

The (un)suitability of dynamometer studies for emission inventories



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ICG II Troposphere

International Workshop on Validation and Evaluation of Air Emission Inventories

- ⇒ Development, evaluation and verification of AEI's and AEI tools

Gothenburg, 14-16 October 2002

Oral presentation 15 minutes
incl. discussion

„**Variability** in the input parameter known as the anthropogenic volatile organic compound (**VOC**) area source emissions had the **most influence** on the variations in the 50 predicted **peak ozone concentrations**.“

Hanna et al., Atmos.
Environ. 32, 3227-3238



Agenda within “MOBINET”



- On-Board-Measurements in Munich
- Construction of a realistic driving cycle
- Measurements on a chassis dynamometer
 - ▶ Comparison of different driving cycles
 - ▶ Comparison of different engine types
(Diesel engine, SI engine, DI-SI engine)
with latest exhaust gas treatment techniques
- Calculation of emission functions

The test vehicle

- Analytes

- ▶ Oxygen (O_2)
- ▶ Carbon Oxides (CO , CO_2)
- ▶ Nitrogen Oxides (NO ; NO_2 ; N_2O)
- ▶ Total Hydrocarbons (HC)
- ▶ Speciated Hydrocarbons (NMHC $C_2 - C_{10}$) - offline

- Driving parameters

- ▶ Distance, Velocity, Acceleration
- ▶ Engine speed, λ -value
- ▶ Fuel Consumption, Air Mass

