

# A fast integrated mobility spectrometer (FIMS) for rapid measurement of aerosol size distribution

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# Airborne Aerosol Size Distribution Measurements

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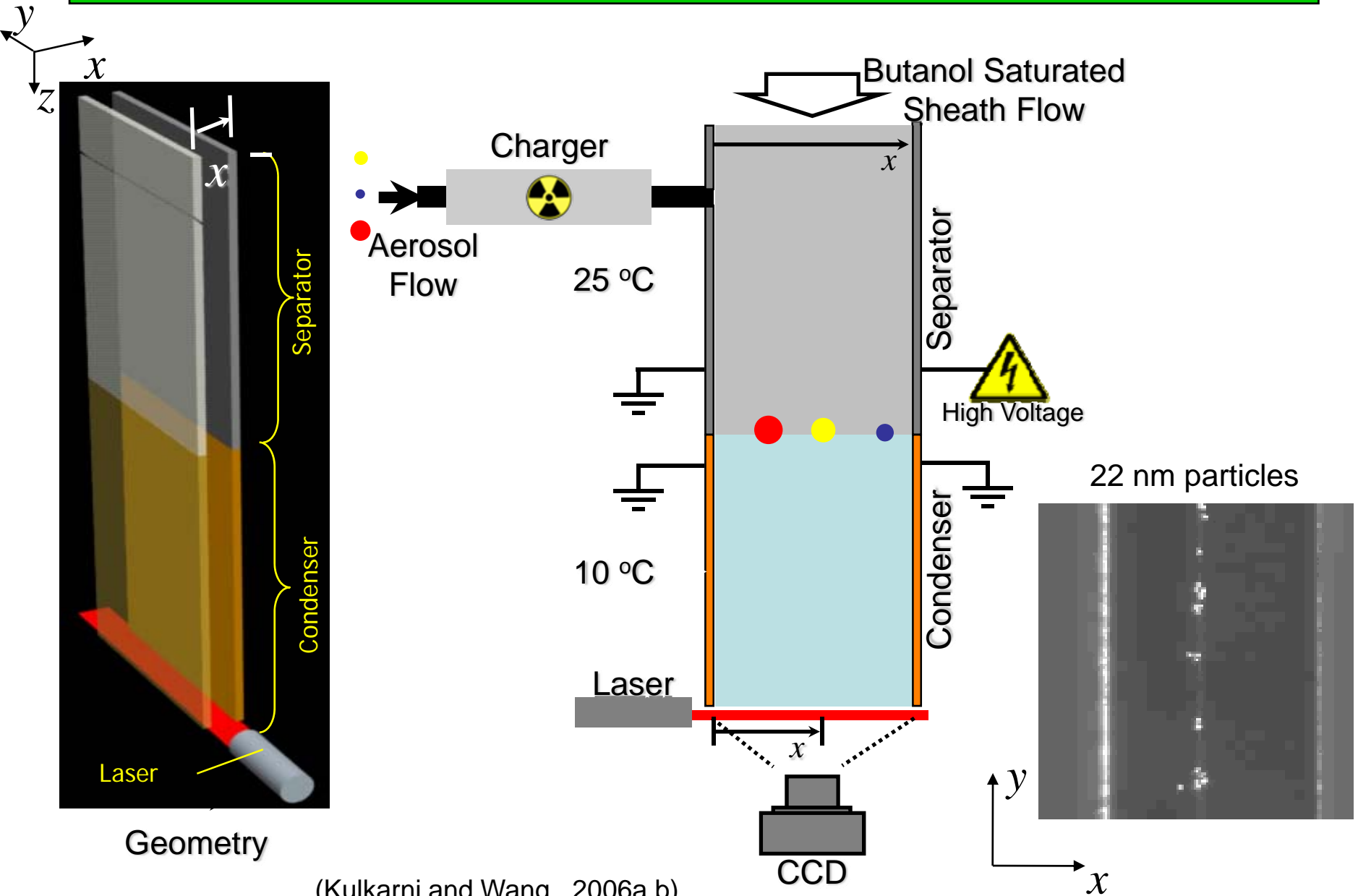
For aircraft-based measurements, an instrument need to have:

- fast response time for good spatial resolution.
- high sensitivity and good counting statistics.

