Automated Cart3D Off-Body Pressure Analysis Results

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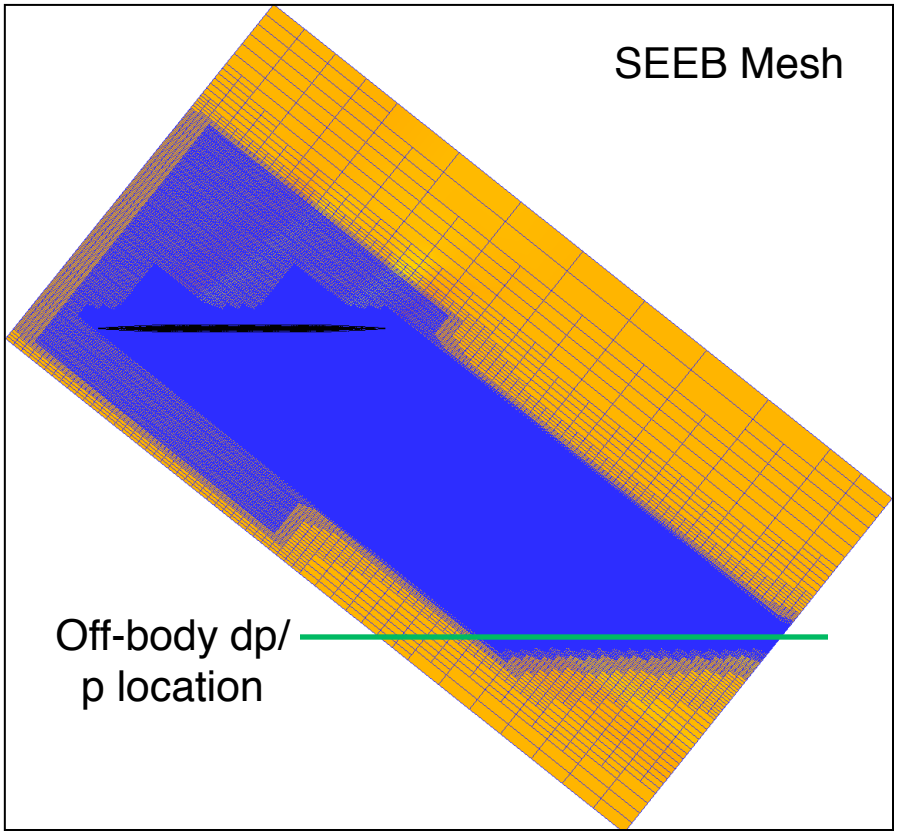
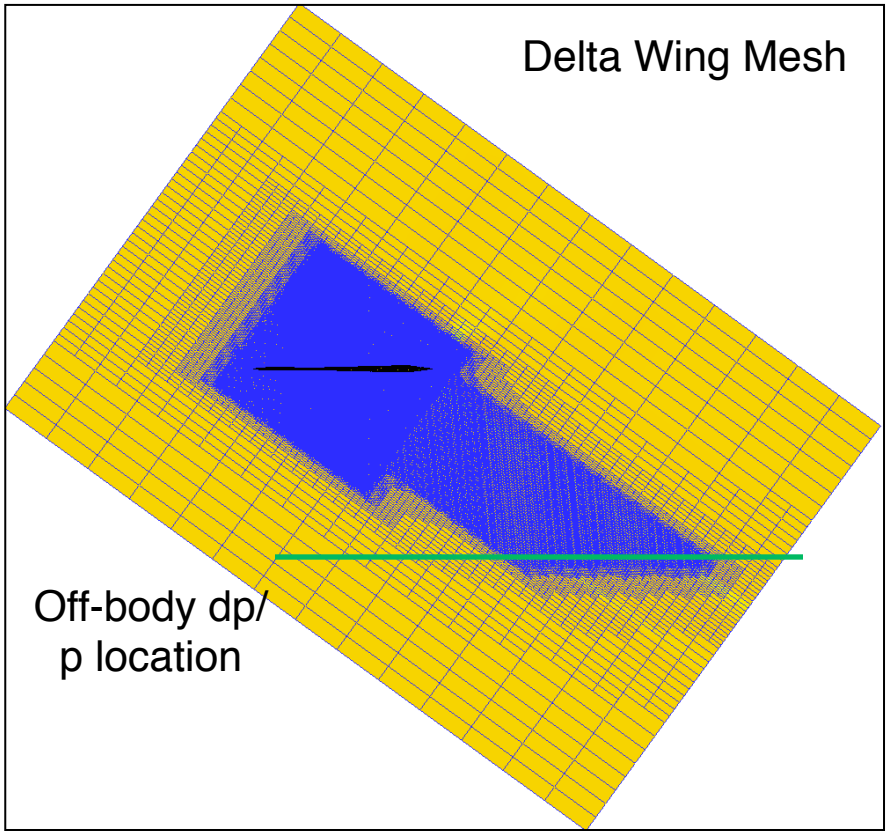
Introduction

- Cases analyzed, flow solver, and computing platform
  - Cart3D inviscid solutions on Linux clusters using shared memory
  - SEEB: Under-track pressure distributions at H = 21.2 and 42.0 inches
  - Delta Wing: All off-body pressure distributions for off-track angle phi = 0, 30, 60, and 90 deg at H = 0.0127, 0.53848, 0.62992, and 0.80772 m
- Automated Cart3D sonic boom analysis process
- Analysis results for SEEB body-of-revolution
- Analysis results for Delta Wing
- Conclusions

