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

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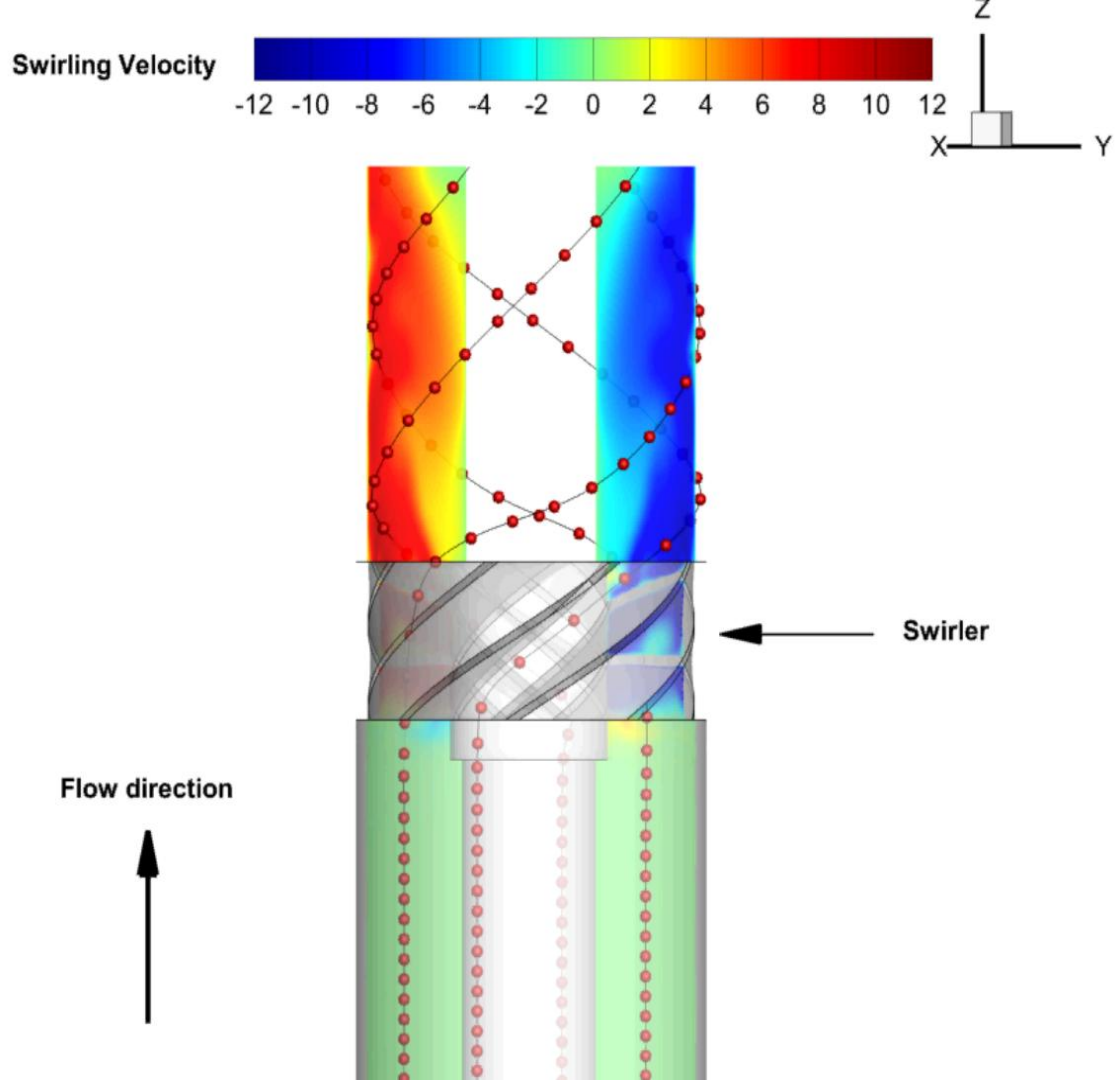
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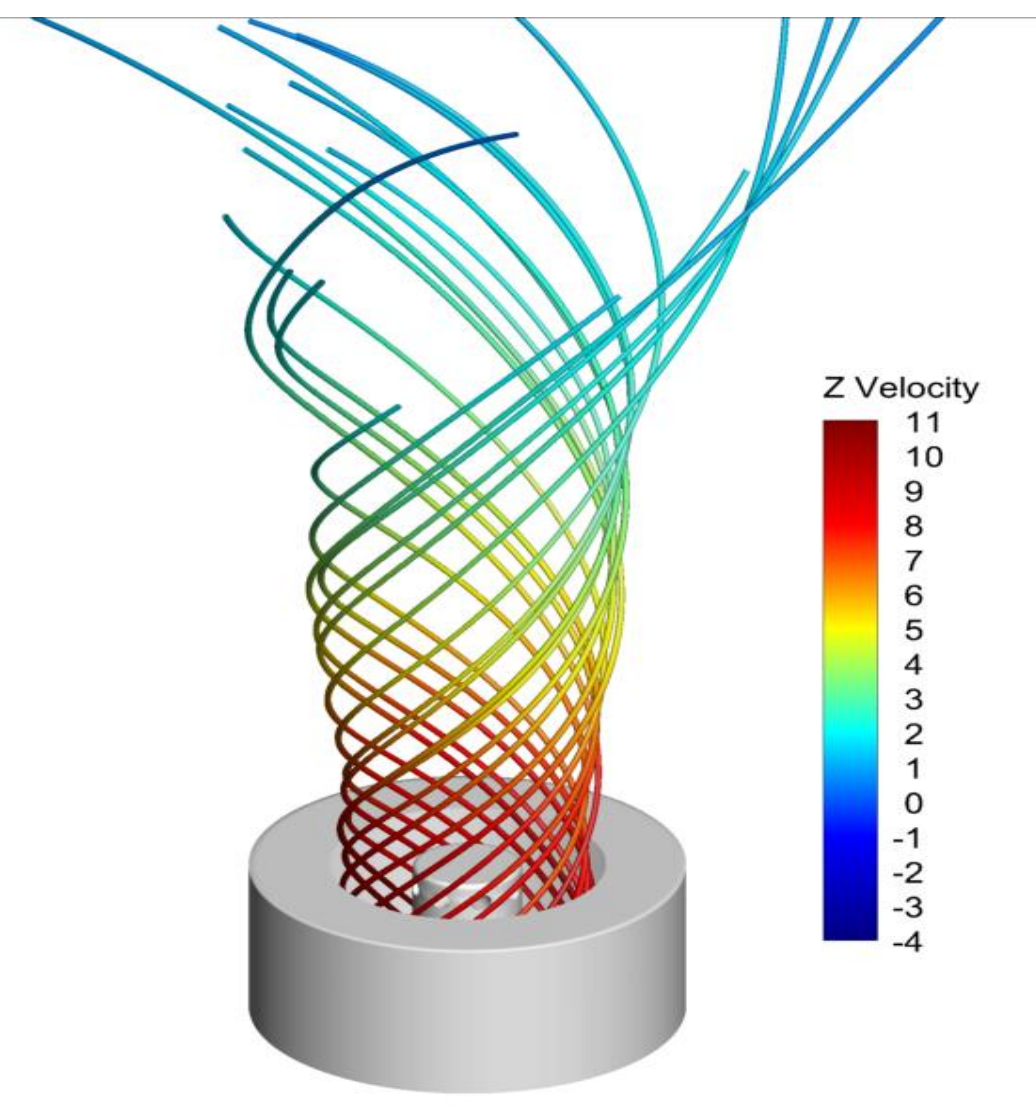
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Context and objectives

