ANR/RSF project NORMA : Efficient simulation of noise of rotating machines (scientific start : March 1, 2020)

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Consortium

2 French partners, expert in CFD (funded by the ANR, 48 months) :

- INRIA Sophia-Antipolis, ECUADOR team :
  - A. Dervieux (scientific leader) + 1 PhD student (to hire)
  - Skills : Numerical methods / Mesh adaptation / HPC
- University of Montpellier, IMAG laboratory :
  - B. Koobus (coordinator) + 1 PhD student (to hire)
  - Skills : Turbulence modeling / Numerical methods / HPC

1 Russian partner, expert in CAA and CFD (funded by the RSF, 36 months) :

- Keldysh Institute of Applied Mathematics of RAS, Moscow :
  - T. Kozubskaya (coordinator), I. Abalakin, P. Bakhvalov, V. Bobkov, A. Duben, A. Gorobets, L. Kudryavtse, P. Rodionov, V. Tsvetkova, N. Zhdanova
  - Skills : Computational aeroacoustics / Numerical methods / Turbulence models / HPC

- **Long experience of collaboration between the partners**

Context and objectives

Context

Ecology of urban/extra-urban areas increasingly deteriorated by noise emission generated by rotating machines (helicopters, future aerial taxis, unmanned aerial vehicles, wind turbines...)




Need/challenge

Necessity for large/small companies building such machines to have accurate and efficient tools for the simulation of the acoustic radiation generated by single-rotor/multi-rotor systems

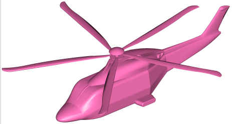
$\Rightarrow$ A difficult numerical challenge

Context and objectives

Objectives of this project

- Development of new high-accurate and parallel implicit algorithms for predicting rotating machines noise with scale-resolving turbulent flow simulations and far field acoustics
- Three key ingredients that must be combined :
  - Hybrid turbulence modeling
  - High accurate low dispersion/dissipation schemes for unstructured meshes
  - Immersed boundary methods

  with adaptation of these methods to aeroacoustic analysis in various rotating machines
- Challenging applications : Single-rotor with fuselage / multi-rotor systems



Scientific obstacles

Scientific obstacles

- Development of performant hybrid turbulence models for aeroacoustics
- Combination of compressible hybrid turbulence modeling and immersed boundary methods
- Adaptation of turbulent boundary layer treatment to immersed boundary
- Development of high-order approximations for very irregular unstructured meshes
- Combination of high accurate low dispersion/dissipation schemes and immersed boundary methods
- All turbulence/numerical models developed in a parallel context

To address these scientific obstacles

- The French teams bring : know-how in turbulence modeling, highly accurate schemes for unstructured meshes, multirate methods for massively separated flows
- The Russian team brings : know-how in immersed boundary methods, rotating machines, applications to aeroacoustics with unstructured meshes, very massive parallel computing