

***Taking a Supersite on the  
Road:*** Monitoring Particulate  
Matter in Community Air

A Cooperative Project

**California Air Resources Board**

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**Los Angeles PM Center/Supersite**

Lead Investigator Costantinos Sioutas

# Overview

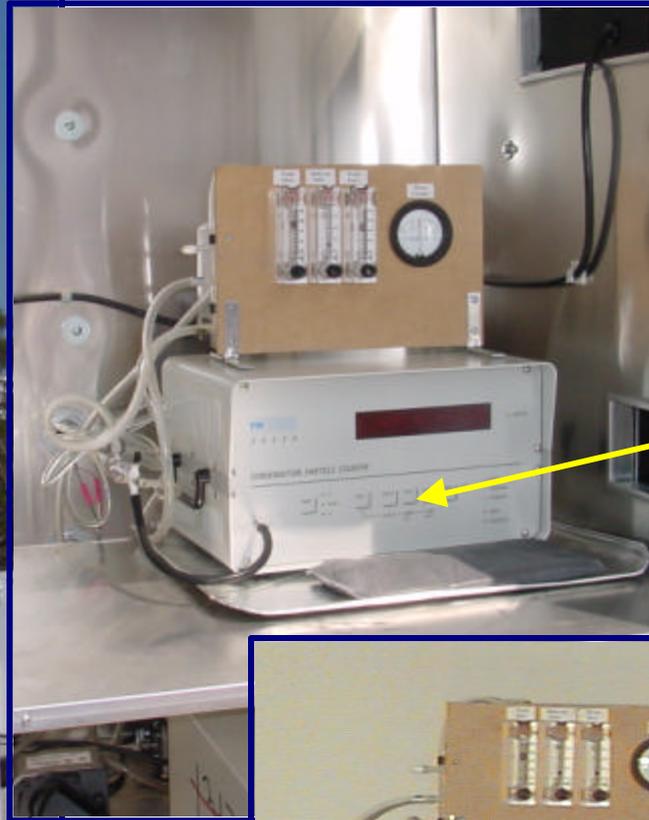
- Background
- Concept and Objectives
- Approach
- Findings and Observations
- Applications
- The Future

# Background

- PM is harmful to health
- Initial concerns regarding PM<sub>10</sub> and PM<sub>2.5</sub>
- Current concern for ultrafine PM (PM <0.1µm)
  - A common product of combustion
  - Vehicles important in urban settings
  - Contains many toxic components
  - ARB's 12 station UFPM network
    - In operation for over 3 years
    - Findings complex, location specific, point to traffic
    - Network is a unique application of a lab instrument (3022A CPC)
    - A first attempt at taking laboratory UFPM instruments into field



Enclosure



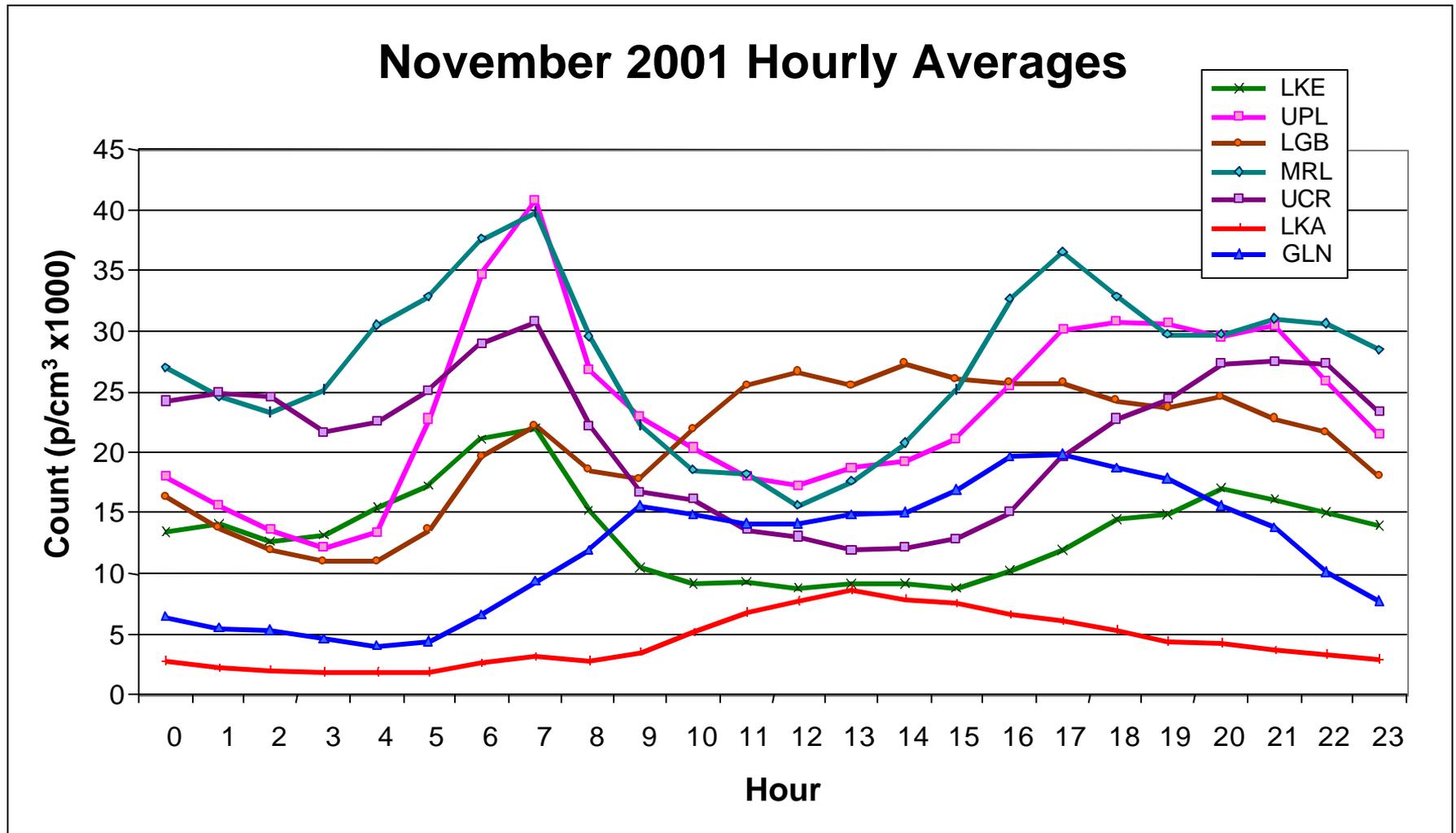
3022a CPC



Ultrafine PM Monitoring in Children's Health Study Network  
(taking laboratory instruments into community air)

# Ultrafine PM Spatial Differences

(suggests traffic drives UF PM)



# Mobile Monitoring Project

## Overarching Concepts

People don't live at monitoring sites

Fixed-site monitors don't capture complexities of urban air

Fixed-site monitoring may not measure new pollutants of concern

## Objectives of Pilot Level Studies

Evaluate methods to determine community exposures to fine and ultrafine PM and gases

Observe many microenvironments, especially on-road

Compare observations with fixed site monitors

# **Prior studies are problematic**

## **Routine air monitoring**

operated primarily for compliance determinations

## **Air monitoring studies**

seldom performed in communities

## **Dyno-based emission studies**

difficult to relate to ambient

## **On-road studies**

limited and complicated by own exhaust

# North Long Beach A Traditional Air Monitoring Site



# Supersite Trailer--Los Angeles



Mobile Monitoring Project

# One Approach to Mobile Monitoring



Mobile Monitoring Project

# Next Step: The Electric RAV4



## **Unique Features of Electric RAV4 Platform**

- Mobile, Compact, Nimble, Flexible
- Non-polluting vehicle and power supply
- Operates in communities
- Advanced instrumentation
- Captures data with high time resolution
- Operating range/time—80 miles/7 hours
- Linked to USEPA Supersite

## Mobile Monitoring Project

# Parameters Monitored

<u>Equipment</u>	<u>Metrics</u>	<u>Averaging Times</u>
SMPS (2 units)	UF PM count/size	60 sec
NOx analyzer	NO, NO2, NOx	20-30 sec
Q-trak	CO, CO2, RH, Temp	2 sec
Dustrak	PM2.5 mass	10 sec
Scout	PM2.5 mass	10 sec
PAS2000	PAH mass	1 sec
EAD	UF PM particle length	2 sec
Aethalometer	Black Carbon mass	1 min
CPC (3007)	UF PM counts	2 sec
CPC (3022a)	UF PM counts	2 sec
CO analyzer	CO	~1 min
GPS	Location	1 min
Video Camera	Continuous video	continuous

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# Electric RAV4 Instrument Deployment

Video Camera (removed)

