BAA06-47
Proposer Information Pamphlet (PIP)

for

Defense Advanced Research Projects Agency (DARPA)
Strategic Technology Office (STO)

Quantum Sensors Program (QSP)

Technical POC: Dr. Michael Zatman, DARPA/STO
All emails regarding this solicitation should be sent to quantum@darpa.mil

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This BAA will be open for one (1) year from the date of its publication in www.fbo.gov and www.grants.gov.

NOTE: Although this BAA will be open for one (1) year from the date of its publication on www.fbo.gov and www.grants.gov, the Government anticipates that the majority of Base funding for this program will be committed during First Selections. To be considered for funding during First Selections, full proposals must be received no later than **4:00 PM local Arlington, Virginia time on November 22nd 2006.** (Note: Those offerors that are proposing efforts under Grant instruments may alternately submit full proposals through www.grants.gov).

A Proposers' Day Conference will be held approximately on 17 October 2006, to encourage discussion and teaming on this topic. It is not mandatory to attend the Proposers' Day Conference to respond to this BAA. To register, send an email to quantum@darpa.mil or visit the QSP website at https://dtsn.darpa.mil/qsp. Questions regarding this solicitation may also be emailed to quantum@darpa.mil, and answers will be posted at https://dtsn.darpa.mil/qsp.

BAA06-47, Quantum Sensors Program

1. INTRODUCTION

The Defense Advanced Research Projects Agency's (DARPA) Strategic Technology Office (STO) is soliciting proposals under this BAA for the performance of research, development, design, and testing to support the DARPA Quantum Sensors Program.

1.1. APPROACH

This BAA affords proposers the choice of submitting proposals for the award of a Grant, Cooperative Agreement, Procurement Contract, Technology Investment Agreement, or other such appropriate award instrument. The Government reserves the right to negotiate the type of award instrument determined appropriate under the circumstances.

1.2. PROPOSERS

The Government encourages proposals from non-traditional defense contractors, nonprofit organizations, educational institutions, small businesses, small disadvantaged business concerns, Historically-Black Colleges and Universities (HBCU), Minority Institutions (MI), large businesses and Government laboratories. Teaming arrangements between and among these groups are encouraged. However, no portion of this BAA will be set aside for HBCU/MI, small or small disadvantaged business participation due to the impracticality of preserving discrete or severable areas of research in the technologies sought. Government/National laboratory proposals may be subject to applicable direct competition limitations, though certain Federally Funded Research and Development Centers are excepted per P.L. 103-337 § 217 and P.L 105-261 § 3136. Any responsible and otherwise qualified Proposer is encouraged to respond.

Proposers may be foreign firms or may team with foreign firms as long as the firm meets the criteria in this BAA and the Government is otherwise permitted to conduct business with the firm. Proposers may include foreign personnel as part of their proposed resources as long as these personnel qualify technically, the proposed effort is unclassified, and such foreign personnel sign any and all appropriate non-disclosure agreements prior to participating in the research effort.

1.3. PROGRAM SCOPE AND FUNDING

The Government intends to issue awards based on the optimal combination of proposals that offers the best overall value to the Government. The Government reserves the right to award without discussions. The Government reserves the right to select for award all, some, or none of the proposals received in response to this BAA. The Government also reserves the right to select for award some portion(s) of the proposals received; in that event, the Government may select for negotiation all, or portions, of a given proposal. The Government may incrementally fund any award issued under this BAA.

It is anticipated that Phases I and II of the Quantum Sensors Program will continue through July 2009.

While the earliest anticipated award is planned to occur in January 2007, the Government may select for funding any full proposal or portions of a proposal at any time during this year.

1.4. PERIOD OF PERFORMANCE

The total period of performance for the effort will be 24-30 months as follows:

- Phase I Theory (Base): 12-18 months after the effective date of award
- Phase I Experiment (Option): 12-18 months after the effective date of award, concurrent with Phase I Theory
- Phase II (Potential Downselect): 12 months after the effective date of Phase II award.

The Government may incrementally fund any awards under this BAA.

1.5. TECHNICAL AND ADMINISTRATIVE SUPPORT

It is the intent of this office to use contractor support personnel in the administration of all submittals to this BAA. The Government intends to use non-government employees and subcontractors to assist in administration and, if needed, provide technical expertise on portions of the proposals. These personnel will have signed and be subject to the terms and conditions of non-disclosure agreements. These non-government employees are local (Arlington, VA) DARPA support contractors from Schafer Corp. and Booz-Allen-Hamilton. By submission of its proposal, a proposer agrees that its proposal information may be disclosed to employees of these organizations for the limited purpose stated above. If you do not send notice of objection to this arrangement, the Government will assume you consent to use the subject personnel in review of your submittal(s) under this BAA. Only Government personnel will make technical evaluations and award recommendations or decisions under this BAA.

1.6. INSTRUCTIONS AND POINTS OF CONTACT

All questions pertaining to this BAA must be submitted to DARPA at the following e-mail address: quantum@darpa.mil DARPA may post updates to questions or comments periodically to the QSP website: https://dtsn.darpa.mil/qsp. This web site may also be utilized to find teaming partners. Potential proposers considering joining a team or adding to their team may post their contact information and a brief summary of capabilities offered or desired.

2. OVERVIEW OF QUANTUM SENSORS

2.1. PROGRAM OVERVIEW

The Quantum Sensors Program will develop imaging and remote sensing systems that exploit non-classical states to achieve superior resolution compared to a classical sensor. Examples of non-classical states include entangled, squeezed, and cat. Discrete and continuous variable entanglement and mixtures of entangled states are of potential interest. Examples of sensors of interest include lidar/radar, synthetic aperture lidar/radar, imaging cameras, and passive RF sensors.

