



|                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>Project Title:</i></b>                                                                            | <b>Electric-field-assisted switching in magnetic tunnel junctions</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b><i>Project Short description</i></b>                                                                 | <p>The groundbreaking discovery of the giant magnetoresistive (GMR) effect in 1988 created the field of Spintronics, in which the spin of the electron is used to transport and store information. The subsequent development of spin valves (SVs) and magnetic tunnel junctions (MTJs) opened the study of spin-dependent electrical transport at the nanoscale and supported the exponential increase of the areal density of hard disk drives up to today. Until recently, Spintronic research relied solely on external magnetic fields (H) to manipulate the spin of the electron and obtain novel capabilities and functionalities. However, it was recently possible to tune the perpendicular anisotropy of MTJs using an applied electrical voltage [1]. This opened the prospect for novel applications that will be here followed. In particular, one aims:</p> <ul style="list-style-type: none"> <li>-to fabricate CoFeB/MgO/CoFeB magnetic tunnel junctions having a free layer with out-of-plane anisotropy;</li> <li>-to characterize the structural, magnetic and electrical properties of the developed structures;</li> <li>-to assemble an experimental setup to test the effect of an applied voltage on the perpendicular anisotropy of magnetic tunnel junctions;</li> <li>-to measure how an applied voltage affects the perpendicular anisotropy of the fabricated magnetic tunnel junctions.</li> </ul> <p>[1] Wei-GangWang, Mingen Li, Stephen Hageman and C. L. Chien, “Electric-field-assisted switching in magnetic tunnel junctions”, Nat. Mater. 11, 64 (2012).</p> |
| <b><i>Expected Start/end date</i></b>                                                                   | November 1st, 2015 – July 30th 2016                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b><i>Required degree and Background knowledge of students, minimum grade point average, etc...</i></b> | <p>Students applying to this project should preferably have a background on Physics/Physics Engineering.</p> <p>Students with prior experience on any of the following topics are preferred:</p> <ul style="list-style-type: none"> <li>- Magnetism</li> <li>- Micro and Nanofabrication</li> <li>- Automation of Data Acquisition Systems</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

**Supervisor at INL**

|                  |                                                                        |
|------------------|------------------------------------------------------------------------|
| <b>Name:</b>     | Ricardo Ferreira                                                       |
| <b>Position:</b> | Staff Researcher                                                       |
| <b>email:</b>    | <a href="mailto:Ricardo.Ferreira@inl.int">Ricardo.Ferreira@inl.int</a> |