# *A New, Portable, Real-time Ozone Monitor*

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# *Introduction*

- People spend ~90% of time indoors
- Ozone routinely monitored outdoors
- Ozone penetration factor ranges from 0.1 to 0.9
- Need to understand indoor levels to assess and control ozone exposure

# *Ozone Exposure Assessment*

- Epidemiological studies of adverse health effects
- Ozone control strategies / regulatory standards
- Methods of assessing ozone exposure
  - direct measurement
  - indirect measurement
  - modeling

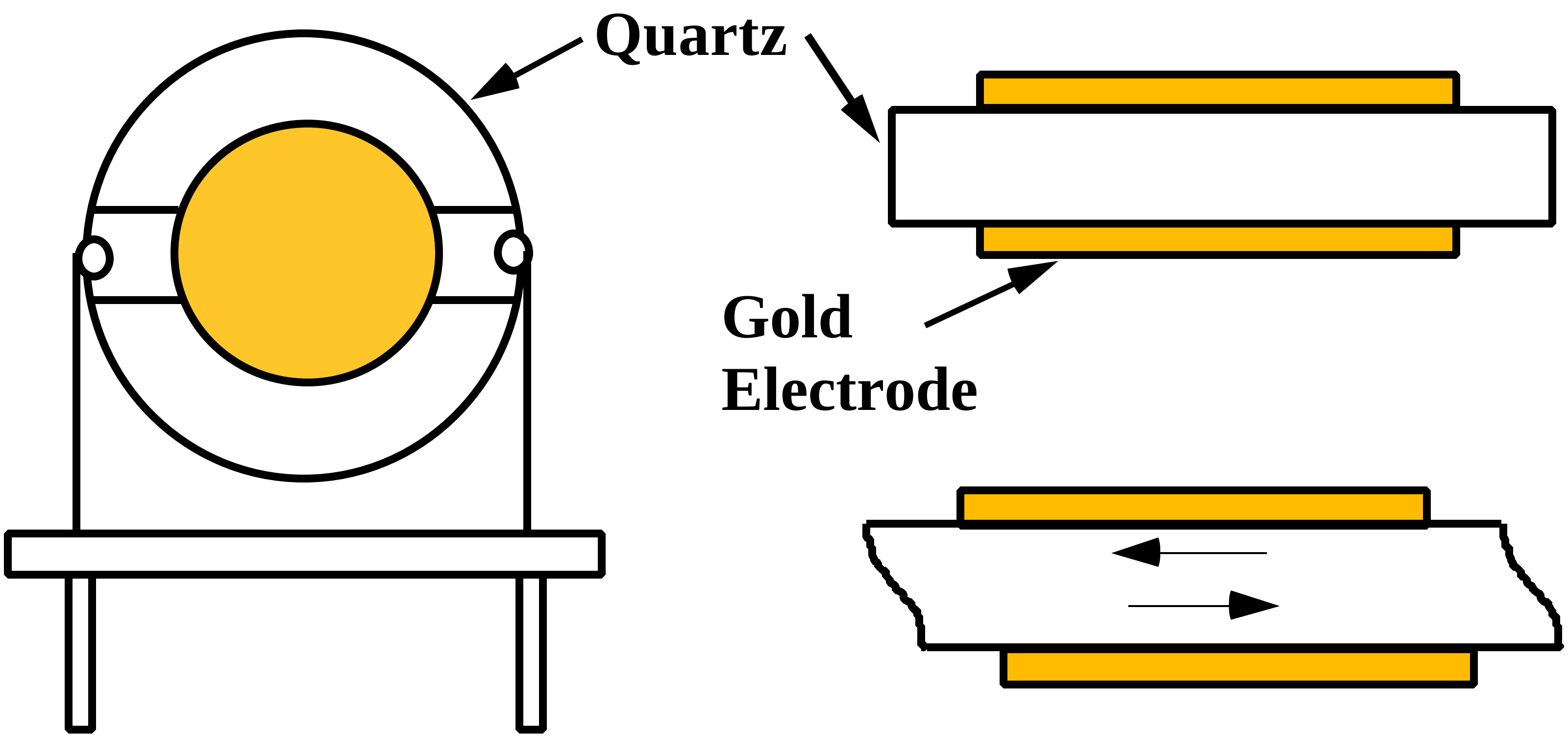
# *Need for Portable Ozone Monitor*

- Assessment of exposure requires accurate characterization of indoor ozone
  - UV ozone monitors are large, noisy, and expensive
- Assessment of acute ozone exposures requires high temporal resolution
  - diffusive badge samplers provide ozone concentration averaged over 8 hours or more and require costly and time-consuming lab analysis

# *Sensor Design*

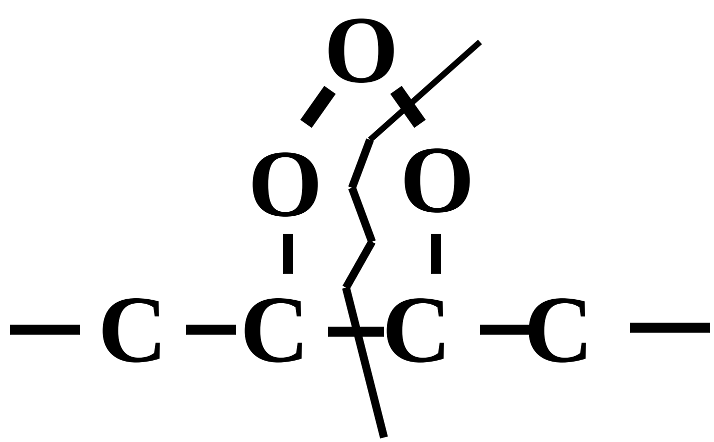
- Piezoelectric quartz crystal
- Polybutadiene coating
- Reaction with ozone causes mass increase and decrease in oscillation frequency
- Rate of change of frequency is proportional to ozone concentration

