6th Diesel Engine Emissions Reduction Workshop

Exhaust Aftertreatment, Gas Phase Measurements *in situ*

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Challenges of New Aftertreatment Technology

Increasing aftertreatment system complexity

- Driven by more stringent regulations
- Results in active aftertreatment systems
- Produce rapid dynamic events

Lack of fundamental understanding

- Need for engineering data
- Laboratory/on-engine differences

Measurement Needs

Critical Requirements:

- Catalyst surface temperature
- Catalyst surface composition
- **Exhaust gas composition**
- **Fast response times - T_{90} << 1 second**
- **Measure inside operating device**

Current Measurement Limitations

Available Gas Analysis Instrumentation

- Responds slowly, 1- 10 sec. T_{90}
- Samples large volume, 0.1- 5 l/min.
- Measures single component
- Has long sampling delays
- Requires sample pretreatment
- Do not measure absolute pressure

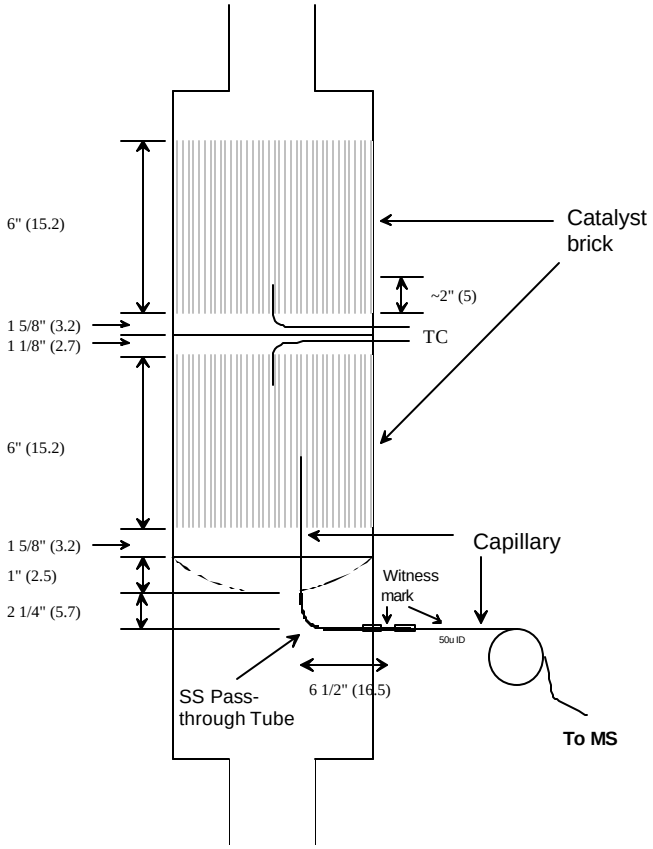
SpaciMS

Requirements

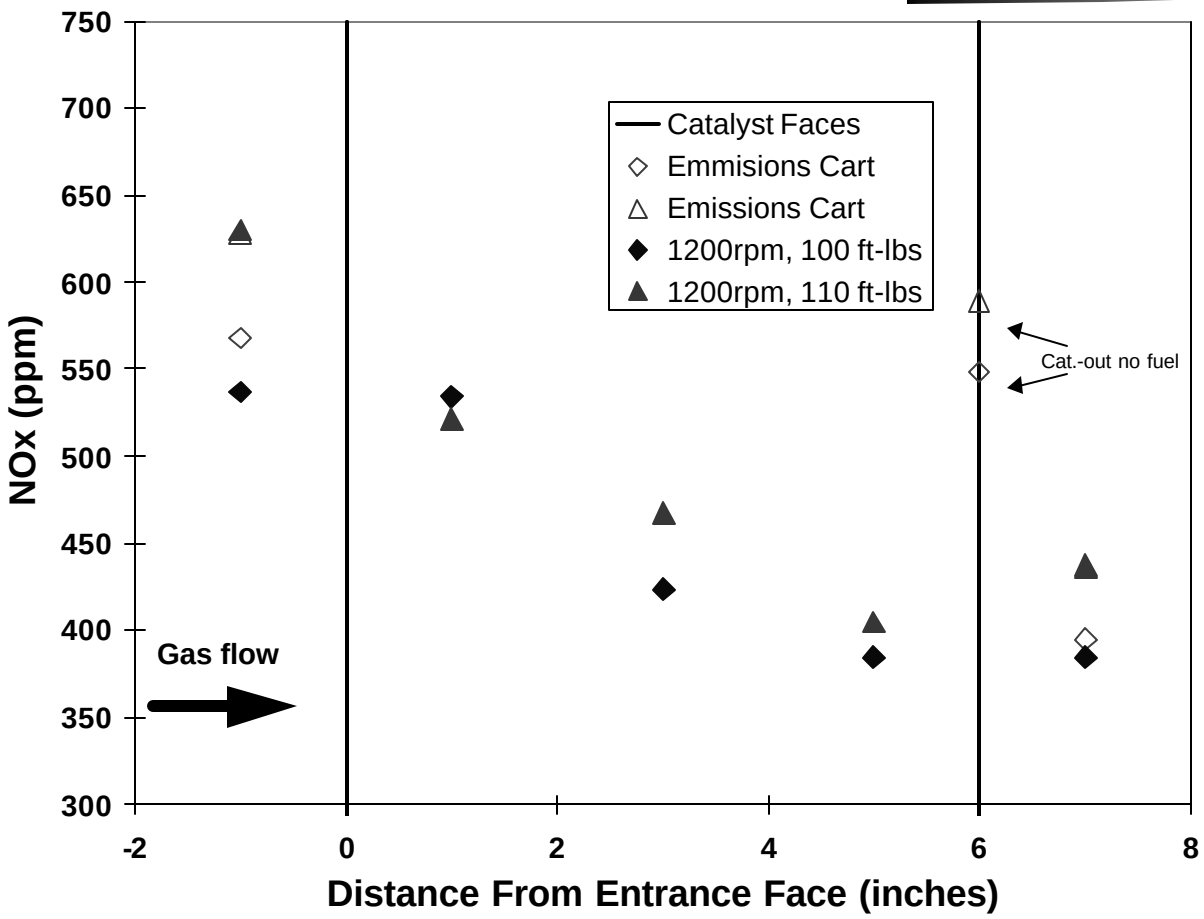
- Measure NOx, O_2, CO_2, & HC simultaneously
- Sample at high speed - T_{90} < 0.1seconds
- Sample inside catalyst monolith
- Disturb gas flow minimally

