DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DARPA)
14.2 Small Business Innovation Research (SBIR)

1.1 INTRODUCTION

DARPA's mission is to prevent technological surprise for the United States and to create technological surprise for its adversaries. The DARPA SBIR and STTR Programs are designed to provide small, high-tech businesses and academic institutions the opportunity to propose radical, innovative, high-risk approaches to address existing and emerging national security threats; thereby supporting DARPA's overall strategy to bridge the gap between fundamental discoveries and the provision of new military capabilities.

The responsibility for implementing DARPA's Small Business Innovation Research (SBIR) Program rests with the Small Business Programs Office.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Attention: DIRO/SBPO
675 North Randolph Street
Arlington, VA 22203-2114
(703) 526-4170
sbir@darpa.mil
Home Page http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_STTR.aspx

Offerors responding to the DARPA topics listed in Section 12.0 of the DoD 14.2 SBIR Solicitation must follow all the instructions provided in the DoD Program Solicitation. Specific DARPA requirements in addition to or that deviate from the DoD Program Solicitation are provided below and reference the appropriate section of the DoD Solicitation.

3.0 DEFINITIONS

3.1 Export Control

The following will apply to all projects with military or dual-use applications that develop beyond fundamental research (basic and applied research ordinarily published and shared broadly within the scientific community):

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

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

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

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

Please visit http://www.pmddtc.state.gov/regulations_laws/itar.html for more detailed information regarding ITAR requirements.

3.2 Foreign National

A foreign national is anyone who is NOT a U.S. citizen. ALL offerors proposing to use foreign nationals MUST follow Section 5.4. c.(8) of the DoD Program Solicitation and disclose this information regardless of whether the topic is subject to ITAR restrictions. There are two ways to obtain U.S. citizenship: by birth or by naturalization. Additional information regarding U.S. citizenship is available at http://travel.state.gov/law/citizenship/citizenship_782.html.

4.0 PROPOSAL FUNDAMENTALS

PLEASE NOTE: Use of the DARPA SBIR/STTR Information Portal (SSIP) is MANDATORY. Offerors will be required to authenticate into the SSIP (via the DARPA Extranet) to retrieve notification letters regarding select and non-select status of their proposals, request debriefings, and upload reports (awarded contracts only). DARPA SBPO will automatically create an extranet account for new users and send the SSIP URL, authentication credentials, and login instructions AFTER the 14.2 source selection period has closed. DARPA extranet accounts will ONLY be created for the individual named as the Corporate Official (CO) on the proposal coversheet. Offerors may not request accounts for additional users at this time.

Not later than September 25, 2014, the CO will receive an e-mail from sbir@darpa.mil with instructions for retrieving their official notification from the SSIP. The CO should add this address to their address book and whitelist to ensure all communications are received.

4.1 Classified Proposals

DARPA topics are unclassified; however, the subject matter may be considered to be a “critical technology” and therefore subject to ITAR restrictions. See **Export Control** requirements above in Section 3.1.

4.2 Debriefing

DARPA will provide a debriefing to the offeror in accordance with FAR 15.505. The notification letter referenced below (4.4 Information on Proposal Status) will provide instructions for requesting a proposal debriefing. Please also refer to section 4.0.

4.3 Notification of Proposal Receipt

After the solicitation closing date, the individual named as the “Corporate Official” on the Proposal Cover Sheet will receive an e-mail from sbir@darpa.mil acknowledging receipt of the proposal. A separate e-mail will be sent for each proposal – please make note of the topic number and proposal number for your records. Acknowledgement e-mails will be sent within 5 business days of solicitation close.

4.4 Information on Proposal Status

The source selection decision notice will be available no later than **September 25, 2014.** The individual named as the "Corporate Official" on the Proposal Cover Sheet **will receive an e-mail from sbir@darpa.mil with instructions for retrieving their official notification from the SSIP**. The CO must retrieve the letter from the SSIP 30 days from the date the e-mail is sent. Please also refer to section 4.0.

4.5 Phase I Award Information

a. Number of Phase I Awards. The number of Phase I awards will be consistent with DARPA's budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until evaluation of all qualified proposals for a specific topic is completed. Normally proposing firms will be notified of selection or non-selection status for a Phase I award within 90 days of the closing date for this solicitation. Selections are posted at www.dodsbir.net/selections.
b. Type of Funding Agreement. DARPA Phase I awards will be Firm Fixed Price contracts.
c. Dollar Value. DARPA Phase I awards shall not exceed $100,000 for the base effort and shall not exceed $50,000 for the option if exercised.
d. Timing. Across DoD, the median time between the date that the SBIR solicitation closes and the award of a Phase I contract is approximately four months.

5.0 PHASE I PROPOSAL

5.1 Phase I Option

DARPA has implemented the use of a Phase I Option that may be exercised to fund interim Phase I activities while a Phase II contract is being negotiated. Only Phase I companies selected for Phase II will be eligible to exercise the Phase I Option. The Phase I Option covers activities over a period of up to four months and should describe appropriate initial Phase II activities that may lead to the successful demonstration of a product or technology. The statement of work for the Phase I Option counts toward the 20-page limit for the Technical Volume.

A Phase I Cost Volume ($150,000 maximum) must be submitted in detail online via the DoD SBIR/STTR submission system. Proposers that participate in this solicitation must complete the Phase I Cost Volume, not to exceed the maximum dollar amount of $100,000, and a Phase I Option Cost Volume, not to exceed the maximum dollar amount of $50,000. Phase I awards and options are subject to the availability of funds.

Offerors are REQUIRED to use the online Cost Volume for the Phase I and Phase I Option costs (available on the DoD SBIR/STTR submission site).