# *Piezoelectric Quartz Crystal*

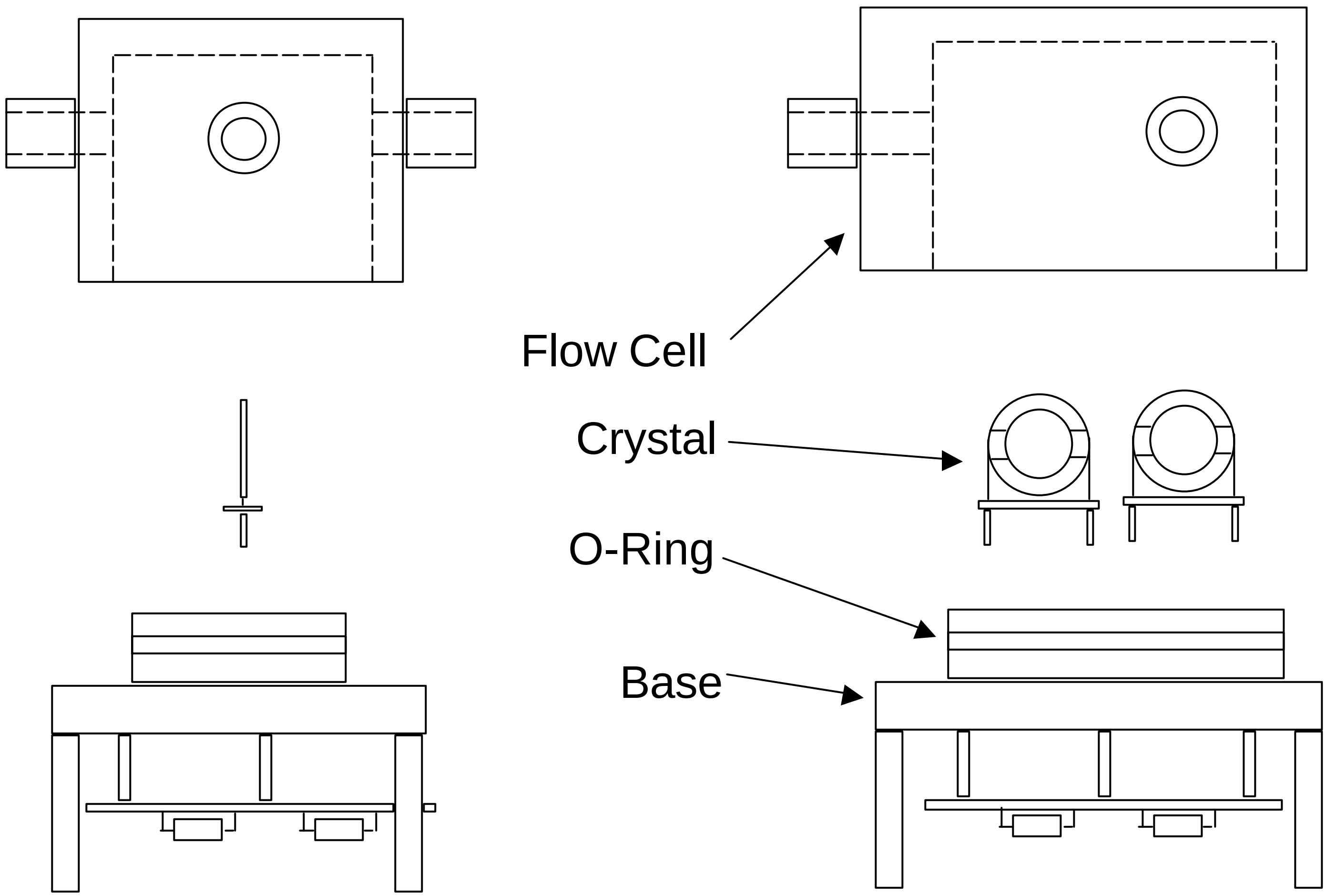


# *Ozone / Polybutadiene Chemistry*

$$\left[ C-C=C-C \right]_n + O_3 \longrightarrow$$



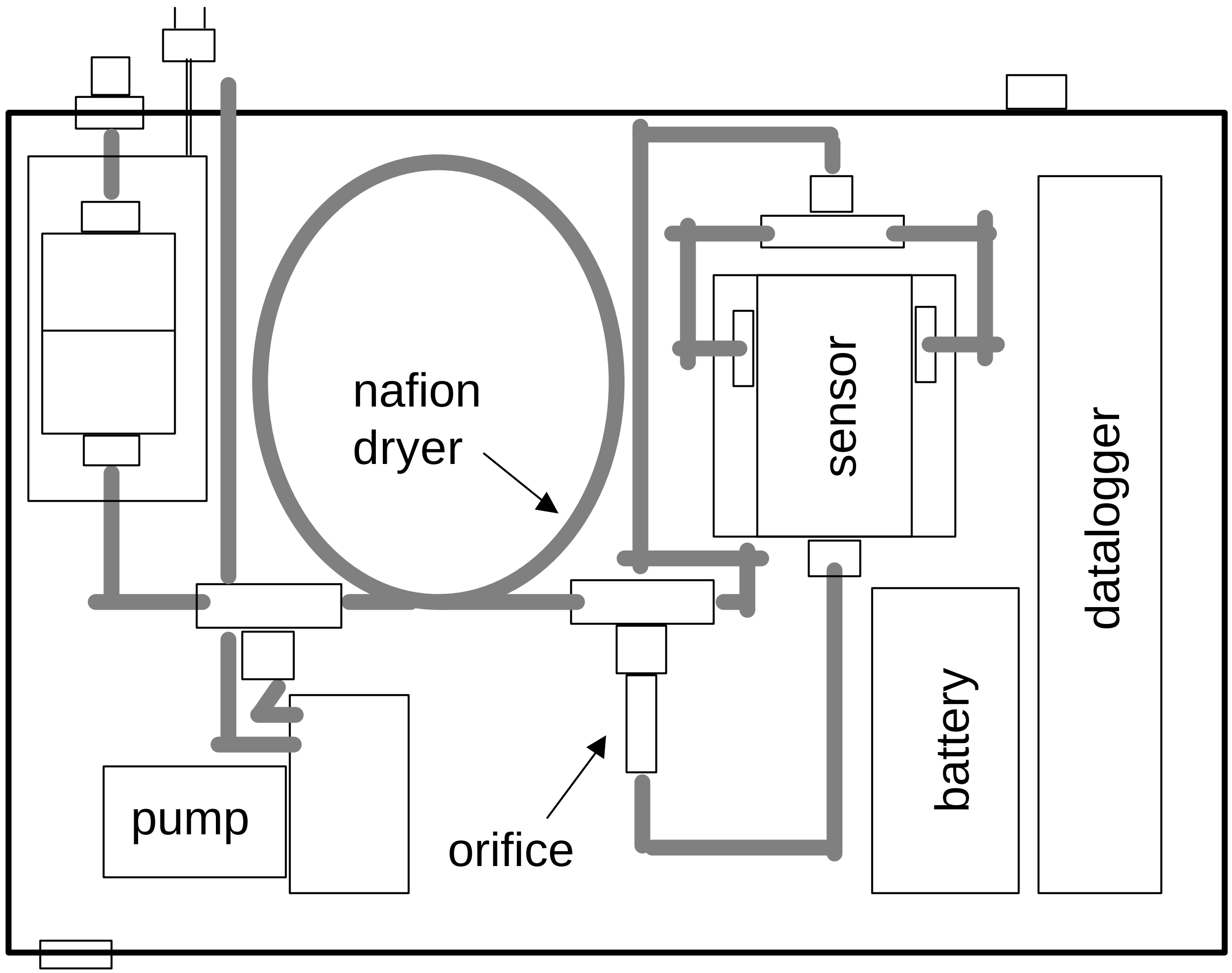
# *Sensor Housing*



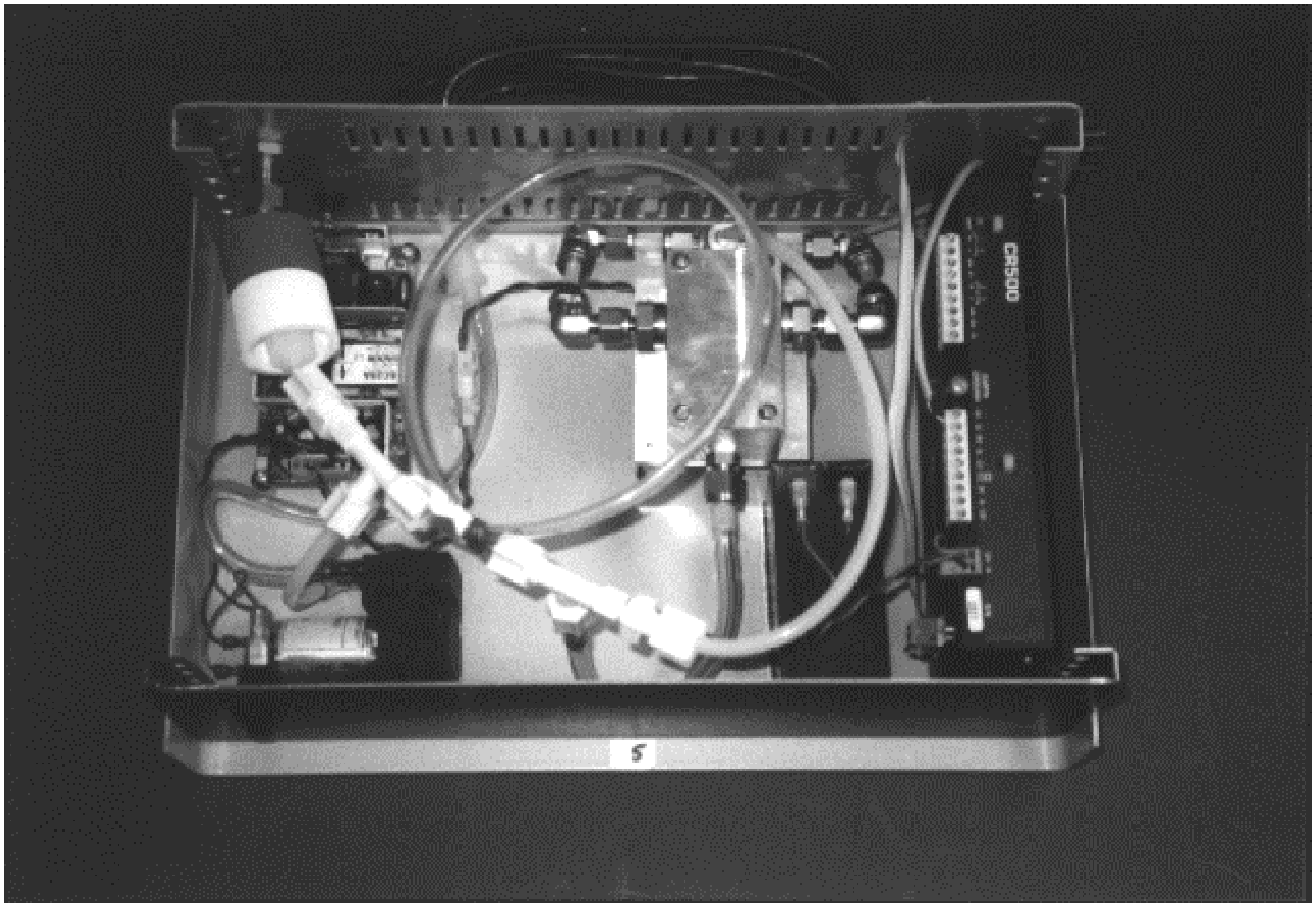
# *Portable Ozone Monitor*

- Stand-alone unit
  - sampling pump
  - programmable datalogger
- Teflon filter to remove particles
