Airfoil Tutorial

O Grid

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- Changing the density
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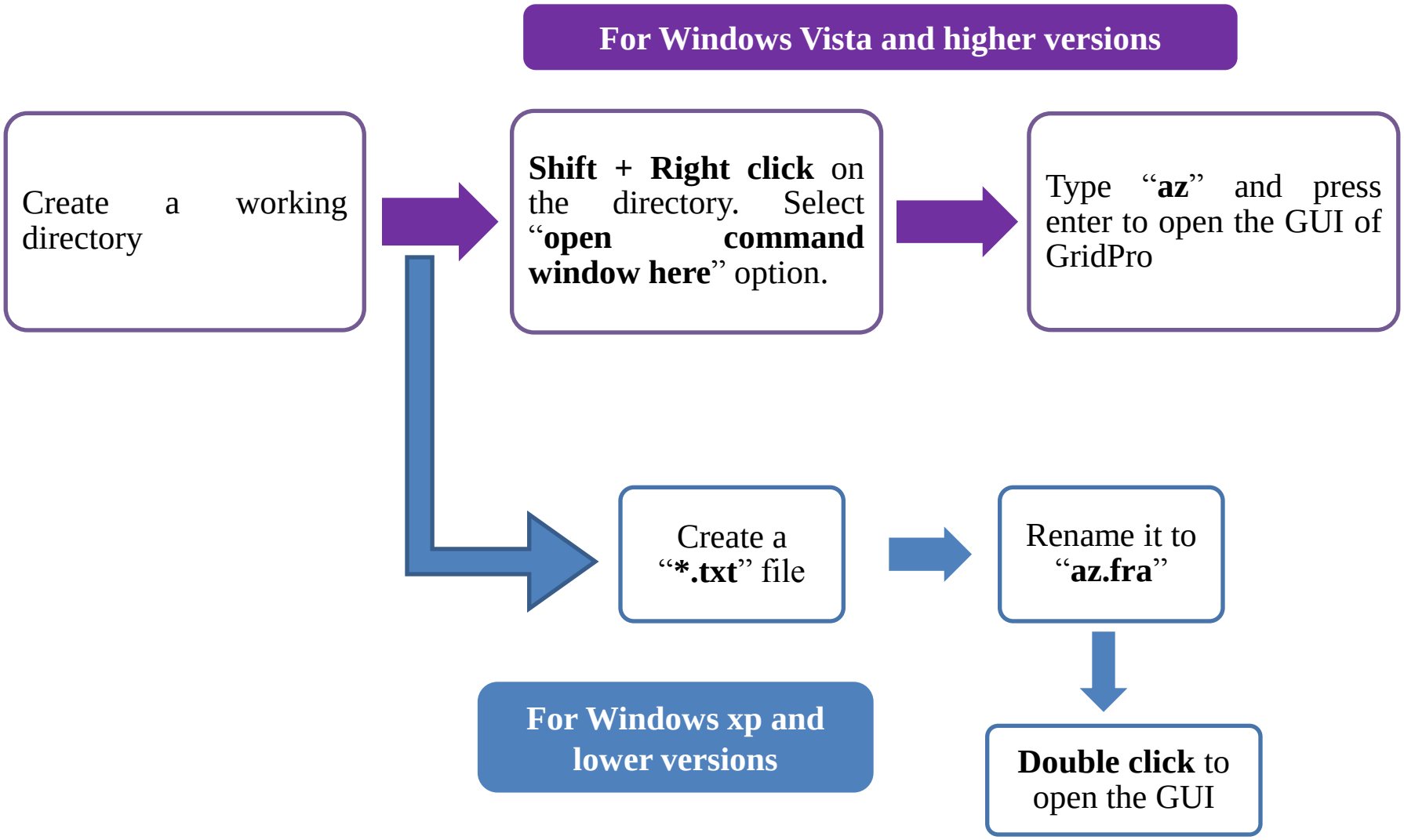
Starting a GridPro session



For Linux and MAC users

Open a terminal

Set the path to the working directory

Type “**az**” and press enter to open the GUI of GridPro

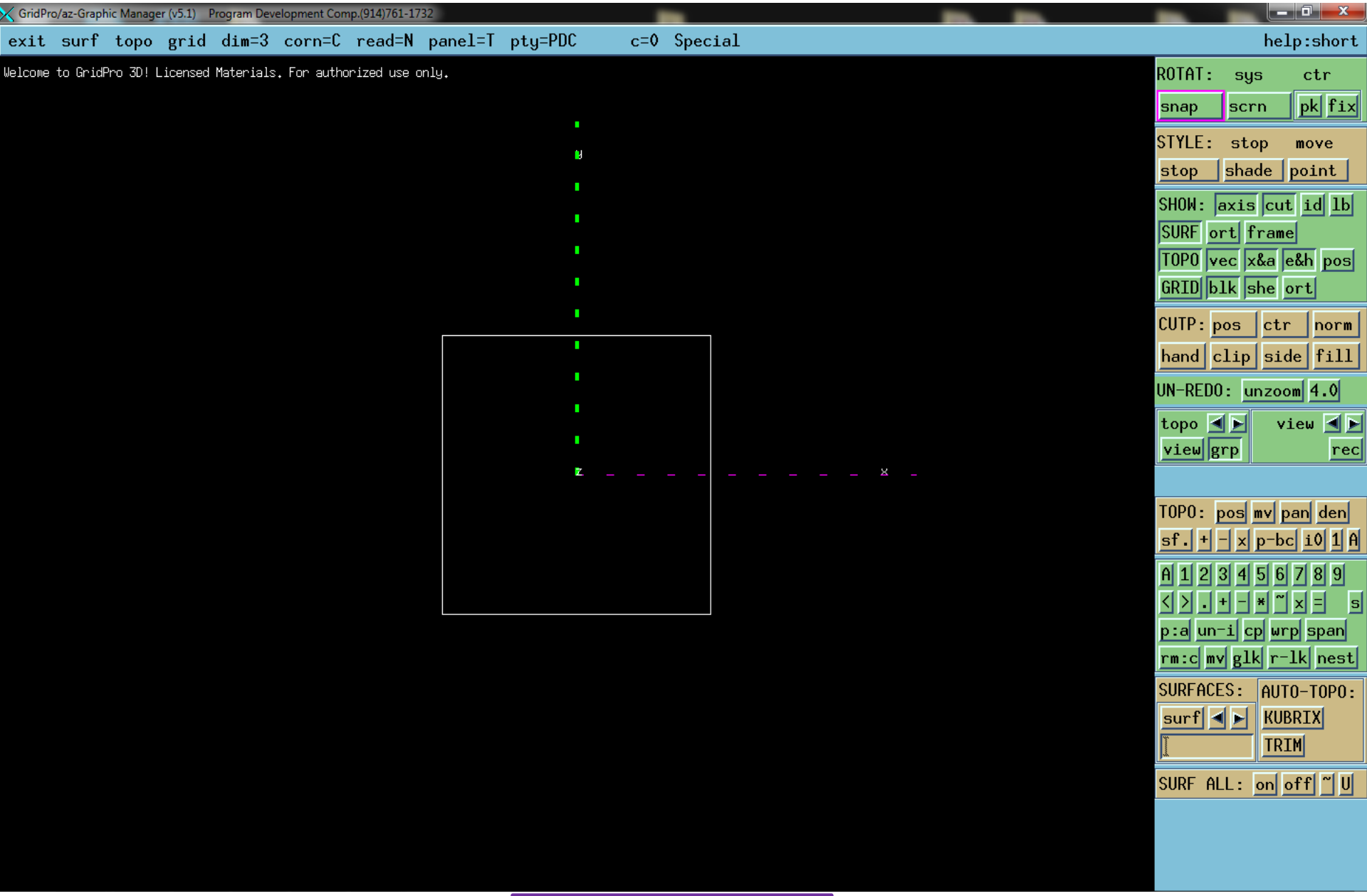
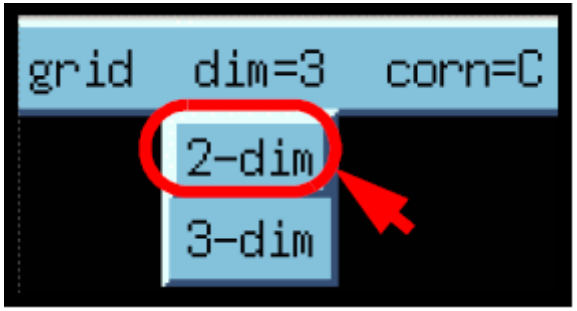


Figure: GridPro GUI

Working in 2D

Change the working mode to 2D from the `dim=2` pull down menu in the menu bar.



4 Major Steps

Surface Preparation

Creating the wireframe

Corner Assignment

Grid Generation

Surface Preparation

Importing airfoil coordinates

Open the "***.dat**" file(coordinates file) in the text editor.

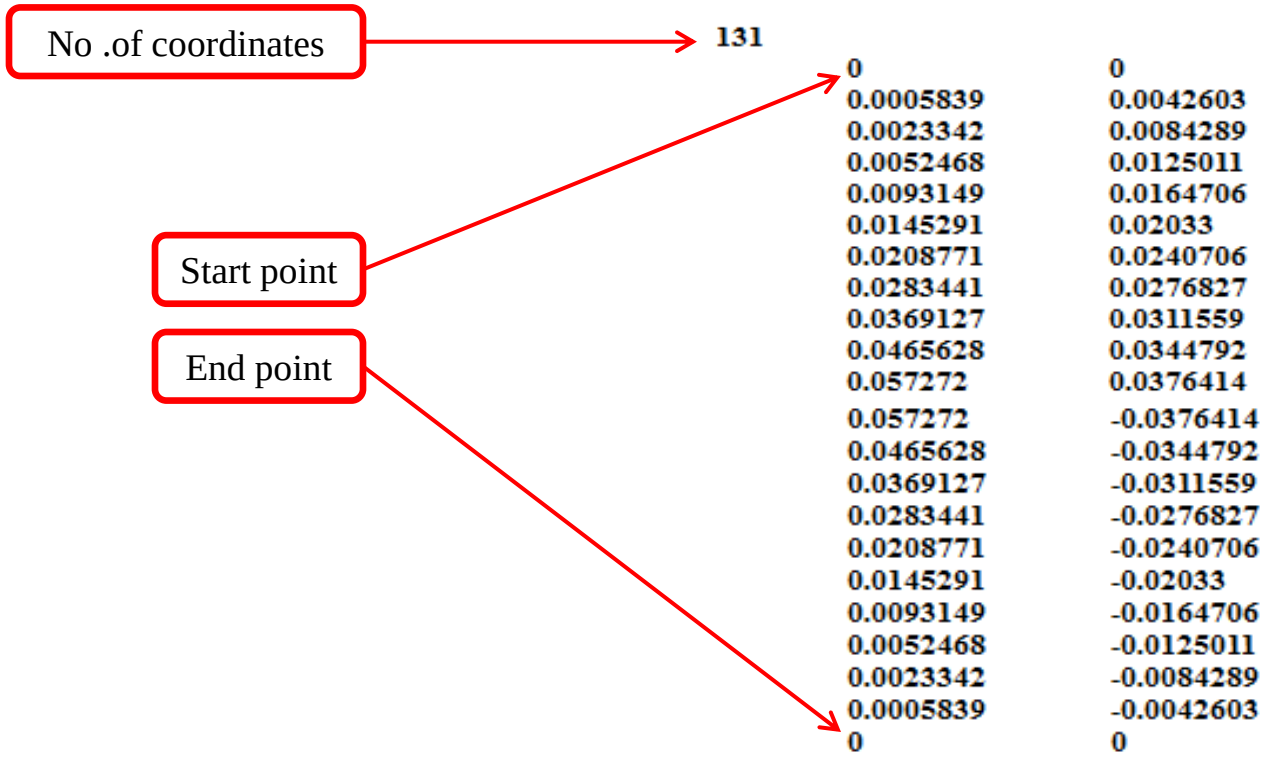
Remove all line spaces and details other than the coordinates.

Mention the total number of coordinates in the first line of the file

The coordinates of the start point and the end point should always be 0,0.

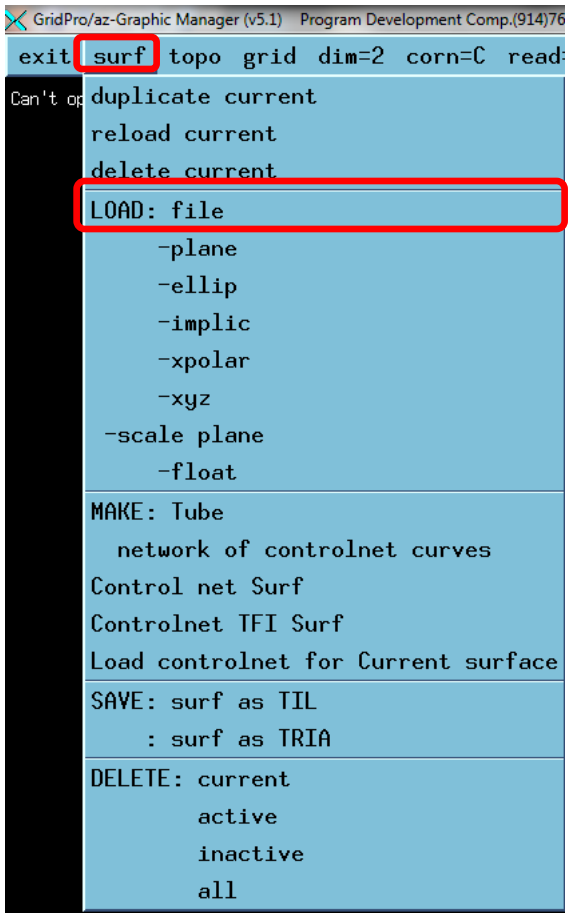
Save the file as ***.dat** or ***.lin** file

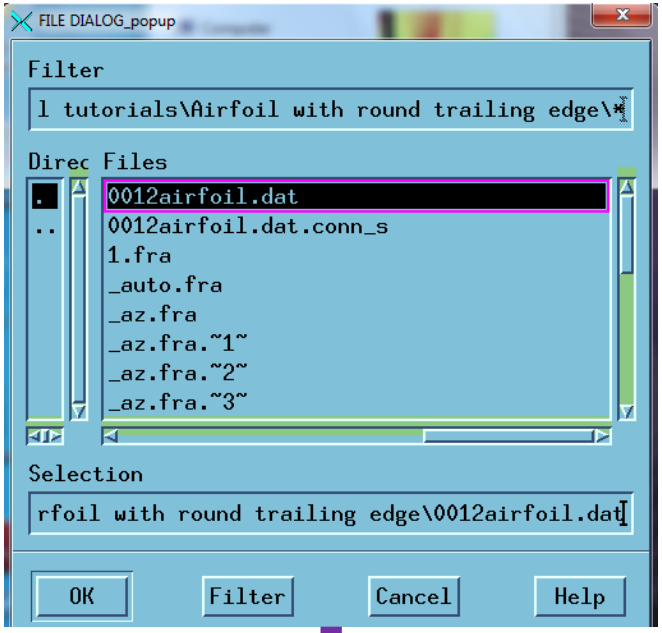
Note: If the coordinates are separately specified for the two surfaces of an airfoil i.e. upper and lower surface, copy them into a single file in order to have a single surface.

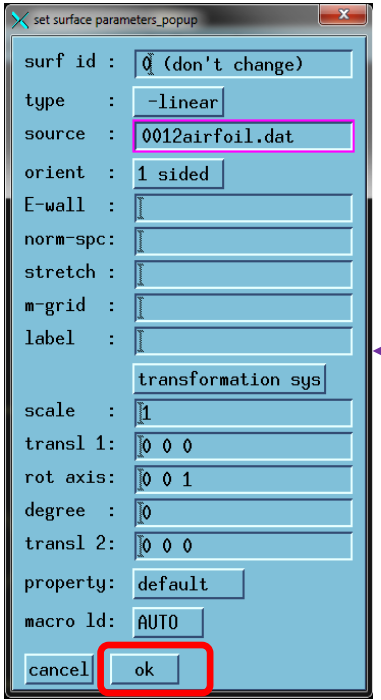


Note: Always arrange the coordinates from 0 to 1 for the upper airfoil surface and 1 to 0 for lower airfoil surface as shown in the figure above.

Load the file from the **surf** pull down menu.







Press ‘ok’

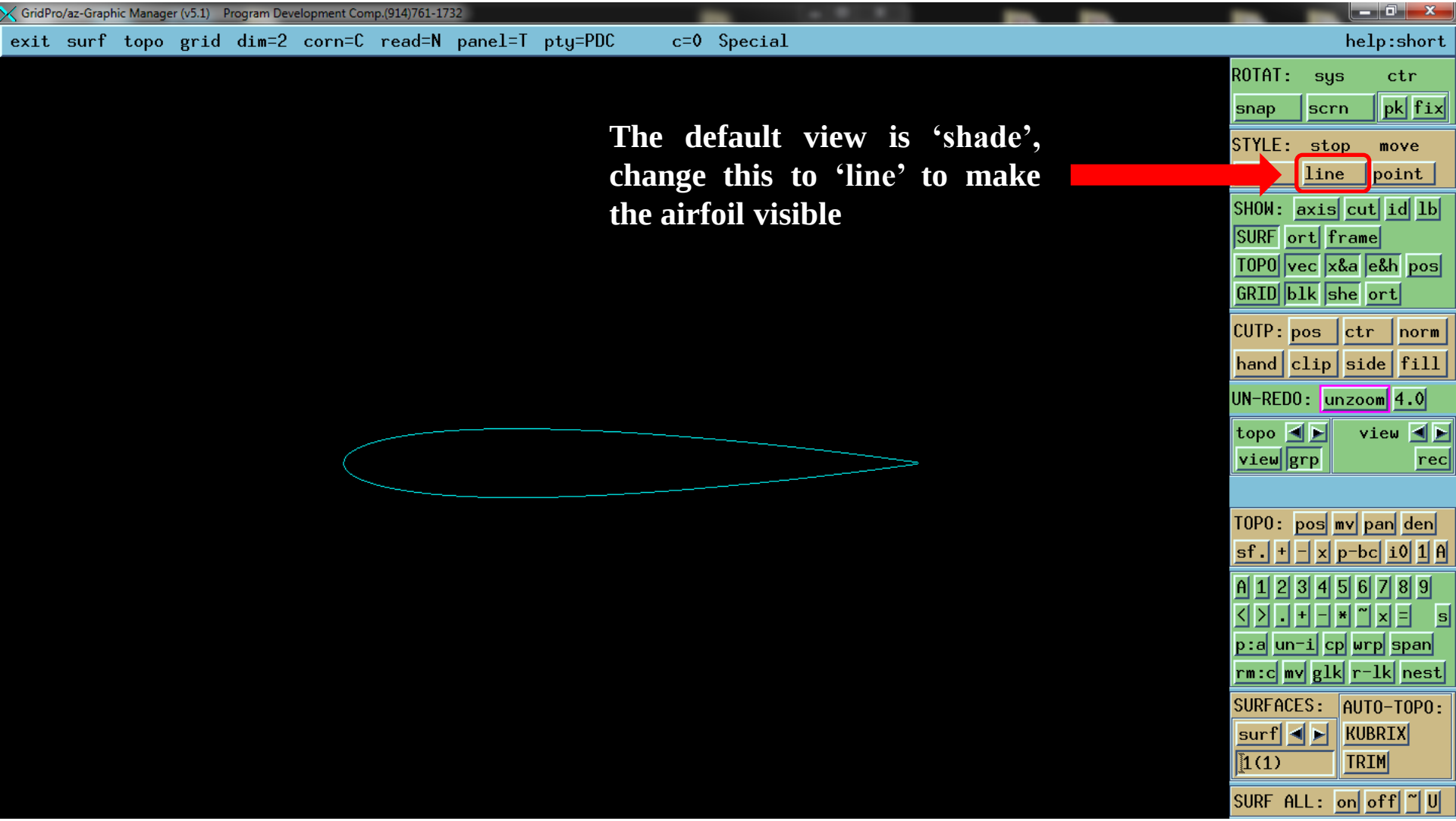
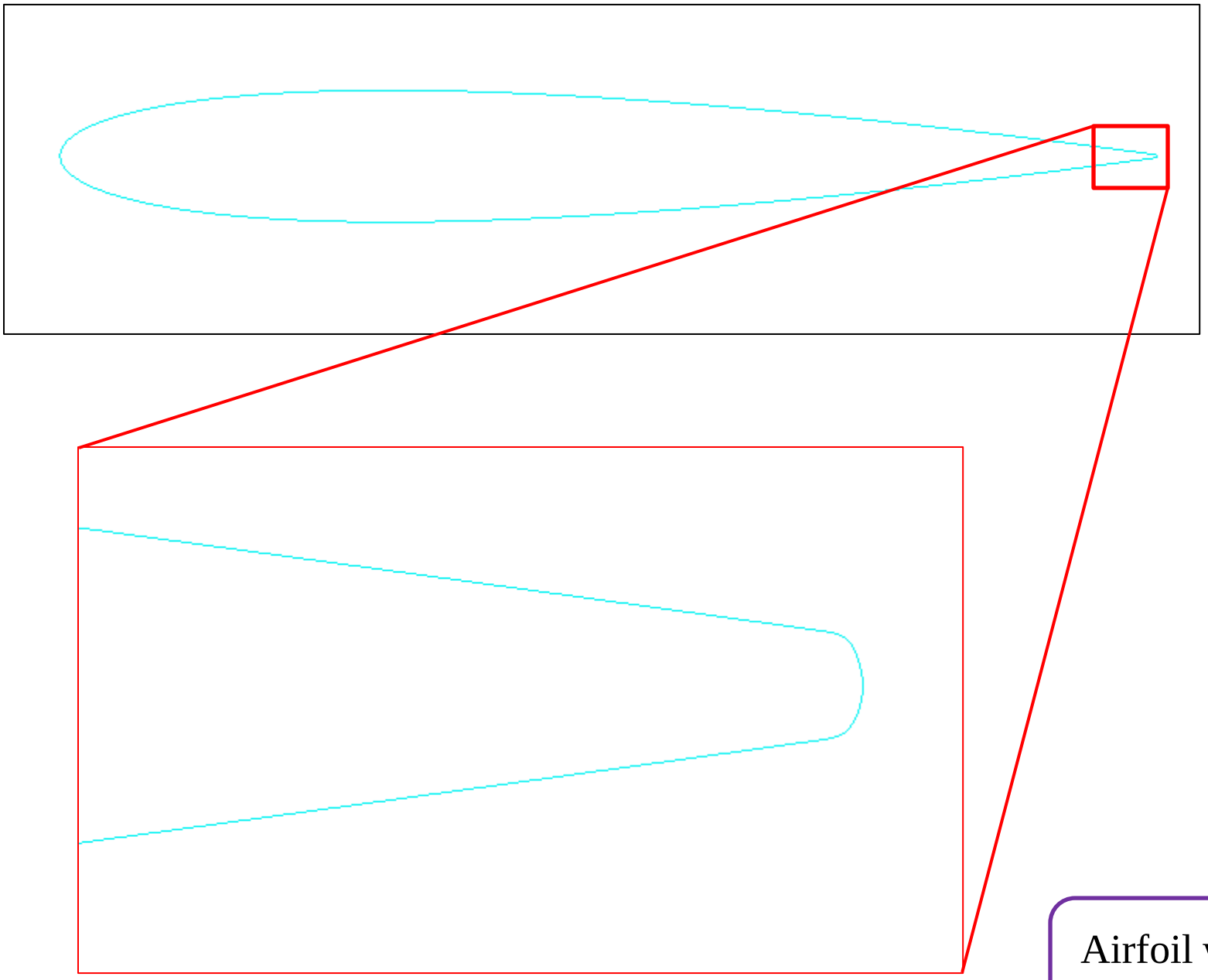


