

DIURNAL VARIATIONS IN ROADSIDE PARTICLE SIZE DISTRIBUTIONS

By

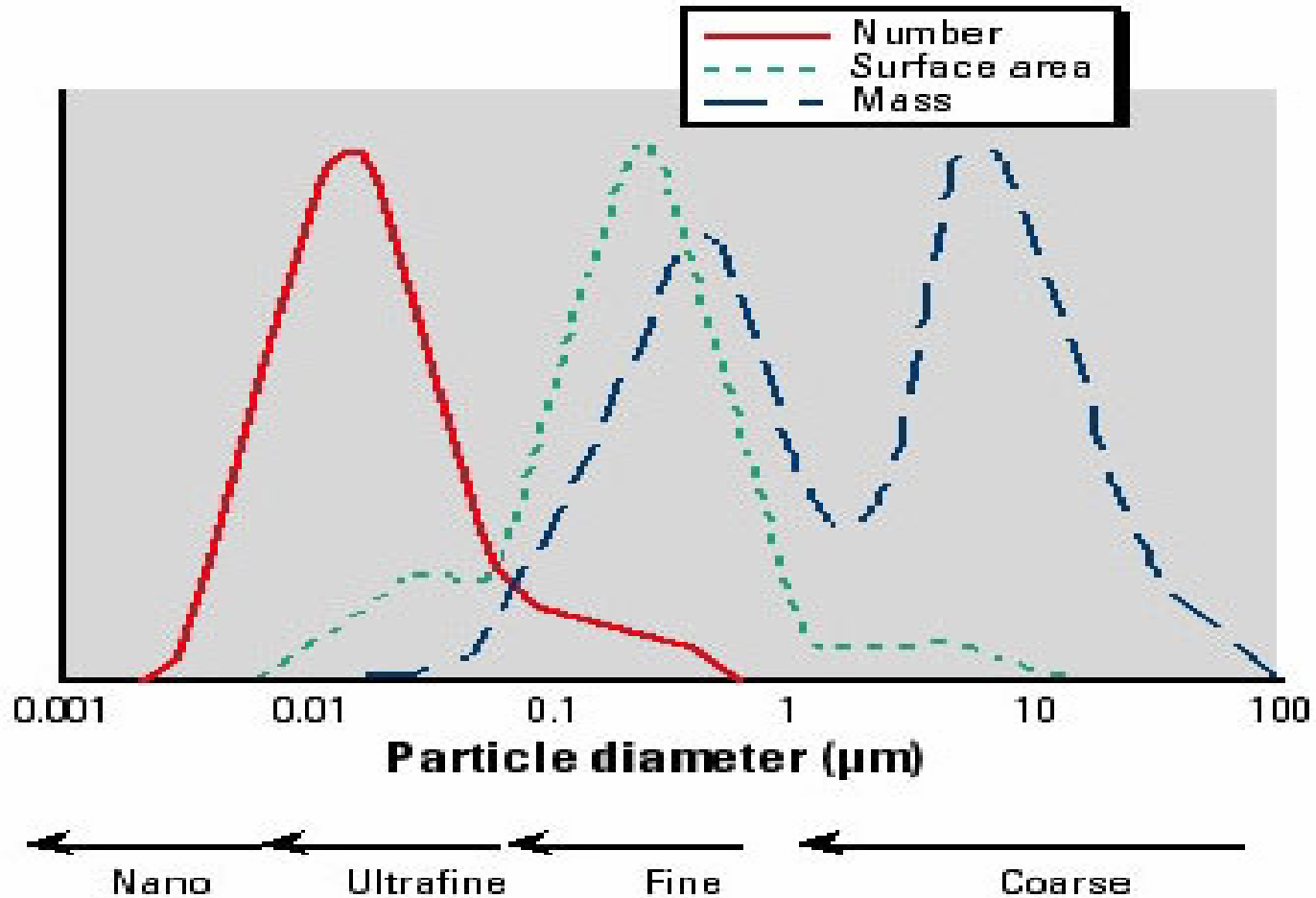
David Young

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University of Leeds

Introduction

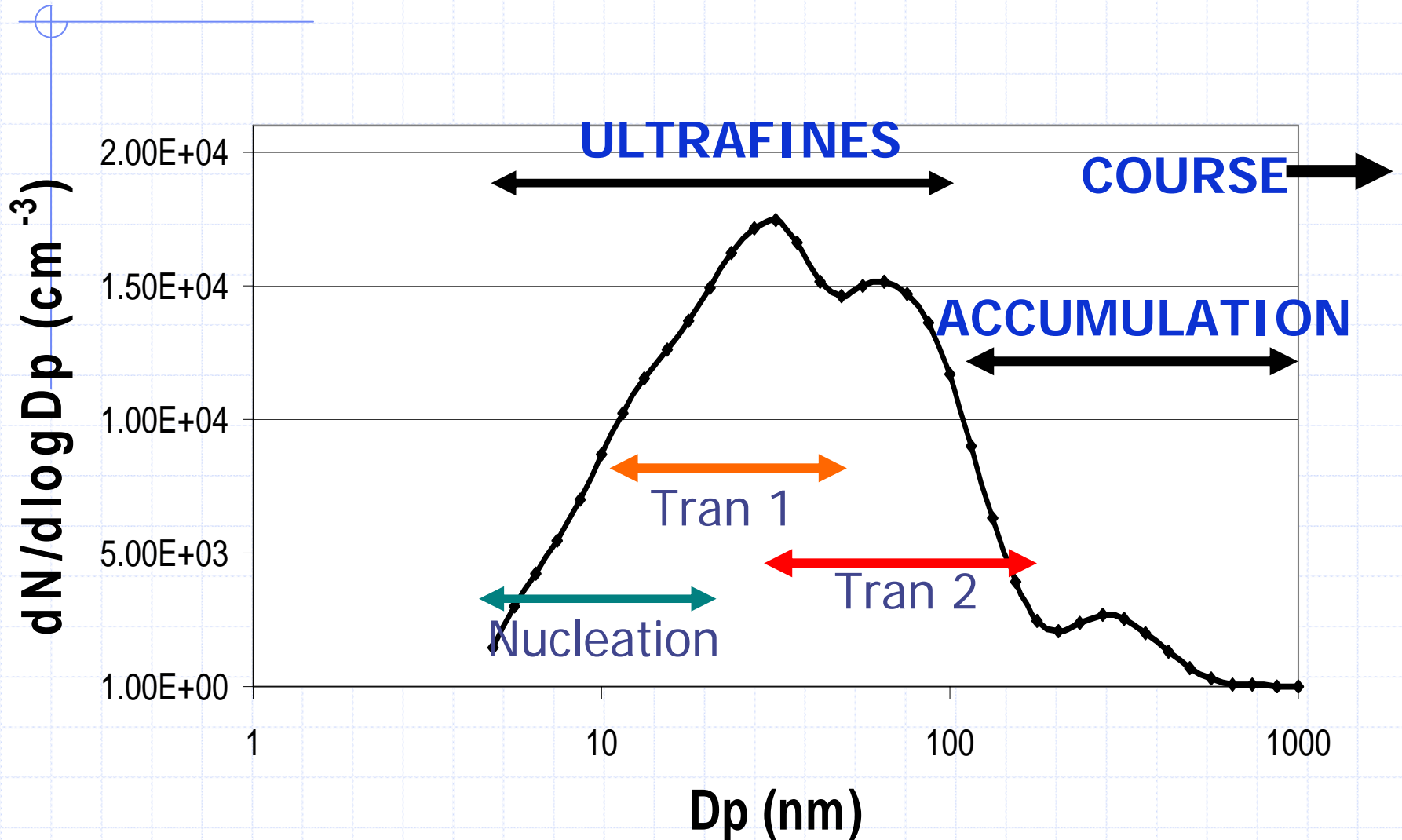
- ◆ Adverse health effects of particulate matter shown by a wide range of epidemiological and toxicological studies
- ◆ Widely hypothesised that the smallest (ultrafine) particles are responsible for toxic effects on body
- ◆ Smallest particles not covered by current legislative standards

Introduction



Source, Oberdorster, 2002

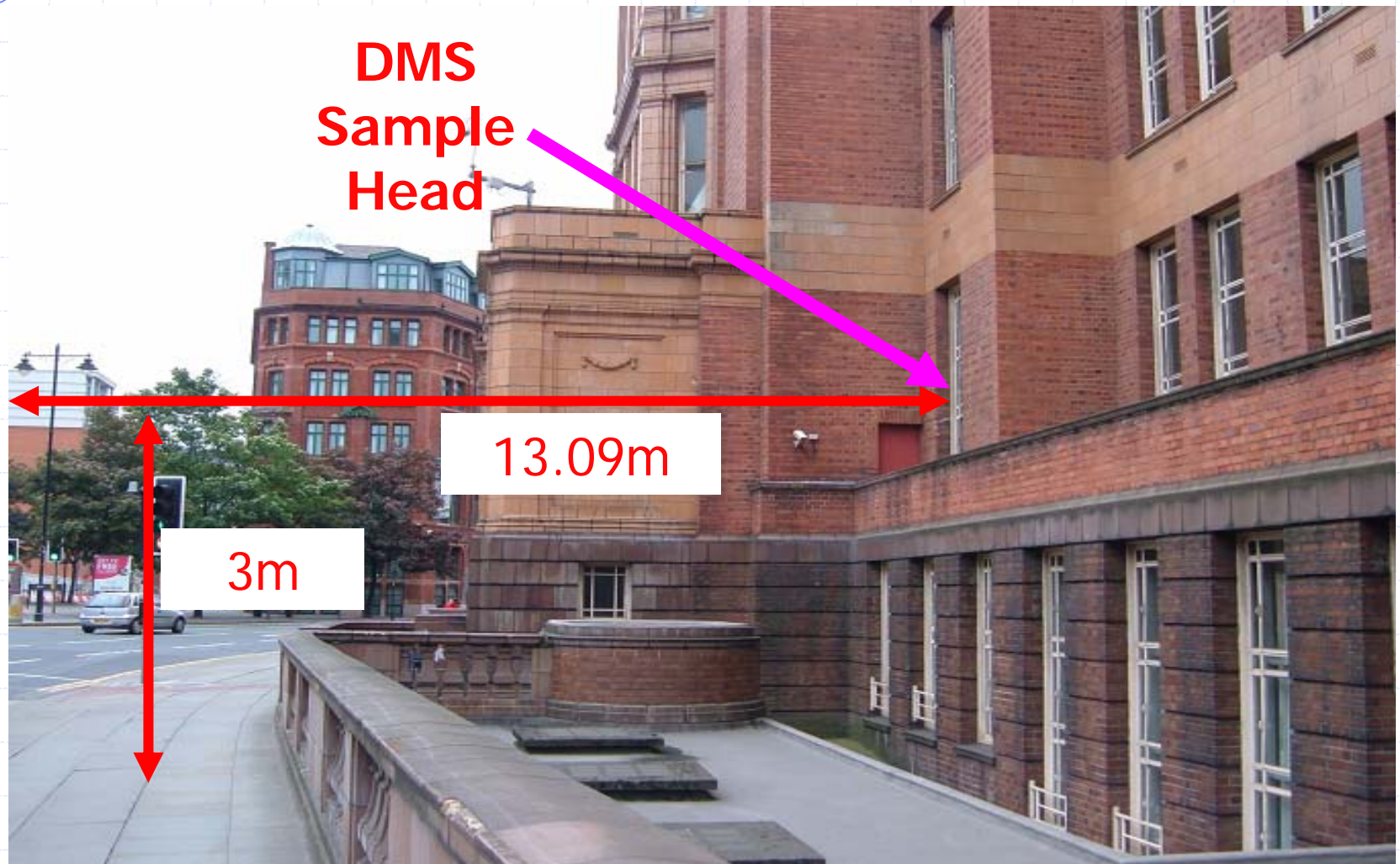
Typical Roadside Particle Size Distribution



Results Shown In This Presentation

- ◆ Results from field experiments conducted in Leicester and Manchester
- ◆ DMS500 used to obtain particle measurements between 4.87 and 1000nm
- ◆ Meteorological and gaseous pollutant measurements taken
- ◆ Automated traffic counts obtained

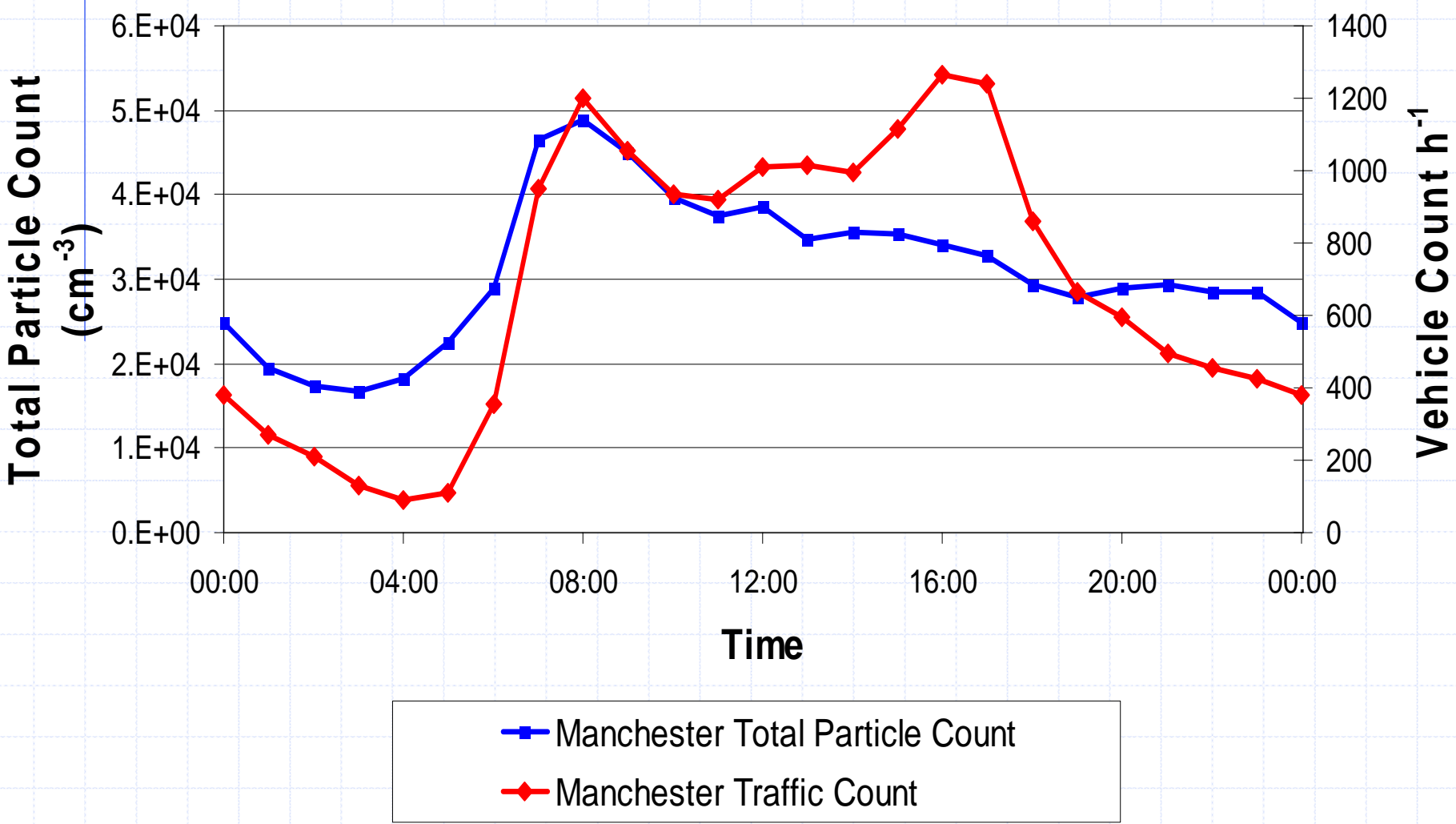
Manchester Sampling Site, Whitworth Street



