

How AethLabs ensures instrument quality and how users can maintain data quality

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Overview

Intro to AethLabs

Component inspection

Lab testing assembled instruments

Field testing assembled instruments

QA considerations for users

Summary



Intro to AethLabs

- AethLabs is a small manufacturer of Black Carbon (BC) monitors in San Francisco, CA
 - BC is a dark aerosol often coated with toxic metals
 - BC is a subset of $PM_{2.5}$ (PM_1)
 - BC is emitted from combustion
 - e.g., traffic (soot), agricultural burning, wild fires, household heating with wood
- AethLabs makes portable instruments
 - Sizes range from a deck of cards to a large brick
 - Custom instruments for customers like JPL NASA
- Our devices allow users to quantify BC by its sources (fossil fuel vs. biomass burning)
- We often sell to regulators, scientists, and community groups

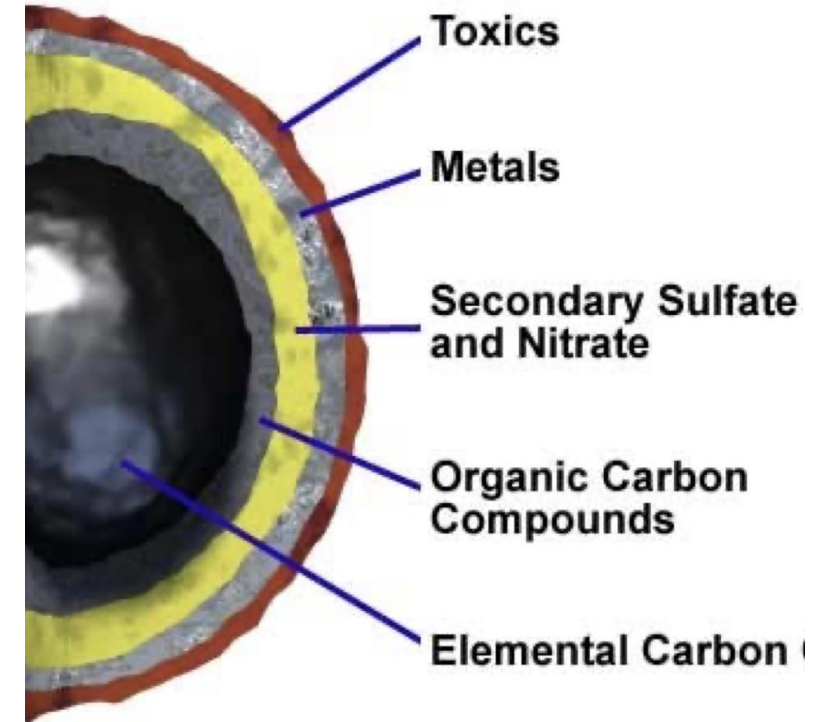


Figure source: Schneider and Hill 2005

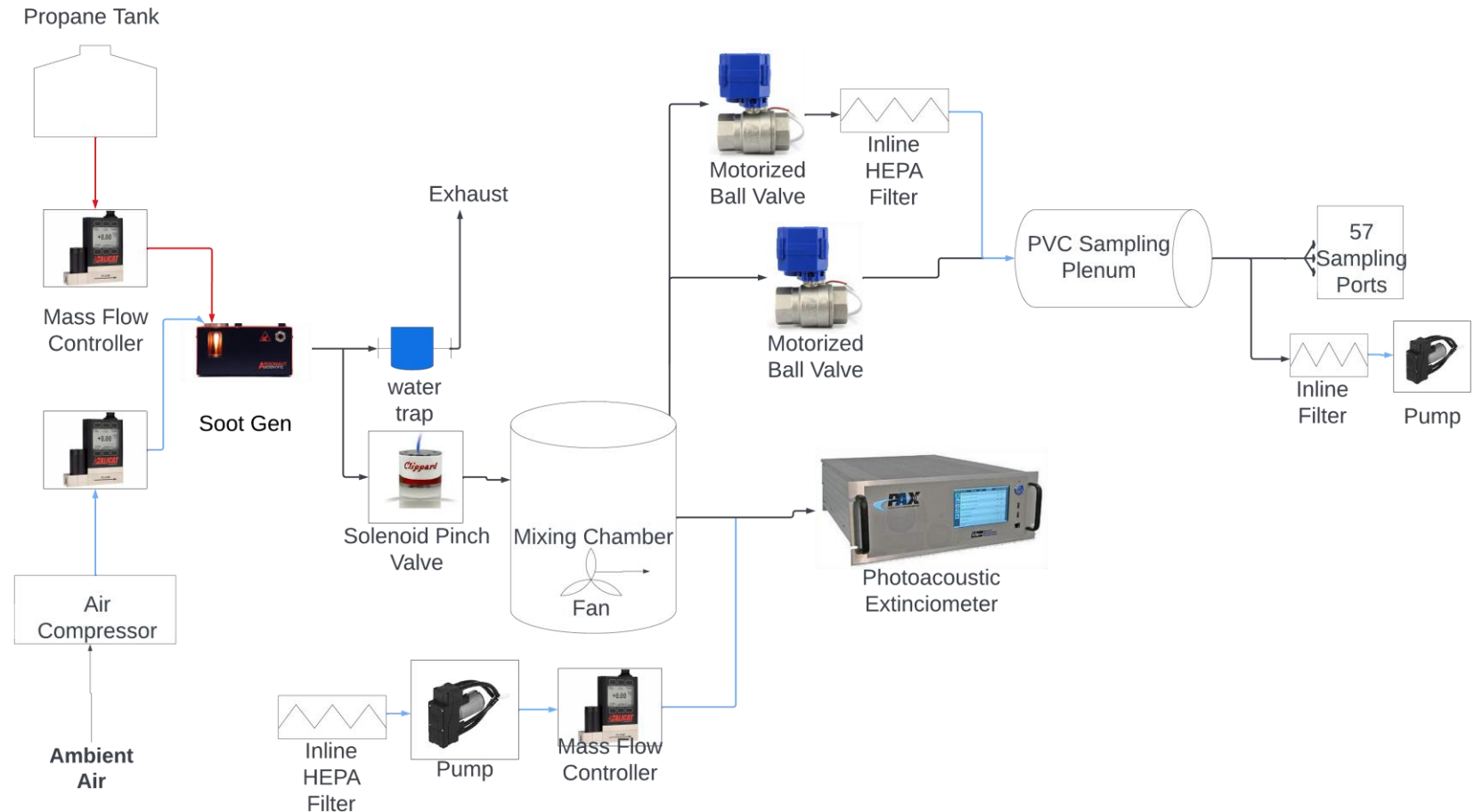
Component inspection

- Many of AethLabs' components are custom designed and assembled in-house
 - e.g., mechanics, electronics (PCBs), tape cassettes, and optical assemblies
- We also use commercial off-the-shelf components like temperature & RH sensors, and customized air pumps
- Mechanical and optical components are inspected on arrival and during assembly
- Individual circuit board level components are tested after assembly onto printed circuit board



