Helden Aerospace

HeldenMesh / HeldenAdapt Grids

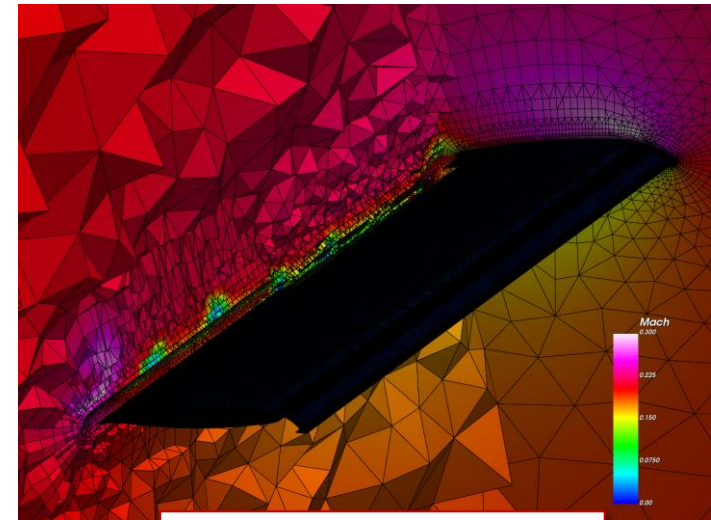HLPW6 Case 1 RANS/Adaptive Meshes

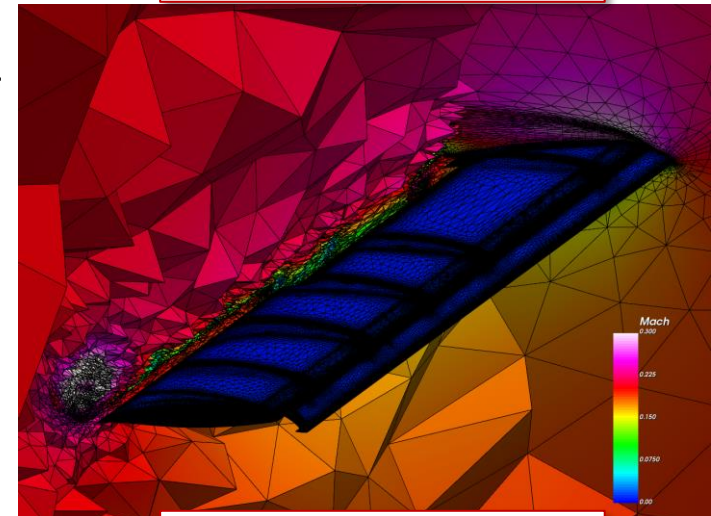Andrew Wick   Rick Hooker

Case 1 HeldenMesh RANS

- 2 Mesh series were created with differing techniques
  - **Series 03 = R.1.TC1.01 = Fixed mesh series.**
    - Series was designed primarily with resolving the surface mesh spacing with no special resolution of volume.
    - Wing, slat, and flap upper surface was resolved to specific scale
    - Finer mesh spacing applied to curvature and sharp edges
    - Uniform boundary layer spacing was prescribed using the estimated average Y+
  - **Series 04 = R.2.TC1.02 = Adapted mesh series.**
    - HeldenAdapt was used to develop a mesh spacing field based on USM3DME solutions at alpha 10, 15, 20, 25 (pre-stall / pizza sep)
    - HeldenAdapt bases the mesh spacing on Mach Hessian of all 4 alpha solutions simultaneously
    - Local viscous normal spacing was sized for local Y+
    - Meshes are hybrid elements (prisms, pyramids, tets)
    - Final meshes are based on multiple cycles of creating new mesh / updating the solution, until mesh convergence achieved.
    - Final meshes are suitable for running from scratch at any alpha near from 10 deg up to stall (30)

3D Level Mesh (38M Cells)
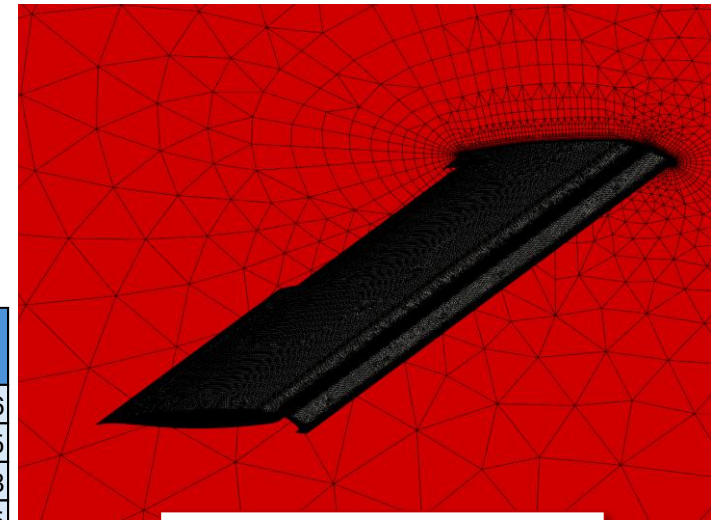

4D Level Mesh (34M Cells)