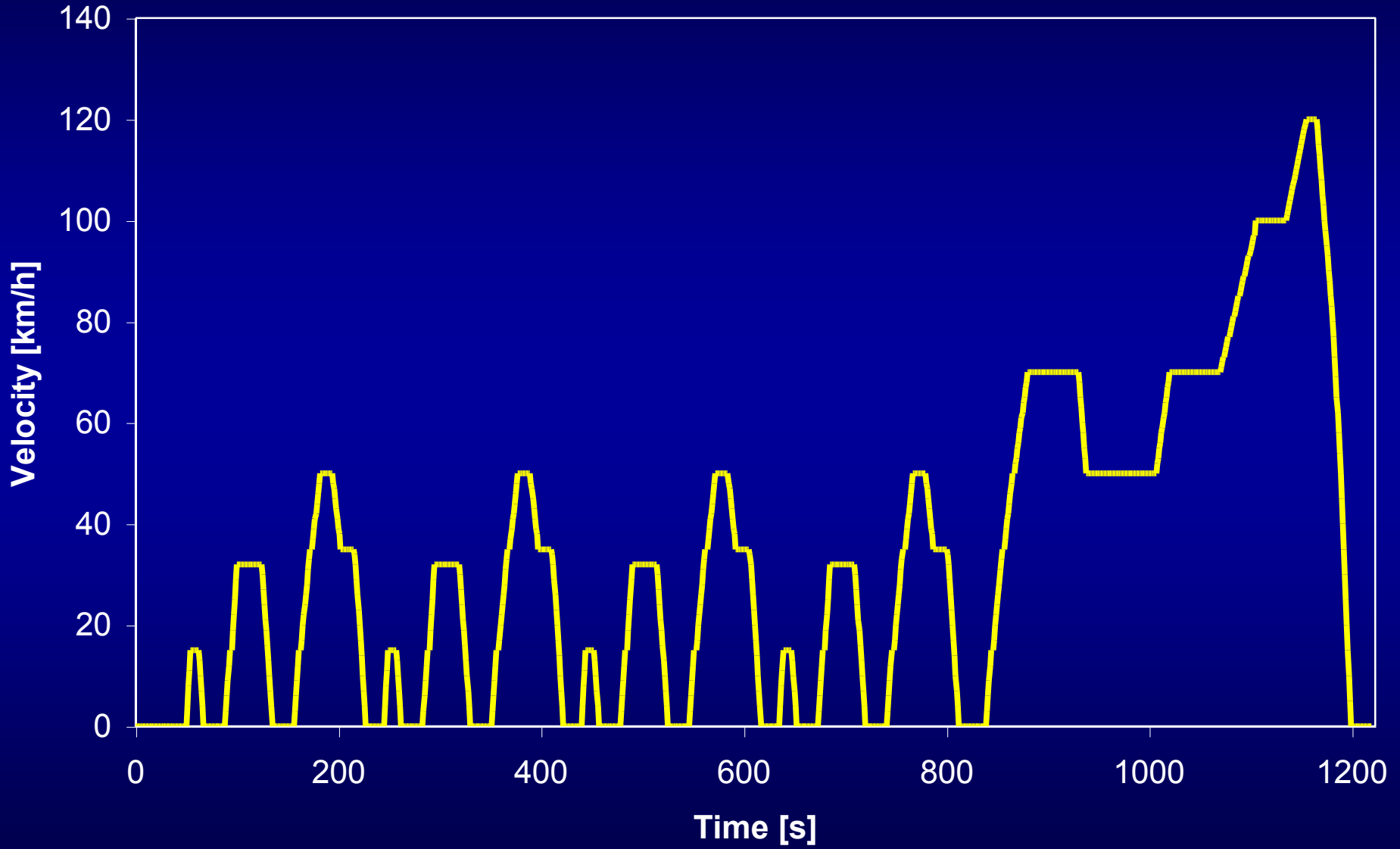


**Ford Mondeo, gasoline, 85 kW,
1796 cm³, exhaust regulation D4**

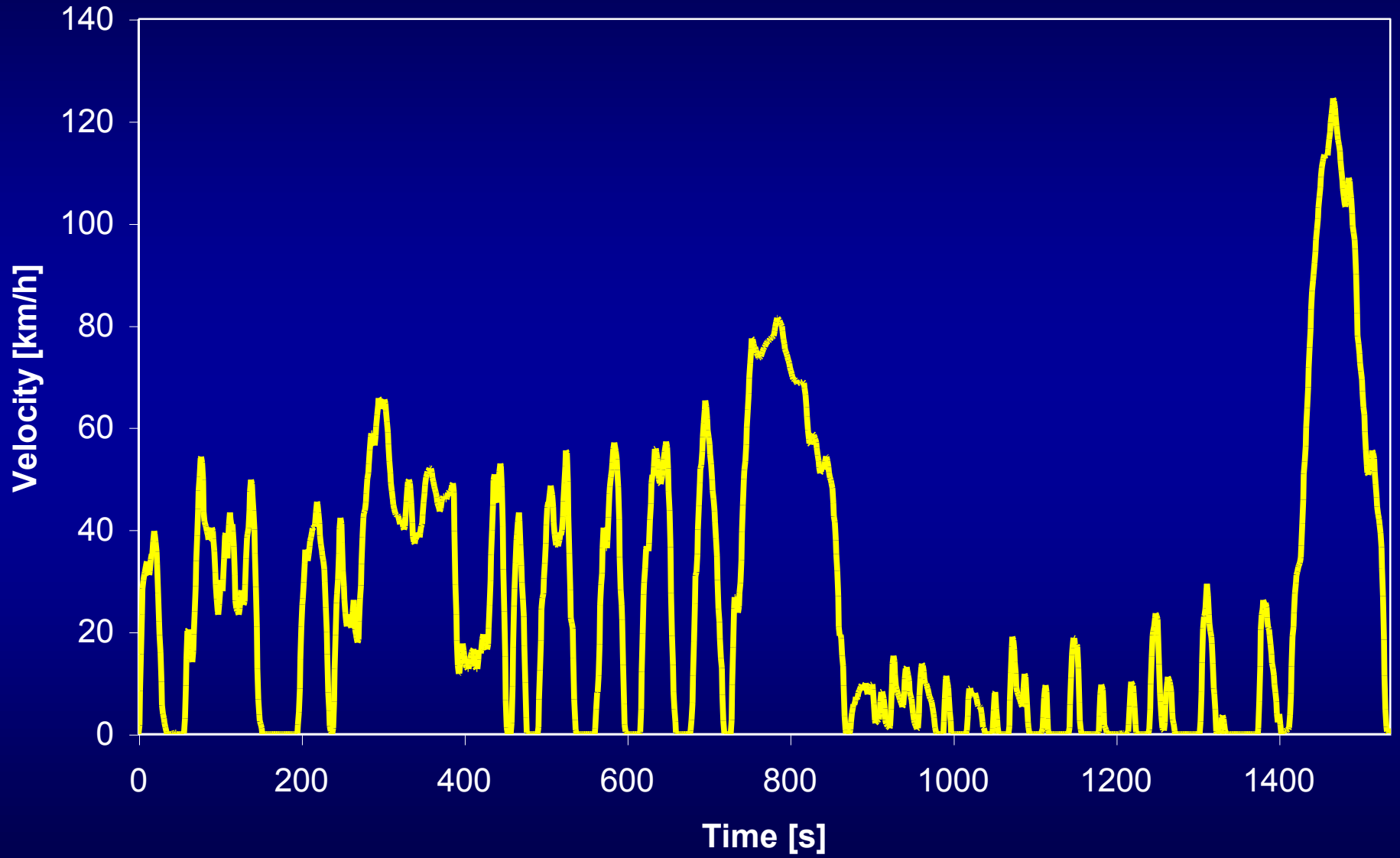
Questions

- Does the European certification cycle MVEG meet real world driving conditions?
- Are emissions of modern cars calculable from former measurements?
- Do dynamometer studies reflect real world emissions at all?

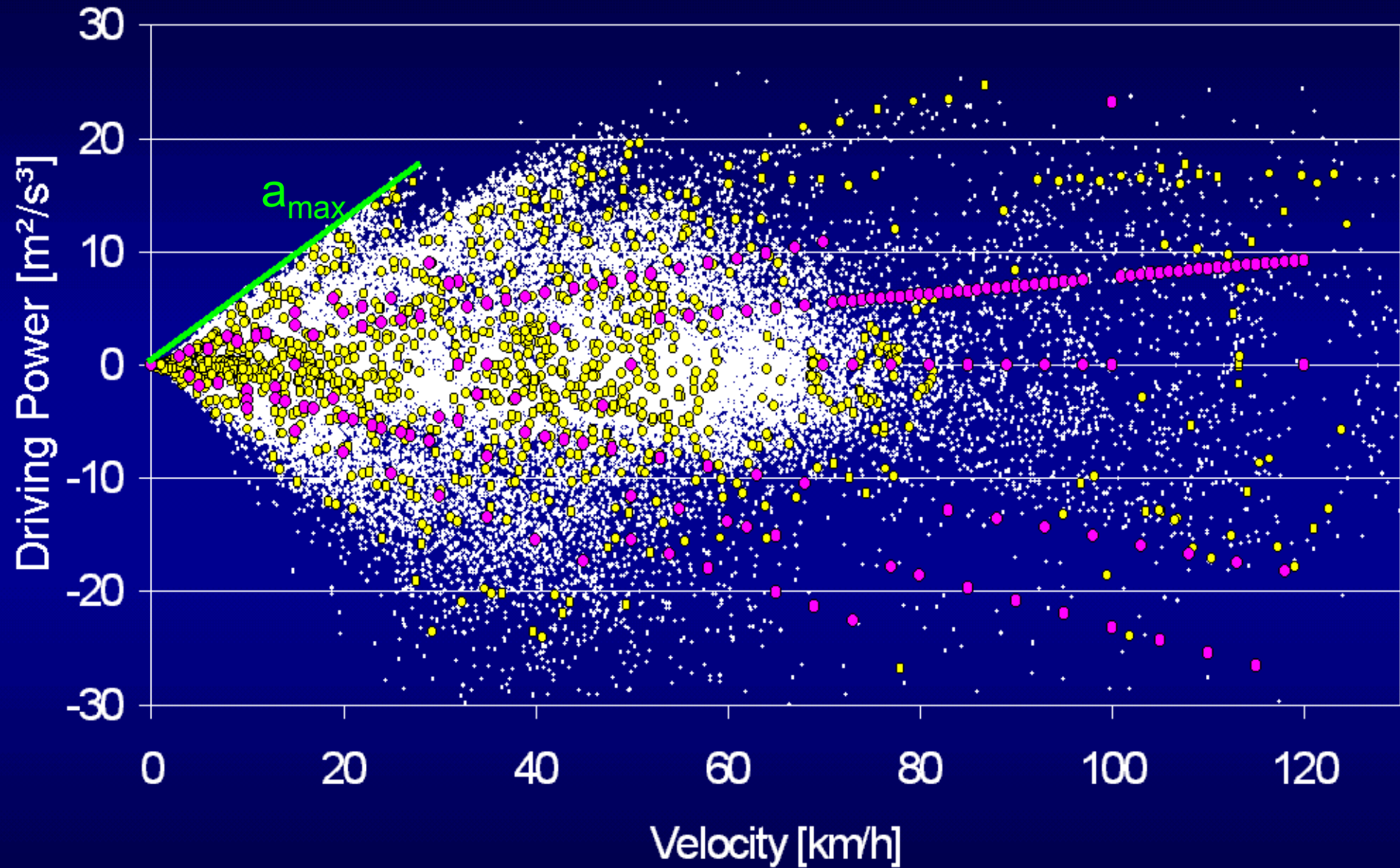
European Certification Cycle MVEG



MOBINET-Cycle



Power vs. Velocity of the Munich measurements (white) compared to MOBINET-cycle (yellow) and MVEG (pink)



Chassis dynamometer measurements: Results of MVEG and MOBINET-Cycle

	CO ₂ [g/km]	NO _x [mg/km]	CO [mg/km]
Limit D4		70	700
MVEG	208	61	335
MOBINET			
increase			

Chassis dynamometer measurements: Results of MVEG and MOBINET-Cycle

	CO ₂ [g/km]	NO _x [mg/km]	CO [mg/km]
Limit D4		70	700
MVEG	208	61	335
MOBINET	313		
increase	+ 50%		

Chassis dynamometer measurements: Results of MVEG and MOBINET-Cycle

	CO ₂ [g/km]	NO _x [mg/km]	CO [mg/km]
Limit D4		70	700
MVEG	208	61	335
MOBINET	313	147	
increase	+ 50%	+ 141%	

