

Diesel Soot Pollution in School Buses & Benefits of Retrofit Emissions Controls

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According to NAPT, Riding to School on a Bus is the Statistically Safest Way to Get to School...but is it the Healthiest?





**A number of studies have documented
cabin air pollution in school buses...**


**But is it roadway pollution or is the bus
polluting itself?**





Our research shows that cabin pollution can come from both the roadway and the bus itself.

But in quiet residential areas with no nearby diesels, spikes in cabin pollution at bus stops confirms significant self-pollution



**Most Importantly, This Study
Demonstrates that Retrofit Emissions
Controls can Virtually Eliminate Diesel
Soot Self-Pollution from Schools Buses**



Goals

- **Investigate causes of PM pollution on conventional school bus;**
- **Retrofit same buses to assess cabin benefits.**

Measurements / Instrumentation

Particle Parameters Measured:

- **PM2.5-Fine Particles**
- **Ultrafine Particles**
- **Carbon Soot**
- **Particle Toxics /PAH**



Methods:

Lead Car is Control



Methods, cont'd:

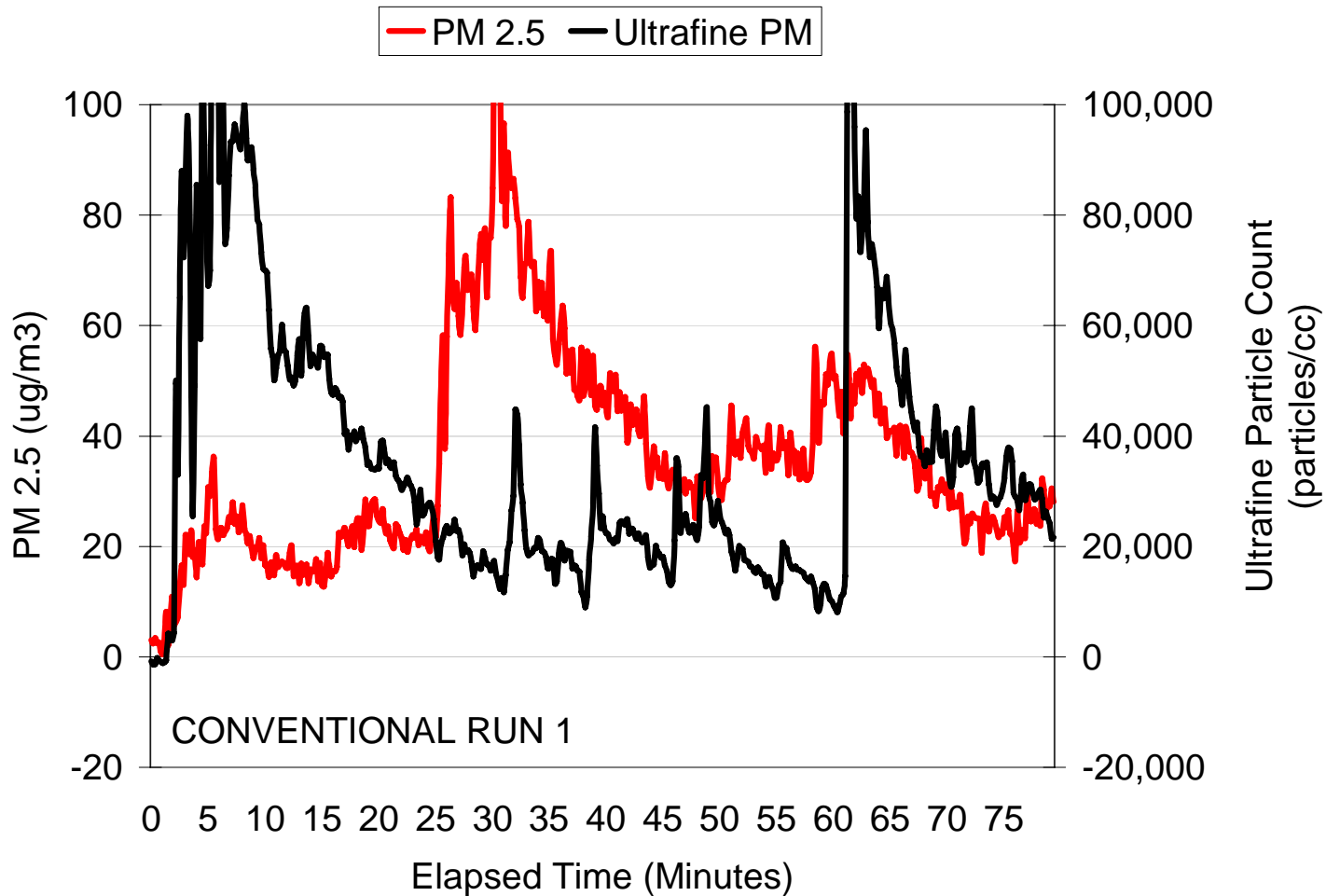
- **Buses: fleet mid-age and mileage;**
- **Bus windows up;**
- **'Typical' bus route selected by fleet mgr 12-20 one minute stops;**



