USING SINGLE-MOLECULE SPECTROSCOPY METHODS TO INVESTIGATE THE ENVIRONMENTAL DEPENDENCIES OF PHOTOPROTECTION IN THE MAIN PLANT LIGHT HARVESTING COMPLEX.

UNIVERSITEIT VAN PRETORIA
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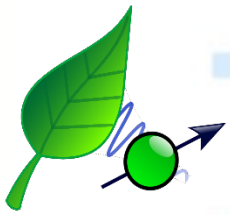
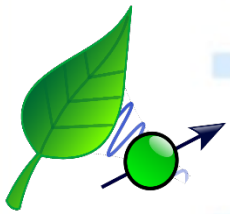
SAIP 2015
3rd July 2015
Port Elizabeth

Theoretical Background



- Earth's surface is irradiated by ~178000 TW of sunlight
- Humans use ~17 TW of electricity
- Photosynthesis converts ~1500-2200 TW into biomass

Theoretical Background



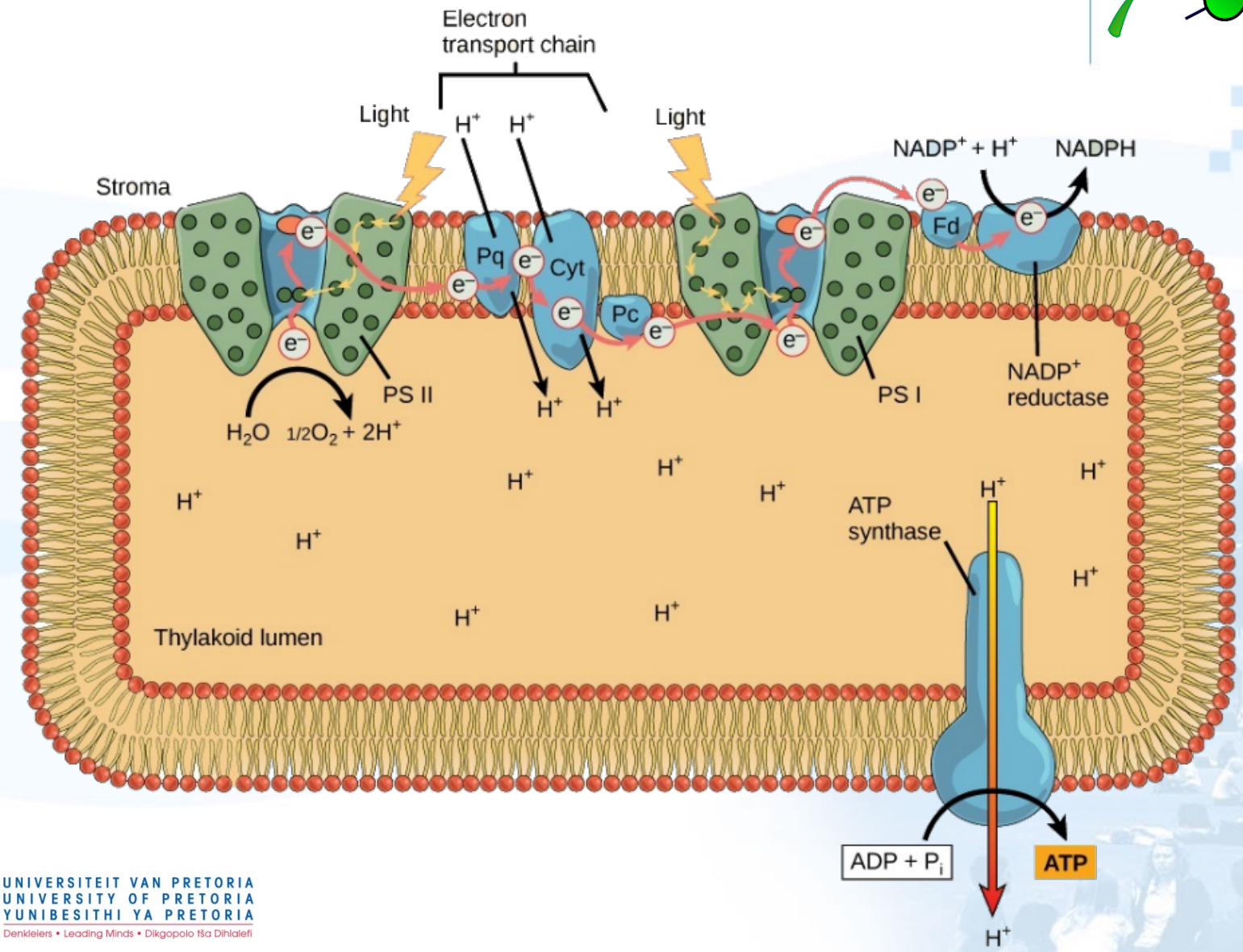
- Quantum efficiency ~100%
- Rate of absorption > Rate of storage
- Over absorption leads to formation of free radicals
- Non-Photochemical Quenching (NPQ): all photoprotective processes that reduce the solar energy conversion efficiency of plants
- NPQ => qI + qT + qE
  - Photoinhibition through long-term acclimation (qI)
  - Antenna size changes through state transition (qT)
  - Rapidly activated thermal dissipation (qE)

10^s min

min

sec - 10^s sec

Theoretical Background



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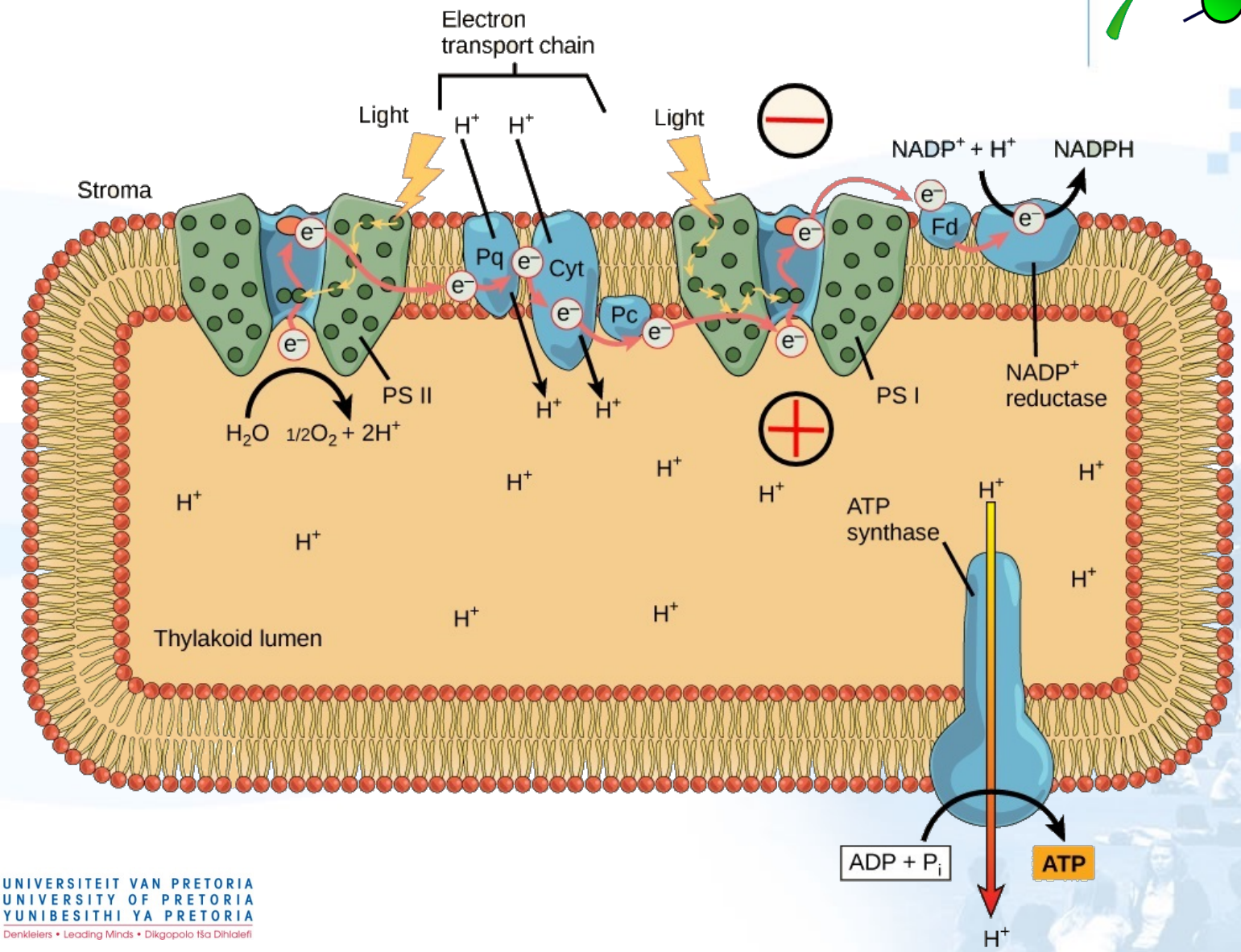


