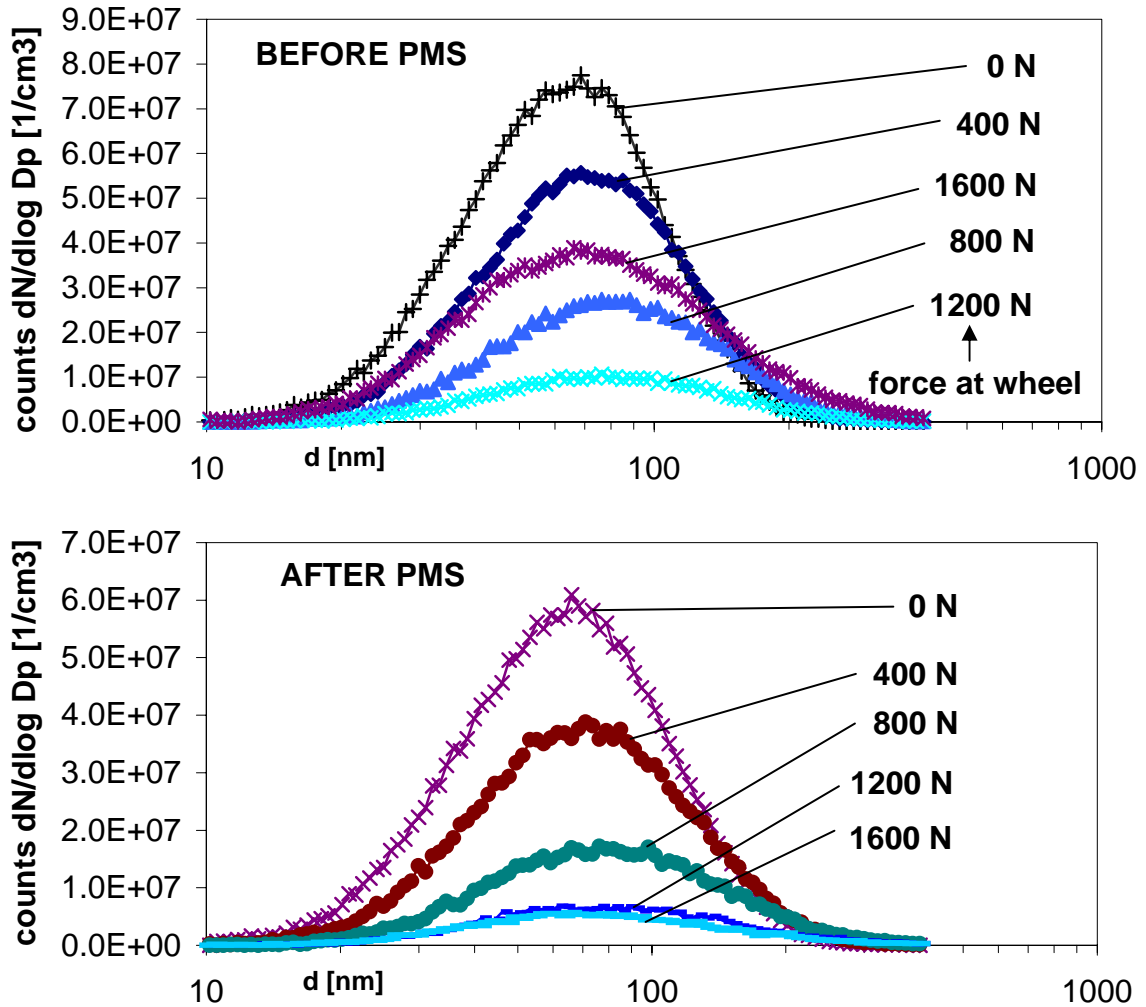


# SMPS : nanoparticle filtration efficiency at 85 km/h with engine warm and engine load variations.

Measured before and after GAT2-PMS; VW Passat 1.9 TDI; low sulfur diesel

SMPS PSD - spectra



Configuration	BEFORE	AFTER
	SMPS [10-400 nm]	SMPS [10-400 nm]
0 N	41720086	33725843
400 N	31249936	22943350
800 N	16577184	10863756
1200 N	6538863	4510830
1600 N	25979466	3692582

Configuration	PZAG SMPS [10-400 nm] [%]
	0 N
400 N	26.58
800 N	34.47
1200 N	31.02
1600 N	85.79

Configuration	w/o	AFTER
	PM [g/km]	PM [g/km]
0 N	0.0074	0.0062
400 N	0.0189	0.0154
800 N	0.0383	0.0374
1200 N	0.0461	0.0200
1600 N	0.0545	0.0219

Configuration	PMAG PM [%]
	0 N
400 N	18.52
800 N	2.35
1200 N	56.62
1600 N	59.82

Procedure :  
 10 min stabilization  
 10 min measurements before PMS  
 10 min measurements after PMS

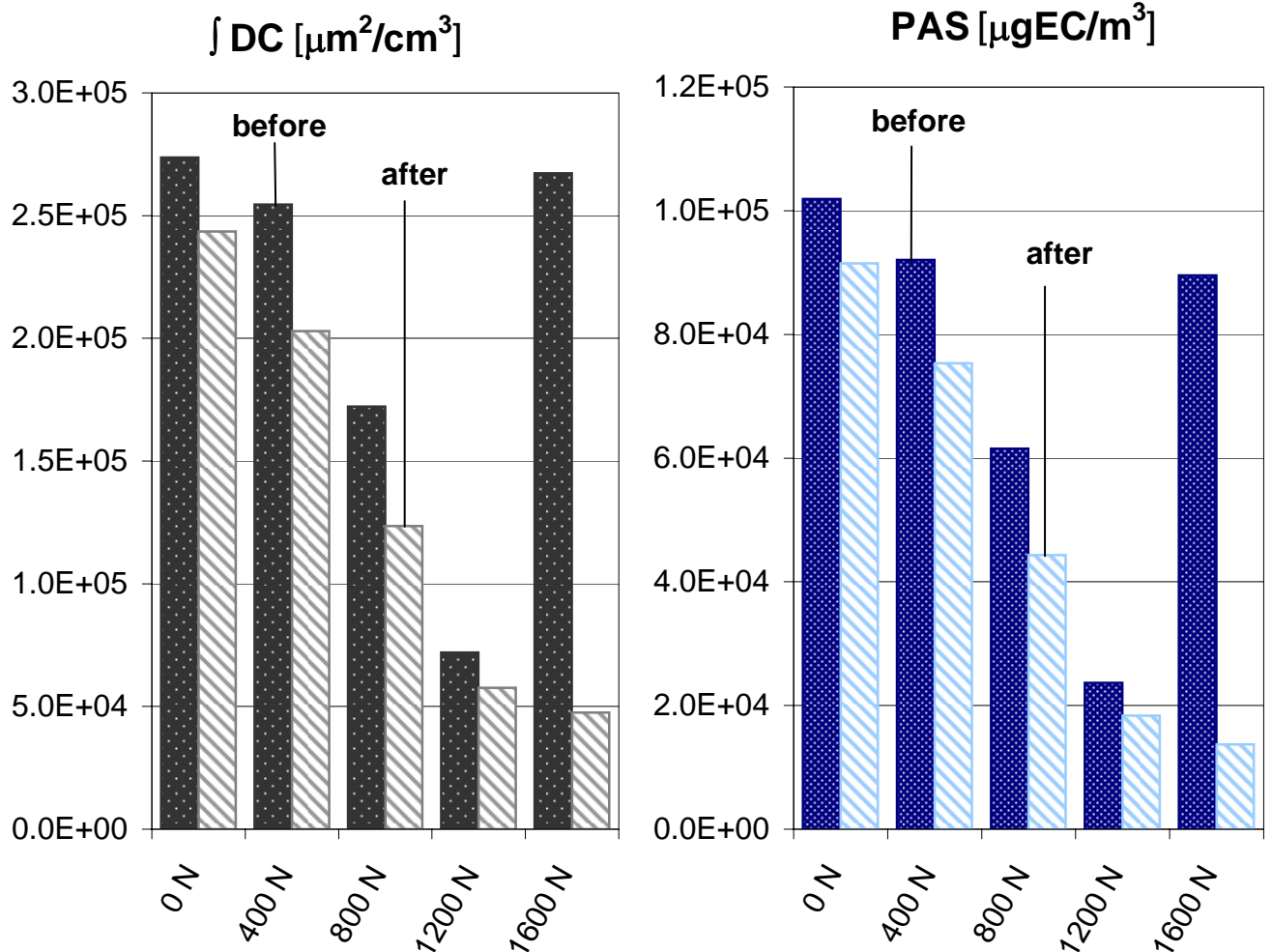
# NanoMet : nanoparticle filtration efficiency at 85 km/h with engine warm and engine load variations.

