

# Preliminary PM 2.5 BAM/TEOM/FRM Data

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MARAMA Monitoring Meeting

Richmond, VA

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# Brief History of the BAM

- 1930's for paper thickness
- 1970's pollution measures
- 1990's PM 10 FEM
- 2002 E-BAM developed
- 2008 PM 2.5 FEM

# Beta Attenuation

Carbon 14 beta rays are emitted to a detector. Particles absorb the radiation and the monitor measures the reduction in the Beta count in relation to the Beer-Lambert law.

# BAM 1020

(Beta Attenuation Monitor)

Met One Instruments

Grants Pass, Oregon

August, 2008

# FEM Status

EPA Granted Federal Equivalent Method  
(FEM) Status to the BAM 1020 for the  
Measurement of PM<sub>2.5</sub> on 3/12/08

# To Maintain FEM Status the BAM 1020 Must:

- Provide 1-hour Average Concentration Values
- Provide at Least 18 1-hour Average Values per 24-Hour Period
- Provide Concentrations Based on Actual Flow (local ambient conditions of Temp./Pressure)

## To Maintain FEM Status, Cont'd

- Use Firmware Version 3.2.4 or Later
- Use Tape Drive Transport 8470-1 Rev D or later
- Control Shelter Temperature to within  $\pm 2$  Degrees C over any 1-Hour Sampling Period
- Use a  $PM_{10}$  Head and a  $PM_{2.5}$  VSCC

## To Maintain FEM Status, Cont'd

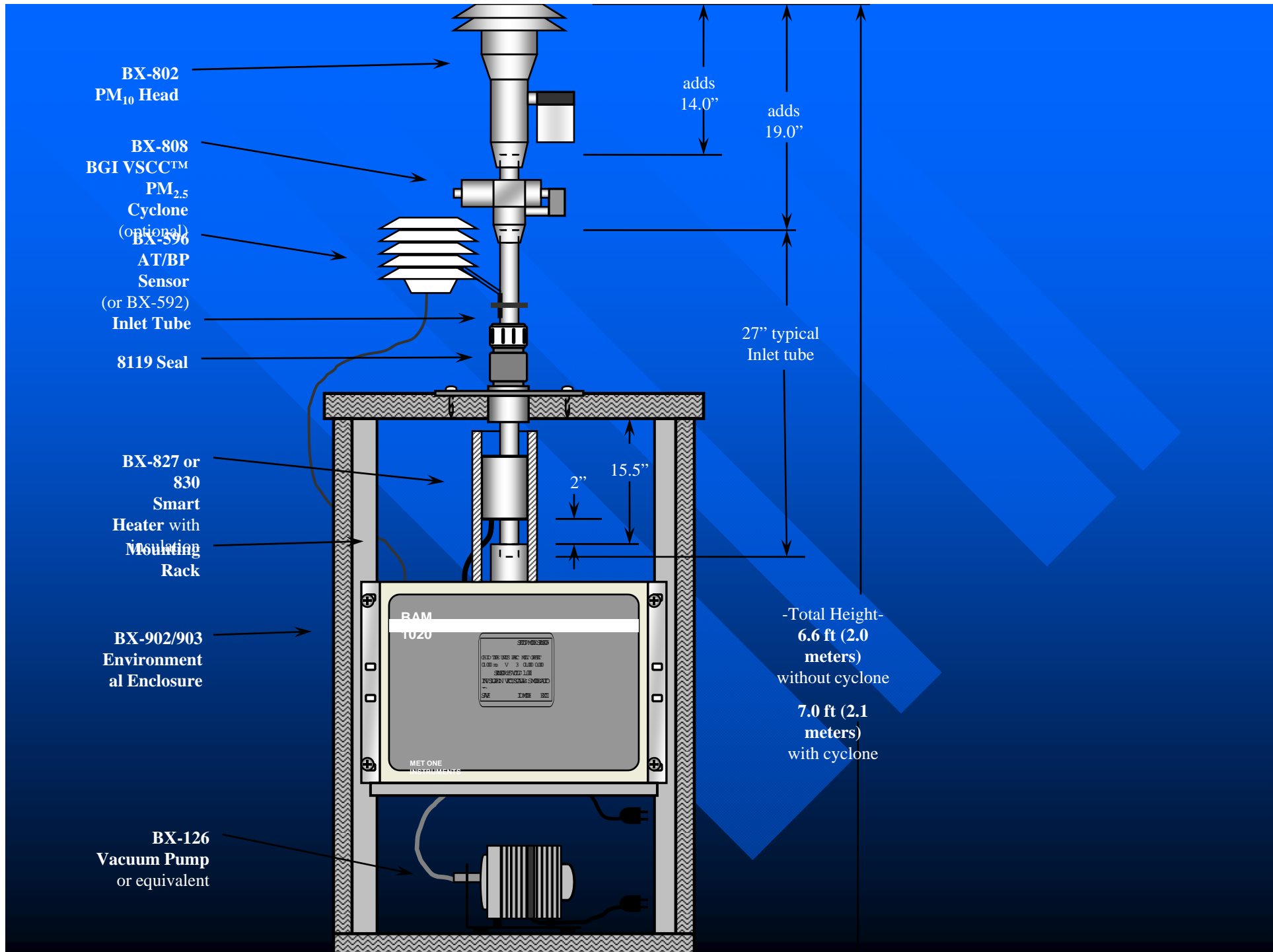
- Maintain Sample RH < 35%
- Use a Glass Fiber Filter Tape
- Sample for 42 Minutes of Each Hour
- Count Beta Particles For 8 minutes
- Operate at a Flow Rate of 16.67 LPM

