

Turbulent Combustion of Future Transportation Fuels

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Overview

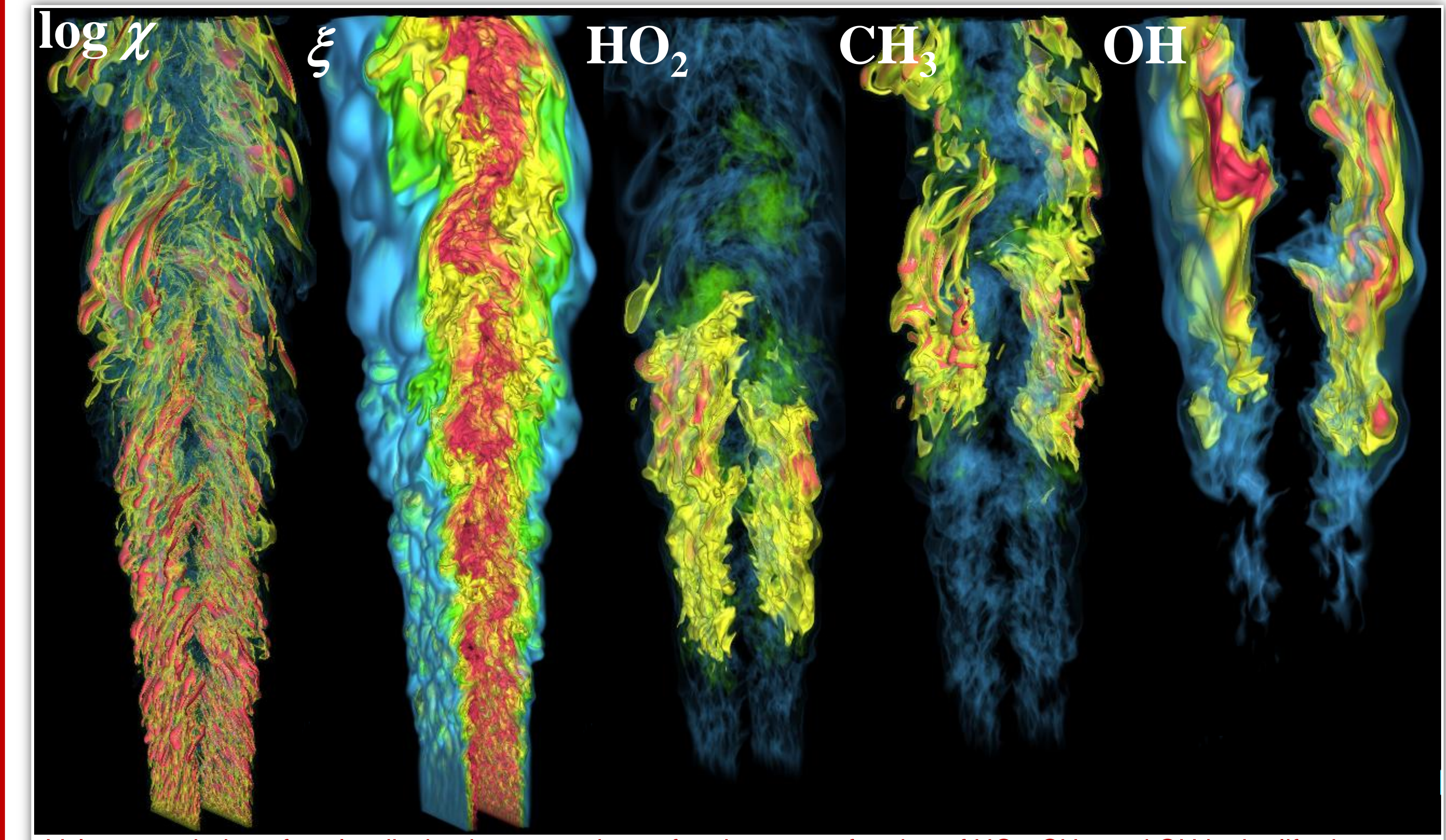
