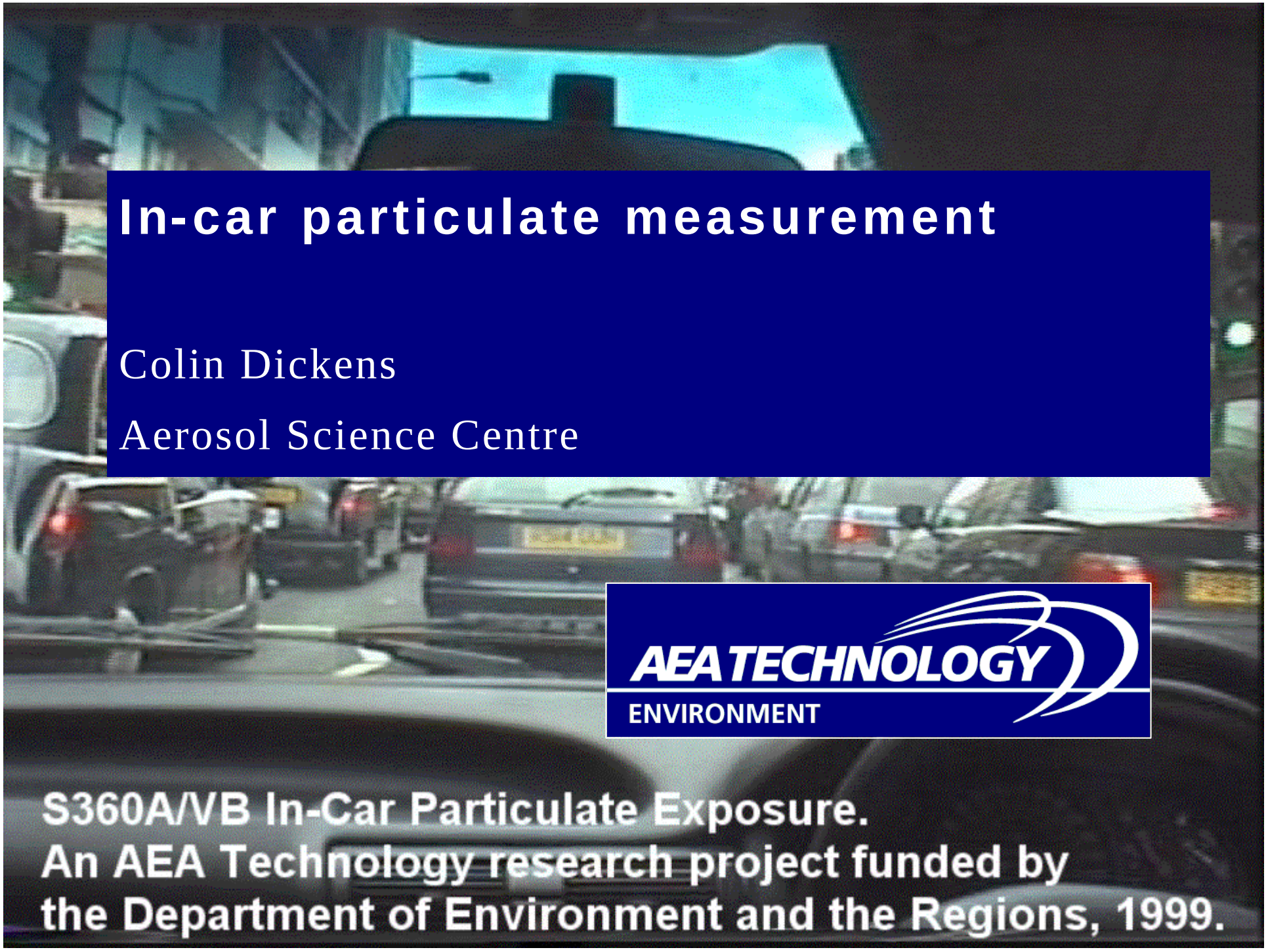
C. Dickens
AEA Technology
Abingdon
England

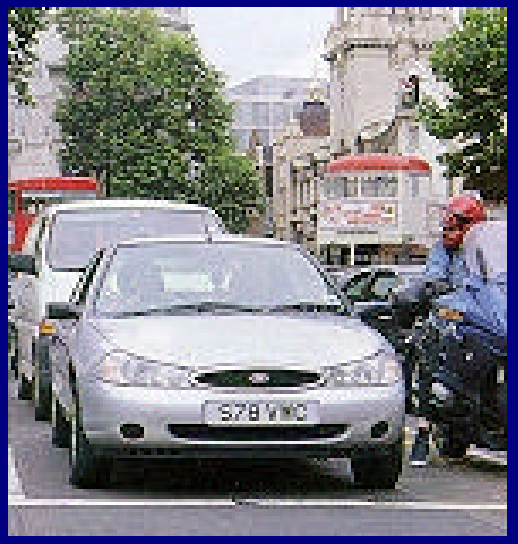


# In-cabin particle exposure from vehicle emissions


In-car particulate measurement
Colin Dickens
Aerosol Science Centre
AEA TECHNOLOGY
ENVIRONMENT
S360A/VB In-Car Particulate Exposure.
An AEA Technology research project funded by
the Department of Environment and the Regions, 1999.