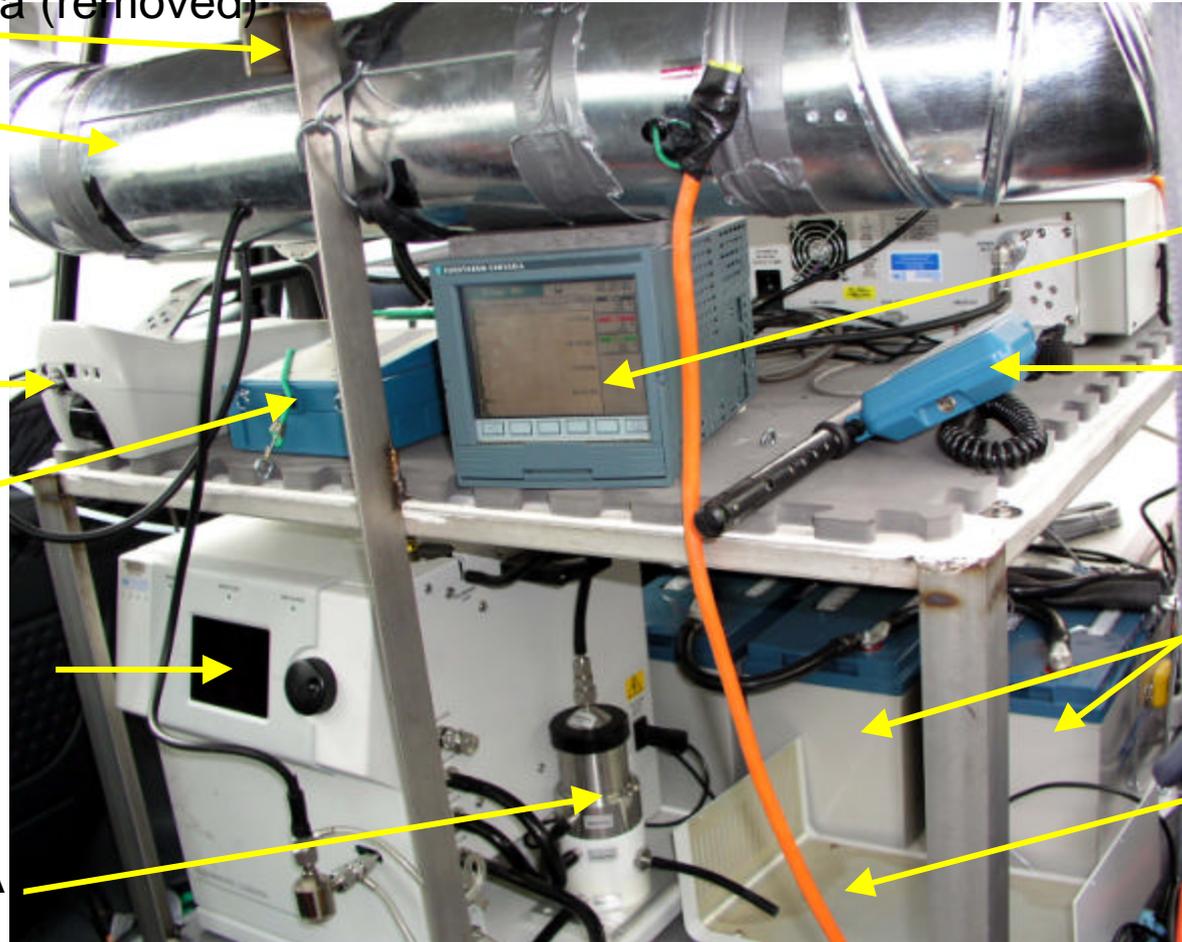
Plenum

3007 CPC

Dustrak

3096 SMPS

3085  
Nano DMA



Data Recorder

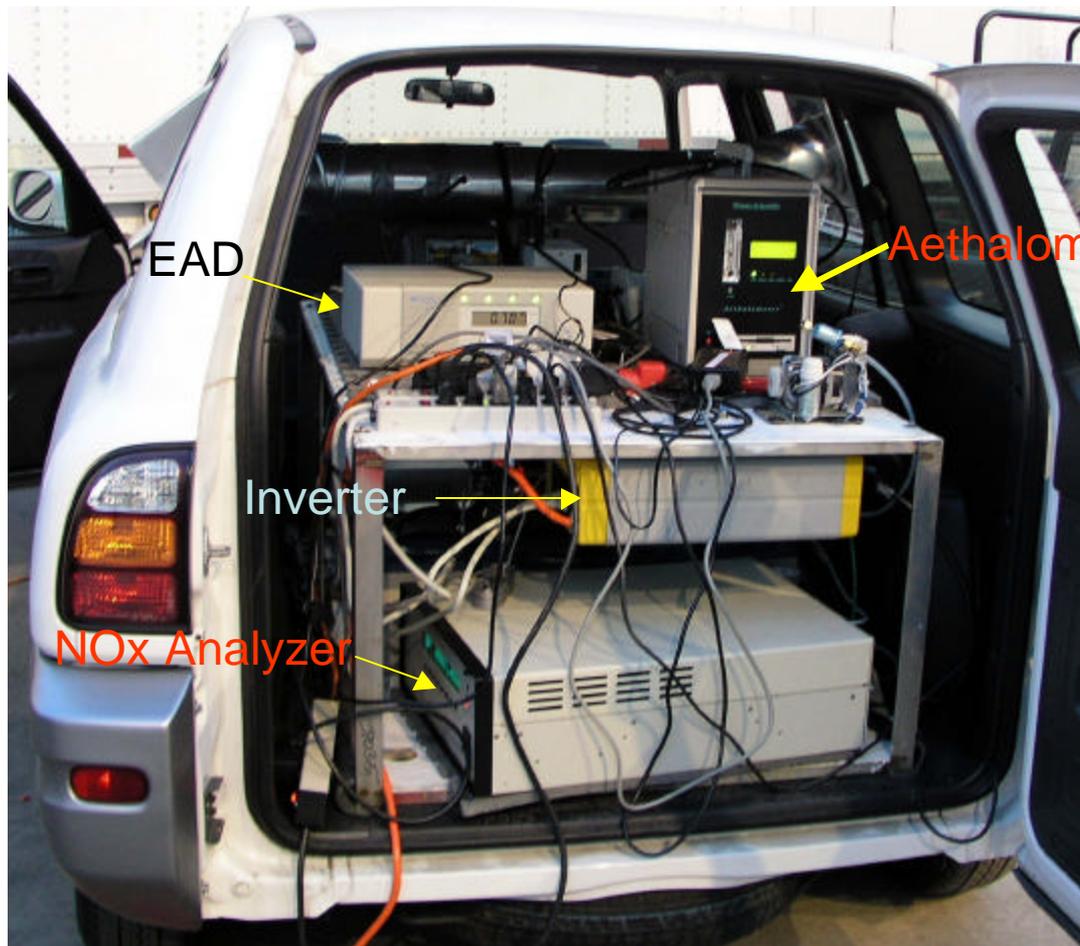
Q-Trak  
CO/CO2

Batteries

3025  
CPC (removed)

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# Electric RAV4 Instrument Deployment



EAD

Aethalometer

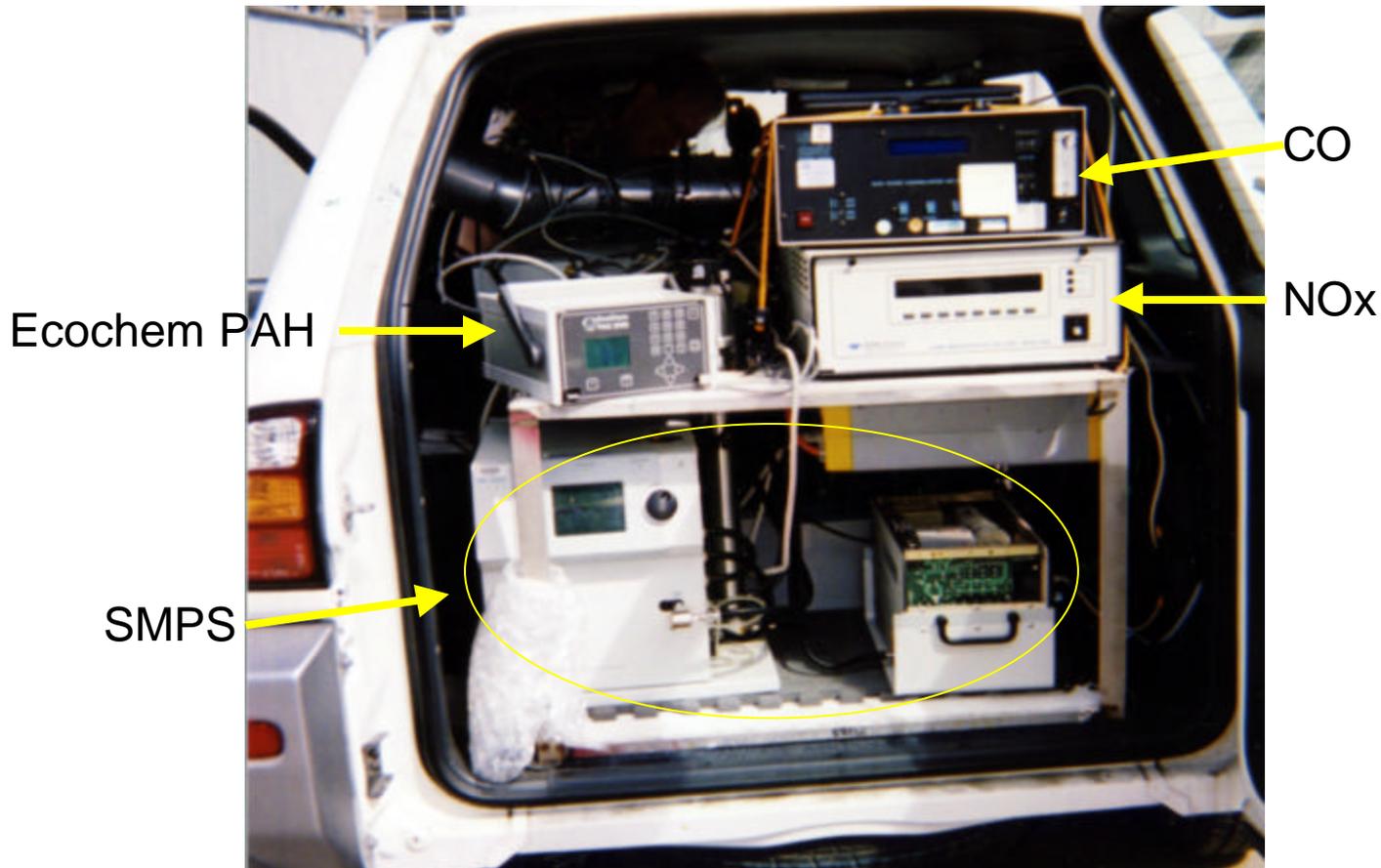
Inverter

NOx Analyzer

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# Rear View as Study Ends

PAH, CO, NO<sub>x</sub>, SMPS



# **Operational strategy**

- **Study pollutants on freeways, arterials, urban canyons, and in microenvironments**
  - Where people live, work, play, and commute
  - Where important UF exposures may occur

