

Nano-particle Emissions Characteristics with Metal Foam Gasoline Particle Filter (GPF) for Turbo-charged Gasoline Direct Ignition Vehicle on FTP-75

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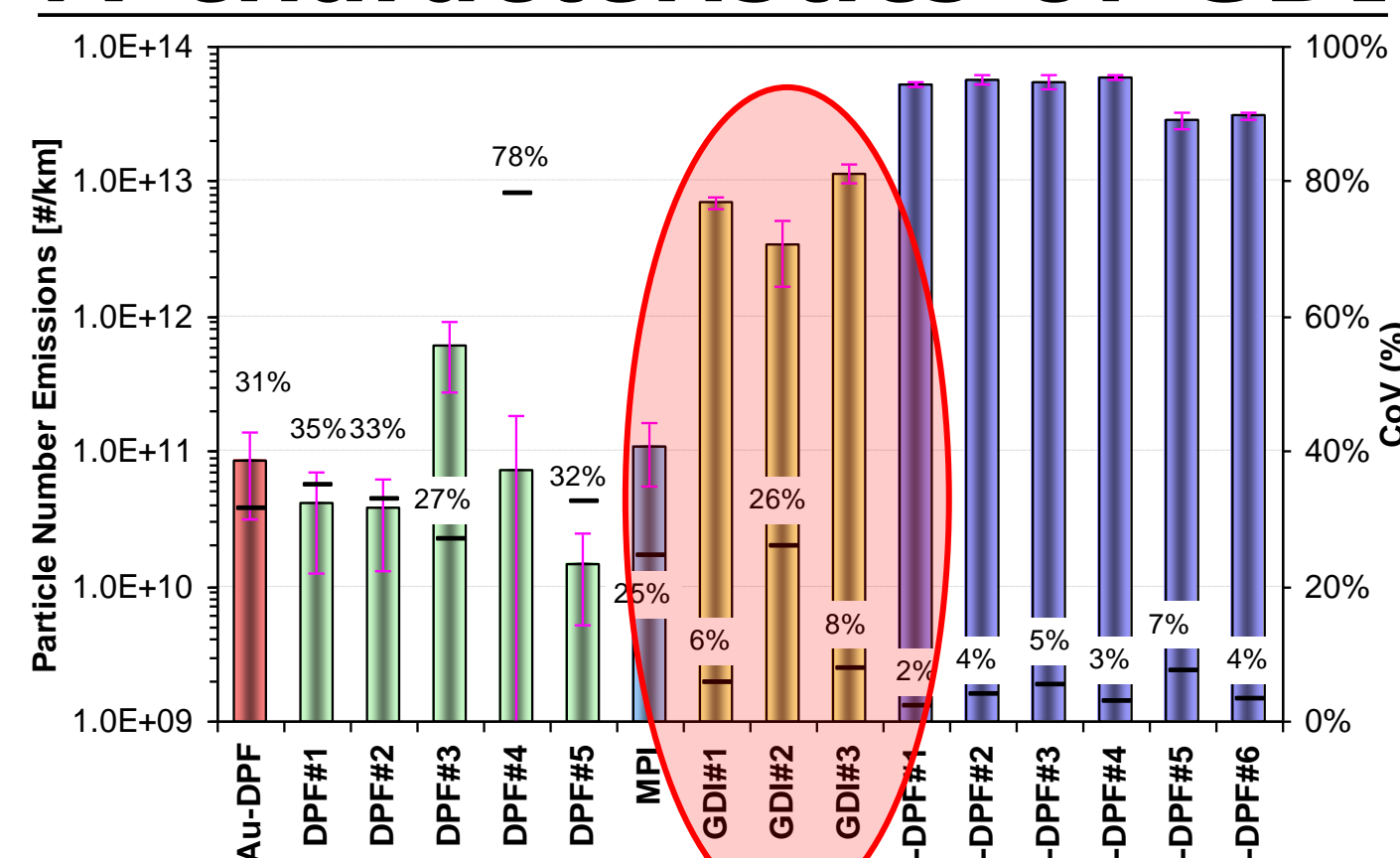
Introduction

➤ Main Global environmental issue about GDI vehicle

⇒ Particulate Matter (PM)

- Locally rich A/F mixture in cylinder
- Wall-wetting phenomena by direct injection with high pressure
 - Cylinder wall and Piston crown