Theoretical Background

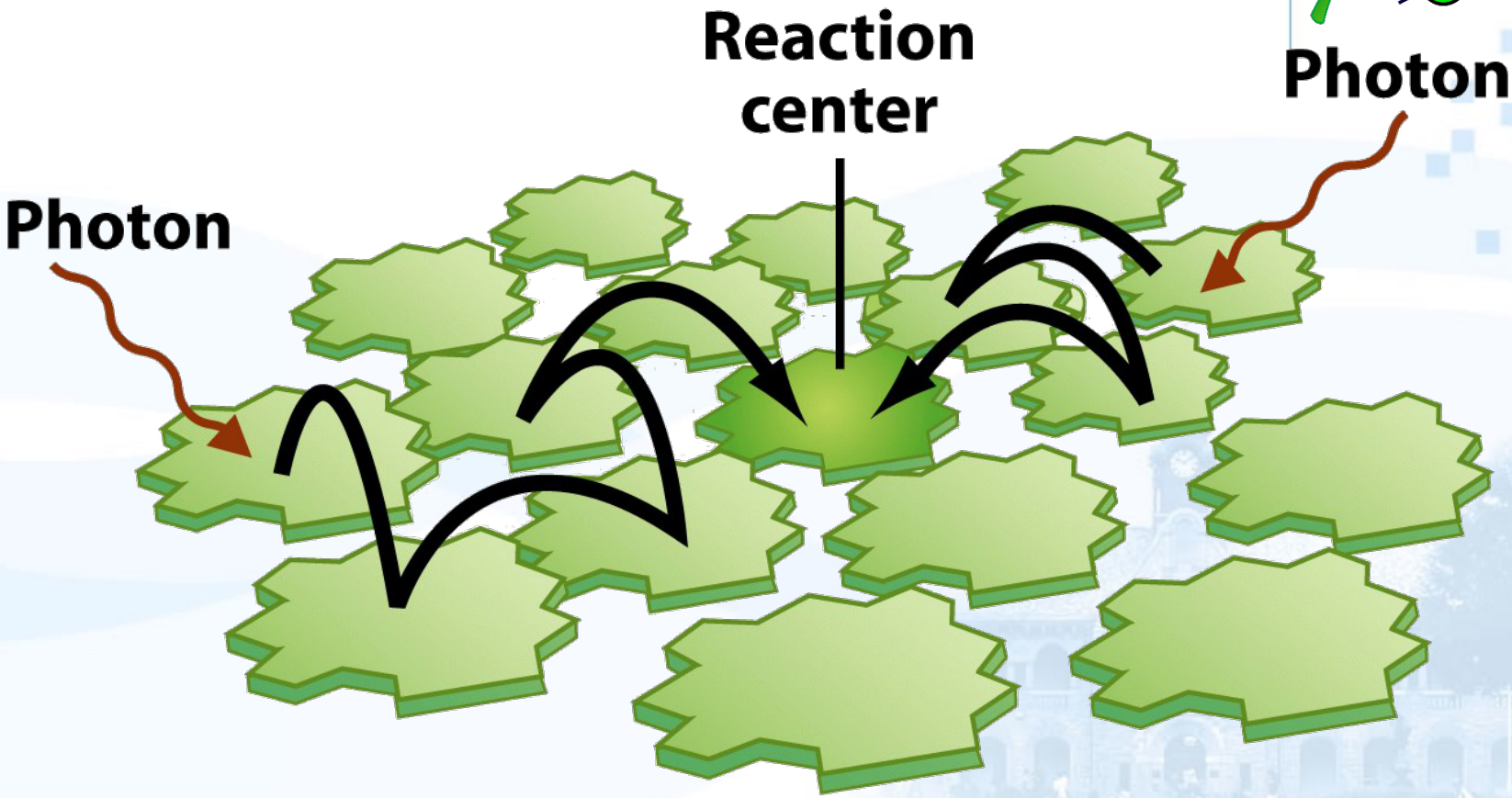
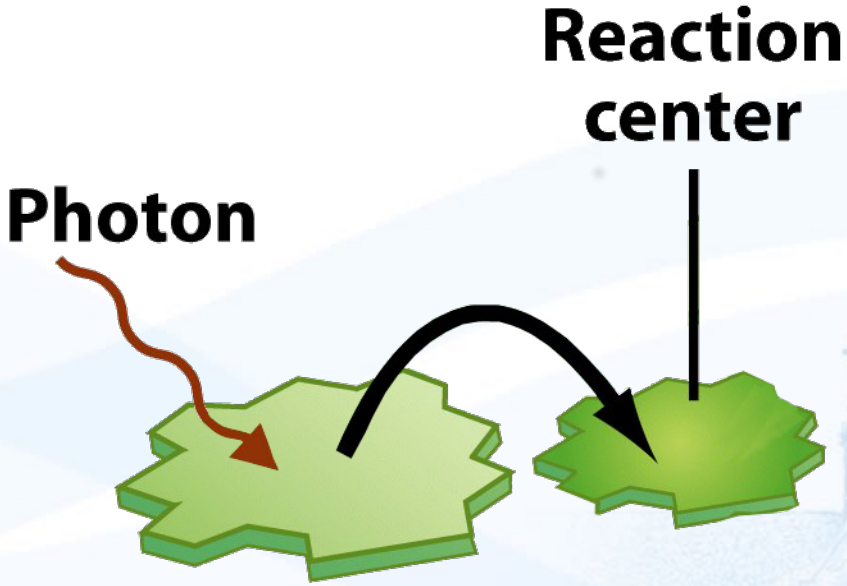


