OZOptics
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BRIGHT POLARIZATION-ENTANGLED PHOTON SOURCE BROADBAND TELECOM

Features

- Highest counts/coincidence rate available in the market
- High Heralding efficiency and excellent fidelity
- Turn-key, highly stable, room temperature operation
- Rugged, alignment free, proprietary design
- Built-in noise-suppression filters
- Built-in stable pump laser with variable attenuator
- Customizable

Applications

- Quantum key distribution
- Quantum computing and information processing
- Quantum LIDAR
- Subsystem integrable for quantum communication

Bright entangled photon source with a built-in pump laser

Product Description

OZ Optics' bright entangled photon sources capitalize on the high optical confinement within a periodically poled nonlinear waveguide (PPNW) to achieve excellent efficiency and abundant photon pairs. Photons are generated via spontaneous parametric down-conversion (SPDC) within a periodically poled lithium niobate (PPLN) type-0 waveguide, placed within a fiber-based Sagnac loop. The PPNW is thermally stabilized to maintain the ideal phase matching condition. Upon creating the photon pairs, the pump photons and associated fluorescence noise are completely filtered out from the remaining pairs via a built-in set of optical filters.

The highly stable performance is achieved through the self-compensation effect of an all-in-fiber Sagnac interferometer. This is combined with a single frequency external cavity laser operating at 775 nm with an ultra-narrow linewidth. As a result, bright, high-performance and low-noise entangled photon sources operating at room temperature are realized. The polarization-entangled photon pairs are generated to cover a broad spectral bandwidth of 80 nm, centered at 1550 nm in the telecom C-band.

The standard bright source has a built-in optical switch as shown in Figure 1. Users have the option of directing the photon pairs either to a single common output port or the pair can be divided into two output ports, where an internal wavelength splitter is used to separate the Signal and Idler polarized-entangled photon pairs. In addition, a built-in variable optical attenuator is added to control the pump power and hence, the accidental photons and the counts noise floor. A rotatable half-wave plate (HWP) is integrated to control the number of photon pairs, generated in each of the two interferometric paths (see Figure 2). Consequently, the polarization reference bases can be set while the entanglement is switched between the polarization and energy domains. This feature is expected to support the quantum optics R&D community around the world.
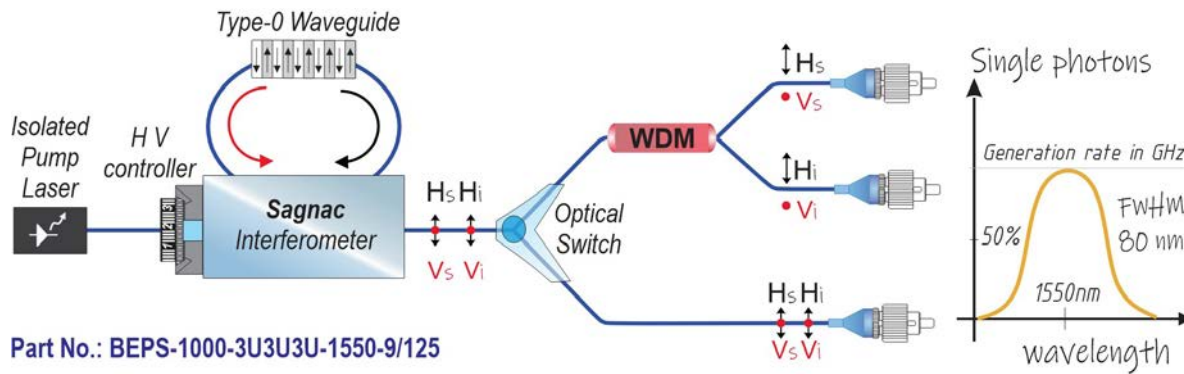
Figure 1. Schematic of a standard broadband bright polarization-entangled photon source implementing a type-0 waveguide and a built-in optical switch to rout pairs either to a common output port or to an internal wavelength splitter (WDM) separating photon twins into two output ports.

