RECENT DEVELOPMENT AND APPLICATIONS OF THE EPOGS TOOLSET FOR AUTOMATIC STRUCTURED OVERSET MESH GENERATION

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Computational Aerosciences Branch

NASA Ames Research Center

Advanced Modeling & Simulation (AMS) Seminar Series
NASA Ames Research Center, January 23, 2025

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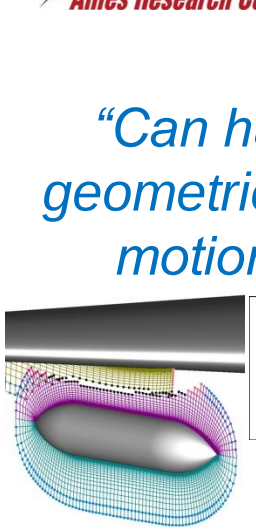
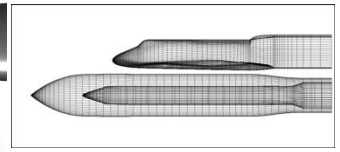
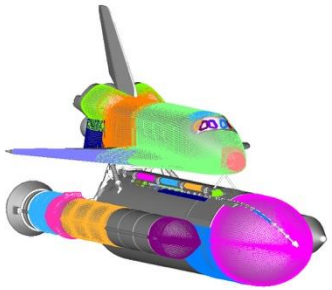
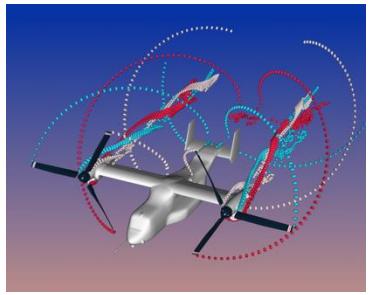
STRUCTURED OVERSET MESH GENERATION DEVELOPMENT

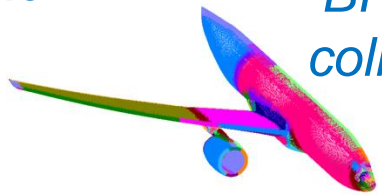
"Can handle simple geometries with relative motion capability"

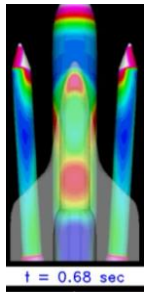
"Complex geometries require significant user expertise, effort, time"

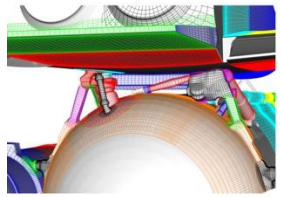
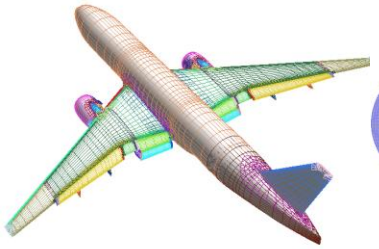
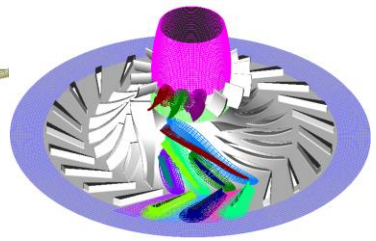
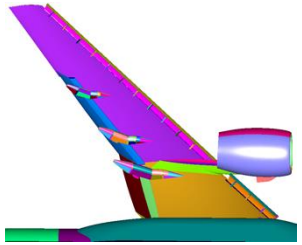
Goal: "Is not difficult starting with not so clean BREP geometries or collection of surfaces"

"Is not difficult starting with clean BREP geometries"







2024

1980 1990 2000 2010 2020 2030

Introduction of overset grid concept

Introduction of Chimera Grid Tools (CGT)

Space Shuttle / DoD CHSSI

Development of Scripting Approach

Effort: Days/Weeks

Development of Meshing Automation

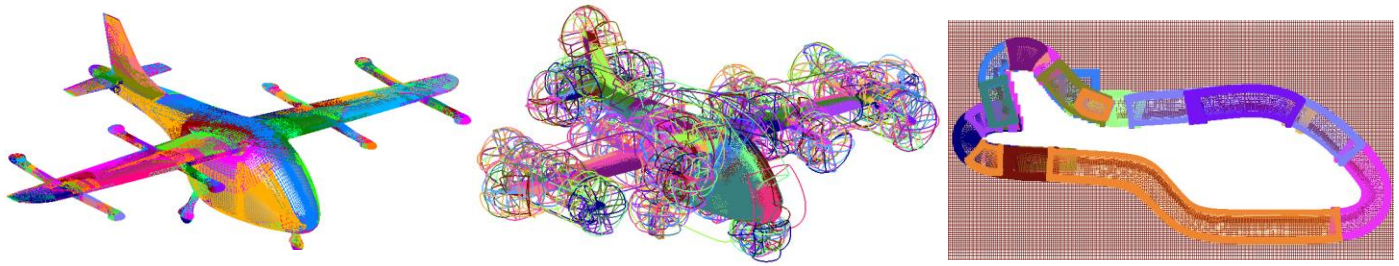
Effort: Hours/Days

TTT

RVLT

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OUTLINE



- Motivation & objectives
- Automation tools
- Automation scheme
- Applications

AIAA Paper 2024-4305, July, 2024
Overset Grids Symposium (OGS), Oct 2024

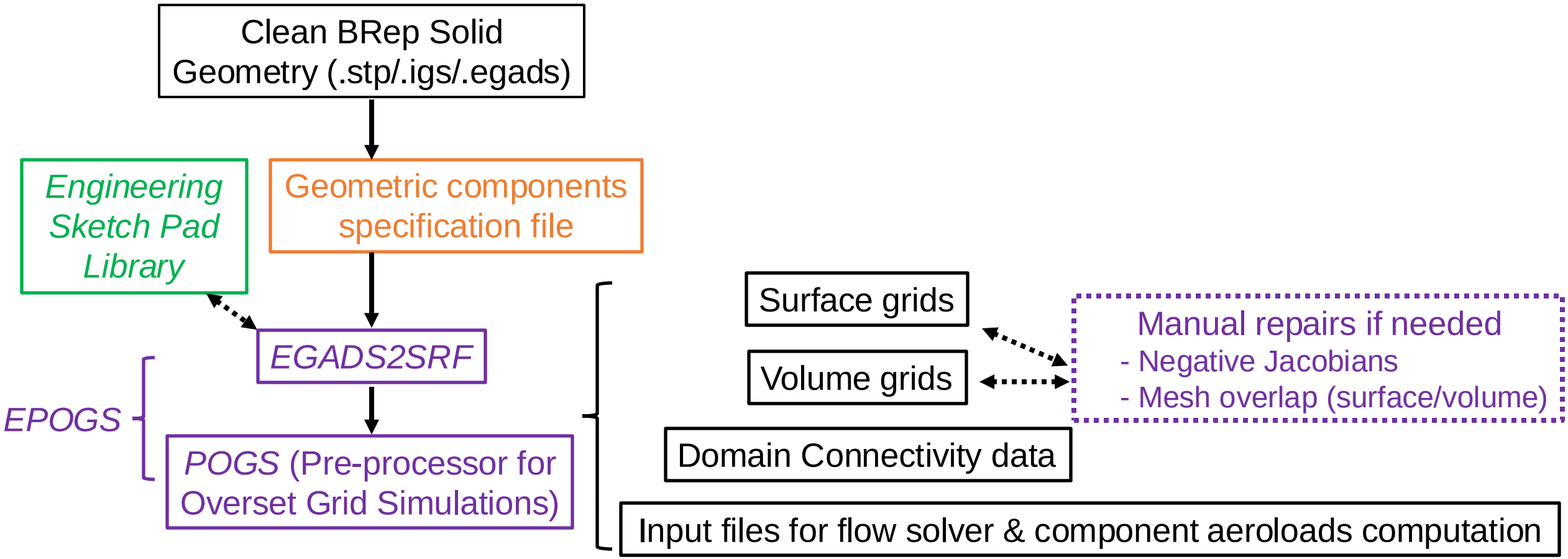
- Recent developments
- Large test cases
  - AIAA Drag Prediction Workshop 8
  - Tiltwing Test Rig Studies

Work in progress

- Concluding remarks

AUTOMATION TOOLS

AUTOMATION SOFTWARE FLOW CHART

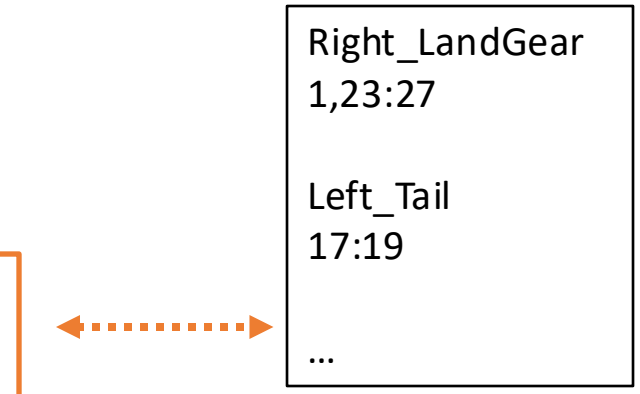


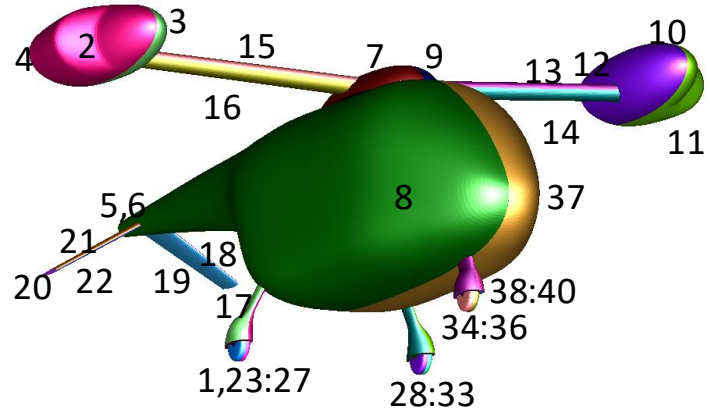
AUTOMATION SOFTWARE FLOW CHART

Clean BRep Solid Geometry (.stp/.igs/.egads)

Engineering Sketch Pad Library

Geometric components specification file





EGADS2SRF

EPOGS

POGS (Pre-processor for Overset Grid Simulations)

Surface grids

Volume grids

Manual repairs if needed
- Negative Jacobians
- Mesh overlap (surface/volume)

Domain Connectivity data

Input files for flow solver & component aeroloads computation

AUTOMATION SOFTWARE FLOW CHART

Clean BRep Solid Geometry (.stp/.igs/.egads)

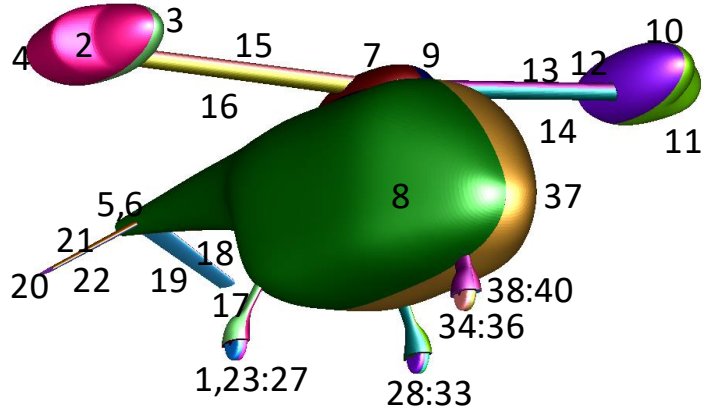
Engineering Sketch Pad Library

Geometric components specification file

Right_LandGear
1,23:27

Left_Tail
17:19

...



EPOGS

EGADS2SRF

POGS (Pre-processor for Overset Grid Simulations)

Surface grids

Volume grids

Manual repairs if needed
- Negative Jacobians
- Mesh overlap (surface/volume)

Domain Connectivity data

Input files for flow solver & component aeroloads computation

Global Control Parameters

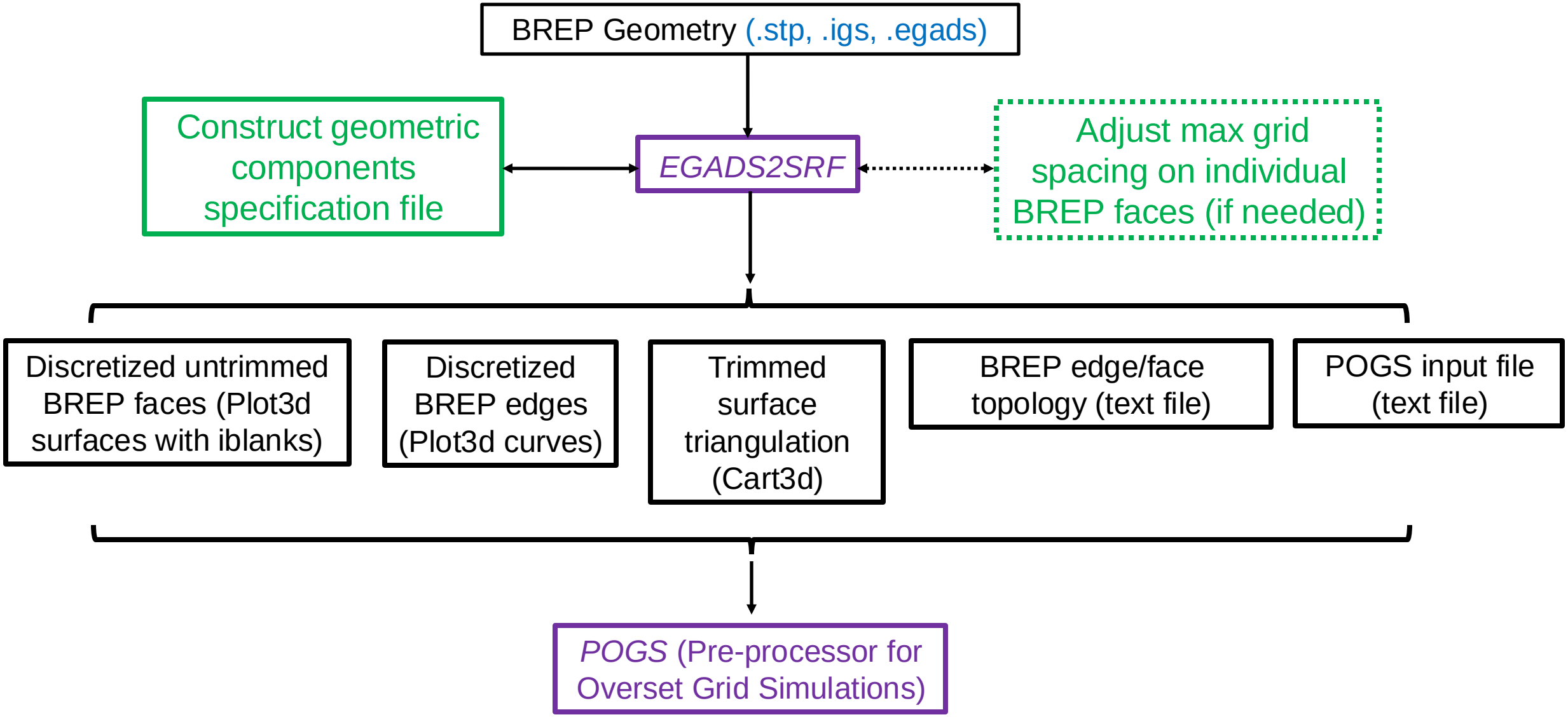
Max grid spacing maxe	Wall normal spacing Δs_{wall}
Max dihedral angle maxa	Distance to far field dfar
Max stretching ratio sr_{max}	# Fringe layers Nf
# Pts on shortest edge np_{min}	Min donor stencil quality SQ_{min}

Mesh Automation Metrics

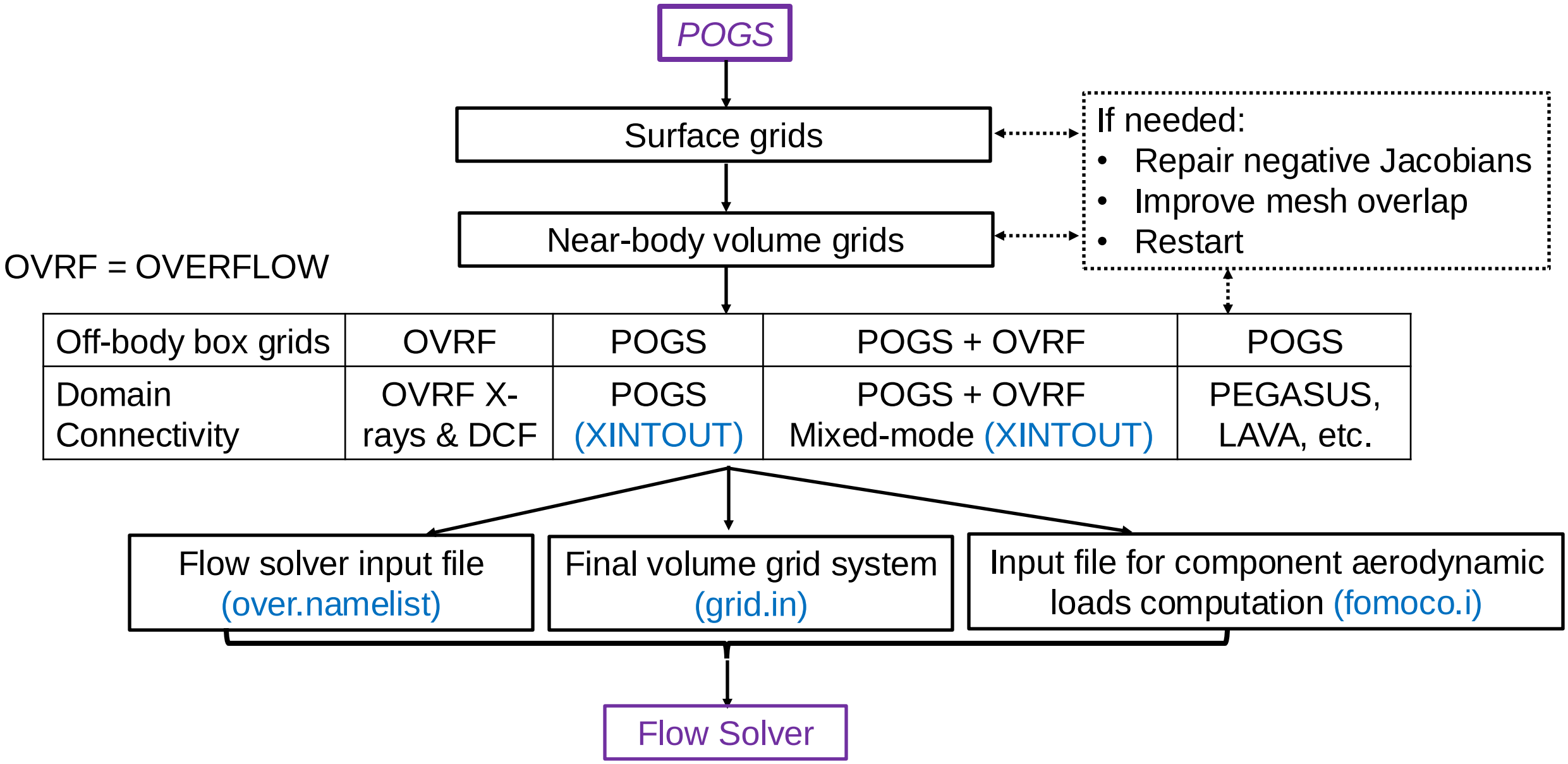
% grids free of negative cell areas/Jacobians
% fringe pts with acceptable donor stencils

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EGADS2SRF WORKFLOW

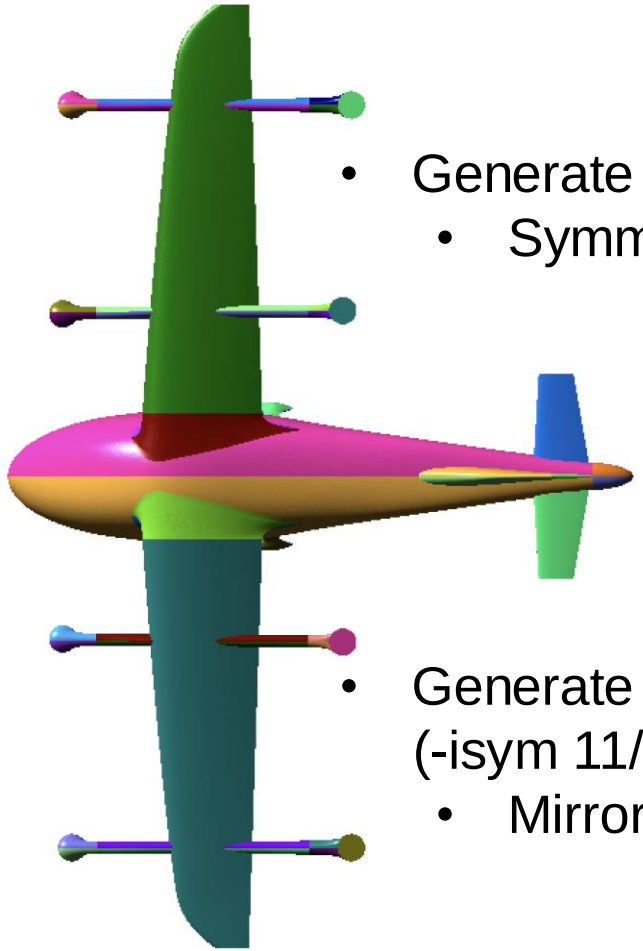


POGS WORKFLOW



EPOGS: CONFIGURATIONS WITH SYMMETRY OR GROUND PLANE

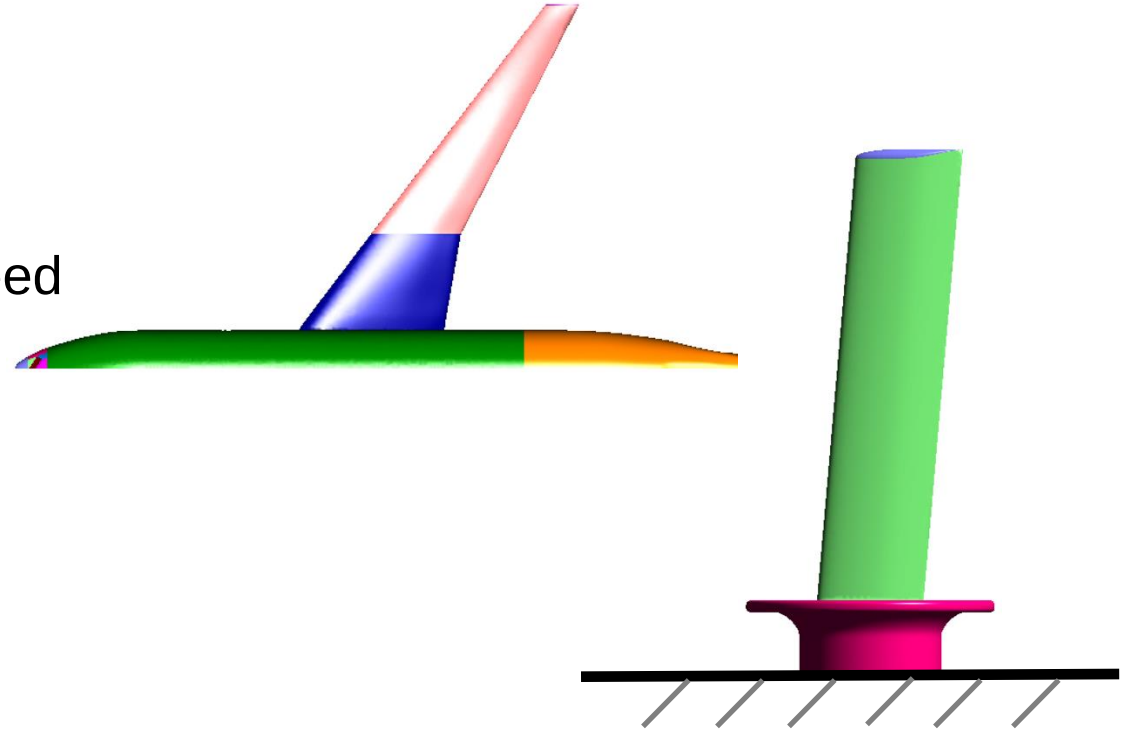
Input geometry: Full-body



- Generate grids on full body (-isym 0)
  - Symmetric grid system not guaranteed

- Generate grids on half-body (-isym 11/12/13 for x/y/z symmetry)
  - Mirror to guarantee symmetric grid system