Fixed Mesh and Adaptive Sourcing Employed for Case 1

Case 1 HeldenMesh RANS
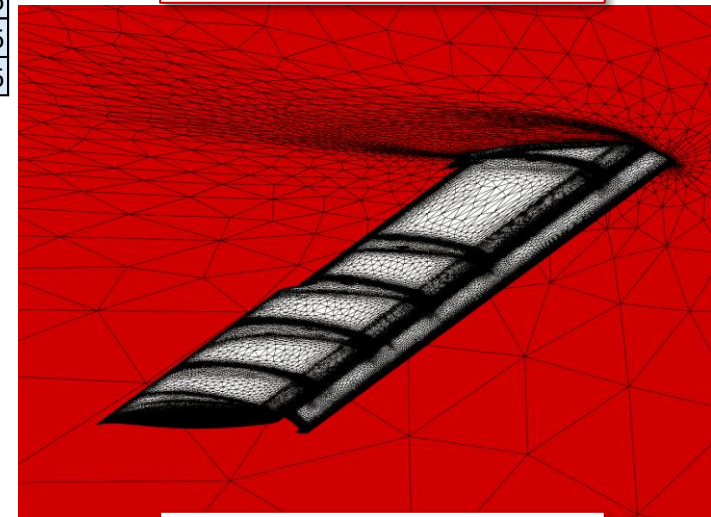
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- Mesh series were created by linearly scaling all mesh length scales (including the boundary layer)
    - Globally varying is the best approach for verifying mesh convergence, even though the "efficiency" doesn't appear as good as targeted refinement
    - 7 mesh levels (A-G) ranging from 2.6M to 933M cells

Name	#Cells	#Nodes	Avg Y+	#Pts in BL	S_UPPER	S_MIN	Growth Rate
h6c1_rans_3a_1	2,661,338	1,156,796	2	15	0.5	0.01	0.6
h6c1_rans_3b_1	5,730,017	2,563,947	1.5	20	0.375	0.0075	0.45
h6c1_rans_3c_1	17,156,244	7,925,531	1	30	0.25	0.005	0.3
h6c1_rans_3d_1	38,396,606	18,023,391	0.75	40	0.1875	0.00375	0.225
h6c1_rans_3e_1	121,556,755	57,968,323	0.5	60	0.125	0.0025	0.15
h6c1_rans_3f_1	279,592,041	134,413,941	0.375	80	0.09375	0.001875	0.1125
h6c1_rans_3g_1	933,874,390	451,567,875	0.25	120	0.0625	0.00125	0.075

Name	#Cells	#Nodes	Target Local Y+	Length Scale	S_MIN	Growth Rate
h6c1_rans_4a_1	4,188,184	1,113,311	2	2	0.01	2
h6c1_rans_4b_1	7,184,160	1,948,002	1.5	1.5	0.0075	1.5
h6c1_rans_4c_1	16,534,903	4,605,475	1	1	0.005	1
h6c1_rans_4d_1	34,012,512	9,953,907	0.75	0.75	0.00375	0.75
h6c1_rans_4e_1	101,719,719	30,840,679	0.5	0.5	0.0025	0.5
h6c1_rans_4f_1	323,271,637	106,917,219	0.375	0.375	0.001875	0.375
h6c1_rans_4g_1	732,412,476	224,931,952	0.25	0.25	0.00125	0.25

3D Level Mesh (38M Cells)

4D Level Mesh (34M Cells)