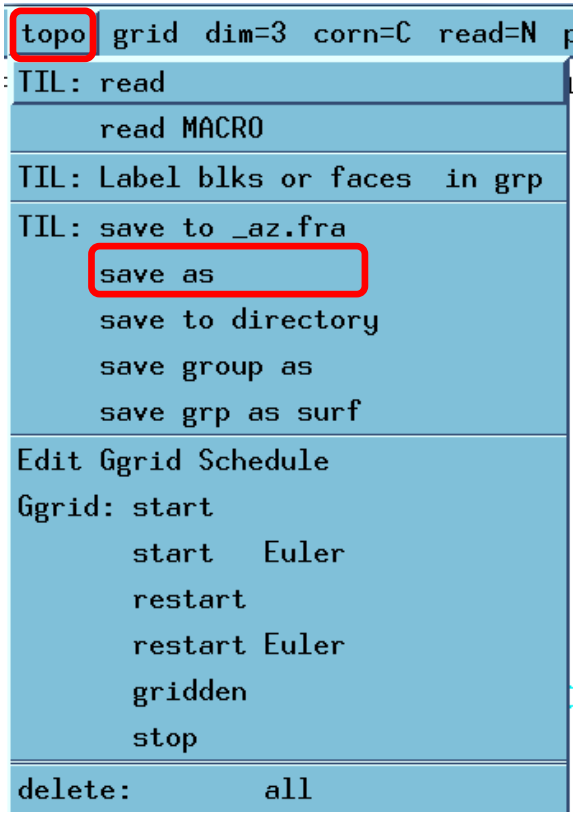
Figure: Airfoil

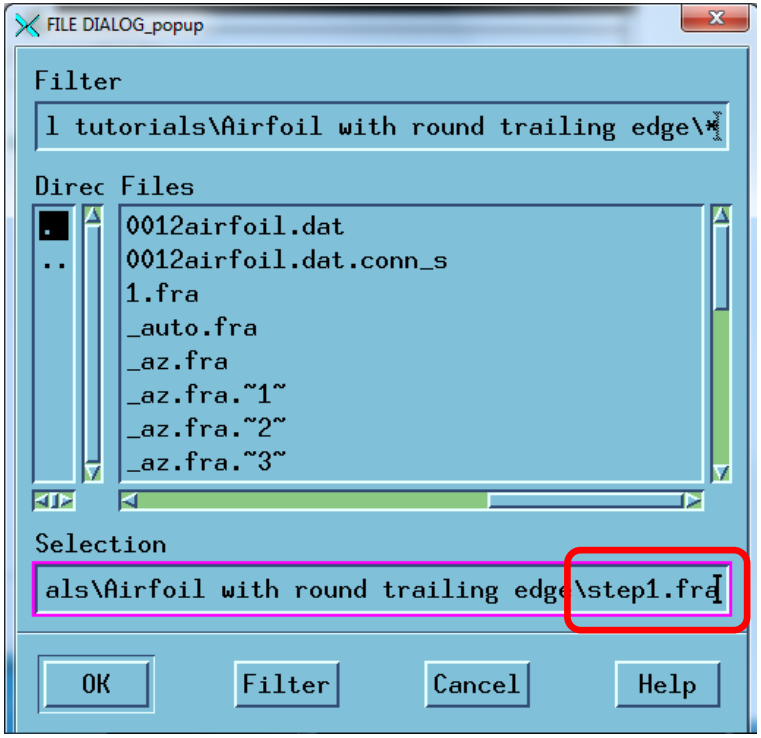


Airfoil with round trailing edge

Saving the file

Go to ***'topo'*** pull down menu and select ***'save as'*** option



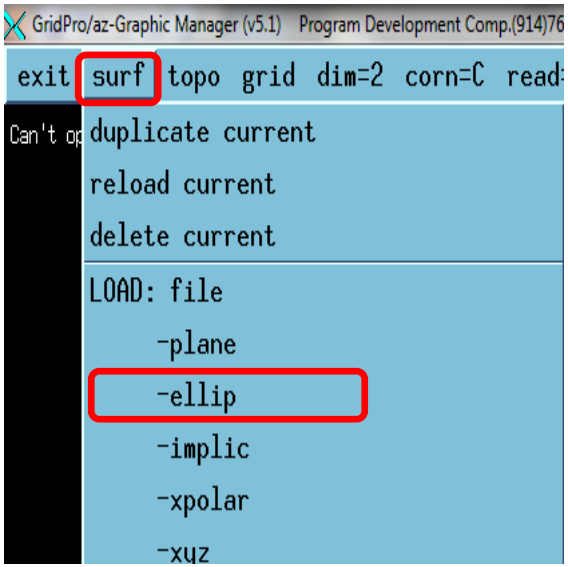


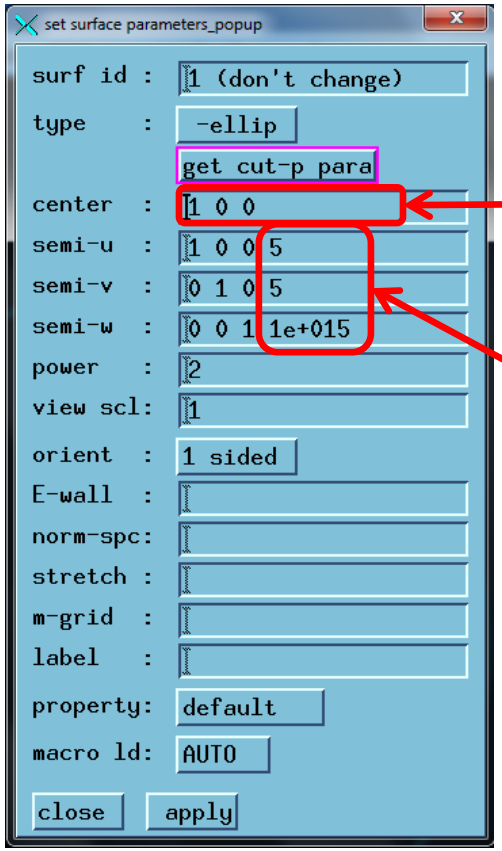
Enter a name with extension, say 'step1.fra' and click 'ok' to save the file

It is highly recommended to save the file after each operation in order to avoid the file losing if the GUI crashes.

Creating the far field boundary

To create the far field boundary, go to surf pull down menu and click on **LOAD: -ellip**



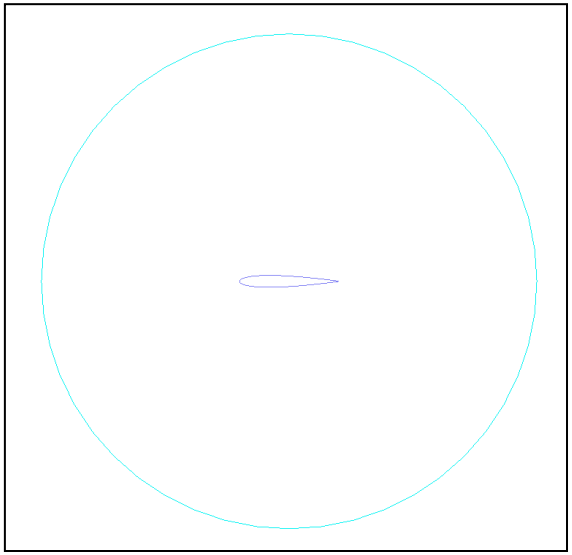


Centre of the circle

Magnitude(radius) in x,y,z direction. Since it is a circle, use the 3rd dimension as e+15

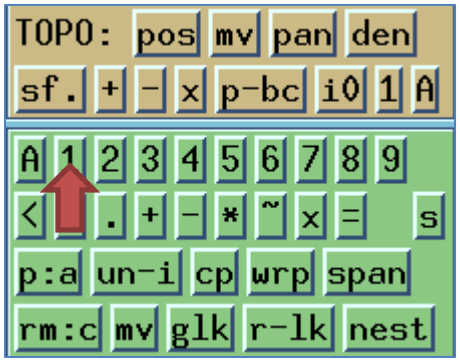
Press ‘apply’

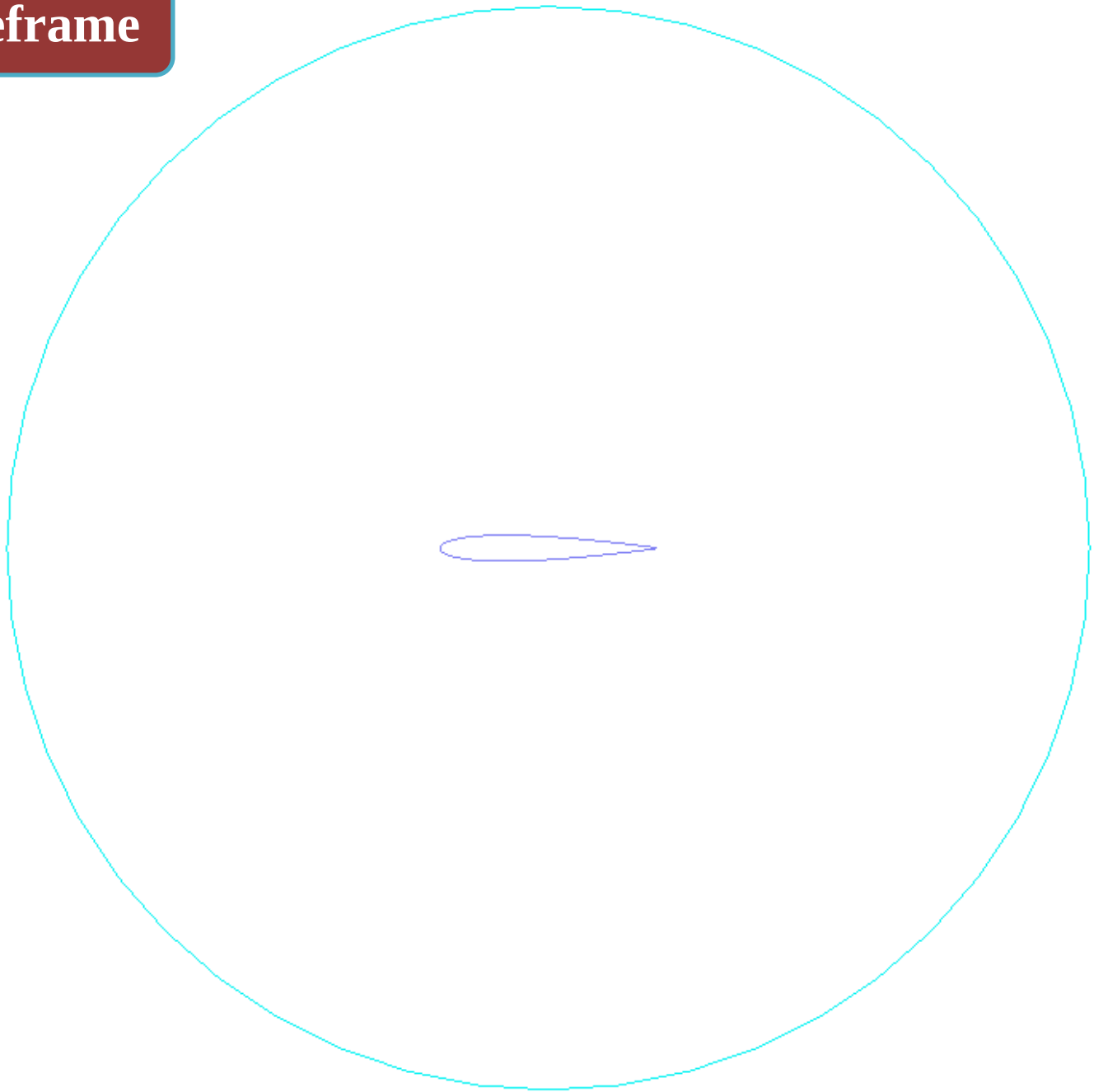
Save file as ‘step2.fra’



Creating the wireframe

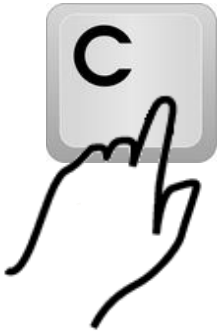
Before we start building the topology, select a group say **group 1** by clicking on it. Now the corners and edges that are going to be created will be added to the **group 1**.





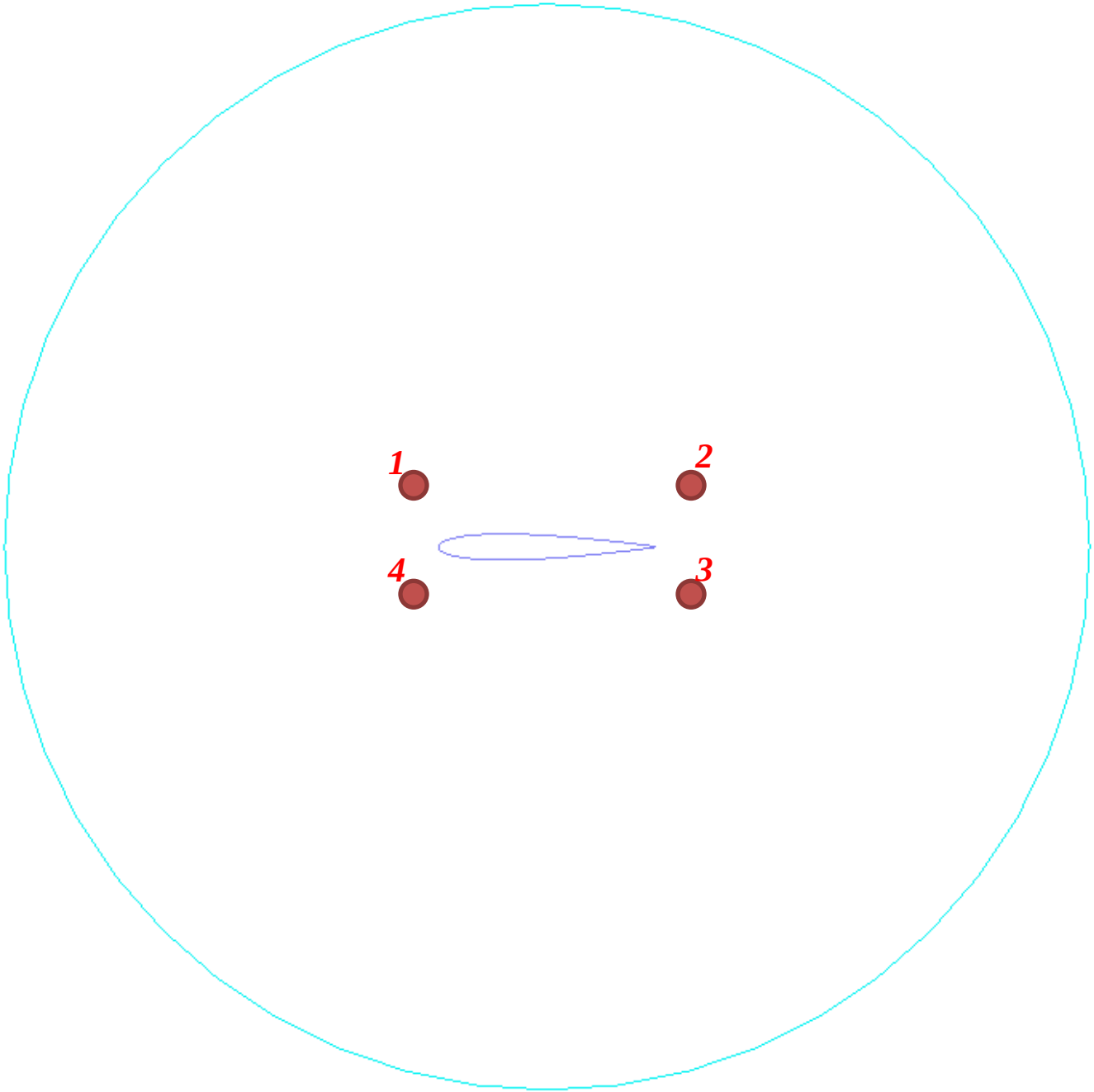
STEP: 1

Hold the "**C**" Key on your keyboard .



Left click on the screen around the airfoil (as shown) to create corners.

Save file as 'step3.fra'

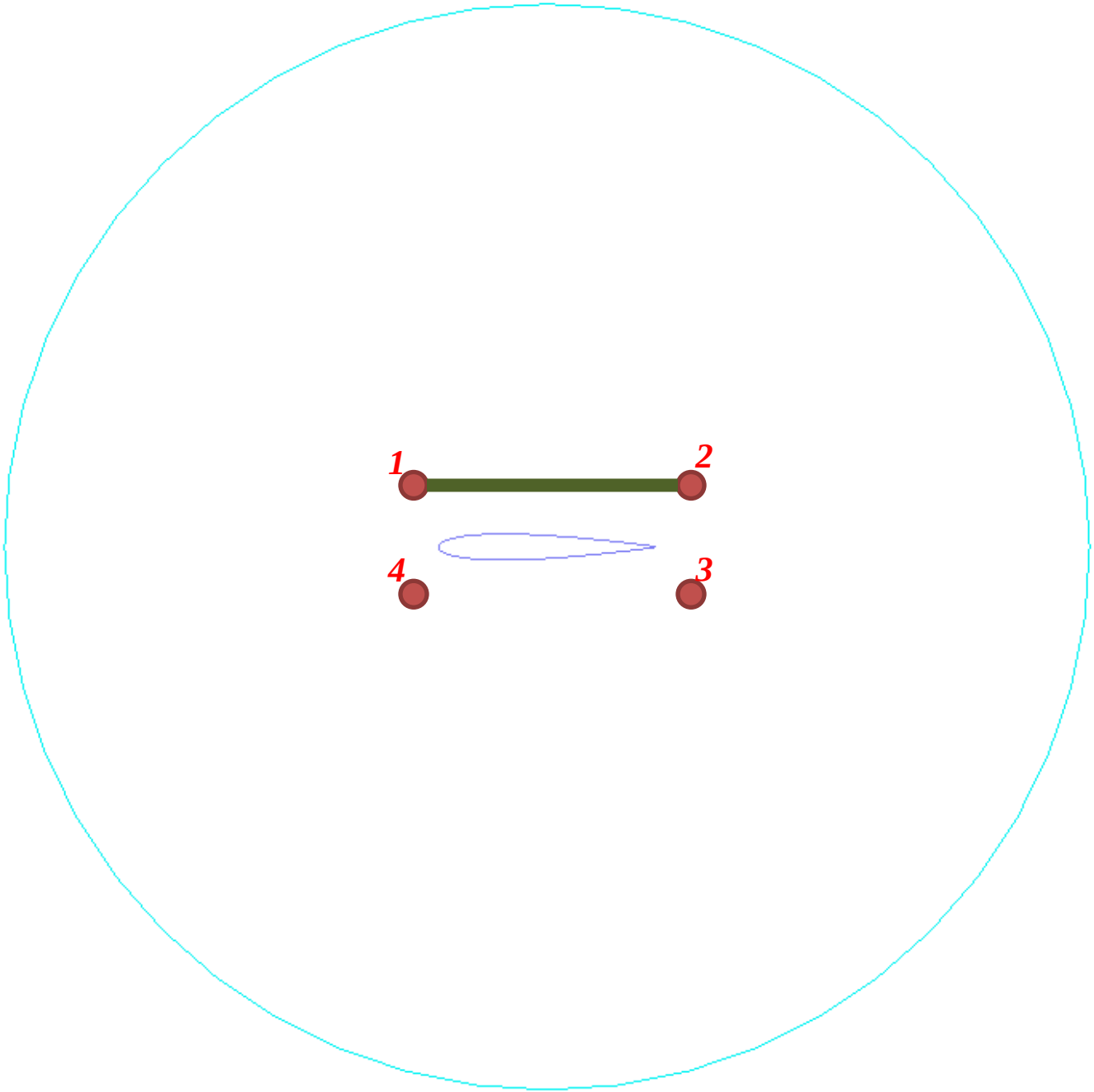


STEP: 2

Hold the “**E**” Key on your Keyboard

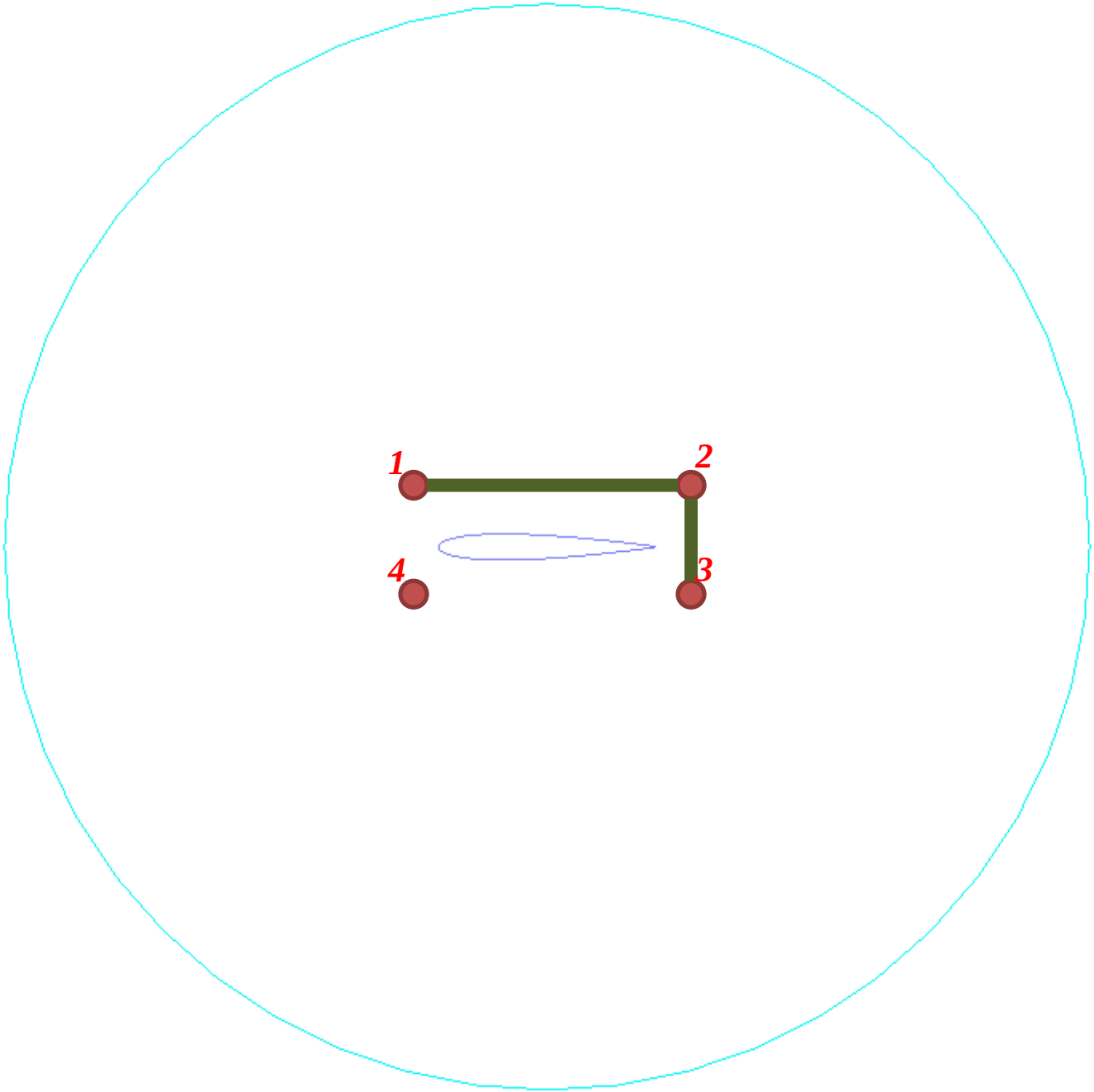
Click on the corners to create edges (as shown).

Save file as ‘step4.fra’



STEP: 3

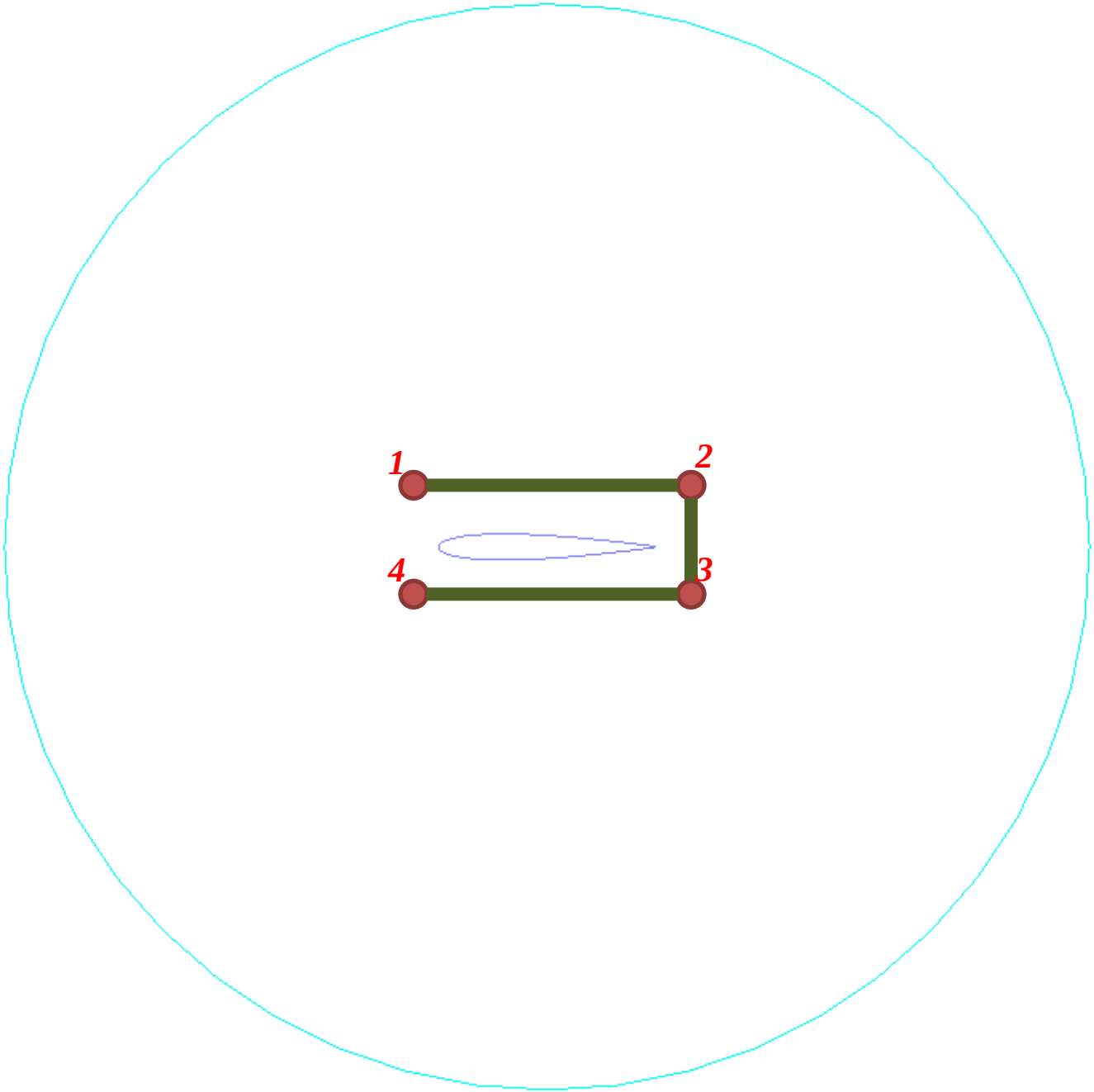
Hold the “**E**” Key link the corners to create a wireframe.



