Structured Overset Grids for the NASA Common Research Model (CRM)

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4th AIAA Drag Prediction Workshop
San Antonio, Texas
20-21 June 2009

Gridding Guidelines

Initial spacing normal to all viscous walls (RE = 5M based on C_{REF}=275.80”):

- Coarse: y^+ ~ 1.0 Δy = 0.001478 in
- Medium: y^+ ~ 2/3 Δy = 0.000985 in
- Fine: y^+ ~ 4/9 Δy = 0.000657 in
- Extra-Fine: y^+ ~ 8/27 Δy = 0.000438 in

Total grid size to grow ~3X between each grid level for grid convergence cases

- For structured meshes, this growth is ~1.5X in each coordinate direction

Growth rate of cell sizes in the viscous layer should be < 1.25

Farfield located at ~100 C_{REF}’s for all grid levels

For the Medium Baseline Grids:

- Chordwise spacing for wing and tail leading edge (LE) and trailing edge (TE) ~0.1% local chord
- Wing and tail Spanwise spacing at root ~0.1% local semispan
- Wing and tail Spanwise spacing at tip ~0.1% local semispan
- Cell size near fuselage nose and after-body ~2.0% CREF

Wing and Tail Trailing Edge Base:

- Minimum of 8 cells across TE base for the coarse mesh
- Minimum of 12 cells across TE base for the medium mesh
- Minimum of 16 cells across TE base for the fine mesh
- Minimum of 24 cells across TE base for the extra-fine mesh

Be multi-grid friendly

Gridding Guidelines (continued)

Suggested Grid Size for the NASA CRM Wing-Body:

- Medium = ~8M cells/nodes

Suggested Grid Sizes for the NASA CRM Wing-Body-Tail ($i_H = 0^o$):

- Coarse = ~3.5M cells/nodes
- Medium = ~10M cells/nodes
- Fine = ~35M cells/nodes
- Extra-Fine = ~100M cells/nodes

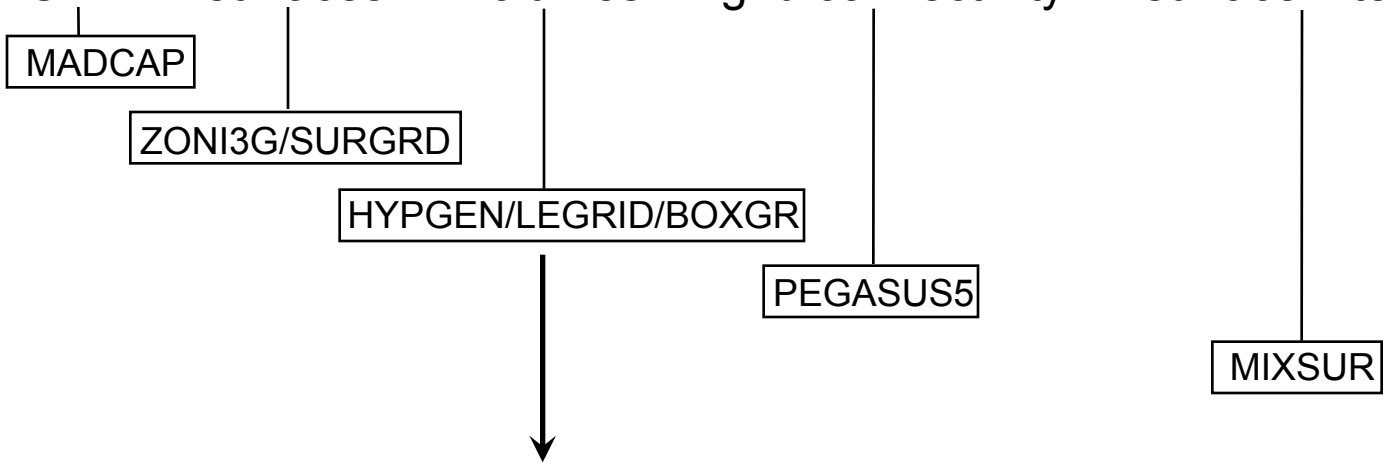
Overset Grid Generation Process

First built the medium grid following established “best practices” for overset grid generation

- Chan, Gomez, Rogers, Buning, “Best Practices in Overset Grid Generation”, AIAA 2002-3191
- Vassberg, DeHaan, Sclafani, “Grid Generation Requirements for Accurate Drag Predictions Based on OVERFLOW Calculations”, AIAA 2003-4124

