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Computed Tomographic X-ray Velocimetry of Biofluid Flows

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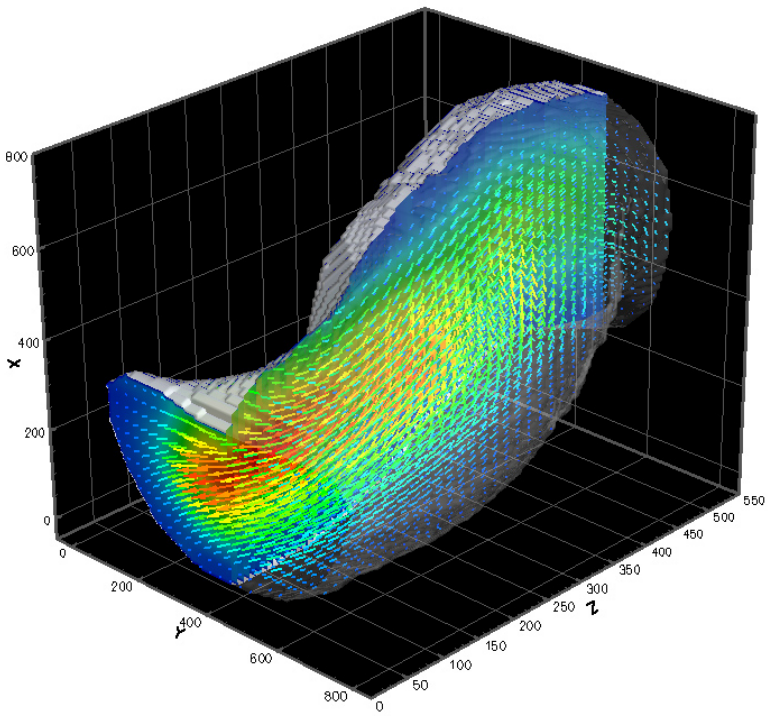
Abstract

Fluid mechanists have long developed techniques of imaging and measurement to investigate the velocities, pressures and shear stresses in fluid flows. In recent decades, the quantitative method of Particle Image Velocimetry (PIV) has been used to provide fields of flow velocities in traditional areas, such as bluff body wakes, wind engineering and automobile design. With the rise of biology, fluid mechanists are turning increasingly to the study of living systems; here, we describe the application of PIV to synchrotron X-ray imaging of biofluid flows.

Atherosclerosis is a major health problem in the developed world, being a major factor leading to cardiovascular disease. To study the effects of blood flow properties on the development, diagnosis, and treatment of atherosclerosis, it is important to be able to measure three dimensional blood flow fields *in vivo*. This is a difficult task as noninvasive measurement through optically opaque tissue at high resolution is required. The popular magnetic resonance imaging (MRI) based techniques suffer from poor spatial and temporal resolution.

An X-ray velocimetry technique will be presented that provides three components of velocity measurement in three dimensional space; *a priori* knowledge of the flow field is not required. The proposed method uses multiple projection angles to overcome the constraints of current X-ray velocimetry techniques, which are limited to two components of velocity measurement.



The three-dimensional velocity field is tomographically reconstructed directly from two-dimensional image pair cross-correlations, circumventing the need to reconstruct three-dimensional particle images. The method is shown to be effective in the measurement of complex blood flow in opaque vessel (see Fig. 1).

Other applications, including *in vivo* imaging of intra cardiac blood flow, will be presented at the conference.

Fig. 1: Velocity field of flow through a corkscrew vessel measured using X-ray Synchrotron velocimetry.

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