HPCMP CREATE™-Genesis CFD

DOD HPC MODERNIZATION PROGRAM

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Overview

1. Genesis CFD
2. Sample Curriculum
3. Examples
   - Supersonic Airfoil
   - Transonic Wing

Genesis-CFD Components/Capabilities

- Single Mesh Unstructured Solver
  - Euler/Laminar/RANS/DES
  - Ideal Gas
  - Limited cores per job (128-256)
- Motion
  - Prescribed (including arbitrary)
  - 6-DOF without constraints
- Structures
  - Modal solver
- Plugins useable, but without SDK to develop

- Propulsion
  - 0-D Linear engine model for BC's
  - Rotating reference frame
  - Sliding interfaces
- Visualization features
  - Full Volume write to Tecplot, FieldView, Ensight
  - Extracts for FieldViewXDB, Silo, Tecplot, VTK
  - In-Situ using VisIt

Sample Curriculum

- Core courses
  - Fluids I (Incompressible)
  - Fluids II (Compressible)
  - Experimental Methods / Labs
- Electives
  - Applied CFD
  - Propulsion

Sample Curriculum - Fluids

- Lectures – Use canned CFD solutions for illustration (cylinder, sphere, airfoil), examples
  - Langrangian derivative terms on a cylinder, e.g. $v\frac{\partial u}{\partial y}$
  - Fluid "particle" deformation types (e.g. angular/linear deformation, rotation, strain, volume dilitation).
  - Gradients (e.g. pressure)
  - Steady vs. Unsteady
  - Streamlines, Streaklines, Pathlines

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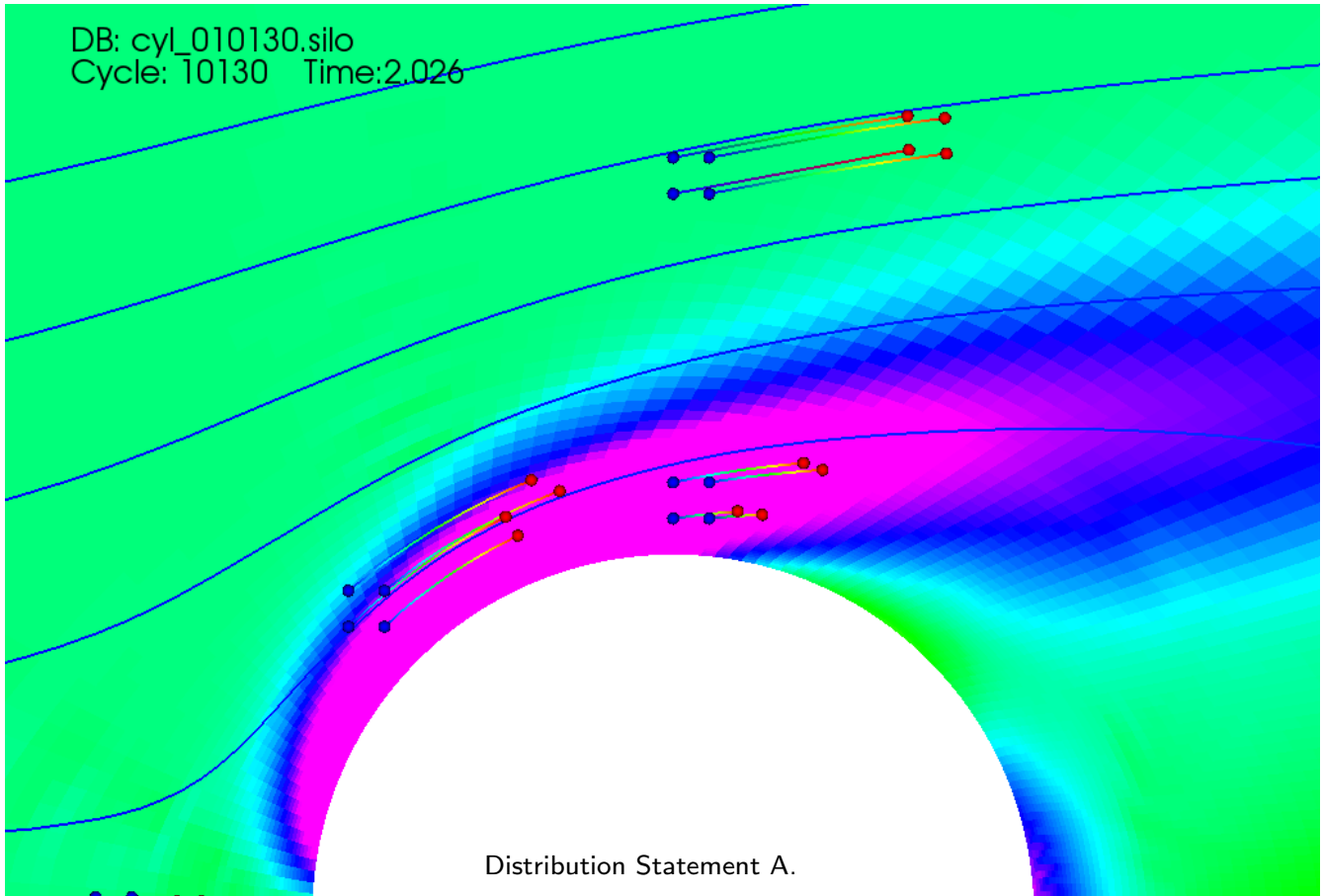

