AIAA CFD Drag Prediction Workshop

Thomas Scheidegger, Greg Stuckert, Sutikno Wirogo

Fluent Inc.

Anaheim CA, June 9-10, 2001

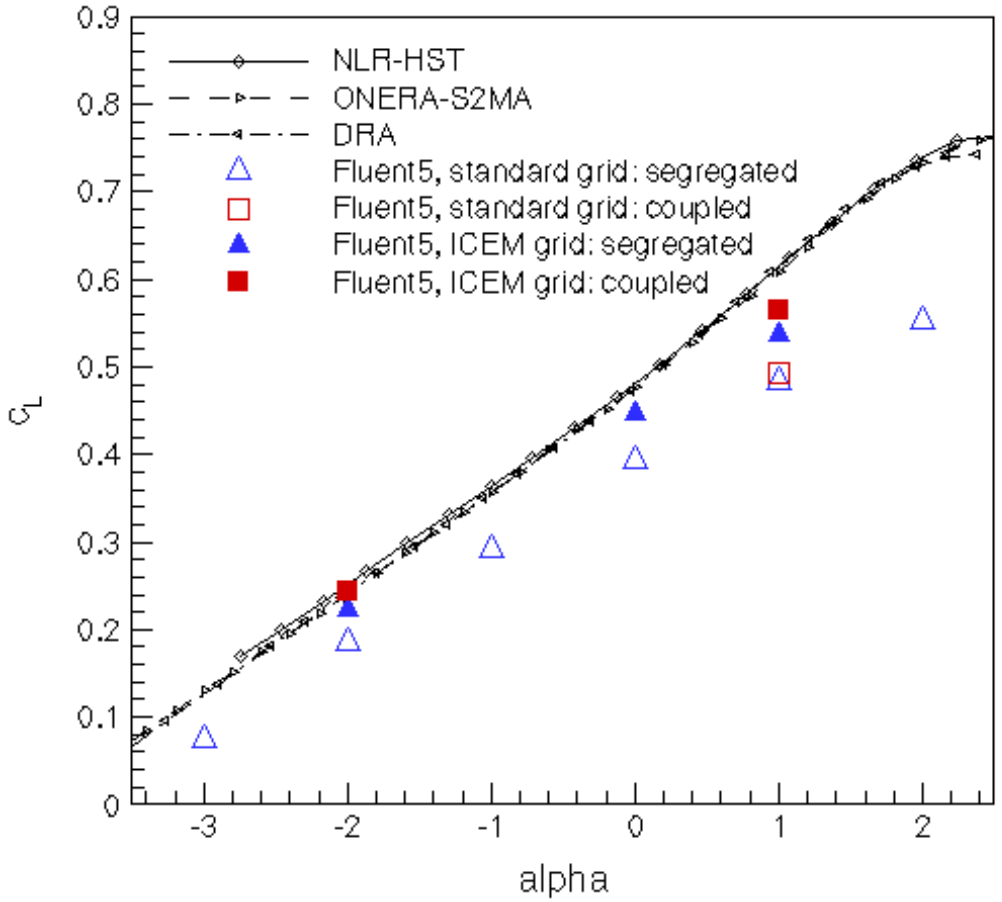
DLR-F4 Wing-Body Simulations

- Fluent5 - Unstructured solver
- Drag polar for M=0.75, Re=3.0x10^6 (case 2) on provided (standard) grid
- Selected points on optional ICEM CFD grid
- Grid quality and convergence behavior

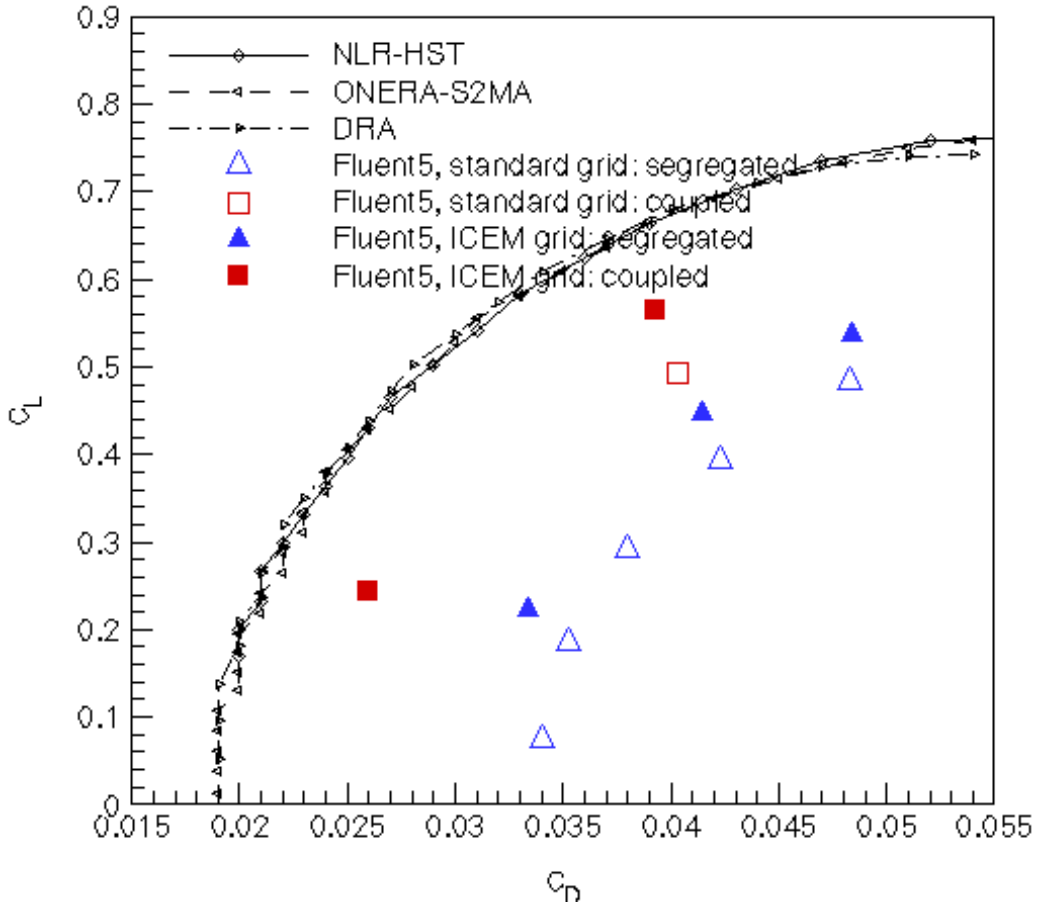
Fluent5 Settings

- Cell-centered unstructured on hybrid meshes
- Segregated implicit (pressure based, SIMPLE) and coupled implicit solver
- Second-order upwind reconstruction
- Algebraic Multigrid
- Realizable k-ε turbulence model
- Two-layer zonal model for wall treatment