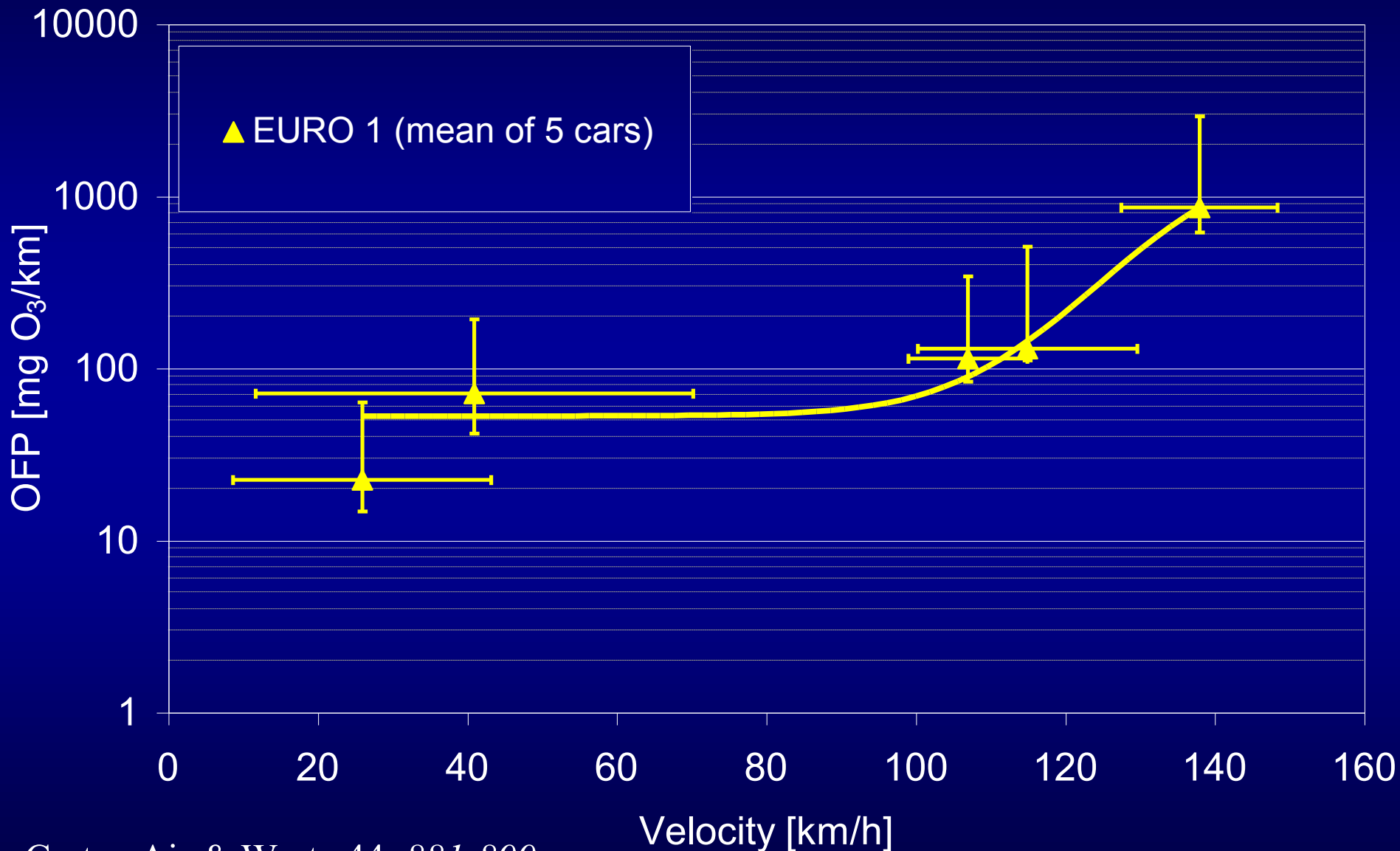
Chassis dynamometer measurements: Results of MVEG and MOBINET-Cycle

	CO ₂ [g/km]	NO _x [mg/km]	CO [mg/km]
Limit D4		70	700
MVEG	208	61	335
MOBINET	313	147	3368
increase	+ 50%	+ 141%	+ 905%

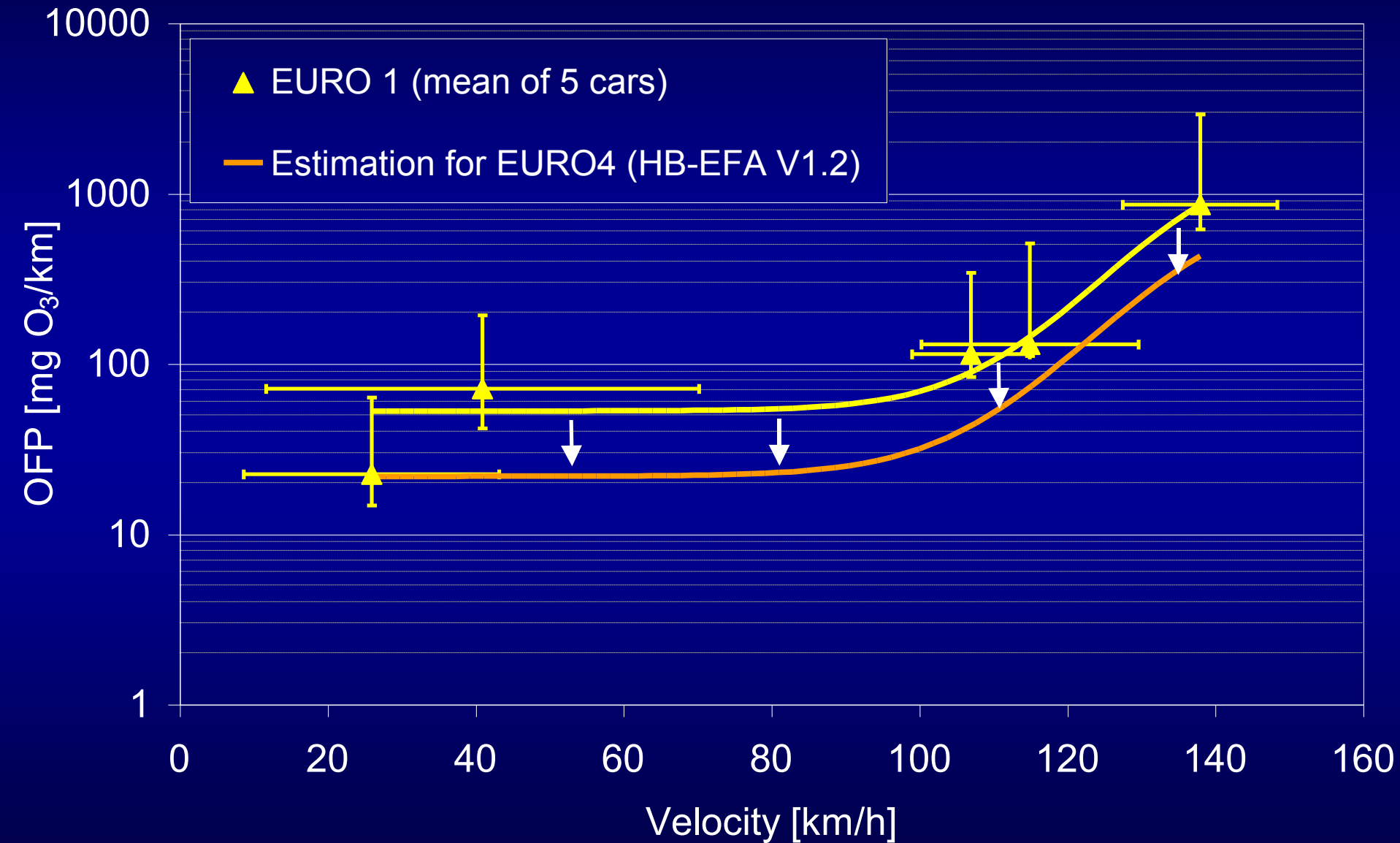
Results (1)

- The European Certification Cycle MVEG poorly reflects real driving behavior.

