Basic and Applied Research Technical Proposal

Subtype

Basic Research

Section 1 – Project Overview

Proposal Title

The High Energy Electromagnetic Field Generator (HEEMFG)

Principal Investigator

Name: (b) (6)

Code: (b) (6)

Phone: (b) (6)

Email: (b) (6)

Associate Investigator

Name: (b) (6)

Code:

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STAIRS Tracking and Project Details

The STAIRS tracking information below is for reference only. These details can be modified in the Edit Proposal Package Details interface in STAIRS.

T-Code: 4.4T

Portfolio: NAWC

Estimated start date: 10/3/2016

Estimated end date: 9/30/2017

NAWC lab: AD

Starting TRL: TRL 2: Technology concept and/or application formulated.

Estimated TRL at completion: TRL 2: Technology concept and/or application formulated.

Funding Summary

The funding summary below is derived from the cost proposals entered in STAIRS for this proposal package. It is for reference only. To modify funding amounts, please edit the cost proposals using the STAIRS interface.

Fiscal Year	Labor	Travel	Materials	FY Total
2017	$151.96K	$0.00K	$0.00K	$151.96K
			Total:	**$151.96K**

Section 2 – Objective

Objective

Clearly and concisely state the overall objective and deliverable(s) of the project in one to three sentences. **Do not include any government proprietary information.**

Design a test article and related instrumentation as part of a one-year study to demonstrate the experimental feasibility of achieving high, electromagnetic (EM), field-energy, flux values toward the design of advanced concepts for High Density / High Power systems under the 4.4 Core Capability of Power and Energy Systems. The PIs will deliver technical reports and possible journal publications based on the results of this study with the intent to quantify expected EM energy flux.

Reduced Total Ownership Cost (RTOC)?

Will this project help reduce total ownership cost?

No

Improved / Increased Readiness?

Will this project help improve or increase readiness?

No

Section 3 – Approach

Technical Approach

Clearly state the hypothesis, provide a concise background description, and describe theoretical/ experimental methodology to achieve your objectives.

Hypothesis:

By coupling an electrically charged system's high frequency of axial spin with high vibration frequencies (i.e., abrupt pulsations/harmonic oscillations) operated in an accelerated mode, this project could obtain extremely high, electromagnetic, field-intensity values.

Background description:

This concept's governing physics entail the coupling of Gyration (high-frequency spin), Vibration (high-frequency abrupt pulsations / harmonic oscillations), and possible Curvilinear Translation (i.e., non-axial rotation or linear displacement) of electrically charged systems. As such, EM field-energy flux values on the order of 10^{33} Watts/m^2 (i.e., complete [quantum] vacuum polarization) are theoretically feasible with the concept at hand in an accelerated high frequency spin and accelerated vibration operational mode.

These extremely high EM, field-intensity values emphasize the novelty of this concept and are especially suited for the design of energy generation machinery with power output levels much higher than those currently achievable. The utilization of such high power sources for aerospace power and propulsion generation, as it pertains to reduction in a hybrid craft's inertial (or gravitational) mass as a direct result of local Vacuum Polarization, is an important application of the described concept. In this manner, extreme hybrid aerospace / undersea craft (HAUC) speeds can be achieved.

Refer to the technical paper entitled "The High Energy Electromagnetic Field Generator (HEEMFG)" attached to the STAIRS project proposal for additional explanation of the advanced physics associated with this project. Also, refer to the Test Plan summary attached to the STAIRS proposal for a better understanding of testing measurands.

Theoretical/Experimental Methodology:

A one-year feasibility study to demonstrate the experimental ability to fully address the concept of HEEMFG is proposed. The intent of this study is design of the test asset and detailed design of the experiment. If successful, subsequent years' efforts could include building the test asset, instrumenting it, and conducting the experiment in Propulsion System Evaluation Facility's (PSEF) Rotor Spin Facility (RSF). Safety of test will dictate a build-up approach to testing where the RPMs, complexity of test asset shape, accelerations, and vibration amplitude are gradually (or possibly abruptly) incremented with test data analysis occurring between increments. The abrupt accelerations (i.e., both spin and vibration) will seek to explore the non-linear effects of the far-from-equilibrium physics which ensue.

The testing to be evaluated in the one-year feasibility study includes an electrically charged test object (i.e., notionally 1-foot diameter and 1/8 to 1/4 inch thickness) in the shape of an aluminum disc (i.e., domed disc) or hollow cone that will be axially spun at rotational speeds up to 10,000 RPM. While higher speeds are desirable to achieve the predicted results, the physics can be confirmed at lower speeds that are within the test capabilities of AIR 4.4. Ultimately, the goal is to vibrate the test object, possibly by use of the piezoelectric effect by mounting lead zirconate titanate (PZT) modules circumferentially in a cruciform configuration on the underside of the test article. These PZT modules are vibrated by DC voltage (up to 1,000 Volts) applied to them from the same power source which electrifies the outside surface area (only) of the test object. Vibration frequencies (preferably from a "new" physics viewpoint) should be in the range of 10^5 Hertz (Hz) to 10^9 Hz, with vibration amplitudes of 0.04 inch (1 mm).