5.2 Technical Assistance

In accordance with the Small Business Act (15 U.S.C. 632), DARPA will authorize the recipient of a Phase I SBIR award to purchase technical assistance services, such as access to a network of scientists and engineers engaged in a wide range of technologies, or access to technical and business literature available through on-line data bases, for the purpose of assisting such concerns in—

A. making better technical decisions concerning such projects;
B. solving technical problems which arise during the conduct of such projects;
C. minimizing technical risks associated with such projects; and
D. developing and commercializing new commercial products and processes resulting from such projects.

If you are interested in proposing use of a vendor for technical assistance, you must provide a cost breakdown in the Cost Volume under "Other Direct Costs (ODCs)" and provide a one-page description of the vendor you will use and the technical assistance you will receive. The proposed amount may not exceed $5,000 and the description should be included as the LAST page of the Technical Volume. This description will not count against the 20-page limit and will NOT be evaluated. Approval of technical assistance is not guaranteed and is subject to review of the contracting officer.

5.3 Human or Animal Subject Research

DARPA discourages offerors from proposing to conduct Human or Animal Subject Research during Phase I due to the significant lead time required to prepare the documentation and obtain approval, which will delay the Phase 1 award.

5.4 Commercialization Strategy

DARPA is equally interested in dual use commercialization of SBIR project results to the U.S. military, the private sector market, or both, and expects explicit discussion of key activities to achieve this result in the commercialization strategy part of the proposal. The discussion should include identification of the problem, need, or requirement relevant to a Department of Defense application and/or a private sector application that the SBIR project results would address; a description of how wide-spread and significant the problem, need, or requirement is; and identification of the potential DoD end-users, Federal customers, and/or private sector customers who would likely use the technology.

Technology commercialization and transition from Research and Development activities to fielded systems within the DoD is challenging. Phase I is the time to plan for and begin transition and commercialization activities. The small business must convey an understanding of the preliminary transition path or paths to be established during the Phase I project. That plan should include the Technology Readiness Level (TRL) expected at the end of the Phase I. The plan should include anticipated business model and potential private sector and federal partners the company has identified to support transition and commercialization activities. In addition, key proposed milestones anticipated during Phase II such as: prototype development, laboratory and systems testing, integration, testing in operational environment, and demonstrations.

5.5 Phase I Proposal Checklist:

The following criteria must be met or your proposal may be REJECTED.

____1. Include a header with company name, proposal number and topic number to each page of your Technical Volume.
____2. Include tasks to be completed during the option period and include the costs in the Cost Volume.
____3. Break out subcontractor, material and travel costs in detail. Use the "Explanatory Material Field" in the DoD Cost Volume for this information, if necessary.
____4. The base effort does not exceed $100,000 and six months and the option does not exceed $50,000 and four months. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the Cost Volume, and in the statement of work section of the Technical Volume.
____5. The technical volume does not exceed twenty (20) pages. Any page beyond 20 will be redacted prior to evaluations.
____6. Upload the Volume 1: Proposal Cover Sheet; Volume 2: Technical Volume; Volume 3: Cost Volume; and Volume 4: Company Commercialization Report electronically through the DoD submission site by 6:00 AM (ET) on June 25, 2014.

____7. After uploading your file on the DoD submission site, review it to ensure that all pages have transferred correctly and do not contain unreadable characters. Contact the DoD Help Desk immediately with any problems.

6.0 PHASE I EVALUATION CRITERIA

The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for DARPA SBIR or STTR awards in the SBIR/STTR topics they review and/or provide comments on to the Government. All advisors are required to comply with procurement integrity laws and are required to sign Non-Disclosure and Rules of Conduct/Conflict of Interest statements. Non-Government technical consultants/experts will not have access to proposals that are labeled by their proposers as "Government Only".

Please note that qualified advocacy letters will count towards the proposal page limit and will be evaluated towards criterion C. Advocacy letters are not required for Phase I. Consistent with Section 3-209 of DoD 5500.7-R, Joint Ethics Regulation, which as a general rule prohibits endorsement and preferential treatment of a non-federal entity, product, service or enterprise by DoD or DoD employees in their official capacities, letters from government personnel will NOT be considered during the evaluation process.

A qualified advocacy letter is from a relevant commercial procuring organization(s) working with a DoD or other Federal entity, articulating their pull for the technology (i.e., what need the technology supports and why it is important to fund it), and possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program. If submitted, the letter should be included as the last page of your technical upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

6.1 Limitations on Funding

DARPA reserves the right to select and fund only those proposals considered to be of superior quality and highly relevant to the DARPA mission. As a result, DARPA may fund multiple proposals in a topic area, or it may not fund any proposals in a topic area.

7.0 PHASE II PROPOSAL

All firms awarded a Phase I contract under this solicitation will receive a notification letter with instructions for preparing and submitting a Phase II Proposal and a deadline for submission. Visit http://www.darpa.mil/Opportunities/SBIR_STTR/SBIR_Program.aspx for more information regarding the Phase II proposal process.

Direct to Phase II

15 U.S.C. §638(cc), as amended by NDAA FY12 Sec. 5106, PILOT TO ALLOW PHASE FLEXIBILITY, allows the Department of Defense to make an award to a small business concern under Phase II of the SBIR program with respect to a project, without regard to whether the small business concern was provided an award under Phase I of an SBIR program with respect to such project.

DARPA is conducting a "Direct to Phase II" pilot implementation of this authority for this 14.2 SBIR solicitation only and does not guarantee the pilot will be offered in future solicitations. Each eligible topic will indicate what documentation is required to determine if Phase I feasibility has been met and the technical requirements for a Direct to Phase II proposal.

