OpenFOAM Course

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HW1

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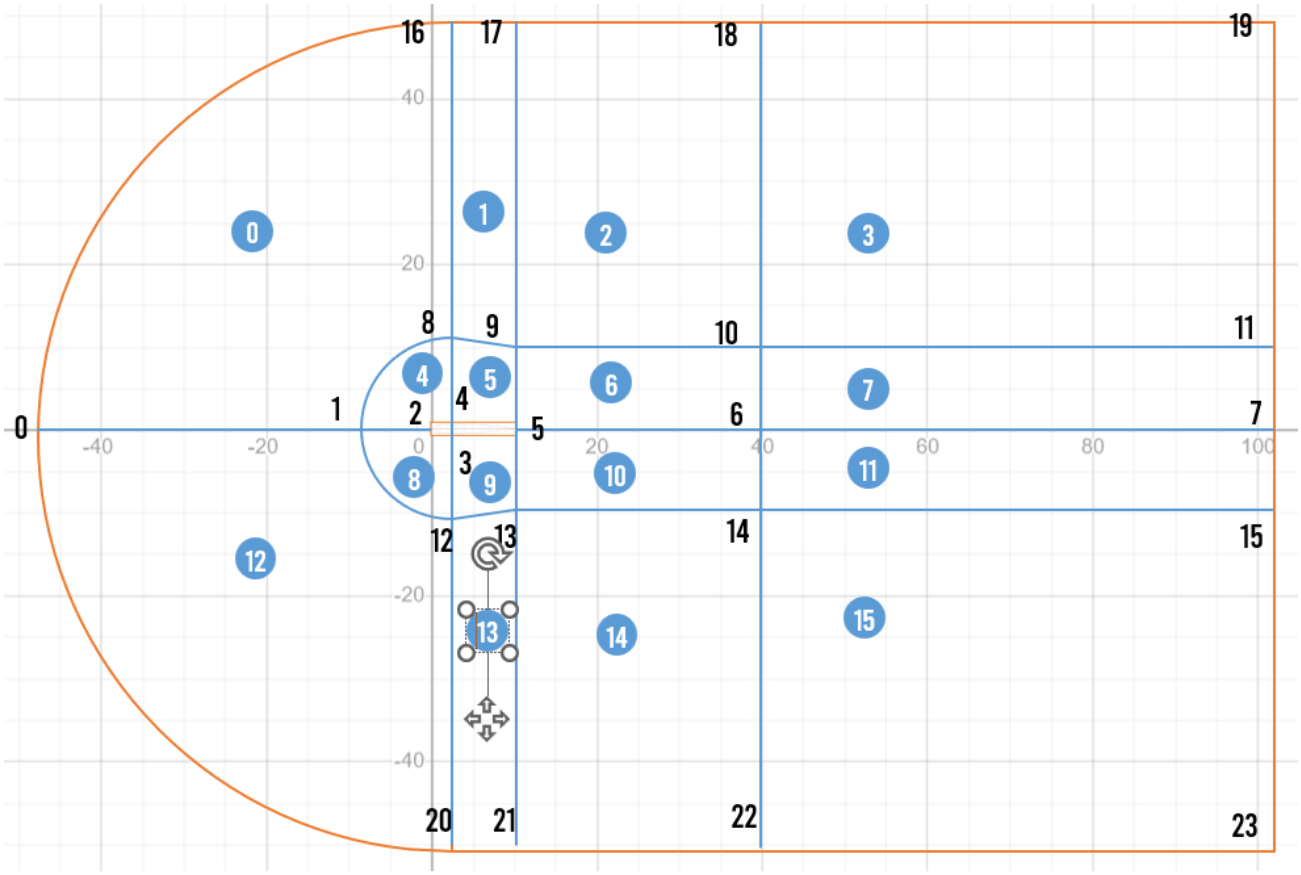
Problem Definition

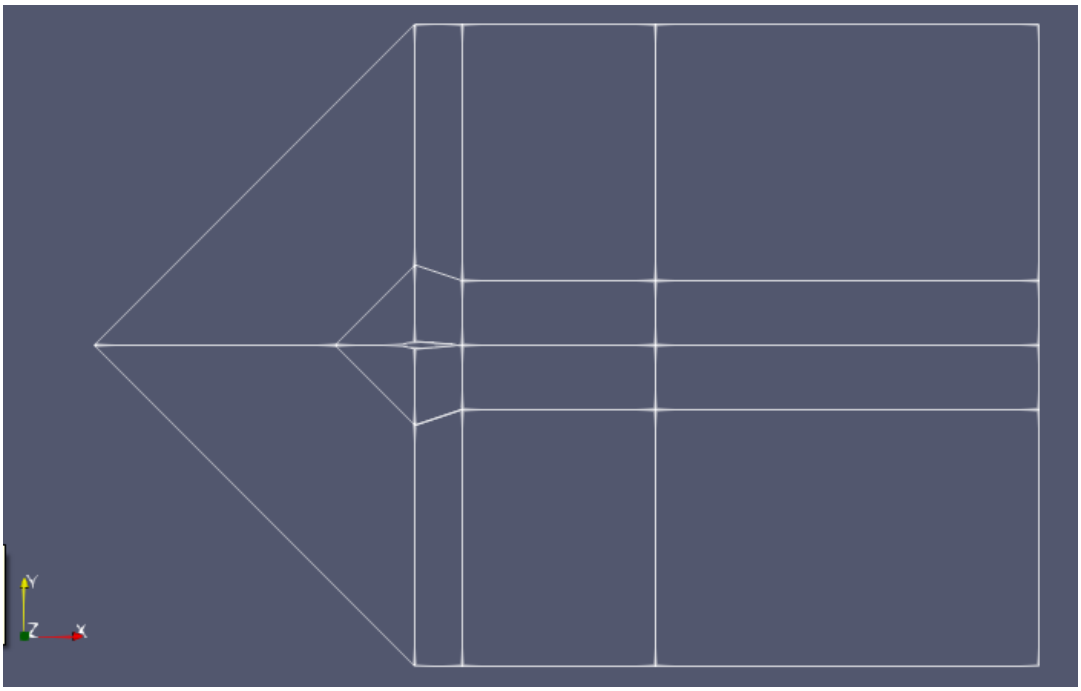
The domain has 23 vertices in each plane: front and back. It has 16 blocks, 8 circular arcs, and 8 polylines. The below figure shows the domain of investigation and the numbering system followed. Dimensions are in centimeters.



