High-Spectral-Resolution Imaging Spectroscopy with a Dual-Comb Interferometer

Edoardo Vicentini, Zaijun Chen, Jeong Hyun Huh , Gianluca Galzerano, Theodor W. Hänsch, Nathalie Picqué

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Outline

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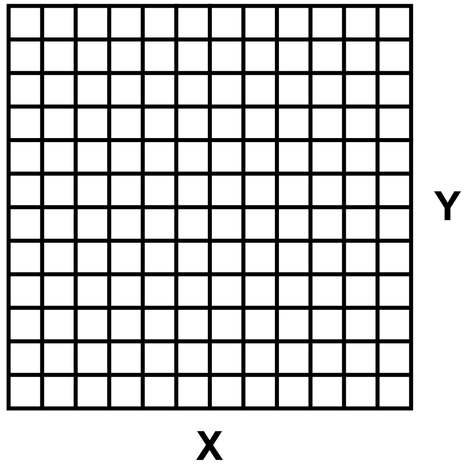
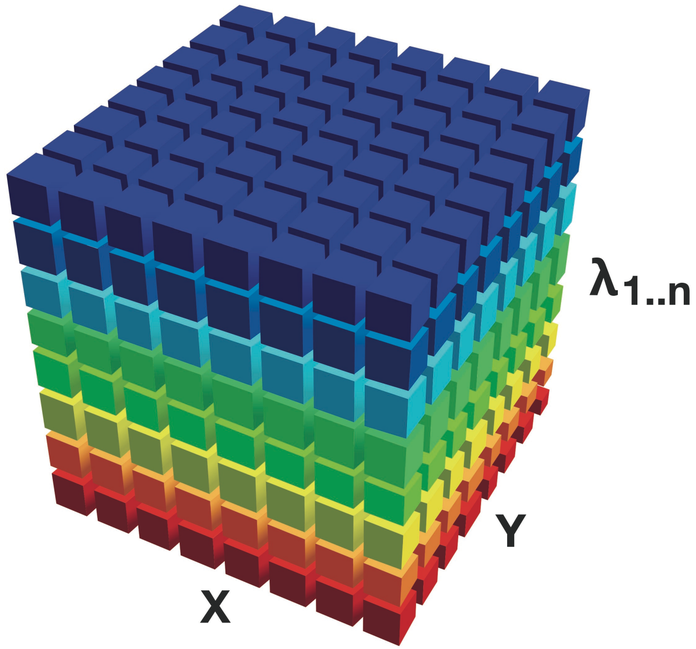
- INTRODUCTION
  - Hyperspectral Imaging
  - Dual-comb spectroscopy
- EXPERIMENT
  - High-Spectral-Resolution Imaging Spectroscopy
- CONCLUSION

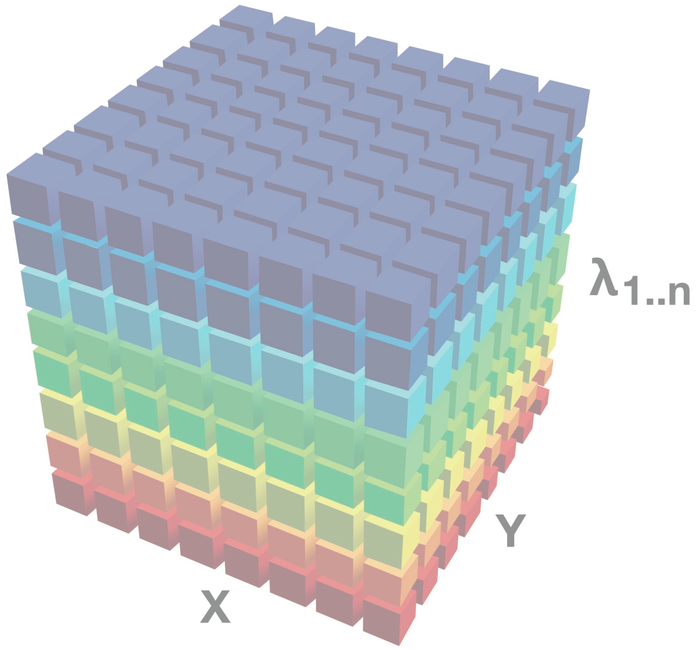
Imaging

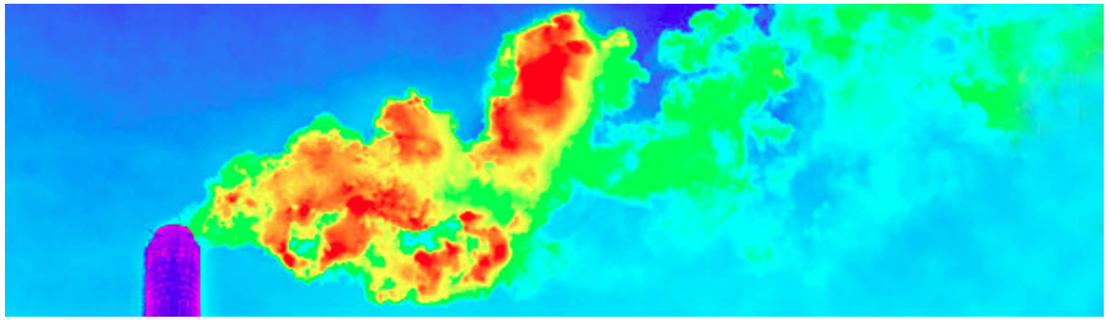


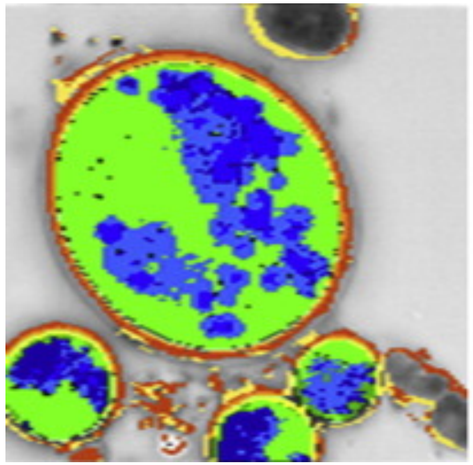
Hyperspectral Imaging

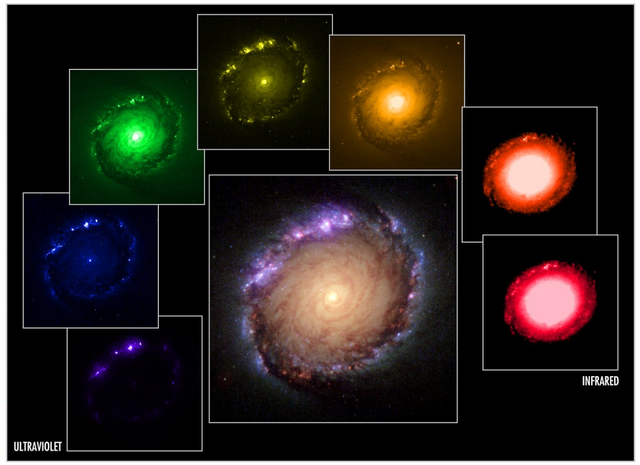


Hyperspectral Imaging





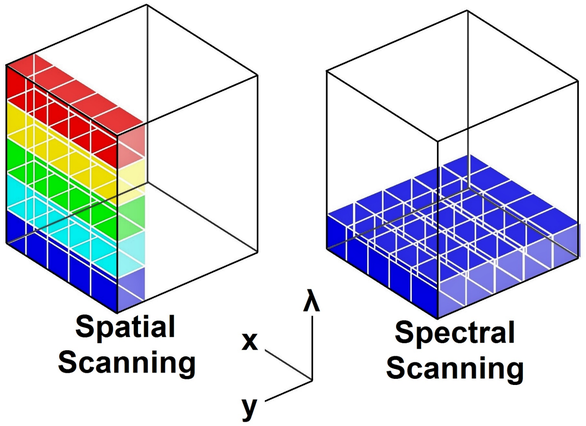




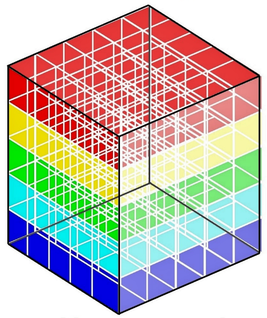
Applications:

- Astronomy
- Environmental sensing
- Biology
- Agriculture
- .....

Hyperspectral Imaging

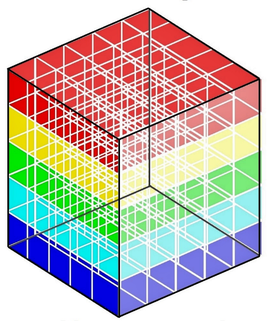


Hyperspectral Imaging



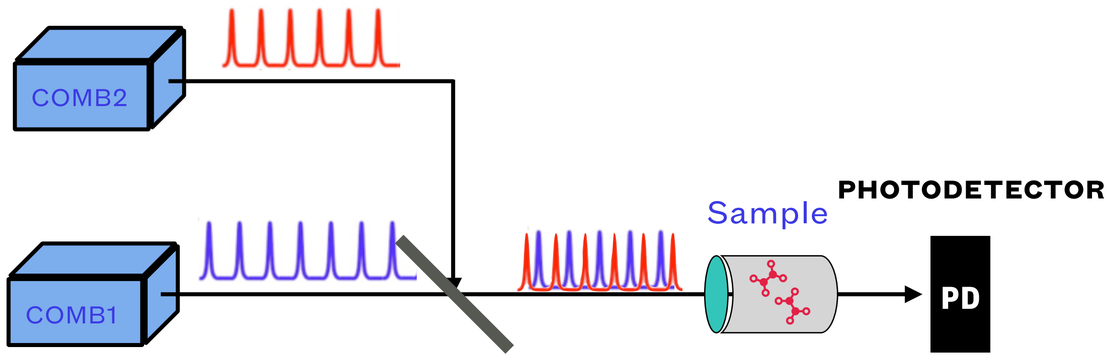
Non-scanning

Hyperspectral Imaging



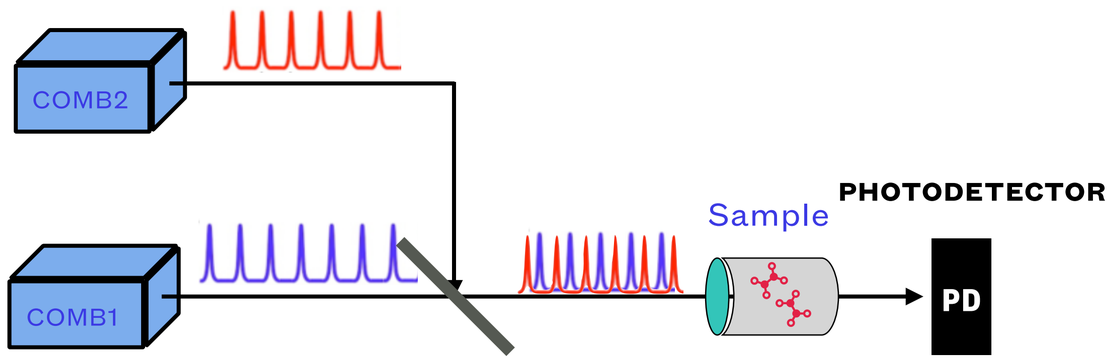
Non-scanning

Dual-comb spectroscopy

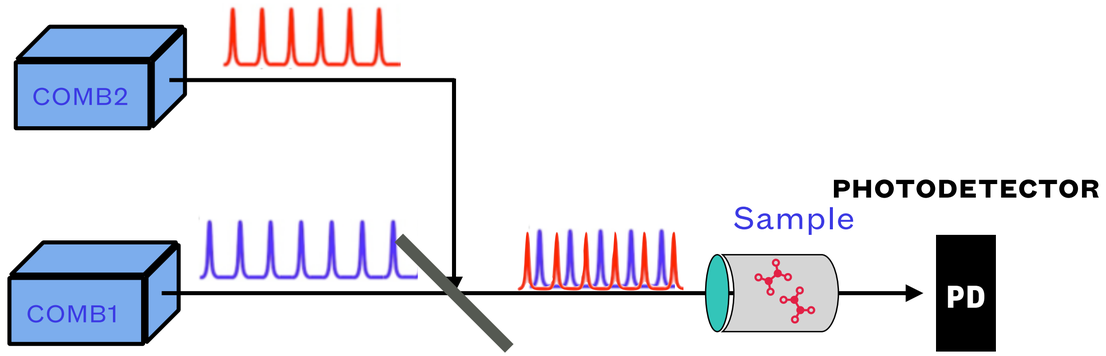


- Scan less
- Fast acquisition
- Broad bandwidth
- High resolution
- High precision

