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CHARACTERIZATION OF A NON-CATALYST BASED DIESEL PARTICLE FILTER: PERFORMANCE AND EMISSION CONTROL

Shaohua Hu, Jorn Herner, William Robertson, M.-C. Oliver Chang, Tao Huai,
John Collins, Harry Dwyer, and Alberto Ayala



CARB'S HEAVY-DUTY VEHICLE EMISSIONS LABORATORY



Collaborators,
co-sponsors,
and in-kind
contributors

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 California Energy Commission

 CALIFORNIA DEPARTMENT OF TRANSPORTATION




OBJECTIVES

- Compare non-catalyst based DPF (NCB-DPF) with baseline emissions and with catalyst based DPF for different driving cycles
- Examine effects on
 - Gas phase species
 - PM mass and size distribution
 - PM composition
 - Oxidative potency (toxicity related)

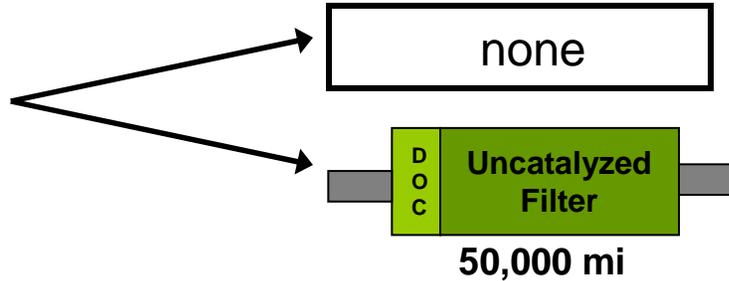
TEST MATRIX

Vehicle

Aftertreatment

Abbreviation

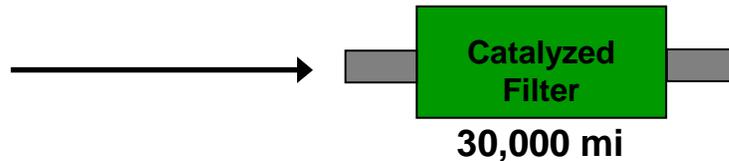
- Veh#1, 1998 Cummins Diesel (11L, 360,000 miles)



Baseline

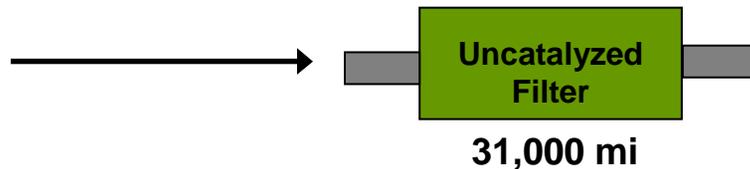
Veh#1 CRT®

- Veh#2, 1999 International Diesel (7.6L, 40,000 miles)



