

PARTICLE MEASUREMENTS USING DMS500 DURING PHCCI TESTS AT VOLVO TECHNOLOGY

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BUSINESS AREAS AT AB VOLVO



Mack Trucks



Renault Trucks



Volvo Trucks



Volvo Buses

TRUCKS



Volvo Construction Equipment



Volvo Penta

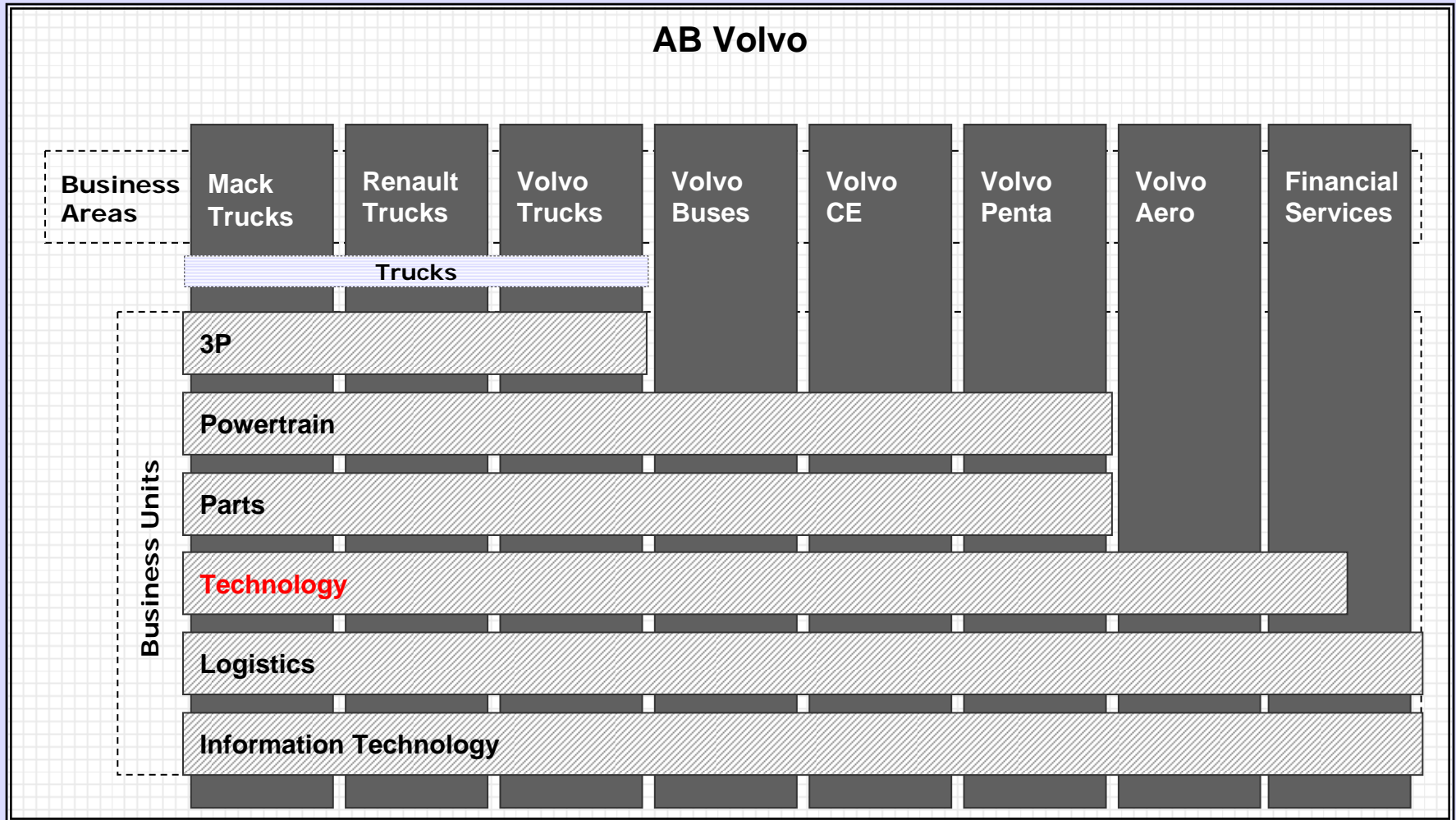


Volvo Aero



Volvo Financial Services

