

## Hollow Waveguide Laser Delivery System for Digital Particle Image Velocity

### Technology Summary

Particle Image Velocimetry (PIV) is a non-intrusive, laser optical measurement technique where the velocity field of a region of medium is measured to determine flow, turbulence, microfluidics, and spray atomization. **This technology is an improved laser optical system dubbed an all-hollow-waveguide digital PIV (AHW-DPIV) illumination system to illuminate particles within a fluid under observation.** The AHW-DPIV illumination system consists of: a) a hollow and tapered glass funnel (optical taper); b) a hollow optical waveguide coupled to the hollow optical taper; and c) a beam shaping optical system coupled to the waveguide.

FDA inventors improved the high-peak-power delivery capabilities of the AHW-DPIV illumination system through the developed of a cyclic olefin polymer (COP)-coated hollow glass waveguide. The (COP)-coated hollow glass waveguide minimizes the waveguide attenuation losses of a typical DPIV laser (532nm). Studies confirm the COP-coated hollow glass waveguide provides significantly higher laser power without damaging effects (>1 GW/cm<sup>2</sup>) compared to a conventional solid-core fiber link. Additional features include flexible formatting of thin (0.5-1.0 mm), wide (10 mm or wider) and uniform laser illumination sheets; immunity to external influences (including vibrations and angular laser beam drift), and safe and confined laser delivery.

### Potential Commercial Applications

- Optics
- Particle imaging
- Velocimetry

### Competitive Advantages

- Higher laser power capabilities
- Higher damage threshold
- Amplified signal for detection
- Reduced wavelength attenuation losses
- Simplified alignment
- Reduced external noises

**Development Stage:** Early

**Inventors:** Ilko Ilev, Ronald Robinson, Ronald Waynant

### Publications:

- IK Ilev and RW Waynant. Grazing-incidence-based hollow taper for infrared laser-to-fiber coupling. Appl Phys Lett. 1999 May;74(20):2921-2923. [PMID: 25362372](#)
- IK Ilev and RW Waynant. Uncoated hollow taper as a simple optical funnel for laser delivery. Rev Sci Instrum. 1999 Oct;70(10):3840-3843. [Link](#)
- IK Ilev et al. Ultraviolet laser delivery using an uncoated hollow taper. IEEE J Quantum Electron. 2000 Aug;36(8):944-948. [Link](#)
- IK Ilev et al. Attenuation measurement of infrared optical fibers using a hollow-taper-based coupling method. Appl Opt. 2000 Jul 1;39(19):3192-6. [PMID: 18349883](#)

### Intellectual Property:

United States Patent No. [7,787,106](#) issued 08.31.2010

**Product Area:** optic taper, laser, optics, particle imaging, velocimetry, flow, velocity, detection, wavelength, waveguide, coating, glass, system, measurement

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