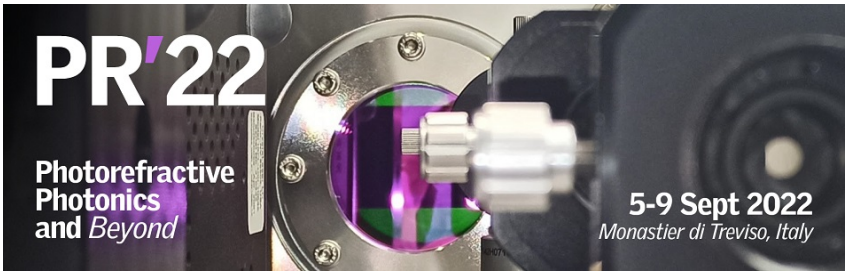

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Cancer Holography for Personalized Medicine

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This paper reviews the uses of optical holography in cancer biology and personalized medicine. Holography of living tissue occurs in two stages: a coherence-domain stage with depth-selection through holographic interferometry (hologram writing), followed by a reconstruction stage (hologram readout). With its beginnings in photorefractive holography, the writing and the readout of cancer holograms were both in the optical domain through four-wave mixing. However, better performance is obtained by retaining the optical writing stage while relying on digital cameras to perform the holographic playback electronically—known as digital holography (DH). Interestingly, DH is the reverse of Gabor's original idea for holography that used electrons to expose film and only used optics for the hologram readout. Today, digital holography is the most commonly used technique for coherent optical imaging of biological samples.

An example of such medical-inspired holography is full-frame optical coherence tomography (OCT) that relies on digital holography, as does dynamic contrast OCT, also known as biodynamic imaging, to make phase-sensitive measurements of the Doppler spectra of light scattered from intracellular motions in living tissue samples. Full three-dimensional maps of cellular metabolism of active cancer tumors can be obtained using holographic Doppler spectroscopy. Applying anti-cancer drugs to these biopsy samples and measuring shifts in the Doppler spectra can help identify cancer patients who will benefit from alternative cancer therapies, thereby directing those patients to more effective treatments. Several recently-completed pilot human clinical trials will be described that test the clinical utility of cancer therapy selection using holographic Doppler spectroscopy.

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