# BAM Operational Features

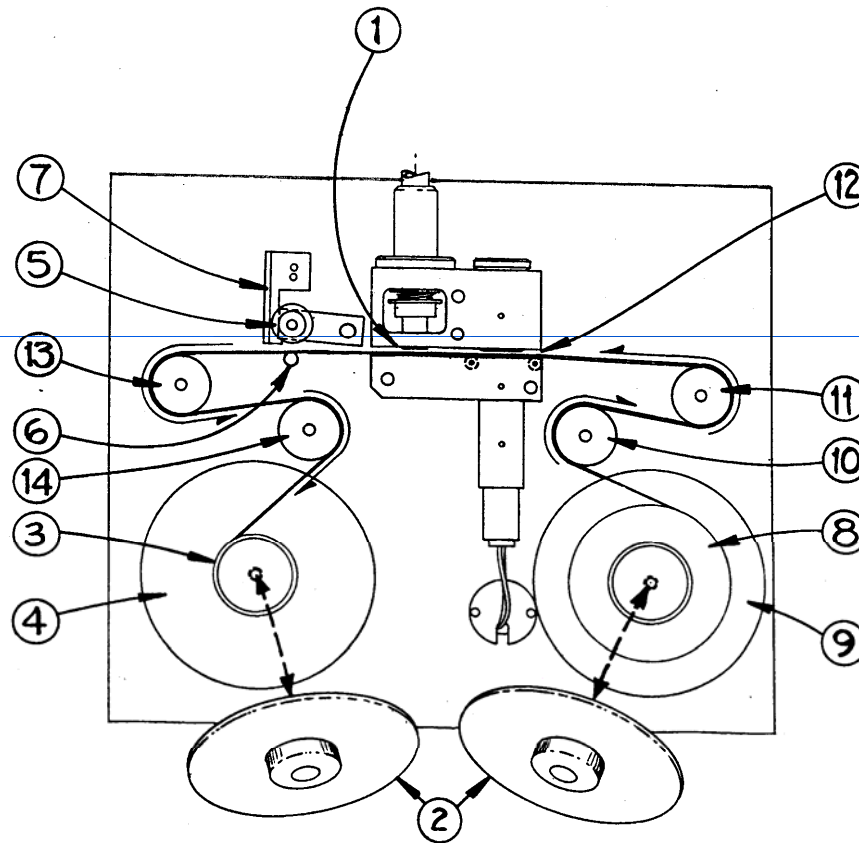
- Attenuation of Beta Particles
- Carbon 14 (exempt source)
- New Filter “Spot” Every Hour
- Hourly “Zero” and “Span” Checks
- Filter Tape Good for Two Months
- Changing PM Composition Has No Affect On Beta Attenuation
- Post Filter Analysis Possible
- Standard Range is 0 – 1000  $\mu\text{g}/\text{m}^3$

# Bam Operational Features, Cont'd

- Accuracy (24 hour Average) =  $\pm 2$  ug
- Resolution =  $\pm 1$  ug/m<sup>3</sup>
- Maintains Sample Stream RH < 35%
- Compatible With ESC Data Loggers



# BAM Components



1---NOZZLE IN "UP" POSITION  
2---CLEAR SPOOL COVER WITH KNOB  
3---EMPTY CORE TUBE  
4---TAKE-UP SPOOL  
5---PINCH ROLLERS  
6---CAPSTAN SHAFT  
7---LATCH

8---FILTER TAPE  
9---SUPPLY SPOOL  
10---SUPPLY TENSION ROLLER  
11---RIGHT END ROLLER  
12---SAMPLING/MEASURING AREA  
13---LEFT END ROLLER  
14---TAKE-UP TENSION ROLLER

# Method Comparison

(Flow Rate Through Filter)

■ FRM	16.7 LPM
■ BAM	16.7 LPM
■ TEOM	3.0 LPM

# Method Comparison, Cont'd

(PM Collection Time Period)

- FRM 24 hours
- TEOM Continuous 1 hr. Readings
- BAM Continuous 1 Hour

# Method Comparison, Cont'd

(Filter Material)

- FRM Teflon
- TEOM Teflon Coated Glass Fiber
- BAM Glass Fiber

# Method Comparison, Cont'd

(Filter Conditions)