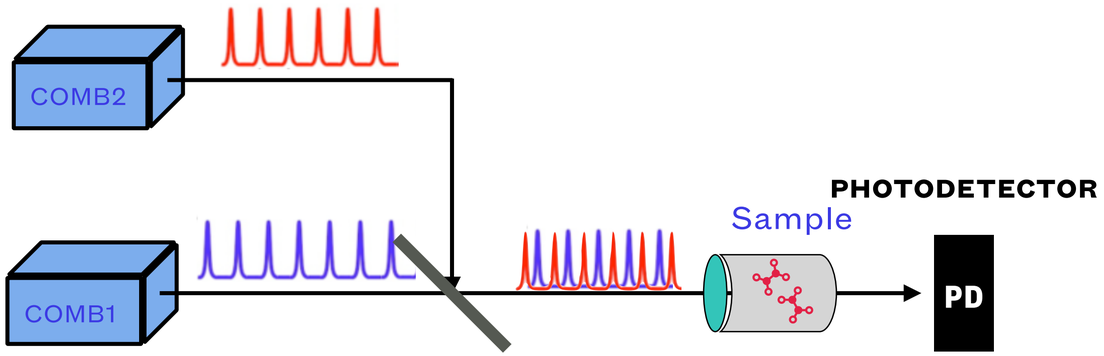
Dual-Comb Spectroscopy

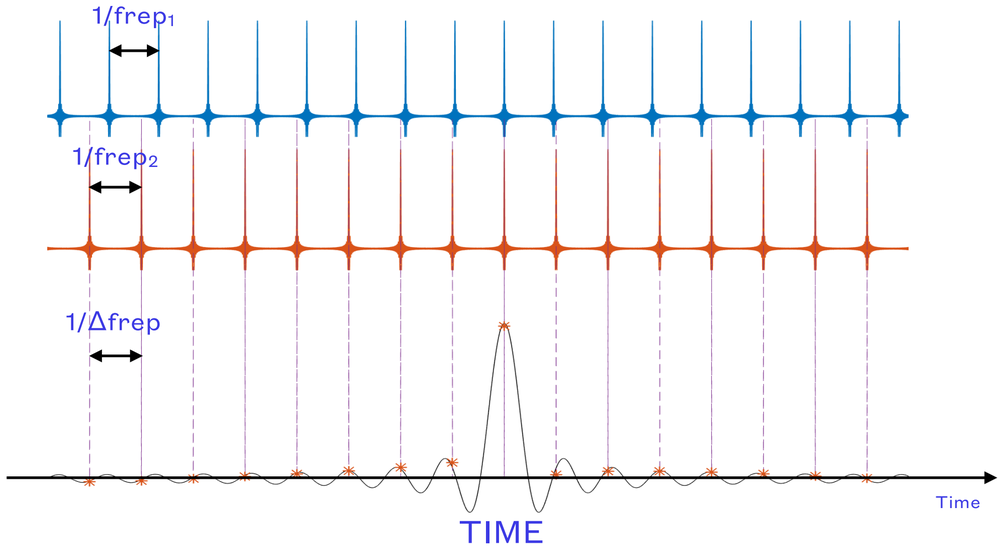


Dual-Comb Spectroscopy

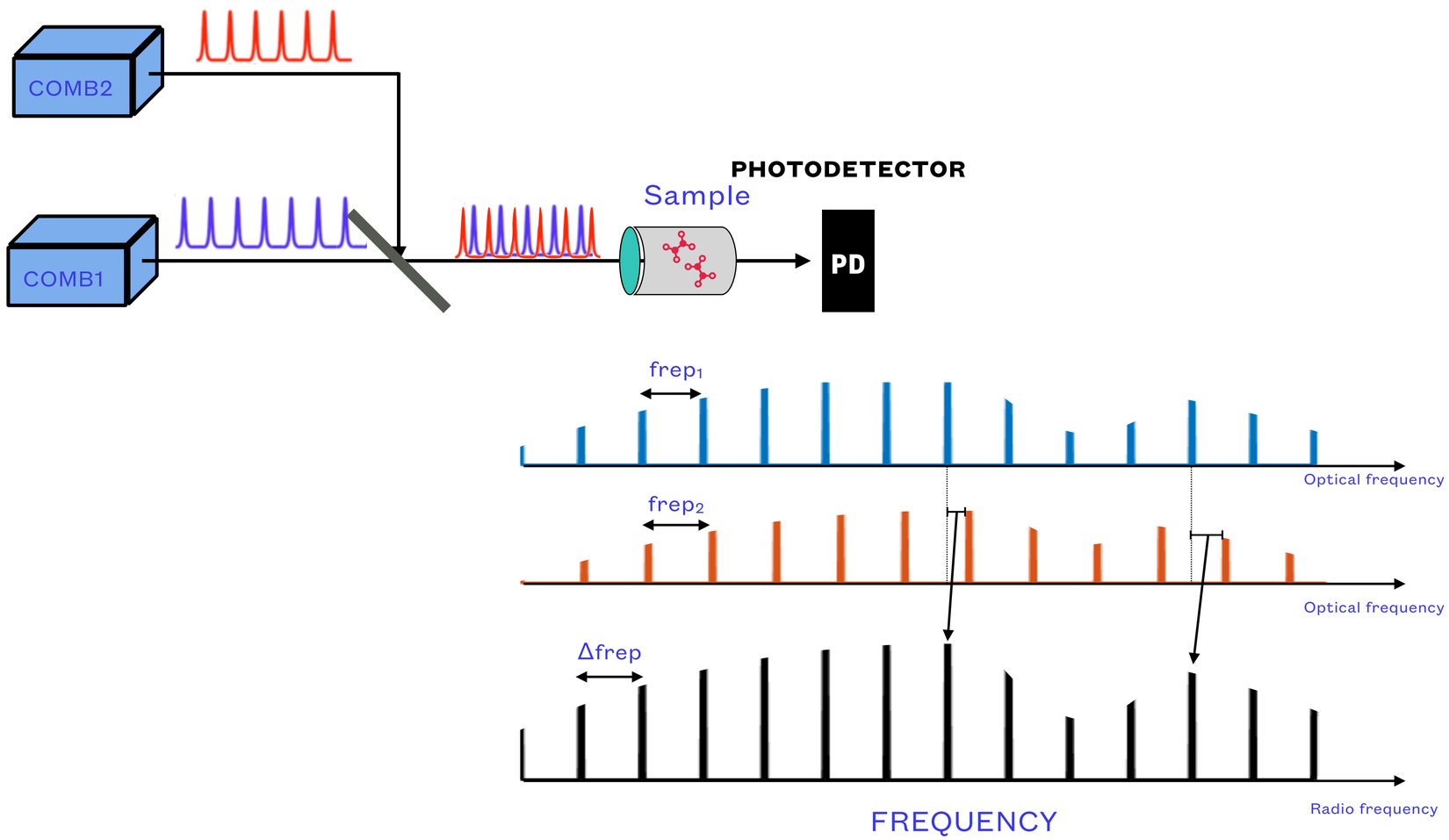


Dual-Comb Spectroscopy





Dual-Comb Spectroscopy



Dual-Comb Spectroscopy

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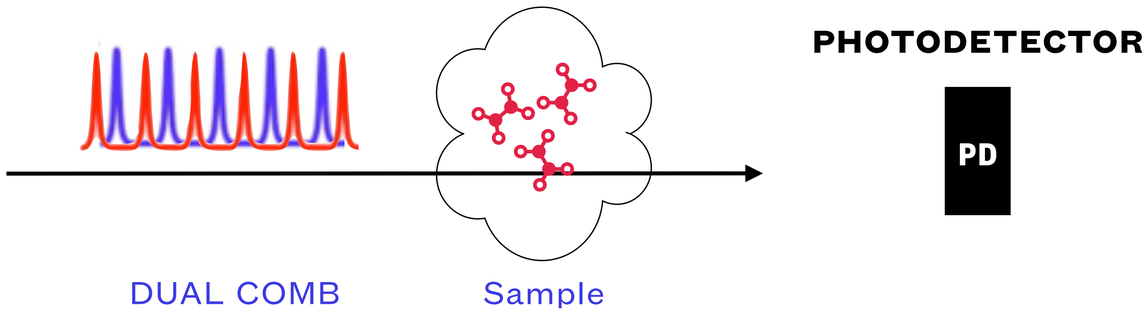
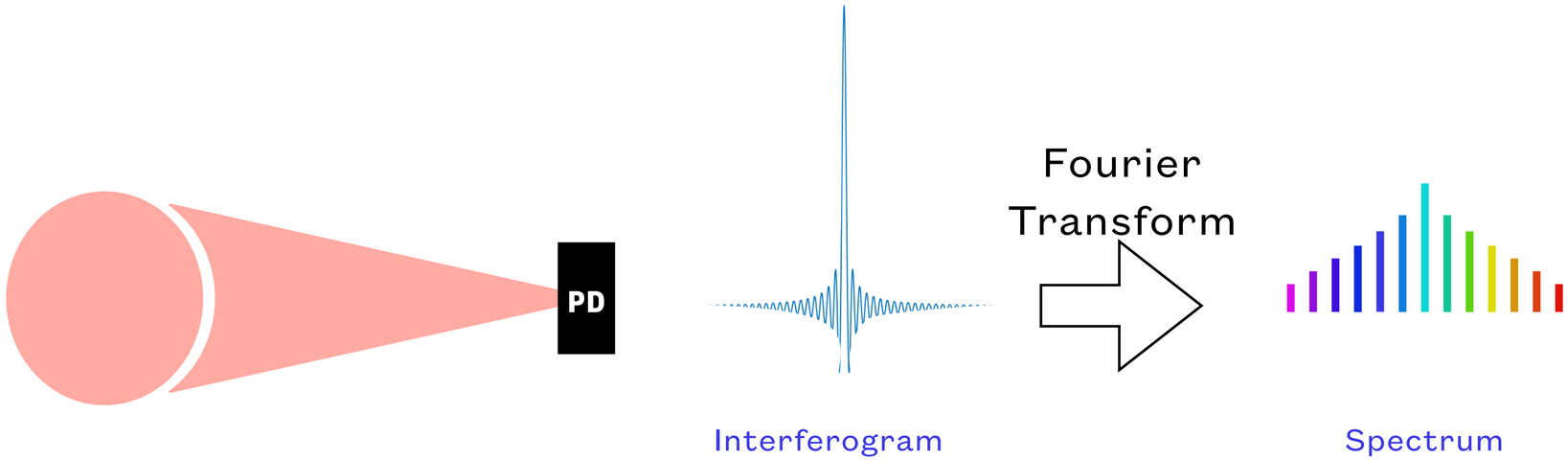
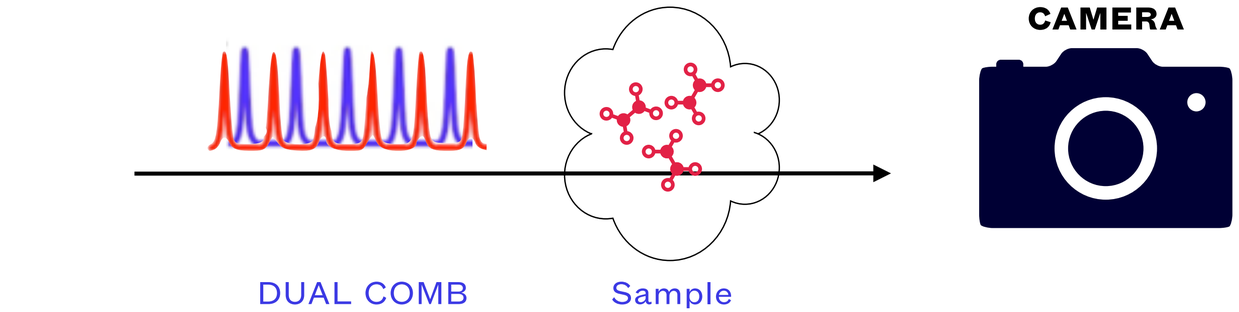
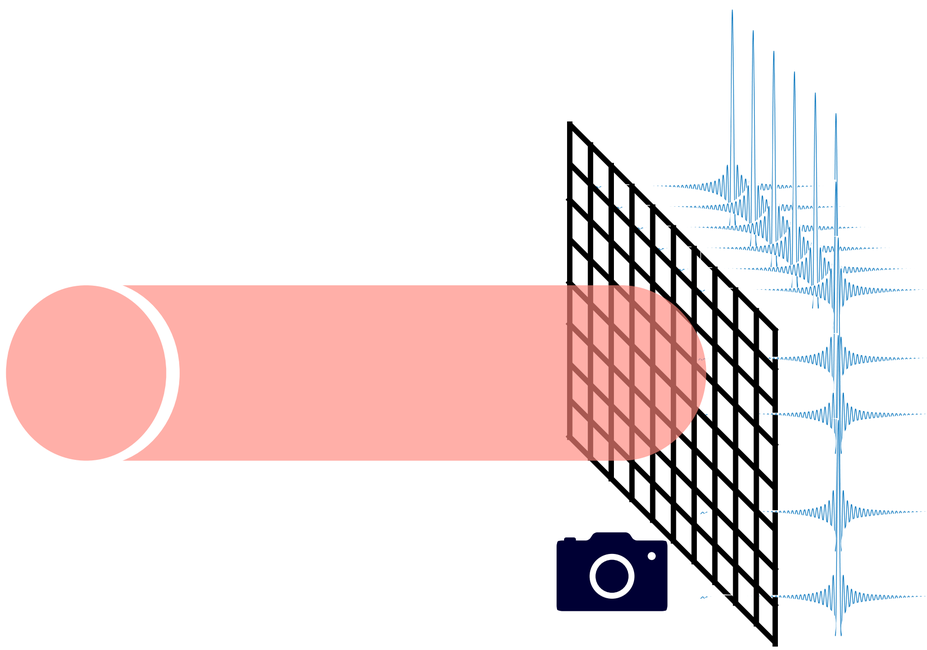


