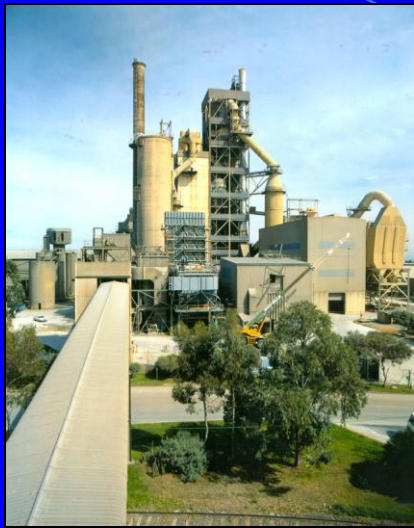


# Particulate Monitoring for Cement Kiln Stacks



McIlvaine  
Hot Topic Hour  
March 19, 2010



Craig Clapsaddle  
MSI/Mechanical Systems, Inc.

# Types of Particulate Monitors

- Indirect Indicators

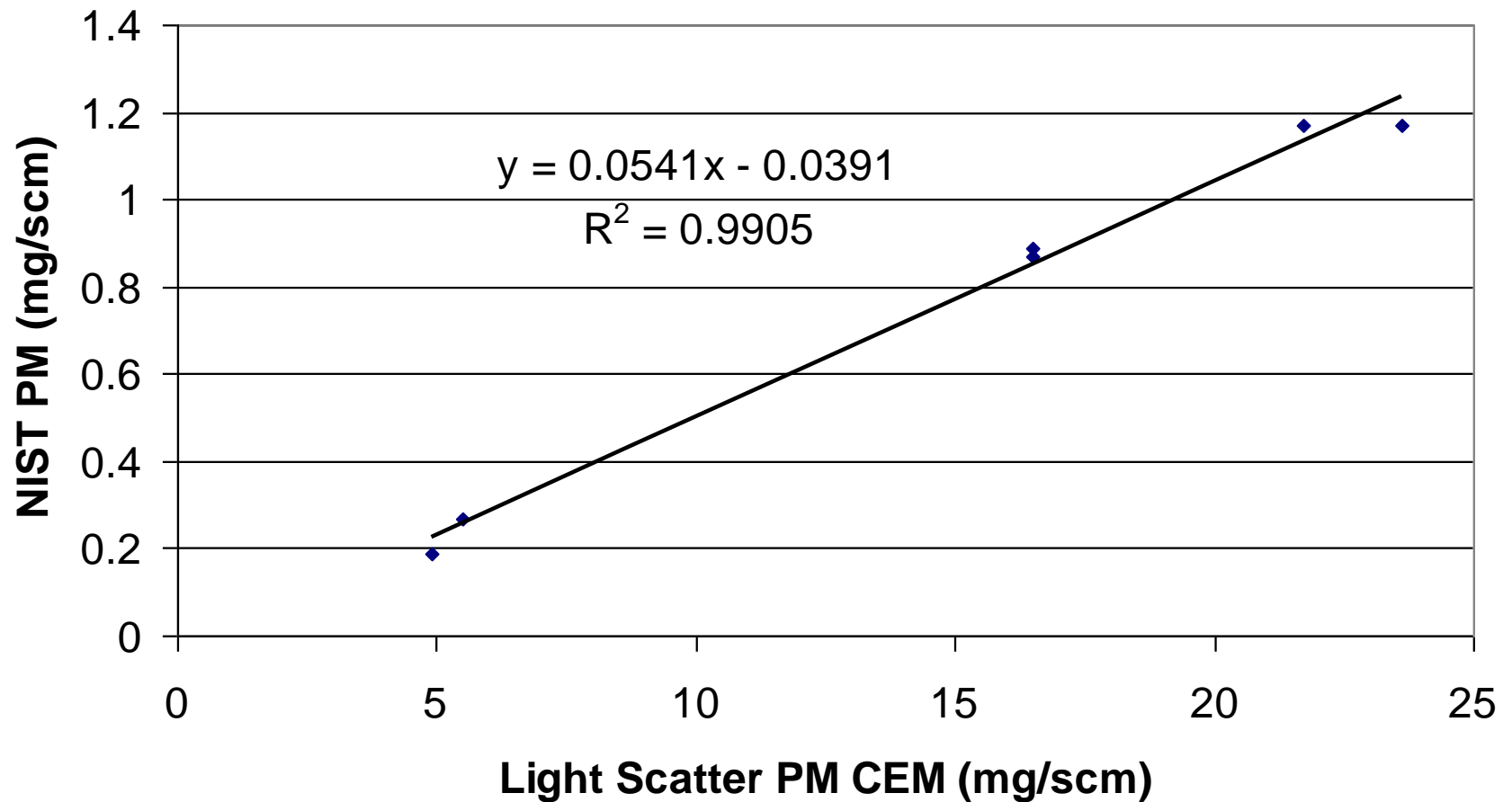
- Scintillation
- Triboelectric & electrodynamic
- Light scatter

