# Ultrafast pump-probe spectroscopy of Zinc Phthalocynine (ZnPc) and light harvesting complex II (LHC II)

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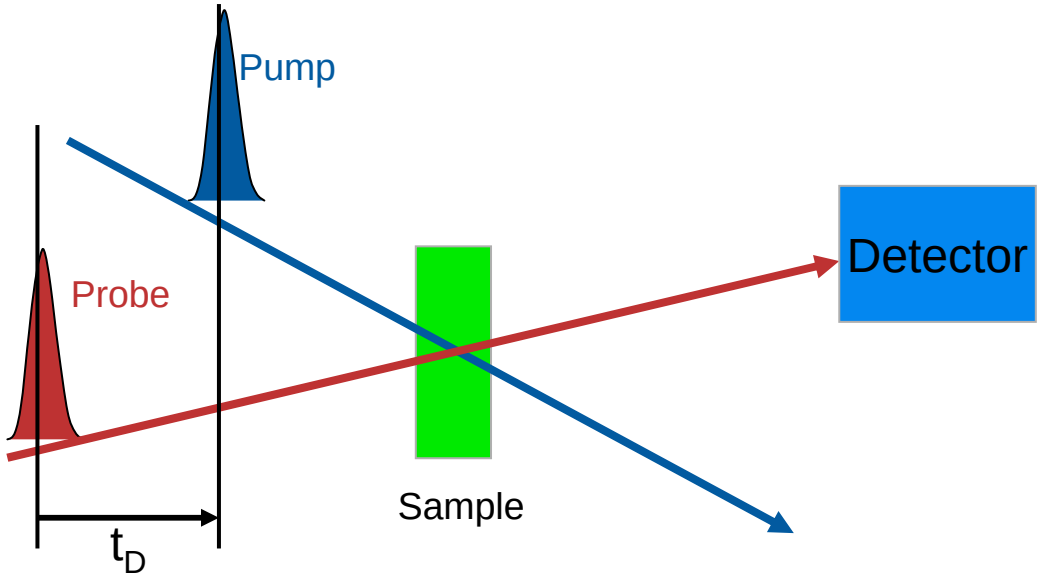
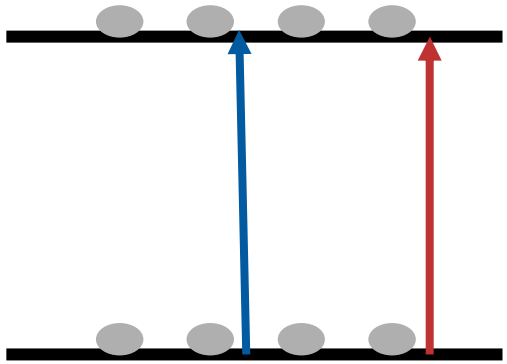
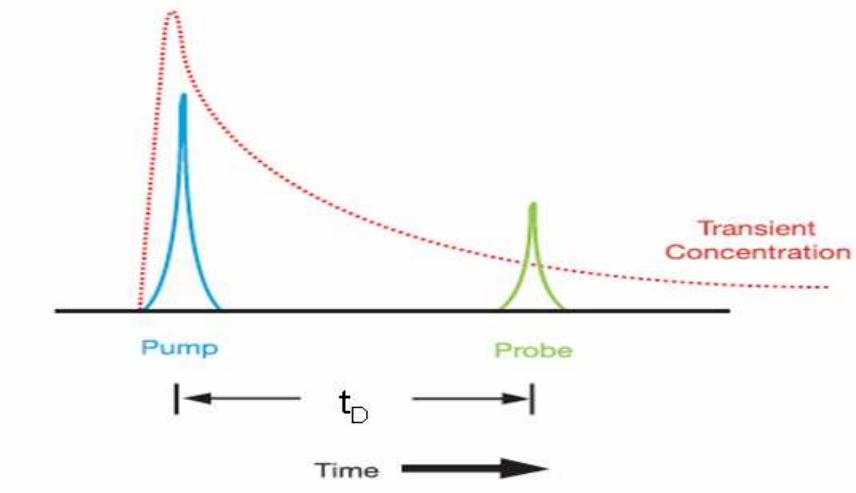
# Outline

- Basic principle of pump-probe technique.
- Possible transient absorption signals.
- Why LHC II and ZnPc?
- Experimental setup
- Chirp measurement and correction methods
- Results
  a) LHC II
  b) ZnPc
- Conclusion
- Future work

