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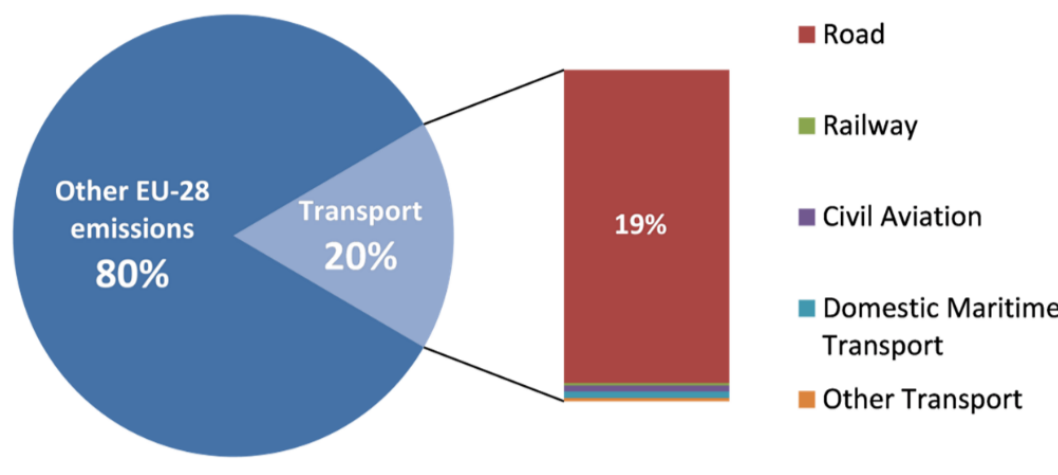
EXPERIMENTAL INVESTIGATION OF TURBULENT PREMIXED FLAMES UNDER SPARK-IGNITION ENGINE-LIKE CONDITIONS

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Introduction

Nowadays, one of the main challenge in the automotive sector concerns the increase of internal combustion engine (ICEs) efficiency in order to improve the fuel economy and cut the pollutant missions

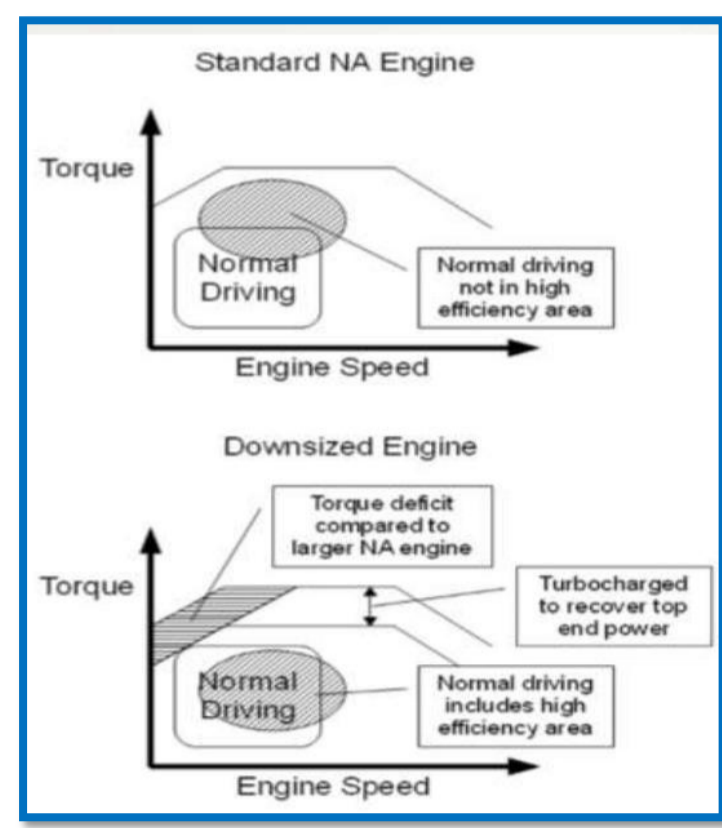


The main reason is due to the great impact of transport sector on Greenhouse Gas (GHG) emissions. Particularly due to the light vehicles

