Lag Model Predictions for UFAST SBLI Flowfield

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Shock Boundary Layer Interaction(SBLI) Workshop

Simulations of Shock Boundary Layer Interaction

Experiments:

- 3 Experiments Submitted by University of Michigan
- 1 Experiment Submitted by UFAST
- IGES files defined Experimental Geometries
- Experimental Data Given on UFAST and one U. of M. Case

Simulations:

- UFAST Case Comparison Reported

Experiment

Wind Tunnel Data obtained at IUSTI http://iusti.polytech.univ-mrs.fr/IUSTI/

Geometry – From IGES File (8° degree Case)

- 2-D Contraction, 170mm wide, 600mm Long Test section
- Height 60mm with 0.3° Boundary Layer Splay
- Origin of Experimental Profiles Assumed to be Tunnel Wall

Flow Conditions – From Readme File

- Total Pressure 50.5kPa
- Total Temp 293K
- – Test Section Mach ≈ 2.25

Computational Method

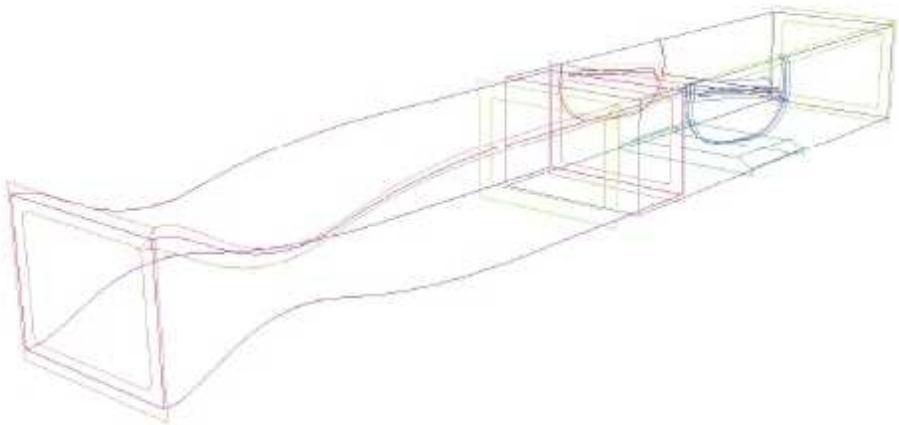
Flow Solver

- Overflow 2.0 Flow Solver – Overset Grids
- Eddy viscosity Lag turbulence model – AIAA 2005-101 Also AIAA 2001-2564
- 2nd order Central Difference with Matrix Dissipation – AIAA 2001-2664

Physical Boundary Conditions

- Full 3D UFAST Geometry Modelled – Shock Generator Spanned Tunnel
- Transition Assumed in Stagnation Chamber
- Downstream Boundary Condition: Very Low Pressure
- Adiabatic Viscous Walls

Grid System: 8 Overset Zones, 53M Grid Points



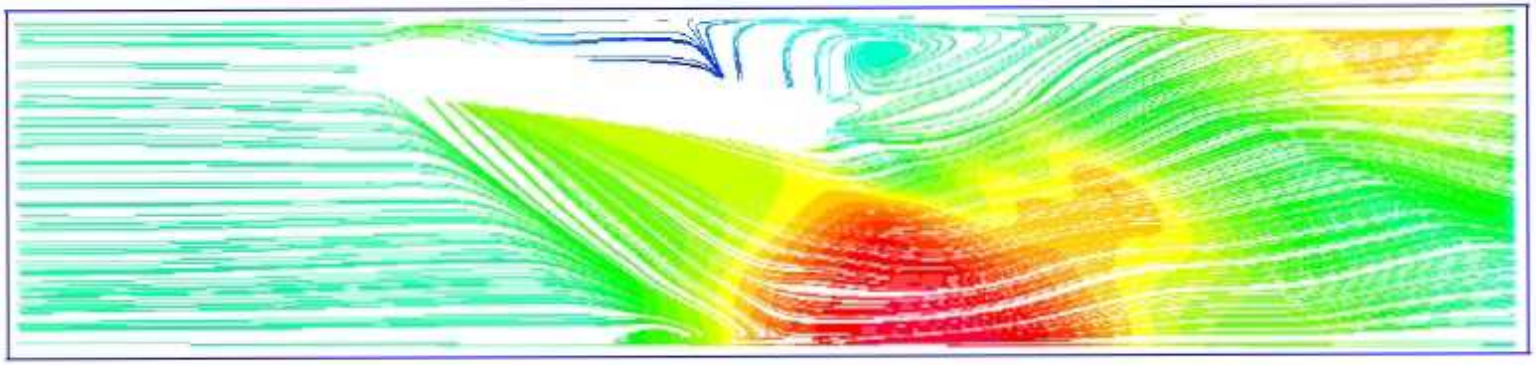
6 Viscous Tunnel Grids: All 129 Points Wall Normal

