Overview and Background

- The present work solves the problem of laser flare in Particle Image Velocimetry (PIV) by using fluorescent particles.
- PIV is a laser flow diagnostics technique used to map a velocity field in a moving fluid.
- In PIV, a camera takes two images of seed particles in the flow illuminated by a laser causing Mie scattering. Velocity is calculated from the displacements of the particles.
- PIV is widely used in the aerospace, mechanical engineering, and medical fields.

Motivation

- A major problem with PIV is laser flare, coming from reflections off of solid objects in the flow.
- In regions of laser flare, particles cannot be tracked and velocity cannot be calculated.
- Surface treatments are available for object surfaces, but they are expensive, fragile, labor intensive, and/or potentially carcinogenic.

Experimental Setup and Theory

- The present research uses 1 micron plastic microspheres doped with Kiton Red 620 fluorescent dye.
- Fluorescent light is emitted at a higher wavelength than the laser light, due to the Stokes shift.
- An optical filter is used to block all laser light.

Experimental Results

- Two cameras imaged the same region of flow: one using fluorescent PIV, the other using traditional PIV methods.
- The fluorescent signal was measured to be 100-225 times lower than Mie scattered signal from particles.
- With appropriate laser strength and optics, this signal difference can be easily overcome, and fluorescent particles can be used in any PIV application.

- Tests were run with an aluminum flat plate placed in the flow.
- The resulting laser flare is easily visible in the raw image (top left).
- In this test, flow velocities could not be measured within 5-10 mm of the plate surface (bottom left).
- The use of fluorescent light eliminates all of the laser flare except for particles stuck on the plate surface (top right).
- Flow velocities can be calculated all the way down to the plate surface (bottom right).

<table>
<thead>
<tr>
<th>Technique</th>
<th>Percent Valid Data</th>
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<tbody>
<tr>
<td>Fluorescence</td>
<td>99.0%</td>
</tr>
<tr>
<td>Mie</td>
<td>36.6%</td>
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</tbody>
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Publications and Future Work

- Current Publications:

- Future work:
  - Expand testing to include larger flow facility applications
  - Optimize particle doping techniques for greatest fluorescent light signal

* A typical “good” value in PIV is 95% valid.