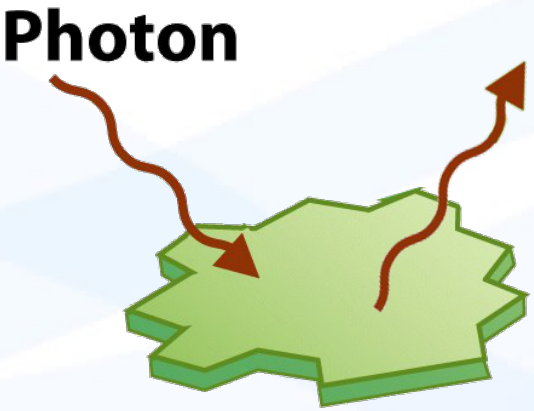
Figure 10-12a Biological Science, 2/e

Theoretical Background



$$k_L = k_R + k_{ISC} + k_{IC} + k_q + k_{RC}$$

Theoretical Background



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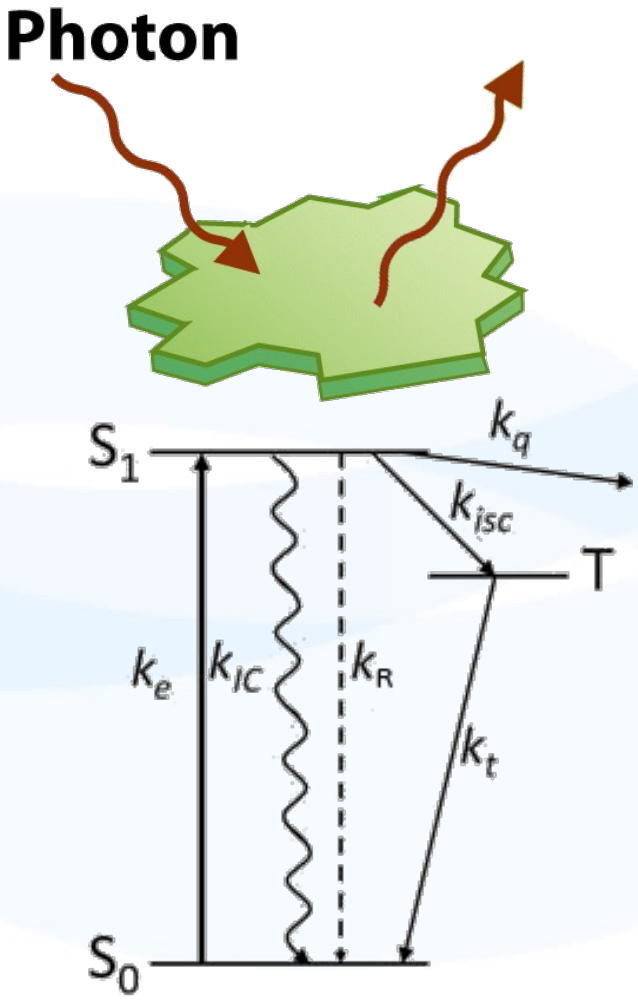
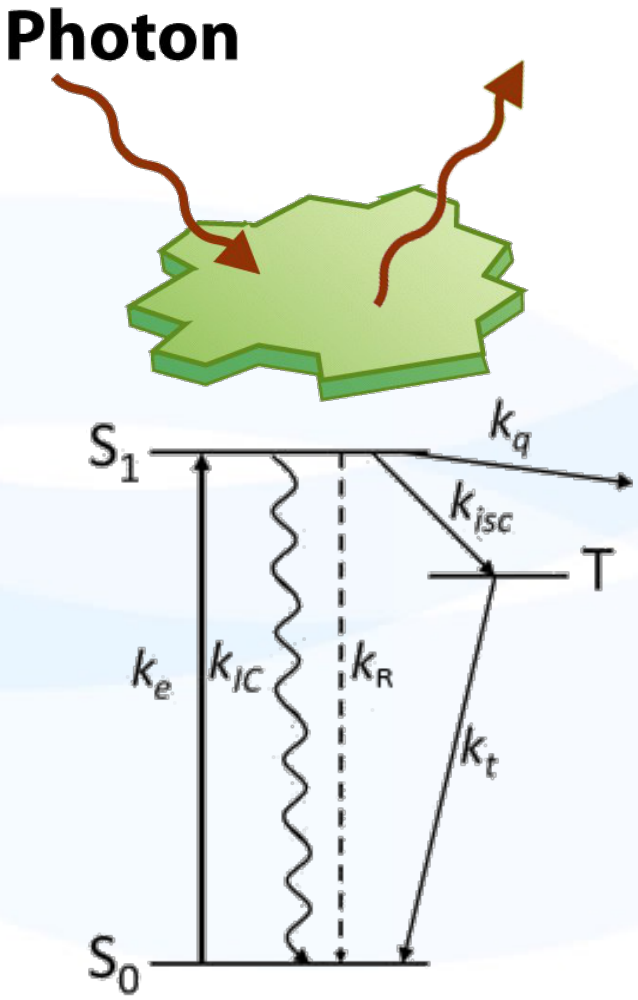
Theoretical Background



$$k_L = k_R + k_{ISC} + k_{IC} + k_q$$

- k_R, k_{ISC}, k_{IC} → Characteristic of the system (Constant)

Theoretical Background



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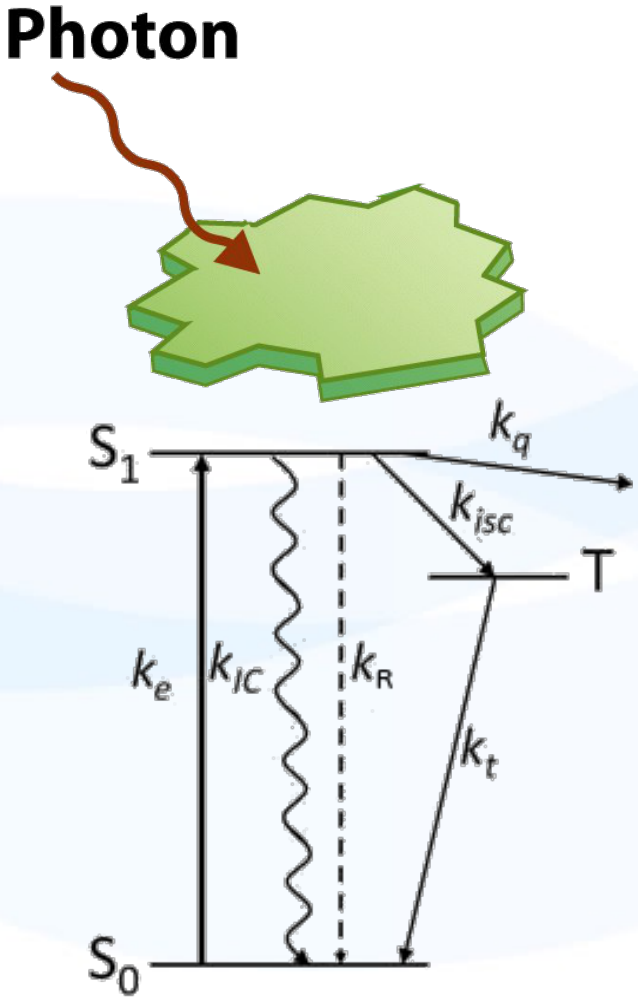

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- k_q measurable through $tau_L = 1/k_L$
- Intensity switches on & off with quenching

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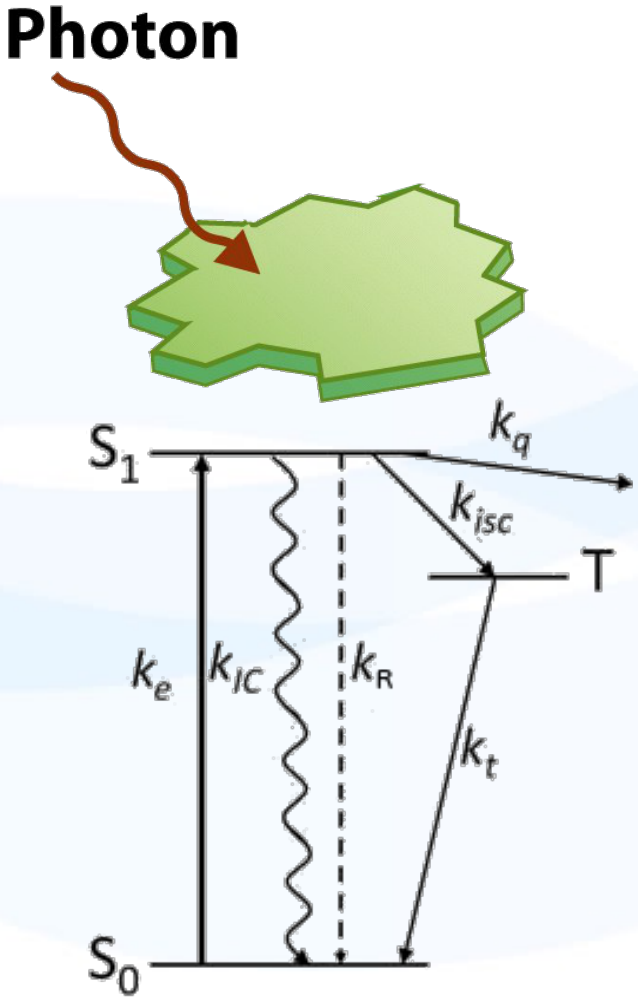
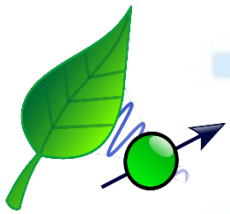


$$k_L = k_R + k_{ISC} + k_{IC} + k_q$$

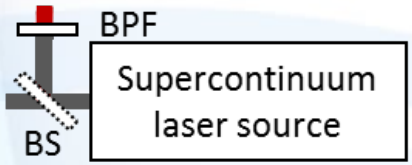
- k_R, k_{ISC}, k_{IC} → Characteristic of the system (Constant)
- k_q measurable through $tau_L = 1/k_L$
- Intensity switches on & off with quenching
- Ensemble measurements
  - average out all rare phenomena
  - single mean value of observable
  - less specific