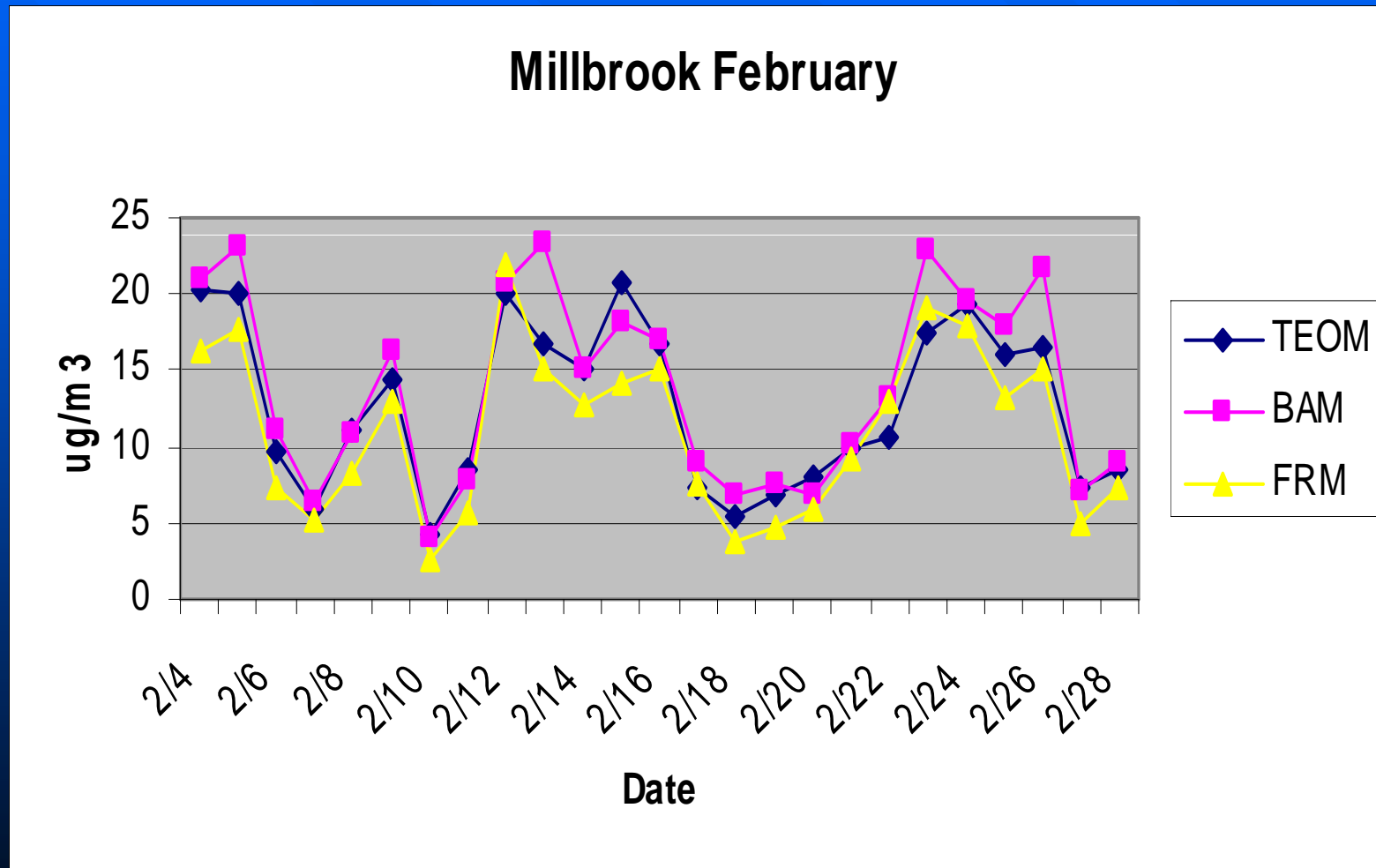
- FRM Subject to Ambient Conditions of Ambient Temp. and RH
- TEOM Operates at 50 Degrees C
- BAM RH Controlled to 35% or Less