- Contraction/Nozzle ($-471\text{mm} \leq x \leq 145\text{mm}$)
  469 Circumferential x 265 Streamwise
- Test Section ($35\text{mm} \leq x \leq 600\text{mm}$)
  513 Circumferential x 193 Streamwise
- Shock Generator (3 Grids)
  353 points(periodic) around, 121 spanwise
- Interaction($275\text{mm} \leq x \leq 386\text{mm}, -62\text{mm} \leq y \leq -44\text{mm}$)
  257 Streamwise x 145 Spanwise

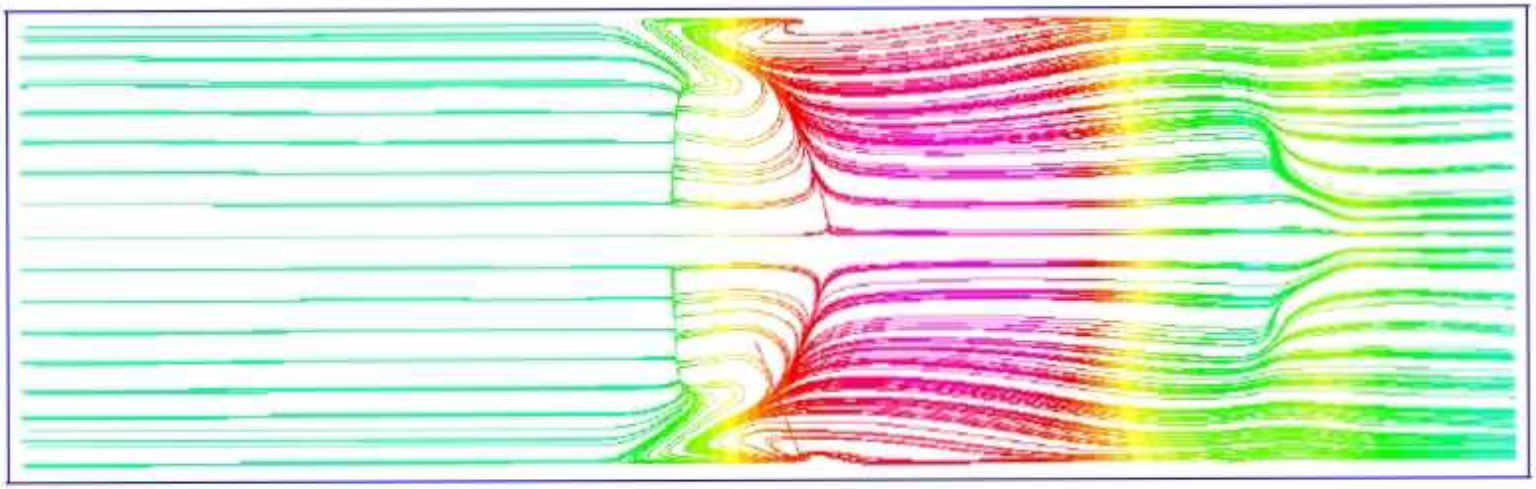
2 Tunnel Core Grids

- Contraction/Nozzle 265 Streamwise x 59 Spanwise x 165 Vertical
- Test Section 465 Streamwise x 115 Spanwise x 145 Vertical

Wall Flowfield(Oil Flow Colored by Pressure)