- Nafion dryer to remove water vapor
- Flow control by critical orifice

# *POM Component Layout*



# POM Component Layout



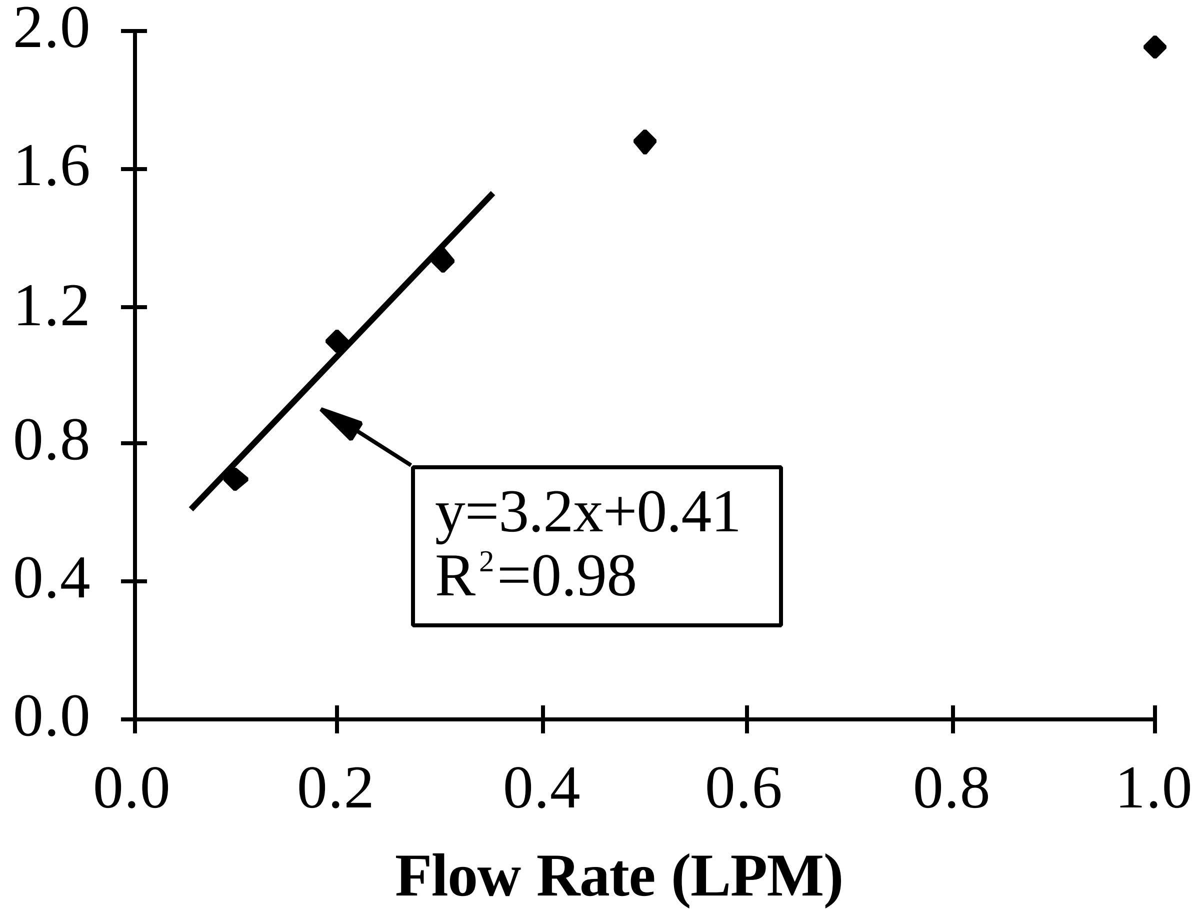
# *Monitor Operation*

- Coat crystals to be used for sampling
- Install and condition crystals
- Run sampler (1000 ppb-hr)
- Download ozone concentration data from logger with laptop PC
- Remove crystals, clean, and re-coat