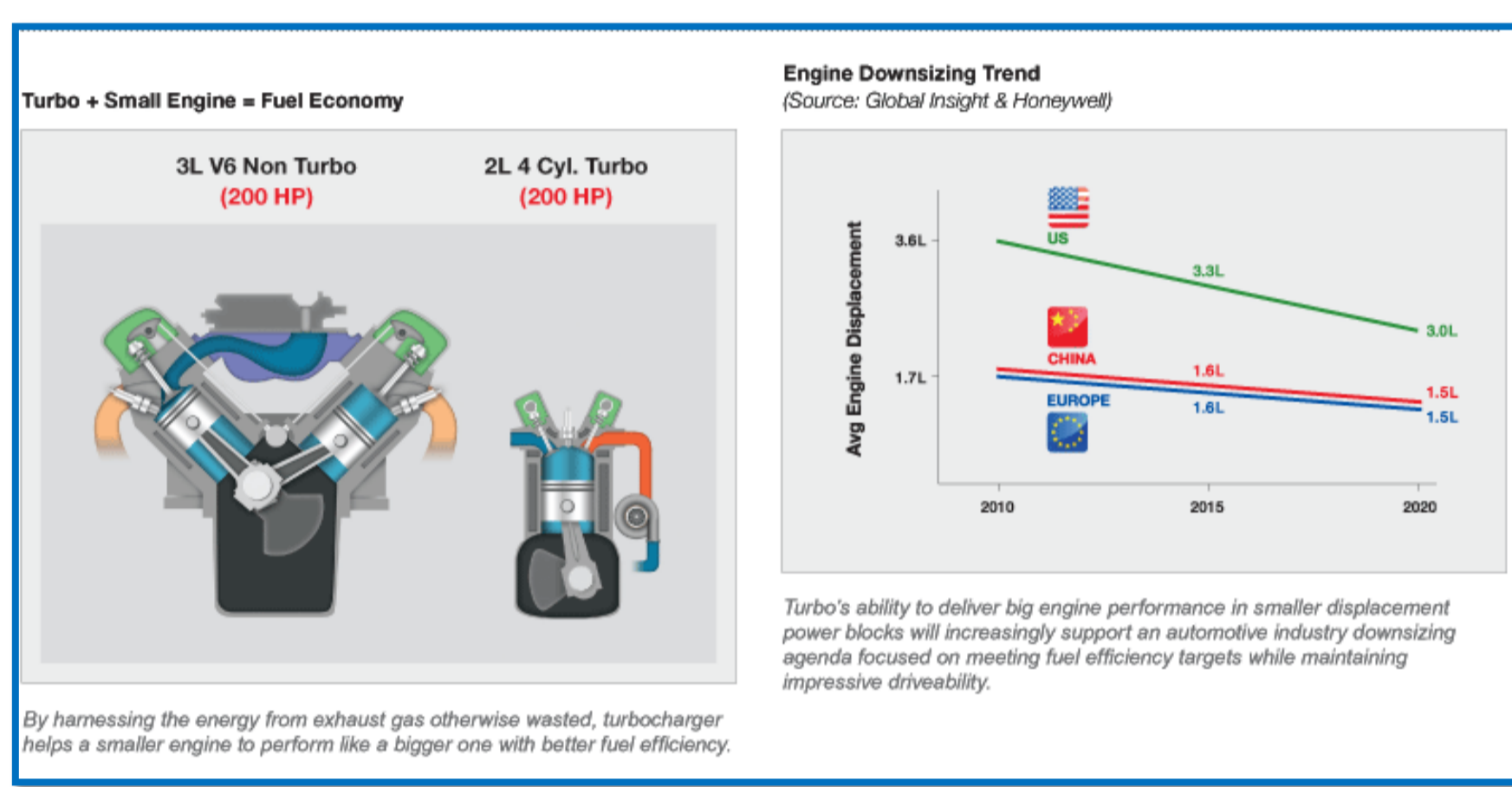
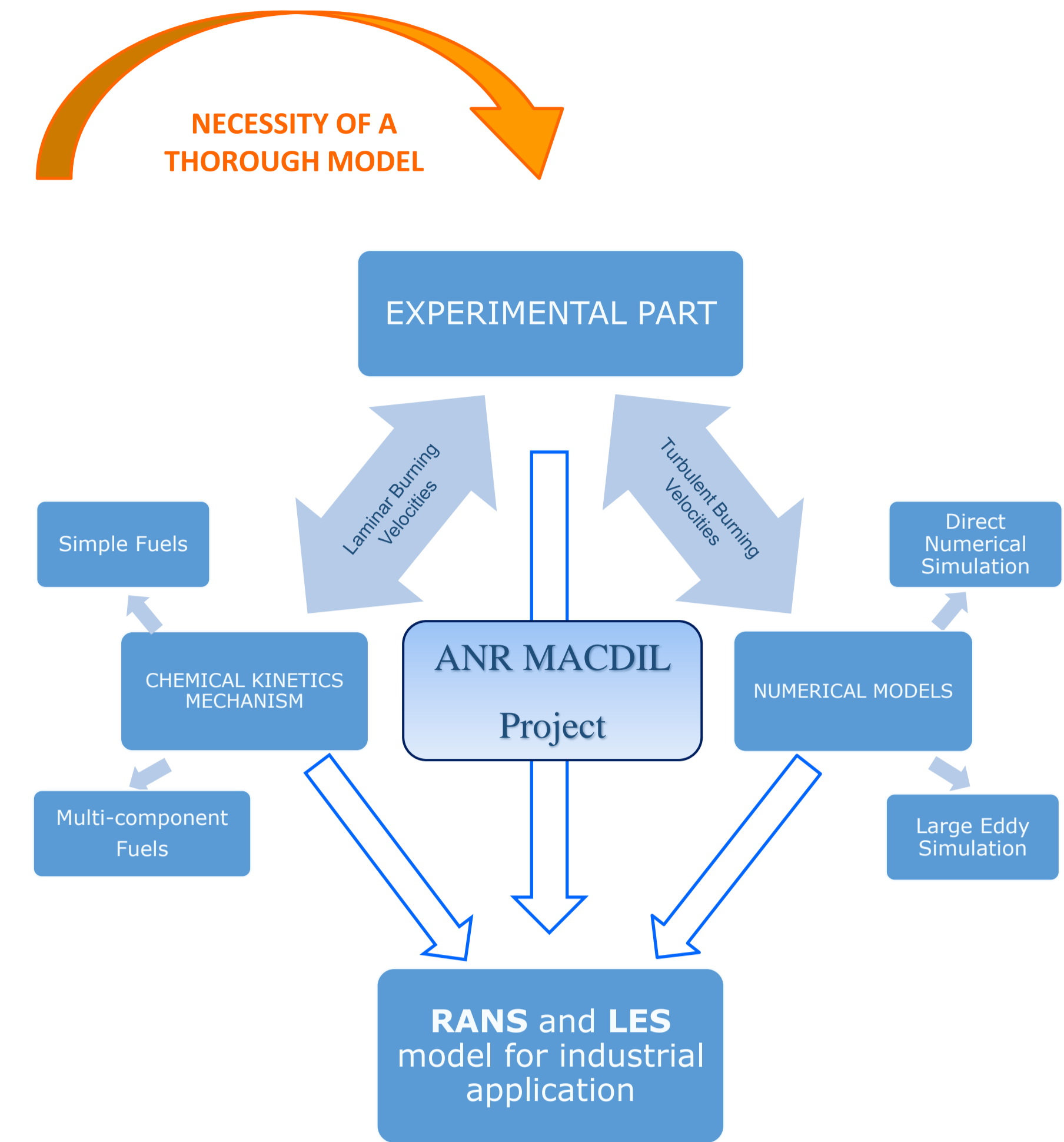
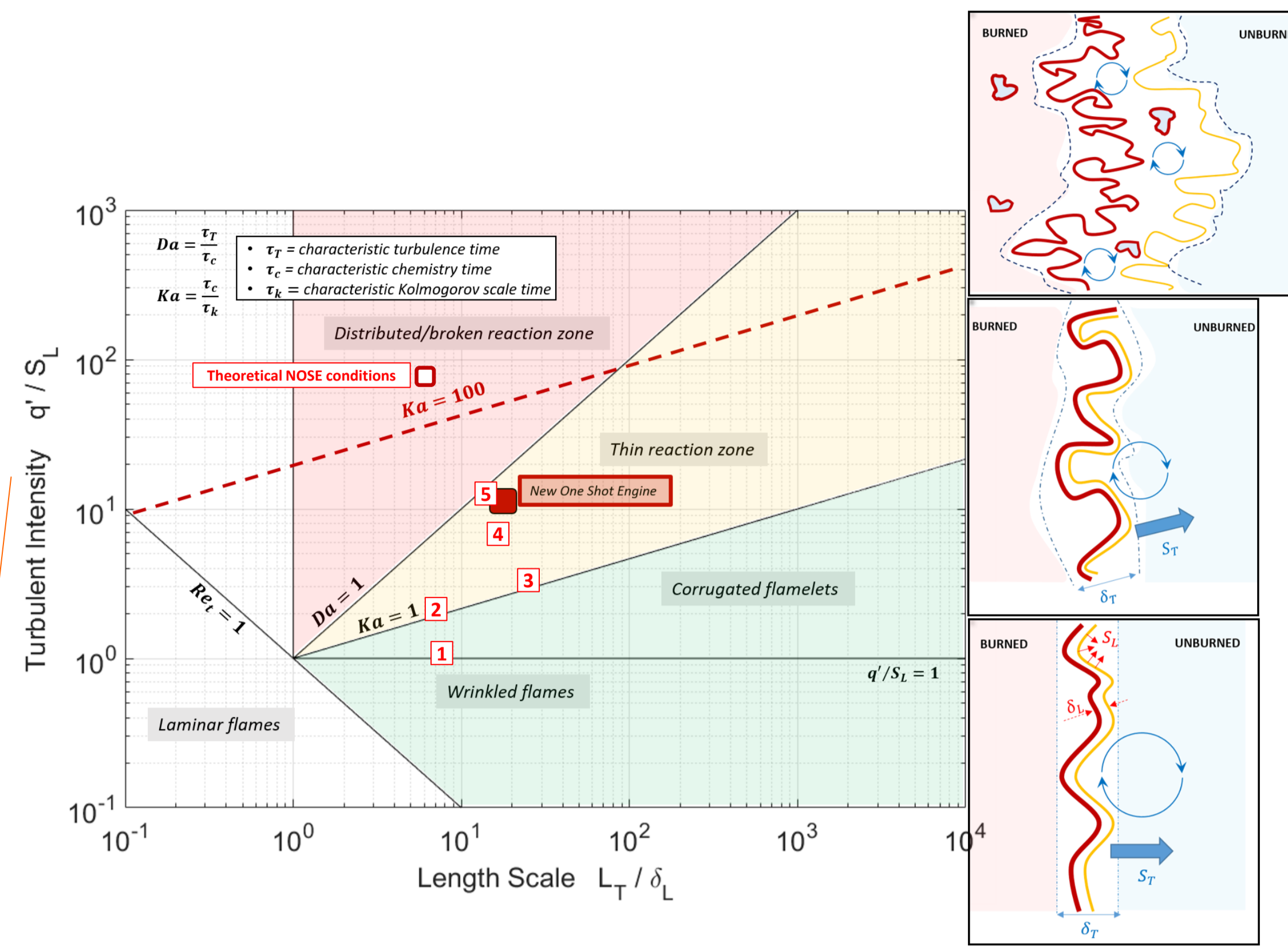
Downsizing is one of the most exploited solution: reducing the displacement by maintaining the performance through a turbocharger. Downsizing means reduced friction, thermal losses and mass moved, boosting fuel economy and cutting CO2 emissions