# In-car particulate exposure Objectives

- Measure in-car pollution for commuter journeys
- Weather effects
- Road type and traffic conditions
- Ventilation (heater, windows etc)
- Filters
- Vehicle ahead
- Remedial action?



DETR

Department of the Environment, Transport and the Regions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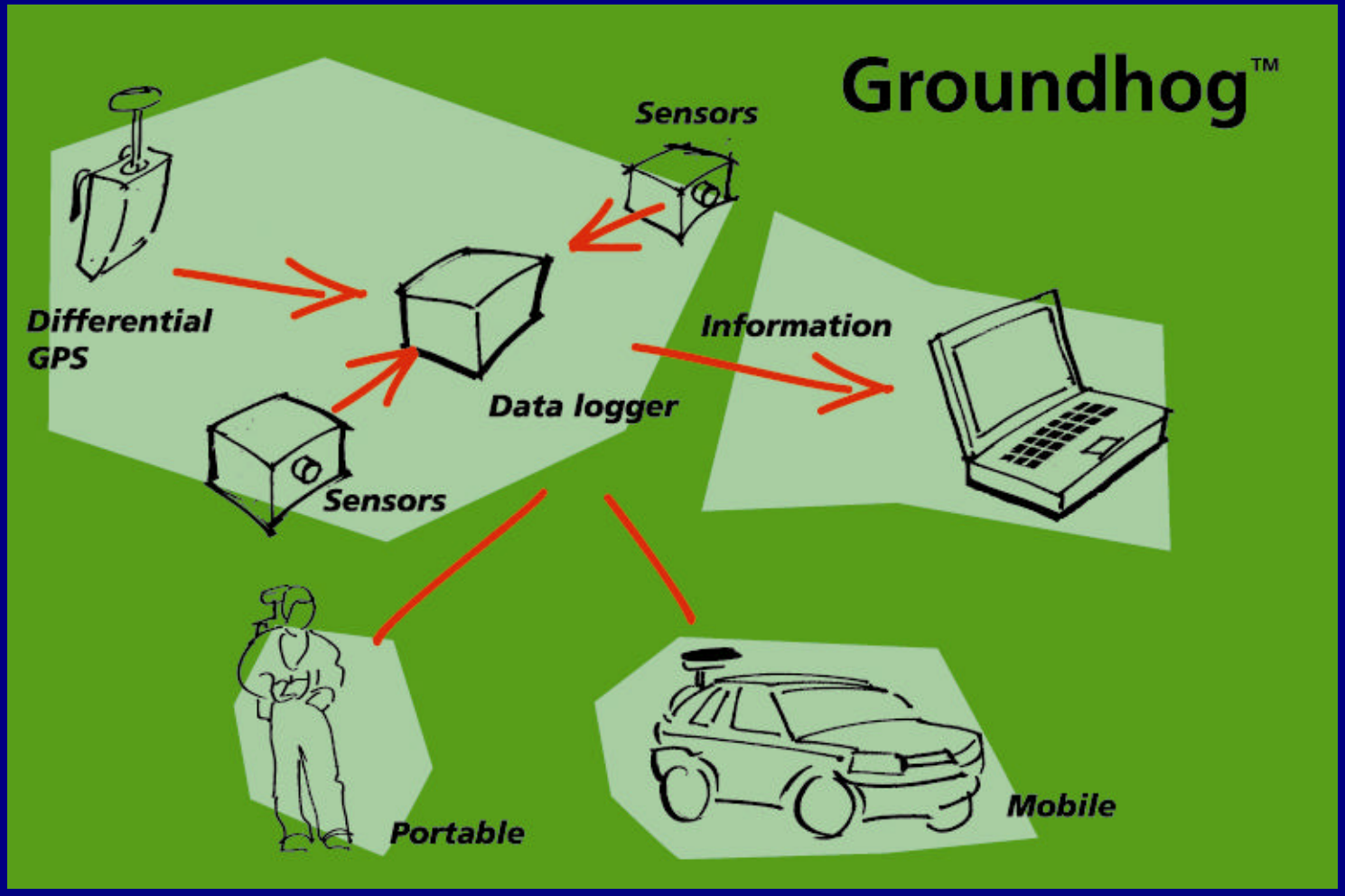
# What is Groundhog?





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# In-car particulate exposure

## *Project Stages*

- Equip test vehicle:
  - particle number & mass
  - $NO_2$ & CO
  - GPS positional data
  - Video
  - Road/car conditions
- Measure over several commuter trips
- Analyse data

