

Turbulent Jet - Laminar Results

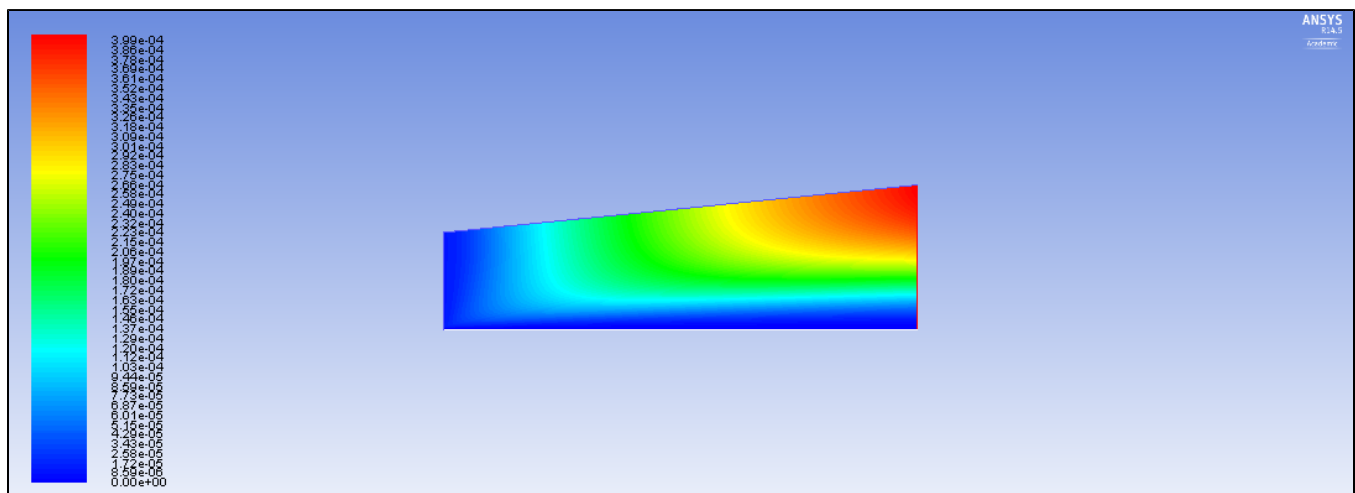
Authors: Lara Backer, Cornell University - taken in part from MAE 7340 Analysis of Turbulent Flows and Dr. S. Pope

Problem Specification

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Laminar Jet Results

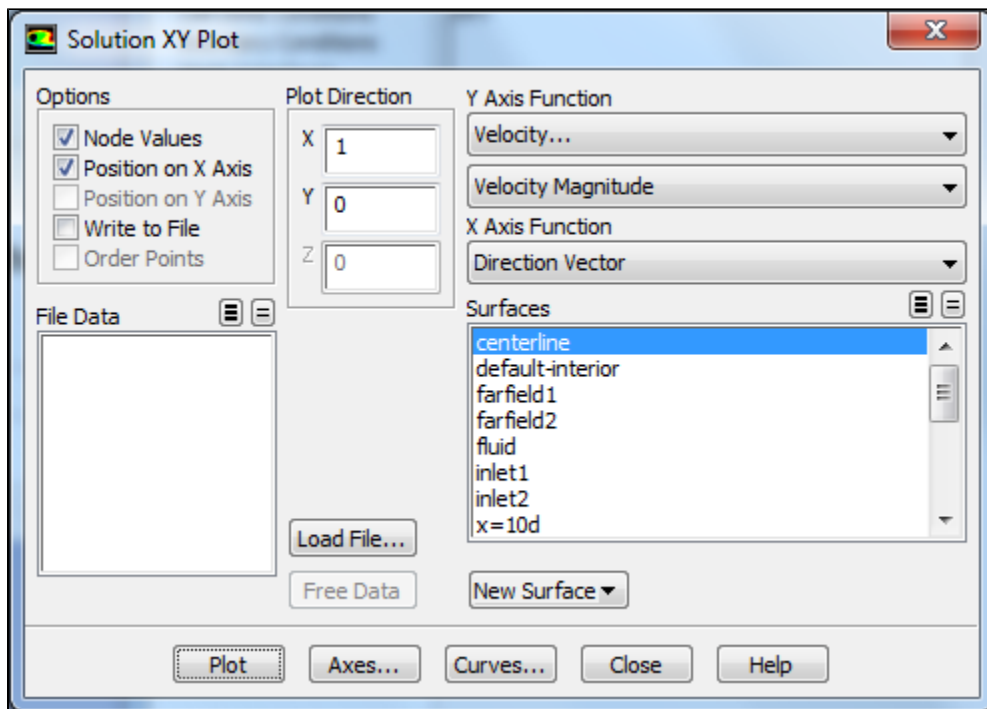
From the converged solution, plot the stream function as you did in the previous section (use the Results-Graphs and Animations Contours dialogue box):



