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

Cambridge Particles Meeting

24 May 2013

Association for Emissions Control by Catalyst AISBL

Association for Emissions Control by Catalyst (AECC) AISBL

AECC members: European emissions control companies

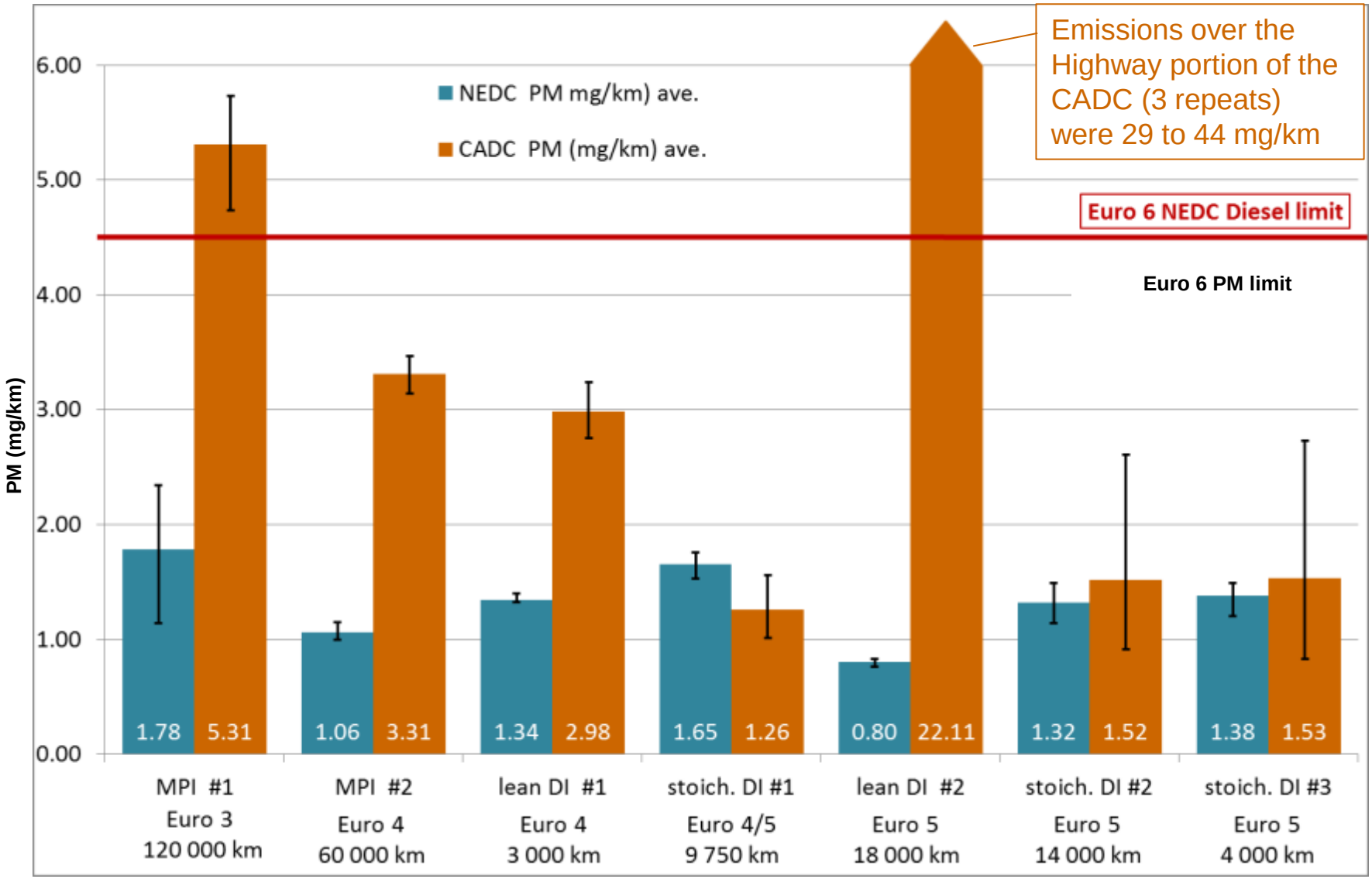
Technology for exhaust emissions control on all new cars (OEM and Aftermarket) and an increasing number of buses & commercial vehicles, non-road applications and motorcycles.

AECC Tests on Euro 3 to 5 PI Vehicles

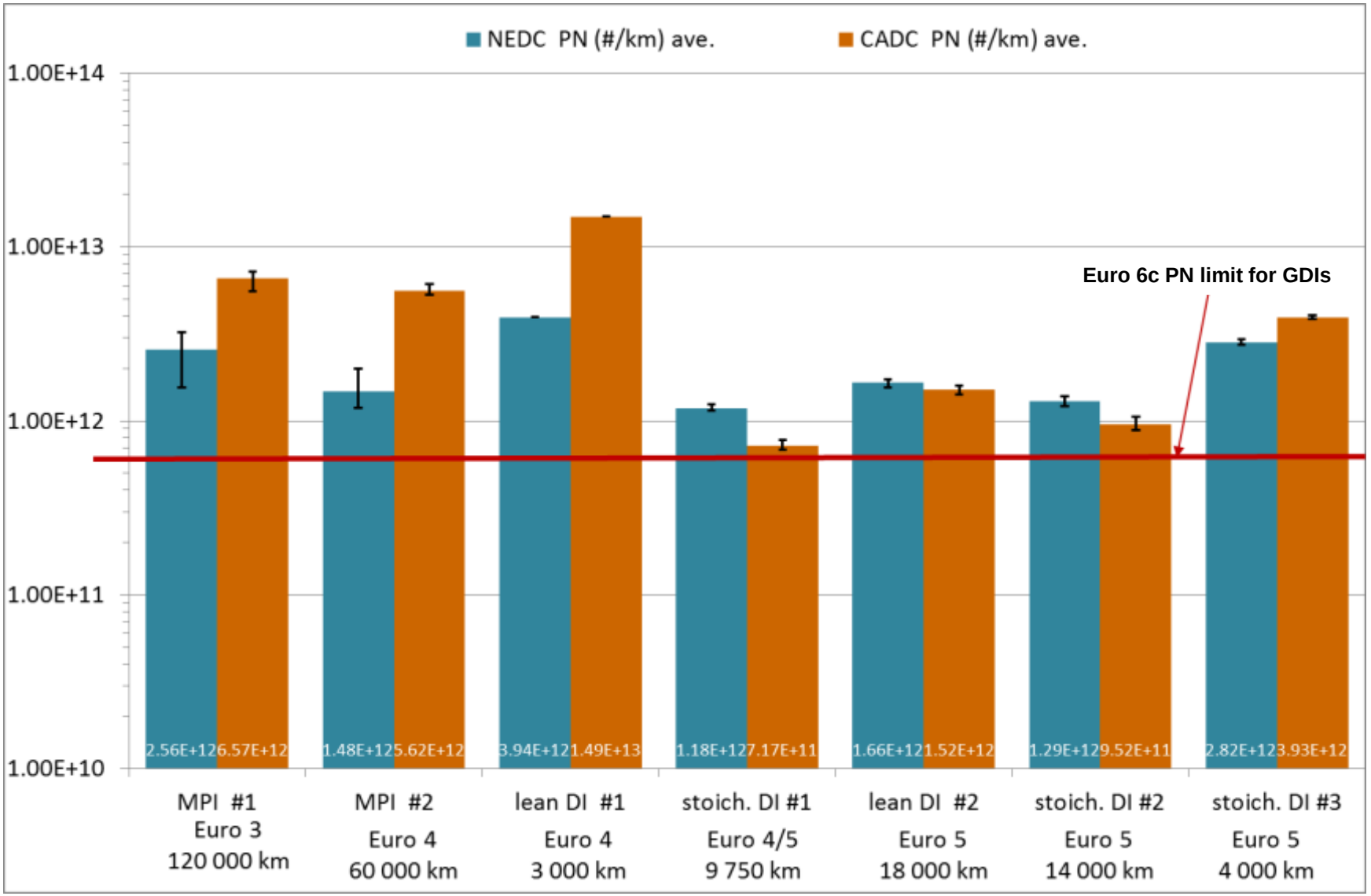
Working Principle	Engine Capacity	Power (kW)	Emission Approval	Registration Date	Gearbox	Inertia (kg)	Mileage (km)	Date of Test
MPI #1	2 litre	85	Euro 3	01/12/1999	M5	1360	120000	Apr-08
MPI #2	2 litre	85	Euro 4	27/03/2001	M5	1360	60000	Nov-08
lean DI #1	2 litre	105	Euro 4	17/06/2008	M6	1470	3000	Aug-08
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