Current techniques for measuring aerosol size distributions:

- Scanning Mobility Particle Sizer (SMPS) - The 'industry standard', but ~1 min is needed for each scan.
- Optical Particle Counter (OPC) - Fast measurements but range limited to  $D_p > 100$  nm, and uncertainties due to particle shape and refractive index.
- Electrical Aerosol Spectrometers (Cambustion's DMS & TSI's EEPS) - Response time less than 1 s, but have low sensitivity.

# Principle of the Fast Integrated Mobility Spectrometer (FIMS)



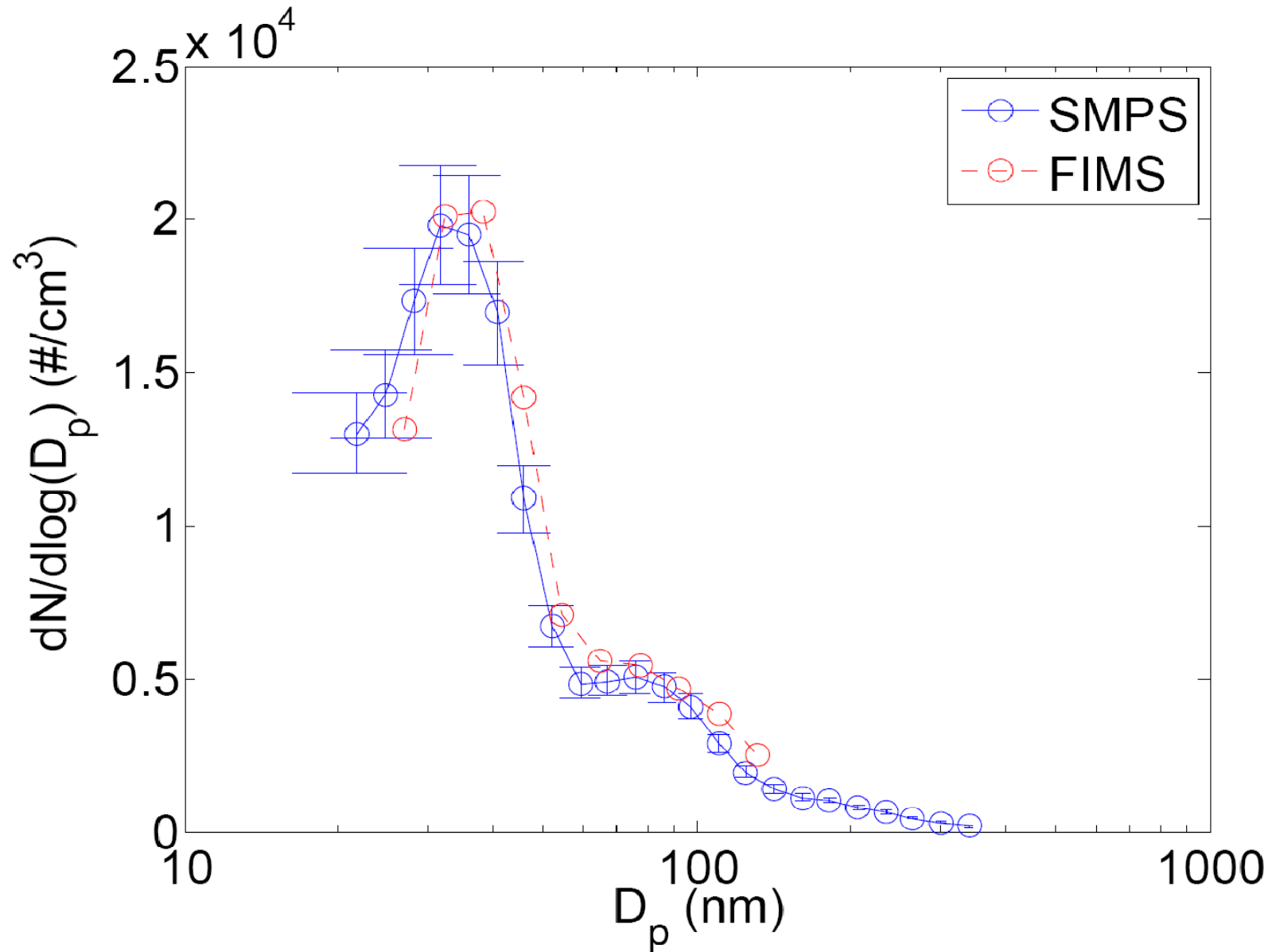
(Kulkarni and Wang, 2006a,b)

