HiFiLeD SYMPOSIUM

2ND HIGH-FIDELITY INDUSTRIAL LES/DNS SYMPOSIUM

PAVING THE WAY FOR FUTURE ACCURATE CFD

HYBRID EVENT

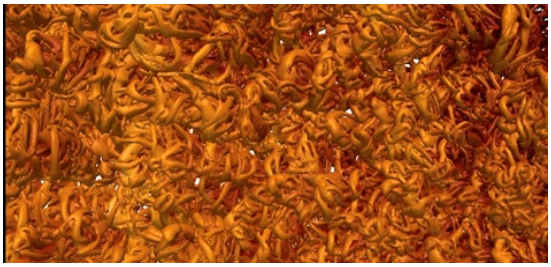
New date: 22th-24th September 2021, Toulouse, France

Supported by the EU Horizon 2020 HiFi- TURB project

HiFiLeD Symposium objectives

The simulation of turbulent flows using CFD methods has progressed rapidly over the last decades and has given rise to significant changes in the design processes of many areas of fluid mechanics. However, despite over a century of research, the modelling of turbulence and transition in industrial relevant configurations is still far from being achieved successfully.

With the advent and growing availability of large scale computing power and facilities, a new area of turbulence research is opening with the ability to perform reliable high-fidelity large-eddy simulations (LES) and direct numerical simulations (DNS) for industrial relevant flow configurations.



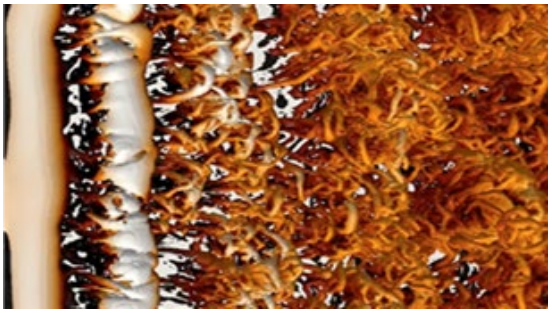
This availability is opening exciting new avenues towards understanding and modeling turbulence and transition by:

i. Direct generation of High-Fidelity LES/DNS to fully predict complex flows, by capturing most or all of the relevant turbulent scales and interactions

ii. Analyzing in depth the underlying physics, supported in particular by new technologies of Machine Learning

iii. Confronting available turbulence and transition models, identifying their deficiencies, improving the range of validity of current models and generate new ones.

This novel approach of High-Fidelity LES/DNS data has attracted many researchers in recent years, stimulated by other emerging areas, as Big Data, Artificial Intelligence (AI) and Machine Learning (ML), providing new efficient methodologies for interrogating and investigating very large data sets.



The HiFiLeD Symposium will be focusing on all aspects related to these objectives, ranging from issues concerning the complexity, reliability, accuracy and uncertainties in generating the High-Fidelity LES/DNS data, to their application towards turbulence and transition modelling.

It will include progress on the underlying high-order numerical methods (HOMs), innovative approaches for CPU acceleration for LES and DNS, exploitation of massive parallel architectures, efficient post-processing on massive parallel hardware, innovative machine learning methods, as well as experimental data.

Moreover, the Symposium offers the opportunity to communicate and exchange knowledge for academic researchers, graduate students, industrial engineers, as well as industrial R&D managers and consultants working in the fields of turbulent flow modelling, simulations, measurements and multidisciplinary CFD applications.

Call for Contributions

Contributions by participants are expected on the following topics, either as presentation, or as an organizer of a Mini-Symposium:

- Understanding Turbulence and Transition from High-Fidelity LES/DNS simulations
- Understanding Turbulence and Transition from new experimental data
- Advances in Turbulence and Transition modelling, based on LES/DNS databases
- Machine Learning applications to LES/DNS analysis and modelling
- New LES/DNS data generation for reference configurations
- Applications of high fidelity LES/DNS to industrial configurations
- Algorithmic and modelling issues for LES simulations, including Wall Modelled LES (WMLES)
- Advances in high-order methods, including curved grid generation
- HPC related issues on multiple platforms (CPU/GPU)

Keynote speakers

- **Philippe Spalart**: *Turbulence Research in the 21st Century*
- **Luc Vervisch**, CORIA: *Turbulent reactive flow simulation, from physical modelling to machine learning*
- **Mujeeb R. Malik**, NASA: *Computational Technology Toward Enabling Certification by Analysis*
- **Stefan Hickel, TU Delft**: *Wall modelling in Large Eddy Simulations*
- **Peter Vincent, Imperial College London**: *Application of high-order methods to the simulation of turbulent flows*

Abstract submission

An abstract (1-2 page(s) max.) is requested with the **ultimate deadline** being **15 August 2021**. Acceptance to present will be notified by the end of August 2021.

