DEPARTMENT OF THE AIR FORCE
24.A SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) Phase I
PROPOSAL SUBMISSION INSTRUCTIONS

Amendment 2

This Amendment modifies the DAF STTR Phase I instructions as follows:

1. The export control statement previously associated with topic SF24A-T005 is deleted in its entirety.
2. The export control statement previously associated with topic SF24A-T006 is deleted in its entirety.

All other terms and provisions of the DAF STTR Phase I instructions remain unchanged as a result of this Amendment.

DEPARTMENT OF THE AIR FORCE
24.A SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) Phase I
PROPOSAL SUBMISSION INSTRUCTIONS

Amendment 1

This Amendment modifies the DAF STTR Phase I instructions as follows:

1. The Period of Performance (PoP) associated with the Phase I portion of the topic AF24A-T003 is 12 months.
2. The Phase I Description and Phase II description are altered to indicate that this is a STTR topic.
3. The export control statement previously associated with topic SF24A-T004 is deleted in its entirety.

All other terms and provisions of the DAF STTR Phase I instructions remain unchanged as a result of this Amendment.

DEPARTMENT OF THE AIR FORCE
24.A SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) Phase I
PROPOSAL SUBMISSION INSTRUCTIONS

The Air Force intends these Phase I proposal submission instructions to clarify the Department of Defense (DoD) Broad Agency Announcement (BAA) as it applies to the topics solicited herein. **Offerors must ensure proposals meet all requirements of the STTR 24.A BAA posted on the Defense SBIR/STTR Innovation Portal (DSIP) at the proposal submission deadline date/time.**

Proposers are encouraged to thoroughly review the DoD Program BAA and register for the DSIP Listserv to remain apprised of important programmatic and contractual changes.

- The DoD Program BAA is located at: https://www.defensesbirsttr.mil/SBIR-STTR/Opportunities/#announcements. Be sure to select the tab for the appropriate BAA cycle.
- Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

Complete proposals **must** be prepared and submitted via https://www.dodsbirsttr.mil/submissions/ (DSIP) on or before the date published in the DoD SBIR 24.A BAA. Applicants are responsible for ensuring proposals comply with the requirements in the most current version of this instruction at the proposal submission deadline date/time.

The DAF recommends early submission, as computer traffic gets heavy near the proposal submission date/time and could slow down the system. **Do not wait until the last minute.** The DAF is not responsible for incomplete proposal submission due to system lag or inaccessibility. Please ensure contact information, i.e., names/phone numbers/email addresses, in the proposal is current and accurate. The DAF is not responsible for ensuring notifications are received by firms for which this information changes after proposal submission without proper notification. Changes of this nature shall be sent to the Air Force SBIR/STTR One Help Desk.

Please ensure all e-mail addresses listed in the proposal are current and accurate. The DAF is not responsible for ensuring notifications are received by firms changing mailing address/e-mail address/company points of contact after proposal submission without proper notification to the AF. **If changes occur to the company mail or email addresses or points of contact after proposal submission, the information must be provided to the AF SBIR/STTR One Help Desk.** The message shall include the subject line, "24.A Address Change".

Points of Contact:

- General information related to the AF SBIR/STTR program and proposal preparation instructions, contact the AF SBIR/STTR One Help Desk at usaf.team@afsbirsttr.us.
- Questions regarding the DSIP electronic submission system, contact the DoD SBIR/STTR Help Desk at dodsbirsupport@reisystems.com.
- For technical questions about the topics during the pre-announcement and open period, please reference the DoD SBIR 24.A BAA.
- Air Force SBIR/STTR Contracting Officer (CO):
    - Mr. Daniel J. Brewer, Daniel.Brewer.13@us.af.mil

General information related to the AF Small Business Program can be found at the AF Small Business website, http://www.airforcesmallbiz.af.mil/. The site contains information related to contracting opportunities within the AF, as well as business information and upcoming outreach events. Other informative sites include those for the Small Business Administration (SBA), www.sba.gov, and the Procurement Technical Assistance Centers (PTACs), http://www.aptacus.us.org. These centers provide

Government contracting assistance and guidance to small businesses, generally at no cost.

PHASE I PROPOSAL SUBMISSION: The DoD STTR 24.A Broad Agency Announcement, https://www.dodsbirsttr.mil/submissions/login, includes all program requirements. Phase I efforts should address the feasibility of a solution to the selected topic's requirements.

The complete proposal must be submitted electronically through DSIP. Ensure the complete technical volume and additional cost volume information is included in this sole submission. The preferred submission format is Portable Document Format (.pdf). Graphics must be distinguishable in black and white. VIRUS-CHECK ALL SUBMISSIONS.

The System for Award Management (SAM) allows proposing small business concerns interested in conducting business with the Federal Government to provide basic information on business structure and capabilities as well as financial and payment information. Proposing small business concerns must be registered in SAM. To register, visit www.sam.gov. A proposing small business concern that is already registered in SAM should login to SAM and ensure its registration is active and its representations and certifications are up-to-date to avoid delay in award.

On April 4, 2022, the DUNS Number was replaced by the Unique Entity ID (SAM). The Federal Government will use the UEI (SAM) to identify organizations doing business with the Government. The DUNS number will no longer be a valid identifier. If the proposing small business concerns has an entity registration in SAM.gov (even if the registration has expired), a UEI (SAM) has already been assigned. This can be found by signing into SAM.gov and selecting the Entity Management widget in the Workspace or by signing in and searching entity information. For proposing small business concerns with established Defense SBIR/STTR Innovation Portal (DSIP) accounts, update the Small business concern profile with the UEI (SAM) as soon as possible.

