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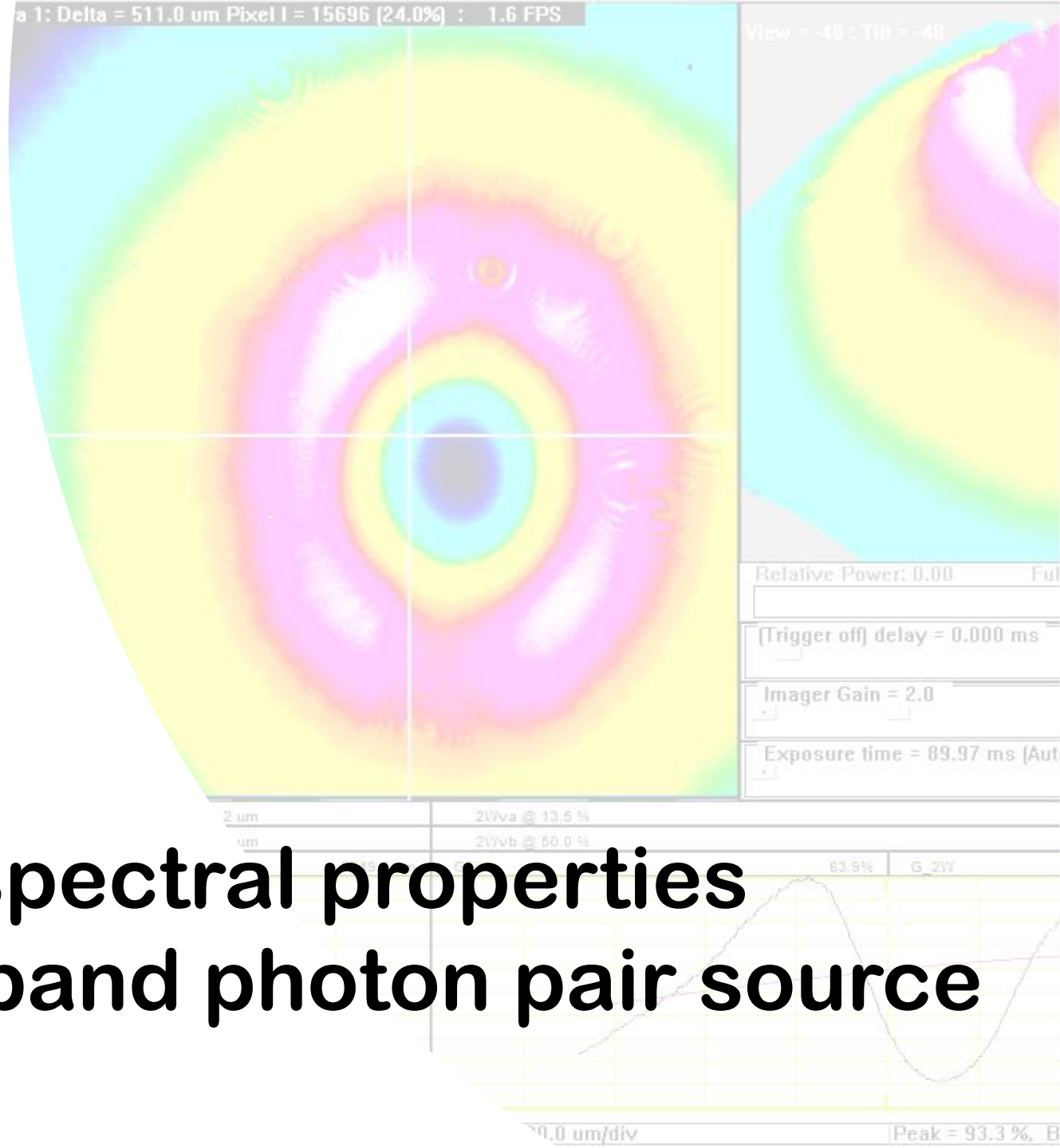
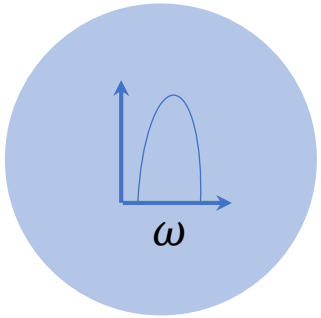


