TEOM® Series 4200 Combustion Efficiency Monitor

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TOPICS

- System Overview
- Field Installation
- Measurement Results
- Operating Summary

TEOM Series 4200 Monitor
What Does It Do?

- Performs an automatic measurement every 12 minutes of the fly ash carbon content using a test patterned after the loss-on-ignition (LOI) method (ASTM C311).
- Provides near real time feedback to plant operators for maximizing combustion efficiency and/or fly ash sales.

Applications

TEOM Series 4200 Combustion Efficiency Monitor

- Increase combustion efficiency
- Increase amount of quantity of low-carbon fly ash available for sale
- Reduce the amount of fly ash landfilled
- Increase the consistency, availability of LOI-type measurements
- Eliminate or reduce manual LOI procedures

Series 4200 System Specifications

Accuracy

- The carbon-in-ash resolution is ±0.5% (based on side by side comparisons with isokinetically-drawn manual samples).

Operating Range

- Flue temperature: 250 °F (120 °C) to 800 °F (425 °C).
- Ambient temperature (sensor unit): 65 °F (18 °C) to 140 °F (60 °C). An enclosure is required for temperatures outside of this range.
- Distance between sensor unit and data reporting computer: Up to 1000 feet (300 m).

System Requirements

- Instrument air: 70 to 100 PSI (4.5 to 6.8 atm), 20 CFM (0.57 m^3/min) peak.
- Power: 120 VAC/60 Hz: 6 A OR 240 VAC/50 Hz: 3A.
- Sample port: 3" modified bushing attached directly to the boiler.
- Installed data transmission cable and sample port.

Sampling System

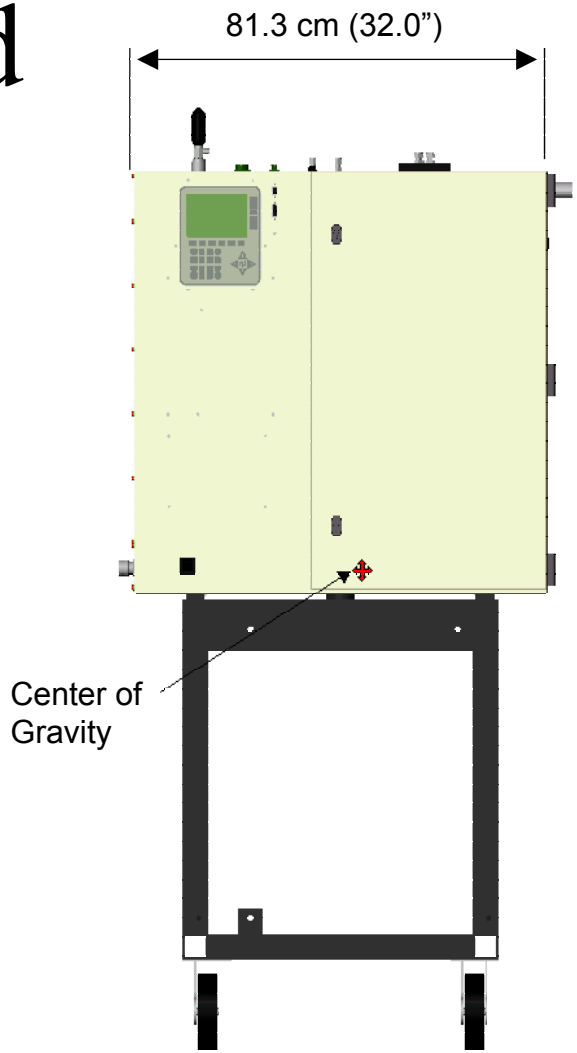
- The standard sampling system includes main sample tube, manual sample tube, “S”-type pitot, and “K”-type thermocouple.
- Main sample tube and manual sample tube are 6 ft (1.9 m) long, 316 thickwall SS tubing.
- Optional dual point configuration for alternating sampling of two sample points in the same or different duct. Sampling locations can be up to 16 ft (4.8 m) from the monitor.
- Automatic purge of Pitot tubes and sample probe.

