Particulate Emissions from Petrol-Engined Light-Duty Vehicles taken from the European Fleet

Cambridge Particles Meeting

24 May 2013

AECC Association for Emissions Control by Catalyst AISBL

Association for Emissions Control by Catalyst (AECC) AISBL

AECC members: European emissions control companies

Technology for exhaust emissions control on all new cars (OEM and Aftermarket) and an increasing number of buses & commercial vehicles, non-road applications and motorcycles.

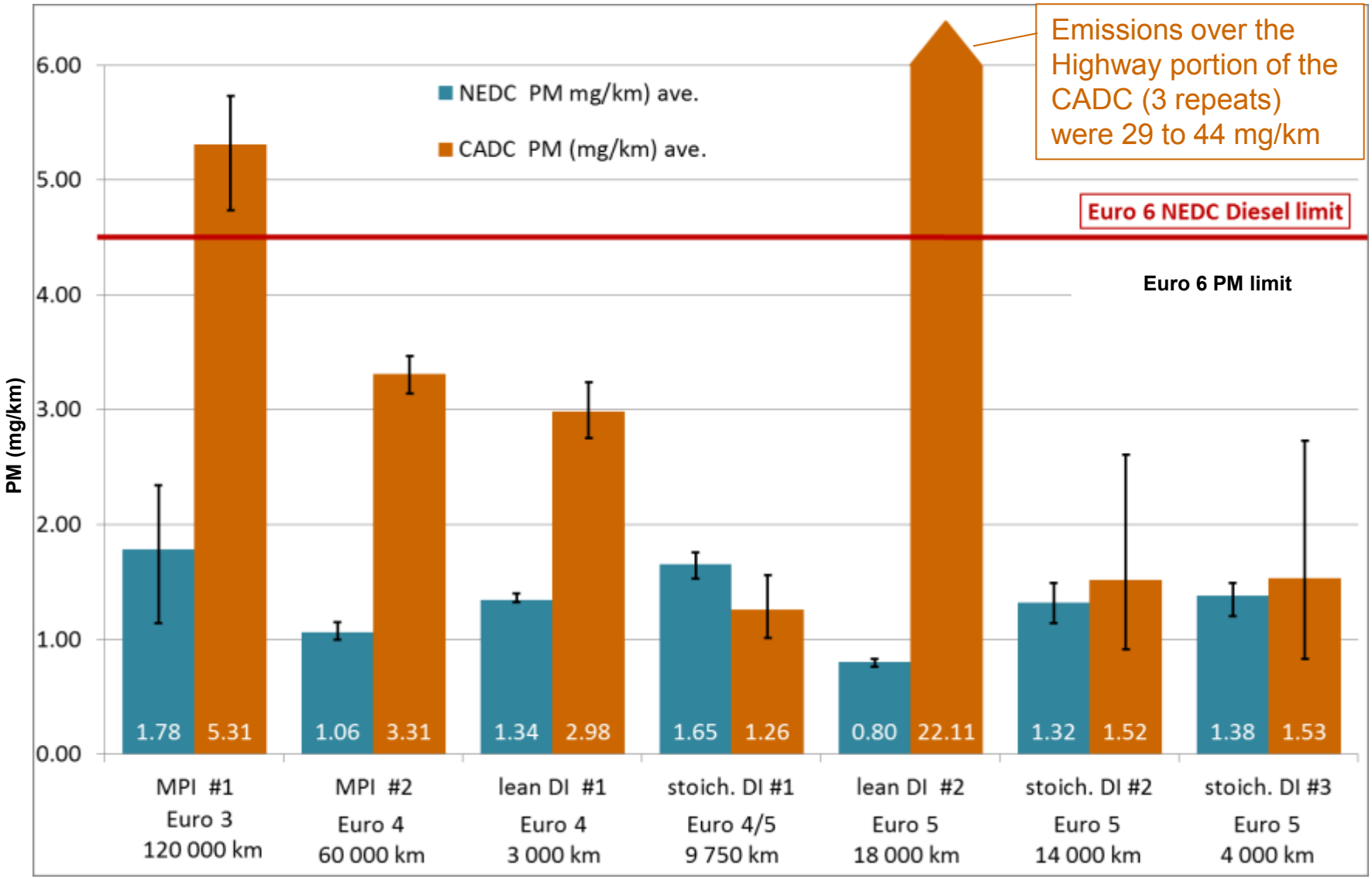
Association for Emissions Control by Catalyst AISBL

AECC Tests on Euro 3 to 5 PI Vehicles

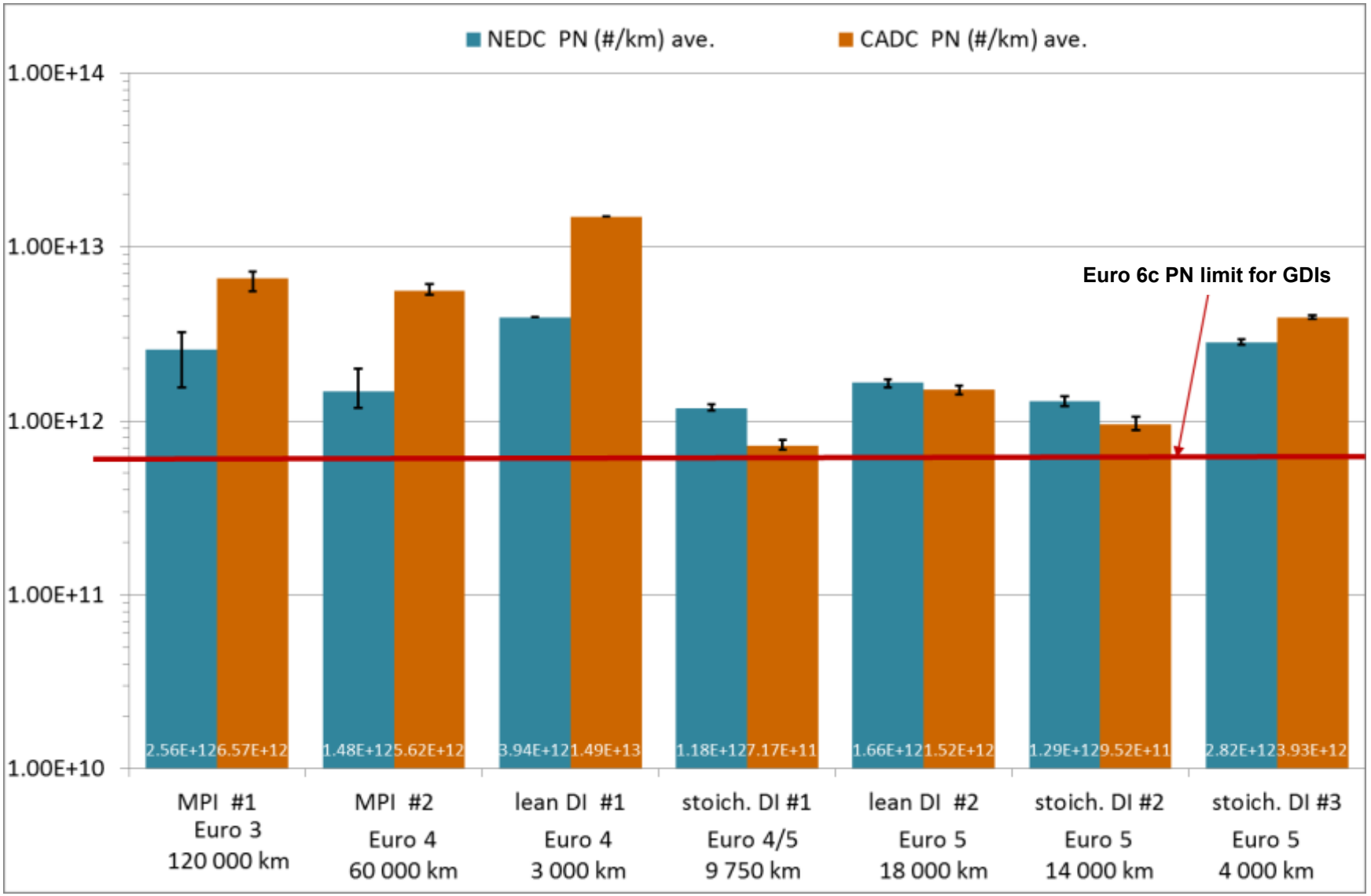
Working Principle	Engine Capacity	Power (kW)	Emission Approval	Registration Date	Gearbox	Inertia (kg)	Mileage (km)	Date of Test
MPI #1	2 litre	85	Euro 3	01/12/1999	M5	1360	120000	Apr-08
MPI #2	2 litre	85	Euro 4	27/03/2001	M5	1360	60000	Nov-08
lean DI #1	2 litre	105	Euro 4	17/06/2008	M6	1470	3000	Aug-08
stoichiometric DI #1	1.4 litre	92	Euro 4 / 5	30/04/2008	M6	1470	9750	Nov-08
lean DI #2	3.5 litre	215	Euro 5	26/10/2009	AT7	1930	18000	Nov-10
stoichiometric DI #2	1.6 litre	115	Euro 5	23/10/2009	M6	1590	14000	Dec-10
stoichiometric DI #3	1.2 litre	63	Euro 5	13/09/2010	M5	1360	4000	Jan-11