THE VOLVO GROUP ORGANISATION

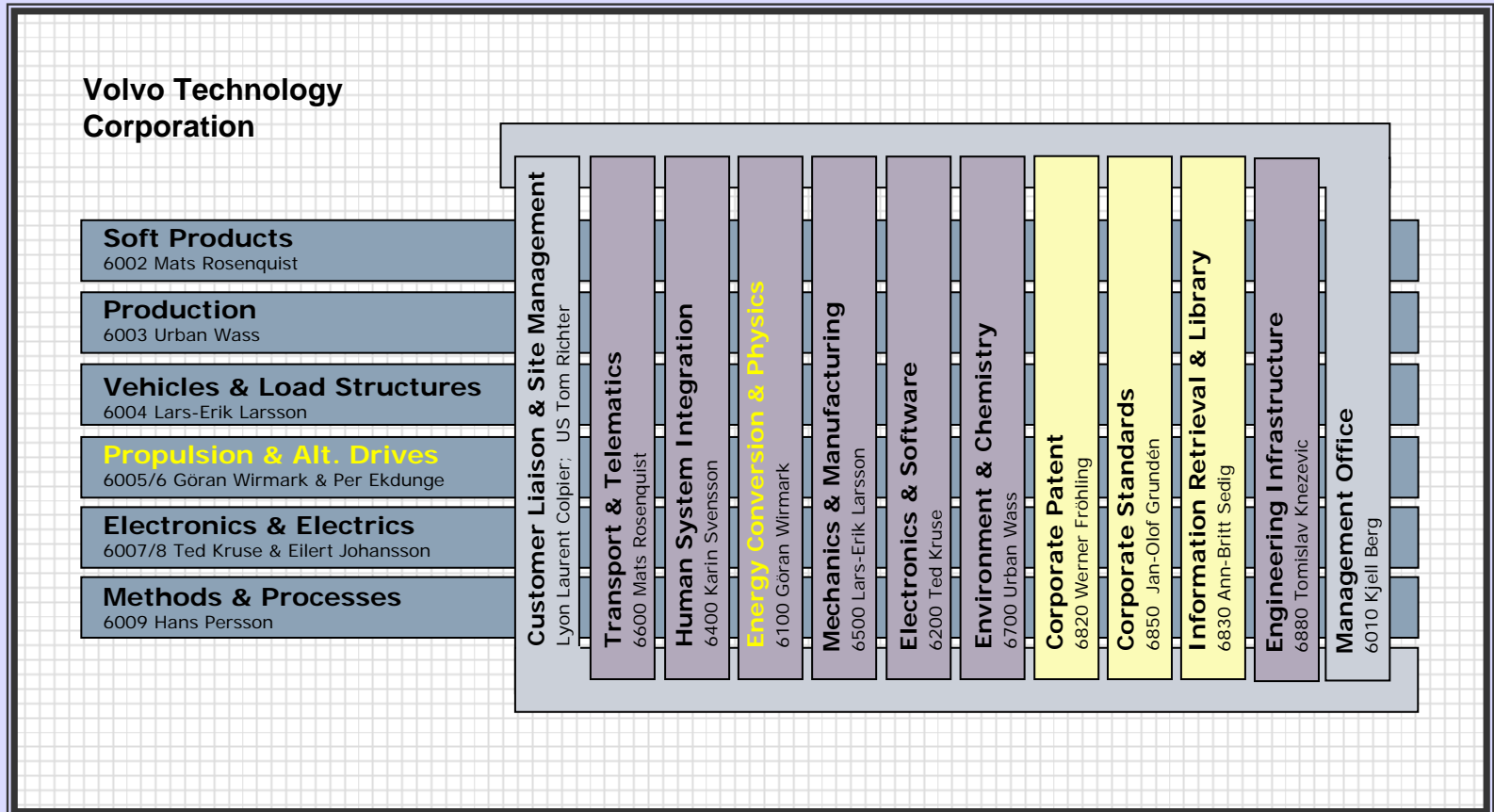


FACTS ABOUT VTEC

- 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



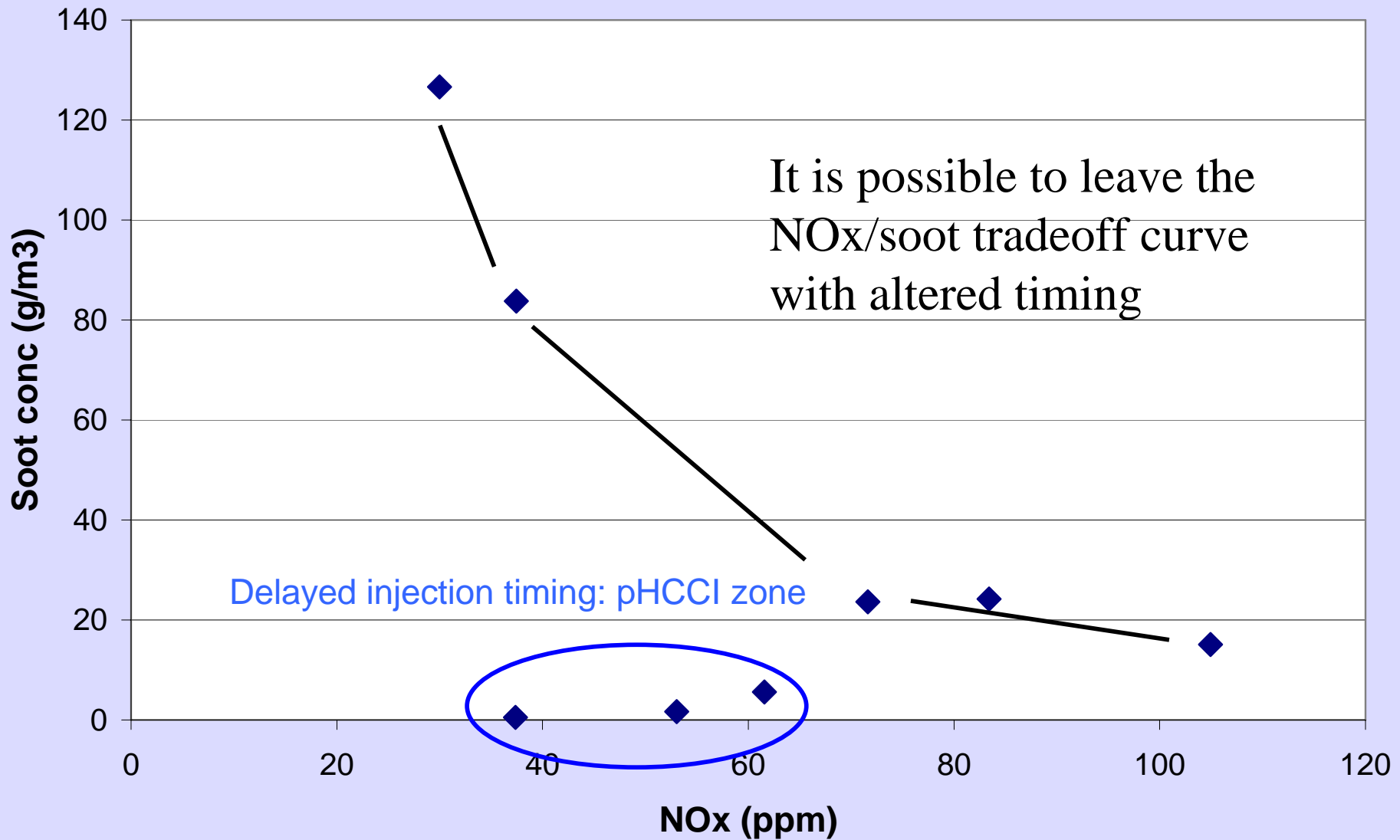
Volvo Group

- Technology Areas
- Strategic Competencies
- Expert Functions

PARTICLE MEASUREMENT AT VTEC

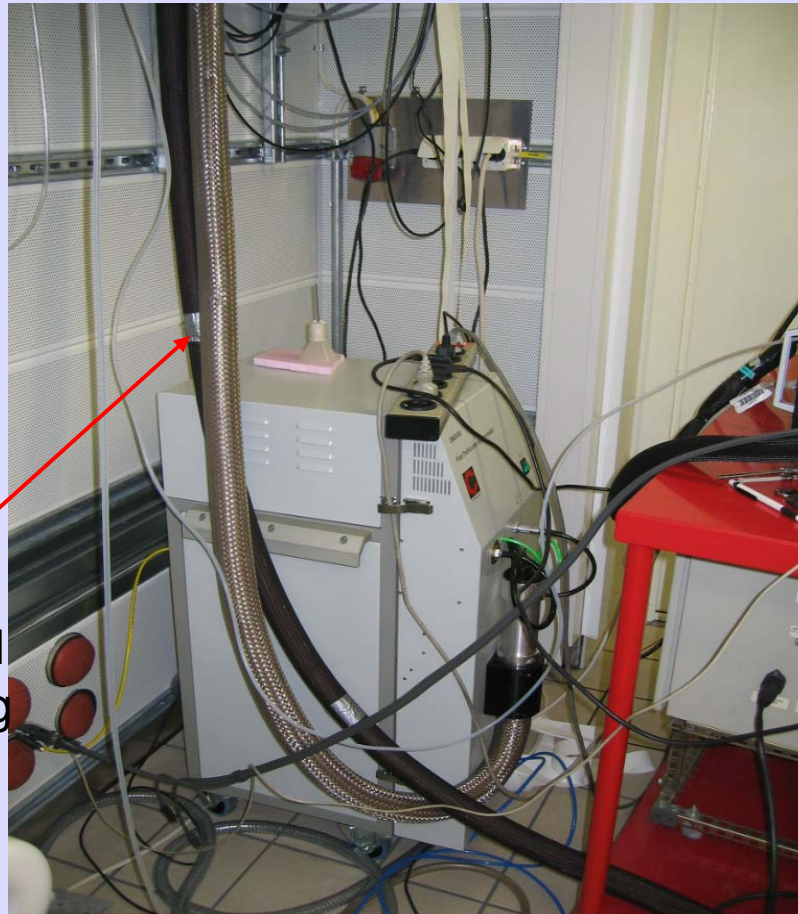
- Obtained a differential mobility spectrometer in Nov 2005 from Cambustion, the DMS500
- Examined particle size and number density during partial Homogenous Charge Coupled Ignition, pHCCL, testing at various steady state points (i.e. given load and speed) at a single cell engine bench
- Larger goal 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 °ATDC OF ~8-10