Input geometry: Half-body or body on ground plane

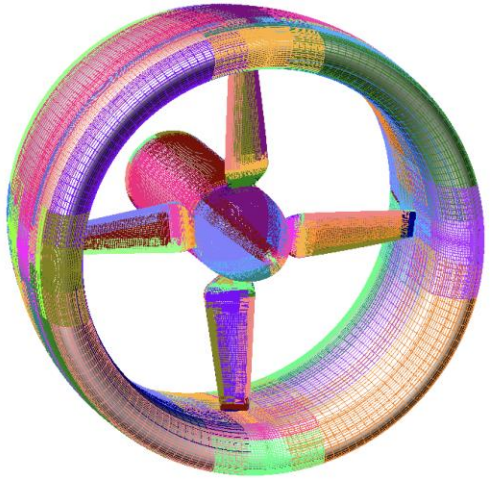


- Constant x/y/z plane on open boundary (-isym 1/2/3)

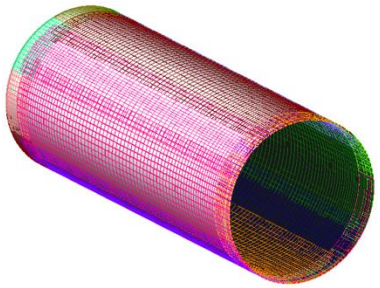
EPOGS: NON-CONNECTED COMPONENT BUILD-UP

Non-connected components example

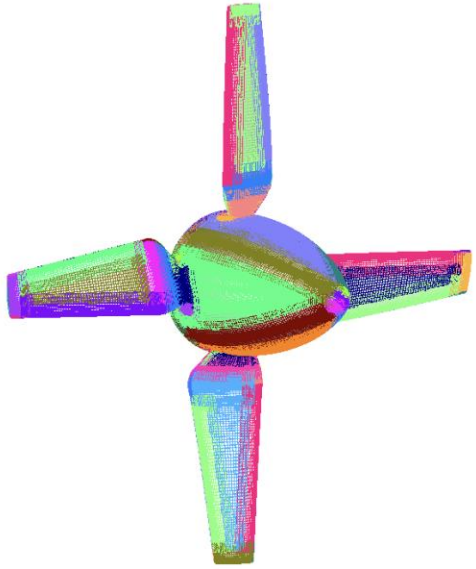
- Three solids
- Create grids for each solid in its own sub-directory
- Run with “combine” option in top level directory to get combined grid file, input files for flow solver and aeroloads computation



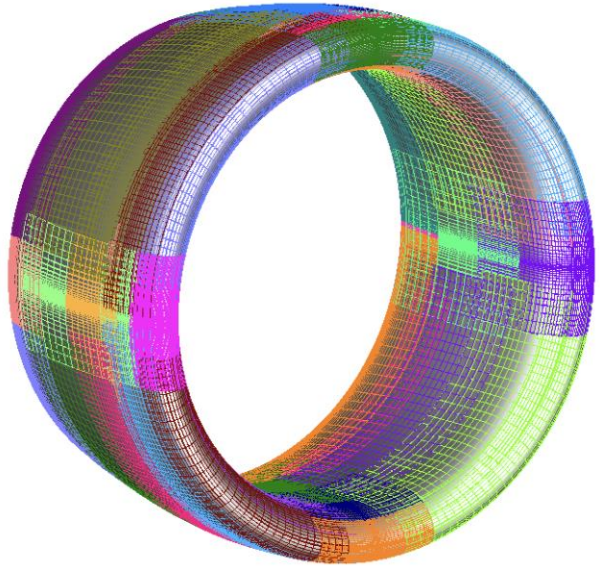
- Connected components - to be implemented



Stationary centerbody (1)

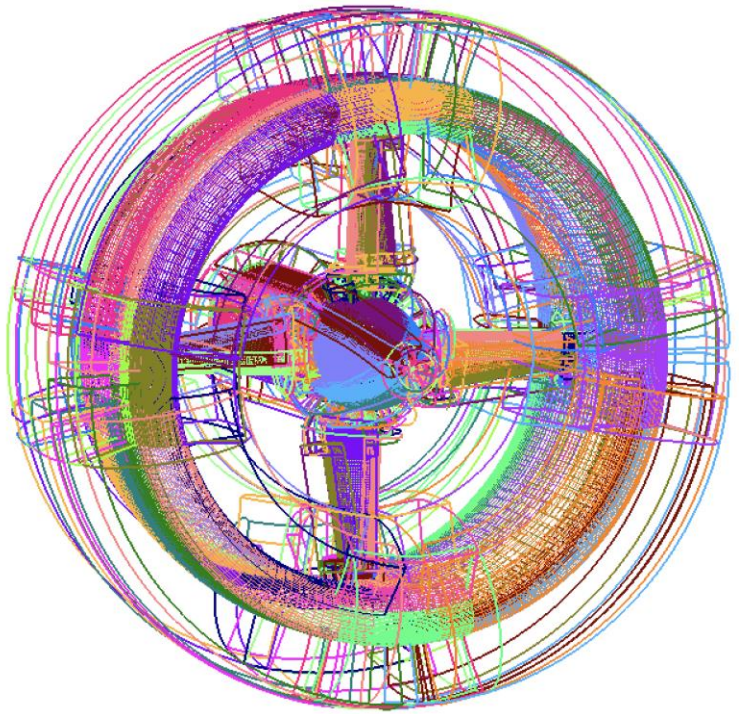


Rotor (2)



Shroud (3)

Final system



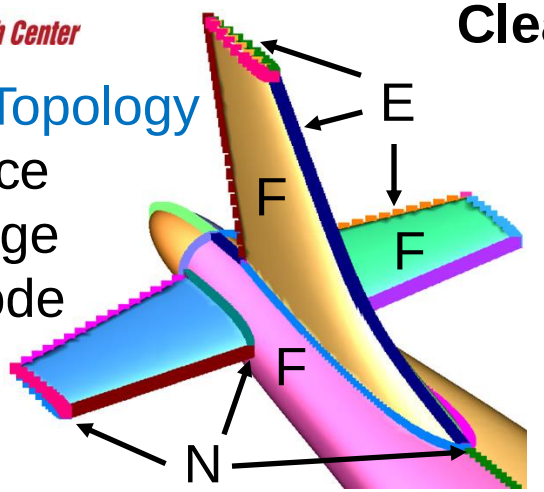
AUTOMATION SCHEME

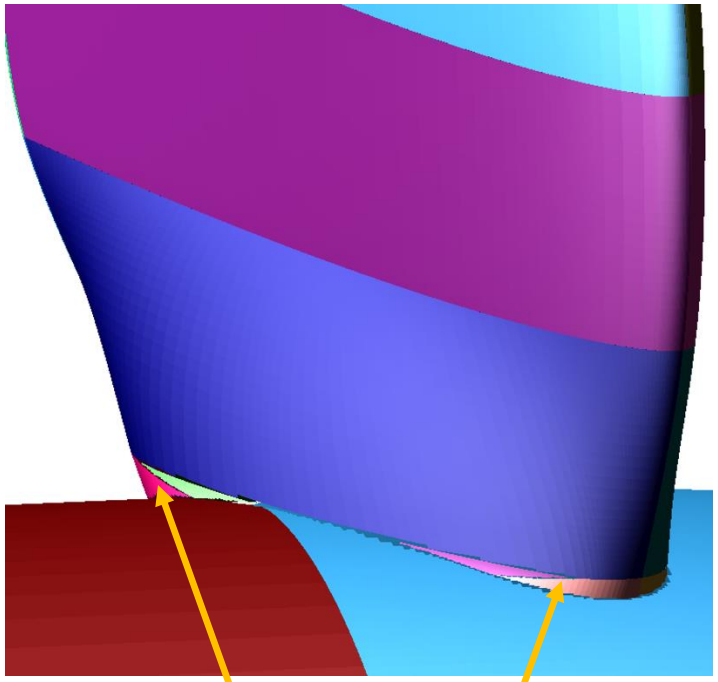
GEOMETRY INPUT

Clean Boundary Representation (BRep) Solids

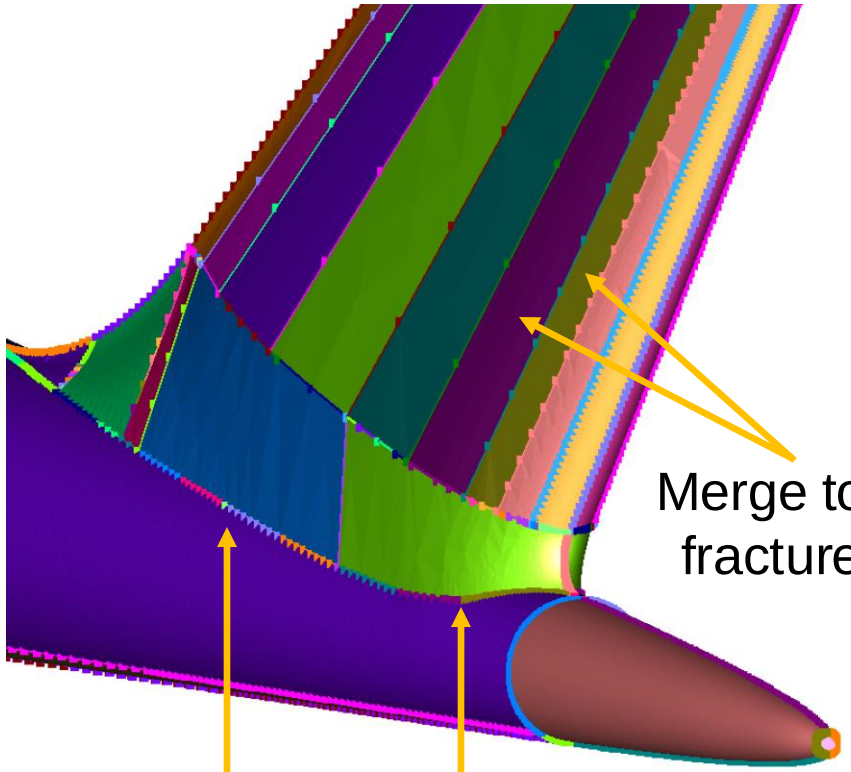
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BRep Topology
F = Face
E = Edge
N = Node



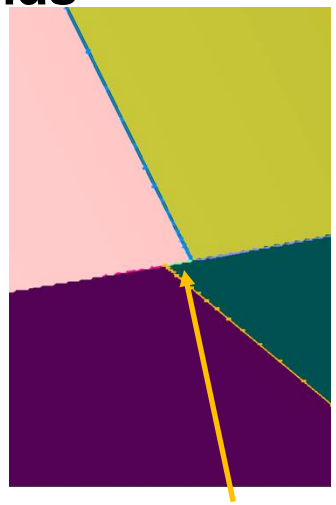


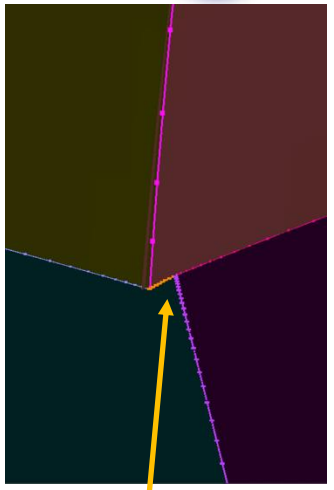
Remove tiny sliver faces



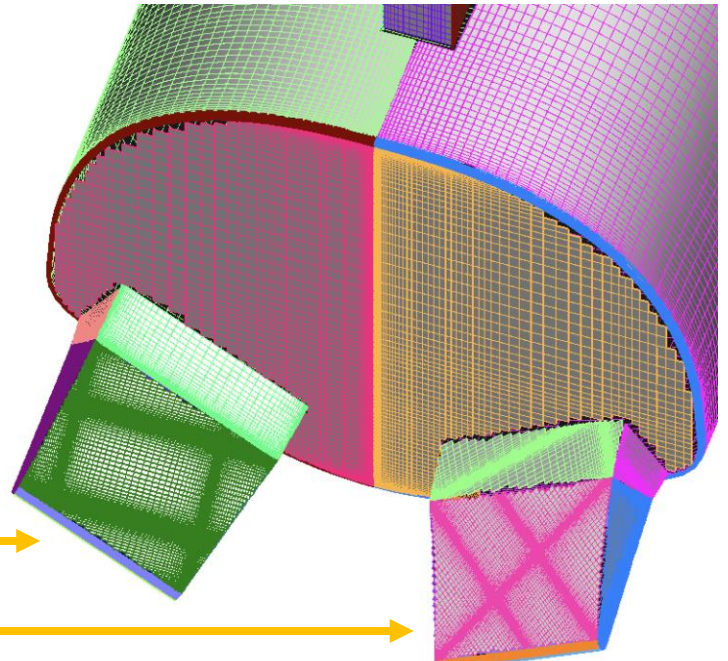
Merge to remove fractured faces

Remove spurious nodes





Check tolerance to remove tiny edges

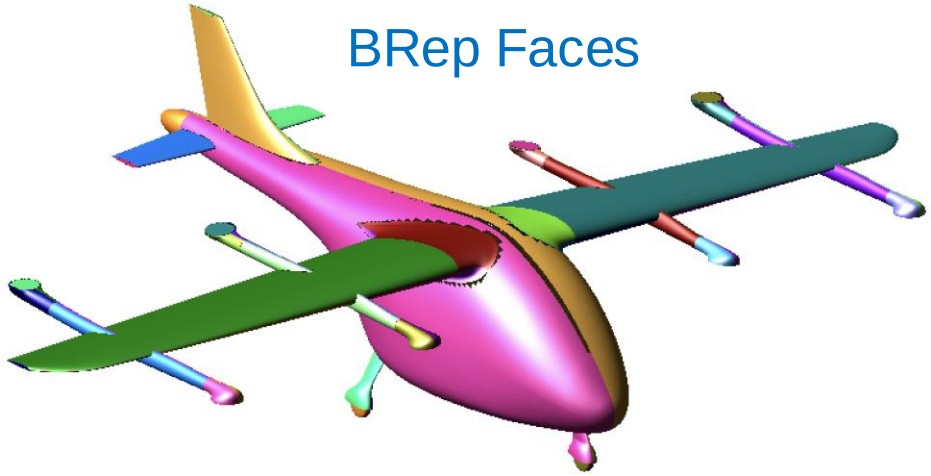


Reparameterize to align u/v lines with edge and/or curvature if possible

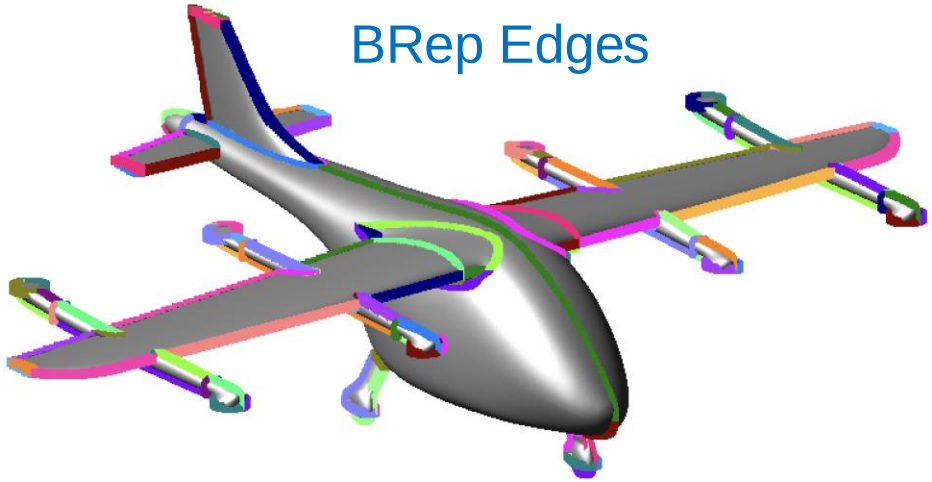
STEP 1: DISCRETIZE BREP FACES AND EDGES

Geometry Input

BRep Faces

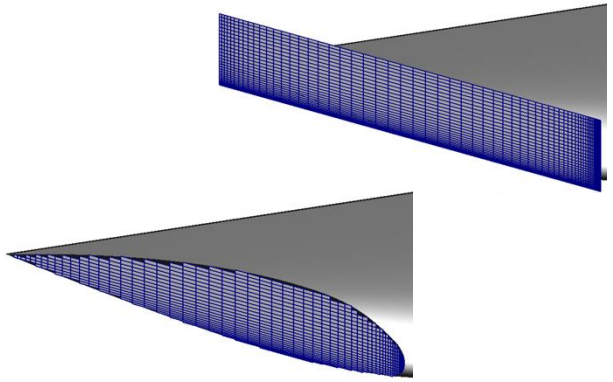


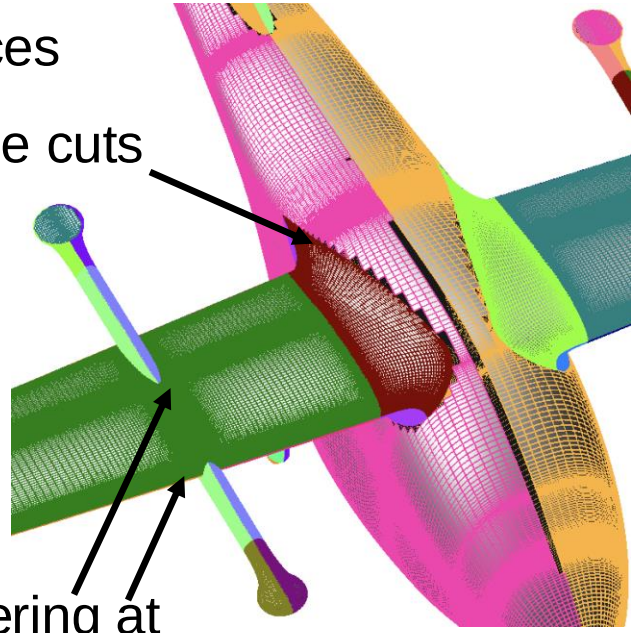
BRep Edges



Discretized untrimmed Faces

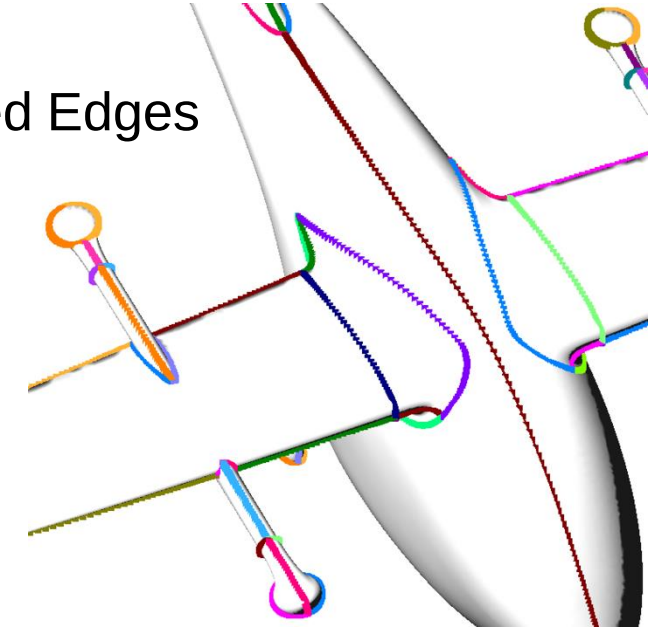
iblanks mark minimum surface hole cuts





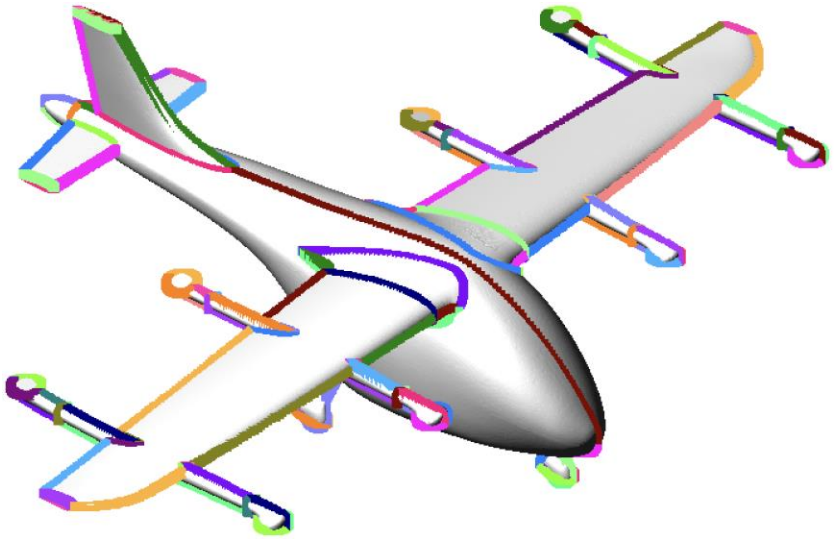
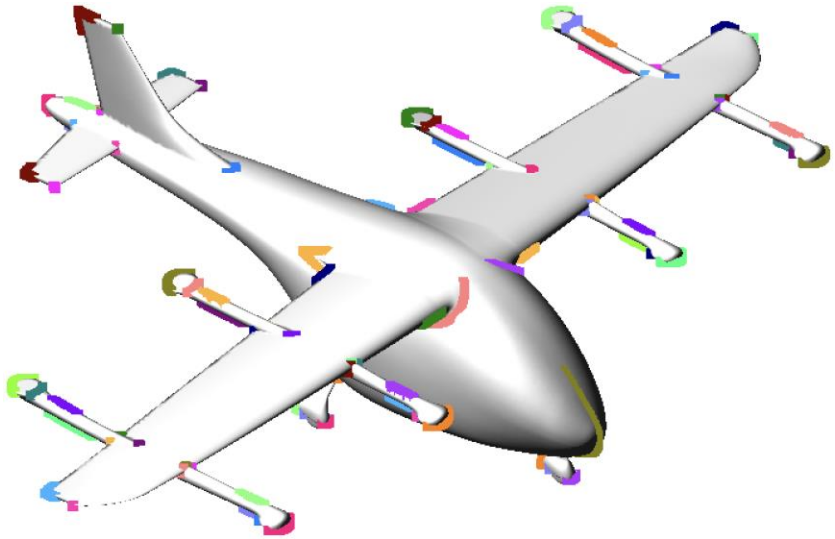
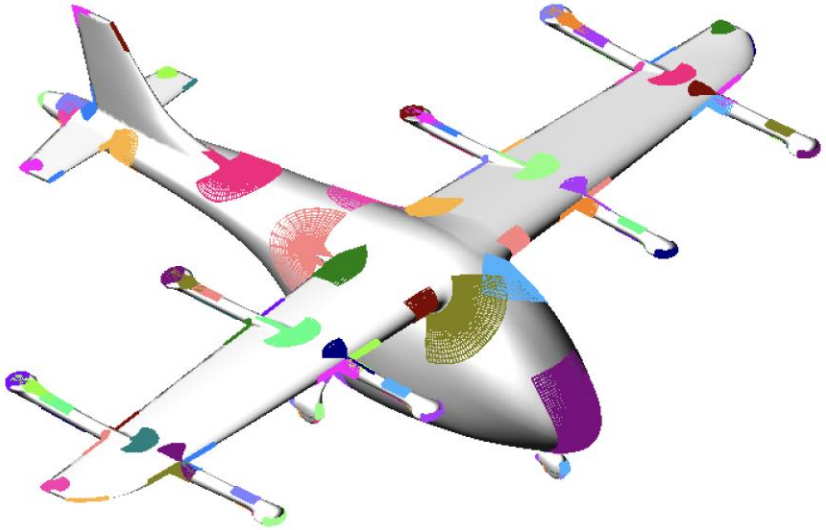
Grid clustering at surface features

Discretized Edges

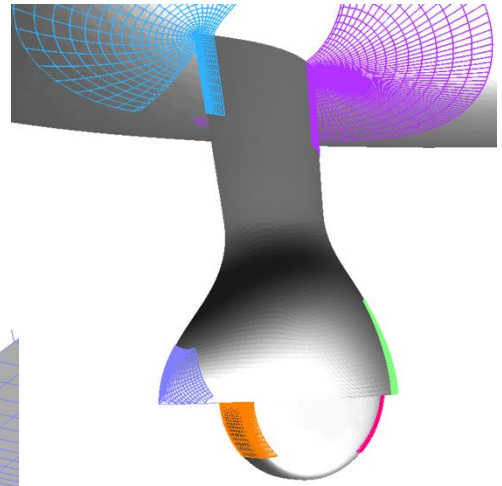
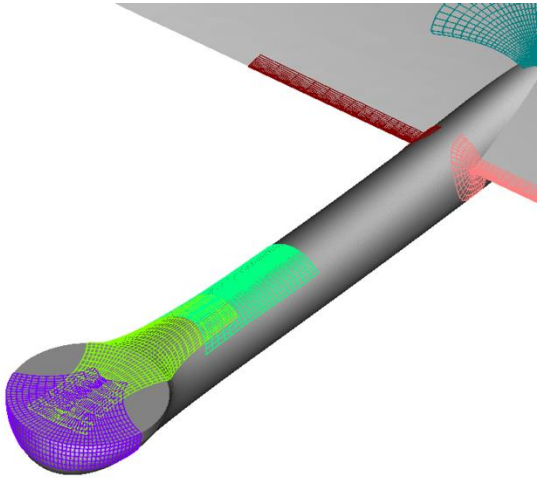
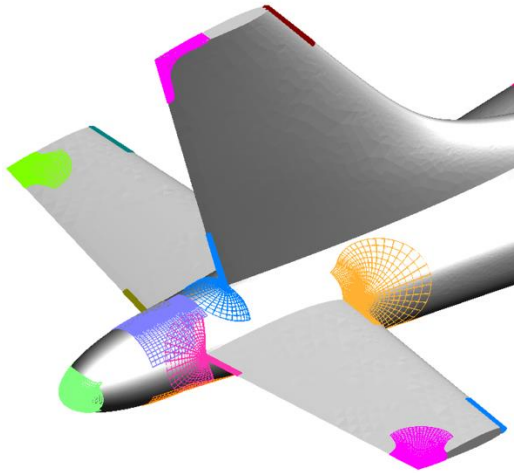


