A Mixed Pegasus 5/DCF Overset Grid Assembly Process in OVERFLOW

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Outline

- Motivation
- Review Peg5 and DCF overset grid processes
- Mixed mode process
- Grid adaption
- Issues
- Summary

Motivation

Problem:

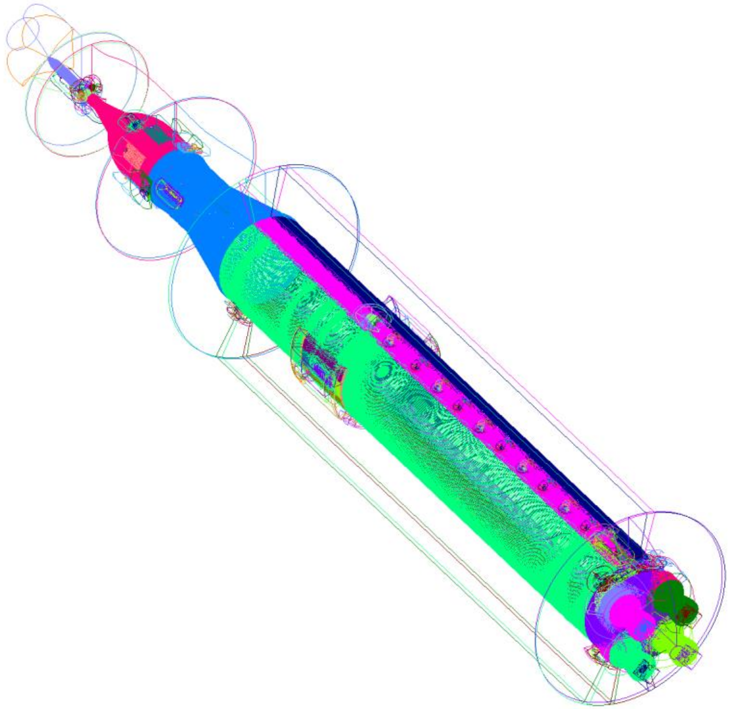
- Need to do moving body analysis on a complex overset grid system assembled using Pegasus 5 (or c3p).

Approach:

- Maintain Peg5 grid connectivity within each body, but allow use of X-rays to cut holes in body and background grids.

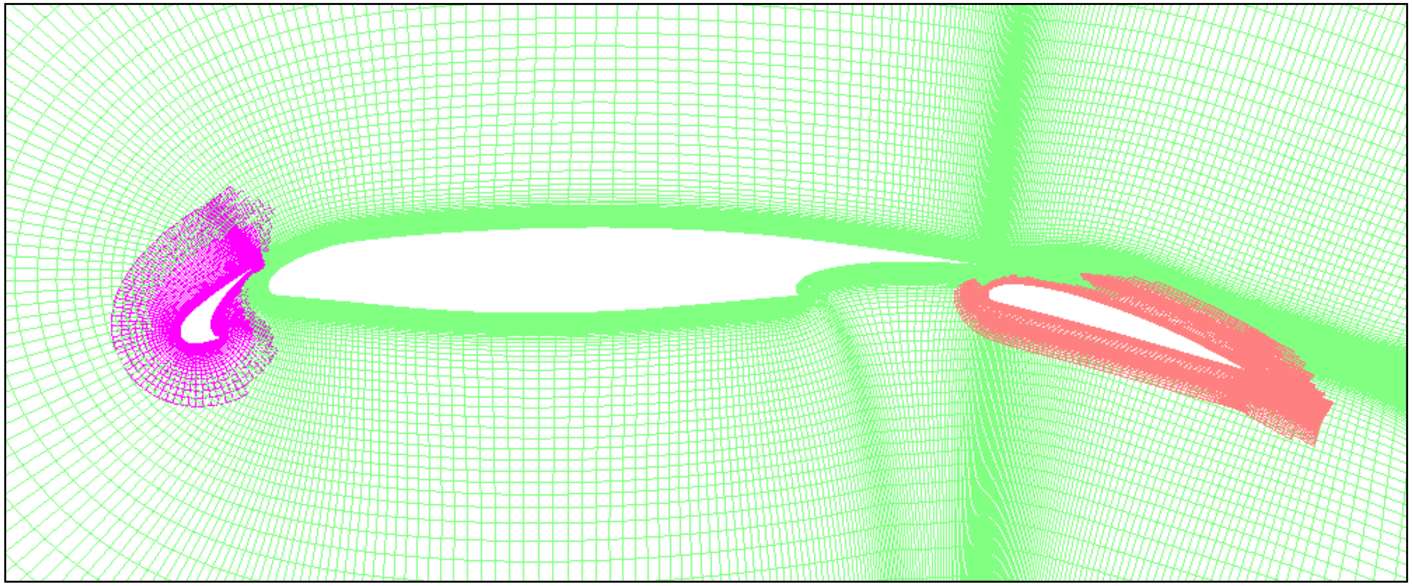
Bonus:

- In addition, it would be nice to allow Cartesian off-body grid generation (and grid adaption).
- And near-body grid adaption!