Medium Grid Generation Process

CAD ➔ surfaces ➔ volumes ➔ grid connectivity ➔ surface integration



Built coarse, fine and extra-fine grids using the medium volume grids

- Used an in-house program called P3D_REDIM
- Re-ran PEGASUS5 and MIXSUR

Structured Overset Grid Information

Structured Overset Grid Systems

- 11 zones for Wing-Body
- 17 zones for Wing-Body-Horizontal

Medium grid is typical for drag quality design studies

Wing-Body

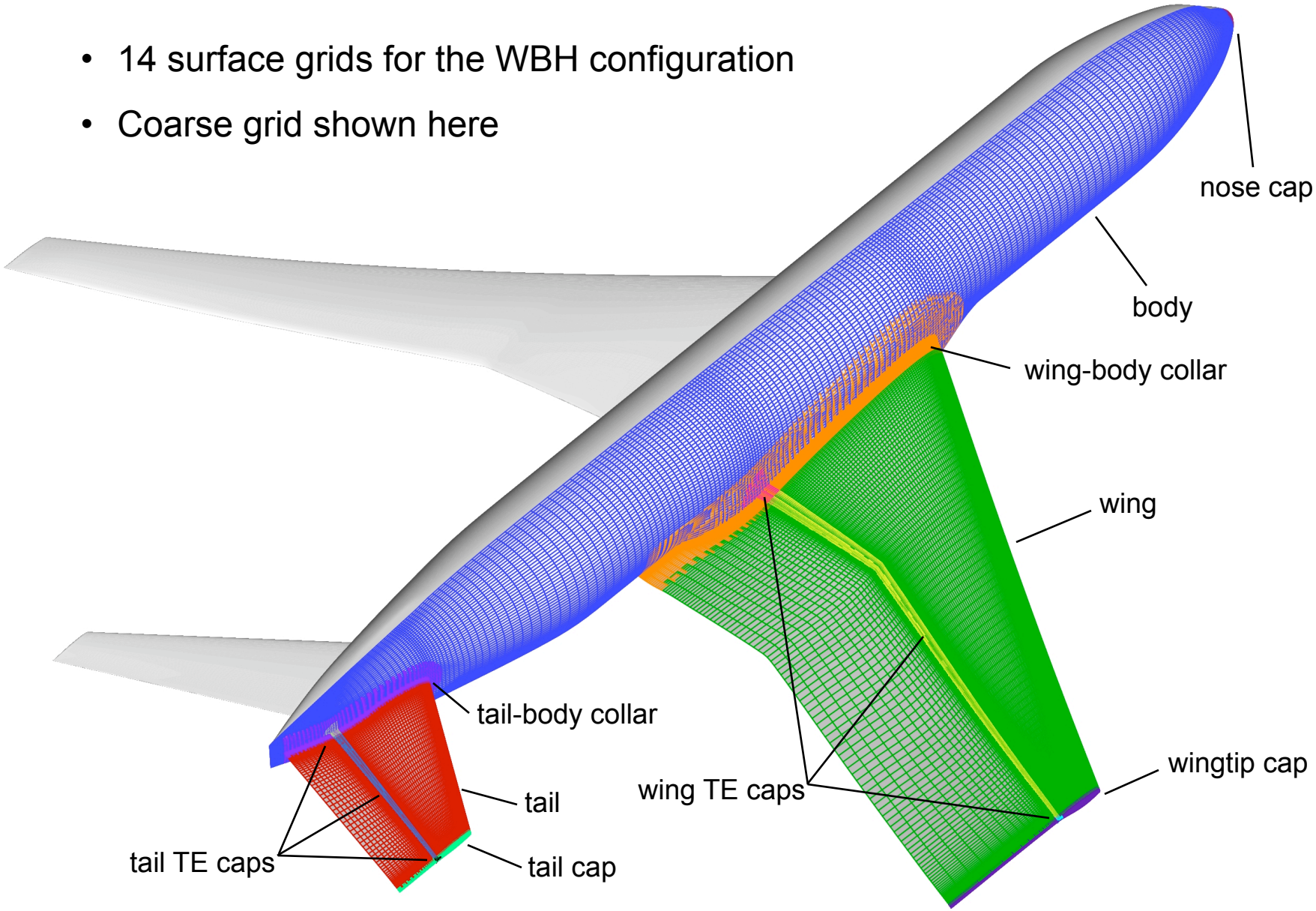
Grid	Points	$1/N^{2/3} \times 10^5$	1st Cell Size	y^+	Constant Cells	Growth Rate
Medium	12,267,995	1.88	.00079 in	.66	3	1.19

Wing-Body-Horizontal

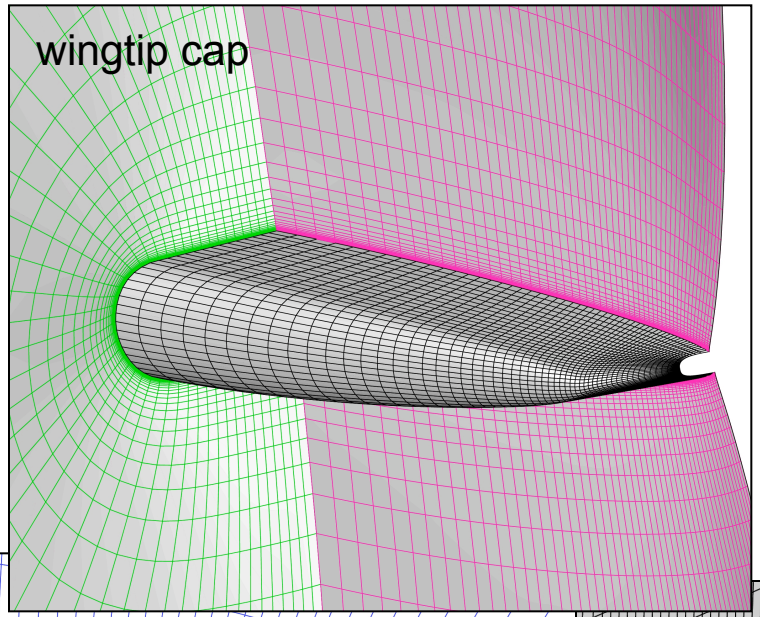
Grid	Points	$1/N^{2/3} \times 10^5$	1st Cell Size	y^+	Constant Cells	Growth Rate
Coarse	7,221,233	2.68	.00104 in	.87	2	1.26
Medium	16,932,913	1.52	.00079 in	.66	3	1.19
Fine	56,531,489	0.68	.00052 in	.44	4	1.12
Extra Fine	189,413,153	0.30	.00035 in	.29	6	1.08