Save file as ‘step5.fra’

STEP: 3

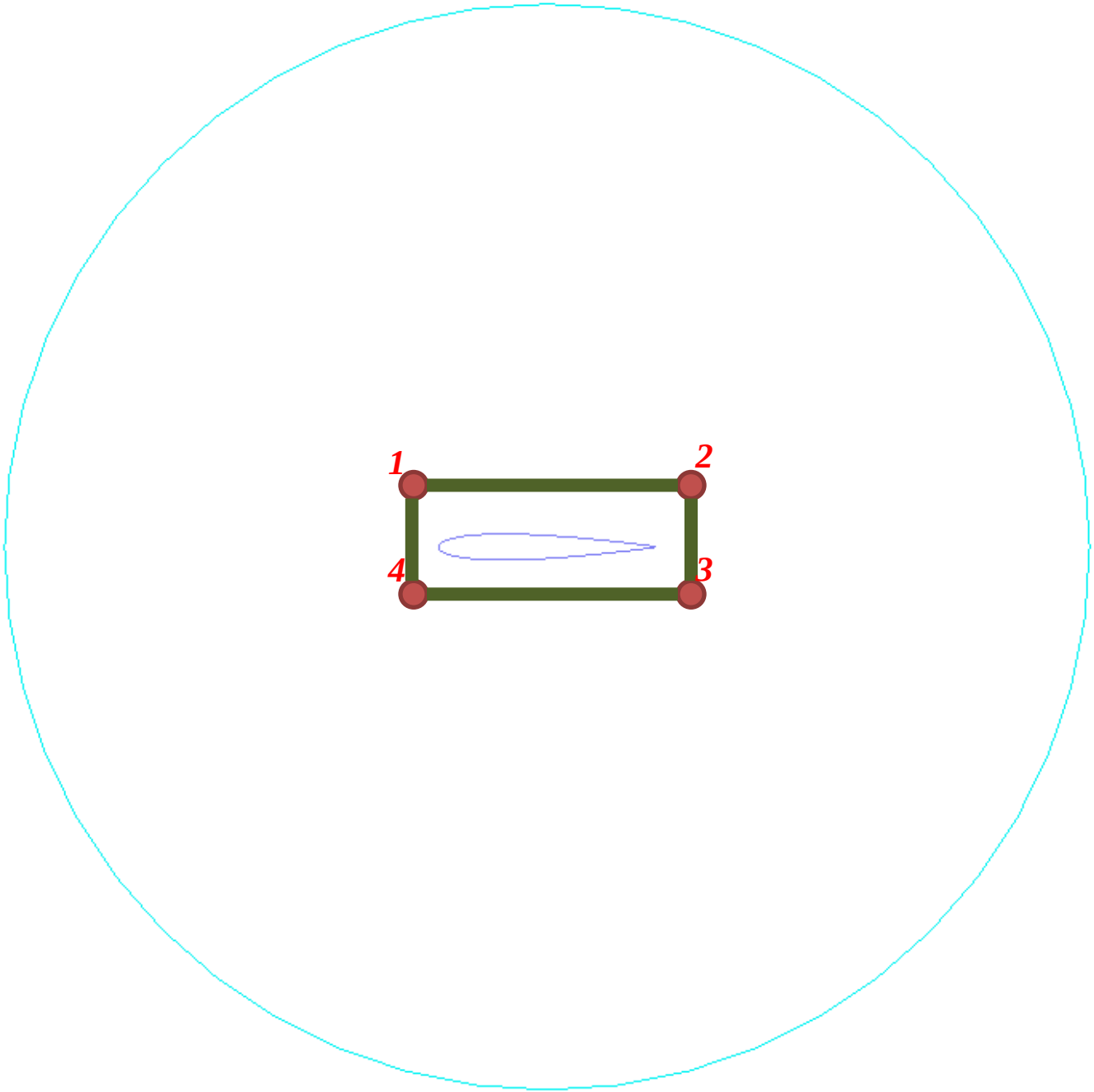
Hold the “**E**” Key link the corners to create a wireframe.



Save file as ‘step6.fra’

STEP: 3

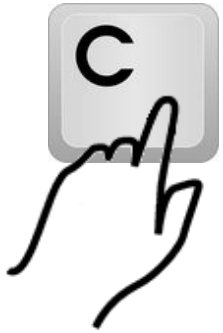
Hold the “**E**” Key link the corners to create a wireframe.



Save file as ‘step7.fra’

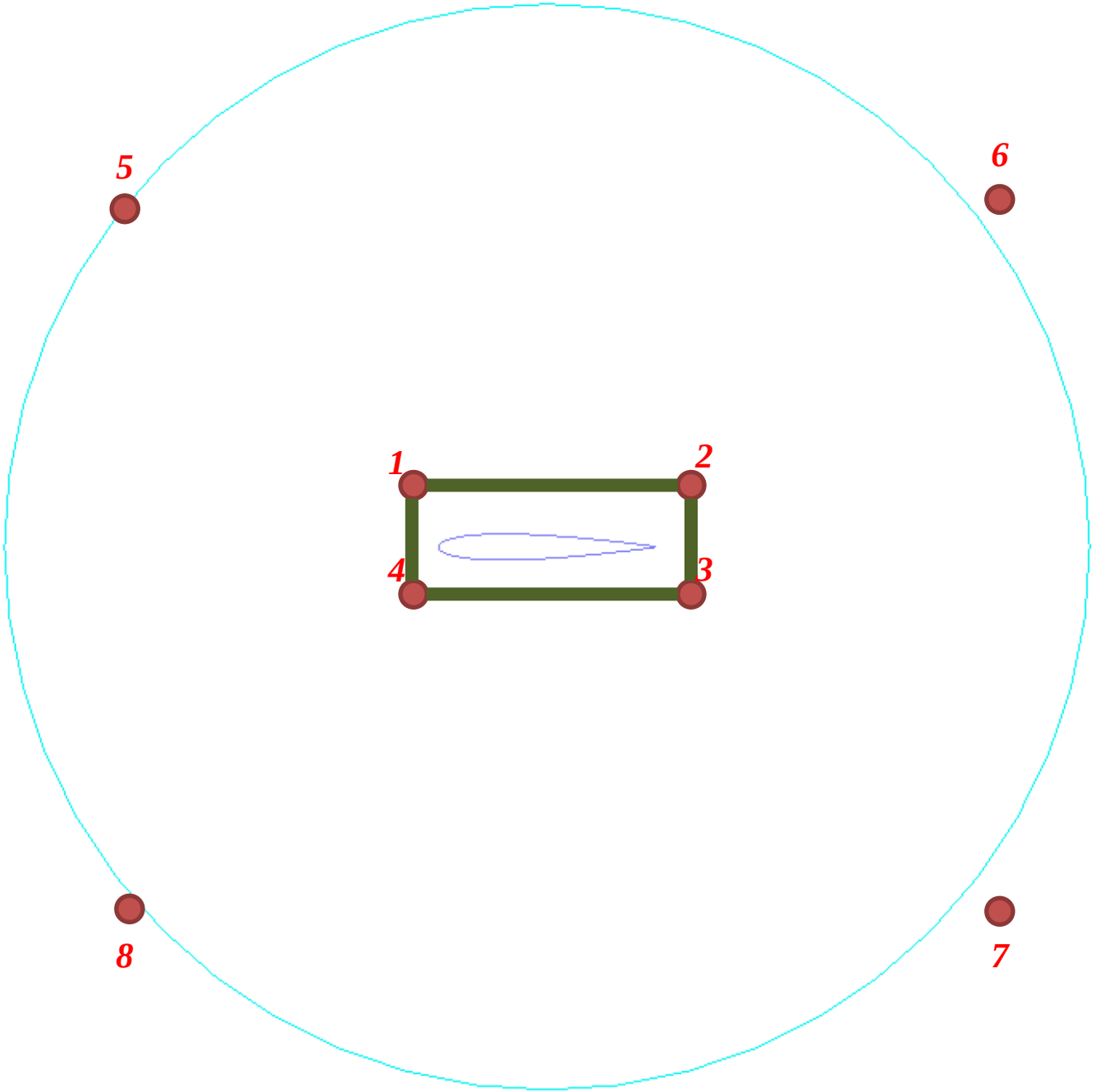
STEP: 4

Hold the “**C**” Key on your keyboard .



Click on the screen on the convex side of the outer sphere (as shown) to create corners.

Save file as ‘step8.fra’

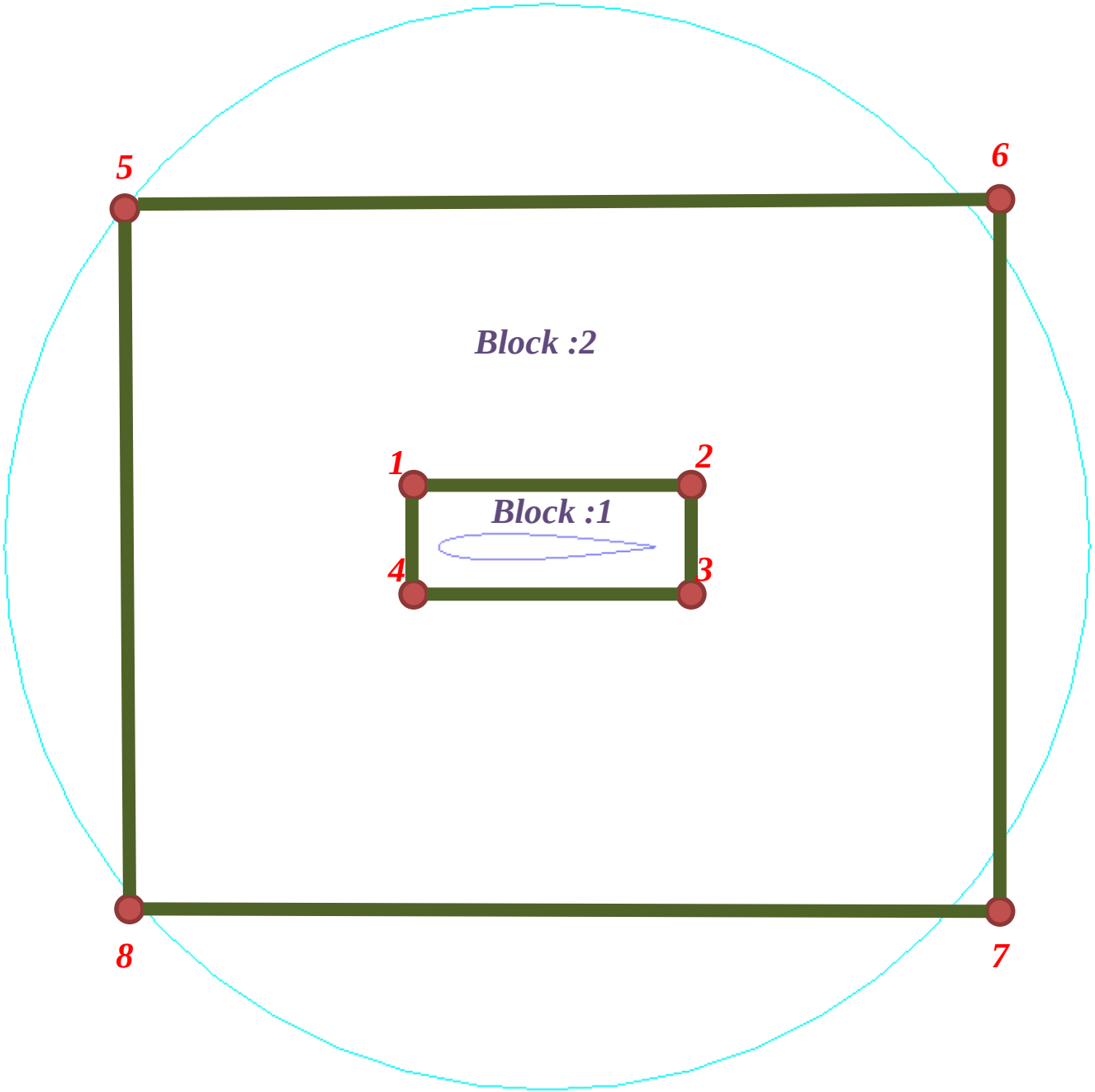


STEP: 5

Hold the “**E**” Key on your Keyboard

Click on the outer corners to create edges.

Save file as ‘step9.fra’

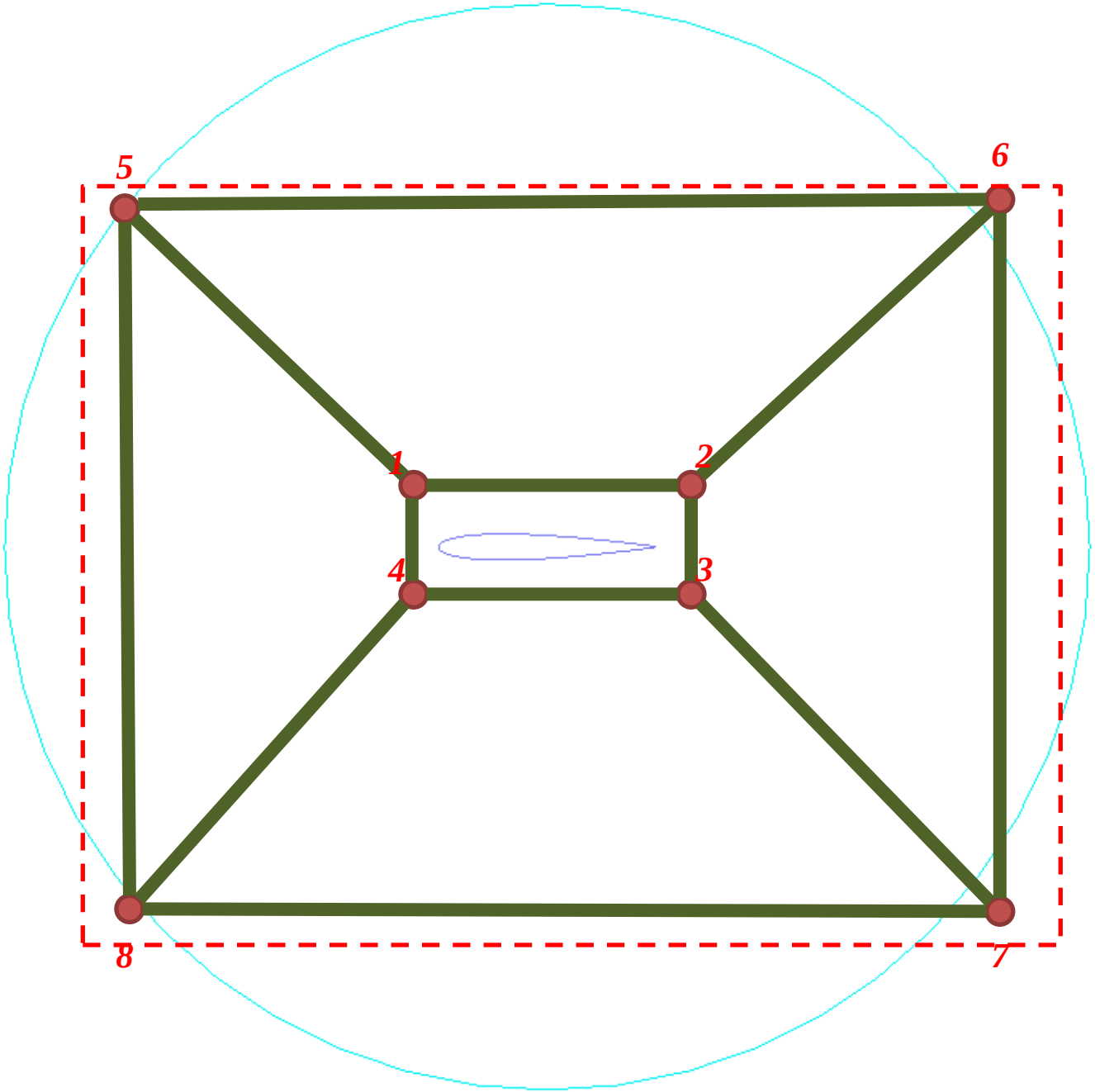


STEP: 5

Hold the “**L**” Key on your Keyboard

Right click on the mouse and drag a box around the entire set of corners (as shown) to link the two wireframes.

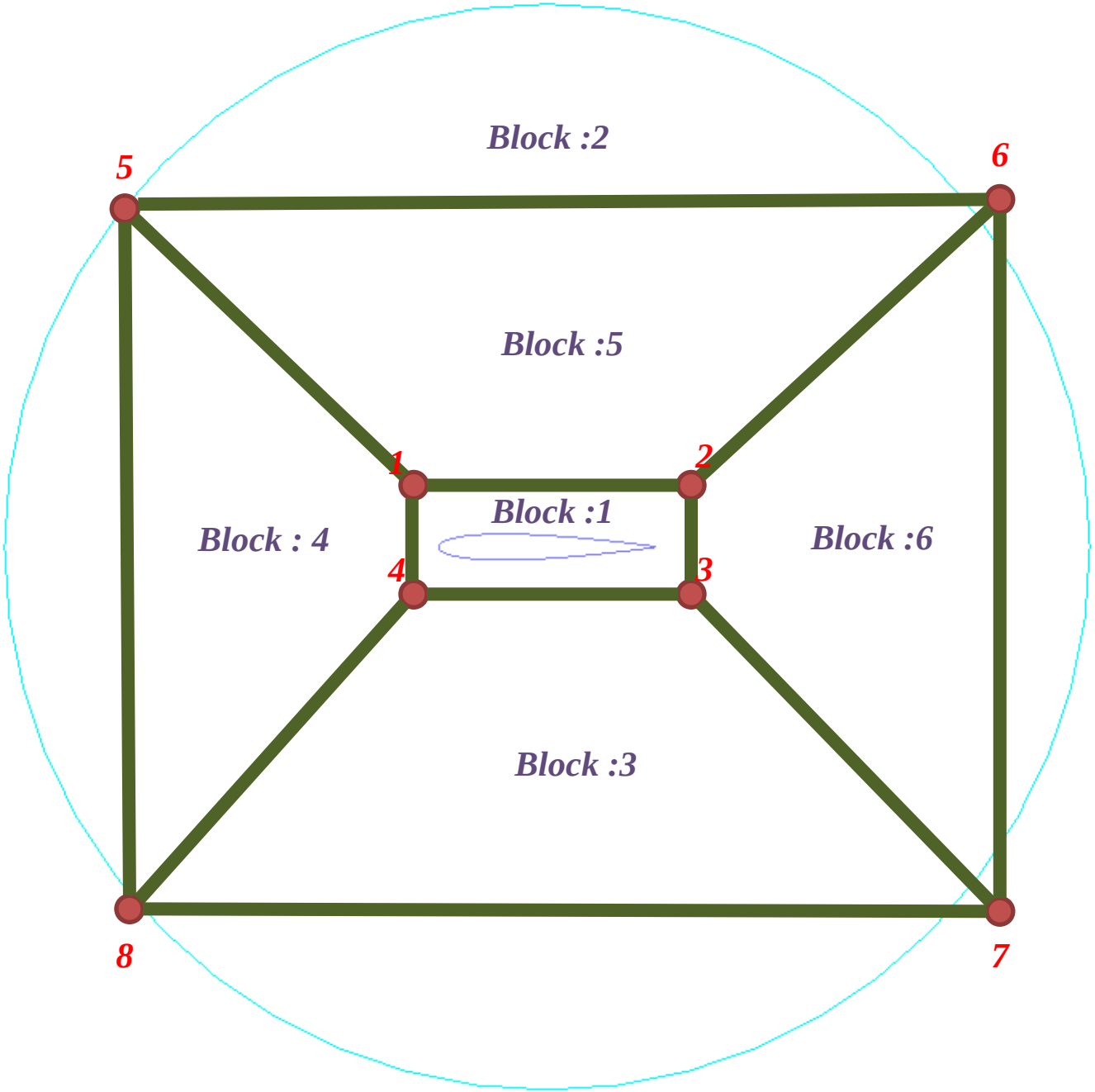
Save file as ‘step10.fra’



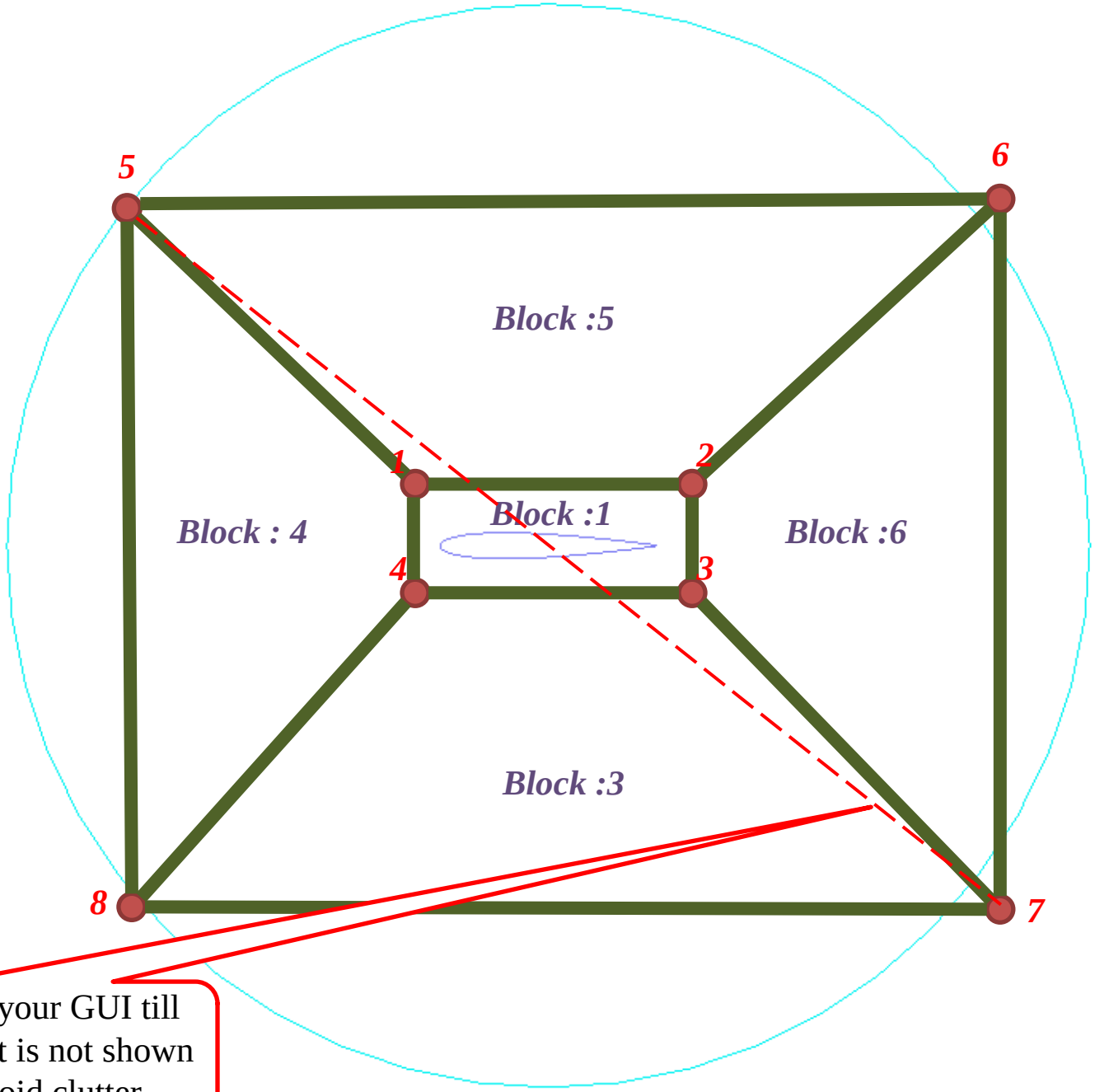
In this wireframe there are 6 blocks.