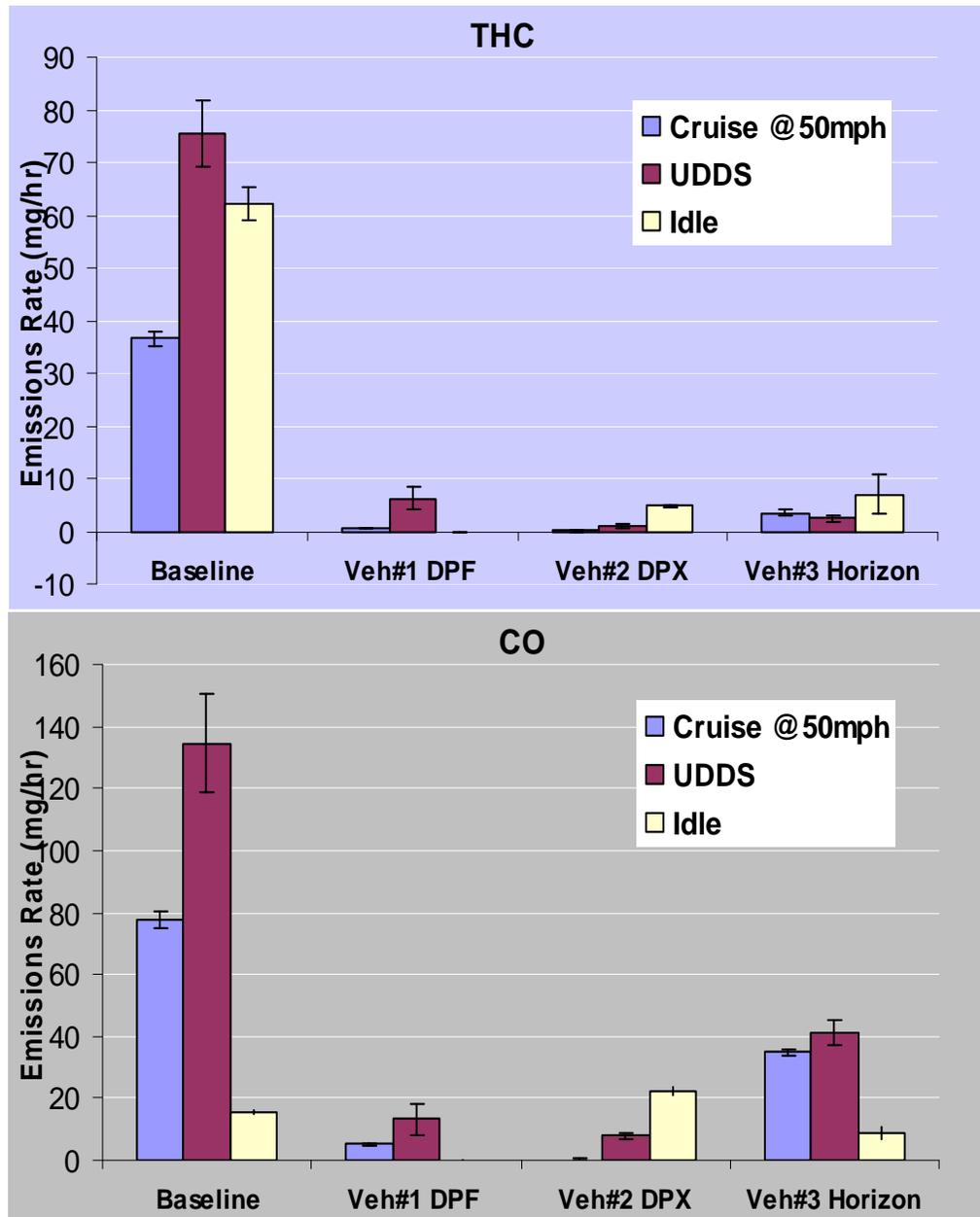
Veh#2 DPX

- Veh#3 2003 Cummins Diesel (5.9L, 50,000 miles)



