
Mass Measurements of PM_{10} , $PM_{2.5}$, and $PM_{10-2.5}$ using the Teledyne API Model 602 Beta^{Plus} Particle Measurement System

Tim Morphy
Product Manager

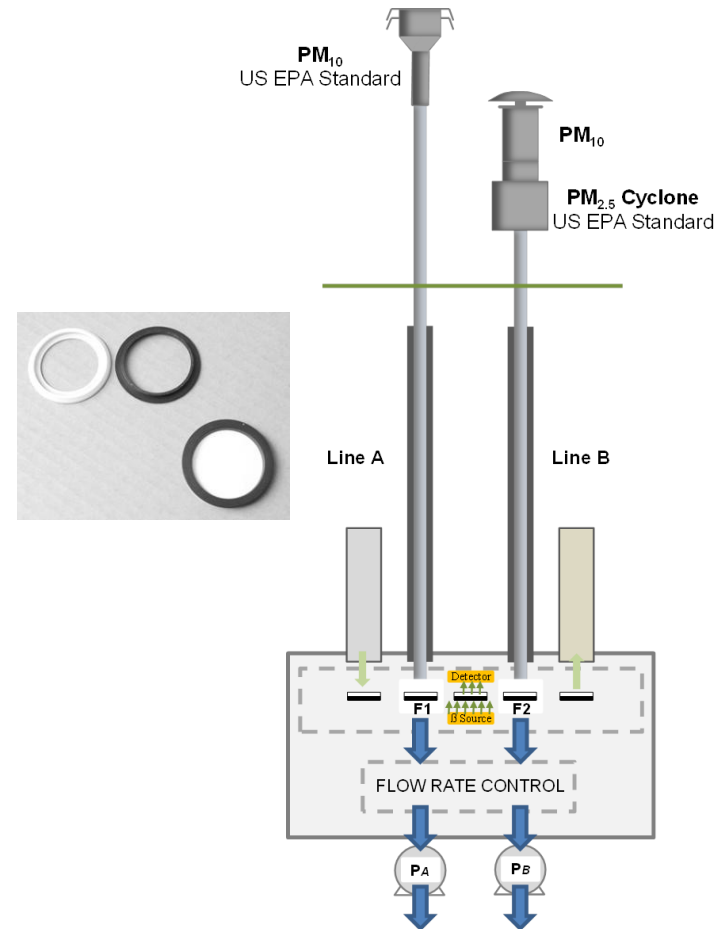
October 20, 2011

AWMA-Ontario Section
Real-time Particulate Matter Monitoring Workshop
Toronto, Canada



Model 602 Beta^{Plus}

- Dual-channel sequential sampler
- Collect onto 47mm filters
- Internal PM mass measurement with hourly resolution
- Independent sampling & analysis
 - >98% active sampling time
 - Long analysis period – high precision
- Completely automated with built-in diagnostic and audit features
 - Internal flow transfer standard for each sampling channel
- Remote communications with software
- Two-year warranty



Humidity Control

- During sampling:
Humidity is controlled using a sample line heater(s) with %RH set point
- During analysis: A 'spy filter' is measured every four minutes to account for humidity changes on the filter during the analysis process

