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International Workshop on Validation and Evaluation of Air Emission Inventories
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The (un)suitability of dynamometer studies for emission inventories

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Traffic and ozone

- Emission data play a major role in photochemical models.
  - Their uncertainty influences the overall uncertainty at most.*
- Traffic is a major source of ozone precursors.
  - Current AEI’s base on questionable emission data from mobile sources.

*Hanna et al., Atmos. Environ. 32 (1998), *3227-3238*

Findings & Questions

Results from dynamometer studies are used as input data of emission models.

Do dynamometer studies reflect real world emissions?

Findings & Questions

Currently, experimental data are available only from EURO1/2-cars. Emissions of new cars are estimated.

Are emissions of modern cars calculable from former measurements?

Findings & Questions

The European certification cycle MVEG is a frequent basis for dynamometer studies and hence emission calculations.

Does the MVEG meet real world driving conditions?

Agenda within "MOBINET"

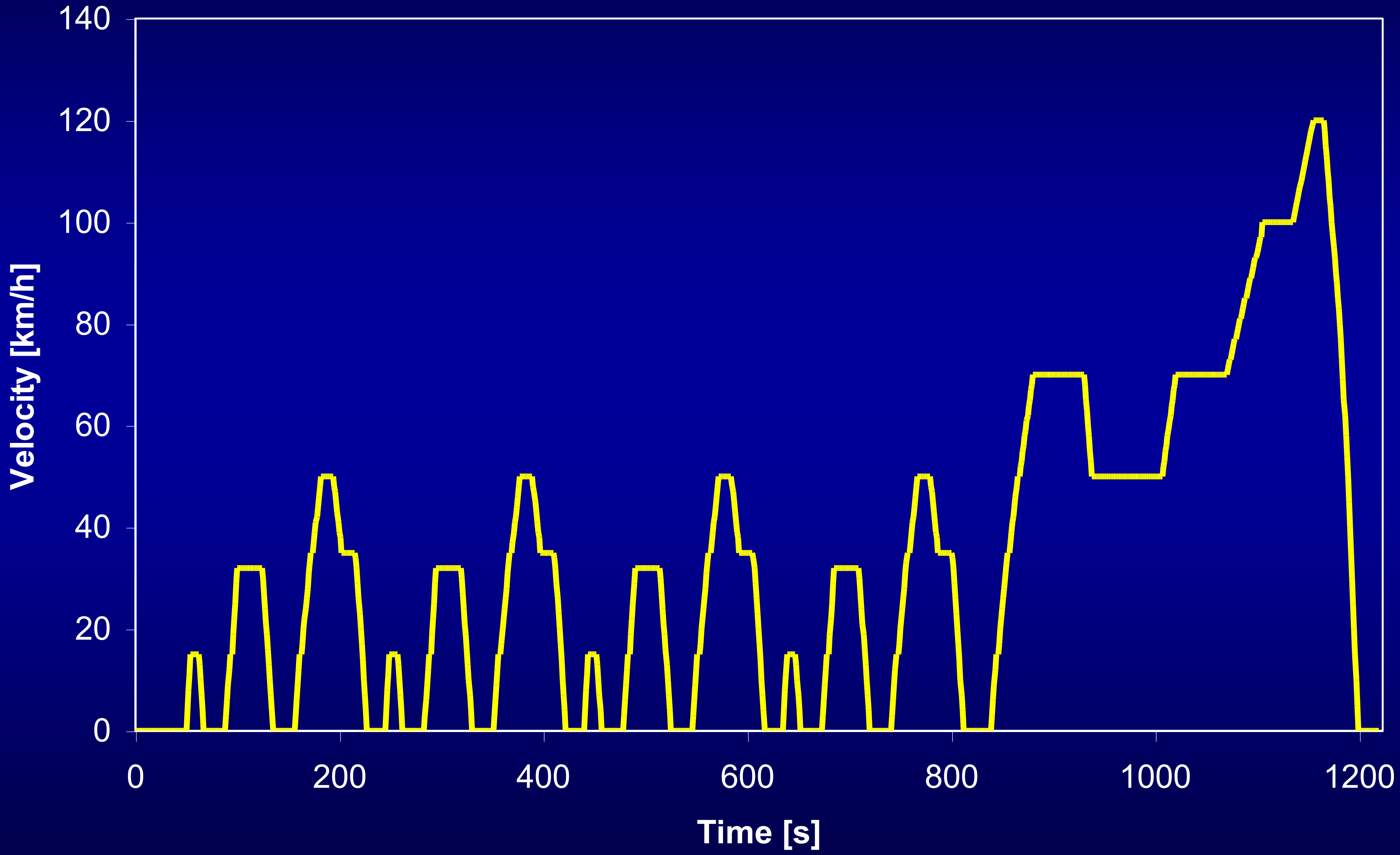
- On-Board-Measurements in Munich
- Construction of a realistic driving cycle
- Measurements on a chassis dynamometer
  - Comparison of different driving cycles
  - Comparison of different engine types (Diesel engine, SI engine, DI-SI engine) with latest exhaust gas treatment techniques
- Calculation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

