
Spatially Resolved Dynamic Measurement of Gas Phase Composition Inside Operating Catalysts - Support of Catalyst Model Development

Neal Currier



Bill Partridge, Sam Lewis

OAK RIDGE NATIONAL LABORATORY
U.S. DEPARTMENT OF ENERGY

Jim Parks



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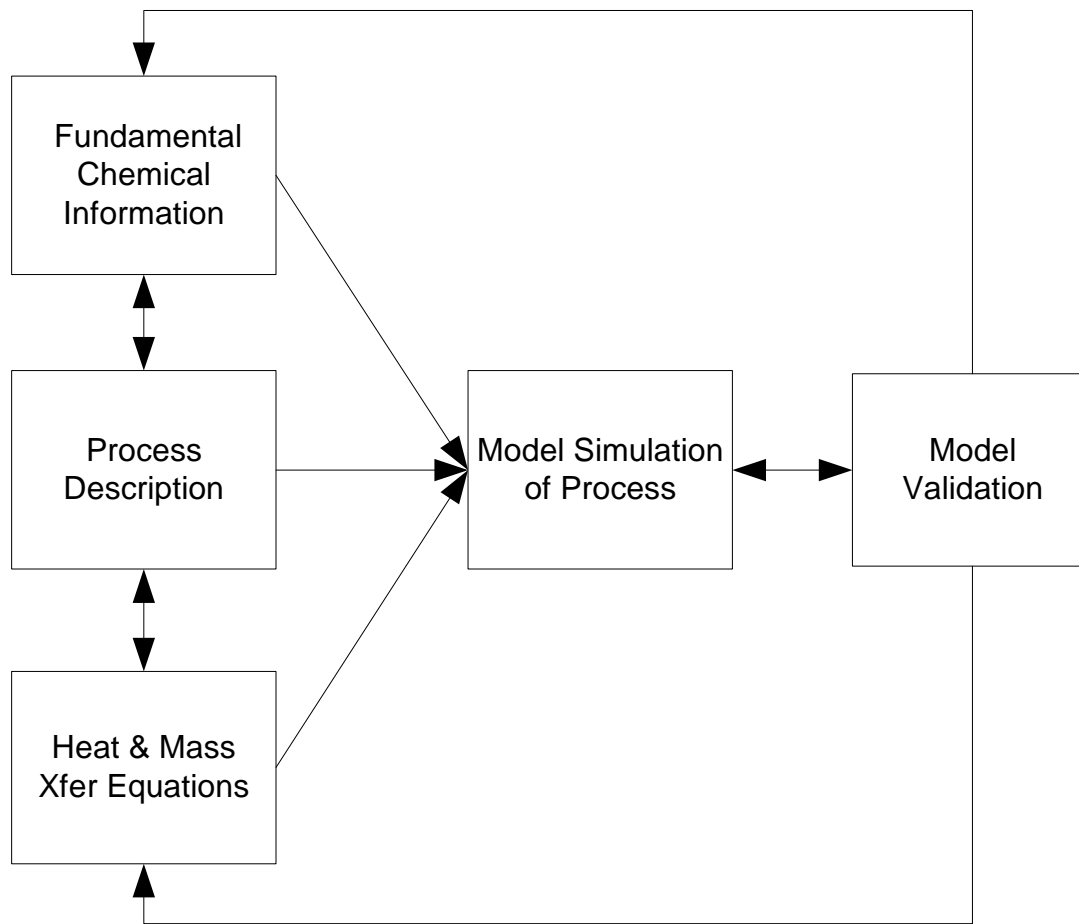
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Preview



- Model Development
 - Need for mechanistic information
 - Need for validation data sets
- Need for new tools
 - Improvement opportunities
 - SpaciMS technique
 - SpaciMS implementation
- Application examples
 - LNT NO_x absorption
 - LNT Regeneration
- Summary