# Femtosecond pump-probe technique





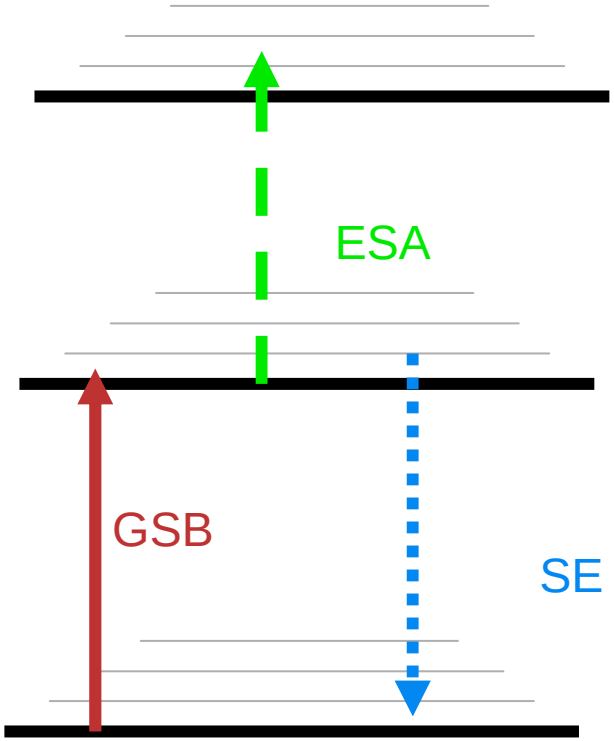

- Start process with an intense ultrashort pump pulse.
- Probe process after $t_D$ with a weaker ultrashort probe pulse.
- slow detector.
- Repeat experiment with different delay times $t_D$.
- Follow the transient concentration.

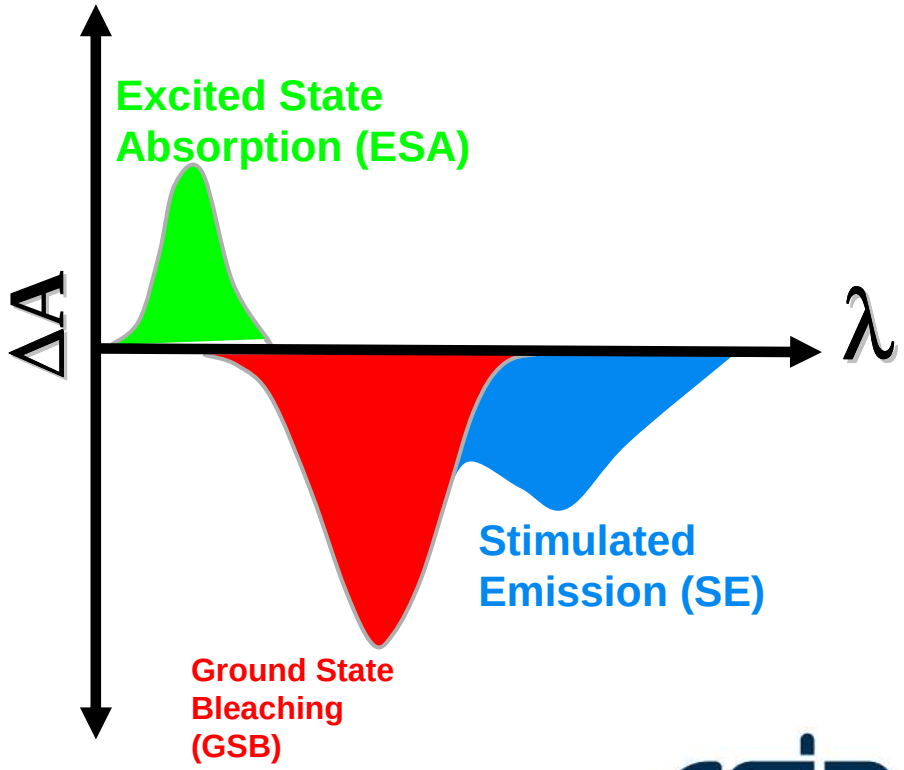
# Possible transient absorption signals

Result are presented in form of time-resolved difference spectrum

$$\Delta A = \Delta A(t,\lambda) = A_{pumpON} - A_{pumpOFF} = \log\left(\frac{I_{ref}}{I_{signal}}\right)_{ON} - \log\left(\frac{I_{ref}}{I_{signal}}\right)_{OFF}$$