The test vehicle

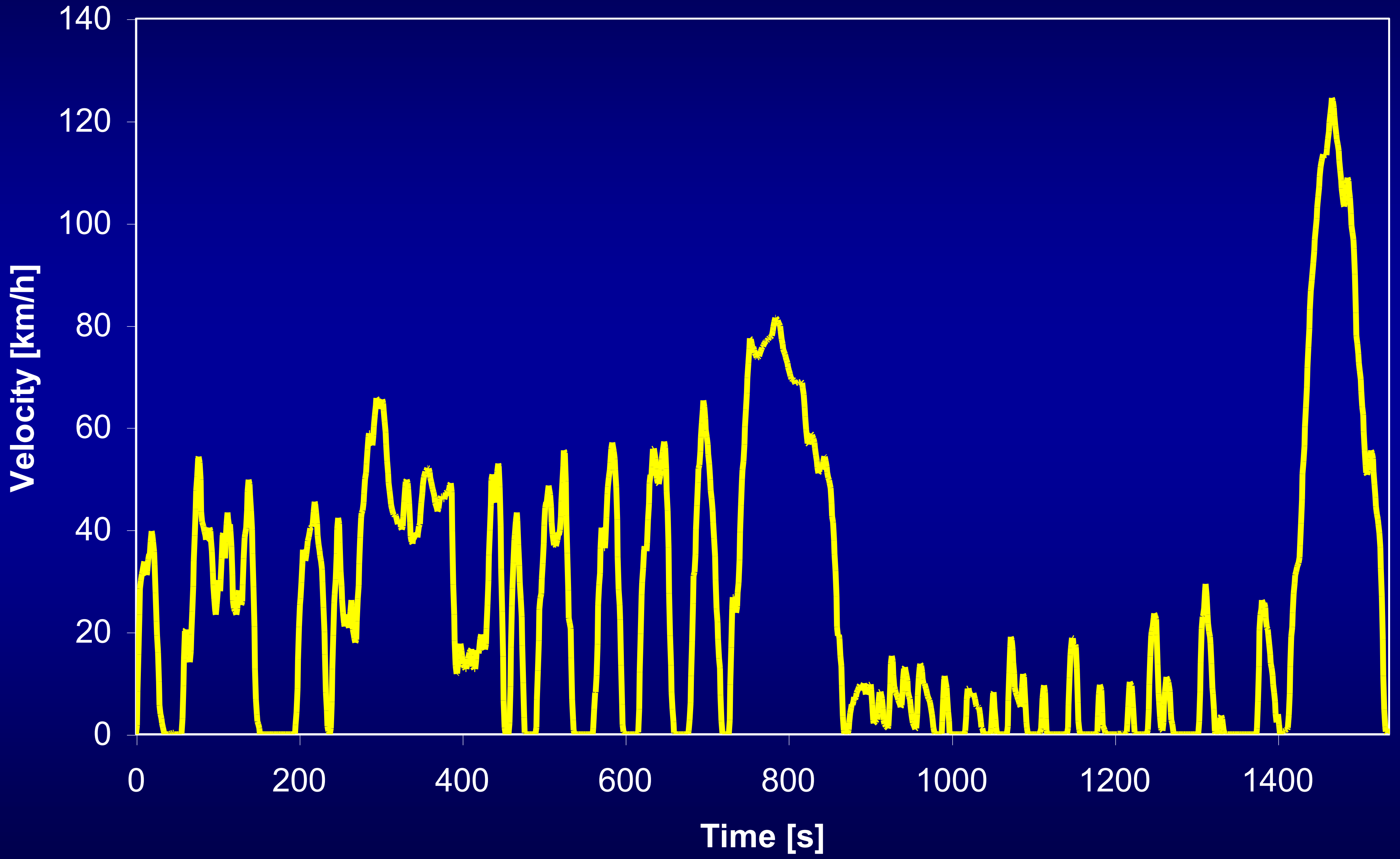
Ford Mondeo, gasoline, 85 kW, 1796 cm³, exhaust regulation D4

