



HAL
open science

Effects of CO₂-H₂O dilution on the characteristics of CH₄-air-O₂ flames

H. Zaidaoui, T. Boushaki, J.C. C Sautet, C. Chauveau, I. Gökalp

► **To cite this version:**

H. Zaidaoui, T. Boushaki, J.C. C Sautet, C. Chauveau, I. Gökalp. Effects of CO₂-H₂O dilution on the characteristics of CH₄-air-O₂ flames. 9th European Combustion Meeting, Apr 2019, Lisboa, Portugal. . hal-02110516

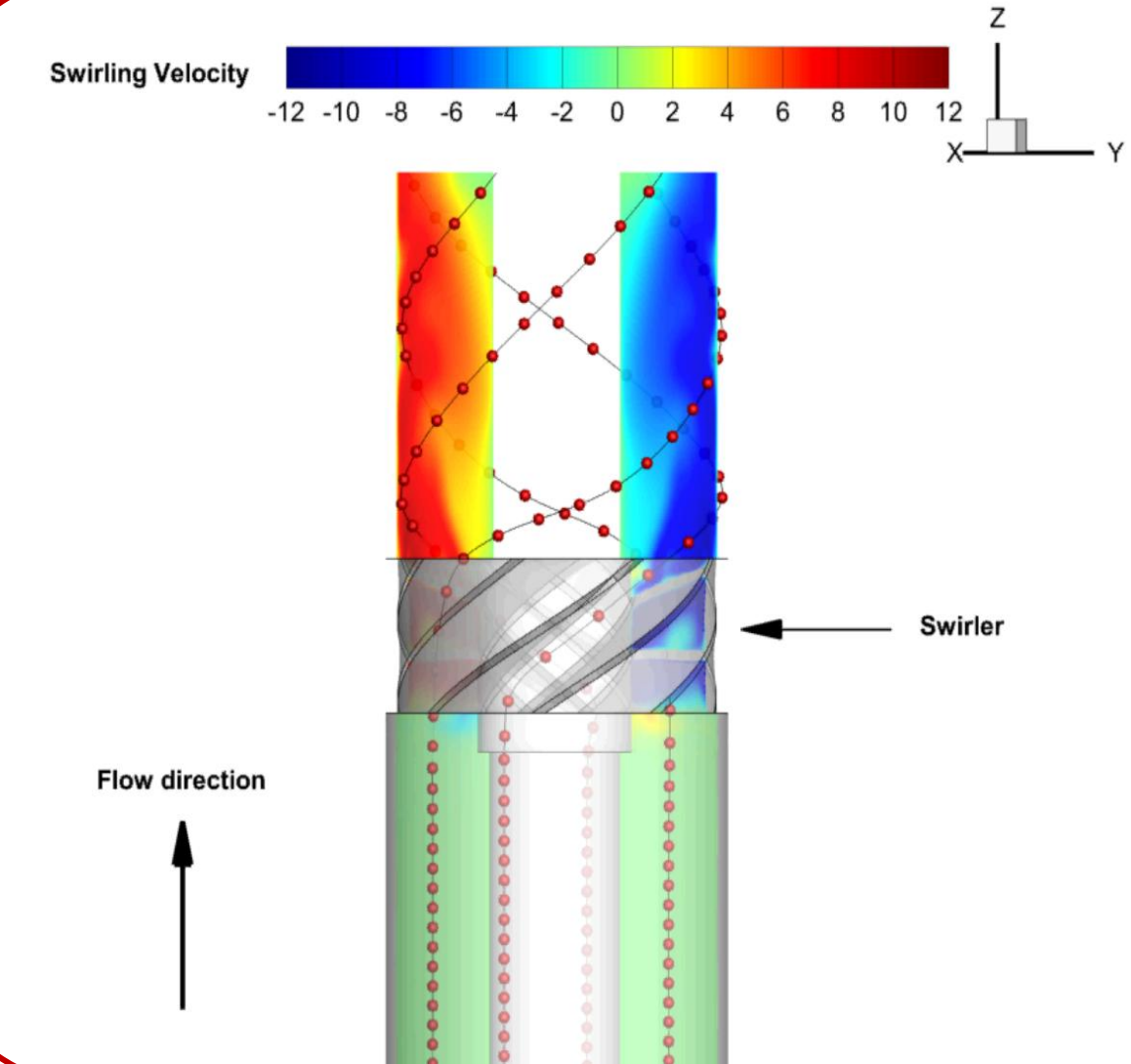
HAL Id: hal-02110516

<https://hal.science/hal-02110516v1>

Submitted on 25 Apr 2019

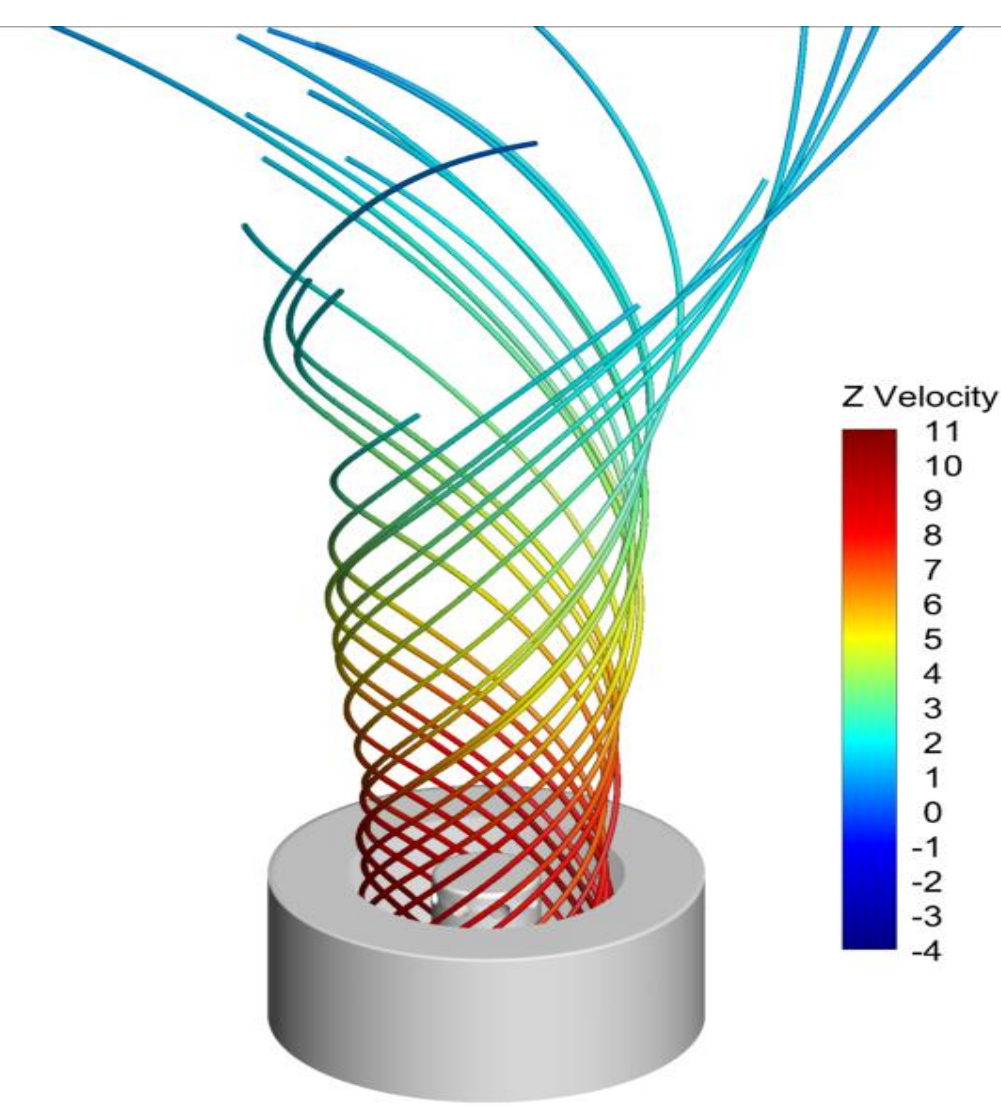
HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Context and objectives