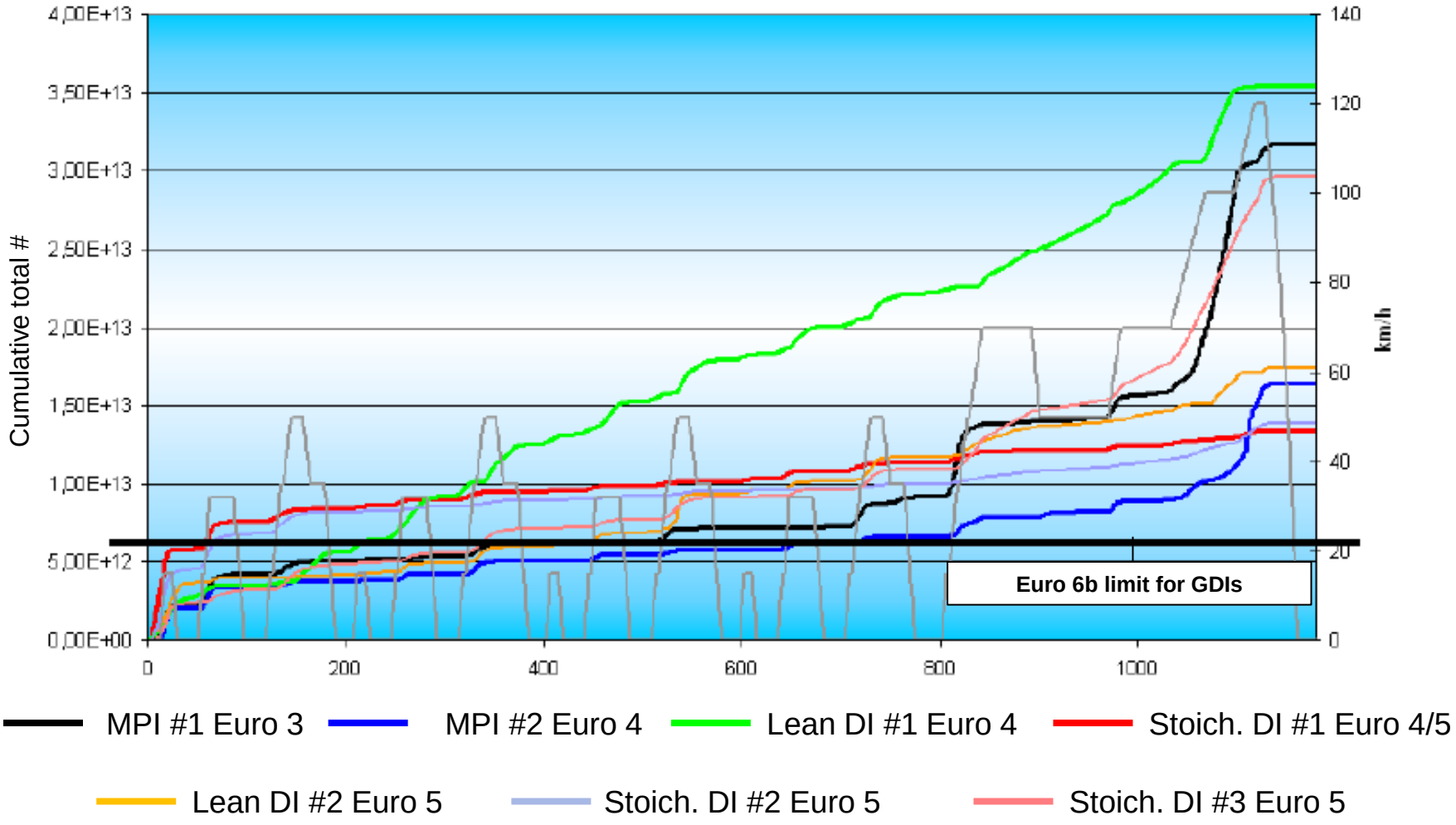


Particle Number Emissions on NEDC & CADC



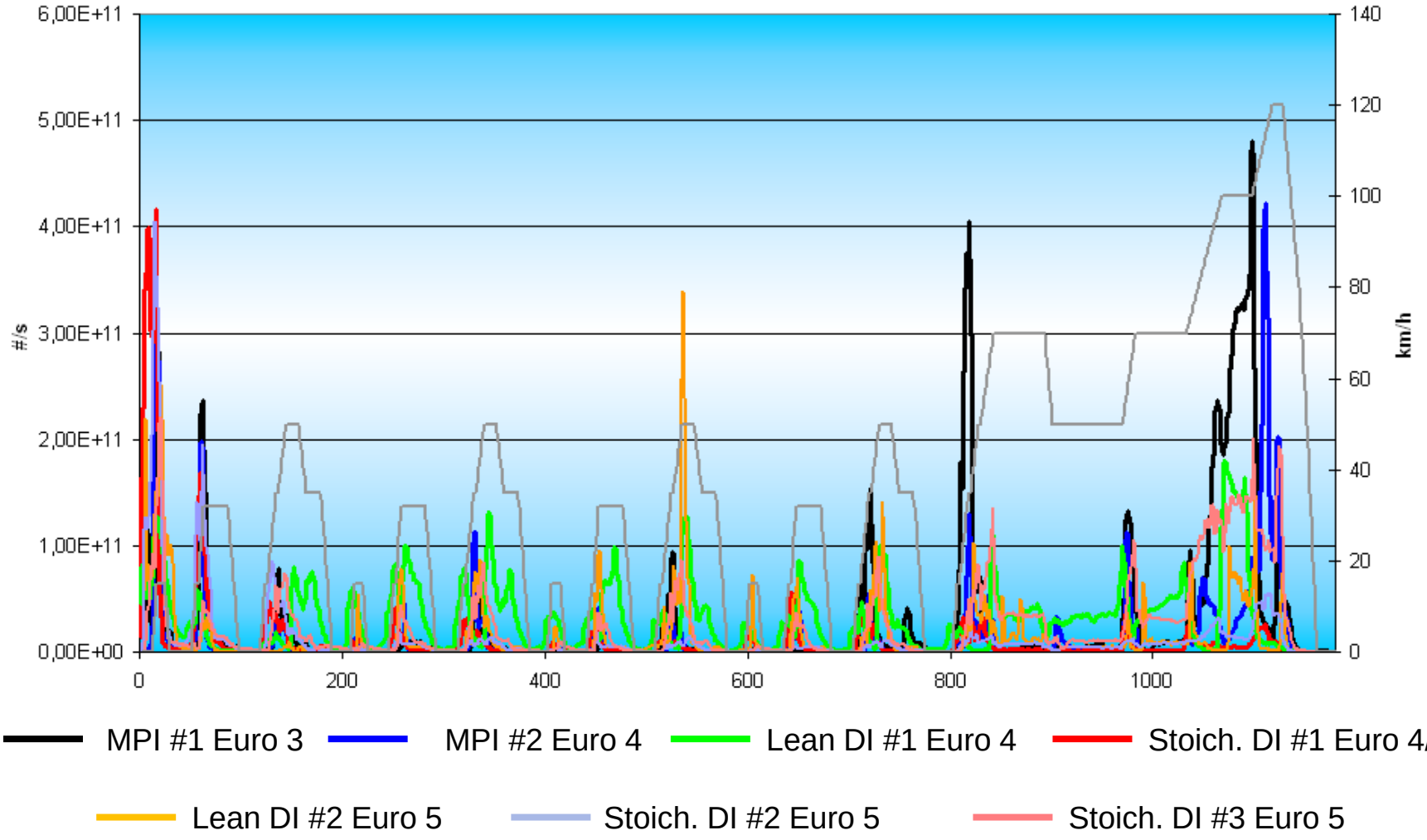
Cumulative PN Emissions on NEDC

Examples from single tests



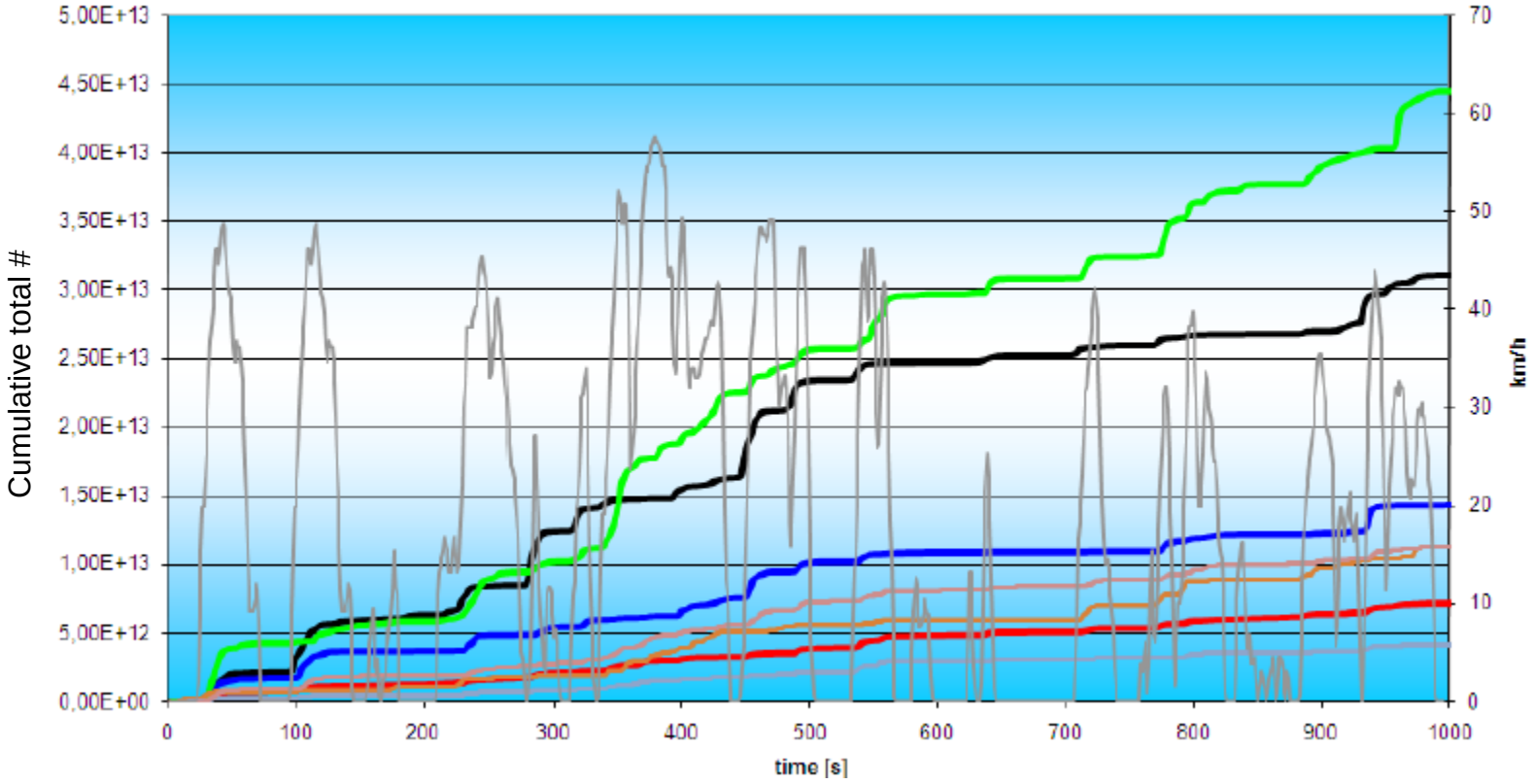
Continuous PN Emissions on NEDC

