A Personal, Thermophoretic Sampler for Airborne Nanoparticles

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Colorado State University
Knowledge to Go Places

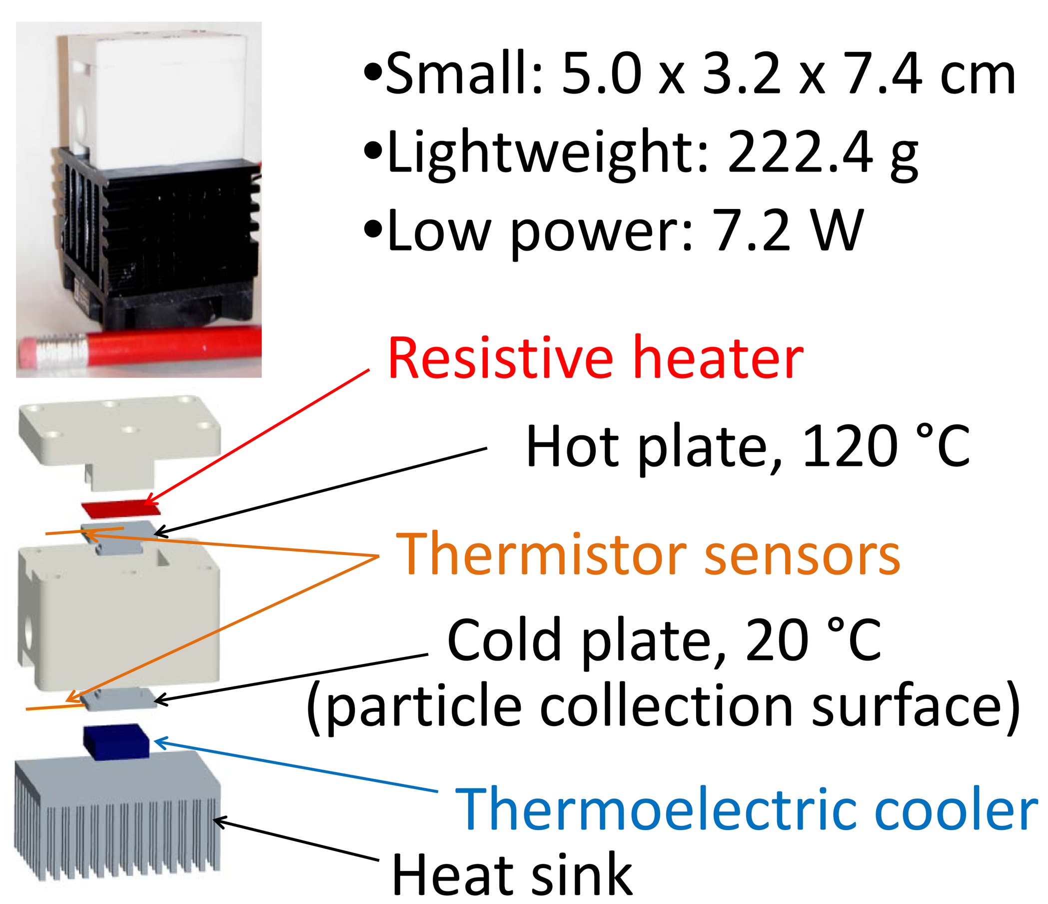
I. Abstract

A personal, thermophoretic particle sampler was designed to collect airborne nanoparticles in the breathing zone of exposed workers. The thermal precipitator captures aerosol by creating a 1000 ˚C/cm temperature gradient between two aluminum plates (0.1 cm separation distance) using a resistive heater, a thermoelectric cooler, a temperature controller, and two thermistor sensors. The objective was to make the device small, lightweight, and efficient at collecting airborne nanoparticles over an 8 hour workshift. Particle collection efficiency was determined by challenging the sampler with monodisperse aerosols from 15 - 240 nm at flow rates of 5 and 20 mL/min. The sampler collected particles with 100% efficiency at a 5 mL/min flow rate and with approximately 65% efficiency at a 20 mL/min flow rate. The uniformity of particle deposition across the collection plate varied, but was most representative near the center of the cold plate.

