NIST
National Institute of Standards and Technology

FY 2006

Small Business Innovation Research PROGRAM SOLICITATION

Opening Date: November 3, 2005
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NIST-06-SBIR

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology

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US DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

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US DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

1.0 PROGRAM DESCRIPTION

1.01 Introduction

The Department of Commerce (DOC) National Institute of Standards and Technology (NIST) invites small businesses to submit research proposals under this solicitation. Firms with strong research capabilities in any of the areas listed in Section 9 of this solicitation are encouraged to participate. **Unsolicited proposals are not accepted under the SBIR program**.

Objectives of this program include stimulating technological innovation in the private sector and strengthening the role of small business in meeting Federal research and development (R&D) needs. This program also seeks to increase the commercial application of innovations derived from Federal research and improve the return on investment from federally funded research for the economic benefit of the Nation.

1.02 Three-Phase Program

The "Small Business Research and Development Enhancement Act of 1992", as amended, requires the Department of Commerce to establish a three-phase SBIR program by reserving a percentage of its extramural R&D budget to be awarded to small business concerns for innovation research.

This document solicits Phase 1 proposals only.

NIST has the unilateral right to select SBIR research topics and awardees in both Phase 1 and Phase 2. As funding is limited, NIST reserves the right to select and fund only those proposals deemed to be superior in overall technical quality and highly relevant to the NIST mission. As a result, NIST may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior or it may not fund any proposals in a given topic area.

1.02.01 Phase 1 - Feasibility Research

The purpose of Phase 1 is to determine the technical feasibility of the proposed research and the quality of performance of the small business concern receiving an award. Therefore, the proposal should concentrate on research that will significantly contribute to proving the feasibility of the proposed research, a prerequisite to further support in Phase 2.

1.02.02 Phase 2 - Research and Development

Only firms that receive Phase 1 awards will be given the opportunity of submitting a Phase 2 proposal following completion of Phase 1. Instructions for Phase 2 proposal preparation and submission will be provided to Phase 1 awardees typically during the fourth month of the Phase 1 period of performance.

Phase 2 is the R&D or prototype development phase. It will require a comprehensive proposal outlining the research in detail. Further information regarding Phase 2 proposal requirements will be provided to all firms receiving Phase 1 awards.

1.02.03 Phase 3 - Commercialization

In Phase 3, it is intended that non-SBIR capital be used by the small business to pursue commercial applications of Phase 2.

1.03 Manufacturing-related Priority

Executive Order (EO) 13329 “Encouraging Innovation in Manufacturing” requires SBIR agencies, to the extent permitted by law and in a manner consistent with the mission of that department or agency, to give high priority within the SBIR programs to manufacturing-related research and development (R&D). “Manufacturing-related” is defined as “relating to manufacturing processes, equipment and systems; or manufacturing workforce skills and protection.” More information on the national manufacturing initiative may be found through links located on the NIST SBIR website www.nist.gov/sbir

The NIST SBIR Program solicits manufacturing-related projects through many of the subtopics described in this Solicitation. Further NIST encourages innovation in manufacturing by giving high priority, where feasible, to projects that can help the manufacturing sector through technological innovation in a manner consistent with NIST’s mission.

1.04 Eligibility

Each organization submitting a proposal for both Phase 1 and Phase 2 **must** qualify as a small business concern (Section 2.10) for research or R&D purposes (Section 2.7) at the time of award. In addition, the primary employment of the principal investigator must be with the small business at the time of the award and during the conduct of the proposed research. More than one-half of the principal investigator's time must be spent with the small business for the period covered by the award. **Primary employment with a small business precludes full-time employment with another organization.**

Also, for both Phase 1 and Phase 2, the work must be performed in the United States. "United States" means the fifty states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana

Islands, the Trust Territory of the Pacific Islands, and the District of Columbia. However, based on a rare and unique circumstance, for example, a supply or material or other item or project requirement that is not available in the United States, agencies may allow that particular portion of the R/R&D work to be performed or obtained in a country outside of the United States. Approval by the funding agreement officer after consultation with the agency SBIR Program Manager/Coordinator for each such specific condition must be in writing.

Joint ventures and limited partnerships are eligible, provided the entity created qualifies as a small business as defined in this solicitation. **Consultative arrangements between firms and universities or other non-profit organizations are allowed, with the small business serving as the prime contractor.**

For Phase 1, a minimum of two-thirds of the research and/or analytical effort must be performed by the awardee. For Phase 2 - a minimum of one-half of the research and/or analytical effort must be performed by the awardee.

Unsolicited proposals or proposals not responding to stated topics or subtopics are not eligible for SBIR awards. Only proposals that are directly responsive to specific subtopics as described in section 9 will be considered.

Phase 2 proposals may be submitted only by Phase 1 awardees. Instructions for phase 2 proposal submission are provided to phase 1 awardees during the phase 1 period of performance.

1.05 Contact with NIST

In the interest of competitive fairness, all oral or written communication with NIST concerning a specific technical topic or subtopic during the open solicitation period is strictly prohibited - with the exception of the public discussion group located at http://www.nist.gov/sbir. Discussion group questions will be routed to the appropriate person for a response. All questions and responses will be publicly, though anonymously, posted on the discussion group web site.

Potential awardees may not participate in the selection of any topic or subtopic nor in the review of proposals. All offerors, including Guest Researchers, contractors, Cooperative research and Development Agreement (CRADA) partners and others working with NIST may only submit a proposal if they:

Had no role in suggesting, developing, or reviewing the subtopic; and

Have not been the recipient of any information on the subtopic not available in the solicitation or other public means; and

Have not received any assistance from DOC in preparing the proposal (including any 'informal' reviews) prior to submission.

An Agency may not enter into, or continue an existing CRADA with an awardee on the subtopic of the award.

Requests for general information on the NIST SBIR program may be addressed to:

SBIR Program
100 Bureau Drive, Stop 2200
Gaithersburg, MD 20899-2200
Telephone: (301) 975-3085, Fax: (301) 548-0624
email: sbir@nist.gov

For information on contractual issues contact:

Myrsonia Diaz
Acquisitions and Logistics Division
Telephone: (301) 975-8329. Fax: (301) 975-8884
email: myrsonia.diaz@nist.gov

2.0 DEFINITIONS

2.01 Commercialization

The process of developing marketable products or services and producing and delivering products or services for sale (whether by the originating party or by others) to the Government or commercial markets.

2.02 Essentially Equivalent Work

This occurs when (1) substantially the same research is proposed for funding in more than one contract proposal or grant application submitted to the same Federal agency; (2) substantially the same research is submitted to two or more different Federal agencies for review and funding consideration; or (3) a specific research objective and the research design for accomplishing an objective are the same or closely related in two or more proposals or awards, regardless of the funding source.

2.03 Feasibility

The practical extent to which a project can be performed successfully.

2.04 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal agency and any SBC for the performance of experimental, developmental, or research work, including products or services, funded in whole or in part by the Federal Government.

For purposes of this Solicitation, NIST intends to award purchase orders and/or contracts under the authority of the Federal Acquisition Regulations.

2.05 Historically Underutilized Business Zone (HUBZone) Small Business Concern

An SBC meeting the following criteria:

1. Located in a "historically underutilized business zone" or HUBZone area located in one or more of the following: a) A qualified census tract (as defined in section 42(d)(5)(C)(i)(I) of the Internal Revenue Code of 1986; b) A qualified "non-metropolitan county" (as defined in section 143(k)(2)(B) of the Internal Revenue Code of 1986) with a median household income of less than 80 percent of the State median household income or with an unemployment rate of not less than 140 percent of the Statewide average, based on US Department of Labor recent data; or, c) Lands within the boundaries of federally recognized Indian reservations.

2. Owned and controlled by one or more US Citizens; and;

3. At least 35% of its employees must reside in a HUBZone.

2.06 Joint Venture

An association of persons or concerns with interests in any degree or proportion by way of contract, express or implied, consorting to engage in and carry out a single specific business venture for joint profit, for which purpose they combine their efforts, property, money, skill, or knowledge, but not on a continuing or permanent basis for conducting business generally. A joint venture is viewed as a business entity in determining power to control its management and is eligible under the SBIR and STTR Programs provided that the entity created qualifies as a "small business concern" as defined in herein.

2.07 Primary Employment

Primary employment means that more than one half of the principal investigator's time is spent in the employ of the small business concern. This requirement extends also to “leased” employees serving as the principal investigator. Primary employment with a small business concern precludes full time employment at another organization.

2.08 Research or Research and Development

Any activity that is (a) a systematic, intensive study directed toward greater knowledge or understanding of the subject studied; (b) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (c) a systematic application of knowledge toward the production of useful materials, devices, services, or methods, and includes design, development, and improvement of prototypes and new processes to meet specific requirements.

In general, the NIST SBIR program will fund Phase 1 and 2 proposals with objectives that can be defined by (b) and (c) above.

2.09 SBIR Technical Data

All data generated during the performance of an SBIR award.

2.10 SBIR Technical Data Rights

The rights an small business concern (SBC) obtains in data generated during the performance of any SBIR Phase 1, Phase 2, or Phase 3 award that an awardee delivers to the Government during or upon completion of a Federally-funded project, and to which the Government receives a license.

2.11 Small Business Concern (SBC)

A small business concern is one that, at the time of award of Phase I and Phase II, meets all of the following criteria:

1. Is independently owned and operated, is not dominant in the field of operation in which it is proposing, has a place of business in the United States and operates primarily within the United States or makes a significant contribution to the US economy, and is organized for profit.

2. Is (a) at least 51% owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States or (b) it must be a for-profit business concern that is at least 51% owned and controlled by another for-profit business concern that is at least 51% owned and controlled by one or more individuals who are citizens of, or permanent resident aliens in, the United States.

3. Has, including its affiliates, an average number of employees for the preceding 12 months not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns are generally considered to be affiliates of one another when either directly or indirectly, (a) one concern controls or has the power to control the other; or (b) a third-party/parties controls or has the power to control both.

Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.103. The term "number of employees" is defined in 13 CFR 121.106.

A business concern may be in the form of an individual proprietorship, partnership, limited liability company, corporation, joint venture, association, trust, or cooperative. Further information may be obtained at http://sba.gov/size, or by contacting the Small Business Administration’s Government Contracting Area Office or Office of Size Standards.

2.12 Socially and Economically Disadvantaged Small Business Concern

A socially and economically disadvantaged small business concern is one that is at least 51% owned and controlled by one or more socially and economically disadvantaged individuals, or an Indian tribe, including Alaska Native Corporations (ANCs), a Native Hawaiian Organization (NHO), or a Community Development Corporation (CDC). Control includes both the strategic planning (as that exercised by boards of directors) and the day-to-day management and administration of business operations. See 13 CFR 124.109, 124.110, and 124.111 for special rules pertaining to concerns owned by Indian tribes (including ANCs), NHOs or CDCs, respectively.

