Emission reduction using Gecam™ fuel alone and in combination with different DPF

8th ETH-Conference on Combustion Generated Particles

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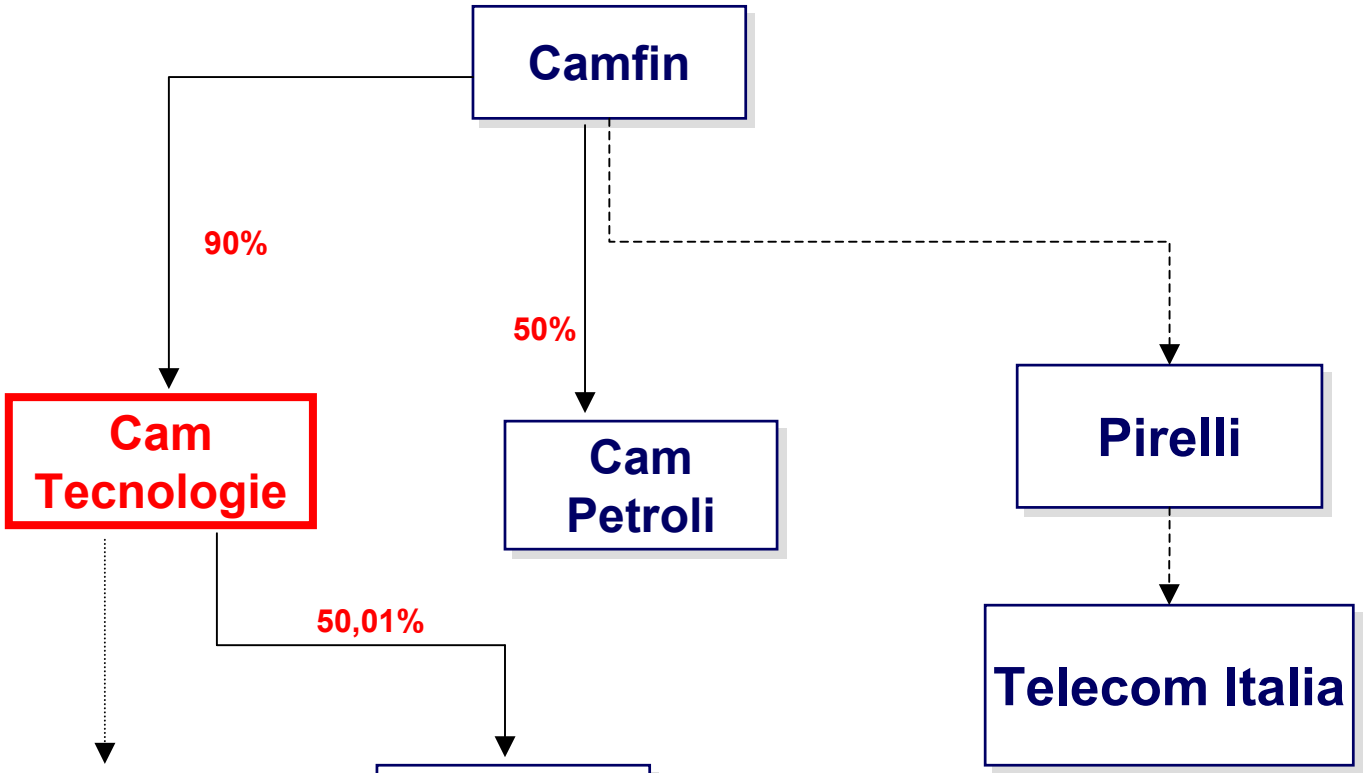
CAM TECNOLOGIE S.p.A.

- Cam Tecnologie, founded in 1997, is active in the field of emission reduction technology for diesel vehicles
- Cam Tecnologie is the market leader in the field of low emission fuels with Gecam™, the white diesel, and is now also offering after-treatment devices for exhaust gases
- Cam Tecnologie is owned by Camfin Group, holding of the PIRELLI / TELECOM Group

	1998	1999	2000	2001	2002	2003
Employees	16	18	21	25	30	31
Sales, M€	1,4	2,9	19,9	41,2	45,7	50,8

CAM TECNOLOGIE: THE GROUP



Gecam™

- Italy
- Switzerland
- China
- Czech Republic

- **Wired network**
- **Mobile network**
- **IT**
- **Internet**
- **Television…**

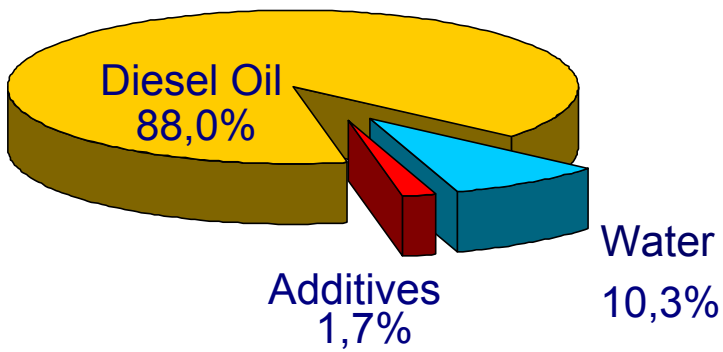
GECAM™, THE WHITE DIESEL

The white diesel is a **WATER IN DIESEL OIL EMULSION**

- **ENVIRONMENTALLY FRIENDLY**
- **"FILL AND GO"**, without any modification to engines or boilers
- **RELIABLE**, widely adopted
- Available on the **WHOLE ITALIAN AND FRANCE TERRITORY**