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# Condition Logging

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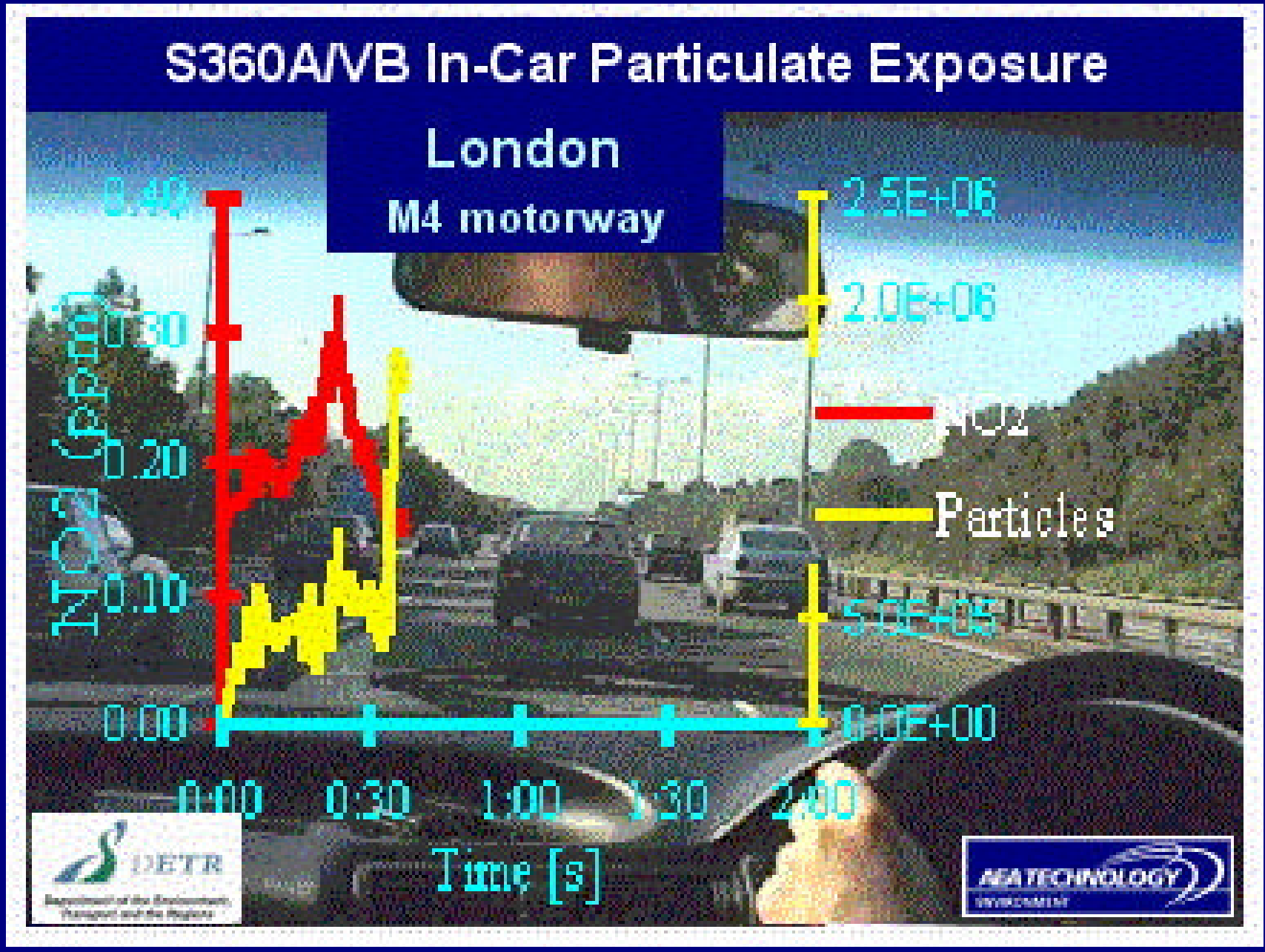
# London to M4


S360A/VB In-Car Particulate Exposure
London
M4 motorway
0.40
0.30
0.20
0.10
0.00
NO2 (ppm)
2.5E+06
2.0E+06
NO2
Particles
5.0E+05
0.0E+00
0:00
0:30
1:00
1:30
2:00
Time [s]
DETR
AEA TECHNOLOGY

# Data Reporting

- 15 days testing, average of 5 hours testing per day, at 1s time resolution
- 180,000 data points x 22 parameters
- Resolved to ‘event’ periods
- 22,000 data event points x 22 parameters
- Database format, allows queries and correlations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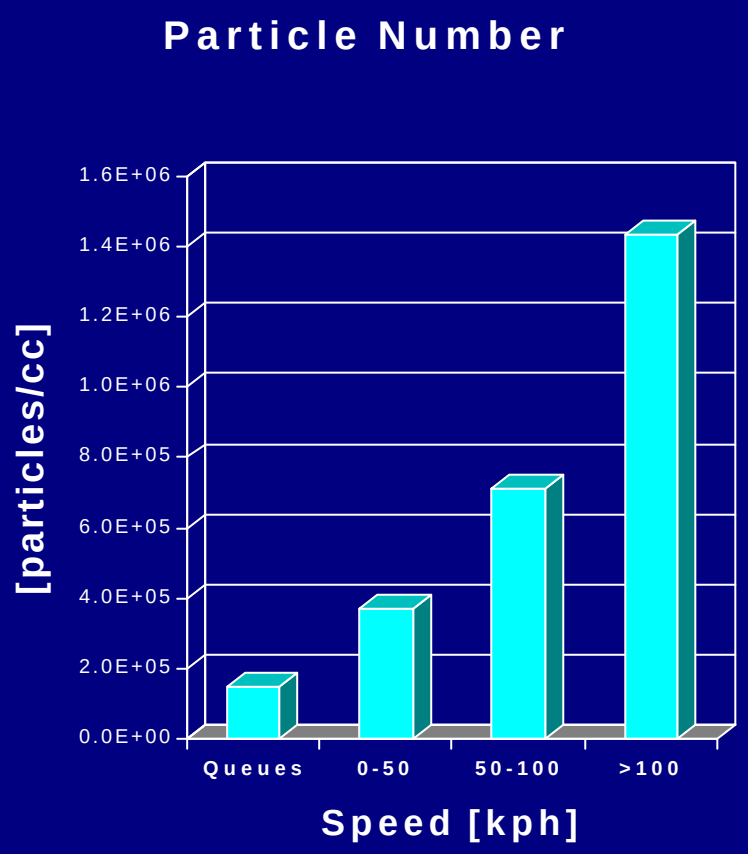
# Traffic Speed




