Sod's shock tube

- This case has an analytical solution and plenty of experimental data.
- This is an extreme test case used to test solvers.
- Every single CFD solver use this case for validation of the numerical schemes.
- The governing equation of this test case are the Euler equations.

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{U}) = 0$$

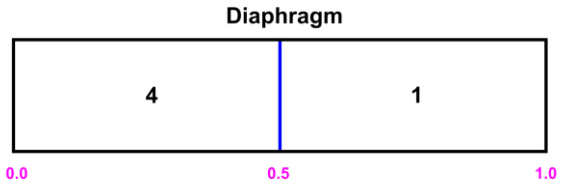
$$\frac{\partial (\rho \mathbf{U})}{\partial t} + \nabla \cdot (\rho \mathbf{U}\mathbf{U}) + \nabla p = 0$$

$$\frac{\partial (\rho e_t)}{\partial t} + \nabla \cdot (\rho e_t \mathbf{U}) + \nabla \cdot (p \mathbf{U}) = 0$$

$$p = \rho R_g T$$

Shock tube. The driver section, including vacuum pumps, controls, and helium driver gas.
Photo credit: Stanford University.
http://hanson.stanford.edu/index.php?loc=facilities_nasa

Sod's shock tube



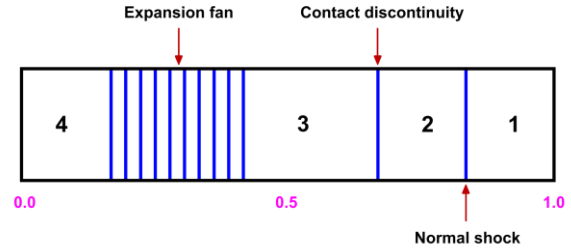
All walls are slip

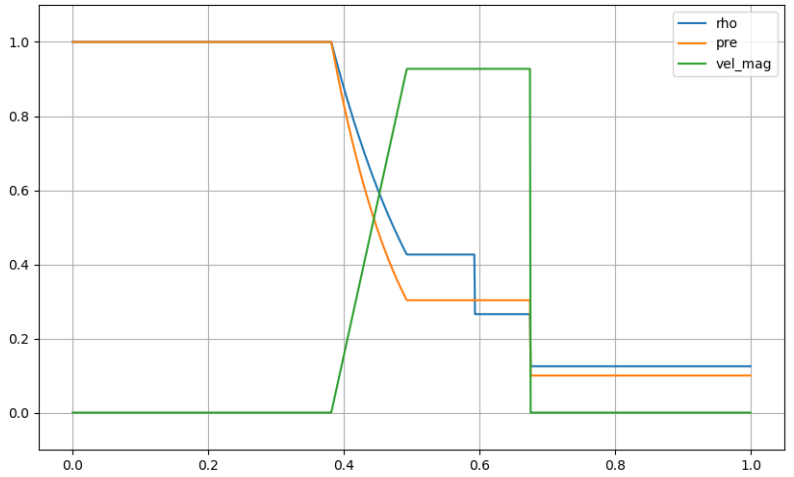
$$\mathbf{U_4} = \mathbf{U_1} = 0$$

$$p_4 = 1, \quad p_1 = 0.1$$

$$T_4 = 0.00348, \quad T_1 = 0.00278$$

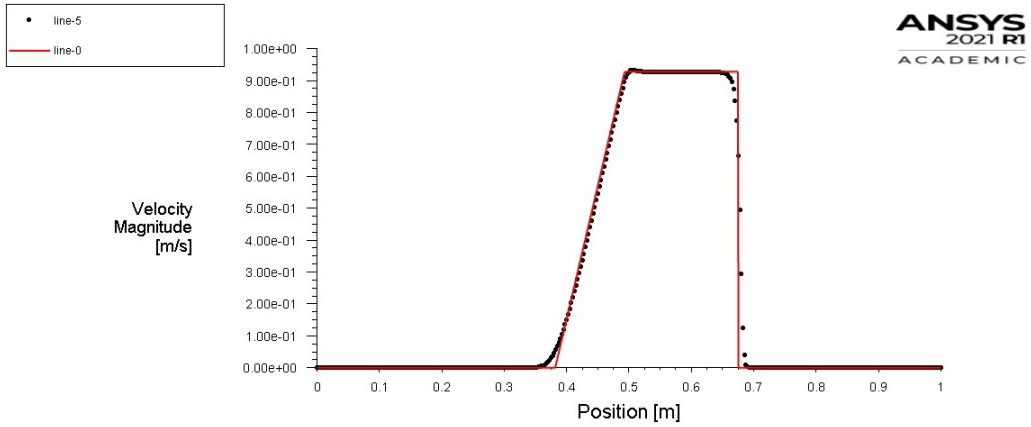
Boundary conditions and initial conditions