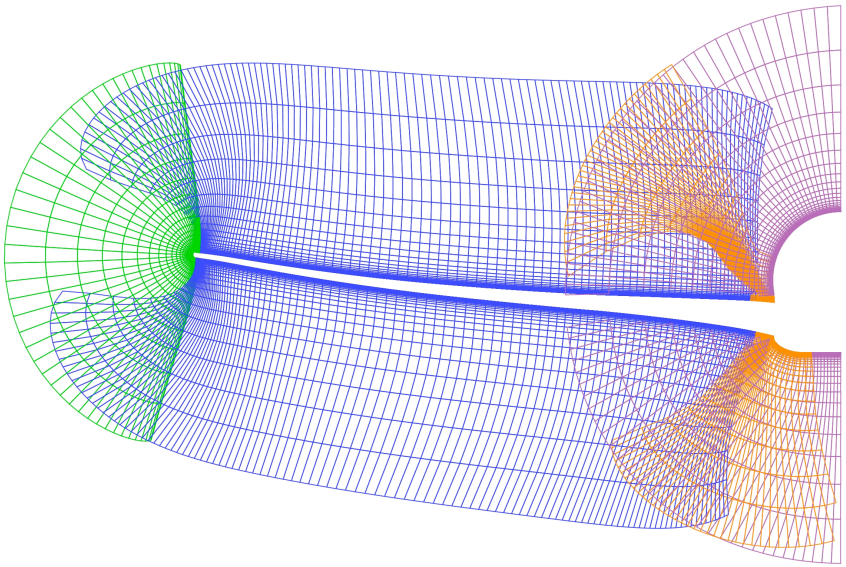
Wing-Body-Horizontal Surface Abutting Grids

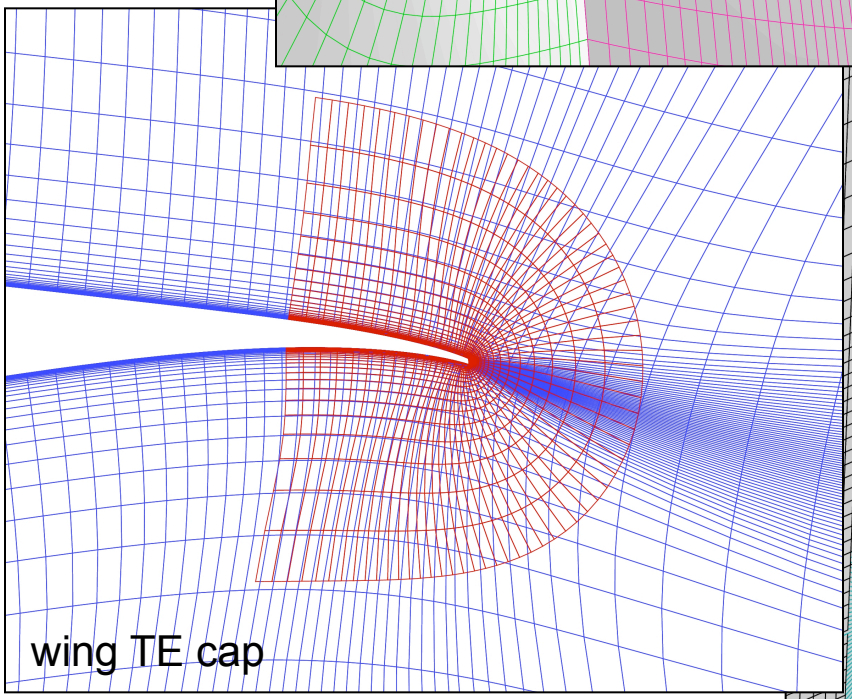
- 14 surface grids for the WBH configuration
- Coarse grid shown here

