

BetaGuard PM – Ability to Measure PM Mass Concentration Continuously



McIlvaine
Hot Topic
Hour
October 13, 2011



Craig Clapsaddle
MSI/Mechanical Systems, Inc.

BetaGuard PM CEM

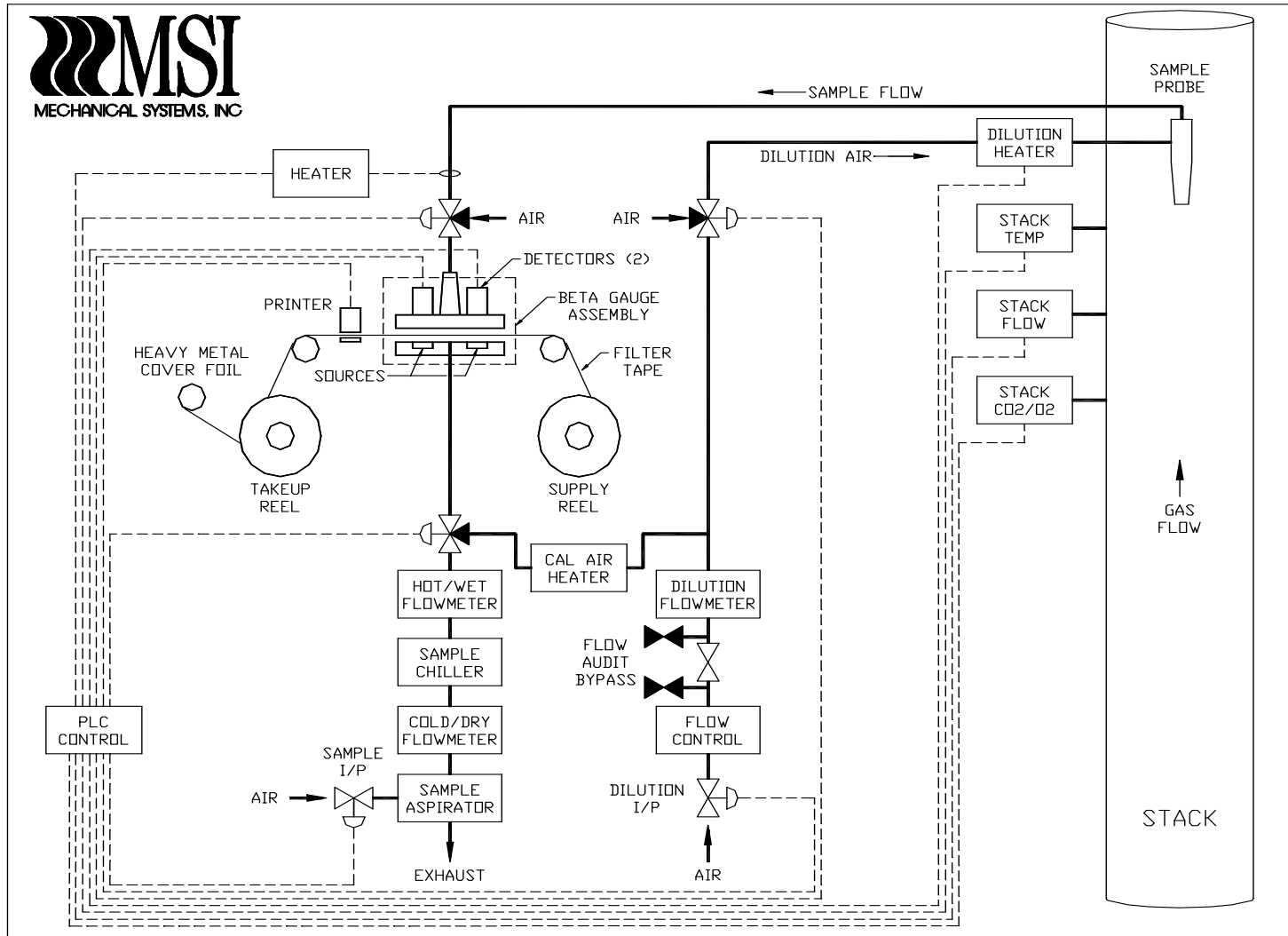
- Development began in 1995
- Field trials in 1998 and 1999
- Commercial product in January 2001
- First commercial installation in 2002
- Accumulated over 1 million operating hours
- Meets all US EPA PS-11 specifications
- Uses beta gauge technology and mass flow meters to directly measure PM mass concentration

MSI BetaGuard PM Details

- Direct measure of mass concentration
- Replicates EPA Methods 5, 5B
- NIST traceable mass standards used to calibrate monitor's mass measurement
- Beta attenuation mass measurement is independent of particle characteristics
- Dilution sampling probe
- 100% Isokinetic sampling
- Automatic daily mass and flow drift checks
- Designed for long-term unattended operation with high availability (>90%)
- Minimal moving parts
- Meets all US EPA requirements