A turbo provides the engine with the mass of air needed to ensure highly efficient and clean combustion

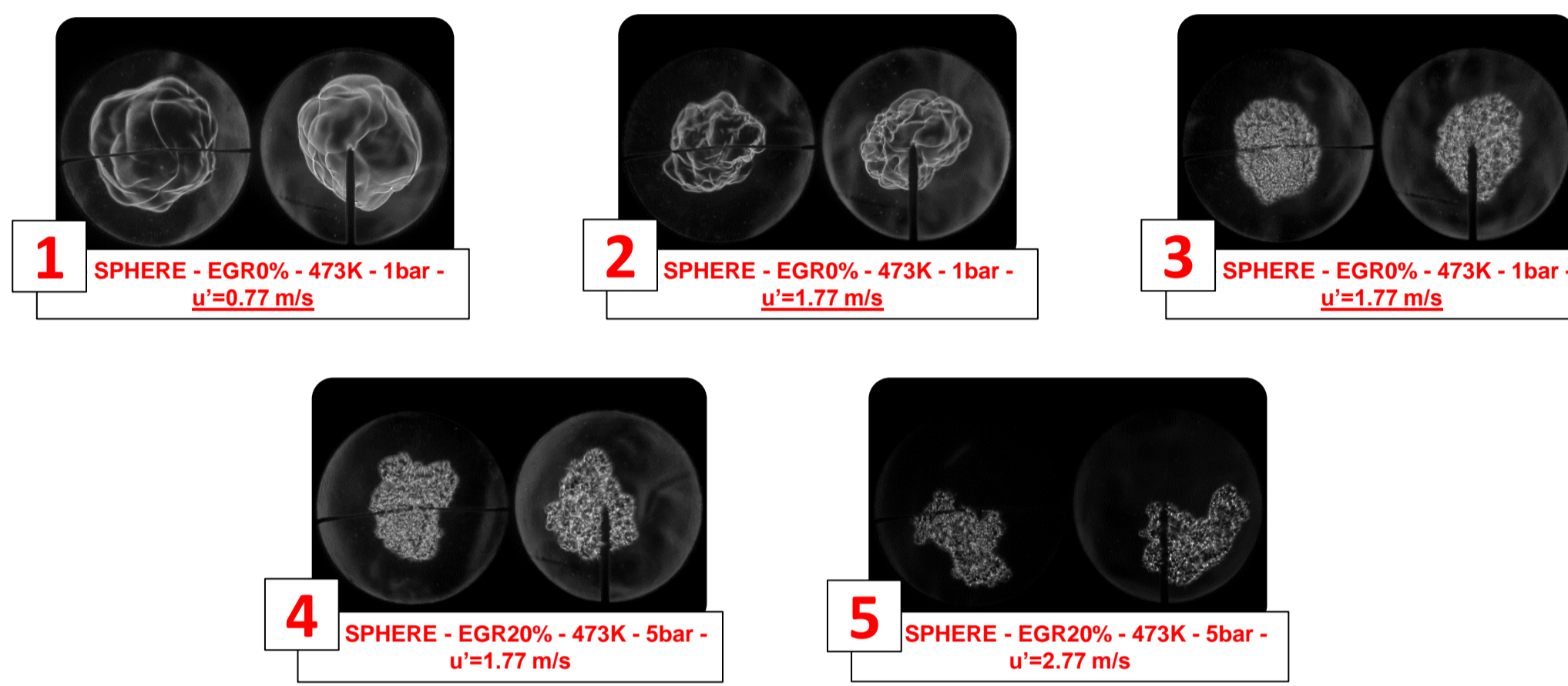
The higher intake conditions lead to an increase of the abnormal combustions
High dilution rates may be used in order to mitigate such phenomena



Increasing dilution, turbulence and pressure may cause the shifting from the actual flamelet regime to the thin reaction zone



