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# **Gemini Aero Foam**

A powerful, versatile and user-friendly GCode generator for 4 axis foam cutting

Made for hobbyists and engineers by hobbyists and engineers

## **User manual**

v1.0.1.2

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## 1 Introduction

Gemini Aero Foam (G.A.F.) is a 4 axis foam cutting CAD/CAM GCode generator, running on Microsoft Windows and Linux. It's aimed at curious modelers and model aircraft designers, as well as drone professionals, academics and aeronautical engineering schools, not forgetting amateur ultralight builders.

In G.A.F., the CAM process is divided into logical steps, with a screen dedicated to each one, so even complex cuttings can be done in a very simple way, with maximum efficiency and minimum time. This modular architecture also means that G.A.F. can be easily maintained and improved over time.

A [forum](#) is also available for suggestions for new functions and bug reports.

A few highlights:

- Very easy to learn and use : step by step and fully reversible modifications, integrated help and tips
- Files format supported : .dat (Selig points coordinates), .dxf ascii (all entities including splines, all formats from AutoCAD 11 to 2024), .plt, .prn, .hpgl, .eps
- Can cut almost any shape, not only wings : fuselage sections, letters, etc.
- Profile modifier : point(s) or global(thickness, trailing edge thickness, etc.) modifications
- Right and left wing can be cut simultaneously
- Delta wing rotation : allow to cut delta and high sweep wings with a perfect result
- Powerful "extra cuts" features : fully parametrable (insertion point, angle, dimensions) and chainable forms (spars, cut at leading and trailing edge, etc.)
- Adaptive speed and kerf offset automatic calculations : no master or slave axis, speeds and kerfs are simultaneously recalculated for both sides between each synchro point according to local length
- Independent speed and kerf calibration for each foam
- 2D and 3D plots, with zoom, pan, etc.
- Integrated point by point simulator
- Safety warnings : axis max travels and speeds, min speed cutting, max wire diagonal
- Machine fully parametrable, including axis letters
- Fully independent of any electronics or communication protocols
- Output high quality GCode, with G93 inverse time, compatible with most of GCode senders (recommended : [Gemini Aero Cutter](#) + grbl 1.1 to 1.2 or grblHAL)

**Gemini Aero Foam is supplied as is, and the author cannot be held liable in any way whatsoever in the event of an accident involving an aircraft designed or adjusted using this software.**

## 2 General presentation

### 2.1 Compatibiliy

G.A.F. runs on Windows, from 7 SP1 to 11, in 32 and 64 bits. It is also compatible with Linux (requires WinHQ and WineTricks) and potentially MacOS (with the same tools as for Linux, untested).

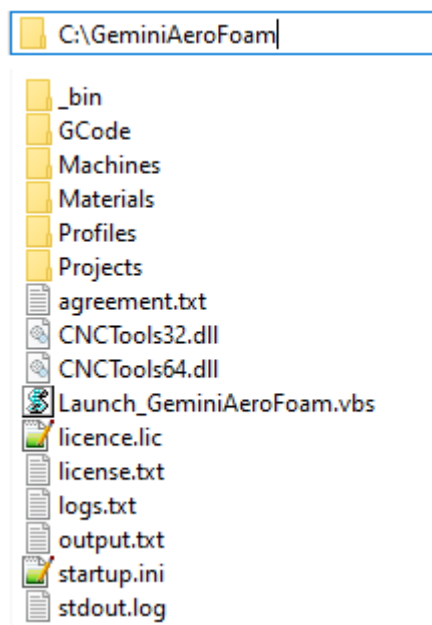
In all cases, the [Microsoft Visual C++ Redistributable](https://www.catalog.update.microsoft.com/Home.aspx) must be installed. Old version of Windows needs also KB3063858 and KB2999226 (required for MS VS redistrib, download link : <https://www.catalog.update.microsoft.com/Home.aspx> ).

All package are provided here : <https://icedrive.net/s/vN8y24FV8Yw6tWaD9D443t1yy1kC> .

### 2.2 Installation and package contents

G.A.F. works in portable mode, i.e. without formal installation. All you need to do is :

- copy the zip file to the G.A.F. installation folder of your choice (on a hard disk or an USB key), for example C:\GeminiAeroFoam.
- extract the contents of the archive into this folder, using the Windows integrated tool (mouse right click on zip, then “extract here”) or a dedicated tool (7Zip, WinZip, WinRar, etc.) :



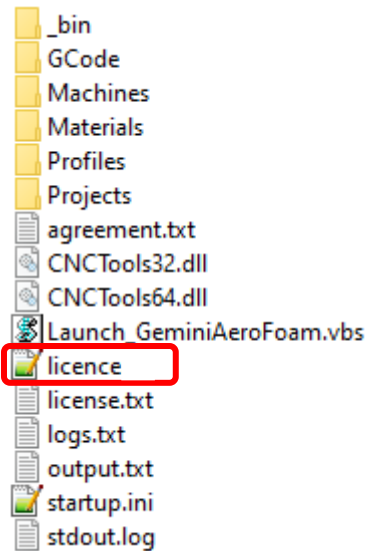
- launch the application by double-clicking on 'Launch\_GeminiAeroFoam.vbs'

NOTA :

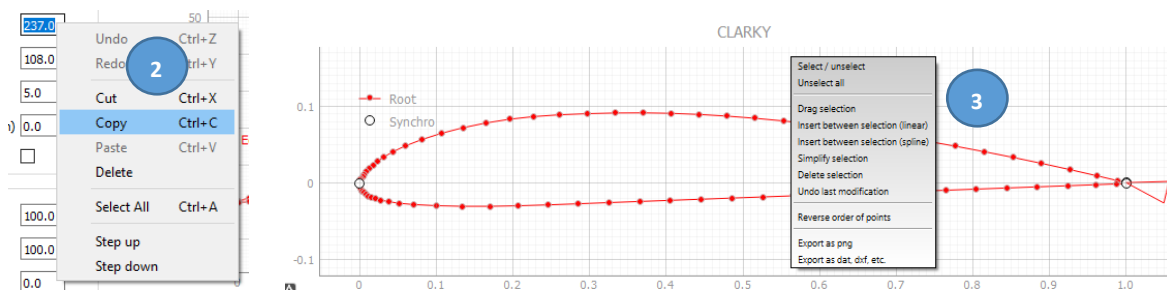
- Several instances of G.A.F. can be launched simultaneously, and each can open the same file as the others (file are not reserved by application but duplicate inside application memory).
- To upgrade the software : replace the “\_bin” folder by the one provide in the new release zip file, so you can keep your own files (profiles, projects, etc.).

### 2.3 Registering

After purchasing, you will receive (usually in one business day) your license. Just put the provided file in the root folder of the application :



## 2.4 Main interface



- (1) in each tab, you will find several "?" help buttons : place the mouse on it and wait 1 or 2 second to show the contextual help.
- (2) interaction with cells :
  - to enter a cell, use tab key from the neighbouring cell or mouse left click directly on it.

- scroll mouse wheel to step up / down a value (no need to enter the cell). Pressing the "ctrl" key makes scrolling 10x faster.
- keyboard + enter key to change a value or a text.
- right click to open a contextual menu (undo/redo works only for text fields).

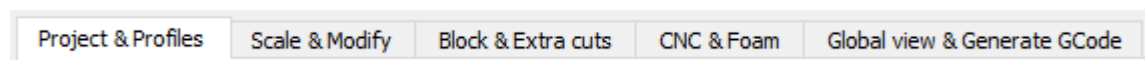
(3) right click on plot to open a contextual menu.

Mouse interaction on plots :

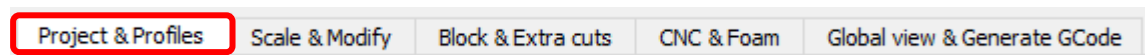
- left button clic : select / unselect a synchro point
- right button clic : show menu
- left button pressed + drag : dynamic pan
- middle button pressed + drag : zoom window
- right button pressed + drag : dynamic zoom centered on mouse position, points selection box or drag selected points
- scroll : dynamic zoom centered on mouse position
- 'A' button at left low corner of plots : reset view (= view All)

## 2.5 Menu bar

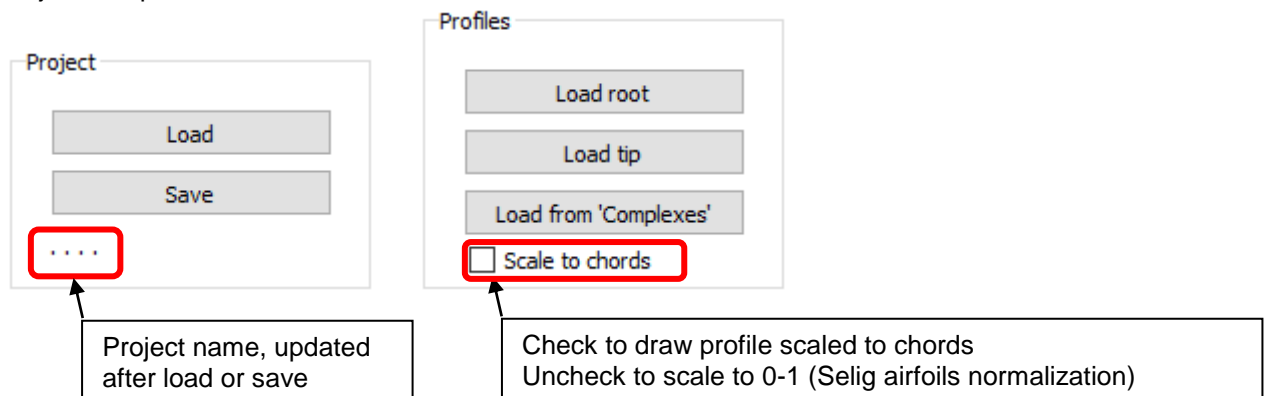
Each tab in the horizontal menu bar corresponds to a step in the CAM process, from loading profiles to GCode generation :



## 2.6 Files and project menu



Project and profiles files are handled on this menu :



## 2.7 Data handled and associated files

Several types of file are handled :

- profiles (folder **\Profiles**) : airfoils Selig .dat (text) and vectoriel (.dxf, .plt, hpgl, .eps) files
- projects (folder **\Projects**) : .txt (text) files
- CNC machine configuration (folder **\Machines**) : .txt (text) files
- Foam cutting parameters (folder **\Material**) : .txt (text) files
- GCode (folder **\GCode**) : .nc (text) files

All the files are independent of each other. Project files are self-sufficient, as they contain all the necessary data (profiles, material, CNC and hot wire configuration). Via the user interface, each included sub-file in a project can later be extracted for reuse separately from its container file.

## 2.8 About .dat and .dxf files

About .dat files (Selig convention) :

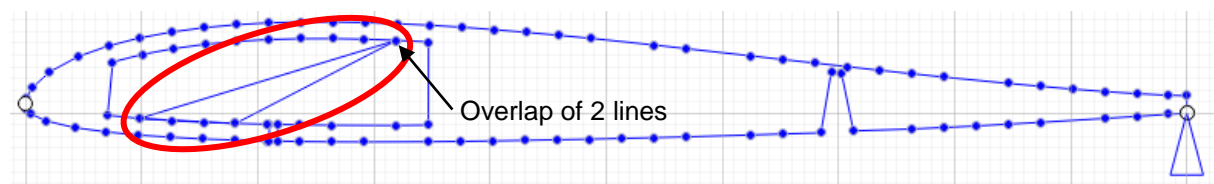
These files contain the name of the profile (first line) and a list of coordinates of points, which are read in the order of appearance from (1,0) to (0,0) then (1,0). The first part is the upper side, the second part is the lower side.

1	FAD16	
2	1.000000	-0.011806
3	0.984192	-0.011406
4	0.956878	-0.010005
5	0.929165	-0.008204
6	0.901351	-0.006103
7	0.873737	-0.003702
8	0.846023	-0.001201
9	0.790595	0.004202
0	0.762882	0.007104
1	0.735268	0.010005
2	0.707554	0.013107
3	0.679940	0.016208
4	0.652226	0.019210
5	0.624612	0.022311
6	0.569185	0.028514
7	0.541571	0.031616
8	0.486143	0.037419
9	0.458529	0.040020
0	0.430815	0.042521
1	0.403102	0.044822
2	0.375388	0.046923
3	0.347574	0.048624
4	0.319860	0.049925
5	0.292146	0.050925
6	0.264332	0.051426
7	0.236618	0.051326
8	0.208804	0.050625
9	0.181091	0.049025
0	0.153477	0.046523
1	0.125863	0.042821
2	0.098449	0.037819
3	0.071436	0.031016
4	0.044922	0.021711
5	0.020510	0.008604
6	0.000000	0.000000
7	0.000300	-0.022711
8	0.004702	-0.027514
9	0.017309	-0.033317
0	0.042021	-0.039120

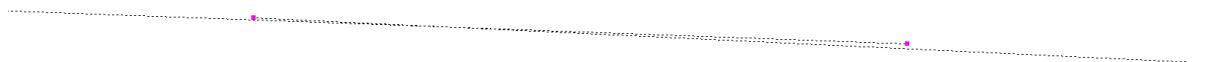


About .dxf files :

These files must be in ASCII format (binary not supported, a converter is provided on Gemini deposit). The entities must be all contiguous, without any breaks or overlaps. Otherwise, we may have this type of anomaly :



Looking closely at the .dxf file, we see a small overlap of two lines, instead of having consecutive lines with a single joining point :



Note :

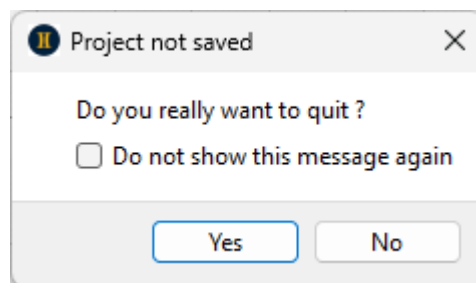
- There must be only one continuous path in a file. So, for example, you can't have a hole alone inside a profile, this hole must be connected to the rest of the path that will be followed by the wire.
- As .dat files are normalized to a length of 1, according to Selig airfoils standard, .dxf files are loaded with the same convention. The lengths (chords) are automatically extracted from the file and can be modified in the "Scale & Modify" tab.