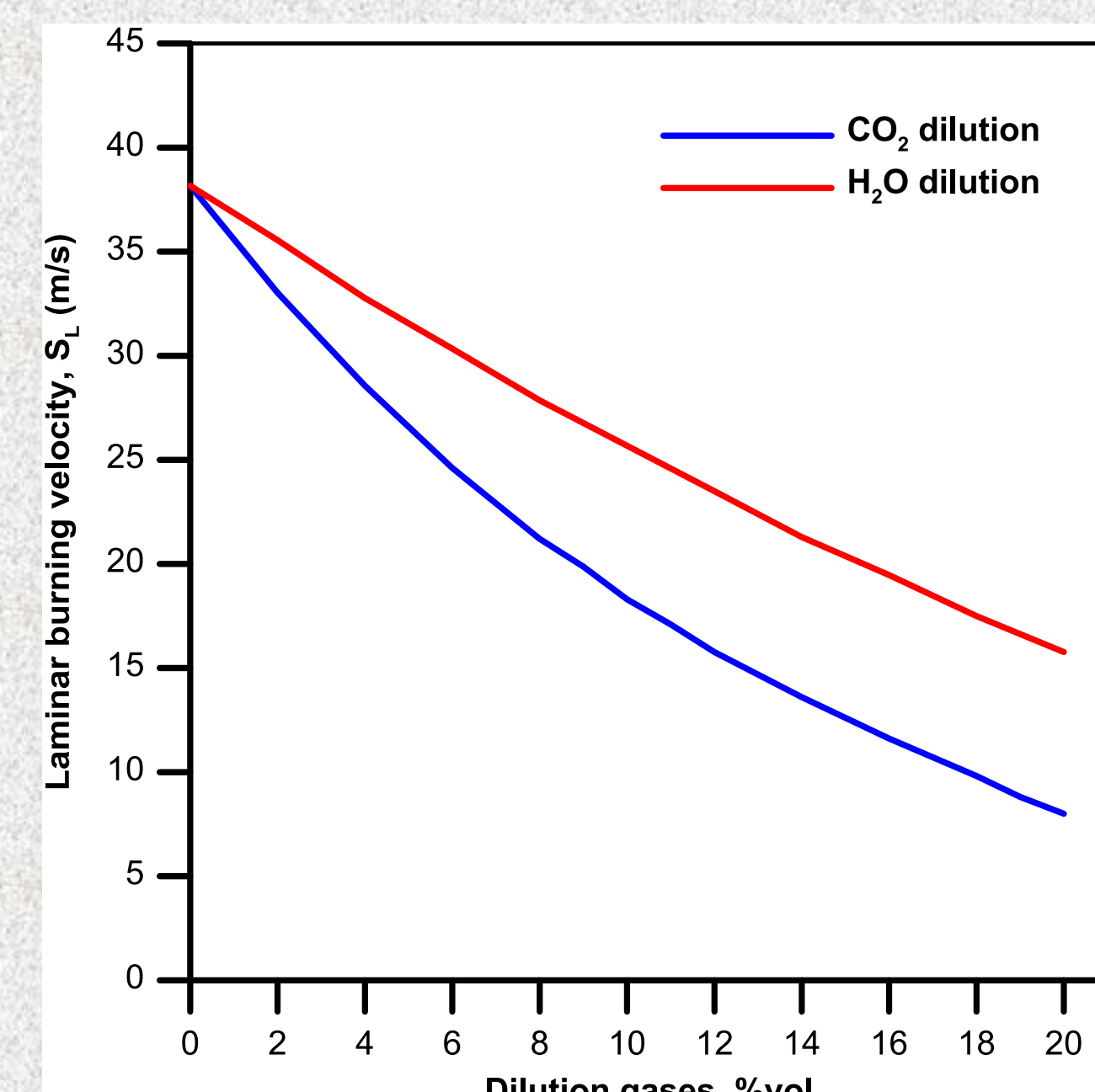
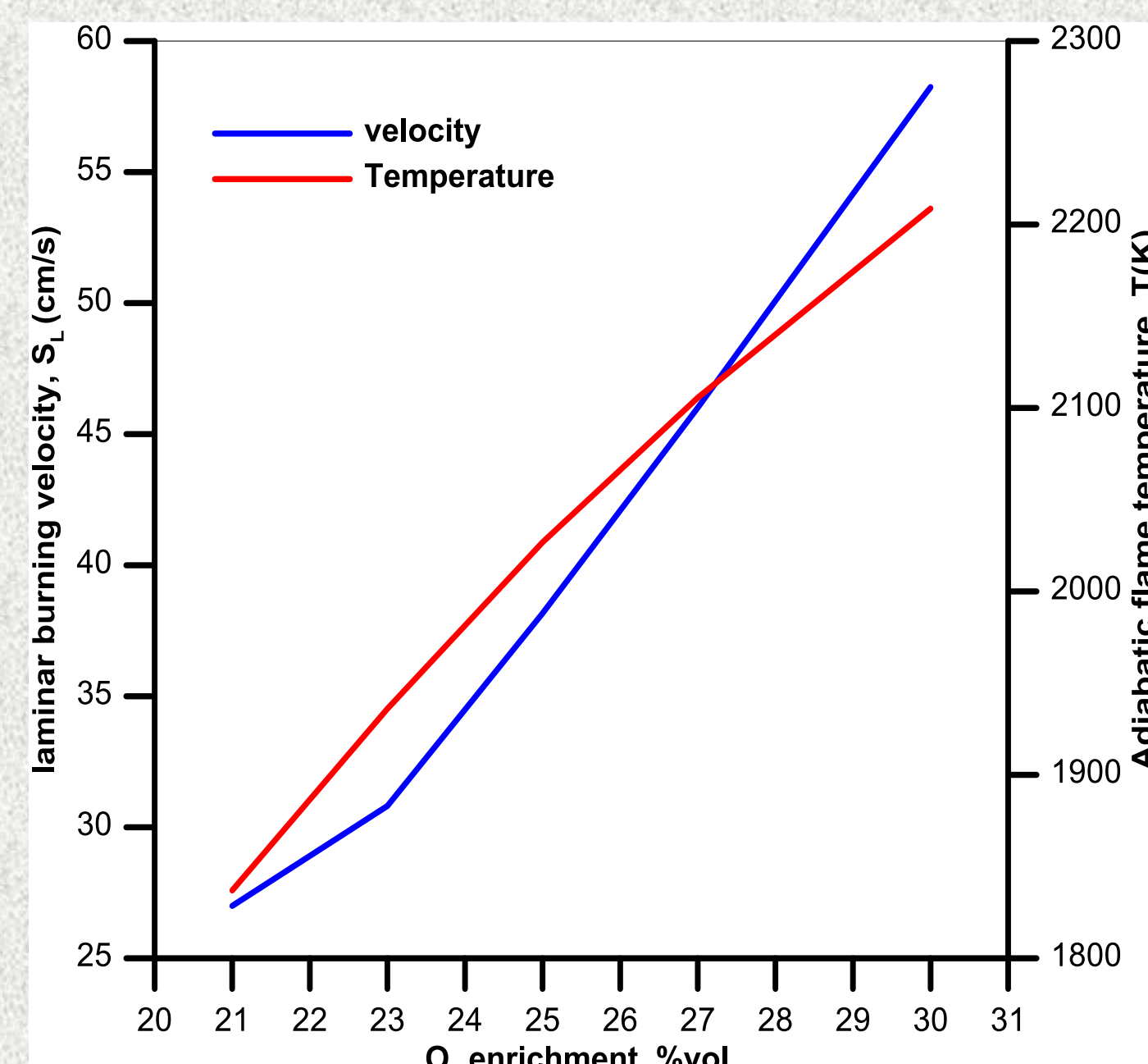
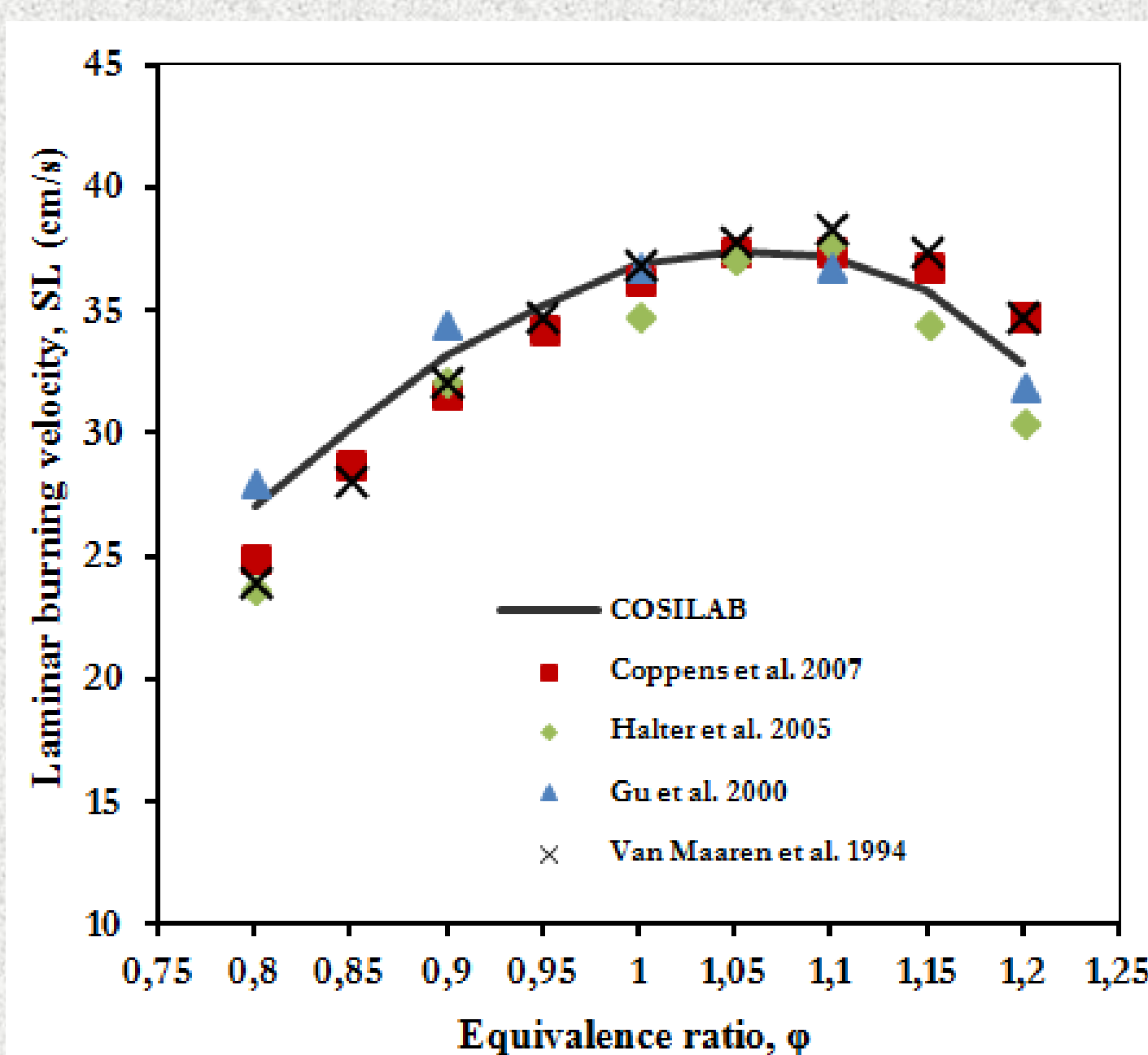
- **Study of non-premixed turbulent flames stabilized by a swirler**
 - Control of pollutant emissions / emissions standards
 - Improve performances of combustion plants
- **Investigations on flame characteristics**
 - Effects of oxygen enrichment
 - Effects of steam and CO₂ dilution
 - Effects of swirl intensity