II. Experimental Design

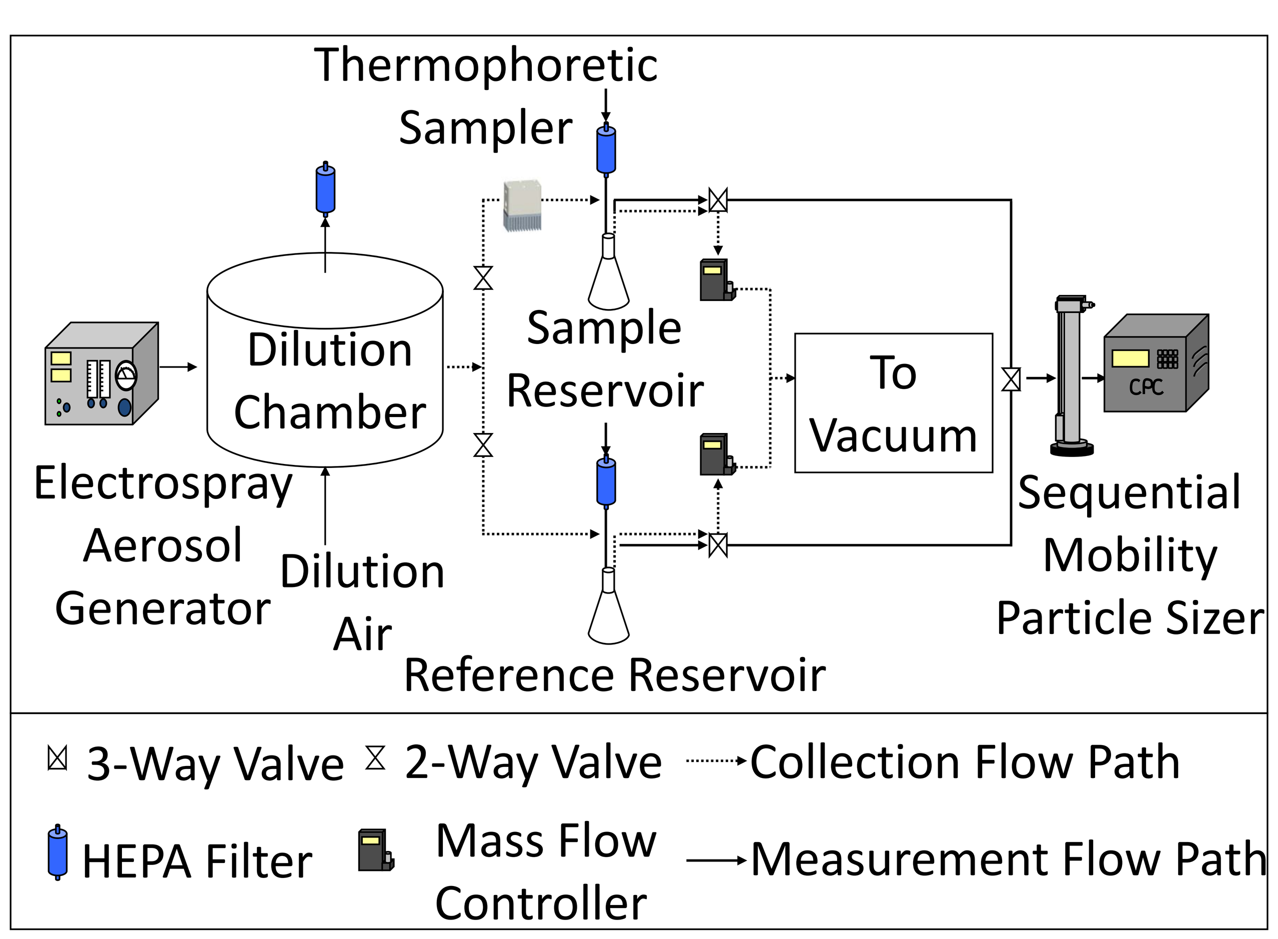
Sampler Design Considerations

•Small: 5.0 x 3.2 x 7.4 cm
•Lightweight: 222.4 g
•Low power: 7.2 W



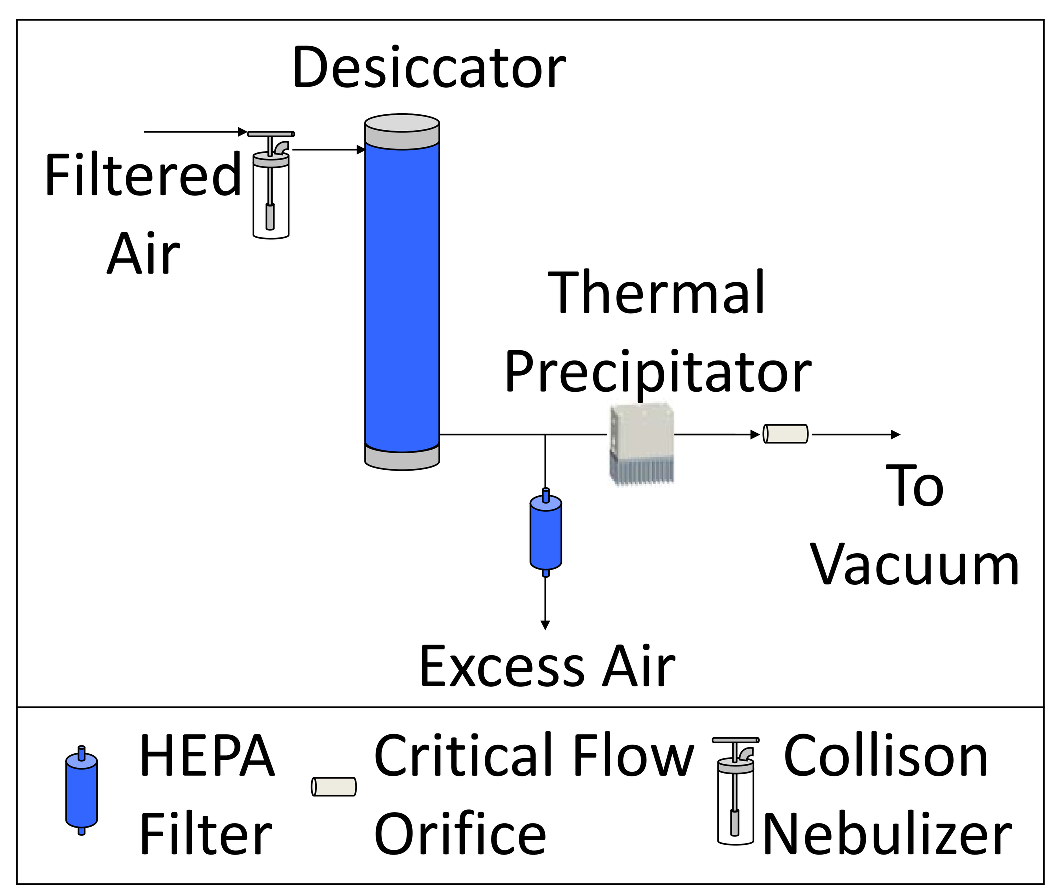
Collection Efficiency and Diffusion Loss Test Setup

- Measured collection efficiency at flow rates of 5 and 20 mL/min
- Repeated with no temperature gradient to determine diffusional losses
- Collection efficiency measured by relative particle concentrations in reservoirs