➤ PN characteristics of GDI



➤ Necessity solution against stringent emission legislation for PM

Experimental Apparatus

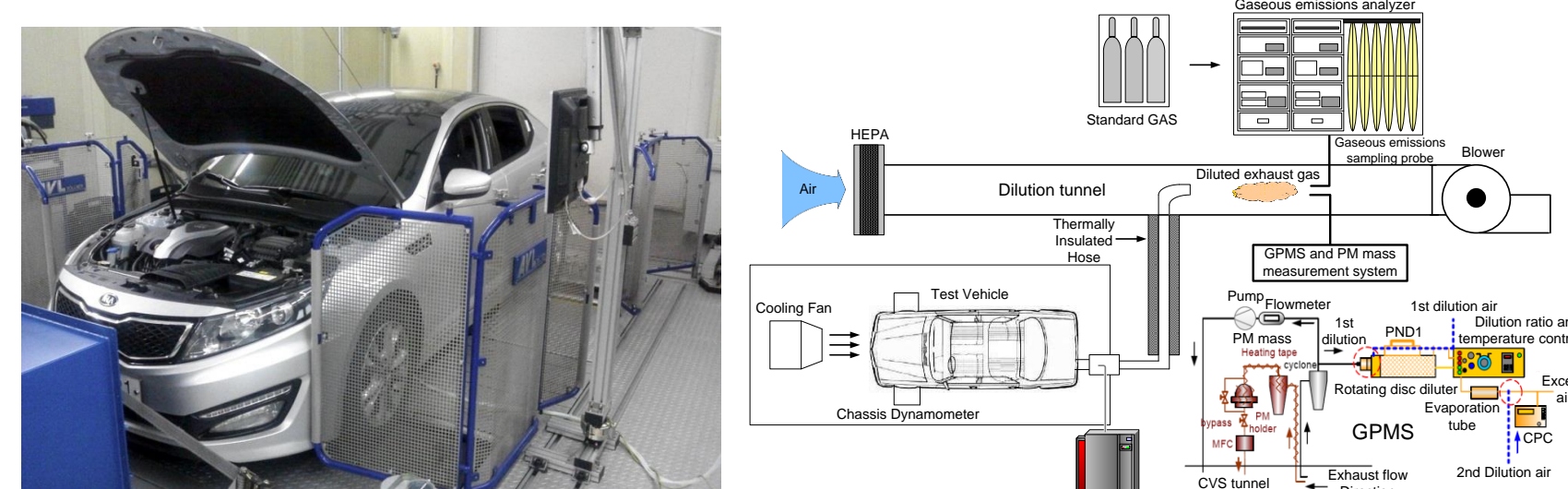
Test Vehicle Specifications



Engine Type	I4 DOHC Turbo-charged GDI
Displacement	1,998 cc
Compression ratio	9.5 : 1
Fuel system	Camshaft-driven high pressure pump
Exhaust system	Under-floor catalytic converter
Fuel economy (km/l)	12.8
CO ₂ emission(g/km)	183
Unloading weight (kg)	1,520