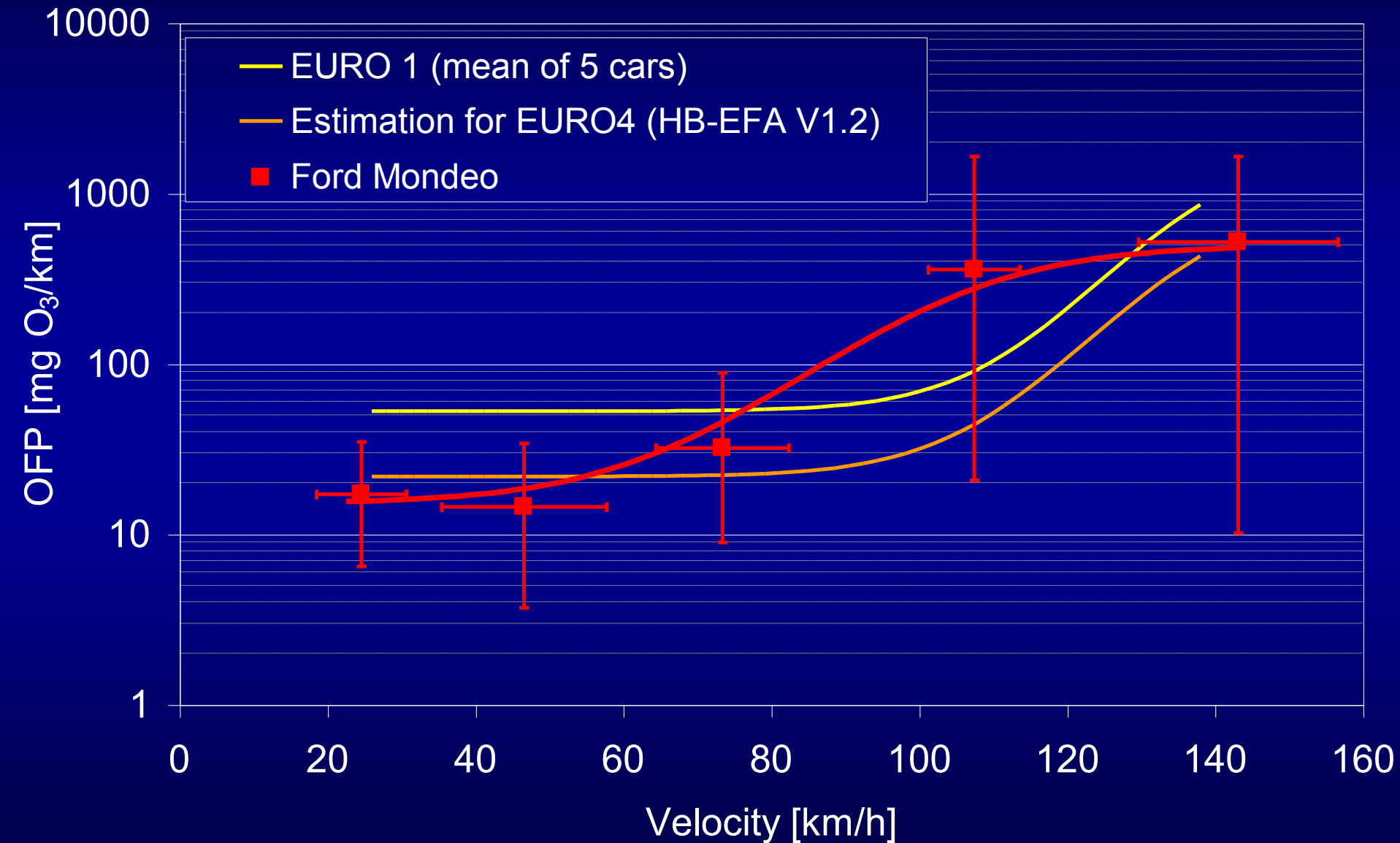
Ozone Formation Potential (OFP)



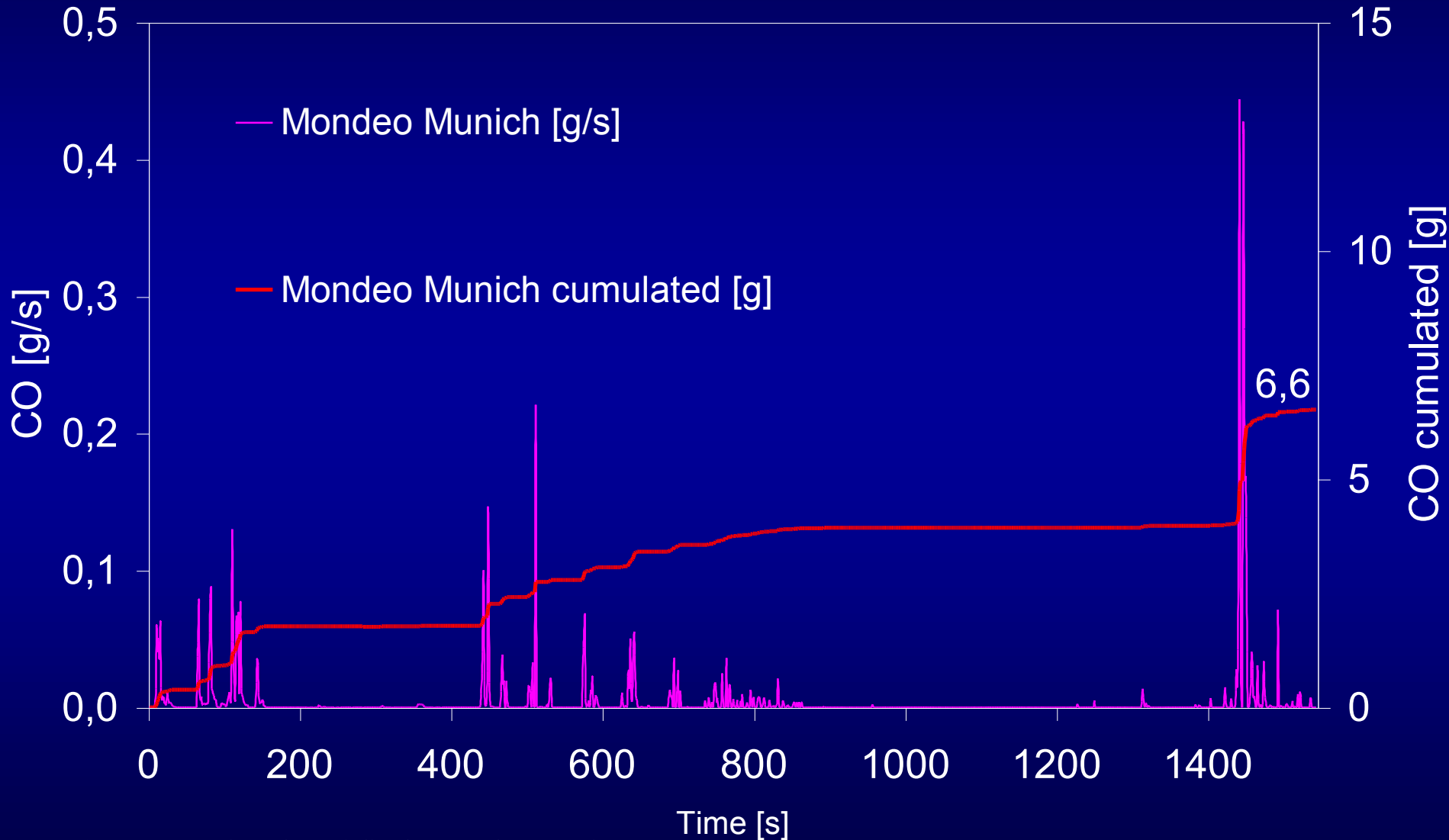
Ozone Formation Potential (OFP)