# Method Comparison, Cont'd

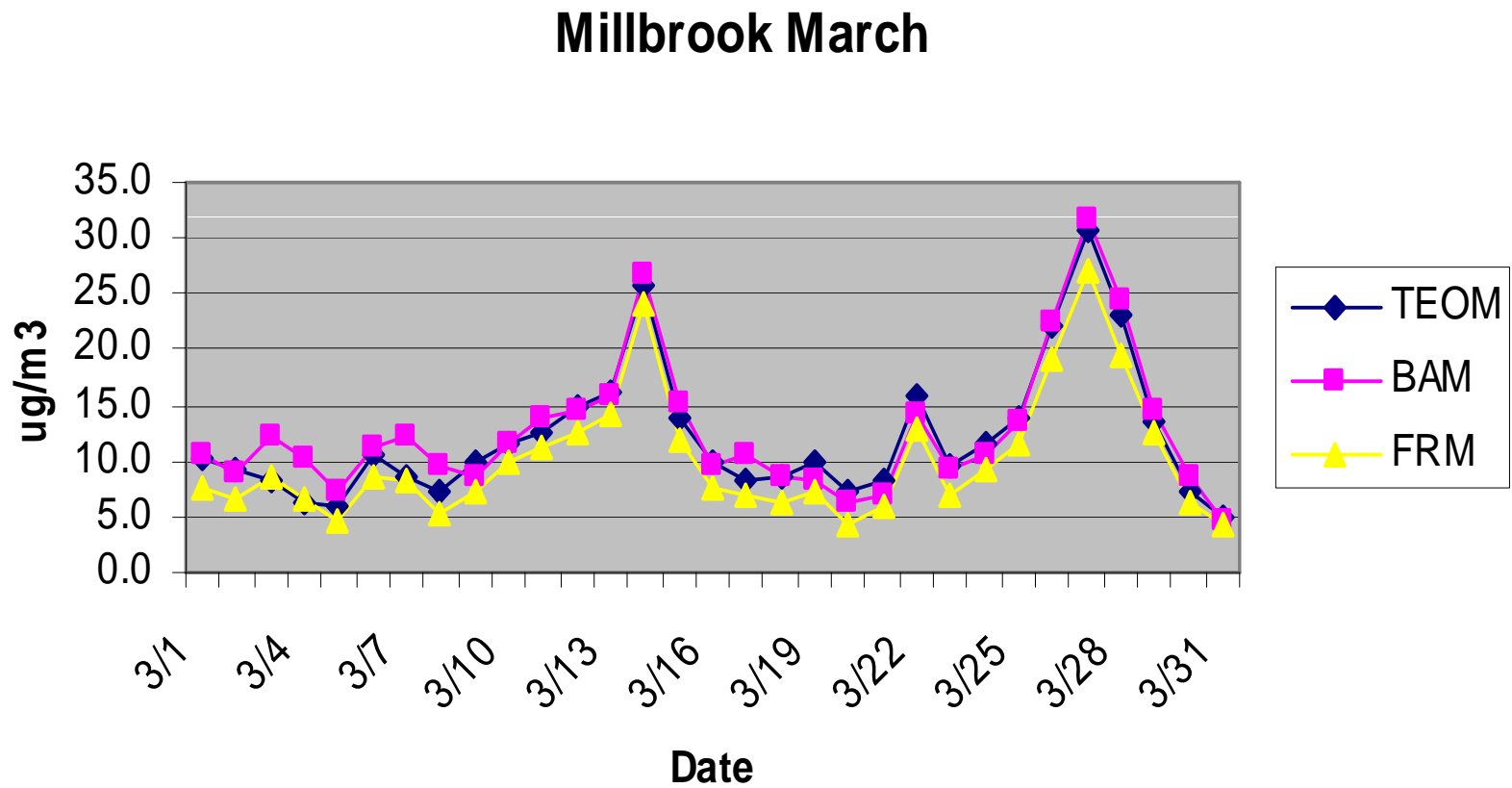
(Data Availability)

- FRM 4-5 Days After Sampling
- TEOM Hourly
- BAM Hourly

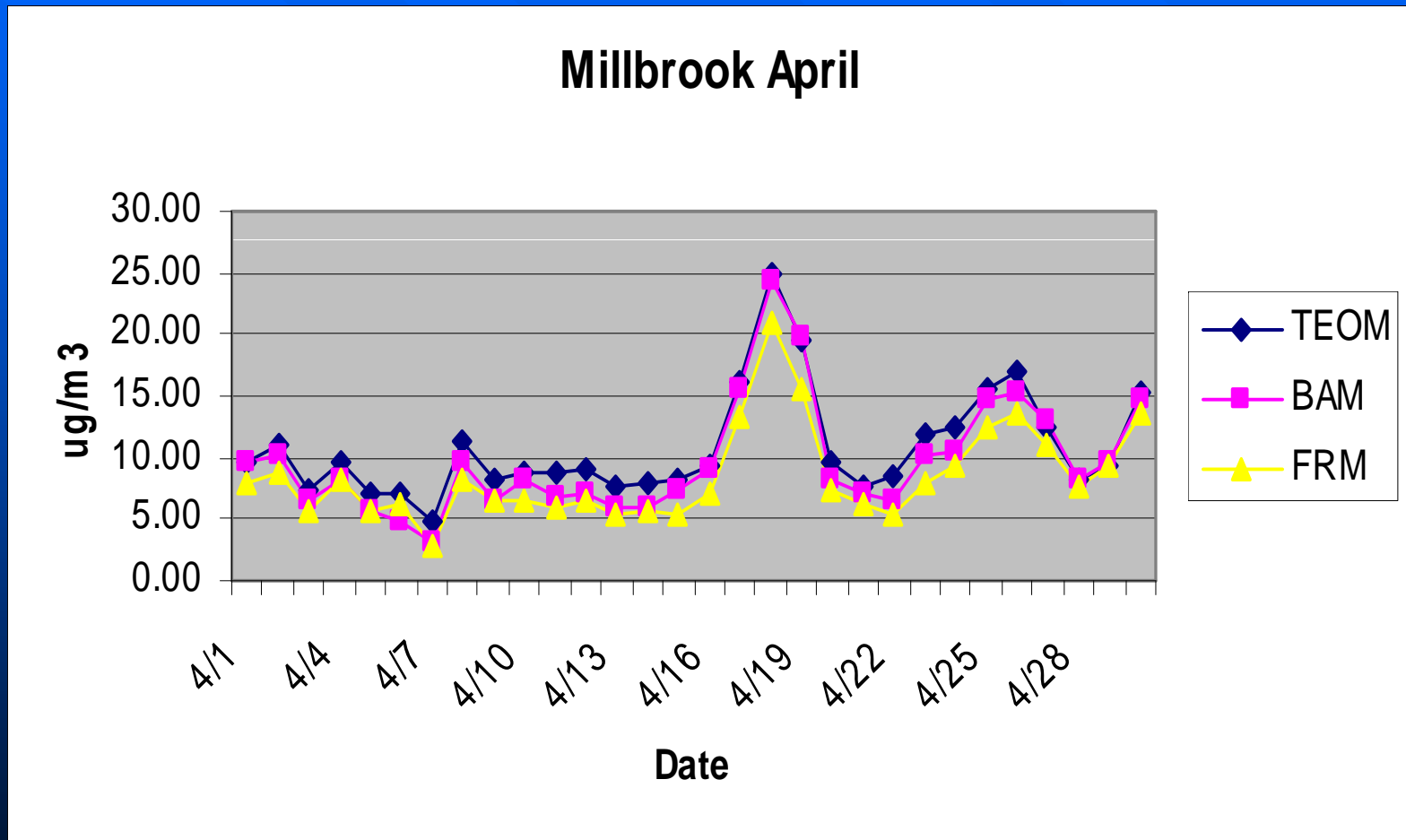
# TEOM vs BAM vs FRM (February)



