

U.S. ARMY RESEARCH OFFICE
BROAD AGENCY ANNOUNCEMENT

W911NF-05-R-0009



Experimental and Theoretical
Development of Quantum Computers

August 2005

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QUANTUM COMPUTERS

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I. INTRODUCTION

The U.S. Army Research Office (ARO) together with the Advanced Research and Development Activity (ARDA) solicits proposals for experimental and theoretical studies relating to the possible physical realization of quantum computers and for achievement of effective computation on them.

II. FUNDING OPPORTUNITY DESCRIPTIONS

Proposals sought are in five categories:

- 1) “Quantum Computing Concept Maturation” 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” 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) “Enabling Studies in Quantum Computing” proposals are smaller, short-term (1-3 year) experimental or theoretical studies that advance the state of the art in *traditional* implementations of quantum computing, or advance our understanding of the fundamental resources and power of quantum computation.
- 4) “Quantum Algorithm” proposals should primarily develop new quantum computing algorithms but may also consider issues of quantum computational complexity and computability.
- 5) “Quantum Computing Graduate Research” Fellows, or QuaCGR Fellows, are graduate students who are U.S. citizens working on quantum computing for investigators funded or requesting funding through the ARO/ARDA quantum computing program. QuaCGR Fellows are funded through supplemental proposals submitted in response to this Broad Agency Announcement (BAA).

Each proposal should indicate how the proposed work will conform to or extend beyond the quantum computing roadmap devised by ARDA. 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 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 will 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. 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.

A separate BAA funding opportunity (Quantum Enabling Technology) is available for the development of specific components that would further the proposed QCCM. Additional information on this BAA can be found at www.nbc.gov/qisbaa.html. Any planned or submitted proposal to the Quantum Enabling Technology BAA to further the proposed QCCM should be referenced in the QCCM white paper and full proposal.

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. Responsive 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 will 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.

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 required to perform work on a 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.

Enabling Studies in Quantum Computing (ESIQC) Proposals

The objective of ESIQC proposals must be one of the following:

- a) Addressing a specific unresolved question or set of related questions, either experimental or theoretical in nature, relevant to traditional physical implementations of a quantum computer.
- b) Developing a critical experimental or theoretical technique to enable a specific physical implementation of quantum computing.
- c) Performing critical measurements directly related to a traditional physical implementation of quantum computing.
- d) Developing physics-based and other alternative approaches to the foundation of quantum information theory specifically directed towards elucidating the power of quantum computation.

ESIQC proposals must be very specific as to how the work will enable quantum computation. Preference will be given to proposals that will pursue improved methods or techniques, as opposed to those that are simply novel.

ESIQC proposals are anticipated to request less than \$300K per year for primarily experimental work and less than \$200K per year for primarily theoretical work for up to three years. Proposals must provide both a schedule of measurable research milestones that demonstrate the removal of key theoretical and/or experimental barriers and metrics quantifying performance enhancements.

Quantum Algorithm (QA) Proposals

Unlike QCCM and STIC proposals, QA proposals are for three-year grants 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 quantify 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.

QA proposals may impose architectural constraints for implementing algorithms, but they should otherwise concentrate on developing the algorithm. 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 Computing Graduate Research (QuaCGR) Fellow

To stimulate the involvement of U.S. citizens in research related to quantum computing, investigators submitting a proposal or already being supported by the ARO/ARDA quantum computing program may apply for a QuaCGR fellowship for the supplemental three-year funding of a U.S. citizen graduate student. The goal of this fellowship program is to add outstanding U.S. citizen graduate students to new or existing QCCM, STIC, or QA grants.

The QuaCGR proposal must outline the research activities that the candidate will undertake during the three-year length of the fellowship. The proposed work must either augment the existing research grant of the investigator or expand the group's activities in a new direction. The proposal must also provide detailed information about the student's undergraduate and graduate career to date. Transcripts and recommendation letters may be submitted but are not necessary as long as the proposal provides the following information: undergraduate institution, final undergraduate GPA and any honors obtained, GRE general and subject test scores, a summary of any prior independent 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 investigator on quantum computing-related research if awarded a QuaCGR fellowship.

In most cases, a QuaCGR fellowship proposal will request less than \$50K per year for three years to cover the costs of the student's stipend, travel, tuition, and fees only. A QuaCGR fellowship proposal may be submitted as part of a new or renewal grant proposal,

but the QuaCGR part must be a self-contained supplement of this larger proposal. Alternatively, the QuaCGR fellowship proposal may be submitted as a separate proposal to augment an active ARO/ARDA-supported grant. In either case, the QuaCGR fellowship award may continue even if the parent grant ends.