PARTICLE MEASUREMENT AT ENGINE BENCH

- Differential Mobility Spectrometer Cambustion DMS500



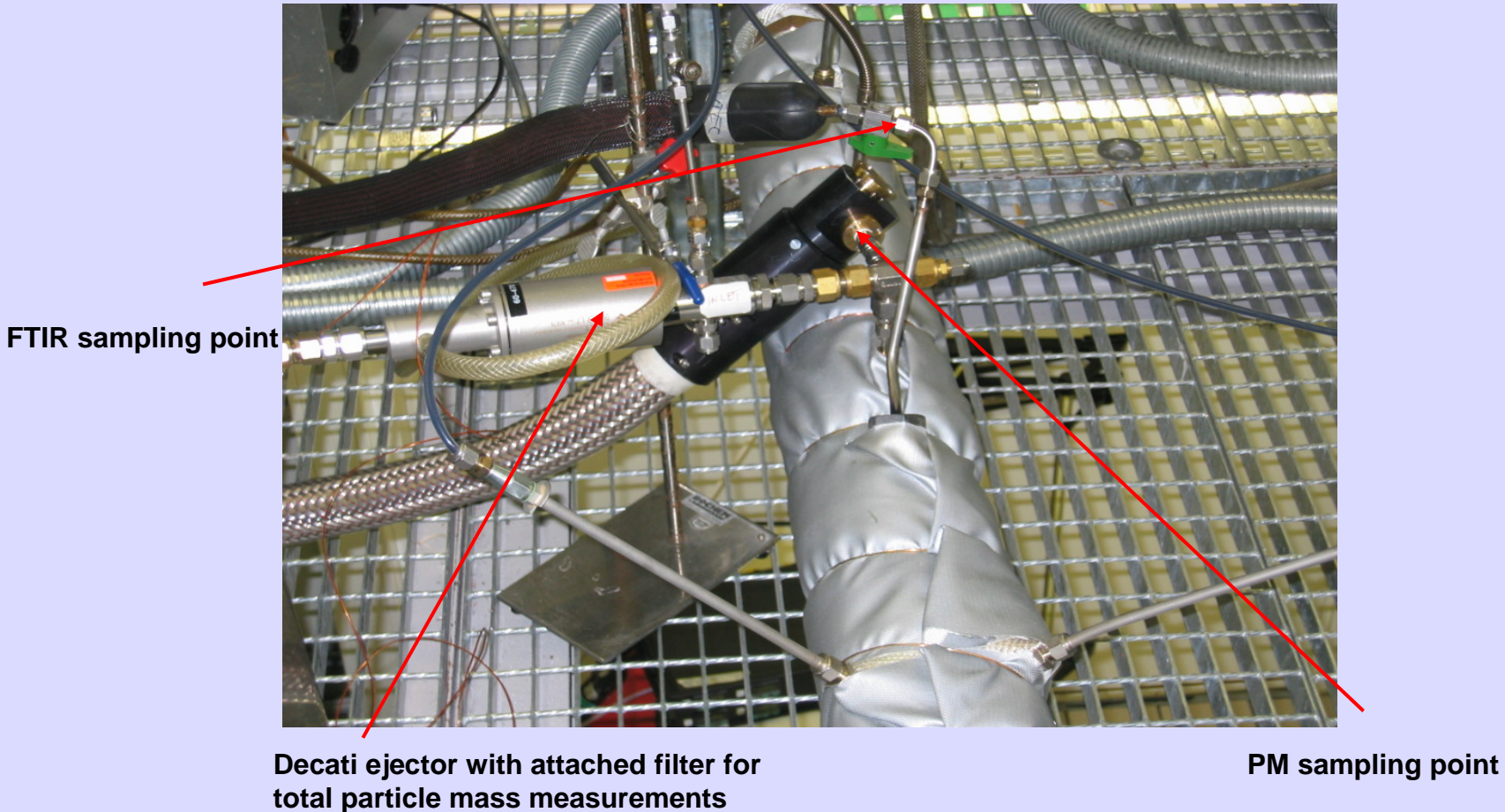
- Inbuilt 2-stage dilution 1:1 up to 5000:1
- Real time (up to 10 Hz) acquisition of particle size spectrum from 5 to 2500 nm

