microscope objective. The scattered field of higher spatial frequency would not be captured in the hologram, and therefore, not be considered in the phase conjugation. Besides, the scattered field is recorded by off-axis holography which inevitably degrades the resolution of the optical system. To minimize this effect, we experimentally remove the non-interferometric part (i.e. the signal and reference) from the digital hologram by subtracting a background of the two pulses not being temporally overlapped. As a result, the spatial resolution is controlled to be decreased by a factor of 2 in only one transversal direction. The resolution of the optical system can be increased by using a higher NA microscope objective, and thus a tighter phase-conjugated focus is achievable.

4. Conclusion

We demonstrated focusing coherent light on a nanoparticle through a turbid medium ($\mu_s l$ ~8.5) based on the digital phase conjugation of the SHG signal emitted from the nanoparticle. Non-centrosymmetric nanoparticles act as coherent point sources at SHG frequency under excitation which provide great contrast in a turbid medium for optical phase conjugation. We observed a nearly ideal focus on the nanoparticle through digital phase conjugation. 30 times more optical power was successfully delivered to the diffraction limit area centered at the nanoparticle in our experiment. Our work enables concentrating optical energy on the nanoparticles inside a turbid medium. While 300 nm $BaTiO_3$ particles were used in our demonstration, our approach can be easily extended to smaller SHG-active nanoparticles. We expect in the future to be able to use smaller particles by improving the sensitivity of the detector and the SHG efficiency of the nanoparticles [28]. Combining the phase conjugation technique with the functionalized SHRIMPs [29], one can specifically label the targets of interest inside the turbid medium with the SHRIMPs and then deliver the optical power efficiently to the desired locations.

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