Multifrequency HBT measured with LinoSPAD2

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SII Workshop at Porquerolles

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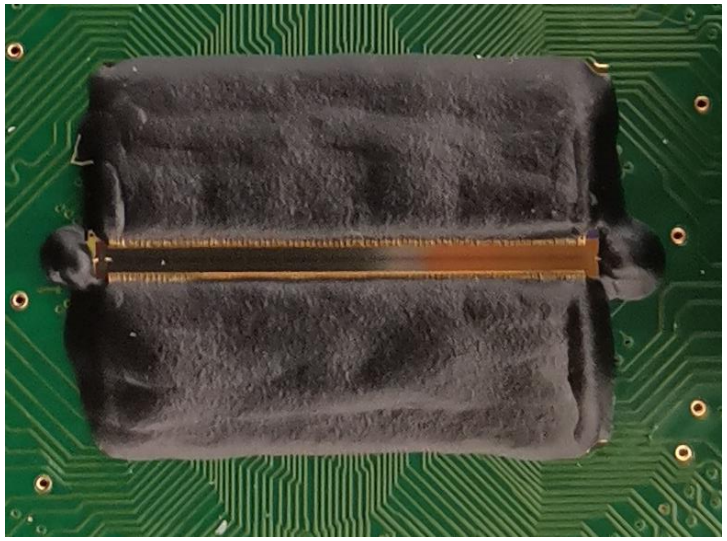
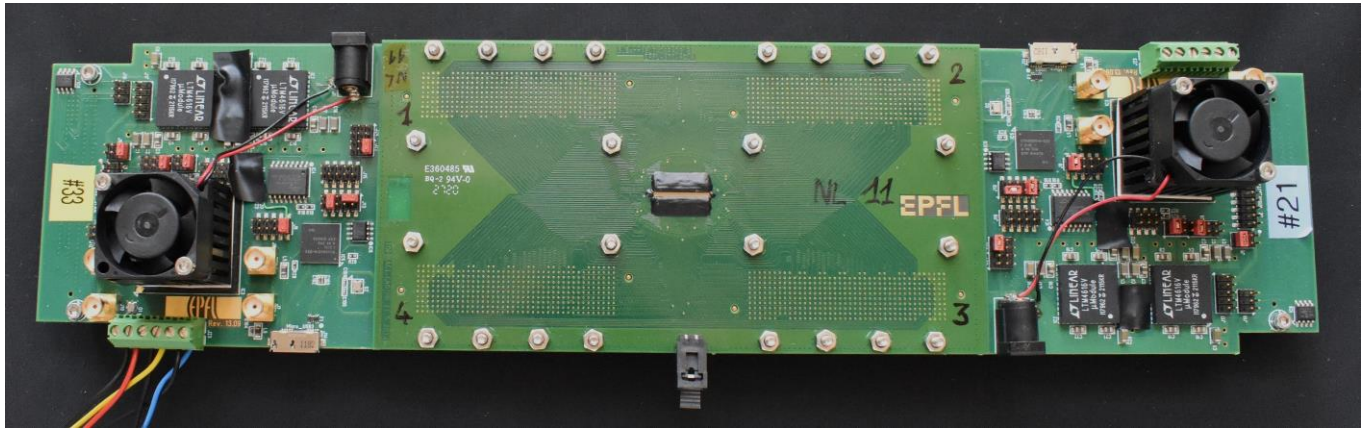
The LinoSPAD2 detector

LinoSPAD2 (1)

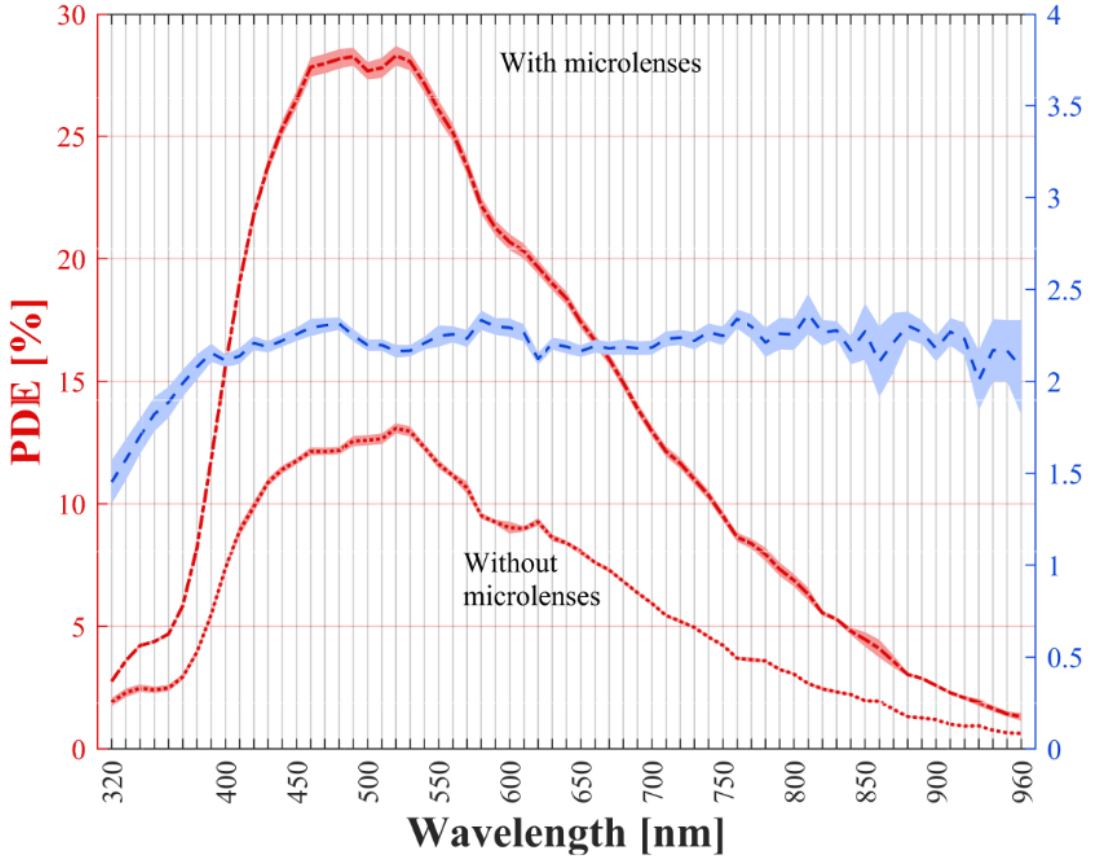
- Designed by AQUA lab, EPFL, Neuchâtel
- 512 x 1 SPADs
- Single-photon sensitivity
- 26.2 um pitch (~13 mm sensor)
- TDCs for timestamping
- 40 ps rms timing resolution
- ~ 20 ns dead time





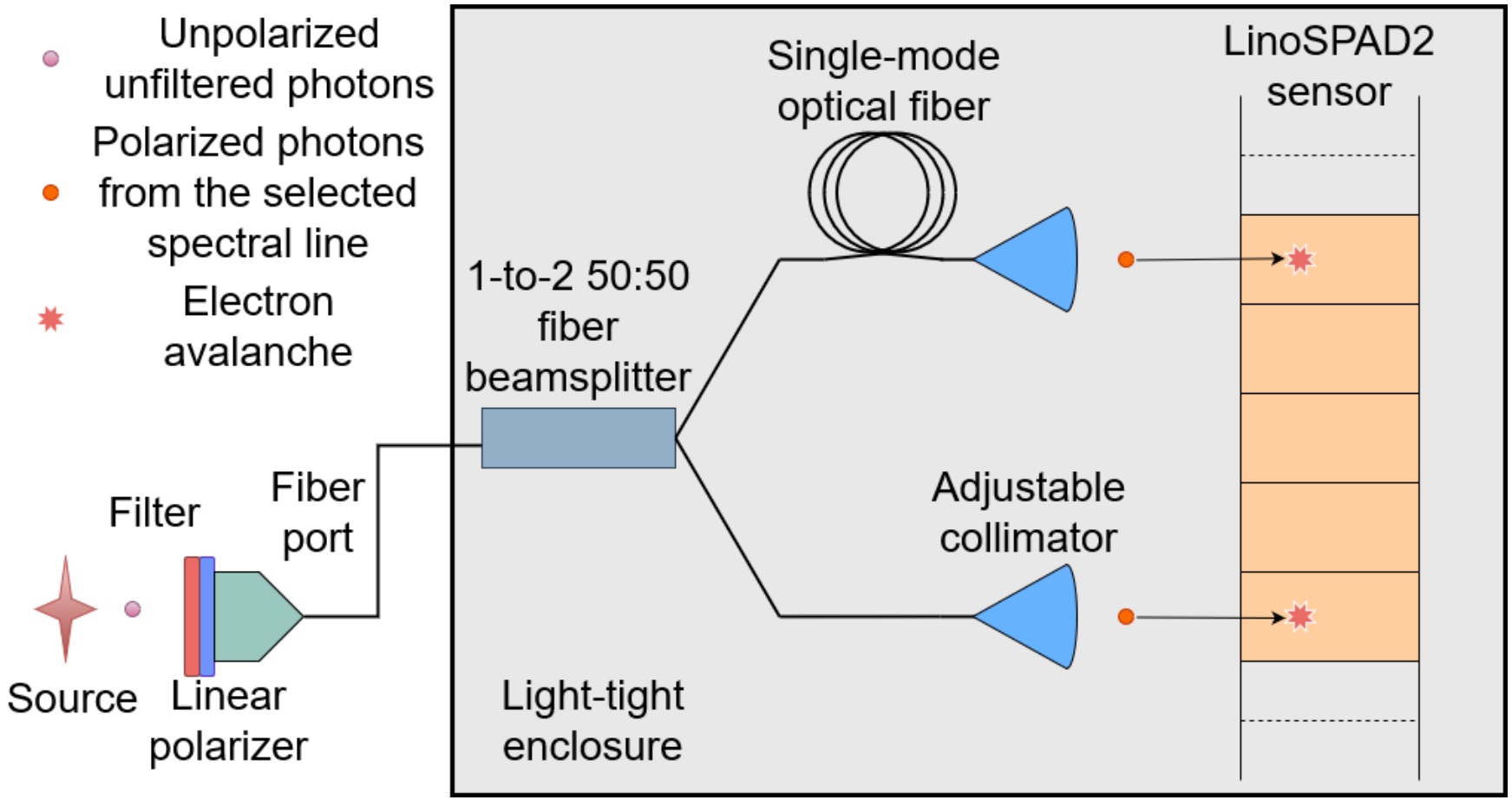
LinoSPAD2 (2)

- Designed by AQUA lab, EPFL, Neuchâtel
- 512 x 1 SPADs
- Single-photon sensitivity
- 26.2 um pitch (~13 mm sensor)
- TDCs for timestamping
- 40 ps rms timing resolution
- ~ 20 ns dead time