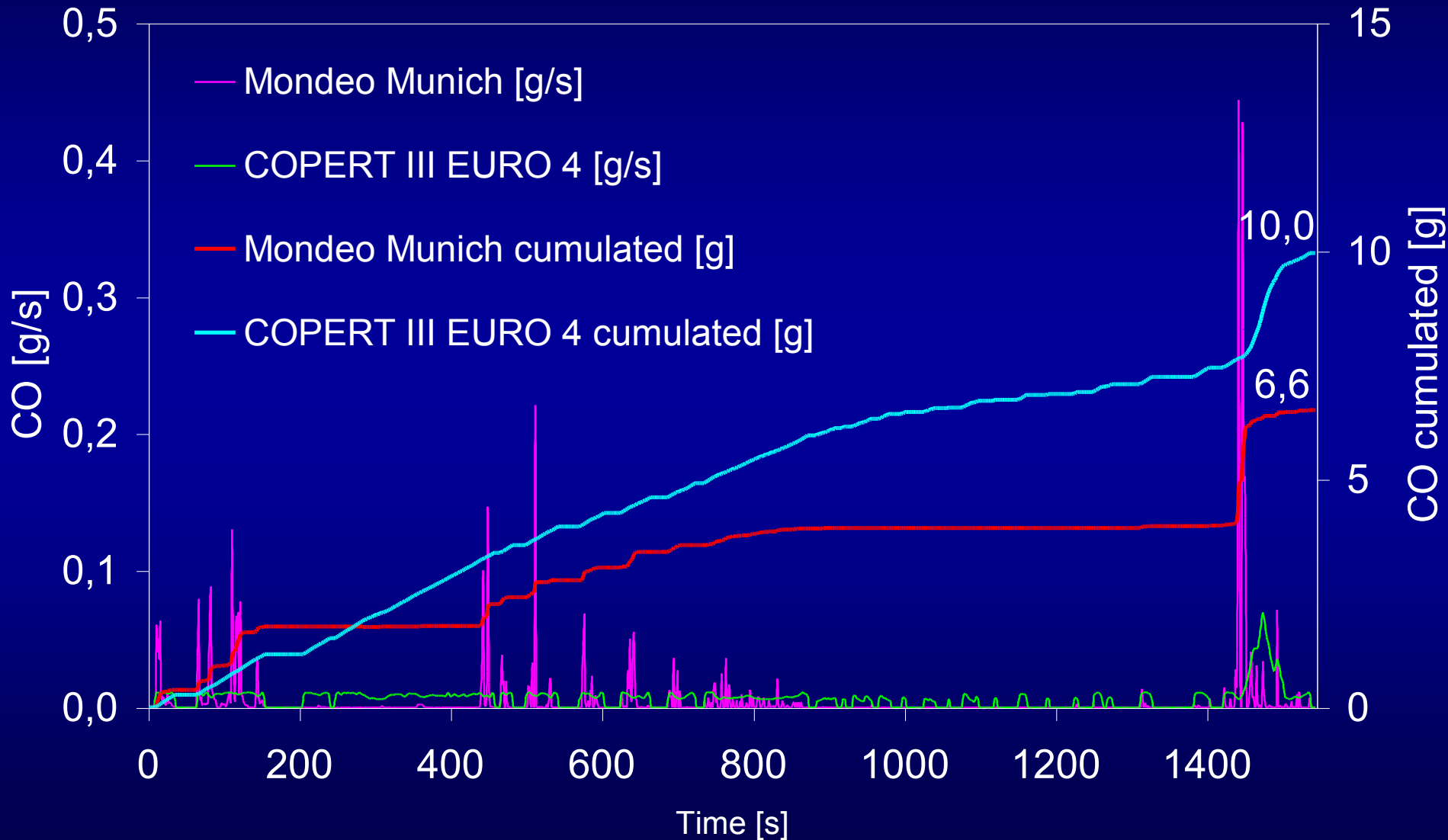
Ozone Formation Potential (OFP)



