Ionization Detector (FIDOR)

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PM CEMs in Wet and Dry Applications

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PM CEM Solution

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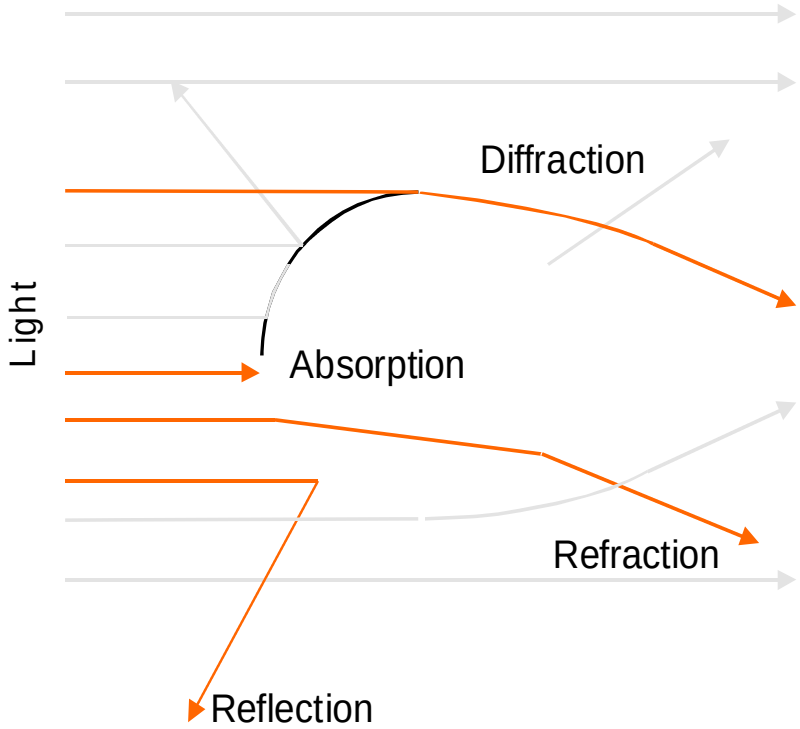
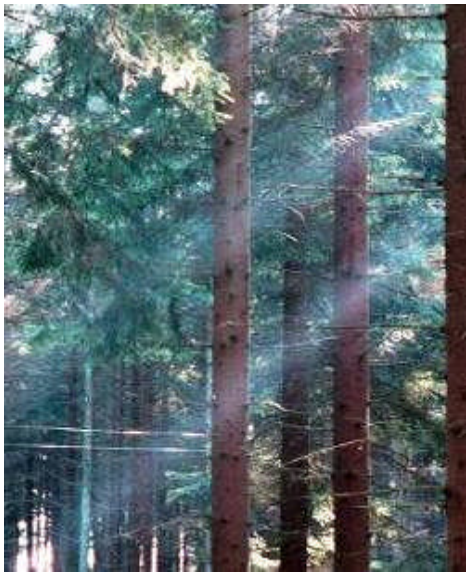
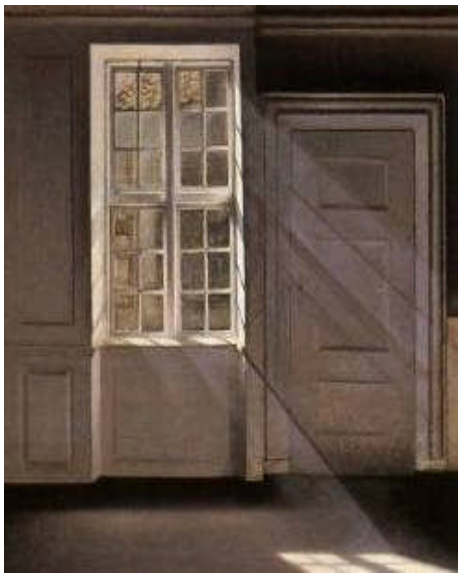
- Scatter light - Optical principle
- When light hits the particle, it is scattered
- Relation between the scattered light intensity and dust concentration
- Usable for low to medium dust concentrations







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PM CEM Solution

- Light attenuation depends on different application parameters (E.g.: grain size, dust density, dust dispersion)
- Application specific regression curve through a gravimetric comparison measurement: $cc2E^2 + cc1E + cc0$
  - Relationship between mA and dust concentration
- Data imported into dust measurement device

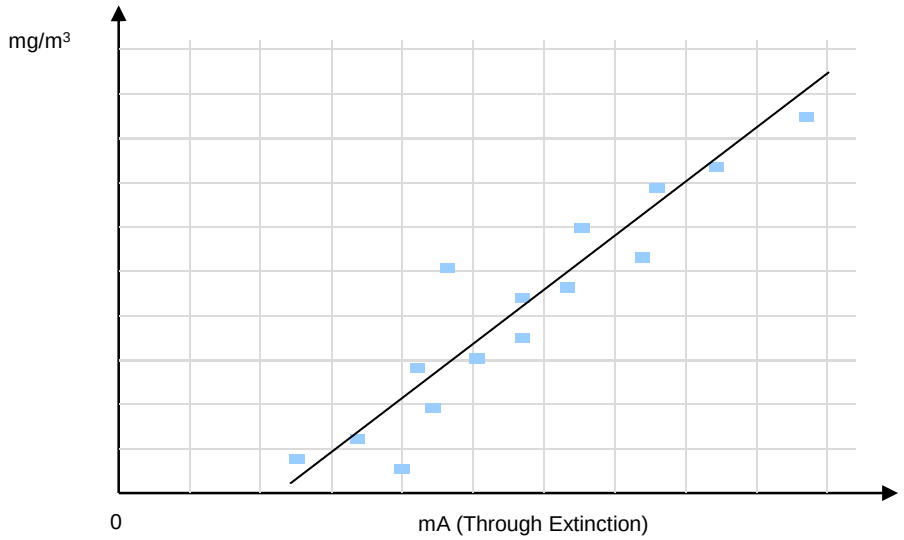
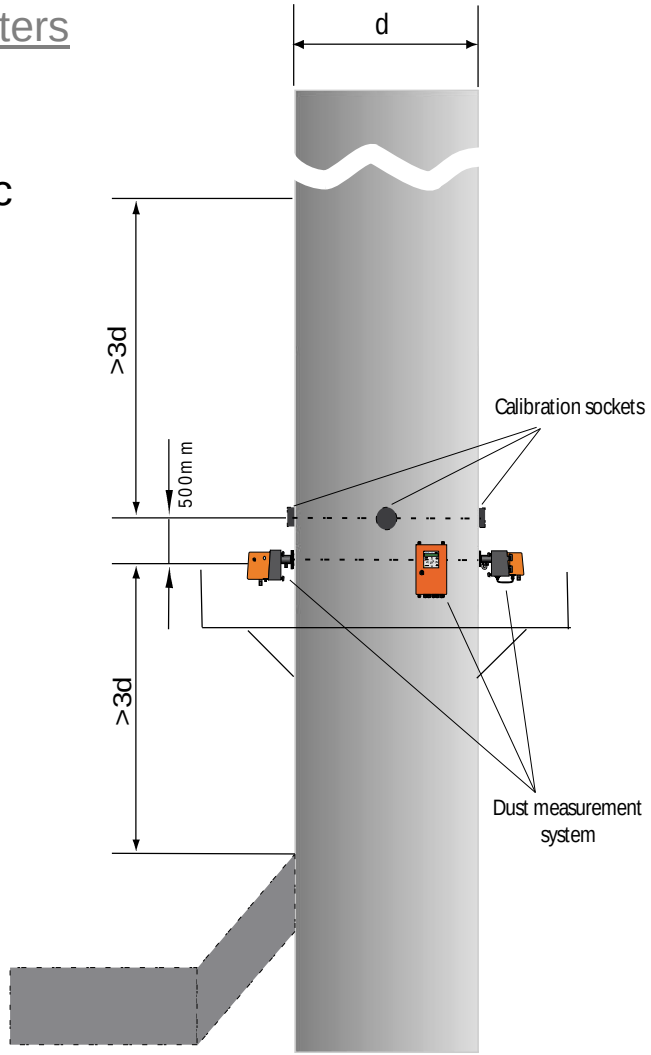