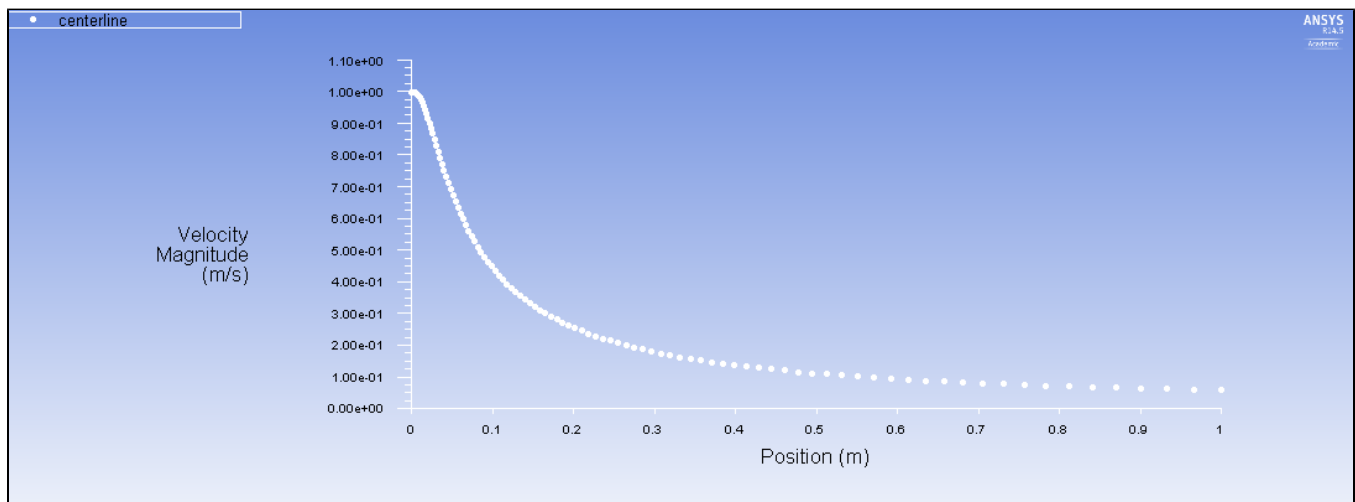
From these contours, you can observe that the air is being entrained near the jet inlet, and that the jet expands slightly along the x-direction. By knowing that the flow velocity is related to the stream function by $U = \partial \psi / \partial y$ and $V = -\partial \psi / \partial x$, one can see that the stream function values will be smaller in the entrainment and jet stream areas, because the flow is more strongly linear there.

Now go to Results-Plots. Select XY Plot and click "Set Up". Make a plot of how the axial velocity varies with axial distance x. This plot and the half-width plot that you will create below can be used to examine the self similarity of the solution.

To make the plot of the velocity variation along the centerline, adjust the XY plot dialogue box as shown below (in particular, adjust the values under Plot Direction so that the direction is along X):



Click "Plot". This will give you the centerline plot:

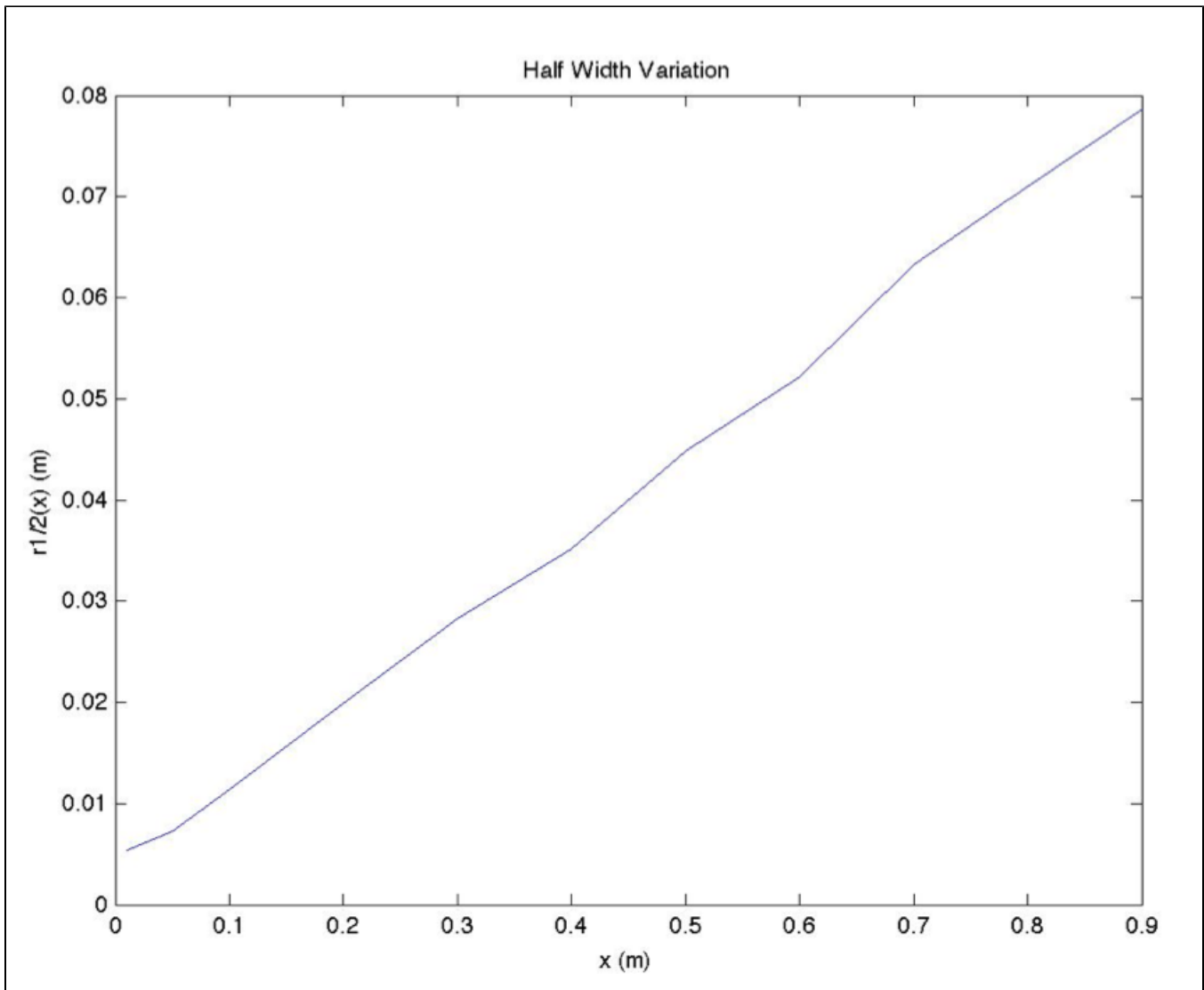


You can see that the axial velocity at the centerline (U_{center}) decreases sharply after the inlet, and that it will asymptotically approach 0m/s far from the jet. However, the half-width (Y distance at which $U=U_{\text{center}}/2$) increases along X as the spray expands.

