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Fluid mechanics

Lab on FPG

1. The local temperature measured at the lab room is around and the air pressure is . The properties of the air can be calculated with the following equations, the Sutherland’s law, the universal gas law and the definition of the kinematic viscosity.

So, the following result can be calculated.

1. The data file measured at the distance has 3 bad points and for the data file measured at the there are 4 bad points. The plots are showed below.

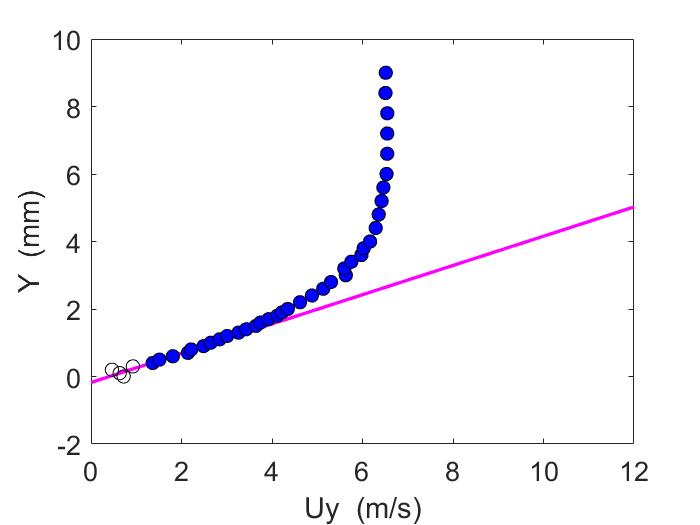
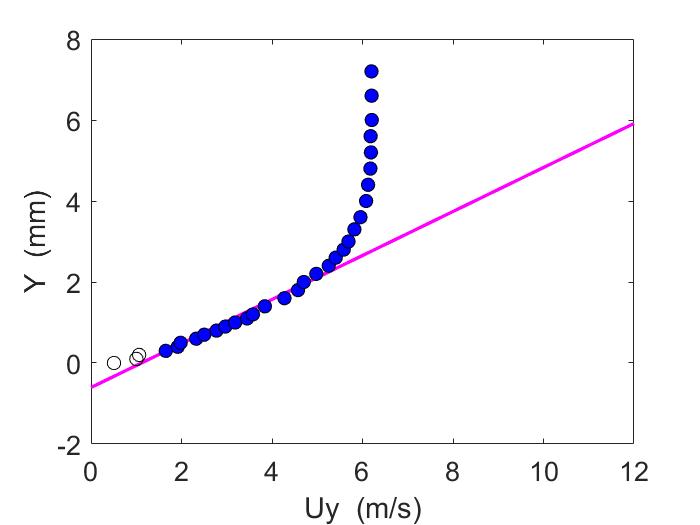
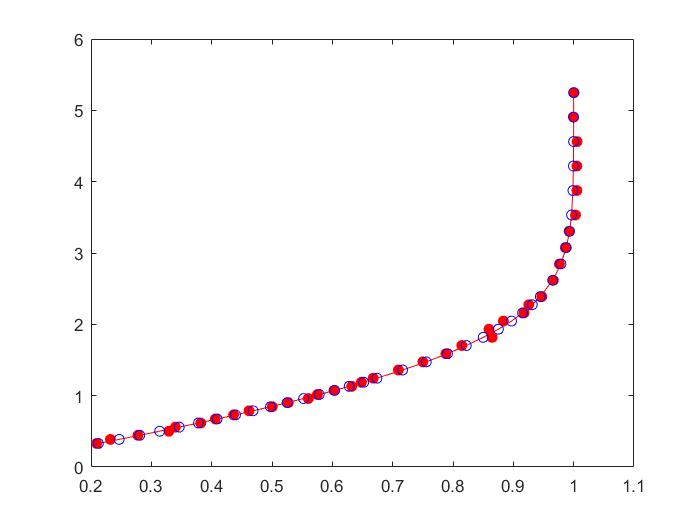
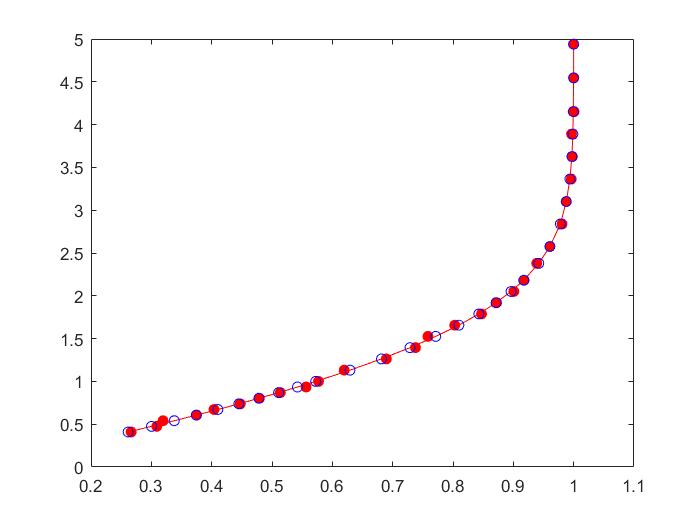


Fig 1: velocity profile at 500 mm Fig 2: velocity profile at 740 mm

The displacement thickness and the momentum thickness can be calculated with the following equations.