Corners which form the respective blocks

Block : 1
C1-C2-C3-C4
Block : 2
C5-C6-C7-C8
Block : 3
C3-C4-C8-C7
Block : 4
C1-C4-C8-C5
Block : 5
C1-C2-C6-C5
Block : 6
C2-C3-C7-C6



The block created by the corners **C5-C6-C7-C8 (Block :2)** should marked as invalid since it has been divided into 4 blocks 3,4,5 and 6 . In order to exclude use the "F" key and click on the diagonal corners of the block (**C5-C7 or C6-C8**) which creates face exclusion (dotted line in red)



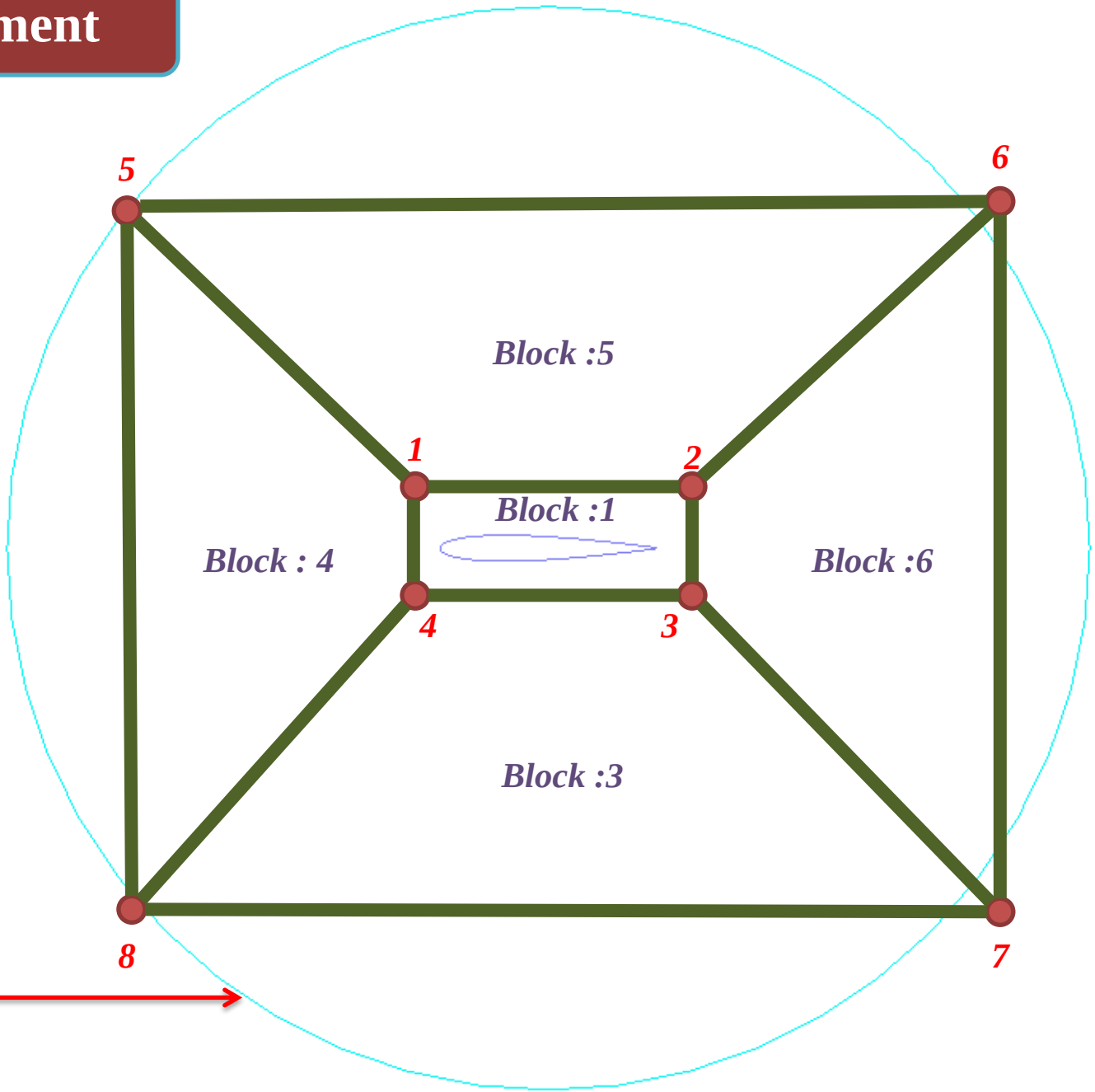
The line will be visible in your GUI till the end of the tutorial ,but it is not shown in the future slides to avoid clutter.

Corner Assignment

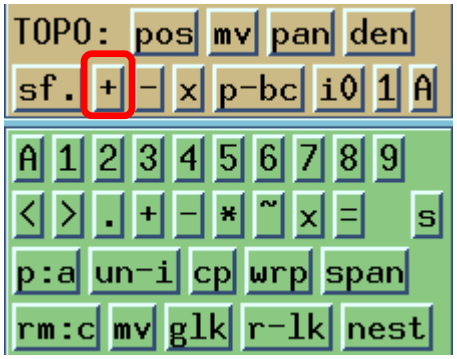
The wireframe structure of the blocks is created , A relation between the given surfaces and the wireframe is established only when the corners are assigned.

Select the outer surface to be the current surface by using the scroll

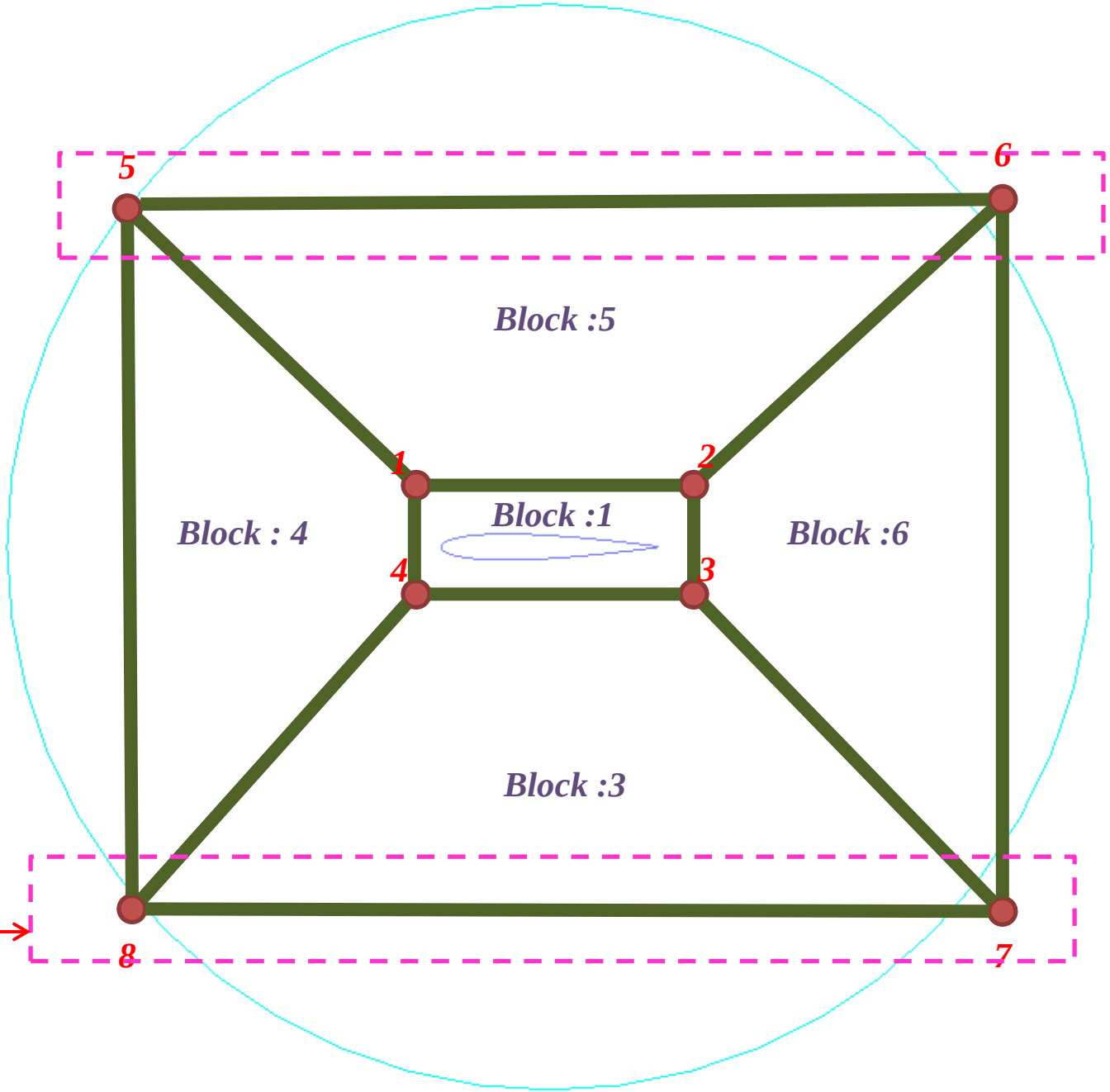
The current surface is always blue in colour



Once the surface is selected ,click the “+” button as shown in the below, then **right click** and drag a box on the corners 5, 6 and 7,8 to assign them to the outer circle.



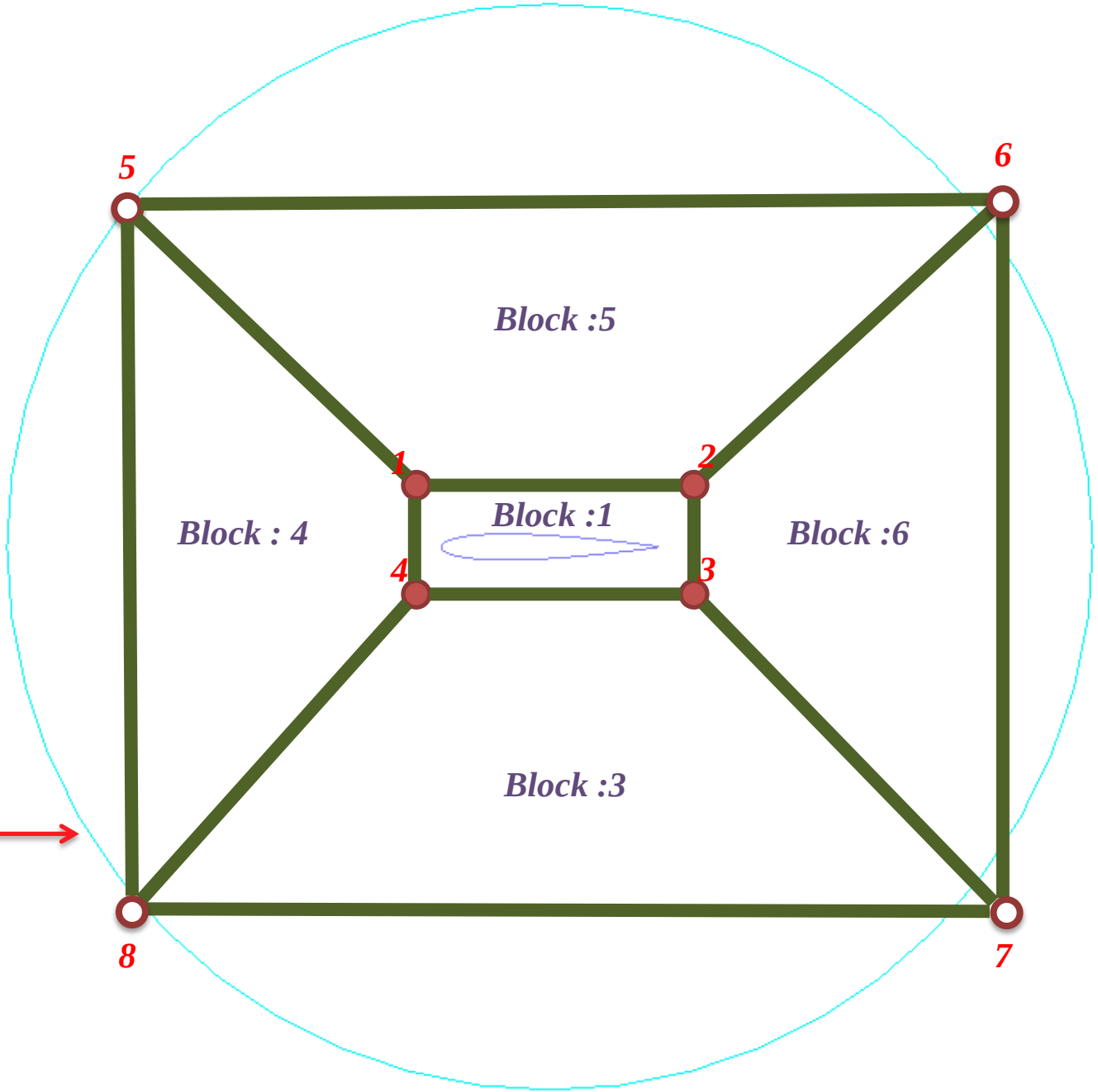
The box which is being dragged will be highlighted in pink colour



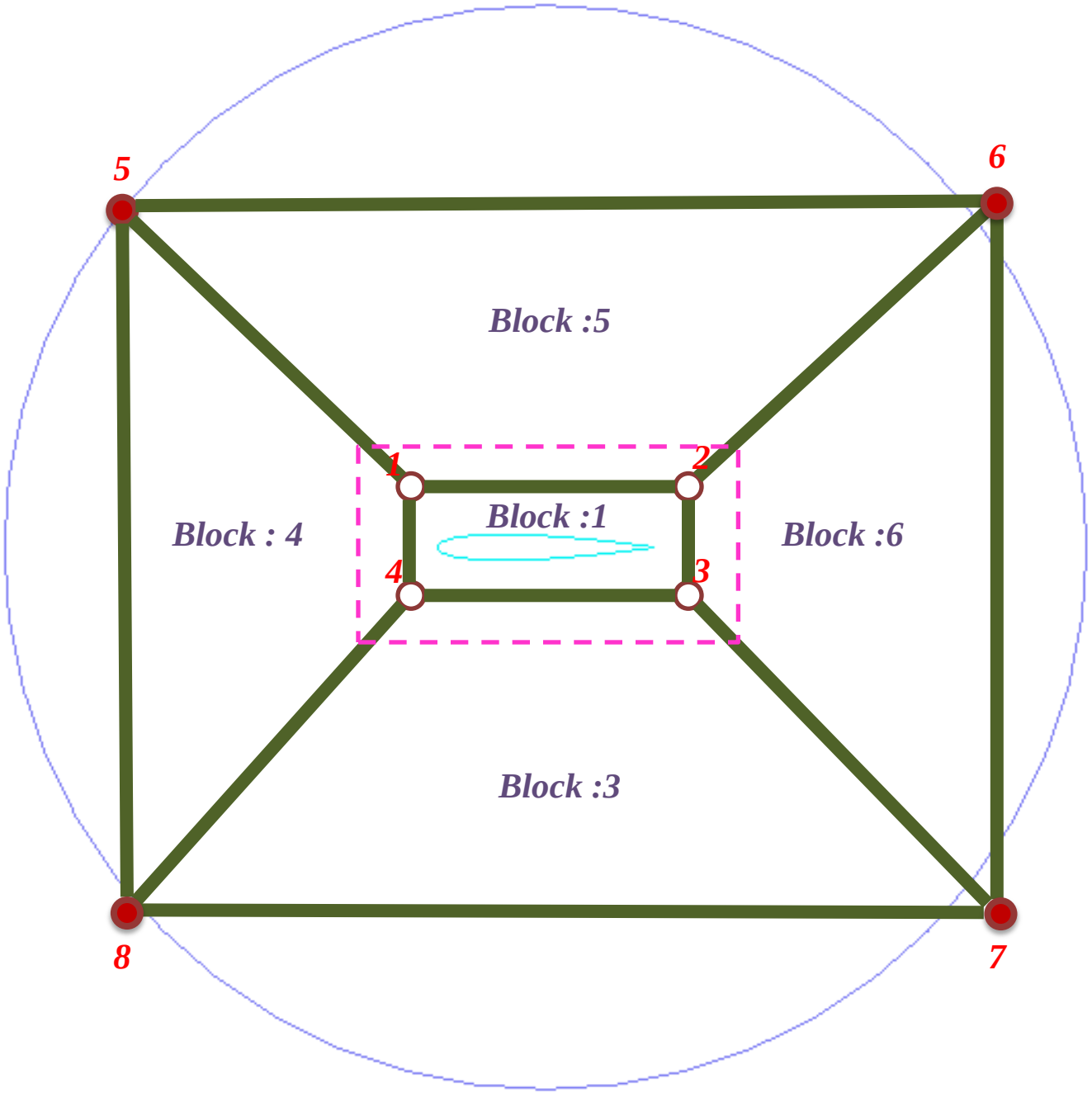
The corners assigned have white dot inside, denoting that it has been assigned to the current surface

Note: As said earlier, the current surface is blue in colour.

Save file as ‘step11.fra’



Similarly assign the inner corners (1,2,3 and 4) to the airfoil

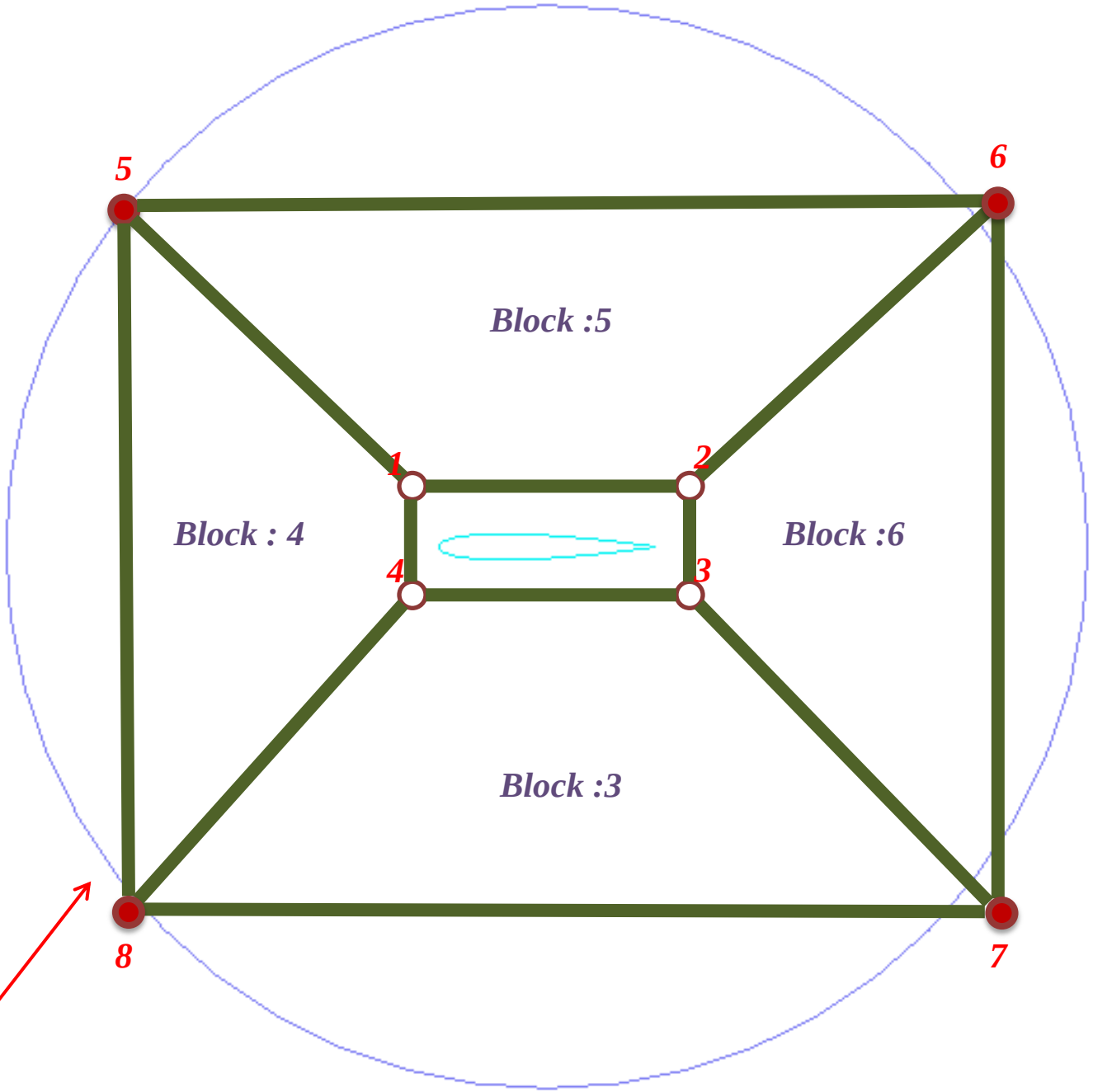


Save file as ‘step12.fra’

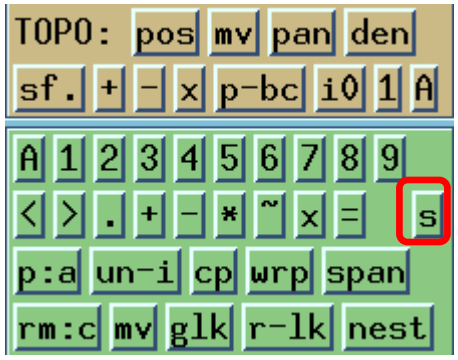
Once the corners are assigned to the surfaces, the wireframe is called as '**topology**', since it contains the block information as well as the surface information.

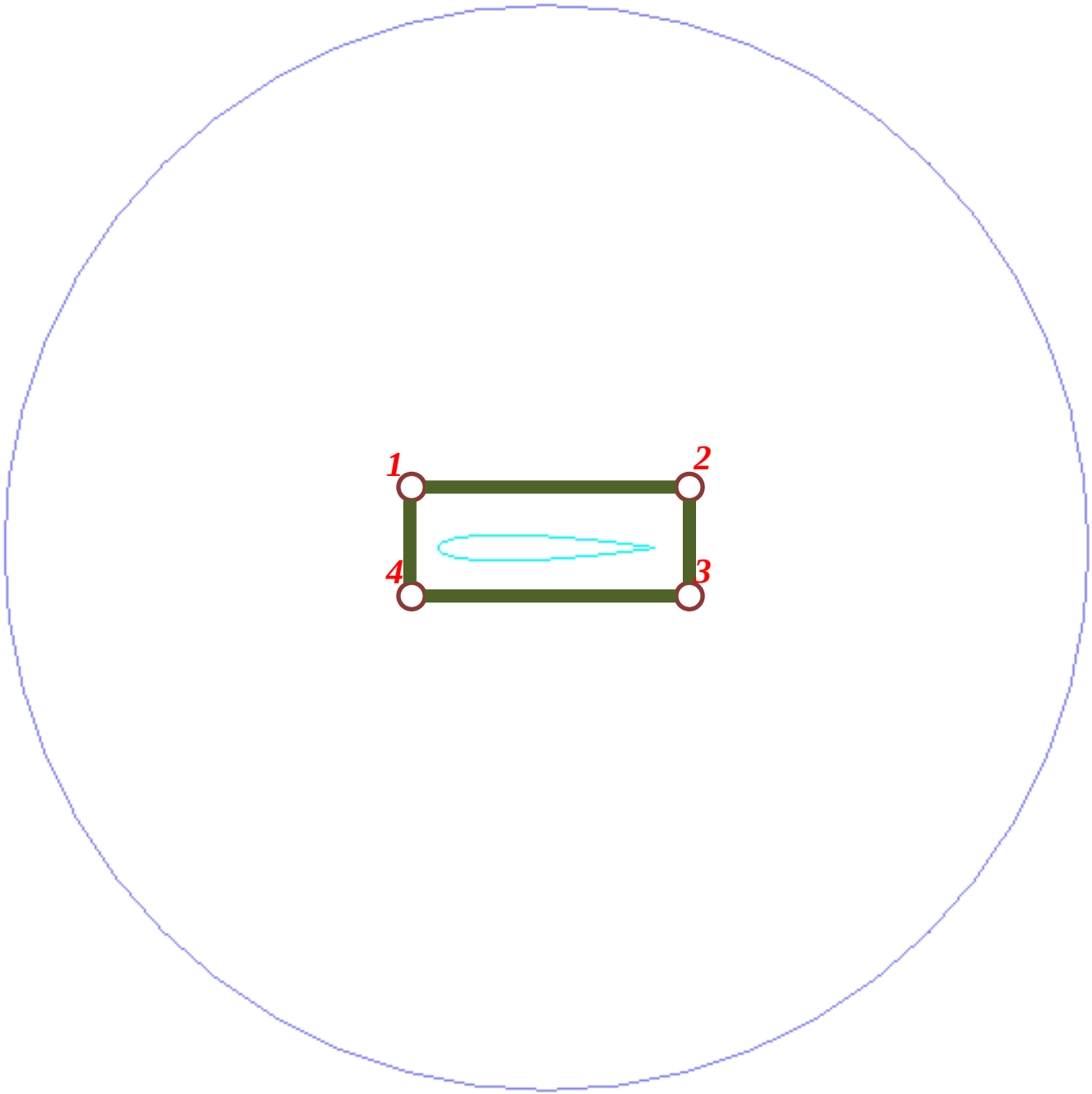
Since the corners **C1, C2 ,C3,C4** are assigned to the airfoil, the Block:1 is excluded automatically.

Blocks will be renumbered by the grid generator when the grid is created.