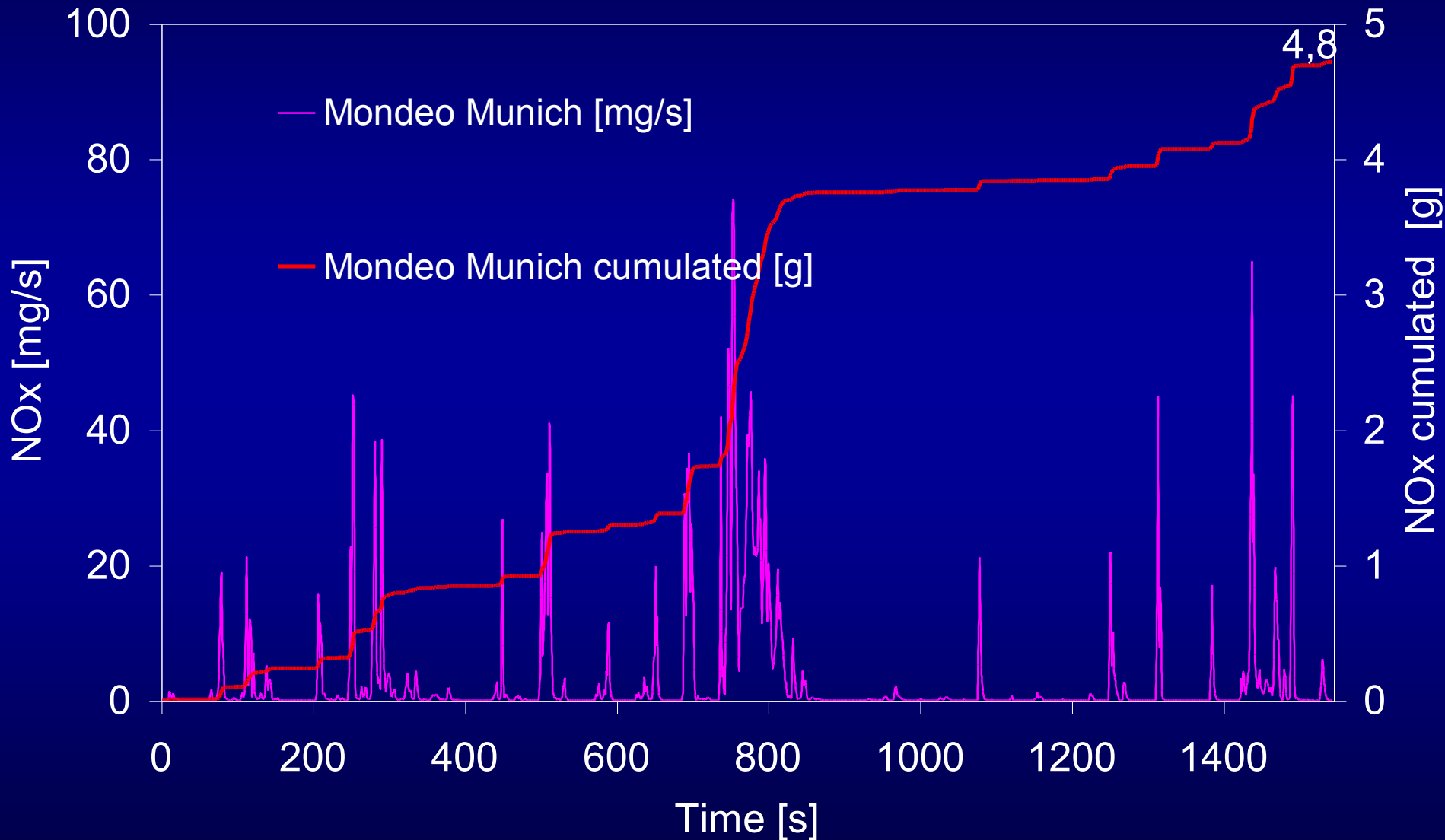
Munich vs. COPERT III - CO



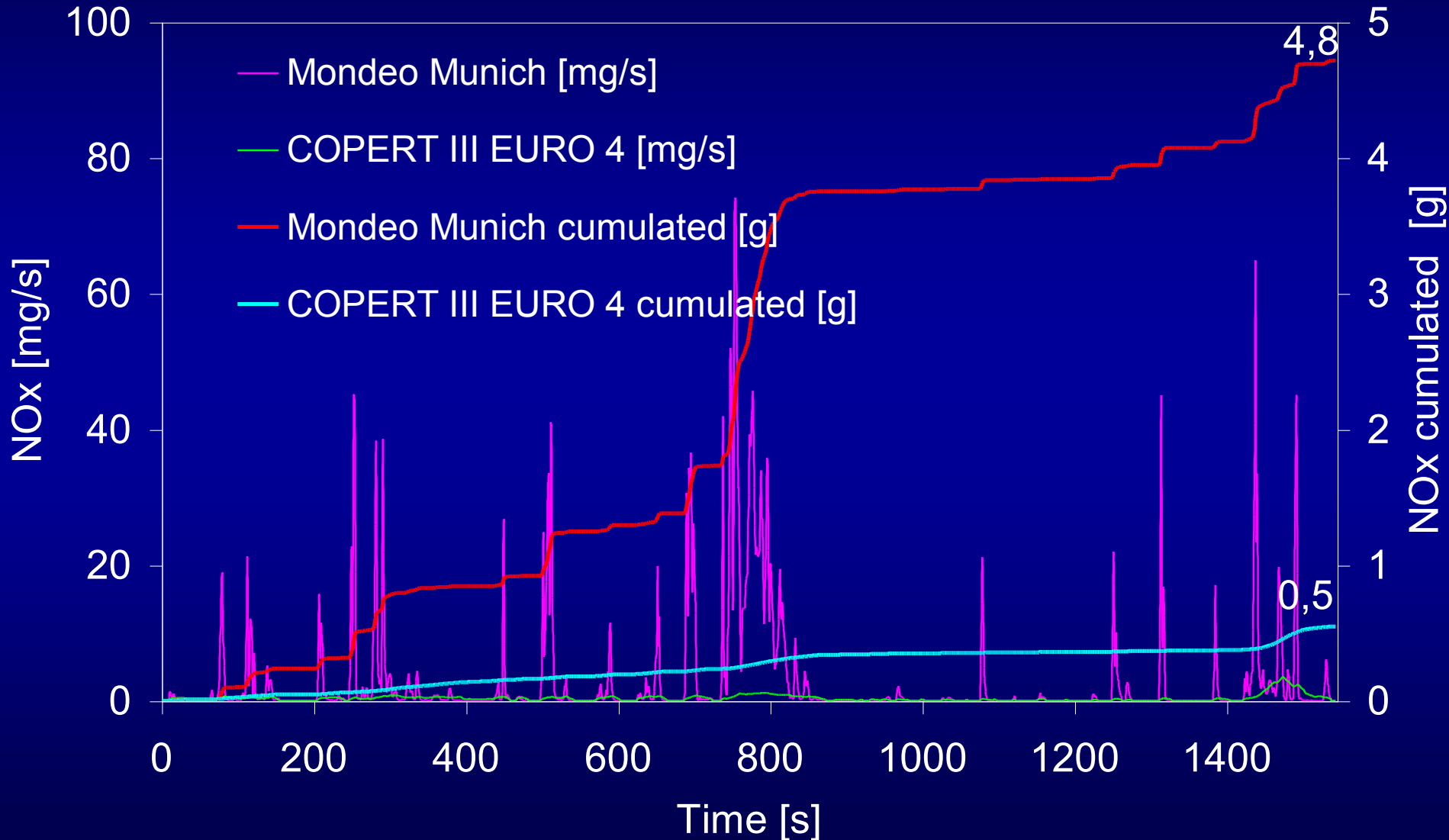
Munich vs. COPERT III - CO



Munich vs. COPERT III - NO_x



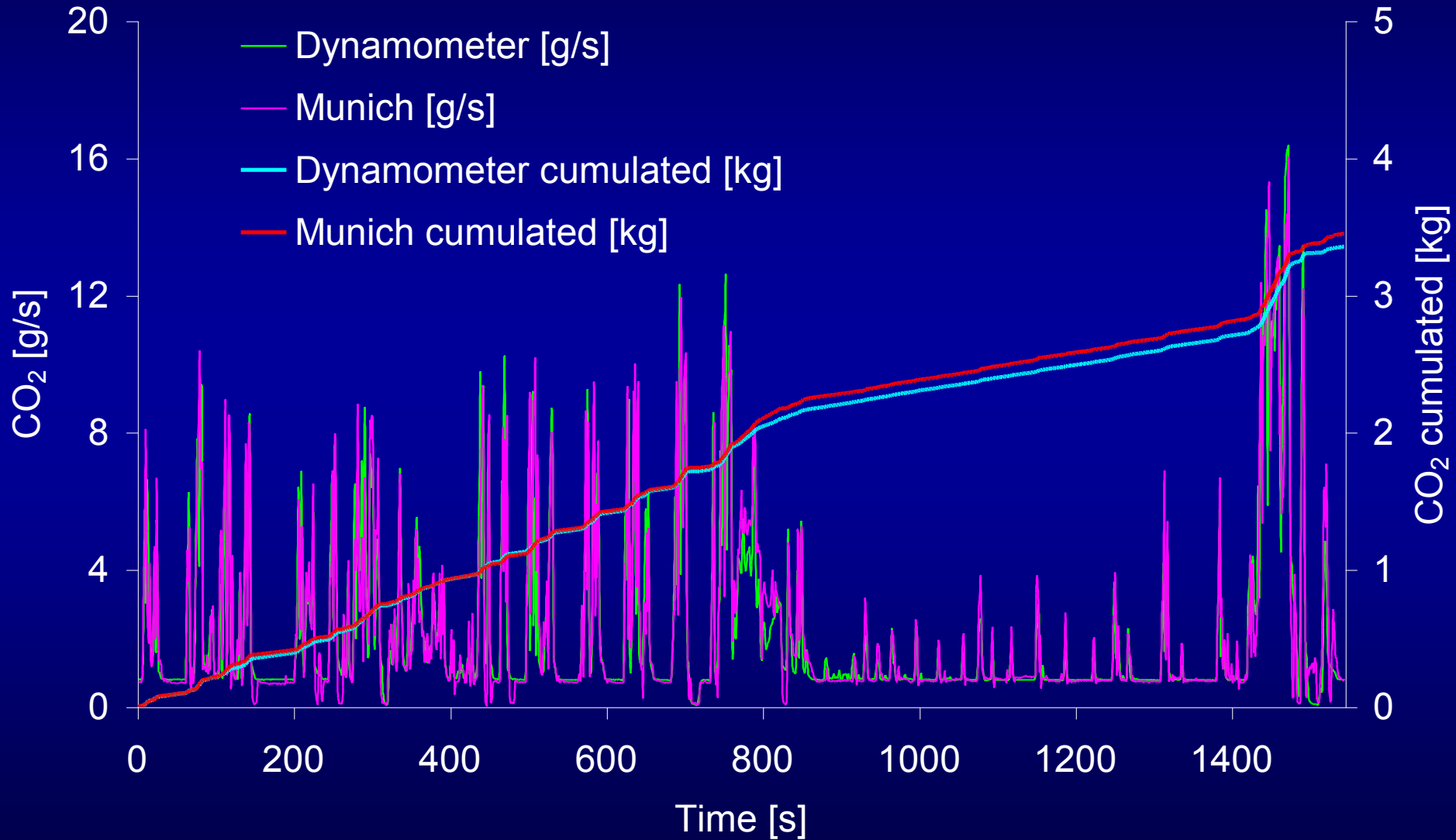
Munich vs. COPERT III - NO_x