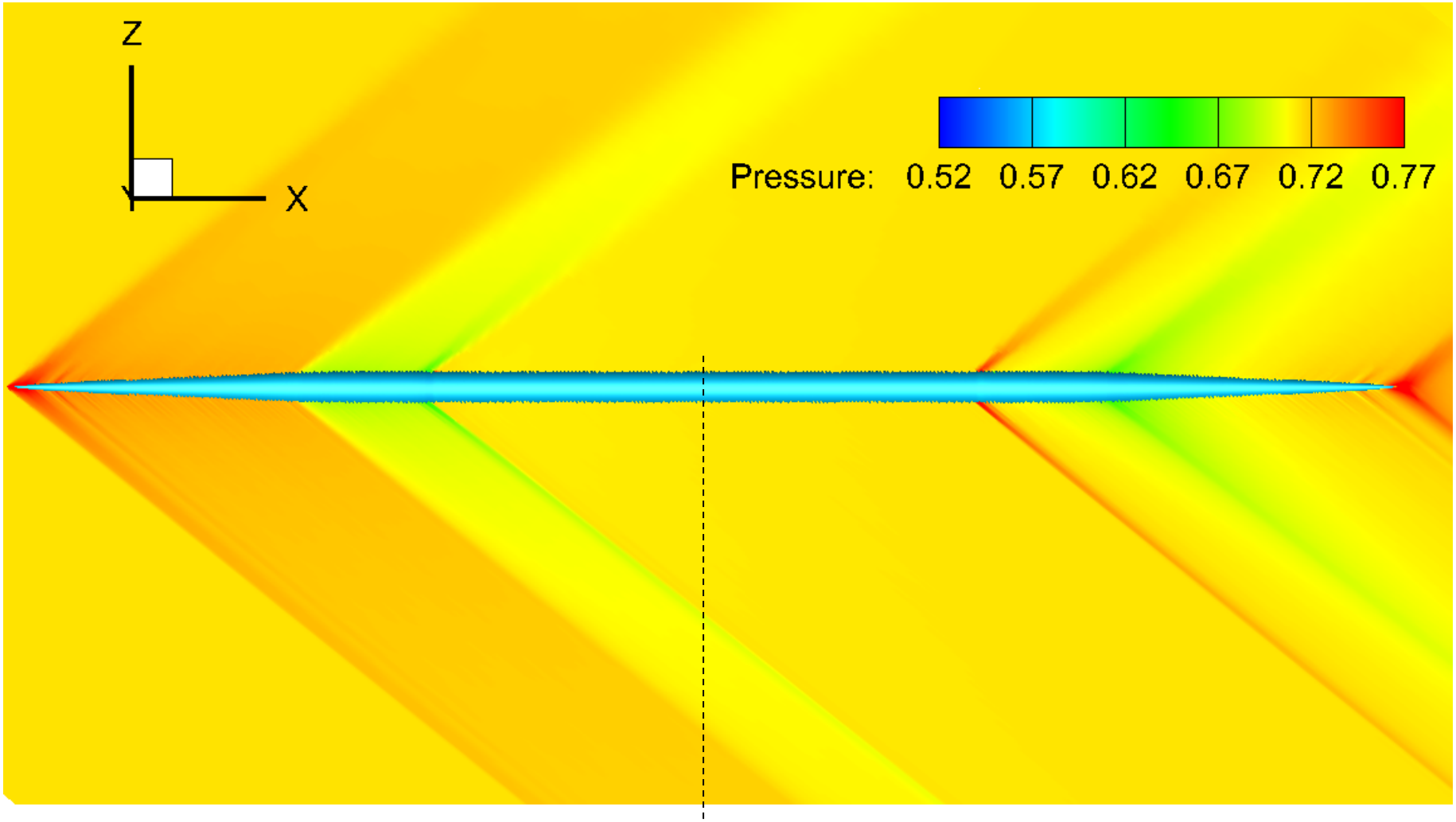
Automated Cart3D Off-Body Analysis Process

- User inputs: Mach, AoA, off-body location, Xverts (*x*-direction grid density), and surface triangulation.
- Trial-and-error process: Adjust Xverts until the volume mesh has the desirable density (20M+ cells for our standard under-track 3BL dp/p analysis).
- Verification: Use the largest Xverts that the computer will generate a volume mesh.





