

Status of US Navy Ship Airwake CFD Efforts

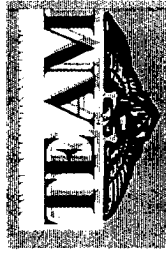
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Ms. S. A. Polsky

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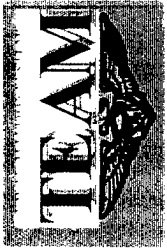
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Outline



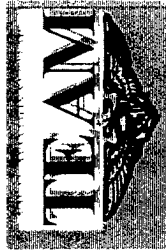
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- Brief Review of Physics
 - The Ideal CFD Code Validation Experiment
 - Generic Frigate Results
 - LHA Results



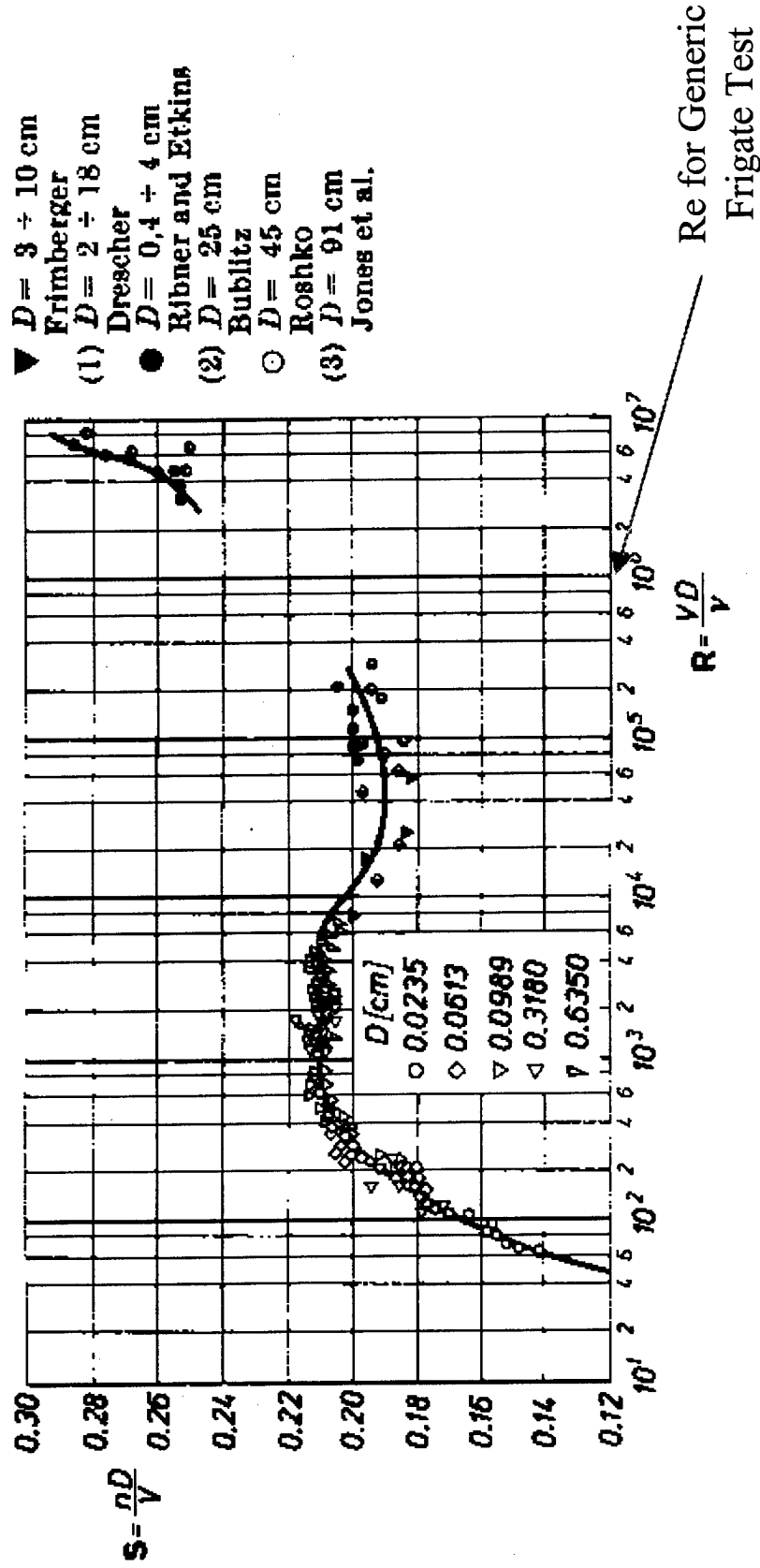
Simple Geometry, Complex Physics

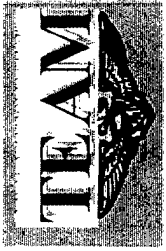


- Wake-dominated
- Strong Vortices
- Vortex Shedding
 - may be periodic, or not, depending on Reynolds number
- Data for full-scale Re is extremely hard to find (Bruce Johnson @ USNA?)



Schlichting Data for a Circular Cylinder