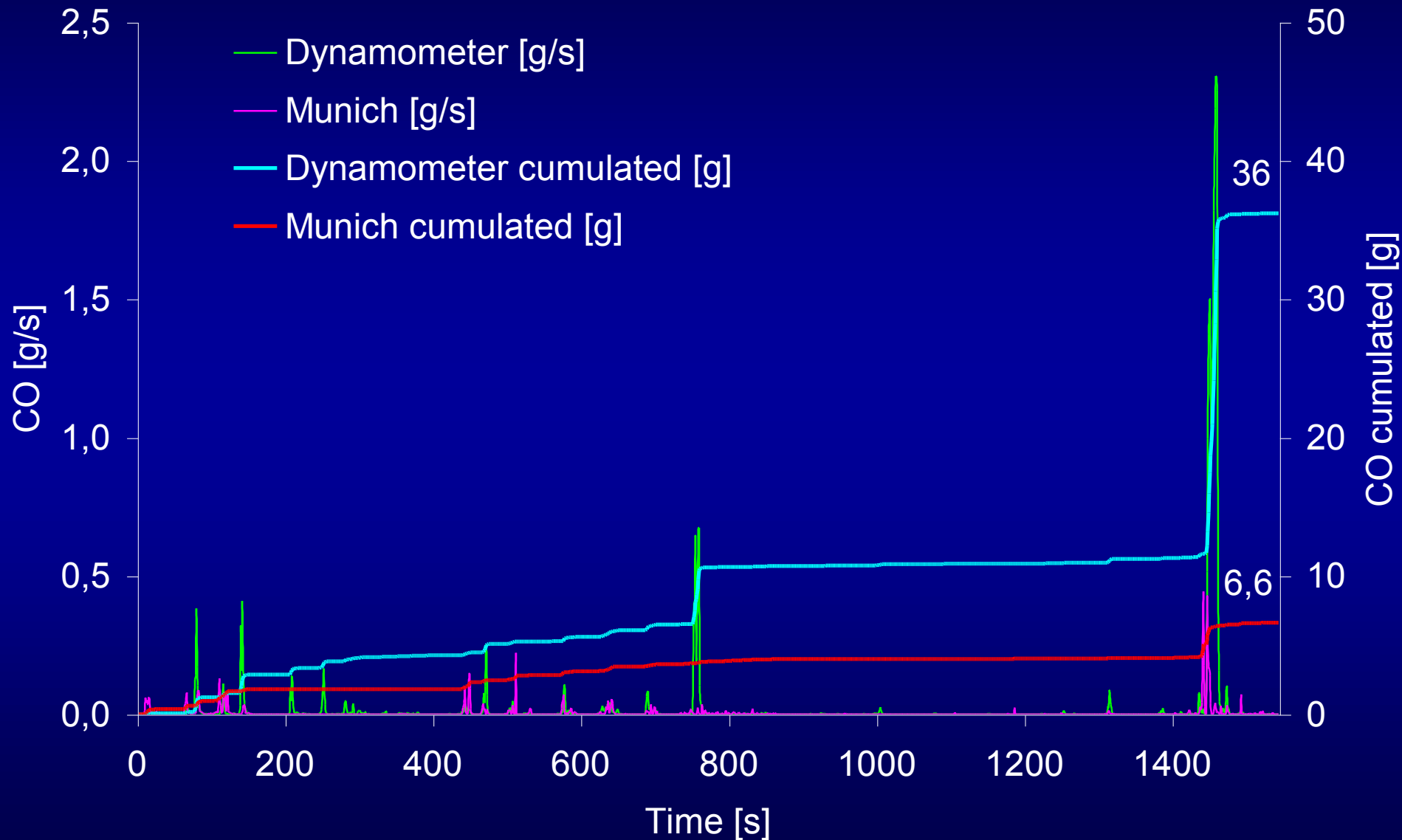
Results (2)

- The European Certification Cycle MVEG poorly reflects real driving behavior.
- Modern catalysts act as non-linear filters; emissions can't be calculated from measurements of older cars.