Single Molecule Spectroscopy



Supercontinuum laser source

Single Molecule Spectroscopy



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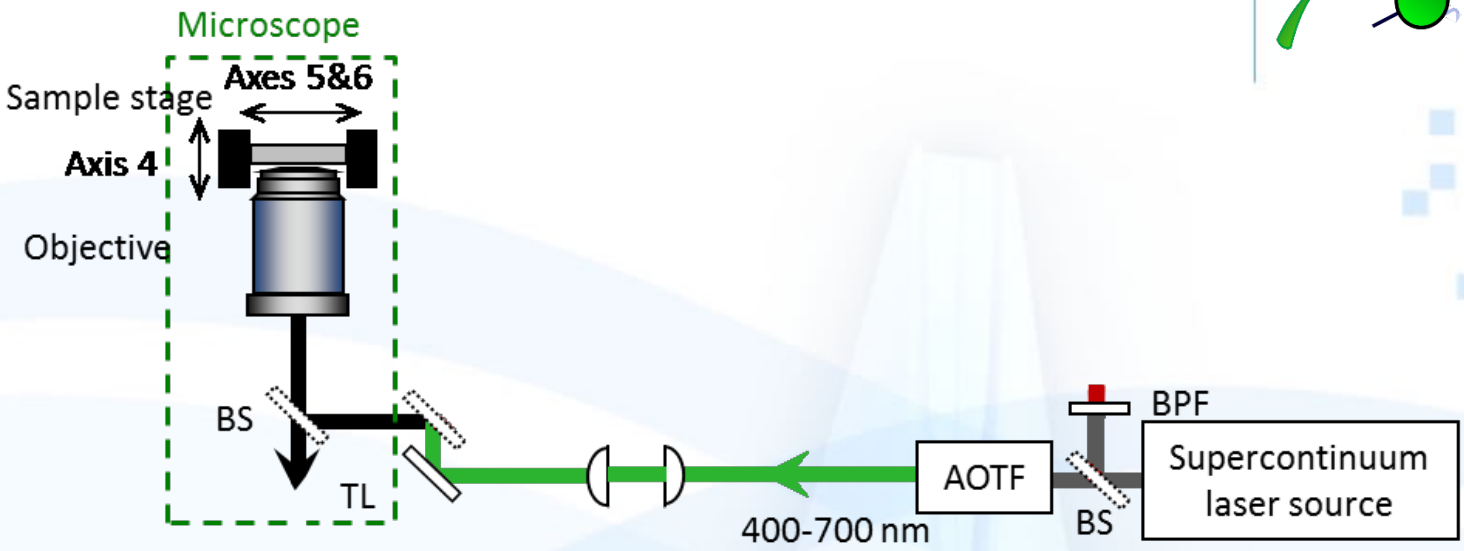

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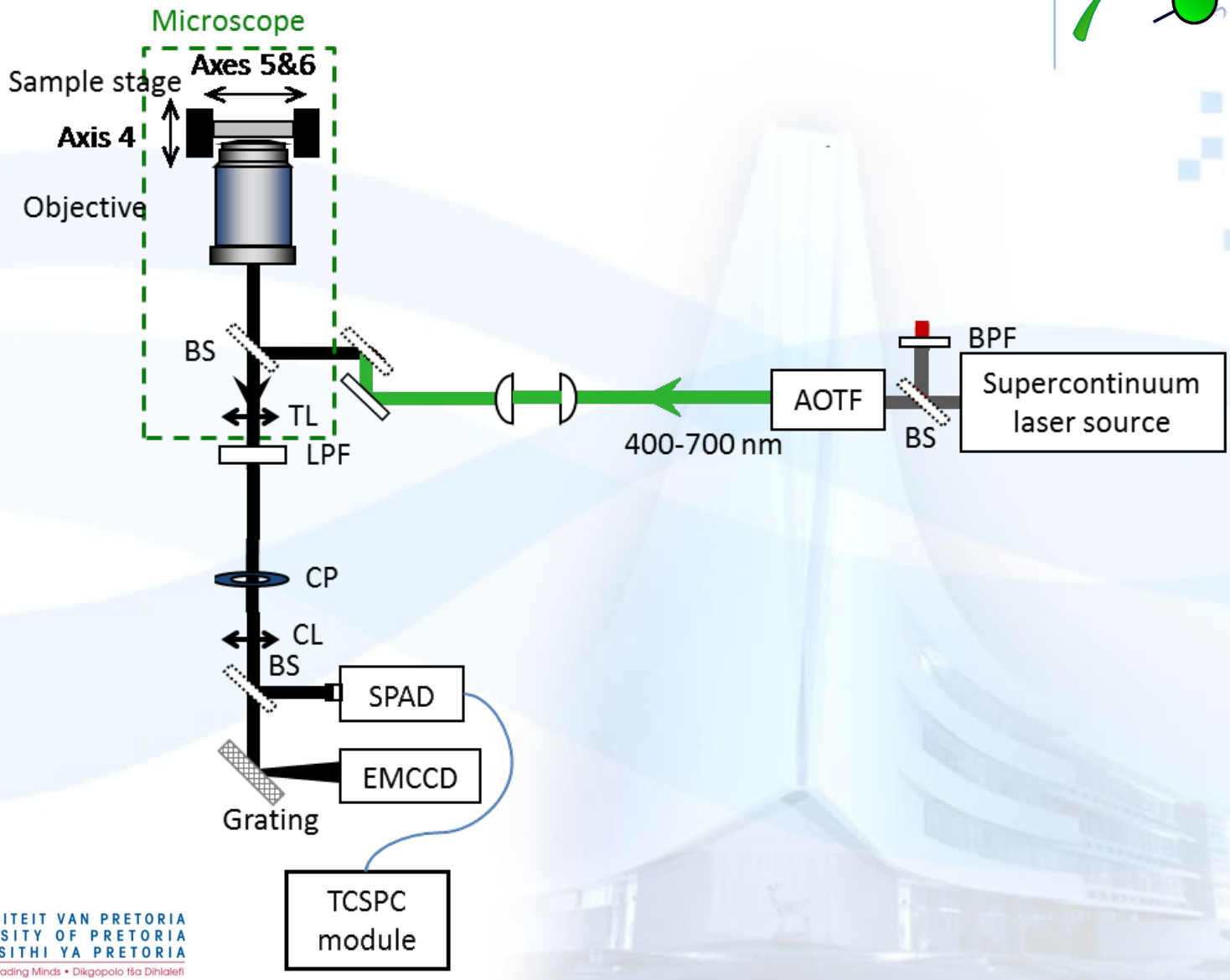

