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New approaches in particulate size and morphology measurements

'New Approaches in Particle Size and Morphology Measurement'

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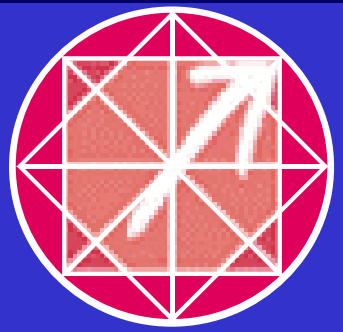
Zürich, 6th of August 2001

Background

This presentation is based on investigations founded by the European Union, during the

PSICO-DEXA Project

Particle SIze and COmposition measurements for Diesel EXhaust Aftertreatment



The European Commission

Community Research

Competitive and Sustainable Growth

Contents

- Objectives
- Overview of used measurement technology
- Correlation to gravimetric particulate matter results
- Transient nanoparticle size measurement
- Particle morphology and analysis
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Objectives

Development and evaluation of ...

- size
- composition and
- joint size- composition measurement techniques

for diesel particulate emissions in the ...

- raw and
- diluted exhaust,

with emphasis on the evaluation of...

- sample preparation and
- sampling conditions.

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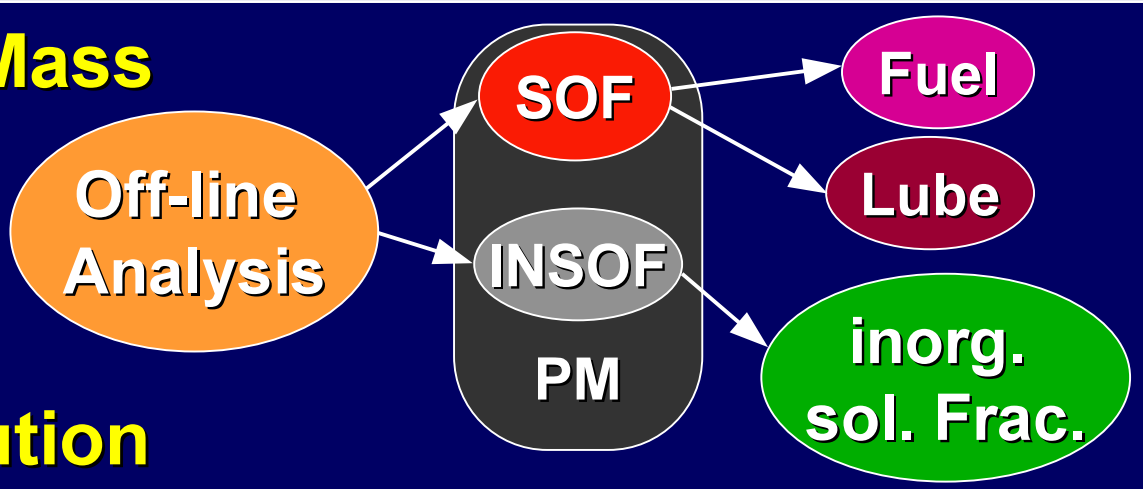
Measurement Technology

Integral Particulate Mass

AVL Smart Sampler
AVL Dilution Tunnel



Particle Size Distribution

steady state

DDMPS (Dual Differential Mobility Particle Spectrometer)

TDMPS (Transient Differential Mobility Particle Spectrometer)

transient

Particle Morphology

TPS (Thermophorethic Sampling Method)
AEM (Analytical Transmission Electron Microscopy)

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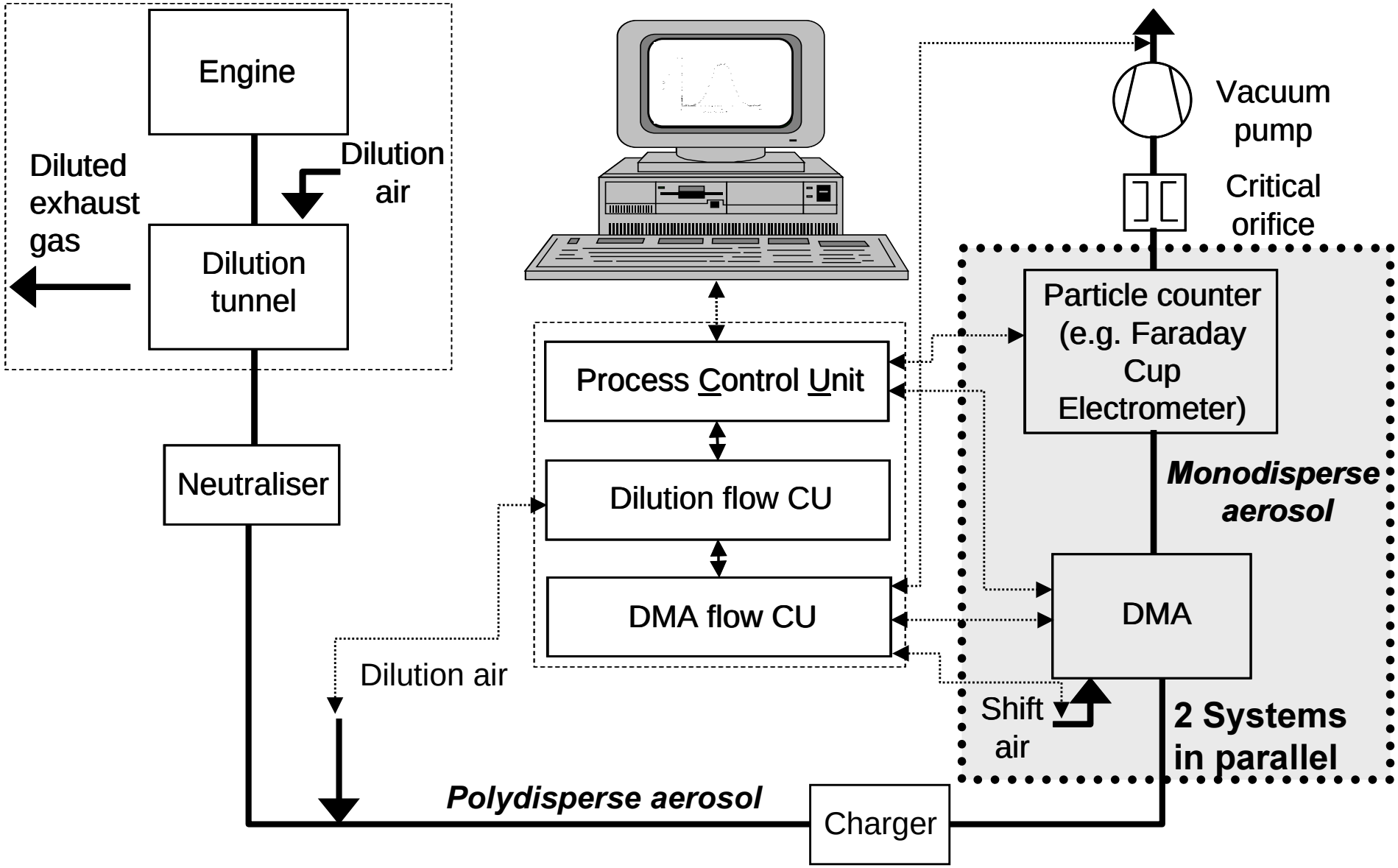
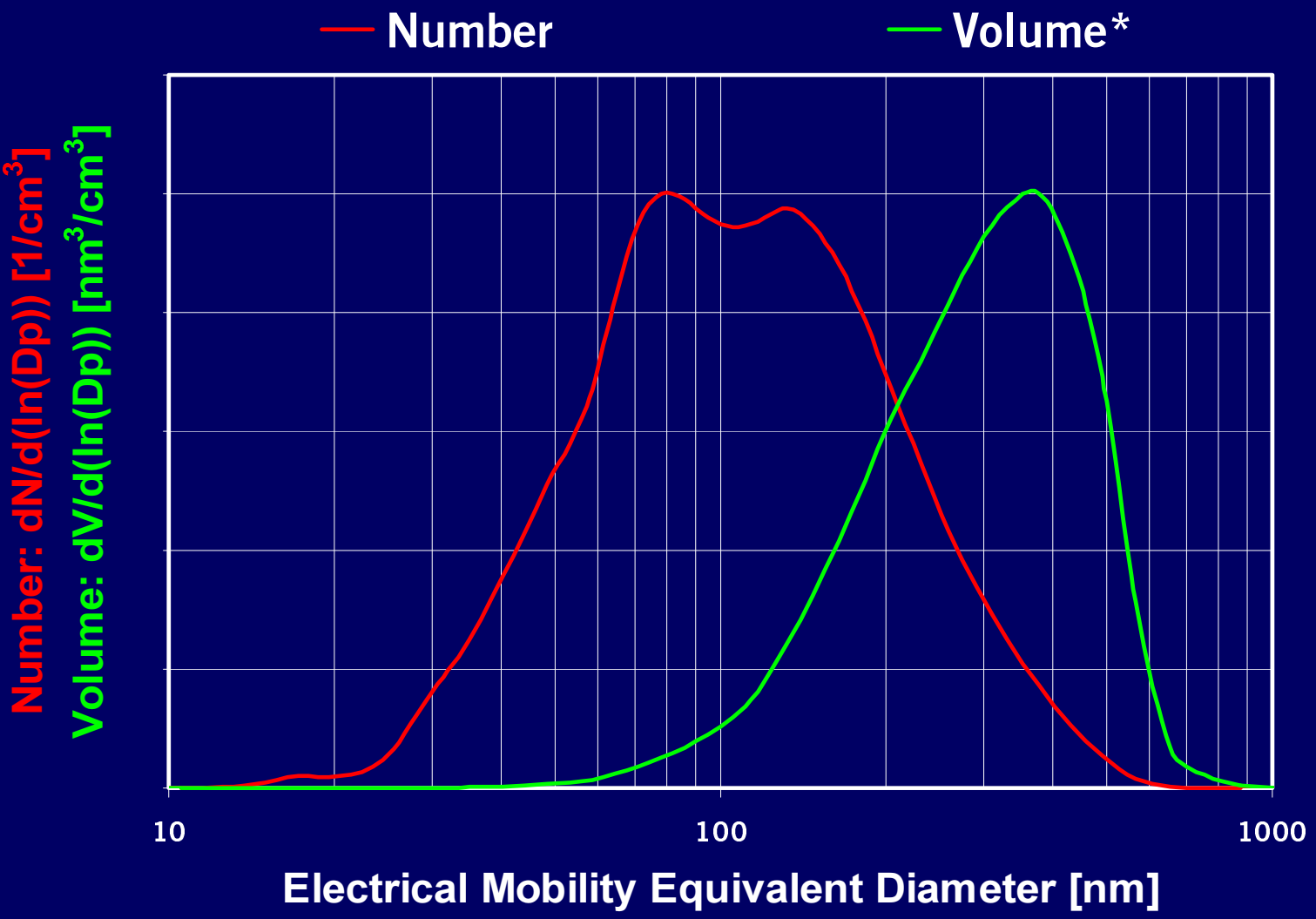
Double Differential Mobility Particle Spectrometer