Operation Principle

The pump photons are linearly polarized. Their polarization state is controlled via a rotatable HWP. As shown in Figure 2, the polarization state of the pump photons in xy-plane is defined by the angle, δ, while the beam enters the polarizing beam splitter (PBS) in the negative z direction. The beam is then split to p-polarization component along x-axis and s-polarization component along y-axis while the ratio is controlled via δ. Both polarization components are coupled to the slow axis of the PM fiber that forms the Sagnac loop. By controlling δ through the HWP, the user can correlate the lab frame with the polarization bases of the photon pairs at 0° and 90° as shown in Figure 2(a) and (b), respectively. The polarization entanglement is achieved at 45°, shown in Figure 2(c).
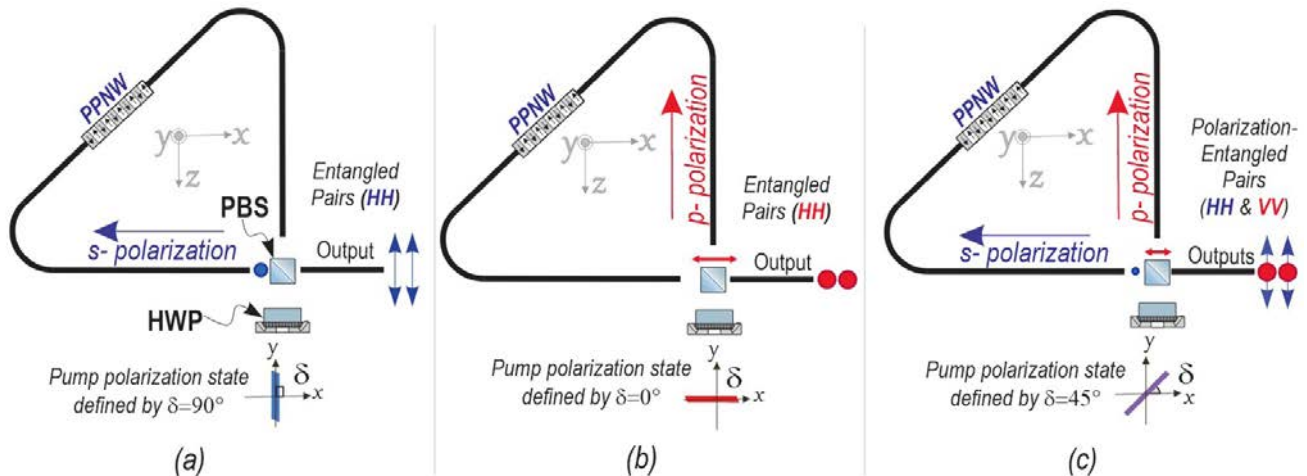

Figure 2. Illustration of the of photon pairs polarization as a function of the polarization state of a linearly polarized pump photons passing the PBS and exciting a Type-0 SPDC PPNW, placed within the Sagnac loop.

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Performance Specifications[1]

Part number: BEPS-1000-3U3U3U-1550-9/125				
Parameter	**Max.**	**Typical**	**Min.**	**Unit**
Signal/Idler degeneracy wavelength[2]	–	1550 ±0.6[2]	–	nm
Photon pairs bandwidth FWHM[3]	–	80	–	nm
Noise suppression	–	>75	–	dB
Pair-generation rate[4]	–	>5x10^{6}	–	Pairs/second
Fidelity[5]	–	>98%	–	
Two-photon interference visibility	–	>98%	–	
Variable output power of Pump laser	12	variable	0	mW
Physical Dimensions	Width x depth x height (cm)	39 x 34.4 x 8.6		
	Weight (kg)	~4		
	Front panel color	Red		

Note:
1. Under continuous-wave (CW) operation.
2. Can be customized for high volume orders
3. This bandwidth refers to 3-dB spectral brightness.
4. Measured at low power level in µW regime. Refer to Figure 3.
5. Limited by detector dark counts.