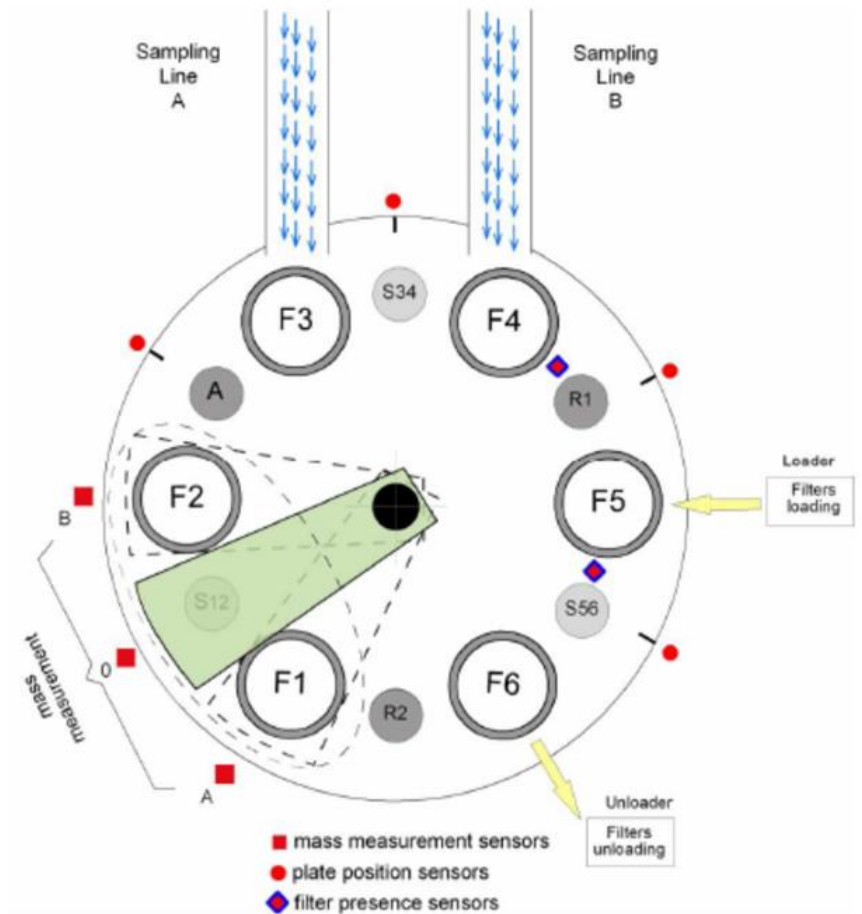


Fig 1. Inserting spy filter into position



Model 602 Beta^{Plus}

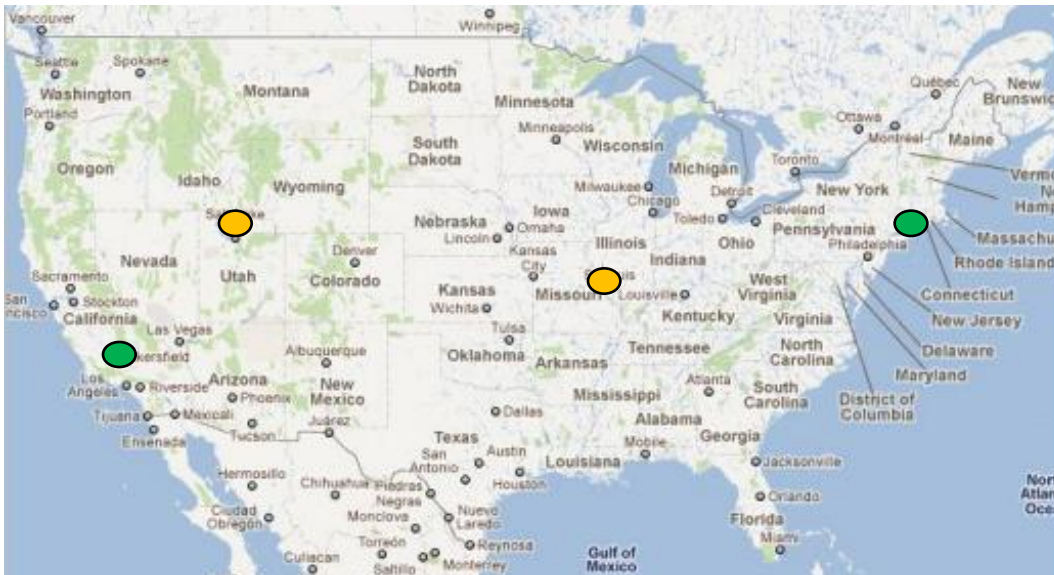
- Rotating plate filter holder design
 - Step 1: Filter Loading / Unloading
 - Step 2: Filter Sampling
 - Step 3: Filter Analysis
- Multiple Step Analysis
 - Air Counts
 - Dark Counts
 - Blank Counts
 - Natural Counts
 - Collect Counts
- Isolate and counteract known causes of uncertainty
 - Flow, humidity, sample density, detector performance, semi-volatile losses, background radiation