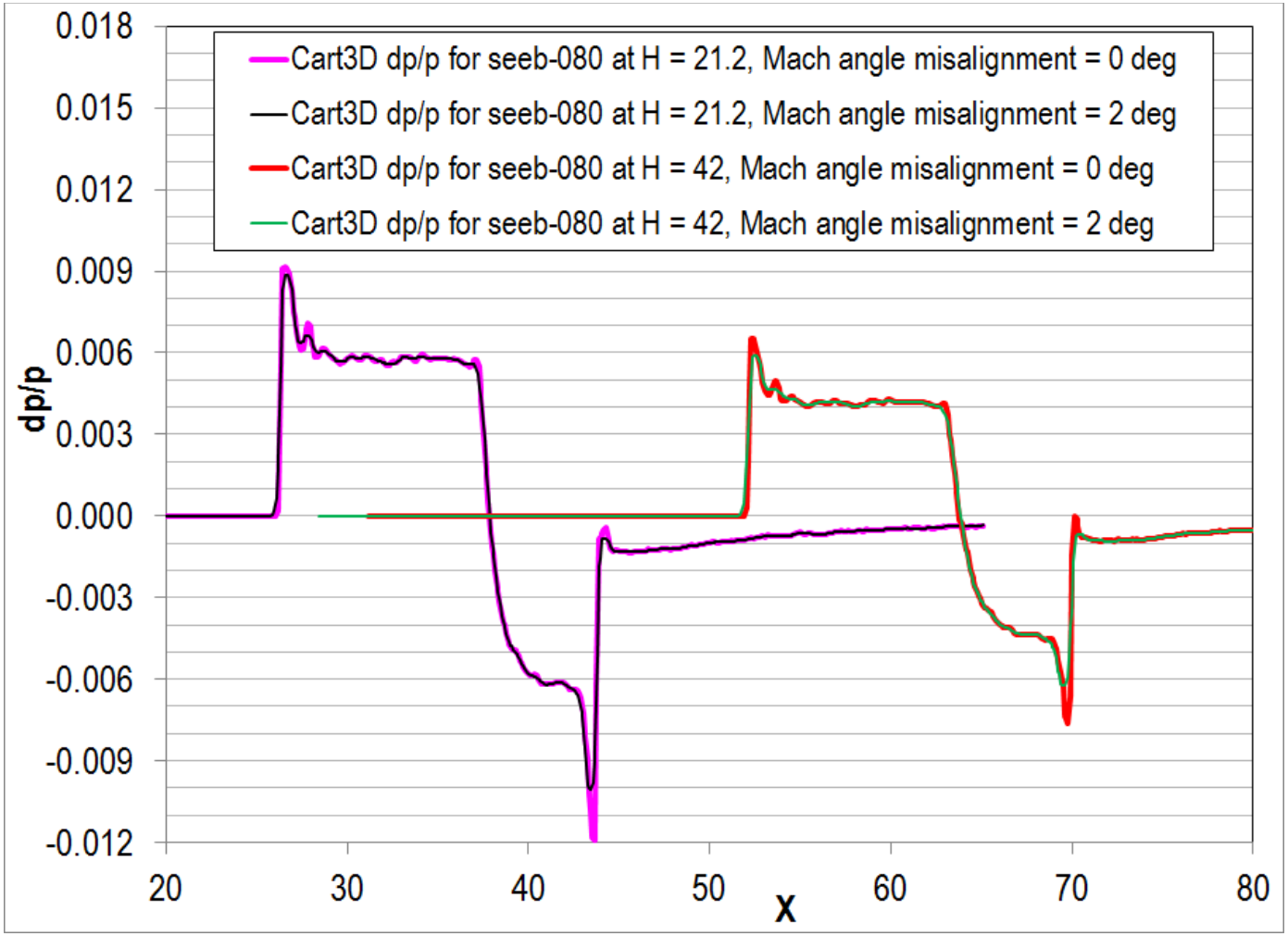
Contour Plot for SEEB-080

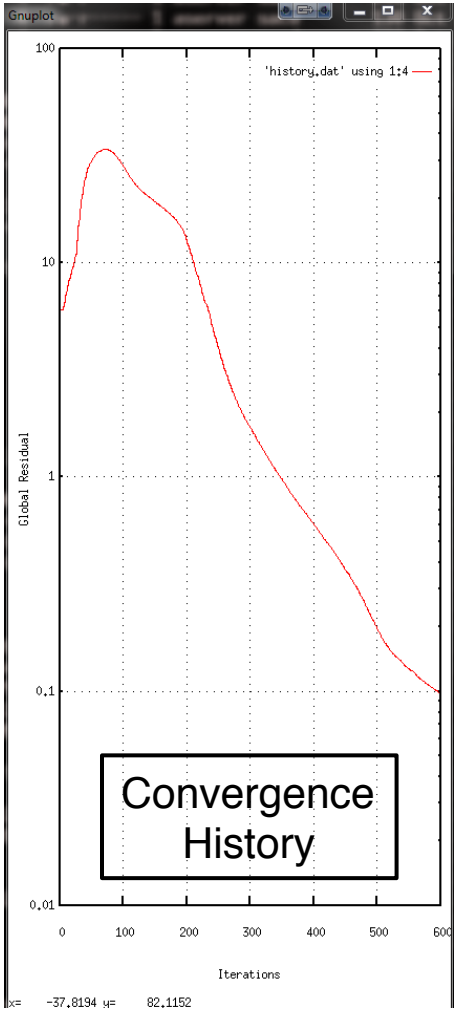


The *yz*-plane for SEEB geometry reflection

Cart3D Analysis of SEEB-080

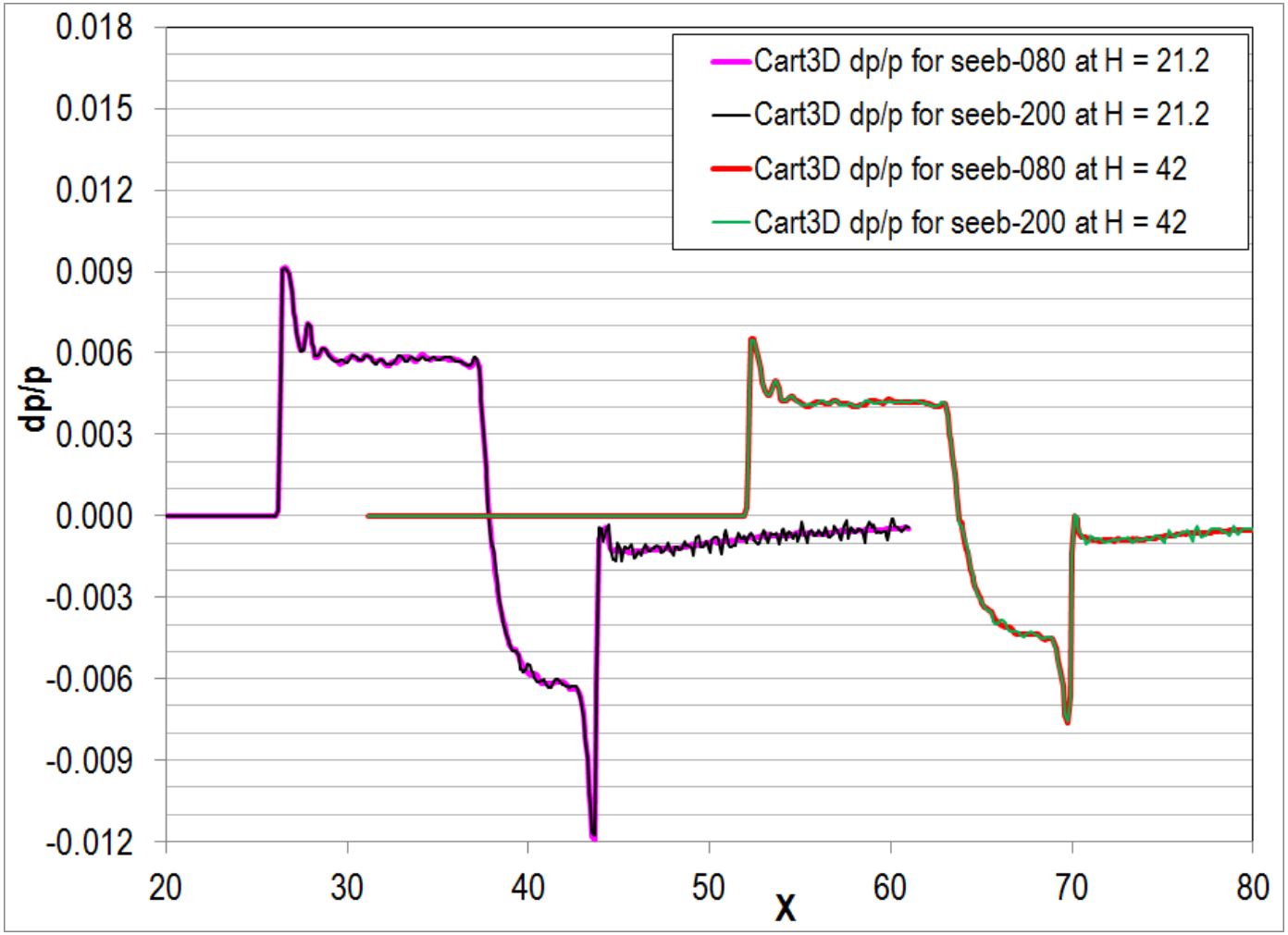
- Mach = 1.6, AoA = 0, mesh size is about 18M cells, global residual < 0.1, 600 iterations.
- Two sets of analysis results for off-body dp/p (d*x* = 0.12): one set uses a grid perfectly aligned with Mach angle and another has a 2 deg off-set between grid line and Mach angle.





