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Thermo Scientific PM CEMS

December 1, 2011
McIlvaine Hot Topic Hour
PM CEMS

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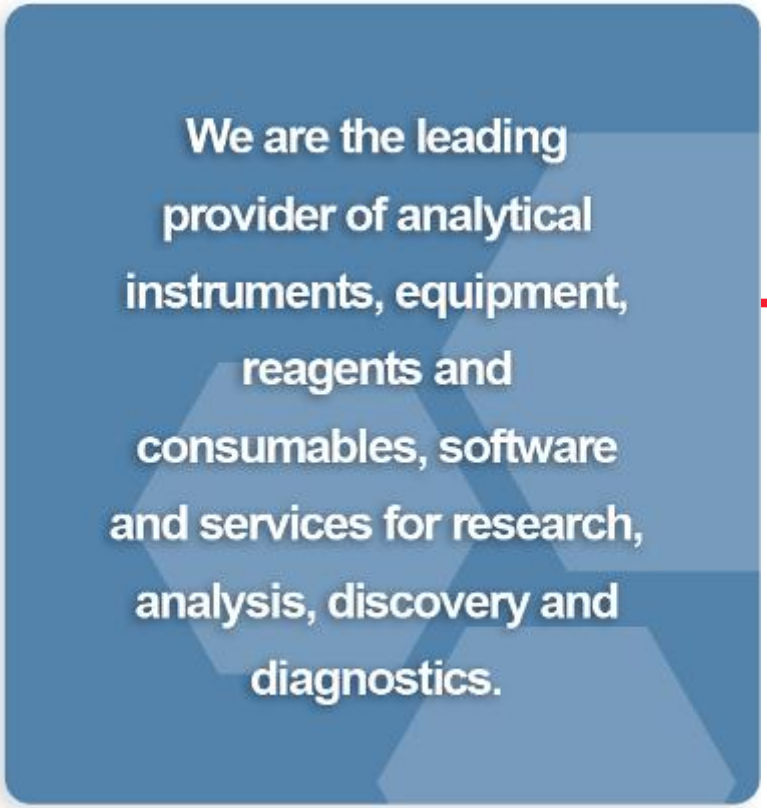
Headlines

- Thermo Fisher Scientific: The world leader in serving science
- Newer regulations are requiring the use of PM CEMS
- PM CEMS overcome the significant limitations of Opacity Monitors
- Many existing PM CEMS technologies use surrogate methods
- Thermo Scientific PM CEMS applies an advanced hybrid approach
- Field results validate design advantages in varying plant conditions

Global Industry Leadership



The world leader in serving science

Scale

- $10 billion in revenues
- 35,000 employees in 40 countries
- 350,000 customers in 150 countries
- #234 on Fortune 500

