

**U.S. ARMY RESEARCH OFFICE**  
**BROAD AGENCY ANNOUNCEMENT**

**W911NF-06-R-0010**



**Experimental and Theoretical  
Development of Quantum Information Science**

**July 2006**

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EXPERIMENTAL AND THEORETICAL DEVELOPMENT OF  
QUANTUM INFORMATION SCIENCE**

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This publication constitutes a Broad Agency Announcement (BAA) and sets forth basic research areas of interest in the area of experimental and theoretical development of quantum information science. This BAA is issued under the provisions of Federal Acquisition Regulation (FAR) 6.102(d)(2) and Department of Defense Grant and Agreement Regulations (DODGARS) 22.315. Awards based on responses to this BAA are considered to be the result of full and open competition.

## **OVERVIEW INFORMATION**

**Agency Name:** U.S. Army Research Office, Physics Division, P.O. Box 12211, Research Triangle Park, NC 27709-2211

**Issuing Acquisition Office:** U.S. Army RDECOM Acquisition Center, RTP Contracting Division, P.O. Box 12211, Research Triangle Park, NC 27709-2211

**Research Opportunity Title:** Experimental and Theoretical Development of Quantum Information Science - 2006

**Announcement Type and Date:** Initial Announcement – July 2006

**Research Opportunity Number:** W911NF-06-R-0010

**Catalog of Federal Domestic Assistance (CFDA) Number and Title:** 12.431 – Basic Scientific Research

**Response Dates:** White Papers are due by 4:00 PM Eastern Daylight Saving Time on Wednesday, August 30, 2006. Proposals are due by 4:00 PM Eastern Standard Time on Monday, December 11, 2006. See Section IV.C. for additional information.

## **I. RESEARCH OPPORTUNITY DESCRIPTION**

The U.S. Army Research Office (ARO) together with the Disruptive Technologies Office (DTO) (formerly ARDA) solicits proposals for (a) experimental and theoretical studies relating to the possible physical realization of quantum computers and for achievement of effective computation on them; and (b) enabling technologies for quantum information science.

Proposals sought are in five categories:

- 1) **“Quantum Computing Concept Maturation”** (QCCM) proposals are specifically for combined experimental and theoretical studies of potential physical embodiments of quantum bits and quantum logic, perhaps including

studies in the related fields of quantum error correction, control, decoherence, and entanglement.

- 2) “**Short-Term, Innovative Concept**” (STIC) proposals are smaller, short-term (1-3 year) experimental or theoretical studies exploring *new* quantum computing concepts that could engender a larger scale project in the future.
- 3) “**Quantum Algorithm**” (QA) proposals should primarily develop new quantum computing algorithms, but may also consider issues of quantum computational complexity and computability.
- 4) “**Quantum Enabling Technologies**” (QET) proposals should primarily develop special technologies or devices difficult to procure, or unavailable commercially, that are critical to the quantum computing and quantum communications projects.
- 5) “**Quantum Computing & Communications Research**” (QuaCCR)  
**Fellowships:** QuaCCR Fellows are graduate students or postdocs who are U.S. citizens working on quantum computing or communications research in the topical areas described in this BAA and in the roadmap identified below.

Each proposal should indicate how the proposed work will conform to or extend beyond the quantum computing or quantum cryptography roadmaps devised by DTO. The roadmap may be found at the web site <http://qist.lanl.gov/>. Milestones in the proposed project should be clearly linked to the roadmap.

#### Quantum Computing Concept Maturation (QCCM) Proposals

These large scale, four-year physical implementation studies must combine fabrication, characterization, and phenomenological theory expertise into a single team working cohesively to develop proof-of-concept demonstrations of quantum bits and quantum logic. Preference will be given to approaches that have a clear potential for large scalability within the framework of existing or emerging technologies. If the proposed system is not based on any of the conventional models of quantum computing, the proposal should explain why it is expected to have comparable computational strength.

Minimum objectives at the conclusion of a four-year QCCM project are the experimental demonstrations of physical quantum bits, entangling operations, and error correction that remove key obstacles toward demonstrating a logical quantum bit, and theoretical analyses that prove the feasibility and scalability of the logical quantum bit. The proposal must discuss these objectives in the context of a logical qubit design. In addition, proposals may optionally consider architectural issues related to the proposed concept. Proposals should provide annual, measurable milestones to indicate how progress toward these objectives will be accomplished and the quantitative metrics by which success or failure of these milestones will be assessed. QCCM proposals must specify the qubits, the physical properties and operations to be used, and the mechanisms for switching interactions on and off. They should specify how entanglement would be created, stored, and verified. Effective proposals will also include preliminary feasibility calculations and estimates of parameters such as decoherence times and achievable operational accuracy and speed. Effective proposals should also include at least a notional concept of operations for how the technology being considered would be part of

a quantum information processing system. Metrics should include these parameters and other physically meaningful measures of performance and progress.

