U.S. DEPARTMENT OF ENERGY | Office of Science

Quantum Testbed Stakeholder Workshop

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ASCR Must Explore "Beyond Moore's Law" Technology

Approach:

Advance New Hardware/Software Computing Paradigms to Glean Unexploited Efficiencies:

- Extending CMOS
- Non-CMOS computing

Quantum Computing Community Engagement

- Workshop on Materials Opportunities for Quantum Computing,* October 7-8, 2014, LANL
- Grand Challenges at the Intersections of QIS, Particle Physics, and Computing, December 11, 2014, joint DOE/HEP & ASCR
- NNSA Workshop on Applications of Quantum Computing, February 5-6, 2015, SNL (organized by LANL)
- DOE/ASCR Workshop on Quantum Computing in Scientific Applications, Date: February 17-18, 2015
- Workshop on Beyond Exascale: Qubits for Quantum Computing,* ORNL, August 20-21, 2015
- Quantum Testbeds Study Group, August 23, 2016
- Also … NSF and NIST community events (2015 - present)

**Community organized*

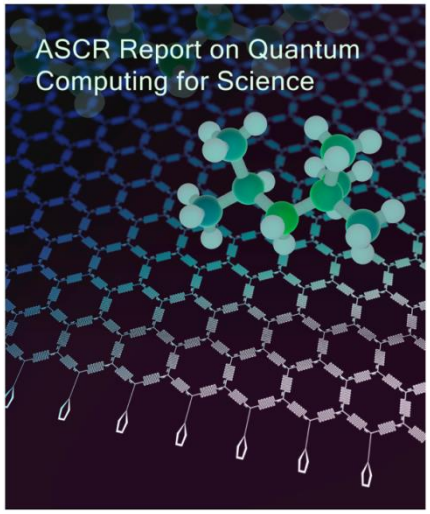
DOE/ASCR Workshop on Quantum Computing in Scientific Applications (Feb 17-18, 2015)

Preceded by Quantum Computing in Scientific Applications Meeting (January 15th, 2014), the workshop explored the following topics:

- **Mission relevance:** What aspects of DOE's science mission are suitable for quantum computing?
- **Impact on Computing:** How will quantum computing improve the properties of the computation with respect to conventional contemporary computational systems?
- **Challenges:** What are the challenges in adopting quantum computing technologies and developing the required infrastructure?

The consensus in the workshop was that quantum computing has reached a level of maturity that warrants considering how it will impact the DOE mission in the near and long term. The report listed the following research opportunities:

- **Quantum Algorithms:** Develop speedups for the fundamental primitives of applied mathematics such as linear algebra, optimization and graph theory.
- **Quantum Simulation:** Solve problems in chemistry, materials science, and nuclear and particle physics by developing and optimizing simulation algorithms.
- **Models of Computation and Programming Environments:** Develop software infrastructure for quantum computation.
- **Co-Design Approach:** Adopt a co-design approach in developing models and algorithms along with prototype quantum computing systems.



http://science.energy.gov/~/media/ascr/pdf/programdocuments/docs/ASCRQuantumReport-final.pdf

Quantum Testbed Stakeholder Workshop

Date and Location: Feb. 14-16, 2017 in Washington, D.C.

Workshop Purpose:

- **identify individual capabilities and interests in quantum computing hardware and its use for science applications**
- **share best practices for management of collaborative research facilities, including topics such as workforce training and building strong relationships with the research community**
- **identify technology that will be important for the success of a testbed facility with the goal of advancing quantum computing for scientific applications in the next five years**

Quantum Testbed Stakeholder Workshop

Agenda:

- **Overview of DOE lab capabilities**
- **Breakout discussions on topics including user community development, workforce training, quantum co-design, technical challenges**
- **Discussion with industry to identify synergistic activities across the national quantum ecosystem**

Participation: more than 160 people over 3 days

- **DOE labs: ANL, FNAL, LANL, LBNL, LLNL, ORNL, PNNL, SLAC, SNL**
- **Industry**
  - IBM, Intel, Google, Rigetti Computing, IonQ, Quantum Circuits, ColdQuanta, D-Wave, QxBranch, Raytheon/BBN, Harris, Applied Communication Sciences, Honeywell, Lockheed Martin
- **Universities**
- **Other government labs and FFRDCs**

Quantum Testbed Stakeholder Workshop

Organizing Committee:

Jonathan Carter, LBNL

David Dean, ORNL

Greg Hebner, SNL

Jungsang Kim, Duke University

Andrew Landahl, SNL

Peter Maunz, SNL

Raphael Pooser, ORNL

Irfan Siddiqi, LBNL/UC Berkeley

Jeffrey Vetter, ORNL

A workshop report is under development, and expected to be publicly available in June, 2017.