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14. ABSTRACT
This new research effort will investigate the fundamental limitations of the necessary components of a quantum network. Specifically, we will design and construct a set of compact single atom traps with integrated optics, suitable for heralded entanglement and loophole free Bell's inequality measurements. The goal of this effort is two-fold: technical development and scientific investigation. The objective of the technical development is to achieve fast loading and qubit manipulation in the single-atom traps, which will enable our scientific investigation. The goal of our scientific investigation is to demonstrate high-fidelity and fast atom-atom entanglement between physically

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Report Title

Final Report: Compact Single Site Resolution Cold Atom Experiment For Adiabatic Quantum Computing

ABSTRACT

This new research effort will investigate the fundamental limitations of the necessary components of a quantum network. Specifically, we will design and construct a set of compact single atom traps with integrated optics, suitable for heralded entanglement and loophole free Bell's inequality measurements. The goal of this effort is two-fold: technical development and scientific investigation. The objective of the technical development is to achieve fast loading and qubit manipulation in the single-atom traps, which will enable our scientific investigation. The goal of our scientific investigation is to demonstrate high fidelity and fast atom-atom entanglement between physically separated and optically addressed qubits. We will also demonstrate device-independent randomness expansion, once the entanglement is experimentally demonstrated and verified. Our further scientific efforts will focus on the fundamental limitations and efficiency of entanglement distribution between unlike quantum systems, e.g. ions to single atoms.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Post Doctorates

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Faculty Supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: 0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