The numerical computations were conducted with **COSILAB** software

- Freely propagating methane-air flames.
- One-dimensional premixed flame.
- GRI-mech 3.0 mechanism.
- Atmospheric pressure and 300K.
- Equivalence ratio : from 0.8 to 1.2
- Oxygen enrichment : from 21% to 30%vol.
- Dilution : (0-20%vol) for both CO₂ and H₂O.

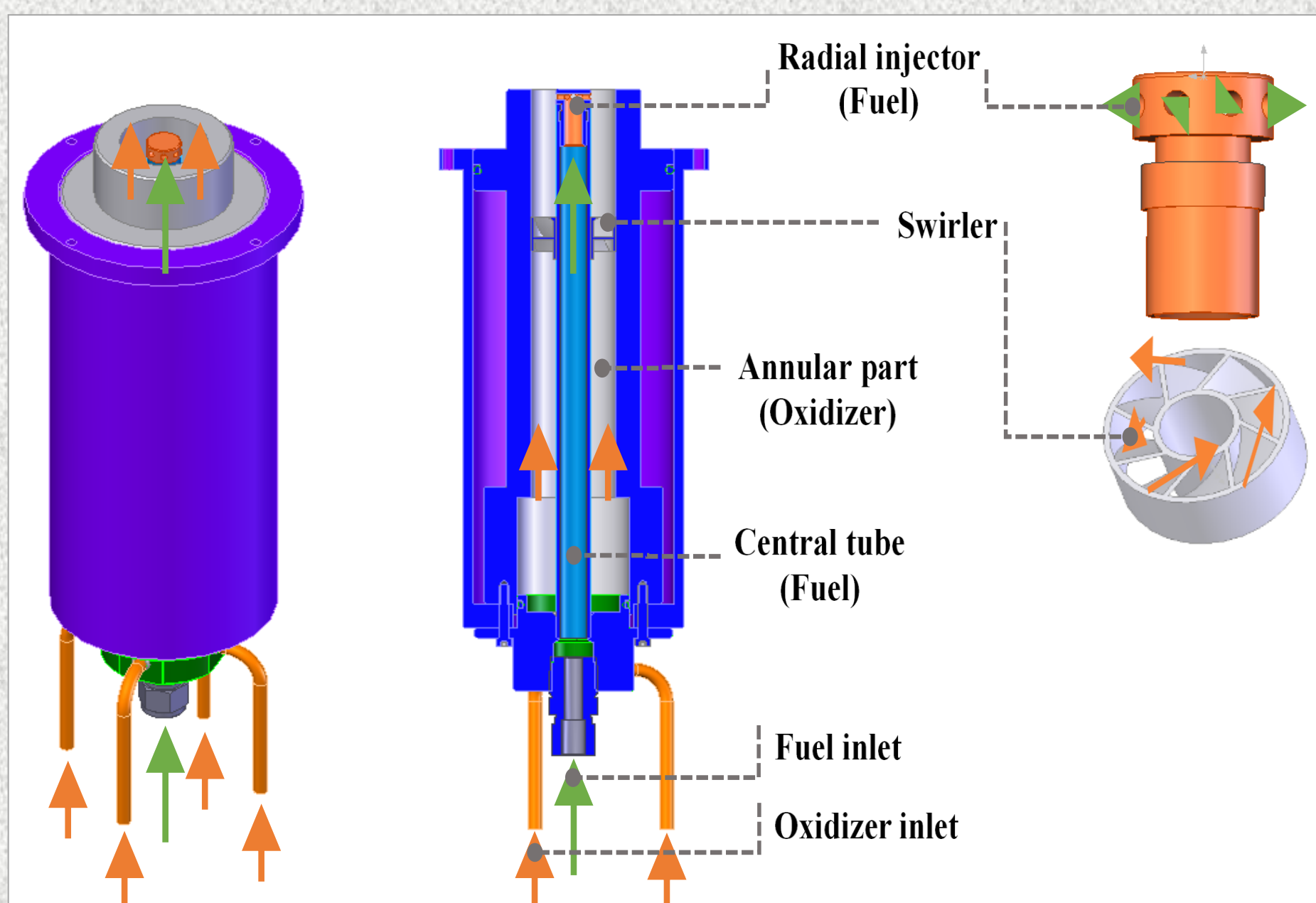
Numerical calculations



- With O₂: notable increase in flame temperature and laminar burnig velocity.
- With dilution: significant decrease in laminar burning velocity, the effect of CO₂ is greatest.