Fig.: Regression curve (Schematic)



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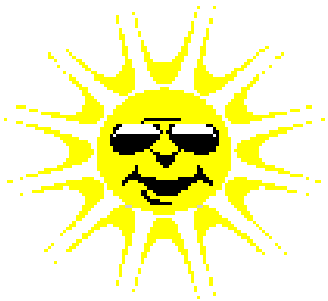
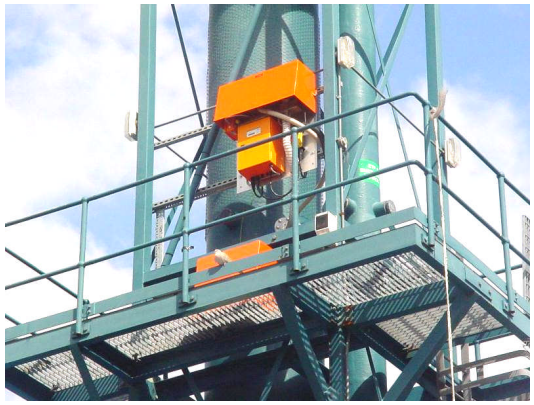
PM CEM Solution

Dry gas



SP100

FWE200



Wet gas

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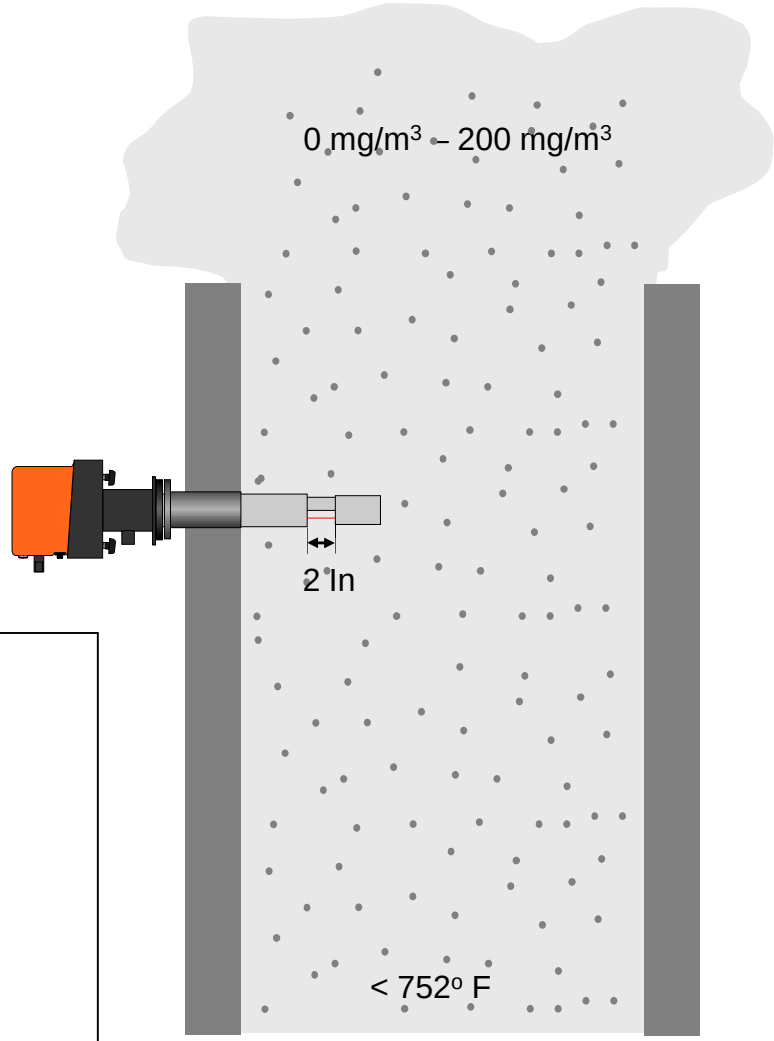
SP100 – Scatter Forward Probe



- Different probe lengths available
- High gas temperatures (up to 752° F)
- HASTELLOY material for Corrosive gases
- Maintenance interval of 3 months
- Meets EPA Performance Spec 11