**Studies performed from February-April 2003**

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# Locations Monitored

I-710

I-110

I-105

Downtown LA

Wilmington

Long Beach

Port Facility

Schools

LAX

South Central LA

Wilshire District

Pasadena

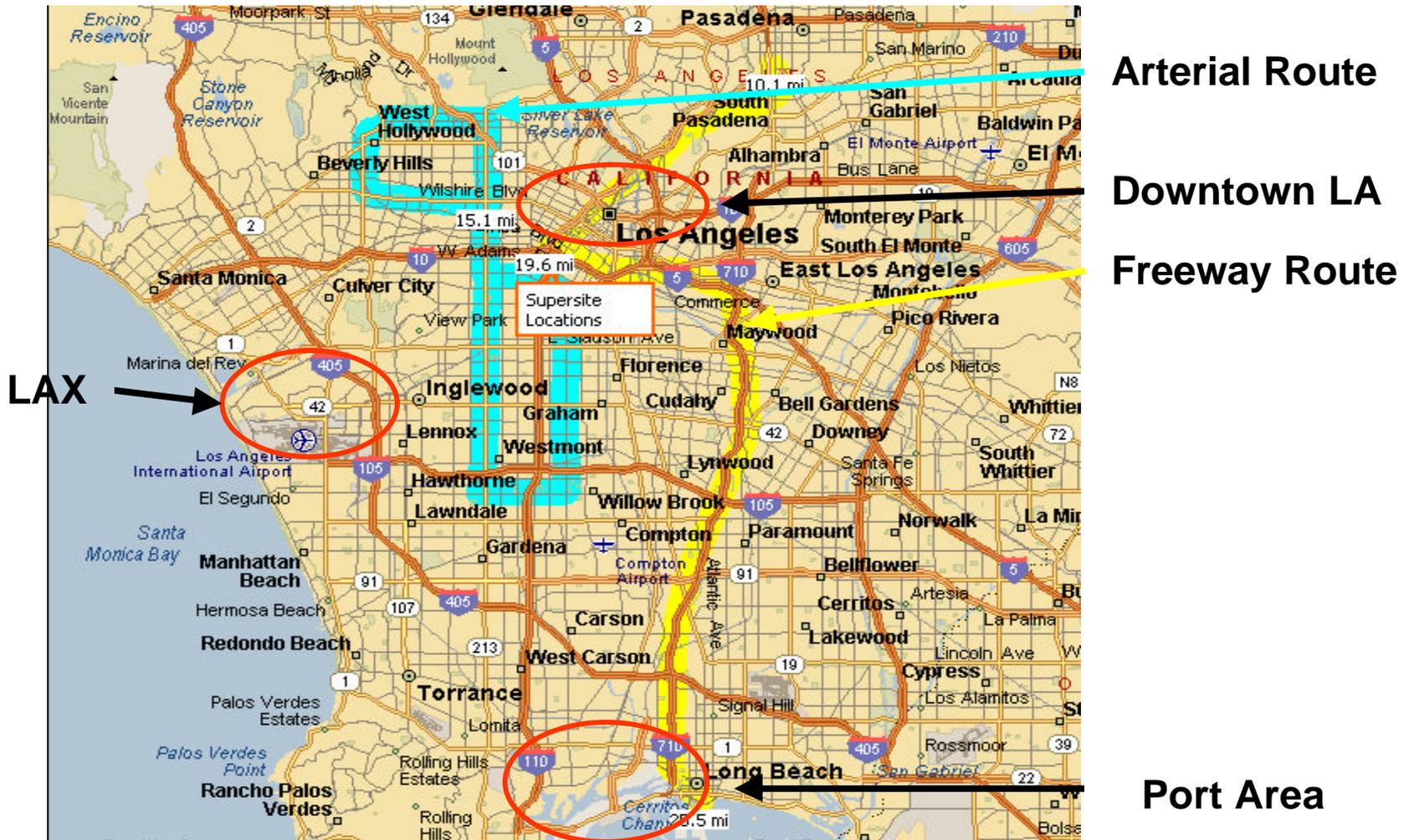
Boyle Heights

I-405

West LA

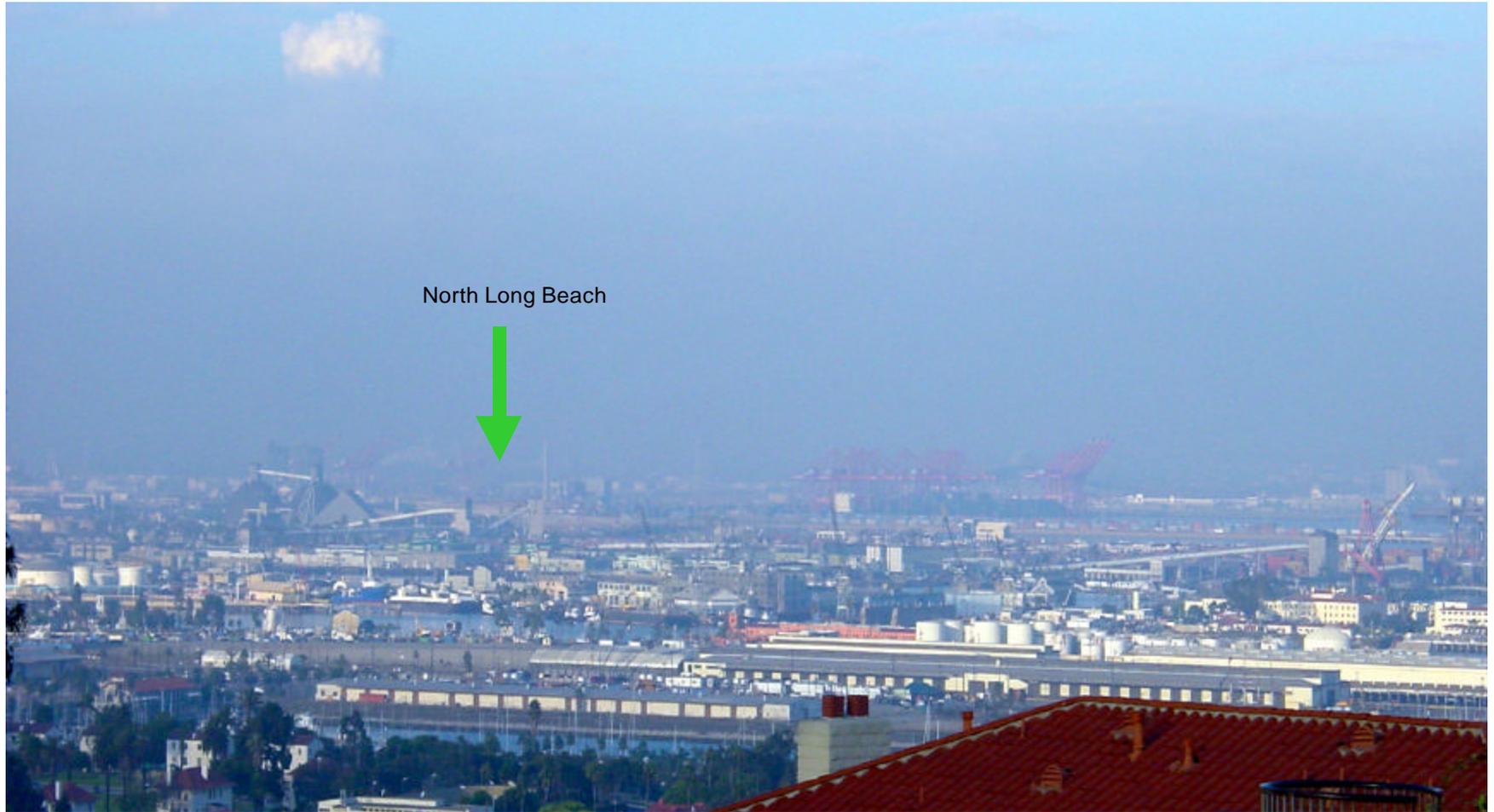
Arterial Highways

# Typical On-Road Sample Circuits



# Long Beach/Wilmington

Very Complex Sources and Community Air



North Long Beach

# 710 Freeway



# Trucks From Port



# Intermodal Container Transfer Facility



# Petrochemical Storage Wilmington



RAV4

# Measured Sources of Urban Ultrafine PM

- diesel powered trucks and buses
- gasoline powered cars and vans
- cooking facilities
- chemical/industrial facilities
- construction projects
- garden equipment
- airports

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# Highest On-Road UF Source

A Mid-80s Ford Diesel pickup



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# A High Emitter of Ultrafine PM

A gasoline fueled van



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# High Ultrafine PM and Black Carbon



# Summary Findings--Ultrafine PM

- 600-2000 counts/cc at coast
- 500-2000 c/cc in office spaces
- 10,000-40,000 c/cc in urban air
- 30,000-hundreds of thousands c/cc on arterials
- 40,000-over a million c/cc on freeways
  - Predictably high in certain locations
- several hundred thousand near an industrial site
- thousands- several million c/cc near LAX airport

## Summary Findings--Black Carbon

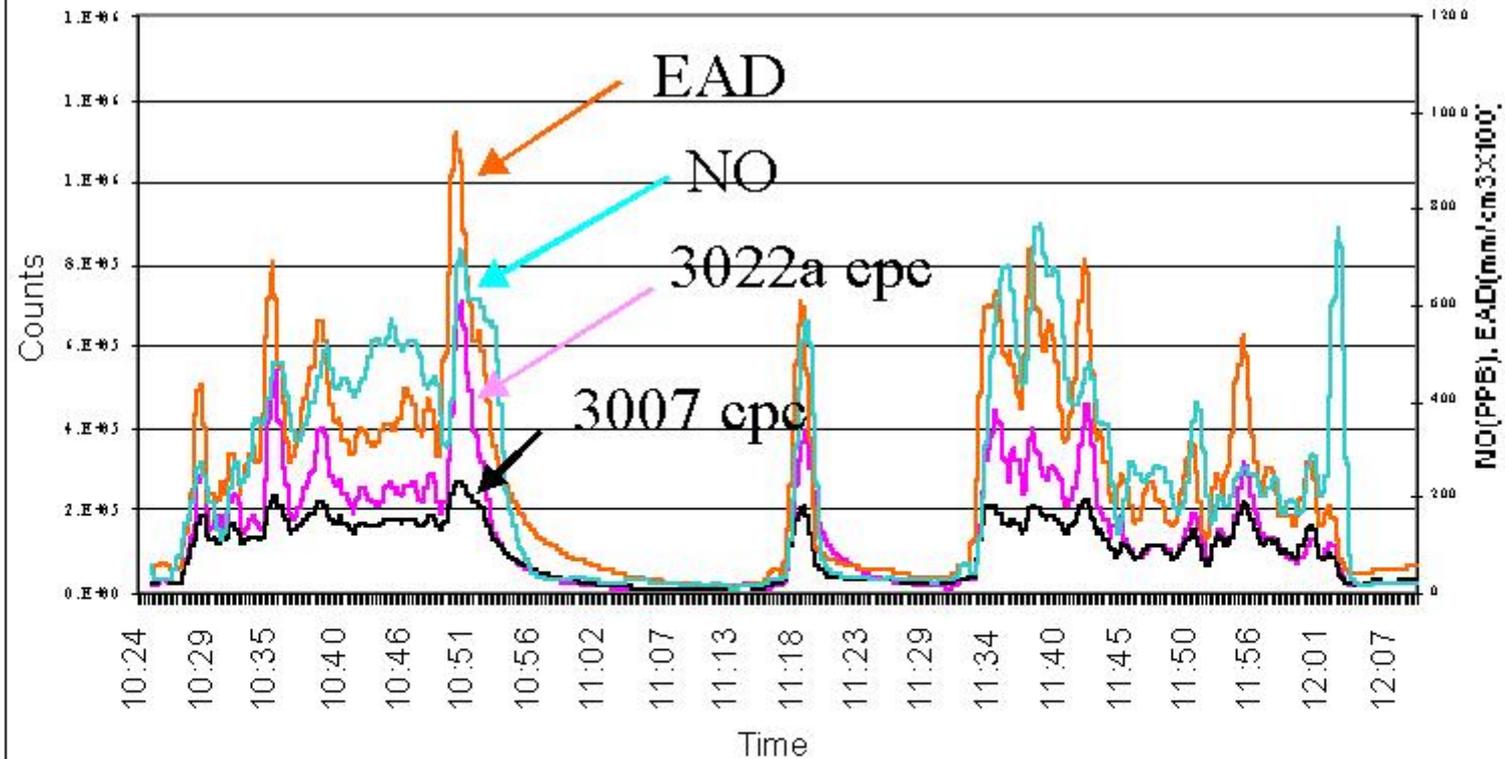
- 0.5-3 ug/m<sup>3</sup> typical in community air
- 3-10 ug/m<sup>3</sup> typical on arterial highways
- 5-50 and above ug/m<sup>3</sup> on freeways
  - highest on freeways with diesel traffic
  - predictably highest at certain locations

