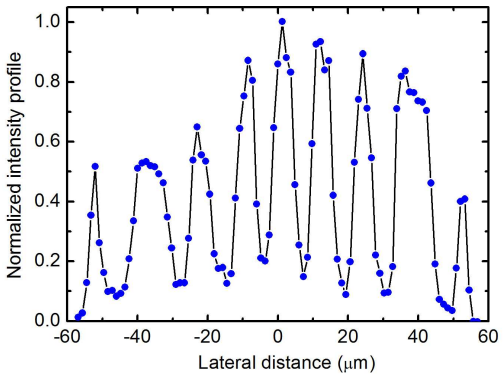

Fig. 7. The normalized intensity profile along the dashed line in the phase-conjugate scanning image shown in Fig. 6 (b). The experimental data points are shown as blue dots.

Conclusion

In conclusion, we demonstrated a phase-conjugate scanning microscopy which allows us to image through a thin turbid medium. We showed that the phase-conjugated focus can be scanned over 220 μm on the sample. We scanned the area around the SHRIMP in the two transverse directions but it is possible to scan the beam in the longitudinal direction as well by appropriately modifying the phase wave front on the SLM. While we demonstrated the phase-conjugate scanning microscopy with transmission detection, it can be easily extended to fluorescence microscopy. The phase-conjugated scanning focus can excite fluorescent probes and the fluorescent signal can be collected both in the transmission through clear media or in the epi-direction through the turbid medium. Two-photon fluorescence microscopy coupled with three-dimensional (3D) scanning can provide a 3D visualization of the volume surrounding each SHRIMP. Larger imaging coverage can be achieved by sequentially using multiple SHRIMP beacons and imaging the volumes around them. It is possible to illuminate the SHRIMPs at the fundamental frequency through the turbid medium rather than from the back-side as was done in these experiments. It will result in the illumination on the SHRIMPs being a speckle pattern, requiring fine scanning to locate individual SHRIMPs. The excitation intensity will also decrease significantly due to the scattering. This can be partially compensated by using brighter SHRIMP beacons with higher SHG efficiency [23,24]. Finally, the technique we demonstrated is applicable to relatively thin scattering media. We expect some real application such as imaging crustaceans, eggs, or blood vessels, where the imaging targets are surrounded by non-diffusive matters that are hidden by thin diffusive layers. As the thickness of the scattering region increases, the field of view decreases proportionally. Extension of this imaging technique to thicker scattering media remains a challenge.

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