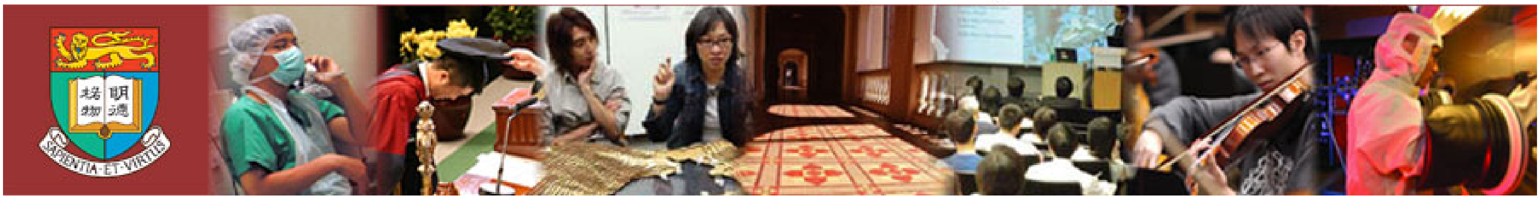

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Optical time-stretch microscopy enabled by free-space angular-chirp-enhanced delay (Conference Presentation)

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ABSTRACT

Optical time-stretch microscopy enables cellular images captured at tens of MHz line-scan rate and becomes a potential tool for ultrafast dynamics monitoring and high throughput screening in scientific and biomedical applications. In time-stretch microscopy, to achieve the fast line-scan rate, optical fibers are used as the pulse-stretching device that maps the spectrum of a light pulse to a temporal waveform for fast digitization. Consequently, existing time-stretch microscopy is limited to work at telecom windows (e.g. 1550 nm) where optical fiber has significant pulse-stretching and small loss. This limitation circumscribes the potential application of time-stretch microscopy.

Here we present a new optical time-stretch imaging modality by exploiting a novel pulse-stretching technique, free-space angular-chirp-enhanced delay (FACED), which has three benefits: (1) Pulse-stretching in FACED generates substantial, reconfigurable temporal dispersion in free-space with low intrinsic loss at visible wavelengths; (2) Pulse-stretching in FACED inherently provides an ultrafast all-optical laser-beam scanning mechanism for time-stretch imaging. (3) Pulse-stretching in FACED can be wavelength-invariant, which enables time-stretch microscopy implemented without spectral-encoding.

Using FACED, we demonstrate optical time-stretch microscopy with visible light (~700 nm). Compared to the prior work, bright-field time-stretch images captured show superior contrast and resolution, and can be effectively colorized to generate color time-stretch images. More prominently, accessing the visible spectrum regime, we demonstrate that FACED enables ultrafast fluorescence time-stretch microscopy. Our results suggest FACED could unleash a wider scope of applications that were once forbidden with the fiber based time-stretch imaging techniques.

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