Because of the comprehensive team and resources that must be assembled to perform a QCCM project, it is anticipated that most proposals will require between \$500K - \$1M per year. QCCM proposals must provide a schedule of measurable milestones, quantified by metrics, which demonstrate the removal of key experimental and theoretical barriers to the advancement of quantum computing science and technology. A critical on-site milestone review will take place in year two to assess demonstrated progress and accomplishment of year two milestones. Exercise of funding options and levels of funding, including cancellation, for the remaining two years will be determined based upon the results of this review.

#### Short-Term, Innovative Concept (STIC) Proposals

The objective of short-term, innovative concept experimental and theoretical research proposals is to encourage exploratory investigations of novel, emerging concepts for new physical implementations of a quantum computer or for solving looming problems in quantum information processing as systems grow larger and more complicated.

Responsive experimental proposals must specify and consider the feasibility of the new physical implementation and must outline both its potential advantages and disadvantages as compared to more traditional implementations. Like QCCM proposals, STIC proposals must specify the qubits, the physical properties and operations to be used, and the mechanisms for switching interactions on and off. They should specify how entanglement would be created, stored, and verified. Effective proposals will also include preliminary feasibility calculations and estimates of parameters such as decoherence times and achievable operational accuracy and speed.

Responsive theoretical proposals should address issues that are likely to be encountered by physical systems for quantum information processing in the course of scaling, e.g. error correction, control theory, and internal communication. Basic computer simulations of large physical systems should generally be avoided unless it can be clearly demonstrated that such simulations will likely lead to a solution of an otherwise intractable roadblock.

STIC proposals are designed to be smaller in scope (1-2 investigators), time (1-3 years), and funding (see below). Like the QCCM proposals described above, these proposals should make very clear how the proposed work will enhance our understanding of quantum computation and, therefore, facilitate the eventual development of practical quantum computers. Because of the smaller-scale effort, STIC project proposals are anticipated to request less than \$300K per year for 1 to 3 years. All proposals must provide a schedule of measurable milestones that demonstrate the removal of key experimental and/or theoretical barriers.

### Quantum Algorithm (QA) Proposals

Unlike QCCM and STIC proposals, QA proposals are for up to three-year efforts specifically designed to explore quantum algorithms. **Investigators wishing to propose work in the area of quantum algorithms should presuppose the existence of a fully functional quantum computer and consider what algorithmic tasks are particularly well suited to such a machine.** A necessary component of this research will be to compare the efficiency of the quantum algorithm to the best existing classical algorithm for the same problem.

To characterize the efficiency of candidate quantum algorithms, metrics must be developed to quantify the performance of quantum algorithms relative to their classical analogs. The problems to which they are being applied must have well-defined inputs, and well-defined outputs, along with a well-defined statement of what exactly is being computed. A full accounting of all computational resources must be made including such things as numbers of qubits, numbers of quantum gates, amount of memory being used, amounts of classical pre-computation and post-computation, probability of success, and number of times the algorithm must be run. Worst-case analyses of the algorithms are preferable to average case analyses, but if average case analysis is to be used in an efficiency measure, the distribution of all cases must be made explicit as well as the placement of average cases within this distribution. In addition, proposals that study the algorithmic limitations of fully functional quantum computers will be considered as long as similar performance metrics are specified and quantified.

Although QA proposals may impose general architectural constraints (e.g. nearest neighbor only gates) for implementing algorithms, they should otherwise concentrate on developing the algorithm. QA proposals should assiduously avoid tying algorithms to specific types of qubits. Proposals for research in quantum algorithms should be to devise specific quantum algorithms to solve mathematically and computationally hard problems from such diverse fields as algebra, number theory, geometry, analysis, optimization, graph theory, differential equations, combinatorics, topology, logic, and simulation. Quantum algorithms that are developed should focus on constructive solutions for specific tasks and on general methodologies for expressing and analyzing algorithms tailored to specific problems. Complexity analyses such as upper and lower bounds on algorithms relative to specific models of quantum computation are also encouraged.

Because experimental work is not allowed in a QA project, proposals are anticipated to request less than \$200K per year for up to three years. All proposals should provide both a schedule of measurable research milestones that demonstrate the removal of key theoretical barriers and metrics quantifying performance enhancements.

### Quantum Enabling Technologies (QET) Proposals

On-going experimental investigations in the areas of the quantum computing concept maturation and quantum communications may identify specific requirements for improved special technologies or devices difficult to procure or unavailable commercially. The objective of QET proposals is to develop and fabricate such

technology critical to any of the on-going quantum information science projects. Some examples are discussed below.

Enabling technologies should clearly specify which specific quantum technologies they will enable, and how the development of such an enabling technology will accelerate the quantum technology (i.e. for quantum computing, which specific types of qubits will be benefited and how, and for quantum communications, how the development of the enabling technology will help to surmount specific obstacles in specific approaches to QKD).

**Examples of possible enabling technologies:**

- Advanced materials needed to solve identified problems in superconducting or semiconducting qubit technologies.
- Advanced lasers designed specifically to improve atomic physics approaches (i.e. optimized for wavelength, linewidth, amplitude stability, power, and lifetime).
- Advanced detectors with high efficiencies and low dark counts at frequencies specific to the needs of atomic physics.
- Advanced methods of controlling large qubit systems (e.g spatial light modulators optimized for specific qubit systems such as ions, atoms, or optically addressable quantum dots).
- Advanced single photon sources and entangled sources at telecom wavelengths for QKD
- Advanced high-speed photon number resolving detectors that operate at QKD (telecom) wavelengths and have low dark counts.
- Advanced low-loss optical components suitable for incorporation into quantum communications systems.
- Integrated optics specifically tailored to quantum computing and quantum communications applications.