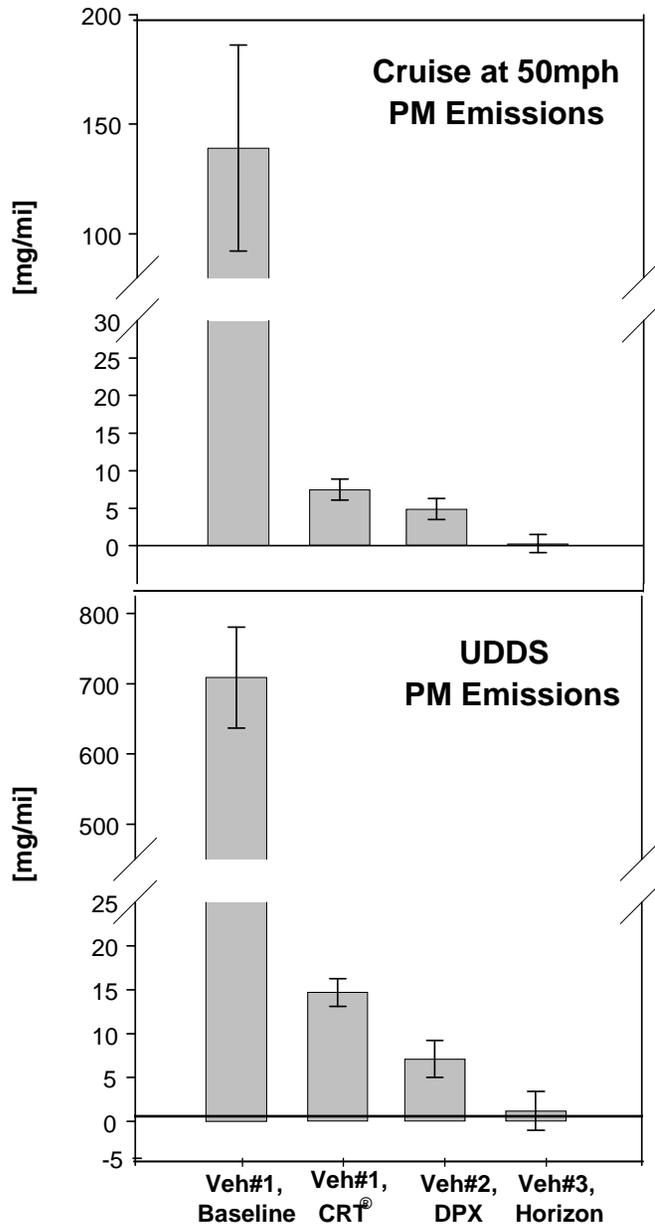
Veh#3 Horizon

GAS PHASE SPECIES

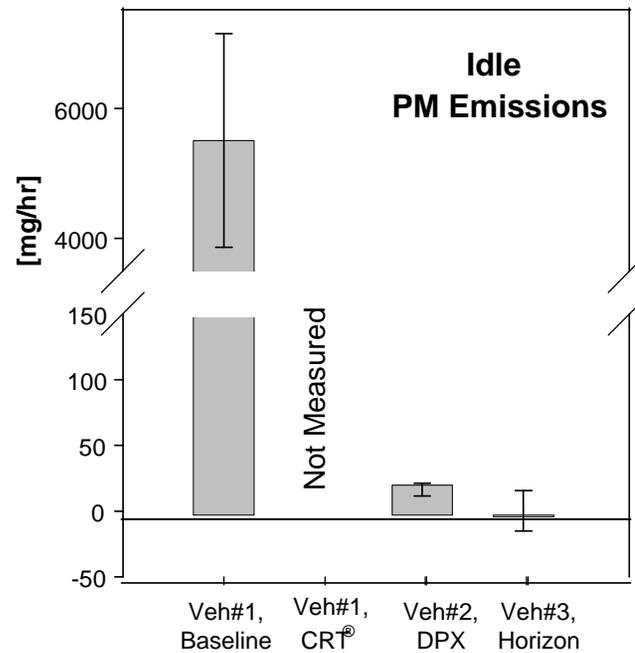


- They both are easily oxidized to the final complete combustion products, H₂O and CO₂
- The emissions can be predicted by
 - Exhaust temperature and
 - the amount of catalyst in the aftertreatment.
- Because its newer and smaller engine, THC and CO emissions from the uncatalyzed Veh#3-Horizon
 - LOWER than Baseline;
 - BUT, 1-2 orders of magnitude GREATER than catalyzed aftertreatment.

