An Accurate Portable Battery Operated Particulate Monitor

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Introduction

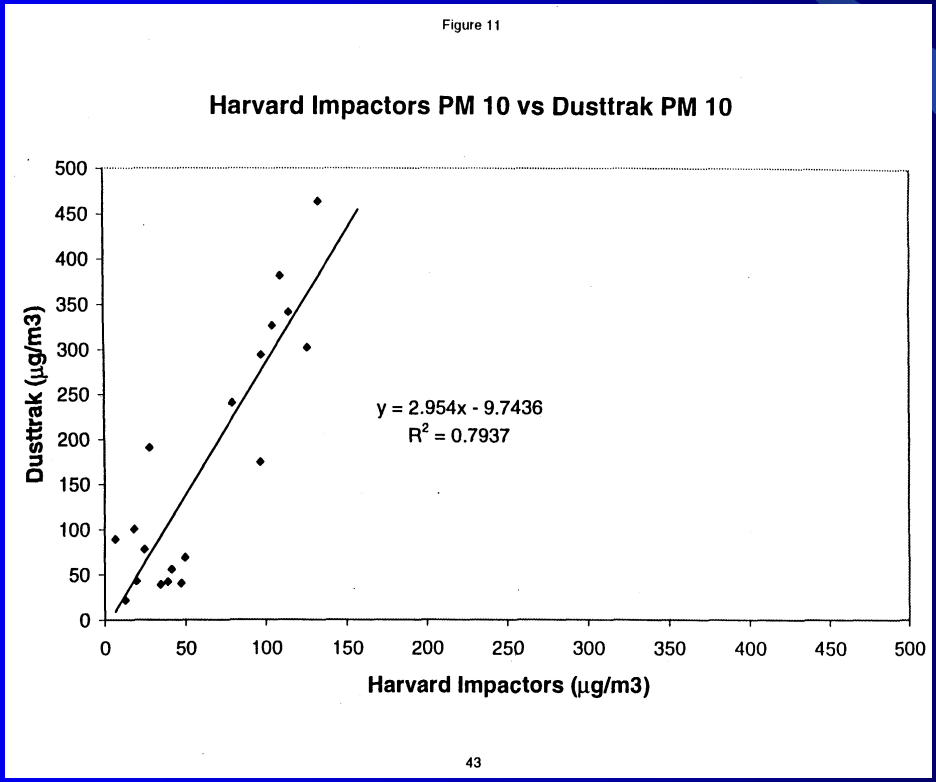
- Met One Instruments Search for an Accurate Portable Continuous Particulate Monitor
  - Problem - Accuracy
  - Solution - Technology
  - Proof - Testing

Problem

- Potential – Market for DC Monitor
- Dominate Technology - Light Scatter
- Improve on the Technology
- Designed new Integrating Nephelometer