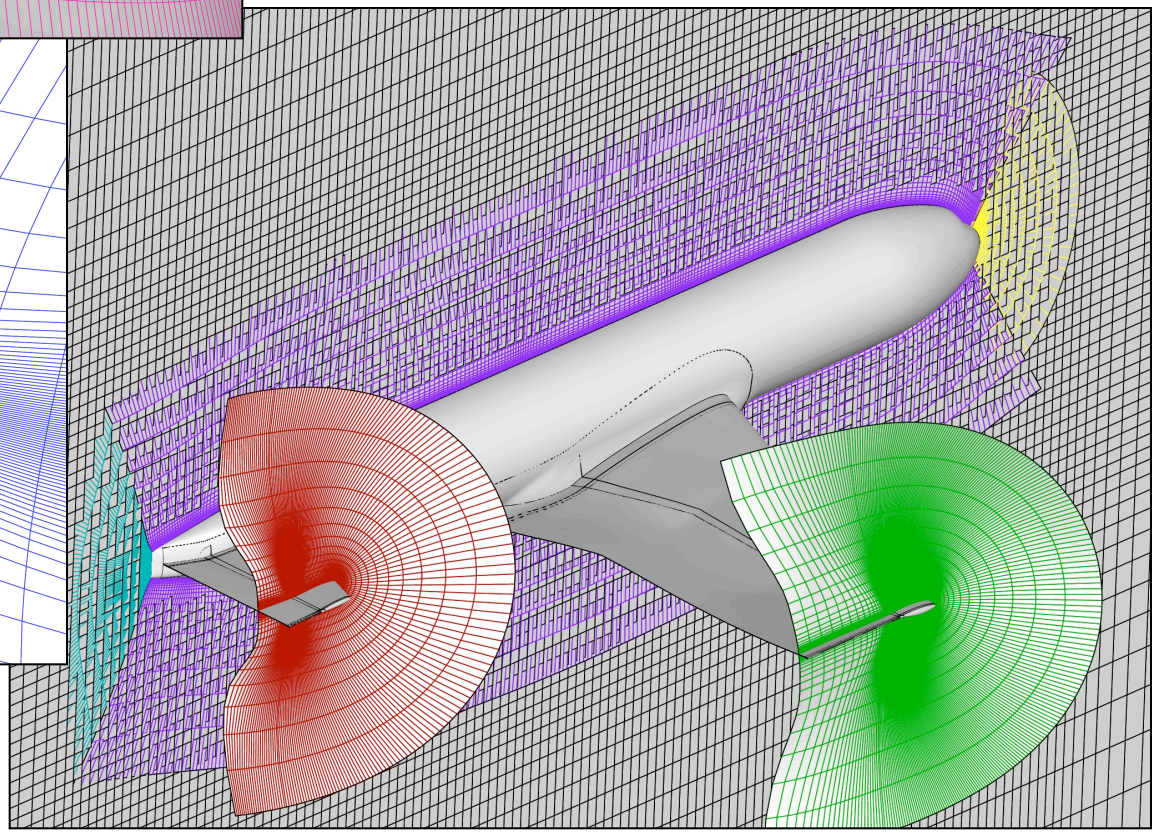


Volume Grids – Coarse Grid Shown Here

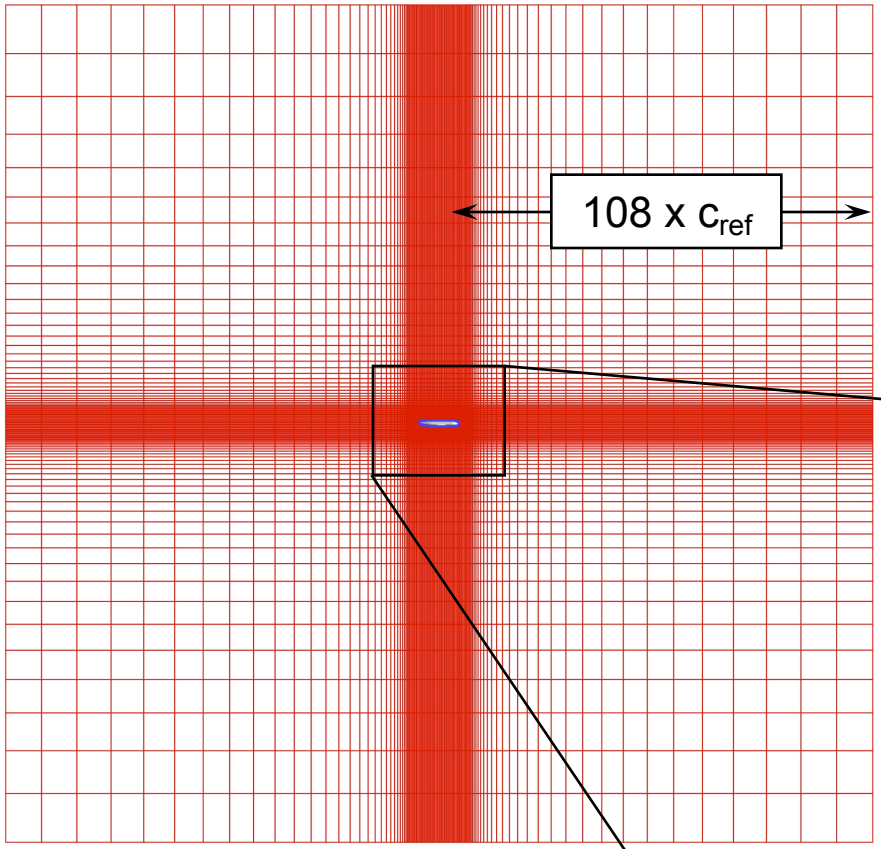








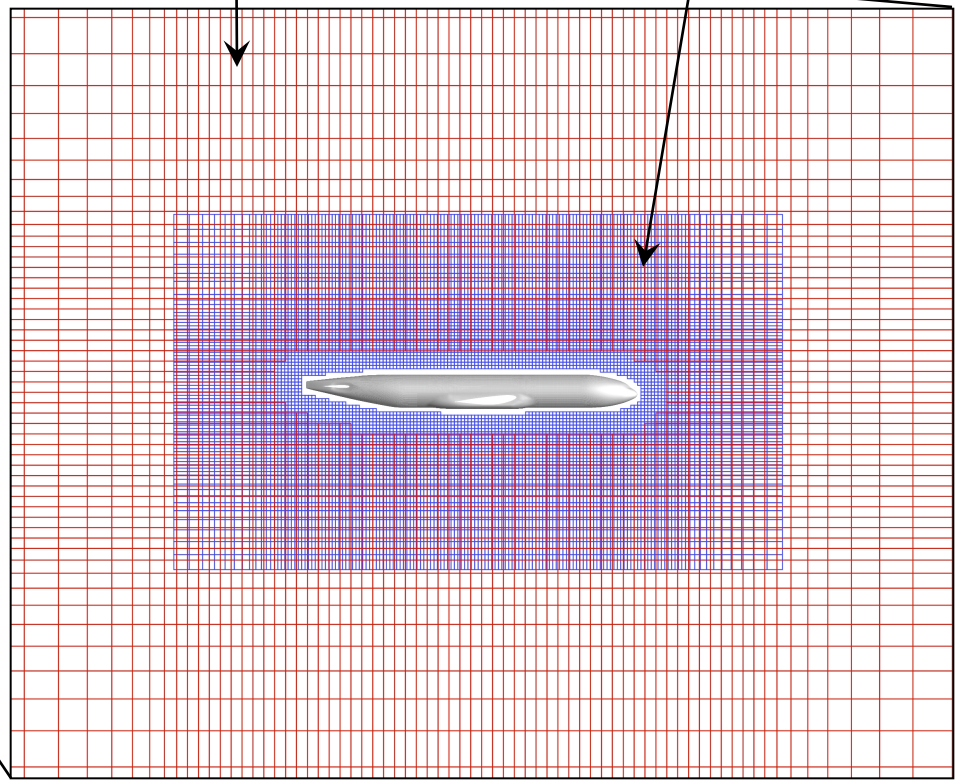
Box Grids at the Symmetry Plane



Coarse grid shown here