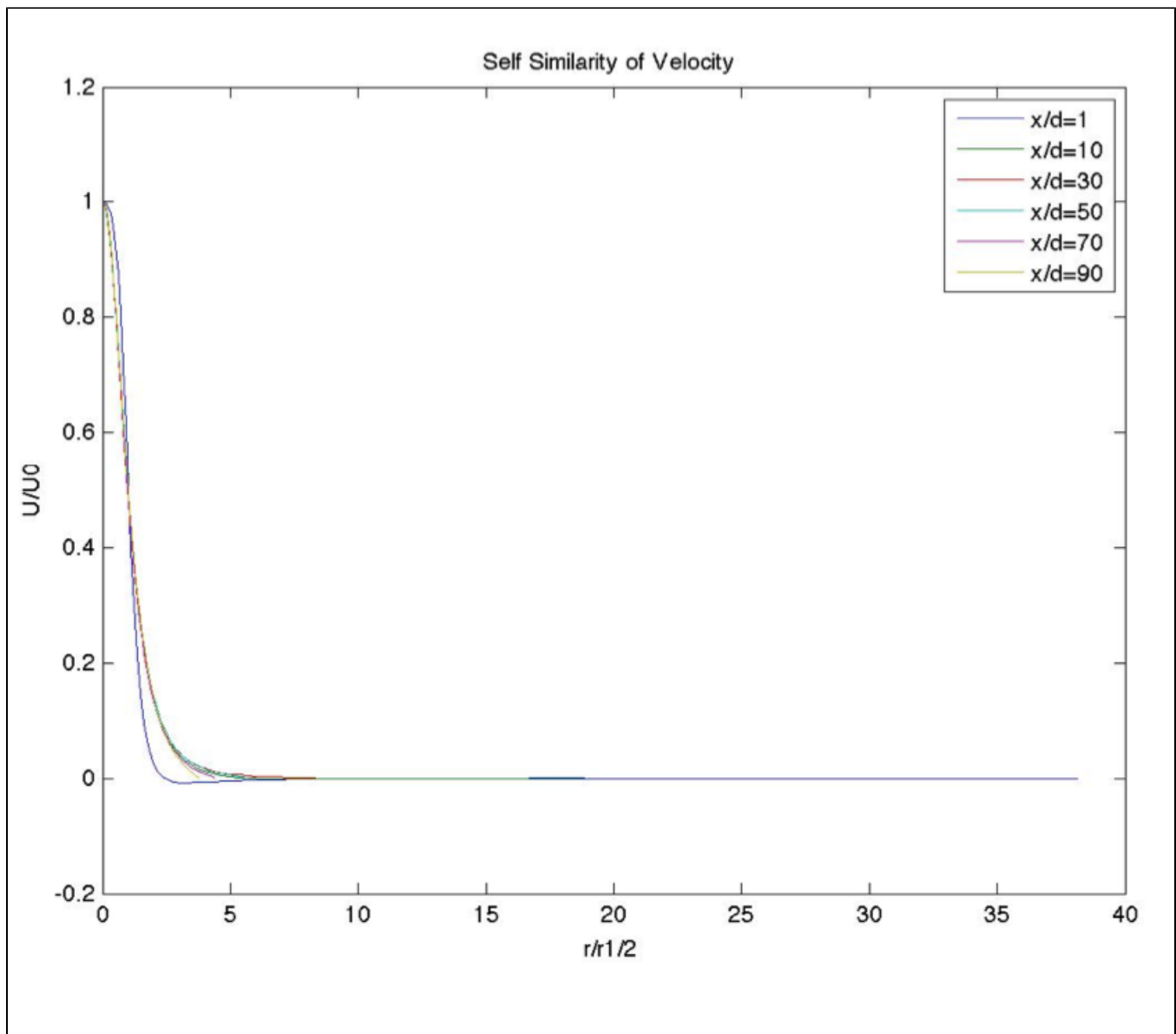
To obtain the half width, export the X coordinate, Y coordinate, and Axial Velocity:

Go to File-Export-Solution Data. Select 'X-coordinate', 'Y-coordinate', and 'Axial Velocity' as values to export. Export them along the centerline, and at various X locations (like surface X=10D) as ASCII file types. With the downloaded data, you can either copy it into Excel, or write a short Matlab script calling [this](#) function to read in ASCII files at the specified X locations (this is the easiest option!).

Using the Matlab script and plotting Y-coordinate half width locations (determined by examining the values read in to Excel/Matlab to find the closest Y-coordinate at each X-location you exported at which $U=U_{\text{center}}/2$) gives the half width variation $R(x)(1/2)$. The half width appears to increase approximately linearly along X. Keep these half width locations saved for future use.



An additional step is to plot the self-similar profiles of the axial velocity U (scaled by the centerline velocity U_{Center}) vs radial distance (the Y-coordinate scaled by the half width $R1/2(x)$ that you computed above) at various X locations, using the same exported data. The profiles appear to be self similar, although at X values closer to the inlet they do not match exactly due to entrainment effects.



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