Please send the abstract to **info@hifiled-conference.eu**

Mini-Symposia

Participation to the mini-symposia are on invitation. Offers to contribute should be addressed to the mini-symposia organizers.

HPC and GPU porting

Organizer: Ivan Spisso - ivan.spisso.ext@leonardocompany.com

Advances in efficient High-Order methods and curved grid generation for high-fidelity simulation of turbulent flows

Corresponding organizer: Alexandre Chemin - alexandre.chemin@uclouvain.be

Current trends in modelling and simulation of turbulent flows

Organizer: Suad Jakirlić - jakirlic@sla.tu-darmstadt.de

Wall modeled LES

Corresponding organizer: Koen Hillewaert - koen.hillewaert@cenaero.be

Location and date:

Centre International de conference de Météo

42 Avenue Gaspard Coriolis, 31000 - Toulouse, France

22th to 24th September 2021

Hotel and travel:

Hotel and travel information will be available on the Symposium website

HiFiLeD Symposium fee

The symposium fee is **450€** - and will contain a booklet-of-abstracts, coffee breaks, lunches and a symposium dinner.

For Students and HiFi-TURB partners a reduced fee of **350€** applies.

For online attendance symposium fee is **200€** and **150€** for the reduced rate.

Registration

Registration to the symposium can be carried out via the HiFiLeD Symposium website: http://www.hifiled-conference.

For further information, please contact the Local Organising Committee members under: **info@hifiled-conference.eu**

Charles Hirsch (NUMECA), Dirk Wunsch (NUMECA), Jean-Francois Boussuge (CERFACS)

Scientific Committee

F. Bassi (Univ. Bergamo), S. Bosniakov (TsAGI), J.F. Boussuge (CERFACS), F. Chal (Dassault Aviation), A. Chemin (UCL), A. Colombo (Univ. Bergamo), V. Couaillier (ONERA), C. Grabe (DLR), C. Hirsch (NUMECA), K. Hillewaert (CENAERO), S. Jakrilic (Darmstadt), O. Lehmkuhl (BSC), M. Leschziner (ICL), M.R. Malik (NASA), F. Menter (ANSYS), S. Mouriaux (SAFRAN), W. Rodi (ERCOFTAC), C.L. Rumsey (NASA), M.V. Salvetti (Univ. Pisa), P. Spalart, I. Spisso (Leonardo Company), P. Vincent (ICL), S. Wallin (KTH), A. Wolkov (TsAGI)

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HiFiLeD Mini-Symposium:

'HPC and GPU porting'

The simulation of turbulent flows using Computational Fluid Dynamics (CFD) has become a mature technology in engineering design, contributing strongly to industrial competitiveness and sustainability across a wide range of sectors. Future growth depends upon the exploitation of massively parallel HPC architectures, which includes the efficient use of GPU-based heterogeneous multi-many cores systems. In a (pre)-exascale strategic vision, it is worthwhile to be noted that:

- Last June 2020's Top500 shows that 6 out of the Top 10 HPC system are Nvidia GPU based
- EuroHPC has announced two forthcoming pre-exascale GPU based systems:
    - Leonardo, NVIDIA GPU pre-exascale system, located in Bologna, Italy
    - LUMI, AMD GPU pre-exascale system will located in Kajaani, Finland.

Actually, the GPU market is dominated by NVIDIA; AMD has released its GPUs, and Intel is on its own way very soon. This will open new challenges for CFD developers regarding performance portability when moving to hybrid GPU accelerated systems. In fact, each GPU has its own proprietary language; there is no silver bullet, and the choice of a programme language to be used is a trade-off between inter-operability and efficiency, taken into account the starting CPU programme language (C, C++ /Fortran).

This mini-symposium aims to provide a platform for discussing the strategies for GPU porting in latest multi-many core hybrid architectures.

