TFAST project - Potential impact and the main dissemination activities

The research topic of TFAST project finds the application in the Flight Physics as well as in the Propulsion. Therefore the impact of TFAST on Air Transport Greening will be manifold. Regarding the strategic development in drag reduction the laminarisation of boundary layers on lifting parts of the airplane has a potential to reduce fuel consumption by 10%. In propulsion systems enhanced laminarity of boundary layers may reduce fuel consumption by 1 or 2 % but it affects also the maximum mass flow rate output of compressor and reduces the heat flux to turbine blades, improving durability of equipment and improving safety. These aspects can not be expressed in terms of fuel consumption.

It is foreseen that the TFAST project very well complies with the structure of the AAT Thematic Priority concerning research for strengthening the competitiveness of the European aircraft industry in the global market but also by providing a new fundamental knowledge base for shock wave/boundary layer interaction. This scope of work may be realised only on the wide international platform, - a European level.

Different groups in TFAST, ensuring a sound critical mass, are working together on a particular set of flows (unsteady transonic and supersonic) and are fostering work by cross-fertilisation and close knowledge dissemination.

The TFAST project plays a major role in providing reliable methods that are applicable to unsteady and highly compressible flows, with the clear goal of becoming recommended for industrially relevant application challenges. It is the technical achievement of the TFAST project which is – supported by the new data base – serve as the basis for a European knowledge of all aspects in the area of transition location effect on unsteady shock wave/boundary layer interaction.

Moreover, it is the formation of trans-national teams - meeting the challenging goals of TFAST - which contribute to the establishment of a more common (at least in the aeronautics sector) environment in Europe that is favourable to innovation. The latter is even more supported by the number of universities in the TFAST project, that will – on the basis of the knowledge gained – educate students by using knowledge base provided by TFAST.

From the Strategic Research Agenda published by the European Commission, two major ideas can be extracted.

The first one is the notion of sustainable growth, with its corollary of more affordable air travel in terms of technical, societal/environmental and financial preoccupations. The TFAST project is focussing on a particular scientific and technological point, namely closing the knowledge and technology gap in the area of laminarity and shock wave interaction. Thus increasing knowledge in this domain of interest is an activity clearly related to innovation and it has a larger strategic impact because it widens the physical understanding with consequences on energy saving, reduction of noise and of the emission of pollution. No doubts, by this the TFAST project matches the recommendations of the Strategic Research Agenda and is an important building block in Europe’s effort to become the dominant region for the design and manufacturing of advanced civil aircraft.

The latter is already the second strategic element, namely TFAST’s contribution to a global leadership for European Aeronautics. It was mentioned above that this can be achieved by a better knowledge of the involved phenomena, and by the provision of new measurements as well as the corresponding theoretical methods. And it is obvious that it can only be achieved by an upstream research project that at the same time tackles real-world situations as they are present nowadays in industry. Of course, strategic impact is achieved to a great deal by joint work of different institutions, research centres, universities, and industry and by their co-operation on the common topic of SWBLI. Surely, by enabling work in a group of sufficient size, and taking advantage of cross-fertilisation between the different teams, it is expected to increase the potential, expertise and the efficiency of each partner at a high level of excellence.

More precisely, the TFAST project includes participants from seven EC member countries and one participant from Russia and one from Ukraine. This group, together with the Advisory Board, offers the right potential for collaborative work and the coherence in the activity for the sake of research in the European Union. In other words, TFAST could not be run at a national level, but in contrast it fosters European synergy and forms a European Research Area.

It must be underlined that among the objectives of strategic importance, education retains a central place. Many of the partners of TFAST are university laboratories. This implies that students participation in the research granted by this project and contribution to advanced work and novel problems with innovative approaches and learning from partners of rather different sites. Their acquaintance with industrially relevant topics contribute to their education at an international and multi-cultural framework.

