Investigating mini-PEMS measurement uncertainties

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Outline

- Why mini-PEMS?
- Scope – technologies for gaseous emissions
- Capabilities
- Areas for improvement

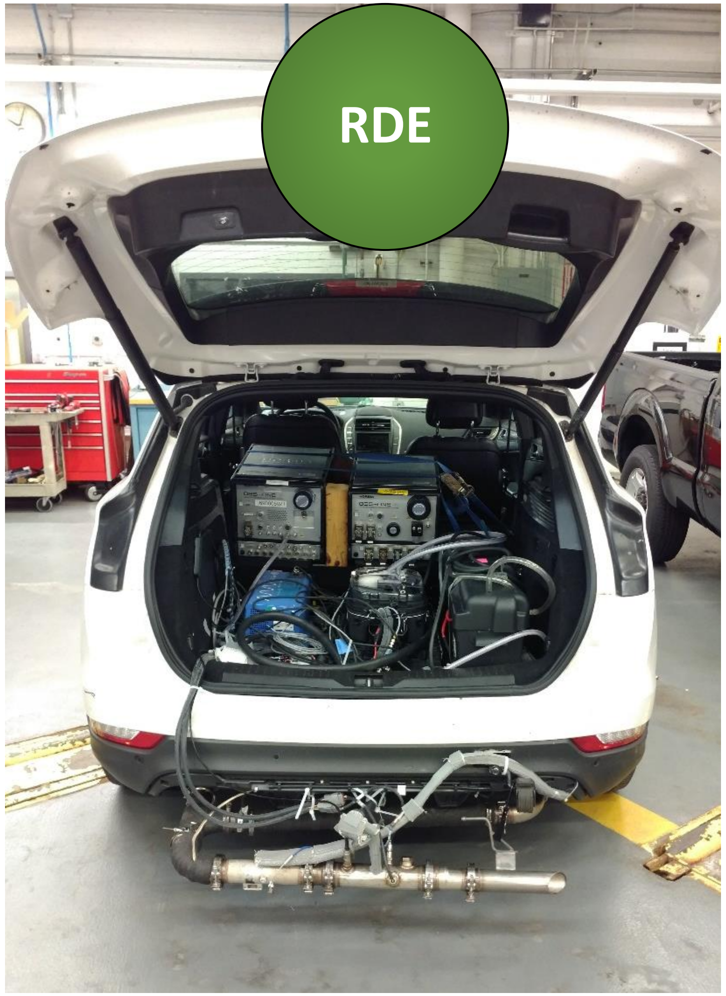
Evolving Emissions Testing: Bridging the Gap

Conventional Emissions Testing – shortage of appropriate testing facilities to meet evolving testing demands of rapidly changing regulatory requirements

Engine Bench

Chassis Dyno

RDE



mini PEMS

- Cost
- Size
- Ease of use

mini-PEMS measurement uncertainties

Context

- Purpose of mini-PEMS – enable gathering vehicle emissions behavior in real world

Study objectives

- Learn about the capabilities of the various gas sensing technologies employed
- Uncover real world measurement issues
- Find areas of improvement and future development

- Wet vs dry
- Zero / span – ambient vs zero air
- Baseline drift
- Time response
- NH3 interference

The data presented

- Emissions are plotted as concentrations
- Avoids uncertainties introduced by exhaust flow measurement
- Comparisons are dry to dry and wet to wet

Gaseous emissions detection

NOx

Electrochemical – same as used for diesel OBD

- Amperometric (ammonia interference)
- Mixed potential

NH_3

Thick film zeolite (durability)

Mixed potential (selectivity)

CO

Non-dispersive infrared (NDIR)

Electrochemical (interferences)