System Diagram



Beta Gauge Operating Principle

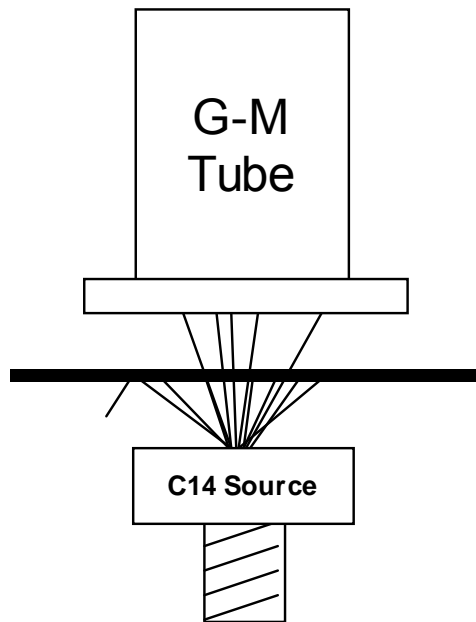
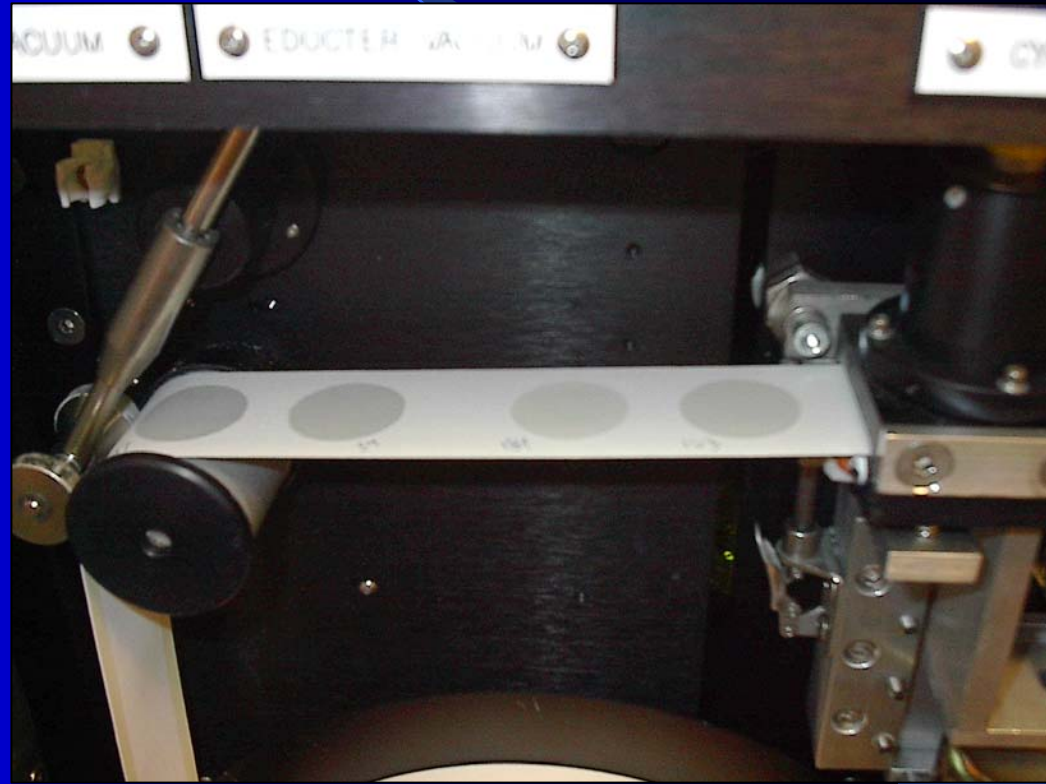


Figure 1: Beta Transmission Sensor

- Beta particles are electrons
- Electrons are absorbed by mass
- Geiger-Müller (G-M) tube detects the number of beta particles not absorbed
- Mass measurement follows Beer-Lambert Law
- Mass of dust is the ratio of the filter masses before and after particulate loading

Particulate Collected on Filter Tape

- Particulate collected on glass fiber filter tape
- Mass measured with a beta gauge
- Sample flow volume measured on both a wet and dry basis
- Concentration output mg/wscm – lb/mmBtu calculated using CO_2 and F-factor