outer box K1 plane

body box K1 plane

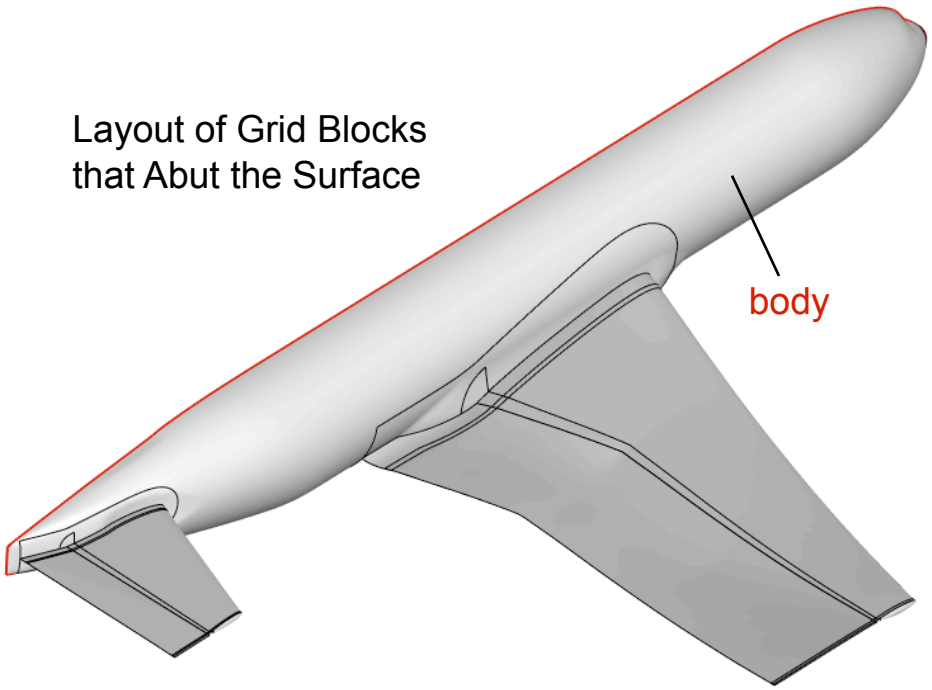


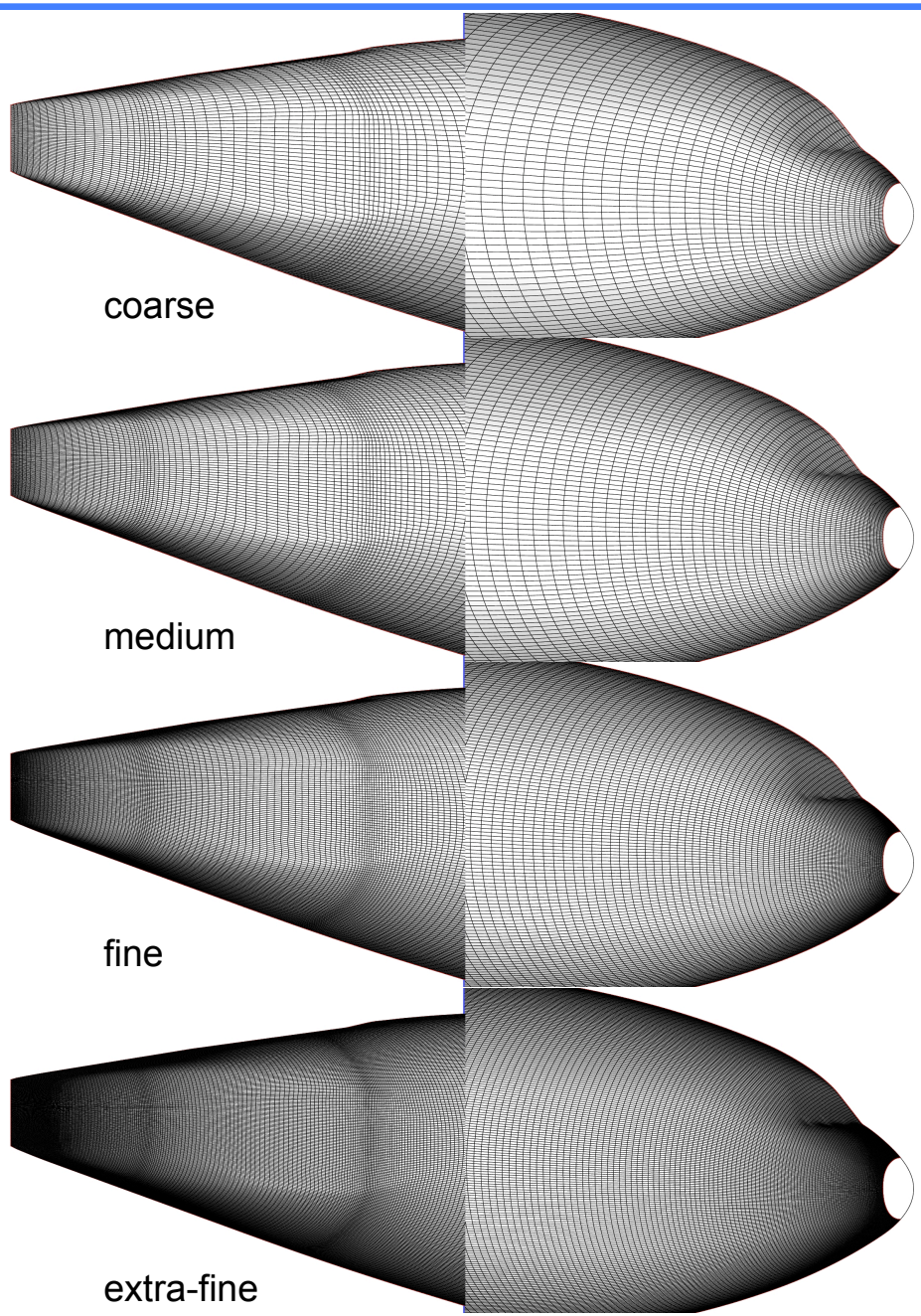
3 box grids

- body box
- wing box (not shown)
- outer box

Body Grids

grid	J	K	L	total
coarse	217 .75 x m	73 .75 x m	49 .75 x m	776,209 .43 x m
medium	**289**	**97**	**65**	**1,822,145**
fine	433 1.50 x m	145 1.49 x m	97 1.49 x m	6,090,145 3.34 x m
extra-fine	649 1.50 x f	217 1.50 x f	145 1.49 x f	20,420,785 3.35 x m

