

Florent DUCHAINE

Senior Researcher in Fluid Dynamics
CERFACS, France

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Research interests :

- Computational Fluid Dynamics (CFD)
- Conjugate Heat Transfer (CHT)
- Combustion instabilities
- Code coupling
- Massively parallel computations
- Large Eddy Simulations (LES)
- Optimization

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CERFACS
42 avenue Gaspard Coriolis
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Nationality : French
39 years old

Professional Background

2010 – ...

Senior Researcher at CERFACS

→ *Multi-physic and multi-component simulations*

- Conjugate heat transfer in gas turbine components with LES
- LES of turbomachinery stages
- LES of combustion chamber/turbine interactions

→ *Software development*

- TurboAVBP : extension of AVBP solver for turbomachinery simulations
- OpenPALM coupler : development, installation and test on massively parallel architectures
- Thermal solver AVTP and radiation solver PRISSMA
- Identification of coupling strategies for computations on massively parallel architectures

→ *Training and formation of Ph.D. students and post-doc*

→ *Setting up, coordination and execution of PRACE projects*

→ *Setting up, coordination and execution of European and national projects*

2009 – 2010

Postdoctoral fellow at Institut de Mécanique des Fluides de Toulouse in PSC Team

Advisor : Dr. Laurent Selle, IMFT (French project ANR SIGLE)

→ *Eulerian models for turbulent spray combustion with polydispersity* : Investigations in droplets coalescence in a LES framework

→ *Numerical investigations of combustor wall temperature effect on Flame Describing Functions (FDFs)* :

- Thermal coupling of a solid conduction solver and a reactive LES fluid code,
- Acoustic forcing of a laminar flame and determination of corresponding FDFs,
- Comparisons with experimental results.

- 2007 – 2009 **Postdoctoral fellow at CERFACS in CFD-Combustion group**
 Advisor : Prof. Thierry Poinsot, IMFT
 → *Numerical investigations of conjugate heat transfer in gas turbines* :
 • Thermal coupling of a solid conduction solver and a LES fluid code,
 • Researches in coupling strategies,
 • Applications to gas turbine components.
- *Collaboration with Airbus on Large Eddy Simulations for heat transfer problems*
 • Assessment of LES in academic flows with experimental and RANS comparisons,
 • CHT in an experimental model of an aero engine nacelle cooling.
- 2006 **Automatization of a multi-physic framework for the prediction of combustion chamber walls temperature. SNECMA Moteur (France)**
 Iterative loop based on 3D solvers : reactive multiphase flows / radiative / conduction in solid media.
- 2004 – 2007 **Ph.D. at CERFACS (preceded by a 7-month training period)**
 Advisors : Prof. Thierry Poinsot, Institut de Mécanique des Fluides de Toulouse and Dr. L. Gicquel, CERFACS
 Ph.D. funded by the European project INTELLECT-DM (contract of the FP6)
 → *Multi-objective Shape Optimization on Parallel Architectures with Metamodels and Couplers. Application to Aeronautical Combustion Chambers.*
 Development of a fully parallel optimization tool based on a CFD reactive RANS code :
 • Researches and developments in design optimization and code coupling applied to CFD,
 • Implementation of the design tool on massively parallel architectures,
 • Shape optimization of a combustion chamber.
- 2004 – 2005 Teaching in numerical fluid dynamics for Undergraduate students for Masters Degree in energetics engineering. ENSEEIHT (France)
- 2003 **Research training (6 months) at Institut de Mécanique des Fluides et des Solides de Strasbourg**
 Advisor : Prof. Pierre Comte, IMFS Strasbourg
 → *Toward noise prediction of 3D turbulent jets.*
 • Implementation and validation of characteristic boundary conditions in a LES solver,
 • Simulations of 3D compressible round jets.

Education

- 2017 **Habilitation à Diriger des Recherches**
Institut National Polytechnique de Toulouse (France)
- 2004 – 2007 **Ph.D. in Fluid Dynamics**
Institut National Polytechnique de Toulouse (France)
- 2003 – 2004 **Mastère Spécialisé (label CGE) in Numerical Fluid Dynamics**
Ecole Nationale Supérieure d'Electrotechnique, d'Electronique, d'Informatique, d'Hydraulique et des Télécommunications (ENSEEIHT) de Toulouse (France)

- 2002 – 2003 **Masters of Science in Mechanics and Energetics**
Institut National Polytechnique de Lorraine (France)
- 1998 – 2003 **Masters Degree in Engineering : Fluid Mechanics and Thermals**
Ecole Supérieure des Sciences et Technologies de l'Ingénieur de Nancy (ESSTIN - France)