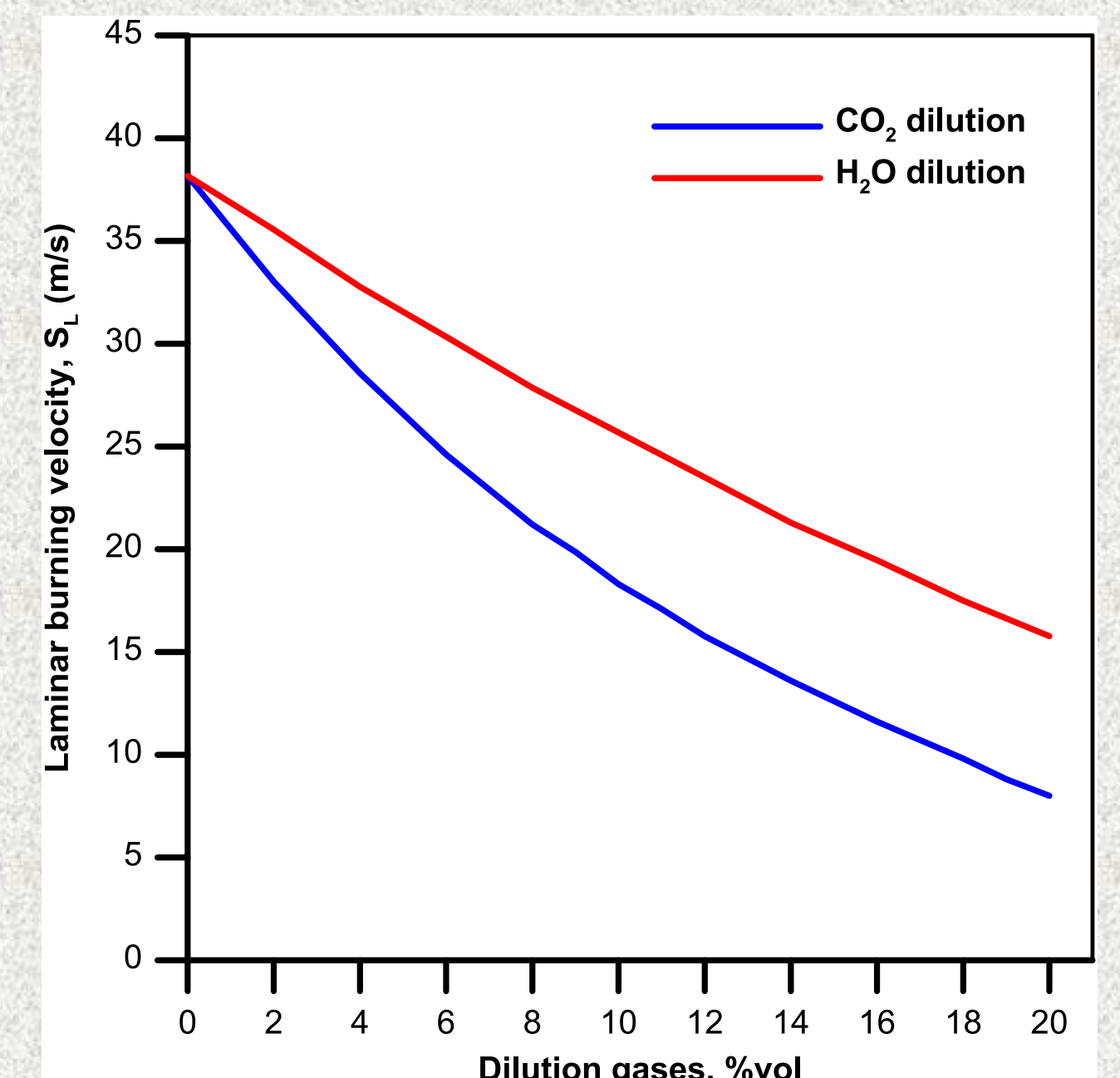
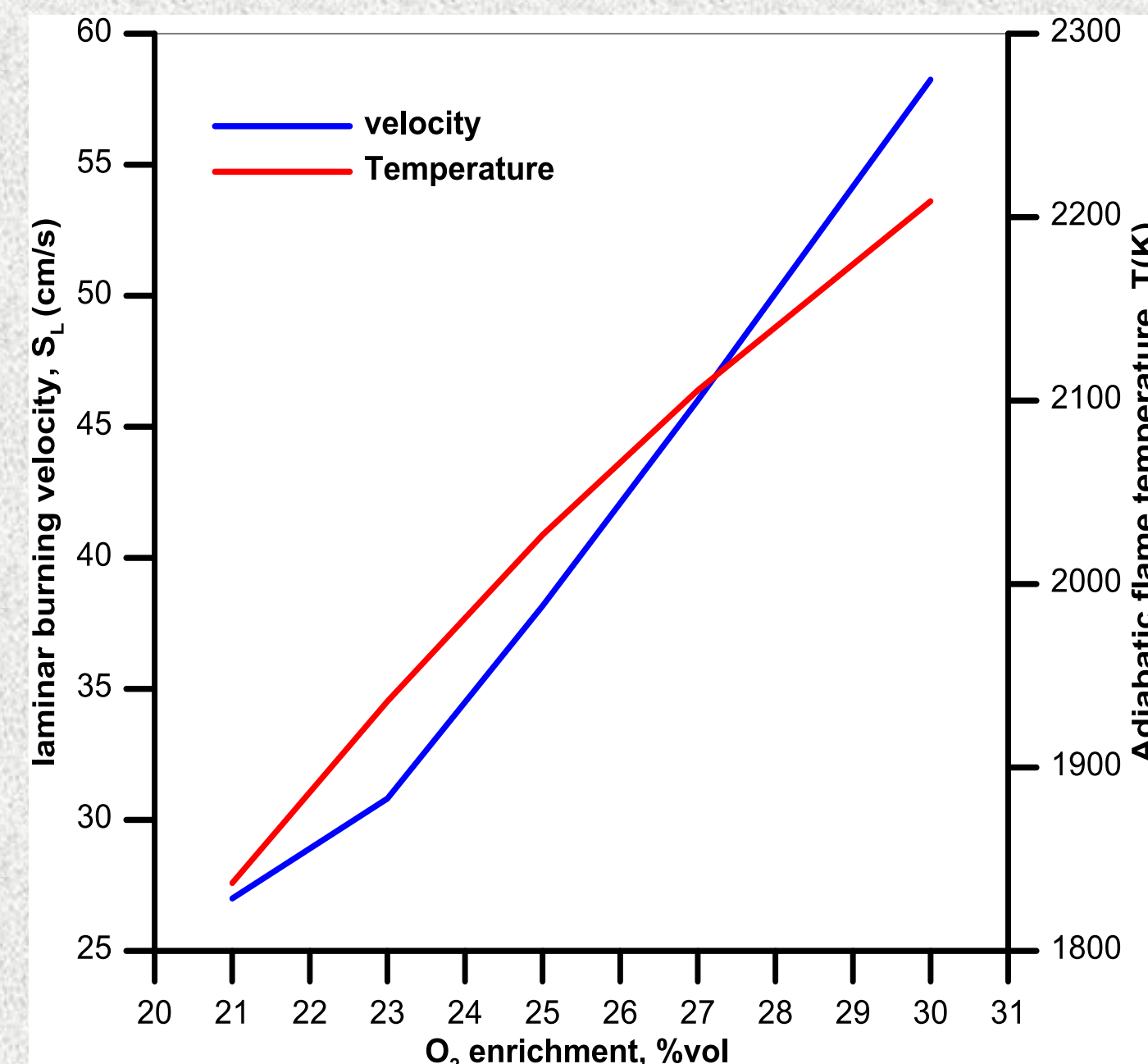
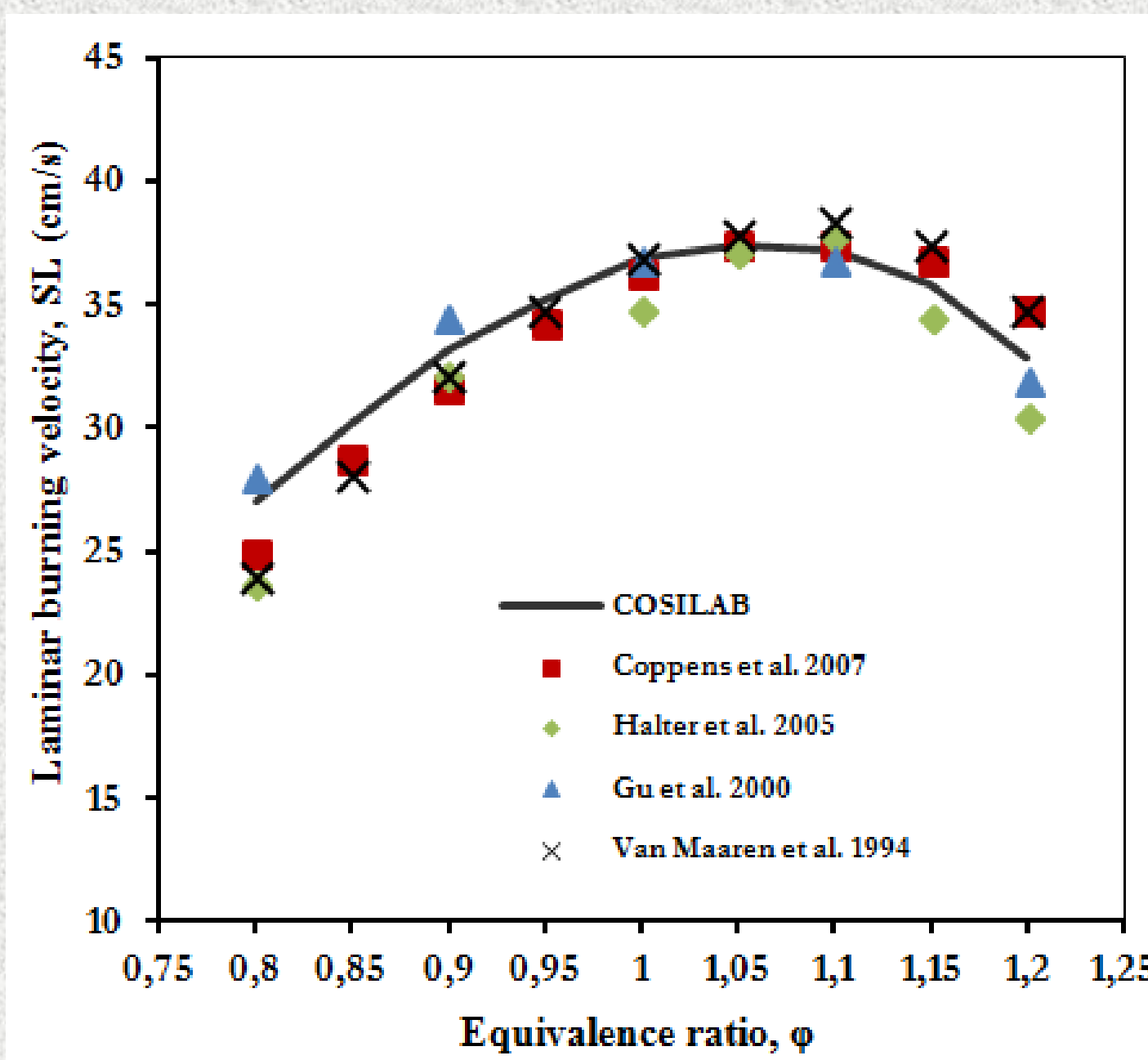
- **Study of non-premixed turbulent flames stabilized by a swirler**
 - Control of pollutant emissions / emissions standards
 - Improve performances of combustion plants
- **Investigations on flame characteristics**
 - Effects of oxygen enrichment
 - Effects of steam and CO₂ dilution
 - Effects of swirl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