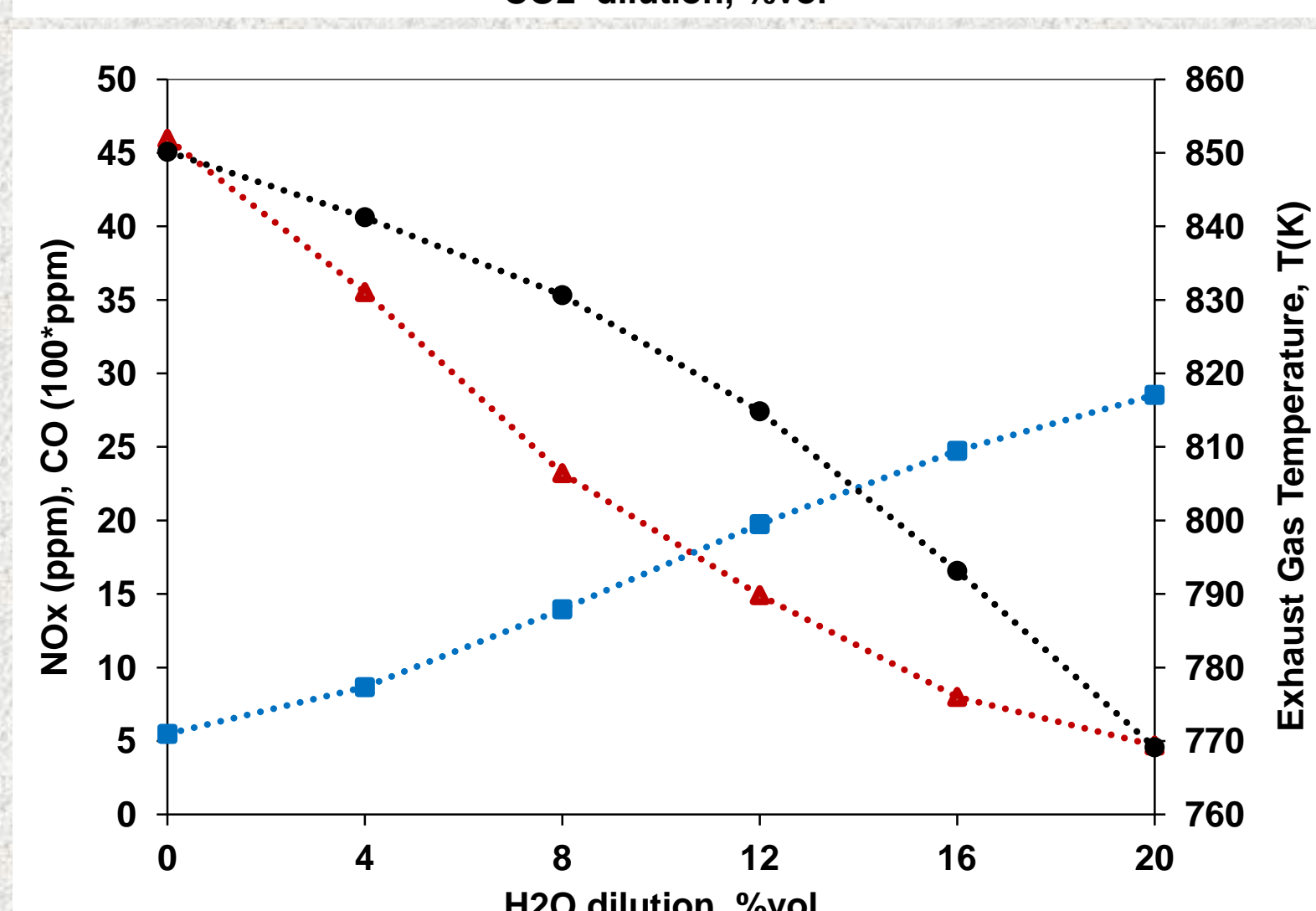
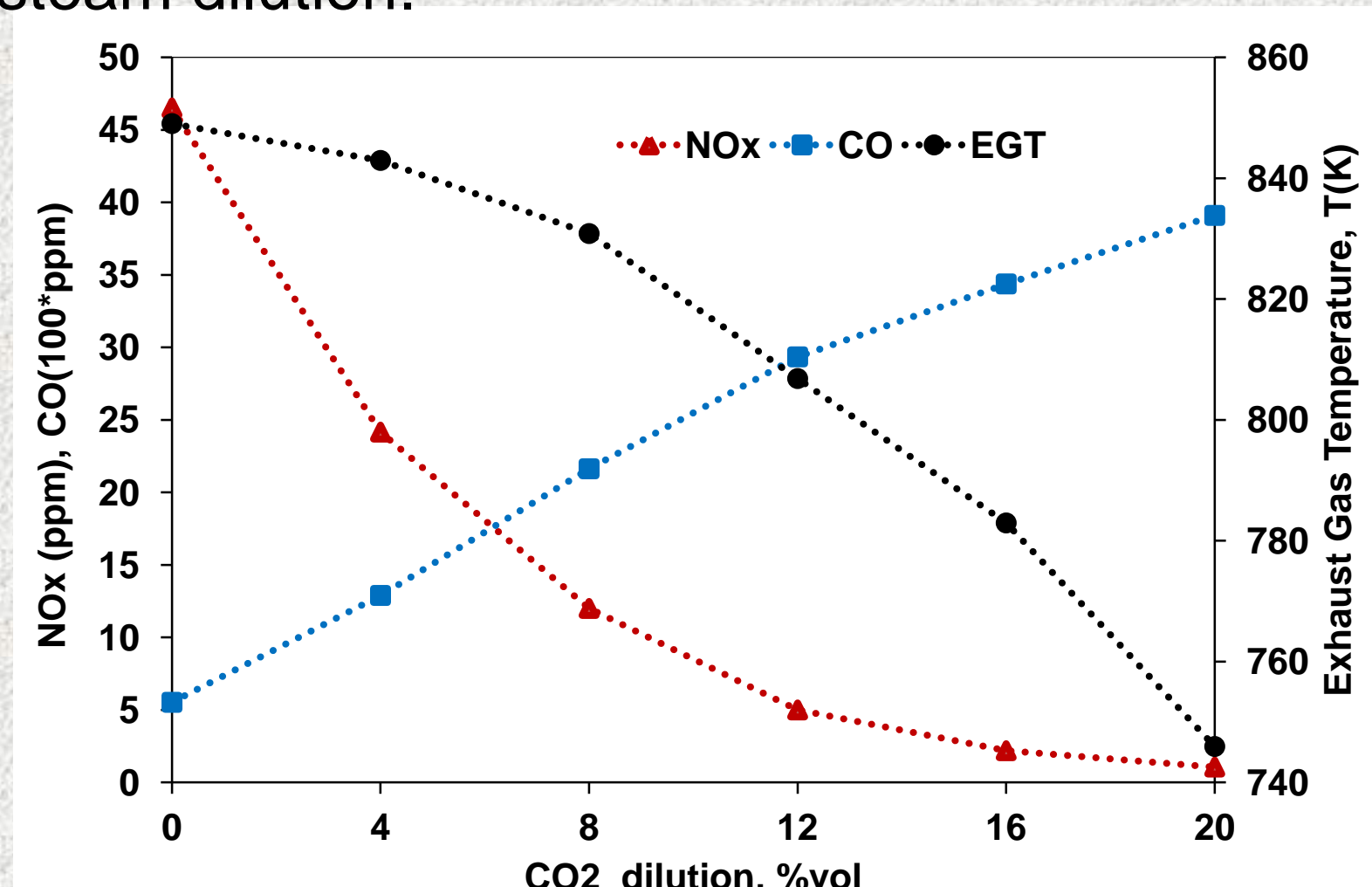
Experimental study

Coaxial swirl burner



NO_x and CO emissions and exhaust gas temperature are reported as a function of H₂O and CO₂ dilution. Case: Sn = 0.8, φ = 0.8, and 25% oxygen enriched methane/air mixture at atmospheric pressure.

