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Characteristics of non-premixed oxygen enriched flames from a swirl burner with a radial fuel injection

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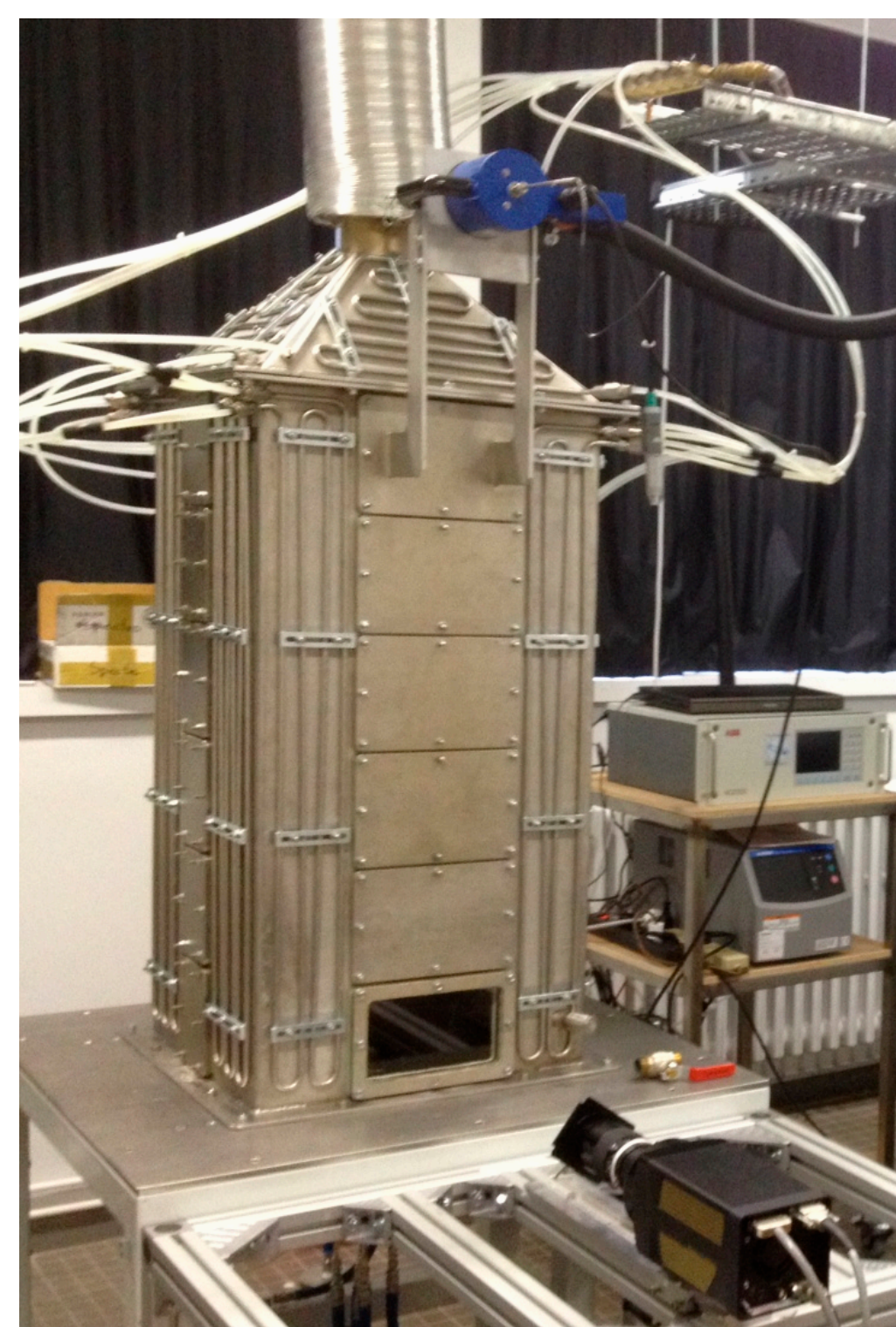
Context

- ✓ The study is motivated by **CO₂ capture applications** further to the increase of CO₂ concentration by the O₂ enrichment.
- ✓ **Support** : French National Research Agency (ANR), CO₂-EnergiCapt project.

