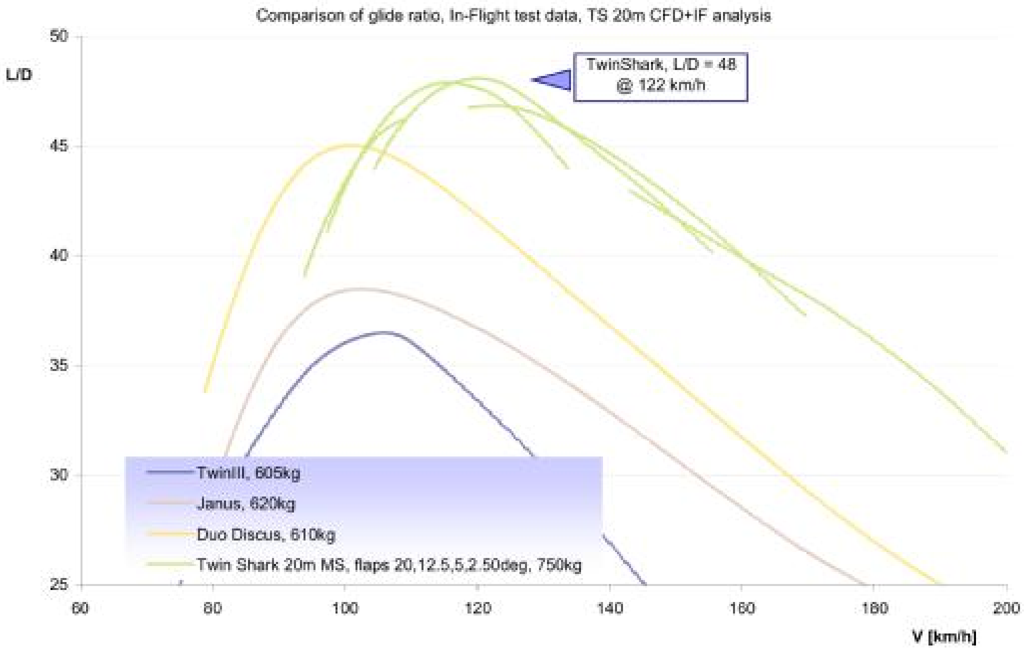
Aerodynamic Design of HPH TwinShark 20m

TwinShark is a new entrance to the category of sailplane two seaters having 20 meter wingspan. Among fleets in operation worldwide, recent single seat sailplanes of flapped 18 meter category brought a significant increase of performance, cockpit comfort and pleasant handling. The very same expectation has been indicated also for a new two seater type.
Historically, flapped two seaters of 18 to 22 meters wingspan, such as Janus and DG500 provided a vast glide ratio margin over the existing sailplanes and enabled effective cross-country training and valuable soaring flights. Aerodynamic development of airfoils allowed another remarkable L/D upgrade in new types, even with unflapped wing sections, such as that of Duo Discus. Larger than mentioned performance gain is available now to create another level of the aerodynamic state-of-the-art technology. Cited progress speaks on its own in mutual comparison using the presented graph of glide ratios.
Prior to the development and design effort, extensive discussion among gliding clubs and individual owners was undertaken. In particular a desire to keep the flying, ergonomic and quality characteristics in line with HPH Shark was articulated.

Three-side view of HPH TwinShark MS

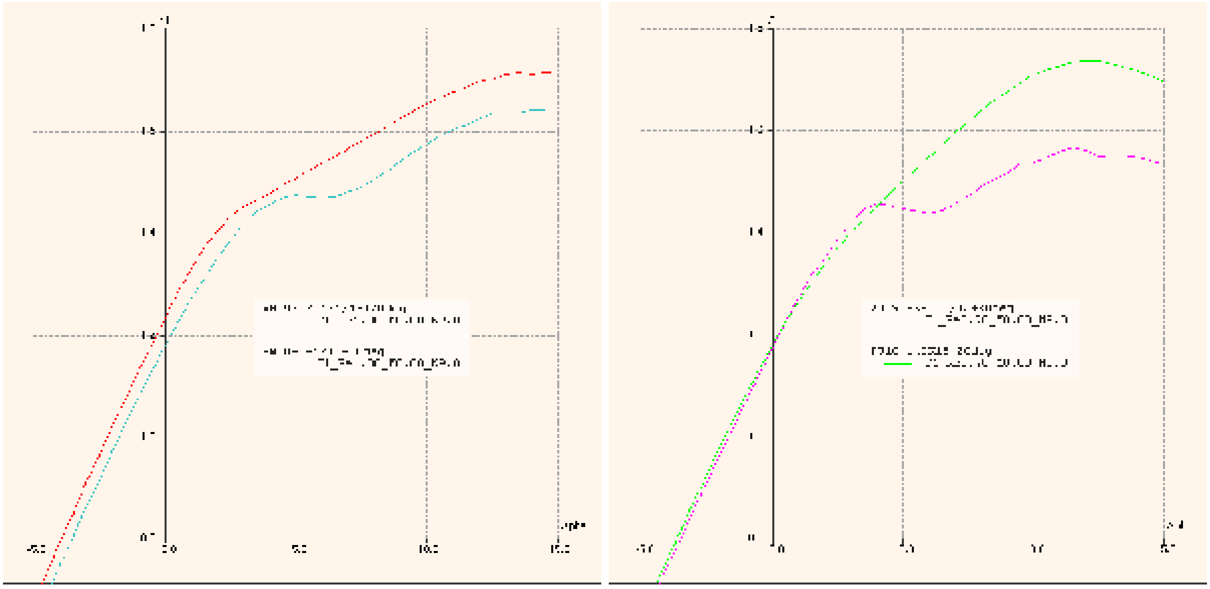
Broad TwinShark development team was set up from top-rated Czech research institutes. As for the aerodynamic specialists, following groups launched their efforts: Academy of Sciences of the Czech Republic IT AS, VSP R&D, being the holders of 2010 OSTIV Diploma, lead by Lukas Popelka, acting also as chief aerodynamicist, Brno University of Technology team of Robert Popela and Zdenek Patek’s team from Aeronautical Research and Test Institute (ARTI).