- 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

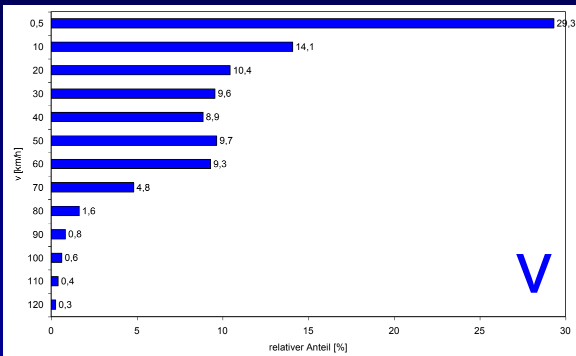
European Certification Cycle MVEG

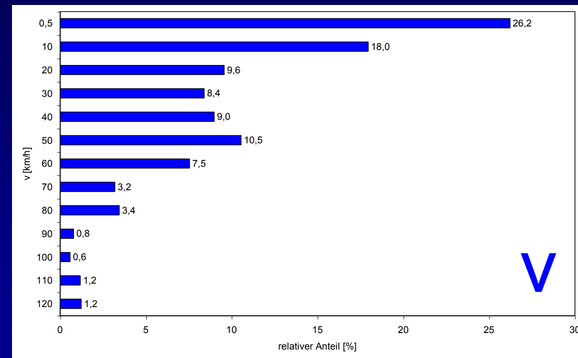


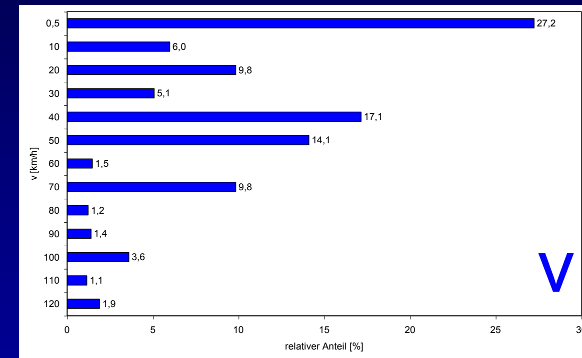
MOBINET-Cycle

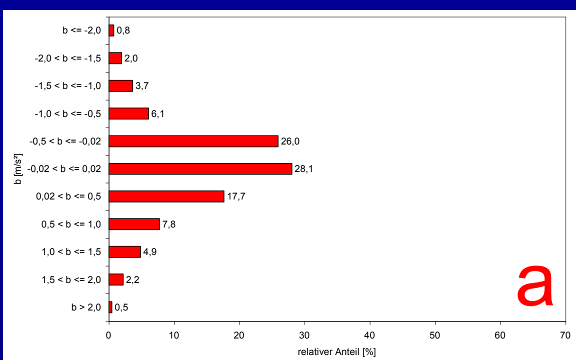


