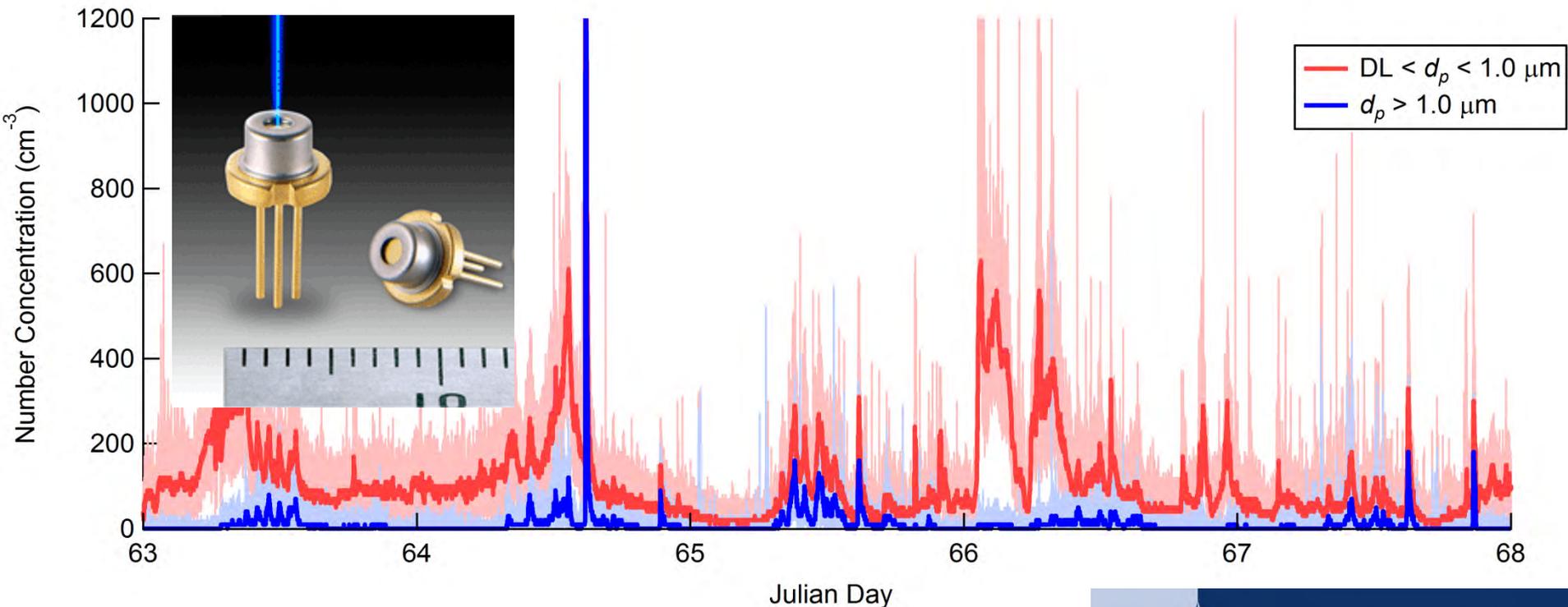


US EPA ARCHIVE DOCUMENT

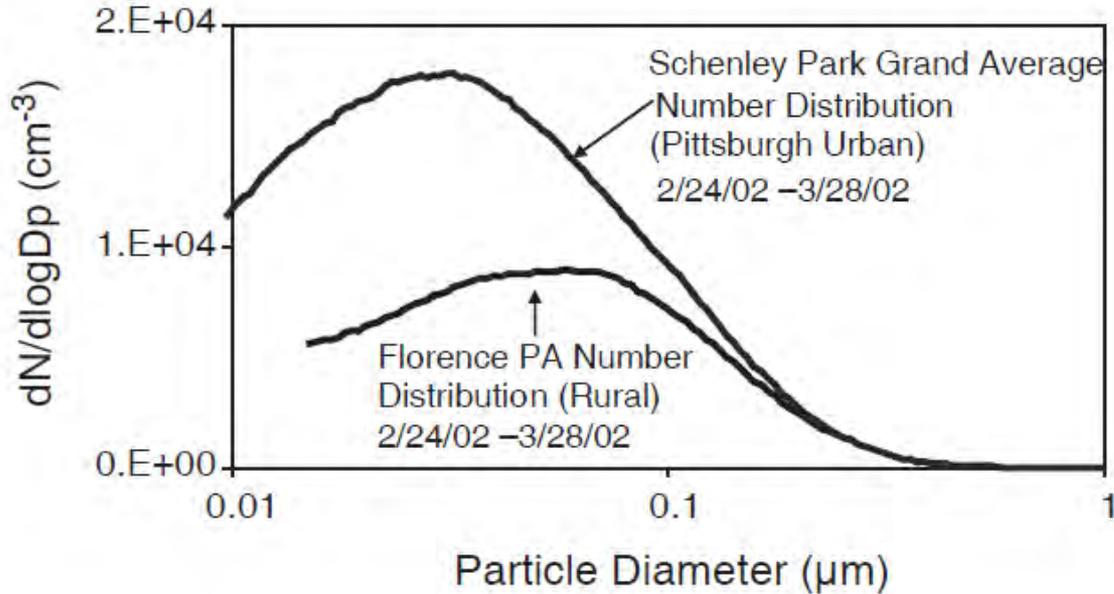
A compact, low-cost, network accessible, optical particle counter for the real time measurement of submicron aerosol particle size distributions

James Brady, Steve Kaiser, Tim Bertram



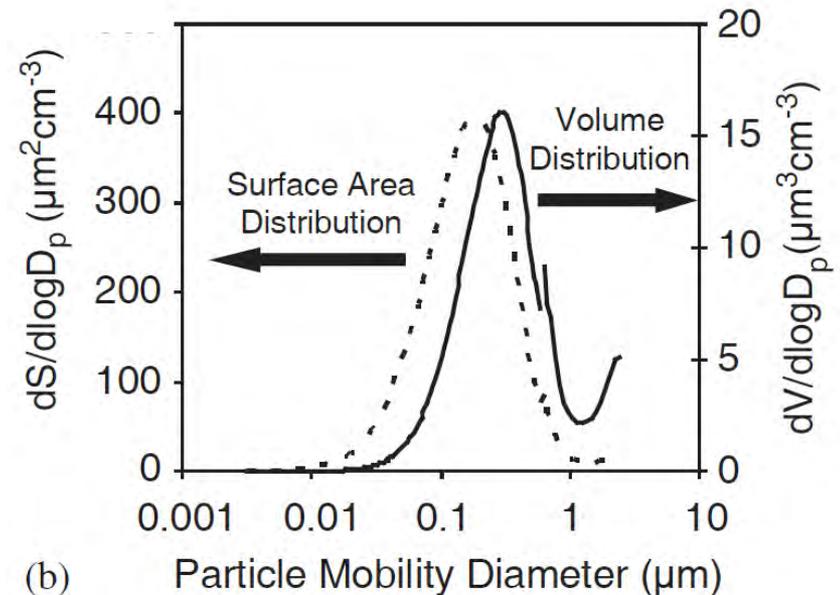
<http://bertramgroup.ucsd.edu/>
thbertram@ucsd.edu

Properties of Ambient Particle Size Distributions



Aerosol particle size distributions vary dramatically in response to changes in anthropogenic emissions, natural sources, and meteorological variables.