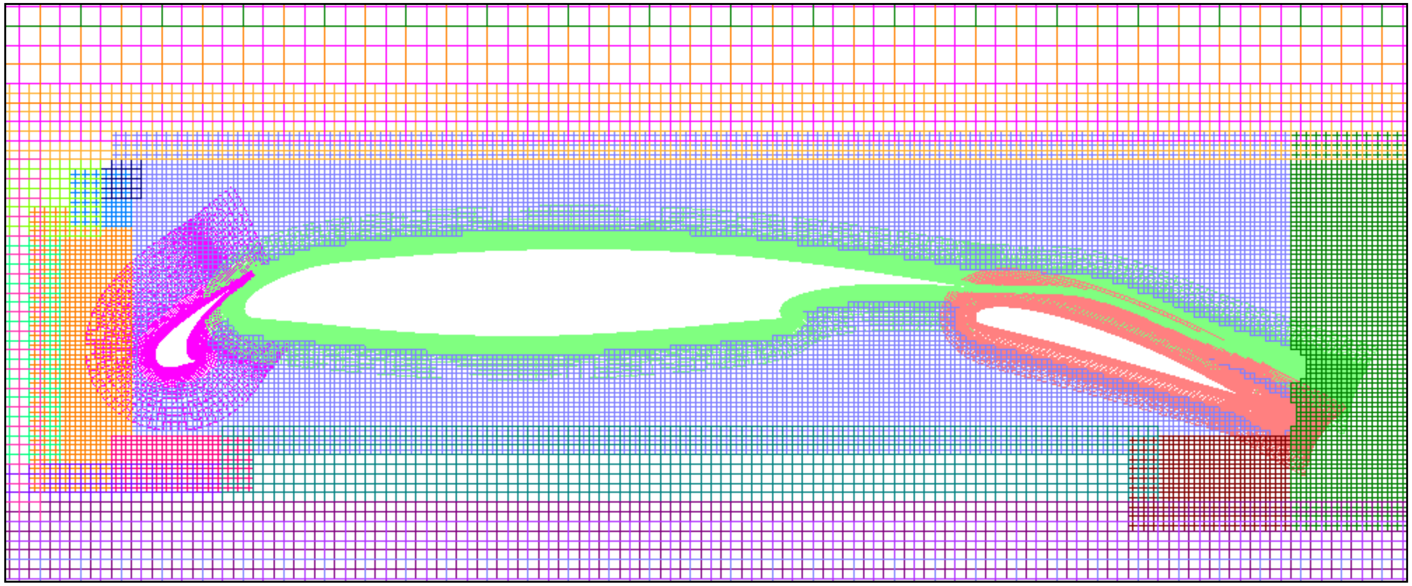
Peg5 Process

- Use original grids and OVERFLOW input file
  - Input file identifies boundary conditions for each grid
  - Produces automatic “optimal” hole cutting and interpolation stencils
  - Output is XINTOUT file containing IBLANK, list of Chimera boundary points (fringe points), and associated interpolation stencils



DCF Process

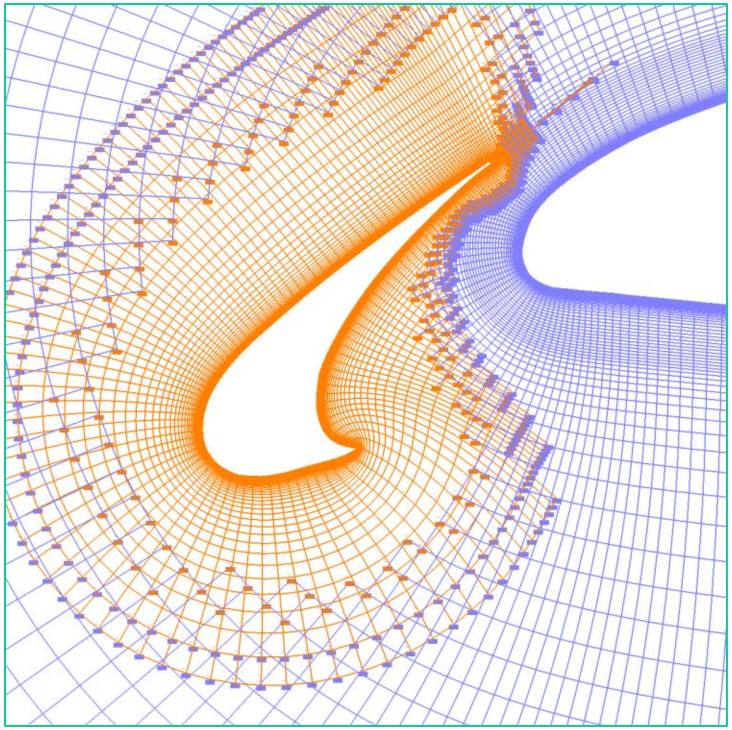
- Code automatically generates Cartesian off-body grids
  - These surround near-body grids and extend to the far-field
- Use X-rays and (namelist) cutters
  - Blank out selected grids within some offset of an X-ray surface