Examples from single tests



Cumulative PN Emissions on CADC urban

Examples from single tests

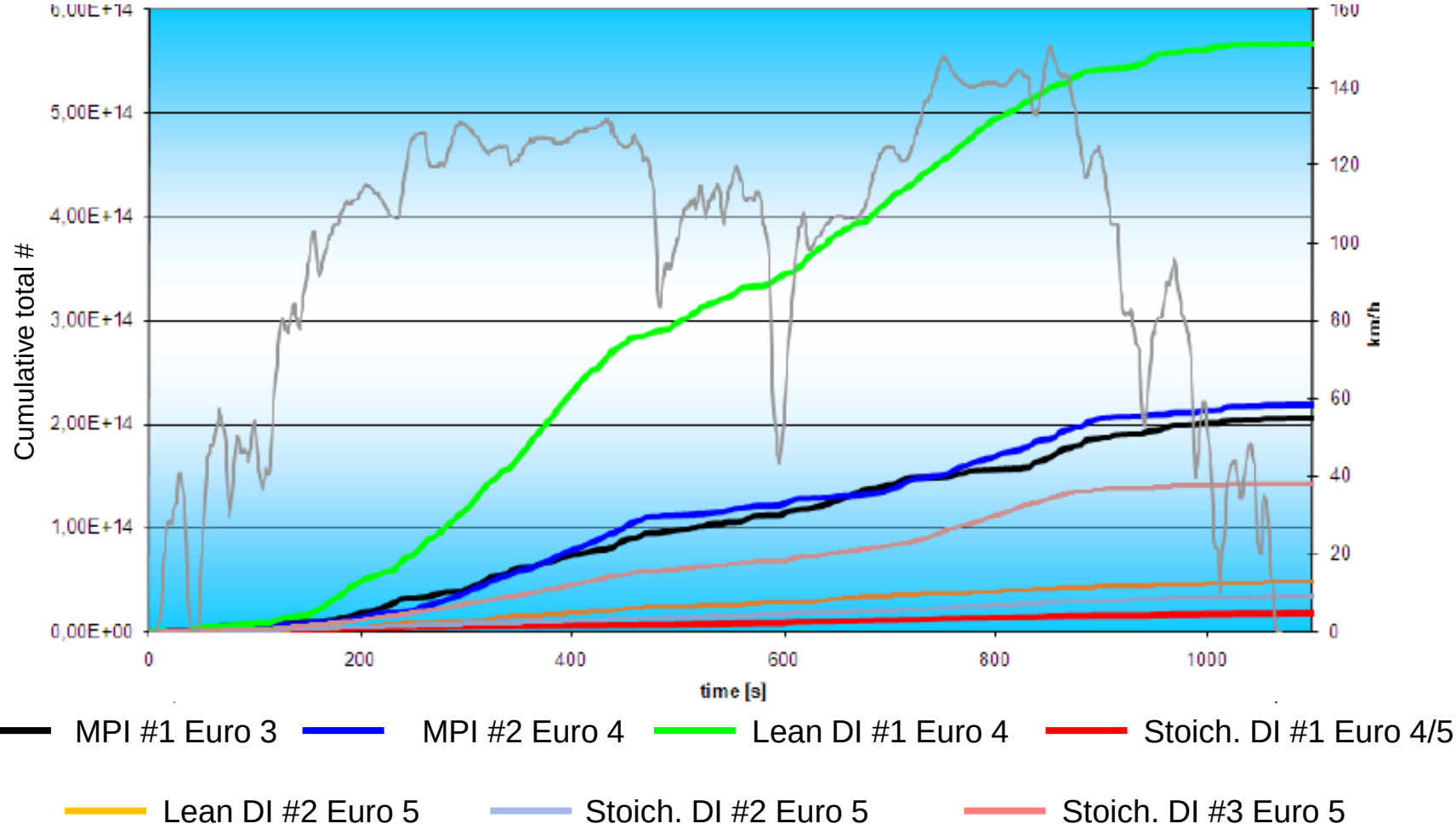


MPI #1 Euro 3 | MPI #2 Euro 4 | Lean DI #1 Euro 4 | Stoich. DI #1 Euro 4/5

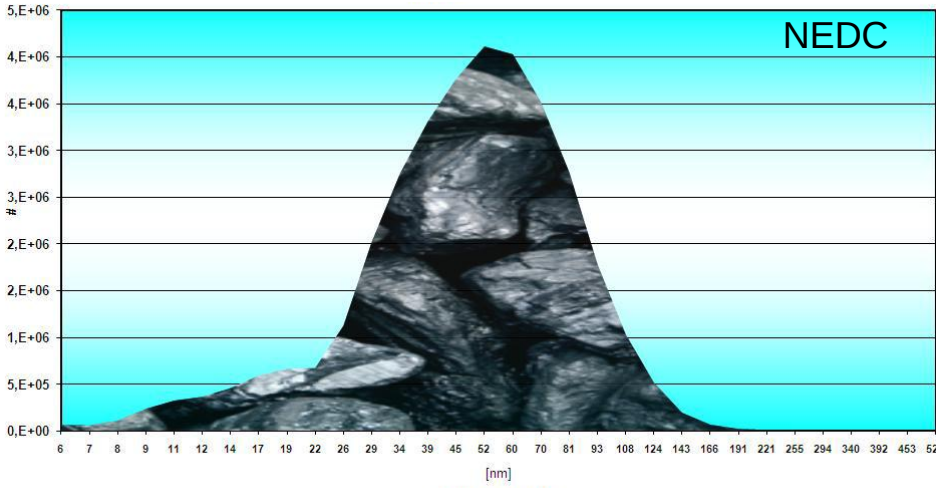