Spherical Vessel reference conditions:



Experimental setup

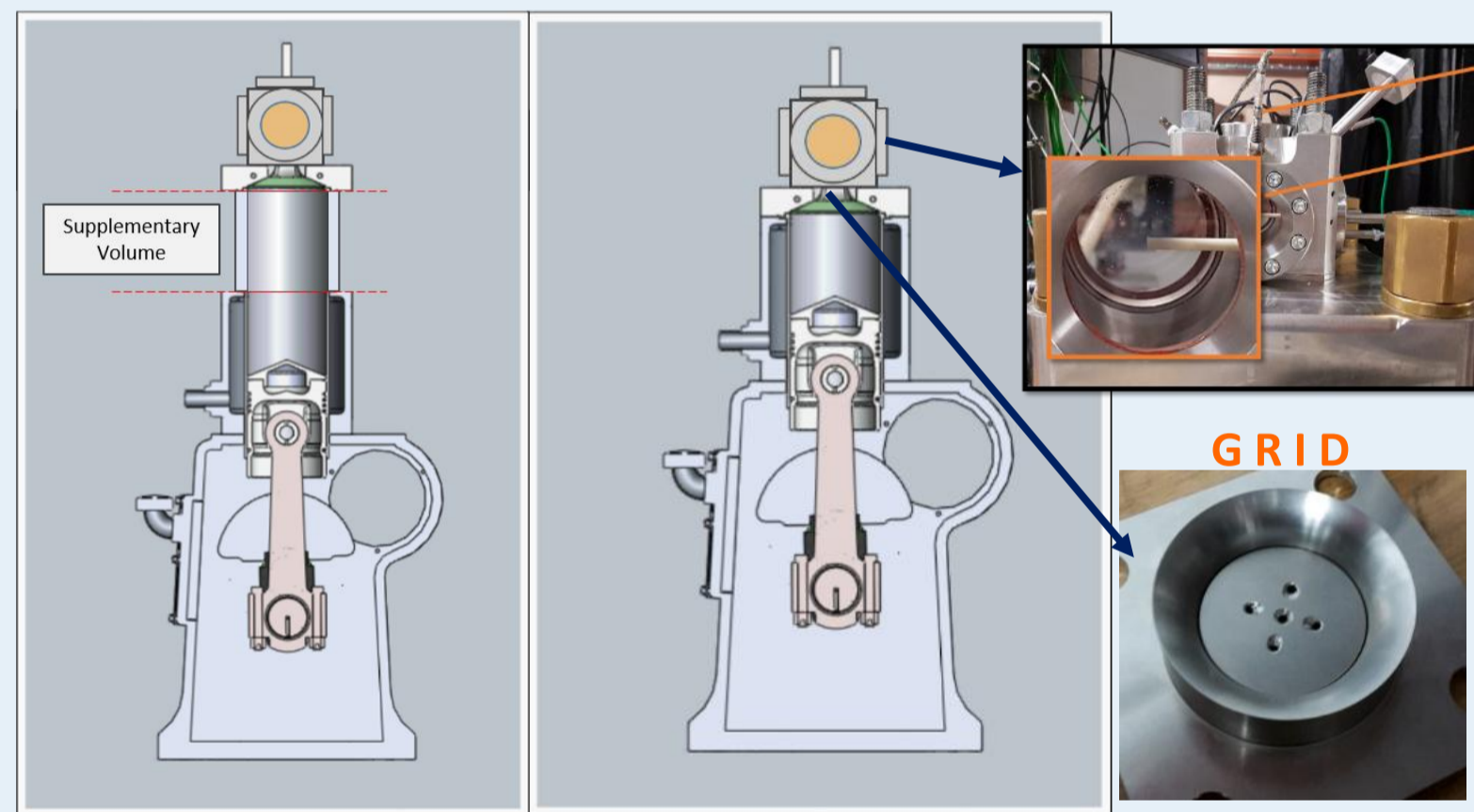
Innovative Turbulent Vessel:

Previously unexplored experimental points of high pressure and high temperature

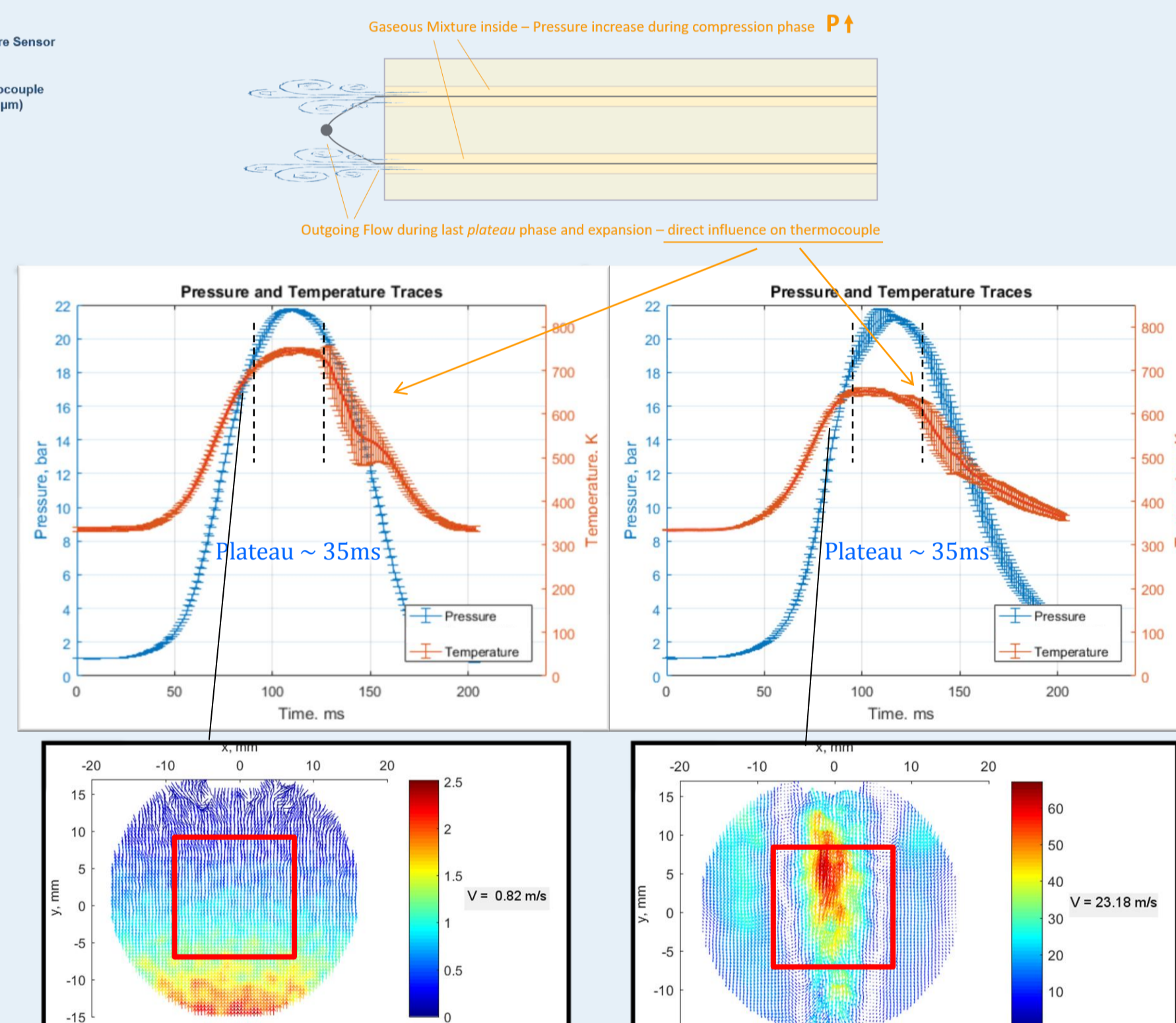
Testing the inflammability limits with increasing dilution