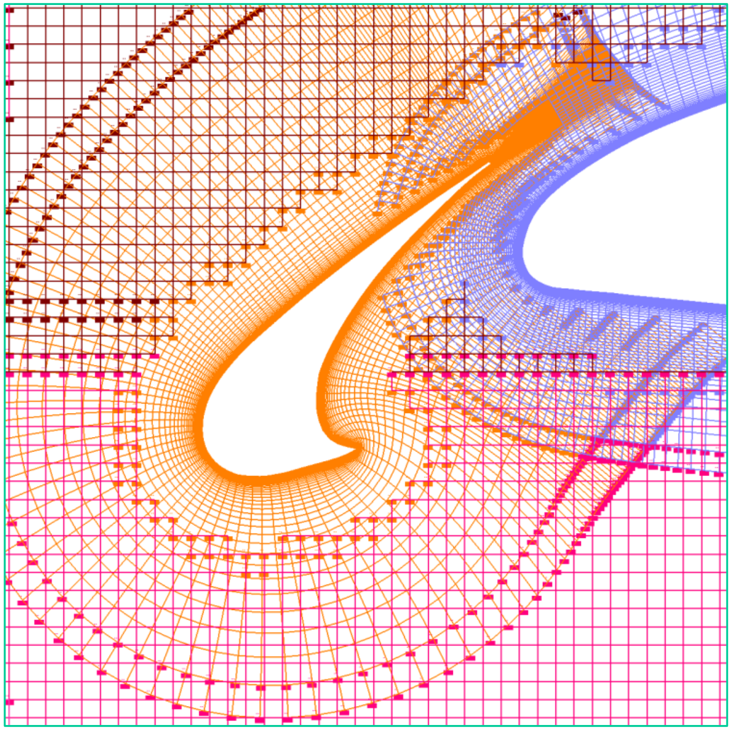
Close-up Comparison

- Holes and fringe points in the slat cove region

Pegasus 5



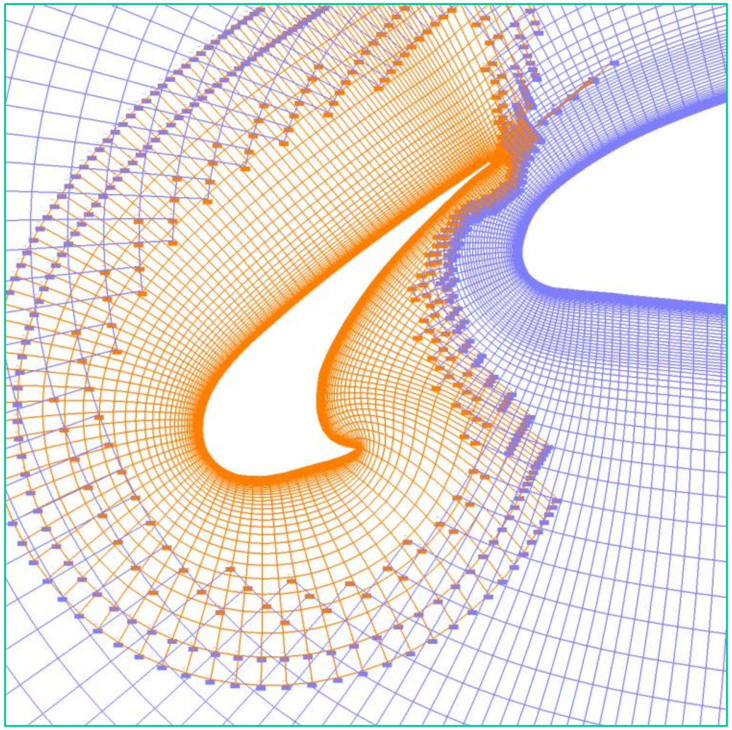
DCF



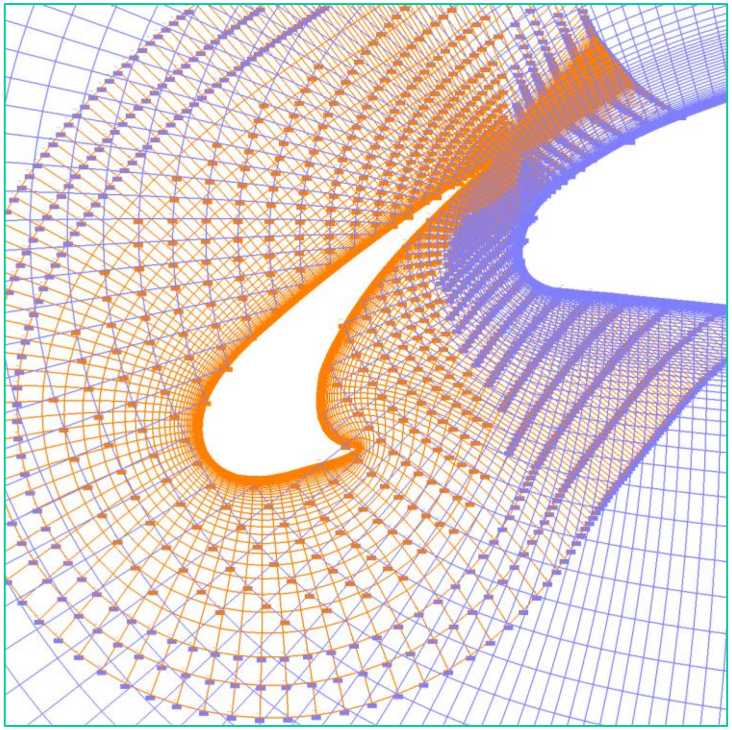
Close-up Comparison

- Holes and fringe points in the slat cove region

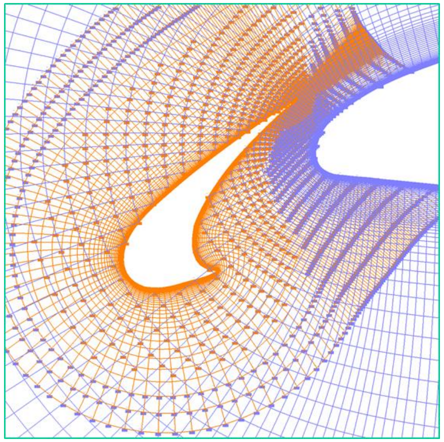
Pegasus 5
(double fringes, extra blanked out)



Pegasus 5
(all fringe points)