Lean DI #2 Euro 5 | Stoich. DI #2 Euro 5 | Stoich. DI #3 Euro 5

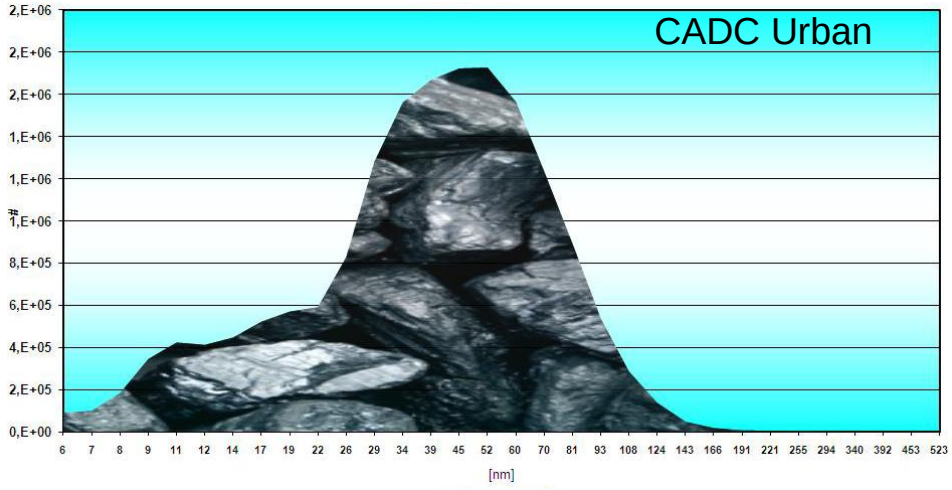
Cumulative Emissions on CADC motorway

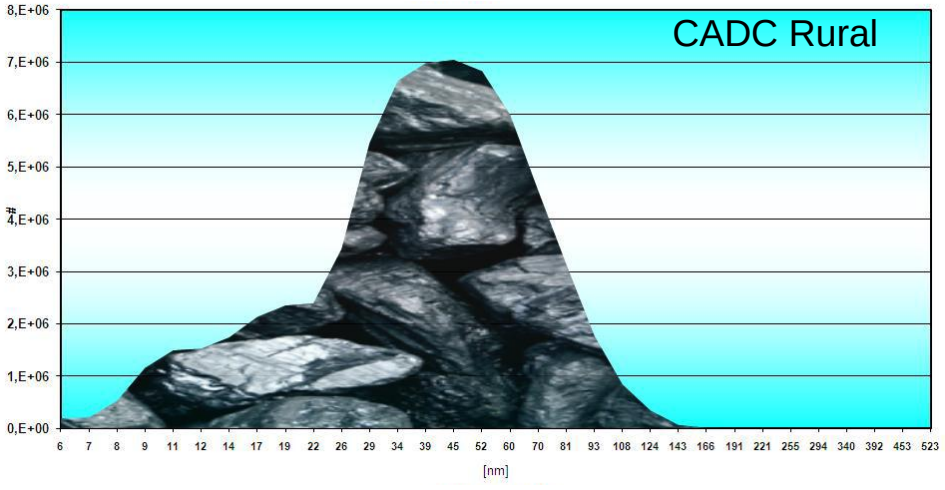
Examples from single tests

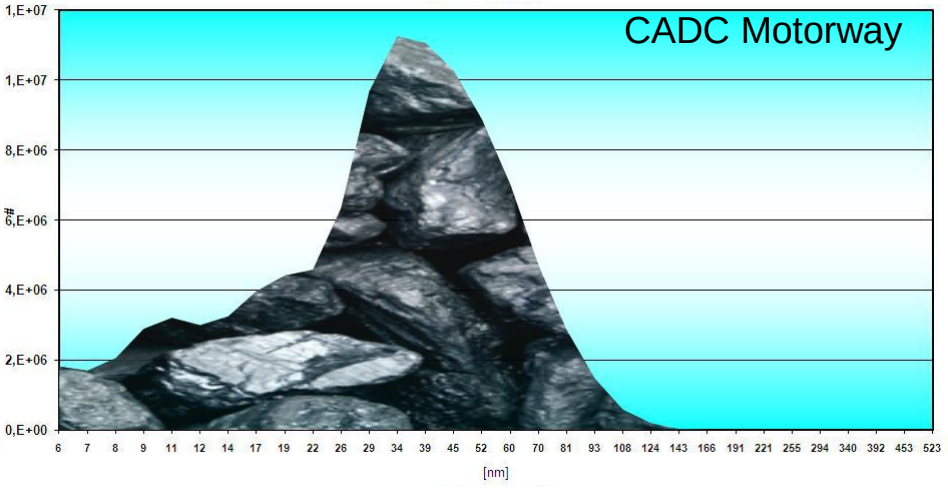


Particle size distributions (Stoichiometric DI #3)