2.13 Subcontract

This is any agreement, other than one involving an employer-employee relationship, entered into under a Federal Government funding agreement, calling for supplies or services required solely for the performance of the original funding agreement.

2.14 Women-Owned Small Business

A small business concern that is at least 51% owned and controlled by a woman or women. Control includes both the strategic planning (as that exercised by boards of directors) and the day-to-day management and administration of business operations.

3.0 PROPOSAL PREPARATION GUIDELINES

3.01 Proposal Requirements

NIST reserves the right to not submit to technical review any proposal which it finds to have insufficient scientific and technical information, or one which fails to comply with the administrative procedures as outlined on the Checklist of Requirements in Section 8.04. Proposals that do not successfully pass the screening criteria given in Section 4.02 will be returned to the offeror without consideration.

The objective is to provide sufficient information to demonstrate that the proposed work represents a sound approach to the investigation of an important scientific or engineering innovation worthy of support. **The proposal must meet all the requirements of the subtopic in Section 9 to which it applies**.

A proposal must be self-contained and written with all the care and thoroughness of a scientific paper submitted for publication. It should indicate a thorough knowledge of the current status of research in the subtopic area addressed by the proposal. Each proposal should be checked carefully by the offeror to ensure inclusion of all essential material needed for a complete evaluation. The proposal will be peer reviewed as a scientific paper. All units of measurement should be in the metric system.

The proposal must not only be responsive to the specific NIST program interests described in Section 9 of the solicitation, but also serve as the basis for technological innovation leading to new commercial products, processes, or services that benefit the public. An organization may submit different proposals on different subtopics or different proposals on the same subtopic under this solicitation. When the proposed innovation applies to more than one subtopic, the offeror must choose that subtopic which is most relevant to the offeror's technical concept.

Proposals principally for the commercialization of proven concepts or for market research must not be submitted for Phase 1 funding, since such efforts are considered the responsibility of the private sector.

The proposal should be direct, concise, and informative. Promotional and other material not related to the project shall be omitted. The complete proposal application must contain four copies of the following:

(a) Cover Sheet (required form, see Section 8.0)
(b) Project Summary (required form, see Section 8.0)
(c) Technical Content
(d) Proposed Budget (required form, see Section 8.0)

One original proposal – this includes original signatures in each of the three required forms along with the technical section - plus three copies of the proposal are required.

3.02 Phase 1 Proposal Limitations

Page length must be **no more than 25 pages**. Each page is to be consecutively numbered, including the cover sheet (2 pages count as one), project summary, main text, references, resumes, any other enclosures or attachments, and the proposal summary budget. The only exception to the page count limitation are those pages necessary to comply with the itemization of prior SBIR phase 2 awards, per Section 3.03.03.02.

Paper size used for the submission must be 21.6 cm X 27.9 cm (8 ½" X 11"). Print size used for the submission must be easy to read with a fixed pitch font of 12 or fewer characters per inch or proportionally spaced font of point size 10 or larger with no more than 6 lines per inch.

Supplementary material, revisions, substitutions, audio or video tapes, or computer floppy disks will **not** be accepted. If submitted these items will not be reviewed by evaluators.

The original and all copies of each proposal should be mailed in one package.

3.03 Instructions for Phase 1 Proposal Submission Forms and Technical Content

Instructions for completing each of the three required forms in contained in this section as well as the format required for the Technical Content section. A complete proposal application must include four copies of each of the following: Cover Sheet, Project Summary, Technical Content, and Proposed Budget. Any applications received missing any of these required items will be returned without review.

3.03.01 Cover Sheet

Complete all items in "Cover Sheet" required form and use as page 1 of the proposal. **NO OTHER COVER WILL BE ACCEPTED.**

No award shall be made under this solicitation to a small business concern without registration in CCR or a DUNS number.

Before NIST can award a contract to a successful offerer under this solicitation, the offerer must be registered in the DoD Central Contractor Registration (CCR) database. The CCR allows Federal Government contractors or firms interested in conducting business with the federal government to provide basic information on business capabilities and financial information. To register, visit http://www.ccr.gov or call 1-888-227-2423.

The DUNS number is a nine-digit number assigned by Dun and Bradstreet Information Services. If the offeror does not have a DUNS number, it should contact Dun and Bradstreet directly to obtain one. A DUNS number will be provided immediately by telephone at no charge to the offeror. For information on obtaining a DUNS number, the offeror, if located within the United States, should call Dun and Bradstreet at 1-800-333-0505, or access their website at http://sbs.dnb.com.

Offerors are cautioned to identify proposal page numbers that contain their confidential information in the Proprietary Notice section at the end of the Cover Sheet.

3.03.02 Project Summary

Complete all sections "Project Summary" as page 2 of your proposal. The technical abstract should include a brief description of the problem or opportunity, the innovation, project objectives, and technical approach. Keywords should be chosen to describe the proposed work both generally and specifically. In summarizing anticipated results, include technical implications of the approach and the potential commercial applications of the research. **The Project Summary of proposals that receive an award will be published by NIST and, therefore, must not contain proprietary information.**

3.03.03 Technical Content

Beginning on **page 3 of the proposal**, include the following items with headings as shown:

(a) **Identification and Significance of the Problem or Opportunity.** Make a clear statement of the specific research problem or opportunity addressed, its innovativeness, commercial potential, and why it is important. Show how it applies to a specific subtopic in Section 9.

(b) **Phase 1 Technical Objectives.** State the specific objectives of the Phase 1 effort, including the technical questions it will try to answer, to determine the feasibility of the proposed approach.

(c) **Phase 1 Work Plan**. Include a detailed description of the Phase 1 R&D plan. The plan should indicate what will be done, where it will be done, and how the R&D will be carried out. The methods planned to achieve each objective or task should be discussed in detail. This section should be at least one-third of the proposal.

NIST technical support or assistance may be available to awardees in the conduct of the research only if specifically provided for in the subtopic description.

(d) **Related Research or R&D.** Describe research or R&D that is directly related to the proposal, including any conducted by the principal investigator or by the offeror's firm. Describe how it relates to the proposed effort, and describe any planned coordination with outside sources. The purpose of this section is to persuade reviewers of the offeror's awareness of recent developments in the specific topic area.

(e) **Key Personnel and Bibliography of Related Work.** Identify key personnel involved in Phase 1, including their related education, experience, and publications. Where resumes are extensive, summaries that focus on the most relevant experience and publications are suggested. List all other commitments that key personnel have during the proposed period of contract performance.

(f) **Relationship with Future R&D.** Discuss the significance of the Phase 1 effort in providing a foundation for the Phase 2 R&D effort. Also state the anticipated results of the proposed approach, if Phases 1 and 2 of the project are successful.

(g) **Facilities and Equipment.** The conduct of advanced research may require the use of sophisticated instrumentation or computer facilities. The offeror should provide a detailed description of the availability and location of the facilities and equipment necessary to carry out Phase 1. **NIST facilities and/or equipment may be available for use by awardees only if specifically provided for in the subtopic description.**

(h) **Consultants and Subcontracts.** The purpose of this section is to convince NIST that: research assistance from outside the firm materially benefits the proposed effort, and arrangements for such assistance are in place at the time the proposal is submitted.

Outside involvement in the project is encouraged where it strengthens the conduct of the research. Outside involvement is not a requirement of this

solicitation. Outside involvement is limited to no more than 1/3 of the research and/or analytical effort, per section 1.04.

1. Consultant - A person outside the firm, named in the proposal as contributing to the research, must provide a signed statement confirming his/her availability, role in the project, and agreed consulting rate for participation in the project. This statement is part of the page count.

2. Subcontract - Similarly, where a subcontract is involved in the research, the subcontracting institution must furnish a letter signed by an appropriate official describing the programmatic arrangements and confirming its agreed participation in the research, with its proposed budget for this participation. This letter is part of the page count.

Absence of such documents explaining such a consultant or subcontract, if applicable, may disqualify the offeror from consideration.

No individual or entity may serve as a consultant or subcontractor if they:
Had any role in suggesting, developing, or reviewing the subtopic; or
Have been the recipient of any information on the subtopic not available to the public.

(i) **Potential Commercial Application and Follow-on Funding Commitment.** Describe in detail the commercial potential of the proposed research, how commercialization would be pursued and potential use by the Federal Government.

(j) **Cooperative Research and Development Agreements (CRADA).** State if the offeror is a former or current CRADA partner with NIST, or with any other Federal agency, naming the agency, title of the CRADA, and any relationship with the proposed work. An Agency may not enter into, nor continue, a CRADA with an awardee on the subtopic of the award.

(k) **Guest Researcher.** State if the applicant is a guest researcher at NIST, naming the sponsoring laboratory.

(l) **Cost Sharing.** Cost participation could serve the mutual interest of NIST and certain SBIR contractors by helping to assure the efficient use of available resources. Except where required by other statutes, NIST does not encourage or require cost sharing on Phase 1 projects, nor will cost sharing be a consideration in evaluation of Phase 1 proposals.

3.03.03.01 Similar Proposals or Awards

WARNING - While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous Federal program solicitations, it is unlawful to enter into funding agreements requiring essentially equivalent work. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

If an applicant elects to submit identical proposals or proposals containing a significant amount of essentially equivalent work under other Federal program solicitations, a statement must be included in each such proposal indicating:

(i) The name and address of the agencies to which proposals were submitted or from which awards were received.
(ii) Date of proposal submission or date of award.
(iii) Title, number, and date of solicitations under which proposals were submitted or awards received.
(iv) The specific applicable research topics for each proposal submitted or award received.
(v) Titles of research projects.
(vi) Name and title of principal investigator or project manager for each proposal submitted or award received.

If no equivalent proposal is under consideration or equivalent award received, a statement to that effect must be included in this section of the technical content area of the proposal and certified within the Cover Sheet.

3.03.03.02 Prior SBIR Phase 2 Awards

If the small business concern has received more than 15 Phase 2 awards in the prior 5 fiscal years, it must submit in its Phase 1 proposal: name of the awarding agency; date of award; funding agreement number; amount of award; topic or subtopic title; follow-on agreement amount; source and date of commitment; and current commercialization status for each Phase 2 award. **This required information shall not be part of the 25 page count limitation.**

NOTE: The Small Business Administration is mandated to establish an SBIR awardee database containing demographic, technical, outcome and output information on all SBIR awards. The database is still being developed as of the date of release of this solicitation. When it becomes available, all NIST SBIR awardees will be required to supply the required data in a timely fashion.

3.03.04 Proposed Budget

NIST will not issue SBIR awards that include provisions for subcontracting any portion of the contract back to the federal government.