## 2.9 Closing the application

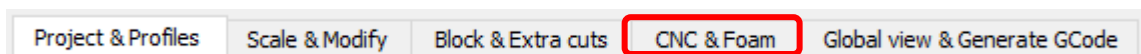
To close the application, click on :



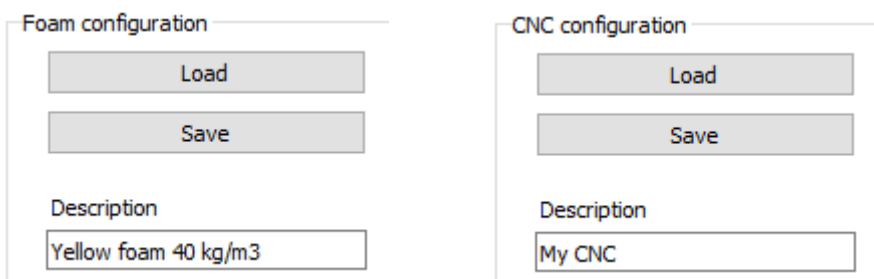
If the project has been modified and not saved, a warning message is displayed :



## 2.10 Setting CNC and Foam



Foam (more precisely, the cutting parameters of the foam) and CNC configuration are automatically saved in project, and can also manually saved in dedicated files, then loaded in a project when necessary.





## 2.11 CNC configuration

Axis limits		
	Travel (mm)	Speed (mm/s)
Horizontal	<input type="text" value="500.0"/>	<input type="text" value="10.0"/>
Vertical	<input type="text" value="250.0"/>	<input type="text" value="5.0"/>

Distances (mm)	
Left to right axis	<input type="text" value="600.0"/>
Left axis to cutting area	<input type="text" value="20.0"/>
Right axis to cutting area	<input type="text" value="20.0"/>
Left to right max diagonal	<input type="text" value="650.0"/>

Heating	
Max heating %	<input type="text" value="100.0"/>
Apply heating before cutting (sec)	<input type="text" value="5.0"/>
Keep heating after cutting (sec)	<input type="text" value="2.0"/>

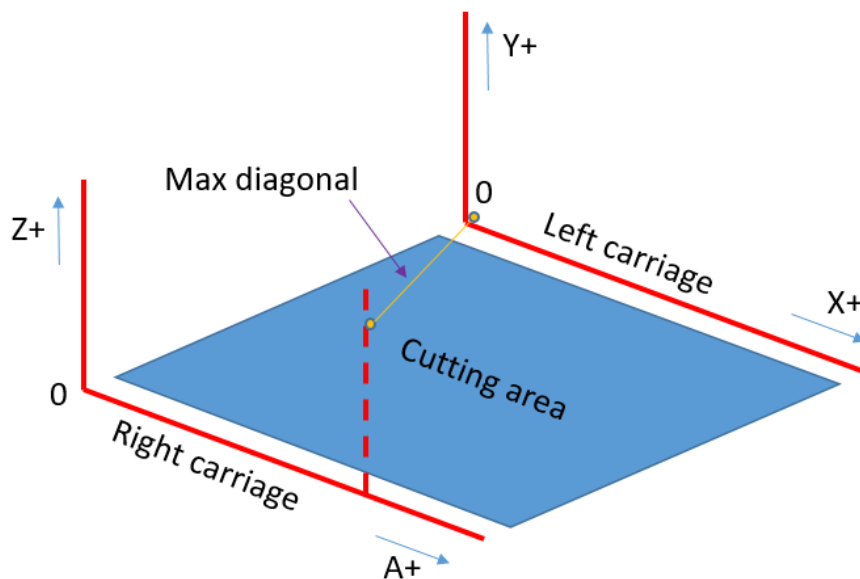
  

GCode	
Start with	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
End with	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
Axis letters	<input type="text" value="XYZ"/>
Heating range	
OFF, S =	<input type="text" value="0"/>
ON 100%, S =	<input type="text" value="1000"/>

All fields as widely self-explanatory...

Note :

- axis distances and limits are measured from hot wire anchor points on axis carriages.
- axis letters are written in the following order : left axis horizontal then vertical, and the same order for right axis.
- start and end GCode are optional, that could be command or comment (in parenthesis : *(this is a comment)* ).
- heat range must be set according to CNC configuration (for hot wire, the range is usually 0-100, 0-255 or 0-1000).



## 2.12 Foam configuration

Hot wire calibration

Wire characteristics
NiCr, 800 mm x 0.3 mm, 24 V

	Nominal	Half	Min	Max
Heating (%)	80.0			
Speed (mm/s)	2.0	1.0	0.5	2.5
Kerf (mm)	0.8	1.5		

To a achieved a perfect result, the hot wire must never come into contact with the foam (which is cut by radiative effect). The width of the cutting groove, called kerf (equivalent to the diameter of the tool in milling) made by the wire in the foam depends of the cutting speed : the slower it is and the thicker it is, and vice versa.

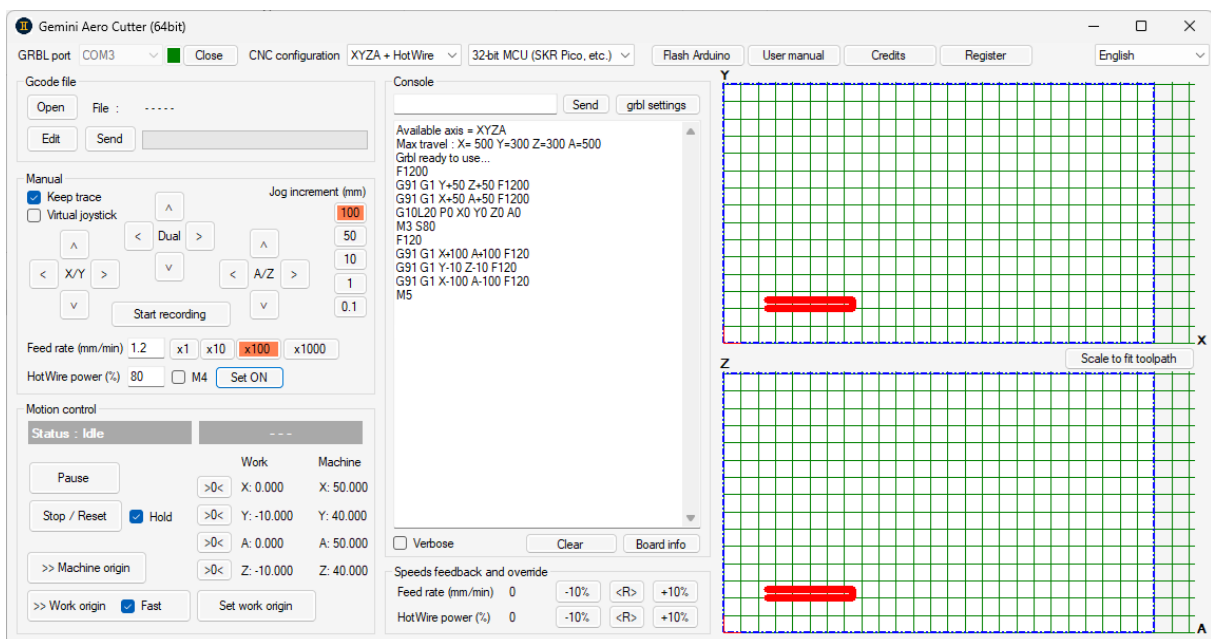
The relation between cutting speed and kerf is established by the hot wire calibration, that has to be done for each foam. Fortunately, this calibration is very easy to do, at the cutting kerf is strickly proportional to cutting speed, so only two points (eq. speed + hot wire power) are necessary to cover all cutting points.

## 2.13 Calibrate the hot wire

Use your favourite CNC driving software to make straight horizontal cuttings (you can use manual jog or a small GCode program).

Warning: make sure to use G93 commands (Gemini Aero Cutter offers this mode for jogging) , so as to have the correct cutting speed (by default, GRBL calculates the vector speed of the 4 axes XYZA, and not on two parallel planes XY and ZA, which distorts the result by a factor of square root of 2).

Here, we have set the working origin at 50 mm vertical and 50 mm horizontal from CNC origin, to position the wire just in front of the foam block to cut. The hot wire power is set at S = 80 (on a range 0-100), then the wire moves 100 mm forward from working origin to cut foam at 2 mm/s (120 mm/min), then moves down 10 mm and finally cut downward at the same speed :



Step 1, find the nominal speed and heating :

- put a foam block (minimum 60 mm width and 60 mm length to avoid any side effects) on the

machine table, with nothing to stop the block from moving (e.g. no weight placed on it).

- choose an arbitrary cutting speed : typically 2 mm/s for extruded EPS foam and 4 mm/s for expanded white polystyrene.
- make some straight horizontal cuts (vertically spaced by 10 mm) with different % heating (set by S value) from high to low (for example 100%, 90%, 80%, etc.) until getting the smaller kerf possible without the foam block being dragged by the wire.
- If the result is not perfect, change the speed (by + or - 0.5 mm/s) and do the same heating test.
- when you find a perfect result on the foam (smooth surface, without angel hair or residual filaments, nor burnt spots, etc.), you have found the nominal speed and heating value (for this foam... not every foam !).

Step 2, measure the kerfs :

- at nominal cutting speed and heating (those found in step 1), make two straight parallel cuts spaced by 10 mm
- measure precisely the resulting thickness (d1) with a caliper :  $\text{kerf} (@V) = 10 - d1$ .
- do the same at half speed and note the resulting thickness (d2) :  $\text{kerf} (@V/2) = 10 - d2$ .

For example, we respectively measure 9.2 and 8.5 mm, so the kerf is 0.8 mm (= 10 - 9.2) at nominal speed, and 1.5 mm (= 10 - 8.5) at half speed.

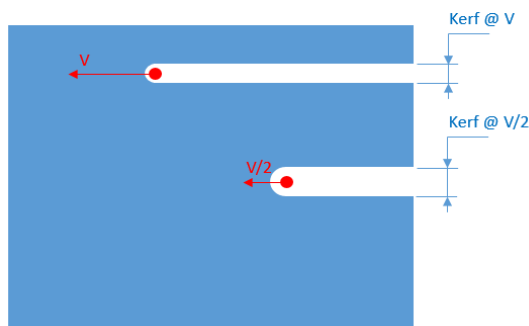
Step 3, find min and max speeds :

- at nominal heating, make some cuttings at low speeds to find the minimal speed that gives a correct result (lower will burn the foam, for ex.).
- do the same to find the maximum speed (that gives angel hair or make the wire touch and drag the foam block)

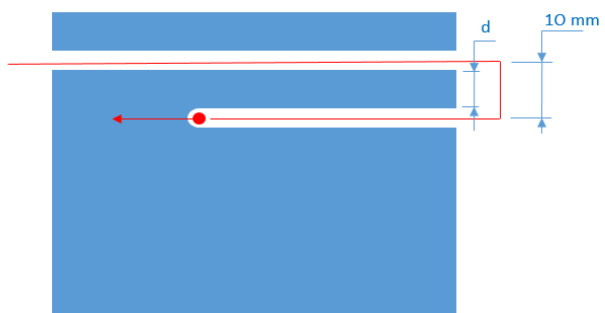
Step4, input the values in G.A.F. :

- wire characteristics (not used, for information)
- heating
- nominal speed
- min and max speeds allowed
- kerf at nominal speed and kerf at half nominal speed

Wire characteristics	NiCr, 800 mm x 0.3 mm, 24 V			
	Nominal	Half	Min	Max
Heating (%)	80.0			
Speed (mm/s)	2.0	1.0	0.5	2.5
Kerf (mm)	0.8	1.5		



*Kerf versus speed*



*Cutting for calibration*

Note :

When generating the GCode, it is highly recommended to use the nominal speed and heating defined here. But if, for some reasons, you use another speed, the cutting offset will be recalculated in consequence. You can also use another % heating, but the cutting offset will not be recalculated.

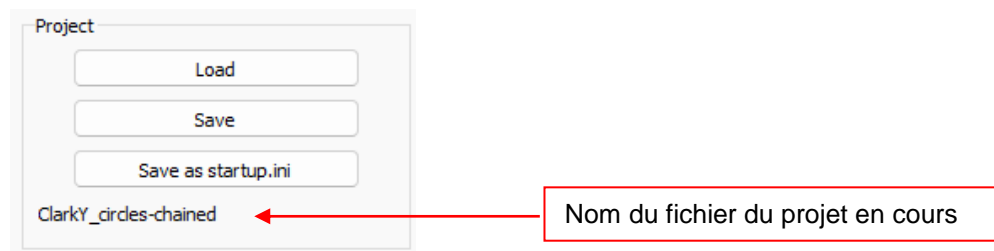
### 3 Using Gemini Aero Foam

#### 3.1 Projects



Projects contain all the data necessary for cutting a part (wing panel, etc.) :

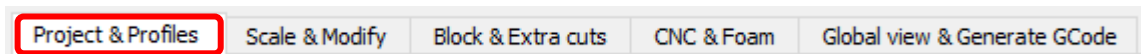
- root profile
- tip profile
- synchronization points
- dimensions: profiles, foam block, etc.
- CNC parameters
- foam parameters to be cut



The project management menu allows you to load and save a project. There is no function to create a new project; to do so, you simply modify the project data.

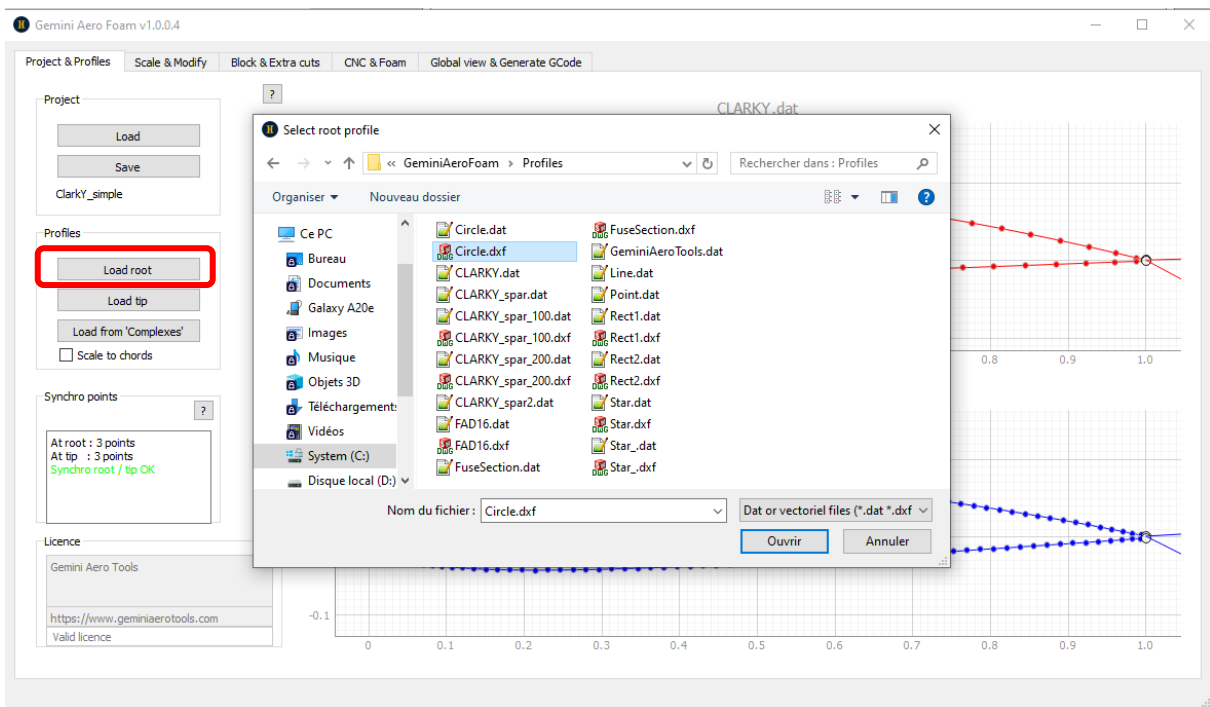
You can also save the current project in the "startup.ini" file, which is automatically loaded when the application starts. This allows, for example, the CNC and foam parameters to be already loaded when modifying the data to create a new project.