US EPA Field Testing Progress

US EPA FEM: PM₁₀

US EPA Class III FEM: PM_{2.5}, PM_{10-2.5}

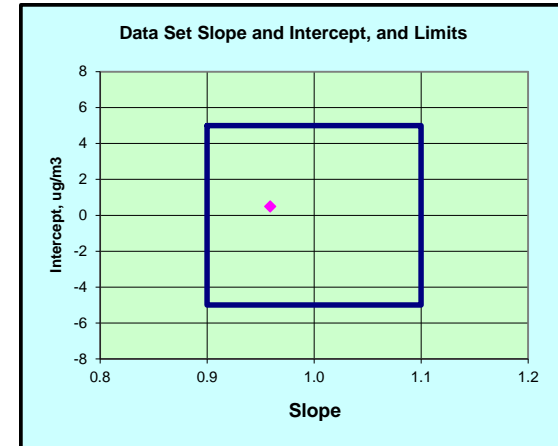
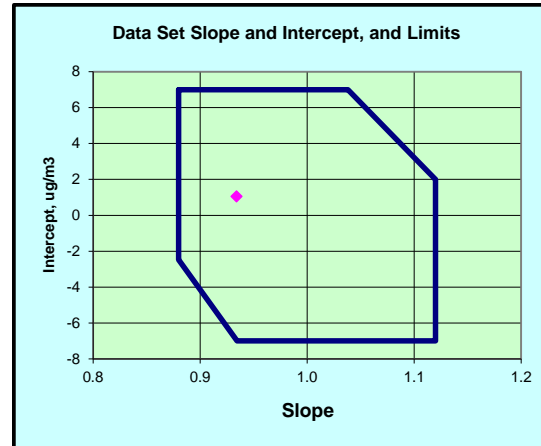
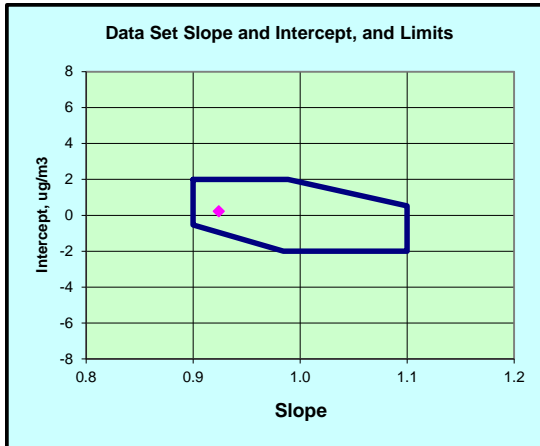
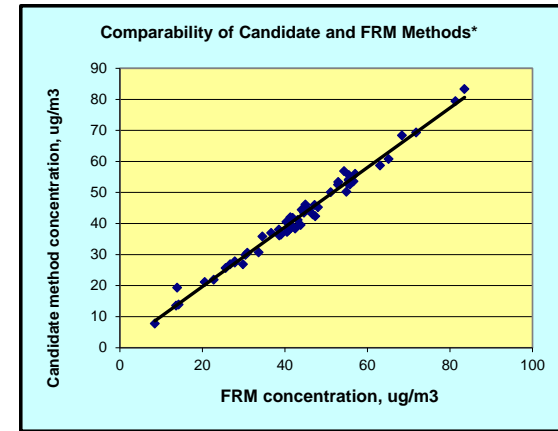
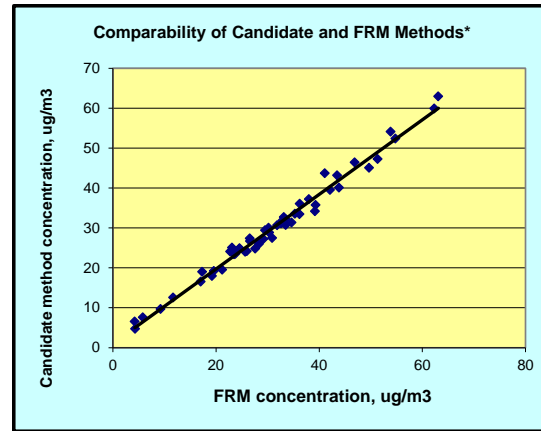
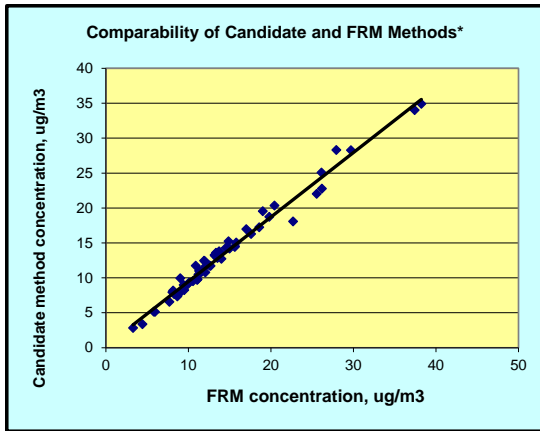


