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Fuel quality effects on Diesel particle emission from HDV and LDV

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Fuel Quality Effects on Diesel Particle Emissions from Heavy Duty Engines & Light Duty Vehicles

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Diesel fuel quality and particle emissions

- Heavy-duty diesel engine tests - SMPS
  Euro II 6 L & 10 L engines
- Light-duty diesel post-96 & post-2000 cars - SMPS
  Common Rail D3 technologies
- Total number measurements - UPM (Ultrafine Particle Monitor)
  Euro II technologies

Diesel Fuel properties

	LSD	ULSD	SCI	N	RME
Sulphur (ppm wt)	350	45	5	10	5
Density (kg/m3)	840	834	815	810	880
Cetane No.	50	55	53	71	52
Aromatics (% wt)	25	28	4	1	0
T90 (ºC)	330	332	270	350	345

Commercial Fuels

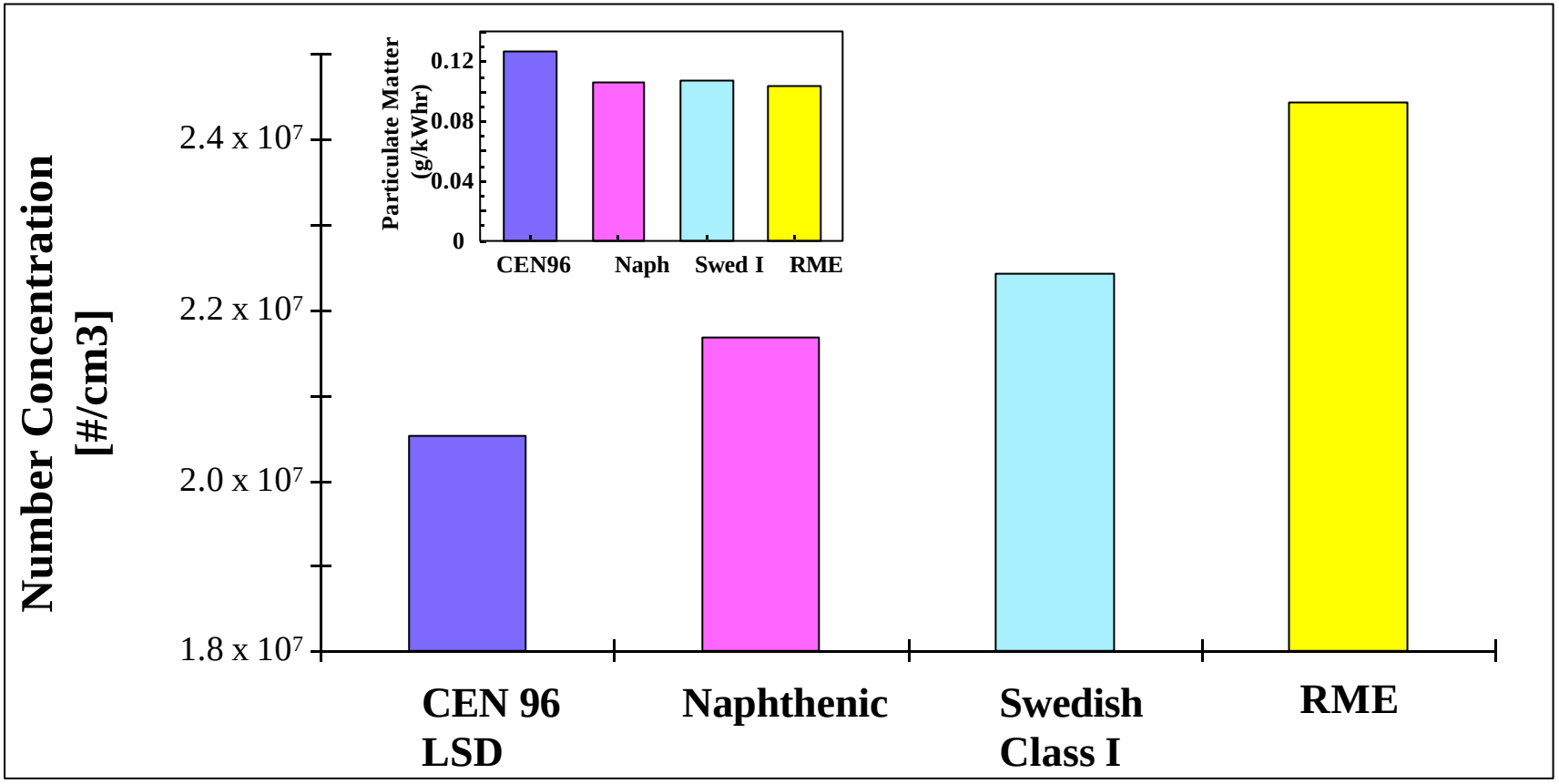
LSD = Low Sulphur Diesel EU 1996-2000 specs
ULSD = Ultra Low Sulphur Diesel UK specs
SCI = Swedish Class I