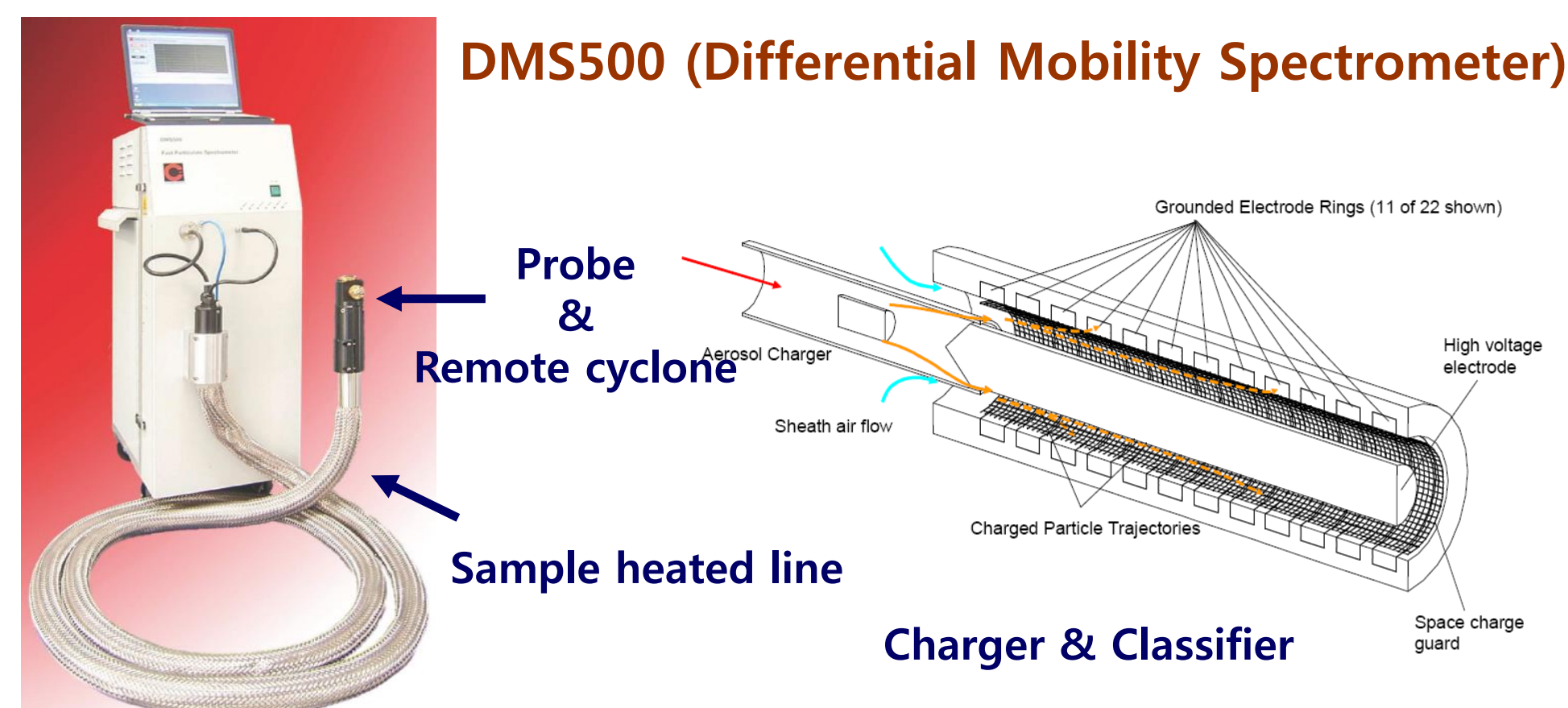


Vehicle test schematic diagram

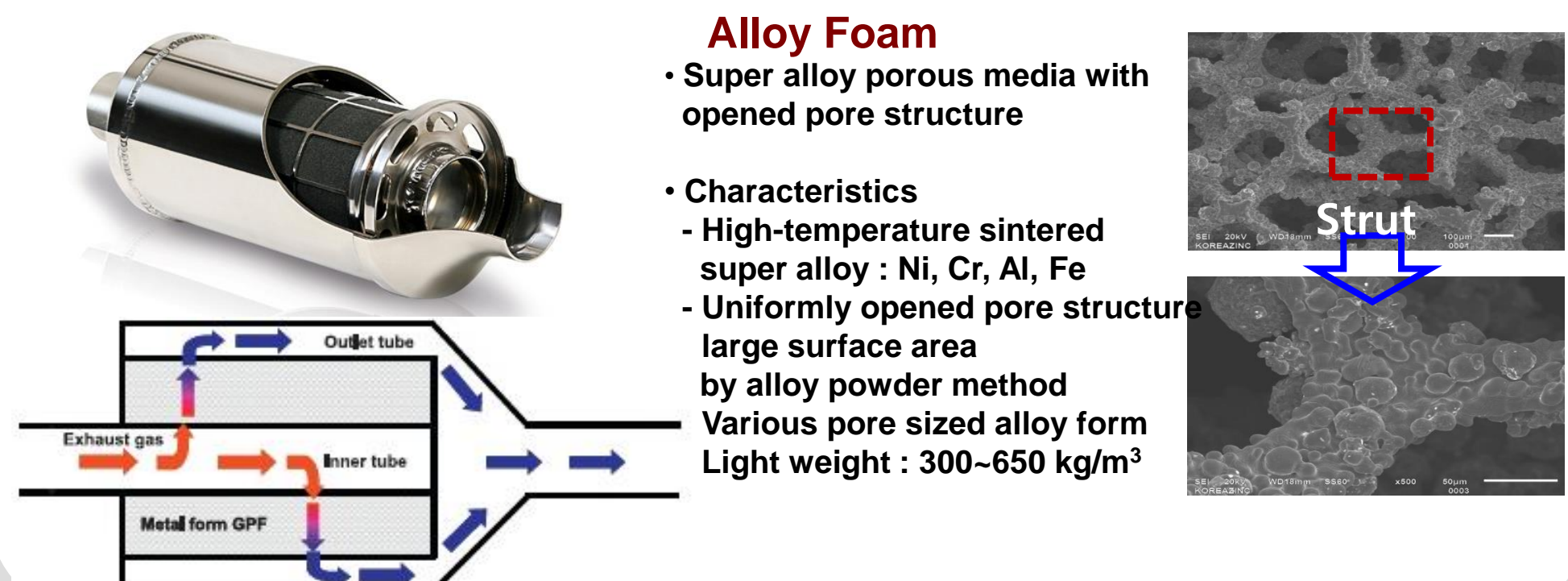


➤ Driving Cycle for Test → FTP-75 (EPA Federal Test Procedure)