For specific examples of hardware configurations and experimental protocols, refer to the 13 May 2004 issue of Nature (volume 429). The “letters to nature” from M. W. Mitchell et. al. (“Super-resolving phase measurements with a multiphoton entangled state”) and Philip Walther et al. (“De Broglie wavelength of a non-local four-photon state”) present approaches that might be developed into Quantum Sensor concepts for proposal in response to this BAA. The proposer seeking a concept more easily scaled to achieve greater advantage over classical sensors might consider continuous variable entanglement (S. Feng and O. Pfister, “Quantum Interference of

Ultrastable Twin Optical Beams", Physical Review Letters, 21 May 2004). The proposer wishing to circumvent transmission loss issues might consider transmitting classical photons and constraining the non-classical states to the detector (Avi Pe'er et al., "Quantum lithography by coherent control of classical light pulses", Optics Express vol. 12 no. 26, 27 December 2004). Although the referenced approaches represent excellent experimental work, other unpublished approaches may better fit the selection criteria for the Quantum Sensors Program.

2.1.1. Phase I Theory (Base)

As referenced in Section 2.1, non-classical metrology and lithography concepts have been experimentally validated. There is a far larger body of theoretical work proving the advantages over classical approaches. It does not logically follow that these advantages extend to practical sensors and targets outside of a controlled laboratory environment. DARPA has established a set of conditions which must be met in order for a specific quantum sensor concept to offer broad potential for practical applications. In the following list, a classical sensor is defined as a remote sensing or imaging system that utilizes coherent photons, whereas a quantum sensor utilizes photons that are squeezed, entangled, or in some other non-classical state. In the comparison of performance, the classical and quantum sensors are assumed to operate at the same single-photon wavelength, and to transmit the same power (if active).

The following conditions must be simultaneously satisfied:

1) The photons' interaction with a target doesn't cause the non-classical state to be entirely lost.
2) The quantum sensor can resolve two targets at a closer spacing than is possible with a classical sensor.
3) The energy that travels between the quantum sensor and the target propagates at the single-photon wavelength.
4) The quantum sensor suffers a loss of sensitivity and resolution that is no worse than the loss suffered by a classical sensor under all of the following conditions:
    a. The transmission medium between the sensor and the target absorbs or diffusely scatters photons.
    b. The target is in a 300K (RF sensors) or daylight (optical sensors) environment.
    c. The target absorbs some incident photons.
    d. The target scatters incident photons non-uniformly over 4π steradians.

The definition of "sensor" is intentionally vague in order to encourage proposal of a wide variety of sensor types. However, it is important to note that the list of conditions refers to measurement resolution rather than accuracy or precision. The "two targets" may be two separate objects or two different scatterers on a single larger object. Depending on the type of sensor, the targets may be separated parallel or perpendicular to the direction of sensor photon propagation. The photons in non-classical states may be transmitted to the target, utilized in the detector, or both. Transmitting classical photons to the target and utilizing the non-classical photons only in the detector will immediately satisfy several of the condition listed above. If the non-classical states are confined to the detector then the sensor may be passive, with no photons transmitted to the target.

During Phase I, the performing contractor will determine whether the proposed quantum sensor concept simultaneously satisfies the conditions listed above. This must be accomplished through 12-18 months of theoretical analysis, possibly supplemented by previous experimental results (including results published by others). The Performer will also make a specific calculation of the resolution improvement achieved with a 3 dB loss in the transmission medium and a resulting 26 dB signal to noise ratio.

As detailed in Section 4, a single proposal may propose multiple sensor concepts. A single concept may have minor variations to be explored and better defined during Phase I. However, potential variations which rely on entirely different non-classical states or entirely different application methods should be proposed as separate concepts within a single proposal document. Refer to the discussion in Section 5 on the evaluation of proposals containing multiple sensor concepts. All proposals should be well matched to the evaluation criteria discussed in Section 5.

2.1.2. Phase I Experiment (Option)

The proposal may include an optional experimental demonstration. The goal of this experiment may be to provide additional validation of some results demonstrated analytically under the Base effort, particularly if the relevant theoretical base is underdeveloped. The goal of a proposed experiment may be to determine results beyond the scope of the Base effort. Simple duplication of previous experiment results is not encouraged for proposal. The proposal technical content should be well matched to the evaluation criteria discussed in Section 5.

If the Government exercises the Phase I Experiment option it will most likely be done concurrent to the Base Phase I Theory work. Thus, the proposed Experiments(s) should be carefully costed in Volume II of the proposal. The proposed duration of a Phase I Experiment Option should match that of the corresponding Phase I Base effort.

2.1.3. Phase II

A successful Phase I will indicate that a specific quantum sensor concept can support practical application, but the system engineering and concept of operation will be undeveloped. Phase II will extend the Phase I results to system engineering and performance evaluation. Phase II should be accomplished through analysis and simulation, potentially supplemented by experiential data collection.

The first task under Phase II is system engineering and flow-down of requirements to sub-systems and components. The resulting system design may require components which are not available or require further development. The emphasis of this task is optimization, achieving maximum performance with minimum of required component development and a minimal resulting sensor system size, weight, power, and cost.