For the potential baseline experiments, the PIs recommend testing with 2,000 RPM spin and 1,000 Hz vibration in order to verify Equation 2 (EM energy flux value) in the technical paper attached within the STAIRS project proposal. This is preferred from a safety and test measurement perspective. Also, the test asset can be tested with accelerated spin only or accelerated vibration only, resulting in uncoupled effects. The test object will be mounted in a vacuum chamber ideally evacuated at pressures on the order of 5×10^{-6} Torr (outer space) with a Faraday cage (possibly stainless steel) mounted around the test device for safety of operation. The test object will be mounted to a hollow shaft with slip rings providing power to the PZTs. This will be a rotatable shaft connected to an electric motor via a gearbox which will control the acceleration of the test object's spin. An auxiliary device may act as a control device capable of accelerating and decelerating the PZT vibration.

It is of extreme importance to have the ability to control the accelerated modes of vibration and spin, in particular the rapid rates of change of accelerated-decelerated-accelerated vibration and/or accelerated-decelerated-accelerated gyration (i.e., axial spin) of the electrified test object. In this manner, we can delay the onset of relaxation to thermodynamic equilibrium, thus inducing a physical mechanism which may produce anomalies (such as inertial and gravitational mass reduction) due to the possible suppression (or reduction) of decoherence effects.

Basic and Applied Research Technical Proposal

Research Justification

Explain why the proposed work constitutes basic or applied research.

This experimental investigation may prove fundamental in generating the high, electromagnetic, energy-flux values necessary to locally polarize the local Vacuum Energy State, thereby manipulating/modifying the local Spacetime, lattice-energy density. If we can engineer the metastructure of the local quantum vacuum state (the quantum vacuum has multiple structures), then we can engineer the fabric of our physical reality at the most fundamental level, and thus affect a physical system's inertial and gravitational properties. This realization would greatly advance the fields of aerospace propulsion and power generation, and eventually enable our dream of Interstellar Flight.

Refer to the technical paper titled "The High Energy Electromagnetic Field Generator" attached to the STAIRS project proposal for a more detailed description of the driving physics (i.e., S.C. Pais, The high energy electromagnetic field generator, Int. J. Space Science and Engineering, Vol.3, No. 4, 2015 pp.312-317; peer-reviewed).

Execution Plan

For each fiscal year, list each task, who performs the task, and break out the labor/ travel/ material costs. Explain travel costs that exceed $5k. In particular, explain reasoning behind laboratory support fees.

FY17:

- Create an Experiment within PSEF facilities capabilities:
  - **Task 1: Design of Experiment (DOE) (October 2016 - September 2017)**
    - Physicist (0.2 WY/348 hrs.); PI will be primary author of experiment
    - Mechanical Engineer, or ME (0.1 WY/174 hrs.); will provide major inputs interfacing with lab equipment
    - Test Facility Engineer (0.1 WY/174 hrs.); required as major contributor for lab equipment knowledge
  - **Task 2: Design the Test Asset(s) (October 2016 - February 2017)**
    - Physicist (0.05 WY/87 hrs.); supporting roll to evaluate trade space
    - ME (0.2 WY/348 hrs.); primary designer will interface with other MEs for expertise in loads, vibes, strength, etc.
  - **Task 3: Feasibility Study of Using, Mounting, and Powering PZTs on Test Asset (January - June 2017)**
    - Physicist (0.1 WY/174 hrs.); PI will be primary planner to achieve desired results from excitation
    - ME (0.1 WY/174 hrs.); primary designer will interface with test engineers and dynamic systems engineers to assess viability of system
    - Test Facility Engineer (0.05 WY/87 hrs.); required to inform integration decisions
  - **Task 4: Determine Electrical Power Requirements and Source Equipment (November 2016 - January 2017)**
    - Physicist (0.1 WY/174 hrs.); PI will detail calculated requirements
    - ME/Test Facility Engineer (0.05 MY/87 hrs.); consists of integration roll to determine need for and source new equipment as needed
  - **Task 5: Design/Source Instrumentation to Measure Anticipated Effects (February - June 2017)**
    - Physicist/ME (0.1 WY/174 hrs.); PI will detail calculated range of anticipated effects to be measured and work with lab instrumentation groups to determine need for additional equipment.

Technology Challenges

Describe the technical or scientific barrier, use metrics if applicable.