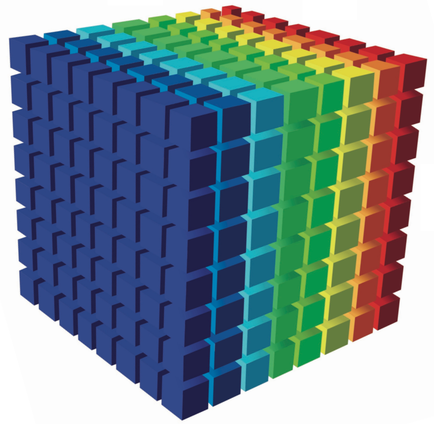


High-Spectral-Resolution Imaging Spectroscopy





Fourier Transform



High-Spectral-Resolution Imaging Spectroscopy

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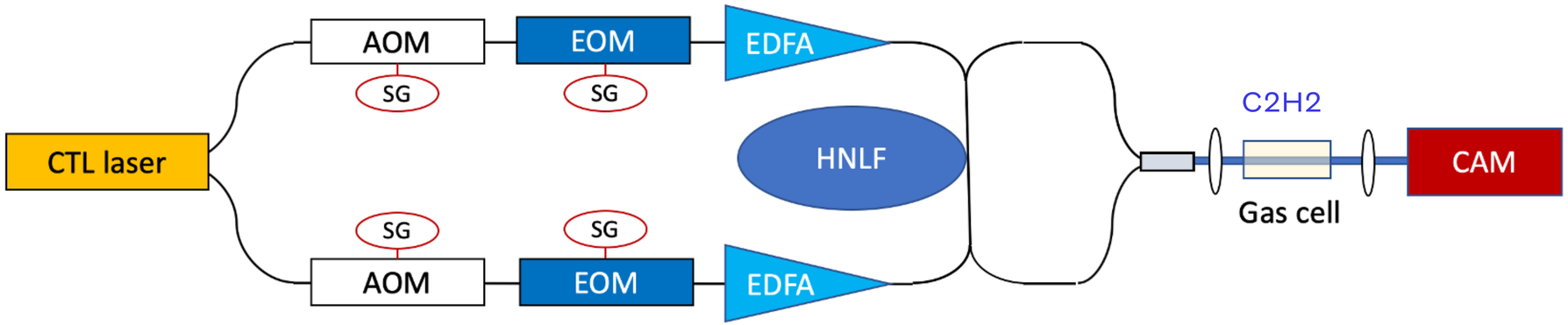
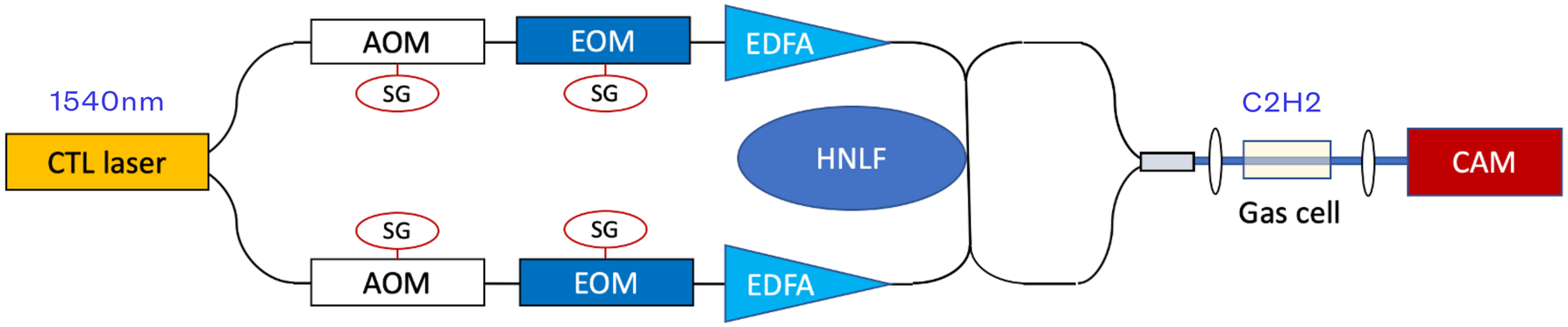
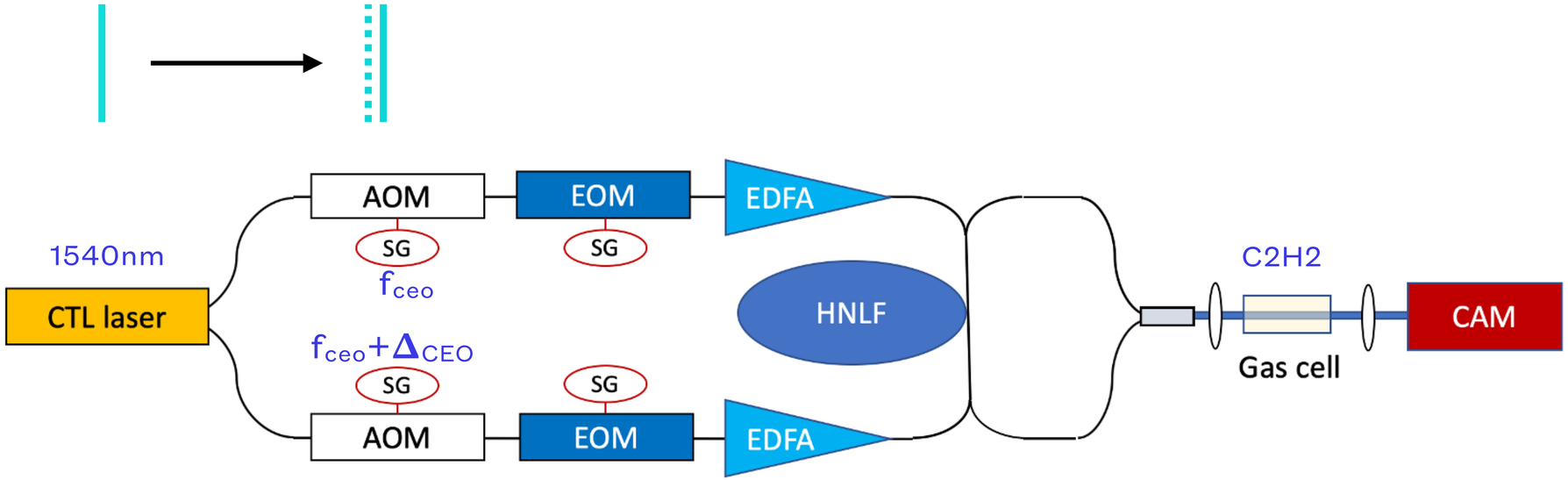


High-Spectral-Resolution Imaging Spectroscopy



High-Spectral-Resolution Imaging Spectroscopy



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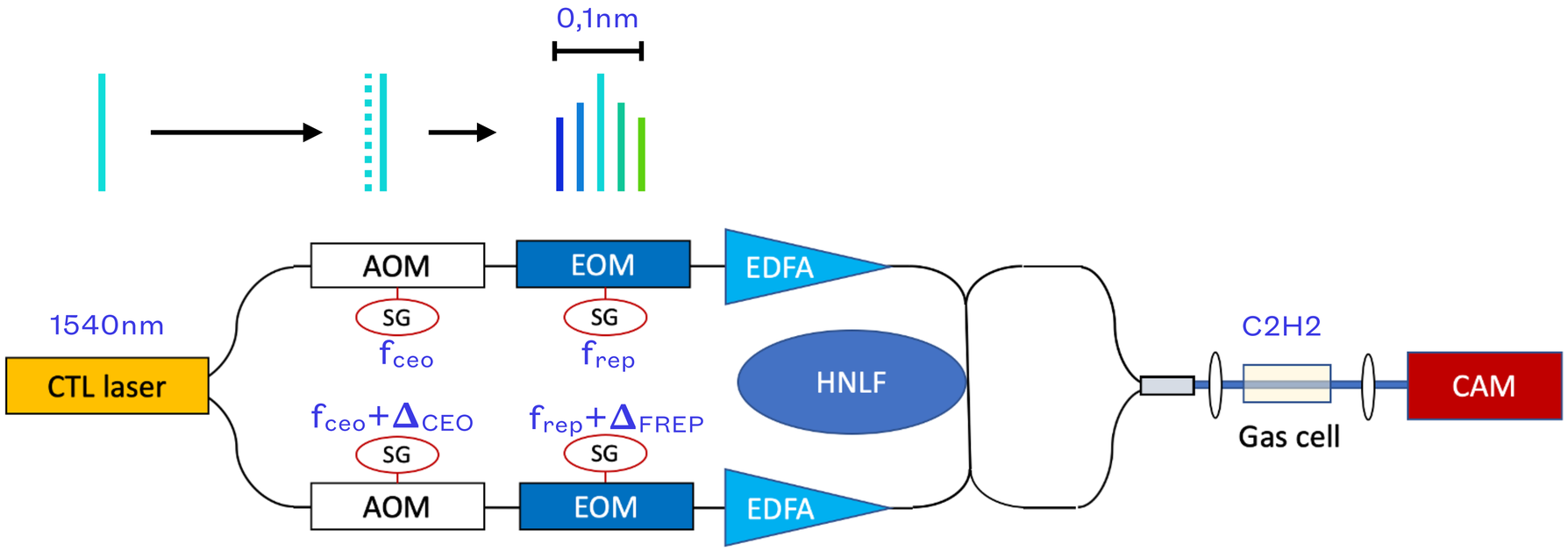