For new proposing small business concern registrations, follow instructions during SAM registration on how to obtain a Commercial and Government Entry (CAGE) code and be assigned the UEI (SAM). Once a CAGE code and UEI (SAM) are obtained, update the Small business concern's profile on the DSIP at https://www.dodsbirsttr.mil/submissions/.

PHASE I PROPOSAL FORMAT

Complete proposals must include all of the following:

Volume 1: DoD Proposal Cover Sheet

Note: If selected for funding, the proposal's technical abstract and discussion of anticipated benefits will be publicly released. Therefore, do not include proprietary information in this section.

Volume 2: Technical Volume
Volume 3: Cost Volume
Volume 4: Company Commercialization Report
Volume 5: Supporting Documents
Volume 6: Fraud, Waste, and Abuse Training

DoD PROPOSAL COVER SHEET (VOLUME 1)

Complete the proposal Cover Sheet in accordance with the instructions provided via DSIP. The technical abstract should include a brief description of the program objective(s), a description of the effort, anticipated benefits and commercial applications of the proposed research, and a list of keywords/terms. The technical abstract of each successful proposal will be submitted to the Office of the Secretary of Defense (OSD) for publication and, therefore, must not contain proprietary or classified information.

TECHNICAL VOLUME (VOLUME 2):

The Technical Volume should include all graphics and attachments but should not include the Cover Sheet, which is completed separately as Volume 1. The Phase I technical volume (uploaded in Volume 2) shall contain the required elements found below. Ensure that all graphics are distinguishable in black and white.

The Phase I Technical Volume page/slide limits identified for the topics do not include the Cover Sheet, Cost Volume, Cost Volume Itemized Listing (a-h). The Technical Volume must be no smaller than 10-point on standard 8-1/2" x 11" paper with one-inch margins. Only the Technical Volume and any enclosures or attachments count toward the page limit. In the interest of equity, pages/slides in excess of the stated limits will not be reviewed. The documents required for upload into Volume 5, "Other", do not count toward the specified limits.

Key Personnel: Identify in the Technical Volume all key personnel who will be involved in this project; include information on directly related education, experience, and citizenship.

- A technical resume of the principal investigator, including a list of publications, if any, must be included
- Concise technical resumes for subcontractors and consultants, if any, are also useful.
- Identify all U.S. permanent residents to be involved in the project as direct employees, subcontractors, or consultants.
- Identify all non-U.S. citizens expected to be involved in the project as direct employees, subcontractors, or consultants. For all non-U.S. citizens, in addition to technical resumes, please provide countries of origin, the type of visa or work permit under which they are performing and an explanation of their anticipated level of involvement on this project, as appropriate. Additional information may be requested during negotiations in order to verify the foreign citizen's eligibility to participate on a contract issued as a result of this announcement. **Note:** Do not upload information such as Permanent Resident Cards (Green Cards), birth certificates, Social Security Numbers, or other PII to the DSIP system.

Phase I Work Plan Outline

NOTE: The DAF uses the work plan outline as the initial draft of the Phase I Statement of Work (SOW). Therefore, **do not include proprietary information in the work plan outline**. To do so will necessitate a request for revision, if selected, and may delay contract award.

Include a work plan outline in the following format:
Scope: List the effort's major requirements and specifications.
Task Outline: Provide a brief outline of the work to be accomplished during the Phase I effort.
Milestone Schedule
Deliverables
Progress reports
Final report with SF 298

COST VOLUME (VOLUME 3)

Cost information should be provided by completing the Cost Volume in DSIP and including the Cost Volume Itemized Listing specified below. The Cost Volume detail must be adequate to enable Air Force personnel to determine the purpose, necessity and reasonability of each cost element. Provide sufficient information (a.-g. below) regarding funds use. The DSIP Cost Volume and Itemized Cost Volume Information will not count against the specified page limit. The itemized listing also may be submitted in Volume 5 under the "Other" dropdown option.

a. **Direct Cost Materials**: Justify costs for materials, parts, and supplies with an itemized list containing types, quantities, prices and where appropriate, purpose. Material costs may include the costs of such items as raw materials, parts, subassemblies, components, and manufacturing supplies.

b. **Other Direct Costs**: This category includes, but is not limited to, specialized services such as machining, milling, special testing or analysis, and costs incurred in temporarily using specialized equipment. Proposals including leased hardware must include an adequate lease v. purchase justification.

c. **Direct Labor**: Identify key personnel by name, if possible, or by labor category, if not. Direct labor hours, labor overhead and/or fringe benefits, and actual hourly rates for each individual are also necessary for the CO to determine whether these hours, fringe rates, and hourly rates are fair and reasonable.

d. **Travel**: Travel costs must relate to project needs. Break out travel costs by trip, number of travelers, airfare, per diem, lodging, etc. The number of trips required, as well as the destination and purpose of each, should be reflected. Recommend budgeting at least one trip to the Air Force location managing the contract.

e. **Subcontracts**: Involvement of consultant in the project's planning and/or research stages may be appropriate. If so, describe in detail and include information in the Cost Volume. A minimum of 40% of each STTR project must be conducted by the SBC and a minimum of 30% of the effort performed by the single partnering Research Institution. Deviations from these performance of work requirements are not permitted. The STTR funded work percentage calculation considers both direct and indirect costs after removal of the SBC's proposed profit. Support subcontract costs with copies of executed agreements. The documents must adequately describe the work to be performed. At a minimum, include a Statement of Work (SOW) with a corresponding detailed Cost Volume for each planned subcontract. Additionally, see DoD SBIR 23.3 BAA for more information regarding the required Allocation of Rights Agreement.

f. **Special Tooling, Special Test Equipment, and Material**: The inclusion of equipment and materials will be carefully reviewed relative to need and appropriateness to the work proposed. Special tooling and special test equipment purchases must, in the CO's opinion, be advantageous to the Government and relate directly to the effort. These toolings or equipment should not be of a type that an offeror would otherwise possess in the normal course of business. These may include items such as innovative instrumentation and/or automatic test equipment.

g. **Consultants**: Provide a separate agreement letter for each consultant. The letter should briefly state what service or assistance will be provided, the number of hours required, and the hourly rate.