Bus Retrofit Combinations Tested

City	Conventional	DPF	DOC	Spiracle	ULSD	CNG	Enviroguard	Biodiesel (B99)
Detroit/Ann Arbor MI	X							
Detroit/Ann Arbor MI					X			
Detroit/Ann Arbor MI				X	X			
Detroit/Ann Arbor MI			X					
Detroit/Ann Arbor MI		X						
Detroit/Ann Arbor MI		X			X			
Detroit/Ann Arbor MI		X		X	X			
Detroit/Ann Arbor MI			X	X				
Detroit/Ann Arbor MI						X		
Detroit/Ann Arbor MI		X			X		X	
Atlanta, GA	X							
Atlanta, GA		X			X			
Chicago, IL	X							
Chicago, IL		X			X			
Charlotte NC	X							
Charlotte NC			X					
Charlotte NC		X		X	X			
Charlotte NC				X				X
Charlotte NC				X				
Houston/Conroe	X							
Houston/Conroe		X						
Houston/Conroe		X		X	X			
Houston/Conroe				X				

Standard Bus (no controls) Substantial Cabin Pollution Multiples of Outdoor Particle Levels



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Ambient Subtracted

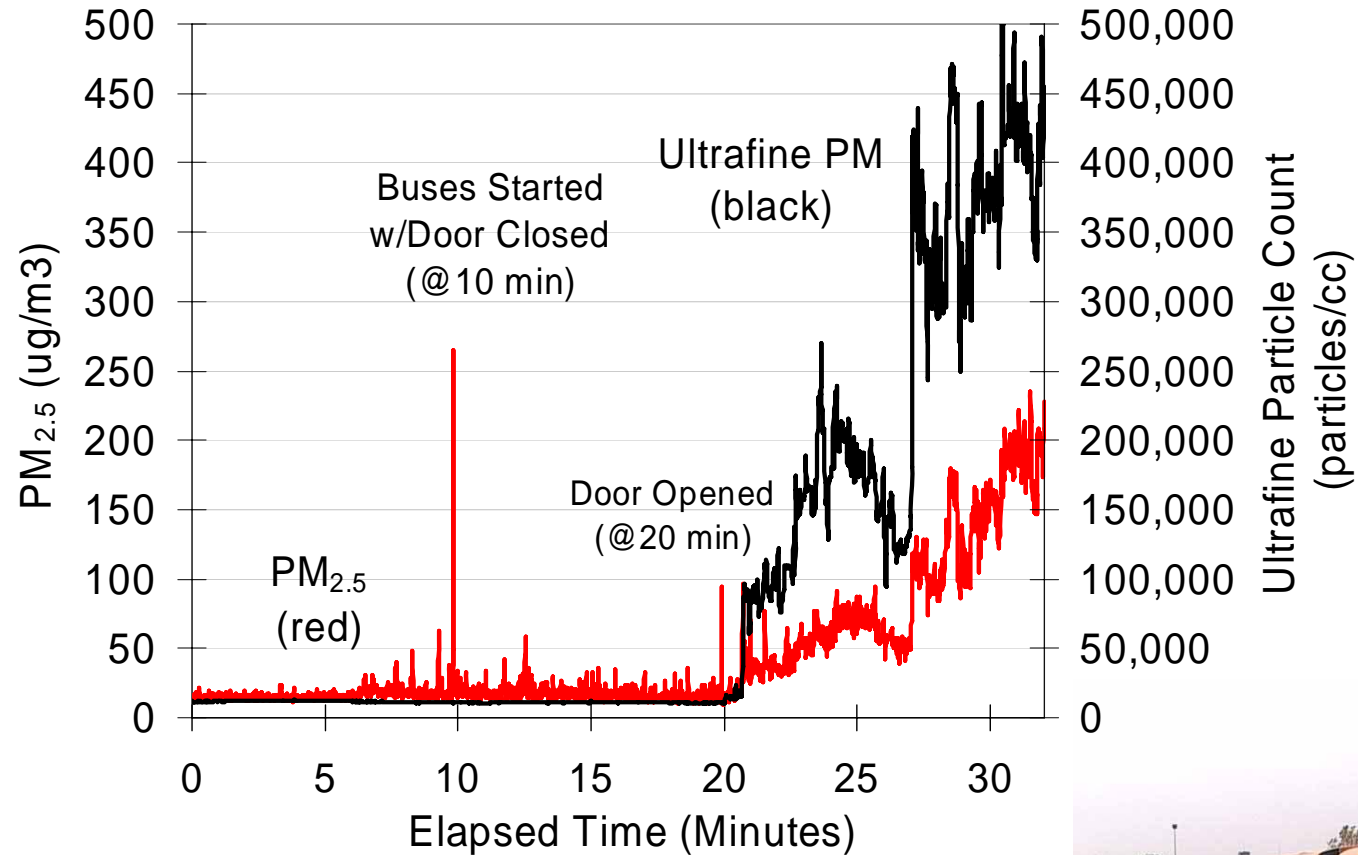
Uncontrolled bus leaves children and exhaust cloud behind at bus stop



