High-rate multiplexed entanglement source based on time-bin qubits for advanced quantum networks

Vol. 2, No. 2, 25 April 2024, Optica Quantum

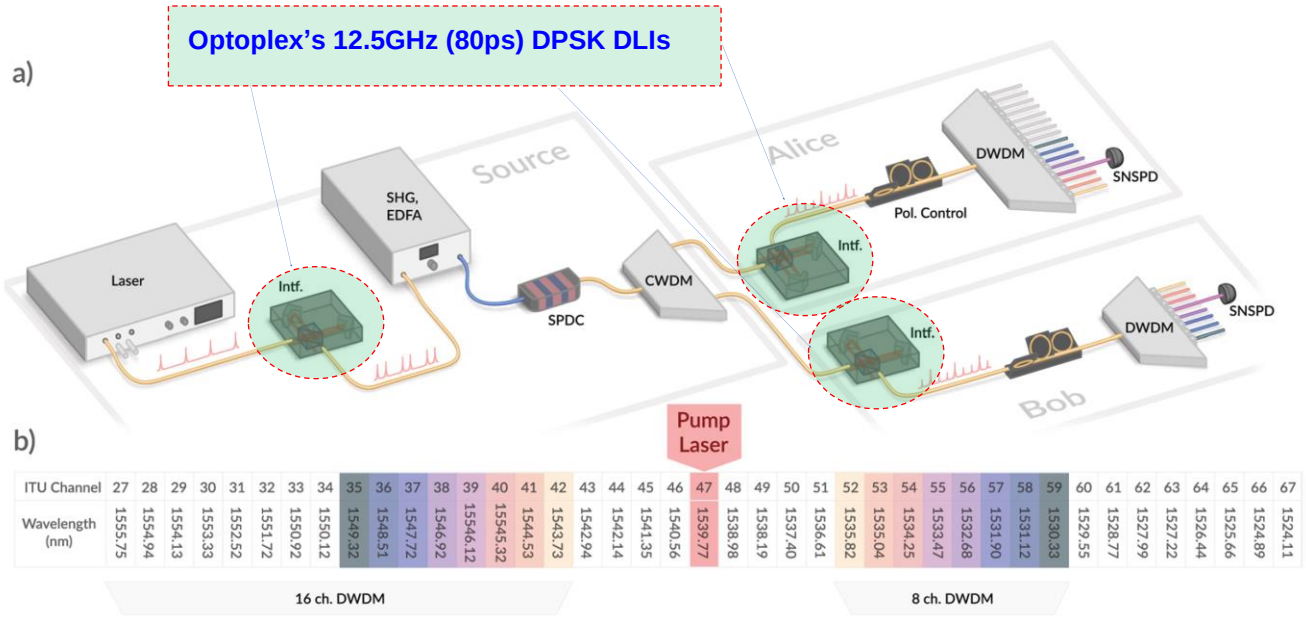

Fig. 1. (a) Pulses from a 1539.47-nm mode-locked laser (Pritel UOC) are split into two by an 80-ps delay-line interferometer (Optoplex) before up-conversion and amplification in a second harmonic generation + erbium doped fiber amplifier (SHG + EDFA) module (Pritel). A short PM fiber from the SHG module connects to a nonlinear crystal generating photon pairs by spontaneous parametric downconversion (SPDC). The coarse wavelength division multiplexing (CWDM) module separates the photon pair spectrum into eight 13-nm-wide bands around 1530 and 1550 nm, for the signal and idler photon, respectively. The signal and idler are directed to the Bob and Alice stations, respectively. The readout interferometers introduce the same time delay as the source interferometer. Polarization controllers are used to maximize the coincidence rates, as the detection efficiencies of each SNSPD is polarization sensitive (⍰}10%). Entanglement visibility is unaffected by readout polarization. The polarization controllers could be removed if future systems adopt polarization insensitive SNSPDs [28]. 100-GHz spacing dense wavelength division multiplexer (DWDM) modules are used to direct each frequency channel into a distinct fiber. Two superconducting nanowire single-photon detectors (SNSPDs) are used to measure a specific frequency multiplexed channel pair. Measurements for different multiplexed channels are performed in succession to resolve full system performance. (b) ITU channels used in the experiment. Pairs of channels highlighted with the same color obey the phase and pump-energy matching condition for SPDC. To assess the full 16 channels (27–42) of Alice's DWDM multiplexer, Bob's 8-channel DWDM is replaced with a narrowband filter with tunable resonance frequency (not shown in the figure).

Authors:

Andrew Mueller,[1,2,*] Samantha I. Davis,[3] Boris Korzh,[2] Raju Valivarthi,[3] Andrew D. Beyer,[2] Rahaf Youssef,[3] Neil Sinclair,[3,4] Cristián Peña,[3,5] Matthew D. Shaw,[2] AND Maria Spiropulu[3]

[1] Applied Physics, California Institute of Technology, 1200 E California Blvd., Pasadena, California 91125, USA

[2] Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, California 91109, USA

[3] Division of Physics, Mathematics and Astronomy, California Institute of Technology, 1200 E California Blvd., Pasadena, California 91125, USA

[4] John A. Paulson School of Engineering and Applied Sciences, Harvard University, 29 Oxford St., Cambridge, Massachusetts 02138, USA

[5] Fermilab Quantum Institute and Experimental Physics Department, Fermi National Accelerator Laboratory, Batavia, Illinois 60510, USA