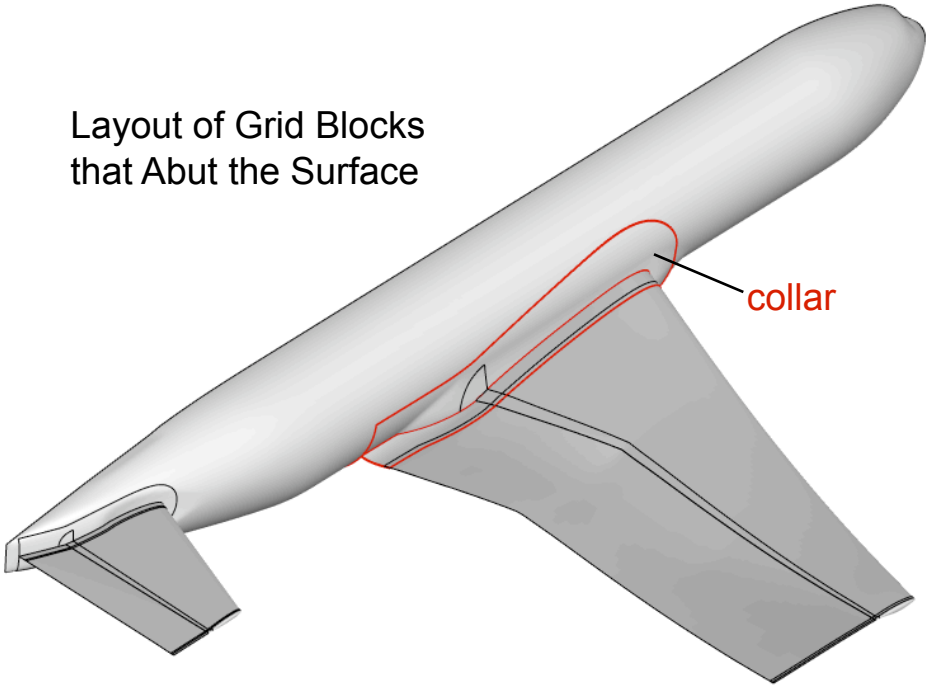


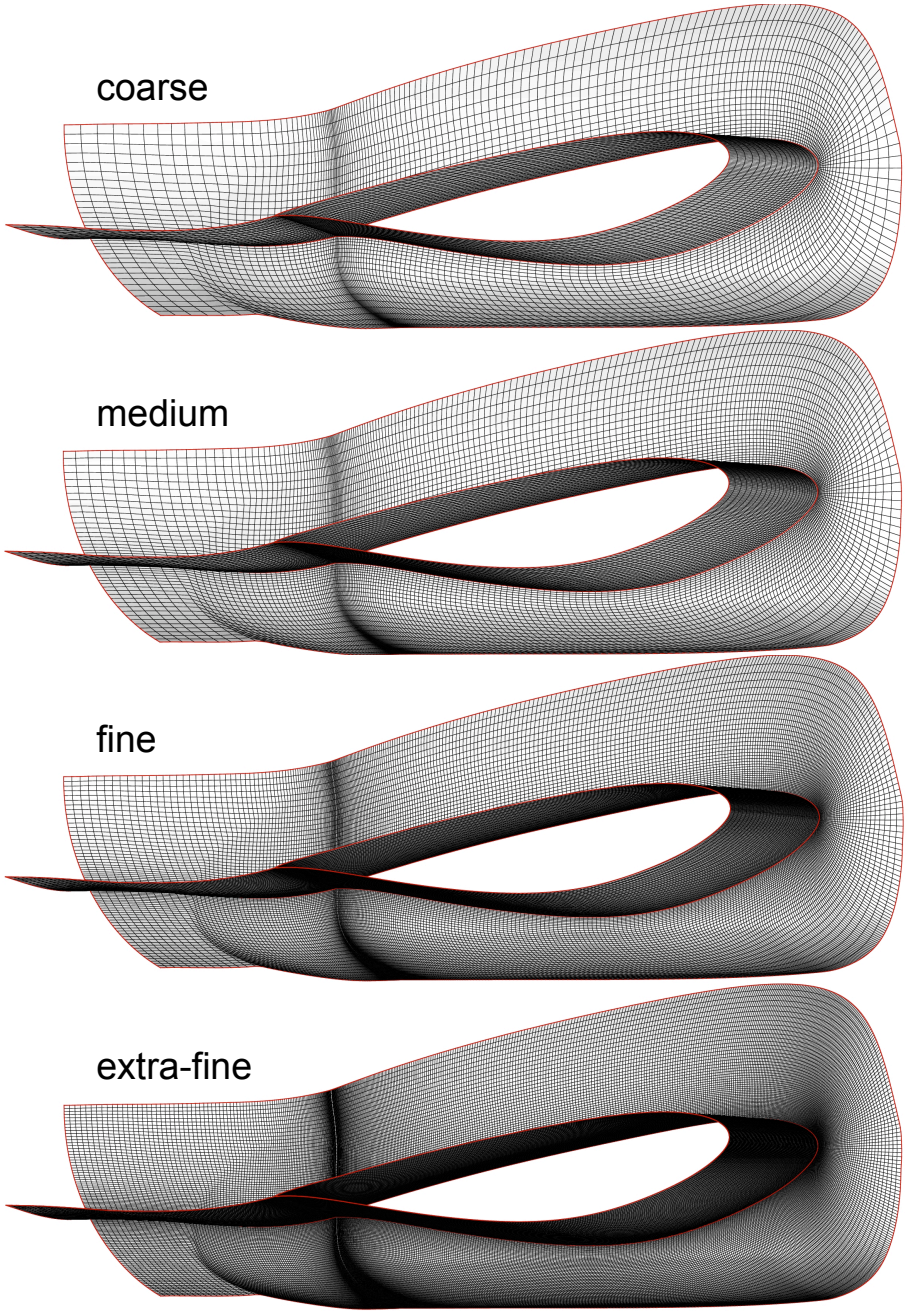


Wing-Body Collar Grids

grid	J	K	L	total
coarse	289 .75 x m	37 .75 x m	49 .75 x m	523,957 .43 x m
medium	**385**	**49**	**65**	**1,226,225**
fine	577 1.50 x m	73 1.49 x m	97 1.49 x m	4,085,737 3.33 x m
extra-fine	865 1.50 x f	109 1.49 x f	145 1.49 x f	13,671,325 3.35 x m

