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Beating the Shot-Noise Limit with Partially-Distinguishable Photons PATRICK M. BIRCHALL, JAVIER SABINES-CHESTERKING, JEREMY L. OBRIEN, HUGO CABLE, JONATHAN C. F. MATTHEWS C. F. MATTHEWS, Centre for Quantum Photonics, University of Bristol — Quantum metrology promises high-precision measurements beyond the capability of any classical techniques. This has the potential to be an integral part of investigative techniques, utilised across all areas of science and technology. However, all sensors must be able to operate despite imperfections to be of practical use. Proposals for photonic quantum sensors typically exploit quantum interference between photons which are perfectly indistinguishable, but achieving this indistinguishability can be a major technical challenge in practice, in particular with immature but promising approaches to photon sources. Here we show that highly indistinguishable photons are not required for quantum-enhanced measurements, nor do partially distinguishable photons have to be engineered to mitigate the effects of distinguishability. We conduct an experiment to verify the utility of two- and four-photon states containing partially distinguishable particles by performing quantum-enhanced measurements with low-visibility quantum interference. This demonstrates that sources producing spectrally-mixed single photons can be readily applied in quantum metrology systems.

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