Not all DARPA topics are eligible for a Direct to Phase II award. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. DARPA reserves the right to not make any awards under the Direct to Phase II pilot. All other instructions remain in effect. Direct to Phase II proposals must follow the steps outlined below:

STEP 1:

1. Offerors must create a Phase I coversheet using the DoD Phase I Proposal submission system (follow the DoD Instructions for the Cover Sheet located in section 5.4.a).
2. Offerors must upload the documentation that satisfies the Phase I feasibility requirement.* You must upload this documentation in the DoD Phase I Proposal submission system as the "Technical Volume" – DO NOT follow the Technical Volume format specified in the solicitation instructions for your justification, follow instructions specified within the topic).
3. Offerors DO NOT upload a Phase I Cost Volume.
4. The Phase I Cover Sheet and applicable documentation must be submitted to http://dodsbir.com/submission by 6:00 a.m. (ET) on June 25, 2014.

**Please Note: Feasibility Documentation MUST NOT CONTAIN marketing material. Marketing material will NOT be evaluated and may be redacted. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).*

STEP 2:

1. Offerors must submit a Phase II proposal using the DARPA Phase II proposal instructions available as an attachment to the solicitation, titled DARPA SBIR/STTR Phase II Proposal Preparation Instructions, dated April 4, 2013.
2. The Phase II proposal must be submitted by 6:00 a.m. (ET) on June 25, 2014.

NOTE: Offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. **DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project or has failed to demonstrate that work submitted in the feasibility documentation was substantially performed by the proposing firm and/or the principal investigator (PI).**

8.0 CONTRACTUAL CONSIDERATIONS

8.1 Publication Approval (Public Release)

NSDD 189 established the national policy for controlling the flow of scientific, technical, and engineering information produced in federally funded fundamental research at colleges, universities, and laboratories. The directive defines fundamental research as follows: "Fundamental research' means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons."

It is DARPA's goal to eliminate pre-publication review and other restrictions on fundamental research except in those exceptional cases when it is in the best interest of national security. Please visit

http://www.darpa.mil/NewsEvents/Public_Release_Center/Public_Release_Center.aspx for additional information and applicable publication approval procedures. Visit http://dtsn.darpa.mil/fundamentalresearch/ to verify whether or not your award has a pre-publication review requirement.

8.2 Phase I Reports

All DARPA Phase I awardees are required to submit reports in accordance with the Contract Data Requirements List – CDRL and any applicable Contract Line Item Number (CLIN) of the Phase I contract. Reports must be provided to the individuals identified in Exhibit A of the contract. Please also reference section 4.0.

DARPA SBIR 14.2 Topic Index

SB142-001	MANUFACTURABLE HIGH ENERGY DENSITY AT HIGH TEMPERATURE CAPACITORS
~~SB142-002~~	(This topic has been removed from the solicitation.)
SB142-003	PROBABILISTIC EXTENSIONS TO MODEL BASED PROGRAMMING LANGUAGES
SB142-004	UNIVERSAL ANTIVENOM
SB142-005	ENABLING TECHNOLOGY FOR COLD ATOM MICROSYSTEMS
SB142-006	EXTENSIBLE HERMETIC NEURAL INTERFACE MICROSYSTEMS

DARPA SBIR 14.2 Topic Descriptions

SB142-001 TITLE: MANUFACTURABLE HIGH ENERGY DENSITY AT HIGH TEMPERATURE CAPACITORS

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: Using scalable fabrication techniques, develop high energy density (2 J/cc) capacitors capable of operating at elevated temperatures (>160 C) to meet the demands of future DoD electrical systems for power conditioning and pulsed power applications.

DESCRIPTION: As the military shifts toward more electrically-intensive vehicles, an increased burden is placed on the underlying electrical components. Fully-electric tanks require a lightweight, compact electrical system to power the drive train and electric armor. Electric ships demand pulsed power for rail guns, propulsion, radar, and superconducting degaussing systems. Airborne pulsed microwave weapons require energy dense and rapid discharge capacitors in order to reduce the total weight of the system on board. The increased burden and elevated performance requirements on the electrical systems to carry out many of these functions simultaneously have created a need for better passive electrical components, particularly capacitors. These capacitors must have long endurance times, high energy storage, high thermal stability and rapid discharge capabilities.

Currently-fielded capacitors suffer from low energy density, making them bulky. Additionally, their poor performance is only compounded at high operating temperatures, which reduces the energy density. This is largely due to the need to manufacture these capacitors at such a scale that the designer dielectrics being made in laboratories are unable meet this large scale demand. This leaves, for example, only unoptimized bulk polymers available for capacitor manufacturers to use. Because these polymers are not necessarily optimized for capacitor manufacturing, there is a severe limitation in the selection and consequently this lack of variability has led to an under-performance of the potential that the dielectric material could contribute to the capacitor's total performance.

Recent progress [1,2] in novel, scalable fabrication and processing of off-the-shelf dielectric materials offers several routes by which rapid innovations can be made, but none are optimized for capacitor manufacturing. In particular, multi-layer films have demonstrated that novel innovations in fabrication can lead to dramatically enhanced capacitance [1] despite using a limited selection of high dielectric polymers. Additionally, high temperature processing may be required to meet the high temperature requirements of these capacitors which may require innovations in manufacturing equipment. Also, innovations in ceramic capacitor [3,4] processing have shown the viability of this family of capacitors for scalable manufacturing. All technologies providing high energy and high temperatures in manufacturable quantities will be considered.

PHASE I: Design a scalable process for manufacturing capacitors with energy density > 2 J/cc, operating temperature > 160 C, a total energy storage > 1000J, and pulse discharge < 10 microseconds. A strategy for extending the lifetime (at full rating) to >10,000 cycles should be included. Provide an analysis including a process flow detailing (1) the starting materials to be used and their intrinsic material properties (e.g. dielectric constant, resistivity, etc…), (2) how the proposed fabrication approach will meet the operational requirements based on these material properties and (3) the limitations in scalability and performance of the capacitors based on the design approach. Establish feasibility of the approach through laboratory demonstrations of critical components.