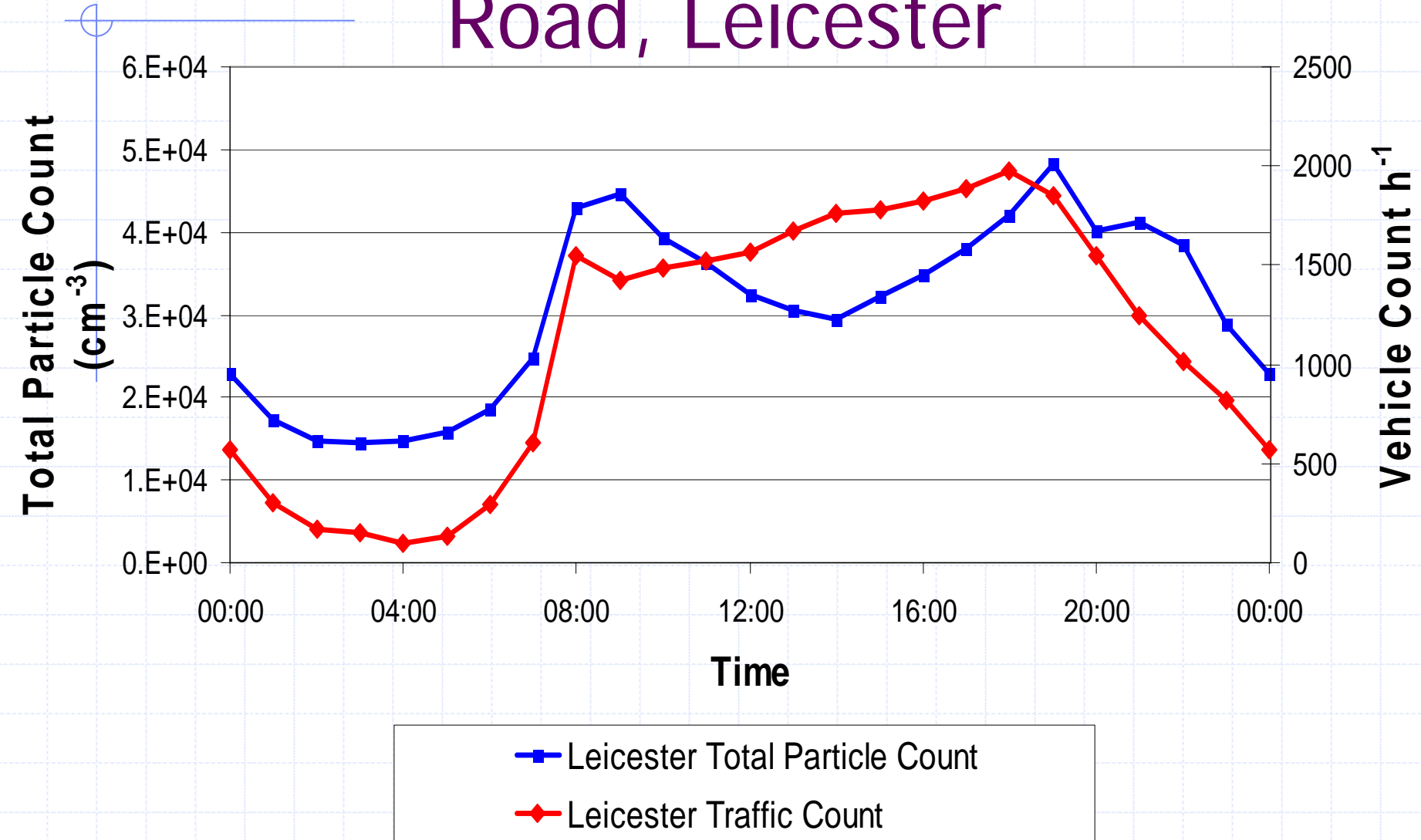
Leicester Sampling Site, Narborough Road



Diurnal Profile of Total Particle Count and Vehicle Count on Whitworth Street, Manchester



Diurnal Profile of Total Particle Count and Vehicle Count on Narborough Road, Leicester

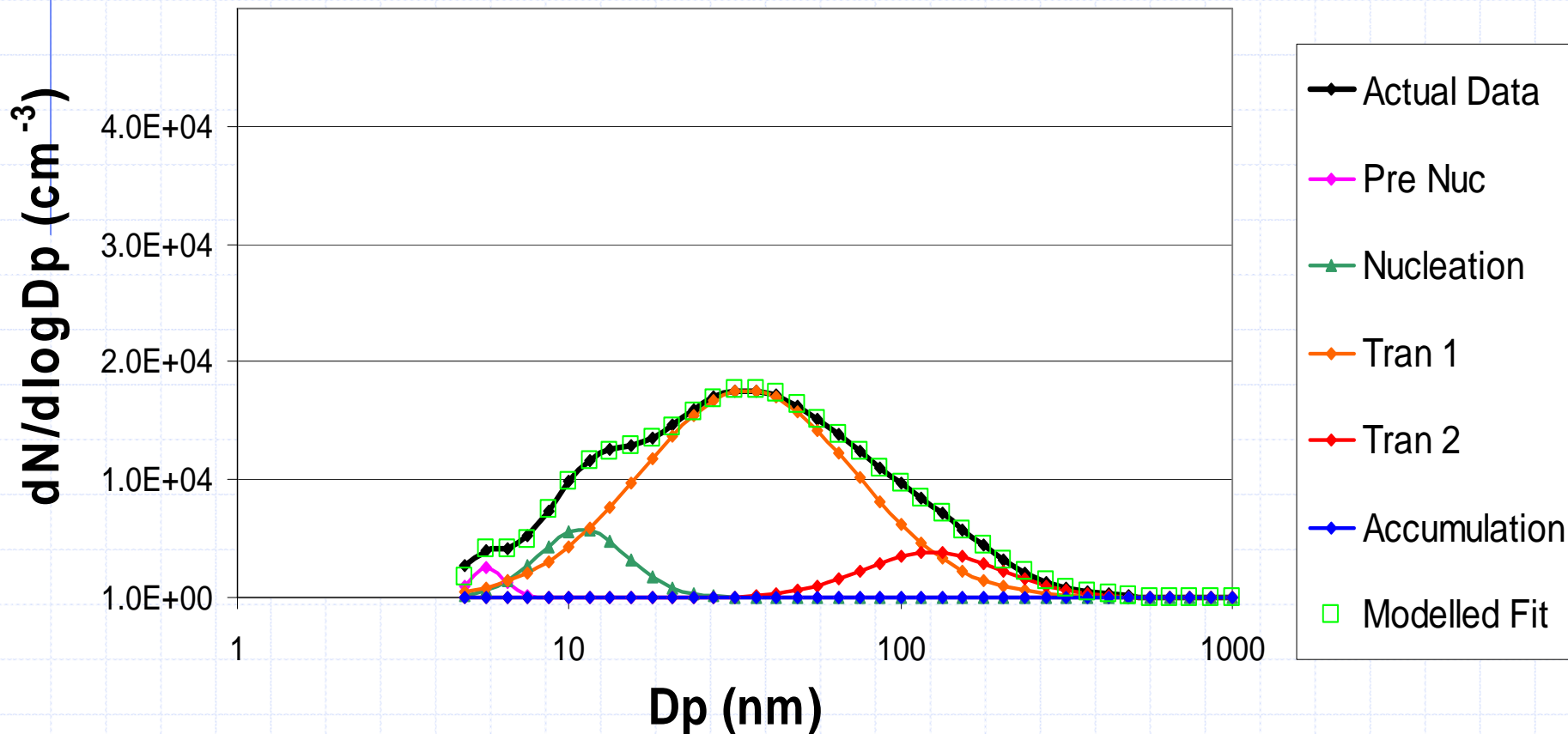


Modelled Particle Size Distributions

- ◆ RMix model used to model size distribution and ascertain different size modes present within size distribution on an hourly basis
- ◆ RMix models a fit to the data based upon initial guess of log diameter parameters

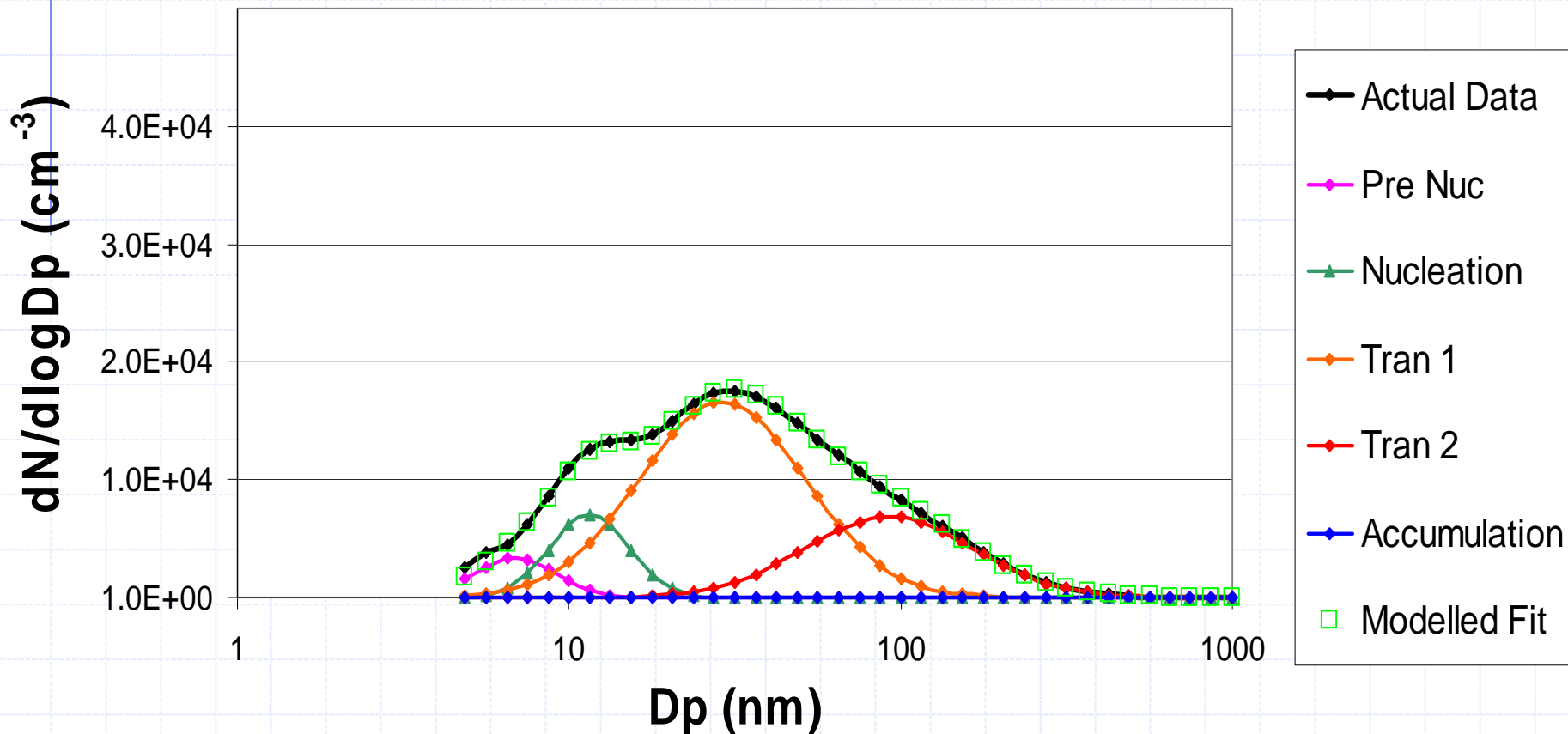
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

02:00



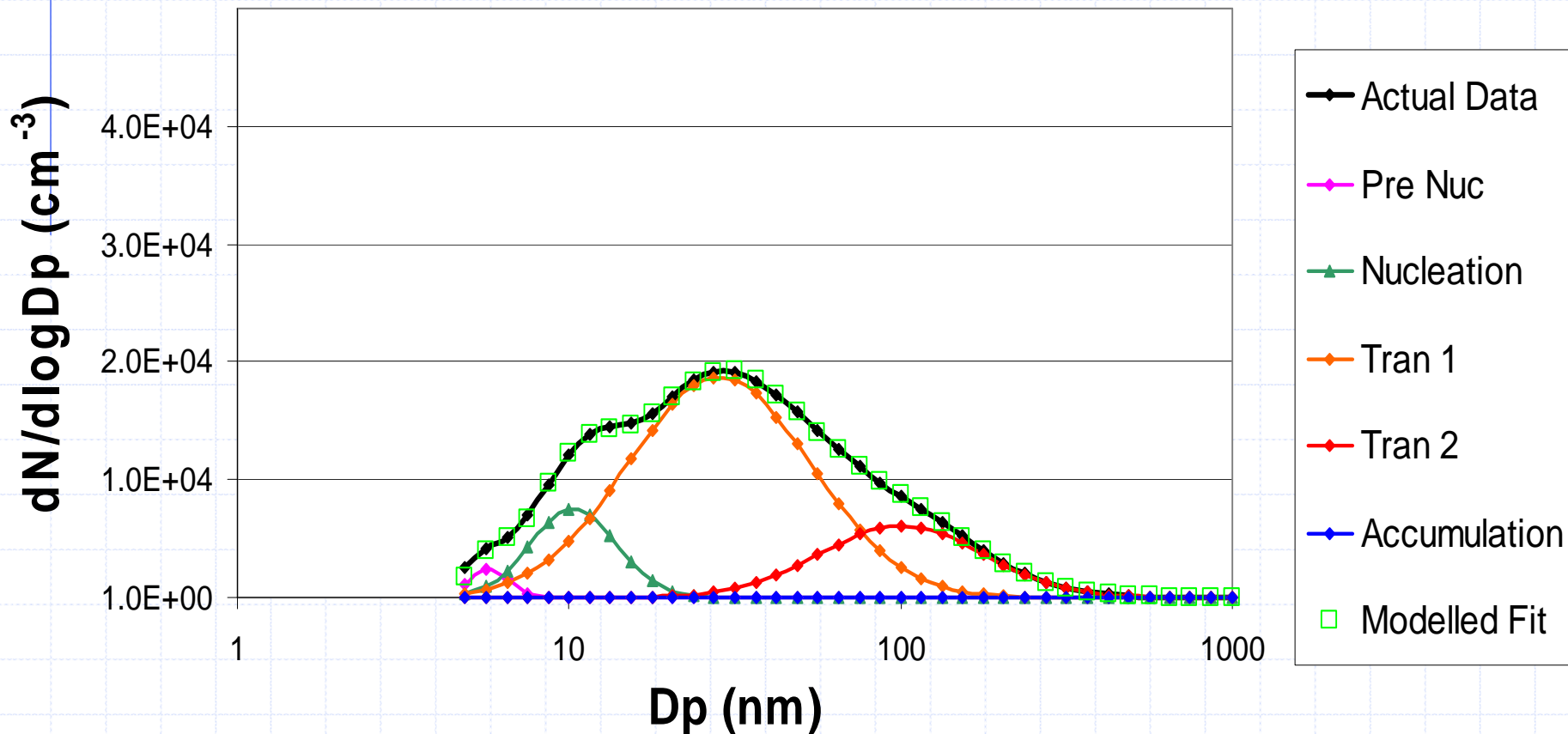
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03:00



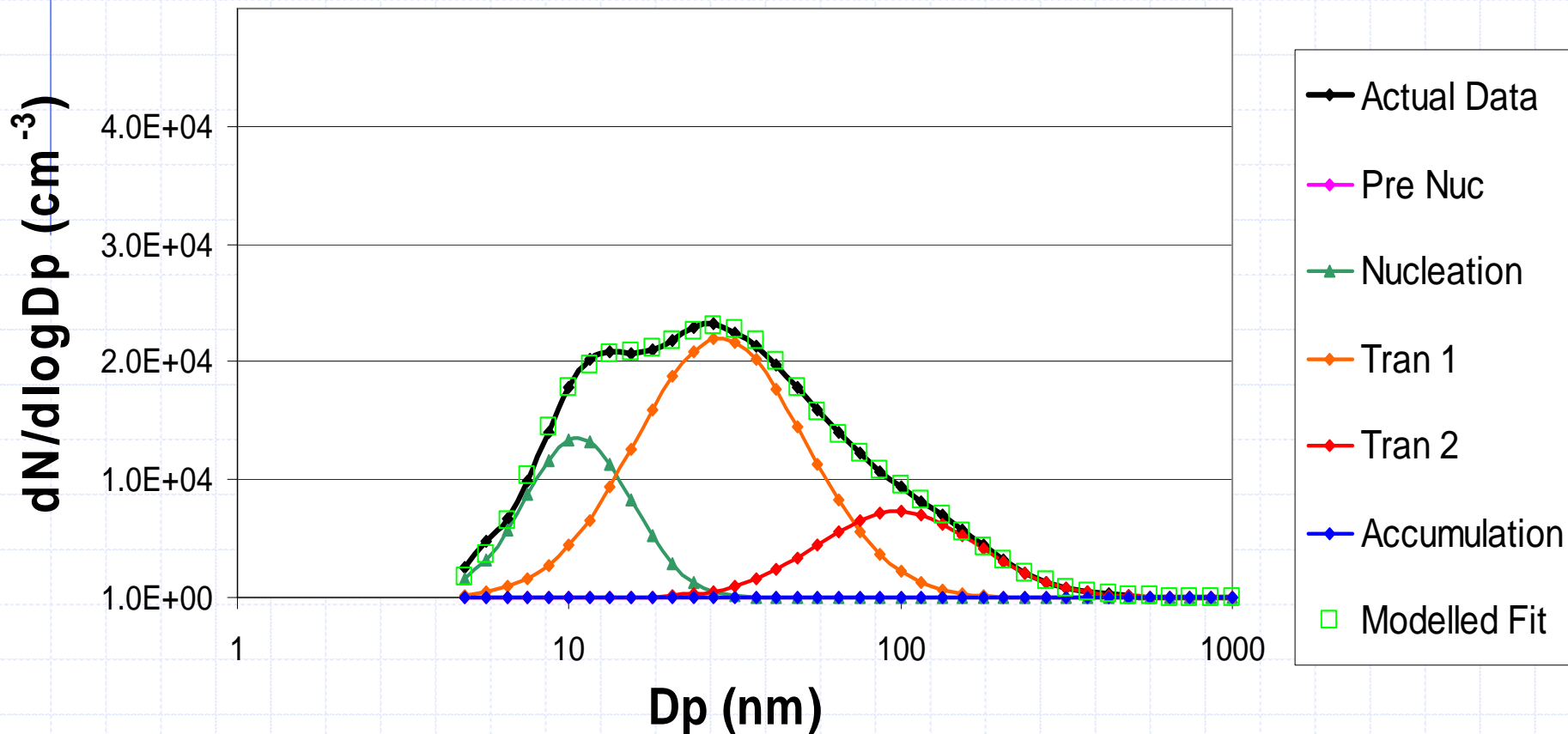
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