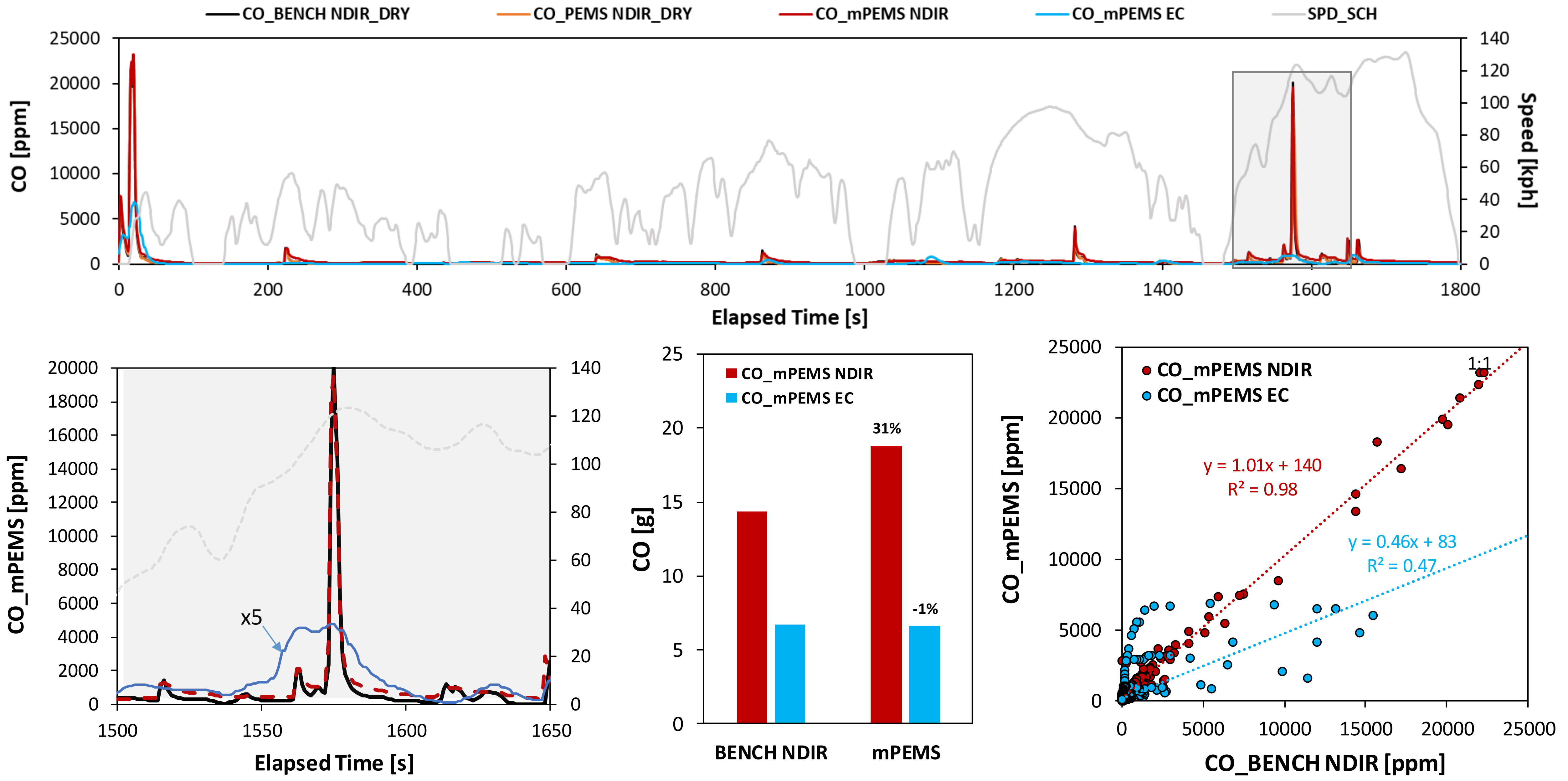
Metal oxide semiconductor (selectivity, sensitivity)

HC

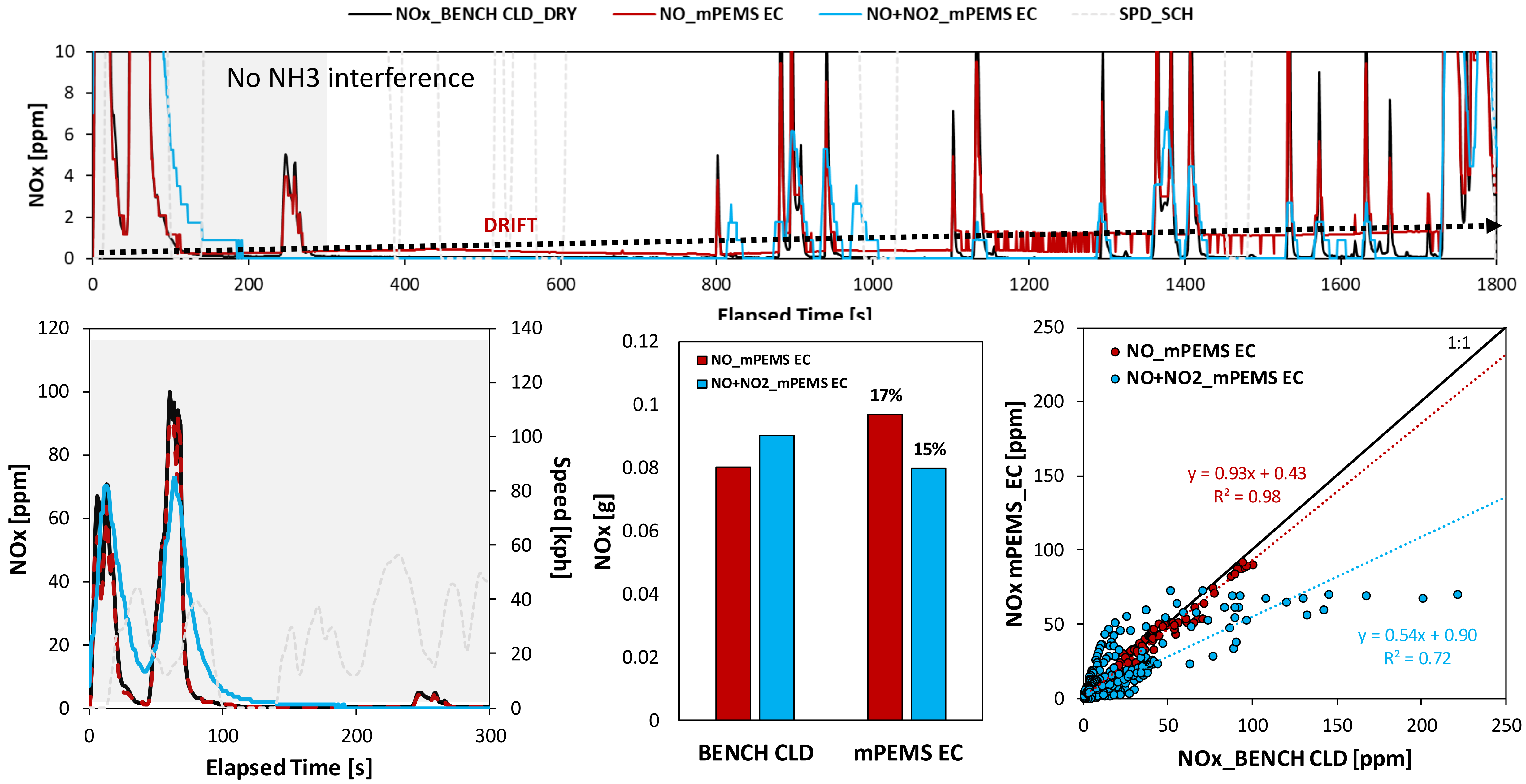
NDIR (selectivity)