Test Fuels

N = High Naphthenic content fuel
RME = Rapeseed Methyl Ester

HD Particle Number & Mass ranking orders are different

RME > Swedish Class I > 96 LSD

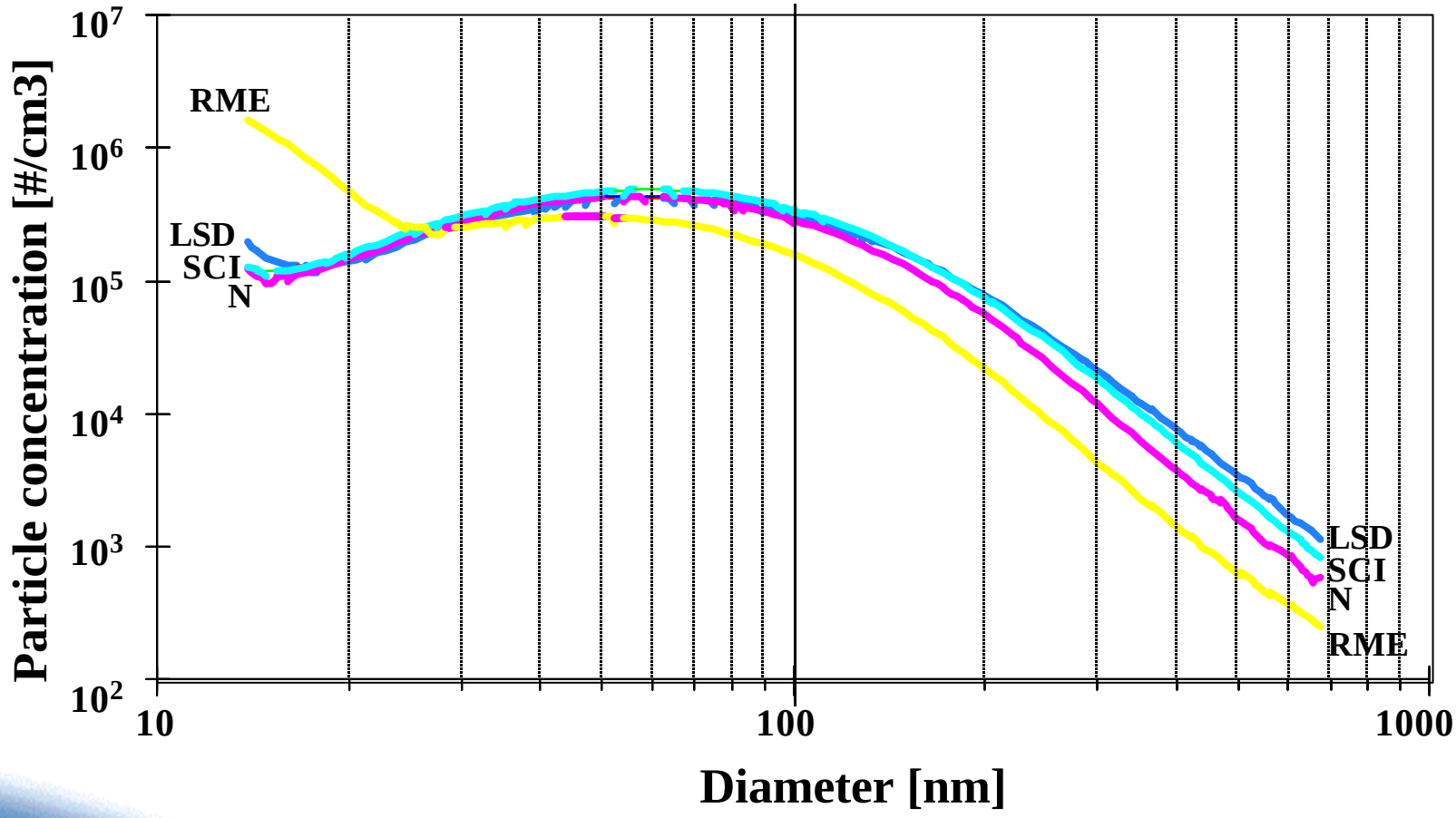


Heavy-duty diesel engine: Total Particle No.

6L Euro II engine, EU R49 cycle, SMPS > 14 nm

HD Particle number distribution: Major peak at 60-80 nm

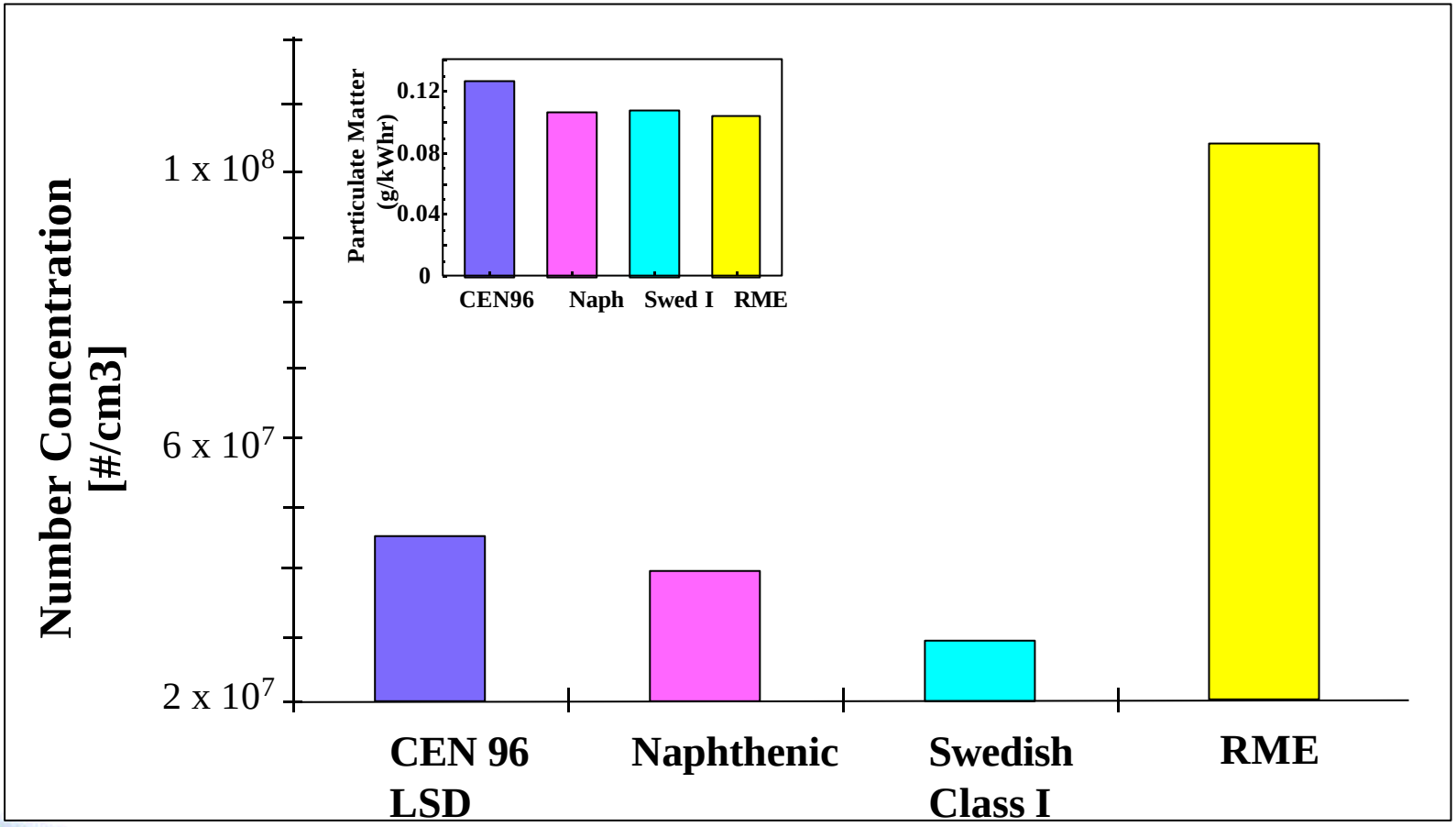
AGO fuels are similar - RME produces more smaller (<30nm) particles