The primary technology challenge is the commercial-off-the-shelf (COTS) acquisition of PZT modules in the vibrational frequency range of 10^5 to 10^9 Hz, especially those on the high end of this frequency spectrum. However, this may not prove a barrier after all, since the experiment can still be performed at vibrational frequencies of approximately 10^5 Hz, as long as we do this at rapid rates of change of both coupled accelerated spin and accelerated vibration of the electrically-charged test asset (i.e., non-uniform accelerations). For our baseline experiments, we recommend testing with 2,000 RPM spin and 1,000 Hz vibration in order to verify Equation 2 (EM energy flux value) in the attached technical paper, as this is preferred from a safety and test measurement perspective. Also, the test asset can be tested with accelerated spin only or accelerated vibration only, resulting in uncoupled effects.

Make or Break Criteria

Describe the make or break exit criteria for each year.

FY17: The output of this one-year feasibility study should yield the completion of each of the five tasks shown in the Execution Plan (above), and should assess the feasibility and requirements (including costs) of conducting future work and experiments (FY18 and beyond) to test the hypothesis discussed in Section 3 (above) of generating and measuring high EM, field-intensity values.

If any step in the execution plan is deemed beyond 4.4 laboratory capabilities or anticipated budget allowances, the investigators will report findings through the leadership chain to determine a new course of action (COA). Possible new COAs could include continuing research in order to pursue cooperative agreements with DARPA, NRL, etc., or project stoppage and return or remaining project funds for this one-year effort.

Section 4 – NAWC / NAE Relevance / Benefit

Alignment

Alignment information below is for reference only. To modify alignments, use the Edit Proposal Alignment interface in STAIRS.

Competency core capability: Power and Energy Systems

Secondary core capability:

NAE Gap/STO: Strike Operations (STK) / STO-1: Responsive Engagement

Secondary NAE Gap/STO: Theater Air and Missile Defense (TAMD) / STO-2: Airborne Missile Defense

Counter IED: No

Overseas contingency operation: No

S&T research area: Power and Energy Technology

S&T research sub-area: Advanced Naval Power Systems

Key technologies: Physics / Electricity and Magnetism, Physics / Quantum Theory and Relativity, Power Production and Energy Conversion (Nonpropulsive) / Electric Power Production and Distribution, Propulsion, Engines and Fuels / Electric and Ion Propulsion

DoN S&T focus area(s): [Primary] Power & Energy / High Energy and Pulsed Power, Power & Energy / Efficient Power and Energy Systems

NAWC / NAE Benefit

Describe value to NAWC/ NAE and identify benefits to core capabilities/ S&T Objectives if successful. Describe any other anticipated benefits to the NAWC laboratory and/ or military capabilities.

The immediate benefit of this experimental work to NAWC/NAE is the development of novel/advanced High Density, High Power Systems, which is one of the core capabilities of the AIR 4.4 organization, under the Power and Energy systems umbrella. Furthermore, this project aligns well with one of the NAWCAD Technology Thrust Areas (viz., 5.0 Transformational Air Vehicle & Propulsion Concepts, in the sub-area of Increased Power Density). As such, these technologies could greatly enhance military capabilities.

Urgency

Describe why this research should be done now.

The results of these experiments can prove crucial for advancing the design of High Density / High Power systems concepts under the 4.4 Core Capability of Power and Energy Systems. If successful, this concept could ultimately be developed to greatly benefit the United States Warfighter in achieving battlefield supremacy, an endeavor of immediate importance and vital to our national security.

Research Products

Describe plans for potential publications/ presentations/ patent applications, etc. Also describe any workforce development impacts (i.e., employee mentoring/ summer students/ training, etc.) associated with this project.

Depending on the experimental results achieved from this effort, the PIs plan to possibly publish findings in AIAA or SAE technical journals. The PI is the author of Navy Case PAX 182, which has become U.S. Patent Application 14807943 entitled, “Electromagnetic Field Generator and Method to create Electromagnetic Field”. Furthermore, I am also the author of Navy Case PAX 205 (The Inertial Mass Reduction Device) which has been recommended by Dr. James Sheehy (Chief Technology Officer) to become a patent application, and has recently been filed with the USPTO. Both these technical works are based on the physical mechanisms described in this proposal.

Section 5 – Project Transition

Transition Details

Transition information in the box below is for reference only. To modify this data, use the Edit Proposal Package Details interface in STAIRS.

Transition type: G - Product transitions to Naval Air Warfare Center / Fleet Readiness Center

Transition sponsor: AIR-4.0

Transition Sponsor Input

Has the transition sponsor provided input into this proposal? If yes, please describe the input provided.

No sponsor exists at this time.

Transition Plan

What is the next step for this research, if successful? Include any follow on plans for the transition of this technology if relevant (i.e. pursue other funding, etc.)

If this experiment is successful, the next step would be to build a device to harvest the energy created.

Section 6 – Related Projects

Related Projects

Identify any related S&T projects associated with this effort, including projects that contributed to, complement, or will be enhanced by this effort. Briefly summarize previous or current work performed in the area of this proposal, explain how the proposed work differs from other previous or ongoing projects.

None.

Section 7 – Collaborations

Collaborations

Identify any other individuals, teams or organizations collaborating on this project.