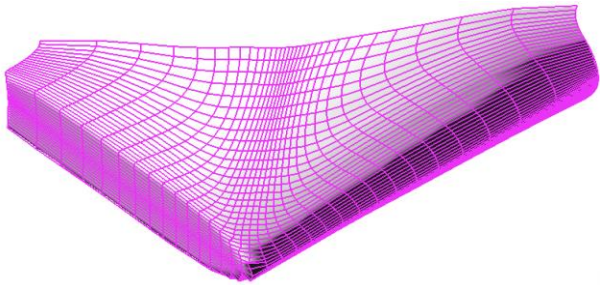
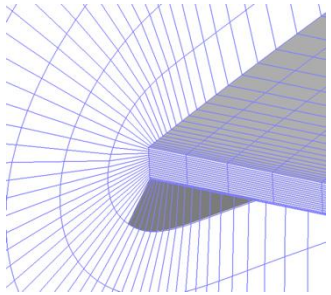
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STEP 2: NODE MESH CONSTRUCTION

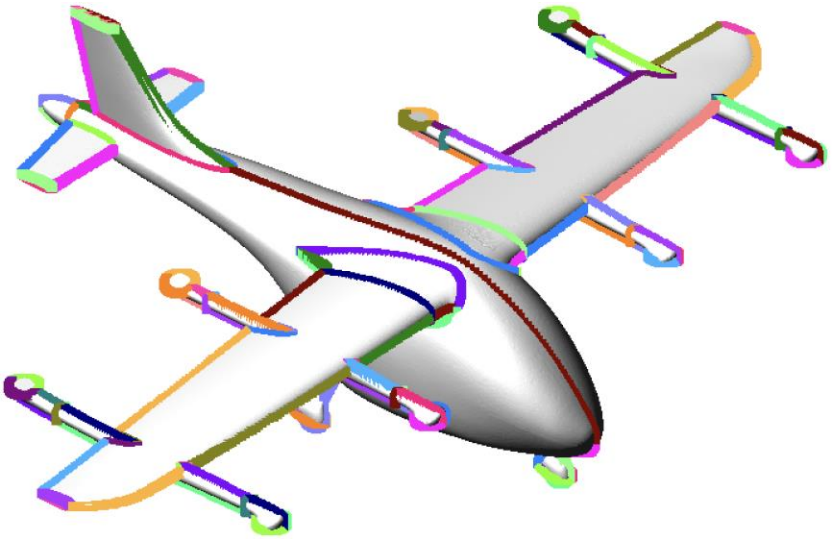
- Select best 2 edges at node to clip and concatenate to form initial curve
- Select hyperbolic or algebraic marching scheme
- Estimate marching distance
- Select initial marching step size

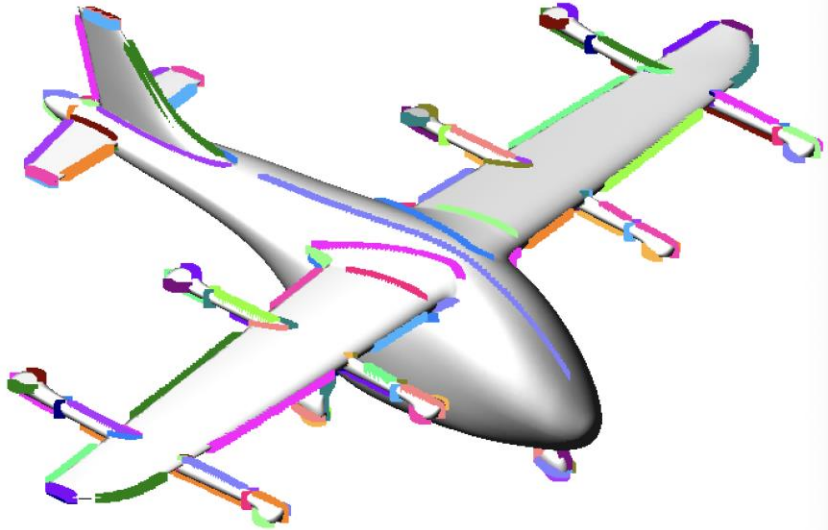




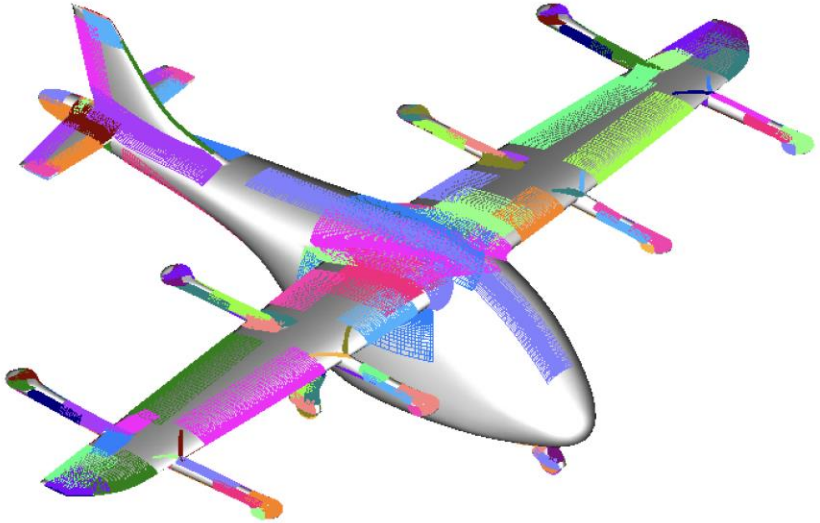



Merge node meshes in close proximity on finite thickness trailing edges

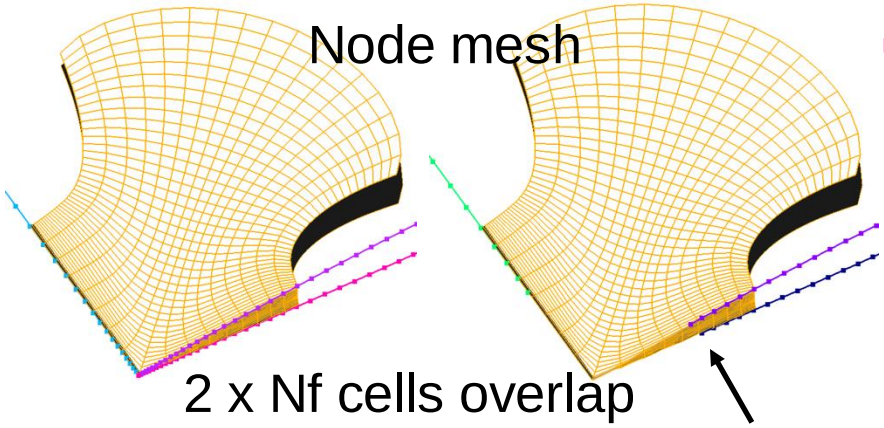
STEP 3: EDGE MESH CONSTRUCTION



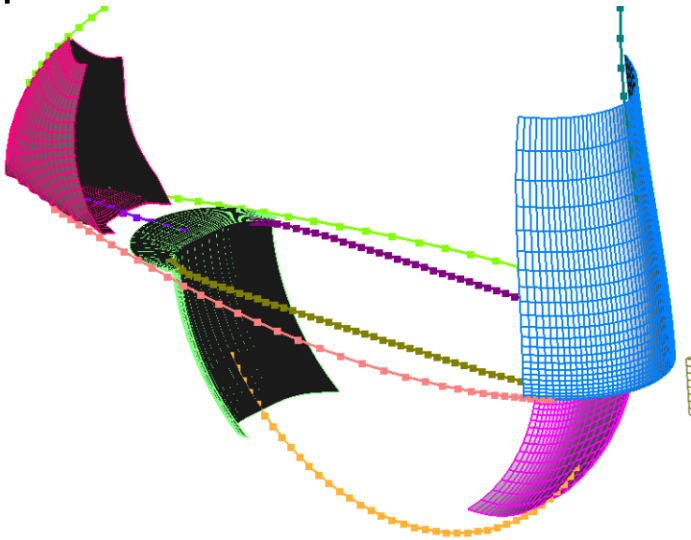


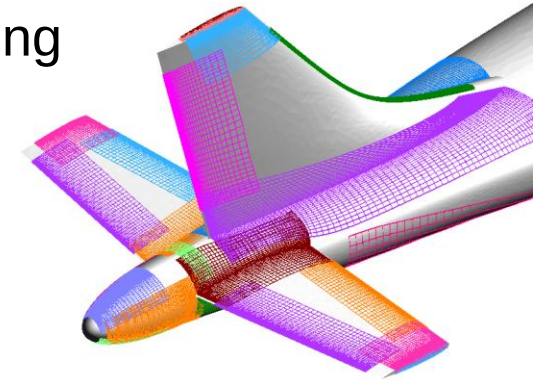


- Construct initial curves by clipping BRep Edges
- Use node meshes to determine clip location to ensure proper overlap

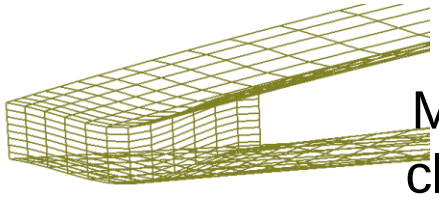


- Same marching scheme





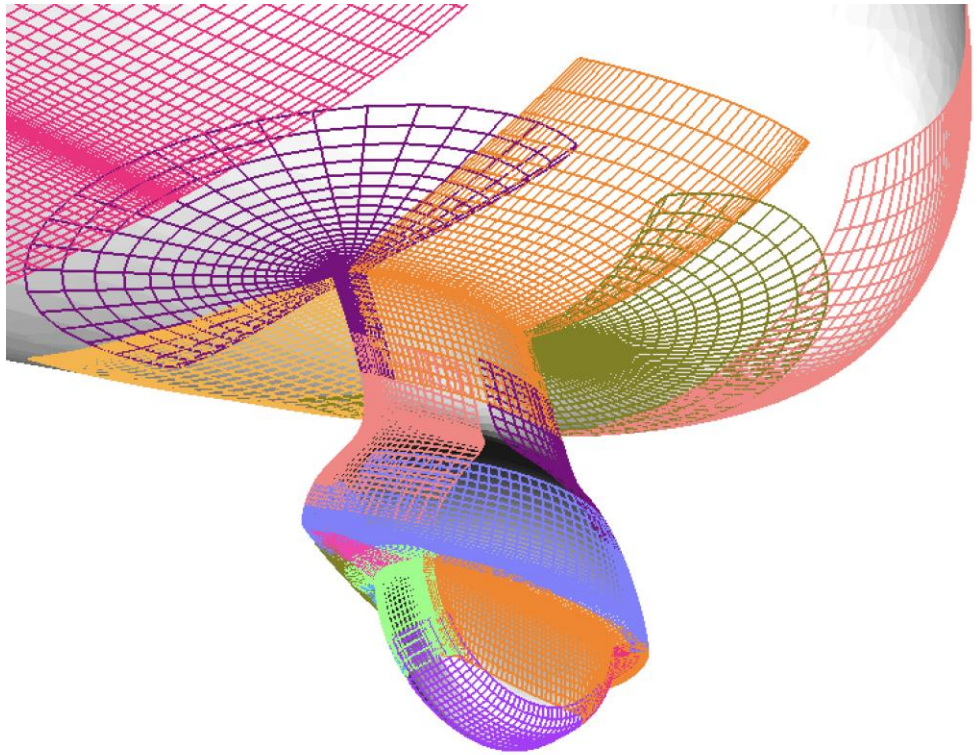




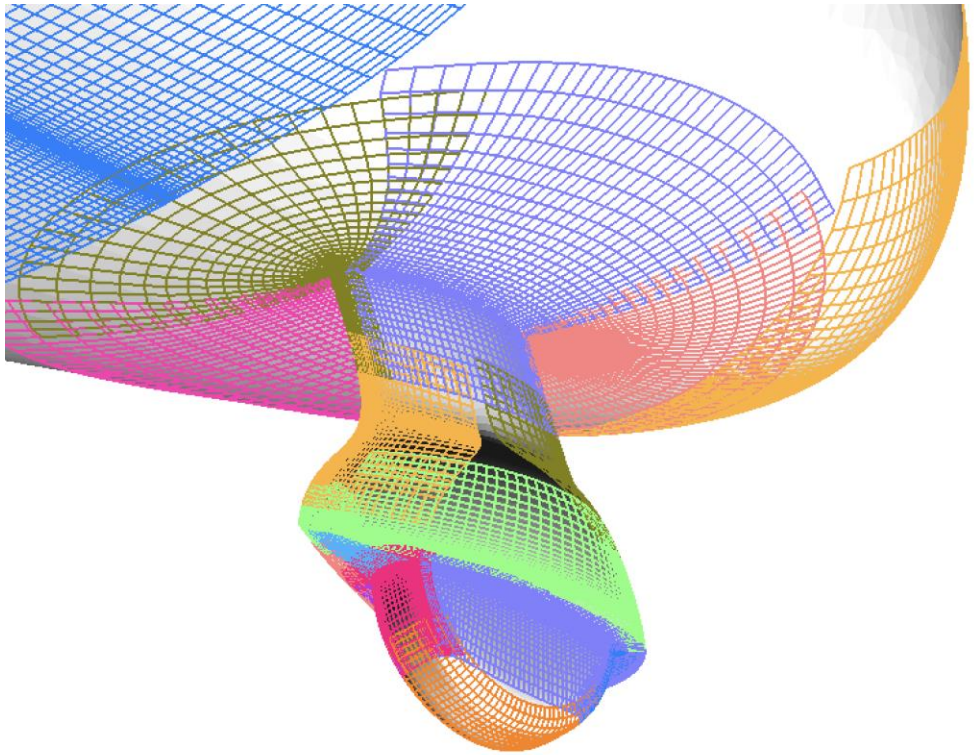
Merge edge meshes in close proximity on finite thickness trailing edges

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STEP 4: BOUNDARY COUPLING ITERATIONS BETWEEN NODE & EDGE MESHES



Before boundary coupling iterations



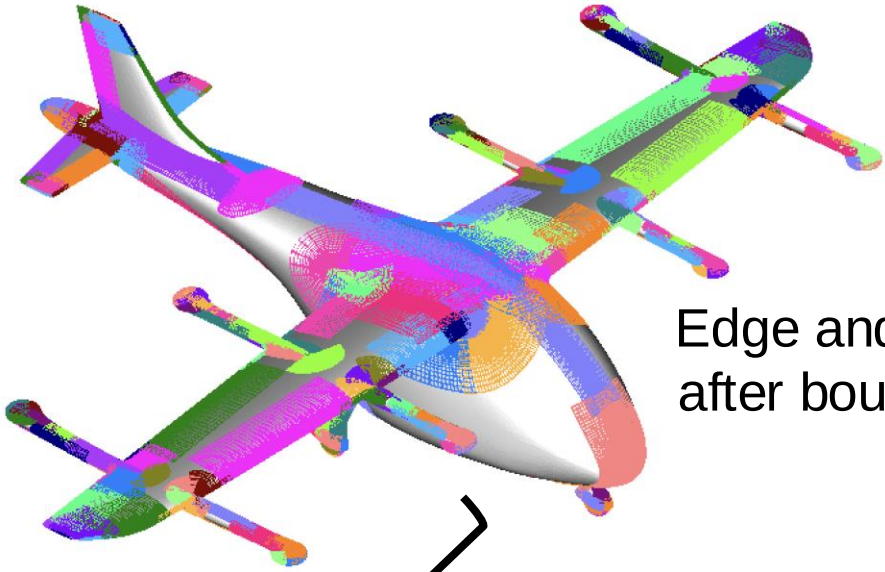
After boundary coupling iterations

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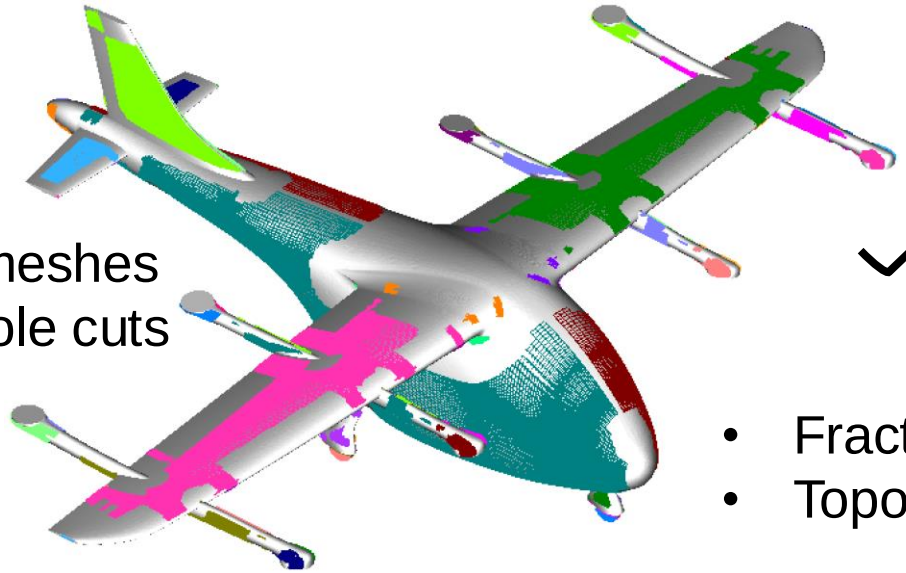
STEP 5: FACE MESH RETRACTION & ELIMINATION



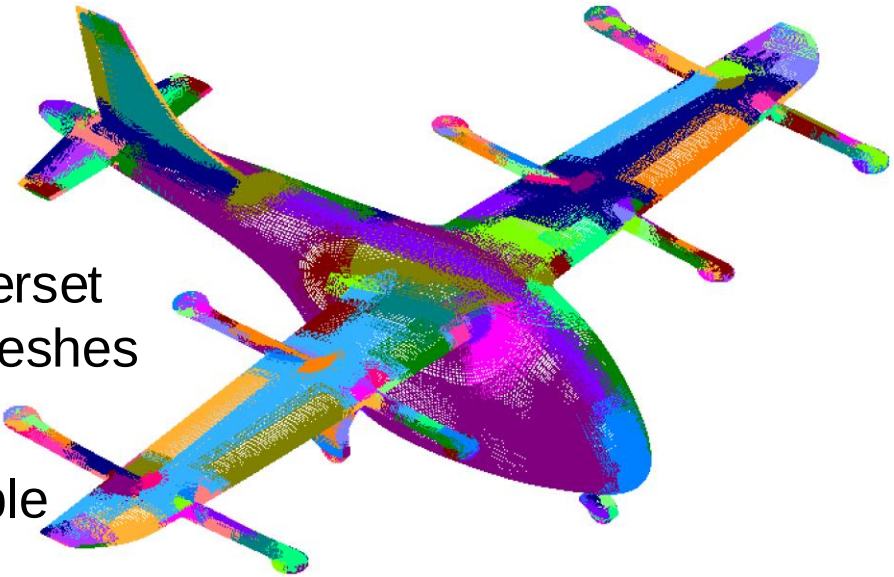
Original face meshes
with minimum hole cuts



Edge and node meshes
after boundary coupling



Retracted face meshes
with expanded hole cuts



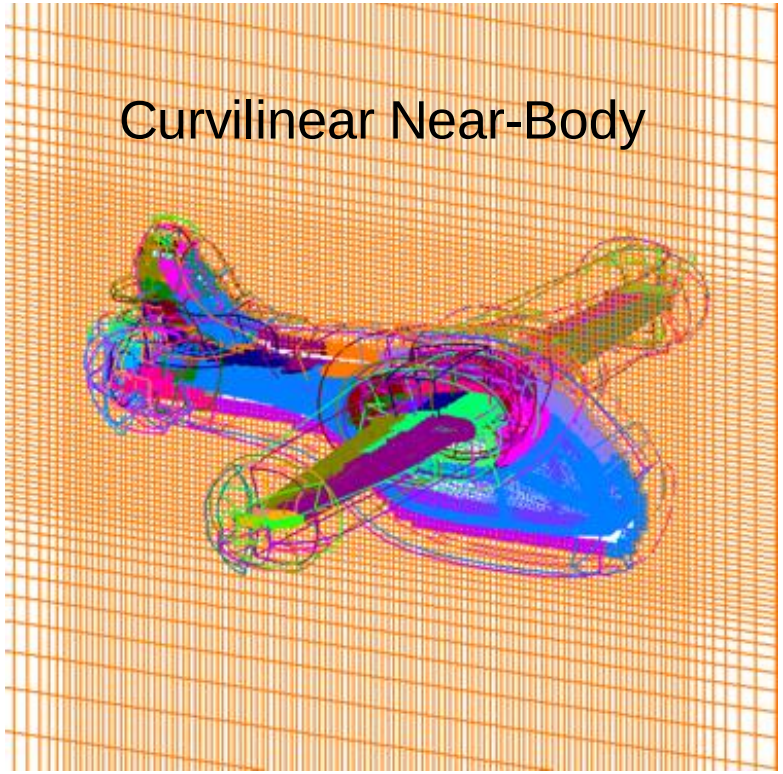
Final overset
surface meshes

- Fractured
- Topologically simple

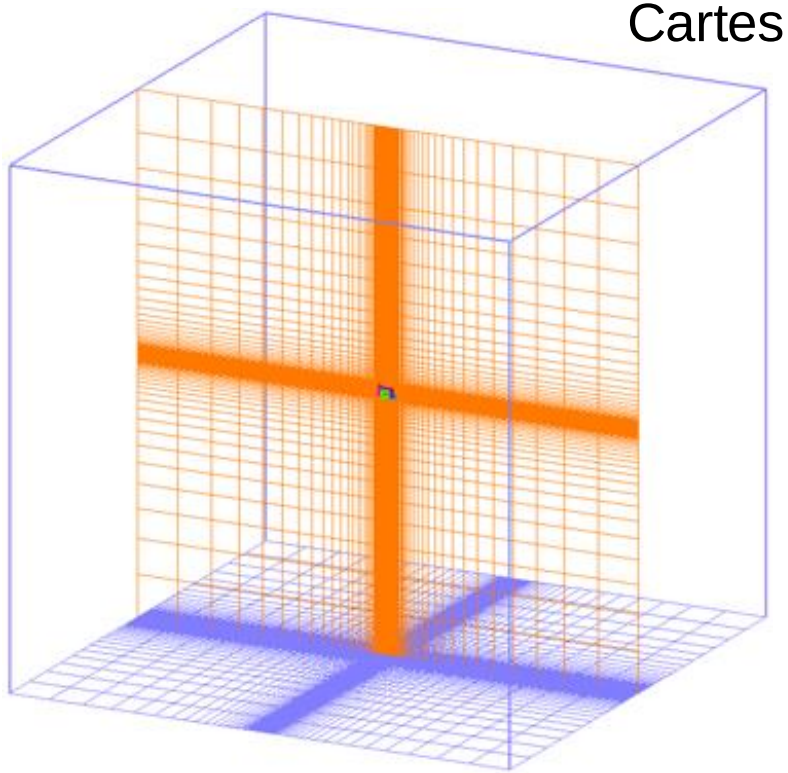
STEP 6: VOLUME MESH GENERATION

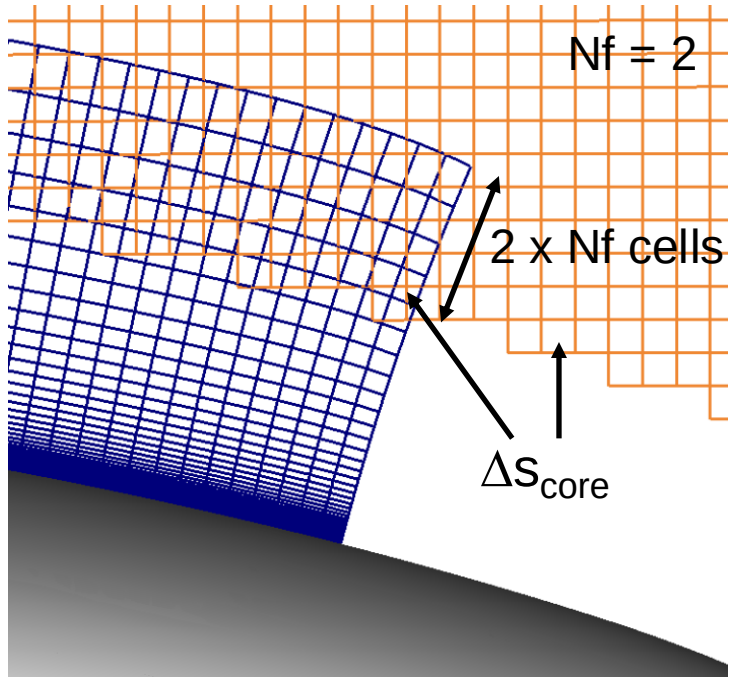
Δs_{max} = max grid spacing
Δs_{wall} = wall normal grid spacing