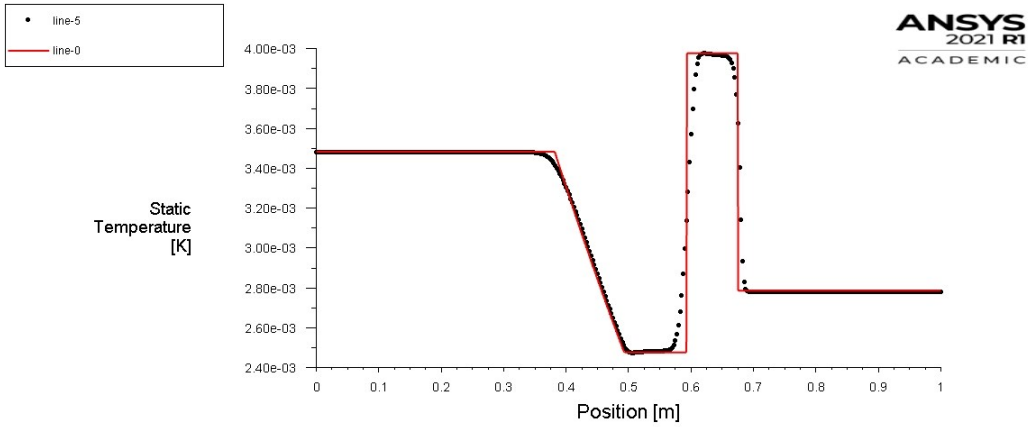


Analytical solution

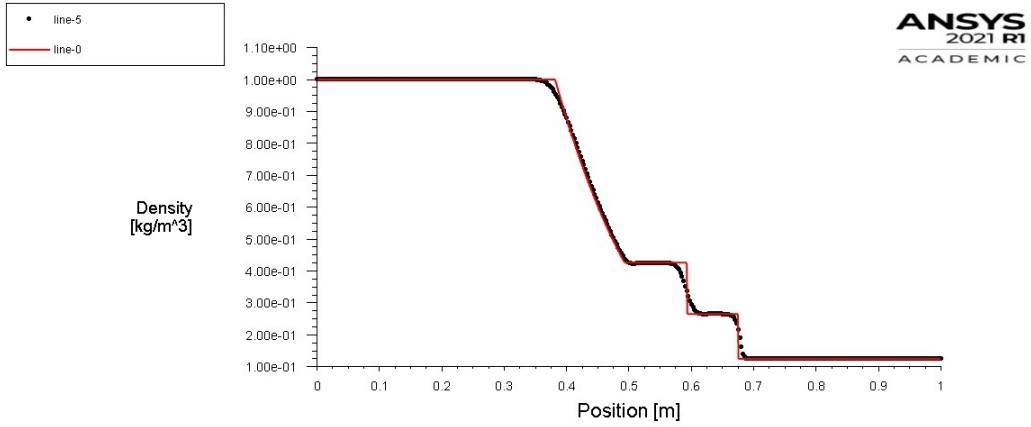
Sod’s shock tube



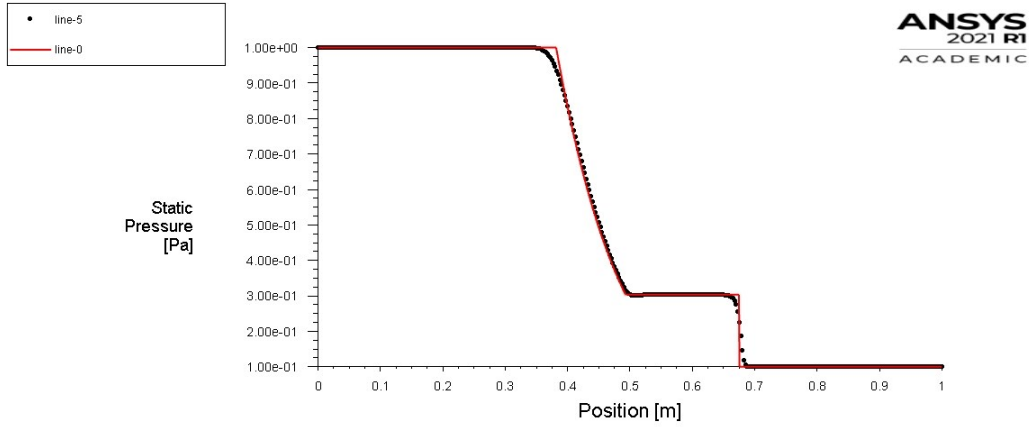
Velocity magnitude



Static temperature



Density



Static pressure

Note: In the plots, the continuous line represents the analytical solution.