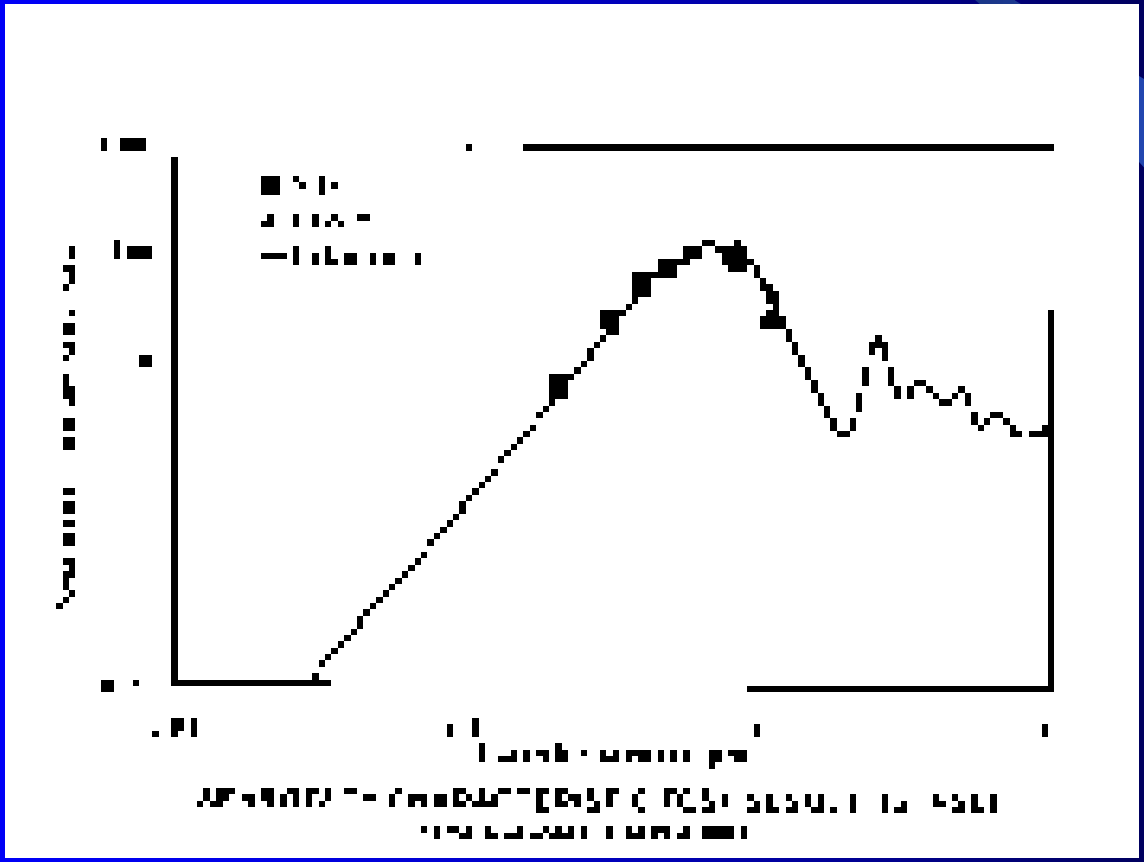
Problem

Accuracy



Problem

Particle Response Curve



Problem

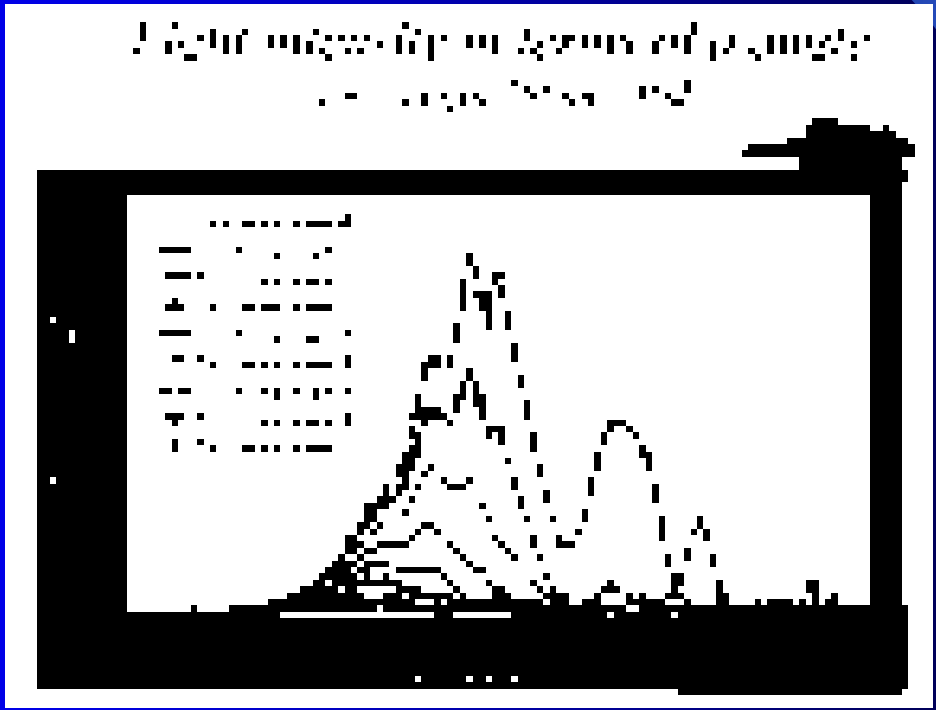
Particle Response Curve

- Curve Maximum at the Wavelength of Light
- Two wavelengths proper optics = 2 Response curves use calculate mean particle diameter

Problem

Particle Response Curve

- Multiple Detector Angles



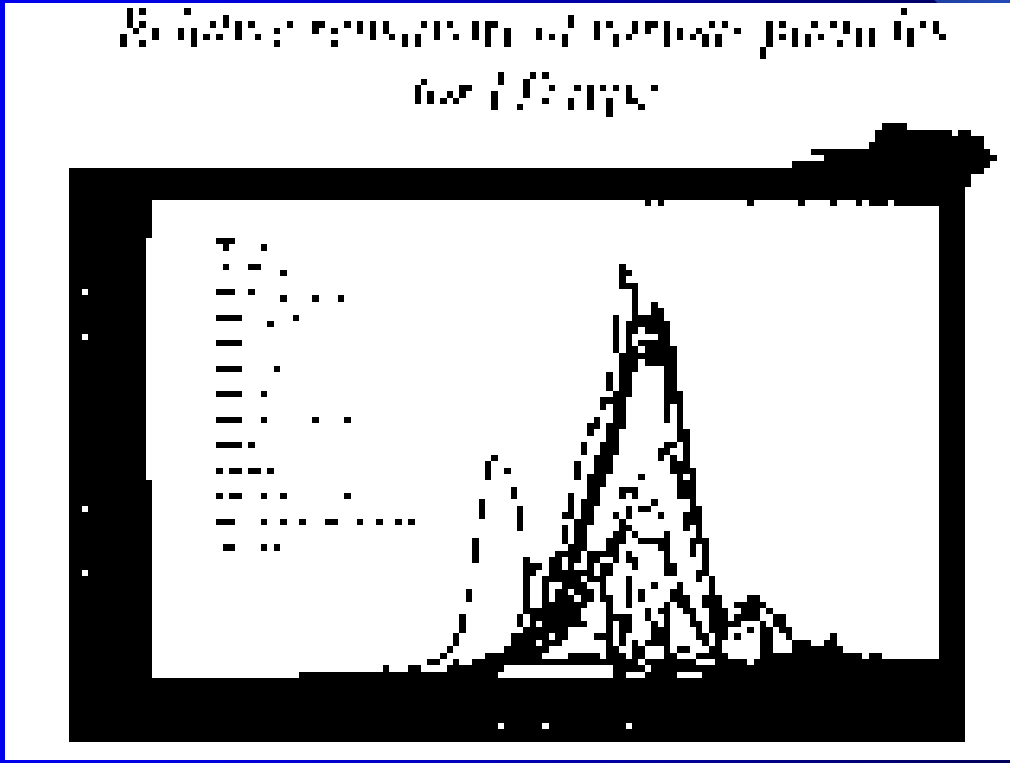
Problem

Particle Response Curve

- Used Multiple wavelengths combined with Particle response curve shift – Mean Diameter
- Used Multiple Detectors
- Results – OK but price outrageous.