- Successfully Completed*
- Bakersfield – Summer
 - Bakersfield – Winter
 - New Haven – Summer
 - Logan – Winter
 - St. Louis – Winter



Bakersfield Results

10 – 9am daily sample collection schedule



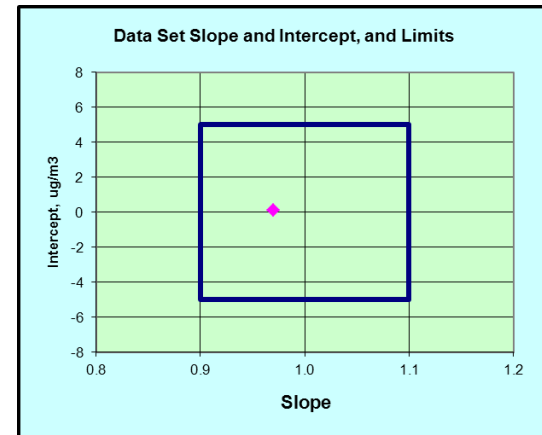
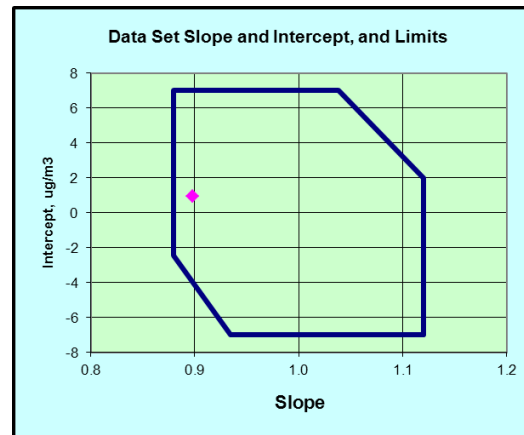
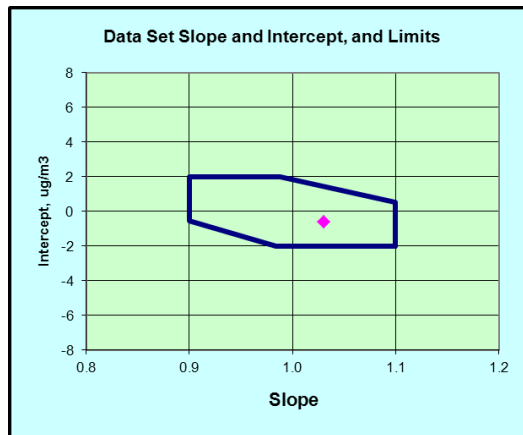
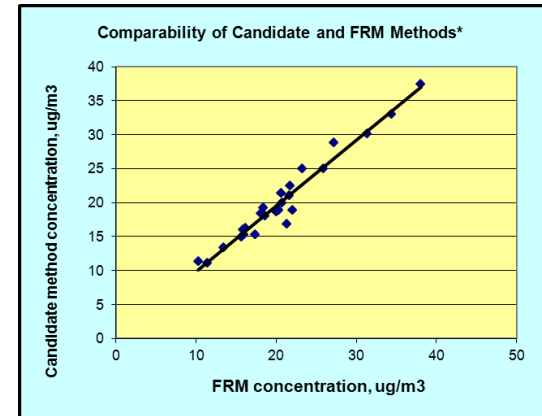
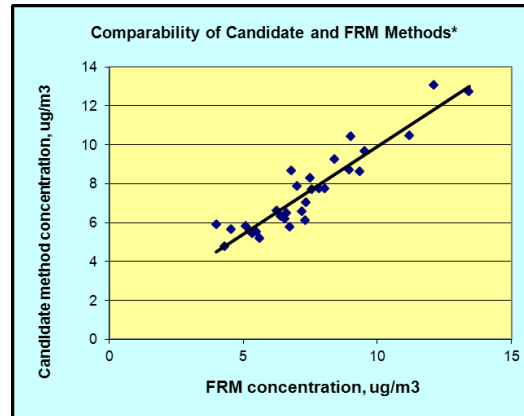
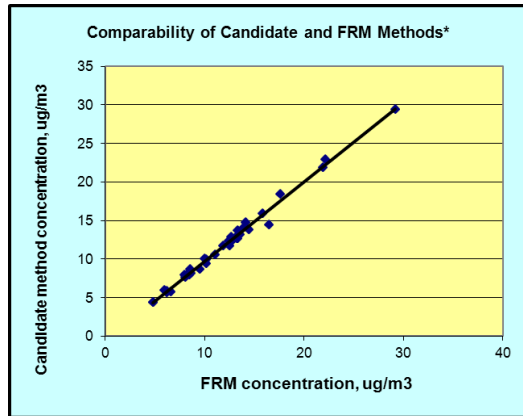
PM_{2.5}