## 3.2 Profiles

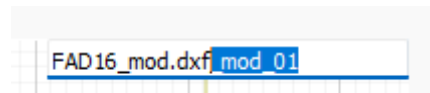


### 3.2.1 Load profiles

By default, G.A.F. load profiles from the **Profiles** folder. It can open Selig .dat files as well as vectoriel files like .dxf or .plt.

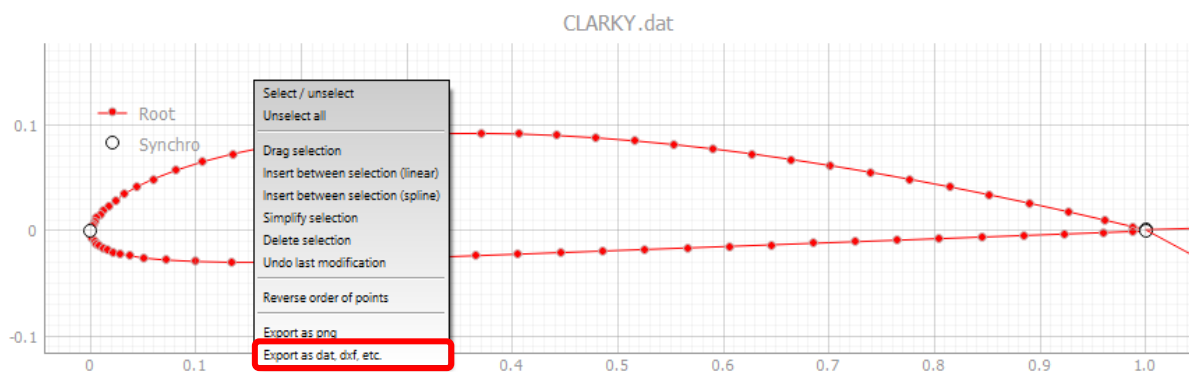


The name of each the profile is editable and can be modified :

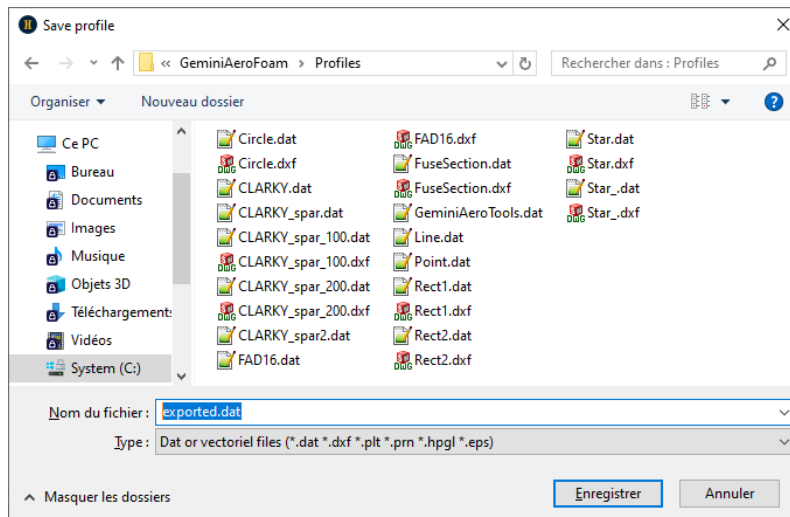


### 3.2.2 Export profiles

After loading or modifying a profile, it is possible to export it in .dat or .dxf file :



Write the name of the exported profile (with the desired extension for the format), then click on the save button.



In the same way, you can also save the whole plot in a .png image.

### 3.2.3 Profiles synchronization

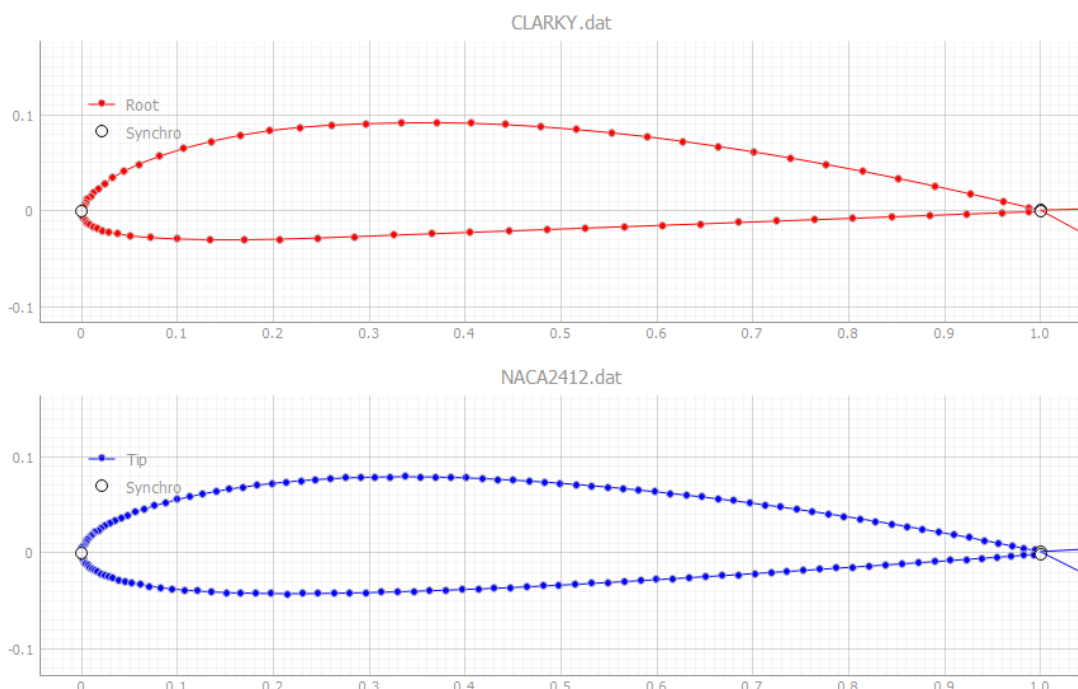
As they do not necessarily have the same number or the same distribution of points, root and tip profiles must be synchronised, so that the hot wire will follow the correct trajectory simultaneously on both sides.

The profile synchronization is done by synchro points, that :

- synchronise the movements of left and right axis
- allow to recalculate kerf on each toolpath portions (delimited by two synchro points) on left and right profiles

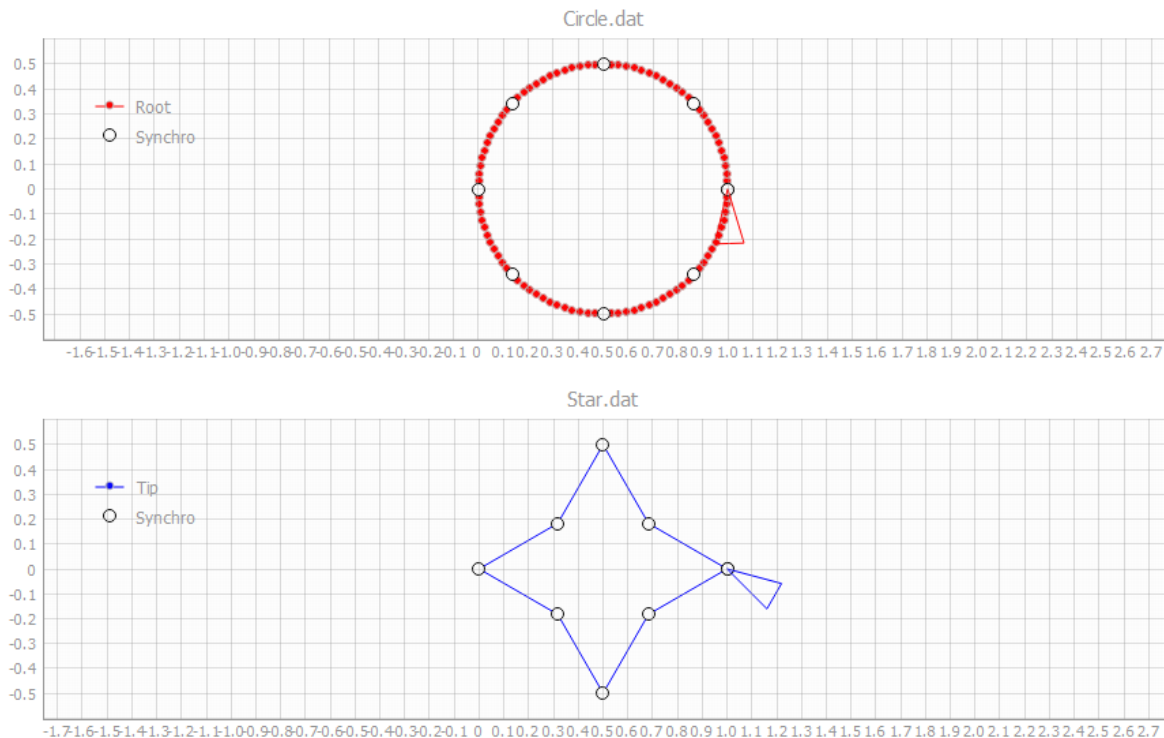
On loading or modifying a profile, G.A.F. detect automatically leading and trailing edges points on root and tip profiles and set them as synchro points :

- one at trailing edge on upper side (wire entry, not modifiable)
- one at leading edge (modifiable)
- one at trailing edge on lower side (wire exit, not modifiable)



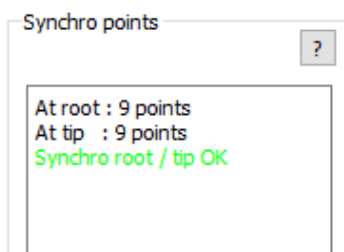
For standard profiles (e.g. wing section), these points are generally sufficient to have a correct result.

For complex profiles (e.g. fuses or wing section with spar) or with very different profiles at root and tip, it is usually required to add additional synchronization points to force the wire to pass at precise locations simultaneously (for example, a corner of the entry of a hole or a major changes of direction).



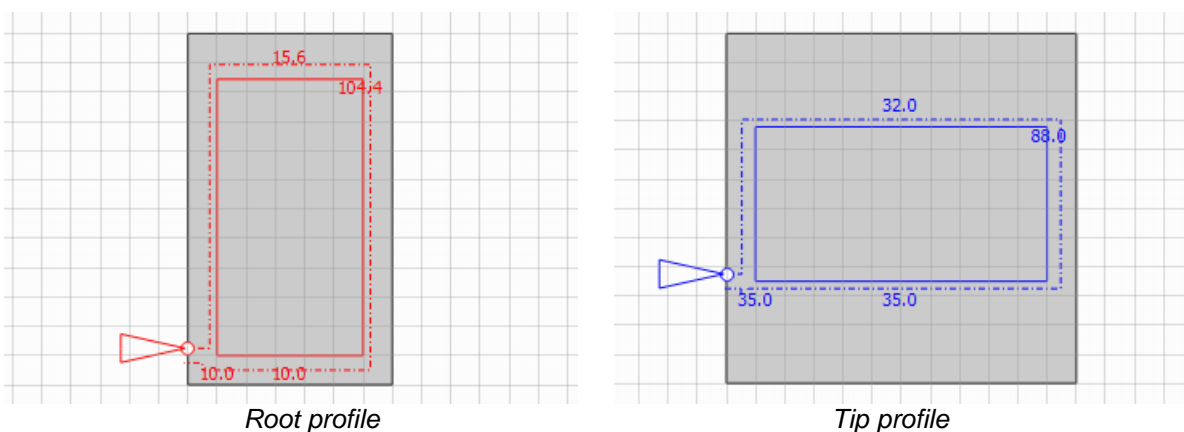
To add/remove synchro point(s), simply click (left button) on the point(s) in the plot.

The number of points must be equal between root and tip :



**Synchro points are fundamental to achieve a good result**, as the length of the synchronized portions can be alternatively greater or lower on root and tip profile, so the kerf must be recalculated for each portion and side according to the local cutting speed.

We can see it clearly on this example, where the speed and the kerf change alternately at each segment of the rectangles :





That's why Gemini Aero Foam use :

- **G93 feedrate** : each motion command include the time in milliseconds to reach next point, instead of the speed of the main axis (that can be alternatively left or right axis)
- **adaptive kerf calculations** : each segment is offseted according to the local speed (so the offset can be different between each segment and between left and right axis)

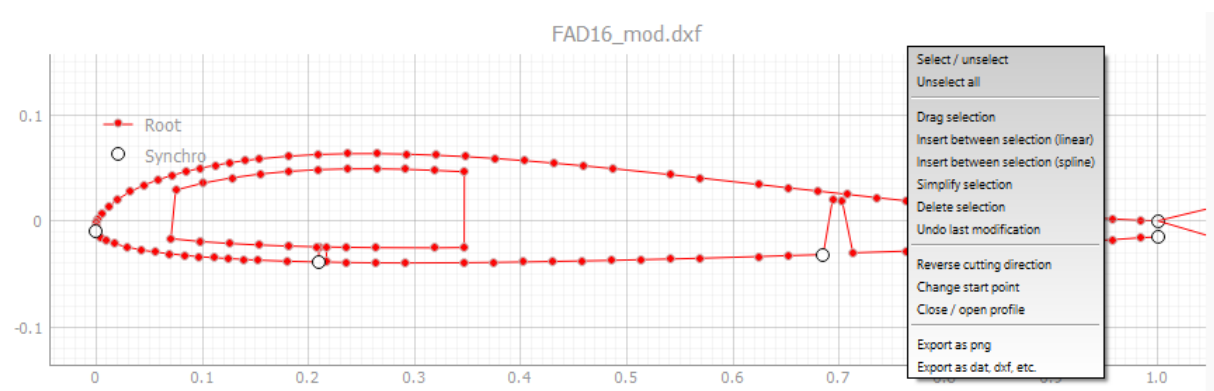
The result can be verified graphically and with the integrated simulator :

- the 2D plots in the "Block & Extra cuts" tab, that will show the wire trajectory on the two profiles.
- the 2D plot and the 3D view in the "Global view" tab, that will show to entire wire trajectory and the resulting surface.