Before and after GAT2-PMS; VW Passat 1.9 TDI; low sulfur diesel

Driving cycle : 85 km/h const.

Configuration	BEFORE		AFTER		PZAG	
	∫ DC *)	∫ PAS *)	∫ DC *)	∫ PAS *)	DC	PAS
	[ $\mu\text{m}^2/\text{cm}^3$ ]	[ $\mu\text{gEC}/\text{m}^3$ ]	[ $\mu\text{m}^2/\text{cm}^3$ ]	[ $\mu\text{gEC}/\text{m}^3$ ]	[%]	[%]
0 N	273596	101868	243500	91486	<b>11.00</b>	<b>10.19</b>
400 N	254471	92063	202903	75354	<b>20.26</b>	<b>18.15</b>
800 N	172179	61527	123487	44303	<b>28.28</b>	<b>27.99</b>
1200 N	72007	23654	57582	18364	<b>20.03</b>	<b>22.36</b>
1600 N	267273	89551	47582	13716	<b>82.20</b>	<b>84.68</b>

\*) ... integral average value of 7.5 min.



Procedure :  
 10 min stabilization  
 10 min measurements before PMS  
 10 min measurements after PMS

## NO<sub>x</sub> emissions by constant speed 85 km/h with different wheel loads, before and after PMS.

GAT2-PMS; 6th gear; n=1710 rpm; low sulfur diesel; hot NO<sub>x</sub>-measurement.

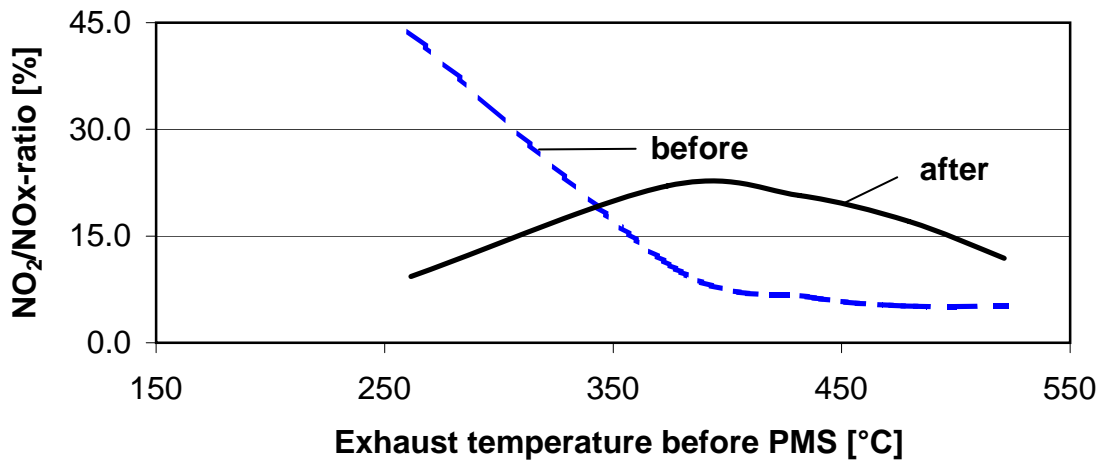
### BEFORE PMS

Fwheel	V	T b. PMS	T a. PMS	NO <sub>2</sub>	NO <sub>x</sub>	NO <sub>2</sub> /NO <sub>x</sub> -ratio
[N]	[km/h]	[°C]	[°C]	[ppm]	[ppm]	[%]
3	85.1	260.7	236.3	16.4	37.5	43.8
399	84.9	375.0	332.1	21.7	199.6	10.9
799	84.7	435.0	392.7	29.3	452.3	6.5
1197	84.5	477.0	438.8	45.0	871.9	5.2
1597	84.3	521.6	477.2	59.3	1151.3	5.2

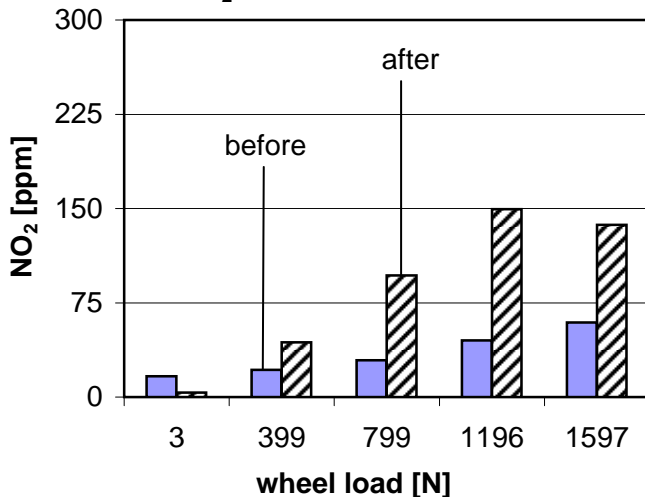
### AFTER PMS

Fwheel	V	T b. PMS	T a. PMS	NO <sub>2</sub>	NO <sub>x</sub>	NO <sub>2</sub> /NO <sub>x</sub> -ratio
[N]	[km/h]	[°C]	[°C]	[ppm]	[ppm]	[%]
3	85.1	261.6	238.7	3.6	38.9	9.3
399	84.9	373.8	331.6	43.5	197.1	22.1
799	84.7	431.7	390.7	96.7	467.1	20.7
1196	84.5	479.6	441.8	149.6	877.7	17.0
1597	84.3	521.2	477.4	136.9	1152.4	11.9