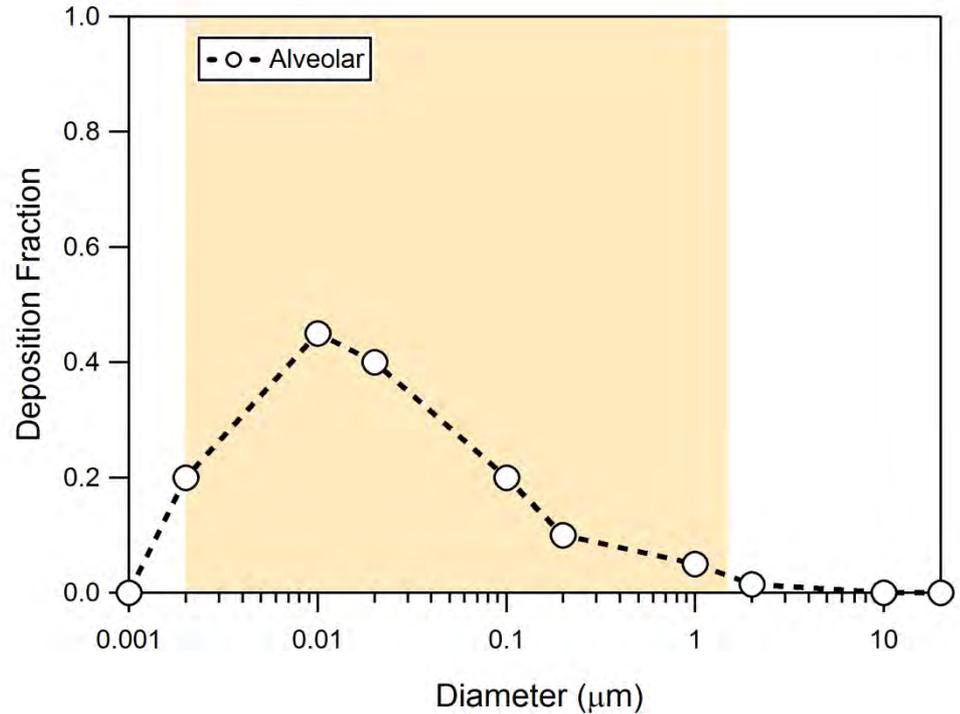
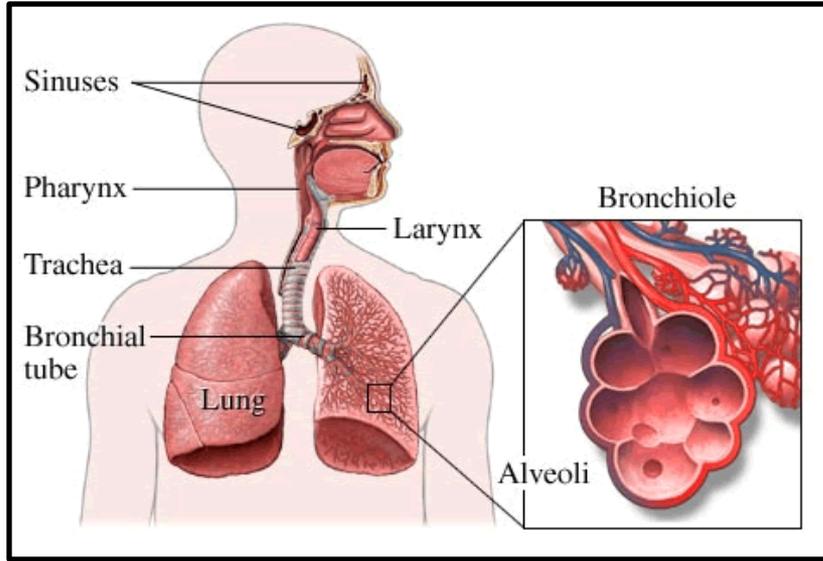
The peak in the surface area and volume distributions are at larger diameters than the number distribution.



(b)

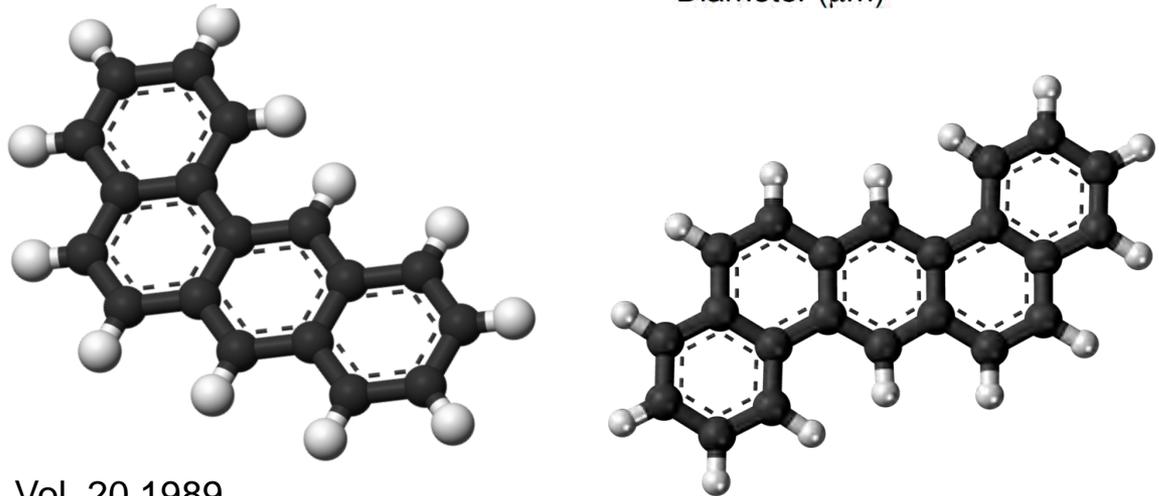
Direct Aerosol Impact on Health

I. Number Based



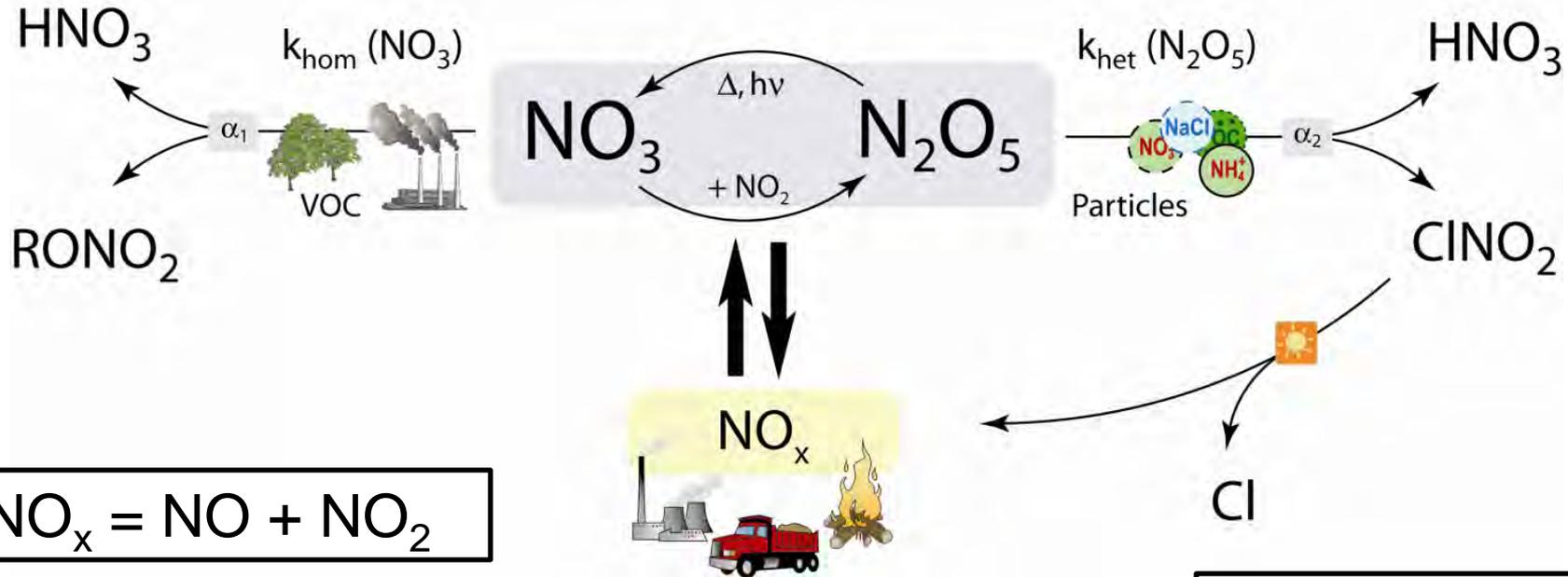
II. Mass Based

e.g., mass of a specific carcinogen or molecules that induce inflammatory response