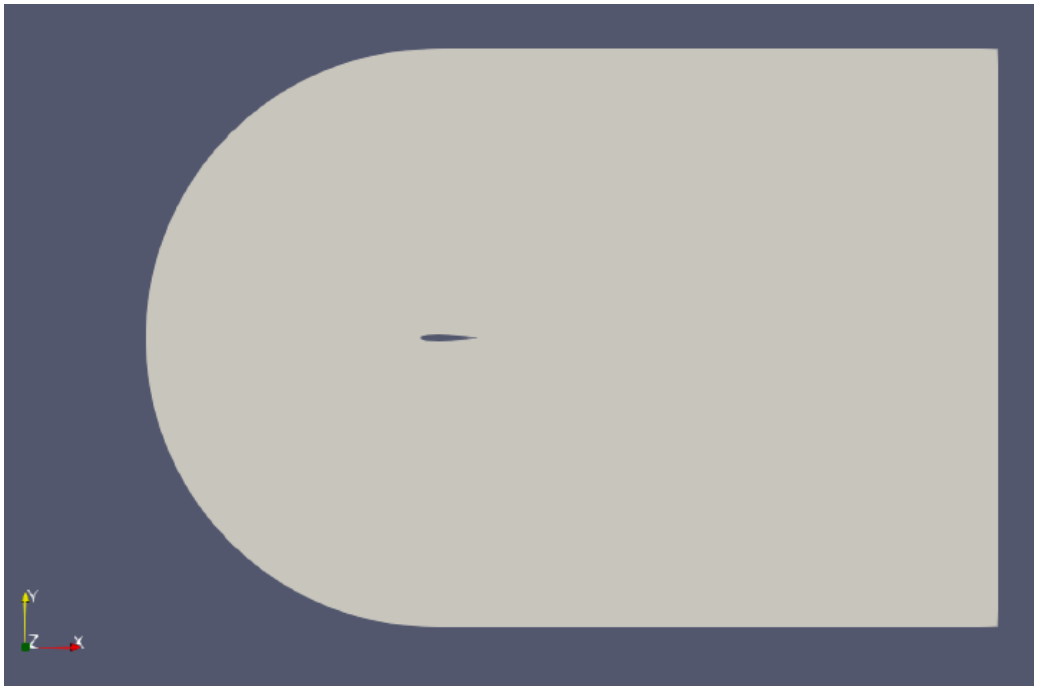
The black numbers are for the vertices and the numbers in circles are for the block/face number. The origin is taken at the leading edge of the airfoil.

