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FLIGHT REYNOLDS NUMBER TESTING

THE EUROPEAN PROJECT FLIRET

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ABSTRACT

Despite considerable progress in computational aerodynamics, wind tunnels are still the prime tool in measuring and predicting aircraft performance for take–off and cruise conditions. However, conventional wind tunnels face physical limits matching the Reynolds and Mach number ranges needed to simulate realistically cruise conditions. A means to overcome this limit are cryogenic pressurised wind tunnels. They have the ability to adjust air pressure, but a specific characteristic they also possess is that the air temperature can be brought down to as low as 110°K allowing a realistic simulation of flight Reynolds and Mach numbers to take place.

Only pressurised cryogenic wind tunnels can perform tests at Reynolds numbers needed for a medium or large sized aircraft. In contrast to convectional wind tunnels, they provide complete fluid dynamics similarity to the flying aircraft. The supports (the attachment of the model) and the interaction of the supports with the model still represent a difficult problem for cryogenic testing. Rather heavy supports are needed in a pressurised cryogenic facility. Optimisation of the stings with regard to model interferences and corrections is to be done to achieve a maximum accuracy for the results. In order to make use of the high potential of cryogenic testing, improvements of the support corrections and predictions are needed. This covers the application of most advanced CFD tools.

The results of FLIRET are to be applied for future testing in cryogenic and pressurised wind tunnels. However, the principal approach, that is the close cooperation between testing and CFD specialists, is recommended also for conventional wind tunnels to combine the ever increasing capabilities of CFD with the needs of wind tunnel testing.
The supports being optimised and manufactured in the project can be used for high loads and cryogenic conditions to minimise the interaction with the model.

The stings are foreseen for different types of measurement focussed on the wing or the rear fuselage of the model. After an optimisation process by CFD tools, 4 different types of supports have been finally developed: An optimised fin sting, 2 blade stings for forward and backward position and a reference sting with extremely small corrections which can be used only in a limited loads range.

Tests with all stings have been performed. The results are used to validate the CFD predictions and to show the performance of the supports for different types of testing.

Low speed tests were performed to understand roughness effects and the behaviour of half models with different peniches at high Reynolds numbers. Comparisons with the results of CFD predictions were done.

The project will be completed in 2008 i.e. the analysis is not completed yet.

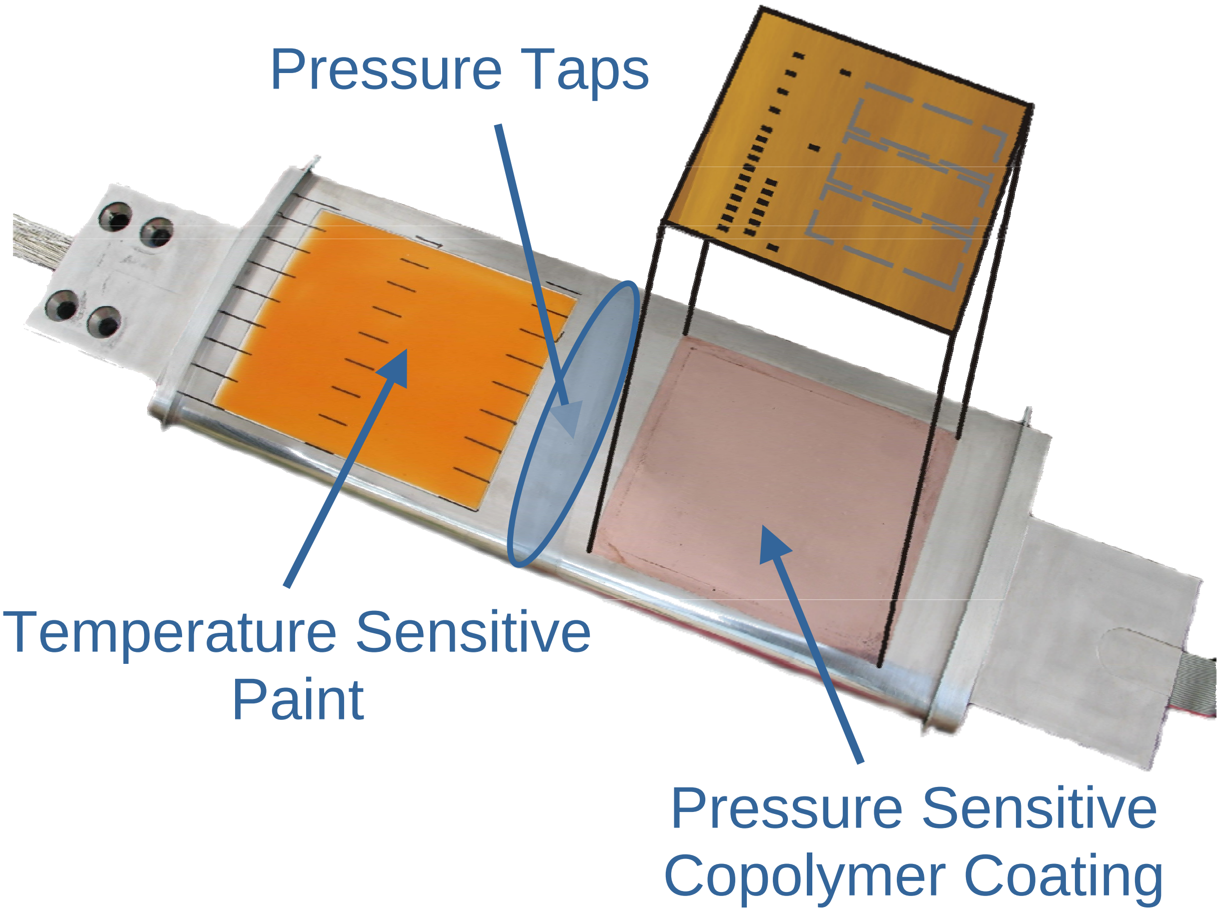

Figure 1 : FLIRET 2D model for pretest in the ETW pilot facility which was used for roughness investigations.

Figure 2 : Half model used to investigate the effect of the peniche under high Reynolds number condition**s.**