HOLOGRAPHIC SECOND HARMONIC GENERATION (SHG) MICROSCOPY

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SUMMARY
The coherent nature of second harmonic generation (SHG) makes possible retrieval of both its amplitude and its phase, by use of a proper phase-sensitive imaging technique such as digital holographic SHG microscopy.

In addition to retrieving both amplitude and phase of second harmonic signals the computer-based hologram reconstruction process also makes possible to bring in focus different sections of a specimen separated by distances exceeding the depth of field of the imaging system. Similarly, its numerical focusing feature is especially useful to compensate drifts of focus over long term experiments or in unstable environment. Holographic SHG microscopy, based on off-axis digital holography, is a nonscanning, single-shot image acquisition technique. As such, it is in principle limited in speed only by the camera frame rate and the available second harmonic signal, which depends in a non-saturating manner on the peak power density of the laser source. In other words, holographic SHG imaging is especially suited for real-time imaging, and has the potential to truly exploit the instantaneous response time of second harmonic generation. Finally, holographic SHG imaging has already found applications for determining the polarization component responsible for second harmonic generation [1], for revealing phase matching conditions in biological specimens [2], and for nanometric 3D tracking of SHG scatterers [3].

Here, we propose to make an overview of holographic SHG microscopy.

REFERENCES
[1] E. Shaffer, N. Pavillon, J. Kühn; C. Depeursinge, "Digital holographic microscopy investigation of second harmonic generated at a glass/air interface," *Opt. Letters*, **34**, 2450-2452 (2009).

[2] E.Shaffer, C. Moratal, P. Magistretti, P. Marquet, and C. Depeursinge, "Label-free second harmonic phase imaging of biological specimen by digital holographic microscopy," *Opt. Letters*, **35**, 4102-4104 (2010).

[3] E. Shaffer, P. Marquet, and C. Depeursinge, "Real time, nanometric 3D-tracking of nanoparticles made possible by second harmonic generation digital holographic microscopy," *Opt. Express*, **18**, 17392-17403 (2010).