Cart3D Comparison of SEEB-080 and SEEB-200

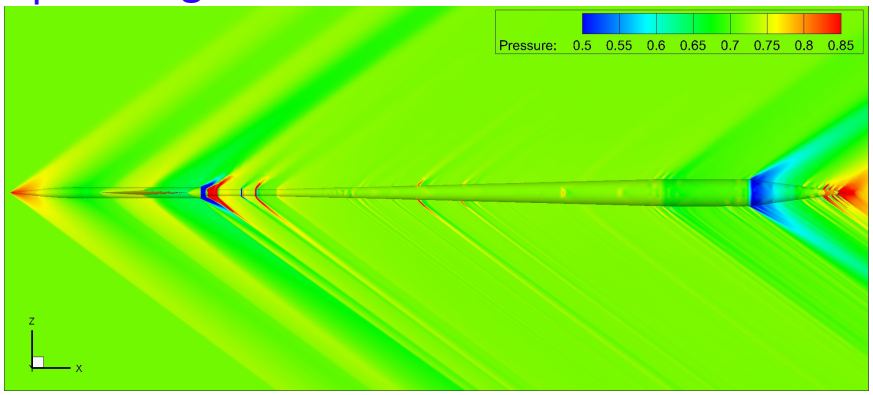
- Mach = 1.6, AoA = 0, mesh size is about 18M cells, global residual < 0.1, 600 iterations.
- Two sets of analysis results for off-body dp/p (d*x*=0.12): one set uses SEEB-080 and another uses SEEB-200.



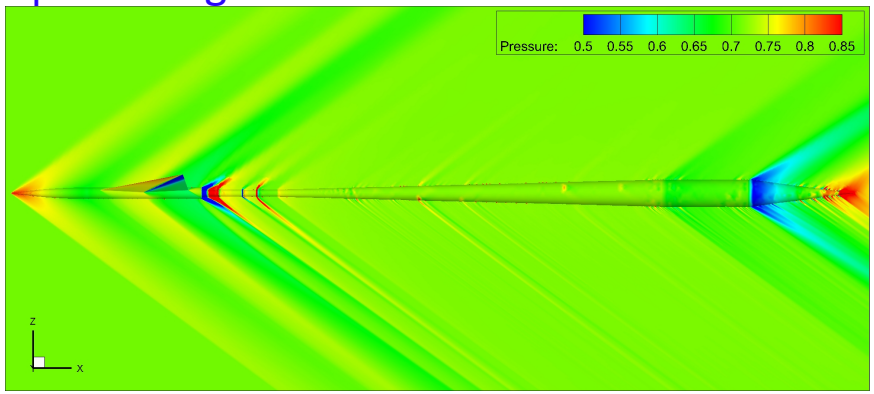
Cart3D Analysis of Delta Wing at Off-Track Locations

- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- For each off-track location, the configuration is rotated by the off-track angle along the *y*-axis to convert the off-track analysis into the under-track one (with a configuration non-symmetric with respect to the *xz*-plane).