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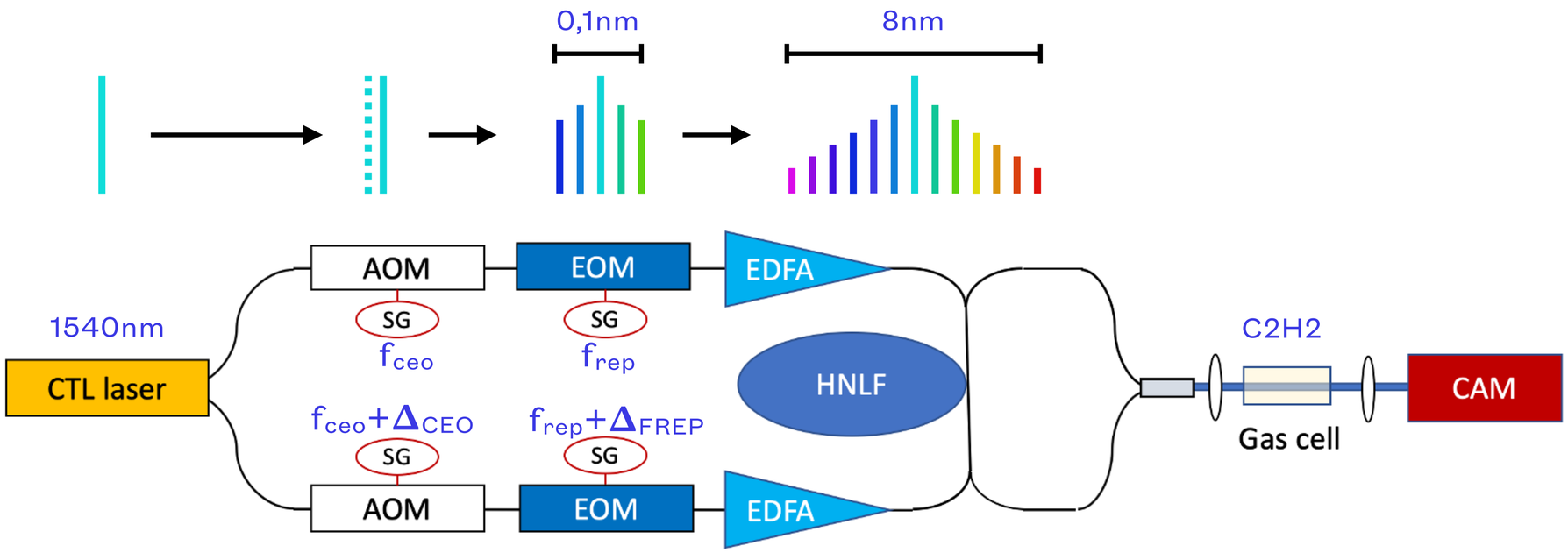

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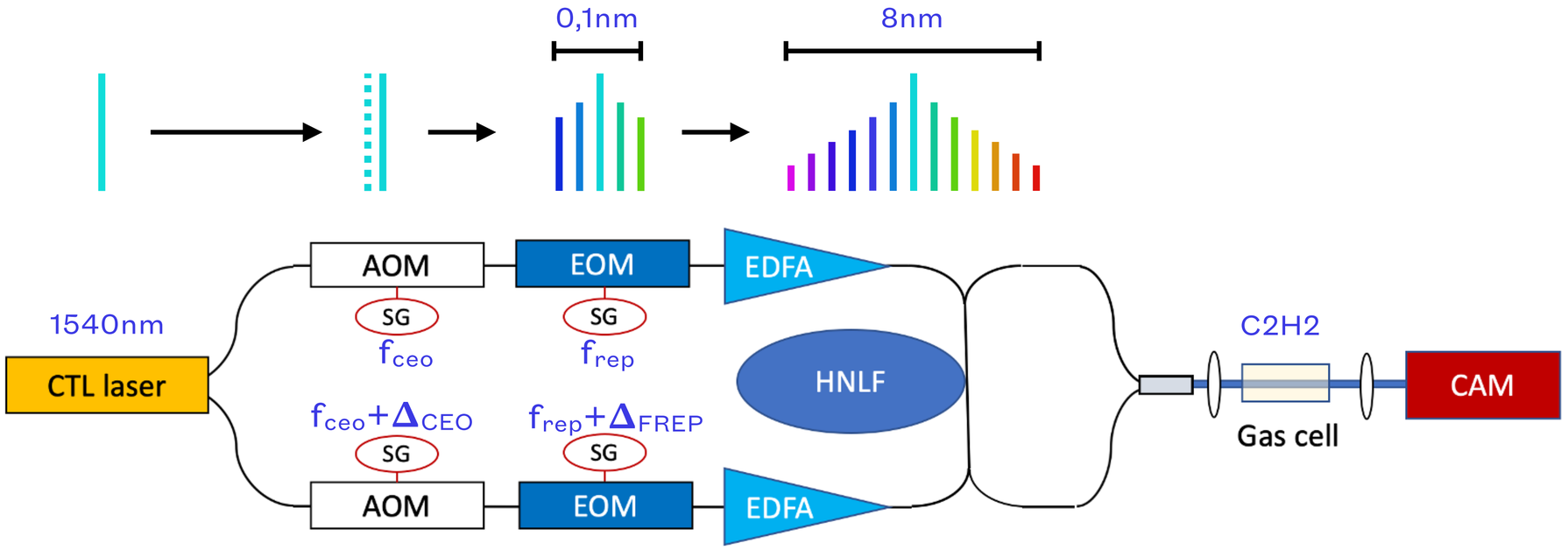
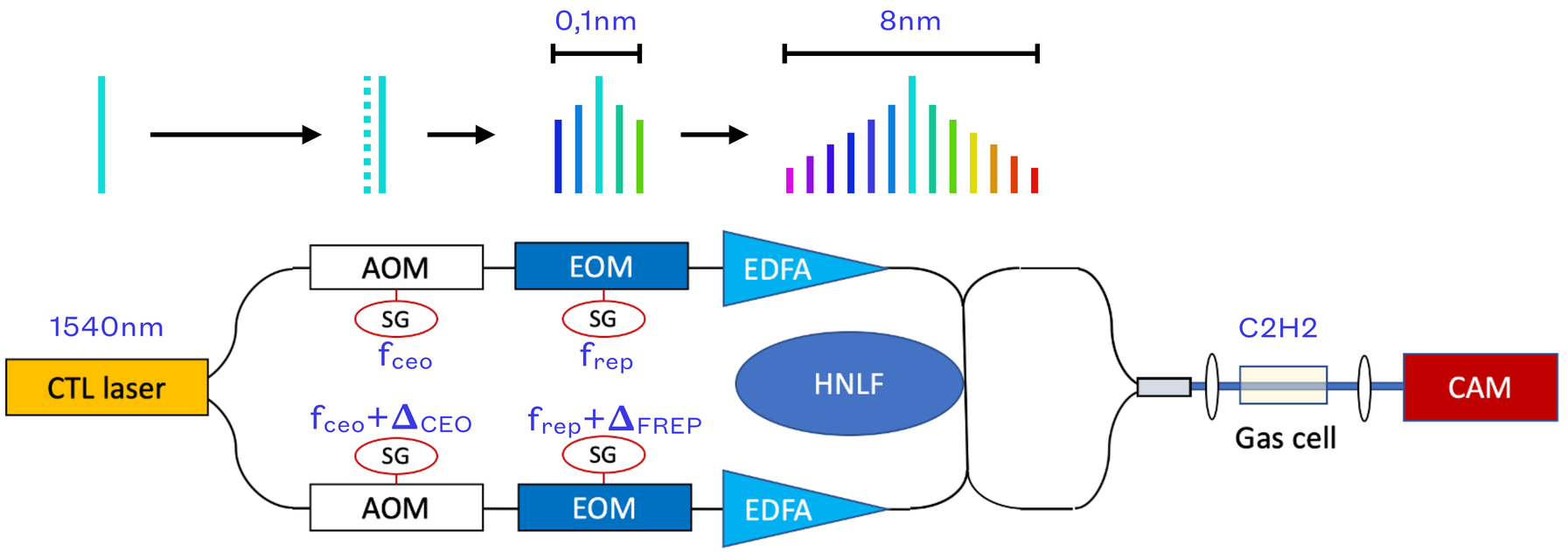


