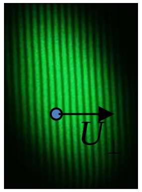
AUR, Inc. Capability

Advanced AUR Laser Doppler Velocimeter

AUR, Inc. Blacksburg, VA

How the Technique Works

Parallel fringe



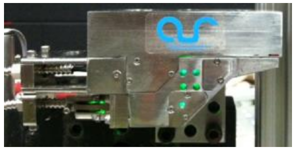
Converging fringe

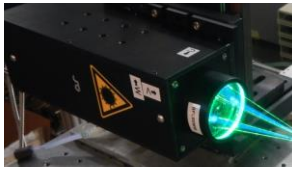
- Coherent laser interference (fringe pattern) used to observe Doppler shift(frequency) of light.
- Particles which follow the flow scatter light when they pass through a measurement volume.
- Frequency of scattered light is detected by a photomultiplier tube.
- Velocity component normal to fringes = (frequency) x (fringe spacing)
- Additional converging fringe pattern provides particle position in a measurement volume.

Setup Photos

Laser Cart

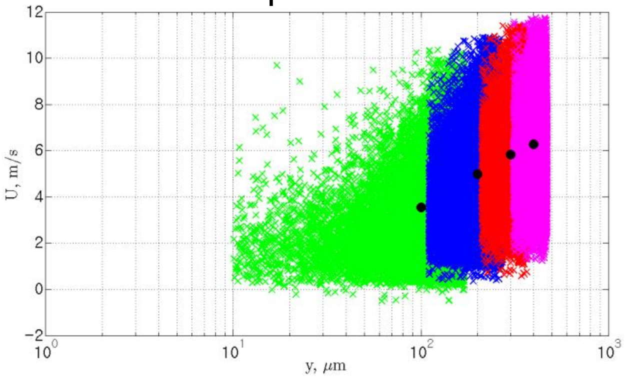
LDV Probe





Laser cart is connected to probe head with fiber optics.

Sample Result



Each color shows the data from one stationary measurement volume; ● mean velocity. Note data at y ≥ 10μm above the wall.

What is measured, with what uncertainty, rate, resolution:

- Instantaneous velocity with data rate ~100Hz/(m/s) and uncertainty of ~0.3% of $|\vec{V}|$.
- Spatial resolution of ~100 μm.
- Reynolds stresses and higher order products.
- Velocity spectra, auto / cross-correlations and small length scales by AURSTUDIO™ signal processing.
- Position resolution of ±5μm within 100 μm measurement volume along a optical axis.
- 3 Velocity components +1 position component.
- Skin friction for wall-bounded flows.

Maturity: TRL 1 2 3 4 5 6 7 **(8)** 9

- Measurements have been demonstrated from Mach 0 to 2.0 in a large scale facility (0.23 meter supersonic facility at Virginia Tech)

Target Environments: **P, T:** 0.1 < P < 10 atm; 80 < T < 2000 K

Subsonic | Transonic | Supersonic | Hypersonic | Combustion | Flight

Not yet demonstrated (Hypersonic, Combustion, Flight)

Key Applications:

AUR LDV can characterize and quantify flow structure for further understanding of flow physics for complex 3-D flows.

Main Advantages:

As small as 8 in^3 to install inside of a test model with one accessing window. Stand-off distance as long as 4 ft. Particle position-resolving 3-velocity-component data within a measurement volume. Customized probe head to satisfy measurement goals.

Main Disadvantages / Limitations / Risks:

Seeding particles (diameter ≥ 30nm) are required.

Resources Required: plan, setup, perform, analyze data, report

Test Duration	Setup days / Teardown	FTE	WYE	Procurement Required
5 days	5/2		0.18	$16k
20 days	5/2		0.33	$30k