Difference between the sample absorption with and without pump pulse



# Why LHC II

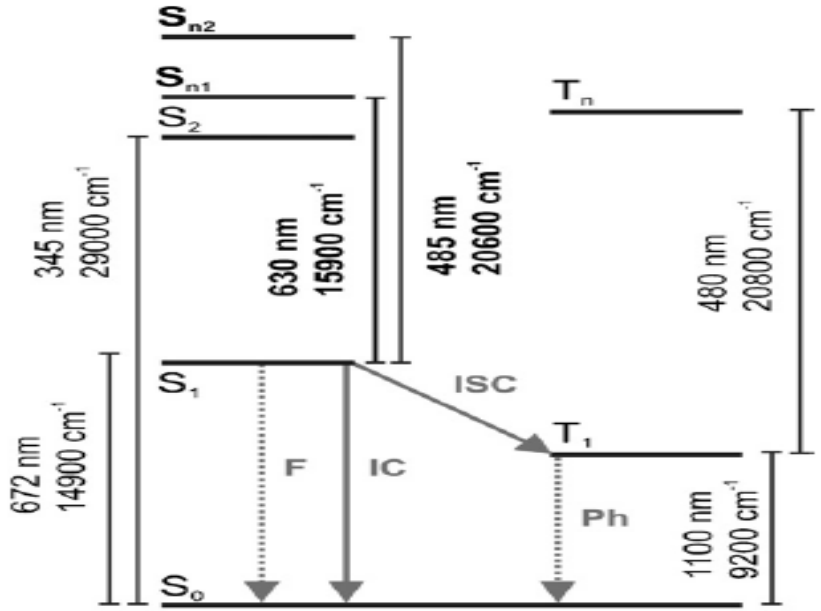
- To develop light harvesting and energy transfer systems having architectures to enable energy transfer.

- To characterize these systems with respect to the direction, efficiency and rate of energy transfer from the site of photon absorption to the terminal energy transfer process.

- Investigate energy transfer processes in LHC II.

# Why ZnPc?

- The processes of light absorption and energy transfer are at the heart of the photodynamic therapy.
- *




- The fast energy transfer process play an important role in the photophysics of zinc phthalocynine (ZnPc).
- It is therefore essential to study the dynamic of ZnPc