DMS500 heated remote sampling tube

FTIR analyser

PARTICLE MEASUREMENT

- PM and FTIR measurements points at ML4

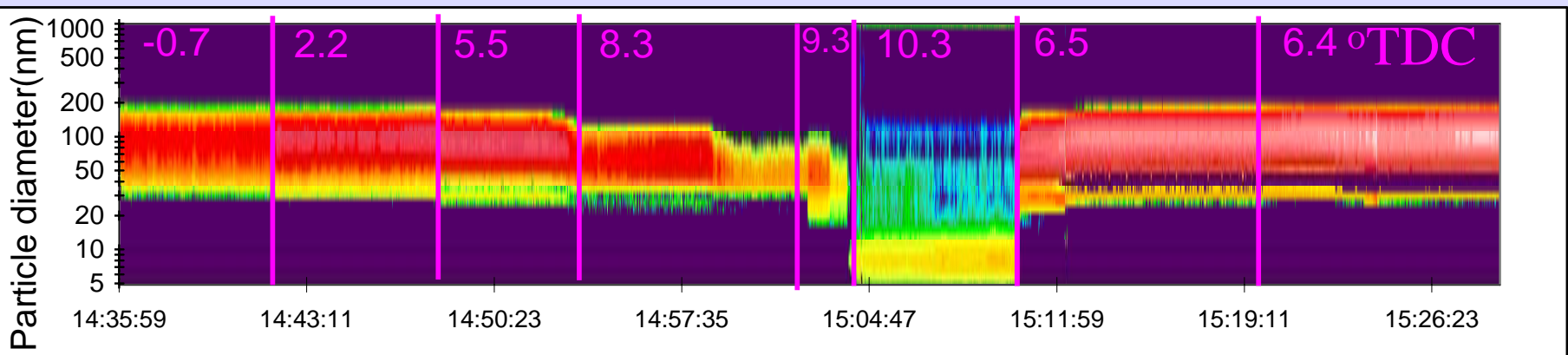
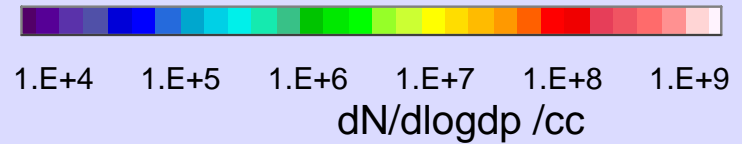