# Current status of FIMS development

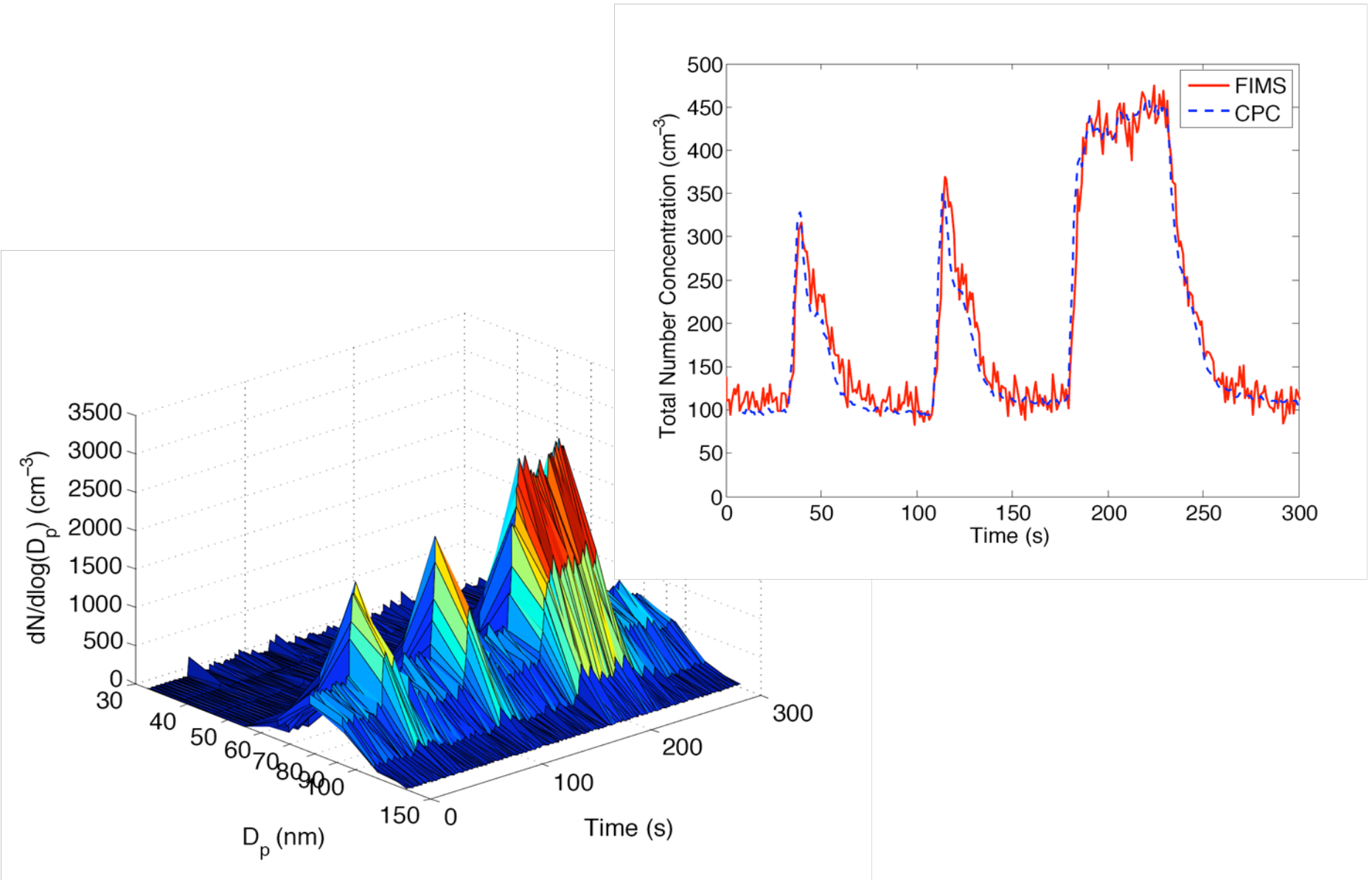
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- A FIMS has been constructed for airborne measurement.
- The performance of the FIMS has been characterized. (Kulkarni and Wang, 2006a and 2006b. Olfert and Wang 2008).
- Data analysis procedure developed (Olfert et al., 2008).
- The FIMS was successfully deployed in the joint Cloud and Land Surface Interaction Campaign (CLASIC) and Cumulus Humilis Aerosol Processing Study (CHAPS) in June, 2007.
- The FIMS is currently being deployed in the VAMOS Ocean-Cloud-Atmosphere-Land Study - Regional Experiment (VOCALS-REx) in Chile.