Indirect Aerosol Impacts on Air Quality

Surface Area Based

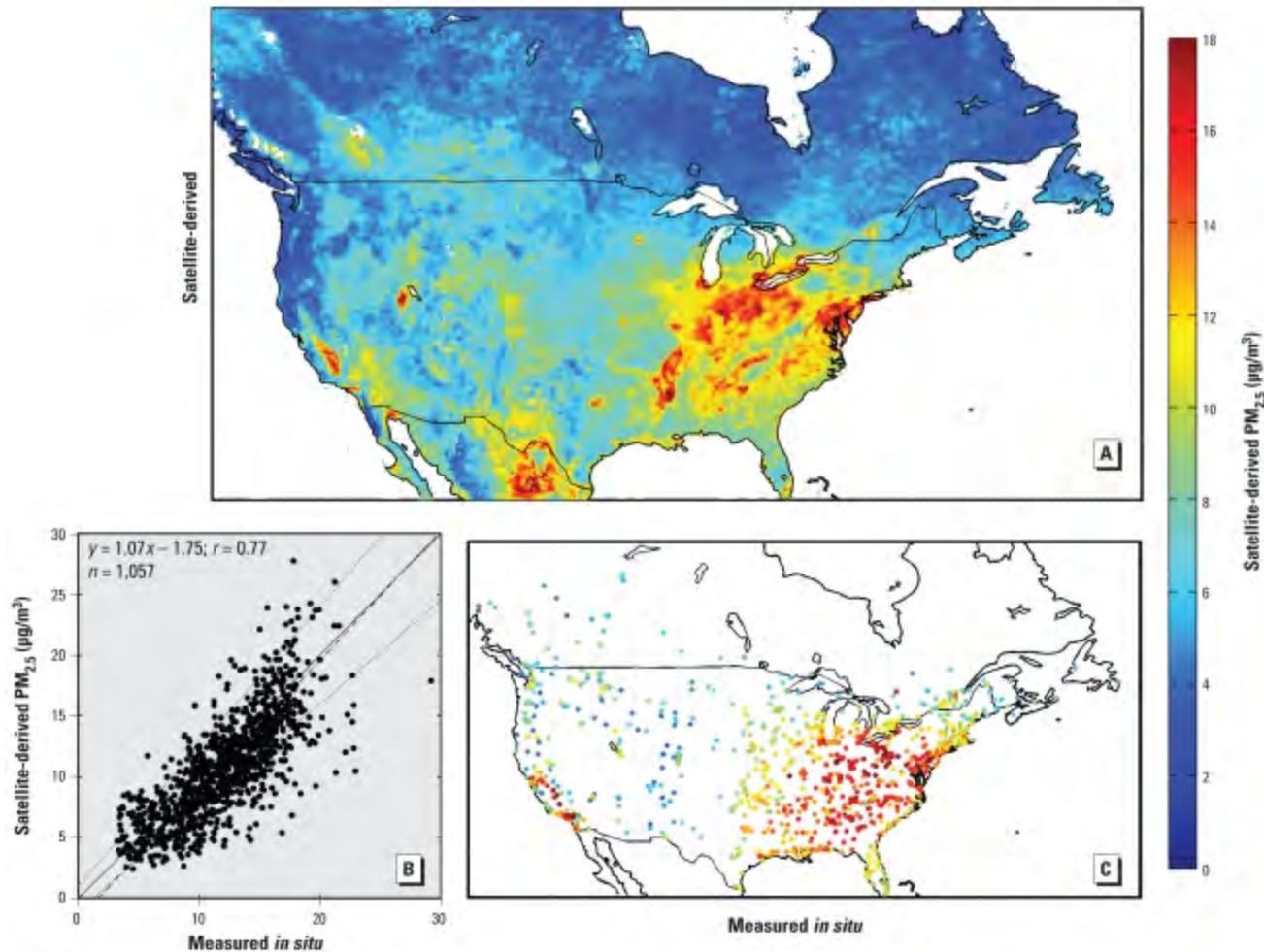


$$\text{NO}_x = \text{NO} + \text{NO}_2$$

$$\gamma(\text{N}_2\text{O}_5) = \frac{4k_{\text{het}}}{cSA}$$

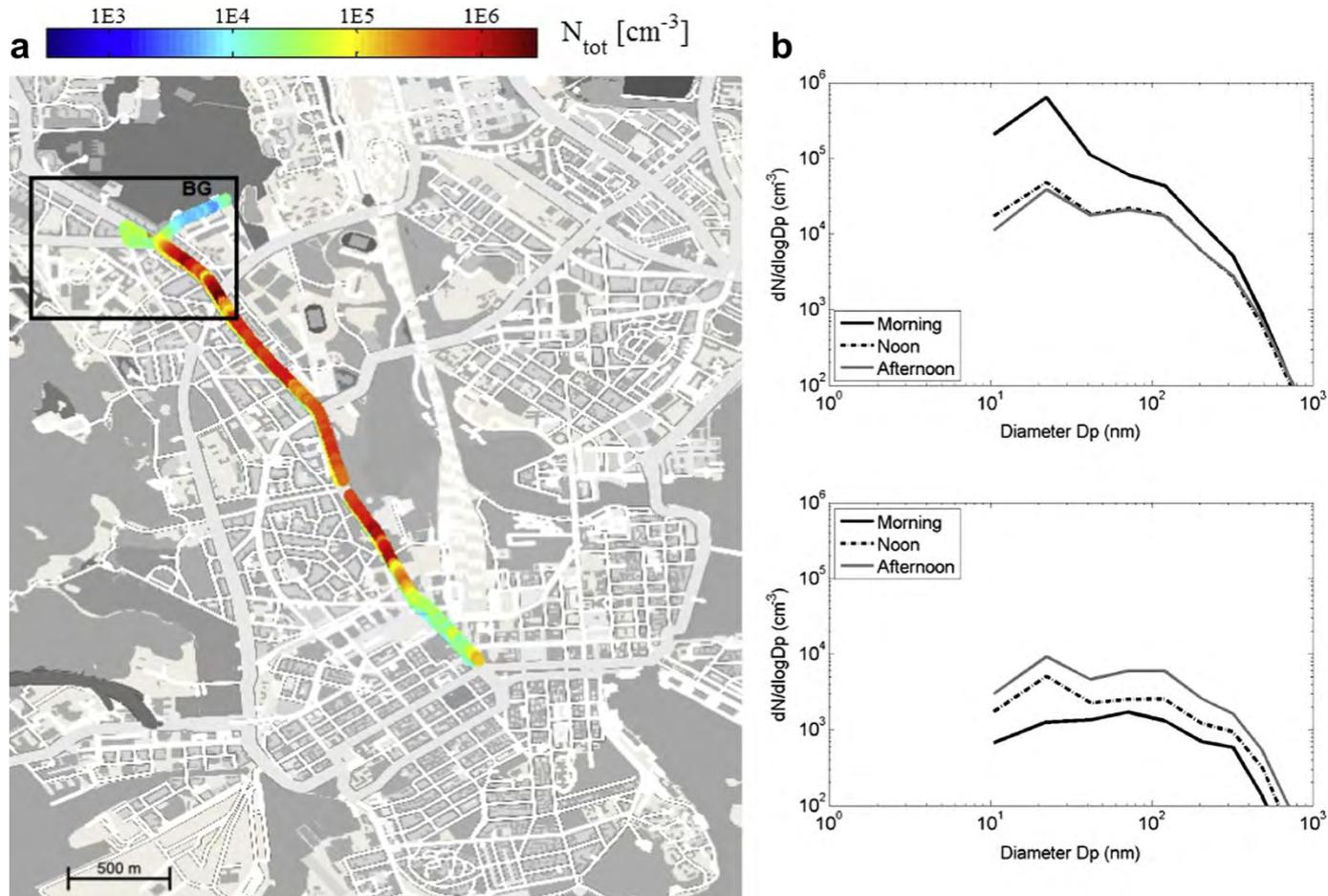
The rate of heterogeneous reactions is dependent on the available aerosol **surface area**.