Academia: Possible correspondence with (b) (6) (University of Puerto Rico) for exchange of ideas regarding present concept.

Government agency: Possible collaboration/correspondence with ONR, NRL, DARPA.

International: This concept may be ITAR restricted, especially any experimental results.

Private sector: Possibility exists, but not anticipated at the present time.

Tri-service: Possibility exists, but not anticipated at the present time.

Section 8 – Alternative Source Solicitation

Alternative Source Solicitation

Identify any other sources of funding you or your departments have solicited for this project - successful or unsuccessful.

None.

The High Energy Electromagnetic Field Generator

FY17 BAR/TT, Basic / Applied Research

FY2017 Cost Proposal

Labor

	Name	Code	GS/GSE	Hourly rate	% WY	# Hours	Est. cost
1.	(b) (6)	4451	PAX - GS/GSE-13	$72.78/hr	50%	870	$63.32K
2.	Salvatore Pais (Physisist)	4451	PAX - GS/GSE-13	$72.78/hr	50%	870	$63.32K
3.	Lab Technician	44	PAX - GS/GSE-13	$72.78/hr	20%	348	$25.33K
						Total labor costs:	$151.96K

Travel

There are no travel costs associated with this cost proposal.

Materials

There are no material costs associated with this cost proposal.

Total FY2017 proposal costs: $151.96K

COLLABORATIONS

There are currently no collaborations identified for this proposal.

FY2017 Cost Proposal Comments / Justification of Costs

There are no comments / justification of costs associated with this cost proposal.

12 MAY 2016

(b)(6)

AIR 4.4.5

NISE BAR Selection Committee

Committee Members:

This letter is my endorsement of the FY17 NISE BAR Proposal, 'The High Energy Electromagnetic Field Generator', submitted by (b) (6) .

This basic research project explores the ability to produce exceptionally high electromagnetic field energy fluxes which is considered instrumental to designing advanced High Density, High Power Systems and significantly increasing future propulsion capability. The basic research project is an important first step toward developing advanced power and propulsion devices. The physics of this experiment have been peer reviewed and deemed sound.

The first year of this BAR proposal encompasses designing the test asset(s) and evaluating experimental conditions. This will determine the feasibility and effectiveness of the experiments. If viable, tests will be conducted in FY18 and provide valuable data in proving the physics needed to design completely new High Density, High Power Systems and Advanced Propulsion devices.

Thank you for your consideration.

(b) (6)

AIR 4.4.5

The high energy electromagnetic field generator

Salvatore Cezar Pais

Department of Defense/Department of the Navy,
Naval Air Systems Command/NAWCAD,
NAS Patuxent River Maryland 20670, USA
Email: (b) (6)
Email: (b) (6)

Abstract: The original concept described is named the high energy electromagnetic field generator. This concept's governing physics entail the coupling of gyration (high frequency spin), vibration (high frequency abrupt pulsations/harmonic oscillations) and possible curvilinear translation, of electrically charged systems. If we couple the system's high frequency of rotation (30,000 to 100,000 RPM, and higher) with high vibration (abrupt pulsations/harmonic oscillations) frequencies in the range of 10^9 to 10^{18} Hertz (and above) we can obtain electromagnetic field intensity values in the range 10^{24} to 10^{28} Watts/m^2 (and beyond). These extremely high electromagnetic field intensity values emphasise the novelty of this concept, especially suited for the design of energy generation machinery with power output levels much higher than those currently achievable. The utilisation of such high power sources for space power and propulsion generation, as it pertains to reduction in a spacecraft's inertial mass as a direct result of local vacuum polarisation, is an important application of the described theoretical concept. In this manner, extreme spacecraft speeds can be achieved.

Keywords: faster than light travel; superluminal propulsion; quantum vacuum plasma; QVP; vacuum energy fluctuations; vacuum polarisation; spacetime manipulation; quantum vacuum engineering; quantum field theory; far from equilibrium thermodynamics; spatio-temporal excursion.

Reference to this paper should be made as follows: Pais, S.C. (2015) 'The high energy electromagnetic field generator', *Int. J. Space Science and Engineering*, Vol. 3, No. 4, pp.312–317.

Biographical notes: Salvatore Cezar Pais obtained his Doctorate in Mechanical and Aerospace Engineering from Case Western Reserve University, while working as a NASA Graduate Student Research Fellow at NASA Glen (Lewis) Research Center. His research studies deal primarily with defence-oriented work, performed as a General Engineer/Advanced Concepts Analyst at Northrop Grumman Aerospace Systems. At the present time, he works for the Department of Defense, Department of the Navy/Naval Air Systems Command at NAS Patuxent River in Maryland.

1 Introduction

The original concept described herein, is named the high energy electromagnetic field generator (HEEMFG). When put in practice, this system can provide the design of energy generation machinery with power output levels much higher than those currently achievable. The utilisation of such high power sources for space power and propulsion generation, as it pertains to reduction in the spacecraft's inertial mass as a direct result of local vacuum polarisation, is an important application of the described theoretical concept.