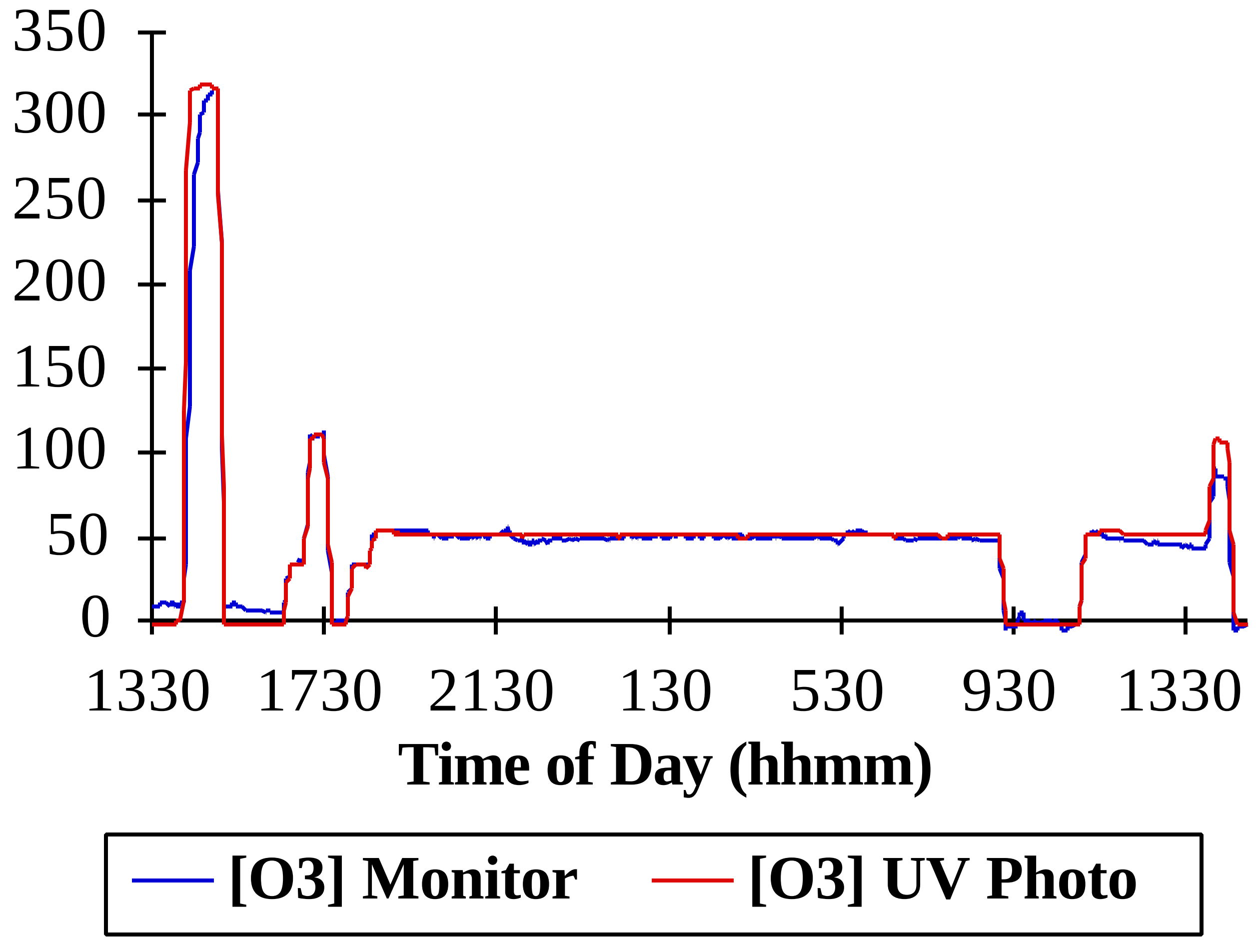
# *Laboratory Testing*

- Vary sample air flow rate
- Calibration
- Interference testing
  - $NO_2$, water vapor, NO, $HNO_3$, and toluene