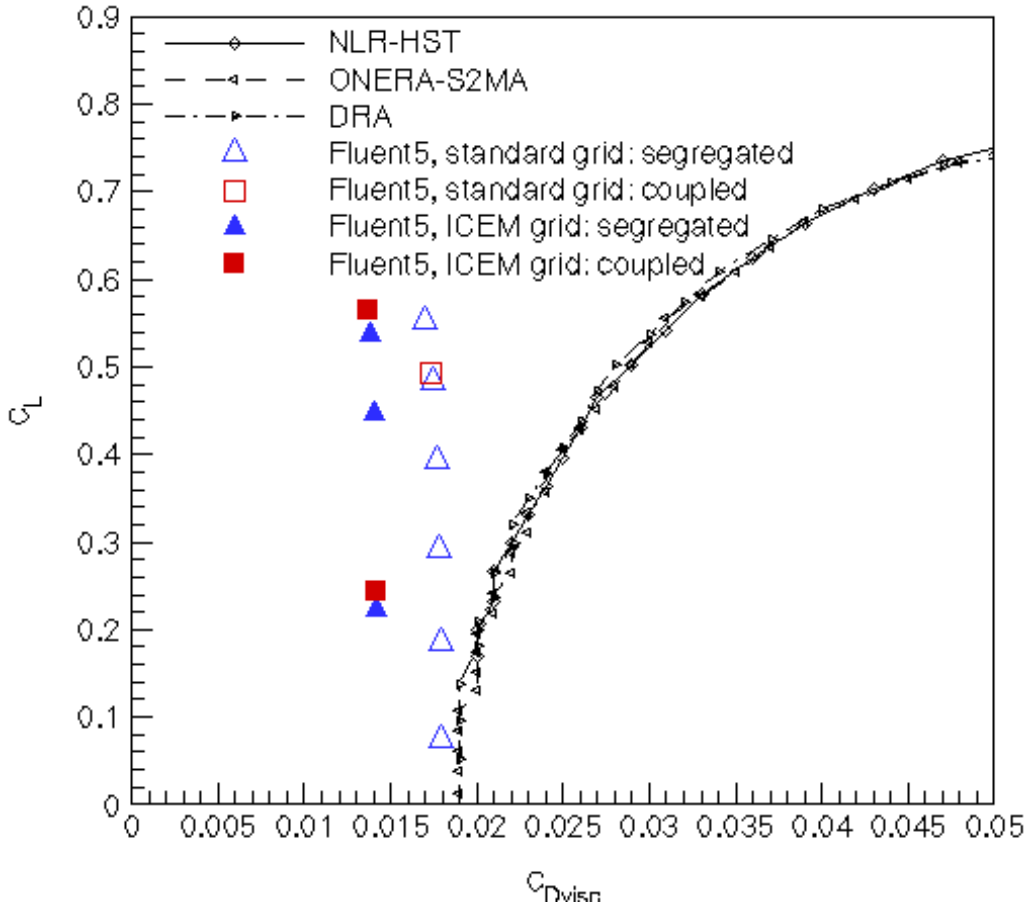
Lift - ICEM Grid



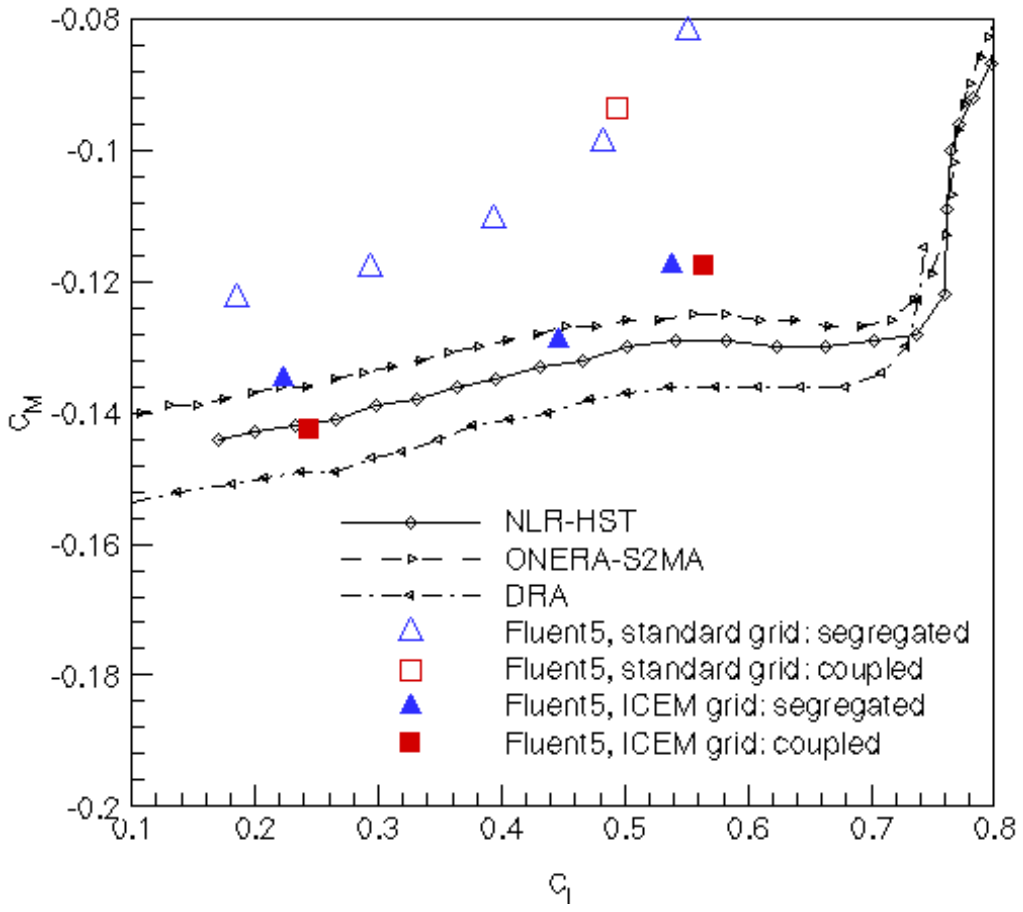
Drag - ICEM Grid



Viscous Drag

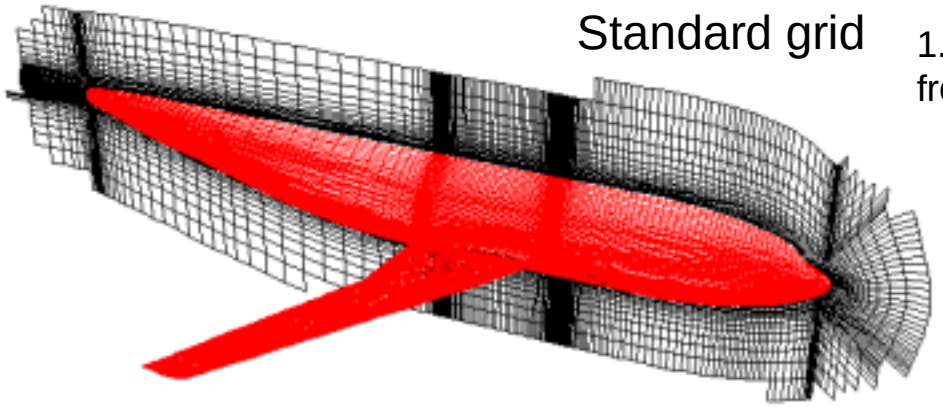


Moment - ICEM Grid



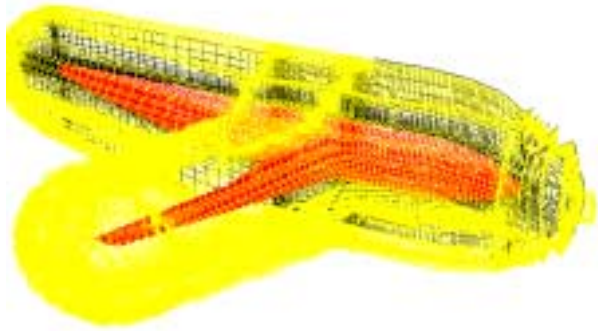
Grid Quality

Standard grid

