# PARTICLE MEASUREMENTS USING DMS500 DURING PHCCI TESTS AT VOLVO TECHNOLOGY

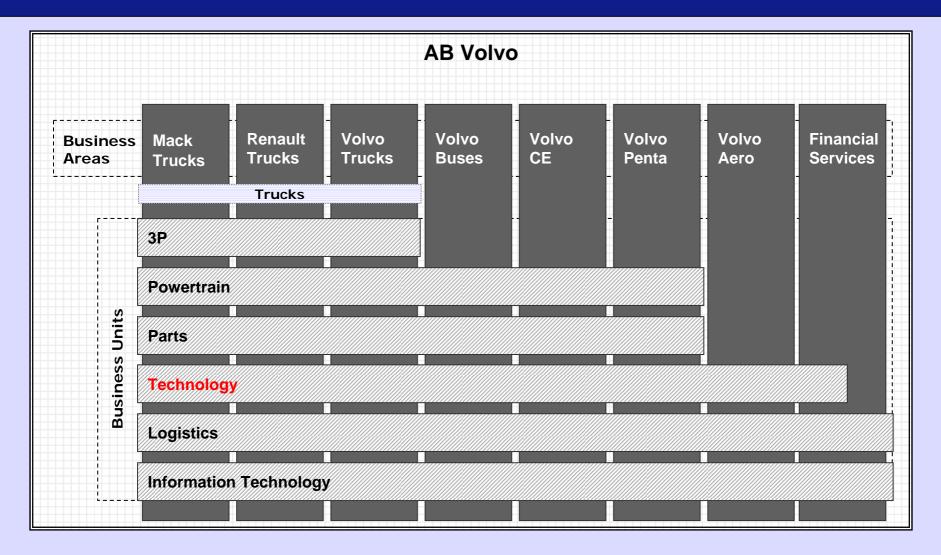
Ann W Grant Volvo Technology Corporation Göteborg Sweden

## **BUSINESS AREAS AT AB VOLVO**





# THE VOLVO GROUP ORGANISATION



# FACTS ABOUT VTEC

- We are 381 employees
- VTEC turnover is €36M
- Established 1969
- Innovation Areas
- services
- production
- vehicles
- powertrain
- electronics
- processes & methods
- Innovation Services
- intellectual asset management
- standardisation intelligence



# **VTEC ORGANISATION**

Corporation												
Soft Products 6002 Mats Rosenquist	agement									2		
Production 6003 Urban Wass	e Mana		tion	<b>ysics</b>	ring		۲.			, Libra	ure	
Vehicles & Load Structures 6004 Lars-Erik Larsson	& Site Ma	<b>Telematics</b> uist	ntegration		& Manufacturing Larsson	Software	Chemistry		rds		structu	e 🗌
Propulsion & Alt. Drives 6005/6 Göran Wirmark & Per Ekdunge	Liaison Colpier; US	<b>Teler</b>		nark	<b>&amp; Manı</b> Larsson	<b>X</b>	×	<b>atent</b> hling	Standa Grundén	Retri edig	I nfra: nezevic	t Office
Electronics & Electrics 6007/8 Ted Kruse & Eilert Johansson	- 0	Transport & Tel	SOL	ran Wirn			<b>nmen</b> Jan Was	rate P	orate Standa Jan-Olof Grundén	<b>ation</b> -Britt Se	<b>eering</b> nislav Kr	emen Il Berg
Methods & Processes 6009 Hans Persson	sust yon L	Transport 6600 Mats Ros	Human 6400 Karin	6100 Göran Wirmark	Mechanics 6500 Lars-Erik	ectr	Environment 6700 Urban Wass	<b>orp(</b> 20 M	Corporate 6850 Jan-Olof	Information Retrieva 6830 Ann-Britt Sedig	Engineering Infrastructure 6880 Tomislav Knezevic	Management