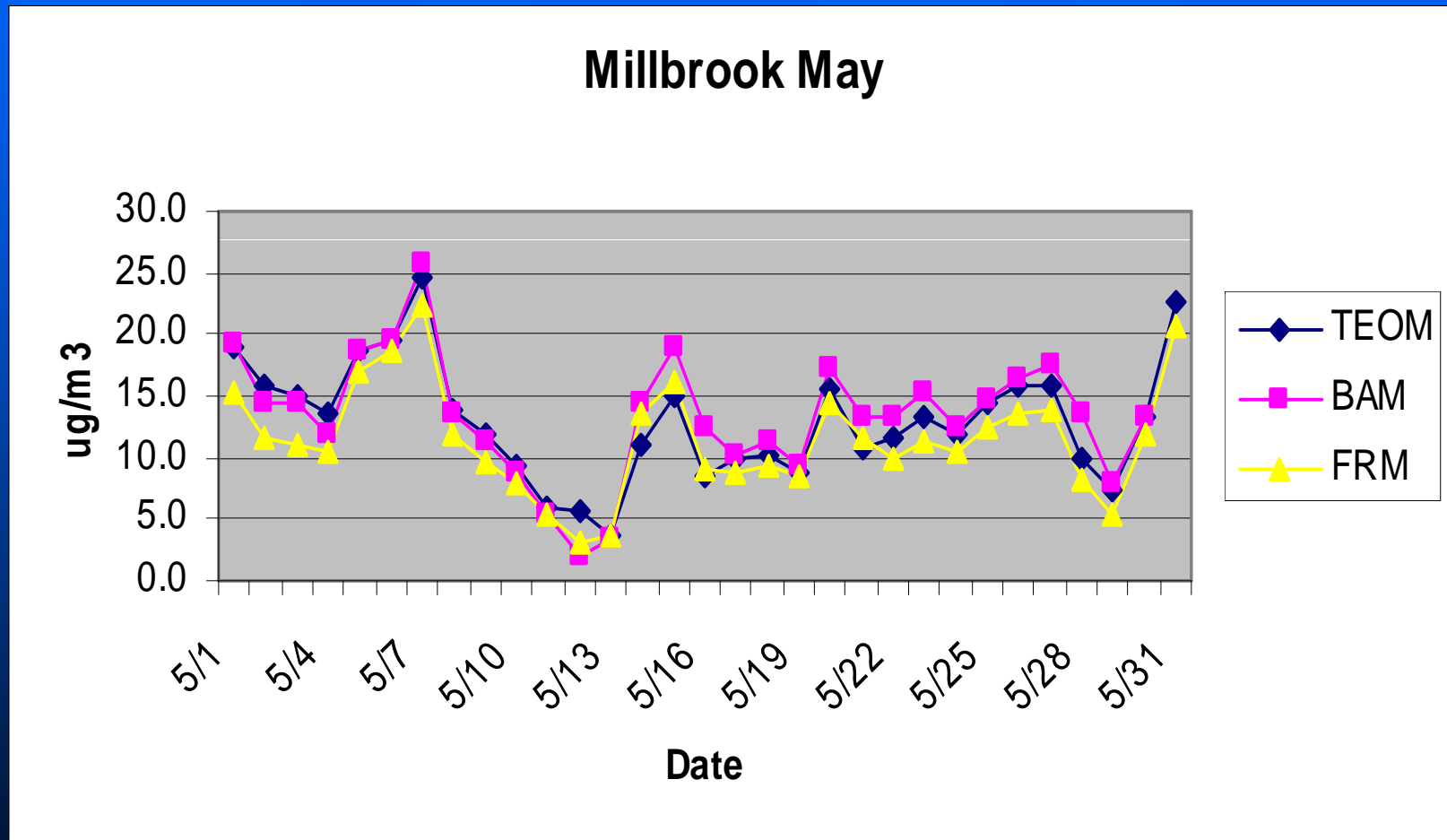
# TEOM vs BAM vs FRM (March)



