ESTEP 2025 Annual Event
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Udine (ITALY)

How decarbonisation, digitisation and circular solutions forge the sustainable European steel future?

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RWTH Aachen University
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APPLICATIONS OF CFD TO H2 COMBUSTION IN INDUSTRIAL-SCALE HEATING PROCESSES OF THE STEEL INDUSTRY

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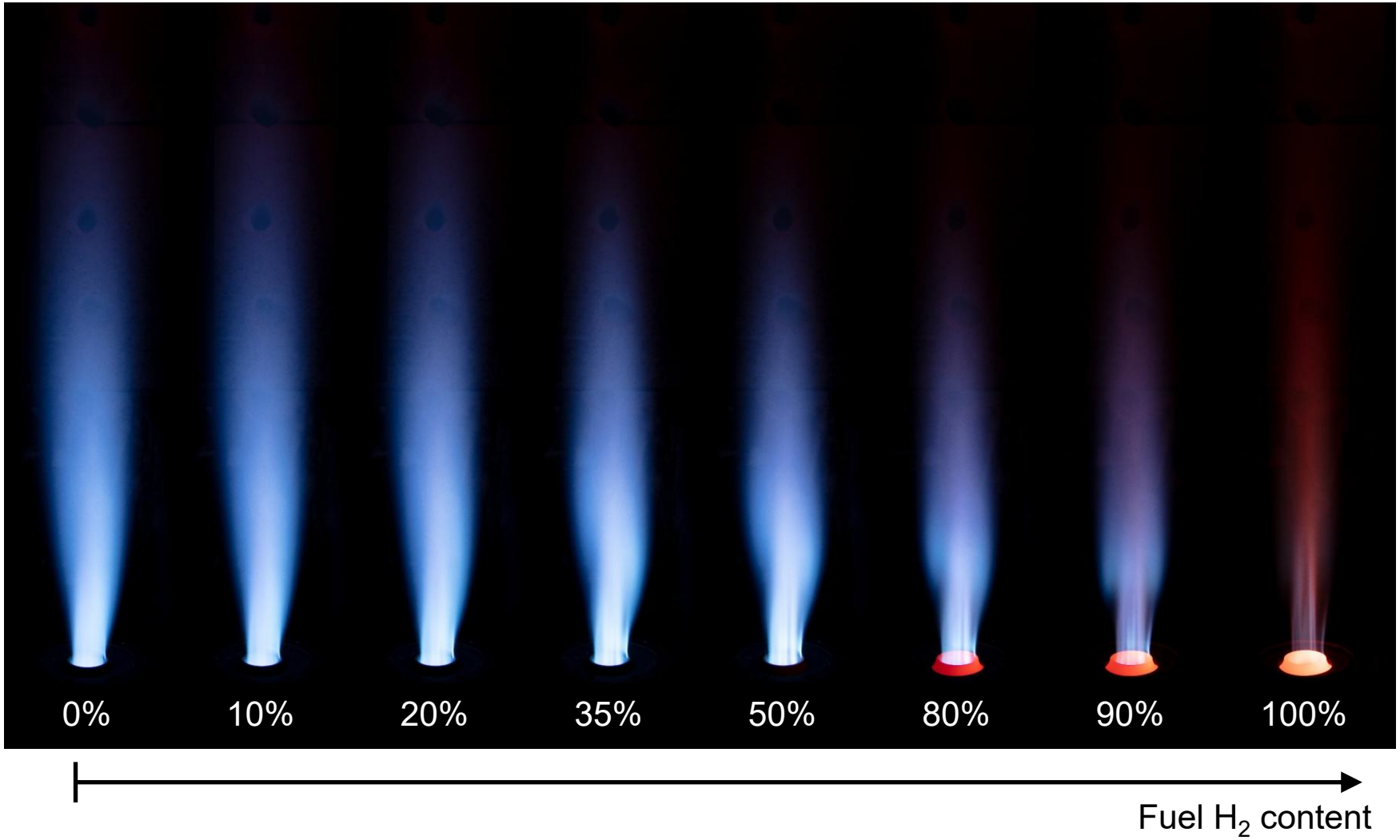
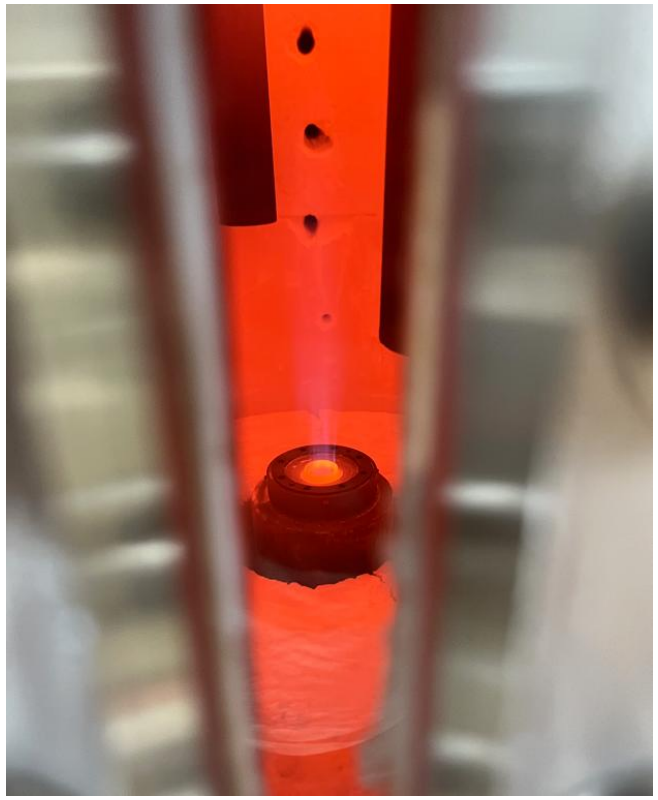
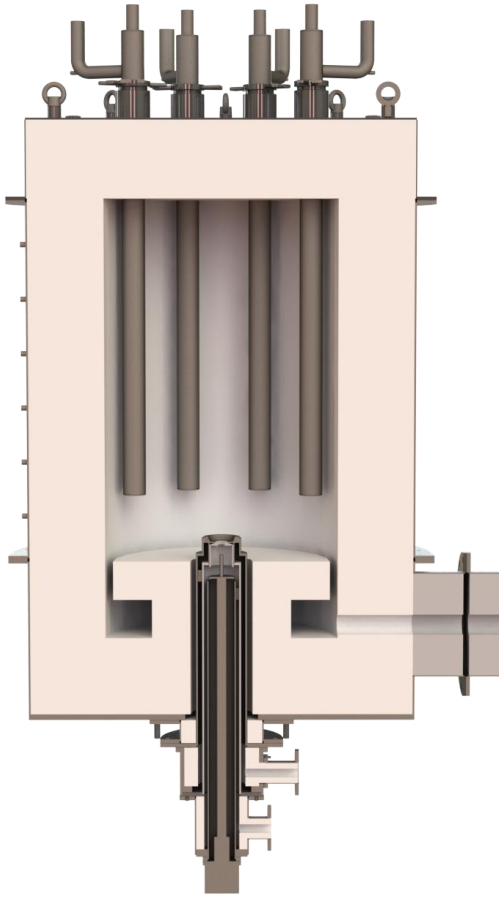
Industrial heating processes may be decarbonized by hydrogen combustion



