

**Report on Viterbi School of Engineering Research Innovation Fund Award:**

## **Second International Conference on Quantum Error Correction (QEC11)**

**University of Southern California, 5-9 December 2011**

Organizers: Daniel A. Lidar and Todd A. Brun (USC), Mark Byrd (SIU)

**Summary of Program Proposal:** We proposed to organize an international conference of researchers and students in the field of quantum error correction at USC in December 2011. This followed on from the First International Conference (QEC07), which took place at USC in December of 2007. The field of quantum computation and quantum information science has exploded since the pioneering quantum factoring algorithm discovered by Peter Shor in 1994. There is now a large, international effort to turn quantum computers (and other quantum information processing protocols) from theoretical constructs into practical technology. The biggest obstacle to this goal is decoherence, or quantum noise: quantum computers are far more sensitive to noise than ordinary classical computers. This has led to the field of quantum error correction. The field combines new types of error-correcting codes, to protect quantum information from decoherence; fault-tolerant design, to allow imperfect quantum computers to be scaled up to tackle nontrivial problems; and various methods of error suppression, such as decoherence-free subspaces and dynamical decoupling.

QEC07 was the first ever to bring together many of the experts in these different approaches to quantum error correction, both theoreticians and experimentalists, along with students and postdocs, in a large international conference. That conference was so successful that we planned a follow-on conference, QEC11, for December 2011. The details of QEC11 and its program can be found at this website:

<http://qserver.usc.edu/qec11/>

**Program Outcome:** QEC11 took place 5-9 December 2011, and was even larger and more successful than QEC07 had been. The conference was held at the Davidson Conference Center, and included a densely packed schedule of talks and other programming. The first day started with a series of four tutorial lectures, aimed principally at students and new postdocs. These lectures covered quantum error-correcting codes, fault-tolerant quantum computation, quantum computing in a two-dimensional architecture, and dynamical decoupling. The speakers were Todd Brun (USC), Andrew Landahl (Sandia), Robert Raussendorf (UBC), and Daniel Lidar (USC).

Each subsequent day of the conference began with a keynote lecture by an eminent practitioner in a different area of quantum error correction. The keynotes were given by Raymond Laflamme (Waterloo), Hideo Mabuchi (Stanford), Emanuel Knill (NIST) and Daniel Gottesman (Perimeter Institute).

In addition to the tutorial and keynote speakers, there were twenty-four invited speakers and twenty-two contributed talks. There were also poster sessions on days 2, 3 and 4, with a total of thirty-two posters. A new facet since QEC07 were two awards for Best Student Papers in theory and experiment. These awards were won by Jeongwan Haah (Caltech) and Matthew Reed (Yale) in theory and experiment, respectively.

In fact, one major goal of both QEC conferences was the inclusion of both theory and experiment. A special effort was made to include talks from top groups in each of the major experimental approaches to quantum computation. On day 4 of the conference there was an organized panel discussion on the relationship between theory and experiment in quantum error correction, and how developments and limitations in experiments can inform theoretical efforts (and vice versa). This panel was moderated by co-organizer Mark Byrd (SIU), and was another innovation since QEC07.

As well as the talks, poster sessions, and panel, on the last day of the conference there was an excursion to the recently opened USC Lockheed Martin Quantum Computing Center at ISI. This included a demonstration of the new D-Wave One superconducting chip by Sergio Boixo of ISI.

In addition to the RIF funding, we also had funding from the Ming Hsieh Institute and Zumberge Grants at USC, funding from the Institute for Quantum Information at Caltech and the Institute for Quantum Computing at the University of Waterloo, department funds from Southern Illinois University, and government funding from the National Science Foundation and Army Research Office.

**New and Continued Directions:** By most objective measures this conference was highly successful. We had over 140 attendees, including more than 50 students and junior postdocs. Participants came from all over North America, Europe, Asia and Australia, and included people from academia, industry, and government. The informal feedback has also been extremely positive—all of the organizers have been told by many participants how interesting and important this conference was. The impact of a meeting like this is difficult to estimate objectively, but we believe that the contribution to both researchers and students is very large. We have no doubt that many new papers and research directions will result from the contacts and cross-fertilization fostered by QEC11. There is also a contribution to the entire field, since slides and recordings of almost all the talks are now available online from the conference website.

For our own research, this meeting has provided a big boost to several projects we are working on. In particular, all three co-organizers are involved in an iARPA-funded program on Quantum Computer Science; many participants in this program attended QEC11 and it has already had a noticeable impact on progress in this program.

Since the first two QEC meetings were so successful, we hope that this series of conferences will continue. While we have no immediate plans for the next conference, we expect that the time will be ripe for another meeting in the next two to four years.