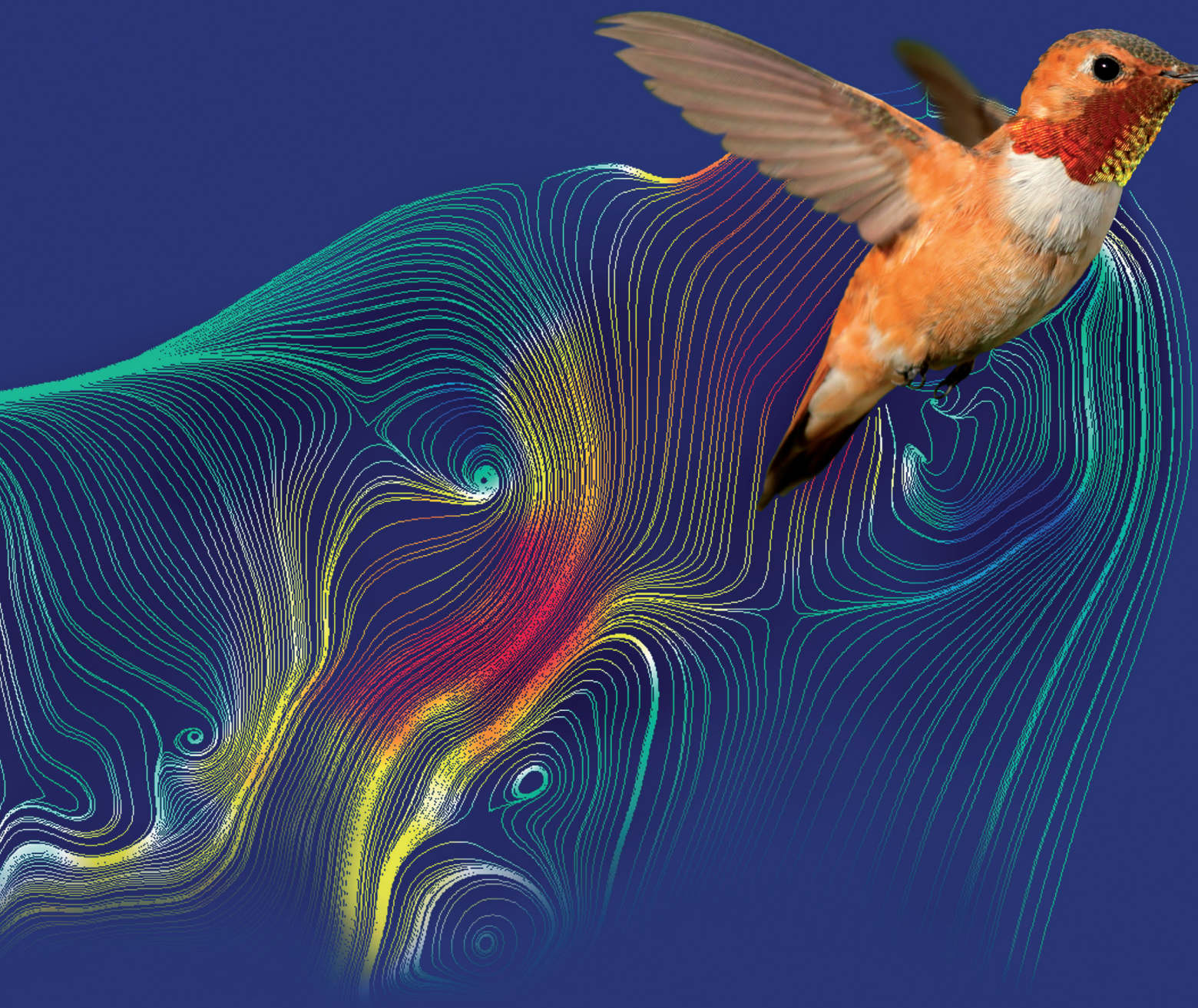
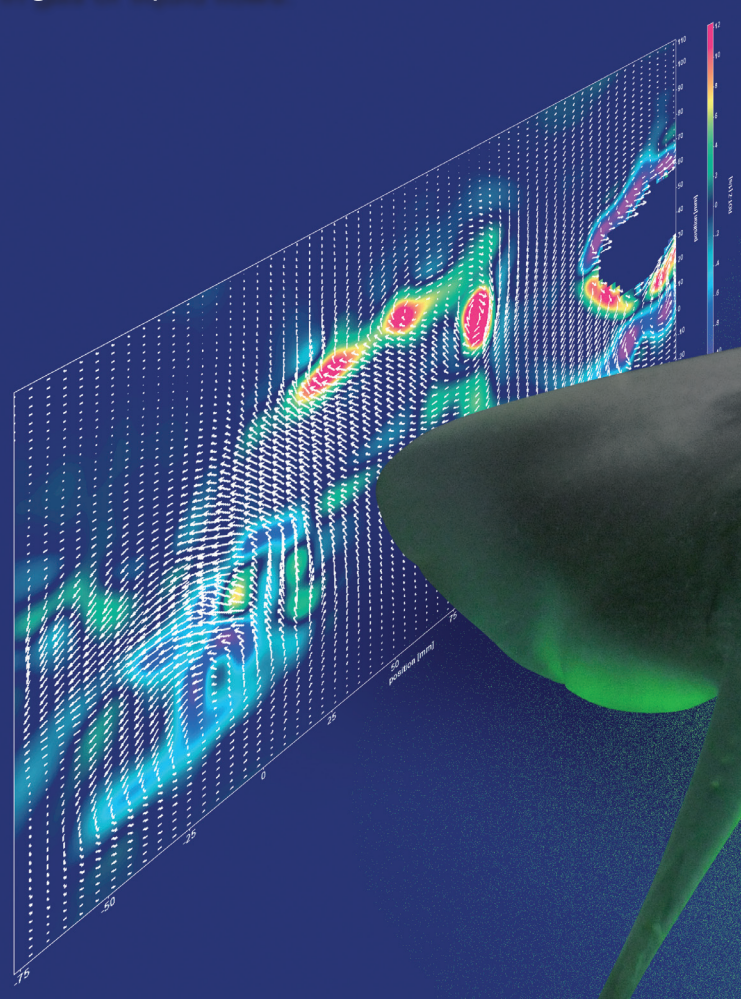