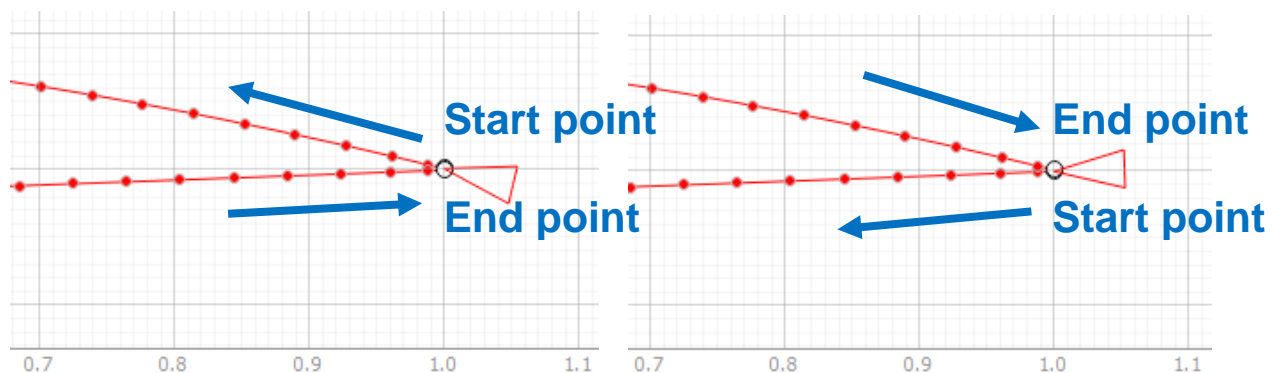
Note : synchro points are not used with Delta Rotation, please see §3.4.5.

### 3.2.4 Modify profiles

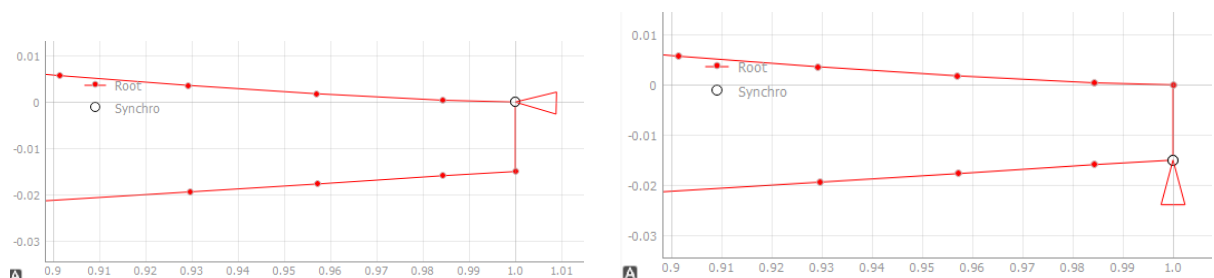
Since release 1.0.0.4, G.A.F. offer a point(s) modification tool, via the right click contextual menu.



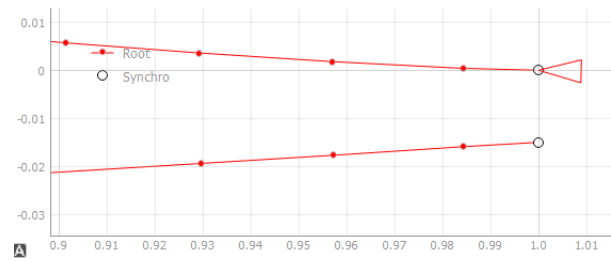
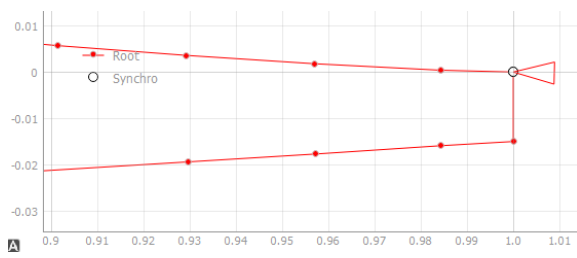
Reverse order of points (to cut an interior profile or reorder an inverted profile) :



Change starting point :



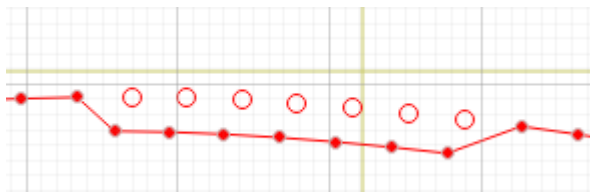
Open / close profile :



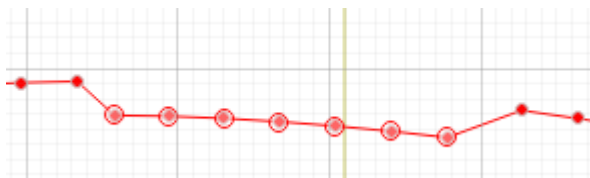
Add a slot for a 29x2 mm balsa reinforcement (functions used : select points, insert linear between selection and drag selection) :



Select points



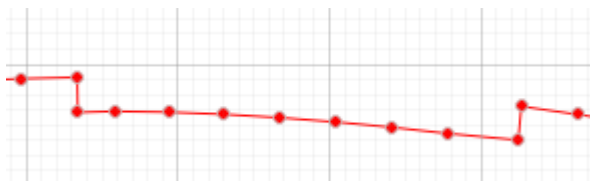
During drag



Drag selection done

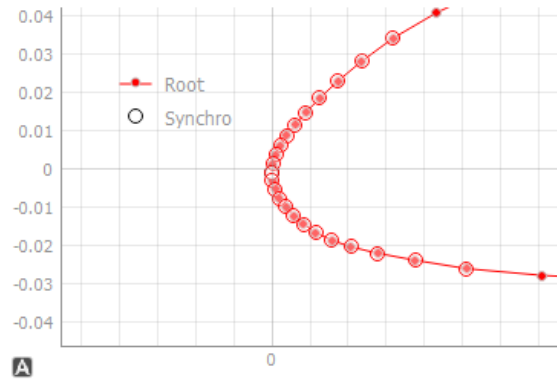
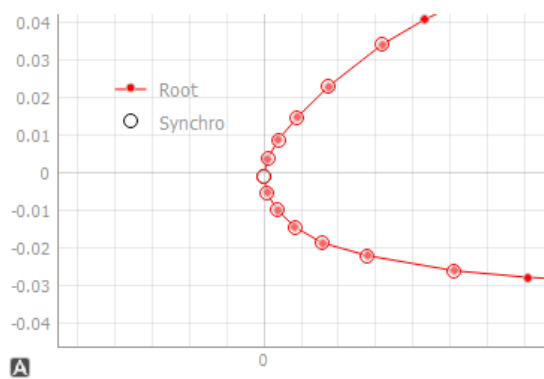


Add one new point at egde (then drag it)

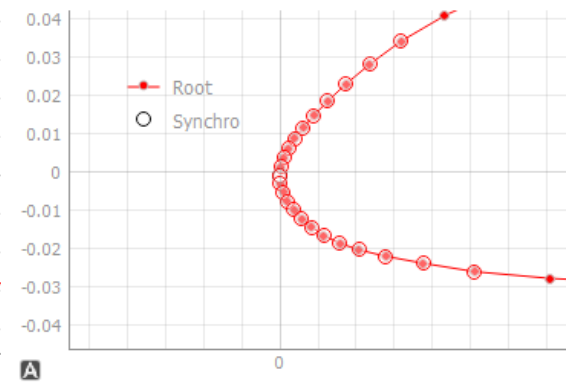
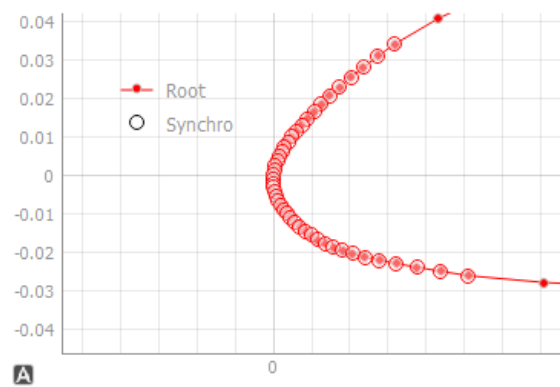


Final result

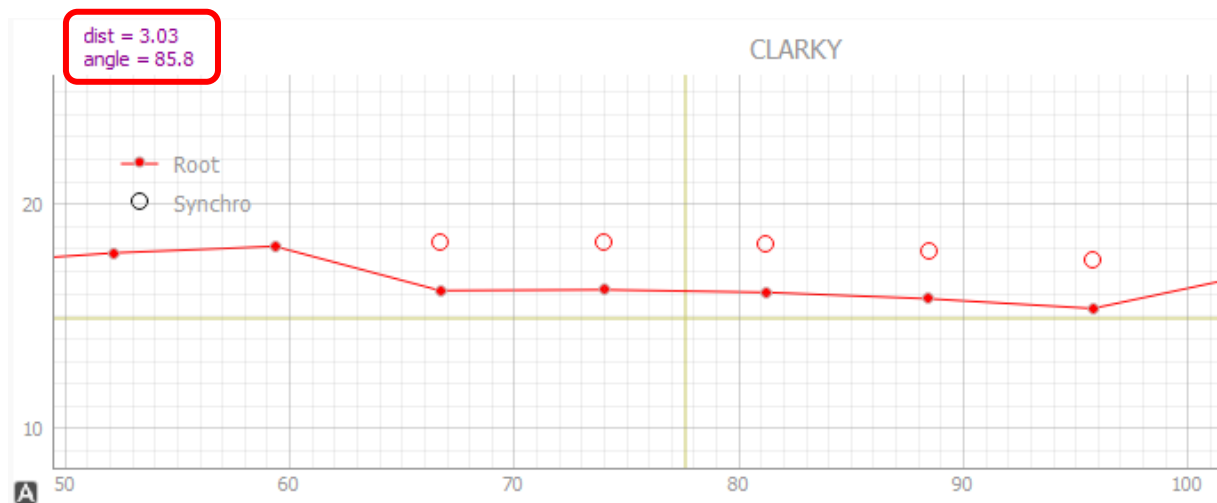
Refine a section (function used : insert spline, to smoothly follow the curvature) :



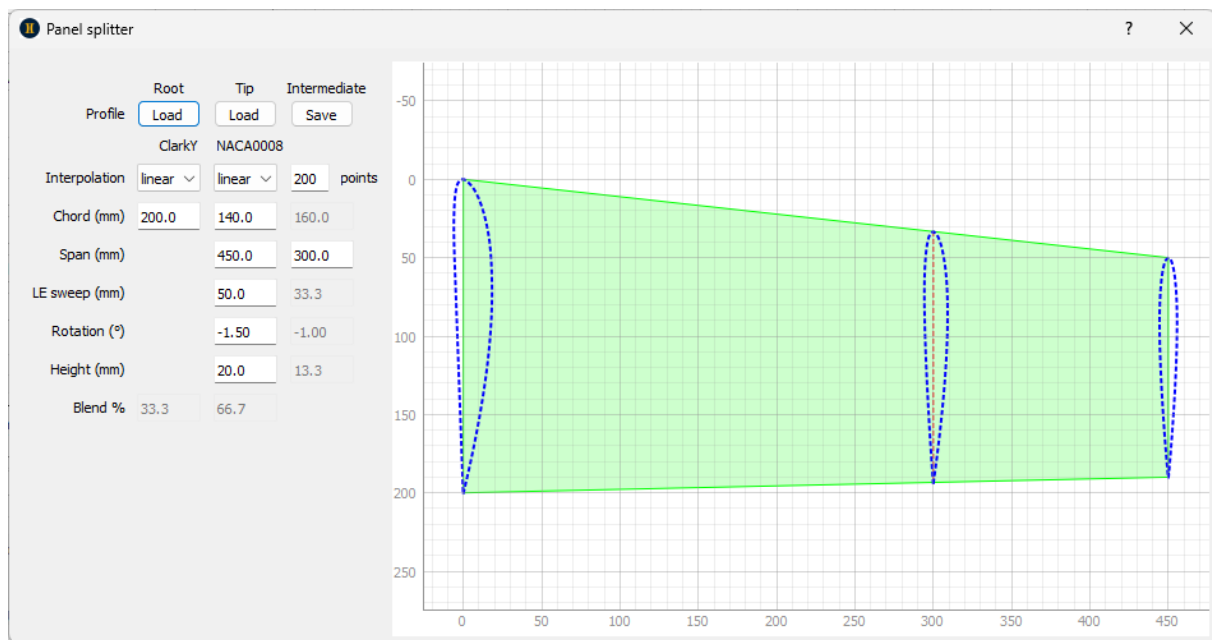
Simplify a selection (delete one point of two) :



Note : during a drag, G.A.F. show the distance and angle of drag direction instead of the current coordinates of the cross.