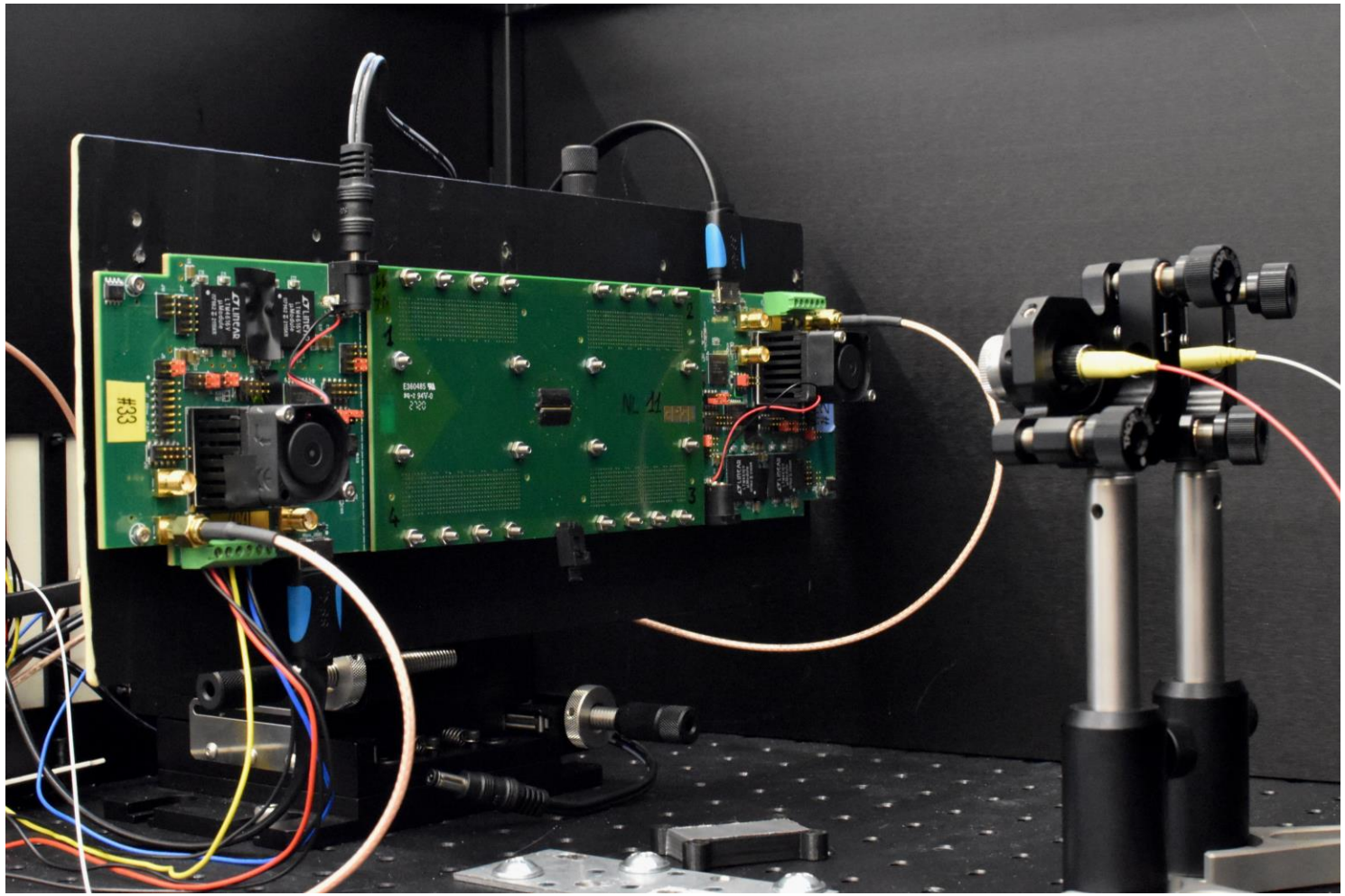


Single-line HBT setup

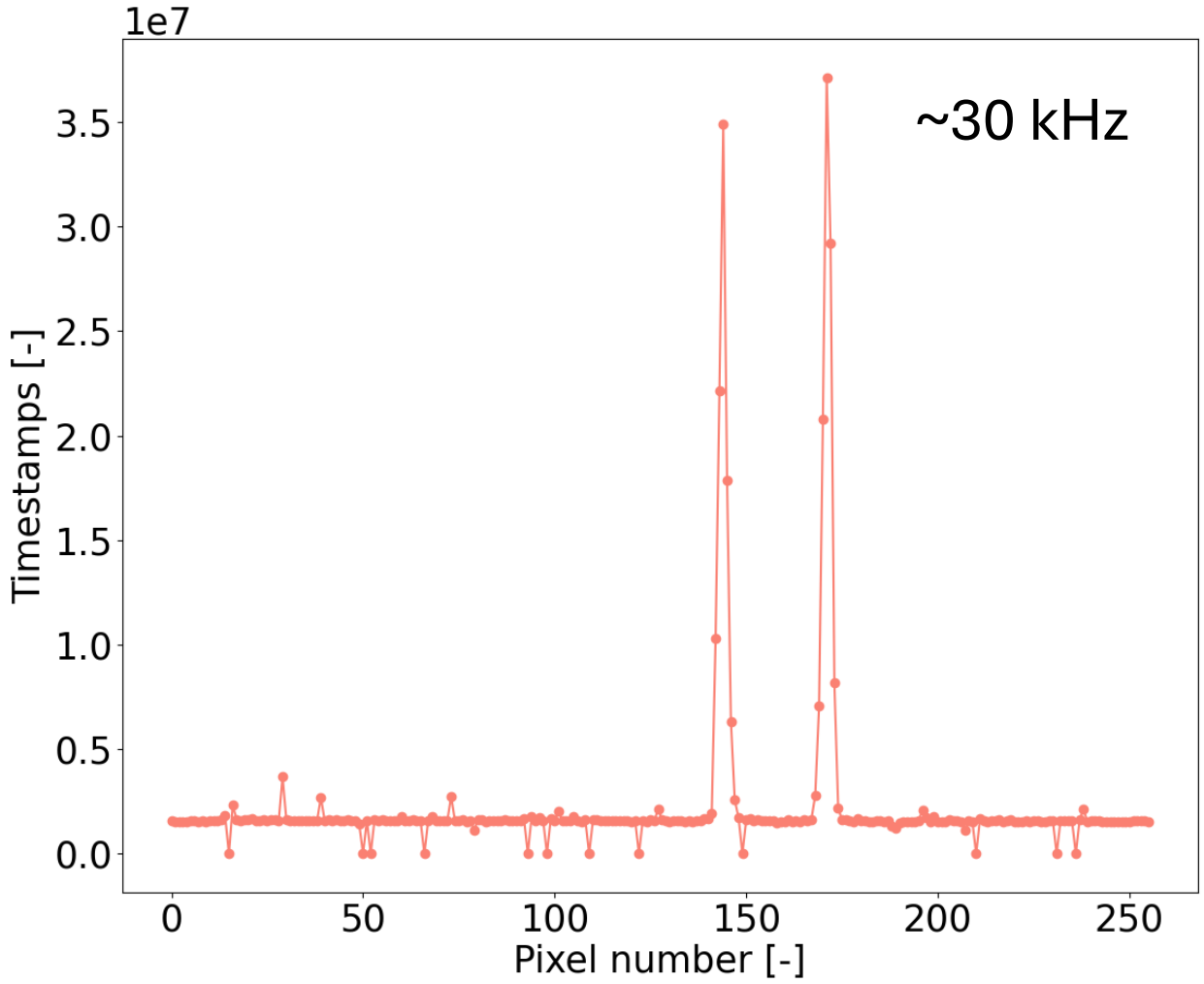
Setup with LinoSPAD2: single-line (1)



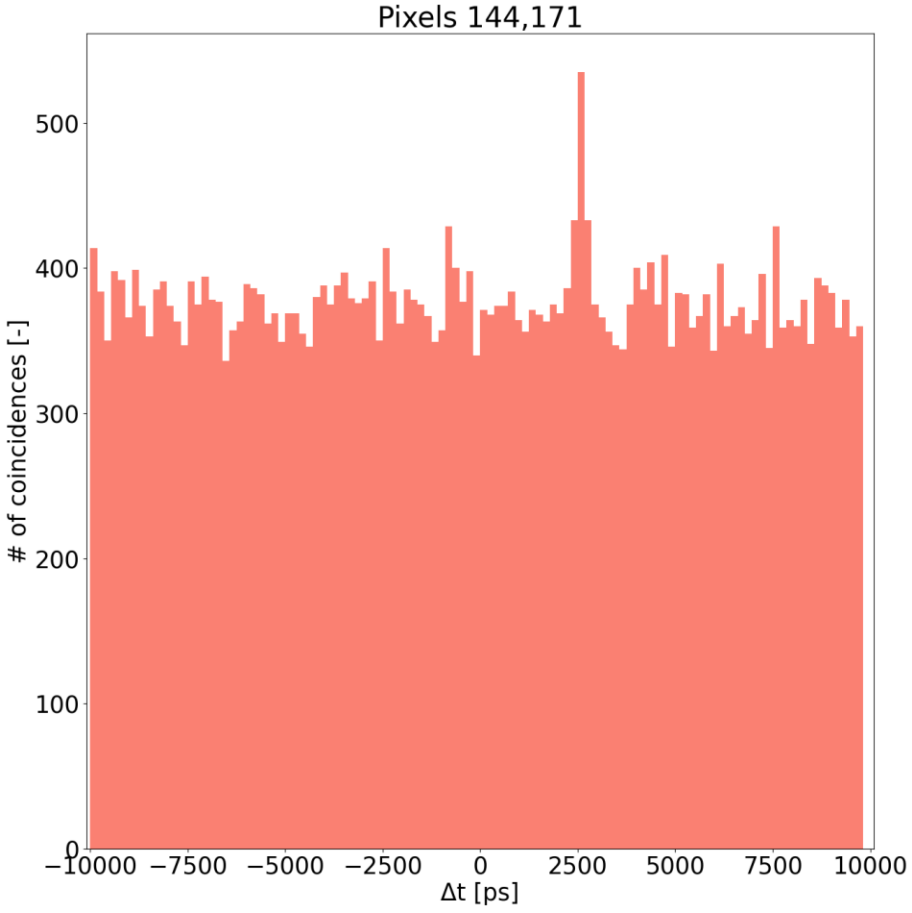
Setup with LinoSPAD2: single-line (2)