PHASE II: Carry out the design process developed in Phase I with the goal of (1) producing a prototype capacitor that meets the requirements for a proposer-chosen DoD platform and (2) providing evidence for the scalability necessary to meet the needs of that platform. The prototype should be tested to assure that it meets the technical requirements outlined in Phase I. To demonstrate scalability, at least a 1000J capacitor bank and the individual capacitors for that 1000J capacitor bank must be delivered and tested for uniformity and consistency to determine if the sample set meets the tolerances of the target platform.

PHASE III: Capacitors that can meet the aggressive goals of this SBIR will find immediate use in current and future military systems. For current naval platforms, a high temperature and high energy density capacitor would be beneficial for power conditioning for new radar platforms, rail guns, and superconducting electromagnets for

degaussing. Design and development of components for a fully-electric tank and electric ships are currently underway and would benefit from this advancement. Airborne pulsed microwave weapons would also benefit from lightweight, pulsed capacitors. Phase III will include showcases and demonstrations to interested government agencies to show the capacitor's performance under the stressful conditions of interest for each agency. Energy-dense capacitors with high temperature stability are key components in electric and hybrid vehicles. Their dramatic rise in recent years is expected to fuel a strong demand for high-stamina, lightweight capacitors. Regenerative breaking and other electrically-based energy recovery systems used in automobiles and trains rely critically on capacitors that can efficiently capture energy in brief pulses of electrical activity.

REFERENCES:
1. Zhou, Z.; Carr, J. M.; Mackey, M.; Yin, K.; Schuele, D. E.; Zhu, L.; Baer, E. "Interphase/interface modification on the dielectric properties of PC/P(VDF-HFP) multilayer films for high energy density capacitors." J. Polym. Sci., Part B: Polym. Phys. 2013, 51, 978-991.

2. Zhang, S., Zellers, B., Henrish, J., Rockey, S., Anderson, D., Zou, C., & Zhang, Q. (2009, June). "High energy density film capacitors." In Pulsed Power Conference, 2009. PPC'09. IEEE (pp. 779-783). IEEE.

3. Chao, Sheng, and Fatih Dogan. "Processing and Dielectric Properties of TiO2 Thick Films for High-Energy Density Capacitor Applications." International Journal of Applied Ceramic Technology 8.6 (2011): 1363-1373.

4. Integrated High Energy Density Capacitors, DARPA Program, http://www.darpa.mil/Our_Work/DSO/Programs/Integrated_High_Energy_Dense_Capacitors.aspx 5.

KEYWORDS: capacitors, high temperature, energy density, pulsed power, electric armor, rail gun, power conditioning

SB142-002 This topic has been removed from the solicitation.

SB142-003 TITLE: PROBABILISTIC EXTENSIONS TO MODEL BASED PROGRAMMING LANGUAGES

TECHNOLOGY AREAS: Information Systems

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).

OBJECTIVE: The objective of this effort is to enhance model based programming languages by adding support for probabilistic programming. This support should include the ability to model various kinds of uncertain processes applicable to cyber-physical systems.

DESCRIPTION: Model-based systems utilize high level descriptions of the composition or behavior of cyber-physical systems to support the development of code to control such systems, or to solve planning problems involving them. There is a rich history of programming language support for model-based development of systems including languages such as Esterel and RMPL. Tools to support model based development include languages, compilers, editors and property checkers. Most modeling languages support the representation of changes in state variables of such systems, and many support constraints on these state variable changes. Some languages even support uncertainty in state variables, or uncertain observation of state values. However none support probabilistic

variables as first class objects whose values come from a probability distribution, as in probabilistic programming languages such as Church. Probabilistic programming languages, on the other hand, generally fail to supply the high level support needed for modeling cyber-physical systems and are thus less well suited to the development of complex control or planning applications involving such systems.

A unified probabilistic model-based programming language should be able to model various kinds of uncertain processes, such as Markov Decision Processes, Partially Observable Markov Decision Processes, and Markov Chain Monte Carlo methods. The first level of such support is the addition of programming language constructs to support variables with distributions, thus allowing the programmer to write code utilizing such models more easily. The second level of support is to add back compiler support for mathematical learning algorithms capable of solving specific problems or answering specific questions about such systems.

PHASE I: Select a model based programming language, design the programming language feature extensions appropriate for that language to incorporate support for probabilistic programming, and design the back end algorithms for selecting machine learning and constraint satisfaction solvers.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow Section 4.0 of the DARPA Instructions. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).

PHASE II: Implement the language features and back end that were designed in Phase I. Phase II development should be informed and guided by a realistic application target. It is not necessary or expected that Phase II development will result in the implementation of an actual solution for a DoD problem, but the researchers should have at least one realistic problem, or a partner with experience addressing DoD challenges to which the technology is applicable, that will guide implementation priorities and decisions.

PHASE III: DoD has challenges similar to the commercial world in large-scale scheduling tasks and sensor design. Additional DoD applications include route and activity planning for autonomous vehicles and robotics as well as cyber security applications such as coupling intrusion detection with automated control of intrusion response. Potential commercial applications of probabilistic model-based programming include large scale scheduling problems such as package delivery and related infrastructure; modeling gene regulation, for example in building genetically engineered biological processes; design of sensors; and design of integrated circuits where probabilistic effects need to be modeled and overcome.

REFERENCES:
1. Continuous Probability Distributions in Model-Based Specification Languages
https://theses.ncl.ac.uk/dspace/bitstream/10443/1696/1/Andrews%2012.pdf.

2. Monolingual Probabilistic Programming Using Generalized Coroutines
http://okmij.org/ftp/kakuritu/embedpp.pdf.

3. Model-Based Programming: Controlling Embedded Systems by Reasoning About Hidden State
http://people.csail.mit.edu/williams/Web%20site/papers/CP177.pdf.