The Ideal CFD Code



Validation Experiment

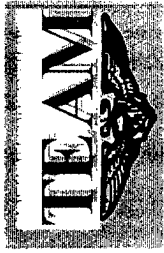
- Detailed Measurement of Boundary Conditions
 - inlet velocity profile
 - outlet pressure map
 - wall boundary layer measurements
- Redundant Data Measurements, e.g.,
 - LDV + pitot-static
 - taps + Kulites



Conclusions from Physics



-
- Experiments Should
 - include unsteady measurements
 - include off-body measurements

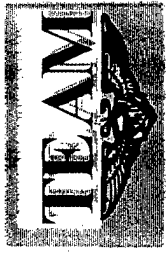


Ideal Validation



Experiment (cont.)

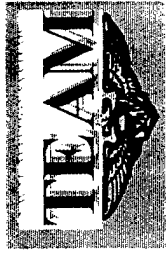
- Data Uncorrected for Wall, BL, Wake Effects
- Off-body Measurements



Pretty Good Validation Experiment



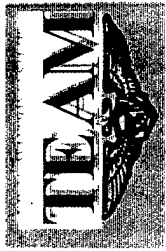
-
- NOT corrected for model or wake blockage
(we can run with walls)
 - Corrected for Tunnel Wall BL (so those
walls can be inviscid)
 - Some off-body data
 - Unsteady surface pressures