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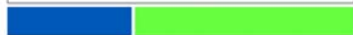
Immediate & Rapid Buildup of Cabin Pollution While Idling in Queue



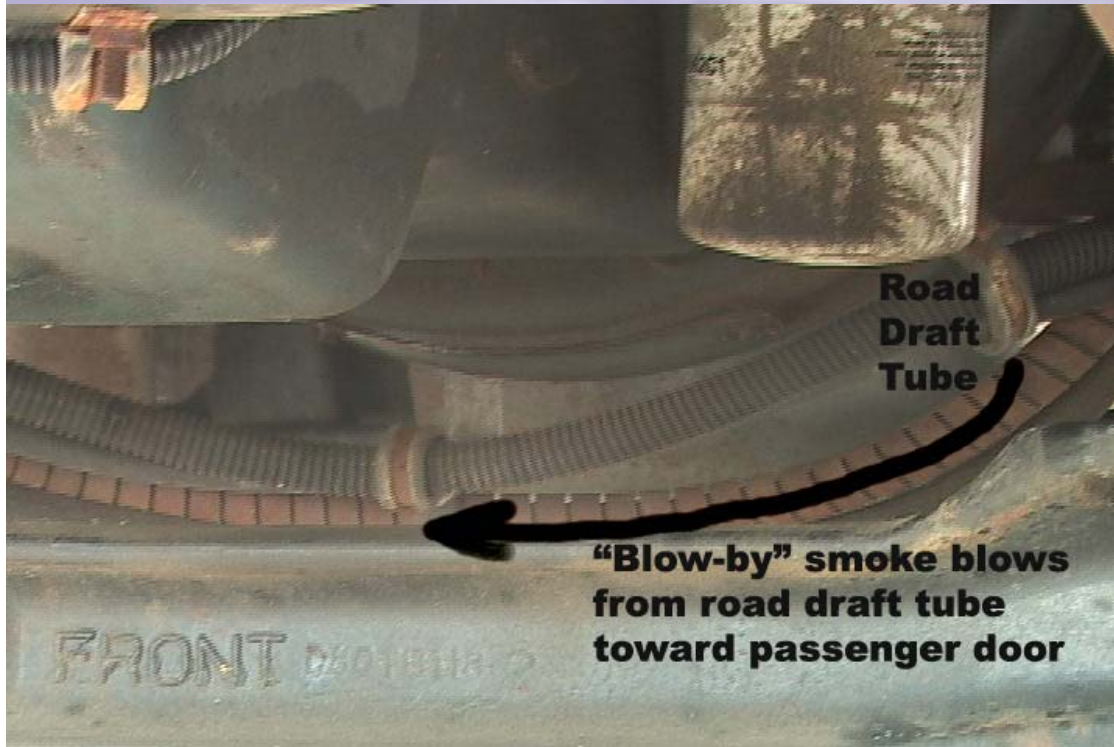
Where is the Cabin Pollution Coming From?