Single line HBT: occupation

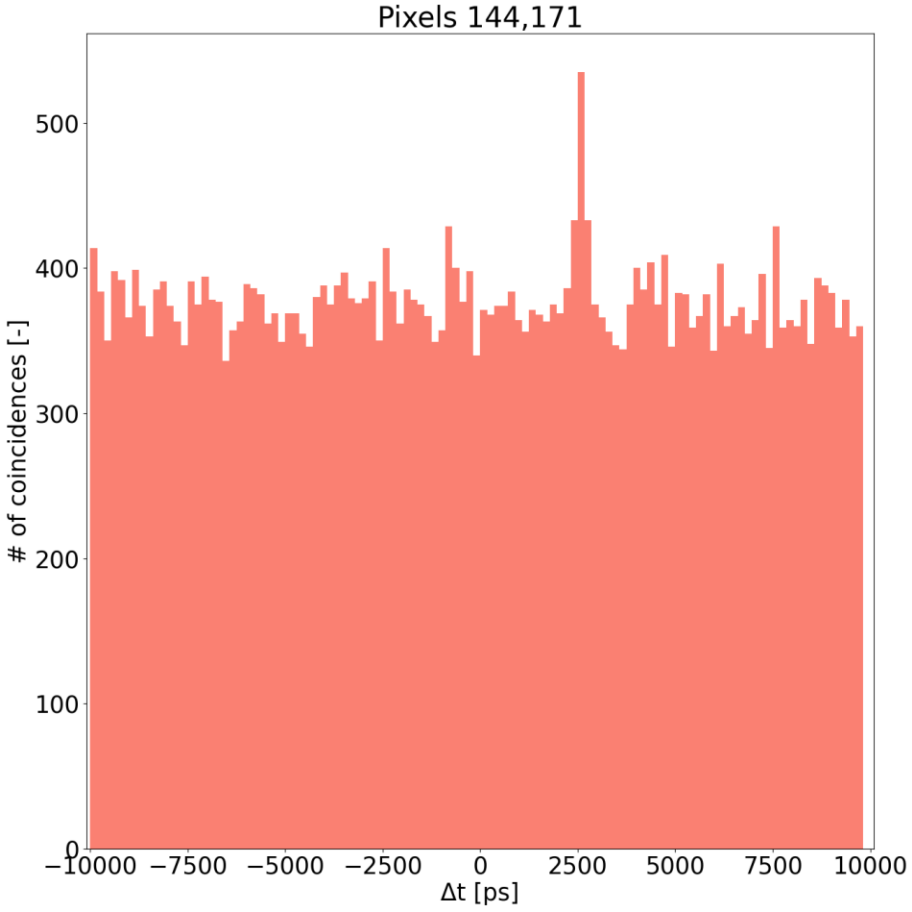


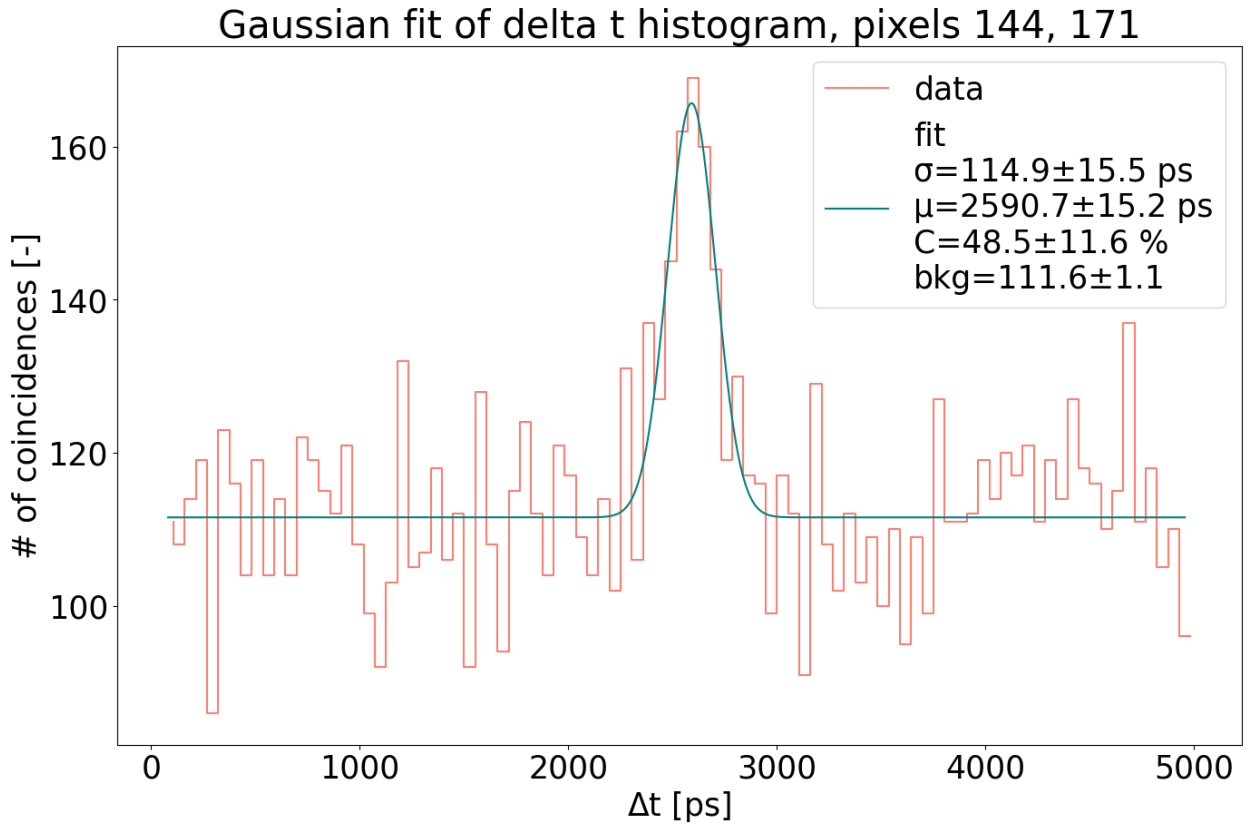
Single line HBT: coincidence (1)



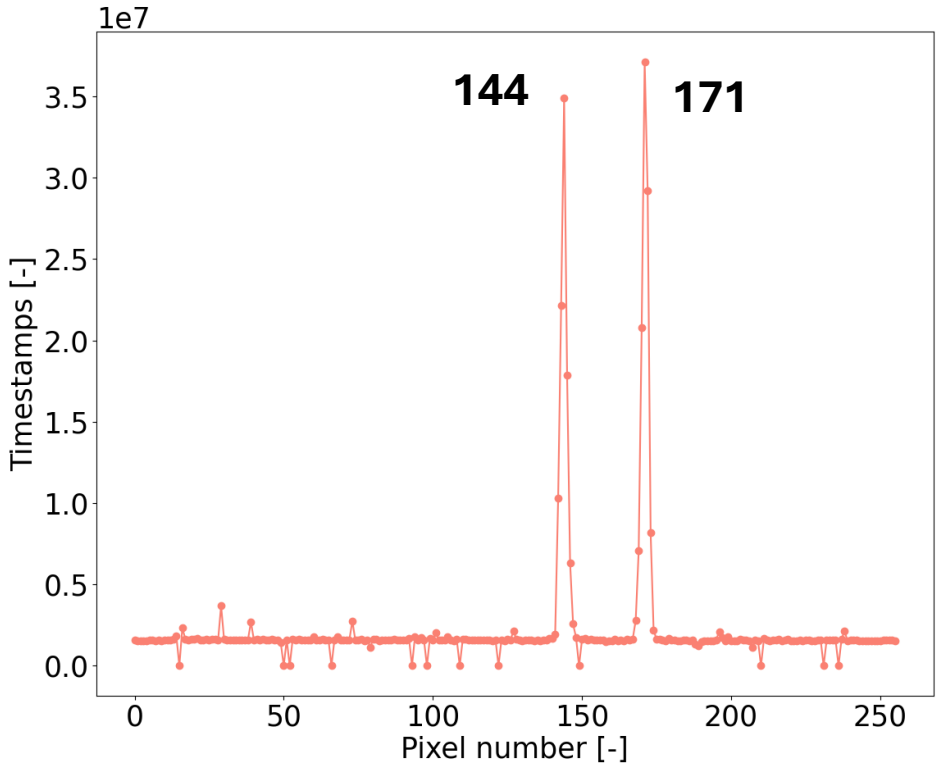
- Data collection ~10 min
- ~10 GB of data
- => 50% contrast!

Single line HBT: coincidence (2)