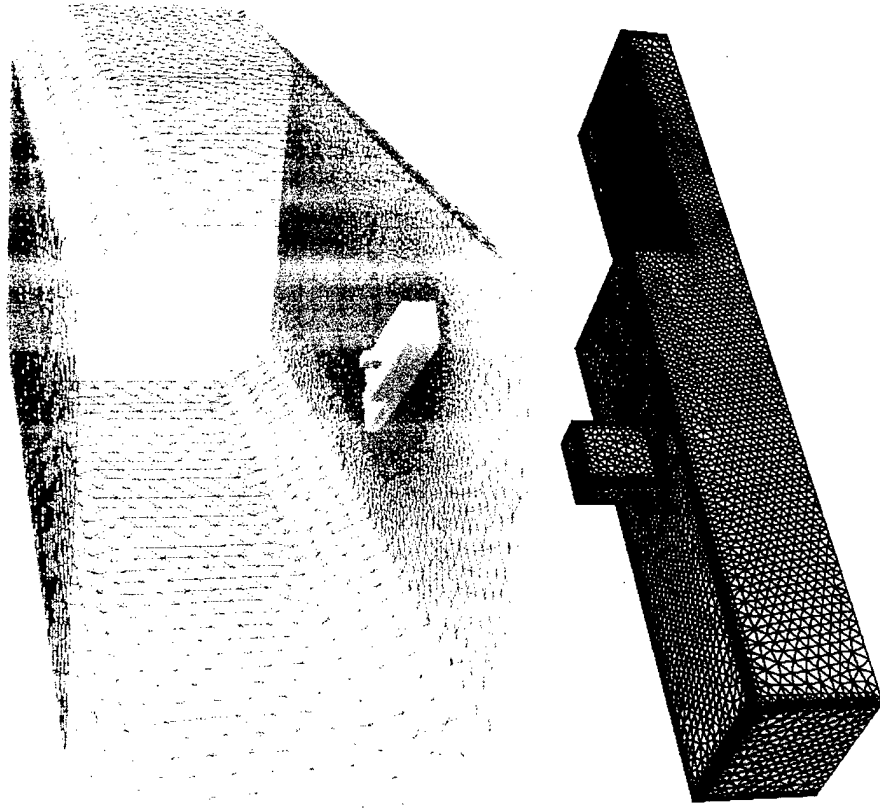
Generic Frigate Results

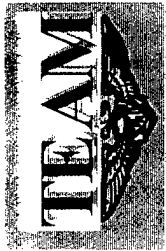


-
- Both structured and unstructured runs completed
 - in tunnel
 - free air
 - Concentrated on 45° case, but have some 0° results as well



Generic Frigate Grids





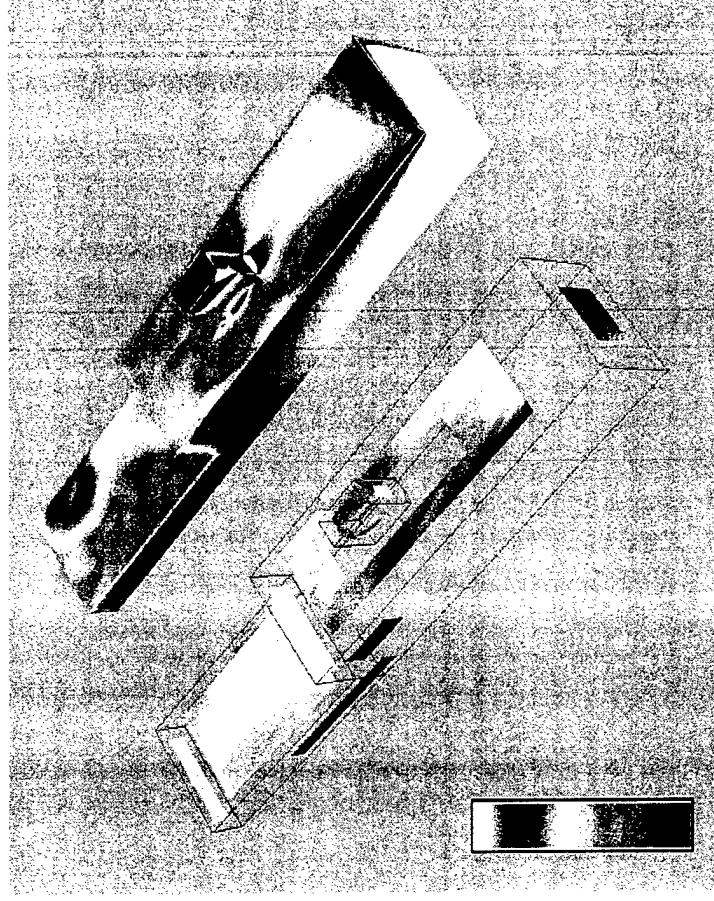
Generic Frigate Pressure Coefficient Contours



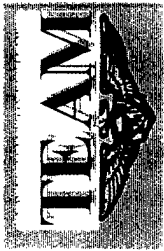
0.77
0.06
Cp -0.65
-1.36
-2.07



Unsteady laminar solution (snapshot)