Nano-particle measurement system

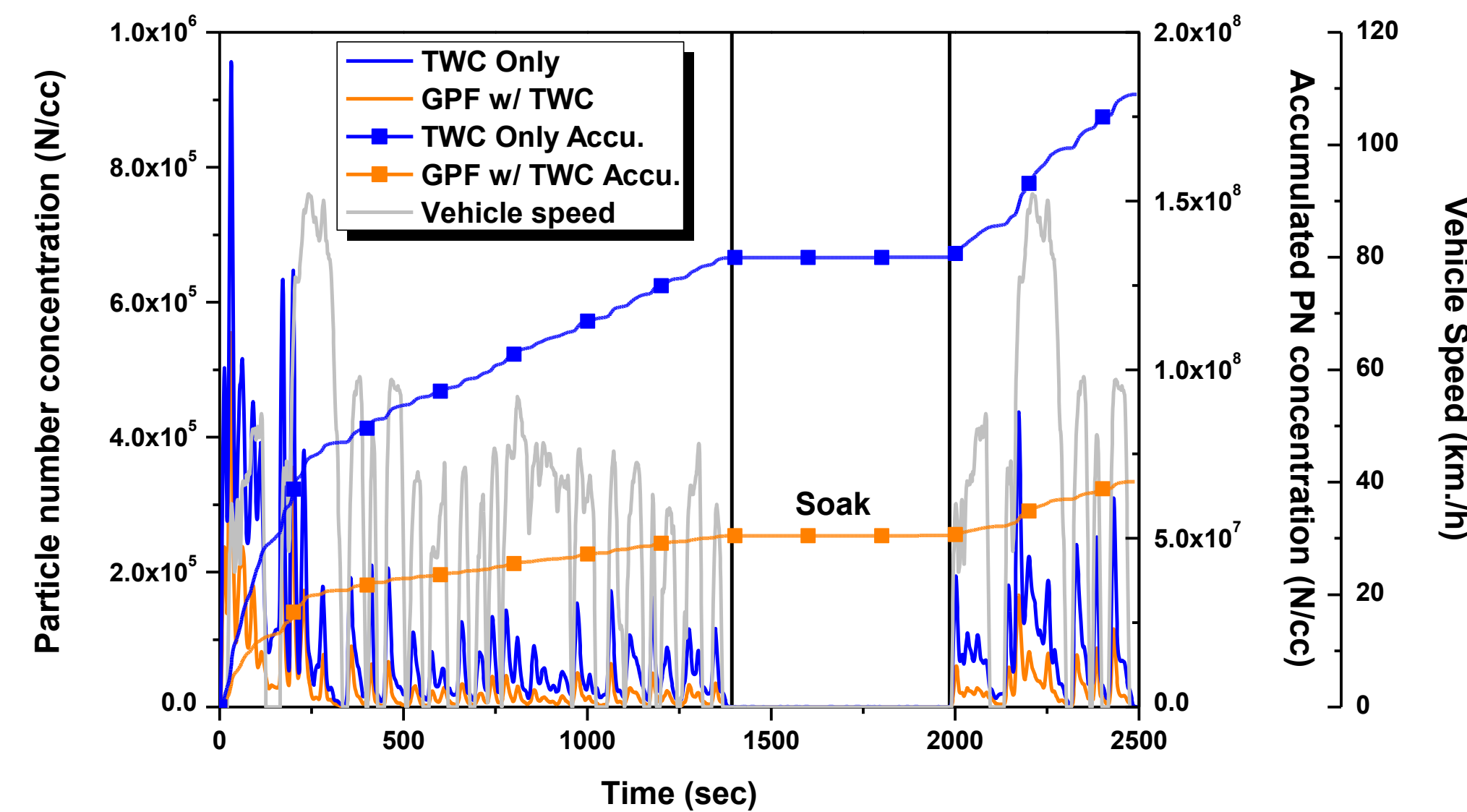


Metal-foam Gasoline Particulate Filter (GPF)