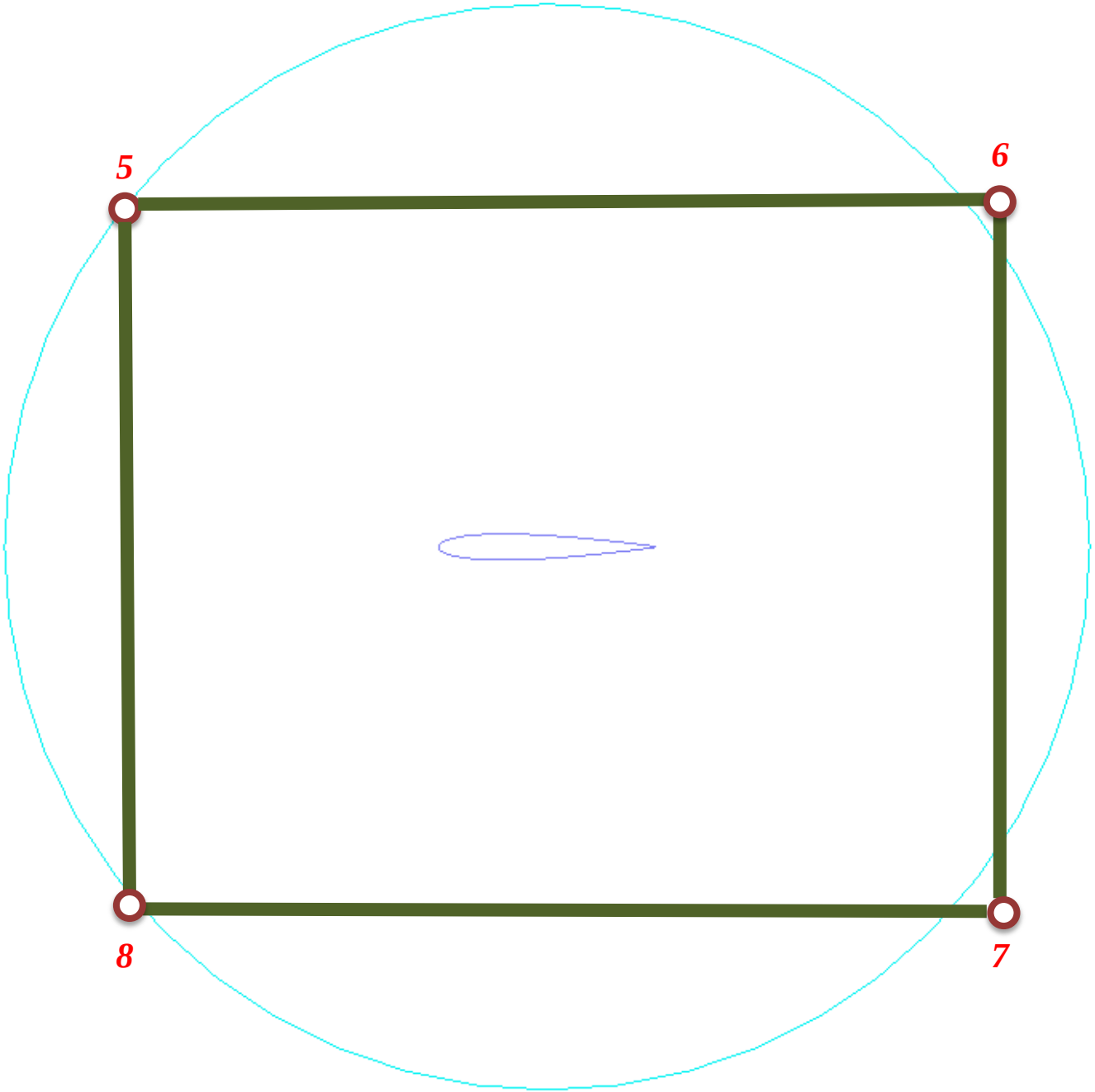


To check whether the correct corners have been assigned, click on the "**s**" group button as shown below. This highlights only the corners that have been assigned to the current surface.



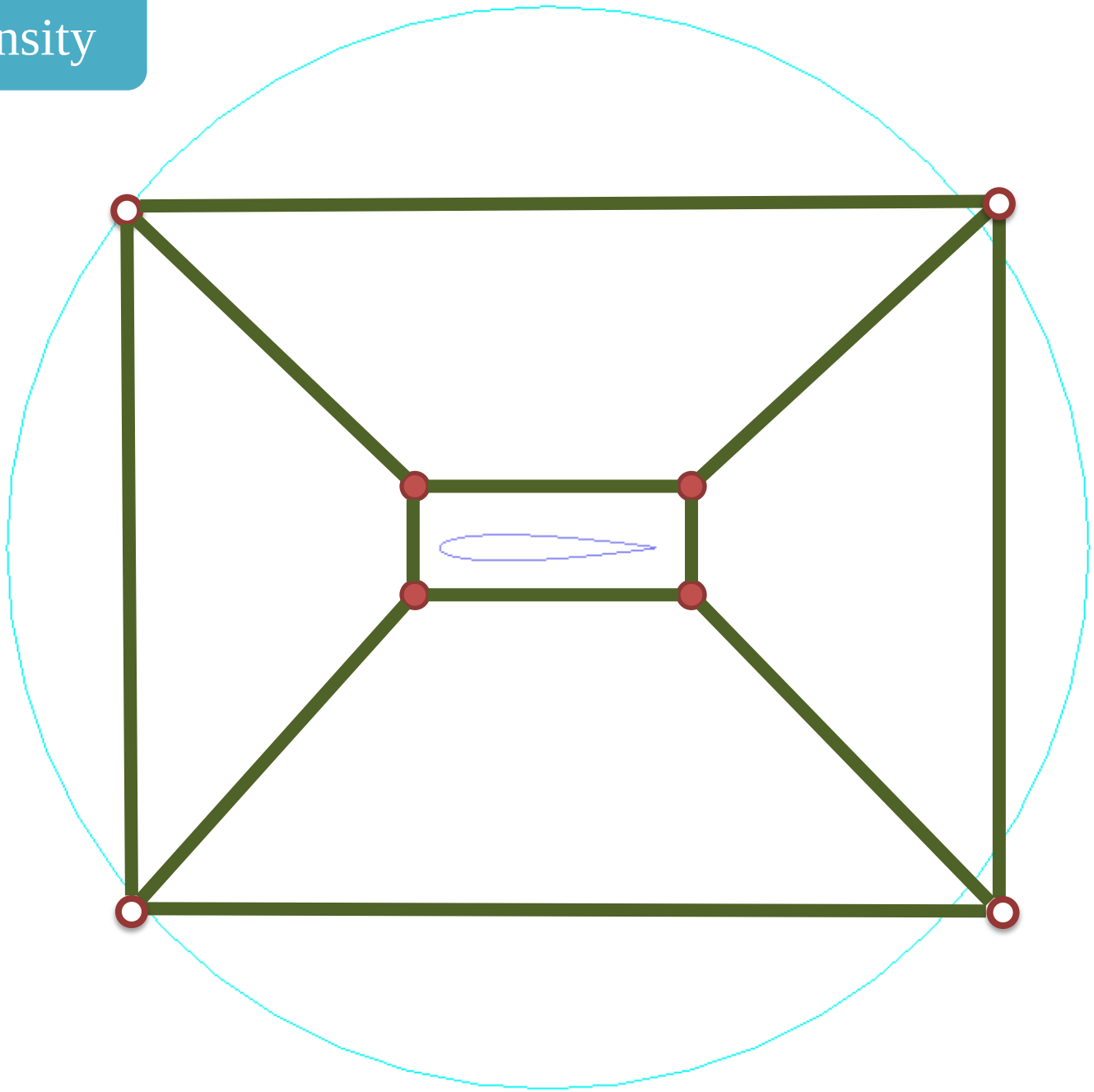


Scroll through surface to check the assignments of the outer surface

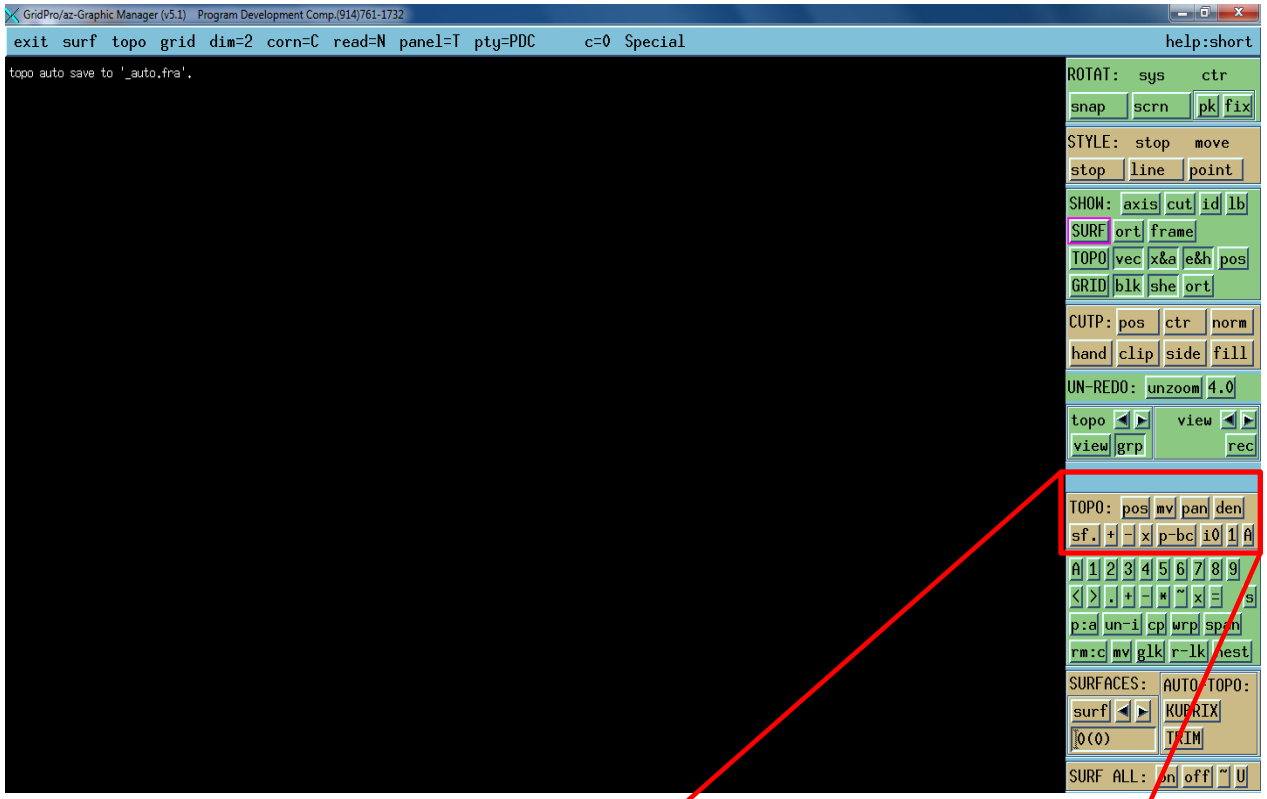


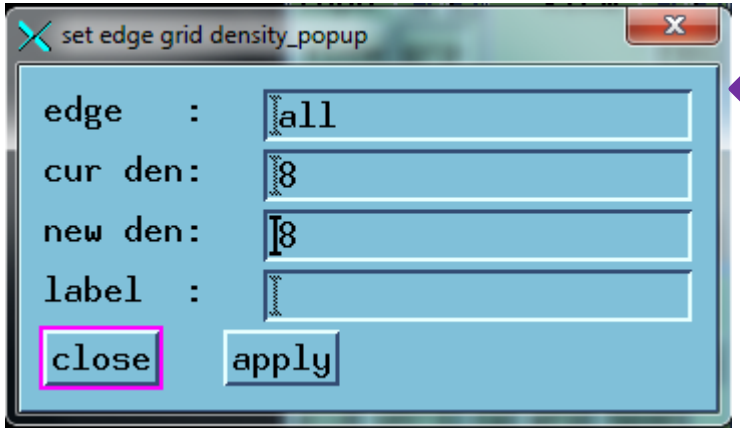
Changing the density

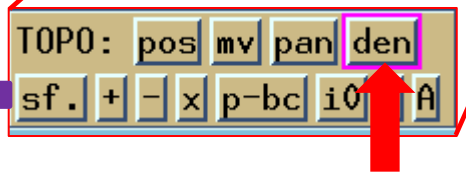
The default density of an edge is 8. The default density is very sparse compared to the size of the domain, so the density needs to be increased.



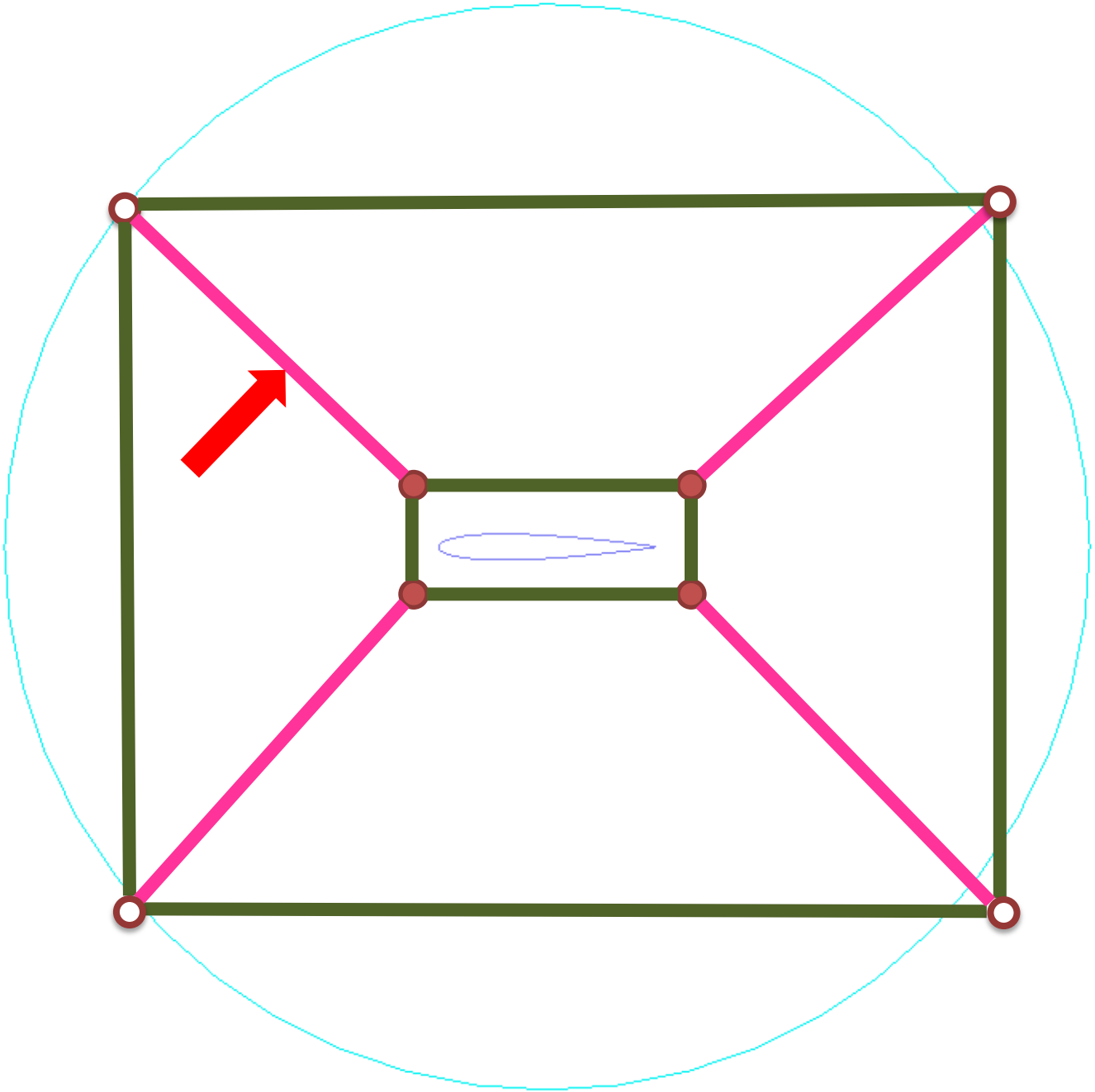
To change the density of an edge click on the '**den**' button as shown below.





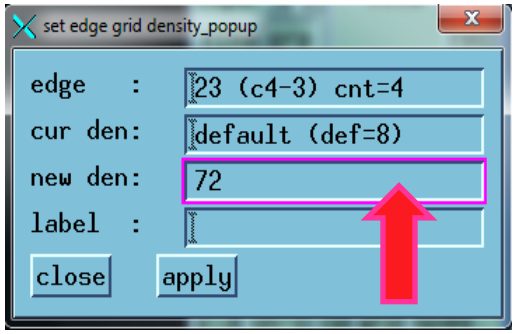


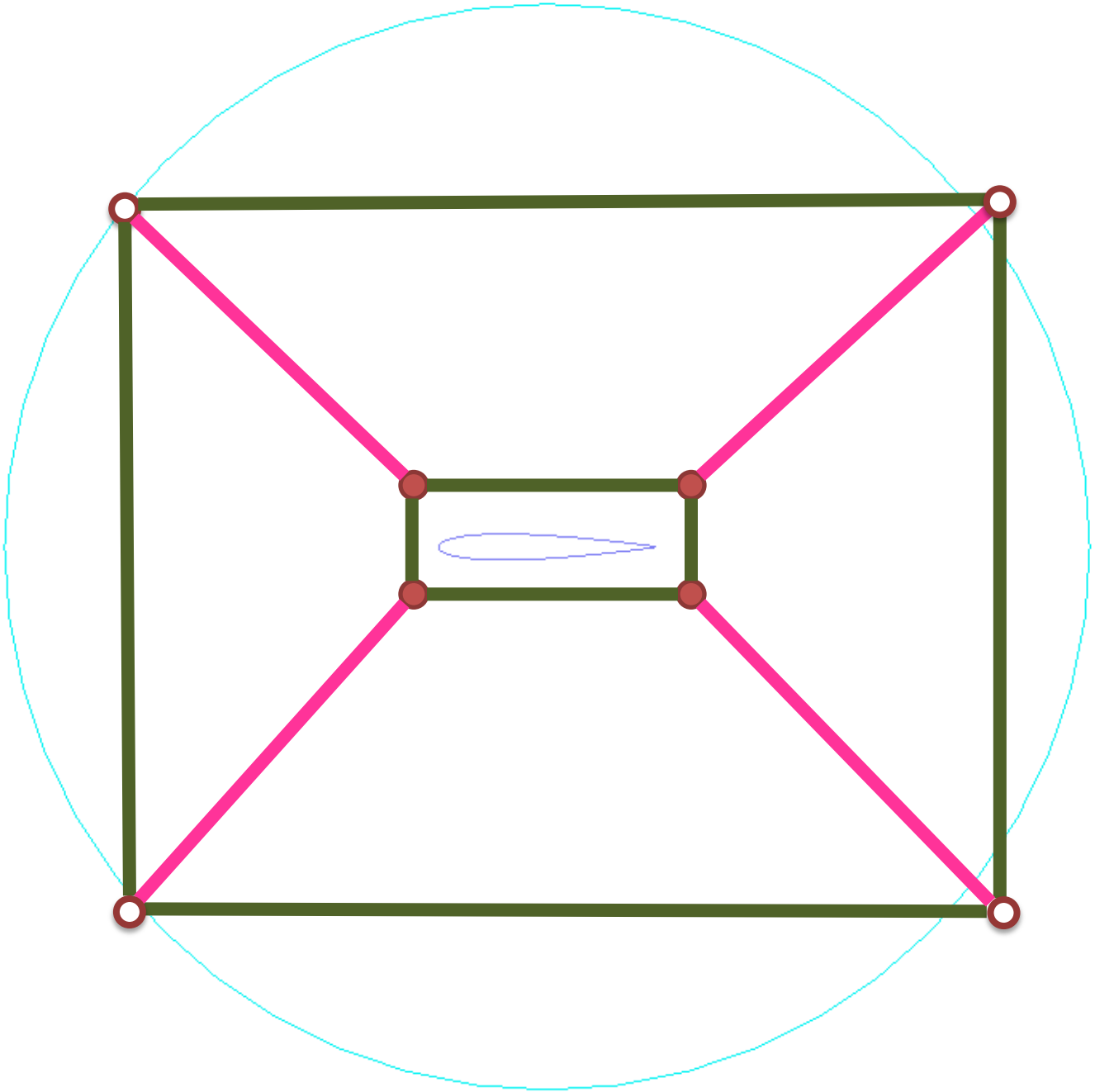
Once the '**den**' button is clicked, click on the edge whose density has to be changed.



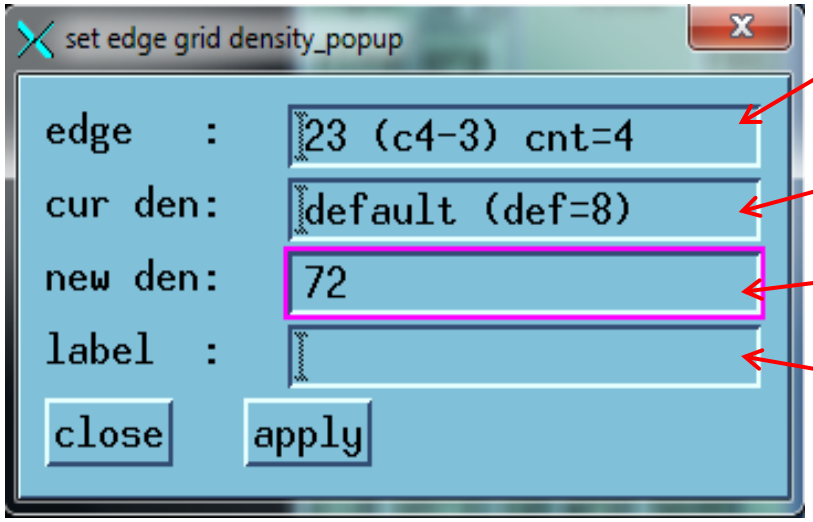
The selected edge will be highlighted in pink colour and it will also highlight the corresponding edges by default

Enter the new density in the place as shown below and click apply





Save file as ‘step13.fra’



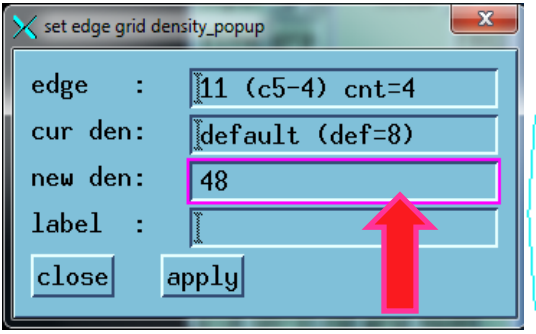
Edge no., corners which are linked to form the edge, total no. of edges selected

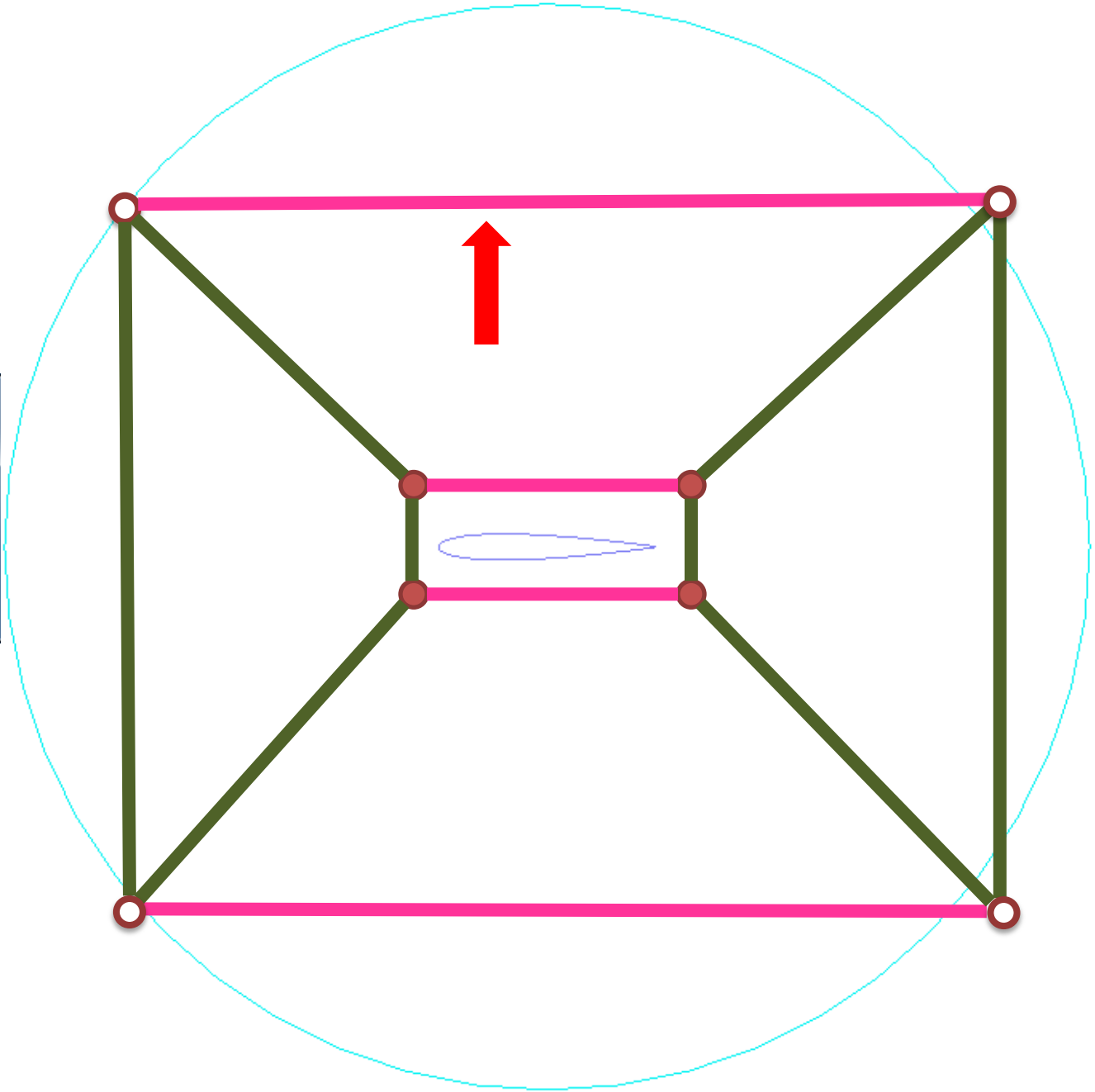
Current density of the edge

New density should be entered here

The selected edge can be named

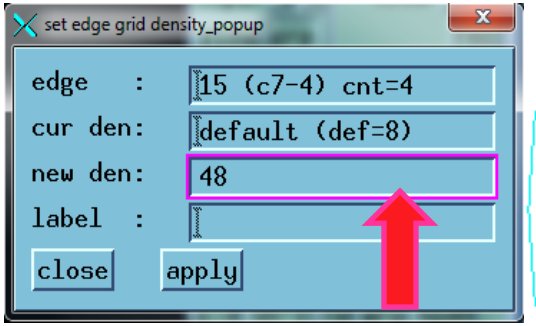
Then click on the other edge as shown and change its density to 48