This concept's governing physics entail the coupling of gyration (high frequency spin), vibration (high frequency abrupt pulsations/harmonic oscillations) and possible curvilinear translation (thus three modes of motion) of electrically charged systems.

There are four known fundamental forces which control matter and therefore control energy, namely the strong and weak nuclear forces, the electromagnetic (EM) force and the gravitational force. In this hierarchy of forces, the EM force is perfectly positioned to be able to manipulate the other three. A stationary electric charge gives rise to an electric (electrostatic) field, while a moving charge generates both an electric and a magnetic field (hence, the EM field); additionally an accelerating charge induces EM radiation in the form of transverse waves, namely light. Mathematically as well as physically, EM field intensity can be represented as the product of electric field strength and magnetic field strength. EM fields act as carriers for both energy and momentum, thus interacting with physical entities at the most fundamental level.

Artificially generated, high energy, EM fields interact strongly with the vacuum energy state (an aggregate/collective state comprised of the superposition of all quantum fields' fluctuations permeating the entire fabric of spacetime), thereby giving rise to emergent physical phenomena (in other words revolutionary/new physics), such as force and matter fields unification. According to quantum field theory, this strong interaction between the fields is based on the mechanism of transfer of vibrational energy between the fields, further inducing local fluctuations in adjacent quantum fields which permeate spacetime (these fields may or may not be EM in nature). Matter, energy, and spacetime are all emergent constructs which arise out of the fundamental framework that is the vacuum, energy state.

Everything that surrounds us, ourselves included, can be described as macroscopic collections of fluctuations, vibrations, oscillations in quantum mechanical fields. Matter is confined energy, 'frozen' in a quantum of time. Therefore, under certain conditions (such as the coupling of hyper-frequency axial spin with hyper-frequency vibrations of electrically charged systems) the rules and special effects of quantum field behaviour also apply to macroscopic physical entities (O'Connell et al., 2010).

Moreover, coupling of hyper-frequency gyrational (axial rotation) and hyper-frequency vibrational electrodynamics (as used in the concept herein disclosed) is conducive to a possible physical breakthrough (force field unification is feasible with the concept at hand) in the utilisation of the macroscopic quantum fluctuations vacuum plasma field (quantum vacuum plasma – QVP, in short) as an energy source (or sink), an induced physical phenomenon, for which the technology readiness level has been considerably advanced by a team of research engineers from NASA JSC (Brady et al., 2014). This research involves the use of high radio frequency/microwave driven resonant cavity Q-thruster technology within the context of QVP physics.

The QVP is the electric glue of our plasma universe. The Casimir effect, the Lamb shift, and spontaneous emission, are specific confirmations of the existence of QVP (Milonni, 1994).

It is important to note that in region(s) where the EM fields are strongest, the more potent are the interactions with the QVP, therefore, the higher the induced energy density of the QVP particles which spring into existence(the Dirac Sea of electrons and positrons). These QVP 'particles' may augment the obtained energy levels of the HEEMFG system (even though they are short-lived, these 'virtual' particles have a real effect).

To be more precise, the EM fields created by the HEEMFG system, interact with the vacuum energy state, which is an aggregate state composed of the superposition of all quantum fields' fluctuations filling the entire fabric of spacetime. Contributions to this vacuum state energy density are made by the quantum vacuum-zero point fluctuations, the quantum chromo-dynamics gluon and quark condensates and the newly discovered Higgs field (exhibiting massive 126 GeV particles), among other yet undiscovered fields (super-symmetry). In other words, major contributions to the vacuum energy state are made by collectives of quantum fluctuations in fermionic fields (fields of matter), quantum fluctuations in bosonic fields (fields of force) and quantum fluctuations in scalar fields (Higgs field).

2 Concept novelty

The physical equation which describes the maximum intensity achieved by the HEEMFG system is described by the magnitude of the Poynting vector, which in non-relativistic form (accounting for all three modes of motion) can be written as:

$$S_{max} = f_G \left(\sigma^2 / \varepsilon_0\right)\left[R_r \omega + R_v v + v_R\right] \tag{1}$$

where f_G is the HEEMFG system geometric shape factor (equal to 1 for a disc configuration), σ is the surface charge density (total electric charge divided by surface area of the HEEMFG system), ε_0 is the electrical permittivity of free space, R_r is the radius of rotation (disc radius), ω is the angular frequency of rotation in rad/s, R_v is the vibration (harmonic oscillation) amplitude, ν is the angular frequency of vibration in Hertz, and the term v_R is the curvilinear translation speed (acquired via a propulsive unit of either chemical, nuclear or magneto-plasma-dynamic (VASIMR) type attached to the HEEMFG system – the integrated unit being the spacecraft).