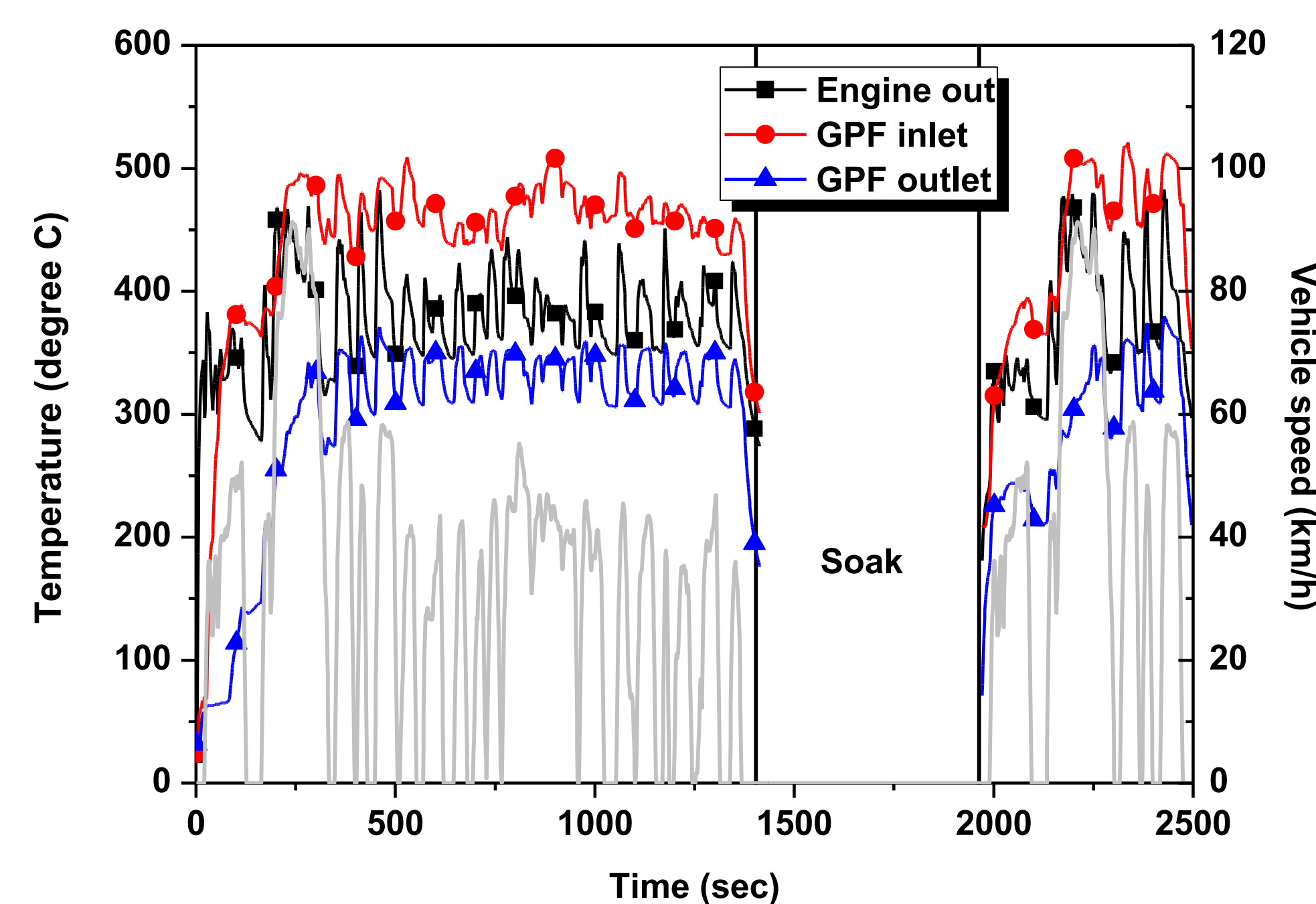


Vehicle Test

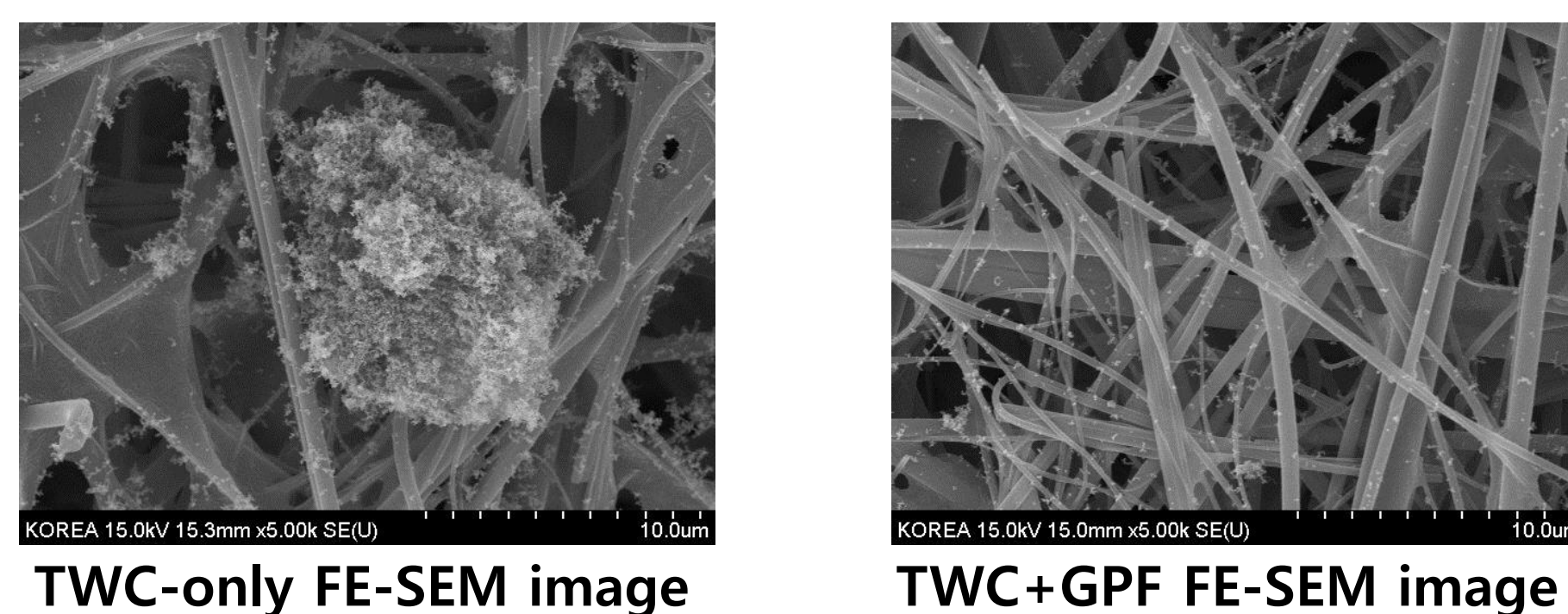
Time-resolved Particle Emissions on FTP-75



