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Guilhem Lacaze

Senior Member of Technical Staff
Reacting Flow Research

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SHORT BIO:

Guilhem Lacaze has extensive experience in research related to a broad range of topics in turbulent combustion simulation, modeling and massively-parallel high-performance computing. His past research has been focused on high-pressure reacting flow simulations of industrial applications such as liquid rockets, diesel engines, and high-pressure gas turbines. The DOE Office of Science, Basic Energy Sciences Program, supported his most recent work, where emphasis was placed on advanced numerical methods, modeling turbulent combustion processes and solver optimization for exascale computing. His current work on Titan reaches unequaled resolutions and details on physical processes piloting efficiency and emissions in advanced propulsion systems. This level of accuracy is only accessible via billion-point calculations over hundreds of thousands of cores. His focus is now to use GPU acceleration to extend attainable precision. This will have a direct impact on the development of cleaner and more efficient propulsion and power devices.

RESEARCH INTERESTS

- Large-Eddy Simulation
- High-performance parallel computing
- Turbulent combustion modeling
- Two phase flow and high-pressure flow modeling
- Numerical methods and simulation accuracy

EDUCATION

Aug. 2005 to May 2009 **Ph.D. thesis**: Energy and Fluid Dynamics.
CERFACS (European Centre for Research and Advanced Training in Scientific Computation) and The National Polytechnic Institute of Toulouse (INPT), France.
Title: Large Eddy Simulation of the ignition of cryogenic rocket engines.
Supervisor: T. Poinsot.

Sept. 2003 to Jun. 2005 **Master's Degree in Engineering**: Fluid Mechanics.
ENSMA (Higher National School of Mechanics and Aeronautics), France, and University of Manchester, United Kingdom.

AWARDS, HONORS AND MEMBERSHIPS

2013 Recipient of the Early Career R&D (ECRD) Grant.
Focus of the research: Development of Quality Assessment Techniques for Large Eddy Simulation of Propulsion and Power Systems in Complex Geometries.
Funded by Sandia National Laboratories for a duration of two years.

2012 Finalist Astronaut Candidate for the HiSEAS project funded by Nasa.
The study is designed to simulate the living and working experience of astronauts on a real planetary mission. The four-month Mars analogue mission will take place in a habitat on a volcanic plateau of the Big Island of Hawaii.

2009 Ph.D. thesis selected for the prize Léopold Escande of the National Polytechnic Institute of Toulouse.

2000 Admitted to Henri IV School, Paris, France.
Henri IV is one of the most prestigious colleges in France.

SELECTED PUBLICATIONS & PATENTS

Journal papers:

Ruiz, **G. Lacaze**, L. Selle, R. Mari, B. Cuenot, T. Poinsot and J. C. Oefelein. On Density Effects and Vortical Structures in a 2D LOx/GH2 Supercritical Turbulent Mixing Layer Physics of Fluids, **2013**, Submitted

G. Lacaze and J. C. Oefelein. Modeling high density gradient flows at supercritical pressures AIAA journal, **2013**, Submitted

J. C. Oefelein, R. N. Dahms, and **G. Lacaze.** Detailed modeling and simulation of high-pressure fuel injection processes in diesel engines. SAE International Journal of Engines, **2012**

G. Lacaze and J. Oefelein. A non-premixed combustion model based on flame structure analysis at

supercritical pressures. Combustion and Flame, 159 (6): 2087–2103, **2012**
G. Lacaze, T. Poinsot, B. Cuenot, and M. Oschwald. Large Eddy Simulation of Laser Ignition and Compressible Reacting Flow in a Rocket-Like Configuration. Combustion and Flame, 156(6):1166–1180, **2009**

Lacaze, E. Richardson, and T. Poinsot. Large Eddy Simulation of Spark Ignition in a Turbulent Methane Jet. Combustion and Flame, 156:1993–2009, **2009**

Conference invitation:

G. Lacaze, invited lecture at Berkeley University, Department of Mechanical Engineering. Introduction to turbulent combustion, theory and modeling. Lecture level: graduated students. hosted by Prof. J.Y. Chen of the Department of Mechanical Engineering, **2013**.

J. C. Oefelein and **G. Lacaze**. Low temperature injection dynamics and turbulent flame structure in high-pressure supercritical flows. In Institute for the Dynamics Institute for the Dynamics Institute for the Dynamics of Explosions and Reactive Systems (ICDERS), Irvine, California, **2011**.

International conferences:

G. Lacaze and J. C. Oefelein. Modeling high density gradient flows at supercritical pressures. In 49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, San Jose, California, USA, **2013**.

J. C. Oefelein, R. N. Dahms, **G. Lacaze**, and A. M. Ruiz. Modeling and numerical treatment of liquid injection processes at high-pressure supercritical conditions. In Society of Industrial and Applied Mathematics (SIAM), San Antonio, Texas, USA, April 8-10 **2013**.

J. C. Oefelein, R. N. Dahms, **G. Lacaze**, J. L. Manin, and L. M. Pickett. Effects of pressure on the fundamental physics of fuel injection in diesel engines, isbn 978-88-903712-1-9. In Proceedings of the 12th International Conference on Liquid Atomization and Spray Systems, Heidelberg, Germany, **2012**.

G. Lacaze and J. C. Oefelein. A model for non-premixed combustion at high pressure a model for non-premixed combustion at high pressure supercritical conditions based on a flame structure analysis. In 2011 Australian Combustion Symposium (ACS), Newcastle, Australia, **2011**.

G. Lacaze and J. Oefelein. A tabulated chemistry model for non-premixed combustion at high pressure supercritical conditions. In 7th Mediterranean Combustion Symposium (MCS), Sardinia, Italy, **2011**.

G. Lacaze, B. Cuenot, T. Poinsot, and M. Oschwald. Experimental study and large eddy simulation of laser ignition in a rocket like configuration (poster presentation). In 32nd Symposium (International) on Combustion, Montreal, Quebec, **2008**.

G. Lacaze, B. Cuenot, and T. Poinsot. LES of Laser Ignition in a H2-O2 Micro-combustor. In Institute for the Dynamics Institute for the Dynamics Institute for the Dynamics of Explosions and Reactive Systems (ICDERS), Poitiers, France, **2007**.

G. Lacaze and B. Cuenot. LES of laser ignition in a micro-combustor. In 3rd Rocket Combustion Modeling Workshop (RCM), Paris, France, **2006**.

Other conferences:

G. Lacaze and J. Oefelein. Requirements and science goals for sustained petascale combustion science. In SciApps-10: Challenges and Opportunities for Scientific Applications: learing to sustain the Petaflop with eyes on the Exaflop horizon, Tennessee, USA, **2010**. Oak Ridge National Laboratories.

G. Lacaze, J. Oefelein, and J. Chen. High performance computing laboratory: High fidelity modeling to optimize engines. In Presentation to Congressman John Garamendi: overview of Sandia's activities in combustion research, California, USA, **2010**. CRF, Sandia.

G. Lacaze, J. Oefelein, and J. Chen. High fidelity computing in turbulent combustion. In Herty foundation discovery day, California, USA, **2010**. CRF, Sandia.

G. Lacaze, E. Richardson, B. Cuenot, and T. Poinsot. LES of the ignition of a non-premixed turbulent jet - ignition probability. In Research Centre on Turbulent Combustion (CRCT), Toulouse, France, **2009**.

B. Enaux and **G. Lacaze**. Ignition model for LES. In Research Centre on Turbulent Combustion (CRCT), Paris, France, **2008**.