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Aerodynamic Measurements on Two New Airfoil Wing Models

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1. Manufacturing of wing models

The airfoil models were manufactured on a DMG DMU60T milling machine with help of the CAD/CAM combination of SolidWorks/SolidCAM.

In the first step, the wing section coordinates of both profiles (Selig S8025 and HQ/W-2,25/8,5) were imported into the CAD-Programm SolidWorks. After the solid models were generated, the machine code for the milling machine was programmed with the integrated CAM module SolidCAM directly on the solid model. Each airfoil wing model was made out of 28 individual aluminium segments and bolted and polished afterwards.

The figures below show the progress from the CAD-model to the mounting of the airfoil wing model.

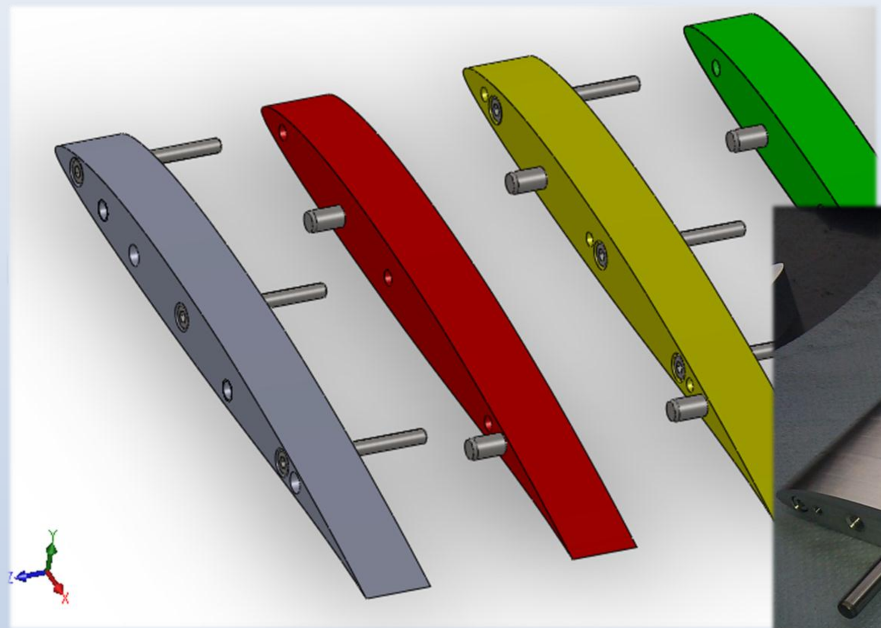

Fig. 1: Airfoil wing model segments in SolidWorks

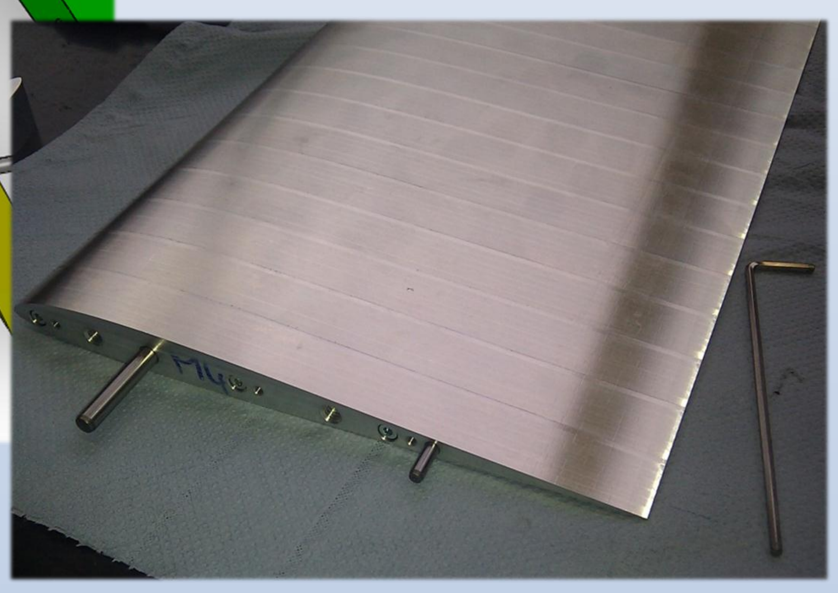

Fig. 2: Mounting of the individual aluminium segments (hardware)

2. Measurement of the profile contour

For a comparison to 2-D simulations, the wing section hardware has to be measured geometrically. It was also needed to estimate the effect of the shortened trailing edge on the flow properties in the numerical simulation with XFOIL.