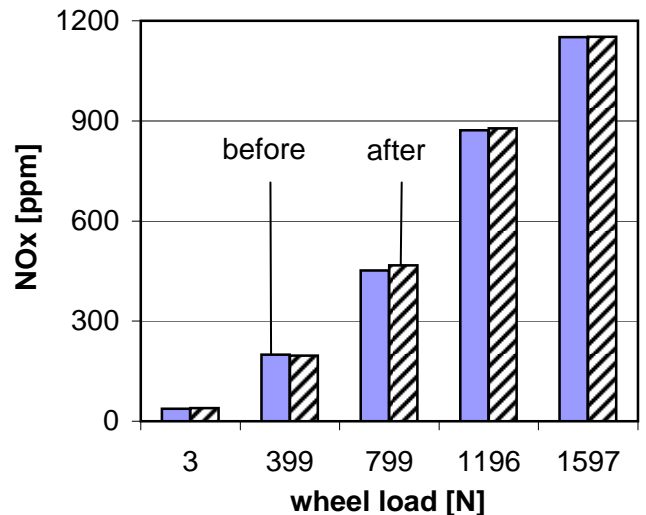
### NO<sub>2</sub>/NO<sub>x</sub>-ratio before and after GAT2-PMS



### NO<sub>2</sub> before and after GAT2-PMS



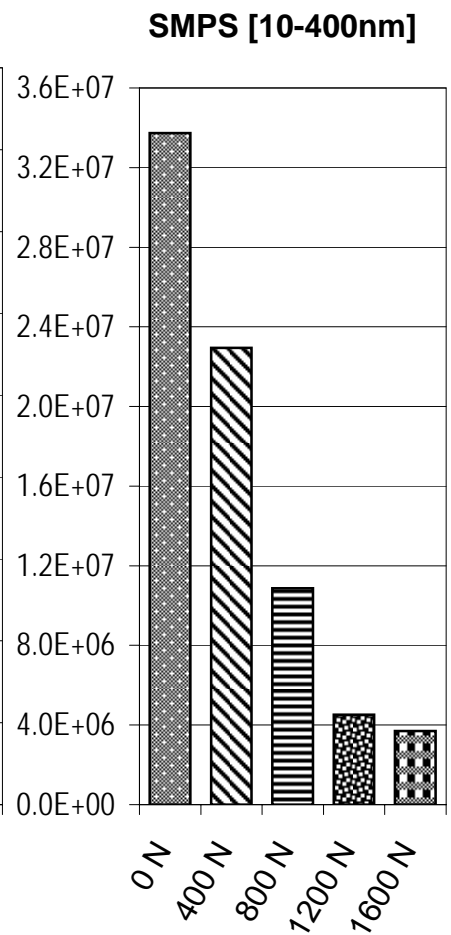
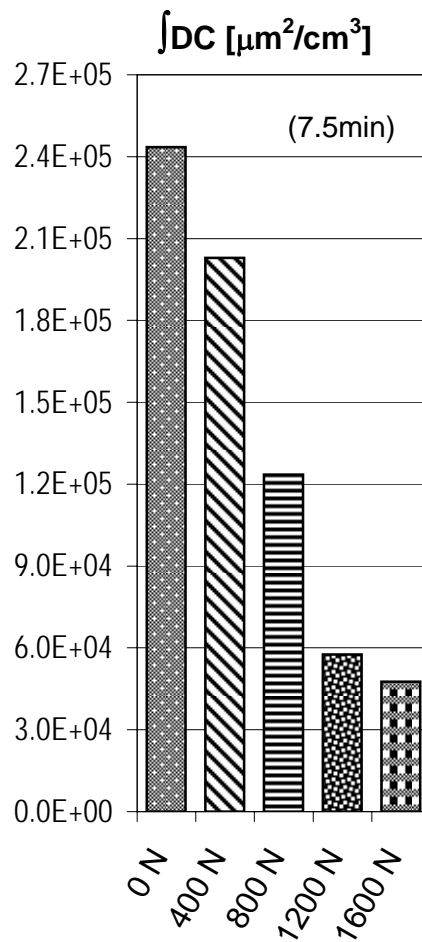
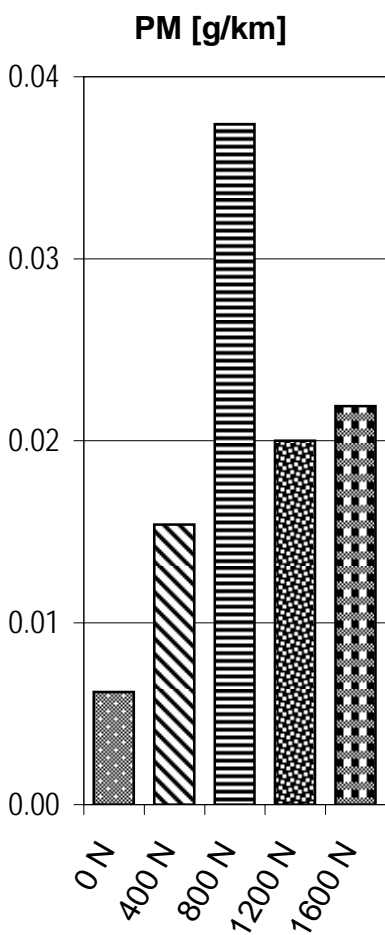
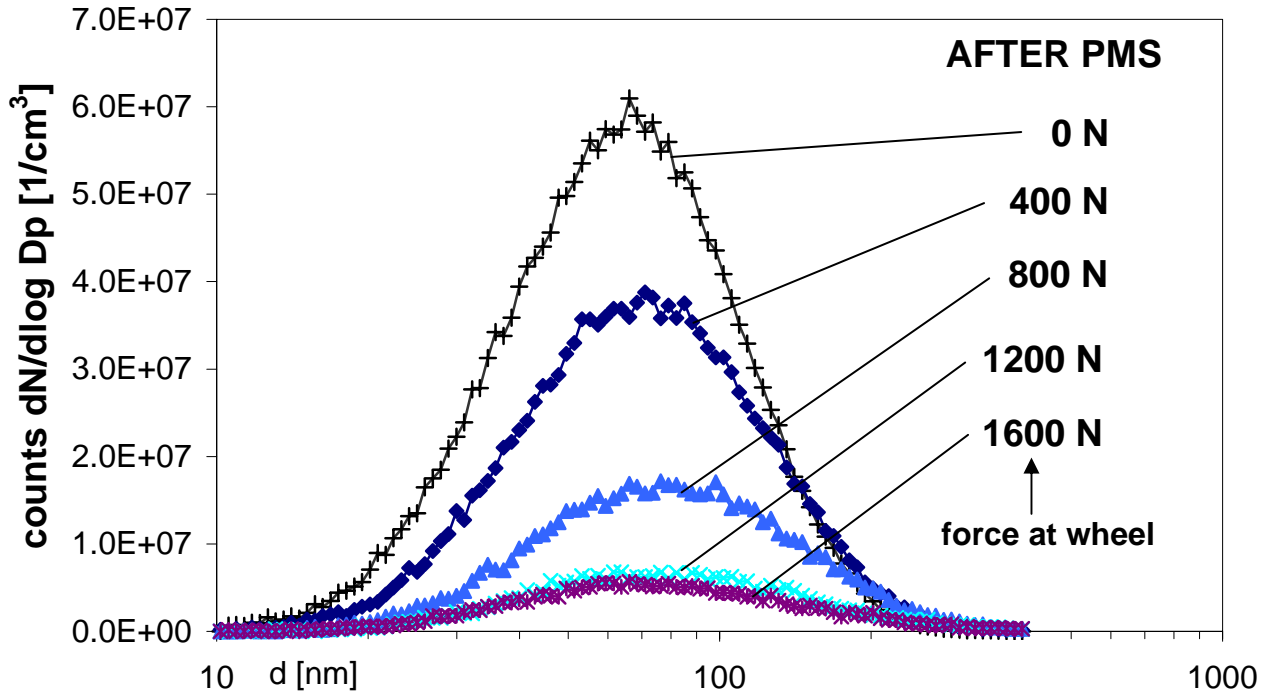
### NO<sub>x</sub> before and after GAT2-PMS