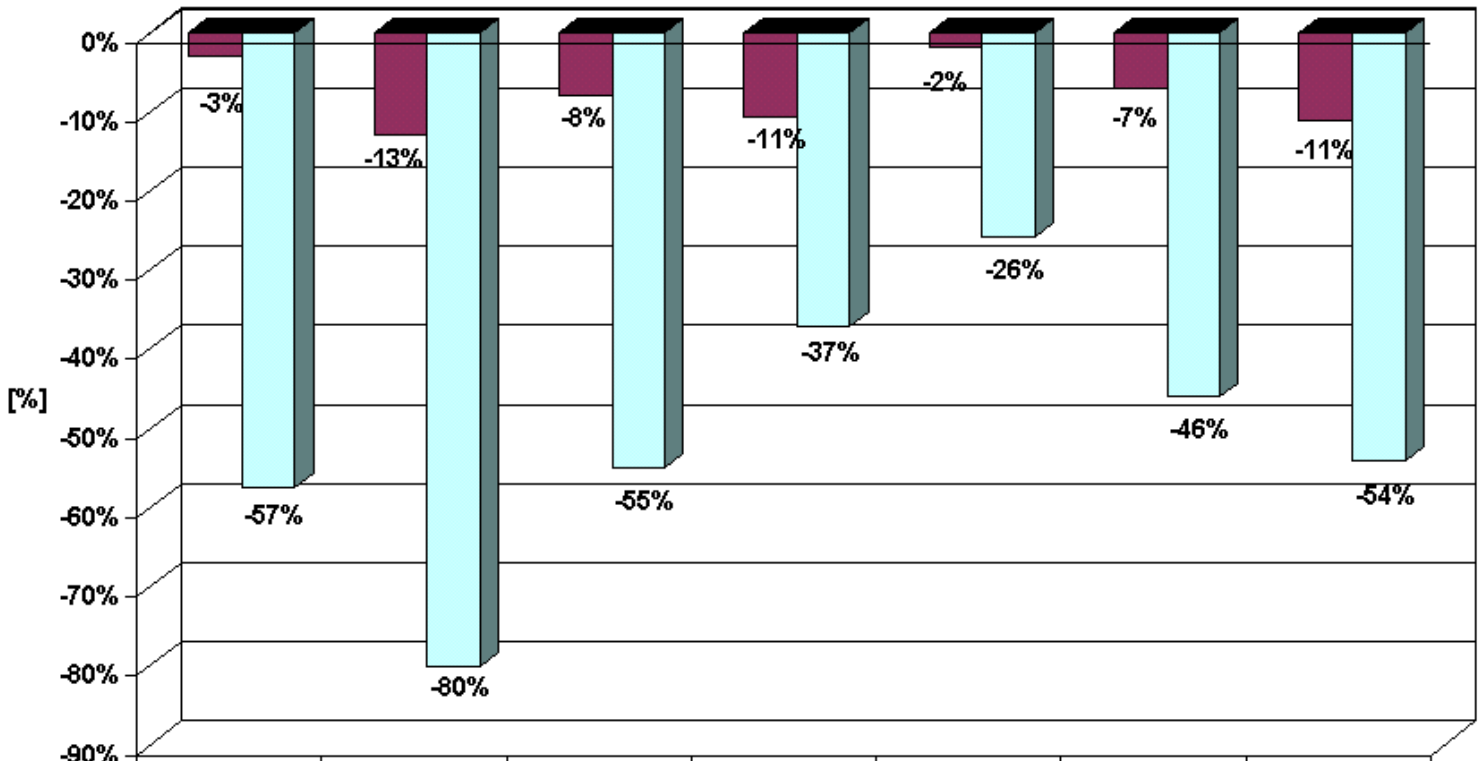
The white diesel is **also** available with ultra-low Sulphur content (10 ppm): **Gecam™10**

COMPOSITION IN VOLUME FOR H.D. ENGINES AND BOILERS



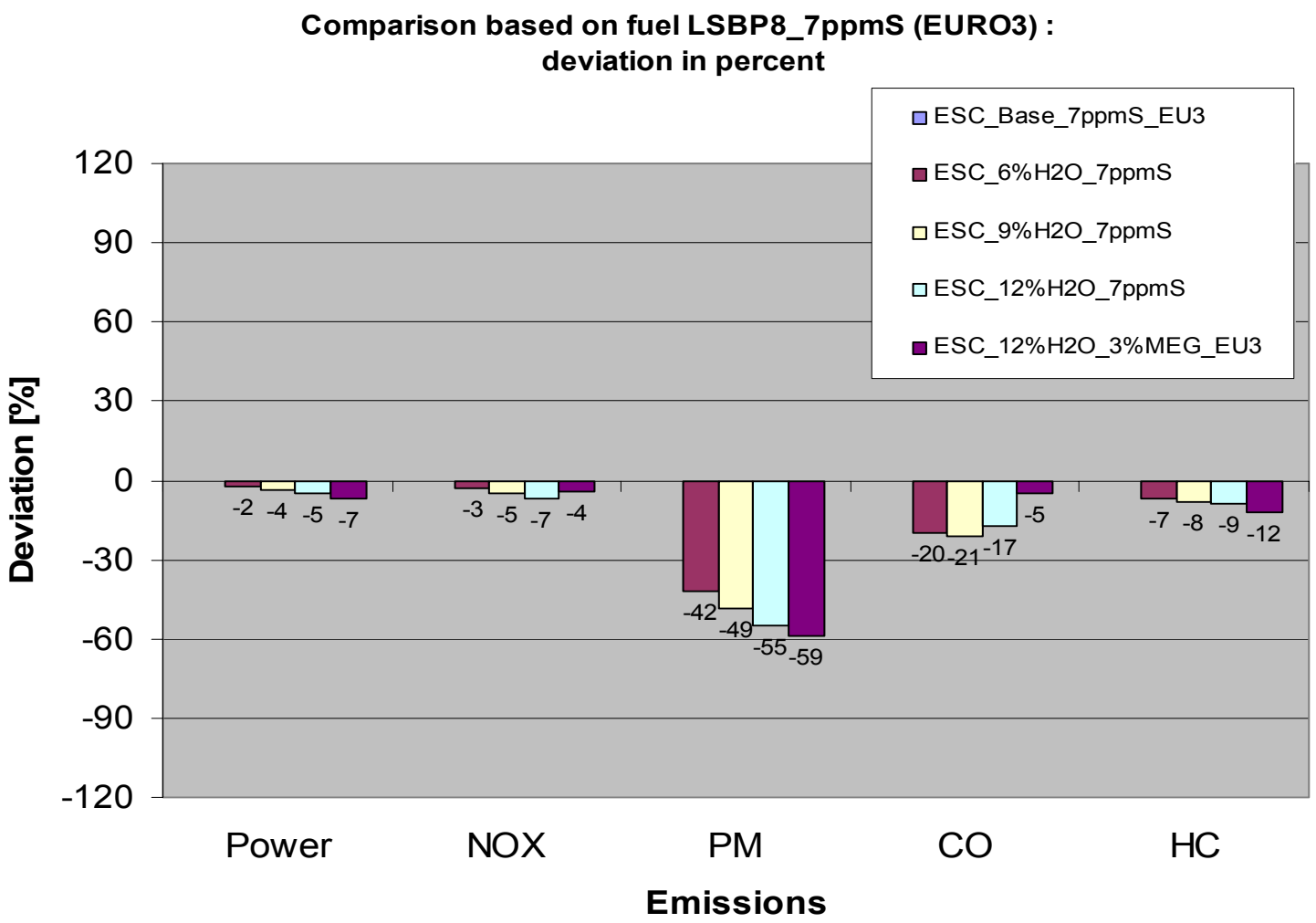
MPACT ON EURO 3 ENGINES EMISSIONS

NO_x and PM reduction



	IVECO Cursor - ESC E3	DEUTZ BF4M1013FC E2	DEUTZ BF4M1013FC E3	MAN D2866LF28 E3	MAN 0834 LFL 03 E3	MAN 0836 LUH 15 E3	SCANIA DC93 E3
NOx	-3%	-13%	-8%	-11%	-2%	-7%	-11%
PM	-57%	-80%	-55%	-37%	-26%	-46%	-54%