Fixed Mesh and Adaptive Sourcing Employed for Case 1
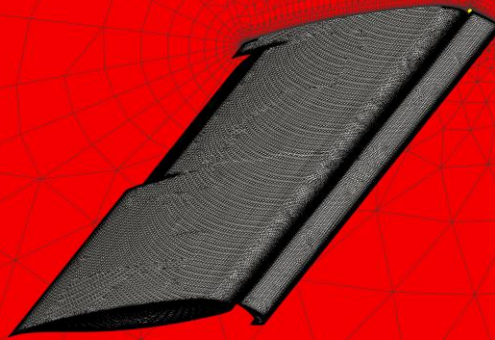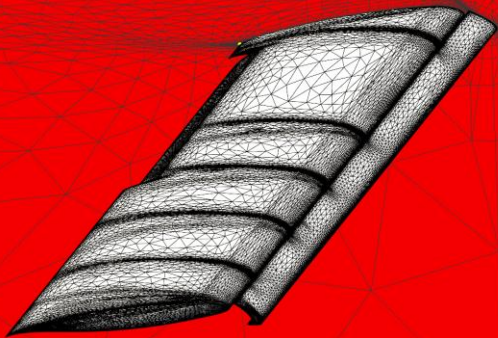
Case 1 HeldenMesh RANS
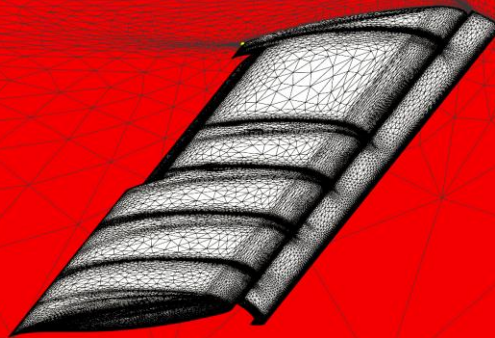
3A Level Mesh (2.6M Cells)
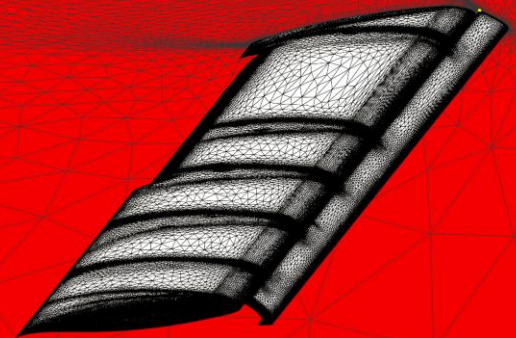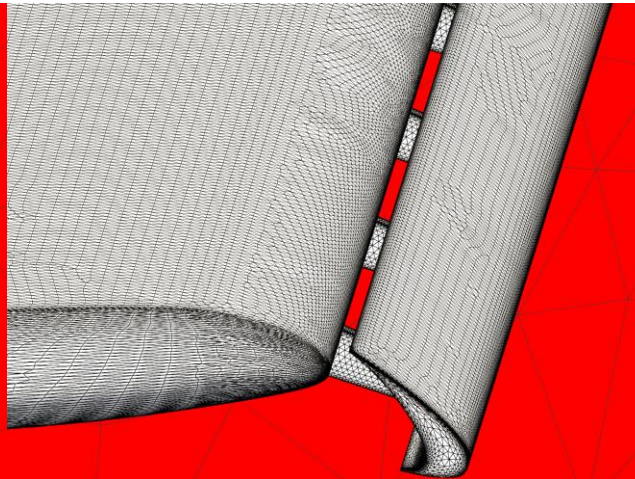
3B Level Mesh (5.7M Cells)
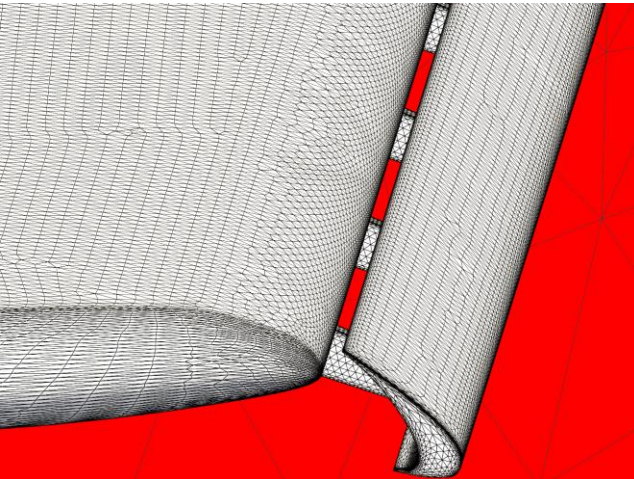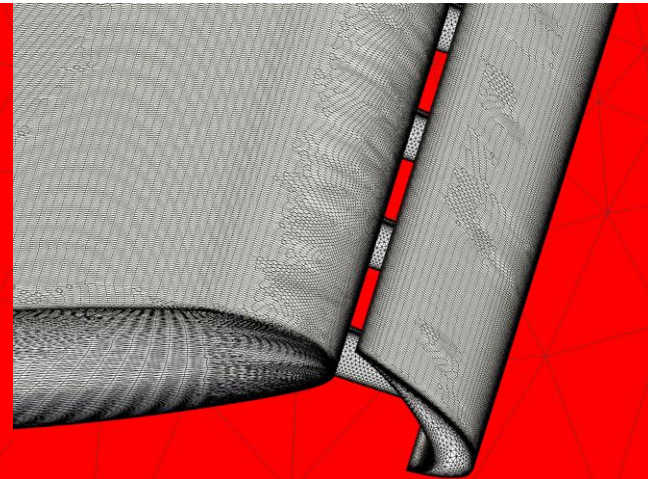
3C Level Mesh (17.2M Cells)