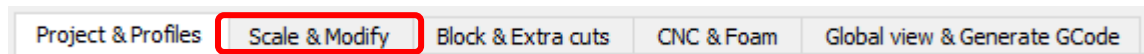
### 3.2.5 Split a panel and blend the two profiles



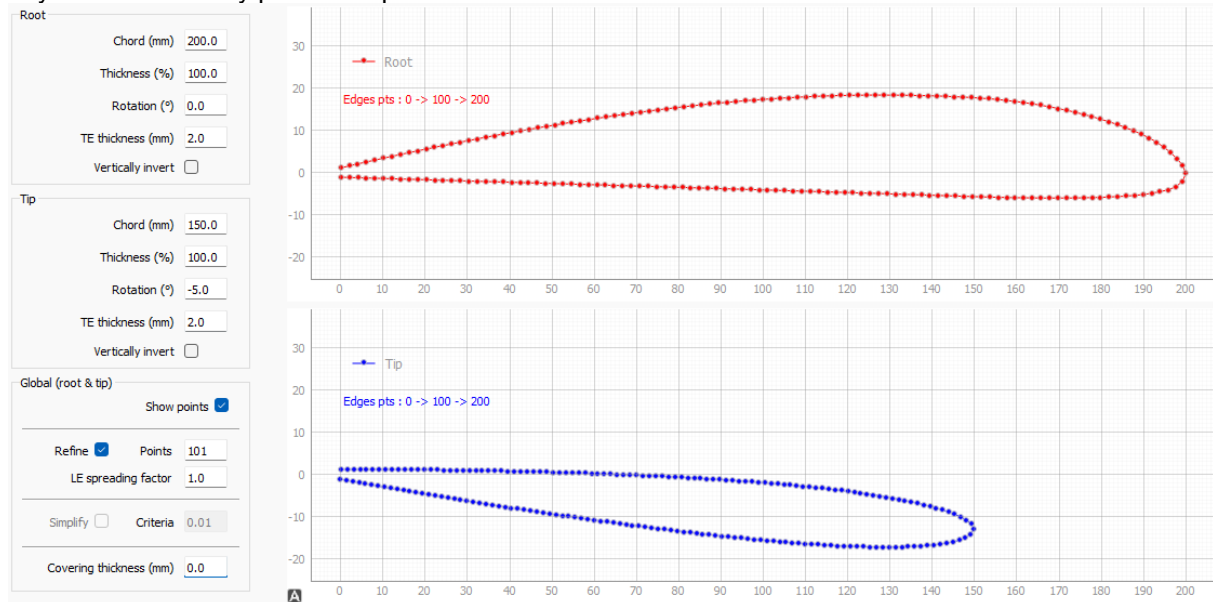
This tool allows you to split a panel too long to be cut in one piece into two sections. All intermediate data (twist, dihedral, camber, chord) and profile are calculated based on the position of the split line.

Note that the values, as in the rest of the application, can be modified using the mouse scroll wheel (press the "ctrl" key) for quick scrolling.

### 3.3 Scale and modify



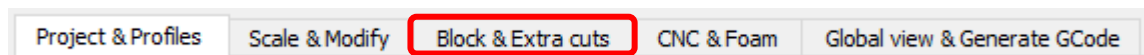
In this tab, the dimensions of the root and tip profiles are defined dynamically and can be changed at any time without any point manipulations.



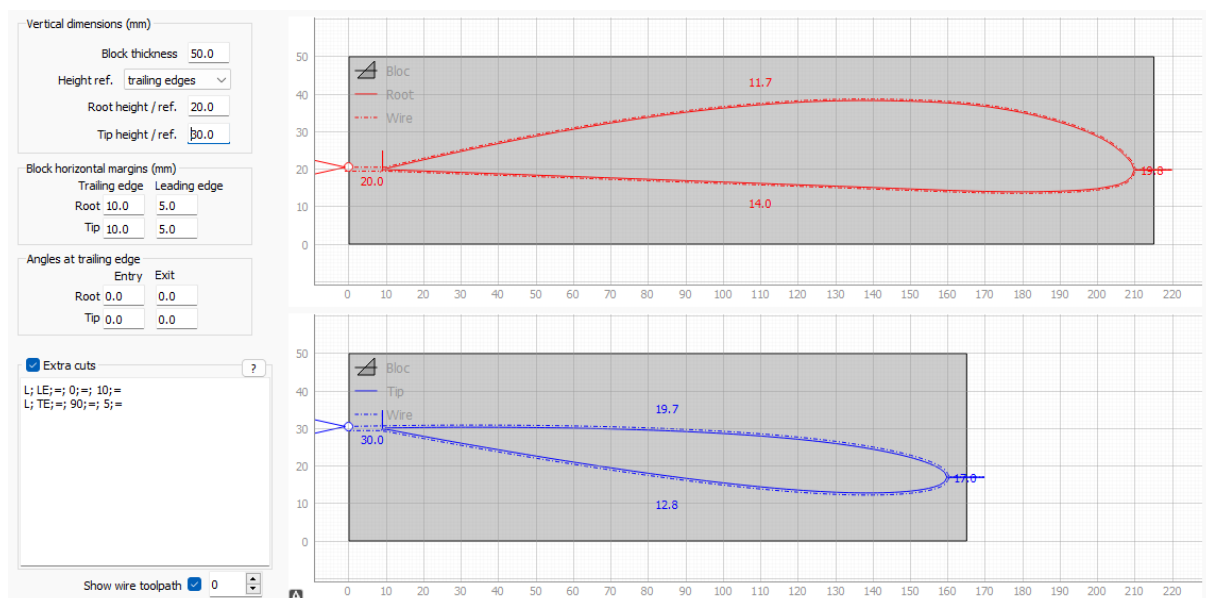
#### Note :

The additional synchro points are usually lost when using covering, as it changes the number of points of profiles.

### 3.4 Block and extra cuts



#### 3.4.1 Block



The dimensions of the block foam and the profiles positions in the block are set here. The wire trajectory is shown (with the kerf offset calculated with the foam configuration).

Default entry and exit angles are generally 0°. Some complex cutting can give strange trajectory of the wire at entry or exit, and setting angles different from 0 can help to achieve a correct result.

### 3.4.2 *Extra Cuts*

"Extra cuts" is a powerful function to add complex additional cuttings, by a simple line by line syntactic editor (use 'enter' key to end a line).

All forms start at a given insertion point, that can be different between root and tip, an return to this point before continuing the profile. The wire will follow a junction line to enter the form, then use kerf offset inside entities to achieve to specified dimensions. The junction line can be positive, zero or negative, to allows any forms like cutting spars, slot, articulations, etc., without worrying about the imprint of the form in the skin of the remains.

"Extra cuts" commands are executed form end to start of the list, so be careful of the order of the insertion points (this method allows to chain forms, see below).

Typical commands :

(This line is a comment)

S; 70 ;70

L; TE;=; 90;=; 5;=

R; 70;=; -90;=; 5;=; 10;=; 5;=

C; 70;=; -90;=; 5;=; 10;=

D; 70;=; -90;=; 5;=; 10;=

T; 70;=; -90;=; 5;=; 10;=; 10;=

X; LE;=; 0;=; 0;=; 8;=; 1;=; 8;=; 2;=; 10;=

E; TE;=; 10;=; 100;=; -200;=

Syntax of a line :

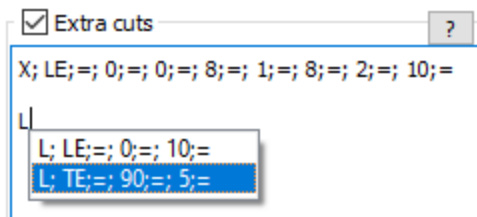
- Separator = ';' , space(s) can be used for readability
- First letter = command key (capital letter, see 'Command key' list), any other character (like '(') will cause the line to be considered as a comment
- First pair after key = insertion points at root and tip
- Second pair = angle (in degrees) of form relative to the horizontal (trigonometric sense : + = upwards, - = downwards)
- Third pair = line insertion length
- Other pairs = form dimensions (diameter, width, height, etc.) at root and tip, please test to see effect

A line can be empty (just press the enter key) to improve readability.

Command keys :

- S = Synchro (convenient for delta rotation, see example project "Rudder\_RotatedSynchro")
- L = Line
- R = Rectangular
- C = Circle
- D = Diamond
- T = Triangle
- X = complex (can be used for the leading edge, or inside the profile for a recess)
- E = Exit (to use only with open profiles that have no return to origin, like letters made by Complexes)

Writing a command key on the editor will propose some example lines, select the appropriate one then press 'enter' on the keyboard to insert the line in the editor. Then you can modify it according to your needs.



Insertion point can be :

- the number of the point on the profile : so it is very useful to use 101 points between synchro points with standard airfoil profiles (that have synchro points at trailing and leading edges), so the upper side points are 0 (trailing edge) to 100 (leading edge) and the lower side points are 101 (next point after leading edge) to 200 (trailing edge)
- LE = find automatically leading edge point
- TE = find automatically trailing edge point (at lower side)

The '=' symbol :

It is used to apply to the tip the values (insertion point, angle, dimension) specified at the root.

Using a form chained to another form :

As each form add points to the profiles (a line add 2 points, etc.), commands can be chained by using insertion point(s) that precede next point (in the sens of reading, end to start of command list).

Example :

C; 137;=; 180;=; 5;=; 10;=

C; 118;=; 90;=; 7;3; 10;=

Interpretation : first entity is applied at point 118. As this entity add 26 points (24 for circle and 2 for junction line), the second circle at point 137 is applied 19 points after starting of first circle, so at 3/4 of the first circle. For the 1/4 we will use 125 (= 118 + 7), and for half 131 (= 118 + 13).

Other example, in project file « ClarkY\_full\_addons.txt » :

X; LE;=; 0;=; 0;=; 8;=; 1;=; 8;=; 2;=; 10;=

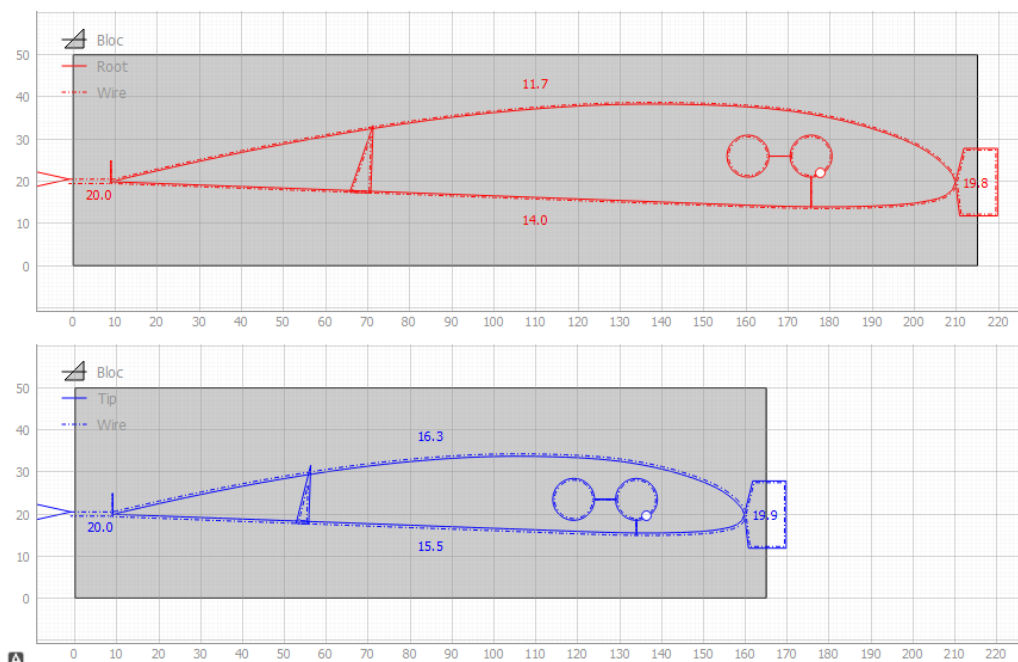
C; 137;=; 180;=; 5;=; 10;=

C; 118;=; 90;=; 7;3; 10;=

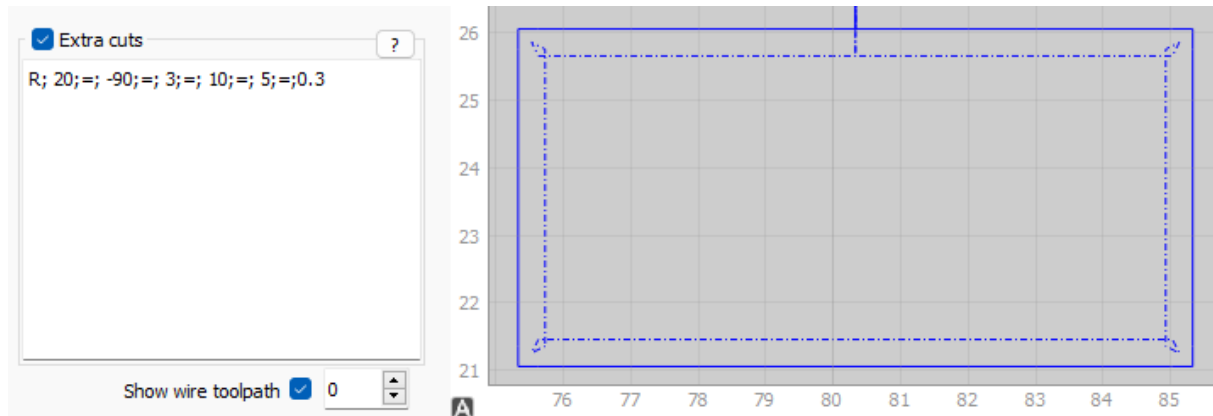
T; 170;=; 133;=; -0.55;-0.8; 16;14; 5;3

L; TE;=; 90;=; 5;=

This include a leading edge X cutting, a trailing edge vertical cutting, an aileron slot and two chained holes for cylindrical spars.



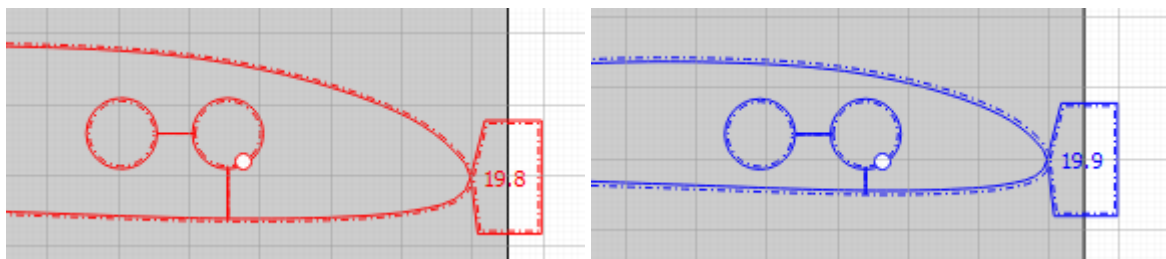
In the case of "D" and "R" commands, it is possible to stitch the corners (to facilitate the insertion of a spar, for example) by adding a staking radius (in mm) :



### 3.4.3 Simulator

Show wire toolpath ☒

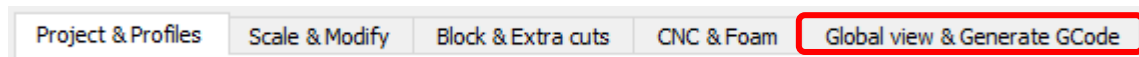
The simulated point can be set manually with keyboard, or can be scrolled by the scroll of mouse or clicking the two little arrows.