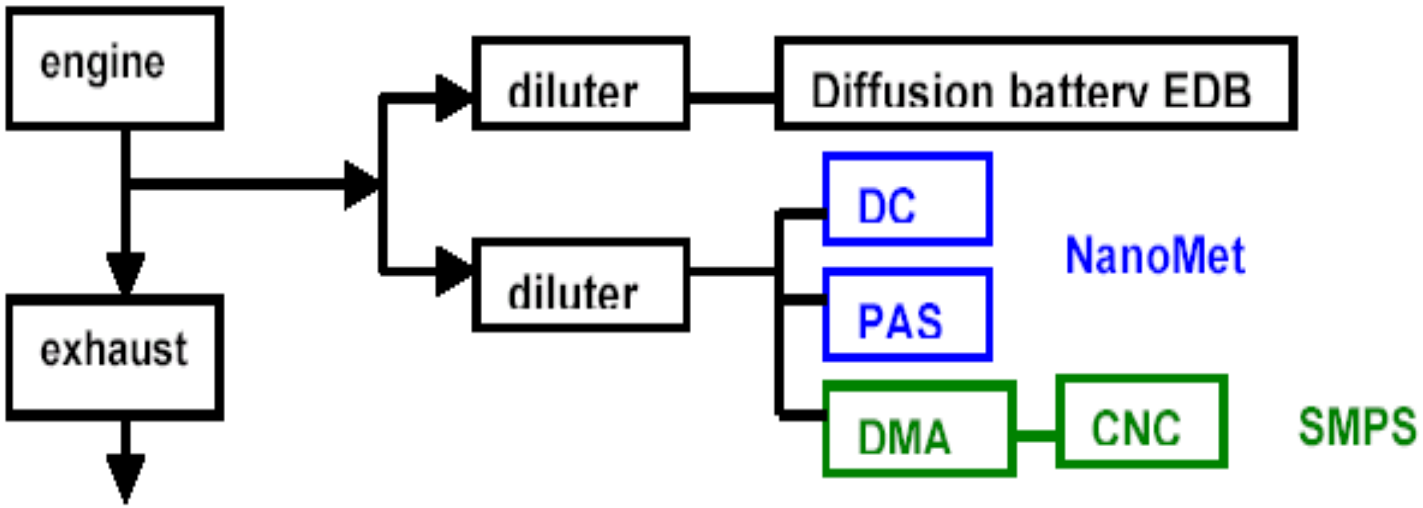
MPACT OF GECAM ™ 10 ON IVECO CURSOR 8 EURO III ENGINE



PARTICLE DIMENSIONAL ANALYSIS

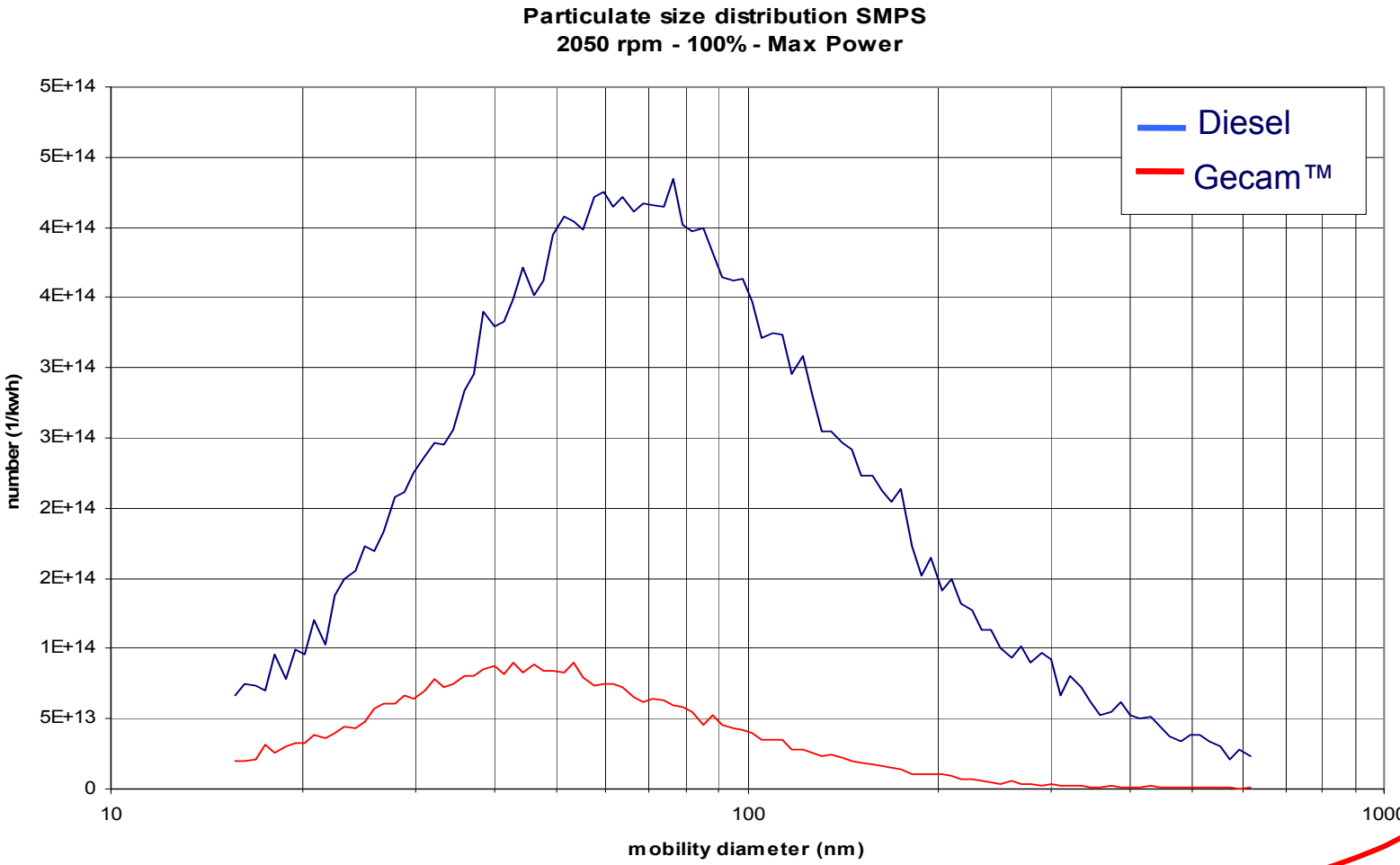
Tested by Matter Eng.- HD BUS ENGINE– PDE Inj. System, Euro 3 config.