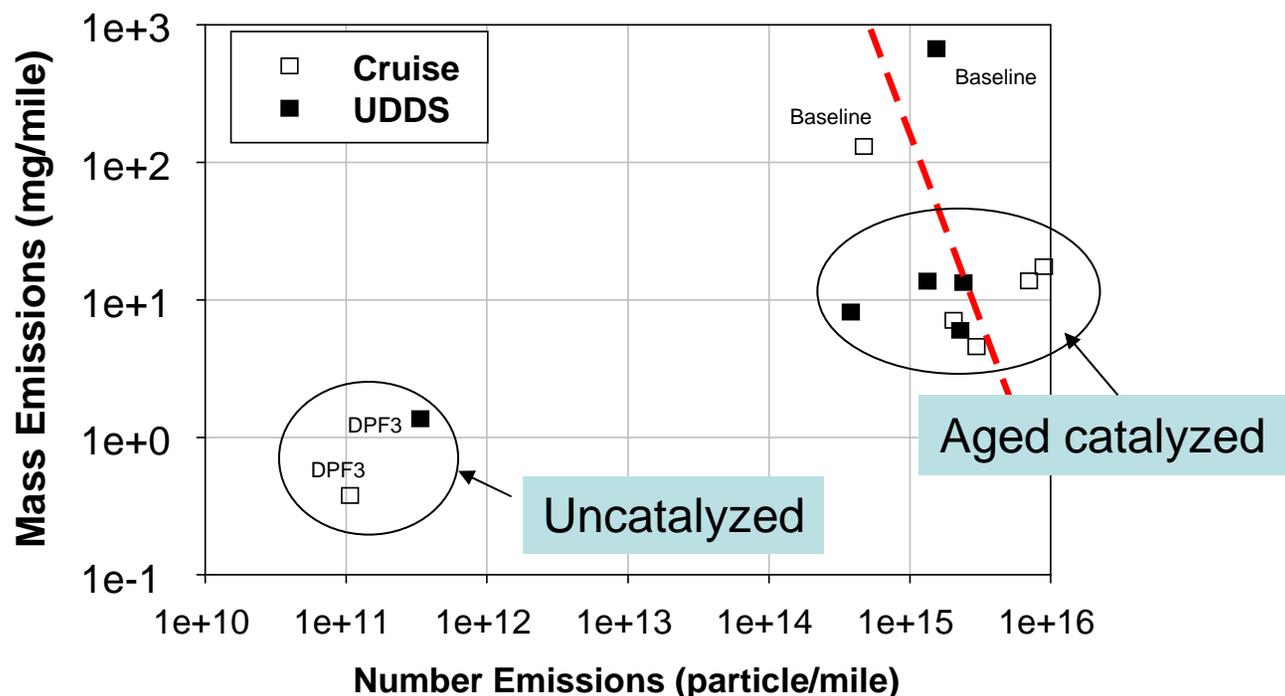
PARTICULATE MATTER MASS



- The average PM emissions for Veh#3 Horizon (NCB-DPF) configuration was very low during all the testing cycles.