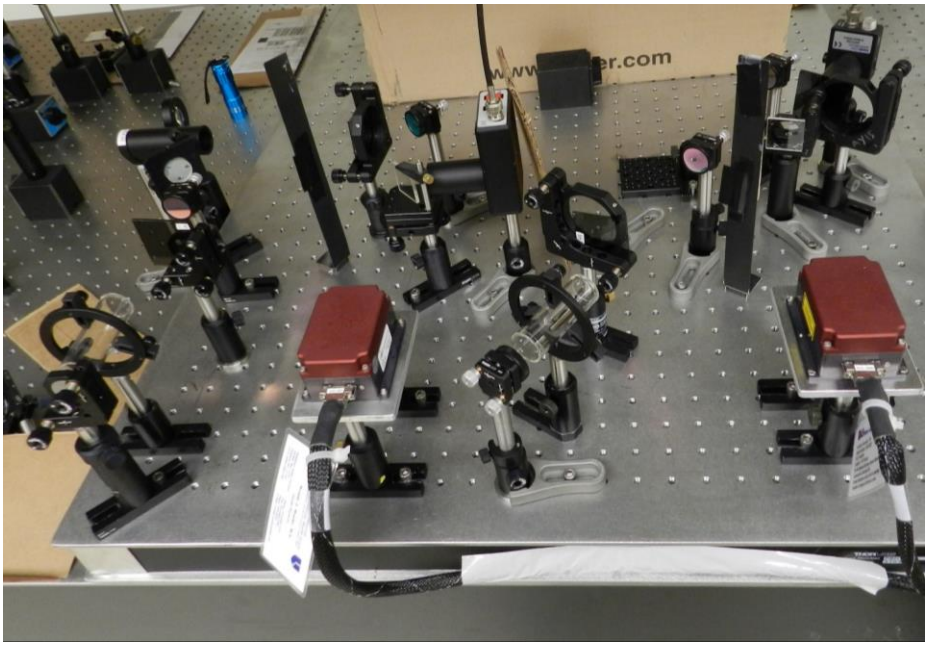
Technology Transfer

Duke Final Report W911NF-04-D-001

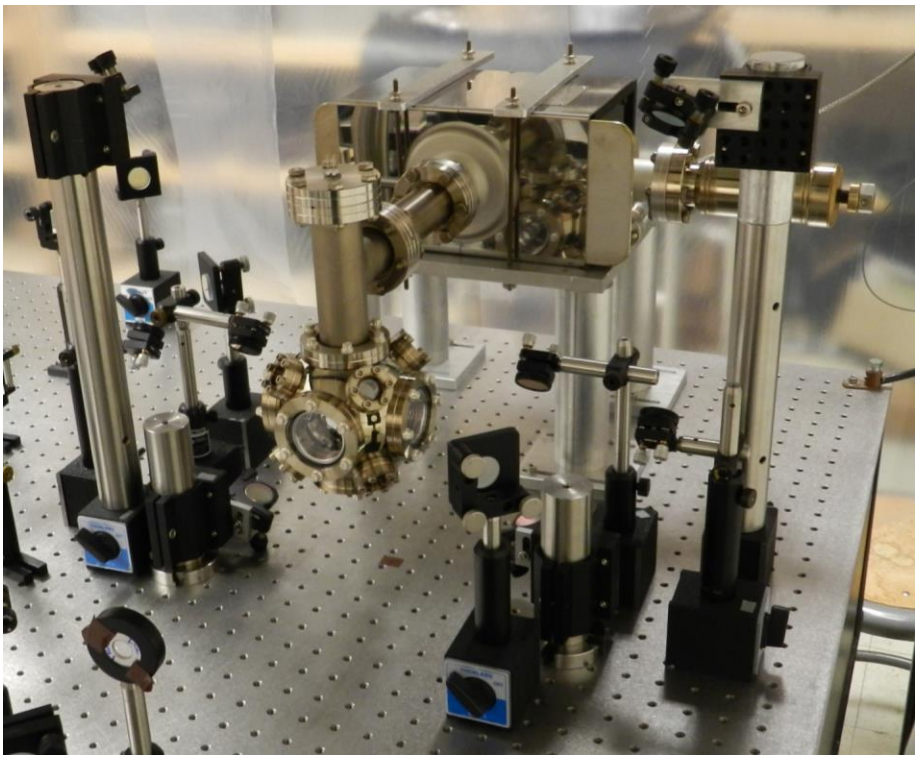
Compact single-site resolution cold atom experiment for adiabatic quantum computing.

With this one year equipment grant (W911NF-04-D-001) we were able to purchase preliminary equipment for the construction of a science system and laser system. Specifically, for the science system we purchased and constructed a vacuum chamber using a 40 L/S ion pump, a Kimball Physics chamber and anti-reflective coated viewports along with other miscellaneous parts.

With remaining funds we acquired and began construction of the laser system. The Laser system consisted of two prototype 780 nm interference filter lasers that were purchased from AO Sense along with additional optical components required for obtaining a magneto-optical Trap (MOT) and the equipment required for generating an appropriate locking feedback signals.



Preliminary optics and laser system.



Preliminary Science Chamber under construction.

With these initial funds and beginning construction, we were able to attract a student (Margaret Shea) to work on the project resulting in obtaining a MOT in June of 2014 and a follow on research proposal (W911NF-15-2-0047) titled Compact single atom entanglement experiment for quantum networks.

This new research effort will investigate the fundamental limitations of the necessary components of a quantum network. Specifically, we will design and construct a set of compact single atom traps with integrated optics, suitable for heralded entanglement and loophole free Bell's inequality measurements. The goal of this effort is two-fold: technical development and scientific investigation. The objective of the technical development is to achieve fast loading and qubit manipulation in the single-atom traps, which will enable our scientific investigation. The goal of our scientific investigation is to demonstrate high fidelity and fast atom-atom entanglement between physically separated and optically addressed qubits. We will also demonstrate device-independent randomness expansion, once the entanglement is experimentally demonstrated and verified. Our further scientific efforts will focus on the fundamental limitations and efficiency of entanglement distribution between unlike quantum systems, e.g. ions to single atoms. Our effort will compose the primary scientific requirements for a global quantum network, which is vital for future precision scientific, commercial, and social enterprises. The equipment provided by the grant was important for facilitating this new effort.