NOTE: If no exceptions are taken to an offeror's proposal, the Government may award a contract without negotiations. . Therefore, the offeror's initial proposal should contain the offeror's best terms from a cost or price and technical standpoint. If there are questions regarding the award document, contact the Phase I CO identified on the cover page. The Government reserves the right to reopen negotiations later if the CO determines doing so to be necessary.

COMPANY COMMERCIALIZATION REPORT (VOLUME 4)

Completion of the CCR as Volume 4 of the proposal submission in DSIP is required. Please refer to the DoD STTR 24.A BAA for full details on this requirement. Information contained in the CCR will not be considered by the Air Force during proposal evaluations.

SUPPORTING DOCUMENTS VOLUME (VOLUME 5)

The following documents are required for all proposal submissions:

1. Contractor Certification Regarding Provision of Prohibition on Contracting for Certain Telecommunications and Video Surveillance Services or Equipment (Attachment 1 to the DOD SBIR 24.A BAA)
2. Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Attachment 2 to the DOD STTR 24.A BAA)
3. Disclosure of Funding Sources (Attachment 4 to the DOD STTR 24.A BAA)

The following documents may be required if applicable to your proposal:

1. DD Form 2345: For proposals submitted under export-controlled topics, either International Traffic in Arms or Export Administration Regulations (ITAR/EAR), a copy of the certified DD Form 2345, Militarily Critical Technical Data Agreement, or evidence of application submission must be included. The form, instructions, and FAQs may be found at the United States/Canada Joint Certification Program website, http://www.dla.mil/HQ/InformationOperations/Offers/Products/LogisticsApplications/JCP/DD2345Ins tructions.aspx. DD Form 2345 approval will be required if proposal if selected for award.
2. Verification of Eligibility of Small Business Joint Ventures (Attachment 3 to the DOD STTR 24.A BAA)
3. Technical Data Rights Assertions (if asserting data rights restrictions)

FRAUD, WASTE, AND ABUSE TRAINING (VOLUME 6)

Note that the FWA Training must be completed prior to proposal submission. When training is complete and certified, DSIP will indicate completion of the Volume 6 requirement. The proposal cannot be submitted until the training is complete.

DISCRETIONARY TECHNICAL AND BUSINESS ASSISTANCE (TABA)

The Air Force does not participate in the Discretionary Technical and Business Assistance (TABA) Program. Proposals submitted in response to DAF topics shall not include TABA.

AIR FORCE PROPOSAL EVALUATIONS

Proposals will be evaluated for overall merit in accordance with the criteria discussed in the 24.A BAA. DAF is seeking varying technical/scientific approaches and/or varying and new technologies that would be responsive to the problem statement(s) and area(s) of interest in the topic. Multiple procurements are planned and anticipated to be awarded as a result of the topic, each proposal is considered a separate procurement and will be evaluated on its own merit, and that the Government may award all, some, or none of the proposals. Any per-award or per-topic funding caps are budgetary estimates only, and more or less funding may become available. Funding decisions are made with complete disregard to the other awards under the same topic.

In accordance with Section 4 of the SBIR and STTR Extension Act of 2022, the DAF will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. The DAF will use information provided by the small business concern in response to the Disclosure of Foreign Affiliations or Relationships to Foreign Countries and the proposal to conduct a risk-based due diligence review on the cybersecurity practices, patent analysis, employee analysis, and foreign ownership of a small business concern, including the small business concern and employees of the small business concern to a foreign country, foreign person, foreign affiliation, or foreign entity. The DAF will also assess proposals utilizing open-source analysis and analytical tools, for the nondisclosures of the information set forth in 15 U.S.C. 638(g)(13). If DAF assesses that a small business concern has security risk(s), DAF will review the proposal, the evaluation, and the security risks and may decide not to select the proposal for award based upon a totality of the review

DAF USE OF SUPPORT CONTRACTORS

Restrictive notices notwithstanding, proposals may be handled for administrative purposes only, by support contractors TEC Solutions, Inc., APEX, Oasis Systems, Riverside Research, Peerless Technologies, HPC-COM, Mile Two, Montech, Wright Brothers Institute, and MacB (an Alion Company). In addition, only Government employees and technical personnel from Federally Funded Research and Development Centers (FFRDCs) MITRE and Aerospace Corporations working under contract to provide technical support to AF Life Cycle Management Center and Space and Missiles Centers may evaluate proposals. All support contractors are bound by appropriate non-disclosure agreements. Contact the AF SBIR/STTR CO Daniel J. Brewer (Daniel.Brewer.13@us.af.mil) with concerns.

PROPOSAL STATUS AND FEEDBACK

The Principal Investigator (PI) and Corporate Official (CO) indicated on the Proposal Cover Sheet will be notified by e-mail regarding proposal selection or non-selection. Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the Proposal Number and Topic Number referenced.

Automated feedback will be provided for Phase I proposals designated Not Selected. Additional feedback may be provided at the sole discretion of the DAF.