The same function exists in global view (see next tab).



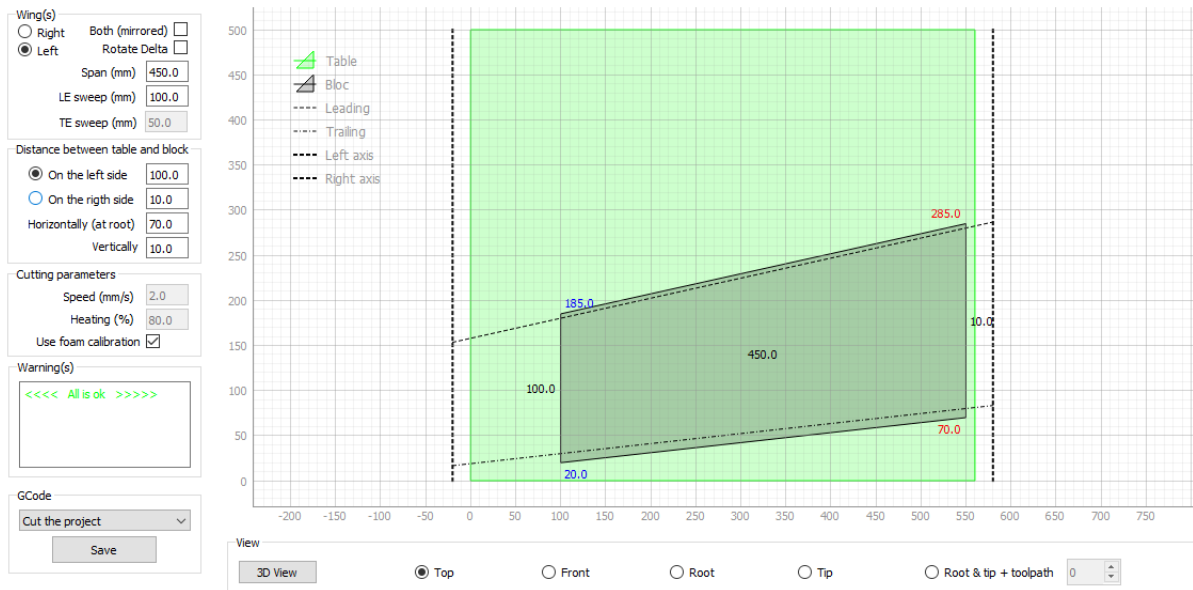
### 3.5 Global view and generate GCode



This tab show the finished foam part (with its top view dimensions) and the block.

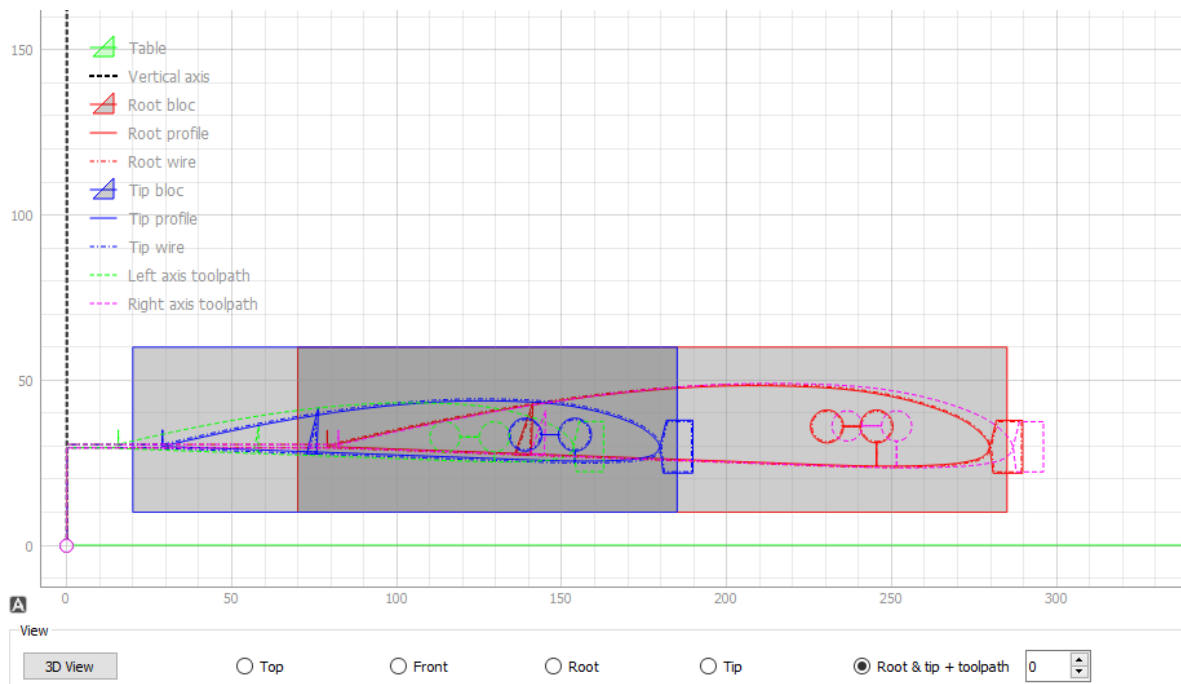
This is where you enter the length of the part (span for a wing) and its sweep.

#### 3.5.1 Top view

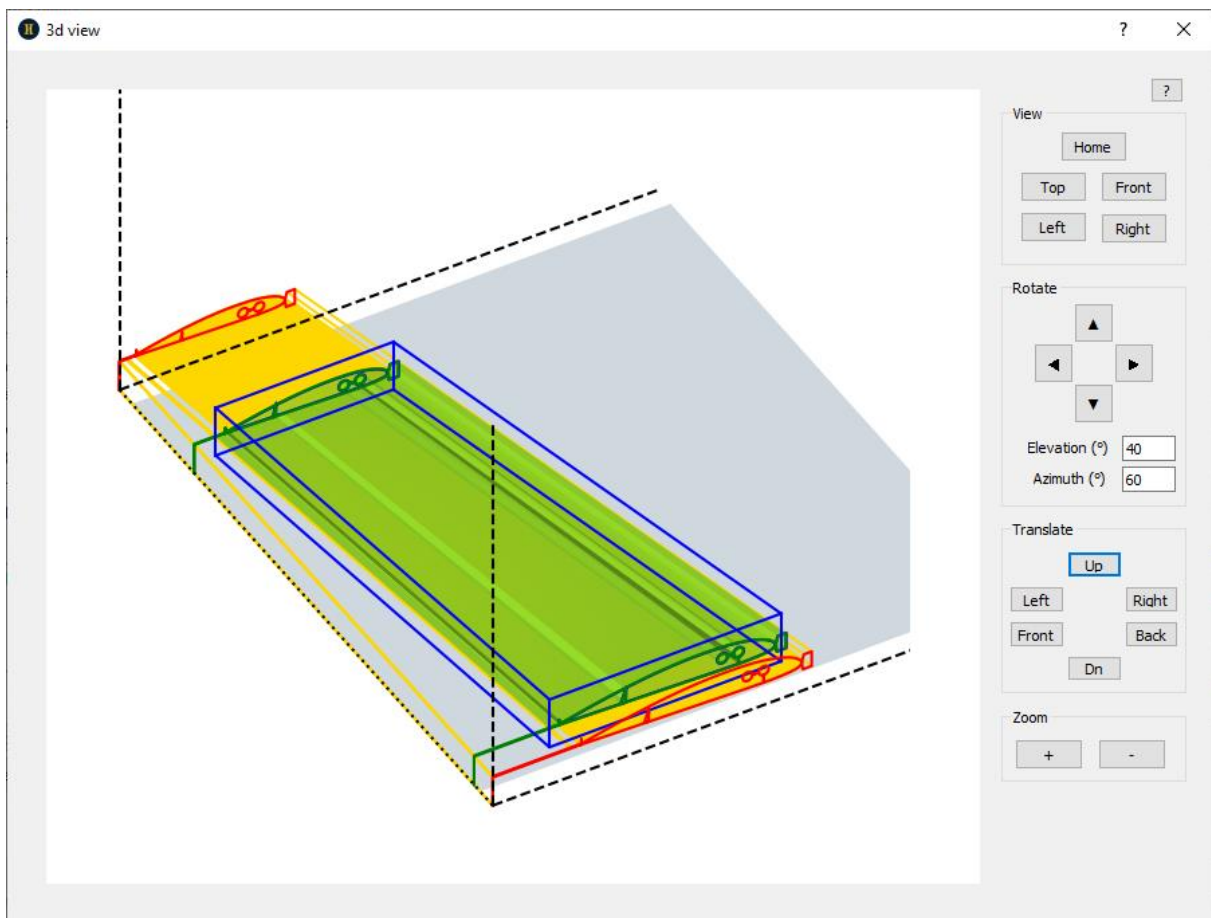


The "Warning" area indicates any impossibilities, such as a part protruding from the cutting table, a carriage path outside the axis limits, or a local speed greater than the maximum allowed speed.

#### 3.5.2 Right view



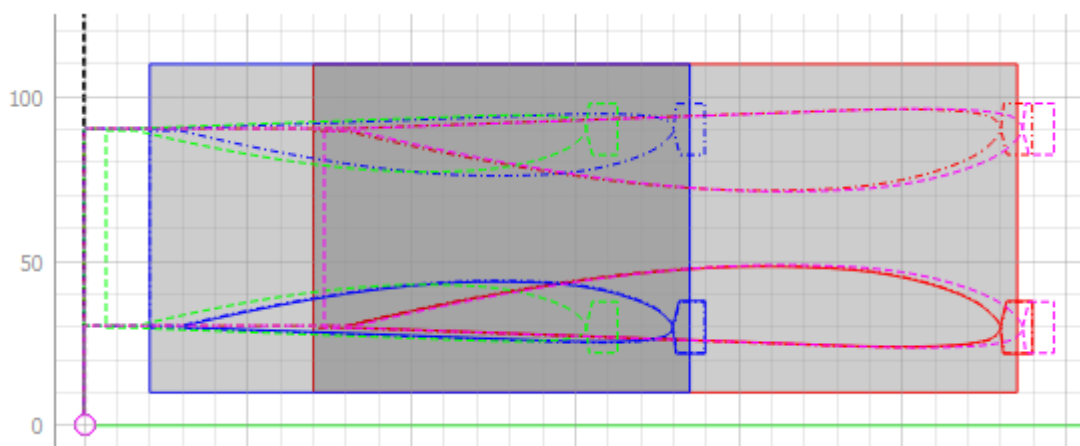
### 3.5.3 3D view



The view can be centered, move or zoomed with mouse or the buttons.

### 3.5.4 Mirrored wings

Both (mirrored) ☒



This functions allows to cut simultaneously the left and right wings of a plane.