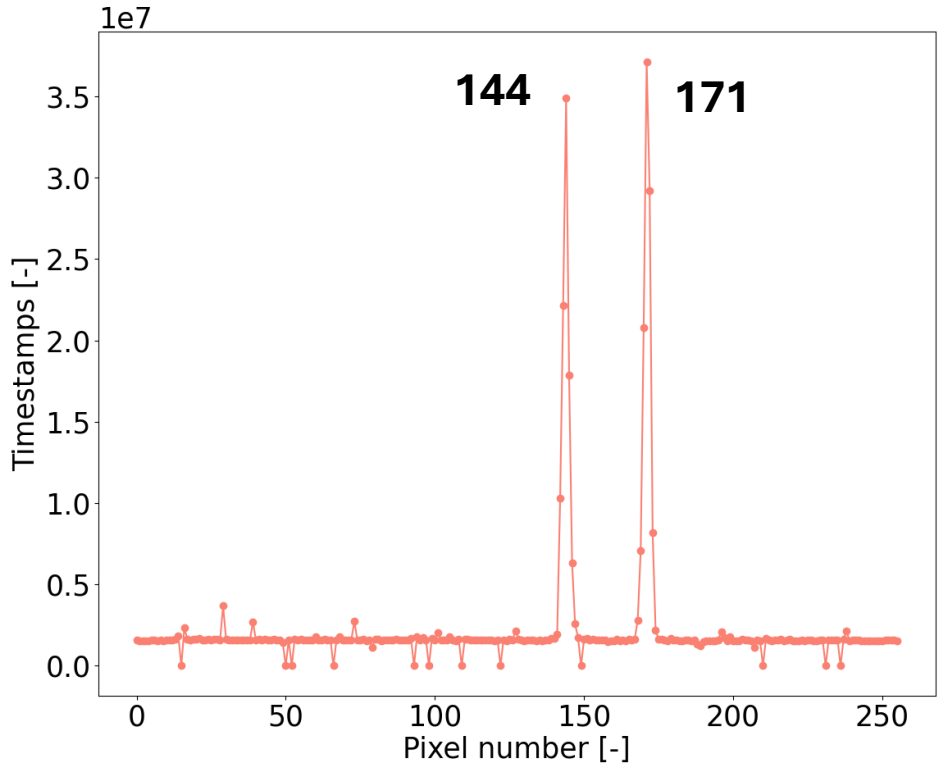


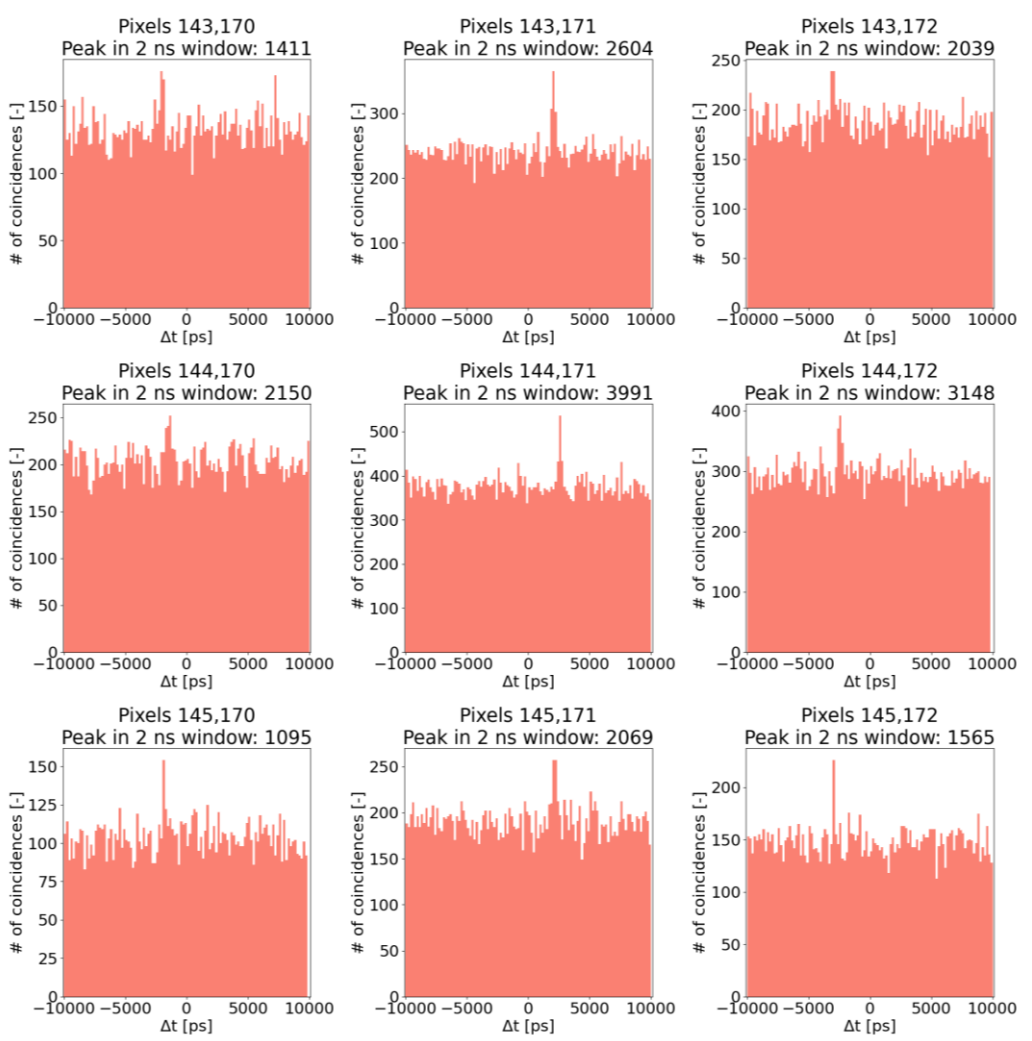


Single line HBT: coincidence (3)

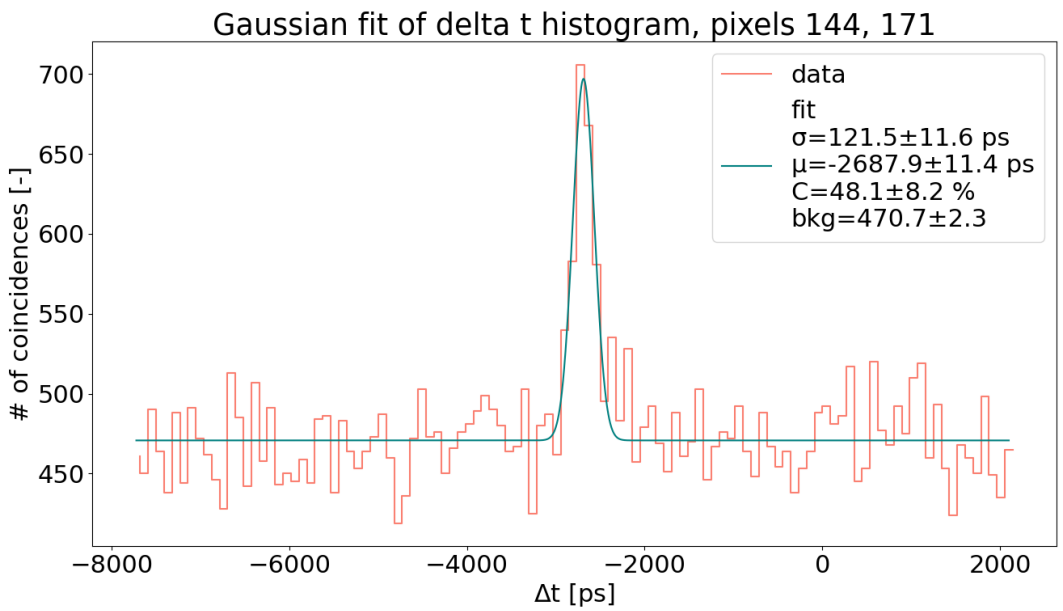


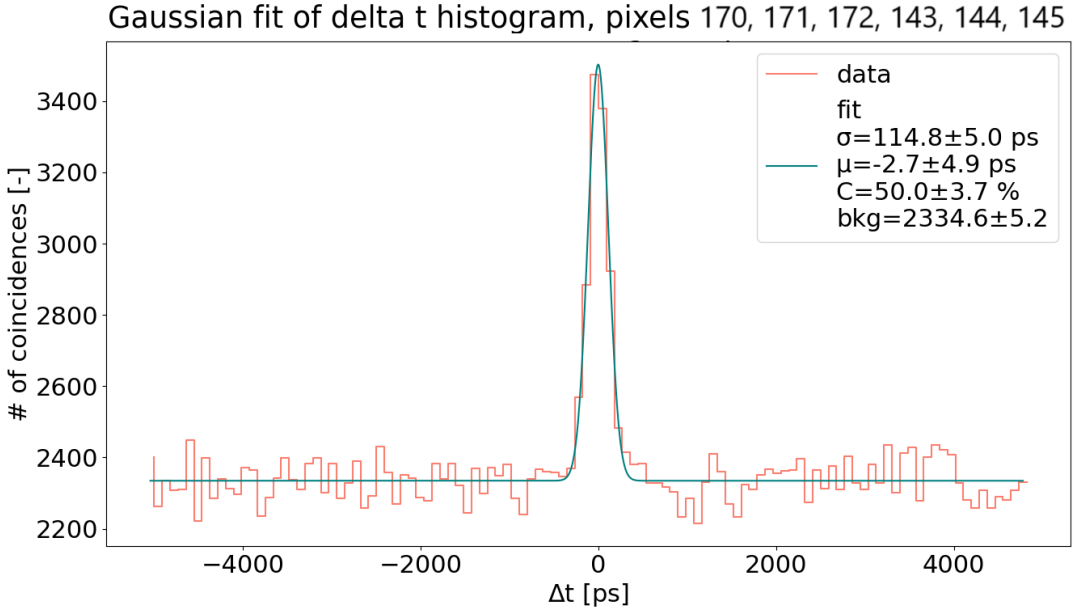
Single line HBT: coincidence (4)





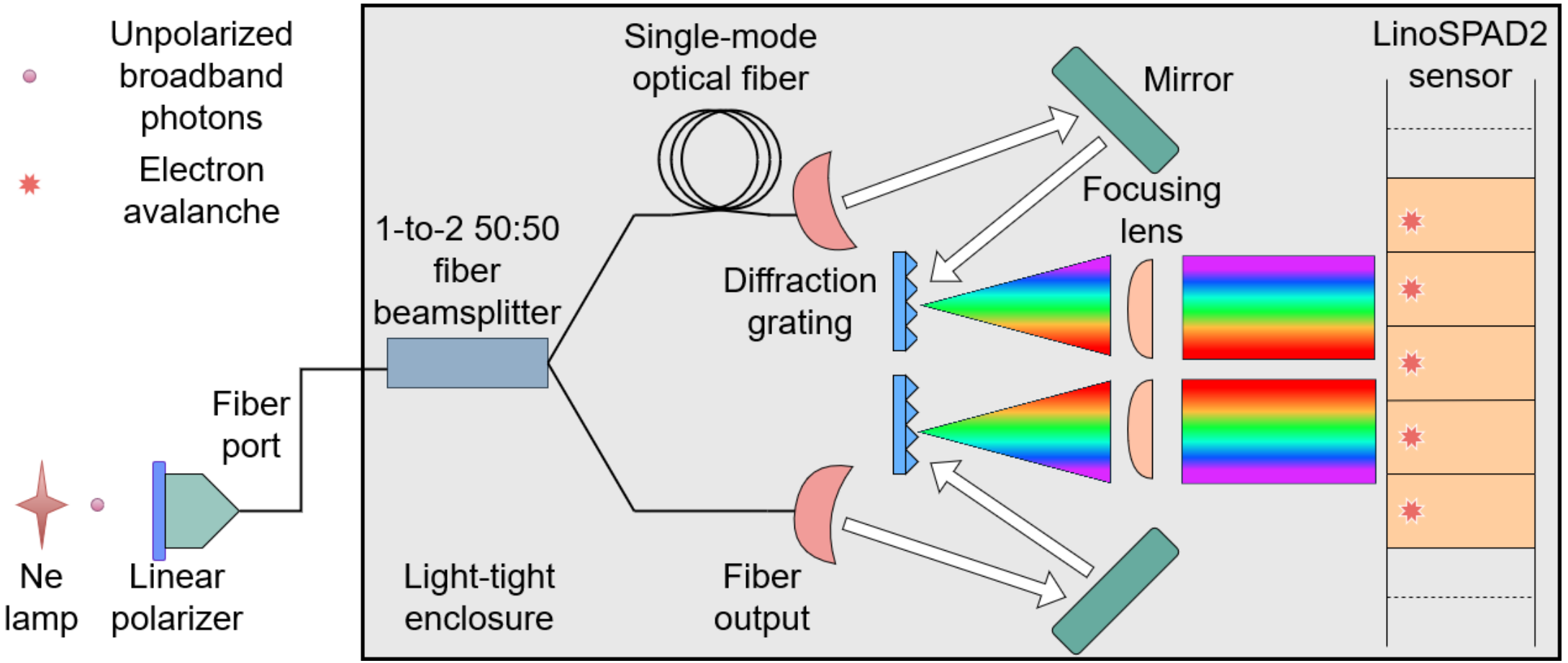
Single line HBT: coincidence (5)