The examples provided above are not meant to exclude additional diverse components important to quantum computing and communications applications.

QET proposals are designed to be narrow in scope, time (1-3 years), and funding. These proposals should make very clear how the proposed work would enable specific quantum information science research projects and, therefore, facilitate the eventual development of practical quantum information systems. Proposals are anticipated to request less than \$300K per year for 1 to 3 years. All proposals must provide a schedule of measurable milestones that demonstrate the removal of key experimental and/or theoretical barriers.

Quantum Computing & Communications Research (QuaCCR) Fellowships

To stimulate the involvement of and train U.S. citizens in research related to quantum computing & communications, investigators may apply for a QuaCCR fellowship for three-year funding of a U.S. citizen graduate student or postdoc. The goal of this fellowship program is to support and train outstanding U.S. citizen graduate students and postdocs for careers in quantum information science.

The QuaCCR proposal must outline the research activities that the candidate will undertake with the candidate's research advisor/investigator during the three-year period of the fellowship. **The proposal must be sponsored and submitted by the candidate's research advisor.** The proposal must provide detailed information about the candidate's undergraduate and graduate academic and research record. Transcripts and recommendation letters may be submitted but are not necessary as long as the proposal provides the following information: Academic institutions attended, final GPA and any honors obtained, GRE general and subject test scores, a summary of relevant research projects undertaken by the candidate, all available indications of the candidate's performance and stature in his/her graduate class, and a statement of commitment by the candidate to work with the research advisor on quantum computing or communication related research if awarded a QuaCCR fellowship.

In most cases, a QuaCCR fellowship proposal will request less than \$55K per year for three years for graduate students or \$85K per year for postdocs to cover the costs of (postdoc) salary or (student) stipend, travel, and any tuition support. A QuaCCR fellowship proposal may be submitted as a stand-alone proposal or as part of a new or renewal grant proposal in which case the QuaCCR part must be a self-contained supplement of this larger proposal. If proposed as part of a new or renewal grant proposal, the QuaCCR fellowship award may continue even if the parent grant ends.

The QuaCCR proposal must name the candidate QuaCCR Fellow and indicate that the candidate is a U.S. citizen who is or will be working in the investigator's group on quantum computing, quantum communications and/or quantum enabling technology-related research for the next three years. The investigator need not be a U.S. citizen, and the sponsoring university need not be a U.S. university. QuaCCR fellowship proposals may not be renewed for a given candidate, but an investigator may have multiple QuaCCR fellows in his/her group. A QuaCCR fellow who either changes advisors or leaves quantum research will void the fellowship, and all remaining unspent funds will be returned to the government.

## **II. AWARD INFORMATION**

Awards made under this BAA are subject to the availability of appropriations and may be in the form of contracts or grants. Multi-year projects must have clear goals for each year. Funding for subsequent years will be contingent upon satisfactory performance and the availability of funds.

Multiple, one- to four-year awards are anticipated. Most QCCM proposals will request more than \$500K per year, while most STIC and QA proposals will request less than \$300K and \$200K per year, respectively. QET proposals will generally request less than \$300K per year. Most QuaCCR proposals are anticipated to require less than \$55K per year for graduate students or \$85K per year for postdocs.

### III. ELIGIBILITY INFORMATION

**A. Eligible Applicants:** Proposals may be submitted by degree-granting universities, nonprofit organizations, or industrial concerns (large and small businesses). Proposals are encouraged from Historically Black Colleges and Universities (as determined by the Secretary of Education to meet requirements of Title III of the Higher Education Act of 1965, as amended (20 U.S.C. §1061) and from Minority Institutions defined as institutions whose enrollment of a single minority or a combination of minorities...exceeds 50 percent of the total enrollment.” [20 U.S.C. § 1067k(3) and 20 U.S.C. § 2323(a)(1)(C)].

**B. Cost Sharing or Matching:** There is no required cost sharing, matching, or cost participation to be eligible under this BAA.

**C. Other:** Federal laboratories, Federally Funded Research and Development Centers, and academic institutions that are federal government organizations (e.g., Naval Postgraduate School) may submit to the federal program for support, but are not eligible to receive funding awarded through this BAA. These organizations are encouraged to contact [kfroeni@nsa.gov](mailto:kfroeni@nsa.gov) for information on how to submit to the internal research program.

### IV. APPLICATION AND SUBMISSION INFORMATION

**A. Application Process:** The application process is in two stages as follows:

Stage 1 - Prospective proposers are required to submit white papers. The purpose of requesting white papers is to minimize the labor and cost associated with the production of detailed proposals that have very little chance of being selected for funding. Based on assessment of the white papers, feedback will be provided to the proposers to encourage or discourage them to submit full proposals.