- Direct Measurement

- Oscillating microbalance
- Beta gauge

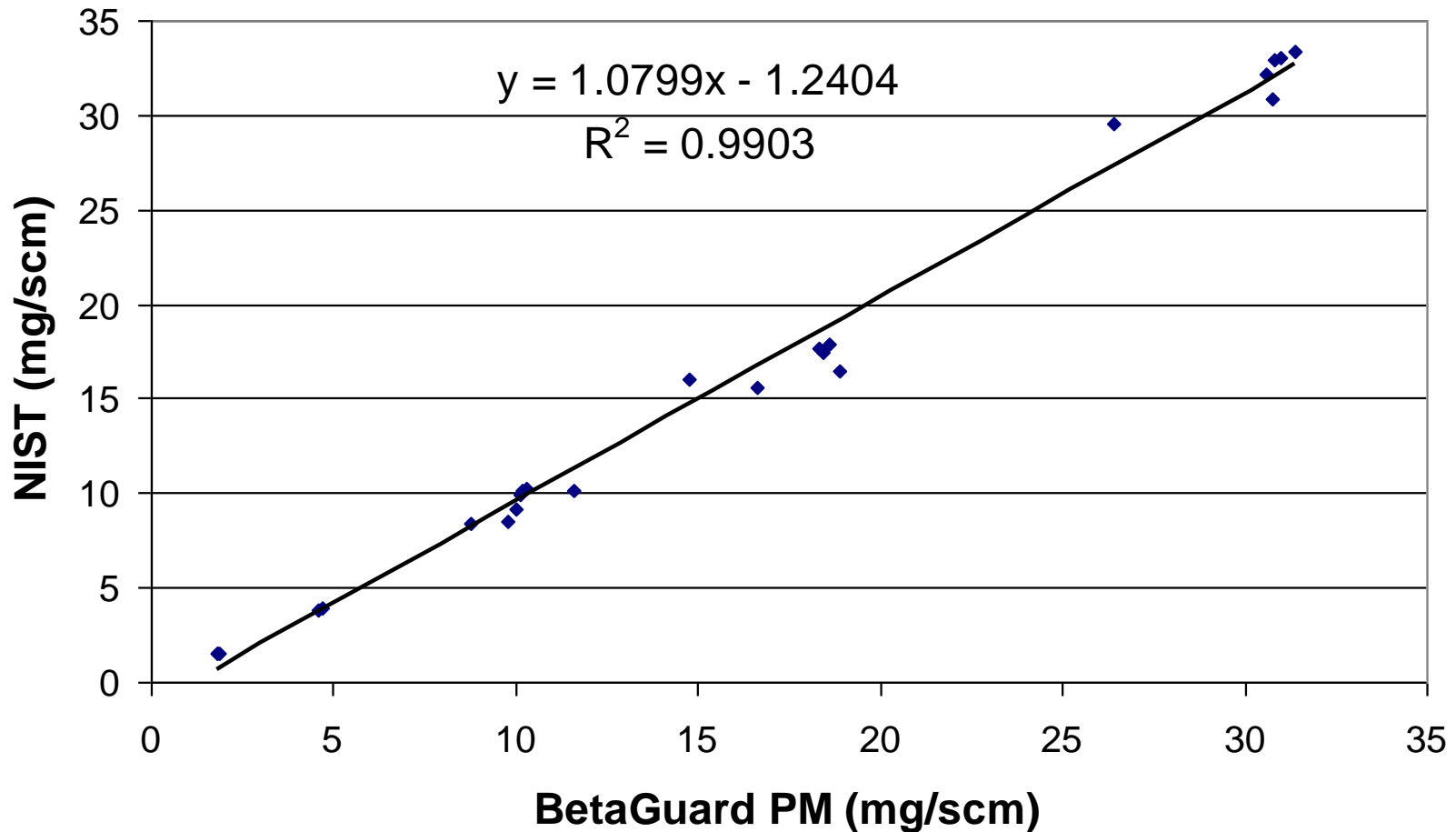
# Indirect Indicator

## Light Scatter PM vs Known PM Generator



# Direct Mass Measurement

BetaGuard PM vs Known PM Generator



# Particle Size & Light Scatter

## Base Case

100 – 0.7  $\mu\text{m}$  particles

200 – 1  $\mu\text{m}$  particles

100 – 2.5  $\mu\text{m}$  particles

10 – 5  $\mu\text{m}$  particles

1 – 12  $\mu\text{m}$  particle

Particles Mass Concentration =  
25  $\text{mg}/\text{m}^3$

Total Scatter Intensity =  
2,260,000

For 680 nm light

Reference: Figure 2.1 Powder  
Technology Handbook, Ed. By  
Gotch, Masuda, Higashitani,  
2nd Edition, published by  
Marcel Dekker, 1997