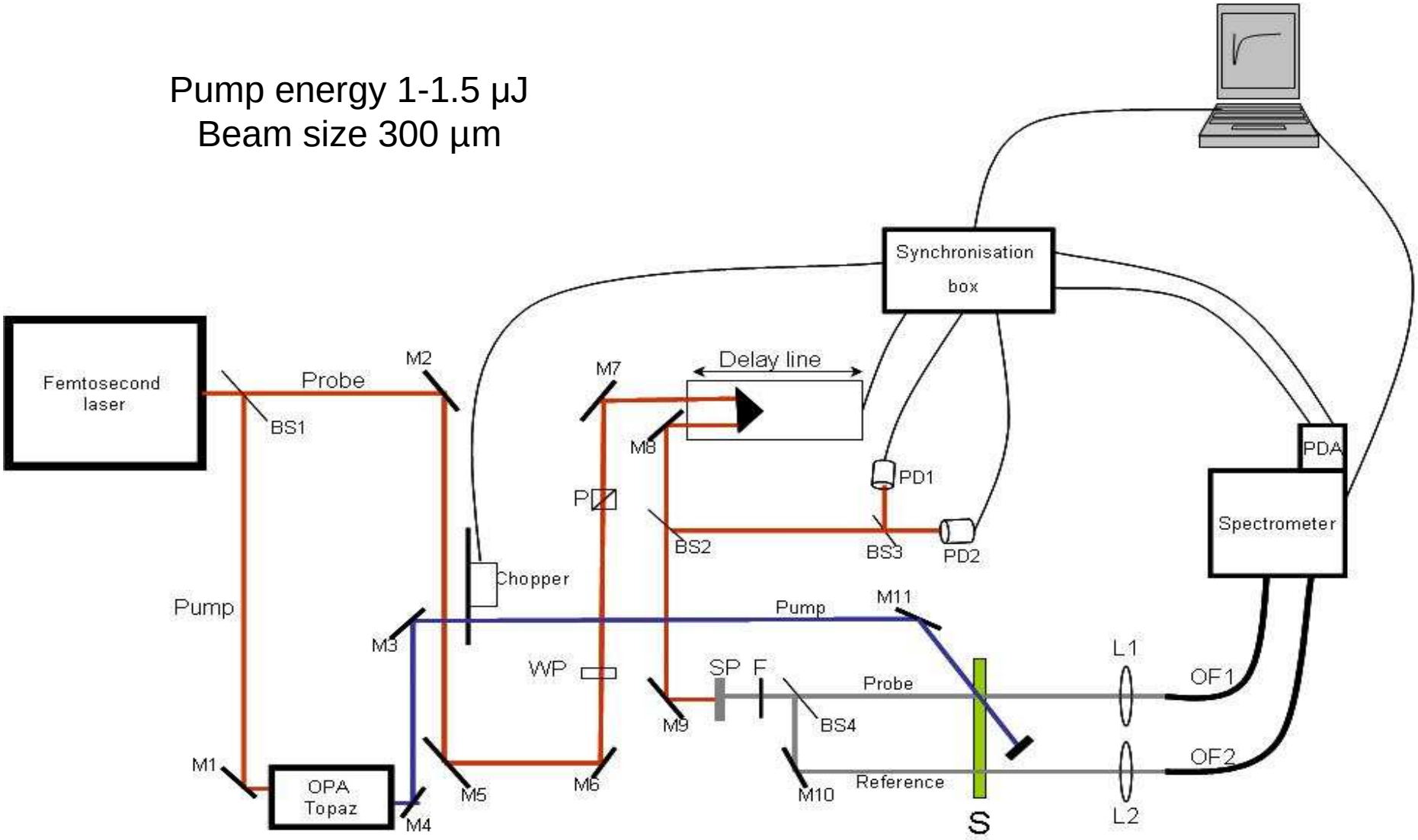




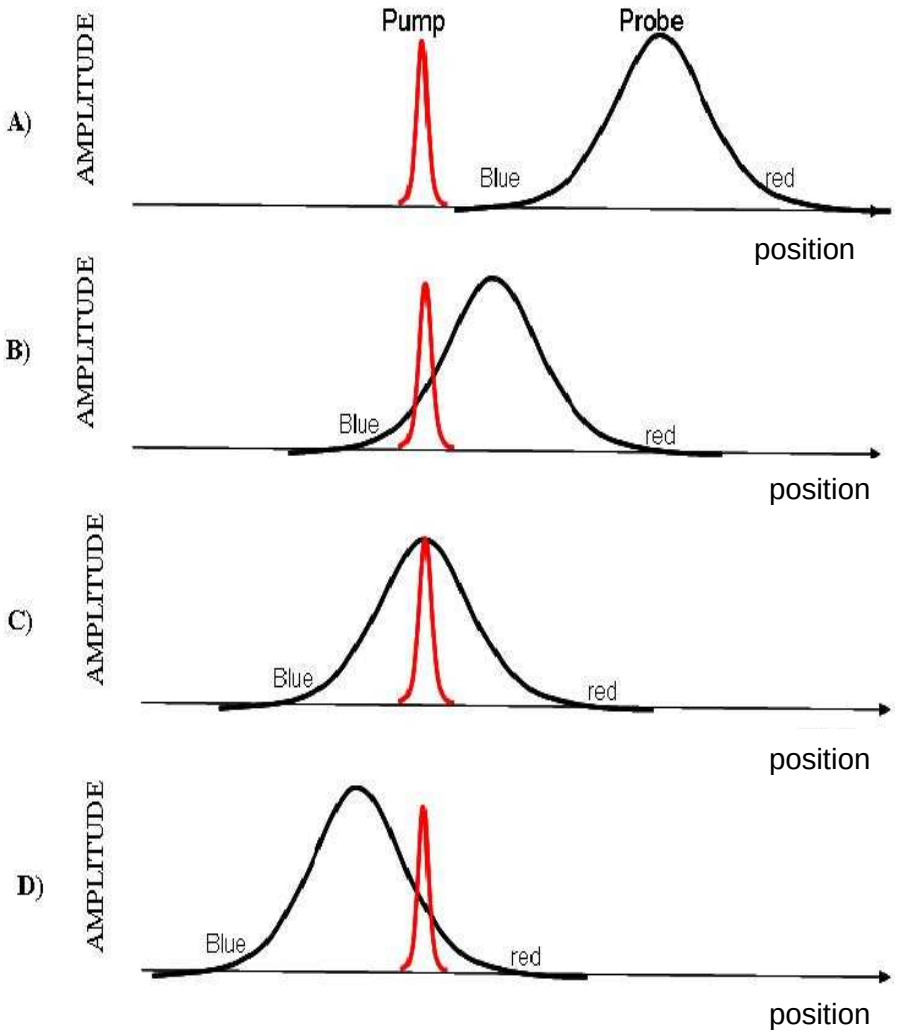
*Savolainen et al, jounal of photochemistry and phtobiology (2008)*