For Phase 1, a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing small business concern. For Phase 2 a minimum of one-half of the research and/or analytical effort must be performed by the proposing small business concern.

Complete the Proposed Budget required form for the Phase 1 effort, and include it as the last page of the proposal. Some items of this form may not apply. Enough

information should be provided to allow NIST to understand how the offeror plans to use the requested funds if the award is made. A complete cost breakdown should be provided giving labor rates, proposed number of hours, overhead, G&A, and profit. A reasonable profit will be allowed.

The offeror is to submit a cost estimate with detailed information for each Line Item, consistent with the offeror's cost accounting system. This does not eliminate the need to fully document and justify the amounts requested in each category. Such documentation should be contained, as appropriate, within the proposal technical content.

Lines A and B, Labor. List the key personnel and consultants by name and function or role in the project. Other direct personnel need not be named, but their role, such as "technician," and total hours should be entered. Personnel whose costs are indirect (e.g. administrative personnel) should be included in Line D. Fringe benefits can be listed for each employee in the space provided, or they may be included within the indirect costs in Line G. The PI must be employed by the small business concern at the time of contract award and during the period of performance of the research effort. Additionally, more than half of the PI's time must be spent with the small business firm during the contract performance.

Line C, Equipment. List items costing over $5,000 and exceeding 1 year of useful life. Lesser items may be shown in Line D. Indicate if equipment is to be purchased or leased. Where equipment is to be purchased or leased, list each individual item with the corresponding cost. The inclusion of equipment will be carefully reviewed relative to need and appropriateness for the research proposed.

Line D, Travel. Itemize by destination, purpose, period and cost for both staff and consultants. Budgets including travel funds must be justified and related to the needs of the project. Inclusion of travel expenses will be carefully reviewed relative to need and appropriateness for the research proposed. Foreign travel is not an appropriate expense.

Line E, Other Direct Costs. The materials and supplies, testing and/or computer services, and subcontracts required for the project must be identified. There is a need to specify type, quantity and unit cost (if applicable), and total estimated cost of these other direct costs.

Line F, Total Direct Costs. Enter the sum of Lines A through E.

Line G, Indirect Costs. Cite your established Overhead (OH) and General and Administrative (G&A) rate, if any. Otherwise include all indirect costs (e.g. facilities, shared equipment, utilities, property taxes, administrative staff) for the period of the project. Indirect costs are costs not directly identified with a single final cost objective.

Line H, Total Costs. Enter the total amount of the proposed project, the sum of Lines F and G.

Line I, Profit. The small business concern may request a reasonable profit.

Line J, Total Amount of this request. Enter the sum of Lines H and I. This amount must equal the amount entered in the Cover Sheet Form.

Line K, Corporate/Business Authorized Representative. A signature of someone with the authority to commit the company must be given.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.01 Introduction

All Phase 1 and 2 proposals will be evaluated and judged on a competitive basis. Proposals will be initially screened to determine responsiveness. Proposals passing this initial screening will be technically evaluated by engineers or scientists to determine the most promising technical and scientific approaches. Each proposal will be judged on its own merit. The Agency is under no obligation to fund any proposal or any specific number of proposals in a given topic. It also may elect to fund several or none of the proposed approaches to the same topic or subtopic.

4.02 Phase 1 Screening Criteria

To avoid misunderstanding, small businesses are cautioned that Phase 1 proposals not satisfying all the screening criteria shall be returned to the offeror without peer review and will be eliminated from consideration for funding. Proposals may not be resubmitted (with or without revision) under this solicitation. The screening criteria are:

(a) The proposing firm must qualify as eligible according to the criteria set forth in Section 1.03.
(b) The Phase 1 proposal must meet **all** of the requirements stated in Section 3.
(c) The Phase 1 proposal must be limited to one subtopic and clearly address research for that subtopic.
(d) **Phase 1 proposal budget must not exceed $75,000,** including subcontract, indirect cost, and fee.
(e) **The project duration for the Phase 1 research must not exceed 6 months.**
(f) The proposal must contain information sufficient to be peer reviewed as research.

4.03 Phase 1 Evaluation Criteria

Phase 1 proposals that comply with the screening criteria will be rated by NIST scientists or engineers in accordance with the following criteria:

(a) The scientific and technical merit of the proposed research (25 points)

(b) Innovation, originality, and feasibility of the proposed research (25 points)

(c) Relevance and responsiveness of the proposed research to the subtopic to which it is addressed (25 points)

(d) Quality and/or adequacy of facilities, equipment, personnel described in the proposal (15 points)

(e) Quality of the proposal with respect to potential commercialization and/or Federal Procurements of the products and/or services sought by the subtopic (10 points)

Technical reviewers will base their ratings on information contained in the proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to, key individuals, or the firm.

Final award decisions will be made by NIST based upon ratings assigned by reviewers and evaluation of additional factors, including possible duplication of other research, the importance of the proposed research as it relates to NIST needs, and the availability of funding. In the event of a "tie" between proposals, manufacturing-related projects will receive a priority in the award selection process. NIST may elect to fund several or none of the proposals received on a given subtopic. Upon selection of a proposal for a Phase 1 award, NIST reserves the right to negotiate the amount of the award.

4.04 Phase 2 Evaluation Criteria

The Phase 2 proposal will undergo NIST and/or external peer review in accordance with the following criteria:

1. Degree to which Phase I objectives were met (25 points)
2. The scientific and technical merit of the proposed research, including innovation, originality, and feasibility (25 points)
3. Quality and/or adequacy of facilities, equipment, personnel described in the proposal (25 points)
4. Quality of the offeror and the proposal with respect to potential commercialization and/or Federal Procurements of the products and/or services sought by the subtopic. This involves some or all of the following factors, as appropriate; how well the proposal meets NIST mission/OU program needs; offeror's record of successful commercialization and/or Federal Procurement of research in the past; existence of non-SBIR Phase 2 funding commitments, existence of Phase 3 funding or partnering commitments (25 points)

4.05 Release of Proposal Review Information

After final award decisions have been announced, the technical evaluations of a proposal that passed the screening criteria will be provided to the offeror with written notification of award/non-award. The identity of the reviewers will not be disclosed.

5.0 CONSIDERATIONS

5.01 Awards

NIST awards **firm-fixed-price purchase orders and/or contracts** as the type of funding agreement to successful offerors. A firm-fixed-price agreement provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the effort. This agreement type places upon the contractor the risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon both parties. NIST also does not allow any advance payments to be made on its awards.

Contingent upon availability of funds, NIST anticipates making about 14 Phase 1 firm-fixed-price awards of no more than $75,000 each. The performance period shall be no more than 6 months beginning on the contract start date.

Phase 2 awards shall be for no more than **$300,000**. The period of performance in Phase 2 will depend upon the scope of the research, but should not exceed 24 months.

It is anticipated that approximately one-fourth of the Phase 1 awardees will receive Phase 2 awards, depending upon the availability of funds. To provide for an in-depth review of the Phase 1 final report and the Phase 2 proposal and commercialization plan, Phase 2 awards will be made approximately 5 months after the completion of Phase 1, contingent upon availability of funds.

This solicitation does not obligate NIST to make any awards under either Phase 1 or Phase 2. Furthermore, NIST is not responsible for any monies expended by the offeror before any award is made resulting from this solicitation.

Upon award of a funding agreement, the awardee will be required to make certain legal commitments through acceptance of numerous clauses in Phase I funding agreements. The outline that follows is illustrative of the types of clauses to which the contractor would be committed. This list is not a complete list of clauses to be included in Phase I funding agreements, and is not the specific wording of such clauses. Copies of complete terms and conditions are available upon request.

These statements are examples only and may vary depending upon the type of funding agreement used.

(1) Standards of Work. Work performed under the funding agreement must conform to high professional standards.

(2) Inspection. Work performed under the funding agreement is subject to Government inspection, evaluation, and acceptance at all times.
(3) Examination of Records. The Comptroller General (or a duly authorized representative) must have the right to examine any pertinent records of the awardee involving transactions related to this funding agreement.
(4) Default. The Government may terminate the funding agreement if the contractor fails to perform the work contracted.
(5) Termination for Convenience. The funding agreement may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the awardee will be compensated for work performed and for reasonable termination costs.
(6) Disputes. Any dispute concerning the funding agreement that cannot be resolved by agreement must be decided by the contracting officer with right of appeal.
(7) Contract Work Hours. The awardee may not require an employee to work more than 8 hours a day or 40 hours a week unless the employee is compensated accordingly (for example, overtime pay).
(8) Equal Opportunity. The awardee will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.
(9) Affirmative Action for Veterans. The awardee will not discriminate against any employee or application for employment because he or she is a disabled veteran or veteran of the Vietnam era.
(10) Affirmative Action for Handicapped. The awardee will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.
(11) Officials Not To Benefit. No Government official must benefit personally from the SBIR funding agreement.
(12) Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the funding agreement upon an understanding for compensation except bona fide employees or commercial agencies maintained by the awardee for the purpose of securing business.
(13) Gratuities. The funding agreement may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the award.
(14) Patent Infringement. The awardee must report each notice or claim of patent infringement based on the performance of the funding agreement.
(15) American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.02 Reports

Three copies of a final report on the Phase 1 project shall be submitted to NIST within 30 calendar days after completion of the 6-month Phase 1 period of performance. The final report shall include a single-page project summary as the first

page, identifying the purpose of the research, and giving a brief description of the research carried out, the research findings or results, and the commercial applications of the research in a final paragraph. The remainder of the report should indicate in detail the research objectives, research work carried out, results obtained, and estimates of technical feasibility.

All final reports must carry an acknowledgment on the cover page such as: "This material is based upon work supported by the National Institute of Standards and Technology (NIST) under contract _____. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of NIST."

5.03 Deliverables

Offers submitted in response to subtopics that require delivery of a prototype should state in the proposal, the plan to develop and deliver the specified prototype. Notwithstanding an absence of such a deliberate statement, if the Solicitation subtopic calls for delivery, a delivery to NIST of the developed prototype shall be deemed to be expected upon conclusion of the contract.

5.04 Payment Schedule

The specific payment schedule (including payment amounts) for each award will be incorporated into the purchase order and/or contract.

No advance payments will be allowed.

NIST will allow the Phase 1 award amount to be paid on a bimonthly interim basis upon delivery and acceptance of three progress reports that describe services performed, and one final payment upon delivery and acceptance of the final report.

NIST will allow the Phase 2 award amount to be paid in equal increments on an interim basis upon delivery and acceptance of four progress reports (at the 2nd, 6th, 12th, and 18th months of the project) that describe services performed, and one final payment upon delivery of the final report and prototype, if applicable per subtopic requirement.

5.05 Proprietary Information, Inventions, and Patents

5.05.01 Limited Rights Information and Data

Information contained in unsuccessful proposals will remain the property of the offeror. Any proposal which is funded will not be made available to the public, except for the "Project Summary" page.