04:00



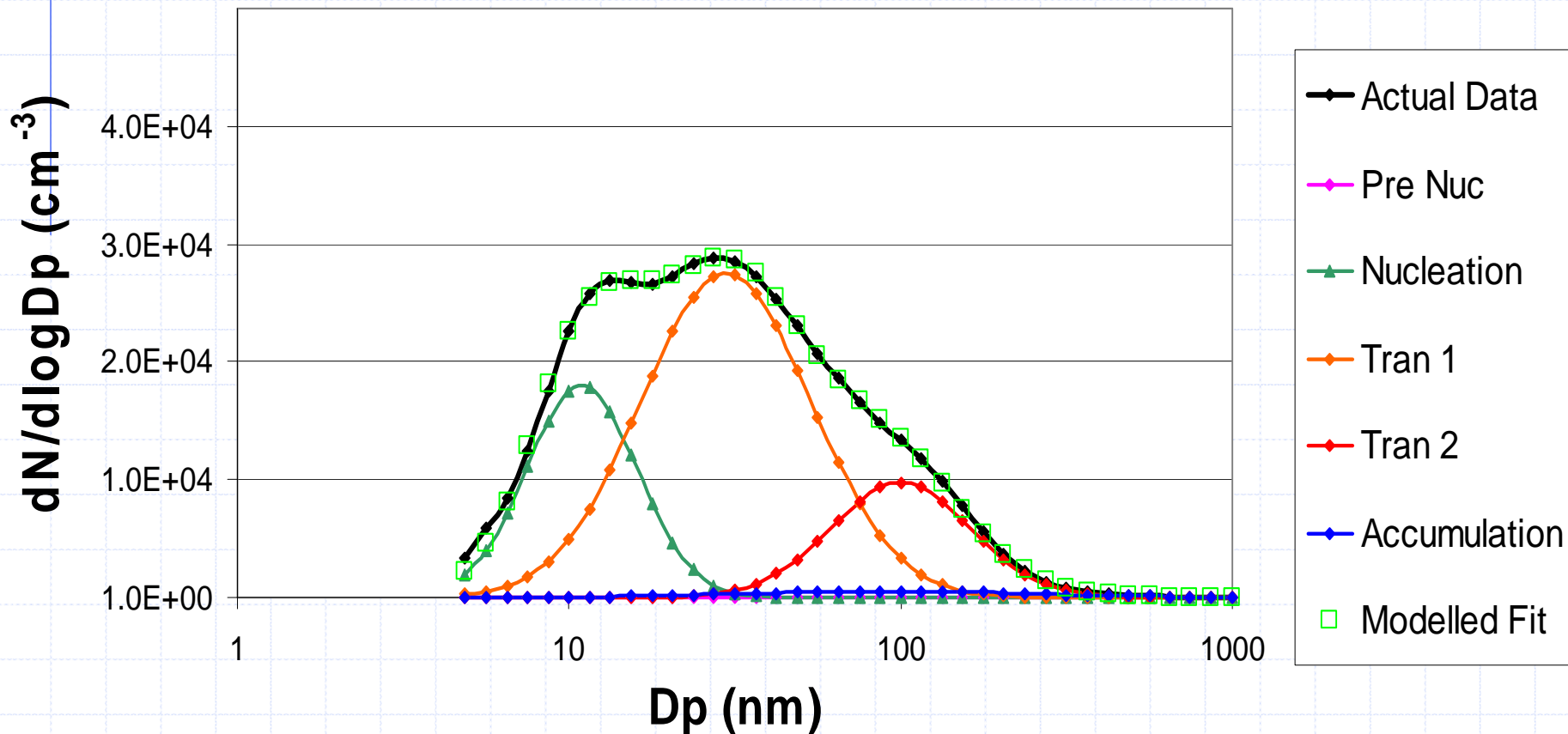
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

05:00



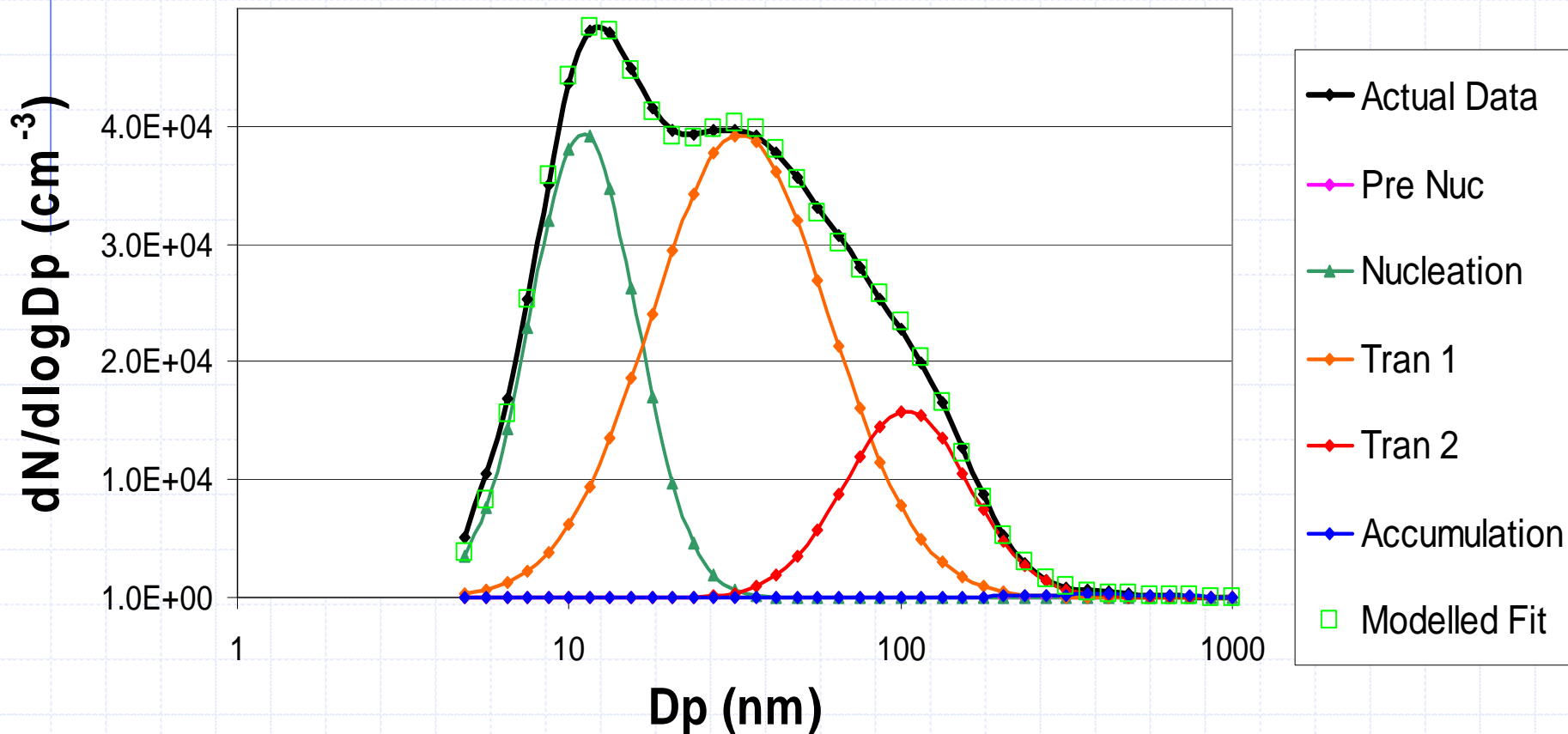
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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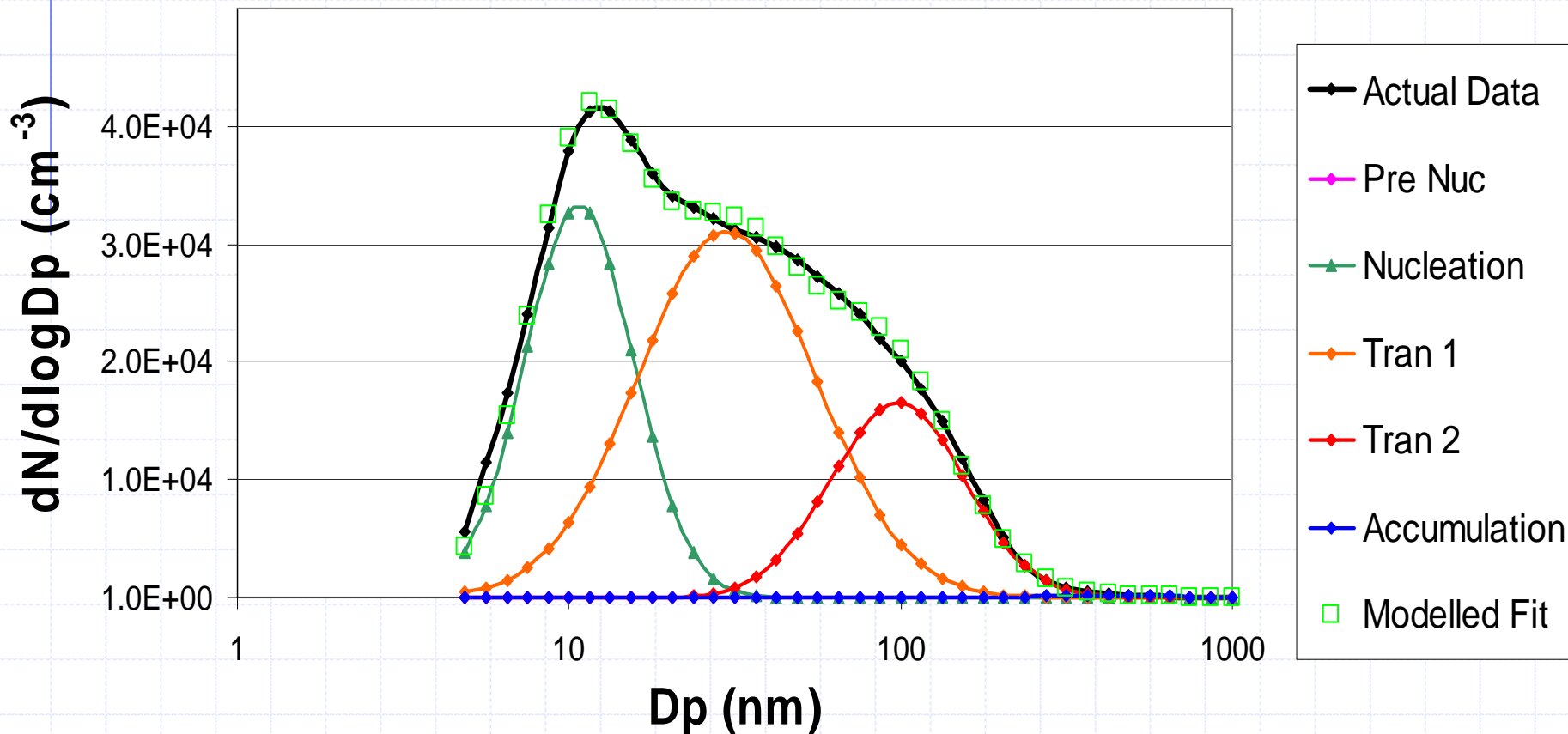
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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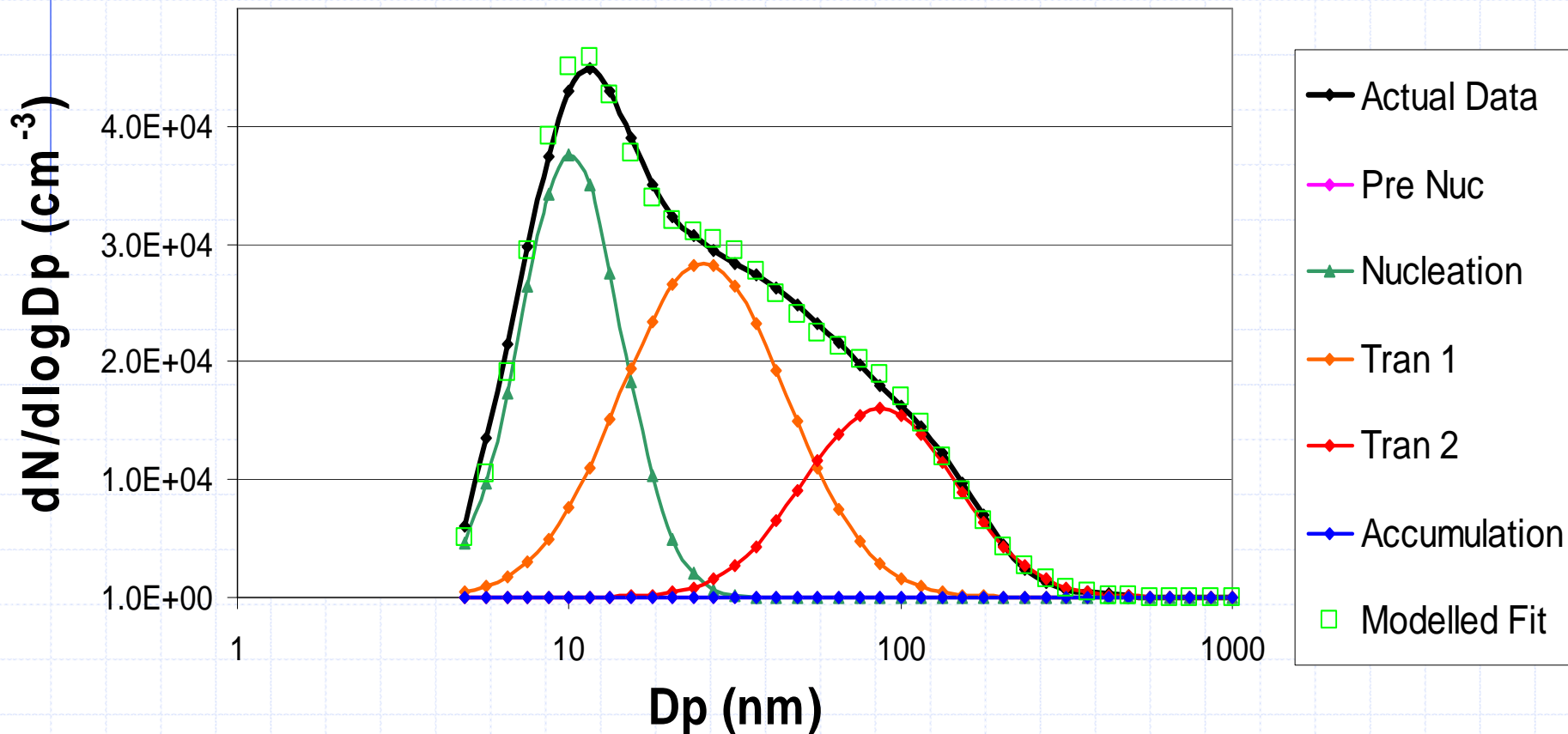
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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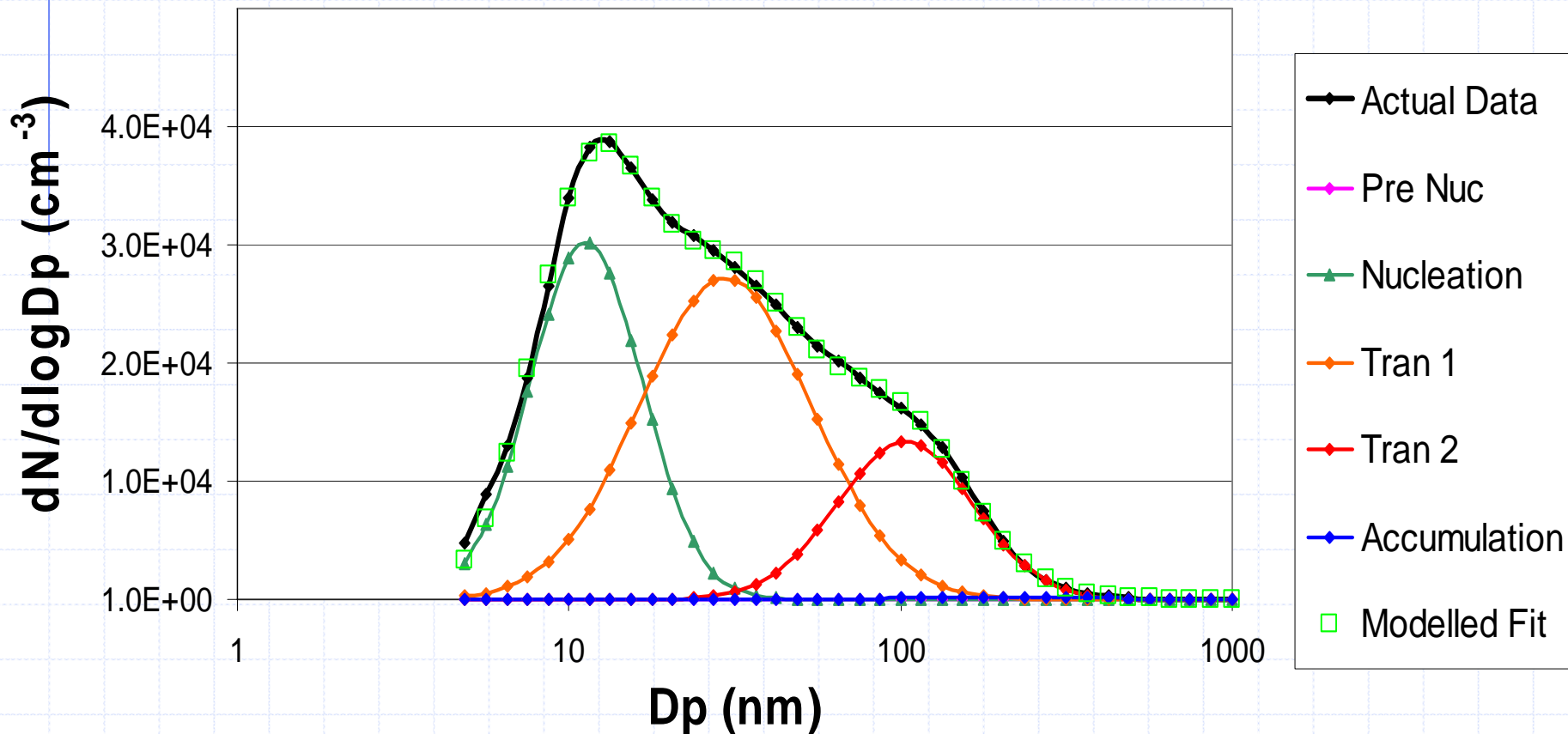
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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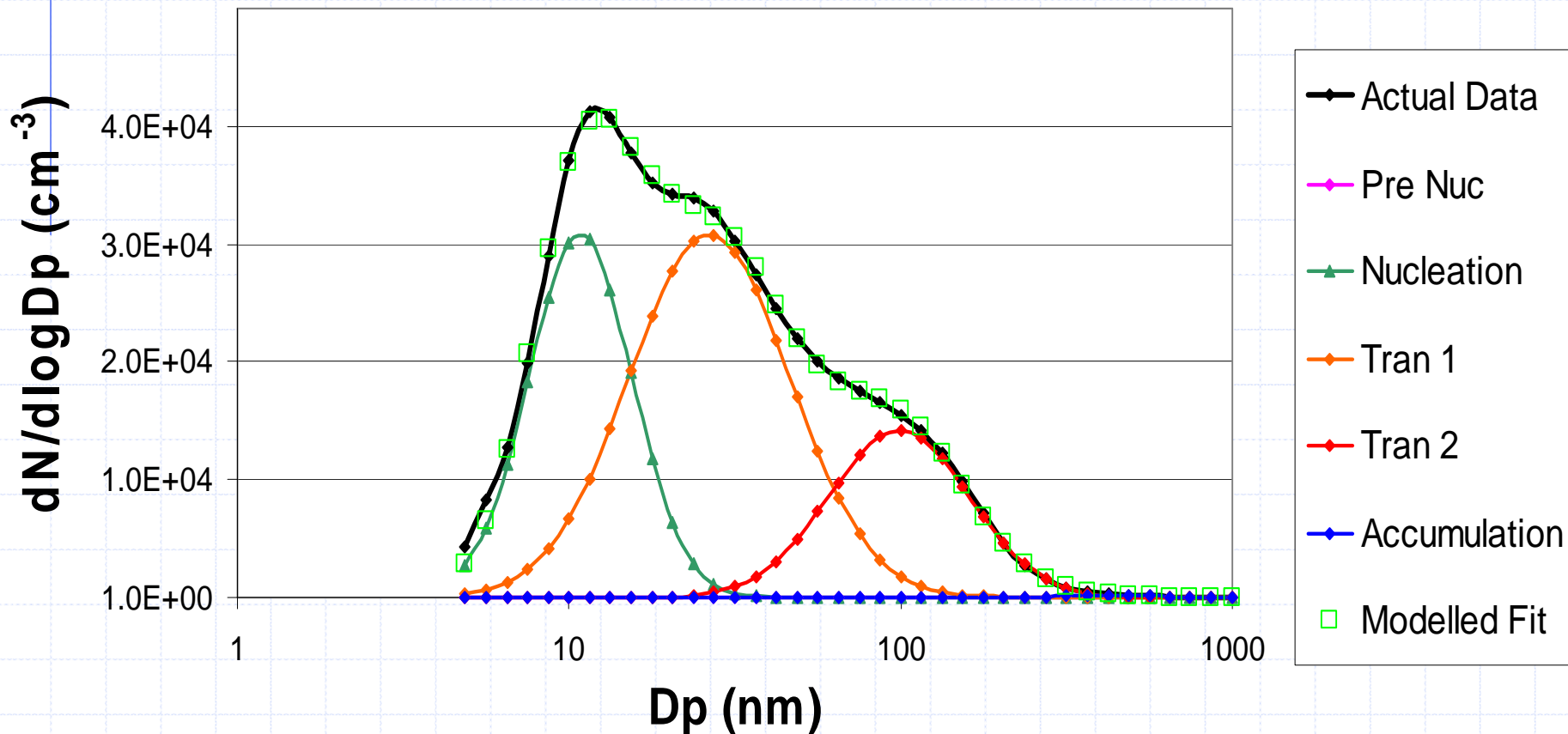
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13:00



