FUN3D Analysis of DPW-II Transport Configuration

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FUN3D Unstructured Grid Code

- Parallel 3D compressible finite-volume RANS for tetrahedral meshes
- Implicit time-stepping using point Gauss-Seidel and line-relaxation for linear system
- Upwind Roe scheme for inviscid fluxes
- Galerkin-type approximation for viscous fluxes
- Spalart-Allmaras turbulence model (loosely coupled)
- Full Navier-Stokes equations

FUN3D Unstructured Grid Code

- Parallel version
  - Domain decomposition using the MeTiS mesh partitioning software (weighted for the line solver)
  - Parallel code execution scheme utilizes MPI

Computational Grids

- Workshop VGRIDns node-based grids (based on the work of Frink and Pirzadeh for cell-based grids)

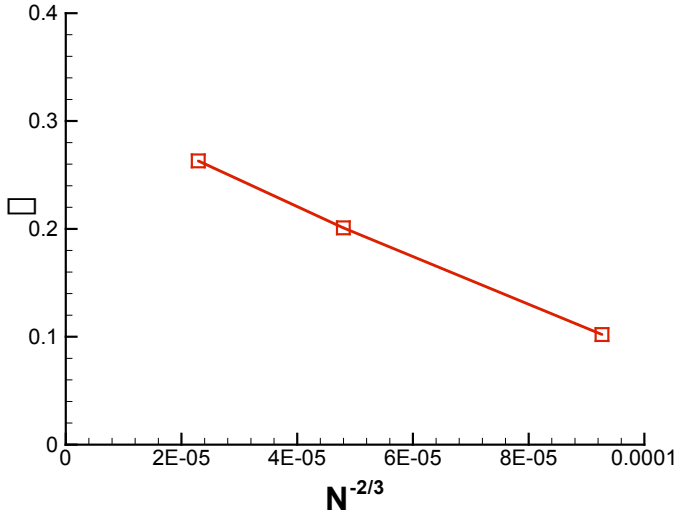
	Wing/Body Total Nodes	Wing/Body/Nac./Pylon Total Nodes
Coarse	1,121,301	1,827,470
Medium	3,010,307	4,751,207
Fine	9,133,352	10,278,588

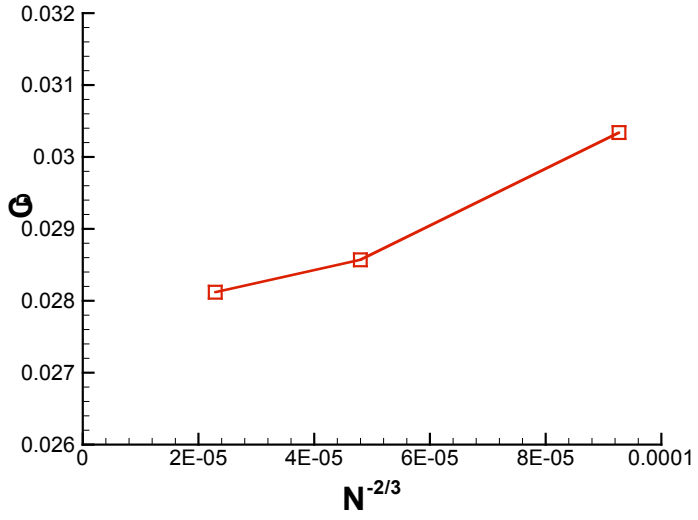
Summary FUN3D Results

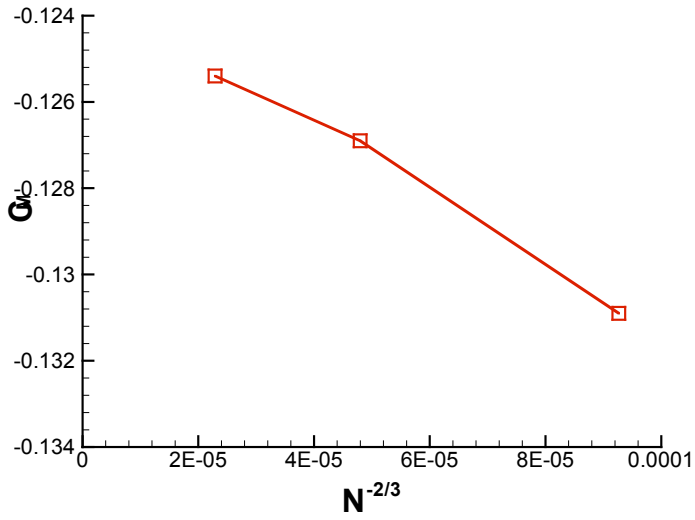
- Case 1: Mach 0.75, C_L=0.5 Re_c 3 million (fully turbulent)
  - Wing/body coarse, medium and fine grids
  - Wing/body/nac./pylon coarse, medium and fine grids
- Case 2: Mach 0.75, C_L=0.5 Re_c 3 million (fully turbulent)
  - Wing/body medium grid
  - Wing/body/nacelle/pylon medium grid
- Case 3: Mach 0.75, C_L=0.5 Re_c 3 million specified transition
  - Wing/body medium grid
  - Wing/body/nacelle/pylon medium grid