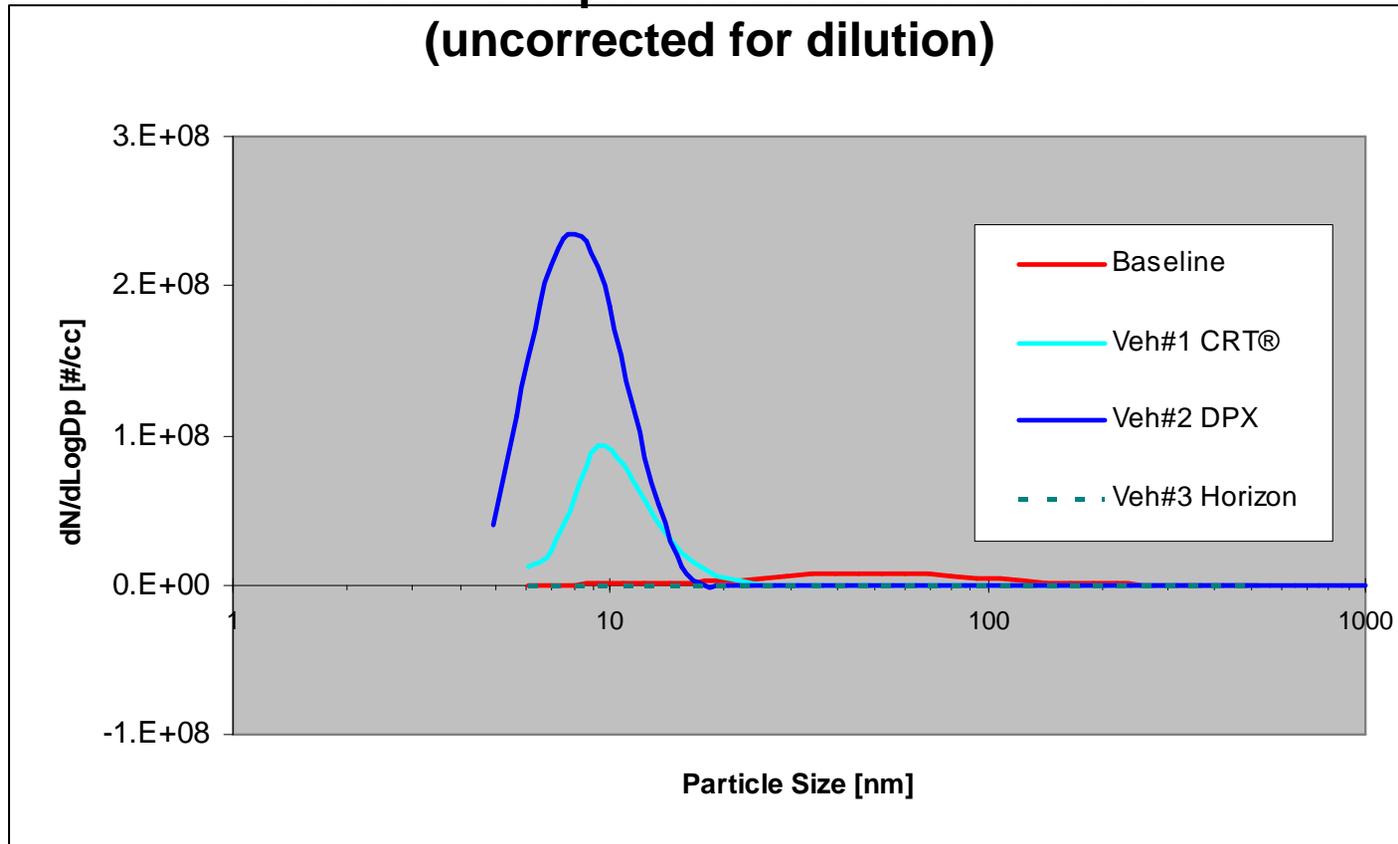
ULTRAFINE PARTICLE



- Retrofits lead to lower particle mass, but sometimes higher ultrafine particle number.
- Exhaust **temperature** promotes substantial formation of nanoparticles for well-broken-in **catalytic** devices.

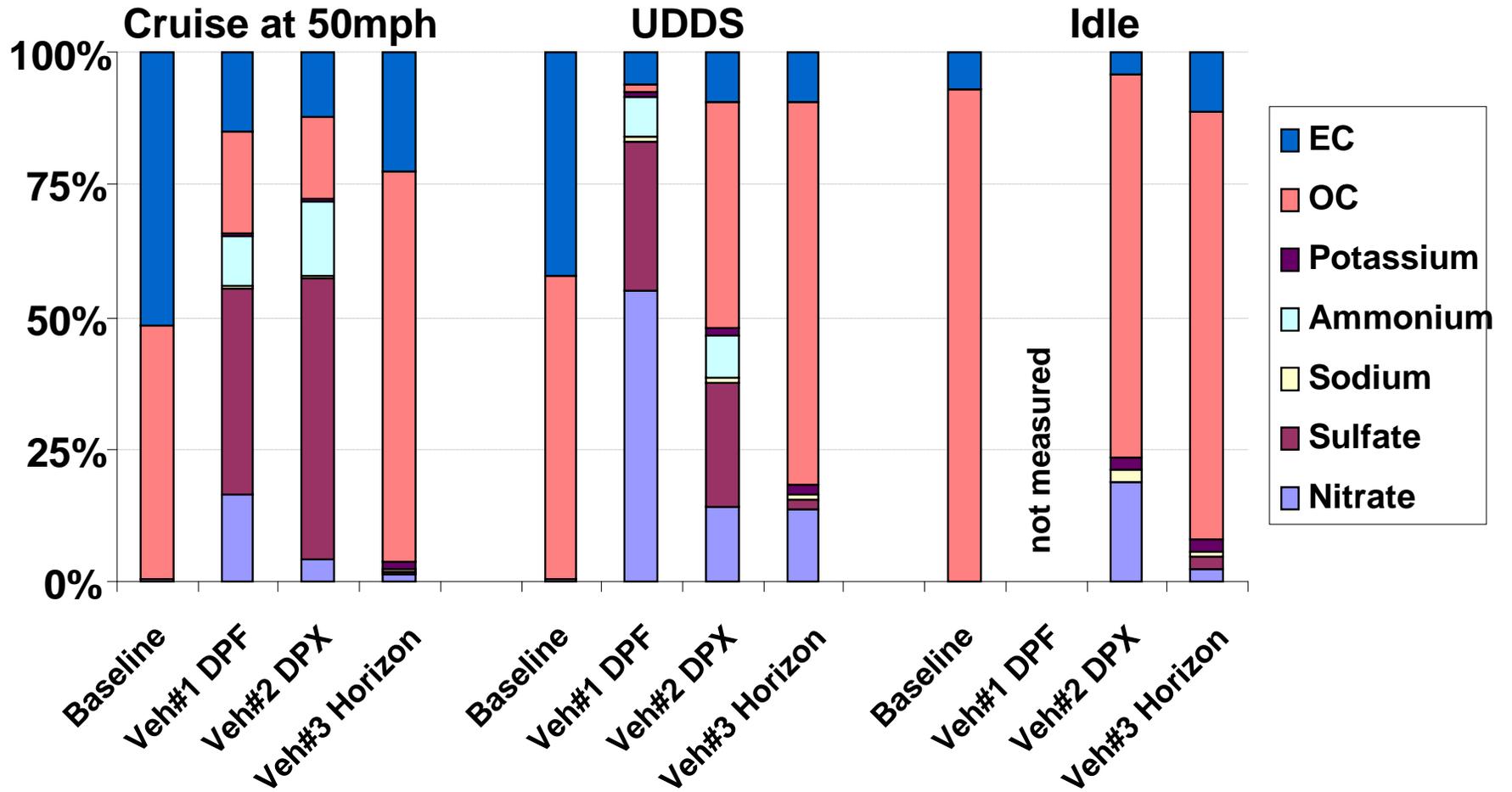
AVERAGE SIZE DISTRIBUTION

Cruise at 50mph - Measured in the CVS
(uncorrected for dilution)