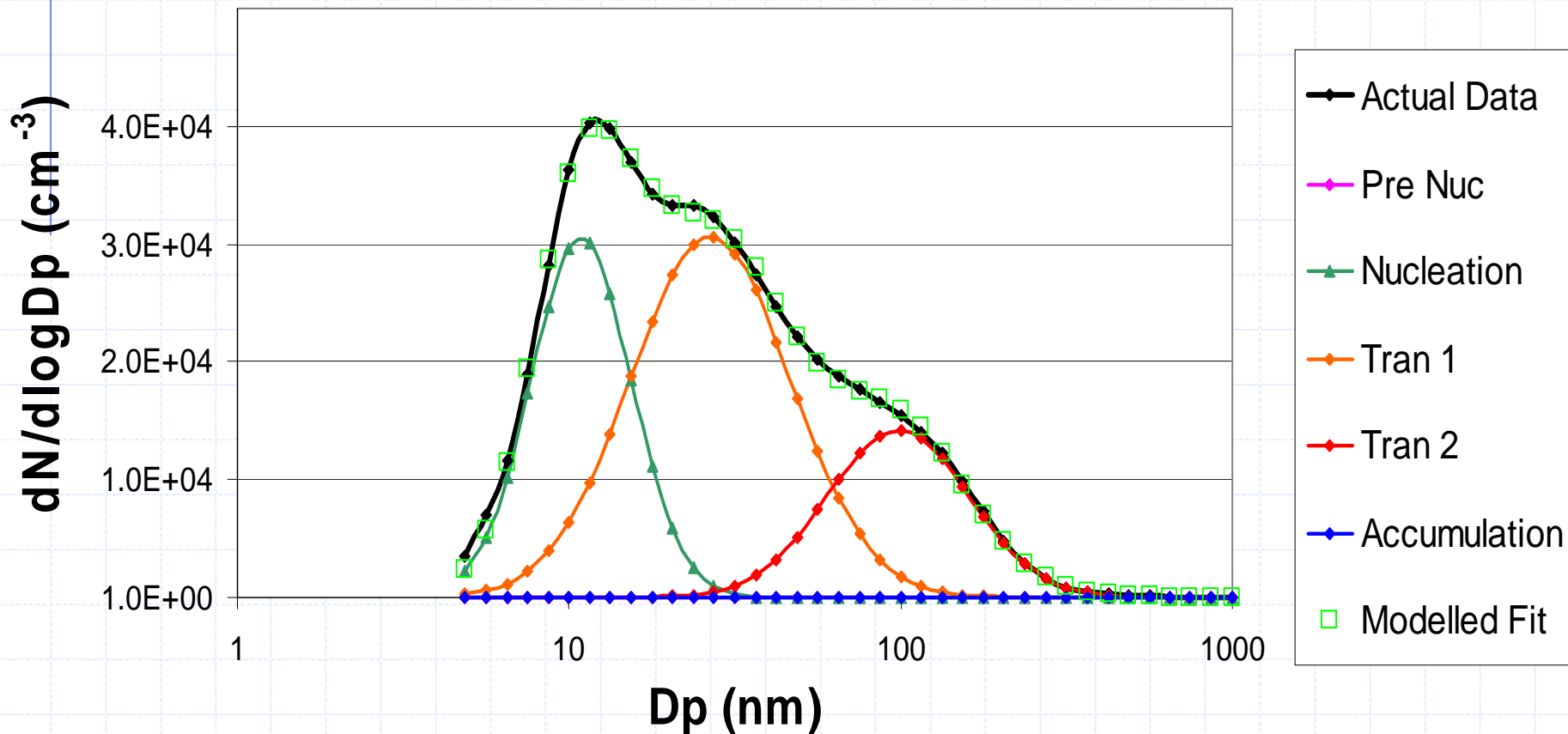
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

14:00



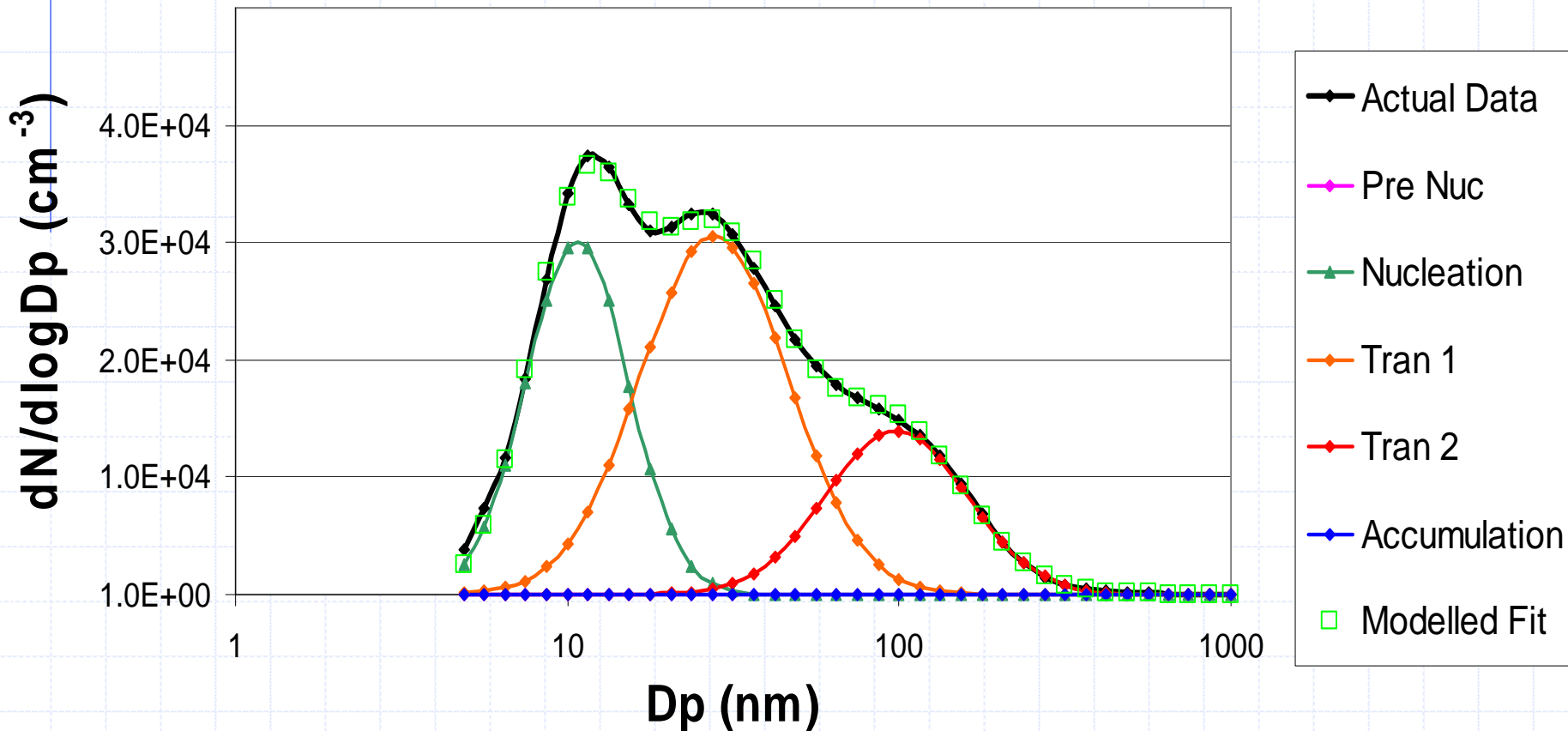
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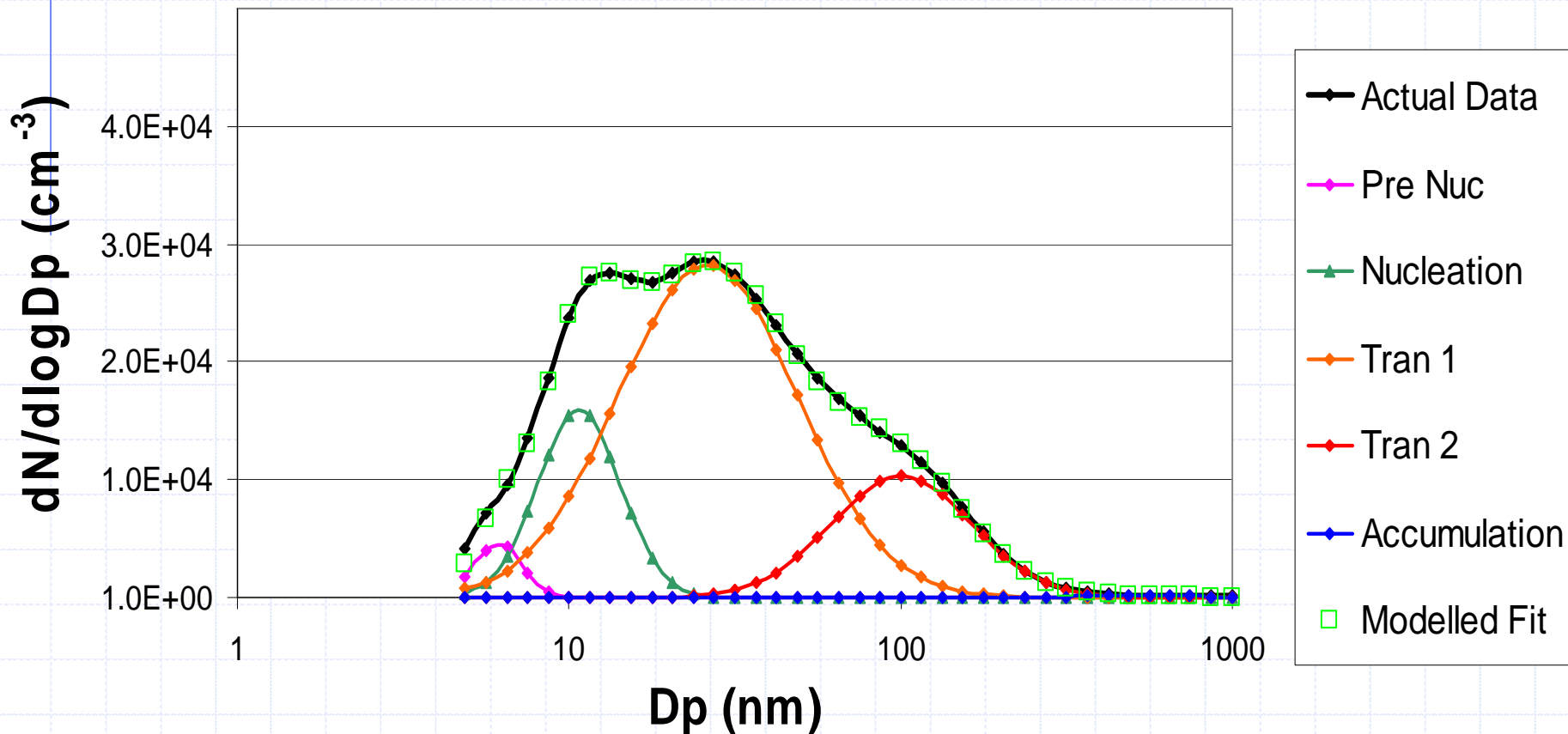
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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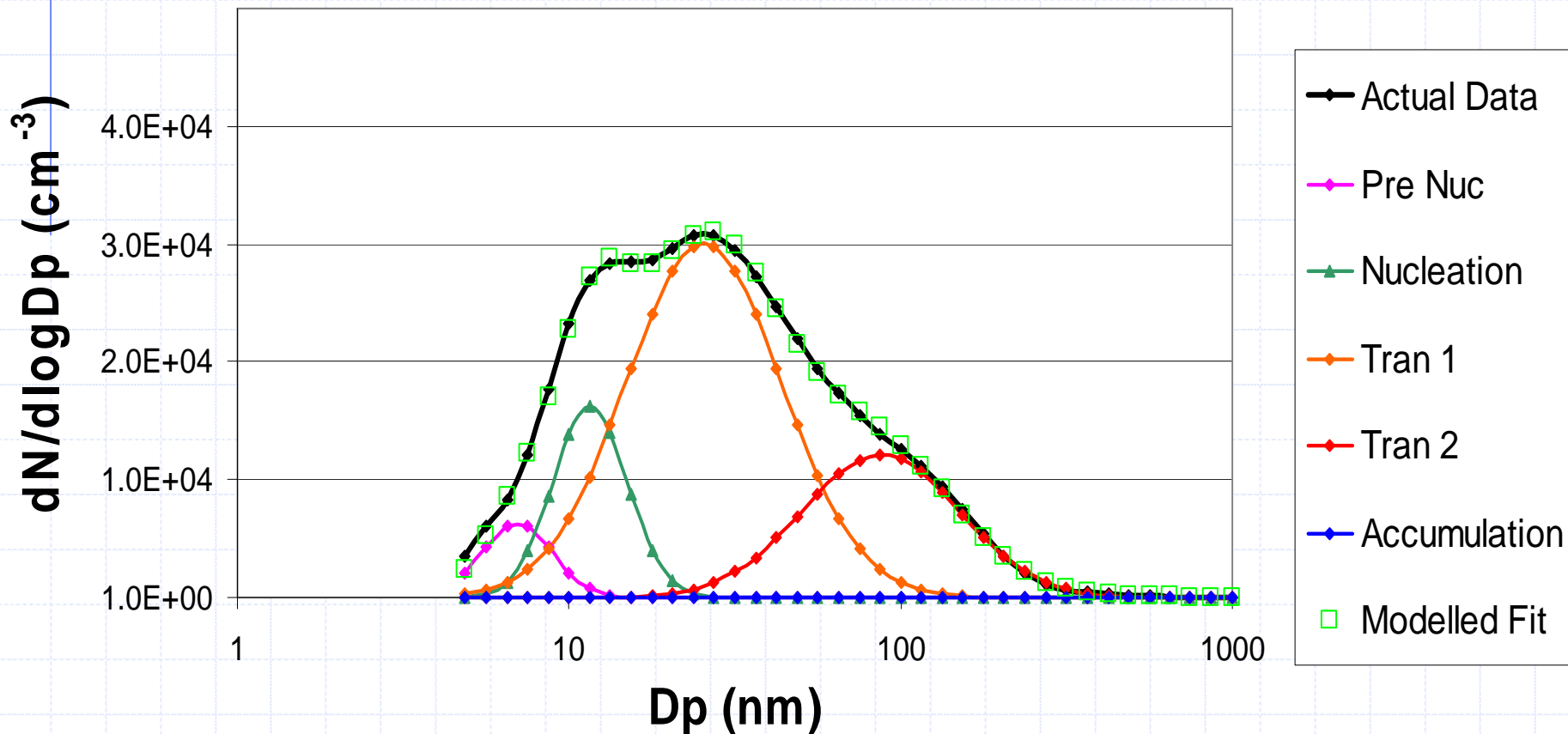
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