LaVision

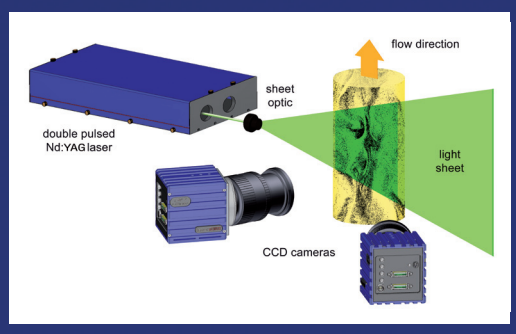
FOCUS ON IMAGING

Particle Image Velocimetry

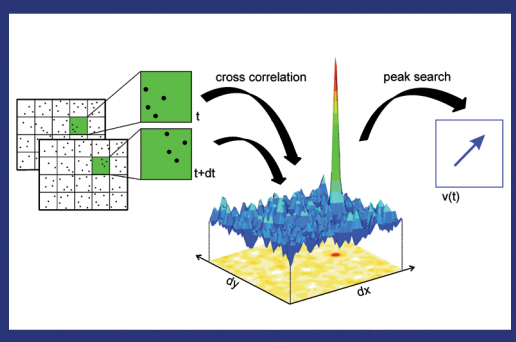
PIV is a non-intrusive optical measurement technique to obtain instantaneous velocity fields in gas or liquid flows.



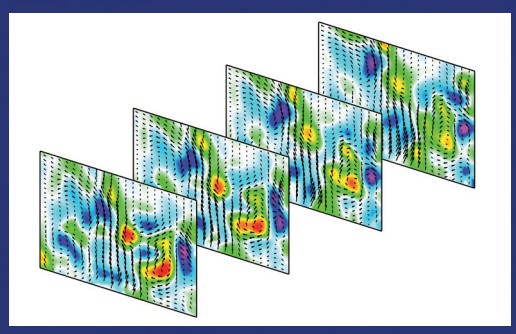
Courtesy: Stingray: Dr. Frank Fish, Liquid Life Laboratory, West Chester University and Dr. Douglas Neal, LaVision Inc.
Hummingbird: Dr. Bret Tobalske, Field Research Station at Fort Missoula, Division of Biological Sciences, University of Montana



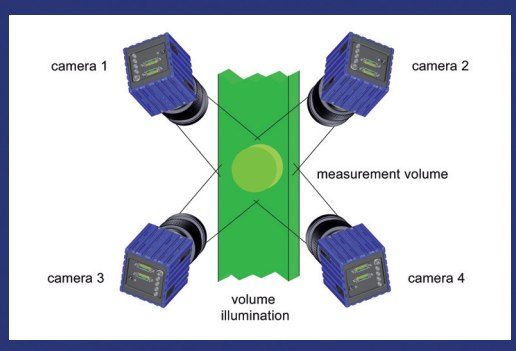
Setup
Light scattering particles are added to the flow. A laser beam is formed into a light sheet illuminating seeding particles twice with a short time interval Δt. The scattered light is recorded onto two consecutive frames of a high resolution digital camera. Microscopic, endoscopic and macroscopic configurations cover a wide range of applications in gaseous and liquid media.



Processing
The particle image of each camera is subdivided into small interrogation windows. The average particle displacement (Δx,Δy) is determined by cross-correlation followed by the localization of the correlation peak. The velocity components (u,v) are given by u=(1/M)(Δx/Δt) and v=(1/M)(Δy/Δt) where M is the local magnification factor. For Stereo-PIV the components (u1,v1) and (u2,v2) of both cameras are combined to (u,v,w) by stereoscopic reconstruction, where w is the out-of-plane component. Perspective correction, distortion compensation and image mapping of the two views is taken care of by (self-) calibration procedures. Advanced multi-pass image deformation techniques are used for higher accuracy and spatial resolution.



Spatial and temporal derivatives
From one velocity field a range of spatial derivatives can be calculated such as vorticity and shear stress. Ensemble statistics provide additional information like turbulent kinetic energy or Reynolds stresses. Time-resolved velocity fields recorded with high-frame-rate cameras and high frequency laser allow for deeper dynamic insights about flow field evolution, fluid element trajectories, acceleration and turbulence statistics.



Tomographic PIV
A Tomographic PIV system with typically 2-4 cameras extends the flow measurement into a full volume. Processing is done by tomographic reconstruction of voxel intensities for each time step followed by 3D3C-cross-correlation between interrogation volumes. This allows for instantaneous measurement of all three velocity components in a three dimensional measurement volume (3D3C) visualizing the 3D flow structure. The complete velocity gradient tensor can be calculated yielding quantities such as 3D vorticity and strain tensor.

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