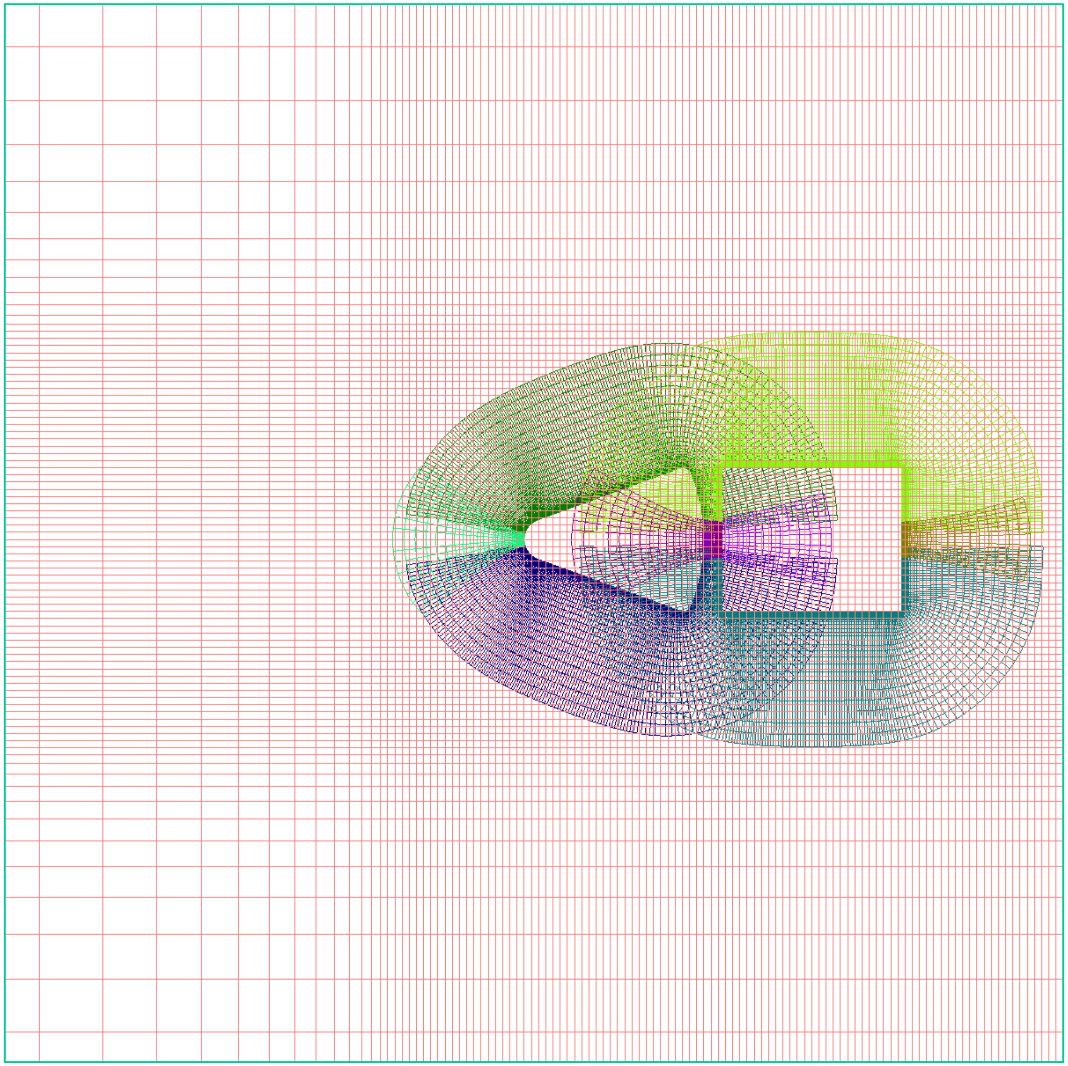
Mixed Peg5/DCF Process



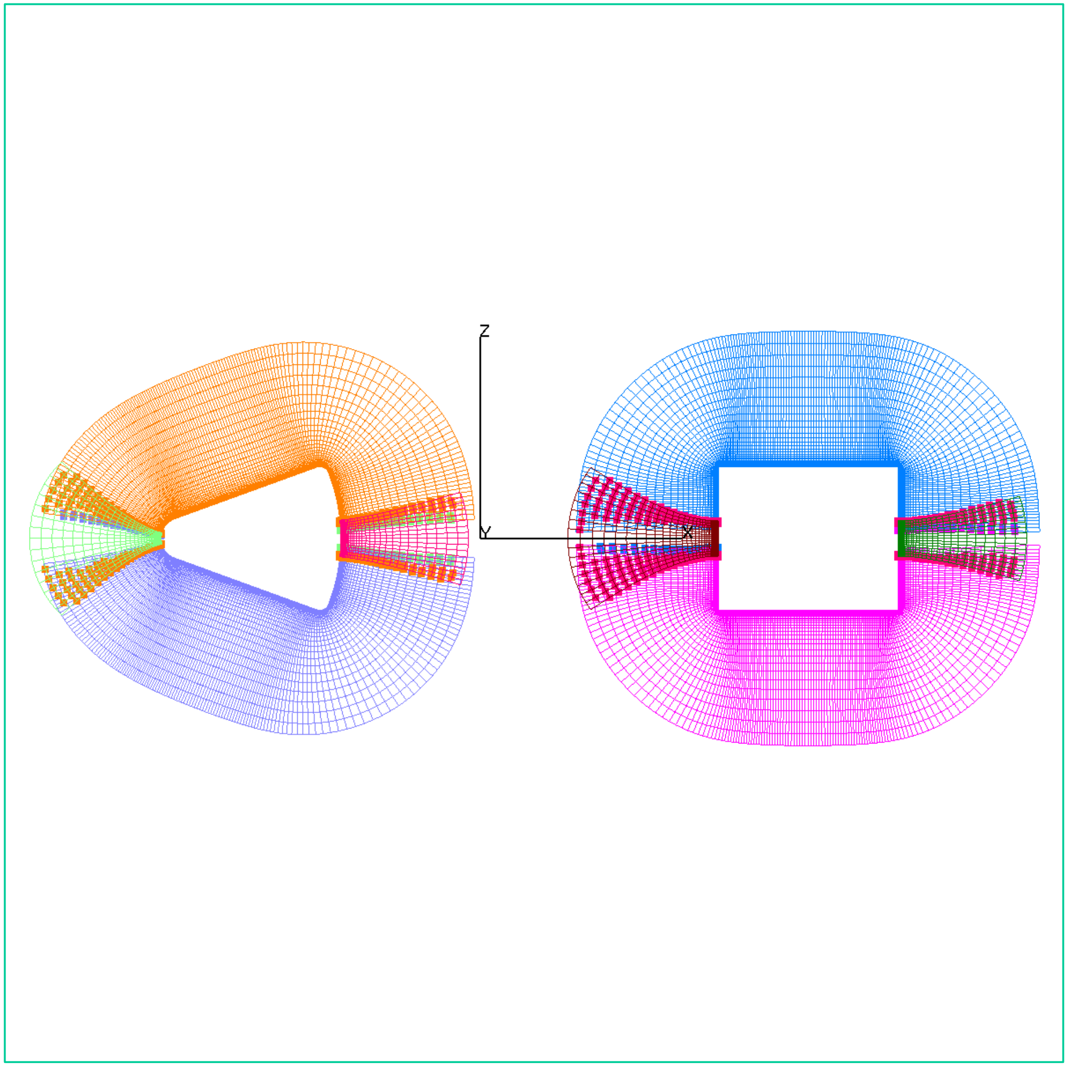
- Assemble overset grids using Peg5
- OVERFLOW uses XINTOUT file:
  - IBLANK maps holes
  - Mark fringe points from list
  - Throw away interpolation stencils!
- OVERFLOW uses DCF X-rays and cutters:
  - Cut any additional holes
  - Find additional fringe points
  - Find interpolation stencils for all fringe points
- OVERFLOW uses Config.xml and Scenario.xml files:
  - These define components (bodies) as collections of grids
  - Initial component transforms to assemble configuration
  - Define prescribed motion or 6-DOF properties for body motion

Example: capsule and upper stage separation

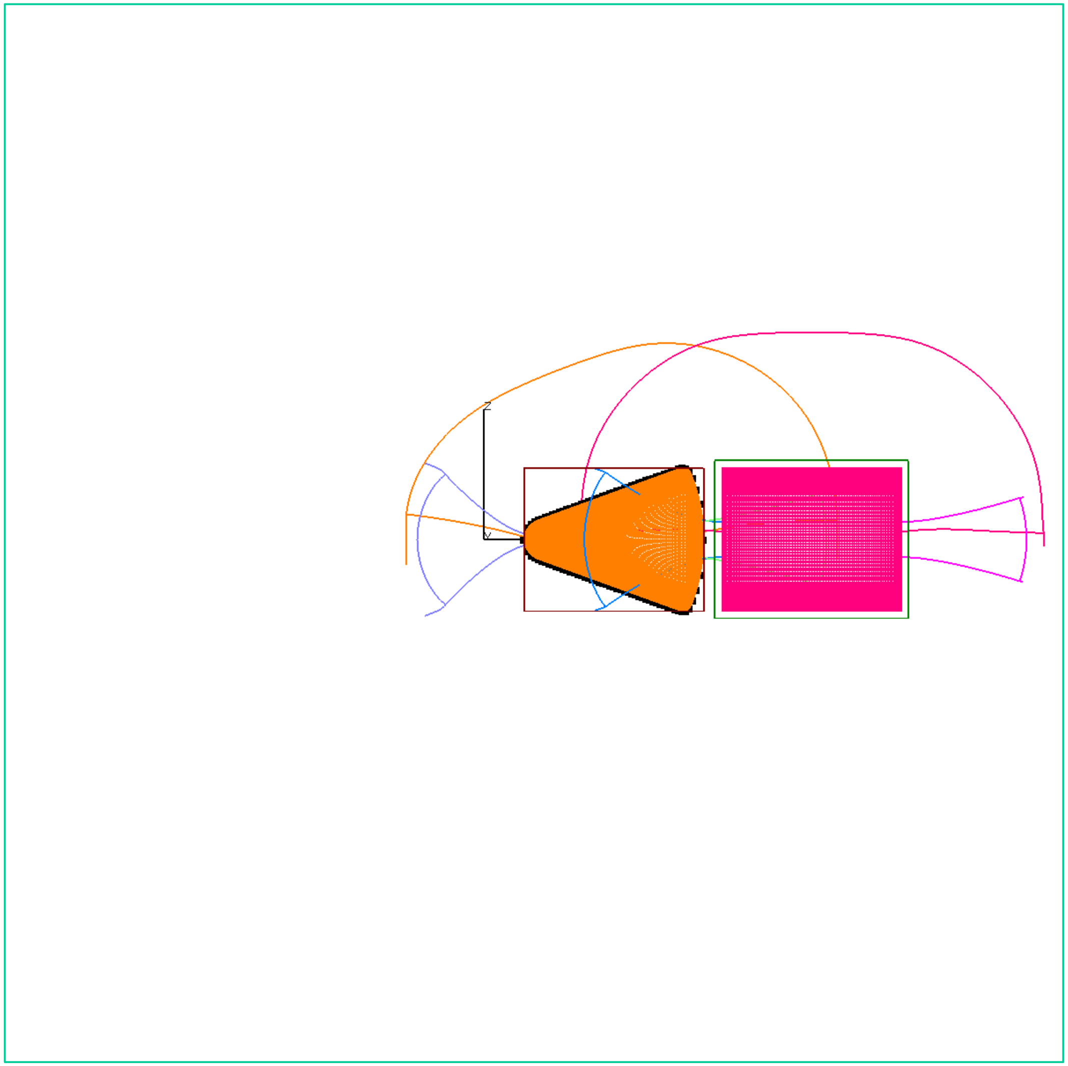
- Full grid system (before running Pegasus 5)