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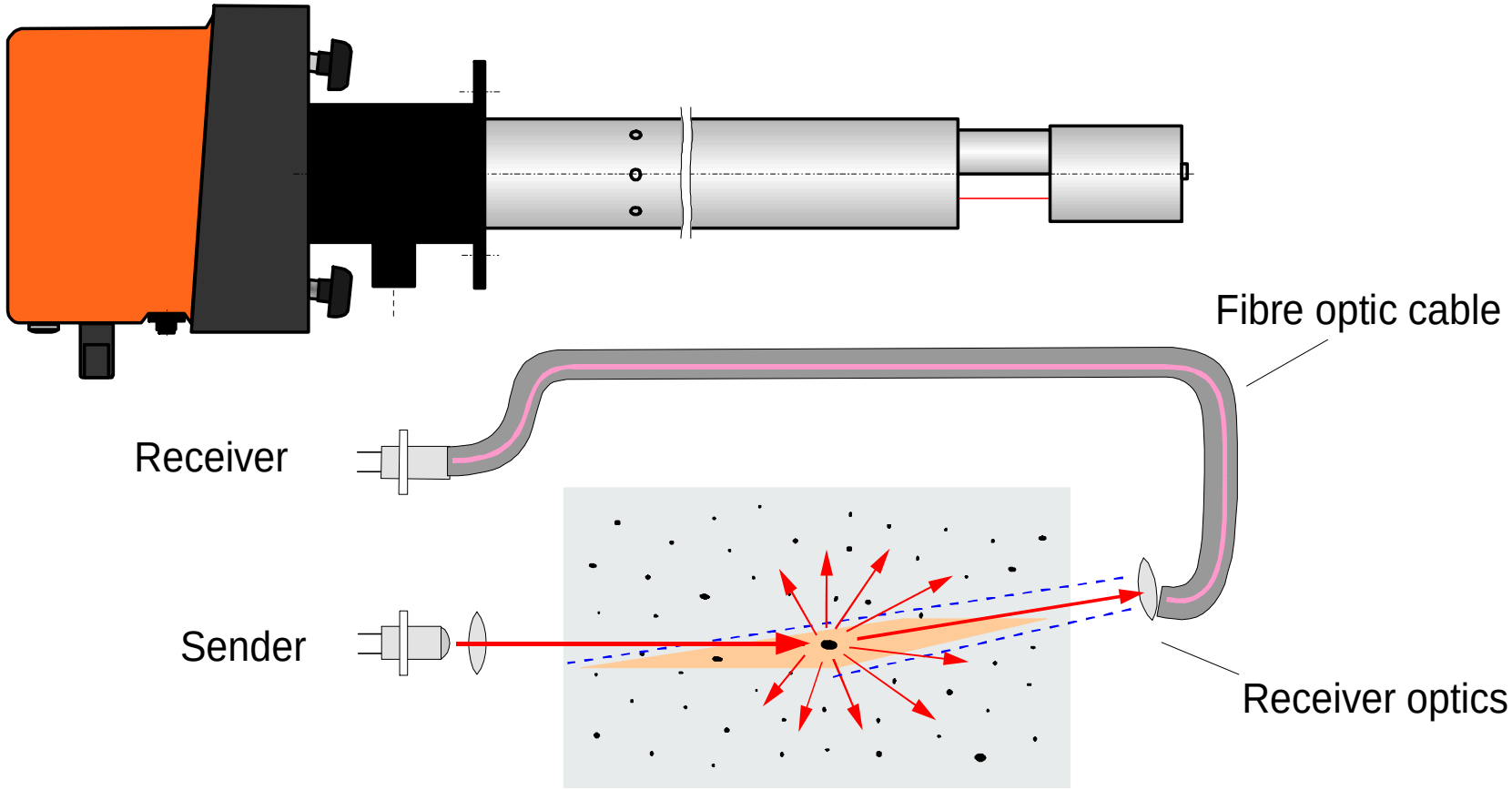
PM CEM Solution



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PM CEM Solution

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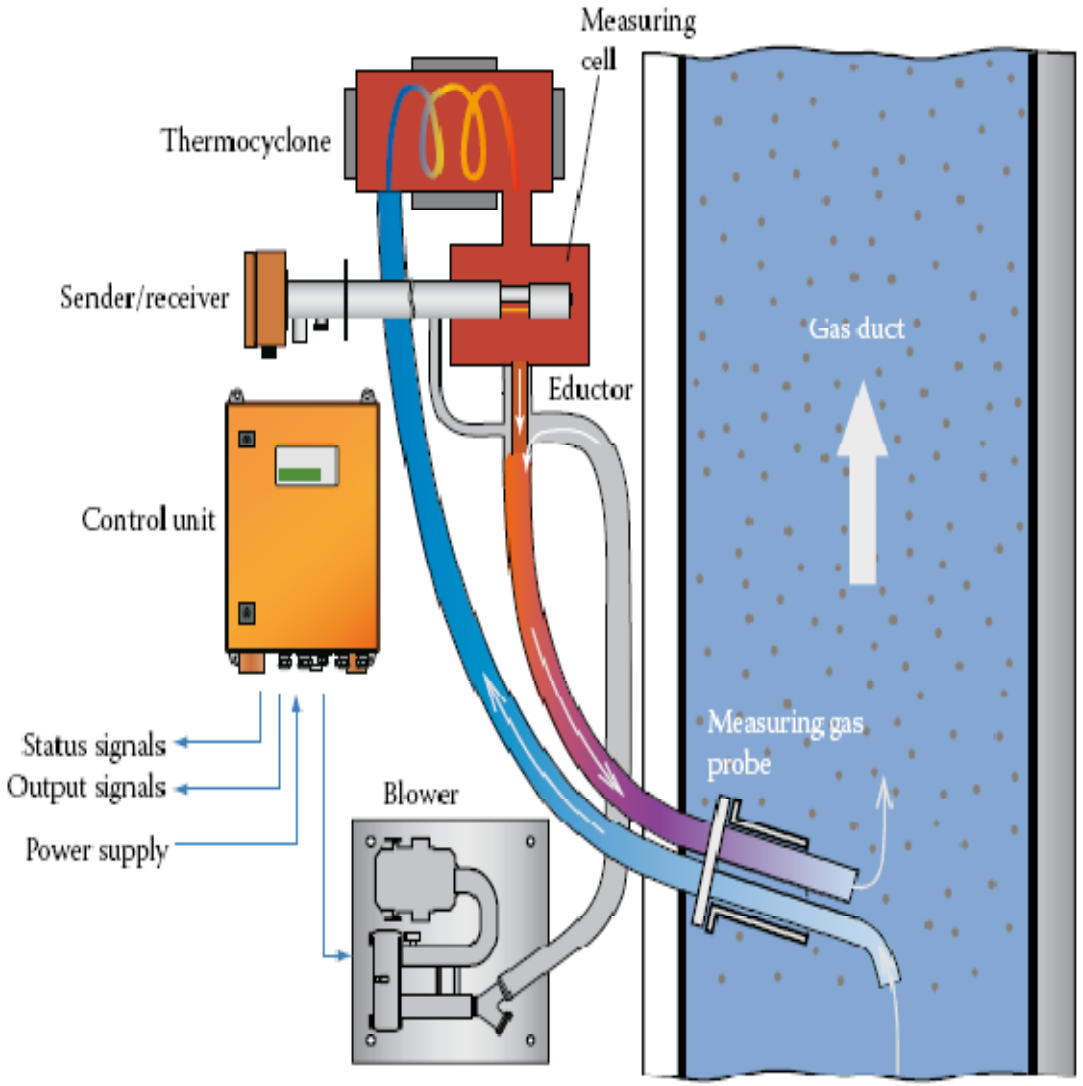
FWE200: Why a Bypass System?

: The light of the monitor attenuated through particles in the light beam.

: The water droplets must be eliminated.

: The heated Bypass System is the solution for a correct PM measurement in wet stacks.



