

Onera Scientific Day *High Fidelity Flow Simulations*

INTRODUCTION

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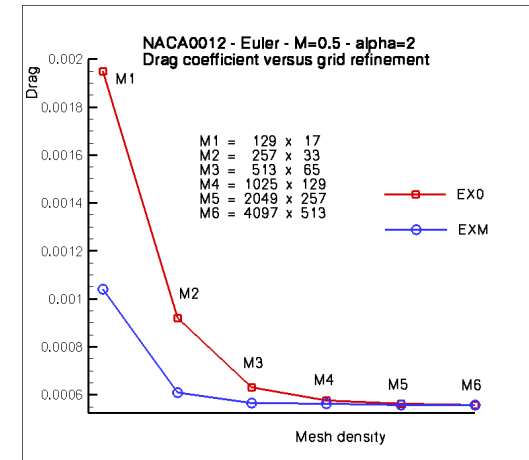
THE FRENCH AEROSPACE LAB

r e t o u r s u r i n n o v a t i o n

High Fidelity Flow Simulations : Introduction

What does (high) **Fidelity** in flow simulation mean exactly ?

- Physical model
 - Level of modeling
 - ...
- Solution method accuracy
 - Dependence in space/time discretization
 - ...
- Management of uncertainties
 - Operational / computational
 - ...
- CFD/CAA software user requirements
 - Past : Comparison to experimental data
(good results could be based on lucky error balance)
 - Now : Wish to understand and manage the points listed above



Increasing activity in the CFD/CAA community to apply and compare in various cooperative projects or workshops :

- High order schemes and mesh adaptation
- DNS, LES, DES
- Management of uncertainties

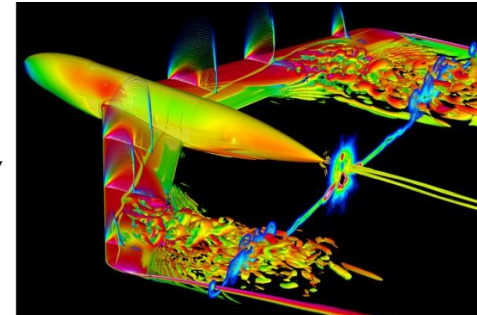
CFD State of the art and challenges - Some elements

« RANS Second order type » CFD mature but

- "Certification" to be done in a more systematic way
- Unsteady computations required (at least) for limit problems
- Mesh convergence analysis show the limit of classical 2nd order methods regarding the current mesh used (regularity, density, ...)
- Boundary condition treatment still a problem for sensitive configurations
- Error estimation and domain of validity have still to be identified
- RANS model limited to « nominal » flow configurations

Challenges : (High) Fidelity in CFD methods requires firstly **accuracy**

- Development of higher order methods : DG, RDS, RBC, ENO, ...
- Need of higher order meshes, hybrid polyhedral meshes, ...
- LES, DES, DNS
- Feasibility :
 - **Robustness** in order to demonstrate the interest (mesh convergence improvement)
 - **Efficiency** in order to make them applicable to industrial type configurations
 - Implicit, H/P multigrid, parallel advanced architecture, new processor (GPU)
 - New software architecture for dynamic adaptation and composite mesh management
 - Adaptation : H (mesh), P (shape functions), M (modeling)
- Application to complex unsteady flow simulation : huge data management



elsA DES computation
ONERA/DAAP

High Fidelity Flow Simulations : Programme

Presentations will mainly address the following topics :

- DG, RBC, RDS : Fundamental aspects and application for CFD and CAA
- Mesh strategies and adaptation with adapted DG/FV/FD solvers
- Complex flow configurations : Unsteady, multidisciplinary coupling
- Physical model and scheme accuracy : DNS, LES, DES



Water-tunnel, ©Onera/Henri Werlé

The future, now
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at least today : HFFS Onera day