Abstract Submitted
for the DAMOP14 Meeting of
The American Physical Society

High-Order Photonic W-states for Random Number Generation

MARKUS GRAEFE, RENE HEILMANN, ARMANDO PEREZ-LEIJA, ROBERT KEIL, FELIX DREISOW, Institute of Applied Physics Jena, MATTHIAS HEINRICH, CREOL, The College of Optics & Photonics, STEFAN NOLTE, Institute of Applied Physics Jena, DEMETRIOS N. CHRISTODOULIDES, CREOL, The College of Optics & Photonics, ALEXANDER SZAMEIT, Institute of Applied Physics Jena, INSTITUTE OF APPLIED PHYSICS, ABBE CENTER OF PHOTONICS, FRIEDRICH-SCHILLER-UNIVERSITÄT JENA TEAM, CREOL, THE COLLEGE OF OPTICS & PHOTONICS, UNIVERSITY OF CENTRAL FLORIDA TEAM — Multipartite entanglement plays a key role in a number of counter-intuitive phenomena in quantum me- chances. A particular type of multipartite entangled states are the so called W-states which are in generalized form a coherent superposition of N single qubit states exhibiting equal probability amplitudes. The entanglement carried by these quantum entities has the remarkable property of being intrinsically robust to decoherence in one of the qubits. In our work, we experimentally realize high order W-states by forcing single photons to exist in a uniform coherent superposition of N (up to 16) spatial optical modes within a multiport integrated system. Interestingly, in the generated W-states, a single photon will emerge from any of the N output ports with exactly the same probability. Based on that fact we have additionally developed a scheme for the generation of genuine random bits on chip, without the need of any post-processig. The authenticity of the random numbers is validated by applying the fifteen statistical tests suggested by National Institute of Standard Technology.

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Date submitted: 20 Jan 2014 Electronic form version 1.4