The inclusion of proprietary information is discouraged unless it is necessary for the proper evaluation of the proposal.

Information contained in unsuccessful proposals will remain the property of the applicant. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements. If proprietary information is provided by an offerer in a proposal, which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law. This information must be clearly marked by the applicant with the term "confidential proprietary information" and the following legend must appear on the first page of the technical section of the proposal:

> "These data 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 evaluation of this proposal. If a funding agreement is awarded to this applicant as a result of or in connection with the submission of these data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement and pursuant to applicable law. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction are contained on pages ____ of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration, without assuming any liability for inadvertent disclosure. The Government will limit dissemination of such information to within official channels."

5.05.02 Copyrights

The contractor may normally establish claim to copyright any written material first produced in the performance of an SBIR contract. If a claim to copyright is made, the contractor shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including funding agreement number) to the material when delivered to the Government, as well as when the written material or data are published or deposited for registration as a published work in the US Copyright Office. For other than computer software, the contractor gives to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable, worldwide license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

For computer software, the contractor gives to the Government a paid-up, nonexclusive, irrevocable, worldwide license for all such computer software to reproduce, prepare derivative works, and perform publicly and display publicly, by or on behalf of the Government.

5.05.03 Rights in Data Developed Under SBIR Contracts

To preserve the SBIR data rights of the awardee, the legend (or statements) used in the SBIR Data Rights clause included in the SBIR award must be affixed to any submissions of technical data developed under that SBIR award. If no Data Rights clause is included in the SBIR award, the following legend, at a minimum, should be affixed to any data submissions under that award:

SBIR RIGHTS NOTICE

> "These SBIR data are furnished with SBIR rights under Contract No. _____ (and subcontract No. _____ if appropriate), Awardee Name _____, Address, Expiration Period of SBIR Data Rights _____. The Government may not use, modify, reproduce, release, perform, display, or disclose technical data or computer software marked with this legend for (choose four (4) or five (5) years). After expiration of the (4- or 5-year period), the Government has a royalty-free license to use, and to authorize others to use on its behalf, these data for Government purposes, and is relieved of all disclosure prohibitions and assumes no liability for unauthorized use of these data by third parties, except that any such data that is also protected and referenced under a subsequent SBIR award shall remain protected through the protection period of that subsequent SBIR award. Reproductions of these data or software must include this legend."

(END OF NOTICE)

The Government's sole obligation with respect to any properly identified SBIR data shall be as set forth in the paragraph above.

5.05.04 Patents

Small business concerns normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty free license for Federal Government use, reserves the right to require the patent holder to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35U.S.C. 205, the Government will not make public any information disclosing a Government supported invention for a minimum 4-year period (that may be extended by subsequent SBIR funding agreements) to allow the awardee a reasonable time to pursue a patent**.**

5.05.05 Invention Reporting

SBIR awardees must report inventions to the NIST SBIR Program within 2 months of the inventor's report to the awardee. The reporting of inventions may be accomplished by submitting paper documentation, including fax or through the iEdison Invention Reporting System at www.iedison.gov.

5.06 Additional Information

(1) If there is any inconsistency between the information contained herein and the terms of any resulting SBIR funding agreement, the terms of the funding agreement are controlling.

(2) Before award of an SBIR funding agreement, the Government may request the applicant to submit certain organizational, management, personnel, and financial information to assure responsibility of the applicant.

(3) The Government is not responsible for any monies expended by the applicant before award of any funding agreement.

(4) This program solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under the SBIR Program are contingent upon the availability of funds.

(5) The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals must not be accepted under the SBIR Program in either Phase 1 or Phase 2.

(6) If an award is made pursuant to a proposal submitted under this SBIR Program solicitation, a representative of the contractor will be required to certify that the concern has not previously been, nor is currently being, paid for essentially equivalent work by any Federal agency.

(7) The responsibility for the performance of the principal investigator, and other employees or consultants who carry out the proposed work, lies with the management of the organization receiving an award.

(8) Cost-sharing is permitted for proposals under this program solicitation; however, cost-sharing is not required. Cost-sharing will not be an evaluation factor in consideration of your Phase 1 proposal.

5.07 Research Projects with Human Subjects, Human Tissue, Data or Recordings Involving Human Subjects

Any proposal that includes research involving human subjects, human tissue, data or recordings involving human subjects must meet the requirements of the Common Rule for the Protection of Human Subjects, codified for the Department of Commerce at 15 CFR Part 27. In addition, any proposal that includes such research on these topics must be in compliance with any statutory requirements imposed upon NIH and other federal agencies regarding these topics, all regulatory policies and guidance adopted by NIH, FDA, and other federal agencies on these topics, and all Presidential statements of policy on these topics. Any questions regarding these requirements should be addressed to Melissa Lieberman at (301) 975-4783 or melissa.lieberman@nist.gov.

IRB Education Documentation. A signed and dated letter is required from the Organizational Official who is authorized to enter into commitments on behalf of the organization documenting that appropriate IRB education has been received by the

Organizational Official, the IRB Coordinator or such person that coordinates the IRB documents and materials if such a person exists, the IRB Chairperson, all IRB members and all key personnel associated with the proposal. The NIST requirement of documentation of education is consistent with NIH notice OD-00-039 (June 5, 2000). Although NIST will not endorse an educational curriculum, there are several curricula that are available to organizations and investigators which may be found at: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-00-039.html.

5.08 Research Projects Involving Vertebrate Animals

Any proposal that includes research involving vertebrate animals (including fish) must be in compliance with the National Research Council's "Guide for the Care and Use of Laboratory Animals" which can be obtained from National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20055. In addition, such proposals must meet the requirements of the Animal Welfare Act (7 U.S.C. 2131 et seq.), 9 CFR Parts 1, 2, and 3, and if appropriate, 21 CFR Part 58. These regulations do not apply to proposed research using pre-existing images of animals or to research plans that **do not** include live animals that are being cared for, euthanized, or used by the project participants to accomplish research goals, teaching, or testing. These regulations also do not apply to obtaining animal materials from commercial processors of animal products or to animal cell lines or tissues from tissue banks.

6.0 SUBMISSION OF PROPOSALS

6.01 Deadline for Proposals

Deadline for Phase 1 proposal receipt (4 copies) at the address below is **3:00 pm** on **January 26, 2006 at the Contracts Office address below. NIST does not accept electronic submission of proposals.**

All Offerors should expect delay in delivery due to added security at NIST. It is the responsibility of the Offeror to make sure delivery is made on time.

Because of the heightened security at NIST, FED-EX, UPS or similar-type service is the preferred method of delivery of proposals.

If proposals are to be hand delivered, delivery must be made on the actual deadline date and a 24-hour notice must be made to the NIST Contracts Office prior to delivery. All Offerors must notify Myrsonia Diaz at 301-975- 8329, or Alba Sanchez at 301-975-6344. The name of the individual or courier company making the delivery must be included in the notification.

NIST assumes no responsibility for evaluating proposals received after the stated deadline or that do not adhere to the other requirements of this solicitation (see checklist in section 8.04).

Federal Acquisition Regulation (FAR 52 215-1) regarding late proposals shall apply.

Letters of instruction will be sent to those eligible to submit Phase 2 proposals. The Phase 2 proposals are due shortly after the deadline for Phase 1 final reports - 5 months after completion of the Phase 1 contract.

Offerors are cautioned to be careful of unforeseen delays, which can cause late arrival of proposals at NIST, resulting in them not being included in the evaluation procedures. No information on the status of proposals under scientific/technical evaluation will be available until formal notification is made.

6.02 Proposal Submission

Submission of Proposal Packages as defined in section 3.3 should be sent in **4 copies** to:

National Institute of Standards and Technology
Acquisitions and Logistics Division
Attn: Myrsonia Diaz, NIST–06-SBIR
100 Bureau Drive STOP 1640
Building 301, Room B129
Gaithersburg, MD 20899-1640

Phone Number: (301) 975-8329

Photocopies will be accepted.

Acknowledgment of receipt of a proposal by NIST will be made. All correspondence relating to proposals must cite the specific **proposal number** identified on the acknowledgment.

(a) **Packaging--Secure packaging is mandatory. NIST cannot process proposals damaged in transit. All 4 copies of the proposal must be sent in the same package. Do not send separate "information copies," or several packages containing parts of a single proposal, or two packages of 4 copies of the same proposal**

(b) Bindings--**Do not use special bindings or covers.** Staple the pages in the upper left hand corner of each proposal. Separation or loss of proposal pages cannot be the responsibility of NIST.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION SOURCES

Background information related to the NIST research programs referenced within the subtopics may be found within the NIST website at: www.nist.gov. Wherever possible, reference citations are provided within the individual subtopics.

8.0 SUBMISSION FORMS AND CERTIFICATIONS

8.01 Click on this link: Cover Sheet in order to access the required form (2 pages) in pdf format.

8.02 Click on this link: Project Summary in order to access the required form in pdf format.

8.03 Click on this link: Proposed Budget in order to access the required form in pdf format.

8.04 Checklist of Requirements

Please review this checklist carefully to assure that your proposal meets the NIST requirements. Failure to meet these screening requirements will result in your proposal being returned without consideration. **Four copies of the proposal must be received by 3:00p.m. EST January 26, 2006.**

1. The **COVER SHEET** (both pages combined) has been completed and is **PAGE 1** of the proposal.
2. The **PROJECT SUMMARY** has been completed and is **PAGE 2** of the proposal.
3. The **TECHNICAL CONTENT** of the proposal **begins on PAGE 3** and includes the items identified in **SECTION 3.3.3** of the solicitation. The technical content section of the proposal is limited to 22 pages in length.
4. The **SBIR PROPOSAL PROPOSED BUDGET** has been completed and is the **LAST PAGE** of the proposal.
5. The proposal is **25 PAGES OR LESS** in length.
6. The proposal is limited to only **ONE** of the subtopics in Section 9.
7. The proposal budget is for **$75,000 or LESS**. No more than one-third of the budget goes to consultants and/or subcontractors.
8. The abstract contains **no proprietary information** and does **not exceed** space provided on the Project Summary.
9. The proposal contains only pages of 21.6cm X 27.9cm size (8 ½" X 11").
10. The proposal contains **an easy-to-read font (fixed pitch of 12 or fewer characters per inch or proportional font of point size 10 or larger) with no more than 6 lines per**

inch, except as a legend on reduced drawings, but not tables.

11. The P.I. is employed by the company.

NOTE: Offerors are cautioned to be careful of unforeseen delays that can cause late arrival of proposals, with the result that they **WILL** not be forwarded for evaluation.