Therefore, if we consider only rotation, given a disc configuration, with σ = 50,000 Coulombs/m^2, a disc (spinning/axially rotating) radius of 2 m and an angular speed of 30,000 RPM, we can generate an EM field intensity (S_{max} = rate of energy flow per unit area, or energy flux) value on the order of 10^{24} Watts/m^2 (this value does not account for any QVP interactions).

Furthermore, if we couple the high frequency of rotation with high vibration (harmonic oscillation) frequencies in the range of 10^9 to 10^{18} Hertz (and above) we can obtain S_{max} intensity values in the range 10^{24} to 10^{28} Watts/m^2 (and beyond). These extremely high EM field intensity values emphasise the novelty of this concept, especially suited for the design of energy generation machinery with power output levels much higher than those currently achievable.

For the case of an accelerating angular frequency of vibration ($a_{max} = R_v v^2$), neglecting rotation and curvilinear translation, equation (1) becomes (note intrinsic significance of acceleration):

$$S_{max} = f_G \left(\sigma^2 / \varepsilon_0\right)\left[\left(R_v v^2\right) t_{op}\right] \tag{2}$$

where t_{op} is the operational time for which the charged electrical system is accelerating.

Close inspection of equation (2) results in an important realisation, namely: strong local interaction with the high energetics of the quantum vacuum fields' fluctuations superposition (macroscopic vacuum energy state) is possible in a laboratory environment, by application of high frequency gyration and/or high frequency vibration of minimally charged objects (order of unity), in an acceleration mode. In this manner, a high degree of vacuum energy polarisation can be achieved.

Local polarisation of the vacuum in the close proximity of a spacecraft equipped with an HEEMFG system would have the effect of cohering the highly energetic and random quantum vacuum fields' fluctuations, which virtually block the path of an accelerating spacecraft, in such a manner that the resulting negative pressure of the polarised vacuum allows less laboured motion through it (Froning, 2009).

Spontaneous electron-positron pair production out of the vacuum (Schwinger, 1951; Kim, 2015) is a strong indicator of vacuum polarisation being achieved. Schwinger gives a value of the electric field (E) on the order of 10^{18} V/m for this phenomenon to take place. The mass production rate $(dm / dt)_{pp}$ of particle/anti-particle pairs can be expressed in terms of S_{max} (energy flux), namely:

$$2\gamma \left(dm / dt\right)_{pp} c^2 = S_{max} A_S \tag{3}$$

where A_S is the surface area from which the energy flux emanates, c is the speed of light in free space, and (γ) is the relativistic stretch factor $[1 - (v^2 / c^2)]^{-1/2}$. Note that the pair production rate increases with increasing energy flux from the spacecraft's generated EM field. Therefore, the level, to which the vacuum is polarised, thus allowing less laboured motion through it, strictly depends on the artificially generated EM energy flux.

If we consider the boundary condition in the close proximity of the spacecraft where the energy density of the artificially generated EM field equals the local energy density of the polarised vacuum (caused in part by the local zero-point vacuum fluctuations on the order of 10^{-15} Joules/cm^3 and in part by the artificial EM field interacting with the local vacuum energy state) we can write the approximate equivalence:

$$S_{max}\left(t_{op} / R_S\right) = \left[\left(h^* v_v^4\right) \big/ 8\pi^2 c^3\right] \tag{4}$$

where R_S is the electromagnetic (EM) field radius at EM wave propagating time t_{op}, such that $R_S / t_{op} = c$ (where c is the light speed in free space), (h^*) is Planck's constant divided by (2π) and (ν_v) is the frequency of quantum fluctuations in the vacuum (modelled as harmonic oscillators).

Furthermore, given that the left side of equation (4) is on the order of ($\varepsilon_0 E^2$) where E is the artificially generated electric field (strength), considering the Schwinger value of (E) for the onset of spontaneous pair production, we obtain a (ν_v) value on the order of 10^{22} Hertz, which matches our expectations, since the Dirac virtual pair production, results in total annihilation, yielding gamma rays, which occupy the EM frequency spectrum of 10^{19} Hertz and above.

A recent paper (Pais, 2015) considers the possibility of superluminal spacecraft propulsion in a special relativity framework. It is observed that under certain physical conditions, the singularity expressed by the relativistic stretch factor 'gamma' as the spacecraft's speed (v) approaches the speed of light (c), is no longer present in the physical picture. This involves the instantaneous removal of energy-mass from the system (spacecraft) when the spacecraft's speed reaches (v = c / 2). The author discusses the possibility of using exotic matter (negative mass/negative energy density) to bring about this effect. This may not have to be the only alternative. The artificial generation of gravity waves in the locality of the spacecraft, can result in energy-mass removal (gravity waves are propagating fluctuations in gravitational fields, whose amplitude and frequency are a function of the motion of the masses involved).

Moreover, it is feasible to remove energy-mass from the system by enabling vacuum polarisation, as discussed by Puthoff (Puthoff, 2002; Haisch et al., 1994); in that diminution of inertial (and thus gravitational) mass can be achieved via manipulation of quantum field fluctuations in the vacuum. In other words, it is possible to reduce a spacecraft's inertia, that is, its resistance to motion/acceleration by polarising the vacuum in the close proximity of the moving spacecraft. As a result, extreme speeds can be achieved.