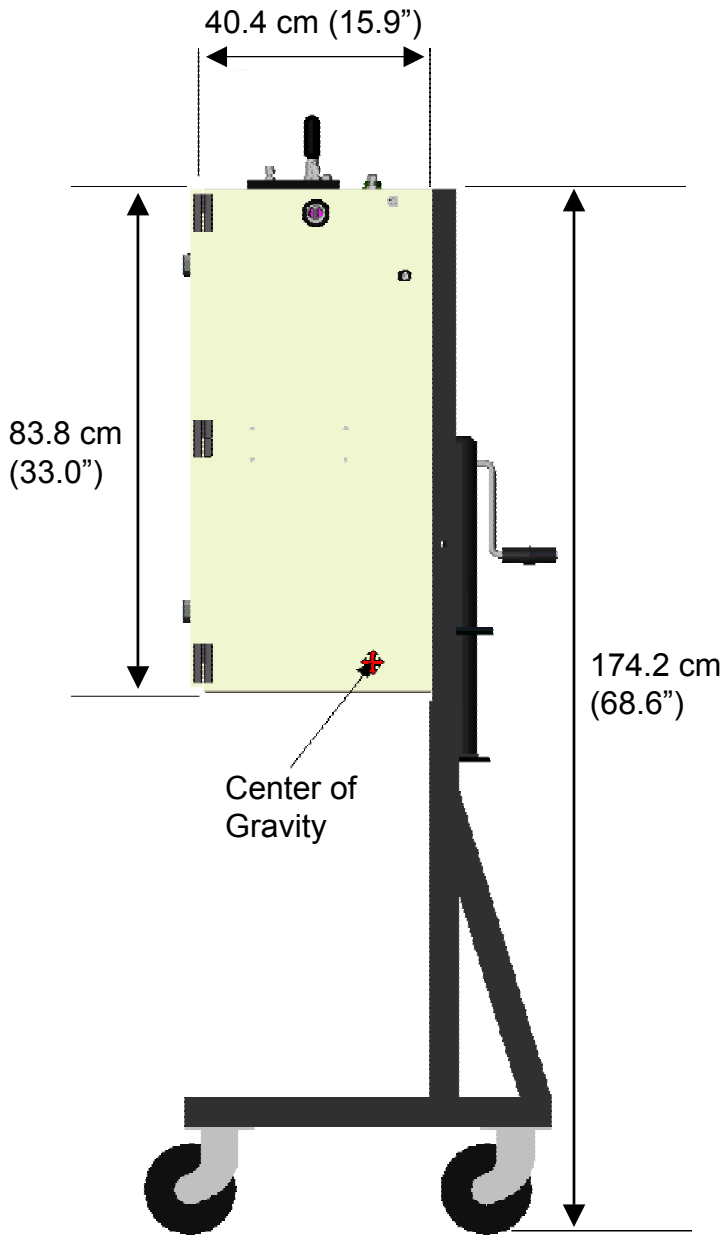
Major System Components

TEOM Series 4200 Combustion Efficiency Monitor

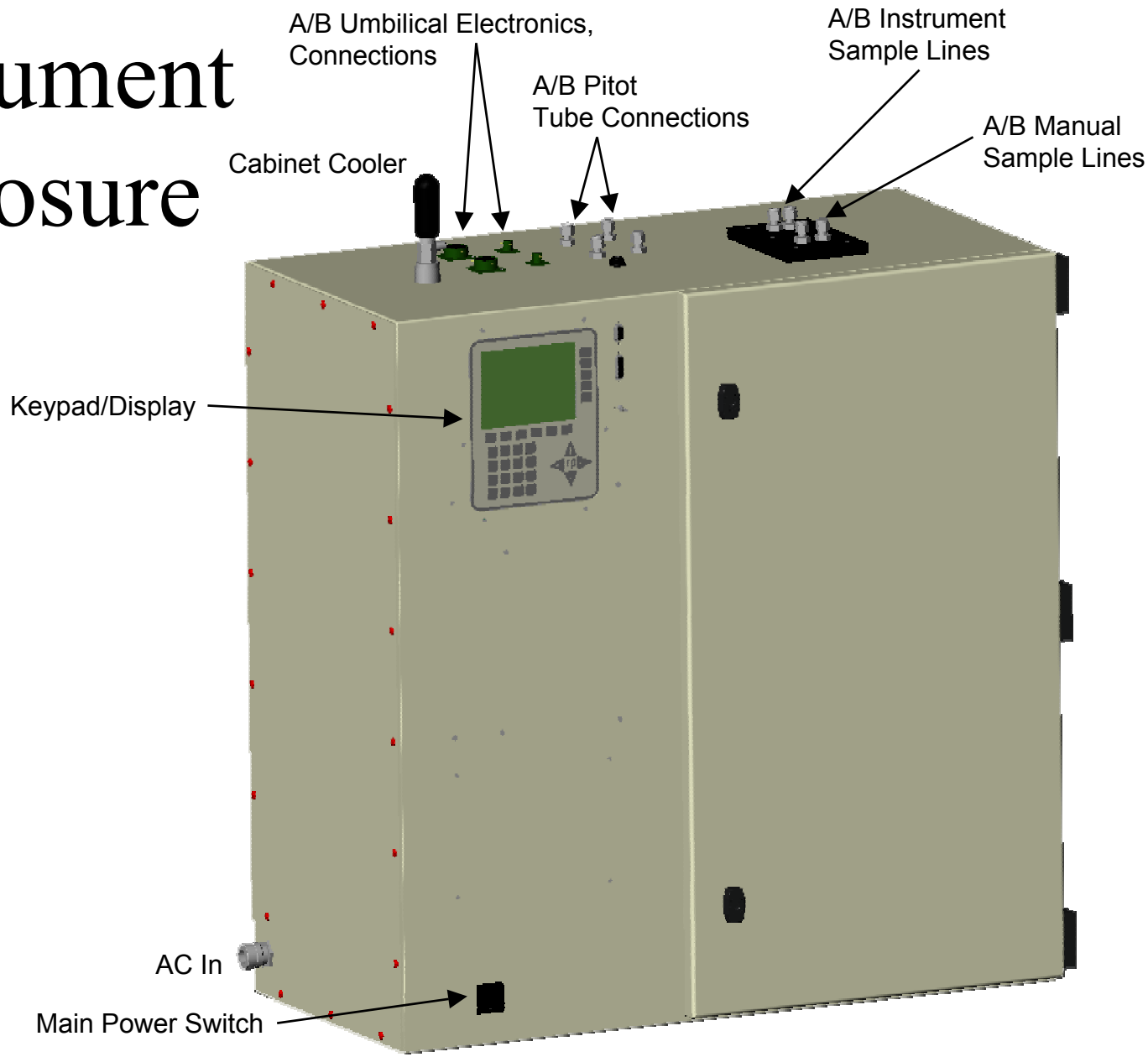
- Heated probe and heated umbilical line deliver the sample to the monitor. Probe bundle includes probe for collecting manual sample. Optional second probe permits two point, time-shared sampling.
- Industrial-grade microbalance for fly ash mass measurement.
- Sample analysis system, including furnace and NDIR CO_2 meter.
- Collection and analysis bench for positioning mass transducer at sampling/analysis/cleaning stations.