The second task under Phase II is development of concepts of operations and calculation of expected performance. The specific application and environment assumed for this analysis will be negotiated if the Government elects to pursue Phase II. The performance calculations will be parametric, quantifying the relationship between the component technology development under consideration for Phase III and the expected payoff in improved sensor system performance. It is expected that this task will require development of a sensor system simulation.

The Government may elect not to pursue Phase II even if Phase I is successful. If the Government is interested in Phase II may be accomplished as a down-selection from Phase I Performers, in which case Phase II proposals will be requested from Phase I Performers and BAA06-47 selection criteria will be updated. Alternatively, the Government may conduct a new solicitation for Phase II.

2.1.4. Phase III – Component Technology Development

The sensor system developed under Phase II is likely to require components which require further development. Phase III will develop these components to the levels required to support sensor system operation. A new solicitation for this development will be issued if the Government chooses to pursue Phase III.

2.1.5. Phase IV – System Demonstration

Phase IV will demonstrate that the component technology development under Phase III was successful. This will be accomplished in the form of a sensor system demonstration which will experimentally validate the Phase II results.

2.2. PROGRAM METRICS

In order for the Government to evaluate the effectiveness of a proposed solution in achieving the stated program objectives, proposers should note that the Government hereby promulgates the following program metrics that may serve as the basis for determining whether satisfactory progress is being made to warrant continued funding of the program. Although the following program metrics are specified, proposers should note that the Government has identified these goals with the intention of bounding the scope of effort, while affording the maximum flexibility, creativity, and innovation in proposing solutions to the stated problem.

Proposals should cite the quantitative and qualitative success criteria that the proposed effort will achieve by the time of each Phase's program metric measurement.

Table 1. Program Metrics.

Phase	Months After Contract Award	Program Metrics
1 (Base)	12-18	1. The quantum sensor concept has been shown to simultaneously satisfy all of the four conditions listed in Section 2.1.1. 2. The quantum sensor concept has been shown to support at least a 10x improvement in resolution over the Rayleigh limit in the presence of 3 dB of transmission medium loss with an SNR of 26 dB.
2 (Potential Downselect)	12 months	TBD (To Be Determined after success in Phase 1)

3. GENERAL INFORMATION

3.1. ELIGIBILITY

This BAA solicits proposals from all interested and qualified sources. Foreign participants and/or individuals may participate to the extent that such participants comply with any necessary Non-Disclosure Agreements, Security Regulations, Export Laws, and other governing statutes applicable under the circumstances.

3.2. PROCUREMENT INTEGRITY, STANDARDS OF CONDUCT, ETHICAL CONSIDERATIONS, AND ORGANIZATIONAL CONFLICTS OF INTEREST (OCIs)

Certain post-employment restrictions on former federal officers and employees may exist, including special Government employees (including but not limited to Section 207 of Title 18, United States Code, the Procurement Integrity Act, 41 U.S.C. 423, and FAR 3.104). If a prospective proposer believes that a conflict of interest exists, the situation should be raised to the DARPA Contracting Officer before time and effort are expended in preparing a proposal. All proposers and proposed sub-contractors must therefore affirm whether they are providing scientific, engineering, and technical assistance (SETA) or similar support to any DARPA technical office(s) through an active contract or subcontract. All affirmations must state which office(s) the proposer supports and identify the prime contract numbers. Affirmations shall be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest (FAR 9.5.) must be disclosed. The disclosure shall include a description of the action the proposer has taken or proposes to take to avoid, neutralize, or mitigate such conflict.

3.2.1 Human Use In Research

Proposals selected for funding are required to comply with provisions of the Common Rule (32 CFR 219) on the protection of human subjects in research (http://www.dtic.mil/biosys/downloads/32cfr219.pdf and the Department of Defense Directive 3216.2 (http://www.dtic.mil/whs/directives/corres/html2/d32162x.htm. All proposals that involve the use of human subjects are required to include documentation of their ability to follow Federal guidelines for the protection of human subjects. This includes, but is not limited to, protocol approval mechanisms, approved Institutional Review Boards, and Federal Wide Assurances. These requirements are based on expected human use issues sometime during the entire length of the proposed effort.

For proposals involving "greater than minimal risk" to human subjects within the first year of the project, performers must provide evidence of protocol submission to a federally approved IRB at the time of final proposal submission to DARPA. For proposals that are forecasted to involve "greater than minimal risk" after the first year, a discussion on how and when the proposer will comply with submission to a federally approved IRB needs to be provided in the submission. More information on applicable federal regulations can be found at the Department of Health and Human Services - Office of Human Research Protections website (http://www.dhhs.gov/ohrp/.

3.3. INTELLECTUAL PROPERTY

All proposers should clearly define all deliverables associated with the proposed research; all proprietary assertions to intellectual property of all types, including any background inventions, should be set forth in detail.

3.3.1. Procurement Contract Proposers

3.3.1.1 Noncommercial Items: (Technical Data and Computer Software)

Proposers responding to this BAA requesting a procurement contract to be issued under the FAR/DFARS, shall identify all noncommercial technical data, and noncommercial computer software that it plans to generate, develop, and/or deliver under any proposed award instrument in which the Government will acquire less than unlimited rights, and to assert specific restrictions on those deliverables. Proposers shall follow the format under DFARS 252.227-7017 for this stated purpose. In the event that proposers do not submit the list, the Government will assume that it automatically has "unlimited rights" to all noncommercial technical data and noncommercial computer software generated, developed, and/or delivered under any award instrument, unless it is substantiated that development of the noncommercial technical data and noncommercial computer software occurred with mixed funding. If mixed funding is anticipated in the development of noncommercial technical data, and noncommercial computer software generated, developed, and/or delivered under any award instrument, then proposers should identify the data and software in question, as subject to Government Purpose Rights (GPR). In accordance with DFARS 252.227-7013 Rights in Technical Data - Noncommercial Items, and DFARS 252.227-7014 Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation, the Government will automatically assume that any such GPR restriction is limited to a period of five (5) years in accordance with the applicable DFARS clauses, at which time the Government will acquire "unlimited rights" unless the parties agree otherwise. Proposers are admonished that the Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the proposer, as may be necessary, to evaluate the proposer's assertions. If no restrictions are intended, then the proposer should state "NONE."