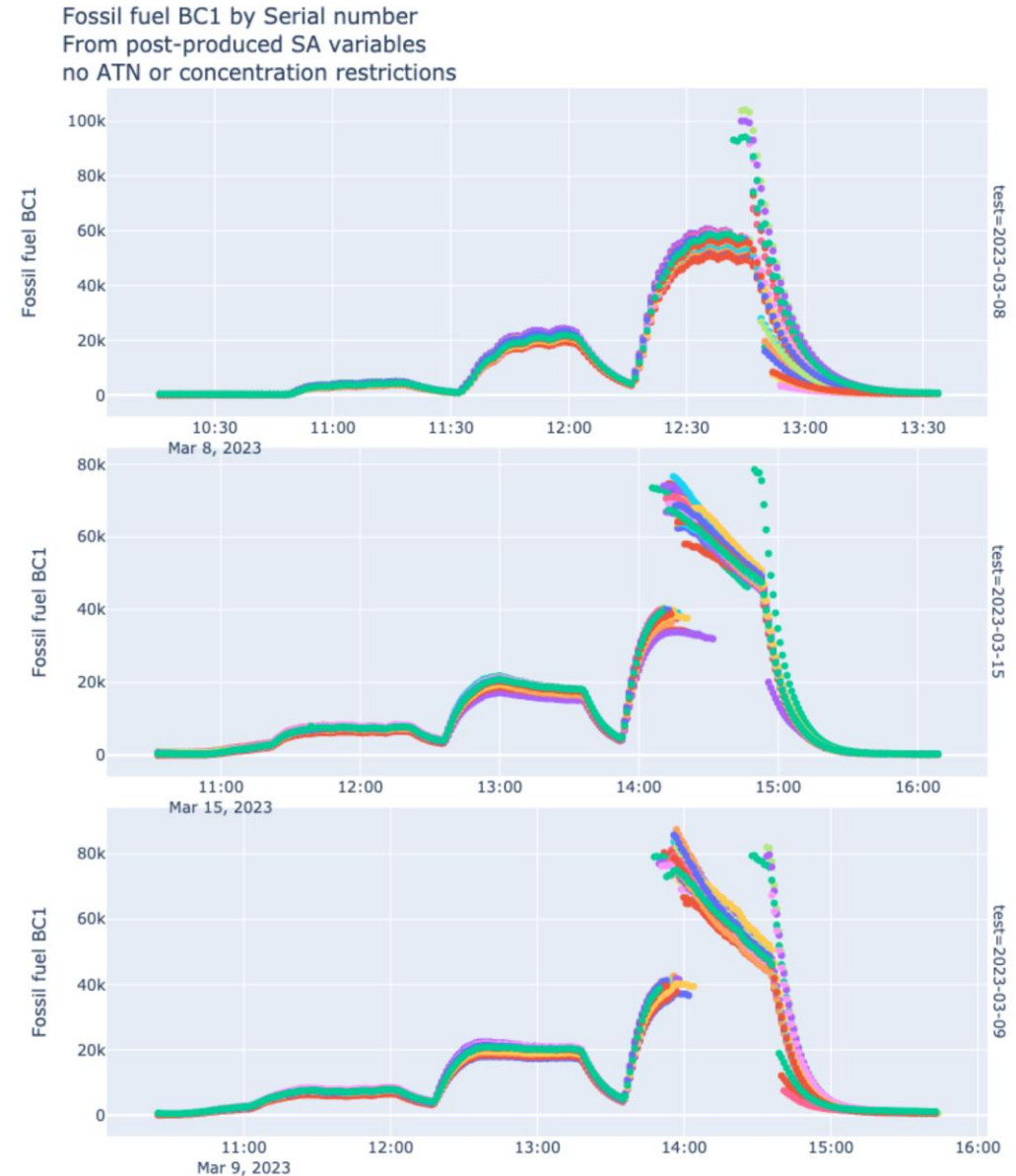
Lab testing assembled & service instruments

- We use a custom soot chamber for assessing device performance
- Instruments draw from sample plenum
- Mixing chamber concentration is programmable
 - Chamber is filled with soot via propane soot generator
 - PAX provides feedback to soot gen system
- A sequence of standardized target concentrations is generated with troughs in-between



QAQC Auto Tool

- Data are aggregated by instrument type
 - e.g., production vs. service, instrument series (AE51, MAx, ALx)
- Critical errors are assessed:
 - Firmware “Readable status” codes (see device manual)
 - Optical saturation, Sample timing error, Flow unstable, Pump drive limit, Tape jam, Invalid date/time
 - Proper tape position advance
 - Optical hardware performance
- Summary statistics produced for key fields and compared to in-house error & bias standards
 - e.g., optical readings, flow stability, flow ratio, BC concentration, source apportionment outputs,
- Automated PDF report produced
 - Failures/concerns identified with reason & offending stat(s)
- Interactive visualizations created for manual review where necessary



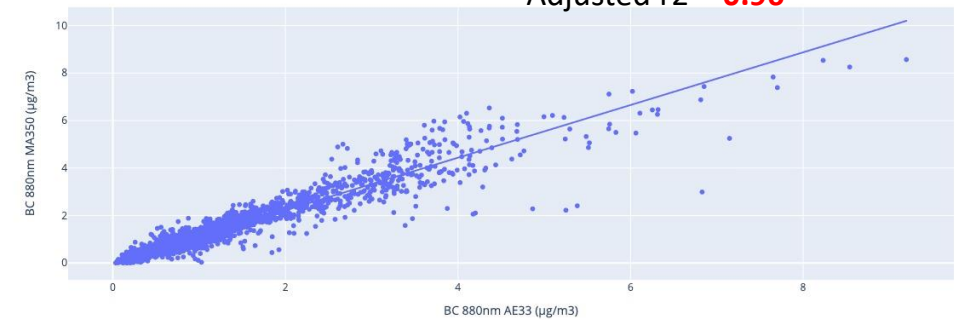
Field testing

- We work with key partners and early adopters for field validation
- Example: Source Apportionment (Hill et al 2023)
 - New feature implemented this summer
 - Several years of lab and field validation
 - Collocation with more-common AE33 by ATMO in several locations in France