#### Volvo Group

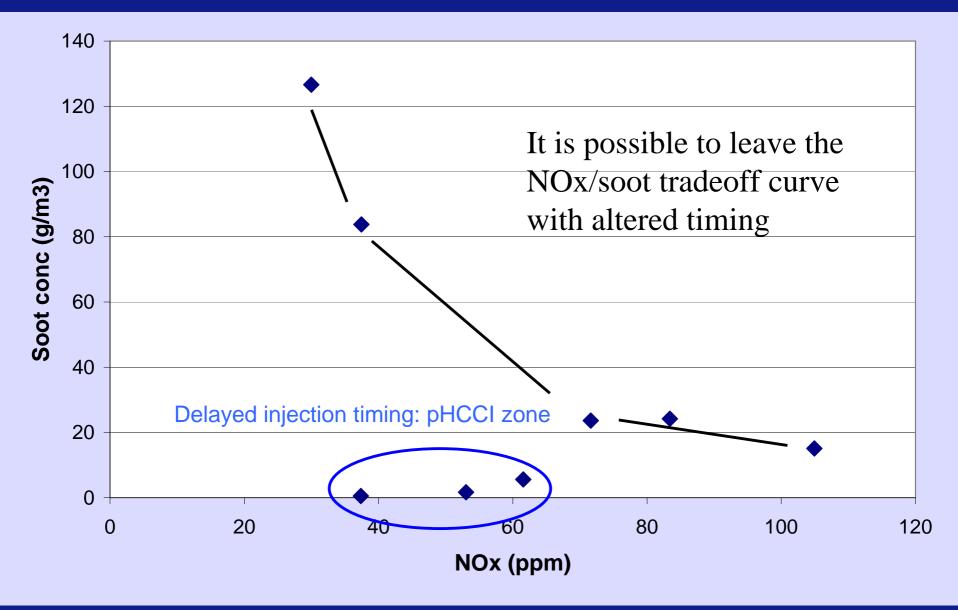


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#### PARTICLE MEASUREMENT AT VTEC

- Obtained a differential mobility spectrometer in Nov 2005 from Cambustion, the DMS500
- Examined particle size and number density during partial Homogenous Charge Coupled Ignition, pHCCI, testing at various steady state points (i.e. given load and speed) at a single cell engine bench
- Larger goal of the engine work was to examine how certain parameters, such as timing and EGR, affect combustion
- Some results of how injection timing affects particle production will be shown

# ENTERING PHCCI ZONE AT <sup>o</sup>ATDC OF ~8-10



#### **PARTICLE MEASUREMENT AT ENGINE BENCH**

Differential Mobility Spectrometer Cambustion DMS500

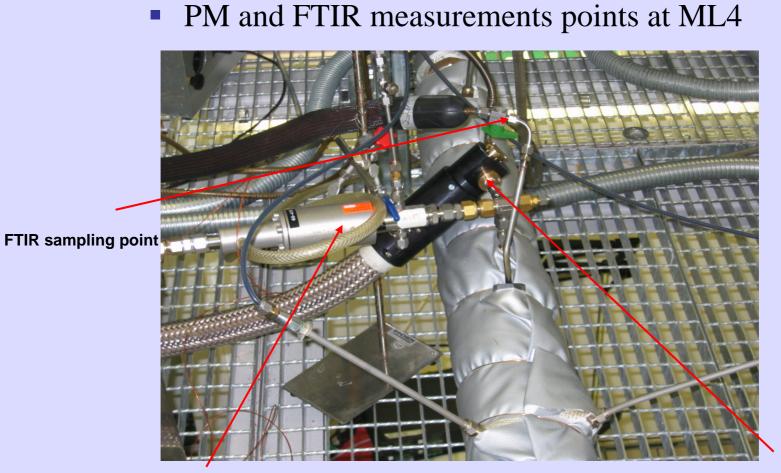


Inbuilt 2-stage dilution
1:1 up to 5000:1
Real time (up to 10 Hz) acquisition of particle size spectrum from 5 to 2500 nm

DMS500 heated remote sampling tube

FTIR analyser

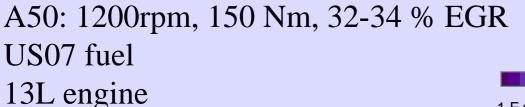
#### **PARTICLE MEASUREMENT**



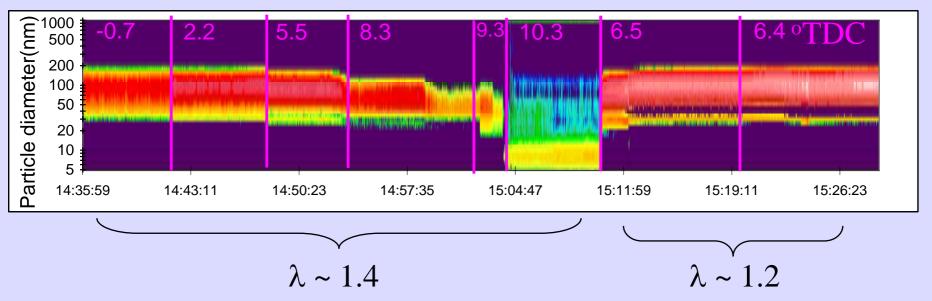
Decati ejector with attached filter for total particle mass measurements