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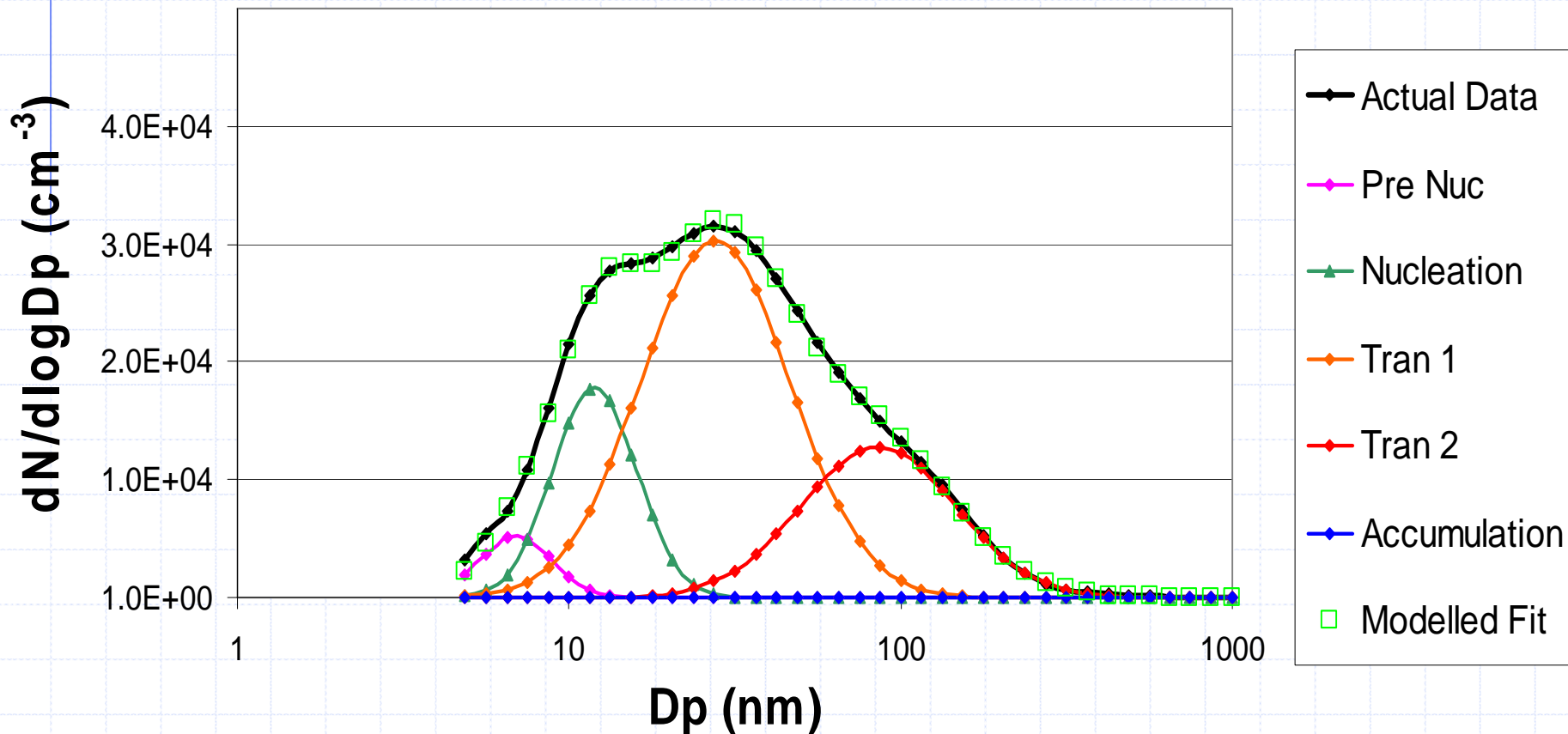
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

20:00



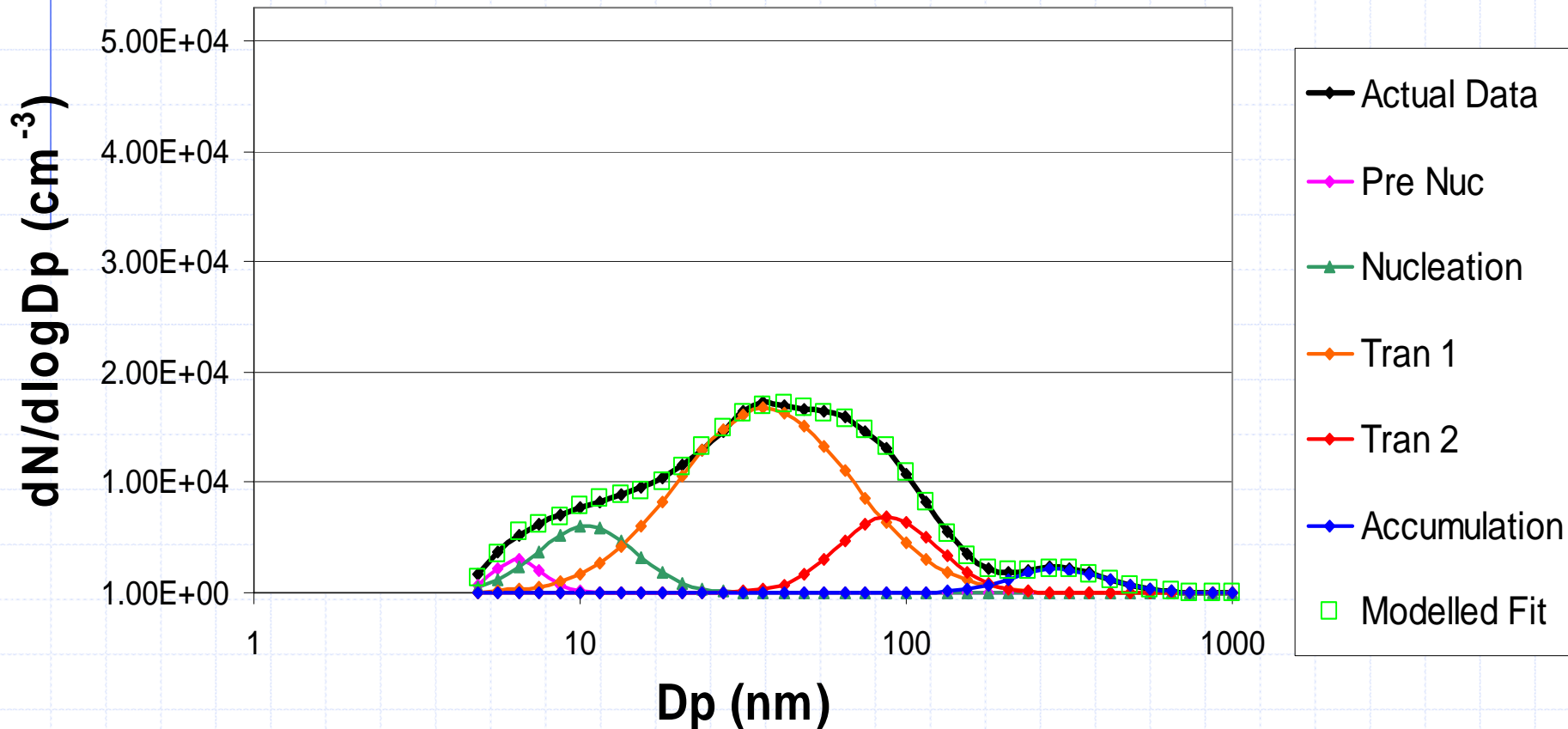
Actual Size Distribution and Modelled Fitting Using R Mix, Manchester

21:00



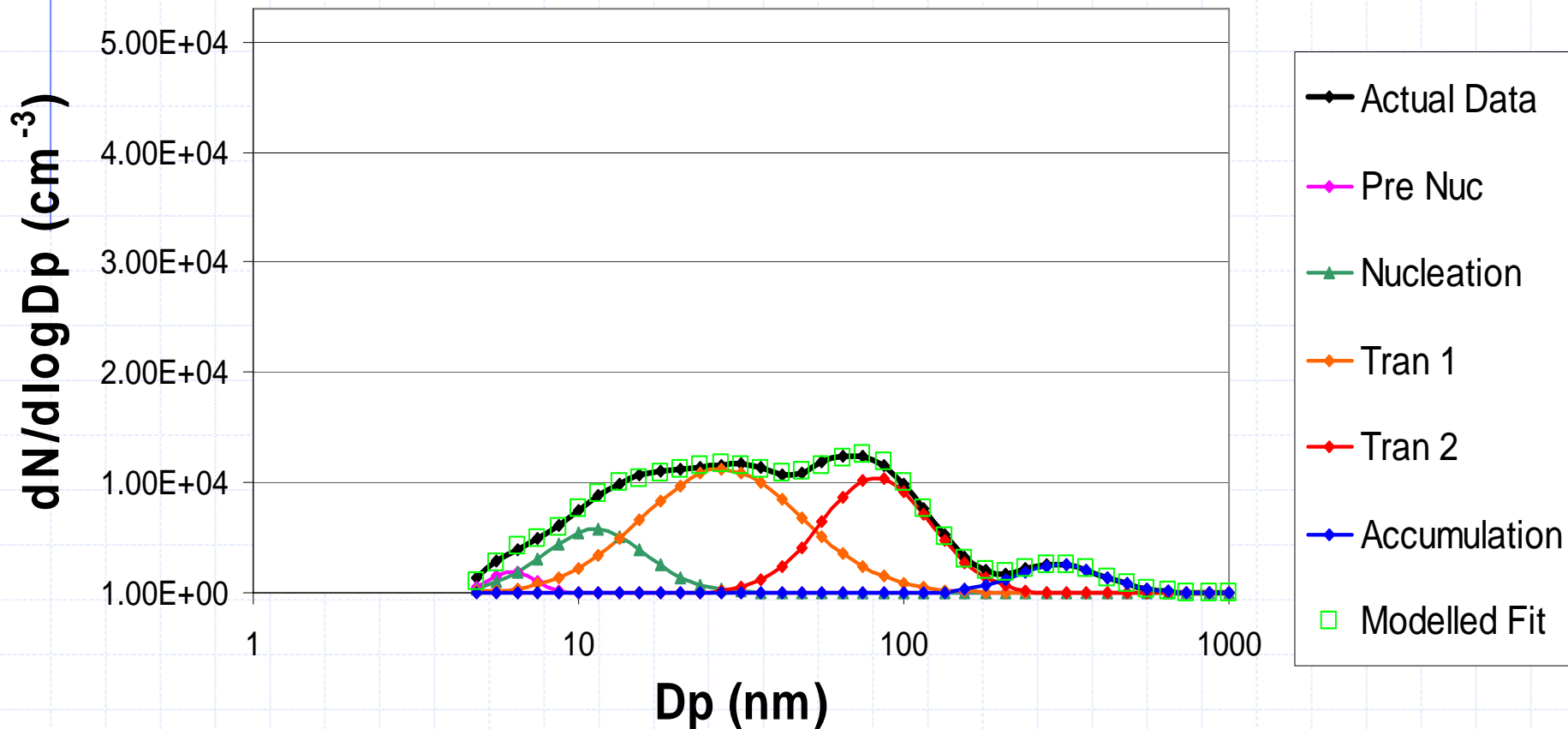
Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