Numerical calculations

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

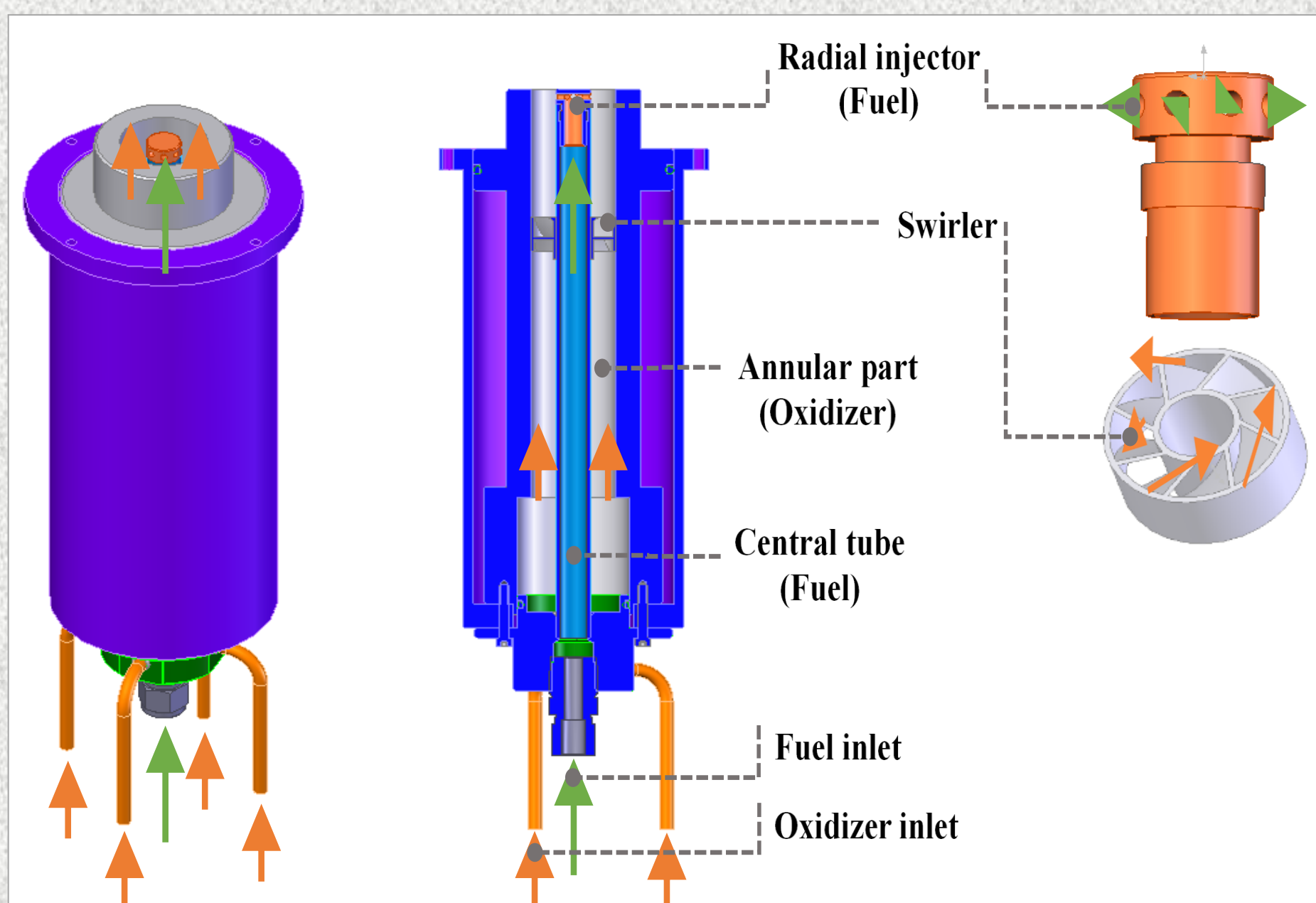
- Freely propagating methane-air flames.
- One-dimensional premixed flame.
- GRI-mech 3.0 mechanism.
- Atmospheric pressure and 300K.
- Equivalence ratio : from 0.8 to 1.2
- Oxygen enrichment : from 21% to 30%vol.
- Dilution : (0-20%vol) for both CO₂ and H₂O.