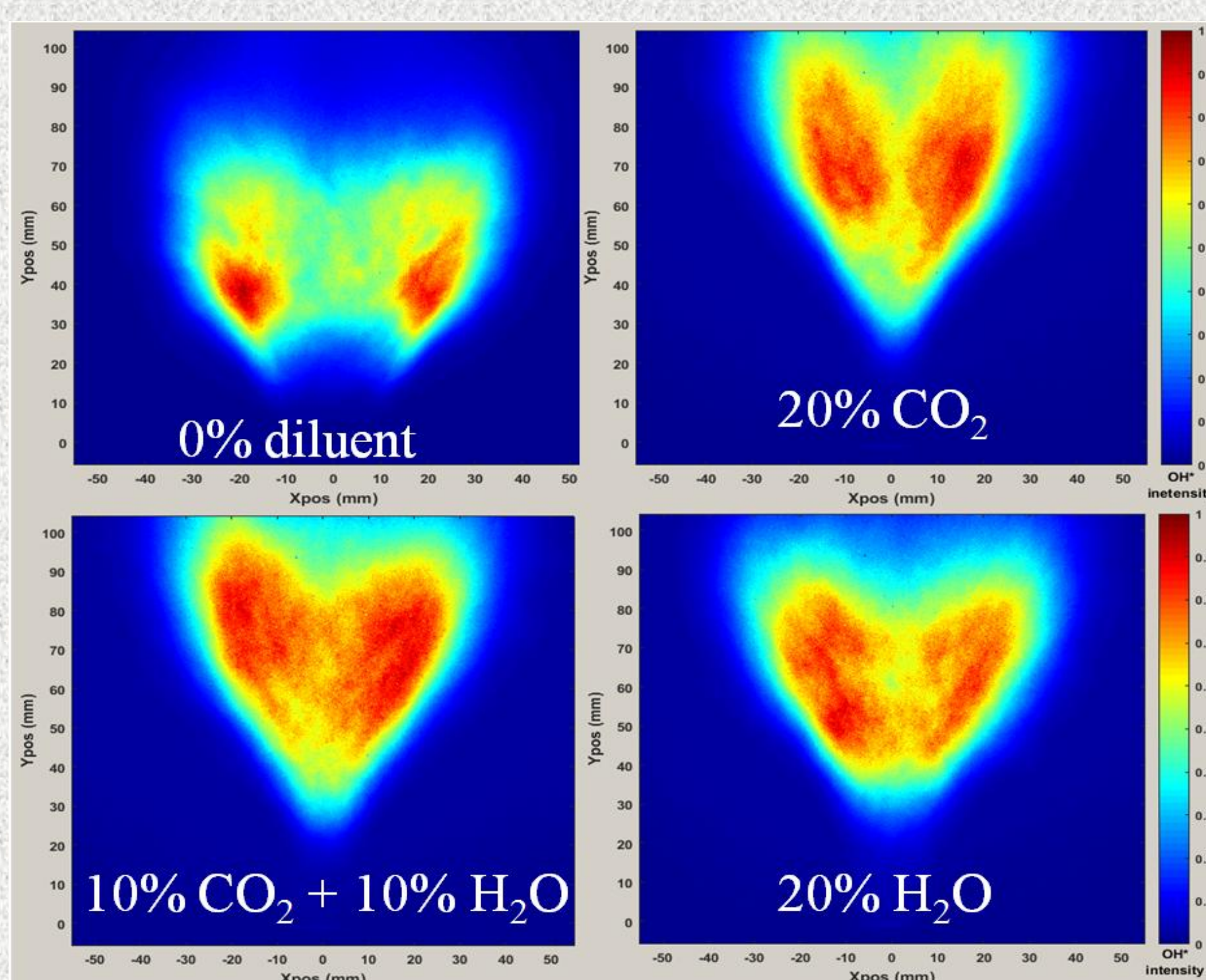
→ Effect of CO₂ dilution is stronger than that of steam dilution.



OH* chemiluminescence

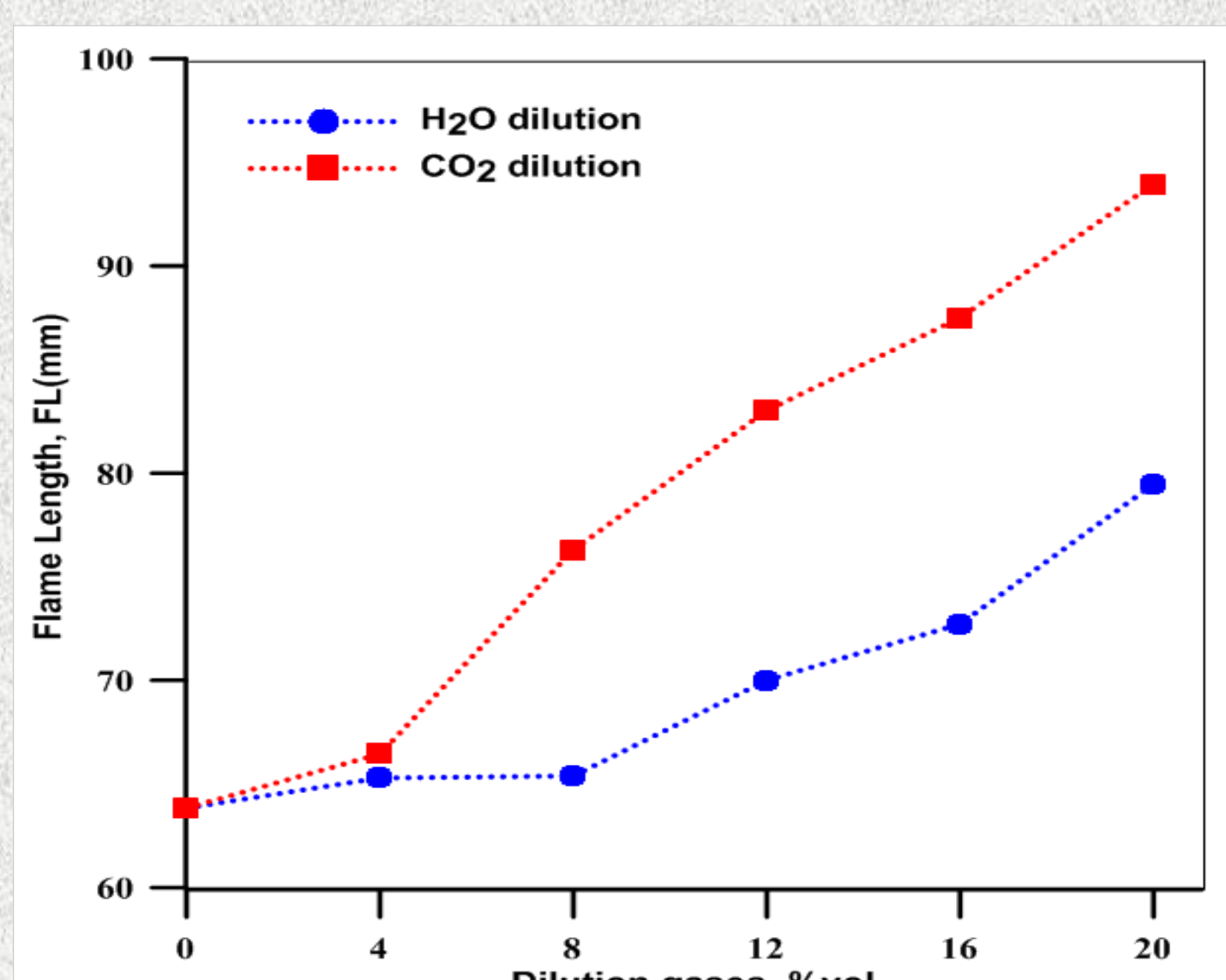
OH* intensity distributions of methane/air swirling flames diluted by CO₂, H₂O and EGR, in the case of 21% O₂, for Sn=0.8 and φ=0.8.