IMPORTANT: Proposals submitted to the DAF are received and evaluated by different organizations, handled by topic. Each organization operates within its own schedule for proposal evaluation and selection. Updates and notification timeframes will vary. If contacted regarding a proposal submission, it is not necessary to request information regarding additional submissions. Separate notifications are provided for each proposal.

The Air Force anticipates that all proposals will be evaluated and selections finalized within approximately 90 calendar days of solicitation close. Please refrain from contacting the BAA CO for proposal status before that time.

Refer to the DoD STTR 24.A BAA for procedures to protest the Announcement.
As further prescribed in FAR 33.106(b), FAR 52.233-3, Protests after Award should be submitted to: Air Force SBIR/STTR Contracting Officer Daniel J. Brewer, Daniel.Brewer.13@us.af.mil.

AIR FORCE SUBMISSION OF FINAL REPORTS

All Final Reports will be submitted to the awarding DAF organization in accordance with Contract instructions. Companies will not submit Final Reports directly to the Defense Technical Information Center (DTIC).

PHASE II PROPOSAL SUBMISSIONS

DAF organizations may request Phase II proposals while technical performance is ongoing. This decision will be based on the contractor's technical progress, as determined by an DAF Technical Point of Contact review using the Phase II review criteria outlined above.

Phase II is the demonstration of the technology found feasible in Phase I. Only Phase I awardees are eligible to submit a Phase II proposal. All Phase I awardees will be sent a notification with the Phase II proposal submittal date and detailed Phase II proposal preparation instructions. If the physical or email addresses or firm points of contact have changed since submission of the Phase I proposal, correct information shall be sent to the AF SBIR/STTR One Help Desk. Phase II dollar values, performance

periods, and proposal content will be specified in the Phase II request for proposal.

NOTE: The DAF primarily makes STTR Phase I and II awards as Firm-Fixed-Price contracts. However, awardees are strongly urged to work toward a Defense Contract Audit Agency (DCAA)-approved accounting system. If the company intends to continue work with the DoD, an approved accounting system will allow for competition in a broader array of acquisition opportunities, including award of Cost-Reimbursement types of contracts. Please address questions to the Phase II CO, if selected for award.

All proposals must be submitted electronically via DSIP by the date indicated in the Phase II proposal instructions. Note: Only ONE Phase II proposal may be submitted for each Phase I award.

AIR FORCE SBIR/STTR PROGRAM MANAGEMENT IMPROVEMENTS

The DAF reserves the right to modify the Phase II submission requirements. Should the requirements change, all Phase I awardees will be notified. The DAF also reserves the right to change any administrative procedures that will improve management of the DAF SBIR/STTR Program at any time.

Air Force STTR 24.A Topic Index

Topic Number	Topic Name	Maximum Value*	Maximum Duration (in months)**	Technical Volume Page Limit***
AF24A-T001	Computer-Aided Tool for Wrapping Periodic Elements onto Doubly-Curved Surfaces	$180,000.00	6	20
AF24A-T002	Automated SysML Model Development	$180,000.00	6	20
AF24A-T003	Test Noise Reduction / Energy Capture Study	$180,000.00	~~6~~ 12	20
SF24A-T004	Integrated Lasers and Non-Magnetic Isolators for Optical Clock Technologies	$180,000.00	6	20
SF24A-T005	High Throughput Visible-Wavelength Multispectral Filter Arrays via Spectral Multiplexing	$180,000.00	6	20
SF24A-T006	Low Size, Weight, and Power, High Flux Atomic Source for Scalable Manufacturing	$180,000.00	6	20
SF24A-T007	SPoC Resilient Basing	$180,000.00	6	20

***Proposals that exceed this amount will be disqualified**
****Proposals that exceed this duration will be disqualified**
*****Pages in excess of this count will not be considered during evaluations**

AF24A-T001 TITLE: Computer-Aided Tool for Wrapping Periodic Elements onto Doubly-Curved Surfaces

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE); Advanced Materials

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: The next generation of airborne platforms will make extensive use of planar periodic electromagnetic structures to manipulate various electromagnetic interactions with surfaces of an air vehicle. In almost all cases, it is desired to wrap these structures over the complex and irregular surfaces of these air-vehicle platforms. However, conforming planar periodic structures over doubly-curved and irregular surfaces causes the planar periodic electromagnetic structures unit cells to become deformed, which alters their electromagnetic properties in an undesirable way.

The objective of this topic is to develop a general-purpose software tool that can wrap any planar periodic structure over any surface while minimizing or eliminating any of the unit cells from being deformed. The tool shall use solid models as inputs and outputs to maximize compatibility with other software.

DESCRIPTION: Future warfighting includes an incredibly complex, contested, and often hostile electromagnetic spectrum environment through which our airborne platforms will operate. Planar periodic structures can be employed to manipulate electromagnetic interactions with the surface of a vehicle. To utilize / cover the full surface area of a platform without any gaps, it is desired to wrap the periodic structures over irregular and doubly-curved surfaces [1]. Unfortunately, doing this also deforms the unit cells of the periodic structures, which alters their electromagnetic properties.

In recent years, several algorithms have been demonstrated with the ability to bend, twist, conform and otherwise spatially vary periodic structures in a special way that minimizes unintended deformations to the unit cells [1,2]. These algorithms have been used to wrap frequency preferred surfaces over doubly-curved surfaces while preserving the electromagnetic performance of the unit cells [1]. Such periodic structures can be called preservational spatially-variant lattices (PSVLs).

It is desired to create a general purpose software tool that can wrap any planar periodic structure over the surface of any object in a way that preserves the size, shape and spacing of the unit cells, all using solid modeling. Meshes are highly problematic because they can contain many errors, such as being non-manifold (e.g. not air tight), and they are less compatible with commercial CAD and simulation software. The inputs and outputs of the Phase II software tool shall be solid models to maximize compatibility with other software and avoid errors that arise when manipulating meshes.