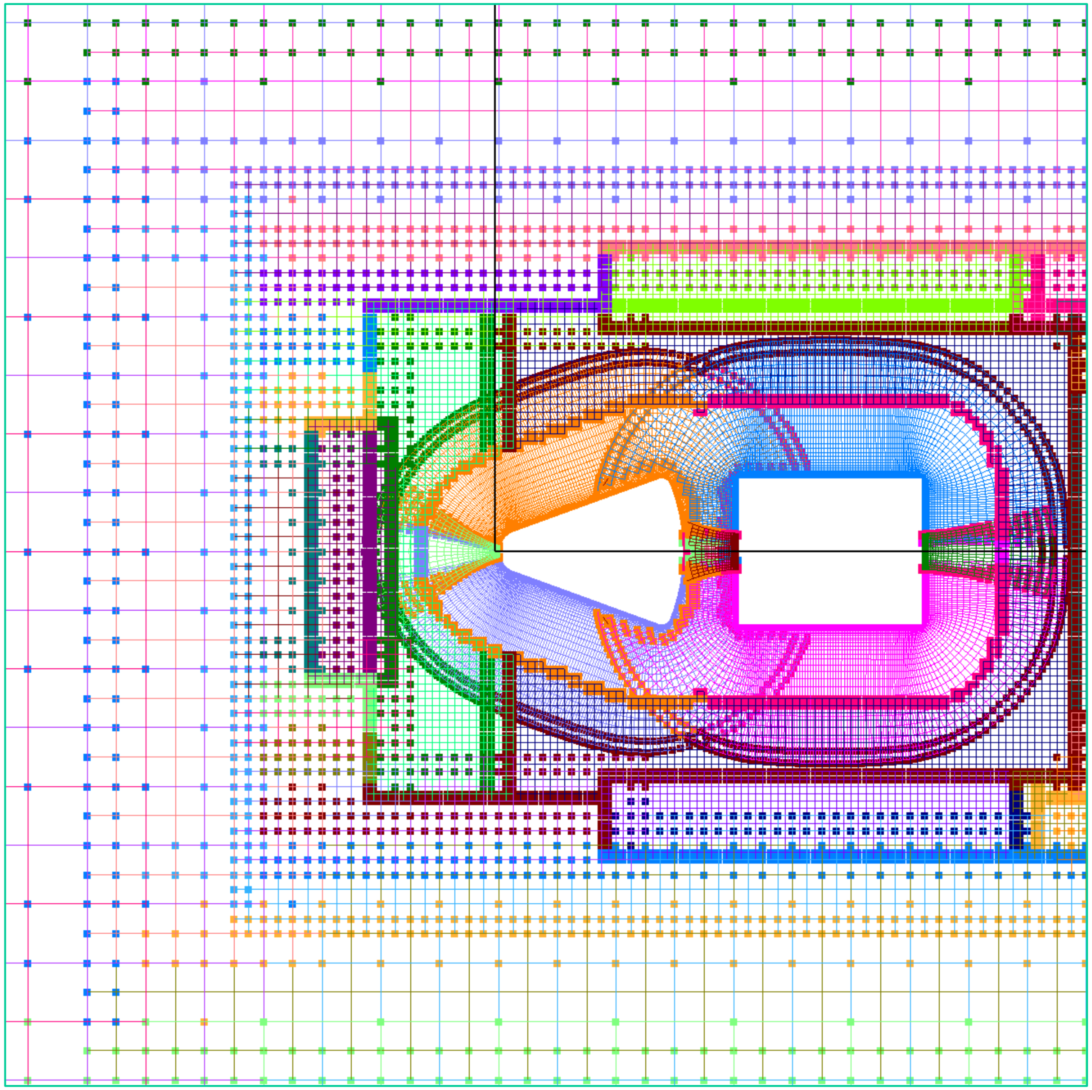
- Throw away background grid and move bodies apart
- Run Pegasus 5 to assemble capsule and upper stage (excluding outer boundaries from fringe point list)



