Appendix F
Translation Stage Requirements and Operation

Appendix F contains a description of and operating instructions for the translation stages used during the study discussed in this thesis. In all, four translation stages were required. One stage, shown in Figure F-1, is used to translate the laser sheet in the Mie scattering flow visualization experiment, whereas the other three stages are used together to translate the LDV probe in three axes, as shown in Figure F-2. All four steppers cannot be used simultaneously, because only three fully functional stepper drivers are available. The stand alone stepper driver, originally used to drive a variable swirl vane swirler, is damaged and currently only functions reliably in one direction. The three drivers mounted together are used during operation of the LDV, one for each axis. One of these drivers is reconnected to the laser sheet translation stage when its use is required for flow visualization experiments.

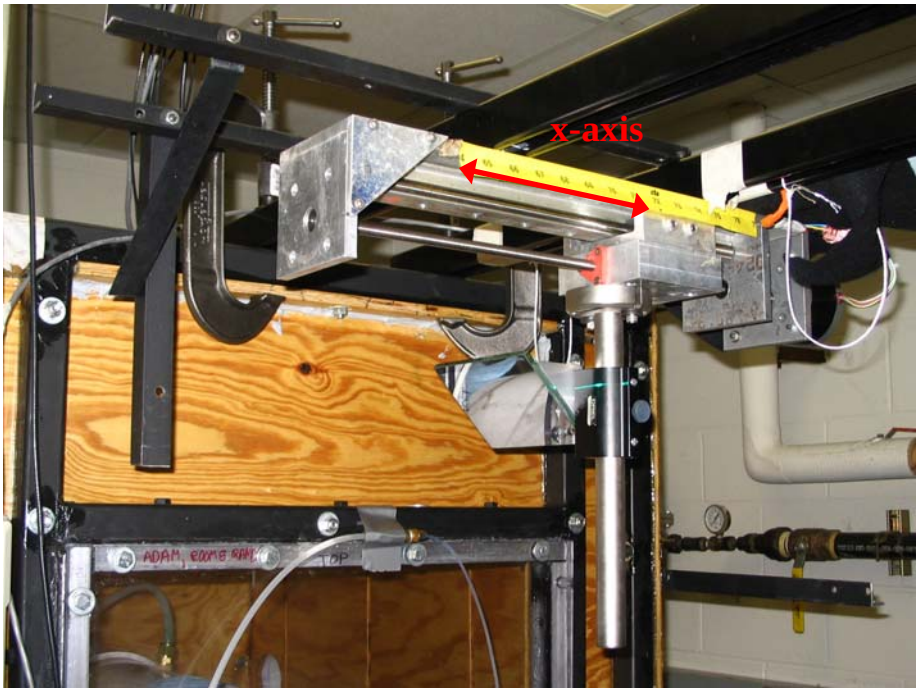

Figure F-1. Single translation stage used for Mie scattering flow visualization experiments.

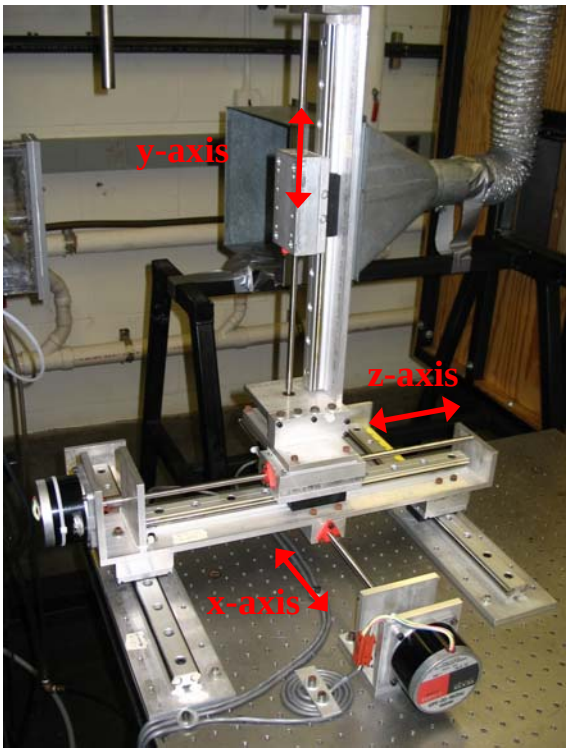

Figure F-2. Coupled translation stages providing three axes of motion for the LDV probe.