Mixed potential electrochemical (selectivity, stability)

CO: NDIR (Bench, mPEMS) vs EC (2.0L GTDI)



NOx: CLD Bench vs EC cartridge mPEMS (GTDI)



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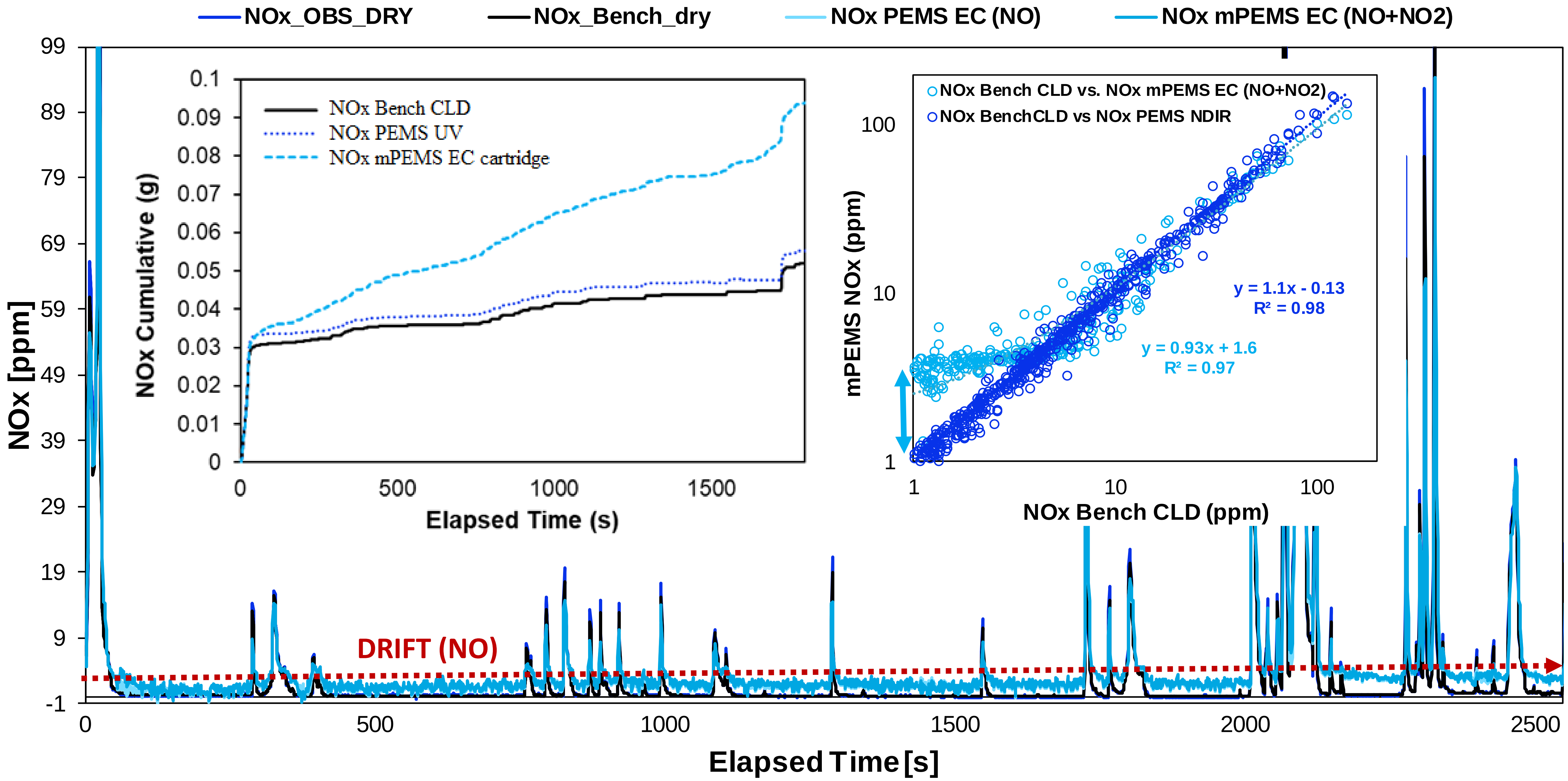
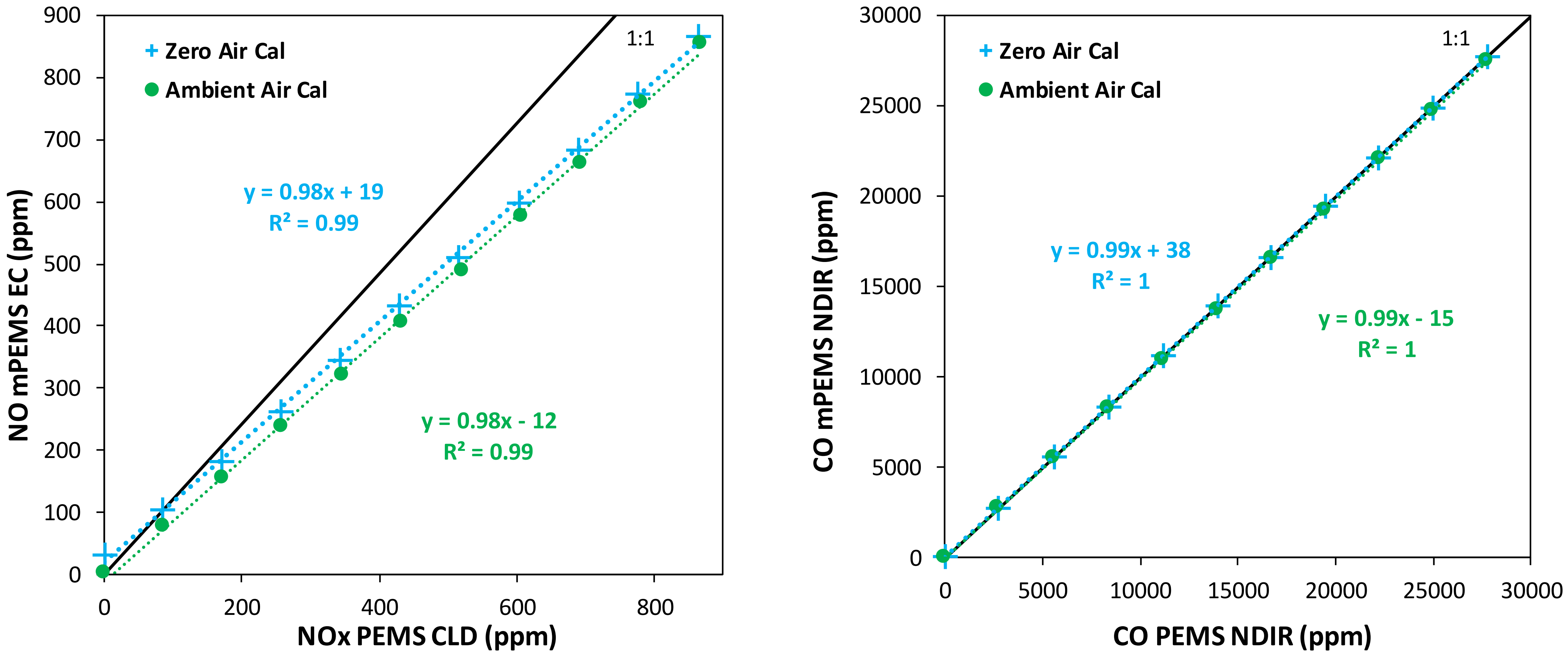
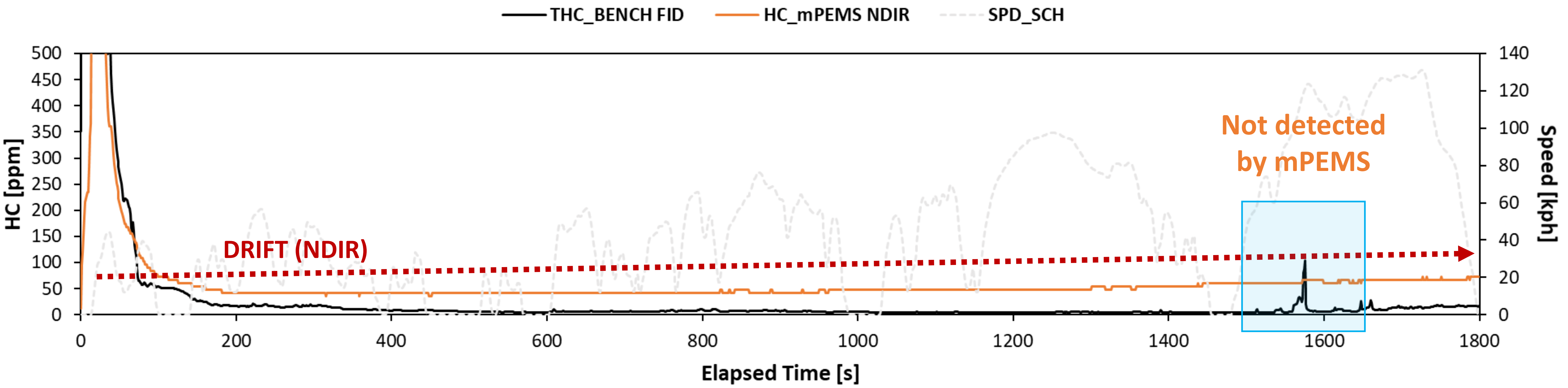


