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Pulse Recycling and Weak Value Amplification for Precision Metrology TRENT GRAHAM, COURTNEY BYARD, PAUL KWIAT, Univ of Illinois at Urbana-Champaign, ANDREW JORDAN, Univ of Rochester — Weak-value measurements have been shown to be useful for making precision optical measurements, owing to the huge amplification of tiny effects which is achievable with the technique (Hosten 2008, Dixon 2009, Egan 2012, Viza 2013). This amplification is especially helpful in the case where technical noise limits the resolution. However, if the intrinsic shot noise limits the resolution, weak-value measurements offer no advantage because the amplification is achieved via a postselection which discards most of the photons input into the measuring system. The reduction in photon number cancels the increase in signal from the amplification, and the resolution is not increased. To overcome this, we implement a method for recycling the discarded photons. We show that, for a given number of photons input to the system, recycling gives an improvement over the resolution of a conventional measurement. Our work with a simple double-pass recycling system demonstrated a 1.4x improvement over the standard shot-noise limit. We also present our work toward achieving a many-pass recycling system, for which we expect a five-fold improvement over the shot-noise limit. Such a weak-measurement recycling system could be combined with quantum states to further enhance the achievable resolution.

Courtney Byard
Univ of Illinois at Urbana-Champaign

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