The functionality of each stage from LabVIEW to the stepper driver to the stage itself is identical, and therefore only one will be discussed here. The LabVIEW file 'StepperSample.vi' is a sample VI for operation of the translation stages. The VI initializes the required digital ports during the first iteration and then waits for user input instructions indicating the direction and distance to move. The direction is controlled by the sign of the distance input. Next, the VI computes the number of steps required to move the desired amount, and writes the direction to the digital port. It then sends the stepper driver a square wave with the number of pulses calculated previously. Finally, the sequence waits five seconds while the stage moves.

The direction and distance signals sent out by the computer go to the stepper driver, which generates the 'high' current needed to turn and hold the stepper, hence the name 'driver.' Each driver has four input pins: ground, step, direction, and enable. The enable pin is always high or 5 Volts. The step pin receives the square wave, and the direction pin is either high or low (0 Volts), depending on whether the distance entered is positive or negative. Figure F-3 shows three stepper drivers mounted together.

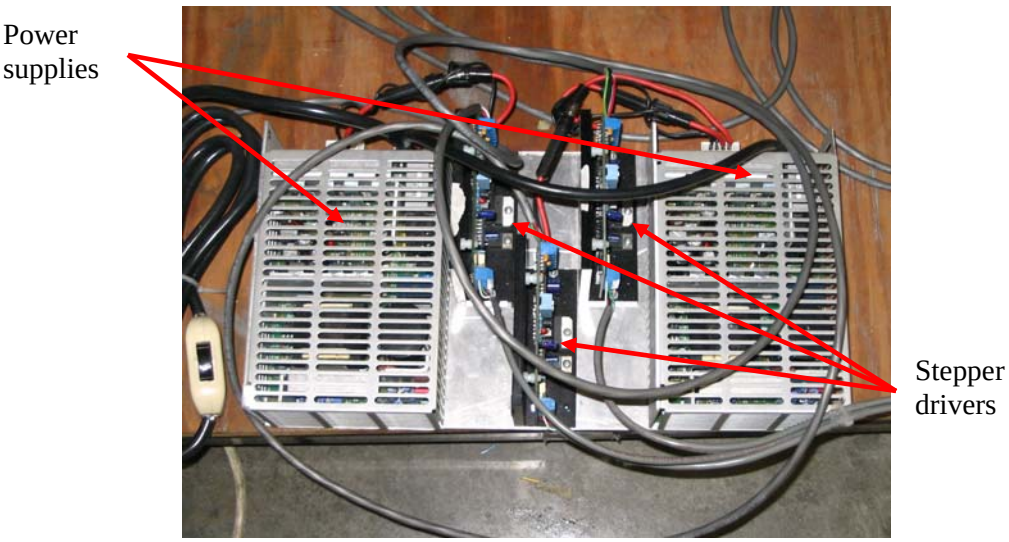

Figure F-3. Three stepper drivers mounted together (center) along with their power supplies (outside).

The stepper turns 1.8 degrees per step and the stage advances 1/16 inch per shaft revolution. Therefore, according to Equation F-1,

$$\left(\#\ of\ \ steps\right)\left(\frac{1.8^{o}\ \ per\ \ step}{360^{o}\ \ per\ \ rev}\right)\left(1/16\ inches\ \ per\ \ rev\right)=\left(\#\ of\ \ inches\right) \qquad \text{(F-1)}$$

the stage moves 0.0003 inches or 0.008 mm per step. This is the maximum theoretical resolution of the stage, which can only be achieved in a single direction. When changing direction, play in the power screw bearings reduces the resolution to 1 mm. For additional specific information regarding the stepper motors and drivers, consult the RFL equipment files.