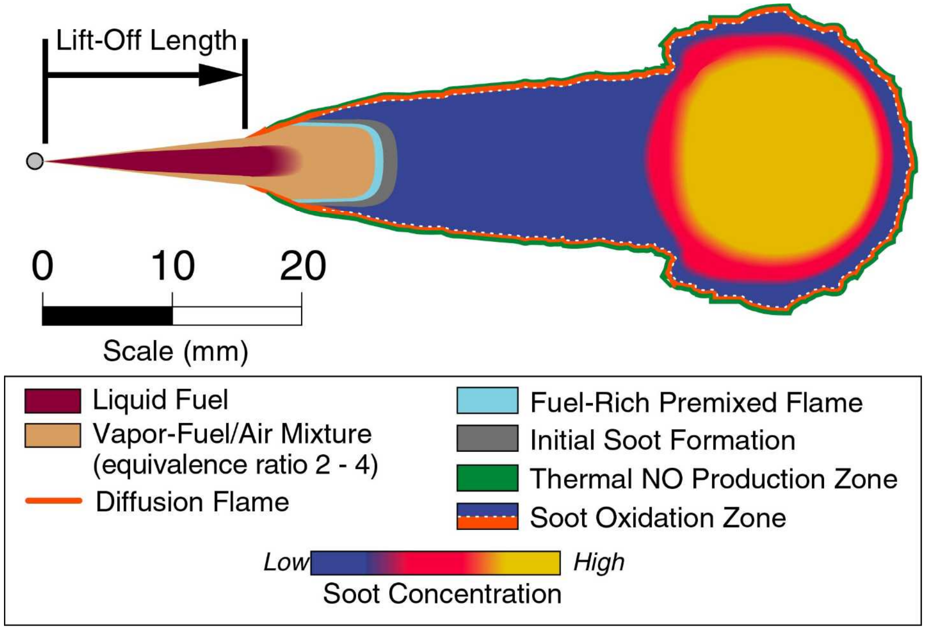
1-D Transient Diesel Spray Model

SAND2007-4756P



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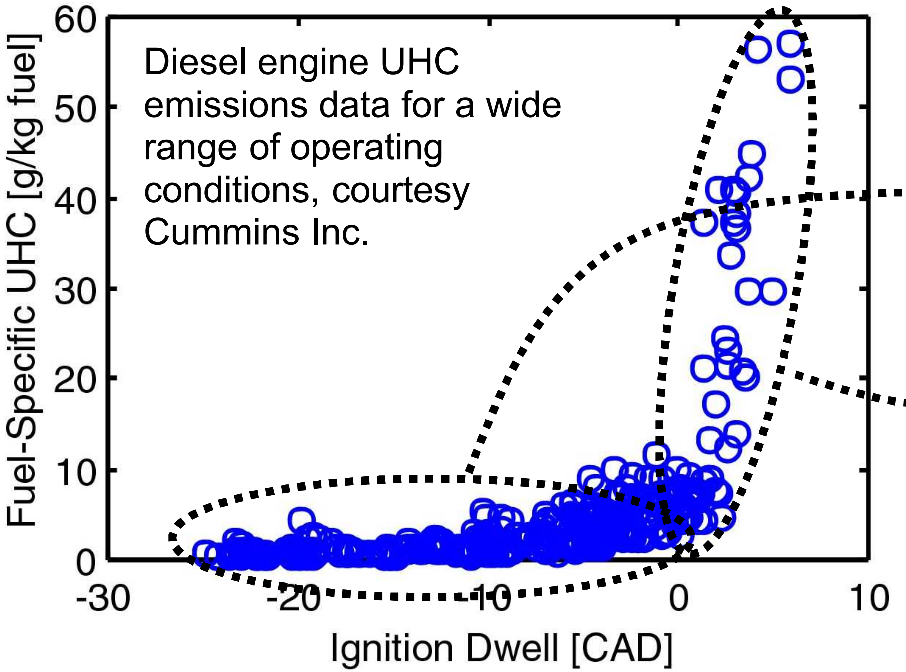
Outline