# Comparing FIMS to SMPS



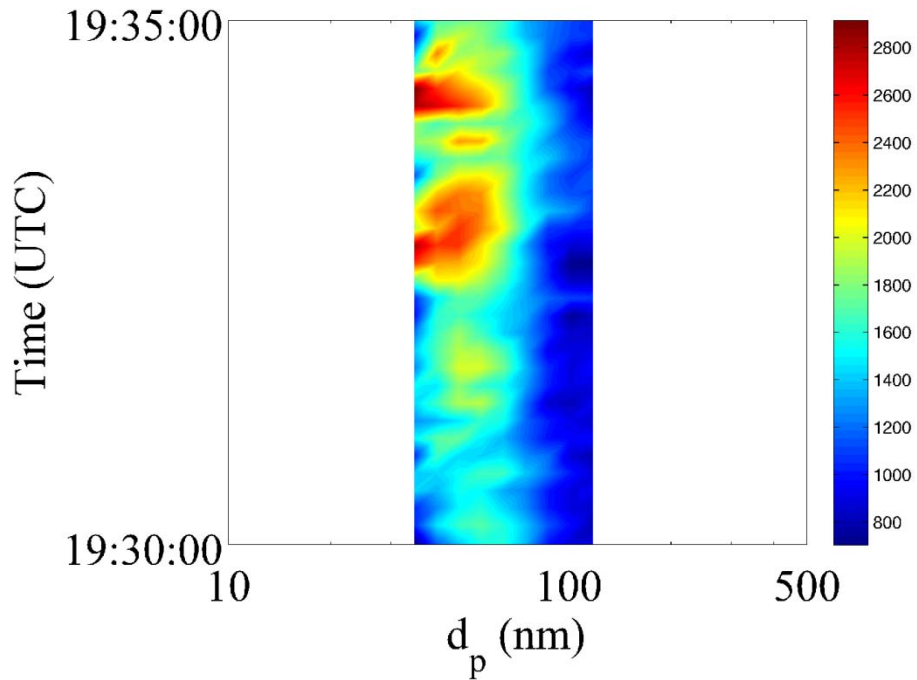
# Examples of fast FIMS measurements



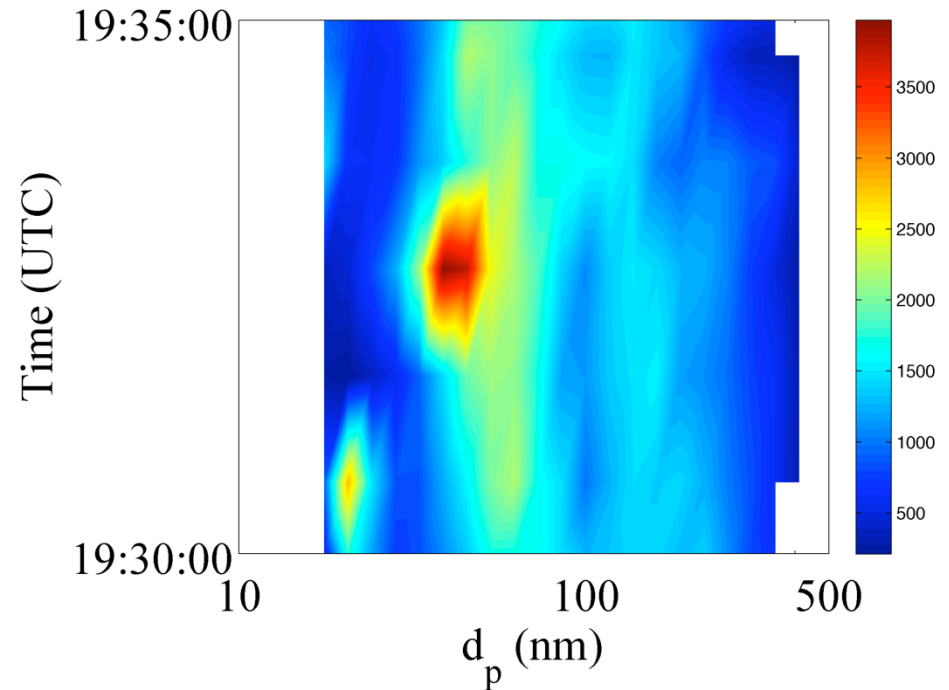
