**Advanced Measurement Techniques in Fluid Mechanics and Heat Transfer**
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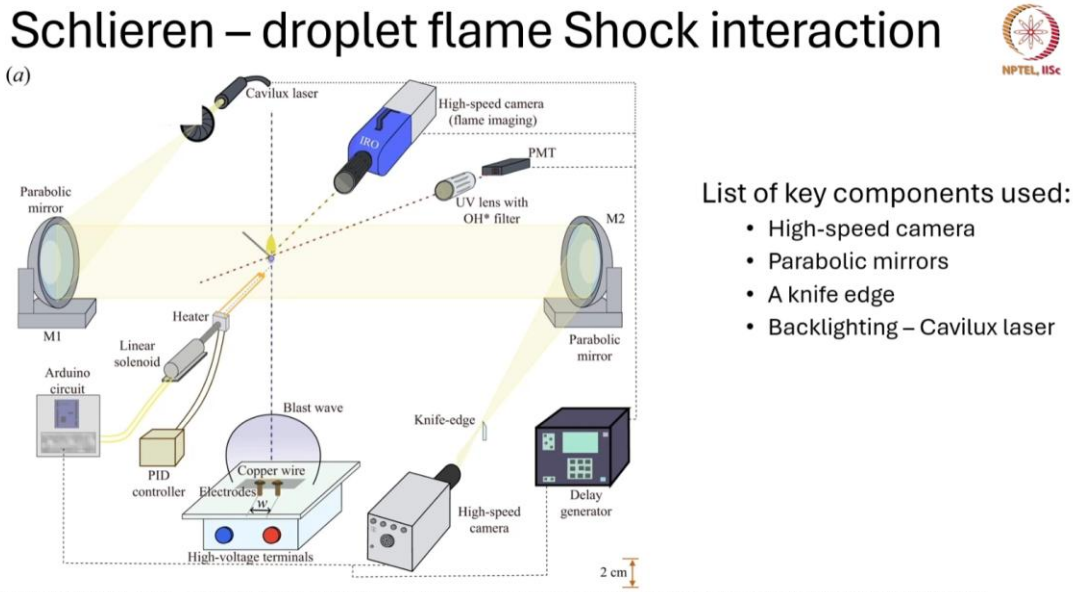
**Week – 05**
**Lecture - 22**
**Overview of Experimental Techniques – 2**

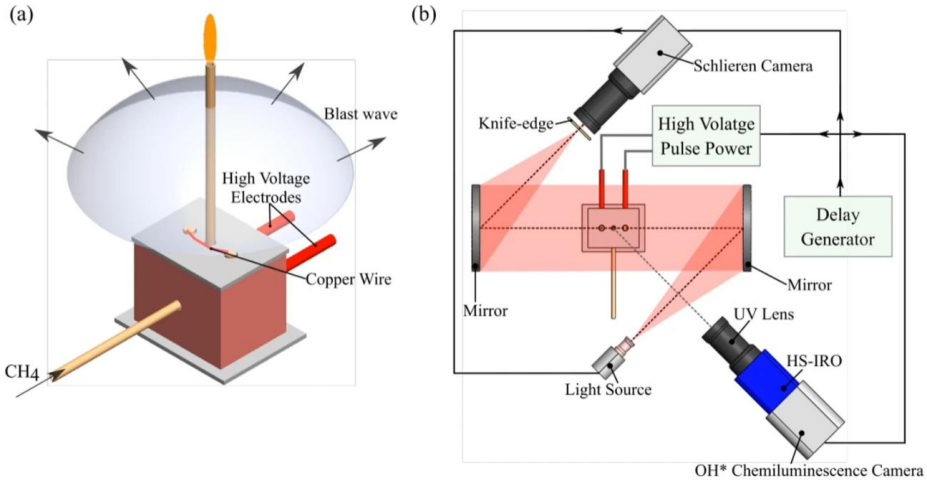
As the next part of our measurement technique series, we will be showcasing the results obtained using the Schlieren technique. In this demonstration, we will observe the interaction between a droplet, a flame, and a shock wave. The Schlieren technique is particularly effective for visualizing density gradient changes in the flow. making it ideal for this type of experiment. As you watch, you will be able to see the shockwave's propagation and interaction with the flame. These interactions reveal the complex flow patterns and flame behavior under the influence of shockwaves.




Vadlamudi G, Aravind A, Rao SJ, Basu S. Insights into spatio-temporal dynamics during shock–droplet flame interaction. *Journal of Fluid Mechanics*. 2024;999:A22. doi:10.1017/jfm.2024.575

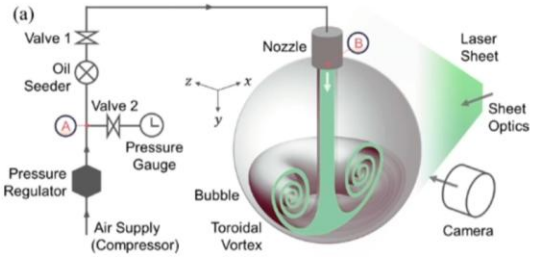
As the next example of Schlieren technique, we will showcase the interaction between a jet flame and a shock wave. To provide a more comprehensive view, we will display an OH chemiluminescence video alongside the Schlieren video. While the Schlieren technique highlights the density gradients and fluid dynamics caused by the shock wave. The OHQM luminescence video captures the flame's radical emissions, allowing us to see how the shock impacts the flame's chemical and thermal structure.

