Time-resolved x-ray full field micro-imaging of transient fluid dynamics

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Abstract

The x-ray beam afforded by third-generation synchrotrons, such as the Advanced Photon Source (APS), has unique properties: extremely high intensity, wide energy tunability extending to over 100 keV, high coherence, and flexible lattice timing structure. To take full advantage of these properties at the APS, we are developing a novel x-ray research tool, involving ultrafast phase-enhanced full-field x-ray imaging, with both micrometer-spatial and sub-nanosecond temporal resolutions. Such a novel capability will make tremendous impact on numerous fields, both scientifically and technologically.

We will present some examples of our work combining the x-rays time-structure and detectors gating possibilities. Many detection modalities are available, ranging from a single 150 ps (or 472 ns) x-ray exposure, to multiple-successive exposures, to ultra-high frame rate videos. We will present highlights from some ongoing research on hydrodynamics singularities, such as droplets pinch-off, breakup and coalescence [1, 2], and jetting and cavity collapse upon impact on liquids [3]. We also applied a variation of this technique to measure velocity field distribution of dense liquid jets near nozzle orifices [4], and cavitations in a Venturi system.

We expect this synchrotron-based time-resolved broadband x-ray edge-enhanced radiography to provide crucial validation data for computer models and increasingly contribute to the fundamental understanding of problems where high penetration depth, temporal, and spatial resolutions are needed.

1. K. Fezzaa and Y. Wang. *Phys. Rev. Lett*. **100**, 104501 (2008)
2. Y. Wang, K-S. Im, and K. Fezzaa. *Phys. Rev. Lett*. In Print.
3. Y. Wang, and K. Fezzaa. In review.
4. Y.J. Wang et al., *Nature Physics*. 10.1038/nphys840 (2008).

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