Depth

- Innovative products
- Applications expertise
- Productivity partner

Leading Brands

- Thermo Scientific: innovation
- Fisher Scientific: convenience

Air Quality Instruments Overview

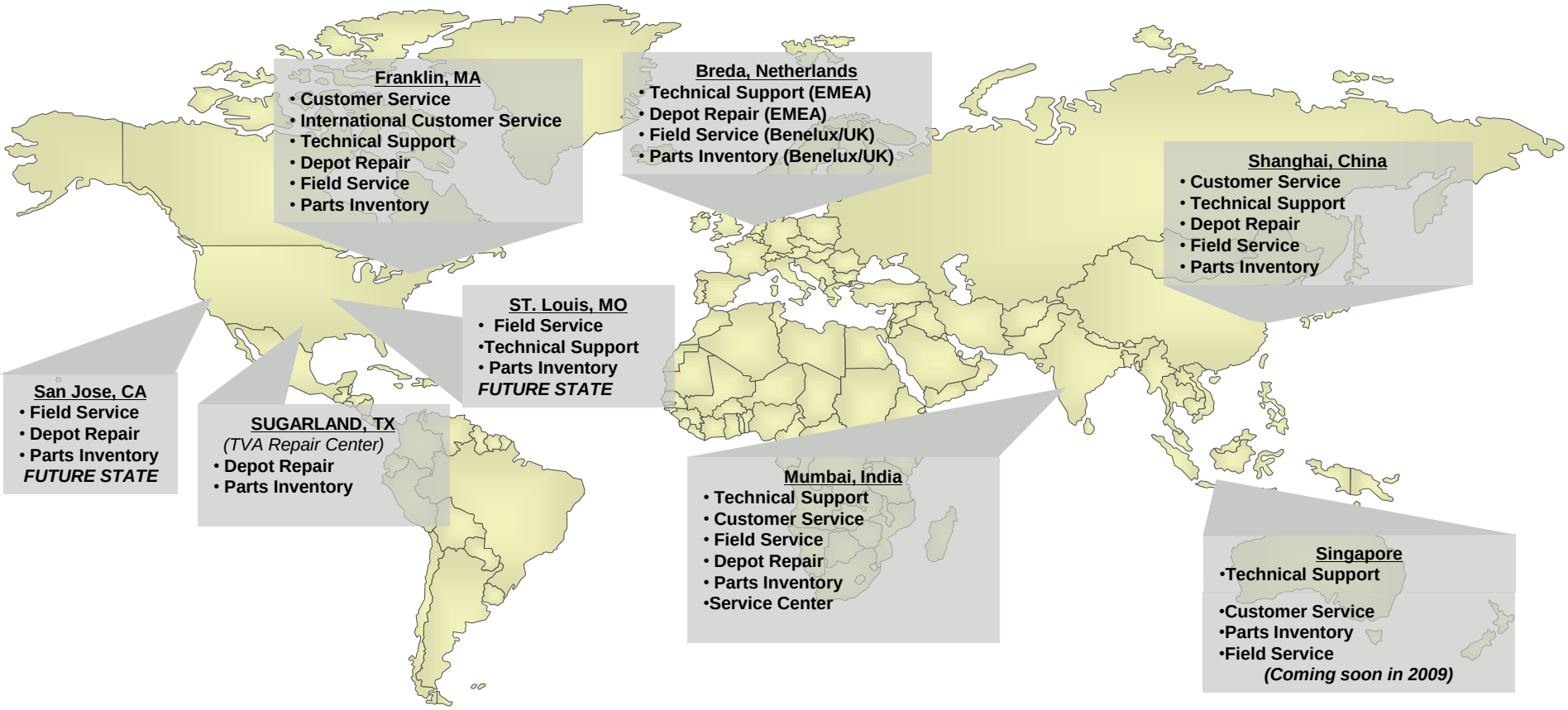
- Headquartered in Franklin, Massachusetts
- Three global manufacturing sites, four systems integration facilities
- Global sales presence, more than 100 distributors in 30+ countries
- More than 100 products using innovative, advanced technologies

Ambient Air

Source

Industrial Hygiene

Global CEMS integration and Service locations



Think globally, Act locally!

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Three recent MACT rules require PM CEMS

- Utility MACT (proposed on May 3, 2011)
  - Coal-fired, IGCC and solid-oil derived fuel sources
  - Filterable PM measurement will be a surrogate for non-Hg metals
  - PM CEMS will also replace the need for opacity monitors
- Industrial Boiler MACT (indefinitely postponed)
  - Units combusting coal, biomass, or residual oil with heat input capacities of 250 MMBtu/hr or greater
- Portland Cement MACT (compliance by October 2013)
  - PM CEMS required at exhausts of cement kiln and clinker cooler