Topics of interest include, but are not limited to:

- Strategies for GPU porting of CFD codes
- Examples of CPU-GPUs hybrid codes with different programming languages (CUDA, OpenCL, oneAPI, HIP, OneAPI, SYCL) and directives (OpenMP, OpenACC)
- Use of external linear algebra libraries
- Recap of different strategies used by the core-codes with table pro/cons and lesson learnt suggestions

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Mini-Symposium Organizer

I. Spisso (Leonardo Company)

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HiFiLeD Mini-Symposium:

'ADVANCES IN EFFICIENT HIGH-ORDER METHODS AND CURVED GRID GENERATION FOR THE HIGH-FIDELITY SIMULATION OF TURBULENT FLOWS'

Recently high-order numerical methods have gained considerable attention in the Computational Fluid Dynamics community due to their ability to efficiently combine high-order accuracy and geometric flexibility.

This feature makes such methods very attractive when considering the Scale-Resolving Simulation (SRS) of turbulent flows, e.g, Large-Eddy Simulation and Direct Numerical Simulation, on the complex geometries proper of industrial applications. However, this class of methods still pose significant challenges, ranging from the generation of high-quality curved meshes to the robustness of the numerical schemes, before reaching a full industrial deployment.

This mini-symposium aims to provide a platform for discussing the latest advances in the high-order framework. Topics of interest include, but are not limited to:

- Figh-quality curvilinear mesh generation;
- Fundamental developments towards improved robustness methods, e.g., entropy-stable formulations;
- Algorithms and implementations of high-order schemes, including mesh and polynomial-degree
- Adaptation techniques;
- High-order solution visualisation;
- Applications of high-order SRS to practical flows.

Mini-Symposium Organizer

A. Chemin (UCL), JF Remacle (UCL), A. Colombo (Univ. Bergamo), F.C. Massa (Univ. Bergamo), K. Hillewaert (CENAERO), M. Rasquin (CENAERO), T. Toulorge (CENAERO)

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HiFiLeD Mini-Symposium:

'CURRENT TRENDS IN MODELLING AND SIMULATION OF TURBULENT FLOWS'

Computational Fluid Dynamics (CFD) has developed to a key technology which plays an important role in design, development and optimization in engineering practice. The CFD technology represents nowadays an indispensable tool for solving the problems of both fundamental importance and industrial relevance. Accordingly, the aspect of decisive importance is closely connected to the credibility and reliability of CFD in terms of both the numerical discretization methods and mathematical models simulating turbulence.

The intended mini symposium should promote the discussion under the scientists, researchers, users and developers from industry and from the academic field focusing on physical rationale and predictive capabilities of variety of statistical turbulence models in the RANS (Reynolds-Averaged Navier-Stokes) framework, SGS (Sub-Grid-Scale) models in the LES (Large-eddy Simulation) framework and hybrid LES/RANS models / novel RANS-based eddy-resolving models - the contributions applying the Direct Numerical Simulation resolving fully the turbulent fluctuations are also welcome - in conjunction with relevant numerical treatment in a broad range of turbulent flow configurations.

Mini-Symposium Organizer
S. Jakirlić (ERCOFTAC – SIG15)

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HiFiLeD Mini-Symposium:

'Wall modelled LES'

The continuous rise in available computational resources, in combination with novel high-resolution simulation methods, holds the promise of enabling scale-resolving simulations, and in particular Large Eddy Simulation (LES) of complex flow problems in industry, as a complement to the Reynolds-averaged Navier-Stokes (RANS) approaches which are now the state-of-the-art tool for design.

RANS simulations still suffer from important limitations, due to model assumptions and calibration, the latter being usually done for simple academic flows. This makes the approach less reliable for off-design configurations or new flow regimes and geometries outside of the experience of the practitioners. Scale resolving methods are less vulnerable due to the much less stringent model assumptions, but come at a much higher computational cost.

For large scale engineering applications the computational resource requirements for resolving the inner parts of the boundary layer are still out of reach for many applications. In any case, a large computational effort is required in the near-wall region, whereas many of the important flow features are found in the core flow. Therefore, wall-modelled LES is at the current time a viable stepping stone between RANS to fully resolved LES.

This mini-symposium will be a platform to present research on various aspects of wall-modelled LES, including but not limited to:

- the analysis of the statistics and dynamics of the boundary layer in different regimes in support of wall-modelling;
- the development of wall-modelled approaches, including wall shear-stress models, hybrid RANS-LES, ... ;
- the integration of the model with the numerical method and the LES, in particular for novel high resolution discretization;
- the use of machine learning or data assimilation techniques in any of the above points;
- comparison and validation

Mini-Symposium Organizer

K. Hillewaert (CENAERO), M. Rasquin (CENAERO), M.V. Salvetti (Univ. Pisa), O. Lehmkuhl (BSC), S. Hickel (TU Delft)