sr_{max} = max stretching ratio
Nf = # fringe layers



Cartesian Off-Body



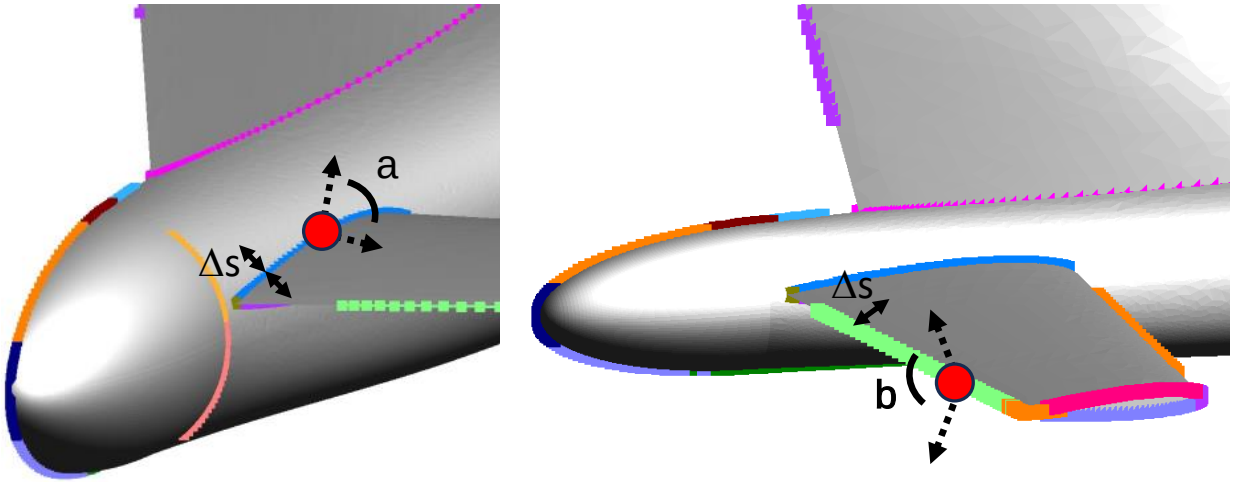


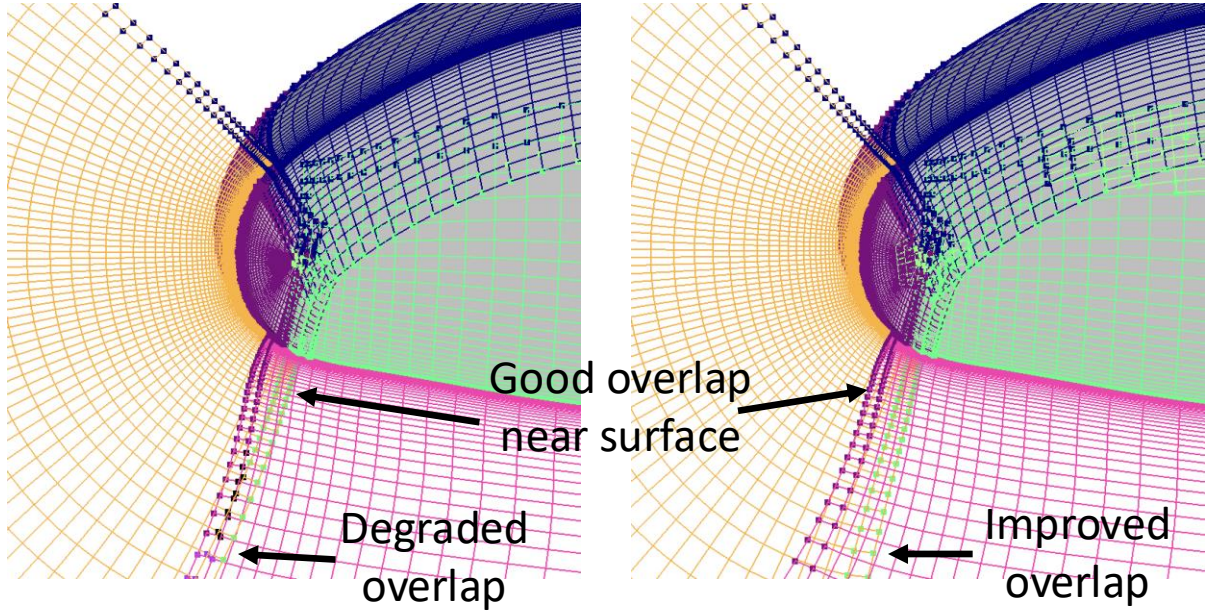
Hyperbolic marching

- Δs_{wall} user-prescribed (Re # based)
- Marching distance = distance where Δs reaches Δs_{max} using geometric stretching with sr_{max}

- Uniform core Δs_{core}
- Stretched to far field with sr_{max}

NEAR-BODY VOLUME MESH AUTOMATION



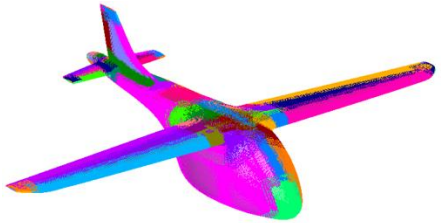


- Automatic surface mesh point distribution based on surface feature angle
  - Concave feature $\Delta s = f(\alpha)$
  - Convex feature $\Delta s = g(\beta)$
- Automatic selection of hyperbolic meshing smoothing parameters
  - 2nd order smoothing coef.
  - # volume smoothing steps
  - # sub-steps
- Automatic splay b.c. selection based on local surface convexity

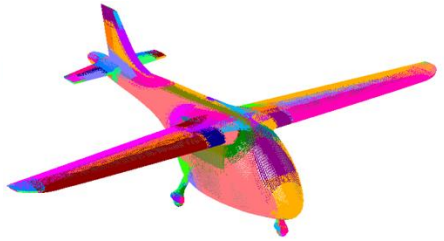
Auto-adjust if negative Jacobians found

VOLUME MESHING TEST CASES

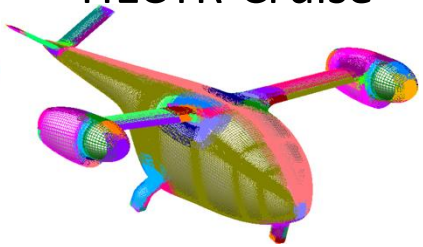
L+C Baseline



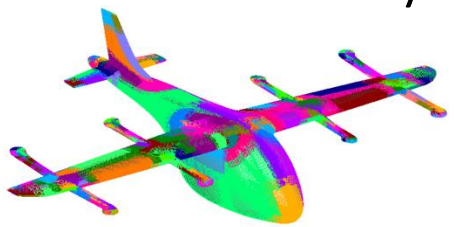
L+C Baseline + LG



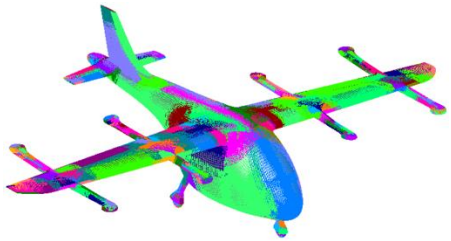
HECTR-Cruise



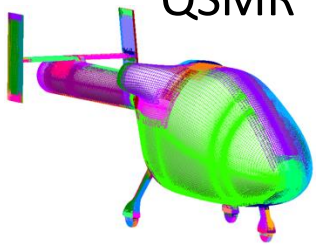
L+C Baseline + Py



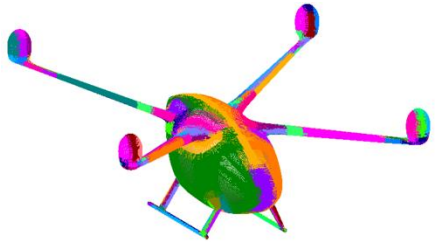
L+C Baseline + LG + Py



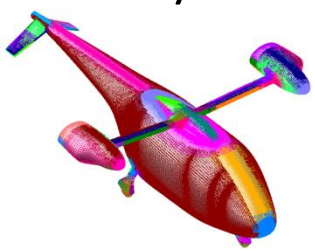
QSMR



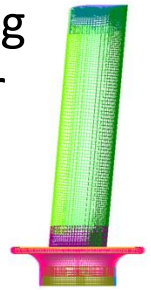
6-PAX Quad



SBS-Hybrid



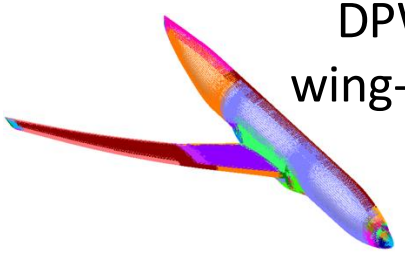
TWTR wing & splitter plate



Juncture Flow



DPW7 wing-body



TWTR blade



Case	# Mesh	# Vol pts (M)	# Defective Prev/current
L+C Base	96	33.5	16 / 0
L+C Base+LG	164	62.1	26 / 0
L+C Base+PY	265	76.4	29 / 0
L+C Base+LG+PY	332	100.5	39 / 1
HECTR	171	29.5	8 / 3
6 PAX Quad	233	20.5	31 / 3
QSMR	173	15.9	19 / 0
SBS-Hybrid	157	30.0	23 / 3
TWTR wing-splitter	29	24.9	- / 1
TWTR blade	21	3.9	- / 0
Juncture Flow	177	35.6	26 / 0
DPW7 wing-body	69	13.2	- / 1

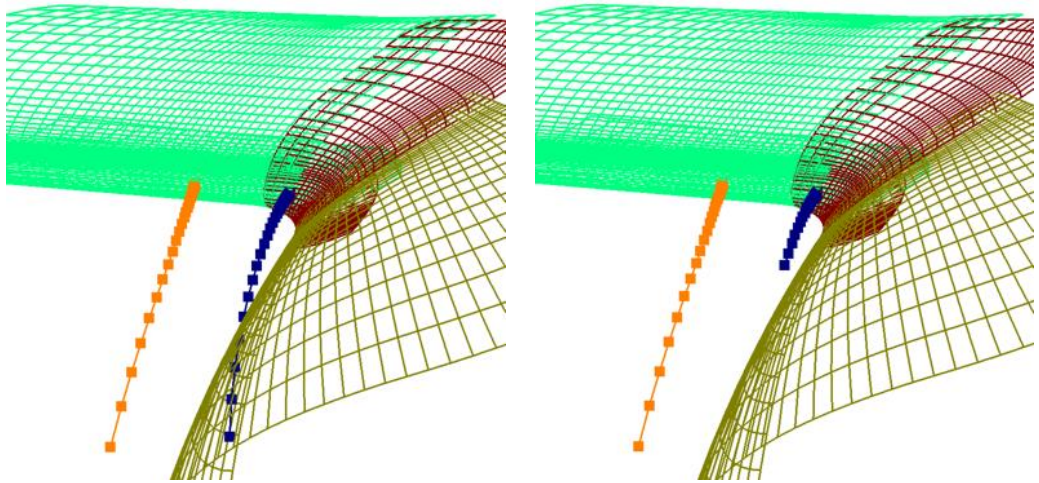
% Acceptable = 97% – 100% M2 MacBook Pro

Wall clock time (surface + volume) = 1 min – 12 min

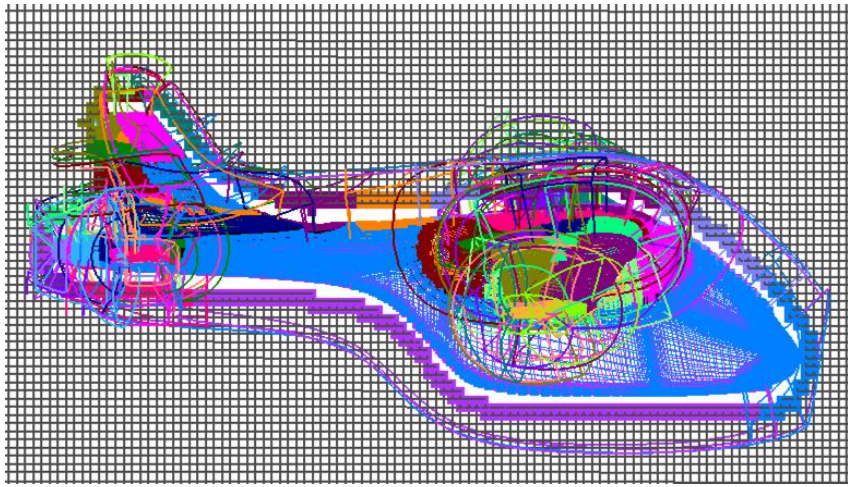
Manual meshing L+C Base+LG+PY ~ weeks

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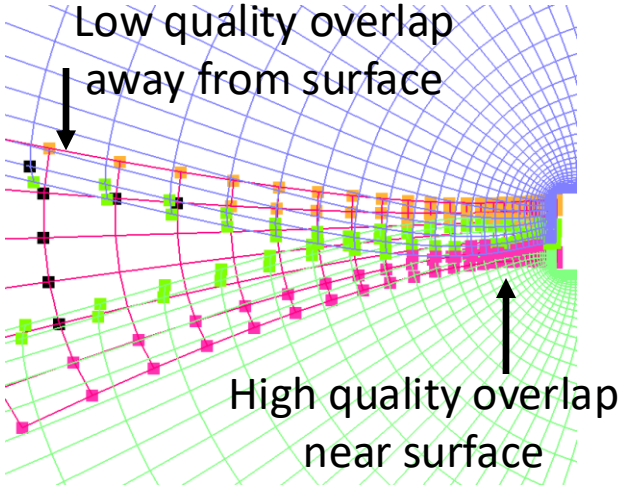
STEP 7: DOMAIN CONNECTIVITY

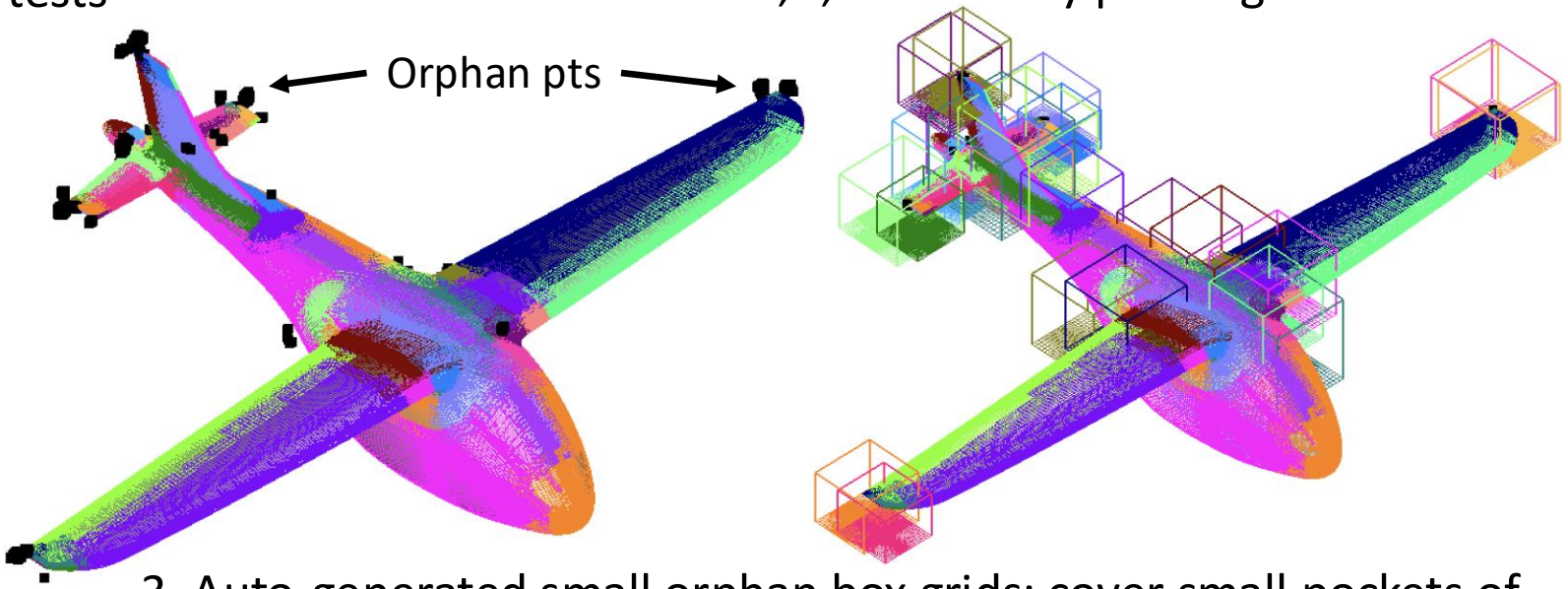


1. Near-body curvilinear volume grids and geometry surface clearance: line segment tests



2. Off-body Cartesian volume grids and geometry surface clearance: X, Y, Z direct ray piercing tests



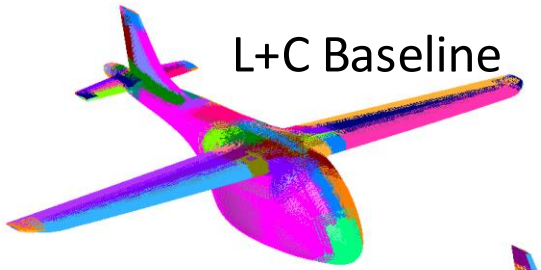


3. Auto-generated small orphan box grids: cover small pockets of off-body orphan points (< ~10% pts overhead)

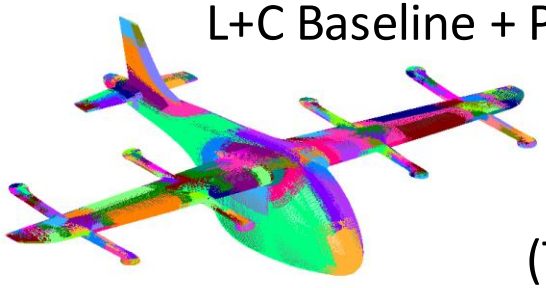
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TEST CASES: GEOMETRY TO SOLUTION

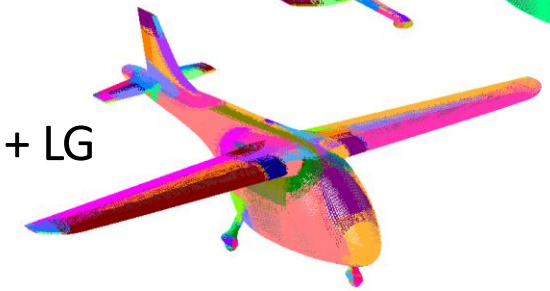
L+C Baseline



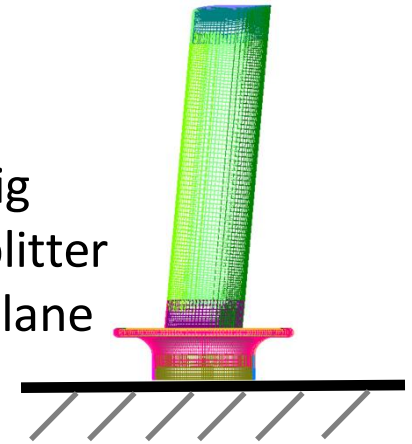
L+C Baseline + PY



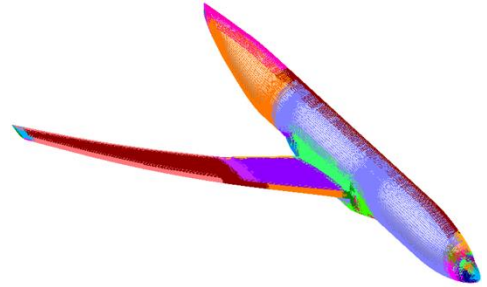
L+C Baseline + LG



Tiltwing Test Rig (TWTR): wing & splitter plate on ground plane



AIAA Drag Prediction Workshop 7 (DPW7): wing-body at α=3 deg. wing deflection

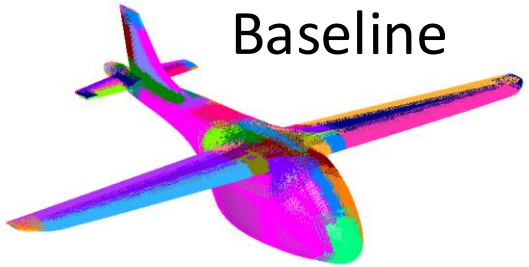


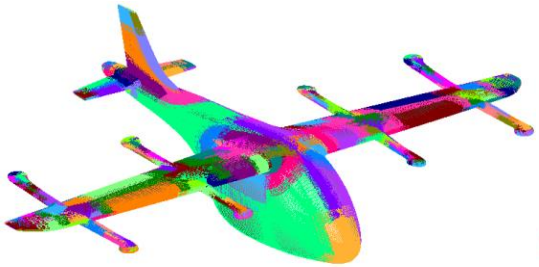
Case	Near-body volume grids		# Defective meshes (% Acceptable)	% Fringe pts with acceptable donor stencils	Total Pre-processing Time	
	# Meshes	# Grid pts			Manual	EPOGS+repair
L+C Baseline	120	60.2 M	0 (100)	99.999	1 w	1 d
L+C Baseline + LG	199	106.1 M	0 (100)	99.978	2 w	2 d
L+C Baseline + PY	347	111.8 M	0 (100)	99.993	2 w	2 d
TWTR	32	22.0 M	1 (97)	99.9996	2 d	2 h
DPW7 (fine)	73	66.1 M	1 (99)	100	2 d	2 h