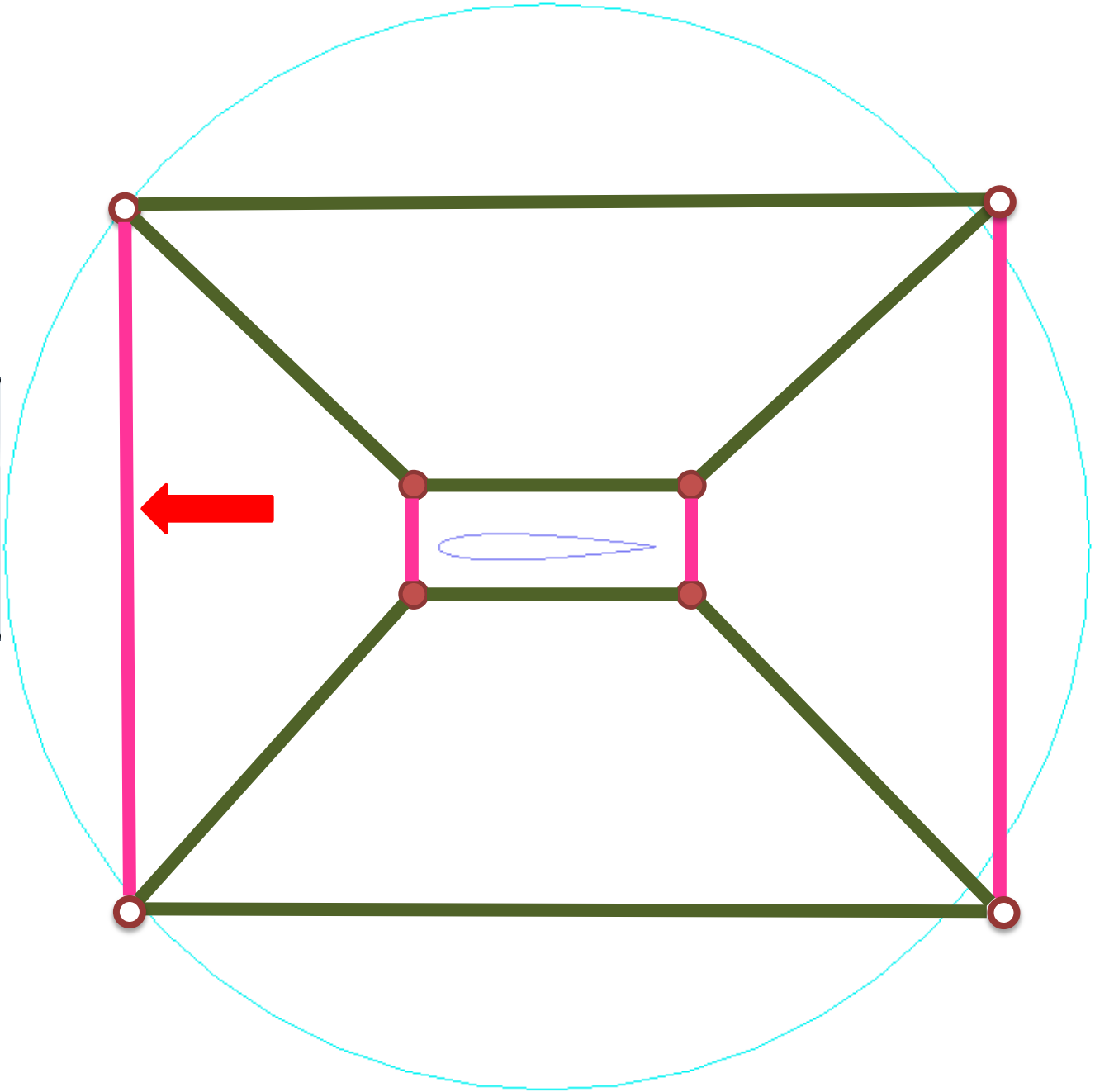




Save file as ‘step14.fra’

Then click on the other edge as shown and change its density to 48

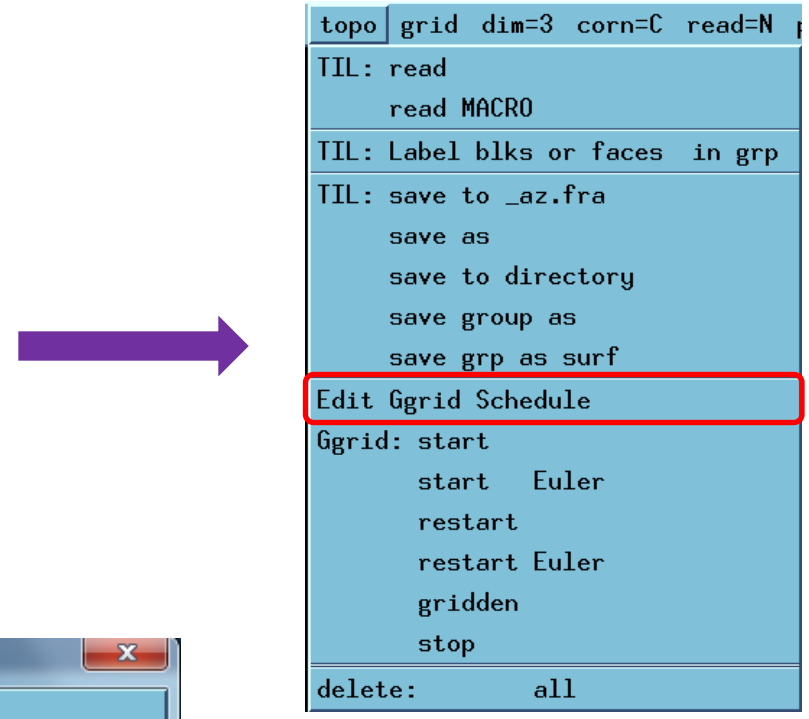


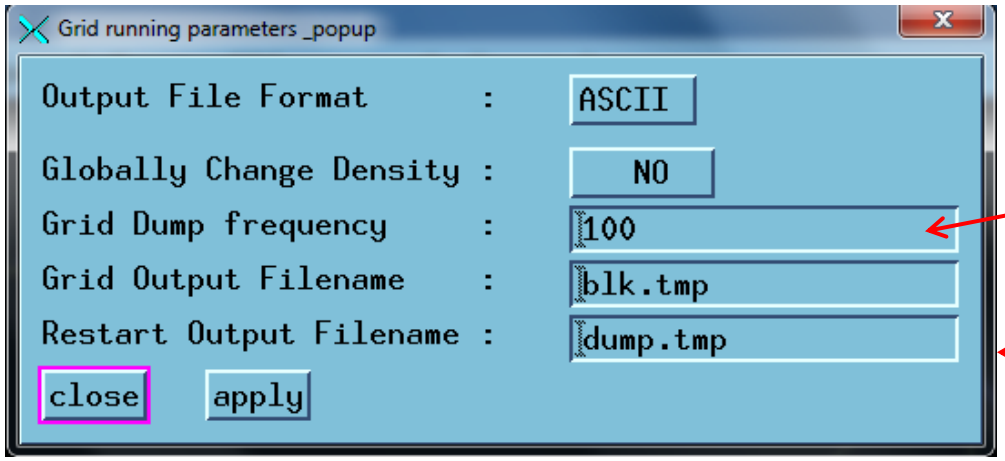


Save file as ‘step15.fra’

Grid Generation

Before starting the gridding process, we have to edit the grid schedule. Go to topo →**Edit Ggrid Schedule**

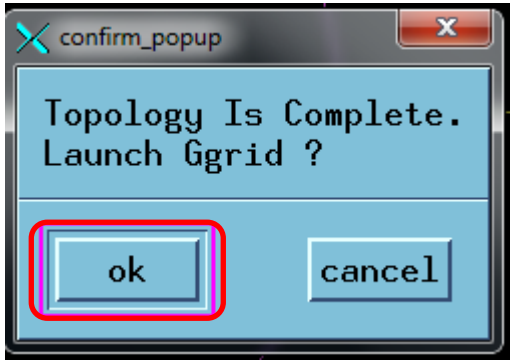




The grid file will be written after every 100 sweeps

These are the default settings. It can be edited by user.

To start the gridding process, go to **topo → Ggrid: start**. It opens a window saying topology complete.



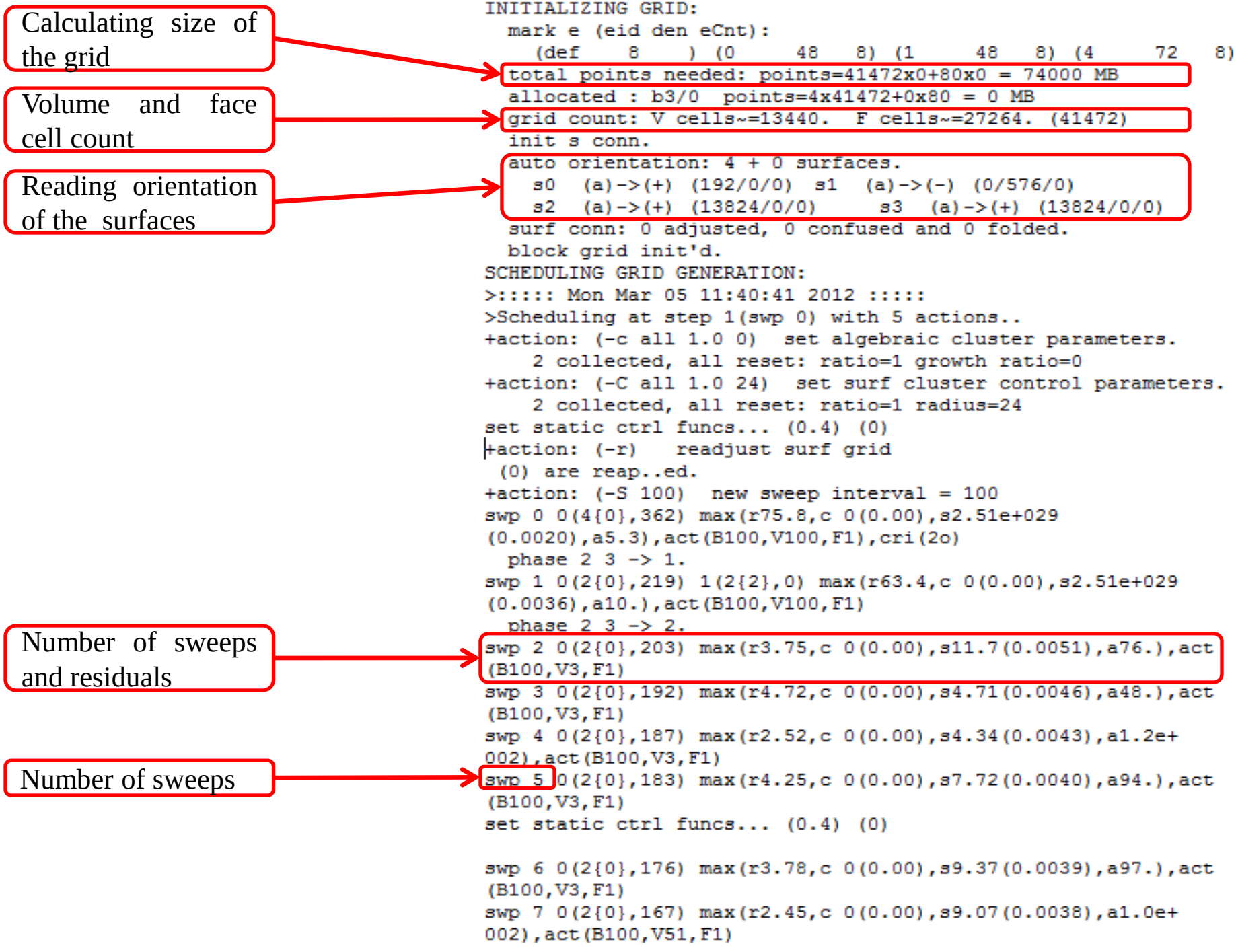
Press ‘ok’

Monitor the command window to view the grid generation process

Checking license details

Reading the topology information

```
#Version: GridPro-v5.1(Aug 27 11:00 2009)    Topology:
..TUTORIAL/Airfoil tutorials/Airfoil with round trailing edge/
_az.fra
#Start  : Mon Mar 05 11:40:41 2012      Current : Mon Mar 05
11:40:41 2012
Version  : 5.1 (Aug 27 10:52 2009)
User Info:
WAIT.FN _stamp.tmp     (_stamp.tmp)     _stamp.tmp
SEARCH.SEED 1330927841
PROCESSING TIL INPUT:
  parsing '_az.fra' as header:  1/1
       'main'     'surf'     'corn'
  linking components:
c272 e208 f240 b276 s1272 sd112
  expanding topology:
GENERATING TOPOLOGY:
       4 surfaces.
      16 corners
      32 edges
      24 faces.  excluded: manual 0.
   a solid b btw f5(7 1 0 6) and f1(5 2 3 4) on surf 2....
   a solid b btw f10(11 3 0 8) and f7(10 2 1 9) on surf 0....
   a solid b btw f20(15 9 8 14) and f12(13 10 11 12) on surf
3....
   a solid b btw f23(15 7 5 13) and f17(14 6 4 12) on surf 1....
       4 blocks. excluded: manual 0, solid 4
   f0(3 1) with 0 b is auto excluded.
   f3(7 4) with 0 b is auto excluded.
   f8(11 9) with 0 b is auto excluded.
   f18(15 12) with 0 b is auto excluded.
  Auto exclusion:
    b 4 -> 4, f 24 -> 20 (detail in 'log.tmp').
  Statistics of singularities:
  There are 4 edge groups.
LOADING SURFACES:
  s0 (a) linear '..Airfoil tutorials/Airfoil with round trailing
edge/0012airfoil.dat':  dim 4289X1X1
     2 cells adjusted for ort.
    init tree: branchs=4  bs=(m3,M4,avg3.1,lmt=4) depth_max=7
  s1 (a) ellip  model axes (1 0 0) (0 1 0) (0 0 1)
     inv scales (0.2 0.2 0), ctr (1 0 0)
  s2 (a) plane( -Z = -100 )
  s3 (a) plane(  Z = -100 )
```



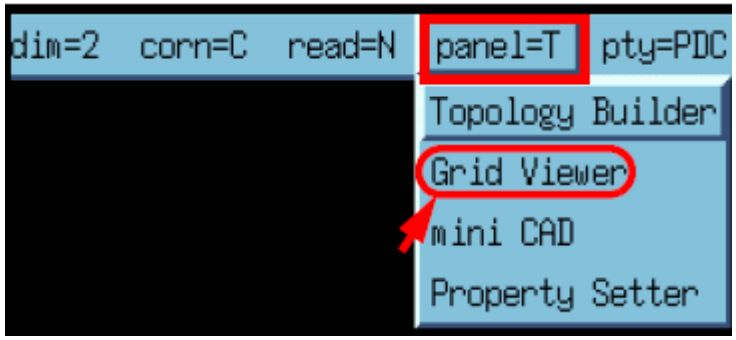

```
INITIALIZING GRID:
  mark e (eid den eCnt):
    (def     8     ) (0      48    8) (1      48    8) (4      72    8)
  total points needed: points=41472x0+80x0 = 74000 MB
  allocated : b3/0  points=4x41472+0x80 = 0 MB
  grid count: V cells~=13440.  F cells~=27264. (41472)
  init s conn.
  auto orientation: 4 + 0 surfaces.
    s0   (a)->(+)  (192/0/0)  s1   (a)->(-)  (0/576/0)
    s2   (a)->(+)  (13824/0/0)      s3   (a)->(+)  (13824/0/0)
  surf conn: 0 adjusted, 0 confused and 0 folded.
  block grid init'd.
SCHEDULING GRID GENERATION:
>::::: Mon Mar 05 11:40:41 2012 :::::
>Scheduling at step 1(swp 0) with 5 actions..
+action: (-c all 1.0 0)  set algebraic cluster parameters.
    2 collected, all reset: ratio=1 growth ratio=0
+action: (-C all 1.0 24)  set surf cluster control parameters.
    2 collected, all reset: ratio=1 radius=24
set static ctrl funcs... (0.4) (0)
+action: (-r)   readjust surf grid
 (0) are reap..ed.
+action: (-S 100)  new sweep interval = 100
swp 0 0(4{0},362) max(r75.8,c 0(0.00),s2.51e+029
(0.0020),a5.3),act(B100,V100,F1),cri(2o)
  phase 2 3 -> 1.
swp 1 0(2{0},219) 1(2{2},0) max(r63.4,c 0(0.00),s2.51e+029
(0.0036),a10.),act(B100,V100,F1)
  phase 2 3 -> 2.
swp 2 0(2{0},203) max(r3.75,c 0(0.00),s11.7(0.0051),a76.),act
(B100,V3,F1)
swp 3 0(2{0},192) max(r4.72,c 0(0.00),s4.71(0.0046),a48.),act
(B100,V3,F1)
swp 4 0(2{0},187) max(r2.52,c 0(0.00),s4.34(0.0043),a1.2e+
002),act(B100,V3,F1)
swp 5 0(2{0},183) max(r4.25,c 0(0.00),s7.72(0.0040),a94.),act
(B100,V3,F1)
set static ctrl funcs... (0.4) (0)

swp 6 0(2{0},176) max(r3.78,c 0(0.00),s9.37(0.0039),a97.),act
(B100,V3,F1)
swp 7 0(2{0},167) max(r2.45,c 0(0.00),s9.07(0.0038),a1.0e+
002),act(B100,V51,F1)
```

```
swp 95 max(r0.225,c 0(0.00),s1.90(0.0022),a8.1),act(B81,V33,F2)
  surf conn: 0 adjusted, 0 confused and 0 folded.
set static ctrl funcs... (0.4) (0)
swp 96 max(r0.420,c 0(0.00),s1.88(0.0021),a8.1),act(B93,V36,F2)
swp 97 max(r0.418,c 0(0.00),s1.88(0.0021),a8.1),act(B81,V31,F2)
swp 98 max(r0.420,c 0(0.00),s1.89(0.0022),a8.1),act(B75,V31,F2)
swp 99 max(r0.419,c 0(0.00),s1.91(0.0022),a8.1),act(B87,V28,F3)
Amount of time taken for 100 sweeps is 0 hours 0 minutes 0
seconds
+action: (-w)  output blocks
  all to 'blk.tmp':
Write action took 0 hours 0 minutes 0 seconds
  all to 'dump.tmp':
Write action took 0 hours 0 minutes 0 seconds
>::::: Fri Mar 02 15:48:33 2012 :::::
>Scheduling at step 2(swp 100) with 5 actions..
+action: (-c all 1.0 0)  set algebraic cluster parameters.
    2 collected, all reset: ratio=1 growth ratio=0
+action: (-C all 1.0 24)  set surf cluster control parameters.
    2 collected, all reset: ratio=1 radius=24
set static ctrl funcs... (0.4) (0)
+action: (-r)   readjust surf grid
 (0) are reap..ed.
+action: (-S 100)  new sweep interval = 100
swp 100 max(r0.420,c 0(0.00),s1.88(0.0021),a8.1),act(B68,V26,F2)
set static ctrl funcs... (0.4) (0)
swp 101 max(r0.234,c 0(0.00),s1.88(0.0022),a8.1),act(B75,V32,F2)
swp 102 max(r0.238,c 0(0.00),s1.89(0.0021),a8.1),act(B68,V27,F2)
```

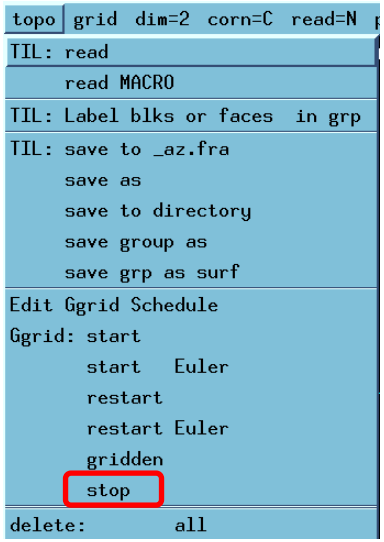
Run the gridding process to get 0 surface folds

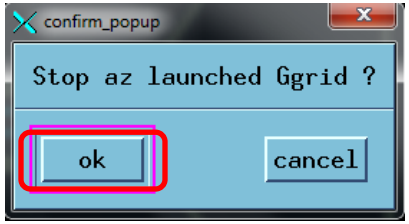
Writing after 100 sweeps

To view the grid, change the screen to grid viewer using the `panel=T` pull down menu in the menu bar



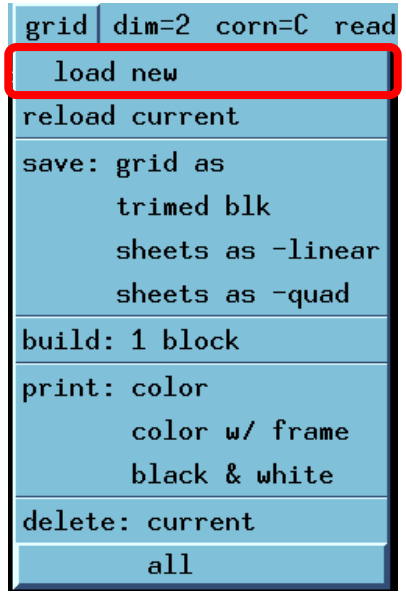
After 3000 sweeps, Do **topo → Ggrid: stop** to stop the gridding process



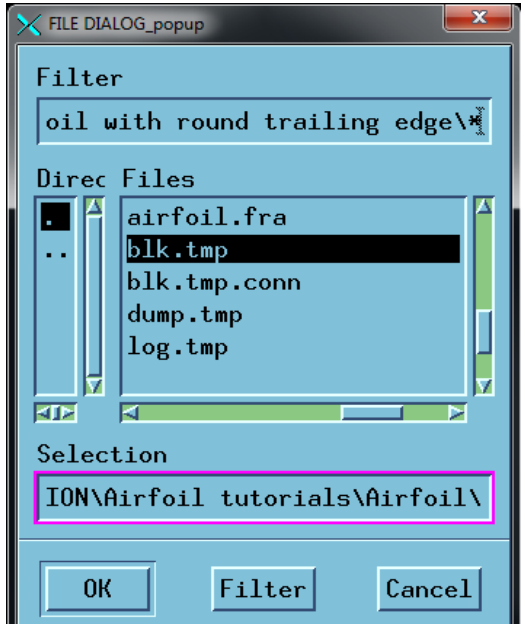


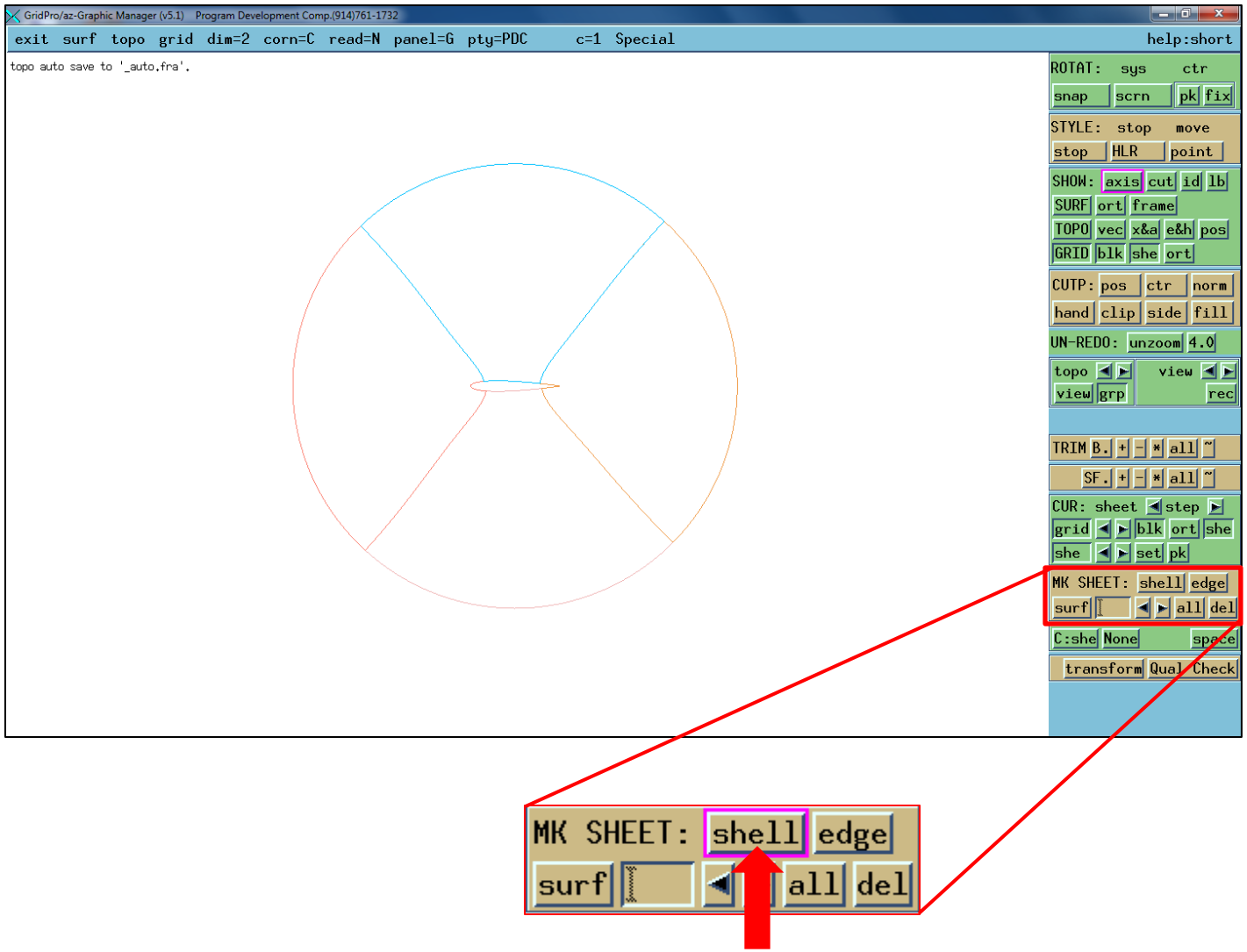
Note: Do not stop the grid while writing, it will corrupt the grid file.