Spatially resolved, capillary inlet mass spectrometer

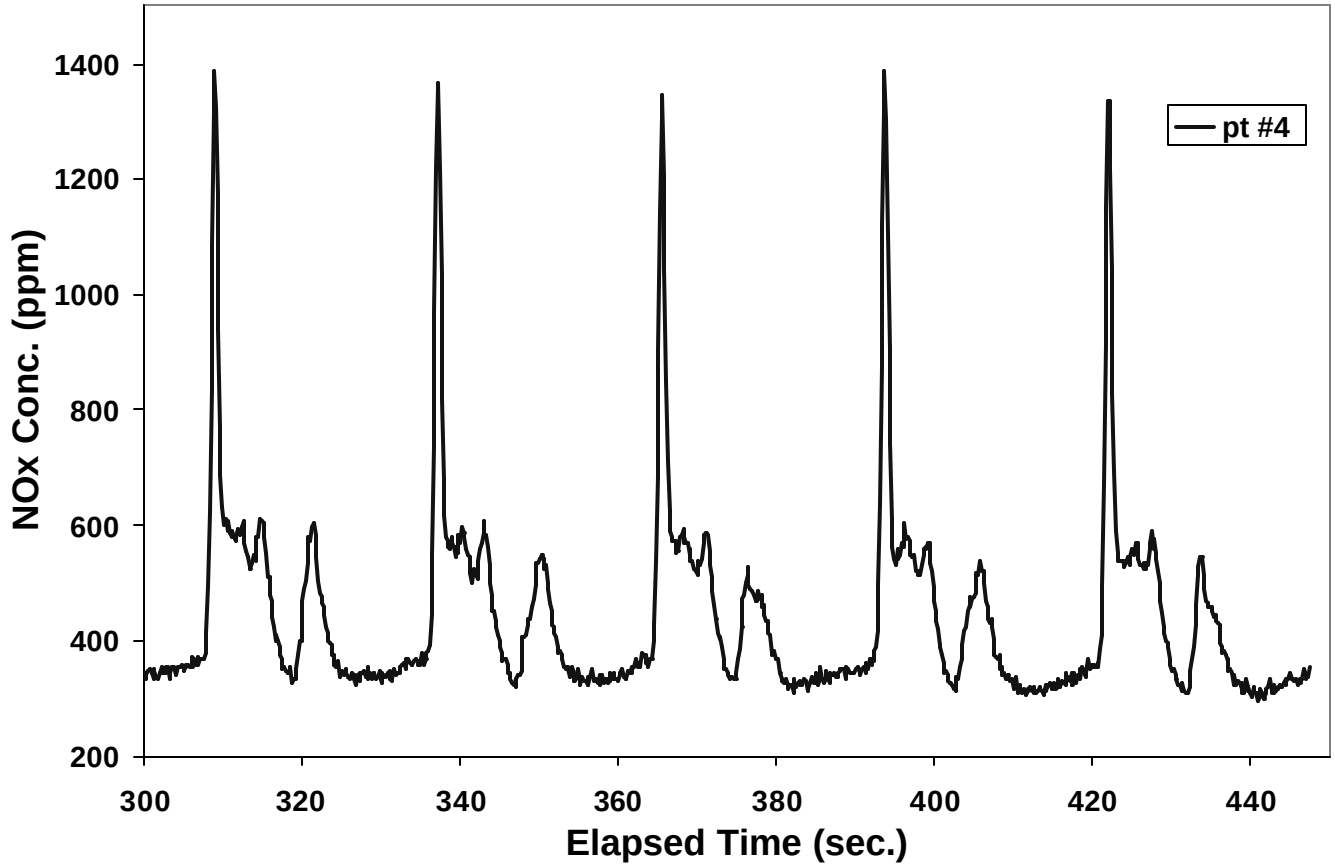
Experimental



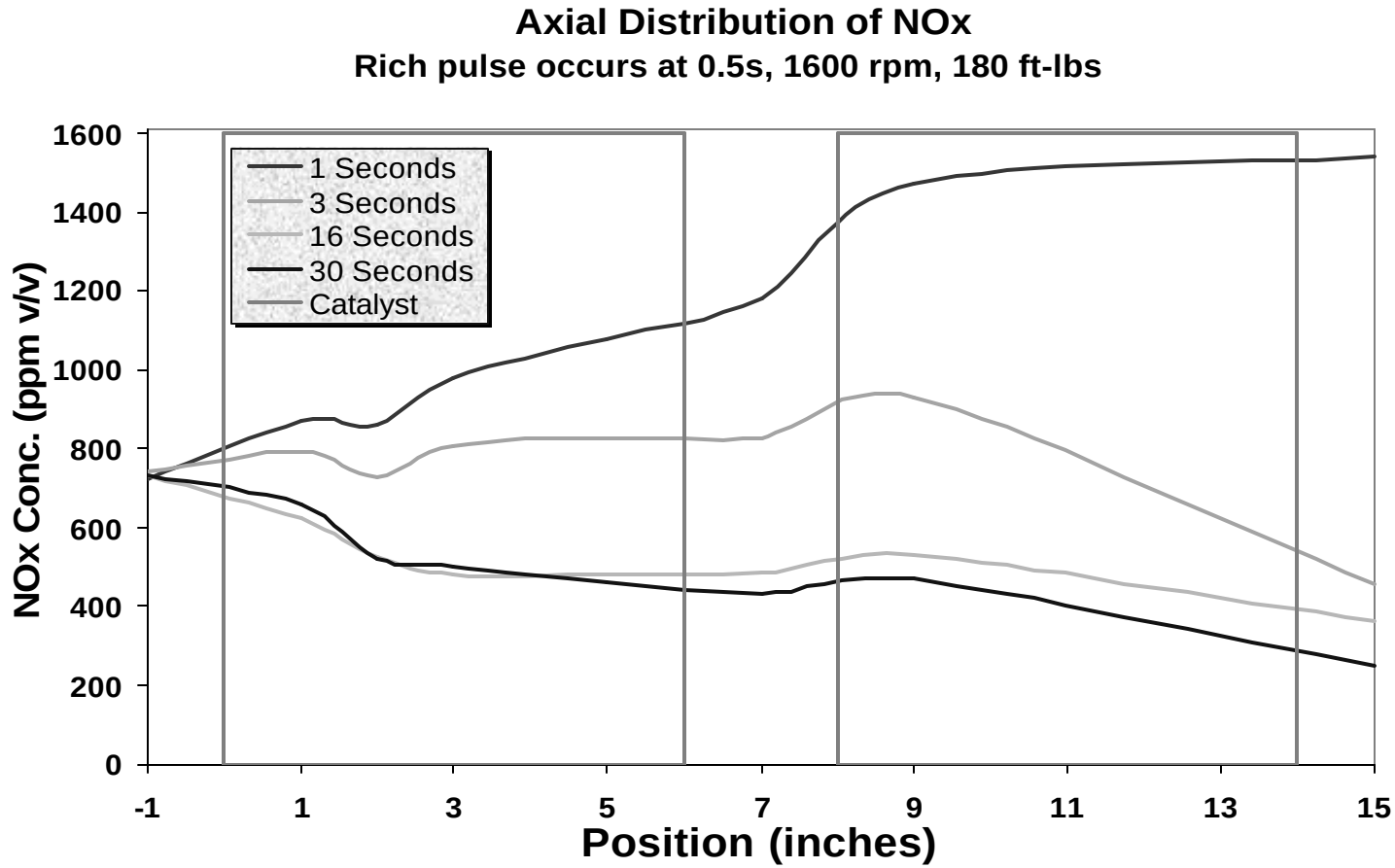
SpaciMS Measured NOx



Combining Spatial and Temporal