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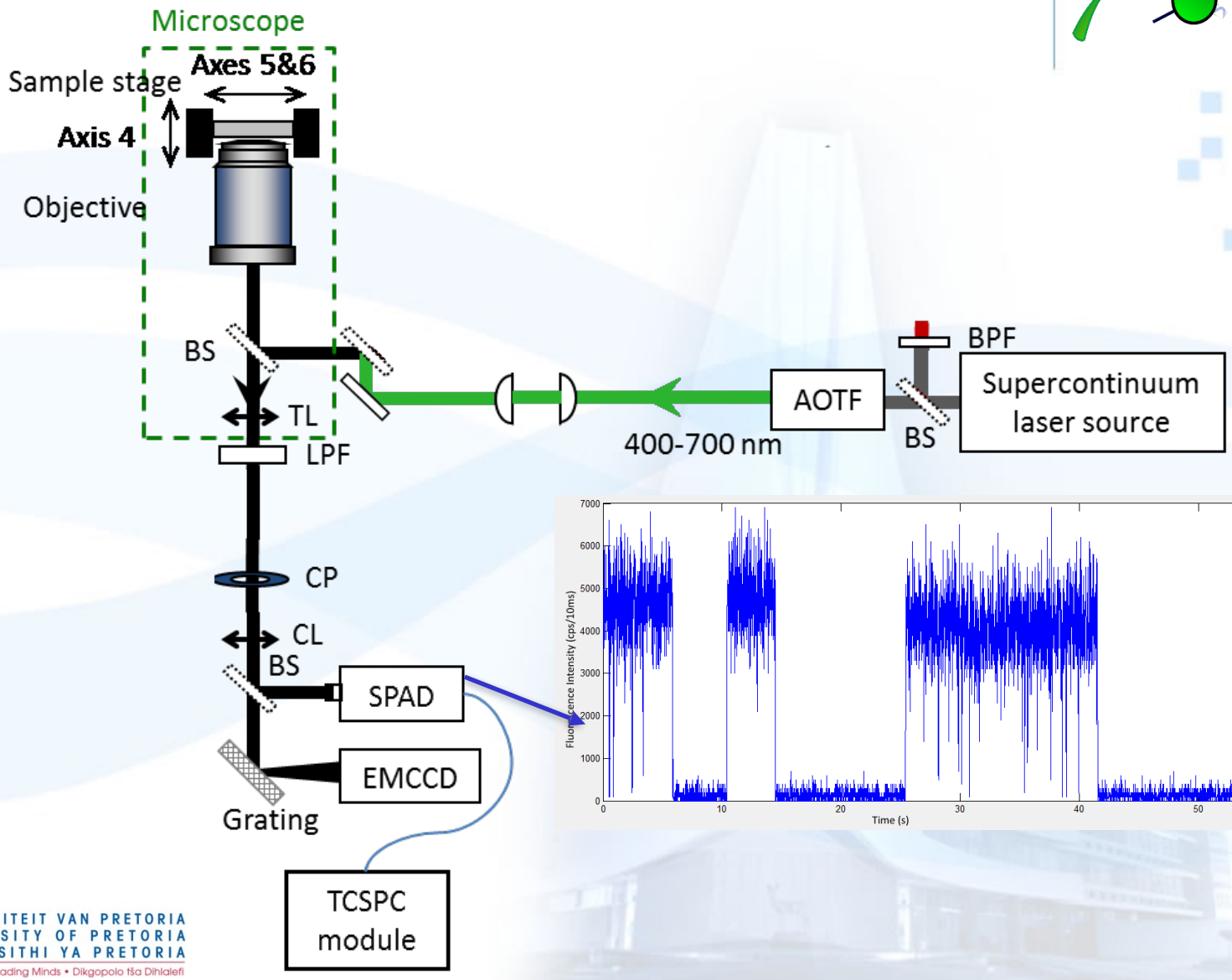

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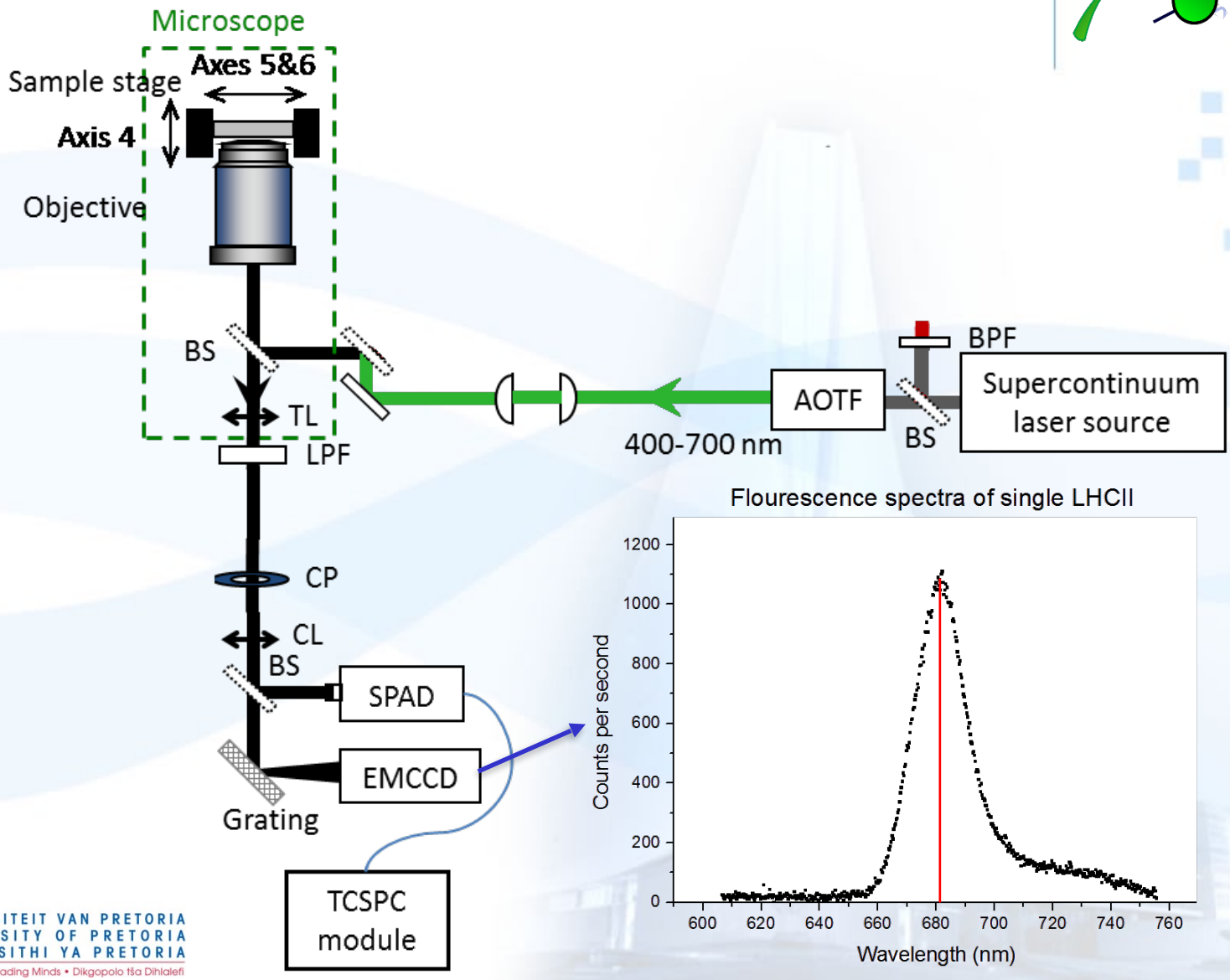