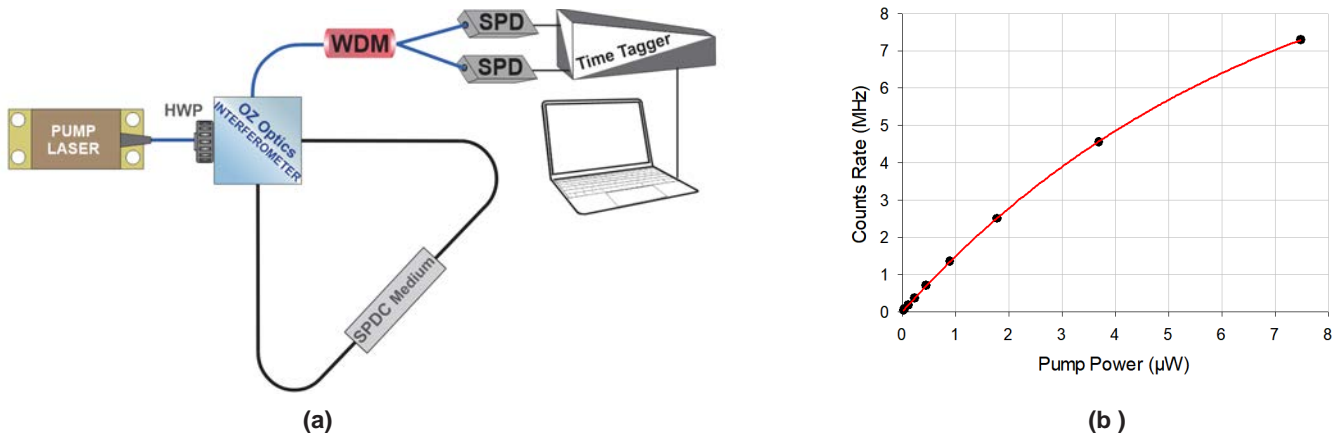## Optical Specifications

(a)

(b)

Figure 3. (a) Test setup demonstration of the type-0 bright polarization-entangled photon source, where the spectral bandwidth of the photon pairs is about 80-nm wide (b) Counts rate of the singles as a function of the built-in laser pump power.

Customized sources

Robust, alignment-free and miniature sources can be customized upon request to meet the industrial standards for system integration purposes. For example, a miniature version can be constructed within a compact block based on a proprietary interferometric scheme as shown in Figure 4.

Please contact OZ optics to get a customized part number.
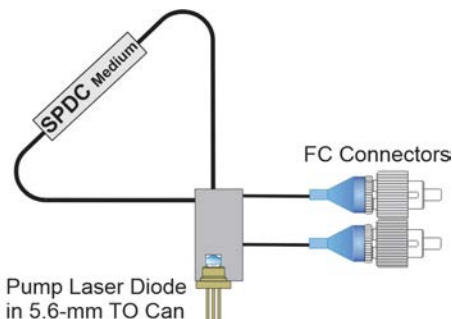

Figure 4. Schematic diagram showing a miniature bright polarization-entangled photon source. All of the parts including the wavelength splitter, electro-optical birefringent crystal and pump laser diode are integrated into a compact housing.

Operating and Storage Conditions

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

Part Numbers

As illustrated in Figure 1 the standard source includes a pump laser, wavelength splitter, accessible HWP, accessible attenuator and controllable optical switch.

Broadband Telecom Bright Polarization-Entangled Photon Sources

BEPS-1000- *XYZ*- *W*- *F*

XYZ:
- 3A = FC/APC
- 3S = FC/SPC
- 3U = FC/UPC

F= 9/125 single mode

W = Specify in nanometers
1550: 1550 nm

Example: BEPS-1000-3U3U3U-1550-9/125