## More small particles

500 – 0.7  $\mu\text{m}$  particles

1000 – 1  $\mu\text{m}$  particles

200 – 2.5  $\mu\text{m}$  particles

5 – 5  $\mu\text{m}$  particles

Particles Mass Concentration = 26  $\text{mg}/\text{m}^3$

Total Scatter Intensity = 4,100,000

## More larger particles

10 – 0.7  $\mu\text{m}$  particles

100 – 1  $\mu\text{m}$  particles

120 – 2.5  $\mu\text{m}$  particles

15 – 5  $\mu\text{m}$  particles

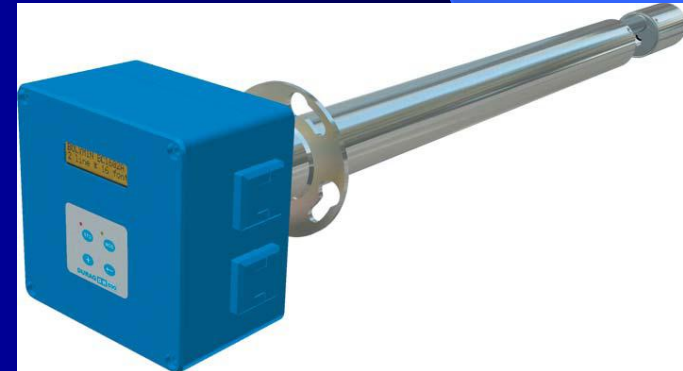
2 – 12  $\mu\text{m}$  particles

Particles Mass Concentration = 38  $\text{mg}/\text{m}^3$

Total Scatter Intensity = 2,902,000

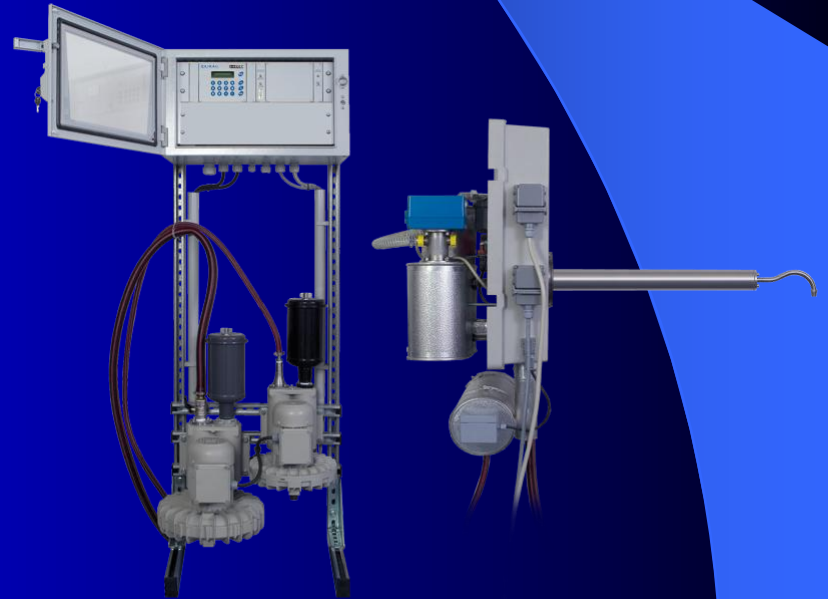
# Available Particulate Monitors

- In-situ light scatter – for dry stacks only
  - LaserHawk 360
  - FW 100
  - D-R 800