PHASE I: In Phase 1, the performer shall conceptualize a software tool that offers a user the capability to wrap any planar periodic structure over any surface as a PSVL. The software tool shall take as inputs solid models of the unit cell and the surface over which to generate the PSVL. The performer shall lay out a software tool development strategy for implementation during the Phase II effort.

PHASE II: The Phase II effort shall develop and demonstrate a software tool that offers a user the capability to wrap any planar periodic structure over any surface as a PSVL. The software tool shall take as inputs solid models of the unit cell and the surface over which to generate the PSVL. The software tool shall export a solid model of the PSVL that can be directly and easily imported into manufacturing and simulation software. Any proposals using meshes as inputs or outputs will not be considered for funding. The Phase II software shall provide a modern user interface. The performer shall address how the PSVL software could be parallelized for computationally intensive jobs, operated in secure cloud environments suitable for DOD and defense contractors, and connected to manufacturing software during a Phase III effort.

PHASE III DUAL USE APPLICATIONS: Operating air platforms through complicated and hostile electromagnetic environments is a high priority for the Air Force. The Phase III will focus on complete maturation and commercialization of the technology including a user-friendly interface and integration with manufacturing software.

REFERENCES:

1. Valle, Cesar L., Gilbert T. Carranza, and Raymond C. Rumpf. "Conformal Frequency Selective Surfaces for Arbitrary Curvature." IEEE Transactions on Antennas and Propagation (2022);
2. Digaum, Jennefir L., et al. "Tight control of light beams in photonic crystals with spatially-variant lattice orientation." Optics express 22.21 (2014): 25788-25804.;

KEYWORDS: Planar; conformal mapping; periodic structures; spatially-variant; electromagnetics; irregular surfaces; planar periodic electromagnetic structures.

AF24A-T002 TITLE: Automated SysML Model Development

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy; Advanced Computing and Software

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Obtain the ability to ingest Microsoft Word, Microsoft Excel, Adobe PDF, and use AI/ML to create a SysML Model in Cameo Enterprise Architecture based off selected fields and relationships.

DESCRIPTION: Deliver a tool that has the capability to be integrated with existing IDE that performs the above SysML Modeling requirement.

PHASE I: Develop a tool that is beginning to ingest documents of various data types and establish relationships based off AI/ML methodologies that is capable of graphical modeling.

PHASE II: Tool must exhibit capability of USAF personnel to ingest documents and form all operations required of the tool to result in a graphical SysML Model within Cameo Systems Architecture without dependency on the tool developer.

PHASE III DUAL USE APPLICATIONS: Tool must have the ability to integrate with IDE and be distributed to all USAF personnel necessary to operate.

REFERENCES:

1. Schevchenko, N. (2020, December 21). An introduction to model-based systems engineering (MBSE). SEI Blog. https://insights.sei.cmu.edu/blog/introduction-model-based-systems-engineering-mbse/;
2. What is the systems modeling language (SysML)? SysML.org. https://sysml.org/sysml-faq/what-is-sysml.html;

KEYWORDS: SysML; MBSE; Automated Modeling; Graphical Modeling

AF24A-T003 TITLE: Test Noise Reduction / Energy Capture Study

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Renewable Energy Generation and Storage

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Development of potential solutions for noise reduction and energy recapture to be used in future engine test cell designs. Documented Analysis of Alternatives and sub-scale system should be produced to demonstrate the optimized solution.

DESCRIPTION: Initial study to determine the feasibility and identification of potential solutions for the incorporation of energy capture and advanced noise reduction in future ACETC facility plans in an effort to comply with the Air Force's goal of 100% carbon-free electricity by 2030. The testing of jet engines produces an immense amount of heat, vibration, and air. There is potential opportunity to capture the forced air and heat to recycle energy. To protect those working in the facility and provide a safe working environment, advanced noise reduction solutions should be considered to avoid the need of excessive PPE.

PHASE I: This will be a ~~SBIR~~ STTR phase I project with a ~~24~~ 12 month Period of Performance. This project will evaluate jet engine test energy recapturing and noise reduction. The scope of the project validation through computer modeling and verification through a developed subscale physical model utilizing a minimal of 20 pound thrust jet engine to analyze energy recapture and noise reduction. PMXG is open to evaluations of all energy recapturing opportunities as well as all noise reduction opportunities, through a documented Analysis of Alternatives. Noise measurements are expected to be is Decibel (db). Final electrical recapture is expected to be in Watts. Sub-scale computer model will be generated/developed by applicant, demonstrating the test envelope, engine, air flow, electric consumption, electric production, a noise levels. It is important to keep air flow in the test envelope laminar, so the performance of the engine is not compromised. An optimized demonstration of physical sub-scale model with measured electrical and noise parameters is expected as part of the deliverable. An initial study, multiple presentations, a working prototype (with 20 lb-thrust or higher engine test) and air flow monitoring and noise level readings are some milestones in this project.

