For a fixed average energy, the simultaneous estimation of multiple phases can provide a better total precision than estimating them individually. We show this for a multimode interferometer with a phase in each mode, using Gaussian inputs and passive elements, by calculating the covariance matrix. The quantum Cramér-Rao bound provides a lower bound to the covariance matrix via the quantum Fisher information matrix, whose elements we derive to be the covariances of the photon numbers across the modes. We find our simultaneous strategy to yield no more than a factor of two improvement in total precision. In spite of the Gaussian nature of the problem, these elements require the calculation of non-Gaussian integrals, which we accomplish analytically. We prove that this bound can be saturated. Our work shows that no modal entanglement is necessary for simultaneous quantum-enhanced estimation of multiple phases.