Regional Scale Variability in PM_{2.5}

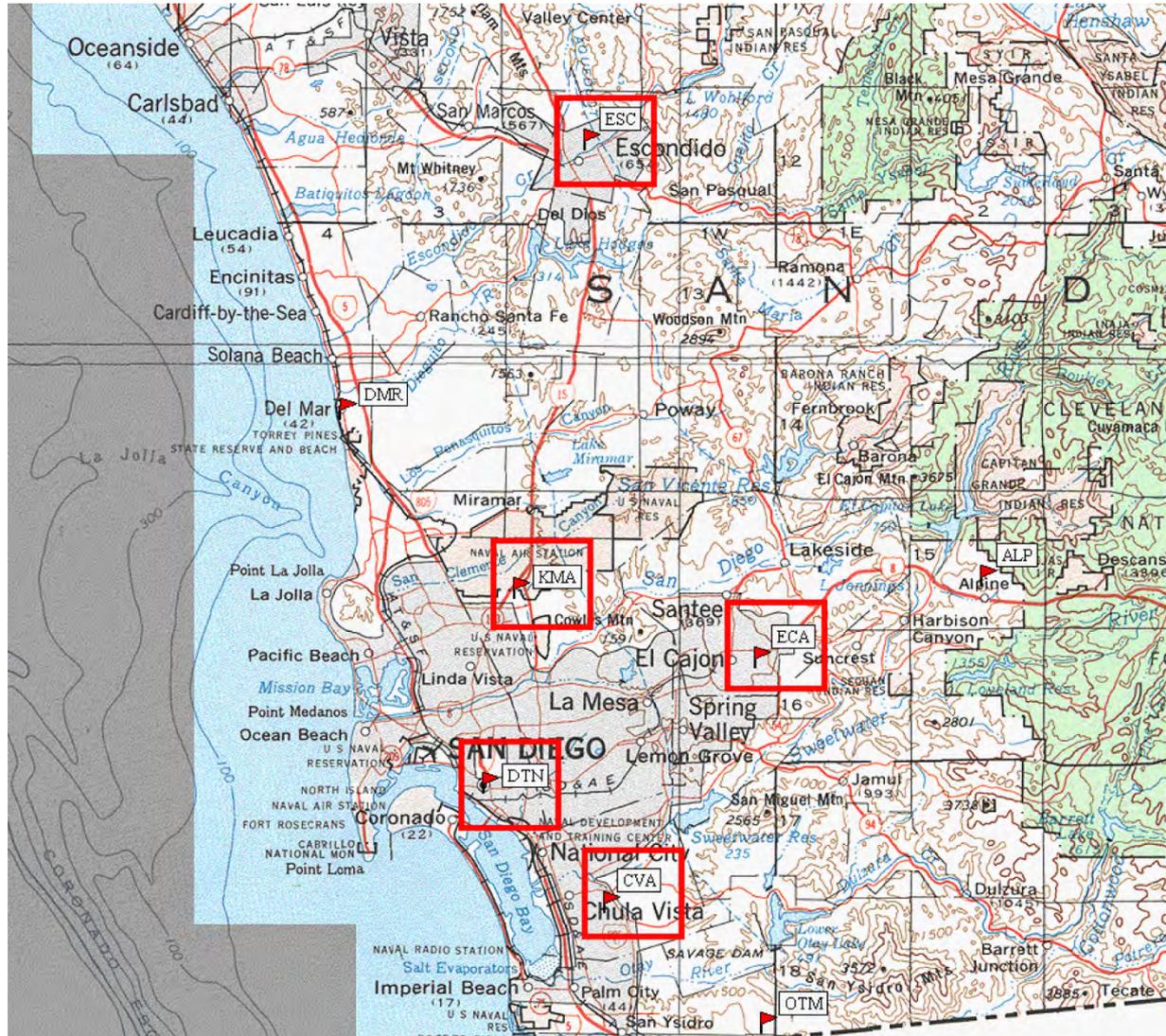


City Scale Variability in Particle Number

Variability in Street Level Particle Concentrations, Helsinki Finland



Constraints on City Scale Variability in Particle Number



In San Diego county (3.7 million residents), five measurements of PM 2.5 (hourly)

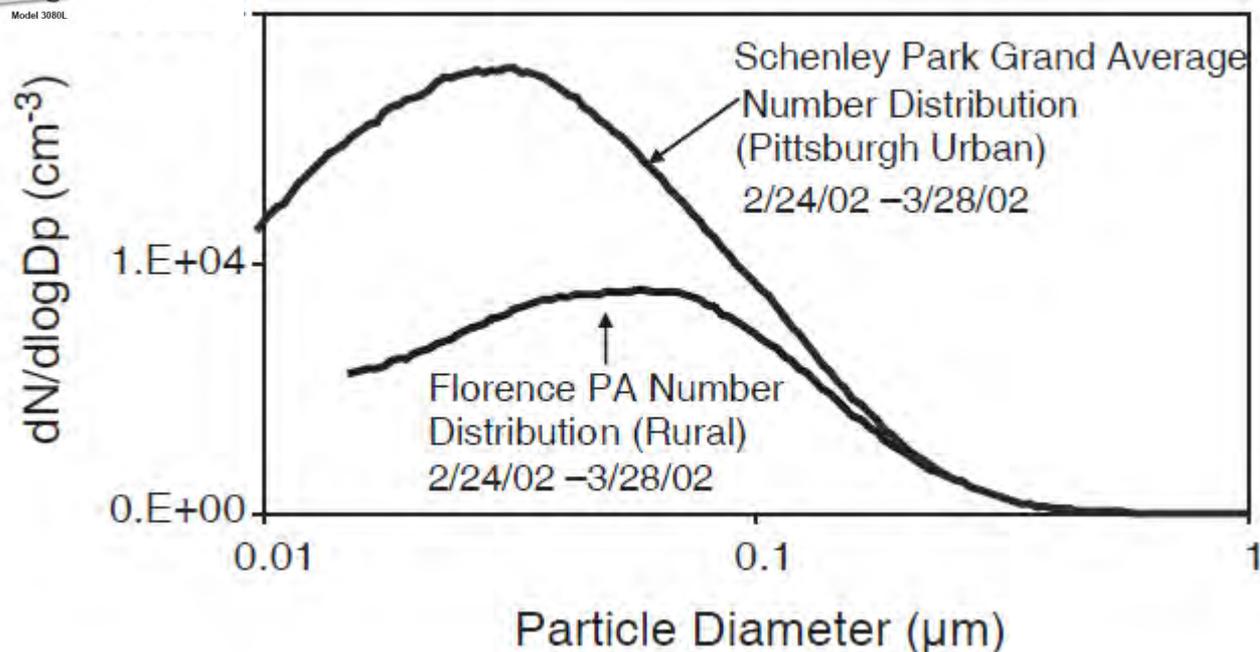
Methods for Determining Particle Size Distributions



