PhD Project: *Picosecond spintronic*

When :	October 2021 – October 2024(~3 years)
Where :	Institut Jean Lamour / Université de Lorraine (Nancy, France)
Supervision :	Dr. Jon Gorchon (jon.gorchon@univ-lorraine.fr)
	& Dr. Juan Carlos Rojas-Sánchez (juan-carlos.rojas-sanchez@univ-lorraine.fr)

The project aims to demonstrate that ***ultrashort electronic current pulses can be used to manipulate and probe magnetization in spintronic devices at ultrafast timescales.*** The success of the project will pave the way for the creation of a new field in physics: "picosecond spintronics".

In a 2014 breakthrough we demonstrated that femtosecond light pulses can be used to manipulate magnetization in a large variety of magnetic nanostructures [1,2]. These discoveries proved that ultrafast optical control is a much more general phenomenon than previously assumed and challenges current theoretical understanding. Following these works, we demonstrated that femtosecond *hot electron* pulses could also induce ultrafast demagnetisation [3] and even switch the magnetization in a picosecond timescale [4,5]. Finally, in a work we started at the University of California Berkeley we showed that ultra-short THz electrical pulses could also lead to demagnetization and switching in ultrafast timescales [6,7]. Recently, we were able to fully reverse the magnetization of a common thin Co ferromagnetic film, by injecting 6 picosecond-wide spin current pulses (via the spin Hall effect) [8]. These works are the first step towards the realization of electrically controlled ultrafast magnetic devices, and more generally, towards a new field of study: *picosecond spintronics.*

The PhD student will develop innovative approaches to study and exploit our cutting-edge methods for ultra-short current pulse generation and injection into spintronic devices to offer radically game-changing solutions for ultrafast memory and logic applications. We will measure the transport properties and magnetization dynamics of the fabricated spintronic devices submitted to ultrashort current pulse injection.

For this international project, the student will have access and training to ultrahigh vacuum thin film growth facilities, clean room facilities, electronic transport and femtosecond laser setups. The student will be brought to collaborate with world leaders from major institutions such as UC Berkeley or UC San Diego with possible exchange visiting plans. A good understanding of English is required, and learning of French will be strongly encouraged.

Interested candidates should contact Dr. Gorchon or Dr. Rojas-Sánchez.

[1] S. Mangin, et al., Nature Mat. **13** (3), 286-292 (2014)
[2] C-H. Lambert, et al., Science **345** (6202), 1337 (2014)
[3] N. Bergeard, et al., Phys. Rev. Lett 117 **14** 147203 (2016)
[4] R.B. Wilson, et al., Phys. Rev. B **95** 180409 (2017)
[5] Y Xu, et al., Adv Matter (2017)
[6] R.B. Wilson et al., Phys. Rev. B **96** 045105 (2017)
[7] Y.Yang et al., Sciences Advances **3** 49 (2017)
[8] K. Jhuria et al., Nature Electronics **3**, 680 (2020)