Wing/Body Grid Refinement

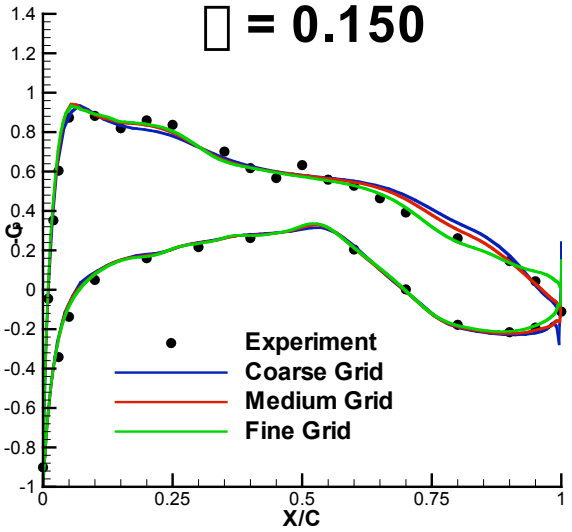
Mach 0.75, C_L=0.5

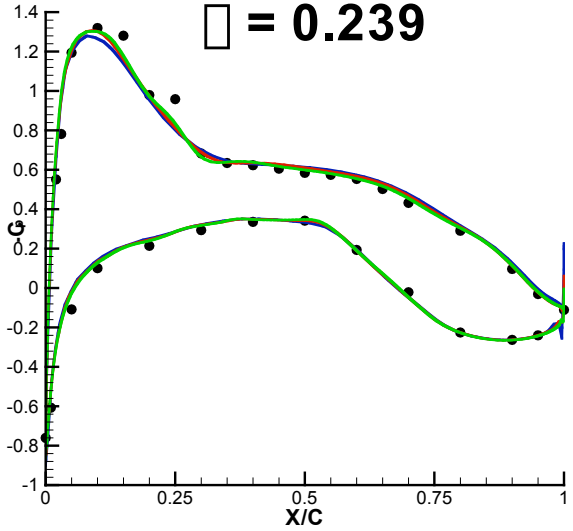


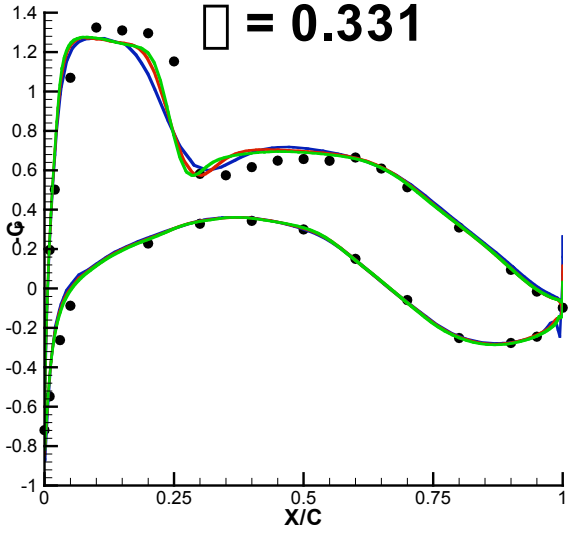


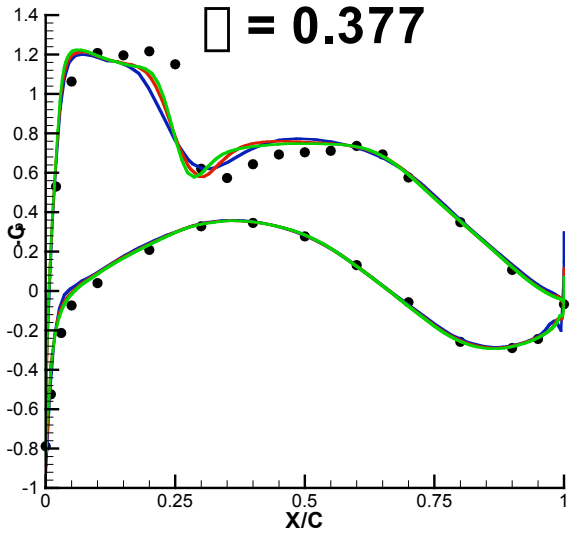


Wing/Body Grid Refinement

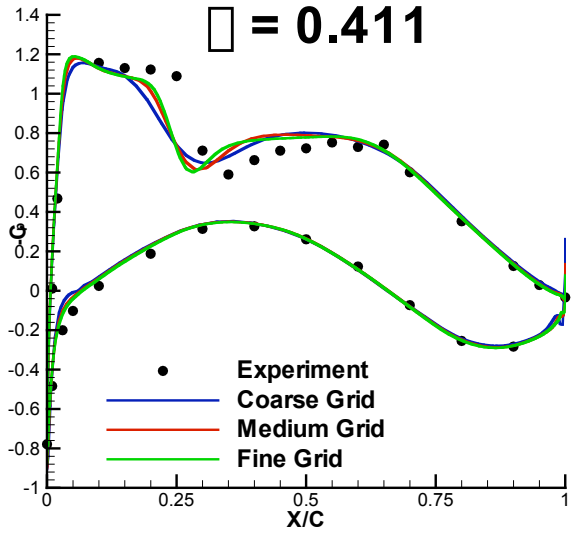