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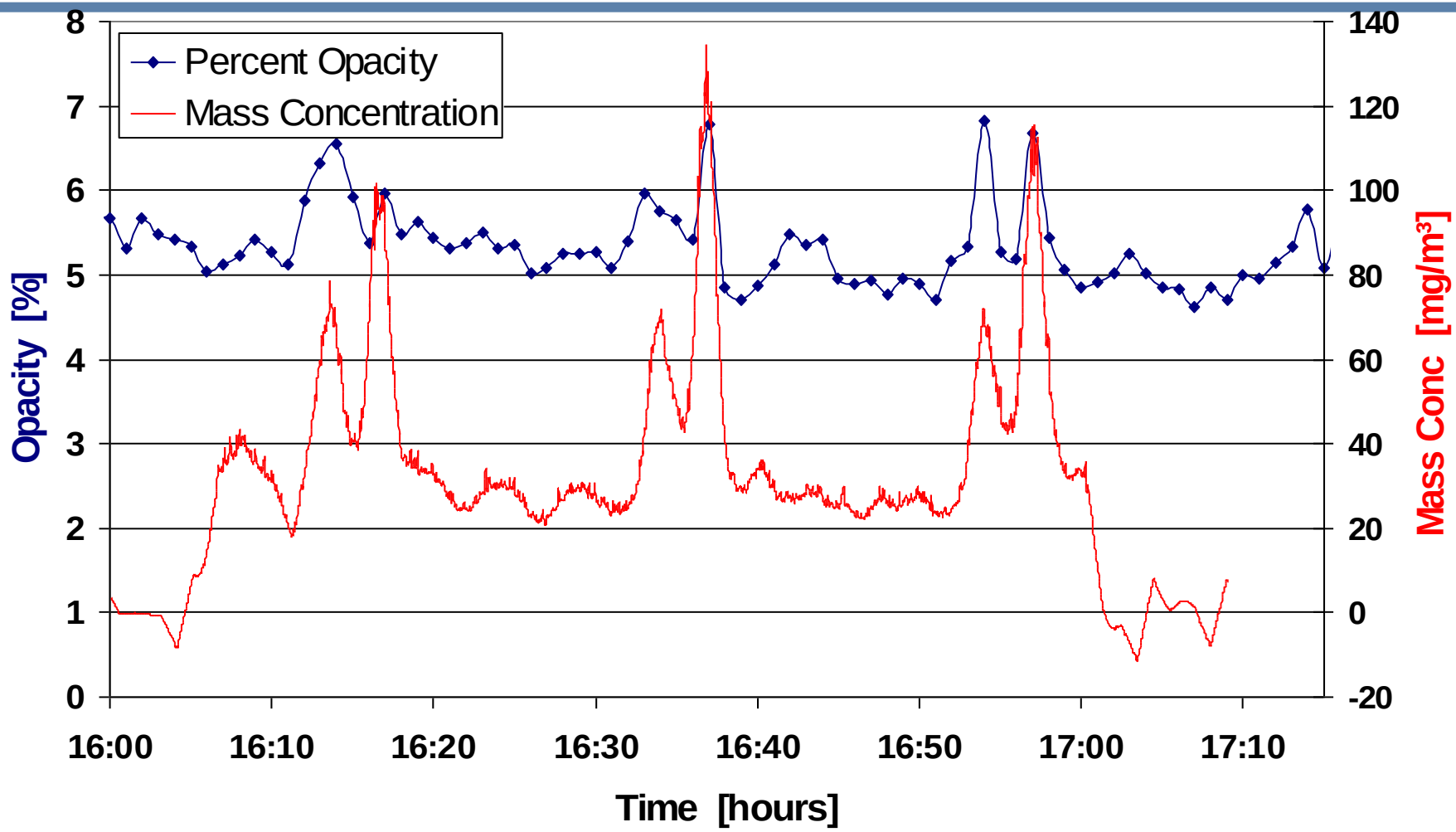
Opacity monitors have many limitations

- Light attenuation measurement
- Adversely affected by
  - Particle size, shape, density changes
- Measures liquid drops as PM
- Not sensitive to low PM concentration
- Correlation to PM mass concentrations not linear

Inertial Microbalance Stack Sampler vs. Opacity



Plot demonstrates that opacity monitors do not respond to changes in particulate concentrations.