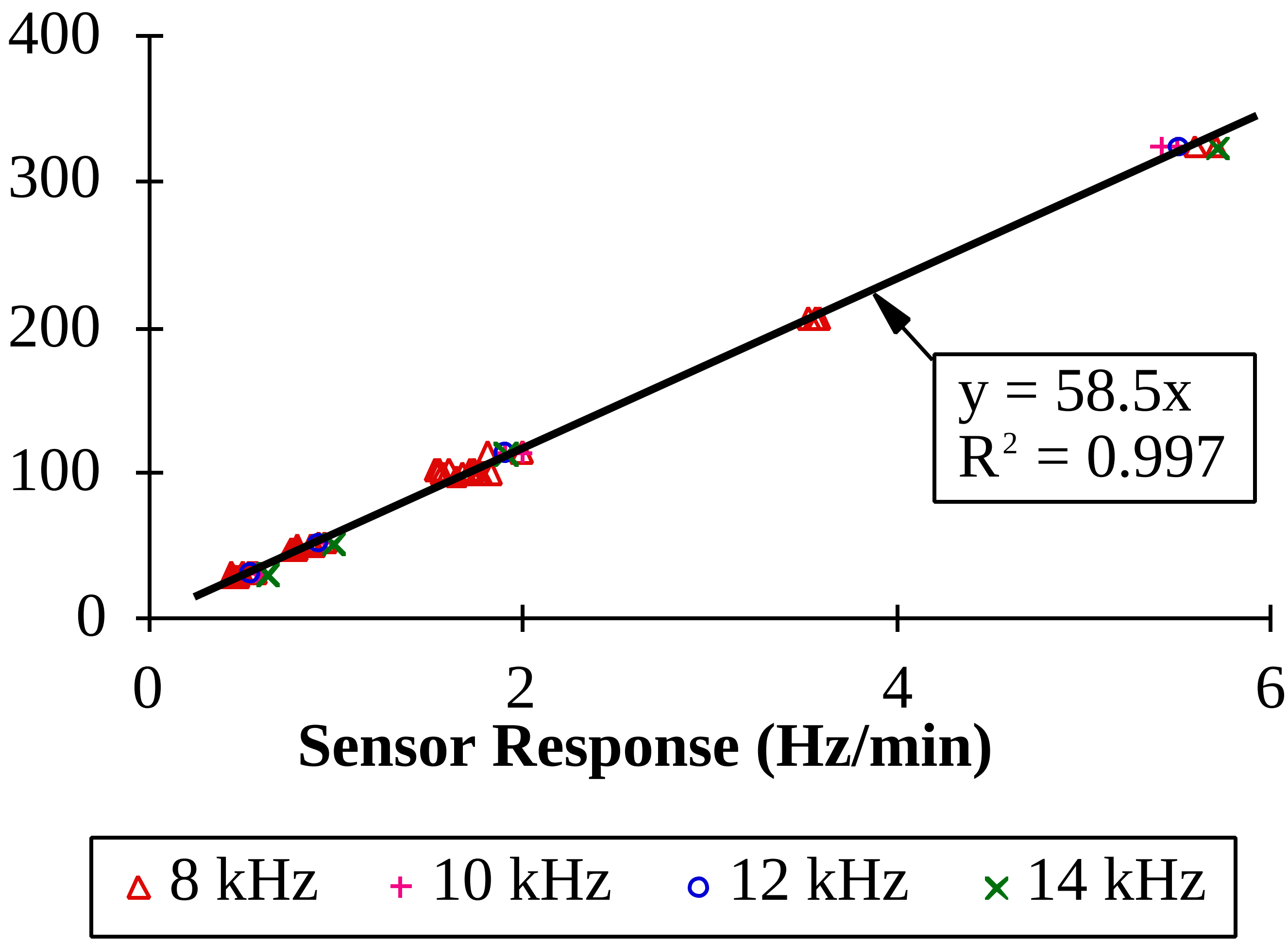
# *Sensor Response vs. Air Flow Rate*



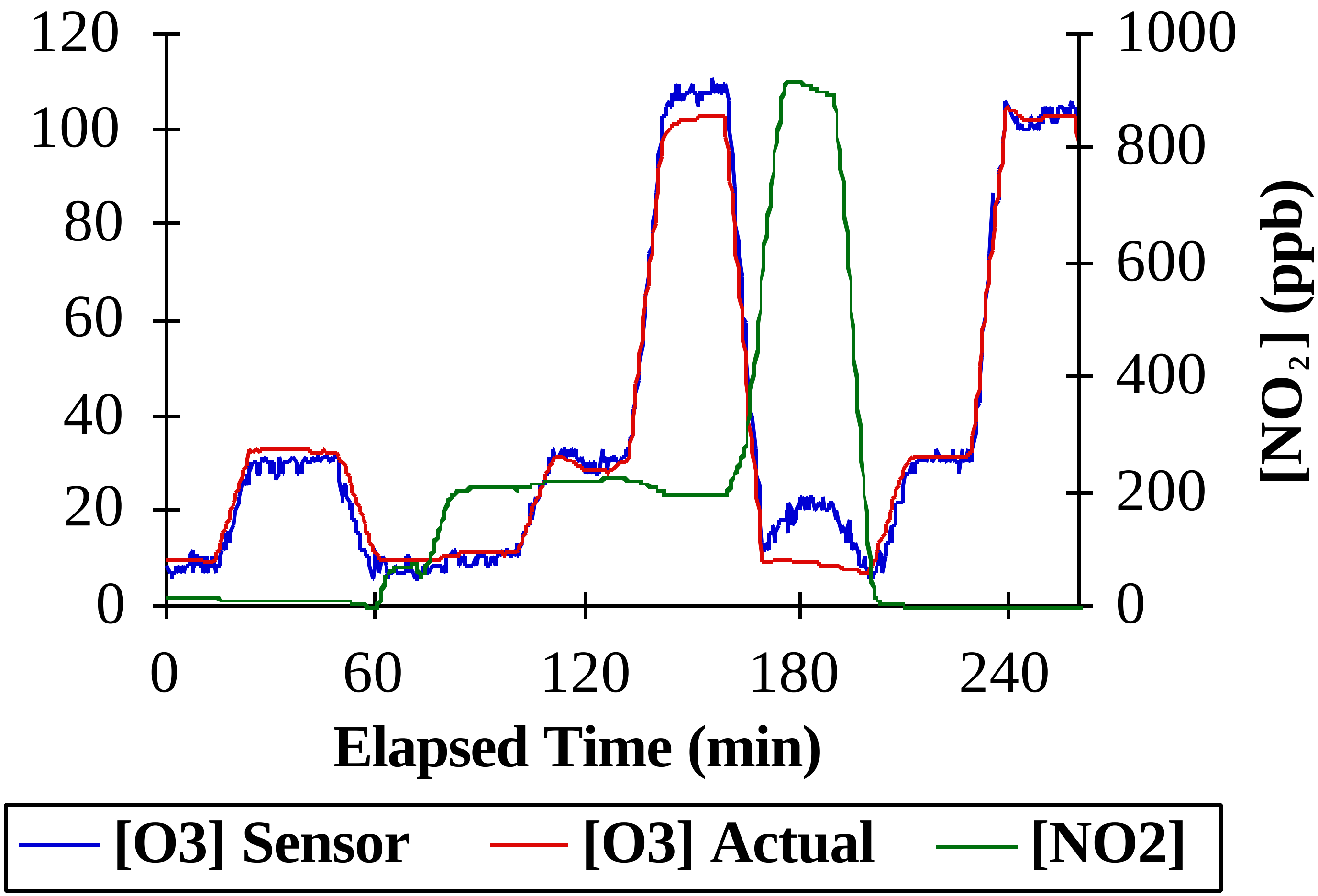
# *POM Measurements in Lab over 24 hrs*



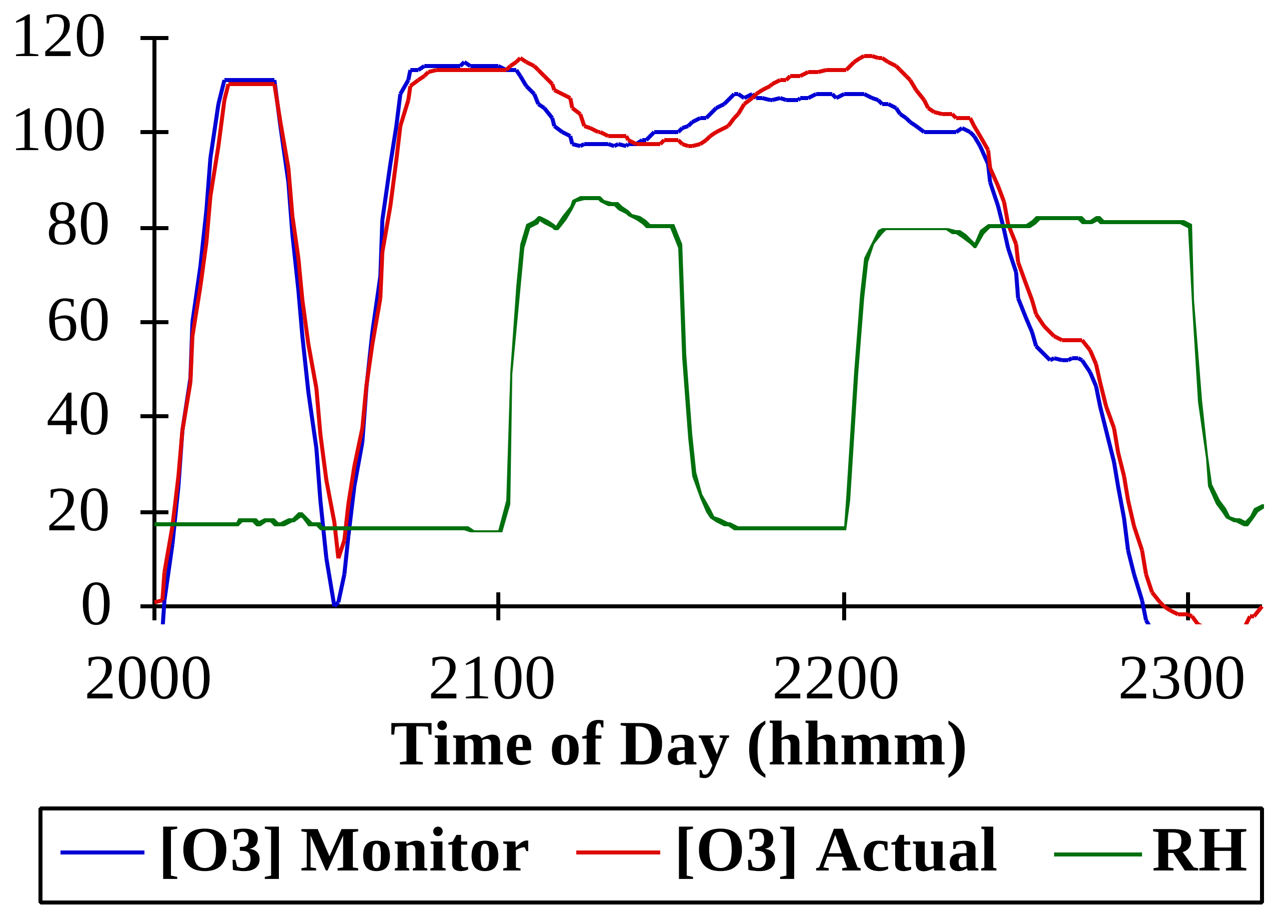