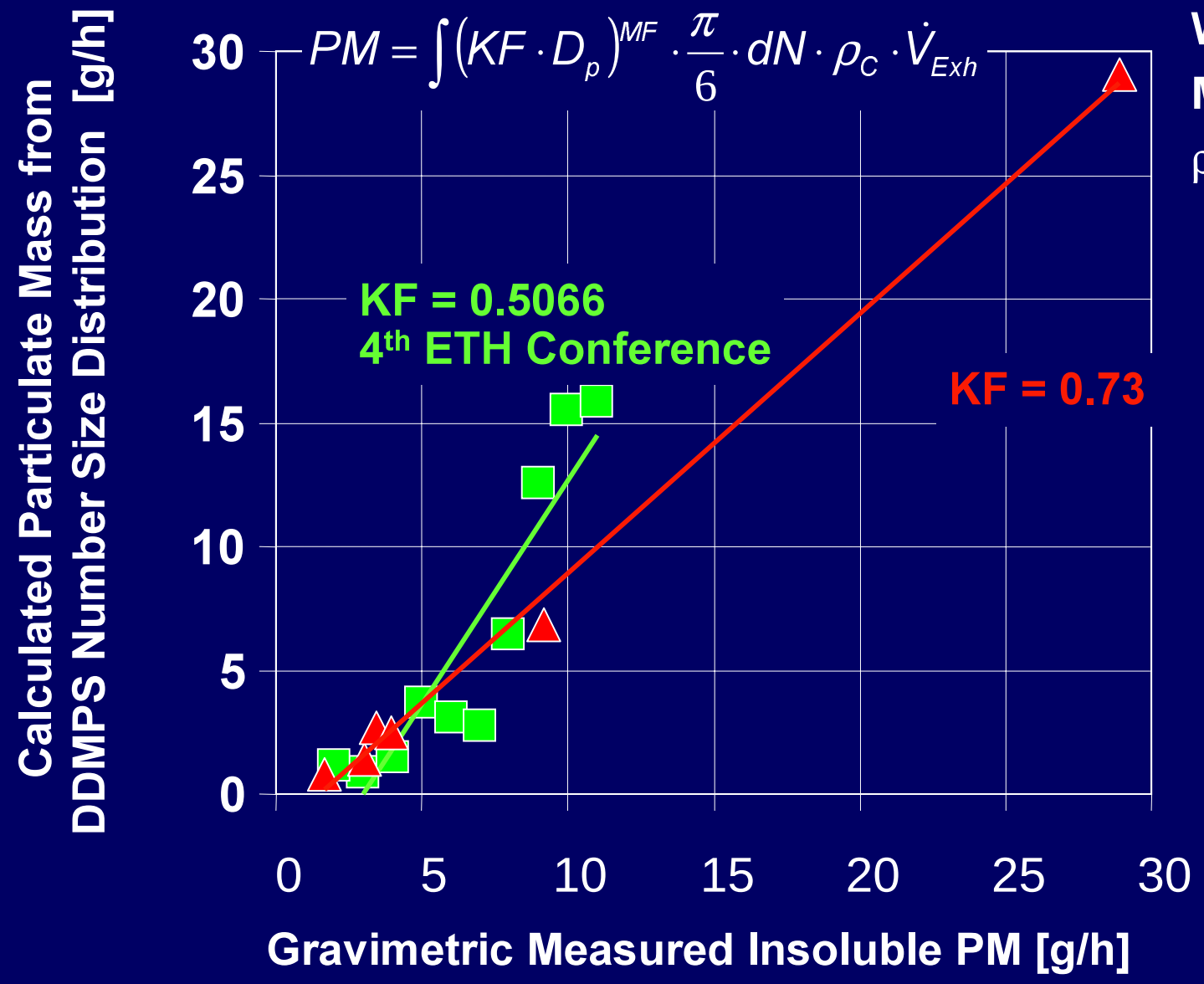


Number and Volume Concentration



* Spherical particles assumed!