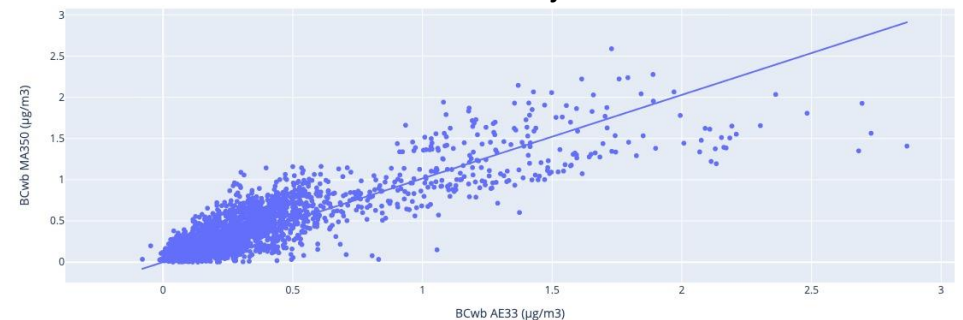
Lyon: BC 880nm AE33 vs BC 880nm MA350-0302

BC MA350 $\sim 1.11 \cdot$ (BC AE33).
Adjusted r2 = **0.96**



Lyon (MA350-0302): BCwb MA350 vs BCwb AE33

BCwb MA350 $\sim 1.01 \cdot$ (BC AE33)
Adjusted r2 = **0.87**



QA considerations for users

- “Readable status” column can indicate poor data quality
 - Invalid data for analysis:
 - Start up and Tape advance
 - Pump drive limit, Optical saturation, or Sample timing error
 - User skipped tape advance (likely to result in filter loading effects, bias)
 - Partially valid data:
 - Invalid date/time
 - Device needs troubleshooting or maintenance
 - Tape jam, Tape not ready, Tape transport not ready, Tape error, WiFi Line Full (missing data)
- Flow values depend on temperature & pressure at time of calibration
 - Device flow-calibration required if environmental conditions (temp & pressure) change considerably
 - Create volumetric flow using device temp and pressure readings, historical flow calibration data available as of firmware v1.12 (Spring 2023)
- Stable temperature and RH produce the best data quality
 - Condition instrument and sample inlet whenever possible
 - Avoid rapid temperature change (insulate housing, keep out of direct sun)

Summary

- AethLabs produces Black Carbon monitors
 - Assess soot; quantify by biomass vs traffic related emissions
 - We are always looking to engage with community monitoring projects!
- Instruments are hand-assembled using custom and commercial off-the-shelf components in San Francisco, CA
- Each device is rigorously tested after manufacturing and servicing
- Field testing and validation is carried out with collaborators and early adopters
- Users can ensure data quality by:
 - Taking advantage of the “Readable status” data column
 - Calibrating flow in new environments and sampling conditions
 - Using temperature-controlled enclosures, conditioned inlets

Thank you!

References

1. Hill, L. Drew, Vincent Crenn, Mario Duval, Didier Grenier, Alexandre Marpillat, Ivan Iskra, Olivier Favez, and Jeff Blair. “Results from Winter Field Collocations of the AethLabs MA350 MicroAeth and AE33 Rack Mount Aethalometer in Lyon and Clermont-Ferrand, France: An Analysis of Filter Loading Compensated Black Carbon and Source Apportionment Measurements.” In ACTRIS: Innovation in Atmospheric Measurement Techniques. Paris, France, 2023.
2. Schneider, Conrad, and L. Bruce Hill. “Diesel and Health in America: The Lingering Threat.” Clean Air Task Force, 2005.