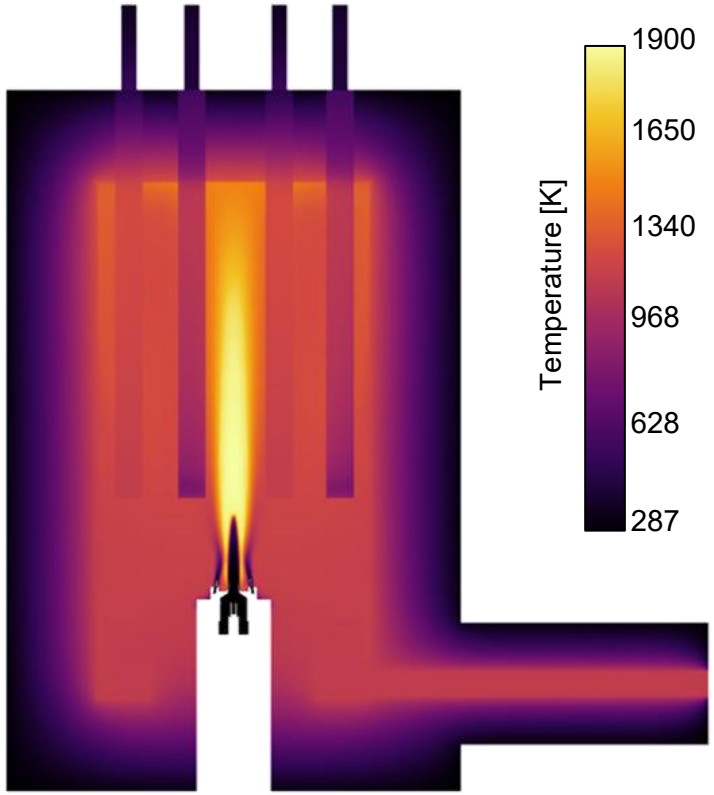
Computational Fluid Dynamics support the transformation to hydrogen fueled processes