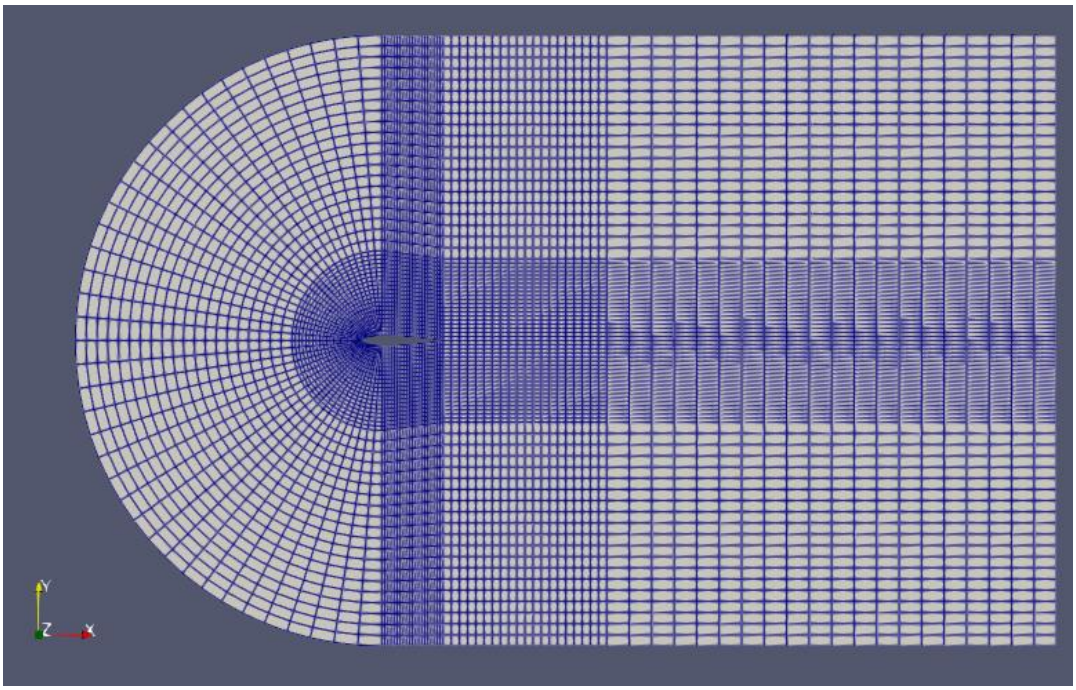
Initial Domain

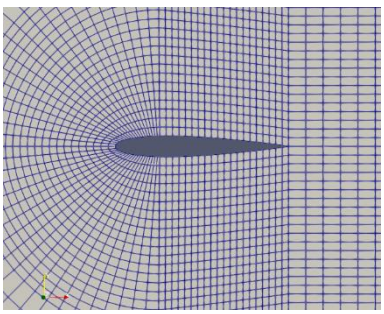
The following is the initial domain with all straight edges and only 1 cell in each block.