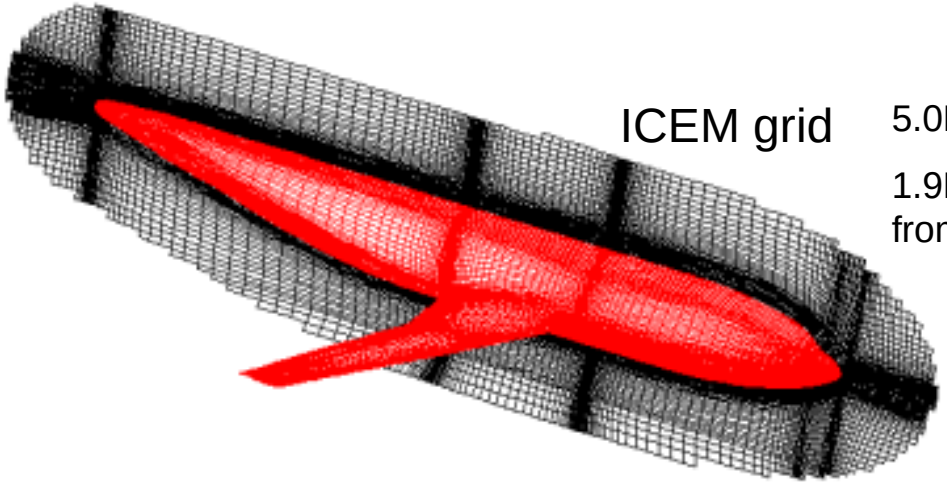


3.2M cells

1.0M cells within one chord distance from surface



ICEM grid

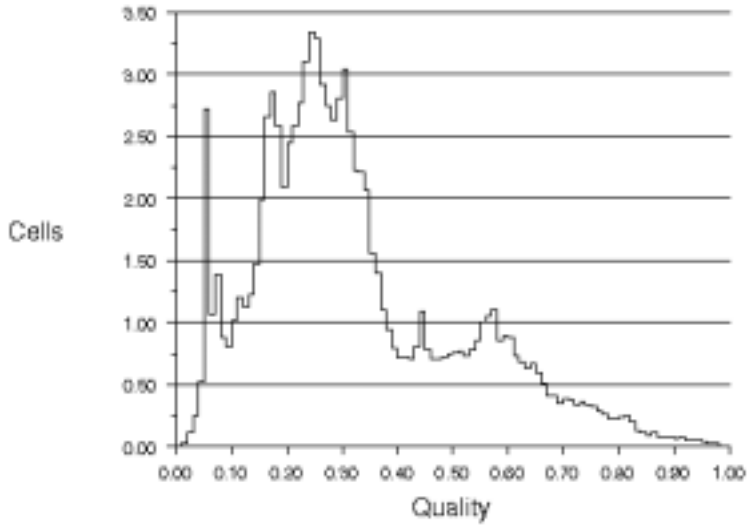


5.0M cells

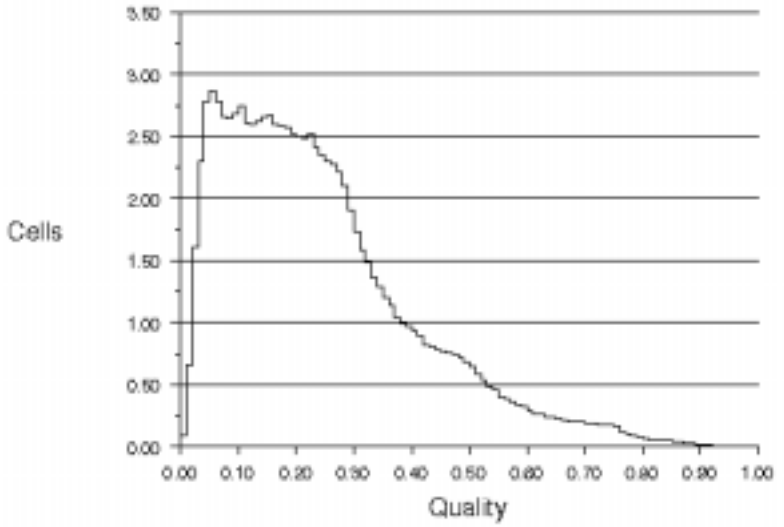
1.9M cells within one chord distance from surface

