

## **NDnano Undergraduate Research Fellowship (NURF) 2012 Project Summary**

- 1) Student name: Timothy Bontrager
- 2) Faculty mentor name: Greg Snider
- 3) Project title: Ultra Low Energy Computations
- 4) Briefly describe any new skills you acquired during your summer research: I learned how to design, fabricate and then solder circuits. I also learned basic software programming skills for the operation of cryostats.
- 5) Please briefly share a practical application/end use of your research: The end use of this research is to find whether there is an absolute limit on energy use in reversible computation. If there were not such an absolute limit, then it would become practical to develop a new system of devices that can exploit this limit.

### Project summary:

The primary issue that we were researching this summer was whether there was an absolute limit to power dissipation in reversible computation. Because irreversible computing must dissipate energy, it will soon reach a limit where we can no longer dissipate the energy from the circuit efficiently. If reversible computation does not dissipate energy, then we can trade off computing speed for increased circuit density.

Unfortunately, due to technical failures, the team was not able to complete our project's summer goals. Over the course of the summer, the team designed, fabricated, and constructed several pieces of equipment that will ensure the team can continue in earnest in the fall. Of special note was a clocking circuit for the testing of reversible circuits, figure 1, a break-out box for the testing of wafers within the clean room, figure 2, the creation of a mobile cryostat stand, and several amplifier designs and iterations.



Figure 1. Clocking circuit for Reversible Logic



Figure 2. Break-out box

Publications (papers/posters/presentations):