# Particle mass and nanoparticles at const. speed 85 km/h, warm, with engine load variations.

with GAT2-PMS; VW Passat 1.9 TDI; low sulfur diesel

## SMPS PSD - spectra



# Comparison of emissions during the measurements of nanoparticles by engine load variations

Low sulfur diesel; CO, HC, NOx bag values

## VW Passat 1.9 TDI

w/o PMS

Driving cycle : 85 km/h const., warm

Configuration	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [ $\mu\text{m}^2/\text{cm}^3$ ]	∫ PAS *) [ $\mu\text{gEC}/\text{m}^3$ ]	SMPS [10-400 nm]	Cons. [l/100km]
0 N	0.004	0.008	0.041	0.0074	288881	105098	3.57E+07	2.27
400 N	0.010	0.008	0.331	0.0189	212401	76953	2.11E+07	4.93
800 N	0.017	0.014	1.030	0.0383	126780	44778	1.06E+07	7.32
1200 N	0.033	0.013	2.402	0.0461	59223	18689	4.45E+06	9.92
1600 N	0.053	0.007	3.242	0.0545	65968	20492	4.48E+06	12.34

\*) ... integral average value of 7.5 min.

## GAT2-PMS

Driving cycle : 85 km/h const., warm, after PMS

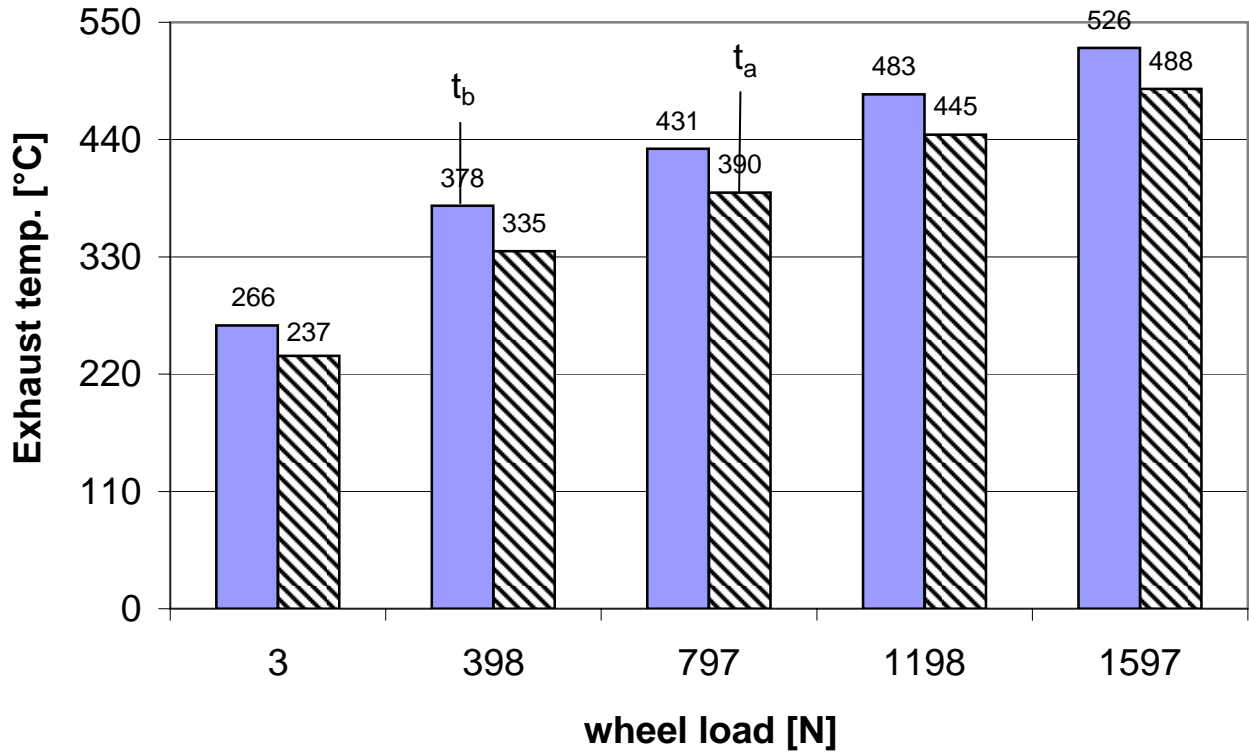
Configuration	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [ $\mu\text{m}^2/\text{cm}^3$ ]	∫ PAS *) [ $\mu\text{gEC}/\text{m}^3$ ]	SMPS [10-400 nm]	Cons. [l/100km]	$\Delta$ Cons. [%]
0 N	0.004	0.006	0.031	0.0062	243500	91486	3.37E+07	2.24	1.32
400 N	0.005	0.003	0.319	0.0154	202903	75354	2.29E+07	4.81	2.43
800 N	0.008	0.003	1.005	0.0374	123487	44303	1.09E+07	7.21	1.50
1200 N	0.017	0.002	2.405	0.0200	57582	18364	4.51E+06	9.77	1.51
1600 N	0.020	0.003	3.710	0.0219	47582	13716	3.69E+06	12.56	-1.78

\*) ... integral average value of 7.5 min.