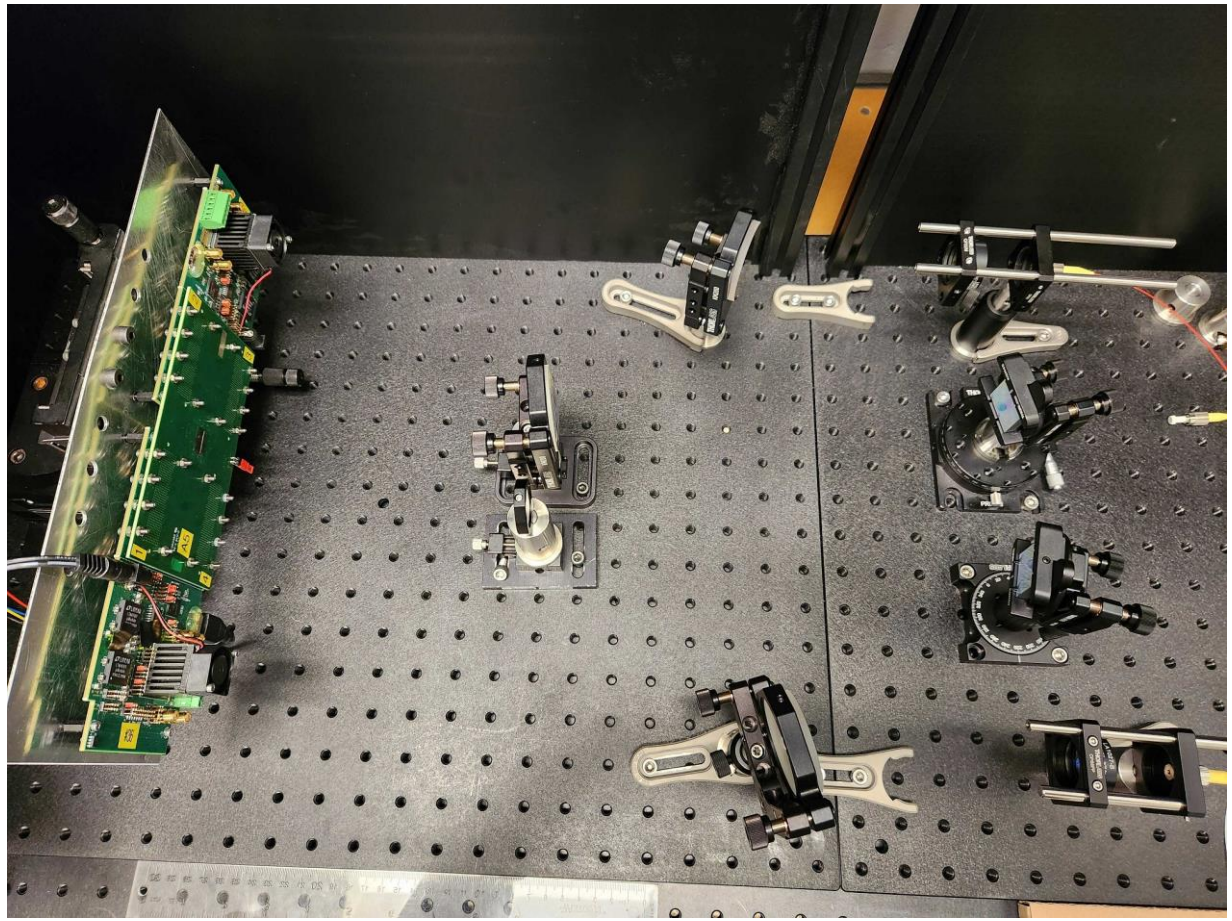


Multiple-line HBT setup

Setup with LinoSPAD2: spectrometer (1)

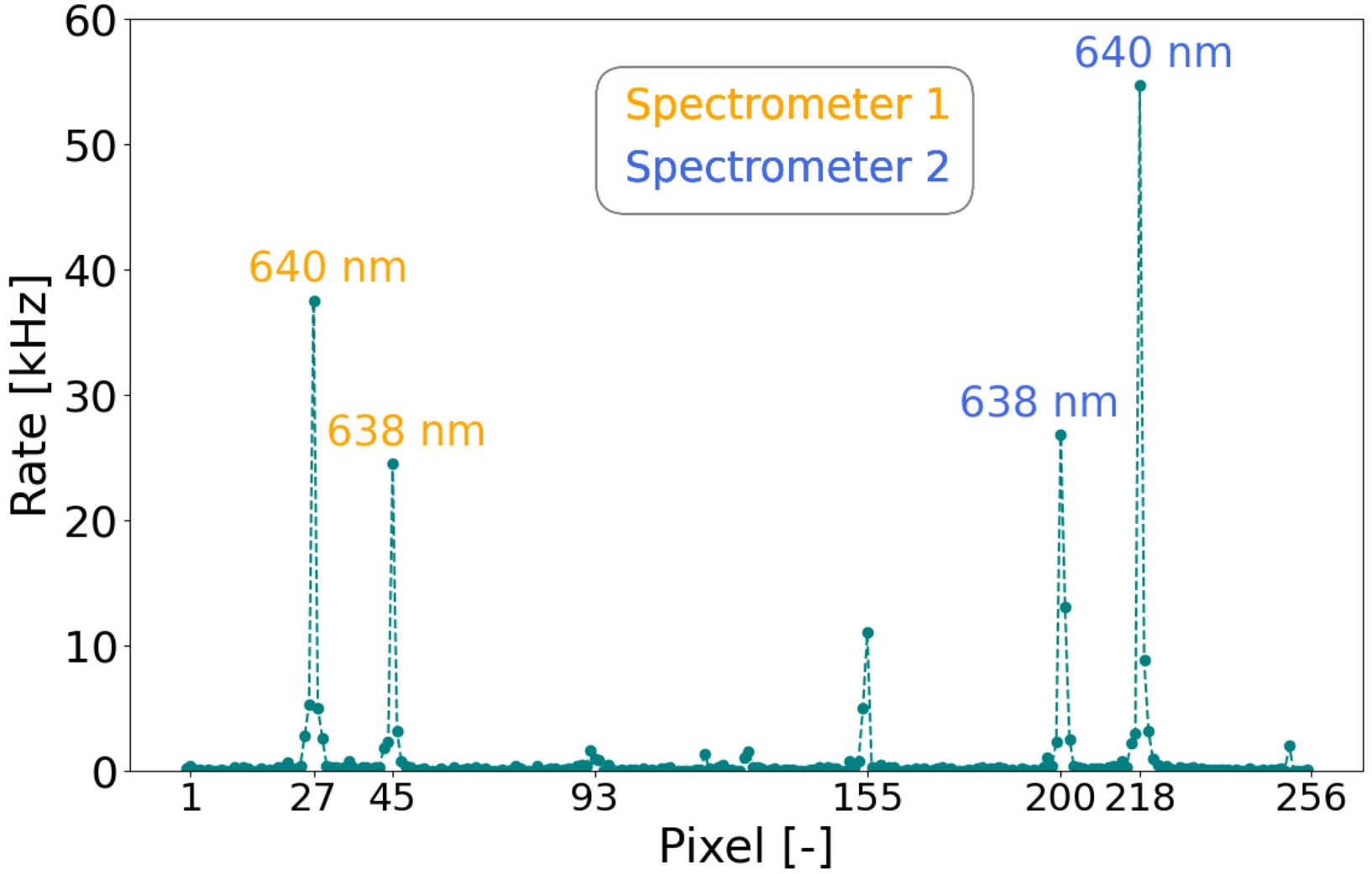


Setup with LinoSPAD2: spectrometer (2)