# Examples of fast FIMS measurements

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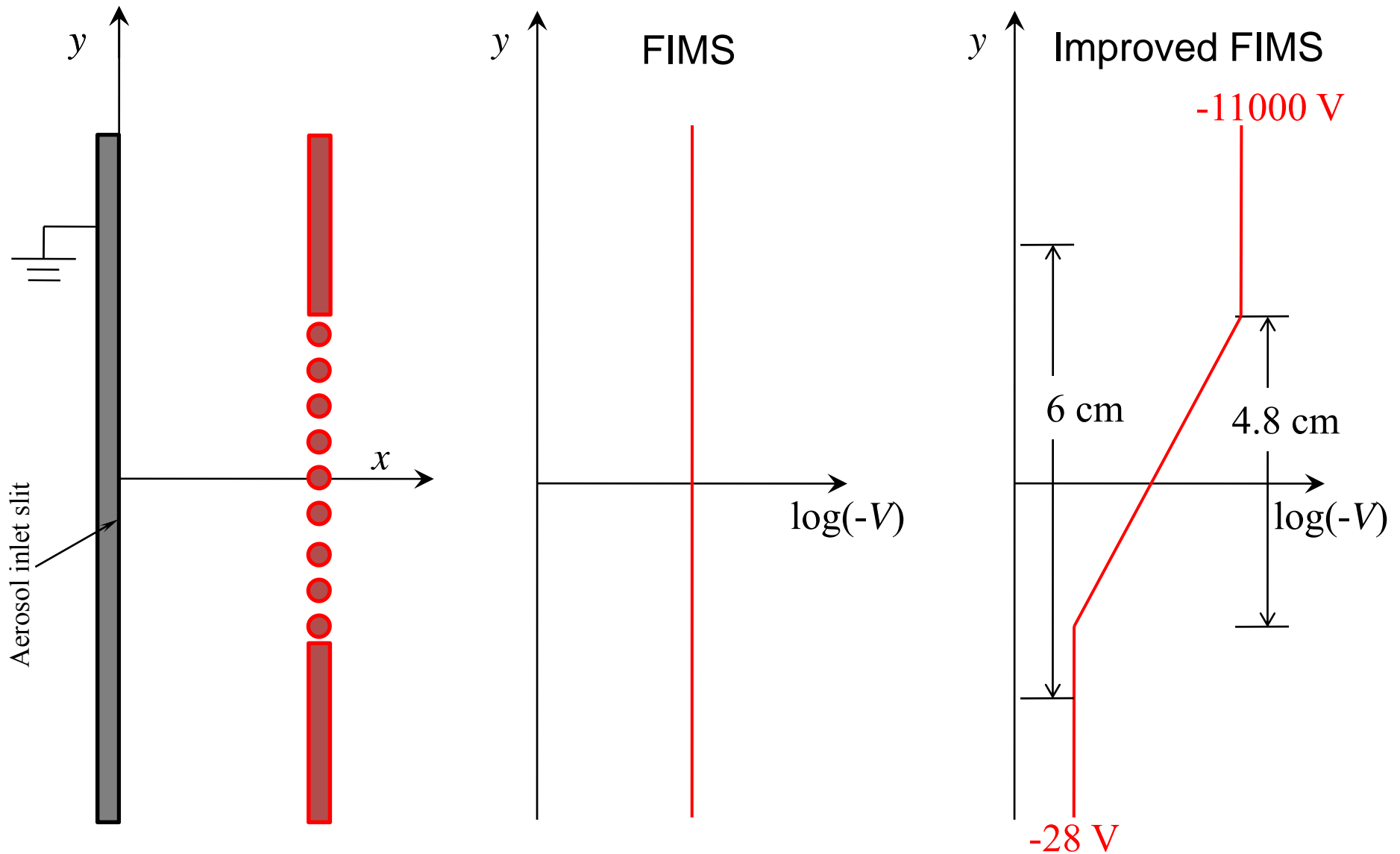
FIMS Data: 15-Jun-2007