Output Mass Concentration

- Calculate lb/mmBtu using the following formula:

$$\text{lb/mmBtu} = \text{mg/wscm} * \text{Fc} * 6.24 \times 10^{-8} * (100 / \% \text{CO}_{2w})$$

$$0.0298 = 30 * 1800 * 6.24 \times 10^{-8} * 100 / 11.3$$

- No correction needed for temperature, moisture, or pressure







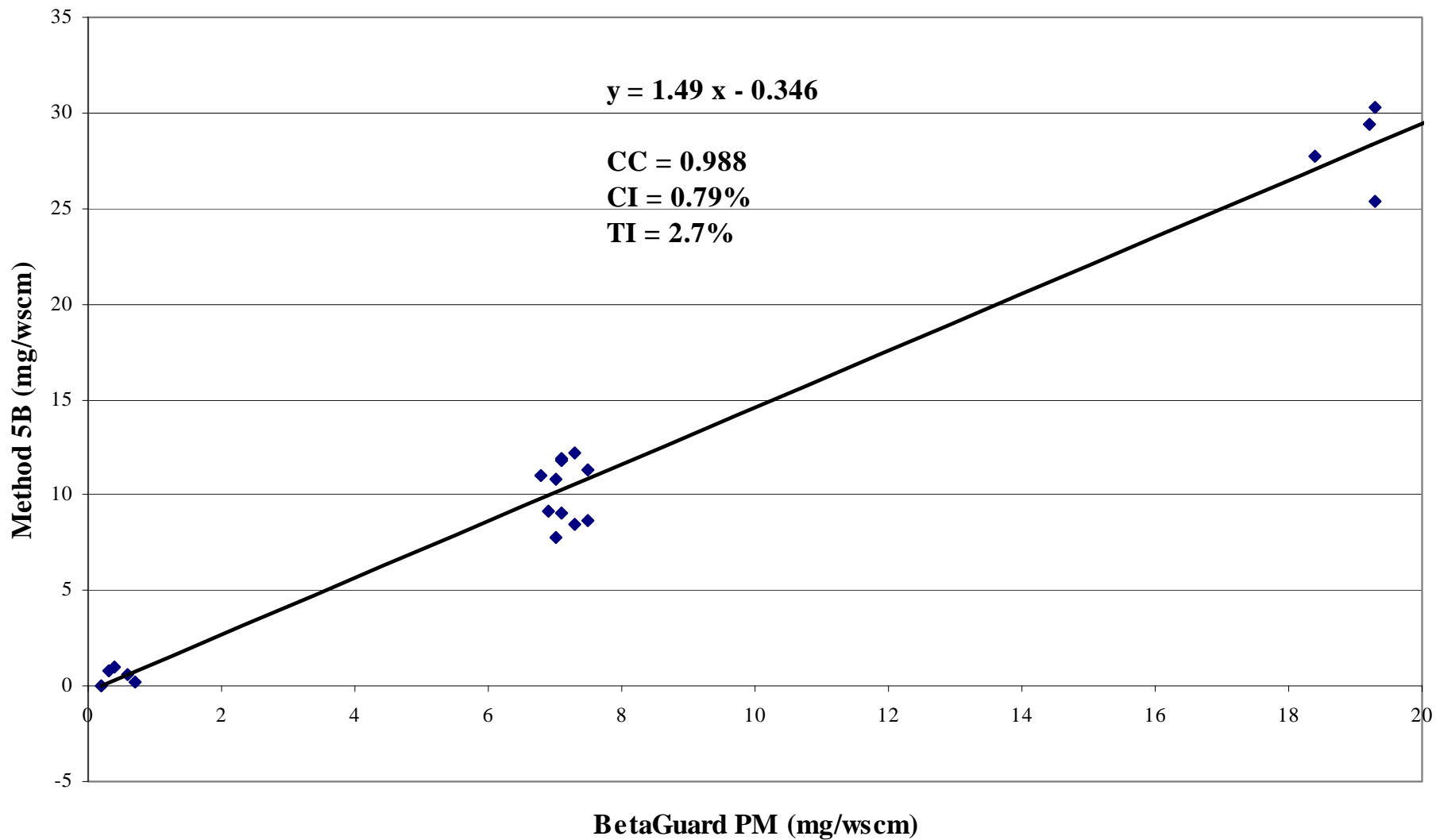
Performance Specification-11 Certification