# Available Particulate Monitors

- Extractive light scatter – for wet stacks
  - FWE 200
  - D-R 820



# Available Particulate Monitors

- Extractive beta gauge – for wet & dry stacks
  - BetaGuard PM





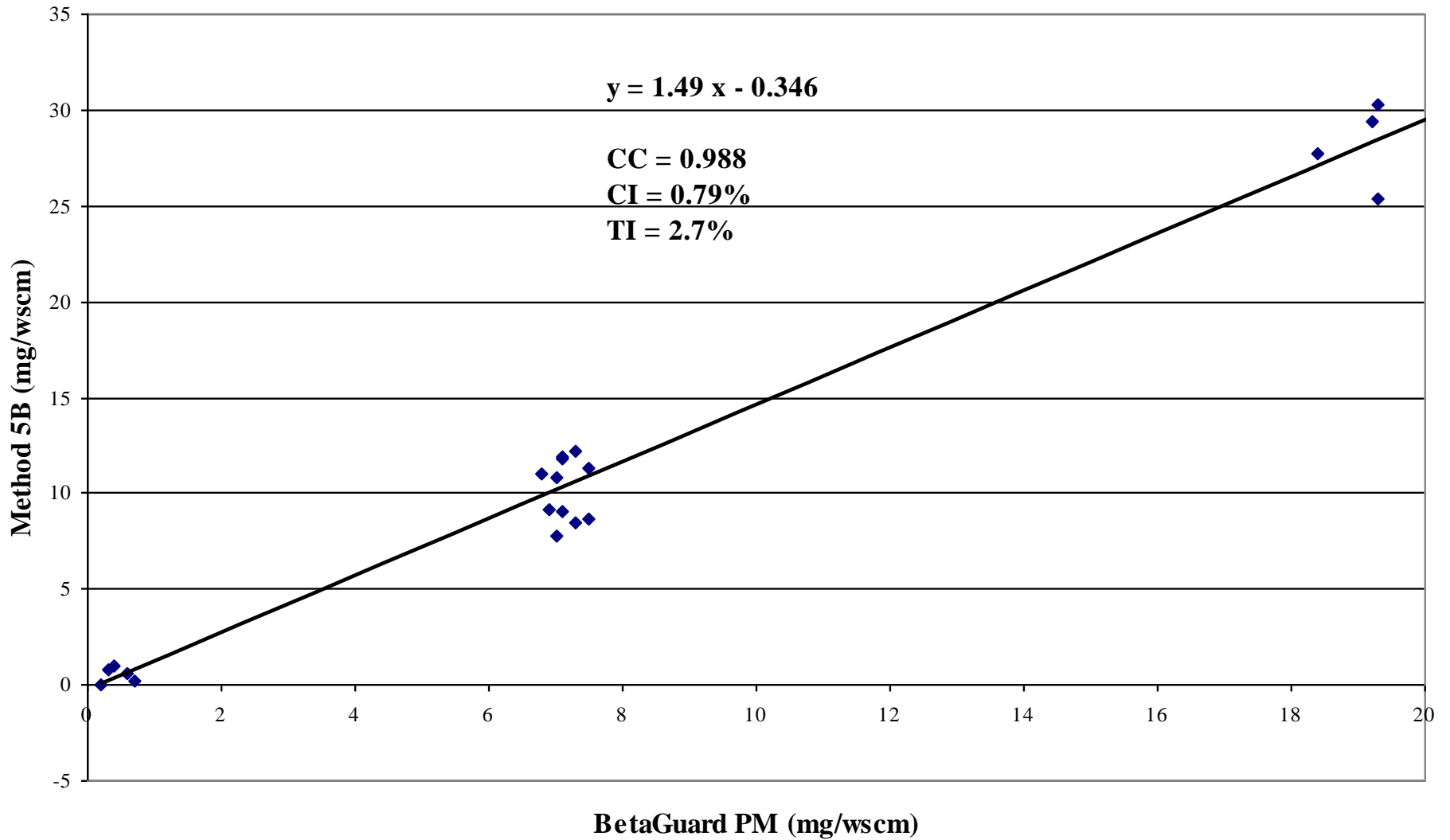
# PS-11 Requirements

- Select a CPMS appropriate for your source
- Monitor at location representative of PM emissions measured by Method 5
- Install CPMS and determine what process changes affect PM emissions
- Certification process
  - 7-day drift test
  - Correlation test

