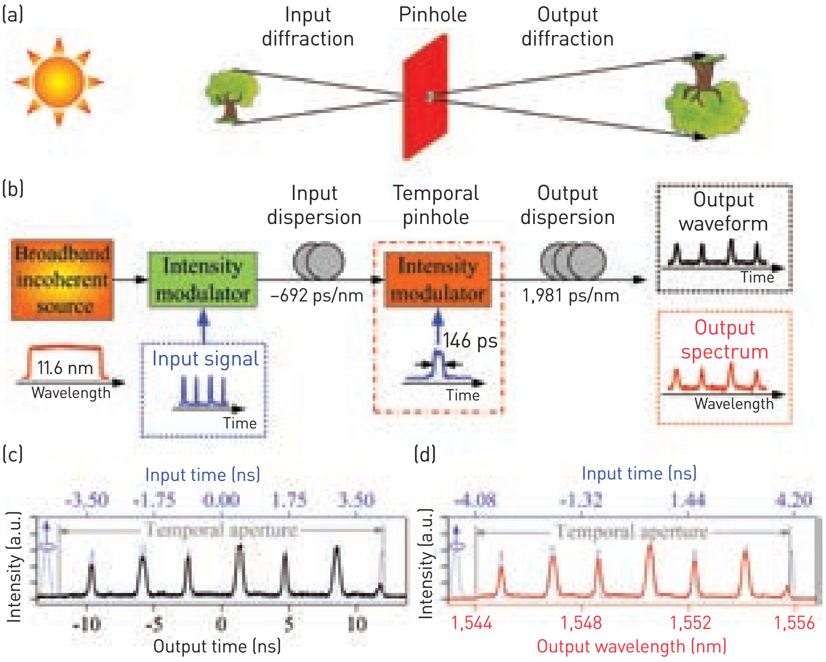
IMAGING

# Incoherent-Light Temporal Imaging of Intensity Waveforms

Temporal imaging and related concepts provide new, unique opportunities for generation, measurement, cloaking and processing of time-domain waveforms across a wide range of frequency regimes, from electronic and radio frequency (RF) signals to ultrafast optical information.[1–3] Temporal imaging systems developed to date are based on suitable combinations of dispersive processes and time lenses, and they generally rely on coherent optics. Thus, these systems require the use of short-pulse (broadband) light sources (e.g., mode-locked lasers[1–3]) and precise coherent phase control of the involved waveforms.[1–3] These requirements represent a fundamental hurdle to the practical use of these methods. Temporally incoherent light sources are inherently broadband and they are significantly simpler and more affordable than their coherent counterparts. Mechanisms have been demonstrated for temporal dispersion of incoherent optical waveforms; however, no system based on time lenses has been previously realized using an incoherent lightwave approach.[4]

We have recently proposed and experimentally demonstrated an important scheme for temporal imaging, including time-to-frequency mapping and temporal magnification or compression of incoherent-light intensity waveforms.[5] The scheme is based on a time-domain equivalent of a classical pinhole camera illuminated by incoherent light, and it employs only temporal intensity modulation (time-domain pinhole) combined with two dispersive lines. We have reported incoherent-light temporal imaging of RF waveforms with a resolution of about 50 ps over a temporal aperture exceeding 8 ns, using a 146 ps temporal pinhole.[5] Our proposal opens up entirely new possibilities for realization of a wide variety of critical high-speed signal processing modules using simple and practical incoherent light-wave schemes. OPN




(a) An incoherent-light spatial imaging system based on free-space diffraction and a pinhole. (b) Scheme for incoherent-light temporal imaging, constructed as the temporal equivalent of the incoherent-light pinhole camera, involving temporal group-velocity dispersion and intensity modulation with a fast temporal shutter (temporal pinhole). (c) Temporal intensity profile (black) of the output image compared with the scaled input temporal waveform (blue), where the scaling between input time and output time is the predicted magnification factor M = –(1,981 ps/nm)/(–692 ps/nm) = 2.86. (d) Spectrum (red) of the output image compared with the input temporal waveform (blue), where the scaling between input time and normalized output wavelength is the time-to-frequency mapping factor, –(– 692 ps/nm) = 692 ps/nm.


**Researchers**

**Bo Li** (liboresearch@gmail.com) and **José Azaña**
*Institut National de la Recherche Scientifique—Energie, Matériaux et Télécommunications, Montréal, Québec, Canada*



**References**

1. M.A. Foster et al. Nature **456**, 81 (2008).
2. M. Fridman et al. Nature **481**, 62 (2012).
3. K. Goda et al. Nat. Photon. **7**, 102 (2013).
4. C. Dorrer. Opt. Express **17**, 3341 (2009).
5. B. Li et al. Opt. Lett. **39**, 4243 (2014).