

# HPC & Numerical Simulation

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EADS INNOVATION WORKS



# Outlines

- **Presentation of EADS Innovation Works (IW)**
- Activities in Numerical Simulation & HPC at IW
- Current projects & perspectives

# What is EADS ?

European Aeronautics Defense and Space Company

#1 in Europe, #2 in the World (behind Boeing)

EADS Business Units:

- Airbus / Airbus Military
- Astrium
- Cassidian (Defence & Security)
- Eurocopter

Shareholder in MBDA

140.000 employees

56,5 Md€ revenue





# EADS at a glance





# Presentation

Innovation Works

Former CCR (in France)

Located in Suresnes (F), Ottobrun (G), Filton (UK), Getafe (S) + offices in Singapore, Moscow, Beijing, Bangalore,...

Research for all EADS

>800 employees

Our team : Applied mathematics

Activity in BEM since mid-80's for all physics

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# Outline

## Existing methods & Applications

- *Multipole solver*
- *H Matrix*
- *Delayed Potentials*
- *FDTD*
- *HF*

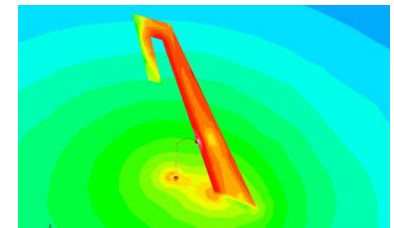
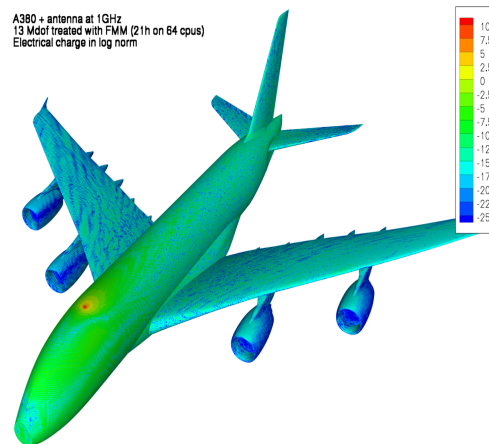
## Current & Futur Researchs

- *Multipole method in TD*
- *Low frequency computation in TD*
- *Variable time steps in TD BEM*
- *Low frequency FMM*
- *HPC & GPU Computing*



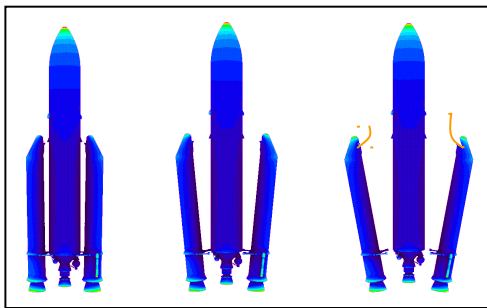
## Content of the HPC domain

- Many common research domain between EADS IW and Inria :
  - Direct solver
  - Iterative solver
  - Multipole algorithm
  - Coupling of schemes (BEM/FEM)
  - All this on HPC machines
- Used in EADS solvers for numerical simulation :
  - Electromagnetism with ASERIS
  - Acoustics with ACTIPOLE
  - Electrostatic

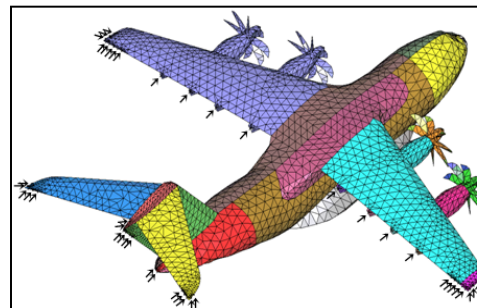


## Context of BEM

- BEM : Boundary Element Method
  - Numerical Method developed since 80's at IW
  - Interest : accuracy, surfacic mesh
  - Mainly used in frequency domain : highly optimised
- Several state-of-the-art fast solvers :
- SPIDO (1995) : direct // ooc
- FMM (2002) : // ooc
- H-matrix (2013) : relies on runtime
- Applications : CEM, Antenna design, Installation effects, electrostatics, ...



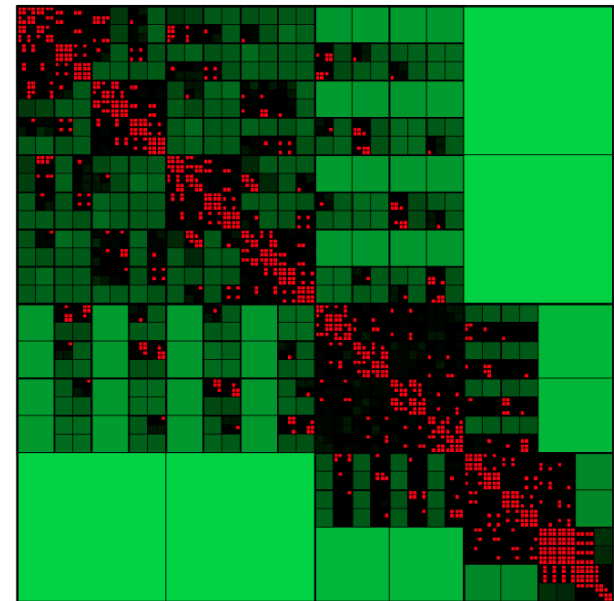
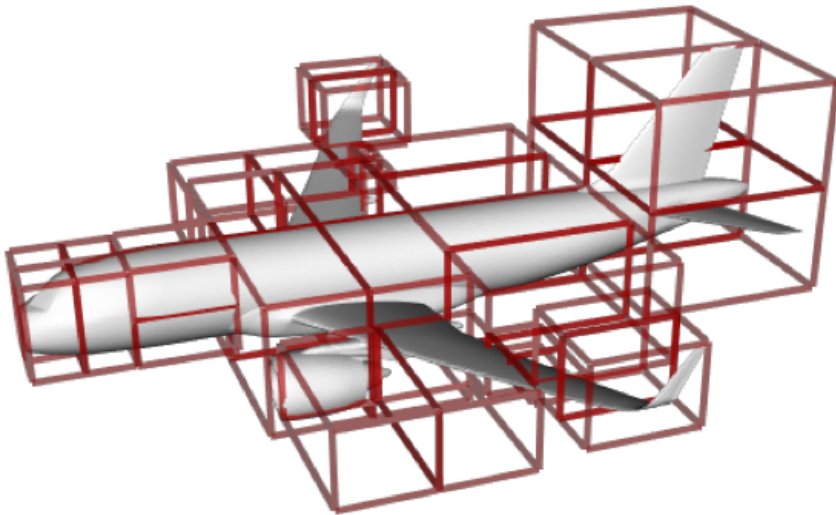
Charge/discharge analysis of A5  
Objective : ESD protection sizing