Heavy-duty diesel engine:
6L Euro II engine, EU R49 cycle, SMPS > 14 nm

HD Lower size limit increases numbers 2-4x

no. ranking order changed, now 96 LSD > Swedish Class I

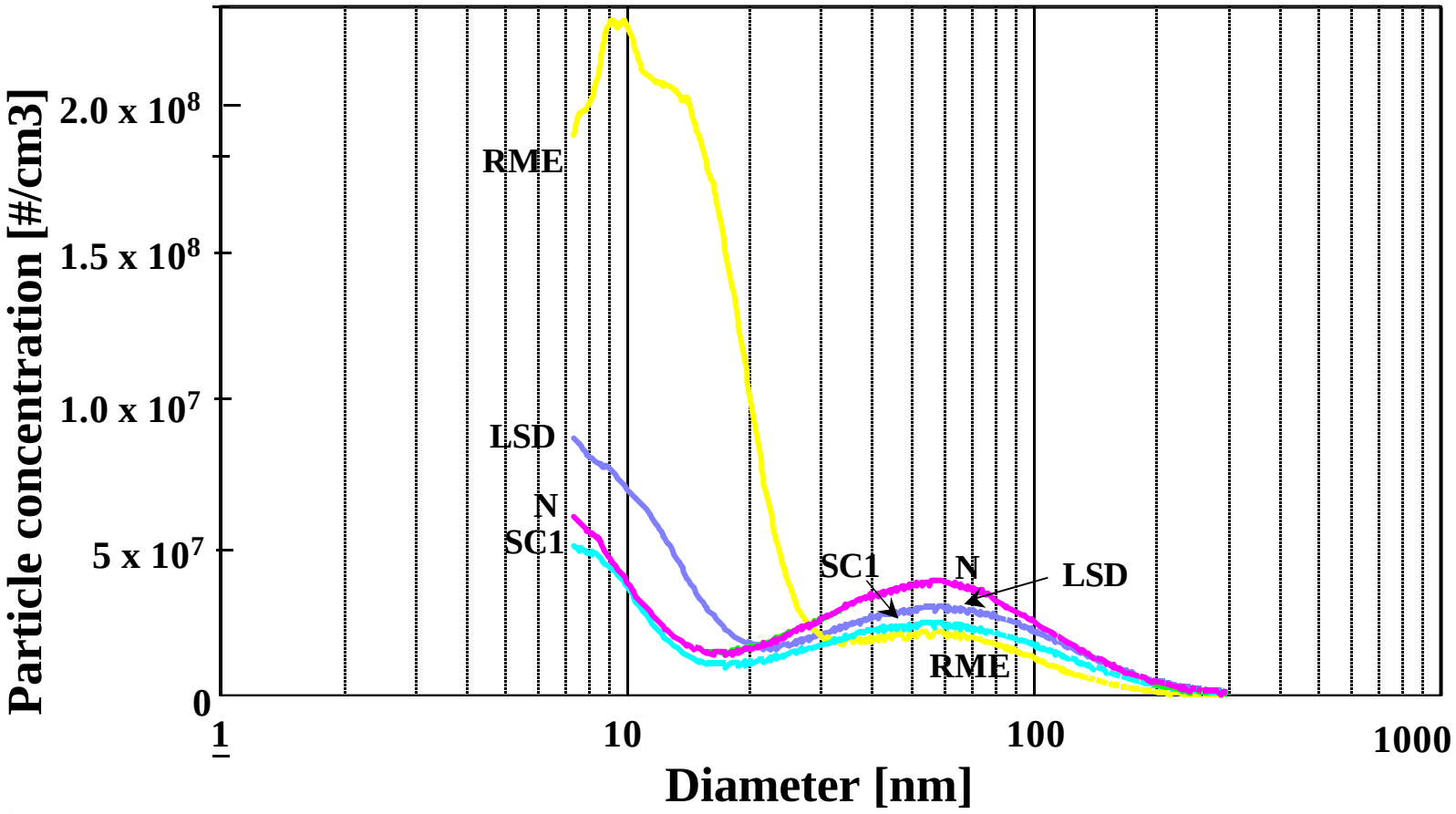


Heavy-duty diesel engine:

6L Euro II engine, EU R49 cycle, SMPS > 7 nm

HD Particle Numbers - Is the distribution bimodal?