Grid Quality - Skewness

Standard grid

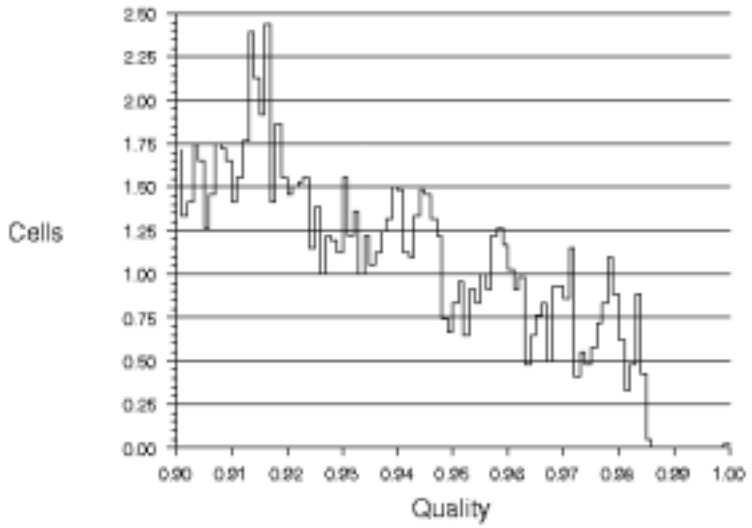


ICEM grid



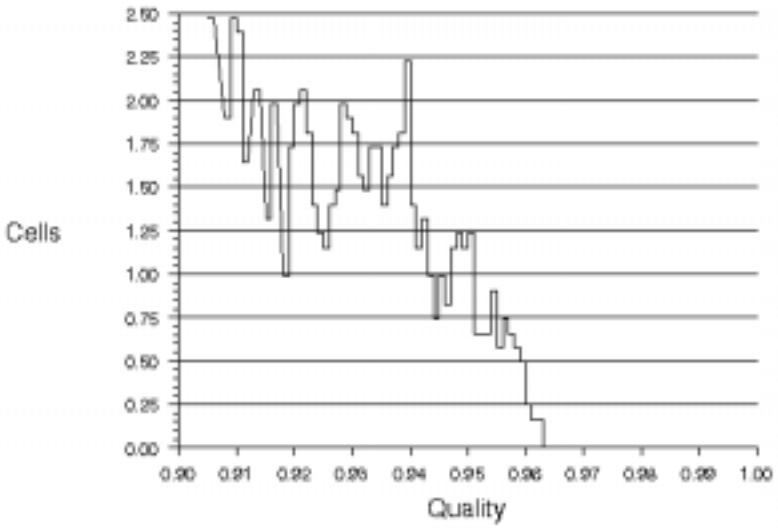
Grid Quality - Skewness

Standard grid



Histogram of Cell Quality, Equilateral Volume Deviation Method
Jun 05, 2001
TGrid 3.4 (3D)

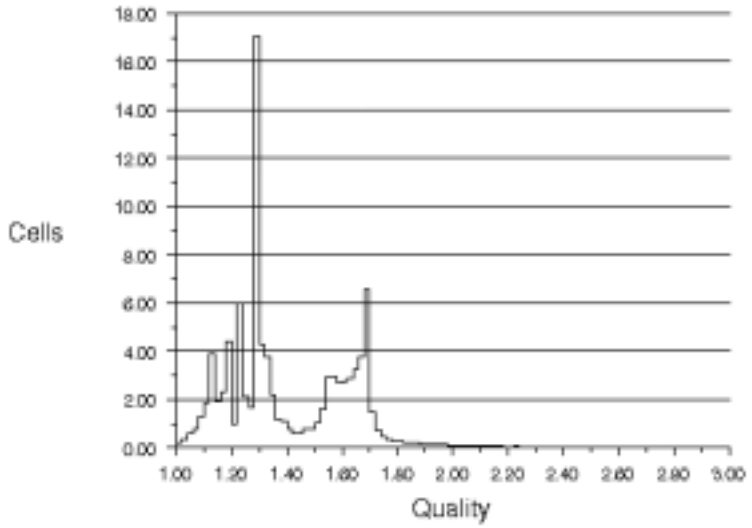
ICEM grid



Histogram of Cell Quality, Equilateral Volume Deviation Method
Jun 05, 2001
TGrid 3.4 (3D)

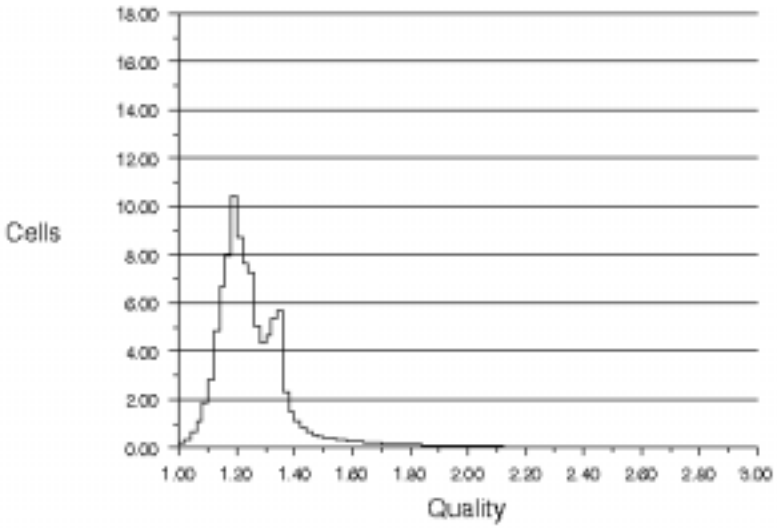
Grid Quality - Size Change

Standard grid



Histogram of Cell Quality, Size Change Method
Jun 05, 2001
TGrid 3.4 (3D)

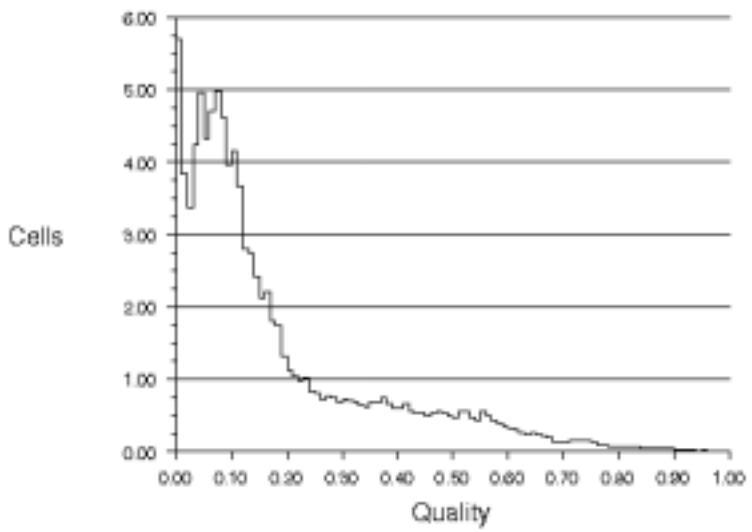
ICEM grid



Histogram of Cell Quality, Size Change Method
Jun 05, 2001
TGrid 3.4 (3D)

Grid Quality - Squish

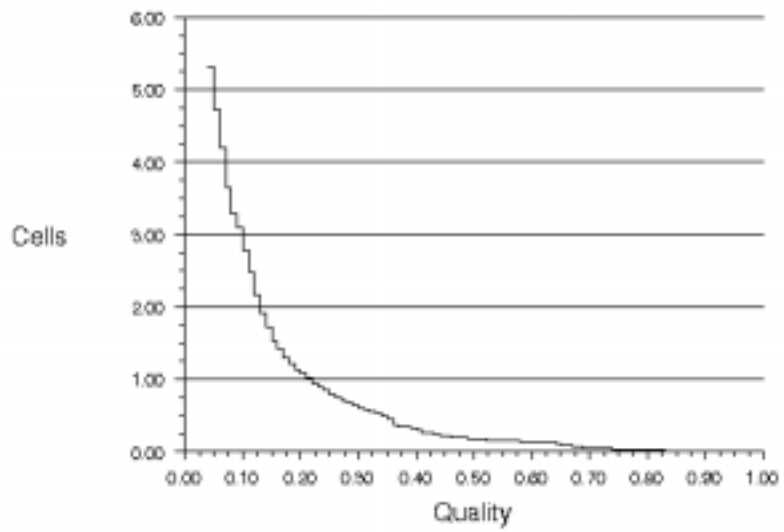
Standard grid



Histogram of Cell Quality, Squish Method

Jun 05, 2001
TGrid 3.4 (3D)