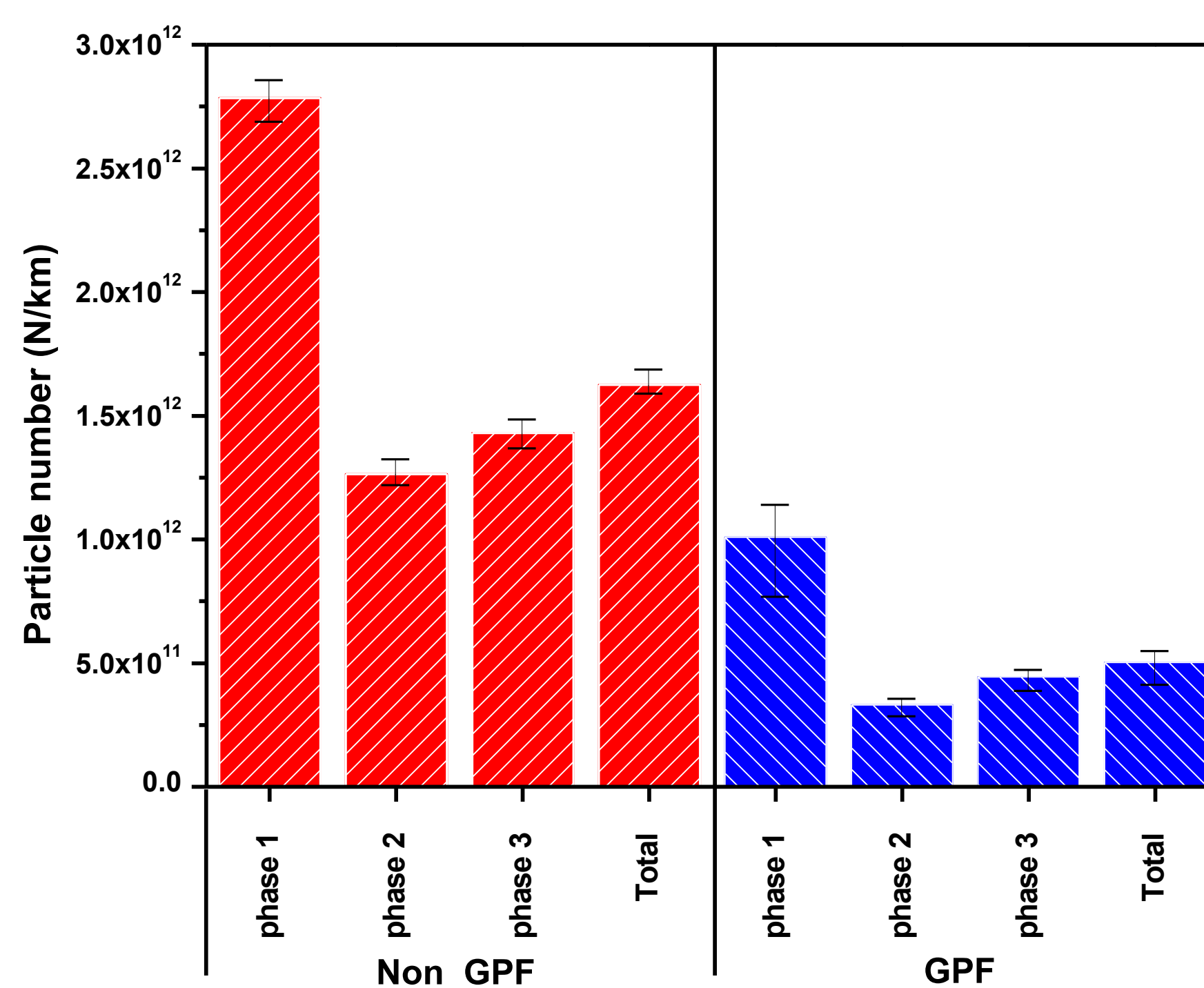
Temperature of Exhaust system



FESEM images of Filtrated PM



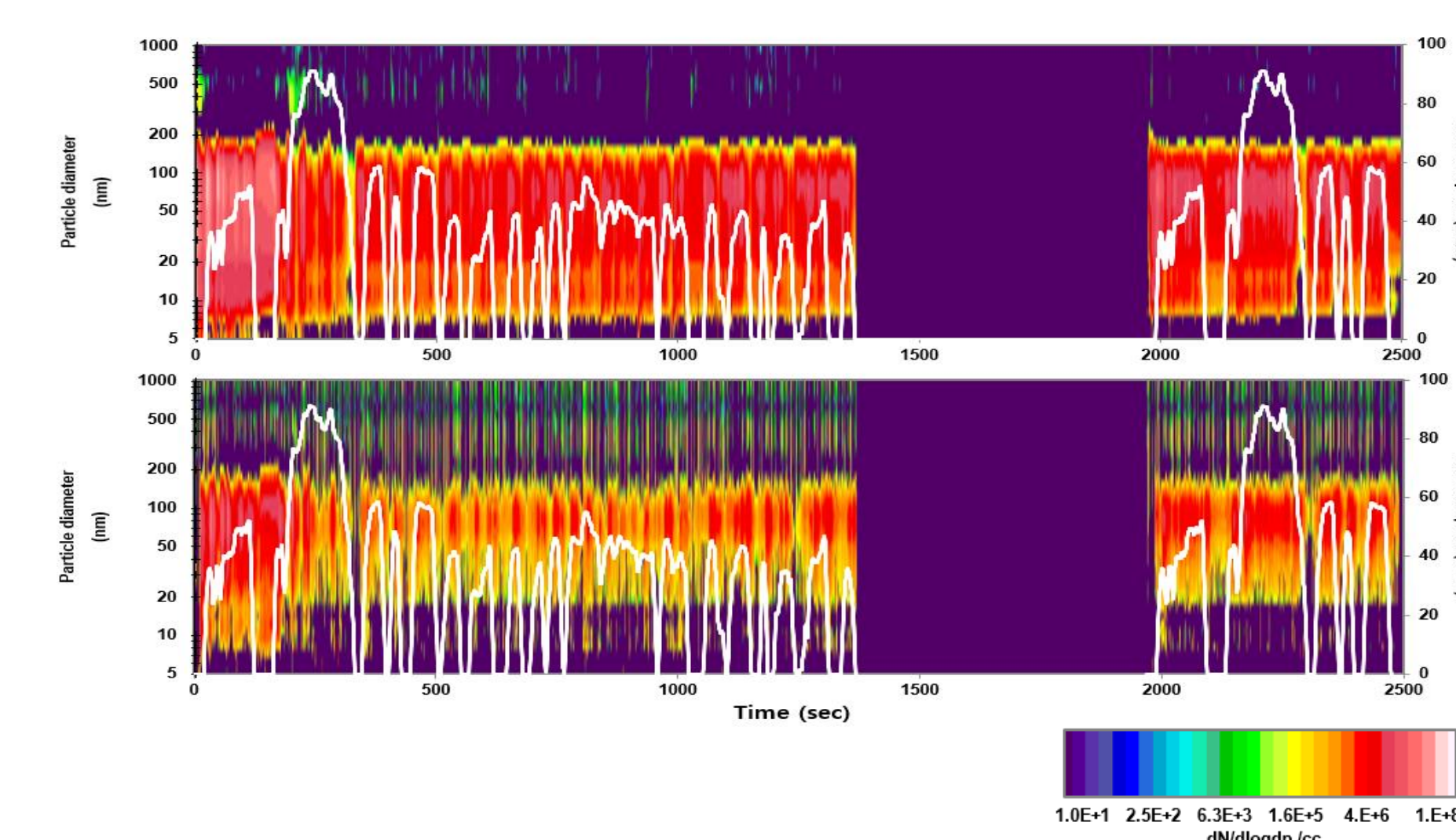