- All vehicles tested on the NEDC and the full suite of Artemis (CADC) tests.
- Data is available for ECE 1+2, ECE 3+4, EUDC, and for the full CADC Urban, CADC Rural and CADC Motorway tests.
- CADC tests are hot start, but single cold-start tests (at normal test temperature) are available for the final 3 vehicles.
- Regulated emissions, PM, PN and selected non-regulated emissions were measured for all vehicles.
- For the final 3 vehicles particle size analysis (EEPS) was included.
- Error bars shown on graphs are min., average and max. of 3 results.

Particulate Mass Emissions NEDC & CADC

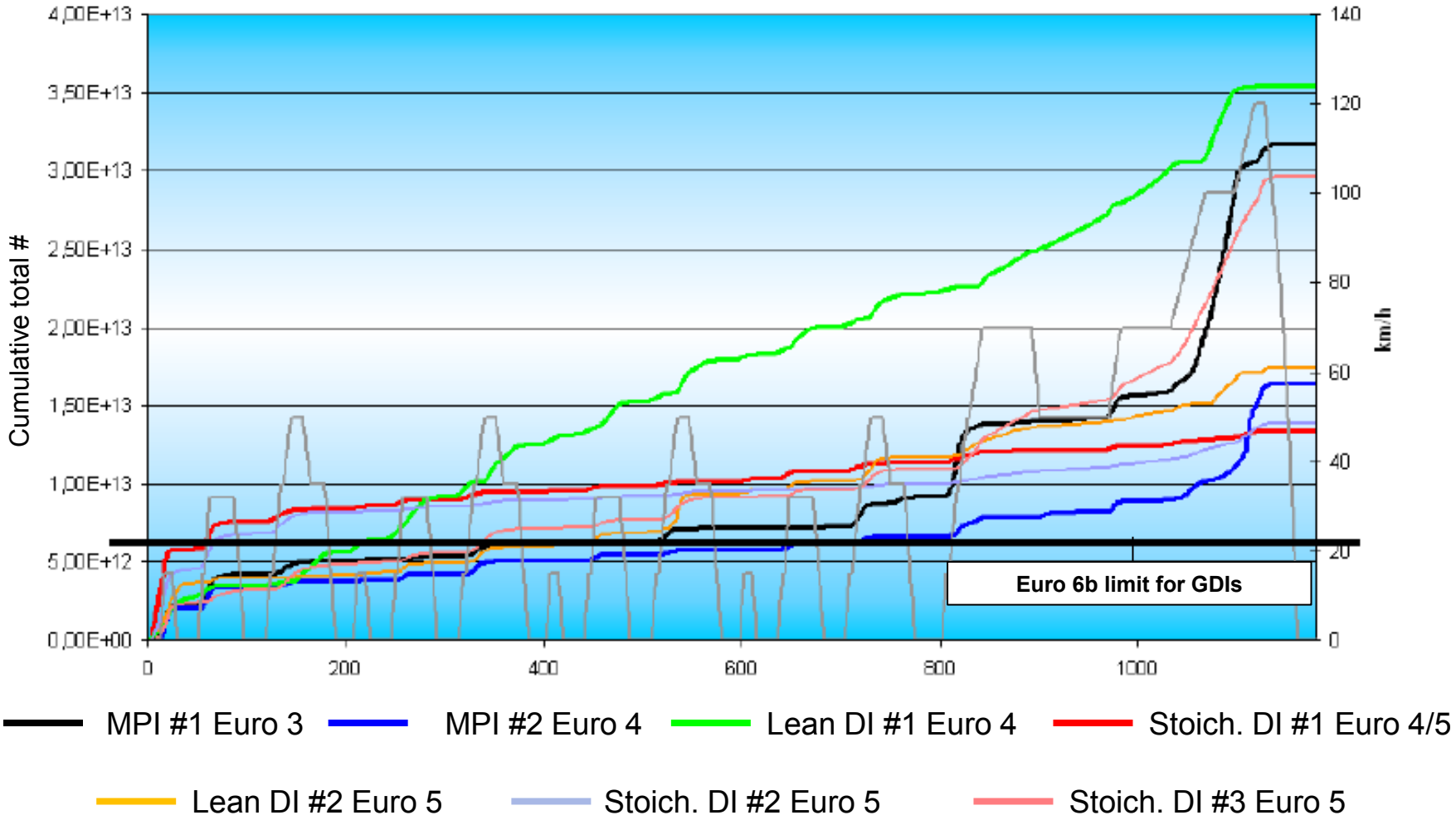


Particle Number Emissions on NEDC & CADC



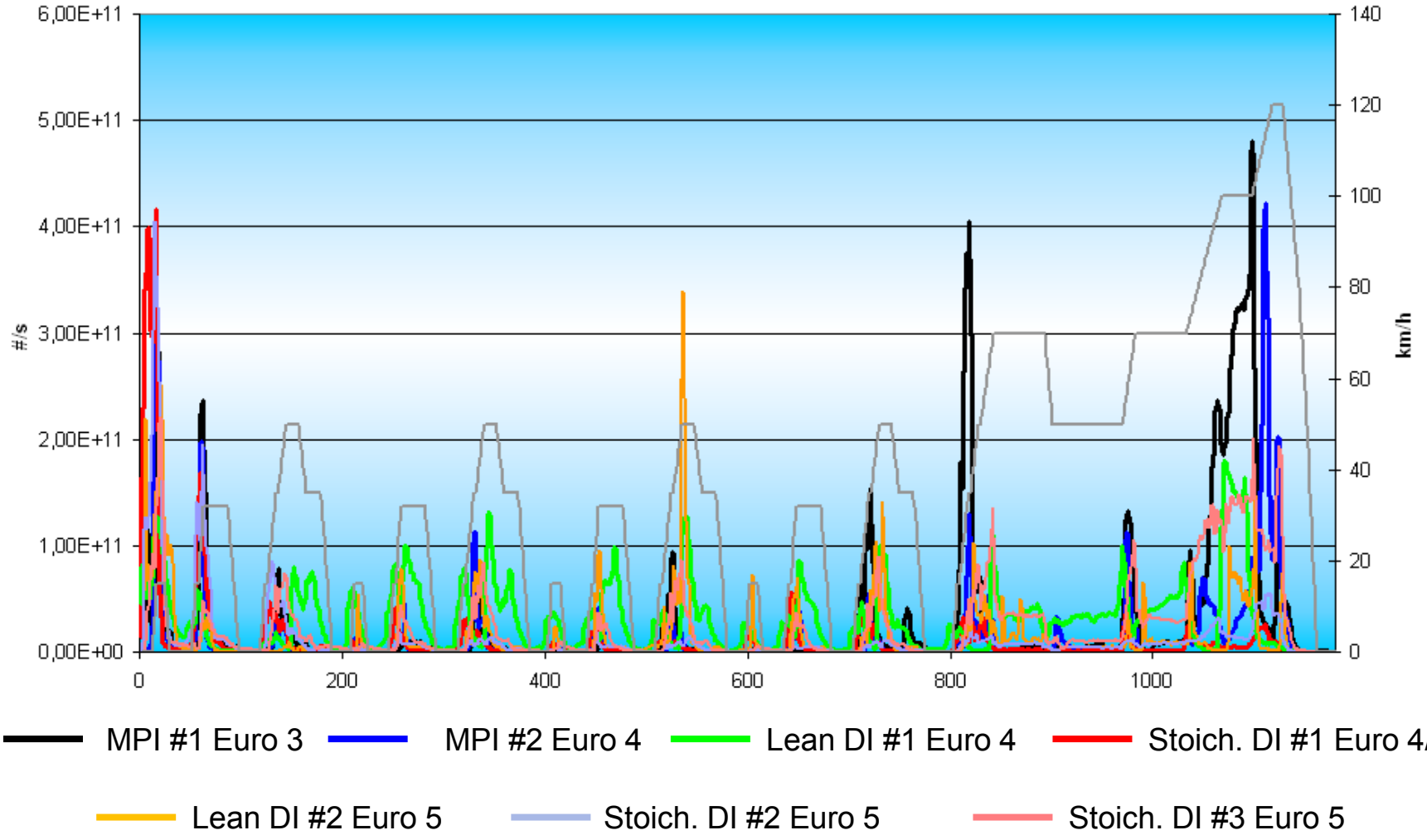
Cumulative PN Emissions on NEDC

Examples from single tests



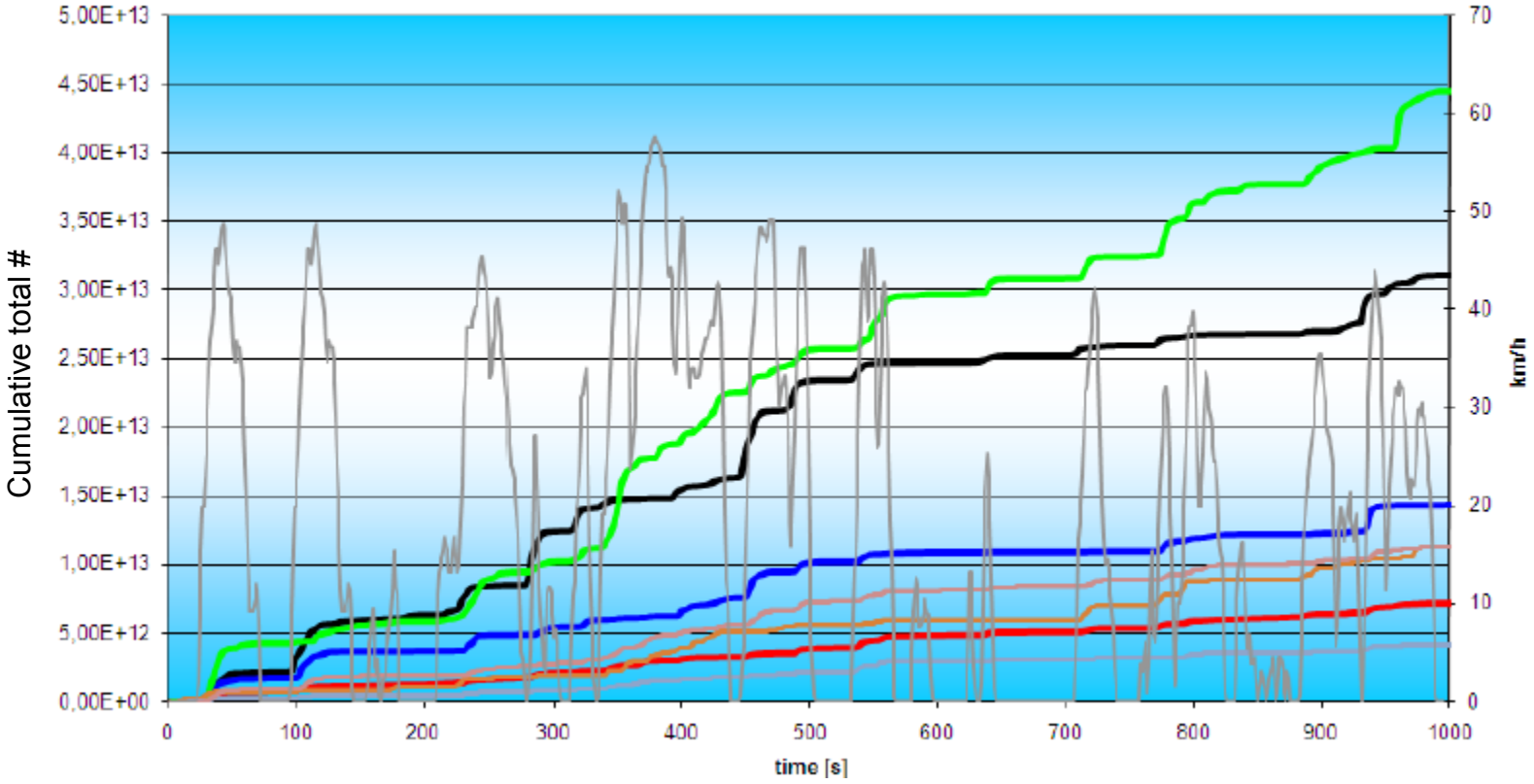
Continuous PN Emissions on NEDC

Examples from single tests



Cumulative PN Emissions on CADC urban

Examples from single tests