ICEM grid

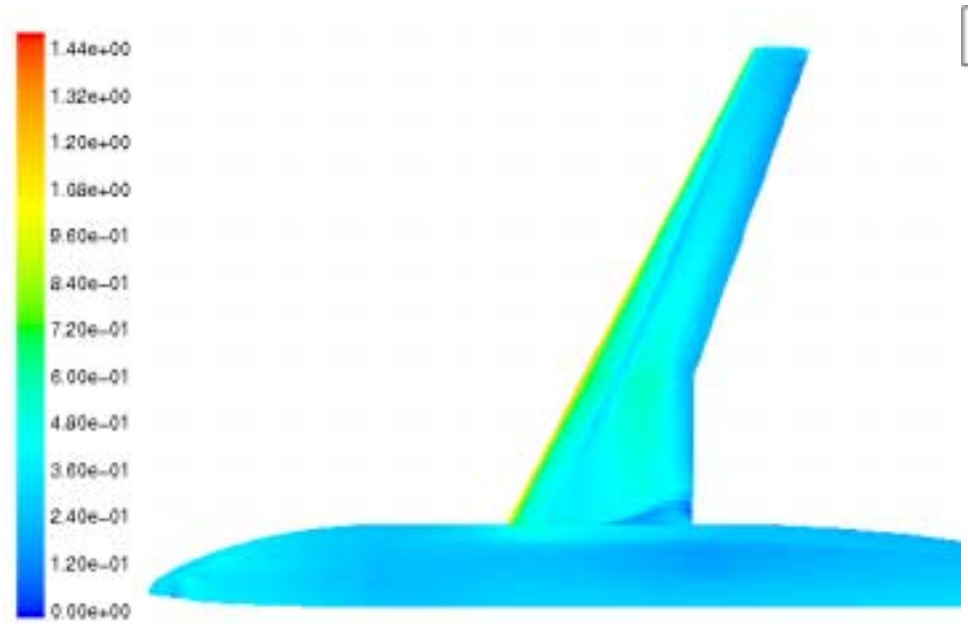


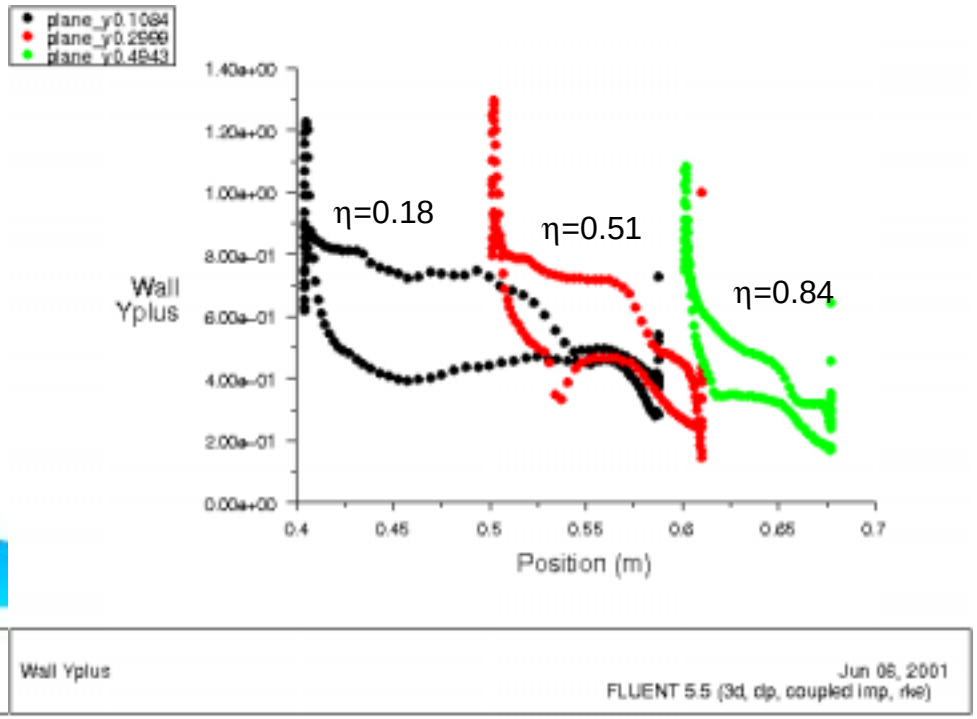
Histogram of Cell Quality, Squish Method

Jun 05, 2001
TGrid 3.4 (3D)