## Summary Findings--NOx

- NO dominates NOx on freeways
- NO exceeds 1ppm in ambient air on freeways, 600ppb common on I-710
- NO is dynamic on freeways
- NO is predictably high on portions of freeways
- NO<sub>2</sub> rarely exceed 200ppb on freeways
- NO<sub>2</sub> is less dynamic than NO on freeways

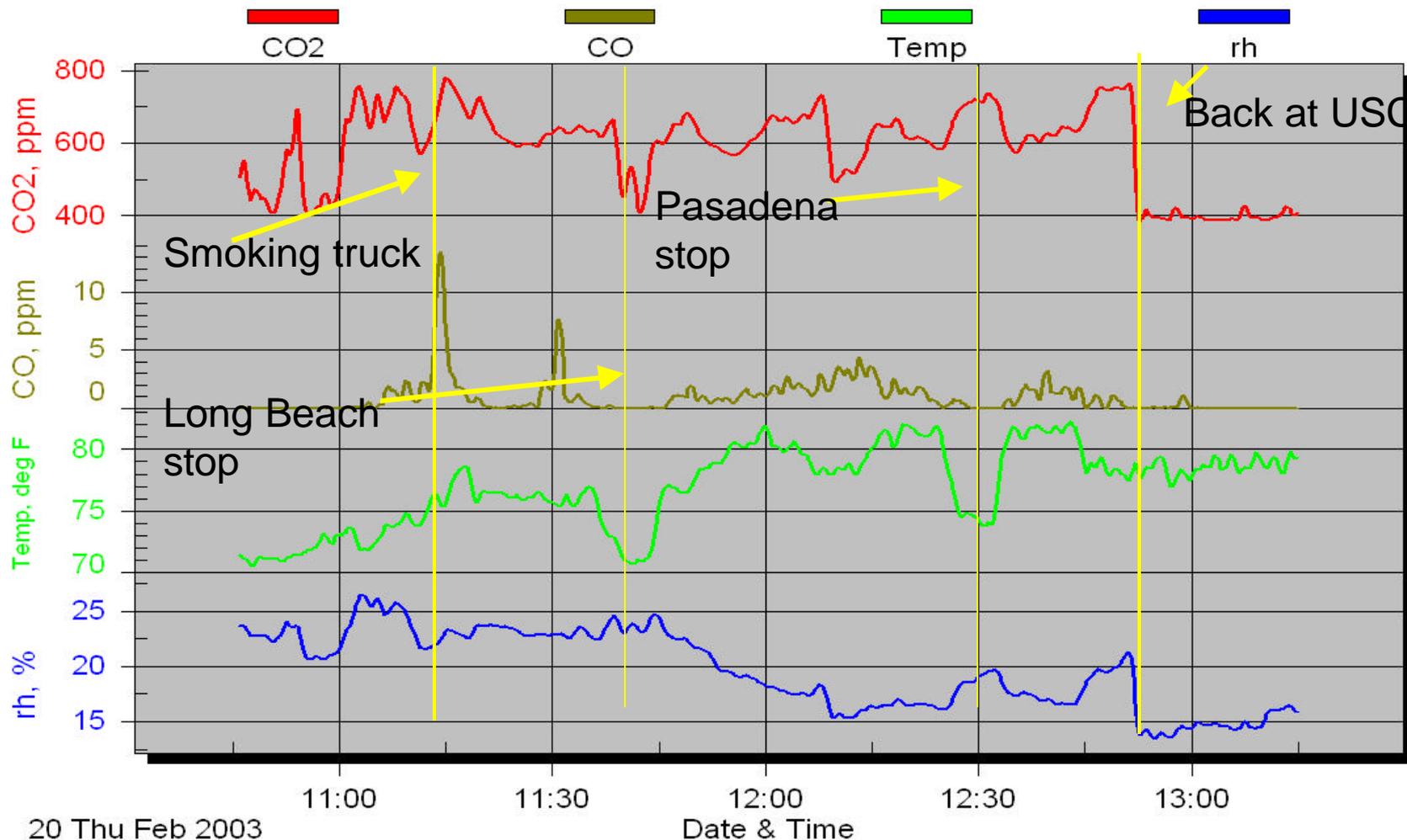
# Correlative Findings

April 24 CPC, NO, and EAD



# Freeway Monitoring--CO, CO2

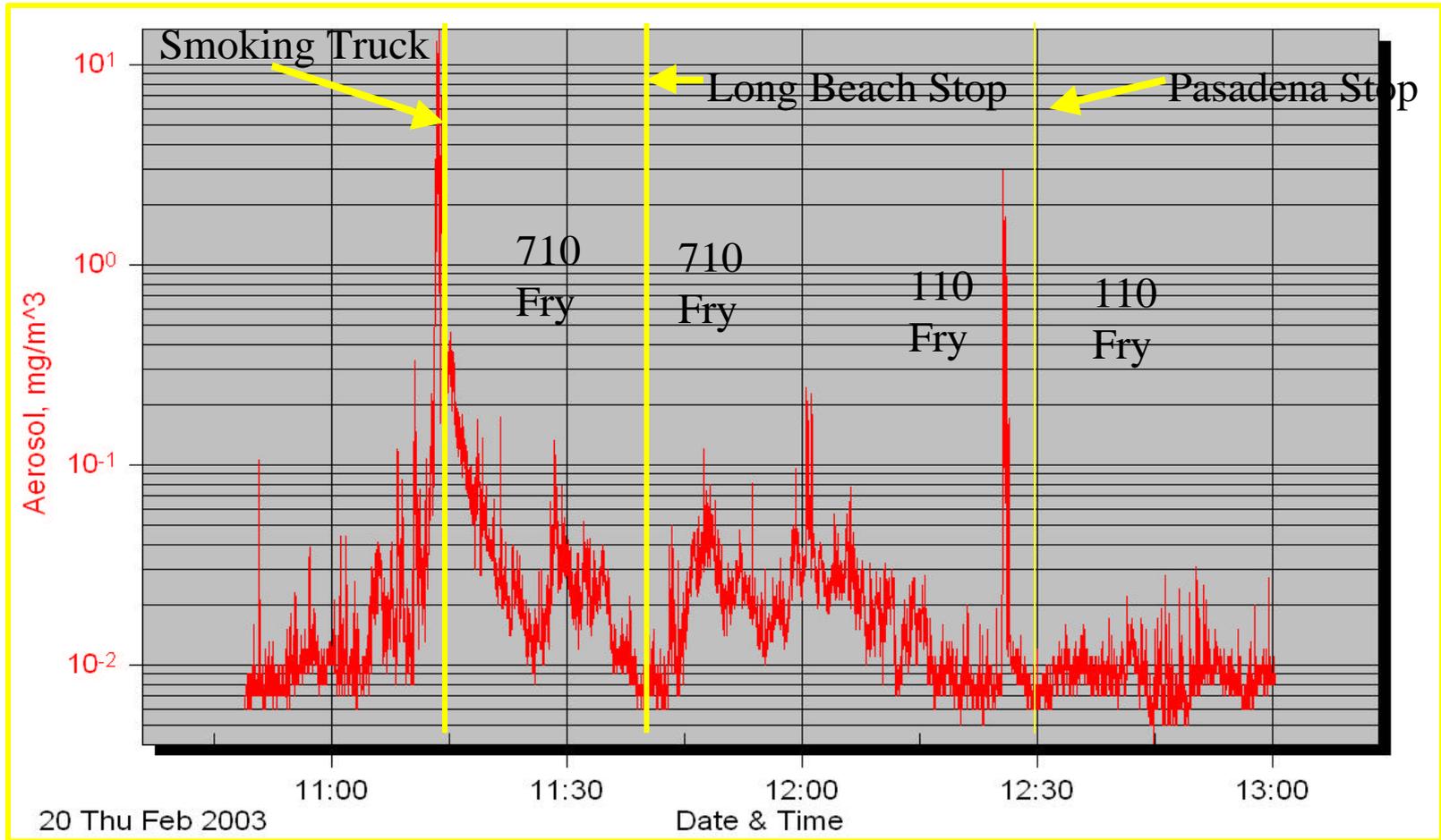
TSI Q-trak



(Location and traffic mixtures impact many pollution metrics—CO and CO<sub>2</sub>)