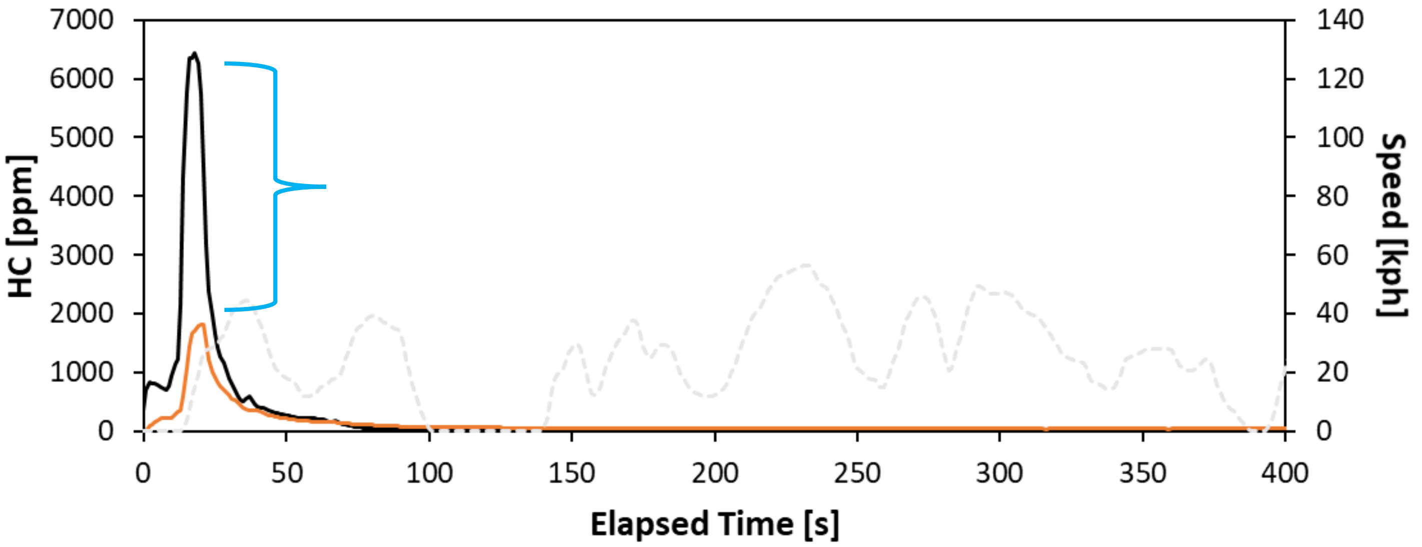
Ambient vs Zero Bottle Cal (Steady State – Span bottle/GDC)