Experiment



Model



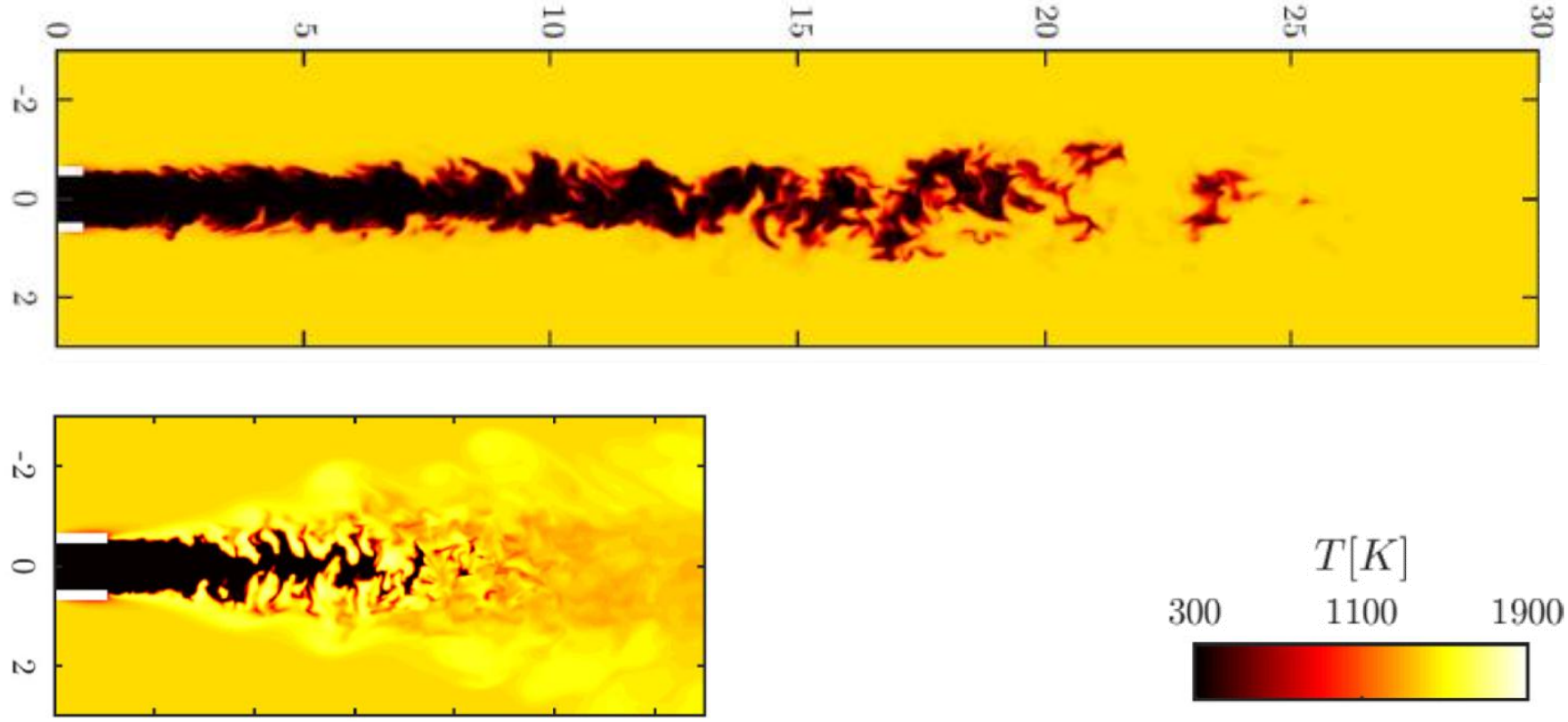
CFD

Challenges in modeling industrial hydrogen combustion

Preferential diffusion of hydrogen impacts local flame stability

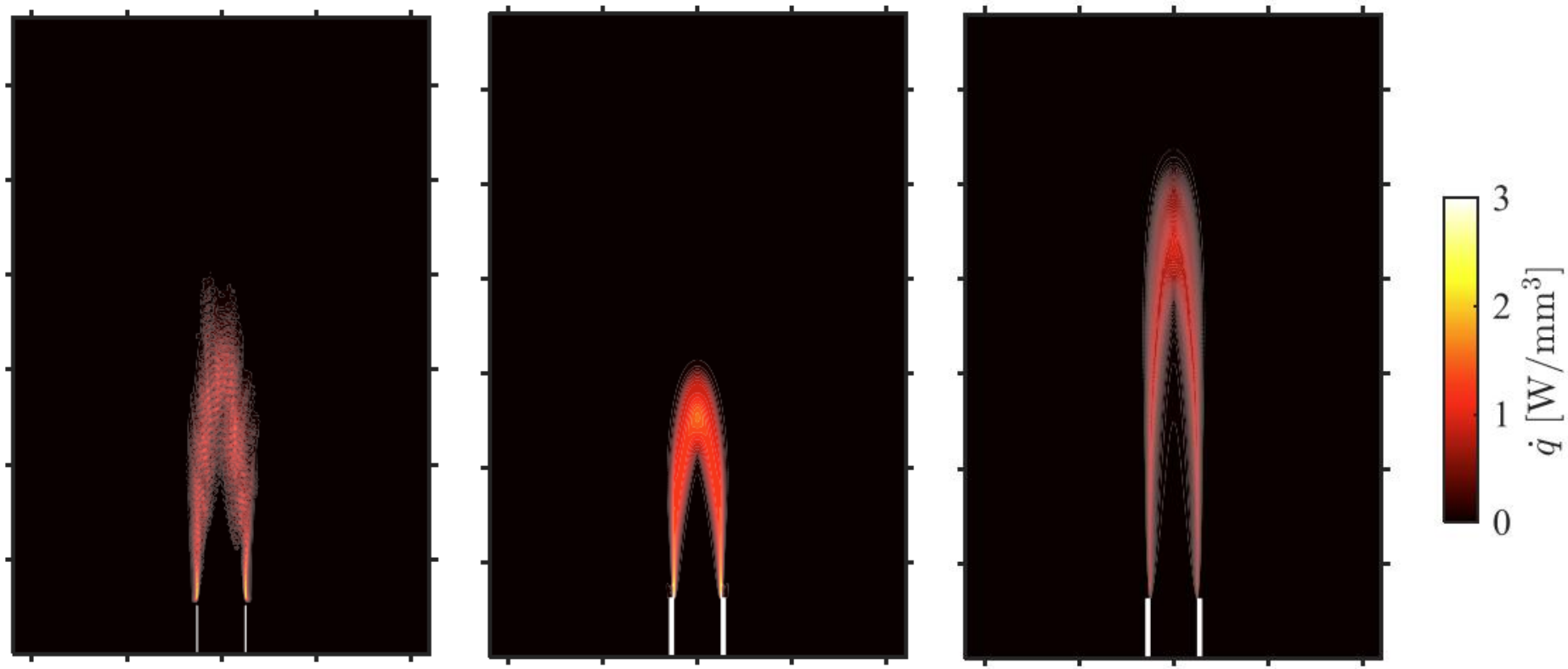
$Le = 1$

$Le \neq 1$



[1] Berger et.al. 2022, Synergistic interactions of thermodiffusive instabilities and turbulence in lean hydrogen flames, Combusiton and Flame