Instrument Stand



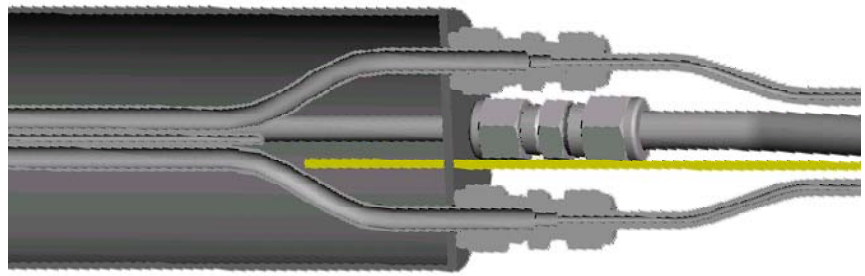


Instrument Enclosure



Heated Probe/Umbilical Line

TEOM Series 4200 Combustion Efficiency Monitor



Transition Between Heated Probe and Inlet Section

Heated Probe

Pitot Tubes

Thermistor

Manual and Automatic Sample Inlets

System Schematic

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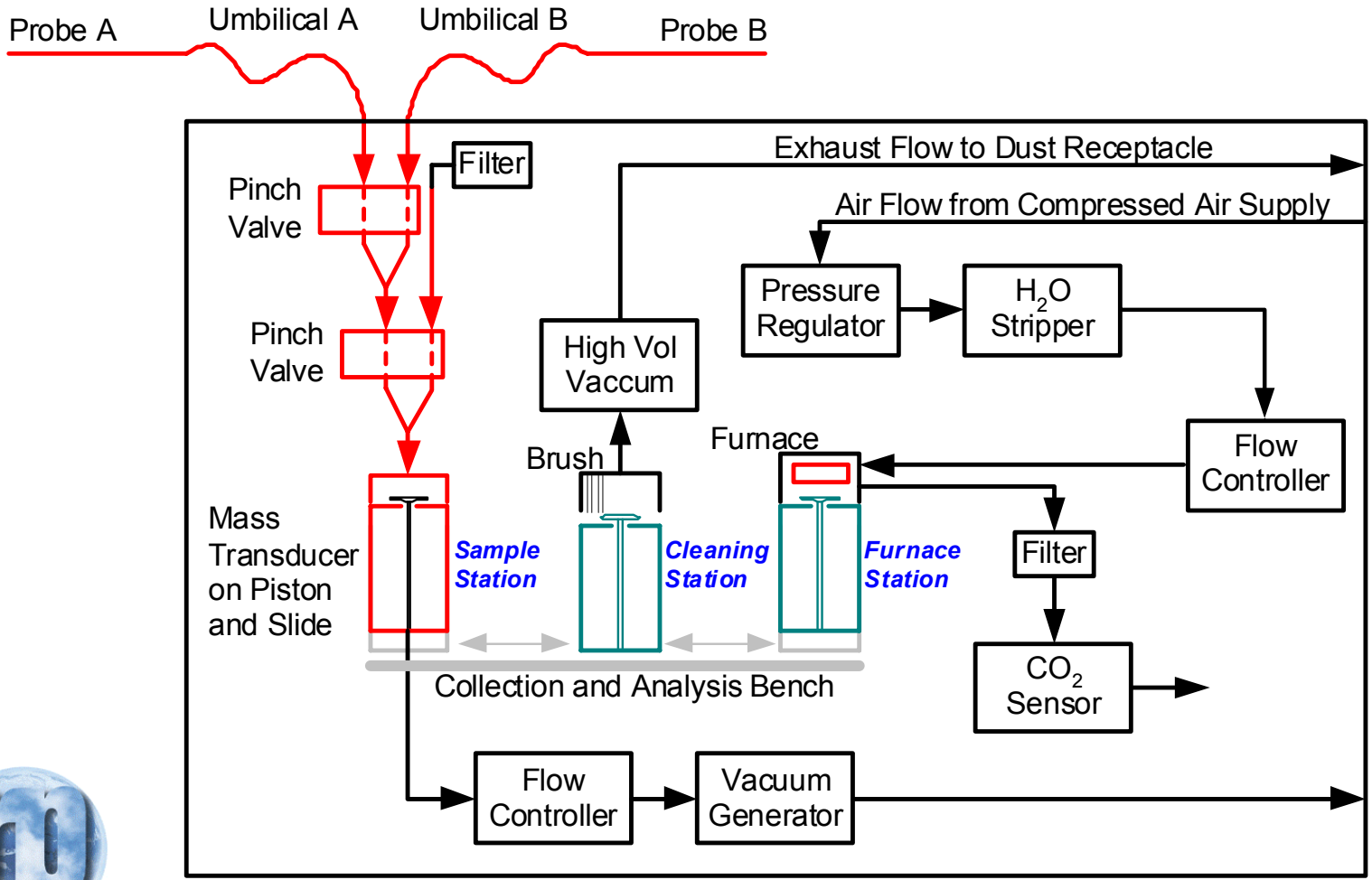
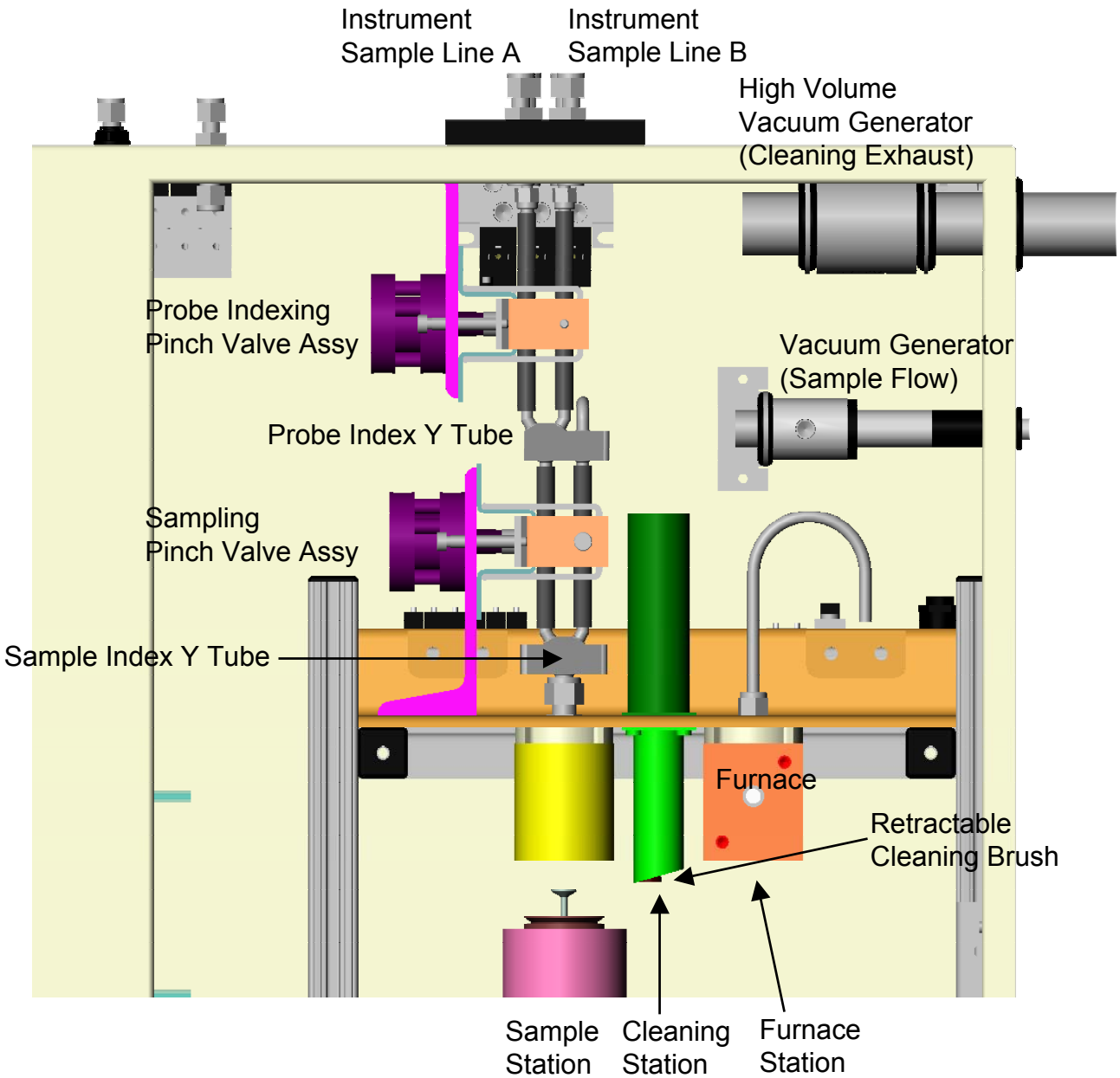


