OZ Optics

BRIGHT ENTANGLED PHOTON SOURCES

Features

- Highest counts/coincidences rate available in the market
- Highly-stable handheld device with excellent fidelity
- Rugged, alignment free, all-in-fiber proprietary design
- Controllable accidental photons rate
- Built-in noise-suppression filters
- Turn-key and room-temperature operation
- High Heralding efficiency (45%-70%)
- Hyperentangled pairs routed deterministically into two output ports
- Customizable:
  - Polarization-entangled photon pairs
  - Correlated photon pairs
  - Broad-band spectrum
  - Narrow-band spectrum
  - Free-space or fiber pigtailed outputs

Fig:1. Photo of a bright entangled photon source with a built-in pump laser

Applications

- Compact, highly-stable and low noise source for:
  - Quantum satellite communication
  - Quantum key distribution
  - Quantum computing and information processing
  - Quantum LIDAR
- Enabler for:
  - High-dimensional quantum information processing
  - Frequency and polarization superdense teleportation for space application

Product Description

OZ Optics offers a versatile product line for generating entangled and polarization-entangled photon pairs, distributed in either a narrow or broad spectral band. Design simplicity, and thus the final product stability capitalizes on the high optical confinement within periodically poled nonlinear waveguides (PPNWs), which improve the spontaneous parametric down-conversion (SPDC) efficiency. This is combined with the inherent stability, established via the self-compensation effect of a Sagnac all-in-fiber interferometer. These bright, stable and low-noise entangled photon sources operating at room temperature are constructed within a compact and lightweight enclosure with a built-in pump laser diode for either alignment-free stand-alone operation or integration purposes.

This source has a built-in attenuator to control the accidental photons and the noise floor. A rotatable half-wave plate (HWP) can be integrated to control the number of the photon pairs generated in each of the two interferometric paths (see Fig. 2) so that the polarization-entanglement or energy entanglement can be set by the user. Hyper-entanglement in polarization and frequency domains is generated using a Type-2 SPDC PPNW. In the case of using a Type-0 waveguide, rotating the polarization state of the pump photons can switch between the correlation and the polarization-entanglement modes. This feature is expected to support the quantum optics R&D community while the HWP can be replaced by an integrated electro-optical birefringent crystal to precisely and actively tune the pump polarization state for compact industrial devices as shown in Fig. 10.

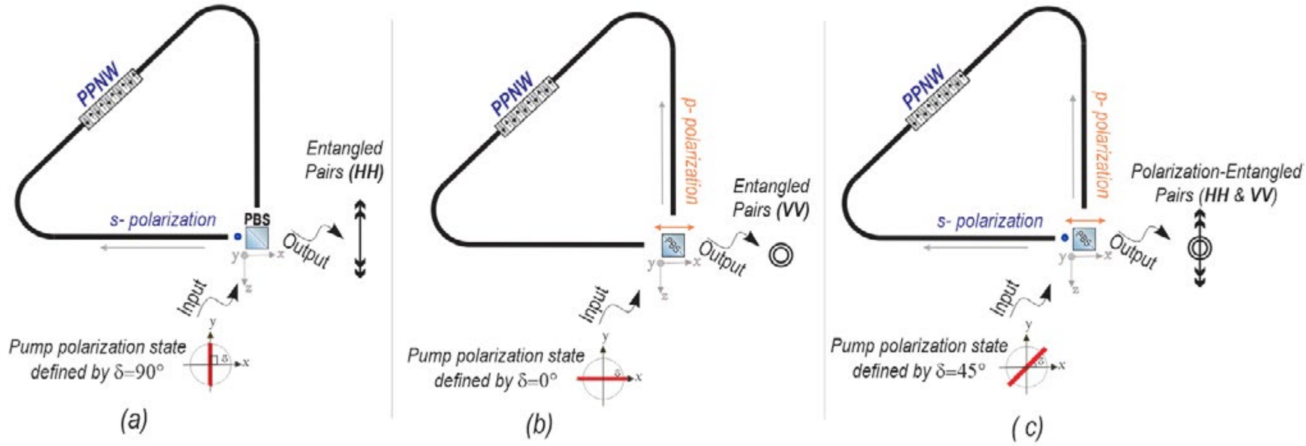


Fig:2. Illustration of the of photon pairs state as a function of the polarization state of a linearly polarized pump laser passing a polarization beam splitter (PBS) cube when deploying a Type-0 SPDC PPNW in the Sagnac loop.