01:00



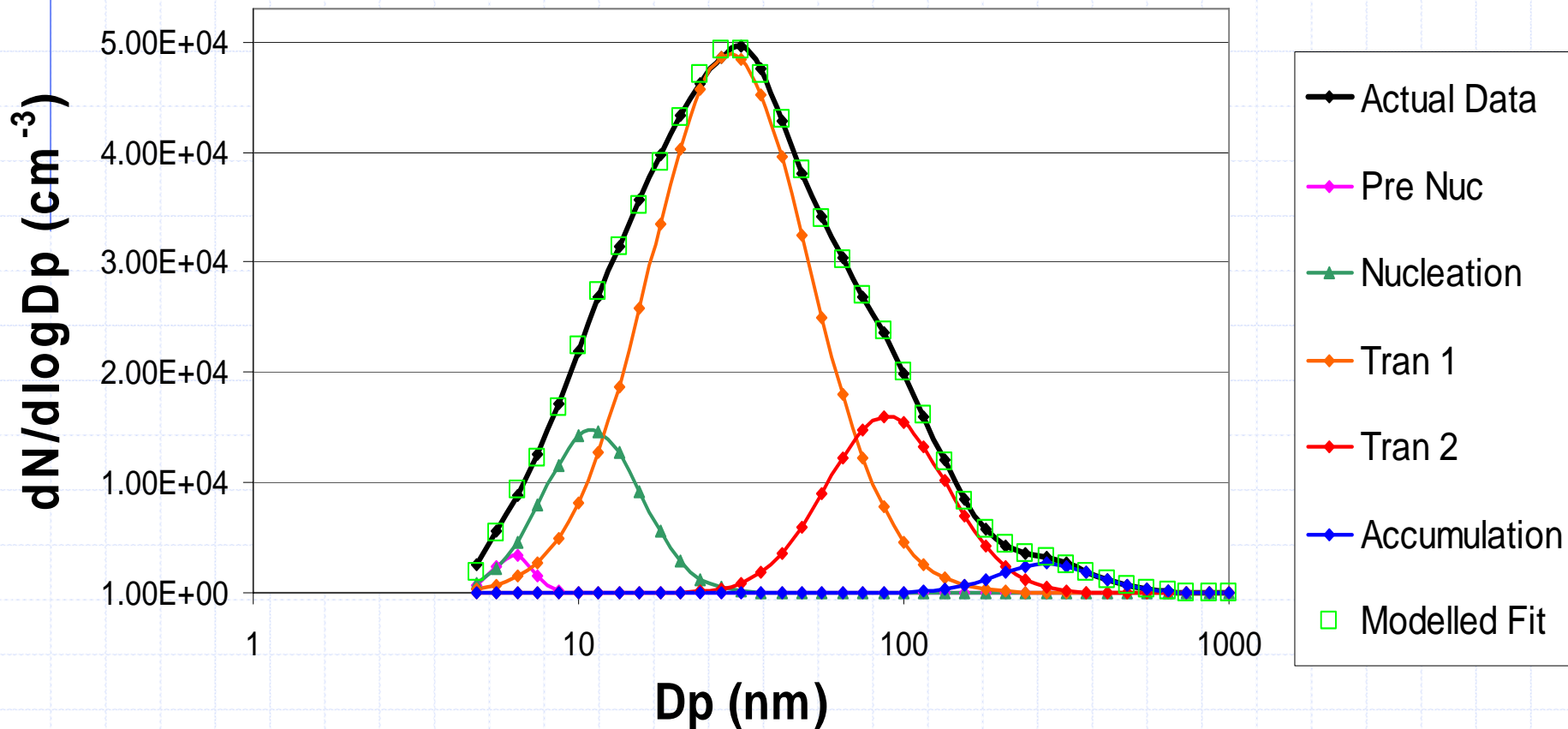
Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

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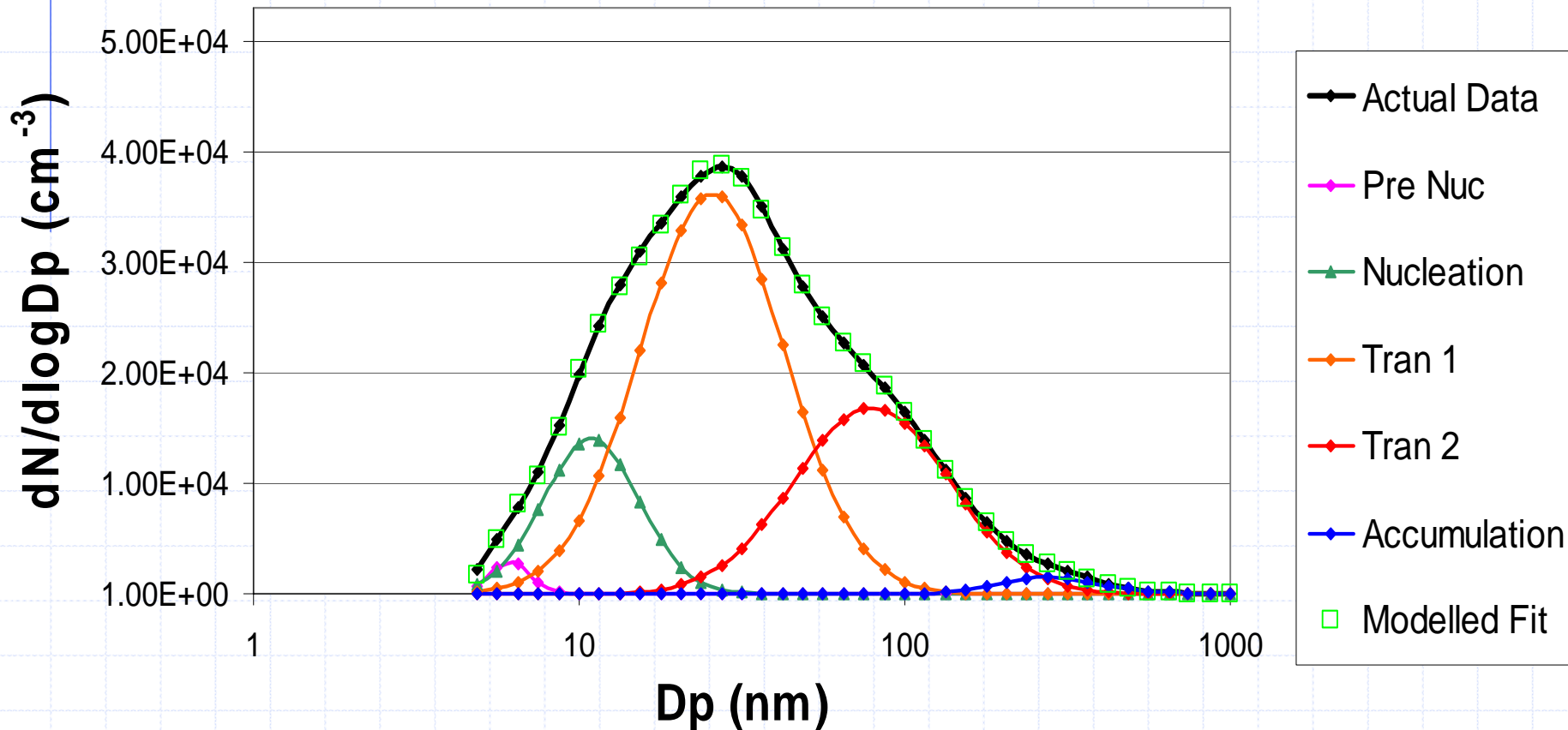
Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

09:00



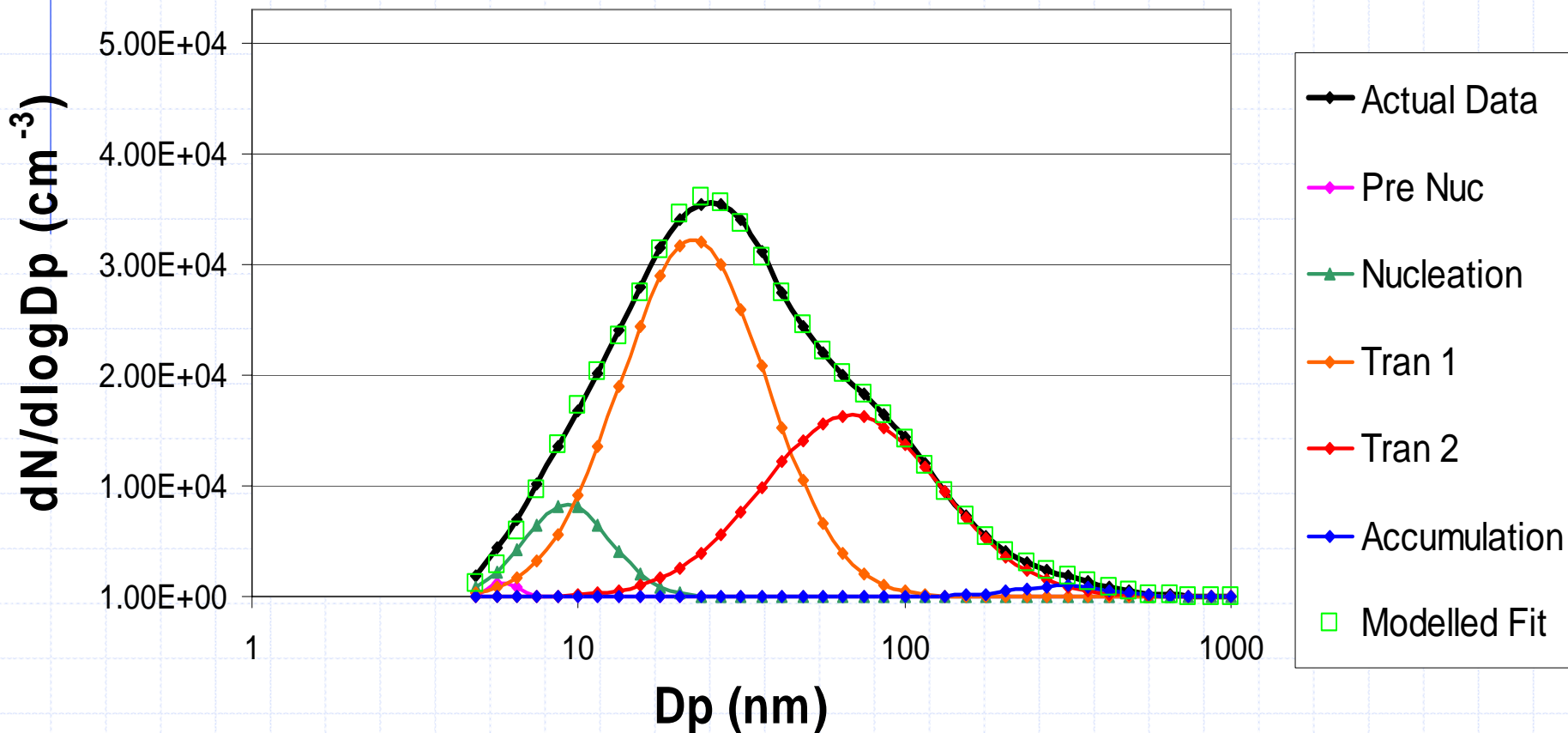
Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

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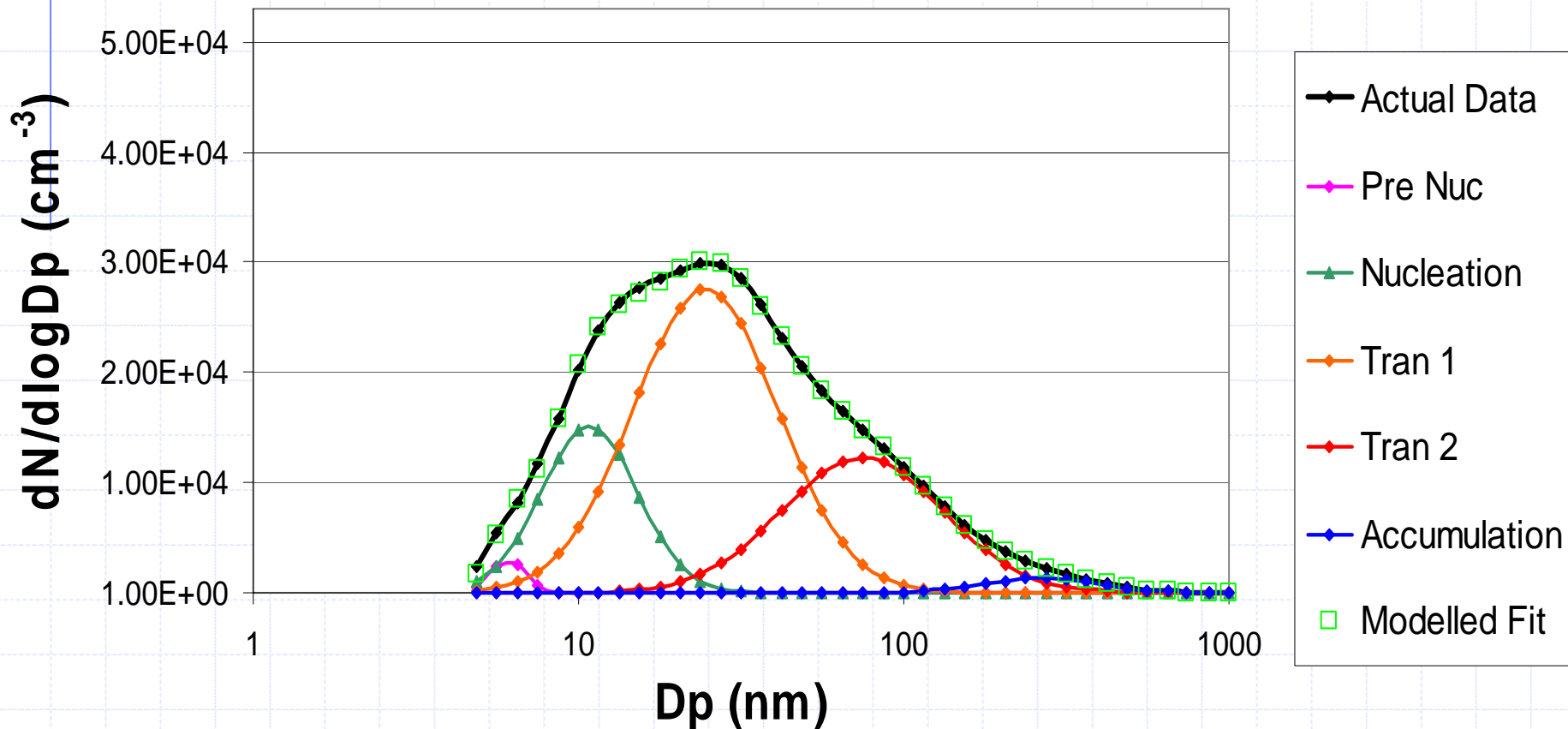
Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

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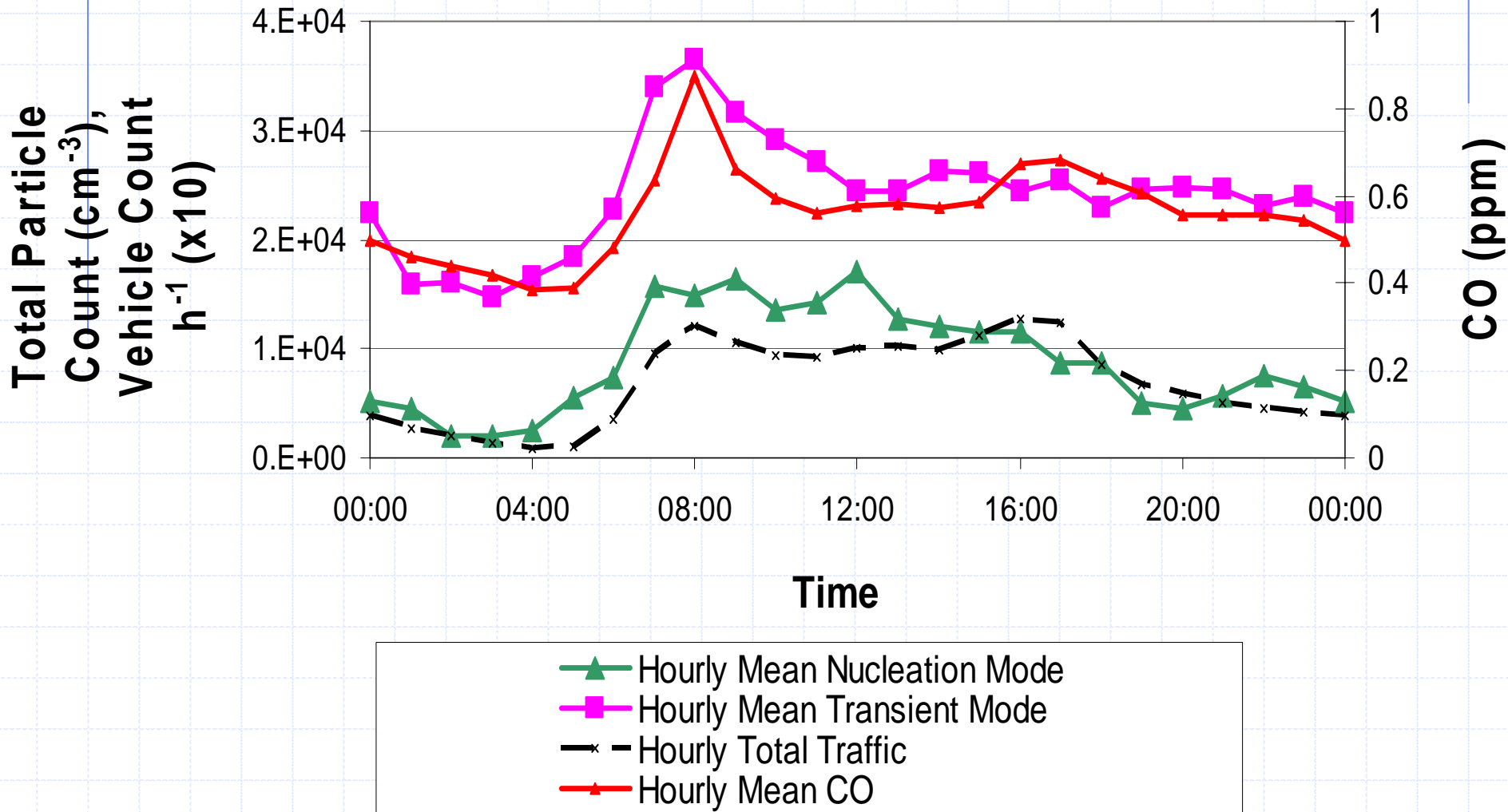