A sample list for complying with this request is as follows:

NONCOMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

3.3.1.2 Commercial Items: (Technical Data and Computer Software)

Proposers responding to this BAA requesting a procurement contract to be issued under the FAR/DFARS, shall identify all commercial technical data, and commercial computer software that may be embedded in any noncommercial deliverables contemplated under the research effort, along with any applicable restrictions on the Government's use of such commercial technical data and/or commercial computer software. In the event that proposers do not submit the list, the Government will assume that there are no restrictions on the Government's use of such commercial items. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional

information from the proposer, as may be necessary, to evaluate the proposer's assertions. If no restrictions are intended, then the proposer should state "NONE."

A sample list for complying with this request is as follows:

COMMERCIAL			
Technical Data Computer Software To be Furnished With Restrictions	Basis for Assertion	Asserted Rights Category	Name of Person Asserting Restrictions
(LIST)	(LIST)	(LIST)	(LIST)

3.3.2. Non-Procurement Contract Proposers (Noncommercial and Commercial Technical Data and Computer Software)

Proposers responding to this BAA requesting a Grant, Cooperative Agreement, Technology Investment Agreement, or Other Transaction for Prototype shall follow the applicable rules and regulations governing these various award instruments, but in all cases should appropriately identify any potential restrictions on the Governments use of any Intellectual Property contemplated under those award instruments in question. This includes both Noncommercial Items and Commercial Items. Although not required, proposers may use a format similar to that described in Paragraphs 3.4.1 and 3.4.2 herein. The Government may use the list during the source selection evaluation process to evaluate the impact of any identified restrictions, and may request additional information from the proposer, as may be necessary, to evaluate the proposer's assertions. If no restrictions are intended, then the proposer should state "NONE."

3.3.3. All Proposers (Patents)

Please include documentation proving your ownership of or possession of appropriate licensing rights to all patented inventions (or inventions for which a patent application has been filed) that will be utilized under your proposal for the DARPA program. If a patent application has been filed for an invention that your proposal utilizes, but the application has not yet been made publicly available and contains proprietary information, you may provide only the patent number, inventor name(s), assignee names (if any), filing date, filing date of any related provisional application, and a summary of the patent title, together with either: 1) a representation that you own the invention, or 2) proof of possession of appropriate licensing rights in the invention.

3.3.4. All Proposers (Intellectual Property)

Please also provide a good faith representation that you either own or possess appropriate licensing rights to all other intellectual property that will be utilized under your proposal for the DARPA program**.**

3.4. REPORTING REQUIREMENTS

The number and types of reports will be specified in the award document, but will include as a minimum monthly R&D and financial status reports (see sample at attachment A). The reports shall be prepared and submitted in accordance with the procedures contained in the award document and mutually agreed on before award. A Final Report that summarizes the project and tasks will be required at the conclusion of the performance period for the award, notwithstanding

the fact that the research may be continued under a follow-on vehicle. Each performer will also be required to submit period reports on invention disclosure, election of title, and filing of patent applications. Classified reports must be submitted on CD-ROM. Unclassified reports may be submitted on CD-ROM, via email, via upload to a designated Government computer, or via Government download from a Performer computer. All reports must be formatted to be readable by one of the following four software applications:

- Adobe Reader
- Microsoft Word
- Microsoft PowerPoint
- Microsoft Excel

3.5 REQUIRED REVIEW AND INTERCHANGE MEETINGS

A kickoff meeting, quarterly technical review meetings, and a final review meeting are mandatory for the Base and all Options.

For the Base contract, the final review meeting and one mid-point review meeting will be held at a location in CONUS selected and provided by DARPA. These will be organized as two-day Workshops with all QSP Performers attending and presenting to the full Performer community and Government team. The kickoff meeting and remainder of the quarterly review meetings will be one-day meetings held at a location selected and provided by Performer. The Government will not invite other Performers to these one-day meetings.

All briefings presented at these meetings must be provided to DARPA at least three days prior to the meeting.

3.6 SUBCONTRACTING

Pursuant to Section 8(d) of the Small Business Act (15 U.S.C. 637(d)), it is the policy of the Government to enable small business and small disadvantaged business concerns to be considered fairly as subcontractors to contractors performing work or rendering services as prime contractors or subcontractors under Government contracts, and to assure that prime contractors and subcontractors carry out this policy. Each proposer who submits a contract proposal and includes subcontractors is required to submit a subcontracting plan IAW FAR 19.702(a) (1) and (2) should do so with their proposal. The plan format is outlined in FAR 19.704.

3.7 EXPORT LICENSES

The following provision will be incorporated into any resultant contract:

(1) The contractor shall comply with all U. S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 DFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this contract. In the absence of available license exemptions/exceptions, the Contractor shall be responsible for obtaining the appropriate licenses or other approvals, for obtaining the appropriate licenses or other approvals, if required, for exports of hardware, technical data, and software, and for the provision of technical assistance.