Flow field characterization (turbulent and pseudo-laminar conditions)

Investigation of well-known mono-component fuels and characterized gasoline surrogate

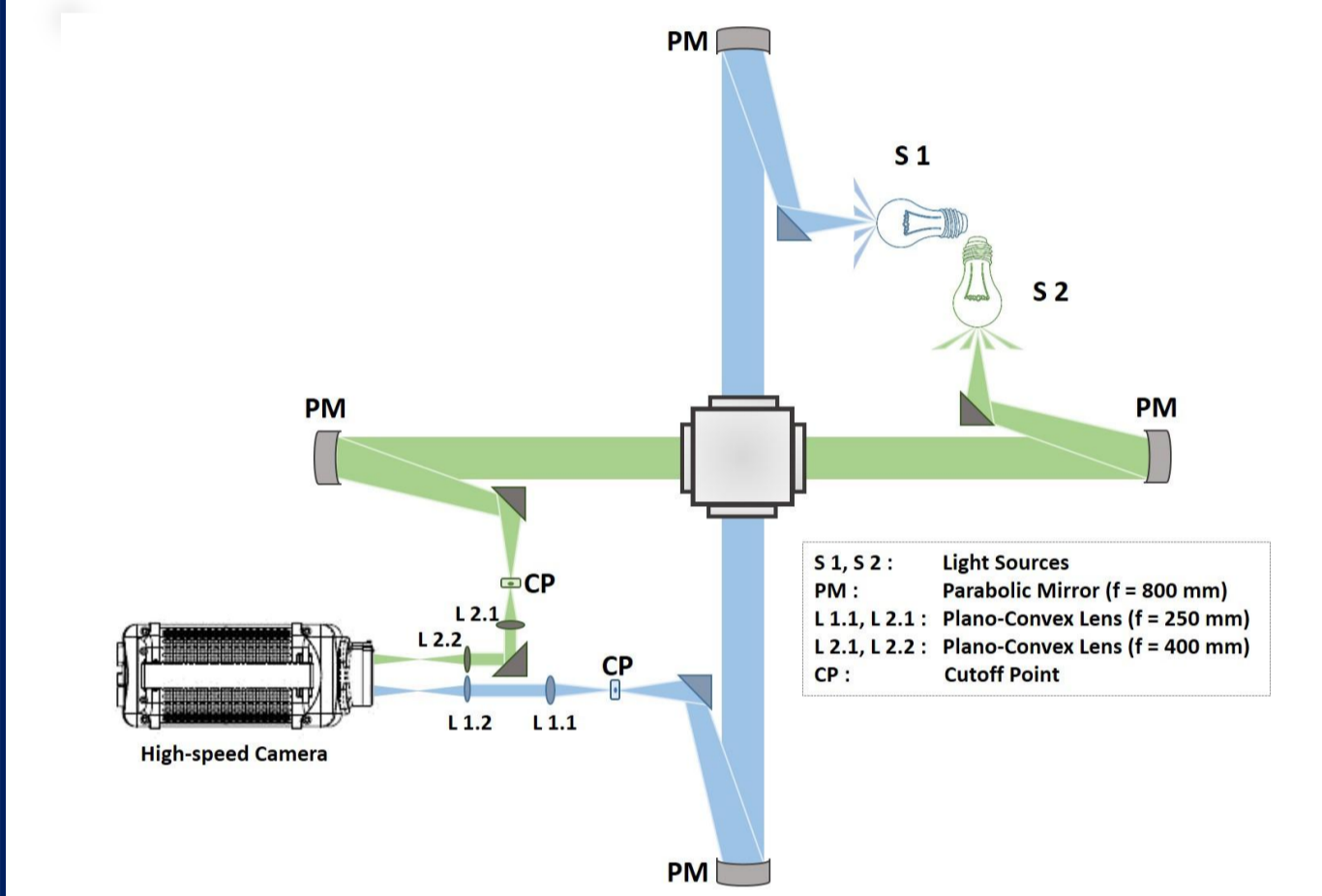


Configuration: Large Volume (LV)	Configuration: Small Volume (SV)
Press. 4-20 bar	Press. 10-60 bar
Temp. 373-573 K	Temp. 550-900 K
GRID → Turbul. ~ 0.5-1.5 m/s	GRID → Turbul. ~ 2-2.5 m/s
NO-GRID → Pseudo-Laminar Flow	NO-GRID → Turbulent Flow (due to the compression, not interesting)