PM sampling point

# **DMS500 MEASUREMENT OF PARTICLE SPECTRAL DENSITY**

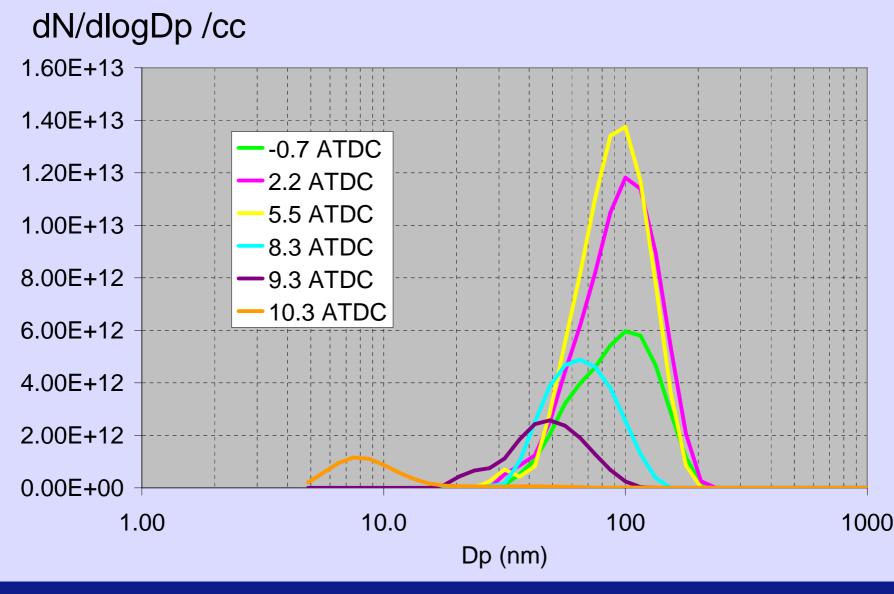


1.E+4 1.E+5 1.E+6 1.E+7 1.E+8 1.E+9 dN/dlogdp /cc

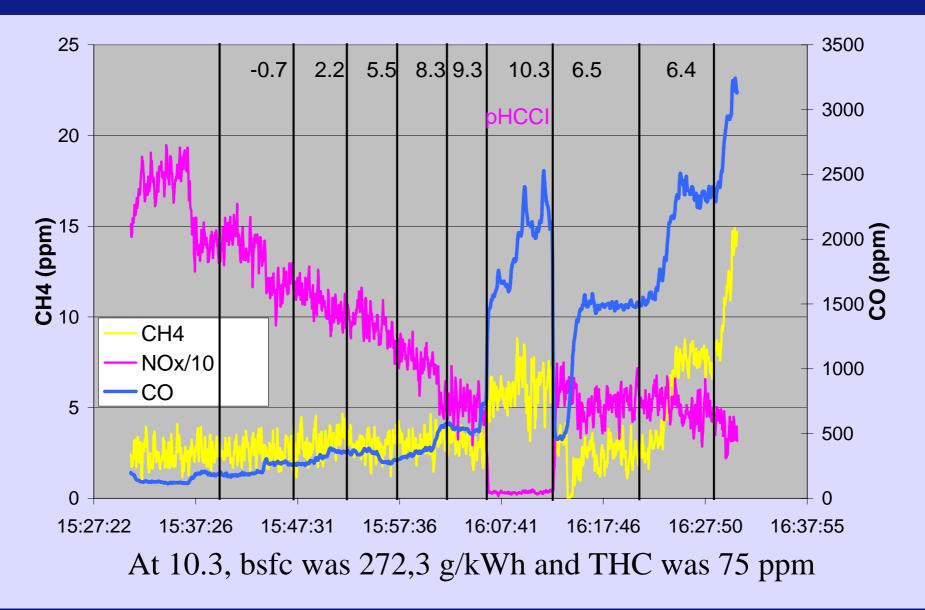


The average particle size varies from ~90 down to 9 nm during the latest timing cycle °TDC = angle in degrees from Top Dead Center