Potential offerors are advised to sign up within www.fedbizopps.com to receive notification of any amendment to the solicitation that may be released after opening date. Also, potential offerors are advised to check the public Q&A website for up to date information concerning specific subtopics that may be posted during the Solicitation open period.

9.0 RESEARCH TOPIC AREAS

9.01 Advanced Biological and Chemical Sensing Technologies

9.01.1-1 Broadly-Tunable CW Terahertz Single-Port Source

NIST is developing terahertz detection systems for imaging and spectroscopy of biological and chemical agents for healthcare applications. We have developed terahertz receivers with near quantum-noise limited heterodyne detectors. This technology will play a major role in imaging and spectroscopy throughout the terahertz frequency range (defined roughly as 300 GHz to 10 THz). Spectroscopic systems require broadband terahertz sources with sufficient powers to bias focal-plane arrays consisting of heterodyne detectors.

Proposals are solicited for the development of a broadly-tunable CW terahertz single port source covering the range of 0.8 to 1.2 THz. Such source should produce about 50 μW at the high-frequency end, rising to about 200 μW at the low-frequency end. The frequency of the output signal is to be digitally programmable over the full frequency range and any transition between internal frequency ranges must be automated. The power level of the source must be controlled by an externally applied analog signal provided by the user. Innovative designs and improvement of current solid-state device technology have to be demonstrated. This prototype of a broadly-tunable terahertz source can be extended in frequency range and output power level at future developmental stages.

Phase 1 of the program should demonstrate a single chain of frequency multiplier components over a bandwidth of 100 GHz and a power level control via external analog signal. Switching technology between different multiplier chains has to be developed and demonstrated. Finally, an architecture and a roadmap for the development of the complete source described above has to be developed in Phase 1 of the program. The system prototype is to be

delivered to NIST for evaluation and retention. A fully developed version of the system is deliverable at the end of Phase 2 (if awarded). NIST is willing to work collaboratively with the contractor in development of the prototype unit.

9.02 Analytical Methods

9.02.1-3 Ideal Liquid Optical Particle Sensor

There is need for a single particle sensor that can be used to both size and count individual particles suspended in a liquid by optical methods. The application for NIST is to aid in the development of particle liquid suspension standard reference materials and for applications related to biological warfare/health related areas. This instrument should provide an increased capability and performance over exiting commercial instruments. Large counter manufacturers are not motivated toward innovation in this technology because they have marketed designs that are accepted by industry. Therefore, most likely the development will be undertaken by a small company, but the instrument has great commercial viability. Phase 1 objective is to develop a prototype sensor with further enhancements implemented during a phase 2 effort, if awarded. The prototype developed will be deliverable to NIST at the end of each phase. The NIST researcher will collaborate with the contractor in designing and making the prototype instrument. The instrument may be internally calibrated for size or require external calibration by known accepted particulate standards. The sensor may use either light scattering or extinction. The sensor may use multi wavelength light or monochromatic light. The design should minimize the sensor response to effects related to index of refraction. No loss in sensitivity should be detectable for index of refraction differences between particles and liquid of 0.2 or more. This may be accomplished using multiple angles or other technology. The size range should be one micrometer diameter to 100 micrometers. The concentration range must be comparable to current single particle optical sensors (approximately 5% to 10% coincidence counting at 16,000 particles/mL).

9.03 Homeland Security

9.03.1-6 Development of a Large-Area Solar Simulator Using Light Emitting Diodes

The photovoltaic industry is experiencing an annual growth exceeding 30 percent and globally generates over $4 billion in revenues. Greater utilization of photovoltaic and other renewable resources is a vital part of the nation’s strategy to reduce our dependence on foreign energy resources and vulnerability to terrorist’s attacks, an important aspect of NIST’s “Homeland Security” strategic focus area.

Photovoltaic modules are sold based upon their power output at a specified set of conditions, and thus the measurement procedures used to capture their performance is extremely important to the photovoltaic industry. Due to variable outdoor weather conditions and time considerations, the majority of photovoltaic manufacturers choose to test and rate their products indoors using a solar simulator. Major deficiencies of indoor photovoltaic testing are spectral irradiance mismatch between indoor and outdoor test conditions and from one solar simulator to another, the inability to easily vary the solar simulator's spectrum to simulate different outdoor environmental conditions, and the limited lifespan of xenon and tungsten filament lamps used in the vast majority of solar simulators.

The objective of this SBIR proposal is to fabricate a large area simulator capable of irradiating a 1.5 meter by 1.5 meter photovoltaic module using light emitting diodes (LED Solar Simulator) while providing irradiance levels that can be varied from 500 W/m2 to 1100 W/m2. Based on a grid of 150 cm x 150 cm blocks, the uniformity of the irradiance level among measurement blocks shall be tunable within +/- 2 percent over the 2.25 square meter area. The generated spectrum in each 150 cm x 150 cm block shall replicate the ASTM's air mass 1.5 solar spectral irradiance distribution as defined within "ASTM's G159-98 Standard Tables for References Solar Spectral Irradiance at Air Mass 1.5; Direct Normal Hemispherical for a 37 Tilted Surface". Finally, for the LED Solar Simulator developed under this SBIR proposal, each 150 cm x 150 cm measurement block shall additionally meet the temporal and spectral match requirements of a Class A simulator as defined within ASTM Standard E 927-05 "Standard Specification for Solar Simulation for Photovoltaic Testing". Although not mandatory, it is desirable that the LED Solar Simulator's spectrum is variable such that air mass conditions other than 1.5 could be replicated by varying the intensity of selected LED groups.

Proposals to improve/develop solar simulators that do not utilize light emitting diodes are not solicited. Phase 1 will require a deliverable prototype solar simulator that meets all of the stated requirements above with the exception of the irradiated area. The Phase 1 prototype may be limited to an area that is equal to or greater that 150 cm by 150 cm. In Phase 2 a functioning system will be delivered to NIST for its retention and ownership that meets all the described specifications. NIST is willing to work collaboratively with the contractor to measure the spectrum and uniformity of the resulting Phase 1 prototype and Phase 2 working model.

9.03.2-4 Vibration Detection for the Suppression of PM noise

Phase modulation (PM) noise caused by acoustic and structure-borne vibrations degrade the static performance of oscillators in transmitters and receivers, thereby degrading communications systems. This is because vibrations cause mechanical distortions of the frequency-determining

element, usually a quartz crystal resonator, in an oscillator. In many cases, modern narrowband communications systems employ a spectrally pure carrier signal that carries the information as a low-index modulation so that each communicator has close carrier-frequency spacing relative to adjacent communicators. Frequency management usually calls for a “guard channel” of approximately one channel’s frequency allotment that separates each communicator’s frequency to avoid interference. Communications disruptions can occur where a large number of such systems are brought into operation in close proximity to one another and each is subject to vibration, a situation that often occurs during responses to major disasters. In such situations, vibration can induce high phase noise on the reference carrier of the affected communicator in both transmit and receive modes to the point that the channel’s allotment is exceeded, the guard channel is no long effective, and adjacent channels are subject to interference. Given a large number of communicators, this noise can severely compromise critical two-way communications in an emergency.

Traditional methods for dealing with such vibration problems have focused on soft mounting of a frequency-determining element on its own physical suspension arrangement. But traditional suppression schemes cannot effectively remove more noise without additional burdensome size and weight. However, the noise can be readily detected and measured by small accelerometers, such as MEMS accelerometers. One can electronically correct for vibration-induced spurs and noise (predominantly in the audio range) by subtracting a digitally generated version of the noise based on their detection from accelerometers. This approach is used in the audio spectrum for noise-cancellation, auditorium feedback suppression, and blower HVAC noise suppression, and even enhancement of signal-to-noise ratio in noisy music and speech transmissions. Successful suppression of vibration-induced oscillator noise would have significant impact on virtually all applications requiring oscillators or clocks, many of which must be able to operate in environments where the acoustic and structure-born vibration induces noise well-above the random electronic noise of communications systems such as in an emergency vehicle.

The phase 1 portion of this opportunity calls for an investigation of methods of using digital detection and subsequent subtraction of oscillator phase noise (caused by vibration) that are above the random noise level. Phase 2, if awarded, would require development and delivery to NIST of a prototype oscillator system for demonstration of concepts (e.g., electronic suppression of vibration spurs). We do not anticipate working collaboratively with the company to accomplish the project goals, but arrangements could be made for consultation or laboratory access.

9.03.3-1 Emergency Beacon for First Responder Radios

NIST seeks innovative and practical ways of improving radio links for first responders in difficult reception environments through the application of techniques similar to those developed for the military and deep space communications. The weakest link in the first-responder's communication system is the transmission power of a portable handset. Even when the base station is able to transmit powerful and intelligible signals to a first responder, the first responder is often unable to complete the communication link with the reduced power available in his or her handset, typically 1 to 5 watts. The radio signals emanating from the first-responder's portable handset, after being attenuated by structural materials, become so weak that they become indistinguishable from electrical noise from other sources.

However, it is often possible to detect simple codes, consisting of only a few well-defined symbols, from a portable handset even when attenuation is high enough to make voice communication impossible. This is the notion behind deep space communications, where slow data rate signals and signal processing are used to pick signals out of the noise. In an emergency scenario, use of a beacon based on a slow data rate would allow the first responder to receive voice instructions from the base station and communicate back with simple codes. It is envisioned that such code-based communications could be incorporated into existing first responder handsets through a retrofit or even a firmware upgrade. Ultimately, emergency beacons based on slow data rate signals could even be built into cell phones. This project has high potential for commercialization in both the public safety sector and the cell phone/mobile communication industries.

Phase 1 of this SBIR solicitation will demonstrate the feasibility of a data-based emergency beacon that is easy to use, straightforward to implement in hardware or firmware, inexpensive, and retrofittable to first responder radios. Phase 1 of this research should develop a plan for commercializing and integrating the beacons into communication systems for first responders. Systems based on open standards preferred. Contractor should demonstrate successful reception of information from signals at least 30 dB beneath the noise floor of standard first responder handset radios (we have demonstrated 20 dB improvement using simple Morse Code techniques in our lab). NIST is willing to work with the contractor to help with evaluation of the system. Phase 2 will deliver a working prototype system.