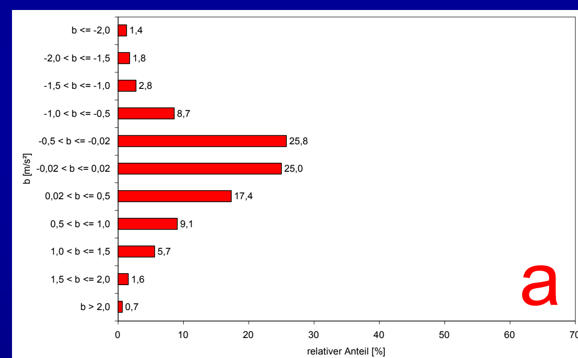
Munich MOBINET-cycle MVEG

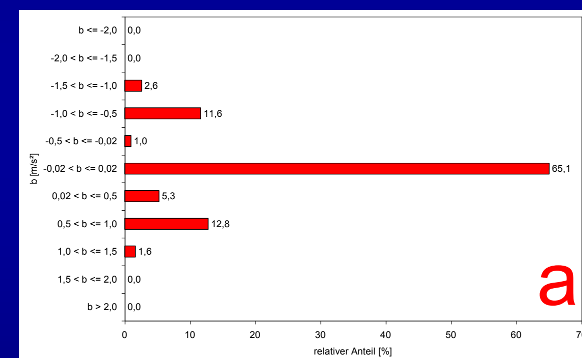


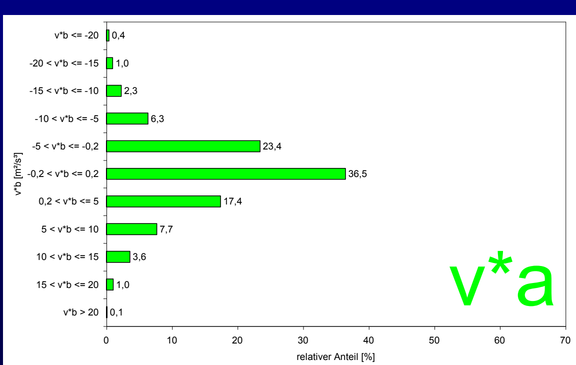


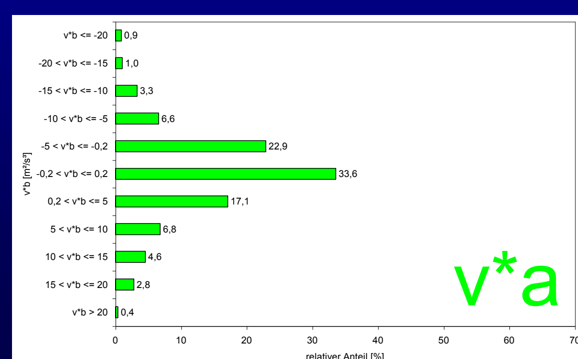


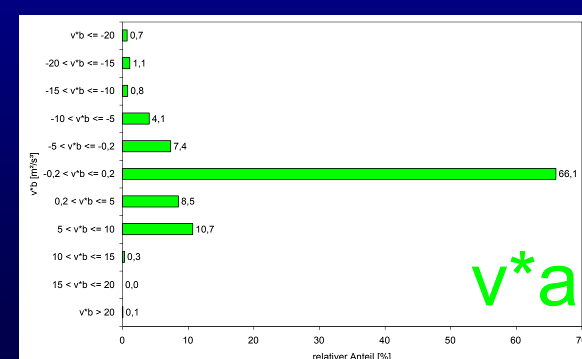