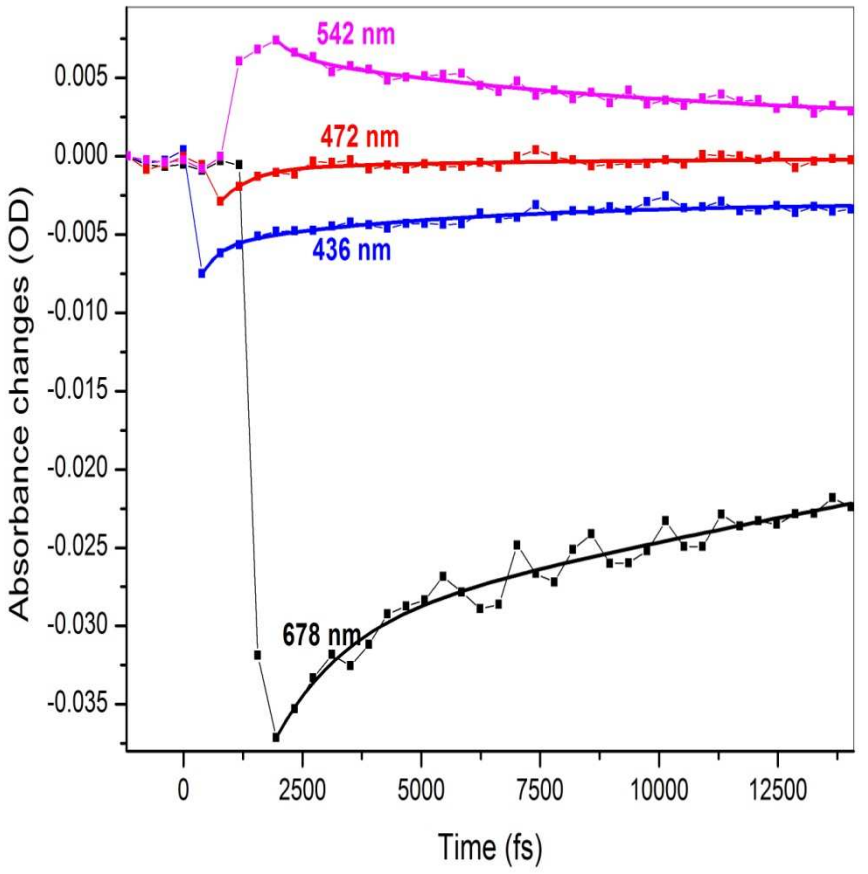
# Experimental setup

Pump energy 1-1.5 µJ
Beam size 300 µm

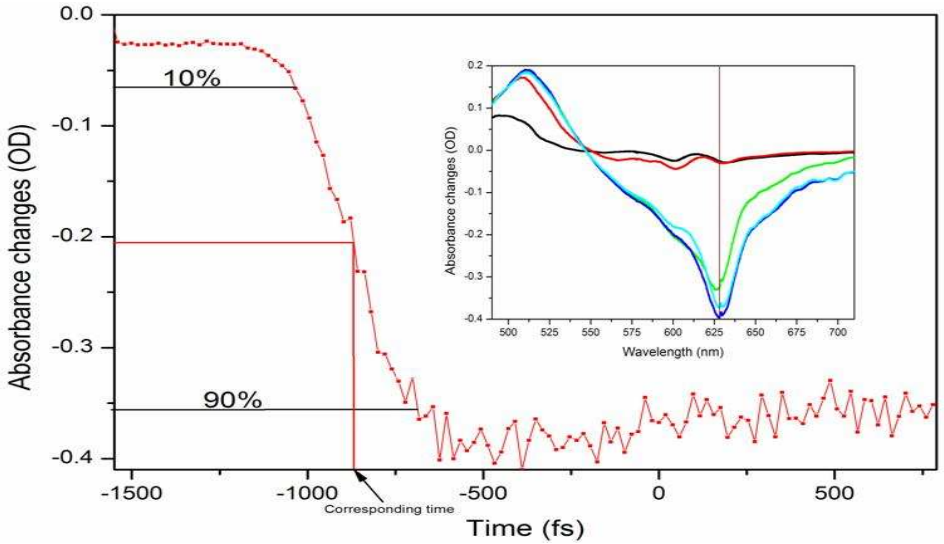


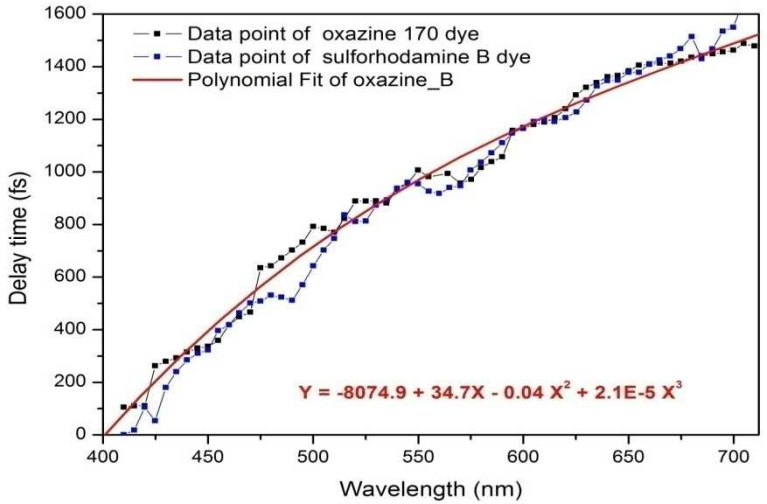
# Chirp measurement

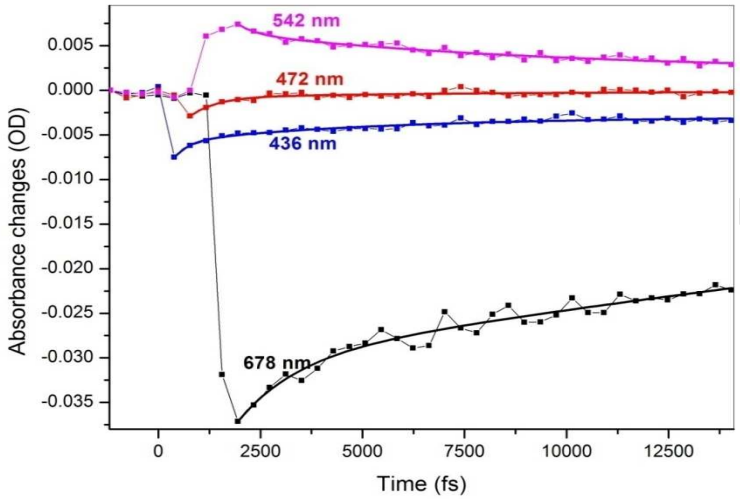


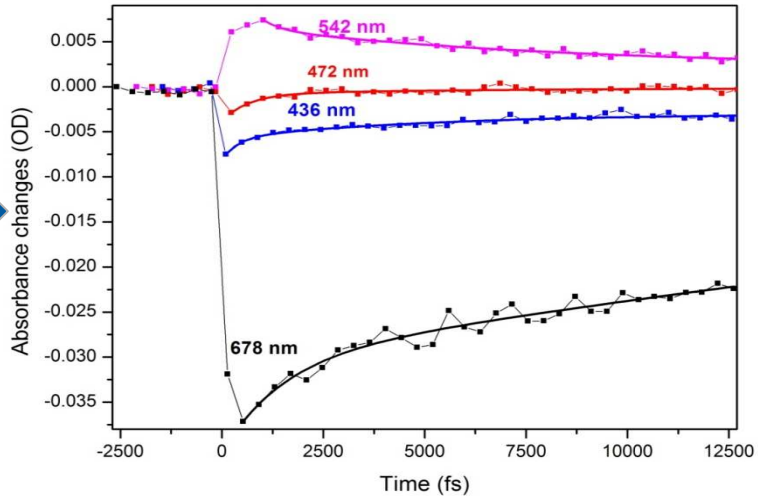



# Chirp correction



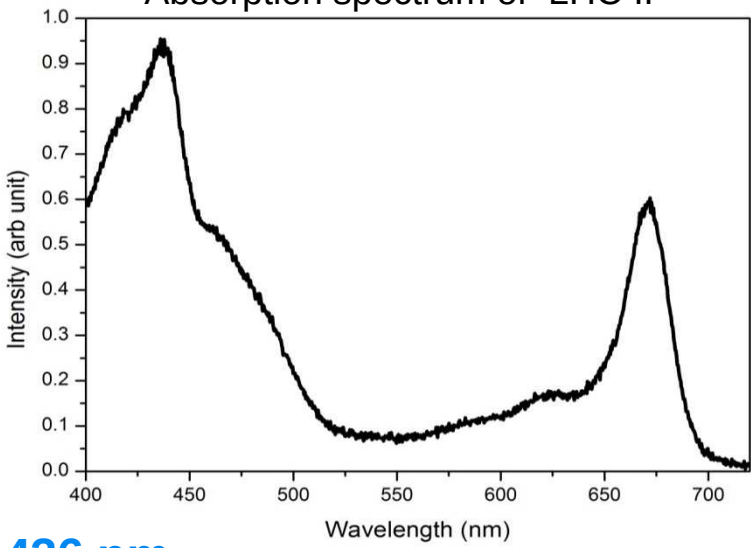