Problem
Index of Refraction

- Show Stopper combined with price



Conclusion to the Problem

- Lot of Time, $, Testing
- Different Technology

Solution

Spec's For New Method

- Respond to particle mass not particle size
- Measurement impervious to Chemical Composition
- Proven Technology
- Standard Flow Rate $1m^3/hr$

Solution Technology

- Beta Attenuation
  - Unaffected by particulate size PM10, PM2.5
  - Absorption is independent of ambient particulate chemical composition
  - Met One has Scientific/Engineering knowledge of Beta Attenuation
  - Adaptable to Standard Flow Rate

Solution

Beta Attenuation

- Lambert-Beers Law
  - $I = I_o e^{-\mu x}$
  - **Solve for *x*** $x = -\frac{1}{\mu}\ln(\frac{I}{I_o})$

***I* – Beta counts across clean filter paper**

***Io* – Beta counts across dirty filter paper**

μ – Beta absorption coefficient

***x* – mass density of deposition on filter**

Solution

Beta Attenuation

- Calculating Concentration

$$C = \frac{Ax}{V}$$

A – Area of dust spot deposition (m^2)

V – Sampled Volume of Air (m^3)

x – mass density of deposition on filter (mg/m^2)

C – Concentration (mg/m^3)

Solution
EBAM

Solution
EBAM Features

- Battery Operated 12 VDC
- Portable
- 5 minute Setup
- Flow Rate 1 m^3/hr
- Range to 65 mg/m^3
- Real-Time Measurement
- Filter Tape Life of One Year
- Ambient Sampling for Accurate measurements of semi-volatile nitrates and organic compounds

Proof Testing

- Biscuit Fire PM10
- FRM Comparison PM2.5

Proof

Biscuit Fire Test (BFT)