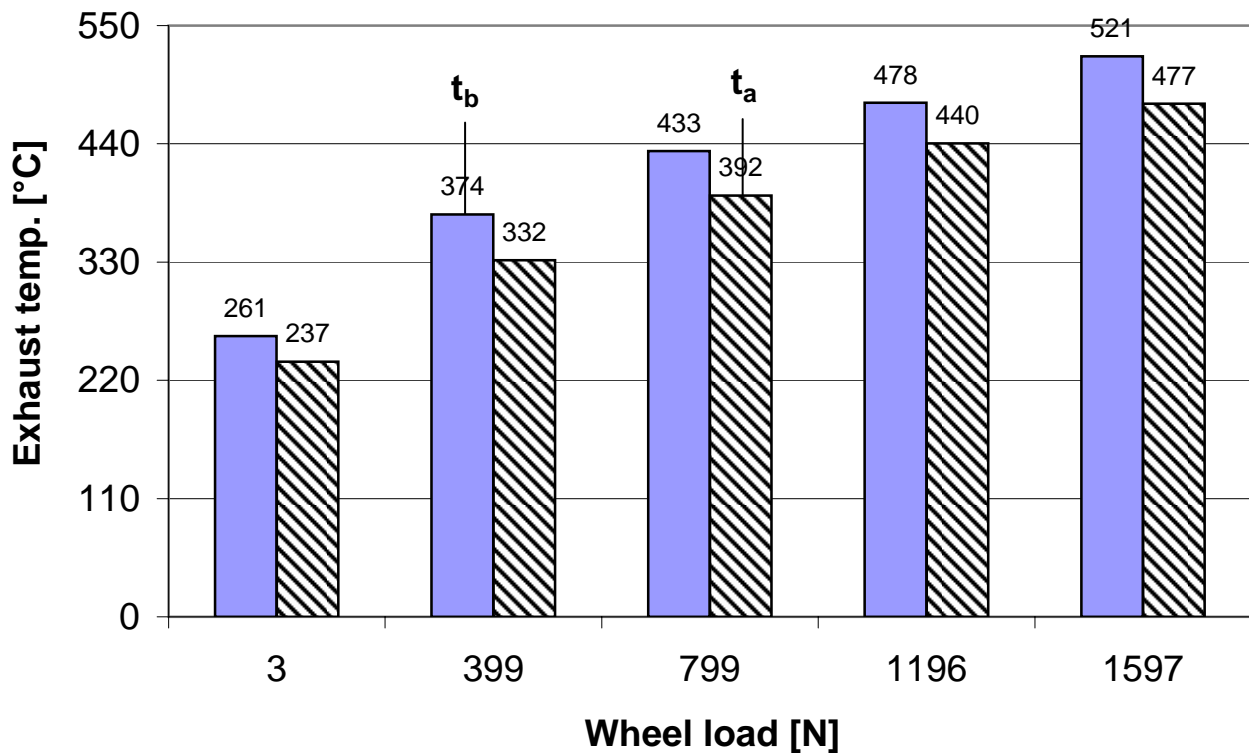
## Temperatures before / after GAT PMS.

VW Passat 1.9 TDI; low sulfur diesel

### Load steps GAT 1



### Load steps GAT 2



## Comparison of limited and unlimited emissions during different driving cycles

w/o and with GAT2-PMS; low sulfur diesel; CO, HC, NOx bag values

### VW Passat 1.9 TDI

1st day, w/o

Total cycle values

Cycle	CO	HC	NOx	PM	∫ DC *)	CPC	∫ PAS *)
	[g/km]	[g/km]	[g/km]	[g/km]	[ $\mu\text{m}^2/\text{cm}^3$ ]	[TPN]	[ $\mu\text{gEC}/\text{m}^3$ ]
NEFZ c.	0.209	0.054	0.331	0.032	47354	5.27E+13	13813
NEFZ w.	0.043	0.018	0.325	0.027	42166	4.81E+13	11477

\*) ... integral average value

1st day, with GAT2 PMS

Cycle	CO	HC	NOx	PM	∫ DC *)	CPC	∫ PAS *)
	[g/km]	[g/km]	[g/km]	[g/km]	[ $\mu\text{m}^2/\text{cm}^3$ ]	[TPN]	[ $\mu\text{gEC}/\text{m}^3$ ]
NEFZ c.	0.723	0.169	0.361	0.036	30842	4.63E+13	12030
NEFZ w.	0.144	0.041	0.344	0.021	25037	3.79E+13	9870

\*) ... integral average value

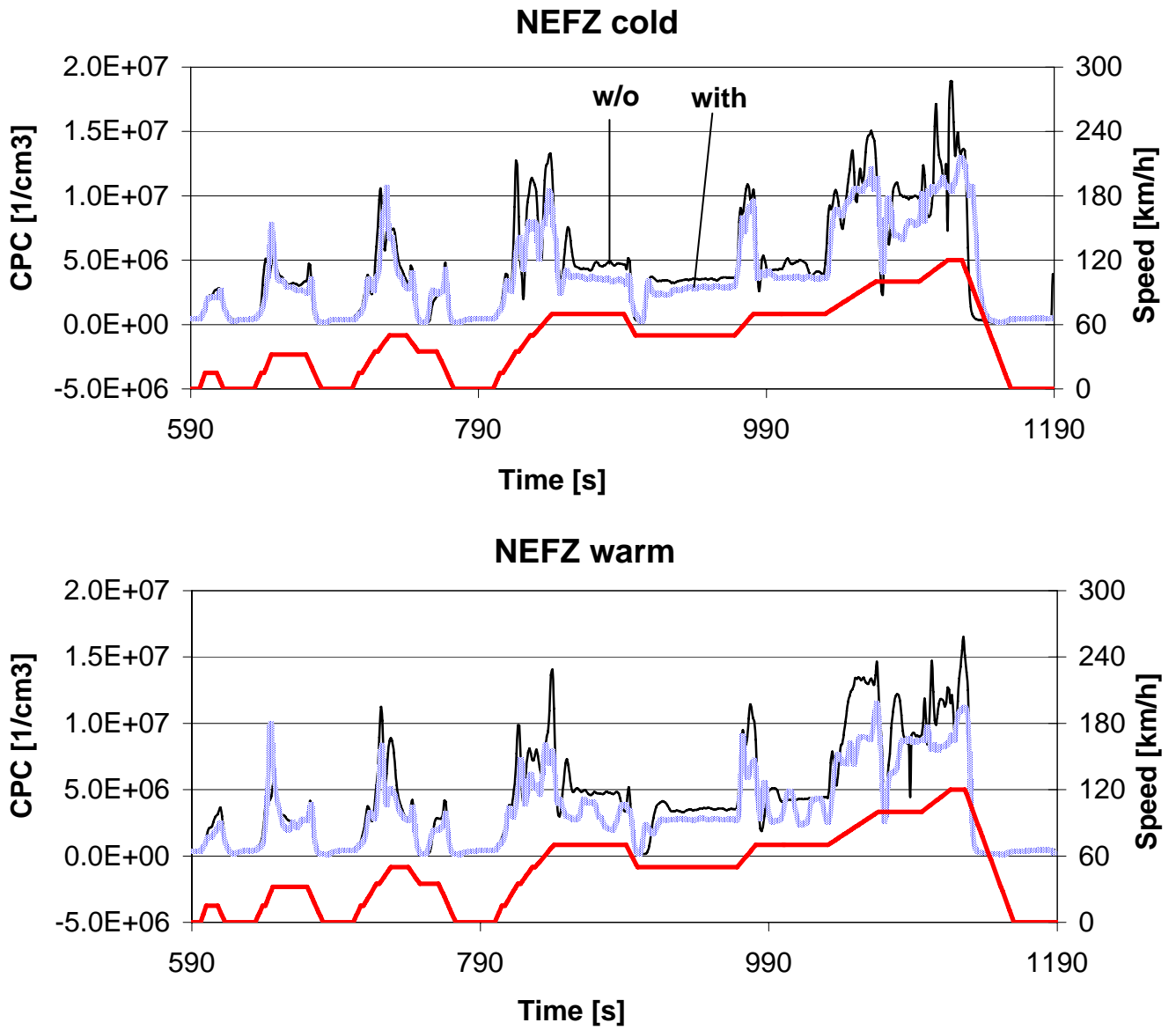
### Exhaust emissions conversion rate and filtration efficiency