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Cabin Pollution Sources: Tailpipe & Crankcase



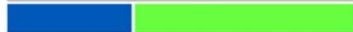
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Retrofit Tests



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Diesel Particulate Filter (DPF)



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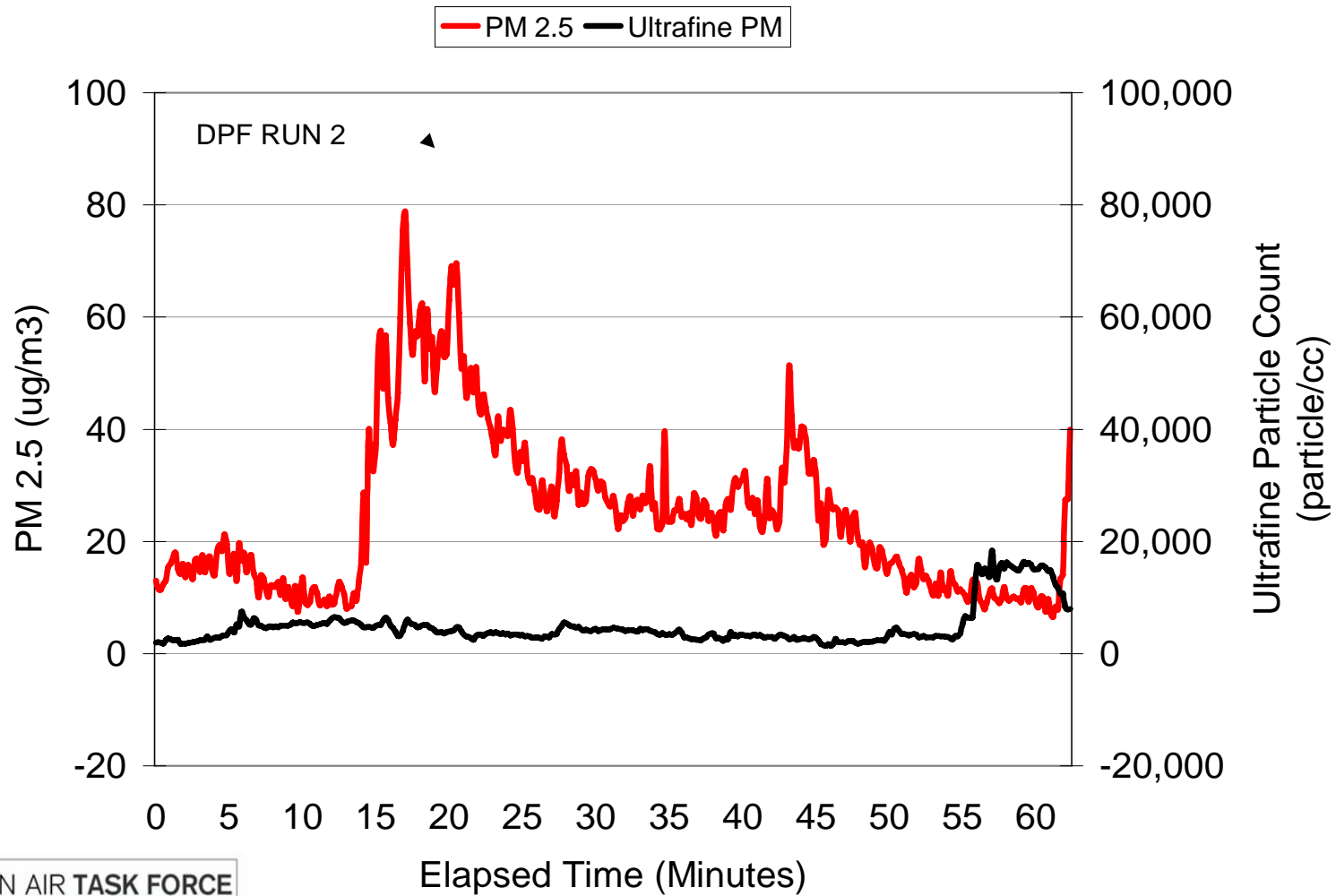
DPF is VERY effective at removing all particle types from Tailpipe