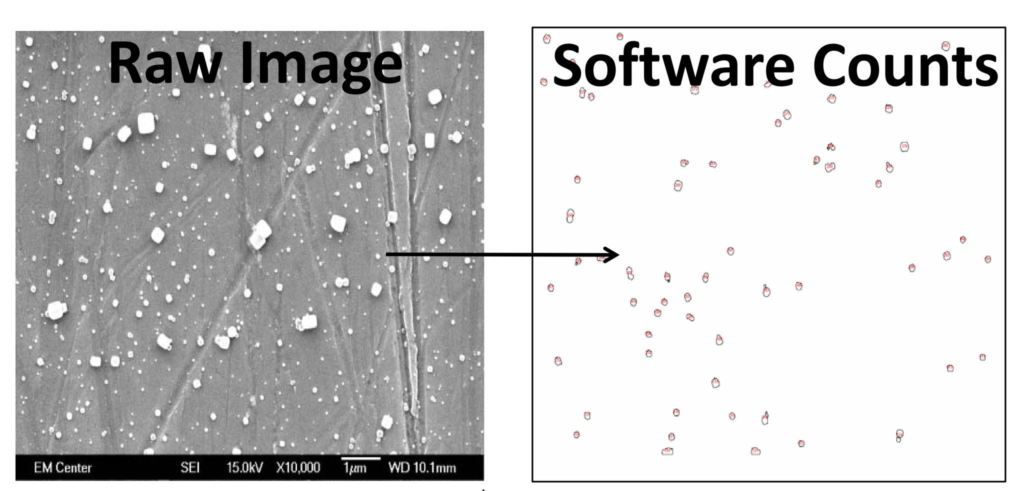


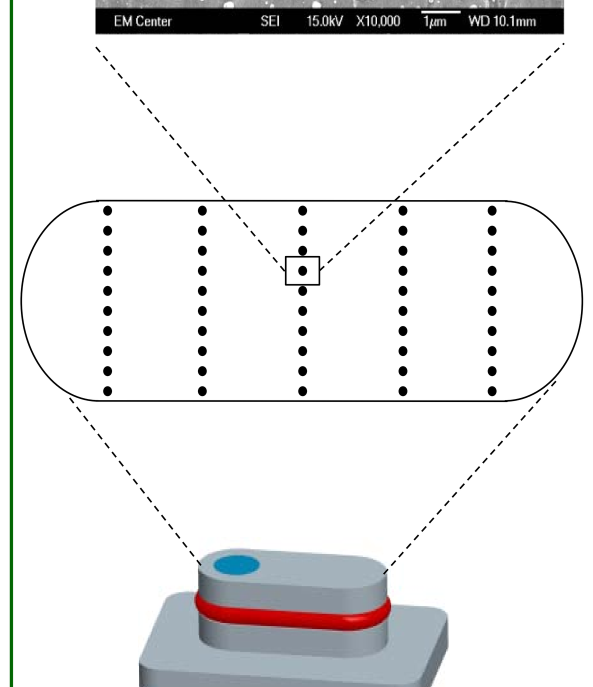
Collection Uniformity Test Setup

- Collected particles were imaged to determine spatial uniformity of deposition across the collection plate



Imaging the Collection Plate



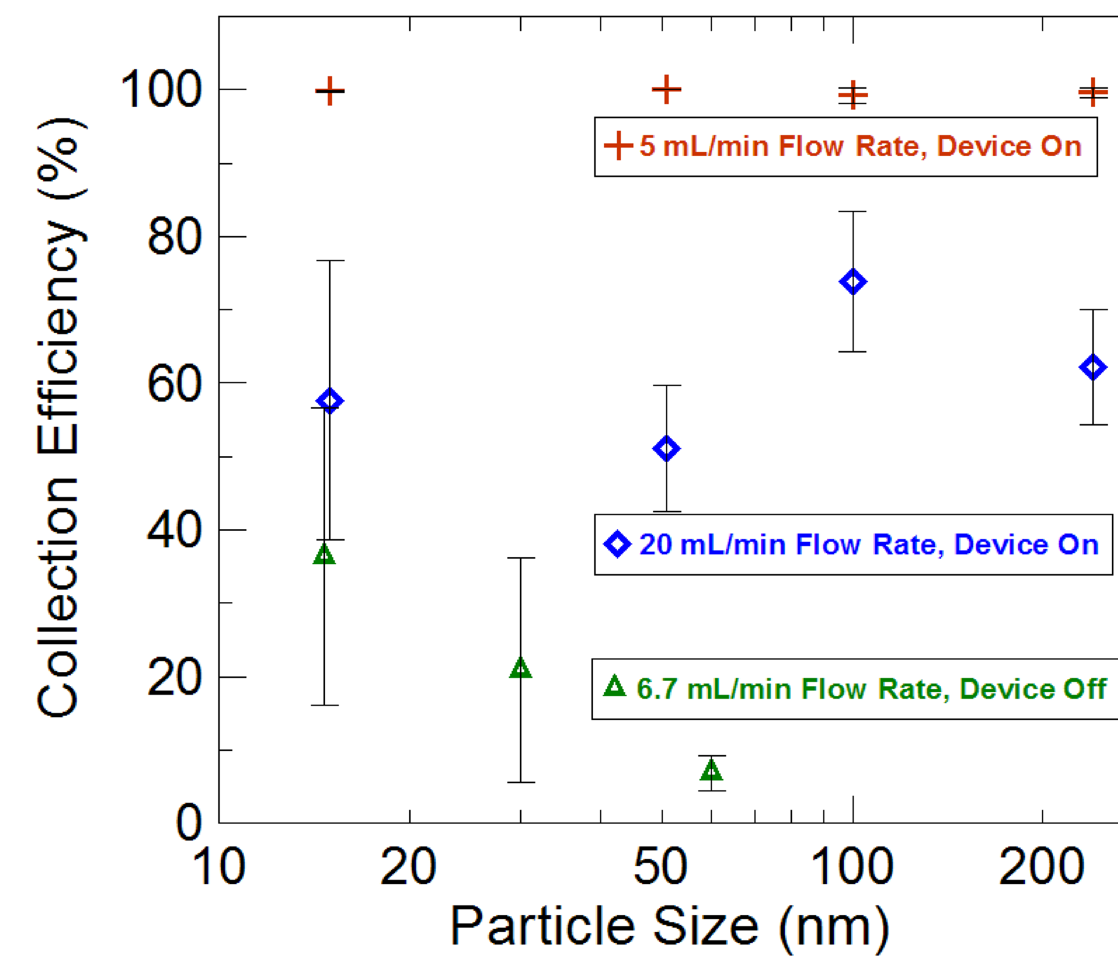


Collection Plate
(5 x 12 mm)

- 10 images taken across 5 areas
- 50 images total
- Software sorts particles into 3 size ranges

