

Dear *Phys. Rev. Lett.* Editors,

I am submitting to your editorial office the attached manuscript entitled “Experimental Estimation of Average Fidelity of a Clifford Gate on a 7-qubit Quantum Processor” for your consideration as a Letter in your highly prestigious journal *Phys. Rev. Lett.*

How to quantify the level of coherent control in a quantum information processing device is an important task for both comparing different devices and indicating a device’s prospects with respect to fault-tolerant quantum computation. The traditional approach by quantum process tomography scales exponentially with the number of qubits, and is thus impractical in experiments – actually people can only certify at most 3-qubit gates using process tomography.

We benchmarked an important 7-qubit gate which can entangle all the qubits in our 7-qubit quantum processor via a twirling protocol. Compared with over 108 experiments required by process tomography, we conducted only 1656 experiments to satisfy a confidence level 99%. An important feature of this protocol is the number of experiments is independent of the number of qubits, which means it is completely scalable and has the potential to become standard tools for characterizing gates.

We also demonstrate reliable coherent control of our 7-qubit system experimentally. To our best knowledge, this is the largest gate-characterization reported to date.

For these reasons, we trust that that the submitted manuscript is of sufficient interest to the broad audience of *Phys. Rev. Lett*. For your convenience, we suggest the following list of experts to serve as impartial referees due to their renowned research closely related to our work.

* Emanuel Knill (NIST and U Colorado Boulder --- A leading physicist in quantum controls and benchmarks, as well as nuclear magnetic resonance)

[emanuel.knill@nist.gov](mailto:emanuel.knill@nist.gov)

* Marcus P. da Silva ([Raytheon BBN Technologies](http://www.bbn.com) --- A pioneer in designing practical protocols for the verification of quantum devices)

[msilva@bbn.com](mailto:msilva@bbn.com)

* [David Poulin](http://www.physique.usherbrooke.ca/poulin/index.php?lan=FR) (University of Sherbrooke --- An expert in the )
* Tal Mor

Sincerely,

Dawei Lu

On behalf of myself and all other coauthors: Hang Li, Denis-Alexandre Trottier, Jun Li, Aharon Brodutch, Anthony P. Krismanich, Ahmad Ghavami, Gary I. Dmitrienko, Guilu Long, Jonathan Baugh and Raymond Laflamme.