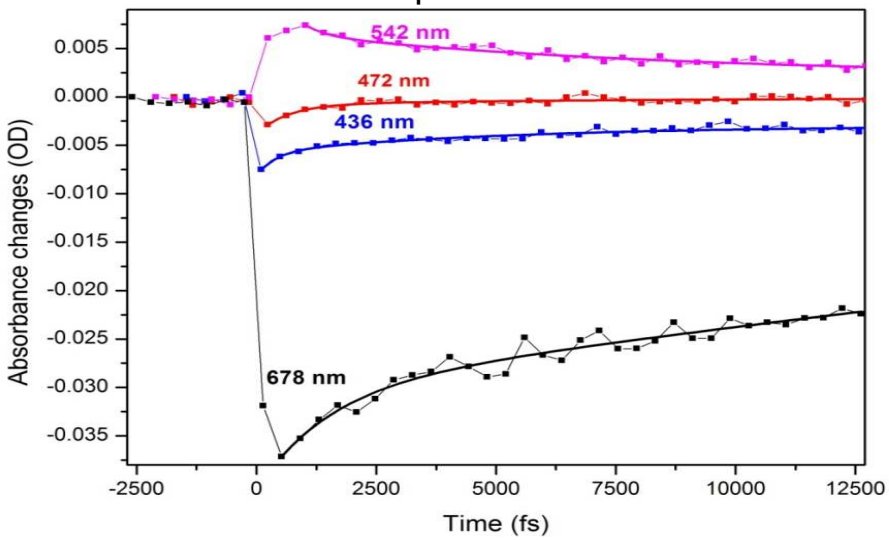

$$Y = -8074.9 + 34.7X - 0.04\,X^2 + 2.1*10^{-5}X^3$$

# Results

Absorption spectrum of LHC II



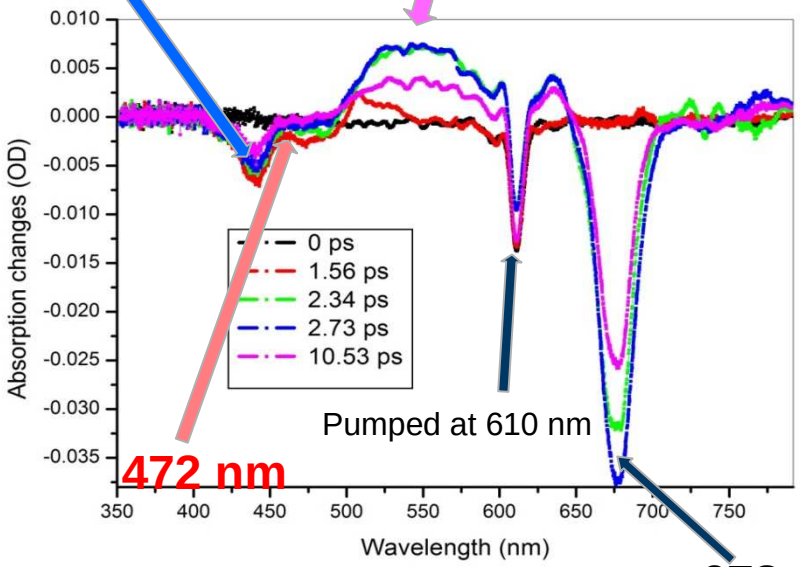

Transient absorption kinetics of LHC II




436 nm

542 nm

Transient absorption spectra of LHC II




Pumped at 610 nm

472 nm

678 nm

- 350 fs and 6.90 ps chl a - chl a energy equilibration (croce et al 2003)
- 800 fs and 9.95 ps the energy transfer from chl b to chll a. (van Grondelle et al 2006, 600 fs and 10-12 ps)
- 1.3 ps singlet-singlet annihilation within monomer and the 24.5 ps annihilation in trimer (Visser et al 1996, 1 and 20 ps)