Tailpipe Retrofit Bus Leaves No Exhaust at Bus Stop. Eliminates self pollution.



Despite Tailpipe Filter, Fine Particle Pollution in Cabin

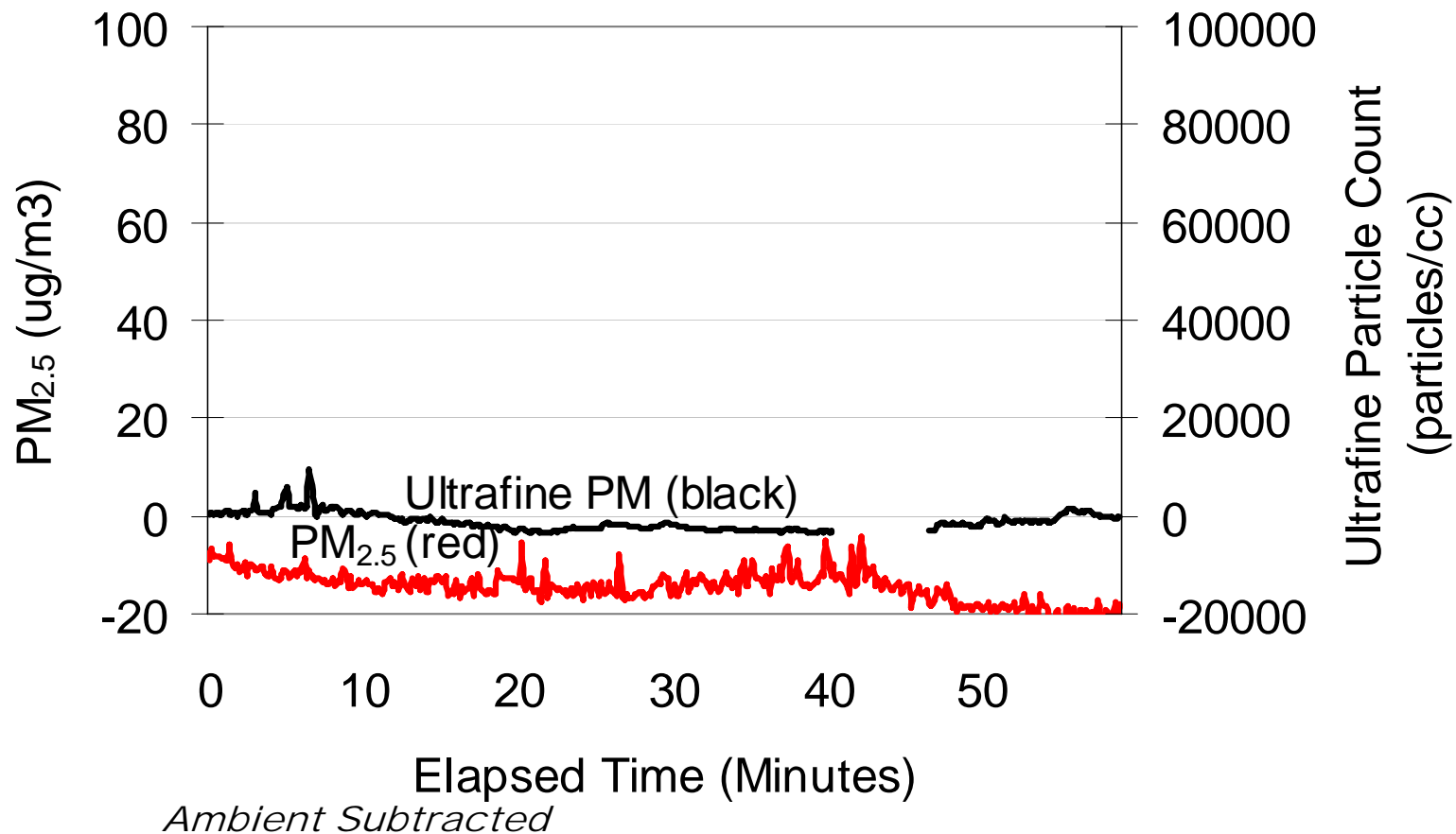


