Femto-SWITCH:
Ultrafast spectroscopy of bio-mimetic photoswitches - Towards rational design

PhD in Physics or Physical Chemistry

For candidates with interest in ultrafast optics, molecular spectroscopy and functional materials

Starting date: October 2026

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Submit your application here
Applications must include: your CV, including short summaries of your master internships, a letter of motivation, and a letter of recommendation, preferably from your master supervisor

Photoswitches are molecules, which, after absorption of light, change their chemical structure and hence their "color"/absorption spectrum. Many examples exist for organic photoswitches, also in Nature, where photo-switching is very useful for biological processes like in rhodopsin, the light-sensing protein for vision (figure 1), or for many other light-dependent processes, like protein expression (plant growth). Inspired by the high photo-isomerization reaction yield of these proteins, the French-German FEMTO-Switch project aims to establish **rational bases between the chemical structure of synthetic organic photo-switches and their ultrafast reaction dynamics including the reaction quantum yield**. These new switches are based on oxindole [1] and oxopyrrole [2] frameworks. According to many quantum mechanical simulations, conical intersections, i.e. the crossing points between molecular potential energy surfaces, (cf. figure 1) ultimately determine the

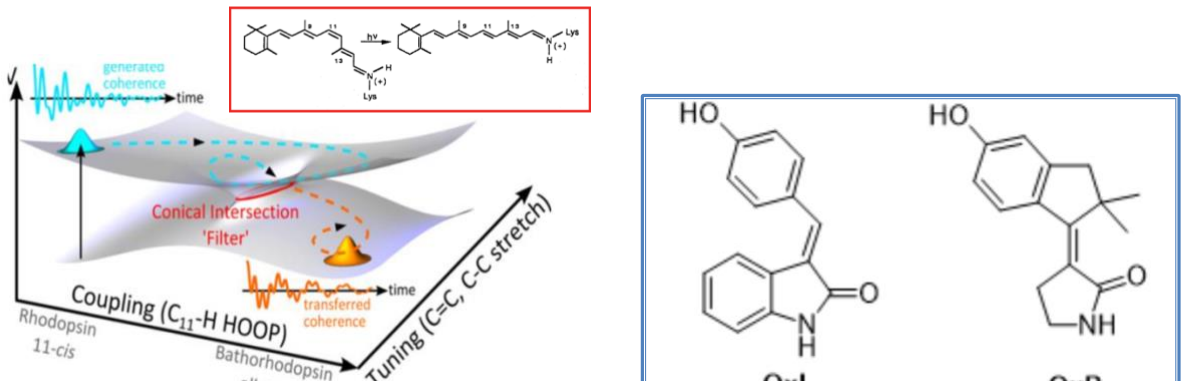

Figure 1: Left : *Photo-isomerisation of 11-cis retinal in rhodopsin, with a schematic of the reaction coordinates spanning the excited and ground state potential energy surfaces around the Conical Intersection, leading to the all-trans isomer (from Schnedermann et al., JACS 2015).* ***Right :*** *Basic structures of the oxindole (OxI) and oxopyrrole (OxP) photo-switches. Chemical modification will be introduced by our chemistry partner, with the aim of tuning the excited state potentials and the reaction QY.*

quantum yields of photoswitch reactions, the probability of reaching the all-trans isomer in the case of rhodopsin. **Finding rational principles to enhance** these quantum yields by chemical design would have large impacts for important applications in photoswitching of nanomaterials, in molecular motors and photo-pharmacology [3].

FEMTO-Switch is a new French-German project, which started in January 2025. Five research teams in Berlin, Strasbourg, Marseille, Padua (Italy) and Uppsala (Sweden) combine their experimental and theoretical know-how for the investigation of organic photoswitches mimicking the ultrafast photoisomerization of retinal pigments of vision (rhodopsins).

In the BIODYN team at IPCMS (University of **Strasbourg**-CNRS), we study the details of the photo-isomerization reaction in small rhodopsin-mimicking photo-switches and motors [1-2,4-5], which are presently being used for photo-regulating the expression of DNA. We use femtosecond transient absorption, and fluorescence spectroscopy (300 – 1050 nm), in order to detect the effect of chemical substitutions on the speed and efficiency of the photo-reactions.

Candidates must hold a master degree in Physics or Physical Chemistry. A good background in molecular spectroscopy and nonlinear optics is a plus, but not mandatory. Additional qualifications such as proficiency in Python and/or Matlab are valuable assets.

[1] M. Mgbukwu et al., J. Phys. Chem. B, (2025), https://doi.org/10.1021/acs.jpcb.4c06856

[2] M. Paolino et al., J. Am. Chem. Soc. 2016, 138, 9807−9825, https://doi.org/10.1021/jacs.5b10812

[3] « *Molecular Photoswitches : Chemistry, Properties, and Applications* », Ed. Z L. Pianowski, Wiley-VCH (2022)

[4] M. Gueye et al. Nature Comm. **9**, 313 (2018) ; http://www.nature.com/articles/s41467-017-02668-w

[5] M. Filatov et al., Nature Comm. **13**, 6433 (2022) ; https://www.nature.com/articles/s41467-022-33695-x