w=week, d=day, h=hour

LIFT+CRUISE (L+C)
Surface Grids

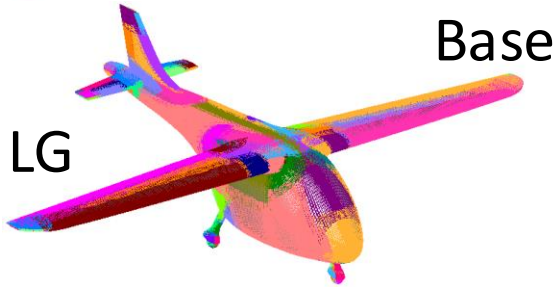
Baseline

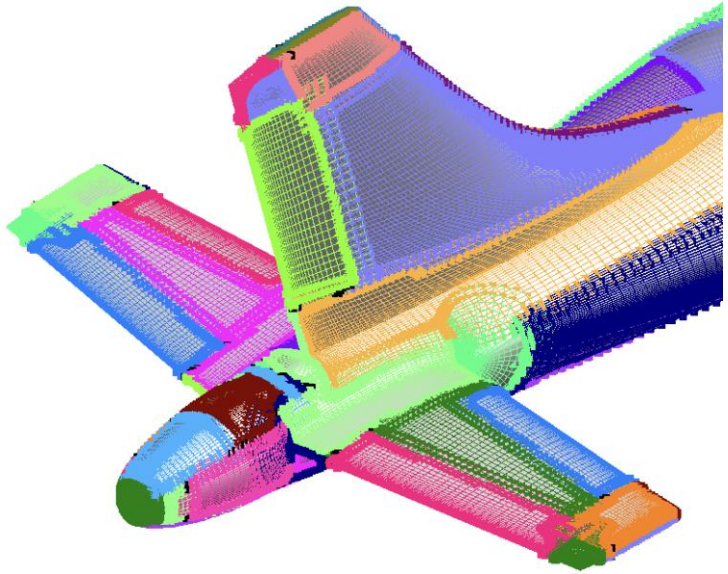


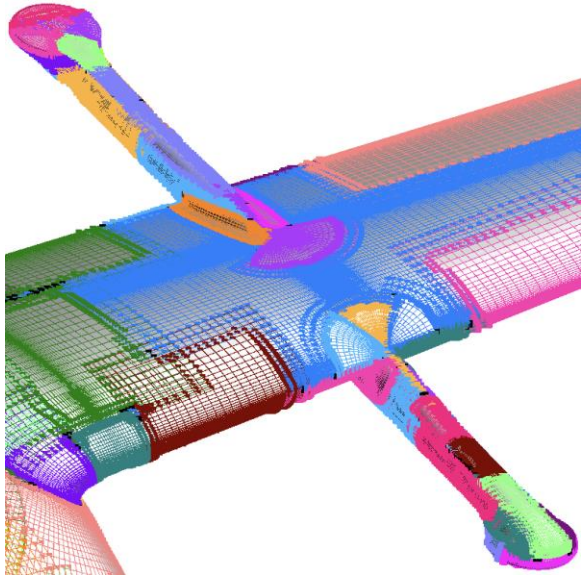


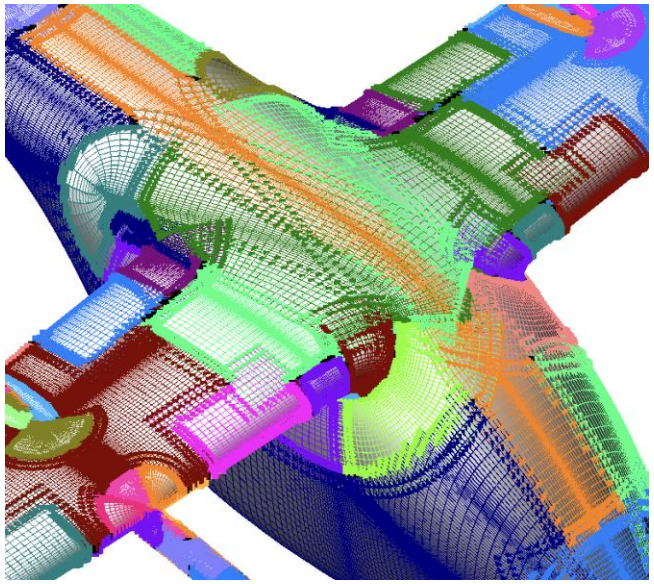
Baseline + PY

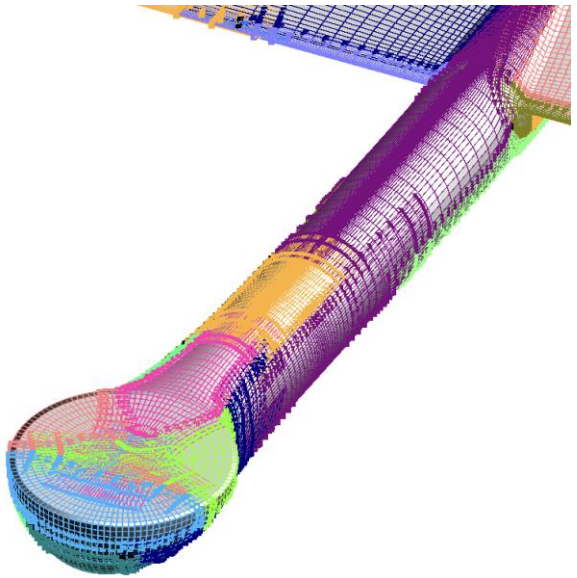
Baseline + LG

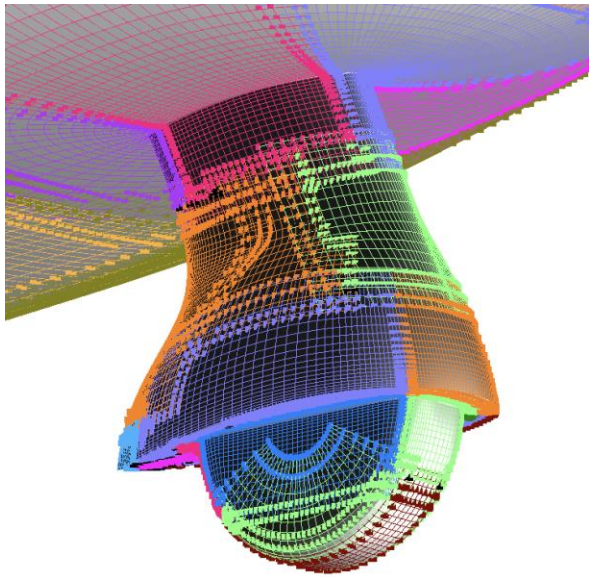












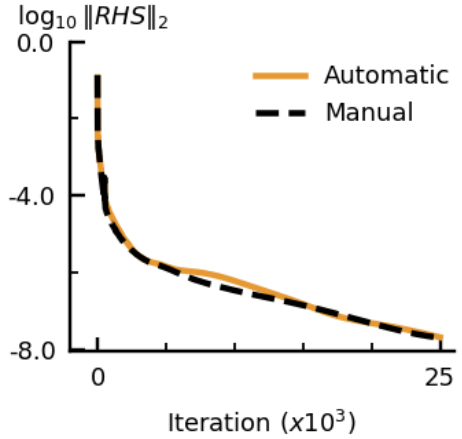
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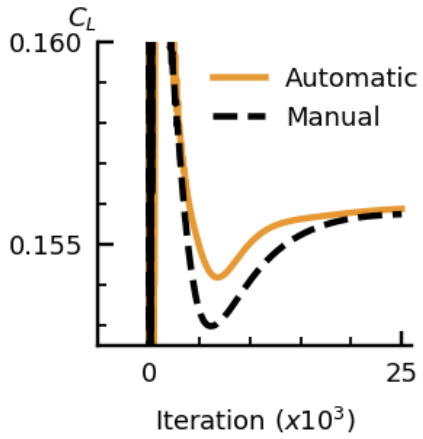
LIFT+CRUISE (L+C)

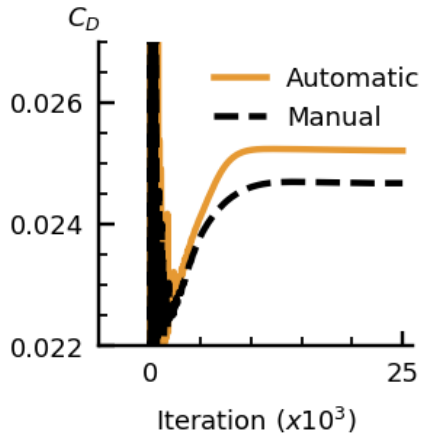
Residuals & Aerodynamic Loads Convergence

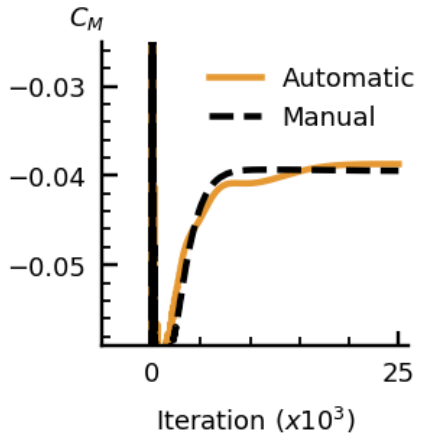
- Compare behavior using automatic & manual connectivity

Baseline

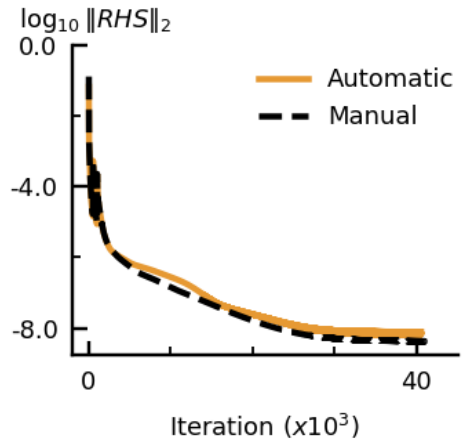


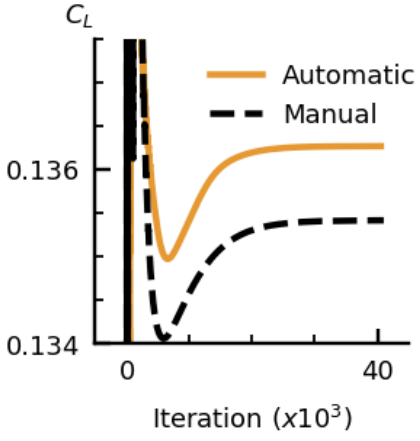


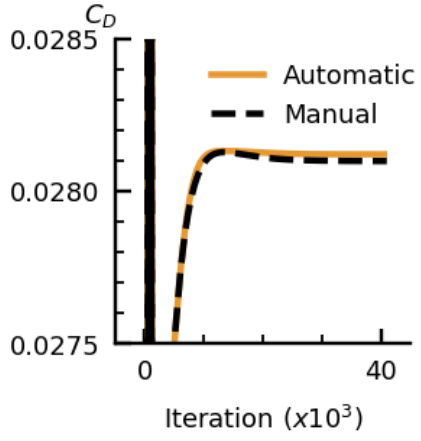


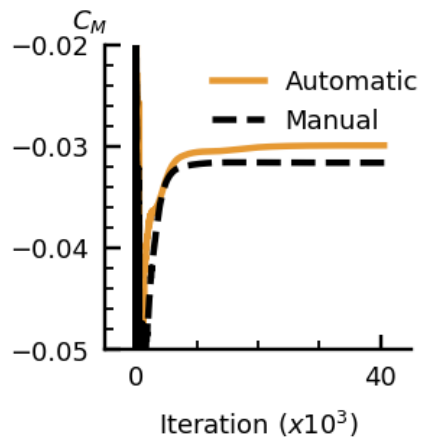


Baseline + PY

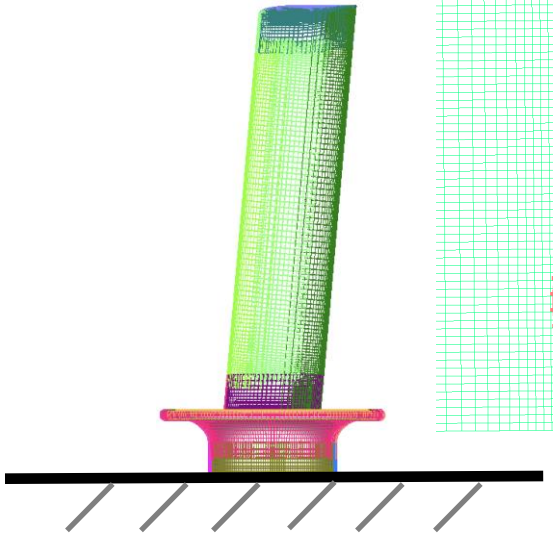




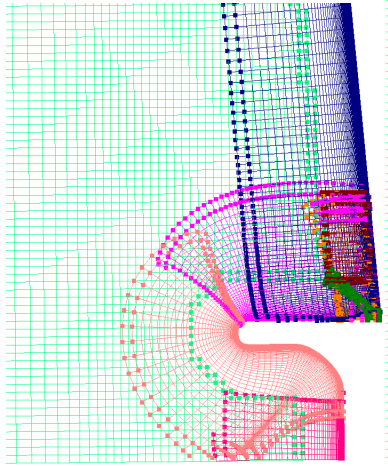




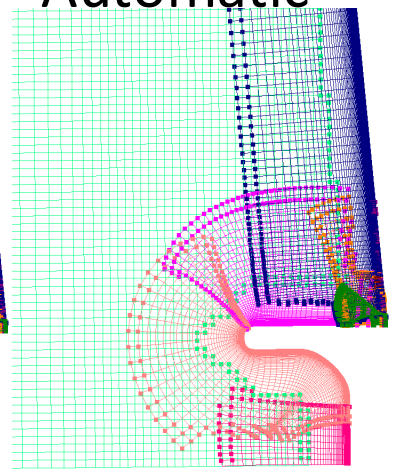
TILTWING TEST RIG (TWTR)
Baseline Wing & Splitter Plate on Ground Plane

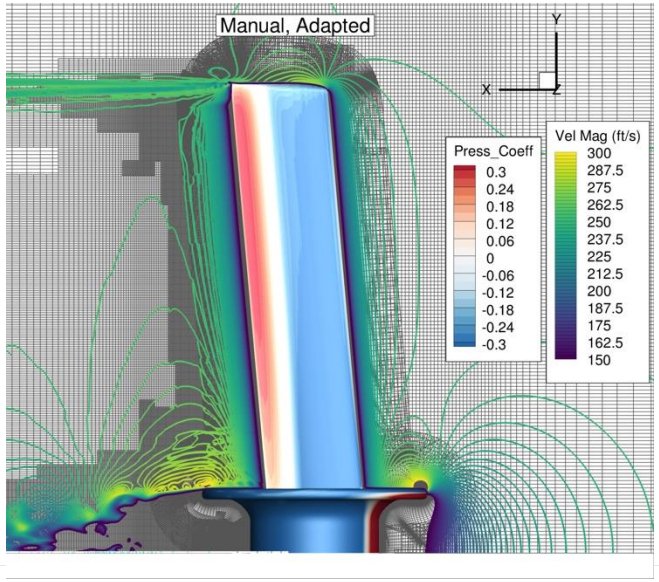


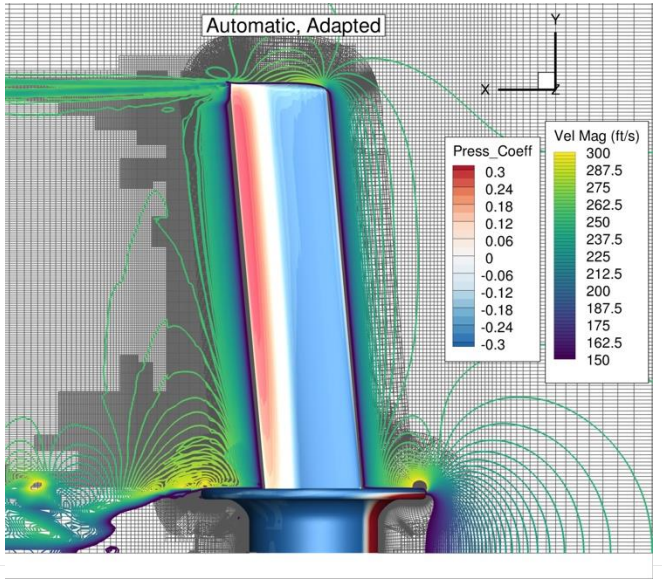
Manual



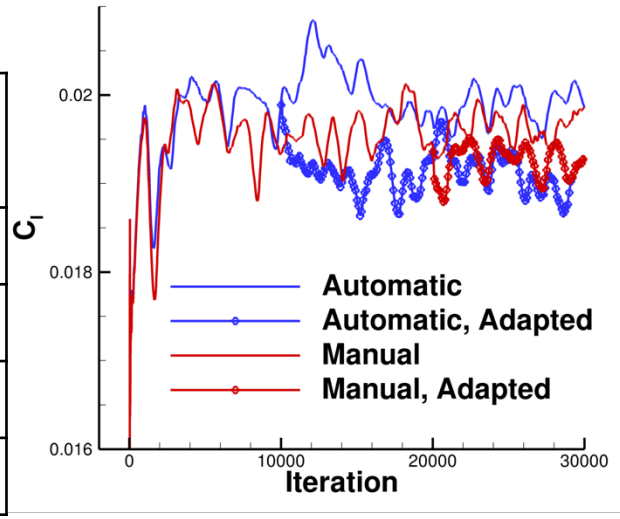
Automatic

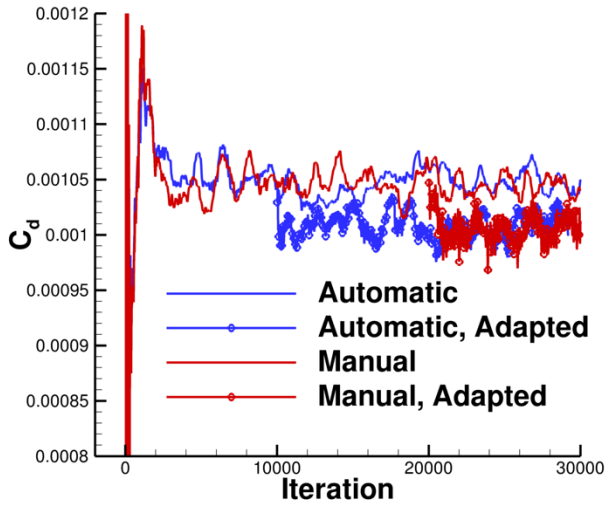


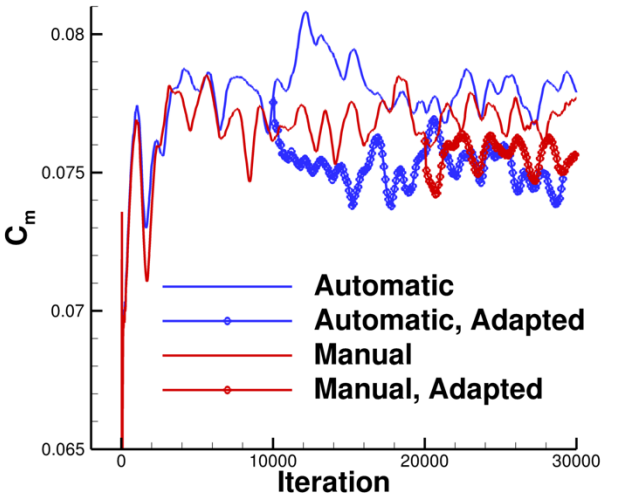




Case	Connect-ivity	Wake Adaption
1	A	Off
2	M	Off
3	A	On
4	M	On



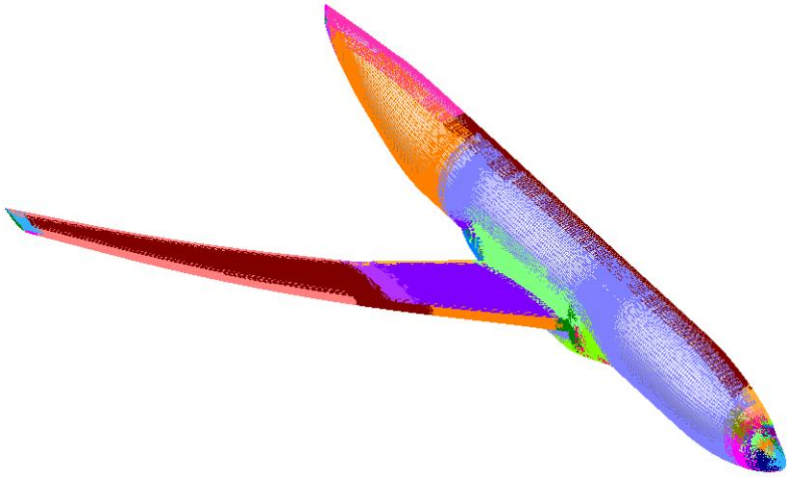


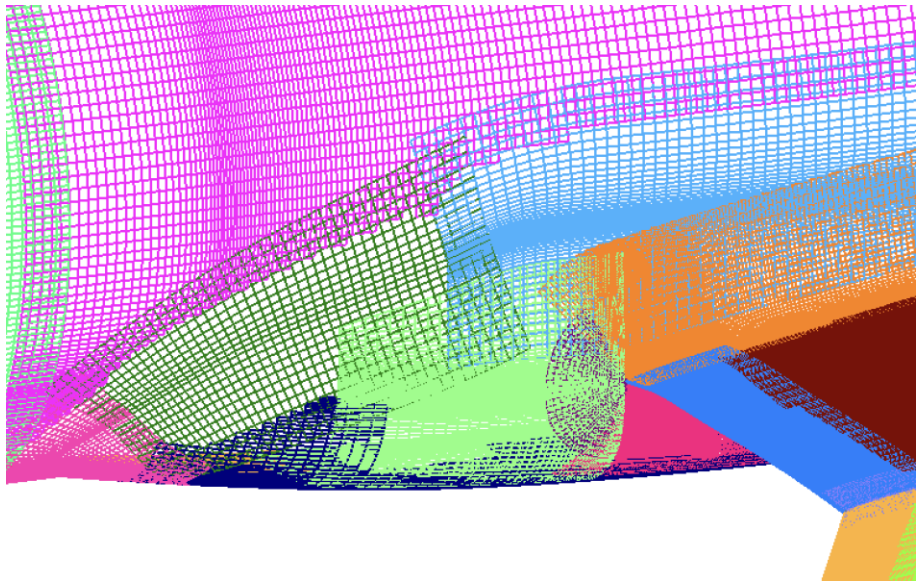


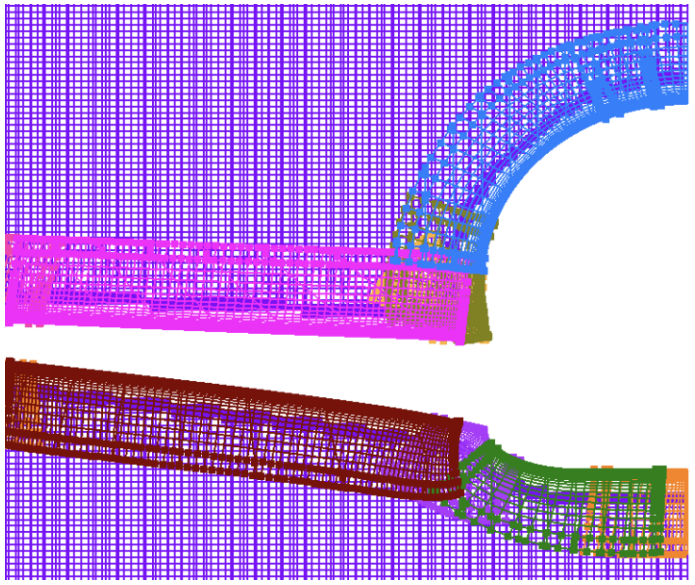
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7TH AIAA DRAG PREDICTION WORKSHOP (DPW7)

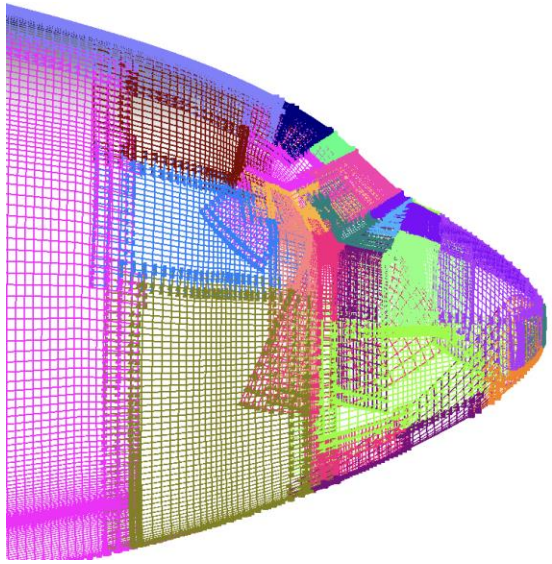
Wing Deflection at alpha = 3.0 deg., Re = 5M

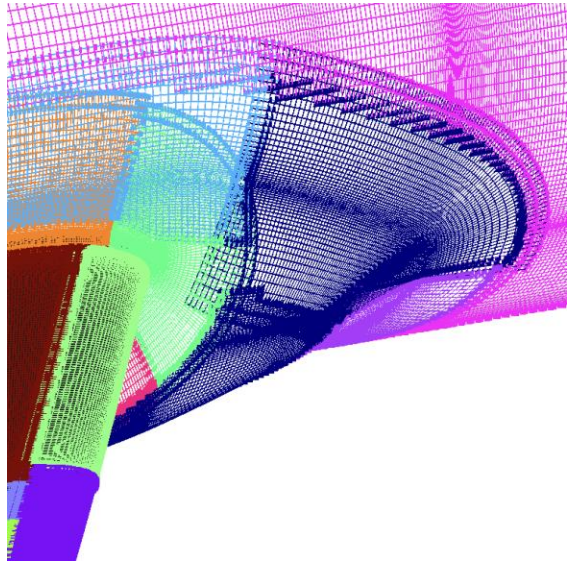


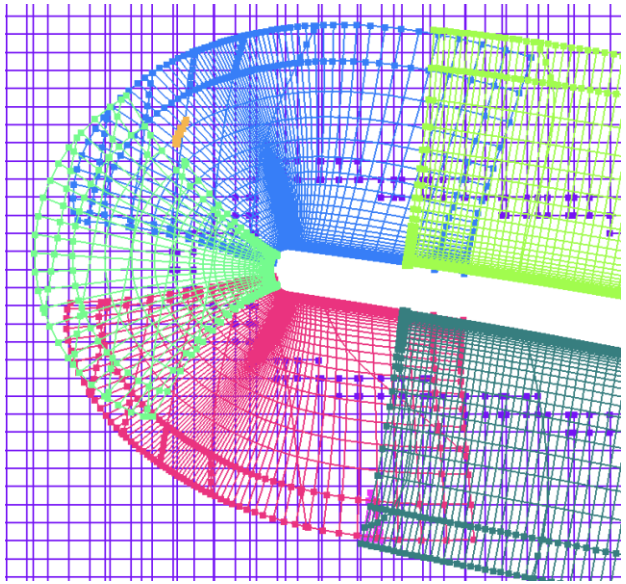




Case	# Surface grid pts	# Near-body volume grid pts
Coarse	0.23 M	13.6 M
Fine	0.64 M	66.1 M