(2) The Contractor shall be responsible for obtaining export licenses, if required, before utilizing foreign persons in the performance of this contract, including instances where the work is to be performed on-site at any Government installation, where the foreign person will have access to export-controlled technical data or software.

(3) The Contractor shall be responsible for all regulatory record keeping requirements associated with the use of licenses and license exemptions/exceptions.

(4) The Contractor shall be responsible for ensuring that the provisions of this clause apply to its subcontractors.

3.8 PUBLIC RELEASE OR DISSEMINATION OF INFORMATION

The following provision will be incorporated into any resultant contract:

(a) There shall be no dissemination or publication, except within and between the Contractor and any subcontractors, of information developed under this contract or contained in the reports to be furnished pursuant to this contract without prior written approval of the Contracting Officer Representative (COR). All technical reports will be given proper review by appropriate authority to determine which Distribution Statement is to be applied prior to the initial distribution of these reports by the Contractor. Papers resulting from unclassified contracted fundamental research are exempt from prepublication controls and this review requirement, pursuant to DoD Instruction 5230.27 dated October 6, 1987.

(b) When submitting material for clearance for open publication, the Contractor must furnish DARPA Technical Information Officer, 3701 North Fairfax Drive, Arlington VA 22203-1714, telephone (703) 526-4163 with five copies and allow four weeks for processing. Viewgraph presentations must be accompanied with a written text. Whenever a paper is to be presented at a meeting, the Contractor must indicate the exact dates of the meeting or the Contractor's date deadline for submitting the material.

3.9 AWARD ADMINISTRATION INFORMATION

(1) Central Contractor Registration. Selected offerors not already registered in the Central Contractor Registry (CCR) will be required to register in CCR prior to any award under this BAA. Information on CCR registration is available at http://www.ccr.gov.

(2) Representations and Certifications. In accordance with Federal Acquisition Regulation 4.1201, prospective proposers shall complete electronic annual representations and certifications at http://orca.bpn.gov.

4. PROPOSAL PREPARATION

4.1. GENERAL GUIDANCE

All proposals submitted must follow the instructions in this Proposer Information Pamphlet (PIP) and include only the information requested to avoid delays in evaluation or disqualification. It is

anticipated that within 50 days of completing the evaluation, proposers will be notified that: 1) its proposal has been selected for negotiation, or 2) its proposal has not been selected.

4.1.1. Restrictive Markings on Proposals

All proposals should clearly indicate limitations on the disclosure of their contents. Proposers who include in their proposals data that they do not want disclosed to the public for any purpose, or used by the Government except for evaluation purposes, shall-

(1) Mark the title page with the following legend:

> This proposal includes data that shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed-in whole or in part-for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this proposer 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 resulting contract. This restriction does not limit the Government's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained in sheets [*insert numbers or other identification of sheets*]; and

(2) Mark each sheet of data it wishes to restrict with the following legend:

> Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this proposal.

Markings like "Company Confidential" or other phrases that may be confused with national security classifications shall be avoided. See Section 6.0, for additional information.

4.1.2. Confidentiality

It is the policy of DARPA to treat all proposals as competitive information and to disclose their contents only for the purpose of evaluation. No proposals will be returned. The original of each proposal received will be retained at DARPA and all other copies of non-selected proposals destroyed. Documentation related to the source selection process will be marked SOURCE SELECTION INFORMATION – SEE FAR 2.101 AND 3.104.

4.1.3. Submission Timelines

This BAA shall remain open for one (1) year from the date of publication on www.fbo.gov and www.grants.gov. Although the Government may select proposals for award at any time during this period, it is anticipated that the majority of Base funding for this program will be committed during the initial selection period as stipulated on the first page of this Proposer Information Pamphlet (PIP.) Proposers may submit a full proposal in accordance with the instruction provided herein at any time up to the proposal due date.

All submitted proposals will be reviewed. In order to be considered during the initial round of funding, full proposals must be submitted to DARPA, 3701 North Fairfax Drive, Arlington, VA 22203-1714 (Attn.: **BAA06-47**) **on or before 4:00 PM local Arlington, Virginia time,**

November 22nd 2006. (Note: Those offerors that are proposing efforts under Grant instruments may alternately submit full proposals through www.grants.gov).

Proposals submitted under this BAA may be either mailed or hand-delivered.
Mailing address: DARPA
ATTN: **BAA06-47**
3701 North Fairfax Drive
Arlington, VA 22203-1714

For hand deliveries, the courier shall deliver the package to the DARPA Visitor Control Center at the address specified above. The outer package, as well as the cover page of the proposal, must be marked "Quantum Sensors Program, BAA06-47."

4.2. FORMATTING CHARACTERISTICS

All submissions must be submitted electronically on CD-ROM. Paper copies are not required. Proposers must submit two duplicate CDs, each containing all proposal documents. Each CD must be clearly labeled with "BAA06-47**"**, proposer organization, and proposal title (short title recommended). Files on the CD should be organized into two folders called "Volume I" and "Volume II". All documents on the CD must be formatted to be readable by one of the following four software applications:

- Adobe Reader
- Microsoft Word
- Microsoft PowerPoint
- Microsoft Excel

4.2.1. Proposal Format

Proposals shall consist of two volumes.

