Optimization Activities on Rotorcrafts Using CFD and Multiobjective Evolutionary Algorithms

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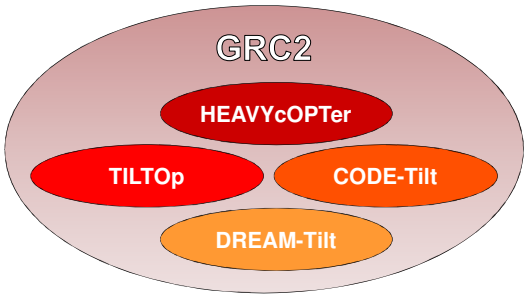
Clean Sky Green Rotorcraft 2 Programme

In line with the EU environmental objectives for 2020 the **Clean Sky Green Rotorcraft** Programme main objectives are:

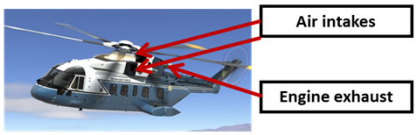
- Reduction of CO_2 emission by 26-40% and NO_x emission by 53-65% per flight
- Reduction of the noise perceived on ground by 10 EPNdB, or halving the noise footprint area by 50%



In the framework of the **GRC2**, which is focused on ***aerodynamic drag reduction*** of different rotorcraft components, the **University of Padova** in collaboration with **Hit09 S.r.l.** is responsible for four different projects: **HEAVYcOPTer, TILTOp, CODE-Tilt, DREAM-Tilt**.

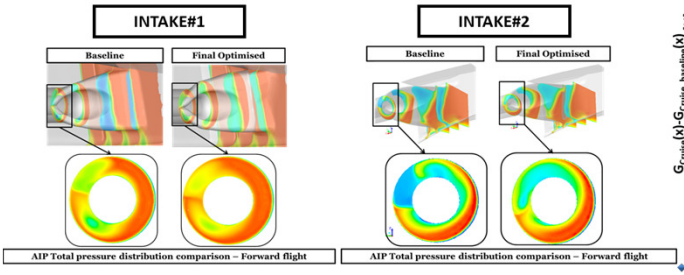
HEAVYcOPTer

- Multi-point **(cruise and hover)** multi-objective aerodynamic optimization of the **engine installation** on the **AW101 helicopter**
- Three different components are separately subjected to the optimization: **two intakes and exhaust duct**
- A genetic algorithm performs changes in component geometry by means of mesh morphing; each new design is evaluated with a CFD analysis
- **Innovative multiobjective genetic algorithm GEDEA**, developed at UNIPD, is employed
- **Objective function: total pressure loss with penalty function given by distortion index (intake); backpressure and entrainment ratio (exhaust)**



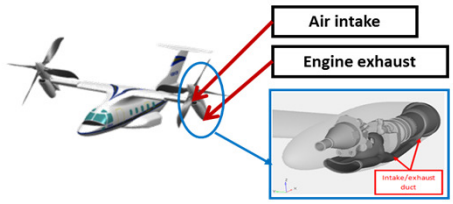
Shape optimization for efficient design of a heavy helicopter engine installation for losses reduction and improvement of both plume trajectory and engine bay cooling

Reduced total pressure losses and flow distortion at AIP at both intakes



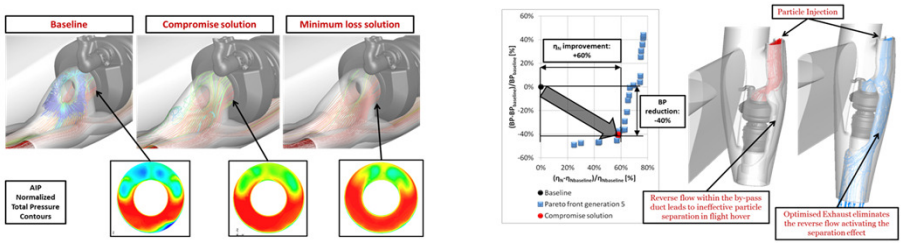
TILTOp

- Multi-point multi-objective aerodynamic optimization of the **airframe-engine integration** into the **ERICA tilt-rotor** nacelle
- Two different components are separately subjected to the optimization: **intake and exhaust nozzle**
- **Objective function: total pressure loss (intake); nozzle backpressure and efficiency (exhaust)**
- Optimization process carried out in both hover and cruise conditions
- Optimization process is constrained by satisfactory operation of the particle by-pass separator



Improved aerodynamic behavior of the optimized intake-exhaust system, in terms of inlet total pressure loss, inlet distortion and exhaust back pressure, performance improvement of the inertial particle by-pass separator

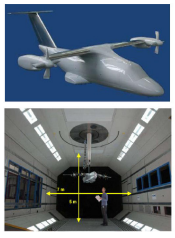
Estimated reduction in fuel consumption: 2.1% in cruise and 1.3% in hover

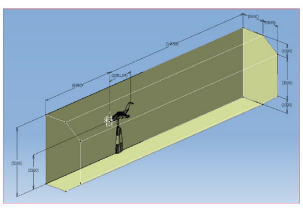


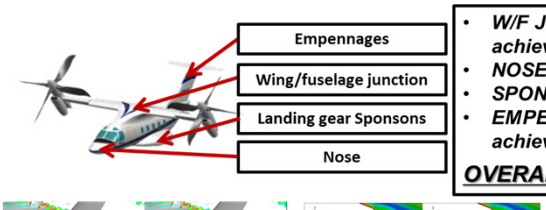
CODE-Tilt & DREAM-Tilt

CODE-Tilt: Multi-objective aerodynamic optimization of the **ERICA tiltrotor** fuselage for **drag minimization in cruise condition**

DREAM-Tilt: Assessment of **ERICA tiltrotor** fuselage drag reduction by **wind tunnel tests at RUAG (Switzerland)**







- ***W/F JUNCTION: -0.7% drag reduction achieved***
- ***NOSE: -0.6% drag reduction achieved***
- ***SPONSON: -5.7% drag reduction achieved***
- ***EMPENNAGES: -0.7% drag reduction achieved***

OVERALL DRAG REDUCTION: 8%