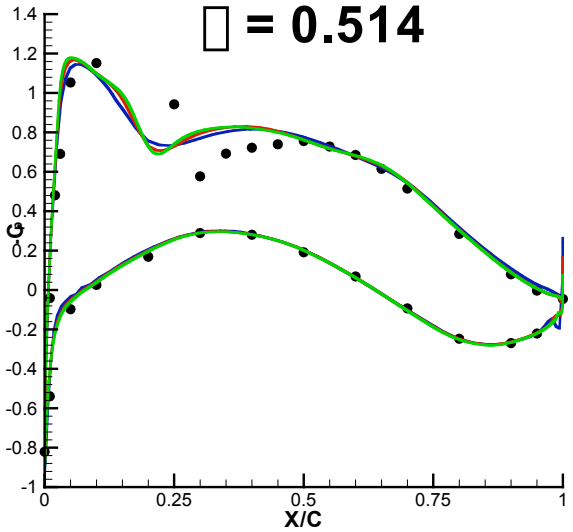


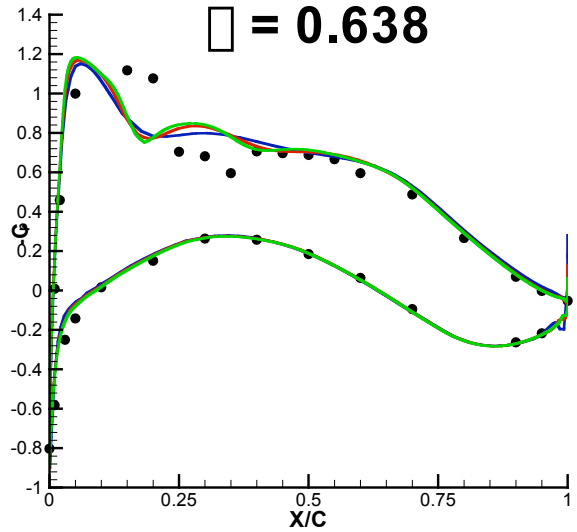


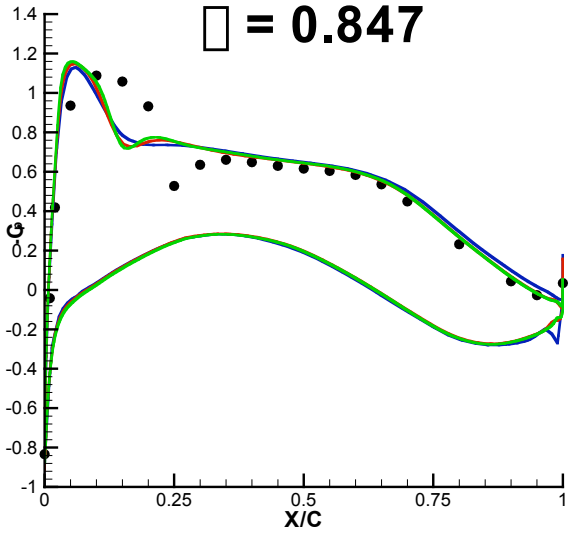


Wing/Body Grid Refinement



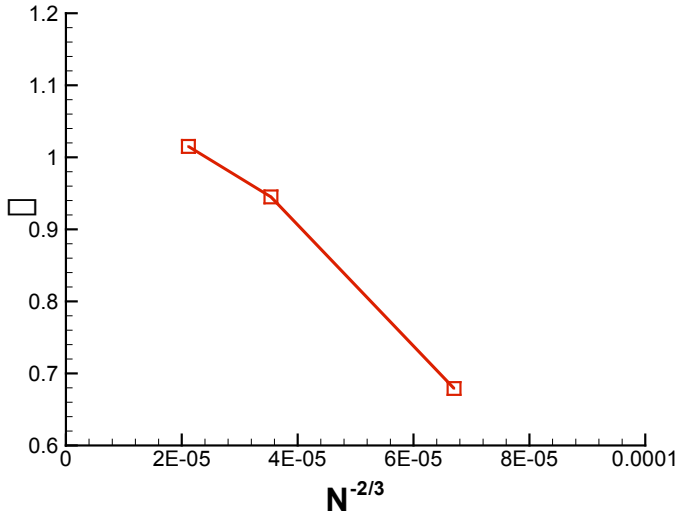


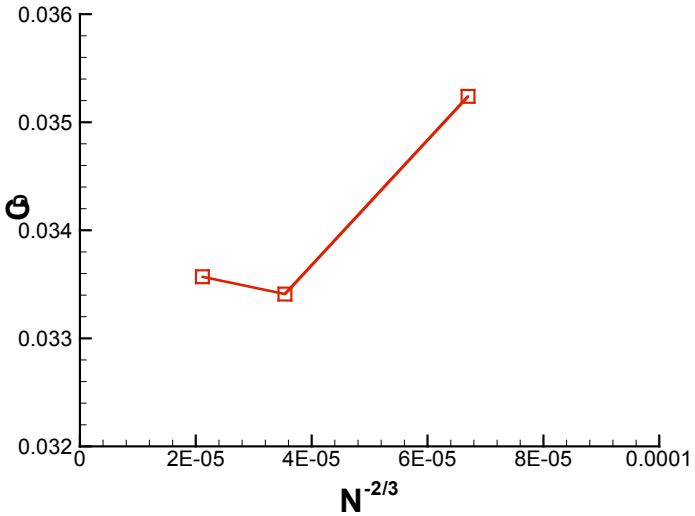


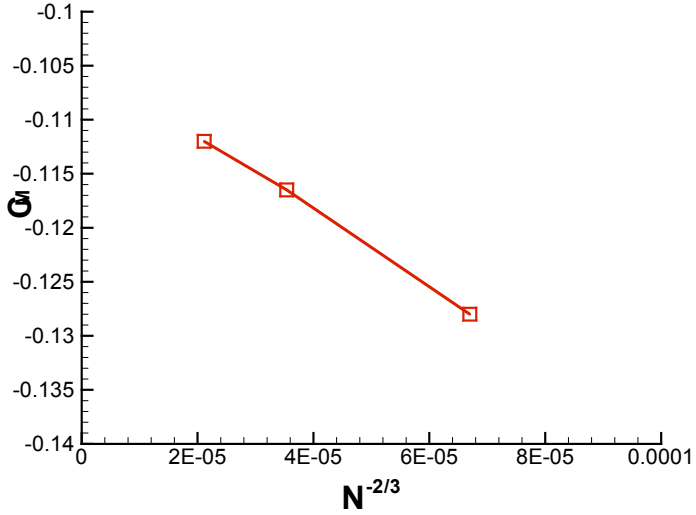


