1. Jet characterization

- Freestream PLRS (Planar Laser Rayleigh Scattering) can not visualize downstream region in the vicinity of the jet.
- PLRS with CO$_2$ jet injection shows a trajectory of the jet, but hard to define what the signal means, probably, concentration field describing jet mixing (temperature/pressure distribution needs to be defined in advance).
- Measurement of jet upstream pressures including the jet chamber.
- Probably, improved Schlieren illustrating detailed jet/shock structure.
Jet Injection in Unstart Experiments

- Jet has been injected through complex geometry (will be modified to be smoother/simpler).
- Jet plenum pressure ($P(t)$) will be measured.
• Fully developed jet appears at $t = 12 - 13$ ms.
• The earliest evidence of jet injection is observed at $t = 8$ ms.
Jet Momentum Ratio

Ashkenas-Sherman Correlation

\[
\frac{l}{d} = 0.67 \sqrt{\frac{P_{\text{plenum}}}{P_a}}
\]

\[
P_{\text{exit}} = P_{\text{plenum}} \times (1 + \frac{\gamma - 1}{2})^{\frac{-\gamma}{(\gamma-1)}}
\]

Square Root of Jet Momentum Ratio \((R)\)

\[
R = \sqrt{\frac{(\rho u^2)_{\text{jet}}}{(\rho u^2)_{\infty}}} = \sqrt{\frac{\gamma_{\text{jet}} P_{\text{exit}} M_{\text{exit}}^2}{\gamma_{\infty} P_{\infty} M_{\infty}^2}}
\]

\[M_{\text{exit}} = 1 \text{ (Sonic Jet)}\]

- \(P_{\text{exit}}\) would vary with boundary layer and freestream flow conditions.
- Ashkenas-Sherman correlation has a finite associated uncertainty.
Jet Characterization

400 psi Jet (200 torr)  450 psi Jet  500 psi Jet  550 psi Jet

600 psi Jet (200 torr)  600 psi Jet (100 torr)
Jet Characterization

400 psi Jet

- Pure CO₂ jet injection with air freestream. (Concentration Field representing mixing characteristic??)
- These images are taken without upper splitter plate: in the presence of the upper plate, the scattering signal was not detected until tunnel unstart.
Jet Characterization

450 psi Jet
Jet Characterization
550 psi Jet
Validation and Comparison
Density Gradient Contours

• Qualitative features (density gradient) and quantitative properties (velocity) were compared.