1139-81-536 **Aram W. Harrow** and **Saeed Mehraban*** (mehraban@mit.edu), 32 Vassar Street, 32-G636, Cambridge, MA 02139. *Approximate unitary t-designs by short random quantum circuits using nearest-neighbor and long-range gates.*

We prove that poly$(t) \cdot n^{1/D}$-depth local random quantum circuits with two qudit nearest-neighbor gates on a D-dimensional lattice composed of n qudits are approximate t-designs in various measures. Previously, the best bound was poly(t) $\cdot\, n$ due to Brandão-Harrow-Horodecki (BHH)(arXiv: 1208.0692) for $D = 1$ and it was not known how to improve this to take advantage of better connectivity when $D > 1$. One consequence of our result is to confirm the conjecture of the Google Quantum AI group which asserts that $O(\sqrt{n})$-depth random circuits on n qubits laid out in a 2-D lattice have output which is "anti-concentrated", meaning roughly that its entropy is near maximal. Along with some conjectures in complexity theory, this would imply that the output of such circuits is hard to sample from classically. The proof is based on a previous construction of t-designs by BHH, an analysis of how approximate designs behave under composition, and an extension of the quasi-orthogonality of permutation operators developed by BHH. For random circuits with long-range gates, we use different methods to show that anti-concentration, and thus hardness of simulation happens at size $O(n \ln n)$. (Received February 19, 2018)