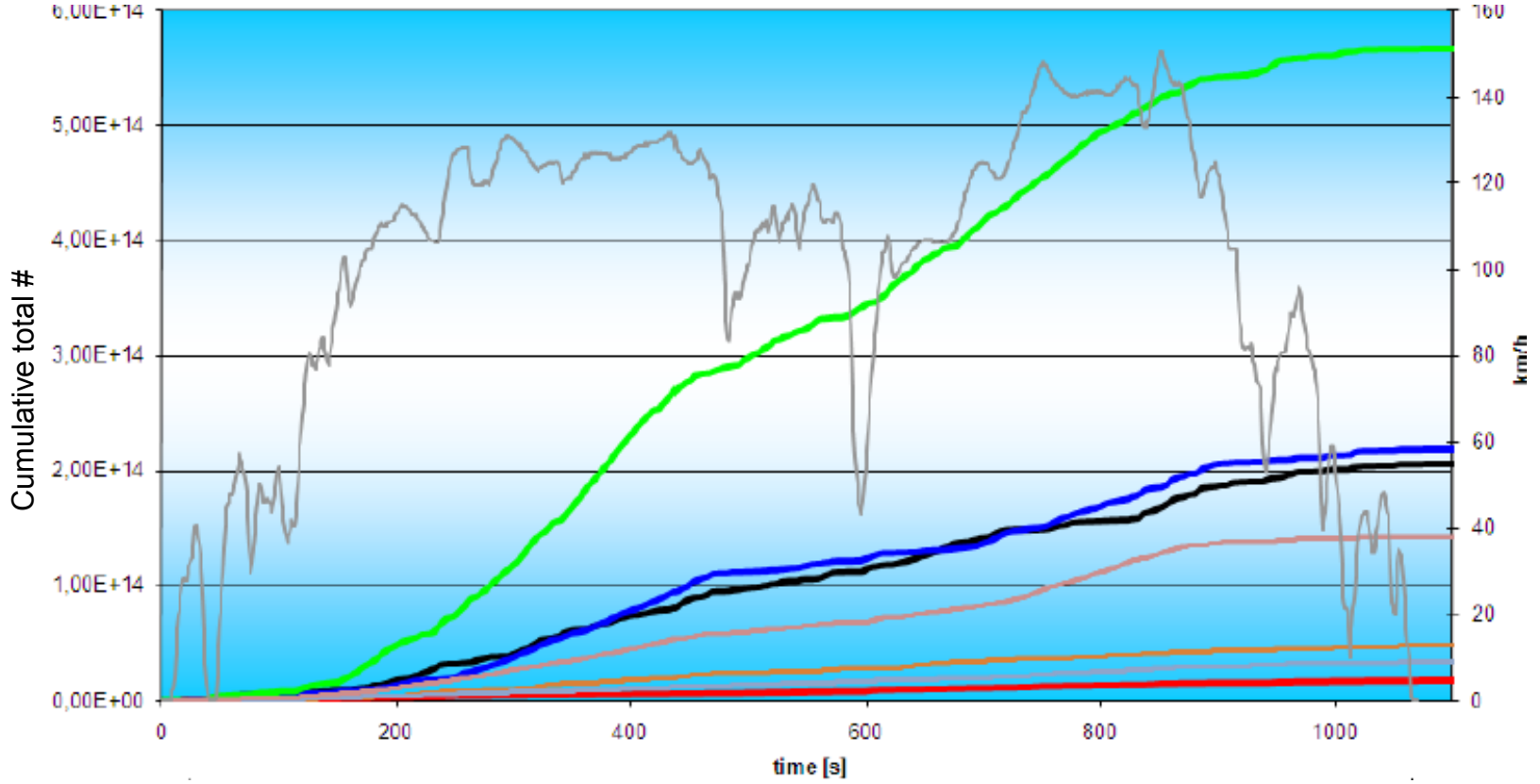


MPI #1 Euro 3 | MPI #2 Euro 4 | Lean DI #1 Euro 4 | Stoich. DI #1 Euro 4/5

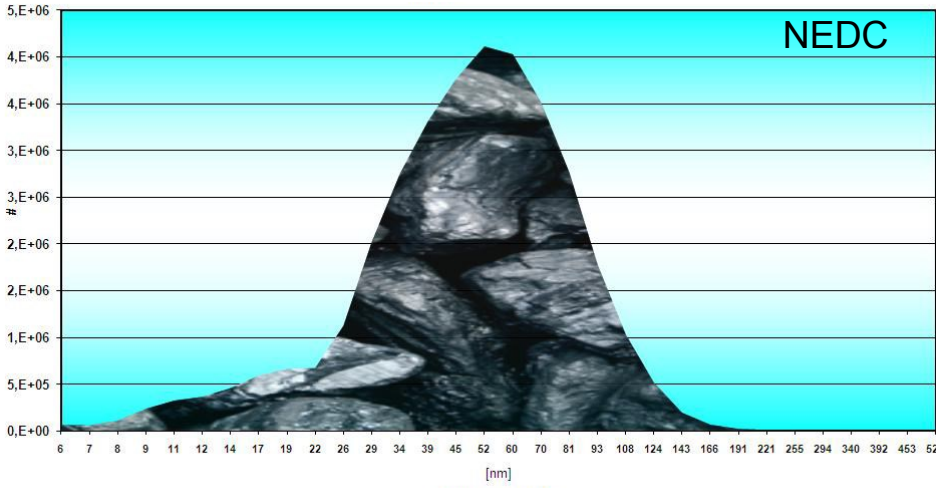
Lean DI #2 Euro 5 | Stoich. DI #2 Euro 5 | Stoich. DI #3 Euro 5

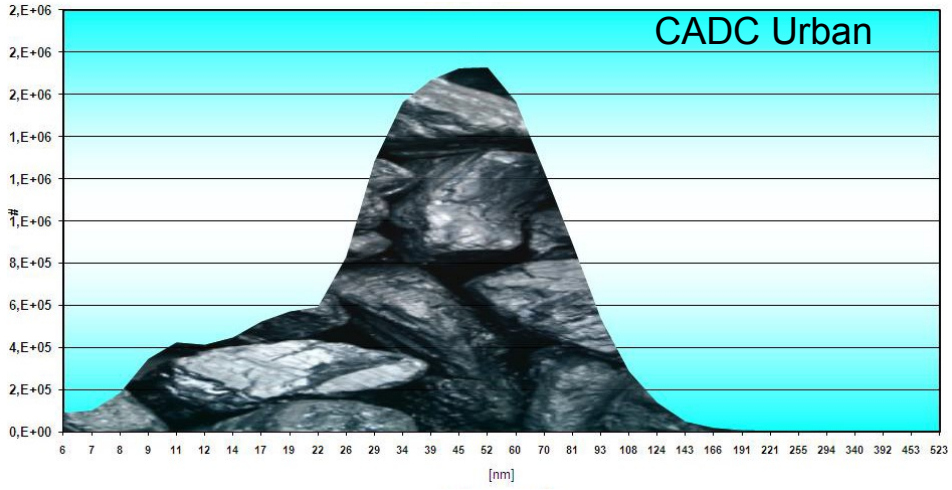
Cumulative Emissions on CADC motorway

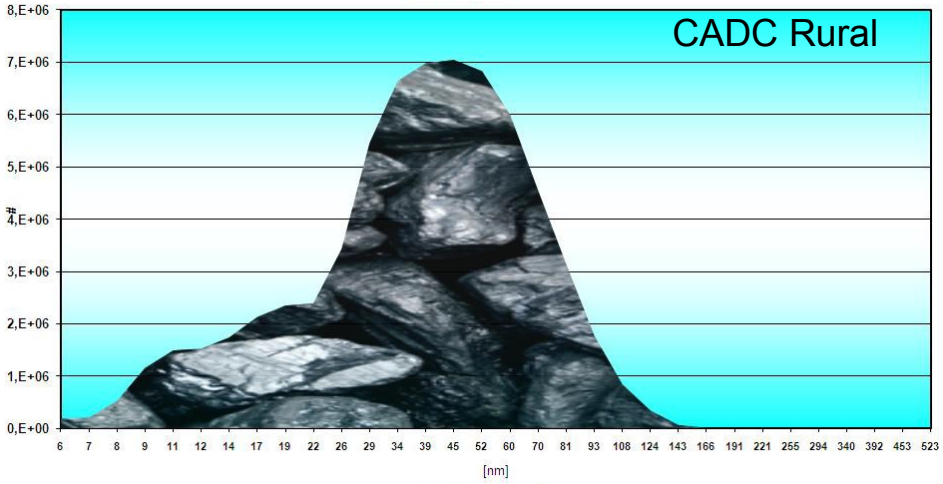
Examples from single tests

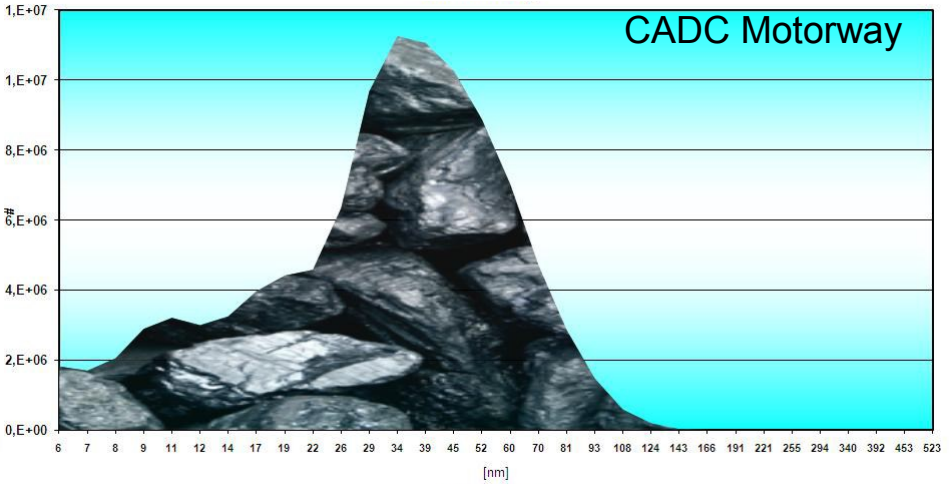


Particle size distributions (Stoichiometric DI #3)

