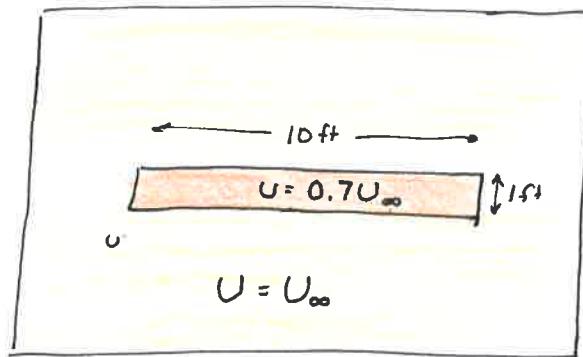
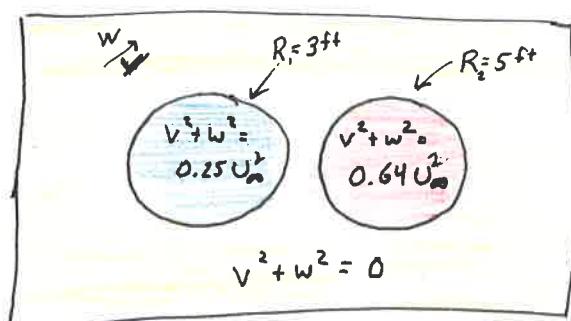
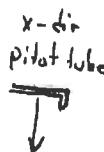
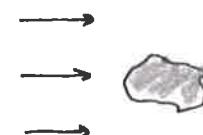


Ex: Behind an aircraft, we measure $\underbrace{axial\ velocities}_U$ and $\underbrace{radial\ velocities}_{v, w}$

Compute the drag at SSL and $100 \text{ ft/s} = U_\infty$



Axial velocity



Radial Velocity



Soln:

$$\begin{aligned} \text{Drag profile} &= \iint \rho U (V_\infty - U) dS = \iint \rho U_\infty (V_\infty - U_\infty) dS + \iint \rho (0.7 U_\infty) (V_\infty - 0.7 U_\infty) dS \\ &= 0.00237 \frac{\text{slugs}}{\text{ft}^3} \left| \frac{0.21}{\text{sec}} \right| \frac{100^2 \text{ft}^2}{\text{sec}} \left| \frac{10 \text{ ft}}{\text{slugs ft}} \right| \frac{1 \text{ lb f s}^2}{\text{slugs ft}} \\ &= \cancel{50 \text{ lb f}} \end{aligned}$$

$$\rho (0.7)(0.3) U_\infty^2 \cdot 10 \text{ ft}^2$$

$$\begin{aligned} \text{Drag}_{\text{vortex rotation}} &= \iint \frac{1}{2} \rho (v^2 + w^2) dS = \iint \frac{1}{2} \rho (0) dS + \iint \frac{1}{2} \rho (0.25 U_\infty^2) \pi R_1^2 dS \\ &\quad + \iint \frac{1}{2} \rho (0.64 U_\infty^2) \pi R_2^2 dS \\ &= \left[\frac{1}{2} \left| \frac{0.00237 \text{ slugs}}{\text{ft}^3} \right| \frac{0.25 \cdot 100^2 \text{ ft}^2}{\text{sec}} \left| \frac{\pi}{\text{sec}} \right| \frac{3^2 \text{ ft}^2}{\text{sec}} + \frac{1}{2} \left| \frac{0.00237 \text{ slugs}}{\text{ft}^3} \right| \frac{0.64 \cdot 100^2 \text{ ft}^2}{\text{sec}} \left| \frac{\pi}{\text{sec}} \right| \frac{5^2 \text{ ft}^2}{\text{sec}} \right] \frac{1 \text{ lb f s}^2}{\text{slugs ft}} \\ &= 680 \text{ lb f} \end{aligned}$$

$$\boxed{\text{Drag} = 729 \text{ lb f}}$$