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Hypersonic non-equilibrium Computational Fluid Dynamics (CFD) analysis and effect of underbelly shape on a conceptual lifting body spaceplane

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APPENDICES

Theoretical stagnation point wall temperature
Sutton-Graves correlation:

$$q_{stag} = k\left(\frac{\rho}{r_n}\right)^{\frac{1}{2}} * V^3$$

where Sutton-Graves coefficient k for Earth = 1.7415x10^{-4}

ρ=1.03x10^{-3} kgm^{-3}

r_n=4m

Therefore q_{stag}=39.29 Wcm^{-2}

Assuming q_R=0 from Tauber-Sutton for Earth and applying Stefan-Boltzmann law, both from (NASA TFAWS, 2012), to find the stagnation point wall temperature (assuming a TPS emissivity of 0.85 (same as the Space Shuttle TPS, from (Gnanasekaran, 2017):

$$q_{rad} = \varepsilon\sigma T_w^4$$

$$T_w = \frac{39.29e^4}{0.8 * 5.67e^{-8}}^{0.25}$$

$$T_w = 1715.6\ K$$

BILBO turbulent viscosity pathlines

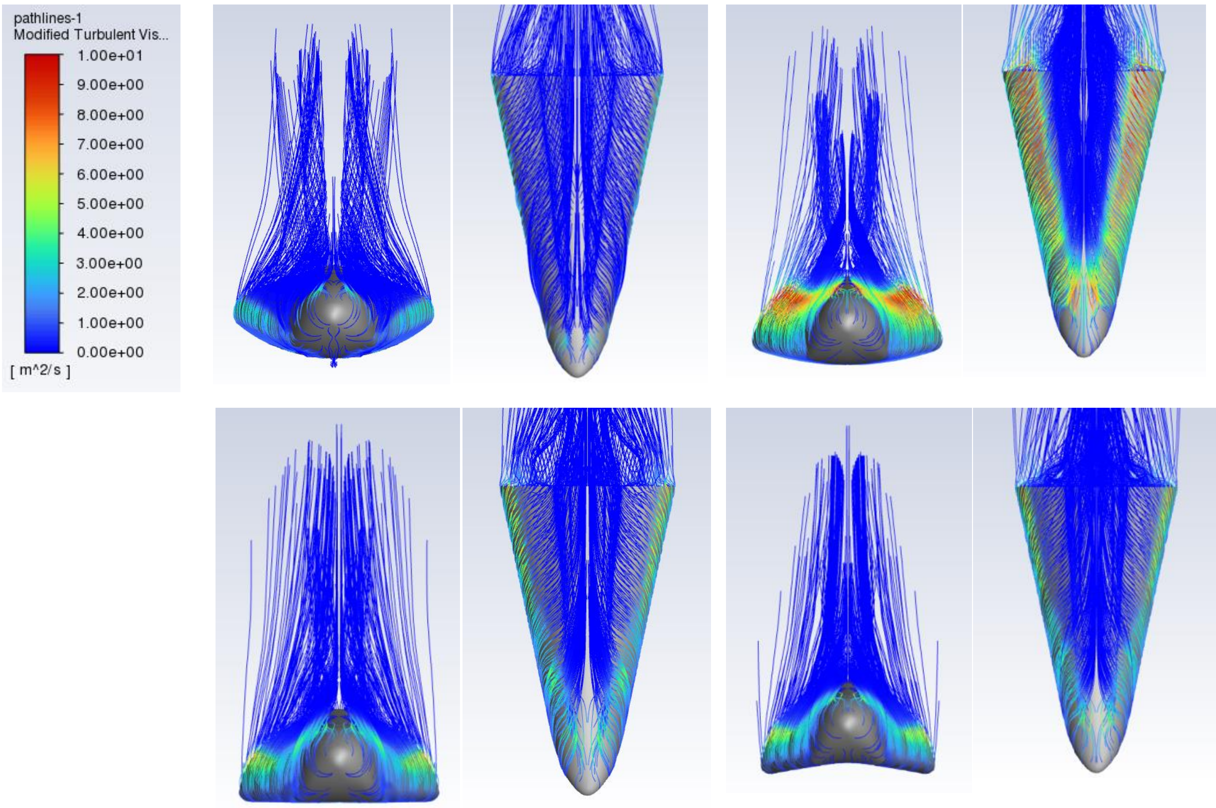

Figure 1: Turbulent viscosity pathlines for all BILBO shapes