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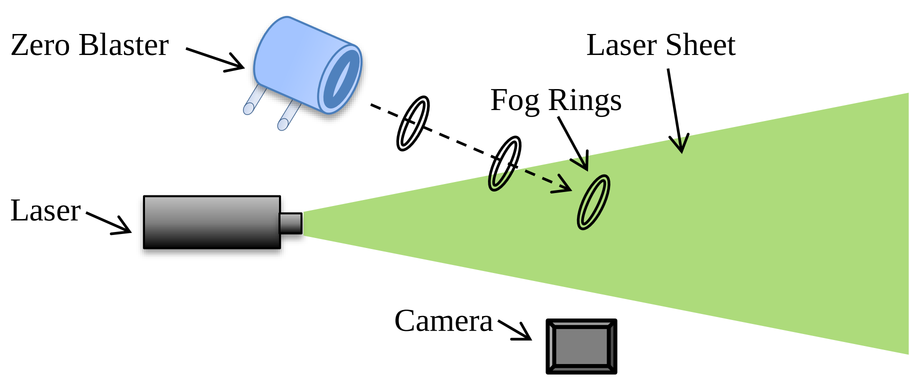
Team Image 1 Report:

This image was taken for my second group project. Our group decided to set up an experiment where we could photograph a turbulent jet as well as vortex rings. The turbulent jet was the result of fog being ejected from the fog machine while the vortex ring was created using a ZeroBlaster fog cannon. Using a laser sheet the team tried to capture slices of turbulent jets as well as parts of the vortex ring. We had seen awesome images of turbulent jets highlighted by a laser sheet and were excited to try to recreate such images.

To splice the flow, the team used a laser focused through a series of lenses to produce a laser sheet in Prof. Hertzburg's lab. The sheet was about 0.5 meters tall at the location being photographed. The diameter of the nozzle of the ZeroBlaster was 16 cm and the approximate velocity of the exiting fog was 1 m/s. The diagram below shows our experimental setup used to capture my image.



To capture this image we used the cylindrical lenses to spread the laser into a thin sheet. A fog machine was then used to fill the ZeroBlaster with dense stage fog. The ZeroBlaster was then fired at a diagonal along the length of the beam as illustrated by the figure above. All lights were shut off and the laser highlighted only a slice of the vortex ring as it moved across the sheet. The camera was shooting at 30 frames per second in order to capture the ring at many stages.

A vortex ring is formed by the development of a varying velocity profile. Vortex rings or toroidal vortices occur when a region on fluid rotates around a central access due to varying velocities. The velocity in the middle of the ring is moving forward at a constant speed while the outside of the ring has a higher pressure that causes it to rotate around itself. The shear forces in the air slow down the outer part of the ring while the inside of the ring is driven forward, these cause the swirling of the fog around itself creating a continuous ring. Surprisingly, the ring held it shape for almost a meter before beginning to dissipate due to frictional losses. Calculating a Reynolds number for vortex rings can range from about 320 to 7300 and span both laminar and turbulent flows.

The image was captured with a Canon EOS 10D DSLR camera. The camera was about 1 meter from the laser sheet and was fixed on a tripod. The total field of view was about 40 cm wide and 25 cm tall. The camera was manually focused and had a shutter speed of 1/1000 second. The aperture value was f/4.5 with and ISO of 400 and a focal length of 60mm. The final edited image was 1280 pixels wide and 719 pixels tall. I chose this image out of the sequence of images that we shot because I felt that it did the best job capturing the physics of a vortex ring. The contrails of the fog clearly illustrate that it is moving and the bright whites within the ring itself show the internal rotation of the ring. I slightly adjusted the contrasted and enhanced that saturation of this image to reveal the highlights on the ring itself.

Overall, the image does a good job revealing the physics of a vortex ring and the varying velocity profiles that create them. Unfortunately the powerful laser and the safety requirements associated with it limited the angles and shooting options that we could use. The room was also completely dark during the capturing of images so it was difficult to tell what was being captured. I was pleased with this image and thought that it looks like a jellyfish which is interesting because jellyfish produce vortex rings as a means of propulsion.