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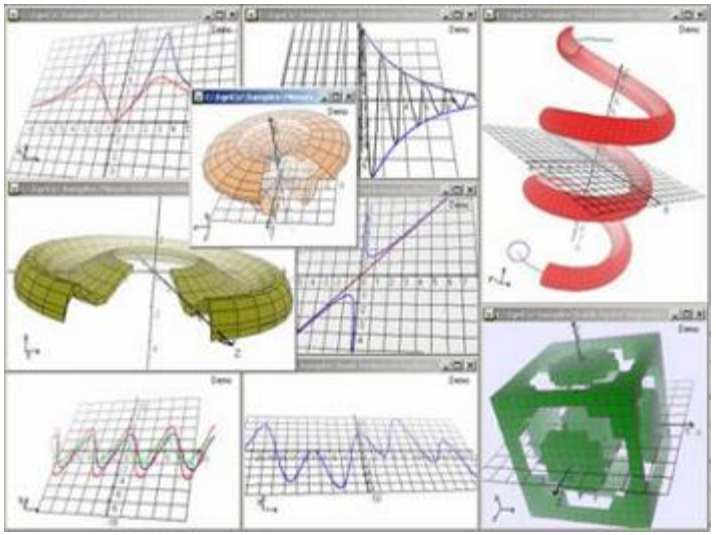
Most measurement methods are surrogate

- Light scattering — *f* (scattered light)
- Beta attenuation — *f* (beta reduction)
- Light extinction — *f* (attenuation of light)
- Inertial microbalance — *f* (frequency)



Surrogate methods are inadequate for particulate measurement under varying plant conditions

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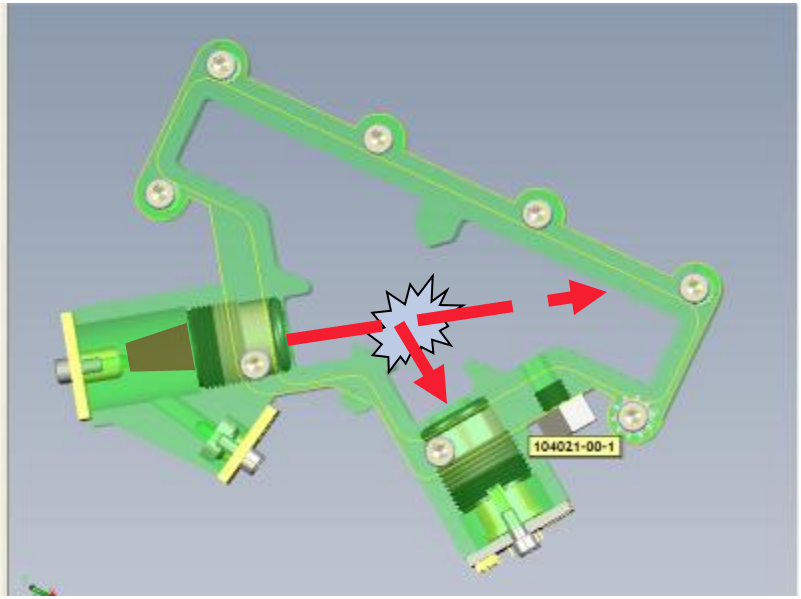
Thermo Scientific PM CEMS uses a hybrid method

- Measures filterable particulate, in accordance with PS-11
- Hybrid technology combines the light scattering and inertial microbalance methods
- Methods 5 and 17 are the reference methods used for comparison
- Early R&D effort was targeted at measuring primary particulate
- Field demos performing under different plant conditions