Model 3080L

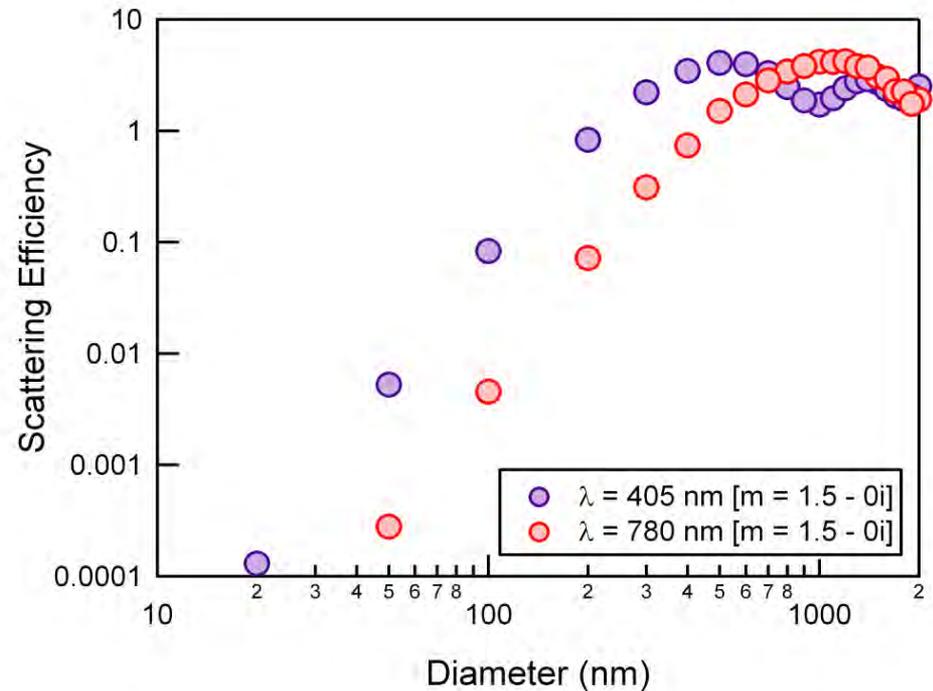
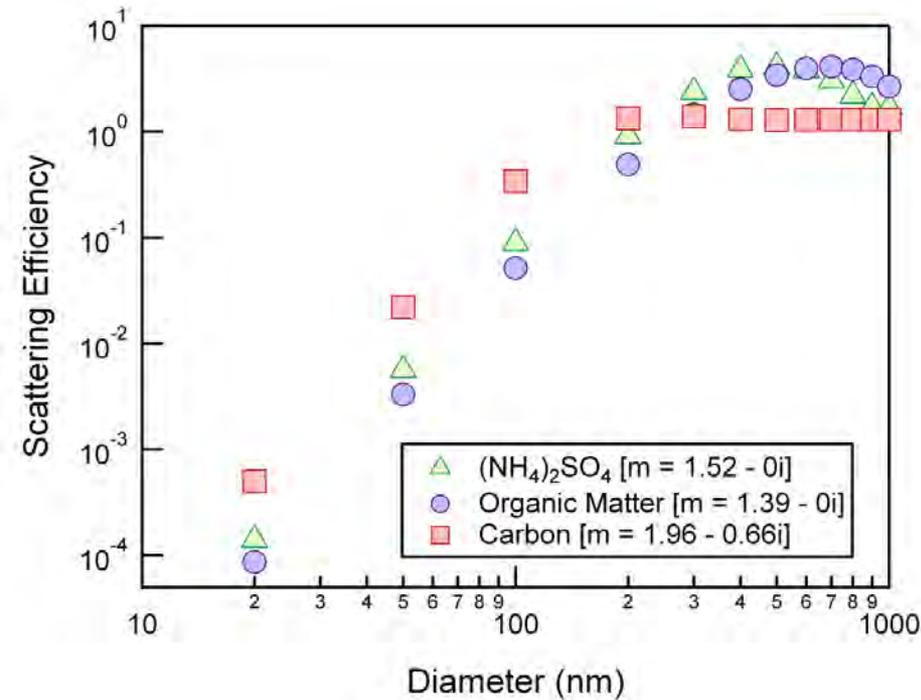
Electrical Mobility Instruments

Light Scattering Instruments



Here, we describe the development of a inexpensive ($< \$1\text{k}$) multichannel blue diode based optical particle counter (OPC)

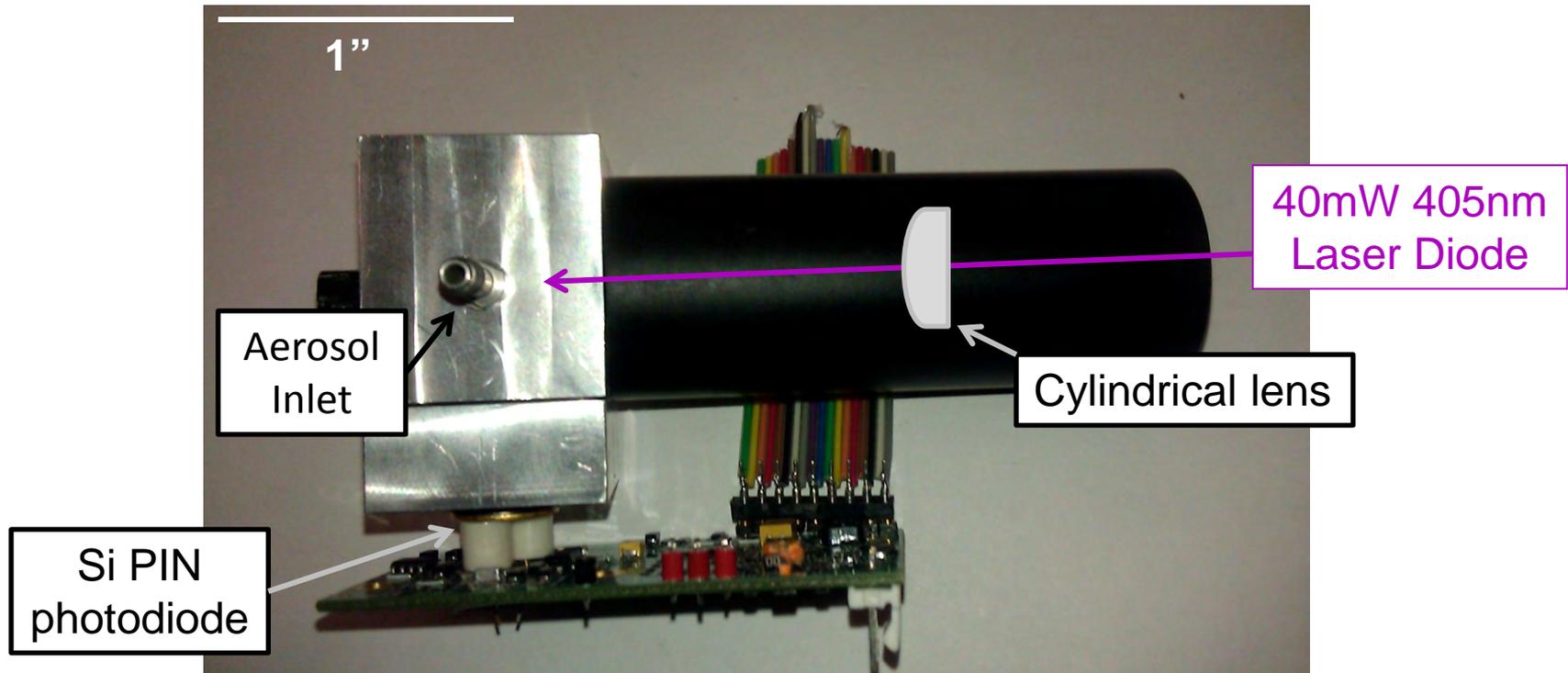
Optical Particle Counter: Mie Scattering