Stage 2 - Interested offerors are required to submit full proposals. All proposals submitted under the terms and conditions cited in this BAA will be reviewed regardless of the feedback on a white paper. However, submission of a white paper in Stage 1 is required.

Details, URLs, and other links necessary for submission of white papers and proposals are provided in the subsections below.

## **B. Format and Content of White Papers/Proposals:**

### **1. White Paper Format and Content.**

a. White papers must be submitted electronically to [carolyn.c.wolfe@us.army.mil](mailto:carolyn.c.wolfe@us.army.mil) in the following format:

- Single PDF formatted file as an email attachment
- Page Size: 8 ½ x 11 inches
- Margins – 1 inch
- Spacing – double
- Font – No smaller than Times New Roman, 10 point
- Number of Pages – no more than ten (10) single-sided pages. White papers exceeding the page limit may not be evaluated.

b. White papers should loosely follow the format described for the full proposal in Section IV.B.2.c.(2) below and must contain the following:

- Title page. (Not to exceed one page) The title page should be labeled “Proposal White Paper” and should include the BAA number, proposed title, proposer’s Principal Investigator (PI) with telephone number and email address, and an executive summary. Proposers must specify whether the effort proposed is to be considered a QCCM, a STIC, a QA, or a QET. A white paper is not necessary for a QuaCCR fellowship proposal.
- Expected expenditures and justifications. (Not to exceed one page.)
- Curriculum vitae sketches. (Not to exceed one page.)
- Technical portion including all references and figures. (Not to exceed seven pages.)

### **2. Proposal Format and Content.**

a. Proposals must be submitted electronically using one of the two following formats. A proposal should not be submitted through more than one format.

(1) Apply through the Grants.Gov APPLY portal, <http://www.grants.gov/Apply>. A Grant Application Package is available for download through the Grants.Gov Apply portal under CFDA Number 12.431/Funding Opportunity Number W911NF-06-R-0010. The following documents are mandatory: (1) Application for Federal Assistance (Research and Related) (SF 424 (R&R)), and (2) Attachments form.

(a) The SF 424 (R&R) must be fully completed. Do not use all CAPITAL letters when entering data.

(b) The Attachments form must contain the information requested in “Content Instructions” (See Section IV.B.2.c) including three electronic forms as follows: (1) ARO Form 51-GG, Proposal Cover Page; (2) ARO Form 99, Summary Proposal Budget; and (3) ARO Current and Pending Support (unnumbered form) (Not required for QuaCCR proposals). These forms may be accessed at

<http://www.aro.army.mil/forms/forms2.htm>. The PDF Forms may be saved to a working directory on a computer and opened and filled in using Adobe Reader 5.0 or later software application. All documents must be combined into a single PDF formatted file titled “W911NF-06-R-0010 (PI’s Name)” and uploaded into the mandatory Attachments form.

NOTE: Prospective grantees must complete several steps in order to participate in the Grants.Gov application process. Starting early is extremely important as it may take several weeks to complete the processes necessary to submit an application through the Grants.Gov Apply portal. See Section VII.C. for additional information on electronic proposal submission through Grants.Gov.

(2) E-mail directly to baa@arl.army.mil. All e-mailed proposals must contain the information requested in “Content Instructions” (See Section IV.B.2.c) including three electronic forms as follows: (1) ARO Form 51, Proposal Cover Page; (2) ARO Form 99, Summary Proposal Budget; and (3) ARO Current and Pending Support (unnumbered form) (Not required for QuaCCR proposals). These forms may be accessed at <http://www.aro.army.mil/forms/forms2.htm>. The fillable PDF forms may be saved to a working directory on a computer and opened and filled in using Adobe Reader 5.0 or later software application. The ARO Proposal Cover Page (ARO Form 51) must be completed, printed, **signed**, and scanned into a PDF document. All documents must be combined into a single PDF formatted file titled “W911NF-06-R-0010 (PI’s Name)” to be attached to the e-mail.

- b. Proposal documents (excluding required forms) must use the following format:
- Page Size – 8 ½ x 11 inches
  - Margins – 1 inch
  - Spacing – double
  - Font – Times New Roman, 10 point
  - Number of Pages – Page limitations are specified in “Content Instructions” below.

c. Content Instructions: The Department of Defense is concerned with research in critical areas of science and engineering, with science and engineering education, and with the availability of equipment required to meet research objectives. For this reason, proposals must adequately describe the technical objectives and approaches, support of any students, and expenditures for equipment, all of which will be evaluated by scientific reviewers in accordance with Section V.

Proposals must include:

- (1) Cover Page. (Excluded from page count.)

- ARO Form 51-GG. Required for Grants.Gov submission (See Section IV.B.2.a.(1)). Complete Blocks 1-9, as applicable. In Block 1, check “Physics.”

OR

- ARO Form 51. Required for E-mail submission (See Section IV.B.2.a.(2)). Complete Blocks 2-27d, as applicable. In unnumbered block titled Solicitation Number (upper left hand corner of form), type “W911NF-06-R-0010 .” In Block 2, check “Physics.” In Block 19, check “Other” and specify “QC.”

