Due Wednesday, March 9, 2015

A written report is required from each member of the student group performing the laboratory exercise. You are encouraged to work together to analyze the data. Your report should include the following:

- A brief description of the experiment.
- A sketch of the experimental apparatus, with all relevant dimensions, and the coordinate system.
- A description of the experimental set-up and procedure, including data reduction methods, and the value of all relevant parameters (i.e., Re, x/D, r1/2).
- You should submit your analyzed data as the following plots:
  - $\overline{w}(z/r_{1/2})/U_0$
  - $\overline{v}(z/r_{1/2})/U_0$
  - $\overline{w}(z/r_{1/2})/U_0$
  - $\sqrt{u'^2}(z/r_{1/2})/U_0$
  - $\sqrt{v'^2}(z/r_{1/2})/U_0$
  - $\sqrt{w'^2}(z/r_{1/2})/U_0$
  - $\overline{u'v}(z/r_{1/2})/U_0^2$
  - $\overline{uw}(z/r_{1/2})/U_0^2$
  - $\overline{vw}(z/r_{1/2})/U_0^2$
  - PDF’s of $u'/U_0$, $v'/U_0$, $w'/U_0$ at three representative $z/r_{1/2}$ locations (e.g., centerline, $z/r_{1/2} = 1$, and $z/r_{1/2} = 2$).
  - Scatter plots of $u'v'/U_0^2$, $v'w'/U_0^2$, $u'w'/U_0^2$ at three representative $z/r_{1/2}$ locations (e.g., centerline, $z/r_{1/2} = 1$, and $z/r_{1/2} = 2$).
  - Spectra of $u'$, $v'$, $w'$ at three representative $z/r_{1/2}$ locations (e.g., centerline, $z/r_{1/2} = 1$, and $z/r_{1/2} = 2$).
- A brief discussion of your results
Your group should select a distance from the jet orifice that is in the range $40 < x/D < 100$ and measure the profile of the velocity. Please report your $x/D$ location as part of your report! You may assume the flow is radially symmetric so you can make measurements in half of the jet flow only. You should measure beyond the centerline by a point or more to help verify that you have passed through the centerline and estimate the location of the true centerline.

The jet orifice diameter was drilled with a 15/64” drill. The flow rate, $Q$, has been measured with the current configuration by simply measuring how long it takes to fill a fixed volume. The determined flow rate is $Q = 103$ ml/s. Other useful values include that the jet centerline is located a distance 32.23 cm above the tank bed and a reading of 1.40 ft on the Vernier scale attached to the ADV is equivalent to the ADV central transducer a distance of 38.7 cm from the tank bed.

The Nortek Vectrino head has a thermistor embedded within it for the determination of water density (fresh water systems) and hence sound speed. Make sure to record the water temperature as viscosity is quite temperature sensitive and you will want to note the Reynolds number of your experiment. Also make sure that the salinity is set to 0 in the set-up.

Think a bit about how you will measure where the ADV measurement volume is in space and take advantage of the information above. The instrument reports the distance of the measurement volume to a boundary if the boundary is within about 30 cm. You could reference the ADV to the tank bottom by locating the ADV within 30 cm of the bed. Then note the elevation on the ADV mount scale (it is a Vernier) and reference this as your datum and then record the position of the ADV on the scale for each measurement. Given that you would prefer to work in the top-half of the jet profile (so as not to block the jet flow with the instrument) you may have to move too far from the bed for the instrument to detect the bed. If this happens you could put an object on the bed (i.e., piece of aluminum block) to give the ADV a fairly repeatable reference point that should always be within 30 cm of the ADV as you measure the jet profile. Make sure to remove any object before you actually make measurements and let the flow reestablish for at least one minute prior to making measurements.

You are left to decide how long you wish to sample each record. Keep in mind you need to get a reasonable estimate of the means, variances, and covariances. Also keep in mind that you will need to calculate three spectra so you may wish to grab longer records at those locations to allow ensemble averaging of multiple spectra.

Note that the tank leaks a bit. You should monitor the total water depth and adjust if it changes much to ensure that the free surface is at the same elevation above the bed.

Feel free to play and go beyond what is required!

Enjoy!