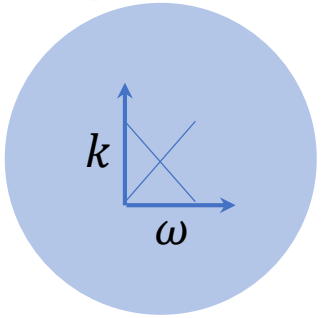
Coupled spatial and spectral properties of a spectrally broadband photon pair source in bulk PPLN

Outline

Broadband photon pair sources

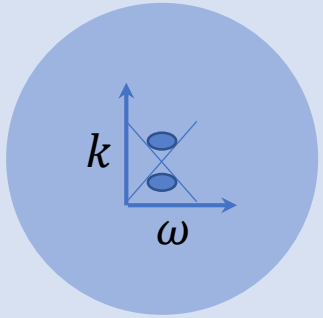


X-spectrum:
Spatial-spectral correlations



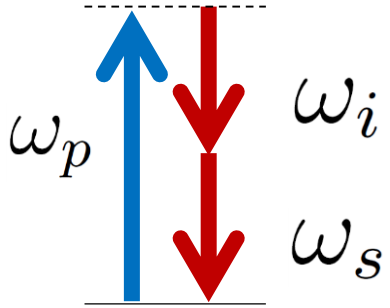
Experimental measurements

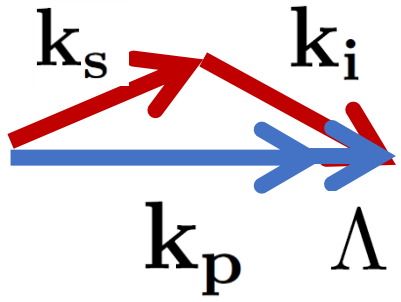
New characterization method:
“X-blobs”

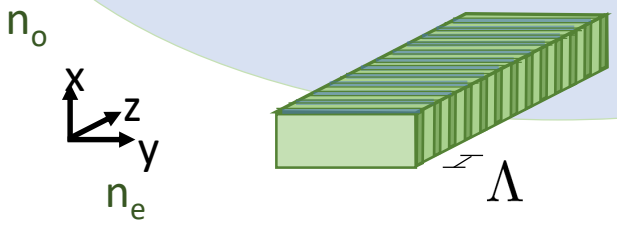


Photon pair sources

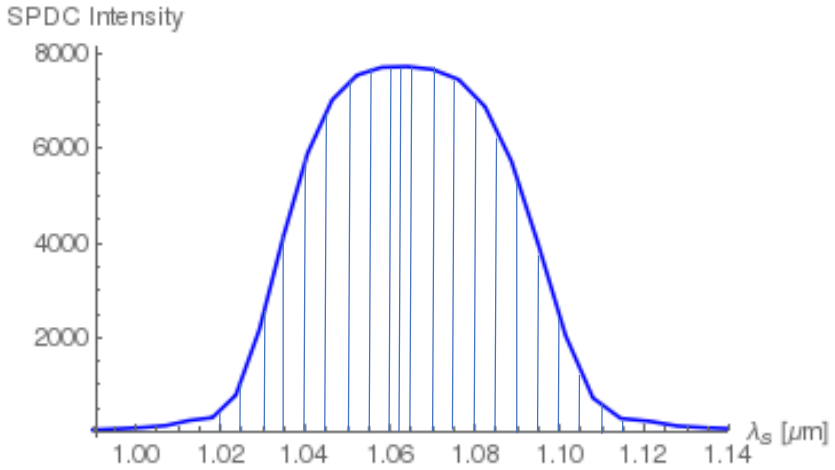
Spontaneous parametric down-conversion (SPDC) is a popular method for creating single-photon pairs in nonlinear crystal