Languages and Computer skills

- Languages *French* : Native
English : Fluent conversational and written
- Computer *Massively parallel computations* : C3I label from GENCI (<http://c3i.genci.fr>)
Programming : Fortran 90, MPI-1, HTML

Activities and Interests

- Reviewer *Scientific Journals* : Combustion and Flame, International Journal of Numerical Methods in Fluids, Heat and Mass Transfer, Applied Thermal Engineering, Aerospace Science and Technology, Computer and fluids, ASME
French funding agency : Agence Nationale pour la Recherche (ANR) - evaluation of research projects
- Capoeira President of the association *Capoeiragem* that promotes Brazilian arts (Toulouse)
Graded student entitled to give lessons

Awards

- 2017 Elected ASME Member 2017 / 2018
- 2015 Teratech/Usine Digitale - Meilleure collaboration dans la simulation numérique
- 2013 Most Innovative Industrial HPC End-User Application in Europe

Publications (more details on <http://www.cerfacs.fr/~duchaine/>)

Papers in refereed journals

1. F. Duchaine, T. Morel and L.Y.M. Gicquel. Computational-Fluid-Dynamics-Based Kriging Optimization Tool for Aeronautical Combustion Chambers. *AIAA Journal*, 47(3) :631-645, 2009
2. F. Duchaine, S. Mendez, F. Nicoud, A. Corpron, V. Moureau, and T. Poinso. Conjugate heat transfer with large eddy simulation. Application to gas turbine components. In *C.R.A.S. Mécanique*, 2009. 337(6-7), 550-561
3. N. Gourdain, L. Gicquel, G. Staffelbach, O. Vermorel, F. Duchaine, J-F. Boussuge and T. Poinso. High performance parallel computing of flows in complex geometries - part 2 : applications, *Computational Science & Discovery* 2(1) : 015004, 2009
4. F. Duchaine, A. Corpron , V. Moureau , F. Nicoud , T. Poinso. Development and assessment of a coupled strategy for conjugate heat transfer with Large Eddy Simulation. Application to a cooled turbine blade. *International Journal of Heat and Fluid Flow*, 30(6) : 1129-1141, 2009

5. F. Duchaine, F. Boudy, D. Durox and T. Poinso. Sensitivity analysis of transfer functions of laminar flames. *Combustion and Flame*, 158(12) :2384-2394, 2011
6. D. Poitou, J. Amaya and F. Duchaine. Parallel computation for the radiative heat transfer using the DOM in combustion applications : direction, frequency, sub-domain decomposition and hybrid methods. *Numerical Heat Transfer, Part B Fundamentals*, 62-1, 2012
7. E. Collado Morata, N. Gourdain, F. Duchaine, L.Y.M. Gicquel. Effect of free-stream turbulence on high pressure turbine blade heat transfer using structured and unstructured LES. *International Journal of Heat and Mass Transfer*, 55(21-22) :5754-5768, 2012
8. M. Boileau, F. Duchaine, J.-C. Jouhaud and Y. Sommerer. Large Eddy Simulation of of heat transfer around a square cylinder using unstructured grids. *AIAA Journal*, Vol. 51, No. 2 (2013), pp. 372-385
9. F. Duchaine, N. Maheu, V. Moureau, G. Balarac and S. Moreau. Large Eddy Simulation and Conjugate Heat Transfer Around a Low-Mach Turbine Blade. *Journal of Turbomachinery* 136(5), 2013
10. S. Jauré, F. Duchaine, G. Staffelbach and L.Y.M. Gicquel. Massively parallel conjugate heat transfer solver based on Large Eddy Simulation and application to an aeronautical combustion chamber. *Journal of Computational Science and Discovery*, 6 :015008, 2013.
11. C. Koupper, T. Poinso, L. Gicquel and F. Duchaine. On the ability of characteristic boundary conditions to comply with radial equilibrium in turbomachinery simulations. *AIAA Journal*. Vol. 52, No. 12 (2014), pp. 2829-2839.
12. G. Lecocq, D. Poitou, I. Hernandez, F. Duchaine, E. Riber and B. Cuenot. A methodology for soot prediction including thermal radiation in complex industrial burners. *Flow Turbulence and Combustion*, 92(4) :947-970. 201. 2014
13. A. Bonhomme, G. Wang, L. Selle, F. Duchaine and T. Poinso. A parallel multidomain coupled strategy to compute turbulent flows in fan-stirred bombs. *Computers and Fluids*, 101 :183-193. 2014
14. G. Wang, F. Duchaine, D. Papadogiannis, I. Duran, S. Moreau and L.Y.M Gicquel. An overset grids method for large eddy simulation of turbomachinery stages. *Journal of Computational Physics*, 274 :333-355. 2014
15. F. Duchaine, M. Boileau, Y. Sommerer and T. Poinso. Large Eddy Simulation of the flow and heat transfer around two square cylinders in a tandem arrangement. *Journal of Heat Transfer*. 2014. 136(10), 101702
16. N. Gourdain F. Sicot, F. Duchaine and L. Gicquel. Large Eddy Simulation of flows in industrial compressors : a path from 2015 to 2035. *Philosophical Transactions A*. 2014. 372(2022) :20130323
17. C. Koupper, G. Bonneau, G. Cacioli, B. Facchini, L. Tarchi, L.Y.M. Gicquel and F. Duchaine. Development of an Engine Representative Combustor Simulator Dedicated to Hot Streak Generation. *Journal of Turbomachinery*. 2014. 136(11), 111007
18. T. Leonard, N. Gourdain, L. Gicquel and F. Duchaine. Steady / Unsteady Reynolds Averaged Navier-Stokes and Large Eddy Simulations of Turbine Blade at High Subsonic Outlet Mach Number. *Journal of Turbomachinery*. 2014. 137(4), 041001
19. C. Koupper, L. Gicquel, F. Duchaine and G. Bonneau. Advanced combustor exit plane temperature diagnostics based on Large Eddy Simulations. *Flow, Turbulence and Combustion*. 2015. 95(1) :79-96
20. A. Poubeau, R. Paoli, A. Dauplain, F. Duchaine and G. Wang. Large Eddy Simulation of a solid rocket booster jet : towards a better prediction of the impact of solid-fuel launchers on the atmosphere. *AIAA Journal*. 2015. Vol. 53, No. 6, pp. 1477-1491
21. S. Scholl, T. Verstraete, J. Torres-Garcia, F. Duchaine and L. Y. M. Gicquel. Influence of the Thermal Boundary Conditions on the Heat Transfer of a Rib-Roughened Cooling Channel using LES. *Proceedings of the Institution of Mechanical Engineers, Part A : Journal of Power and Energy*. 2015. 229(5), 498-507
22. F. Duchaine, S. Jauré, D. Poitou, E. Quémerais, G. Staffelbach, T. Morel and L. Gicquel. Analysis of High Performance Conjugate Heat Transfer with the OpenPALM Coupler. *Journal of Computational Science and Discovery*. 8 :015003, 2015