Chemical Process Modeling

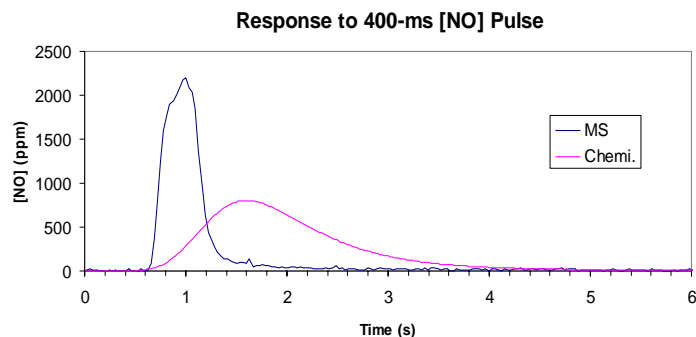
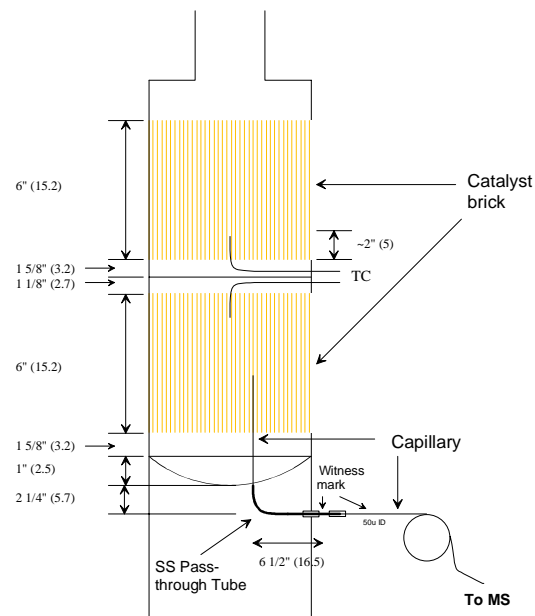


The Need for New Tools

- Fundamental understanding of new technologies is lacking
 - Details of chemical processes and their relative importance are limited.
 - Laboratory and on-engine data are often different.
 - Black-box measurements are often insufficient to understand the processes.
- What information would help overcome the lack of understanding
 - Catalyst surface temperature
 - Catalyst surface composition
 - **Gas composition**
 - **Fast response times - $T_{90} \ll 1$ second**
 - **Measure inside operating device**

SpaciMS Capillary-inlet, Spatially-resolved, Mass Spectrometry

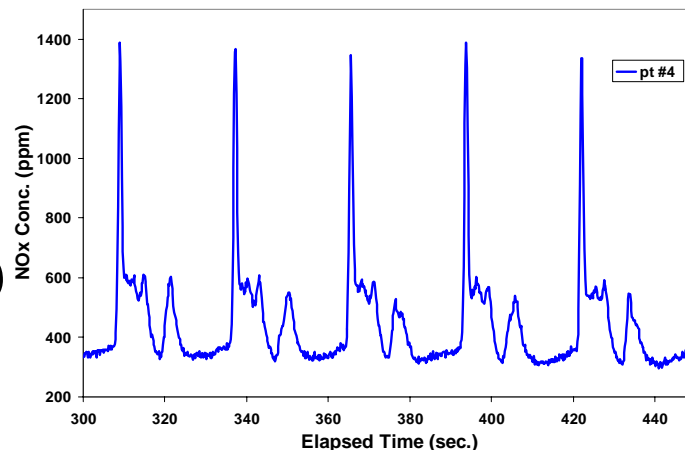
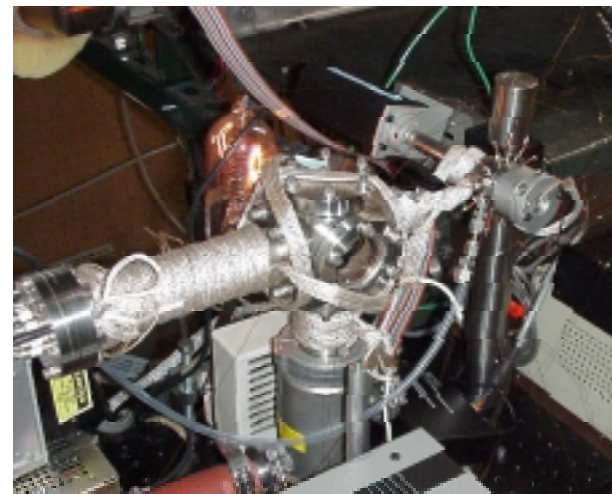
- *In situ* sample probe
 - minimal disturbance
 - resistance to environment
- Fast Response
 - follow fast transients
- Multiple Species
 - NO_x (NO, NO₂), O₂, CO₂, HC
- Portable