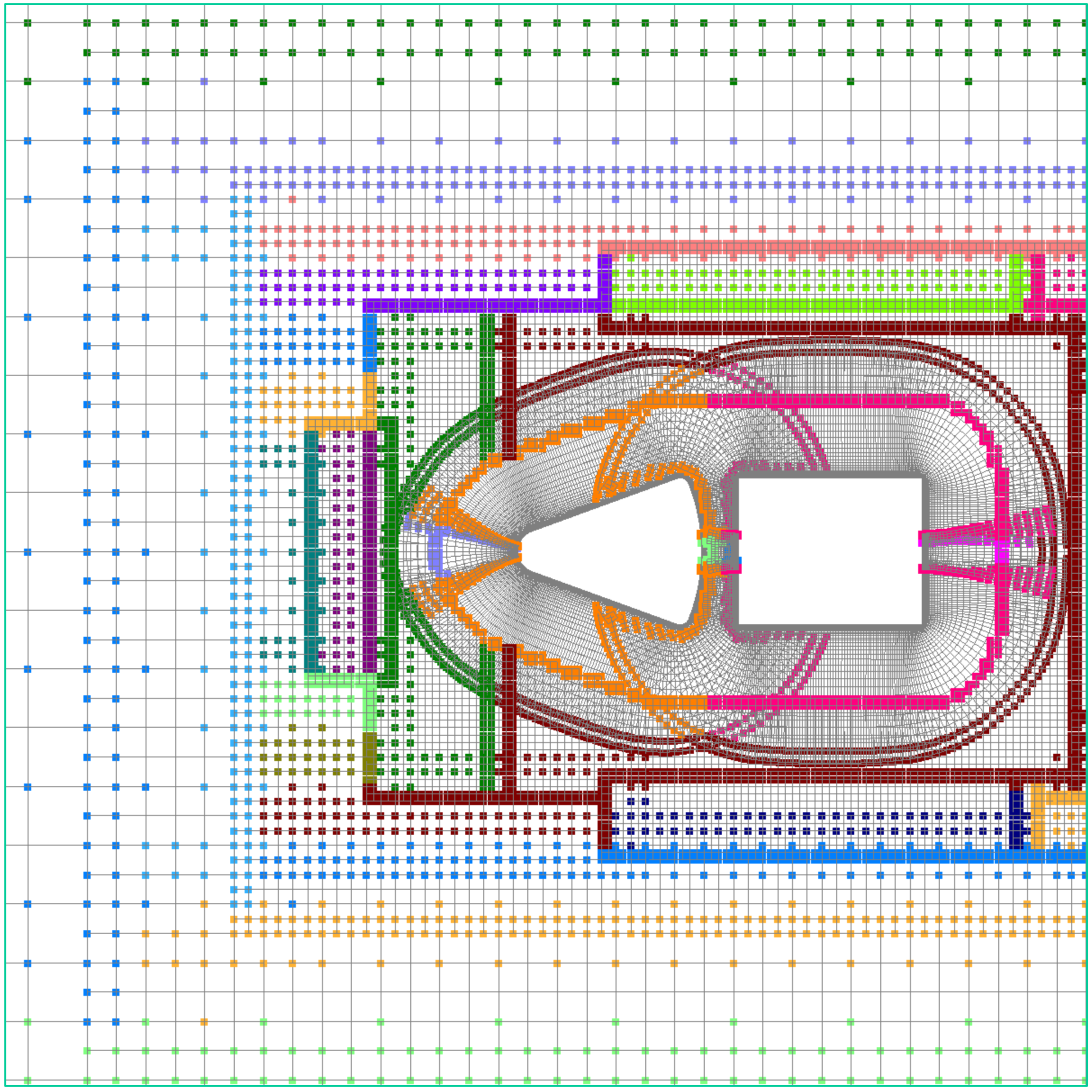
- Generate X-rays for each body, to cut holes in off-body grids and each other



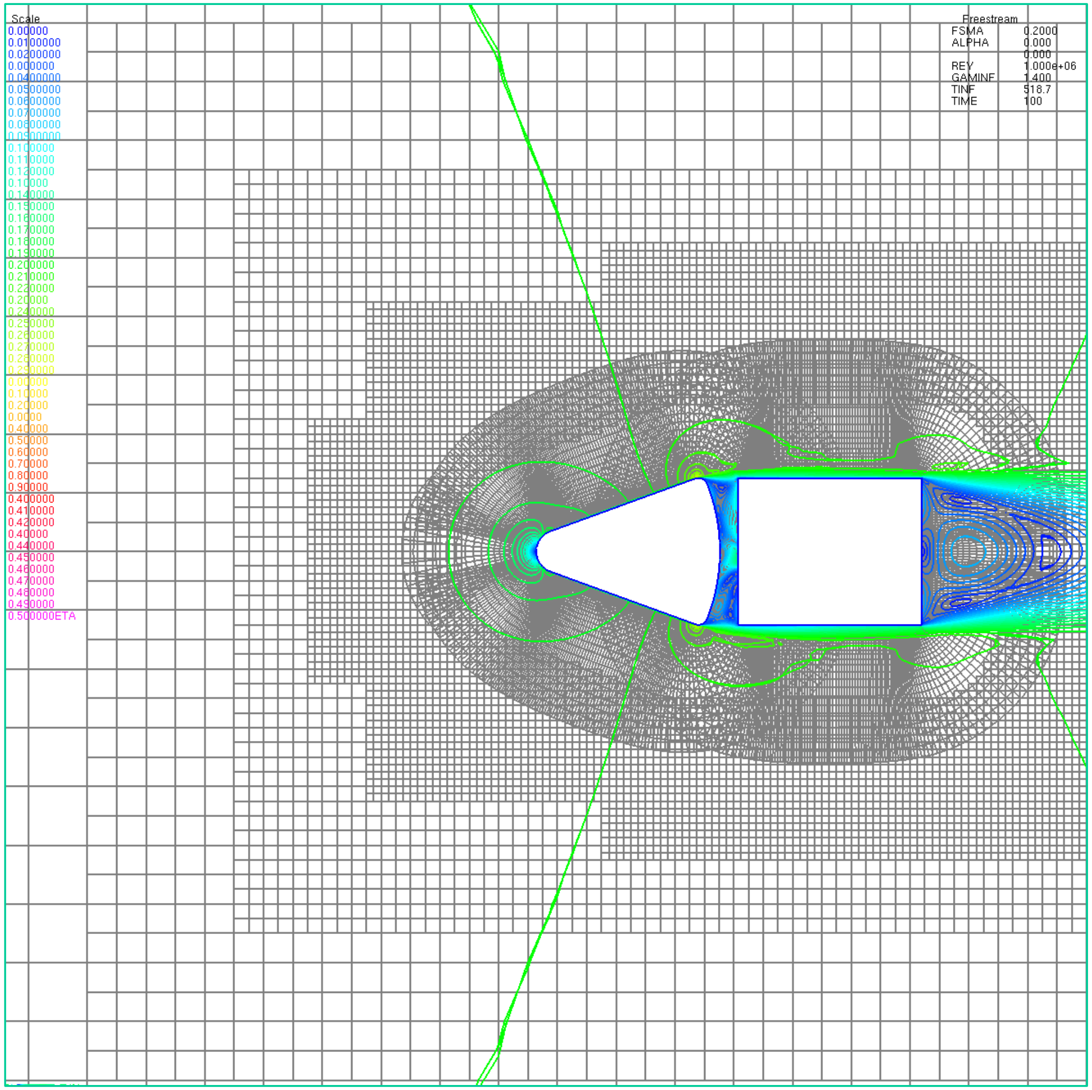
- Use motion control to move bodies to proper initial position, and define body motion



Near-body and off-body dynamic grid connectivity:



Flow simulation during separation:



Moving Body Process (DCF Restart)