Analyzer Cabinet



Carbon-in-Ash Test

Series 4200 Combustion Efficiency Monitor

1) Collects a fly ash sample isokinetically
2) Transports the fly ash to the Sample Station
3) Weighs the fly ash sample collected on the filter
4) Heats the sample in a high-temp furnace to 800 deg C
5) Measures the amount of CO_2 generated during the sample oxidation process
6) Calculates the percentage of carbon in the fly ash
7) Reports information to plant personnel and systems
8) Recycles to start another test

Calculations

- Total Mass: $\Delta M = K_0 * \frac{1}{\left(f_1^2 - f_0^2\right)}$

- CO_2 Mass: $CO_2(kmol) = \frac{vol_{CO_2}(l)}{22.4\left(\frac{l}{gmol}\right)}$

- C Mass: $C(gmol) = CO_2(gmol)$

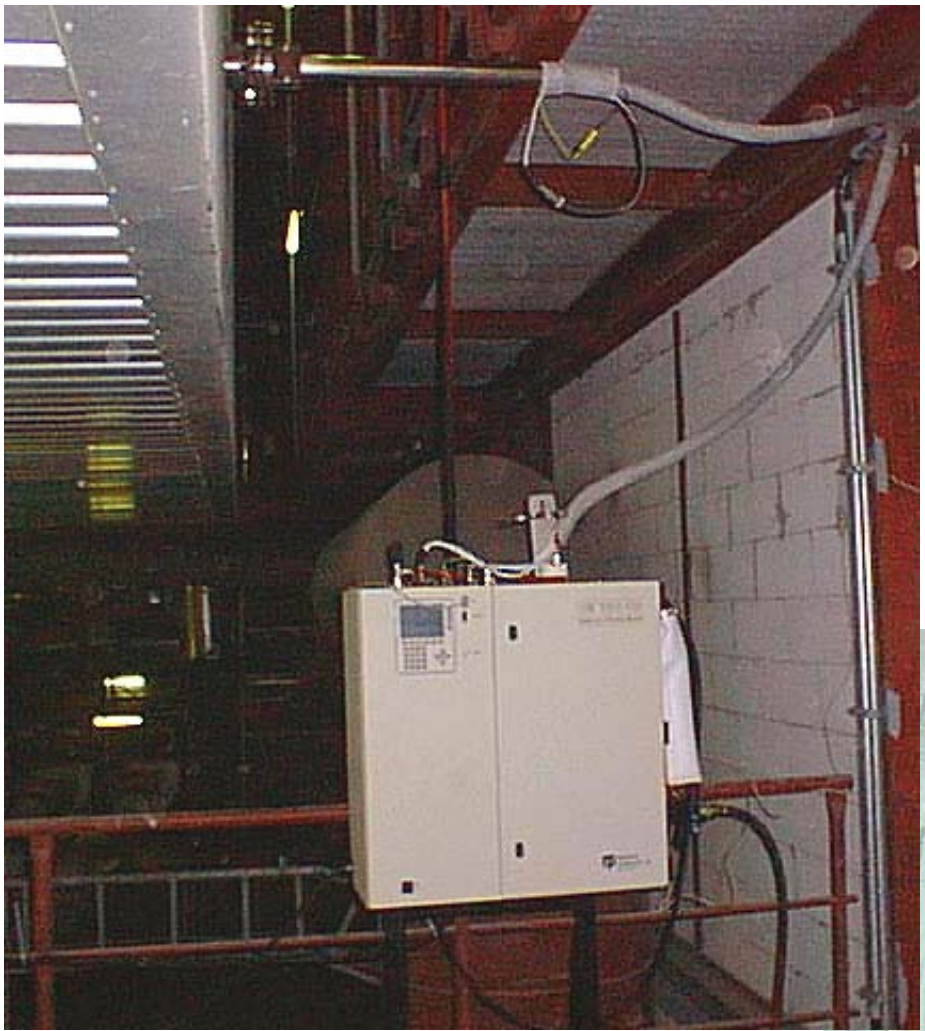
$$C(g) = C(gmol) * 12.011\left(\frac{g}{gmol}\right)$$