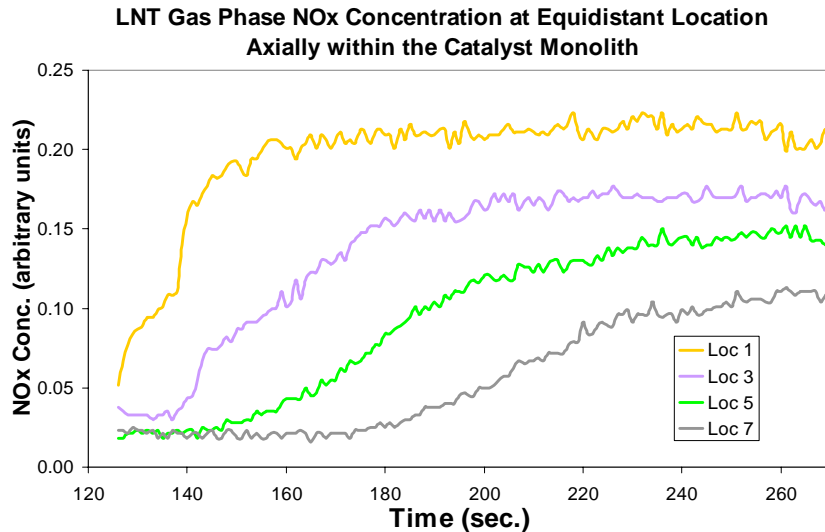
SpaciMS

Capillary-inlet, Spatially-resolved,
Mass Spectrometry

- Built with standard off-the-shelf equipment
 - Quadrapole mass spectrometer
 - GC sampling valve
 - Fused silica capillary tubing
- Fast Response
 - Sampling rate of ~30 Hz
 - Synchronized to external events
- Multiple Species
 - NO_x, O₂, CO₂, HC
- Multiple Sampling Locations (10)
- Applicable to multiple aftertreatment technologies

