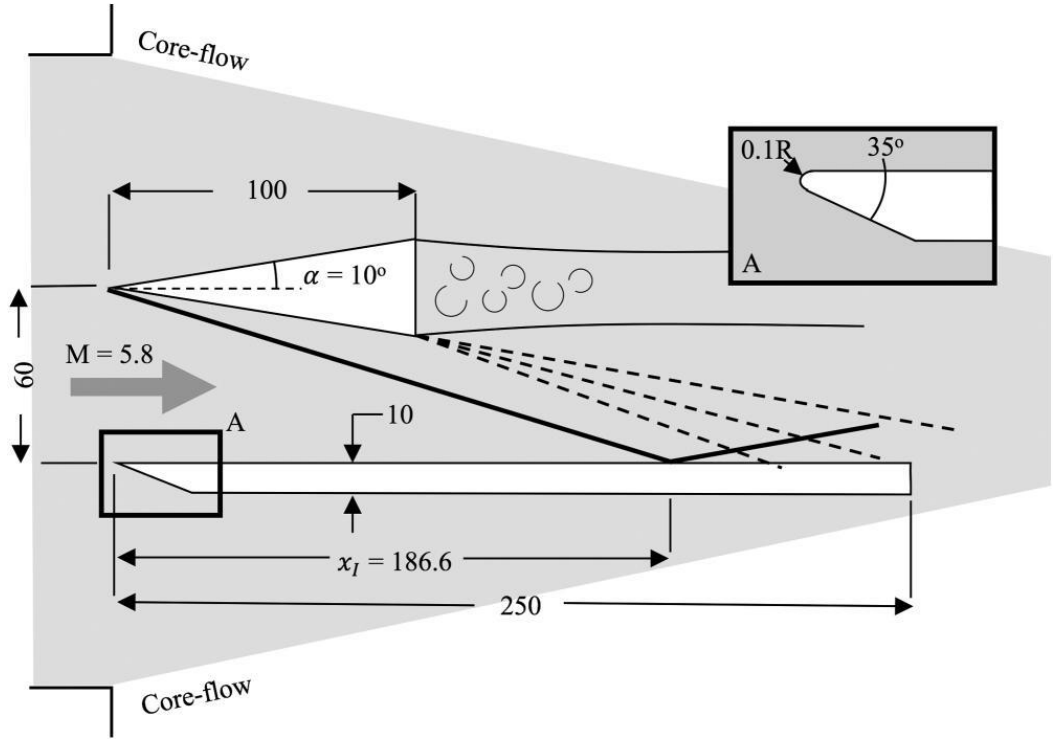
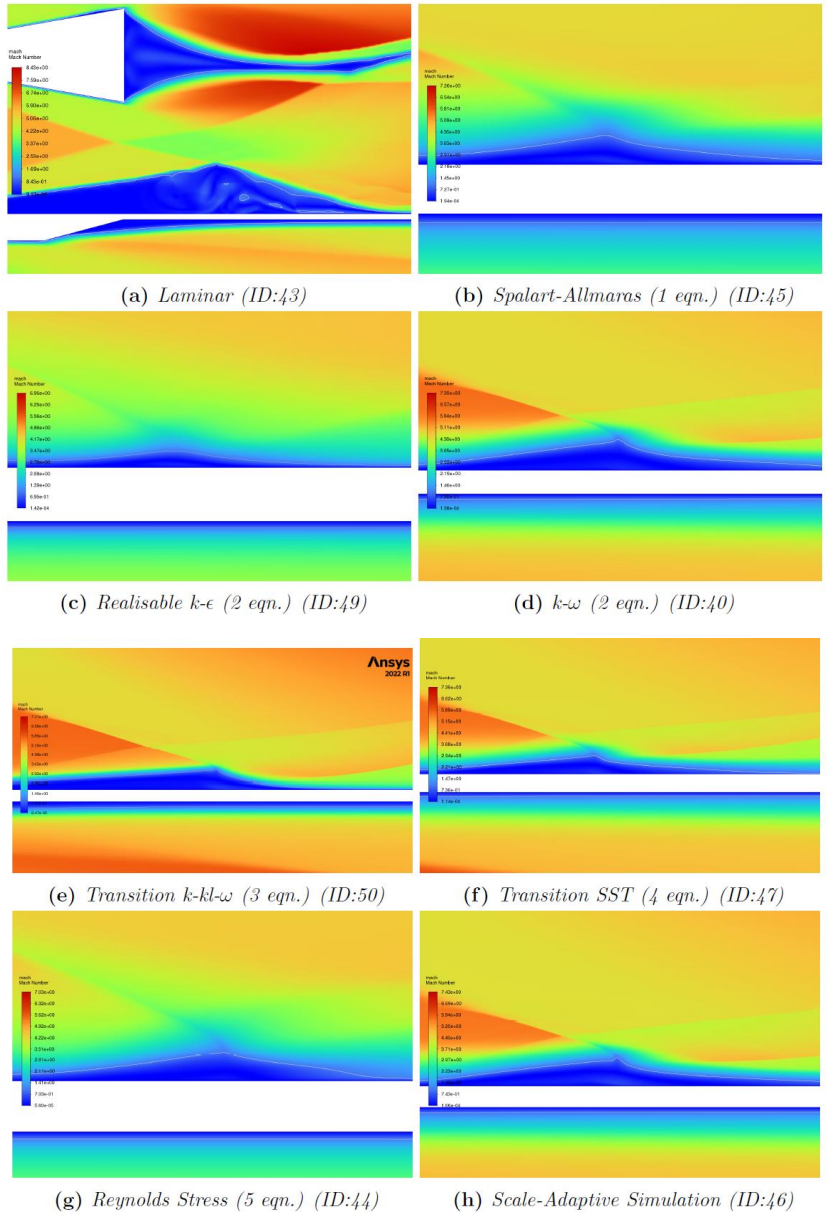
Validation case