Volume I, Technical and Management Proposal, consists of three Sections as detailed below. Volume I may be supplemented by a separate bibliography and technical papers (published and unpublished) which document the technical ideas and approach upon which the proposal is based. Since the reviewers may not have time to review these additional documents, all critical information should be included in the formal proposal. The bibliography and background papers are not included in the page counts given below. Volume I must be formatted so that it may be printed on standard 8.5" by 11.0" paper with 1.0" margins (left, right, top, and bottom). It must contain fonts no smaller than 12 point (figures and tables included).

Volume II, Cost Proposal, has no page limit. Volume II should have a single central summary document formatted for reading by Adobe Reader or Microsoft Word. Spreadsheets may be incorporated into this document or referenced and provided as separate files in Microsoft Excel format.

4.2.1.1. Volume I, Technical and Management Proposal

Section I. Summary Slide – Limit of **1 page**

A single page PowerPoint summary chart. After individual reviewers have reviewed each proposal, this PowerPoint summary will be utilized to remind the full Source

Selection Committee of the sensor concept while it develops a consensus opinion of the proposal. Thus, all critical and distinguishing features of the proposed concept should appear in the summary.

Section II. Administrative, Overview, and Background – Limit of **20 pages**

1. Cover sheet to include:
   a. BAA number (**BAA06-47**)
   b. Lead Organization Submitting proposal
   c. Type of business, selected among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT"
   d. Contractor's reference number (if any)
   e. Other team members (if applicable) and type of business for each
   f. Proposal title
   g. Technical point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available)
   h. Administrative point of contact to include: salutation, last name, first name, street address, city, state, zip code, telephone, fax (if available), electronic mail (if available)
   i. Funds requested from DARPA for the Base Effort, each option and the total proposed cost; and the amount of cost share (if any)
   j. Date proposal was prepared.
2. Official transmittal letter.
3. {Not included in page count} Table of Contents. The Table of Contents should be keyed to the page numbers of the proposal sections.
4. Executive Summary of the entire proposal: This section should succinctly describe the uniqueness and benefits of all of the proposed quantum sensor concepts relative to classical sensors.
5. Deliverables associated with the proposed research.
6. Intellectual Property. Include in this section all proprietary claims to results, prototypes, intellectual property, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. NOTE: This information will not be counted in the proposers page count.
7. Discussion of proposer's previous accomplishments and work in this or closely related research areas.
8. Description of the facilities that would be used for the proposed effort.
9. Formal teaming agreements that are required to execute this program and a brief synopsis of all key personnel. A clearly defined organization chart for the program team that includes, as applicable the:
   a. programmatic relationship of team members;
   b. unique capabilities of team members;
   c. task responsibilities of team members;
   d. teaming strategy among the team members; and

e. key personnel along with the amount of effort to be expended by each person during each year.

10. Phase I Base Statement of Work (SOW). Outline the scope of the effort and divide it into specific tasks. A Management task should outline the management plan. If multiple sensor concepts are proposed, each concept should have its own set of tasks. Explain who will perform each task and what level of effort is allocated.
11. Cost, schedule, and milestones . Provide a graphic schedule with milestones and cost for each task.
12. Phase I Experiment Option. If a Phase I Experiment Option is proposed, provide a SOW that divides the Experiment into specific tasks. Hardware procurement, fabrication, setup, and measurement should appear in distinct tasks. Explain who will perform each task and what level of effort is allocated. Provide a graphic schedule with milestones and cost for each task.

Section III. Phase I Technical Approach – Limit of **12 pages** Base plus 8 pages Experiment
The content should be written to provide the reviewers with an understanding of the proposed effort and to specifically address the evaluation criteria discussed in Section 5. If multiple sensor concepts are proposed, each additional concept receives an additional allocation of 12 pages (plus 8 more pages if an associated Experiment is proposed). Each proposed concept should be contained in a separate iteration of Section III. Refer to the discussion in Section 5 on the evaluation of proposals containing multiple sensor concepts.

1. Sensor Concept. Describe the classical sensor that serves as a basis for comparison. Detail the non-classical photon states to be exploited and how they will be utilized in the quantum sensor system. Describe the advantage of the quantum sensor over the classical sensor, and how the concept can be scaled to improve this advantage.
2. Comparison with Other Approaches. Explain the advantages of the proposed approach over alternative quantum sensor candidates.
3. Optional Experiment. Illustrate and describe the proposed experimental facility, equipment setup, measurements, data collection, and data processing.

4.2.1.2. Volume II, Cost Proposal – {No page limit}

1. A cover sheet to include:
   a. Name and address of Proposer (include zip code);
   b. Name, title, and telephone number of Proposer's point of contact;
   c. Award instrument requested: cost-plus-fixed-fee (CPFF), cost-contract--no fee, cost sharing contract--no fee, or other type of procurement contract (specify), grant, agreement, or other award instrument;
   d. Place(s) and period(s) of performance;
   e. Funds requested from DARPA for the Base Effort, each option and the total proposed cost; and the amount of cost share (if any);
   f. Name, mailing address, telephone number and Point of Contact of the Proposers cognizant government administration office (i.e., Office of Naval Research/Defense Contract Management Agency (DCMA)) (if known);

g. Name, mailing address, telephone number, and Point of Contact of the Proposer's cognizant Defense Contract Audit Agency (DCAA) audit office (if known);
h. Any Forward Pricing Rate Agreement, other such Approved Rate Information, or such other documentation that may assist in expediting negotiations (if available);
i. Contractor and Government Entity (CAGE) Code,
j. Dun and Bradstreet (DUN) Number;
k. North American Industrial Classification System (NAICS) Number [NOTE: This was formerly the Standard Industrial Classification (SIC) Number]; and,
l. Taxpayer Identification Number (TIN).
m. All subcontractor proposal backup documentation to include items a. through l. above, as is applicable and available).