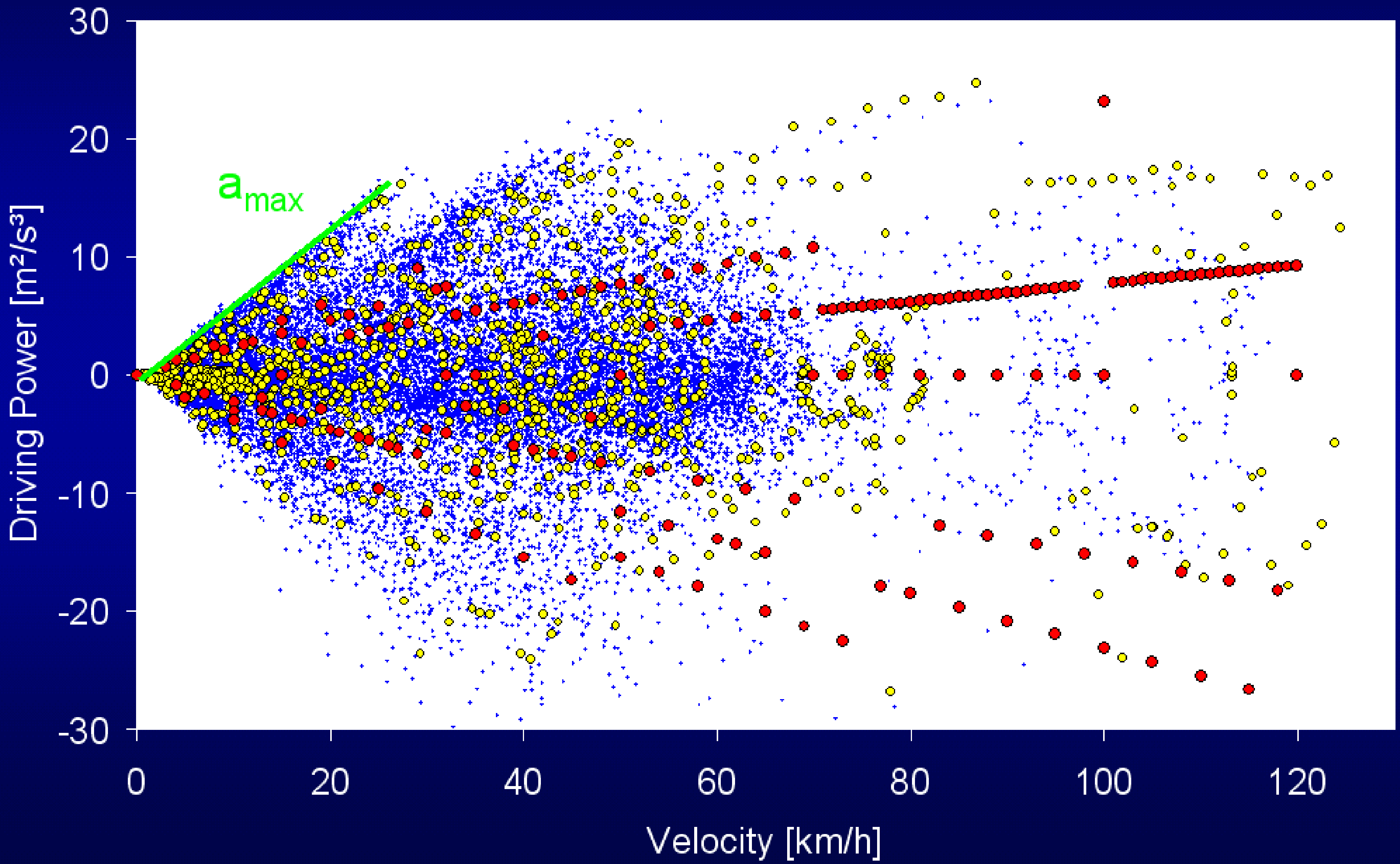








Power vs. Velocity of the Munich measurements (blue) compared to MOBINET-cycle (yellow) and MVEG (red)



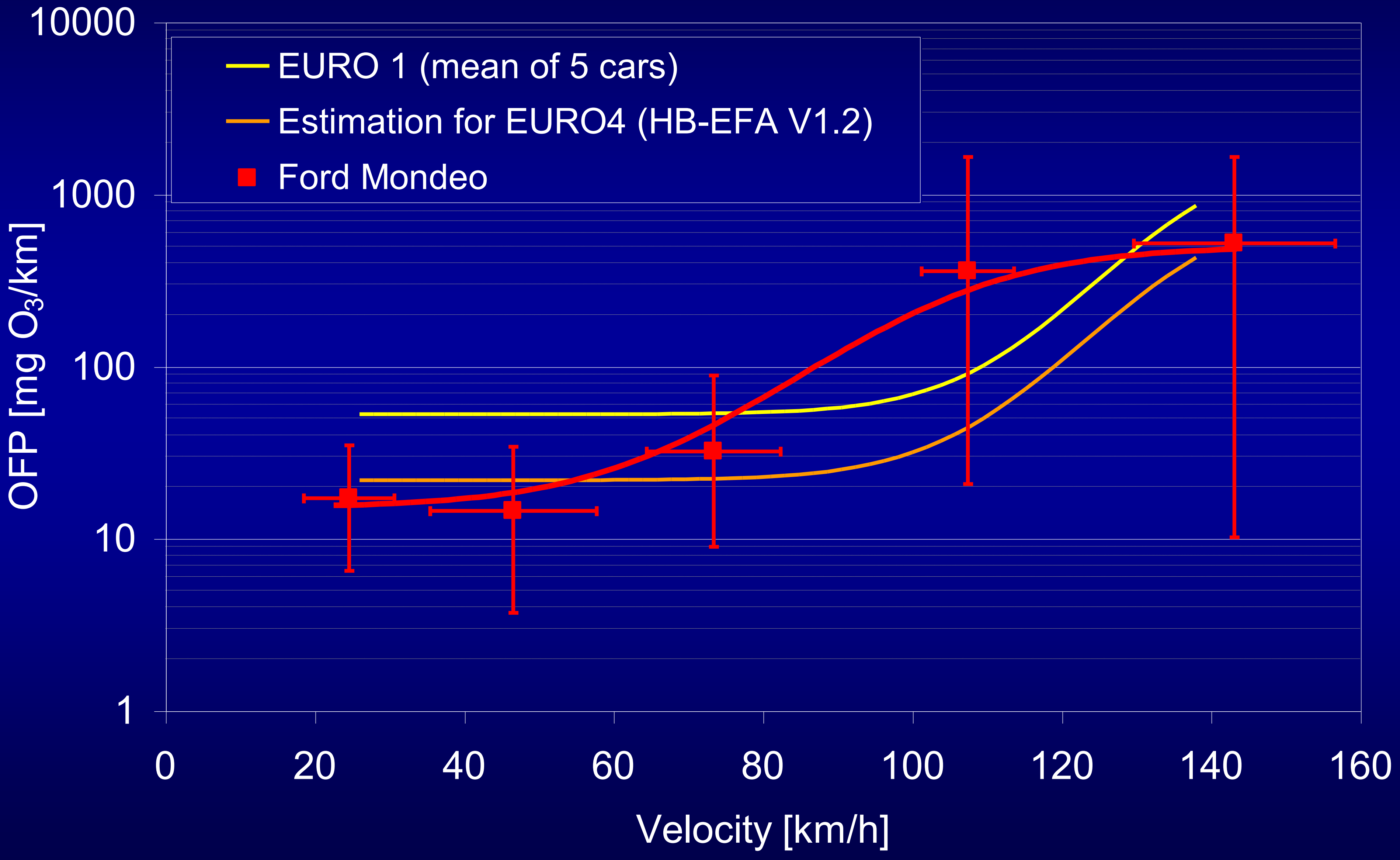
Chassis dynamometer measurements: Results of MVEG and MOBINET-Cycle