Particulate Size and Gravimetric Results



With:

MF= 3.0

ρ_C = 1 kg/dm³

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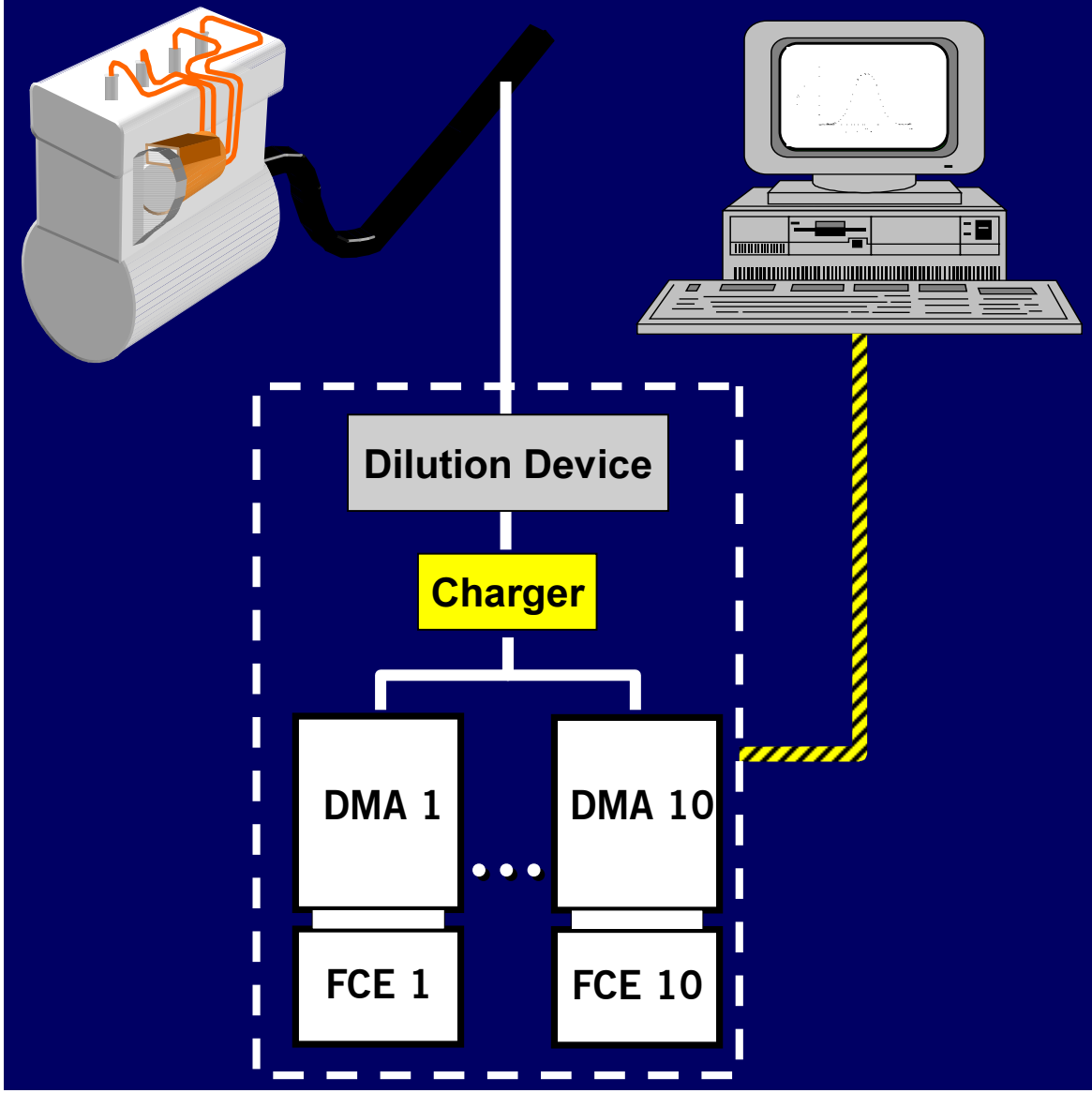
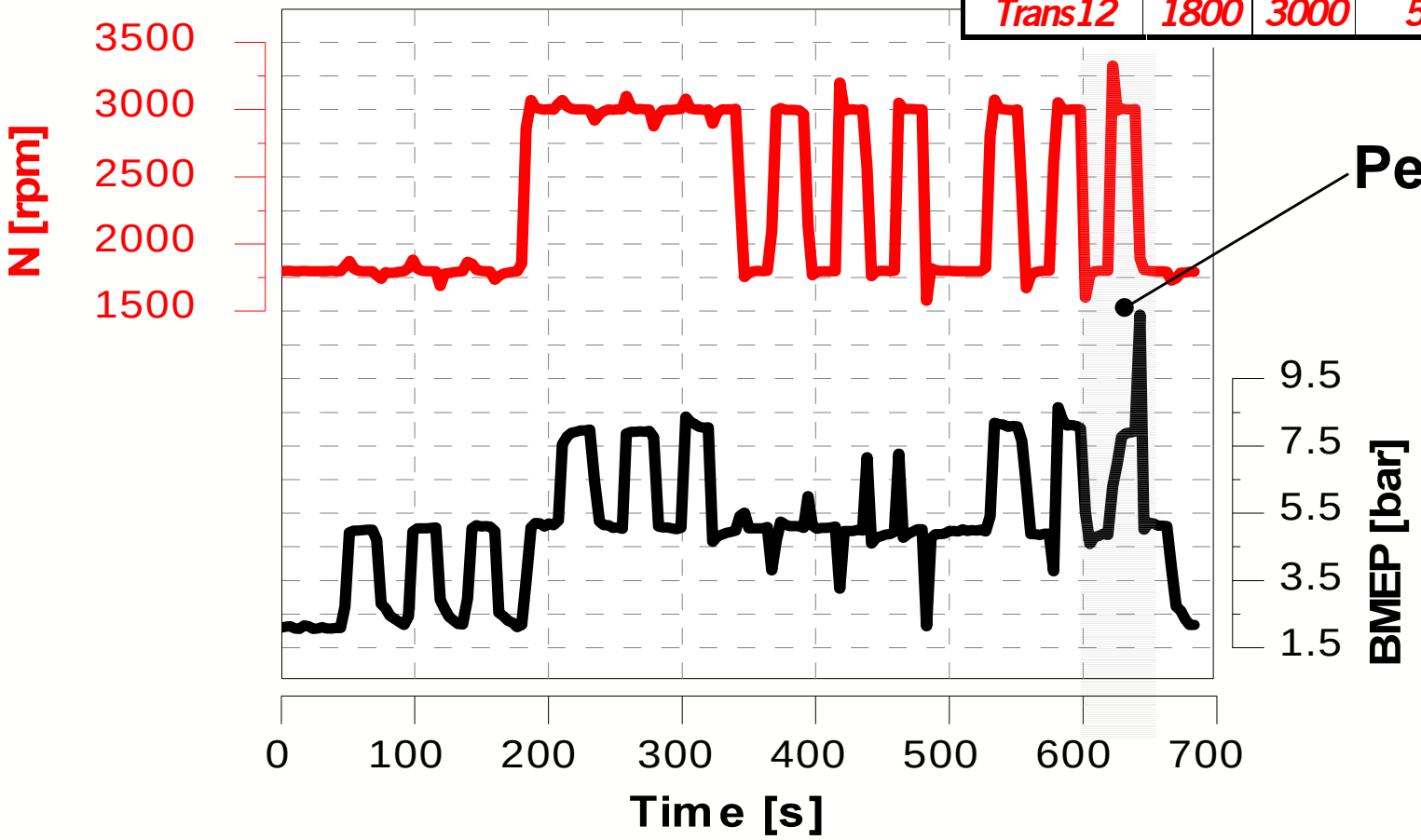
Transient Differential Mobility Particle Spectrometer