Performance Specifications[1]

Part number: BEPS-1000-3A3A3A-1550-9/125-S				
Parameter	**Max.**	**Typical**	**Min.**	**Unit**
Signal/Idler degeneracy wavelength	–	1550 [2]	–	nm
Signal/Idler degeneracy wavelength accuracy	–	±2	–	nm
Photon Pairs bandwidth FWHM				
For broad bandwidth	–	80 [3]	–	nm
For narrow bandwidth	–	3	–	nm
Pair-generation rate[4]				
For broad bandwidth at 15mW pump	–	>20x10^{9}	–	Pairs/second
For narrow bandwidth at 15mW pump	–	>100x10^{6}	–	Pairs/second
Coincidences rate				
For broad bandwidth at 8 μW pump	–	>2x10^{6}	–	Pairs/second
For narrow bandwidth at 350μW pump	–	>0.6x10^{6}	–	Pairs/second
Fidelity	–	>98%	–	
Two-photon interference visibility	–	>98%	–	

Note:
1. Under continuous-wave (CW) operation.
2. Can be customized for high volume orders..
3. This bandwidth refers to 3-dB spectral brightness. Not all other specs are satisfied over this broad bandwidth.
4. Calculated based on power output measurement s, where the SPDs get saturated and the counts can not be realized.

Optical Specifications

1. Correlated Photon Source

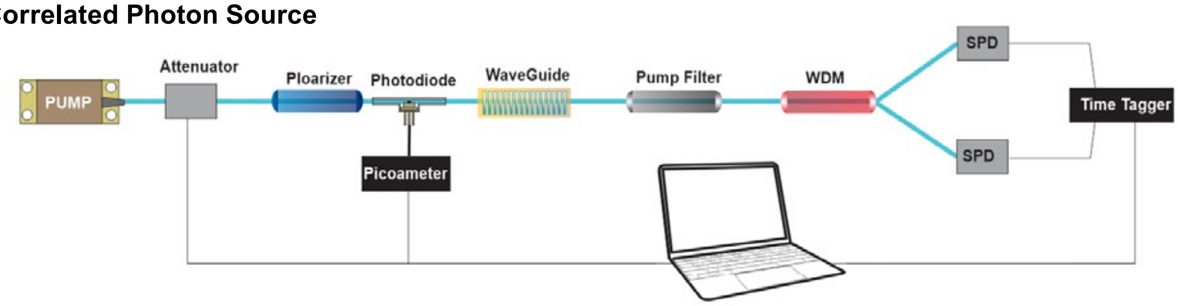


Fig:3. Schematic of the setup used to measure the counts and coincidences rates.

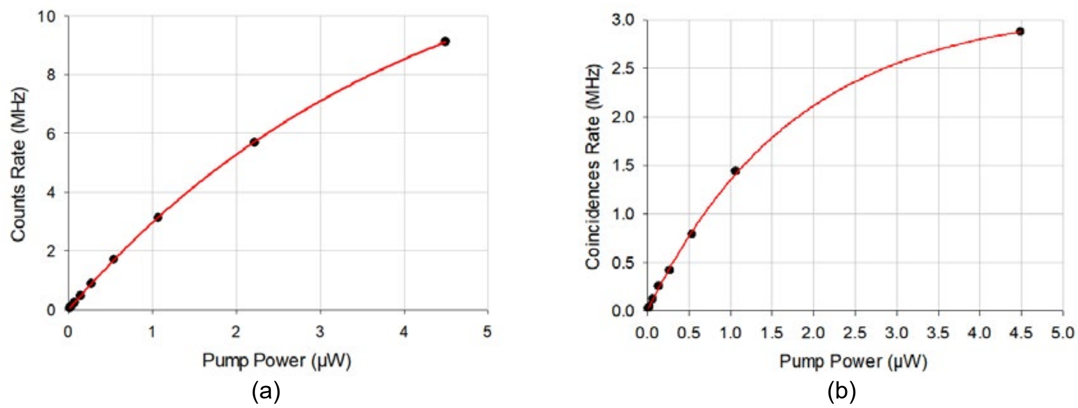


Fig:4. (a) Counts and (b) Coincidences rate of Type-0 PPNW as a function of the pump power based on the setup, illustrated in Fig. 3, while the photon pairs are distributed in a broad spectral bandwidth.
Note: the measurements are affected by the non-linear response of the free-running InGaAs SPADs.

