This excess loss will be larger when including fabrication disorder-induced losses. For unbalanced directional coupler, the internal phase shift will be further away from 180° with corresponding reductions in the visibility. Formally, the output annihilation and creation operators of a lossy directional coupler have to include Langevin noise operators to maintain the commutation relation, while at the same time inducing additional phase shifts [53].

6. Conclusion

We have observed 1550-nm Hong-Ou-Mandel interference in silicon quantum photonic circuits, with raw quantum visibility up to 90.5% in near-symmetric directional couplers. With thermally-stabilized spectrally-bright PPKTP chip-scale waveguides as the entangled biphoton source, we examined the constituents of residual visibility degradation through numerically-designed directional couplers, multiphoton pairs, polarization effects, excess loss, and imperfect internal phase shifts. With our sequential triggering approach for negligible coincidental dark counts, we present the theoretical analysis for multipair biphoton contribution to Hong-Ou-Mandel visibility reduction. The results presented here support the scalable realization of two-photon interaction elements on-chip, for quantum information processing and communications.

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