The goal of quantum metrology is to achieve the ultimate fundamental bounds on estimation precision of unknown parameters (typically the phase), using certain types of entangled input states. Given the uncertainty in phase prior to making a measurement, Bayesian inference allows us to construct a posterior uncertainty after evidence is gathered. This can be used to study the uncertainty reduction for a sequence of measurements. Multiple measurements allow the use of non-adaptive and adaptive measurement strategies. In each case, minimizing the posterior uncertainty globally as well as locally, we devise a measurement strategy that yields the lowest phase uncertainty after a single measurement. We then show how many measurements it would take on average to reduce phase uncertainty to a target level and ultimately to the lowest achievable fundamental bound on phase estimation precision. These theoretical results are compared with a Monte Carlo simulation using frequentist inference. In both methods of inference, the local non-adaptive method is shown to be the most effective practical method to reduce phase uncertainty.

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