Cycle	K <sub>CO</sub>	K <sub>HC</sub>	K <sub>NOx</sub>	PMFE	DCFE	CPCFE	PASFE
	[%]	[%]	[%]	[%]	[%]	[%]	[%]
NEFZ c.	-245.9	-213.0	-9.1	-13.9	34.9	12.1	12.9
NEFZ w.	-234.9	-127.8	-5.8	22.2	40.6	21.1	14.0
AVERAGE	-240.4	-170.4	-7.5	4.2	37.7	16.6	13.5

FE... Filtration efficiency (GAT2)

# CPC nanoparticle count concentrations in NEFZ driving cycles

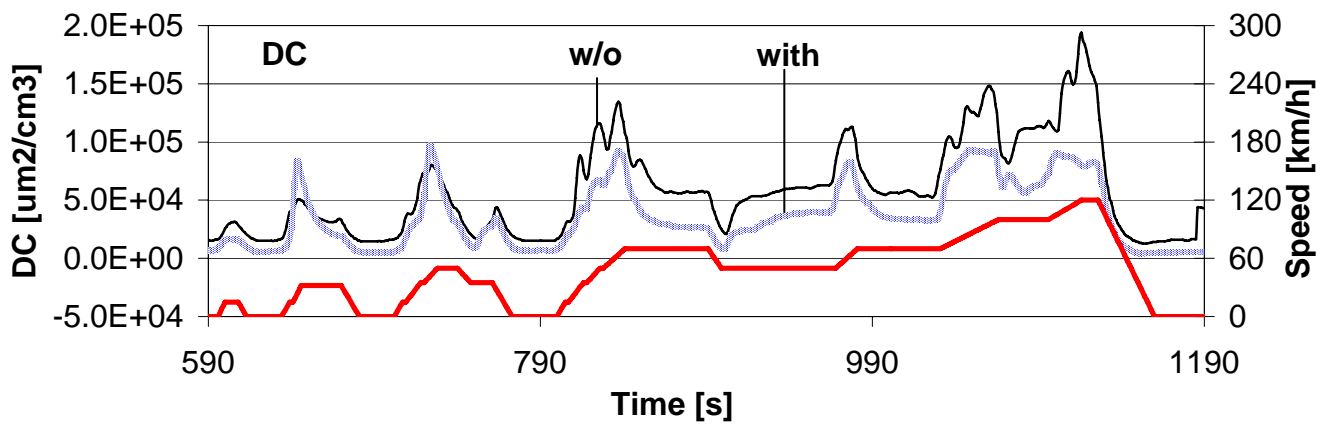
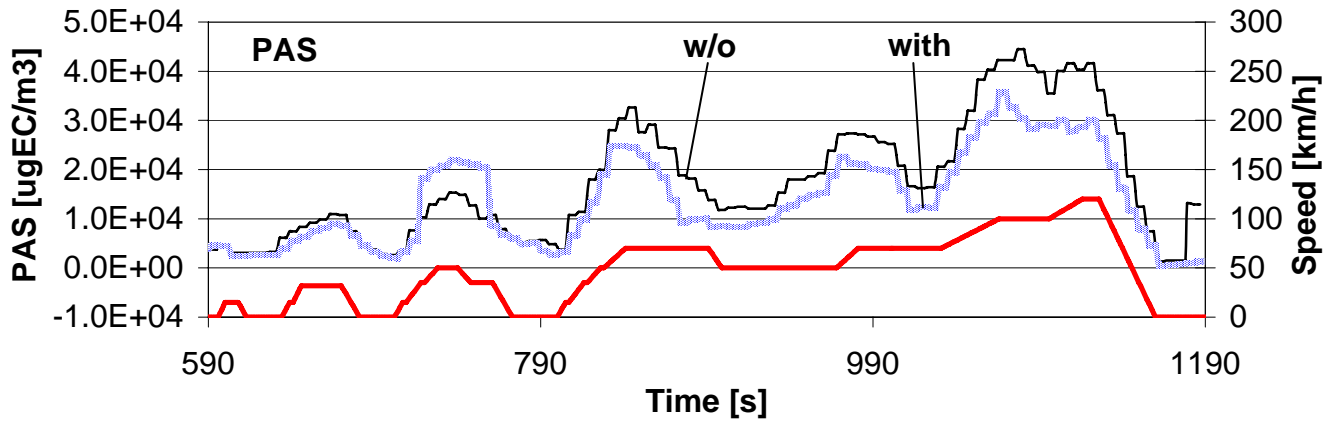
w/o and with GAT2-PMS; VW Passat 1.9 TDI; low sulfur diesel