- 7-day drift test
- Correlation test

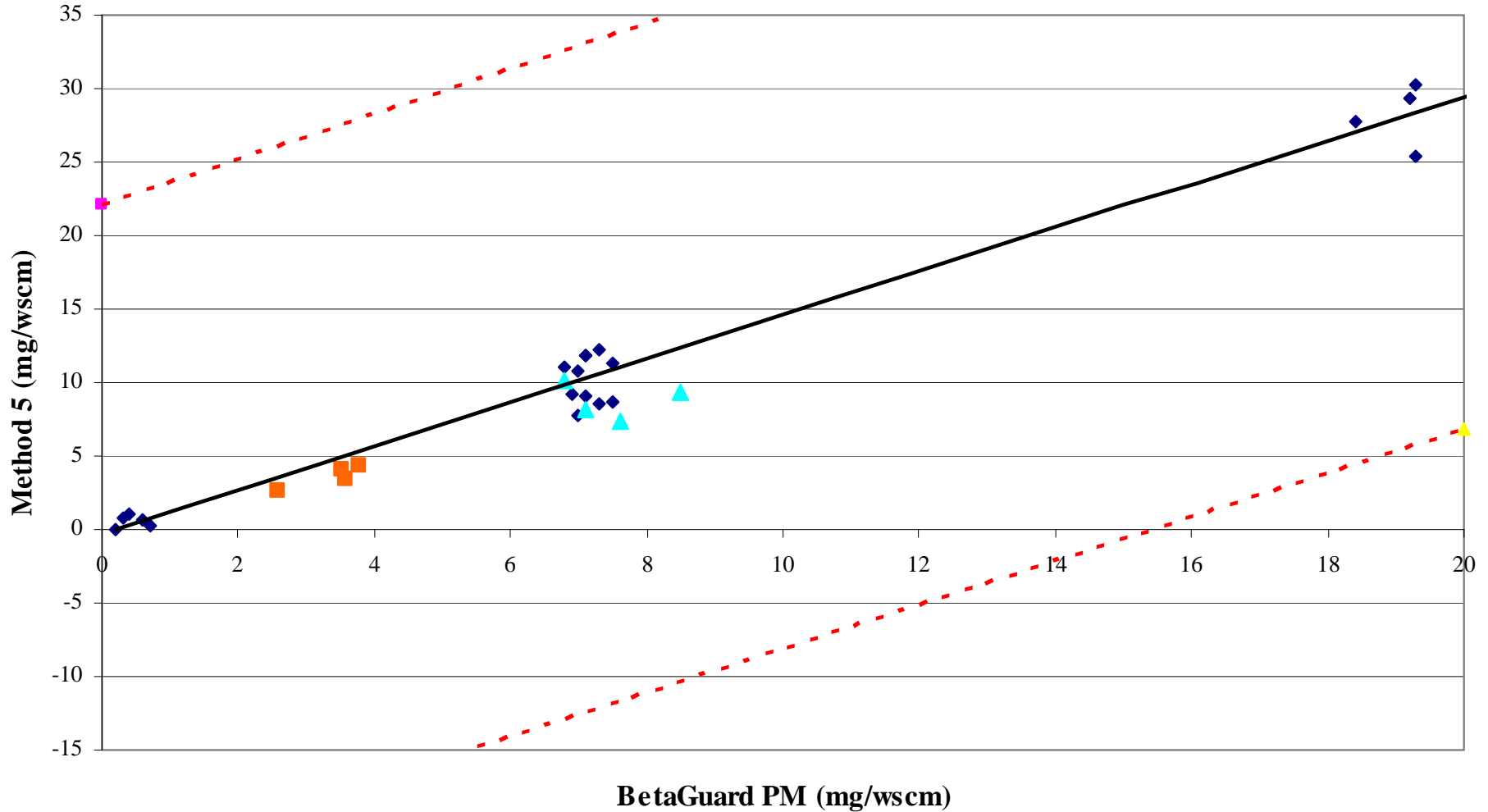
PS-11 Correlation Test

- 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)
- Get Method 5 results on-site
- Calculate "correlation" between monitor and RM
 - Determine CC, CI, TI – compare those to criteria
- See BetaGuard PM results below