Particle number on FTP-75



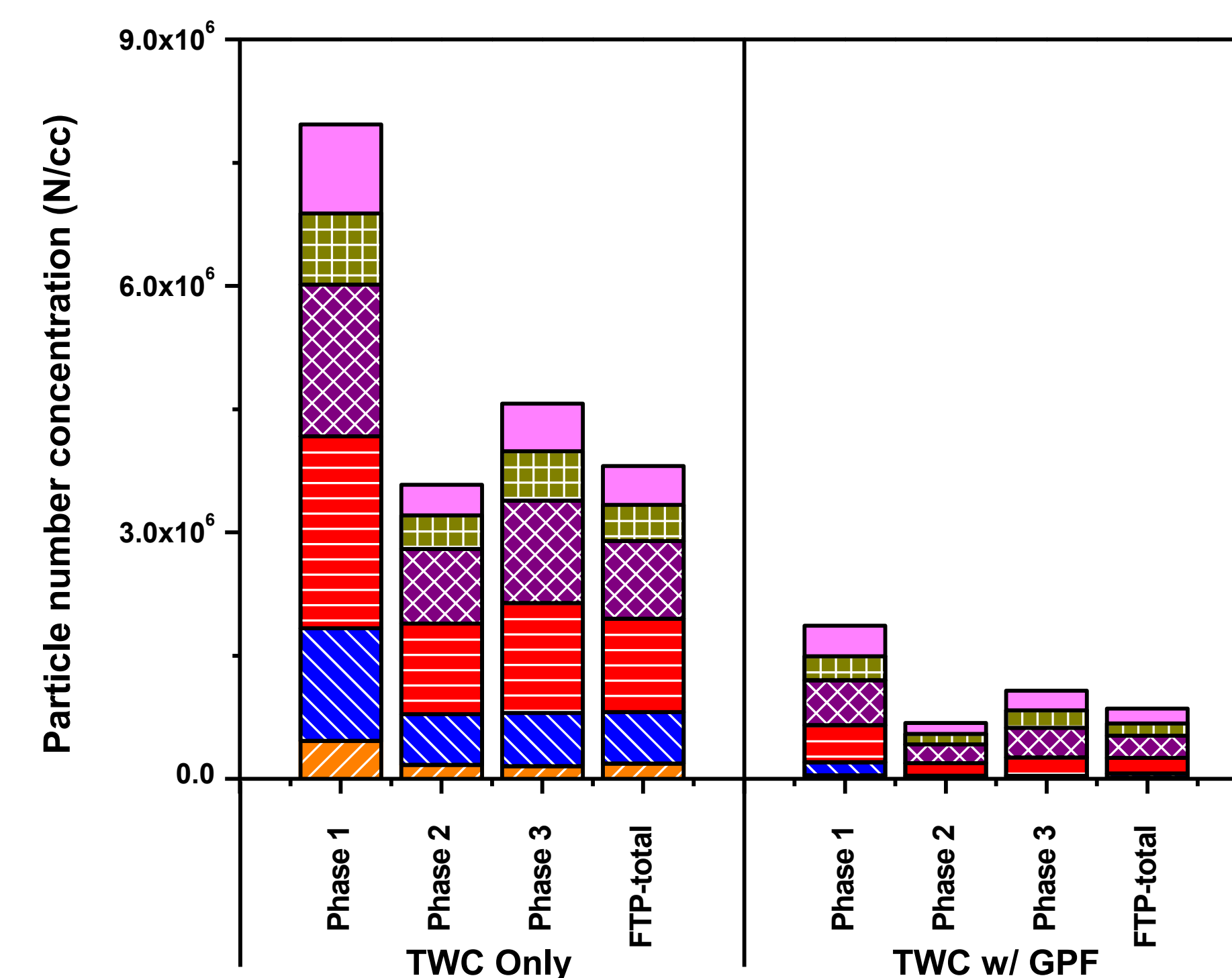
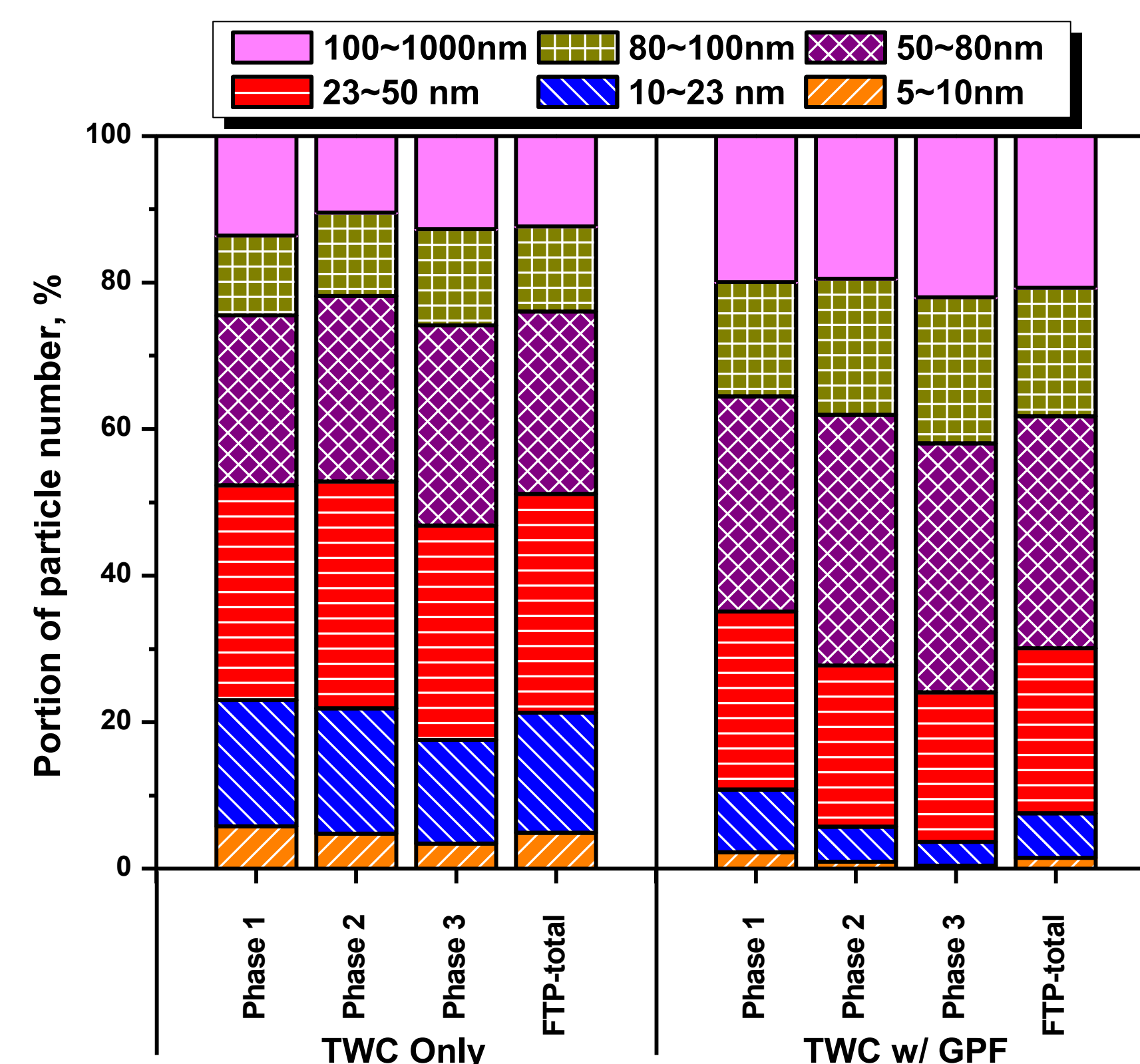
Nano-particle emission evaluation