# *Monitor Calibration Curve*



# *Sensor Response to Ozone and $NO_2$*



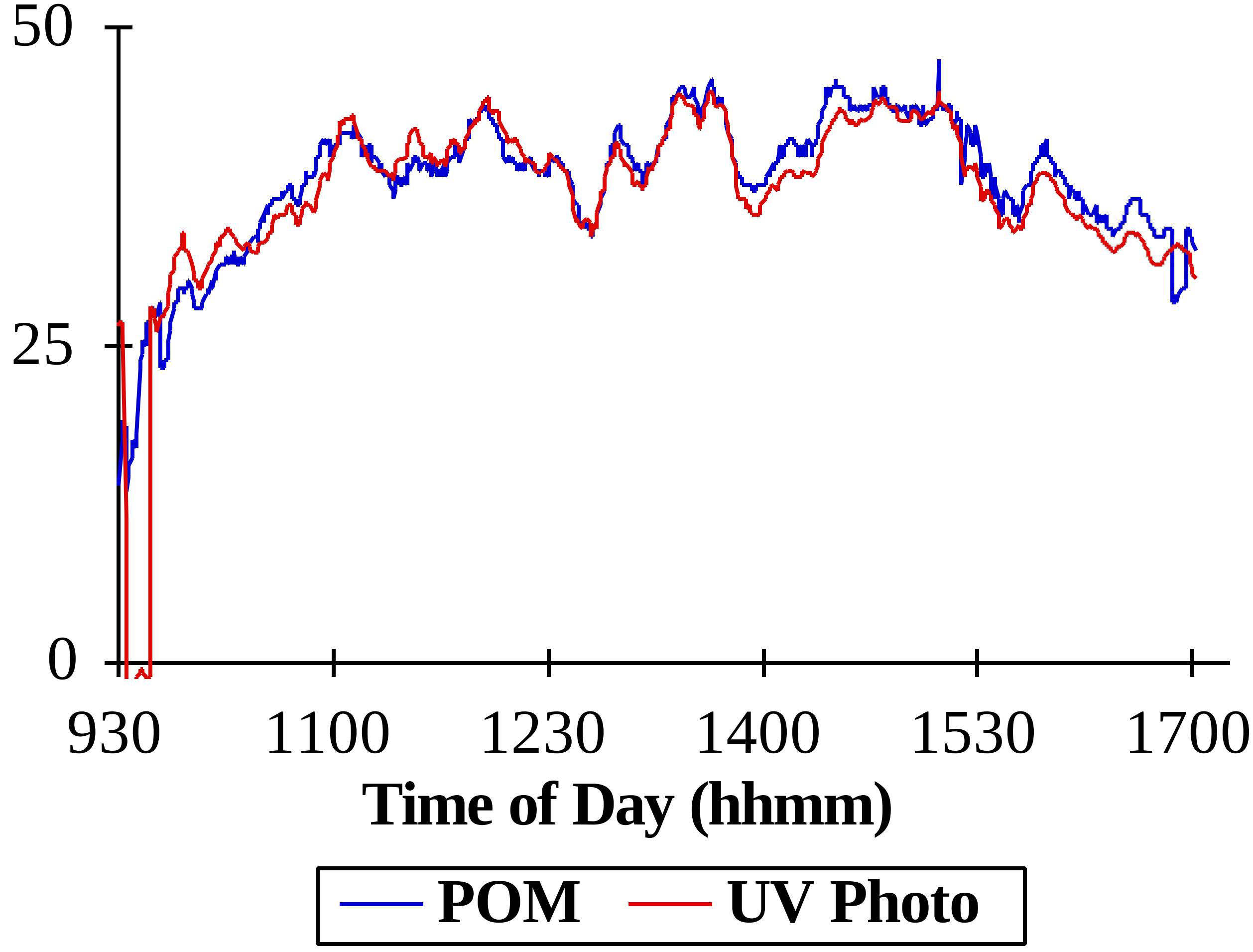
# *Sensor Response to Ozone and Water Vapor*