NOx Concentration Profiles



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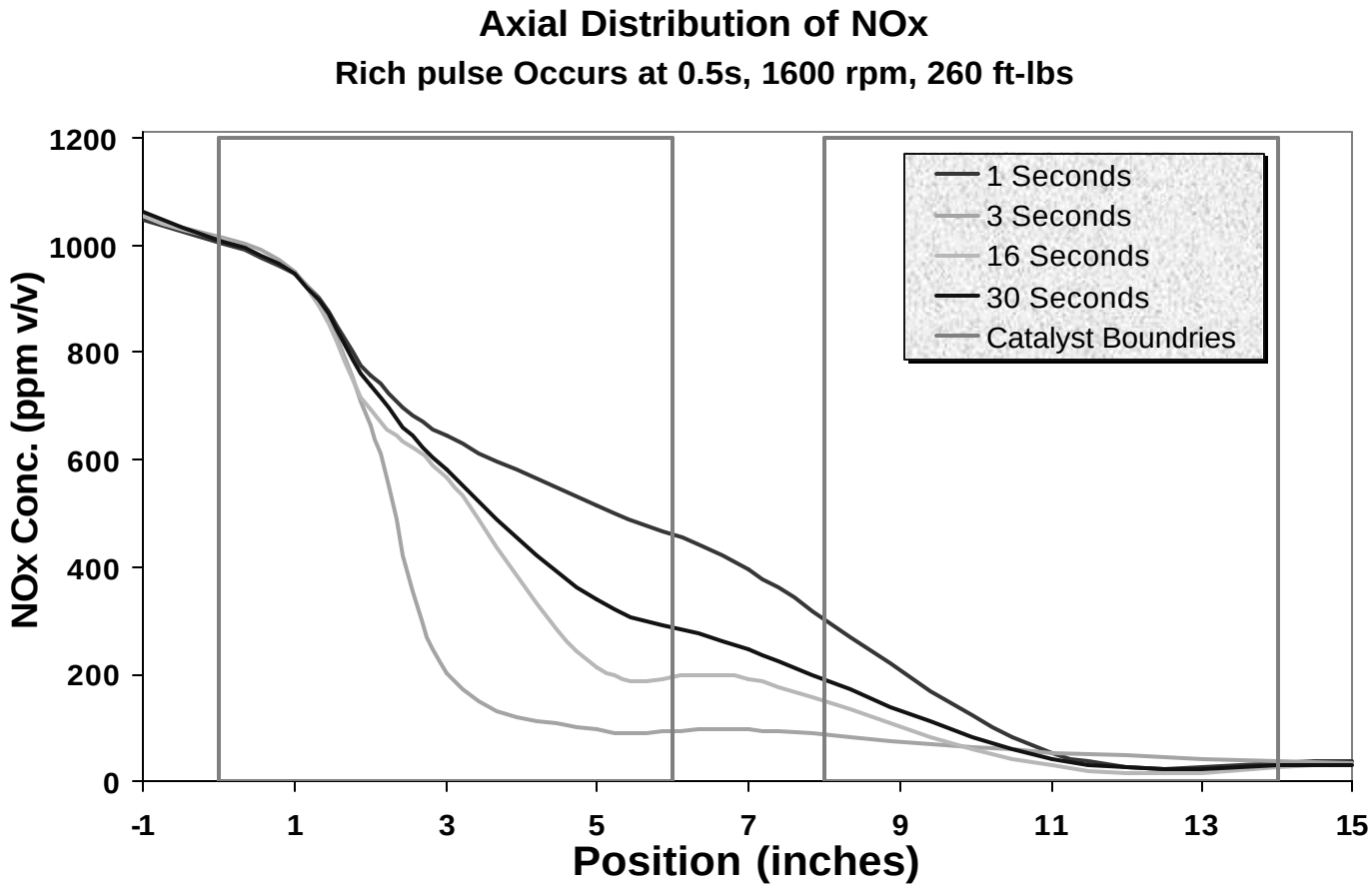

Advantages of SpaciMS

Resolve catalyst behavior spatially & temporally

- Measure anywhere in the catalyst device
- Follow fast events
- Provide temporal relationship between events

Investigate Chemistry

- Absorption, desorption/conversion rates
- concentration effects

Predict effects of catalyst size and shape

Diagnose failures