The QuaCGR proposal must identify the candidate QuaCGR 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-related research for the next three years. The lead investigator need not be a U.S. citizen, and the sponsoring university need not be a U.S. university. QuaCGR fellowship proposals may not be renewed for a given graduate student, but an investigator may have multiple QuaCGR fellows in his/her group. A QuaCGR fellow who either changes advisors or leaves quantum computing research will void the fellowship, and all remaining unspent funds will be returned to the government.

III. INFORMATION FOR OFFERORS

A. General Information

Based on budget projections and availability of funds, the ARO anticipates making only a very small number of awards for one- to four-year performance periods through this competition. If any awards are made, these 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.

Proposals on related topics but those that fall outside the scope of this solicitation may be submitted in response to other solicitations sponsored by ARO, ARDA, or other organizations. Further information regarding other solicitations may be obtained by contacting Dr. T.R. Govindan, Physics Division, (919) 549-4236, email: tr.govindan@us.army.mil, or Dr. Mark Heiligman, email: miheili@nsa.gov.

B. Eligibility

The competition is specifically for experimental and theoretical development of quantum computers as described in Section II. Potential offerors are advised to read this announcement carefully. It explains the agencies' research needs upon which the topic is based and the terms and conditions of the competition.

Proposals may be submitted by degree-granting universities, nonprofit organizations, or industrial concerns. Proposals are encouraged from Historically Black Colleges and Universities (as determined by the Secretary of Education to meet requirements of 34 CFR Section 608.2) and from Minority Institutions, defined as institutions meeting criteria contained in 10 U.S.C. 2323(a)(1)(C) which reads: "minority institutions (as defined in section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)), which, for

the purposes of this section, shall include Hispanic-serving institutions (as defined in section 316(b)(1) of such Act (20 U.S.C. 1059c(b)(1)).”

Federal laboratories, Federally Funded Research and Development Centers, and academic institutions that are federal government organizations (e.g., Naval Postgraduate School) may participate, but they may not receive funds awarded through this competition. Instead, they are encouraged to contact qc_proposals@lps.umd.edu and miheili@nsa.gov for funding information.

C. 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 of denying, and that it is not an institution of higher education that effectively prevents, the Secretary of Defense from obtaining for military recruiting purposes: (A) entry to campuses or access to students on campuses; or (B) access to directory information pertaining to students. If the recipient is determined, using procedures in 32 CFR Part 216 to be such an institution of higher education during the period of performance of this agreement, and therefore to be in breach of this clause, the Government will cease all payments of DoD funds under this agreement and all other DoD grants and cooperative agreements, and it may suspend or terminate such grants and agreements unilaterally for material failure to comply with the terms and conditions of award.” (32 CFR Part 216 may be accessed electronically at <http://www.access.gpo.gov/nara/cfr/>).

If your institution has been identified under the procedures established by the Secretary of Defense to implement Section 558 of Public Law 103-337, then: (1) no funds available to DoD may be provided to your institution through any grant, including any existing grant; (2) as a matter of policy, this restriction also applies to any cooperative agreement; and (3) your institution is not eligible to receive a grant or cooperative agreement in response to this solicitation.

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.

D. Points of Contact

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

E. Department of Defense (DoD) Central Contractor Registration (CCR)

Prospective contractors/grantees must be registered in the CCR database prior to award of an 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/index.cfm>. Assistance with registration is available by phone at 1-888-227-2423.

IV. PROPOSAL PREPARATION

A. White Paper Submission and Content

Informal white papers no more than ten pages in length outlining the proposed project, a summary of investigator qualifications, and a budget estimate must be received by 4:00 PM Eastern Daylight Savings Time, Tuesday, October 4, 2005. **White papers are required prior to proposal submission.**

White papers must be transmitted to the following e-mail address: carolyn.c.wolfe@us.army.mil. The e-mail subject line should contain the following: W911NF-05-R-0009 White Paper.

White papers should loosely follow the format described for the full proposal. White papers must be submitted in a single PDF formatted file in type not smaller than 10 pitch and double-spaced. Each white paper shall contain a single title page containing an executive summary, a single budget page outlining expected expenditures and justifications, and a single page containing curriculum vitae sketches. This leaves a maximum of seven pages, double-spaced for the technical portion of the white paper, including all references and figures. Proposers must specify whether a white paper is to be considered a QCCM, a STIC, an ESIQC, or a QA white paper. A white paper is not necessary for a QuaCGR fellowship proposal.

Feedback on the white papers will be e-mailed directly to the proposed Principal Investigators on or about the week of November 7, 2005. It is possible that a proposer will be asked to submit a proposal in response to this solicitation to an agency other than ARO. Such guidance will be provided in the feedback e-mailed to the Principal Investigators.

B. Proposal Submission

All proposals under this BAA must be submitted electronically. Proposals must contain all information specified in Proposal Content below. The electronic proposal must be received at the Army Research Office by 4:00 PM Local Time on Tuesday, January 10, 2006.