- Project Motivation
- Experimental Results
- Model Development
- Model Validation
  - Steady-State
  - Transient
- Model - Rethink
- Future Plans

Project Motivation – Lower Emissions

- Current Technology
  - Low Temperature Combustion
    - Lowers NOx and particulate matter
    - **Increases** unburned hydrocarbons

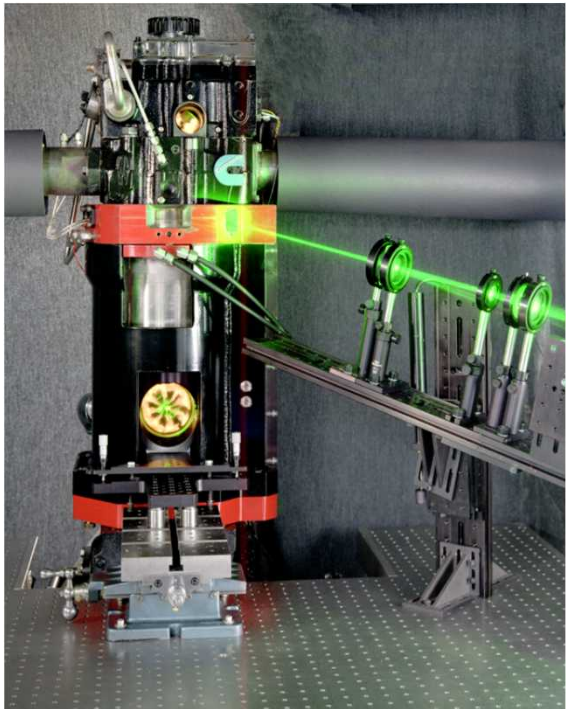


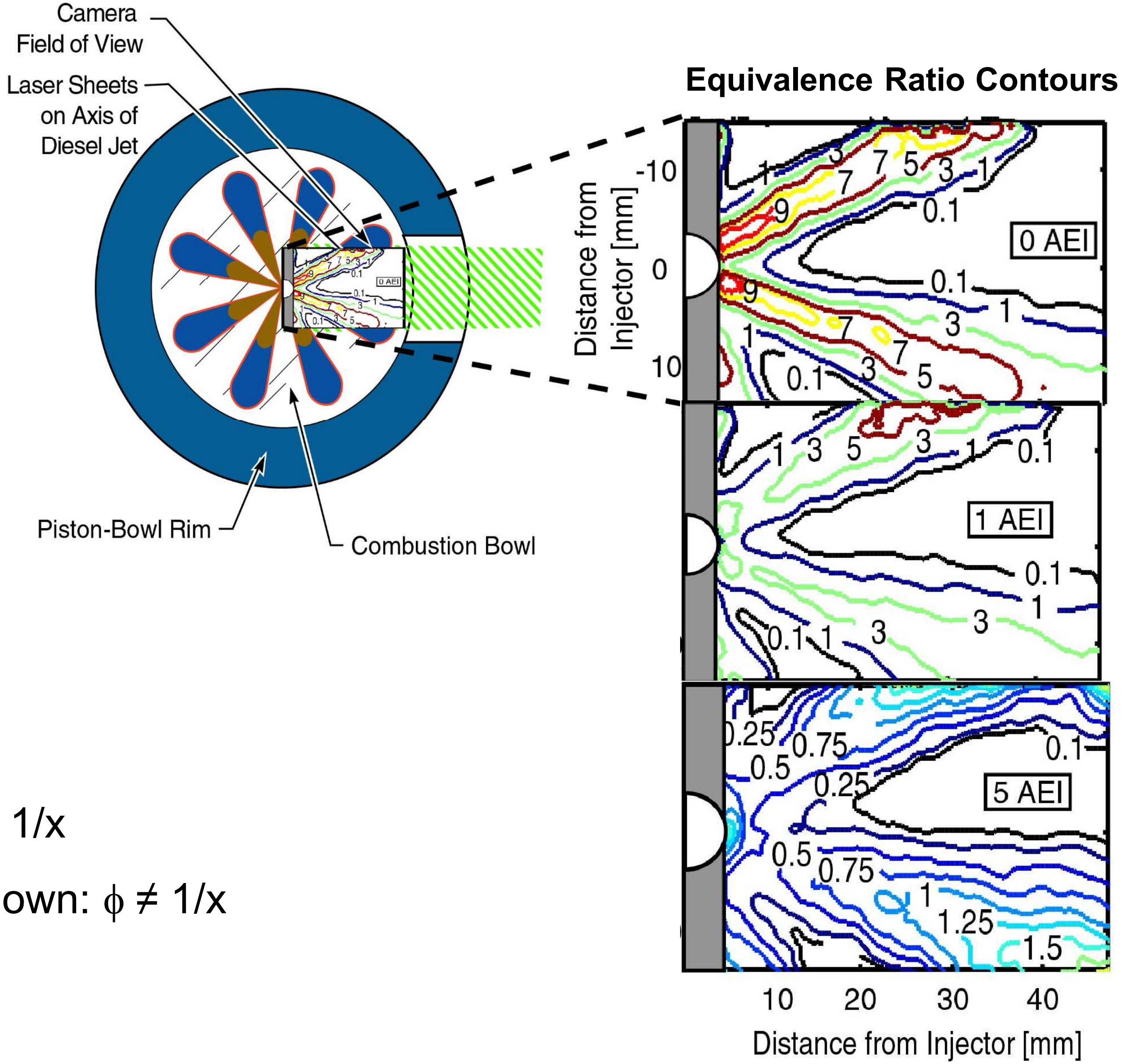
"Ignition Dwell" ≡ Time from end of injection to start of combustion