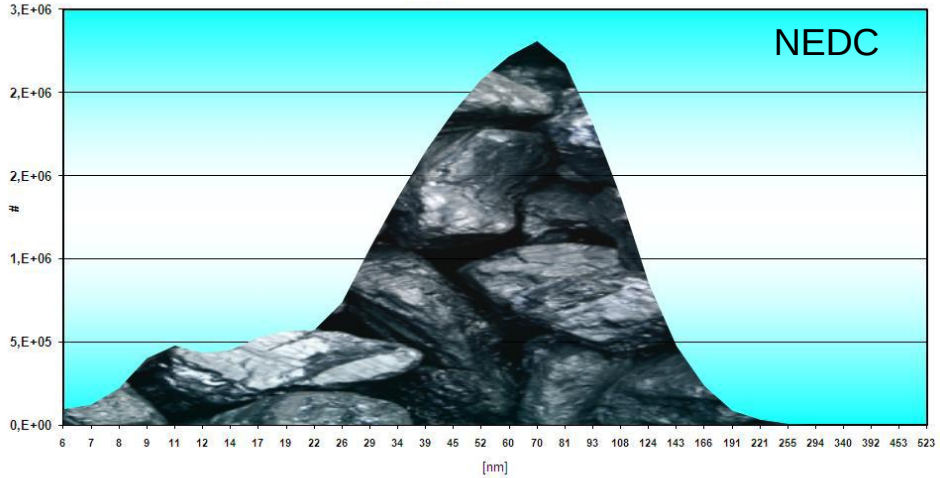


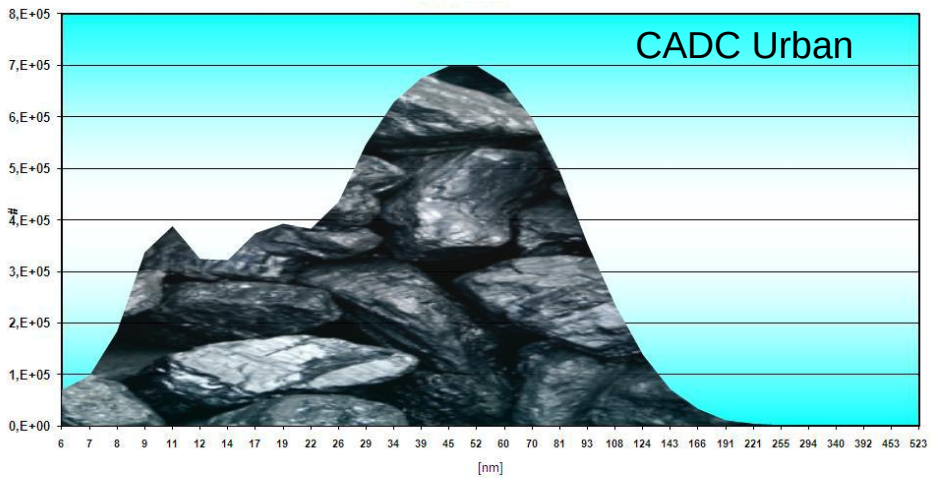


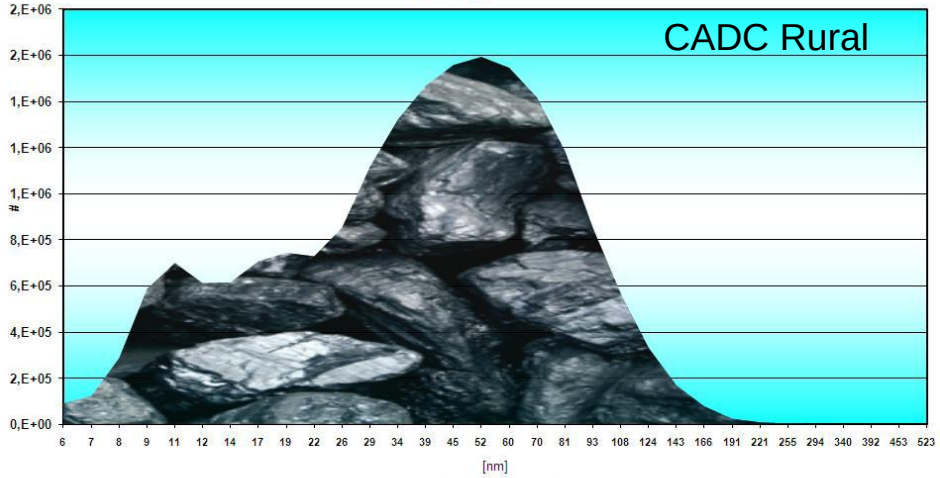


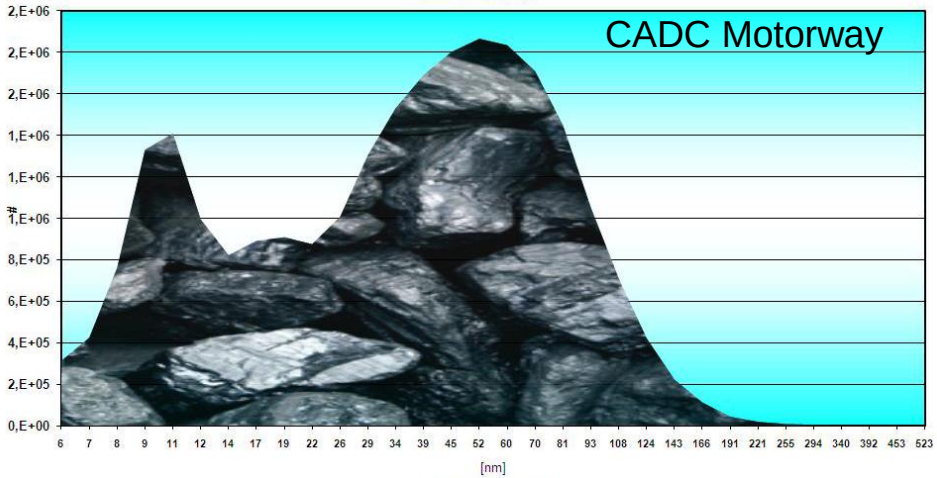


Particle size distributions (Stoichiometric DI #2)