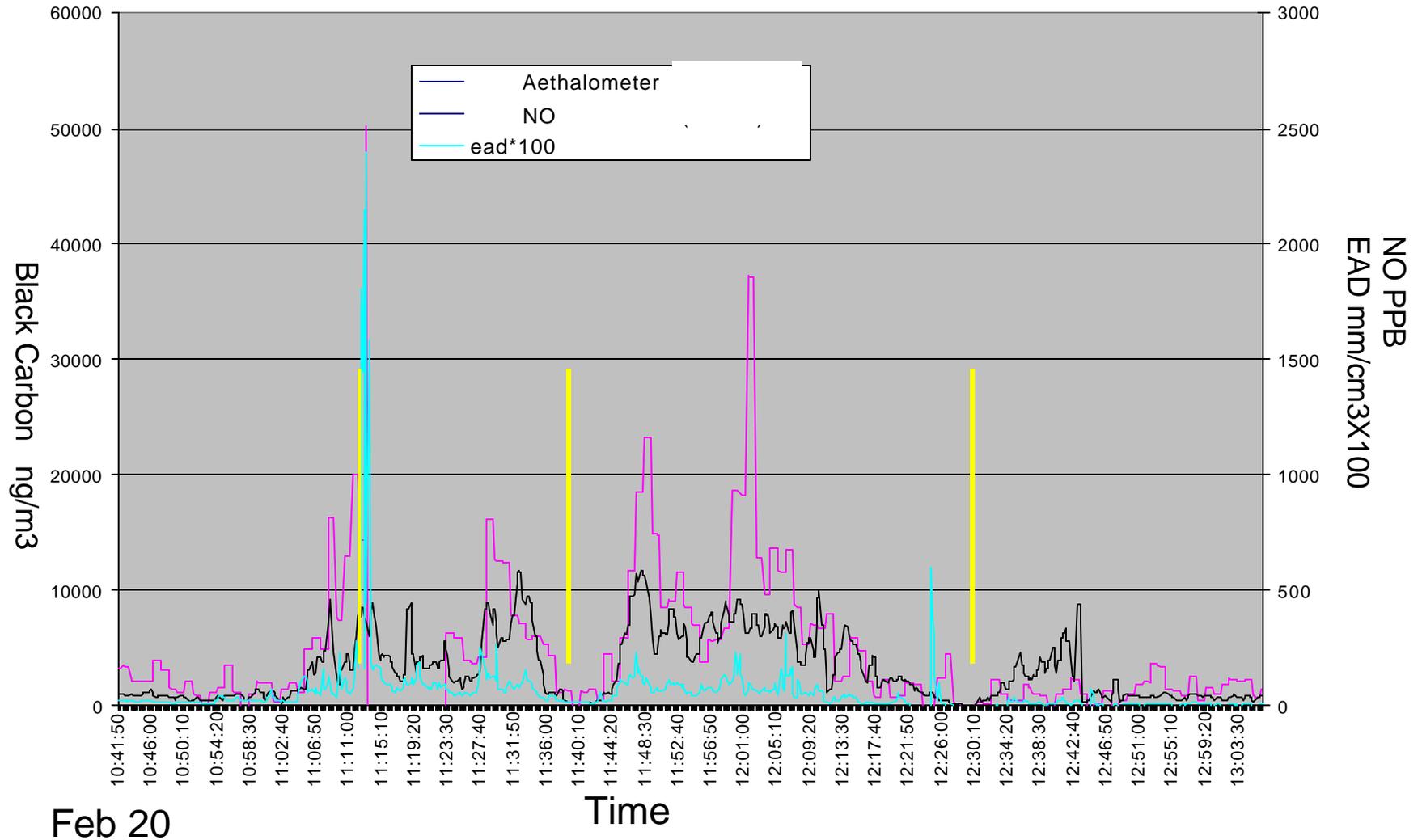
# Freeway Monitoring--PM2.5

TSI Dustrak



# Mobile Monitoring Project

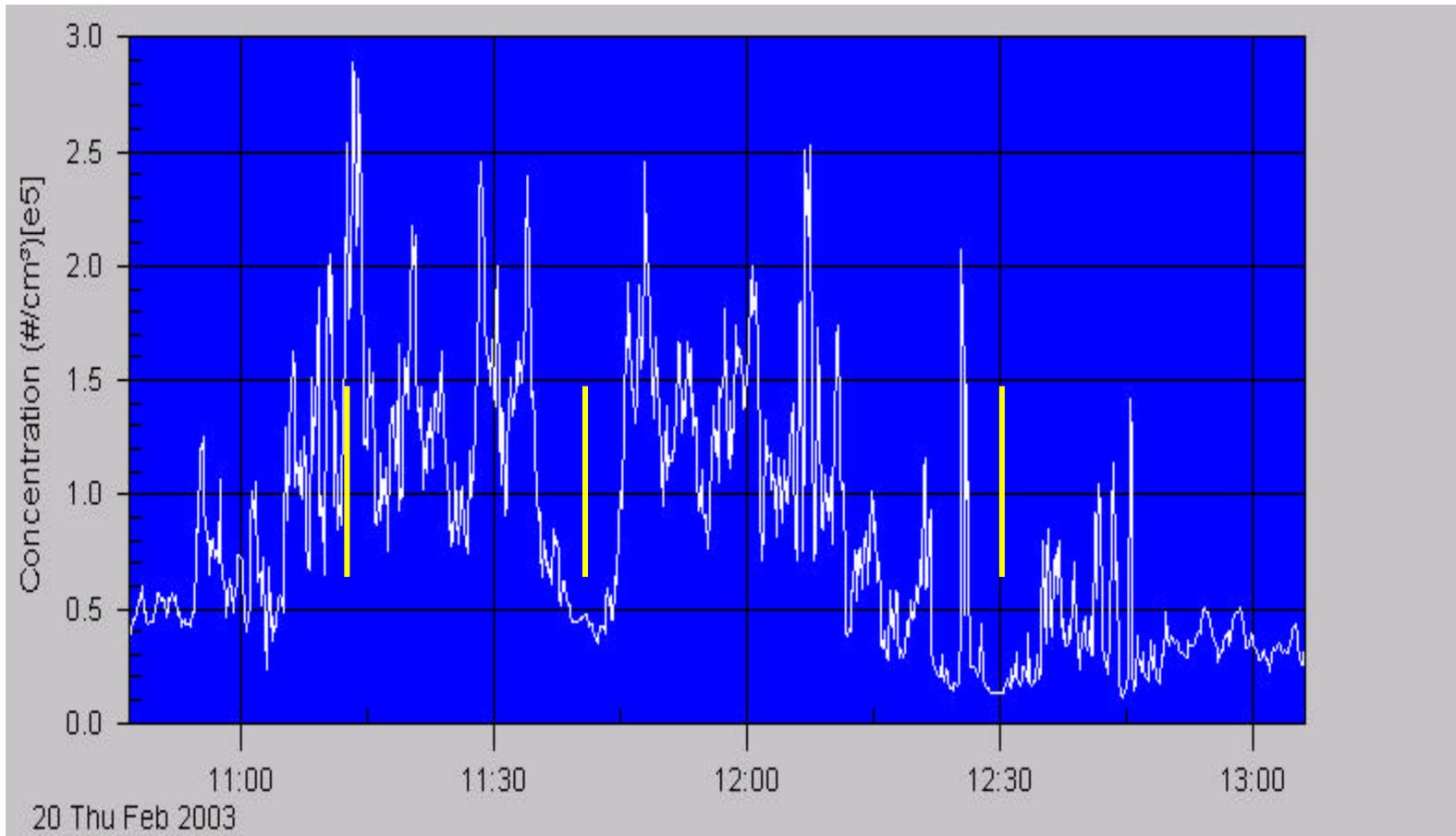
## Freeway Monitoring--Carbon, NO, and EAD



# Freeway Monitoring--UF PM

levels are higher on freeways with diesel trucks

TSI 3007



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# Smoking Truck on Feb. 20



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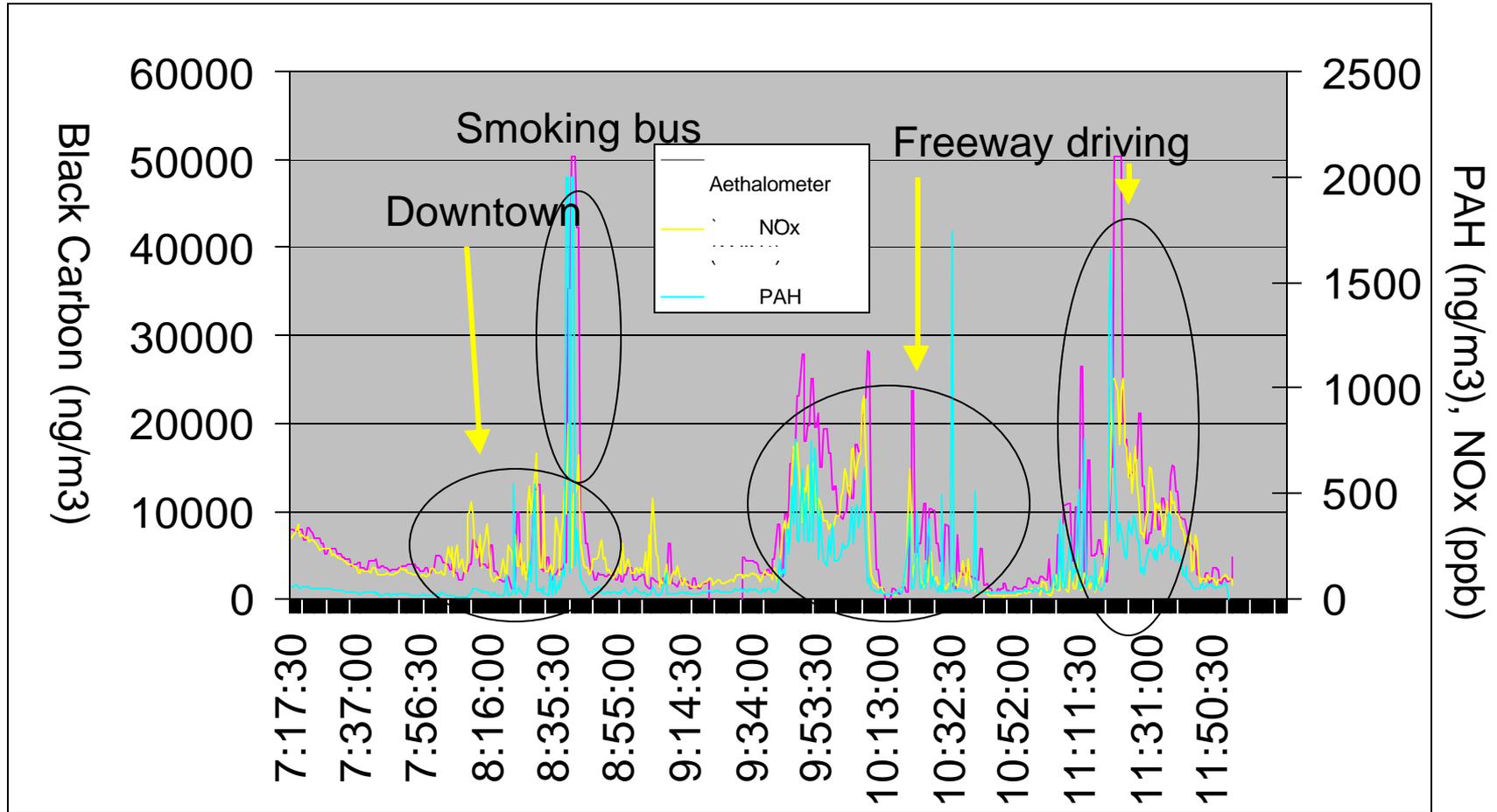
# Clear Skies on I-710