4. Lightweight Implementations of Probabilistic Programming Languages Via.

5. Transformational Compilation http://www.stanford.edu/~ngoodman/papers/WSG-AIStats11.pdf.

KEYWORDS: Programming languages, Model-based reasoning, Probabilistic Programming, Statistical processes

SB142-004 TITLE: UNIVERSAL ANTIVENOM

TECHNOLOGY AREAS: Chemical/Bio Defense, Biomedical

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).

OBJECTIVE: Develop an antivenom effective against a broad spectrum of venomous bites that can be safely administered in the field without identification of the venomous species.

DESCRIPTION: Venomous bites and stings from various snake, spider, scorpion and insect species negatively impact the health and effectiveness of our warfighters. For example, Special Operations Forces typically train and deploy in austere areas that are associated with an increased risk of envenomation. Bites by venomous snakes cause: severe paralysis that may prevent breathing; bleeding disorders that can lead to fatal hemorrhage; irreversible kidney failure; and severe local tissue destruction that cause permanent disability and limb amputation.

Current treatment of venomous bites requires correct identification of the venomous species to select the appropriate anti-venom, but identification of the specific species is frequently problematic or mistaken. If an antivenom is available for an identified species, it must be administered in a higher echelon military treatment facility in part due to the risk of severe adverse reactions such as serum sickness and hypersensitivity.

The World Health Organization recently declared snake-bite a neglected tropical disease, with approximately 2.5 million poisonings from snake-bite occurring each year. Annually, snake bites result in at least 100,000 deaths and around three times as many amputations. While many antivenoms exist throughout the world, significant challenges exist in their manufacture and effective use. The majority of antivenoms are based on species-specific immune reaction to venom exposure. Antivenom manufacture is problematic - few countries produce snake venoms of adequate quality and Good Manufacturing Practice (GMP) production of antivenom is resource-intensive and costly. Very few antivenoms are approved for use by the Food and Drug Administration (FDA).

This topic focuses on developing a universal antivenom that will be effective without identification of the venomous species and can be used in the field without fear of significant adverse side-effects. Successful proposals to develop broad spectrum antivenom may include, but are not limited to, aptamers, engineered proteins, nucleic acid vaccines, or other nanotherapeutic-based technologies. Proposals should focus on broad applicability and ease of use in austere conditions. The regions of particular interest are AFRICOM and PACOM. Consideration should be given to the systemic neurotoxic, myotoxic, hemorrhagic, coagulant, and hypotensive effects of envenomation. Proposals to improve existing polyvalent treatments that require high and/or repetitive dosing and/or require administration in a critical care facility are specifically excluded from this solicitation.

PHASE I: Define the component technologies needed to develop a broad spectrum antivenom that can be used in austere conditions without concern of serious side-effects. Technical approaches may include, but are not limited to: aptamers, engineered proteins, nucleic acid vaccines, or other nanotherapeutic-based technologies. Investigate potential categorization of broad classes of antivenom against species native to the regions of interest, if necessary. Treatment categorization must determine use without relying on speciation. Define and develop FDA (and/or EU) regulatory approval plan for any initial and follow-on therapies. Begin in vitro screening for safety and efficacy.

Phase I deliverables include: a report defining (1) Opportunities and limitations of potential developed treatments with regards to safety, efficacy, and manufacturability, (2) PK/PD model of therapeutic mechanism of action, (3) Preliminary in vitro data (4) Any therapeutic categorization (if required) (5) Phase II animal use plan, and (6) FDA regulatory approval plan.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow Section 4.0 of the DARPA Instructions.

PHASE II: Synthesize and iteratively refine universal antivenom with in vitro testing. Validate concept in a small animal model with unknown (or category) venom. Examine the PK/PD, biodistribution, safety, and efficacy of the concept. Demonstrate feasibility of GLP/GMP scale-up with appropriate yield efficiencies.

Phase II deliverable will include: (1) Report detailing design, synthesis, and validation of antivenom system, (2) Plan for regulatory approval.

PHASE III: Validate concept in large animal model and transition therapeutic to pharmaceutical company. A clear plan towards FDA approval for the therapeutic agent(s) and delivery platform will be in place, and additional testing to meet FDA requirements will be completed. Additional funding may be provided by DoD sources. While additional funding may be provided for DoD applications, awardee must also look toward other government or civilian funding sources to continue the process of translation and commercialization.

REFERENCES:
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KEYWORDS: Antivenom, Aptamer, Protein, Nucleic Acid, Nanotherapeutic, Therapeutic, Vaccine

SB142-005 TITLE: ENABLING TECHNOLOGY FOR COLD ATOM MICROSYSTEMS

TECHNOLOGY AREAS: Sensors, Battlespace

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).

OBJECTIVE: The objective of Enabling Technology for Cold Atom Microsystems is to address technology gaps in chip-scale, high-performance atomic clocks and inertial sensors. Technologies of interest include low-SWaP,

narrow-linewidth, tunable light sources; high-speed, high-attenuation optical shutters; low-loss optical isolators; phase modulators; techniques for precise and agile laser frequency control; and chip-scale micro vacuum pumps that are suitable for Rb- & Cs-based atomic physics packages.

DESCRIPTION: High-precision inertial navigation and timing, in GPS-challenged environments, is a topic of great interest to DARPA and DoD. The development of techniques for laser cooling and manipulation of alkali atoms has revolutionized atomic physics in recent decades, including laboratory-scale demonstrations of atomic clocks and inertial sensors (gyroscopes and accelerometers) based on laser-cooled atomic samples, which have demonstrated extraordinary performance. These include high-performance atomic "fountain" clocks and cold-atom interferometers.

