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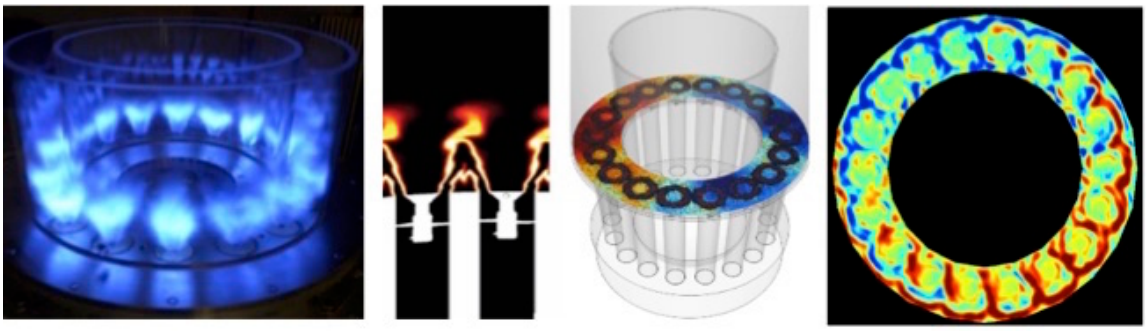

Annular instabilities and transient phenomena in gas turbine combustors

Numerical methods for Large Eddy Simulation

8th to 12th April 2019

CERFACS
(Le Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique)
Toulouse, France

Lecturers:

Prof Thierry Poinsot (CERFACS/IMFT)

Dr O Veromorel (CERFACS)

Dr G Staffelbach (CERFACS)

Dr L. Gicquel (CERFACS)

Dr B. Cuenot (CERFACS)

Dr E Riber (CERFACS)

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Preliminary Schedule

The ESRs will be trained on the use of the numerical code solver AVBP which is in-house code developed in CERFCS and has been conceived for massively parallel, time-dependent simulations of compressible turbulent flow. ESRs will gain proficiency in the basic workings of the numerical methods and execution of the AVBP solver including: numerics, boundary conditions, LES closures and combustion modeling. The CFD code AVBP (version 7.0.2) co-developed by CERFACS and IFPEN is used for hands-on to compute both academic and realistic configurations of reacting compressible flows.

Day 1 – Introduction / numeric for LES

- 9h00 Welcome and coffee
- 9h15 LES of reacting compressible flows – Introduction
  The differences between RANS and LES.
  The codes for LES.
- 10h45 How does AVBP work
  Files – scripts – general organization.
- 11h30 Installation on computers – accounts – computer organization
- 14h00 Numerical schemes needed for LES. Dissipation and dispersion of waves.
  Implementation of numerical schemes in AVBP.
- 15h00 Hands-on work on computers: measurement of dispersion and dissipation, effect of mesh and scheme for two canonical cases: the convection of two-dimensional vortices and the shear layer

Day 2 – Bounday conditions

- 9h00 Boundary conditions in compressible flows: characteristic methods
- 9h45 Implementation of boundary conditions in AVBP
- 10h30 Hands-on: simulation of one-dimensional acoustic waves reaching non-reflecting boundaries
  Generation of propagating acoustic waves.
- 14h00 Hands-on: manipulation of boundary conditions to mimic reflexions or to produce non-reflecting conditions
  Applications to vortices going through outlet.

Day 3 – LES of gaseous turbulent reacting flows

- 9h00 LES of reacting flows: thermodynamics, kinetics, laminar flames and turbulent combustion model, closure models for LES and wall modelling
- 10h30 Hands-on: post-processing LES of turbulent flow. Effect of subgrid-scale model, wall model and grid refinement
- 14h00 Hands-on: simulation of one-dimensional laminar flame (initial flame file (CANTERA) is provided) with and without flame thickening
- 16h00 Hands-on: simulation of a forced two-dimensional laminar flame

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Day 4 – LES of two-phase flow turbulent reacting flows

9h00 LES of two-phase reacting flows: Euler-Euler (EE) and Euler-Lagrange (EL approaches, evaporation, injection, liquid-wall interactions, two-phase combustion mode

10h30 Hands-on: simulation of two-phase canonical cases using both EE and EL approaches

14h00 Hands-on: simulation of a one-dimensional two-phase laminar flame

16h00 Hands-on: LES of an heptane air swirled combustor

Day 5 – Detailed analysis of LES – spot the difference

9h00 Hands-on: spot the difference on a three-dimensional LES deliberately riddled with errors

14h00 Custom made afternoon: participants are welcome to discuss about their current objectives/perspectives/problems using AVBP with the senior researchers of the CFD team