9.03.4-1 Emergency-Vehicle Electrical System Conducted-Interference Test System

Emergency-first-responder vehicles, such as all police and fire vehicles (fire trucks, medical response units, control vehicle), ambulances, and those of other agencies required to participate in emergency incidents, contain a plethora of electrical and electronic components not found in consumer vehicles. These additional components comprise sirens, lights, emergency

medical instruments, speed detection devices, computers, etc. Each of these devices generates a conducted emission that can impact the performance of other components of the vehicle electrical system. Moreover, each of these components has a unique susceptibility to conducted emissions. Although most of the additional components do not cause or experience functional problems during normal driving conditions, they typically are not used until the vehicle is stopped and the motor is idling. In this situation, the charging system of the vehicle may not be adequate to provide the electrical current necessary for operation of all the components connected to the electrical system, and large conducted emissions may arise that have an adverse effect on these components. Until now, only a few recorded events of failure of electrical components, primarily those used for speed measurement, have been noted. The failure was attributed to conducted emissions. Although the failure of a speed measuring device may have no impact on human health and safety, it provides further evidence of the conducted interference problem. These conducted susceptibility failures are presumed to be a result of inadequate charging system capacity, the effects of which can be ameliorated by increasing the charging system capacity or providing special filters between the components and the electrical system. These failures may also be caused by inadequate product design and/or specifications. It is necessary to identify the causes of the failures before proposing possible solutions, neither of which can be done without knowledge of the magnitude of the interference. Development of the capability to do the types of tests envisioned can improve reliability assessment of the vehicular electrical systems, thereby allowing improvements in design and specifications of the electrical system.

The requirements for this test system are:

- instrumented and functional electrical system of representative emergency vehicle (work with NIST in selection of vehicle)

- instrumentation shall provide information necessary to accurately (within 2 %) measure the electrical signal parameters (voltage and current) relevant to the study of conducted susceptibility and emissions (will work with NIST to identify circuit nodes where instrumentation is necessary)

- the electrical system shall include all components (lamps, radios, air conditioner, battery, alternator, etc.) found in the representative emergency vehicle

- the electrical system shall also have a means for emulating variations in engine rpm

The expected outcome of the Phase 1 work will be a complete measurement system design, including measurement system layout, circuit schematics for

any non-commercial circuitry, and mechanical drawings of any mechanical components, to meet the above requirements.

The expected outcome of the Phase 2 (if awarded) work will be a functional system exhibiting the performance requirements listed above and a complete uncertainty analysis of all measured parameters. The contractor will work with NIST in the development of the uncertainty analysis.

9.04 Information Technology

9.04.1-1 Reference Flat Pulse Generator

Reference flat pulse generators are used as measurement standards in two major electrical metrology applications, time-domain reflectometry (TDR) and pulse metrology. In TDR, pulses propagate along a transmission line and are partially reflected at any impedance discontinuities encountered. The amplitude of these reflections provides a measure of the impedance discontinuity. TDR measurements are used in product quality assurance for printed circuit boards, transmission line and fabrication process design and model verification, and process control and monitoring. In both TDR and pulse metrology, the flatness and transition duration (rise/fall time) of the pulses are important. The flatness relates to the low-frequency content of the pulse and the transition duration to the high-frequency content. In TDR, the flat region of the pulse allows the reflected pulses to be distinguished and separated from the incident pulse. The flatter the pulse, the more reliable is the separation. In pulse metrology, the flatness is important to measuring the gain flatness and settling performance of samplers and other pulse generators. In TDR, the high-frequency content of the pulse is essential to accurate measurements of the properties of transmission lines over the operating bandwidth of their associated circuits. High speed flat pulse generators would allow the complete characterization of the step response of the oscilloscope over its entire bandwidth. Such a calibrated oscilloscope can then be used to characterize other step generators, which are typically used as transfer standards. Accurate information on the performance of these devices will contribute to improved product design and specifications and advancement of pulse metrology.

There presently are no commercially-available pulse generators that are adequate to test high-performance interconnects or high-speed (transition duration < 5 ps) oscilloscopes over the rated bandwidths.

The minimum requirements for the flat pulse generator are:

- number of pulse states: 2 (high and low)
- pulse repetition rate, R: 10 Hz ≥ R ≥ 10 GHz

- pulse duration, D: 0.1d**SUB**f (at R = 10 GHz) ≥ D ≥ 0.9df (at R = 10 Hz), df is duty factor
- positive transition duration, t10-90:≤ 5 ps (ideally, ≤ 3.5 ps)
- negative transition duration, t10-90: ≤ 5 ps (ideally, ≤ 3.5 ps)
- pulse amplitude: 0.4 V to 0.6 V
- pulse flatness: monotonic tilt for either the high or low state with slope less than 0.001 % of pulse amplitude per 100 ns.
- output signal impedance: 50 Ω
- input signal/clock, type: electrical, impulse-like (pulse duration < 10 ps) to square-wave (ideally, optical with pulse duration from 100 fs to 100 ps)
- input signal/clock connector: 3.5 mm, 50 Ω impedance (ideally, fiber coupled for FC SM fiber)

The expected outcome of the Phase 1 work will include circuit designs and layout with simulations, chip and circuit fabrication plan, identification of other participants necessary to complete device development, and test reports of similar circuits they have designed but do not meet the indicated specifications. The contractor will work with NIST to simulate circuit performance.

The expected outcome of the Phase 2 (if awarded) work will be two functioning prototypes, test results showing how the devices met the performance requirements, and a program plan for commercialization including partners and their contribution to production. The contractor will work with NIST in the performance measurement of the prototypes.

9.04.2-4 Gigabit/second Random Number Generators

The NIST Quantum Information Testbed project is a demonstration platform for accomplishing quantum cryptographic key distribution at gigabit/second transmission rates. A limiting factor in this process is the generation of random numbers that constitute the key. Accordingly, NIST seeks research proposals for hardware-based random number generators capable of producing 109 random bits per second. It is envisaged that such a generator will use some random physical process, such as electrical noise in a circuit element or a quantum transition, as the basis of a random sequence. Devices that are based on deterministic algorithms are not acceptable. Phase 2 work on this subject should result in the delivery to NIST of a prototype device that can be incorporated into the testbed. Further information on the testbed project is available at http://qubit.nist.gov

Though not necessary, NIST would consider working collaboratively with the contractor.

9.05 Intelligent Control

9.05.1-2 Applying AI Tools and Techniques to the Real-Time Control of Intelligent Systems

There is a clear gap between traditional Artificial Intelligence (AI) systems that typically work solely on symbolic representations, and real-time control systems that rely on processed sensor data, usually in the form of geometric knowledge or metrical maps. However, with constant advancements in object recognition technologies and the ever increasing computer processing speeds, these control systems seem primed to be able to leverage existing AI tools and techniques to allow for more suitable and robust control of intelligent systems.

This solicitation is seeking proposals for AI tools, representations and/or techniques that could enhance the ability of real-time control systems to understand the environment and propose suitable actions. Prime areas for applying AI techniques are in the areas of situation awareness and dynamic planning (also referred to in some domains as tactical behaviors); in particular, providing the ability for an intelligent system to be able to identify and understand a situation it encounters, be able to reason over the situation to deduce additional pertinent information, be able to understand the actions that are available to it when confronted with that situation, and be able to decide among those actions to determine which best accomplishes a given goal. The need for this type of deductive logic is ubiquitous, and can be applied to many manufacturing and non-manufacturing areas, ranging from manufacturing cell control to autonomous vehicle navigation.

The contractor will work closely with NIST staff members who are developing control systems based upon the 4D/RCS reference model architecture. The Phase 1 deliverables are a detailed design document and a proof-of-concept implementation showing the overarching architecture and detailed interactions between the proposed AI tool suite and the 4D/RCS control architecture. The proof-of-concept implementation should show how the proposed solution could be applied to a sample scenario in the manufacturing or autonomous vehicle domain. The Phase 2 deliverable, if awarded, is a prototype implementation of the entire system – a copy of which is to be proved to NIST upon completion. This will serve as the baseline for the hardened tool set that will be made available for commercialization in Phase 3. If successful, the proposed tool set should have a strong potential customer base made up of researchers and developers wishing to embed more intelligence in their control systems, independent of their domain of interest.

References:

Albus J., and Meystel A., Engineering of Mind: An Introduction to the Science of Intelligent Systems, New York: John Wiley and Sons, 2001.

Evans, J., Messina, E., Albus, J., and Schlenoff, C., "Knowledge Engineering for Real Time Control," Proceedings of the International Workshop on Intelligent Knowledge Management Techniques (I-KOMAT 2002), Crema, Italy, 2002.

Uschold, M., Provine, R., Smith, S., Schlenoff, C., and Balakirsky, S., "Ontologies for World Modeling in Autonomous Systems," Submitted to the IJCAI'03 Conference: Workshop on Ontologies and Distributed Systems, 2003.

9.05.2-5 High-Speed Non-Contact Thermography

Non contact thermography is required to measure temperature in many important manufacturing processes such as thermal spray coating, planar flow casting, and metal spray forming, as well as for providing calibrated temperature data in advanced materials property measurement instruments. This SBIR subtopic seeks to address the specific need of providing calibrated temperature data from Infra-Red (IR) thermal radiance images of metallic materials using the emitted electromagnetic radiation in the 1 to 5 μm wavelength range. The thermal imaging device suitable for this purpose will need to produce high resolution images (at least 320 X 256 pixel count) and have software control of windowing and binning the image pixel count to enhance framing rate. The framing rate at full pixel count must be at least 300 fps. The focal length (FL) and field of view (FOV) must be adjustable via suitable optics. FL should have a minimum of at least 80 mm and a maximum no less than 220 mm. FOV at minimum FL should be no less than 6.9 X 5.5 mm. At maximum FL the FOV should be no more than 2.5 X 2 mm. The detector material (InGaAs, InSb, or another with suitable properties) and detector array performance must be optimized for maximum sensitivity and dynamic range. The proposed detector array sensitivity should be expressed as Noise Equivalent Irradiance (NEI) or Temperature Difference (NEdT), and the dynamic range should be expressed in bits. The proposed device should transfer digitized images to a PC for hard disk storage and have software for thermal image analysis. Consideration will be made for novel optical and/or software technology that provides enhanced calibrated temperature measurement capabilities. The contractor will make a prototype system available to NIST for testing in a laboratory environment. NIST will collaborate with the contractor on software and device testing. The software source code and device prototype will be a deliverable for the phase 1 effort and a more developed system shall be deliverable for the phase 2, if awarded.

9.06 Manufacturing System Integration

9.06.1-2 RFID-Based Supply Chain Optimization and Simulation

Radio Frequency Identification (RFID) technology has advanced to the point where industry and government agencies are now mandating placement of RFID tags in materials being shipped and stored. RFID supporting Location Based Services has provided material visibility at shipping and destination locations. Emerging technology can extend the reach by using existing infrastructure in a passive environment to provide detailed, near real-time knowledge of material's location and status as it moves through the supply chain. As a consequence of this, there will be an enormous amount of data available for analysis. Inventory levels, inventory locations, batch sizes and frequency of shipments can be discerned from this data.

NIST seeks proposals addressing how the data can be used to determine behavioral characteristics of existing supply chains and then use network optimization and simulation technology to drive improvements. These analytical tools may also be used to simulate "what if" scenarios, and to restructure supply chains to respond to disruptions. Analytical results should reveal opportunities for improvement in infrastructure, process design, enterprise resource planning software configuration, customer service level, and cost savings in the sizing of returnable container pools.