- %CIA: $\%CIA = \frac{C(g)}{TM(g)} * 100\,\%$

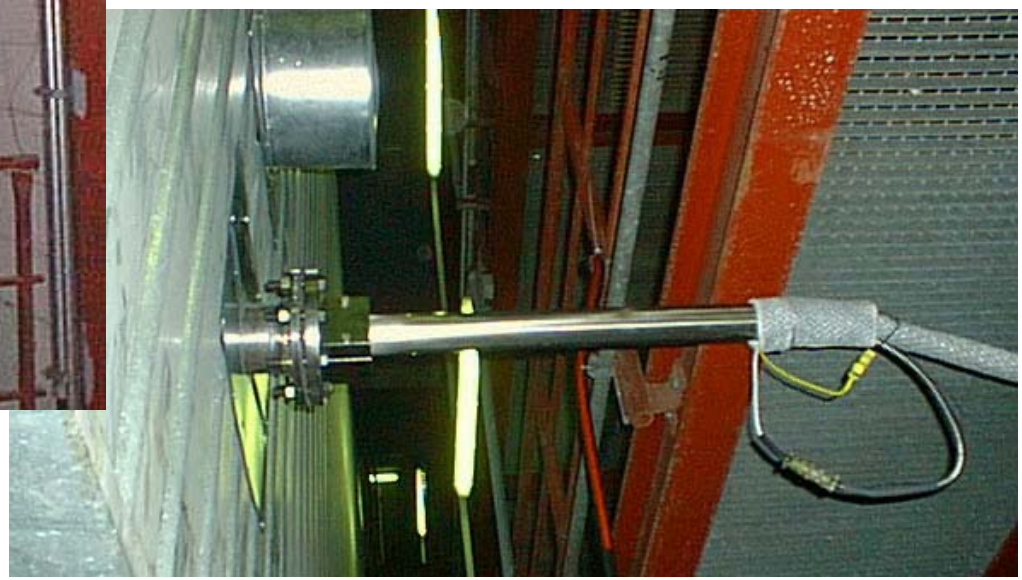
TEOM Series 4200 Installation

GKW
Mannheim, Germany

GKW - TEOM Series 4200 Installation



Monitor and Port Locations