4A Level Mesh (4.2M Cells)

4B Level Mesh (7.2M Cells)

4C Level Mesh (16.5M Cells)

Case 1 HeldenMesh RANS
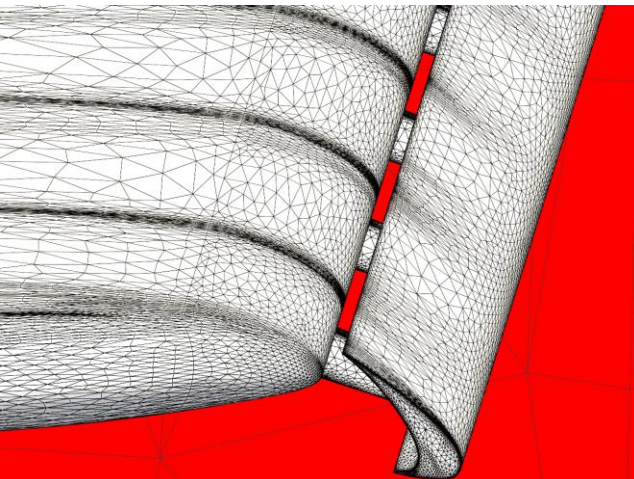
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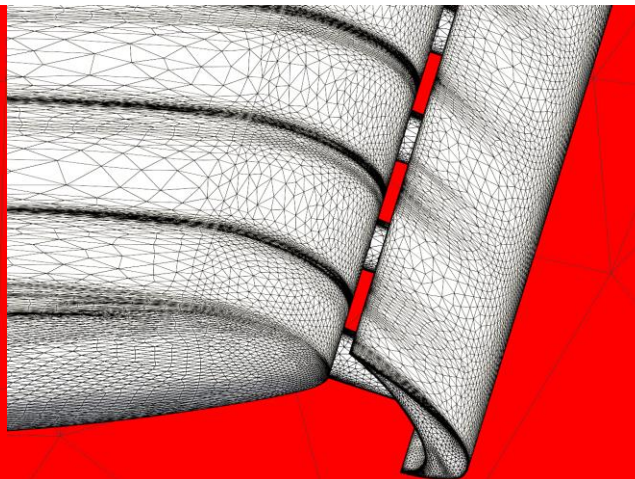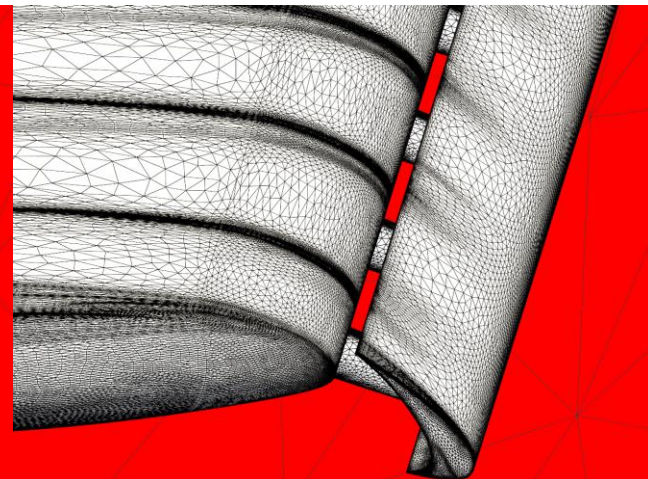3A Level Mesh (2.6M Cells)

3B Level Mesh (5.7M Cells)

3C Level Mesh (17.2M Cells)

4A Level Mesh (4.2M Cells)

4B Level Mesh (7.2M Cells)

4C Level Mesh (16.5M Cells)