Including preferential diffusion improves heat release predictions of tabulated chemistry model



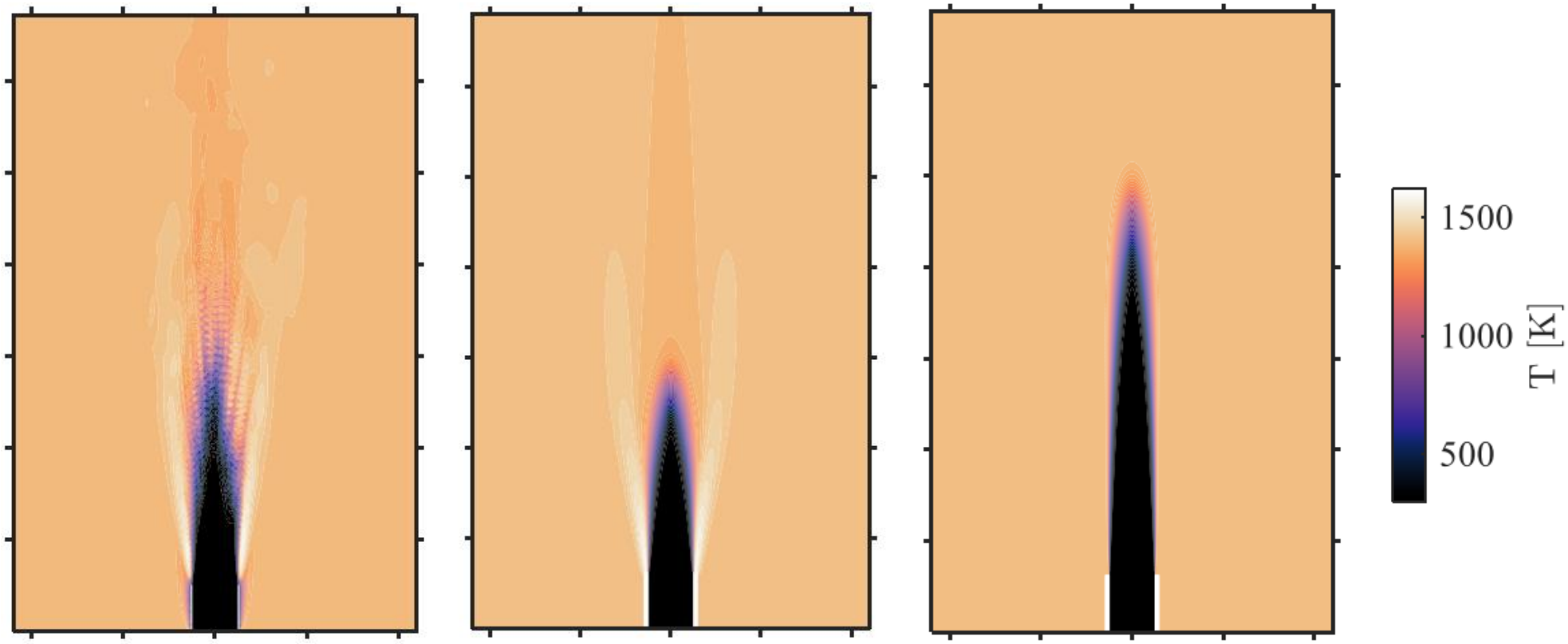
DNS
$Le \neq 1$

RANS
$Le \neq 1$

RANS
$Le = 1$

[2] Report on simulation framework for H2/O2 and H2/air combustion, HyInHeat D2.3

Including preferential diffusion improves temperature predictions of tabulated chemistry model