Pixels	FPS
8x8	18000
16x16	12000
32x32	5600
64x64	3000
128x128	1000
256x320	320

High-Spectral-Resolution Imaging Spectroscopy



Pixels	FPS
8x8	18000
16x16	12000
32x32	5600
64x64	3000
128x128	1000
256x320	320

f_{rep}=250MHz

Δ_{FREP}=3Hz

Δ_{CEO}=4.5kHz

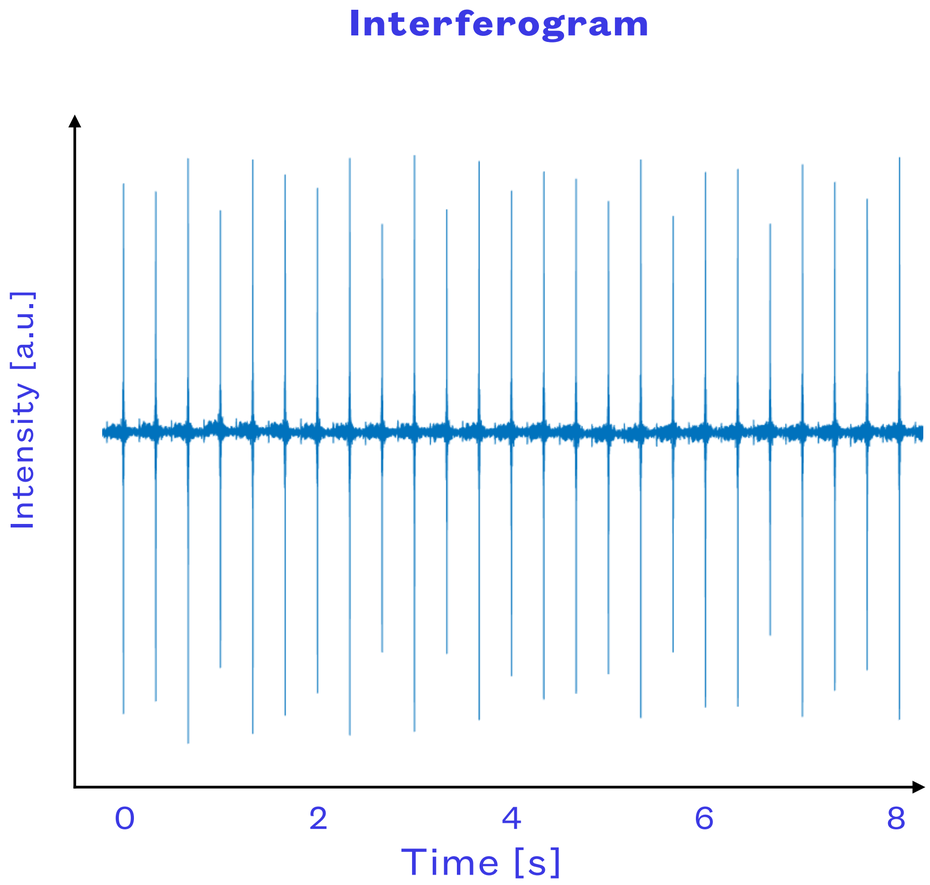
$\Delta\lambda$=6nm

$\delta\lambda$=0.002nm

192 spectra/s

High-Spectral-Resolution Imaging Spectroscopy

High-Spectral-Resolution Imaging Spectroscopy



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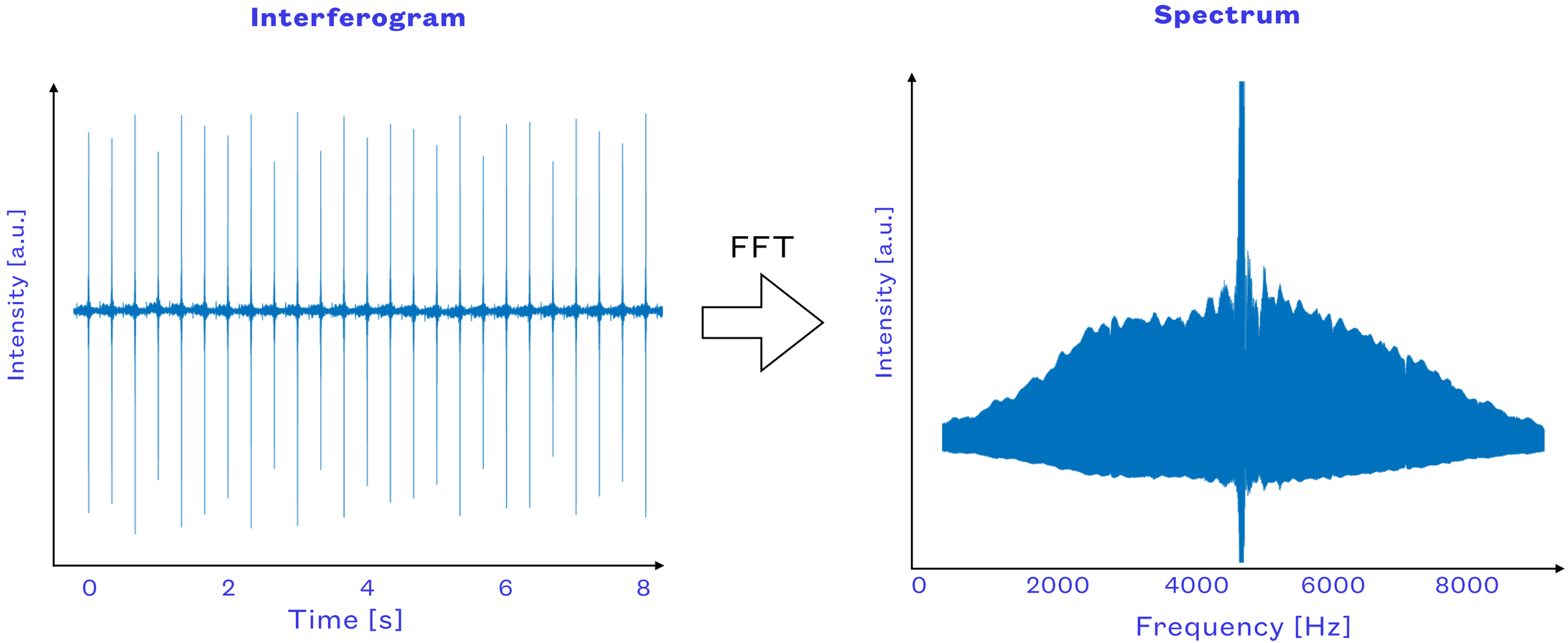

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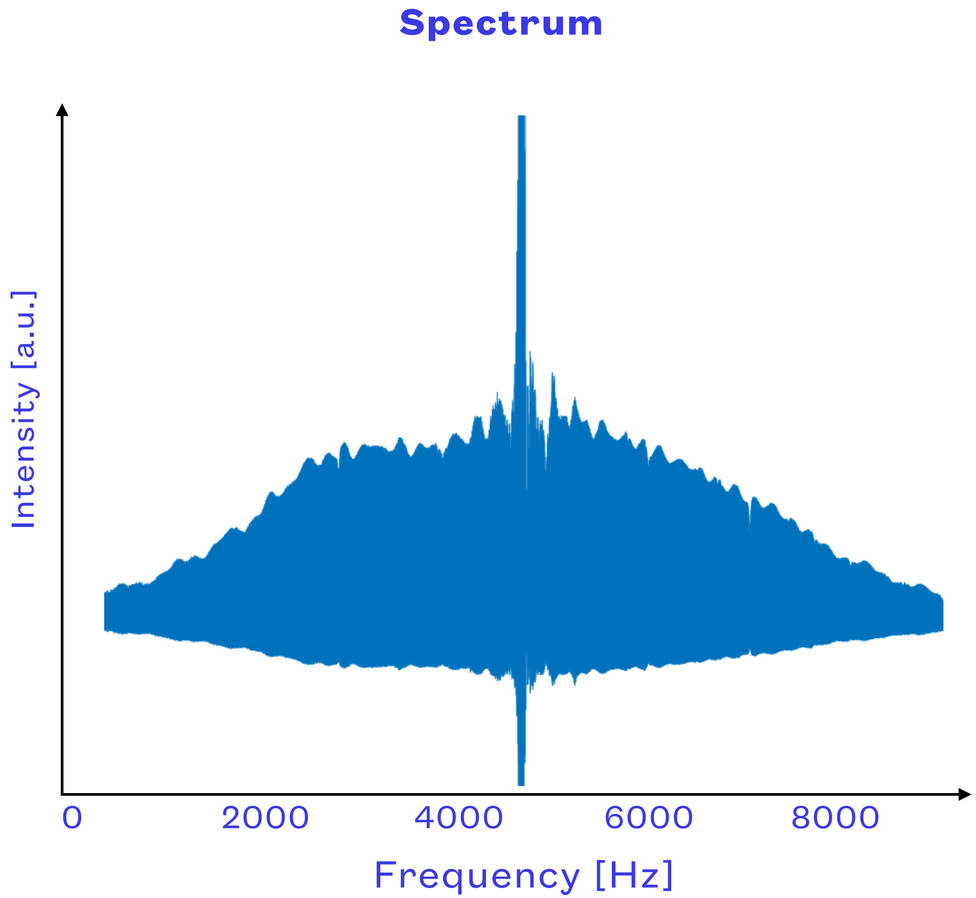

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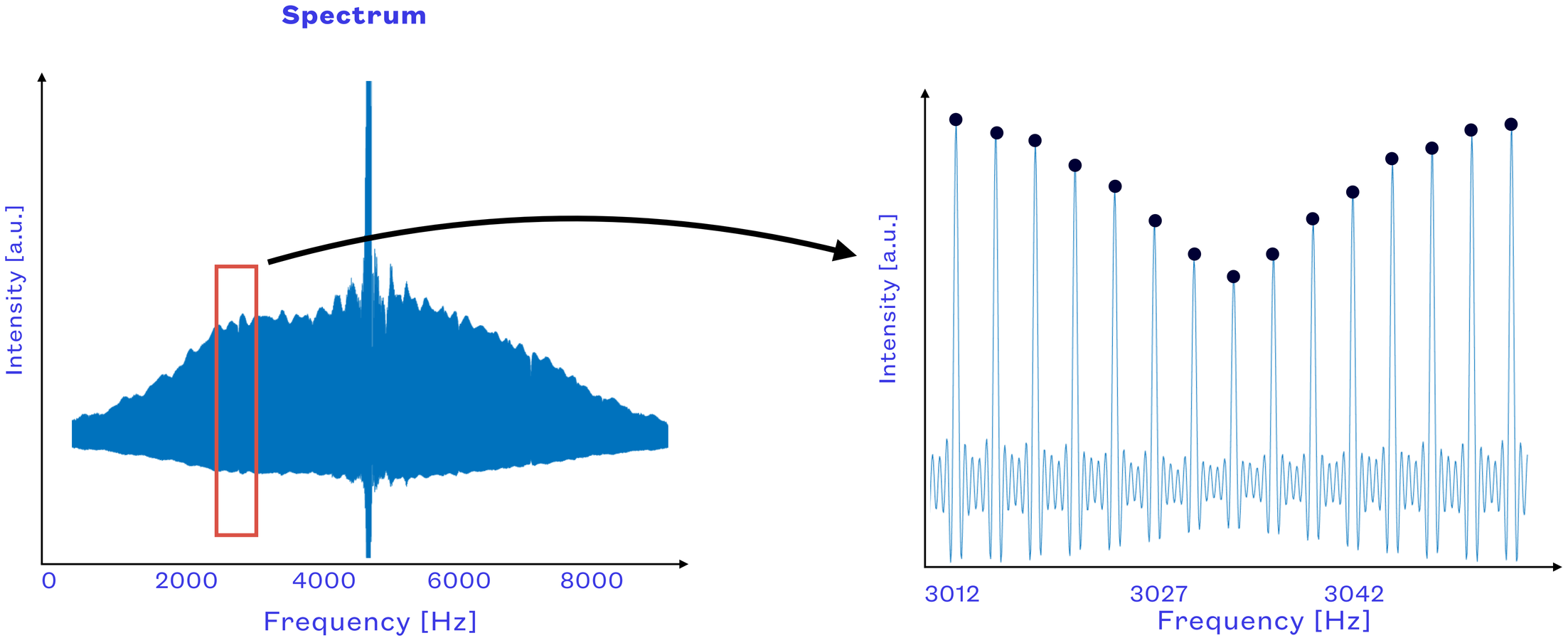

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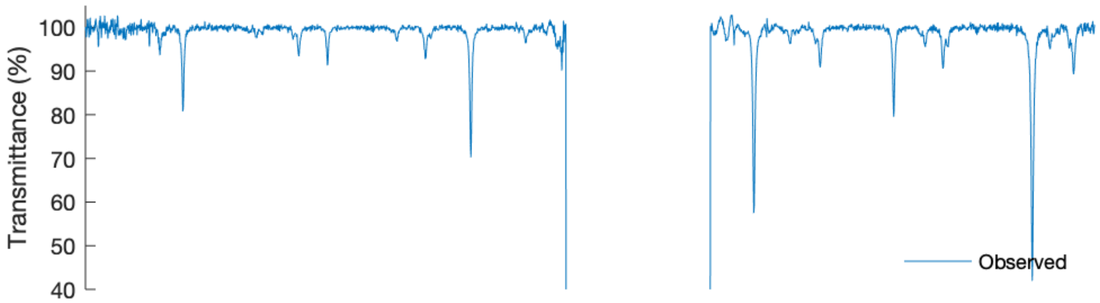