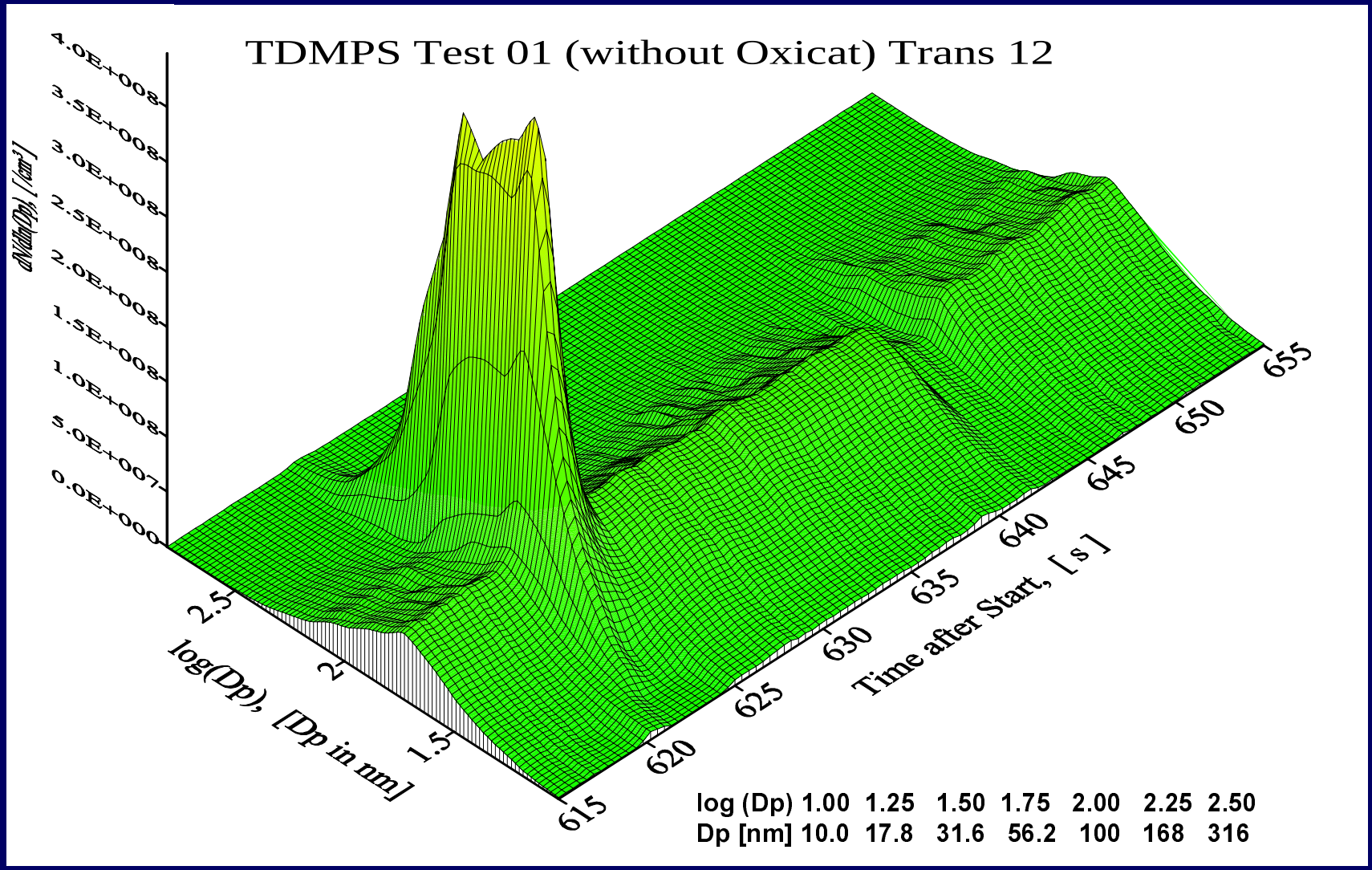


Transient Test with TrDMPS

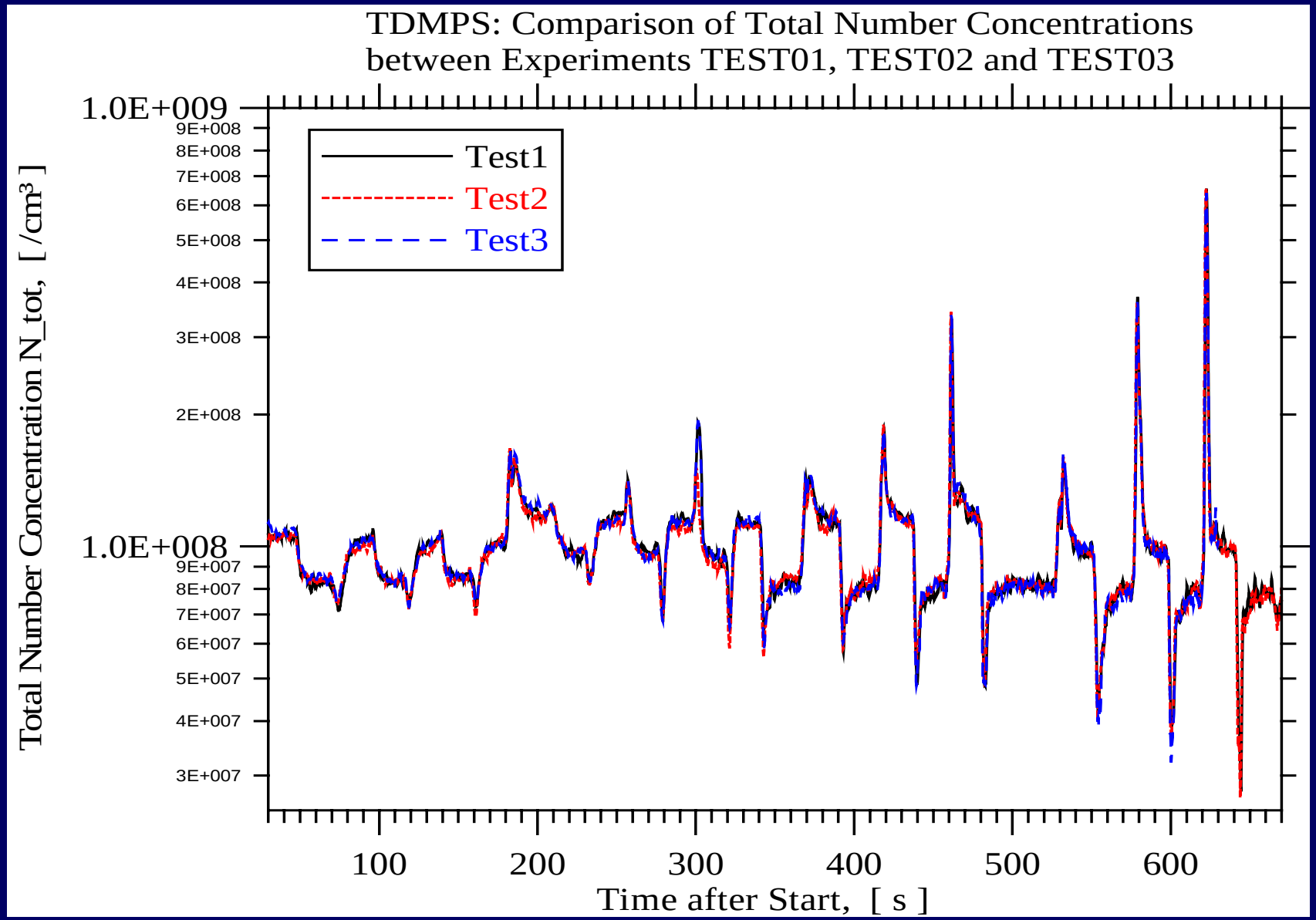
Name of Test	N_1	N_2	$BMEP_1$	$BMEP_2$	t_{A1-A2}
-	rpm	rpm	bar	bar	s
Trans12	*1800*	*3000*	*5*	*8*	*0*