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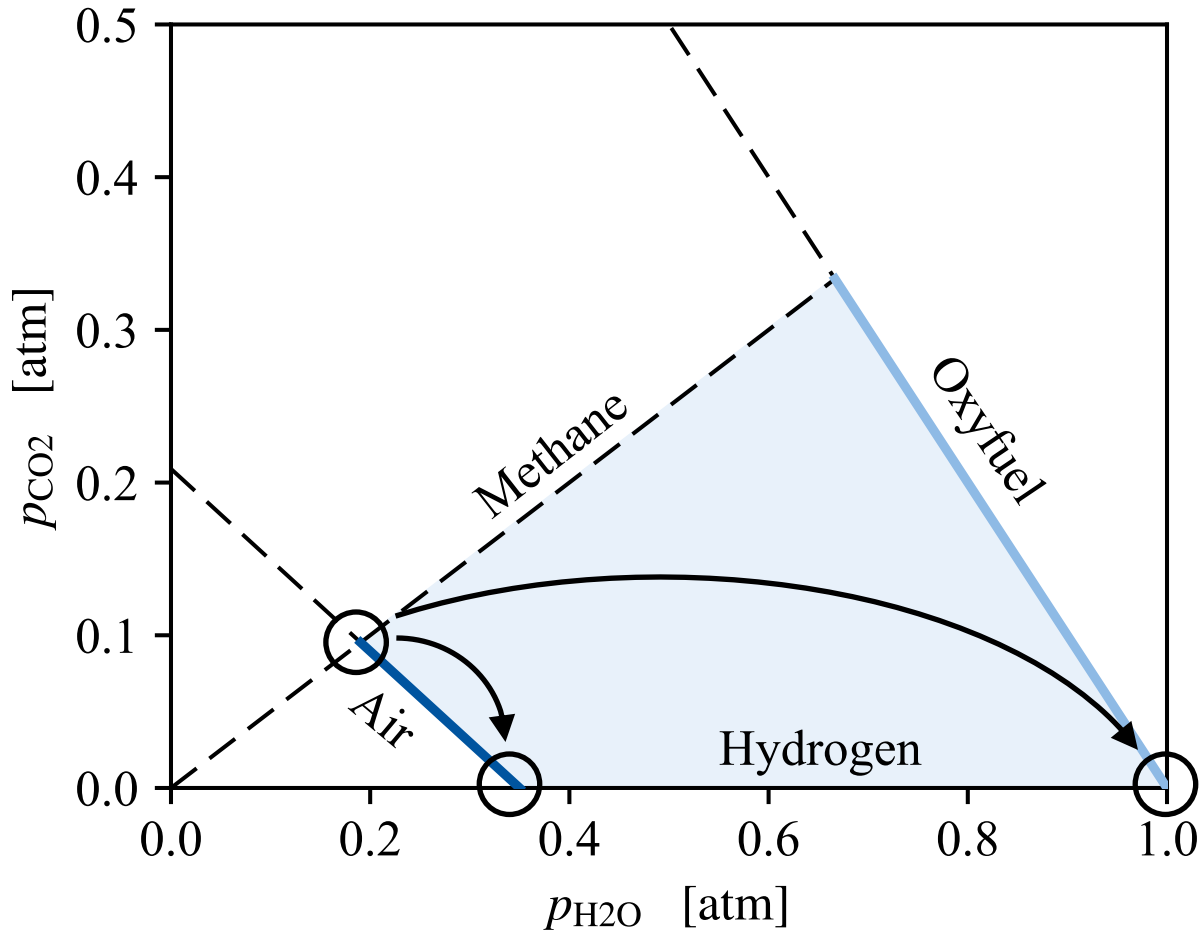
[2] Report on simulation framework for H2/O2 and H2/air combustion, HyInHeat D2.3

Hydrogen admixture to the fuel alters the flue gas composition



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IOB Department for Industrial Furnaces and Heat Engineering