- Strong correlation between particle number and speed
- No correlation of $NO_2$, CO or particle mass with speed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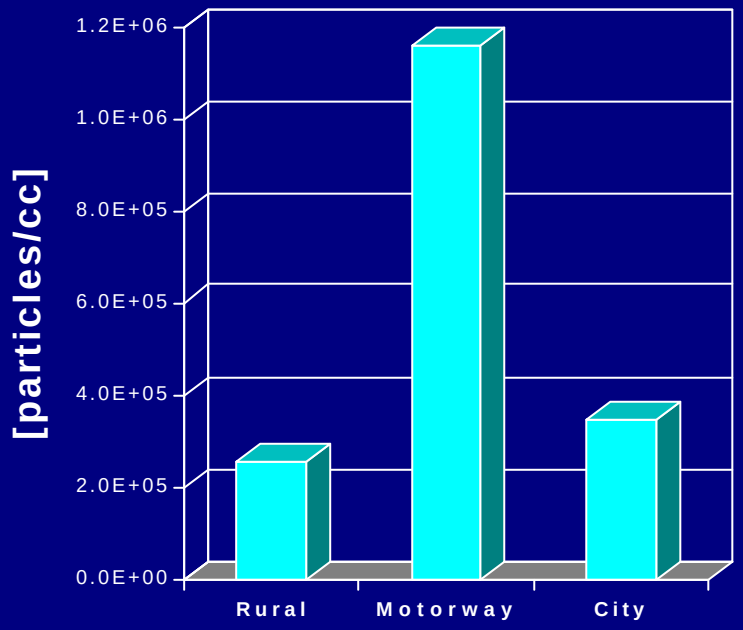
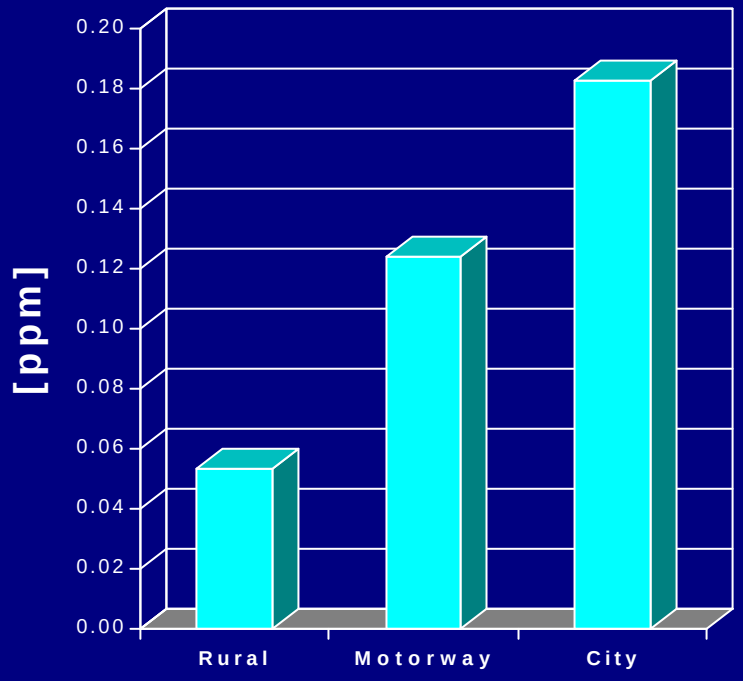
# Road Type - Rural/Motorway/City