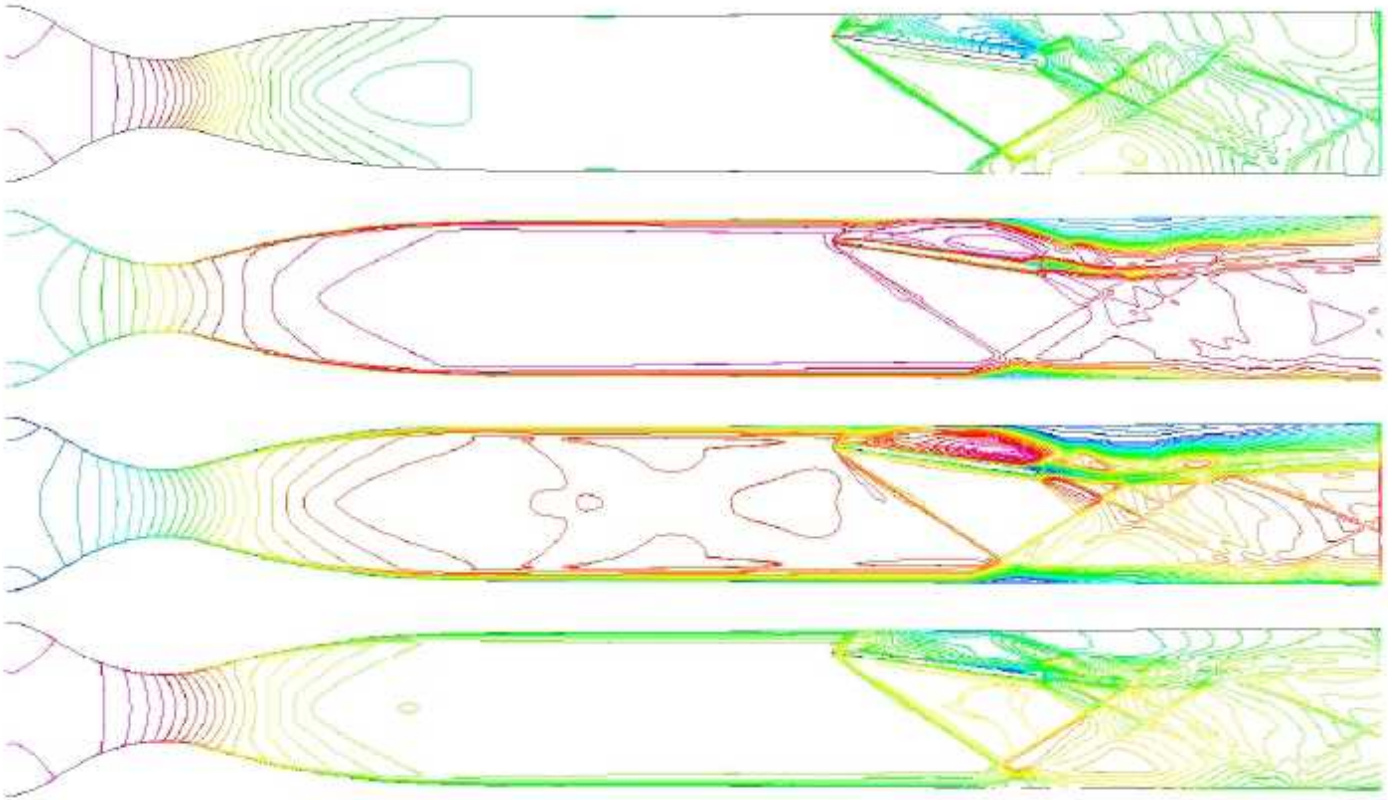
Side



Bottom

- Sidewall Boundary Layer Separation Extensive
- Lower Wall Shows Separation, Reattachment and Expansion off End of Shock Generator