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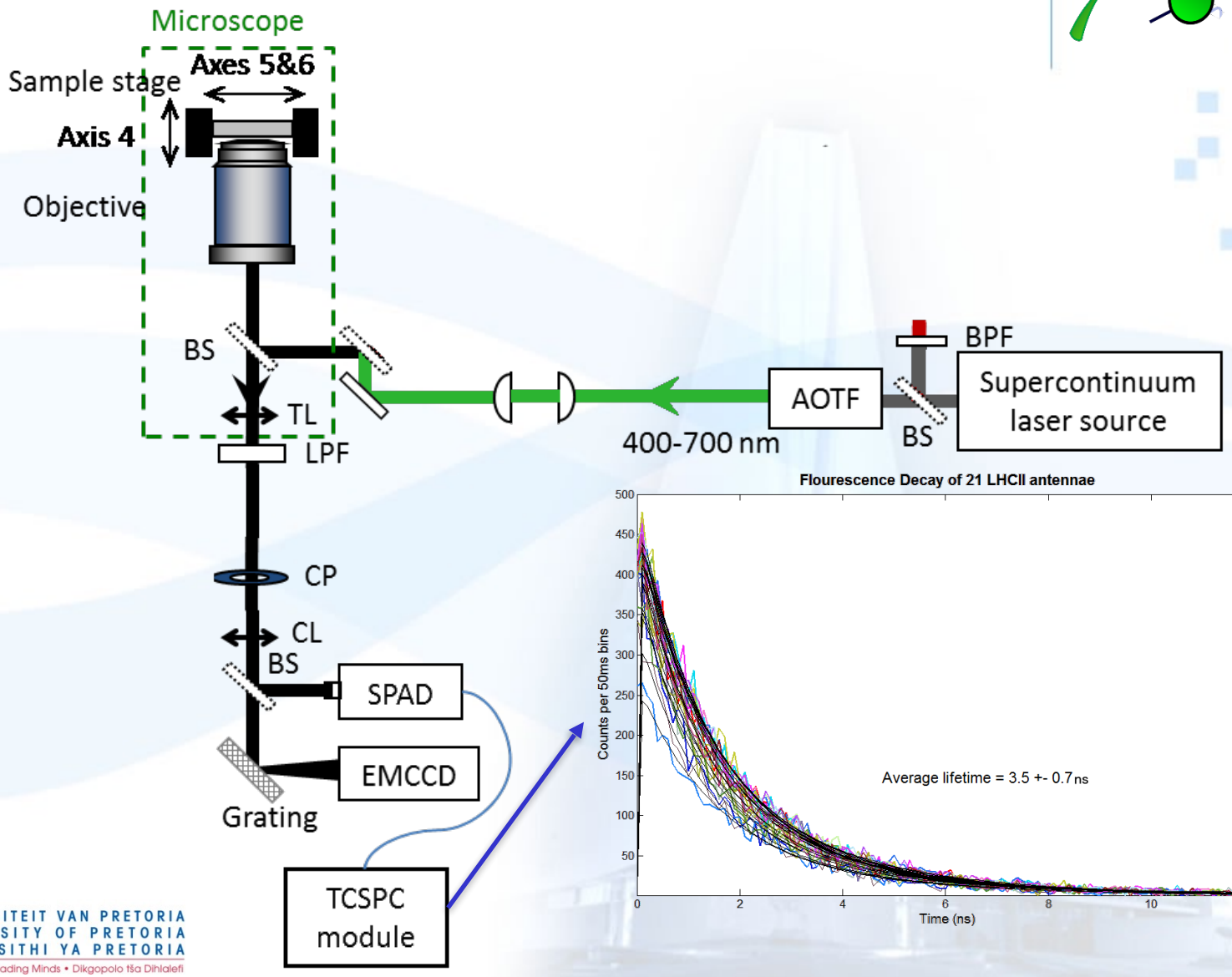
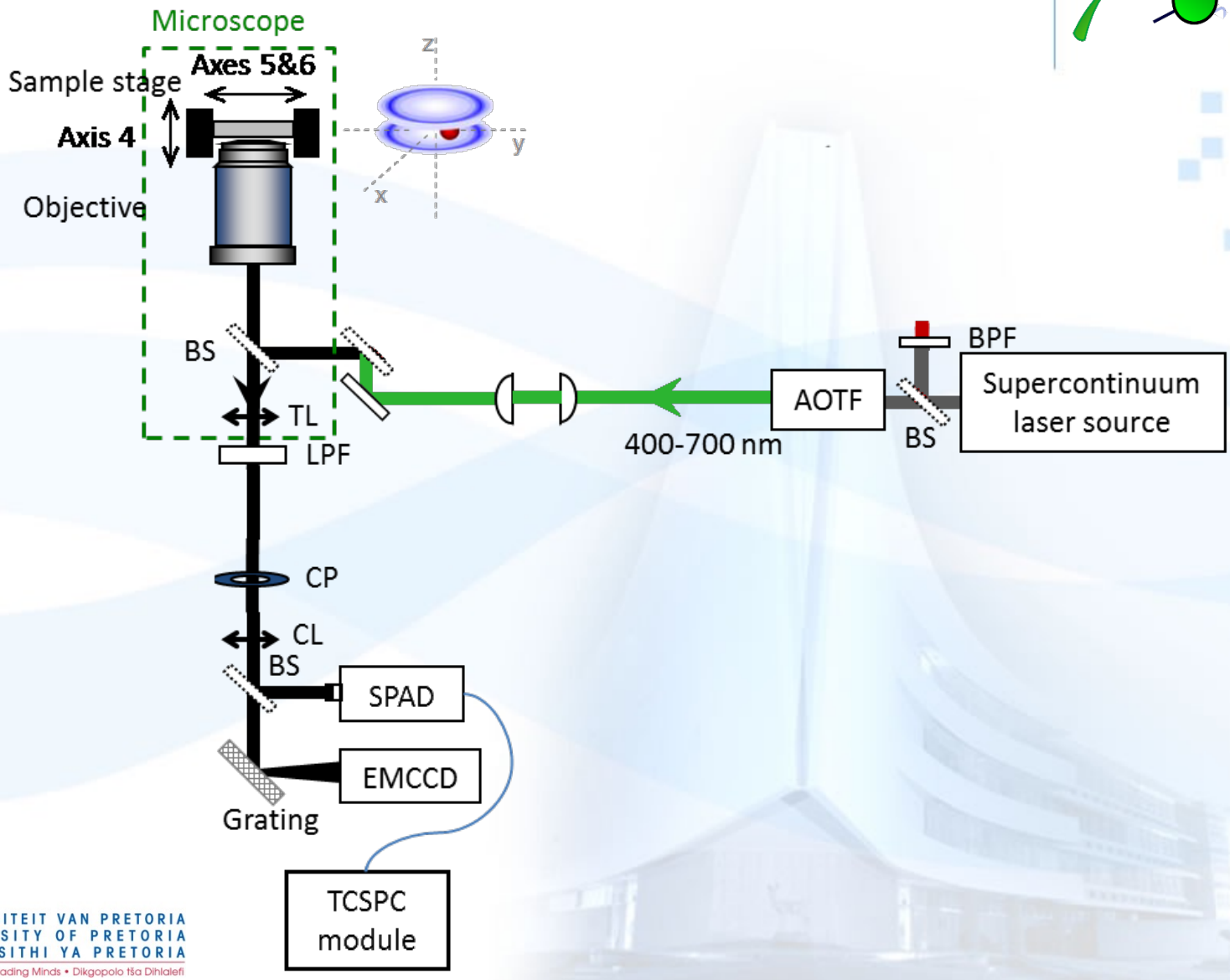


Single Molecule Spectroscopy



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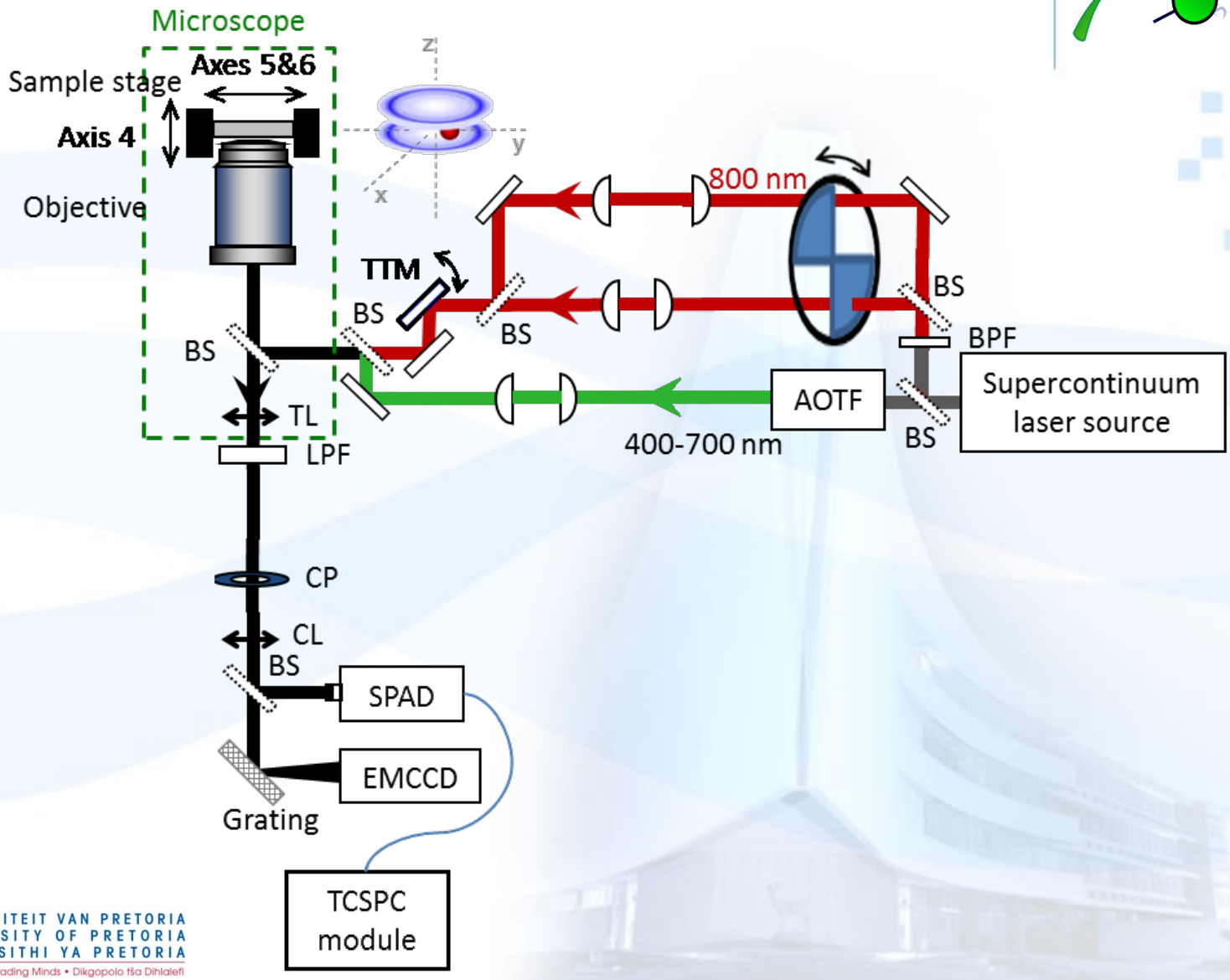