## Particle Number




## NO2 Concentration





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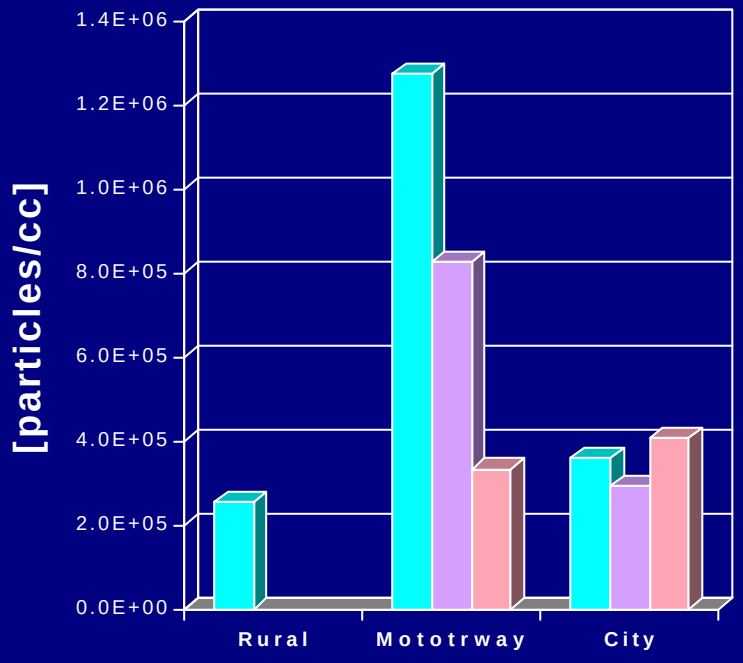
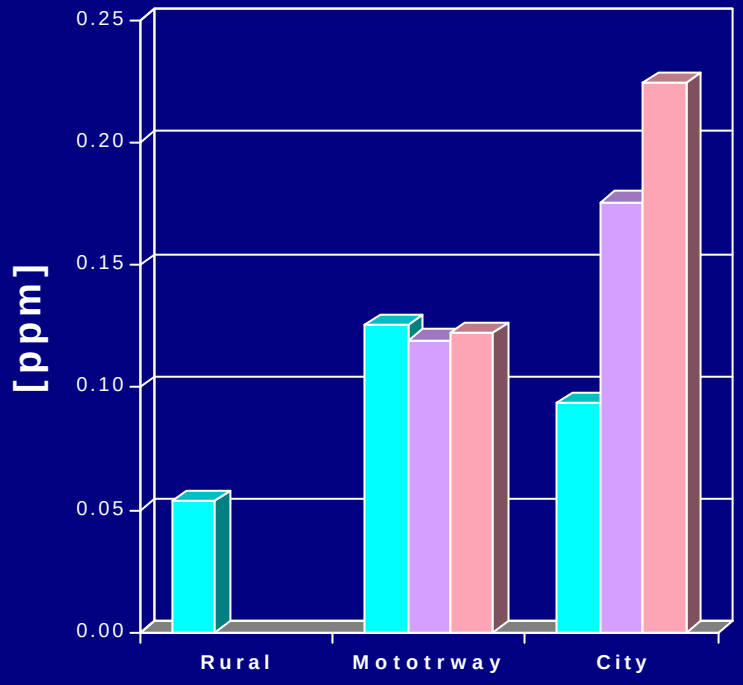
# Traffic Density

## Particle Number




## NO2 Concentration




Light Heavy Congested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# Pollution Levels

- High pollution levels in vehicles
- $NO_2$ and CO higher than roadside measurements
- PM same as roadside measurements
- Ultrafine 2 orders of magnitude higher than background
- Average $NO_2$ and CO levels higher that AQS 2005 targets

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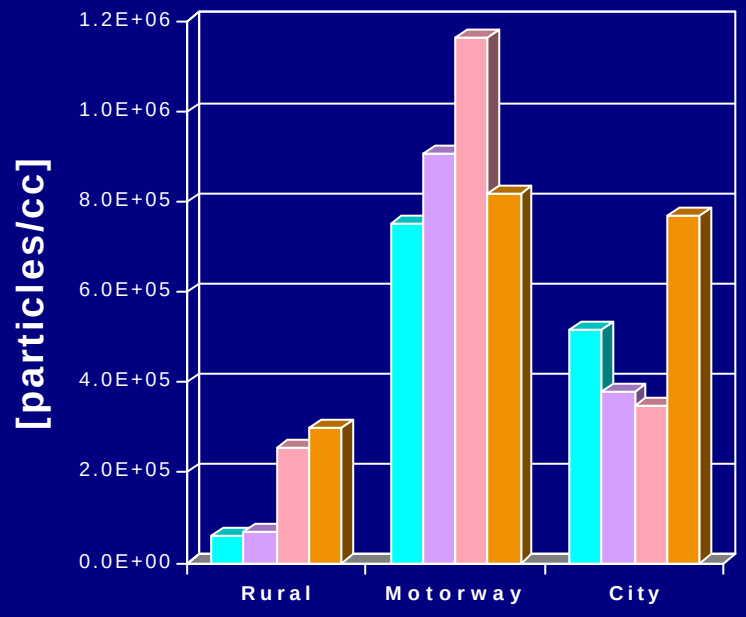
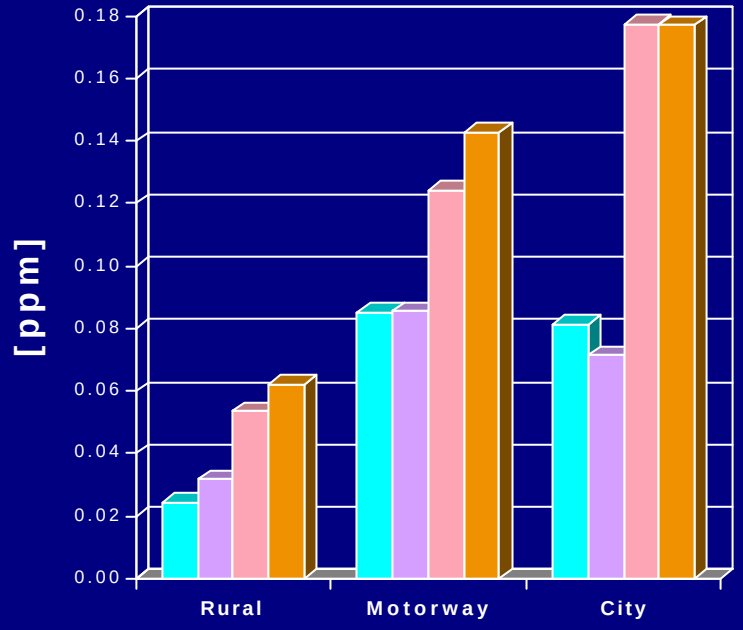
# Car Conditions