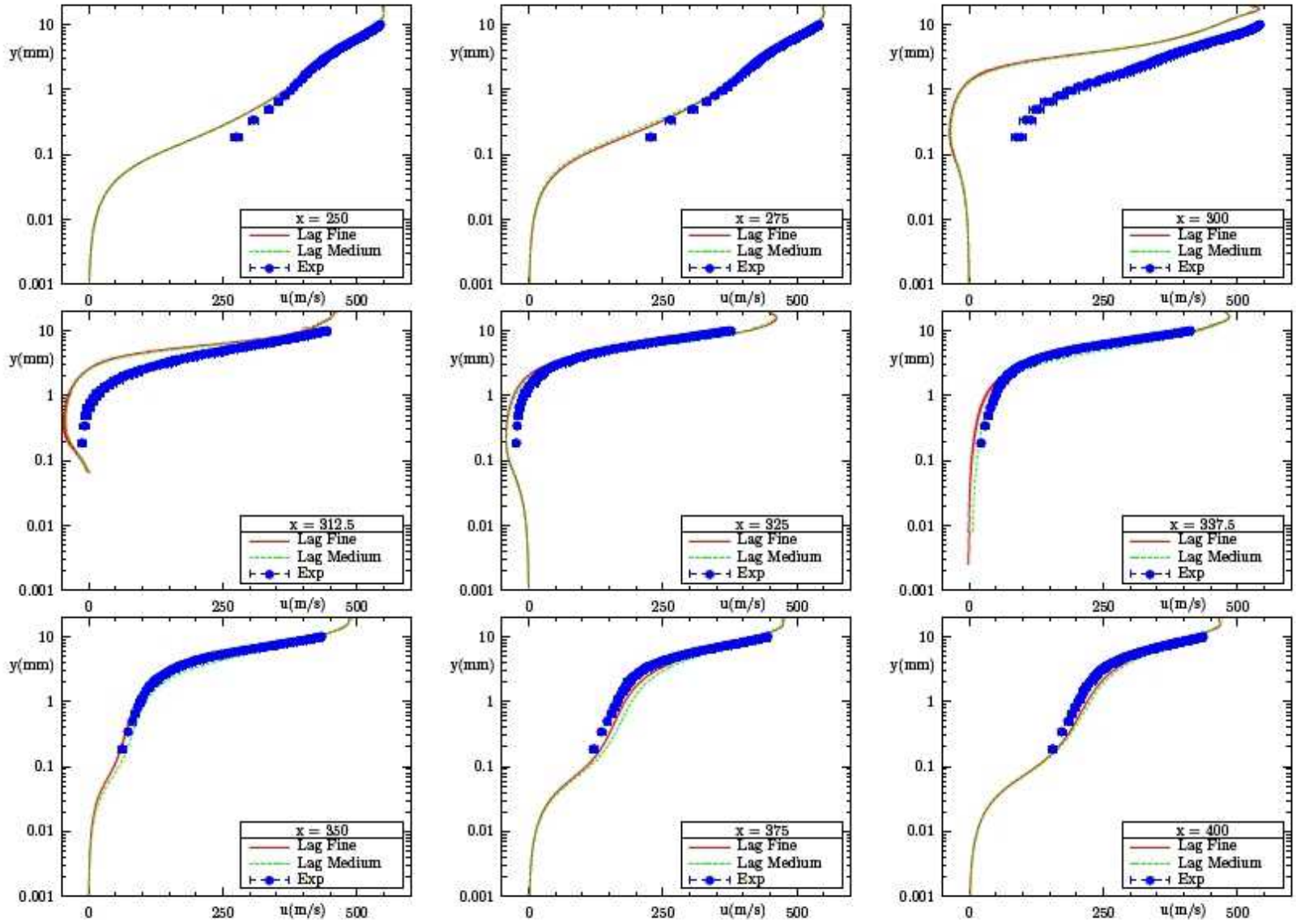
Midplane Flowfield



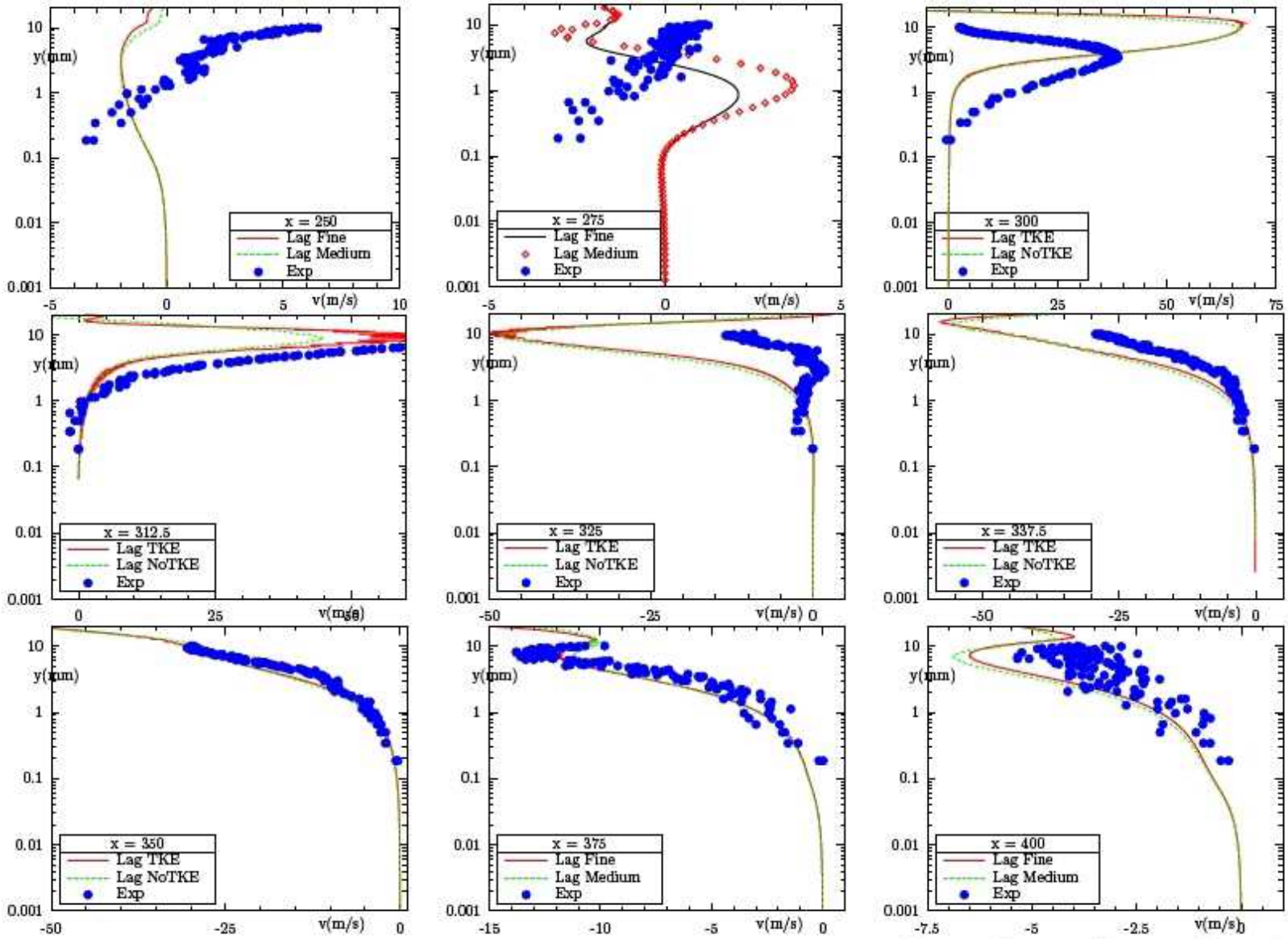
- Complicated Flow along Top Side of Shock Generator
- Expansion at End of Shock Generator Impacts Lower Wall Well After Reattachment(Effects Seen in Wall Oilflow)

Grid Convergence: u velocity profiles

M.E. Olsen



Grid Convergence: wall normal velocity profiles



Conclusions

Conclusions:

- Reasonable Prediction of Separation Location
- Wall Normal Velocity Predictions Better Downstream of Separation
- Complicated Sidewall Flowfield

Plans:

- Comparison with Other Turbulence Models
- U of M Case Simulations