Elevated Ultrafine PM, Black Carbon



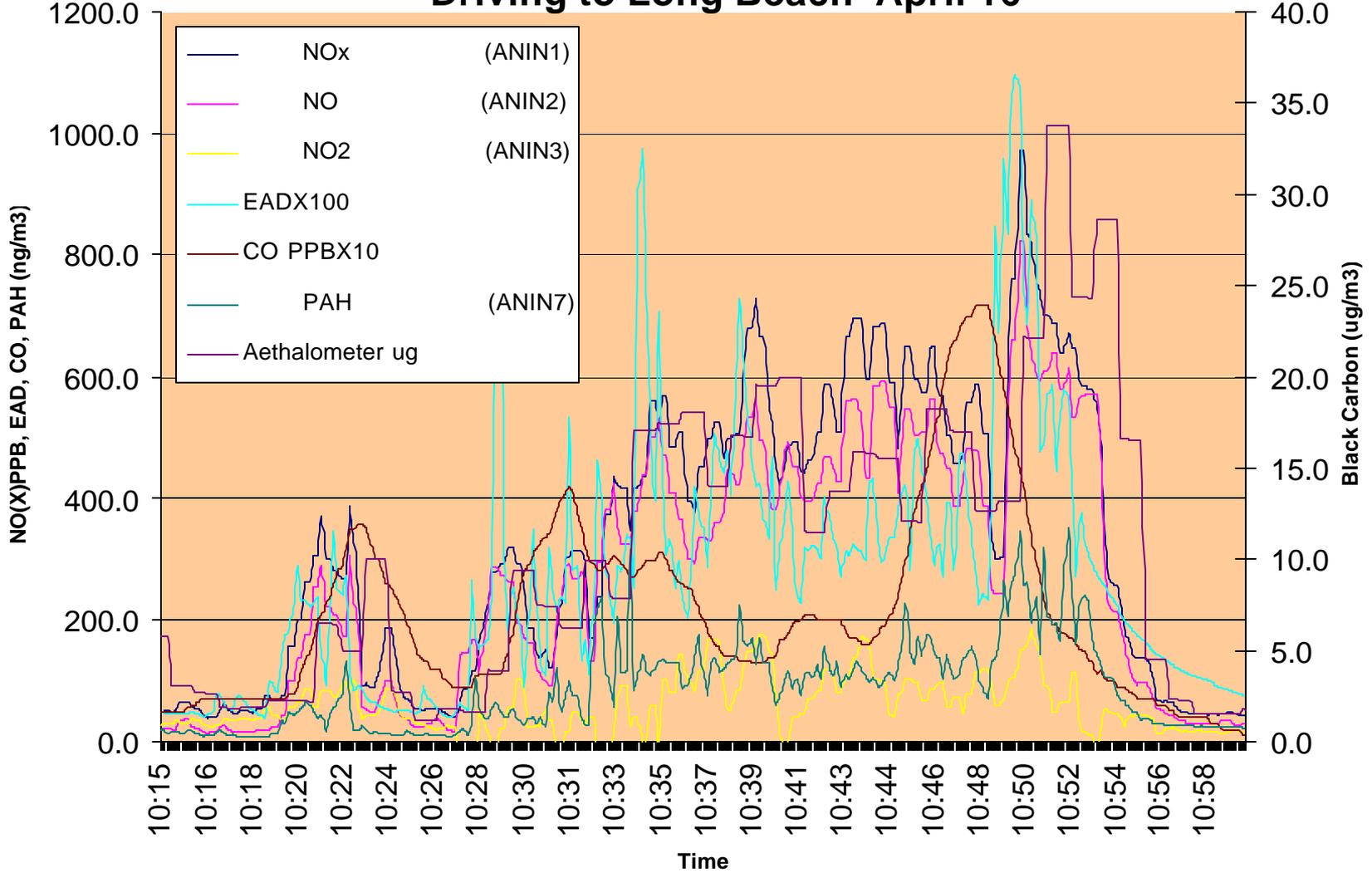
# On Road PAH, Carbon, and NOx

(Diesel trucks and buses emit all 3, gasoline may emit less PAH??)



March 19

# Unadjusted Datalogger Record Driving to Long Beach April 16



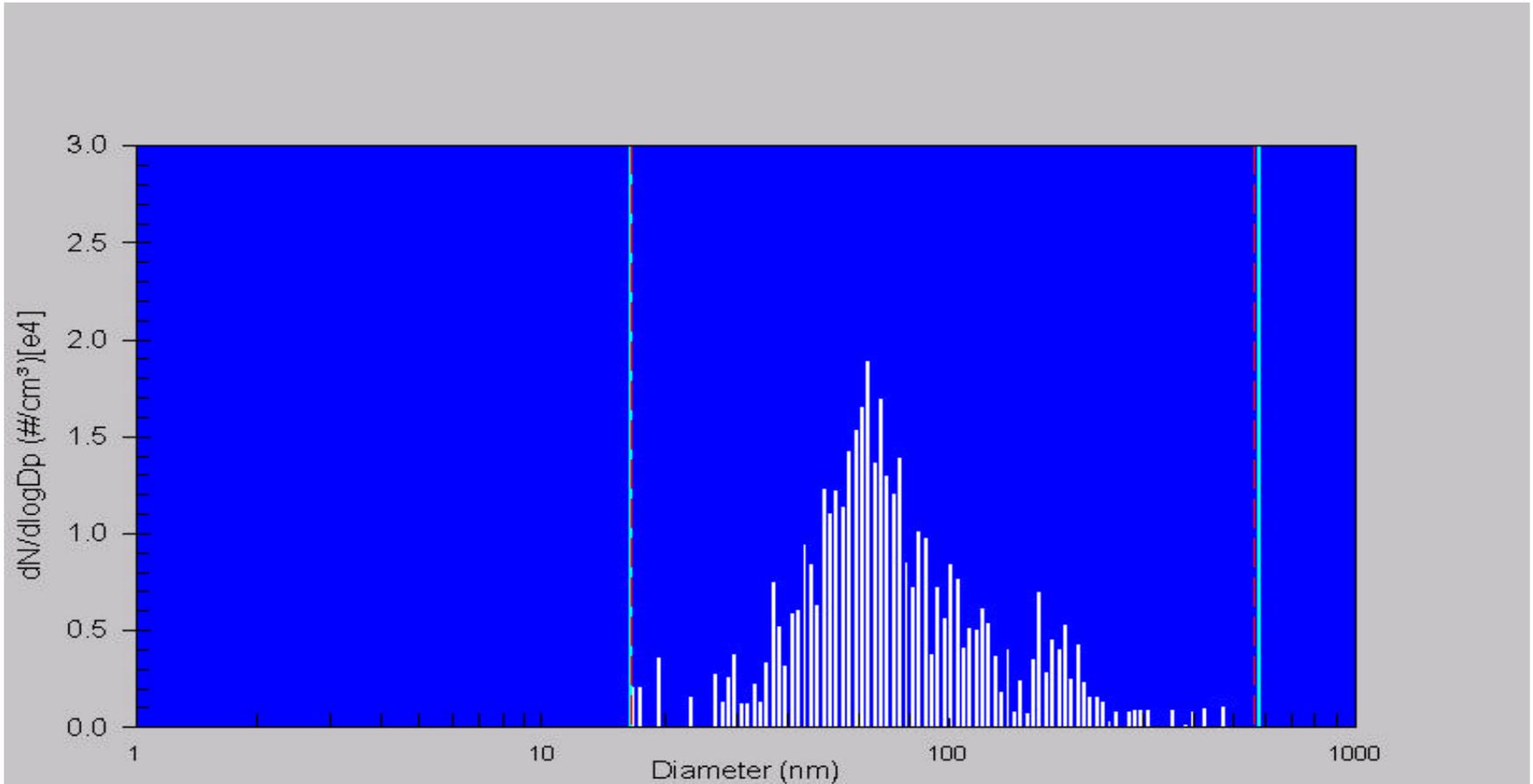
# Ultrafine PM Size Distributions

- Complex Observations
- Novel data for community air
- Limited temporal resolution
- May determine possible health impacts
- Difficult and cumbersome to gather