DMS500 MEASUREMENT OF PARTICLE SPECTRAL DENSITY

A50: 1200rpm, 150 Nm, 32-34 % EGR

US07 fuel

13L engine



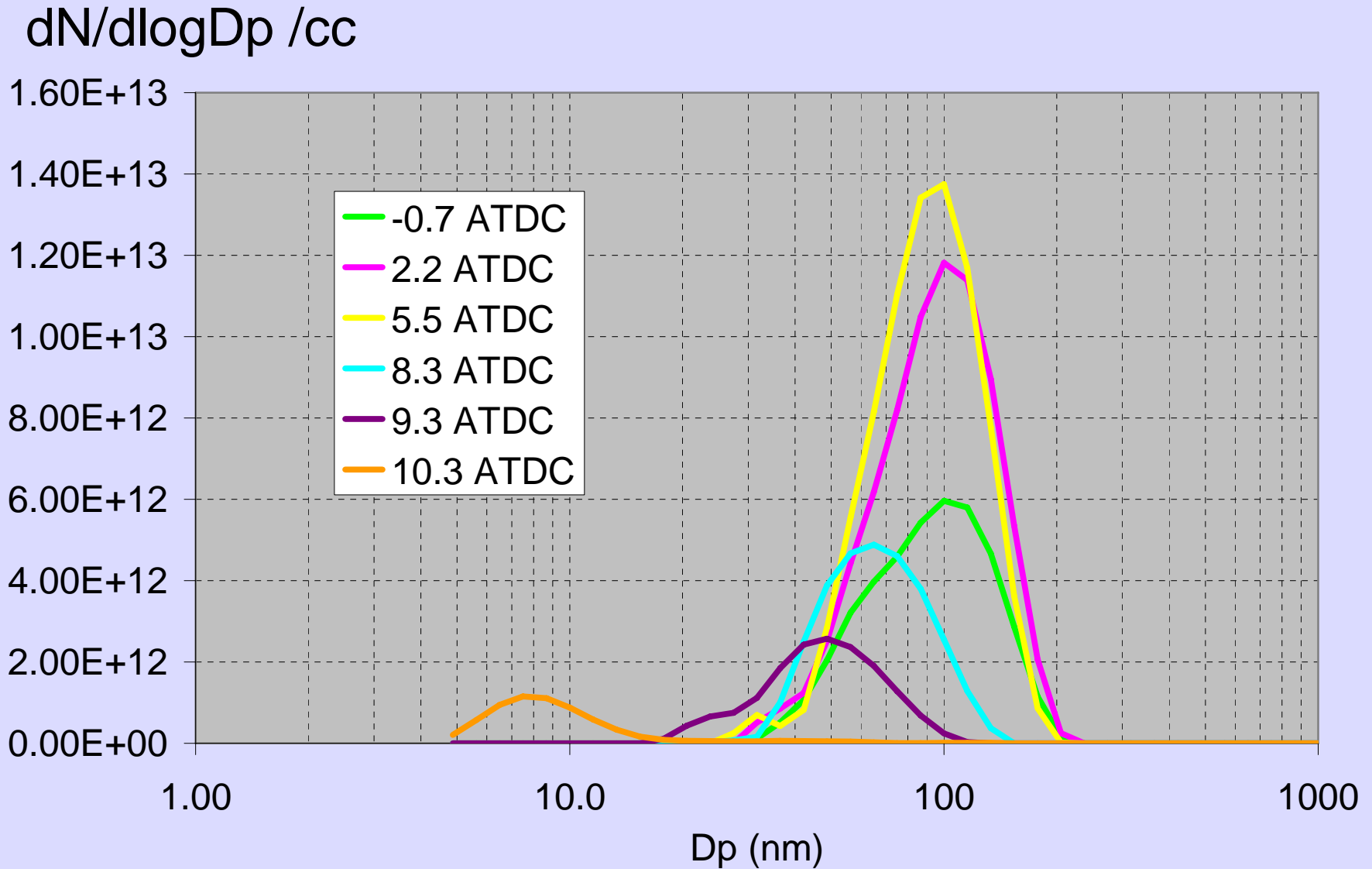
$\lambda \sim 1.4$

$\lambda \sim 1.2$

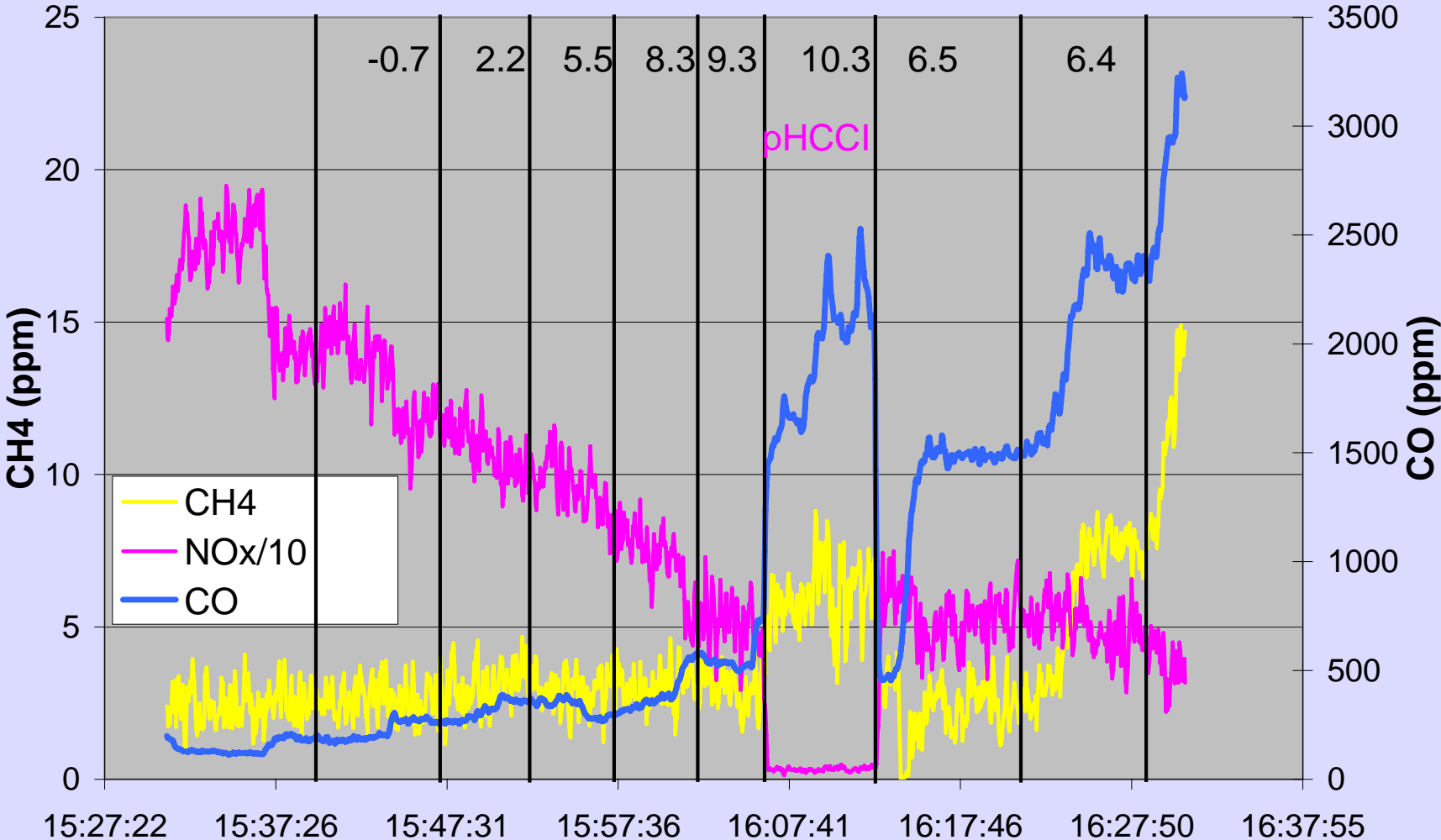
The average particle size varies from ~90 down to 9 nm during the latest timing cycle