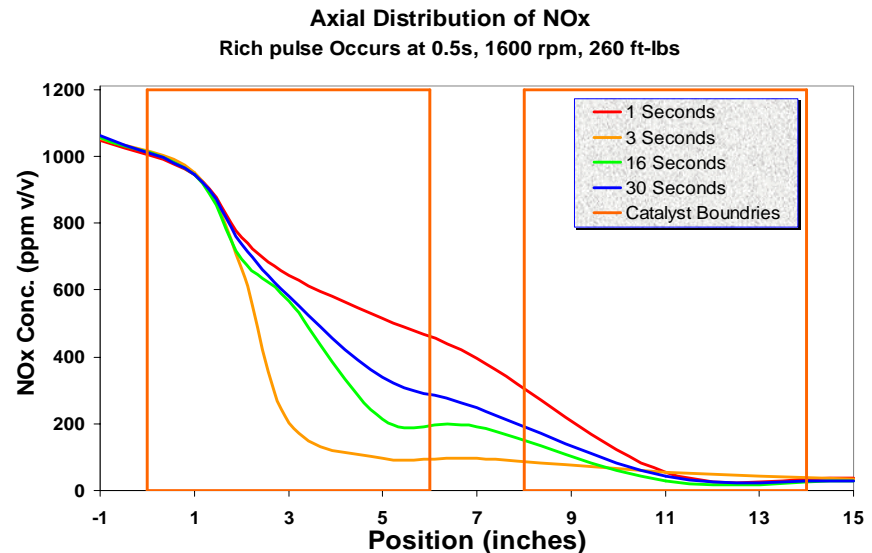


LNT Breakthrough Profiles



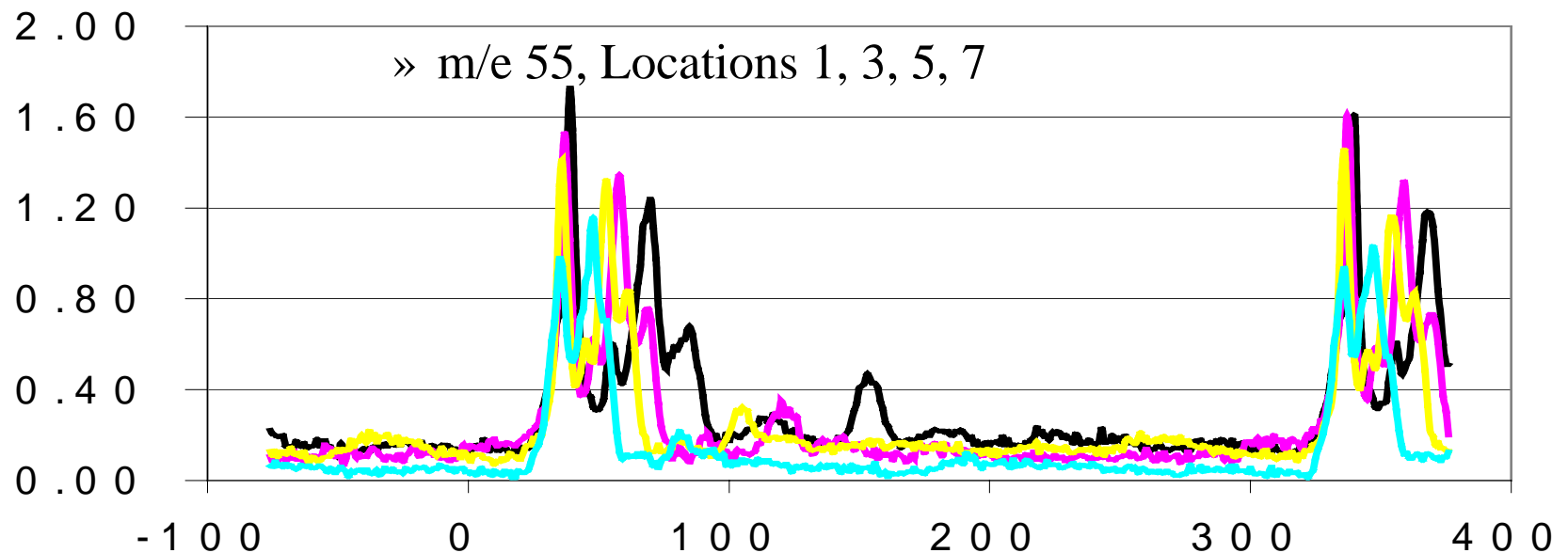
- Seems to be independent of LNT catalyst

- Profiles show an initial steep gradient followed by a much shallower gradient.



