

## MAP-fis Essay Proposal, 2016-2017

### Supervisor

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### Title

Large scale synchronization of spin torque oscillators via electrical mutual synchronization

### Area

Spintronics

### Summary of Proposal

The proposed work plan aims to perform the large-scale integration of the synchronization of an array of spin transfer torque nano-oscillators (STNOs). STNOs are novel nanoscopic microwave oscillators based on spintronic magnetic tunnel junctions (MTJs) [1,2]. They have ultrawide operating frequency ranges [3], can be easily integrated with RF CMOS technology and have an ultra-small footprint, being highly attractive for application such as chip-to-chip or wireless communications [4]. Here, one aims to surpass the major roadblock still preventing the wide spread application of STNOs by integrating and synchronizing a large number (from 2 to 1000) of STNOs in an array to increase the delivered output power. This will be achieved by the optimized fabrication and characterization of state-of-the-art MTJs with perpendicular electrodes (based on the prototype CoFeB/MgO/CoFeB structure [5]) and the strict control of their resistance and dynamic properties (oscillating frequency, linewidth, phase noise and their dependence with field and bias current). This will be achieved using automated multi-probe techniques to measure a large number of samples and statistically compare them. STNO dynamics will be characterized both in frequency and time domains, providing information on both power and linewidth. Moreover, synchronization experiments to both noiseless high frequency currents and multiple STNOs connected in parallel and in series will be performed.



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## References

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  - [2] Z. Zeng et al., Nanoscale 5, 2219 (2013).
  - [3] W. H. Rippard et al., Phys. Rev. Lett. 92, 027201 (2004).
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  - [5] S. Ikeda et al., Nat. Mater. 9, 721-724 (2010).
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