2. Detailed cost breakdown to include:
   a. Total program cost broken down by month and government fiscal year (GFY) [Note: Government Fiscal Year runs from October 1st to September 30th] and Base and Options; further broken down by major cost items as follows:
      i. Direct Labor – Individual labor category or person, with associated labor hours and unburdened direct labor rates;
      ii. Indirect Costs – Fringe Benefits, Overhead, General and Administrative Expense, Cost of Money, etc. (Must show base amount and rate);
      iii. Travel – Number of trips, number of days per trip, departure and arrival destinations, number of people, etc.
      iv. Subcontract – A cost proposal as detailed as the Proposer's cost proposal will be required to be submitted by the subcontractor. The subcontractor's cost proposal can be provided in a sealed envelope with the Proposer's cost proposal or will be requested from the subcontractor at a later date;
      v. Consultant – Provide consultant agreement or other document which verifies the proposed loaded daily/hourly rate;
      vi. Materials – Should be specifically itemized with costs or estimated costs. An explanation of any estimating factors, including their derivation and application, shall be provided. Please include a brief description of the Proposer's procurement method to be used;
      vii. Other Direct Costs – Should be itemized with costs or estimated costs. Backup documentation should be submitted to support proposed costs.
   b. Costs of major program tasks and major cost items by year and month;
   c. An itemization of major subcontracts (labor, travel, materials and other direct costs) and equipment purchases;
   d. A summary of projected funding requirements by month; and
   e. The source, nature, and amount of any industry cost sharing, if applicable. Where the effort consists of multiple phases that could reasonably be partitioned for purposes of funding, these should be identified as options with separate cost estimates for each.

3. Supporting cost and pricing information in sufficient detail to substantiate the summary cost estimates above. Include a description of the method used to estimate costs and supporting documentation. Provide the basis of estimate for all proposed labor rates, indirect costs, overhead costs, other direct costs and materials, as applicable.

5. PROPOSAL EVALUATION

In accordance with FAR 35.016(e), the primary basis for selecting proposals for award shall be technical, importance to agency programs, and funds availability. Cost realism and reasonableness shall also be considered to the extent appropriate. The criteria to be used to evaluate and select proposals for this Program are, in order of importance: (a) Scientific Merit; (b) Innovation; (c) Technical Qualifications and Management; (d) Cost Realism and Reasonableness; (e) Potential Contribution and Relevance to the DARPA Mission. These criteria are detailed in the following sections. Funding decisions will depend on the proposal evaluations as well as availability of funds. Proposals may be evaluated as they are received, or they may be collected and periodically reviewed. Proposals will be evaluated in their entirety; multiple sensor concepts within a single proposal will not be evaluated separately.

5.1 PROPOSAL COMPLIANCE

Proposals that are not considered compliant will not receive full evaluation. The BAA PIP (Proposer Information Pamphlet) provides detailed requirements on proposal formatting, content, and the scope of proposed work. For example, the proposal must define a specific sensor concept rather than propose to develop a concept after funding is received. As another example, the proposal must include a clear explanation of why the sensor concept is believed to offer superior performance over a classical sensor.

Proposals that are considered compliant will receive full evaluation according to the five following categories of criteria.

5.2 SCIENTIFIC MERIT

The technical review will consider all aspects of the effort. In particular, the Base proposal will be evaluated against the following items:

- Clearly Defined Sensor Concept – The non-classical photon states must be described. All components and their arrangement in the sensor must be defined. The utilization of the non-classical photons deserves extra detail. Common classical components do not require a detailed description. The proposal must explain the resolution advantage of the sensor concept over classical sensors.
- Likelihood of Success – The proposal should explain why the proposed sensor concept is likely to meet the Phase I Program Metrics in Table 1. Prior work and publications should be cited to support this argument.
- Scalability – A sensor concept that has unlimited scaling to achieve increased advantage over classical sensors is preferred. The proposal should explain how the sensor concept can be scaled to achieve increased performance advantages.

If an optional Phase I Experiment is proposed, the technical review will consider the following items:

- Clearly Defined Experiment – An illustration must show the arrangement of all hardware components. The function and performance of each component must be described. The experimental procedure should be outlined.
- Hardware Sources – The proposal should identify the source of all required facilities, test equipment, and test hardware. Some of these may be identified as already in the possession of the Proposer team and others may be proposed to be obtained with Phase I Experiment funding. For items not already in the Proposer's possession, potential sources and lead times should be identified.
- Data Products and Utility – The proposal must clearly state the experimental measurements to be collected. The proposal must state how these results will contribute to an understanding of the potential for application to practical sensor systems. This may include data collection specifically to support potential Phase II work.

5.3 INNOVATION

A few potential quantum sensor concepts have received significant attention and publication. DARPA prefers to have Performers explore multiple promising quantum sensor concepts rather than multiple explorations of a single concept. The following will be considered:

- Proposed sensor concepts should show innovation over published concepts
- Proposed sensor concepts that do not appear in other proposals will be considered innovative.

If an optional Phase I Experiment is proposed, innovation over previous experimental results is necessary. The following will be considered:

- Proposed experiments should yield measurements and information previously unavailable from experimental sources.

