Experimental control of the frequency correlations of photon pairs for a pure heralded single photon source.

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Introduction

In quantum optics, the production of single photons on demand is an important topic of research due to their multiple applications [1]. Single photons on demand are difficult to produce, an alternative is to use a Spontaneous Parametric Down Conversion source (SPDC) since the detection of one photon heralded the existence of its partner creating a heralded single photon source. This pair of photons have spectral and spatial correlations [2]. In order to have a pure Heralded Single Photon (HSP) with high heralded efficiency it is necessary to break these correlations between the pairs. One alternative is to use spatial and spectral filters [3]. In this work, we break the spatial correlation using spatial filters and the spectral correlation is changed with interference filters. The spectral filtering effects on the heralding efficiency and the purity of the heralded photon are experimentally study by measuring the joint spectrum (JS) under different filtering conditions.

Heralded single photon source

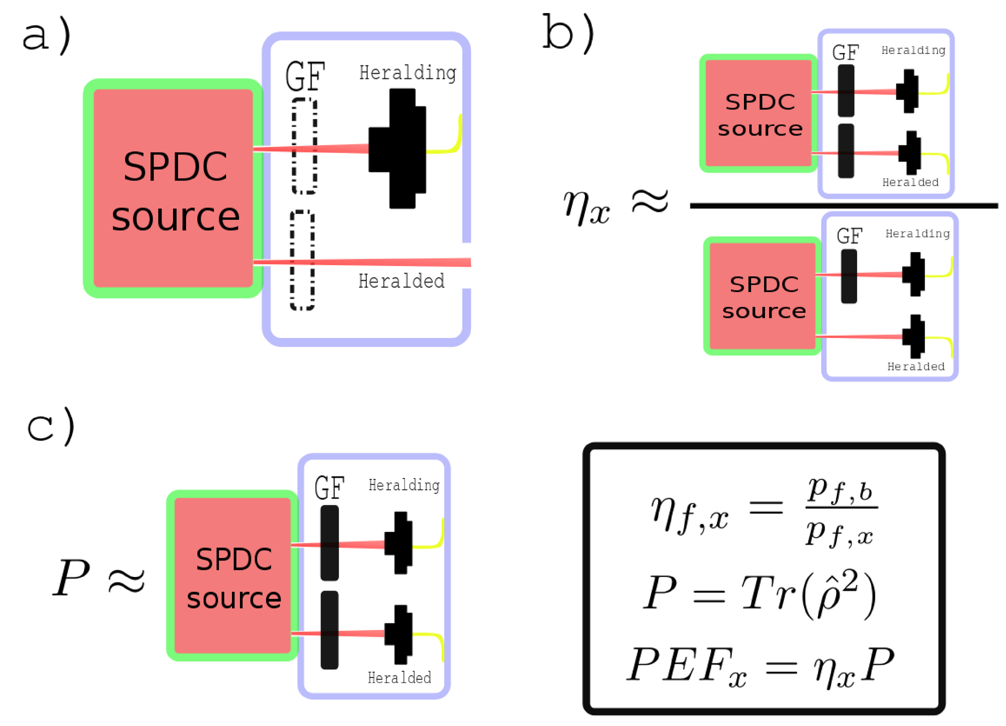

Figure 1: ***a)*** *A heralding photon announce its partner.* ***b)*** *Heralded efficiency is proportional to joint detection with filters in both arms over the joint detection with a filter in the heralding arm.* ***c)*** *The purity is obtained by measuring the joint detection with spatial and spectral filters in both arms.*

