TELECOM-BROADBAND HYPERENTANGLED PHOTON SOURCE

PRELIMINARY

Features

- High-quality hyper-entanglement in polarization and frequency
- Hyperentangled biphotons routed deterministically in two output ports
- Compatible with fixed or programmable filters for high-dimensional entanglement in frequency domain
- Broad bandwidth covering C- and L- bands
- High fidelity and excellent stability
- Turn-key and room-temperature operation
- Low power consumption
- Compact design and lightweight optics
- Rugged, alignment free, all fiber design

Applications

Enabler for

- High-dimensional quantum information processing
- Quantum superdense coding
- Frequency and polarization superdense teleportation for space application

Product Description

The OZ Optics hyperentangled photon source uniquely fulfils three important requirements to enable high-dimensional quantum information processing and quantum superdense teleportation for modern defence and space applications:

1. Reliable all-in-fiber and alignment-free source.
2. Compact footprint, lightweight fiber and high-quality performance that can be easily integrated easily into any portable system.
3. Hyper-entanglement generation along with high-brightness and unprecedented fidelity for quantum inter-satellite link technologies.

Based on periodically-poled silica fiber (PPSF) technology, this source features turn-key, room-temperature operation, and needs little maintenance. The all-fiber design makes it environmentally stable for challenging applications. It generates telecom hyperentangled photon pairs with about 80 nm of bandwidth, and can be combined with fixed or programmable filters to create entangled frequency combs and high-dimensional frequency entanglement.

Performance Specifications[1]

Part number: HEPS-1000-3A3A-1566-9/125-S				
Parameter	**Max.**	**Typical**	**Min.**	**Unit**
Signal/Idler degeneracy wavelength[2]	1580	1566 ±2	1530	nm
Signal/Idler degeneracy wavelength accuracy	–	±2	–	nm
Biphoton bandwidth (3 dB)[3]	>120	80	60	nm
Signal/Idler sum frequency bandwidth (3 dB)	0.4	0.2	0.1	nm
Pair-generation rate	$4x10^6$	$3x10^6$	$1x10^6$	Pairs/second
Coincidence-to-accidental ratio[4]	–	1000	100	
Lower bound of the fidelity defined as[5] : $F_{p\omega} = \langle \Psi^-_\omega \mid \langle \Phi^+_p \mid \rho_{p\omega} \mid \Phi^+_p \rangle \mid \Psi^-_\omega \rangle$, With frequency bin separation of < 7 nm	99%[6]	98%	97%	

Note:

1 Under continuous-wave (CW) operation.

2 The degeneracy wavelength is usually conveniently set at the boundary of C- and L-bands. Customized degeneracy wavelength in the indicated range is possible.

3 This bandwidth refer to 3-dB spectral brightness. Not all other specs are satisfied over this broad bandwidth.

4 Coincidence counts are measured on signal/idler FWHM bandwidth of 16 nm each, over 0.65 ns window, with free-run SPAD detectors having dark counts of ~5 kHz.

5 For detailed definition, assumptions, and method of determining the fidelity to the frequency-polarization hyperentangled state, please refer to [1].

Optical Specifications

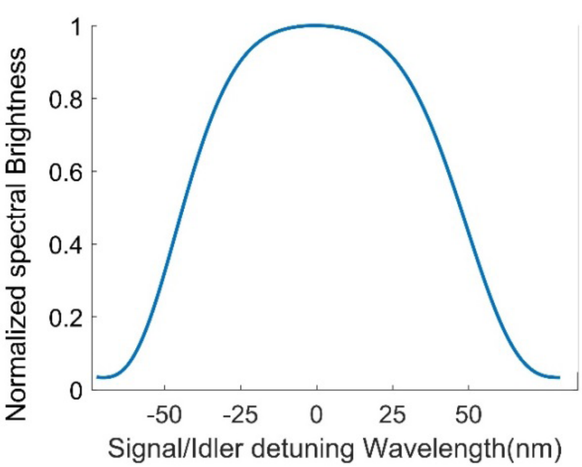
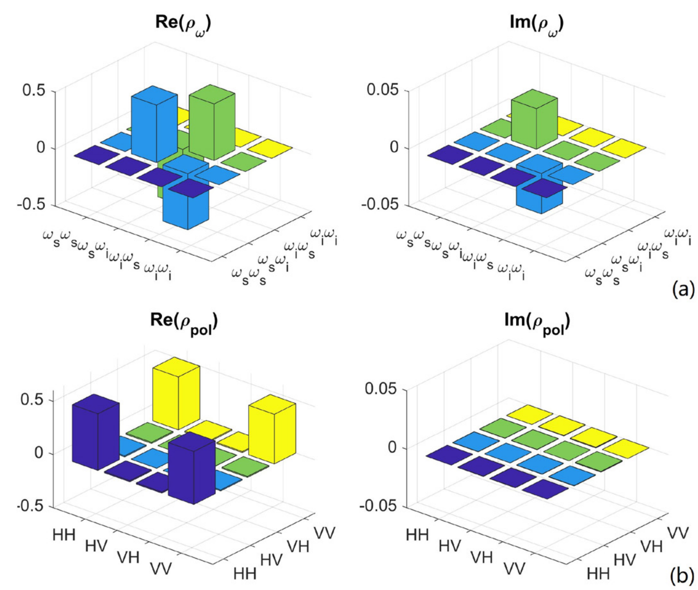


Figure 1. Typical biphoton spectrum



The real and imaginary parts of the reduced density matrices of the PF hyperentangled state which are reconstructed from the experimental data in: (a) Frequency domain $\rho\omega$; (b) Polarization domain ρpol

Figure 2. Typical polarization density matrix

Operating And Storage Conditions

Parameter	Min.	Max.
Operating temperature	15°C	25°C
Operating relative humidity (% RH)	5	60
Storage temperature	-40°C	40°C
Storage relative humidity (% RH)	0	90

Links To White Paper

[1] Changjia Chen, Calvin Xu, Arash Riazi, Eric Y. Zhu, Alexander Greenwood, Alexey V.Gladyshev, Peter G. Kazansky, Brian T. Kirby, Li Qian ,"Telecom-band Hyperentangled Photon Pairs from a Fiber-based Source" arXiv: 2112.03369 [quant-ph](2021)

[2] Changjia Chen, Eric Y. Zhu, Arash Riazi, Alexey V. Gladyshev, Costantino Corbari, Morten Ibsen, Peter G. Kazansky, and Li Qian, "Compensation-free broadband entangled photon pair sources," Opt. Express 25, 22667–22678 (2017). https://www.osapublishing.org/oe/abstract.cfm?uri=oe-25-19-22667

[3] Zhu, E. Y., et al. "Multi-party agile quantum key distribution network with a broadband fiber-based entangled source," arXiv preprint arXiv:1506.03896 (2015).

[4] Changjia Chen, Arash Riazi, Eric Y. Zhu, Alexey V. Gladyshev, Mili Ng, Peter G. Kazansky, and Li Qian. "A Compact All-fiber Polarization Entangled Photon Source Pumped by a Laser Diode," Conference on Lasers and Electro-Optics, 2018, San Jose, CA, USA. https://arxiv.org/abs/1506.03896