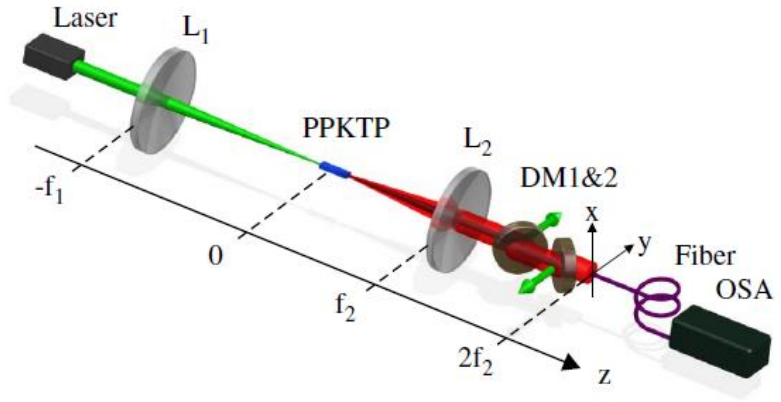


Periodically-poled Lithium niobate (PPLN) is a common nonlinear crystal used for frequency conversion

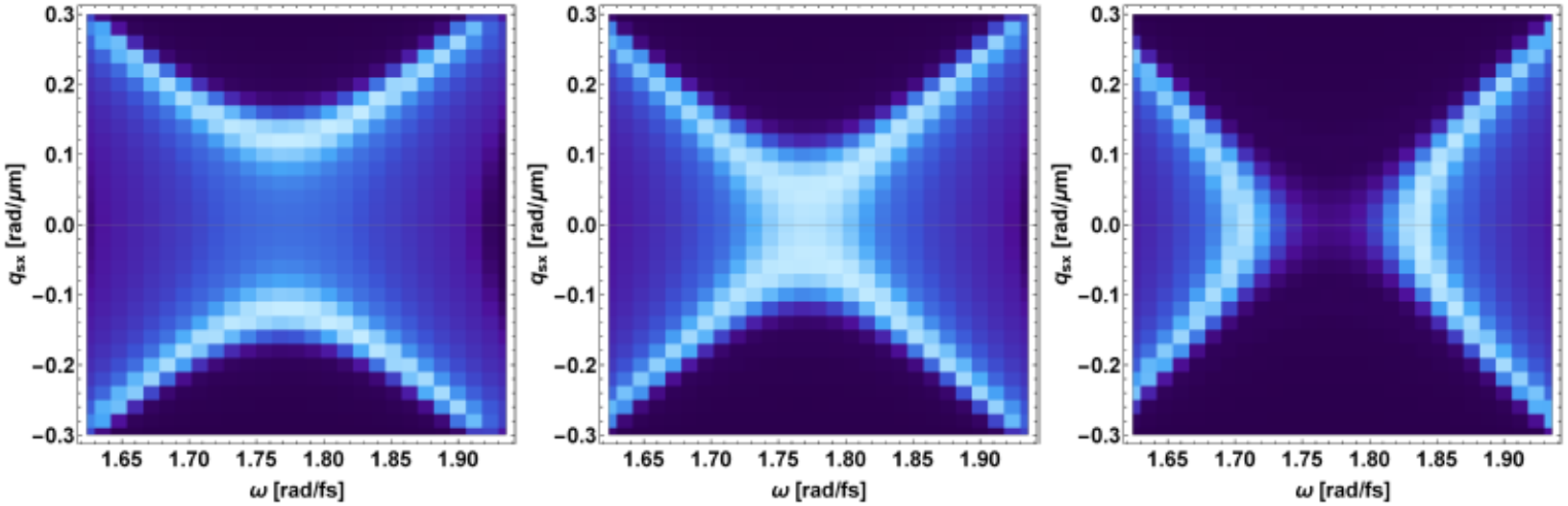


Existing spatial-spectral characterization methods

- These properties have been previously measured in BBO and PPTKP crystals but not PPLN