Load the grid from the **grid** pull down menu

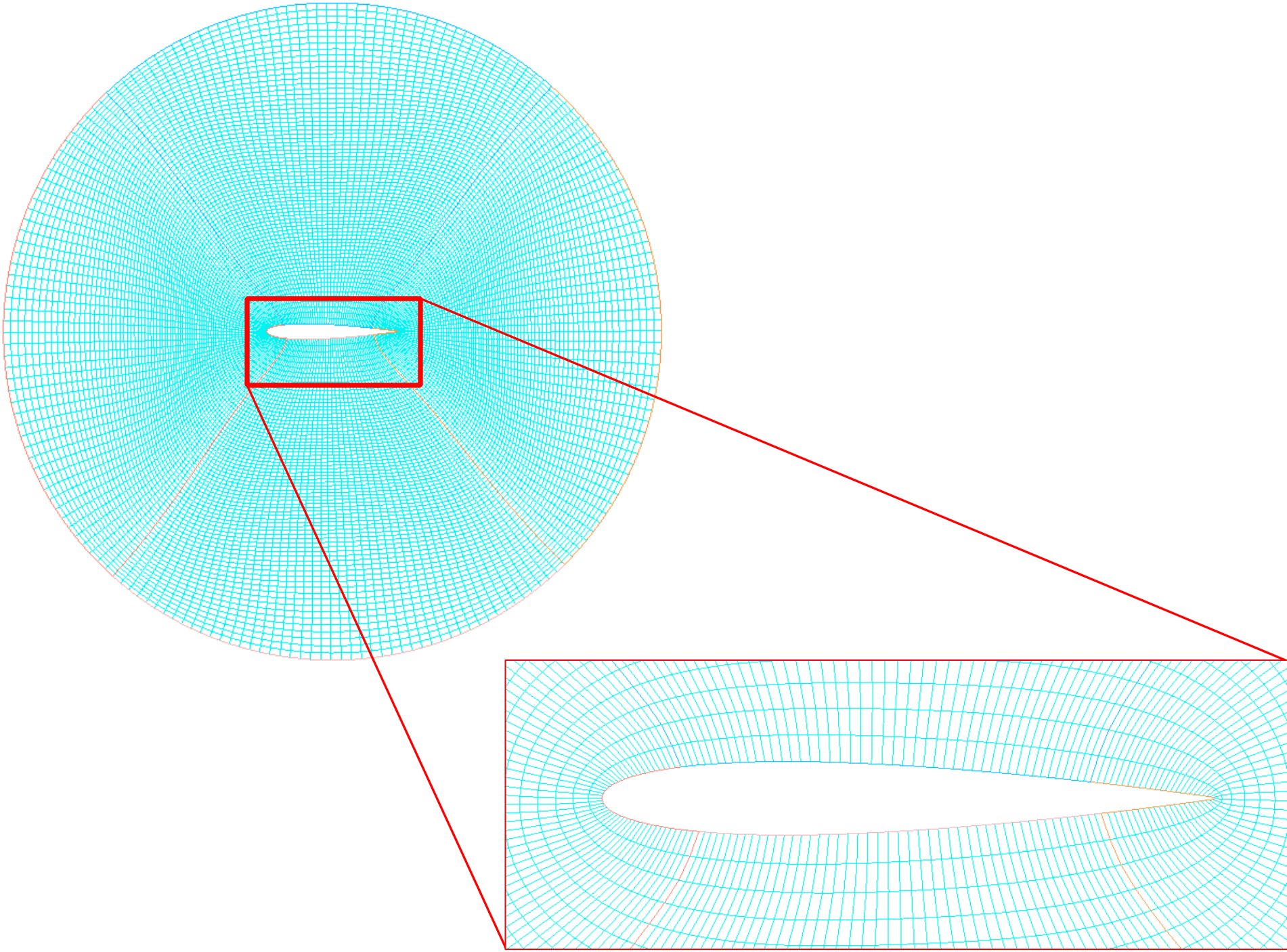


Select the file "**blk.tmp**" from the list and click ok.

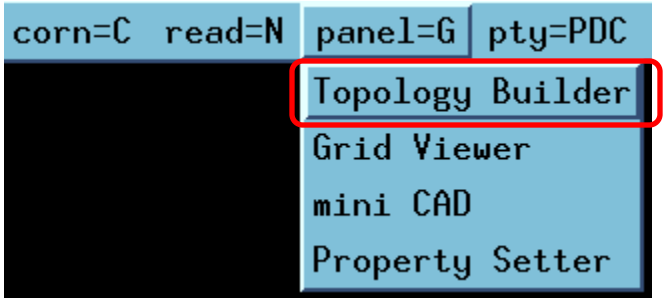




Select the '**shell**' button to view the grid lines



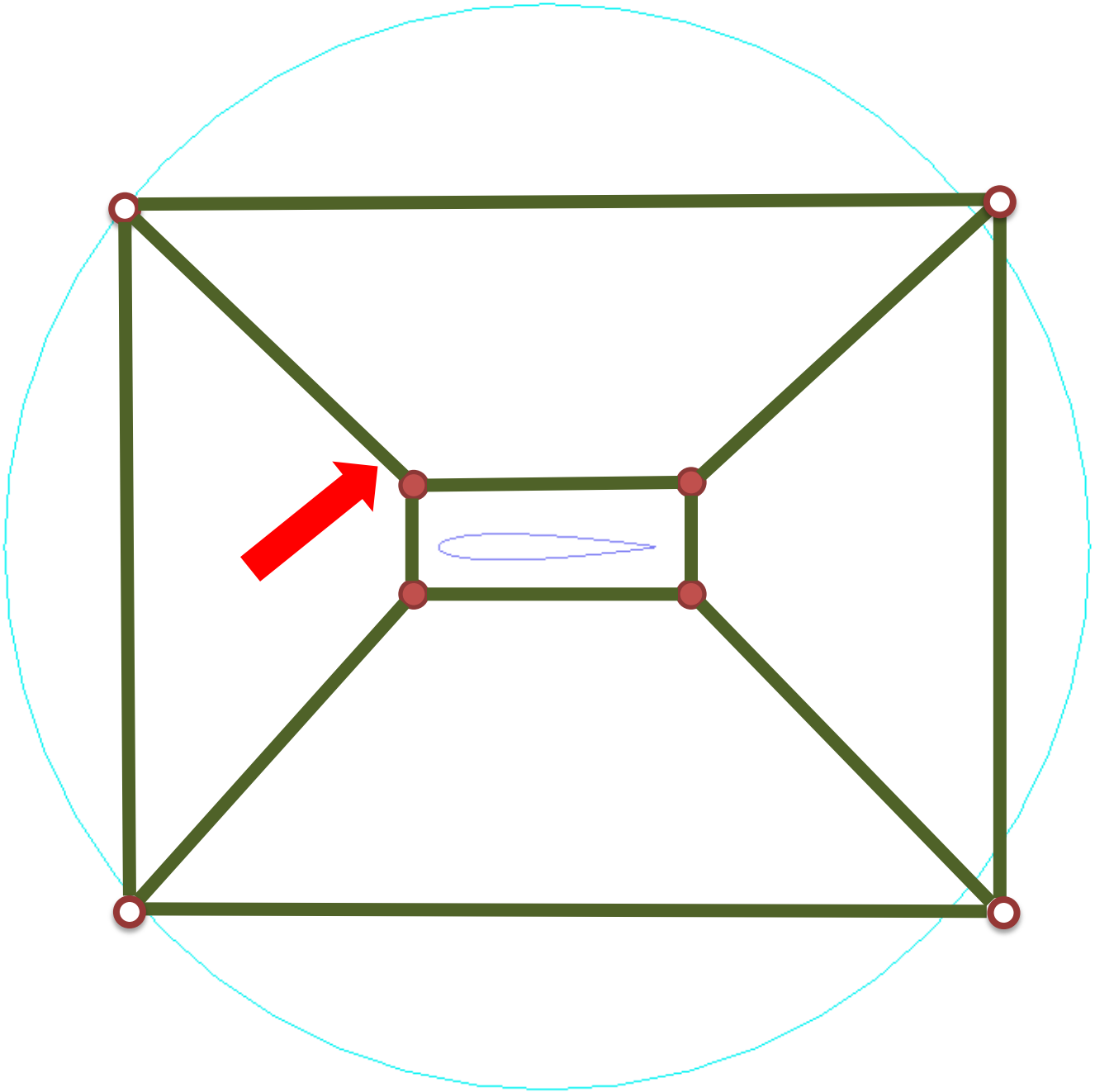
Change from grid viewer panel `panel=G` to the topology builder panel `panel=T`



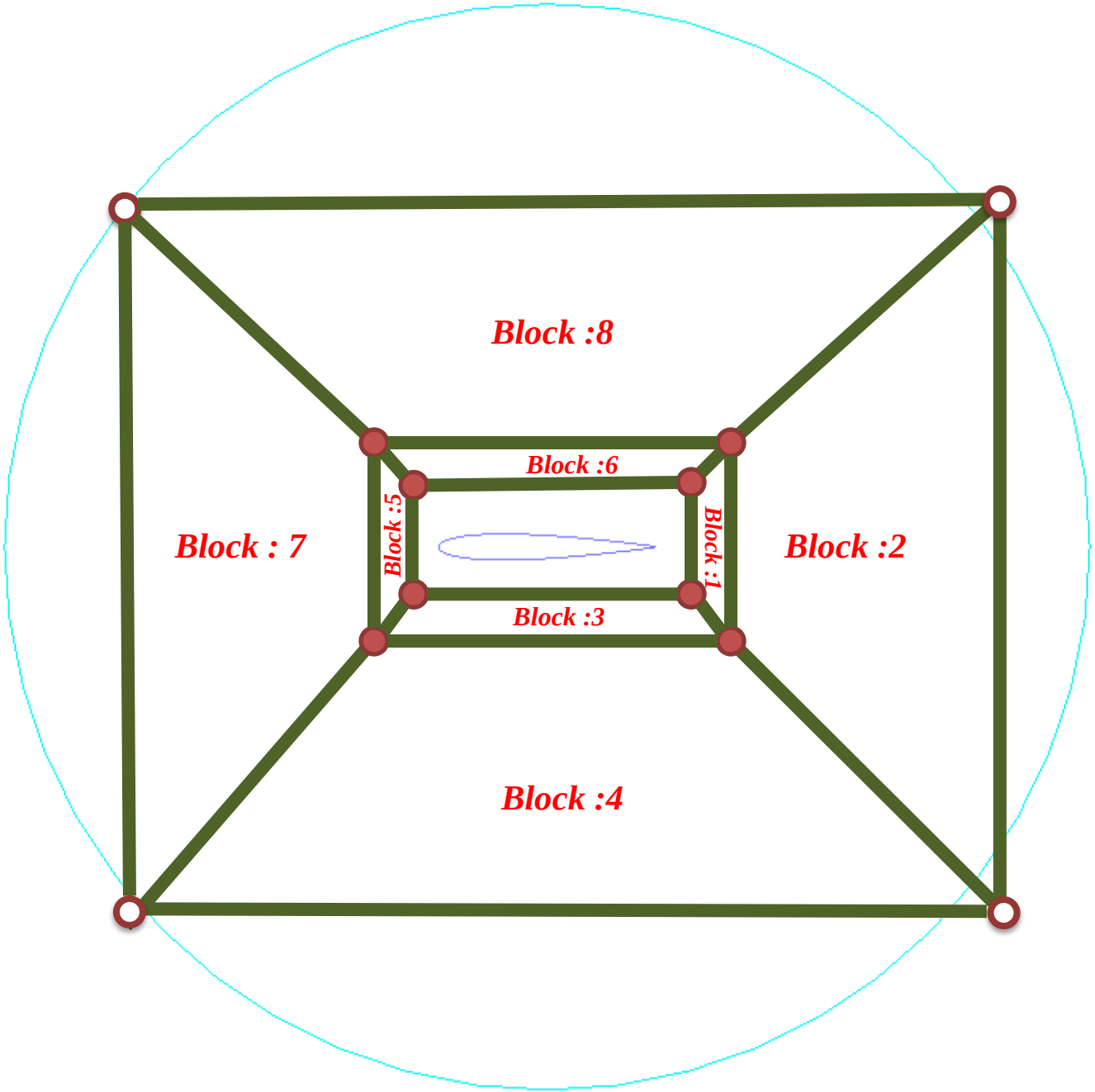
For better orthogonality around the airfoil, additional block boundaries around the geometries are required.

Hold the “**I**” Key on your Keyboard

Click on the edge closer to the inner box(as shown)

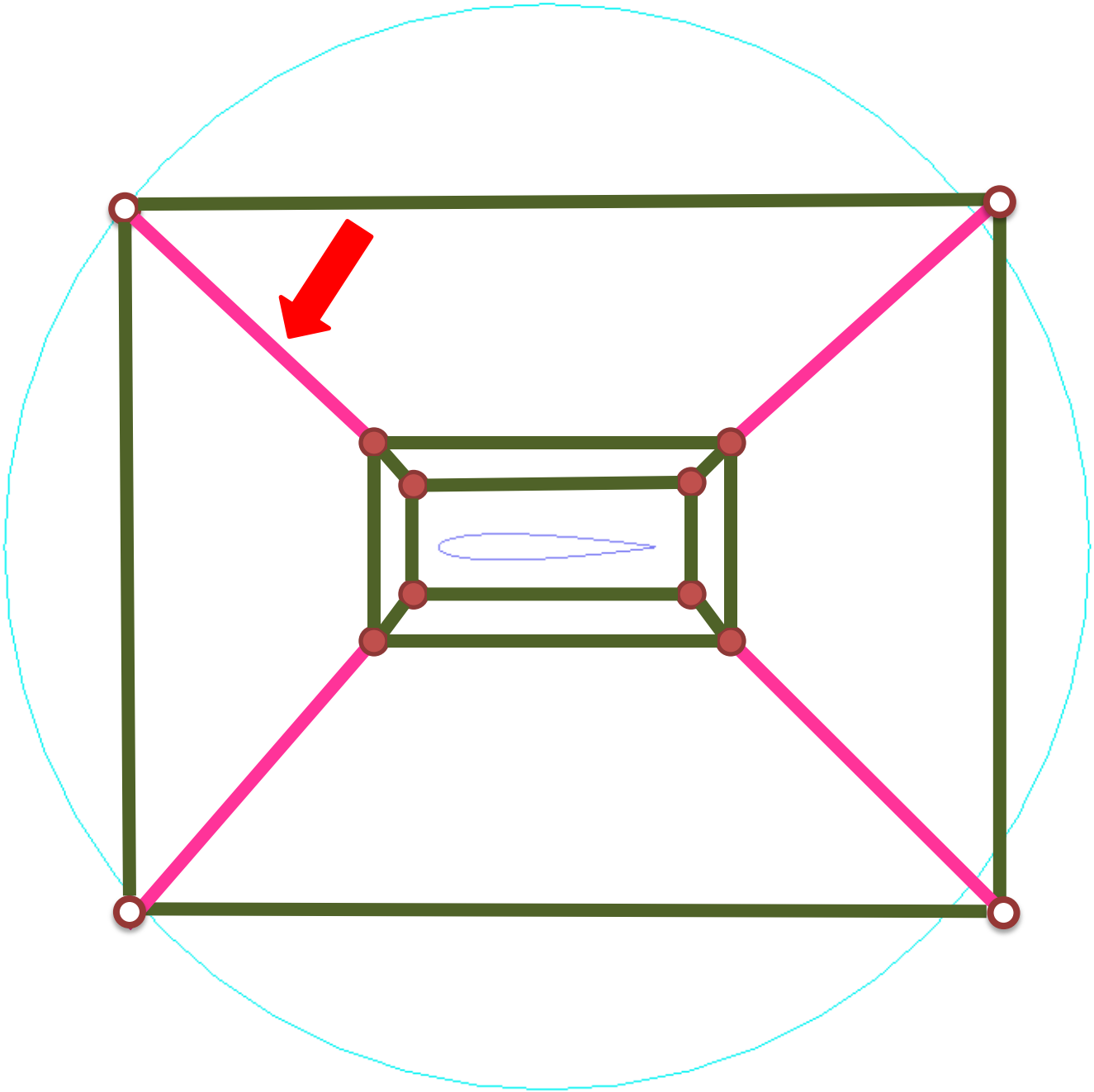


Now the block numbers of the topology has increased to 8



Save file as ‘step16.fra’

Now change the density of the shown edges to 80

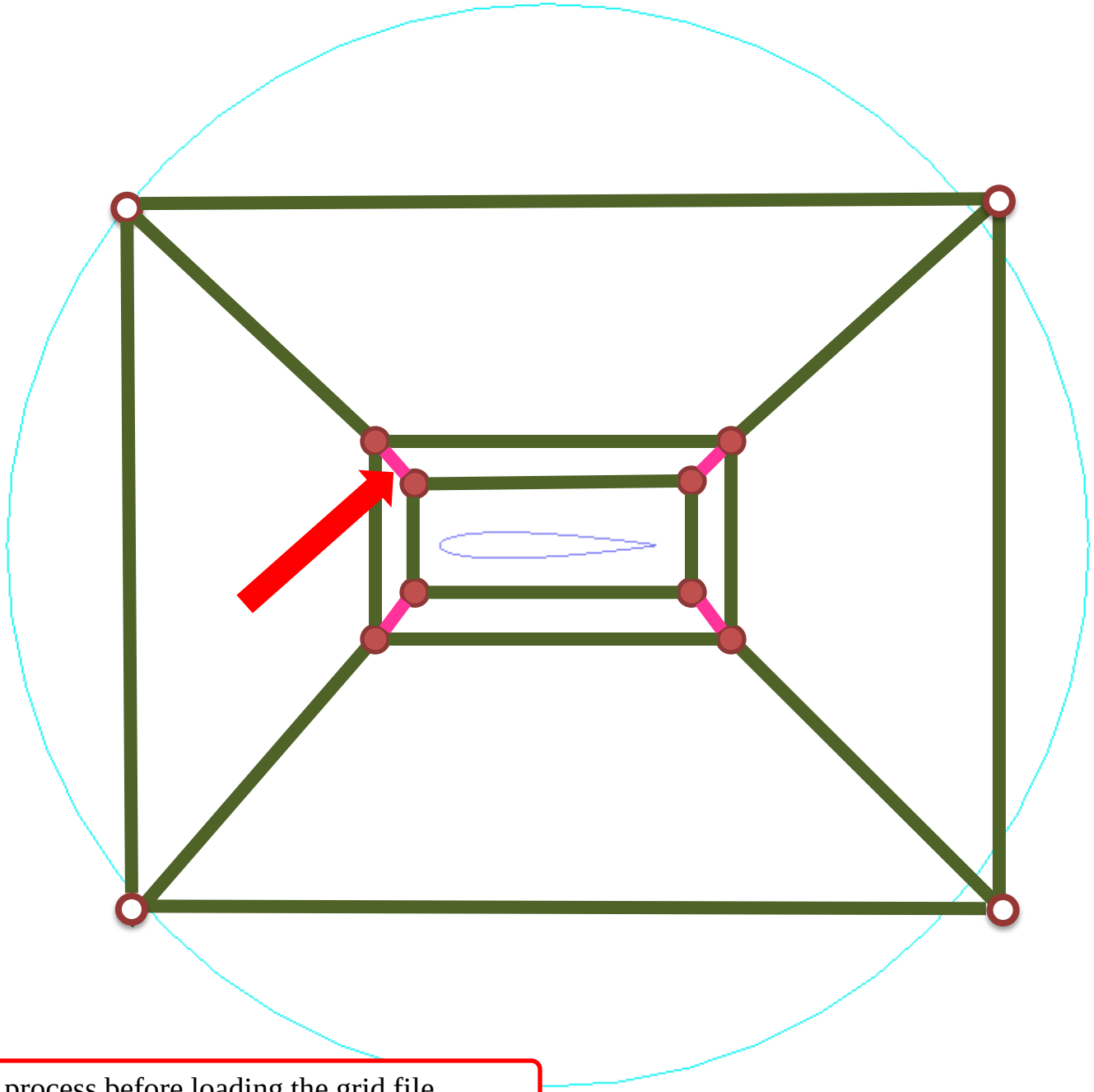


Save file as ‘step17.fra’

Similarly change the density of these edges to 16

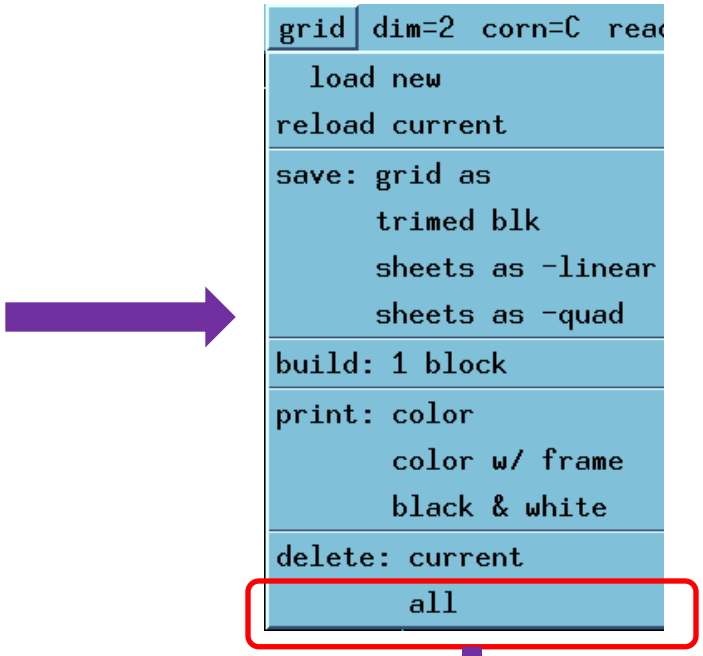
Save file as ‘step18.fra’

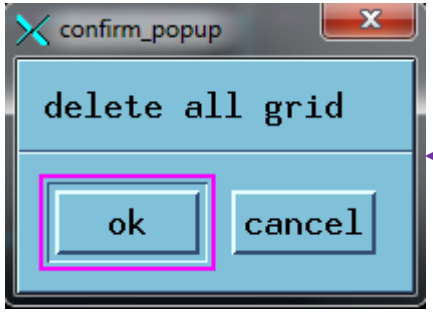
Then start the gridding process again.