Light scattering has been used to detect particles for almost a century:

- 1) Scattering Theory: Reported by Gustav Mie (1908),
- 2) Early OPCs were developed in the 1920's (Patterson and Whytlaw-Gray, 1926)
- 3) Laser based OPC were in operation as early as 1968 (Schleusener, 1968)

Optical Particle Counter: Detection Axis

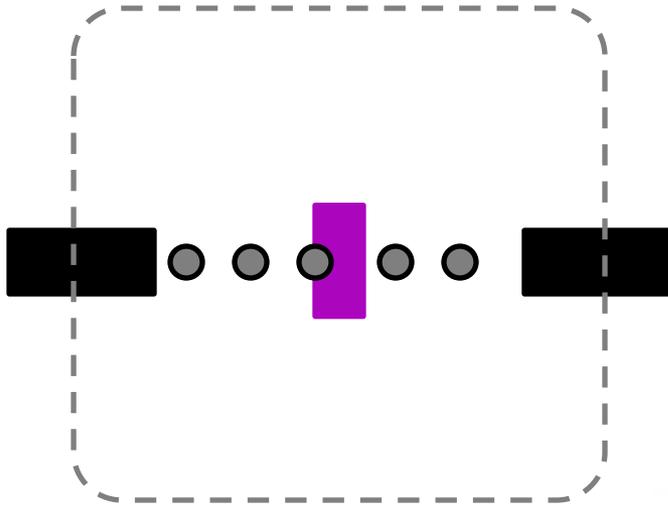


Design Objectives:

- 1) Compact (4" x 6" x 3")
- 2) Low power consumption (< 15W)
- 3) Inexpensive (< \$1k)
- 4) Autonomous, with potential to be network accessible
- 5) Continuous, real time data streaming

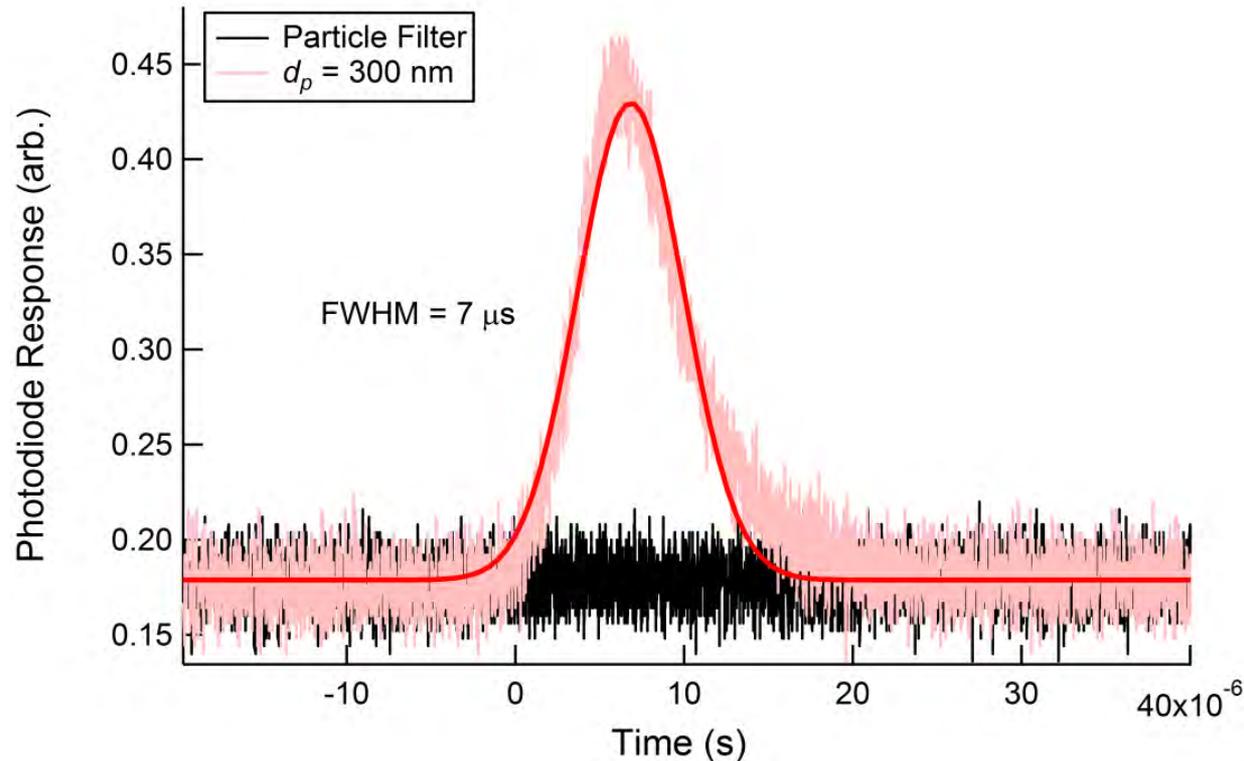
Optical Particle Counter: Single Pulses

x-section of detection cell



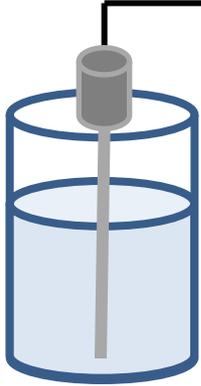
Blue Diode OPC prototype is currently being characterized and calibrated in the laboratory.