- 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.

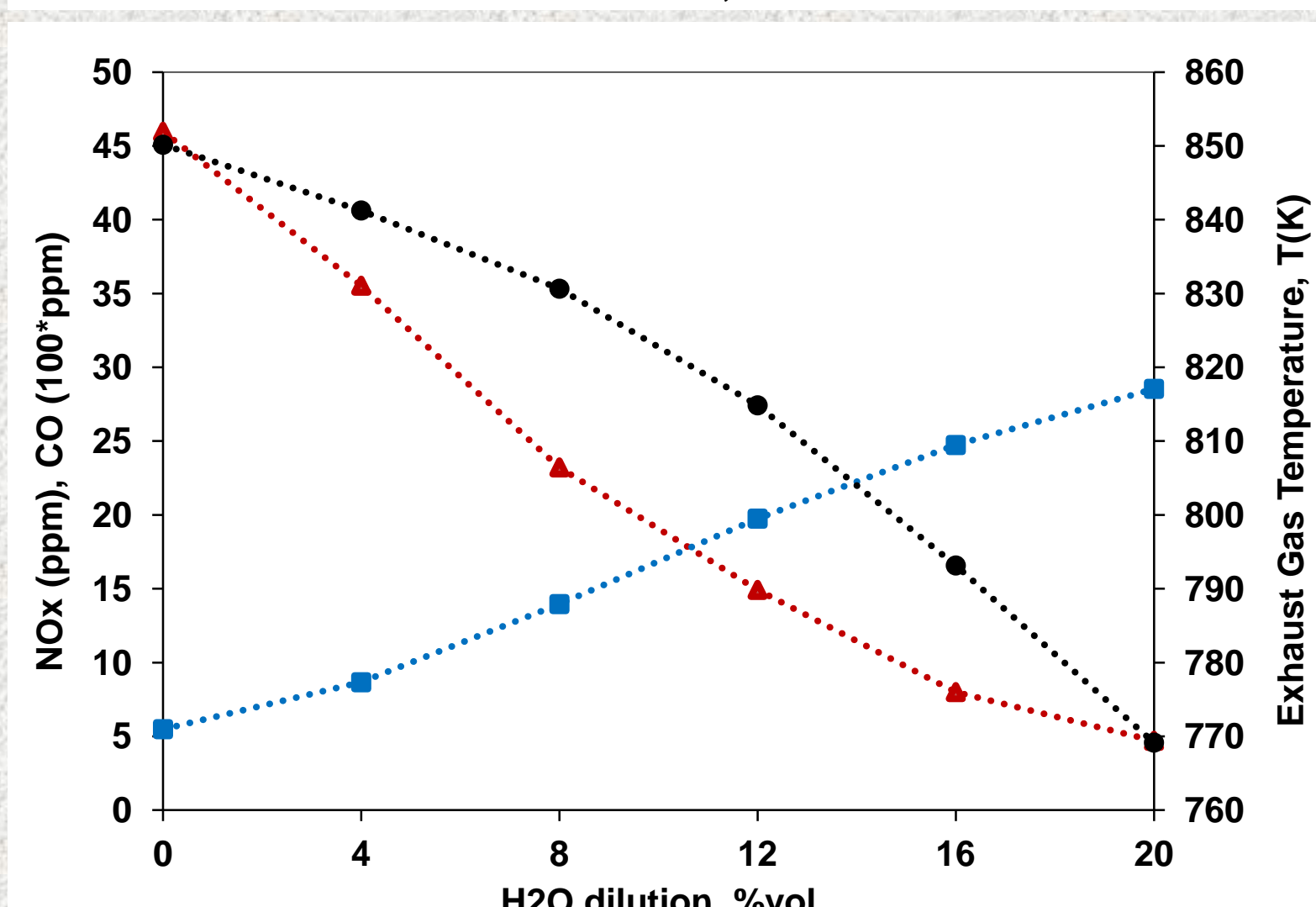
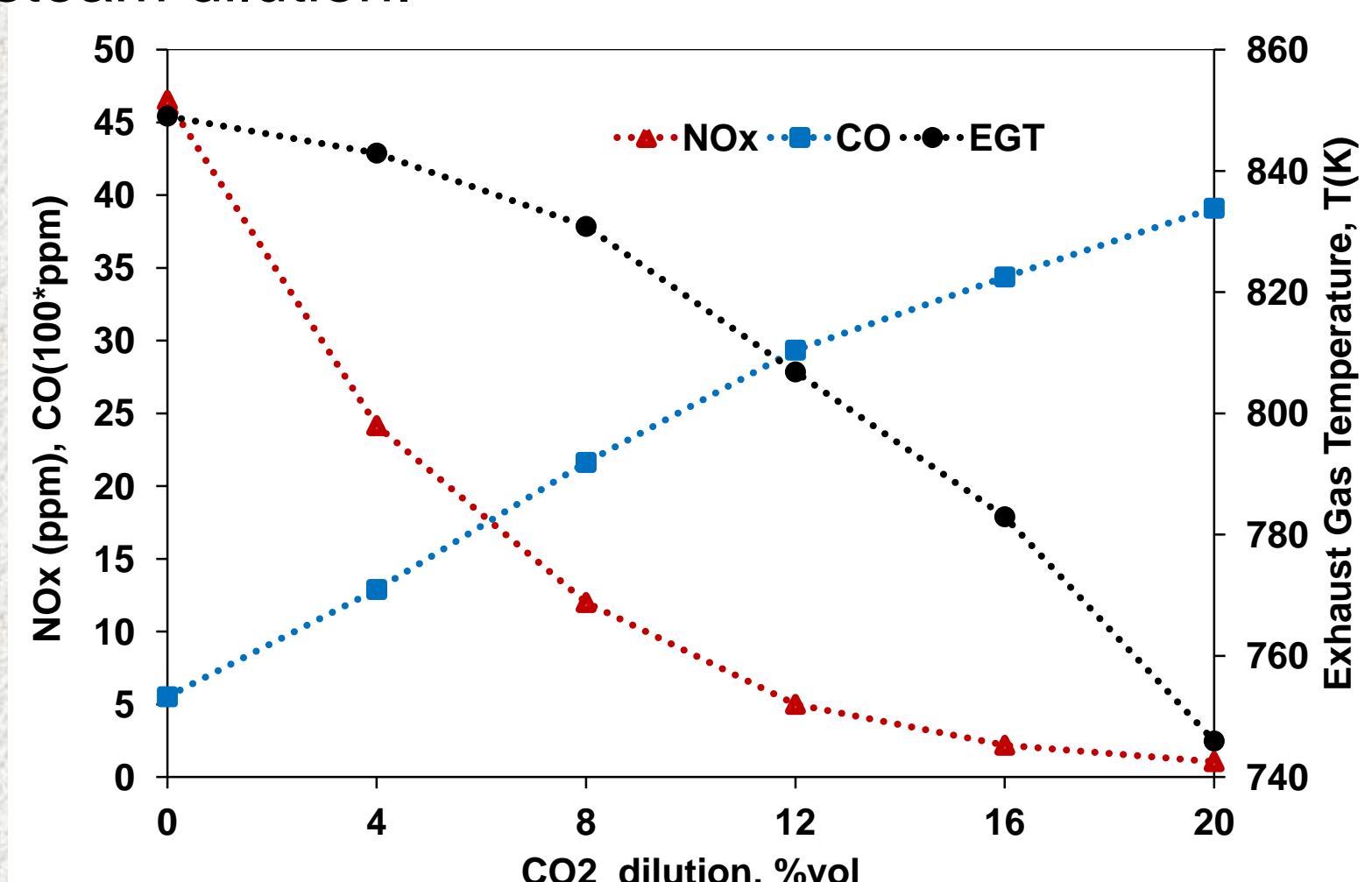
Experimental study

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.