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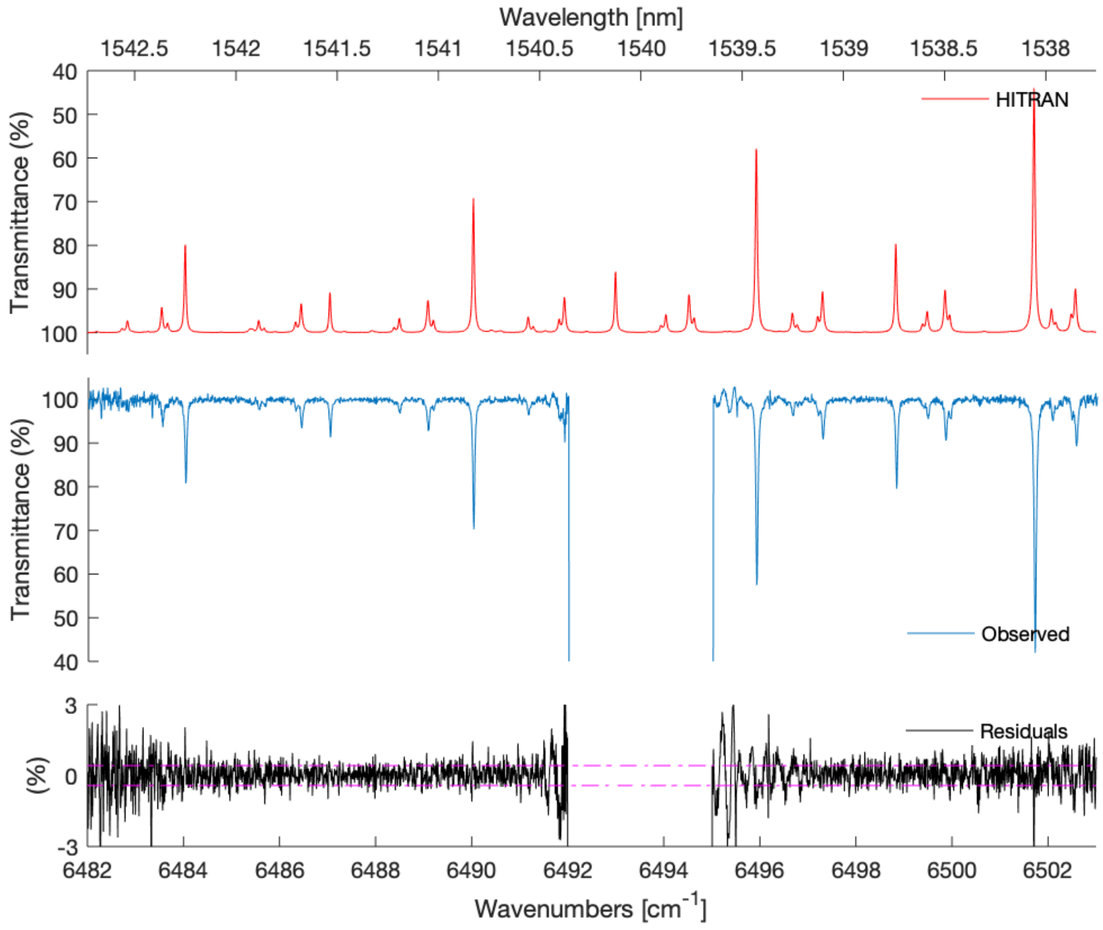

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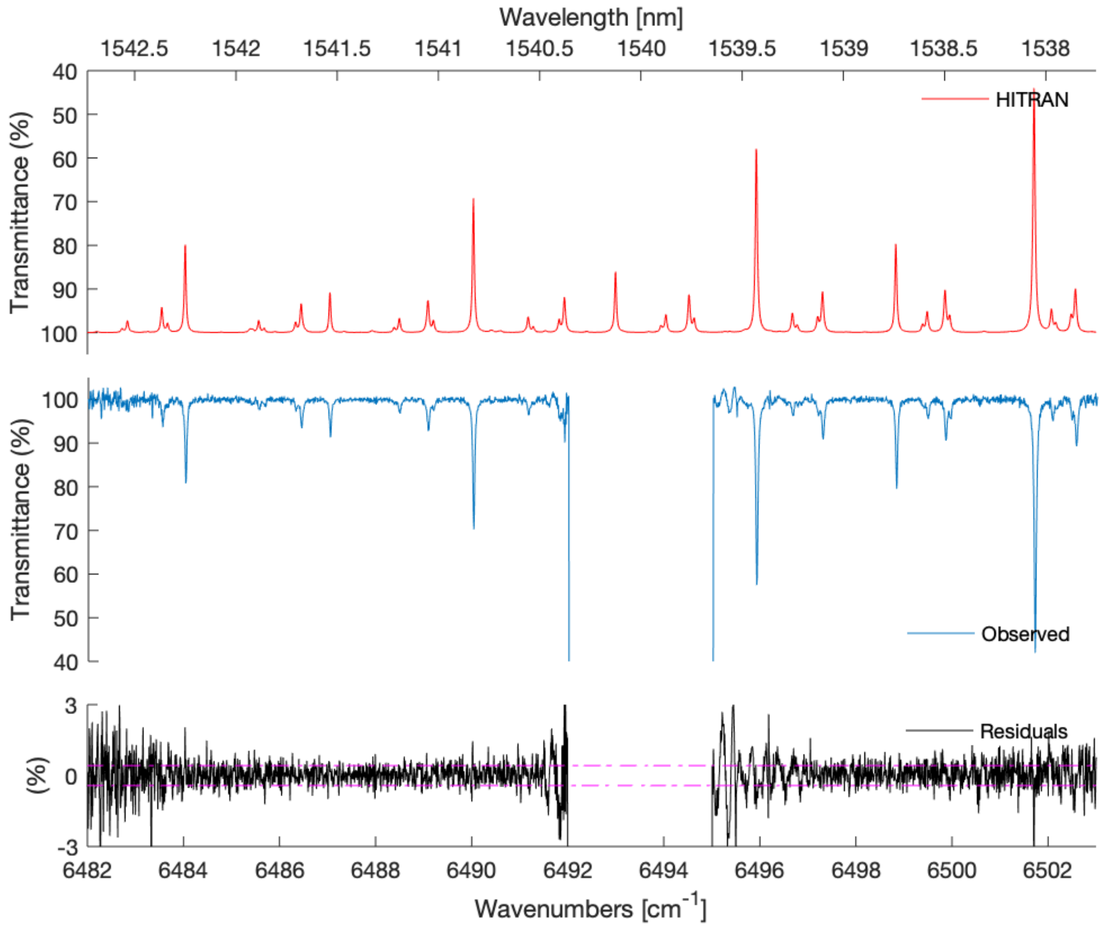

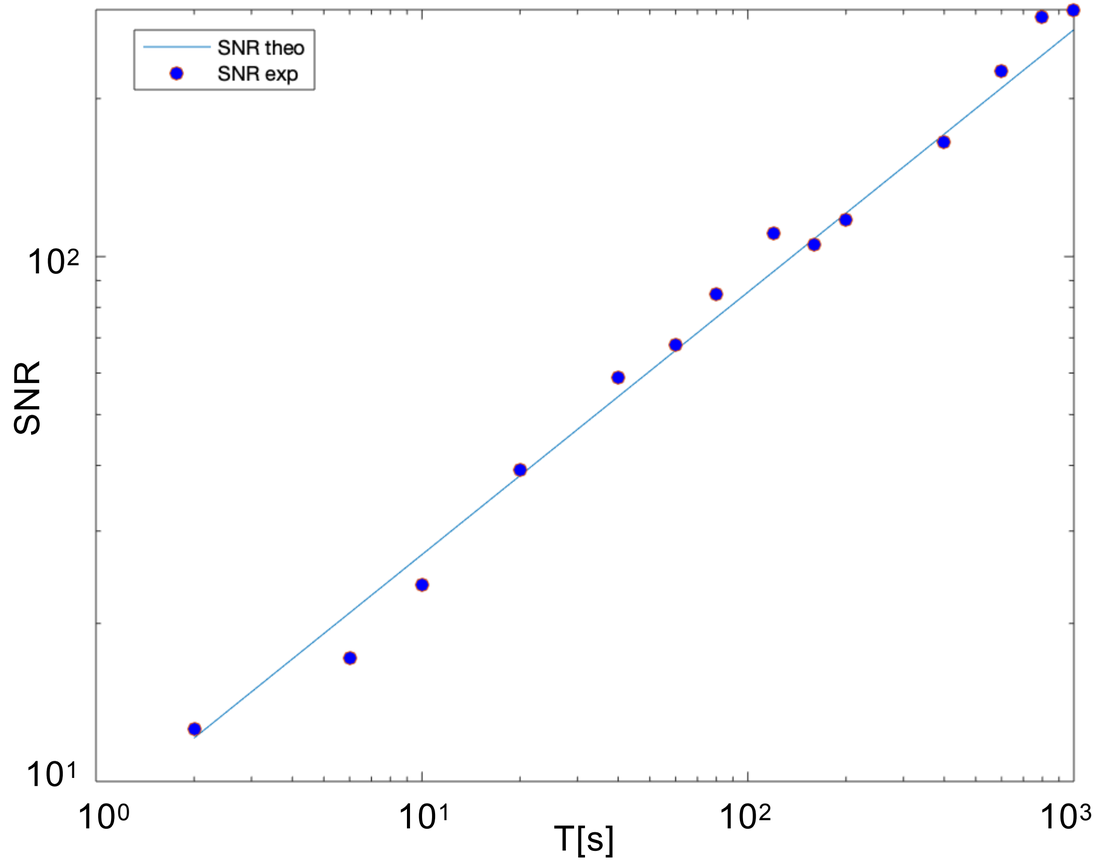

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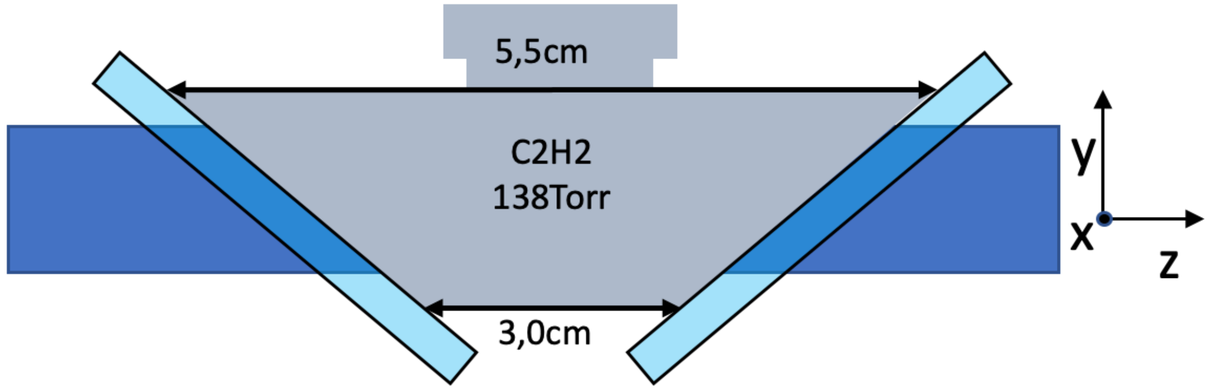