The DARPA/MTO Microtechnology for Position, Navigation and Timing Program (microPNT) is developing low size, weight, power, and cost (SWaP+C) timing units and inertial sensors based on cold-atom technology. These programs have shown that the scaling laws of cold-atom physics allow the development of miniature devices that promise disruptive capabilities in portable low-SWaP+C devices. While the development of the physics techniques and architectures for portable sensors is ongoing under microPNT, transition of this technology to practical deployment requires the development of a number of supporting components and technologies. The proposed Cold-Atom MicroSystems (CAMS) SBIR topic represents an initial step towards the development and supply availability of the necessary component technologies. The DARPA MTO office believes that many of the necessary skills and capabilities to investigate the development of these components are present in U.S. based small businesses and that these organizations are best capable to demonstrate the agility to rapidly investigate and prototype candidate device technology.

Of particular necessity to the development of portable robust low-SWaP+C cold atom microsystems are the following proposed topic areas:

1. Light Sources: The CAMS SBIR topic seeks novel approaches to producing low-SWaP+C narrow-linewidth optical sources at wavelengths of interest, including 780 nm, 795 nm, 852 nm, and 894 nm. Of particular interest are devices that demonstrate sub-MHz linewidths (1 kHz resolution BW) and deliver > 10 mW of output power, with overall wall-plug efficiency (WPE) of > 25%, including all necessary temperature-stabilization and control electronics in a DoD-relevant environment. Of particular note here is the relatively high loss and SWaP+C of Faraday optical isolators at these wavelengths (addressed separately below), which are typically necessary to ensure narrow-linewidth operation in the presence of optical back-reflections. Towards this end, the topic also welcomes proposals for laser devices whose linewidth is relatively insensitive to back-reflections and/or devices which incorporate on-chip optical isolation.

2. Optical Isolators: The CAMS SBIR invites proposals for miniature, low-loss Faraday optical isolators at the wavelengths of interest (see above). This may include the investigation of novel materials or architectures for low SWaP+C high-throughput isolation. Successful development will deliver isolators that occupy a volume less than 0.5cc with less than 1 dB forward loss, greater than 40 dB isolation, and greater than 1mm clear aperture.

3. Precise and Agile Laser Frequency/Wavelength Control: CAMS typically require that the laser wavelength be stabilized with a precise and rapidly adjustable offset to a reference atomic resonance. The CAMS SBIR solicits novel approaches to low-SWaP+C atomic-resonance offset laser stabilization. This may include novel techniques for acousto- or electro-optical modulation as well as techniques for offset-locking to miniature atomic vapor cells, etalons, or other reference structures. Typical requirements might include 0-2 GHz offset control, > 100 kHz tuning bandwidth, and overall size and power not to exceed 1 cm^3 and 10 mW, respectively.

4. Laser Shuttering: CAMS require rapid and high-extinction shuttering of laser light at the aforementioned wavelengths, typically < 10 microseconds and 70 dB, respectively. This SBIR seeks proposals for low-SWaP+C shuttering technology, based on MEMS or electro-optic techniques. Preference will be given to proposals which simultaneously address co-integration with one or more of the topics above.

5. Alkali Vapor Pressure Control: For optimum operation, CAMS require that the background alkali vapor pressure inside the vacuum chamber of the cold-atom device be maintained at a stable equivalent vapor pressure of 10-20°C (depending on the alkali species and details of the apparatus). Maintaining constant alkali vapor pressure over the

full DoD ambient temperature range (-40°C to +85°C) is a significant challenge, particularly in a low-SWaP+C package, without the use of (high-power) thermoelectric coolers. The CAMS SBIR invites proposals for the investigation and development of novel techniques for alkali vapor pressure control, with preference given to the development of novel materials and/or systems which permit bidirectional control (e.g. source or getter) without consumption of alkali material.

6. Micro-Scale Vacuum Pump Technology: CAMS typically require extraordinarily high vacuum conditions (< 10^-9 Torr) to mitigate the detrimental effects of background "hot" atoms colliding with the cold atomic sample. The CAMS SBIR topic seeks innovative proposals for low-SWaP+C vacuum pumps, particularly those which effectively pump noble gases, such as helium, and which do not produce externally-detectable magnetic fields. The ultimate objective of the program would be to demonstrate a micro-scale vacuum pump capable of sustained pumping at a rate of 0.01 liters/second, occupying a volume of < 1 cm^3, and consuming < 10 mW of power.

PHASE I: Phase I of the effort would design and investigate an innovative concept for the enabling technology for cold atom microsystems being proposed.

Light Source Development:
• Determine technical feasibility and operating parameter space for low SWaP+C narrow-linewidth laser devices at near IR wavelengths meeting the objectives for CAMS operation.
• Develop process flow for laser fabrication.
• Develop detailed analysis of predicted performance metrics.

Optical Isolators:
• Investigate and test suitable materials and determine technical feasibility.
• Develop an initial concept design and model key elements, including forward loss, isolation, aperture.
• Provide analysis of anticipated manufacturing process and performance metrics for proposed isolators.

Laser Frequency Control:
• Develop technique for precise frequency-offset control of laser sources, based on existing sources of relatively low-SWaP+C (DBR, DFB, or VCSEL).
• Perform laboratory demonstration of laser offset lock technique.
• Provide analysis of SWaP+C for an integrated system and propose development path to achieve performance and SWaP+C objectives.

Optical Shutters:
• Prototype low-SWaP+C optical isolator demonstrating < 1 dB forward loss and >70 dB extinction in a free-space or integrated configuration.
• Provide analysis of anticipated SWaP+C for an integrated system and propose development path to achieve performance and SWaP+C objectives.

Alkali Vapor Pressure Control:
• Investigate materials and systems for bidirectional control of alkali vapor pressure
• Provide laboratory and/or theoretical demonstration of bidirectional vapor pressure control
• Provide analysis of anticipated SWaP+C for an integrated system and propose development path to achieve performance and SWaP+C objectives.