Deliverable of the Phase 1 of this research shall include:

• A written report that identifies an appropriate pairing of RFID technology to data collection infrastructure. The report should outline the mapping of raw data to concepts and parameters in the proposed analytical tools.

• A written report detailing the analytical techniques to be applied in the simulation and network optimization.

• A written report identifying how a Phase 2 industrial partner could apply the technology in an actual supply-chain.

Deliverables of the Phase 2 project (if awarded) shall include:

• Prototype system software with source code to be delivered to NIST

• A written report describing experimental results, the limitations and abilities of the system.

Copyright to any software remains with the contractor.

Testing of the Phase 2 prototype will be done with the cooperation of the NIST staff.

9.07 Microelectronics Manufacturing

9.07.1-1 40 Gb/sec Bitstream Generator

The Quantum Voltage Project requires a high-speed 40 Gb/sec programmable bitstream generator to drive the next generation quantum-based ac Josephson Voltage Standard (acJVS). In order for the acJVS system to produce accurate metrologically useful waveforms, the generator must be able store a pre-defined bit sequence in memory of up to 40 Gbits and stream it to a single output port at a rate of 40 Gb/sec. Such a generator is currently unavailable in the commercial sector. In addition to metrology applications, the generator would also be useful to the Telecommunication Industry for testing next-generation high-speed devices, as well as for the Electronic Instrumentation Industry for evaluating instrument performance with broadband analog and digital signals at frequencies up to 20 GHz.

NIST is willing to work collaboratively with the contractor in design, evaluation, and testing of the prototype unit.

Phase 1 will involve a feasibility study of the design, and to evaluating components and design features using evaluation circuits.

Phase 2 will build and deliver a working prototype system to NIST for evaluation and use with the ac Josephson Voltage Standard.

9.08 Microwave Technology

9.08.1-1 DC Substitution Microwave Power Detectors

NIST seeks the development and manufacture of DC substitution microwave power detectors for one or more of the following connector types; WR-15 waveguide (50-75 GHz), WR-10 waveguide (75-110 GHz), 2.4 mm coaxial connector (up to 50 GHz) and 1.85 mm coaxial connector (up to 65 GHz). The detectors should operate in the 1 to 10 mW range and be compatible with operation in a NIST microwave calorimeter. A commercial product based on this type of sensor would have the lowest uncertainties available for microwave power measurement. The commercial product could be identical to the detectors sold to NIST or a modified version. Identical versions would be of particular interest to calibration and standards laboratories worldwide.

Primary standards for microwave power rely on DC substitution in which the heat generated by absorption of microwave power is compared with the heat produced by absorption of known DC power. NIST's standards consist of sets of calorimeters and bolometric detectors. The efficiency of the DC substitution process in a bolometric detector is evaluated in a calorimeter. The bolometric detector is then used to evaluate customer devices. Existing bolometric detector types are no longer available. Hence, NIST and other laboratories do not have an ability to maintain microwave power measurement standards

and are dependent on the development of new detectors such as those being solicited. Examples of appropriate detectors include thermistor and thin film bolometric detectors. Key attributes of a good detector are:

1) all DC power dissipated in the detector must be accurately measured,

2) a low thermal mass is preferred, and

3) temperature compensation is not needed since NIST's measurements are done in a controlled environment.

Phase 1 will consist of the preliminary design of the detector. In Phase 2, prototype detectors will be made and tested in the NIST calorimeter. NIST staff will provide guidance for detector design, perform the calorimeter measurements, and provide feedback on performance during Phase 1. By the end of Phase 2, a final design and detector should be produced and delivered to NIST. If successful, we expect that NIST would purchase additional units. If the new detector is operated with a NIST Type IV power meter [1], then NIST will supply its own power meters. If the new detector requires a modification of the Type IV power meter, NIST will work collaboratively with the contractor on the modifications. For example, we have modified Type IV's that work with positive temperature coefficient bolometers from 600 to 1000 Ω. If a different power meter is required, the contractor will need to supply one.

An example of an appropriate detector for a Type N coaxial connector is described in reference 2. New waveguide calorimeters are being built in the WR-15 and WR-10 waveguide bands. The earlier models are described in reference 3. The newer models can accommodate a much wider range of detector geometries than the old versions. Either 2.4 mm or 1.85 mm detectors will initially be operated in NIST's 2.4 mm calorimeter [4] with an adapter used for 1.85 mm detectors. All references and more detailed information about the present calorimeters will be available during the solicitation period. NIST staff will also work collaboratively with the contractor to insure that the new detectors are compatible with NIST calorimeters. Although not directly related to this solicitation, references 5 and 6 give more detailed information about the NIST Type N calorimeter. Much of the Type N information also pertains to the connector types in this solicitation.

References

[1] Neil T. Larsen, "A New Self-Balancing DC-Substitution RF Power Meter", IEEE Trans. Instrum. and Meas., IM-25 (4), pp. 343-347 (1976).

[2] Fred R. Clague and Paul G. Voris, "Coaxial Reference Standard for Microwave Power", NIST Tech. Note 1357 (April 1993).

[3] J. Wayde Allen, Fred R. Clague, Neil T. Larsen, Manly P. Weidman, "NIST Microwave Power Standards in Waveguide", NIST Tech. Note 1511 (Feb. 1999).

[4] T. P. Crowley and F. R. Clague, "2.4 mm Diameter Coaxial Power Standard at NIST", presented at the British Electromagnetics Conference, November, 2001, available on CD.

[5] Fred R. Clague, "Microcalorimeter for 7 mm Coaxial Transmission Line", NIST Tech. Note 1358 (Aug. 1993).

[6] Fred R. Clague, "A Calibration Service for Coaxial Reference Standards for Microwave Power", NIST Tech. Note 1374 (May 1995).

9.09 Nanofabrication

9.09.1-1 Multiple Contact Nano-Probes for Electrical and Optical Characterization

Physical probe stations to contact and electrically characterize microelectronics devices have been a critical tool for controlling microelectronics manufacturing. These probe stations contain multiple independent probes and use optical microscopes to guide probe placement with micrometer accuracy. This type of probe station is limited by the spatial resolution of the optical microscope, the size of the probes, how close two probes can be placed with respect to each other, the lack of feedback between the probe and the sample, and the general requirement of fabricated metallic probe pad structures. Nanoscale structures of interest to NIST, such as silicon and GaN nanowires, are in general not electrically contactable with a traditional probe station, but can be electrically contacted with an AFM probe. Measurements of the multiple-contact, electrical properties of nano-structures have required time-consuming and expensive fabrication of lithographic contacts and gates. Non-destructive methods to electrically contact and characterize nano-structures are a widely-recognized high priority need, and a critical measurement need for NIST nanoelectronic and nanofabrication related programs.

This subtopic seeks innovative methods to make multiple, independent, non-destructive electrical contacts to nano-structures. The system should have two components: 1) The probe system itself, and 2) Innovative techniques to measure small and high-frequency voltage, current, capacitance, and optically pumped electrical measurements. For the probe system, a system with multiple AFM like probes is one possibility. The system should ideally contain at least four independently controllable probes (to enable 3-probe transistor like measurements and 4-probe Kelvin type measurements). Probe spacings as close as 10’s of nanometers are desirable, though systems with

lesser (~ 200 nm spacing) would be useful. Probes should be able to hold their position within ~10 nm for times useful for an electrical measurement (a few minutes). The secondary parts of the system are innovative methods of integrating the desired electrical measurements into the probes. For example, quantitative (as opposed to relative) capacitance measurements in the attto-Farad range would be desirable. The ability to quantitatively apply strain to a nanowire structure with a single probe, and development of probe tips from materials with lower work functions (like Ti, Al) for low resistivity ohmic contacts are also desirable. Proposals submitted under this subtopic may address access to NIST facilities. The contractor will work closely with NIST staff members who are developing various nanoelectronic devices, including nanowires, to help define the probe positioning and electrical measurement constraints.

A successful phase 1 system should demonstrate three probe contacts to nanostructures with probe spacings less than that available from any traditional probe station, including: 1) Three electrical contacts to a horizontal nanowire structure 5 micrometer long and 100 nm in diameter; 2) Measurement of the “transistor-like” properties of this nanostructure, ie I-V through the long dimension, while applying a independent “gate” voltage with the third probe, 3) Useful electrical contact to the top of a vertical nanowire structure, 4) current, voltage, and capacitance measurements using two or more probes useful for measuring the transport properties of nanostructures, and 5) Assessment of the needs and limitations for atto-capacitance measurements, logarithmic current, pico-voltage and pico-current measurements on nanostructures using the demonstrated probe system.

Phase 2 would include the construction and testing of a prototype system with cooperation of the NIST staff. The phase 2 system should improve probe separation beyond the current state of the art towards a goal of 10 nm, improve probe stability, and demonstrate four probe “Kelvin” measurements on nanostructures. The phase 2 system should also include instrumentation for electrical measurements specifically using the probe system that have been optimized to control and minimize, noise, stray signals, and optical interference. This may include custom instrumentation for attoFarad capacitance measurements, logarithmic current, pico voltage, and pico current measurements as determined to be desirable in phase 1. Work on probe work function engineering and use of a probe for applying strain to a device under test could also be included in phase 2.

9.10 Optics and Optical Technology

9.10.1-4 Development and Manufacture of High-Efficiency, Low-Dark-Count Detectors for IR Photon Counting

Photon counting in the infrared (IR) spectrum is a difficult task, but of pressing interest for emerging quantum information applications. The most commercially advanced detector in this region is the InGaAs avalanche photodiode (APD), which, as currently available, has low detection efficiency (~10 % to 30 %), significant afterpulsing requiring long dead time, and high dark count rates (~50,000 s-1) requiring gated biasing for practical operation. Last year's solicitation included a subtopic for development of better detectors, and a number of good proposals were received. This year, we call for development of detectors with yet greater detection efficiency and at alternative wavelengths.

We seek proposals for the development of IR detectors optimized for photon counting at either 1.3 micrometer or 1.5 micrometer wavelength. The detectors must have a detection efficiency of 80 % or greater and dark count rate 1000 s-1 or less. The detector should be capable of operating at count rates of more than 1 MHz with dead time less than 1 microsecond. For the intended applications, timing is critical, so the timing jitter of the detector output relative to the input pulse should be less than 1 ns. Proposals for InGaAs APDs are expected, but other detector types meeting the same characteristics and final form factor, including any necessary cooling apparatus, would also be considered. However, the total price of the detector and support apparatus, as estimated for production manufacturing, should be comparable to InGaAs APDs. An additional practicality requirement is that the design should be robust with a mean time between failures of 10,000 hours or greater. A fiber coupled detector is preferred, but not a necessary requirement. Proposals that demonstrate innovation in semiconductor electronics manufacturing are also preferred.