## Schlieren – jet flame interaction with shock



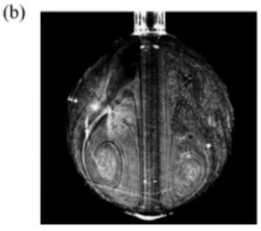

As the next part of our measurement technique, we will introduce you to particle image velocimetry, or shortly called PIV. This PIV is a widely used technique for visualizing and measuring velocities within a flow field. In this method, tiny particles are introduced into the flow, and these particles move along with the fluid. By tracking their motion, we can map the velocity distribution across the flow field. For this experiment, we will be using a high-speed camera, a high-speed laser, a PTU for synchronization, and a bandpass filter to ensure that only the laser light signals are captured by the camera.

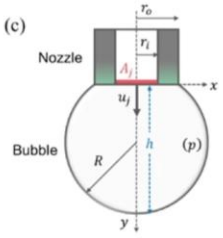
## Particle Image Velocimetry – Soap Bubble Inflation




List of key components used:

- High-speed camera
- High Speed Laser
- Programmable Timing Unit (PTU)
- Band pass Filter



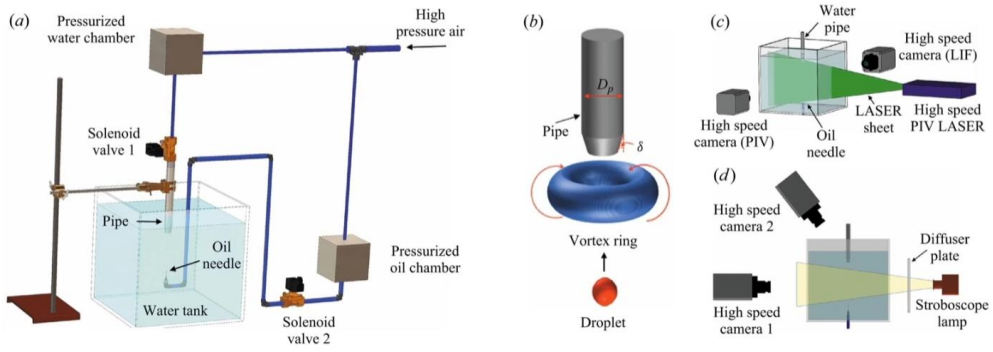




Rao, Saini Jatin and Jain, Siddhant and Basu, Saptarshi, "Dynamics of soap bubble inflation", Phys. Rev. Fluids, 2024. doi = {10.1103/PhysRevFluids.9.L051602}

To demonstrate this technique, we will. Showcase the results obtained from the inflation of a soap bubble; as the next example, we will showcase the interaction of a droplet with a vortex ring. In this visualization, you will observe the vector field of a vortex ring and

how it evolves as it approaches and interacts with the droplet. The particle image velocimetry technique provides. Detailed insights into the velocity field and flow dynamics around the droplet.

## PIV – Vortex Droplet interaction



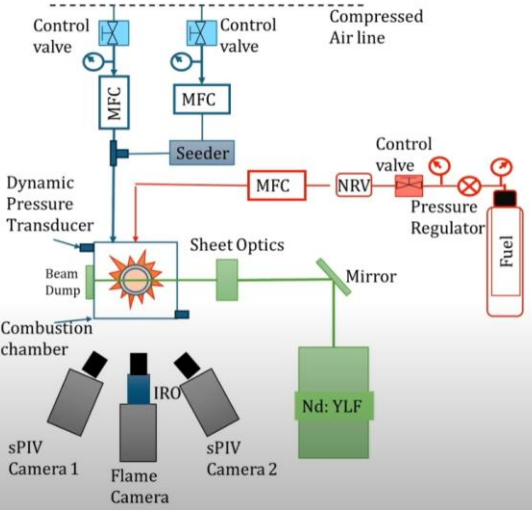


harma S, Singh AP, Basu S. On the dynamics of vortex–droplet co-axial interaction: insights into droplet and vortex dynamics. *Journal of Fluid Mechanics*. 2021;918:A37.
oi:10.1017/jfm.2021.363


To provide a more comprehensive understanding, we will present the shadowgraphy images side by side with the PIV results. This combination allows you to compare the structural visualization of the interaction with the quantitative velocity data. In this example, we will visualize the velocity field within the soil-reacting flow. To provide a comprehensive analysis, we have included OH chemiluminescence videos alongside the velocity field measurements. The chemiluminescence imaging highlights the radical emissions and gives insights into the chemical reactions occurring within the flow.

In the velocity field, you will observe the movements of the vector field that depict the dynamic flow behavior. Finally, we will present the corresponding streamlines, enabling a clear visualization of the vortex movements and how they evolve within the soil flow.

# PIV – Swirl flow




List of key components used:

- High-speed camera
- High Speed Laser
- Programmable Timing Unit (PTU)
- Band pass Filter
- High Speed IRO