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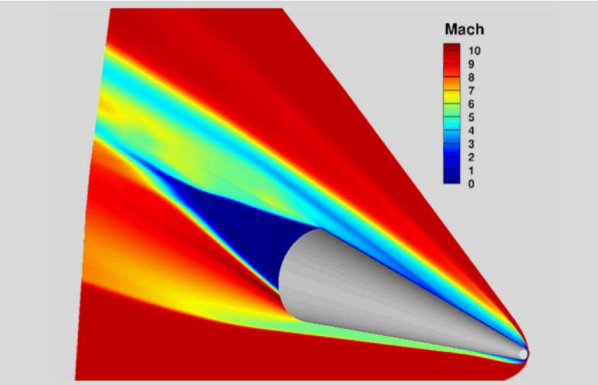
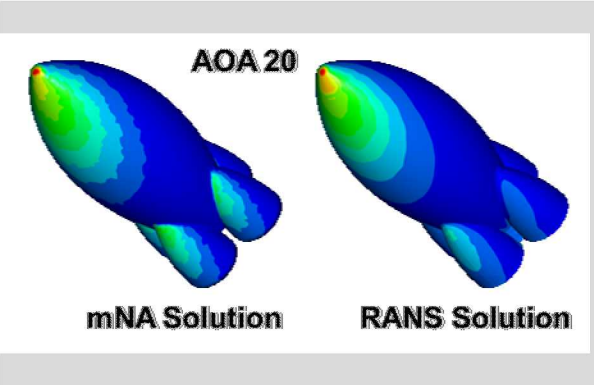
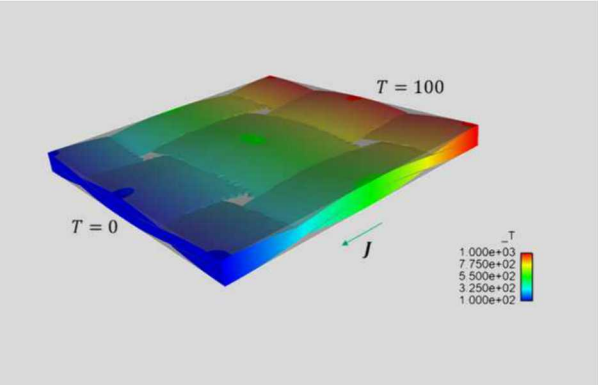






Hypersonic Research at Sandia National Labs

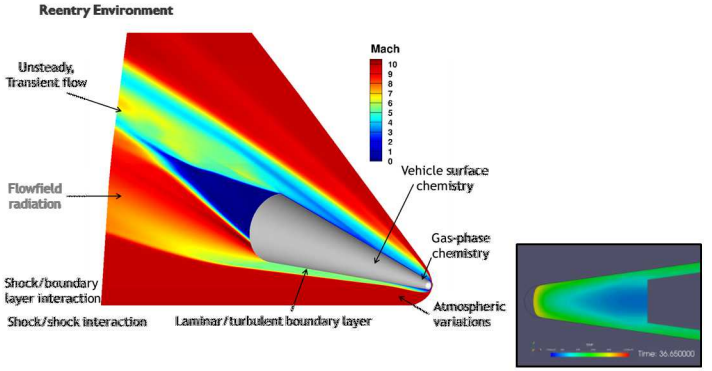
Engineering Sciences Center

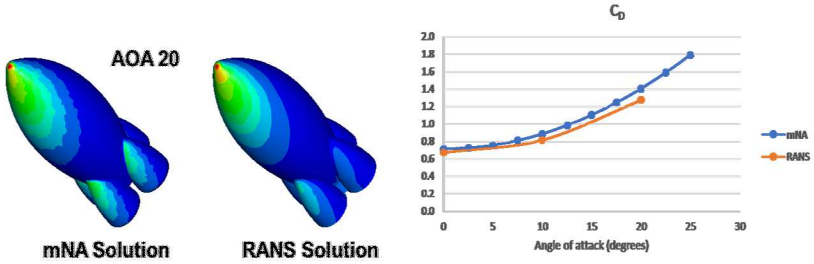
2/26/19

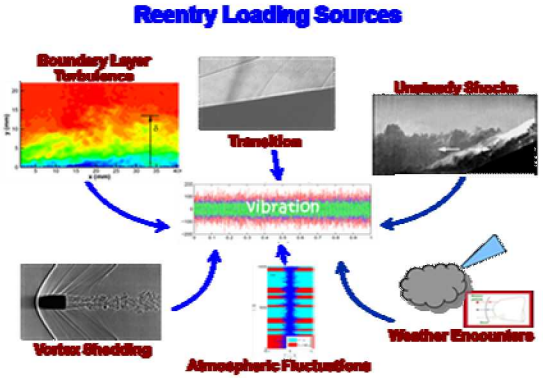
Hypersonics Research Areas

Predictive flight phenomena

- Hypersonic Vehicle flight performance
  - SPARC – next-gen aero/thermal response solver
    - Exa-Scale Computers
    - Hybrid RANS-LES
  - Aero/Shape Change/Trajectory Coupling
- Autonomy for Hypersonics
  - Multi-fidelity toolkit
  - Enabling on the fly performance prediction
- Environmental loading
  - Reentry Random Vibration
  - Hostile Shock