Objective

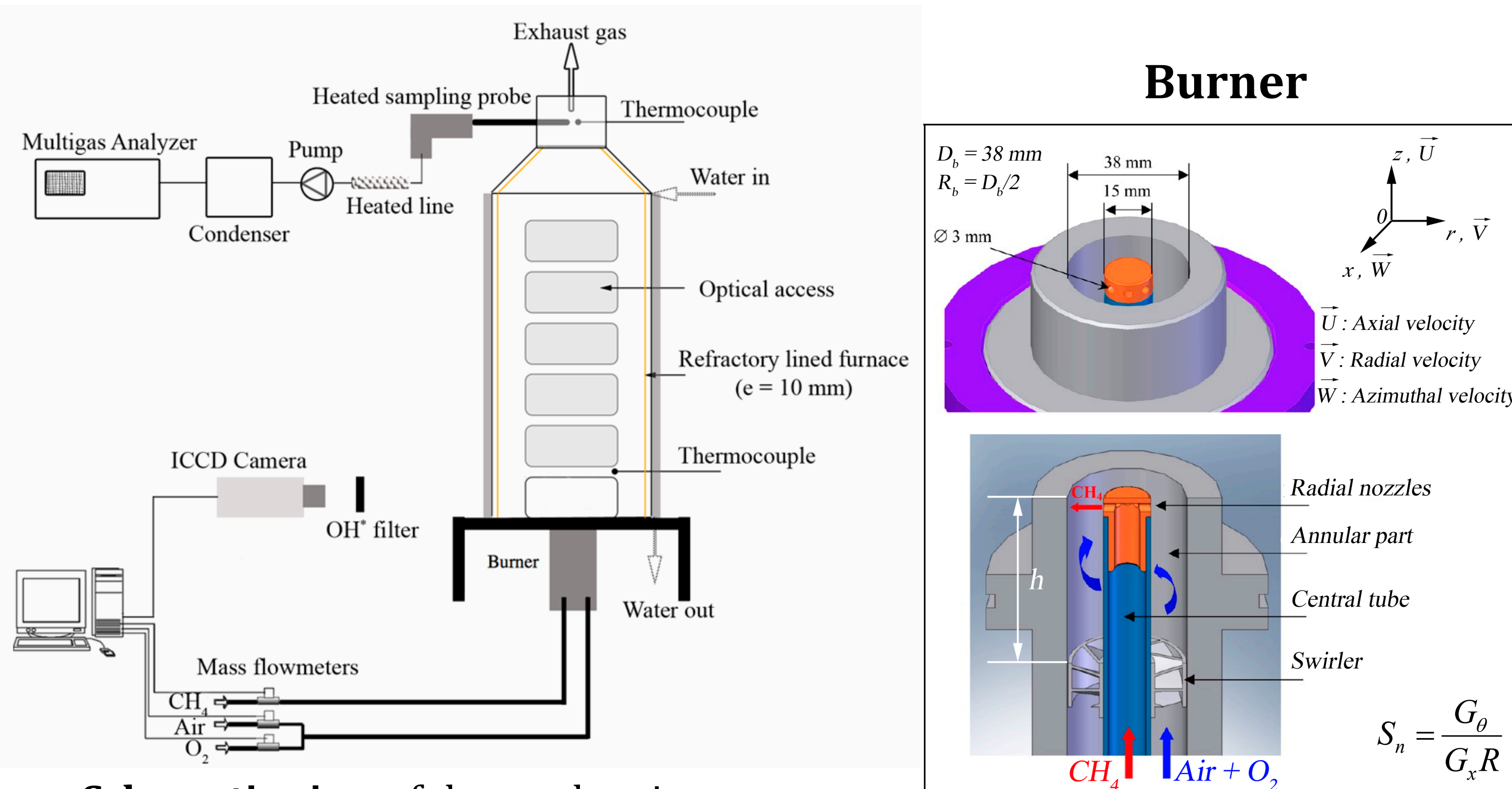
- ✓ Optimization of **industrial boilers** by the combination of combustion air enriched with oxygen and reducing CO₂ by a membrane capture.
- ✓ Study the characteristics of turbulent CH₄-air flames with O₂ enrichment : **Flame stability, Pollutant emissions (CO, NO_x, CO₂), Velocity fields.**