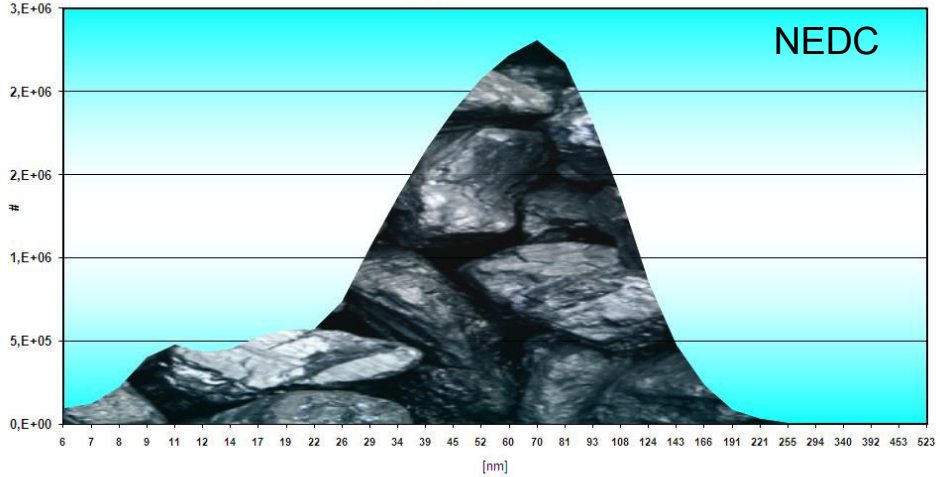


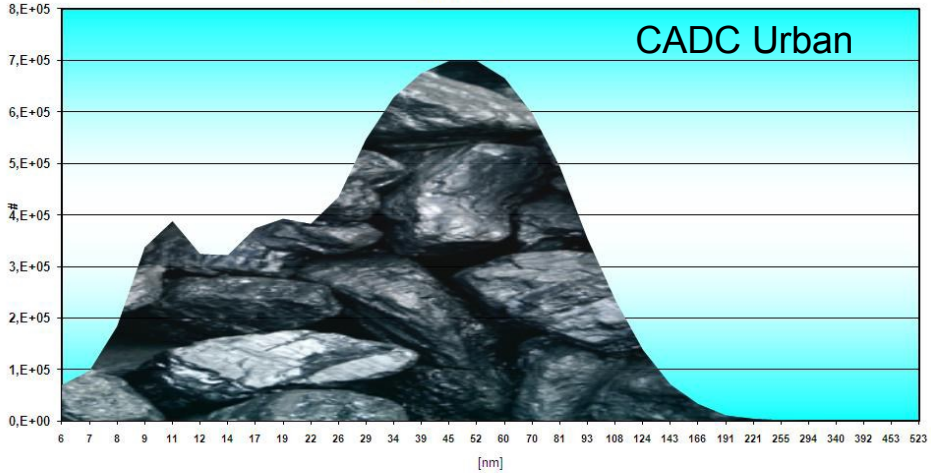


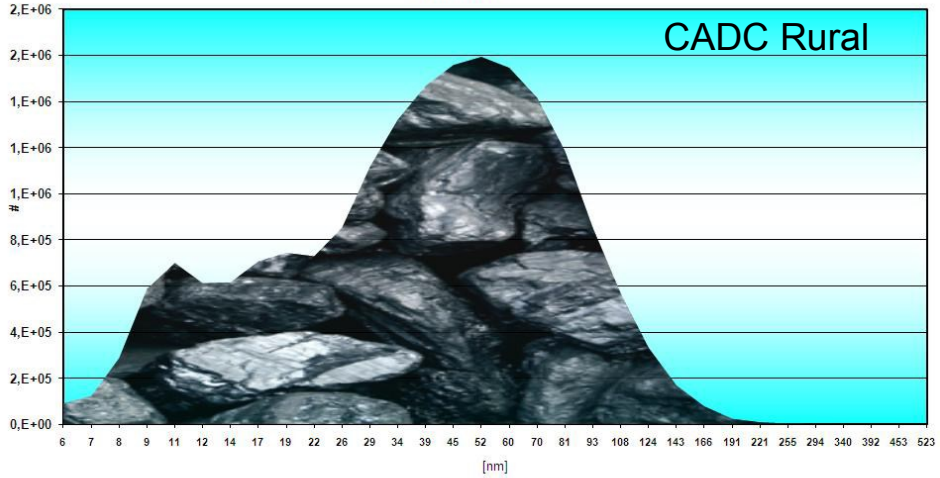


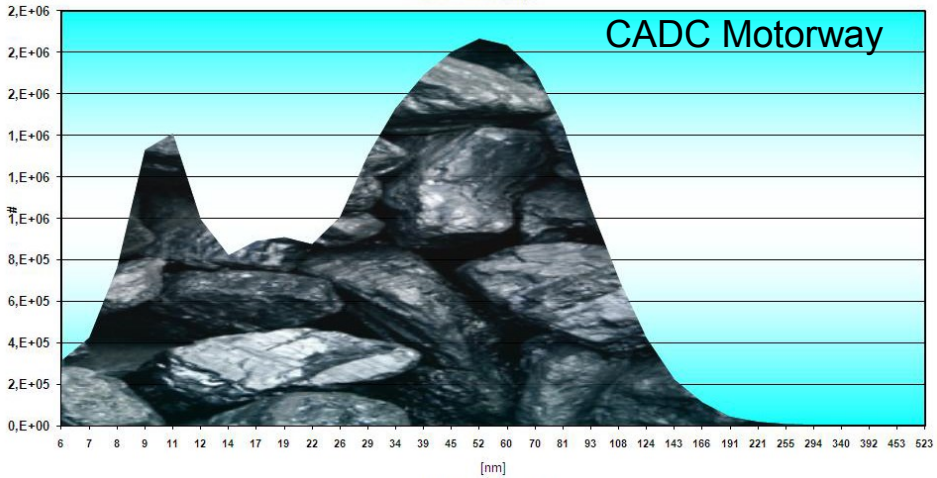


Particle size distributions (Stoichiometric DI #2)