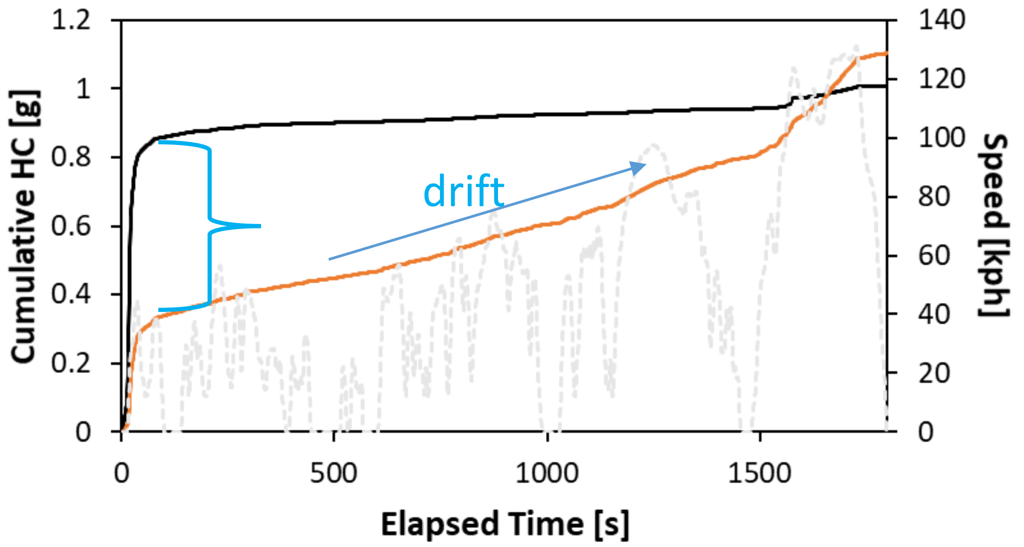


*Note: TP NOx sensors are not calibrated prior to each test

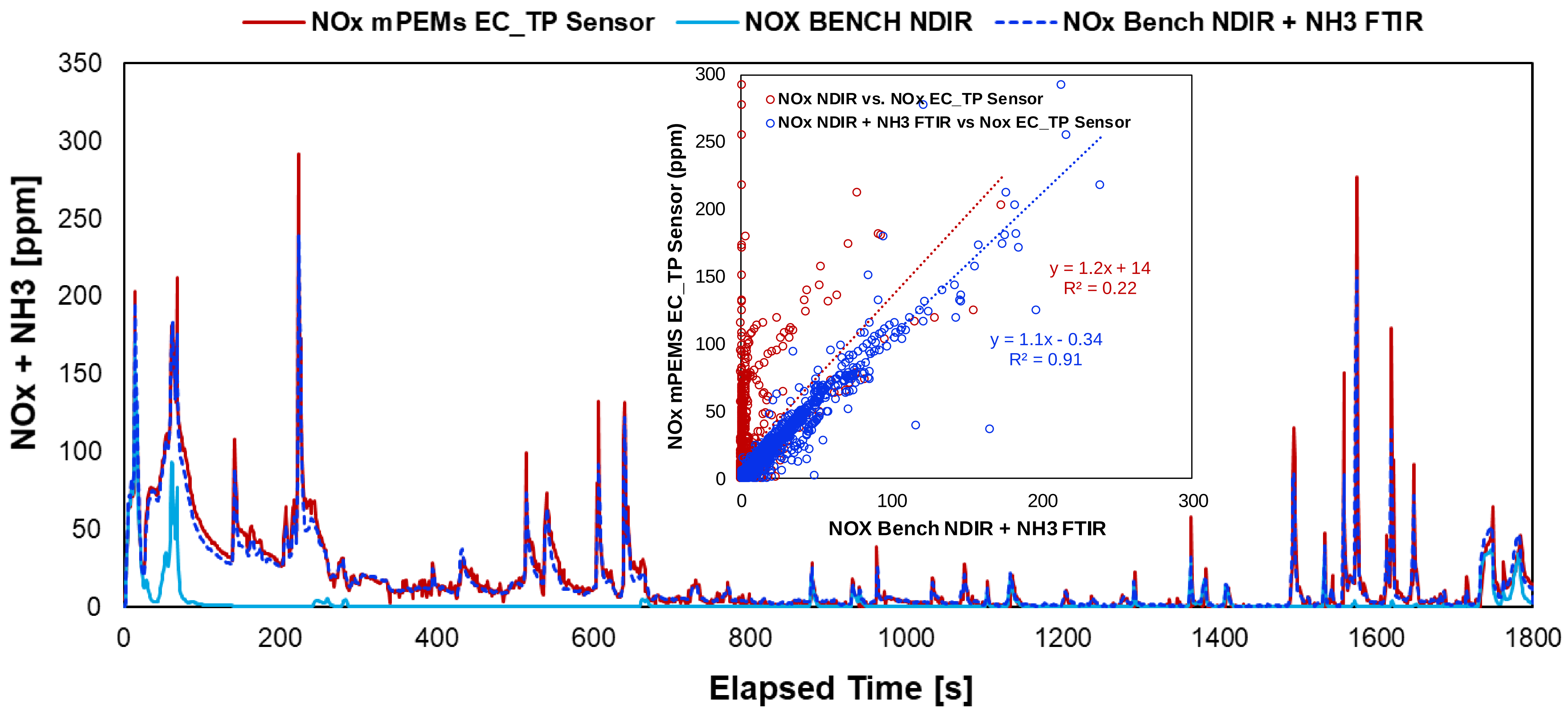
HC: Bench FID vs. mPEMS NDIR (0-4000ppm)