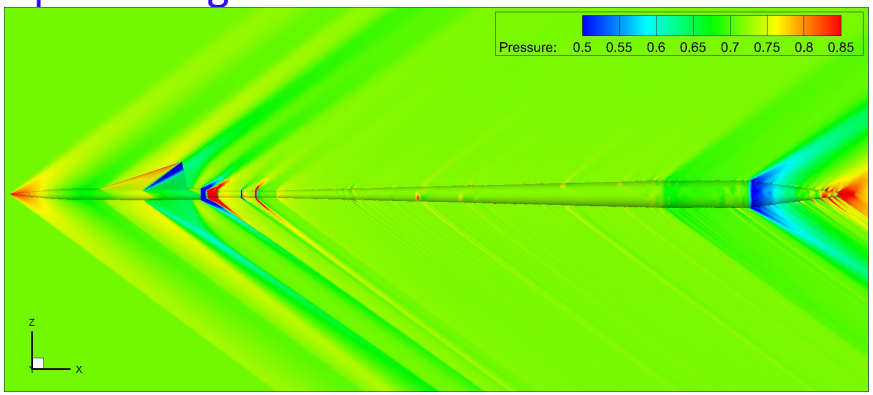
φ = 0 deg



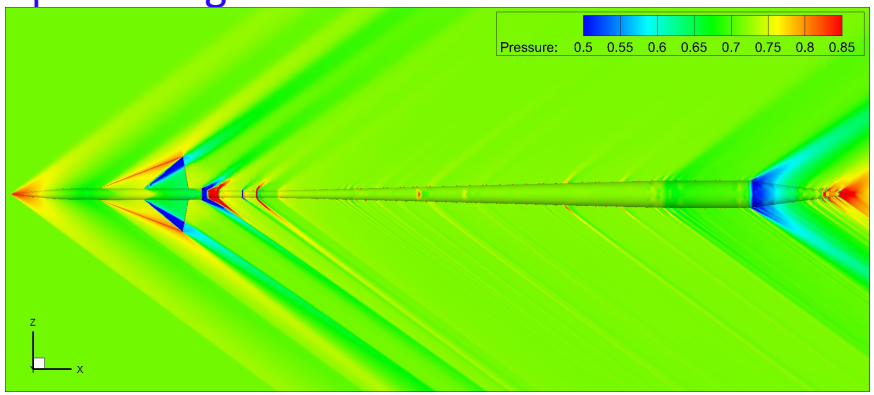
φ = 30 deg



φ = 60 deg

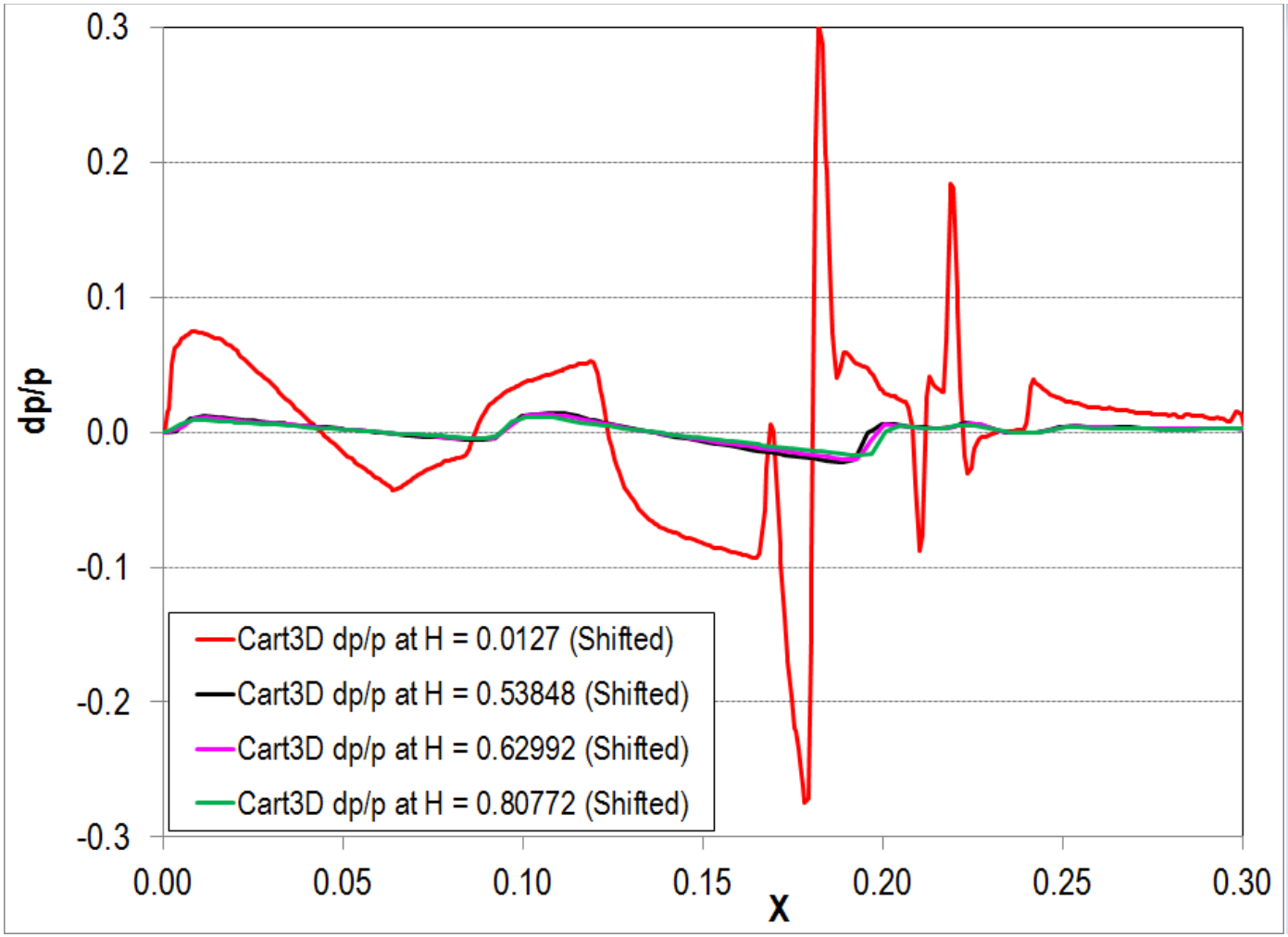


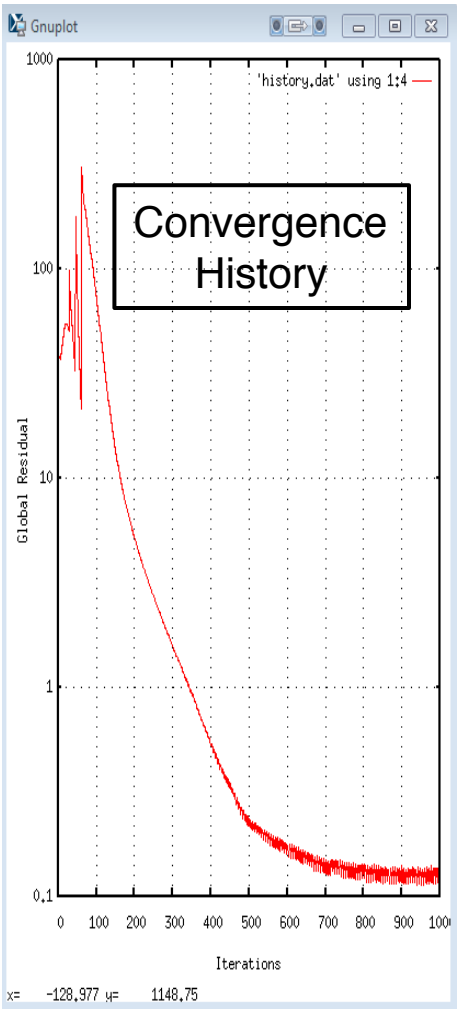
