# Combustion – overview

Despite the growth of renewable energies, combustion still is and will remain the first energy source on earth for a very long time. Optimizing combustors is therefore a high-priority objective worldwide. It is also a very complex scientific task, relying mostly today on simulations. Traditionally, the summer program at CTR is the occasion chosen by multiple teams to work on their most advanced simulation tools and 2010 was an excellent example, featuring computations of combustion devices never seen before. A few facts have characterized the combustion projects:

• Multiphysics is now an essential ingredient for combustion simulations. At CTR, two projects (Duchaine and Poinsot, Amaya *et al.*) have used coupling tools on massively parallel systems to link LES computations with radiation and heat transfer simulations in solids to predict the two-way interaction of flames and combustion chambers. These projects have confirmed that taking into account the coupling between these phenomena leads to first-order changes in the prediction of the temperature field of a high pressure stator or in the transfer function of an acoustically forced flame.

• Despite the clear progress observed in simulation of flames in complex geometries, the fundamental issue of flame / turbulence interaction remains an obstacle which has no fully satisfactory solution yet and remains a very weak point in most present LES codes for reacting flows. The groups of Chatakonda *et al.* and Moureau *et al.* have focused on tests of flame / turbulence interaction models for premixed turbulent combustion and produced very original and important results.

• Acoustics and combustion remain another essential issue for the combustion community: combustion instabilities in full annular chambers were studied at CTR by Wolf *et al.* in association with Argonne National Laboratory to produce the largest LES of compressible reacting flow ever performed in a real helicopter chamber geometry. Combustion noise mechanisms were also studied using DNS by Talei *et al.* to study noise generation due to flame surface changes.

• Finally, the CTR 2010 summer program has seen for the first time a possible fusion of DNS and LES roads: the projects of Moureau *et al.* and Chatakonda *et al.* have used DNS codes which can now be applied to real geometries (and not cubic periodic boxes) thanks to revolutionary simulation methods. Typically, these codes allow researchers to move from grids of typically 10 million cells to 10 billion. This significant step opens new paths for combustion simulations: one of them is to use DNS to validate LES models by running both on the same geometry. On a longer term, DNS might even replace LES for certain flames.

Thierry Poinsot