Transient Test with TDMPS



Reproducibility of TDMPS Measurements



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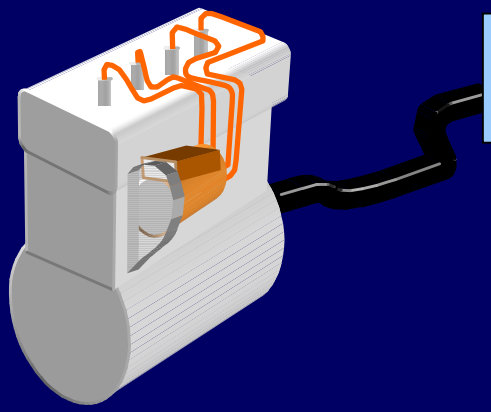
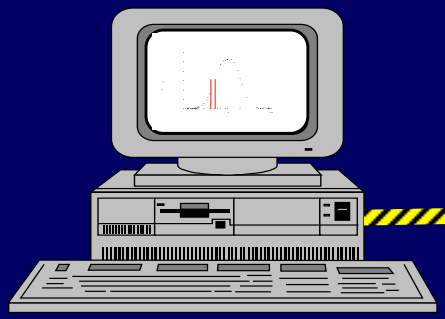
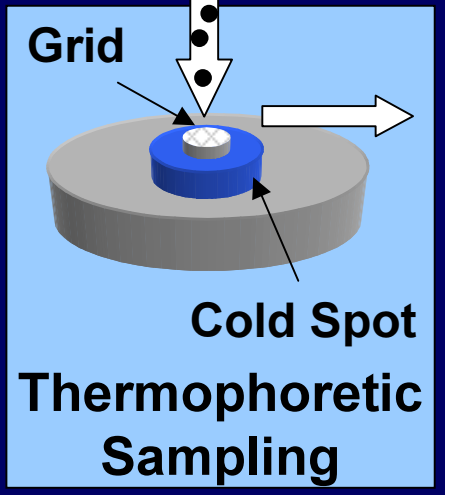
Particle Morpholgy and Composition