Southeastern NYS TEOM Series 4200 Installation

Port Location

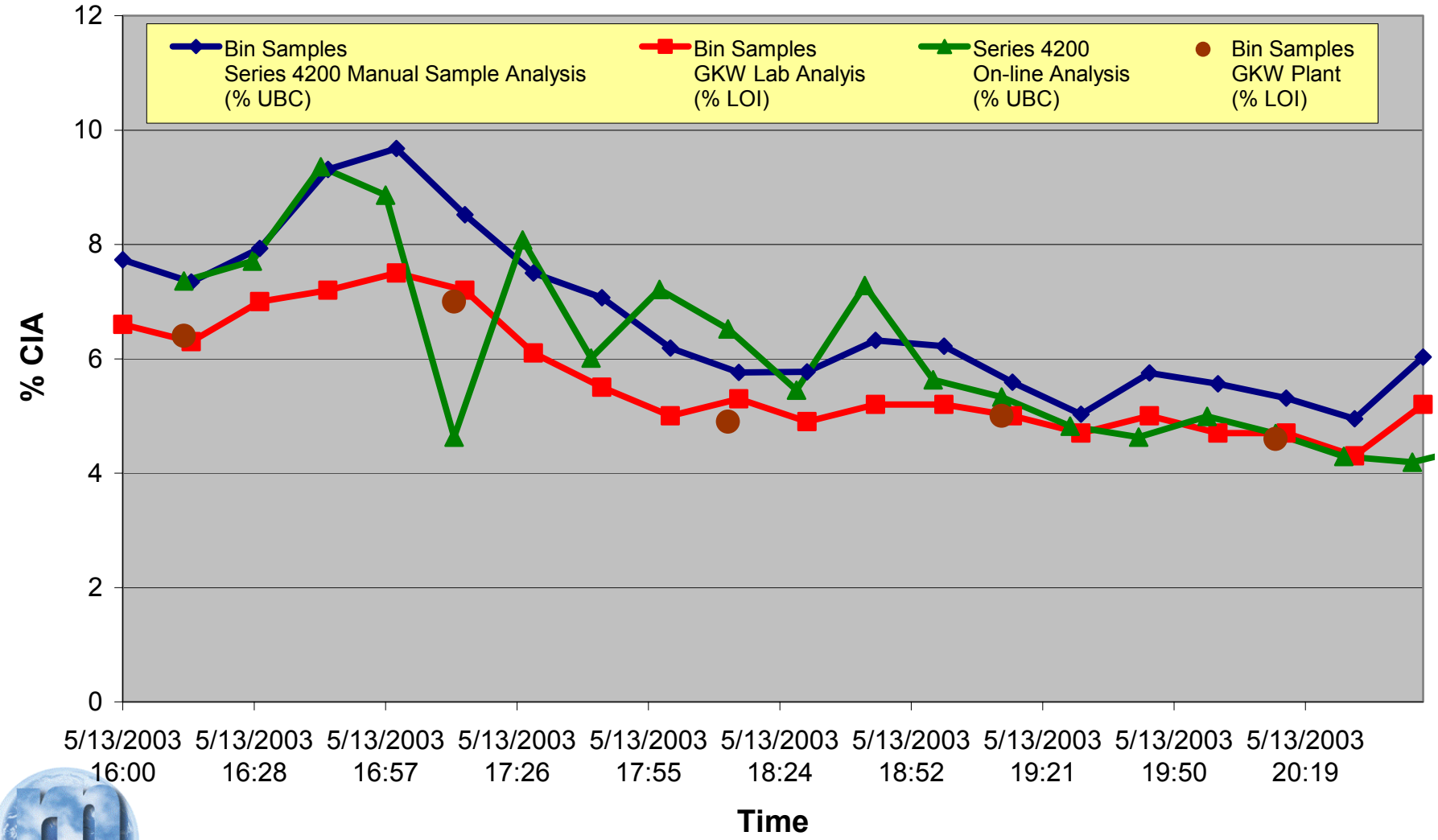
And

Monitor Inside Shelter

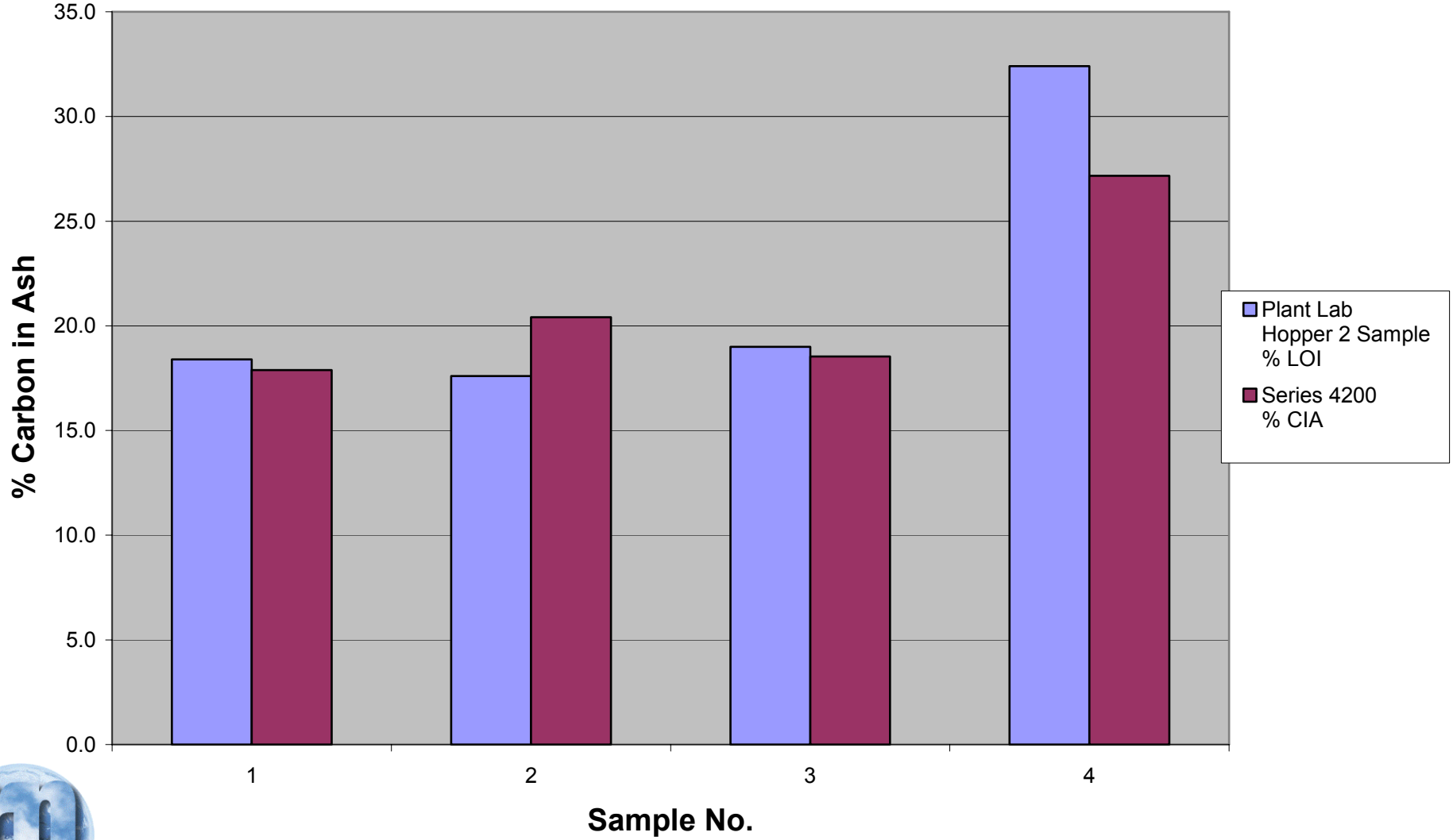
Method Comparison – Accuracy Results
Series 4200 vs. LOI at GKW