- Use Peg5 IBLANK as initial hole cut, then apply x-ray hole cuts
- Existing fringe points with donors from grids that are part of the same body don't change
- Existing fringe points with donors from grids in relative motion find new donors using stencil walk
- Find donors for new fringe points
- Drop old fringe points

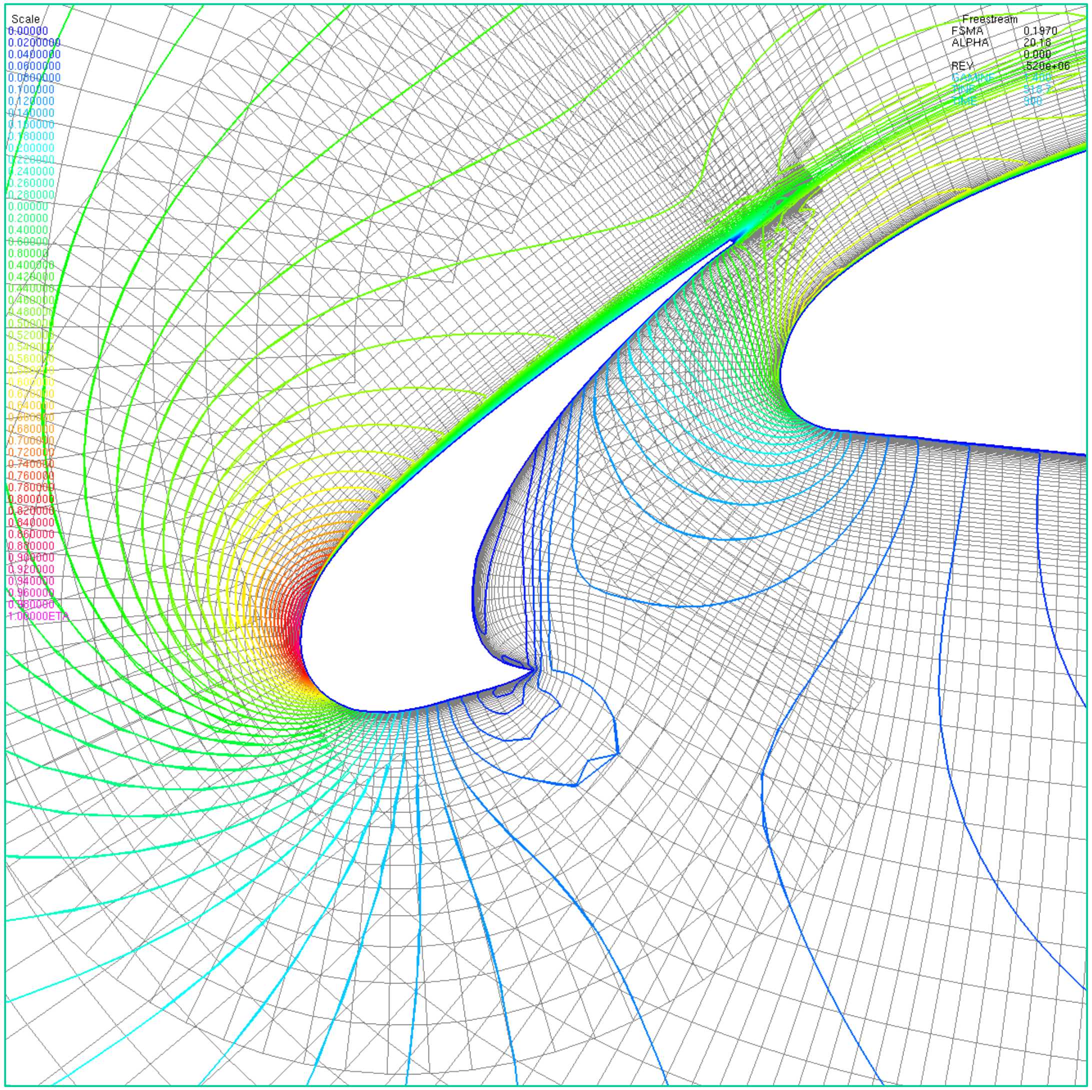
How to Do This in Parallel?

- Grids are distributed among processors for flow solver
- Peg5 IBLANK and fringe point list stays with each grid
- If grid is split (for parallelization), split IBLANK and fringe point list
- For refinement grids, interpolate IBLANK and fringe point list