PHASE II: This will be a ~~SBIR~~ STTR phase II project with a 24 month Period of Performance. This project will demonstrate a feasibility plan, implementation plan, and a demonstration of a functional physical sub-scale model (with 20 lb-thrust or higher engine test) with physical measurements. Documented Analysis of Alternatives shall be evaluated to show a robust poka-yoke design to optimize airflow constraints and reduce backflow opportunities, utilizing the physical sub-scale model for confirmation. Airflow, noise reduction and energy production shall be evaluated for variations in Type, Model, Series (TMS) engines. It is important to keep air flow in test envelope laminar, so the performance of the engine is not compromised. Scalability plans for test cell, engine, models and supporting documents shall be provided to Air Force jet engines to project requirements. Simulation models will be delivered with editable features to the test cell and TMS for internal Government use. Implementation plans to store captured energy into a local sub-station will be a deliverable. The optimized demonstration of physical sub-scale model with measured electrical and noise parameters is

expected as part of the deliverable. Applicate will provide the Government formal studies, multiple presentations, a working optimized prototype (with 20 lb-thrust or higher engine test) with air flow monitoring, energy recapturing and noise level readings, scalability plans are some milestones in this project.

PHASE III DUAL USE APPLICATIONS: This will be a SBIR phase III project is to integrate design elements, where feasible, into the Agile Common Engine Test Cell (ACETC) construction projection. This “Test Cell of the Future” concept opens up the perfect aperture to explore innovative green technology ideas and actively seek to reduce known safety challenges. If economically feasible, these concepts could apply to the commercial industry, especially for new construction opportunities. With construction conceptionally planned to begin in CY29, the opportunity to change tomorrow starts with today.

REFERENCES:

1. Energy Capture;
2. Noise Reduction;

KEYWORDS: Energy; Green; Noise Reduction; Jet Engine; Test; Energy Capture

SF24A-T004 TITLE: Integrated lasers and non-magnetic isolators for optical clock technologies

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum Science; Advanced Materials

~~The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.~~

OBJECTIVE: Development of a low size, weight, and power photonically integrated laser system that includes a narrow linewidth (under 10 kilohertz) laser natively at 778.1 nanometers, specifically the rubidium two-photon transition frequency, and a non-magnetic or minimally magnetic on-chip optical isolator with at least 30 decibels of isolation. The device should be packaged in a standard enclosure such as a butterfly package with all electrical connections made, and fiber-coupled with at least 40 milliwatts out of a polarization-maintaining fiber.

DESCRIPTION: Atomic clocks have seen a revolution in technology over the past decade as they have pushed towards chip-scale sizes, allowing them to be used in communications, navigation, and other defense-related technologies [1]. Future technologies such as clocks for "5G" networks and future Global Navigation Satellite System architectures could potentially incorporate more advanced clocks. Optical clocks such as the rubidium two-photon clock offers potential improvements over current chip scale clocks and surpass rubidium atomic frequency references [2]. One limiting factor in future, more advanced optical clocks is the development of the needed laser technology. Optical clocks require narrow linewidths down to kHz linewidths for the rubidium two photon optical clock, or even more narrow for other optical clocks such as strontium. These devices must be optically isolated to ensure the narrow linewidth and to avoid reflections causing unwanted lasing modes. Current systems typically employ a series of free space or fiber coupled components to achieve narrow linewidths and high optical power [2], but they can be susceptible to vibrations and shock. Furthermore, these systems typically have optical isolators with large magnetic fields, limiting the compactness of the device due to the effect of the magnetic field on the atoms. Recently, there have been advancements in each individual area such as narrow linewidth lasers [3, 4], on-chip non-magnetic isolators [5, 6], and new integration techniques [7]. The creation of such a device will not only enhance the manufacturability of the clock and lower the overall size, weight, and power, but it will also increase the environmental robustness to effects such as shock and vibration [8]. However, these devices have not been integrated into a single photonically integrated package. The DoD seeks the development of a photonically integrated circuit that includes a narrow linewidth laser and an on-chip non-magnetic optical isolator in a single package to serve the needs for next generation optical clocks.

PHASE I: Initial design and simulation of a sub-10 kilohertz linewidth laser at 778.1 nanometers, specifically the rubidium two-photon transition frequency, as well as a non-magnetic or minimally magnetic on-chip optical isolator with greater than 30 decibels of isolation and a fiber-coupled output greater than 40 milliwatts. Also a method for integrating the devices into a single package, either heterogeneous or hybrid integration, that allows for mass fabrication, ideally at the foundry level.

PHASE II: Packaged device with a sub-10 kilohertz linewidth laser at 778.1 nanometers, specifically the rubidium two-photon transition frequency, integrated with a non-magnetic or minimally magnetic on-chip isolator that provides at least 30 decibels of isolation, and fiber coupled. The means of integration should

allow for mass fabrication, ideally at a foundry level. It should provide at least 40 milliwatts out of a polarization-maintaining fiber with greater than 25 decibels polarization extinction ratio. The packaging should contain all electrical connections and thermal control, and be mounted in a standard style enclosure, such as a butterfly package, with a polarization maintaining fiber out. At least 2 prototypes are expected to be delivered.

PHASE III DUAL USE APPLICATIONS: These devices will be extremely useful for a variety of applications such as next generation optical and atomic clocks, but will require further testing for shock and vibration, acceleration sensitivity, radiation tolerance, etc.