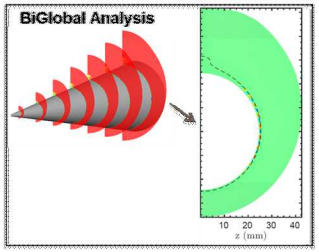


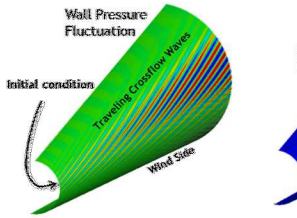


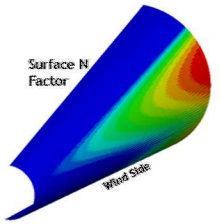
Hypersonics Research Areas

Predictive flight phenomena

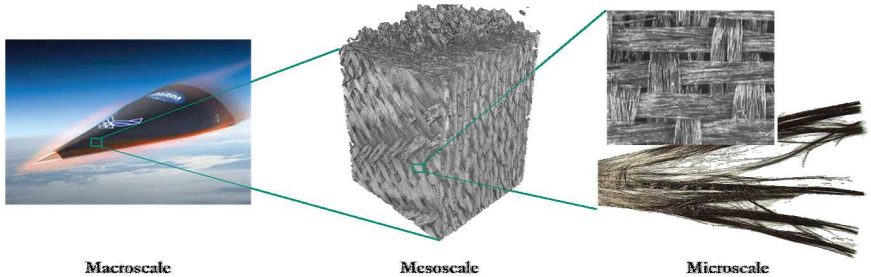
- Compressible fluid Mechanics
  - Mechanism-based turbulent to laminar Transition
  - DNS of Hypersonic Boundary Layers
  - Wake flows







- Material Ablation Modeling
  - Improving macro-scale models
  - Fabrication processes/uncertainties
  - Meso-scale modeling
  - Experimental characterization

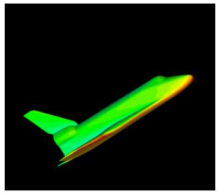


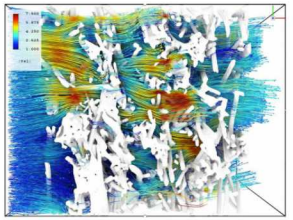
Macroscale
Typical performance assessments and modeling (e.g. CMA). Composite properties required

Mesoscale
Woven fiber surrounded by phenolic resin. Governed by weave geometry, resin/tow properties

Microscale
Individual fiber filaments spun into tocs of 1,000+ fibers, impregnated with resin. Fiber arrangement affects toe properties

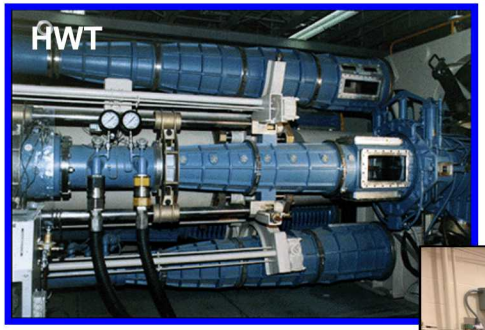
- DSMC
  - Non continuum flow
  - Molecular scale turbulence
  - TPS Fiber scale flow

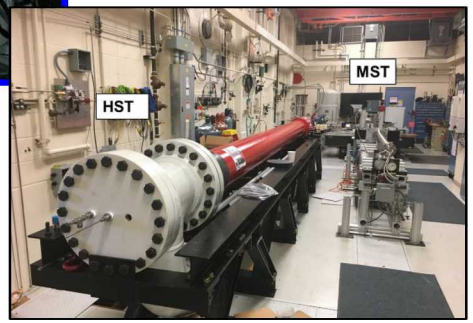


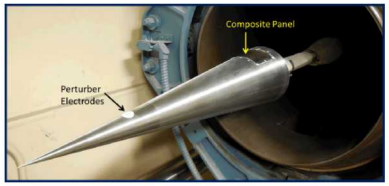


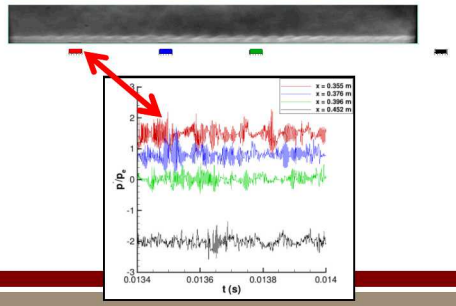
Hypersonics Research Areas

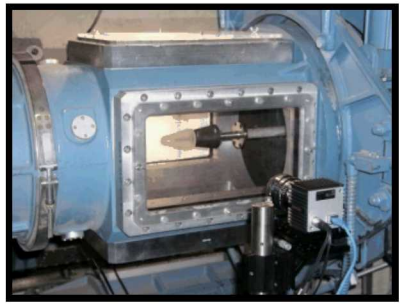
- Experimental Research
  - Aerodynamics
  - Random Vibration
  - Boundary Layer Transition
  - Low Temperature Ablators
  - PIV (in development)
  - Shock-Particle Interaction
  - Ablation Chemistry

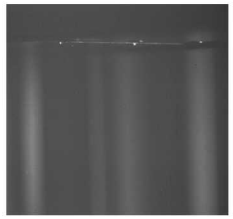


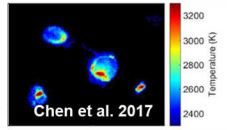












Emission / Absorption Spectroscopy

Holography / Pyrometry

USE THE EXTREME CONDITIONS IN HST TO INGNITE METAL PARTICLE CURTAINS

DEVELOP AND APPLY ADVANCED GAS PHASE AND PARTICLE DIAGNOSTICS

Future Capability