CEMS Design - Light Scattering

Strengths

- Easy to install
- Low maintenance
- Sensitive to low PM concentration



Limitations

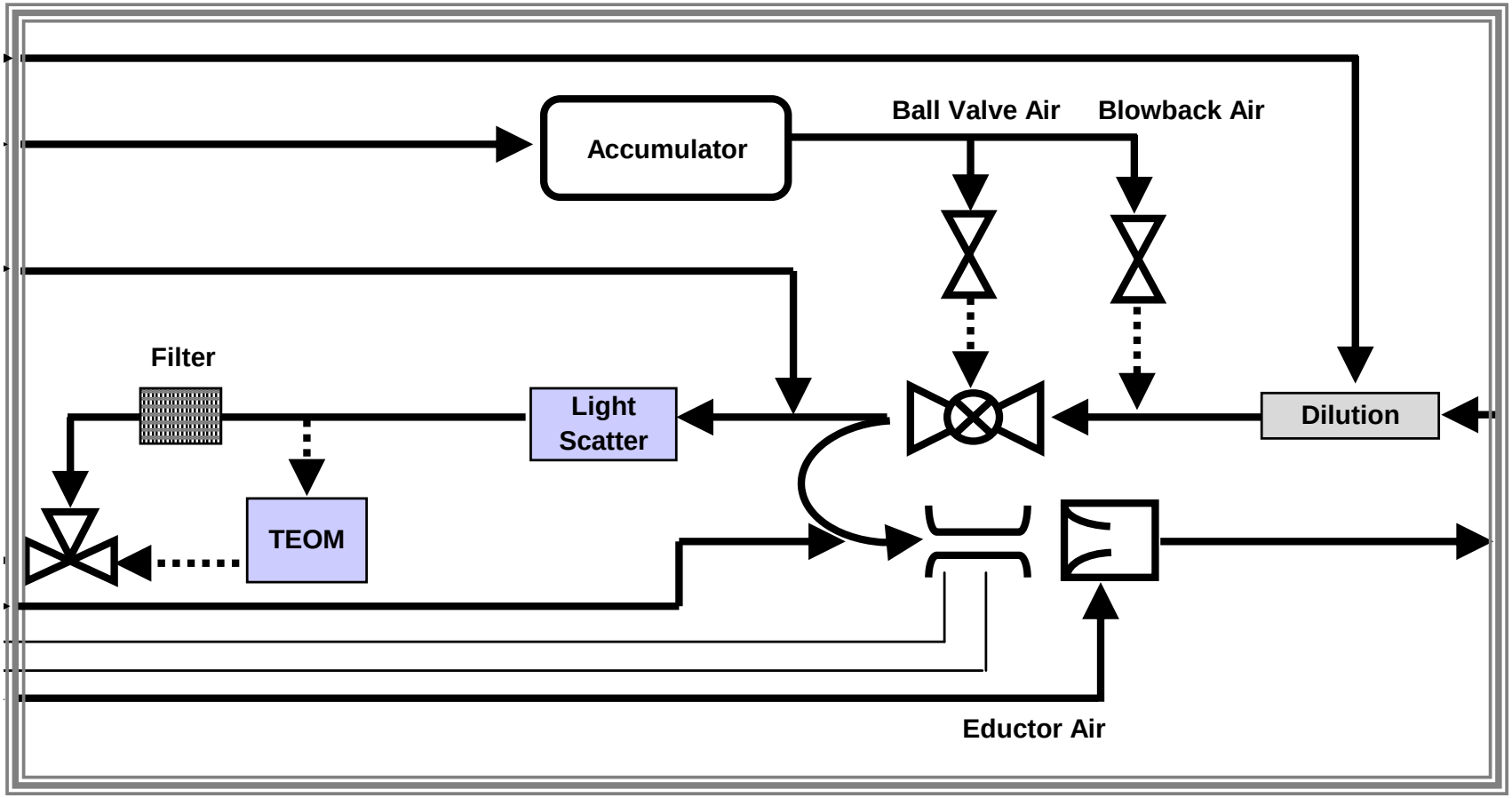
- Indirect mass measurement
  - Measures secondary properties of PM
- Affected by particle size, density, shape
- IR light better than visible light
- Measures liquid drops as PM