Wing/Body/Nac./Pylon Grid Refinement

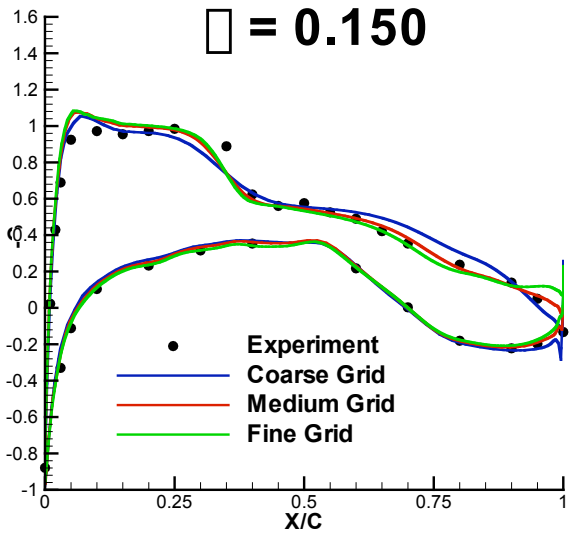
Mach 0.75, C_L=0.5

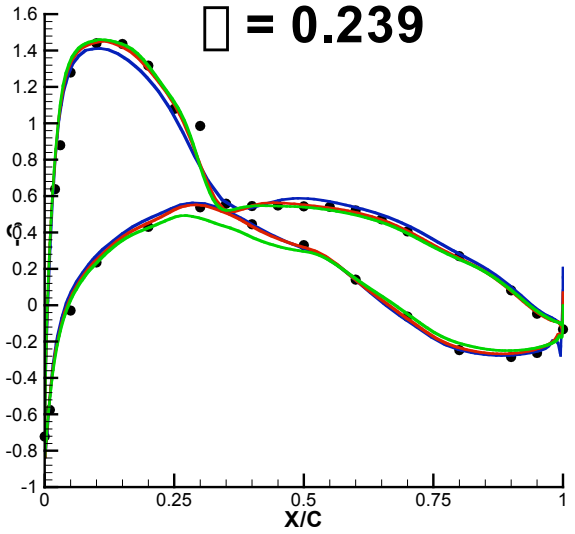


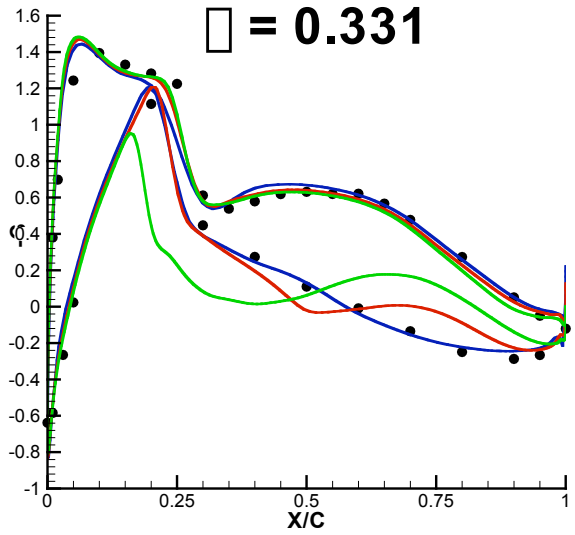


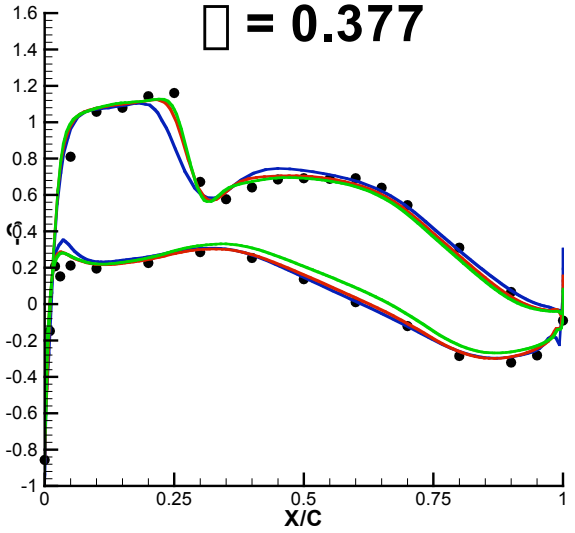


Wing/Body/Nac./Pylon Grid Refinement