Hydrogen Chloride - HCl

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HCl Solution

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- Keys to proper HCl Measurement
  - Continuous and accurate measurement of HCl in ppm levels can only be made when you measure wet.
  - The entire sample train must be kept hot and insulated to prevent cold spots.
  - Sample at high temperature and high flow rate
    - 185^{o} C for 3ppm HCl to avoid absorption and salt formations
    - > 5 l/min
  - Calibration Issues
    - Absorption / Desorption (wet cal vs. spiking)
    - Stability of cal gas – use a reputable supplier

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HCl Solution

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- The measurement of HCl offers multiple solutions

  - IR Measurement using Gas Filter Correlation – SICK MCS100E
    - Hot/Wet measurement to ensure no sample loss.
    - Integration of HCl Channel to existing MCS100E
    - Complete replacement of existing CEM with mulit-component MCS100E
      - Measurement of HCl, and additional CEM gases; SO2, Nox, CO, CO2, O2 in one monitor

  - Tunable Diode Laser Spectroscopy – SICK GME700
    - Hot/Wet measurement to ensure no sample loss.
    - Measures only at the desired wavelength, meaning high sensitivity and no cross-interference.
    - Possible integration into existing sample system

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HCl Solution

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MCS100 E HW – Multi-component CEMS

- Multi-component
- Undiluted Hot Wet Extractive
- IR Absorption with Gas Filter Correlation
- Complies with Part 60 & 75
  of U.S. EPA 40 CFR
- >1000 units sold worldwide
- Well known and accepted in the cement industry

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HCl Solution

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Relevant Measuring Ranges

HCl	0	-	10	ppm
NH_3	0	-	15	ppm
SO_2	0	-	25	ppm
CO	0	-	40	ppm
NO	0	-	80	ppm
CO_2	0	-	25	Vol.-%
H_2O	0	-	40	Vol.-%
O_2	0	-	21	Vol.-%
NO_2	0	-	50	ppm
N_2O	0	-	50	ppm
CH_4	0	-	70	ppm

Smallest ranges @ standard conditions dry (H_2O, O_2: wet)

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HCl Solution

- A complete TDLS system in one housing
- Laser spectrometer based on GM700
- Laser selectivity means high sensitivity and minimal cross-interference effects
- Minimum Range: 0-5 ppm HCl
- Extractive „hot-wet“ measurement
- Heated, volume- and flow- optimized multi-pass gas cell, 290ml
- 19“-rack for control cabinet installation

GME700

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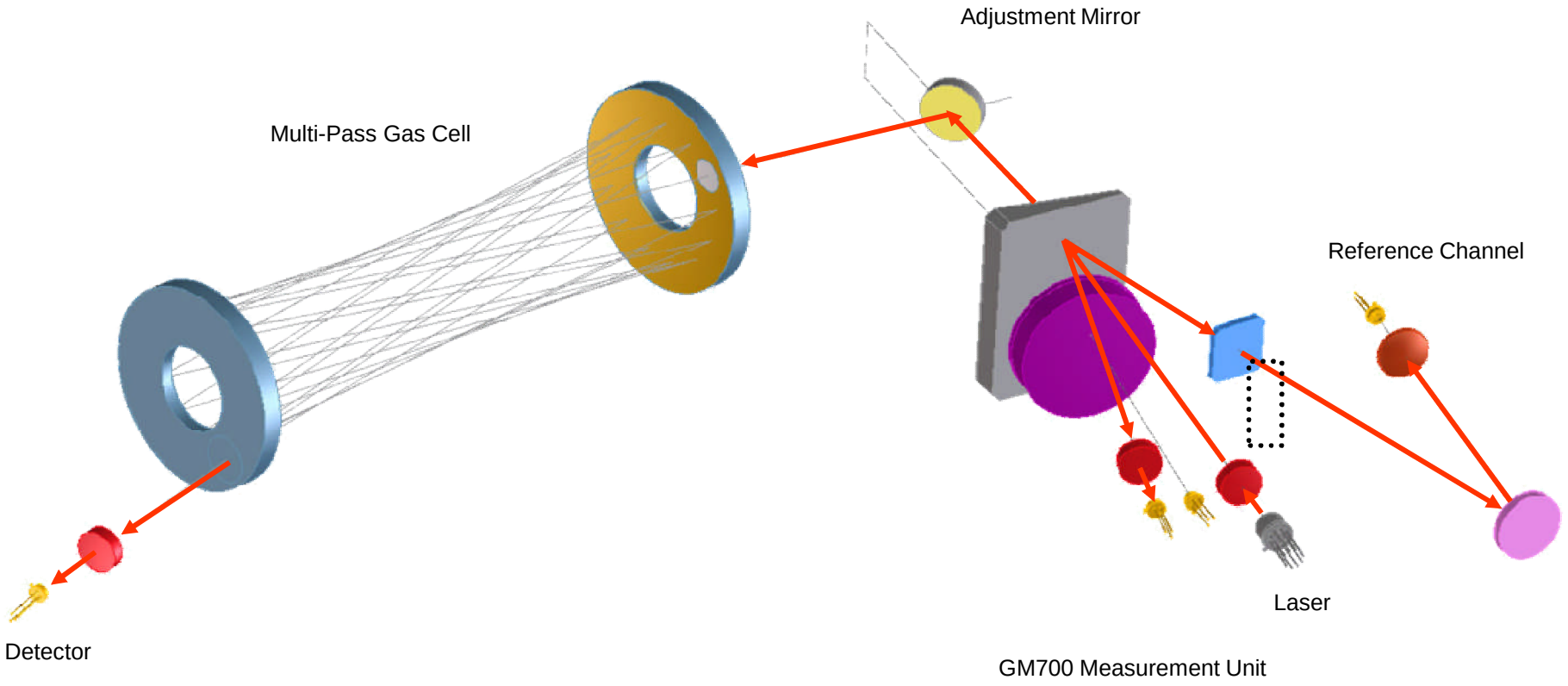
HCl Solution



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Mercury CEM

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Hg CEM Solution

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- **Is there a “best” measuring system?**
  - **No sample gas line → Insitu measuring system**
    - Insitu not possible as conversion of Hg^{2+} to Hg^{0} necessary
    - preferably short sample gas line
  - **Conversion of Hg^{+} to Hg^{0} without use of any consumables**
    - No wet chemical conversion with $SnCl_2$
    - No converter materials
    - High temperature conversion
  - **Measurement method**
    - No cross sensitivities or
    - Optical correction of cross sensitivities
    - Continuous measurement method with short response time
  - **Automatic check with span gas or adequate means**

