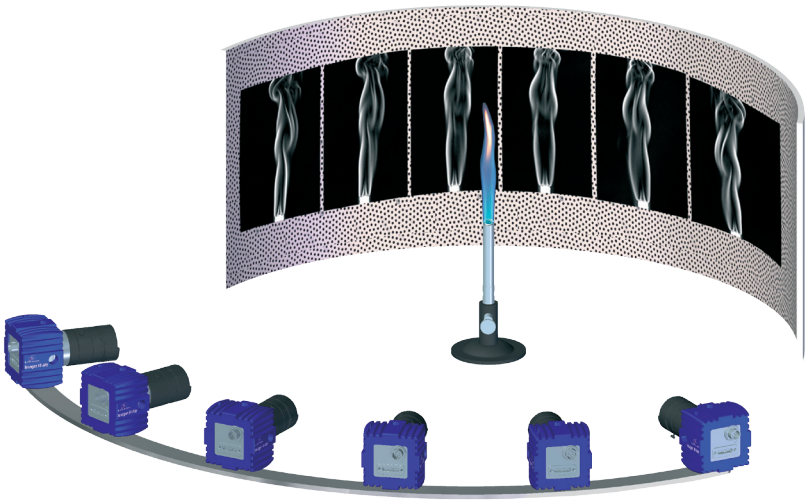
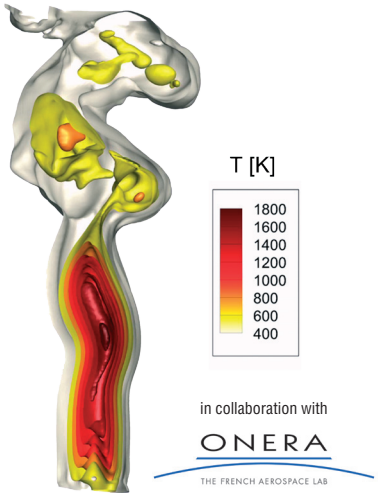
LaVision
FOCUS ON IMAGING

In Application

Quantitative 3D Temperature Imaging

FluidMaster Tomographic BOS System





Multi-camera setup for tomographic BOS imaging

Introduction

Volumetric measurement techniques are essential to capture randomly oriented and three-dimensional flow structures. State-of-the-art 1D or 2D Schlieren and Background Oriented Schlieren (BOS) techniques are great tools for a fast and easy visualization of thermal flows or mixing processes. However, quantitative measurements are often prohibited by the line-of-sight nature of the Schlieren effect.

LaVision's new **FluidMaster Tomographic BOS** system enables instantaneous and three-dimensional imaging of volumetric temperature fields of thermal flows from heating systems or combustion processes. In this application example six cameras were used to obtain 2D Schlieren images from a Bunsen flame and a heated air jet flow. In a collaborative effort with ONERA - The French Aerospace Lab, the volumetric temperature field was tomographically reconstructed. In order to obtain the instantaneous density field, ρ, the equation, $\varepsilon = T \cdot \nabla\rho$, was solved iteratively. The optical alignment of the tomographic camera setup is represented by the matrix T and the deviation, ε was derived from the measured x- and y-displacement on the six Schlieren images.

Then, temperature was determined based on the boundary conditions defined by the air surrounding the flame and the jet flow. For processing of the flame data differences in the index of refraction due to varying gas compositions were neglected.

System Features

- instantaneous 3D temperature measurements without laser and without seeding
- high-resolution Schlieren imaging of thermal flows
- flexible multi-camera setups
- interactive 3D camera calibration procedure
- high-speed tomographic BOS imaging for time-resolved volumetric temperature measurements

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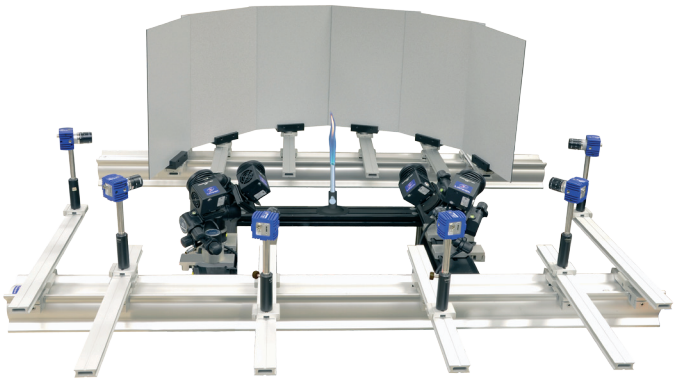
Quantitative 3D Temperature Imaging