CEMS Design - Inertial Microbalance

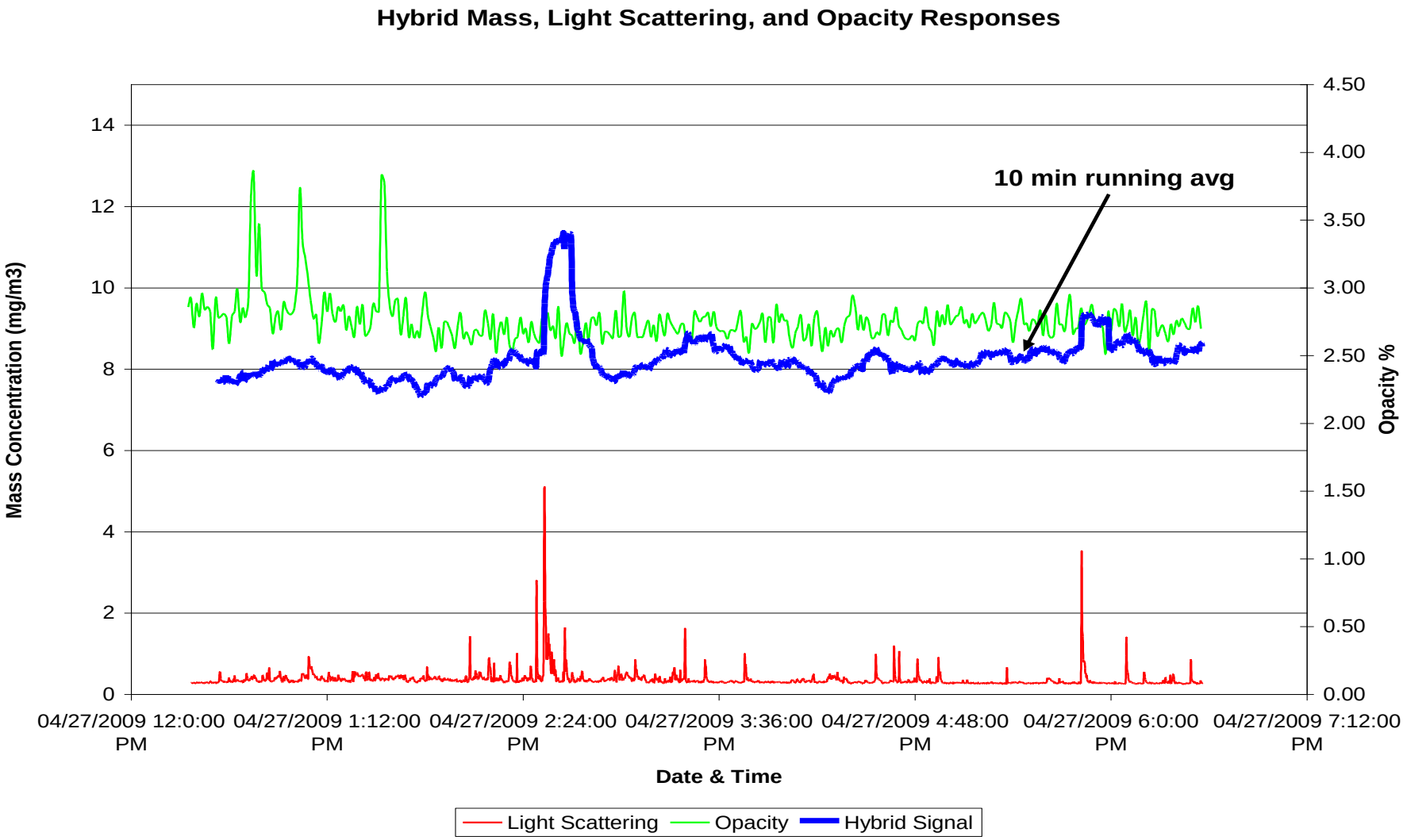
- Real-time Mass Measurement
- NIST Traceable Mass Sensing
  - Direct relationship between mass and frequency change
  - Tapered element oscillates at its natural frequency
  - Frequency decreases with accumulation of mass on filter
- ASTM D 6831-02
  - Equivalent to Methods 5 and 17
  - Recently Renewed
- Limited Duration for sampling

TEOM creates the possibility of self-referencing

Functional block diagram of PM CEMS



Hybrid Signal- 2009 Testing Coal w/Baghouse



Early testing depicting hybrid signal for true continuous measurement.