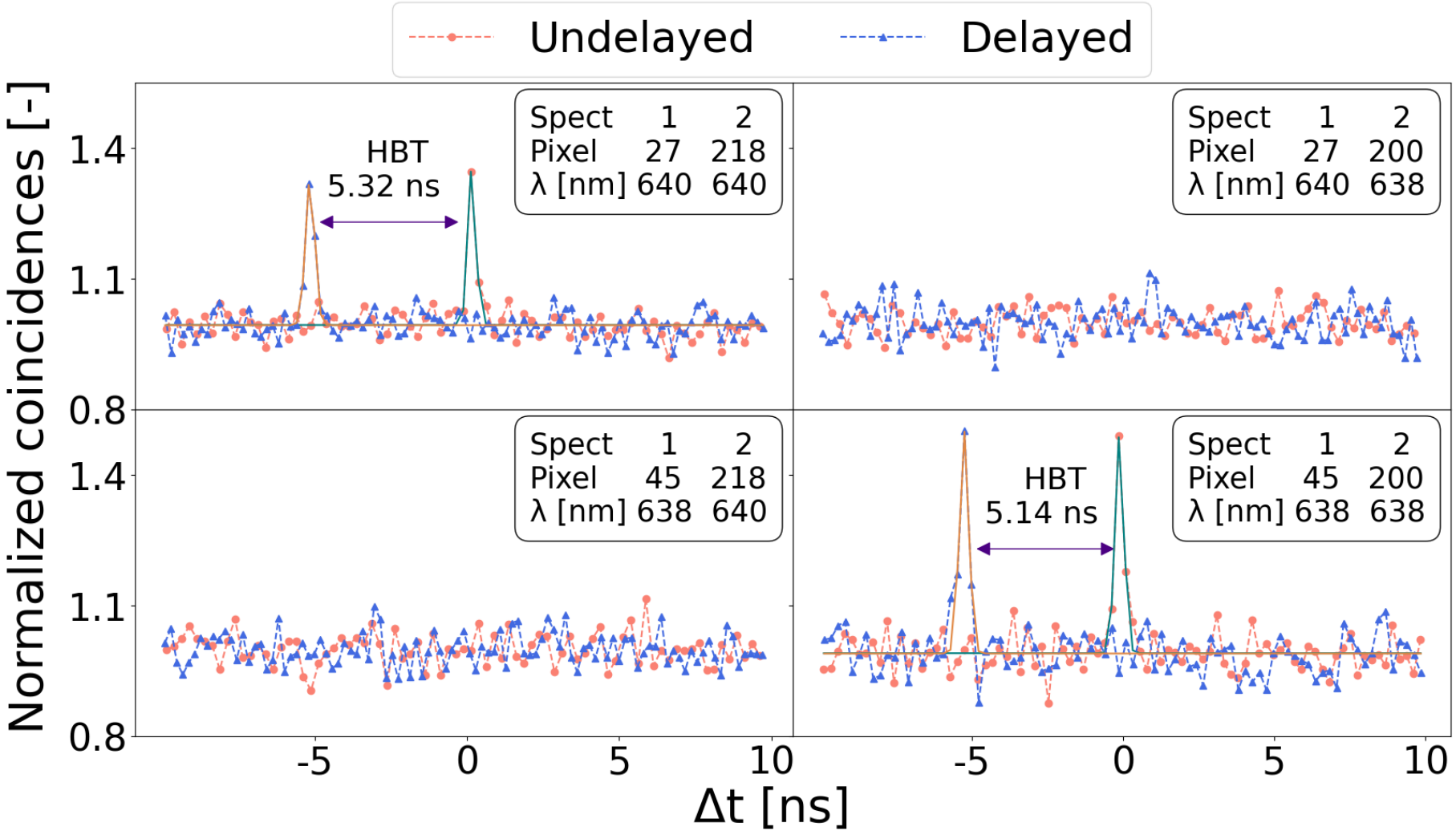


Two-line HBT: occupation

~0.11 nm/pixel



Two-line HBT: coincidence



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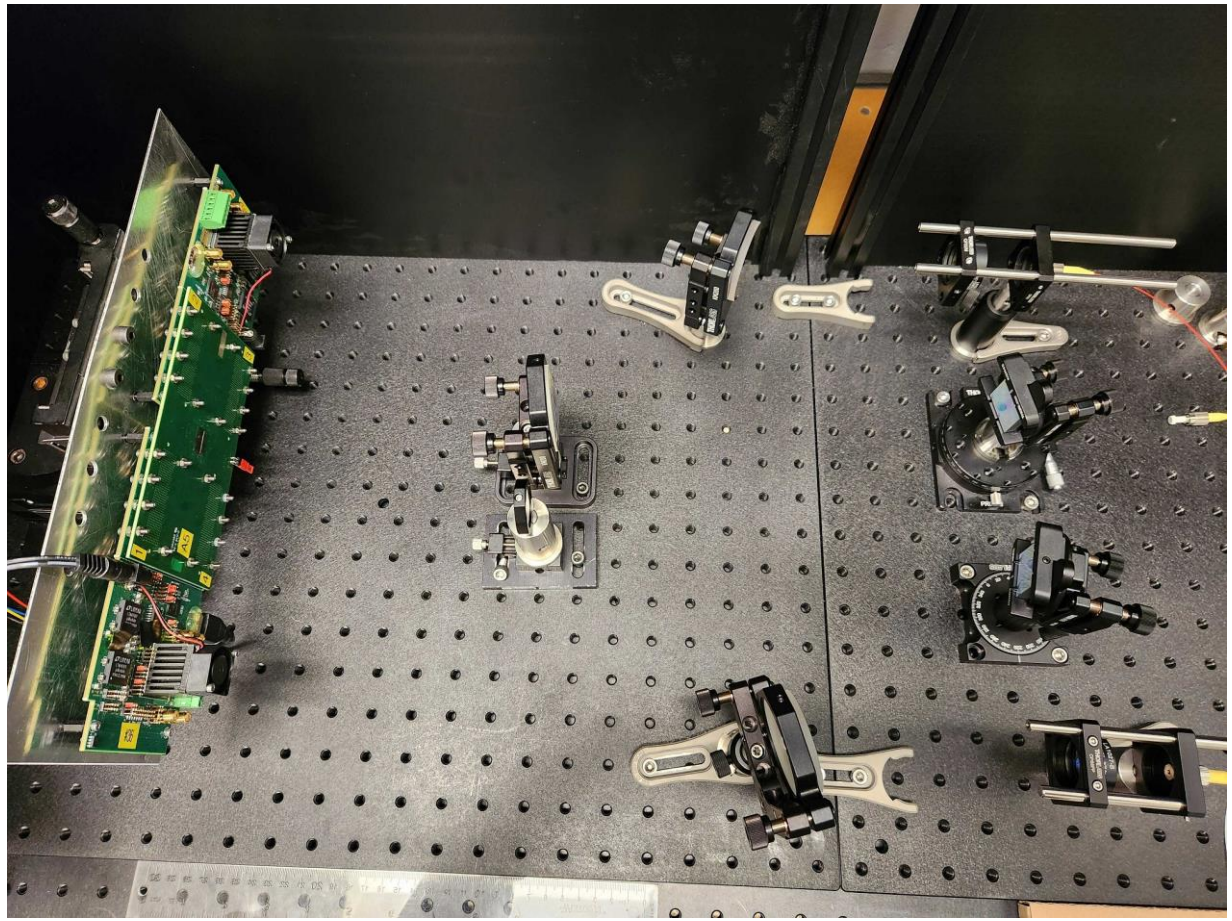
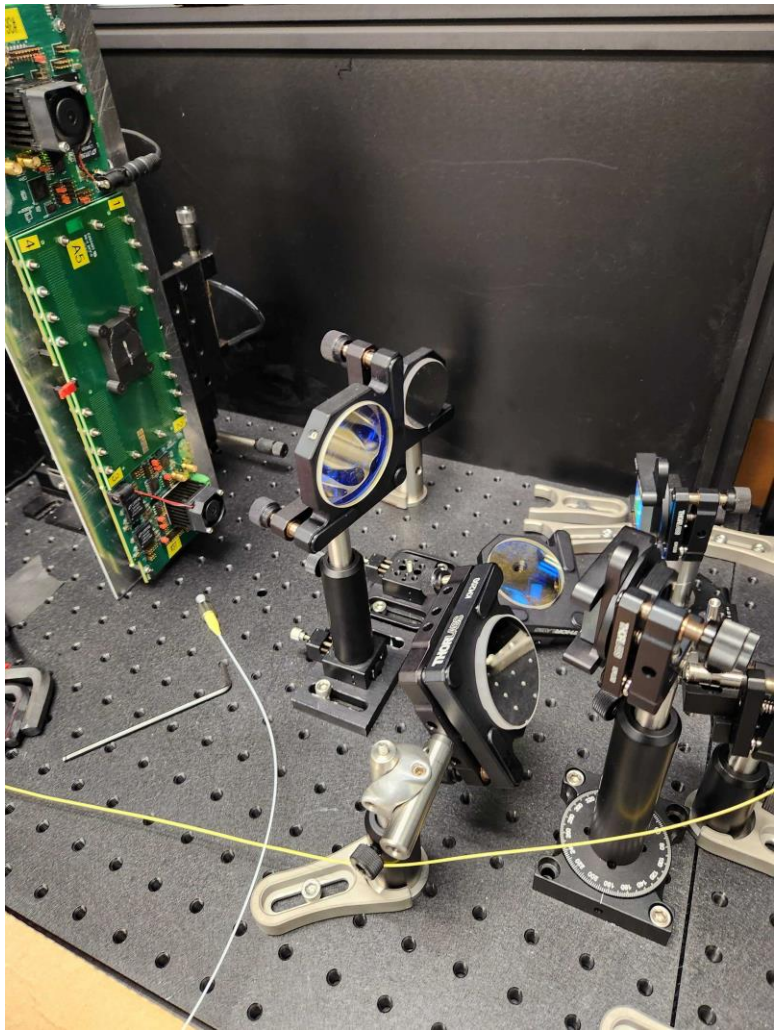
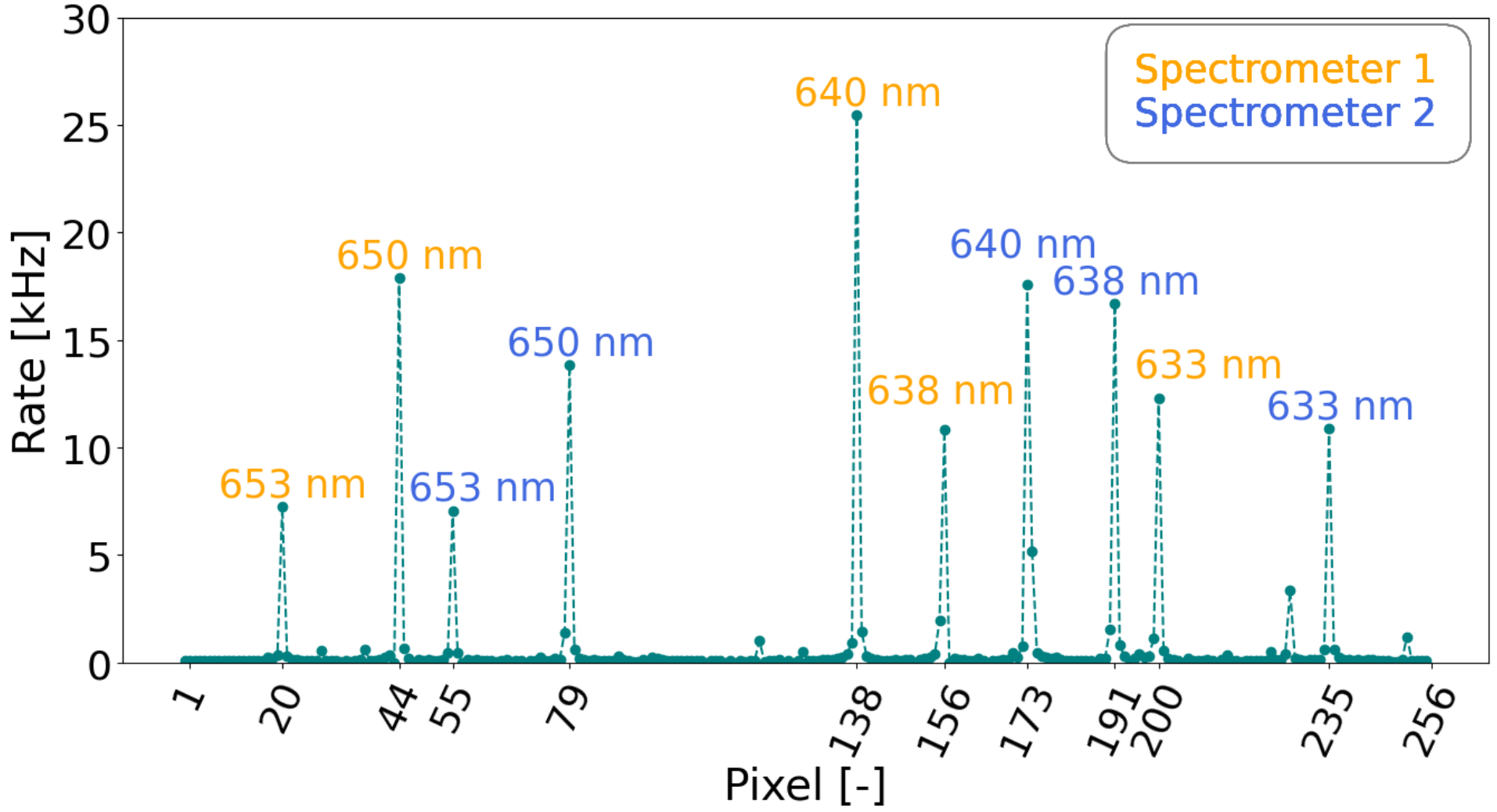
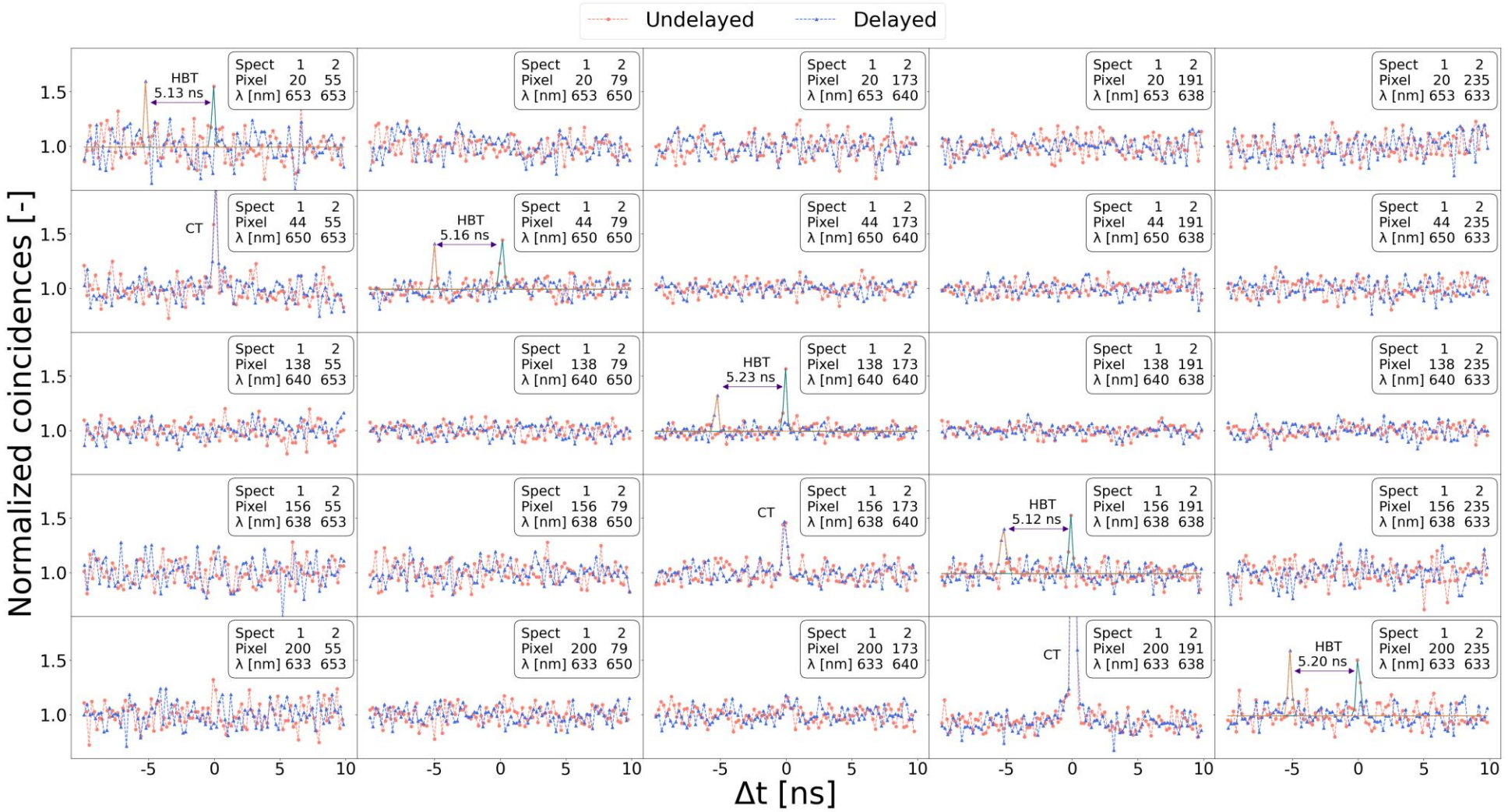




