Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Generic Two-Photon (Two-Qubit) Gates Implemented by Number-Resolving Photodetection[1] DMITRY USKOV, Tulane University — Existing theoretical results on measurement-induced two-qubit photonic gates with number-resolving photodetection [1] are limited to only the controlled-NOT gate (Knill et al Nature **409**, 46-52 (2001)). We use numerical optimization techniques (Uskov et al PRA **79**, 042326 (2009)), to find optimal schemes implementing arbitrary two-qubit entangling gates, represented by generic points in the Weyl chamber of Cartan KAK decomposition of the SU(4) group (Khaneja et al, Chem. Phys. **267,** 11 (2001)). We find that while any two-qubit controlled-U gate, including CNOT and CS, can be implemented using two ancilla photons with success probability $0.05 < \mathrm{S} \leq 2/27$, a generic SU(4) operation requires three unentangled ancilla photons. Our study indicates that direct implementation of a generic SU(4) gate using an integrated optical circuit offers an order of magnitude increase in the success probability and two-fold reduction in overhead ancilla resources compared to standard triple-CNOT and double-B gate decompositions. Our results are consistent with previous work on the optimization of the Deutsch-Toffoli gate, where direct implementation of this three-qubit operation was shown to be four orders of magnitude more efficient than six-fold decomposition into CNOT gates (Uskov et al, arXiv:0908.2482v1).

[1]This work supported by NSF grant PHY-0545390.

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Date submitted: 26 Jan 2010 Electronic form version 1.4