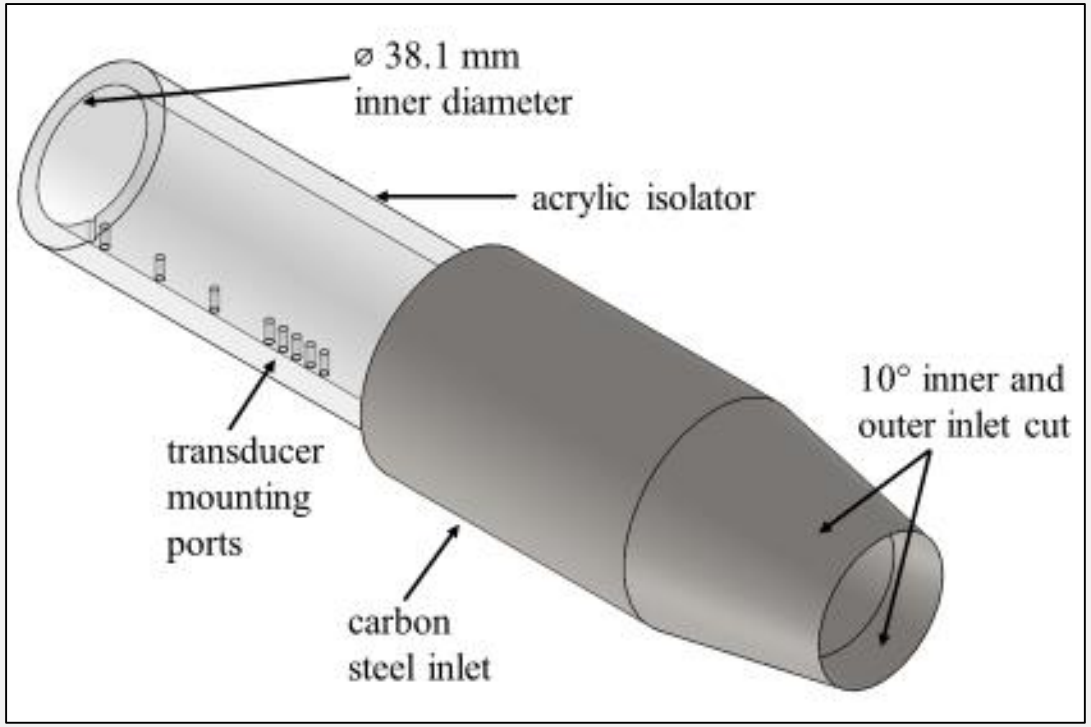
Experimental Investigation of Cylindrical Isolator with Mild Jet Injection Mass Flow Ratios

Sean Murray, Morgan Funderburk, and Venkateswaran Narayanaswamy
Department of Mechanical and Aerospace Engineering,
North Carolina State University, Raleigh, NC 27695

Motivation:

The present work aims to supplement current information on unstart induced by mass jet injection in rectangular geometries through an investigation of the flow characteristics of a cylindrical inlet/isolator model under mild jet injection mass flow ratios.



Experimental techniques

- Surface Streakline Visualization
- High Frequency Wall Static Pressure

Parameter	Value
M_∞	3.0
u_∞	630 m/s
T_∞	110 K
Re/m	4.4×10^7 m^{-1}
p_∞	16.8 kPa

Case	P_{jet} (psig)	$\frac{\dot{m}_{jet}}{\dot{m}_{isolator}}$	J
1	0	0	0
2	100	1.72	3.89
3	250	3.97	8.97
4	400	6.21	14.05
5	600	9.21	20.82

Surface streakline flow visualization

- Uniform wake
- Wake width increases proportionally to J
- Upstream shock train is unaffected

Case	Upstream Shock Impingment (mm)	Downstream Shock Impingment (mm)
1	205.1	274.6
2	204.0	273.6
3	204.6	274.7
4	205.0	275.1
5	204.8	272.8