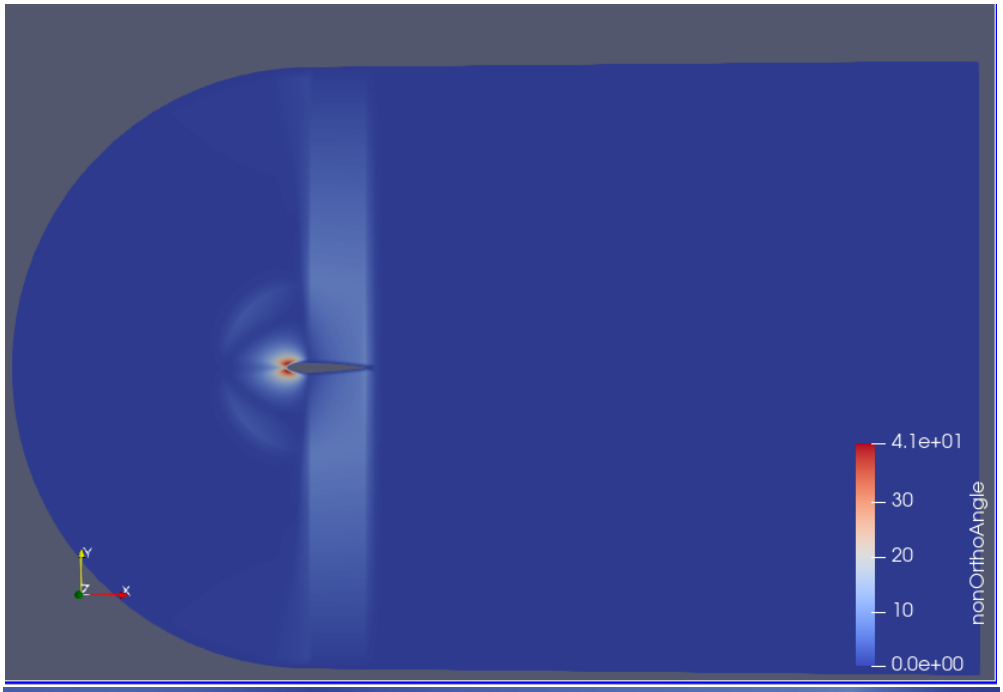
Final Domain

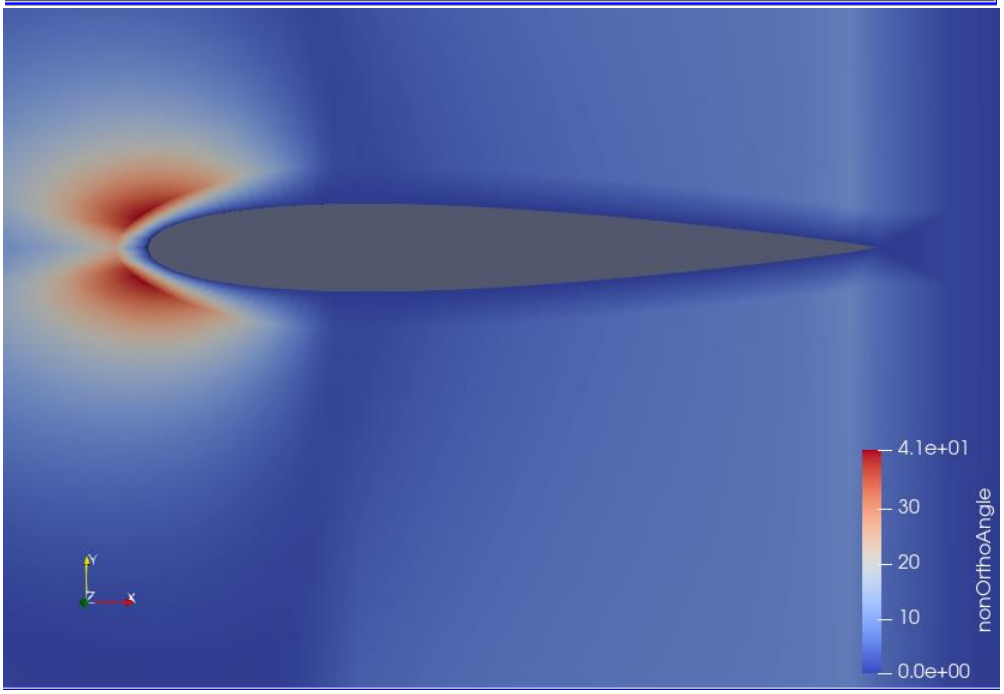


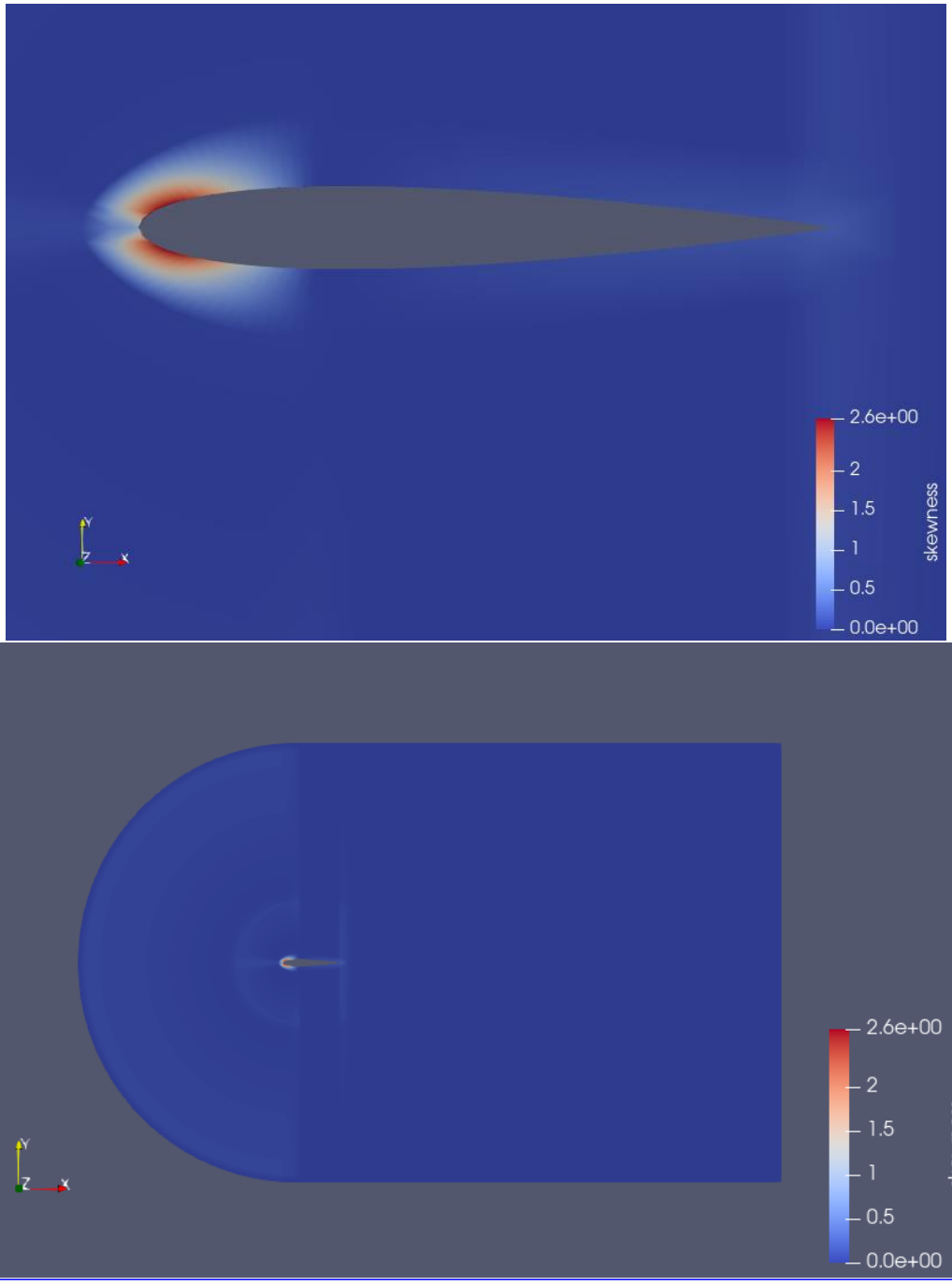


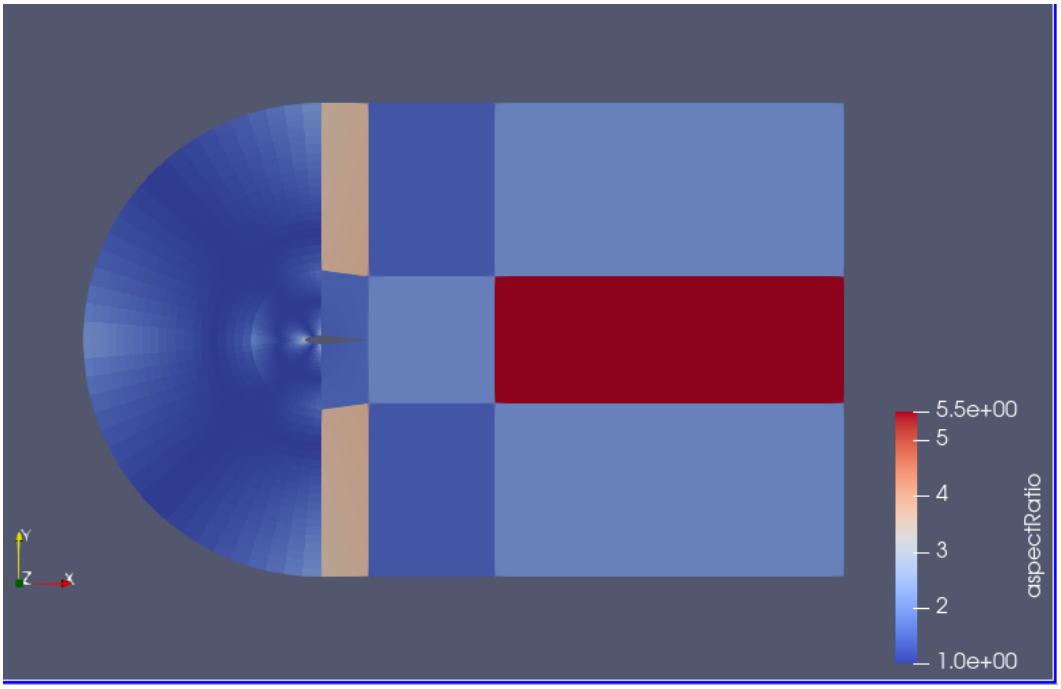


The following figures display different