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Case 1 HeldenMesh RANS

Series 3: D Mesh 38M Cells

Alpha 25

Series 4: D Mesh 34M Cells

Alpha 25

Closeup of Outboard Bracket 2

Case 1 HeldenMesh RANS

Helden Aerospace

Series 3: D Mesh 38M Cells — Alpha 25

Series 4: D Mesh 34M Cells — Alpha 25

cfmag
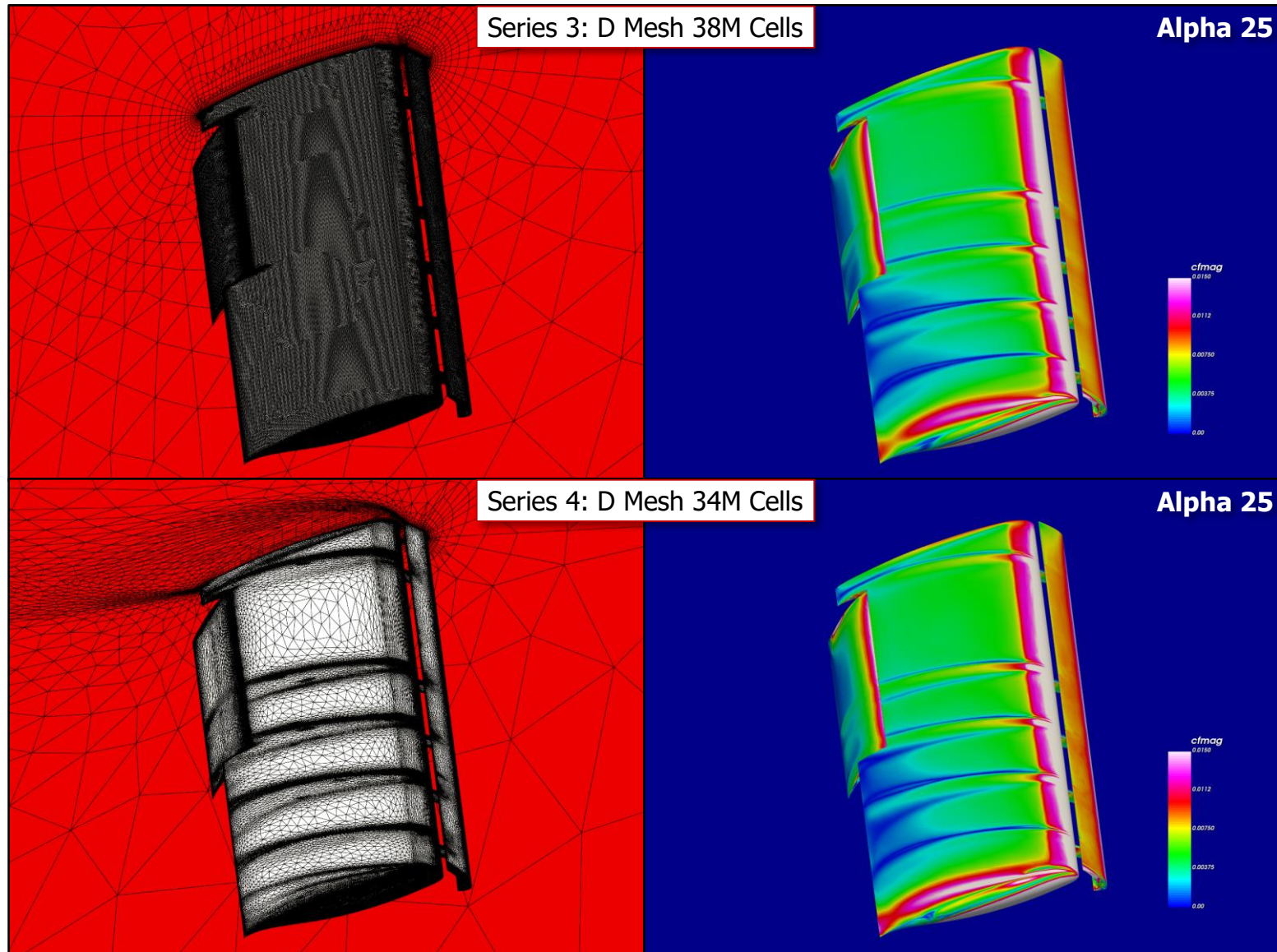
Closeup of Underside of Outboard Bracket 2