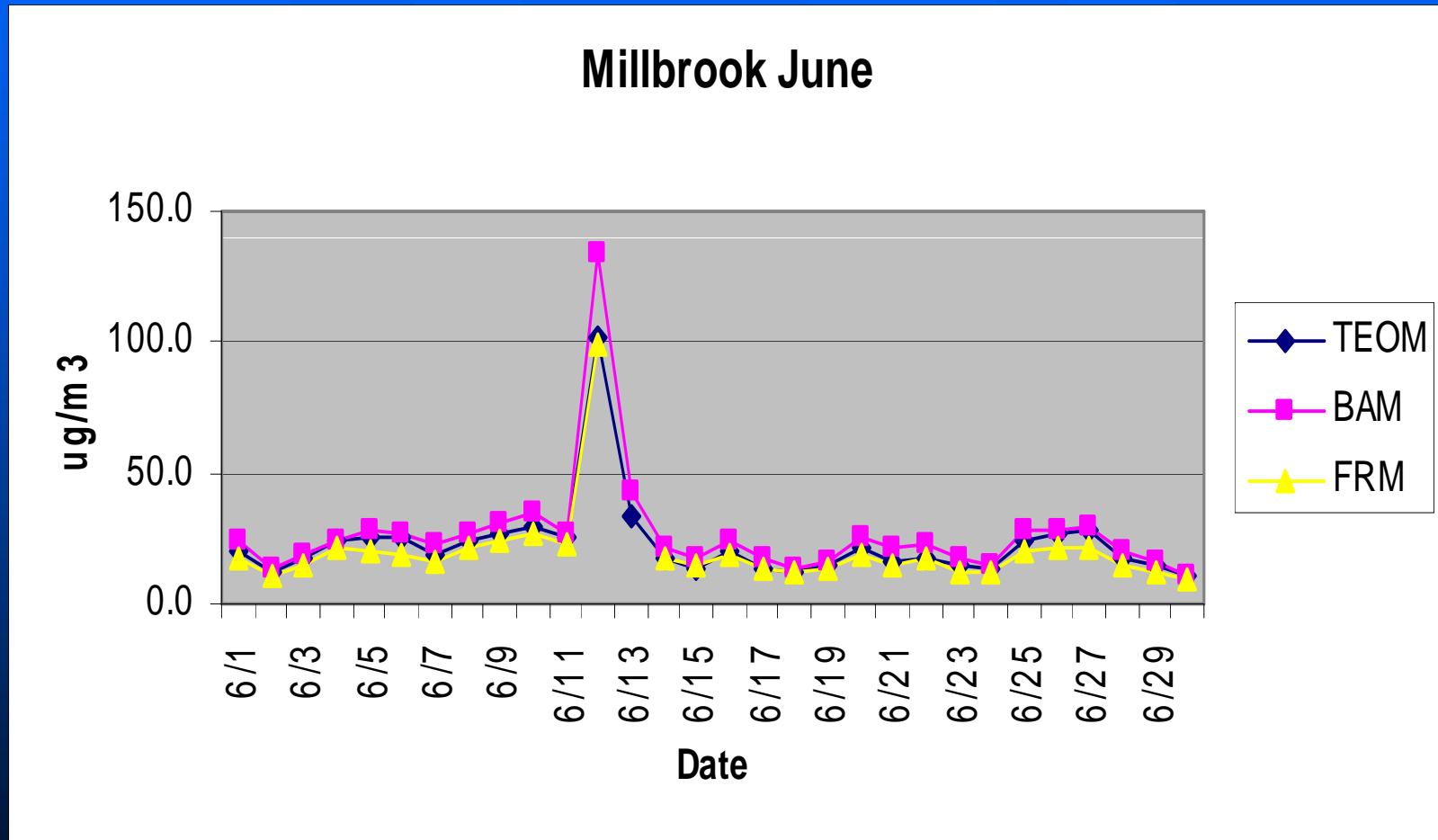
# TEOM vs BAM vs FRM (April)



# TEOM vs BAM vs FRM (May)



# TEOM vs BAM vs FRM (June)



# Data Comparison

(Avg. Monthly Concentration, ug/m<sup>3</sup>)

	<u>Feb</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u> *	<u>June</u> **
FRM	11.1	10.2	8.5	11.5	19.9	17.1
TEOM	12.7	12.1	10.8	13.0	22.6	19.9
BAM	13.9	12.7	9.8	13.3	26.4	23.0

\* Includes 6/12/08 Exceptional Event

\*\* Excludes 6/12/08 Exceptional Event

# Data Comparison, Cont'd

(Avg. Monthly Conc. Difference vs FRM, ug/m<sup>3</sup>)

	<u>Feb</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June*</u>	<u>June**</u>
TEOM	1.6	1.9	2.3	1.5	2.7	2.8
BAM	2.8	2.5	1.3	1.8	6.5	5.9

\* Includes 6/12/08 Exceptional Event

\*\* Excludes 6/12/08 Exceptional Event

# Data Comparison, Cont'd

(BAM vs TEOM)

	<u>Feb</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June*</u>	<u>June**</u>
Avg. ug/m <sup>3</sup> Diff.	1.2	0.5	-1.0	0.7	3.8	3.1
Avg. % Diff.	8.9	6.4	-11.4	4.5	16.1	15.8