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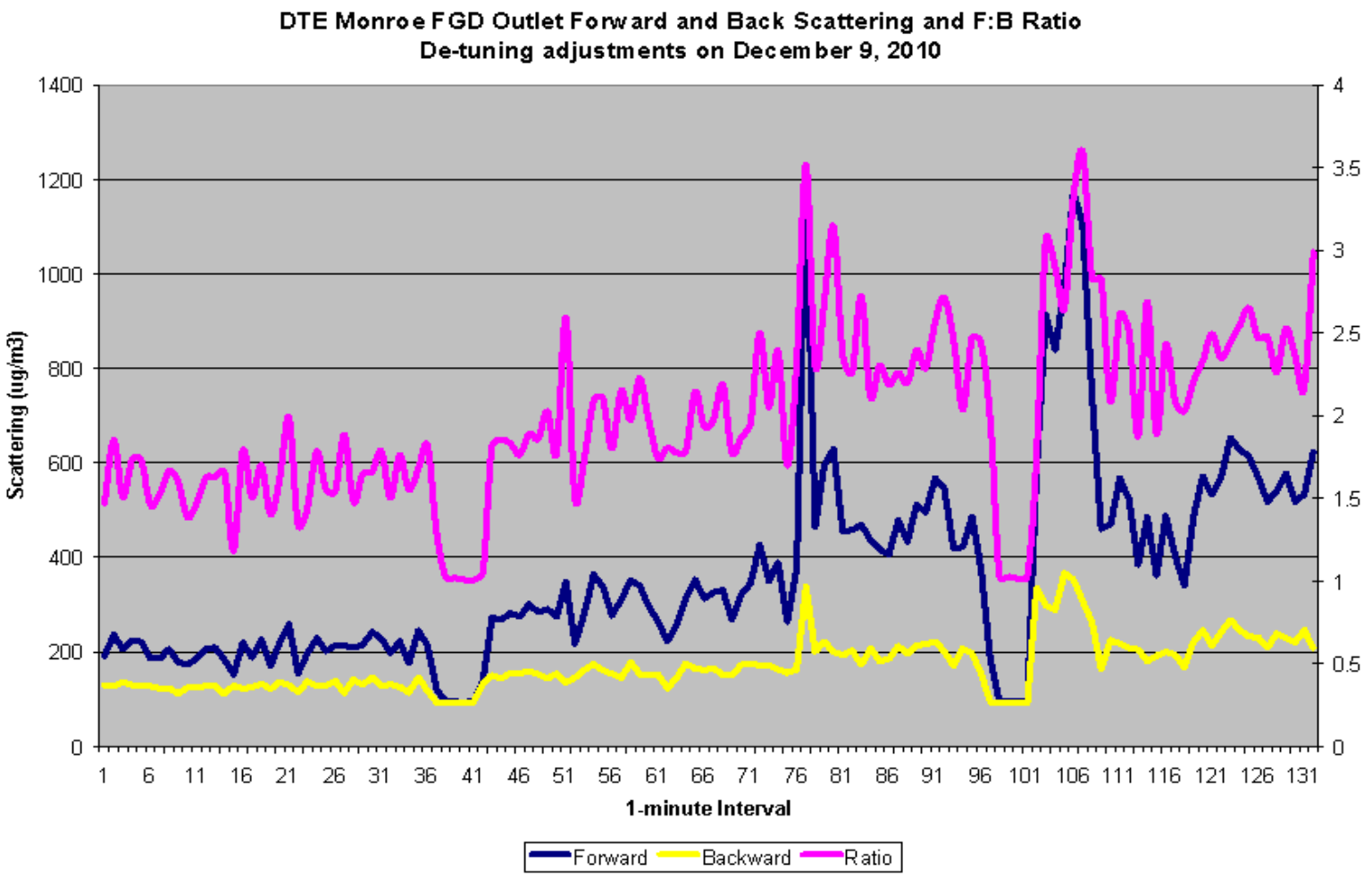
PM CEMS Prototype Installation
DTE Monroe – Monroe, MI



Changing Forward to Backward Scattering Ratio indicates changes occurring in particle size characteristics.