The measurements were performed at Mitutoyo in Ingolstadt on a CRYSTA-APEX S measurement machine. Afterwards, the measured values were analyzed with MATLAB to perform a set-actual comparison. The results showed a high production quality with an average absolute deviation of -0,012 mm for the HQ/W-2,25/8,5 and -0,0282 mm for the S8025 profile.

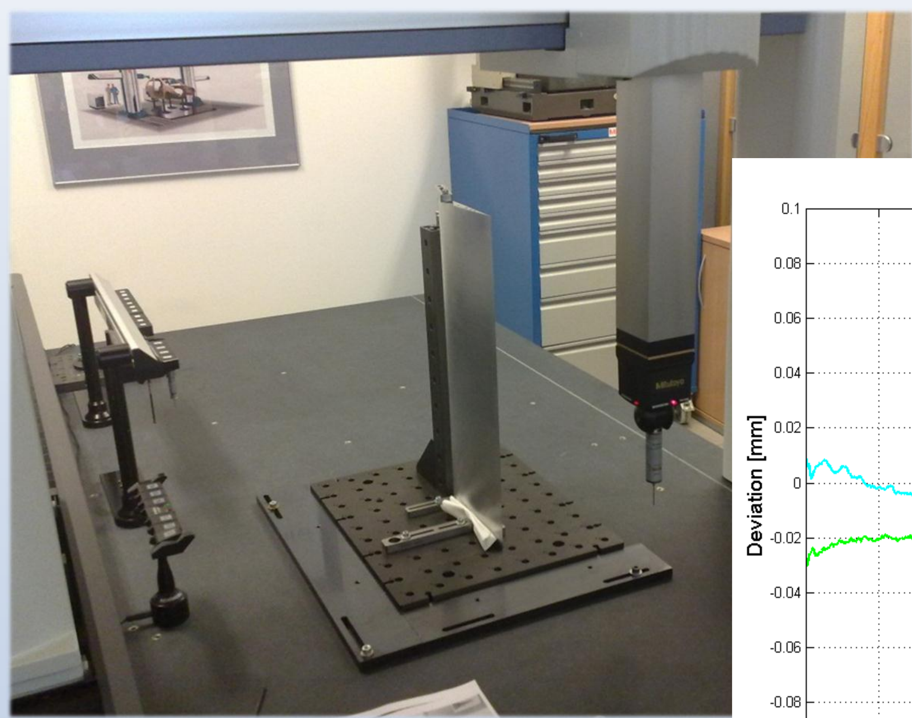

Fig. 3: Measurement machine CRYSTA-APEX S

Fig. 4: This diagram shows the deviation between the definition- and the actual contour

3. Numerical simulations with XFOIL

XFOIL is a public domain numerical simulation under GNU license, which was programmed by M. Drela. It is, among other things, able to calculate the lift- and drag coefficients at different angles of attack.

The numerical simulations were made to compare the flow properties of the definition- and actual contour. It was also used to show the effect of the reduced section length. Furthermore, the simulation results had to be compared to wind tunnel results.