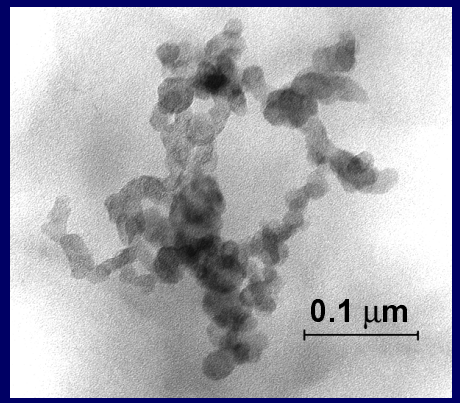
Dilution Device → Charger → DMA

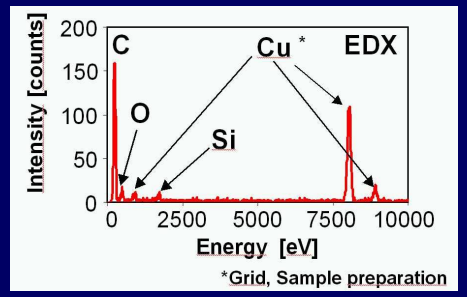


Monodisperse Aerosol



Thermophoretic Sampling



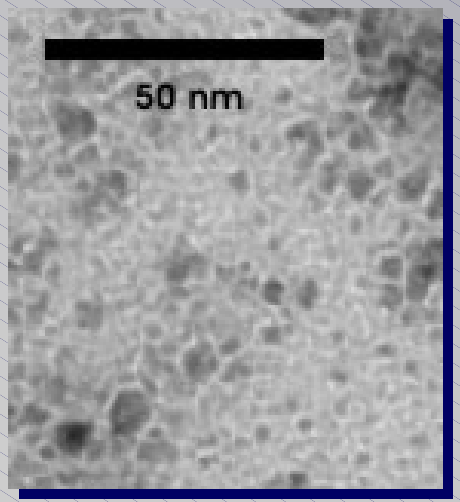


Analytical Electron Microscope

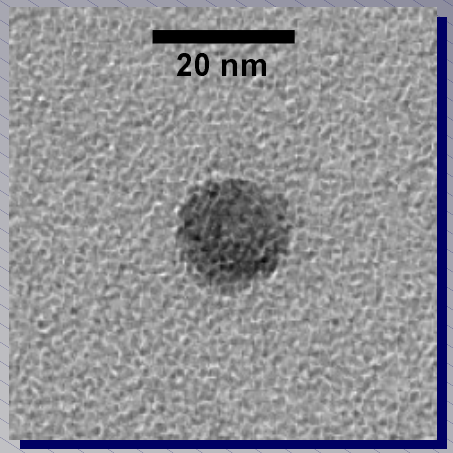
Particle Morphology

Primary Particles

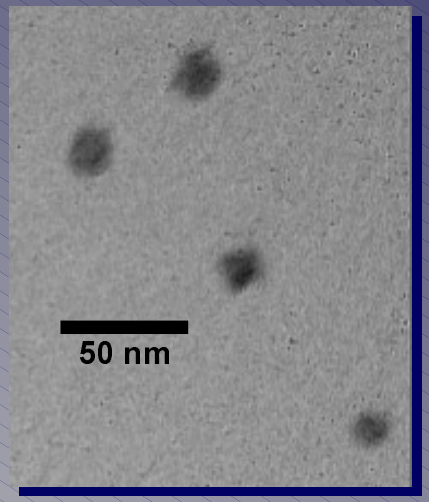
5 nm



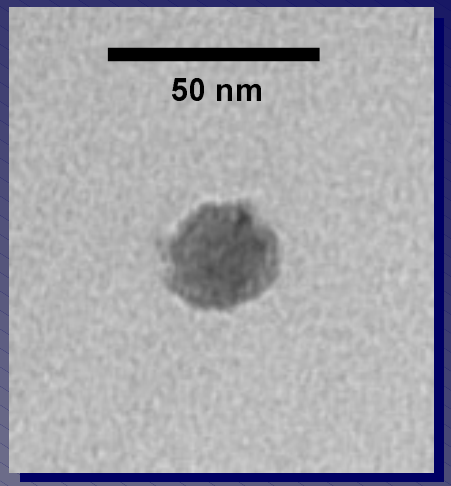
15 nm



20 nm



40 nm

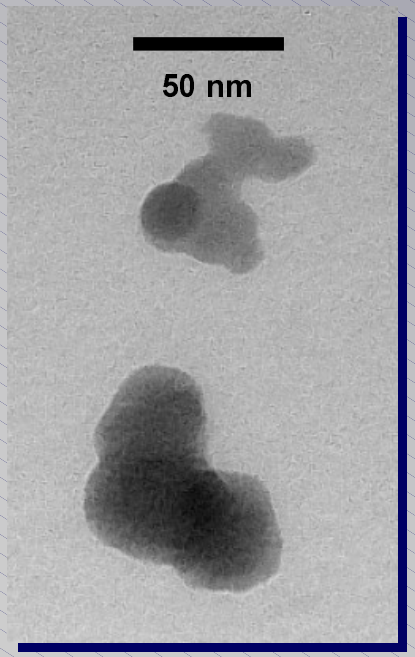


Electromobility Diameter

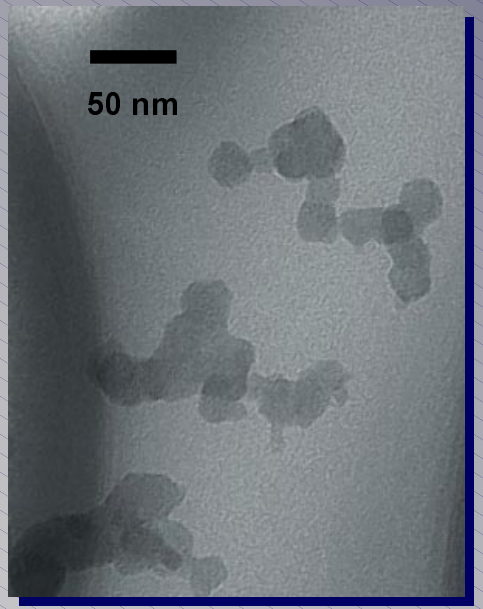
Particle Morphology

Agglomeration Process