Proof

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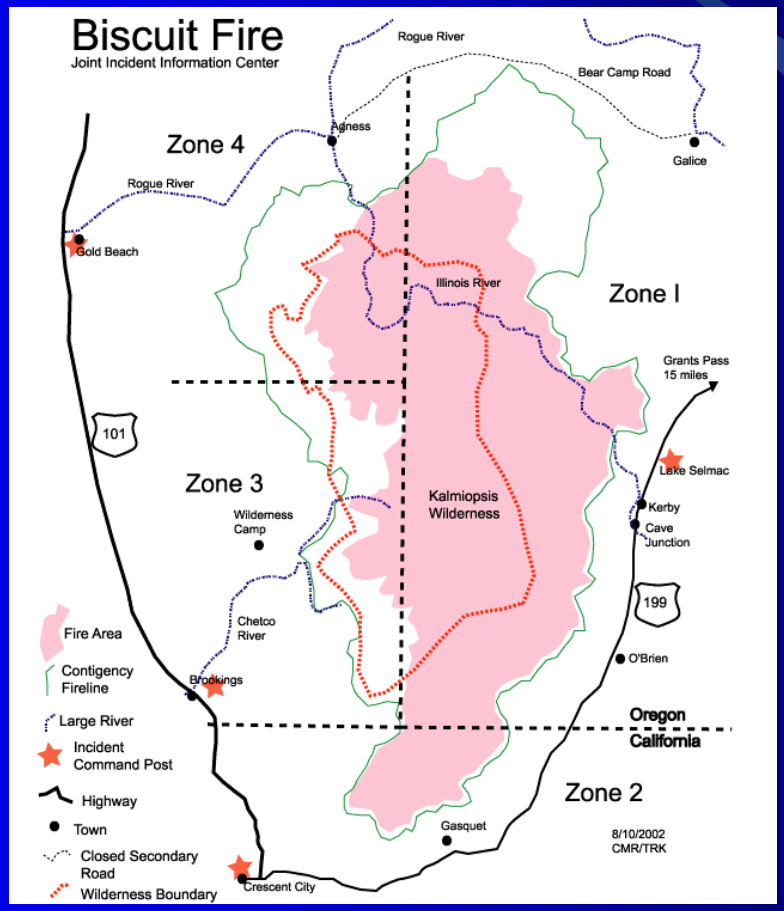
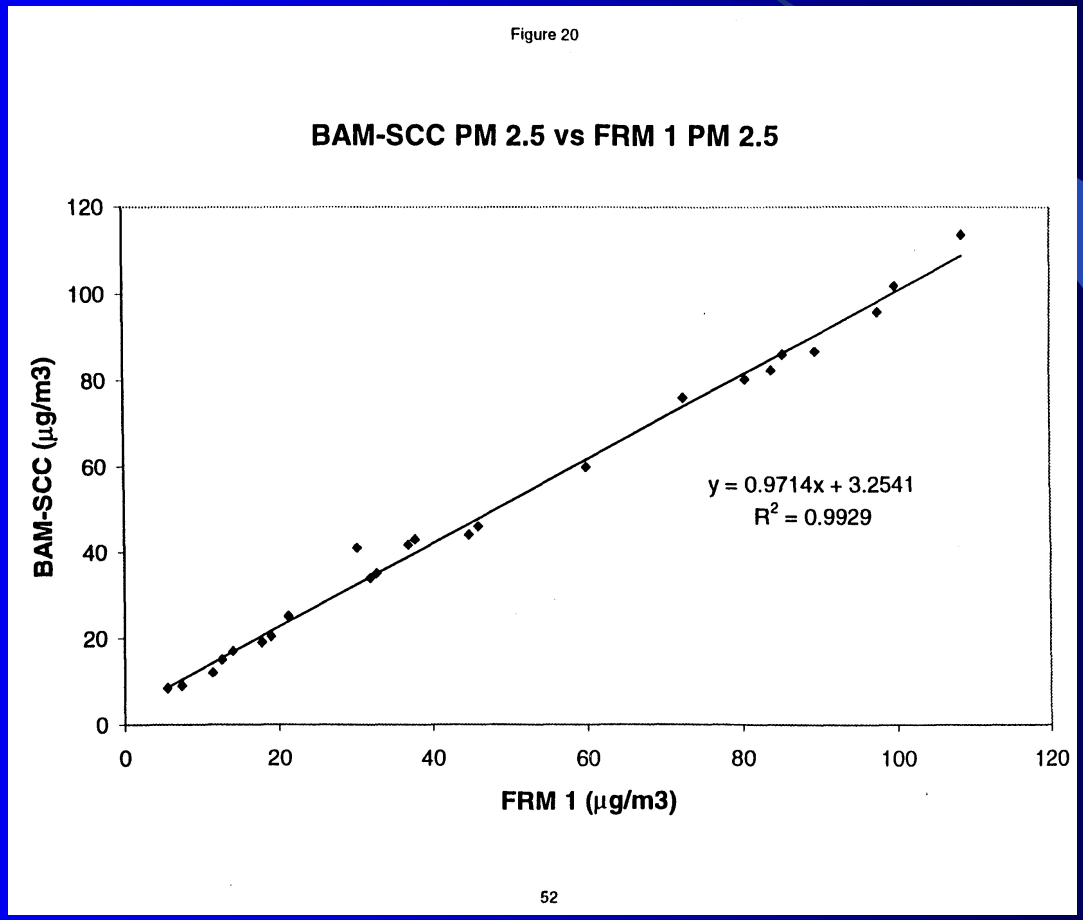


Proof
BFT - Standard

- BAM1020
  - Better Time resolution
  - Same Day Comparisons
  - Proven Accuracy