REFERENCES:

1. Kitching, J., Chip-scale atomic devices, Appl. Phys. Rev. 5, 031302 (2018);
2. Lemke, N., Martin, K., Beard, R., Stuhl, B., Metcalf, A., Elgin, J., Measurement of Optical Rubidium Clock Frequency Spanning 65 Days, Sensors 22, 1982 (2022);
3. Corato-Zanarella, M., Gil-Molina, A., Ji, X. et al. Widely tunable and narrow-linewidth chip-scale lasers from near-ultraviolet to near-infrared wavelengths. Nat. Photon. 17, 157–164 (2023);
4. Chauhan, N., Isichenko, A., Liu, K. et al. Visible light photonic integrated Brillouin laser. Nat Commun 12, 4685 (2021);
5. Tian, H., Liu, J., Siddharth, A. et al. Magnetic-free silicon nitride integrated optical isolator. Nat. Photon. 15, 828–836 (2021);
6. White, A.D., Ahn, G.H., Gasse, K.V. et al. Integrated passive nonlinear optical isolators. Nat. Photon. 17, 143–149 (2023);
7. Tran, M.A., Zhang, C., Morin, T.J. et al. Extending the spectrum of fully integrated photonics to submicrometre wavelengths. Nature 610, 54–60 (2022);
8. Niffenegger, R.J., Stuart, J., Sorace-Agaskar, C. et al. Integrated multi-wavelength control of an ion qubit. Nature 586, 538–542 (2020).;

KEYWORDS: Laser; integrated photonics; optical clock; optical isolators

SF24A-T005 High Throughput Visible-Wavelength Multispectral Filter Arrays via Spectral Multiplexing

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Space Technology

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OBJECTIVE: To design and fabricate a multiplexing multispectral filter array covering the visible wavelengths that achieves a higher optical throughput than a narrowband array with equivalent bandwidth and spectral resolution.

DESCRIPTION: Describe the work you would like to see accomplished to meet the objective stated above. Character limit 25,000.

NOTE: Please do not write any Acronyms in the Topic Description. Spell out everything. Also no mathematical symbols.

To design and fabricate a multiplexing multispectral filter array covering the visible wavelengths that achieves a higher optical throughput than a narrowband array with equivalent bandwidth and spectral resolution.

Current visible-wavelength multispectral filter array technologies suffer from low light throughput because every pixel on the sensor only measures a single wavelength at a single spatial location. Multiple pixels are then considered together to construct the spectral signature over that group of pixels. This approach, while intuitive, leads to low light levels as the spectral resolution increases, since each pixel sees an ever-smaller piece of the object spectrum. The result of this is that high spectral resolution hyperspectral video becomes difficult due to the high integration times necessary to measure the signal. To resolve this issue, the performer will design and fabricate a visible-wavelength multiplexing multispectral filter array, where each filter is sensitive to many wavelengths at once. The performer will then mount their fabricated array onto an off-the-shelf monochromatic camera and demonstrate scene sampling and demosaicking. Success will be defined by the SNR, integration time, and spectral resolution and bandwidth compared to those of an off-the-shelf narrowband multispectral filter array.

PHASE I: Modeling and simulation will be performed to determine a recipe for depositing a multiplexing filter array onto glass. The simulated filter transmission spectra will be used to model the sampling and demosaicking of a standard hyperspectral test image. Facilities for filter array fabrication will be identified by the performer.

PHASE II: The multispectral filter array will be fabricated using the facilities identified by the performer during the Phase I. The performer will then characterize the array and align and mount it to a calibrated sensor. Hyperspectral measurements will then be acquired by the camera, demosaicked to recover the hyperspectral datacube, and then compared to imagery of the same scene acquired with an off-the-shelf pushbroom hyperspectral camera. The Phase II deliverable will be the fabricated filter array attached to the provided sensor.

PHASE III DUAL USE APPLICATIONS: The spatial and spectral resolution of a camera with the affixed filter array will be characterized. A mounting system will be built for the camera to allow it to be attached to an off-the-shelf drone. A field test will be performed in which hyperspectral video of multiple moving ground targets with diverse spectral content will be acquired from a drone.

REFERENCES:

1. Harwitt, M. and Sloane, N., "Hadamard Transform Optics," Academic Press, 1979;
2. Oliver, J. et al., “Filters with random transmittance for improving resolution in filter-array-based spectrometers,” Opt. Expr., 21(4), 2013;
3. Bian et al., "A low-cost integrated hyperspectral imaging sensor with full temporal and spatial resolution at VIS-NIR wide range," arXiv, arXiv:2306.11583v1, 2023.;

KEYWORDS: Multispectral Filter Array; Multiplexing Optics; Hyperspectral Imaging; Remote Sensing; Optical Filter Fabrication; Optical Coatings

SF24A-T006 TITLE: Low Size, Weight, and Power, High Flux Atomic Source for Scalable Manufacturing

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Quantum Science

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OBJECTIVE: Develop thermal atom beam sources with a high-brightness atomic flux density (greater than 10^10 atoms/second per 10,000 micrometer-squared cross sectional area) with a minimum total flux greater than 10^10 atoms/second and suitable for atomic sensing, atomic clocks, or other quantum devices of interest to the Department of Defense. The atom source should be compatible with mass-production techniques with preference being given to devices that can be integrated with established chip-alignment processes and procedures. The atomic sources should focus on simplicity and should use either no lasers or very simple laser configurations. The width of the transverse velocity distribution of the atoms emitting from the source should be no greater than 5 meters/second. Atomic beam sources developed under this topic should achieve the aggressive flux and velocity metrics within a total volume of 250 microliters with a viable path to achieve all metrics within a total device volume of 100 microliters. Preference will be given to sources that are able to reduce and control the longitudinal velocity as well as the transverse velocity.

DESCRIPTION: Atom-based sensors and clocks have shown tremendous promise in laboratory based experiments. In addition, atom-based quantum information processing nodes are likely to be necessary for short term quantum memory storage and transduction between different quantum systems. For clocks and sensors, the signal to noise ratio is typically improved in these devices by using laser cooling to produce a narrow velocity distribution that is within the Doppler width of the atoms or the linewidth of the laser. Using lasers for cooling is a well established technique but often increases the size and complexity of the device due to optical constraints. Several types of past and present atomic devices have avoided laser complexity by using filtered thermal atomic beams as the basis of atomic clocks and inertial sensors. For future atomic sensors that have low size, weight, and power (SWaP) that maintain high performance there needs to be a low-complexity, very compact atomic source with a well defined and narrow velocity range that uses no lasers, or greatly reduced laser paths, to produce a high brightness atomic flux. Ideally, this device will be suited for scalable manufacturing or fabrication techniques and could be compatible to integrate with established chip alignment processes. The device should produce greater than 10^10 atoms/second with a transverse velocity width less than 5 meters/second. The total size should 100 microliters including heaters and vacuum enclosure. Preference will be given to sources that are able to control the longitudinal velocity as well as the transverse velocity.

