2009 National Ambient Air Monitoring Conference

MONDAY, NOVEMBER 2, 2009 –TRAINING SESSIONS

Continuous PM Mass Instrument

Grimm Model 180

Using Optical Technology
A look at the technology used in the GRIMM 180
Main principles of optical particle detection

<table>
<thead>
<tr>
<th>Components</th>
<th>Main Function</th>
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<tr>
<td>Sample air inlet</td>
<td>Reproducibility</td>
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<tr>
<td>Sample air pump</td>
<td>Constant flow rate</td>
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<tr>
<td>Light source</td>
<td>Generating a signal</td>
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<tr>
<td>Optical Beam</td>
<td>Well defined optical volume</td>
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<tr>
<td>Light trap</td>
<td>Eliminate signal noise</td>
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<tr>
<td>Detection optic</td>
<td>Known aperture / backward, forward, 90° optical or aerodynamic focusing</td>
</tr>
<tr>
<td>Detector</td>
<td>scattering light / photo diode, multiplier</td>
</tr>
<tr>
<td>Signal processing</td>
<td>rapid count processing and accurate size classification</td>
</tr>
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</table>

All components together determine the spectrometers counting efficiency (coincidence concentration) and sizing accuracy (particle size resolution)
Basic Principles of Particles Detection

The Nephelometer

aerosol particles

detection volume

Sample in

Light source

Detector

Signal from a group of particles!
Advanced principles of particle detection

Spectrometer with 90° detection

aerosol particles

aerosol focusing

detection volume

Sample in

Light source

Detector

Light trap

Signal from each single particle!

GRIMM can do it !!!
Single Particle Light Scattering

Grimm Spectrometer Principle

- Laser
- Detector
- Sample air
- Light trap
- 90° scattering angle
- 30° aperture angle
- Mirror
Single Particle Light Scattering
Grimm Spectrometer Principle

aerosol focusing

air inlet

aerosol focusing

laser
dust collection filter

clean air outlet to pump

light trap

90° scattering collection

www.GRIMM-aerosol.com
Sheath Air to protect Optics

- Pump
- Laser
- Sample stream with particles
- PTFE-Filter
- Measuring chamber
- Light trap
- Clean air
- Light trap
- Sheath air
- Particle filter
- Outlet
- Purge air
Particle count distribution is the base for the dust mass calculation. We convert these optical count values to a mass distribution. The geometric mean value between two thresholds of each of the 31 different channels is multiplied by a density factor corresponding to the established “urban environment” factor. With this implementation we obtain the proper mass distribution over the full range. Finally we need to correlate the sample air volume to the mass value to obtain mass/volume.

Based on the obtained mass distribution we can now implement the cut points of the sampling heads. The PM10, PM2.5 and PM1 are then applied.
Grimm Model 180 Candidate for US EPA PM 2.5 Class III FEM Approval
### US EPA PM 2.5 Class III FEM Approval

#### GRIMM Test Sites for Class III Continuous Monitors

<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
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<tbody>
<tr>
<td>A</td>
<td>Bakersfield, CA</td>
</tr>
<tr>
<td>B</td>
<td>Denver, CO</td>
</tr>
<tr>
<td>C</td>
<td>St. Louis, MI</td>
</tr>
<tr>
<td>D</td>
<td>New Haven, CT</td>
</tr>
</tbody>
</table>

- **A: Winter & Summer (46 days)**
- **B & C: Winter Only (23 days each)**
- **D: Summer Only (23 days)**
Our choice of reference instrument:
US EPA PM 2.5 Class III FEM Approval

Grimm Trailer

www.GRIMM-aerosol.com
US EPA PM 2.5 Class III FEM Approval

Grimm Trailer
Results Bakersfield – Scatter Plots

Bakersfield Site

\[ y = 0.977x - 0.079 \]

\[ R^2 = 0.9812 \]
Results Bakersfield – Time Series

Bakersfield Site

Concentration (ug/m³)

FRM
Grimm 180

DAY

www.GRIMM-aerosol.com
Results Denver – Scatter Plots

Denver Site

\[ y = 0.965x + 0.0939 \]

\[ R^2 = 0.966 \]
Results Denver – Time Series

Denver Site

Concentration (ug/m³)

FRM
Grimm 180

DAY

Concentration (ug/m³)

FRM
Grimm 180

DAY
Results St-Louis – Scatter Plots

St-Louis Site

\[ y = 0.9936x + 0.1815 \]

\[ R^2 = 0.9466 \]
Results St-Louis – Time Series

St-Louis Site

Concentration (ug/m³)

FRM

Grimm 180

DAY

1 3 5 7 9 11 13 15 17 19 21 23 25
Results New Haven – Scatter Plots

New Haven Site

\[ y = 0.9664x + 0.0377 \]

\[ R^2 = 0.9139 \]
Results New Haven – Time Series

New Haven Site

Concentration (ug/m³)

DAY

FRM
Grimm 180
Results Summary

Bakersfield

St-Louis

Denver

New Haven
Operation & Maintenance

- The Grimm 180 can operate for one year unattended.
- Annual Calibration at Grimm USA Office.
- On-site audits can be easily achieved with the compact Test-Kit available.
  - Flow Check
  - Leak-Test
  - Zero Particle Test
CALIBRATION TOWER
Benefit of the technology

- No Consumable
- Minimal Maintenance
- Real-Time Measurement (6 sec)
- PM2.5 + PM10 + PMc with a single instrument
- Insensitive to vibration → Mobile Application
- Easy Installation
Come to our booth for more information.