Combustion chamber



Combustion chamber : 25 kW, dimensions 0.5x0.5x1 m³

Experimental setup



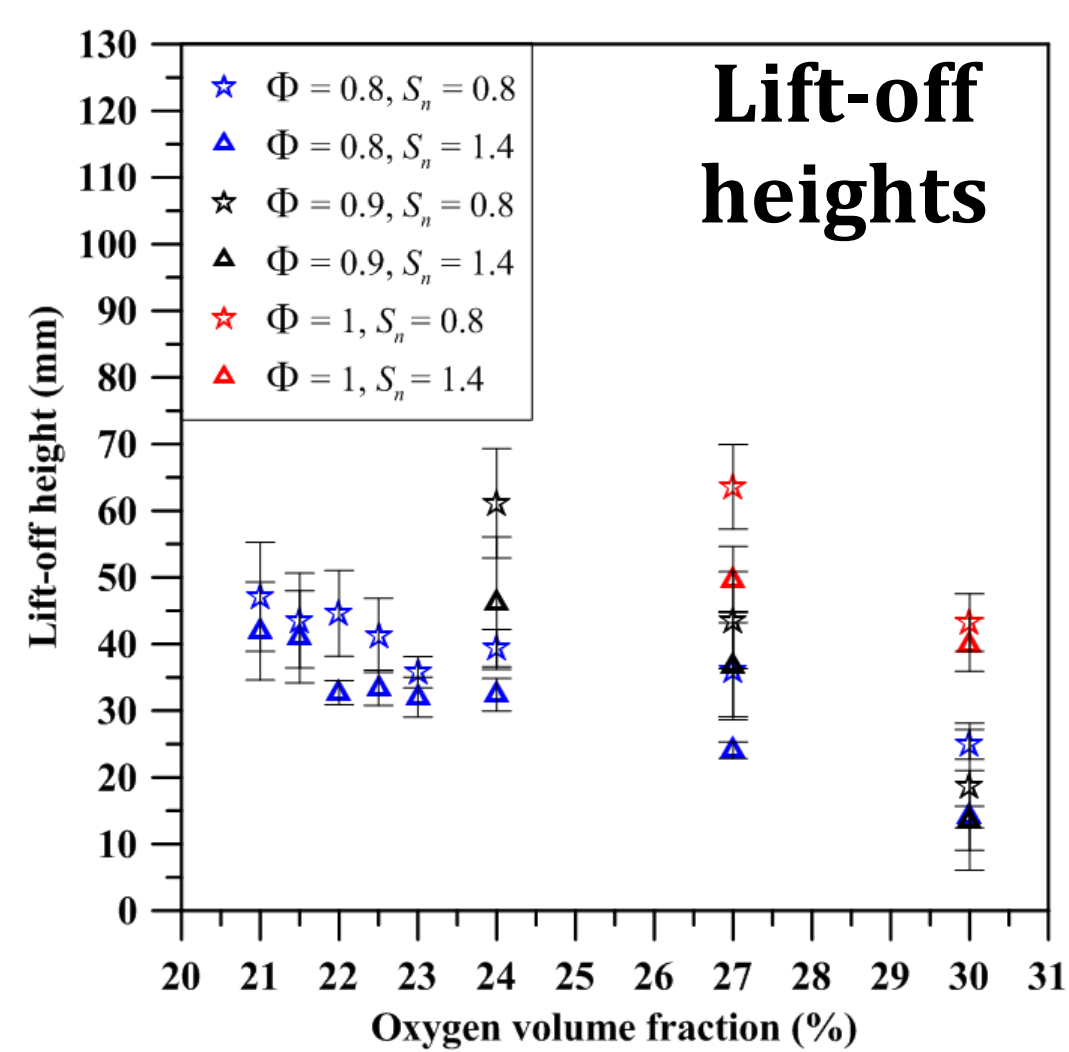
Schematic view of the combustion chamber with the OH Chemiluminescence system and the gas analyzer