Micro-Ion Pump:
• Design a concept for a micro-ion pump, no larger than 1cc that operates at <10mW power consumption with a pumping speed of > 0.01 l/s and no external magnetic fields.
• Perform analysis of vacuum level performance in a deployable system configuration, assuming typical DoD environmental conditions (T ranging from –40°C to + 85°C, and 5g vibration from 5Hz to 5kHz).
Phase I deliverables include full mechanical, electro-magnetic, and thermal (MEMaT) modeling of the design, fabrication and manufacturing development, and plan for prototyping and demonstrating performance metrics.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the

Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow Section 4.0 of the DARPA Instructions.

PHASE II: Phase II of the effort will manufacture and deliver the enabling technology for the cold atom microsystems being proposed.

Light Source Development:
• Develop, demonstrate and validate Phase I model predictions.
• Refine fabrication procedure to fine tune wavelengths produced.
• Conduct life cycle and environmental testing to verify performance, including efficiency, linewidth, linearity and stability.

Required Phase II deliverables will include 5 packaged lasers at the proposed wavelength, including any necessary thermal or electronic control.

Optical Isolators:
• Develop, demonstrate and validate performance metrics derived in Phase I.
• Construct and demonstrate operation of prototypes.
• Conduct life cycle and environmental testing to verify performance over the temperature and vibration ranges (T ranging from –40°C to + 85°C, and 2g vibration from 5 Hz to 5 kHz).
• Required Phase II deliverables will include 20 optical isolators, smaller than 0.5cc, with <1dB forward loss, >40dB isolation, >1mm aperture, at wavelengths of 780nm (quantity 10) and 852nm (quantity 10).

Optical Shutters:
• Develop, demonstrate and validate performance metrics derived in Phase I.
• Construct and demonstrate operation of prototypes.
• Conduct life cycle and environmental testing to verify performance over the temperature and vibration ranges (T ranging from –40°C to + 85°C, and 5g vibration from 5Hz to 5kHz).

Required Phase II deliverables will include 10 optical isolators integrated with laser devices (to be provided as GFE).

Laser Wavelength Control:
• Develop, demonstrate and validate performance metrics derived in Phase I.
• Construct and demonstrate operation of prototypes.
• Conduct life cycle and environmental testing to verify performance over the temperature and vibration ranges (T ranging from –40°C to + 85°C, and 2g vibration from 5Hz to 5kHz).

Required Phase II deliverables will include 2 compact integrated laser wavelength control systems utilizing commercially available low-SWaP+C laser sources.

Alkali Vapor Pressure Control:
• Develop, demonstrate and validate performance metrics derived in Phase I.
• Construct and demonstrate operation of prototypes, particularly be measuring magneto-optical trap loading time and atom number over ambient temperatures ranging from –40°C to + 85°C.
• Required Phase II deliverables will include a vapor cell with integrated alkali vapor pressure control and offering optical access for testing in a MOT configuration.
• Micro-Ion Pump:
• Construct prototype hardware for a micro-ion pump, based on the design concept developed in Phase I.
• Demonstrate operation of the prototype ion pump.
• Provide practical implementation for the micro-ion pump to be deployed attached to a <25cc vapor cell prototype, to be used in a micro cold atom system.

Required Phase II deliverables will include 5 micro-ion pumps demonstrating the performance objectives of the task.

PHASE III: The military need for deployable cold-atom technology is great. Small SWaP+C self-contained clocks and IMUs are in very high demand. Current programs at DARPA are pursing the miniaturization of cold atom technology for such applications as missile guidance, mounted and dismounted soldier navigation in GPS denied environments, or pseudolite navigation. While much progress is being made on existing microPNT programs to miniaturize these devices, the timeline to bring the tech to the warfighter is limited by the availability of the component technology addressed in this SBIR topic. An investment in enabling technology for cold atom microsystems, particularly in the highly relevant small-business arena, will fast-track the technology development of deployable cold atom based inertial sensors and clocks. Since the successful transition of the DARPA-MTO Chip-Scale Atomic Clock (CSAC), a wide variety of commercial applications for atomic-quality, low-SWaP+C timing have emerged. Many of these applications, particularly in telecommunications, electronic test, and remote sensing, would benefit greatly from improved timing accuracy, such as may be enabled by cold-atom microsystems.

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KEYWORDS: lasers, ion pumps, chip-scale vacuum pumps, ion pumps, optical isolators, acousto-optic modulator, electro-optic modulator, Faraday isolators, UHV, VCSEL, DBR, DFB, atomic clock, cold-atom, atom interferometry, inertial navigation

SB142-006 TITLE: EXTENSIBLE HERMETIC NEURAL INTERFACE MICROSYSTEMS

TECHNOLOGY AREAS: Biomedical, Electronics, Human Systems

This topic is eligible for the DARPA Direct to Phase II Pilot Program. Please see section 4.0 of the DARPA instructions for additional information. To be eligible, offerors are required to provide information demonstrating the scientific and technical merit and feasibility of a Phase I project. DARPA will not evaluate the offeror's related Phase II proposal where it determines that the offeror has failed to demonstrate the scientific and technical merit and feasibility of the Phase I project. Offerors must choose between submitting a Phase I proposal OR a Direct to Phase II proposal, and may not submit both for the same topic. Work submitted within the feasibility documentation must have been substantially performed by the proposing firm and/or the principal investigator (PI).

OBJECTIVE: Develop and demonstrate implantable electronic systems to record neural signals from the body and telemetrically send that neural data to an external unit for analysis. Systems with the added ability to program and

transmit electrical pulses to the implanted electrodes in order to provide precise neural stimulation are highly desired.