FluidMaster Tomographic BOS System

FluidMaster Tomographic BOS system for instantaneous, volumetric temperature imaging

Six cameras with 35-mm lenses (f/16) are arranged around a Bunsen flame at a total angle span of 150°. The corresponding dot-patterns are located at the opposite side of the flame which allows to image the line-of-sight Schlieren on each camera from a probe volume of 14 cm x 17 cm x 14 cm at the location of the flame. A 2D calibration target in the object plane is used to obtain the parameters which define a pinhole model of the six-camera optical setup. A µs-pulsed LED illumination enables to image and resolve small and fast moving turbulent flow structures of sub-mm scale.



Experimental setup with fast LED illumination for tomographic BOS imaging

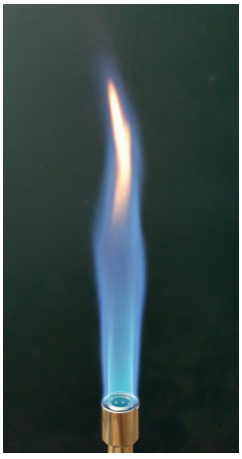
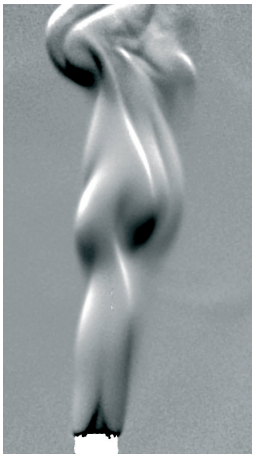


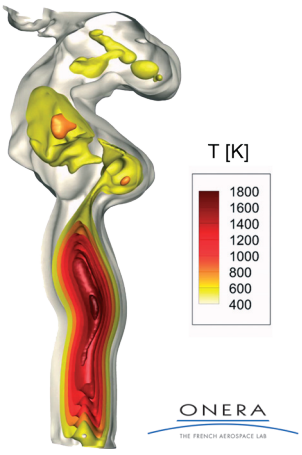
Image of Bunsen flame

Displacement

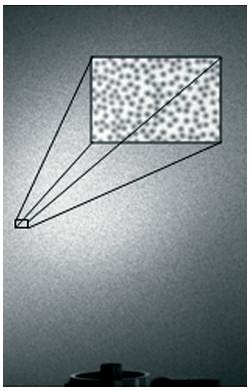
x-Displacement



y-Displacement

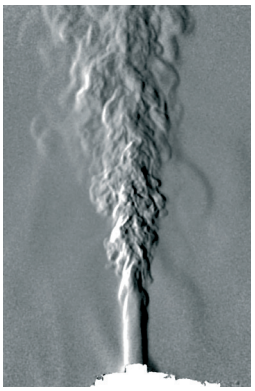


Isosurfaces of reconstructed 3D temperature field

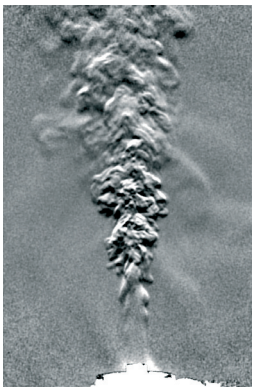


Dot-pattern of 500 K air jet

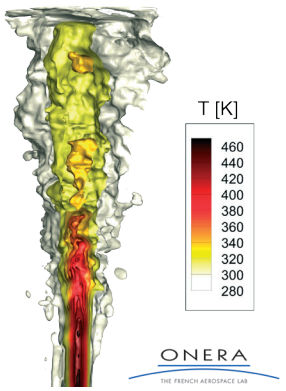
Displacement



x-Displacement



y-Displacement



Isosurfaces of reconstructed 3D temperature field

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