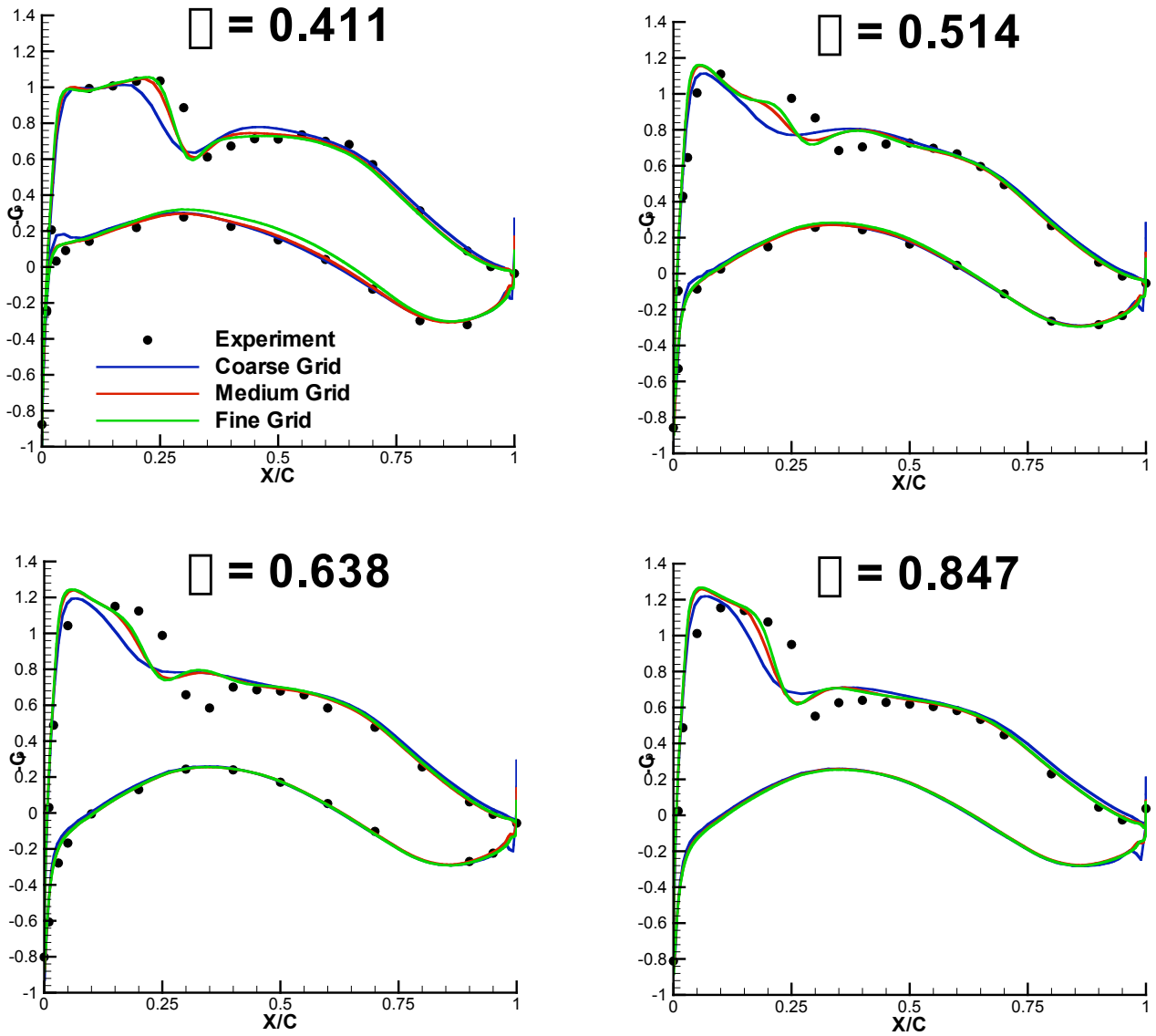




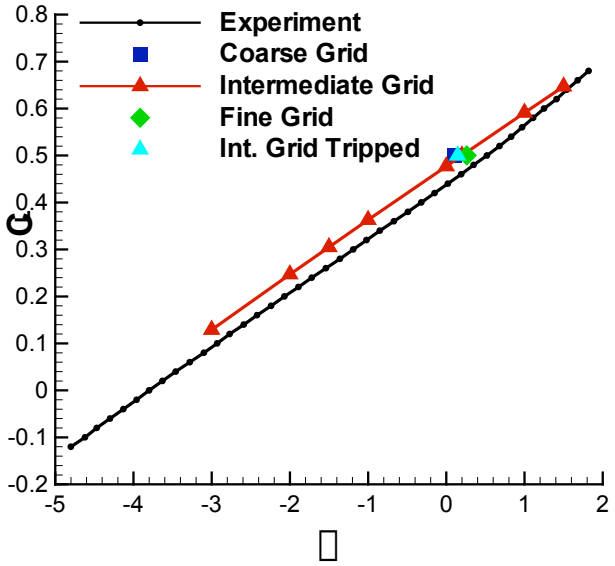




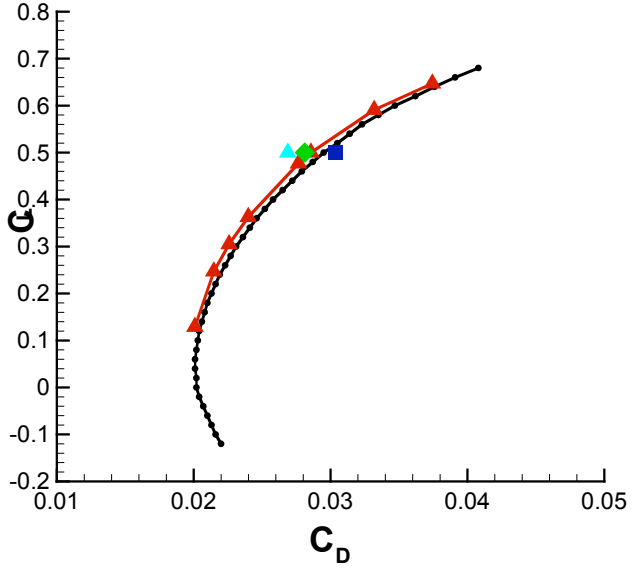
Wing/Body/Nac./Pylon Grid Refinement

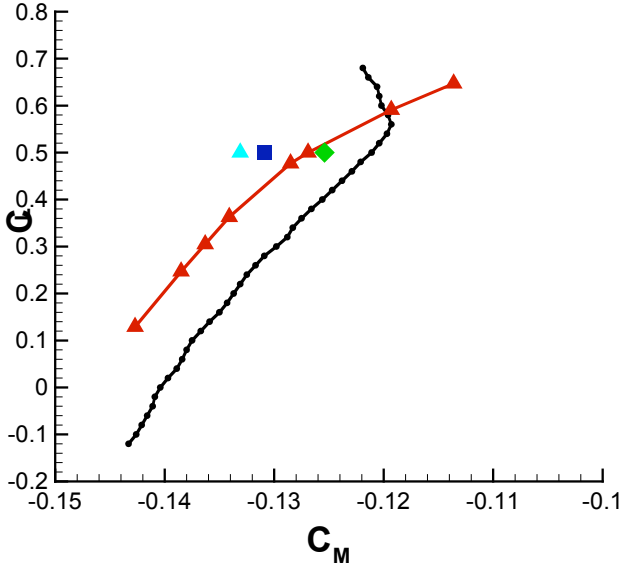


Wing/Body Polar

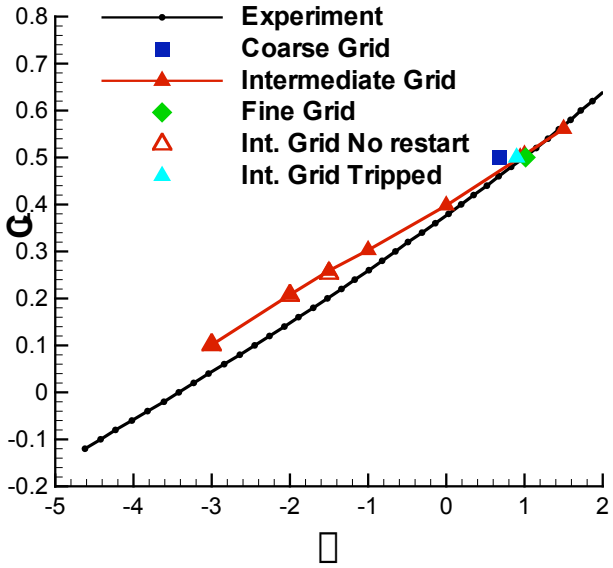


Mach 0.75, Re_c 3 x 10^6