\* Includes 6/12/08 Exceptional Event

\*\* Excludes 6/12/08 Exceptional Event

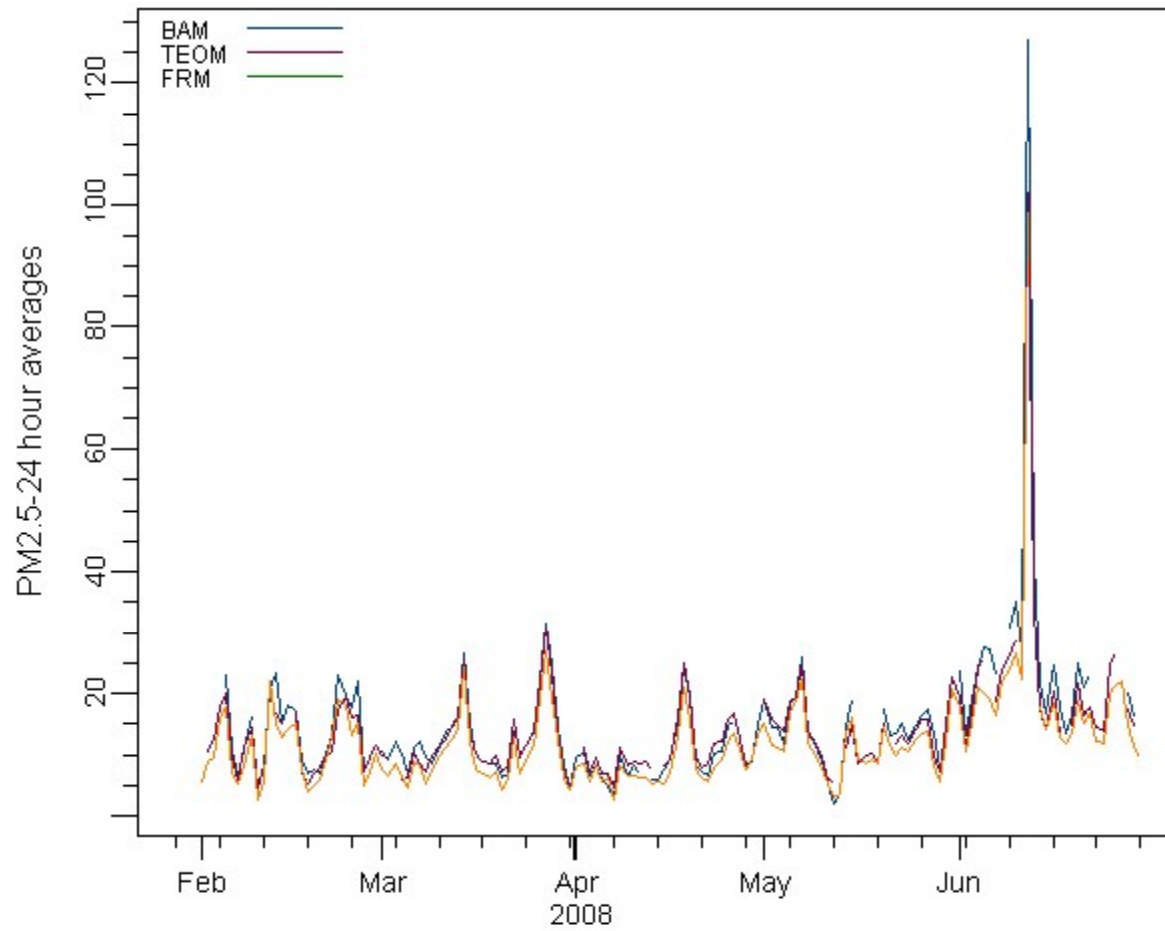
# Data Comparison, Cont'd

(Exceptional Event of June 12, 2008,  
FRM vs TEOM vs BAM)

