Researchers create on-chip interference between pairs of photon sources

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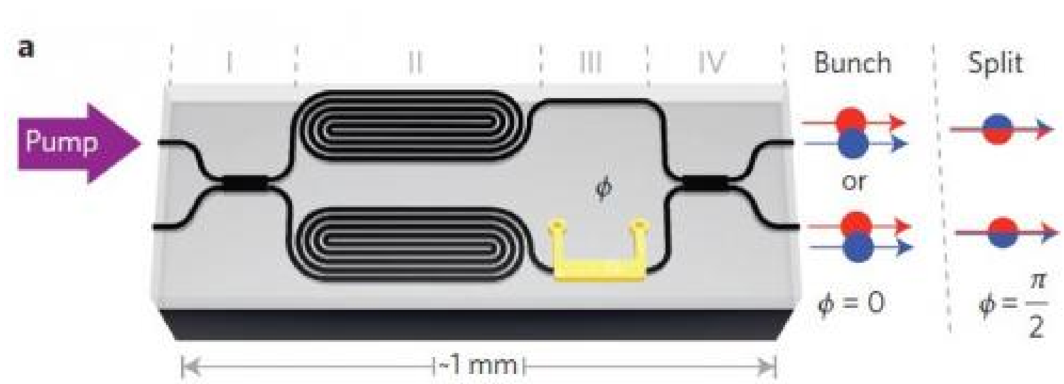

Schematic of device operation. Credit: *Nature Photonics* (2013) doi:10.1038/nphoton.2013.339

(Phys.org) —A team made up of researchers from several countries has succeeded in creating a chip that allows for observation of the interference between silicon photon-pair sources. In their paper published in *Nature Photonics*, the team describes the nature of their chip, how it works and ways it might be used.

In the quest to create a truly useful quantum computer, researchers focus on single areas of research that in the end can hopefully be taken together to reach the ultimate goal. In this new effort, the researchers sought a way to allow for observation of quantum interference on a single chip, and report that they have succeeded by creating what some have described as the most complex quantum circuit ever made.

To allow for observing quantum interference, scientists have discovered, two virtually identical photons are needed, which means they need to be produced from two identical photon sources—no easy feat, but not impossible as the researchers have proven.

The researchers built a chip that is able to accept a laser beam pumped directly into it—that beam is used as the basis for forming photon pairs by means of interaction with a piece of silicon. The quantum light produced was then combined using a beam splitter (which was also integrated into the chip). The path length of the photon beams was controlled by modifying the temperature of the waveguides which allowed for observing two-photon quantum interference. The team reports observations of "up to 100 ± 0.4% visibility quantum interference on-chip up and up to 95 ± 4% off-chip."

The team suggests their apparatus (basically, a quantum system on a chip) makes unnecessary the need for external photon sources creating a path towards a true quantum computer. They also note that what they've created has been achieved without resorting to reinventing fabrication methods—their system can use methods very similar, they say, to those for other CMOS devices, making bulk production relatively easy. They also suggest their device could very well pave the way to multiple photon pair sources which if developed to work together could allow for the construction of highly efficient devices.

The team next plans to scale up their chip to allow for adding quantum processing tasks.

More information: On-chip quantum interference between silicon photon-pair sources, *Nature Photonics* (2013) DOI: 10.1038/nphoton.2013.339

Abstract

Large-scale integrated quantum photonic technologies will require on-chip integration of identical photon sources with reconfigurable waveguide circuits. Relatively complex quantum circuits have been demonstrated already, but few studies acknowledge the pressing need to integrate photon sources and waveguide circuits together on-chip8, 9. A key step towards such large-scale quantum technologies is the integration of just two individual photon sources within a waveguide circuit, and the demonstration of high-visibility quantum interference between them. Here, we report a silicon-on-insulator device that combines two four-wave mixing sources in an interferometer with a reconfigurable phase shifter. We configured the device to create and manipulate two-colour (non-degenerate) or same-colour (degenerate) path-entangled or path-unentangled photon pairs. We observed up to 100.0 ± 0.4% visibility quantum interference on-chip, and up to 95 ± 4% off-chip. Our device removes the need for external photon sources, provides a path to increasing the complexity of quantum photonic circuits and is a first step towards fully integrated quantum technologies.