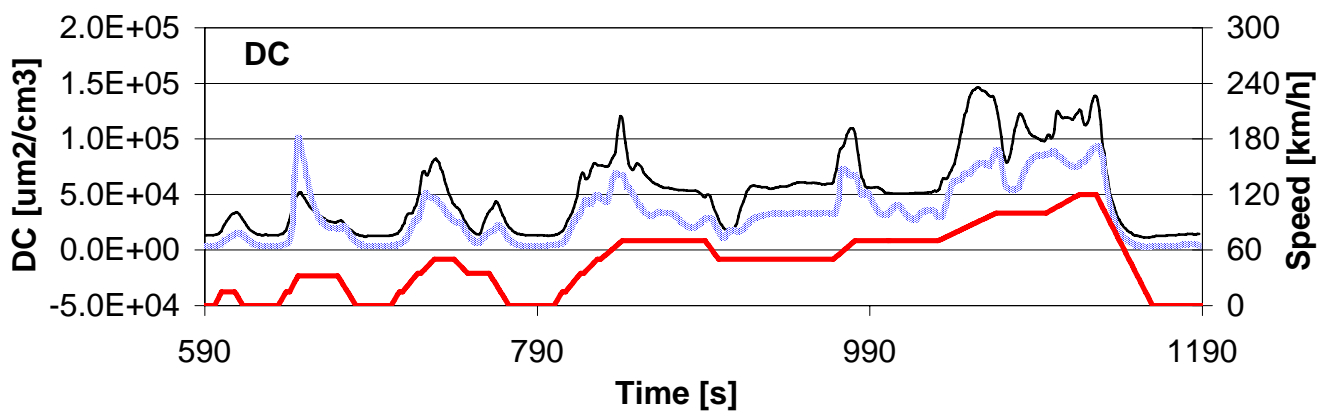
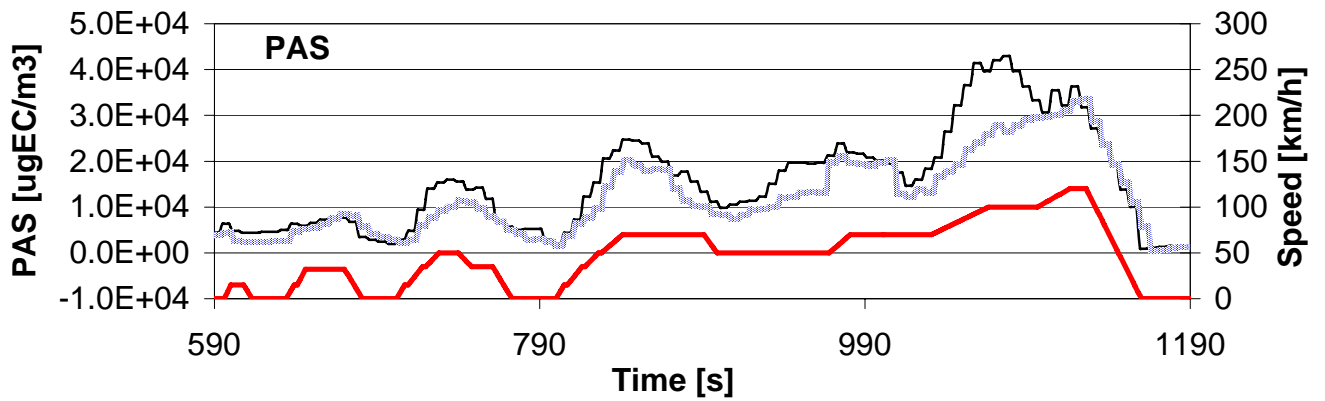
## NanoMet signals PAS / DC in NEFZ driving cycles