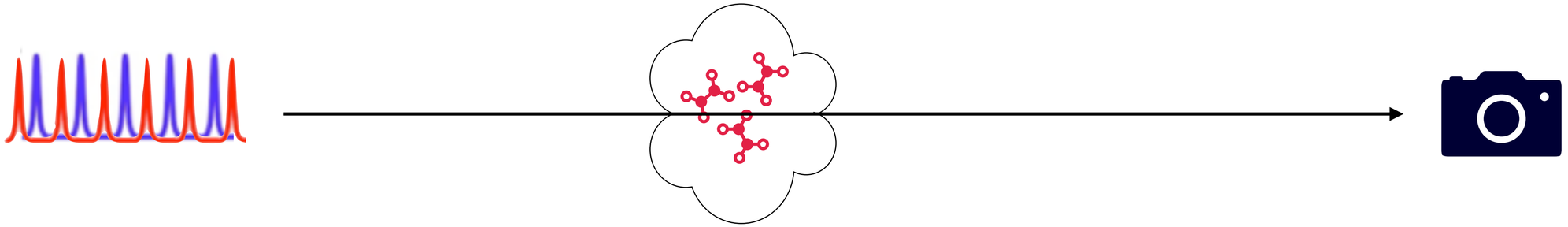

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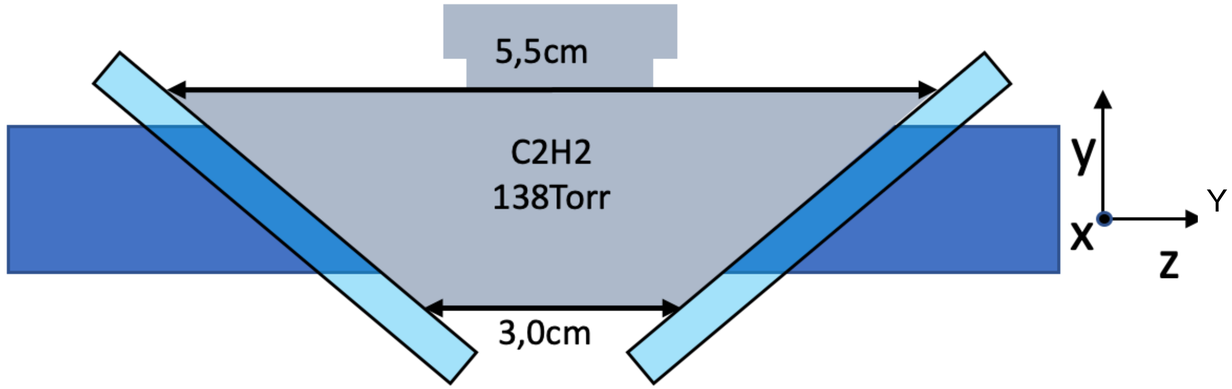

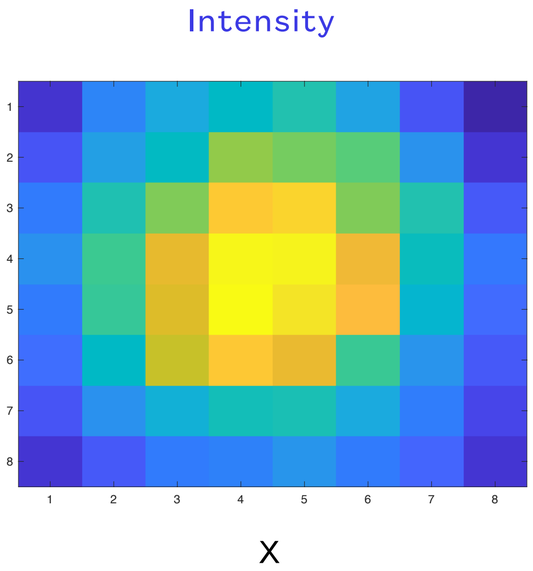

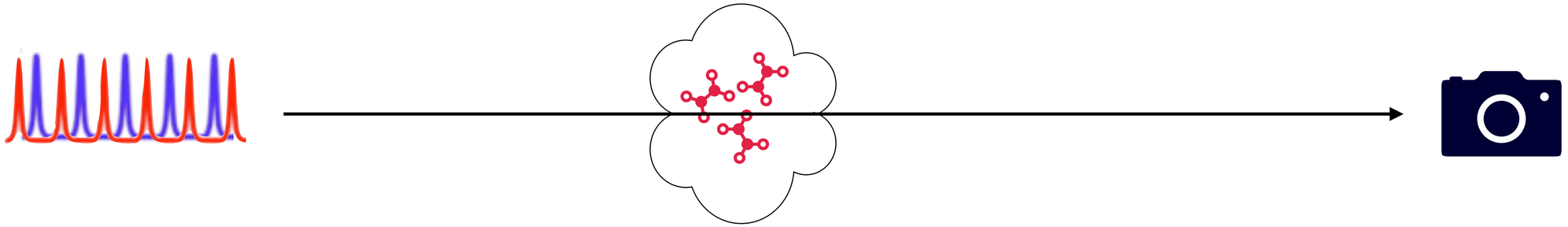

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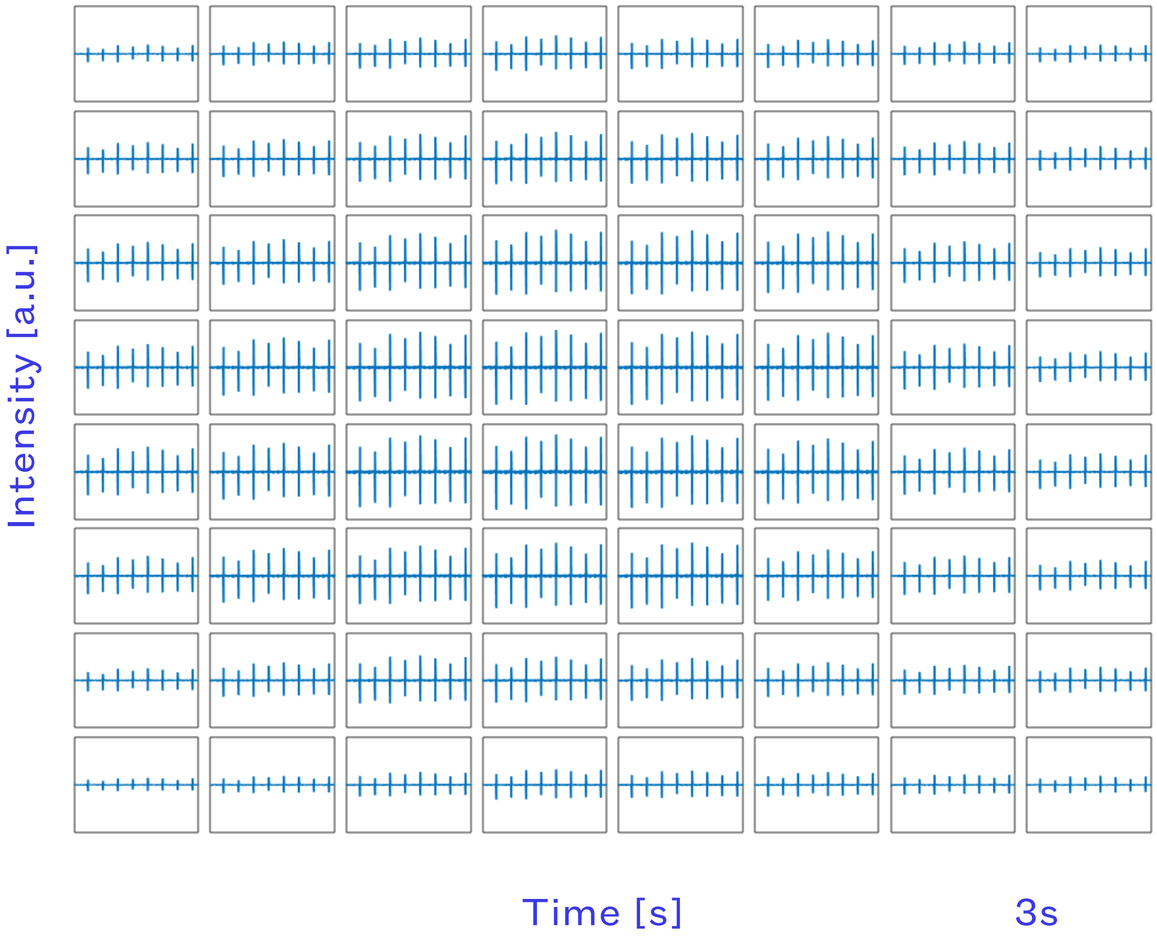