Raster scanning spatial-spectral setup from [1]



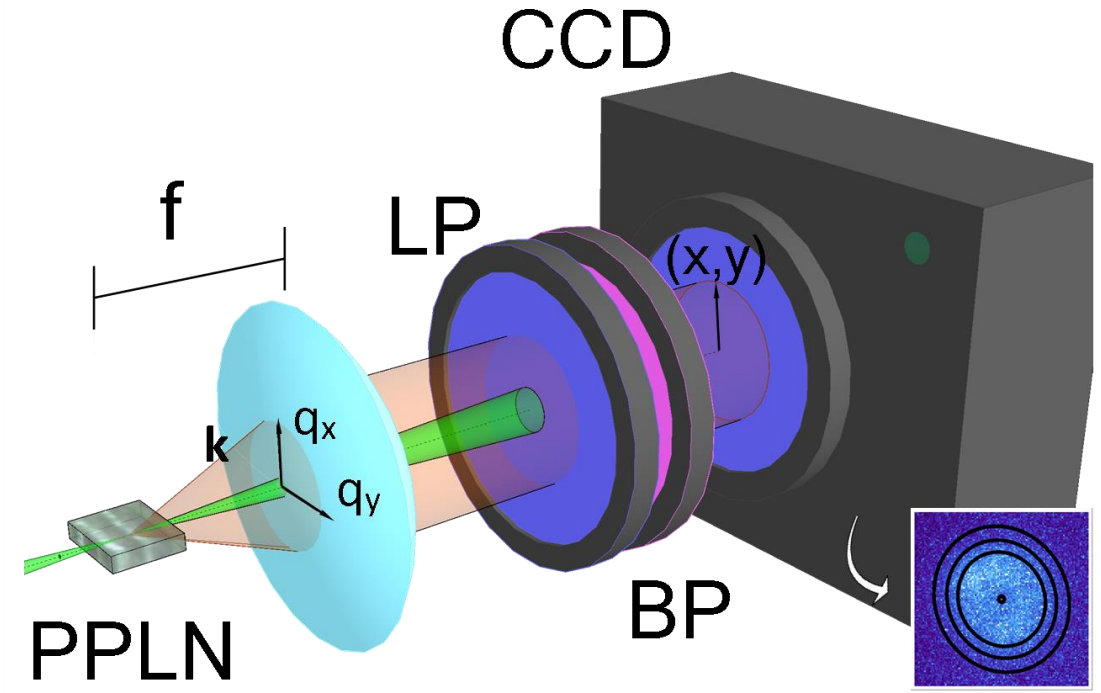
(a) $T = 129.1°C$ (b) $T = 132.4°C$ (c) $T = 136.5°C$

