ND*nano* Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Fiona Edwards-Murphy

2) Faculty mentor name: Prof. X. Sharon Hu

3) Project title: Study of power/performance characteristics of nanomagnet-based circuits

4) Briefly describe any new skills you acquired during your summer research:

Several technical skills were developed, including bash scripting, grid computing, data collection and analysis, testing, energy and power analysis. Knowledge of magnetic principles and concepts was greatly improved.

5) Please briefly share a practical application/end use of your research:

A thorough understanding of how to most efficiently clock NML, and how this clocking effects energy consumption, is vital to make an accurate comparison between NML, traditional CMOS and other logical devices. As well as this, OOMMF simulation results were previously validated through quantitative judgment. The tool developed during this project provides a faster and more accurate method of validation.

Begin two-paragraph project summary here:

Nanomagnets can be used to perform logic computation when they are placed in carefully crafted patterns. These devices have many potential advantages over traditional CMOS, including lower power, non-volatility, and radiation hardness. One package used for simulating nanomagnetic logic (NML) circuits is called "OOMMF". The aim of this project was to develop a tool which would aid simulation of NML and validate these simulation results, then use this tool to assist in collecting data for exploration of the trade-off between phase time, filed strength and number of devices per clocking zone.

The validation is performed over several steps, the input file for the OOMMF simulator is generated and submitted for processing, a specification file outlining the expected behaviour for a working NML structure is generated. The output from the simulation is collected and post processed to extract the required data, and then this processed data is compared with the specification file to identify if the circuit has performed as expected. These steps were previously performed by the user and so the tool will help more efficiently explore the design space of NML.

The data collected is relevant to finding the optimum operation conditions for a row of devices. The required field strength, energy and energy delay were observed for various clock

phase times. It was found that while large numbers of devices per zone are easier to fabricate, smaller numbers are faster and use lower fields. Future work would extend the tool to be able to handle more complex NML structures, and preform a similar analysis on them.

Publications (papers/posters/presentations):

"Tool development for study of power/performance characteristics of nanomagnet-based circuits" - Poster presented at Notre Dame 2012 Undergraduate Research Summer Symposium, August 3rd 2012