Particle velocity = 10 ms^{-1}
Beam width = 0.1 mm
Expected pulse widths of $\sim 10 \mu\text{s}$
Measure up to 3000 cm^{-3}

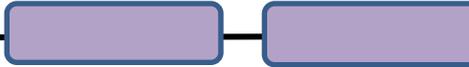


Optical Particle Counter: Laboratory Characterization

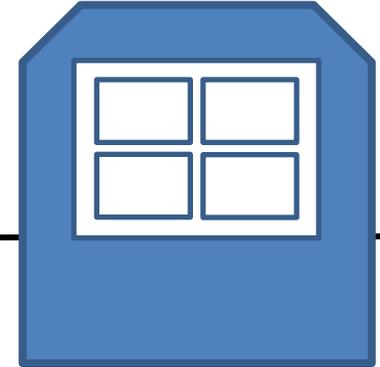
Polydisperse
Aerosol Generation



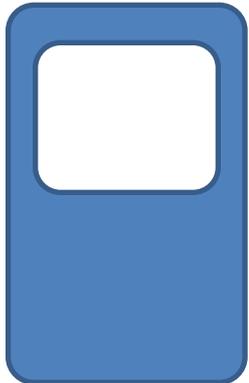
Diffusion Dryers



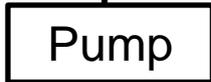
Size Selection
TSI DMA



Total Particle
Concentration
TSI CPC



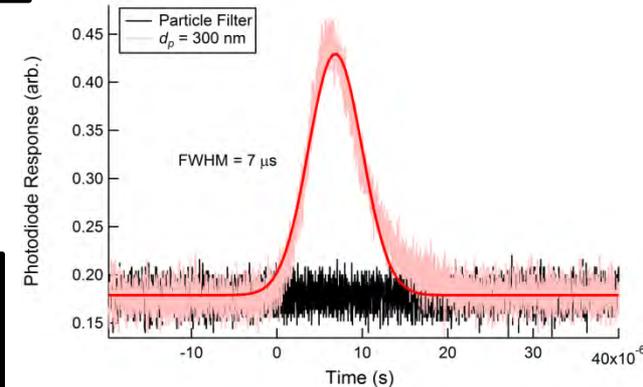
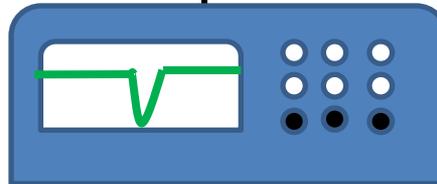
Pump



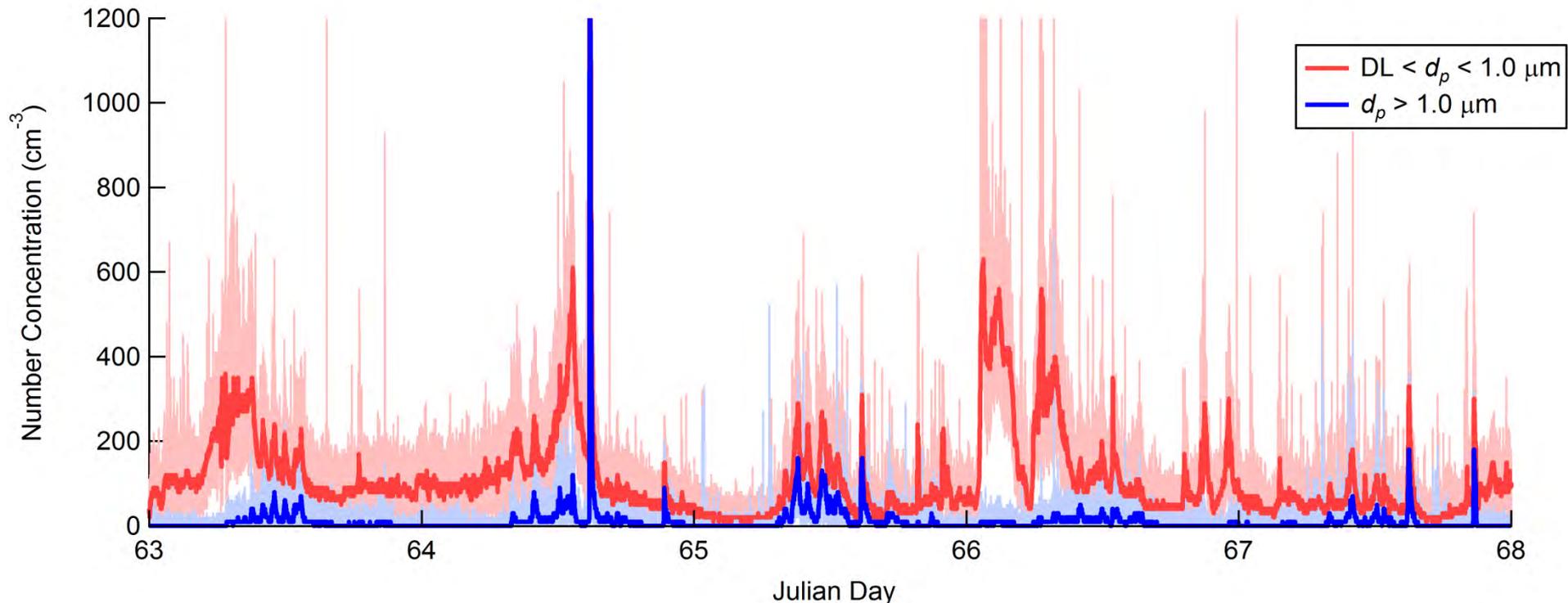
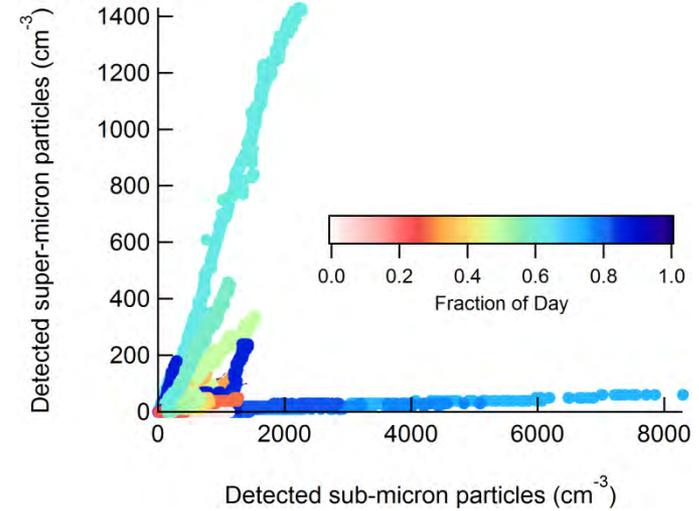
UCSD miniOPC