meshing quality parameters:






2.6e+00
2
1.5
1
0.5
0.0e+00
skewness
Y
Z
X
2.6e+00
2
1.5
1
0.5
0.0e+00
skewness
Y
Z
X



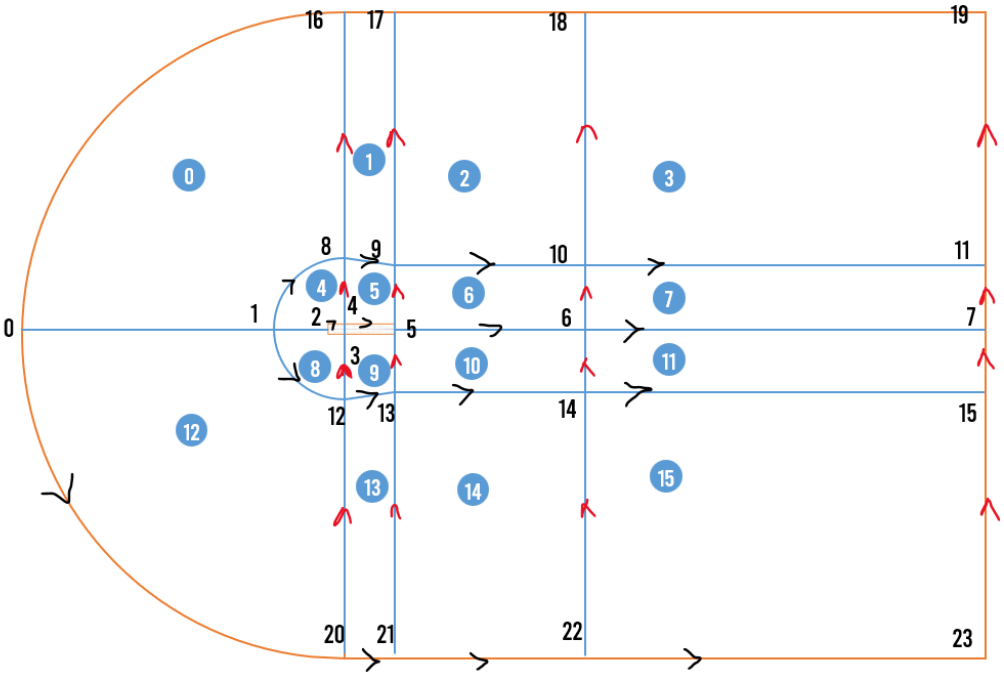
The following figure shows stats for the meshing quality:

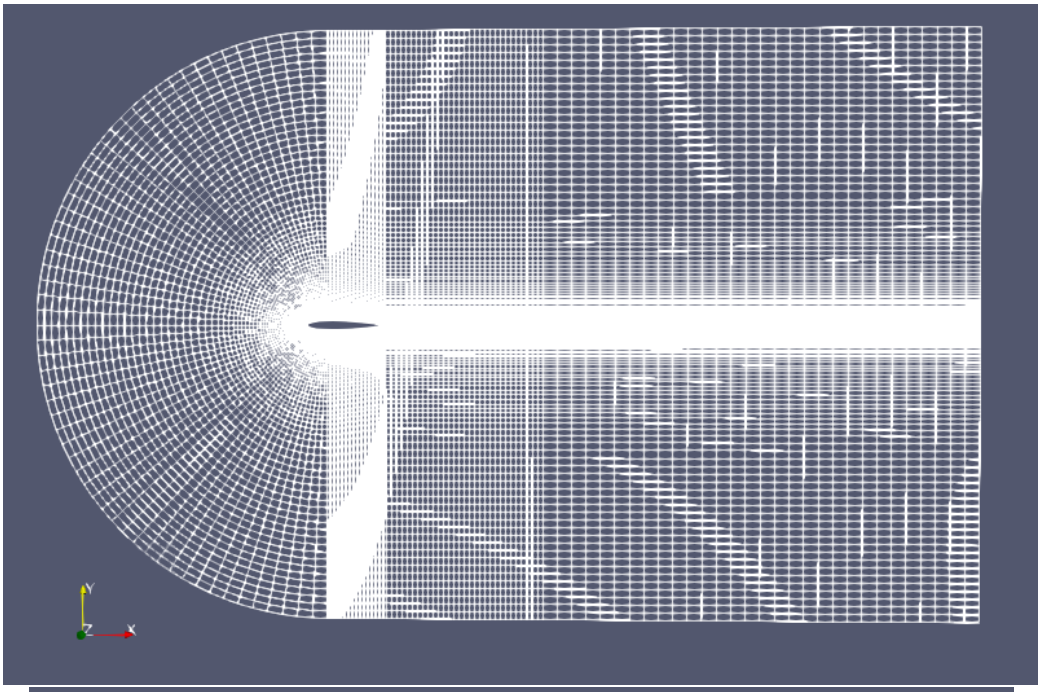
```
Checking geometry...
    Overall domain bounding box (-5 -5 -0.1) (8.25 5 0)
    Mesh has 2 geometric (non-empty/wedge) directions (1 1 0)
    Mesh has 2 solution (non-empty) directions (1 1 0)
    All edges aligned with or perpendicular to non-empty directions.
    Boundary openness (1.5257368e-18 -2.1288536e-18 1.0645389e-15) OK.
    Max cell openness = 2.1808037e-16 OK.
    Max aspect ratio = 5.9666667 OK.
    Minimum face area = 0.00072102315. Maximum face area = 0.067450575.  Face area
magnitudes OK.
    Min volume = 7.2102315e-05. Max volume = 0.0067450575.  Total volume = 12.1647.
  Cell volumes OK.
    Mesh non-orthogonality Max: 41.761545 average: 10.888497
    Non-orthogonality check OK.
    Face pyramids OK.
    Max skewness = 3.1321999 OK.
    Coupled point location match (average 0) OK.
    Face tets OK.
    Min/max edge length = 0.013416112 0.39259568 OK.
    All angles in faces OK.
    Face flatness (1 = flat, 0 = butterfly) : min = 1  average = 1
    All face flatness OK.
    Cell determinant (wellposedness) : minimum: 0.031247015 average: 0.34827768
    Cell determinant check OK.
    Concave cell check OK.
    Face interpolation weight : minimum: 0.088754934 average: 0.49144334
    Face interpolation weight check OK.
    Face volume ratio : minimum: 0.097641878 average: 0.96870458
    Face volume ratio check OK.
```

