Ultrafast magnetization dynamics induced by spin-polarized hot-electron pulses.

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The challenge of this work is to achieve ultrafast magnetization switching via spin transfer torque (STT) in thin magnetic layers (FM2) using femtosecond spin-polarized hot-electron (SPHE) pulses, generated by ultrashort Infra-Red laser pulses. These ultra-short SPHE pulses are generated by laser pulses in a ferromagnetic (FM1) layer, grown on top of the FM2 magnetic layer. We point out that beside its technological relevance, this project will address the fundamental mechanisms defining the interaction between ultrashort SPHE pulses and a magnetic medium. This aspect of the project is crucial since the actual role of hot-electrons on the hot-topic of ultrafast spin dynamics is still heavily debated. To reach our goal we will combine state of the art pump-probe experiments with theoretical approaches. Combined time-resolved and element-resolved spectroscopies will be used during this project [1- 5]. The experiments require dedicated Infra-Red lasers and pulsed synchrotron – or - X-ray Free electron laser (XFEL) sources in order to reveal the ultrafast dynamics of spins with femtosecond time resolution. The new European X-ray Free electron laser facility is now open to users and offers unprecedented experimental conditions, combining high flux and ultrashort X-ray pulses. Single pump - single probe experiments combining chemical and sub-nanometre thickness sensitivity, will thus be possible within this work [4, 5].

[1] C. Boeglin, E. Beaurepaire, V. Halte, V. Lopez-Flores, C. Stamm, N. Pontius, H. A. Dürr, and J. -Y. Bigot, “Distinguishing the ultrafast dynamics of spin and orbital moments in solids”. *Nature* **465**, 458 (2010).

[2] N. Bergeard, V. López-Flores, V. Halté, M. Hehn, C. Stamm, N. Pontius, E. Beaurepaire, and C. Boeglin, “Ultrafast angular momentum transfer in multisublattice ferrimagnets”. *Nature Communications* **5**, 3466 (2014)

[3] T. Ferté, N. Bergeard, G. Malinowski, R. Abrudan, T. Kachel, K. Holldack, M. Hehn, and C. Boeglin “Ultrafast hot-electron induced quenching of Tb 4f magnetic order”, Phys. Rev. B 96, 144427 (2017)

[4] N. Bergeard et al. “Irreversible transformation of ferromagnetic ordered stripe domains in single-shot infrared-pump/resonant-x-ray-scattering-probe experiments. “ *Phys. Rev. B* **91**, 054416 (2015)

[5] T. Wang et al. “Femtosecond Single-shot X-ray Imaging of Nanoscale Ferromagnetic Order“. *Phys. Rev. Lett.* **108**, 267403 (2012)

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