Spalart-Allmaras
Fully Turbulent





Wing/Body/Nac./Pylon Polar



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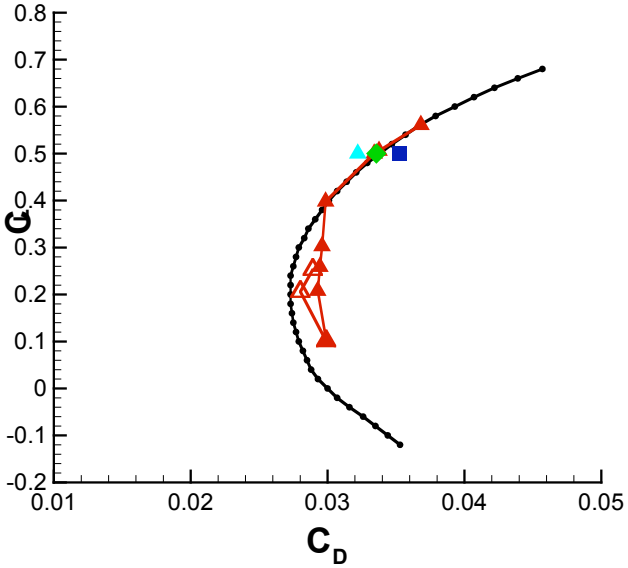
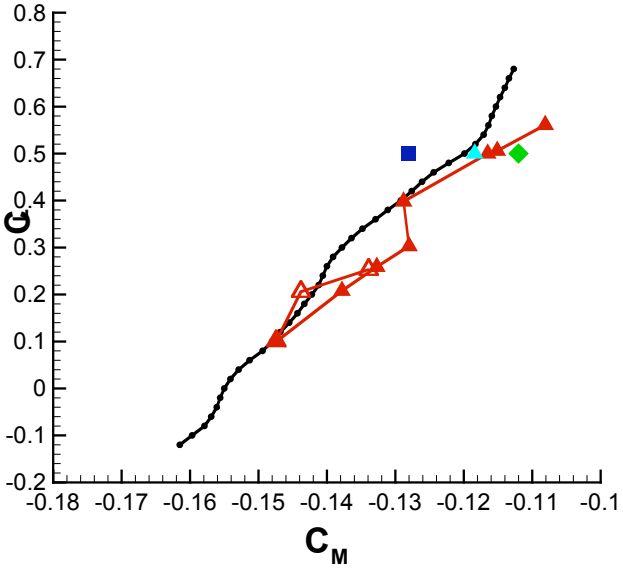
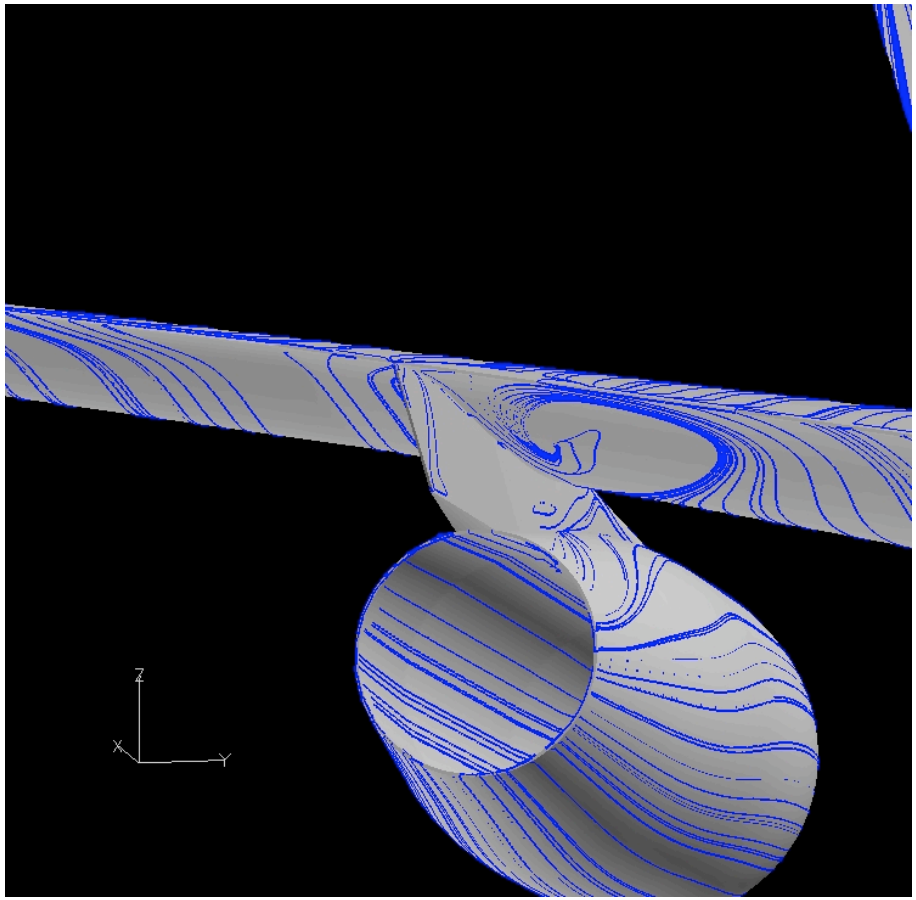
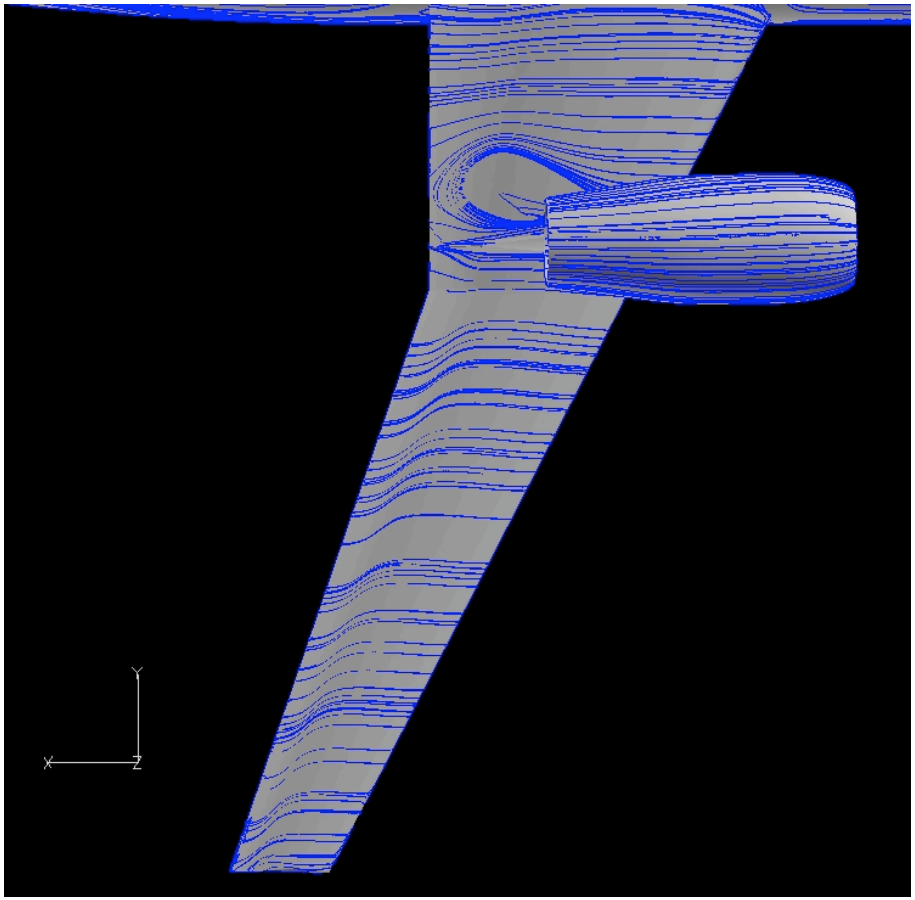




Wing/Body/Nac./Pylon

Mach 0.75, -1.0 deg





Summary

- Case 1
  - Wing/body drag decreasing monotonically with grid refinement
  - Wing/body/nac./pylon drag not changing monotonically with grid refinement
- Case 2
  - Wing/body drag correlates well with exp.
  - Wing/body/nac./pylon drag does not correlate well with exp. at lower angle of attack (solution sensitivity with initialization)

Summary

- Case 3
  - Wing/body drag decreasing 17 counts with specified transition
  - Wing/body/nac./pylon drag decreased 12 counts with specified transition