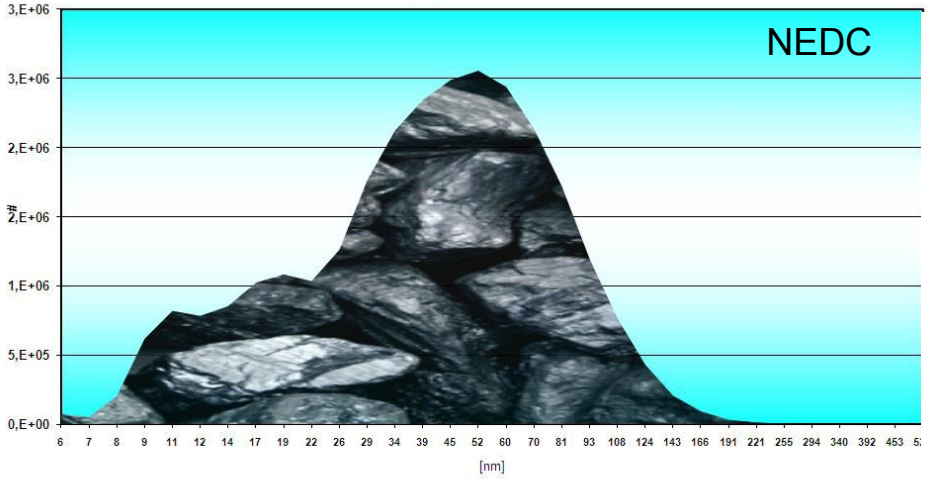


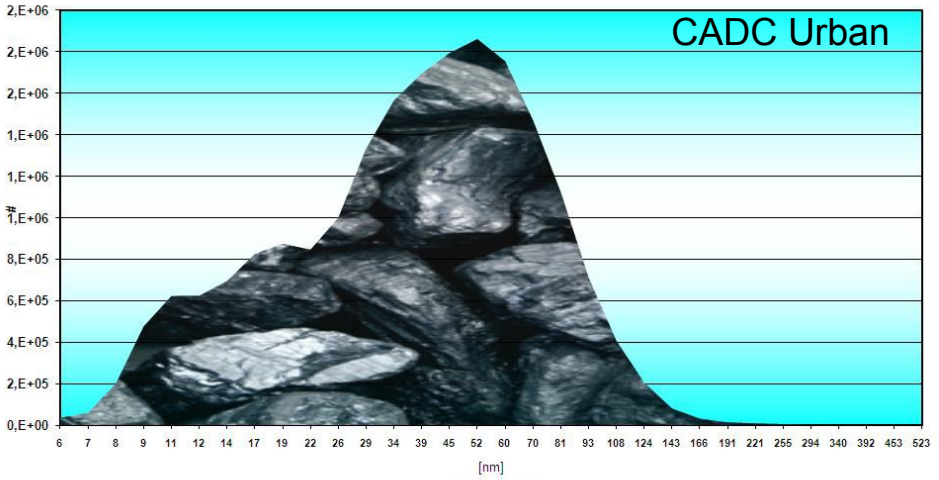


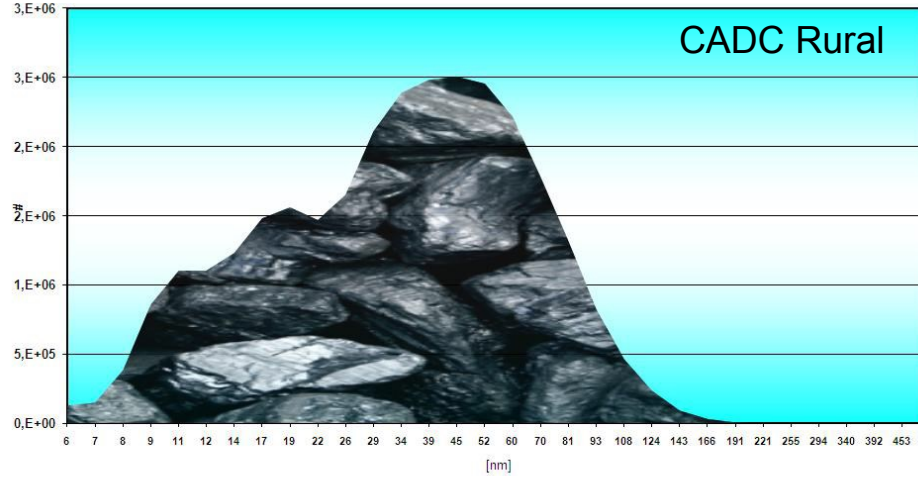


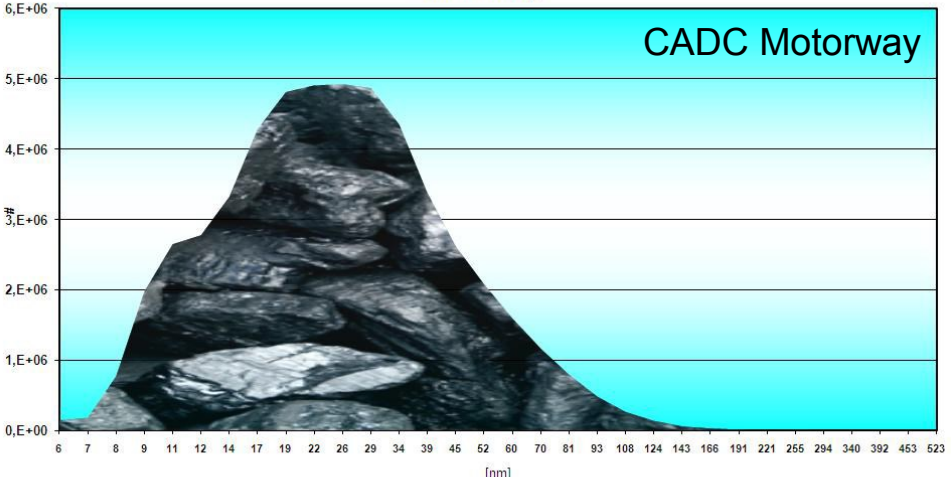


Particle size distributions: lean DI #2

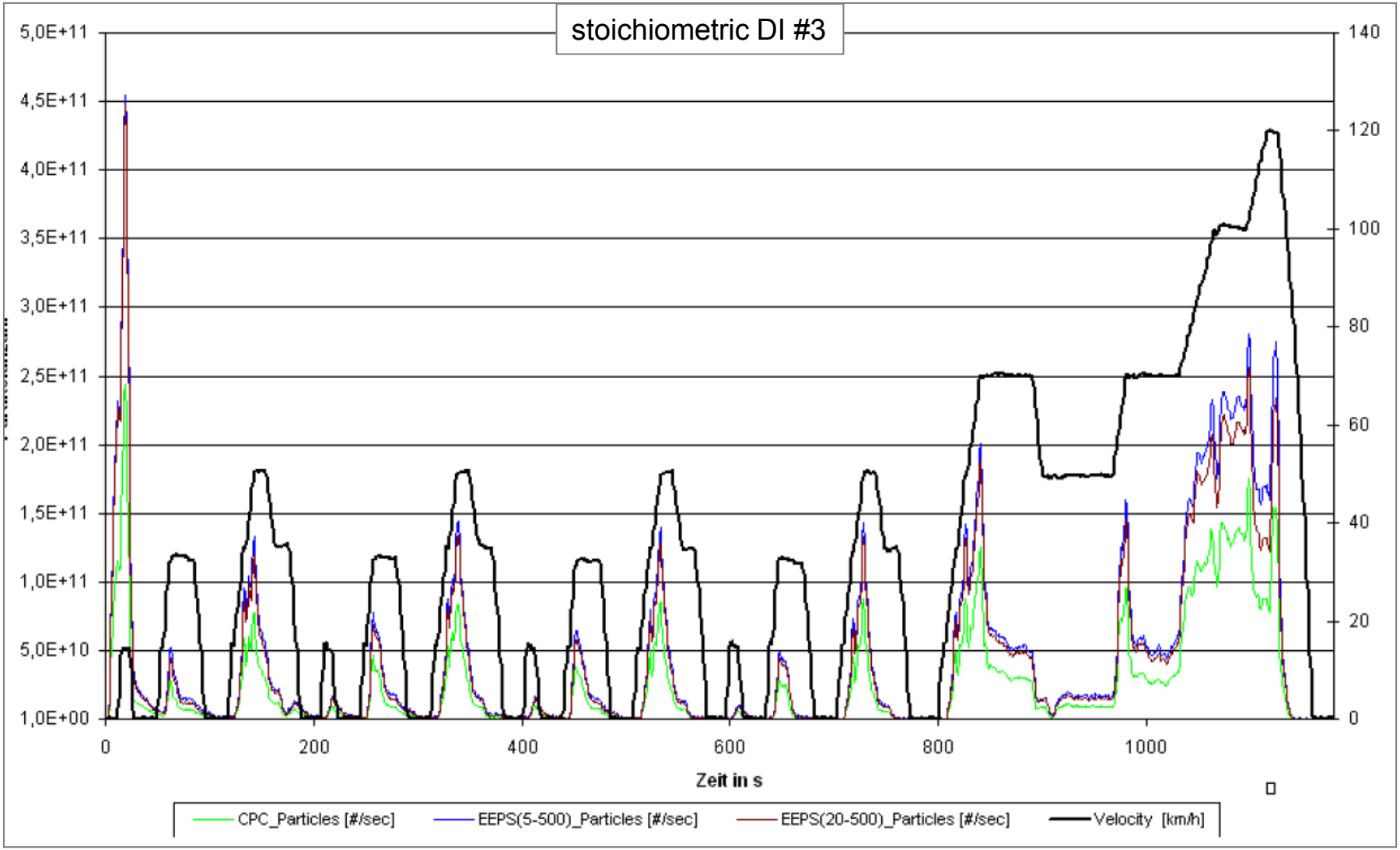






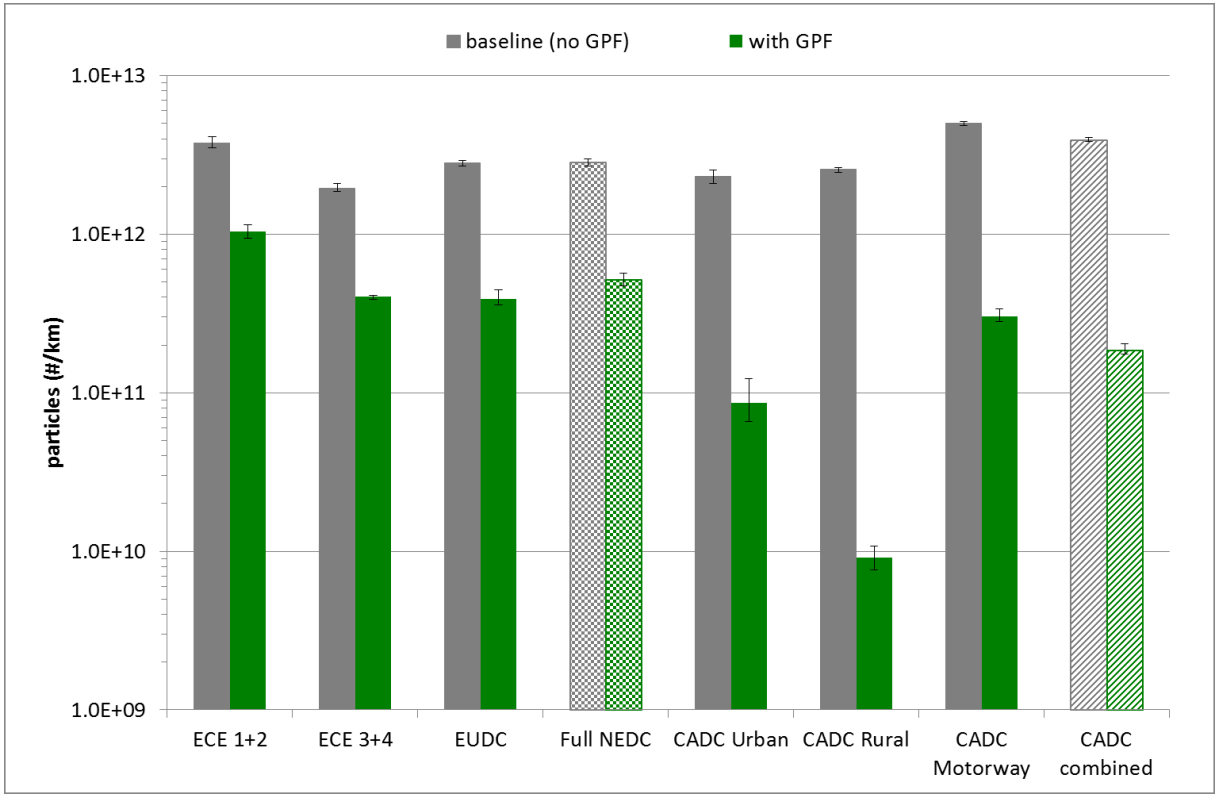


Comparison of CPC and EEPS output



Fitment of a GPF

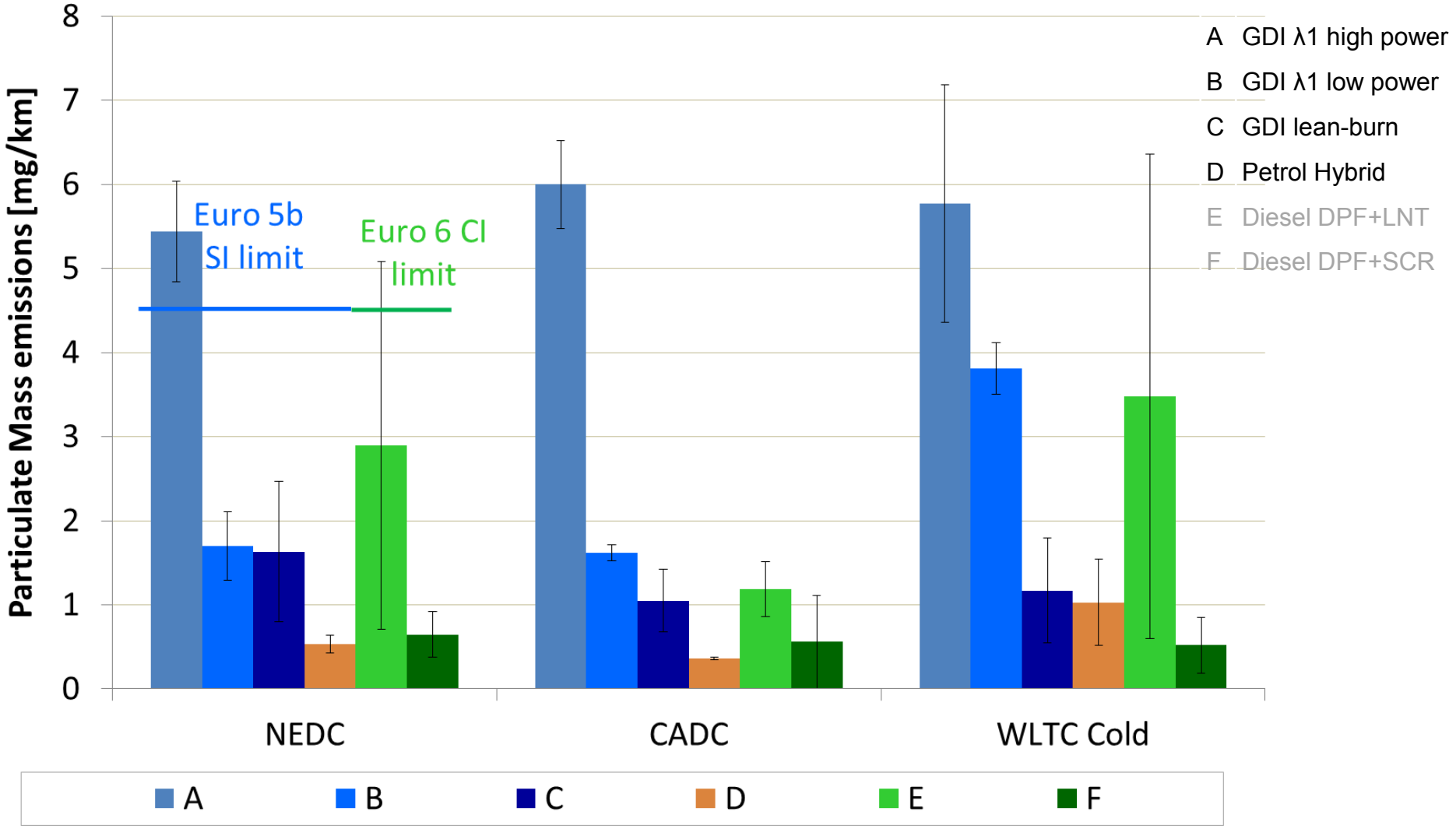
- An experimental GPF was fitted to Stoichiometric DI #3, without any optimisation or adjustments to the calibration.
- The better control of PN over both NEDC and the more transient CADC, indicating it will have a useful effect in reducing real driving emissions.