Steady laminar solution w/experimental data

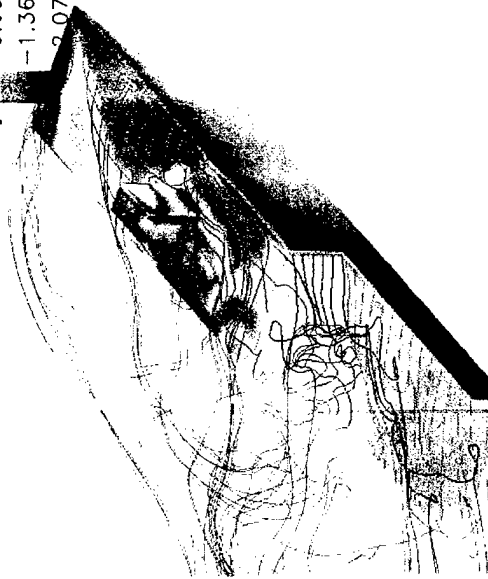


Generic Frigate Streamlines



0.77
0.06
-0.65
-1.36
-2.07

Cp



0.77
0.06
-0.65
-1.36
-2.07

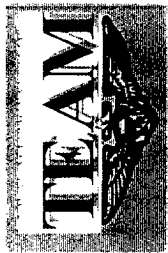
Cp



0.77
0.06
-0.65
-1.36
-2.07

Cp



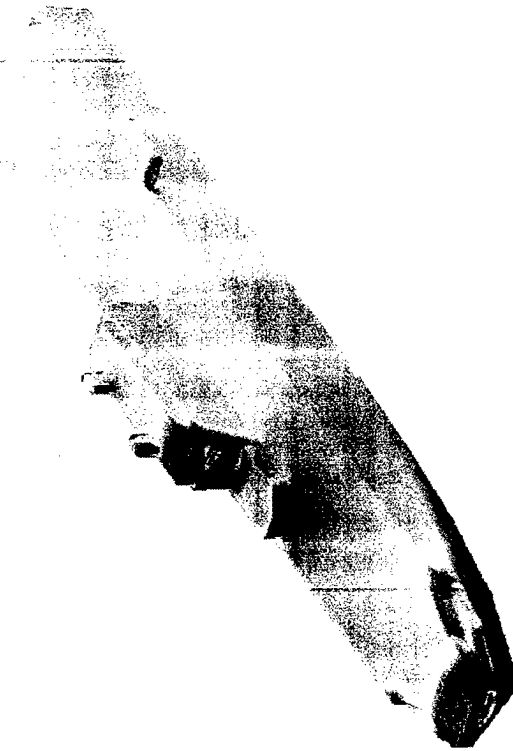


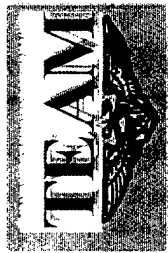
LHA Pressure Coefficient Contours



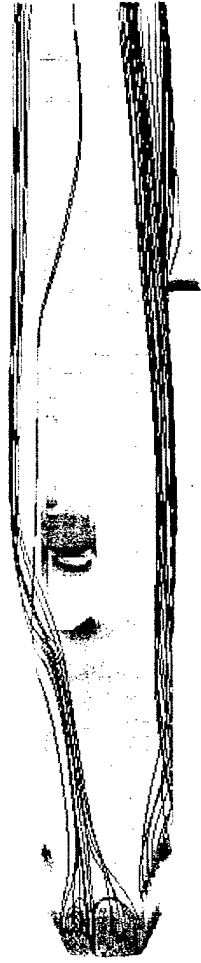
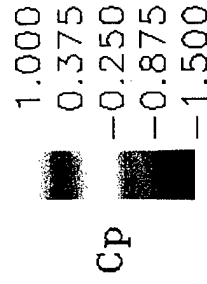
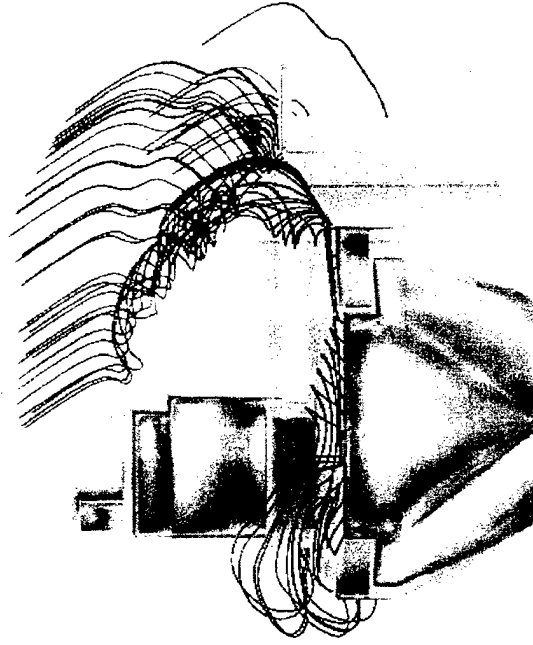
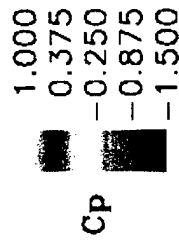
1.000
0.375
-0.250
-0.875
-1.500
Cp