- The flame becomes taller and unsettled with dilution.
- CO₂ has greater effect on the flame lift-off heights.

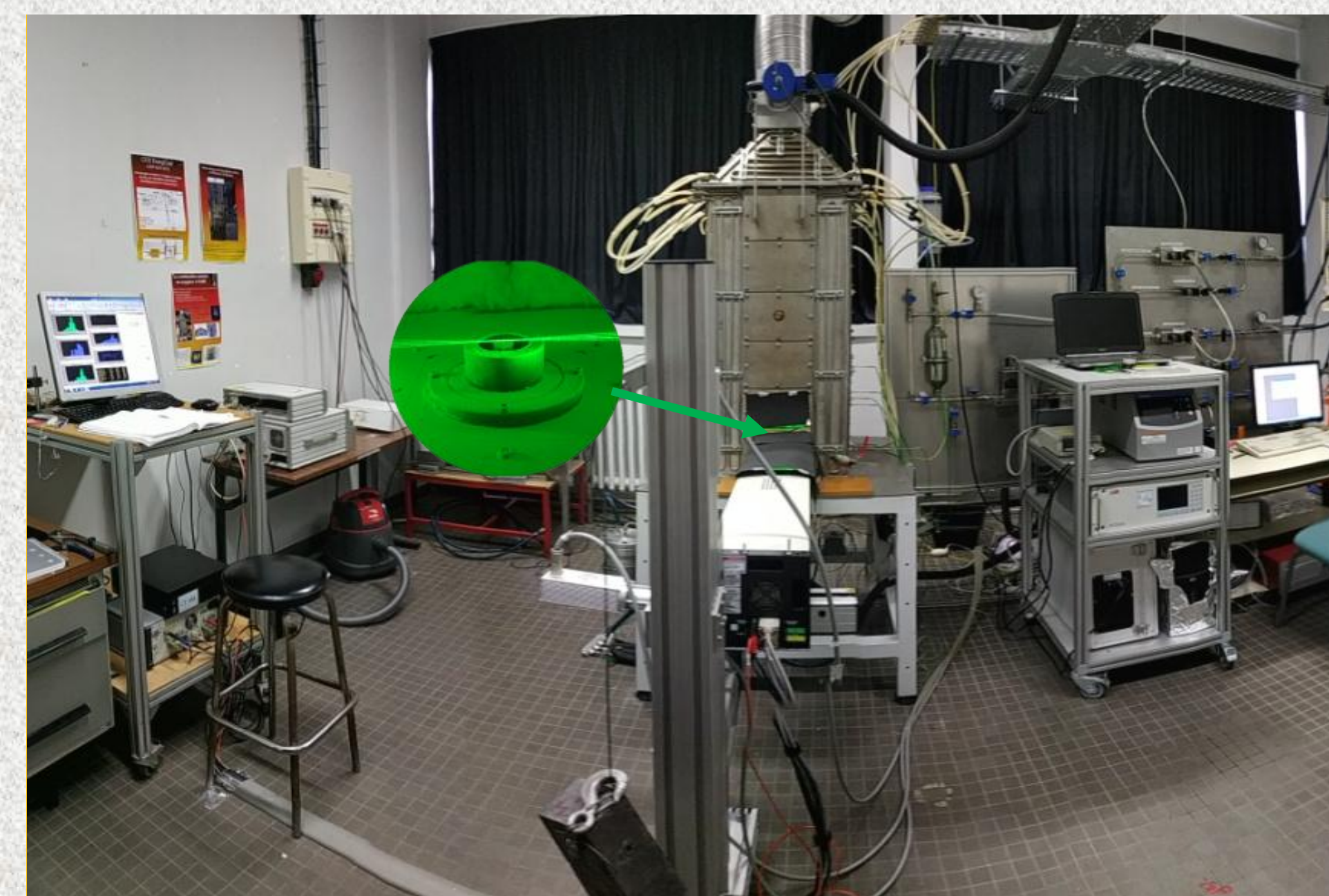


Flame lengths as a function of CO₂ and H₂O diluted for 25% oxygen enriched methane/air mixture for Sn=1.4 and φ=0.8.

- EGR dilution increases lift-off heights about 60% compared to the case without dilution.
- The flame becomes much taller with CO₂ dilution.



Laser Doppler Anemometry



Axial velocity and RMS profiles at z=30mm with & without CO₂ and water vapor dilution for Sn=1.4 and φ=0.8.

- With CO₂ and H₂O dilution, the maximum velocity is higher and the flow is narrower.
- Root Mean Squares are higher in the case of dilution.