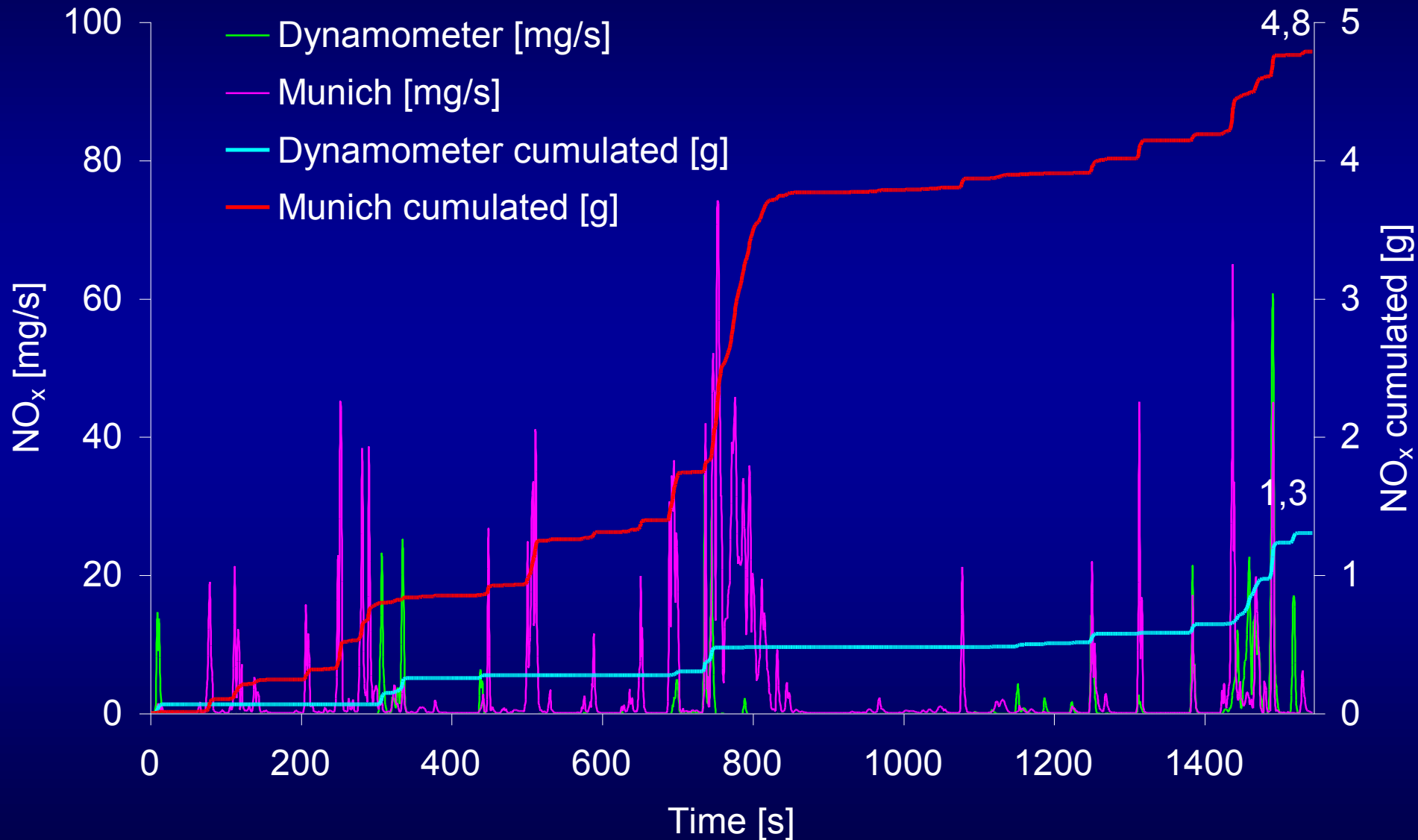
Dynamometer vs. Munich - CO₂



Dynamometer vs. Munich - CO



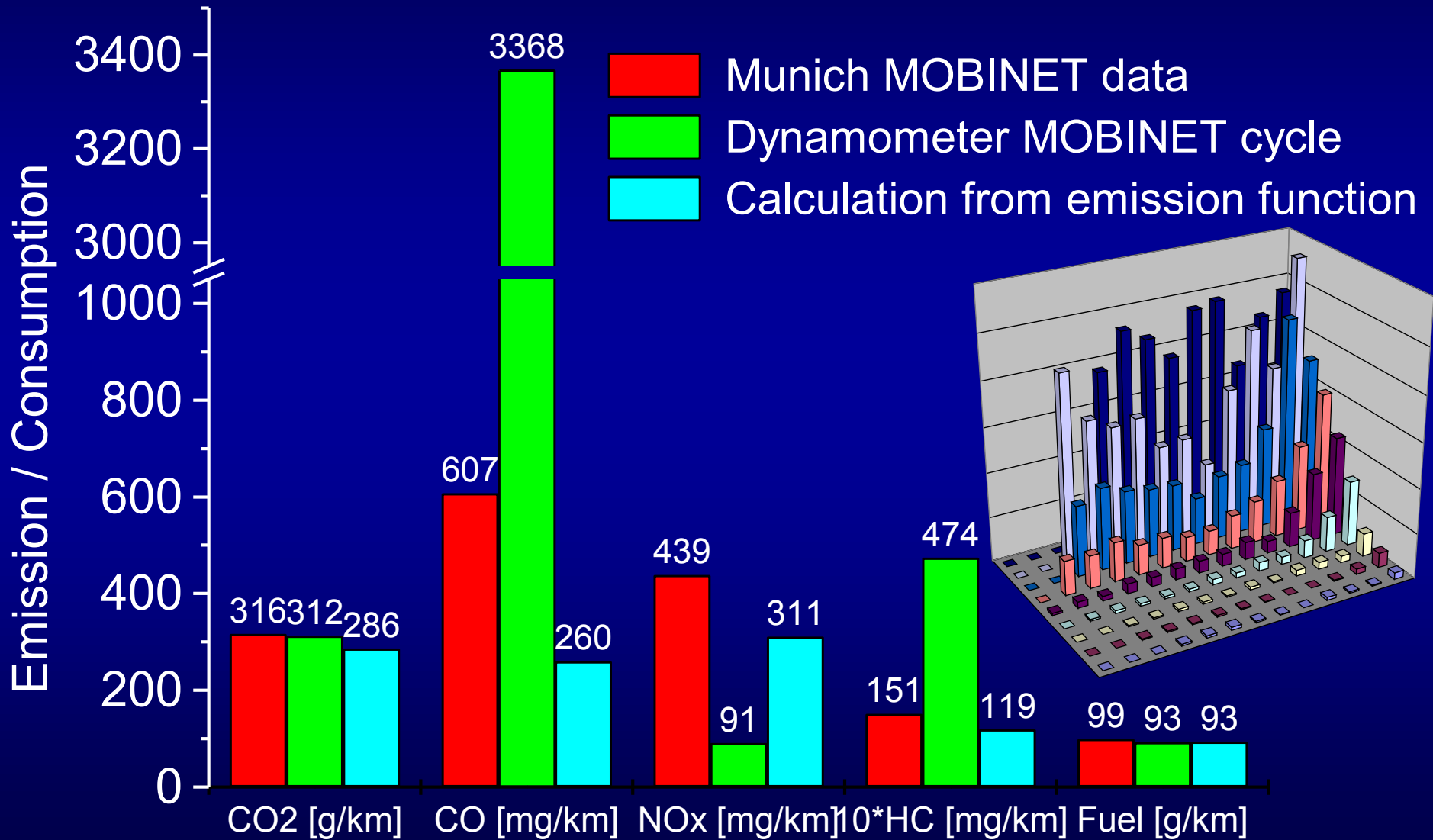
Dynamometer vs. Munich - NO_x



Results (3)

- The European Certification Cycle MVEG poorly reflects real driving behavior.
- Modern catalysts act as non-linear filters; emissions can't be calculated from measurements of older cars.
- Transferability of real world driving to a dynamometer is very limited because emissions are not only $f(v, v*a)$.

Calculation from emission functions - a statistical approach



Results (4)

- The European Certification Cycle MVEG poorly reflects real driving behavior.
- Modern catalysts act as non-linear filters; emissions can't be calculated from measurements of older cars.
- Transferability of real world driving to a dynamometer is very limited because emissions are not only $f(v, a \cdot v)$.
- AEI's should base on emission functions calculated from on-board-measurements.