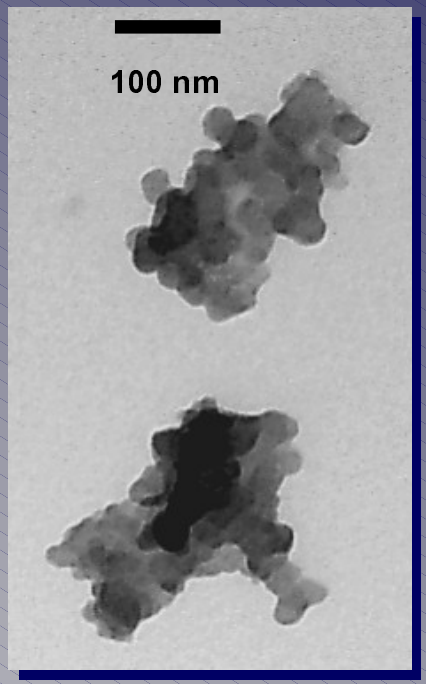
40 nm



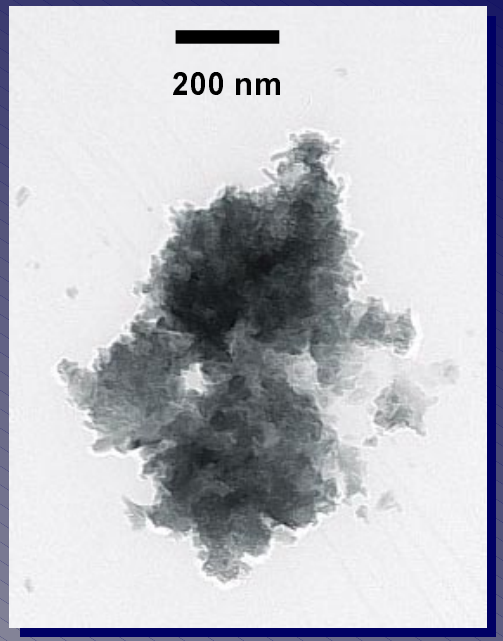
75 nm



100 nm



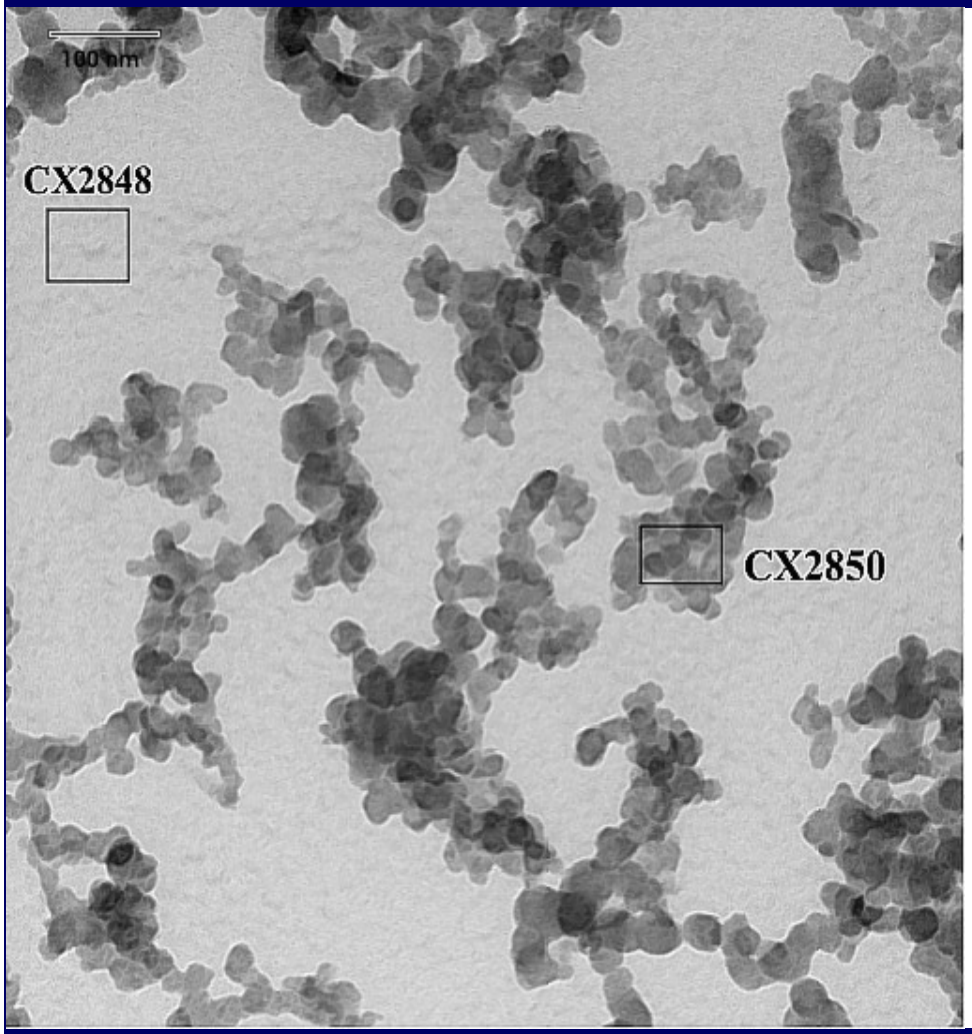
375 nm



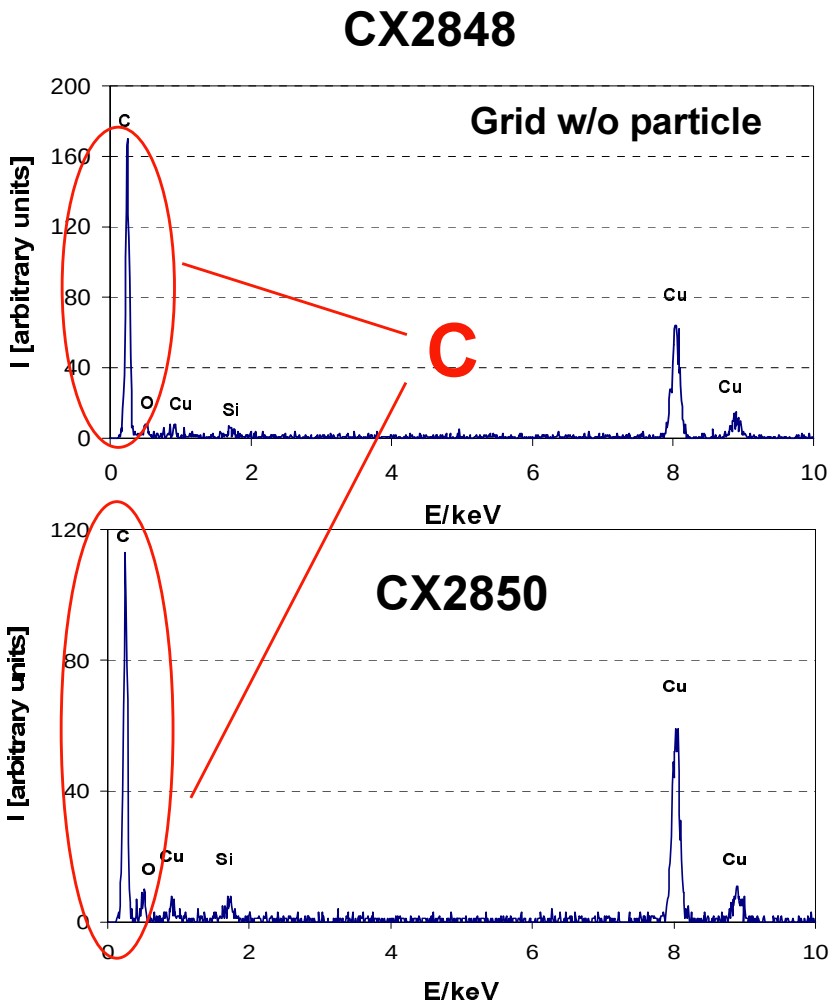
Electromobility Diameter

Analytical Electron Microscopy

TEM image



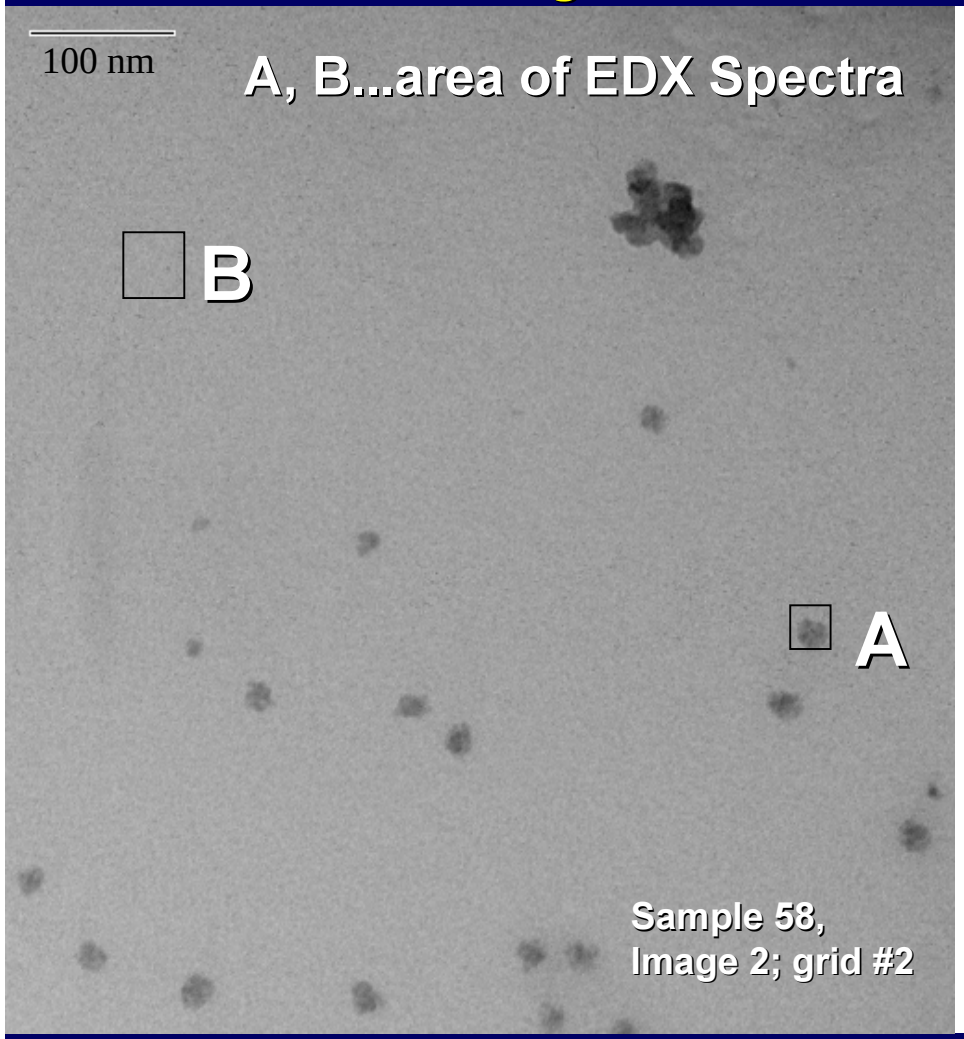
EDX spectra



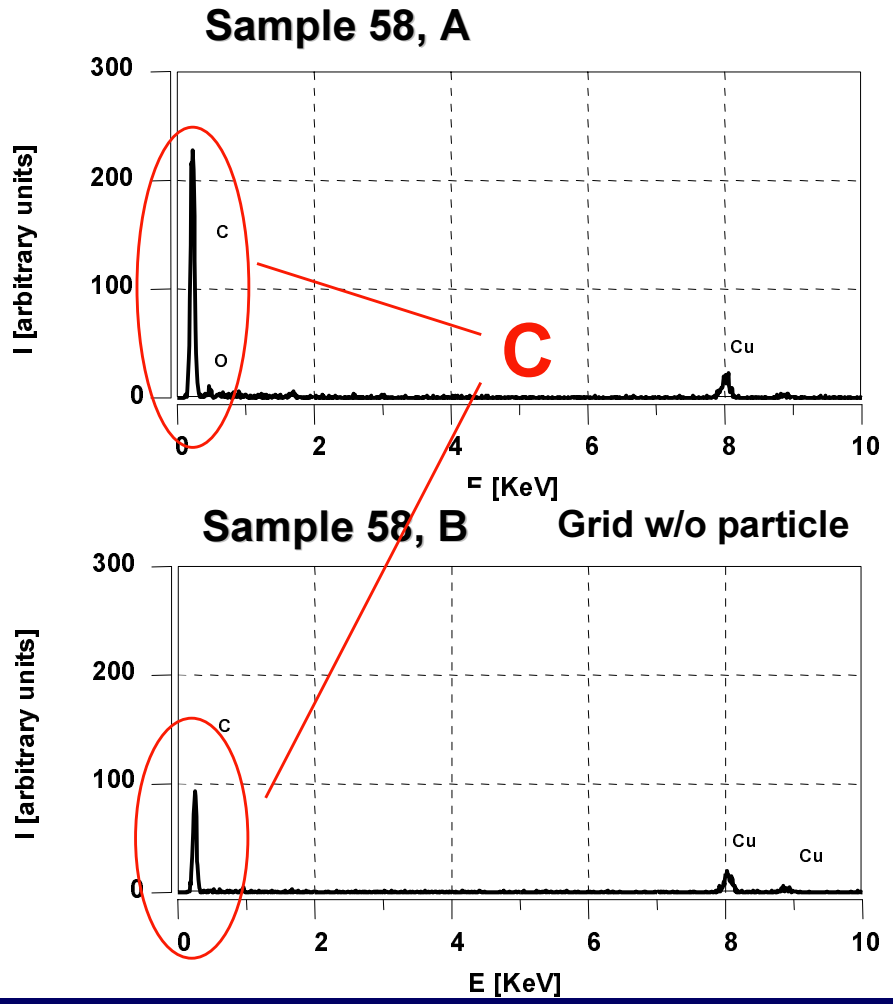
Engine Speed 1500 rpm, 1.9 bar BMEP

Analytical Electron Microscopy

TEM image



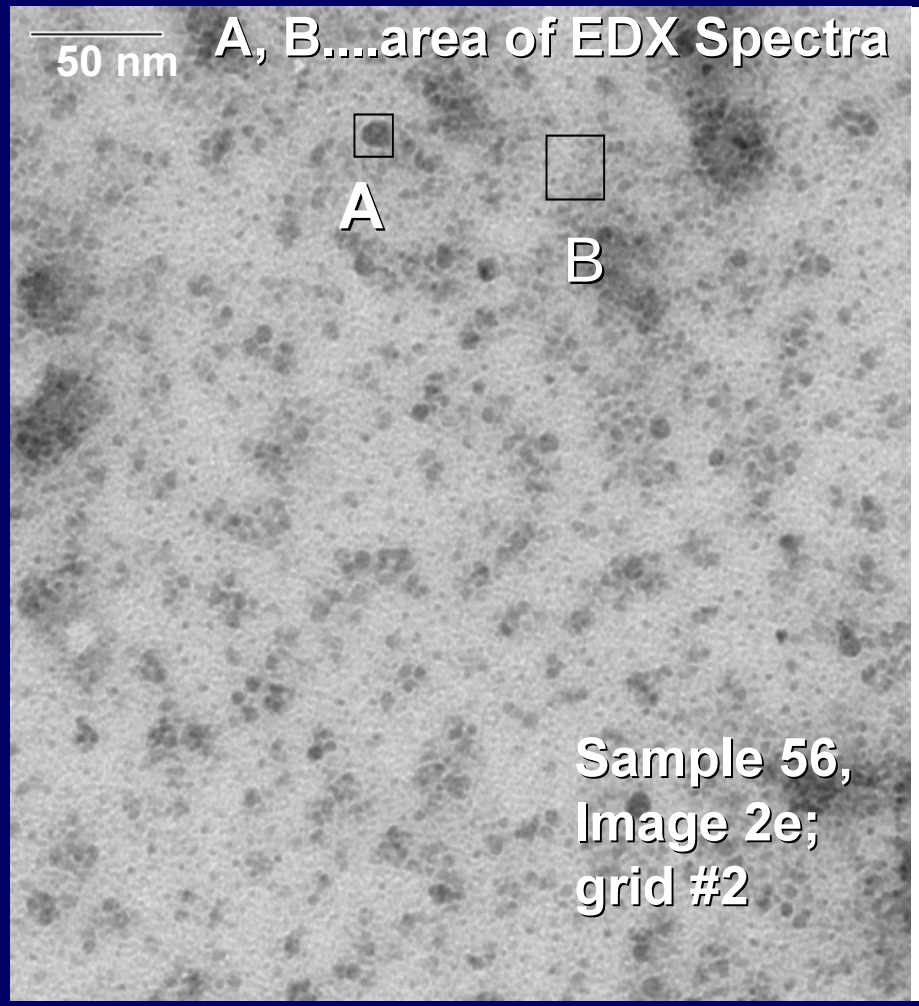
EDX spectra



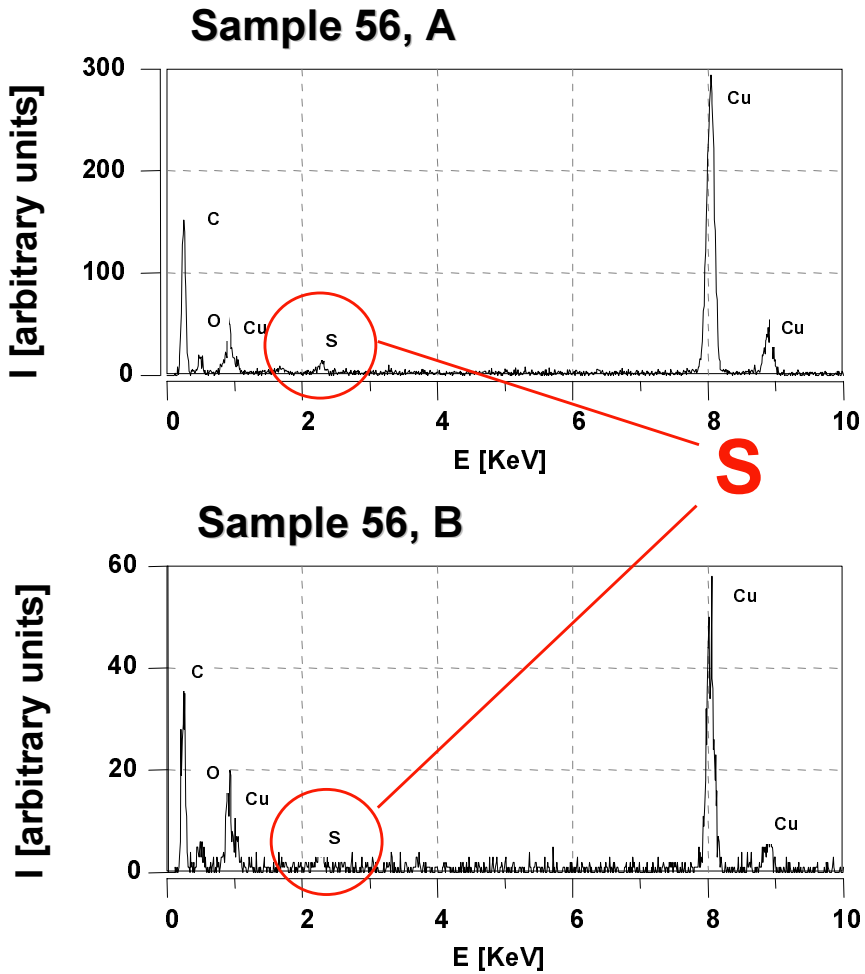
Engine Speed 2000 rpm, 15.5 bar BMEP

Analytical Electron Microscopy

TEM image



EDX spectra



Engine Speed 2000rpm, 15.5 bar BMEP

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Summary and Conclusions

- Correlation between gravimetric (INSOL) and particle size measurement seems possible
- TrDMPS allows transient particle size measurement (up to 5 Hz) with excellent repeatability
- Particle morphology shows primary particles 5 to 50 nm
- Agglomerates were detected ~ 30 nm
- Particles < 20 nm consist of Sulfur compounds (to proof, further investigations necessary)


Thank you very much
for
your attention!