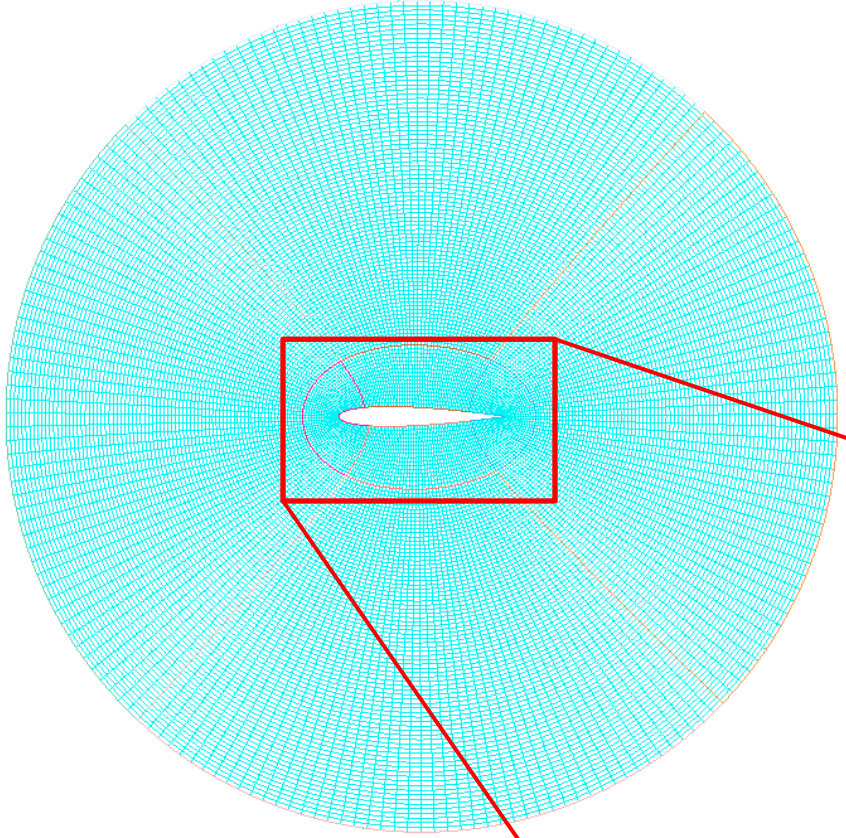


NOTE: Always stop the gridding process before loading the grid file

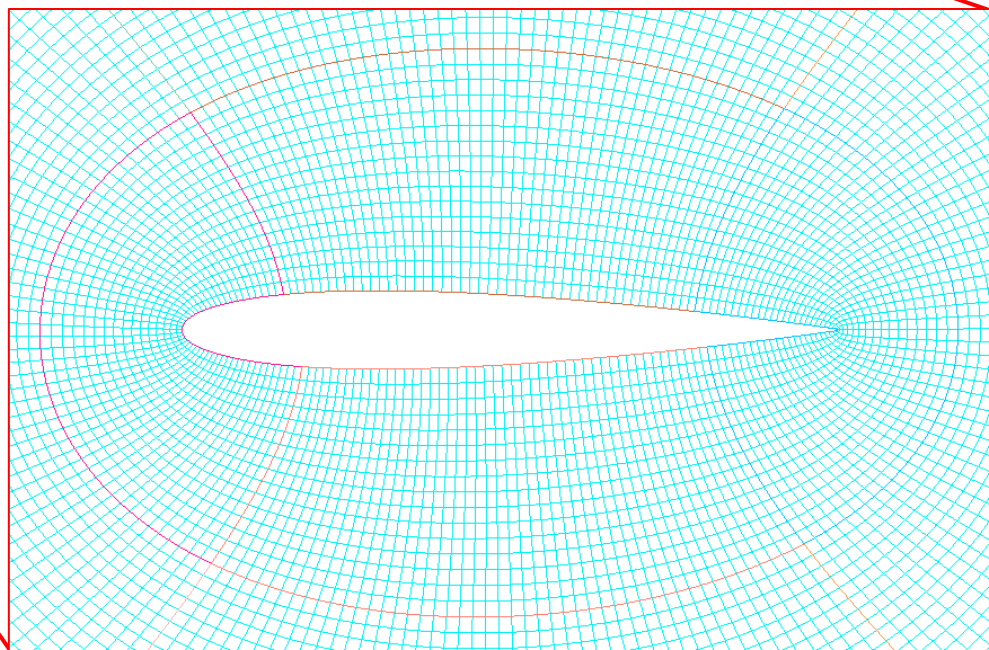
Before the new grid is loaded, the old grid should be deleted. To delete the old grid, go to **grid → delete: all**







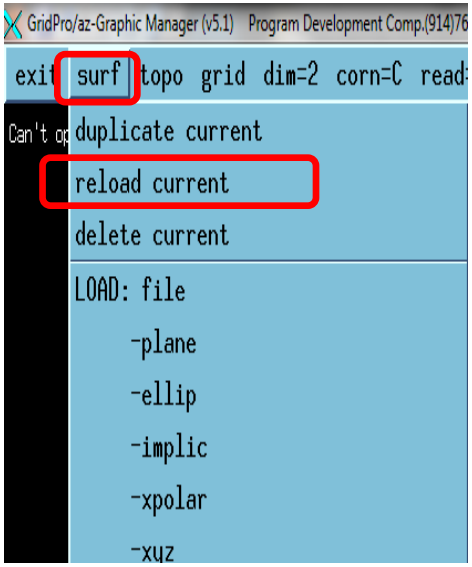
Load the ‘blk.tmp’ file again

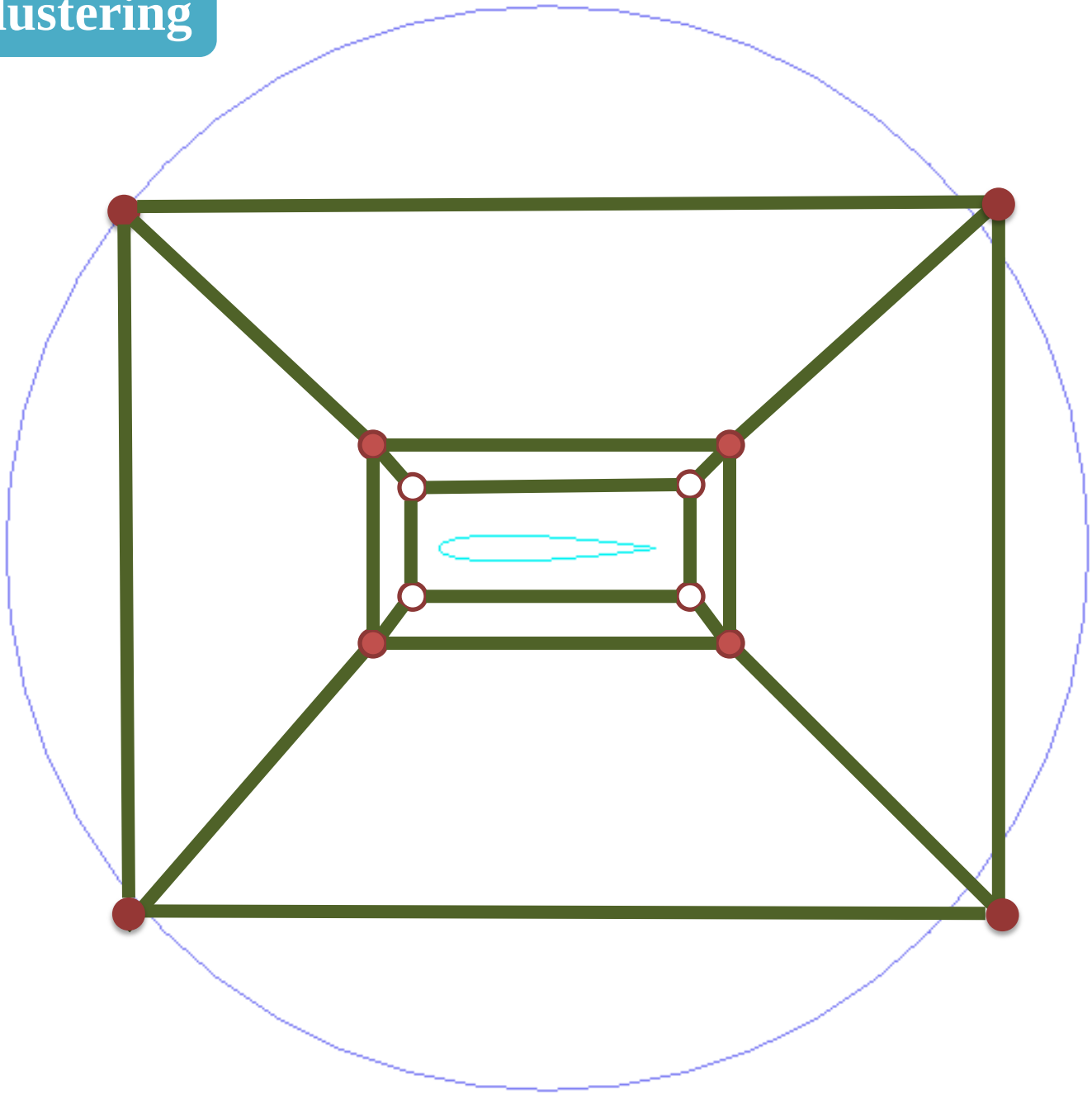


Boundary layer clustering

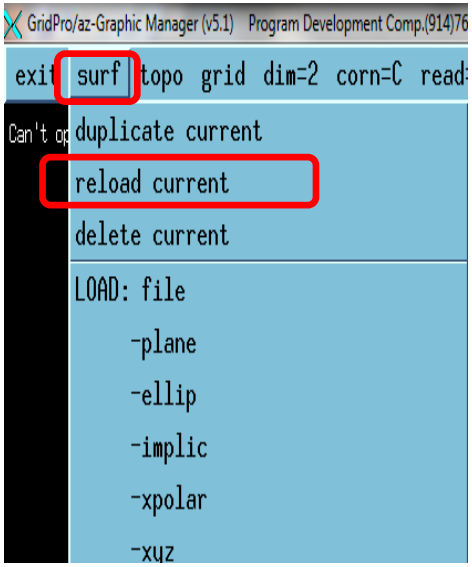
Make the airfoil as CURRENT SURFACE

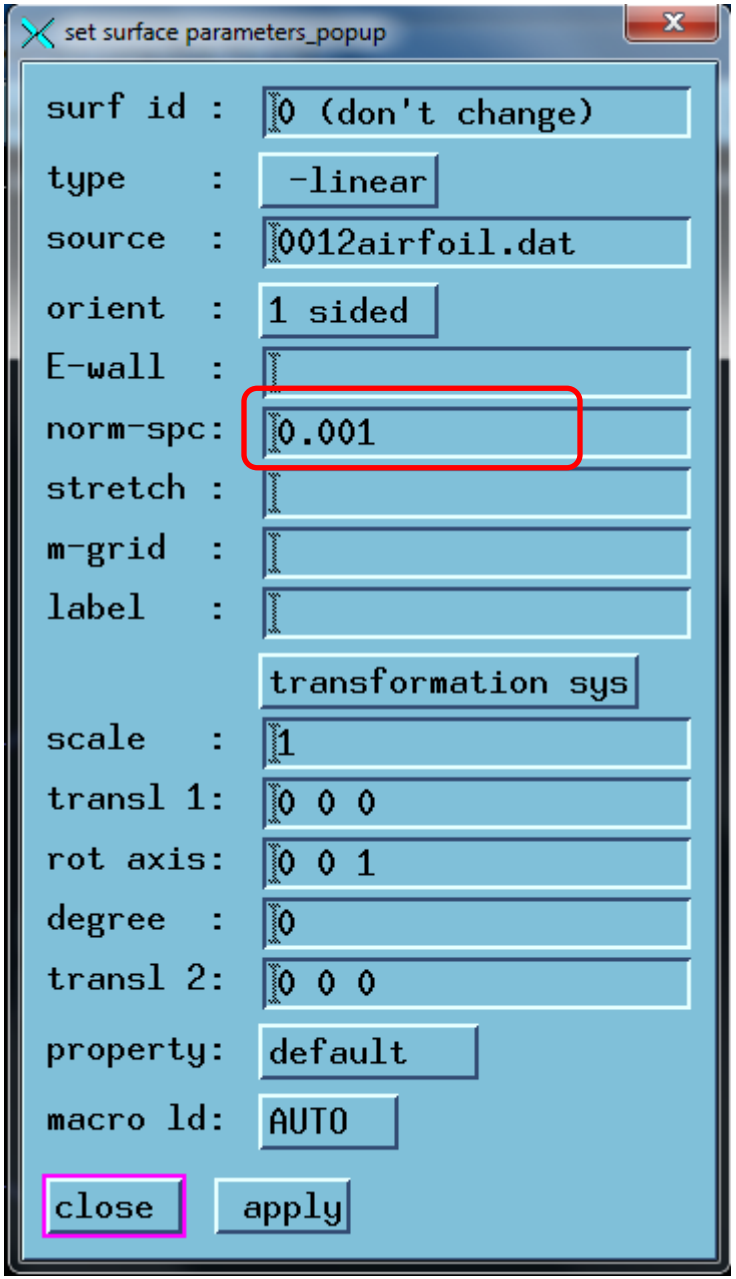
Go to **surf→reload current**





Enter the value in the norm-spc as shown



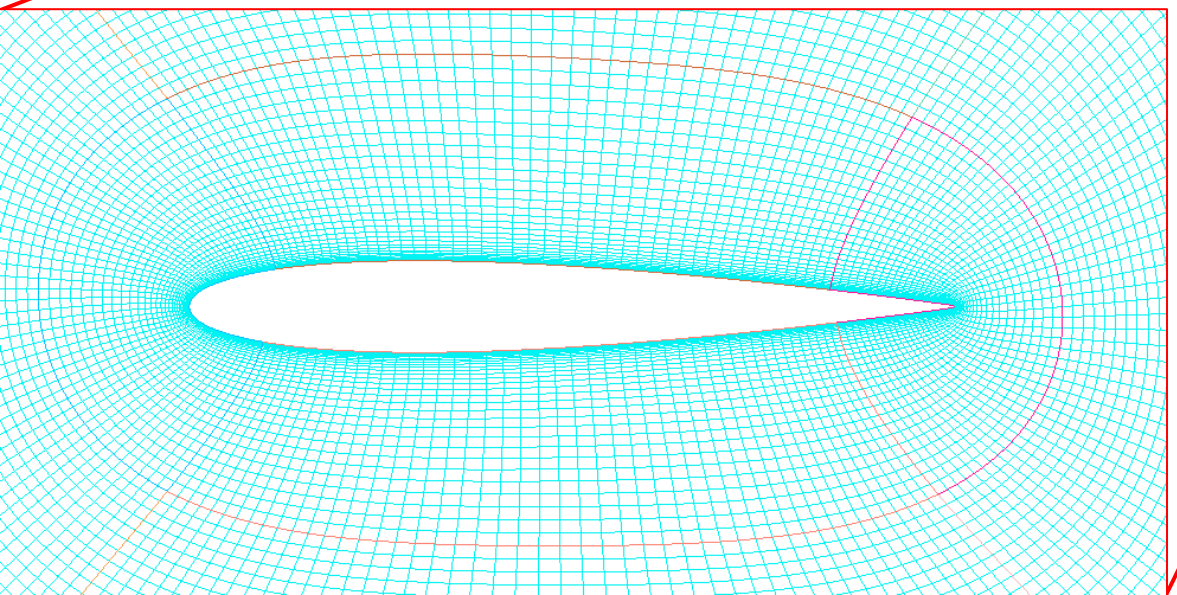


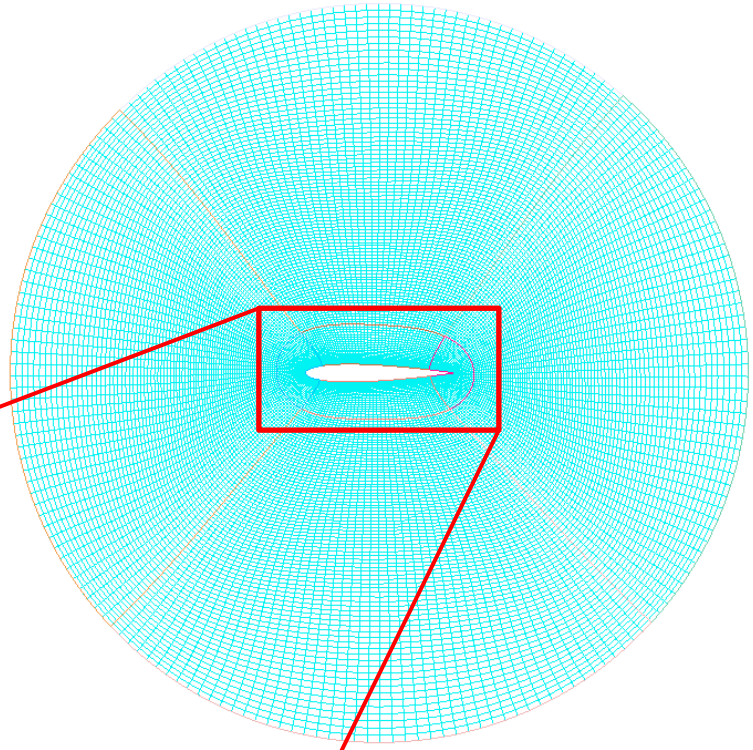
Press ‘apply’

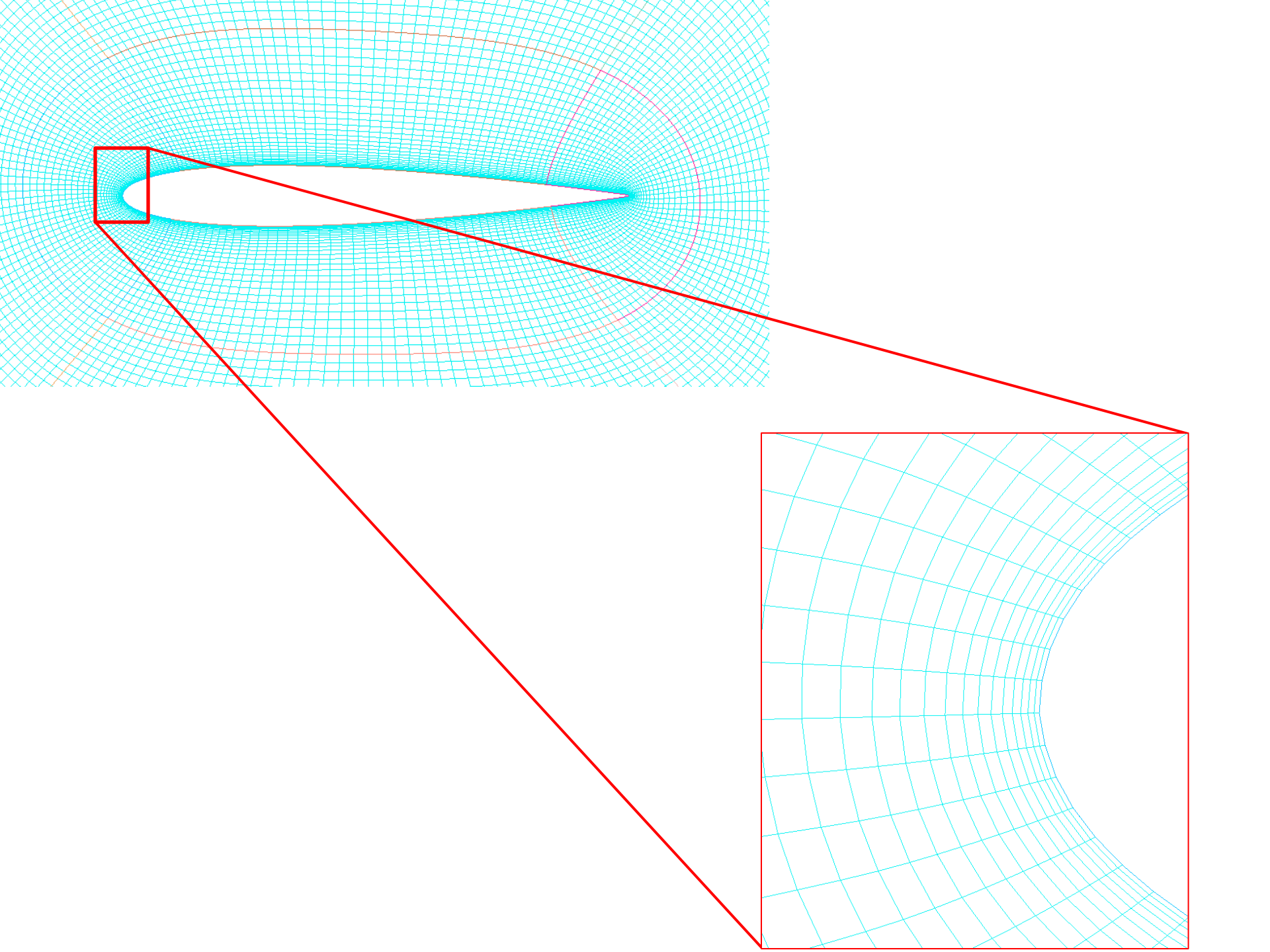
Save file as ‘step19.fra’

Start the gridding process again

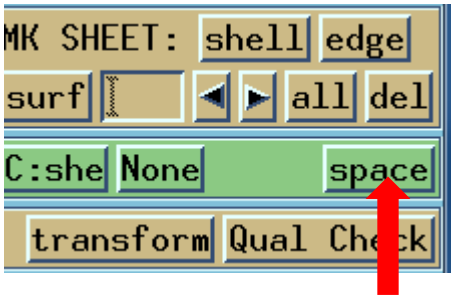
Load the ‘blk.tmp’ file



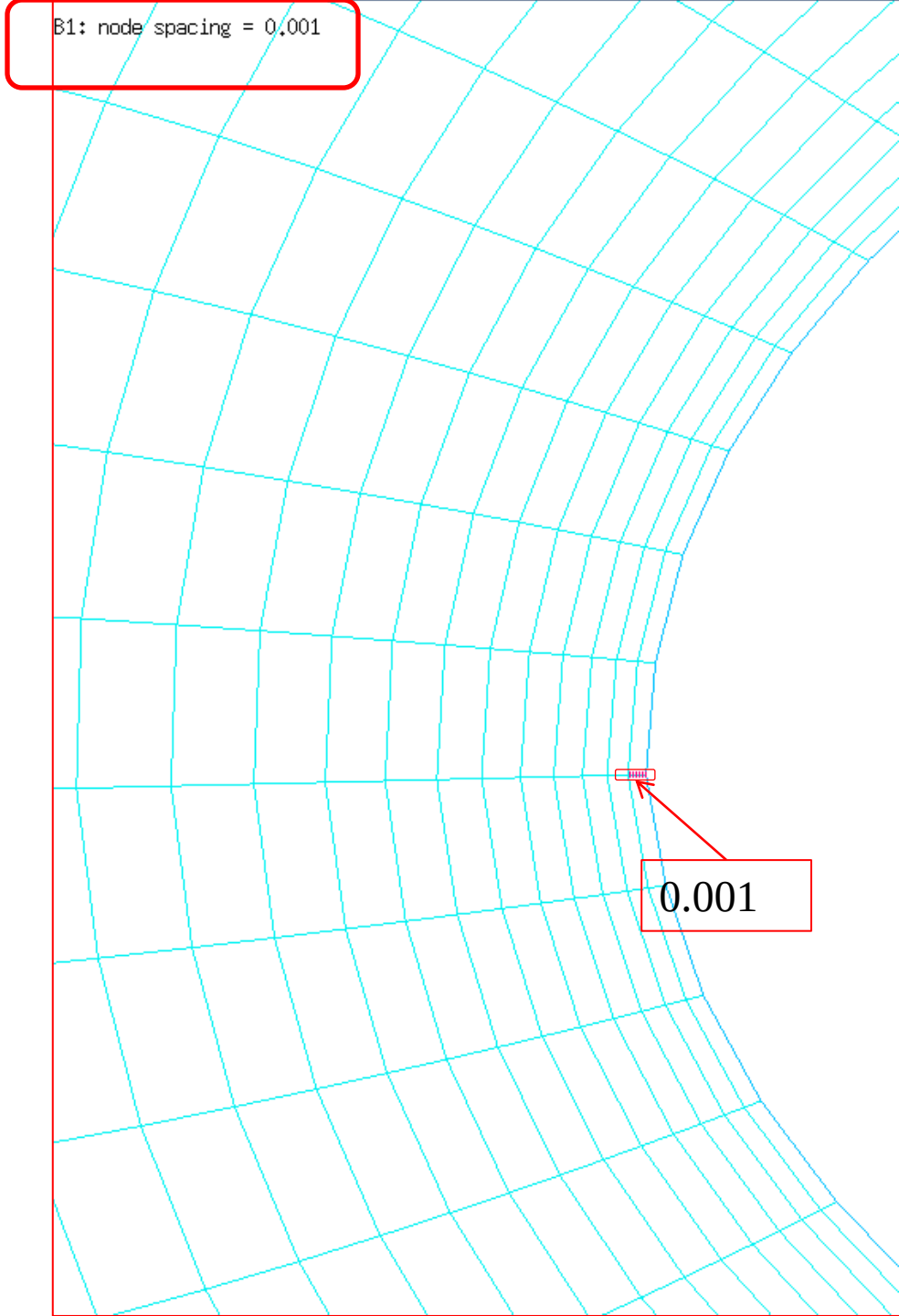




To measure the spacing between the grid lines, select **space button** and click on the grid line whose distance has to be found



Once the grid line is selected, it will be highlighted in pink colour and whose distance will be mentioned at the top



What you should have learnt

- Starting a GridPro session.
- Importing the airfoil coordinates.(any *.dat,*.lin file)
- Creating a basic wireframe.(Use of C,E and L key)
- Assigning corners to the surfaces.
- Creating and viewing the grid.
- Inserting topology edges. (Use of I key)
- Changing the density of the edges.
- Adding boundary layer clustering.

End of the tutorial