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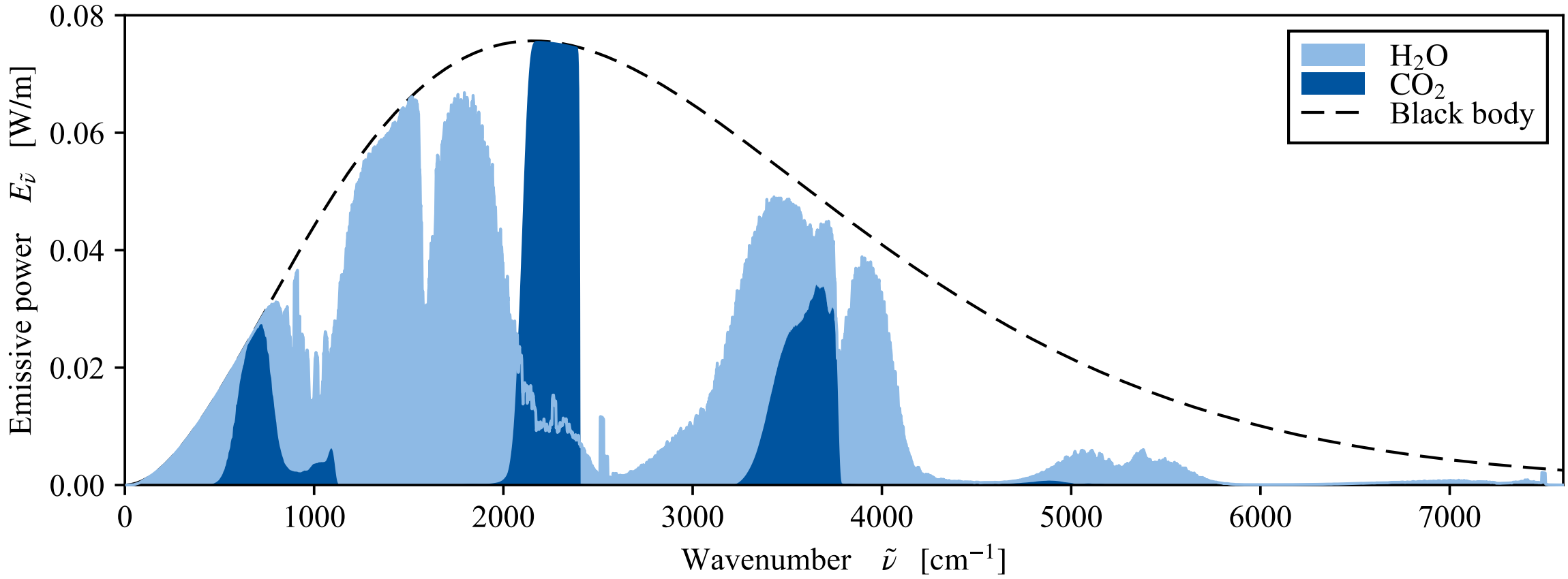
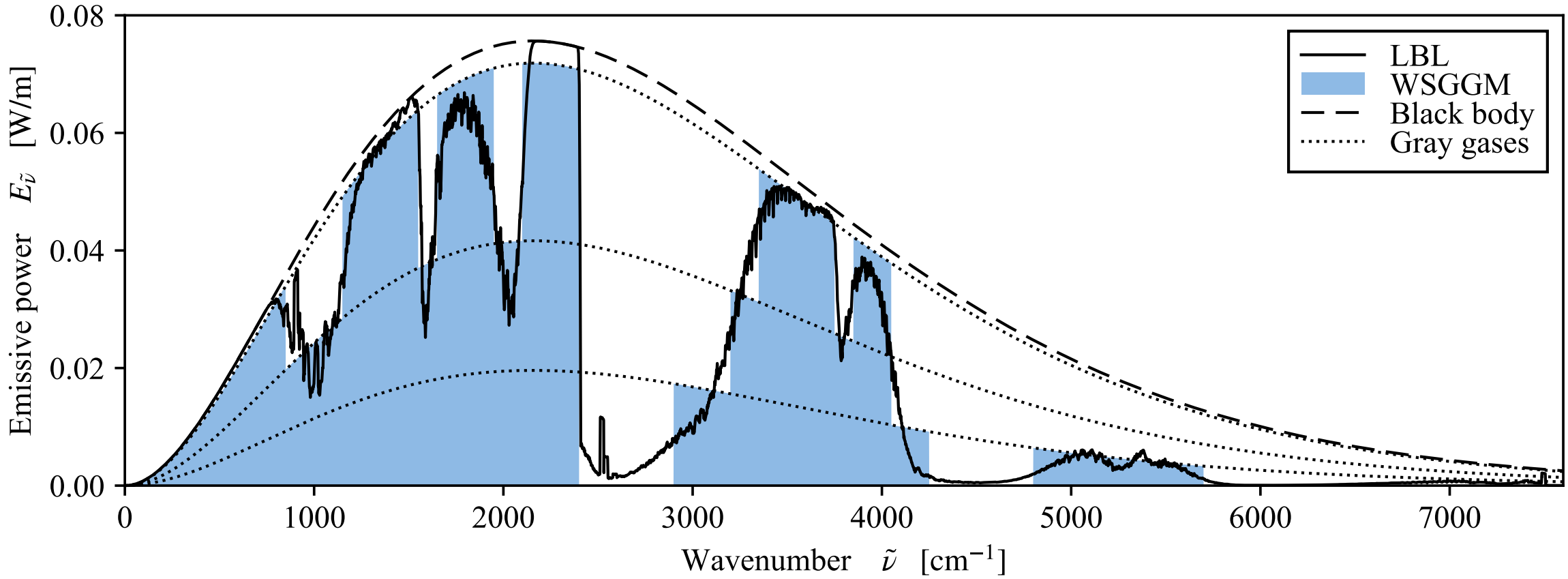
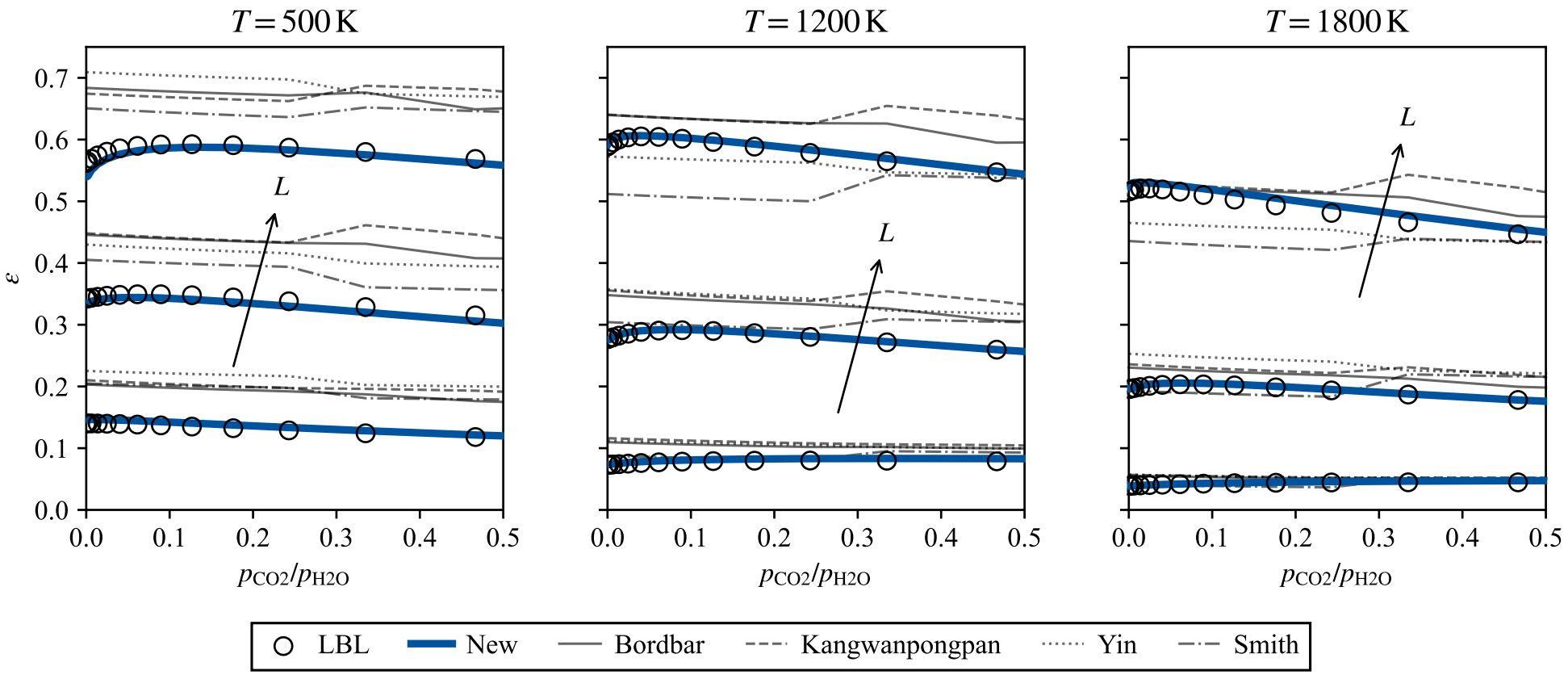
Radiative properties of the flue gas change due to reduced CO_2 content