↳ Most conventional diesel combustion conditions have negative ignition dwell and low UHC emissions

↳ Many LTC (HCCI, MK, etc.) and some low-load diesel conditions have positive ignition dwell, and high UHC emissions

Experimental Measurements





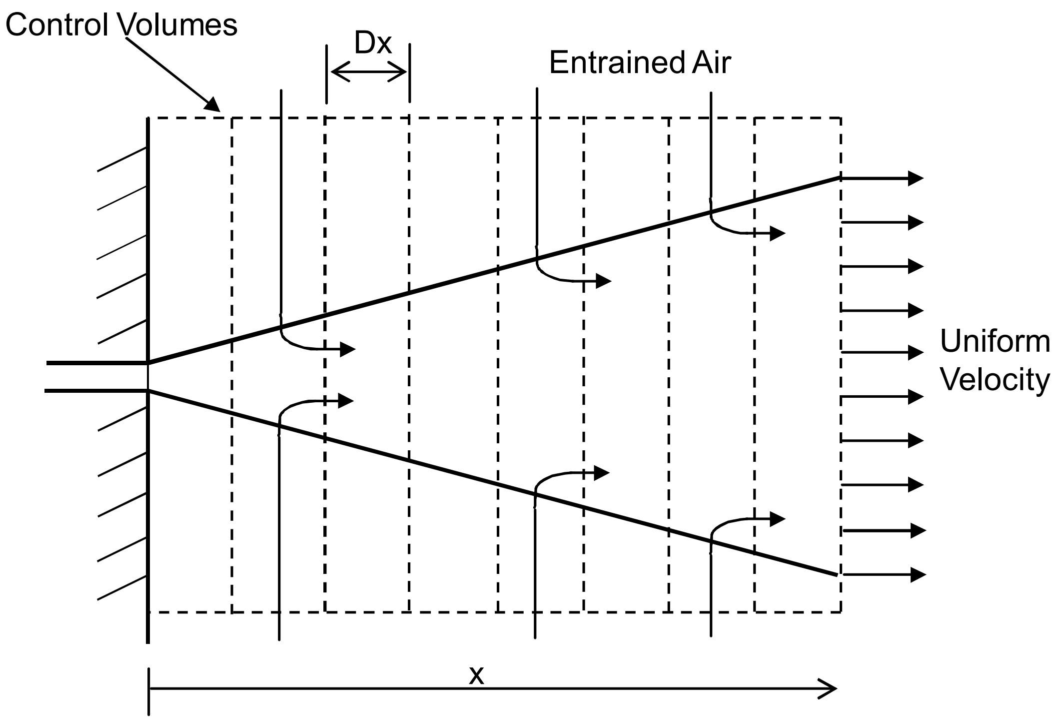
Equivalence Ratio

- Steady-State : $\phi = 1/x$
- Transient Ramp Down: $\phi \neq 1/x$

Model Development

Foundation