PHASE I: Develop necessary plans and concepts to create a high-flux atomic source suitable for atomic sensing, atomic clocks, or other quantum devices while meeting performance metrics highlighted in the objectives of this topic. The designs and concepts should clearly identify how the required performance metrics will be met while simultaneously meeting the required Size, Weight and Power metrics. The plans and concepts should include a clear and convincing pathway towards low-cost, scalable production. This plans should also conceptualize how the atomic source designs could provide advantage over state of the art for a relevant atomic device, such as an atomic inertial sensor, compact atomic clock, or other

quantum information processing device.

PHASE II: Instantiate and demonstrate a functioning prototype meeting the required specifications as described in the topic objectives and as represented by finalized plans and concepts initially developed in Phase I. Perform experiments and analyze results to establish the performance of the device and compare versus the desired topic objectives and demonstrate the adequacy of the device concepts. Demonstrate the feasibility of low-cost, scalable production of the high-flux atom devices still capable of achieving all performance specs identified in the objectives. Develop contacts with potential customers and develop a transition plan supporting future Phase III activity. Provide regular communication to the government sponsor to demonstrate progress and to ensure government understanding of risk mitigation.

PHASE III DUAL USE APPLICATIONS: Mature the prototype technologies developed in Phase II to include ease of integration into full quantum devices. It is anticipated that the devices developed under this effort would be geared towards integration into low Size, Weight, and Power thermal-beam sensors, such as those being developed by the Defense Innovation Unit and the Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E). Phase III efforts should focus on integration into full-quantum systems with prospective transition partners. The contractor will transition the solution for very low Size, Weight, and Power, highly scalable atom sources to a broad range of government and civilian users.

REFERENCES:

1. Li, C., Chai, X., Wei, B. et al. Cascaded collimator for atomic beams traveling in planar silicon devices. Nat Commun 10, 1831 (2019). https://doi.org/10.1038/s41467-019-09647-3;
2. Martinez, G.D., Li, C., Staron, A. et al. A chip-scale atomic beam clock. Nat Commun 14, 3501 (2023). https://doi.org/10.1038/s41467-023-39166-1;
3. T L Gustavson et al 2000 Class. Quantum Grav. 17 2385. https://doi.org/10.1088/0264-9381/17/12/311;

KEYWORDS: low SWaP atom sources; scalable atom sources; atom beam sources; high flux atom sources

SF24A-T007 TITLE: SPoC Resilient Basing

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy; Microelectronics; Integrated Sensing and Cyber; Advanced Computing and Software

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OBJECTIVE: 1.) Digital Transformation AI/ML Capabilities and Automation: Adopt existing technologies or new technologies that increase the efficiency of decision making and routine processes for space professionals in mission accomplishment
2.) Critical Infrastructure Technologies: Adopt technologies which predict and automate critical infrastructure asset stressors and failures to link power projection capabilities with mission assurance goals.

DESCRIPTION: Historically, suitability for new space operation mission growth was assessed in a stovepiped and data constrained fashion. Recent data indicates that shared, whole building systems have reached capacity, thereby potentially impacting or delaying critical mission system or technology upgrades. Space Base Delta 1, in concert with Delta 6, would like to develop an interactive digtial twin of the critical infrastructure (e.g., cooling, power, HVAC) that supports space operations within SBD 1. This digital twin would be used for the following activities: facility space planning, what-if analyses for loading and resiliency, real-time monitoring of critical nodes, development of smart maintenance best practices, energy analysis/efficiency, exercise / wargame support.

PHASE I: Demonstrate through analysis the abilty to perform the functions outlined in the Phase II.

PHASE II: Step 1: Develop an interactive model of a facility or piece of infrastructure supporting space operations. Identify and scope infrastructure at New Boston Space Force Station to convert into a digital twin. Develop an interactive digital twin prototype and implement use-cases (facility space planning, what-if analyses). Capture lessons learned to scale to a larger system-of-systems at Schriever SFB, CO.
Step 2: Add sensors into infrastructure in order to enable smart monitoring of infrastructure performance. Focus on primarily HVAC and electrical equipment. Goal is to detect anomalous conditions that foreshadow a failure. Use date to feed predictive maintenance models.
Step 3: Develop an AI-augmented situational awareness and decision tool for SBD 1's Civil Engineering Squadrons to command and control smart base infrastructure. Tool could be used on all USSF SBDs as well as USAF bases. Create roadmap to scale to all DAF bases and GSUs.

PHASE III DUAL USE APPLICATIONS: Transition pilot program to AFMC for sustainment funding. Scale pilot program to other SBD 1, 2, and 3 instatllations.

REFERENCES:
1. SBD 1_B400 Power - Cooling Assessment MSG_FINAL.pdf;
2. BOS Digital Transformation Strategy (as of 3 March 2023) (CUI version).pptx;
3. SpOC Near Term Top Challenges Memo.pdf;

KEYWORDS: Artificial Intelligence; AI; Machine Learning; ML; Automation; Smart City; Smart Base; digital twin; BOS; Resiliency; Smart Maintenance; what-if analysis; Resilient Basing