A weighted sum of gray gases model for gas absorptivity is calibrated at the new conditions



The new model yields improved predictions for flue gas emissivity



[3] Losacker et.al. 2025, Full-spectrum k-distribution weighted sum of gray gases model for air and oxyfuel combustion of hydrogen-hydrocarbon blends at atmospheric pressure, Thermal Science and Engineering Progress

New models are applied in industrial-scale CFD simulations

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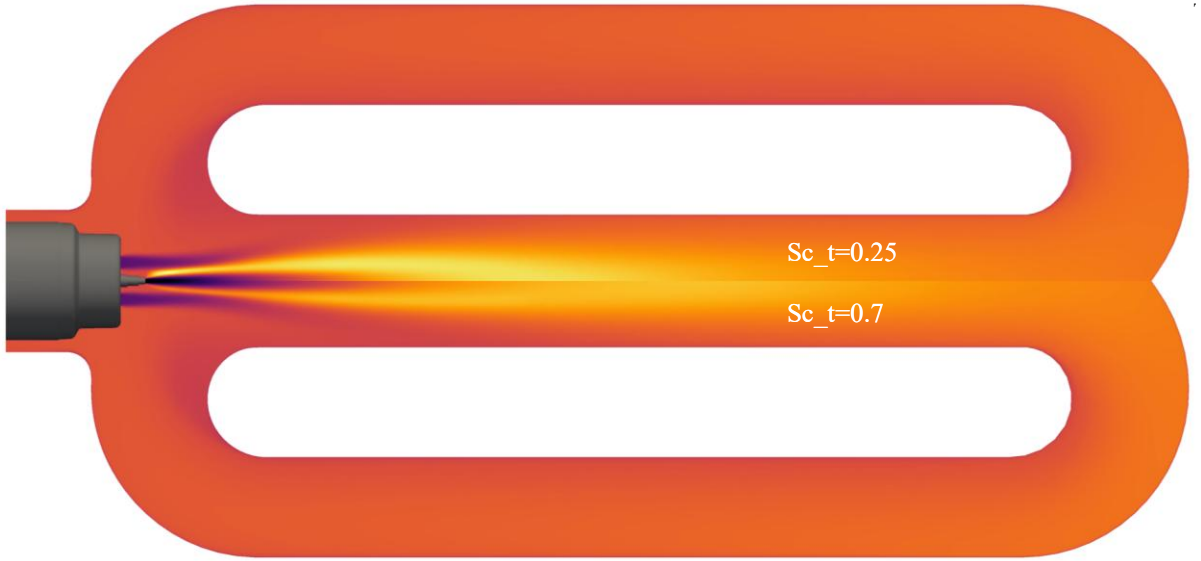
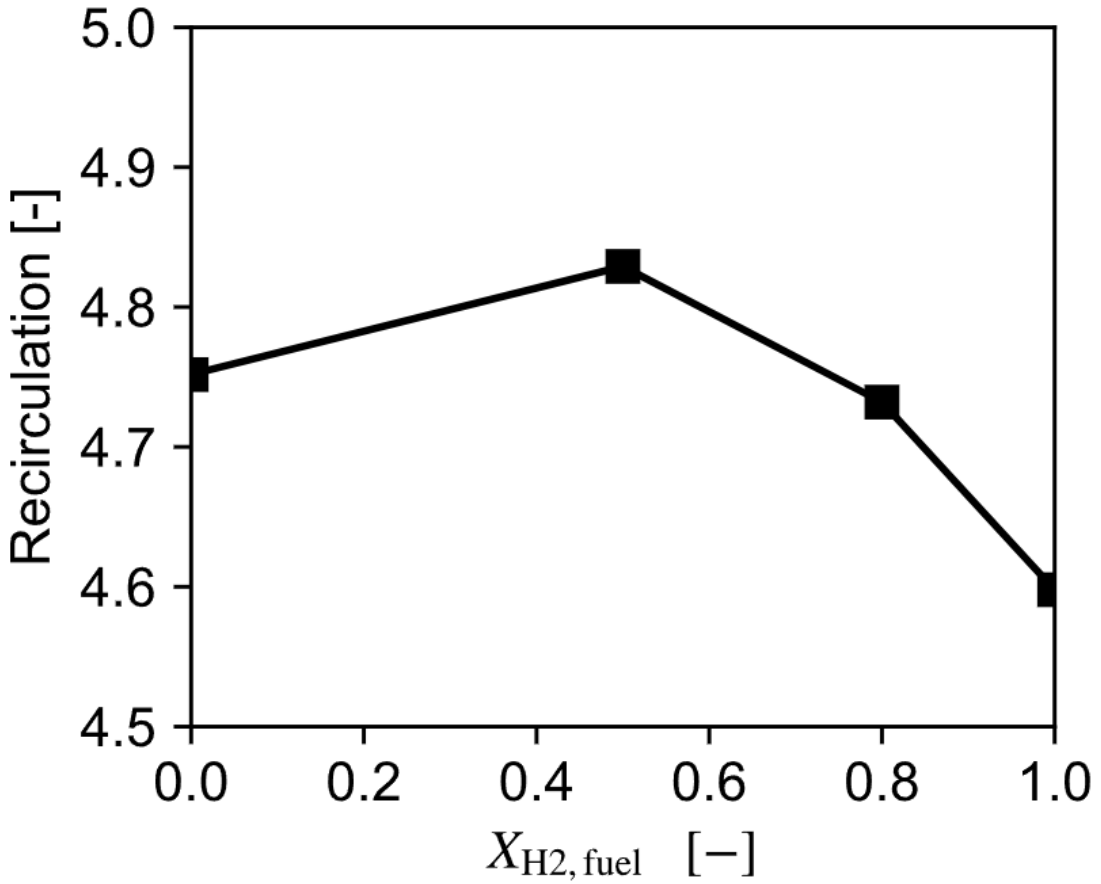
New models are employed to analyse pollutant formation in radiant tubes