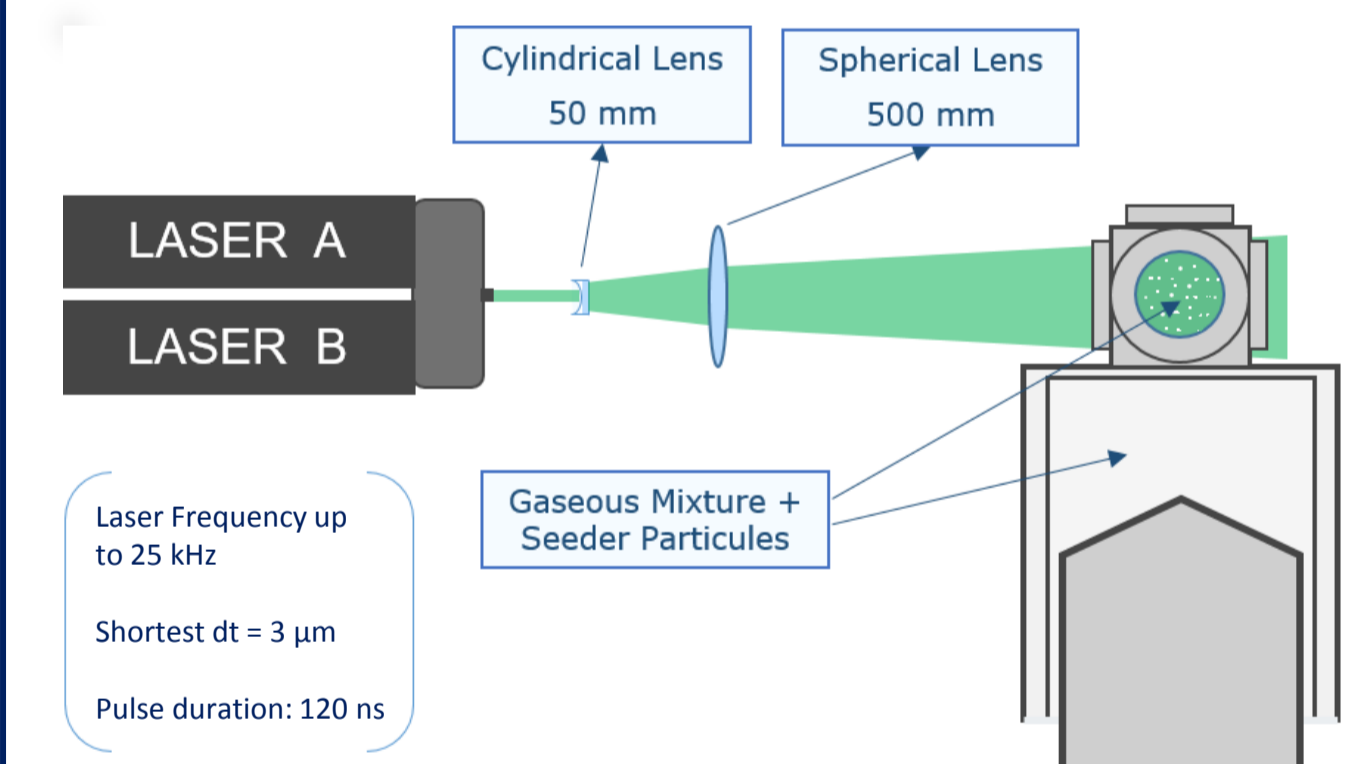
Optical techniques: Double-View Schlieren

Direct optical access from two views allows flame speed propagation and a tridimensional vision of the flame shape.



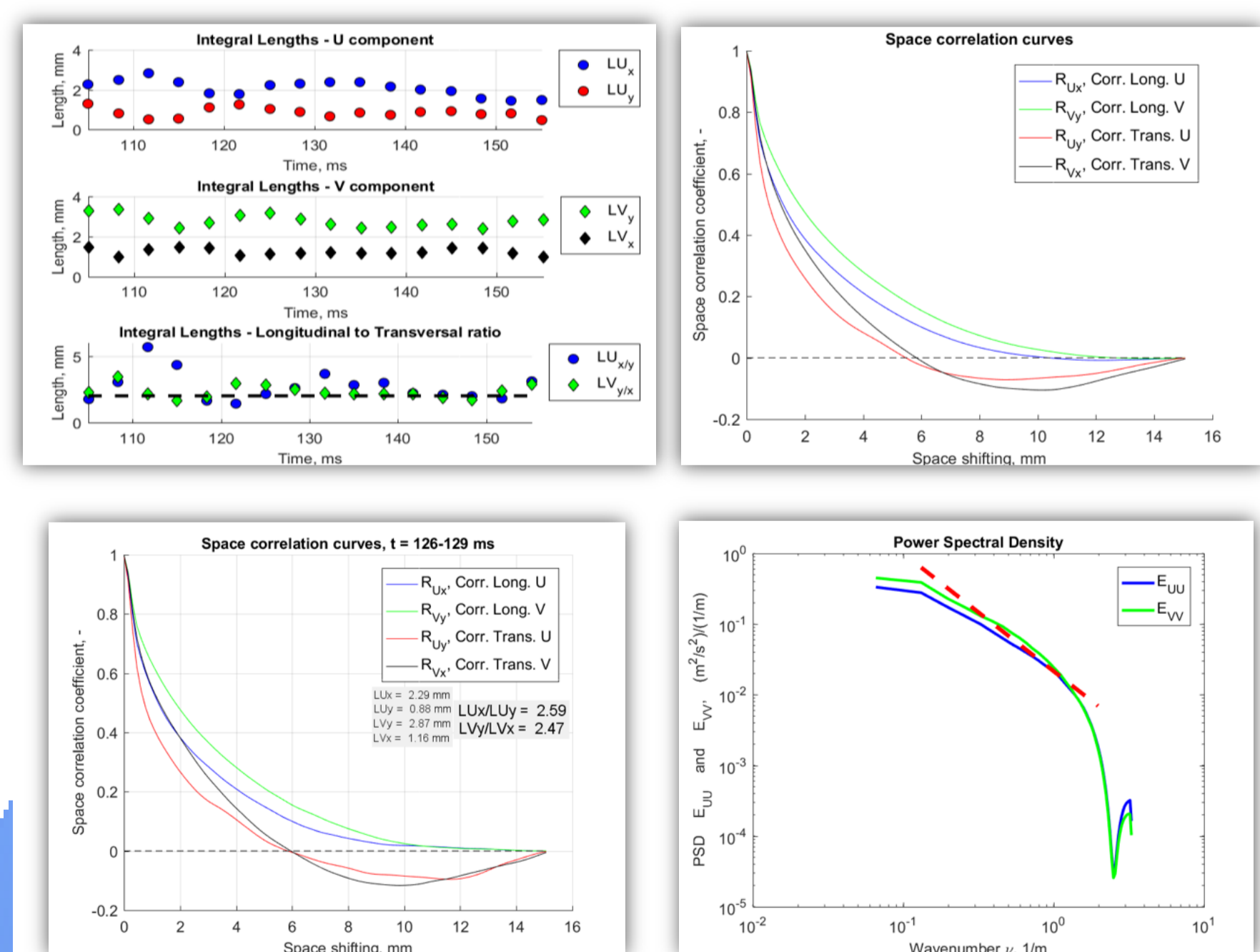
PIV and Tomography

Great spatial and temporal resolution, allowing the flow characterization during compression and plateau phases. Possibility of performing tomography to detect flame contour. PIV performed ZOOMED and UNZOOMED.