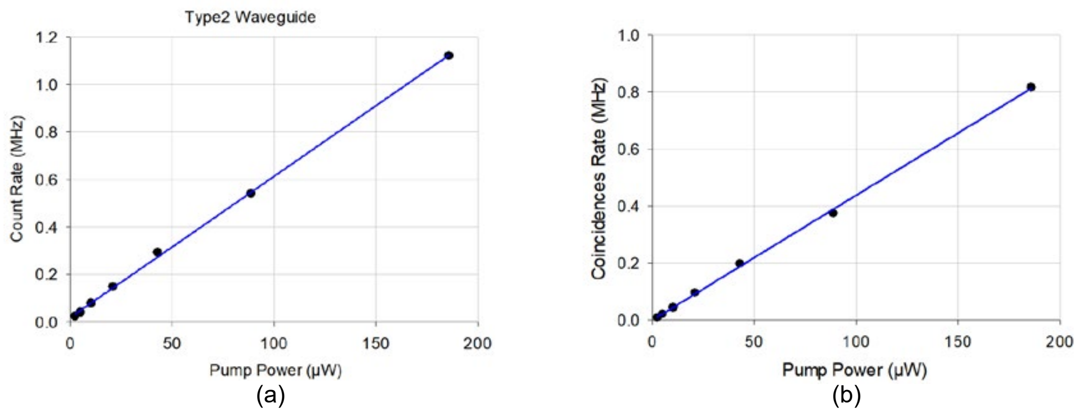


Fig:5. (a) Counts and (b) Coincidences rate of Type-2 PPNW as a function of the pump power routed as shown in Fig. 3, where the photon pairs are generated within a narrow spectral bandwidth

2. Polarization Entangled-Photon Interferometric Source

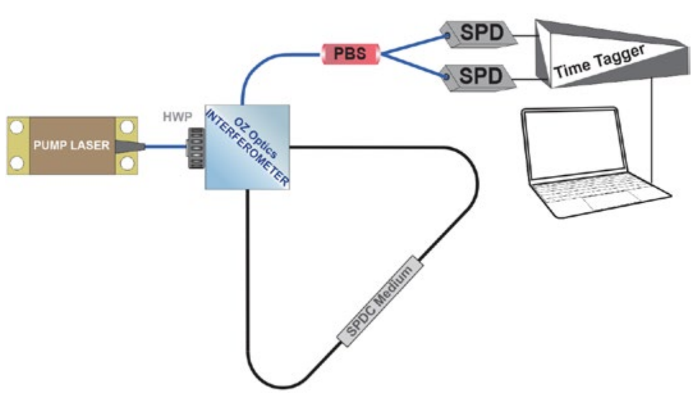
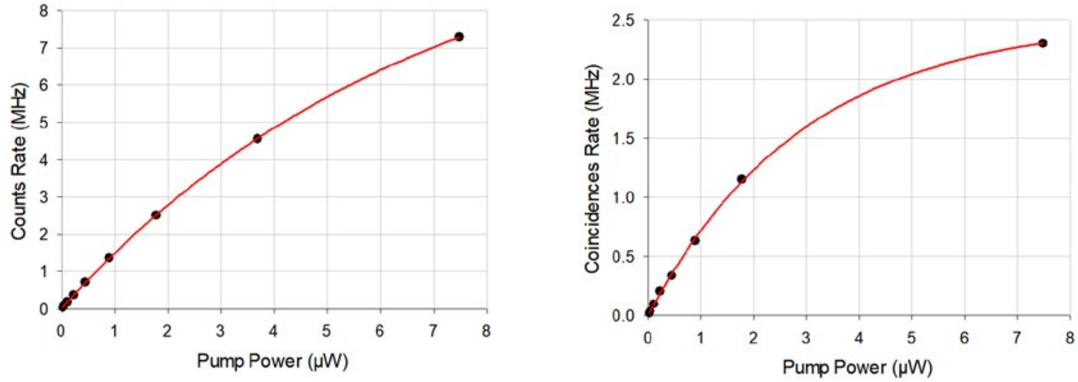


Fig:6. Demonstration of the OZ Optics interferometric engine including a Type-0 PPNW as an SPDC medium. The spectral bandwidth of the photon pairs is about 80-nm.



(a) (b)

Fig:7. (a) Counts and (b) Coincidences rate of polarization-entangled photons as a function of the pump power in the case of Type-0 SPDC illustrated in Fig. 6.