- Multiple Control Volume Analysis
    - Conservation of Mass & Momentum



Model Environment

- Non-Combusting
- Still air

Current Assumptions

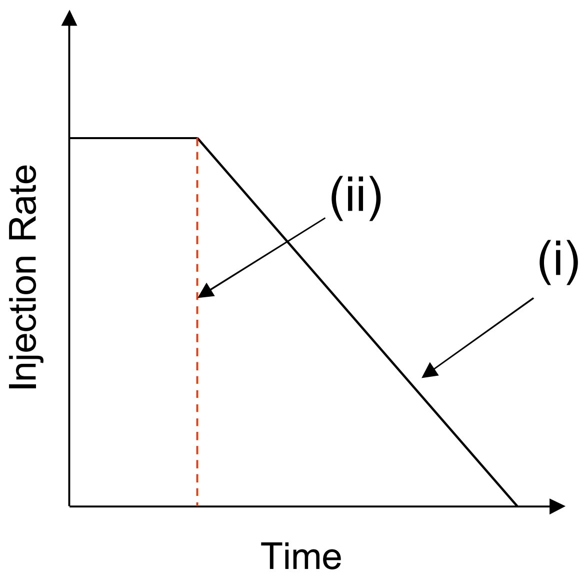
- Constant spray angle
- Uniform Velocity Profiles
- Constant fuel and air densities
- Constant pressure

Validation – Steady-State

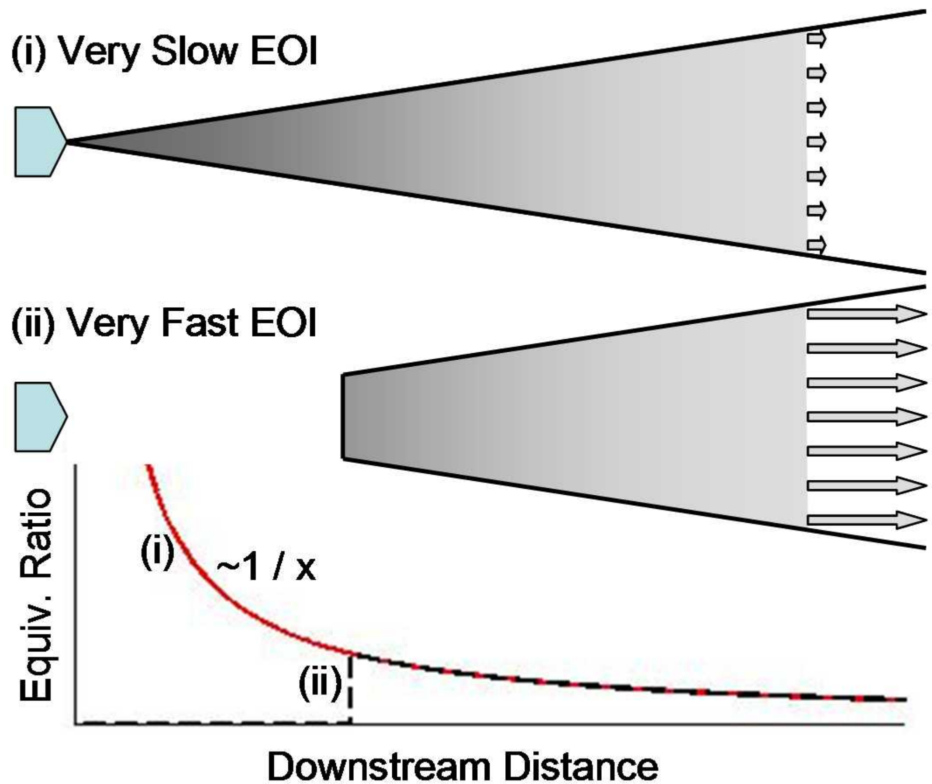
Steady-State Model Predictions vs. Closed Form Analytical Solution