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Hg CEM Solution

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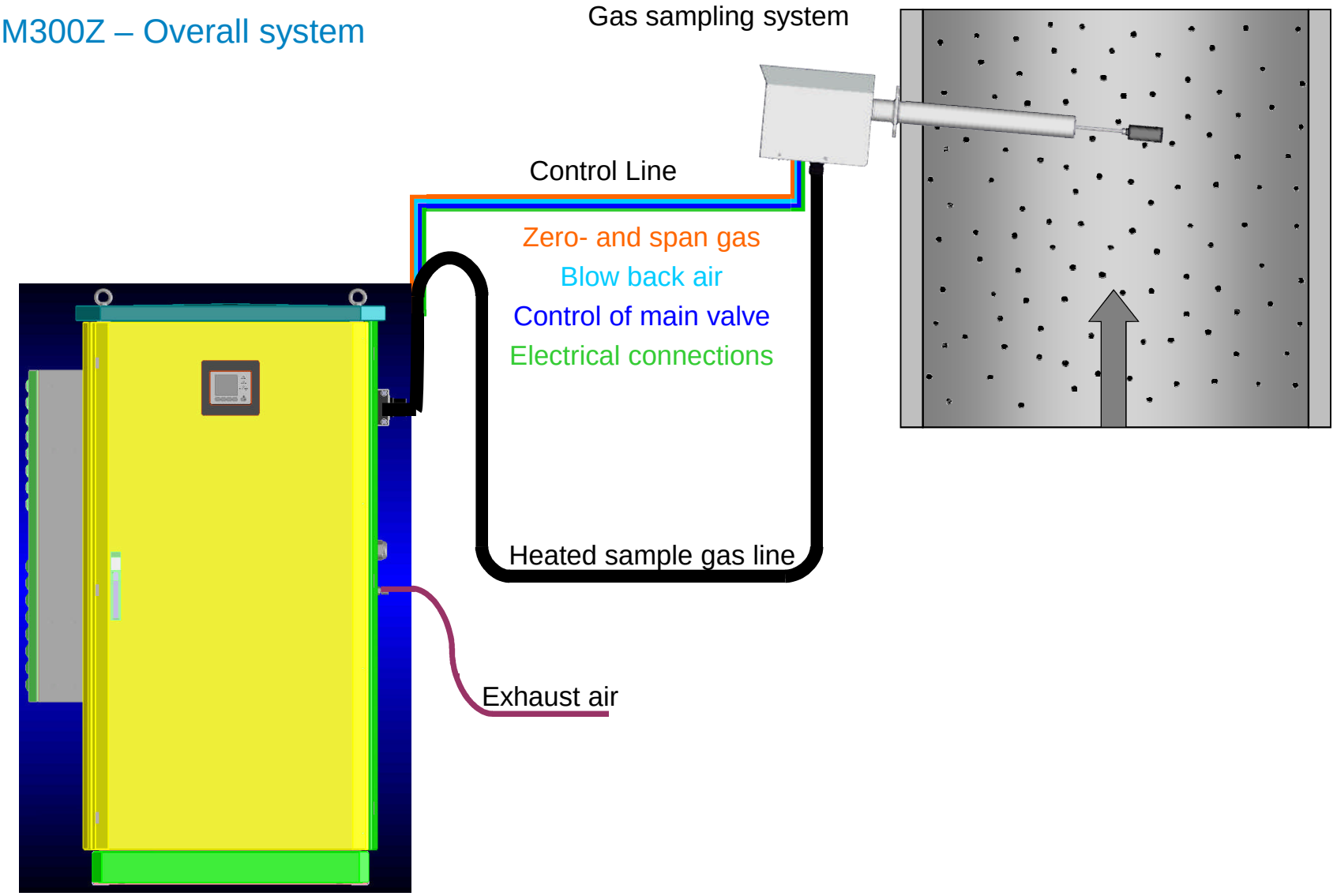
MERCEM300Z – Overall system



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Hg CEM Solution

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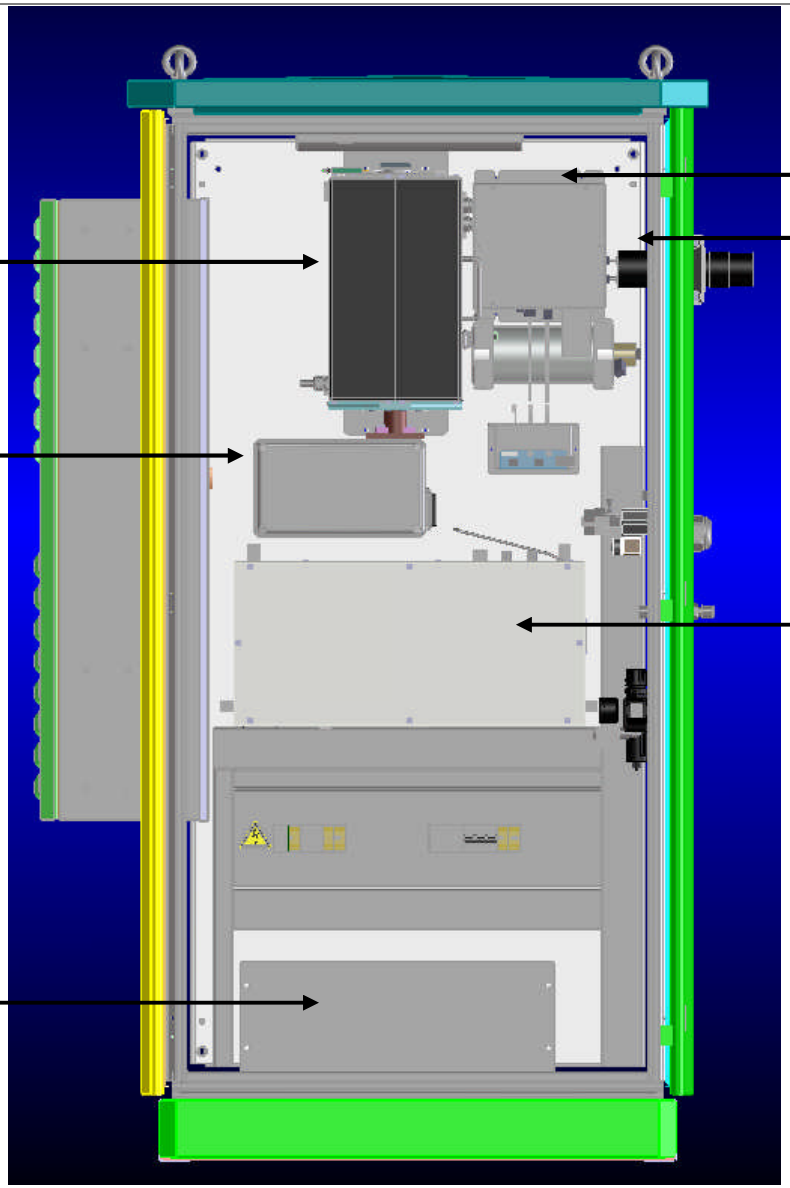