Proposals must be transmitted to the following address: baa@arl.army.mil. Proposals must be submitted in a single PDF formatted file. The e-mail subject line should contain the following: W911NF-05-R-0009 Proposal. Proposers must specify whether a proposal is to be considered a QCCM, an STIC, an ESIQC, a QA and/or a QuaCGR proposal.

The proposal must contain three completed and signed electronic forms: (1) ARO Form 51, Proposal Cover Page; (2) ARO Form 99, Summary Proposal Budget; and (3) ARO Current and Pending Support (unnumbered form). See Proposal Content below. These forms may be accessed electronically at <http://www.aro.army.mil/forms/forms2.htm>. The fillable PDF forms may be saved to a working directory on your computer and opened and filled in using the Adobe Acrobat software application.

If you have questions concerning electronic proposal submission, please contact the Army Research Office at (919) 549-4219. Proposals submitted by facsimile will not be accepted.

Proposals received after the deadline will be handled in accordance with the provisions detailed in Appendix A.

Acknowledgment of receipt of a proposal under this solicitation will be accomplished via e-mail to the addressee submitting the proposal.

C. Proposal Content

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 the Evaluation Criteria and Selection Process.

Proposals should include:

- (1) Cover page: To be eligible for review, proposals must have ARO Form 51 as a cover page (See Proposal Submission above).
- (2) Abstract: The offeror must provide an abstract no longer than one page. Proposers must specify whether a proposal is to be considered a “Quantum Computing Concept Maturation” proposal, a “Short-Term Innovative Concept” proposal, a “Quantum Algorithm” proposal, an “Enabling Studies In Quantum Computing” proposal and/or a “Quantum Computing Graduate Researcher” proposal. This should be clearly specified in the space between the proposal title and abstract.
- (3) Text: The technical portion of the proposal should be typed, double-spaced. This section of the proposal is limited to 30 pages and should:

(a) Adopt the following format: 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.

(b) 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.

(c) Describe plans for the research training of students in science and/or engineering.

(d) 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.

(e) Identify other parties to whom the proposal has been/will be sent.

(4) Personnel: 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.

(5) Cost: The financial portion of the proposal should contain cost estimates sufficiently detailed for meaningful evaluation, including cost details for proposed sub-awards. Use ARO Form 99, Summary Proposal Budget, to submit budget data (See Proposal Submission above). For budget purposes, use an award start date of May 1, 2006. The budget must include the total cost of the project, as well as 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). The cost proposal is not considered part of the page count.

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, appropriate research costs, and tuition. Allowable charges for undergraduate students include salary and research training costs, but not tuition.

(b) Cost of equipment, based on most recent quotations and broken down in sufficient detail for evaluation. Equipment costs should be budgeted primarily during the first year.

(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 QuaCGR 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.

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

(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.)

(6) Statement of Current and Pending Support. 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 (See Proposal Submission above). 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.

(7) Additional information for QuaCGR proposals or supplements: The proposal must outline the research activities that the candidate will undertake during the three-year length of the fellowship. The proposal must specify how the QuaCGR fellow will augment the existing research grant of the investigator or expand the group's activities in a new direction. The proposal must also provide detailed information about the student's undergraduate and graduate career to date. Transcripts and recommendation letters may be submitted but are not necessary as long as the proposal provides the following information: undergraduate institution, final undergraduate GPA and any honors obtained, GRE general

and subject test scores, a summary of any prior independent 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 investigator on quantum computing-related research if awarded a QuaCGR fellowship.

D. Length and Format of Proposals

Each QCCM, STIC, ESIQC, or QA proposal must be no longer than 40 pages, inclusive of vitae and cover, but exclusive of budget and statement of current and pending support. Each proposal must be submitted in a single, PDF format electronic file. A page is defined as 8 1/2 x 11 inch paper, single-sided, with one-inch margins and a font and pitch of Times New Roman 10. All pages should be numbered consecutively, beginning with the first page after the proposal cover page. The Proposal Cover Page, ARO Form 51, is included in the page count. The budget and statement of current and pending support are not included in the page count. The technical portion must be typed, double-spaced, and may not exceed 30 pages. Proposals shorter than 40 pages are heartily encouraged. Separate attachments, such as institutional brochures or reprints, cannot be considered.

QuaCGR proposals, whether submitted as a supplement to another proposal or as a stand-alone proposal, may not exceed 4 pages, exclusive of the requisite cover and budget pages. Transcripts and recommendation letters are not necessary, but if submitted they will not count against the page length restriction. The length of a QuaCGR proposal submitted as a supplement to a larger proposal will not count against the 40-page length of the larger proposal but must conform to the 4 page QuaCGR page limit.

E. Marking of White Papers and Proposals and Disclosure of Proprietary Information outside the Government

1. The white paper/proposal submitted in response to this solicitation 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 white paper/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 white paper/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 white paper/proposal: "For any purpose other than to evaluate the white paper/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 white paper/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 white paper/proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the front page of this white paper/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 white paper/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 white paper/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.