	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%

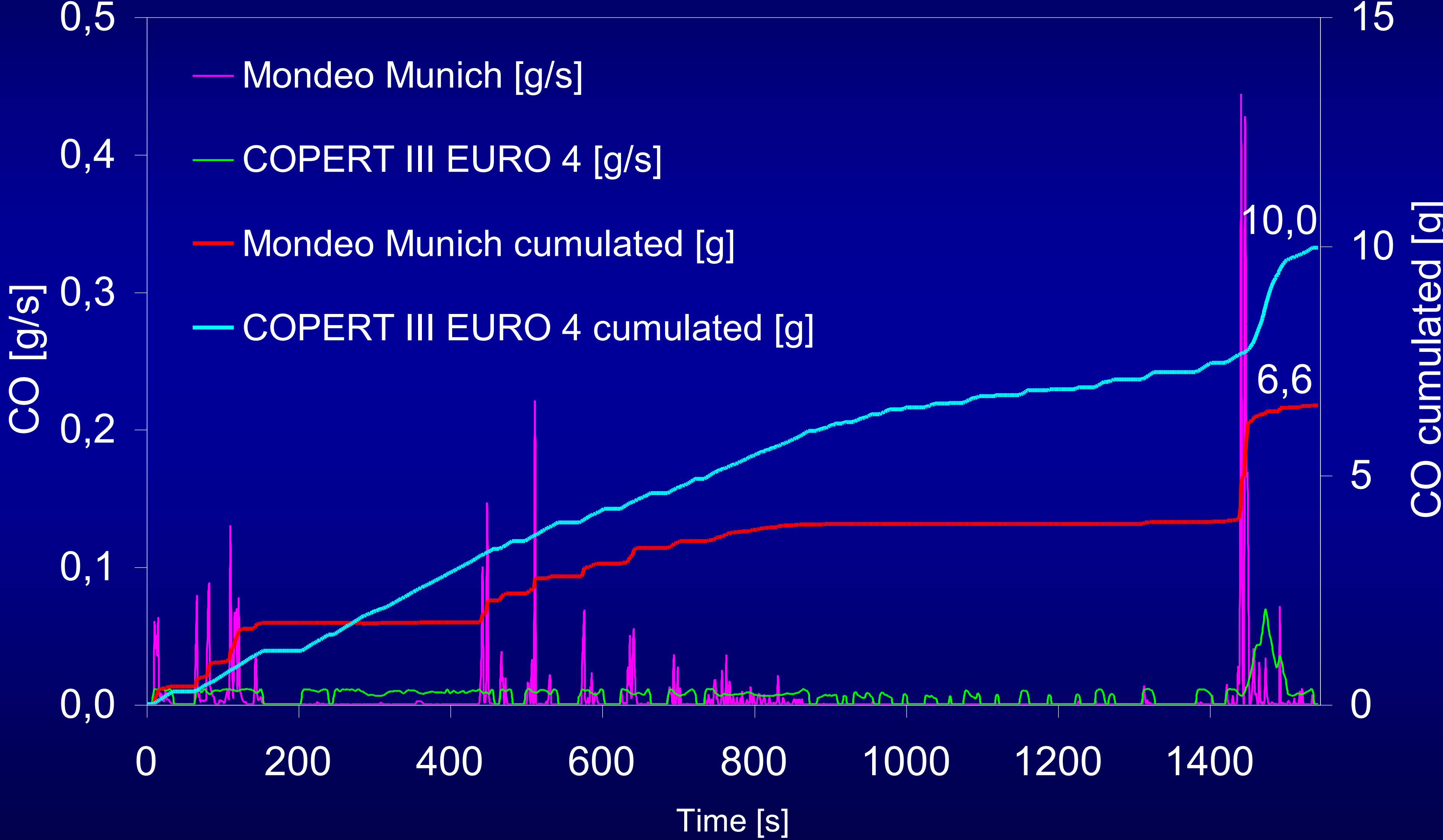
Results (1)

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

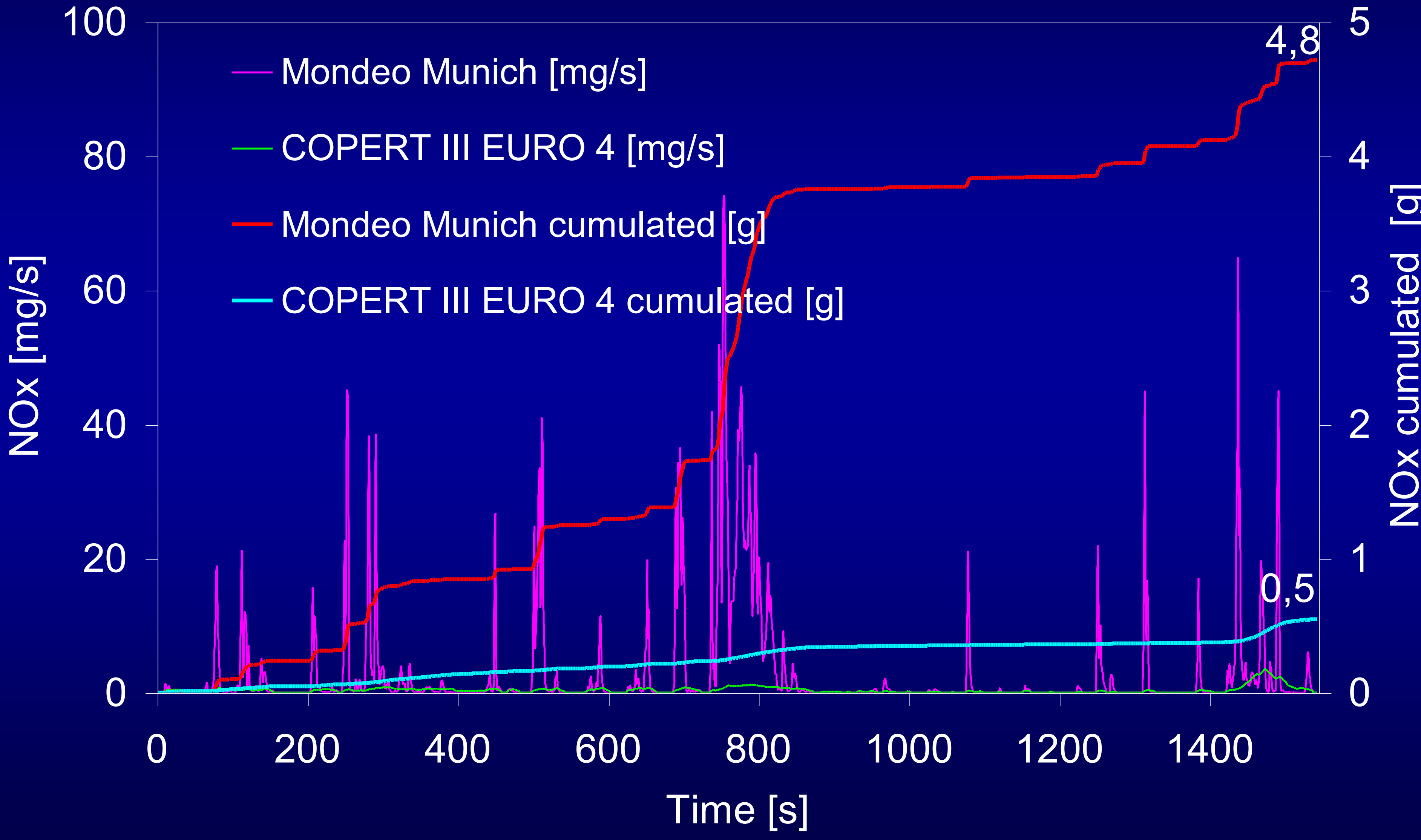
Ozone Formation Potential (OFP)