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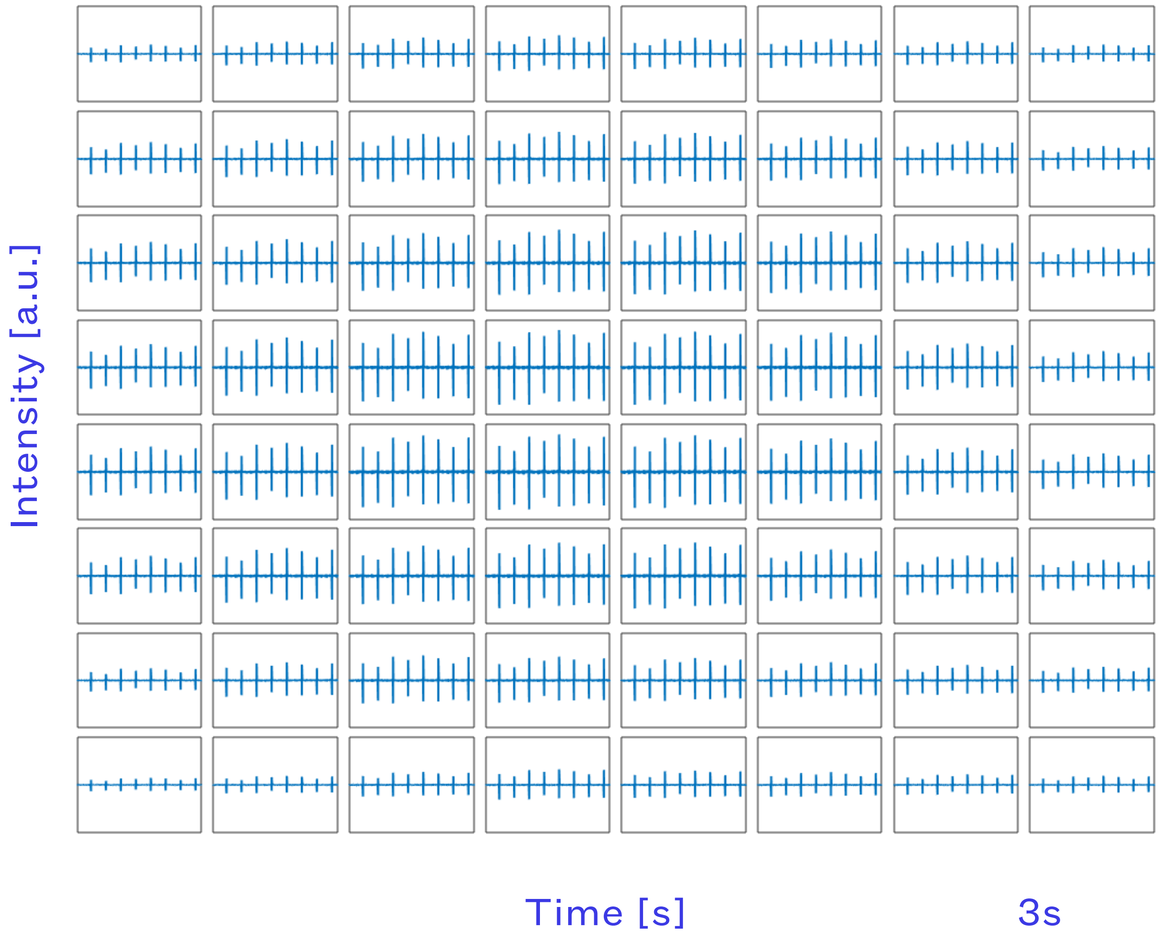
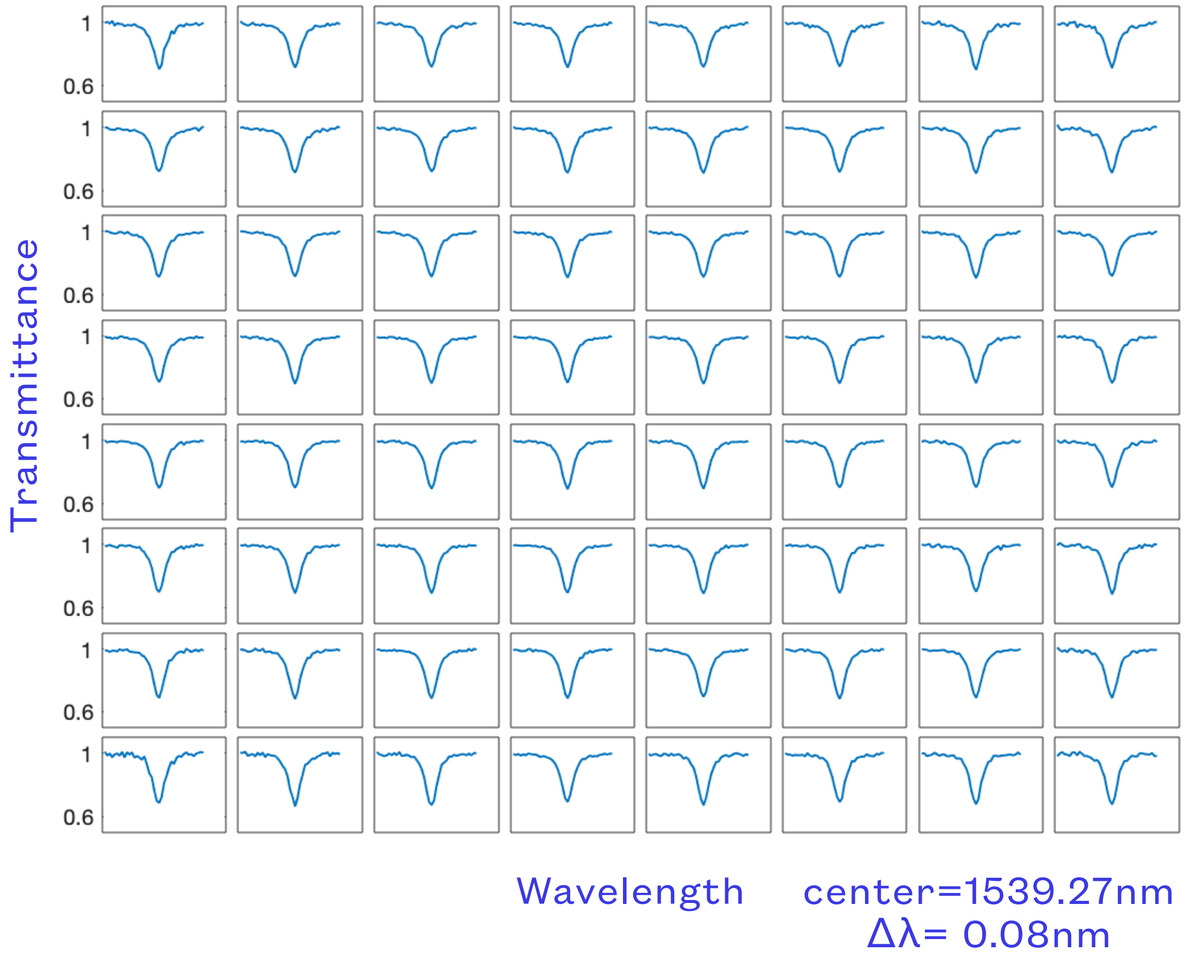
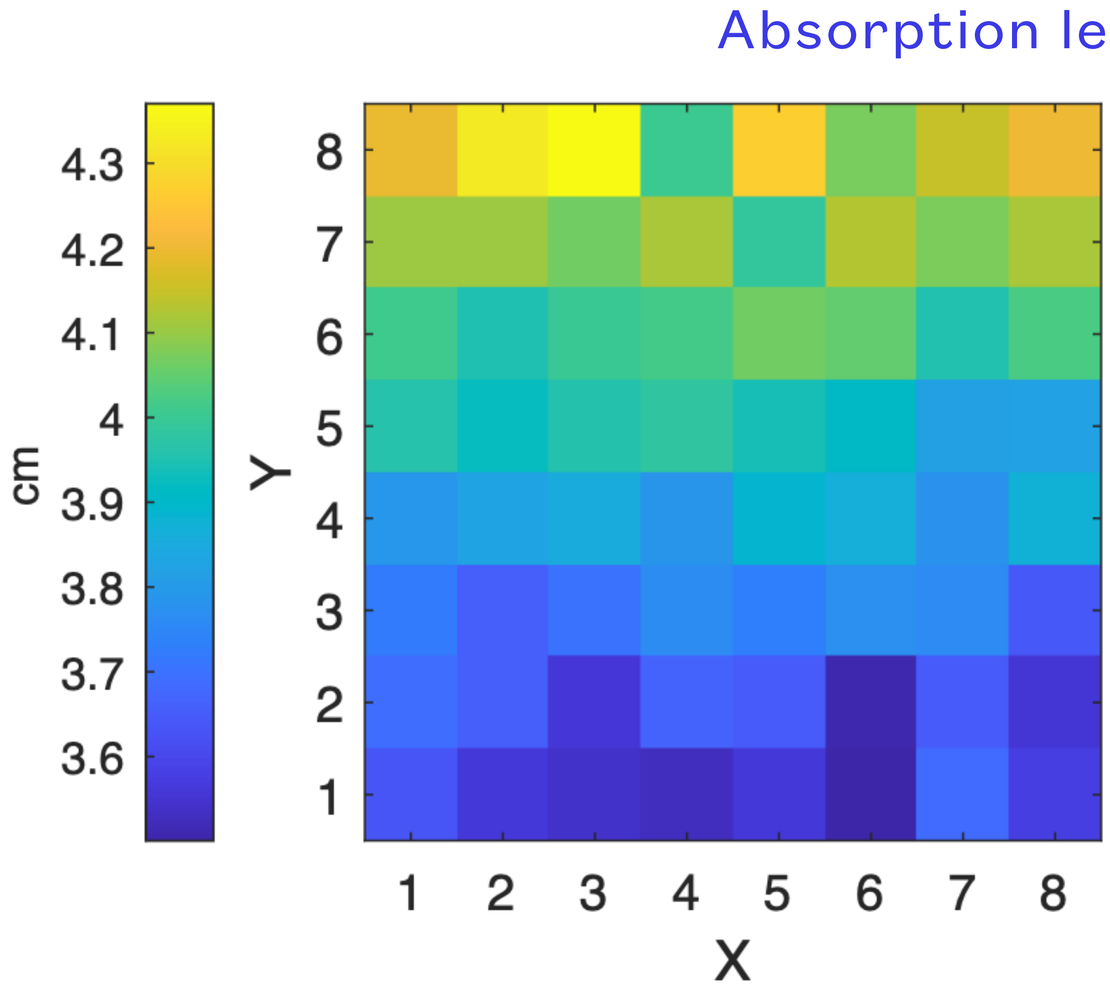


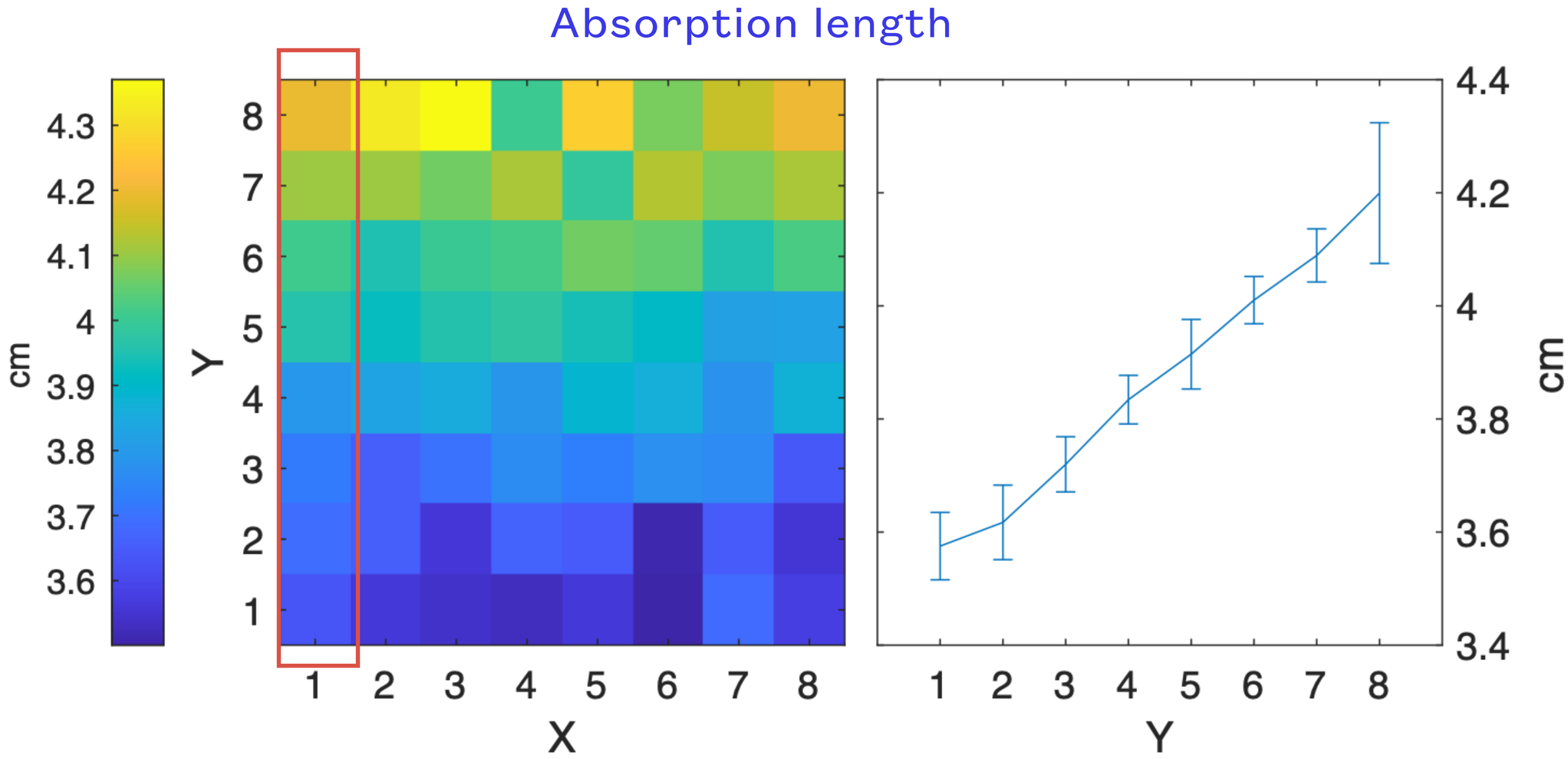


High-Spectral-Resolution Imaging Spectroscopy

High-Spectral-Resolution Imaging Spectroscopy



High-Spectral-Resolution Imaging Spectroscopy



Conclusion

This experiment demonstrate the possibility for high-resolution imaging spectroscopy with a dual-comb interferometer.

Future perspectives

- **Faster camera** can increase
  - # spectra/s
  - # pixels
  - Optical bandwidth
  - Resolution
- **Moving to mid-infrared** will allow different application to this technique (strong characteristic vibrational transitions for molecules)

Thank you for the attention