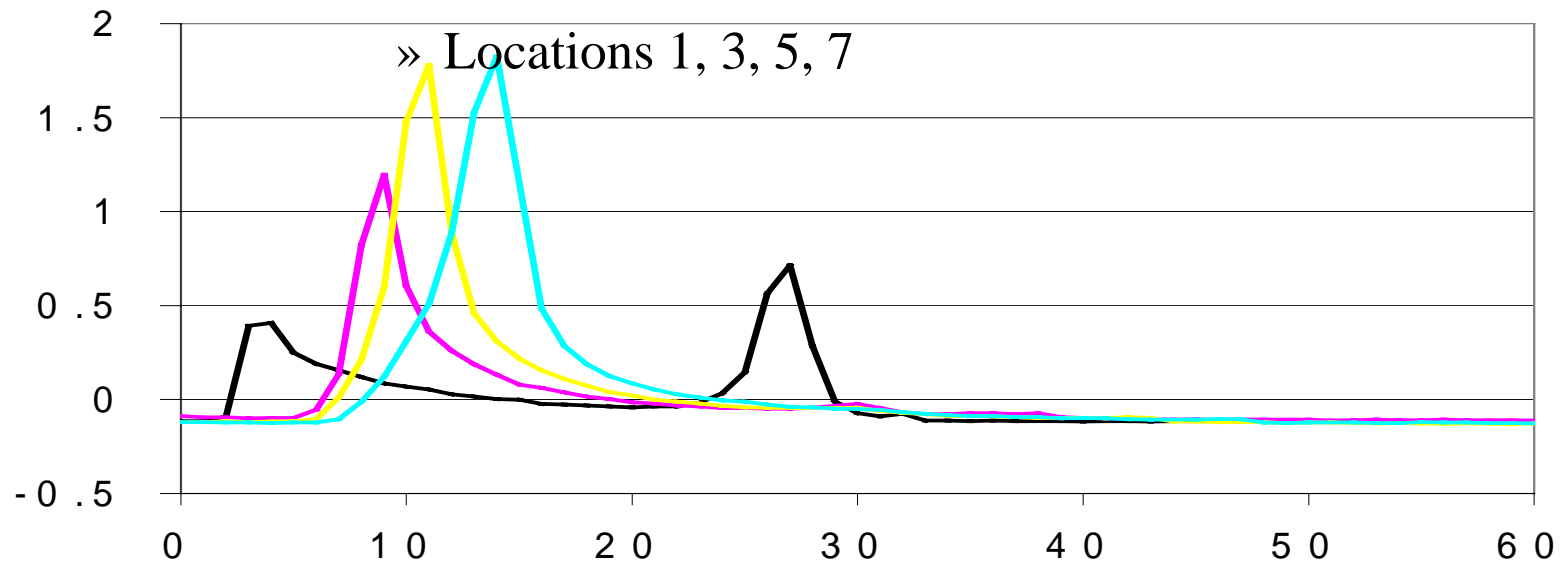
Complex HC Behavior

- HC storage revealed
- Multiple reduction events possible

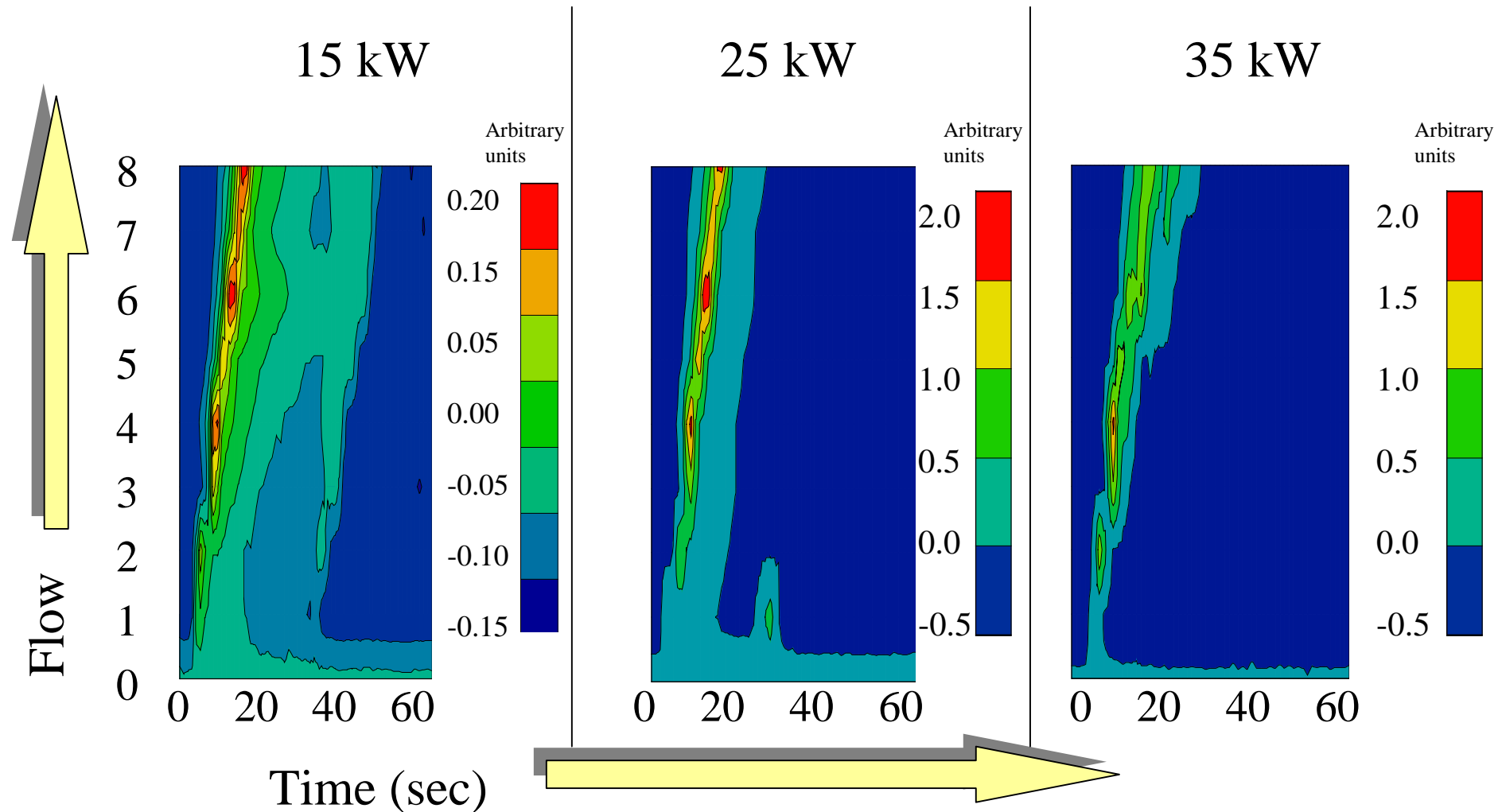


NOx Release During Rich Pulse

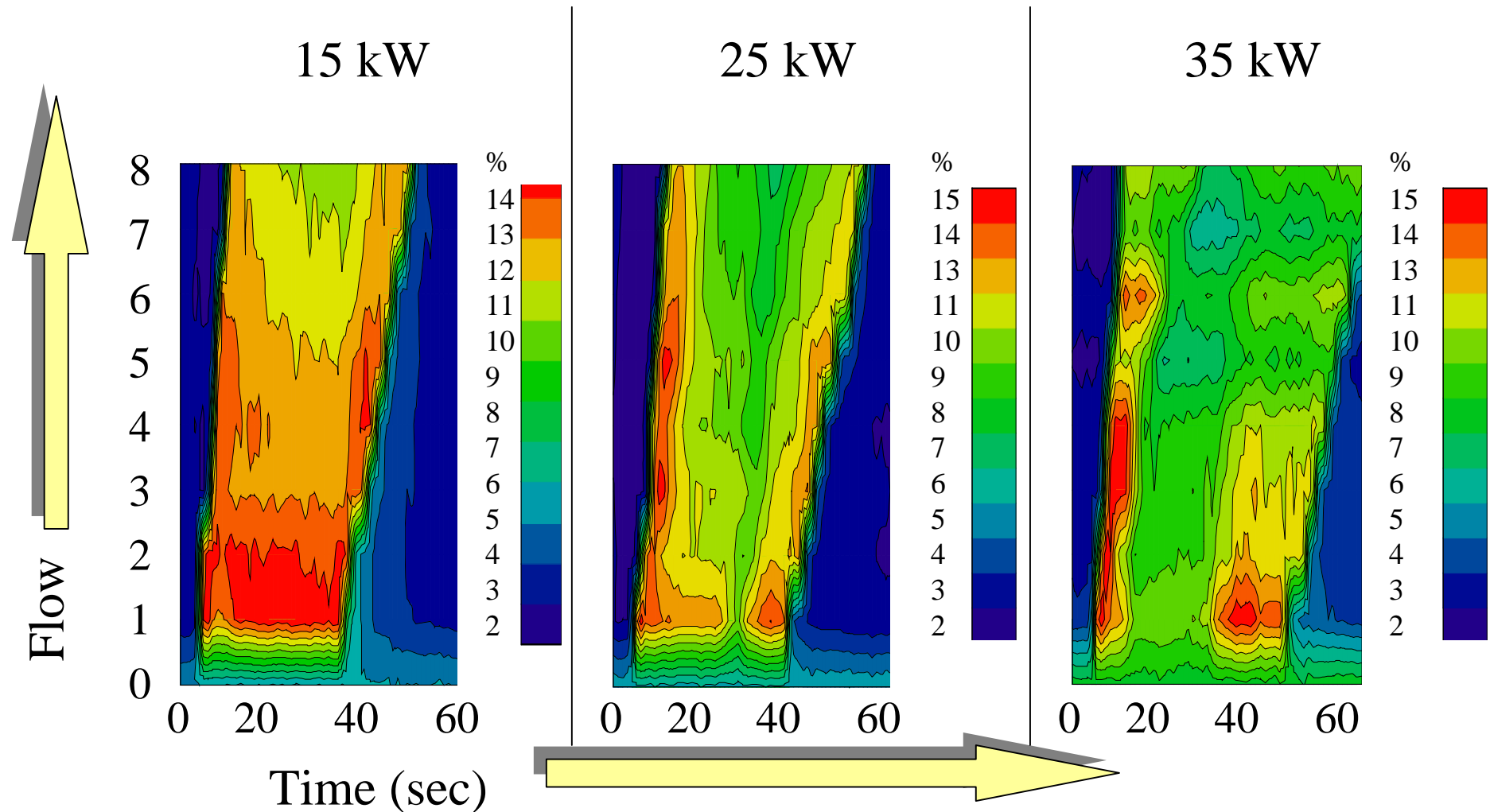
- Multiple NOx release events - catalyst inlet
- Not observed at catalyst out



NO_x During Fuel Pulse



CO₂ During Fuel Pulse



Summary

- New tools are required to provide information for the development and validation of aftertreatment models.
- The SpaciMS has demonstrated the capability to measure gas composition field inside an operating catalyst on engine.
- Data collected to date show significant complexity in LNT operation.