

# IFP Offer

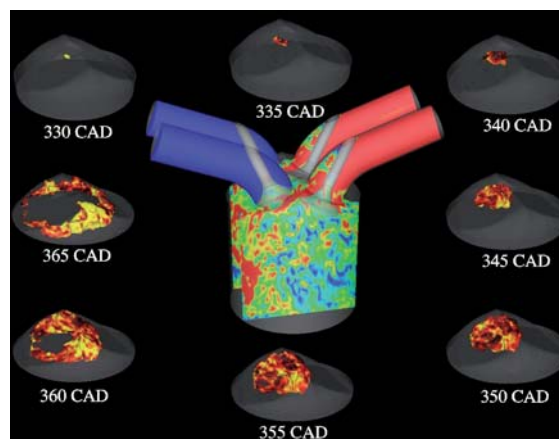
## in Large Eddy Simulation (LES)

### LES IN THE SIMULATION CHAIN

- LES resolves large scales and models only small scales: this reduces the impact of modelling uncertainties.
- LES complements the classical RANS approach by:
  - giving access to HF unsteadiness (cyclic variability, transients, etc.);
  - providing a more detailed insight into complex interactions through an instantaneous view.

### MULTI-CYCLE LES SIMULATION OF A 4-VALVE GASOLINE ENGINE\*

- 9 consecutive cycles simulated;
- $720^{\circ}\text{CA} = 120$  hours on 32 Xeon processors;
- operating conditions
  - 2000 rpm,
  - vol. eff. 0.35,
  - F/A eq. ratio 0.7;
- CFM-LES combustion model;
- Smagorinsky turbulence model with wall laws.

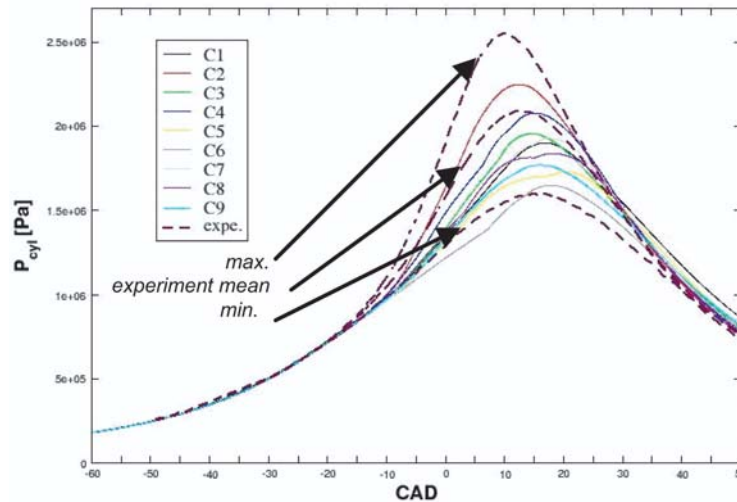


*Illustration of flow fields achieved in a multi-cycle LES with AVBP. Centre: velocity field during one intake stroke. Surround: flame front coloured according to the reaction rate at different crank angles during one combustion stroke. Approx. 25% of the flame surface density is resolved.*

\*Work partly funded by the European Commission in the context of the LESSCO2 project  
<http://project.ifp.fr/lessco2>

## THE AVBP LES FLOW SOLVER

- co-developed by IFP and CERFACS;
- unsteady, fully compressible reactive solver with higher-order FV & FE schemes;
- proven very high efficiency on massively parallel machines;
- unstructured hybrid, moving meshes;
- turbulence models: Smagorinsky, WALE, k-equation;
- turbulent combustion models: TFLES, CFM-LES;
- liquid injection model: Eulerian formalism.



Cylinder pressure predicted in 9 consecutive LES cycles with AVBP, compared to the experimental pressure envelope

	experiment	LES
mean engine work	96.76	92.31
rms around mean	3.95	4.04

Mean engine work from -50°C to +50°C and its RMS variation measured in the experiment and predicted by LES with AVBP

## FOR FURTHER INFORMATION, PLEASE CONTACT

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