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Hg CEM Solution

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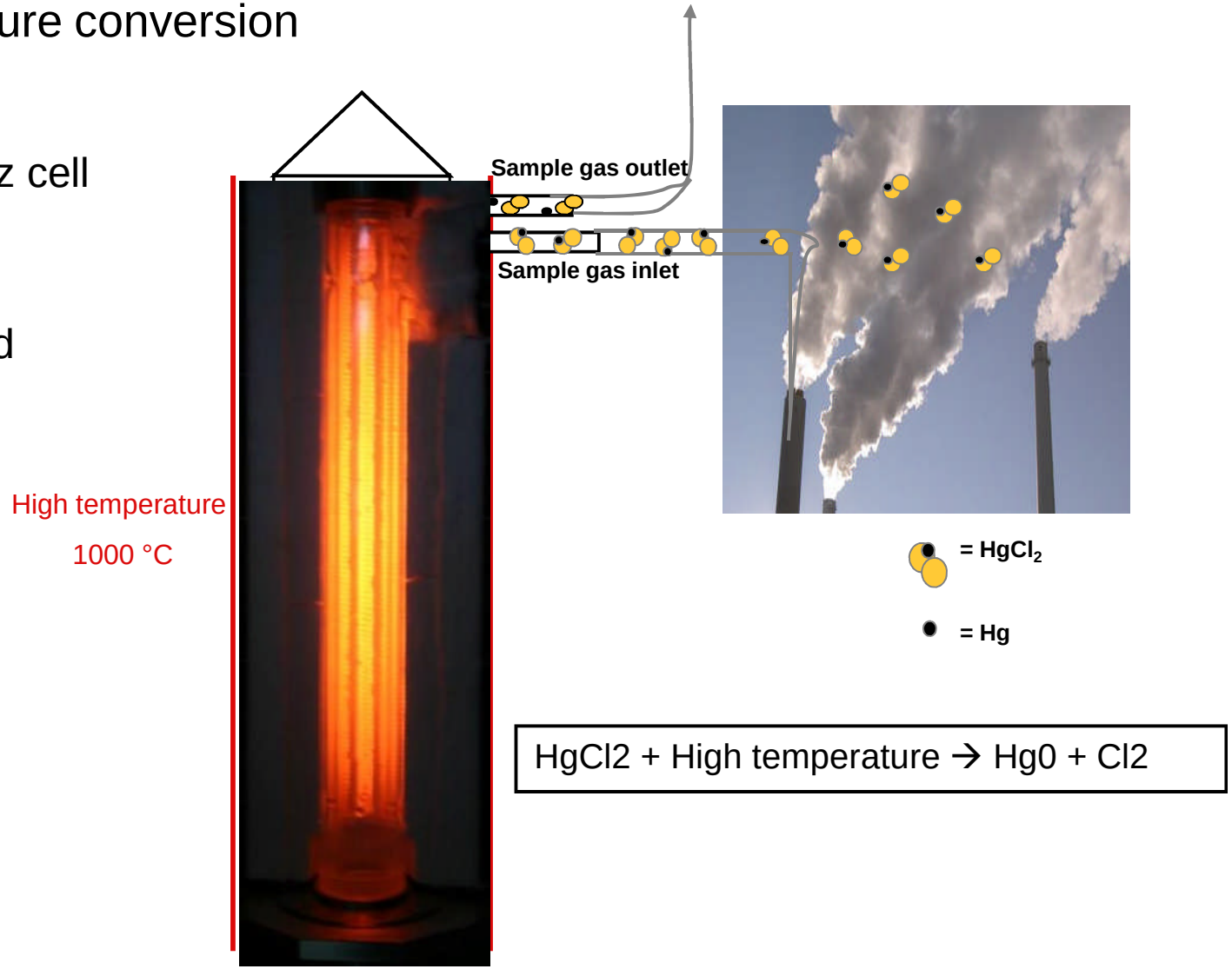
- High temperature conversion

  - Heated quartz cell (1000 °C)
  - Double walled



HgCl2 + High temperature → Hg0 + Cl2

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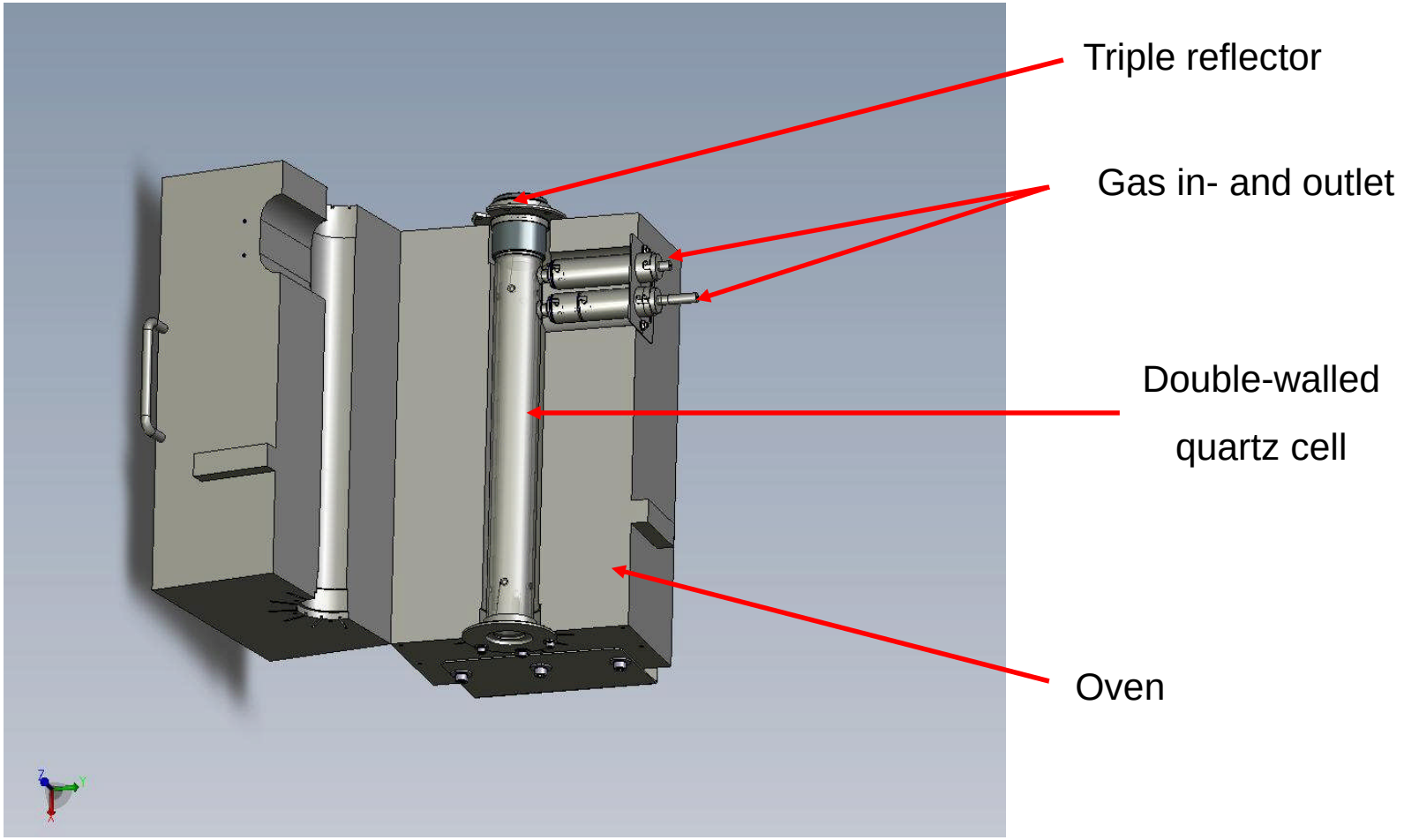
Hg CEM Solution