At the end of Phase I, the contractor must provide a minimum of 10 detector samples to NIST, which will become property of NIST. Though not necessary, NIST would consider working collaboratively with the contractor to help with evaluation of the operating parameters.

9.10.2-3 High Performance NIR Array Detectors for Advanced Sensors

Recent advances in Raman spectroscopy have enabled it to make significant impacts in commercial diagnostics, as a chemical sensor, and as a real-time on-line process sensor. However, many commercial applications are hampered by the fluorescent background generated by visible laser excitation sources. Although the use of near-IR (NIR, chiefly 1064 nm) excitation largely mitigates this problem, the overall performance of NIR Raman spectroscopy is significantly poorer than that of its visible counterpart. This is due to the lack of NIR array detectors with performance comparable to the state-of-the-art, high quantum efficiency, Si CCD array detectors used in the visible range. Over the wavelength range 1000 nm to 1700 nm critical to 1064 nm Raman, the poor performance of cryogenic (LN2 cooled) NIR (primarily InGaAs) array

detectors is determined not by the intrinsic noise performance of the detector element, but by the packaging/read-out electronics.

NIST seeks the development of high performance, NIR array detectors, optimized for use in optical, primarily Raman, spectroscopy. It is anticipated that such detectors would also have use in other NIR spectroscopies (absorption, fluorescence) that are routinely used in sensing applications.

In Phase 1, improved electronics for NIR array detectors optimized for high-sensitivity, low-noise, slow scan read-out will be designed and simulated. Target performance is a minimum of 1064 pixels on a nominal 25 micrometer pitch, > 50% quantum efficiency over the nominal range 1000 nm-1700 nm, 60 Hz frame rate, less than 30 e/pixel/frame read-noise.

In Phase 2, an array, mounted in a LN2 cooled dewar, appropriate for testing as a spectroscopic sensing array, will be delivered to NIST for its retention and ownership.

9.10.3-4 Wide-Bandgap Photodiodes for Extreme Ultraviolet Radiation

We seek improved solar-blind detectors for extreme ultraviolet (EUV) radiation, for use as transfer standards and field-use detectors in various applications. Traditionally, silicon photodiodes have been used to measure the intensity of this radiation, but these devices respond to a broad range of wavelengths from the x ray to the infrared portions of the spectrum. In many applications, this broadband response is undesirable because it leads to spurious signal from out-of-band radiation, which can be significantly more intense than the radiation of interest. While the broadband response of silicon photodiodes can be limited by the deposition of filter materials on the active area, this solicitation seeks detectors where the bandpass of the detector is intrinsically limited to the ultraviolet spectral region due to the material properties of the semiconductor. Particular applications for these devices include but are not limited to solar observations, where the visible-wavelength solar output can be seven orders of magnitude greater than the EUV emission, and EUV lithography for integrated circuit manufacturing, where the multilayer mirrors in production systems reflect visible and near ultraviolet radiation from the source as well as the EUV required to expose the photoresist.

The detectors we seek must have responsivity greater than 0.1 amperes/watt at wavelengths between 5 nm and 100 nm and greater than 0.01 amperes/watt at wavelengths between 100 nm and 200 nm. The responsivity to wavelengths longer than 400 nm must be reduced from the typical responsivity in the 5 nm to 200 nm spectral region by at least a factor of 1000. These detectors must have an active area of at least 50 mm2 with no linear dimension (length, width, diameter, etc.) smaller than 7 mm. The responsivity

of the detectors must not degrade by more than 5 % of the initial value when exposed to an integrated dose of 0.01 J/cm2.

9.10.4-4 Commercially-Available Electrically Substituted Bolometer

NIST has developed an Electrically Substituted Bolometer (ESB) that is finding use as a reference detector in various detector spectral responsivity measurement facilities.1 The control electronics for the existing prototype can be improved.

Proposals are solicited for developing an improved, commercial version of the ESB, transferring NIST technology to the private sector. We believe that a market exists for spectrally flat, spatially uniform reference detectors in the electro-optics community. The design must satisfy five requirements: (a) spectrally flat response from visible (400 nm) through thermal infrared (20,000 nm) wavelengths, (b) noise floor below 100 pW, (c) linearity from the noise floor to 1 mW, (d) response time of tens of ms so as to be compatible with chopping above 10 Hz, and (e) active area of 5 mm diameter or larger. The development approach would consist of developing improved control electronics for the NIST prototype, then developing a commercially viable approach for producing and packaging the detectors themselves.

1. J. P. Rice, “An electrically substituted bolometer as a transfer-standard detector,” Metrologia 37, 433-436 (2000).

Proposals submitted under this subtopic may request access to NIST facilities for access to existing ESB prototype, producing gold-black absorptive coatings for additional ESB prototypes and for electro-optical testing of ESB prototypes.

Deliverables:

Phase 1. Breadboard version of electronics for operation of an existing ESB.

Phase 2: Complete working model of an ESB, including final version of electronics and a detector packaged in a cryogenic dewar, in a form suitable for commercialization.

9.10.5-4 Spatial Light Modulators for Programmable Spectral Projectors

NIST is pioneering the development of programmable spectral projectors for use in testing electro-optical sensors, such as fire-fighter infrared cameras, hyperspectral imagers, bio-chemical agent detectors, and sensors used in the colorimetry and lighting industries. A programmable spectrum is obtained by spectrally dispersing broadband light across a spatial light modulator, which is programmed to pass light of desired wavelengths in desired proportions. Light

transmitted (or reflected) by the spatial light modulator is collected and projected into the sensor under test. The degree to which an arbitrary spectrum can be produced is determined, in large part, by the specifications of the spatial light modulator. Currently NIST is using commercially available, 1024 x 768 pixel digital micromirror arrays as the spatial light modulators. While this format is useful, the small pixel sizes (~ 12 micrometers) result in too much diffraction for many emerging applications.

We seek linear or two-dimensional spatial light modulators having pixel sizes of 40 micrometers or larger to use in programmable spectral projectors spanning the ultraviolet spectrum through infrared. Linear arrays must have 1024 pixels or greater and each pixel must be capable of generating a variable (8 bit or higher) transmittance (or reflectance) level. The switching time between levels should be as fast as possible, with 1 ms considered a realistic goal. NIST realizes that such performance is realizable with liquid crystal display (LCD) spatial light modulators, but this solicitation is open to LCD or any other technology that can meet the requirements. For example, proposals to develop digital micromirror arrays with pixels sizes 40 microns or larger are welcome. If two-dimensional arrays are proposed, they can have binary levels per pixel (on or off) and, when light is spectrally dispersed across the columns, the number of row pixels turned on in a given column will determine the relative intensity projected at the corresponding wavelength. Such two-dimensional arrays should have formats of 1024 x 768 pixels or greater.

Other parameters of interest are throughput for on pixels and blocking for off pixels, both of which should be maximized for maximum contrast. Also, while the whole UV/visible/near infrared spectral region is of interest, there is particular interest in technologies that work in the infrared spectral regions of 1 micrometer to 2.5 micrometers, 3 micrometers to 5 micrometers, and 8 micrometers to 12 micrometers, with a preference to be given to longer wavelengths.

An additional requirement is ready-to-use drive electronics and simple driver software for the spatial light modulators. Drive electronics that can be interfaced to a PC is required, such that images can be sent from the PC to the spatial light modulator. Preference will be given to proposals that present a complete solution to the spatial light modulator: from PC interface and driver software to spatial light modulator hardware. There is no need to propose a complete spectral projector, as NIST can develop the spatial light modulator into a complete spectral projector once the spatial light modulator is realized. NIST is willing to work collaboratively with the contractor to help with evaluation of the operating parameters.

Deliverables:

Phase 1: A spatial light modulator working in the 3 micrometer to 5 micrometer spectral range, with at least 100 linear pixels of any size. Includes supporting PC interface software and hardware for writing the state of each pixel.

Phase 2 (if awarded): A spatial light modulator working in the 3 micrometer to 5 micrometer spectral range or longer, with at least 1000 linear pixels, with a minimum pixel dimension of 40 micrometers. Contrast ratio goal of 500 to 1. Transmittance-on goal of 80 %. Supporting PC interface software and hardware for writing the state of each pixel.

9.11 X-ray System Technologies

9.11.1-5 Imaging Variable Kinetic Energy (0.1 to 8 KeV) Electron Analyzer

NIST seeks the design and construction (delivery of prototypes) of a practical imaging variable kinetic energy (0.1 to 8 KeV) electron analyzer. The new analyzer will be used for synchrotron based depth selective X-ray photoemission spectroscopy (XPS) materials science applications. Our synchrotron beamline offers intense broad range tune-ability (0.7 to 8 KeV) of the X-ray excitation of a specific core level creating a variable electron kinetic energy and thus a new depth selective approach for XPS. By coupling this new depth selectivity and two-dimensional spatial detection the new imaging variable kinetic energy electron analyzer developed will empower a novel three-dimensional XPS non-destructive chemical bond sensitive probe of complex materials. It is anticipated that that this new method will offer strategic chemical and structural insights in nanotechnology applications such as organic electronics, MEMs lubrication, SAM templates, and catalysts.

Thus, we seek a new imaging variable kinetic energy electron analyzer to enable a novel synchrotron based three-dimensional imaging XPS method. The electron analyzer should be tunable over a broad range of kinetic energy preferably from 0.1 to 8 KeV through the development of novel high transmission electrostatic or magnetic electron optics. A novel parallel process-imaging detector will be coupled to the high throughput electron optics to provide a spatial resolution target of 100 nm or less. The delivery and testing of prototypes at NIST synchrotron facilities can be possible in cooperation with NIST personnel.

The successful development of a practical imaging variable kinetic energy (0.1 to 8 KeV) electron analyzer would be a very significant advance in the application of XPS at synchrotron research facilities in the United States. XPS is a valued analytical tool for companies and academia and is routinely applied for creating chemical maps of polymer surfaces, photoresists and other materials problems.

In a broader context the successful development of an imaging variable kinetic energy (0.1 to 8 KeV) electron analyzer would be a very significant advance in X-ray photoemission spectroscopy imaging. Currently, imaging XPS is often limited to one-dimensional analysis at relatively modest spatial resolution. The imaging variable kinetic energy (0.1 to 8 KeV) electron analyzer would provide an important practical improvement in XPS systems found in many analytical and researches laboratories throughout the United States.

NIST anticipates working collaboratively with the contractor and providing access to the NSLS x-ray beamline. The prototype developed during Phase 1 shall be deliverable to NIST. At the end of Phase 2, if awarded, a more developed prototype shall be delivered to NIST.