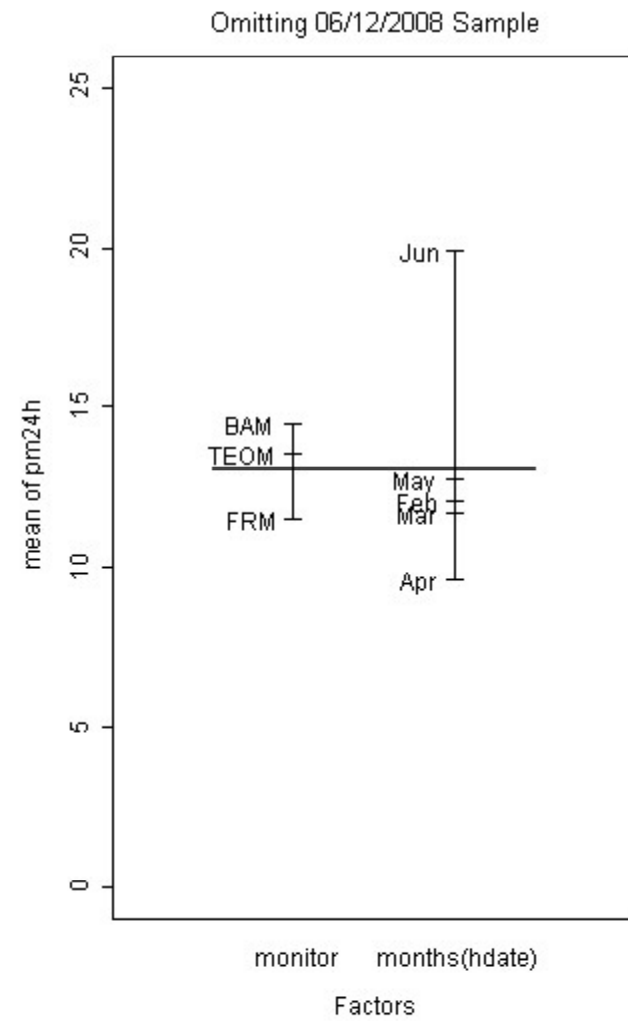
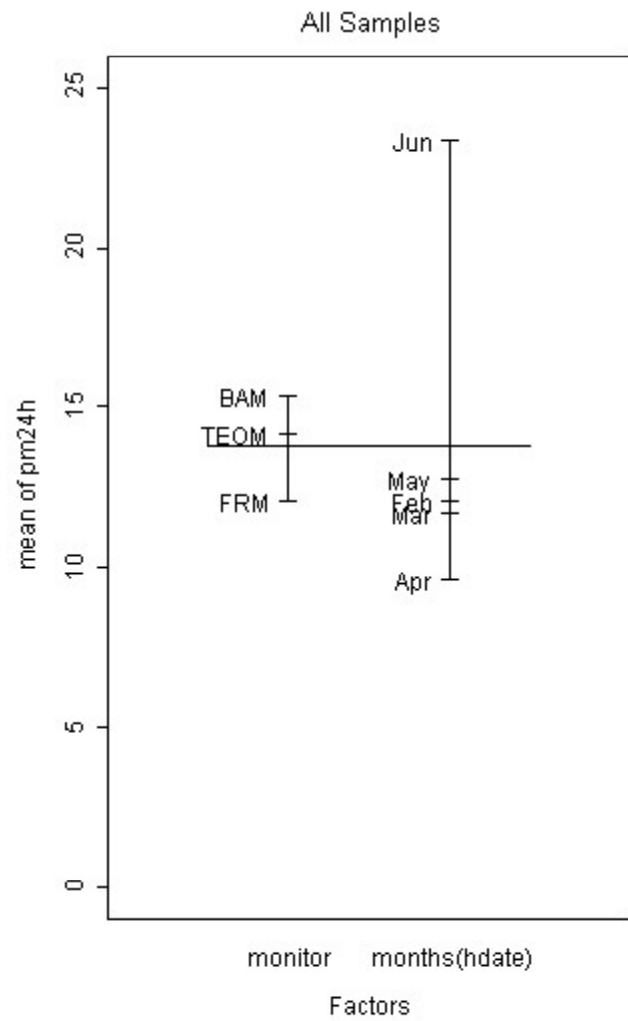
	<u>FRM</u>	<u>TEOM</u>	<u>BAM*</u>
24-Hr. Avg., ug/m <sup>3</sup>	99.0	102	127

\* BAM Measures Volatile Components Lost by FRM and  
TEOM

### Millbrook BAM Sampling Test

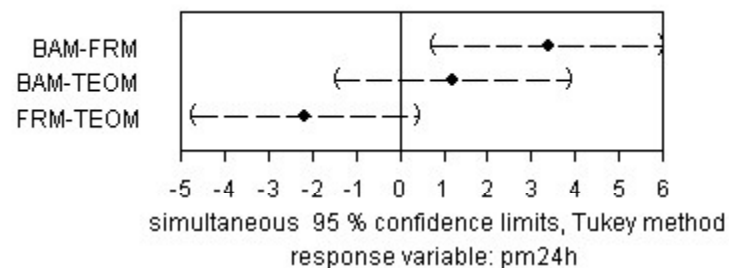


# BAM-TEOM-FRM Multiple Comparisons at Millbrook, Feb-Jun 2008

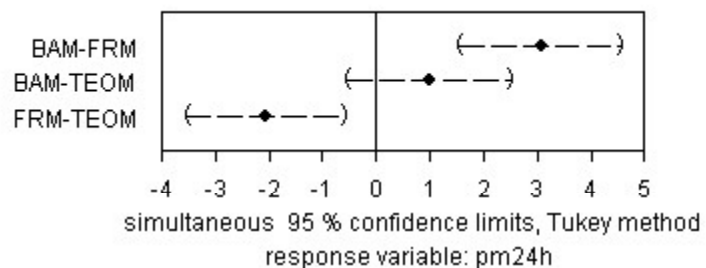


# BAM-TEOM-FRM Multiple Comparisons at Millbrook, Feb-Jun 2008

## All Samples



## Omitting 06/12/2008 Sample



# Conclusions

(Based on Limited Data)

- BAM & TEOM\* > FRM by up to 20-25%
- BAM > TEOM by up to 5-6%
- Including 6/12/08 Exceptional Event Data
- -BAM & FRM are Significantly Different
  - BAM & TEOM are not Significantly Different
  - FRM & TEOM are not Significantly Different

Loss of Volatile PM Reason for Difference

- Need 1 Year of Data From the 3 Proposed Sites
- \* TEOM is normally corrected to be FRM-like

Questions ?