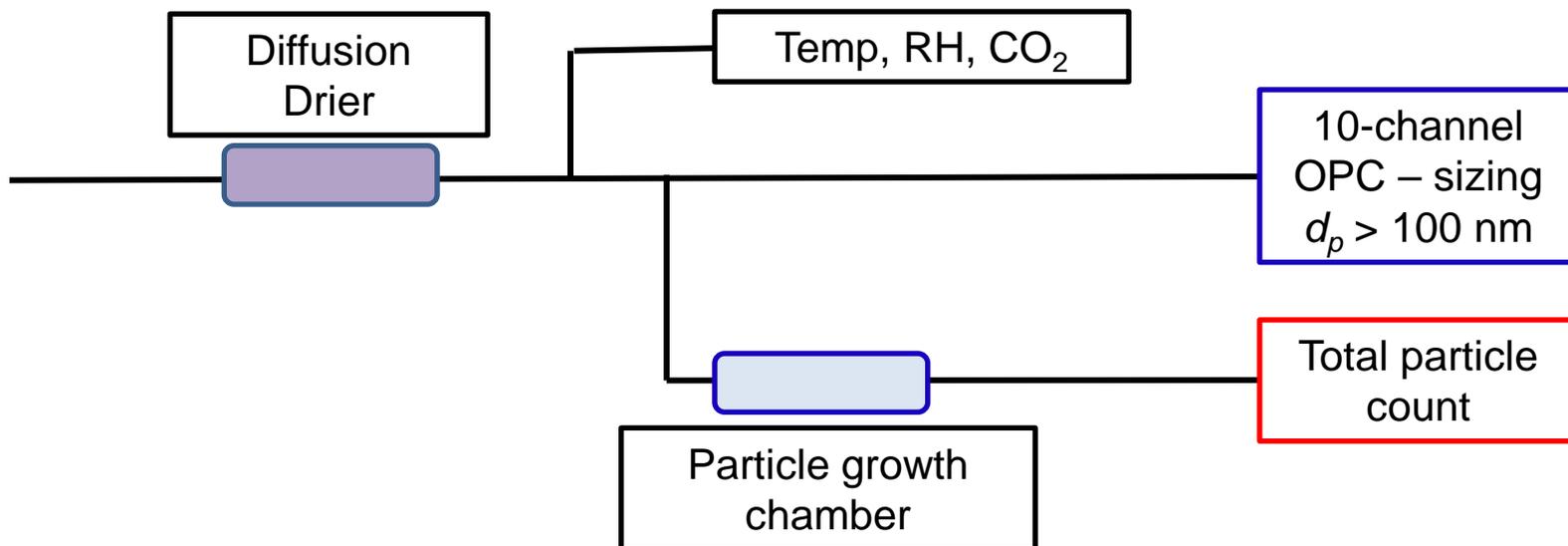
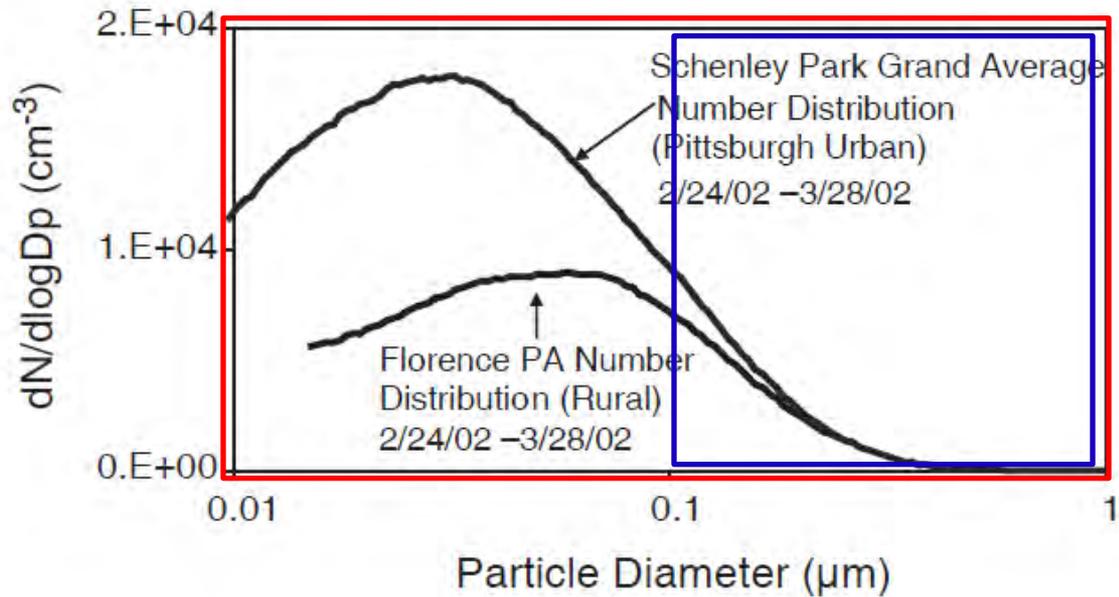
Digital
Oscilloscope



Field Testing: Two Channel Measurements

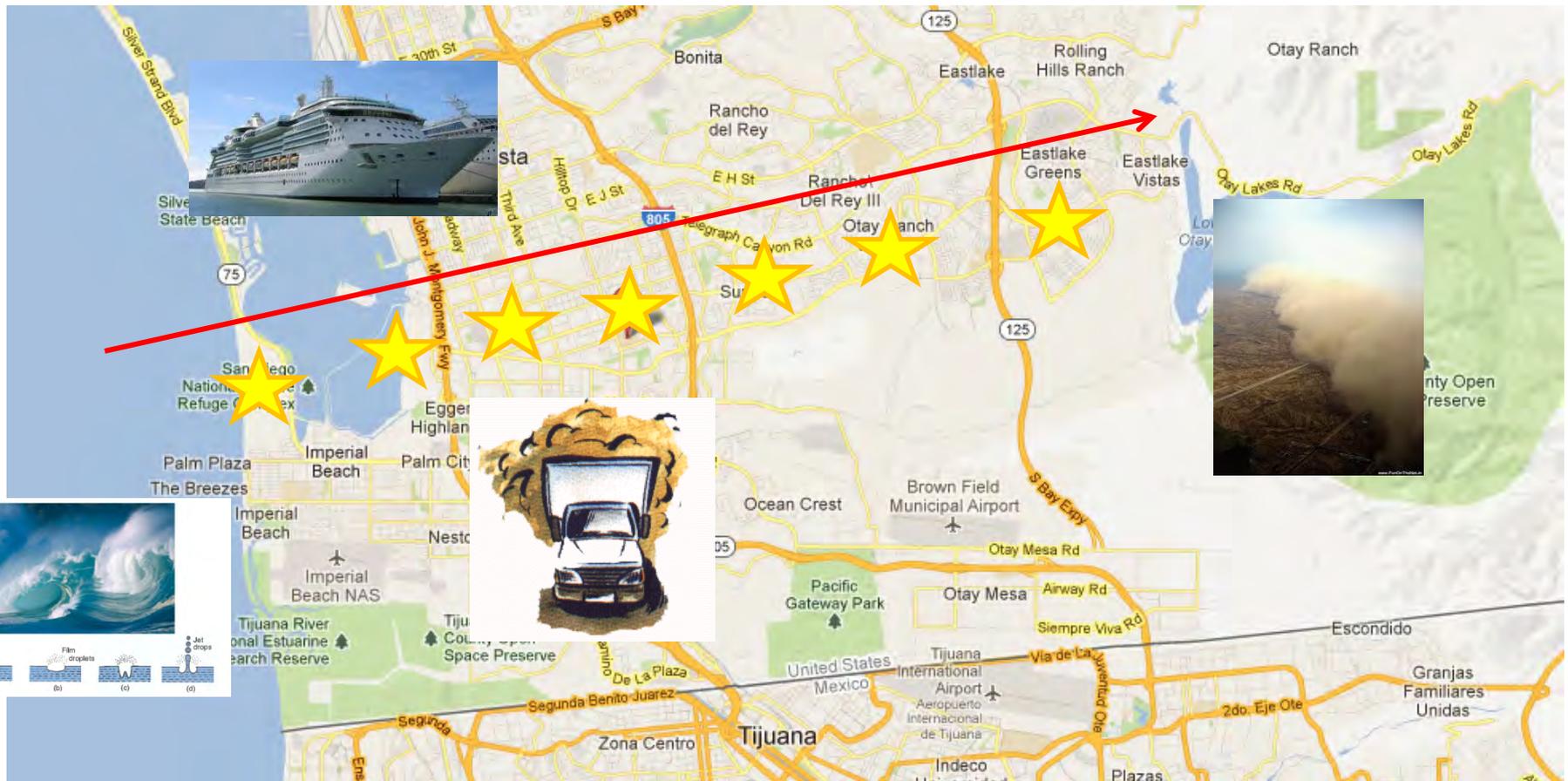


Planned Field Deployable Sensor



Current Directions

- I. Continued laboratory characterization of the UCSD miniOPC and miniOPC electronics using representative aerosol mimics (e.g., NaCl, organic)
- II. Deployment on 5-10 sensors along a Lagrangian transect in San Diego



Acknowledgements



James Brady

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**Steve Kaiser
(UCI Electronics)**