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# Coastal Air at LAX

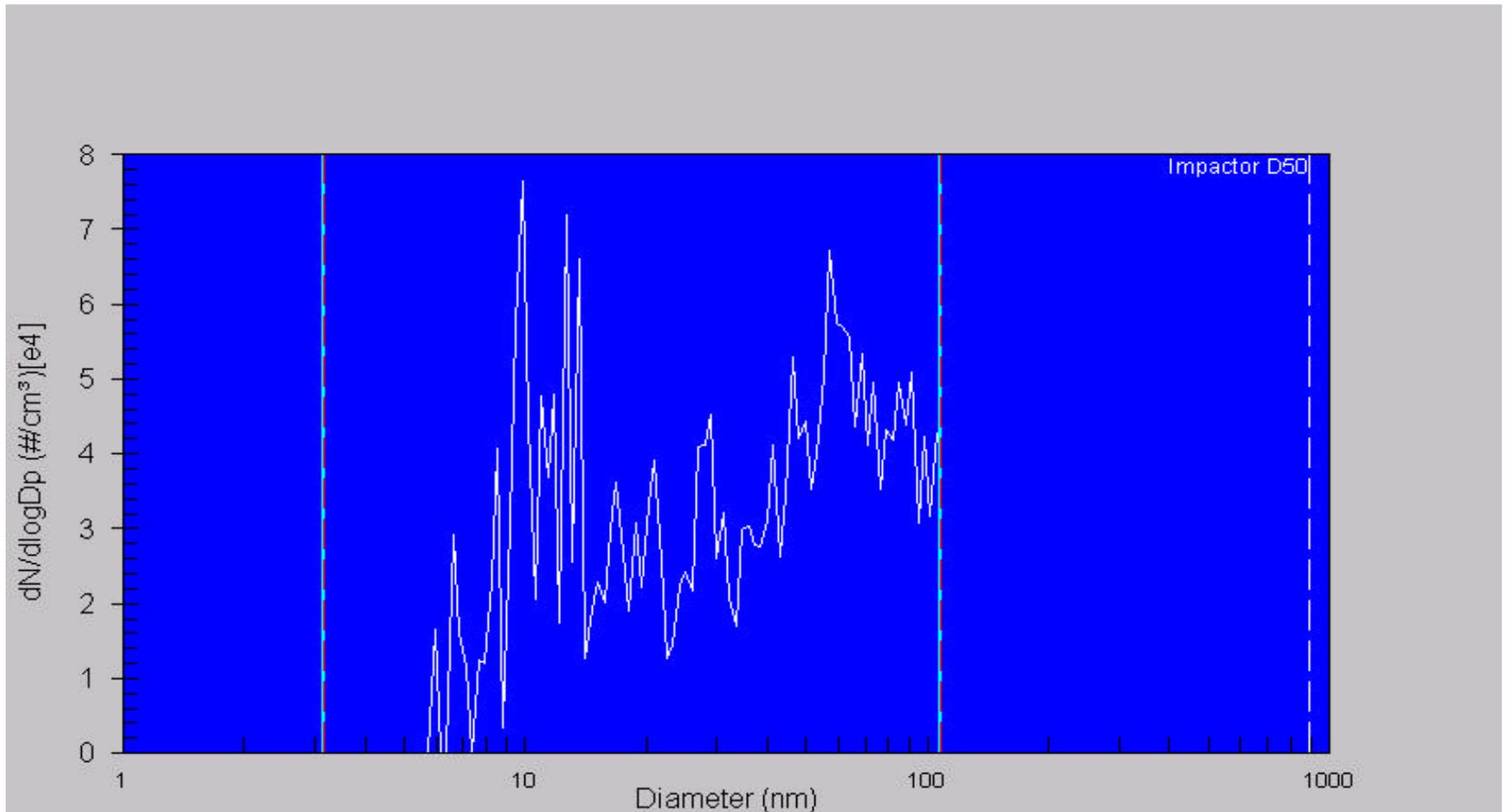
600 particles/cm<sup>3</sup>—large size



April 23

# Ultrafine PM in San Pedro

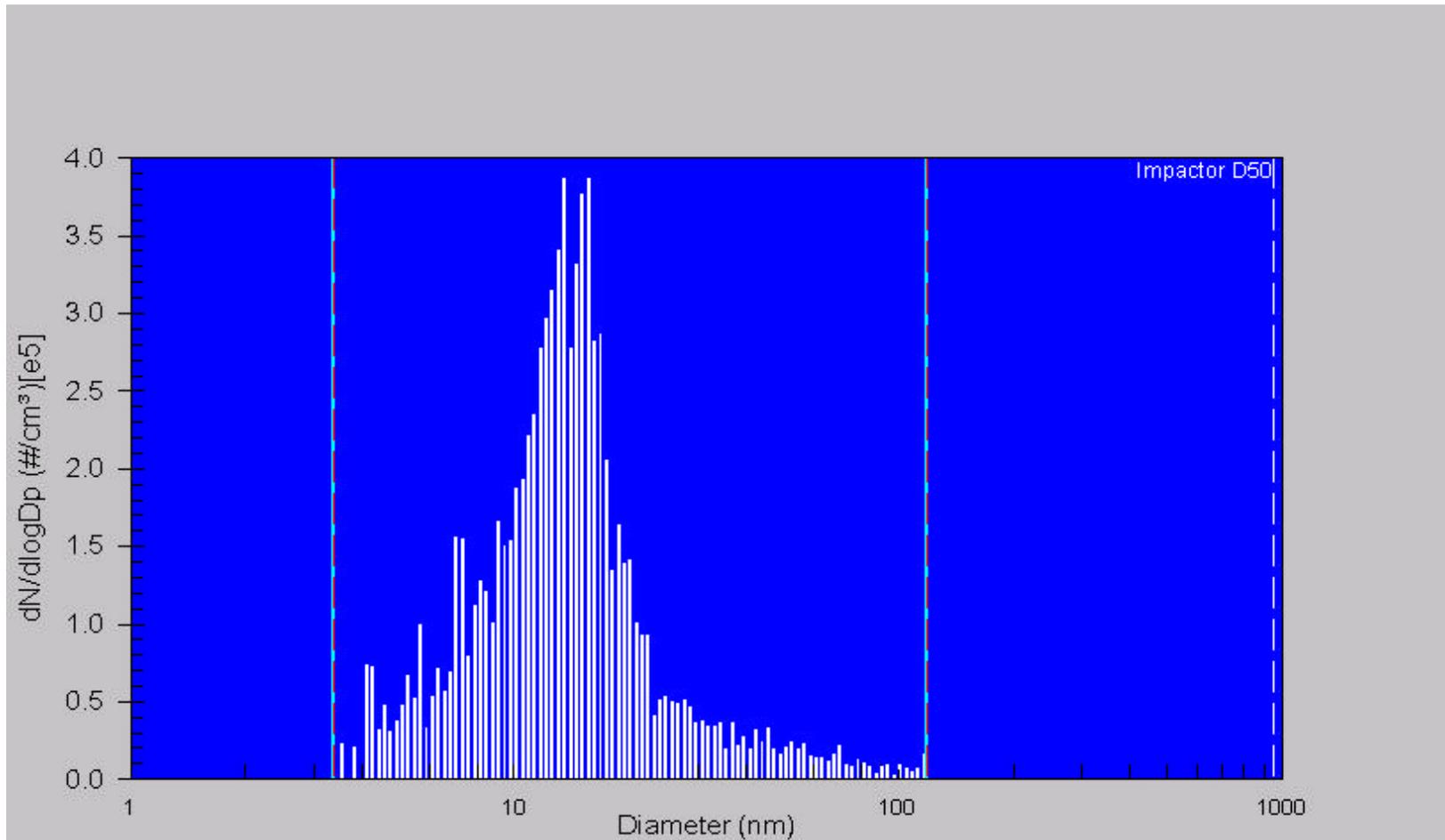
Community Air 42,000 particles/cm<sup>3</sup>—mixed size



March 7

# Freeway 110—No Heavy Diesels

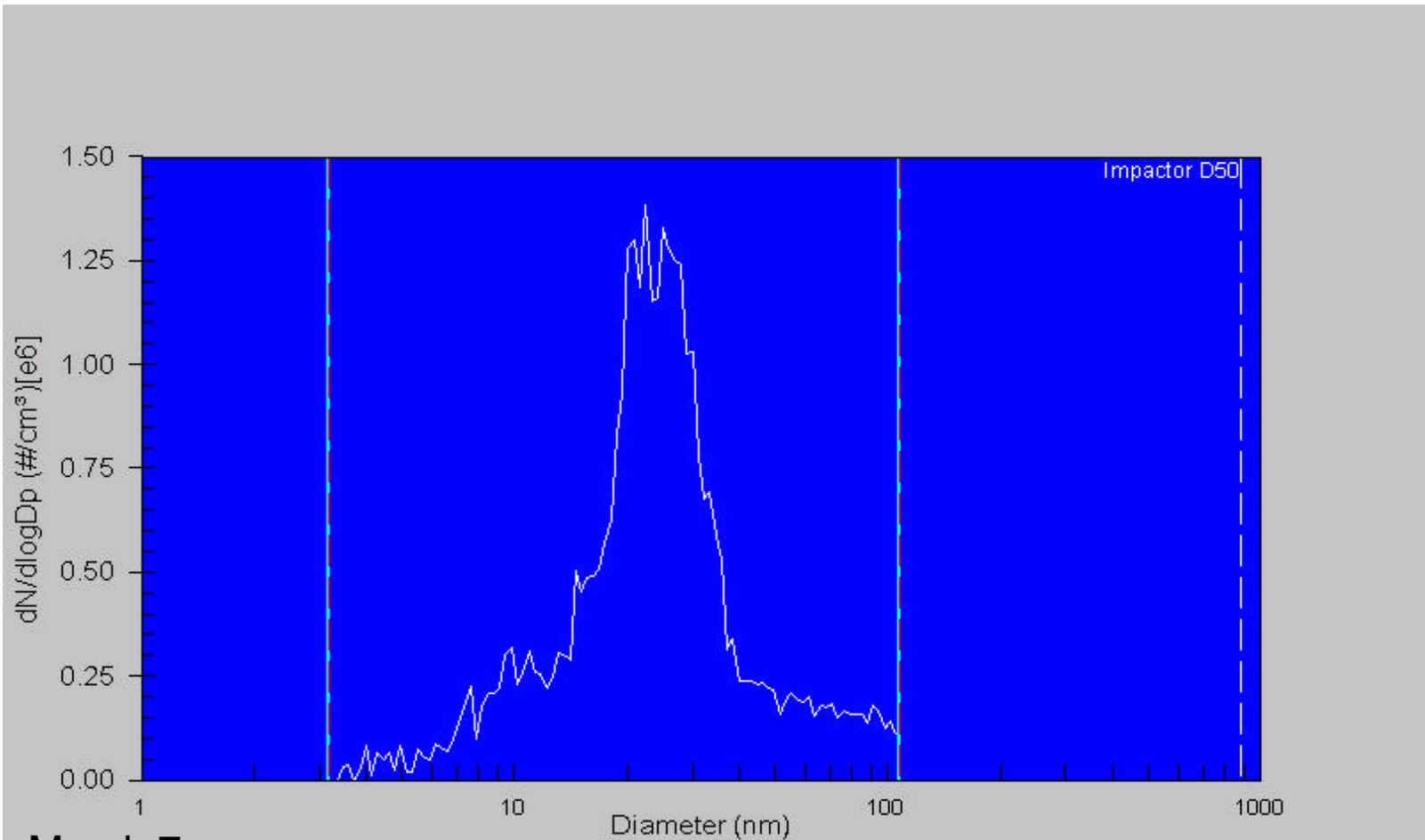
135,000 UF Particles/cm<sup>3</sup>—smaller than 710



Feb. 20

# Ultrafine PM on 710 Freeway

543,000 particles/cm<sup>3</sup>—mostly small



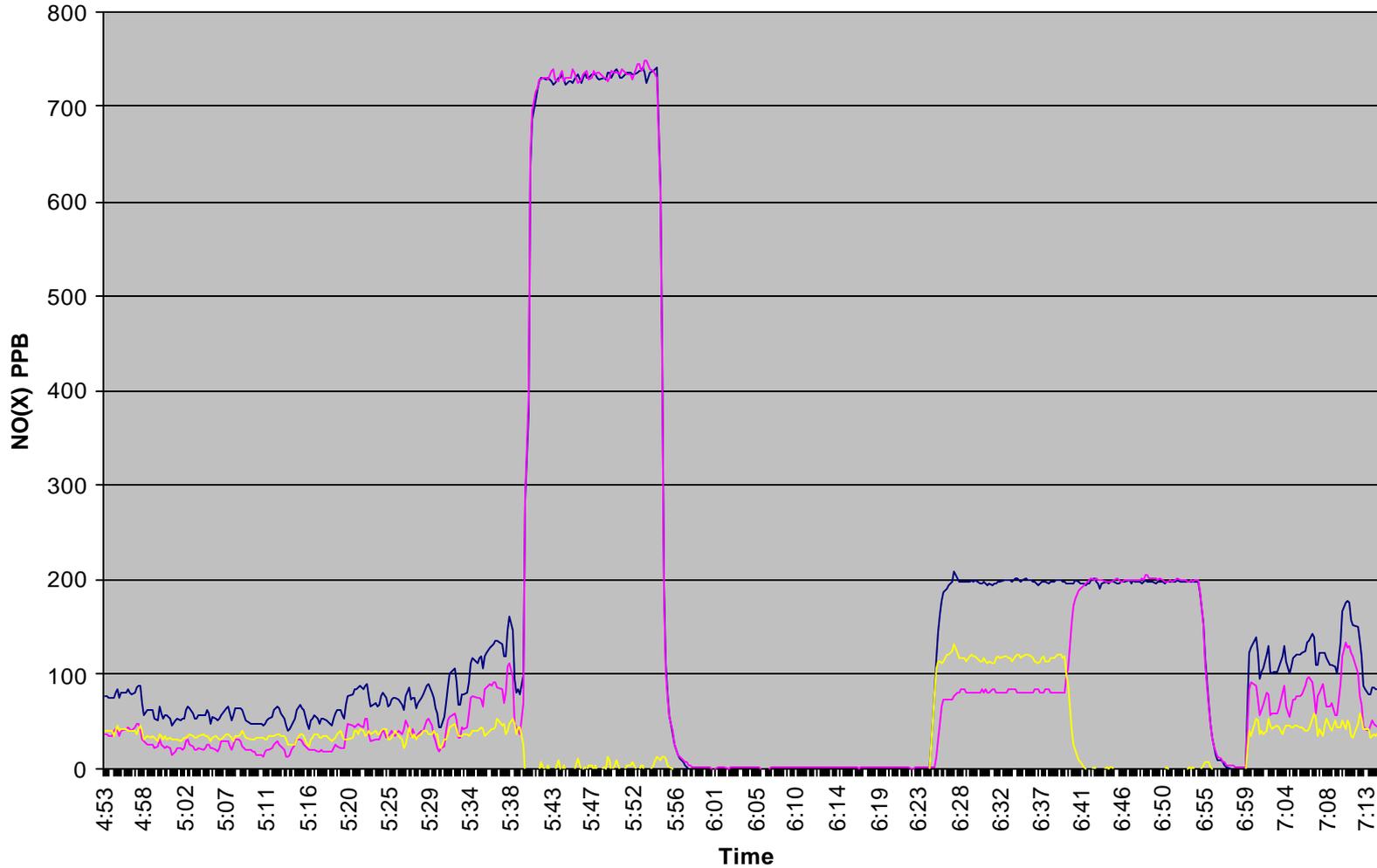
March 7

# Quality Assurance Issues

- Many instruments new to community or on-road monitoring
  - Some very difficult to directly calibrate
  - Some subject to routine calibration techniques
- Instrumental checkups
  - Calibrations on site--CO, NO<sub>x</sub> by SCAQMD
  - Bench testing/calibrations--CO, NO<sub>x</sub> by MLD
  - Flow checks
  - Inter-comparisons
  - Comparisons to Supersite readings

