

Appendix A

Mie Scattering Flow Visualization Testing Procedure

Appendix A contains a detailed presentation of the procedure used to operate the laser sheet flow visualization experiment. The procedure is written assuming that the reader has all necessary equipment set up and properly functioning.

1. Turn on laser head and allow one hour for warm up. Turn on all other required electronic equipment except the intensified camera and smoke generator. The following equipment should be turned on: air supply electronic pressure regulator and flow meter, 'LDV' and 'image capture computers,' and the old LDV electronics box.
2. Use horizontal and vertical rear reflector controls on the laser head to optimize the laser power output, as illustrated in Figure A-1. The laser power can be read on the front panel of the laser power supply, or for a more accurate measurement, a stand-alone laser power meter can be installed in front of the laser head.



Figure A-1. Laser head rear panel showing vertical and horizontal rear reflector controls.

3. Make necessary adjustments to the first and second mirrors of the sheet optics, shown in Figure A-2, to re-center the beam throughout the optical system. The first mirror allows the horizontal and vertical angles of the beam to be adjusted, while the first and second mirrors are used together to translate, or walk, the beam. The details of beam walking are discussed in the laser manual [5].

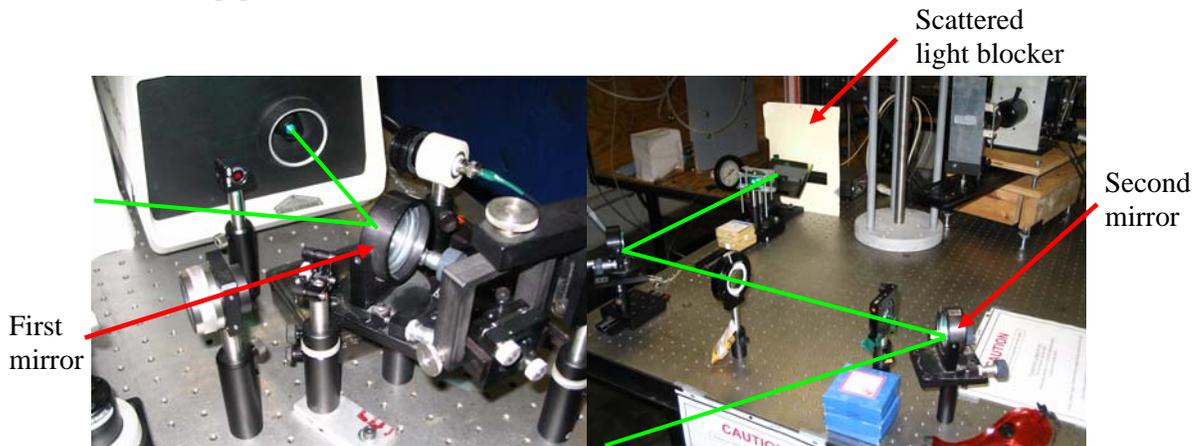


Figure A-2. First and second mirrors used to steer the beam from the laser head to the sheet forming optics. The green line approximates the beam location.

4. Check that the sheet translation stage stepper driver is turned off.
5. Manually adjust the final sheet mirror angle and translation stage so the sheet passes vertically through the center of the nozzle. This mirror and adjustment are shown in Figure A-3.

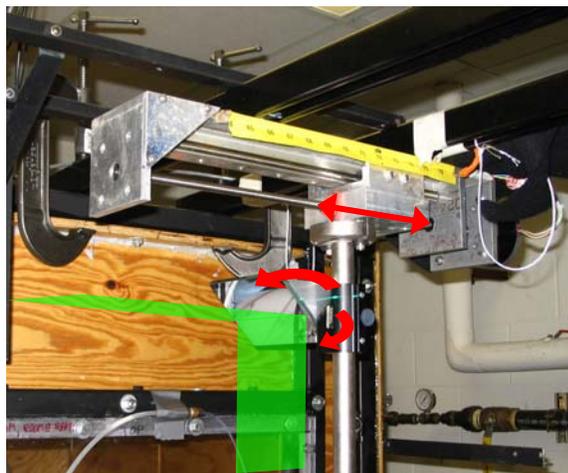


Figure A-3. Adjustment of final sheet mirror as illustrated by the arrows.

6. Adjust third beam mirror, shown in Figure A-4, so the brightest part of the sheet (the center) illuminates the area of interest (in this study, within two nozzle diameters downstream of the nozzle).



Figure A-4. Image showing third beam mirror location.