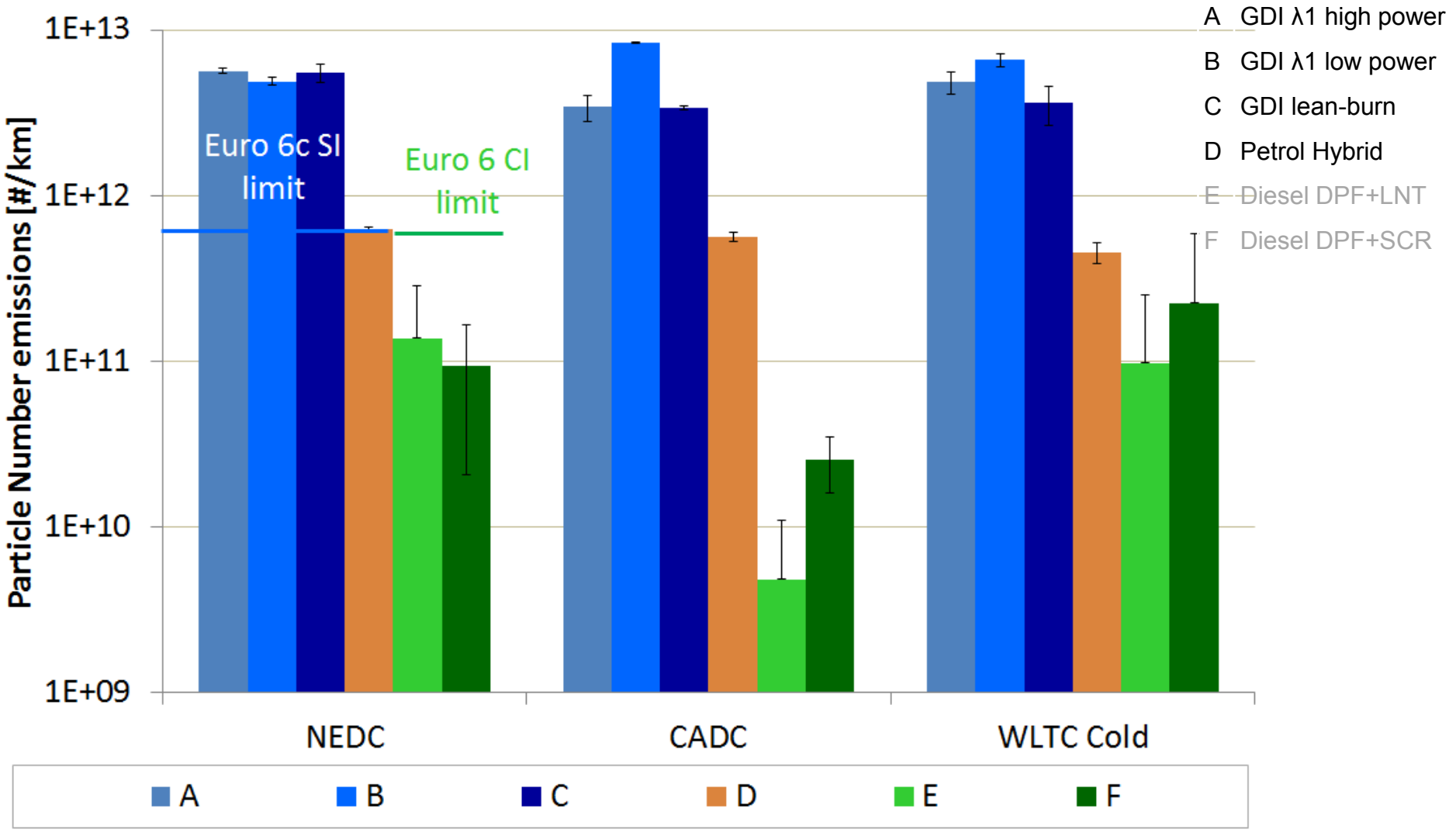
WLTP Testing

- 3 petrol vehicles + 1 petrol hybrid were tested over the new Worldwide harmonized Light vehicles Test Cycle (WLTC).
- Vehicles were tested over the procedure proposed at the time of testing:
  - cold-start procedure (4 phases; low, medium, high and extra-high speed) followed by hot-start repeat of the low and medium speed phases after a soak period (the hot start repeat is no longer included in the draft procedure).
  - All vehicles were tested at the higher inertia weight proposed for WLTP. This was used for all cycles.
- The following slides also show, for comparison, results from two diesel vehicles tested at the same time.