PM_{10-2.5}

PM₁₀

New Haven Results

9 – 8am daily sample collection schedule

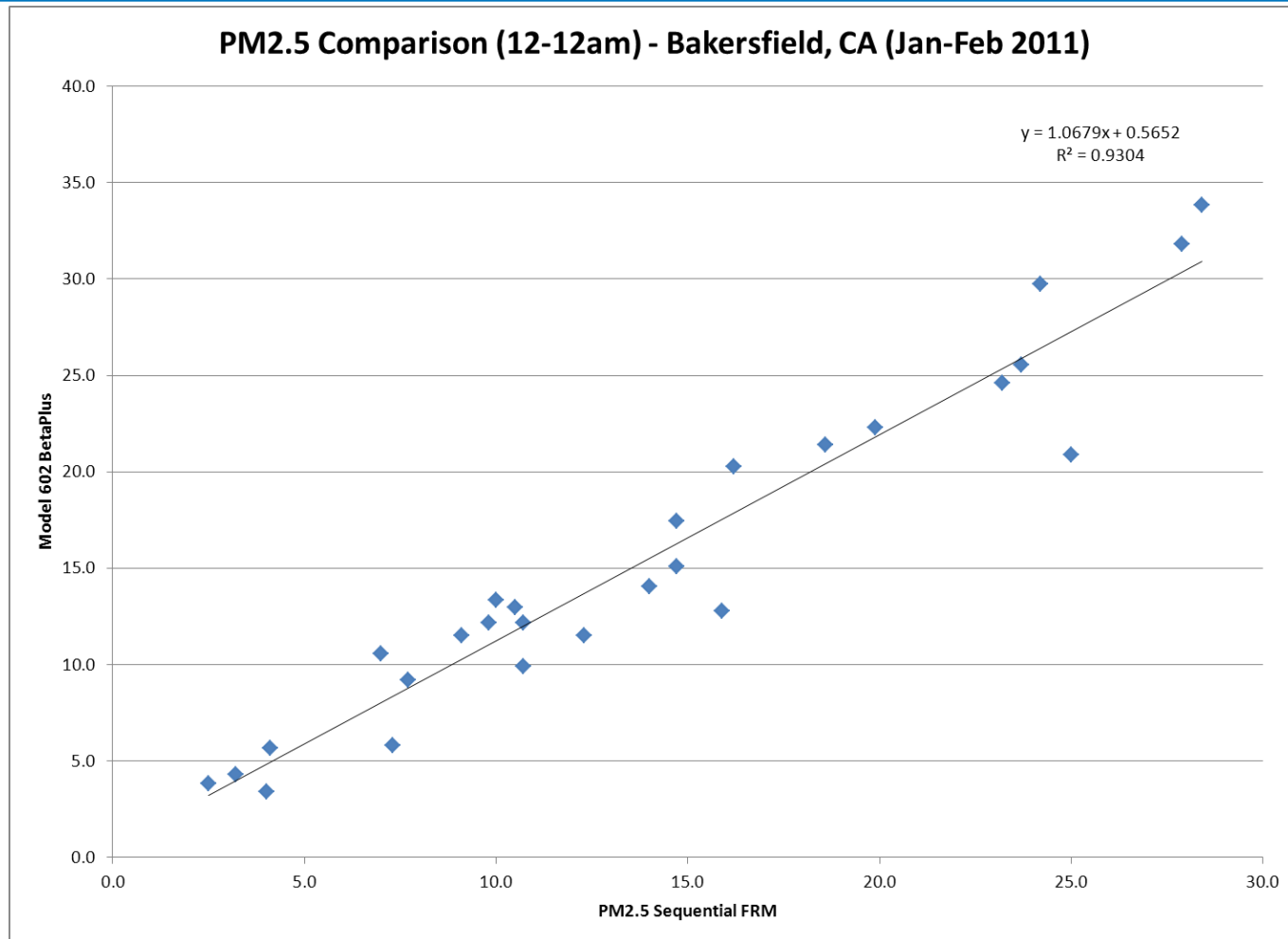


PM_{2.5}

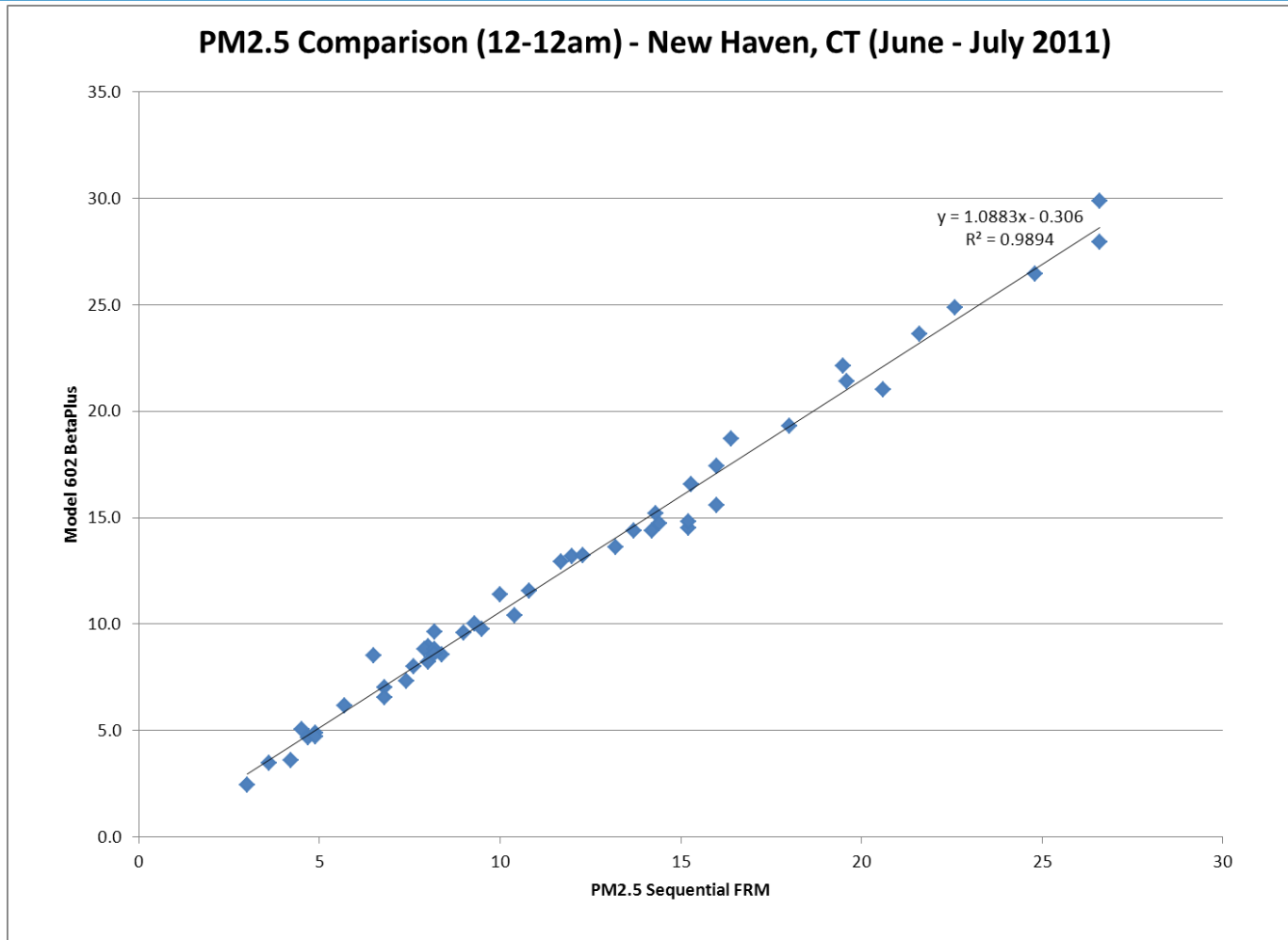
