# Evaluation of CPMA-Electrometer Calibration Method for Black Carbon Aerosols

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Keywords: Aviation, Instrumentation, Combustion, Calibration
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Measurement devices are only as accurate as their last calibration. As such, there is strong motivation to advance calibration tools to both increase the accuracy and efficiency of these procedures.

Within the field of aviation, equipment is calibrated through reference to filters acquired and analysed used Thermal Optical Analysis (TOA). This process requires specialized equipment, which is not mobile, thus, instruments requiring calibration must be shipped to labs specifically for calibration, a non-ideal situation if calibration is required on short notice, or during a measurement campaign. In addition, measurements are not analysed in real time; increasing the length of a calibration event. The repeatability of TOA is ~17% (NIOSH, 2003), a relatively significant uncertainty for a calibration technique.

The purpose of this study was to determine the repeatability and reproducibility of a Centrifugal Particle Mass Analyzer (CPMA)-Electrometer system, as an alternative and preferable calibration method. The CPMA-Electrometer system can conduct a calibration in hours rather than days, is able to test dynamically, and has been previously shown to have a much lower uncertainty of 4.3% (Dickau, 2015).

The CPMA-Electrometer system is composed of 4 stages: particle generation, conditioning, classification, and measurement. Figure 1 displays the general schematic.

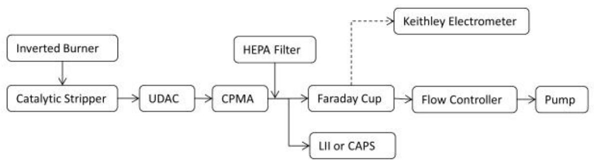


**Figure 1: Test schematic for CPMA-Electrometer measurements.**

To determine the repeatability of the system, multiple measurements were performed over multiple days using a CPMA-Electrometer system and two challenge instruments, a Laser-Induced Incandescence instrument (LII) and a Cavity Attenuated Phase Shift Particulate Matter Single Scatter Albedo instrument (CAPS PMssa). Measurements were taken with mass concentrations ranging from 0.005 mg/m$^3$ to 0.300 mg/m$^3$, a much larger range than previously tested (Dickau, 2015). The results have been displayed together in Figure 2. It was found that the measurements could be repeated with less than 2.5% variation from day to day. In addition, the challenge instruments were found to correlate with the CPMA-Electrometer system with an $R^2$ value greater than 0.998 for all repeatability testing. Reproducibility was assessed by testing a second independent CPMA-Electrometer system against the same two challenge instruments. In order to quantify the reproducibility of the CPMA-electrometer method, each component essential to the measurement of the particulate mass concentration, for each of the two systems used, was individually tested; these results will help to determine major sources of error and variability of the overall system. It was found that the flow controllers each had an uncertainty of 0.5%, the electrometers had a 2% uncertainty, and the Faraday Cups/ Electrometer had a combined reproducibility of about 4%. Preliminary results have displayed a larger uncertainty in the reproducibility as compared to the repeatability, however, further testing is ongoing to fully quantify the variability between the two CPMA's used in the study

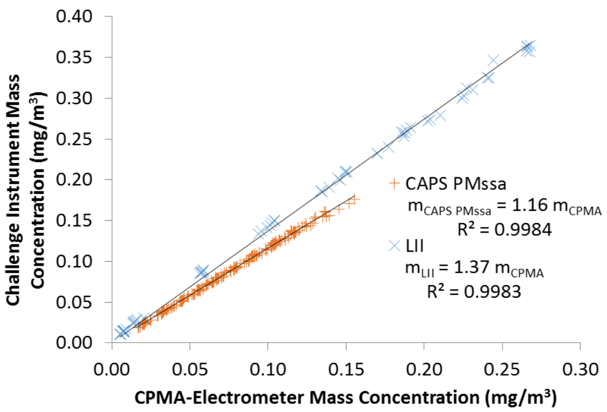


**Figure 2: Mass concentration measurements with the CPMA-Electrometer system and two challenge instruments.**

This project is funded by Transport Canada under the Clean Transportation Initiative.

NIOSH. (2003). *Monitoring of Diesel Particulate Exhaust in the Workplace*, NIOSH, Cincinnati, OH, USA. NIOSH DHHS Publication No. 2003-154.

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