Standard Grid - y+

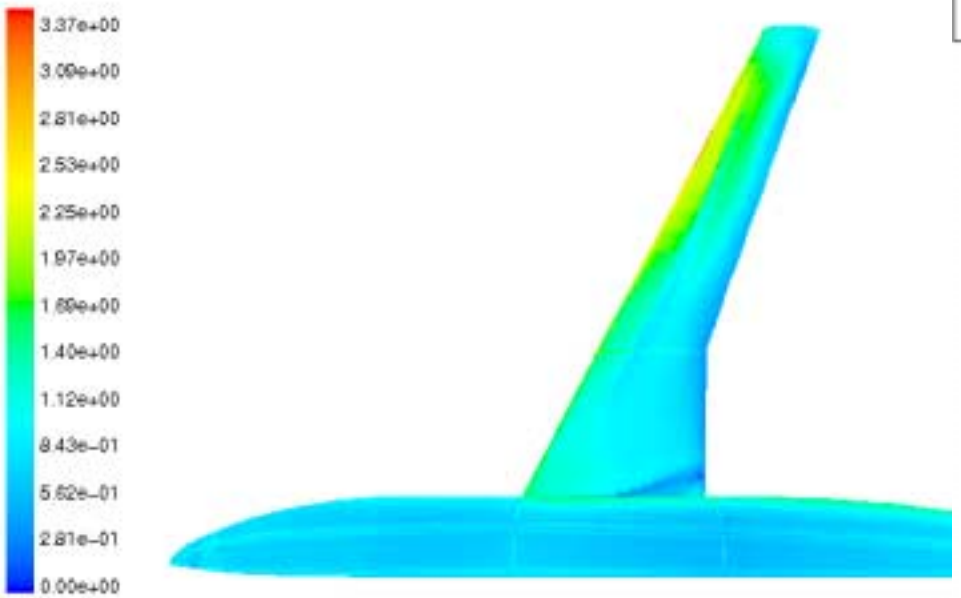
Coupled solver, $\alpha = 1^{o}$

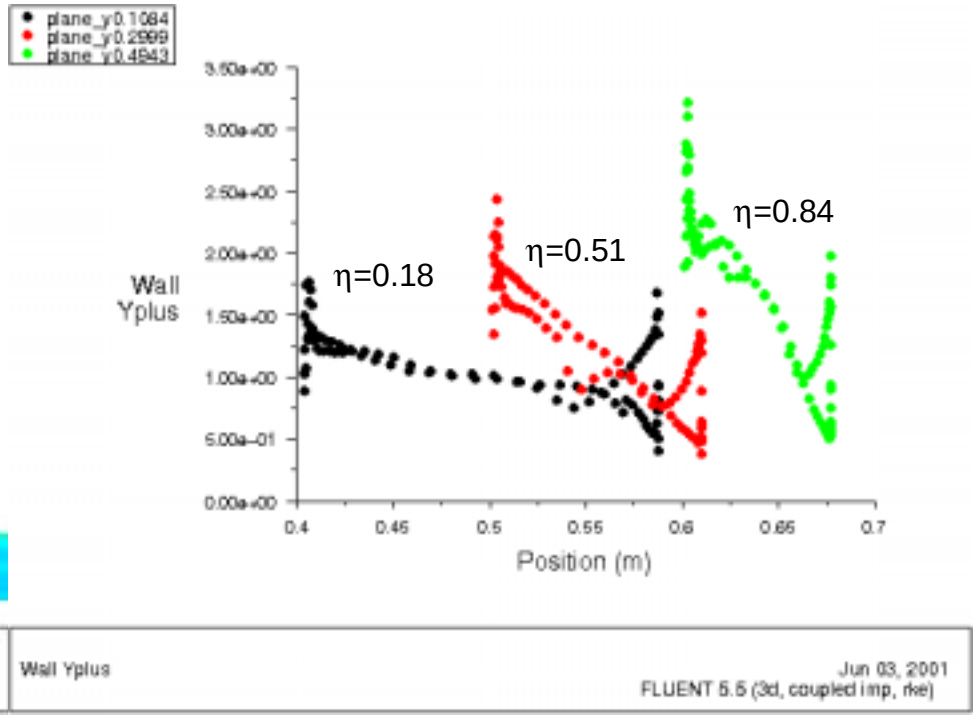




ICEM Grid - y+

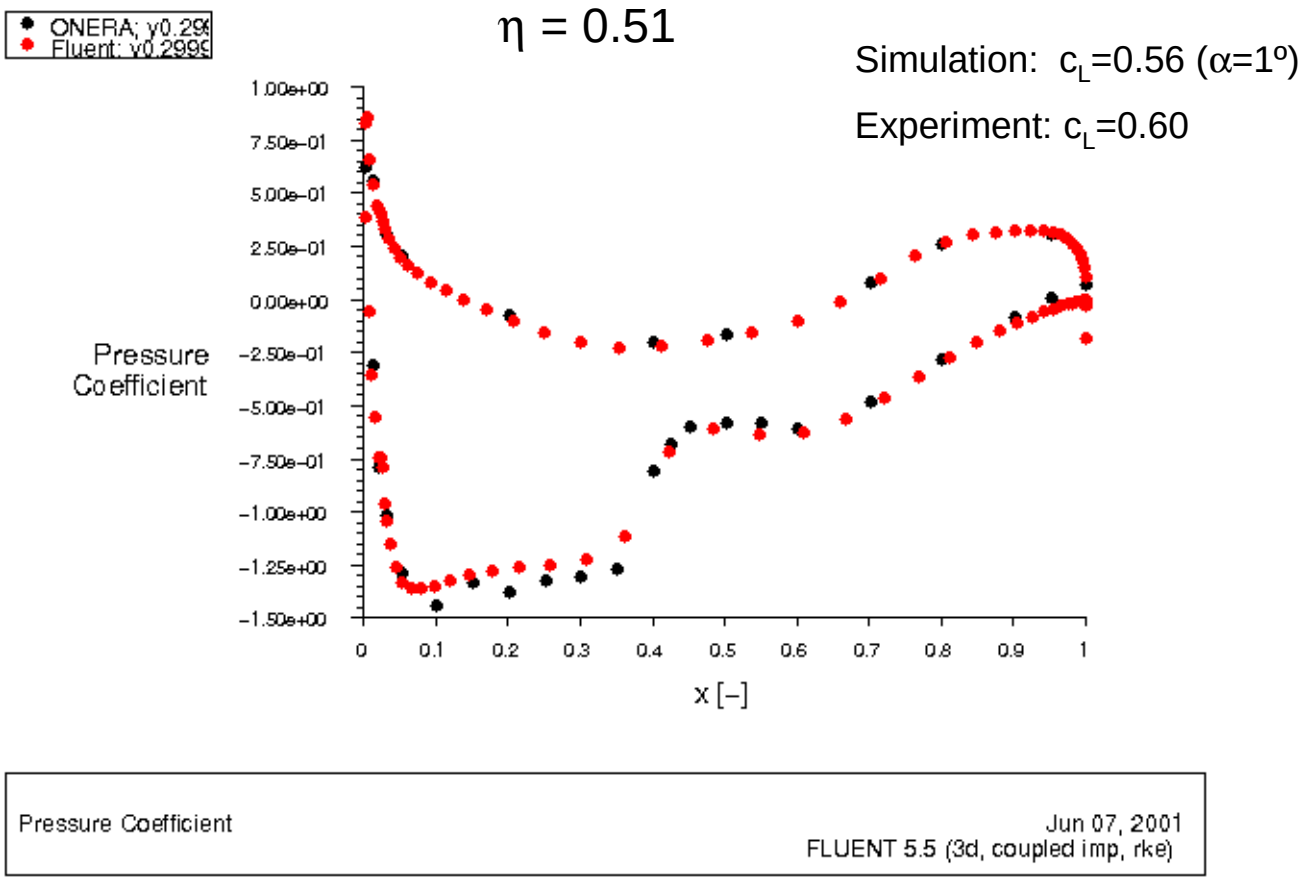
Coupled solver, $\alpha = 1^{o}$





Pressure Distribution

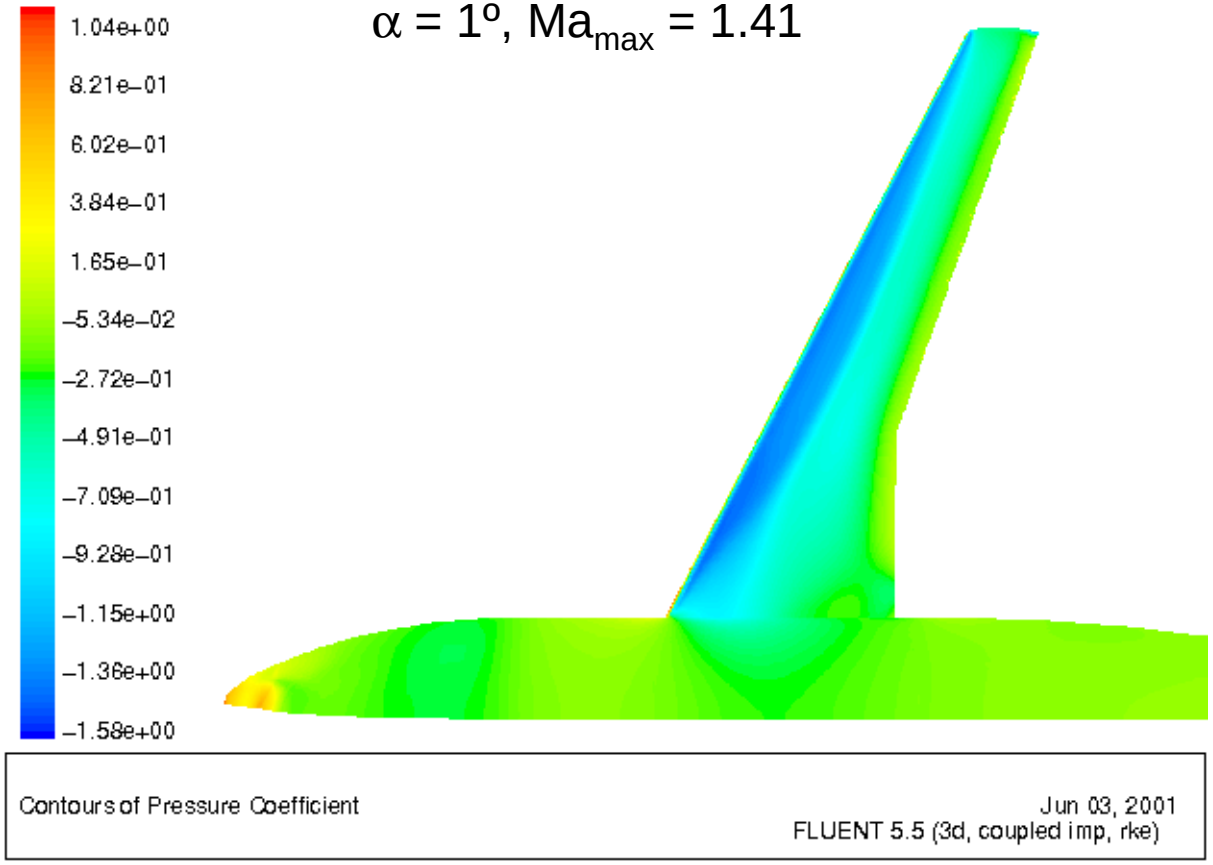
Coupled solver - ICEM grid



Pressure Distribution

Coupled solver - ICEM grid

