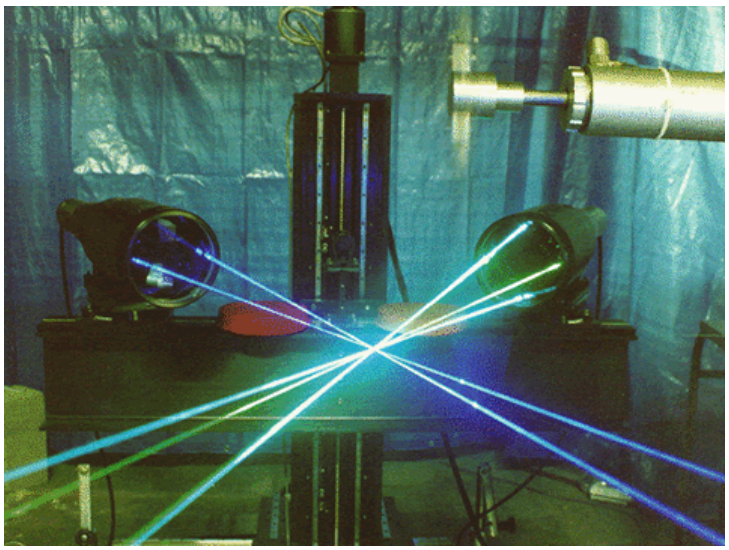
Measurements of Rotor Tip Vortices Using Three-Component Laser Doppler Velocimetry

Courtesy: University of Maryland

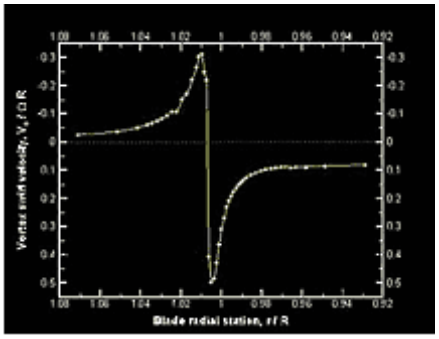
Application Note LDV-004



Phase-resolved measurements were made of the three-dimensional velocity field and tip vortex structure in the wake of a hovering rotor using laser Doppler velocimetry (LDV). A one-bladed rotor was used to generate a single helical vortex in the rotor flowfield. The measurements were analyzed to establish the detailed structure of the rotor tip vortex, such as tangential velocity profile, axial velocity deficit, circulation distribution, core size, and core growth with vortex age.

A three-component fiber optic based LDV system was used to map the wake field. The transmitting optics consisted of a pair of fiber optic probes with beam expanders. Because of the large scale of the experiment, a multi-Watt water-cooled laser and XPD60 beam expanders were used. TSI Digital Burst Correlators were used to process the burst signals. A rotary encoder enabled the measured data to be tagged with blade azimuth information.

This plot depicts a very large amount of LDV data taken over one rotor revolution across a radial grid. This animation is very simple but provided a wealth of information.



Play Animation

(*Flash Movie* - 438K)

The Y-axis is the inflow through the rotor. The X-axis is the radial position where 1 is the blade tip and 0 is the hub. At the beginning of the animation nothing is happening, then you will see the blade passage. Shortly thereafter a very clean vortex will move across the grid. The data was separated into 360 zones - one for each degree that the blade moved. What you are seeing is an animation of every zone. Tecplot graphical display package was used in this way to find out when the vortex moves across the grid.

TSI Incorporated – 500 Cardigan Road, Shoreview, MN 55126 U.S.A

USA	**Tel:** +1 800 874 2811	**E-mail:** info@tsi.com	**Website:** www.tsi.com
UK	**Tel:** +44 149 4 459200	**E-mail:** tsiuk@tsi.com	**Website:** www.tsiinc.co.uk
France	**Tel:** +33 491 95 21 90	**E-mail:** tsifrance@tsi.com	**Website:** www.tsiinc.fr
Germany	**Tel:** +49 241 523030	**E-mail:** tsigmbh@tsi.com	**Website**: www.tsiinc.de
India	**Tel:** +91 80 41132470	**E-mail:** tsi-india@tsi.com	
China	**Tel:** +86 10 8260 1595	**E-mail:** tsibeijing@tsi.com	

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