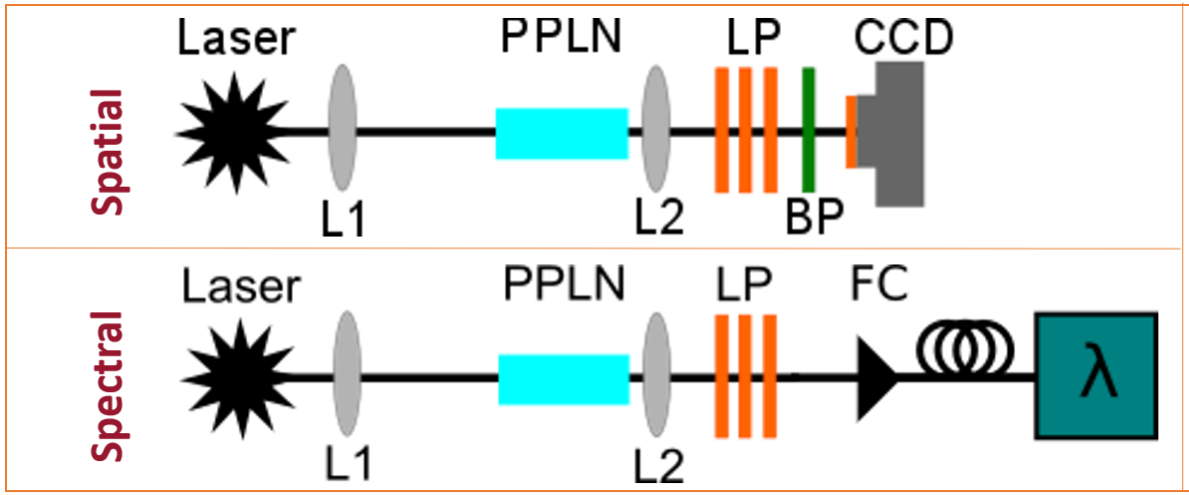
X-spectrum simulations in PPLN

[1] S. Lerch, B. Bessire, C. Bernhard, T. Feurer, and A. Stefanov, J. Opt. Soc. Am. B **30**, 953 (2013).
[2] A. Gatti, E. Brambilla, L. Caspani, O. Jedrkiewicz, and L. A. Lugiato, Phys. Rev. Lett. **102**, 223601 (2009).

Experiments

- 532 nm → 1064 nm + 1064 nm
- 1 W cw pump yields 104 nW of infrared down-conversion which is measured on:
  - Silicon-based CCD camera
  - Optical spectrum analyzer





Legend

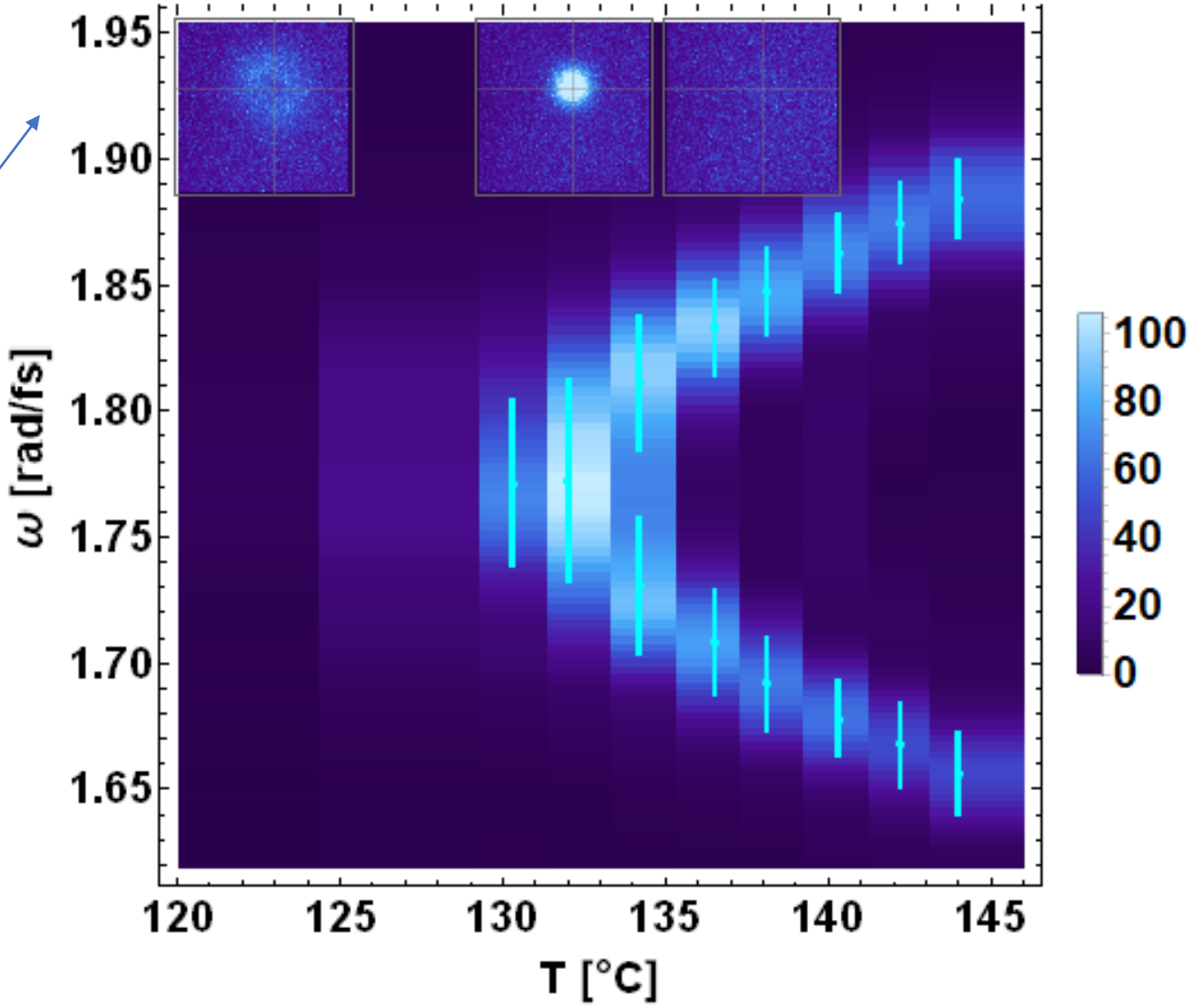
L1	Lens, f=100 mm
L2	Lens, f=11 mm
LP	Long pass filter
BP	Band pass filter, 10 nm centered at 1064 nm
CCD	Beam profiler camera
FC	Lens to multimode fiber