1.000
0.375
-0.250
-0.875
-1.500
Cp



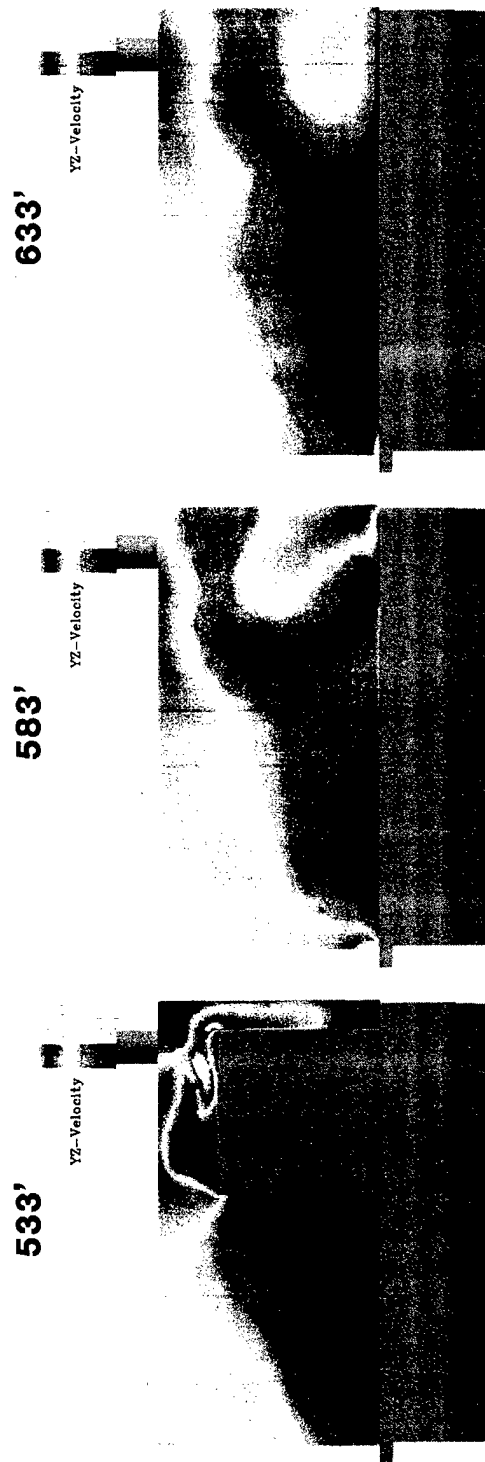


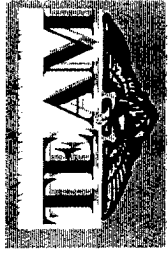
LHA Streamlines





Velocity Countours





Conclusions



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- Unsteady computations are necessary to capture flow physics
 - flow is inherently unsteady
 - Rotor modeling critical to computing hover flight conditions
 - crossflow velocities much smaller than rotor downwash, but a LOT of fluid is affected
 - Full-scale Reynolds number testing is needed