Actual Size Distribution and Modelled Fitting Using R Mix, Leicester

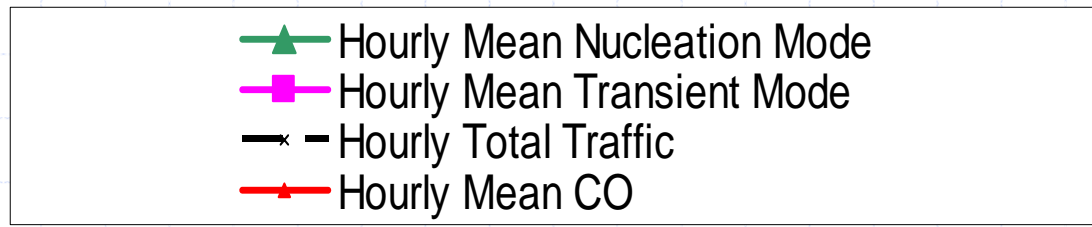
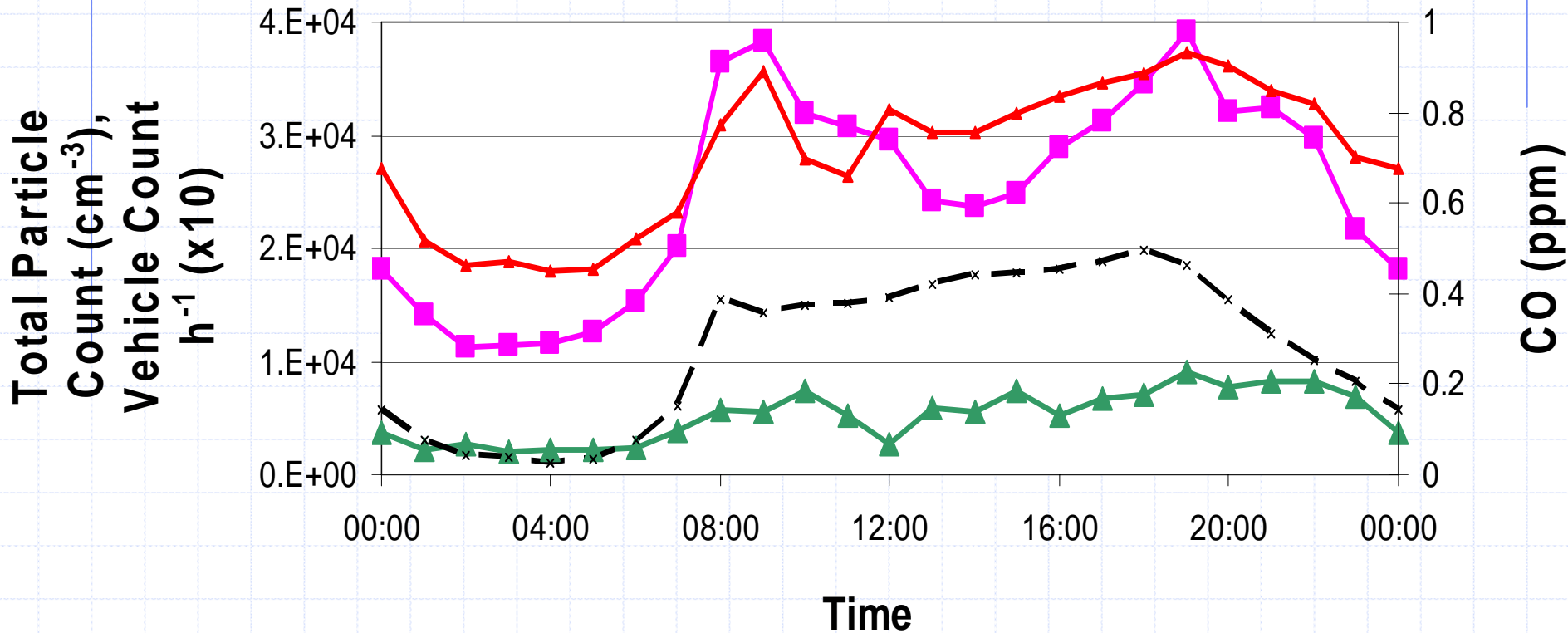
14:00



Diurnal Plot of CO, Total Transient and Nucleation Particle Modes With Traffic Counts – Manchester – Hourly Means



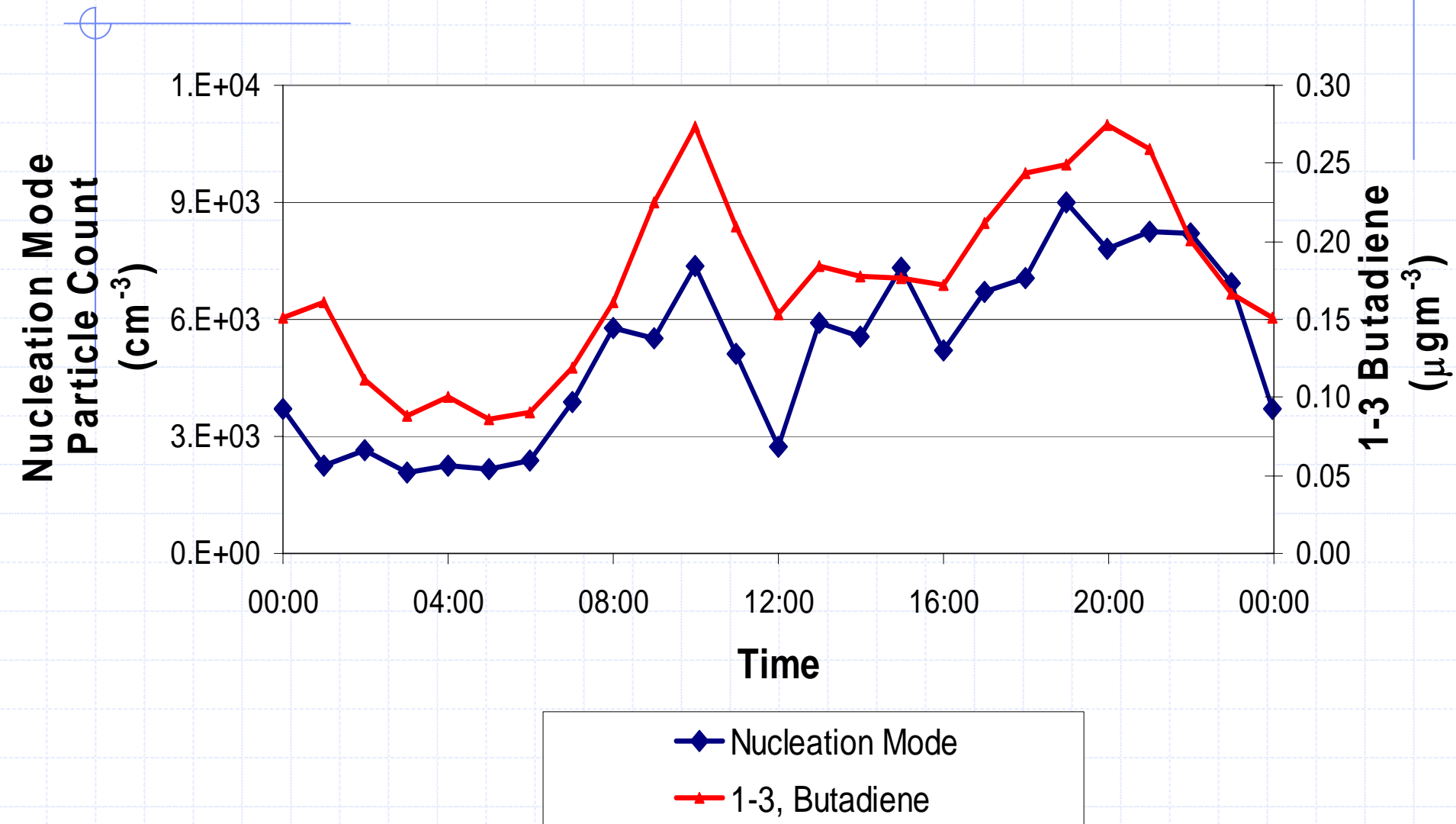
Diurnal Plot of CO, Total Transient and Nucleation Particle Modes With Traffic Counts – Leicester – Hourly Means



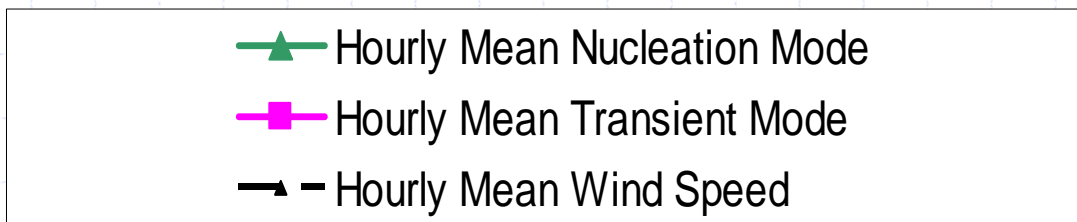
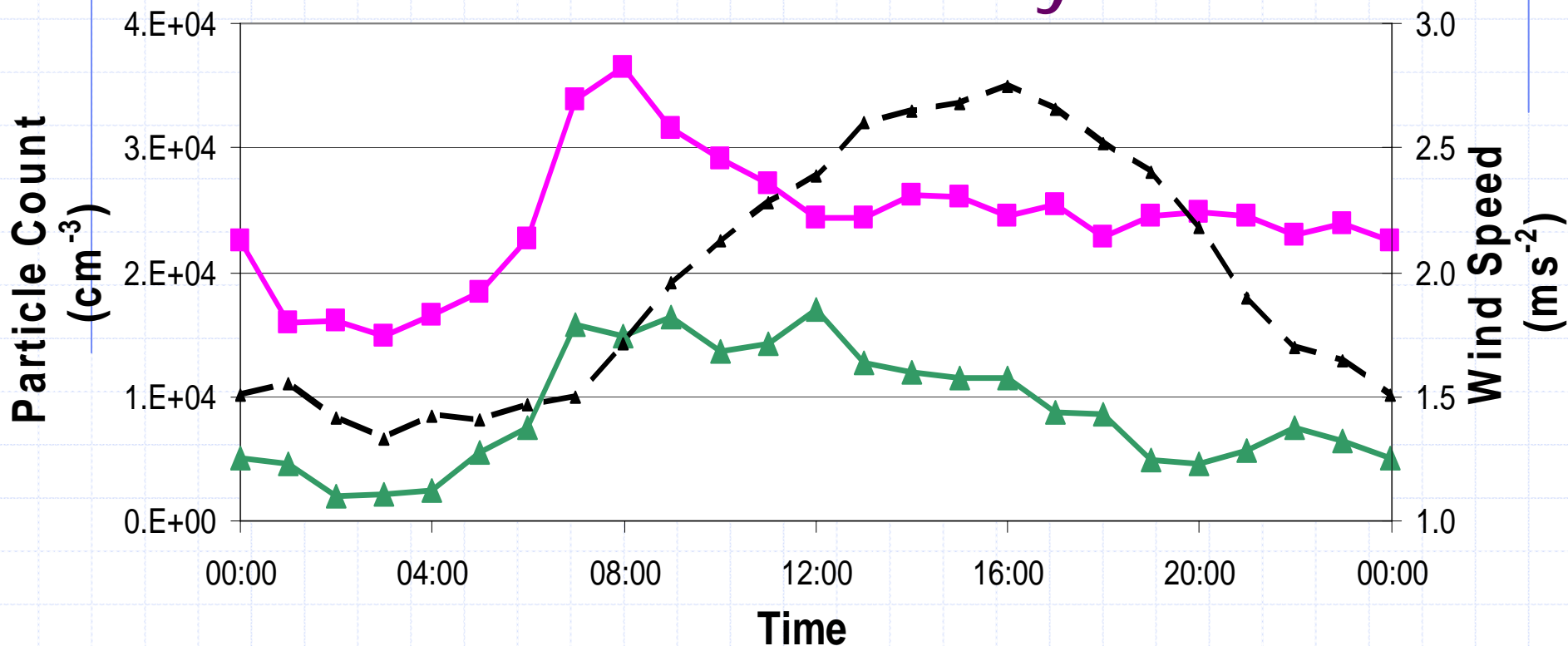
Correlation Values Of Nucleation And Total Transient Mode With Traffic And CO

Location And Size Mode	R² value With Vehicle Count	R² value With CO
Man, Nuc	0.7	0.47
Man, Tot Tran	0.6	0.72
Leics, Nuc	0.55	0.68
Leics, Tot Tran	0.75	0.82

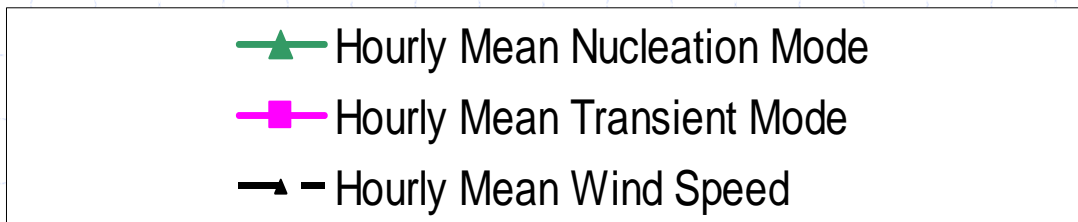
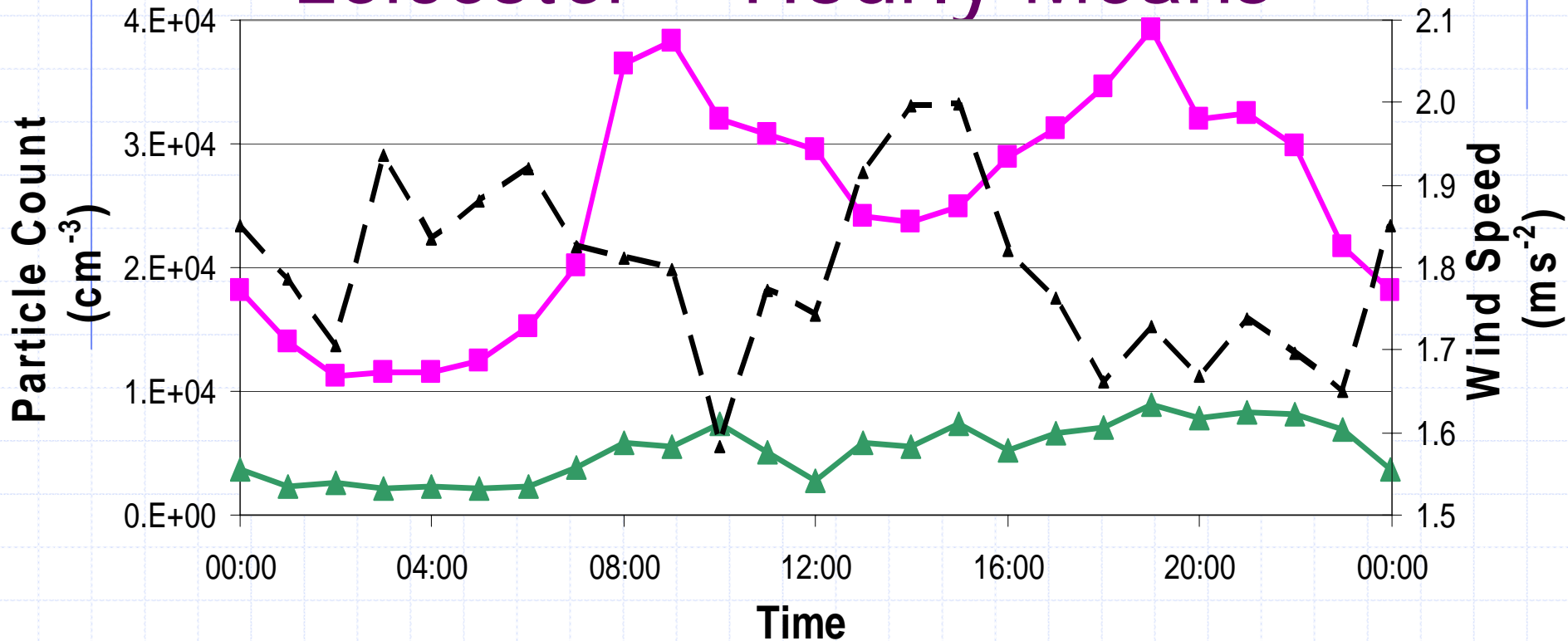
Diurnal Plot of Nucleation Mode With 1,3-Butadiene - Leicester