o Experimental setup



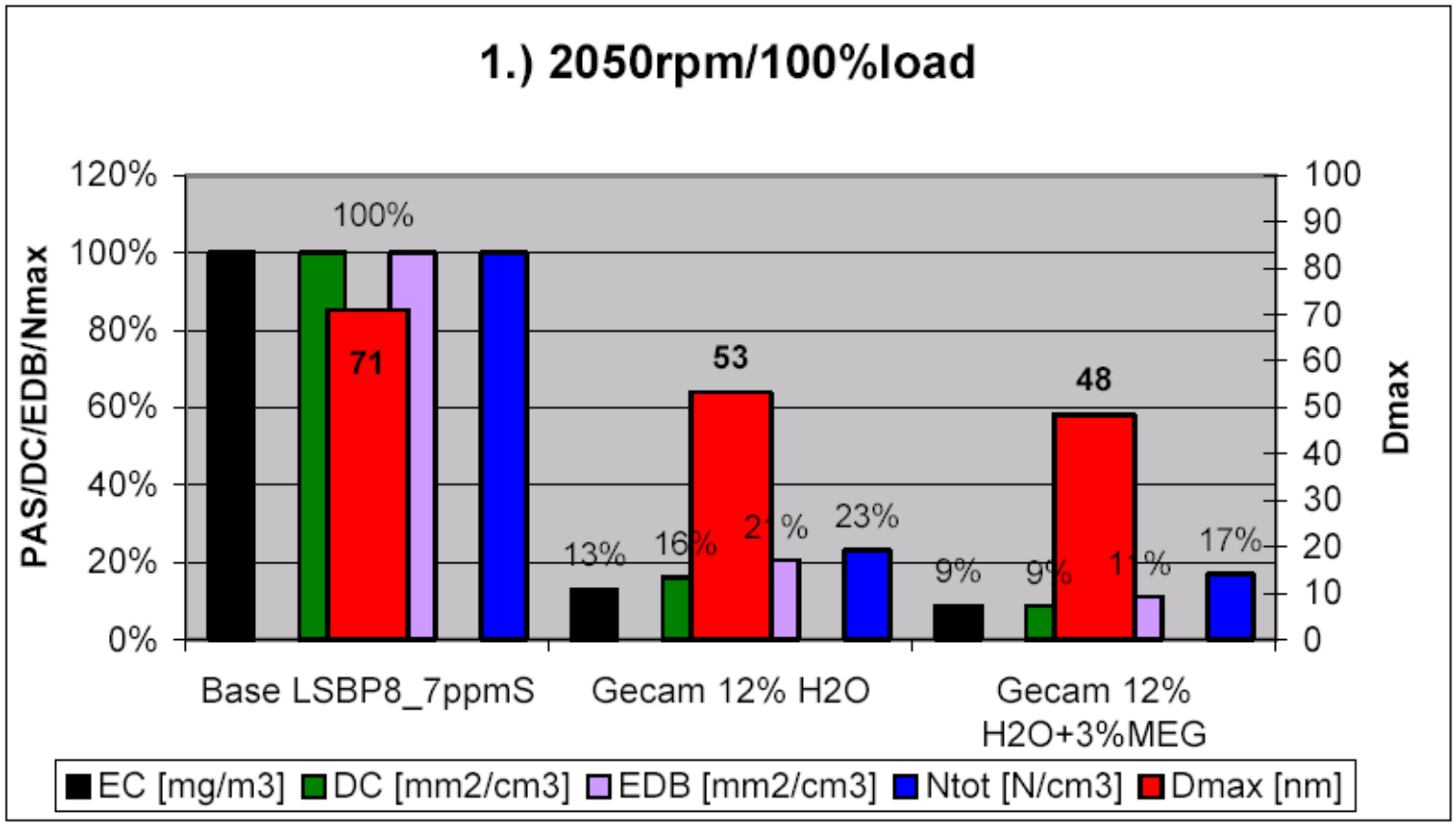
PARTICLE DIMENSION ANALYSIS

SMPS Results – diesel oil Vs. Gecam™ at top power



PARTICLE DIMENSION ANALYSIS

Complete dimensional results – diesel oil base 100



EC = elemental carbon DC/EDB(prototype)= particle surface N = particle number

LIGHT DUTY EMULSIFIED FUEL: TESTING ACTIVITIES

During 2003 ENI and Cam Tecnologie have carried out an extensive testing program on a 6% water in diesel emulsion with the following targets:

- Verification of the ENVIRONMENTAL BENEFITS - against the project targets- of the new formulation on several different vehicles, and considering both REGULATED AND NON-REGULATED EMISSIONS

- Test program on bench and on track, under the supervision of FIAT-GM Powertrain, to verify the reliability of the product on vehicles equipped with the MOST RECENT HIGH PRESSURE INJECTION SYSTEMS

ENI (Euron) test room, and a FIAT Stilo 1.9 JTD on the Nardò track

ENVIRONMENTAL ASSESMENT PROGRAM: SOME FIGRUES

Emissions result were verified on the amplest statistical sample :

- 72+72 comparative tests between emulsified and standard diesel oil (3 runs)
- 5 independent laboratories were used to ensure consistency of results
- 23 different models tested, with various ages and mileages, to better sample the existing circulating fleet
- Tests repeated at different mileages (from 0 km up to 100,000 km) to verify result consistency over time
- Both homologation and urban cycles have been used

Test rooms: ENI (Euron) and Stazione Sperimentale Combustibili

ENVIRONMENTAL ASSESMENT: TEST FACILITIES

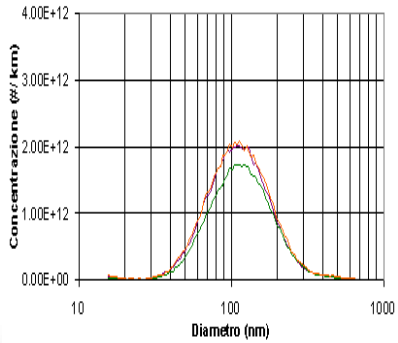
- Tests have been carried out at the following facilities:
  - FIAT GM Powertrain, Torino Sangone
  - Prototipo S.p.A. , Proving Ground di Nardò (LE)
  - ENI Tecnologie, San Donato Milanese Laboratory
  - Stazione Sperimentale Combustibili, San Donato Milanese
  - Engine Institute of the C.N.R. (National Research Center) Naples

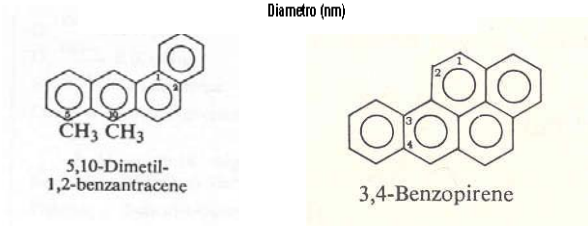
Test room: Prototipo Nardò (LE)