(2) Technical Portion for QCCM, STIC, QA, and QET Proposals. (Not to exceed 40 pages excluding Current and Pending Support form(s). Technical portions shorter than 40 pages are heartily encouraged. All pages in the Technical Portion should be numbered consecutively.) The Technical Portion must include:

(a) Abstract: (Not to exceed 1 page.) The offeror must specify whether a proposal is to be considered a QCCM, STIC, QA, or QET proposal. This should be clearly specified at the beginning of the abstract.

(b) Text: (Not to exceed 30 pages.) This section should:

- Introduce the problem to be addressed, survey related work, identify key obstacles, outline the proposed solution and well-defined objective, detail the yearly research plan with milestones, analyze the impact if successful, identify the investigators and resources, and state the budget requirements. Include appropriate literature citations.
- Describe the facilities available for accomplishment of research objective. Describe the equipment planned for acquisition under this program and its application to the objective. When possible, equipment should be purchased very early in the research award period.
- Describe plans for the research training of students in science and/or engineering.
- Describe in detail proposed sub-awards or relevant collaborations (planned or in place) with industry, government organizations, or other appropriate institutions. Particularly describe how collaborations are expected to facilitate the transition of research results to application. If sub-awards are proposed, make clear the division of research activities and provide detailed budgets for the proposed sub-awards.
- Identify other parties to whom the proposal has been/will be sent.

(c) Personnel: (Not to exceed 9 pages.) Describe the qualifications of the principal investigator and other key researchers involved in the project. Include curriculum vitae. For all proposals, one individual should be the designated principal investigator for purposes of technical responsibility and contact.

(d) State of Current and Pending Support: (Excluded from page count.) A statement of current and pending support must be included for each investigator listed in the proposal. Use the ARO Current and Pending Support form to submit this information. This statement requires that each investigator specify all grants and contracts through which he or she is currently receiving or may potentially receive financial support.

(3) Technical Portion for QuaCCR Stand-alone Proposals or Supplements. (Not to exceed 4 pages.). The Technical Portion must include the following:

(a) Statement that the proposal is to be considered a QuaCCR proposal and identification of the candidate and the candidate's research advisor/investigator.

(b) An outline of the research activities the candidate will undertake during the three-year length of the fellowship.

(c) How the QuaCCR fellow will augment the existing research of the candidate's research advisor or expand the group's activities in a new direction.

(d) Detailed information about the student's undergraduate and graduate academic and research record. Transcripts and recommendation letters may be submitted but are not necessary as long as the proposal provides the following information: academic institutions attended, final GPA and any honors obtained, GRE general and subject test scores, a summary of relevant research projects undertaken by the candidate, all available indications of the candidate's performance and stature in his/her graduate class, and a statement of commitment by the candidate to work with the research advisor on quantum computing-related research if awarded a QuaCCR fellowship.

(4) Cost Portion for QCCM, STIC, QA, QET, and QuaCCR Proposals. (No page limitation.) The Cost Portion should contain cost estimates sufficiently detailed for meaningful evaluation. Use ARO Form 99, Summary Proposal Budget, to submit budget data for each year of support requested and a cumulative budget for the full term of requested support. In addition to the ARO Form 99, provide a budget explanation to clearly justify costs for each year. For budget purposes, use an award start date of May 1, 2007 (the earliest anticipated start date for awards under this BAA). The budget should also provide a breakdown of the amount(s) by source(s) of funding (e.g., funds requested under this BAA, non-federal funds to be provided as cost sharing). Budgeted cost elements should reflect the following:

(a) Time being charged to the project, for whom (principal investigator, graduate students, etc.), and the commensurate salaries and benefits. Allowable charges for graduate students include salary, applicable benefits, appropriate research costs, and tuition. Allowable charges for undergraduate students include salary, applicable benefits, and research training costs, but not tuition.

(b) Cost of equipment, based on most recent quotations and broken down in sufficient detail for evaluation.

(c) Travel costs and time, and the relevance to stated objectives. Travel budgets must be in accordance with ARO travel guidelines (\$2500/year/PI for domestic travel and \$1800/year/PI for foreign travel) for routine travel associated with the completion of the proposed work. In addition, all proposals must include costs for at least the lead investigator and all QuaCCR fellows to attend the mandatory five-day annual program review meeting. A waiver of the travel guidelines may be requested for this purpose only.

(d) Estimate of material and operating costs.

(e) Publication and report costs.

(f) Consultant fees (indicating daily or hourly rate) and travel expenses and the nature and relevance of such costs.

(g) Computer services. Generally, computer services, including software and hardware, are only supported if they are above and beyond those required for normal office desktop requirements (e.g., Microsoft Office, and other common desktop applications). Supportable requirements might include dedicated computers for controlling experiments, and very special purpose computers for dedicated full time computations not feasibly supported by the offeror's enterprise network.

(h) Sub-award costs and type (the portion of work to be sub-awarded and rationale). Include detailed cost summary.

(i) Communications costs not included in overhead.

(j) Other direct costs.

(k) Indirect costs.

(l) Fee, if any, which an industrial/commercial organization proposes.