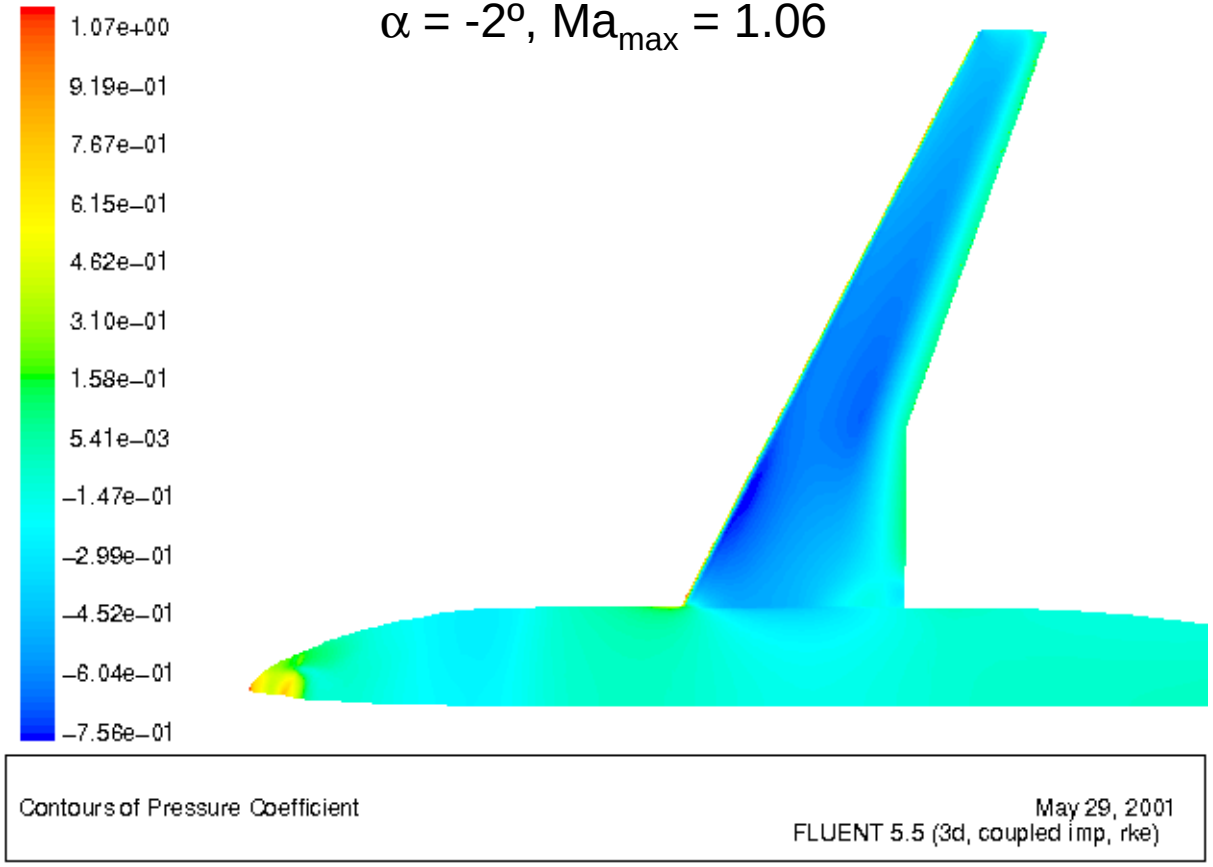
$\alpha = 1^{o}$, $Ma_{max} = 1.41$



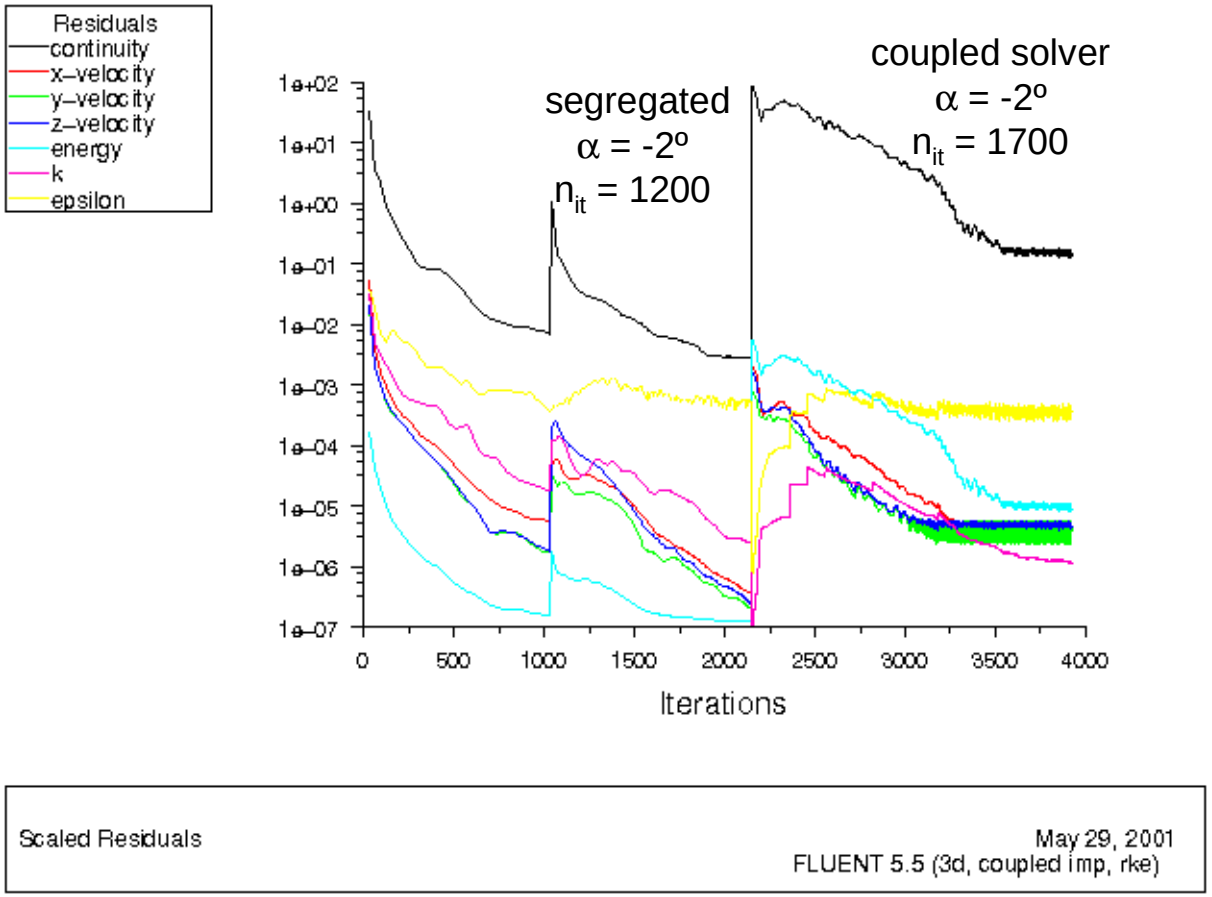
Pressure Distribution

Coupled solver - ICEM grid

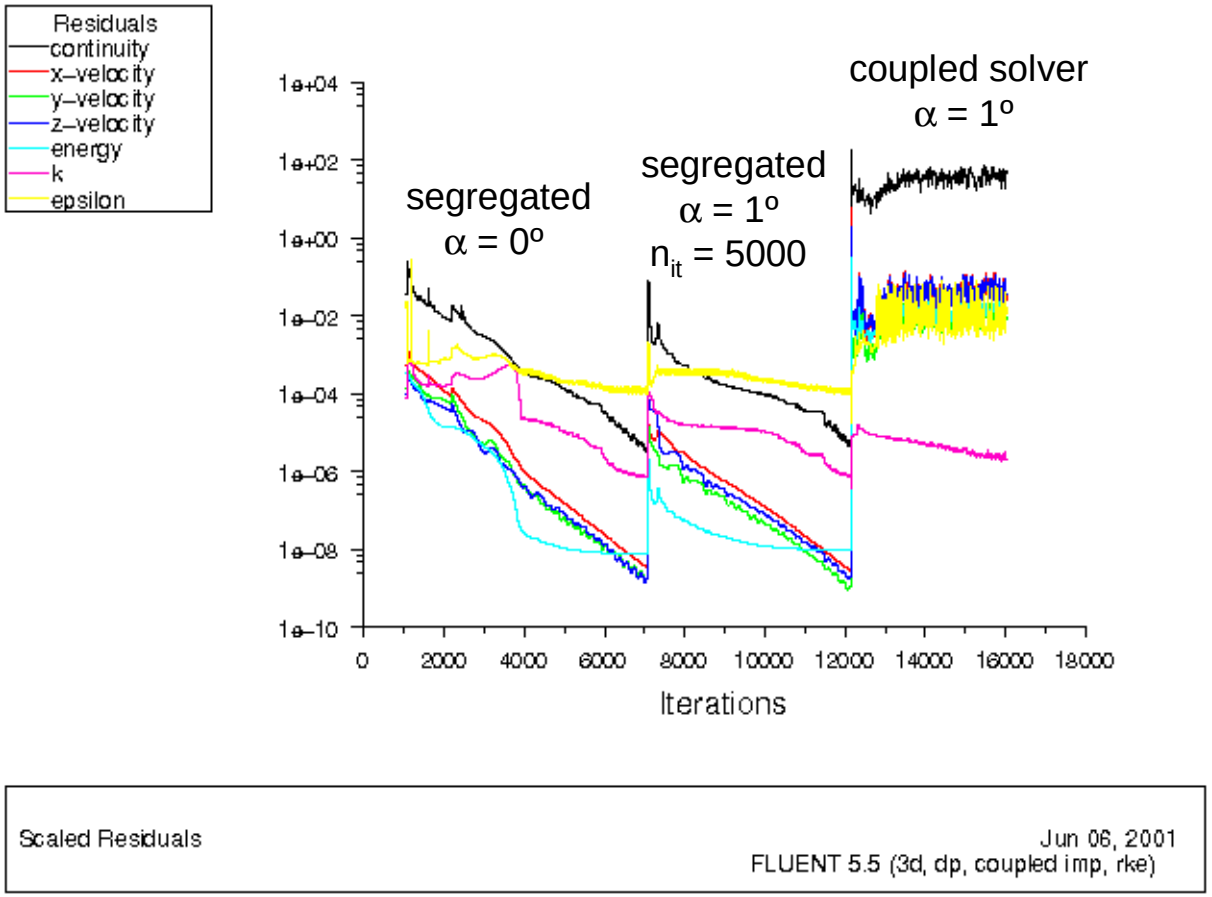
α = -2º, Ma_{max} = 1.06



Convergence - ICEM Grid



Convergence - Standard Grid



Conclusions

- Results and convergence behavior depend strongly on quality of mesh.
- Standard workshop grid resulted in poor convergence and large overprediction of drag.
- Considerable improvement of results on ICEM grid.
- Coupled (density based) solver recommended for transonic drag prediction.
- Discrepancies between segregated and coupled solver likely due to first-order density reconstruction in compressible segregated solver.