Think of the vacuum energy state as a chaotic system comprised of random, highly energetic fluctuations in the collective quantum fields which define it. Considering Prigogine's (1977) work on far from equilibrium thermodynamics, a chaotic system can self-organise if subjected to three conditions, namely: the system must be nonlinear, it must experience an abrupt excursion far from thermodynamic equilibrium, and it must be subjected to an energy flux (order from chaos).

An artificially generated high energy EM field can fulfil all three conditions simultaneously, when strongly interacting (especially in an accelerated vibration/rotation mode) with the local vacuum energy state. Recall that these interactions are induced by the coupling of hyper-frequency axial rotation (spin) and hyper-frequency vibration (harmonic oscillations/abrupt pulsations) of electrically charged systems (HEEMFG), placed on the outside of the spacecraft in strategic locations. In this manner, local vacuum polarisation, namely the coherence of vacuum fluctuations within the immediate proximity of the spacecraft's surface (outside vacuum boundary) is achieved, allowing for 'smooth sailing' through the negative pressure (repulsive gravity) of the void.

As an aside, force and matter fields unification (Gross, 2007) is feasible with the concept at hand, due to the extremely strong interactions (EM in nature) between ordinary matter and the QVP/vacuum energy state (interactions which exhibit extremely high energies on Planck length scales in the immediate proximity of the disc/spacecraft surface).

3 Conclusions

This original concept, which may represent a breakthrough technology, does reveal a novel approach to the design of energy generation machinery with power output levels much higher than those currently achievable by conventional means.

The utilisation of such high power sources for space power and propulsion generation, as it pertains to reduction in the spacecraft's inertial mass as a direct result of

local vacuum polarisation, is an important application of the described theoretical concept. In this manner, extreme spacecraft speeds can be achieved.

To be more exact, the concept at hand can be utilised in the design of a device to manipulate/modify the local spacetime lattice (topology) energy density, which can be achieved via local vacuum energy polarisation. Moreover, due to the nature of the 'emergent physics' involved, it is possible to experience spatio-temporal displacement (excursion) effects.

Disclaimer

The views espoused and conclusions reached in this technical paper are the author's own, and do not necessarily reflect the views or beliefs of the US Government and the Department of the Navy.

References

Brady, D.A. et al. (2014) 'Anomalous thrust production from an RF test device, measured on a low thrust torsion pendulum', *AIAA/ASME/SAE/ASEE Joint Propulsion Conference*, AIAA 2014-4029.

Froning, H.D. (2009) 'Quantum vacuum engineering for power and propulsion from the energetics of space', Presented at the *Third International Conference on future Energy*, Washington DC, 9–10 October.

Gross, D. (2007) *The Coming Revolutions in Theoretical Physics*, The Berkley Center for Theoretical Physics Lecture Series, 19 October, UC Berkley.

Haisch, B., Rueda, A. and Puthoff, H.E. (1994) 'Inertia as a zero-point field Lorentz force', *Phys. Rev. A*, Vol. 49, No. 2, p.678.

Kim, S.P. (2015) 'On vacuum polarization and schwinger pair production in intense lasers', *23rd International Laser Physics Workshop (LPHYS'14), Journal of Physics: Conference Series*, Vol. 594, p.012050.

Milonni, P.W. (1994) *Quantum Vacuum: An Introduction to Quantum Electrodynamics*, Academic Press, INC., San Diego, CA.

O'Connell, A.D. et al. (2010) 'Quantum ground state and single-phonon control of a mechanical resonator', *Nature*, 1 April, Vol. 464, pp.697–703.

Pais, S.C. (2015) 'Conditional possibility of spacecraft propulsion at superluminal speeds', *Int. J. Space Science and Engineering*, Vol. 3, No. 1, pp.89–92 (peer-reviewed).

Prigogine, I. (1977) *Time, Structure and Fluctuations*, Nobel Lecture, 8 December, Sweden.

Puthoff, H.E. (2002) 'Polarizable-vacuum (PV) approach to general relativity', *Foundations of Physics*, June, Vol. 32, No. 6, pp.927–943.

Schwinger, J. (1951) 'On gauge invariance and vacuum polarization', *Phys. Rev.*, Vol. 82, No. 1, p.664.