Validation - Transient

Injection Cases

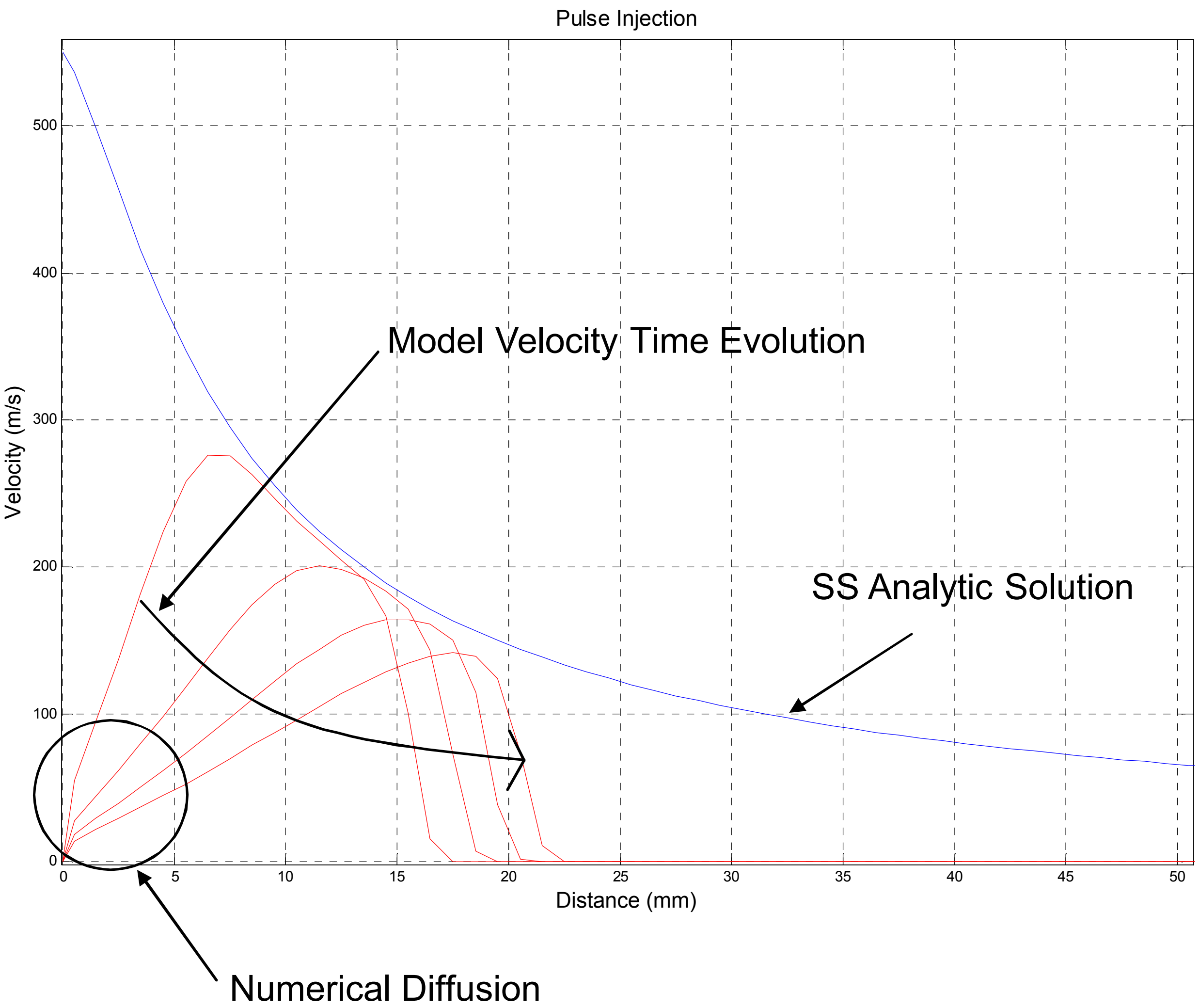


Hypothetical Results



Validation - Transient

Model Results



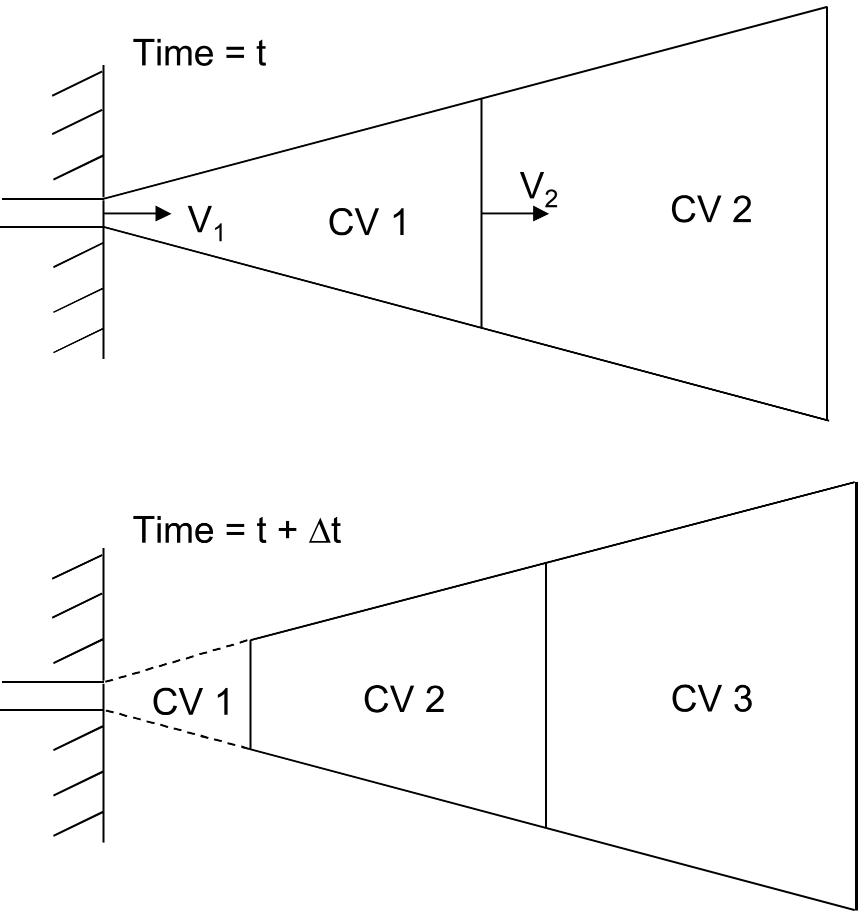
Validation - Transient

Model Results – Numerical Diffusion - 4E-5 sec injection pulse

Model - Rethink

Problem : Upstream and Downstream Numerical Diffusion

Solution : Moving Control Volumes, semi-Lagrangian approach



Future Plans

•Account for gradients within control volumes

•Use a radial non-uniform velocity profile

•Compare model transient predictions to experimental results