Memory effect correlations in random scattering media over space, angle and time

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The scattering nature of tissue makes it challenging to form clear biomedical images. Techniques like adaptive optics and optical phase conjugation can correct for scattering to produce clear images and/or sharp deep-tissue focal spots, but only over a limited field of view (FOV) within a given scattering sample. In both cases of imaging and focusing, the extent of the FOV is a function of how correlated the optical field remains as it is tilted or shifted through different areas of the scattering tissue. In this work, we first present a “generalized memory effect” model of optical correlations inside scattering media that accounts for both the tilting and shifting of incident fields. Our new model can lead to a maximized correction FOV for a given sample. Then, we discuss how temporal degrees of freedom can further extend the memory effect range and experimentally demonstrate a fourfold increase in scan range by using time-gated light.