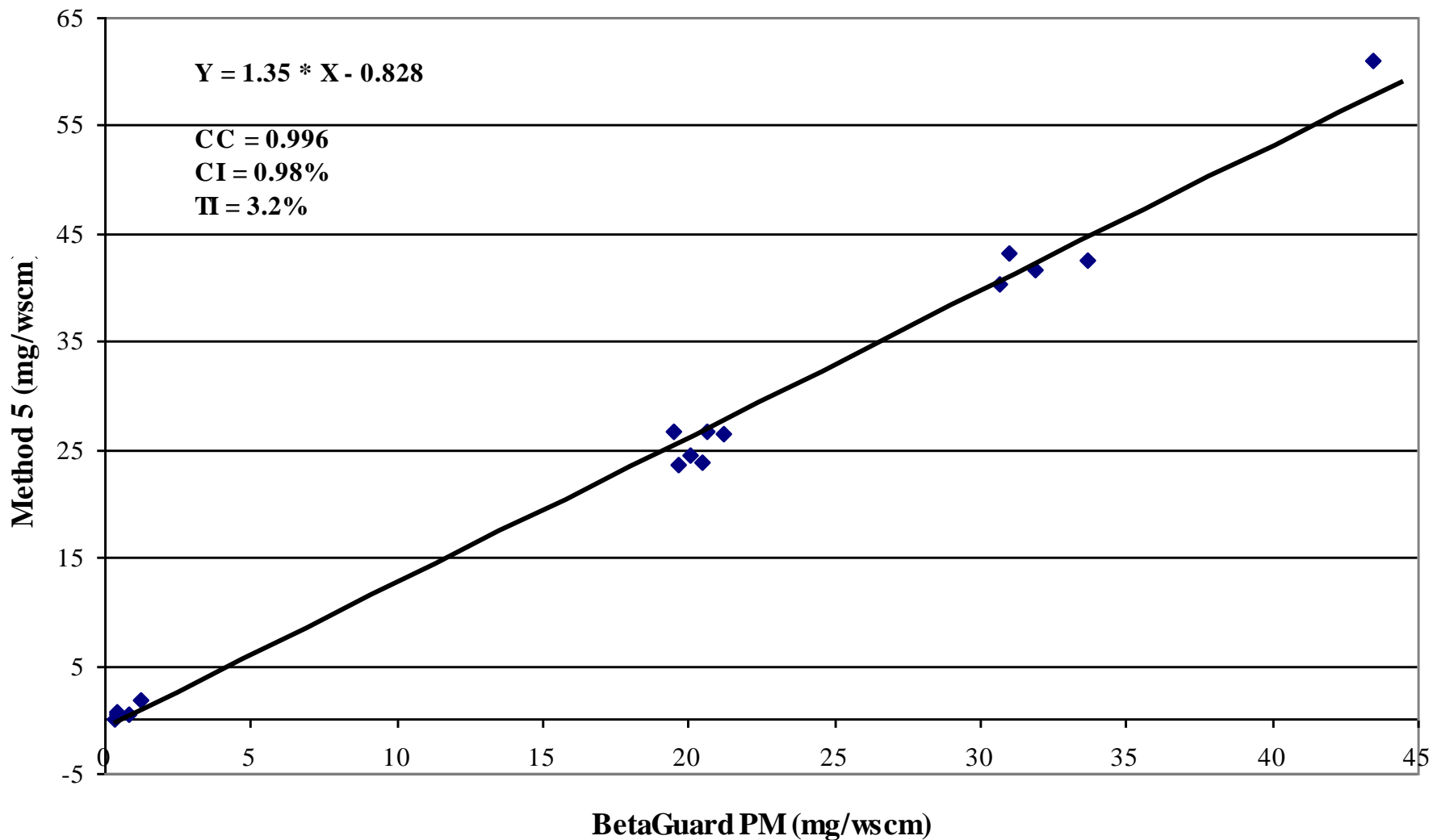
# PS-11 Correlation Test

- Requires 15 data points over a wide range of PM concentrations
  - Need at least 3 PM levels
  - Need at least 20% of data points in each PM level (3)
- Obtaining different PM concentrations is a challenge but not impossible
  - Use different flow or production rates
  - Raw mill On/Off
  - Detune primary PM control equipment
  - Pull probe from stack and sample ambient air for zero (only for the beta gauge monitor)
- Calculate "correlation" between monitor and RM
  - Determine CC, CI, TI – compare those to criteria