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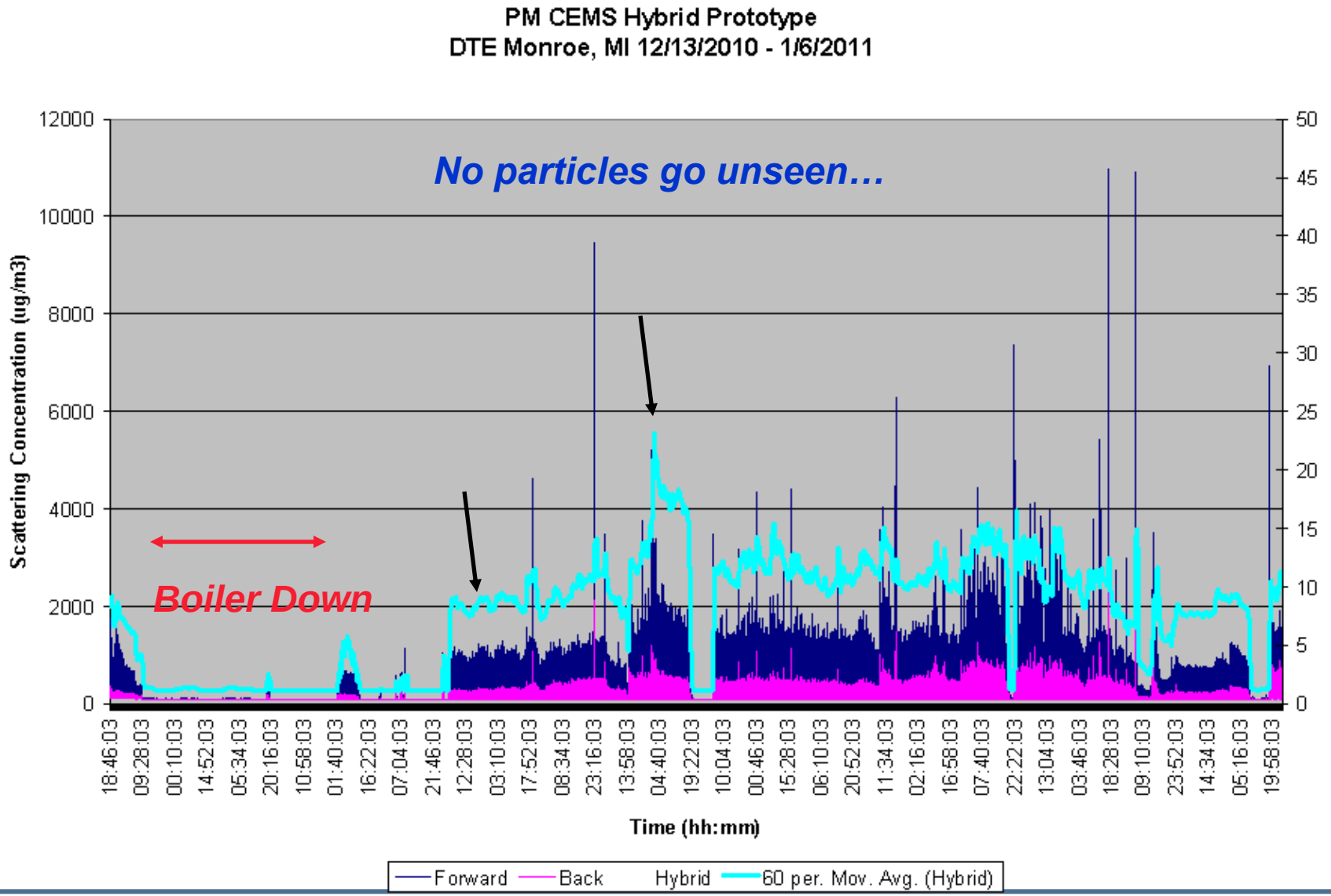
PM CEMS Prototype Installation DTE Monroe, MI



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Summary

- Hybrid PM CEMS uses light scattering calibrated to an inline TEOM
- TEOM offers traceability to NIST standards
- Dual scattering is a dynamic “indicator” of change in particulate characteristics and/or can be a diagnostic tool
- Technology expected to support evolving industrial process needs
- Beta testing beginning in Fall 2011
- PS-11 Correlation testing is meeting EPA requirements