5.4 TECHNICAL QUALIFICATIONS AND MANAGEMENT

In addition to quantum sensor technology development, a goal of the Program is to promote cross-fertilization between the quantum physics and sensor communities. The following will be evaluated:

- The proposed team should include members with prior experience with quantum mechanics and non-classical photons states.
- The proposed team should include members with prior experience with practical classical sensors analogous to the proposed quantum sensor concept.
- The proposal should explain how the team's prior experience will be exploited to ensure success in the proposed effort.
- The task descriptions should indicate how the proposed effort will be divided between the two communities. To promote cross-fertilization, the team members from different organizations cannot work in isolation. The management plan must explain how the different team members will cooperate and coordinate.

If an optional Phase I Experiment is proposed, the following will be evaluated:

- The proposed team should have existing and available facilities required for the proposed experiment.
- The proposed team should have prior experience conducting similar experiments.

- The management plan must explain how the team members with expertise in quantum mechanics theory will be involved in experiment planning and data analysis.

5.5 COST REALISM AND REASONABLENESS

Cost is evaluated not only to determine whether the estimate is reasonable but also to provide valuable insight into the Proposer's understanding of the project, perception of risks, and ability to organize and perform the work. The proposed Phase I work should be divided into tasks, each with a justification for the required labor category and estimated labor hours required to complete the task. The task descriptions, labor hour estimates, and total cost per task must be in Volume I. Volume II must detail the costs of labor. The following will be evaluated:

- The proposed labor category and level of effort should match the task description.
- There should be no apparent problems with meeting the proposed budget, schedule, and technical progress.
- The overall cost should be reasonable in light of the potential improvement over classical sensors that will be achieved if the development path is successful. High cost efforts may be funded if these offer a high potential payoff. Lower cost approaches to achieve the same payoff are preferred.
- Cost reduction approaches that will be received favorably include maximizing direct funding for technology and minimizing diversion of funding into labor overhead, G&A, and fee.

In an optional Phase I Experiment is proposed, an additional factor will be evaluated:

- The budgeted cost and schedule for obtaining test equipment and hardware should be justified in the proposal.

5.6 POTENTIAL CONTRIBUTION AND RELEVANCE TO THE DARPA MISSION

The potential contributions of the proposed effort to the enhancement of national security through innovative research and development will be evaluated. The objective of this criterion is to establish a strong link between this work and the DoD mission. It is NOT necessary that the proposed work be immediately usable in military systems.

ATTACHMENT A: Sample R&D and Financial Status Report

(1) R&D STATUS REPORT
This brief narrative shall contain the following:

(i) For first report only; the date work actually started.
(ii) Description of progress during the reporting period, supported by reasons for any change in approach reported previously.
(iii) Planned activities and milestones for the next reporting period.
(iv) Description of any major items of experimental or special equipment purchased or constructed during the reporting period.
(v) Notification of any changes in key personnel associated with the contract during the reporting period.
(vi) Summary of substantive information derived from noteworthy trips, meetings, and special conferences held in connection with the contract during the reporting period.
(vii) Summary of all problems or areas of concern.
(viii) Related accomplishments since last report.
(ix) Fiscal status, to include reporting of summary level financial data in the following format: (next page)

R&D STATUS REPORT
PROGRAM FINANCIAL STATUS

Work Breakdown		Cumulative to Date			At Completion	
Structure or Task Element	Planned Expend	Actual Expend	% Budget Compl	Latest At Compl	Revised Compl Estimate	Remarks
Subtotal:						
Management Reserve:						
Or Unallocated Resources:						
TOTAL:						

Note: Budget at completion changes only with the amount of any scope changes. (Not affected by underrun or overrun)

Based on currently authorized work:

Is current funding sufficient for the current fiscal year (FY)? (Explain in narrative if "NO")

YES NO

What is the next FY funding requirement at current anticipated levels?

$ _____

Have you included in the report narrative any explanation of the above data and are they cross-referenced?

YES NO

(2) FINAL REPORT

This report shall document the results of the complete effort and should be delivered at the completion of the contract. If the Government chooses to exercise the options under this contract, the due date for the final report is extended accordingly. Title pages shall include a disclaimer worded substantially as follows:

> "The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressly or implied, of the Defense Advanced Research Projects Agency or the U.S. Government."

The Final Technical Report summary shall include:

> Task Objectives
> Technical Problems
> General Methodology (i.e., literature review, laboratory experiments, surveys, etc.)
> Technical Results
> Important Findings and Conclusions
> Significant Hardware Development
> Special Comments
> Implications for Further Research
> Standard Form 298, September 1988

(b) Reports delivered by the Contractor in the performance of the contract shall be considered "Technical Data" as defined in Section I contract clauses entitled "Rights in Technical Data – Noncommercial Items" and "Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation."

(c) All papers and articles published as a result of DARPA sponsored research shall include a statement reflecting the sponsorship. In addition, a bibliography of the titles and authors of all such papers are to be included in the Final Technical Report

(1) The cover or title page of each of the above reports or publications prepared, will have the following citation:

> Sponsored by
> Defense Advanced Research Projects Agency
> STO
> Quantum Sensors Program:
> ARPA Order No. XXX, Program Code: XXX
> Issued by DARPA/CMO under Contract No.:

(2) The title page shall include a disclaimer worded substantially as follows:

> "The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressly

or implied, of the Defense Advanced Research Projects Agency or the U.S. Government."

(3) All technical reports must (i) be prepared in accordance with American National Standards Institute (ANSI) Standard Z39.18; (ii) include a Standard Form 298, August 1998; and (iii) be marked with an appropriate Distribution Statement.