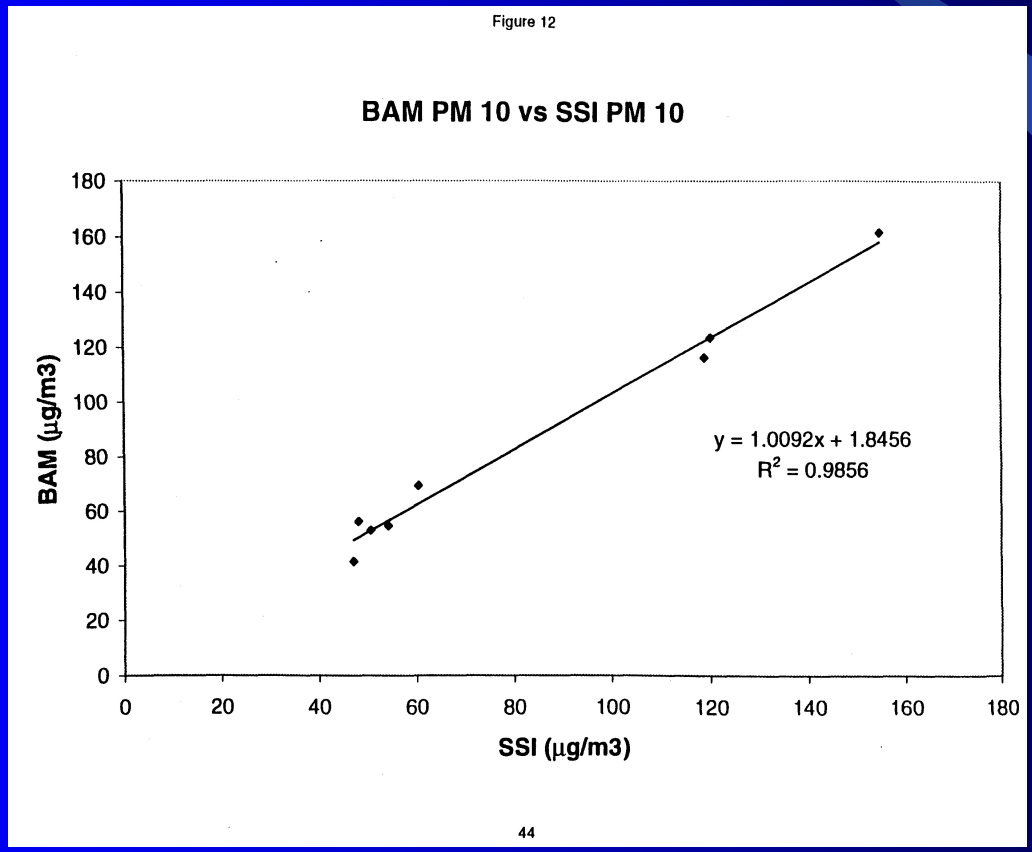
Proof

BFT – Accuracy PM2.5



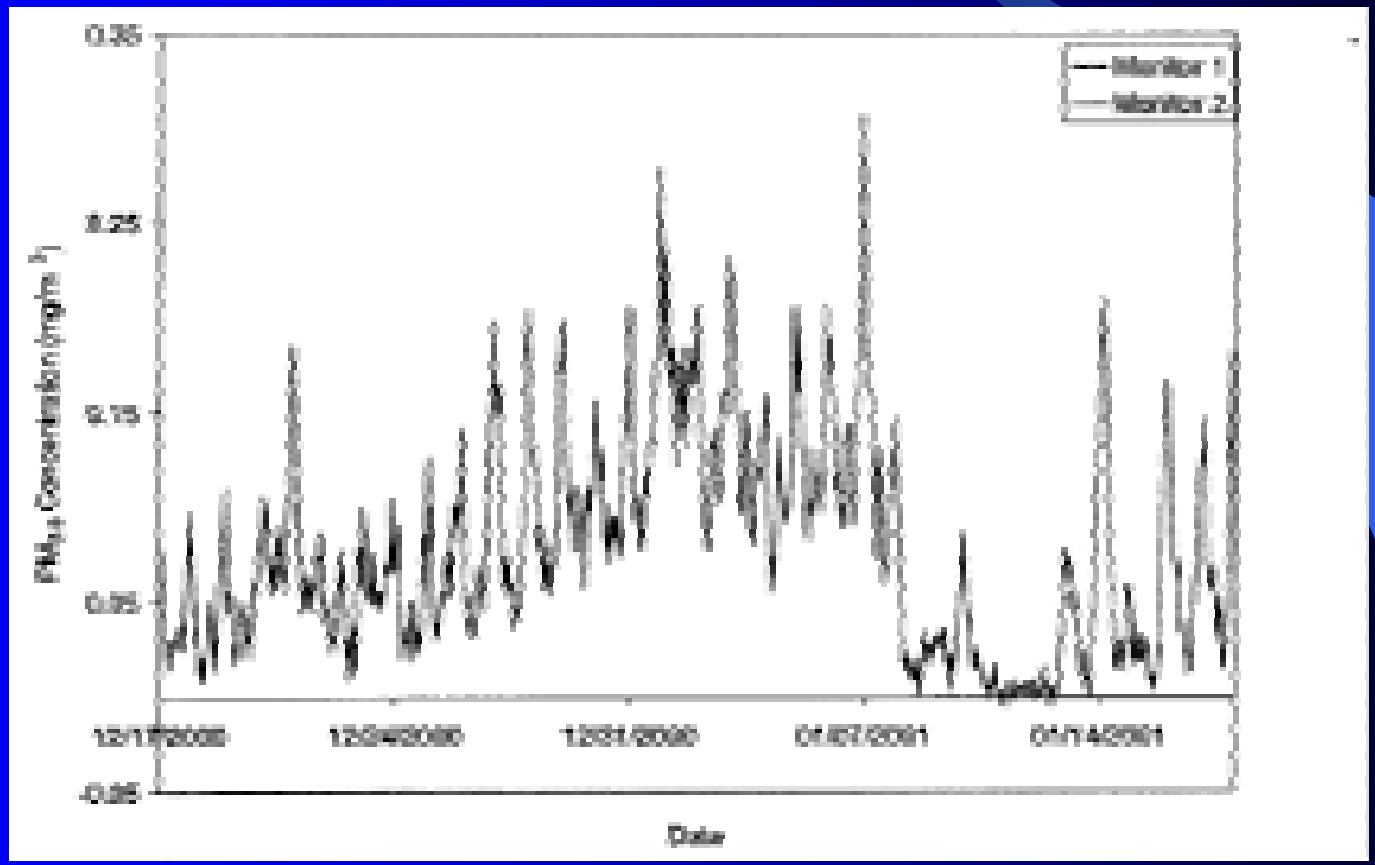
Proof

BFT – Accuracy PM10



Proof

BFT – Precision BAM1020



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BFT – Precision BAM1020

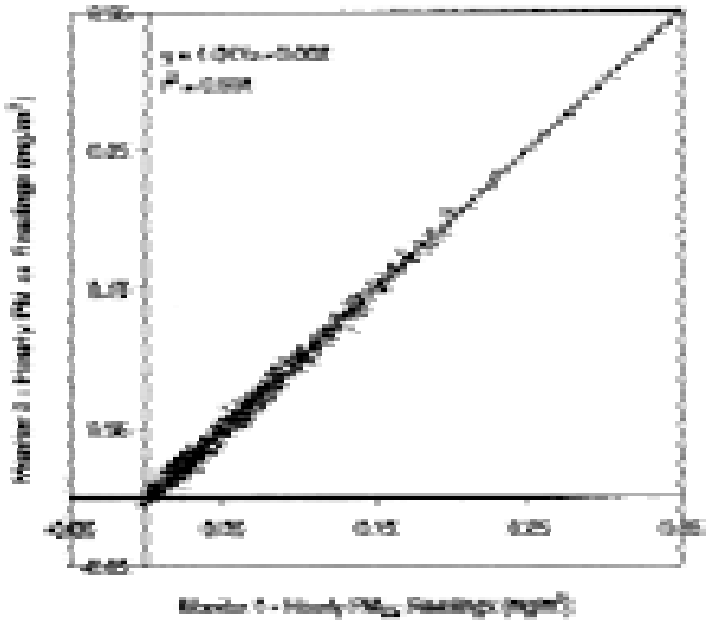


Figure 6-4b. Correlation Plot of Hourly $PM_{2.5}$ Measurements from BAM 1020 Monitors During Phase II of Verification Testing

Proof

BFT – BAM1020 Tests

- Instrument Intercomparison Study Bakersfield, CA 1998-1999
- Environmental Technology Verification Test (ETV) 2000 – 2001
- Second Bakersfield Test Completed February 2002
- RTI Verification Testing for USEPA Completion - August 2002.