Layout of Grid Blocks that Abut the Surface

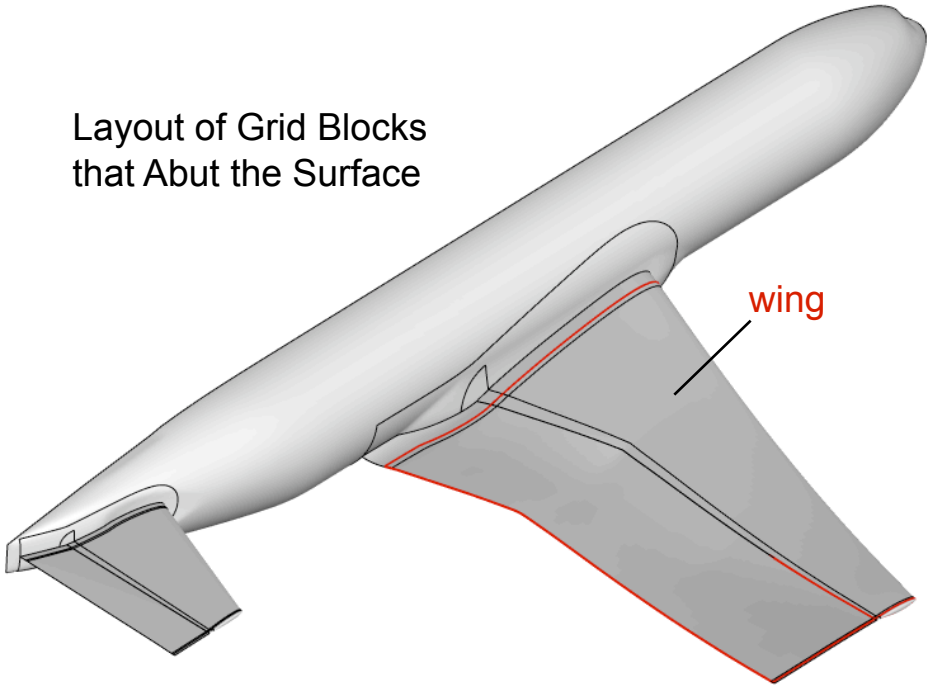


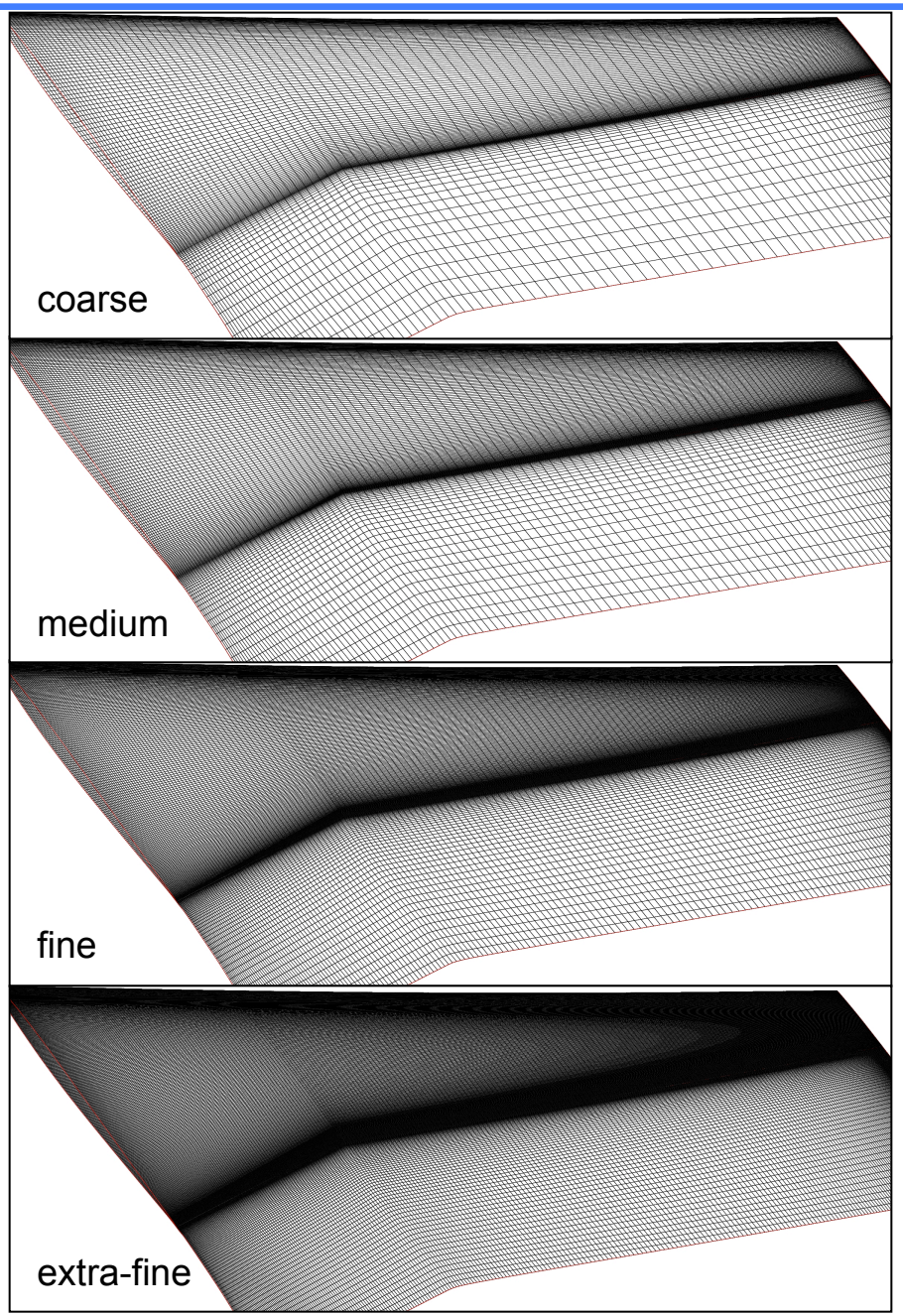


Wing Grids

grid	J	K	L	total
coarse	265 .75 x m	109 .75 x m	49 .75 x m	1,415,365 .43 x m
medium	**353**	**145**	**65**	**3,327,025**
fine	529 1.50 x m	217 1.50 x m	97 1.49 x m	11,134,921 3.35 x m
extra-fine	793 1.50 x f	325 1.50 x f	145 1.49 x f	37,370,125 3.36 x m

Layout of Grid Blocks that Abut the Surface





Wing Trailing-Edge Cap Grids

grid	J	K	L	total
coarse	73 .75 x m	37 .75 x m	37 .75 x m	99,937 .43 x m
medium	**97**	**49**	**49**	**232,897**
fine	145 1.49 x m	73 1.49 x m	73 1.49 x m	772,705 3.32 x m
extra-fine	217 1.50 x f	109 1.49 x f	109 1.49 x f	2,578,177 3.34 x m

Layout of Grid Blocks that Abut the Surface