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  - Gradients (e.g. pressure)
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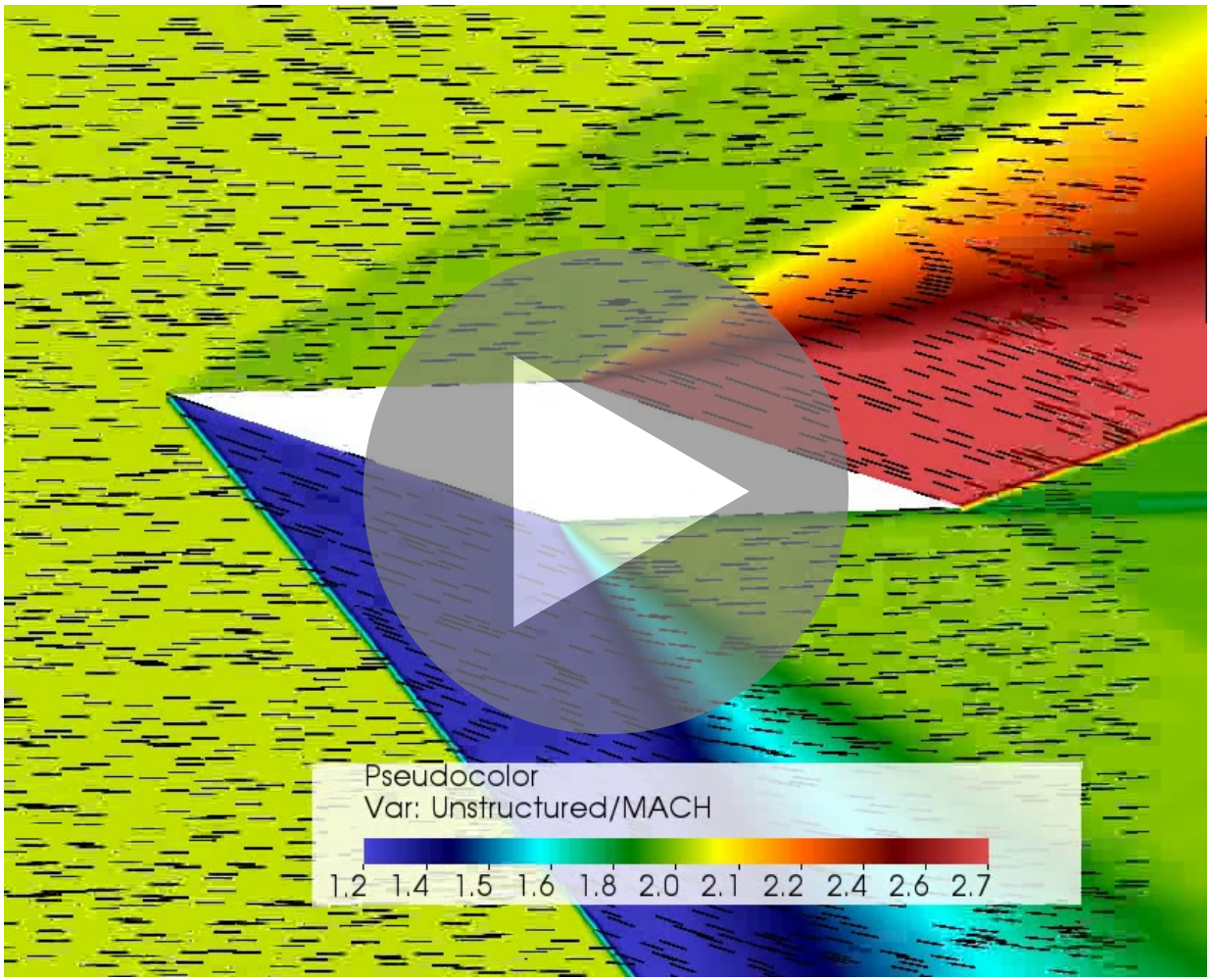
- Basics of CFD (1-2 lectures)
  - Show simple model problem (1-D linear convection, burgers eqn)
  - Finite difference derivation from Taylor series. Order of accuracy
  - Explicit vs. implicit
  - When to use CFD vs. potential based methods
- CFD project (sphere at various Re)
  - Simple geometry or provide meshes
  - Grid and/or timestep refinement
  - Comparison to experimental data