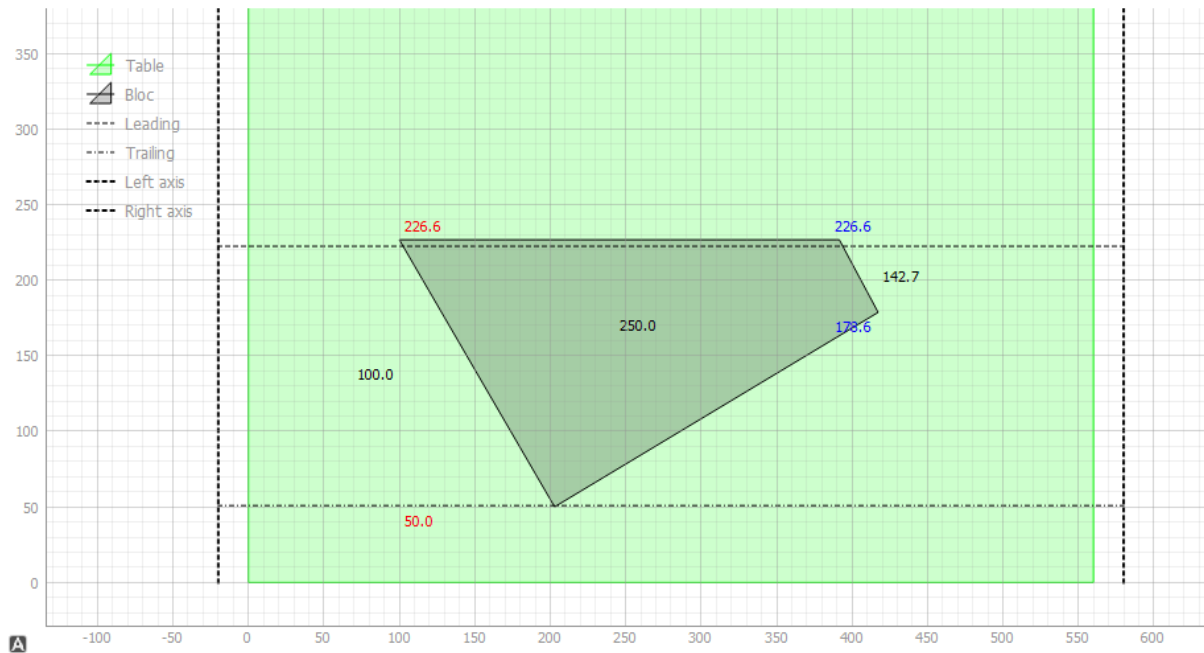
### 3.5.5 Rotated delta wings

Rotate Delta ☒

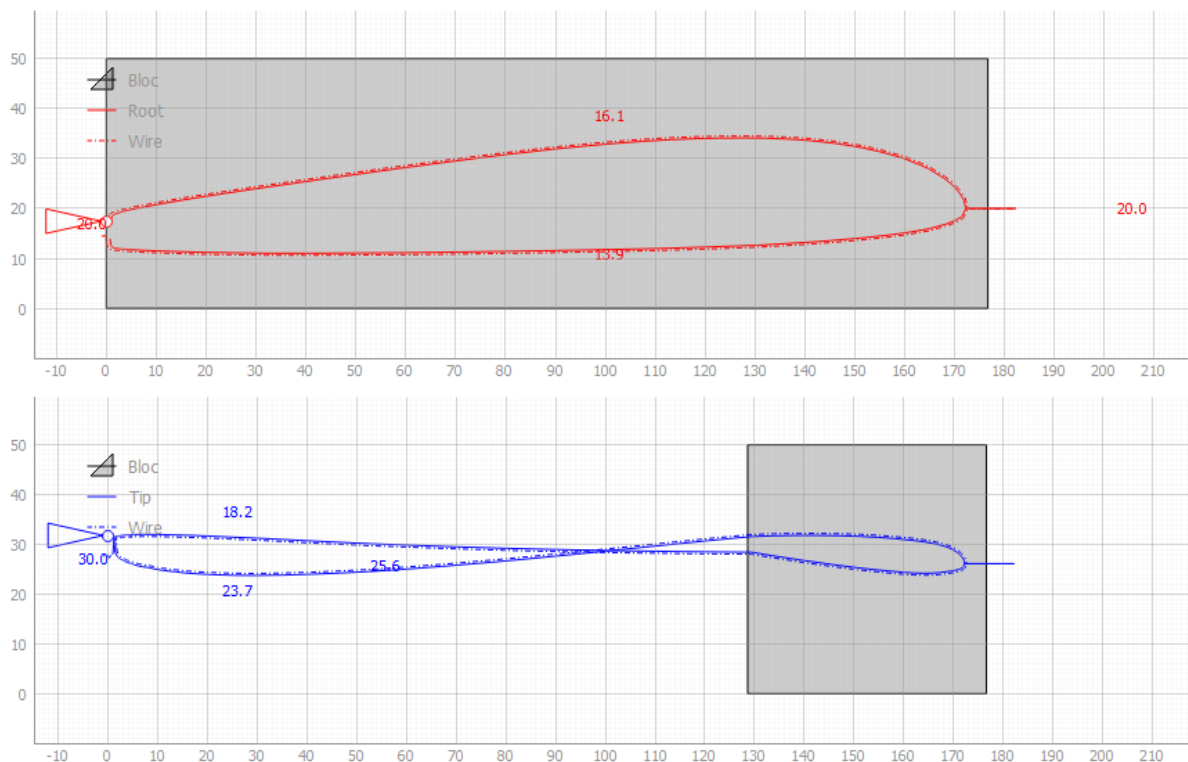
This function allows to cut high tapered and low aspect ratio wings, that are not manufacturable by a classic cut (the tip will be burnt because of the very low speed in this area).

The principle consists of moving the hot wire parallel to the leading edge, following a projection of the profiles, so as to have a similar advance speed between root and tip.

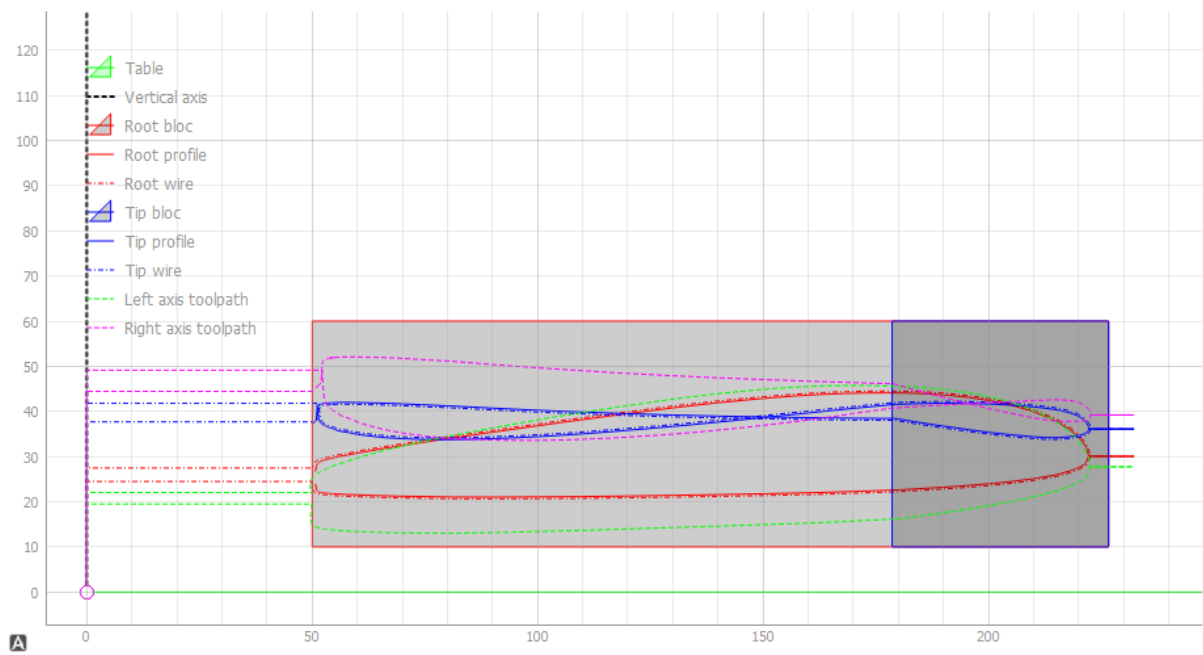
Top view of the rotated wing :



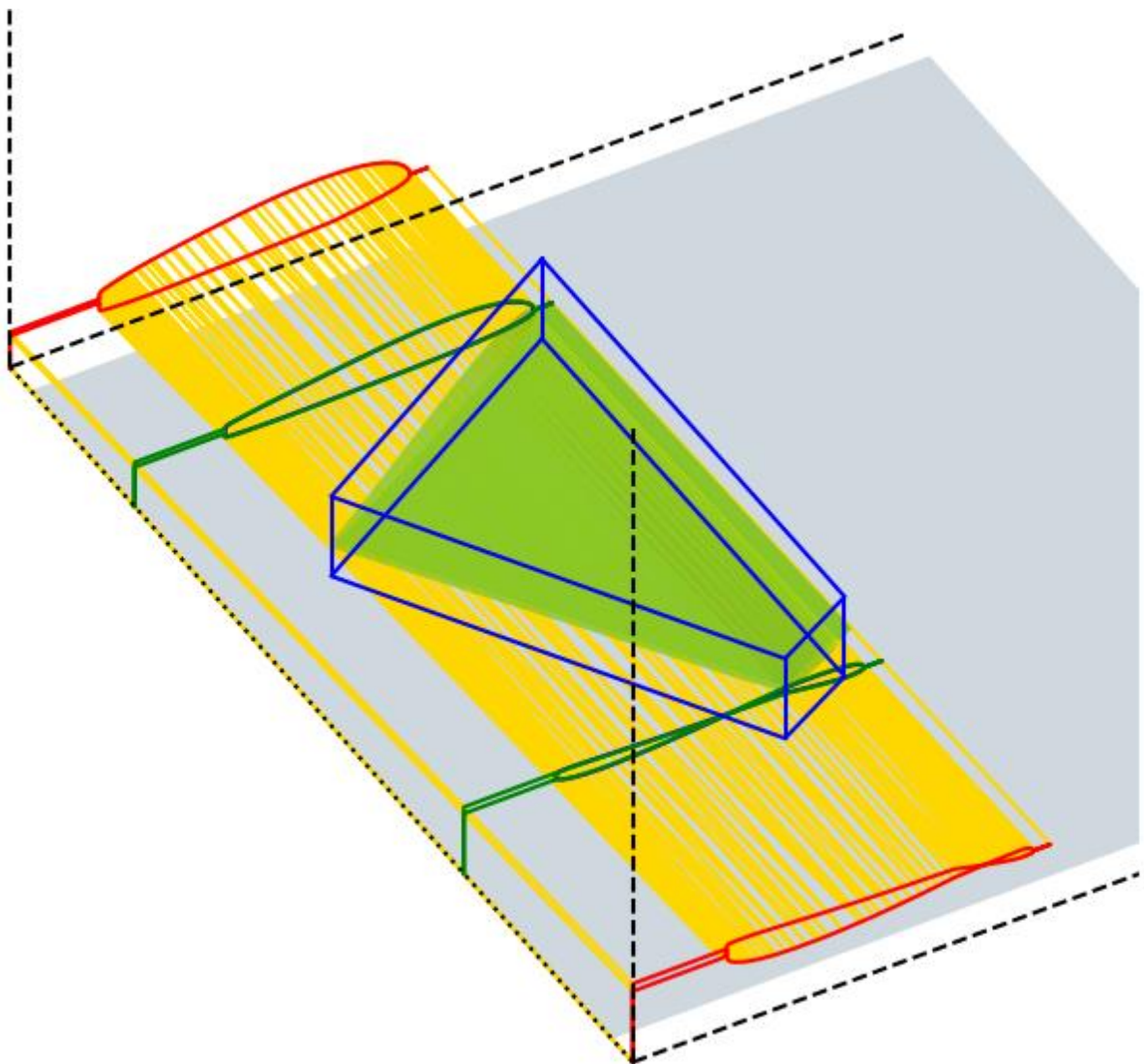
Projected profiles on the foam block :



Hot wire toolpath on the CNC machine :



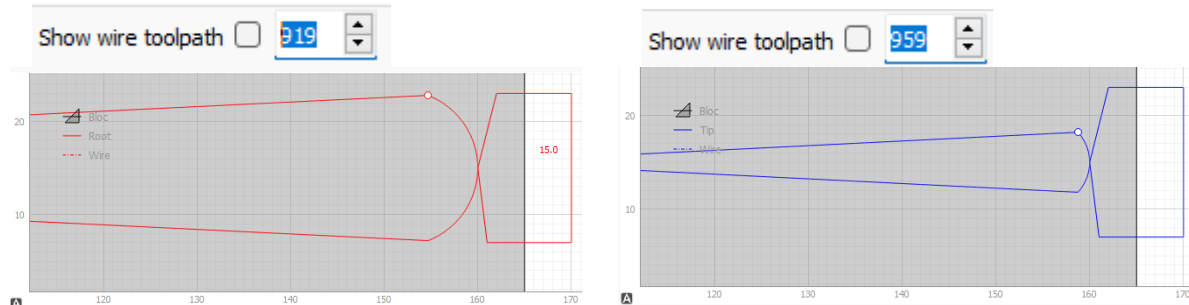
3D view the toolpath :



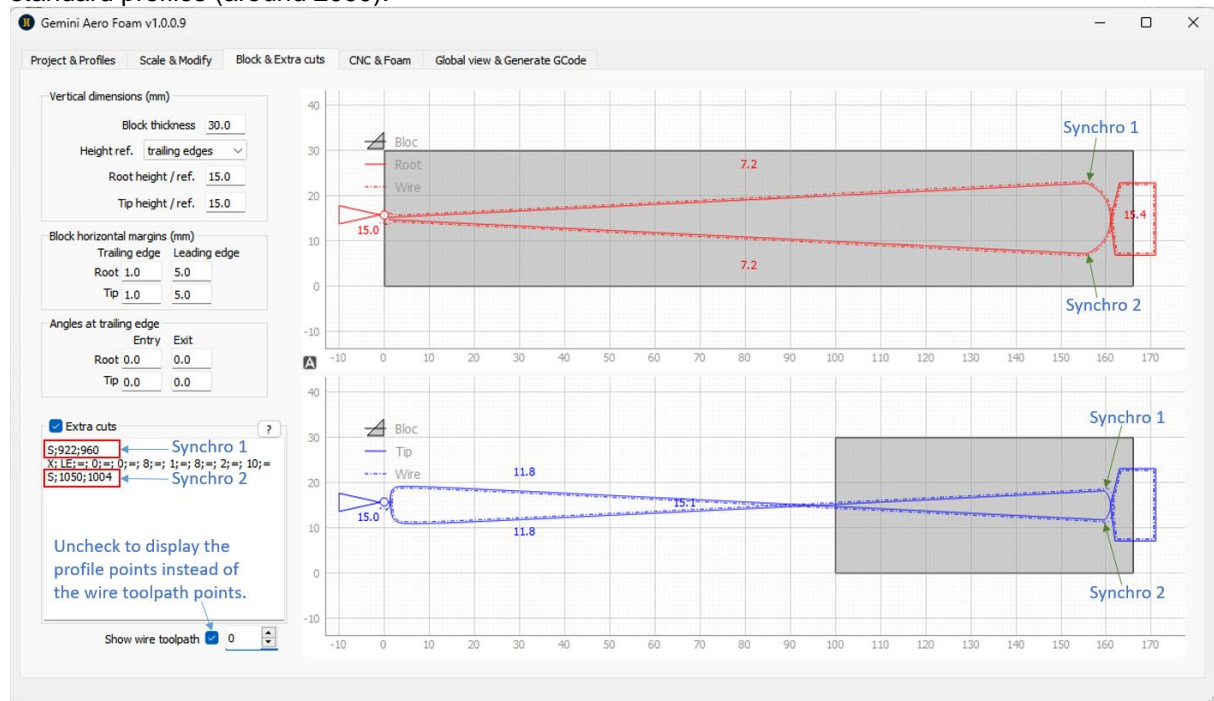
**Note :**

Due to its operation mode (wire always parallel to leading edge), Delta wing rotation cannot cut profiles with, for example, integrated spars.

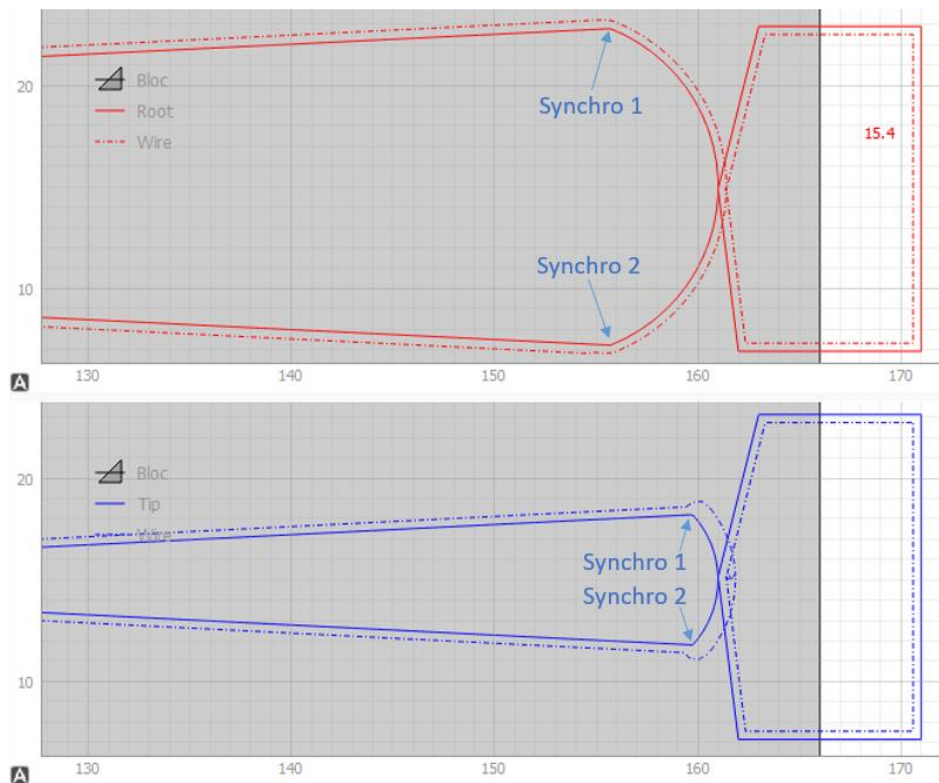
Traditional synchro points are not used but, if you need to synchronize some points with delta rotation, you can add synchro with the extra-cutting feature. To help you choosing the appropriate insertion points, uncheck "Show wire toolpath" then scroll the point on the profile to find its number :



It should be noted that the profiles generated by the "delta rotation" contain many more points than standard profiles (around 2000).