DESCRIPTION: High performance prosthesis systems require high-bandwidth real-time communication of neural signals into and out of the body. Current implantable neural interfaces rely on transcutaneous cables to transmit recorded data and to receive power. These transcutaneous connections greatly limit the mobility of the patient, increase the risk of infection, and significantly reduce the long-term reliability of the entire neural-interface system through mechanical failure.

Although clinically-available [1] and laboratory-grade [2] telemetry systems exist, none meet the stringent demands required to telemeter high-bandwidth information for high-performance prostheses. There has been significant academic research addressing portions of this challenge [3, 4], but none have taken a systems-level approach or yielded a manufacturable technology.

The goal of this effort is to develop a one-size-fits-many solution for the capability gap in the prosthesis community, with broad applicability to neuroscience and neuroengineering. Proposals should aim to develop a uni- or bi-directional telemetry system, capable of transmitting at least 16 channels of high-bandwidth real-time neural signals and operating power across the skin. The architecture's scalability to higher channel count and firmware upgradability to add new in-situ analysis capabilities are strongly desired. The dynamic range of the recording channels should enable capture of neural signals in the micro Volt to Volt range. Such a system must be capable of reliable, chronic use and have a credible trajectory towards FDA [4], FCC, and IEC approval in order to serve the broad medical community for a variety of treatment applications. Traditional chest-mounted telemetry systems require lengthy, limited-bandwidth, failure-prone interconnects between the point of measurement and the transceiver. Successful proposals will describe a functional system with a small form factor to overcome existing problems and allow the telemetry system to be in close proximity to the anatomical target, eliminating issues that may arise from repetitive joint movement. Proposers must consider that various anatomical targets provide distinct electrical signals to record/stimulate, mechanical environments, and abiotic/biotic environments.

Proposed systems that are applicable to one or more of the following anatomical targets are highly desired: the central-nervous-system (CNS) both epidural and subdural [5, 6, 7], the peripheral-nervous-system (PNS) [8, 9, 10, 11], and in residual or reconstructed muscles, cells or fibers [12, 13]. Systems are expected to support a variety of neural interfaces developed for the specific anatomical target. For example a system for direct PNS interfaces would have the ability to support neural probes manufactured by Blackrock, Neuronexus, Microprobes, Tucker-Davis and other international suppliers.

In order to demonstrate a viable prototype by the end of this SBIR, all aspects of system development must be addressed: wireless protocols (telemetry and power), application programming interfaces for CANbus prostheses and USB-connected computers, battery-powered externally-worn electronics, implantable electronics, mechanical modeling and testing of implantable package and interconnects (if any), hermetic sealing, thermal budget under operating conditions, and design for operation in a realistic environment (operating range through tissue, EMI, simulated mechanical behavior). It is expected that the electronics portion will require development of safety features, bioelectric amplification, DAC/ADC, signal processing, power conversion from wireless to battery or capacitive storage, operational reconfigurability (e.g., FPGA), and data telemetry. Successful proposals may also include, but are not required to contain, some integrated processing, analysis, and data compression capability in cases where techniques may not be available to telemeter all of the unprocessed information to and from the system.

Due to the implanted nature of the envisioned system, all capabilities must be fully demonstrated in an appropriate simulated tissue environment, and under accelerated testing conditions equivalent to at least twenty years of operation.

PHASE I: Develop preliminary design concept and determine technological feasibility of a low-power, low-latency, high-bandwidth telemetry system for clinical use. Designs should be informed by, but not be limited to, OSI network models for communications, and practical approaches to address the "CIA triad" (confidentiality, integrity and availability), mechanical models of the enclosure and interconnects, and a detailed analysis of the predicted performance of this system.

Telemetry system parameters, mechanical properties, signal transmission, and power consumption parameters must be defined and quantitatively estimated. In addition, it is expected that detailed system properties and assumptions will be defined including, but not limited to: self-test capability to ensure integrity, error detection and correction capabilities, wireless coding methods, encryption techniques, interface referencing schema, tissue SAR for communication and power signals, and data compression techniques. Prepare plans for testing in pre-clinical subjects if applicable. The final report must include system performance metrics and plans for Phase II. Specifically the final report must include: a) VLSI layout (e.g., VHDL or Verilog); b) modeling and simulation of expected performance; c) mechanical drawings; and, d) a timeline and bill of materials for the systems to be constructed in Phases II. Optimizing usability with various neural interfaces and in various applications will be considered a critical performance metric.

Phase II plans should include preliminary design plans, key component technological milestones and plans for pre-clinical testing and evaluation. Phase I should also include the processing and submission of all required animal and/or human subjects use protocols as appropriate.

DIRECT TO PHASE II - Offerors interested in submitting a Direct to Phase II proposal in response to this topic must provide documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of this topic has been met and describes the potential commercial applications. Documentation should include all relevant information including, but not limited to: technical reports, test data, prototype designs/models, and performance goals/results. Read and follow Section 4.0 of the DARPA Instructions.

PHASE II: Develop and demonstrate a prototype neural telemetry system based on the preliminary design from Phase I. All appropriate engineering testing will be performed, and a critical design review will be performed to finalize the design. Emphasis will be placed upon prototype functionality, accuracy and the ability to reliably send and receive electrical data.

Phase II deliverables will include: (1) a working prototype of the system, including expected life-cycle capability, (2) test data on its performance collected in one or more pre-clinical experiments, and (3) research to ensure compliance with relevant FDA, FCC, IEC, and other regulations for use in humans.

PHASE III: Reliable high-performance neural interfaces used to control advanced prostheses for wounded warriors with upper-limb amputations and spinal cord injuries. Advanced prostheses for civilians with upper-limb amputations, spinal cord injuries, brain-stem stroke, and other clinically relevant applications.

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KEYWORDS: Advanced machining, brazing process, coating processes, computer aided engineering, design for manufacture, design for test, electrochemical measurements, fabrication, integrated product and process design, materials processing