Proof

BFT - Exterior

Proof

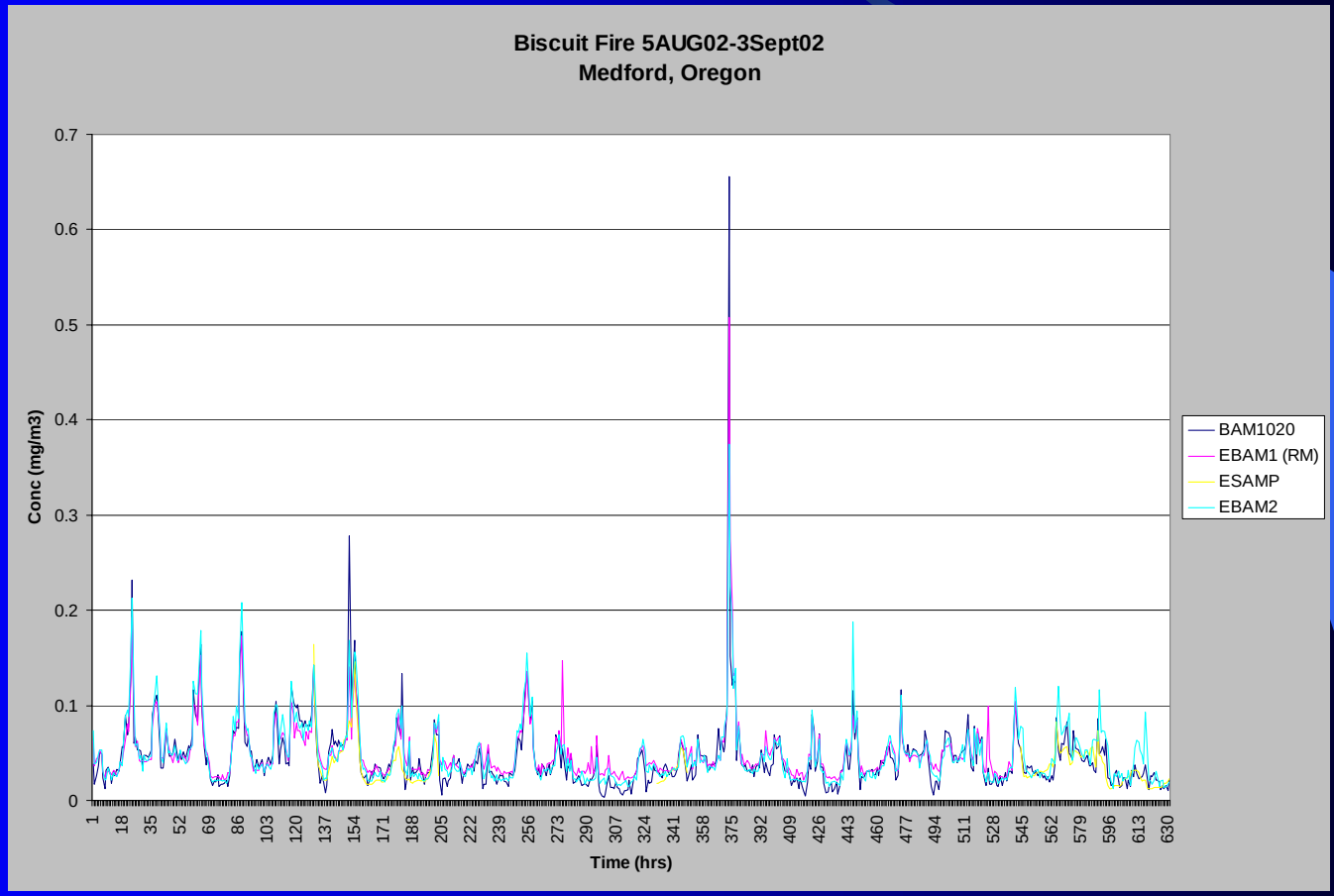
BFT - Interior

Proof

BFT - Interior

Proof

BFT – Results