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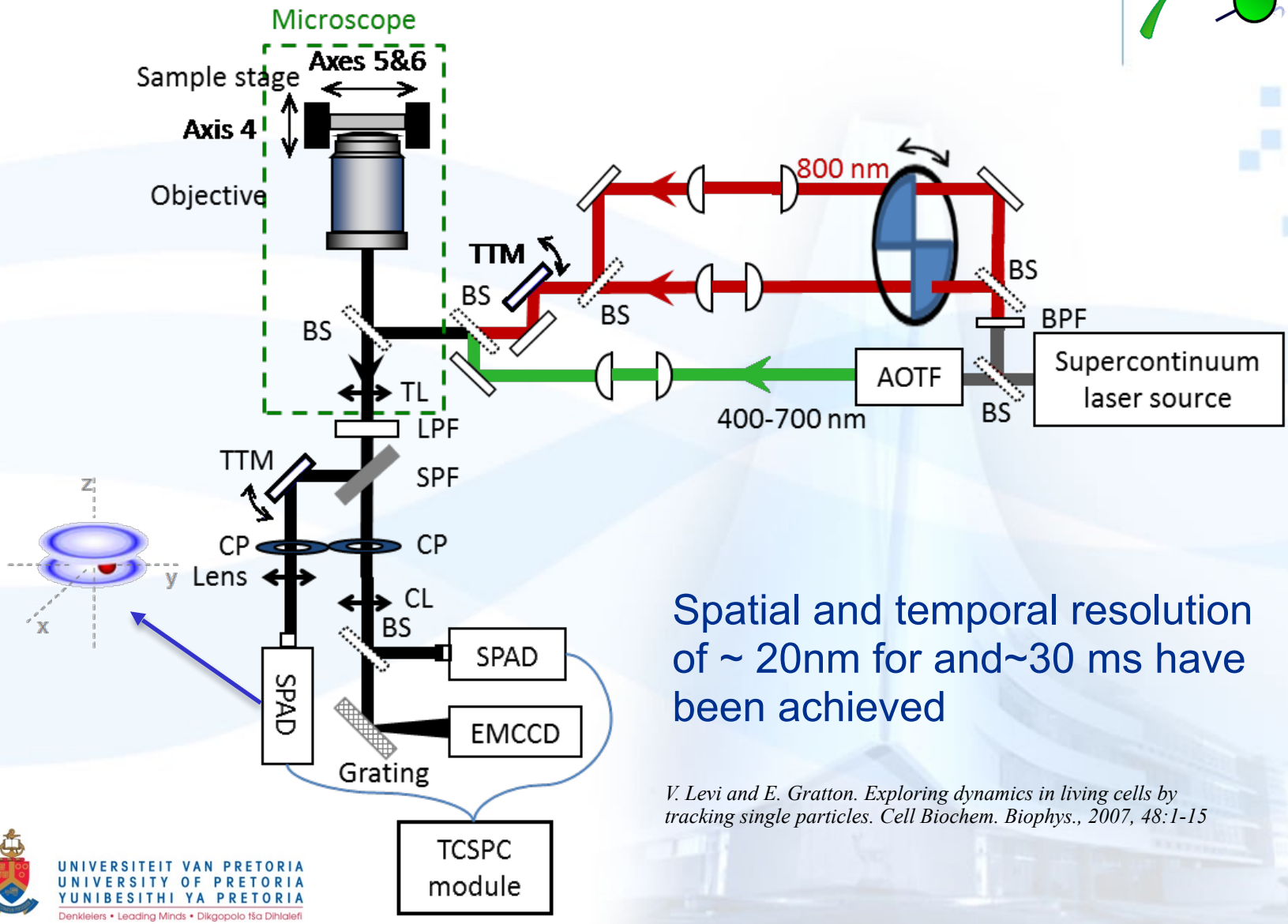
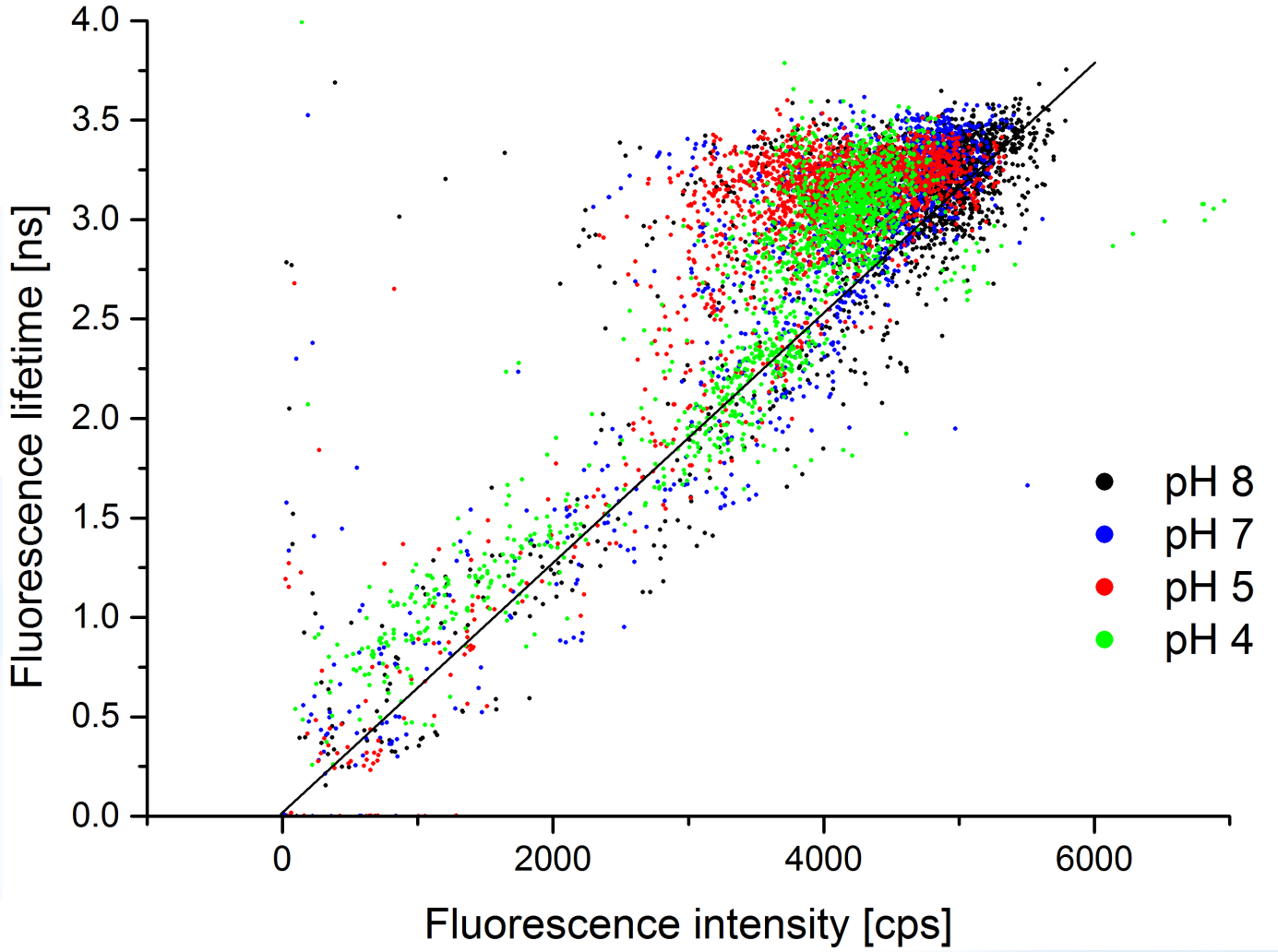