7. Block the beam as it exits the laser head.
8. Mount focusing device in the area of interest, see Figure A-5.

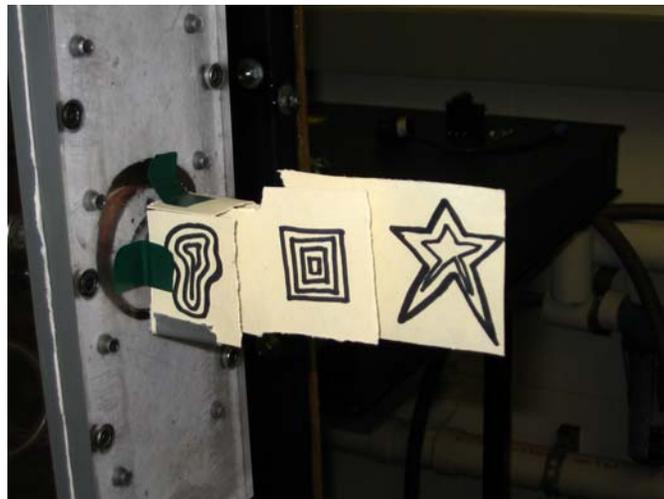


Figure A-5. Image showing the mounting position for a custom made depth of view testing tool.

9. Turn off overhead lights.
10. Open 'CaptureWithAverage.vi,' 'VideoCapture.vi,' and Hyper Terminal file 'IntensifiedCamera.ht.'
11. Run 'CaptureWithAverage.vi' and slowly try a combination of increasing camera gain, increasing intensifier gain, and lengthening exposure time until the focusing device becomes illuminated. If a clear and bright image is not achievable, a light can be projected onto the focusing device to brighten it; however, take care to start adjustments to the camera settings from low gains and short exposure times, to protect the intensifier. If any portion of the image stays bright white for a second, the intensifier could be damaged.
12. Once a clear image is established, adjust the lens focus to bring the squares into focus. Once the squares are in focus, the other two shapes (on the front and rear boundaries of our region of interest) should also be in focus. One of the reasons the lens was specifically selected for this experiment was because its depth of view allowed it to keep the entire flow in focus without adjustment. This step of the procedure provides a check of the depth of view.
13. Install the camera lens cap and turn on the sheet translation stage stepper driver.
14. On the 'LDV computer,' open 'H2controller.vi' and use it to move the sheet beyond the first measurement location and then back to it. Translation beyond and then back to the first point in a scan will counteract any play in the stage.
15. Turn on the air supply by increasing the pressure setting of the electronic regulator until the desired air flow is established. Then, turn on the 'fuel' flow and set the desired flow rate using the smoke rotameter. 'H2Controller.vi' contains the calibration data for the 'smoke' rotameter, so it can perform the conversion from the rotameter reading to flow rate in kg/s automatically.
16. Turn on the smoke generator thermocouple cold reference, multimeter, and set the generator power supply to 40 Volts initially. Monitor the oil bath thermocouple output on the multimeter and reduce the smoke generator power supply setting in order to maintain thermocouple output at or below 13.5 mV for fire prevention. Smoke quality improves as the temperature is increased,

but a fire in the smoke generator will melt the plastic tubing and electrical insulation. If the smoke generator is halfway submerged in an ice bath, the generator voltage can be increased to create additional smoke while the bath will keep the oil bath temperature lower, thus preventing fire. A fire can be detected by observing the air inlet tubing for flashing orange spots.

17. With 'CaptureWithAverage.vi' running, enter a number of images to average and click on the 'average' toggle. Click it off quickly after clicking it on. Give the saved averaged image a file name.
18. Move to the 'LDV computer' and use 'H2controller.vi' to translate the sheet the desired increment in the x direction. Also check that the air flow rate is holding at the desired value and make necessary adjustments.
19. Move back to the 'image capture computer' and capture a new average at this location.
20. Continue steps 18 and 19 until the sheet reaches the desired ending location.
21. Use 'H2controller.vi' on the 'LDV computer' to translate the sheet back to its original location.
22. To record a video: translate the sheet to a desired location, set a desired length of video and frame rate to capture, and run 'VideoCapture.vi' on the 'image capture computer.' This VI will prompt the user for a file name to save the '*.avi' file.

Note:

Blockers, such as the one shown in Figure A-2 must be implemented to block scattered laser light and other light from shining toward the test section. Light reflections off the Plexiglas test section components are much stronger than the light scattered by the smoke, so very bright spots are created in the image. Also, a black background, such as a black cloth, must be hung behind the test section to provide a clear image.