PM_{10-2.5}

PM₁₀

Bakersfield Site FRM Comparison



New Haven Site FRM Comparison

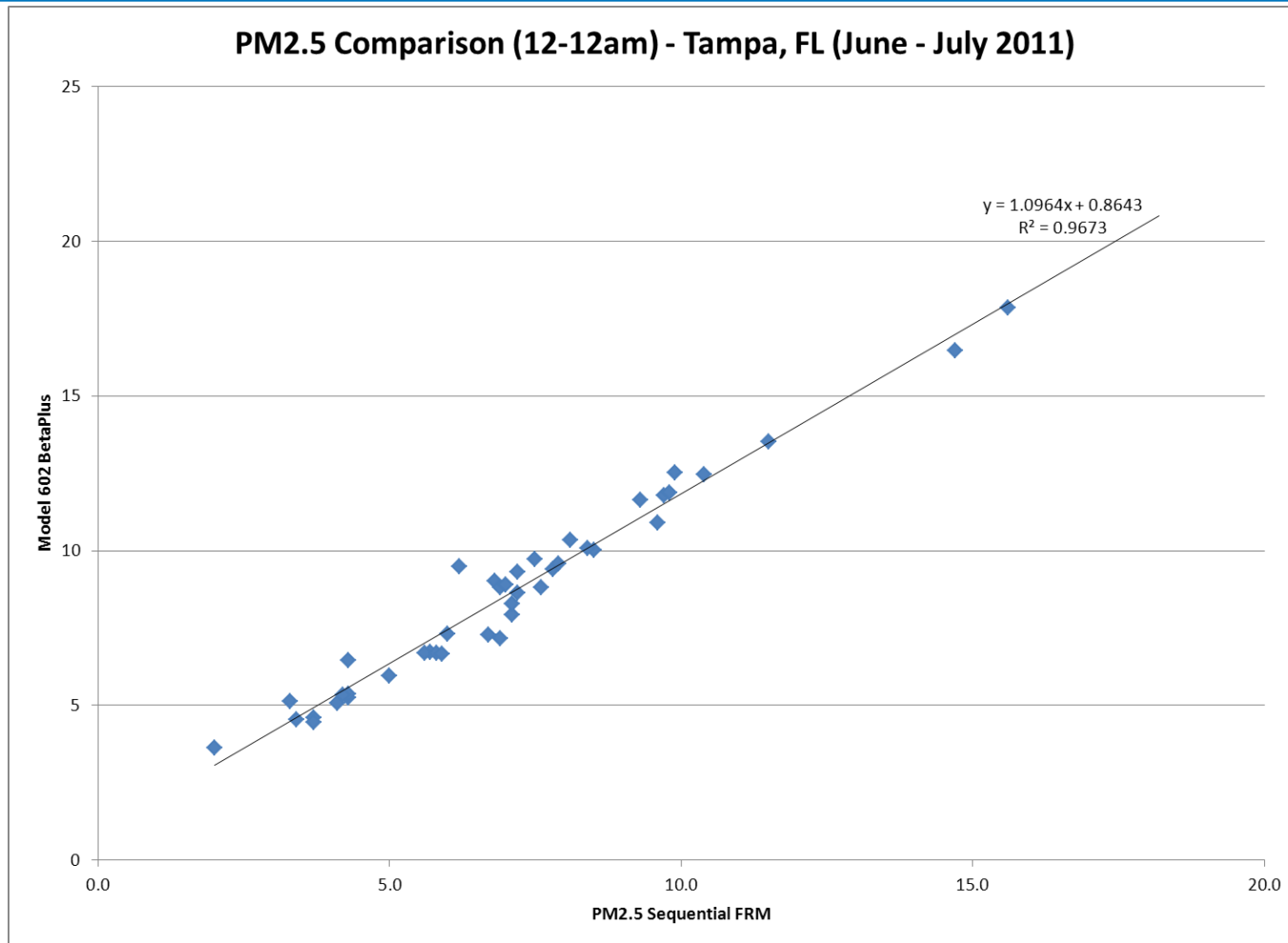


Other Field Trials

- Tampa FL
 - High humidity / dew point (70-75F)
 - Moderate / low PM concentration
- Albuquerque NM
 - Hot / Dry, elevation (5300ft / 1600m)
 - Very high short term PM10 from dust storms