	TWC-only		TWC+GPF		Filtration Eff.	
	PN [# /km]	PM [mg/km]	PN [# /km]	PM [mg/km]	PN [%]	PM [%]
Phase 1	2.77E+12	3.506	1.01E+12	1.603	59	59
Phase 2	1.29E+12	1.385	3.32E+11	0.923	72	43
Phase 3	1.46E+12	1.913	4.44E+11	0.724	68	77
FTP-weighted	1.64E+12	1.970	5.02E+11	1.009	67	59

The Concentration Spectrum during FTP-75



Size resolved particle number fraction



Conclusion

■ Nano-particle emission evaluation

- Tested GDI vehicle was evaluated PN emission characteristics with filtration efficiencies.
- Particle number emissions were reduced up to 67% under FTP-75 mode by GPF
- In the FE-SEM image, it was clearly distinguished that GPF system could drastically reduce nano-particles
- Temperature of Exhaust gas was reached about 450°C and this characteristics has possibility of regeneration during fuel-cut period.

■ Size-resolved characteristics

- Sub-50nm particles were decreased about 20% between TWC-only and TWC+GPF system.
- TWC only vehicle emits 1.64E+12 N/km of nano-particles, which exceeds EURO 6 regulation.
- Dominant point of generated nano-particles is cold start phase of vehicle mode.
- Applying GPF could reduce PN emissions of GDI vehicles, and this point could satisfy future stringent nano-particle regulation.