RME produces more smaller particles at ~10 nm but less at ~70 nm

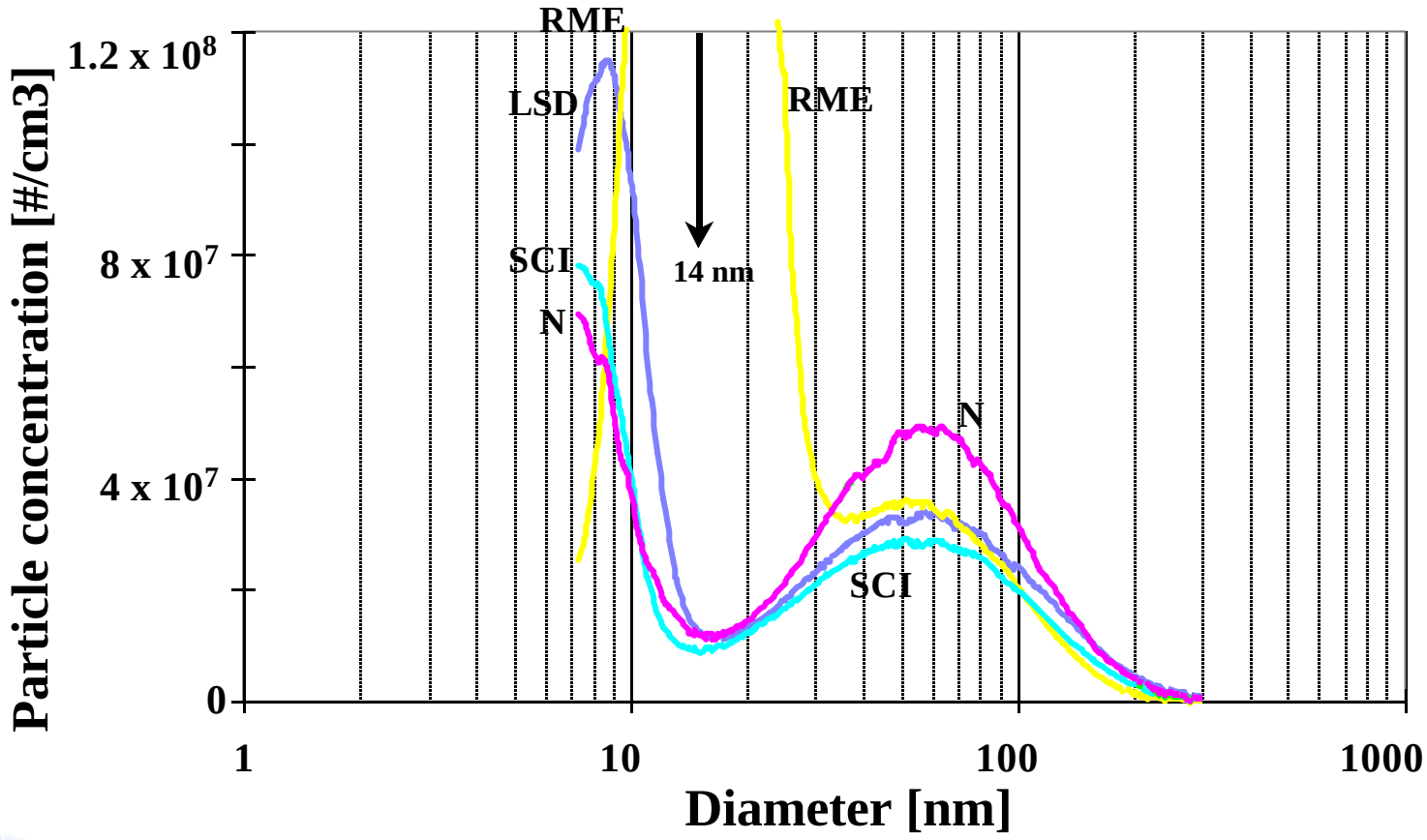


Heavy-duty diesel engine:

6L Euro II engine, EU R49 cycle, SMPS > 7 nm

HD Bimodal particle no. distribution clearer

major peak at 9 nm - what is the end of the measurement range?



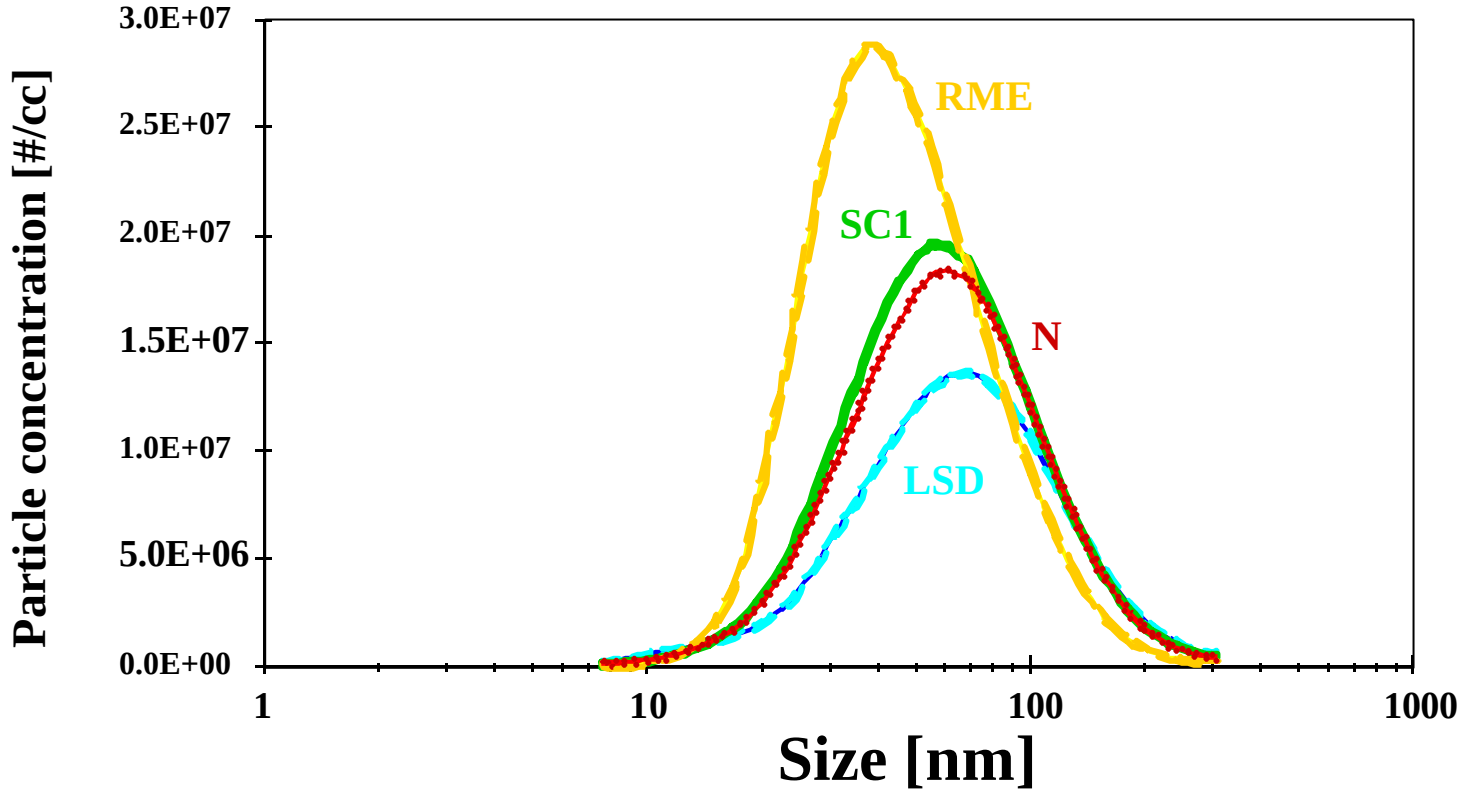
Heavy-duty diesel engine:

6L Euro II engine, Mode 3 of EU R49 cycle, SMPS > 7 nm

Similar Fuel Effects in HD 10 L engine

exhaust sampled via dilution tunnel

AGO fuels are similar - RME produces more smaller (<30nm) particles

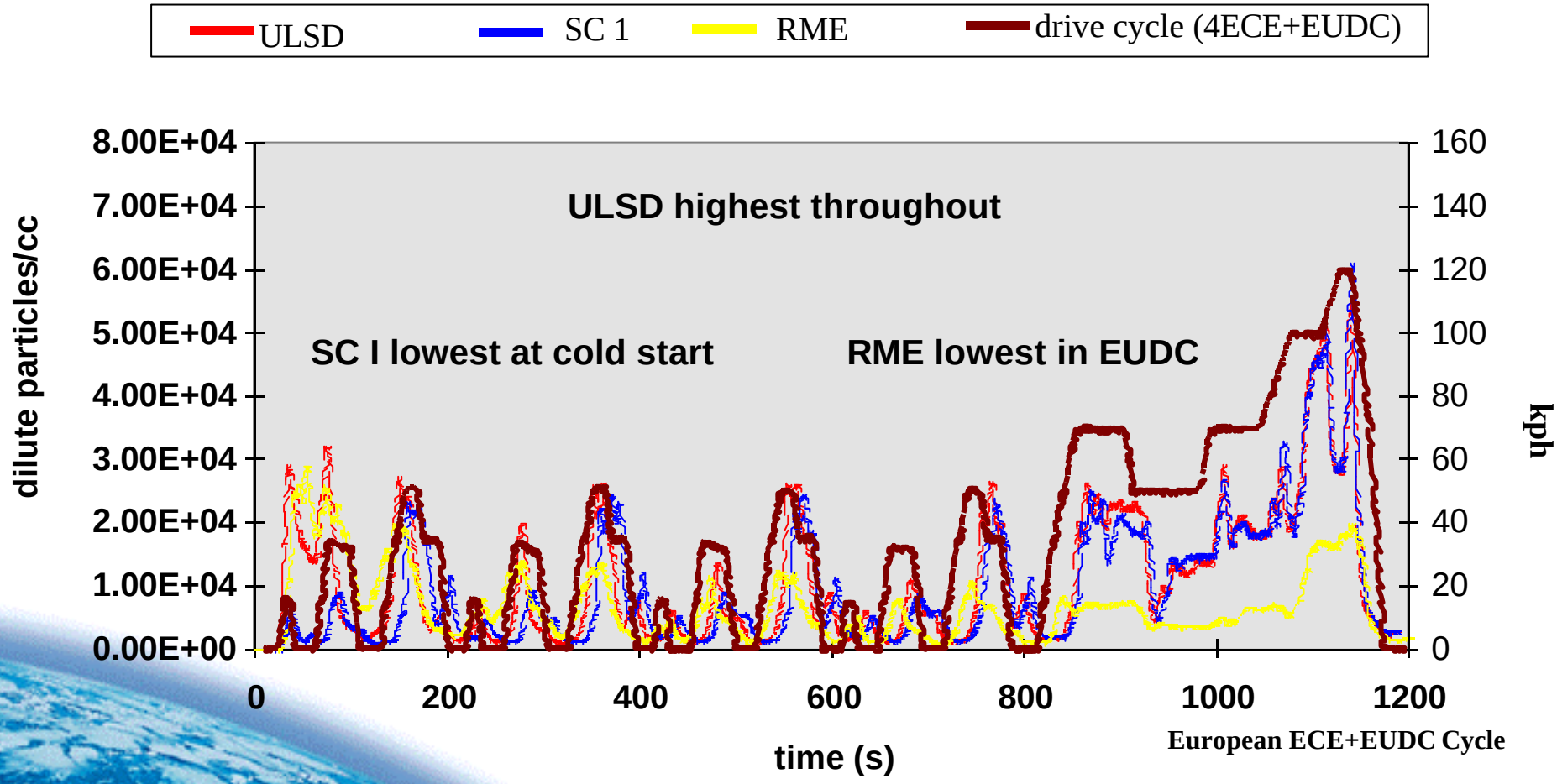


Heavy-duty diesel engine:

10L Euro II engine, EU R49 cycle, SMPS > 7 nm

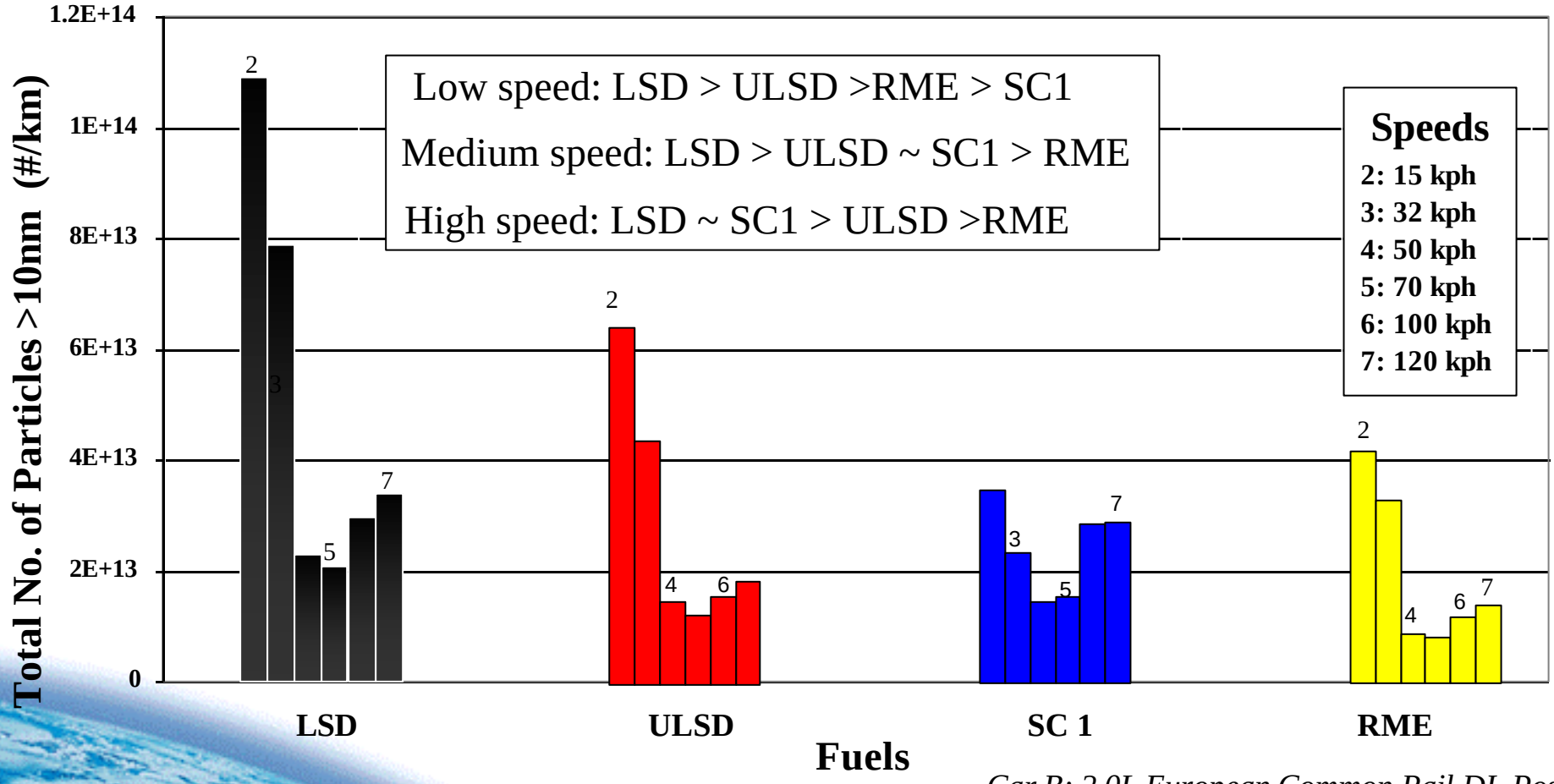
Fuel Differences Change during Test Cycle

Car A: 2.2L European Common Rail DI, Post 2000
"City diesel fuels" (Cold Start MVEG III) 100 nm



Highest emissions at lowest speeds.
Fuel ranking varies with speed

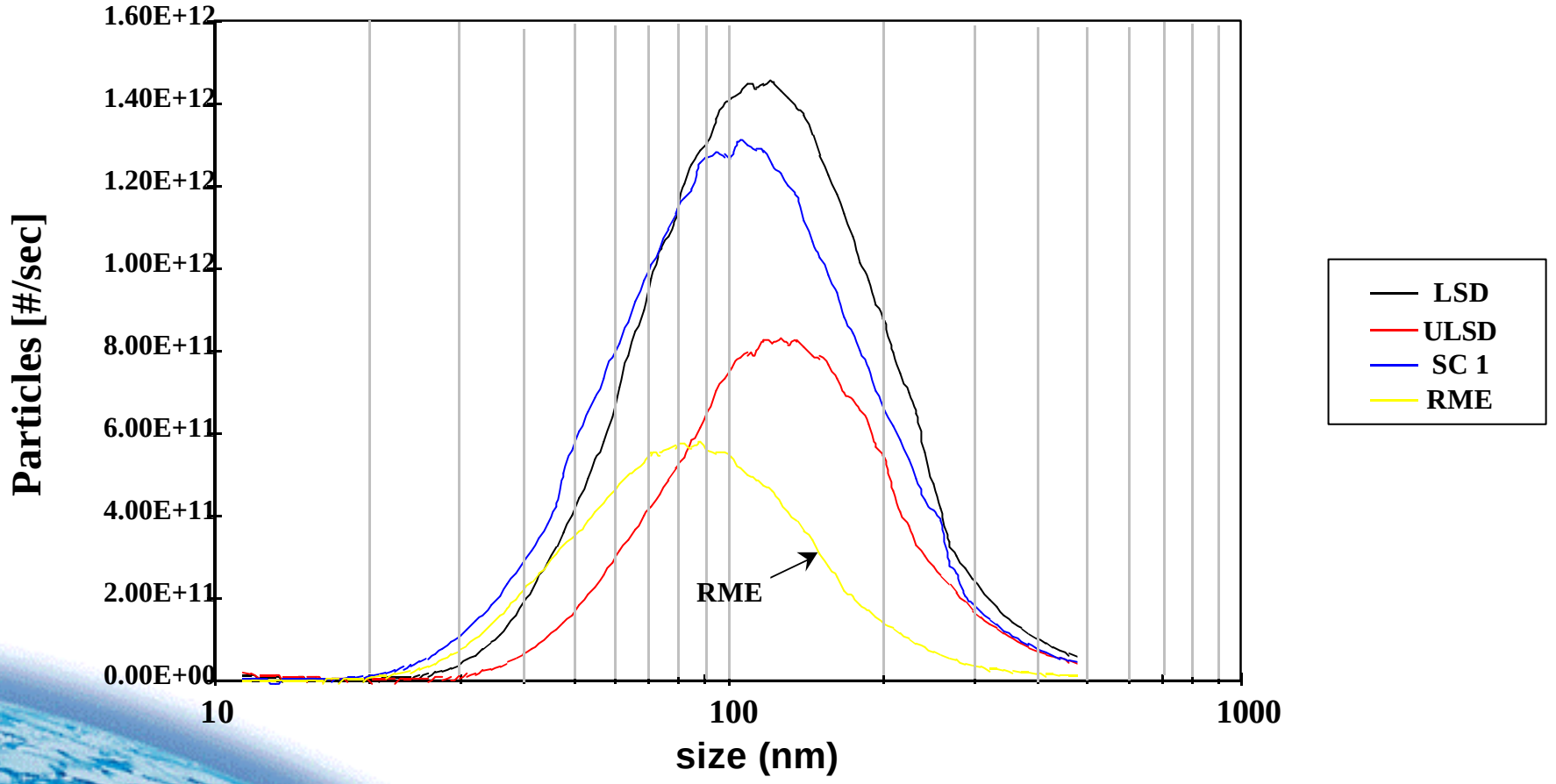
Post 2000 Car B : Total number of particles/km