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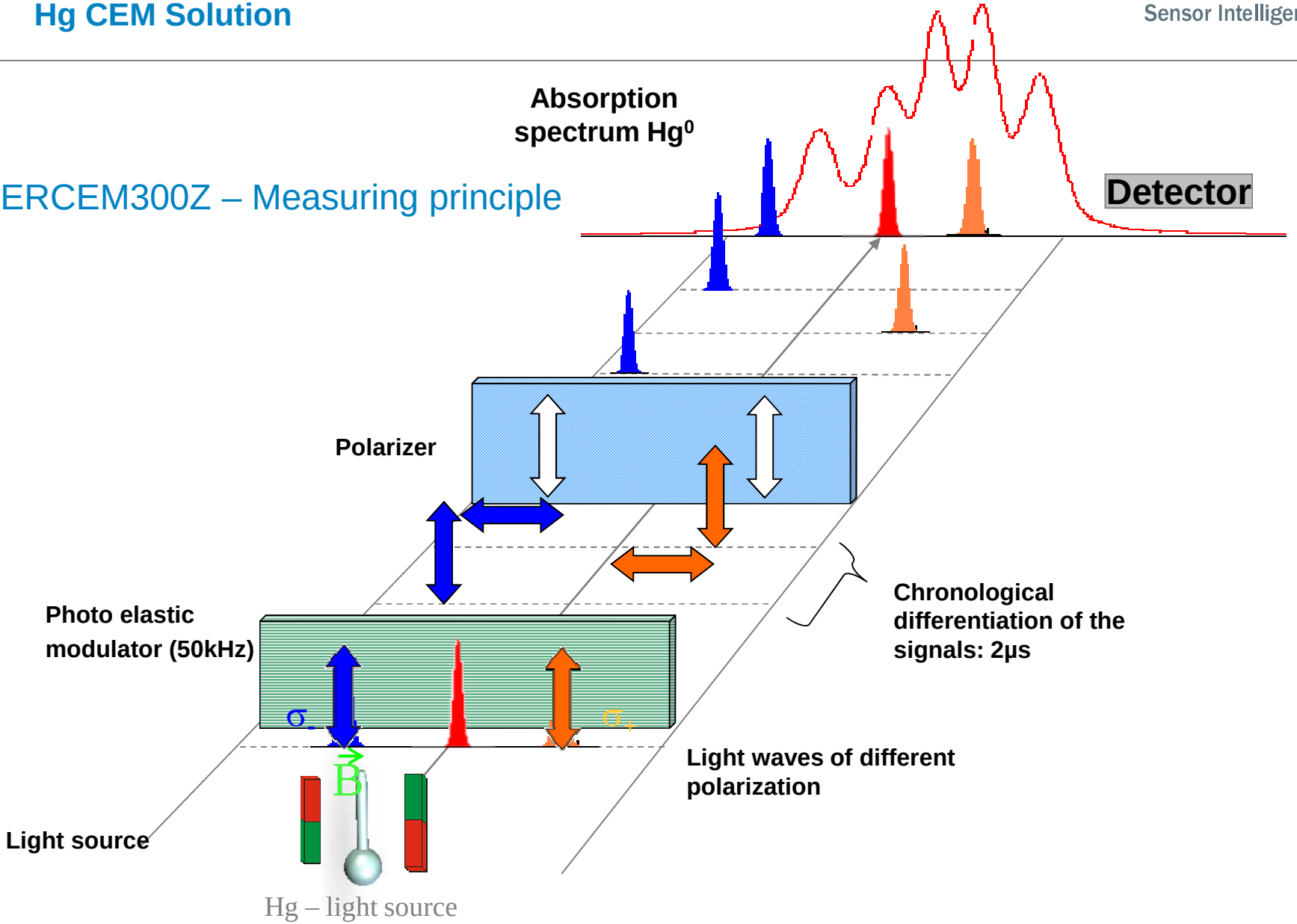
MERCEM300Z – Measuring principle



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Hg CEM Solution

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: Advantages of Zeeman - AAS

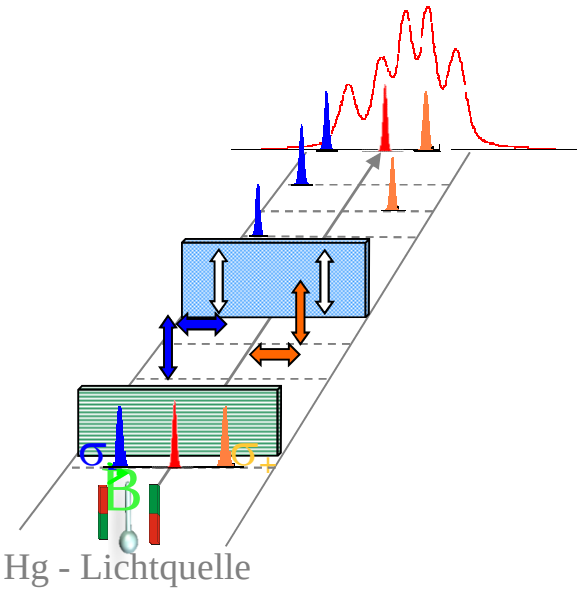
- Continuous measuring method

- No moving parts

  → No mechanical wear

  → Long-term stability

  (Maintenance cycle of light source: ≥ 1 year)



- Automatic drift correction for
  - Light source modifications
  - Contamination of optical surfaces

- Measuring and reference signal are close together on spectrum, meaning interferences are nearly identical across this small area.