ENVIRONMENTAL ASSESMENT: MONITORED POLLUTANTS

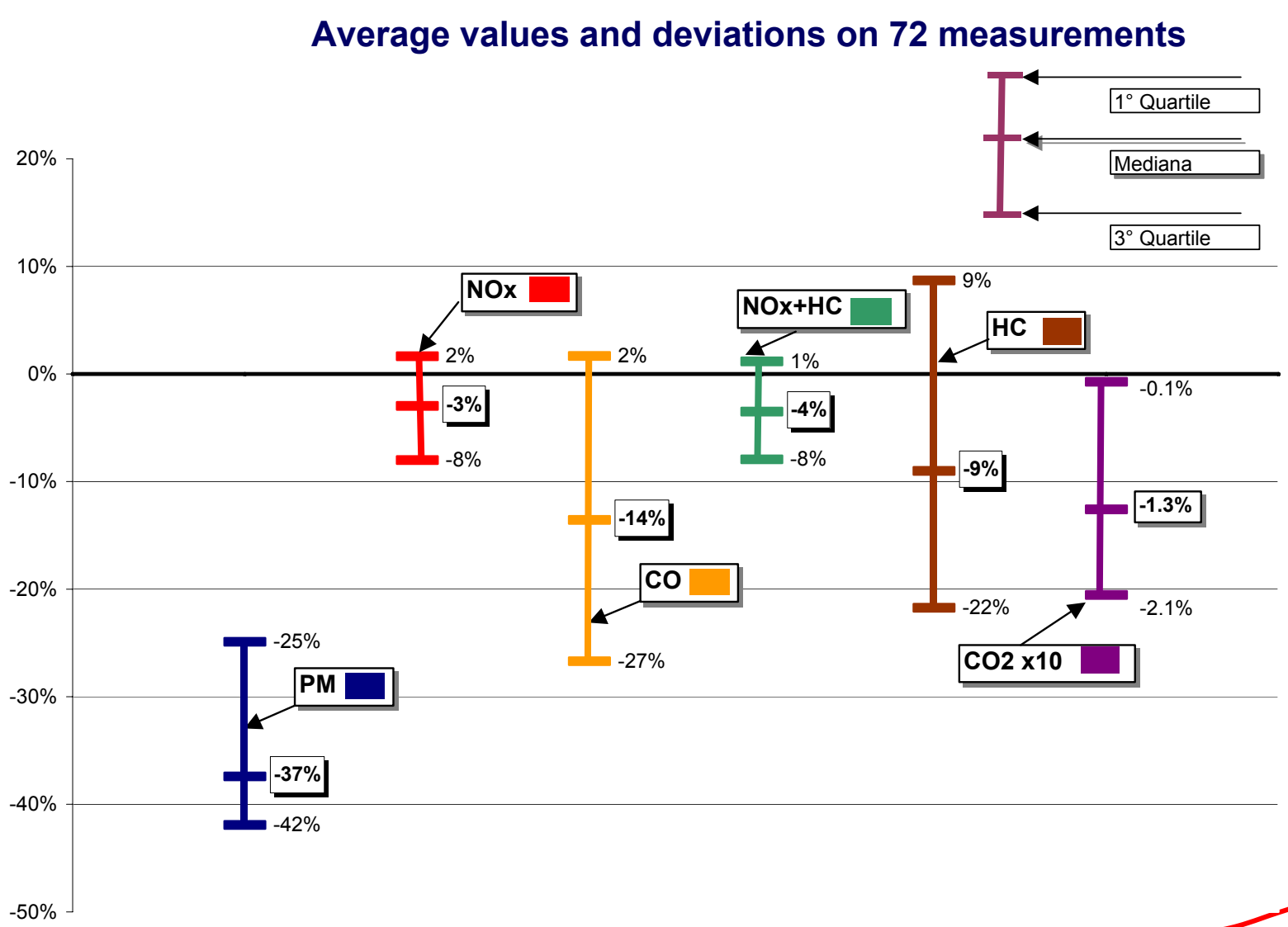
- **REGULATED EMISSIONS** :
  - PM , CO, NOx, NOx+HC

- **NON REGULATED EMISSIONS** :
  - HC
  - Granulometric distribution of particulate (SMPS, ELPI)
  - Polycyclic Aromatics Hydrocarbons
  - Aldehydes
  - Benzene and 1,3 Butadiene