BetaGuard PM Correlation

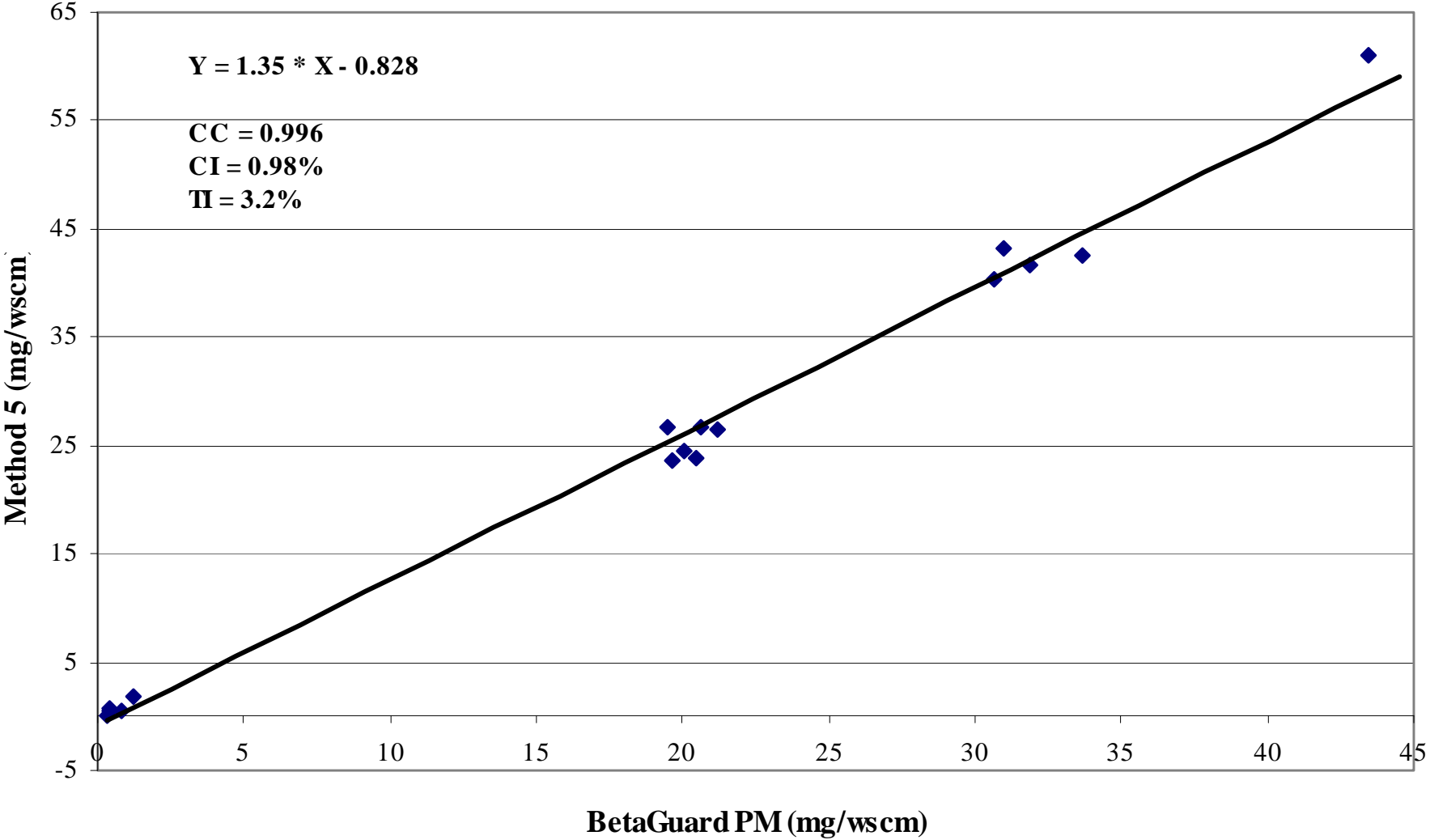


BetaGuard PM Correlation, 2009 RRA & 2010 RRA

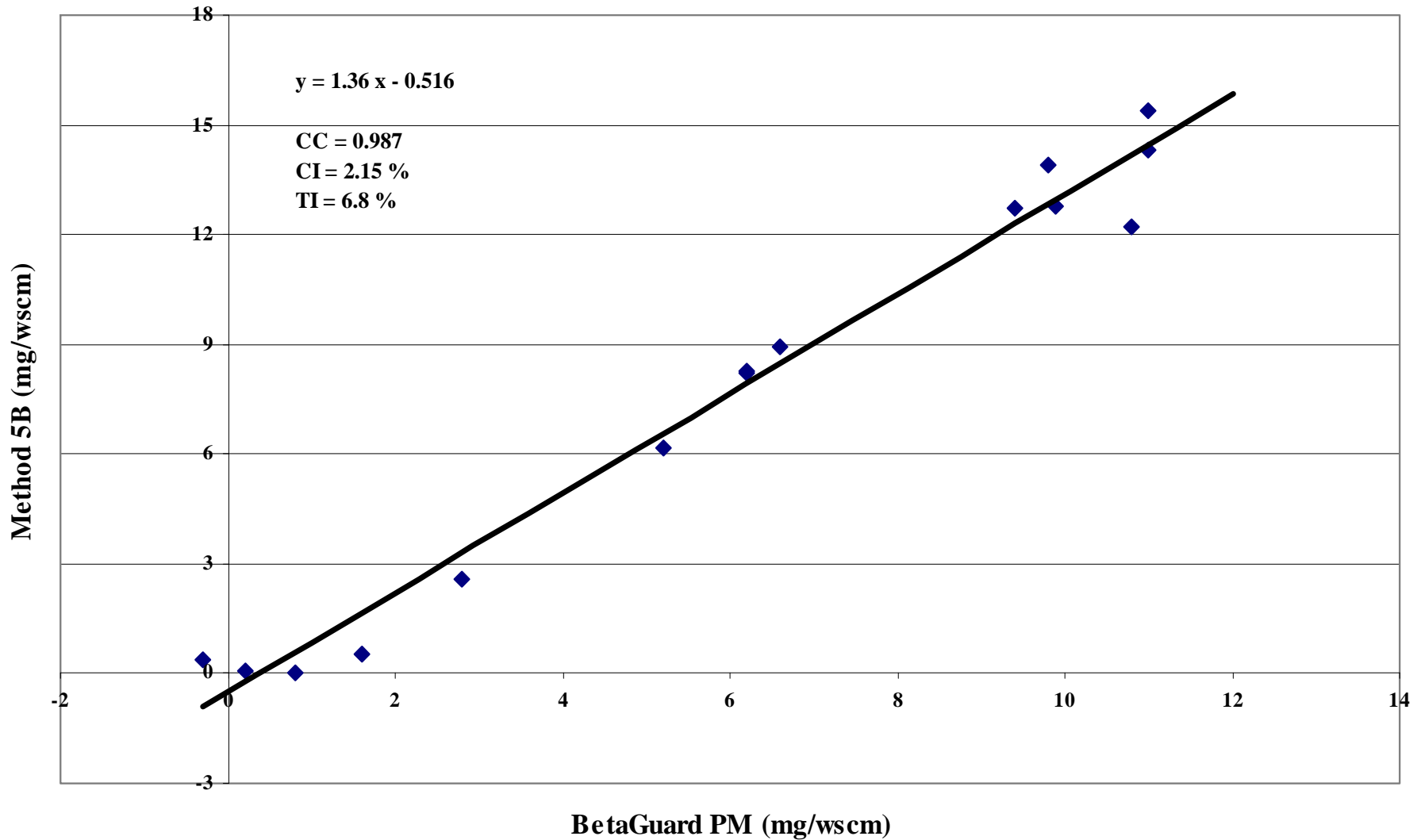


◆ Initial Corr ■ 2009 RRA ▲ 2010 RRA — Linear (Initial Corr) - - - Linear (Upper Limit) - - - Linear (Lower Limit)