Tampa FL Site FRM Comparison



Future Work

- Continue to compare site FRM data (midnight to midnight) during field trials
 - Albuquerque NM (June-July 2011) – *waiting for FRM*
 - Logan, St Louis (Winter Season 2011-2012)
- Perform other field evaluations including a cold weather site (Ottawa)
- Evaluate performance of chemical speciation analysis of 602 Beta^{Plus} sample filters – optical BC, metals, etc.
- Evaluate use as reference mass monitor combined with real-time OPC



Acknowledgements

- California Air Resources Board
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- Environmental Protection Commission of Hillsborough County
 - Tom Tamanini
 - Clemente Lopez
- Teledyne API
 - Stephen Toner





Tampa Installation



Outdoor Cabinet Option



Cycle Data Buffer

1. Record
2. Sampling start
3. Sampling end
4. Cycle
5. Filter
6. Accumulation step
7. Line
8. Power down
9. Leak test [ml/(min*kPa)]
10. Span test [%] Inlet volume [m³]
11. Standard Volume [m³]
12. Sampling time ratio [%]
13. Min.Ext.Temp.[K]
14. Avg.Ext.Temp.[K]
15. Max.Ext.Temp.[K]
16. Min.Filter Temp.[K]
17. Avg.Filter Temp.[K]
18. Max.Filter Temp.[K]
19. RH [%]
20. Min.Atm.Press.[kPa]
21. Avg.Atm.Press.[kPa]
22. Max.Atm.Press.[kPa]
23. RSD[%]
24. Initial Press.Drop[kPa]
25. Final Press.Drop[kPa]
26. Max.Press.Drop[kPa]
27. max.DT[K]
28. max.DT
29. Time DT>5 K
30. Time
31. Avg.DT[K]
32. Dark [cpm]
33. Air [cpm]
34. Spy Blank [cpm]
35. Spy Blank SD [cpm]
36. Blank [cpm]
37. Blank SD [cpm]
38. Temp.Blank[K]
39. Press.Blank[kPa]
40. Geiger HV
41. Blank[V]
42. RH Blank[%]
43. Collect Air [cpm]
44. Nat.Rad. [cpm]
45. Spy Collect [cpm]
46. Spy Collect SD [cpm]
47. Collect [cpm]
48. Collect SD [cpm]
49. Temp. Collect[K]
50. Press. Collect [kPa]
51. Geiger HV
52. Collect[V]
53. RH Collect[%]
54. PBL [cpm]
55. Mass[ug]
56. Mass Error[ug]
57. Conc.[μg/m³]
58. Standard Conc.[μg/m³]
59. Validation Data
60. Warnings



Specifications

<u>Item</u>	<u>Hourly Mode</u>	<u>Multi-Mode</u>
Sampling Period	1 Hour	8-12-24-48-72 Hours
Filter Cartridges	47 mm dia.	47 mm dia.
Spot Size	0.95 cm ²	2.54, 5.2, 7.07, 11.95 cm ²
Filter Media	Glass	Glass, Quartz, PTFE
Filter Capacity		96 Cartridges
Range		Up to 10 mg/m ³
Detection Limit		< 4 µg/m ³ (1hr), 0.3 µg/m ³ (24 hr)
Flow Rate		Adjustable from 14 to 41 LPM
Flow Accuracy		± 1%
Flow Stability		± 0.5% (Typical)
Flow Control		Servo-Controlled Valve
Mass Measurement		Beta Attenuation using ¹⁴ C (less than 100µCi) with Geiger Muller detector
Weight		64 kg. (141 lbs.)
Power Consumption		1200 W



Bakersfield Installation



New Haven Installation