WHY? *Engine Crankcase*
Test: *Closed Crankcase Filtration (CCF)*



Complete Solution DPF-ULSD-CCF

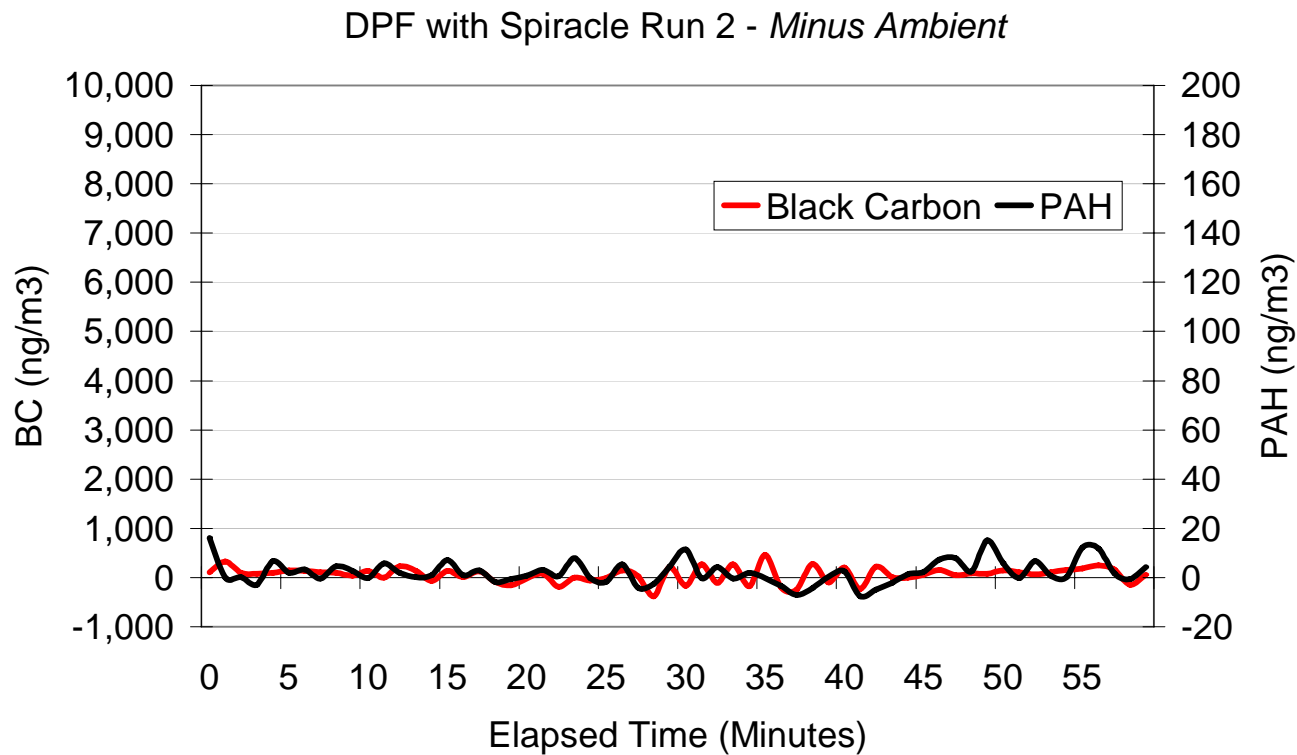
Ultrafine and Fine Particles Eliminated