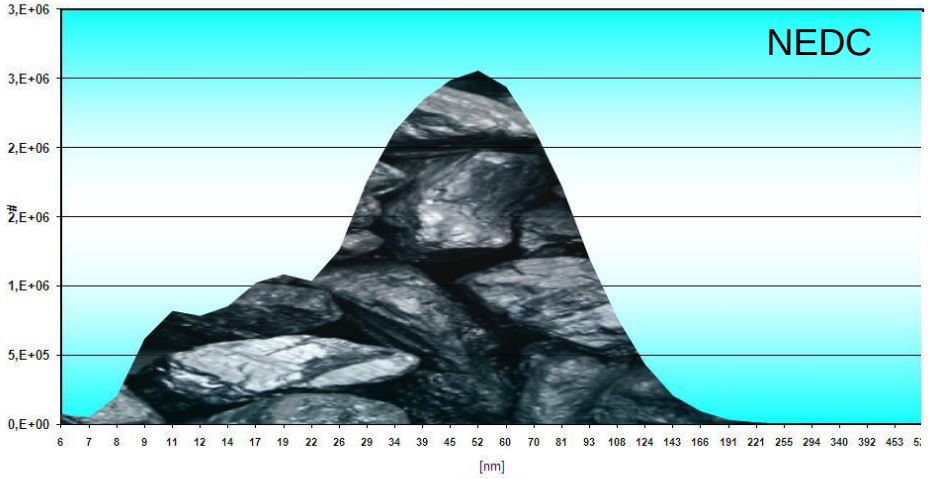


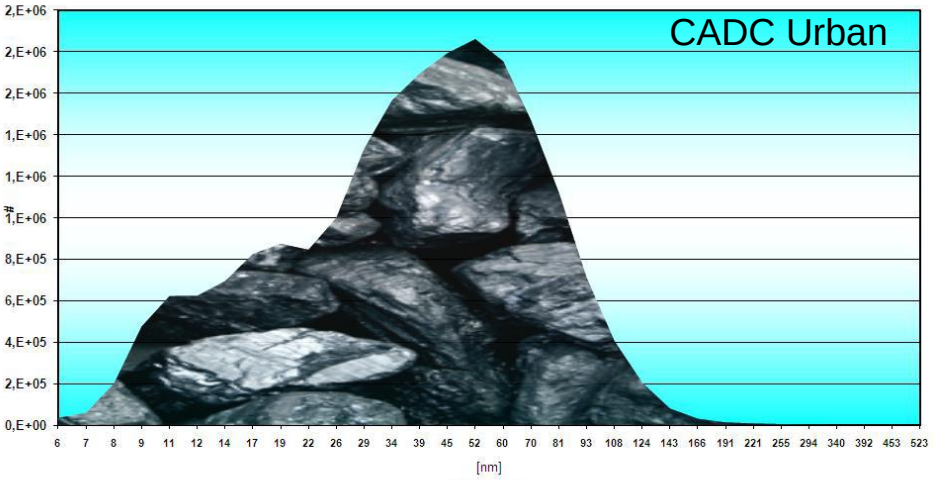


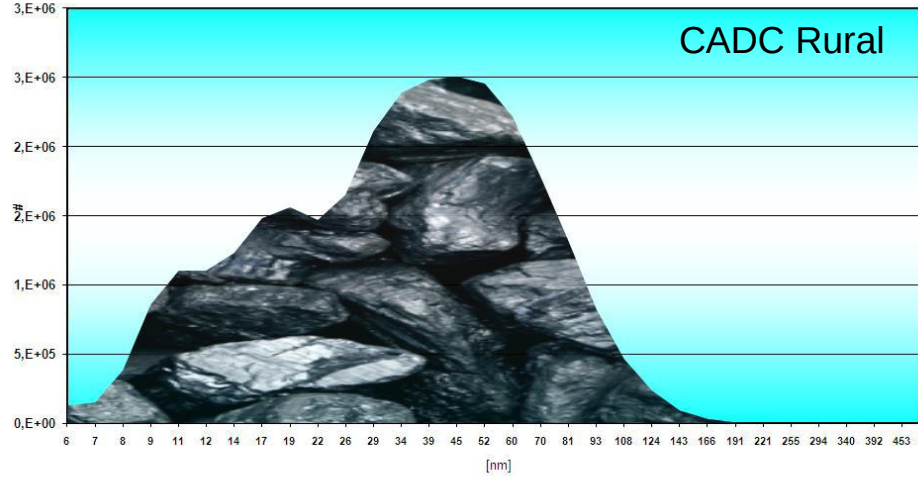


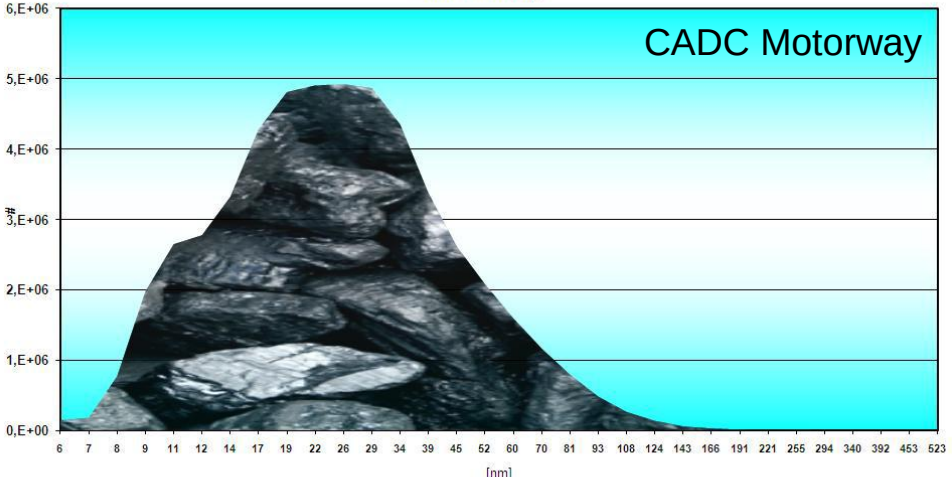


Particle size distributions: lean DI #2

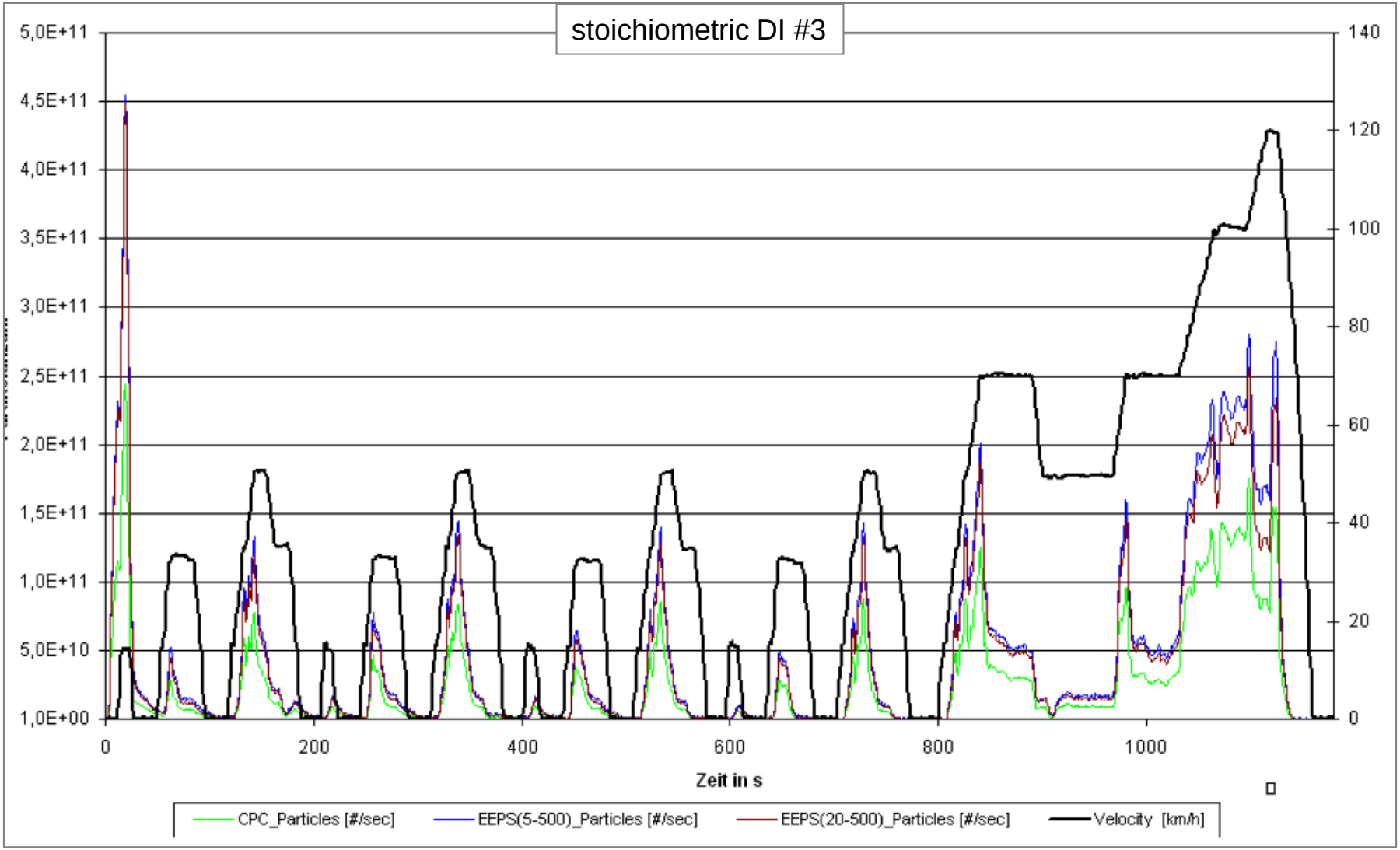






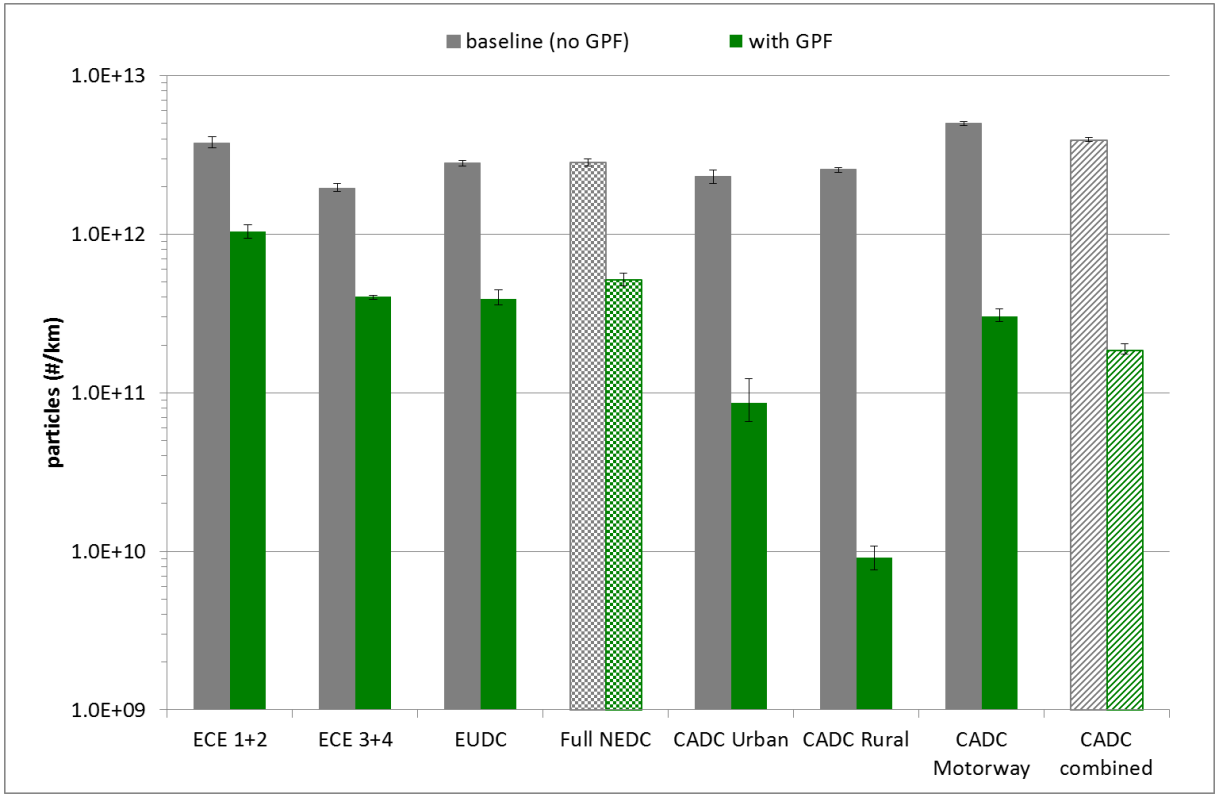


Comparison of CPC and EEPS output