w/o and with GAT2-PMS; VW Passat 1.9 TDI; low sulfur diesel

### NEFZ cold



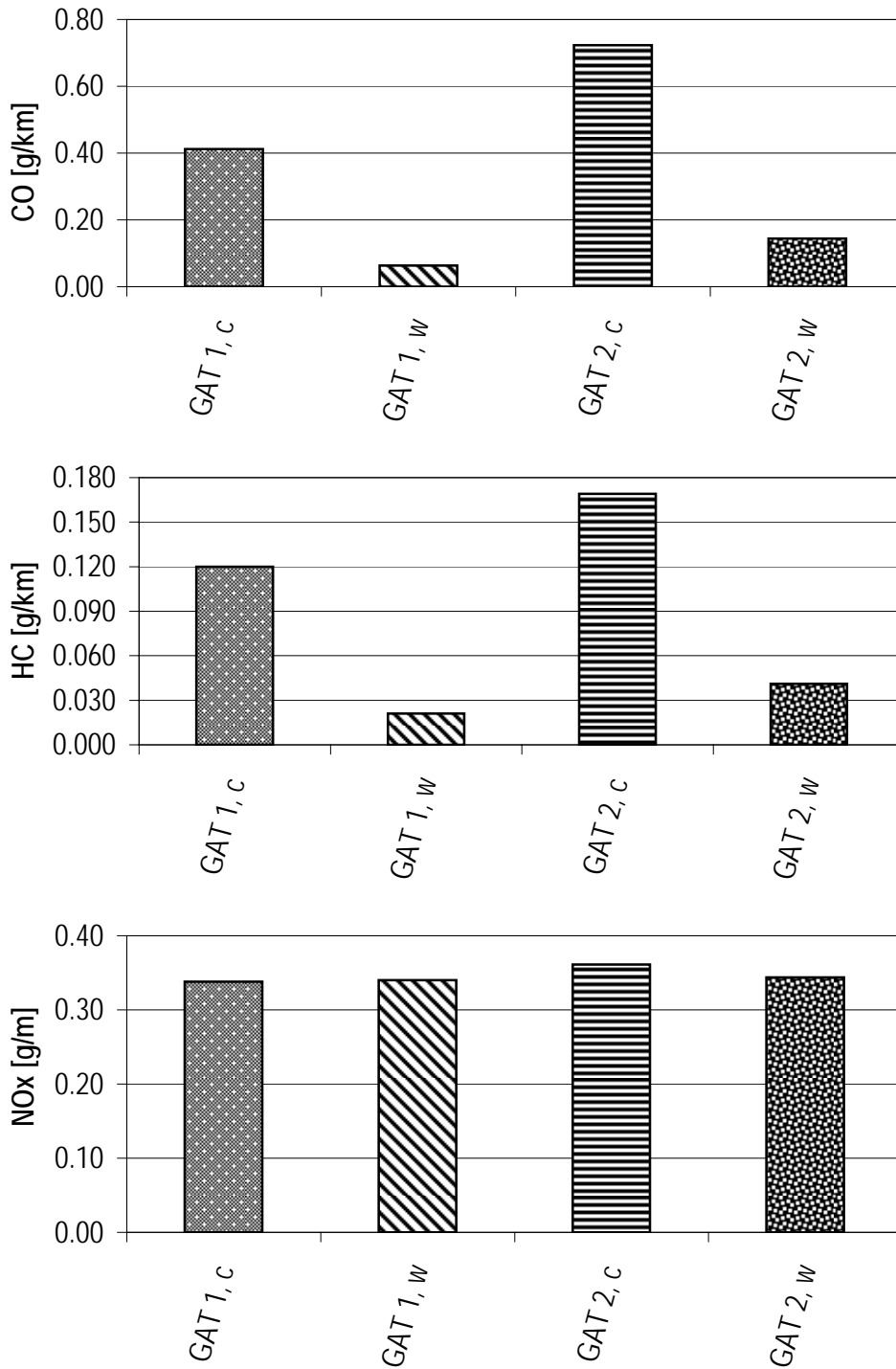
### NEFZ warm



## Comparison of limited emissions during the NEFZ driving cycle with engine cold and warm.

with GAT-PMS; VW Passat 1.9 TDI; low sulfur diesel

### 1st day



GAT 1, c... PMS GAT from manufacturer, with cold start

GAT 1, w... PMS GAT from manufacturer, with engine warm

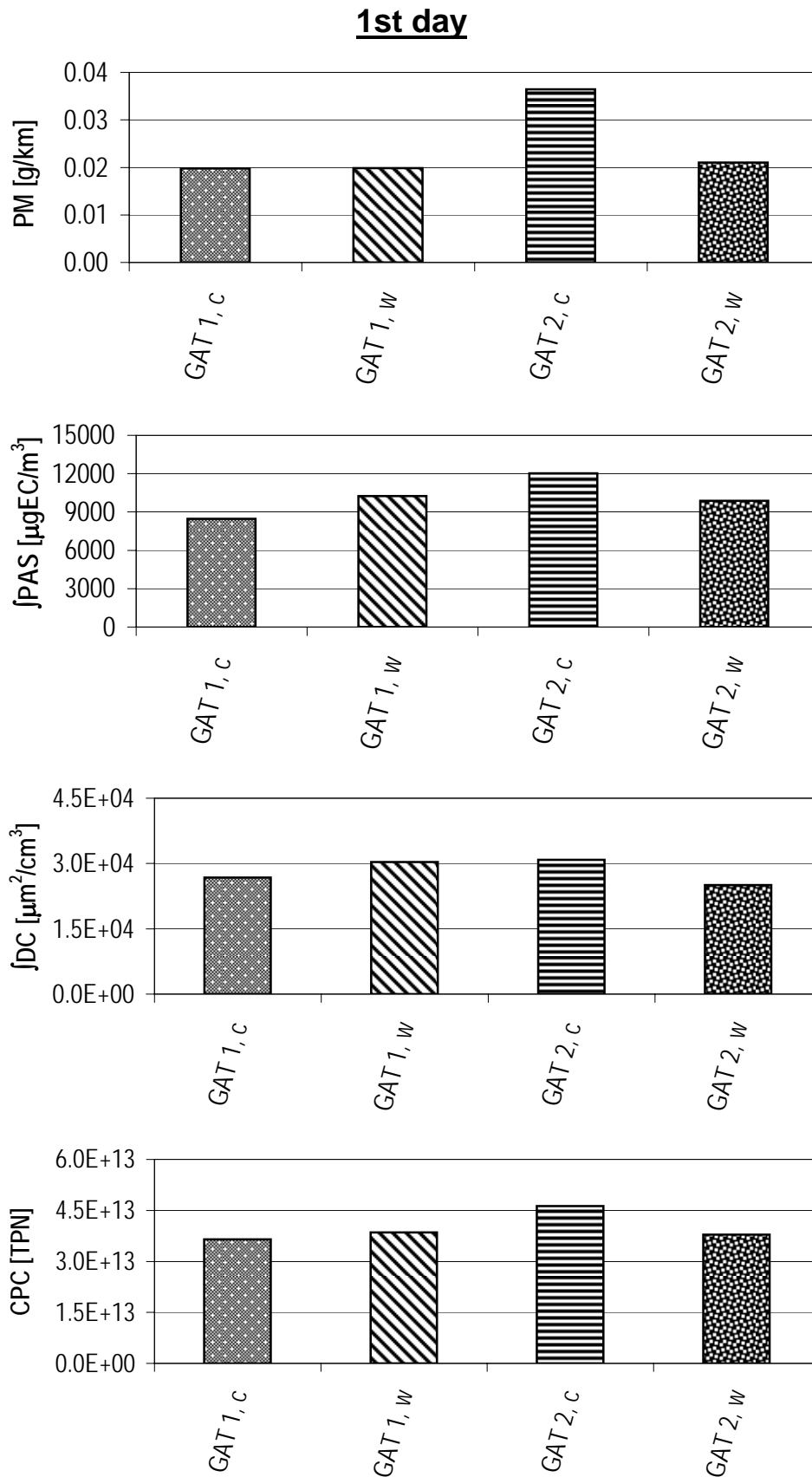
GAT 2, c... PMS GAT from market, with cold start

GAT 2, w... PMS GAT from market, with engine warm

TPN... Total Particle Number [particle/km]

## Comparison of limited and unlimited emissions during the NEFZ driving cycle with engine cold and warm.

with GAT-PMS; VW Passat 1.9 TDI; low sulfur diesel



# Comparison of limited and unlimited emissions during different driving cycles

with GAT2-PMS; low sulfur diesel; CO, HC, NOx bag values

## VW Passat 1.9 TDI

### Total cycle values

Cycle	CO [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	∫ DC *) [μm <sup>2</sup> /cm <sup>3</sup> ]	CPC [TPN]	∫ PAS *) [μgEC/m <sup>3</sup> ]
NEFZ c.	0.723	0.169	0.361	0.0364	30842	4.63E+13	12030
NEFZ w.	0.144	0.041	0.344	0.0210	25037	3.79E+13	9870

\*) ... integral average value

### Values "phase per phase"

Configuration	Meas- 21										
	CO [g/km]	CO <sub>2</sub> [g/km]	HC [g/km]	NOx [g/km]	PM [g/km]	Conso [l/100km]	Distance [m]	Vol (CVS) [m <sup>3</sup> ]	∫ DC *) [μm <sup>2</sup> /cm <sup>3</sup> ]	CPC [TPN]	∫ PAS *) [μgEC/m <sup>3</sup> ]
NEFZ c.	0.723	164.165	0.169	0.361	0.0364	6.21	11103		30842	4.63E+13	12030
NEFZ, 1st phase	1.871	222.266	0.386	0.397	0.0505	8.48	4108	108.430	24654	6.06E+13	9681
NEFZ, 2nd phase	0.049	130.043	0.041	0.339	0.0282	4.88	6995	55.585	42877	3.79E+13	16599
NEFZ w.	0.144	151.779	0.041	0.344	0.0210	5.70	11059		25037	3.79E+13	9870
NEFZ, 1st phase	0.361	194.833	0.086	0.377	0.0273	7.33	4110	108.270	17390	4.68E+13	6831
NEFZ, 2nd phase	0.016	126.315	0.014	0.324	0.0173	4.73	6949	55.518	39913	3.27E+13	15780

## Backpressure with GAT1 / GAT2 - PMS

VW Passat 1.9 TDI; low sulfur diesel

### Load steps GAT 1 / GAT 2