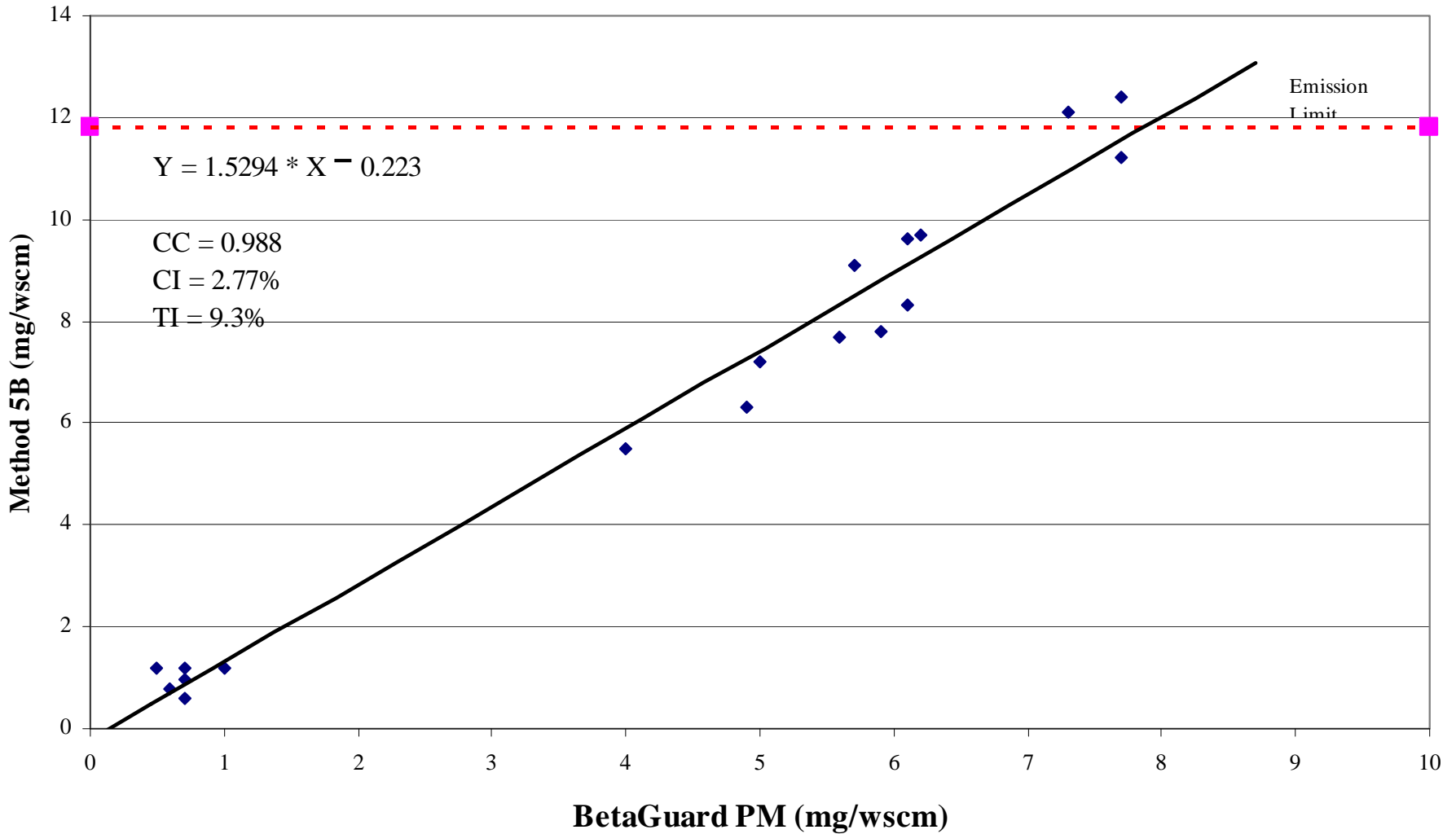
BetaGuard PM Correlation



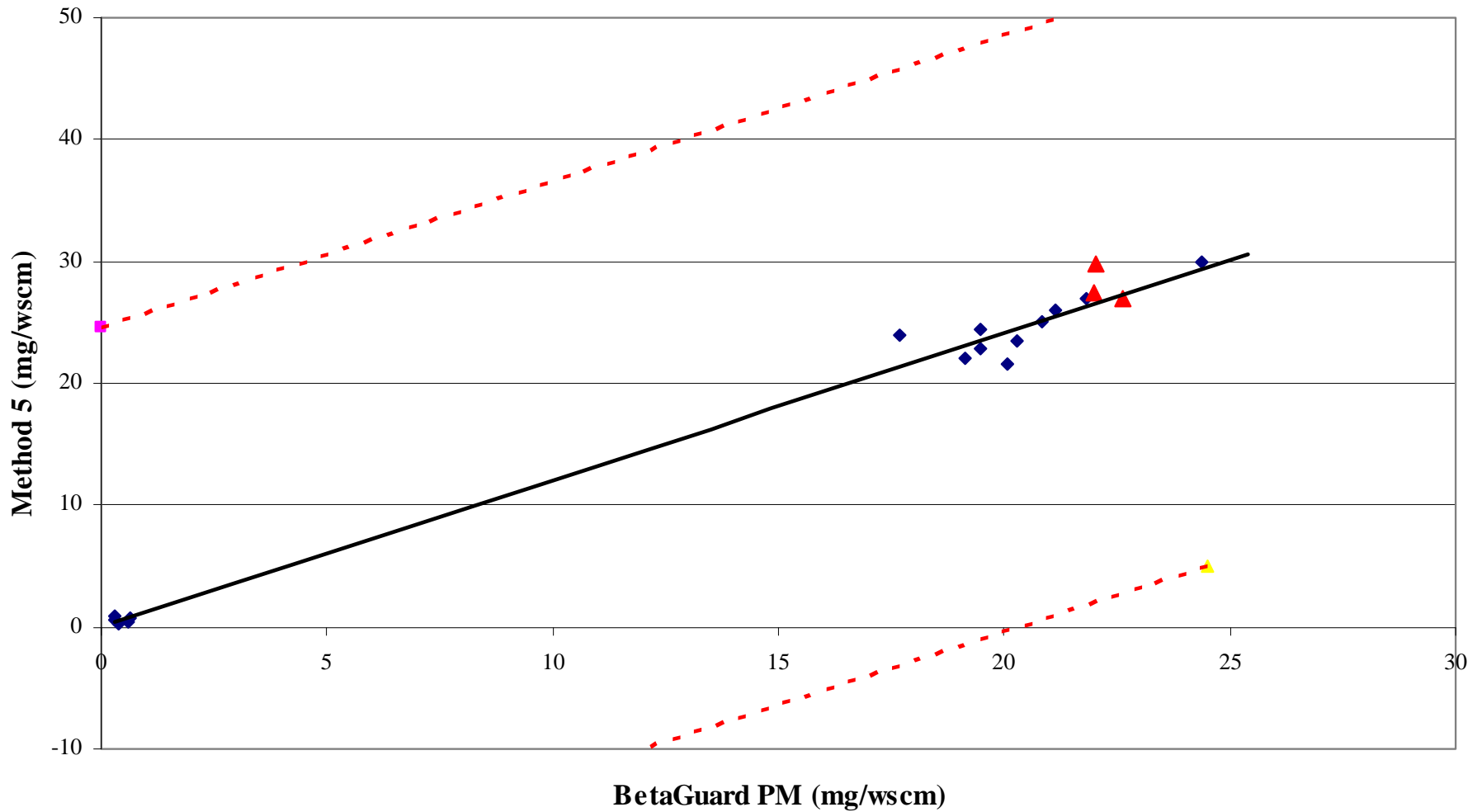
Units 8/9 Stack - BetaGuard PM Correlation