Munich vs. COPERT III - CO



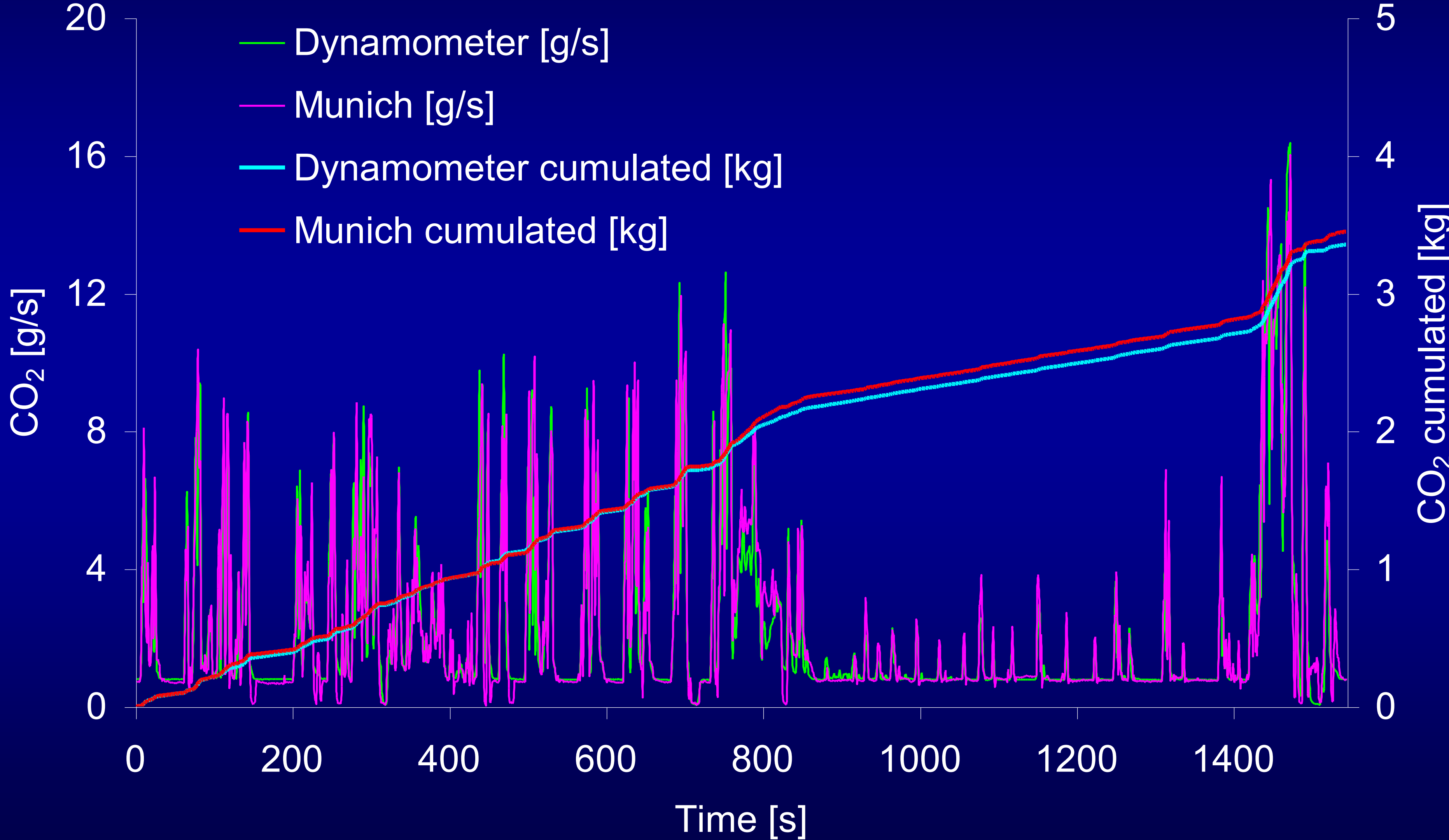
Munich vs. COPERT III - NO_x



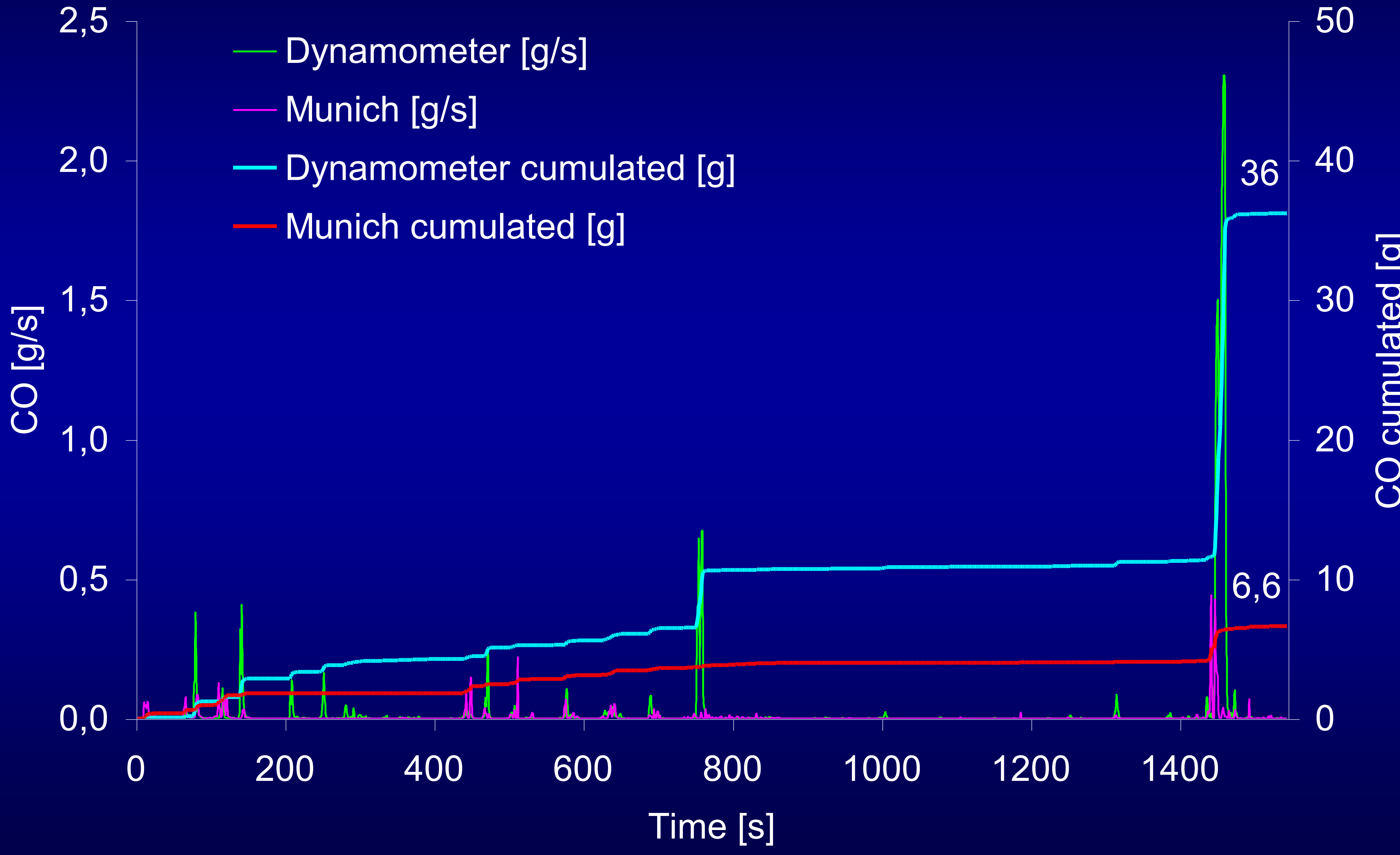
Results (2)

- 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.