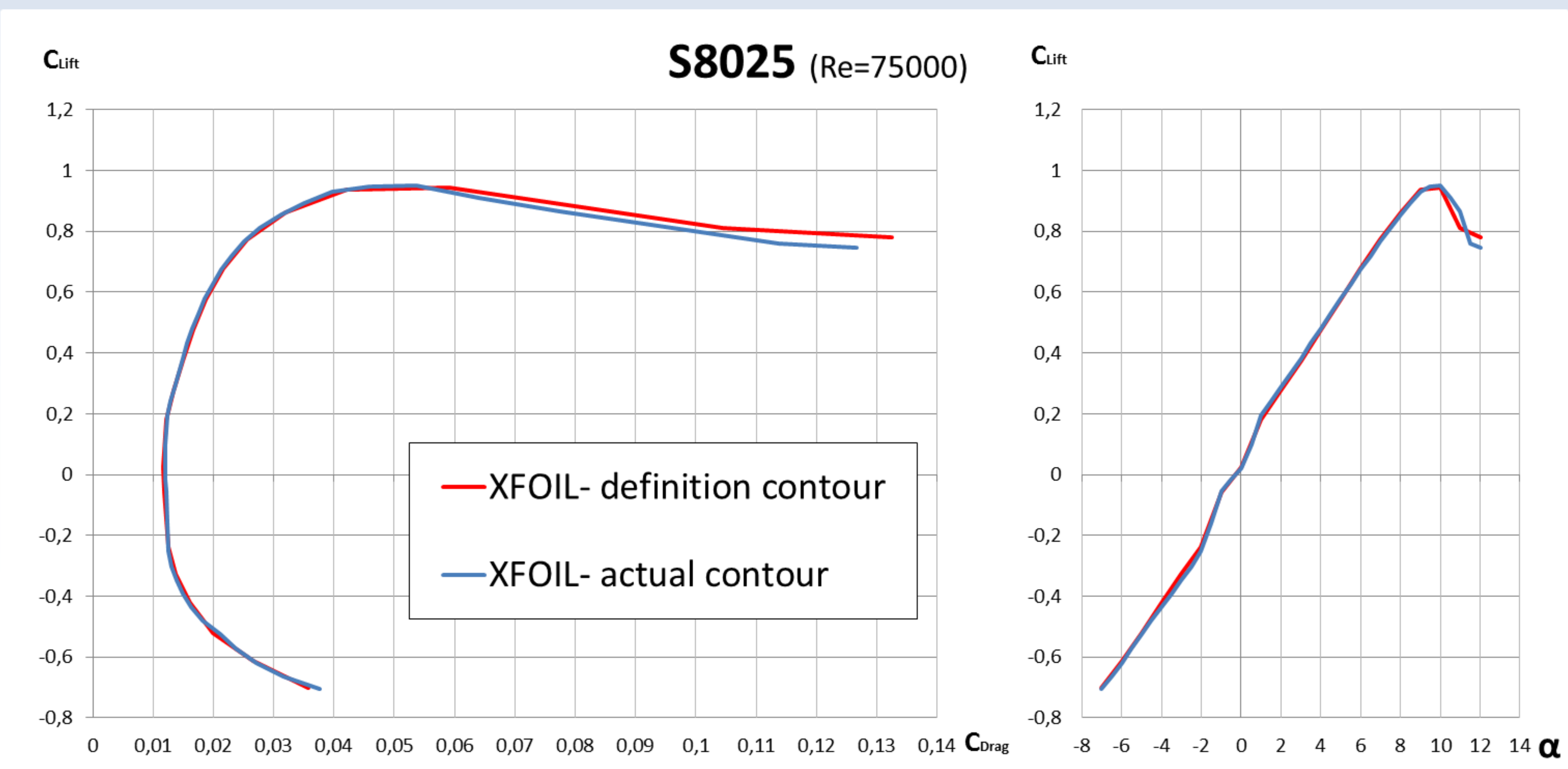

Fig. 5: Polar diagram of the profile S8025 for Re=75000 calculated by XFOIL (n_{crit} = 6.485)

The results show, that there is almost no difference in flow properties between the definition- and actual contour.

4. Wind tunnel tests

The lift- and drag coefficient were measured in the RWT (Regensburg Wind Tunnel) with the pressure measurement set-up. The results were compared to own XFOIL results (n_{crit} = 6.485), EPPLER results (another numerical simulation, calculated with n_{crit} = 11) and to wind tunnel results of the UIUC (University of Illinois).