The TFAST project conducted – as a project objective - a relevant set of well focused experiments, relevant to the above mentioned flow-physics phenomena, and the data base, both of experimental and numerical results provide a sound basis for work to be carried out, which can easily be exploited by other interested groups in Europe, but primarily of course to the aeronautics industry. Experiments are designed by pro-active CFD work in order to link experiment and CFD as closely together as possible and to allow for cross-fertilisation, rather than on competition between them.

Dissemination activities

Publication Type	Number
Number of peer reviewed publications	7
Number of papers in Proceedings of a Conference/Workshop	24
Article/Section in an edited book or book series	1
Thesis/Dissertation	4
University Publication/Scientific Monograph	1

Dissemination of the information and results of TFAST project is closely related to a former project UFAST. This is a very advantageous situation helping a lot in the wide reach of the dissemination activities.

ECCOMAS 2012 in Vienna - A Special Technical Session was offered to the UFAST/TFAST research presentation:

STS04 Turbulent and transitional boundary layer interaction with a shock wave - UFAST and TFAST projects (P. Doerffer)

STS04 Mon, 16:30 - 18:30, M-HS07

This session included presentations from the following partners: George Barakos LIV, Marianna Braza IMFT, Sergio Pirozzoli URMLS, Benoit Tartinville NUMECA.

The consortium was offered by Prof. Wolfgang Rodi to participate in the data basis Qnet-CFD organised by ERCOFTAC. This is possibility for world-wide dissemination of work related to UFAST project, which is delivered by the members of TFAST consortium. Our contribution paves the way for future dissemination of TFAST results. The following topics were selected for Qnet-CFD:

- oblique shock reflection with experiments of Jean-Paul Dussauge from Marseille and CFD from Eric Garnier from ONERA and from Neil Sandham from Southampton. Leading person will be Jean-Paul Dussauge. (Test case 2-dimensional SWBLI is now in the Qnet data base as UFR3-32)
- normal shock following a bump with experiments of Reynald Bur from ONERA and CFD from George Barakos from Liverpool
- normal shock at a convex wall (local supersonic area) with experiments from IMP PAN group and CFD carried out with NUMECA software

The coordinator of TFAST was invited to the ERCOFTAC Workshop on unsteady interaction to present lessons learned from UFAST and TFAST projects.

The key-note lecture was entitled “Unsteady effects and boundary layer type influence on the shock wave and boundary layer interaction.

11:10 – 12:00 Key Note Lecture: P. Doerffer, IMP PAN, Poland

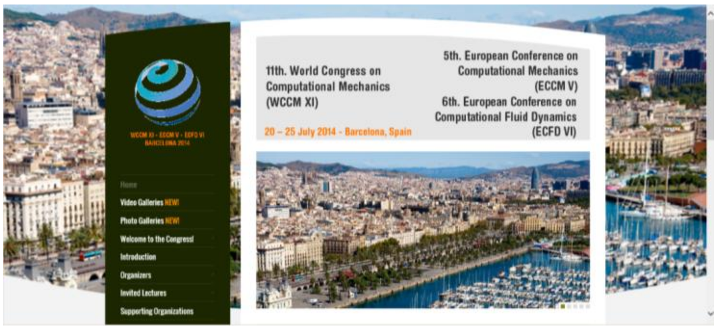
Unsteady Effects and Boundary Layer Type Influence on the Shock Wave Boundary Layer Interaction
Results of UFAST and TFAST European Projects