## Particle Number




## NO2 Concentration




No Ventilation
Aircon
Heater
Window Open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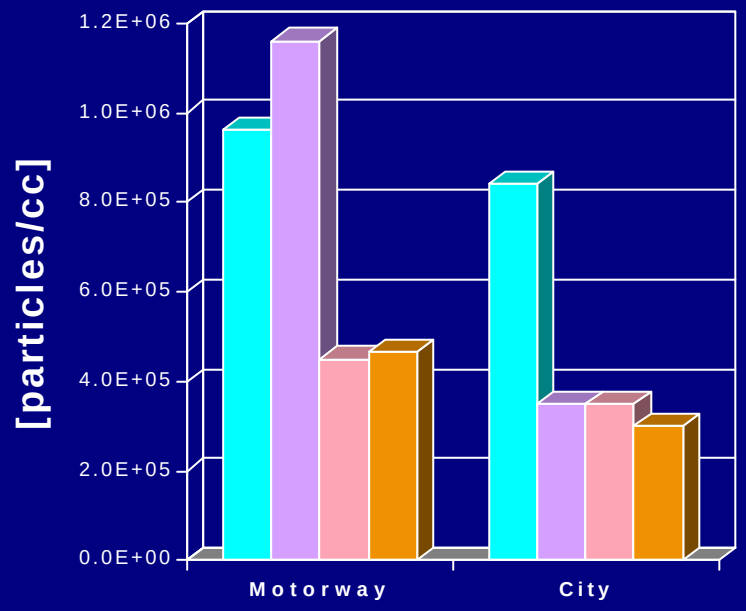
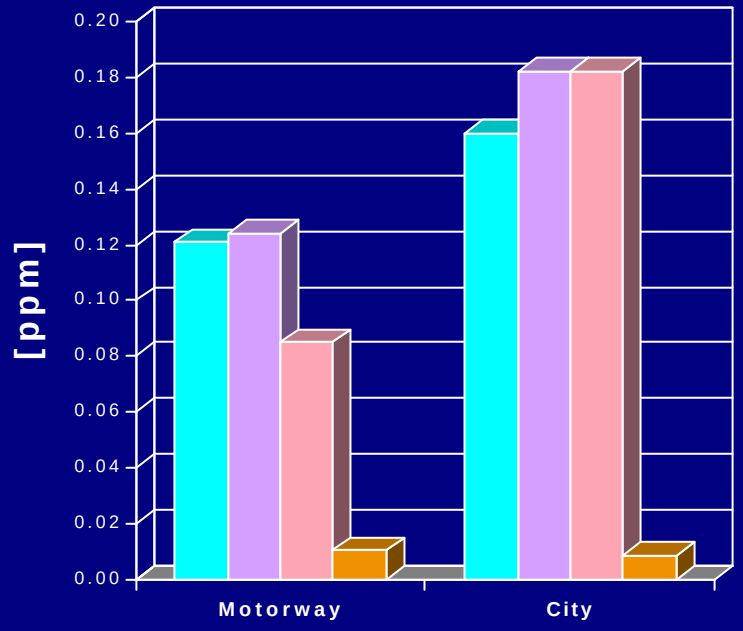
# Air Filters