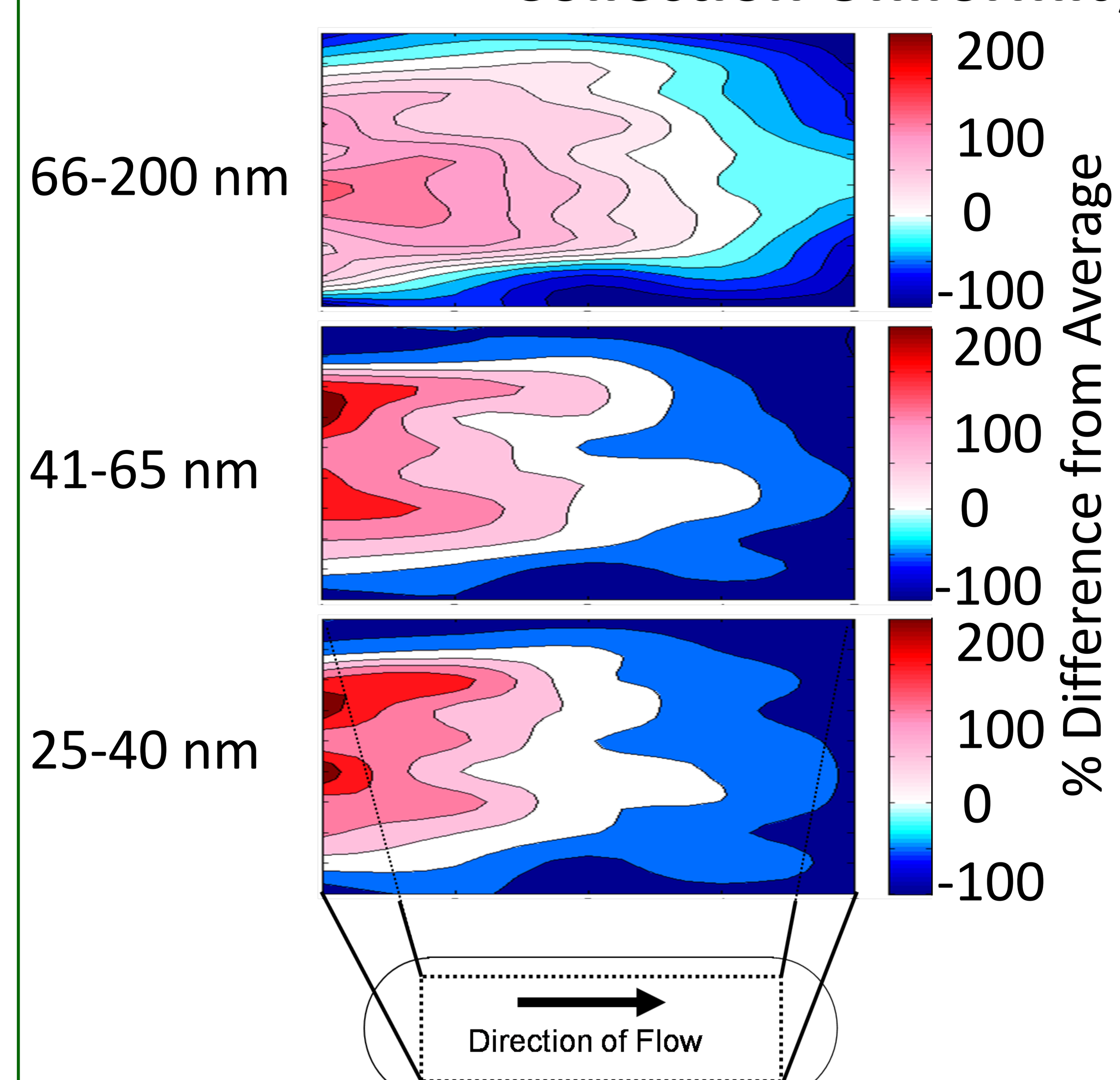
III. Results and Discussion

Collection Efficiency and Diffusion Loss Test Results



- Near 100% collection efficiency at 5 mL/min flow rate
- Highest precision at 5 mL/min flow rate
- About 65% collection efficiency at 20 mL/min
- Reduced precision at 20 mL/min flow rate
- Diffusion losses decrease with increasing particle size

Collection Uniformity Test Results



- White areas indicate regions where particle counts represent a true average
- As expected, increased deposition at the front of the collection plate
- Larger particles (66-200 nm) collect more homogeneously

Suggestions For Future Work

- Analyze collected particles using energy dispersive techniques
- Determine correction factors for particle losses
- Challenge sampler with incidental vs. engineered nanoparticles in laboratory
- Test in the field to estimate incidental, engineered nanoparticle exposures

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