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Creating and manipulating higher-dimensional entangled photonic quantum systems using integrated optics

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ABSTRACT:

The construction of a general photonic platform for experiments in higher-dimensional entangled quantum systems is presented. Crucial steps leading to the final system are discussed: a fully fiber-integrated source creating higher-dimensional path-encoded entangled photons has been constructed. Additionally, the general Multiport, a complex device capable of realizing any unitary transformation in any dimension, has been realized using an on-chip integrated approach. Combining the source and the Multiport completes the system offering a high degree of automation and flexibility of the setup: changing different parameters the entangled state is adjusted while the Multiport realizes any desired local unitary transformation. As a result, a two entangled qutrits quantum system in a 9-dimensional Hilbert space has been implemented. Different experiments are presented, i.a. a full characterization of the entangled two qutrit correlation space. Eventually, extensions of the setup and a path towards higher-dimensional systems are briefly discussed.