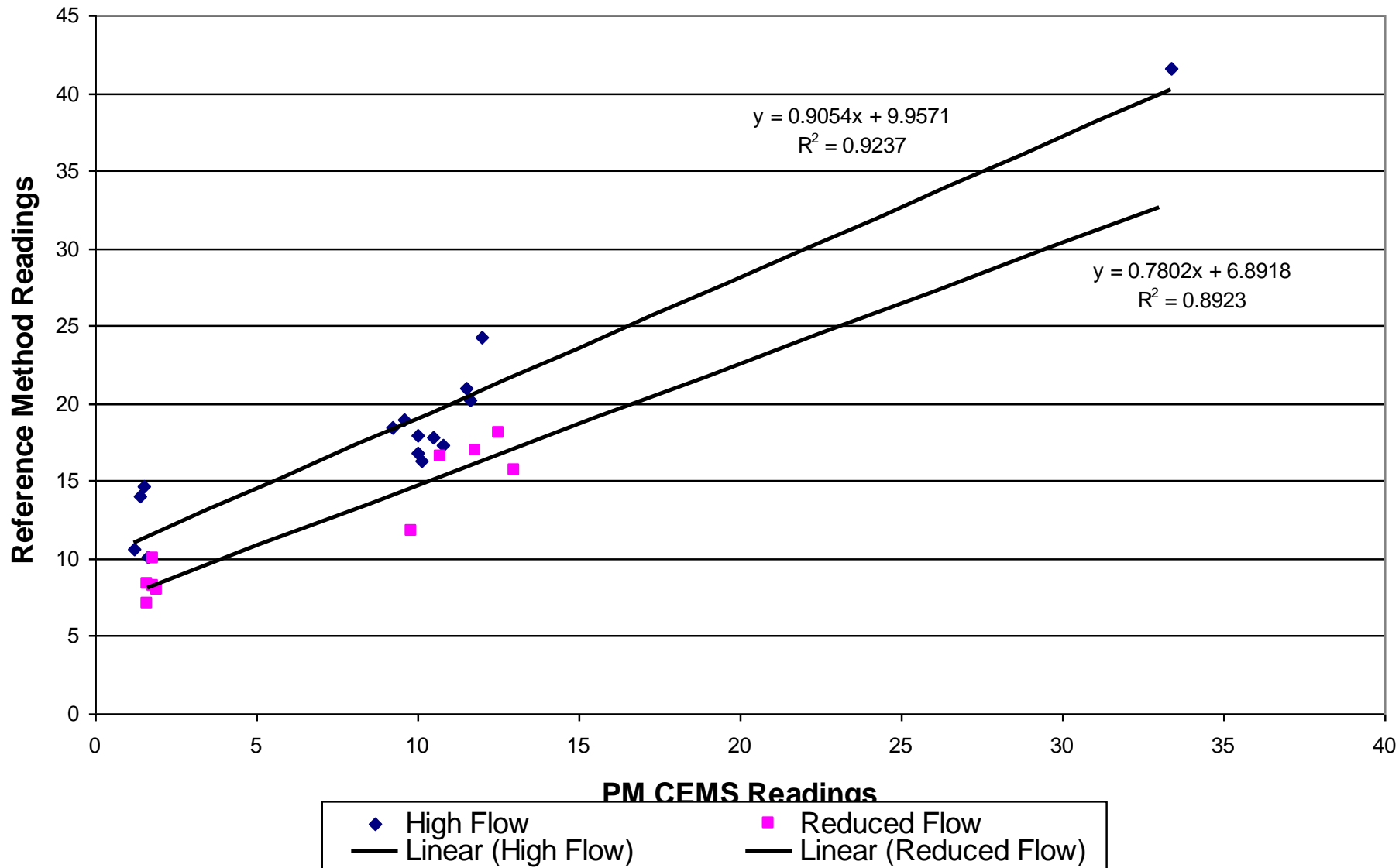
## BetaGuard PM Correlation



## BetaGuard PM Correlation



# Light Scatter PM Monitor



# PS-11 Correlation Test Zero Point

- Section 8.6 describes procedures for correlation test
  - 8.6(5) ... If you cannot obtain three distinct levels of PM concentration, you must ... follow one or more of these steps
  - 8.6(5)(ii) Zero point data for extractive instruments should be obtained by removing the extractive probe from the stack and drawing in clean ambient air
- MSI has used this approach at many correlation tests
- This procedure can only be used on an extractive beta gauge PM monitor, light scatter monitor correlation doesn't pass through zero

# Summary

- Light scatter and beta gauge type particulate monitors installed in US and certified by PS-11
- Light scatter monitors should be used only in specific applications where particles will not change
  - Light scatter monitor is indirect indicator
  - Light scatter intensity affected by changes in particle size
  - Light scatter monitor correlation does not go through zero
- Beta gauge monitors can be used in wet or dry stack and are direct mass concentration measurement
- Non-isokinetic sampling will affect concentration measurement