Car B: 2.0L European Common Rail DI, Post 2000

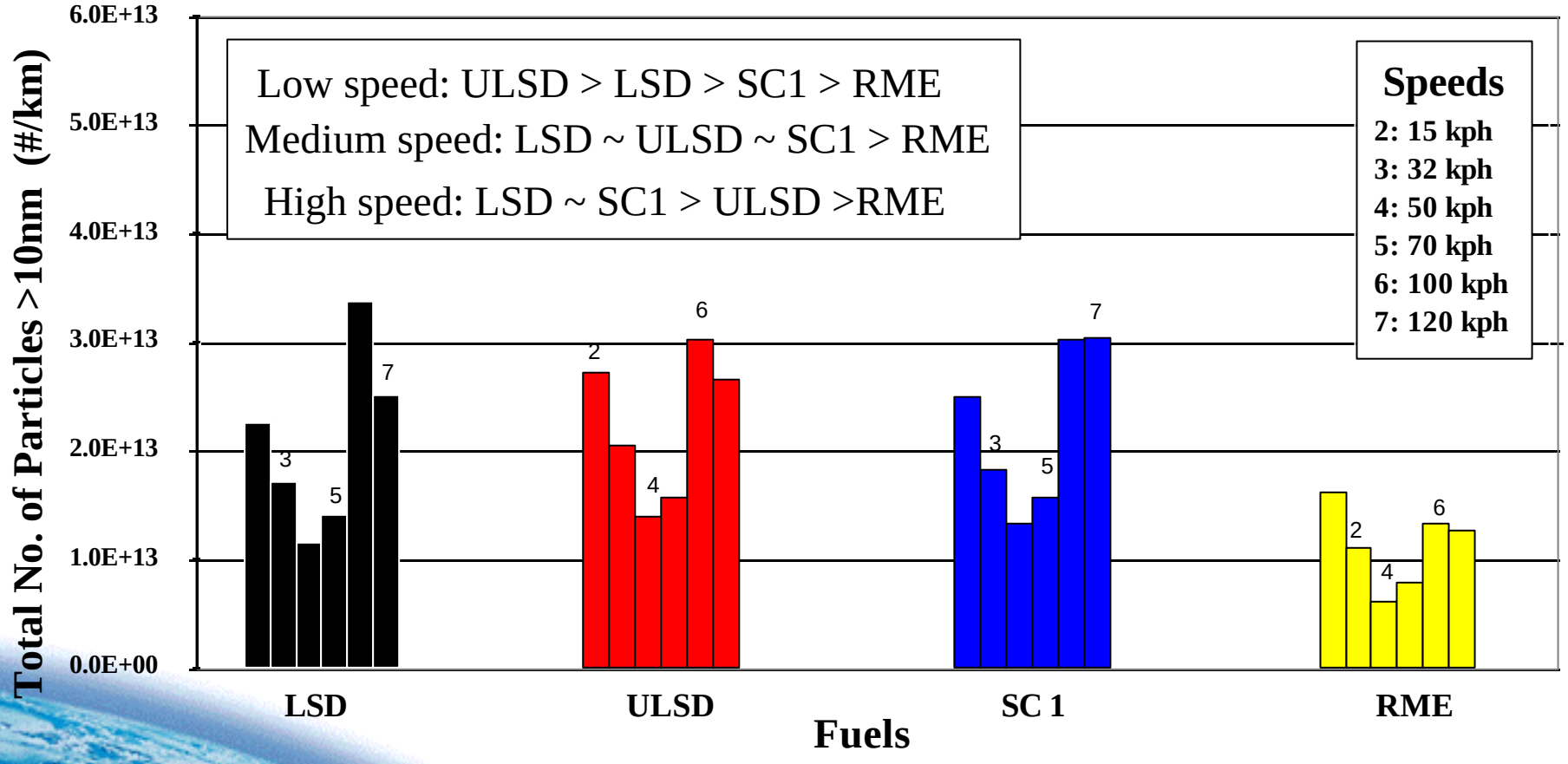
AGOs similar in Post 2000 Car - single peak at 100nm
RME peak lower at 80 nm

Common rail (2.0L) at 100 kph



Post 2000 Car A common-rail car:
Total particle no./km

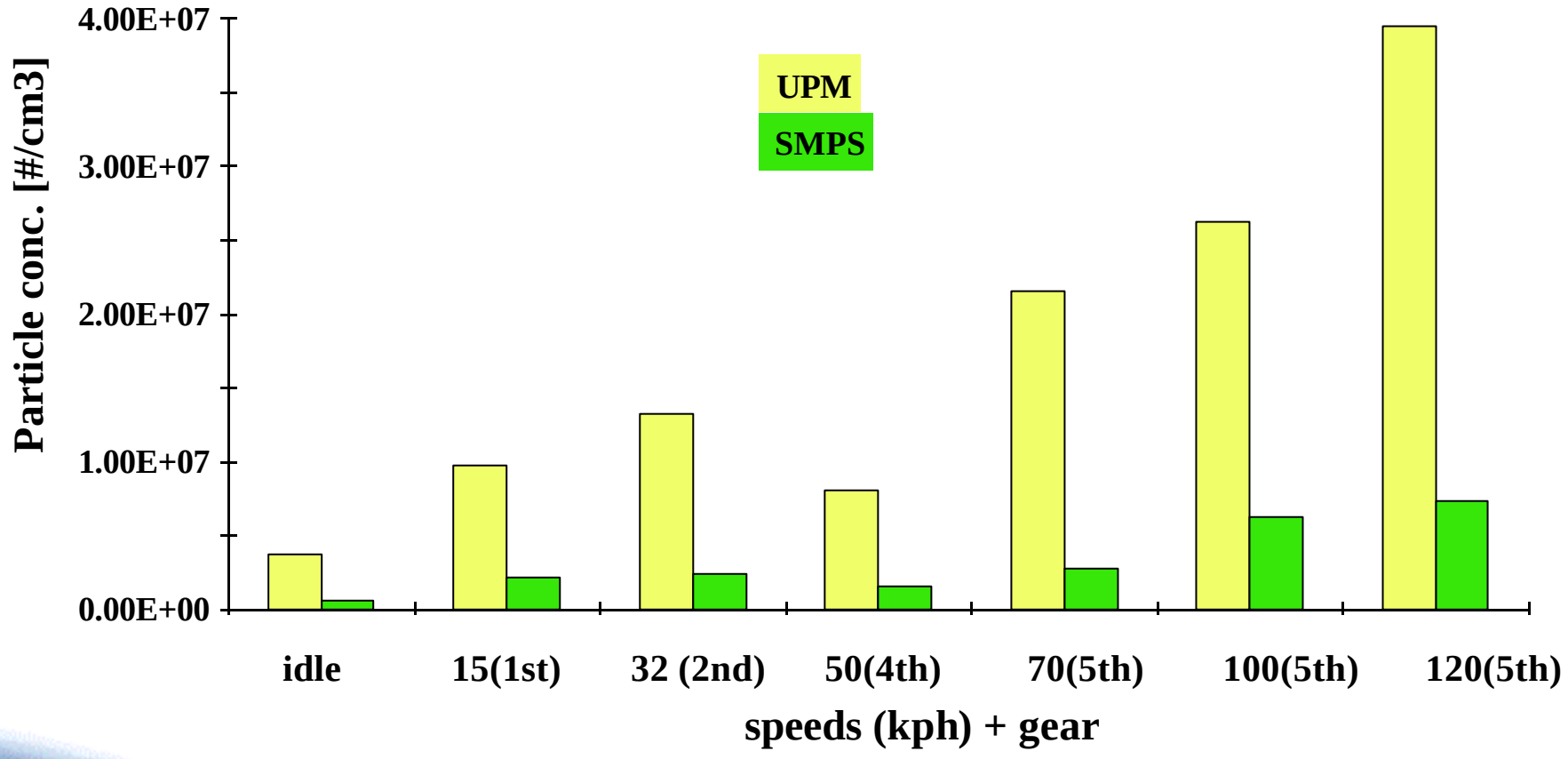
Fuel ranking varies with speed, but RME low & ULSD high