SMPS Data: 15-Jun-2007



# Size range of FIMS measurement



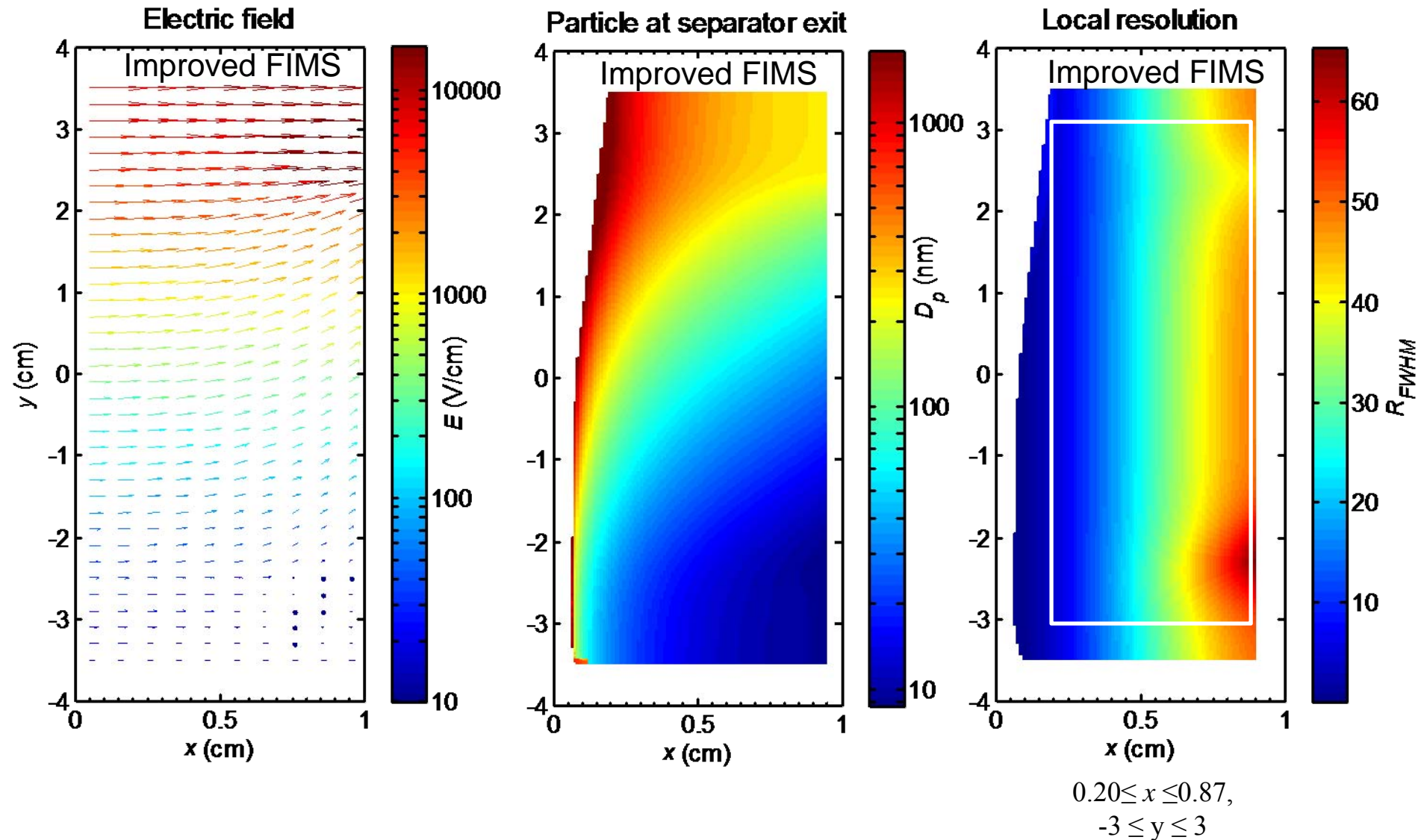
# Simulation of the improved FIMS

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<b>Dimension and operation parameter</b>	<b>Improved FIMS</b>
Distance between separator electrodes	1 cm
Width of separator	10 cm
Width of viewing area	6 cm
Length of separator	25 cm
Minimum Voltage	28 V
Maximum Voltage	11,000 V
Sheath flow rate, $Q_{sh}$	10 L/min
Aerosol flow rate, $Q_a$	0.2 L/min