PPLN experimental results

- SPDC spatial emission is comprised of different frequencies output at different angles

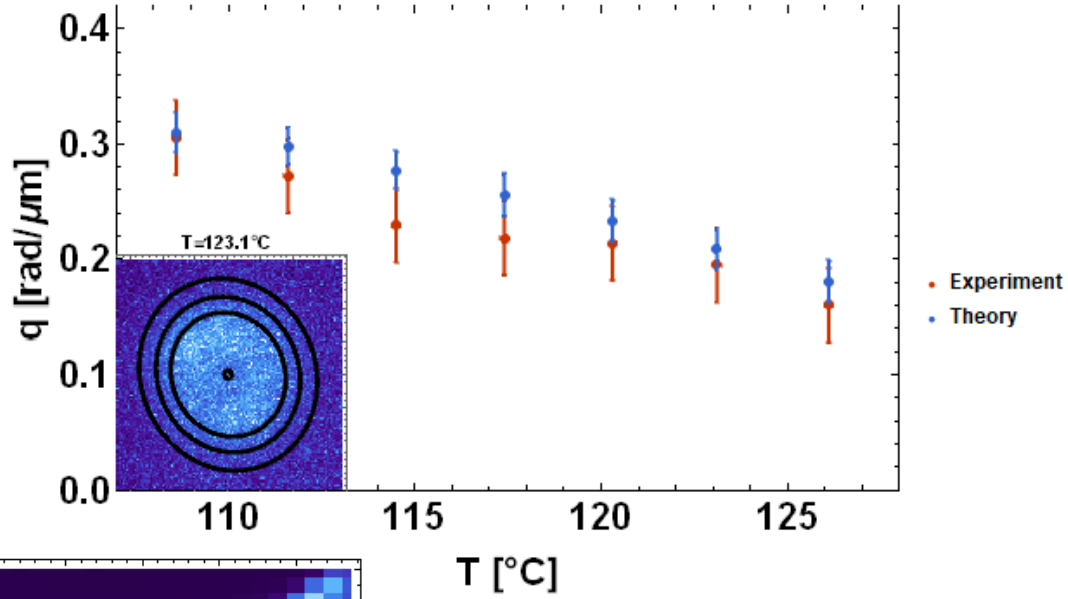
- SPDC spatial mode for a small wavelength range