Five-line HBT: occupation



Five-line HBT: coincidence



The paper

https://arxiv.org/abs/2406.13959

Multifrequency-resolved Hanbury Brown–Twiss Effect

Joseph Ferrantini,[1,a)] Jesse Crawford,[1,a)] Sergei Kulkov,[2,a)] Jakub Jirsa,[2,3] Aaron Mueninghoff,[4] Lucas Lawrence,[1] Stephen Vintskevich,[5] Tommaso Milanese,[6] Samuel Burri,[6] Ermanno Bernasconi,[6] Claudio Bruschini,[6] Michal Marcisovsky,[2] Peter Svihra,[2] Andrei Nomerotski,[2,7] Paul Stankus,[1] Edoardo Charbon,[6] and Raphael A. Abrahao[1,b)]

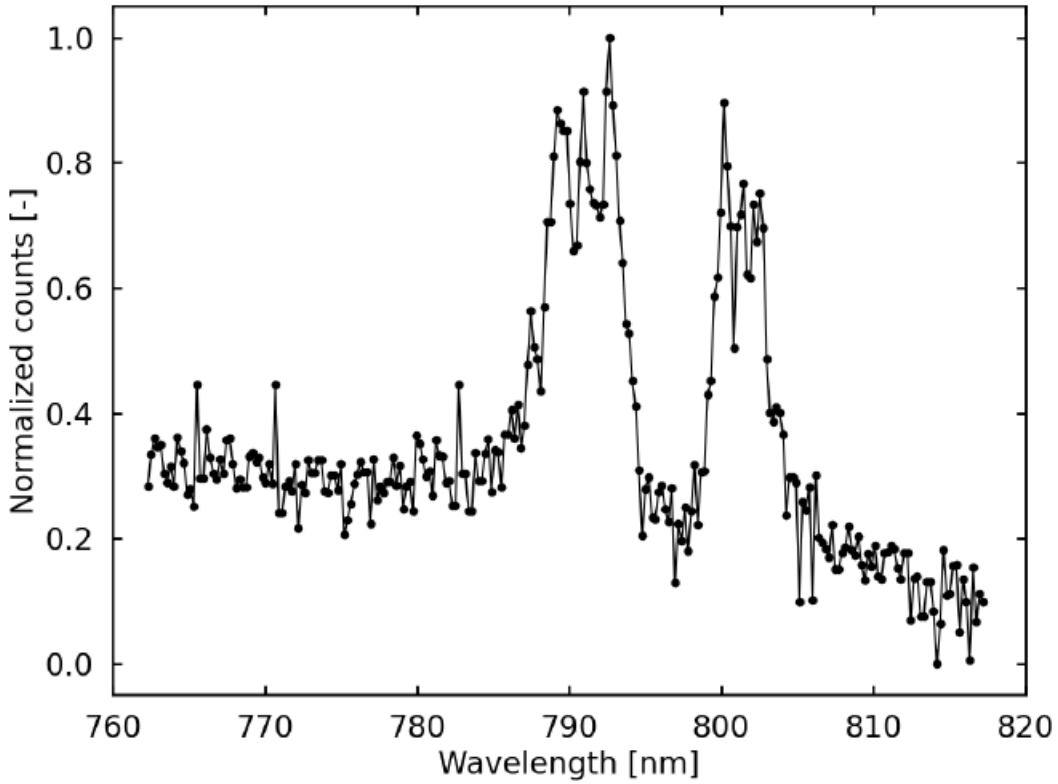
[1)] *Brookhaven National Laboratory, Upton NY 11973, USA*
[2)] *Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University, 115 19 Prague, Czech Republic*
[3)] *Faculty of Electrical Engineering, Czech Technical University, 166 27 Prague, Czech Republic*
[4)] *Stony Brook University, Stony Brook NY 11794, USA*
[5)] *Technology Innovation Institute, Abu Dhabi, United Arab Emirates*
[6)] *École polytechnique fédérale de Lausanne (EPFL), CH-2002 Neuchâtel, Switzerland*
[7)] *Florida International University, Miami FL 33199, USA*

(Dated: 21 June 2024)

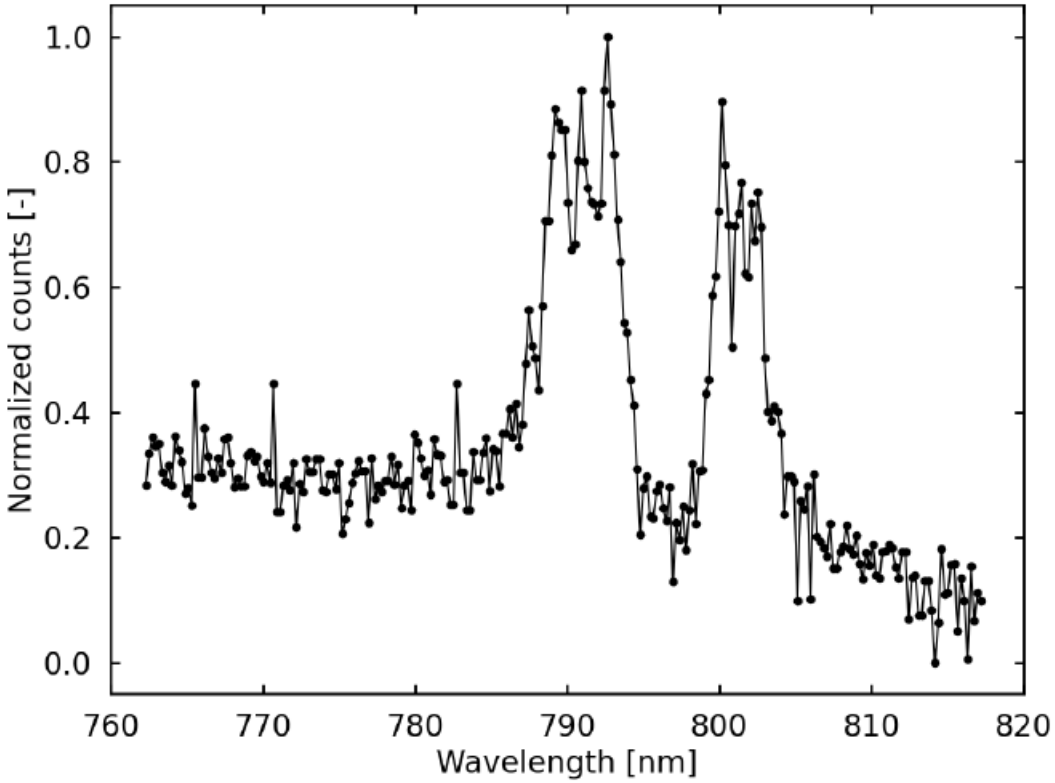
Abstract: The Hanbury Brown-Twiss (HBT) effect holds a pivotal place in intensity interferometry and gave a seminal contribution to the development of quantum optics. To observe such an effect, both good spectral and timing resolutions are necessary. Most often, the HBT effect is observed for a single frequency at a time, due to limitations in dealing with multifrequencies simultaneously, halting and limiting some applications. Here, we report a fast and data-driven spectrometer built with a one-dimensional array of single-photon-sensitive avalanche diodes. We report observing the HBT effect for multifrequencies at the same time. Specifically, we observed the HBT for up to 5 lines of the Ne spectrum, but this can be improved even further. Our work represents a major step to make spectral binning and multifrequencies HBT more widely available. The technology we present can benefit both classical and quantum applications.

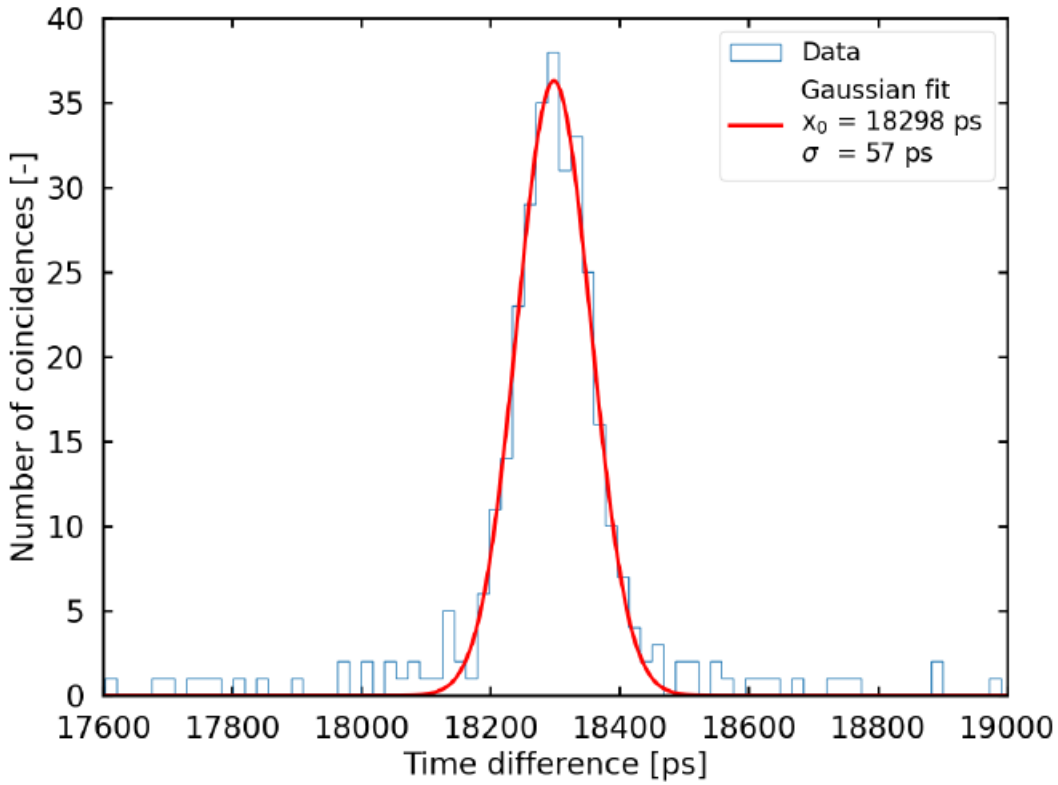
LinoSPAD2 timing resolution

Measurements with SPDC (1)