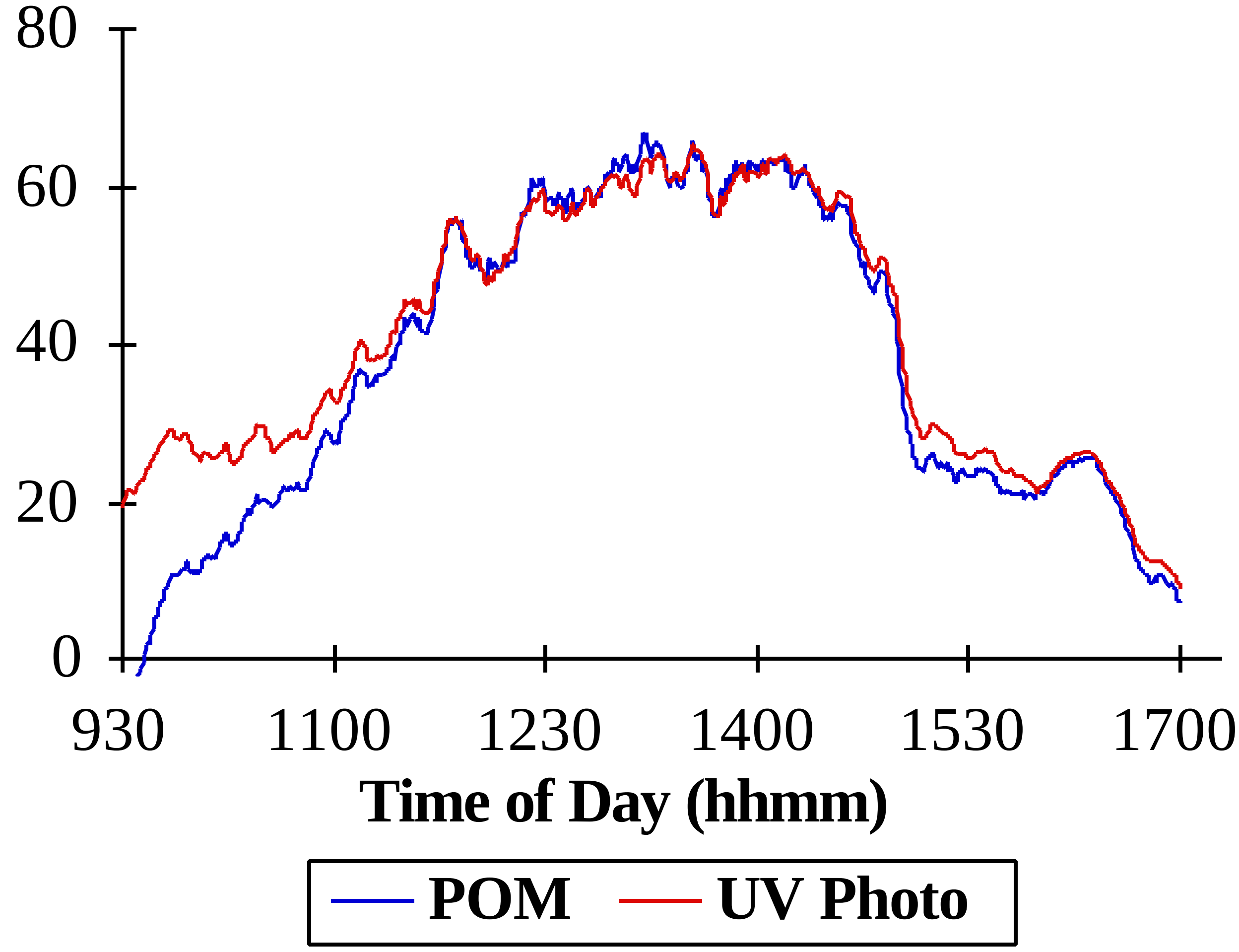
# *Field Sampling*

- Offices in Riverside
  - two POMs, one UV monitor indoors
  - building ventilation fixed
- Residences in Pasadena
  - two POMs, one UV monitor indoors
  - one POM, one UV monitor outdoors
  - vary ventilation with doors and windows

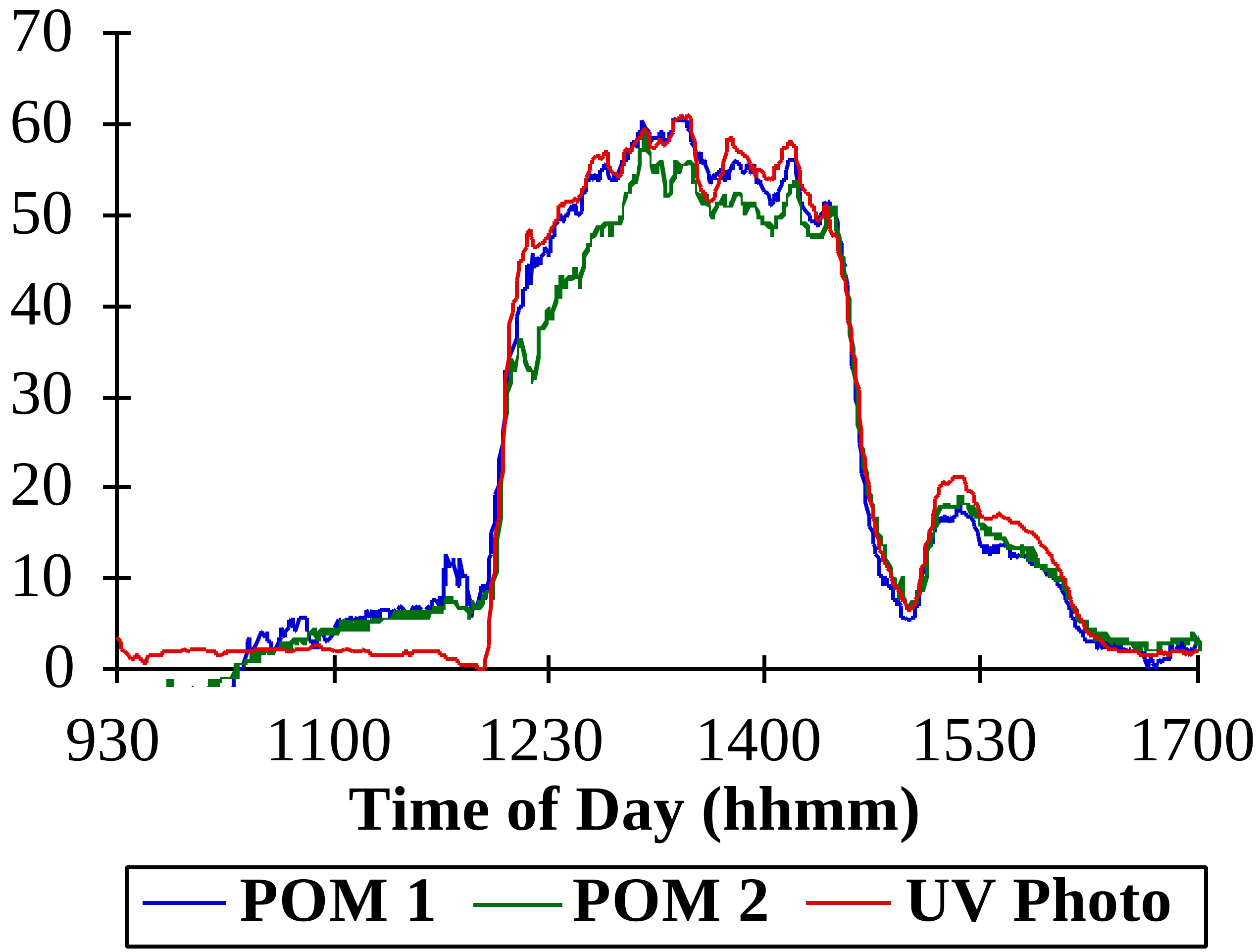
# *Outdoor POM Measurements at Residence 1*