Burner : two concentric tubes with a **swirler** in the annular part

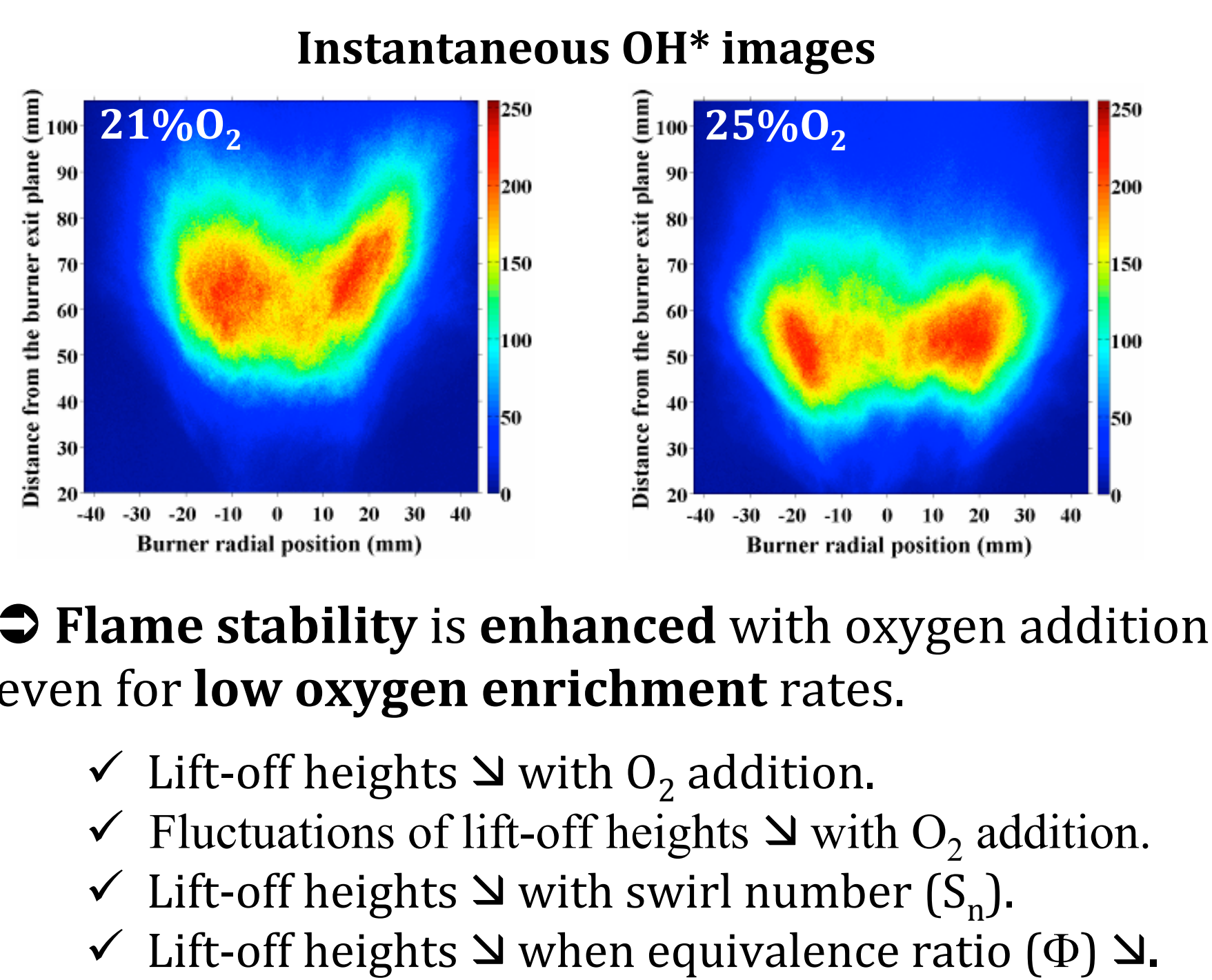
Details of measurement techniques

- ✓ **Multi-gas analyzer** : NO_x, CO, CO₂, O₂, SO₂
- ✓ **OH chemiluminescence**: ICCD camera, a 105 mm UV lens, a 306 nm filter.
- ✓ **Stereo-PIV system** : a double-pulsed Nd:YAG laser (25 mJ/pulse) at 532 nm, 10 Hz. 2 TSI Powerview Plus 4MP, 2048 x 2048 px², Scheimpflug adaptaters. Seeding : Al₂O₃ 0.5-1 μm.
- ✓ **V3V system of TSI**: V3V-9000-TS probe, 3 cameras 4MP-HS, 2 Evergreen 200 mJ PIV lasers.