  → Best possible cross sensitivity correction

Customer benefits

- Reliable measuring values at any time: patented direct measurement
- Maintenance free high temperature – conversion
- Low cost of ownership – measurement without consumables
- Easy, fast access due to modular set-up
- Long-term stability due to automatic drift correction
- Integrated adjustment function: No additional equipment necessary
- Automatic adjustment via integrated gas calibration unit
- Stable measurements in spite of difficult ambient conditions
- Field proven maintenance intervals of >12 weeks.

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Volume Flow

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Flow Solution

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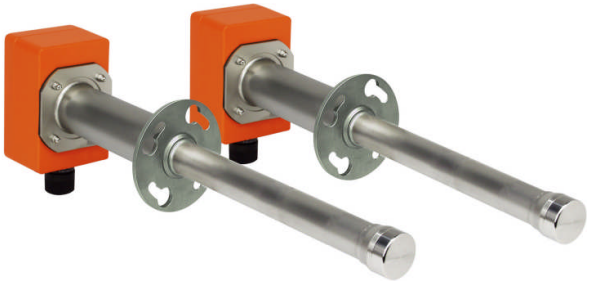

FLOWSIC100 M

FLOWSIC100 PR

FLOWSIC100 H

- **Transducers:**

  - Solid state design with „piezo-electric“ crystals enclosed in titanium as standard

  - High durabilty and low maintenance

  - Standard 3 year warranty

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Flow Solution

- Process and Ambient Temperature :

  - No external purge air requirements for process temperatures up to 500º F

  - External Purge air can :

    - Contribute to excessive condensation and contamination of the transducer heads. Reducing operation life.

    - Cause unstable thermal conditions that create noise and faulty readings.

Total Hydrocarbon - THC

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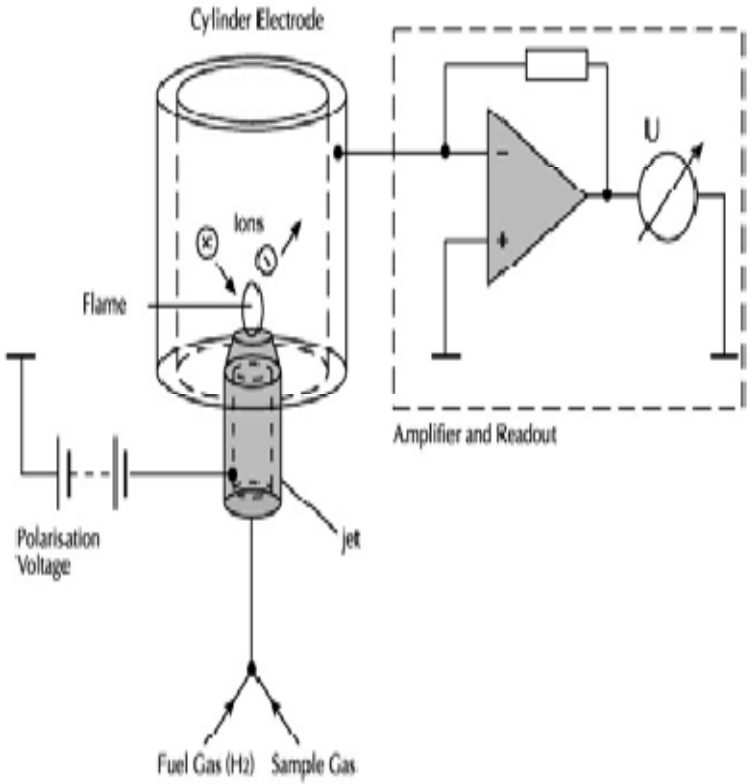
THC Solution

- Most commonly used technique for measurement of THC is the Flame Ionization Detector (FID)
- Hydrogen flame is burnt in the presence of HC free air, around which an electrical field is placed.
- When HC from the sample gas are fed into the flame, they are cracked and stripped and CH-fragments are formed.
- These become oxidized by available O2, and form CHO+ ions.
- The ion flow is measureable in the electrical field and proportional to the carbon content in the sample gas.



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THC Solution

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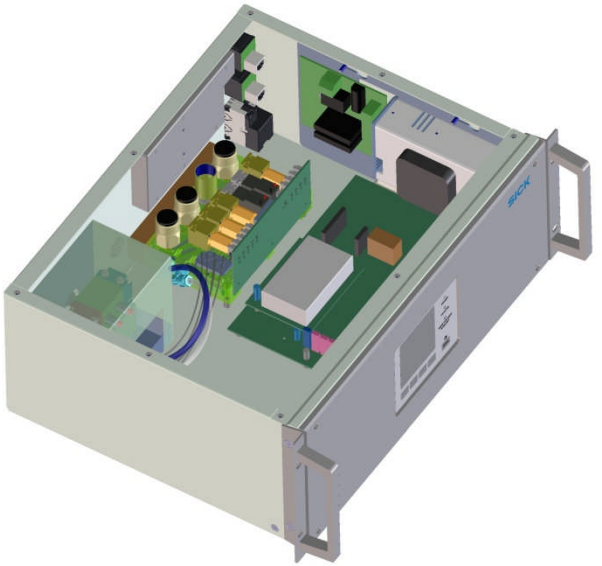
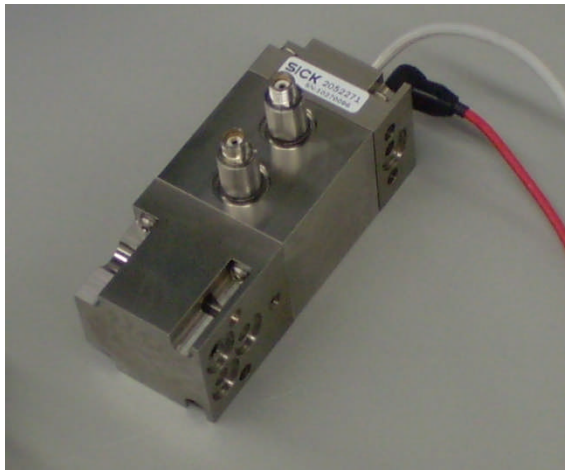
- FIDOR - 19” Mountable FID
  - Range: 0-10/50 ppm THC
  - Burner Gas: Hydrogen
  - HW Extractive concept
  - Maintenance free eductor for sample draw
  - Modbus/Ethernet/OPC
  - Meets US EPA PS-8, and test methods 25 and 25A.
  - Available as a stand-alone system or integrated into existing extractive systems





Summary

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Summary

- SICK is able to deliver all necessary CEM technology to meet the PC MACT rule and fulfill the application requirements.

- This allows SICK to provide solutions based on “best solution”, which is application driven, and not technology driven.

- Experience counts. SICK has a proven track record in monitoring the compounds required by the PC MACT.

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Discussion / Questions