Sample Curriculum - Other

- Experiment/Lab course
  - Subset of students provide CFD support
  - Possible uses of CFD:
    - Analyze wind tunnel wall effects
    - Visualize the flow being measured
    - Test validity of CFD
- Propulsion
  - Single Stage Analysis using rotating reference frame and sliding interfaces
  - Inlet losses using Engine boundary condition
- Design
  - CFD of final designs using DaVinci
  - Verify performance
  - More advanced - look at dynamic stability derivatives

Examples - Diamond Airfoil

- Description:
  - Fluids II
  - Student project or as a lecture aid
  - Slow oscillating pitch motion to show effect of α
- Time:
  - Meshing: 15 minutes
  - Job Setup: 10 minutes
  - Post-processing: 30 minutes



Mach over Diamond Airfoil at Mach=2.0, $\alpha = \pm 10$ deg

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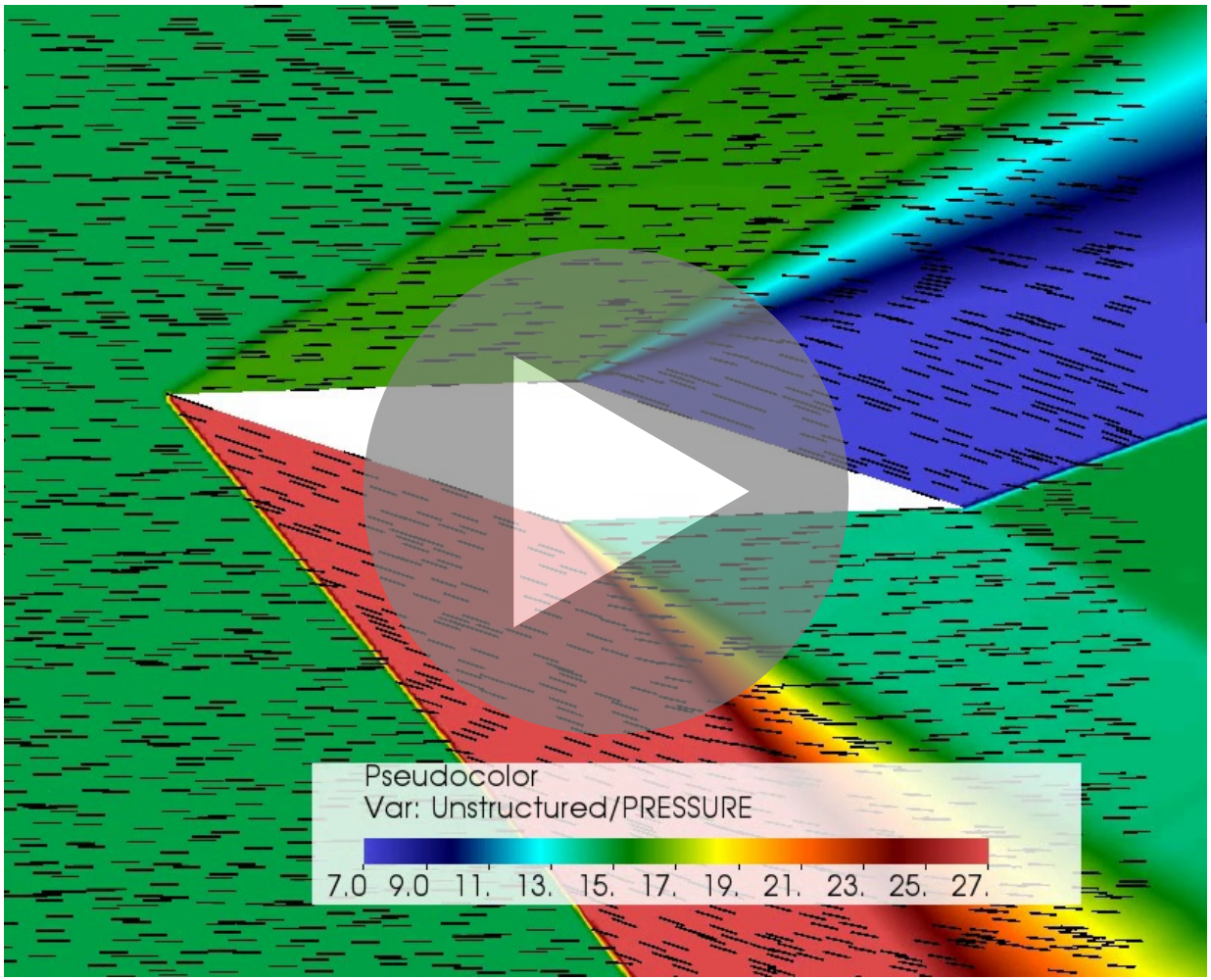
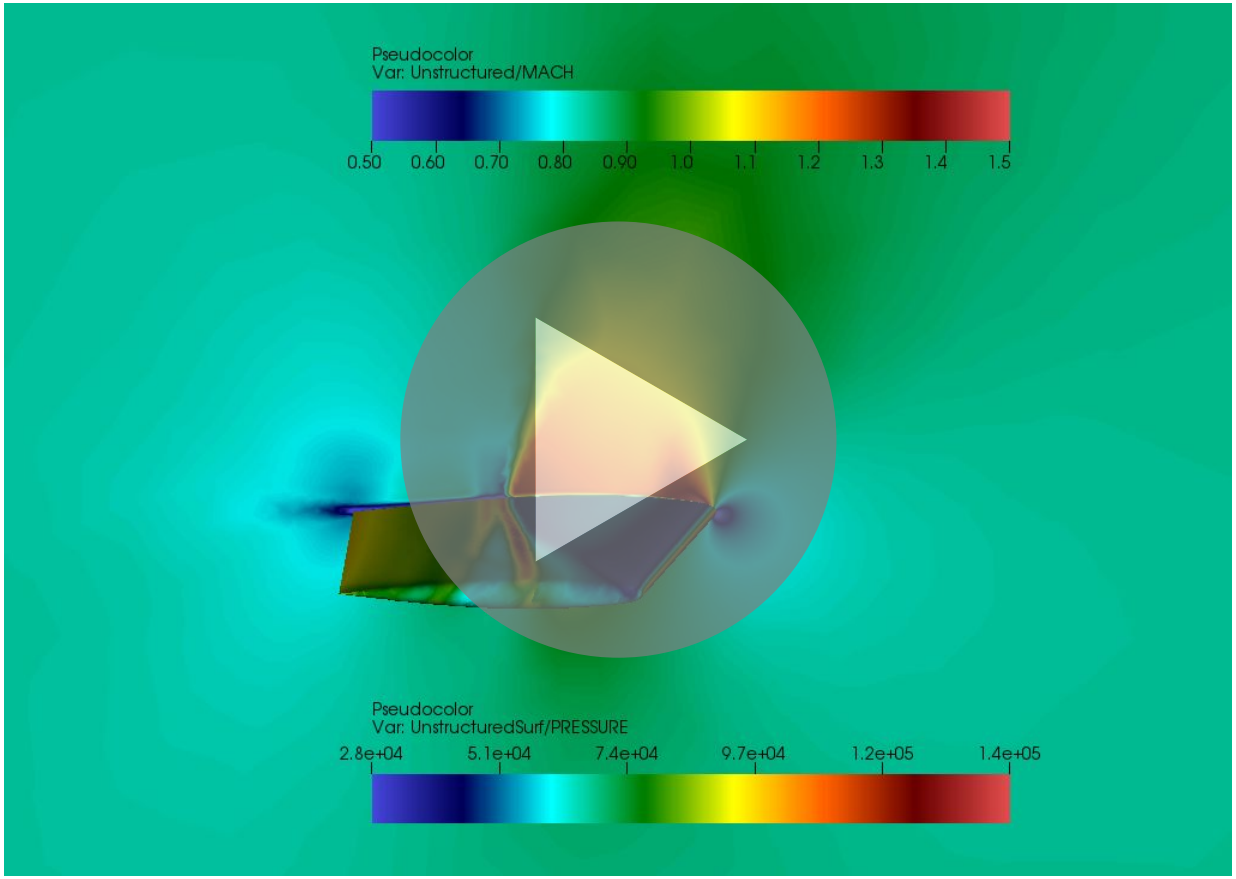


Pressure over Diamond Airfoil at Mach=2.0, $\alpha = \pm 10$ deg

Examples - Onera M6

- Description:
  - Fluids II
  - Student project or as a lecture aid
  - Shows transonic effects
- Time:
  - Meshing: Provided
  - Job Setup: 10 minutes
  - Post-processing: 30-60 minutes



Mach cutting plane with surface pressure on OneraM6 wing