3. Hyper-Entangled Photon Interferometric Source

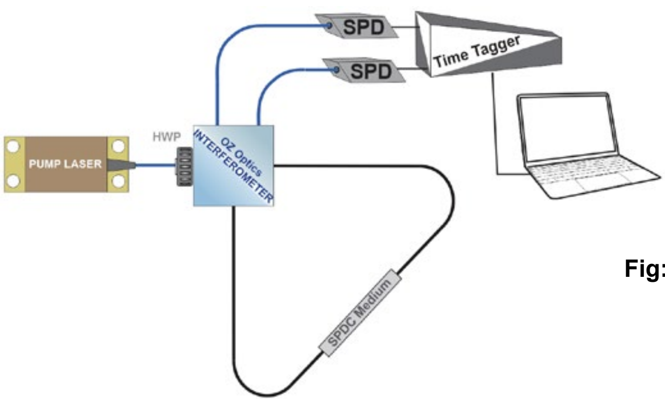
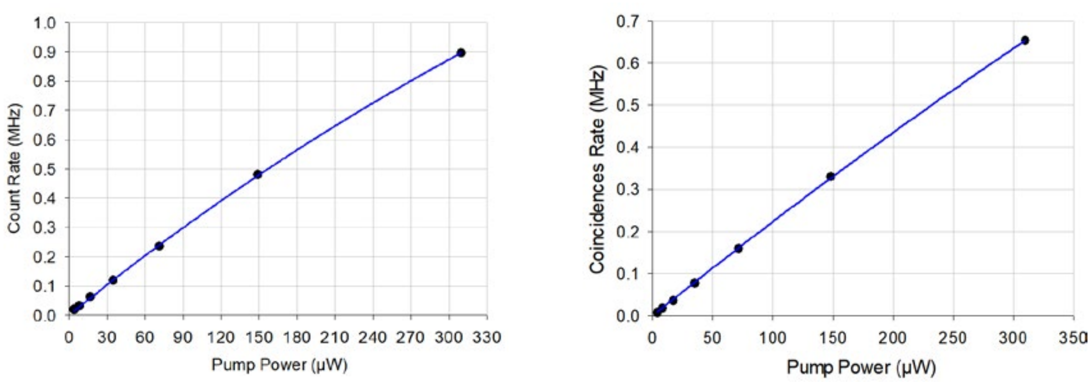


Fig:8. Illustration of the OZ Optics interferometric engine of a Type-2 PPNW. The spectral range of the photon pairs is about 3-nm wide.



(a) (b)

Fig:9. (a) Count and (b) Coincidences rate as a function of the pump power in the case of using a Type-2 PPNW integrated in the Sagnac interferometer, shown in Fig. 8, to generate hyper-entangled pairs.

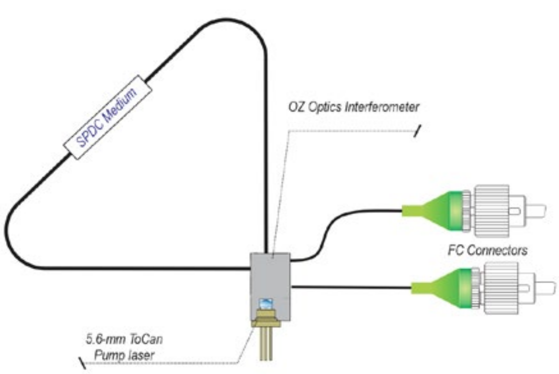


Fig:10. Schematic diagram showing the OZ Optics interferometric engine, where all of the parts including the PBS, noise-suppression filters and pump laser diode are integrated in a compact housing.

Part Numbers

Bright Polarization Entangled Photon-Source

BEPS-PUMP-HWP-X- W- F-O

PUMP: 1 = No pump laser
2 = Built-in pump laser

HWP: 1 = No rotatable HWP
2 = Built-in HWP

X: Connector code:
X = No Connector
XYZ = With Switch
3A = FC/APC
3S = FC/SPC
3U = FC/UPC

W = Specify in nanometers
1550: 1550 nm

F = 9/125 single mode

O: Non = No switch
S = WDM + optical switch with three outputs

Example: BEPS-1-1-3A-1550-9/125-S

Bright Hyperentangled Photon-Source

BHPS-PUMP-HWP-XY- W- F

PUMP: 1 = No pump laser
2 = Built-in pump laser

HWP: 1 = No rotatable HWP
2 = Built-in HWP

XY: Connector code:
3A3A = FC/APC
3S3S = FC/SPC
3U3U = FC/UPC

W = Specify in nanometers
1550: 1550 nm

F = 9/125 single mode

Example: BHPS-2-1-3A-1550-9/125

Bright Correlated Photon-Source

BCPS-PUMP-BAND-X- W- F-O

PUMP: 1 = No pump laser
2 = Built-in pump laser

BAND: N = Narrow bandwidth
B = Broad bandwidth

X: Connector code:
X = No Connector
XYZ = With Switch
3A = FC/APC
3S = FC/SPC
3U = FC/UPC

W = Specify in nanometers
1550: 1550 nm

F = 9/125 single mode

O: Non = No switch
S = WDM + optical switch with three outputs

Example: BCPS-2-N-3A3A3A-1550-9/125-S