## Particle Number




## NO2 Concentration




No Filters
Pollen Filters
Particle Filters
NOx Filters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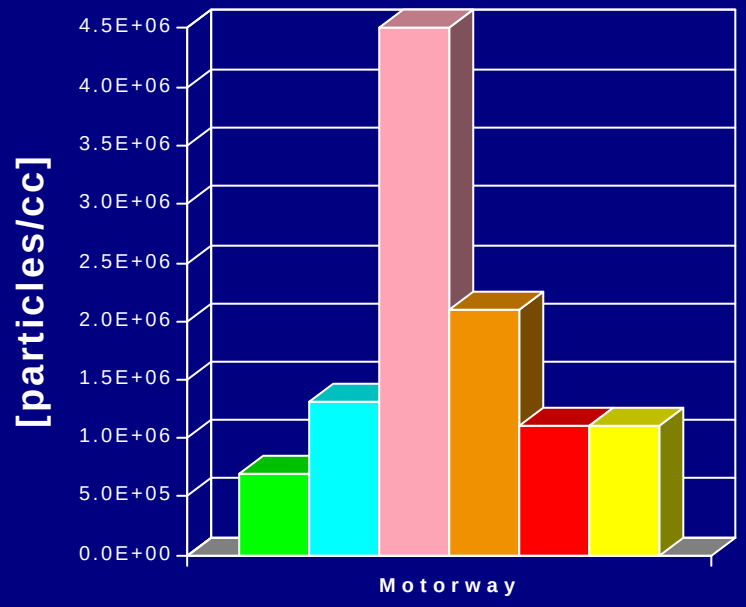
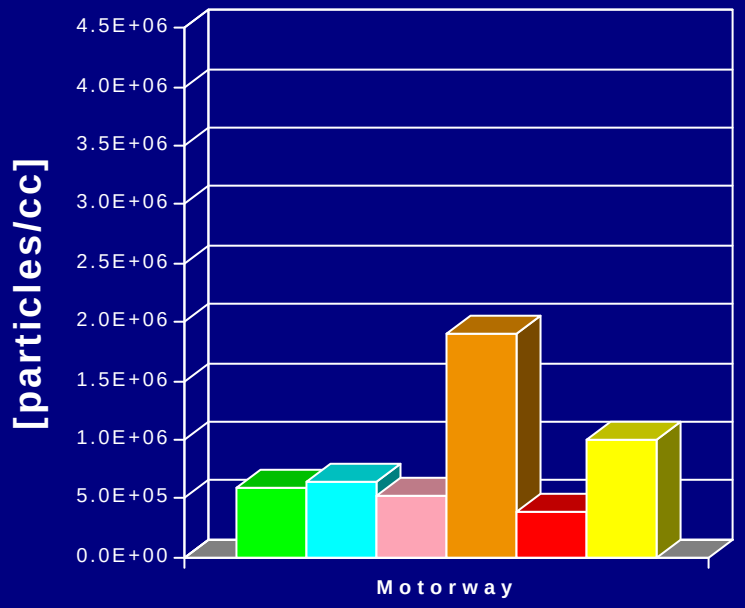
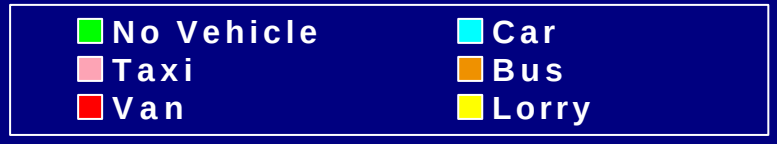
# Vehicle Ahead - Type

## Particle Number - Mean




## - Median





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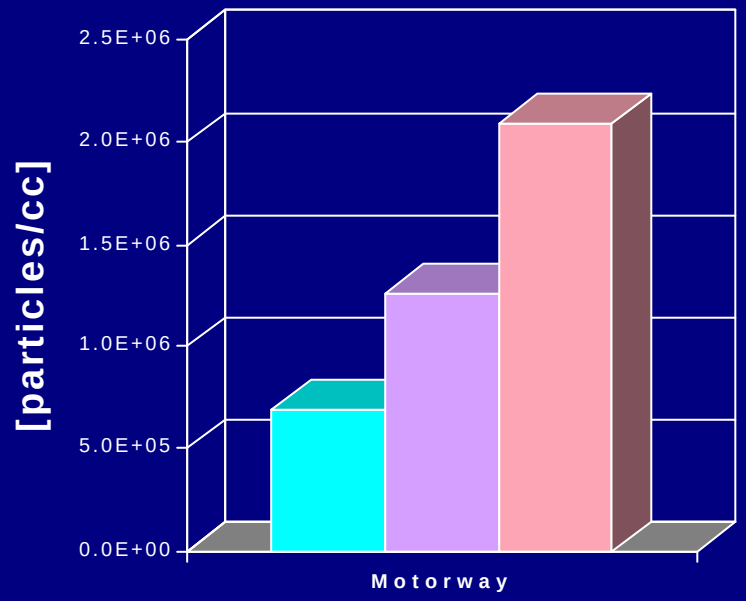
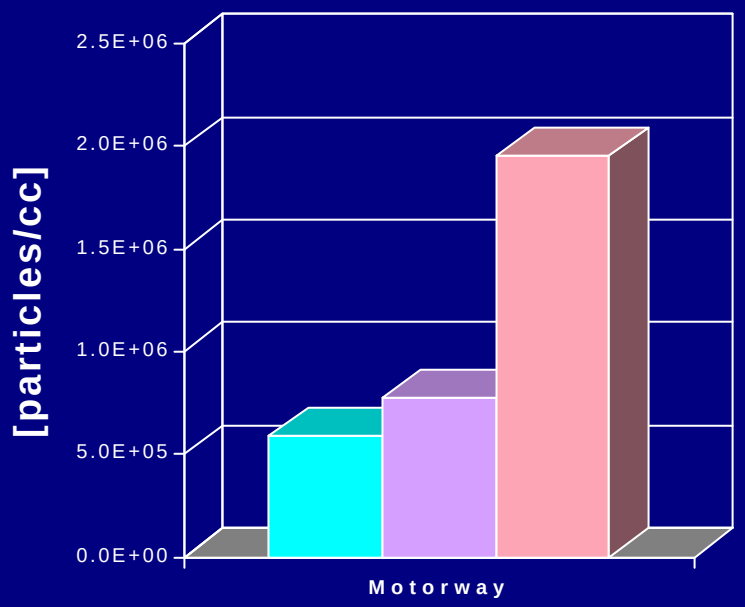
# Vehicle Ahead - Fuel Type