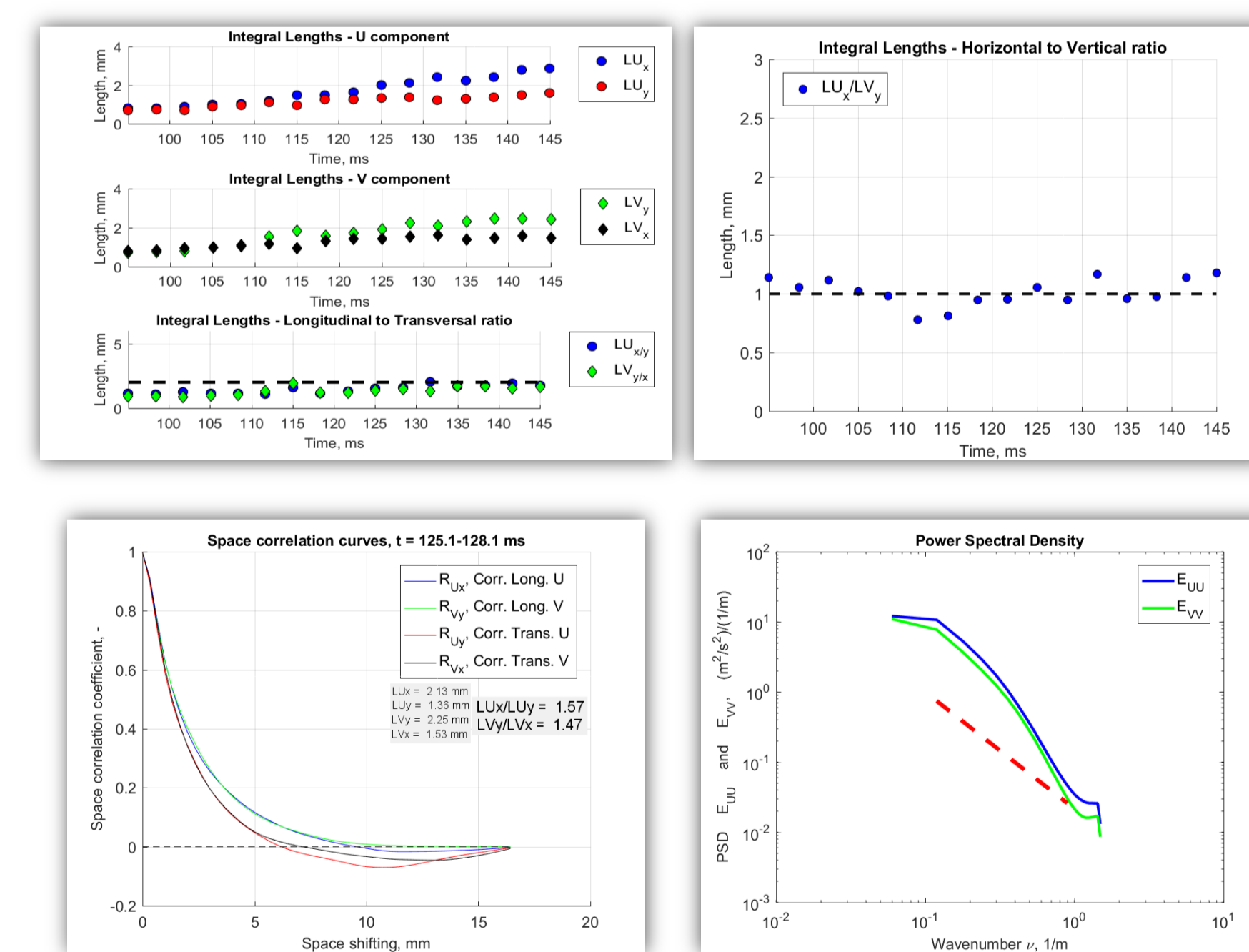
Results

Aerodynamic Characterization – LARGE VOLUME



Results

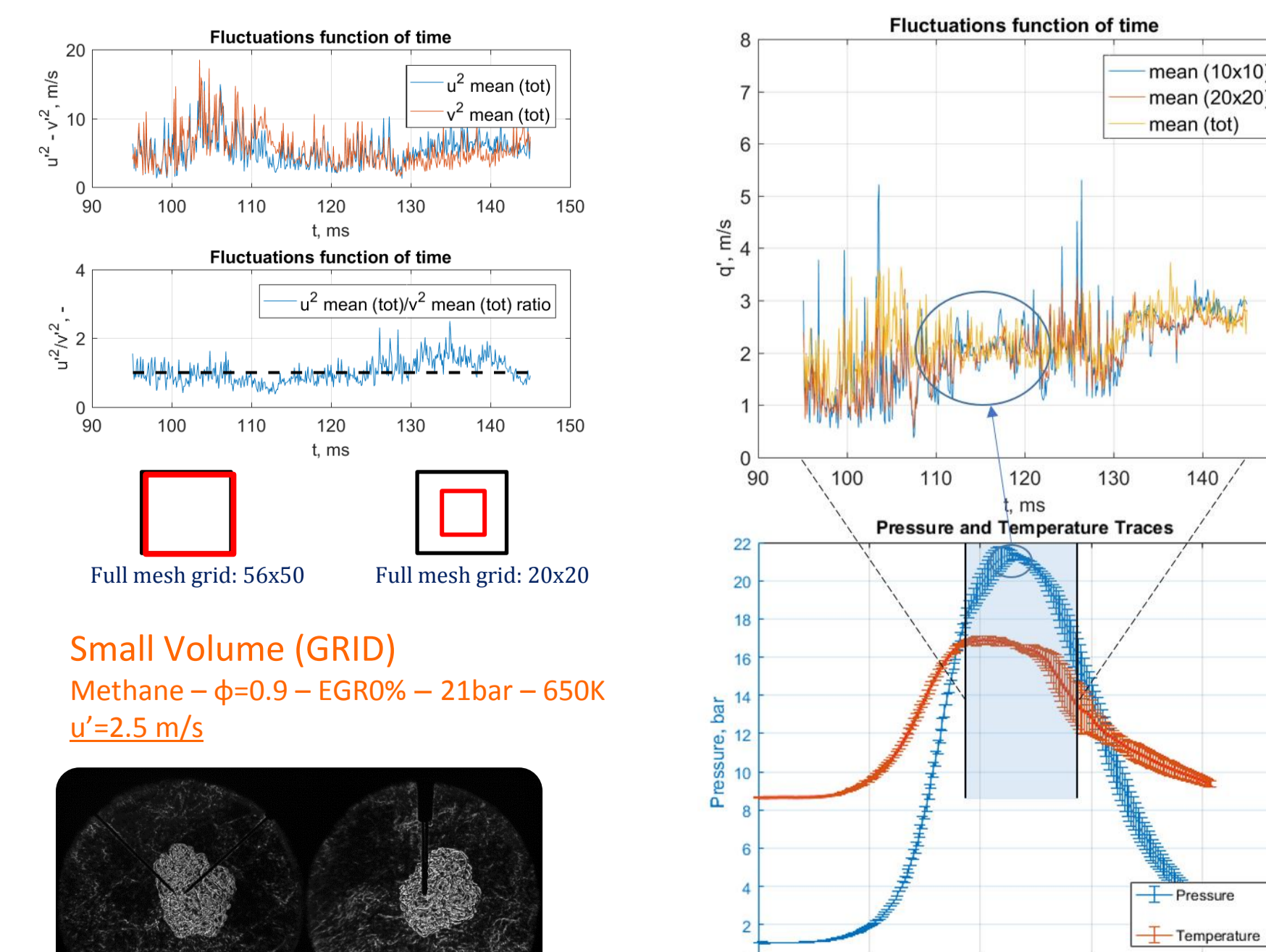
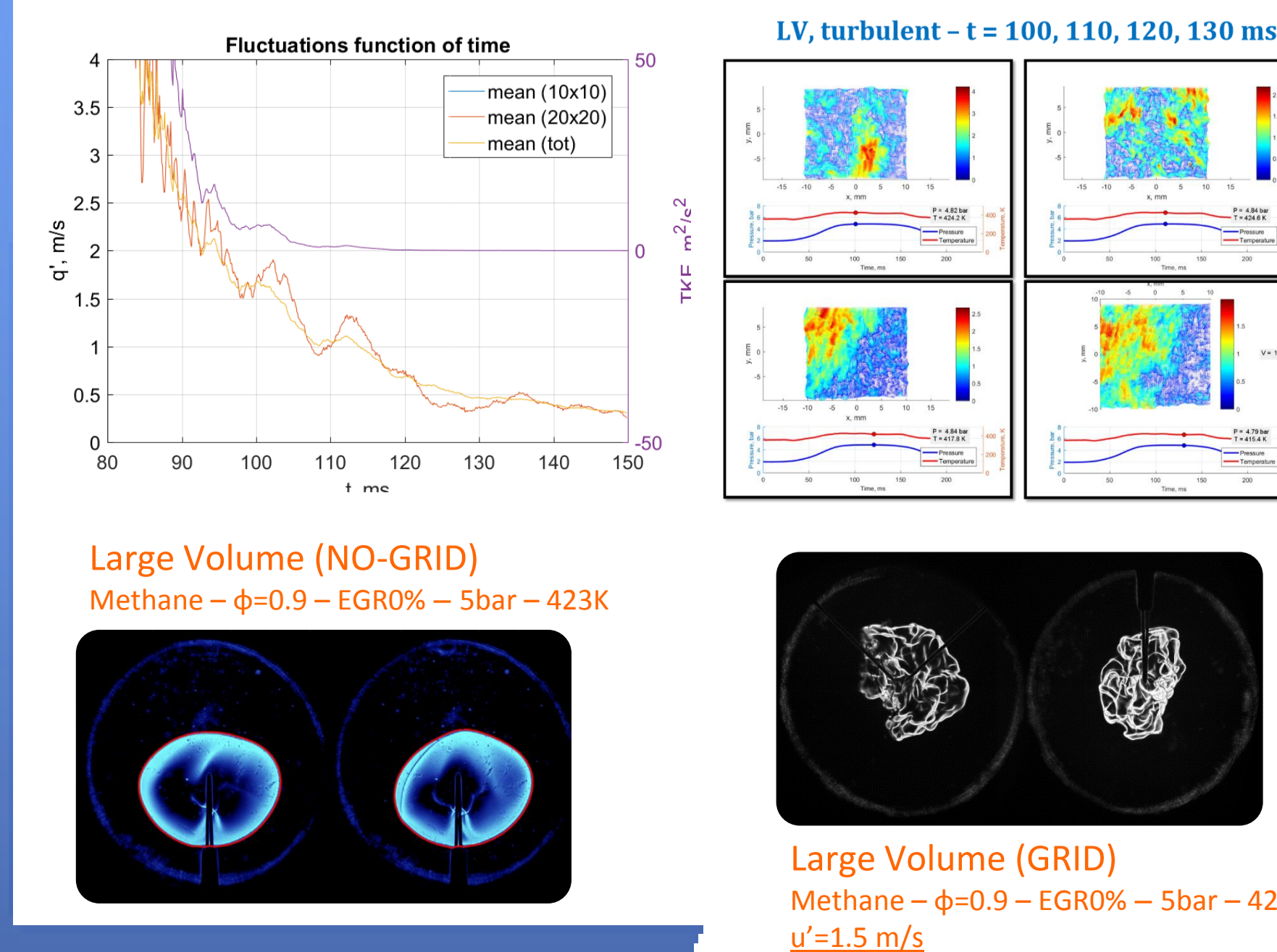
Aerodynamic Characterization – SMALL VOLUME



Integral Lengths evaluation - Homogeneous and Isotropic Turbulence hypotheses investigation

Velocity Fluctuations and Turbulent Kinetic Energy investigation

Flow field view and performed combustion tests examples



Conclusions

No-grid configuration:

- Large volume setup allows to reproduce laminar-like flow conditions during the temperature and pressure plateau.
- In the small volume the high compression ratio promotes the early insurgence of the turbulence (not interesting due to the possibly flame shifting).

Grid configuration:

- Large volume:**
 - Turbulence may be considered homogeneous and isotropic.
 - The turbulence intensity strongly decreases during the plateau, but it does not show significant oscillations.
- Small volume:**
 - Turbulence may be considered homogeneous and isotropic as well.
 - During the plateau the turbulence intensity mean value is constant or slightly increases, even though it presents a lot of oscillations.
- High turbulence intensity values, combined with small integral lengths, allows to reach high Karlovitz number and, thus, investigate the Peters-Borghi diagram unexplored zone.

Next future steps

- Validate the NOSE measurements by testing experimental points in common with the sphere in turbulent and laminar case.
- Test the dilution limit of the TRF-E with increasing temperature and pressure.
- Obtaining turbulent burning velocity measurements from NOSE using Double-View Schlieren and Tomography.