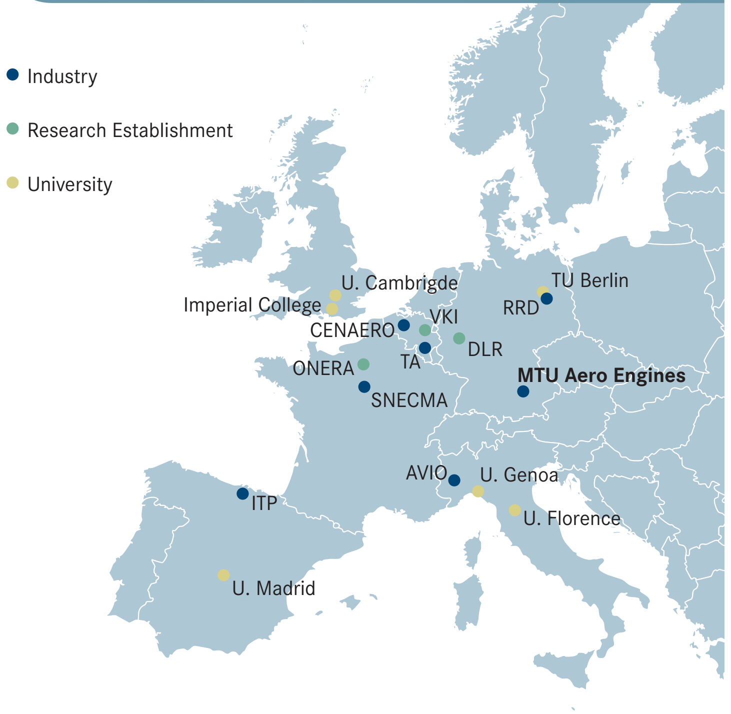
Consortium



Member	Country
AVIO S.p.A.	IT–Italy
Berlin University of Technology	DE–Germany
Centre de Recherche en Aéronautique, ASBL	BE–Belgium
Deutsches Zentrum für Luft- und Raumfahrt e.V.	DE–Germany
Imperial College London	UK–United Kingdom
Industria de Turbopropulsores, S.A	ES–Spain
MTU Aero Engines GmbH (Coordinator)	DE–Germany
Office National d'Etudes et de Recherches Aérospatiales	FR–France
Rolls-Royce Deutschland Ltd & Co. KG	DE–Germany
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The Chancellor, Masters and Scholars of The University of Cambridge	UK–United Kingdom
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Università degli Studi di Genova–Dipartimento di Macchine, Sistemi Energetici e Trasporti	IT–Italy
Universidad Politecnica de Madrid	ES–Spain
von Karman Institute for Fluid Dynamics	BE–Belgium

TATMo Turbulence and Transition Modelling

SIXTH FRAMEWORK PROGRAMME

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Funded by the European Commission
in the Sixth Framework Programme
Contract No. AST5-CT-2006-030939

TATMo Turbulence and Transition Modelling

Turbulence and Transition Modelling
for special Turbomachinery Applications

Background

Today's turbomachinery bladings of Low Pressure Turbines (LPT) can reach extremely high levels of efficiency when operated at high Reynolds numbers. However, special design features are necessary to maintain this performance at very low Reynolds numbers. If the high lift blade philosophy is to be maintained, these features must be reflected in special design concepts or in the implementation of perturbation devices on the blade suction side preventing or reducing the massive separations near mid-span.

Within the TATMo project these approaches aim at maintaining the deflection requirement and even increase the efficiency. The existing data base for higher Reynolds number flows resulting from the FP5 UTAT project will be extended to lower Reynolds numbers in TATMo.

The performance of compressor blades will be improved by lowering or at best avoiding the detrimental corner separations by means of suction and blowing. Additionally, the impact on efficiency of real geometry effects such as roughness, fillet radius and weld will be assessed.

For more information please visit www.tatmo.eu

Objectives

Going along with the two top level objectives identified in the Strategic Research Agenda and the Vision 2020 Report, TATMo represents a major contribution to both of these high level objectives:

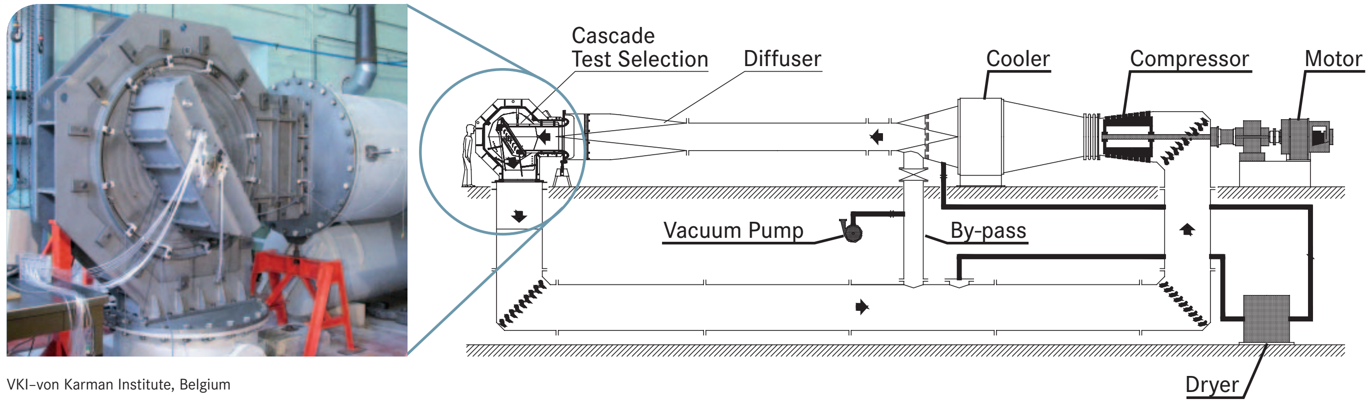
- to meet society's needs for a more efficient, safer and environmentally friendly air transport,
- to win global leadership for European aeronautics, with a competitive supply chain, including small and medium enterprises.