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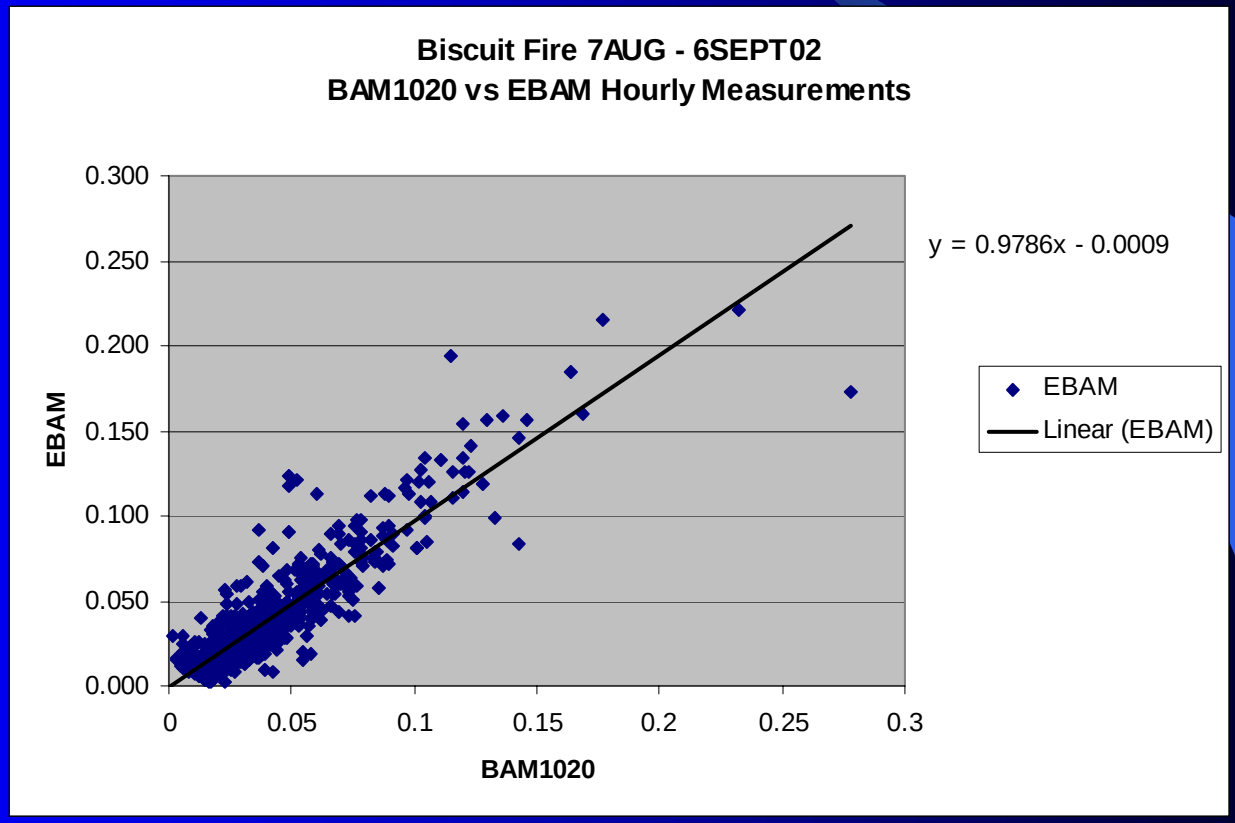
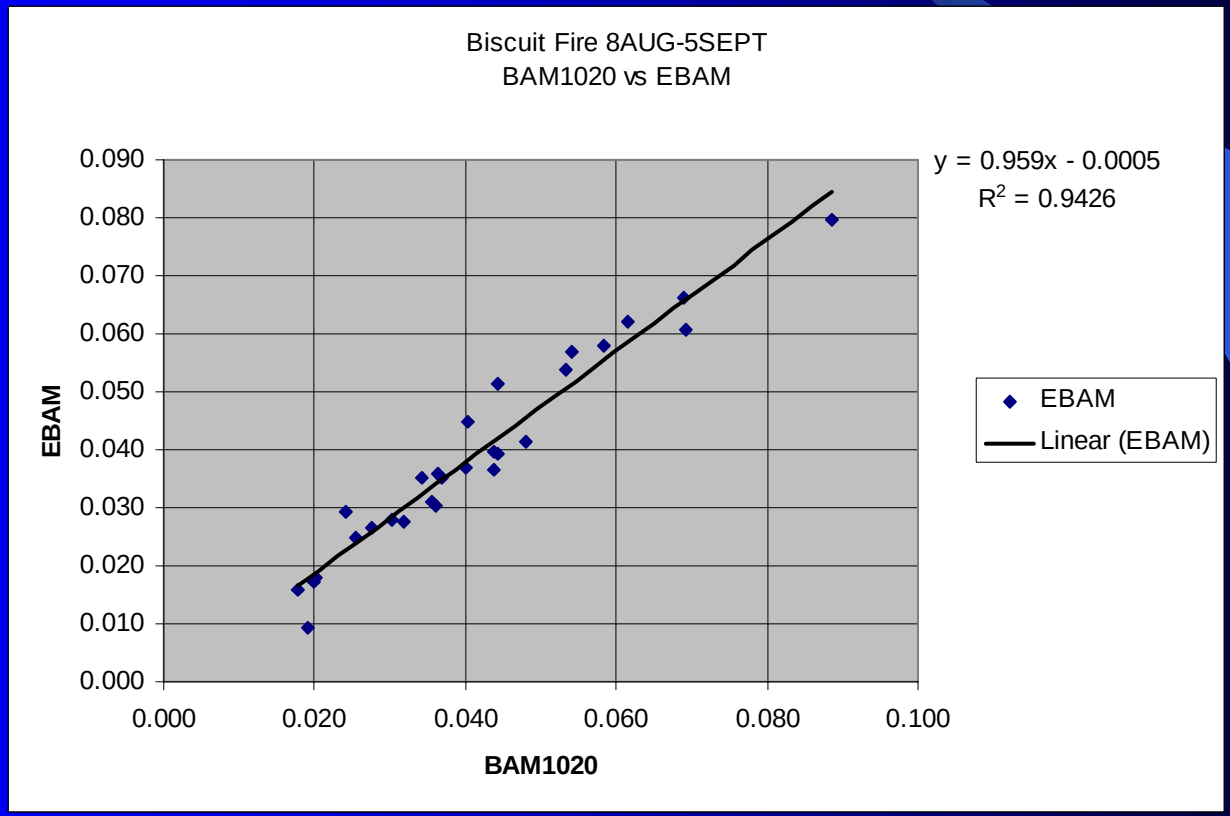
BFT – Results