(m) Facilities Capital Cost of Money: When an offeror elects to claim facilities capital cost of money as an allowable cost, the offeror should submit Form CASB-CMF and show the calculation of the proposed amount. (See FAR 31.205-10.)

d. Failure to provide the requested information or exceed page limits may render the proposal non-responsive, and the proposal may not be evaluated. Separate attachments, such as institutional brochures or reprints, cannot be considered.

### C. Submission Dates and Times:

**1. White Papers.** White papers must be submitted electronically via e-mail to [carolyn.c.wolfe@us.army.mil](mailto:carolyn.c.wolfe@us.army.mil) and received at the Army Research Office by **4:00 PM Eastern Daylight Saving Time on Wednesday, August 30, 2006**. The email subject line should contain the following: W911NF-06-R-0010 White Paper. White papers received after the deadline will not be reviewed.

Feedback on the white papers will be e-mailed directly to the proposed principal investigators on or about the week of October 23, 2006.

#### **2. Proposals.**

a. Proposals transmitted online via the Grants.gov APPLY portal must be date/time stamped by the server as submitted by **4:00 PM Eastern Standard Time on Monday, December 11, 2006**.

b. Proposals submitted electronically via e-mail to [baa@arl.army.mil](mailto:baa@arl.army.mil) must be received at the Army Research Office by **4:00 PM Eastern Standard Time on Monday, December 11, 2006**. The e-mail subject line should contain the following: W911NF-06-R-0010 (PI's Name).

c. Proposals received after the deadline will be handled in accordance with the provisions detailed in Section IV.D.

d. Questions concerning electronic proposal submission may be addressed to the Army Research Office at (919) 549-4219. **Proposals submitted by facsimile or hard copy will not be accepted.**

e. Acknowledgment of receipt of a proposal under this BAA will be accomplished via email to the addressee within one week after submission.

**D. Late Submission and Withdrawal of Proposals:** Offerors are responsible for submitting electronic proposals so as to reach the Government office designated in this BAA by the time specified in this BAA. If the electronic proposal is received at the Government office designated in this BAA after the exact time and date specified for receipt of offers, it is "late" and will not be considered. Acceptable evidence to establish the time of receipt at the Government office includes documentary evidence of receipt maintained by the Government office.

If an emergency or unanticipated event interrupts normal Government processes so that proposals cannot be received at the office designated for receipt of proposals by the exact time specified in the solicitation, and urgent Government requirements preclude amendment of the solicitation closing date, the time specified for receipt of proposals will be deemed to be extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

Proposals may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Contracting/Grants Officer.

## **V. PROPOSAL REVIEW INFORMATION**

**A. Criteria:** Proposals submitted in response to this BAA will be evaluated primarily on the following criteria, both of equal weight:

1. Scientific and technical merits of the proposed research; and
2. Potential contribution of the research to quantum computing and defense missions as specified by annual milestones and their linkage to the roadmap found at <http://qist.lanl.gov/> (QCCM, STIC, QA, QET proposals) or by the qualifications of the candidate (QuaCCR proposal).

Other evaluation criteria, of lesser importance, but weighted equal to each other are:

3. Experience and qualifications of the principal investigator, other key research personnel, and the institution sponsoring the proposal; and
4. The realism and reasonableness of cost.

NOTE: Cost sharing will not be considered in the evaluation.

**B. Review and Selection Process:** The proposal selection process will be conducted based upon a technical peer review according to the evaluation criteria specified in Section V.A. Each proposal will be evaluated based on the merit and relevance of the specific proposal as it relates to the quantum information science program rather than against other proposals for research in the same general area.

## **VI. AWARD ADMINISTRATION INFORMATION**

**A. Award Notices:** Notification of acceptance of proposals will be mailed or e-mailed by ARO to successful offerors on or about February 12, 2007. Unsuccessful offerors will be notified shortly thereafter.

Offerors whose proposals are accepted for funding will be contacted by a Contract/Grant Specialist before award to discuss additional information required for award. This may include representations and certifications, revised budgets or budget explanations, certificate of current cost or pricing data, subcontracting plan for small businesses, and other information as applicable to the proposed award. The award start date will be determined at this time. A contract or grant document signed by the Contracting/Grants Officer is the authorizing award document.

## **B. Administrative and National Policy Requirements:**

**1. Central Contractor Registration (CCR).** Successful offerors must be registered in the DoD CCR database prior to award of any agreement. By submission of an offer resulting from this BAA, the offeror acknowledges the requirement that a prospective contractor/grantee must be registered in the CCR database prior to award, during performance, and through final payment of any agreement resulting from this BAA. The CCR may be accessed at <http://www.ccr.gov>. Assistance with registration is available by phone at 1-888-227-2423.

### **2. Certification Required for Grant Awards.**

The certification at Appendix A to 32 CFR Part 28 regarding lobbying is the only certification required at the time of proposal submission for a grant award. The certification is as follows:

“By signing and submitting a proposal that may result in the award of a grant exceeding \$100,000, the prospective awardee is certifying, to the best of his or her knowledge and belief, that:

(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, “Disclosure Form to Report Lobbying,” in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty or not less than \$10,000 and not more than \$100,000 for each such failure.”