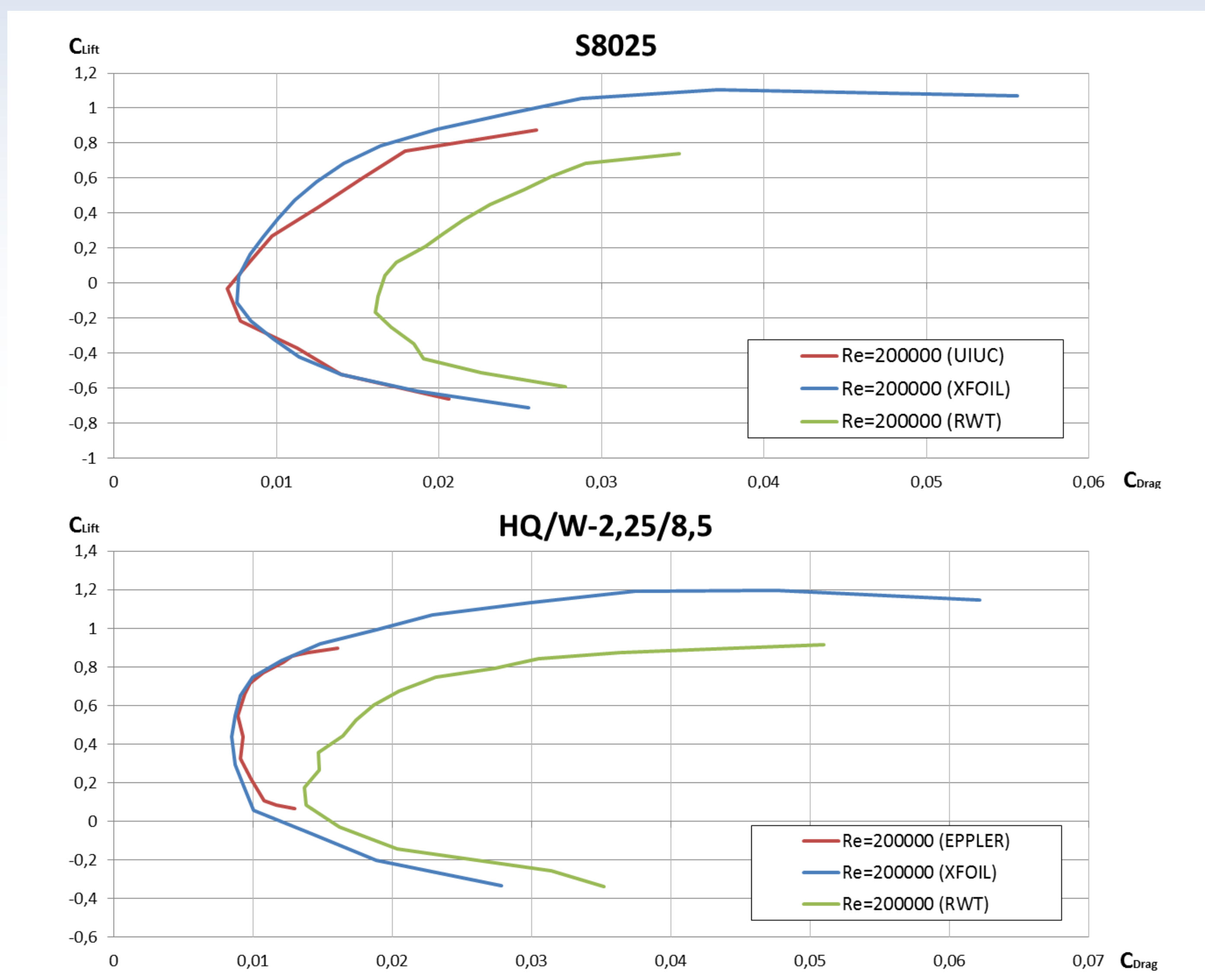

Fig. 6: Polar diagrams of both profiles at Re=200000

The comparisons show, that the RWT results always had a higher drag-coefficient. It could be caused by different correction factors included in the calculation of the coefficients. They have to be verified in future investigations.