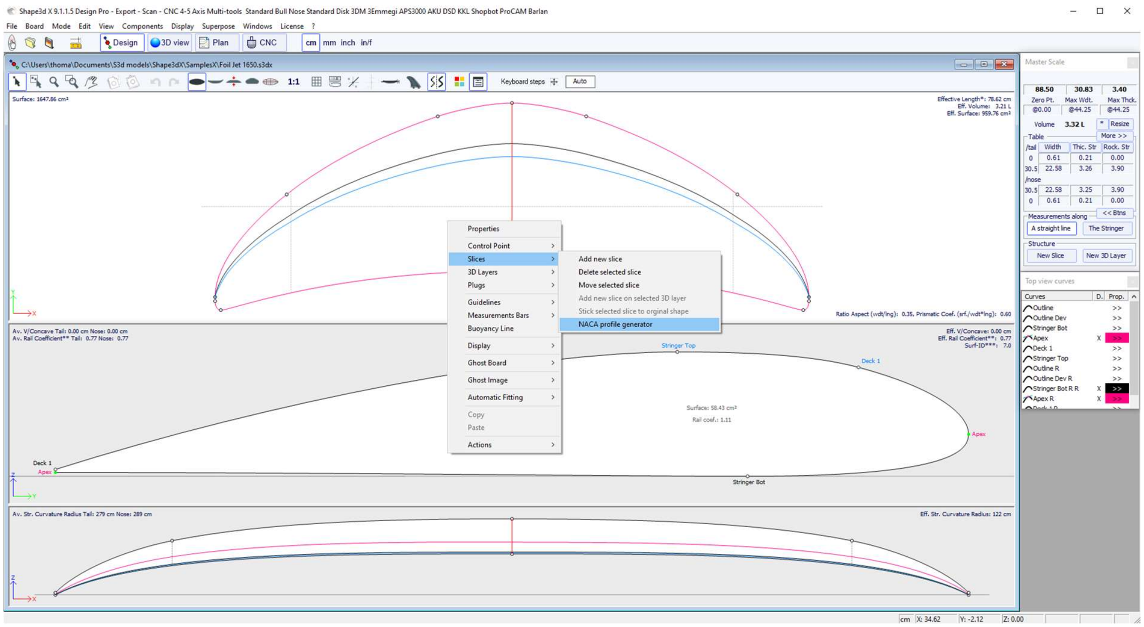
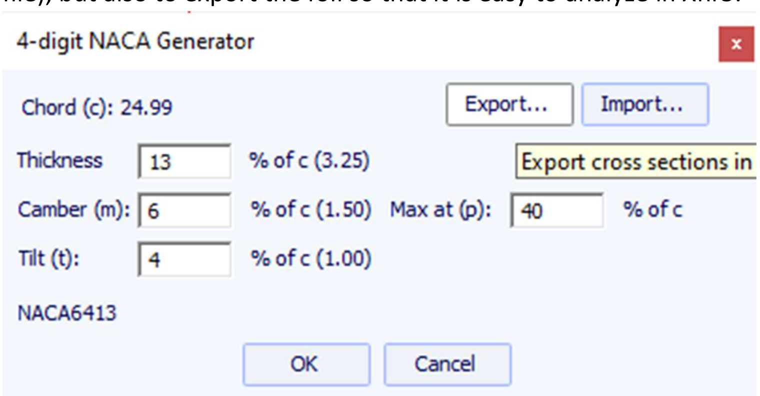
Shape3d to Xflr5 tutorial

Once the foil has been drawn in Shape3d, click on the Component -> Slices -> NACA profile generator menu:



This function allows you to adjust a slice on a NACA profile (or another profile imported from a .dat file), but also to export the foil so that it is easy to analyze in Xflr5.

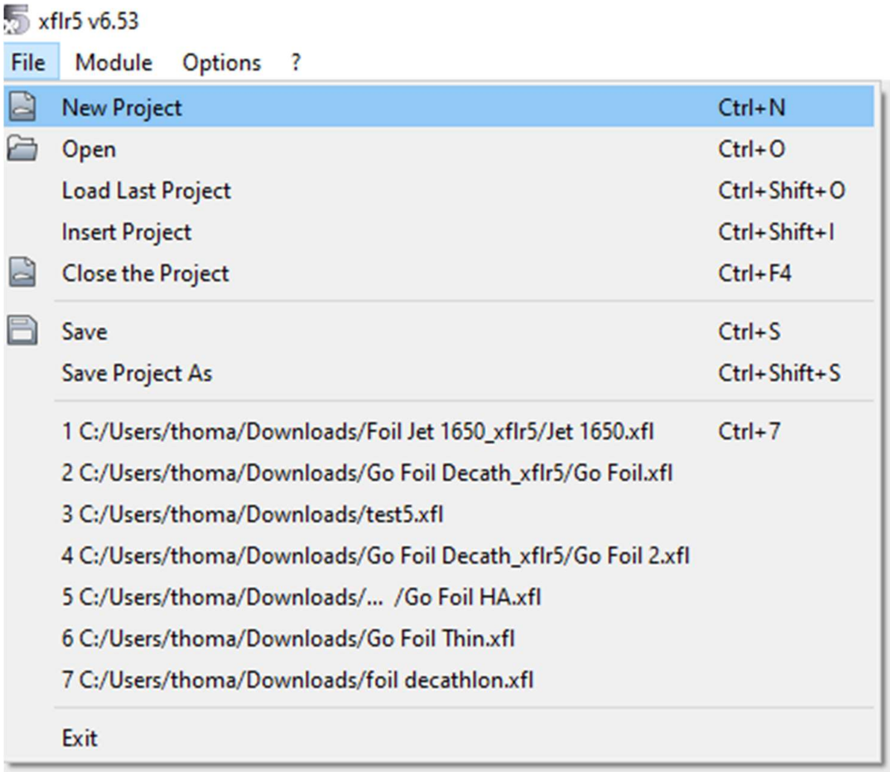


Note that the foil must be drawn as in the screenshot above: with the leading edge to the right, and the trailing edge to the left.