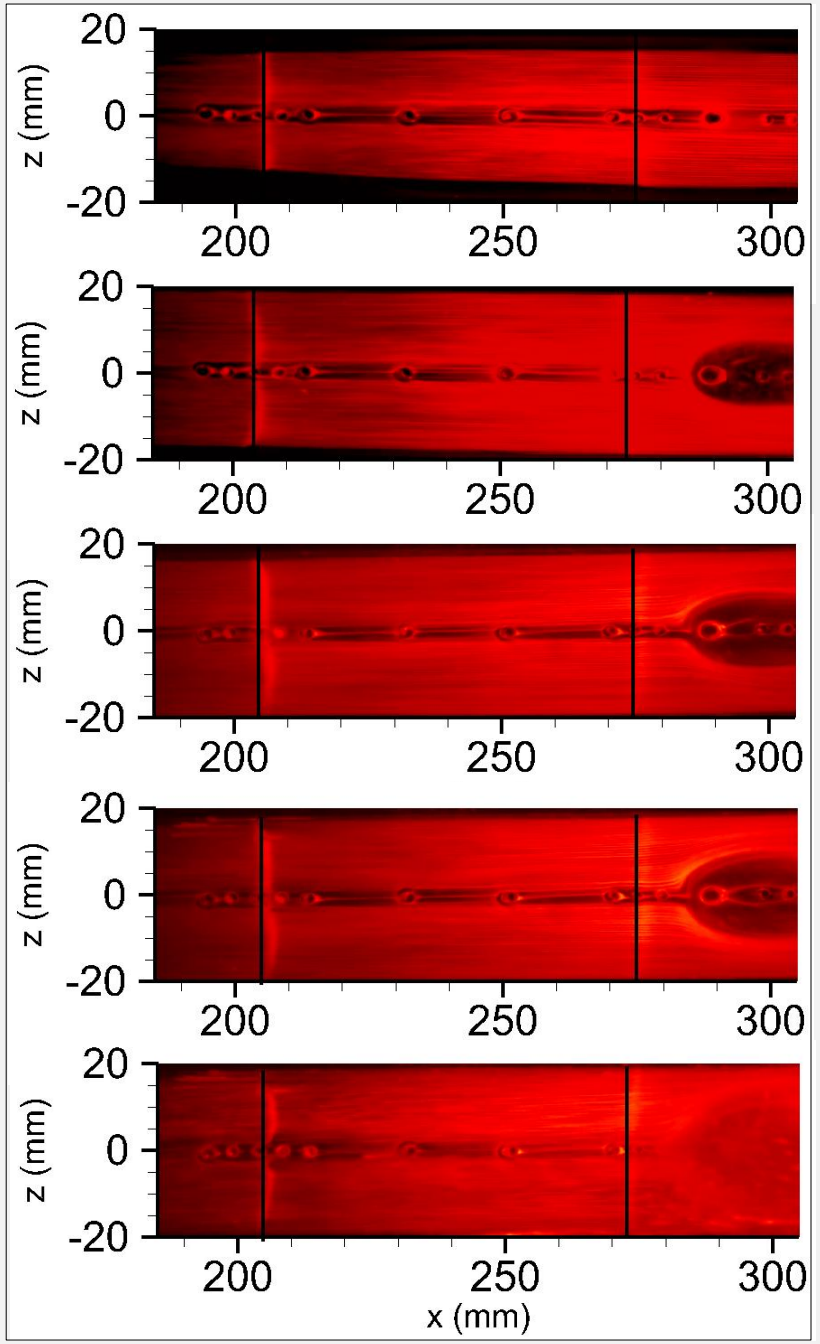
Case 1

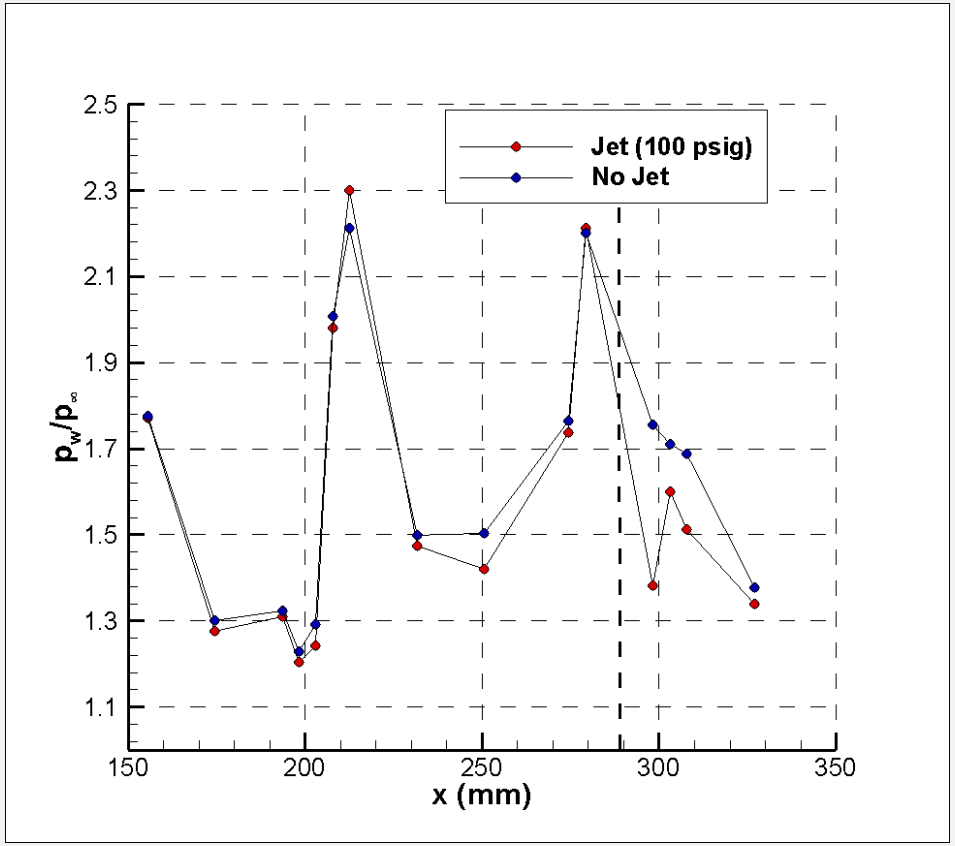
Case 2

Case 3

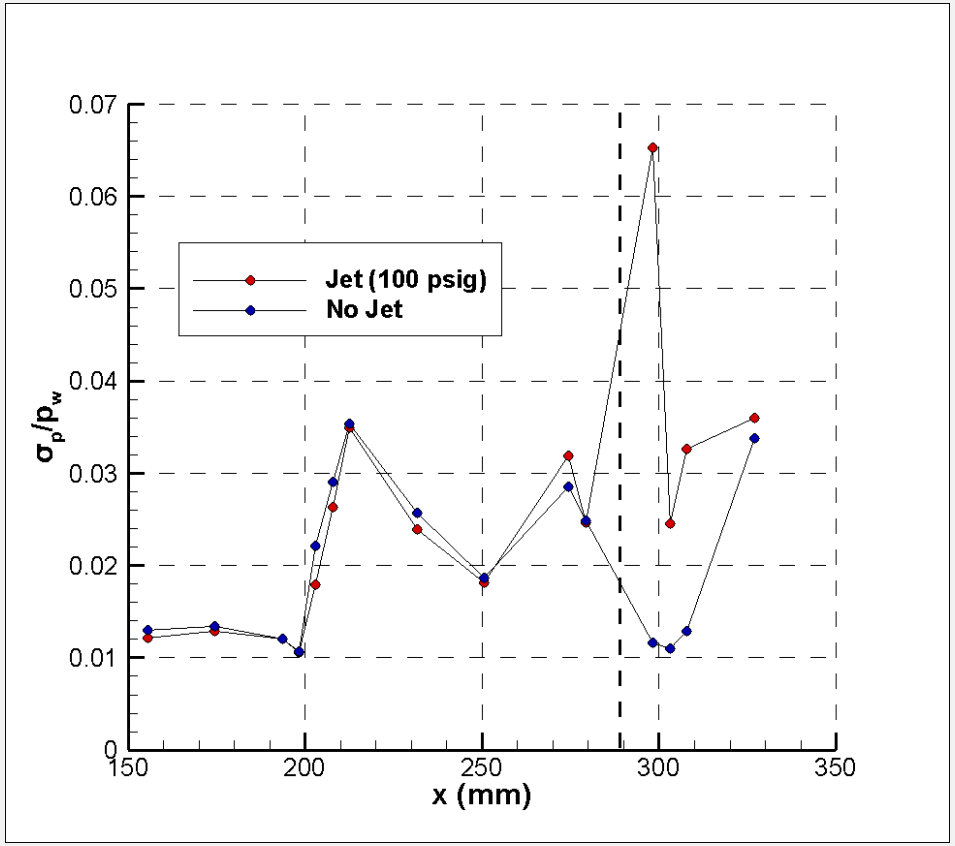