23. D. Papadogiannis, F. Duchaine, L.Y.M. Gicquel, G. Wang, S. Moreau and F. Nicoud. Assessment of the indirect combustion noise generated in a transonic high-pressure turbine stage. *ASME. J. Eng. Gas Turbines Power.* 2015 ;138(4) :041503-041503-8
24. C. Koupper, T. Bacci, B. Facchini, A. Picchi, L. Tarchi, L. Gicquel, F. Duchaine and G. Bonneau. Experimental and numerical calculation of turbulent timescales at the exit of an engine representative combustor simulator. *Journal of Engineering for Gas Turbines and Power.* 2015 ;138(2) :021503-021503-10
25. G. Wang, M. Sanjose, S. Moreau, D. Papadogiannis, F. Duchaine and L.Y.M Gicquel. Noise mechanisms in a transonic high-pressure turbine stage. *International Journal of Aeroacoustics*, 0(0) 118, 2016
26. M.P. Errera and F. Duchaine. Comparative study of coupling coefficients in Dirichlet-Robin procedure for fluid-structure aerothermal simulations. *Journal of Computational Physics.* 2016. 312 :218234
27. D. Papadogiannis, F. Duchaine, L. Gicquel, G. Wang and S. Moreau. Effects of Sub-Grid-Scale modeling on the deterministic and stochastic turbulent energetic distribution in LES of a high pressure turbine stage. *Jurnal of Turbomachinery.* 138(9), 091005. 2016
28. R. Mari, J.P. Rocchi. F. Duchaine, L. Selle and B. Cuenot. Effect of pressure on Hydrogen/Oxygen coupled flame-wall interaction. *Combustion and Flame.* 168 :409-419. 2016
29. S. Berger, S. Richard, F. Duchaine, G. Staffelbach and L. Gicquel. On the sensitivity of a helicopter combustor wall temperature to convective and radiative thermal loads. *Applied Thermal Engineering.* 103(25) :1450-1459. 2016
30. L. Labarrere, T. Poinso, A. Dauplain, F. Duchaine, M. Bellenoue and B. Boust. Experimental and numerical study of cyclic variations in a Constant Volume Combustion Chamber. *Combustion and Flame.* 172 :49-61, 2016
31. M. Brebion, D. Mejia, P. Xavier, F. Duchaine, B. Bedat, L. Selle and T. Poinso. Joint experimental and numerical study of the influence of flame holder temperature on the stabilization of a laminar flame on a cylinder. *Combustion and Flame.* 172 :153-161, 2016
32. S. Scholl. T. Verstraete, F. Duchaine and L. Gicquel. Large Eddy Simulation and conjugate heat transfer of a rib-roughened internal turbine blade cooling channel. *International Journal of Heat and Fluid Flow.* Vol 61 - Part B, pp 650-664, 2016.
33. P. Aillaud, F. Duchaine, L.Y.M Gicquel and S. Didorally. Secondary peak in the Nusselt number distribution of impinging jet flows : A phenomenological analysis. *Physics of Fluids.* 28(9) :, 2016.
34. F. Duchaine, J. Dombard, L.Y.M Gicquel and C. Koupper. On the importance of inlet boundary conditions for aerothermal predictions of turbine stages with Large Eddy Simulation. *Computers and Fluids.* Vol. 154-1. pp 60-73, 2017.
35. D. Mejia, M. Miguel-Brebion, A. Ghani, T. Kaiser, F. Duchaine, L. Selle, T. Poinso. Influence of flame-holder temperature on the acoustic flame transfer functions of a laminar flame. *Combustion and Flame.* Volume 188, 2018.
36. P. Aillaud, L. Y. M. Gicquel, and F. Duchaine. Jet impingement onto flat and concave surfaces : A detailed comparison of flow dynamics and heat transfer. *Phys. Rev. Fluids*, Vol. 2-11, pp 114608-114642, 2017.
37. S. Berger, F. Duchaine and L.Y.M. Gicquel. Bluff-body thermal property and initial state effects on a laminar premixed flame anchoring pattern. *Turbulence and Combustion*, 100(2), pp 561591, 2018.
38. J. de Laborderie, F. Duchaine and L.Y.M. Gicquel. Numerical Analysis of a High-Order Unstructured Overset Grid Method for Compressible LES of Turbomachinery. *Journal of Computational Physics*, 363(15), pp 371-398, 2018.
39. R. Bizzari, D. Lahbib, A. Dauplain, F. Duchaine, L. Gicquel and F. Nicoud. A thickened-hole model for Large Eddy Simulations over multiperforated liners. *Flow Turbulence and Combustion*, 101(3), pp 705-717, 2018.
40. L. Boulet, P. Benard, G. Lartigue, V. Moureau, S. Didorally, N. Chauvet, F. Duchaine. Modeling of conjugate heat transfer in a kerosene/air spray flame used for aeronautical fire resistance tests. *Flow Turbulence and Combustion*, 101(2), pp579-602, 2018.