- Considering earlier experiment
  - Currao, GMD, et al. "Hypersonic fluid–structure interaction on a cantilevered plate with shock impingement." AIAA Journal 57.11 (2019): 4819-4834.
  - Shorter plate, larger wedge angle, wedge farther from plate
- Looking to verify appropriate set up
  - Surface pressures available for validation
  - Explore meshing strategies
  - Vary turbulence model



Validation case

- Setup
  - All wall boundary layers resolved
  - 2nd order upwind convective fluxes
  - 2nd order central diffusive fluxes
- Various turbulence models
  - Laminar, SA, RKE, SST, Transition k-kl-ω, Transition SST, RSM-BSL, SAS
  - Laminar unphysical → leading edge shock interference
  - SA, RKE failed to adequately capture separation & reattachment shocks
  - Others perform similarly → clear resolution of separation shock and expansion waves from rebounding shock



(a) *Laminar (ID:43)* (b) *Spalart-Allmaras (1 eqn.) (ID:45)*

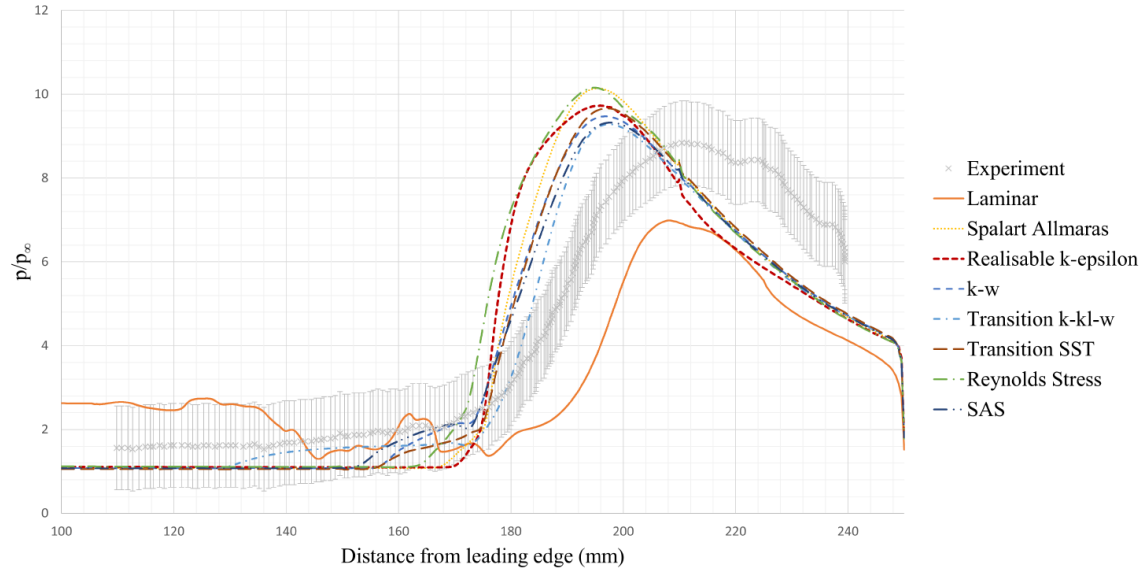
(c) *Realisable k-ϵ (2 eqn.) (ID:49)* (d) *k-ω (2 eqn.) (ID:40)*