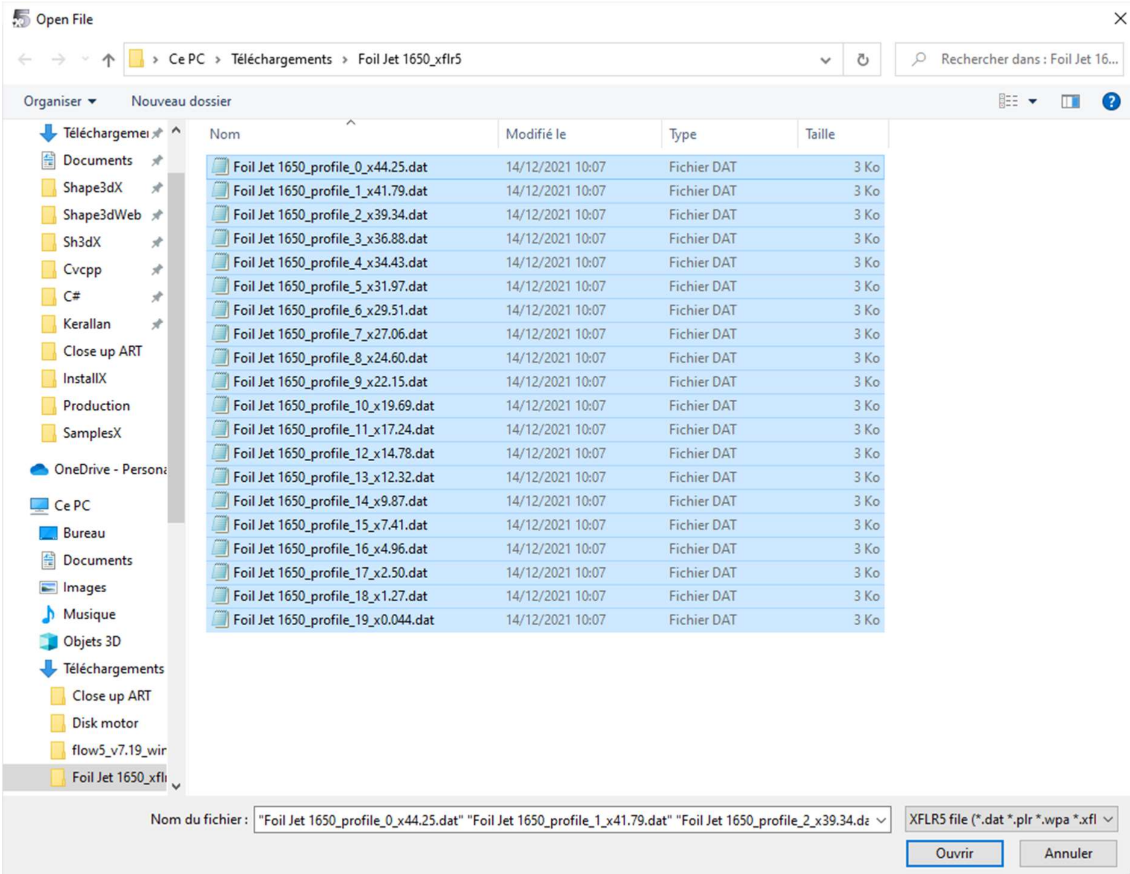
Xflr5 is open source software that can be downloaded from http://www.xflr5.tech/xflr5.htm

The export consists of 20 .dat profiles and an xml file.

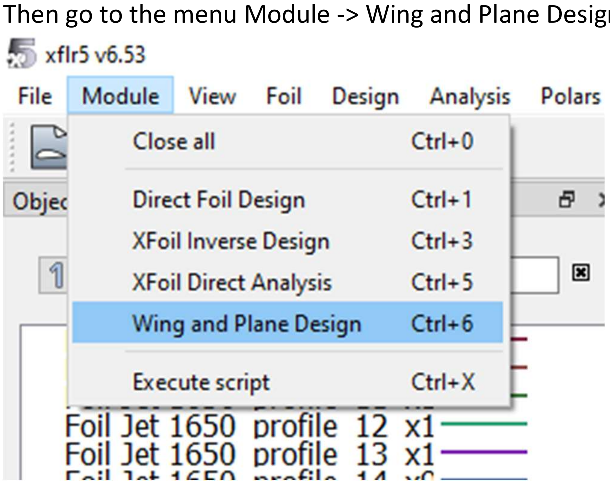
Open Xflr5 and click on the File -> New Project menu:



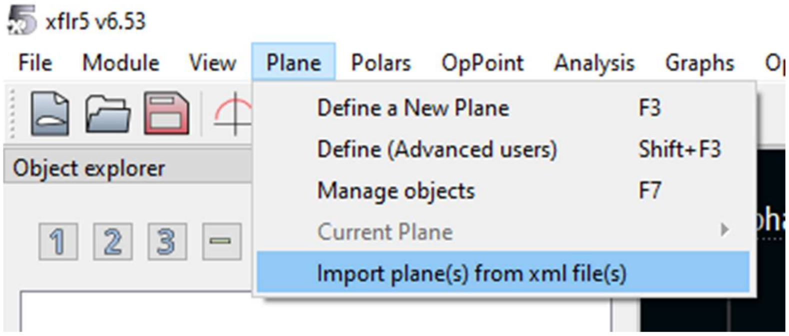
Then File -> Open, and select all the .dat:



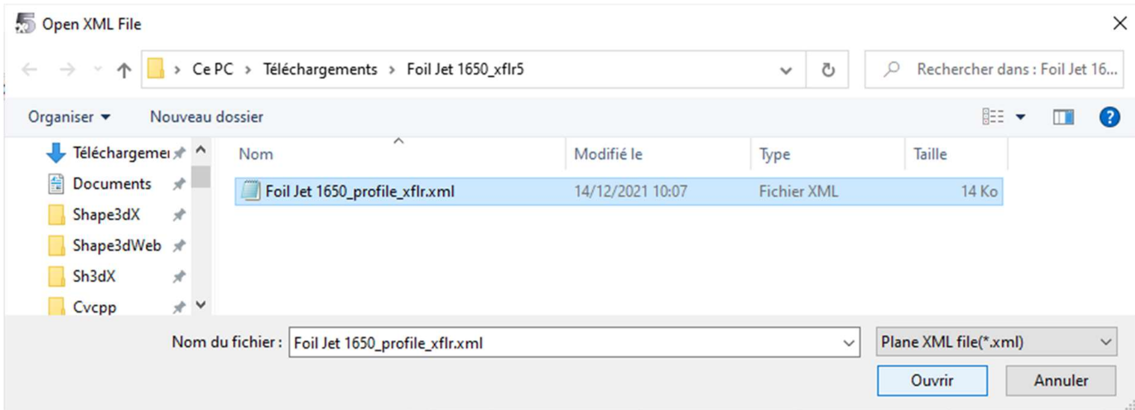
Then go to the menu Module -> Wing and Plane Design:



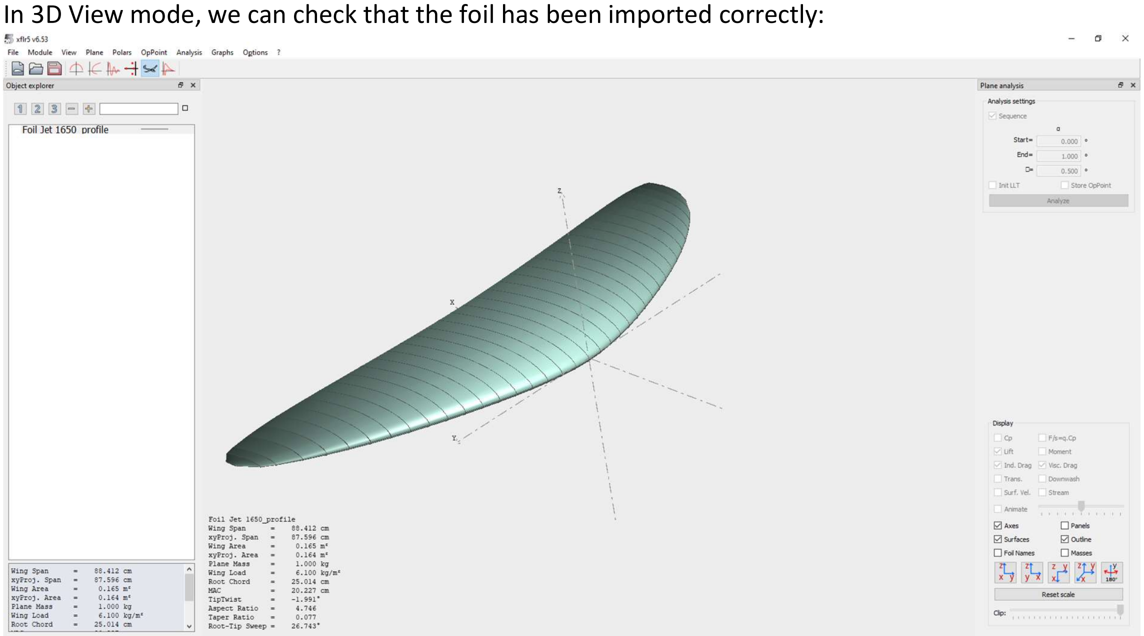
Then Plane -> Import plane(s) from xml file(s):



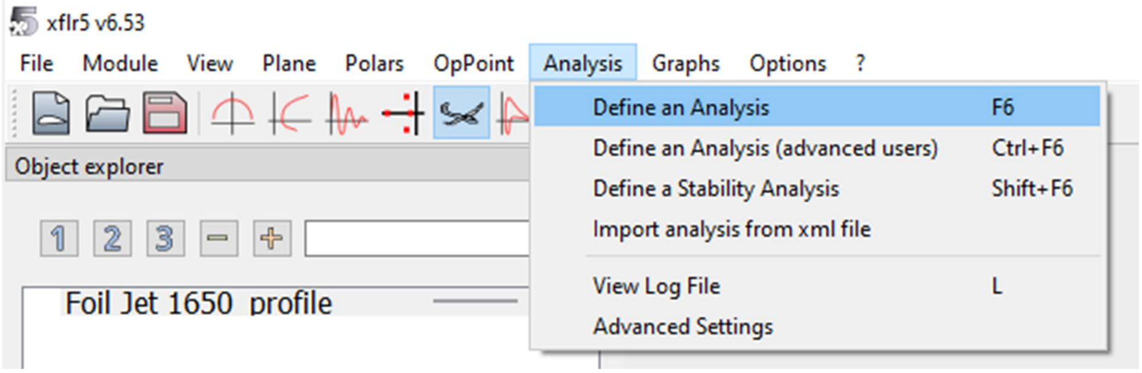
And select the xml file exported by Shape3d:



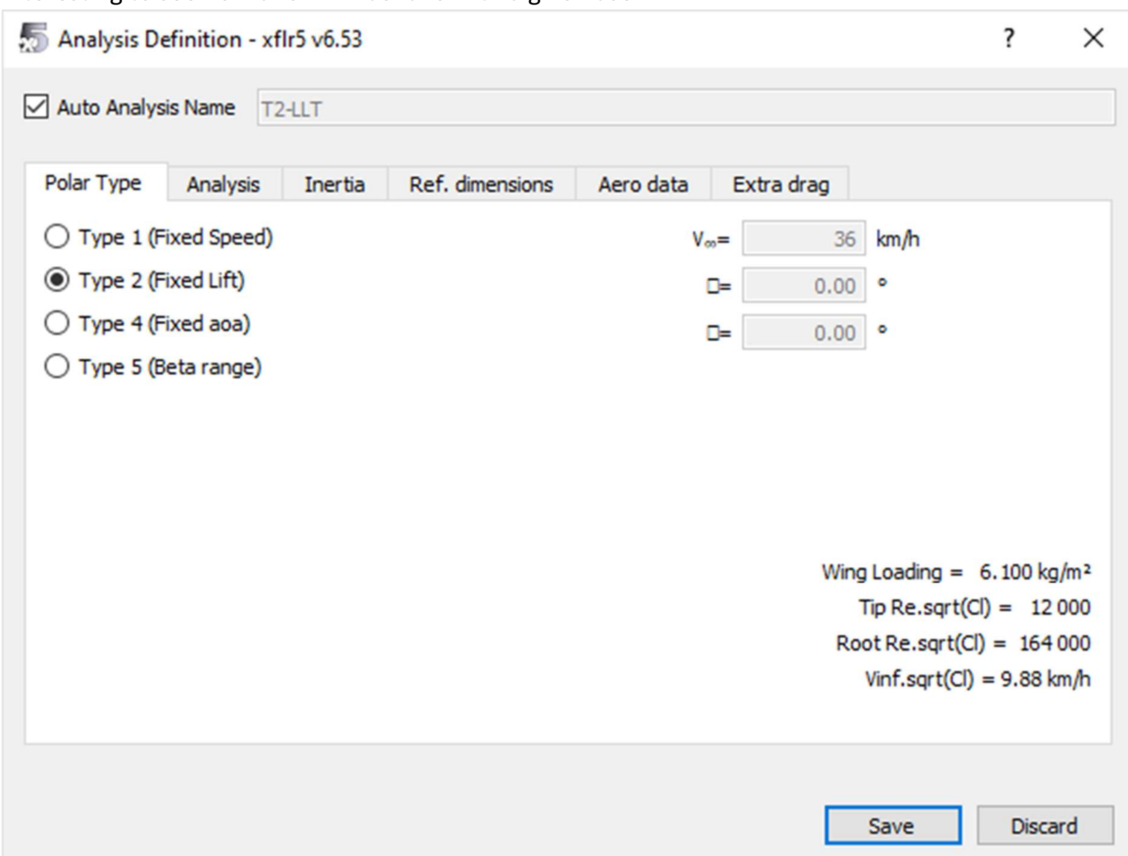
In 3D View mode, we can check that the foil has been imported correctly:



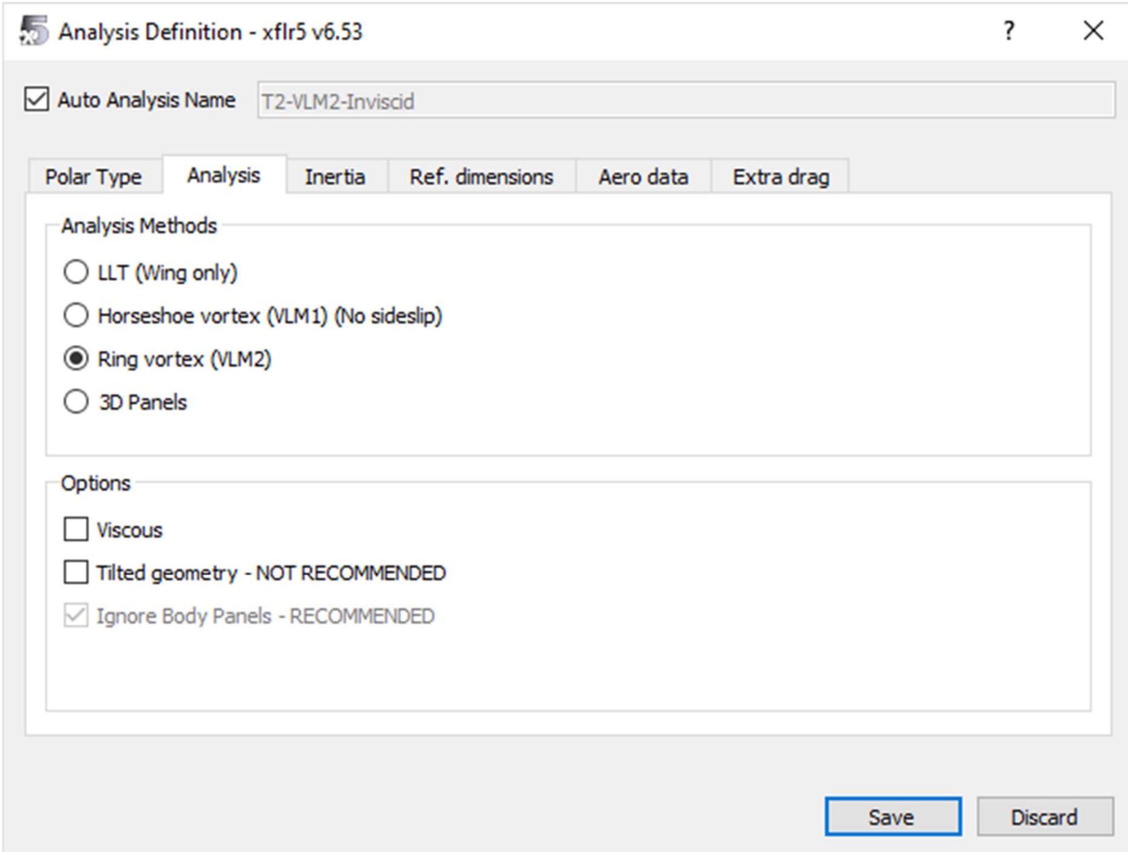
We can then directly launch a lift analysis from the Analysis -> Define an Analysis menu:



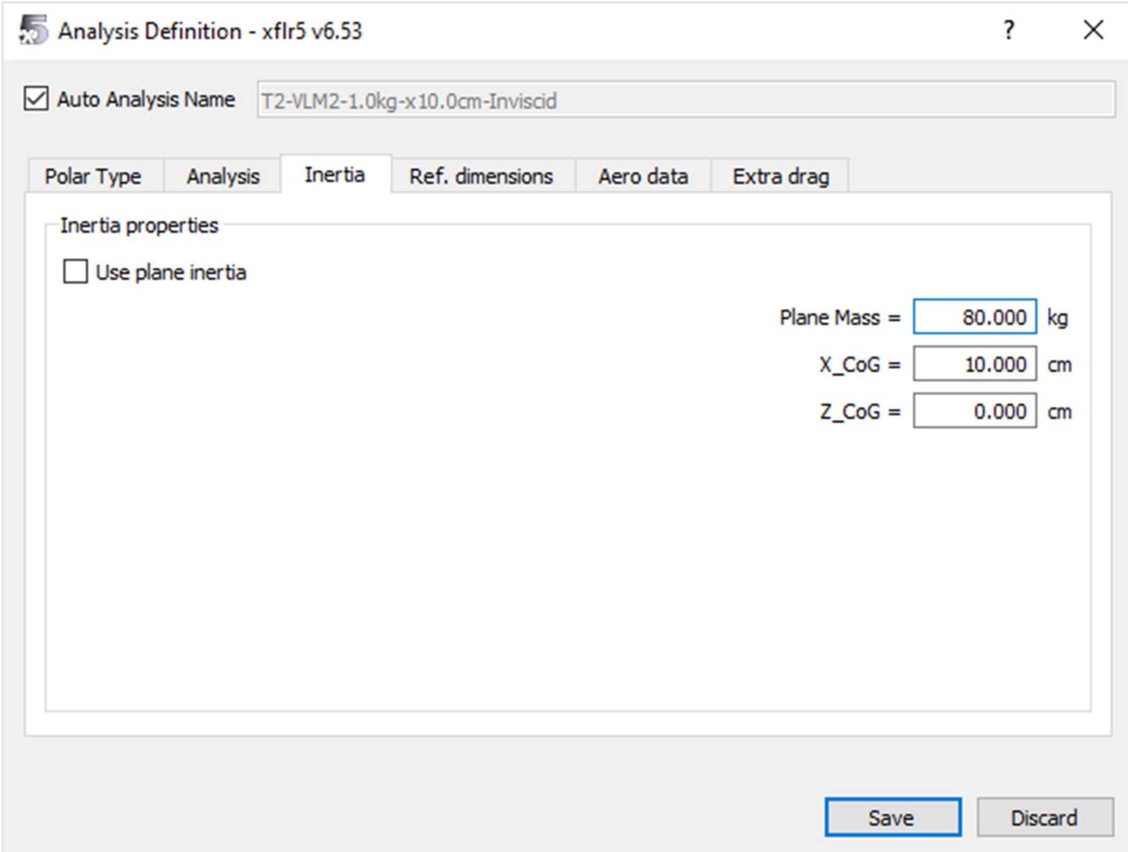
You can do an analysis at a given speed (Type 1), or at a given lift (Type 2). The Type 2 analysis is very interesting to see how a foil will behave with a given user:



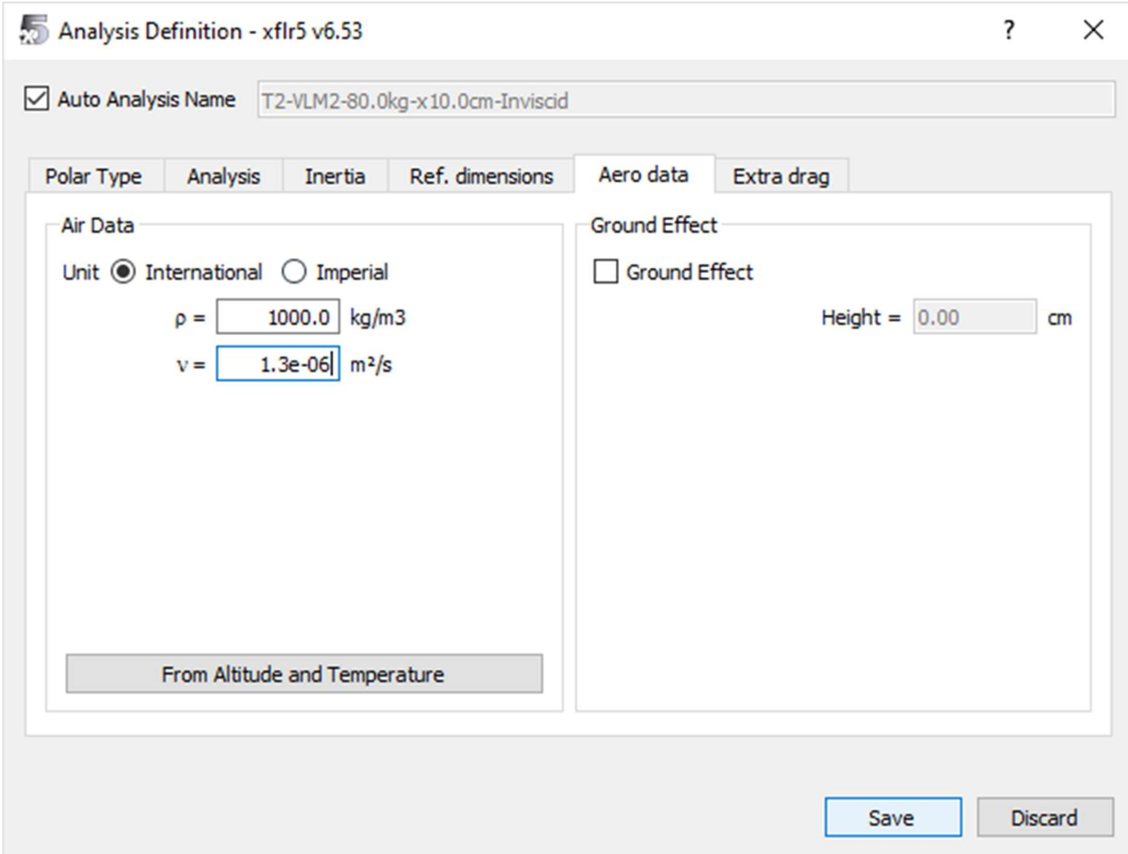
You must then choose the method in the Analysis tab. Ring vortex works well. We're not going to check Viscous just yet, which will allow us to get lift faster.



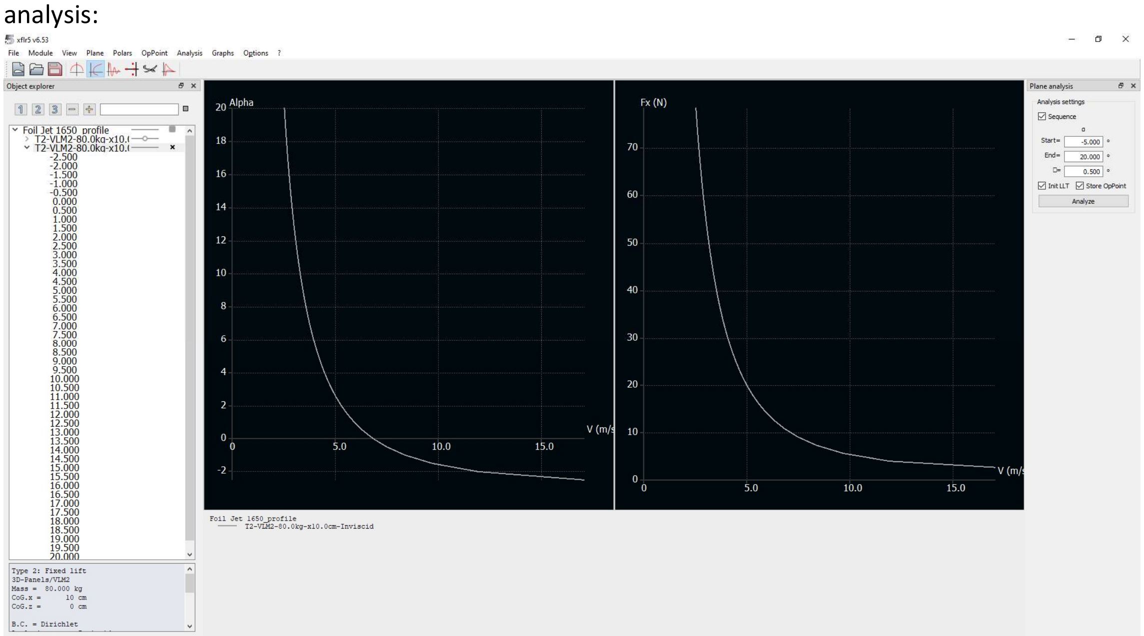
In the Inertia tab we enter the weight of the rider + gear, 80kg for example:



Then in the Aero data if tab, enter the water density 1000kg / m3 and its viscosity 1.3e-6 m² / s:



We click on the Save button, then in Polar View mode we click on the Analyze button to start the analysis:

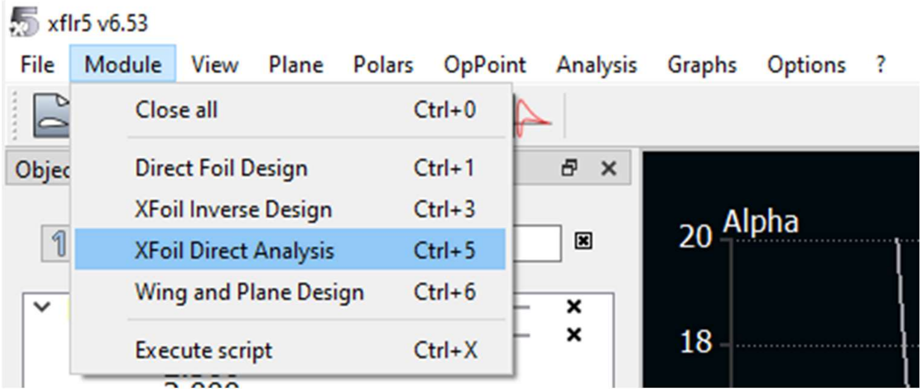


This analysis calculates for each inclination of the foil (here between -5 ° and 20 °) the speed it takes for the foil to carry 80 kg (a lift of 784 N therefore). You can also display the drag Fx for each speed (with the inclination that corresponds to it).

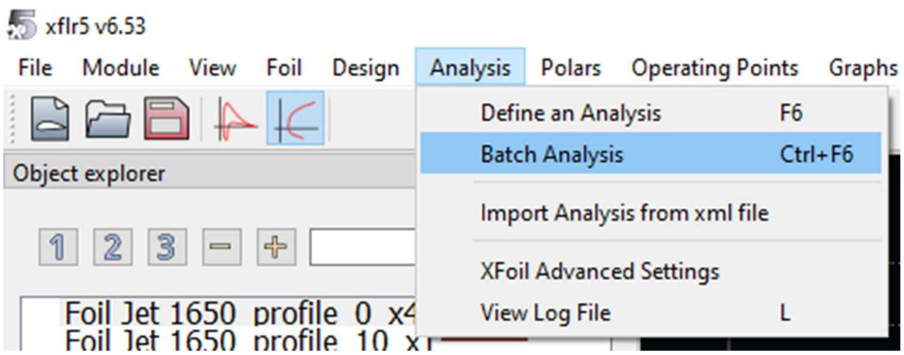
Here we see that for this low aspect 1650cm² foil (rough copy of the Naish Jet 1650), at 5 m/s (~ 10 kt) you need an inclination of 2 °. Below 6 kt it takes more than 12 °... We can deduce that we can start pumping around 6 kt, but that normal navigation is only done from 10 kt roughly.