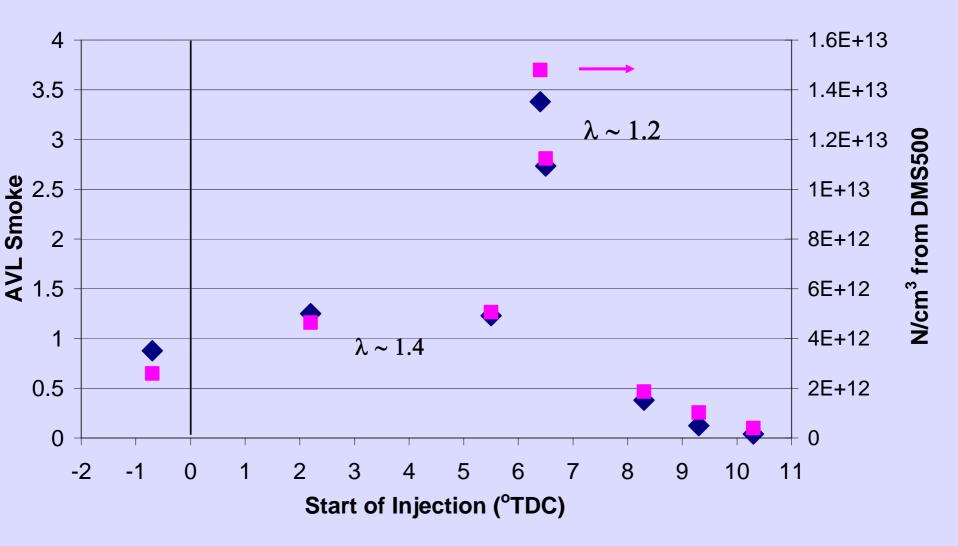
# **EFFECT OF INJECTION TIMING ON SIZE SPECTRAL DENSITY**



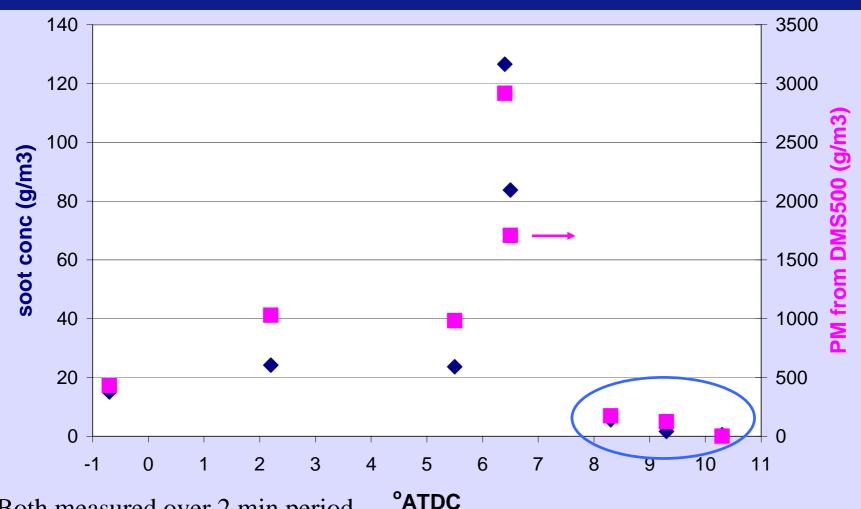
#### **INCREASE IN CH4 AND CO DURING PHCCI**



# **EFFECT OF INJECTION TIMING ON SOOT FORMATION**



# **MASS COMPARISON BETWEEN AVL SMOKE AND DMS500**



•Both measured over 2 min period

•Used water density and volume to calculate particle mass

•Mass from DMS was 20 to 70 times higher from DMS500

# **CONCLUSIONS/QUESTIONS**

- Delayed injection timing, with more homogenous mixing, decreases the size and amount of particles
- Huge fuel penalty

- What is the best way to calculate the mass?
- What is the best type of sampling probe?