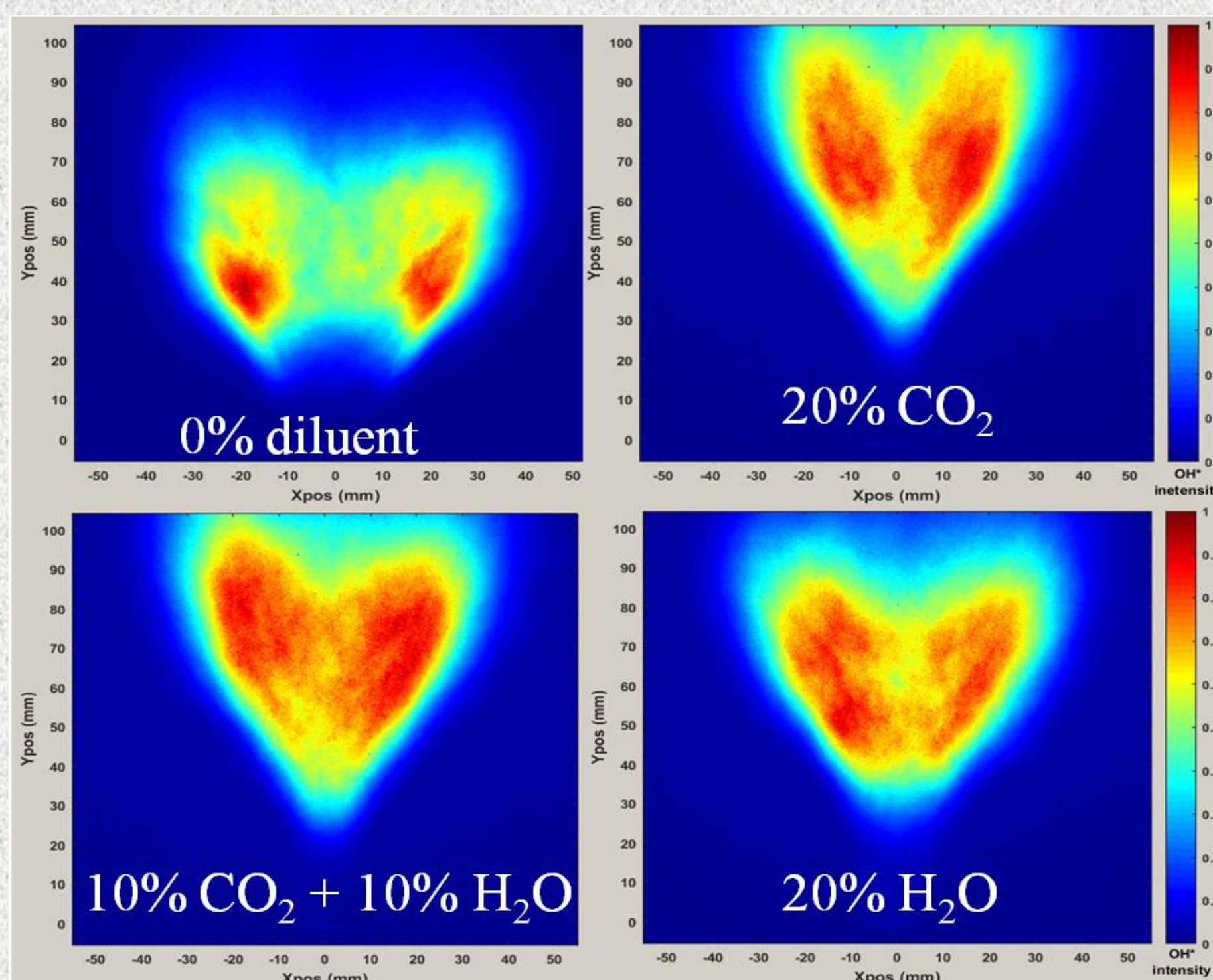
→ Effect of CO₂ dilution is stronger than that of steam dilution.



OH* chemiluminescence

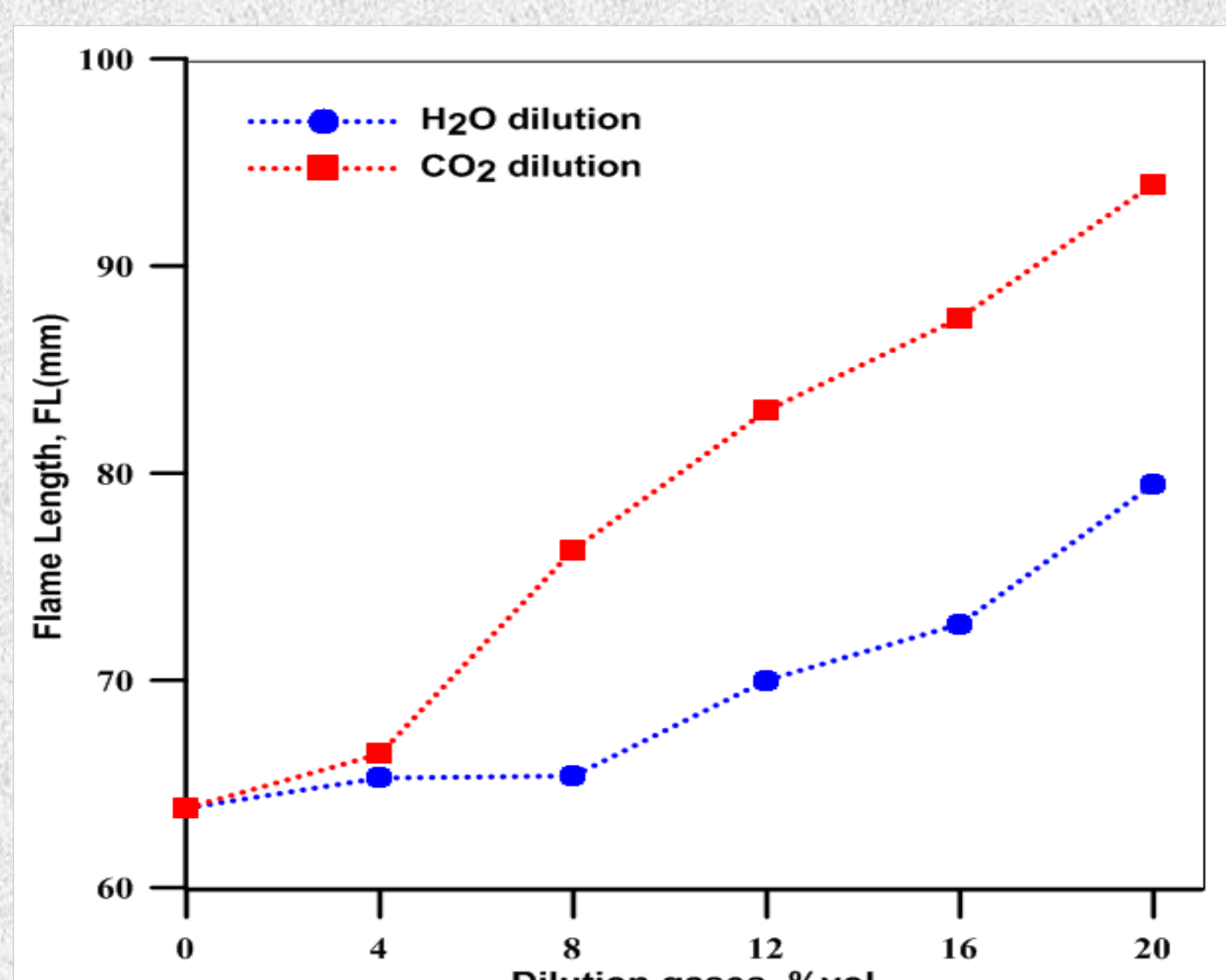
OH* intensity distributions of methane/air swirling flames diluted by CO₂, H₂O and EGR, in the case of 21% O₂, for Sn=0.8 and φ=0.8.