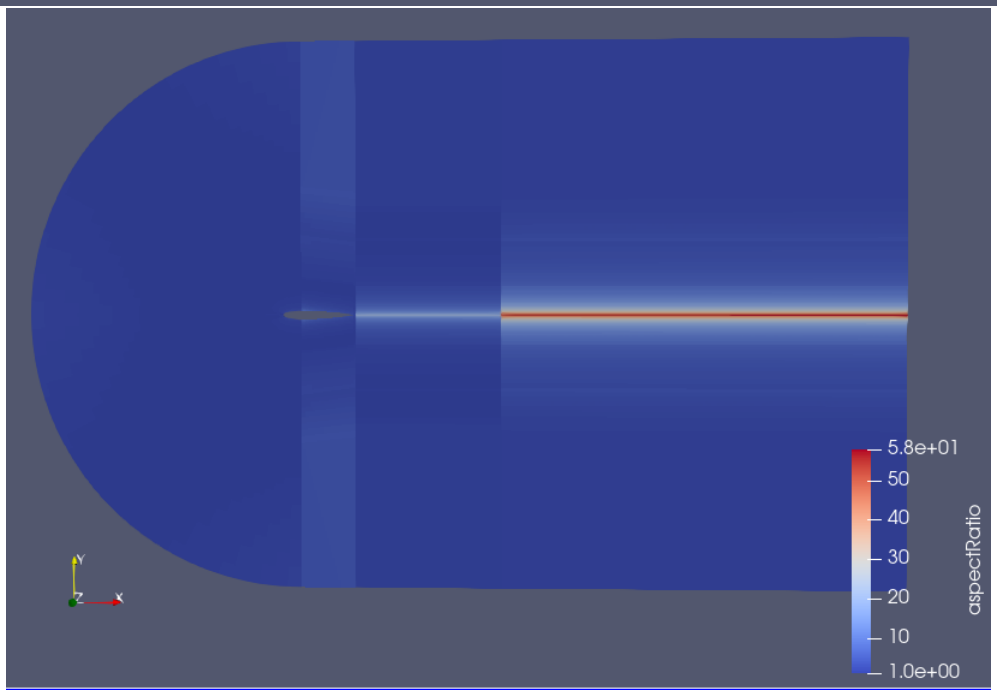
Mesh Clustering

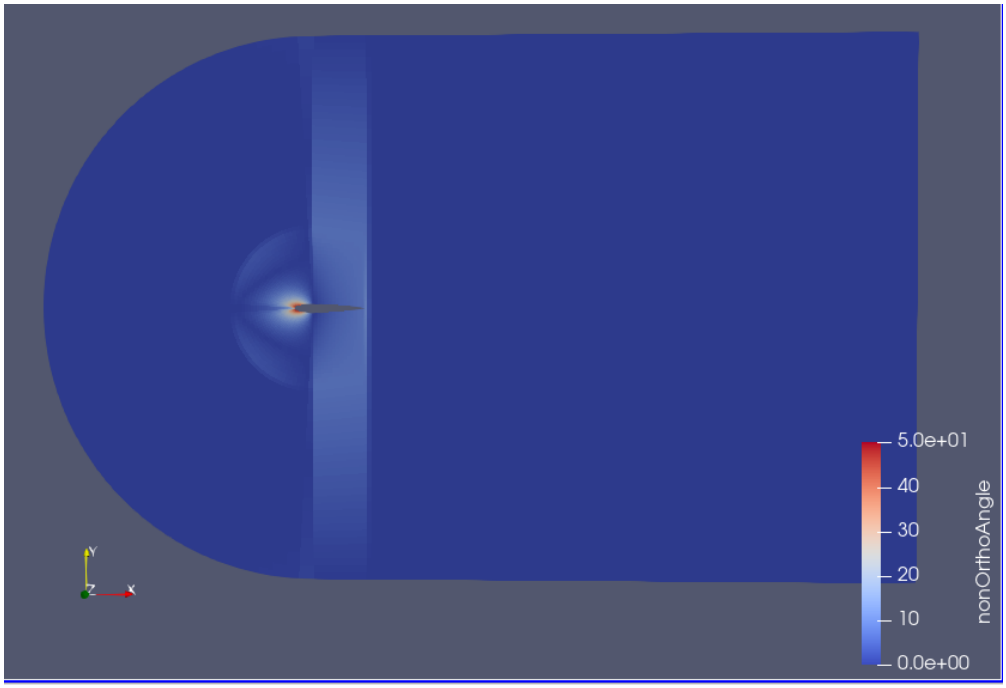
Clustering is done towards the airfoil. The number of cells and clustering concentrations are improved by trial and error, until an eye-pleasing mesh was generated with a good mesh quality.

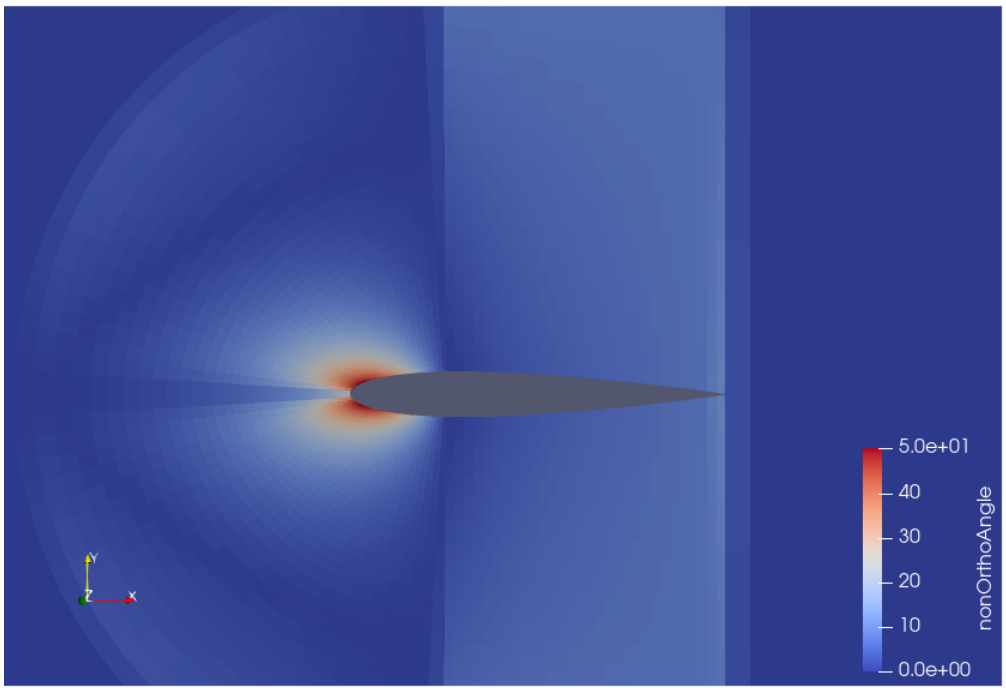
In the below figure, the black arrows denote the x-direction, and the red arrows denote the y0direction.