The drag Fx is here only the residual drag due to the vortices, and we see that it is greater the lower the speed and the large inclination. It only decreases as speed increases, which is unrealistic as there is no viscous drag.

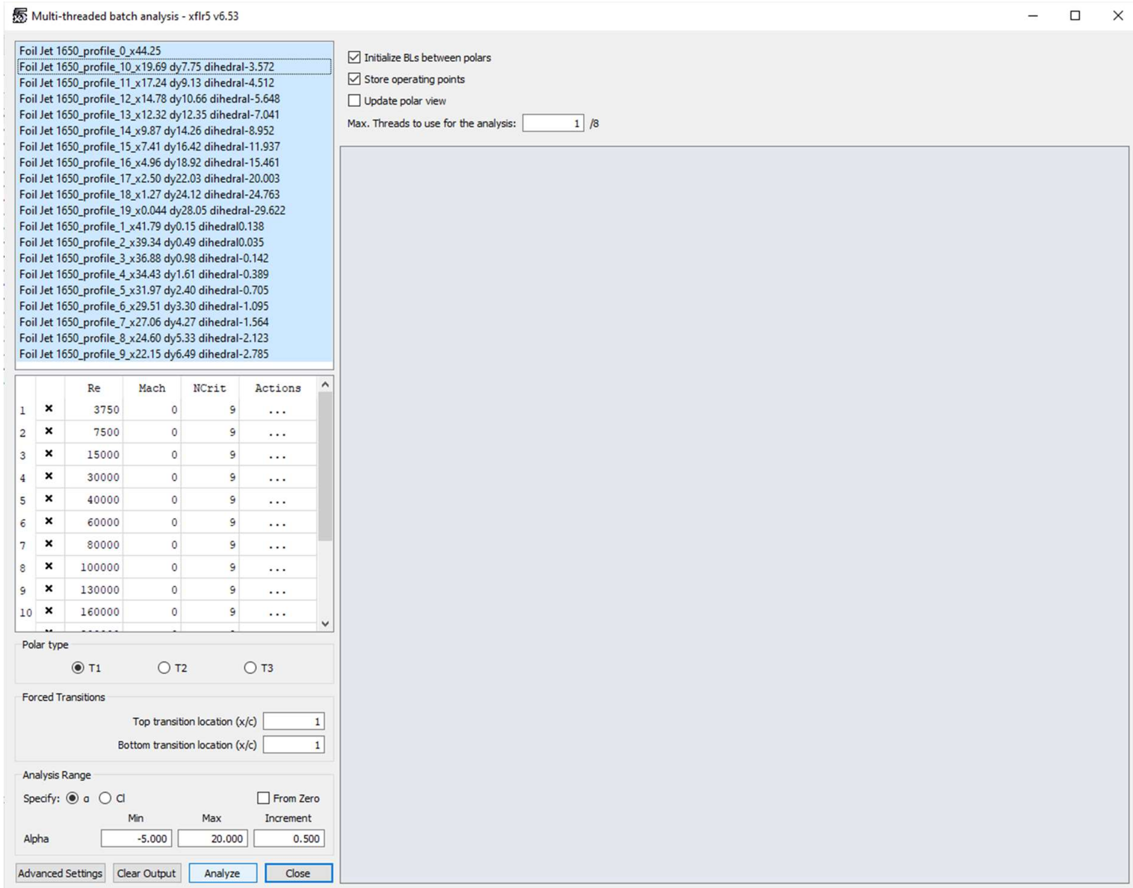
To add the slimy drag it is a bit longer. You have to go to the menu Module -> XFoil Direct Analysis:



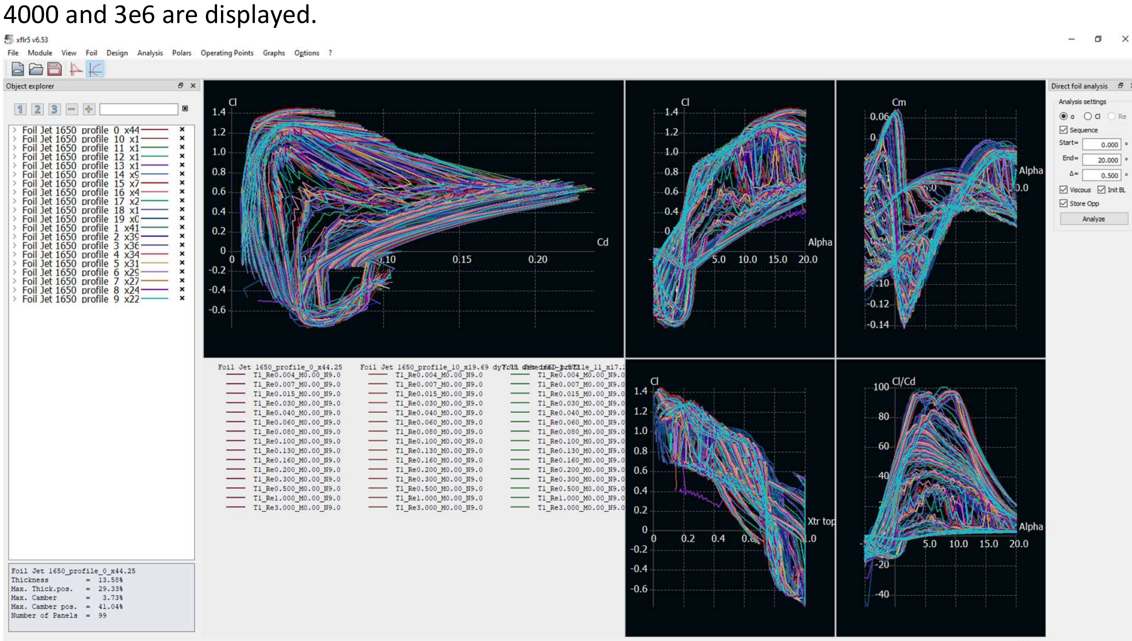
Then in the Analysis -> Batch Analysis menu:



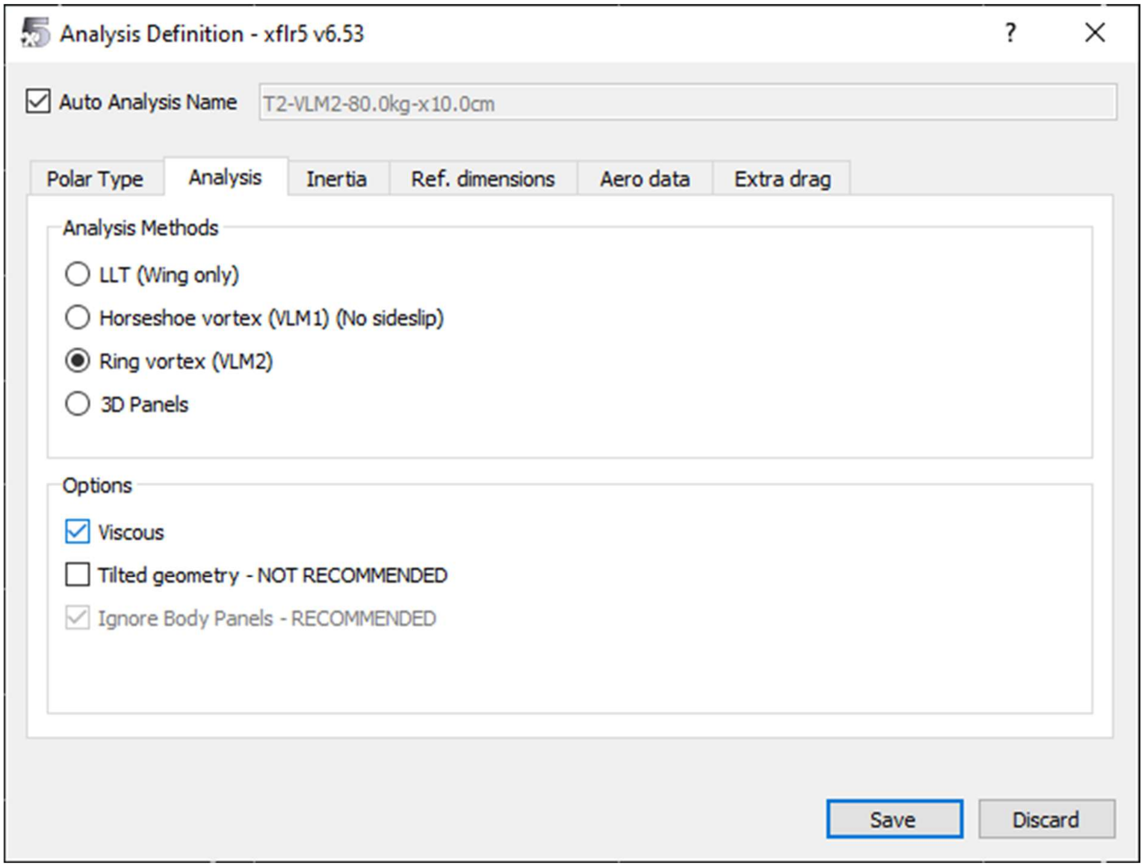
Then select all the profiles, and launch the Type 1 analyzes between -5 ° and 20 °:



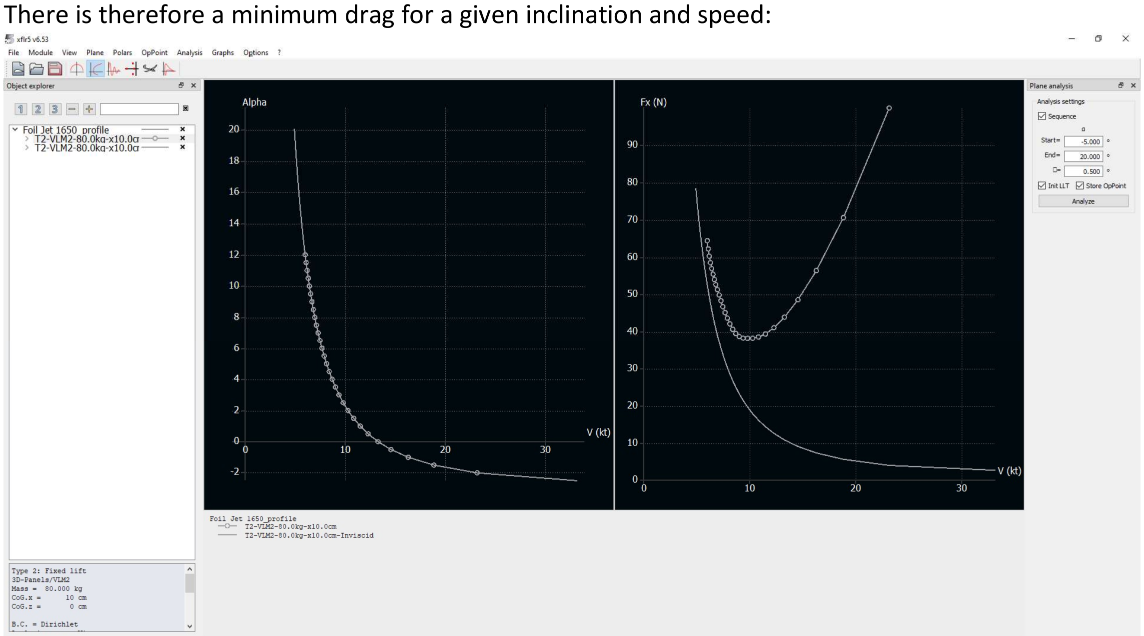
It takes several minutes, and at the end of it, the polars for all angles and Reynolds numbers between 4000 and 3e6 are displayed.



We can then return to the Module -> Wind and Plane Design menu, and define a new analysis, by checking the Viscous box this time:



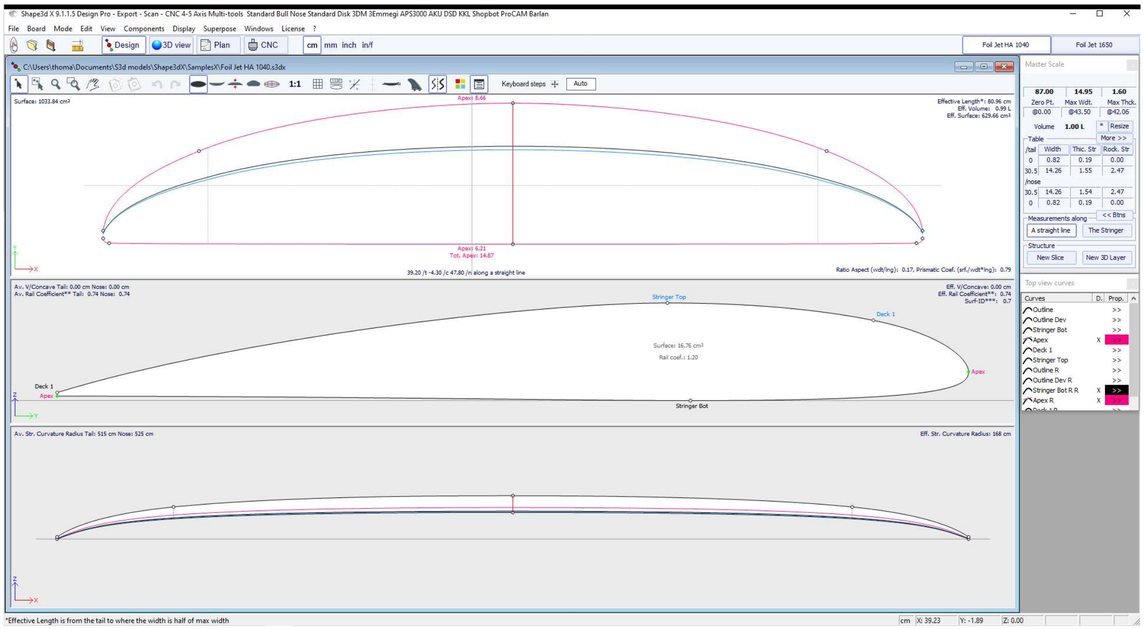
We obtain a lift identical to the previous analysis, but a higher drag which increases at high speed. There is therefore a minimum drag for a given inclination and speed:

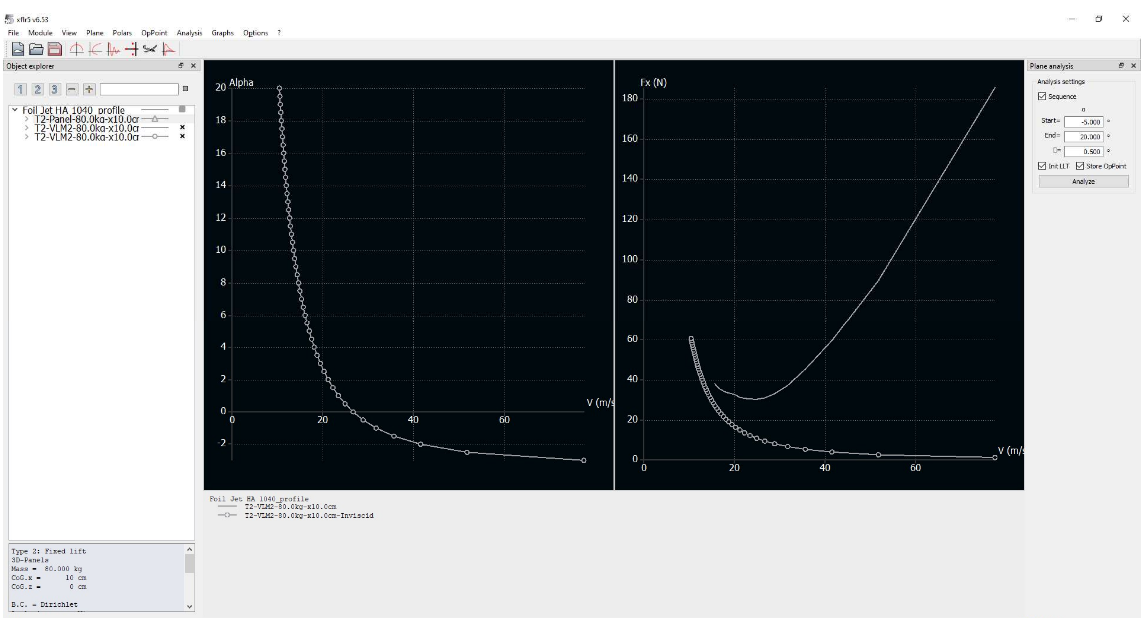


There is therefore an optimum range of use between 9 kt and 12 kt.

Note that you can change the speed unit in the Options -> Preferences menu, but there is a small bug that causes the display to always revert to m/s with a scale that is not always good . You must then right click -> Current Graph -> Define Grapgh Settings, then Reset Graph Scales.

We can compare these results with a foil of 1040 cm² of higher aspect ratio (rough copy of the Naish Jet HA 1040):

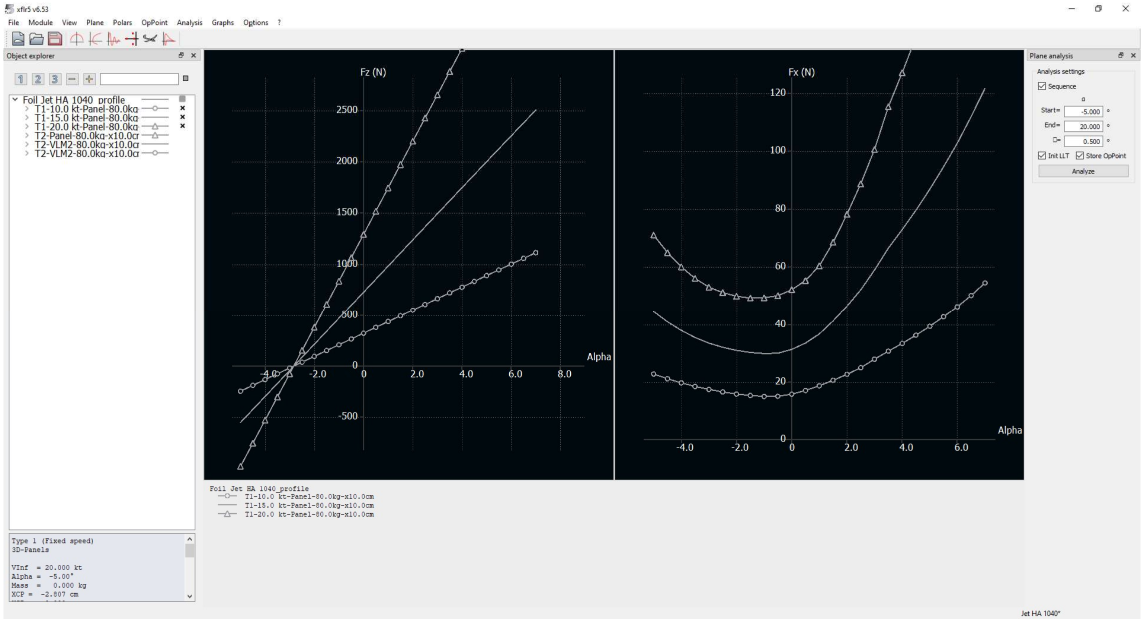




We can see here that the bank at 10 kt is not 2 ° but 4 °. We descend to 2 ° around 12 kt. The minimum drag is around 14 kt, and the optimum range between 12 kt and 16 kt.

These results are not 100% reliable, but fairly true. We made a quantitative comparison with the results obtained with OpenFoam (a large simulation software, the analyzes are very long and require large computers) by Decathlon and we were very close to the lift level for inclinations of up to 15 °. The advantage here is that it takes less than 5 min in total to get an analysis.

You can also do Type 1 analyzes to obtain the optimum incline at a given speed (10-15-20 kt here):



It is also possible to load the stab to have lift and overall drag.

The Flow5 software is an advanced version of Xflr5, paid for, which allows you to do the same thing, with the addition of taking into account the foil / stab interaction ([https://flow5.tech/docs/flow5_doc/Analysis/VPW .html](https://flow5.tech/docs/flow5_doc/Analysis/VPW.html)), and the possibility of optimizing (https://flow5.tech/docs/flow5_doc/MOPSO/MOPSO.html).