Building upon the conventional Mach-Zehnder interferometer, we propose a novel metrological scheme aimed at enhancing phase sensitivity. This approach employs a coherent state and a squeezed vacuum state as input states, integrated with multi-photon subtraction operations and utilizing either intensity detection or homodyne detection. We systematically analyze the phase sensitivity, quantum Fisher information, and quantum Cramér-Rao bound under both ideal and lossy conditions. Our findings reveal that the optimization of photon subtraction schemes and detection methods can substantially improve phase sensitivity and confer increased robustness against photon losses. Remarkably, the proposed multi-photon subtraction schemes can surpass the standard quantum limit even in the presence of losses. Furthermore, homodyne detection enables the scheme to achieve performance that goes beyond the Heisenberg limit. Importantly, an increase in the number of photon-subtraction events further boosts both phase sensitivity and quantum Fisher information. These results underscore the considerable potential of this scheme in advancing quantum precision measurement technologies.**Abstract:** Building upon the foundation of the conventional Mach-Zehnder interferometer, we introduce an innovative metrological scheme designed to augment phase sensitivity. This methodology incorporates a coherent state alongside a squeezed vacuum state as inputs, augmented by multi-photon subtraction operations, and employs either intensity detection or homodyne detection techniques. We conduct a systematic examination of phase sensitivity, quantum Fisher information, and the quantum Cramér-Rao bound under both idealized and lossy conditions. Our findings demonstrate that optimal configurations of photon subtraction schemes and advanced detection methods can markedly enhance phase sensitivity and impart greater resilience to photon loss effects. Notably, the proposed multi-photon subtraction schemes are capable of exceeding the standard quantum limit despite loss scenarios. Additionally, homodyne detection facilitates achieving performance surpassing the Heisenberg limit. Significantly, increasing the frequency of photon-subtraction events further enhances both phase sensitivity and quantum Fisher information. These results underscore the substantial potential of this approach in propelling quantum precision measurement technologies forward.

**Key Points:**- Introduction of an advanced metrological scheme leveraging conventional Mach-Zehnder interferometer principles. - Utilization of coherent and squeezed vacuum states integrated with multi-photon subtraction. - Evaluation of phase sensitivity, quantum Fisher information, and quantum Cramér-Rao bound under diverse conditions. - Demonstration of surpassing standard quantum and Heisenberg limits through optimized methodologies. - Emphasis on robustness to photon losses and enhancements with increased photon subtraction events.