φ = 90 deg



Cart3D Under-Track Analysis Results for Delta Wing

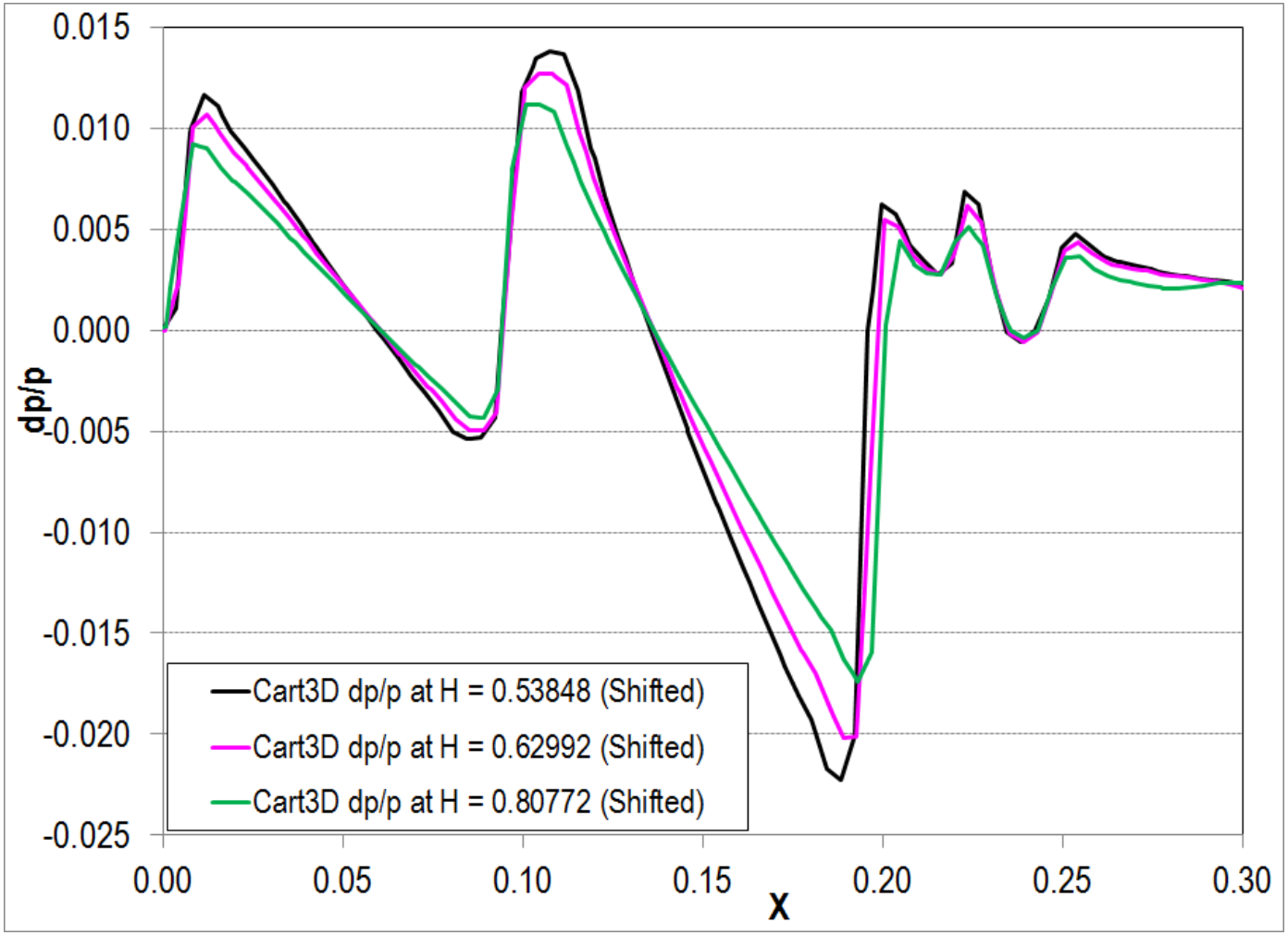
- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- Global residual < 0.2, 1000 iterations.