(e) *Transition k-kl-ω (3 eqn.) (ID:50)* (f) *Transition SST (4 eqn.) (ID:47)*

(g) *Reynolds Stress (5 eqn.) (ID:44)* (h) *Scale-Adaptive Simulation (ID:46)*

Validation case

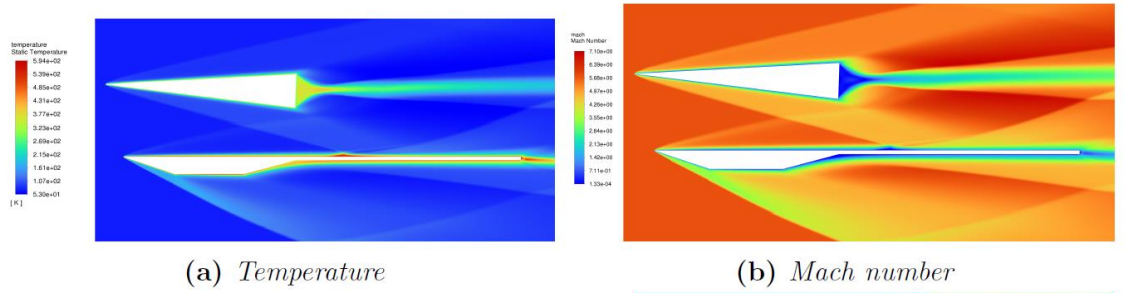
- Transition k-kl-ω results are interesting
  - Peak pressures upstream of exp → requires work
  - Other models share the same small ledge in place of the separation plateau
  - Transition k-kl-ω produces clearly defined separation plateau + upstream separation point
  - Separation point closely aligns with exp
  - Applicability of transition models in high-speed flows?



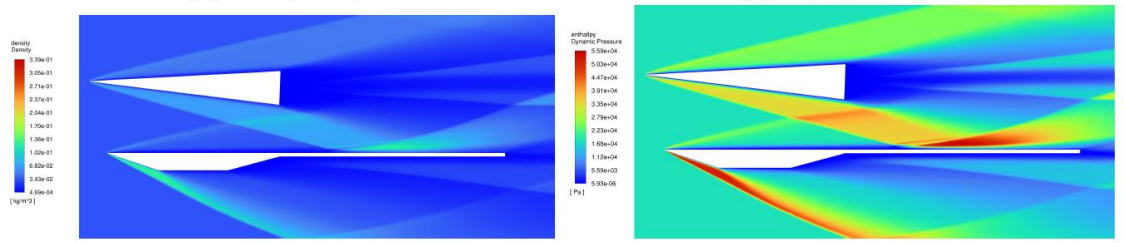
ID	Model	X_S (mm)
45	Spalart-Allmaras (1 eqn.)	169.399
49	Realisable k-ϵ (2 eqn.)	171.669
40	k-ω (2 eqn.)	158.580
50	Transition k-kl-ω (3 eqn.)	127.768
47	Transition SST (4 eqn.)	163.713
44	Reynolds Stress (5 eqn.)	165.419
46	Scale-Adaptive Simulation	154.908
-	Experimental Results	120-130

HyMax Case

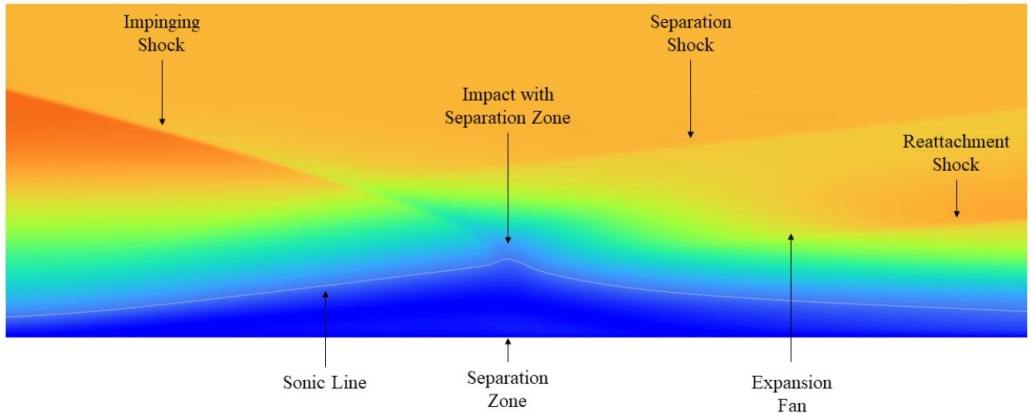
- Incorrect geometry
  - Deflection angle too high (original geometry)
  - Shock impingement too far forward
- Qualitative results
  - Unphysical reflection at lower boundary → does not interfere with plate
  - SWBLI features generally well-captured
  - New meshes for correct geometry generated and running.



(a) *Temperature* (b) *Mach number*



(c) *Density* (d) *Dynamic pressure*



(a) *Mach number*