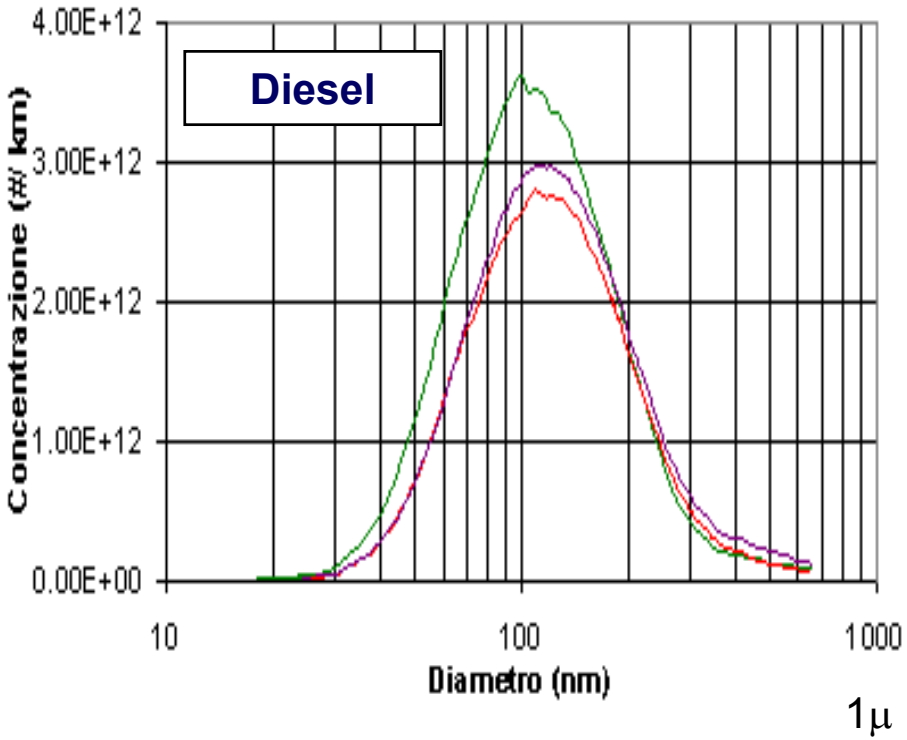


SUMMARY OF THE IMPACT ON EMISSIONS

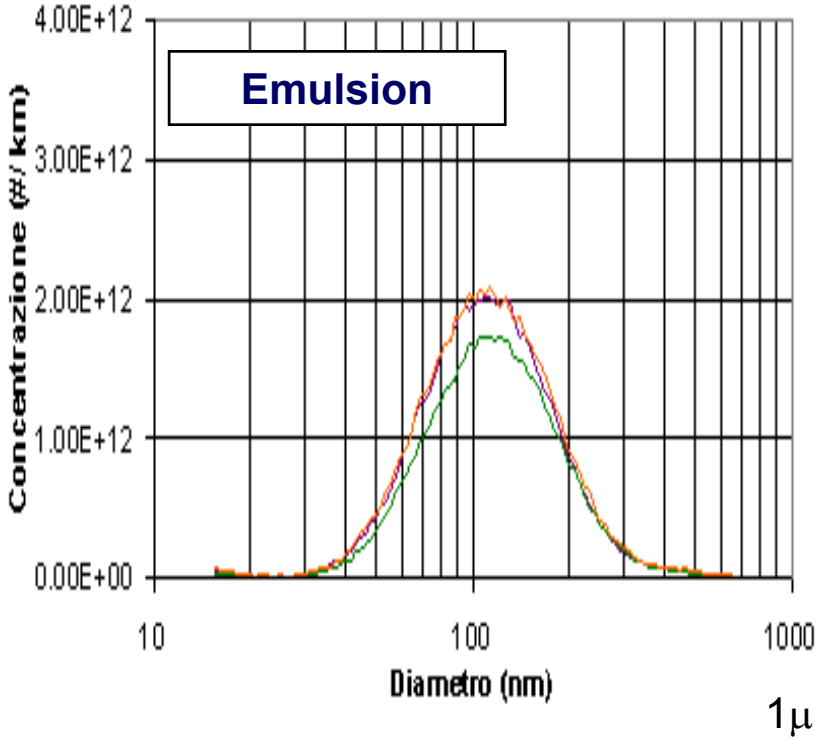


EFFECT ON PARTICULATE SIZE DISTRIBUTION

SMPS measurements on common rail Euro 3 engine at 50 km/h

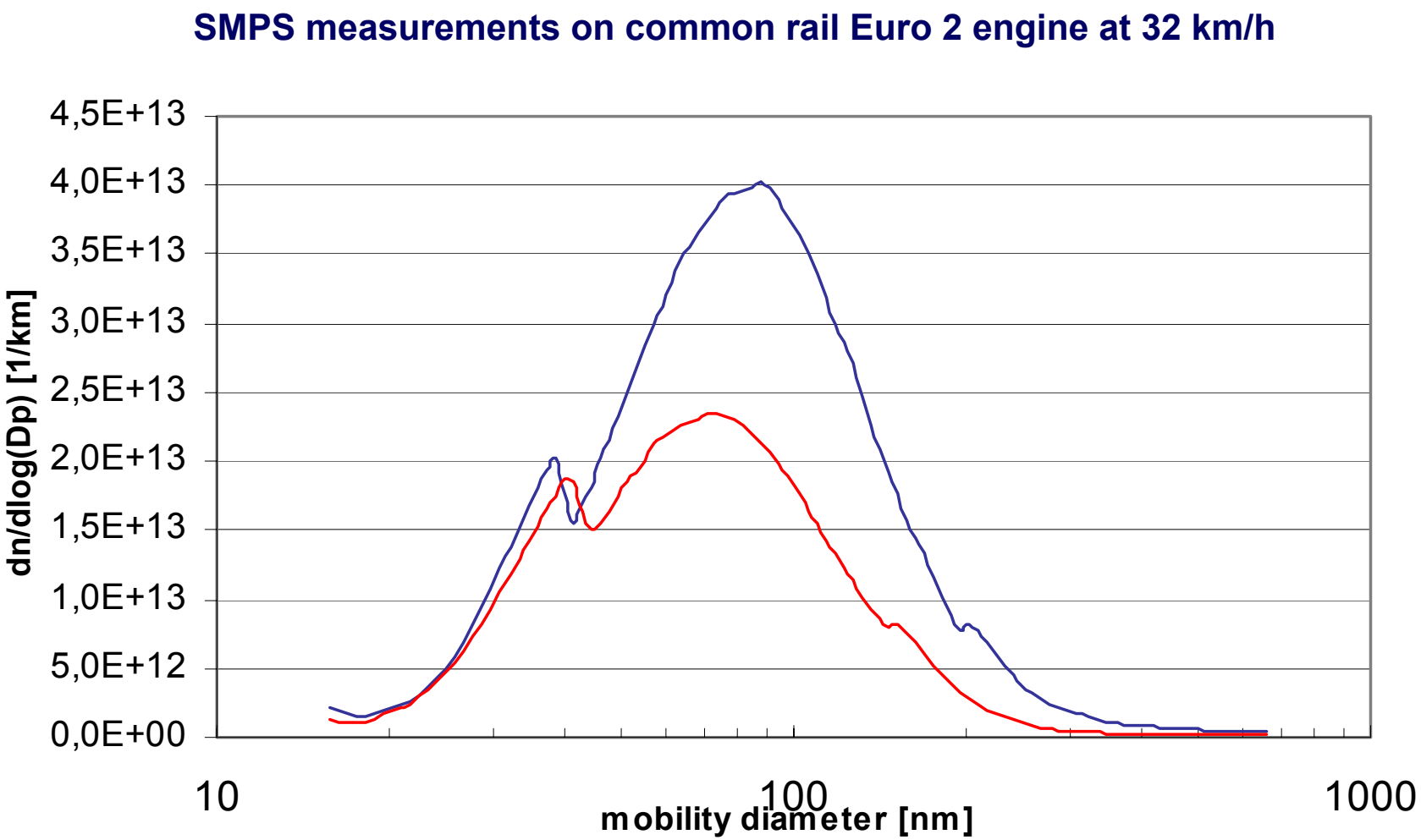


1μ



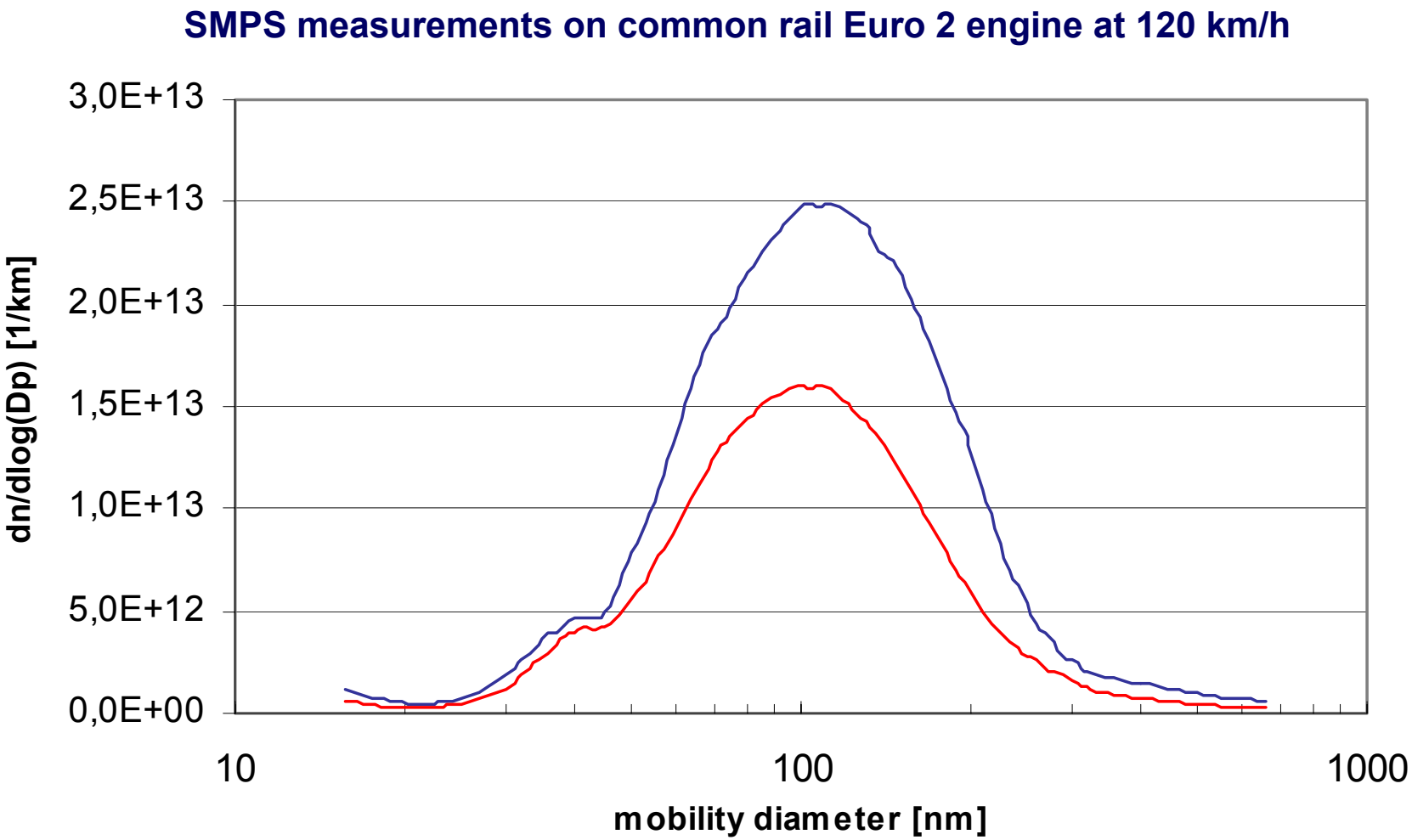
1μ

EFFECT ON PARTICULATE SIZE DISTRIBUTION



ENI Tecnologie, San Donato Milanese

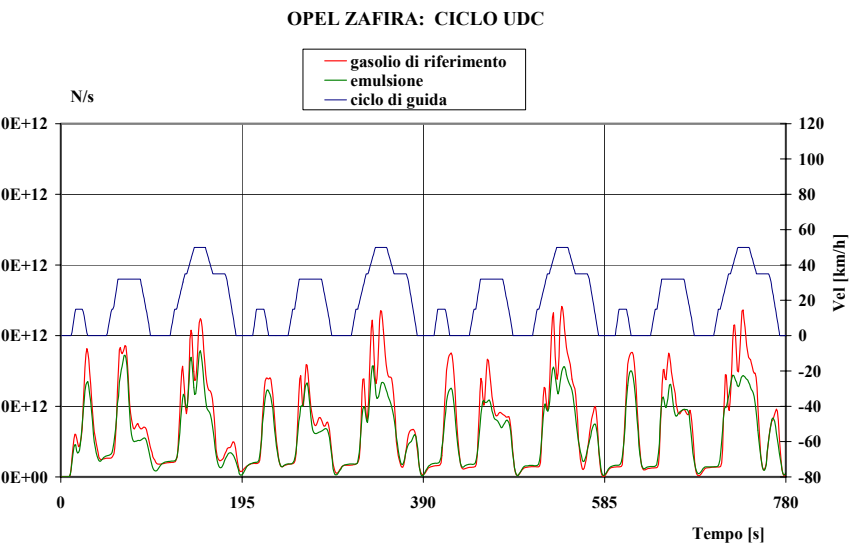
EFFECT ON PARTICULATE SIZE DISTRIBUTION

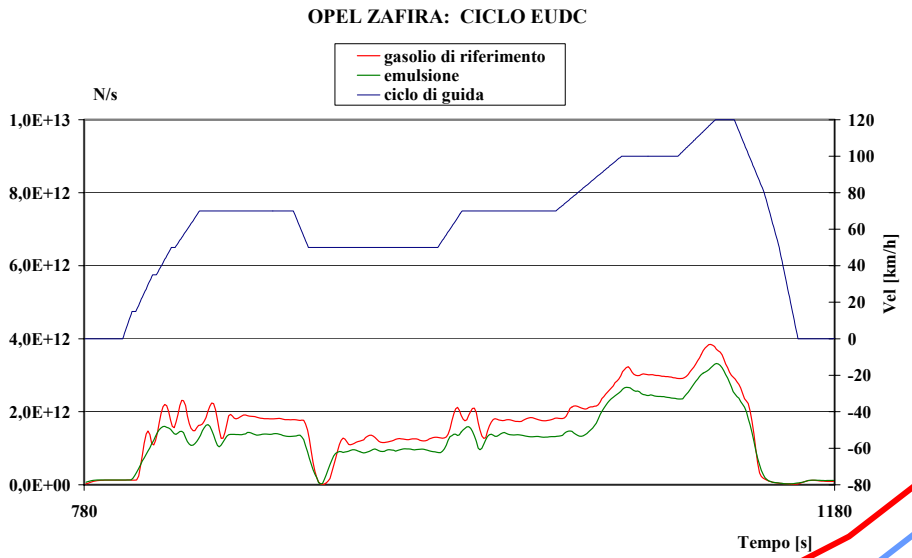


ENI Tecnologie, San Donato Milanese

EFFECT ON PARTICULATE SIZE DISTRIBUTION

ELPI measurements on Euro 3 engine NEDC cycle





Gecam™ & AFTER TREATMENT: Filed test on CRT

WHAT WE HAVE DONE:

- Performance test carried out in 2001 at TTM with good results
- We have switched our production with diesel base at 10 ppm sulphur
- 15 months field application with CRT Eminox on Euro 2 Busses in Milan, more than 40.000 km each bus.

RESULTS:

- Reduced engine soot load, opacity reduced by 70% before filter.
- Back pressure during running was 50% lower than with ULSD (10ppm S)
- No damage or extraordinary maintenance occurred. Positive impact on system maintenance and durability.

DEVELOPING PARTICULATE FILTER SYSTEMS

DEVELOPMENT OF NEW SOLUTIONS BASED ON:

- Strong role of CAM TEC on the Italian bus and truck fleet market
- Know-how on engine emissions, fuels and additives
- Dealers and technical customer support coverage all over the Italian territory
- Knowledge of European and North American retrofit market
- Knowledge of the automotive market evolution

DEVELOPING PARTICULATE FILTER SYSTEMS

DESIGN, DEVELOPMENT AND PRODUCTION OF PARTICULATE FILTER SYSTEMS – OUR CHOICE:

- Silicon Carbide Support (from Liqtech)
- Regenerating Strategy with Fuel Borne Catalyst (for retrofit application)
- Self-developed Additive, Fe-based
- On-site Customer Support and life-cycle service warranty
- No sulphur constrain strategy – emulsified fuel suggest.