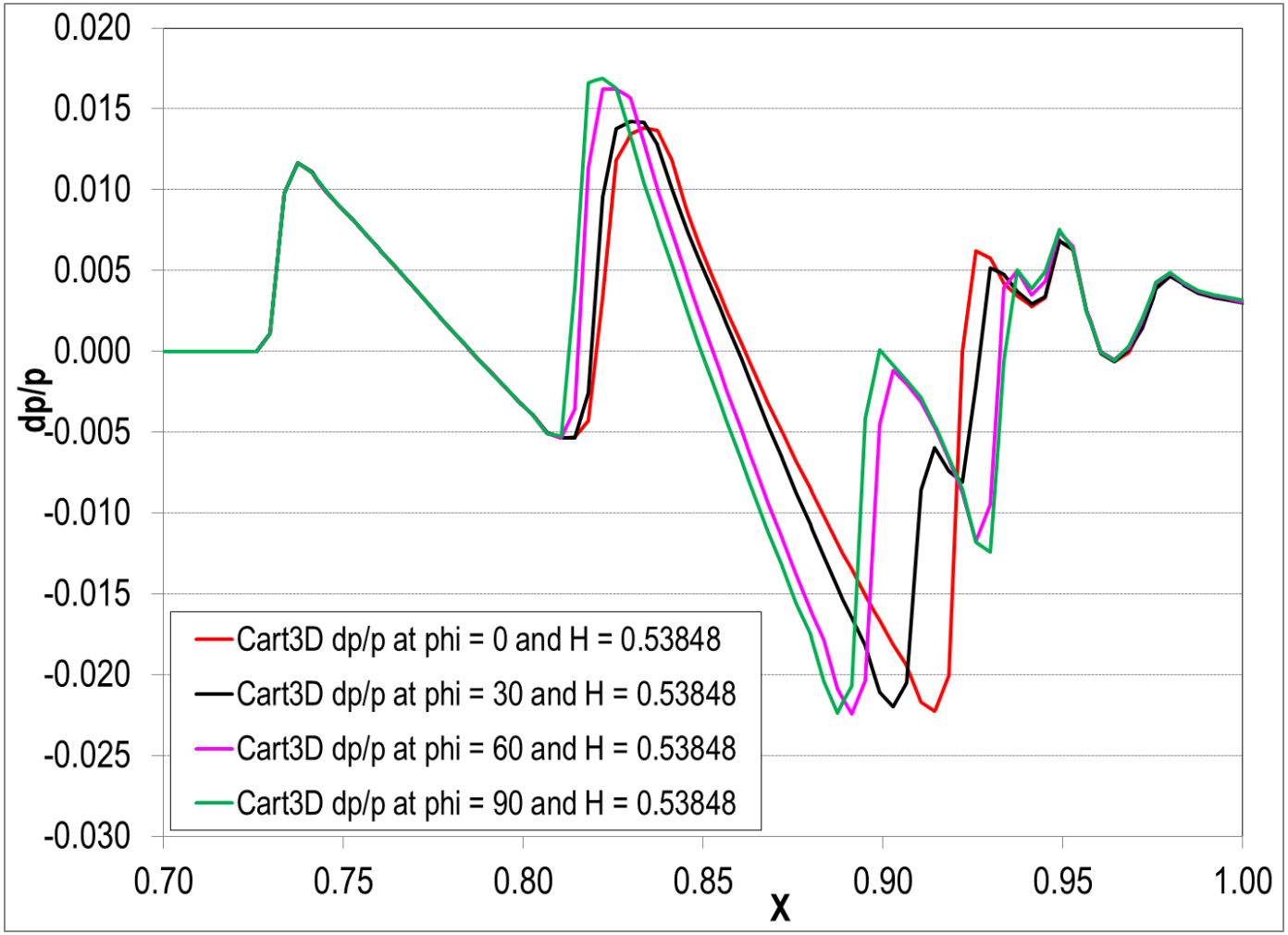
Cart3D Under-Track Analysis Results for Delta Wing (II)

- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- Global residual < 0.2, 1000 iterations.
- The average spacing between dp/p points = 0.003.



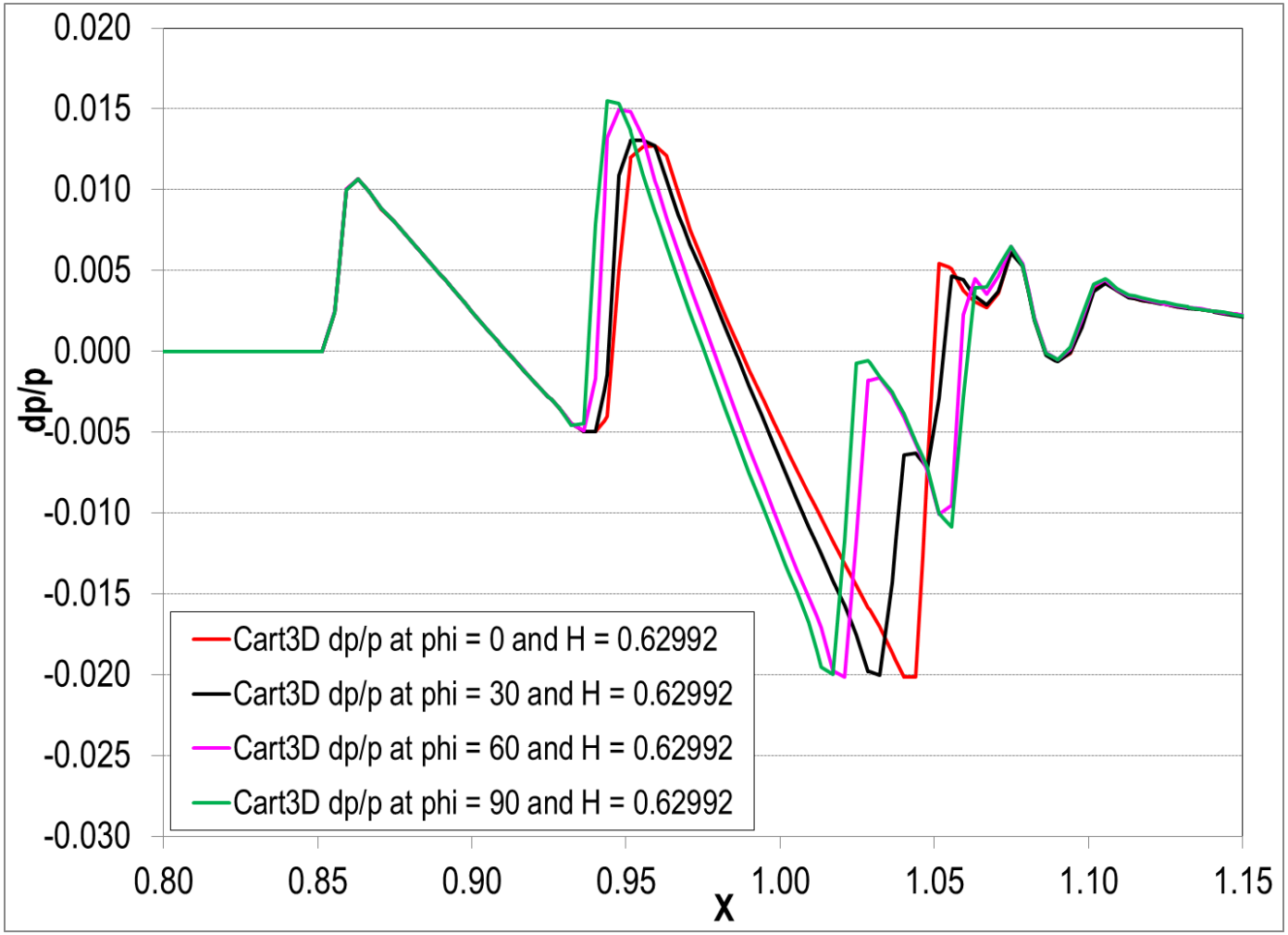
Comparison of Cart3D dp/p at H = 0.53848 for Delta Wing

- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- Global residual < 0.2, 1000 iterations.



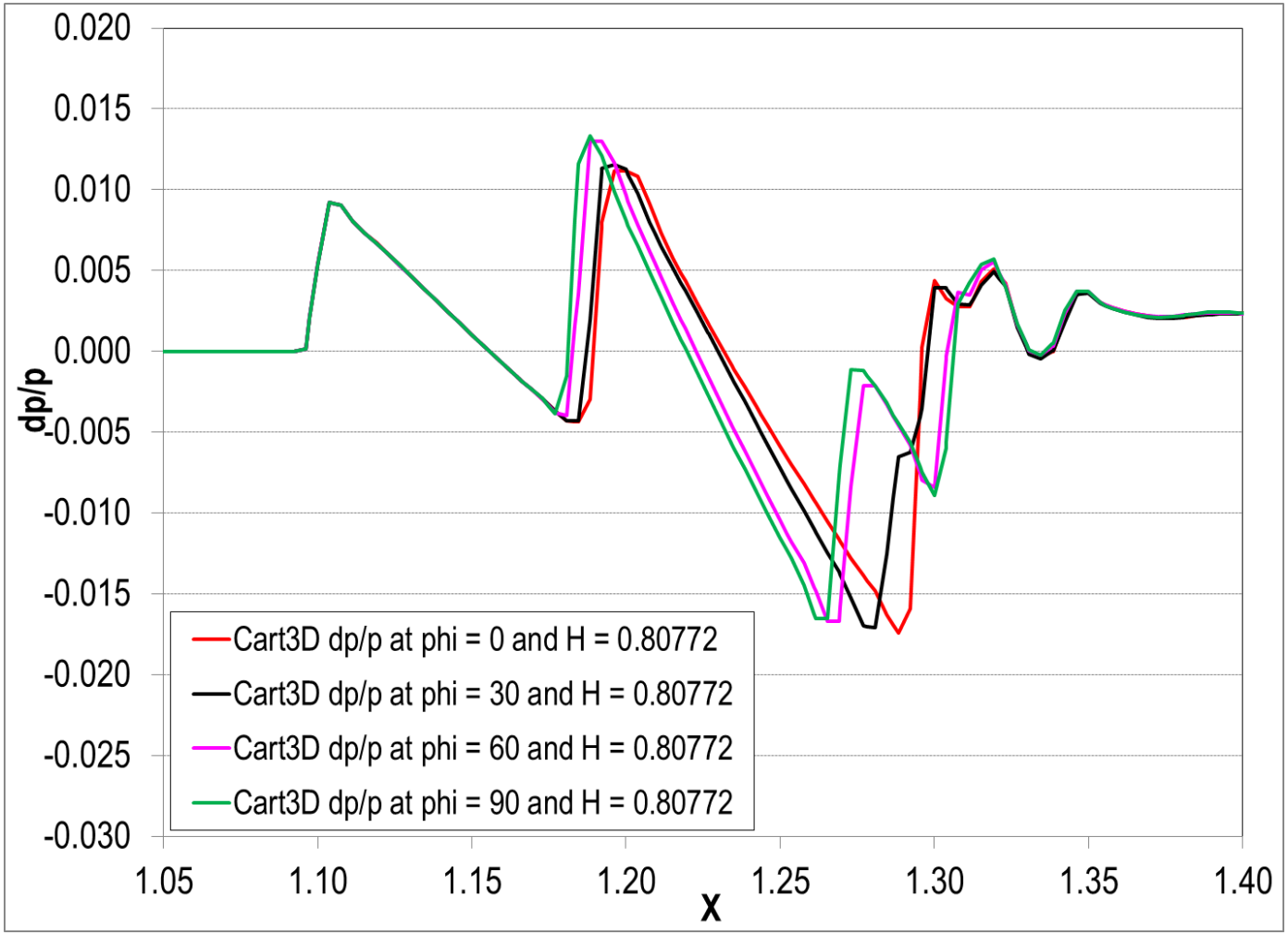
Comparison of Cart3D dp/p at H = 0.62992 for Delta Wing

- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- Global residual < 0.2, 1000 iterations.



Comparison of Cart3D dp/p at H = 0.80772 for Delta Wing

- Mach = 1.7, AoA = 0, mesh size is about 26M for under-track and 54M cells for off-track.
- Global residual < 0.2, 1000 iterations.



Conclusions

- The most time-consuming aspect of the automated Cart3D off-track dp/p analysis is to use a trial-and-error approach for generating a mesh of desirable quality by using one control parameter (x-direction mesh density).
- The current automated Cart3D analysis process for off-body dp/p is very robust and extremely easy to use for analysis of both in-house and external geometry models.
- Knowledge capturing and reduction of manual steps are very important in any engineering analysis process (including CFD analysis) at production level.

Questions?