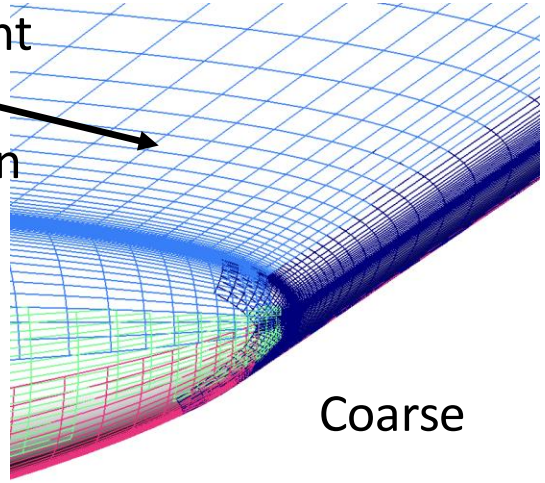




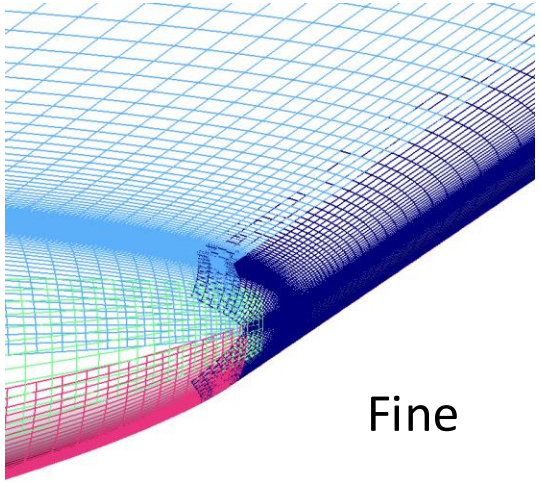
7TH AIAA DRAG PREDICTION WORKSHOP (DPW7)

Residuals & Aerodynamic Loads Convergence

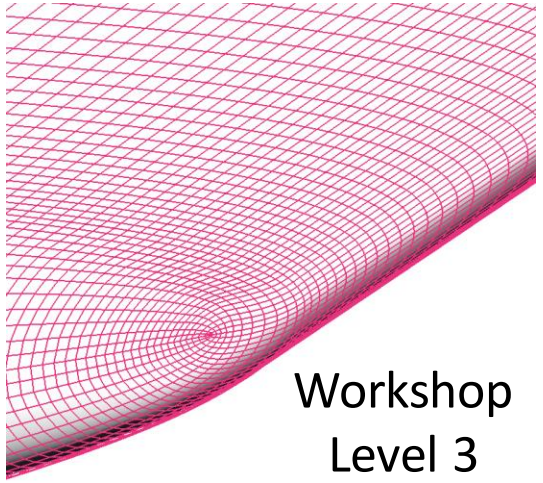
Insufficient grid resolution



Coarse

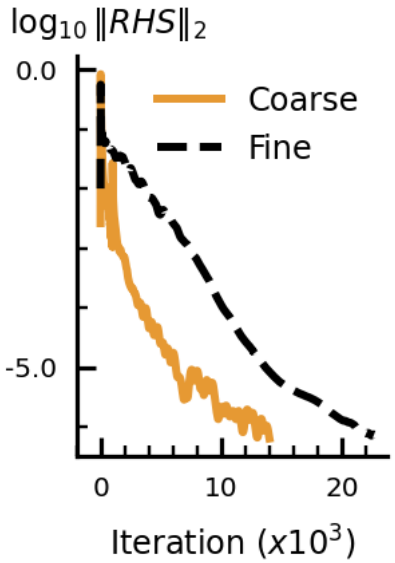


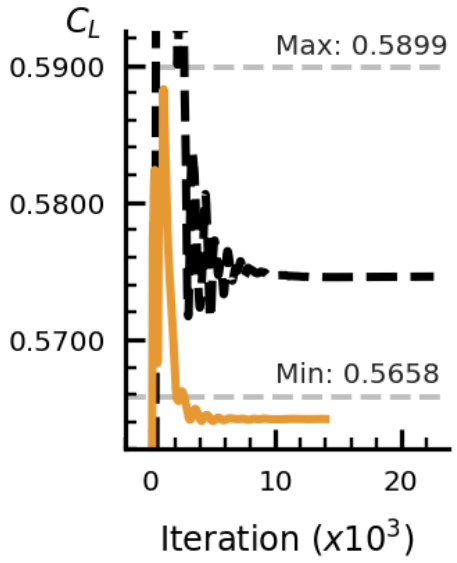
Fine

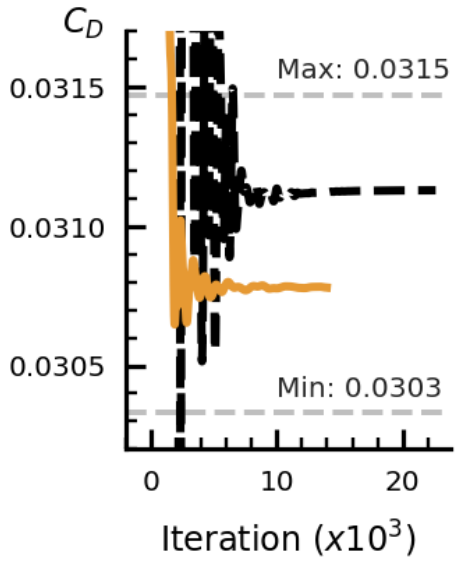


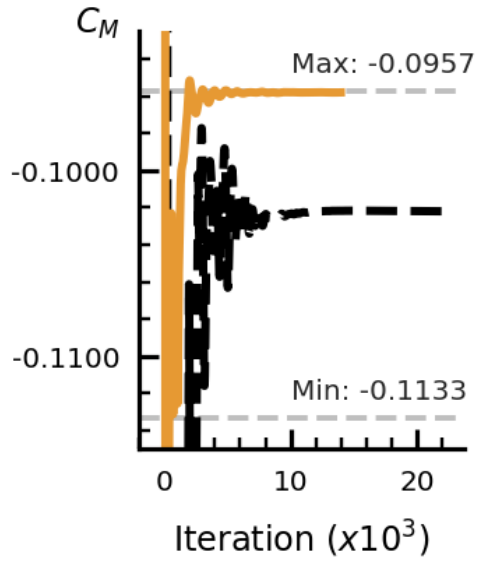
Workshop Level 3

- Workshop min/max from 8 different solvers/datasets





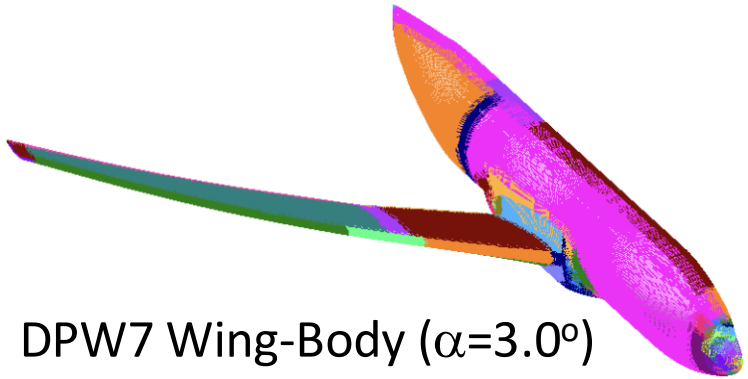




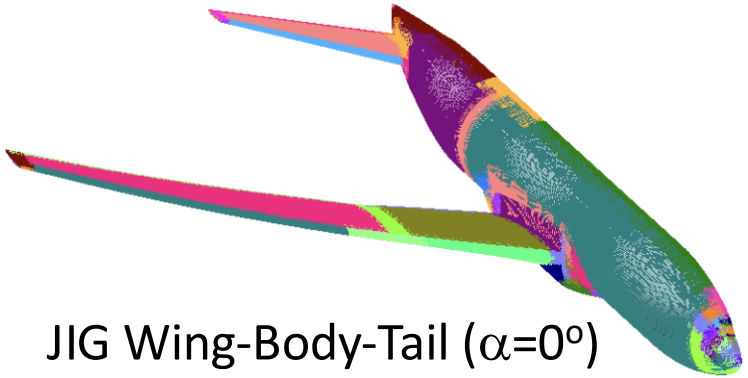
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8TH AIAA DRAG PREDICTION WORKSHOP TEST CASES

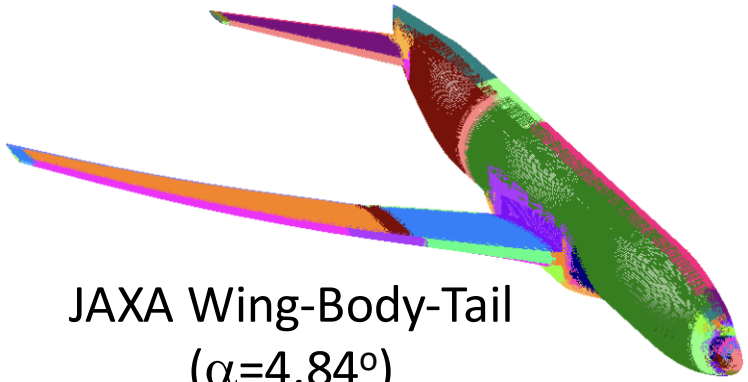
Level 3 Resolution



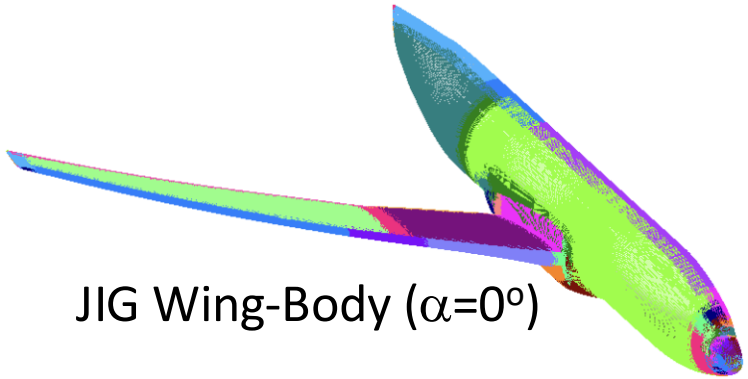
DPW7 Wing-Body (α=3.0°)



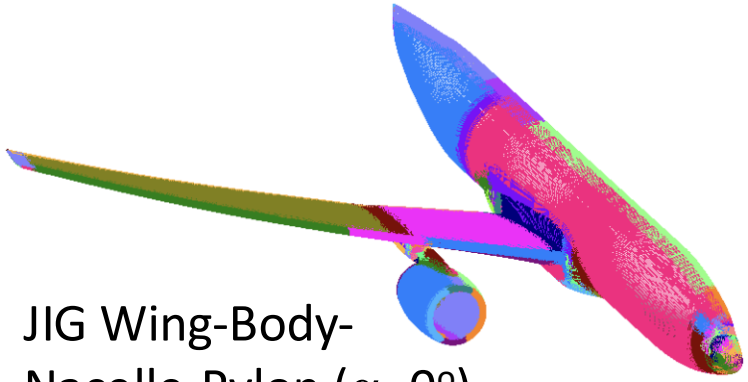
JIG Wing-Body-Tail (α=0°)



JAXA Wing-Body-Tail (α=4.84°)



JIG Wing-Body (α=0°)



JIG Wing-Body-Nacelle-Pylon (α=0°)

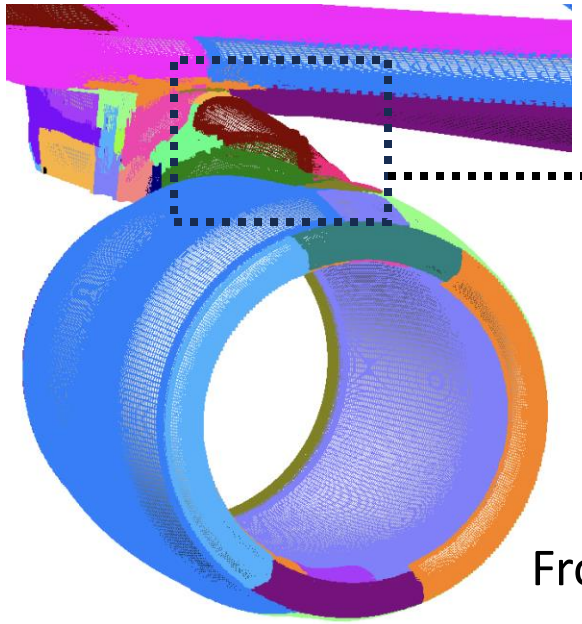
12 OpenMP threads on MacBook Pro M2

Case	# Grids	# Surf. Pts (M)	# NB Vol. Pts (M)	# Repairs		Wall Time (surf+vol)	
				J	O	egads2srf	pogs
DPW7 WB	72	0.40	30.1	0	1	6m 53s	3m 11s
JAXA WBT	85	0.64	48.5	0	3	8m 43s	3m 55s
JIG WB	72	0.41	31.2	0	1	7m 39s	2m 44s
JIG WBT	86	0.64	48.9	0	3	9m 9s	3m 52s
JIG WBNP	127	0.71	54.2	1	3	15m 45s	3m 47s

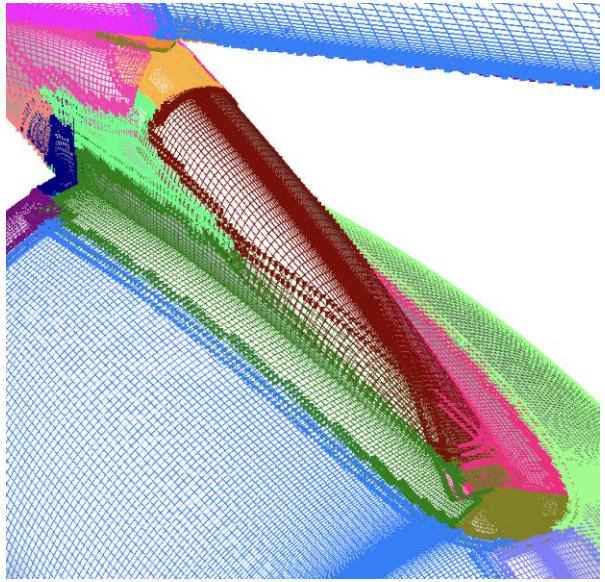
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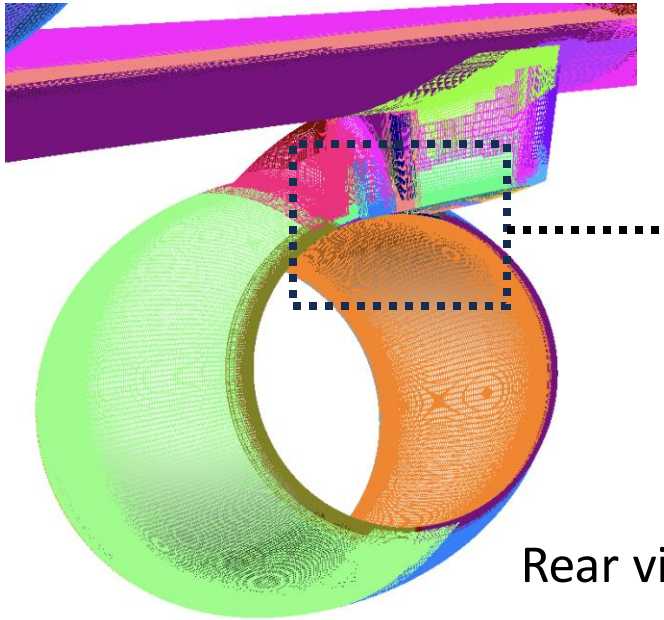
8TH AIAA DRAG PREDICTION WORKSHOP TEST CASES

JIG Wing-Body-Nacelle-Pylon

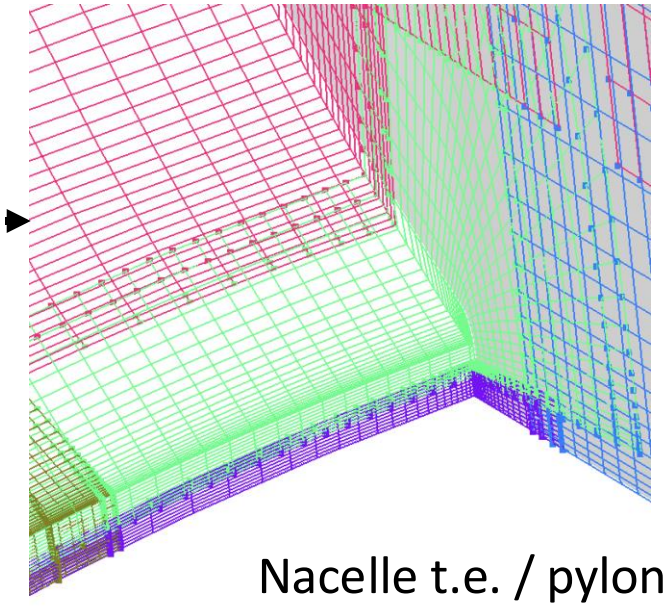


Front view

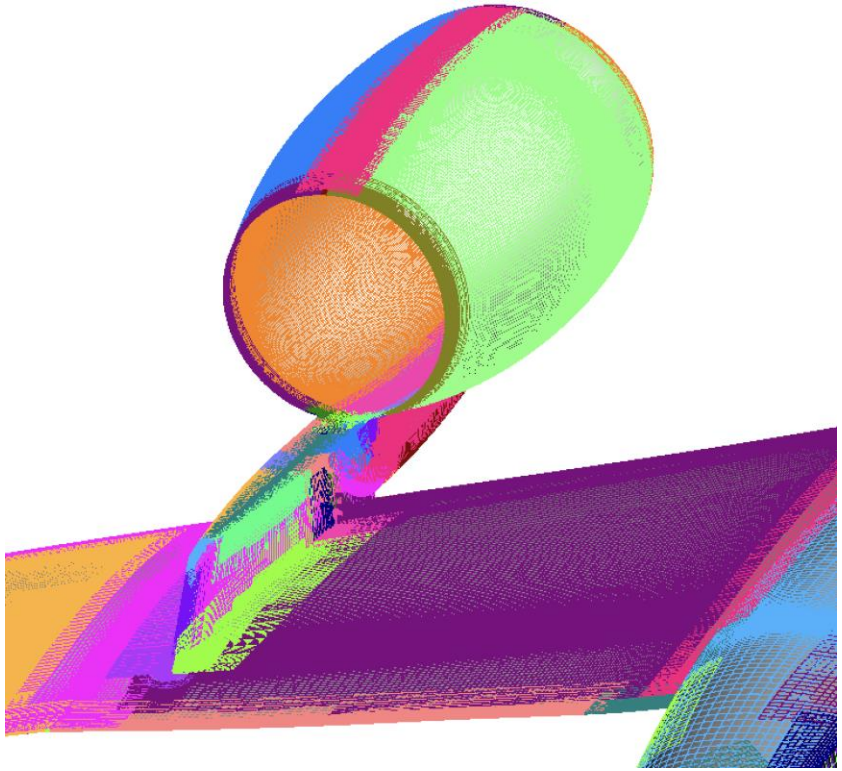




Rear view



Nacelle t.e. / pylon junction



Under-wing view

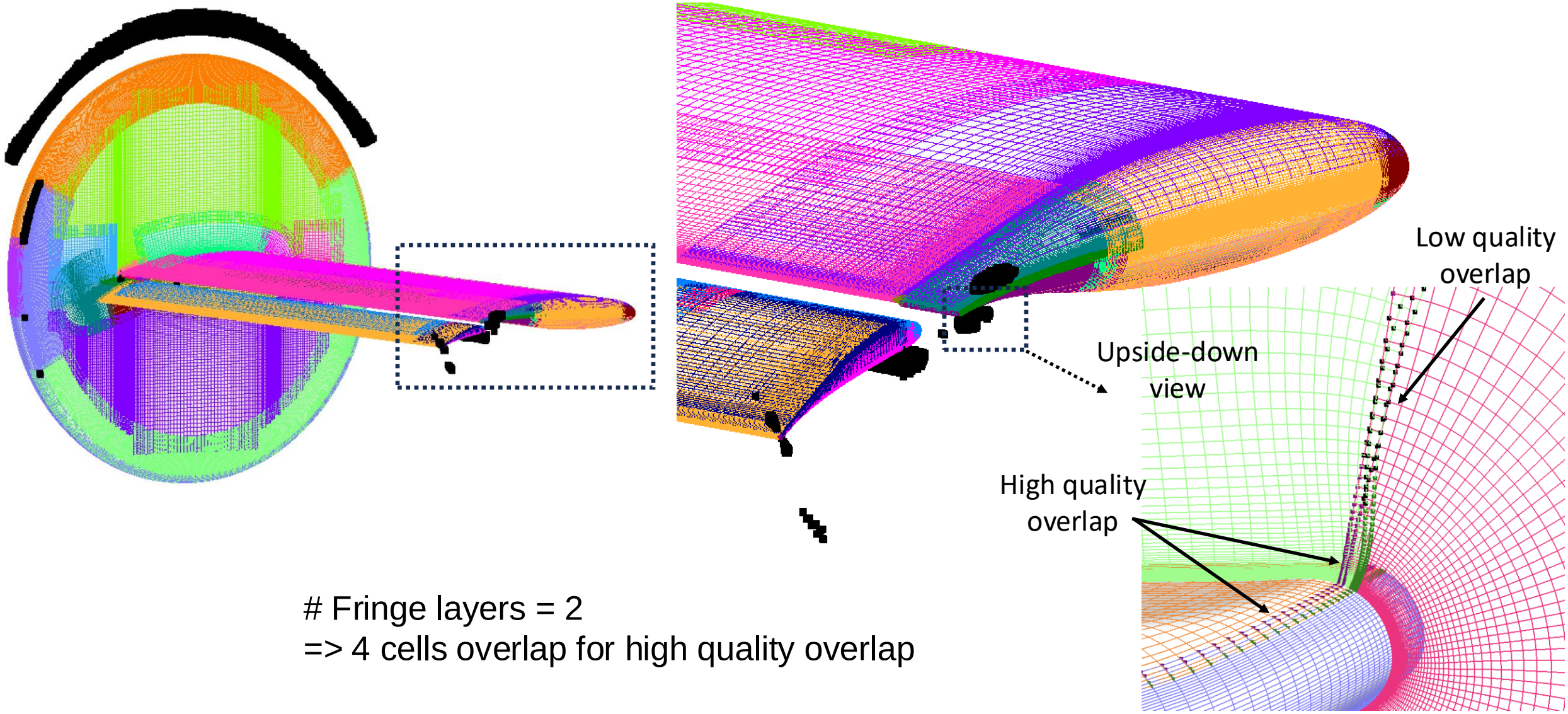
RECENT DEVELOPMENTS (IN PROGRESS)

- Automatic near-body volume mesh splay adjustment
- Domain connectivity improvements
- Large test cases
  - AIAA Drag Prediction Workshop 8 (grid parameter variations)
  - Tiltwing Test Rig Studies (grid topology variations)

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AUTOMATIC SPLAY BOUNDARY CONDITION ADJUSTMENT (1)

Orphan Points Using Default Splay B.C.