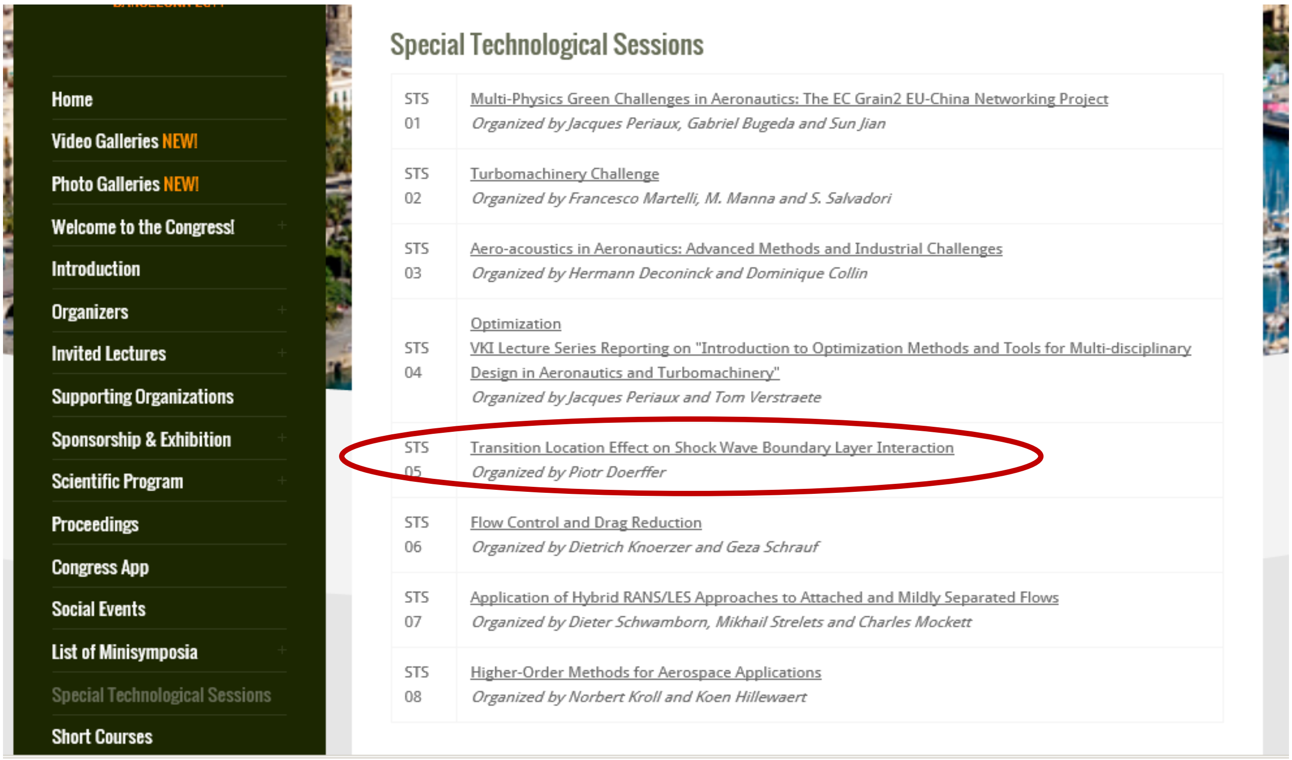
As one can see above the supporting partners and the ERCOFTEC itself secures a wide dissemination platform for project work and results.

Participation of one of the members of the consortium SOTON, presenting results from the Task-1.1, at the 43rd AIAA Fluid Dynamics Conference 24-27 June 2013, San Diego, California.

127-FD-30		
Chaired by: M. BORG, Booz Allen Hamilton and M. CHOUDHARI, NASA Langley Research Center		
0900 hrs AIAA-2013-2981 Real Gas and Surface Ablation Effects on Hypersonic Boundary Layer Instability over a Blunt Cone C. Mortensen, X. Zhong, University of California, Los Angeles, Los Angeles, CA	0930 hrs AIAA-2013-2982 Stability and Unsteadiness in a 2D Laminar Shock-Induced Separation Bubble A. Sansica, N. Sandham, Z. Hu, University of Southampton, Southampton, United Kingdom	000 hrs IAA-2013-2983 igh-Order Simulation of nduced Disturbance in a Mach Boundary Layer . Atkins, NASA Langley Research enter, Hampton, VA

ECCOMAS 2014 in Barcelona – special session for TFAST project





List of presentations:

1. Computational Investigations on Correlation betweenLaminar-Turbulent-Transition Location and Buffet Onset, Katarzyna Surmacz, Janusz Sznajder, Wieńczysław Stalewski, Institute of Aviation (IoA), Poland
2. Effect of the transition location on a shock-boundary layer interaction, Lionel Larchevêque, Aix Marseille Université, CNRS, IUSTI UMR 7343, France
3. Implicit CFD Method For Transitional Shock Wave – Boundary Layer Interaction, G. Zografakis, G.N. Barakos, University of Liverpool, United Kingdom
4. DNS and Stability Analysis of a Transitional Shock-Wave/Boundary-Layer Interaction at M = 1.5 A. Sansica, N. D. Sandham, Z. Hu, University of Southampton, United Kingdom
5. Application of EARSM Turbulence Model to Shock Boundary Layer Interaction with Laminar to Turbulent Transition,B. Tartinville, G. Carabin, Ch. Hirsch, NUMECA Int. S.A., Belgium

<u>4th EASN Association International Workshop on Flight Physics and Aircraft Design</u> – 27-29.10.2014 Aachen

List of presentations:

- P. Doerffer -Transition Location Effect On Shock Wave Boundary Layer Interaction
- G. Barakos -Numerical Simulations of Transitional Shock Boundary Layer Interaction and Buffeting Control
- J.P. Dussauge - The TFAST Project: physical and experimental challenges.

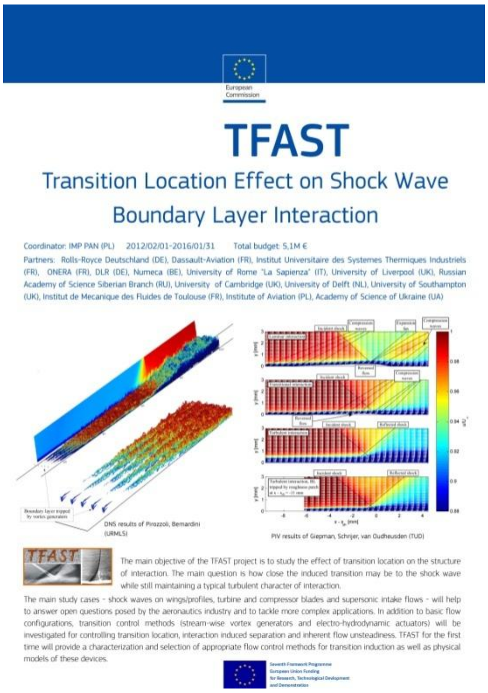
Time		Tuesday 28.10.2014 (afternoon)		
Room:		Ford	Generali	Junkers
Session		#11 Transition & #12 Advanced CFD	#13 Aerodynamic Wing Concepts & Design	#14 Innovative Cockpit Design & #15 Personal Air Vehicle
Session Chair(s)		P. Doeffer / D. Drikakis	A. Rizzi / A. Seifert	R. Habig / F. Nieuwenhuizen
16:30	16:55	TFAST Project: Transition Location Effect on Shock Wave Boundary Layer Interaction– Project overview, *P. Doeffer*	Multifunctional Moveables – from A350 into the future, *D. Reckzeh*	i-VISION Project: i-VISION (Immersive Semantics-based Virtual Environments for the Design and Validation of Human-centred Aircraft Cockpits) – Overall Presentation *L. Rentzos*
16:55	17:20	TFAST Project: Numerical Simulations of Transitional Shock Boundary Layer Interaction and Buffeting Con-trol, *G. Barakos*	DESIREH Project: Low Speed Design of Laminar Wings, *TBC*	i-VISION Project: i-VISION – the Future of Human-centric Cockpit Design, *R. Habig, L. Rentzos*
17:20	17:45	TFAST Project: Physical and Experimental Challenges, *J.P. Dussauge*	Hybrid Laminar Flow Implementation, *K. Risse*	MYCOPTER Project: myCopter – Enabling Technologies for Personal Aerial Transportation Systems, *F. Nieuwenhuizen, H. Bülthoff*
17:45	18:10	Azure: High-Order CFD Software for Aerospace Applications, *D. Drikakis, A. Antoniadis, P. Tsoutsanis*	AFLONEXT Project: 2nd Generation Active Wing Active Flow- Loads & Noise control on Next Generation Wing - Overall Presentation, *A. Seifert*	MYCOPTER Project: Vision Based Control And Navigation For Per-sonal Aerial Vehicles, *M. Achtelik, S. Lynen, S. Weiss, M. Chli, R. Sieg-wart*
18:10	18:35	Ground Testing: Driving Forward Innovation in Fluid Dynamics, *K. Kontis*	UMRIDA Project: Uncertainty Management for Robust Industrial Design in Aeronautics - Overall Presentation *TBC*	MYCOPTER Project: Handling Qualities and Training Requirements for Personal Aerial Vehicles, *M. Jump, P. Perfect, L. Lu, M. White*
END OF DAY 2				
20:00	22:00	Facultative Dinner *		