Now the leading edge of this rudder is perfectly synchronized :



One can also notice the significantly larger offset of the wire at the leading edge of the wingtip, due to the shorter path length compared to the wing root.

### 3.5.6 Spar alone

GCode

Cut only a spar/slot

Save

This function allows to cut a simple shape (line, slot, spar, aileron hinge, etc.) apart the profile project, for example on an already cut wing. The shape can be of constant or evolving section.

The syntax is the same as with the "Extra Cuts" on profiles, but without the point insertion.

#### Syntax of a line :

- Separator = ';', space(s) can be use for readability
- First letter = command key (capital letter, see 'Command key' list)
- First pair after key = angle (in degrees) of form relative to the horizontal (trigonometric sense : + = upwards, - = downwards)
- Second pair = line insertion length
- Other pairs = form dimensions (diameter, width, heigth, etc.) at root and tip, please test to see effect...

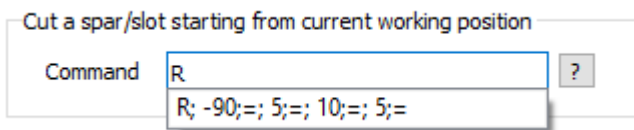
#### Command keys :

- L = Line
- R = Rectangular
- C = Circle
- D = Diamond
- T = Triangle



### The '=' symbol :

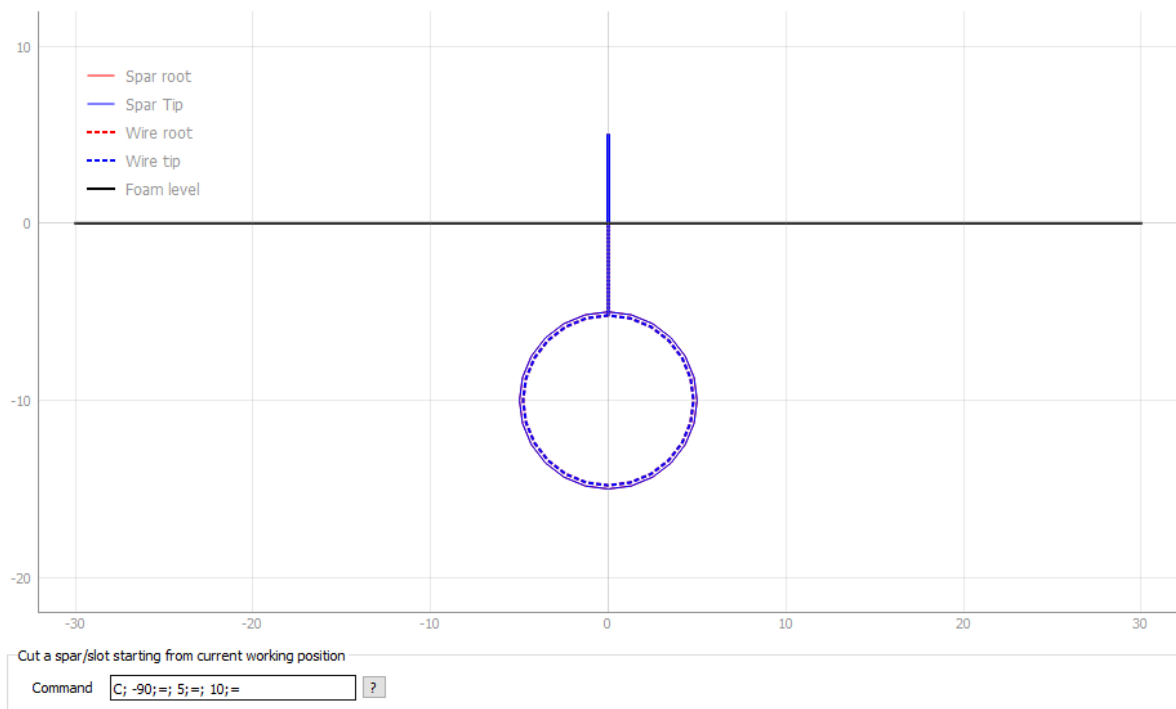
It is used to apply to the tip the value (insertion point, angle, dimension) specified at the root.

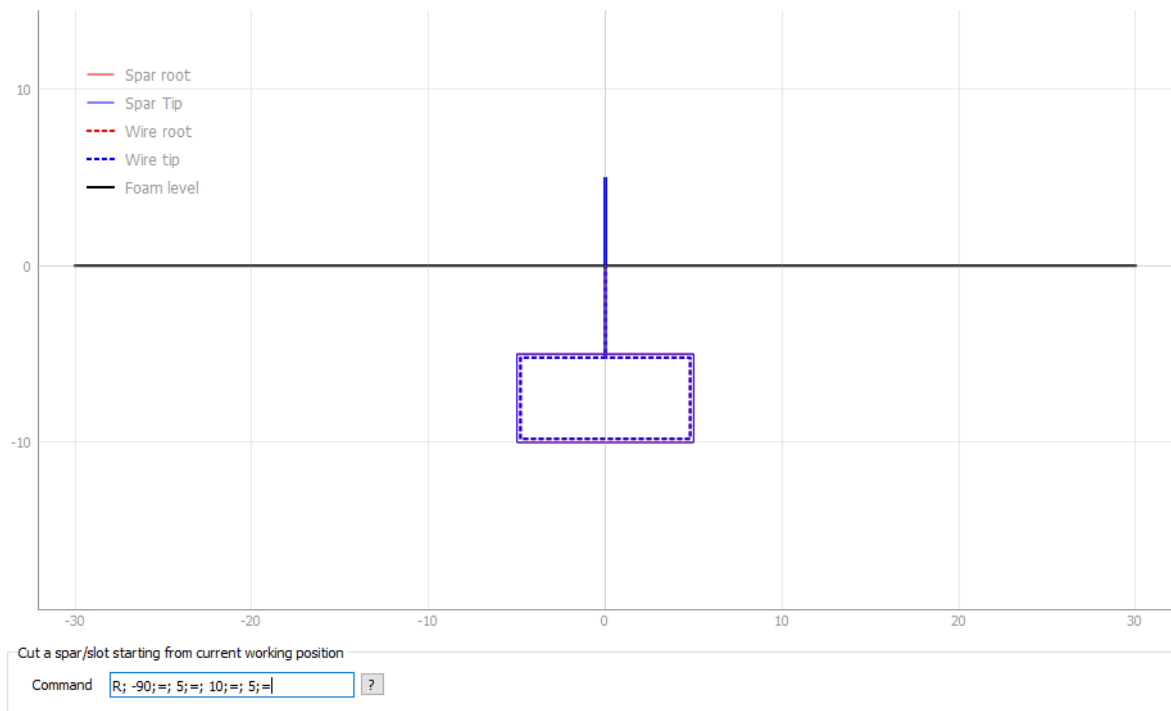


### How to :

- On Gemini Aero Foam :
  - set the form to cut and its dimensions
  - for an evolving section, take care to select the correct option for left/right wing and the distance between table and block on the left/right side.
  - generate the GCode
- On the CNC machine control software :
  - move the wire to be put in contact with the foam where the spar/slot has to be cut
  - the wire should approximatively be parallel to the base of the table (so having the same distance on the left and right side) : if necessary, rotate the wing to position it correctly under the wire
  - set this current CNC position as working origin, so the GCode will start from there
  - launch the GCode : the wire will go 5 mm up, then will wait your action (press resume button) to heat and then cut the shape in the foam

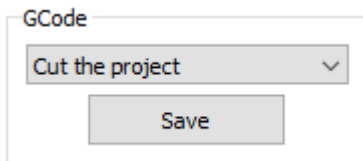
Some spar examples (constant section) :



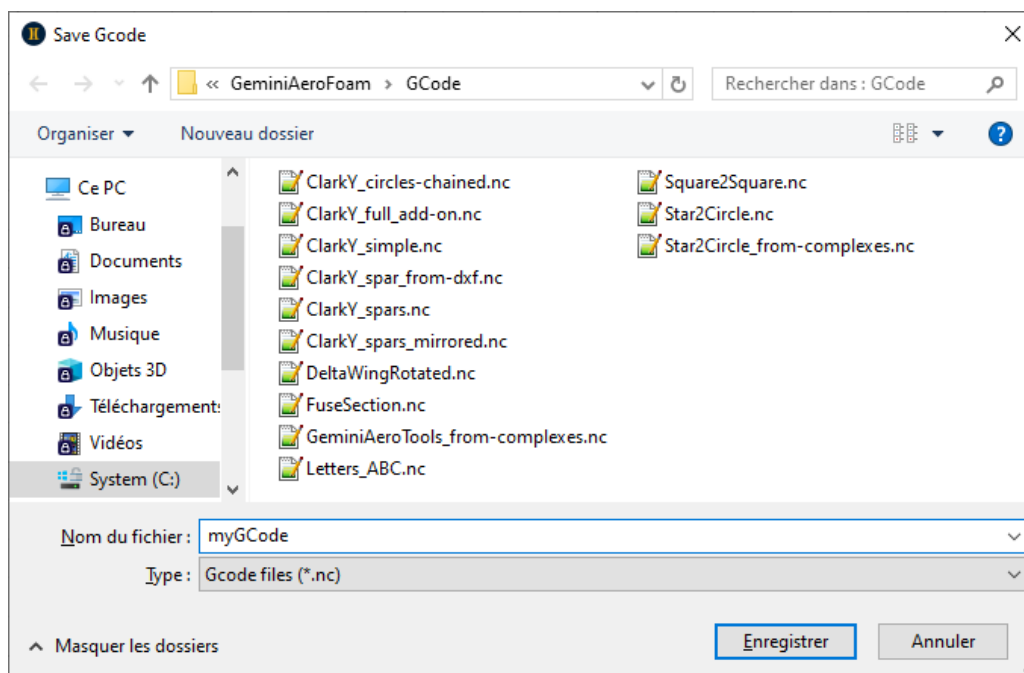
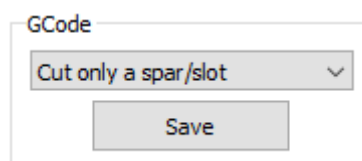


\*

### 3.5.7 Save GCode



or

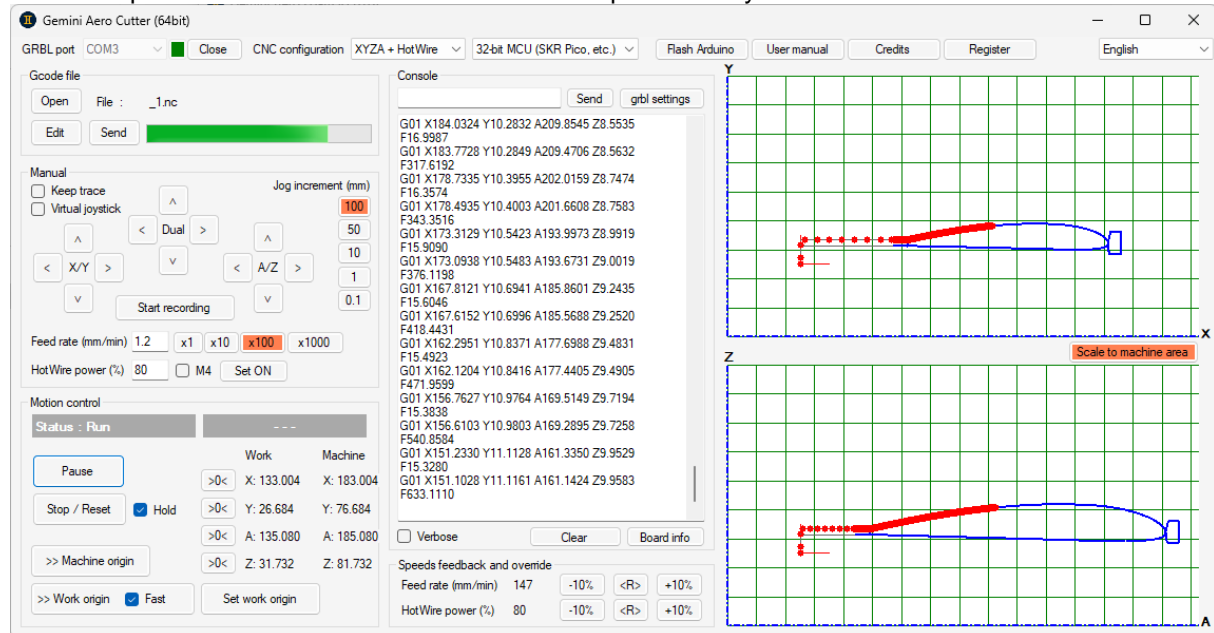


Important : the origin of the GCode produced is the working origin of the CNC machine, that can differ from the absolute origin (set at startup, by limit switches for example).



### 3.5.1 Use GCode

Screen capture of Gemini Aero Cutter with GCode produced by G.A.F. :



Note the working origin, set at 50 mm height and 50 mm right from the machine origin.

The same GCode inside the Gemini Aero Cutter GCode editor :



Note the M0 pause after the wire has positioned itself 1 mm before the foam to be cut. This allows you to finalize, if necessary, the positioning of the block before cutting. Once the pause is ended (= user press the "resume" button), the wire will first heat up, then cut the foam.