Charge/discharge analysis of an A/C  
Objective : Static dischargers scaling

# H-matrix solver (1)

- PhD of Benoît Lizé (cifre)
- H-matrix : Hierarchical & compressed way of storing and manipulating matrices



- Collaboration with Inria teams Runtime & HiePACS
  - Runtime provided the middleware StarPU (well adapted to H-matrix)
  - HiePACS provided know-how on using starPU within solvers (associate team MORSE with Inria, Kaust, UTK, UC Denver)



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## Other collaboration (1)

- EZperf (ADT) : measure of performance in HPC

Objectives : measure efficiency of « real » industrial computations

IJD Matias Hastaran, starting end of october

Applications : Aseris/Actipole in a first time + extension toward runtime analysis

- SOLHAR (ANR) : sparse solver on runtime engine

EADS provides applications & test cases, Inria brings solvers & runtime

Applications : Aeroacoustics in Actipole (Airbus), Anisotropy in Aseris (Astrium ST)

## Other collaboration (2)

- TECSER (ASTRID) : coupling of numerical methods BEM-DGM

EADS IW brings BEM method + test cases

EADS Nuclétudes & Inria Nachos bring DGM method

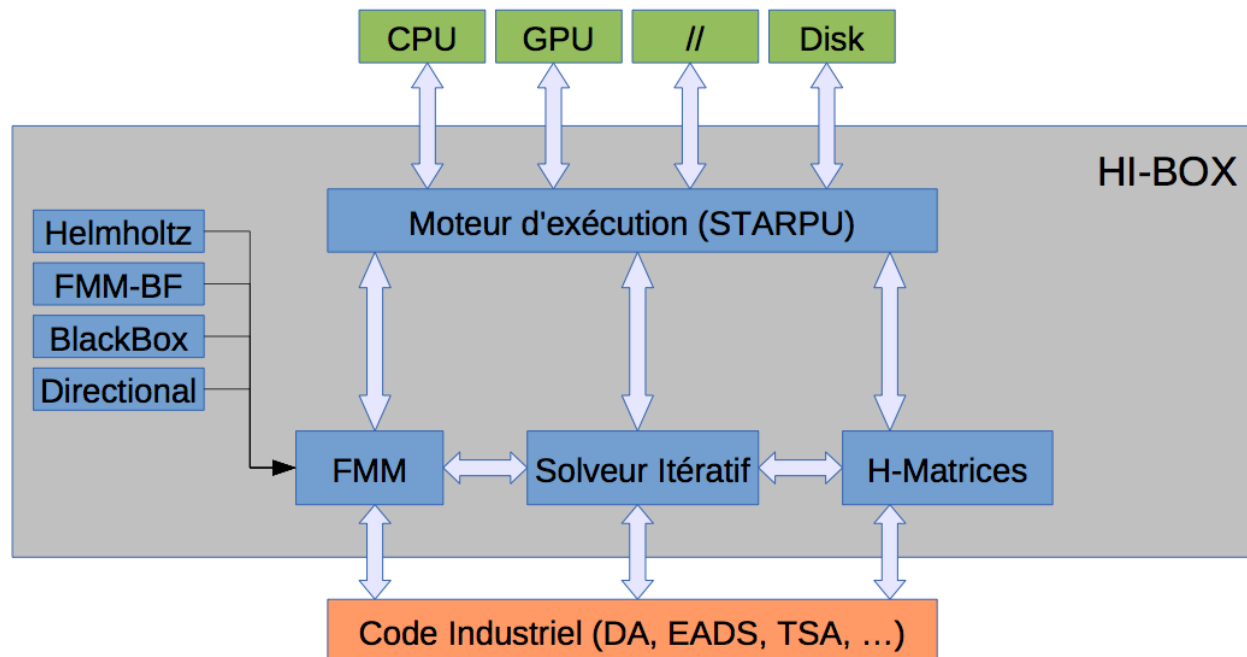
Inria Hiepacs & Corida bring coupling schemes

Applications : Aeroacoustics in Actipole (Airbus), Anisotropy in Aseris (Astrium ST)



# Hi-BOX project

- IMACS, EADS IW, Inria Project funded by DGA (« rapid » project)
- Objectives :
  - Integrate EADS & Inria knowledge in solvers (iterative, direct, FMM, H-mat)
  - Exploit all existing hardwares
  - Industrialize & distribute



## Other topic of interest

- Ability to solve complex block systems :
  - Dense : full, h-mat, fmm, iterative (+precond)
  - Sparse : mumps, pastix, h-mat, iterative
- Find the optimal way to solve a given system