BetaGuard PM Correlation

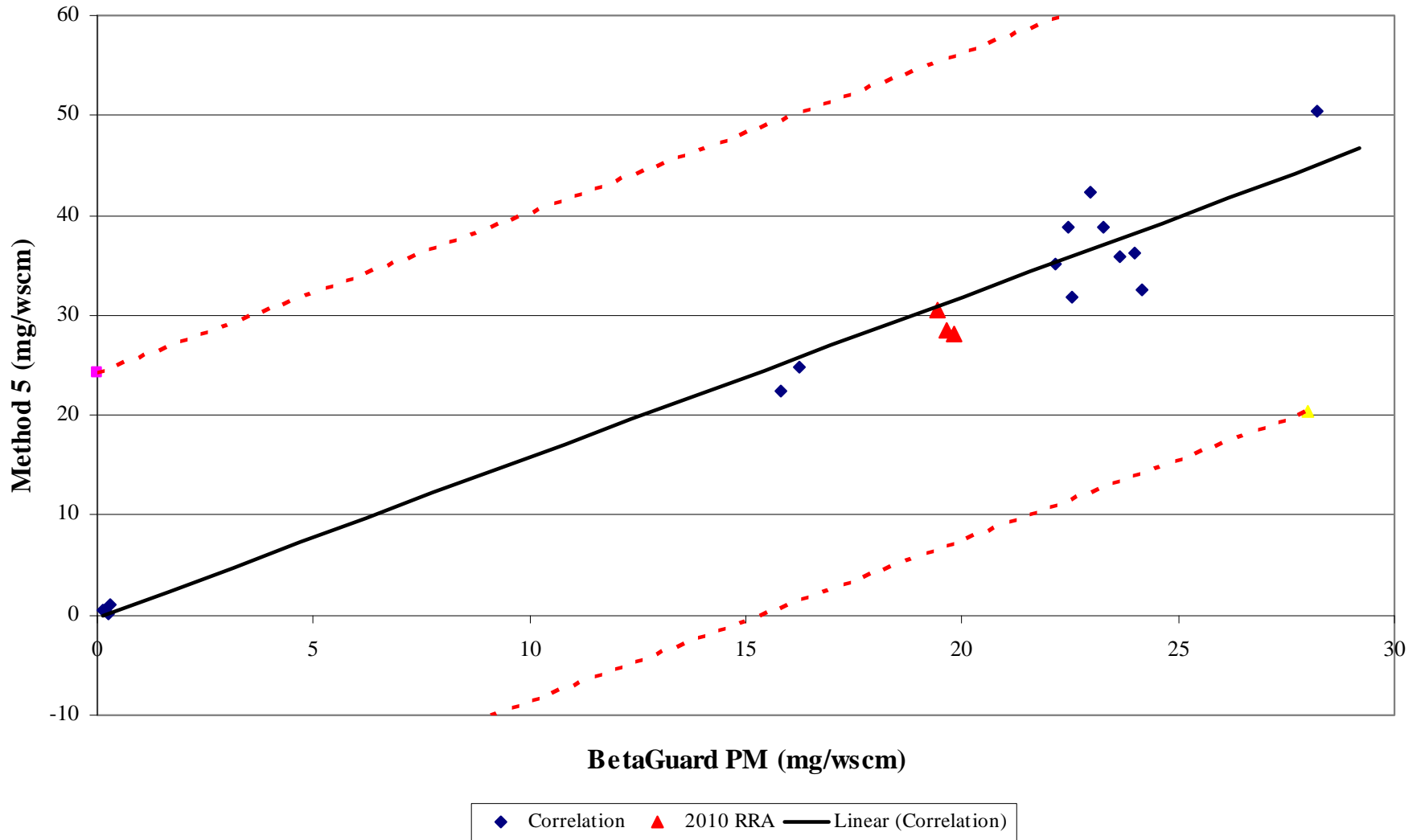


BetaGuard PM Correlation & 2010 RRA Result



◆ Correlation ▲ 2010 RRA — Linear (Correlation)

BetaGuard PM Correlation & 2010 RRA Result



Lessons Learned

The background is a solid blue color. A thin, light blue curved line starts from the top left and arcs across the upper portion of the slide. On the right side, there is a larger, semi-transparent blue shape that appears to be a stylized arrow or a decorative element pointing towards the center.

Plant Variations

- Every stack is different
- Every process is different
- Process changes affect PM emissions
 - SCR on vs. off
 - Sorbent injection on vs. off
- Mist eliminator operation
- Excess air and boiler outlet temperature
- Duct work leaks
- Acid gases are challenging to handle

PS-11 Correlation Test

- Obtaining different PM concentrations is a challenge but not impossible
 - Use different flow or production rates or fuels
 - Detune primary PM control equipment
 - Inject native dust into duct ahead of stack
 - Direct calibration with quantitative aerosol generator (QAG)
 - Pull probe from stack and sample ambient air for zero (only for the beta gauge monitor)
- Method 5 test method improvements are needed
- On-site final analysis of samples is needed

Particulate Characterization Testing

- Developed a procedure that works
- Recommended to find a representative sampling location in the stack
- Particulate stratification does exist

Summary

- BetaGuard is reliable and accurate
- BetaGuard is installed on many stacks with a long history of successful operation
- BetaGuard has wide operational flexibility allowing for site specific optimization
- BetaGuard actively maintains isokinetic sampling
- BetaGuard is simple to operate and easy to maintain
- BetaGuard is direct measure of PM concentration