41. R. Bizzari, S. Richard, F. Duchaine, F. Nicoud, A. Dauplain and D. Lahbib. Low order modeling method for assessing the temperature of multi-perforated plates. *International Journal of Heat and Mass Transfer*, 127(B), pp 727-742), 2018.
42. N. Odier, M. Sanjose, L. Gicquel, T. Poinsot, S. Moreau and F. Duchaine. A characteristic inlet boundary condition for compressible, turbulent, multispecies turbomachinery flows. *Computer and Fluids*, 178, pp 41-55, 2019.
43. C. Laurent, L. Esclapez, D. Maestro, G. Staffelbach, B. Cuenot, L. Selle, T. Schmitt, F. Duchaine, T. Poinsot. Flame-wall interaction effects on the flame root stabilization mechanisms of a doubly-transcritical LO₂/LCH₄ cryogenic flame. *Proceedings of the Combustion Institute*, Volume 37, Issue 4, 2019, Pages 5147-5154.
44. C. Perez Arroyo, T. Leonard, M. Sanjose, S. Moreau and F. Duchaine. Large Eddy Simulation of a scale-model turbofan for fan noise source diagnostic *Journal of Sound and Vibration*, Volume 445, 14 April 2019, Pages 64-76.
45. J. de Laborderie, F. Duchaine, L. Gicquel and S. Moreau. Wall-modeled Large-Eddy Simulations of a Multistage High-Pressure Compressor. Accepted in *Flow, Turbulence and Combustion*.
46. M. Harnieh, M. Thomas, R. Bizzari, J. Dombard, F. Duchaine and L. Gicquel. Assessment of a coolant injection model on cooled high-pressure vanes with Large-Eddy Simulation. Accepted in *Flow, Turbulence and Combustion*.
47. T. Grosnickel, F. Duchaine, L.Y.M. Gicquel and C. Koupper. Large-Eddy Simulation of the flow developing in static and rotating ribbed channels. Accepted in *Journal of Turbomachinery*.