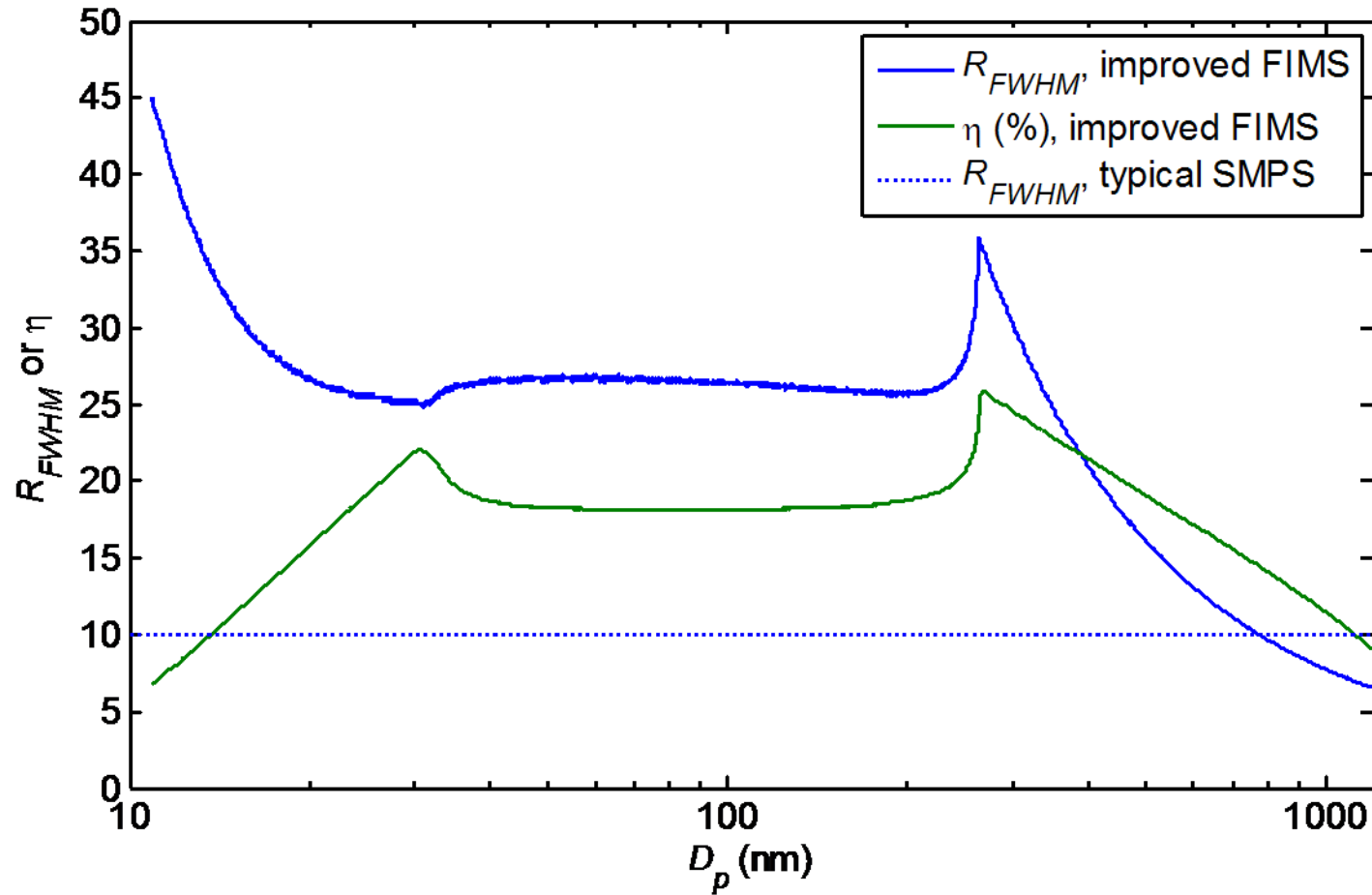
# Electric field, particle trajectory, and local resolution

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# Overall resolution and transmission efficiency