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2/11/2026
Slide #7

Case 1 HeldenMesh RANS

Helden Aerospace

Series 3: D Mesh 38M Cells

Alpha 25

Solution is Smeared out

Series 4: D Mesh 34M Cells

Alpha 25

Closeup of Wing Upper Surface Near Outboard Bracket 2

Case 1 HeldenMesh RANS

Helden Aerospace

Series 3: D Mesh 38M Cells

Alpha 25

Series 4: D Mesh 34M Cells

Alpha 25

Airfoil Cut Through Wing Near Outboard Bracket 2

Case 1 HeldenMesh RANS

Helden Aerospace

Series 3: D Mesh 38M Cells

Alpha 25

Solution is Smeared out

Series 4: D Mesh 34M Cells

Alpha 25

Leading Edge Cut Through Wing Near Outboard Bracket 2

Case 1 HeldenMesh RANS

Helden Aerospace

Series 3: D Mesh 38M Cells

Alpha 25

Solution is Smeared out

Mach

Series 4: D Mesh 34M Cells

Alpha 25

Mach

Fuselage Cut Through Cross Section of Outboard Bracket 2

Helden
Aerospace

Case 1 HeldenMesh RANS

Alpha 10
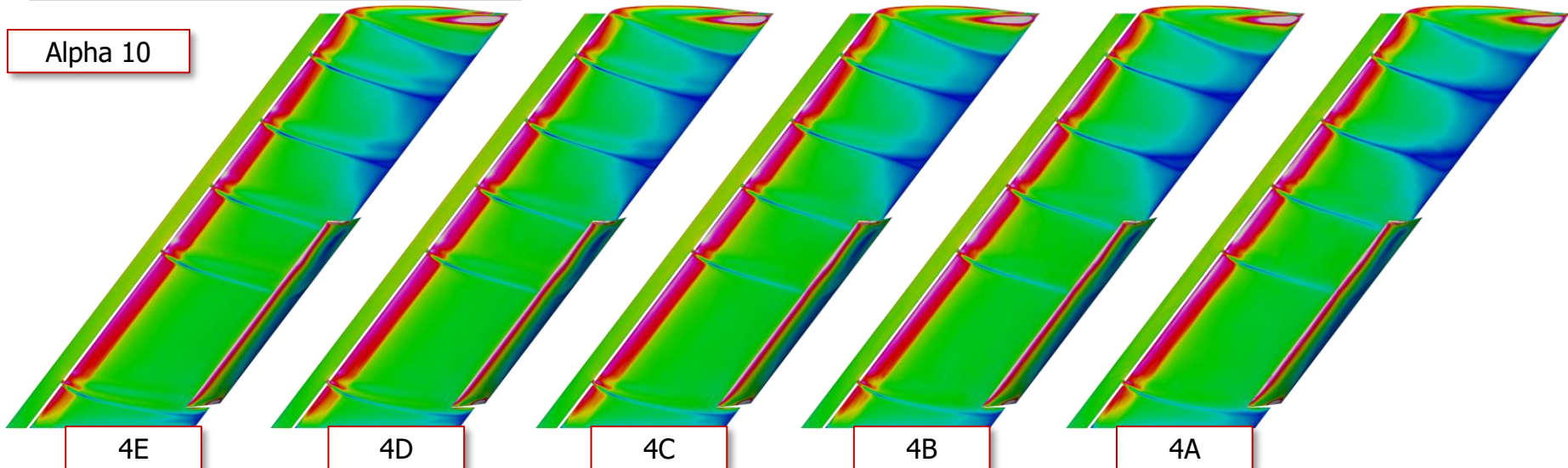
4E   4D   4C   4B   4A
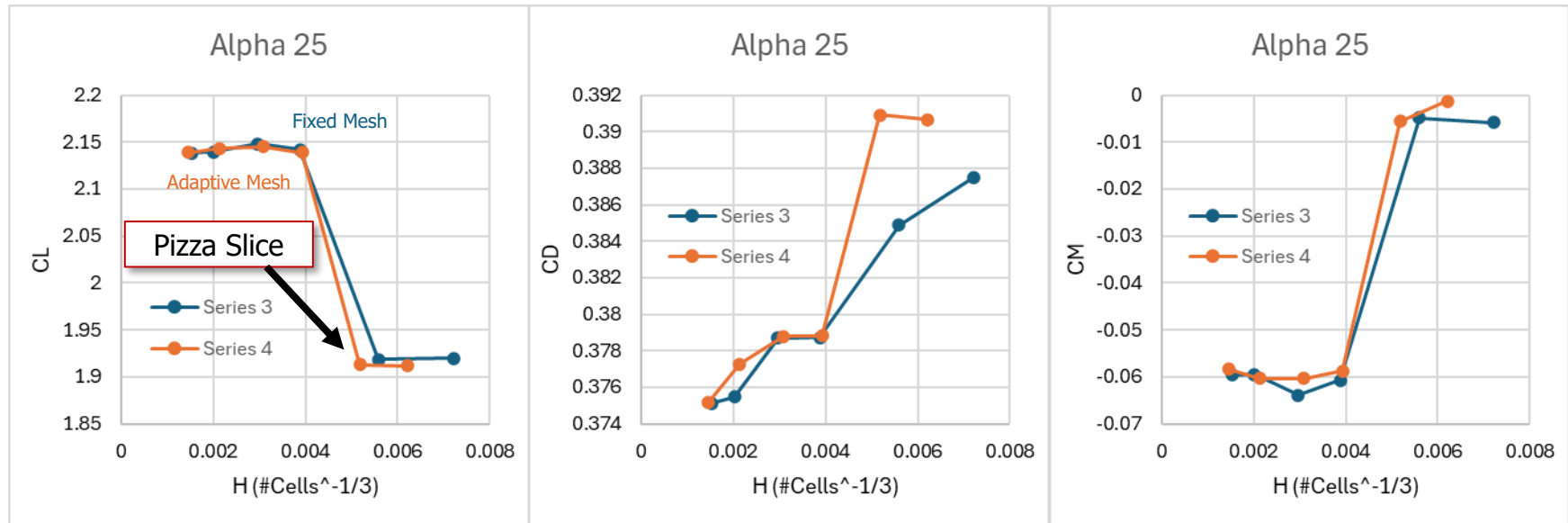
Finer ← → **Coarser**