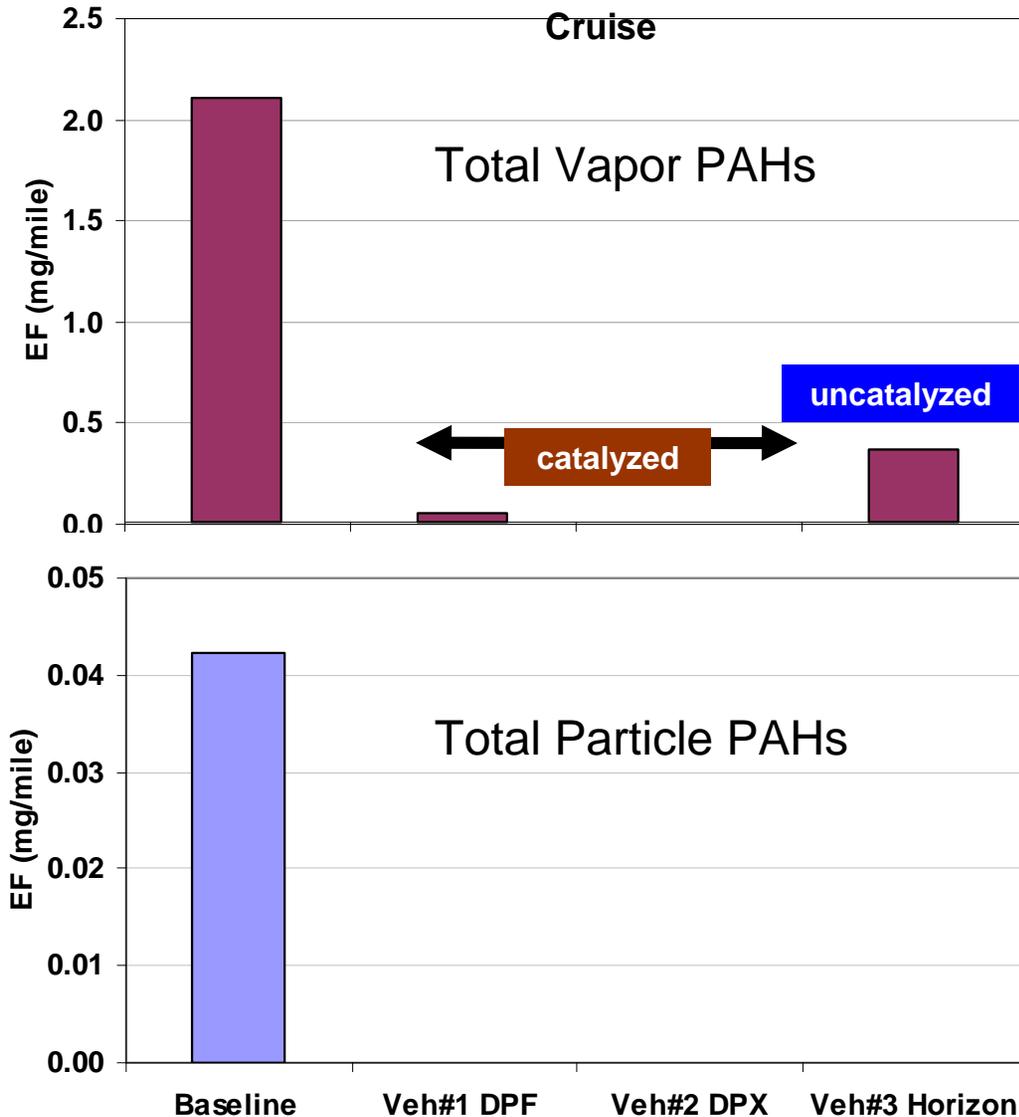


- Accumulation mode seen in: Baseline
- Nucleation mode seen in: Veh#1 CRT® and Veh#2 DPX
- No nucleation mode in: Baseline and Veh#3 Horizon