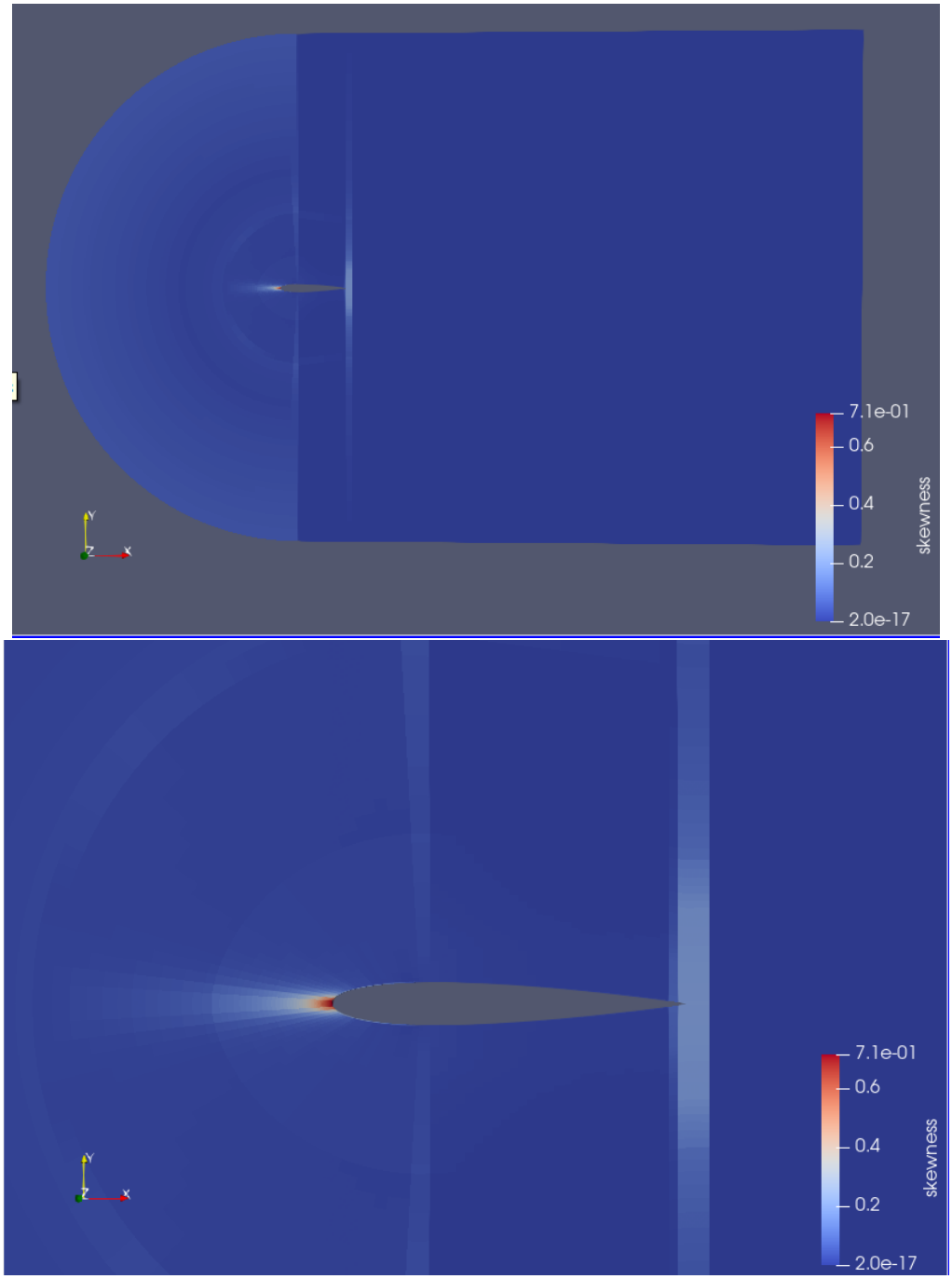





5.8e+01
50
40
30
20
10
1.0e+00
aspectRatio


5.0e+01
40
30
20
10
0.0e+00
nonOrthoAngle


5.0e+01
40
30
20
10
0.0e+00
nonOrthoAngle



Meshing quality stats are previewed below.

```
Checking geometry...
    Overall domain bounding box (-0.35 -0.37417 -0.001) (0.85 0.37417 0.001)    Mes
h has 2 geometric (non-empty/wedge) directions (1 1 0)
    Mesh has 2 solution (non-empty) directions (1 1 0)
    All edges aligned with or perpendicular to non-empty directions.
    Boundary openness (-1.3473727e-18 -1.0918485e-18 2.001853e-14) OK.
    Max cell openness = 2.0916384e-16 OK.
    Max aspect ratio = 57.621702 OK.
    Minimum face area = 1.6369428e-07. Maximum face area = 0.0001926023.  Face area
 magnitudes OK.
    Min volume = 3.2738855e-10. Max volume = 3.8520461e-07.  Total volume = 0.00167
43291.  Cell volumes OK.
    Mesh non-orthogonality Max: 50.244764 average: 7.4657051
    Non-orthogonality check OK.
    Face pyramids OK.
    Max skewness = 0.71404508 OK.
    Coupled point location match (average 0) OK.
    Face tets OK.
    Min/max edge length = 0.00027044209 0.019624426 OK.
    All angles in faces OK.
    Face flatness (1 = flat, 0 = butterfly) : min = 1  average = 1
    All face flatness OK.
    Cell determinant (wellposedness) : minimum: 0.00036823403 average: 0.30337548
 ***Cells with small determinant (< 0.001) found, number of cells: 18
  <<Writing 18 under-determined cells to set underdeterminedCells
    Concave cell check OK.
    Face interpolation weight : minimum: 0.11431663 average: 0.49033531
    Face interpolation weight check OK.
    Face volume ratio : minimum: 0.12912962 average: 0.96245556
    Face volume ratio check OK.
```