Good Mesh Convergence Demonstrated

Case 1 HeldenMesh RANS

Helden Aerospace

Alpha 25 (CL plot)
Fixed Mesh
Adaptive Mesh
Pizza Slice
Series 3
Series 4

Alpha 25 (CD plot)
Series 3
Series 4

Alpha 25 (CM plot)
Series 3
Series 4

Alpha 25

Pizza Slice

4E 4D 4C 4B 4A

Finer ← → Coarser
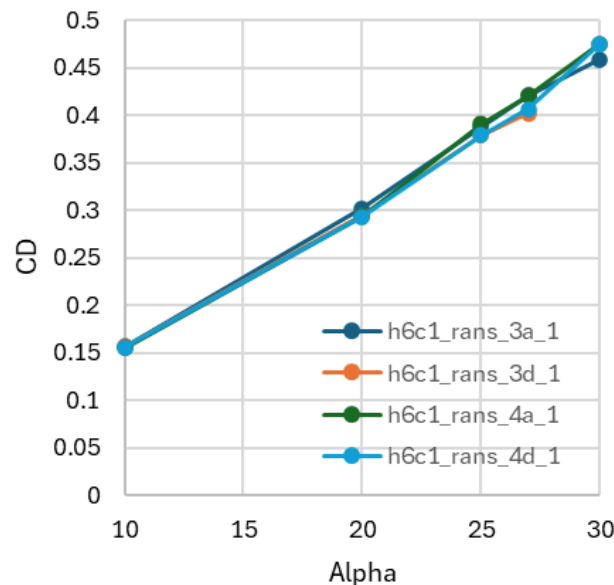
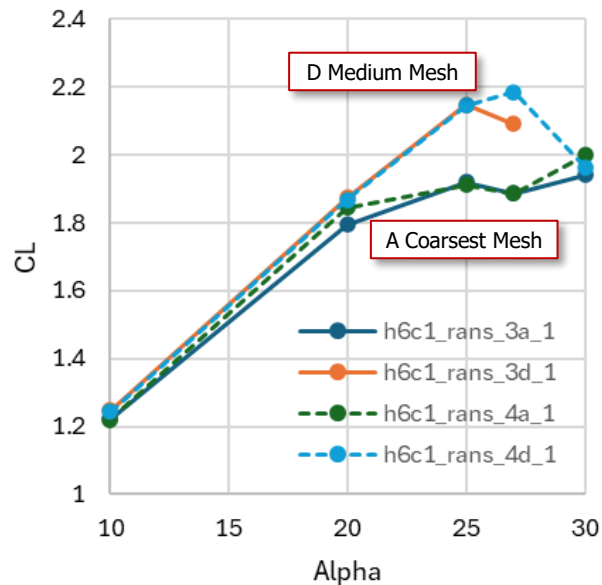**Good Mesh Convergence Demonstrated**
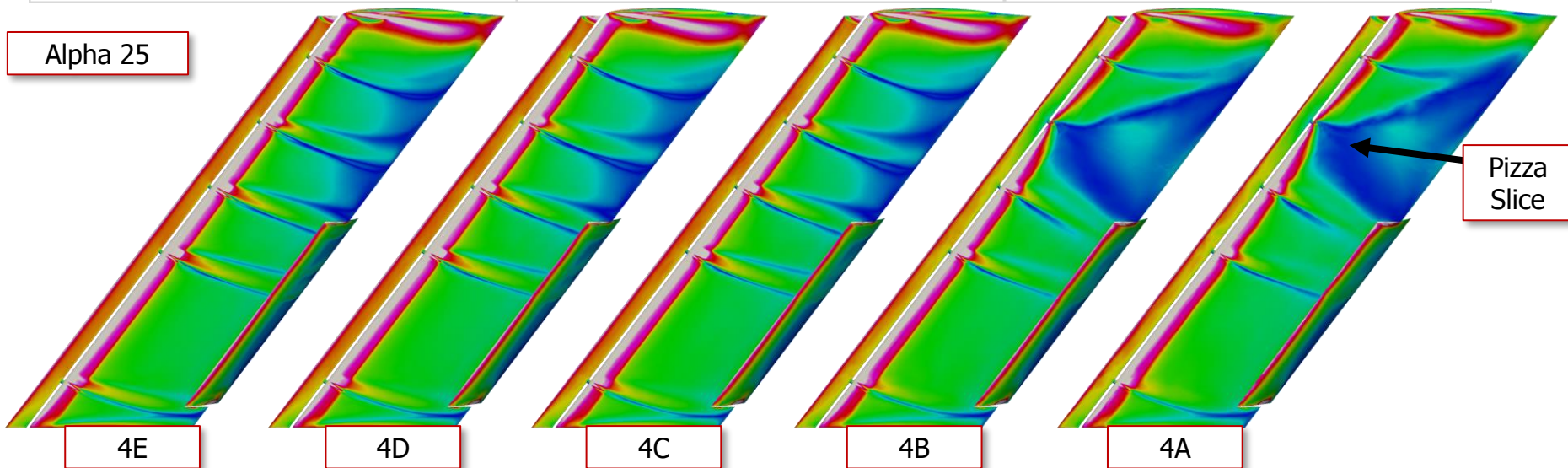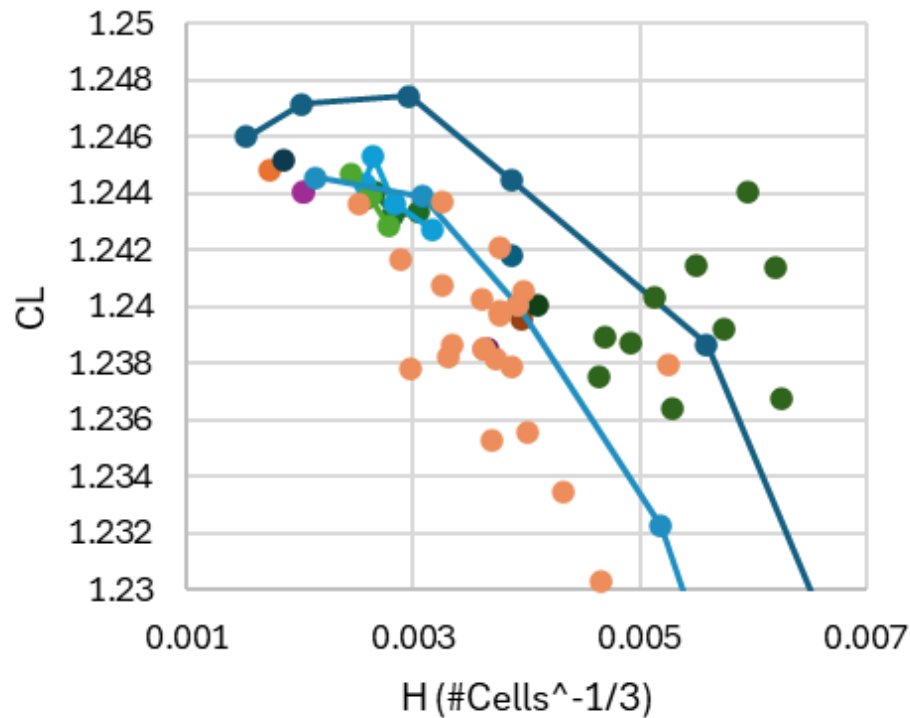
Case 1 HeldenMesh RANS
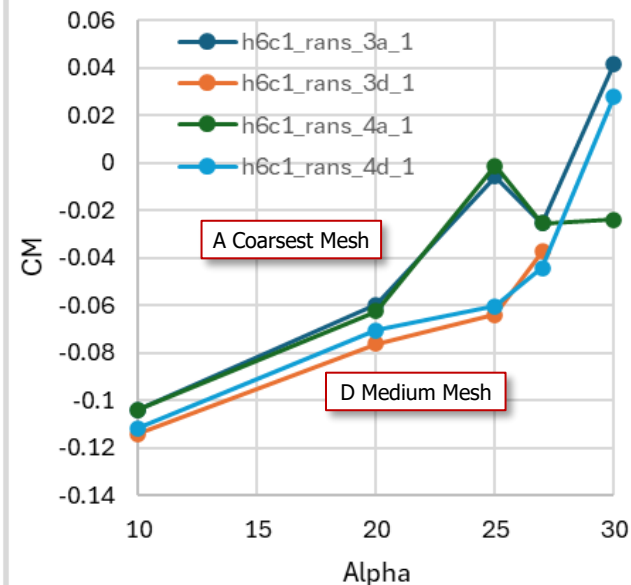
- D level mesh USM3DME solutions appear relatively mesh converged at Alpha 10 and Alpha 25
- Overall, the 2 mesh series seem to give similar results despite completely different designs
  - The only parameter they share is the same SMIN, minimum surface mesh spacing (ie, LE and Sharp Edge spacing)
- Visually, the adapted meshes seem to resolve more features including flow near the brackets
  - Should prove interesting for study of pizza slice separation
- Fixed grids have the appearance of being more accurate (higher lift), but this is likely because the flow around the brackets is being smeared out in a way that promotes lift
  - Combining the spacings from series 3 and series 4 results in a loss of lift
- Solution convergence remains an issue for this geometry (effect of brackets)
  - Results shown are force/moment converged but not machine zero

Case 1 HeldenMesh RANS