Comparison of glide ratio

Conceptual design studies were carried out in order to assess fulfilment of the goals. Employing the entire design team, several updates were taken for accomodation of both self-launching (MS) and jet-sustainer version (SJ), structural, safety demands and so on. Final configuration is presented on three-side view.

Key effort was commited to wing. 5 new main airfoils were designed, not counting the other supporting, which enable the smooth countour spanwise. The multicriteria optimization procedure was applied in airfoil design process, take into account 72 parameters. The concept of laminar boundary layer run up to 95% chord of the airfoil lower side was used to reach low drag on high speed glide. Furthermore, the low-speed performance was markedly improved over airfoil generation employed in production sailplanes nowadays. Not only by lower drag coefficient values, lift curves of TwinShark airfoils with flap positive setting show steady and continuous increase of lift with raising angle of attack. As pioneered by analysis of L.M.M. Boermans, OSTIV President, such feature enables to use the dynamic potential of the thermals. The lift slope courses were proven by wind-tunnel measurement, demonstrating such capability even for the low Reynolds numbers of the wing tip region. Moreover, substantially higher maximum lift coefficients were obtained.



Lift curves of the two PW10-series airfoils, as compared with representative
Reference flapped airfoil

Wing sections were tested in IT AS and ARTI wind tunnels, using aerodynamic balances and pressure measurement; infrared technology confirmed the designed extent of laminar flow.

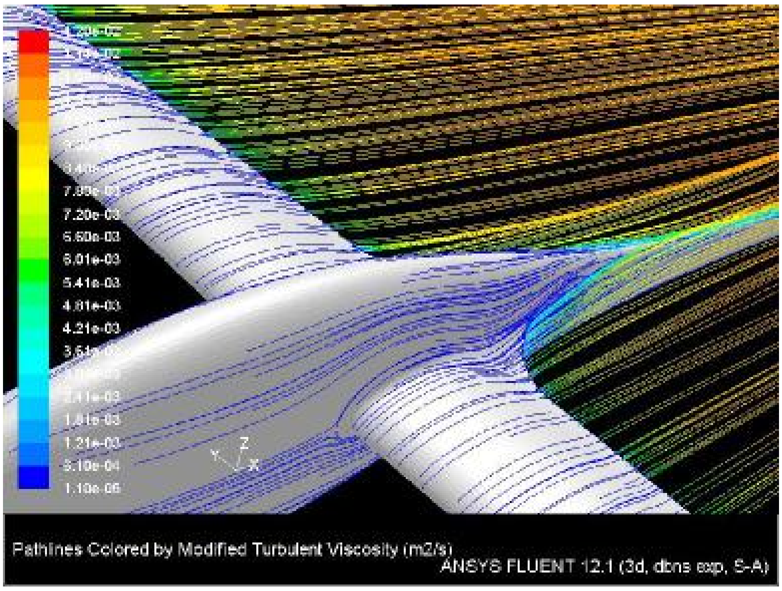
Wind-tunnel testing of TS airfoils: closed test section IT AS (left),
open section (ARTI) with deployed dive brake

Eliptic wing, both in planform and dihedral was introduced. Apart from current designs, trapezoid sections were completely ruled out, reaching true eliptic lift distribution and eliminating vortex generation on section joints. Typical smooth-shaped winglets of the single seated Shark are inherent part of the new design as well.

Using the full 3D CAD model, design variants were compared by CFD software code calculations, modelling the complete sailplane in angles of attack and speeds covering the entire operational range. One of main contribution of this analysis was on flowfield on fuselage downstream the wing and on wing angle of incidence setting related to fuselage axis.

Additional wind-tunnel testing was executed in IT AS, expanding the mentioned OSTIV renowned case on wing-fuselage interaction.

To provide a complete set of information, moreover, the flight test programme on single seated Shark with wing drag rake and tuft visualization was flown.



Calculated flowfield of the wing-fuselage interaction

The presented design methodology, employing synthesis of computer calculation, wind-tunnel testing and in-flight measurements was successfully validated. Manufacturing of the TwinShark prototype is currently underway.

HPH Sailplanes, Czech Republic