°TDC = angle in degrees from Top Dead Center

EFFECT OF INJECTION TIMING ON SIZE SPECTRAL DENSITY

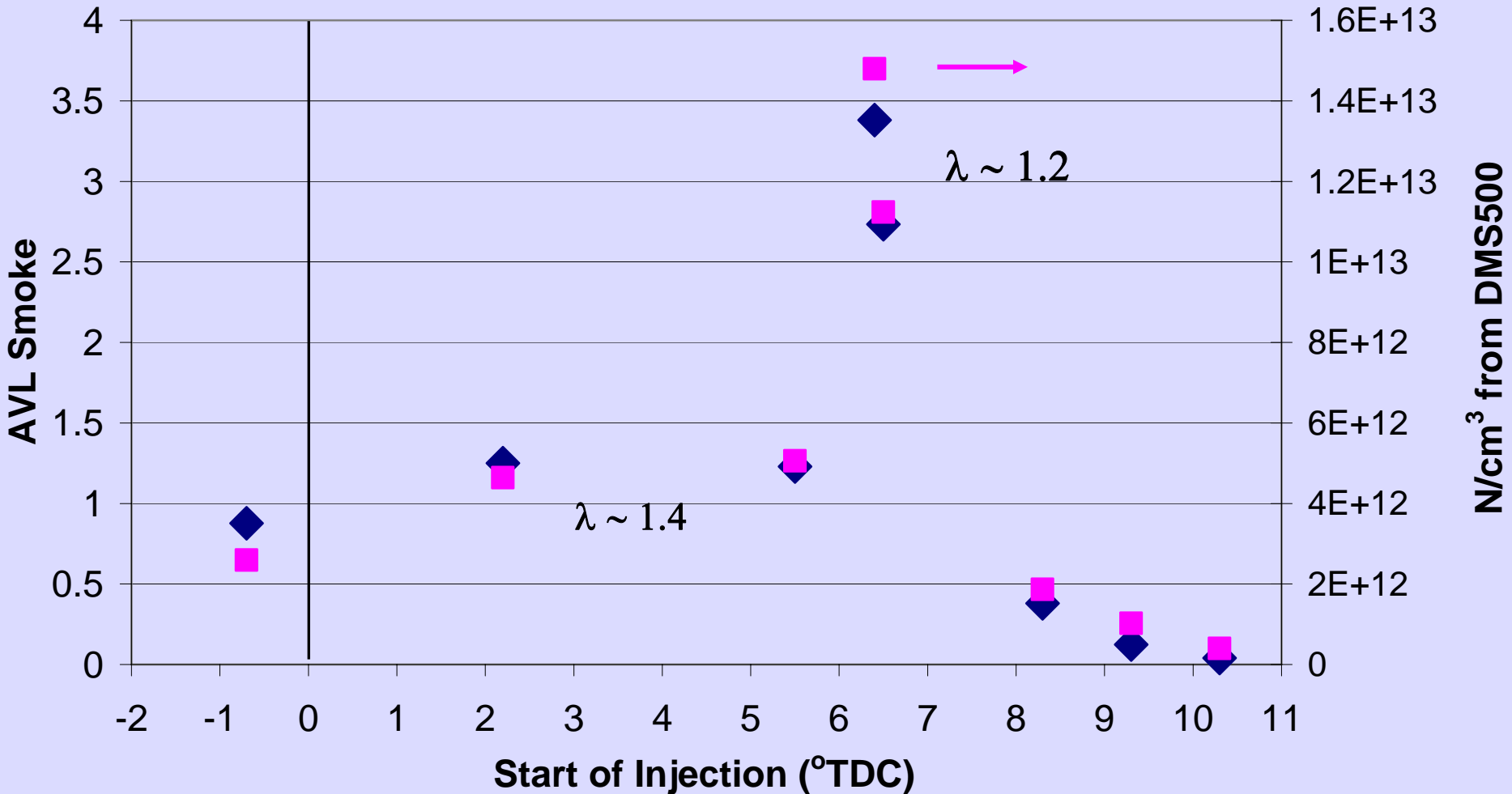


INCREASE IN CH4 AND CO DURING PHCCI

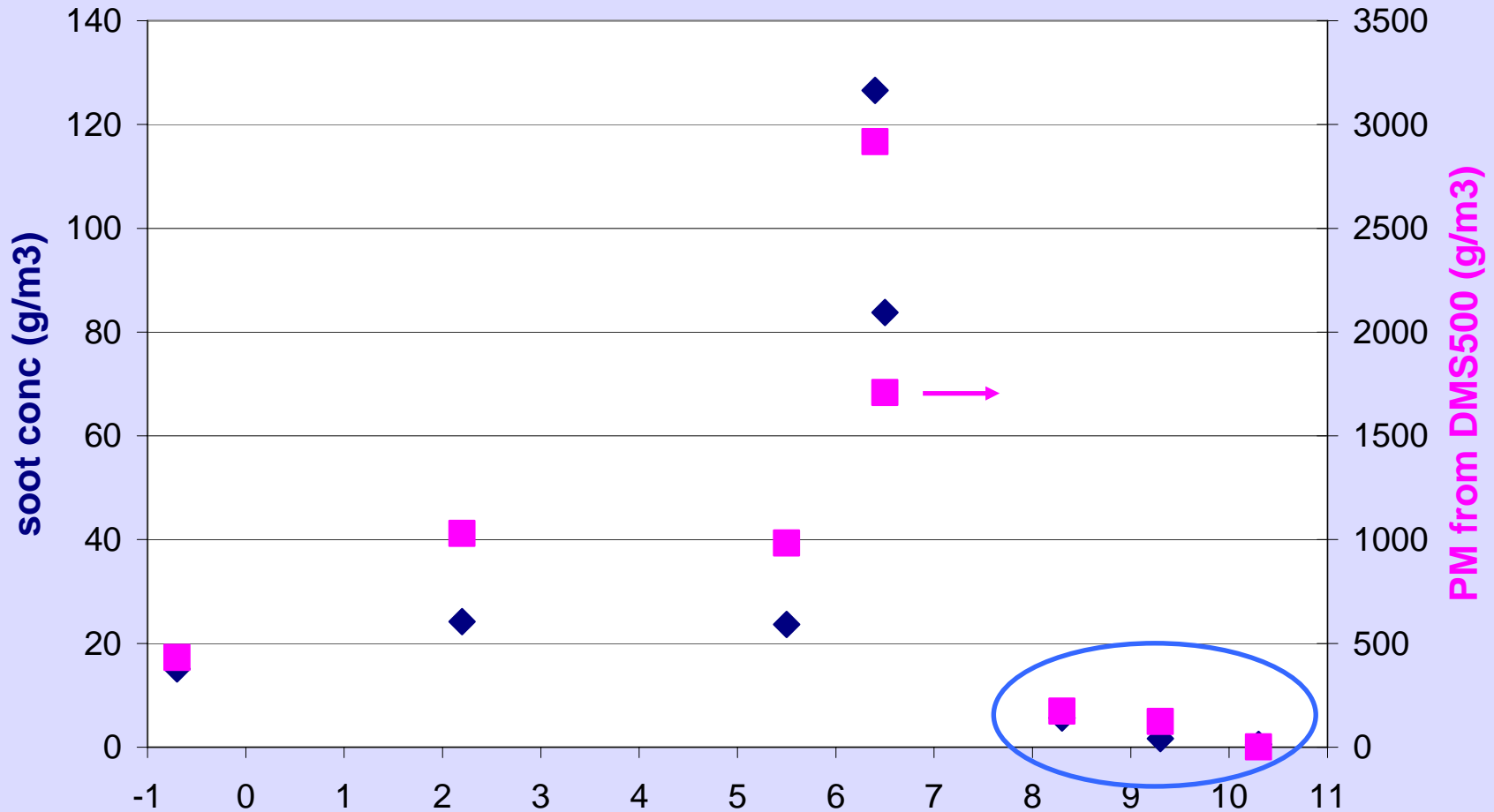


At 10.3, bsfc was 272,3 g/kWh and THC was 75 ppm

EFFECT OF INJECTION TIMING ON SOOT FORMATION



MASS COMPARISON BETWEEN AVL SMOKE AND DMS500



- Both measured over 2 min period °ATDC
- 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?