Particulate Mass Emissions

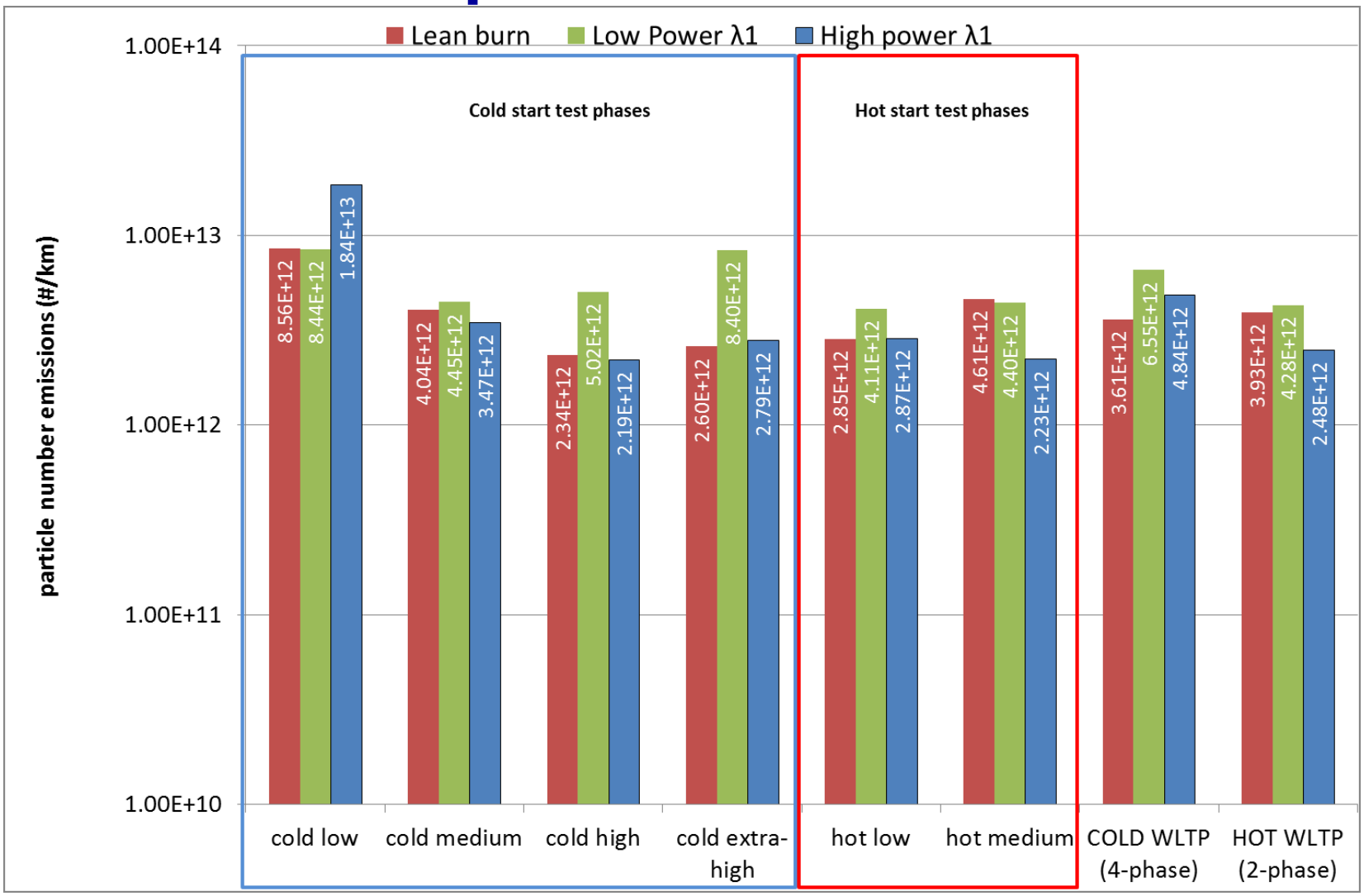


Particle Number Emissions



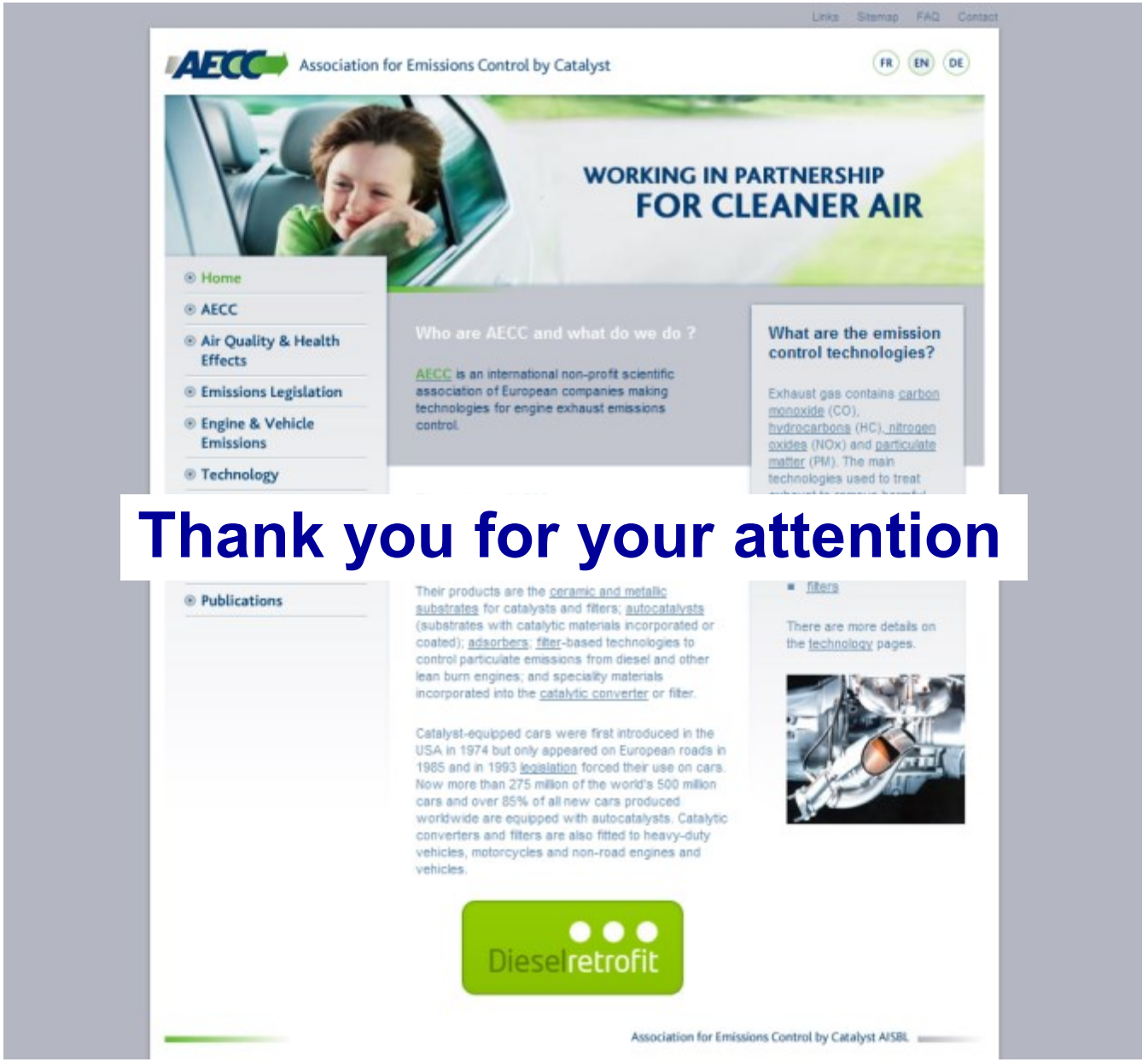
Association for Emissions Control by Catalyst AISBL

Results from WLTC phases
3 petrol vehicles



Summary

- AECC test programmes showed PN emissions from lean-burn and stoichiometric gasoline engines to be in the range of 1×10^{12} to 4×10^{12}/km on the NEDC and 7×10^{11} to 1.5×10^{13}/km on the complete Artemis (CADC) suite.
- New AECC tests from the WLTC VP2 testing show PN emissions in the range 3.6×10^{12} to 6.6×10^{12} for 3 different GDI vehicles on the cold-start 4-phase WLTC.
- There seemed to be no clear relationship between PM & PN results on the WLTC and those on other cycles, supporting the need for assessment of Real Driving Emissions.
- The results from a vehicle fitted with a GPF met the NEDC Euro 6c limit on both the NEDC and CADC tests.



Thank you for your attention