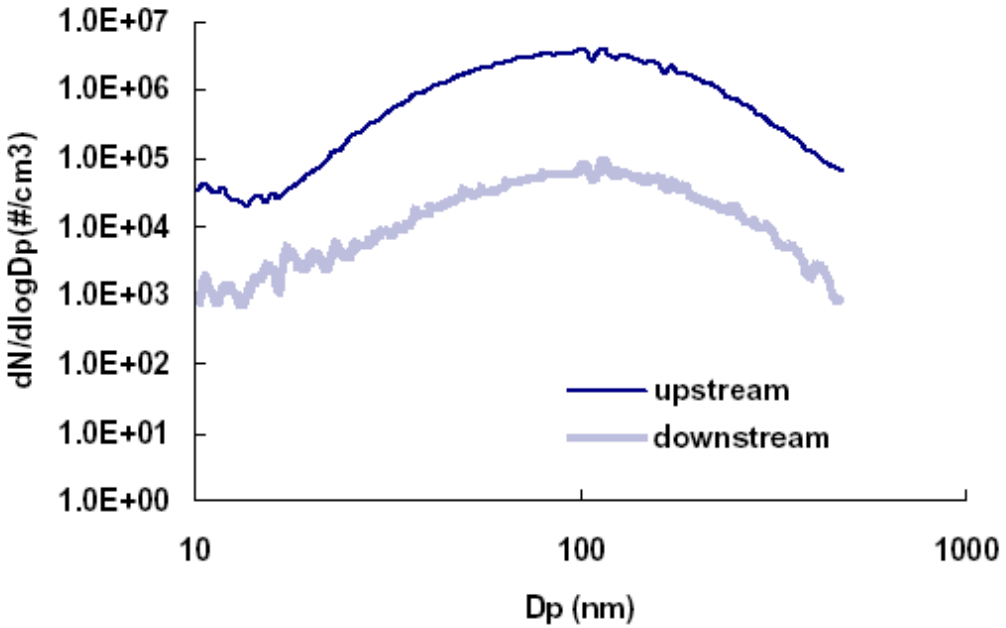
LIQTECH SiC FILTER CHARACTERISTICS

90 Cpsi - HI SOOT LOAD CAPACITY >18g/lt. - PORE SIZE 23 mm

est at TTM in ccordance with VERT:

ARTs Reduction 99,3%

	PZAG [%]			
	pt. 2	pt. 2 (+add)	pt. 6	pt. 6 (+add)
	1400 min-1	1400 min-1	1400 min-1	1400 min-1
	full load	full load	297 Nm	297 Nm
particle trap new	98.194	99.656	99.633	99.708
average on all points	99.30			



Tested at CERTH/CPERI on 1.9 lt CR Engine

PARTs Reduction > 99 %

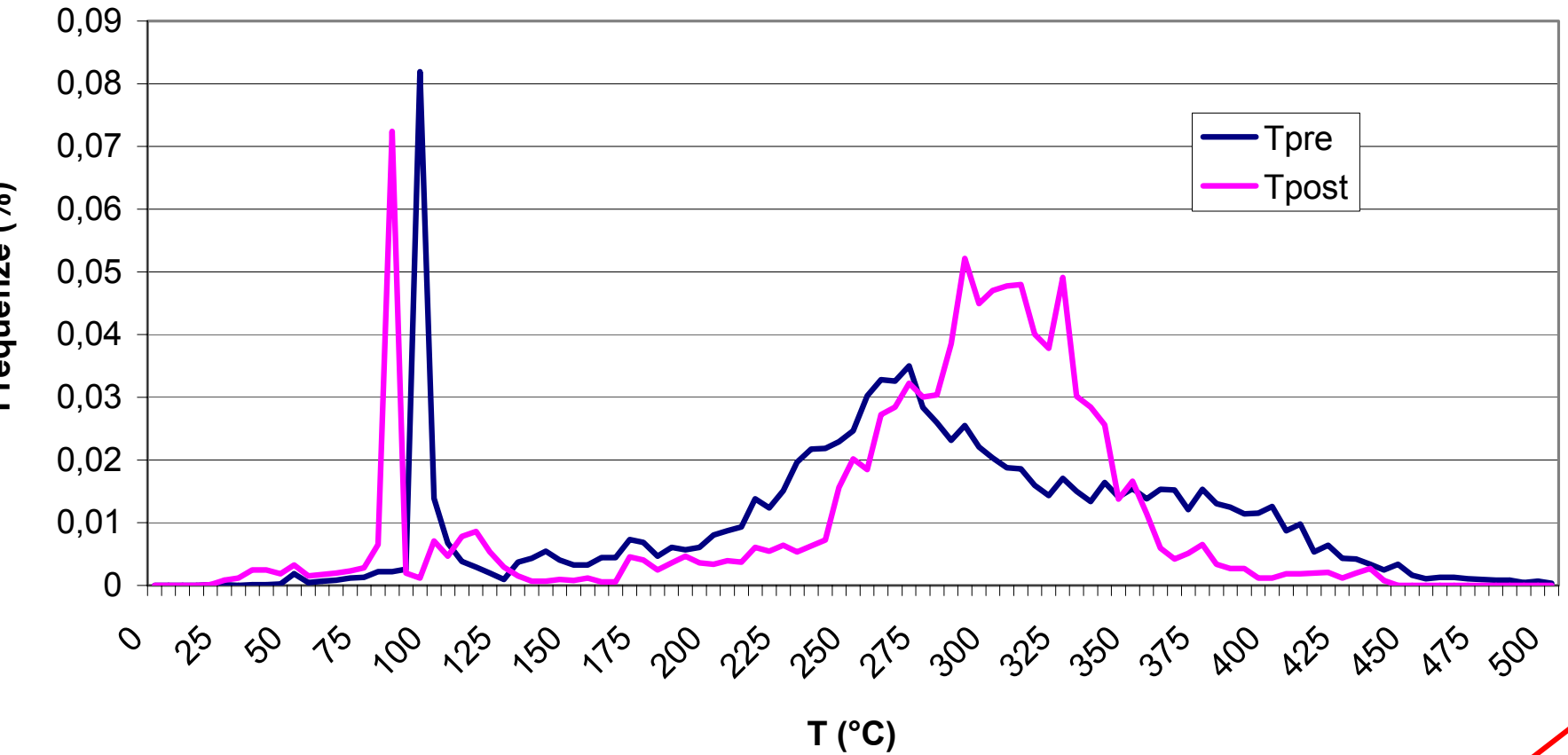
DEVELOPING PARTICULATE FILTER SYSTEMS

TEST ON FIELD - BUS APPLICATION:

- 7 lt. Iveco engine Euro 2 on Sub-urban application
- Constant monitoring dT,dP on road
- Regeneration from 270°C, pressure always below design limits
- 30.000 km covered by every bus with no inconvenience
- FBC CAM additive compared on field with existing products.
- Emulsified fuel Gecam™ (350ppm S) compared with std diesel (350ppm)

REGENERATING PROCESS

T frequency before and after Filter – the process is evident from 250°C and limited at 400°C.



CONCLUSIONS

HOW TO CUT PM AND PARTICLES FOR EXISTING VEICHLES:

- Using emulsified fuels alone the reduction is about 50%.
- DPF give comparable emissions to CNG Vehicles, new support materials and FBC additive give enough warranty with very low initial cost.
- Service, cleaning and maintenance may be sold to users
- No Sulphur constrain would help the large diffusion before 2008
- **EU Legislation on Nanoparticles may lead National and Regional Authorities to promote Retrofit programs for clean fuel and Filters.**

Thank you for attention

From

Carlo A. Bertoglio