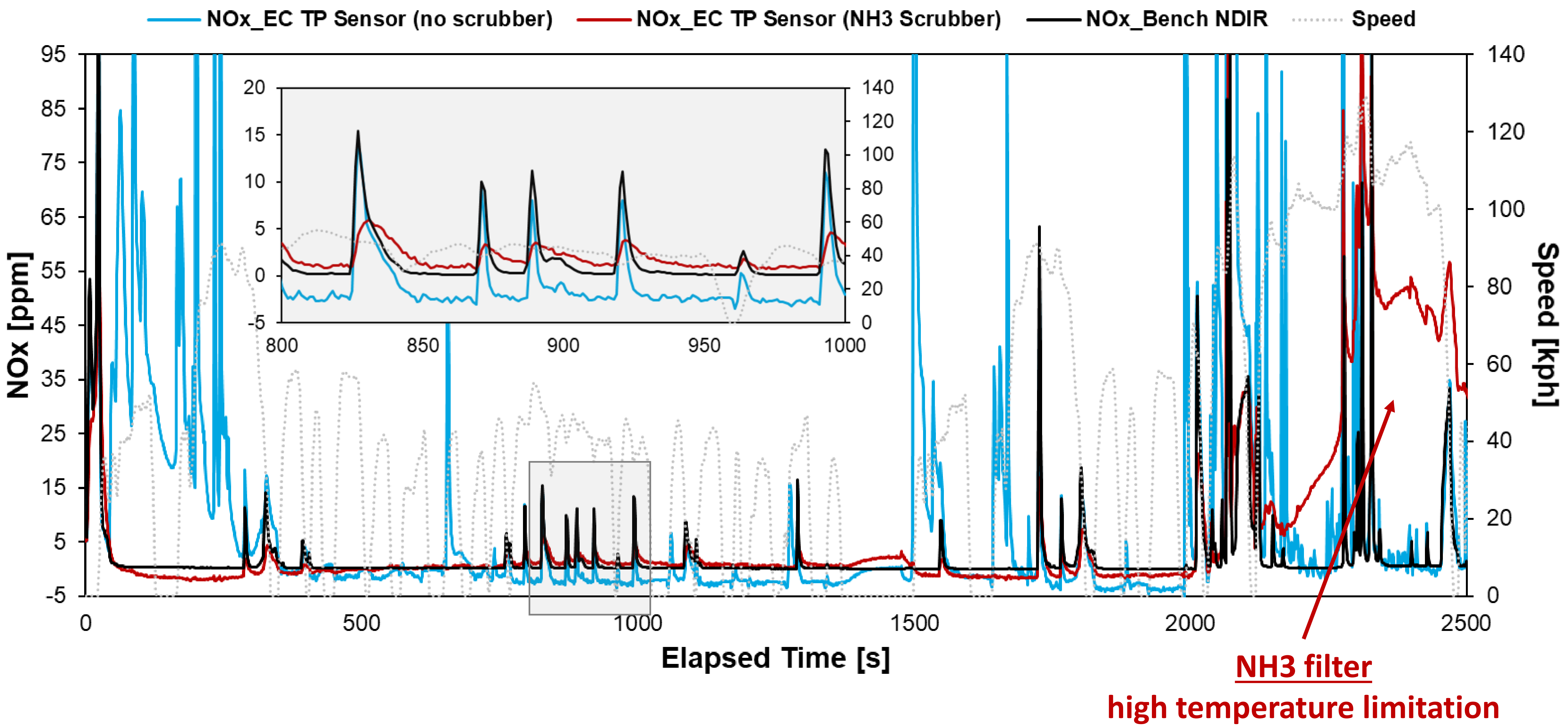




NOx EC TP Sensor: NH3 Interference



NOx EC TP Sensor: NH3 Filter Scrubber



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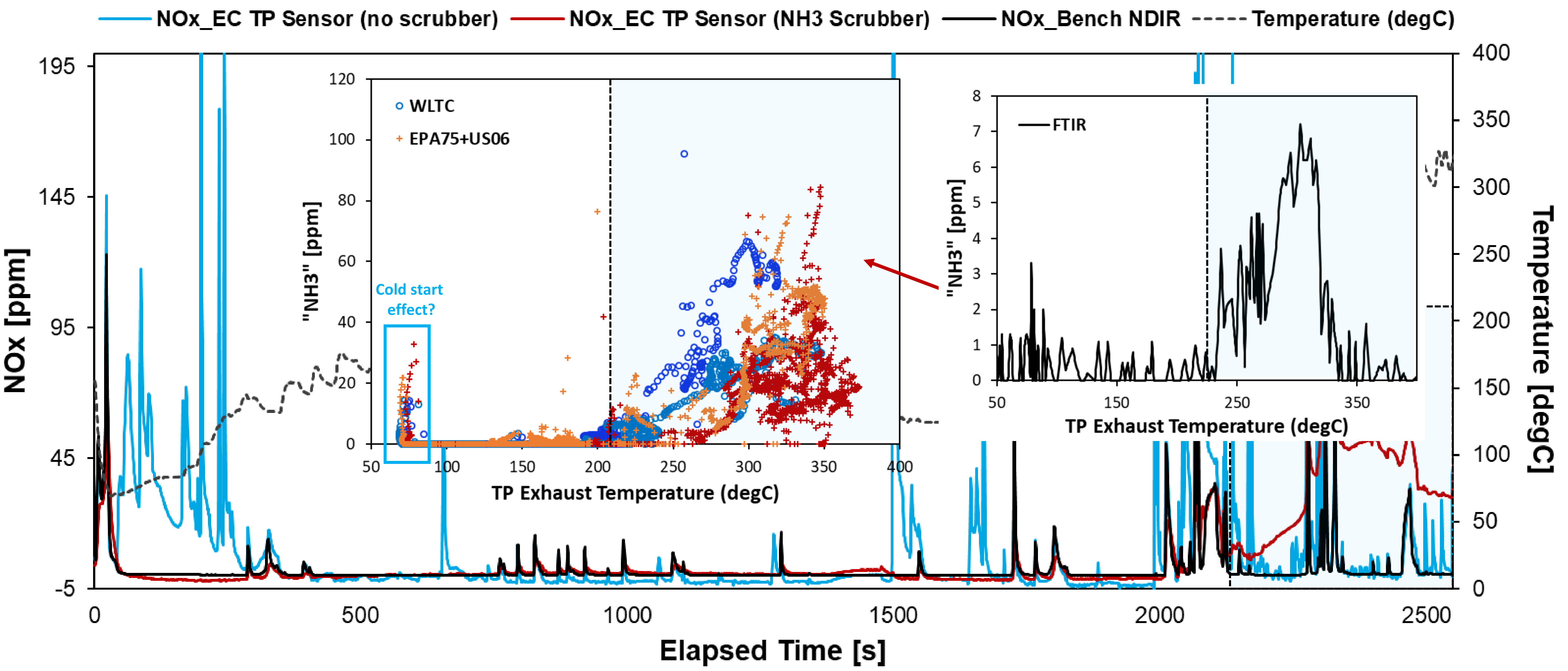
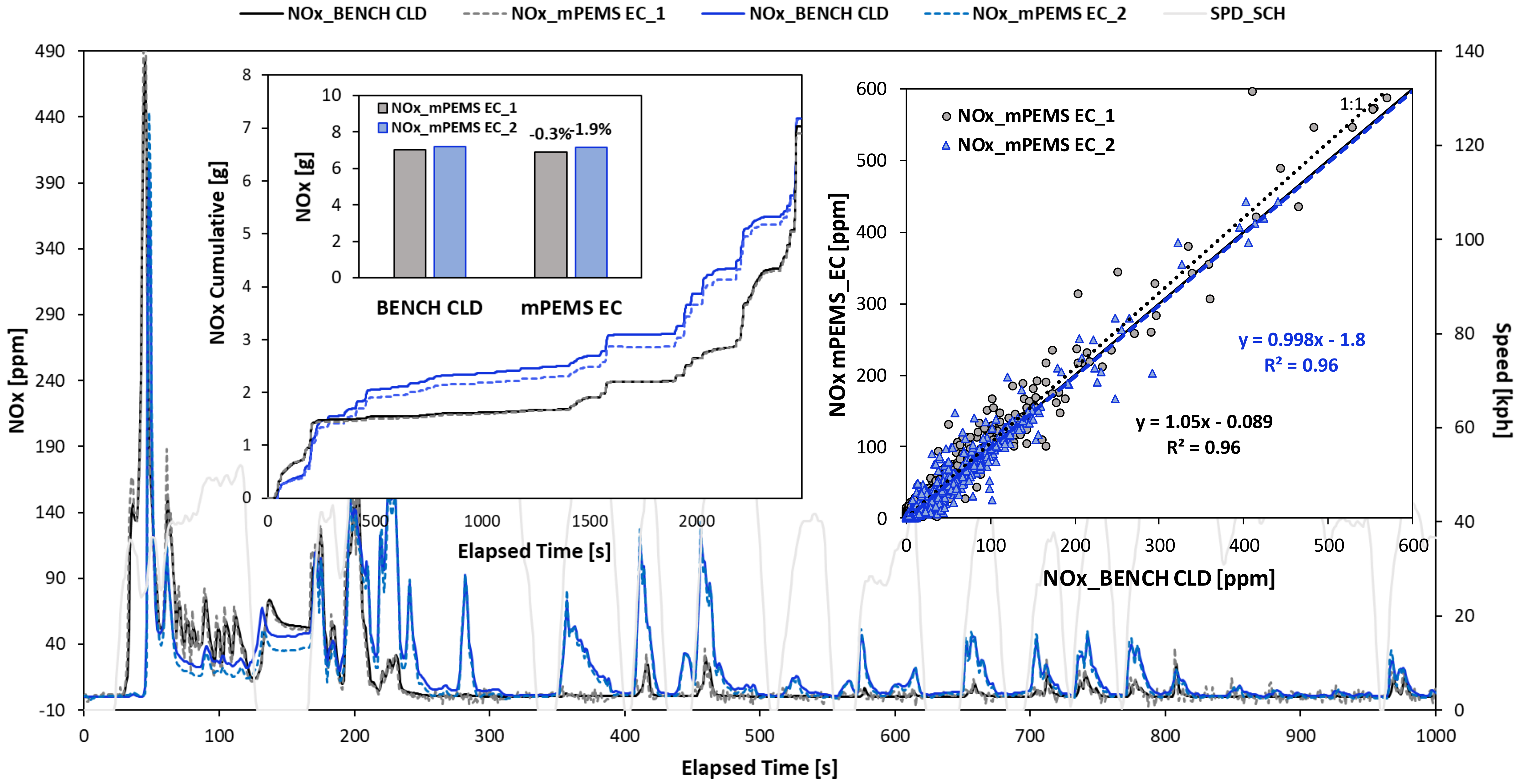


NOx EC TP Sensors: Diesel Performance (6.7L)



Conclusions

Mini-PEMS capabilities are species dependent

- Relatively well developed – NOx, CO, CO2
- More development needed – NH3, HCs

Benefits

- Easier use & calibration than bench or official PEMS
- Ability to detect emissions events (qualitative – quantitative depending on which species and level of accuracy)

Opportunities for future development

- New sensor technologies, e.g., HCs
- Greater selectivity / lower interferences
- Improved baseline & sensitivity

Acknowledgements

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Larry Mattison & David Miller (3DATX Corporation) Chris Church & Ron Patrick (ECM-Engine Control and Monitoring) Earl Leatherland & Jeremy Burne (Global MRV) Brian Jung & Joe Ferdon (NTK/NGK) Jordan Love & Craig McKim (Testo-Direct)

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