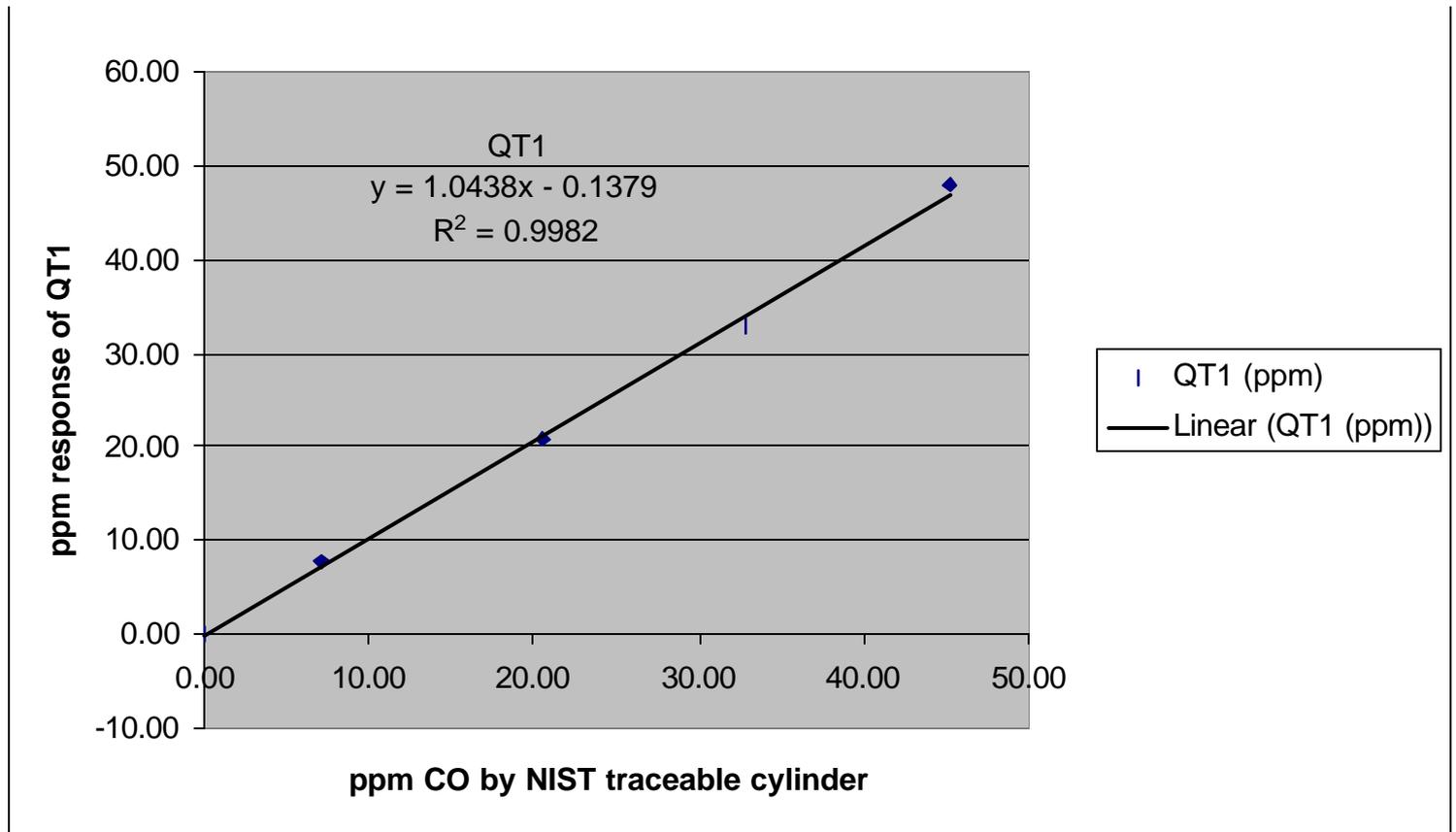
# Mobile Monitoring Project Mobile Monitoring Project

## April 18 Zero Span and Precision Check for NOX Target 750ppb (Zero/Span) 200ppb (Precision)



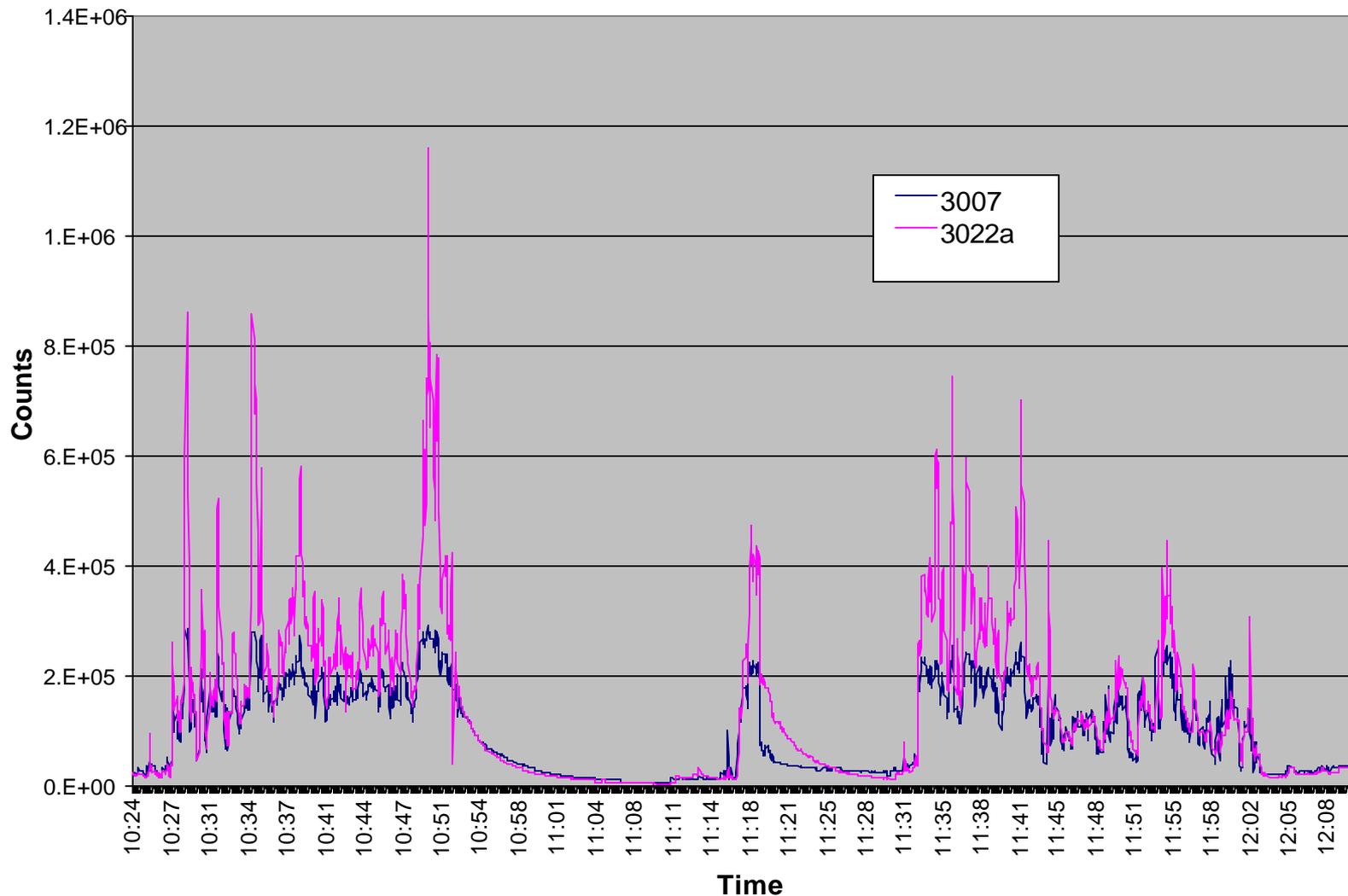
# Calibration of CO Analyzer

## TSI Q-Trak



# Mobile Monitoring Project

## April 24 CPC Comparison



# Mobile Monitoring Project

## A Major Departure From Prior Monitoring

- Accomplishments

- Conceived, designed, and constructed mobile community monitoring facility
- Operated highly advanced instrument package
- Tested performance on highways and in community air
- Coordinated activities with Supersite and USC
- Performed in/outside-vehicle monitoring
- “\$50K” days
- **Cost effective staff effort**

# Feasibility Proven

- Something new almost every day
- System produces quality, time resolved data
- Expands existing data on community UF PM
- The freeway as a community
- In-vehicle exposures on highways assessed

# Key Areas Under Study

Traffic speed

Traffic composition

Traffic density

CNG buses

Arterial emissions

LAX operations

Instrument comparisons

NO(x)

Particle size

Community levels

In-vehicle levels

Industrial sources

Weekday/Weekend

Air purifiers

NOX/CO/CO2/BC

Compare to fixed sites

# Applications

## How can upcoming data be used?

- By atmospheric scientists
- By exposure assessors
- By health risk assessors
- By air modelers
- For UF hot spot identification
- By community monitoring groups
- By emission estimators

# What's Next??

Evaluate results, prepare publications

Secure funding for continued operations

## Future Investigations

- Summer/Fall conditions
- Other communities—more port studies, inland
- Other questions—organic constituents, trajectories
- Spatial complexity issues
- Compare results to prior studies

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# Thanks

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