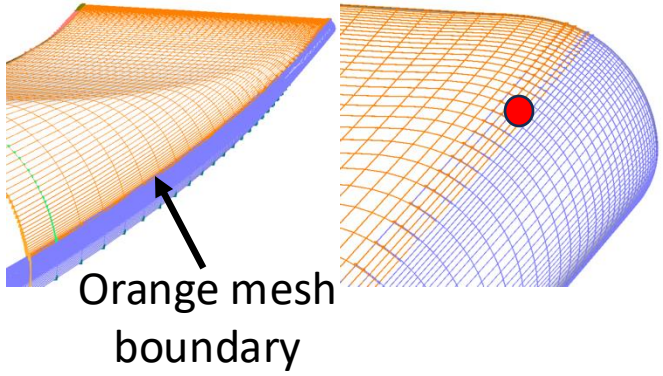


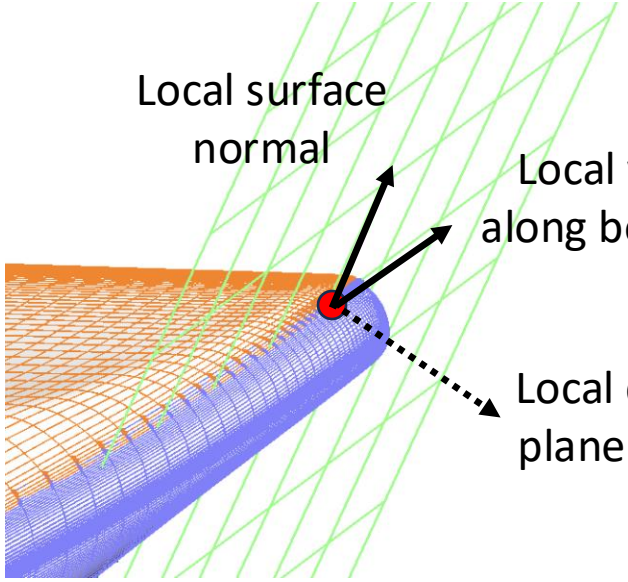
Fringe layers = 2
=> 4 cells overlap for high quality overlap

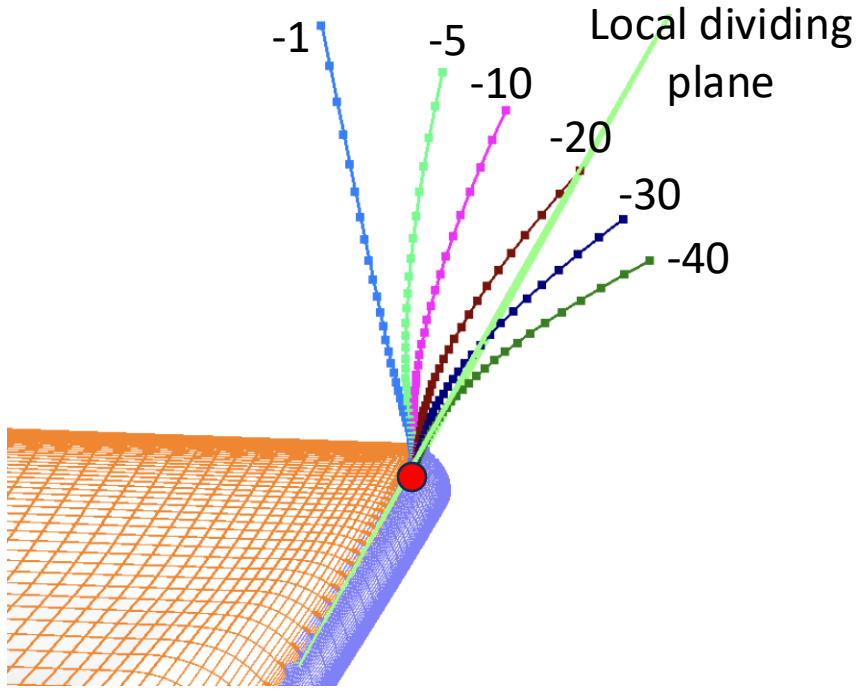
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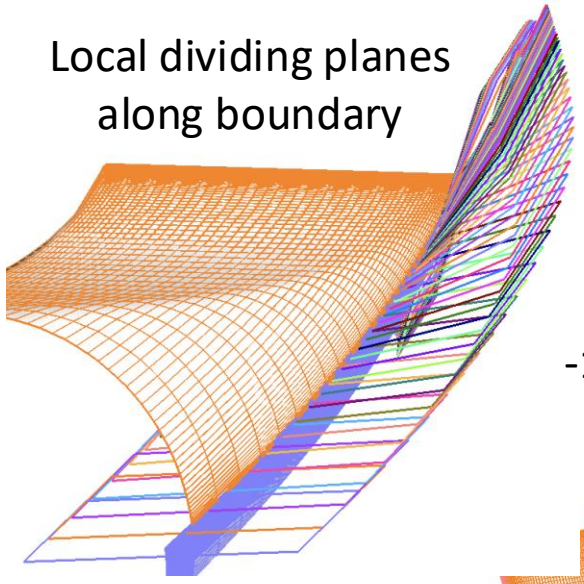
AUTOMATIC SPLAY BOUNDARY CONDITION ADJUSTMENT (2)

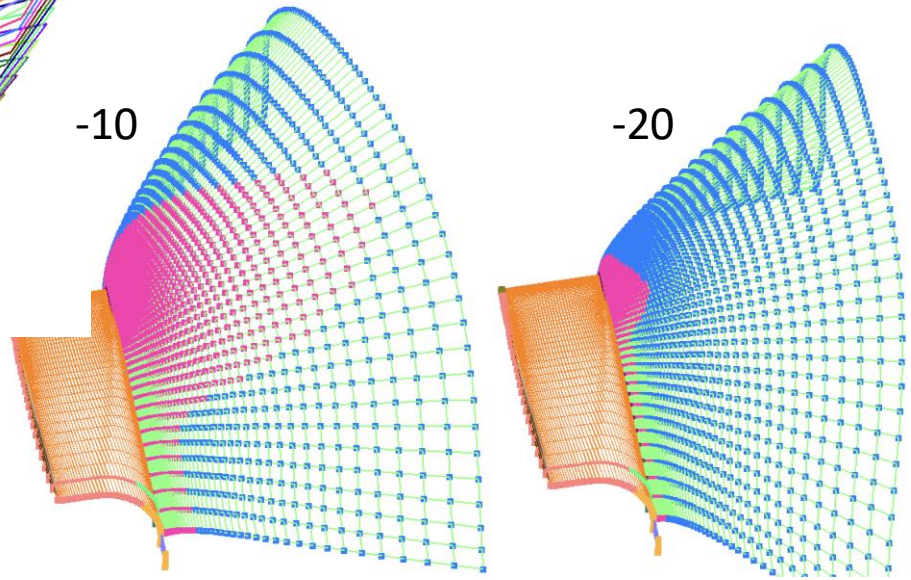
Local Dividing Plane











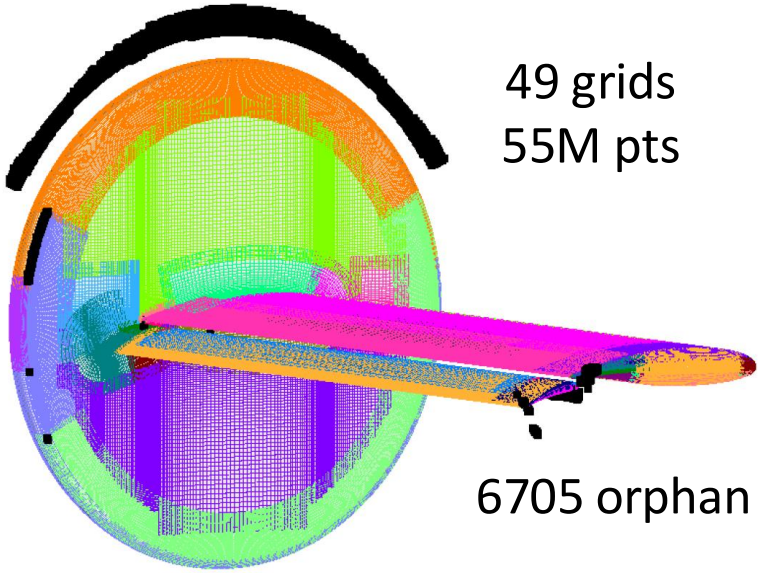
- Nf = # fringe point layers
- Determine % of points on volume grid slice at Nf layer from boundary that reside exterior to or on local dividing plane
- Increase splay parameter until % reaches target value (~90%)

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AUTOMATIC SPLAY BOUNDARY CONDITION ADJUSTMENT (3)

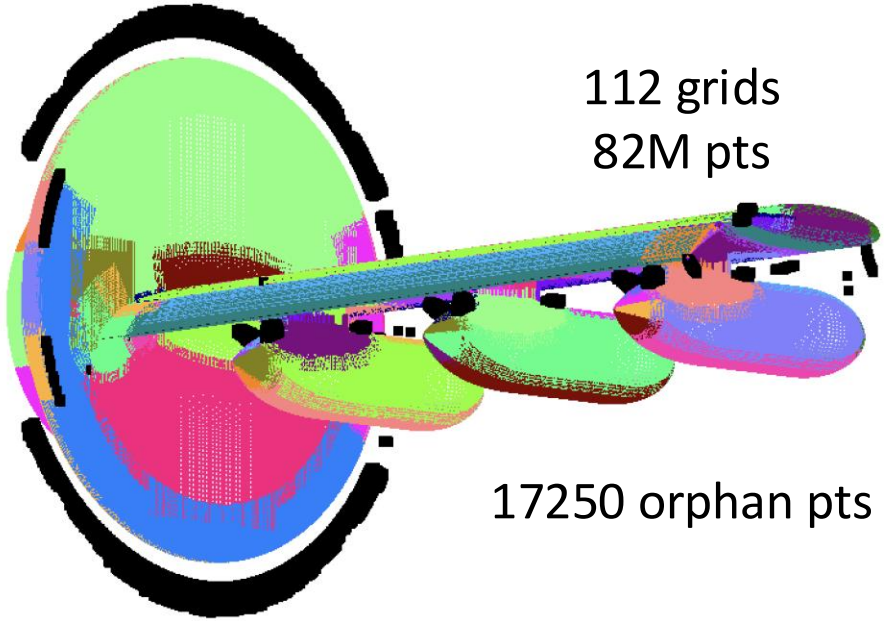
Orphan Points Comparison with and without Auto-Splay Adjustment

No auto-splay adjustment



49 grids
55M pts

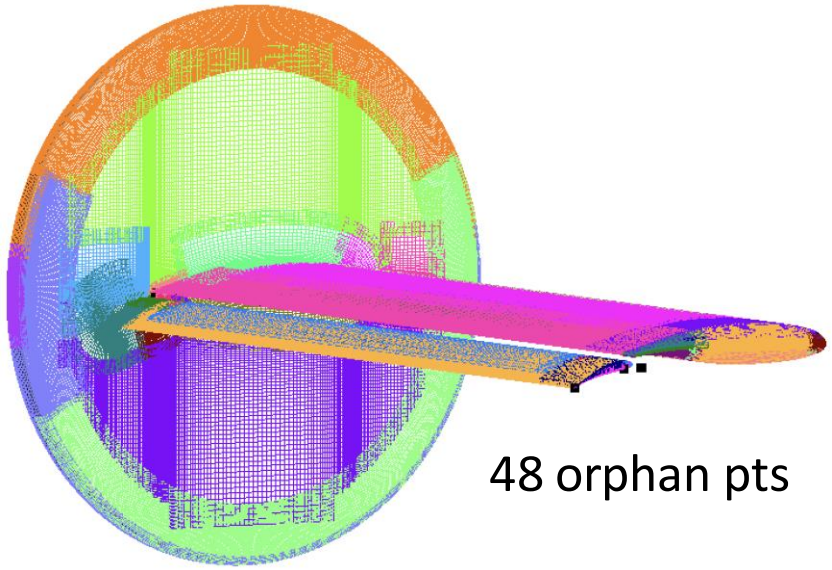
6705 orphan pts



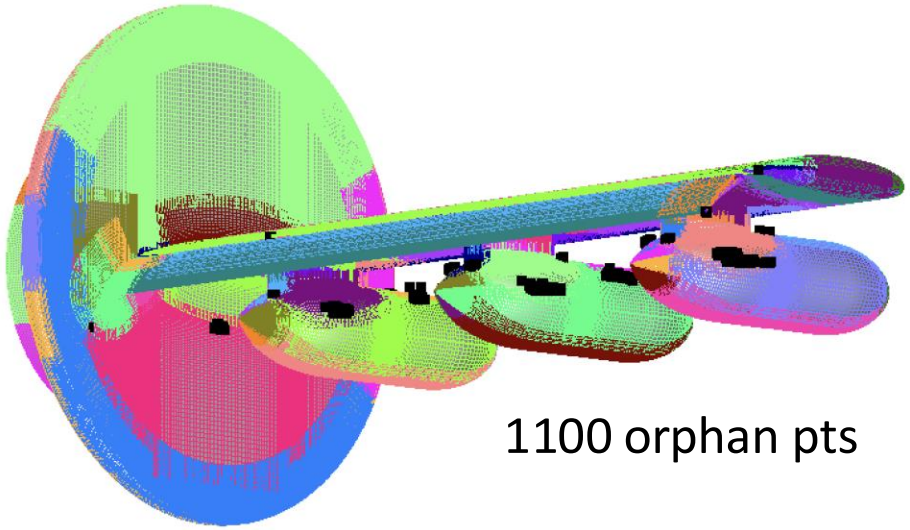
112 grids
82M pts

17250 orphan pts

With auto-splay adjustment

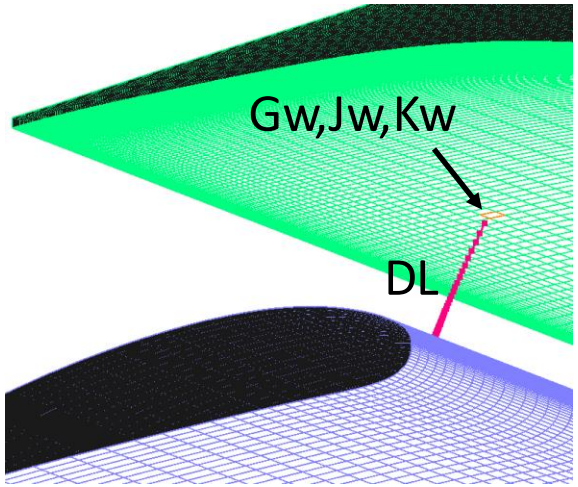


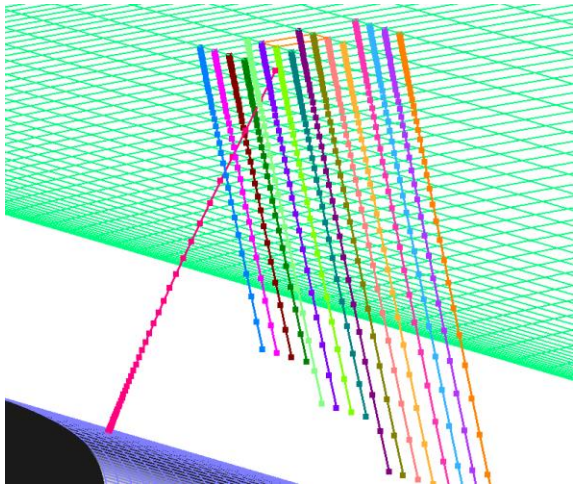
48 orphan pts

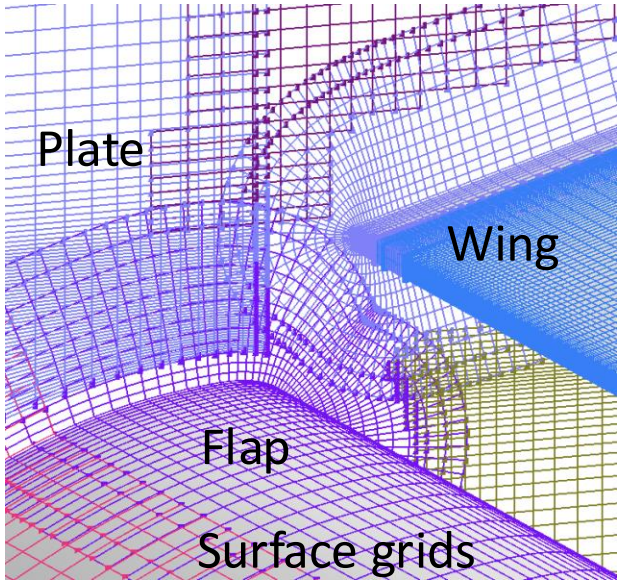


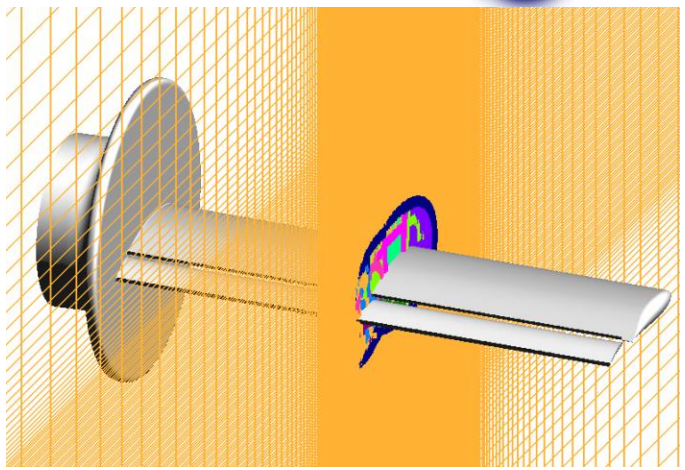
1100 orphan pts

DOMAIN CONNECTIVITY IMPROVEMENTS









Const span cut

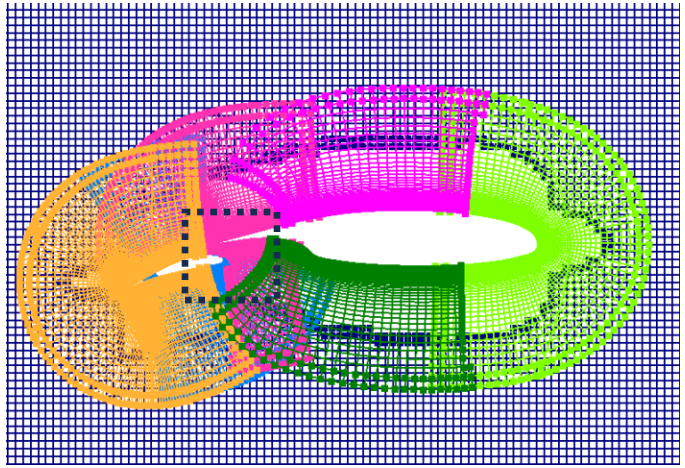
- Near-body grid hole-cuts using distance functions

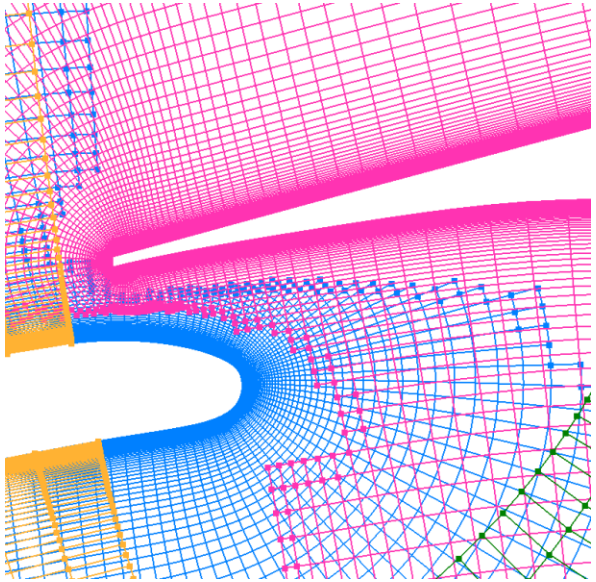
  G = grid #, J,K = surface dirs, L = normal dir

  DL(G,J,K) = arc length of L-strand after min-hole cut

  Gw, Jw, Kw = grid and J,K cell indices of closest wall cell

  Blanking decision based on DL(G,J,K), DL(Gw,Jw,Kw)





- Donor stencil search improvements (~ 4 – 5 x faster than previous scheme)
  - Grid-based SAM bins replaced global SAM bins
  - Usage of surface donor stencil data for near-wall volume fringe point donor stencils

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8TH AIAA DRAG PREDICTION WORKSHOP

Grid Systems Matrix (33 grid systems in progress)

Configuration	Wing Loading α (deg.)	L1	L2	L3	L4	L5	L6
CRM Wing/Body	2.50			x			
	2.75			x			
	3.00	x	x	x	x	x	x
	3.25			x			
	3.50			x			
	3.75			x			
	4.00			x			
	4.25			x			
JAXA Wing/Body/Tail	4.84	x	x	x	x	x	x
	5.89			x			
CRM Wing/Body	0.0	x	x	x	x	x	x
CRM Wing/Body/Tail	0.0			x			
CRM Wing/Body/Nacelle/Pylon	0.0	x	x	x	x	x	x

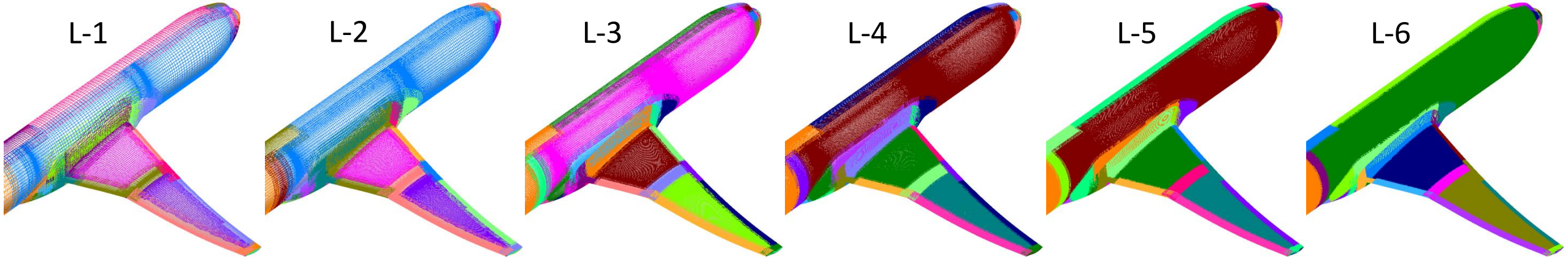
x surface & volume grids & connectivity (ready for flow solver)

x surface + volume grids only

x to be completed

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8TH AIAA DRAG PREDICTION WORKSHOP
CRM Wing-Body Mesh Family: Wing at α=0.0º Deflection
2.5x Mesh Resolution Study



L	maxa (deg)	maxe (x1.5)	npmin (+4)	maxsr	Δs wall 10^{-4} (x1.5)	# nb grid	# Surf. Pt (M)	# Total Vol. Pt (M)	Run Time	Repair Time
1	5.0	15.0	9	1.19	5.423	67	0.13	11.7	< 3 min.	~ 1 hr.
2	4.5	10.0	13	1.135	3.615	68	0.25 (x1.9)	27.3 (x2.3)	⇣	⇣
3	4.0	6.667	17	1.10	2.410	73	0.46 (x1.8)	62.6 (x2.3)	~ 12 min.	~ 2 hr.
4	3.5	4.444	21	1.07	1.607	73	0.88 (x1.9)	160.0 (x2.6)	⇣	⇣
5	3.0	3.0	25	1.05	1.071	74	1.65 (x1.9)	409.0 (x2.6)	⇣	⇣
6	2.5	2.0	29	1.04	0.714	76	3.45 (x2.1)	1053.7 (x2.6)	~ 5 hr.	~1 day

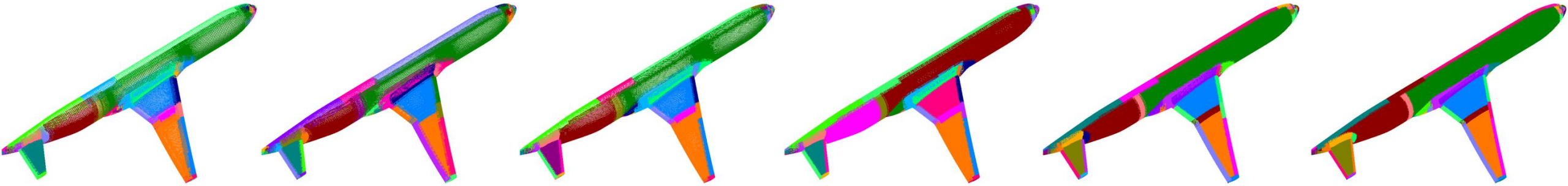
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8TH AIAA DRAG PREDICTION WORKSHOP

JAXA Wing-Body-Tail Mesh Family: Wing at α=4.84º Deflection

2.5x Mesh Resolution Study

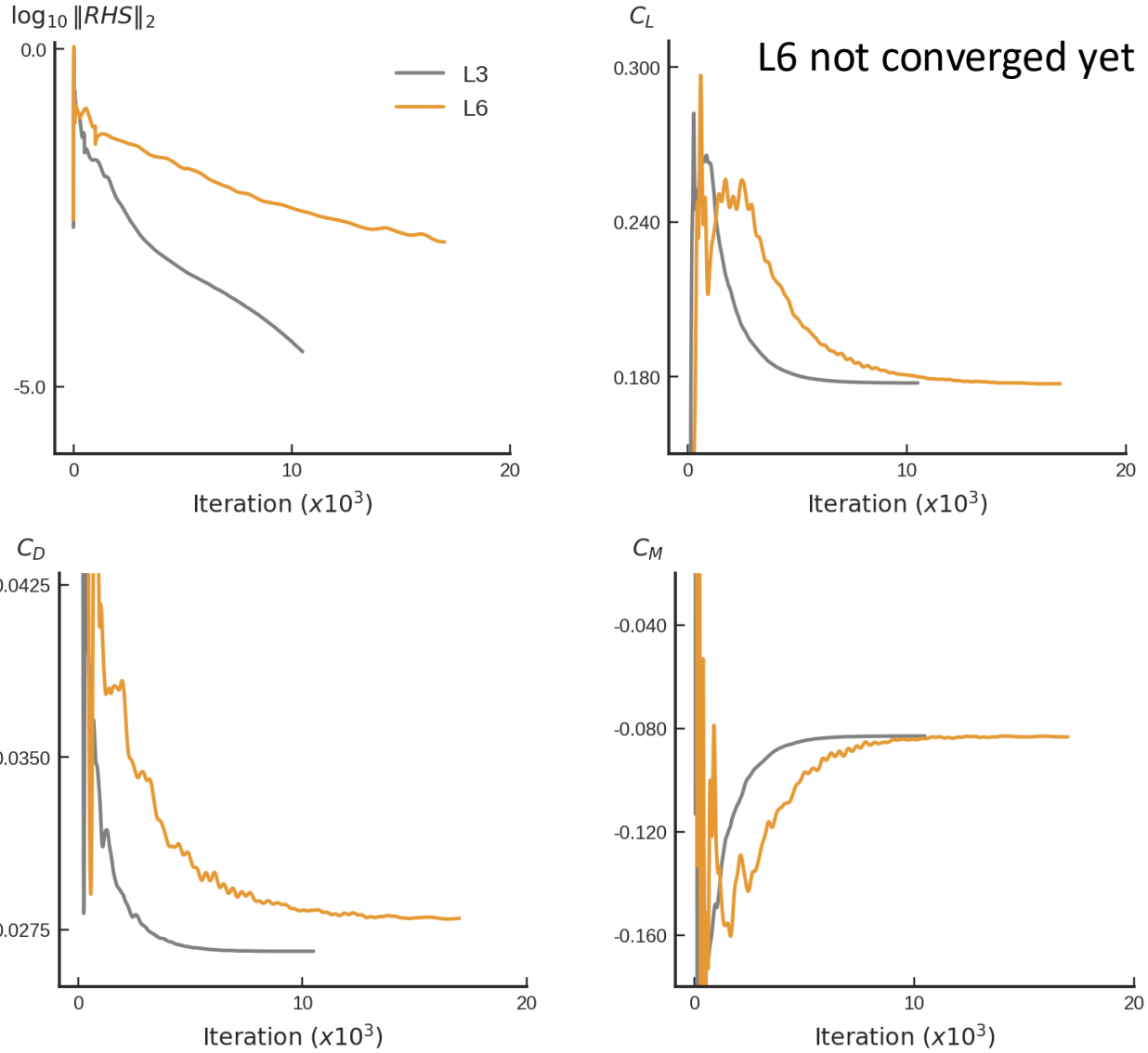
L-1 L-2 L-3 L-4 L-5 L-6



L	maxa (deg)	maxe (x1.5)	npmin (+4)	maxsr	Δs wall 10^{-4} (x1.5)	# nb grid	# Surf. Pt (M)	# Total Vol. Pt (M)	Run Time	Repair Time
1	5.0	15.0	9	1.19	5.423	81	0.21	16.5	< 5 min.	~ 1.5 hr.
2	4.5	10.0	13	1.135	3.615	80	0.39 (x1.9)	39.8 (x2.4)		
3	4.0	6.667	17	1.10	2.410	86	0.74 (x1.9)	96.0 (x2.4)	~ 15 min.	~ 2.5 hr.
4	3.5	4.444	21	1.07	1.607	85	1.38 (x1.9)	241.6 (x2.5)		
5	3.0	3.0	25	1.05	1.071	93	2.72 (x2.0)	647.8 (x2.7)		
6	2.5	2.0	29	1.04	0.714	116	5.37 (x2.0)	1574 (x2.4)	~ 6 hr.	~1.25 day