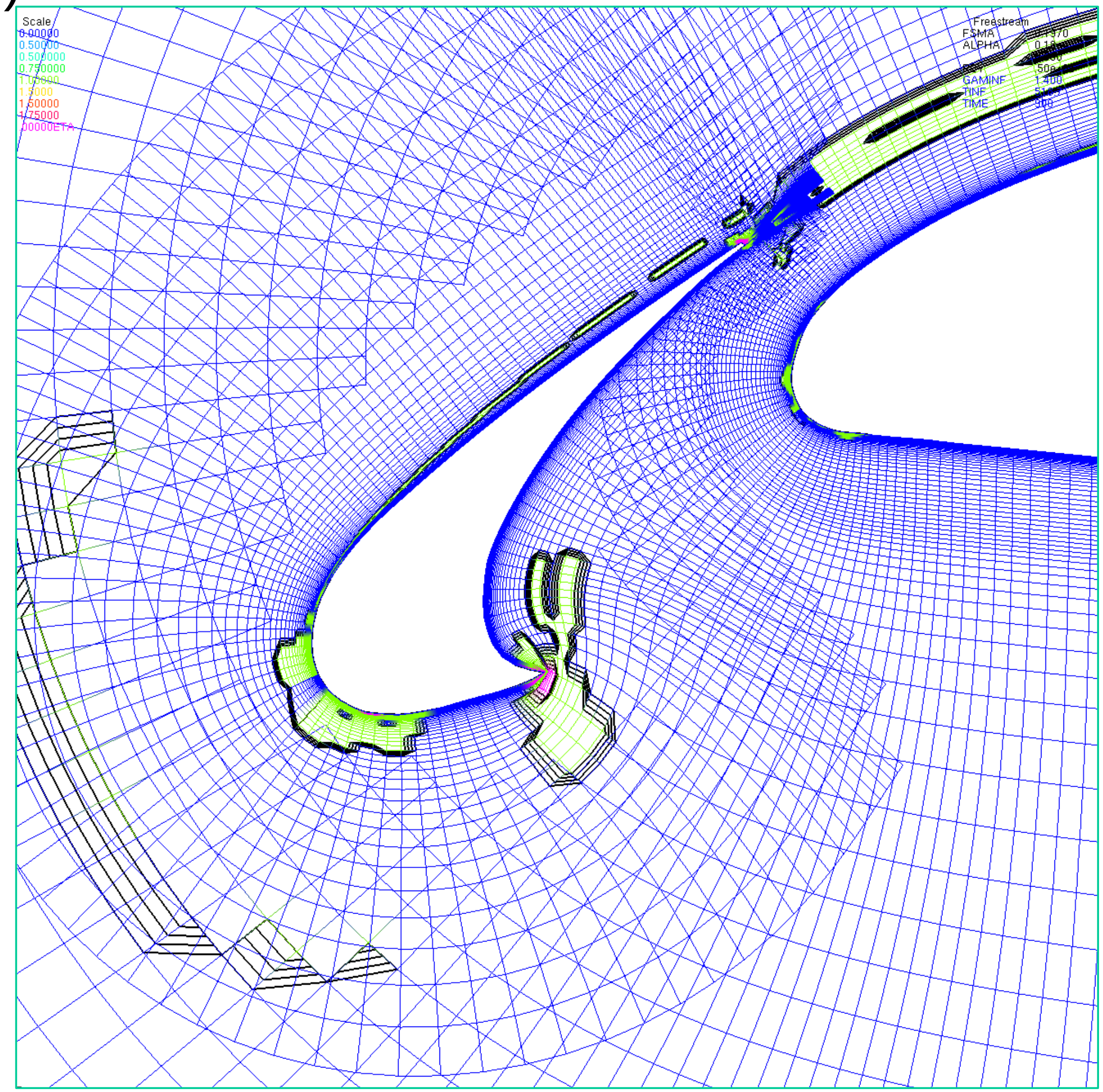
Grid Adaption Process

- Off-body grid adaption is the same as existing DCF process (doesn’t use Peg5 information at all)
- Near-body adaption (refinement):
  - Sensor function is blanked out at holes and Peg5 extended fringe point regions (no need to refine regions that are not used by the flow solver)
  - Peg5 IBLANK is interpolated onto refinement grids to define initial holes
  - Peg5 fringe point list is interpolated onto refinement grids (via IBLANK) to define initial fringe point list

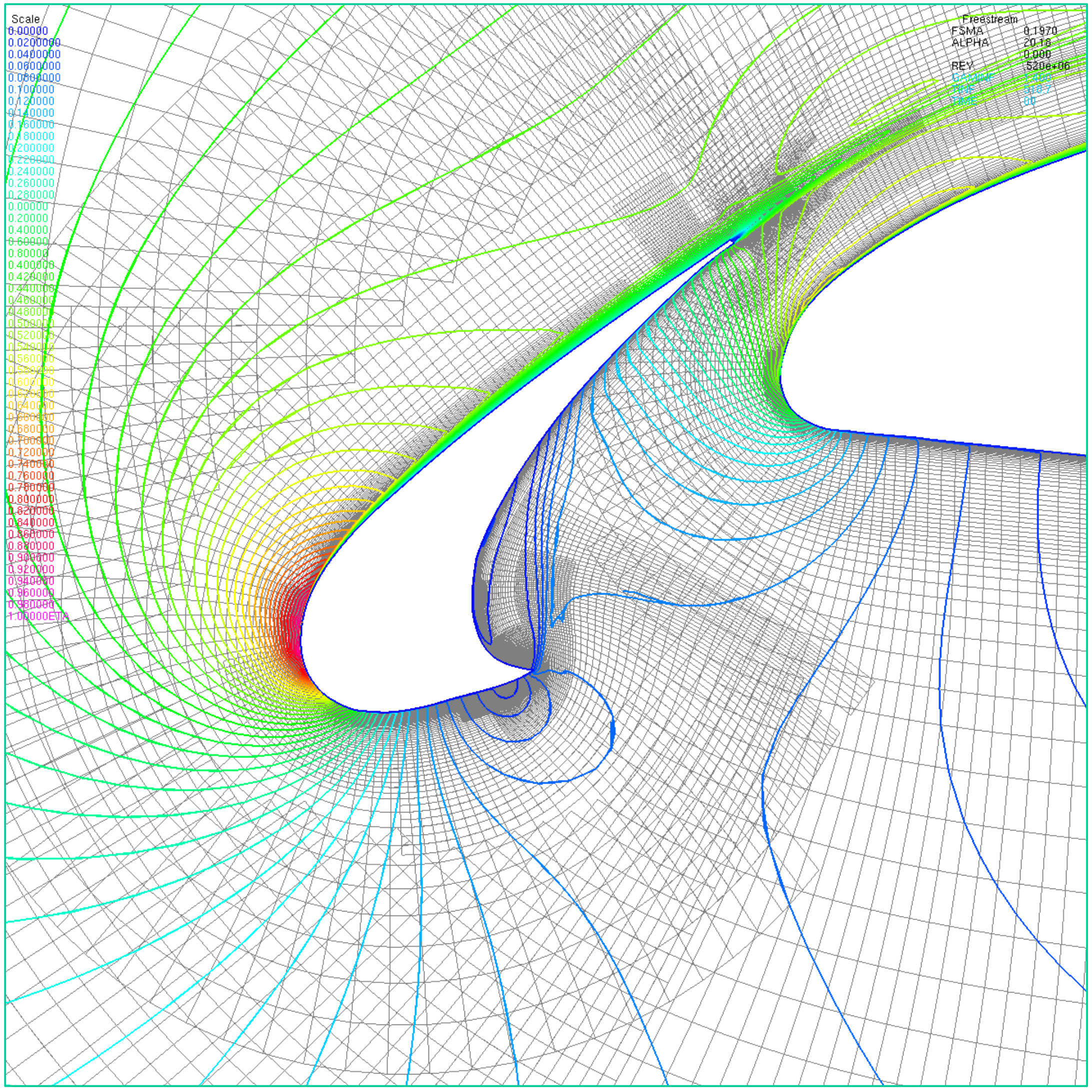
- Multi-element airfoil solution from initial grid system



- Sensor function (2nd undivided difference of conservative flow variables)



- Final solution on grid with two levels of adaption



Issues to be Aware Of

- Viscous wall stencil repair
  - For donor interpolation stencils initially found by Peg5, DCF may find slightly different stencils
  - Controls for projecting surfaces are slightly different
- How to recognize Peg5 orphan points and return them to the fringe point list?
  - Can't find orphan points from XINTOUT file
  - Can find these from grid.in file (as created by **peg_plot** utility)
- Treatment of extra fringe regions
  - These are blanked out in x.save grid output by OVERFLOW (same process as peg_plot)
  - But left as extra fringe points in extracted slices (SPLITM namelist)

Summary

- New mixed Pegasus 5/DCF overset grid assembly capability in OVERFLOW, useful for:
  - Grid adaption on Peg5 grid systems
  - Using DCF for body motion or Cartesian off-body grid generation
  - Using Peg5 to assemble bodies with complex overset grid systems, then using DCF and X-rays for relative body motion

- Looking for more people to test this…