Self-pumped Silicon Ring Source of Photon Pairs.

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Silicon microring resonators have been shown to be very efficient devices for on-chip optical nonlinearities. Light confinement in microring resonators greatly enhances the four-wave mixing (FWM) process, to the point of producing photon pairs with MHz rates[1,2]. So, microrings can act as microscopic, integrated sources of entangled photons[3-5].

However, current experiments need an external tunable optical pump in order to produce photon pairs. This is a very expensive requirement and need to be relaxed in order to adopt microring resonators as accessible quantum sources. In this work, we prove that FWM can be achieved in a silicon microring resonator in a self-pumping[6] geometry, by inserting the resonator inside an external-loop cavity.

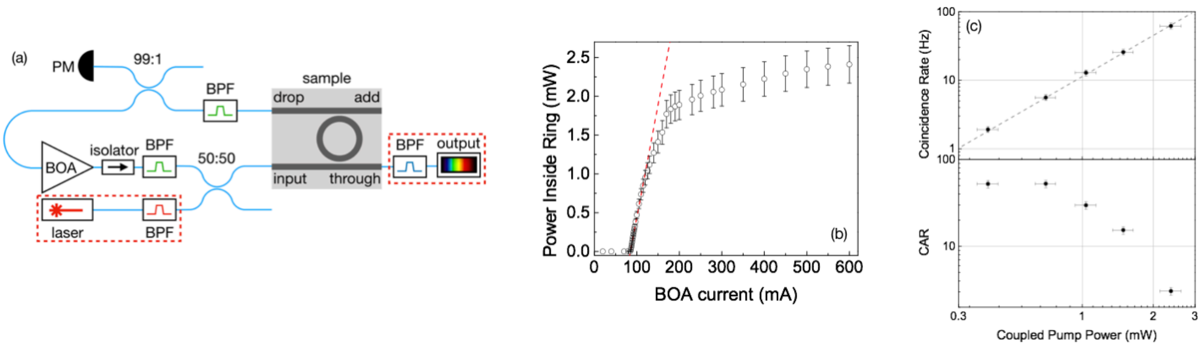

Fig 1: (a) An outline of the setup used in the stimulated FWM experiment, BPF stands for Band pass filter, BOA for booster optical amplifier and continuous lines represent optical fibers. (b) The cavity output at the laser frequency, showing a clear lasing threshold for an amplifier current of 90 mA. The powers are the estimated power inside the ring resonator. (c) Idler-signal coincidence measurement for the SFWM experiment.

We first perform the stimulated FWM experiment. The scheme of the setup in shown in Fig. 1(a). We use a microring in the add-drop configuration and we take advantage of an external source of gain (booster optical amplifier) to build a closed-loop fiber cavity with the source of entangled photons inside the loop. We show that lasing can be achieved with enough power in order to observe FWM emission. The lasing curve is shown in fig. 1(b) as a function of the BOA current. We then measure through a joint spectral density (JSD) technique[7] the correlation of the emitted photons, proving that the pairs emitted in the spontaneous FWM (SFWM) process would be entangled.

Finally, we measure the SFWM emission using a microring with a higher quality factor. As shown in Fig 1(c), we perform a coincidence measurement on the emitted signal and idler photons, finding a strong coincidence peak.

These results are a very important step towards an accessible integrated silicon source of quantum states of light that does not include an external laser.

The Integrated Photonic Technologies Center (INPHOTEC) of Scuola Superiore Sant'Anna in Pisa and Politecnico di Milano (F. Morichetti and A. Melloni) are acknowledged for PIC manufacturing.

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