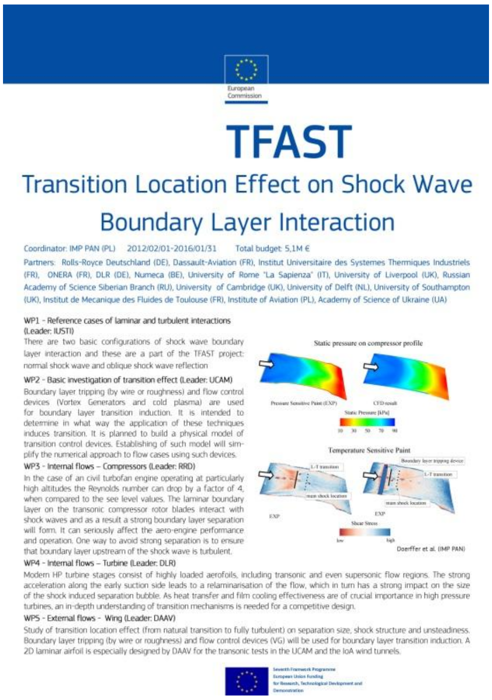
** Facultative Dinner Description & Details.*

<u>Aerodays 2015</u> - 20-23 October 2015 at the QEII Centre, London

aerodays2015
Aviation in Europe – Innovating for Growth
The 7th European Aeronautics Days

Test stand shared with Project: Go4Hybrid, GRAIN2, MARS. Posters and movie showing selected results were presented.





During the conference presentation was given by Prof. Piotr Doerffer "Transition Location Effect on Shock Wave Boundary Layer Interaction ".

<u>ECCOMAS Congress 2016</u>, 5 - 10 JUNE 2016 Crete Island, Greece

Special Technical Session during European Congress on Computational Methods in Applied Sciences and Engineering will be organised

TFAST STS05: Transition Location Effect on Shock Wave Boundary Layer Interaction

<u>Organisers and chairpersons:</u>

Piotr Doerffer, Pawel Flaszynski, IMPAN;

Presentations:

P. Doerffer - *Transition location effect on shock wave boundary layer interaction*

M Braza, D. Szubert, Y. Hoarau, F. Billard - *An experimental and numerical study of shock boundary layer interaction in external aerodynamics configurations*

Anna Petersen - *Application of Air Jet Vortex Generators in a highly loaded Turbine Stator*

W. Stalewski, J. Sznajder - *Load Control of Natural-Laminar-Flow Wing via Boundary Layer Control*

P. Flaszynski, P. Doerffer, R. Szwaba - *Laminar-turbulent transition effect on shock wave boundary layer interaction on compressor profile*

G. Barakos - CFD Methods for Transitional Shock Wave – Boundary Layer Interaction

<u>TFAST project results will be published SPRINGER Book</u>

Series Title:

Notes on Numerical Fluid Mechanics and Multidisciplinary Design

Provisionally entitled: Transition Location Effect on Shock Wave Boundary Layer Interaction – Experimental and Numerical Findings form TFAST project