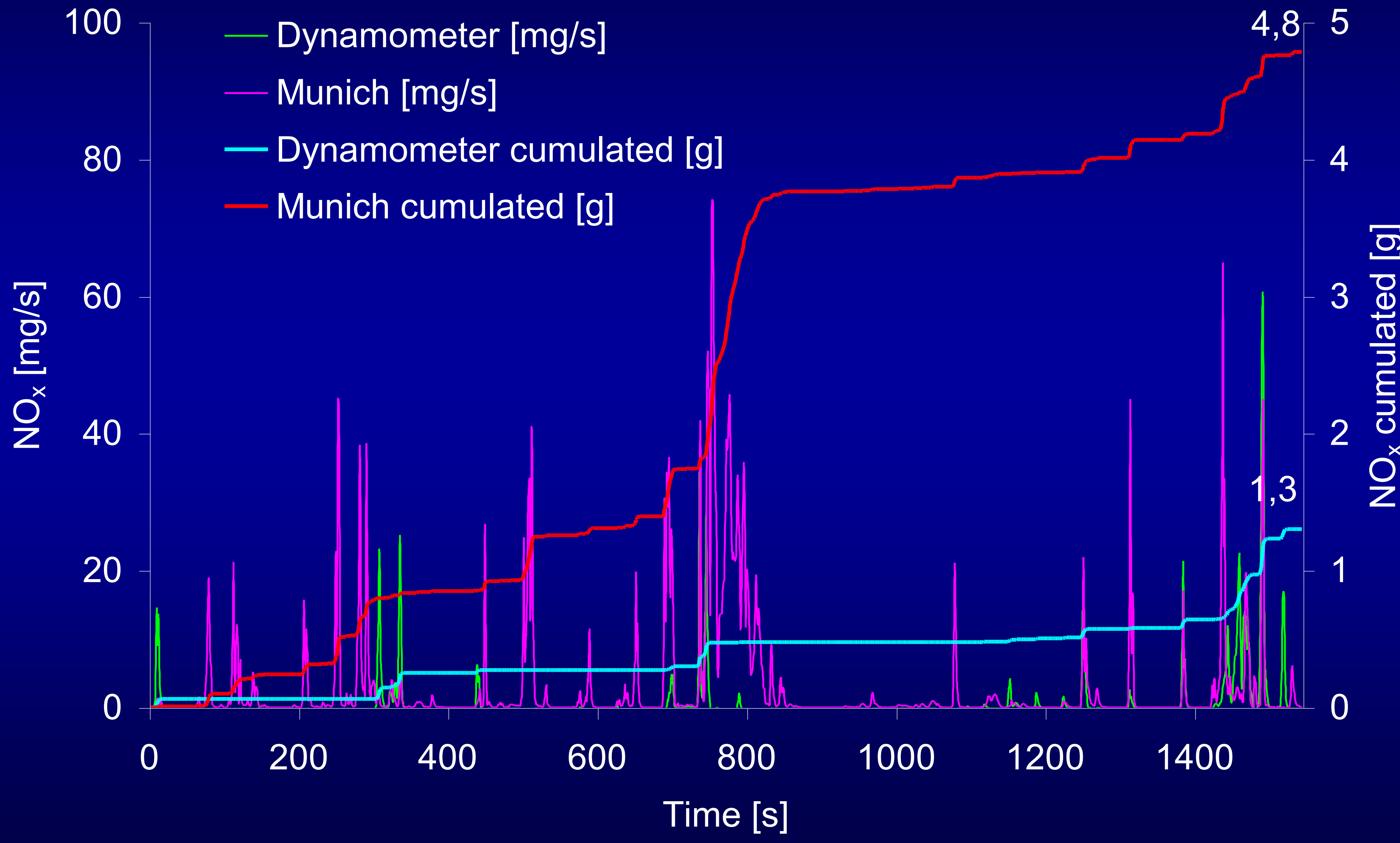
Dynamometer vs. Munich - CO_2



Dynamometer vs. Munich - CO



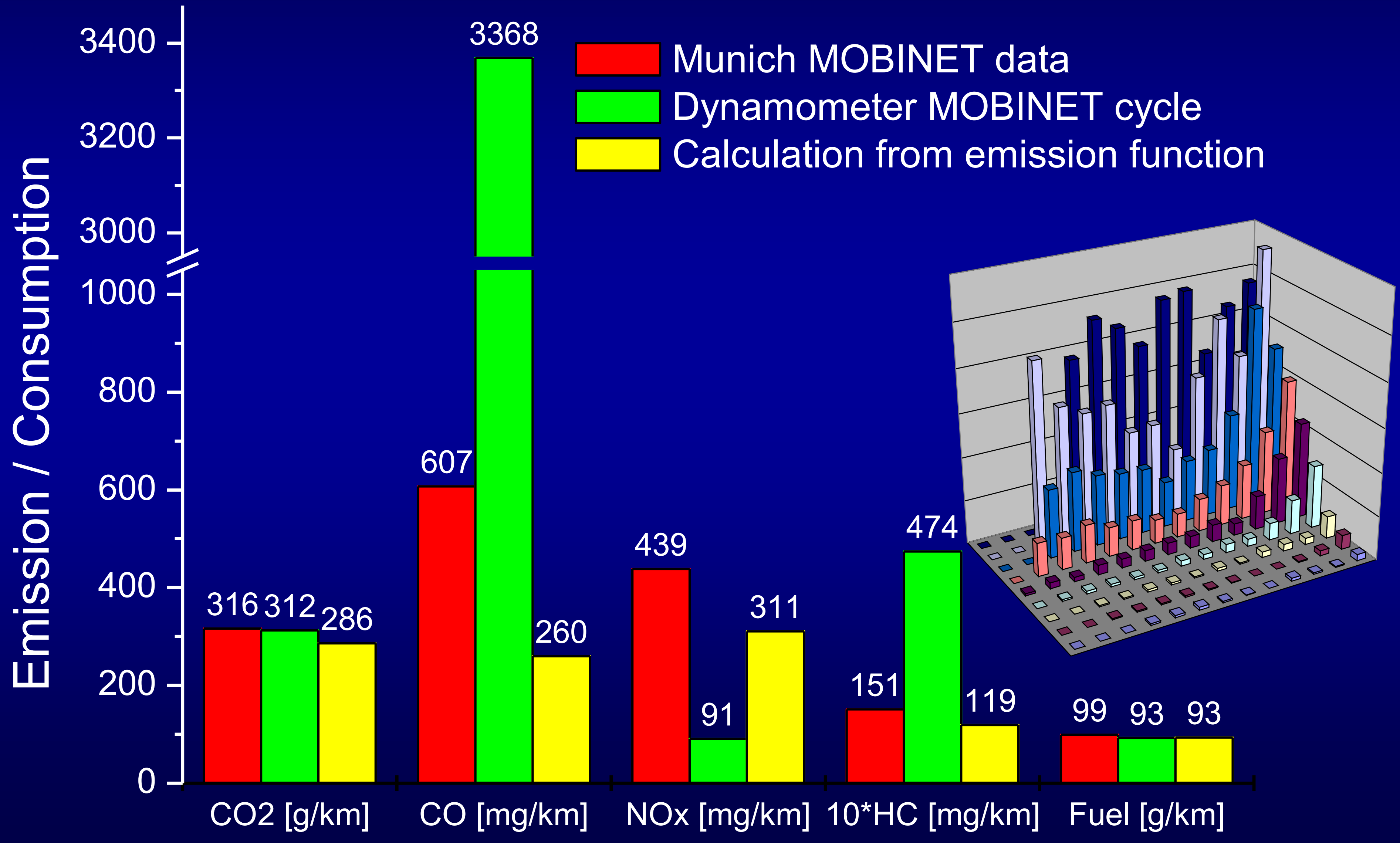
Dynamometer vs. Munich - NO_x



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*v).
- AEI’s should base on emission functions calculated from on-board-measurements.

Conclusions and outlook

- There are strong indications that modern cars have substantially higher emissions in real world driving than expected.
- AEI’s should not estimated the emission of modern cars from former measurements.
- Our findings with one car should be renewed on a broader basis.
- On-board-measurement of several cars with different engine concepts are desirable.