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

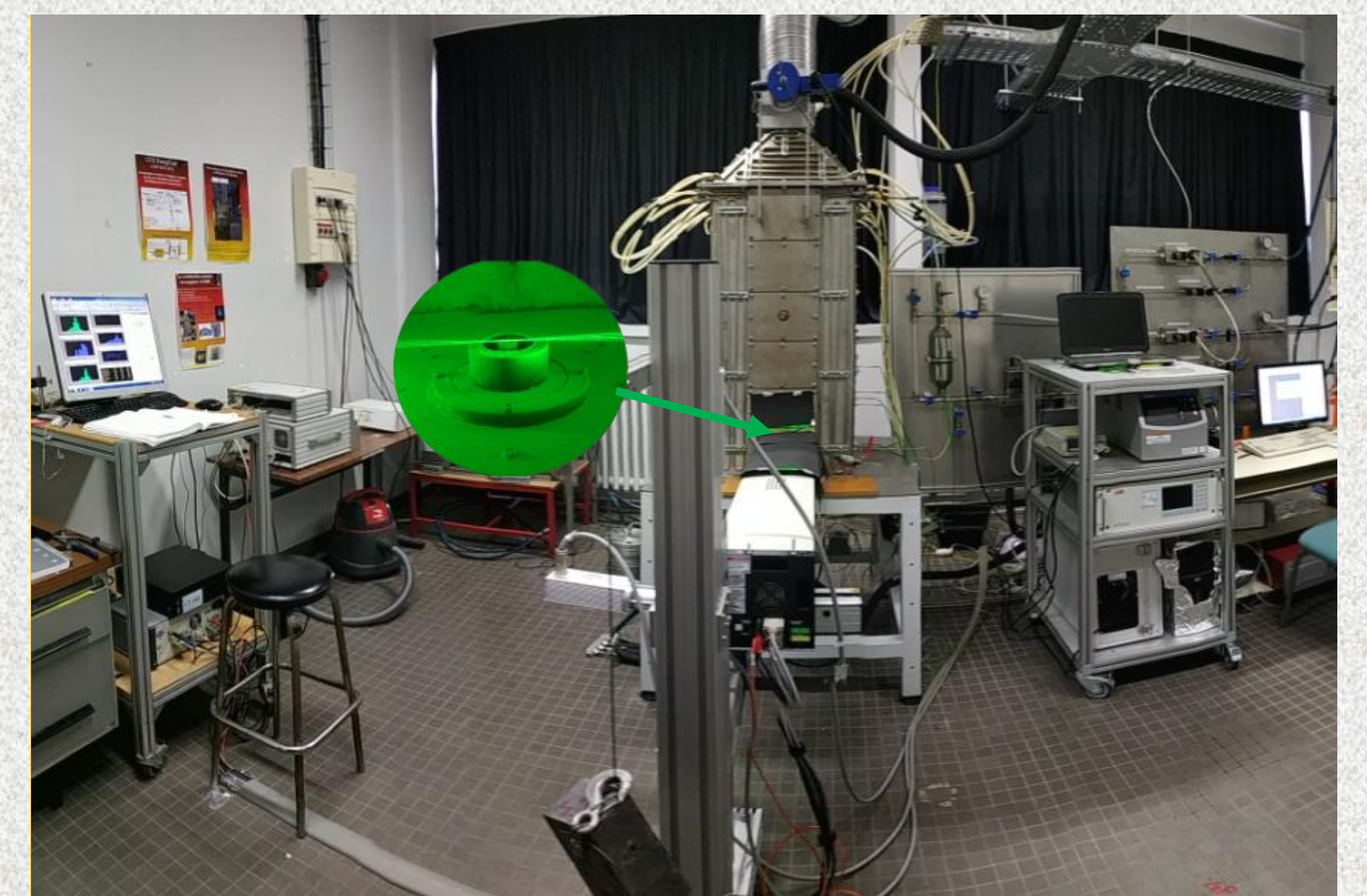


Flame lengths as a function of CO₂ and H₂O diluted for 25% oxygen enriched methane/air mixture for Sn=1.4 and φ=0.8.

- 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.