Correlated photon pairs source

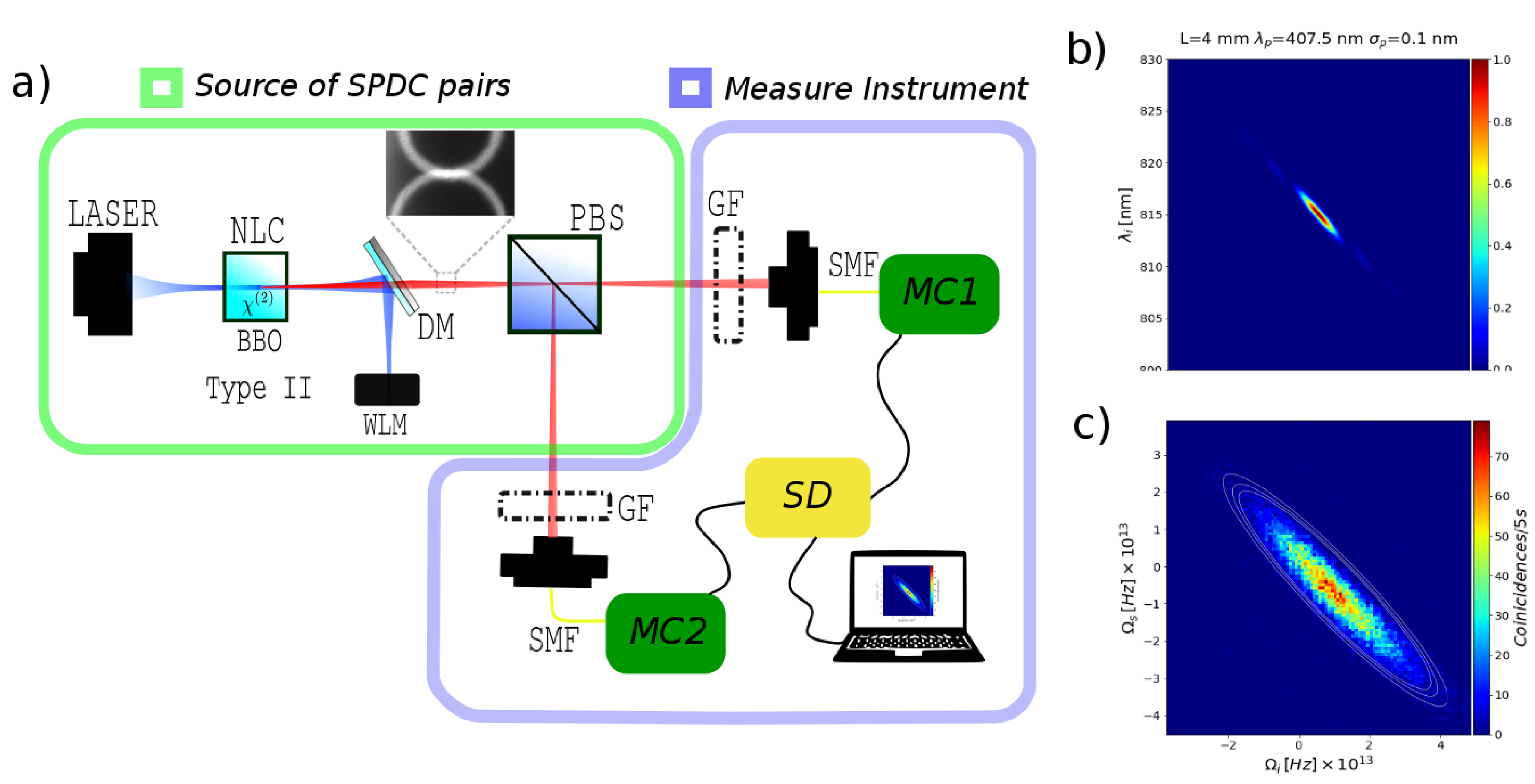

Figure 2: ***a)*** *Experimental setup for the measurement of correlations between photon pairs produced by SPDC process.* ***b)*** *Theoretical and* ***c)*** *experimental measurement of the JS.*

Characterization of the HSPS

To control the frequency correlations and to obtain a *HSPS* we use spectral Gaussian filters (GF) with bandwidth σ_x of $0.82\,nm$, $2.11\,nm$ and $3.62\,nm$. From these measurements we obtain the *Heralded Efficiency* η_x, the *purity* P and the *PEF* factors:

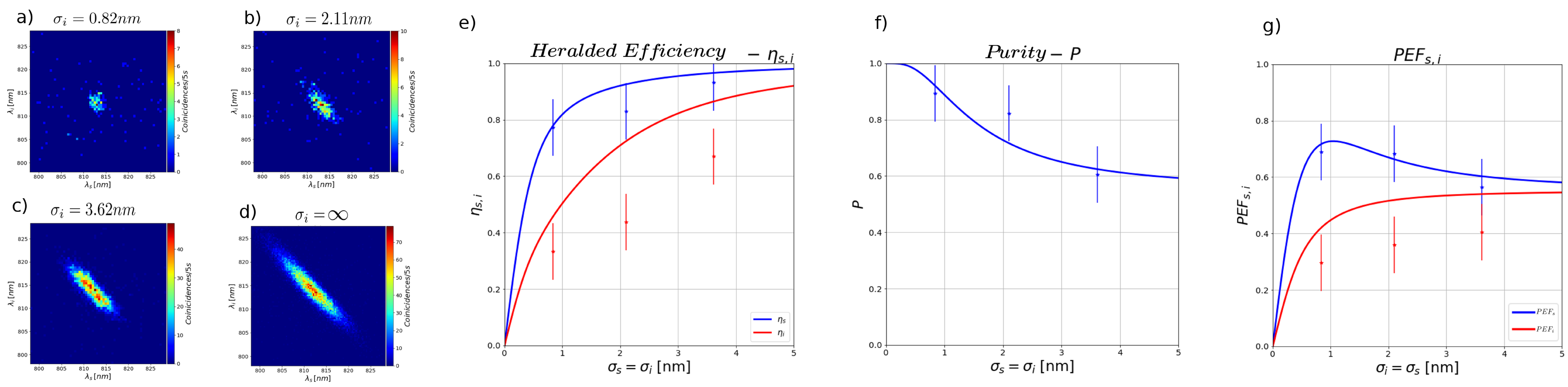

Figure 3: *Measurement of the JS for different filtering conditions* ***a-d)*** *using filters in the idler's arm and fitting the controlled JS as* $\phi(\Omega_s,\Omega_i) = Ne^{(-\frac{a}{2}\Omega_s^2-\frac{b}{2}\Omega_i^2+c\Omega_s\Omega_i)}$ *[4].* ***e-g)*** *The dots are experimental data and the solid line correspond to the theoretical calculations. Behavior of the* ***e)*** *Heralded efficiency* η_x ***f)*** *Purity* P *and* ***g)*** PEF *factors.*

Conclusions

- The use of spectral filters changed the correlation between the pair of SPDC photons.
- There is a different heralded efficiency for signal photon and idler photon. The heralded efficiency is higher for a signal photon.
- The purity, heralded efficiency and PEF factors have the behavior predicted by the theory.
- The experimental result showed that indeed there is an optimal filter band that maximize the Purity and Heralded Efficiency simultaneously: PEF factor.

References

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