Sample Time (Manual Samples)	Bin Samples Series 4200 Manual Sample Analysis (% UBC)	Bin Samples GKW Lab Analyis (% LOI)	Bin Samples GKW Plant (% LOI)	Sample Time (Series 4200 On-line Samples	Series 4200 On-line Analysis (% UBC)	Unit Difference (GKW Lab vs. On-line 4200)	Unit Difference (GKW Lab vs. On-Line 4200 w/ 1.1 span factor
5/13/03 16:00	7.7	6.6	6.4	16:13	7.4	0.8	0.1
5/13/03 16:15	7.3	6.3		16:28	7.7	1.4	0.2
5/13/03 16:30	7.9	7.0		16:43	9.4	2.4	0.3
5/13/03 16:45	9.3	7.2		16:57	8.9	1.7	0.2
5/13/03 17:00	9.7	7.5	7.0	17:12	4.6	-2.9	-0.4
5/13/03 17:15	8.5	7.2		17:27	8.1	0.9	0.1
5/13/03 17:30	7.5	6.1		17:42	6.0	-0.1	0.0
5/13/03 17:45	7.1	5.5		17:57	7.2	1.7	0.3
5/13/03 18:00	6.2	5.0	4.9	18:12	6.5	1.5	0.3
5/13/03 18:15	5.8	5.3		18:27	5.5	0.2	0.0
5/13/03 18:30	5.8	4.9		18:42	7.3	2.4	0.5
5/13/03 18:45	6.3	5.2		18:57	5.6	0.4	0.1
5/13/03 19:00	6.2	5.2	5.0	19:12	5.3	0.1	0.0
5/13/03 19:15	5.6	5.0		19:27	4.8	-0.2	0.0
5/13/03 19:30	5.0	4.7		19:42	4.6	-0.1	0.0
5/13/03 19:45	5.8	5.0		19:57	5.0	0.0	0.0
5/13/03 20:00	5.6	4.7	4.6	20:12	4.7	0.0	0.0
5/13/03 20:15	5.3	4.7		20:27	4.3	-0.4	-0.1
5/13/03 20:30	5.0	4.3		20:42	4.2	-0.1	0.0
5/13/03 20:45	6.0	5.2		20:57	4.5	-0.7	-0.1
Averages	6.7	5.6			6.1	0.4	0.1

Series 4200 Accuracy Results
Series 4200 %CIA vs. GKW %LOI



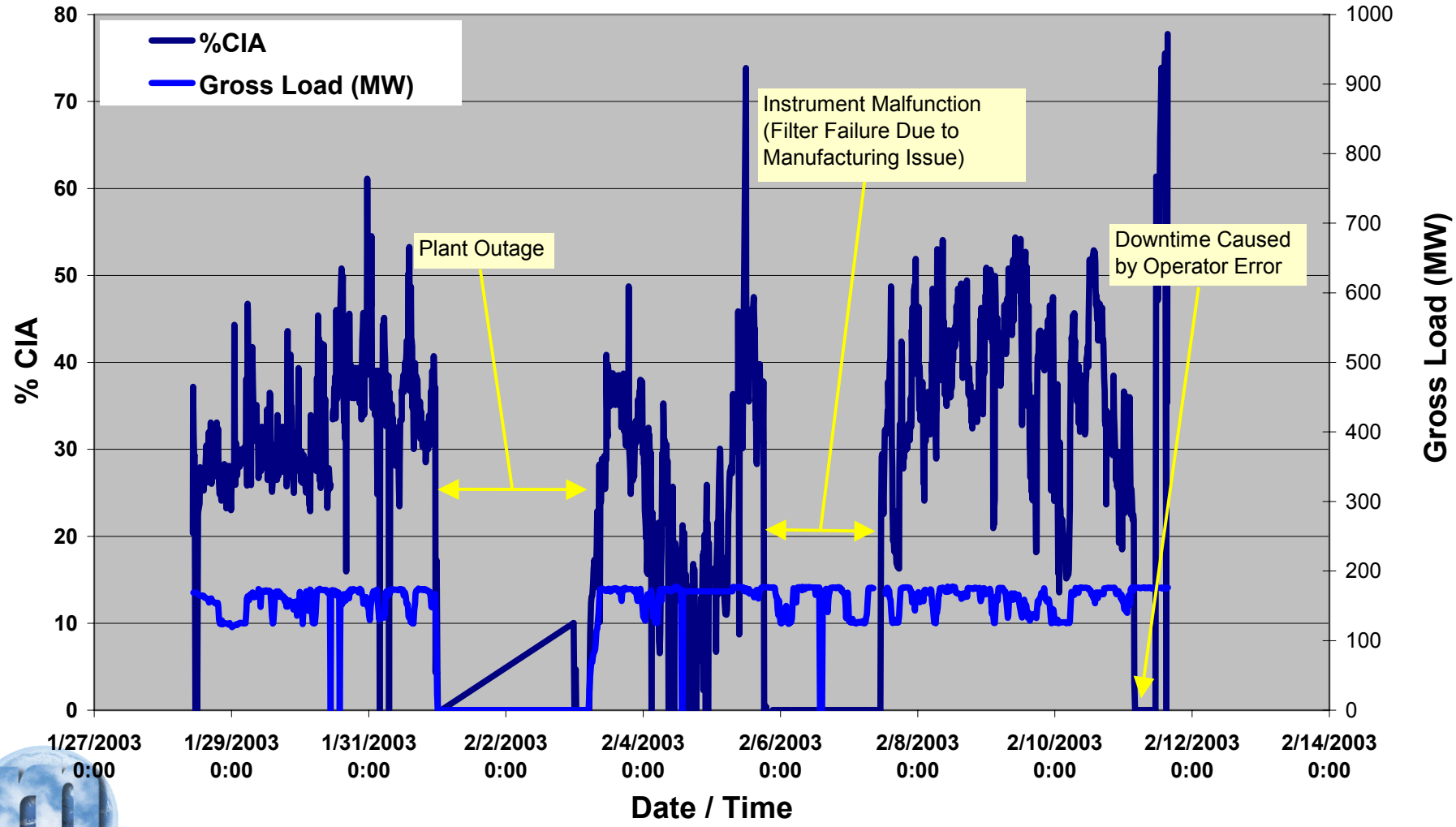
Series 4200 Accuracy Results - NYS Plant
Series 4200 % CIA vs. Plant Lab % LOI