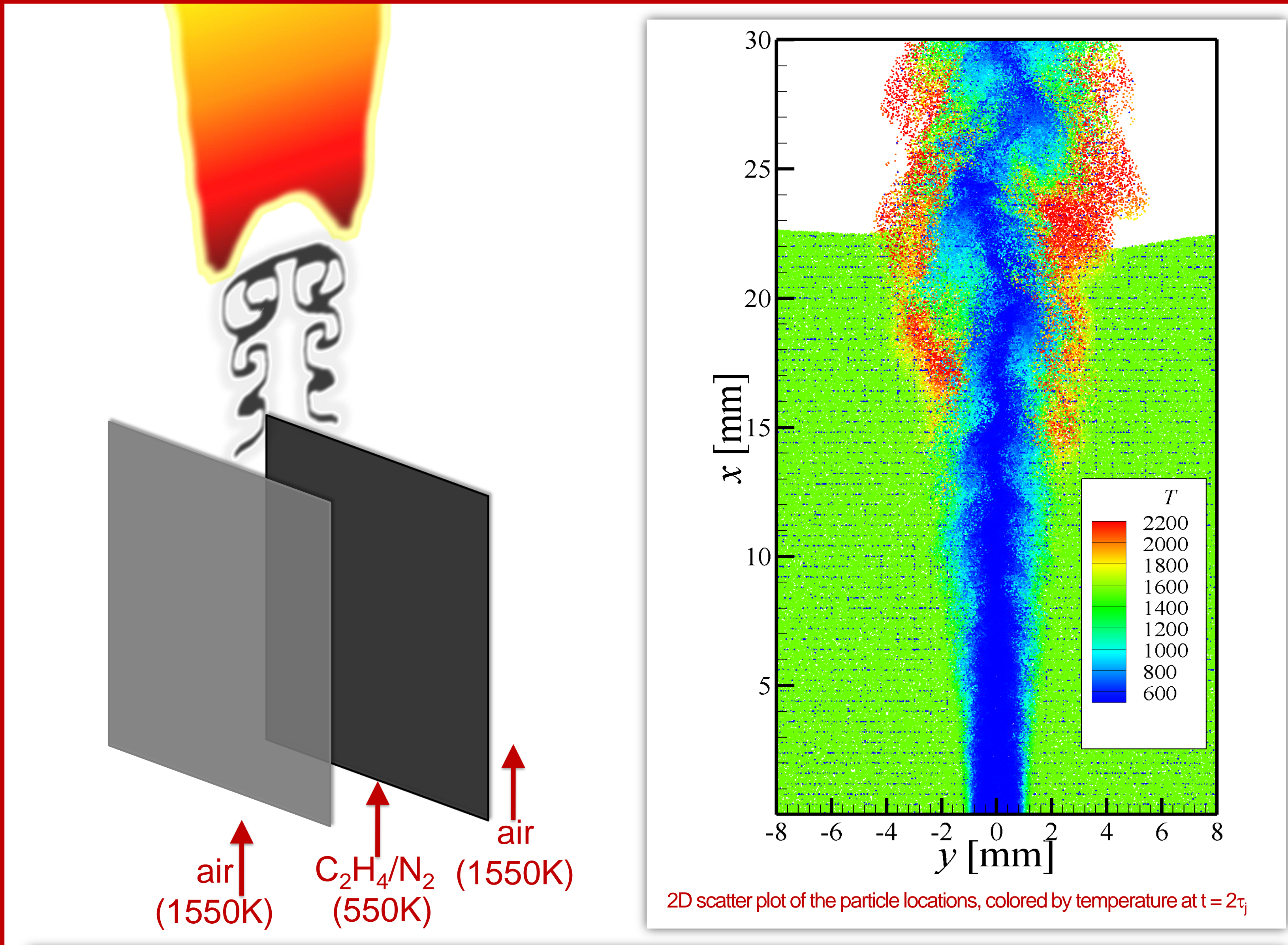
- Two computational approaches (DNS and LES/PDF) for simulating turbulent combustion
- Realistic treatment of complex fuel chemistry