Case 4

Case 5





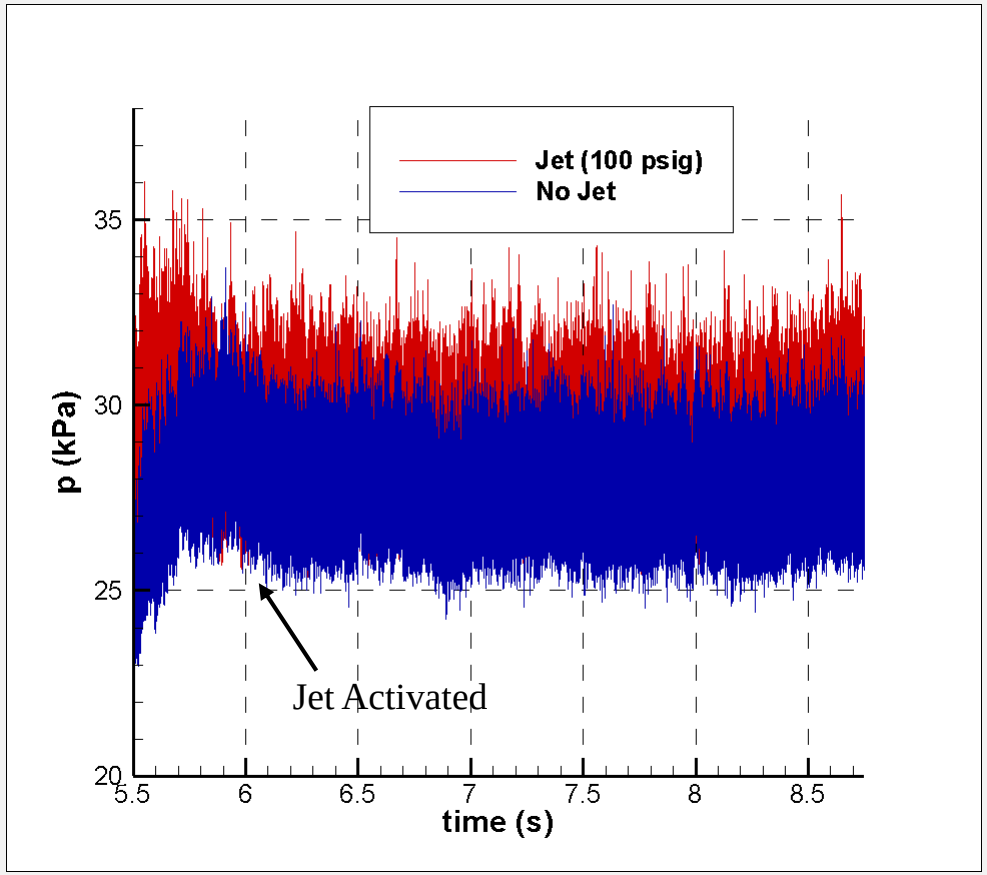
mean pressure profile

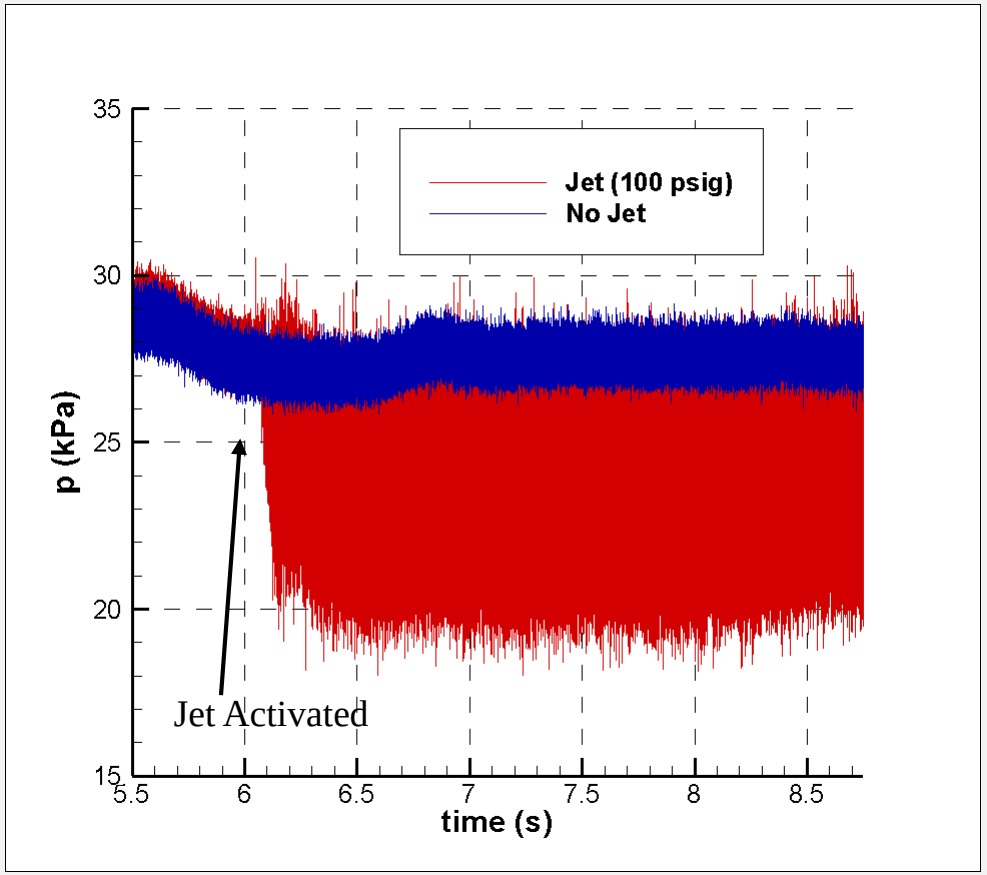


r.m.s pressure profile

Mean and r.m.s pressure profiles

- At least one upstream shock impingement is missed
- Two shock impingements with locations within 1% of those seen in streakline visualization
- No jet influence seen upstream of injection port
- Decreased mean and increased r.m.s pressures downstream of injection port