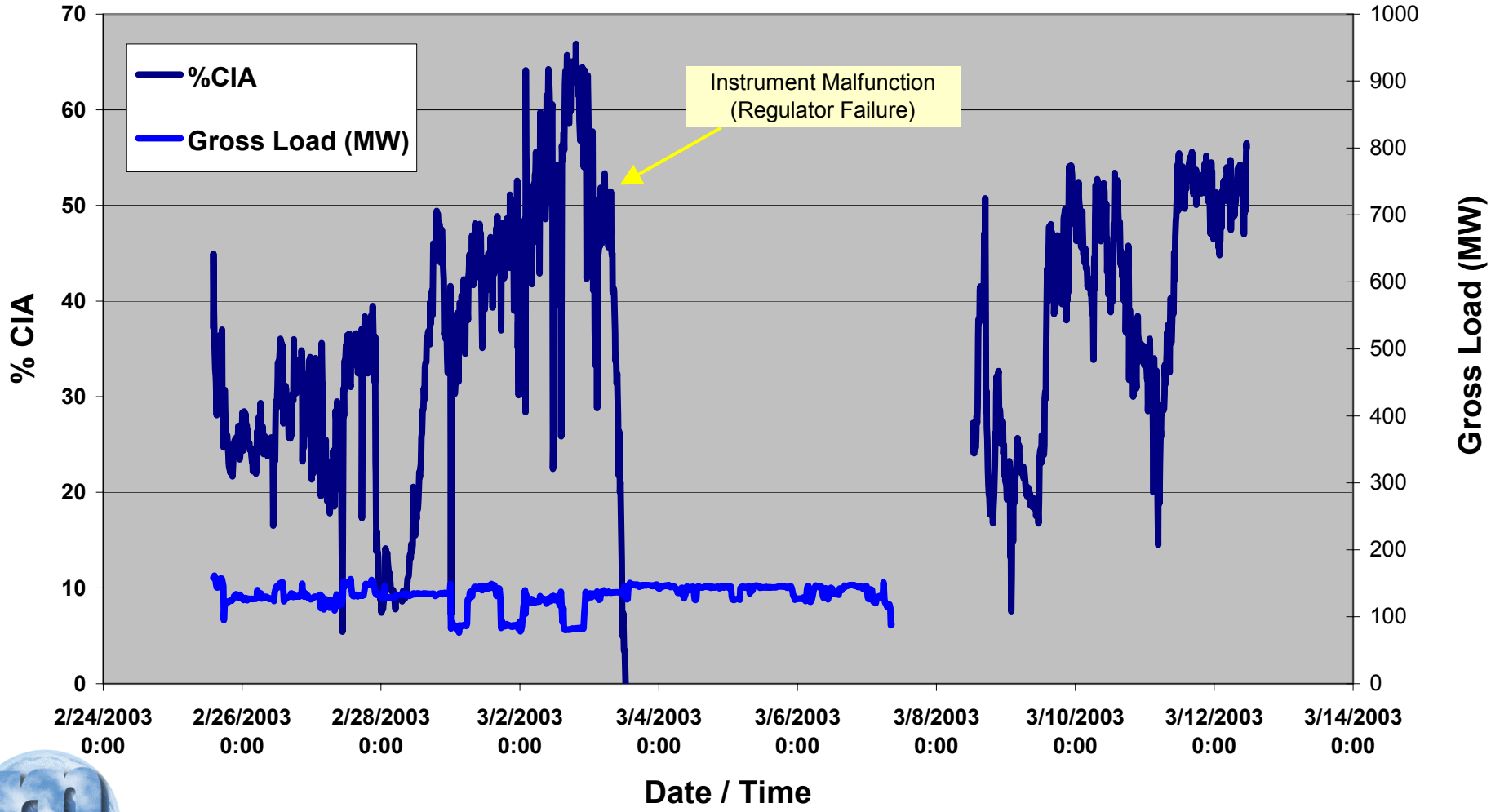
Series 4200 Accuracy Results - NYS Plant
Series 4200 % CIA vs. Plant Lab % LOI

Sample No.	Plant Lab Hopper 2 Sample % LOI	Series 4200 % CIA	Unit Difference
1	18.4	17.9	-0.5
2	17.6	20.4	2.8
3	19.0	18.5	-0.5
4	32.4	27.2	-5.2
Average Unit Difference			-0.8

Series 4200 Operational Evaluation
NYS Power Plant: 1/29 - 2/11/03



Series 4200 Operational Evaluation
NYS Power Plant
Test Period: 2/25 - 3/14/03



Note: Final 4 weeks of test not shown as there was 100% on-line performance after 3/14/03 except for routine maintenance periods.

Summary

TEOM Series 4200 Combustion Efficiency Monitor

- Direct measurement technique generates carbon results independent of coal type.
- Low installation effort required.
- Measurement results demonstrate high resolution and accuracy (~ 0.4% CIA).
- Operational testing found monitor to be easily maintained and reliable.

Acknowledgements

- New York State Research and Development Authority
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