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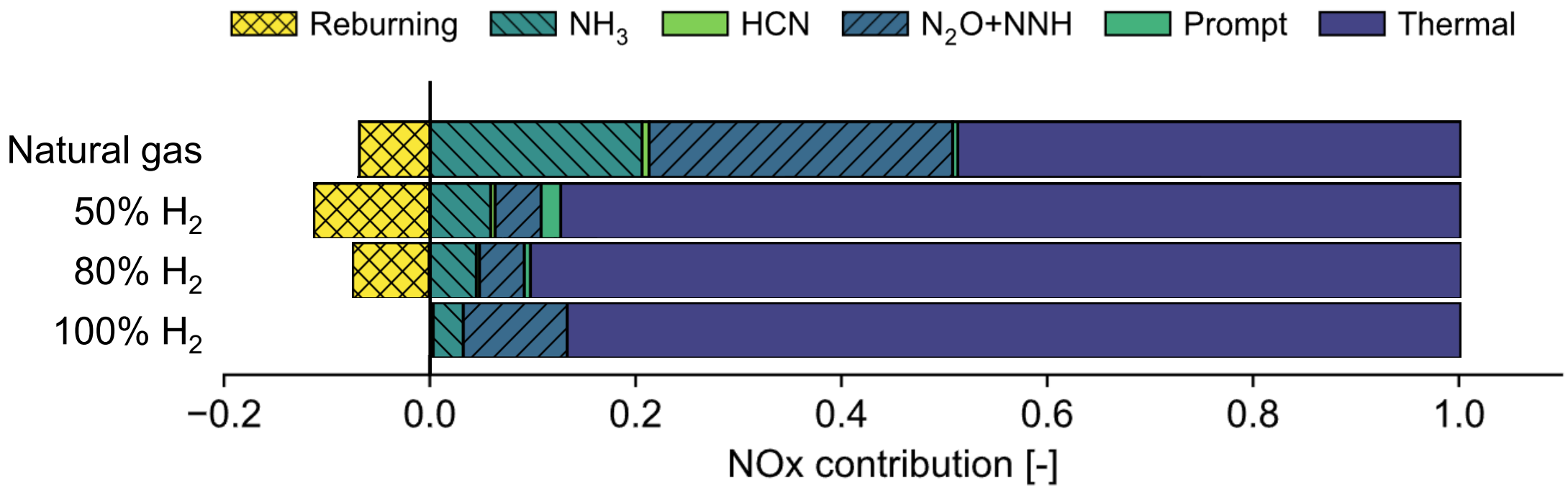
NO formation pathways change with fuel hydrogen admixture



Funded by the European Union

Thinking the Future
Zukunft denken

Thank you
for your attention

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