Fitment of a GPF

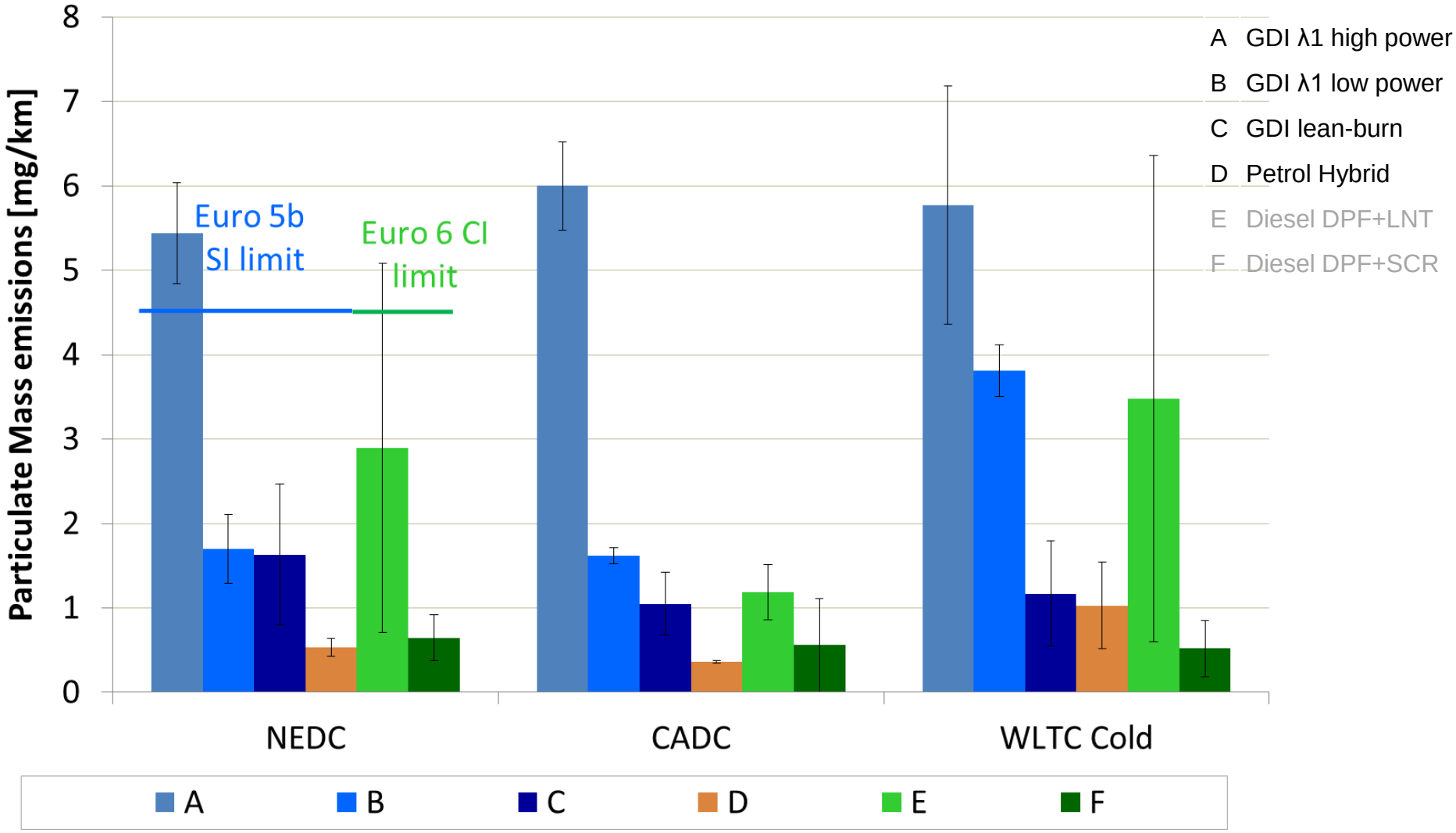
- An experimental GPF was fitted to Stoichiometric DI #3, without any optimisation or adjustments to the calibration.
- The better control of PN over both NEDC and the more transient CADC, indicating it will have a useful effect in reducing real driving emissions.