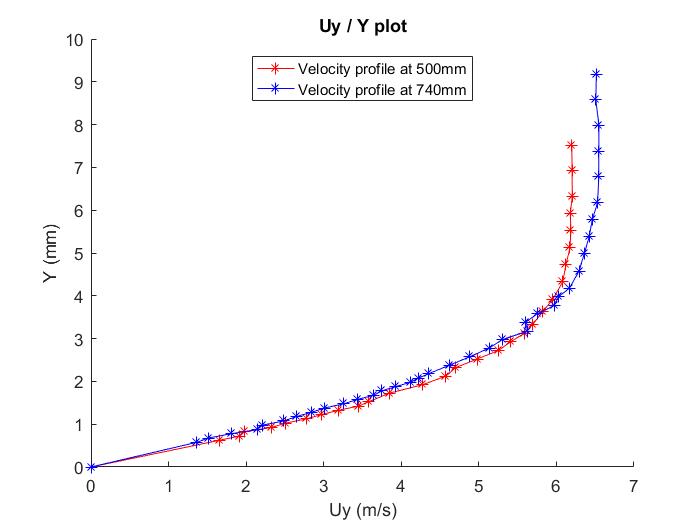
The following two plots contains the two normalized results.



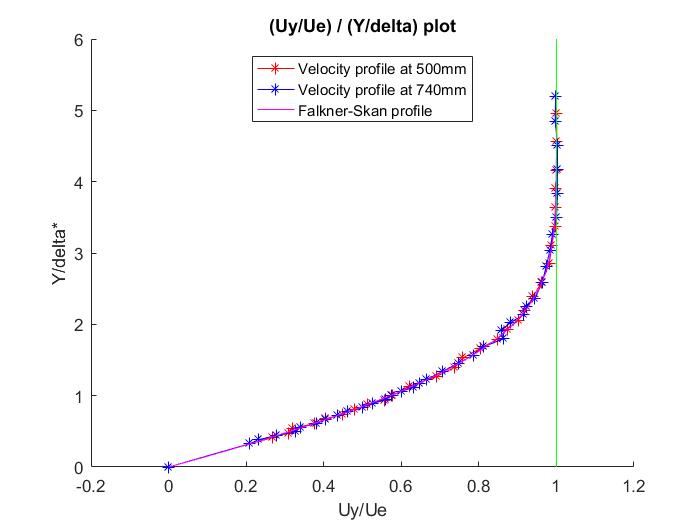
With the Falkner-Skan equation, the coefficient relation to can be calculated as well.

So, the Falkner-Skan profile corresponds to the relation of scaled thickness and velocity is the - relation.

* 1. and . So, the average factor is .
  2. The unscaled plot:



The two scaled plots:

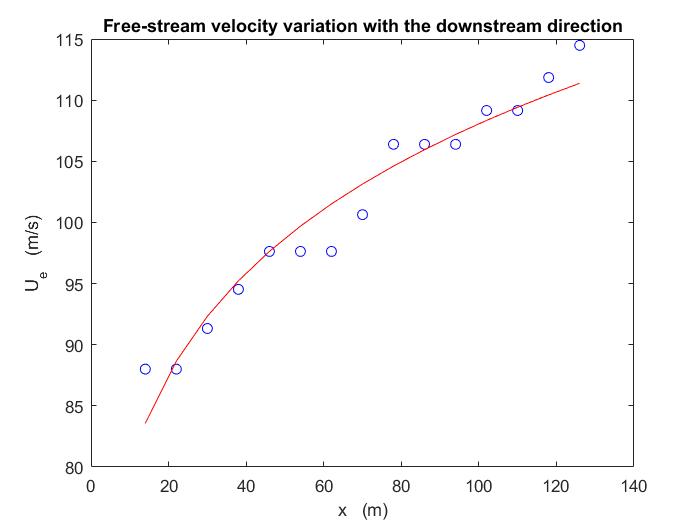


* 1. and . So, the average shape factor is then . With this shape factor, I can get the approximative -value to be around which is close to my .

1. In this task, I am going to calculate the free stream velocity with the pressure differences measure at the lab using the following equation.

Here , and . The height differences are calculated with a reference height . So, the resulting plot is showed below and the corresponding -value I get with this method is around which is approximately same as I got above. The calculated free stream velocity is

* 1. The plot is showed below.
  2. The -value is around .



1. In this task, I am going to derive the von Kármán momentum integral equation by hand so nothing is going to be showed here.
2. Here I am going to compare the skin-friction coefficient calculated from the lab data and from the theory.

In this task the displacement thickness to use is given by this formula.

Here I choose to continue this task with the velocity profile measure at the position of .

The theoretical skin-friction coefficient is given by:

For the theoretical value of we shall calculate it with the middle expression and for the experimental value the last expression shall be used. So, the theoretical skin-frictions coefficient is then:

The parameters in the last expression can be calculated in the following way.

I shall calculate this skin-frictions coefficient with two -values. One from the first task which is the one -value I calculated with the data from the profile measured at the point, i.e. . The second one is the one from the second task which is . So, the corresponding experimental skin-frictions coefficients are the following:

So, we shall get the following results.

* 1. , , .
  2. The ratios between the theoretical and experimental values are the following.