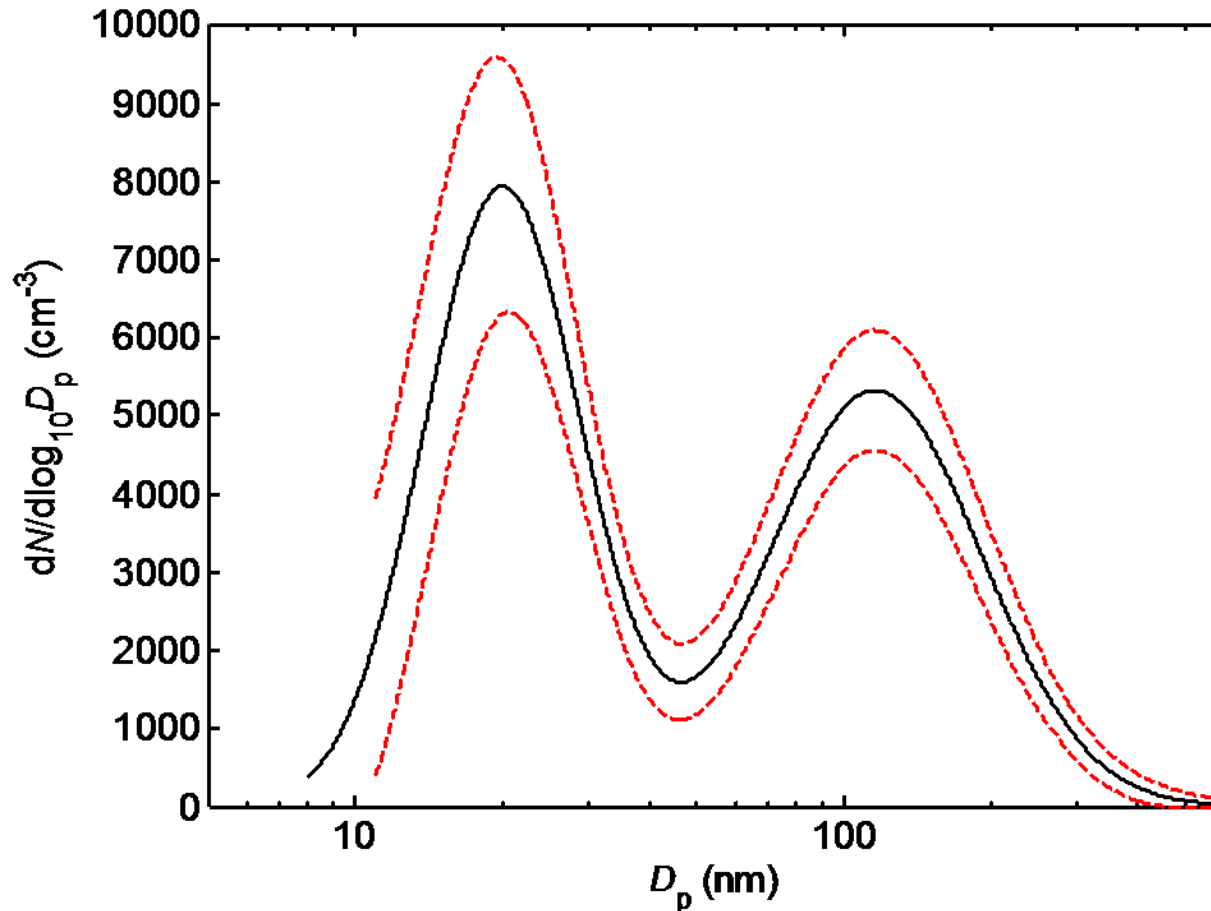
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# Counting statistics of the improved FIMS

$$S/N = \frac{C}{\sqrt{C}} = \sqrt{C} = \left[ Q_a t_c \eta_{chg} \eta \left( \frac{dN}{d \ln D_p} \right) \Delta \ln D_p \right]^{1/2}$$

Remote continental aerosol (Seinfeld and Pandis, 1998),  $t_c = 1$  s



# Conclusions

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- The FIMS is a fast and highly sensitive instrument that is ideal for aircraft-based measurements of aerosol size distributions.
- The size range of the FIMS can be significantly increased by redesigning the HV electrode in the separator.
- The improved FIMS can measure entire sub-micrometer size distribution within 1 second.

# Acknowledgement

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- Dr. Pramod Kulkarni
- Dr. Jason Olfert
- Dr. Peter Takacs and Dr. Jack Fried (Instrumentation Division at Brookhaven National Laboratory).
  
- Funding support:
  - Atmospheric Science Program, Department of Energy
  - Goldhaber Distinguished Fellowship , Brookhaven Science Association
  - Laboratory Directed Research Development program, Brookhaven National Laboratory
  - Office of Global Programs, National Oceanic and Atmospheric Administration

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*Thank you!*  
*Any questions?*