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



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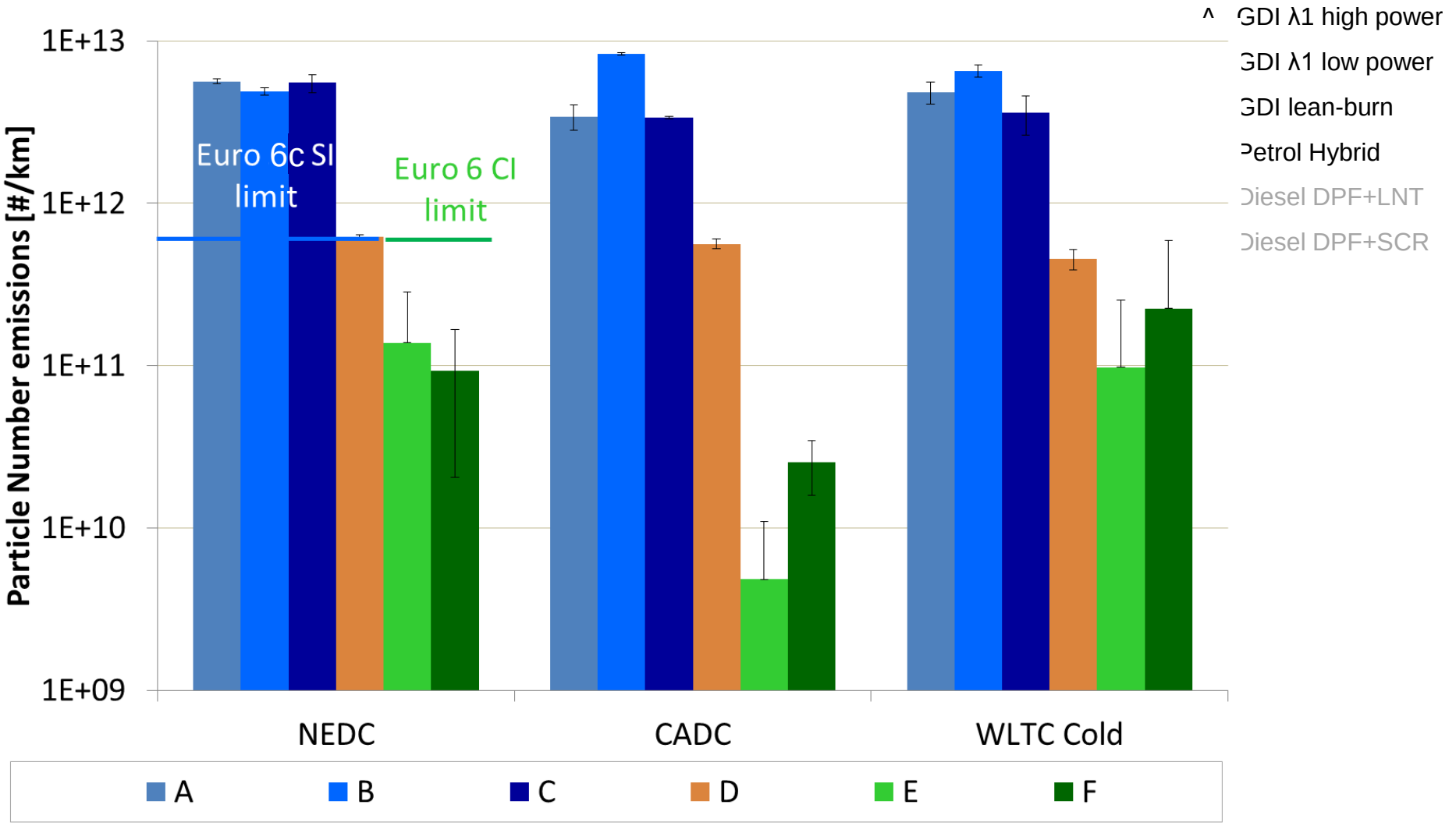
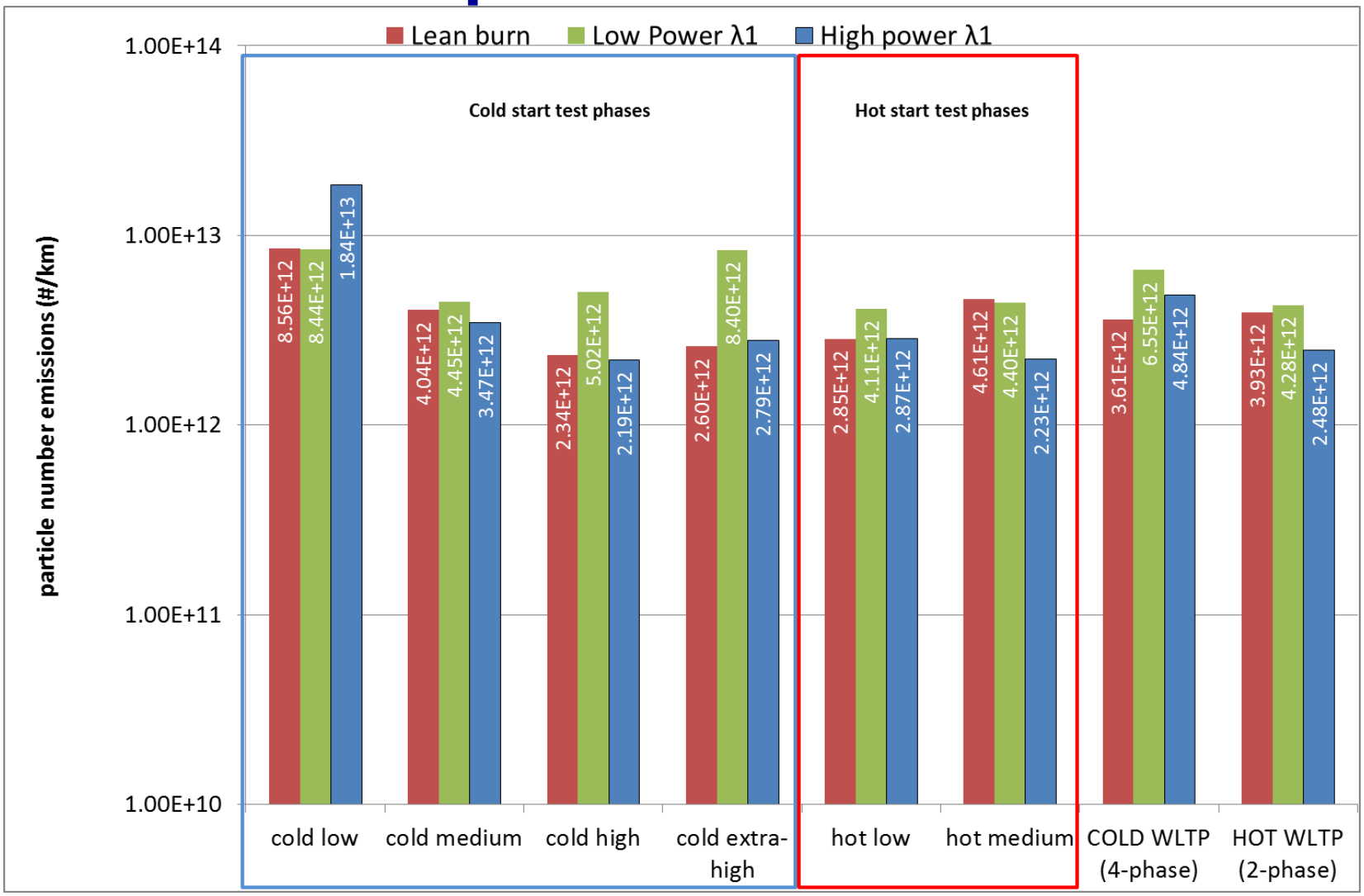
Particle Number Emissions

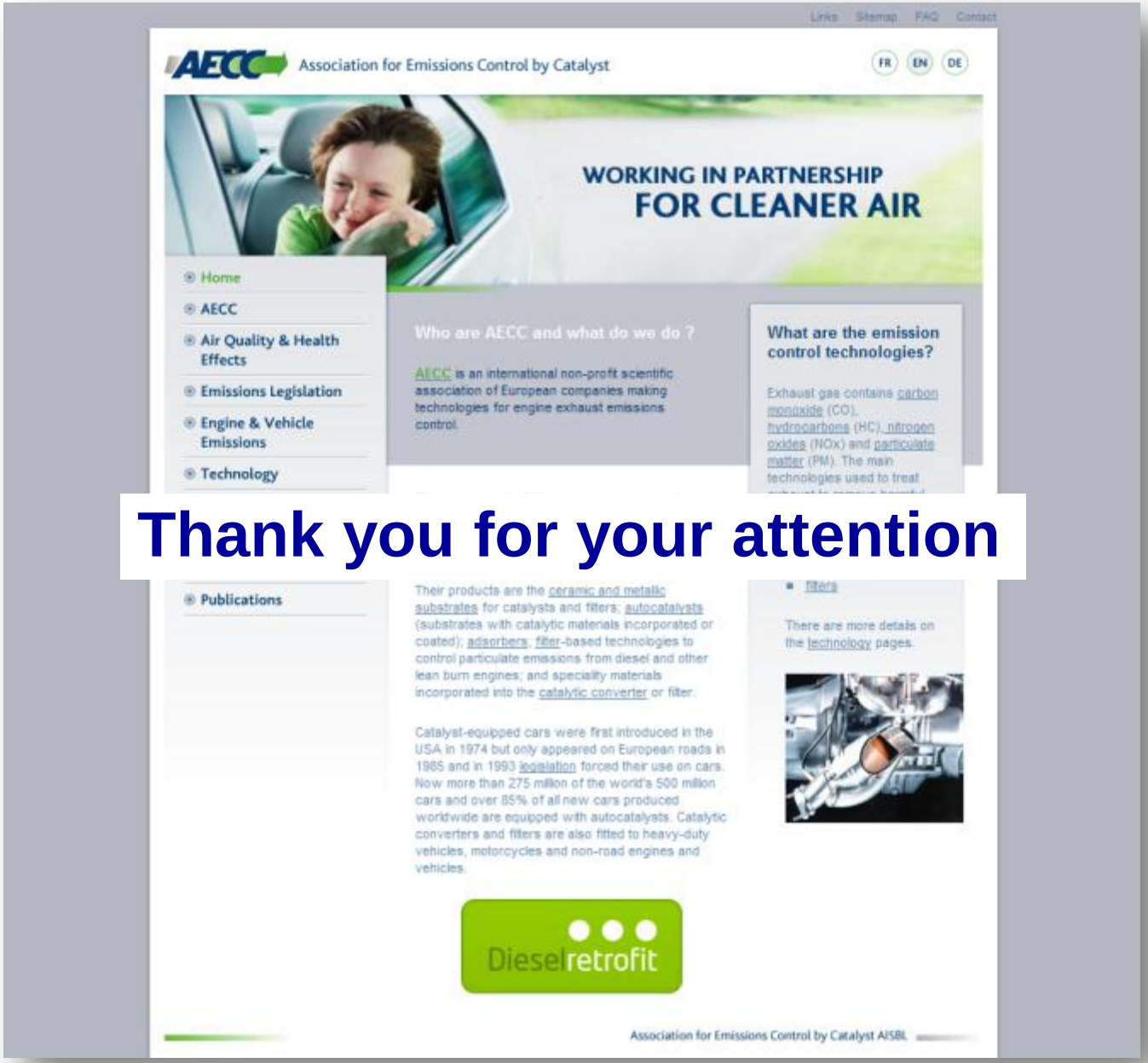


Results from WLTC phases
3 petrol vehicles



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