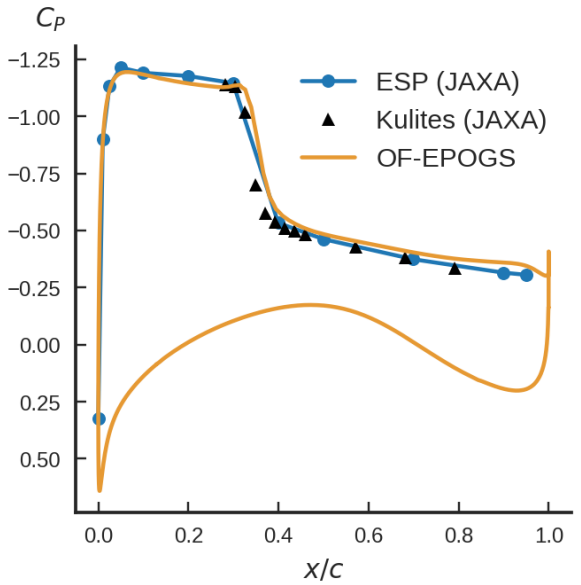
8TH AIAA DRAG PREDICTION WORKSHOP
Preliminary Results

JIG Wing-Body α=0.0



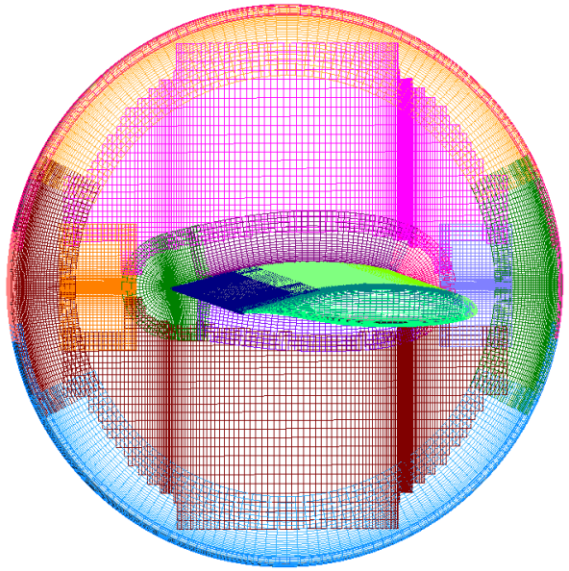
JAXA Wing-Body-Tail α=4.84

Cp cut at η=0.5

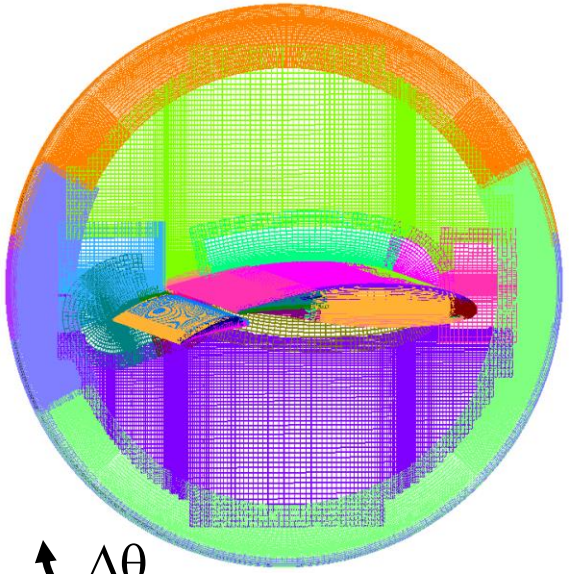


TILTWING TEST RIG (TWTR) Wind Tunnel Test Support

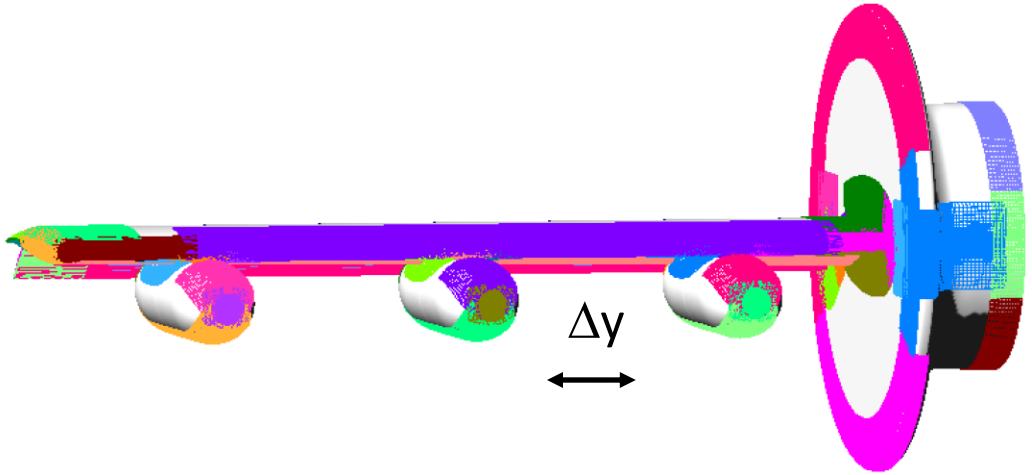
Component Increments and Positioning Studies (in progress)



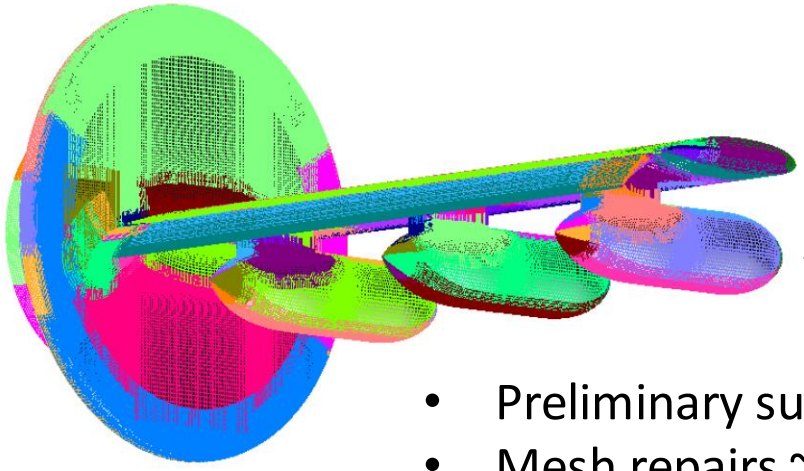
Wing and Splitter Plate on Ground Plane (Baseline)

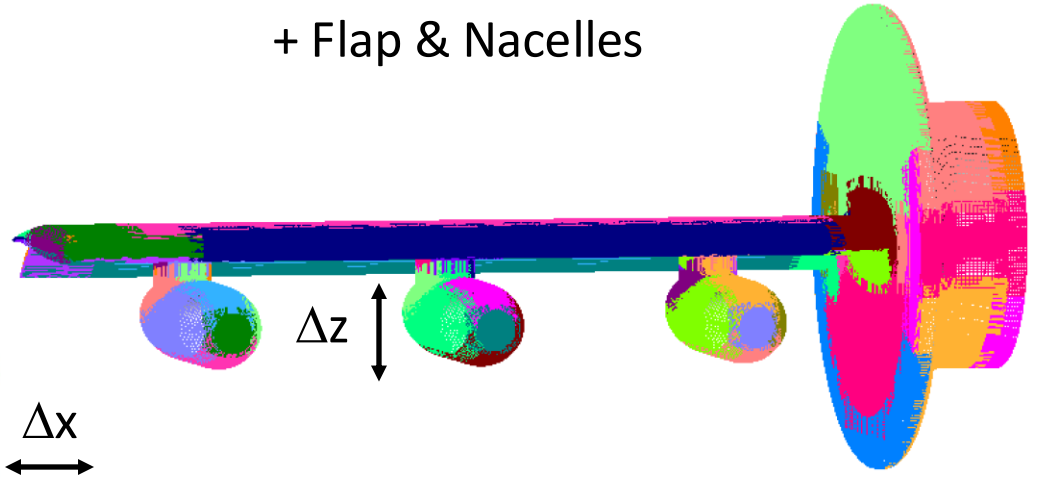


+ Flap



+ Flap & Nacelles





Components to be added

- Flap/wing brackets (x5)
- Rotor disk models (3) / Rotor blades

Other parameters

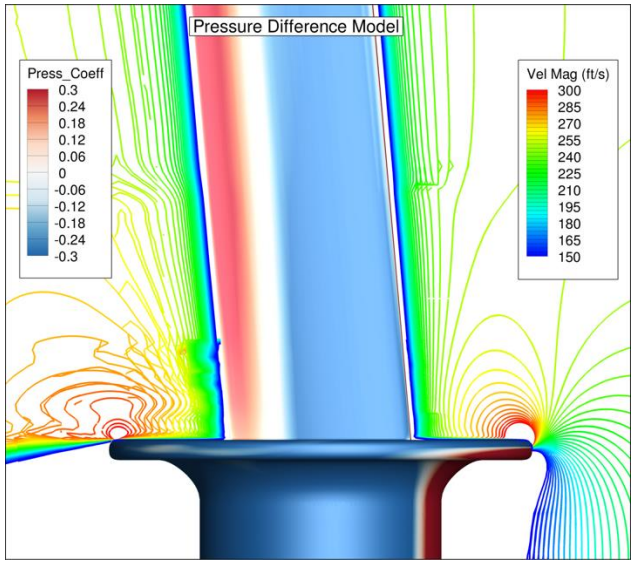
- Alpha sweep (0^o – 90^o)
- Freestream Mach #
- Rotor spin dir

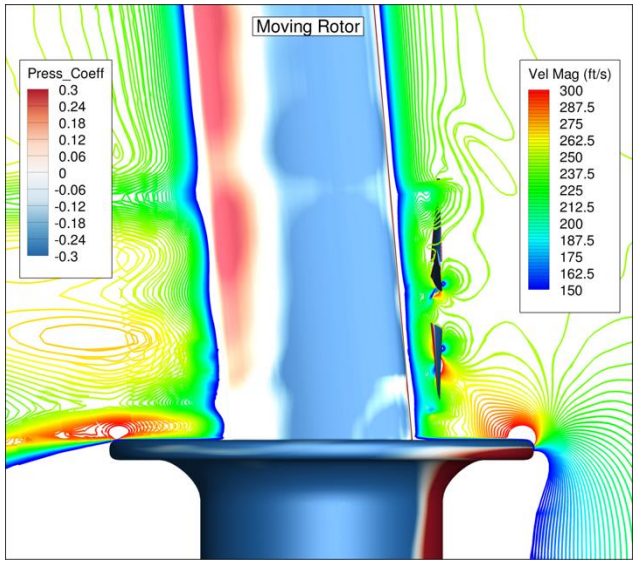
- Preliminary surface + volume grids & connectivity < ~ 10 min.
- Mesh repairs ~ 1 – 2 hrs

TILTWING TEST RIG (TWTR) Wind Tunnel Test Support

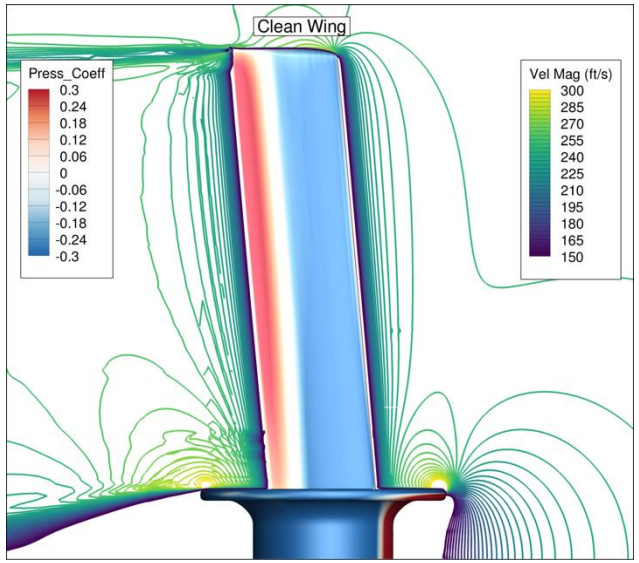
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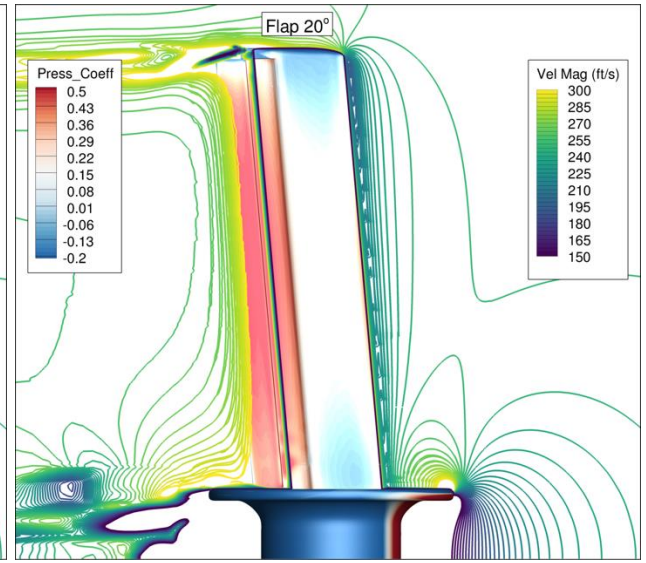
Pressure difference disk model vs. Rotor blades

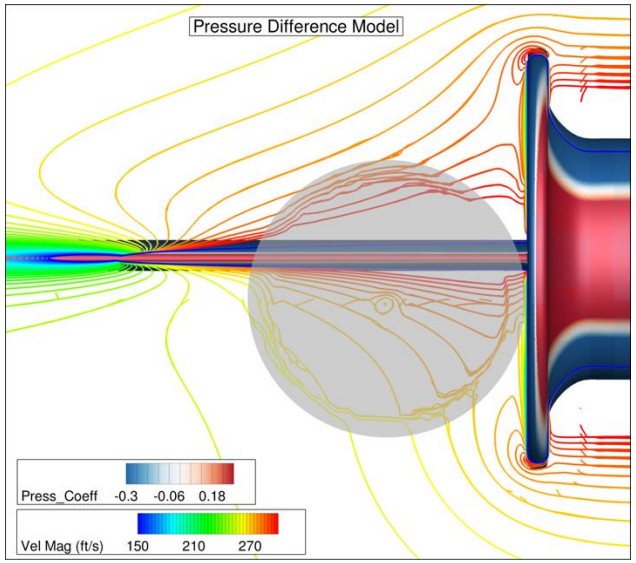


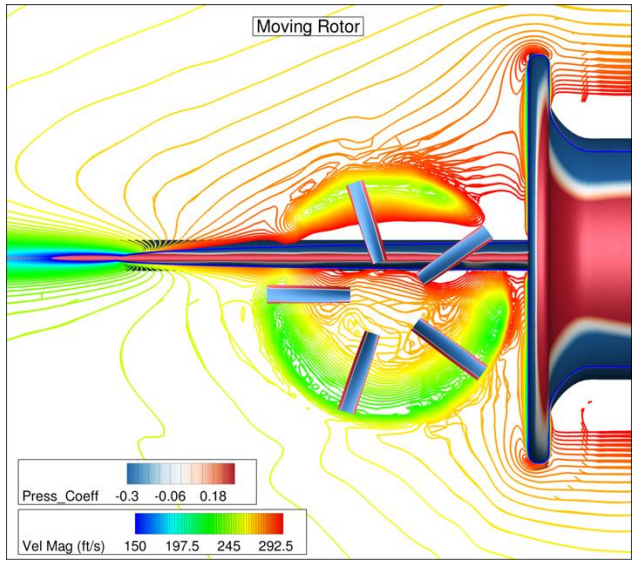


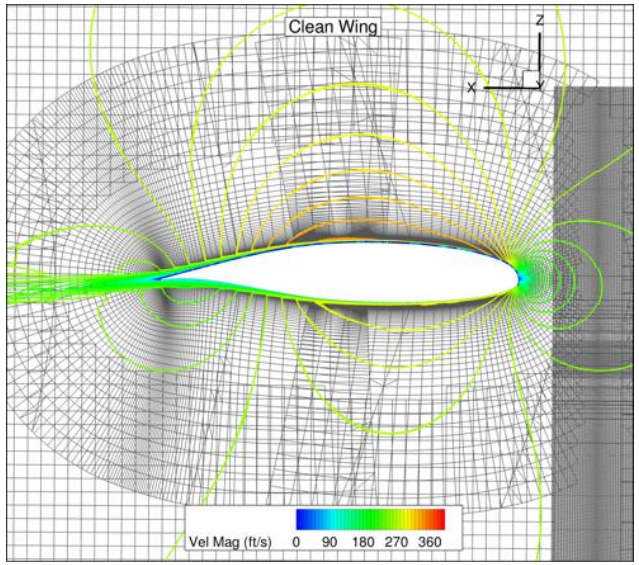
Clean wing vs. wing & 20^{o} flap

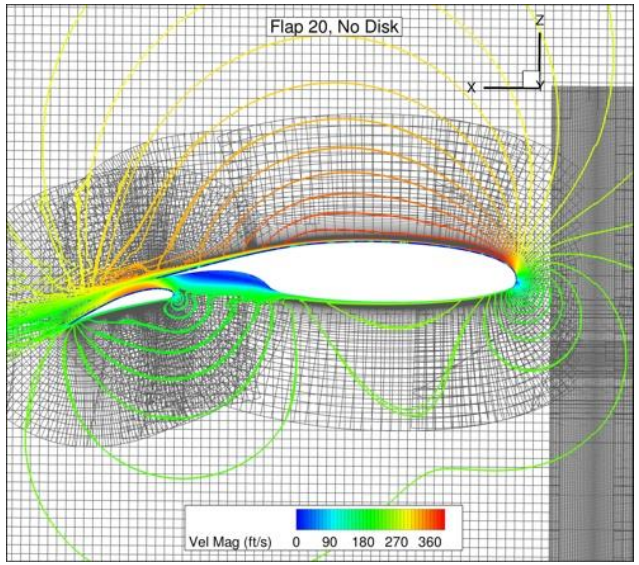












Pressure diff. disk

Rotor blades

Splitter-plate & wing

Splitter-plate, wing, 20^{o} flap

EPOGS CURRENT STATUS

	2018	2021	2022	late 2023	Current (test cases)	Parallelization
Surface Mesh	0	80 - 95%	85 - 100%	98 - 100%	99.9 - 100% (60+)	not yet
Volume Mesh	0	0%	80 - 95%	97 - 100%	98 - 100% (60+)	yes
Domain Connectivity	0	0%	0%	0%	99.978 - 99.999% (20+)	partial
Input files: flow solver & component loads	0	0%	0%	100%	100% (60+)	N/A

- Manual repair time decreasing with code maturity
  - Surface mesh overlap
  - Volume mesh overlap
  - Volume mesh negative Jacobians

- EPOGS included as part of CGT next public release
  - Internal testing and release paperwork in progress
  - Anticipated release date ~ mid 2025

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RECENT PUBLICATIONS/PRESENTATIONS

Chan, W. M., Chuen, A. M., Jensen, J. C., Development of a Toolset for Automatic Structured Overset Mesh Generation, 16th Symposium on Overset Composite Grids and Solution Technology, Dayton, OH, Oct 2024.

Chan, W. M., Chuen, A. M., Jensen, J. C., Advances in Automation of Overset Structured Volume Mesh Generation and Domain Connectivity, AIAA Paper 2024-4305, AIAA Aviation Forum, Las Vegas, NV, Jul 2024.

Hosseini, S. S., Chuen, A. M., Chan, W. M., Computational Aerodynamic Study of the Lift+Cruise VTOL Concept Vehicle Components, 6th Decennial VFS Aeromechanics Specialists' Conference, Santa Clara, CA, Feb 2024.

Chuen, A. M., Hosseini, S. S., Jensen, J. C., Chan, W. M., Aerodynamic Simulations for Complex Geometries Using Automatically Generated Structured Overset Meshes, AIAA Paper 2023-3602, AIAA Aviation Forum, San Diego, CA, Jun 2023.

Chan, W. M., Pandya, S. A., Chuen, A. M., Automation of Overset Structured Surface Mesh Generation on Boundary Representation Geometries, AIAA Paper 2022-3607, AIAA Aviation Forum, Chicago, IL, Jun 2022.

FUTURE WORK

Goal: *"EPOGS is robust, fast and easy to use for creating overset grids"*

- Surface mesh overlap
  - No orphan points
  - Remove excessive overlap
- Volume mesh points
  - Variable marching distances
  - Multi-layered off-body Cartesian grids

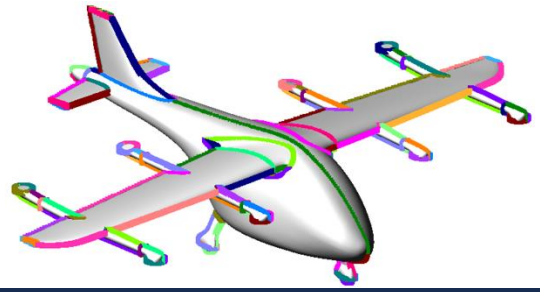
Goal: *"Overset grid generation is not difficult starting with not so clean BREP"*

Automate

- Spurious nodes removal
- Merging of adjacent faces ("Reduced Topology")
- Merging of sliver faces with neighbors
- Automatic u/v reparameterization



Goal: *"Overset grid generation is not difficult starting with collection of surfaces"*



- Potential problems: gaps, overlaps, inconsistencies
- Limit to collection of surfaces that form a closed volume
- Provide
  - Discretized surfaces
  - Discretized curves
  - Edge/face topological relationship

CONCLUDING REMARKS

- First time demonstration: complete overset grid pre-processing automation using EPOGS
  - Creation of surface & volume grids, domain connectivity data, input files for flow solver and component aerodynamic loads computation
  - Mostly automated, may need small manual adjustments
- Five test cases show comparable aerodynamic loads and solution convergence between manual and auto connectivity
- First time demonstration: DPW7 case shows converged aerodynamic loads computed from auto-generated fine mesh fall inside workshop range from 8 datasets
- First time demonstration: creation of 6-level mesh family for DPW8 grid resolution studies
  - 12M – 1.1B pts (JIG), 17M – 1.6B pts (JAXA)
- Significant reduction in effort and time for pre-processing
  - Weeks -> days, Days -> hours

~~"Complex geometries require significant user expertise, effort, time"~~

"Is not difficult starting with clean BREP geometries"

ACKNOWLEDGEMENTS

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NASA Advanced Supercomputing (NAS) Facility

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Dr. Tom Pulliam (ARC)
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Guy Schauerhamer (ARC)