Direct Numerical Simulation (DNS)

- Resolve all length and time scales
- Detailed chemistry and material properties
- No modeling
- Massive computations
- Restricted to small, simple geometries
- Provides understanding of processes, test cases for models

DNS of a Turbulent Lifted Ethylene/air Jet Flame

- Box domain [0 30]x[[-0.40]x[0 6]] (unit: mm)
- Mesh size 2025x1600x400 ~ 1.3G
- Computational cost 14 million CPU hours



- Makes excellent use of exa-scale computations
- Yields valuable insights into the small scale interactions

Motivation

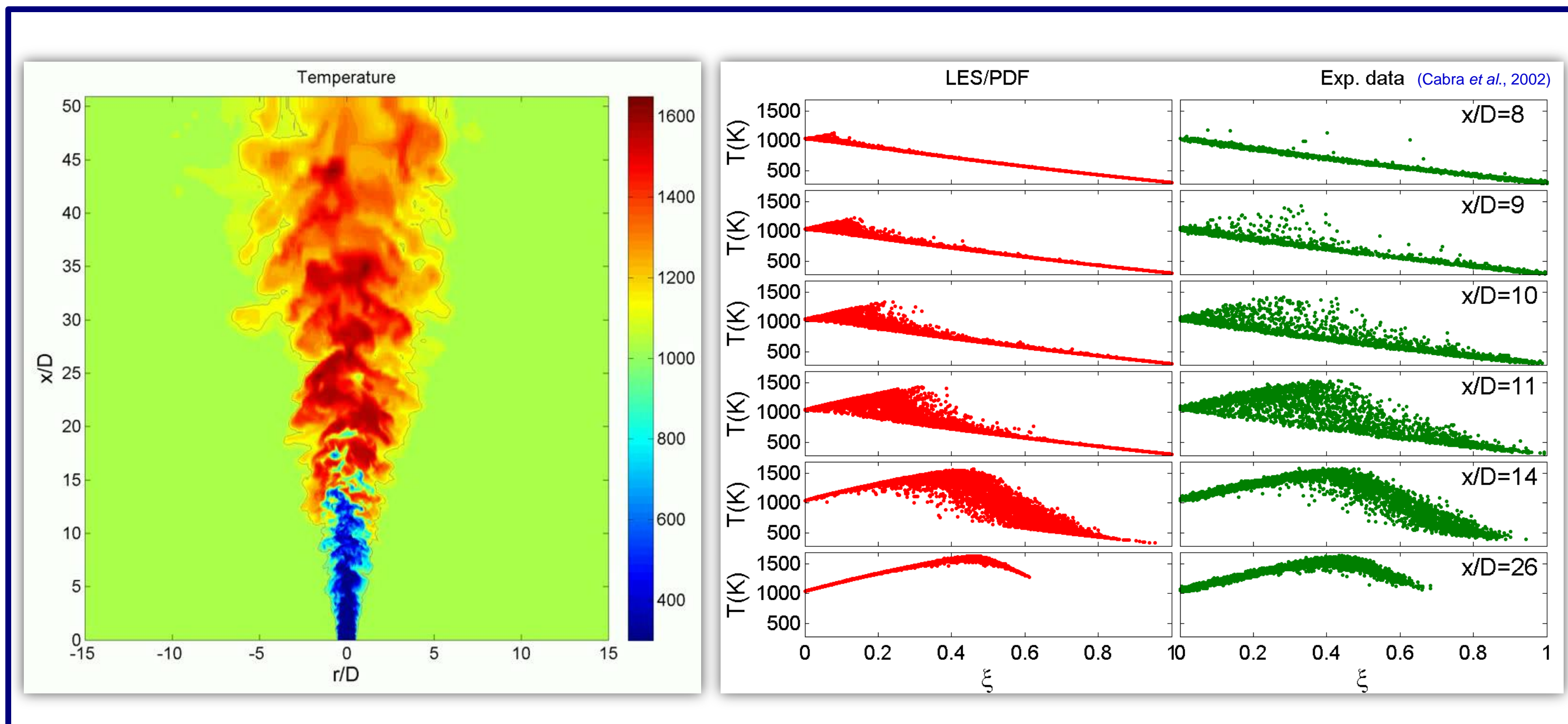
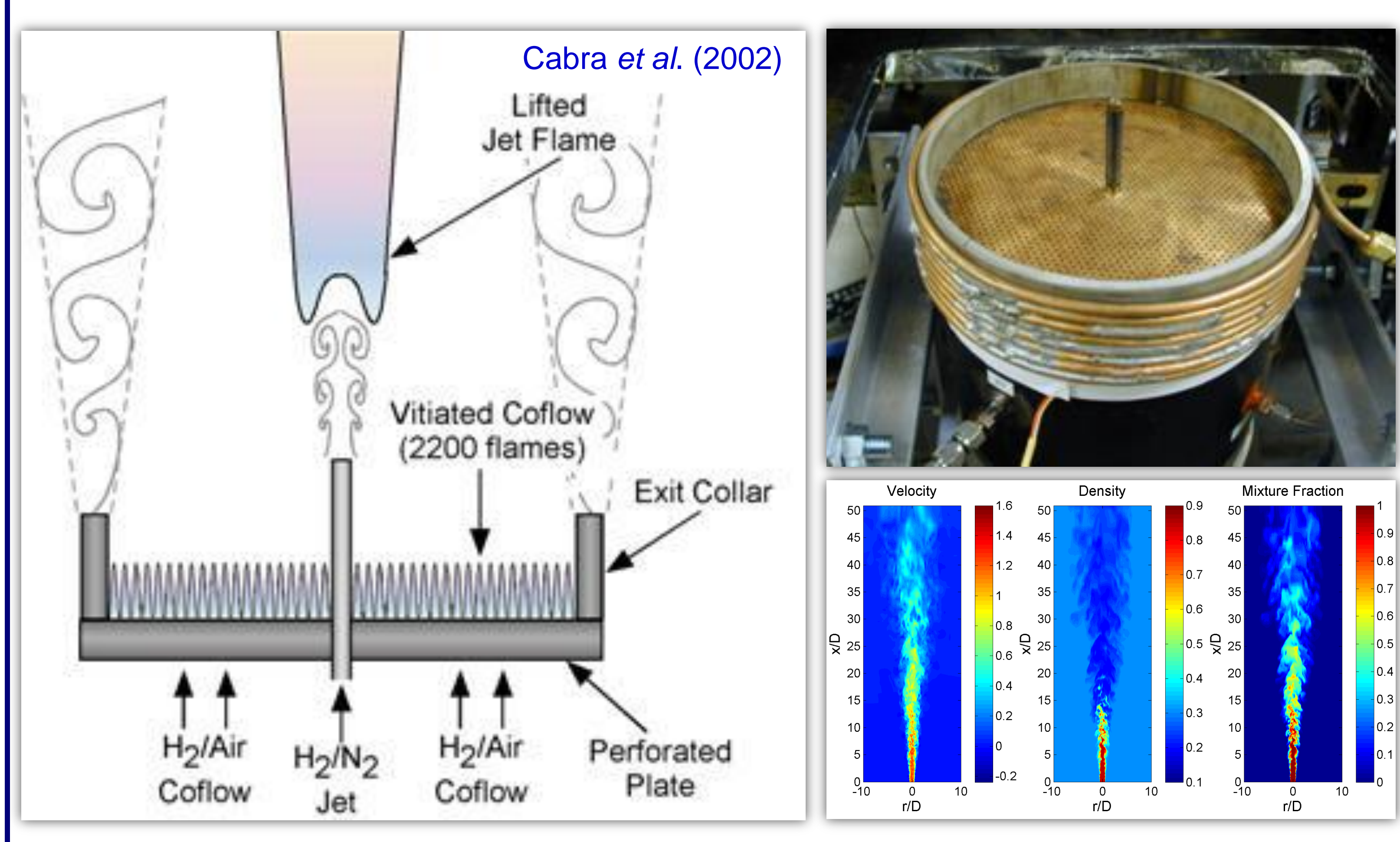
- Computer simulations essential to the development and optimization of new combustion technologies
 - Transportation (automotive, trucks, aircraft, ...)
 - Power generation
- Future transportation fuels
 - From biomass, coal, ...
 - Oxygenated hydrocarbons
 - Different combustion properties

Large-eddy Simulation (LES)/Probability Density Function (PDF)

- Resolve only large scales
- Model turbulence-chemistry interactions
- Applicable in engineering design

LES/PDF of a Turbulent Lifted H_2/N_2 Jet Flame

- Cylinder domain [0 230]x[0 90]x[0 2π] (unit: mm)
- Mesh size 216x144x96 ~ 3M
- Computational cost 0.5 million CPU hours



- Excellent agreement between LES/PDF results and Exp. data
- Promising design tool for engineering applications

Future Work

- Comparative studies with DNS and LES/PDF
- Apply the computer simulation tools to oxygenated fuels



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