Spatial and temporal resolution of ~ 20nm for and~30 ms have been achieved

V. Levi and E. Gratton. Exploring dynamics in living cells by tracking single particles. Cell Biochem. Biophys., 2007, 48:1-15

Preliminary Results



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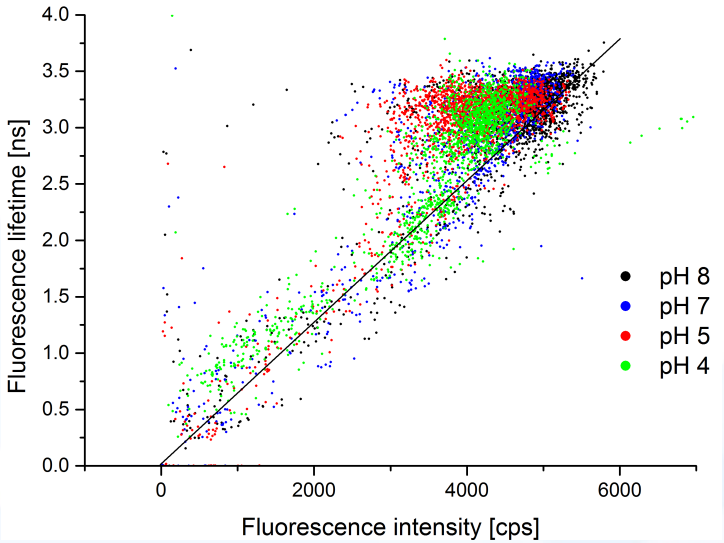

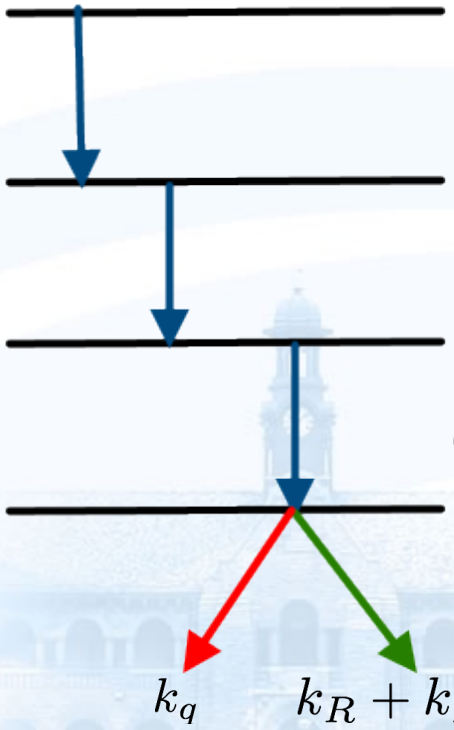

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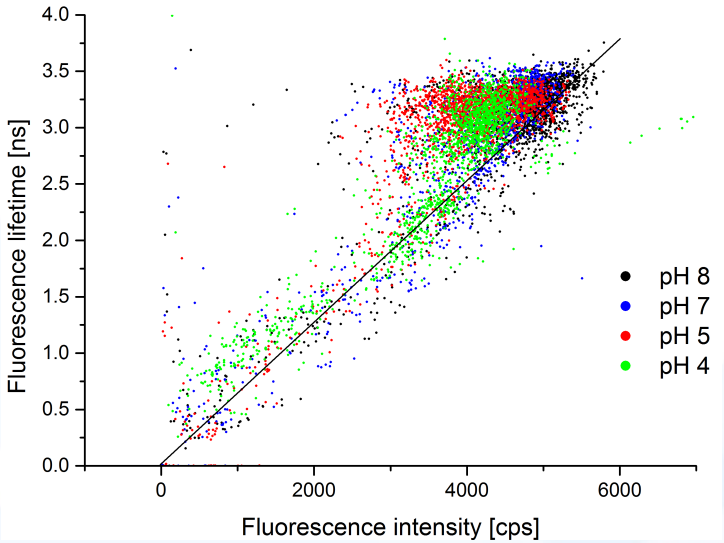
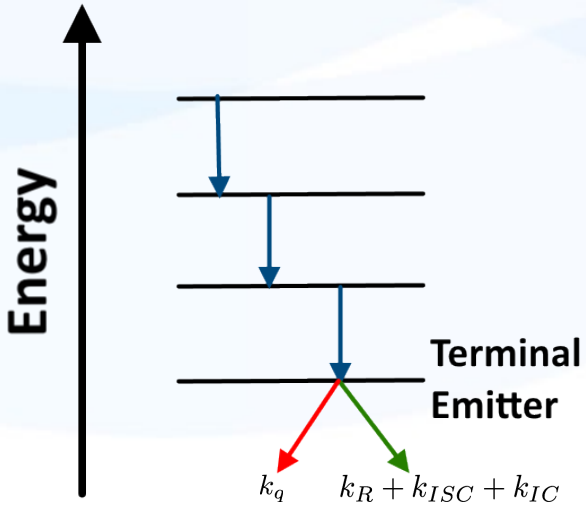
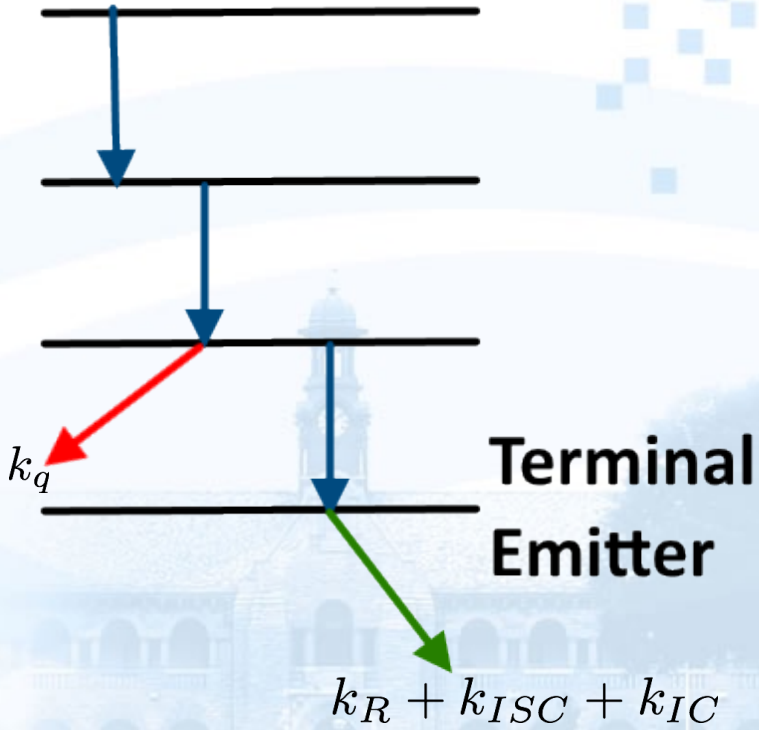
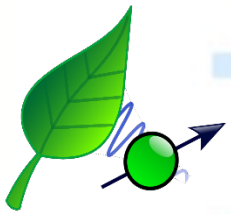






Future Work



- Optimise SMS and implement SPT
- Corroborate preliminary results
- Attempt to deliberate between early quenching and pigment loss

Acknowledgements

Supervisor: Dr. Tjaart Krüger

Dr. Diale

SAFUSA

Michael Gruber