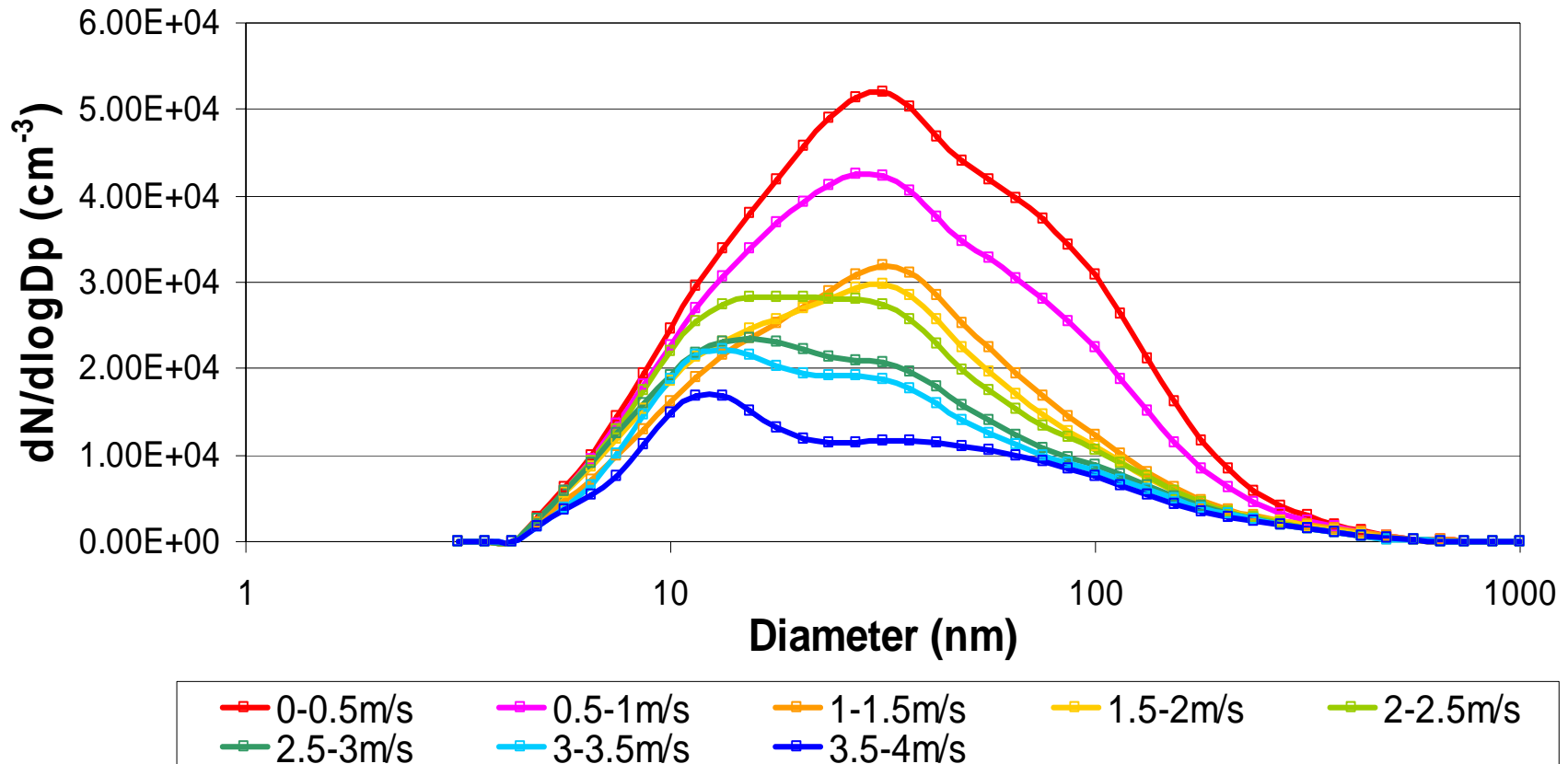
Diurnal Plot of Total Transient and Nucleation Mode With Wind Speed, Manchester – Hourly Means



Diurnal Plot of Total Transient and Nucleation Mode With Wind Speed, Leicester – Hourly Means



Affect of Wind Speed on Particle Size Distribution – Leicester – 5 Minute Means



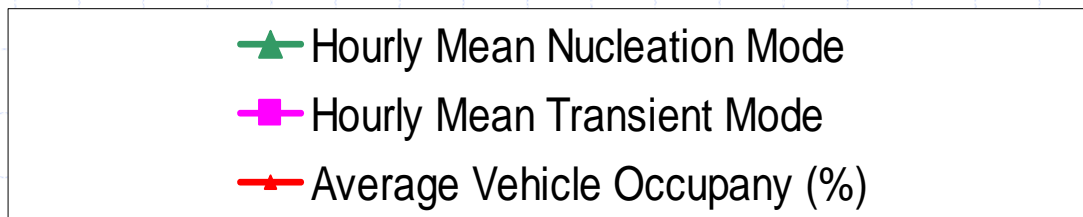
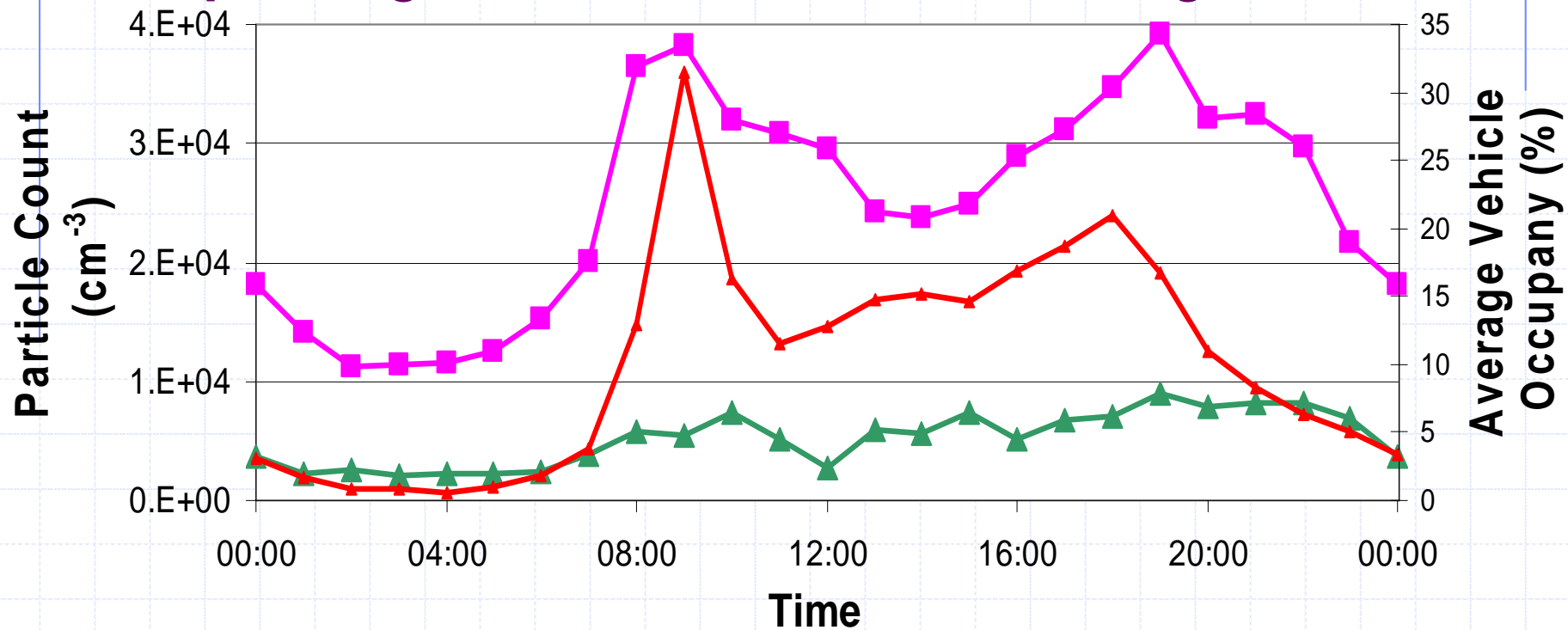
Correlation Values of Different Gaseous Pollutants With Wind Speed

Pollutant	Correlation Coefficient With Wind Speed
NOx	0.8967
NO	0.8976
NO2	0.9242
CO	0.9072

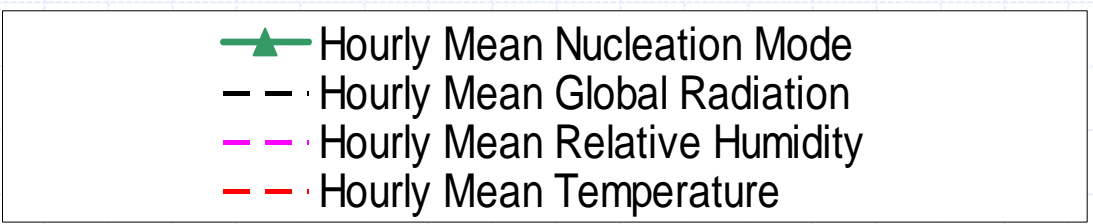
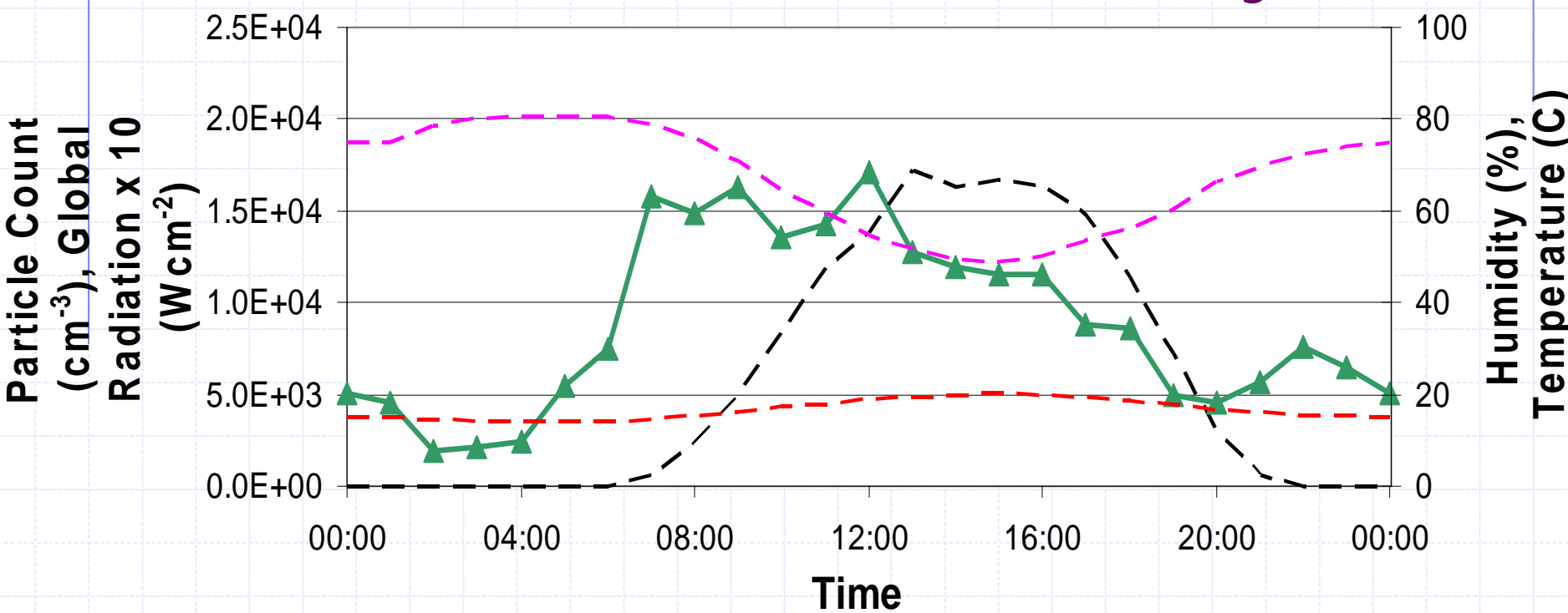
Correlation Values of Different Particle Modes With Wind Speed

Particle Mode	Correlation Coefficient With Wind Speed
Nucleation	0.0186
Transient 1	0.7239
Transient 2	0.8928

Diurnal Plot of Total Transient and Nucleation Mode With Average Vehicle Occupancy, Leicester – Hourly Means



Diurnal Plot of Nucleation mode, Temperature, Humidity, and Global Radiation – Manchester – Hourly Means



Nucleation Mode

- ◆ Shows some relationship with traffic
- ◆ No strong indication in these measurements that it results directly as a due to photochemical reactions in summer
- ◆ Follows similar trend to 1-3 butadiene measurements in Leicester
- ◆ Other factors such as temperature, humidity, and global radiation may be important in formation

Transient Mode

- ◆ Consists mainly of particles larger than 10nm
- ◆ Includes particles emitted directly from traffic. Correlates well with traffic counts and also CO measurements
- ◆ Roadside concentrations appear to be strongly governed by wind speed and vehicle flow characteristics

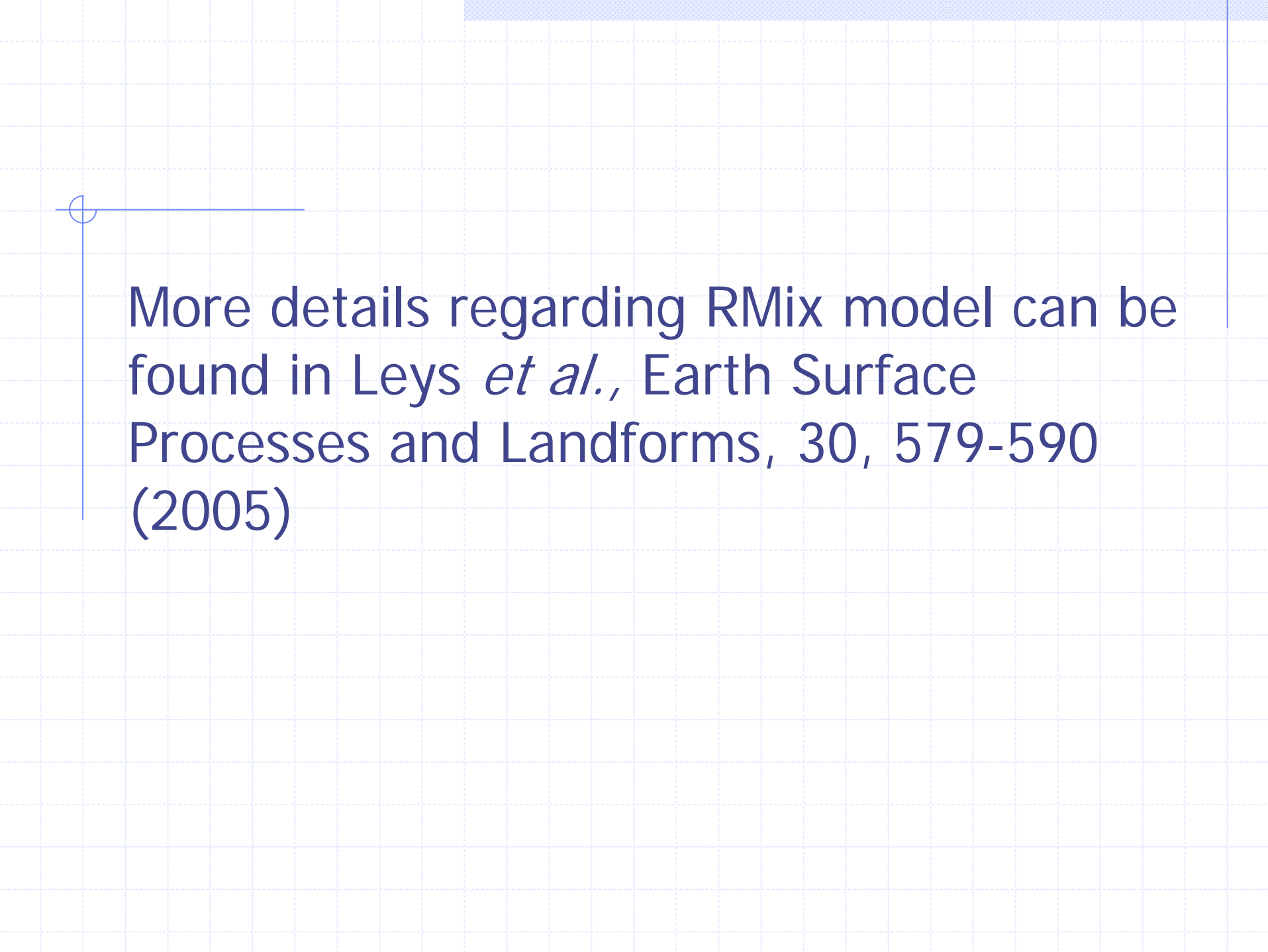
Future Work

- ◆ Normalise data by traffic and VOC emissions to analyse effects of other meteorological parameters such as solar radiation, temperature and humidity on number concentrations
- ◆ Experimental campaign in Kirkstall, Leeds – analysis of the level of volatile substances present on particles throughout day.

References

- ◆ Oberdorster, G., 2002. Environmental Health Perspectives 110. A440-A441
- ◆ Leys *et al.*, 2005. Earth Surface Processes and Landforms 30, 579-590

I would like to thank Dr Ian Longley of Manchester University for providing temperature, humidity and traffic data for the Manchester experiment and also the Meteorological Office for providing global radiation data



More details regarding RMix model can be found in Leys *et al.*, *Earth Surface Processes and Landforms*, 30, 579-590 (2005)