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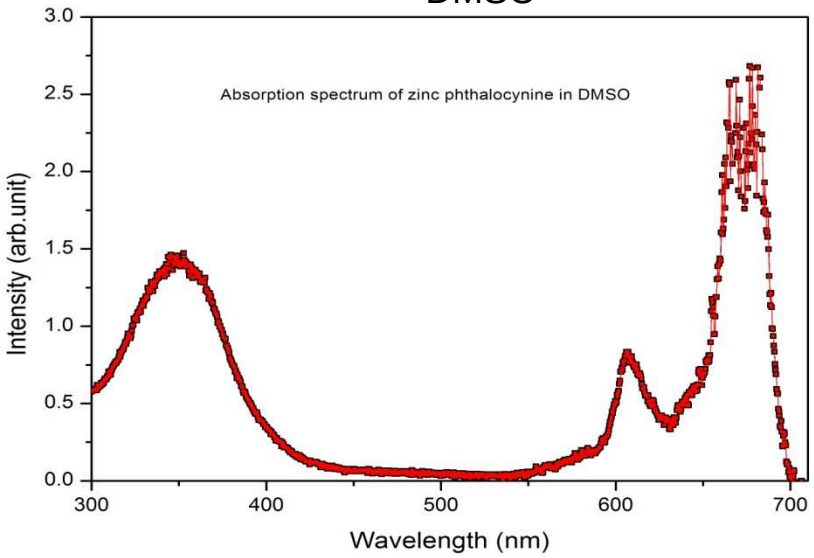
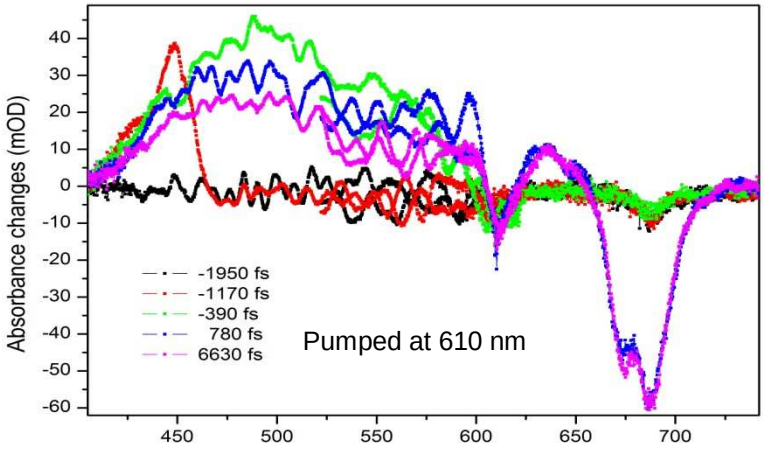
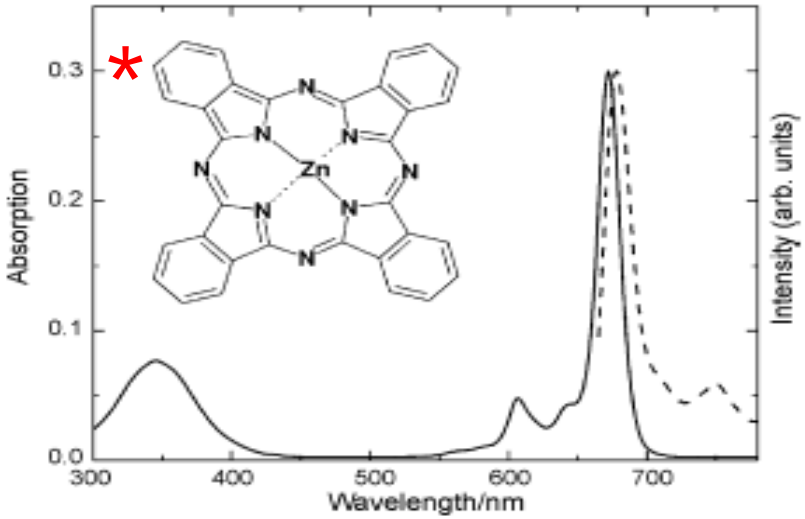
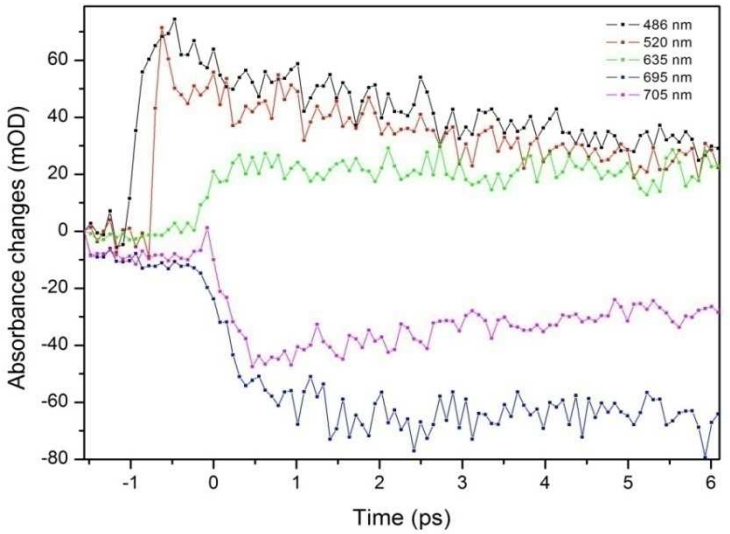
# Results

Absorption spectrum of Zinc phthalocynine in DMSO






*Savolainen et al, jounal of photochemistry and phtobiology (2008)*

# Conclusion

- Presented our method of correcting chirp induced by white light generation.
- Pump-probe technique allows us to measure the time scale of energy transfer from Chlb to Chla as well as energy equilibrium from Chla to Chla in LHC II.
- Time constants obtained are comparable to those reported in literatures.
- Measure the transient absorption spectrum of ZnPc but further work need to be done.

# Future work

- Study of the energy transfer lifetimes as a function of pump laser intensity and wavelength
- Pump LHC II in the blue region.
- Preparation and conditions of experiment of ZnPc

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**ALC**

**University of Stellenbosch**

# Thank you

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