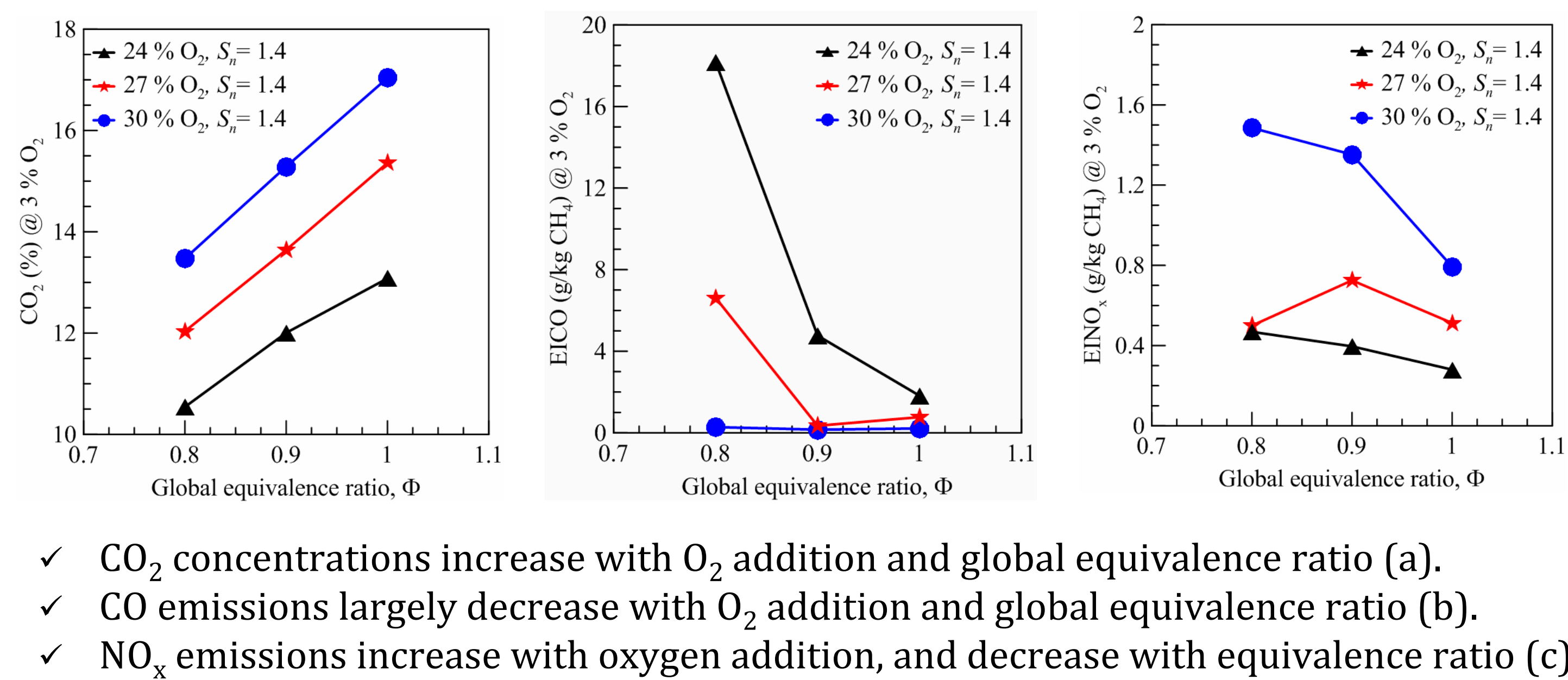
Flame behavior



Lift-off heights

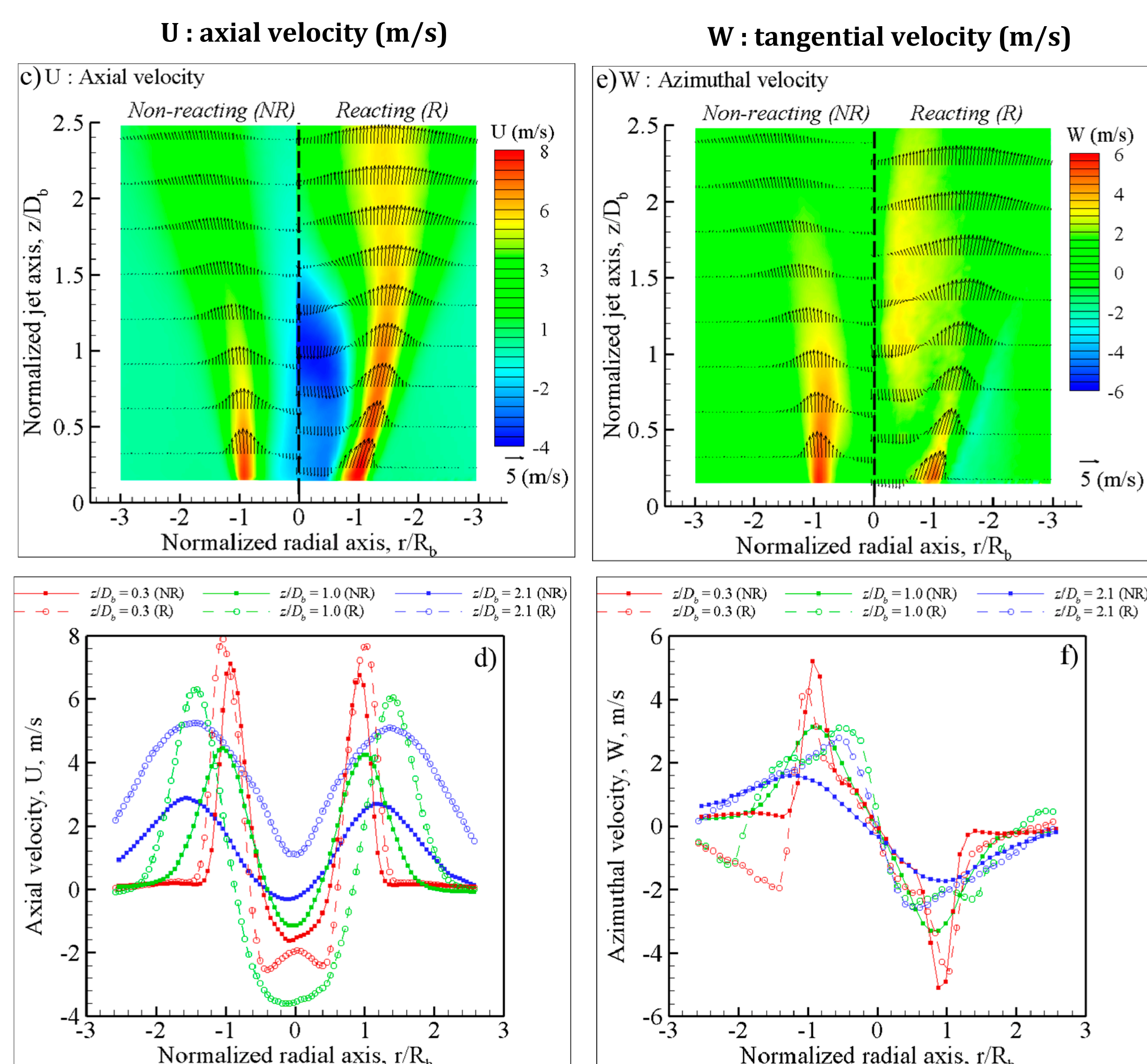


Pollutant emissions



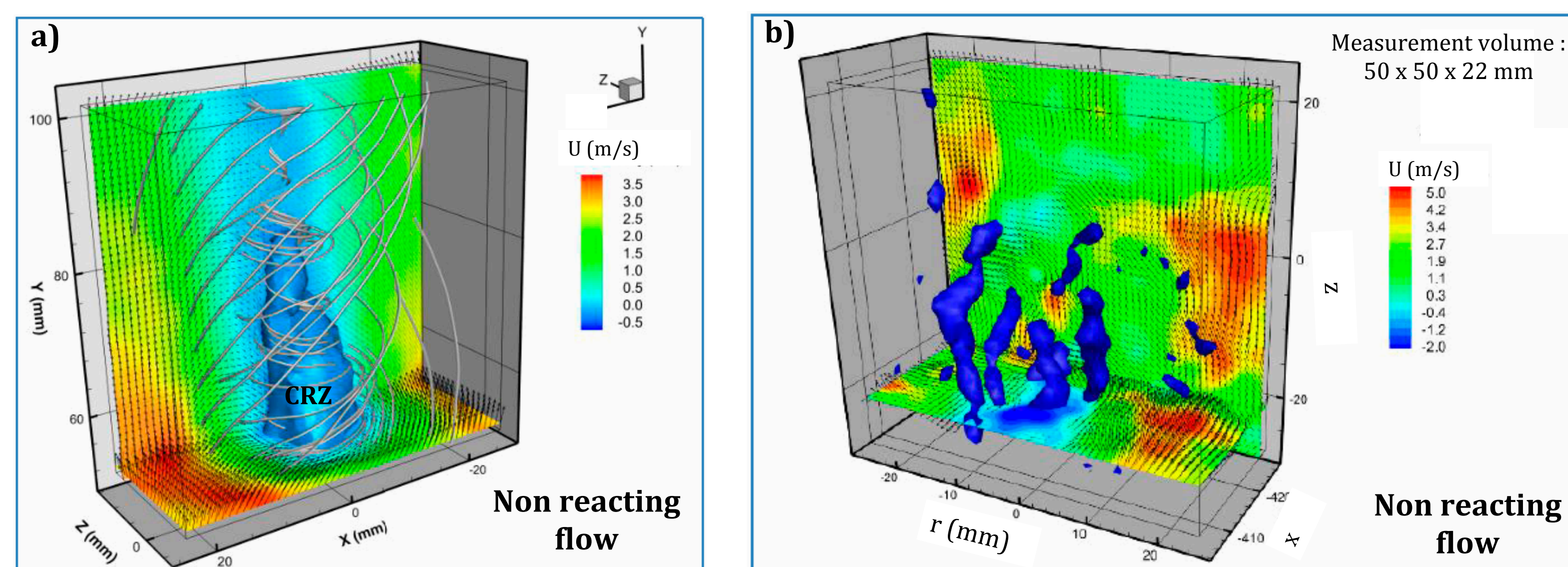
Stereo-PIV results of non reacting and reacting flow

Case : Swirl number $S_n=0.8$, equivalence ratio $\Phi=0.8$



Flow analysis by stereo-PIV and V3V* system

First results of V3V measurements _ Collaboration with TSI® on 2014



- ✓ The presence of flame increases the central recirculation zone (CRZ) (c, d) compared to non reactive cases
- ✓ Strong axial expansion is induced by combustion (c, d)
- ✓ In the reacting the azimuthal velocity field tends to show that the intensity of the swirling motion is lower than the motion originally imposed to the flow (e, f)
- ✓ Increasing $S_n \Rightarrow$ Increasing reverse flow velocities