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

V. EVALUATION CRITERIA AND SELECTION PROCESS

The selection process will be conducted based upon a technical peer review as described in Federal Acquisition Regulation Subparts 6.102(d)(2) and 35.016 and DOD Grant and Agreement Regulations [(DOD 3210.6-R (DODGARS), Section 22.315]. All information necessary for the review and evaluation of the proposal must be contained in the Technical Proposal and Cost Proposal as identified in Section IV.C.

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, ESIQC and QA proposals) or by the qualifications of the candidate (QuaCGR 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.

VI. NOTIFICATION TO OFFERORS

Notification of acceptance of proposals will be mailed by ARO on or about February 20, 2006. Unsuccessful offerors will be notified shortly thereafter.

VII. AWARDS

A. Proposers must specify whether a proposal is to be considered a QCCM, a STIC, an ESIQC, a QA, or a QuaCGR (supplement or stand-alone) proposal. 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. Most QuaCGR proposals are anticipated to require less than \$50K per year. Primarily experimental ESIQC proposals will request less than \$300K per year and primarily theoretical ESIQC proposals will request less than \$200K per year.

B. Reporting requirements for both contracts and grants will be as described in ARO Form 18 located at <http://www.aro.army.mil/forms/forms2.htm>. Additional reports will be specified in the award document.

VIII. INFORMATION TO BE REQUESTED FROM SUCCESSFUL OFFERORS

Offerors whose proposals are accepted for funding will be contacted before award to provide 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.

IX. CERTIFICATIONS FOR ASSISTANCE AWARDS (GRANTS OR COOPERATIVE AGREEMENTS)

1. Certification at Appendix A to 32 CFR Part 28 Regarding Lobbying

By signing and submitting a proposal that may result in the award of a grant or cooperative agreement 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.

2. Certification at Appendix A to 32 CFR Part 25 Regarding Debarment, Suspension, and Other Responsibility Matters --Primary Covered Transactions

(1) By signing and submitting this proposal, the prospective primary participant is providing the certification set out below.

(2) The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

(3) The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

(4) The prospective primary participant shall provide immediate written notice to the department or agency to which this proposal is submitted if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(5) The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive order 12549. You may contact the department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

(6) The prospective primary participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is proposed for debarment under 48 CFR

part 9, subpart 9.4, debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

(7) The prospective primary participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

(8) A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not proposed for debarment under 48 CFR part 9, subpart 9.4, debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the List of Parties excluded from Federal Procurement and Nonprocurement Programs.

(9) Nothing contained in the foregoing shall be construed to require establishment of a system or records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(10) Except for transactions authorized under paragraph 6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is proposed for debarment under 48 CFR part 9, subpart 9.4, suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters--Primary Covered Transactions

The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

Where the prospective primary participant is unable to certify to any of the statements in this certification such prospective participant shall attach an explanation to this proposal.

3. Certification at Appendix C to 32 CFR Part 25 Regarding Drug-Free Workplace Requirements

(1) By signing and/or submitting this application or grant agreement, the grantee is providing the certification set out below.

(2) The certification set out below is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

(3) For grantees other than individuals, Alternate I applies.

(4) For grantees who are individuals, Alternate II applies.

(5) Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

(6) Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

(7) If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph five).

(8) Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules;

Controlled substance means a controlled substance in schedules I through V of the Controlled Substances Act (21 U.S.C. 812), and as further defined by regulation (21 CFR 1308.11 through 1308.15);

Conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

Criminal drug statute means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

Employee means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) All "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

Certification Regarding Drug-Free Workplace Requirements
(Alternate I - Grantees Other Than Individuals)

The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--

(1) The dangers of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace.

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will--

(1) Abide by the terms of the statement; and

(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under paragraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grants officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under paragraph (d)(2), with respect to any employee who is so convicted--

(1) Taking appropriate personnel action against such employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

Check if there are workplaces on file that are not identified here.

(Alternate II - Grantees Who Are Individuals)

(a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;

(b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing within 10 calendar days of the conviction, to every grants officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

B. Certifications for Contract Awards

Certifications and representations will be obtained from successful offerors prior to award.

APPENDIX A: LATE SUBMISSIONS AND WITHDRAWALS OF PROPOSALS

- a. 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.
- b. 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 unless it was received at the initial point of entry to the Government infrastructure not later than 4:00 p.m. Local Time one working day prior to the date specified for receipt of proposals.
- c. Acceptable evidence to establish the time of receipt at the Government office includes, as applicable, documentary evidence of receipt maintained by the installation.
- d. 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.
- e. Proposals may be withdrawn by written notice received at any time before award. Withdrawals are effective upon receipt of notice by the Contracting Officer.