## Particle Number - Mean




## - Median




No Vehicle  Gasoline  Diesel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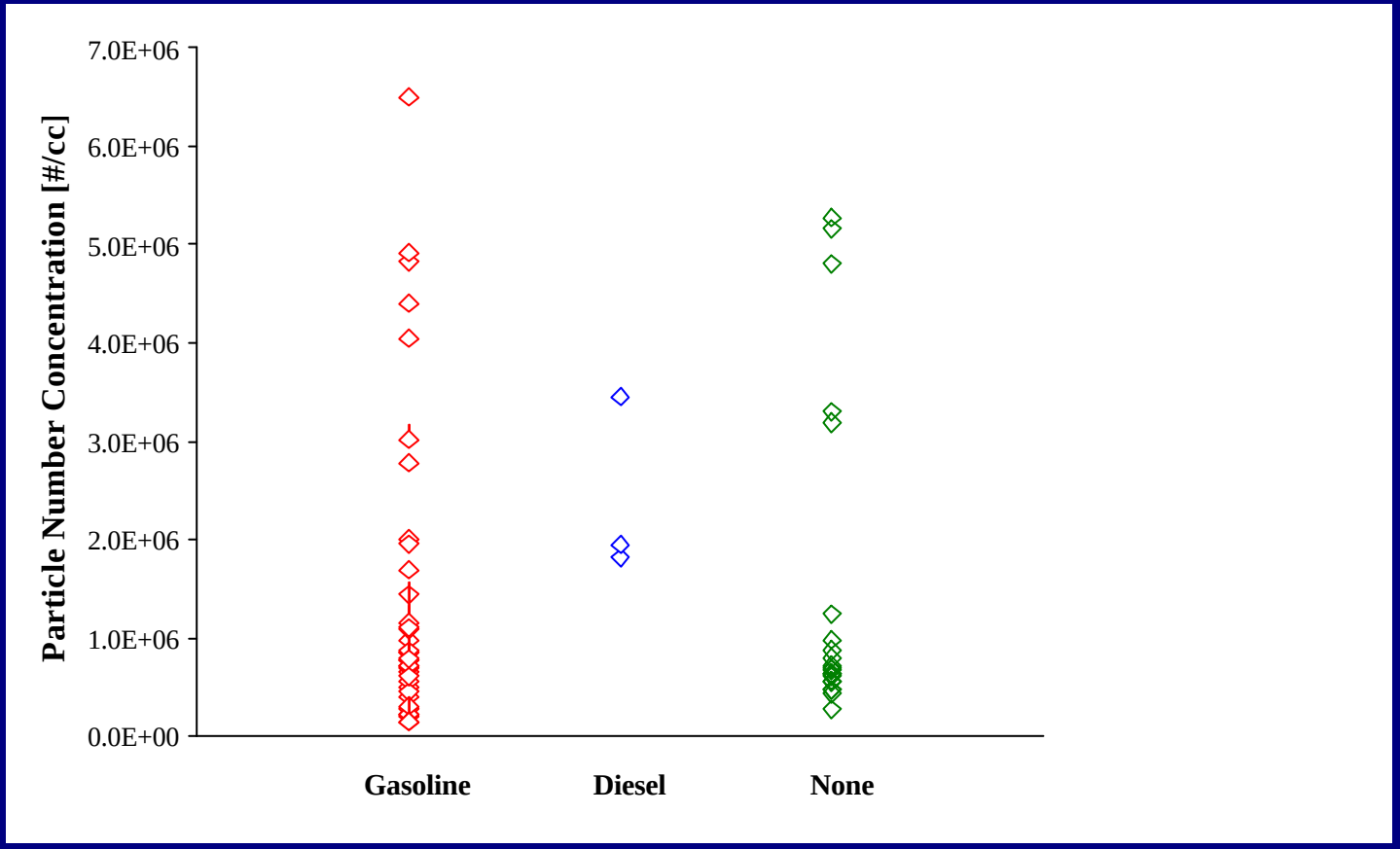
# Particle Number Scatter





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# Conclusions - In-car

- High levels of pollutants found in-car
- Highest level of ultra-fines from motorway
- Highest level of $NO_2$ and CO in city, higher than data from nearby AQN site
- Levels of $NO_2$ in city and on motorway exceed 0.105ppm 1 hour average 2005 AQS target
- Ultra-fines increase with speed
- Diesel ultra-fine higher than gasoline
- Evidence of high gasoline emitters/events


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# Reducing pollution levels

- No ventilation/re-circulating air reduces exposure to pollutants but increases $CO_2$ and reduces $O_2$
- Closed window in city reduces ultra-fine particulate in car
- NOx filter reduces $NO_2$ levels by order of magnitude
- A good particulate filter would reduce ultra-fine

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