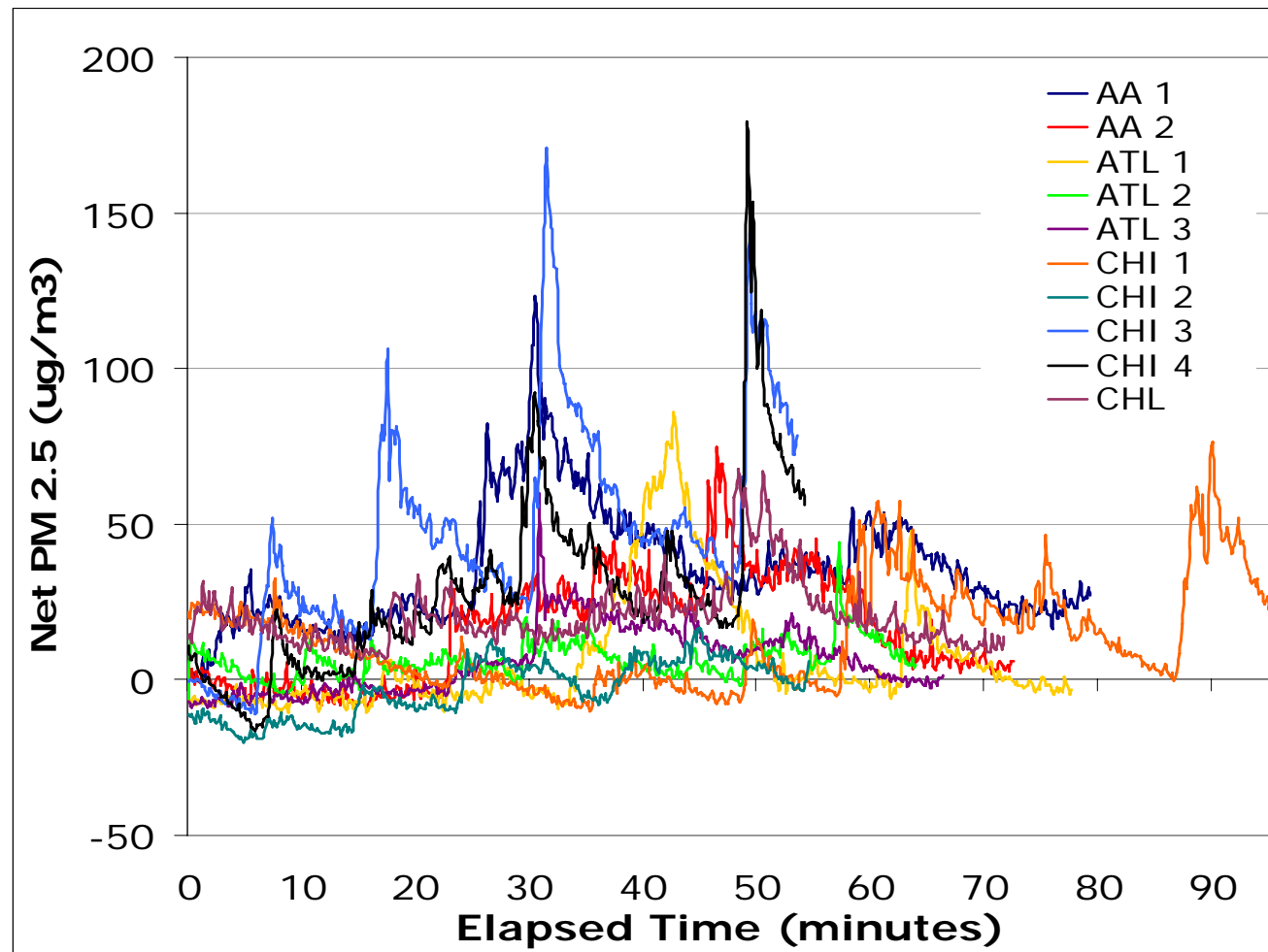
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DPF-ULSD-CCF: *Black Carbon Soot, Toxic Particles Also Eliminated*