**3. Certifications Required for Contract Awards.** Certifications and representations shall be completed by successful offerors prior to award. Federal Acquisition Regulation (FAR) Online Representations and Certifications Application (ORCA) is at website <http://orca.bpn.gov>. Defense FAR Supplement and contract specific certification packages will be provided to the contractor for completion prior to award.

**4. Military Recruiting.** This is to notify potential offerors that each grant awarded under this announcement to an institution of higher education shall include the following term and condition:

“As a condition for receipt of funds available to the Department of Defense (DoD) under this award, the recipient agrees that it is not an institution of higher education (as defined in 32 Code of Federal Regulations (CFR) Part 216) that has a policy or practice that either prohibits, or in effect prevents: (A) The Secretary of a Military Department from maintaining, establishing, or operating a unit of the Senior Reserve Officers Training Corps (in accordance with 10 U.S.C. 654 and other applicable Federal laws) at that institution (or any subelement of that institution); (B) Any student at that institution (or any subelement of that institution) from enrolling in a unit of the Senior ROTC at another institution of higher education; (C) The Secretary of a Military Department or Secretary of Homeland Security from gaining access to campuses, or access to students (who are 17 years of age or older) on campuses, for purposes of military recruiting in a manner that is at least equal in quality and scope to the access to campuses and to students that is provided to any other employer; or (d) Access by military recruiters for purposes of military recruiting to the names of students (who are 17 years of age or older and enrolled at that institution or any subelement of that institution), their addresses, telephone listings, dates and places of birth, levels of education, academic majors, and degrees received; and the most recent educational institutions in which they were enrolled.

If the recipient is determined, using procedures in 32 CRR part 216, to be such an institution of higher education during the period of performance of this agreement, the Government will cease all payments of DoD funds under this agreement and all other DoD grants and cooperative agreements to the recipient, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award.”

This is to notify potential offerors that each contract awarded under this announcement to an institution of higher education shall include the clause: Defense Federal Acquisition Regulation Supplement (DFARS) 252.209-7005, Reserve Officer Training Corps and Military Recruiting on Campus.

**C. Reporting Requirements:** Reporting requirements for contracts and grants awarded under this BAA will be as described in ARO Form 18 located at <http://www.aro.army.mil/forms/forms2.htm>. Additional reports (e.g., monthly status reports) will be specified in the award document.

## **VII. AGENCY CONTACTS**

Technical point of contact for this BAA is Dr. T.R. Govindan, Physics Division, (919) 549-4236, e-mail: <mailto:tr.govindan@us.army.mil>. Questions regarding the administrative content of this BAA may be addressed to ARO at (919) 549-4375.

## **VIII. OTHER INFORMATION**

**A. Marking of Proposal and Disclosure of Proprietary Information Outside the Government:** The proposal submitted in response to this BAA may contain technical and other data that the offeror does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation. Public release of

information in any proposal submitted will be subject to existing statutory and regulatory requirements. If proprietary information which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, is provided by an offeror in a proposal, it will be treated in confidence, to the extent permitted by law, provided that the following legend appears and is completed on the front of the proposal: "For any purpose other than to evaluate the proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if an award is made to the offeror as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the agreement. This restriction does not limit the right of the Government to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) \_\_\_\_\_ of this proposal." Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels. In addition, the pages indicated as restricted must be marked with the following legend: "Use or disclosure of the proposal data on lines specifically identified by asterisk (\*) are subject to the restriction on the front page of this proposal." The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event that properly marked data contained in a proposal submitted in response to this BAA is requested pursuant to the Freedom of Information Act, 5 USC 552, the offeror will be advised of such request and, prior to such release of information, will be requested to expeditiously submit to ARO a detailed listing of all information in the proposal which the offeror believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the offeror will ensure that any information released by ARO pursuant to the Act is properly determined.

By submission of a proposal, the offeror understands that proprietary information may be disclosed outside the Government for the sole purpose of technical evaluation. The ARO/RDECOM Acquisition Center will obtain a written agreement from the evaluator that proprietary information in the proposal will only be used for evaluation purposes and will not be further disclosed or utilized.

**B. Government Obligation:** Offerors are cautioned that only an appointed Contracting/Grants Officer may obligate the Government to the expenditure of funds. Offerors who make financial or other commitments for a research effort in the absence of an actual legal obligation signed by a Contracting/Grants Officer do so at their own risk.

**C. Electronic Proposal Submission through Grants.Gov:**

1. Registration. Each organization that desires to submit applications via Grants.Gov must complete a one-time registration. See <http://www.grants.gov/GetStarted>. The following steps are required:

a. Request a DUNS Number – Follow the instructions at: <http://www.grants.gov/RequestaDUNS> to obtain a DUNS number. It is highly recommended that you request the number by telephone at 1-866-705-5711. This will take about 10 minutes to complete and there is no charge. NOTE: Once the telephone registration is completed, you must wait 24 hours before attempting to use that DUNS for registration in the Central Contractor Registry (CCR).