PARTICLE COMPOSITION

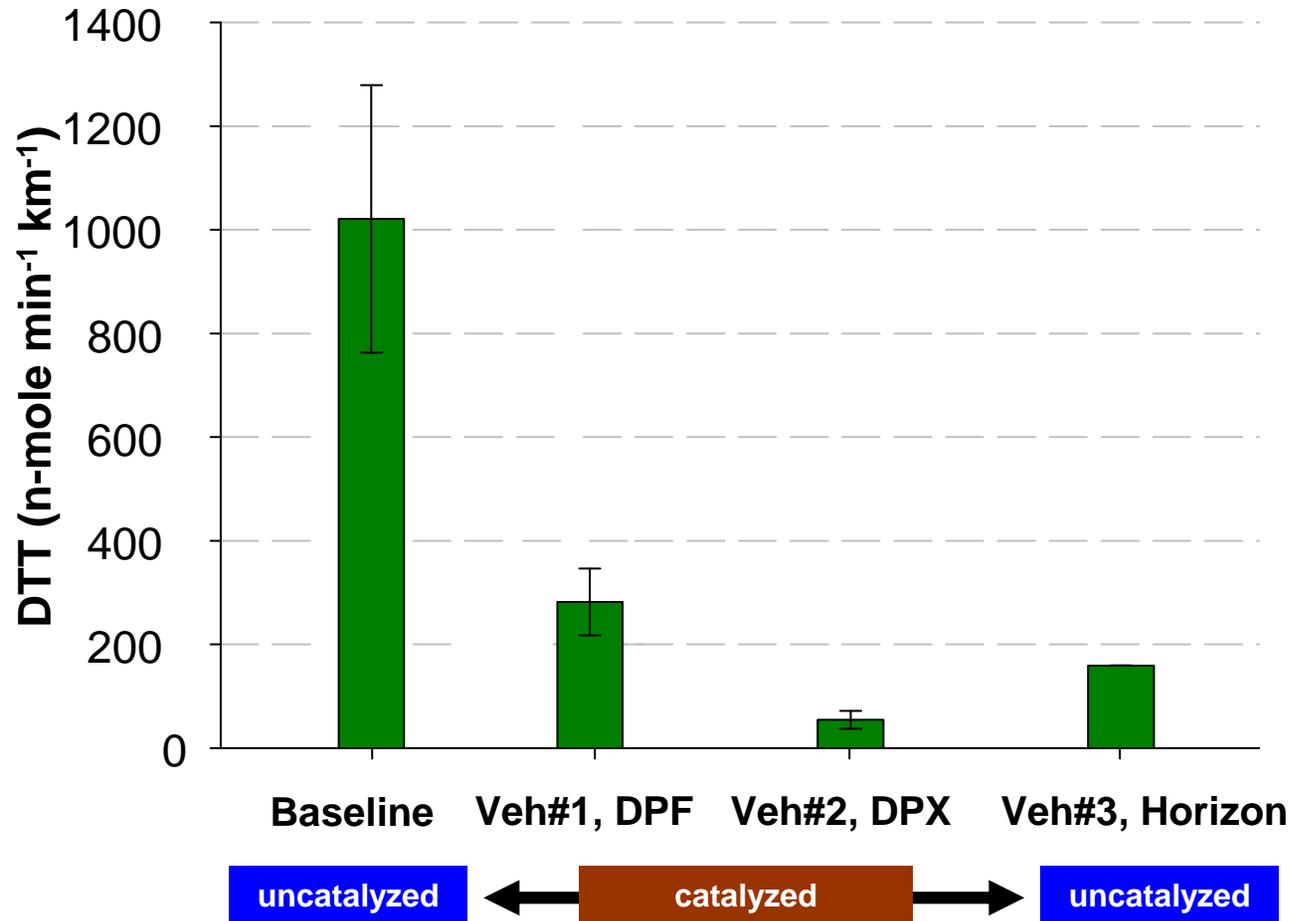


PAHs ARE EFFECTIVELY REDUCED BY RETROFITS

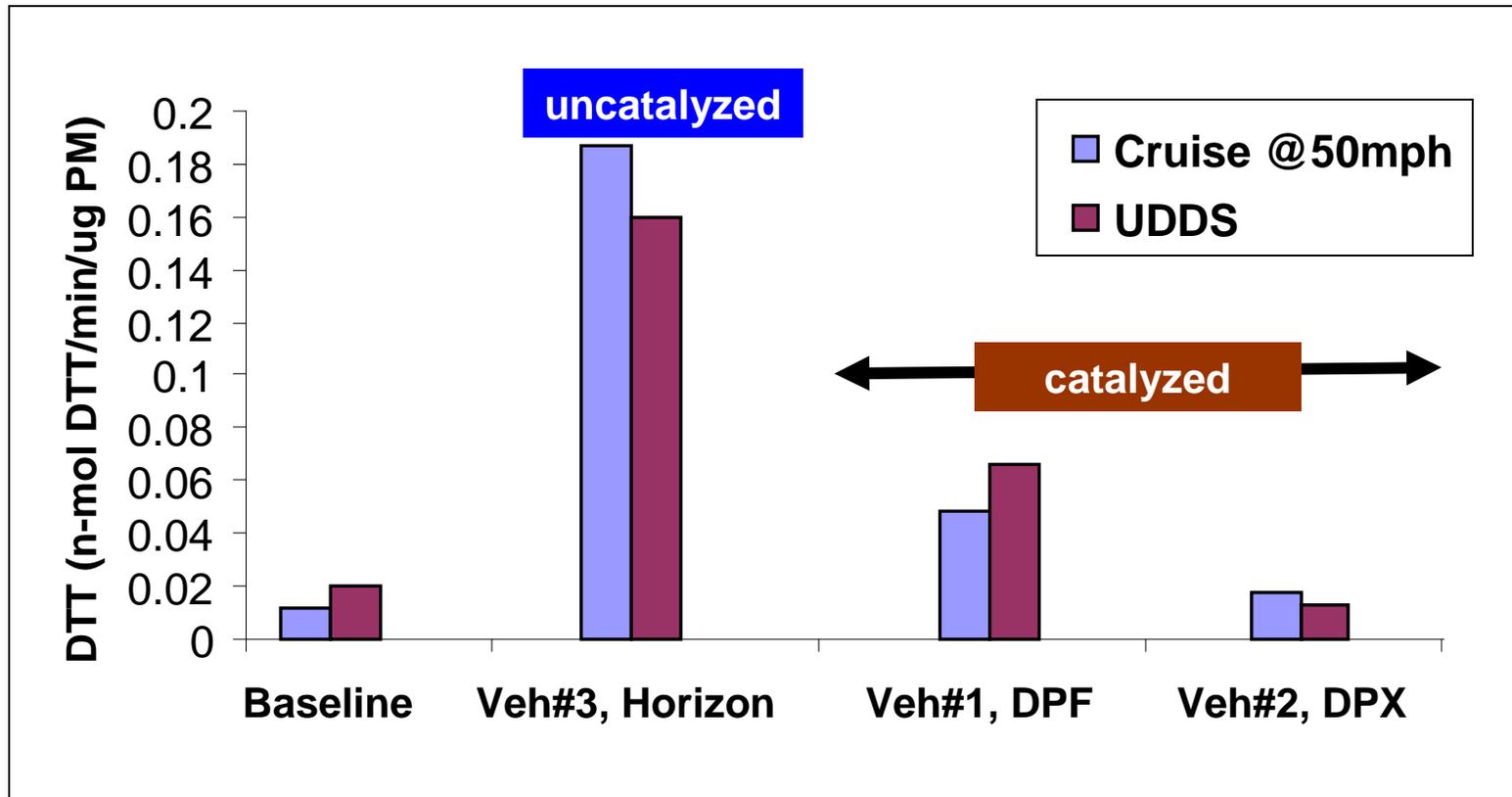


- Vapor phase PAHs dominate the total PAHs
- All DPFs significantly reduce both Particle and Vapor PAHs
- Uncatalyzed DPF are less effective than catalyzed based DPF at removing vapor PAHs

OXIDATIVE STRESS POTENTIAL OF TOTAL PM PER DISTANCE DRIVEN IS REDUCED BY RETROFITS



OXIDATIVE STRESS POTENTIAL OF TOTAL PM PER PM MASS



- DTT activity expressed per PM mass, was seen at a relatively high level for emission controls with non-catalyzed substrate

CONCLUSIONS FOR NCB-DPF

- PM emission reduction (>99%) is not affected by driving cycle (temperature)
- Nucleation mode particles not emitted in any driving cycle
- Emissions have higher THC, CO, and OC/PM fraction than catalyst based DPF during aggressive driving (hot catalyst)
- Oxidative potency per mile is reduced 90%, but oxidative potency per unit mass is higher than baseline or catalyst based DPF

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USC

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