Non-Retrofit Buses Fine Particles Elevated

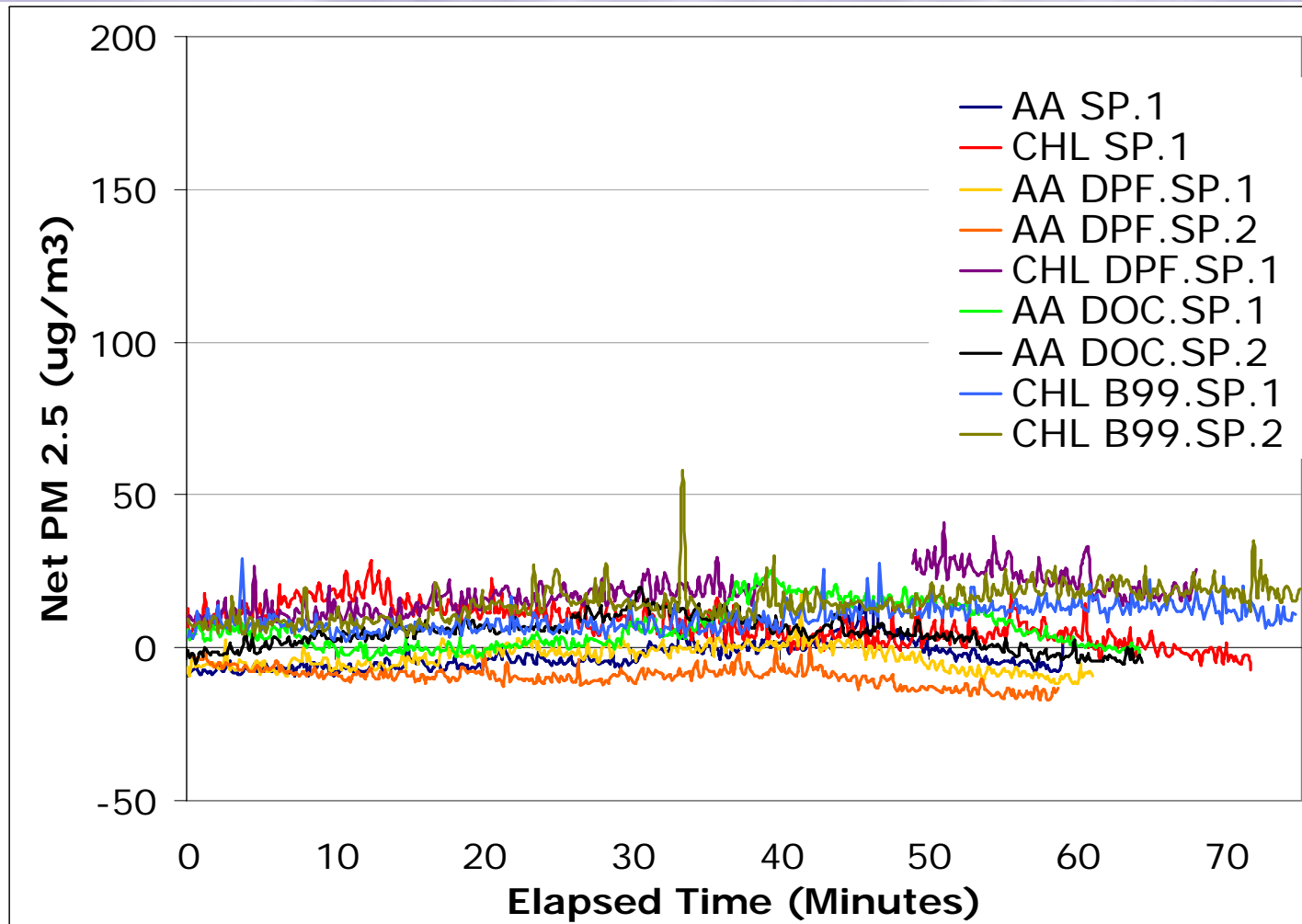


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All Buses w/ Closed Crankcase

Regardless of retrofit configuration, if bus has Spiracle CCF, PM_{2.5} is close to ambient in cabin



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Conclusions (in-cabin only)

- **Fine Particle source is dominantly engine crankcase (CCF is solution)**
- **Ultrafine, Black Carbon, Toxic Particle source is tailpipe (Removed by DPF)**
- **Ultimate Solution requires both a DPF and Closed Crankcase Filtration Device**





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White paper at:
<http://www.catf.us>

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