TATMo will improve the computation capabilities by a better modelling of the flow with and without span-wise roughness elements and synthetic jets and of the associated losses through improved design tools, necessary for an accurate prediction of these complicated flow fields.

An improvement of the simulation tools and of the understanding of the physics dominating the very low Reynolds number flows over compressor and turbine blades will:

- enable the designers to reduce the number of engine design iterations by providing the right design at the first time,
- lead to more efficient and lighter designs and therefore to a reduction in the aircraft fuel burn which finally will cut the emission of CO_2.

Description of Work



VKI–von Karman Institute, Belgium

The TATMo project contributes to the above mentioned objectives of the aeronautics priorities by combined experimental and analytical studies of compressor and turbine flows. The most appropriate test cases are chosen with the help of preliminary CFD computations.

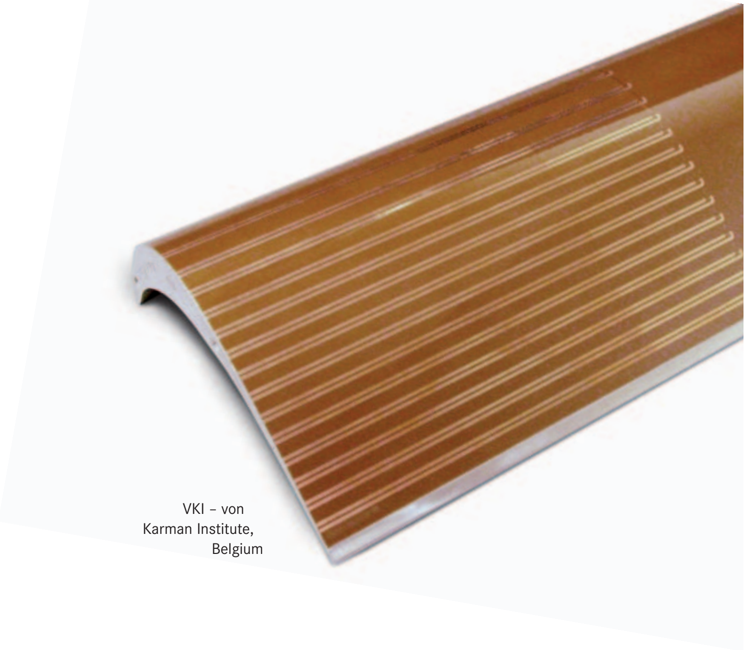
The investigation of LPT's comprises:

- a flat plate with a typical LPT pressure distribution without upstream wakes,
- a flat plate facility with incoming wakes, and finally
- a cascade at design Mach number with and without a high speed upstream wake generator.

The critical Reynolds number where massive separation occurs is determined for three designs. All designs provide the same turning but are characterized by two different suction side diffusions and two different pitch to chord ratios.

Benchmark tests for code validation of flows in compressors with real geometry effects and of very low Reynolds number LPT's high lift designs with and without roughness elements or synthetic jets are generated.

To account for specific flow phenomena and roughness effects, a range of different Turbulence Modelling concepts is investigated. The test cases, as defined in a CFD Test Matrix, are verified with different Turbulence Modelling approaches. The various modelling aspects are mainly addressed by the research establishments and the academic TATMo partners, while the verification work is primarily performed by the industrial partners.



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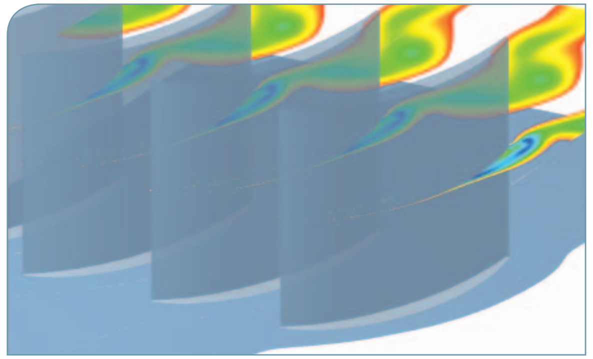
Results



Berlin University of Technology, Germany

The understanding of the physics of separation on highly loaded compressor and turbine blades of axial flow turbomachines and the assessment of the potential benefit of active and passive devices is a pre-requisite to reduce the losses and significantly increase the efficiency of low pressure turbines and compressors.

The exploitable outcomes of TATMo will be:

- improved aerodynamic simulation tools through code calibration and validation against high quality measurements,
- improved understanding of the physics of low Reynolds number flows,
- new views and insights into a massively separated flow field by means of newly developed unsteady measurement techniques,
- data base and validated modelling of perturbation devices for highly loaded turbine blades,
- data base and validated modelling of active flow control devices for highly loaded compressor blades and endwalls,
- derivation of new design rules for compressor and turbine blades in a very low Reynolds number flow regime.

In light of these arguments, the TATMo project outcomes will have a significant beneficial impact on the competitiveness of the European aeronautic industry.