b. Register in the Central Contractor Registry (CCR) – Go to <http://www.grants.gov/CCRRegister> and click on the “Help” button to locate the tutorial. It is recommended that you print the tutorial for reference and follow the instructions in the link above. You are required to designate an Electronic Business Point of Contact (E-Business POC) and a Marketing Partner Identification Number (MPIN) in CCR. It is important to provide the MPIN to the E-Business POC. For assistance with the CCR, contact the Assistance Center at 1-888-227-2423 or at [CCR@dliis.dla.mil](mailto:CCR@dliis.dla.mil). You may also access the CCR Handbook at <http://www.ccr.gov/handbook.asp>. **VERY IMPORTANT: Knowing the MPIN and who is designated as your organization’s E-Business POC in the CCR is a significant step in the process. This person will function as the organizational agent to approve personnel who can submit binding proposals on behalf of your organization.**

c. Install the PureEdge Viewer – Authorized Organizational Representatives (AORs) approved by the E-Business POC are the individuals that will be given the authority to submit proposals on behalf of your organization. All AORs must download and install the PureEdge Viewer on their computer workstation by following the instructions at <http://www.grants.gov/DownloadViewer>. This small, free program will allow AORs to access, complete, and submit applications electronically and securely. If you encounter any problems, contact customer support at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov).

d. Register with the Credential Provider – AORs must register with the Credential Provider. AORs must wait a minimum of 3 business days for the CCR to activate the organization’s account before attempting to register with the Credential Provider at <https://apply.grants.gov/OrcRegister> and click on the “Help” button to locate the tutorial. Print the tutorial for reference and follow the instructions in the link above. Record the user ID and the password that you enter because you will need this information to register with Grants.gov as an AOR. AORs must wait approximately 20 minutes after completing the Credential Provider registration before proceeding to the next step of registering with Grants.Gov. If you encounter any problems, the Credential Provider may be reached at 1-800-386-6820 or via email at [pkihelp@orc.com](mailto:pkihelp@orc.com).

e. Register with Grants.Gov – AORs must register with Grants.Gov, utilizing their User ID and Password obtained from registering with the Credential Provider. Go to <https://apply.grants.gov/GrantsgovRegister> and click on the “Help” button to locate the tutorial for reference and follow the instructions in the link above. After you have completed the Grants.Gov registration process, you will receive a confirmation that

indicates whether your registration was successful. After an AOR successfully registers with Grants.Gov, an email will be generated to your organizations E-Business POC to notify them that an individual has registered in Grants.Gov to be an AOR capable of submitting applications in Grants.Gov on behalf of your organization. AORs will not be able to submit electronic applications until they receive authorization from the E-Business POC. Normally, the E-Business POC should process these requests within 1 Business Day. If you encounter any problems, please contact customer support at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov).

f. Designation of Privileges to the AOR – The E-Business POC is the sole authority of the organization with the capability of designating or revoking an individual’s ability to submit grant applications on behalf of their organization through Grants.Gov. Once the E-Business POC receives the email notification from the individual wishing to be recognized as an AOR, the E-Business POC should go to: <https://apply.grants.gov/agency/AorMgrGetID> and click on the “Help” button to locate the tutorial, then log into the system using the DUNS number and Marketing Partner Identification Number (MPIN) designated for their organization when CCR registration was performed. Once in the system the E-Business POC should follow the instructions for designating privileges to the AOR. If the E-Business POC cannot locate the CCR MPIN, contact the CCR Assistance Center at 1-888-227-2423 or at [CCR@dliis.dla.mil](mailto:CCR@dliis.dla.mil).

2. Submission of Grant Applications to Grants.Gov. Once the E-Business POC has authorized privileges to the AOR, the AOR will receive an email notification that they have been given authorization. The AOR may then proceed to submit applications to Grants.Gov. To find the application on grants.gov, follow the link <http://www.grants.gov/search/basic.do> and enter the BAA number in the “Search by Funding Opportunity Number:” block. For application instructions, go to <http://www.grants.gov/Apply>. The training demonstration at <http://www.grants.gov/CompleteApplication> will assist AORs in the application process. Remember that you must open and complete the Application for Federal Assistance (Research and Related) (SF 424 (R&R)) first, as this form will automatically populate data fields in other forms. If you encounter any problems, contact customer support at 1-800-518-4726 or at [support@grants.gov](mailto:support@grants.gov). If you forget your user name or password, follow the instructions provided in the Credential Provider tutorial.

NOTE: Tutorials may be printed by right-clicking on the tutorial and selecting “Print”.

The User Guide is found at:

[http://www.grants.gov/GrantsGov\\_UST\\_Grantee!/SSL!/WebHelp/userguide.doc](http://www.grants.gov/GrantsGov_UST_Grantee!/SSL!/WebHelp/userguide.doc).

**D. Information on Other Solicitations:** Proposals on related topics that fall outside the scope of this BAA may be submitted in response to other solicitations sponsored by ARO, DTO, or other organizations. Further information regarding other solicitations may be obtained by contacting Dr. T.R. Govindan, Physics Division, (919) 549-4236, e-mail: [tr.govindan@us.army.mil](mailto:tr.govindan@us.army.mil), or Dr. Karl Roenigk, DTO, (443) 479-4363, email: [kfroeni@nsa.gov](mailto:kfroeni@nsa.gov).