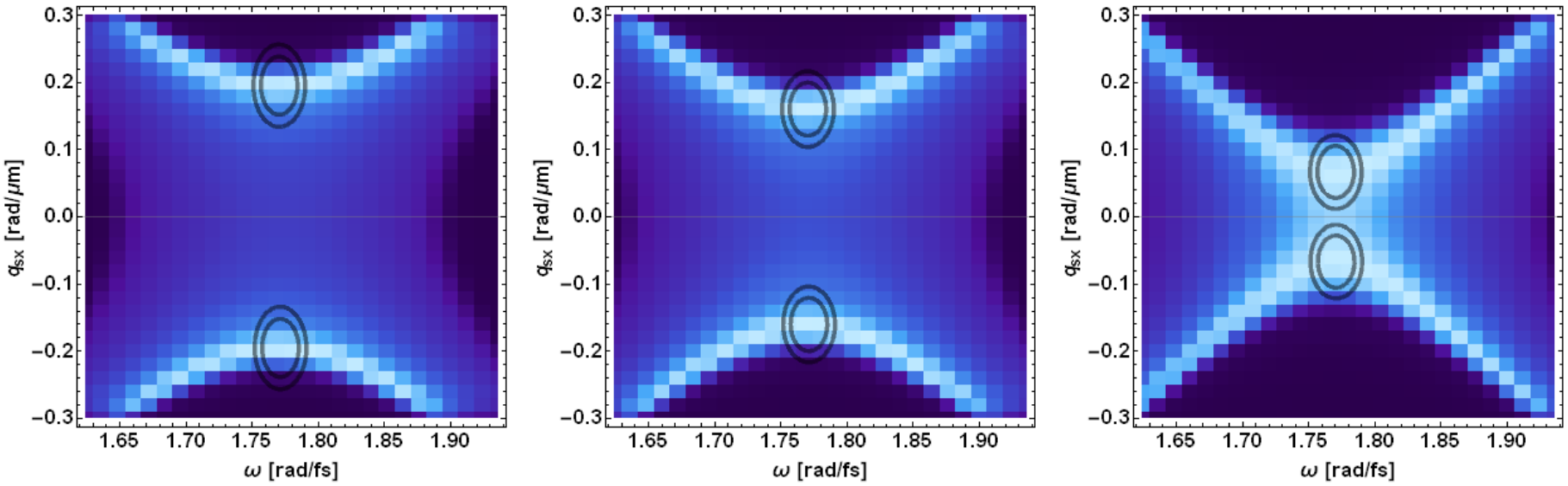
  (10 nm bandpass filter)



“X-blobs”: simple method extracting spatial-spectral information

- A spatial cone comprised of different frequencies at different angles
- Spatial distribution dependent on pump beam waist in the crystal





- **Contours:** experiment
- **Density plot:** theory

Conclusion

- A new simple, experimental method for characterizing the spatial-spectral distribution of bright, broadband photon pairs
- Could be extended to lower-flux photon pair sources with higher-efficiency CCD cameras
- Useful for verifying spectrum for optimizing heralding efficiency via fiber coupling lens choices

Special thanks

- Collaborators
  - Piotr Kolenderski
  - Thomas Jennewein

- Funding agencies

Theoretical model

Pump $e^{-\frac{1}{2}\mathbf{k_{p,\perp}}^2 w_p^2}$

Phasematching $\mathrm{sinc}(\frac{\Delta k_z L_z}{2})$

Spatial distribution

$$I(\boldsymbol{k}_{s\perp}) \propto \int d\omega_s d\boldsymbol{k}_{i\perp} |\Psi(2\omega_0 - \omega_i, \boldsymbol{k}_{s\perp}, \omega_i, \boldsymbol{k}_{i\perp})|^2$$

Spectral distribution

$$I(\omega_s) \propto \int d\boldsymbol{k}_{s\perp} d\boldsymbol{k}_{i\perp} |\Psi(2\omega_0 - \omega_i, \boldsymbol{k}_{s\perp}, \omega_i, \boldsymbol{k}_{i\perp})|^2$$