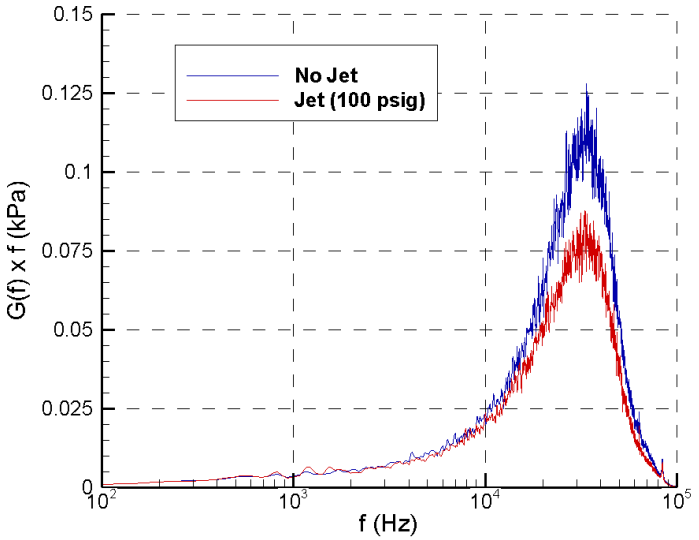




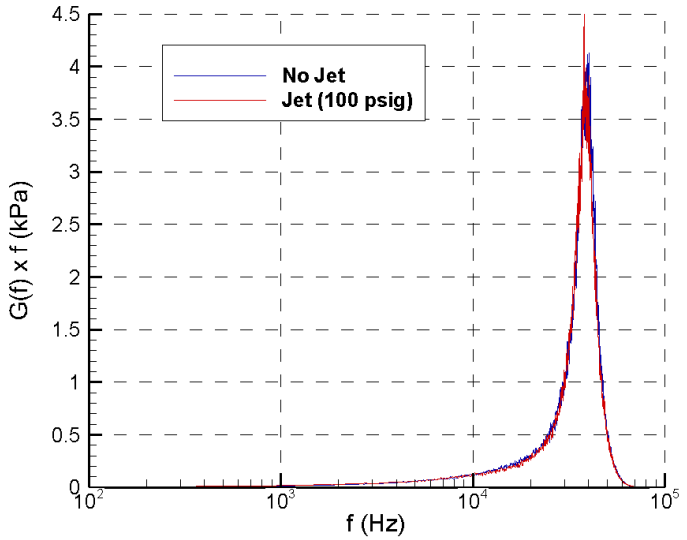
Pressure time traces

- Clear influence downstream of injection port following jet activation
- Supports decreased mean and increased r.m.s pressures downstream of injection port
- Absence of propagation of information upstream

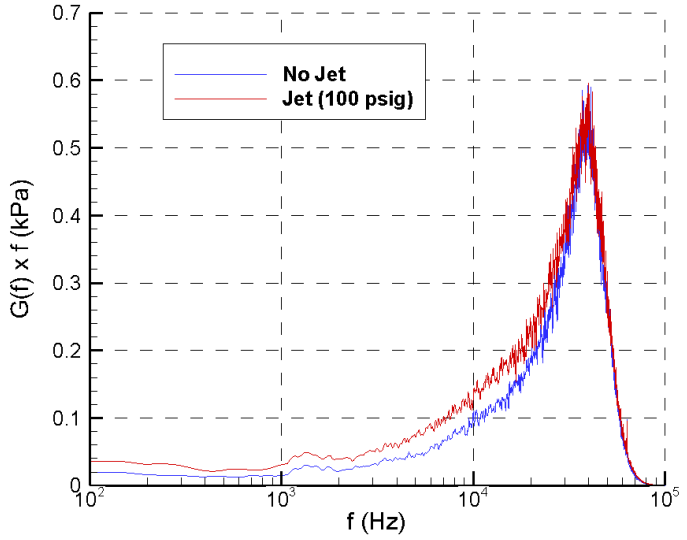
x = 155.4 mm



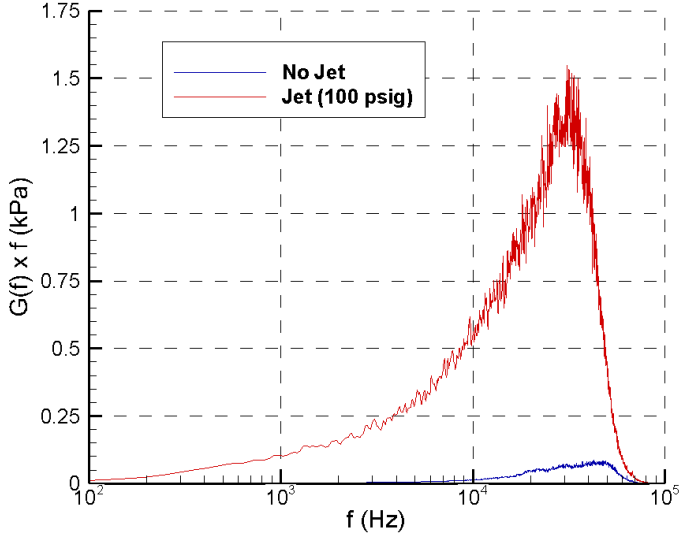
x = 212.6 mm



x = 274.5 mm



x = 298.3 mm



Pressure power spectra

(a) incoming boundary layer
(b)/(c) observed shock impingement locations
(d) downstream of injection port

- PSDs dominated by high frequencies of turbulent boundary layer passage
- No jet influence at upstream shock impingements
- Significant increase in magnitude of all frequencies downstream of jet injection