CONFERENCE ON

'LARGE-EDDY SIMULATION FOR ADVANCED DESIGN OF COMBUSTION SYSTEMS.
METHODS, TOOLS AND APPLICATIONS'

ORGANIZED BY:

COST-P20 LES-AID "LARGE EDDY SIMULATION: ADVANCE INDUSTRIAL DESIGN"

AND

ERCOFTAC SIG28 ON "REACTIVE FLOWS"

May 24-25, 2007 Rouen FRANCE

ORGANIZED BY LUC VERVISCH AND ANANIAS TOMBOULIDES

Background and objectives of the meeting: Computational fluid dynamics has become a key ingredient in the design of modern combustion systems. With recent progress in computer science and turbulence simulation, a non-negligible part of the improvement procedure of industrial combustion devices is now carried out in the light of numerical modeling. To meet the rapidly growing demand for accurate unsteady simulations of such complex systems, appropriate numerical and modeling methods must be combined with specific high-fidelity Computational Fluid Dynamics (CFD) tools that can be applied to real geometries preserving accuracy and prediction capabilities.

The major objective of this meeting was to offer to participants the possibility to discuss and exchange ideas on recent findings in Large-Eddy Simulation (LES) and related subjects. The discussion was triggered by keynote lectures given by invited speakers. Participants also had the opportunity to present their work in contributed paper sessions. In addition to poster viewing, specific short oral presentations were organized. Expenses of the invited lecturers were covered by the COST action P20 LES-AID "Large Eddy Simulation: Advance industrial design" (WG1 on Turbulent Combustion), ERCOFTAC in collaboration with the SIG28 on "Reactive Flows", as well as the GST Turbulence & Combustion of the "Association Française de Mécanique".

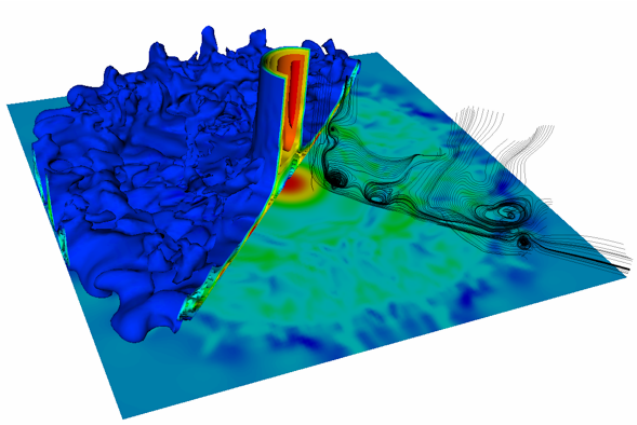
The following points were addressed:

- Sub-grid Scale Turbulence Modeling.
- Sub-grid Scale Combustion Modeling.
- Numerics for LES.
- CFD Tools for LES.
- Quality assessment of LES and Comparison with Experiments.
- Applications of LES for advanced Combustion Design and challenges.

62 scientists from 11 European countries participated to this two-day conference. Keynote lectures were given by C. Angelberger (IFP, France) on 'LES applied to internal engine combustion', K. Boulouchos (ETH, Switzerland) on 'Challenges in Internal engine combustion', P. Comte (LES & ENSMA, France) on 'LES of compressible flows', A. Dreizler (Darmstadt University, Germany) on 'Experiments for LES', B. Geurts (Twente University,

Netherland) on ‘Fundamental of LES’, A. Kempf (IC, UK) on ‘LES validation from experiments’, R. Koch (Karlsruhe University, Germany) on ‘Spray experiments and LES of liquid fuel injection’, U. Maas (Karlsruhe University, Germany) on ‘Detailed chemistry tabulation for LES’, E. Mastorakos (Cambridge, UK) on ‘Experiments for LES’, F. Nicoud (Montpellier University, France) on ‘Acoustics and LES’, T. Poinsot (IMFT & CERFACS, France) on ‘LES of advanced combustion design’ and O. Simonin (IMFT, France) on ‘LES of Two-phases flow’.

The keynotes lectures were accompanied by 4 sessions, where 13 contributed papers were given.



LES of wall-jet interaction. Iso-velocity surface, streamline and temperature at the wall.

Summary of main achievements and results presented: New methods and modeling approaches were presented for LES, and results obtained from novel time-resolved experimental techniques useful for LES validation were discussed together with high-fidelity LES of full-size systems involving high-performance computing.

High-fidelity LES relies on careful validation of both the numerics and the modeling from detailed experiments. Comprehensive and reliable experimental data sets are therefore a crucial part in the development of combustion-LES. An important outcome of this meeting is that using well defined benchmark flames and advanced laser diagnostics, different physical and chemical quantities can be precisely measured and compared to simulations with high temporal and reasonable spatial resolution. This promotes new challenges not only in CFD, but also in the field of diagnostics at high repetition rates and at walls. Before comparing experimentally measured quantities with combustion-LES-predicted counterparts, it was concluded that it is crucial to bring them at the same level of description (averaged or filtered quantities). Along the same lines, it was discussed how LES puts higher demands on validation than Reynolds Averaged Navier-Stokes Simulations (RANS). In addition, remaining real challenge for LES include full scale setups in engineering combustion problems where LES is called to assist in the design process. Thus, there is a need for more “complex”

model/benchmark problems for the validation of LES in reacting flows, in addition to relatively “simple” flow patterns currently available.

New sub-grid scale modeling strategies were carefully discussed with new techniques to account for detailed chemistry in LES of turbulent flames. Specifically, the various tabulation techniques for chemistry in LES were listed and new ideas emerged to include low temperature chemistry driven by molecular diffusion.

The simulation of a full range of systems were discussed, from laboratory jet flames and lean premixed burners up to the ignition phase of a full-size helicopter combustion chamber simulated over 5000 processors by CERFACS, which constitutes a world premiere in the field.

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