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The Quantum-Classical Boundary for Optical Interferometric Measurements PATRICK M. BIRCHALL, JONATHAN C. F. MATTHEWS, HUGO CABLE, Centre for Quantum Photonics, University of Bristol — We study the fundamental precision limits for measurements of optical phase when loss of probe light dominates the decoherence, and a limited number of photons are passed through the sample. It has long-been argued that non-classical states can be used to achieve an important advantage in precision in measurements of this sort, where it is not possible to use high-power laser light. As well as being of fundamental interest for understanding the ultimate physical limits for precision measurement, there are practical applications to measurements of delicate or photosensitive samples. Here we compare optimal measurement strategies using classical and non-classical probe states, where the number of passes through the unknown phase can be freely controlled. We find that the increase in precision that can be achieved using non-classical techniques is in fact small. Our results narrow the potential applications of measurements using non-classical states to cases where there is greater quantum advantage due to practical constraints on the measurements involved.

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