Current Support: NASA LaRC

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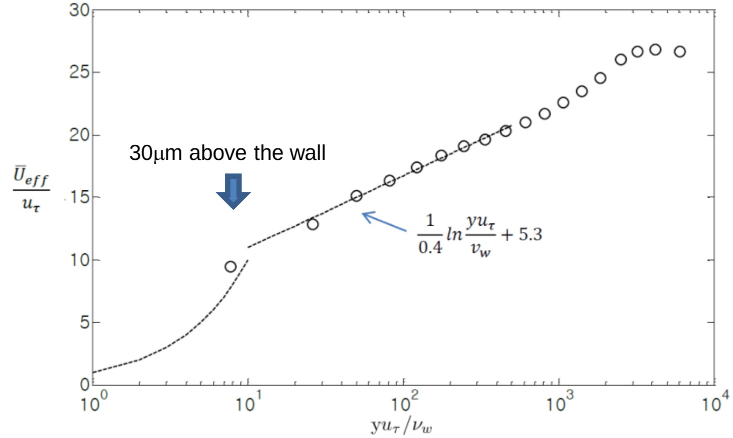
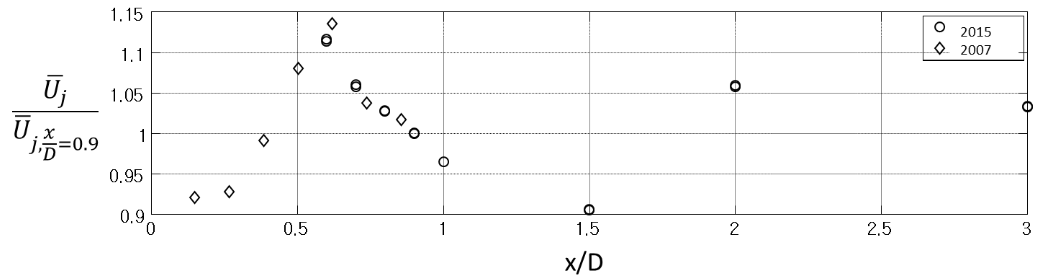
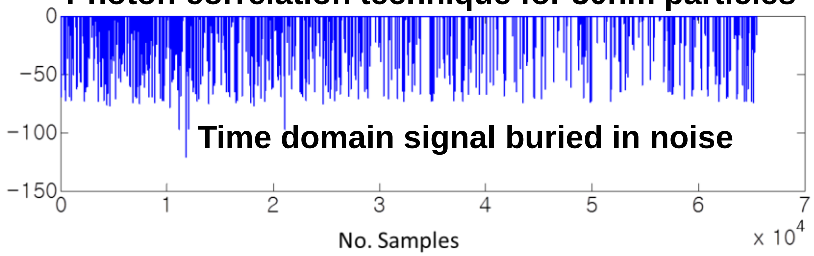
M=2.0 Supersonic Turbulent Boundary Layer[1] Mean Velocity Profile (law of the wall)

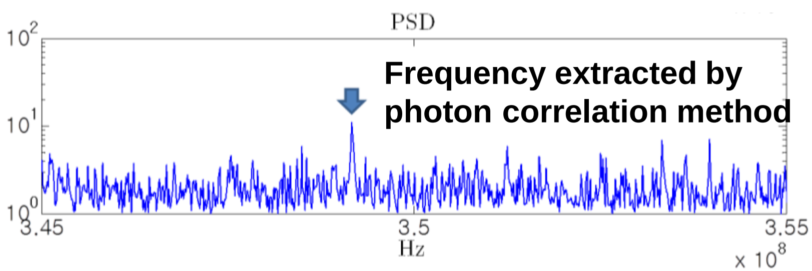


Jet flow along the centerline, $\bar{U}_{j,\frac{x}{D}=0.9}$ = 420m/s [2]

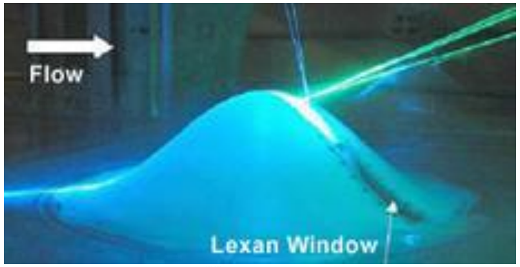


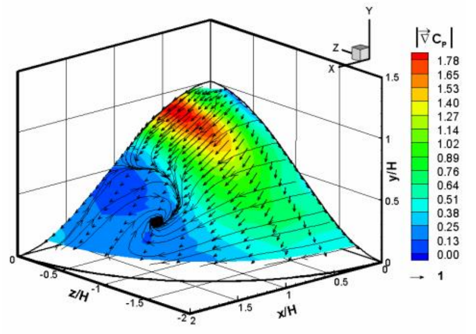
Photon correlation technique for 30nm particles[3]

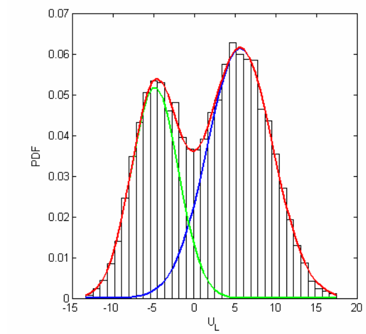




Near-surface velocity field over an axisymmetric bump[4]







References:

1. Byun, G., Lowe, K.T. and Simpson, R.L., 2012, "Surface Roughness Effect on Supersonic Turbulent Boundary Layer Structure", AFOSR Report.
2. Simpson, R.L. and Byun, G., 2017, "Near-Field Velocity Measurement System for Wind Tunnel Testing", Air Force SBIR Report.
3. Simpson, R.L.. And Byun, G., 2016, "Small Sub-micron-Particle Position-Resolving Laser-Doppler Velocimeter for High-Speed Flows", NASA SBIR Report.
4. Byun, G., 2005, "Structure of Three-Dimensional Separated Flow on Symmetric Bumps", Dissertation, Virginia Tech.