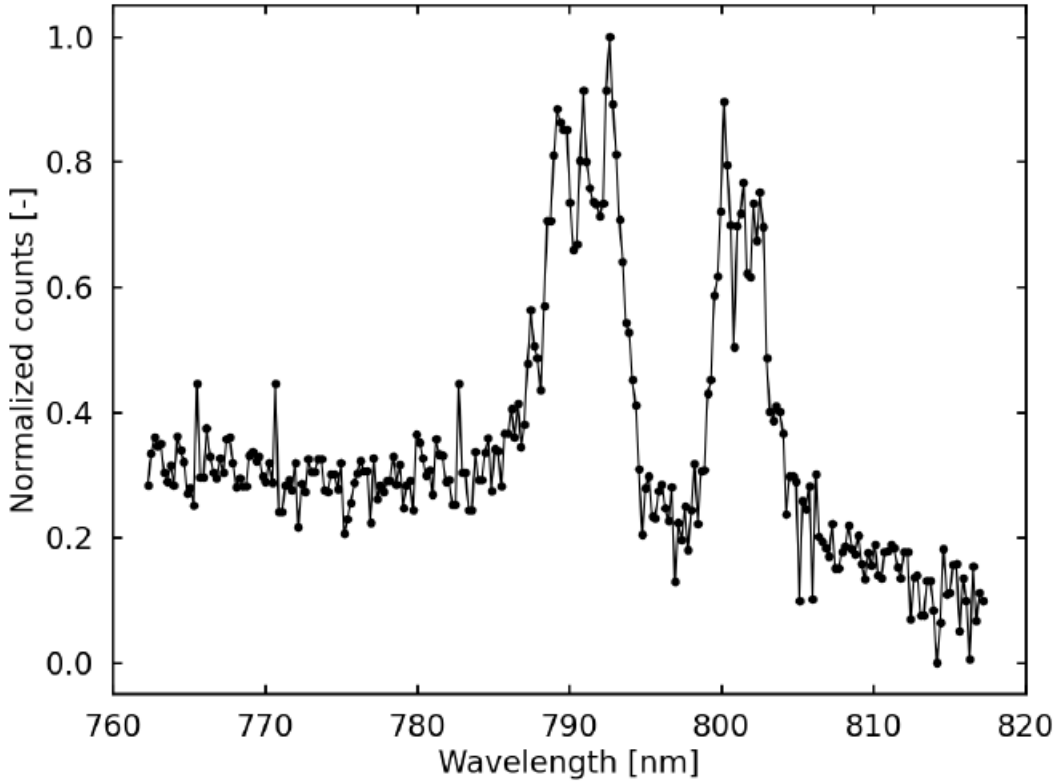
Measurements with SPDC (2)

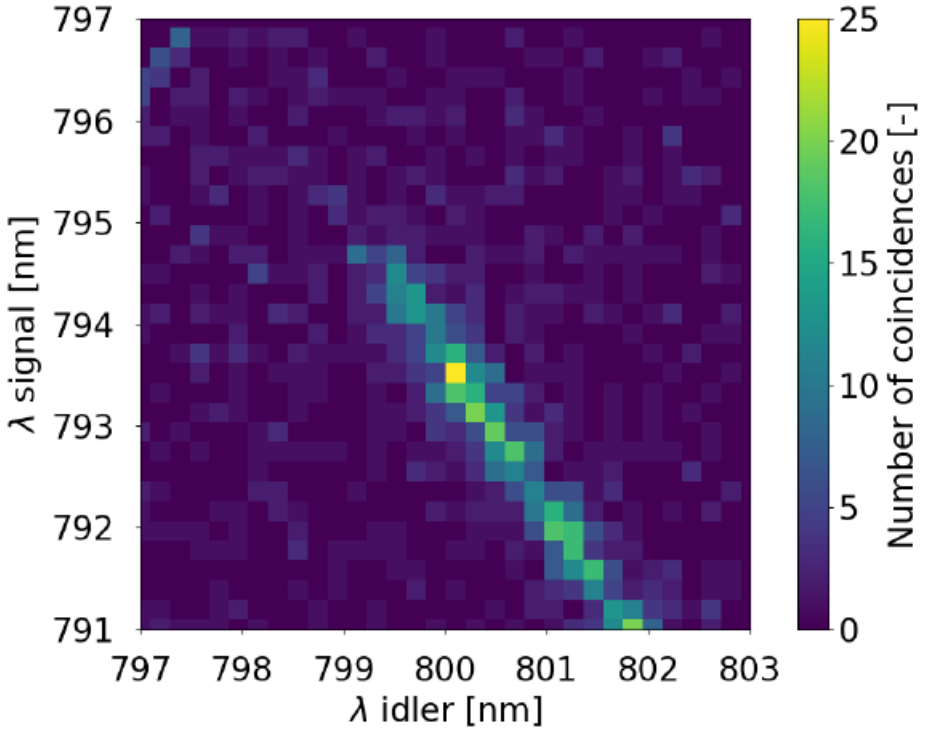




Measurements with SPDC (3)

Arxiv
2304.11999





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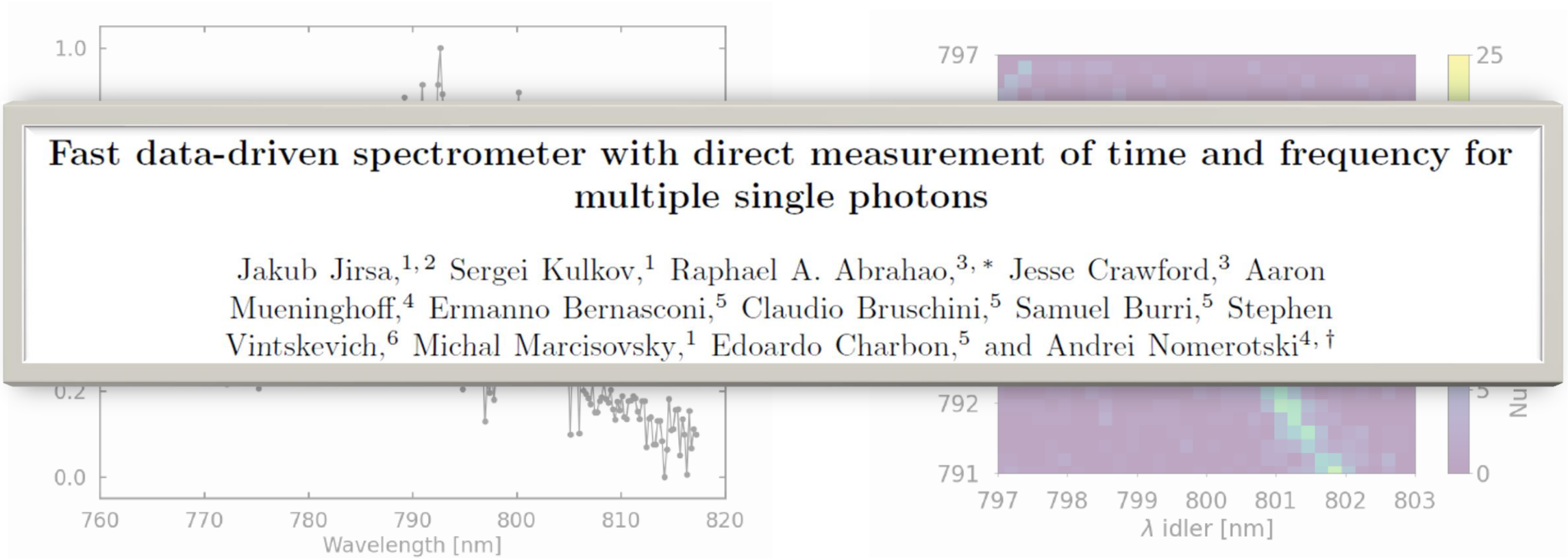
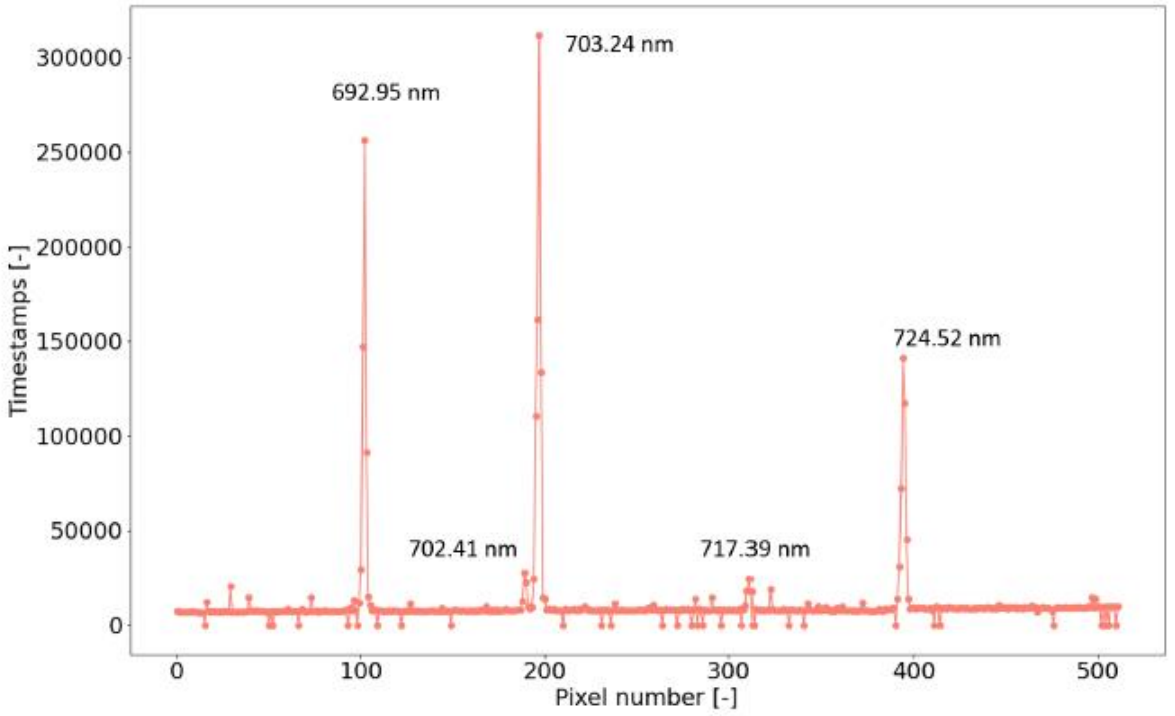


Fast data-driven spectrometer with direct measurement of time and frequency for multiple single photons

Jakub Jirsa,[1,2] Sergei Kulkov,[1] Raphael A. Abrahao,[3,*] Jesse Crawford,[3] Aaron Mueninghoff,[4] Ermanno Bernasconi,[5] Claudio Bruschini,[5] Samuel Burri,[5] Stephen Vintskevich,[6] Michal Marcisovsky,[1] Edoardo Charbon,[5] and Andrei Nomerotski[4,†]

Spectrometer improvement



Summary

- LinoSPAD2 is great for HBT measurements
- Simultaneous HBT measurement at multiple Ne spectral lines
- Broadband HBT with an LED

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Future plans

- Broadband HBT from multiple spectral lines: LED + spectrometer
- Stellar intensity interferometry with LinoSPAD2

Summary

Arxiv papers on HBT with LinoSPAD2	**2406.15323** **2406.13959** **2304.11999**

- LinoSPAD2 is great for HBT measurements
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Future plans

- Broadband HBT from multiple spectral lines: LED + spectrometer
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Thank you for your attention!