Car A: 2.2L European Common Rail DI, Post 2000

Ultrafine Particle Monitor (CNC) - all particles > ~4nm?

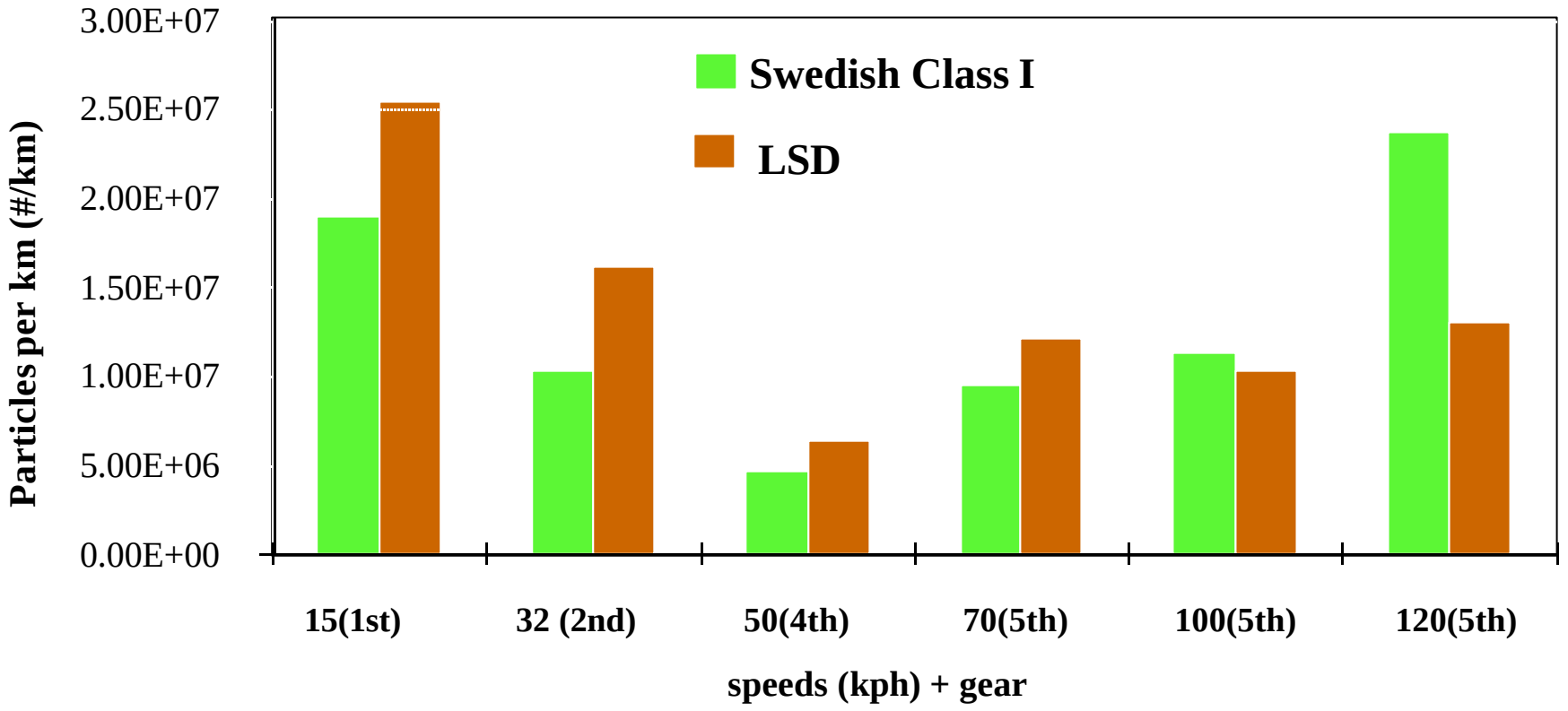
detects more particles (~5x) than SMPS



Euro II IDI 1.8L car - Steady States: UPM v SMPS

Fuel ranking changes at different steady states

At low speeds LSD produces more particles than SC1
At high speeds this order is reversed



Euro II IDI 1.8L car - Steady States: Ultrafine Particle Monitor (CNC)

Conclusions

- **Particulate size & numbers of AGO diesel fuels similar**

  except RME which gives more nanoparticles <15 nm
  but less particles in the 50-100 nm range

- **Trends between fuels affected by**

  operating conditions (e.g. engine speed)

  bimodal distribution

  size range measured, sampling methods, instrumentation

- **Definition of minimum "particle" size needed before real progress can be made**