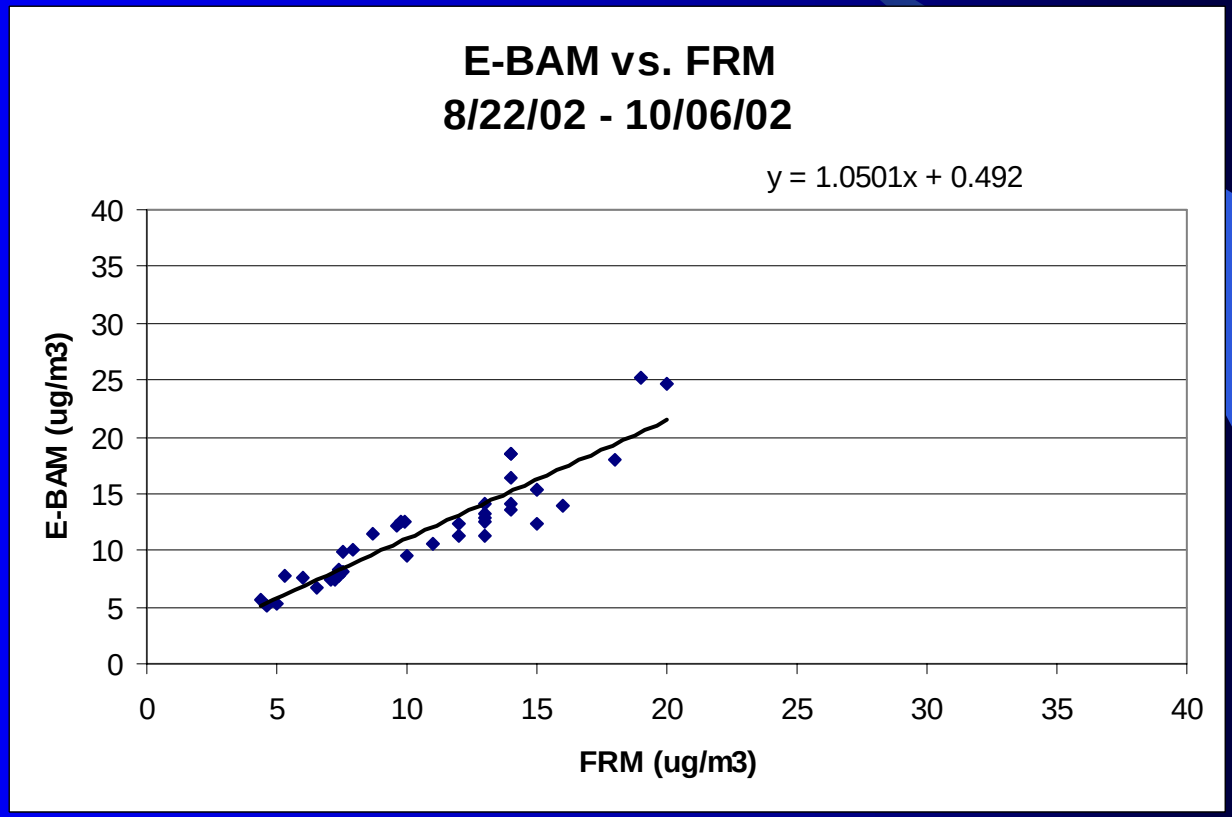
Proof

BFT – Results



Proof

FRM Comparison PM2.5



Conclusion

- Current Light Scatter Methods Intrinsic Accuracy Problems
- Beta Attenuation overcomes these limitations
- EBAM Field Tested to Accurately Match Current Equivalent and Gravimetric Methods