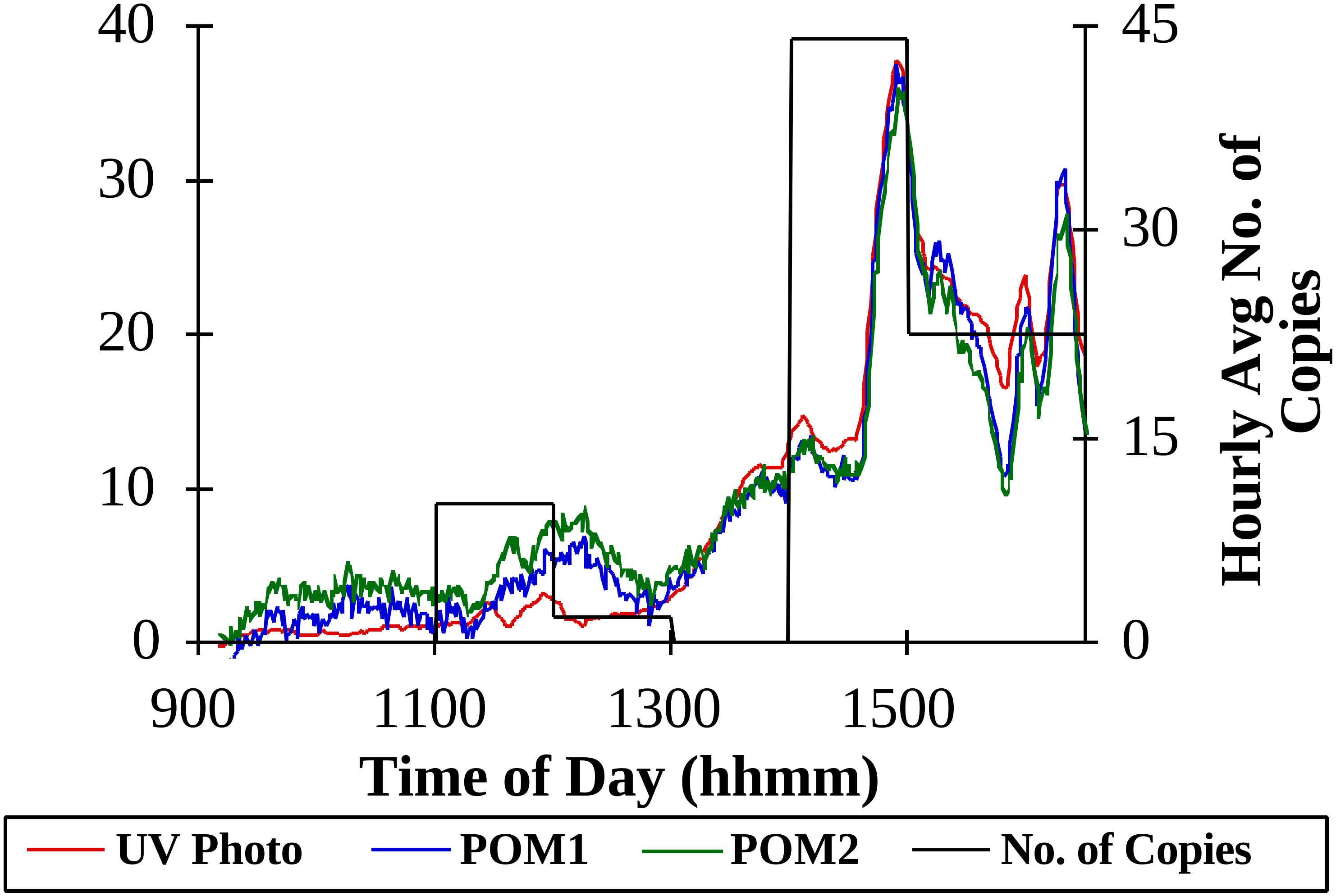
# *Outdoor POM Measurements at Residence 2*



# *Indoor POM Measurements at Residence 2*



# *Photocopy Room Measurements*



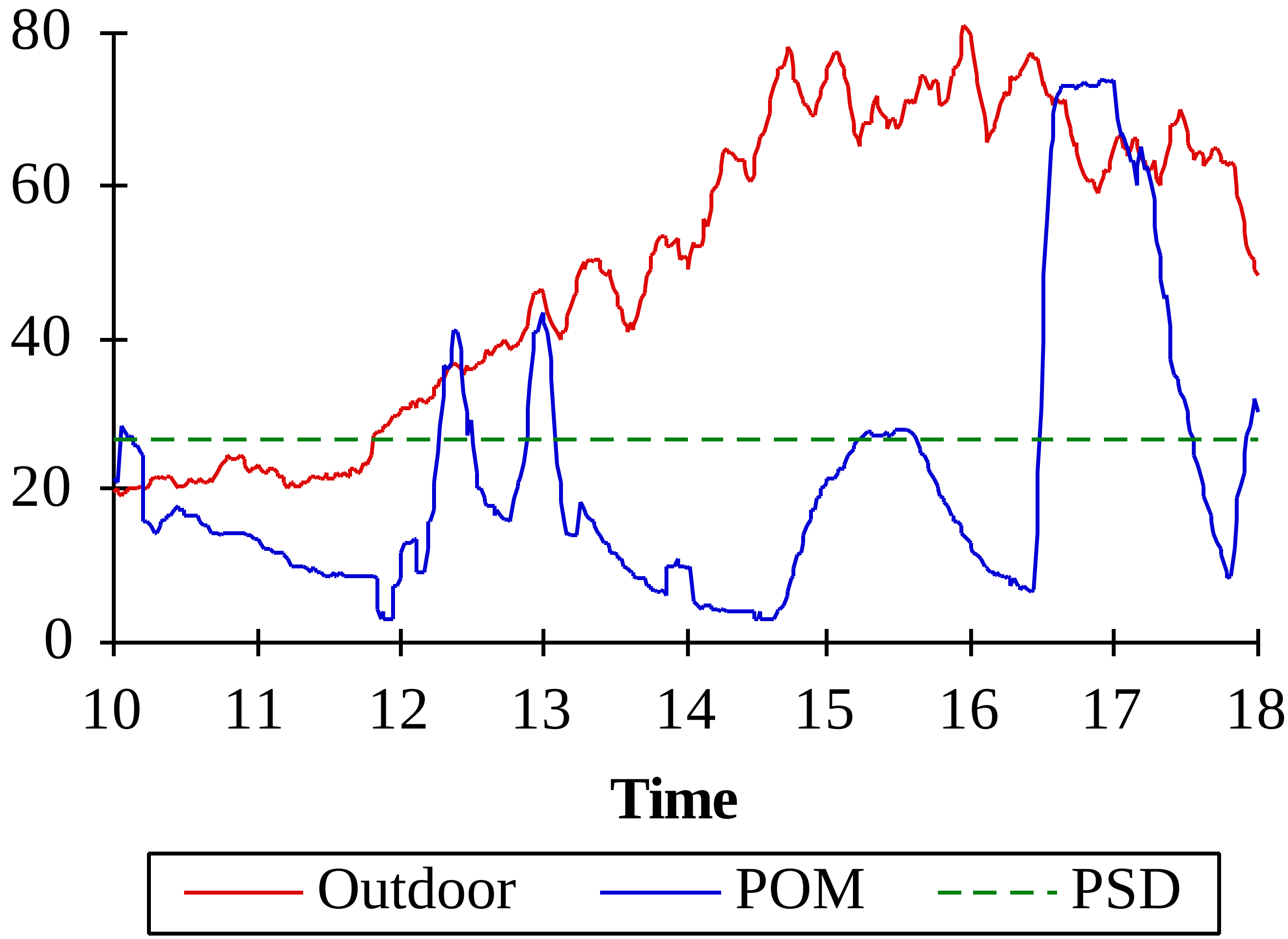
# *Significance of New Monitor*

- Low-cost, small-size, and real-time measurements
  - schools, hospitals, nursing homes, in-transit
  - assess indoor ozone sources
  - exposure model development
- Technology has potential for personal monitoring

# *Personal Monitoring*

- Prototype battery-operated monitor
  - personal sampling pump
  - Nafion dryer with desiccant
- Lighter, smaller enclosure
- Fits in standard backpack
- Preliminary tests with two subjects in Sacramento

# *Personal and Outdoor Ozone Measurements*



# *Acknowledgments*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  - Tom Phillips and Peggy Jenkins