Test Plan Summary / NISE proposal – The High Energy Electromagnetic Field Generator

An electrically charged object (of 1 foot diameter, 1/8 inch to 1/4 inch thickness), in the shape of an aluminum disc (domed disc) or hollow cone, will be axially spun with rotational speeds of 1000 RPM to 10,000 RPM (in an accelerated mode). While it is being rotated the test object is being vibrated by use of the piezoelectric effect, in that lead zirconate titanate (PZT) modules are mounted circumferentially in a cruciform configuration on the underside of the domed disc / hollowed cone in question. These PZT modules are vibrated by DC voltage (up to 1000 Volts) applied to them from the same power source which electrifies the outside surface area (only) of the test object (the inside surface is electrically insulated). Given currently available PZT modules (COTS), vibration frequencies should be in the range of 10^3 Hertz to 10^5 Hertz (preferred), with vibration amplitudes of 1 millimeter (preferred). The vibration would be used as a perturbation to the non-linear far-from-equilibrium system generated by the accelerated spin of the electrically charged disc.

The test object is mounted in a vacuum chamber evacuated at pressures on the order of

500 mili-Torr (rotor spin facility – dictated).

A Faraday cage (possibly stainless steel) is mounted around the test device for safety of operation. The test object is welded to a hollow stainless steel shaft through which all the PZT electrode wiring will be routed. This is a rotatable shaft connected to an electric motor via a gearbox which controls the acceleration/deceleration of the test object's spin.

There is also some control device (drive), preferably manual in nature, which accelerates or decelerates the PZT vibration. Spin acceleration must have manual control as well.

It is of extreme importance that we have the ability to control the accelerated modes of vibration and spin, in particular the rapid rates of change of accelerated-decelerated-accelerated vibration and/or accelerated-decelerated-accelerated gyration (axial spin) of the electrified test object. In this manner we can delay the onset of relaxation to thermodynamic equilibrium, thus producing a physical mechanism which may induce anomalous effects.

Table 1: Test Conditions

Testing Measurands	**Baseline**	**Objective (Desired)**	**Available (Yes/No)**
Test Asset Configuration	Domed Disc	Cone	No (needs fabrication)
Polish of aluminum surface	Smooth (0.1 cm)	Rough surface	Yes
Thickness of test asset	1/4 “	1/8”	Yes
Diameter of test asset	12”	12”	Yes
Faraday cage	N/A	N/A	No (needs procurement)
Evacuated Chamber	0.1 Pa	0.001 Pa	No (not Vacuum desired)
EM Energy Flux detector	> 300 W/m^2	> 300 W/m^2	No (needs procurement)
Vibration acceleration Control	Max in 2 min.	Max in 2 min.	No (manual drive needed)
Spin acceleration Control	Max in 2 min.	Max in 2 min.	Yes (manual drive needed)
PZT Modules (Hertz)	1000	100,000	Yes
Test Asset Spin (RPM)	1000	10,000	Yes

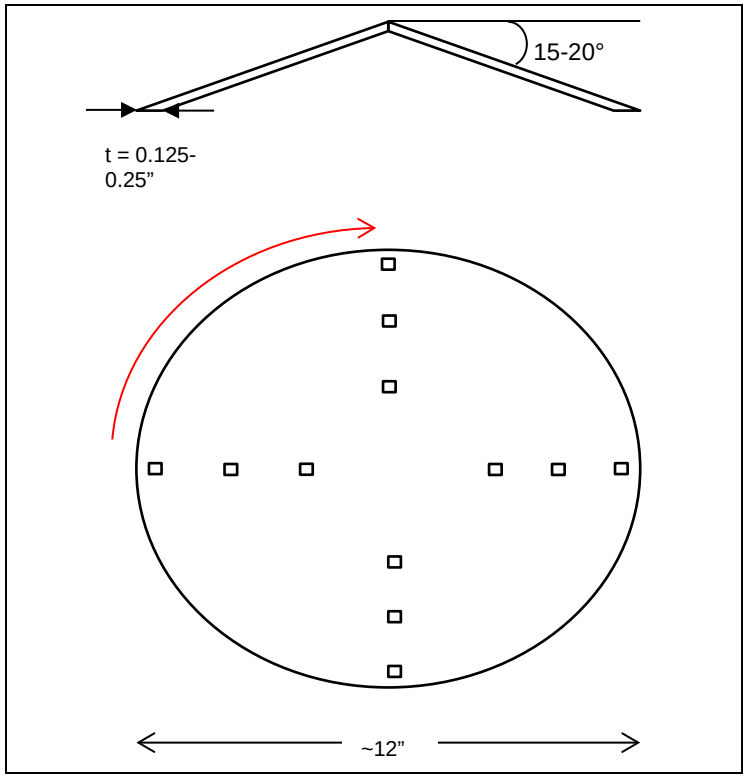
Test Notes:

For our baseline experiments we recommend testing with 1000 RPM to 10,000 RPM accelerated spin and possibly 1000 Hertz vibration, to verify Equation 2, or any departures from it. (EM energy flux value in the attached technical paper). This is preferred from a safety and test measurement perspective. Also the test asset can be tested with accelerated spin only or accelerated vibration only, resulting in uncoupled effects.

The rest of the testing measurands would have to be generated from research performed during our FY17 Feasibility Study – from inputs given by 4.0 Physics/Structures/EMI/ Fuels SMEs.

The High Energy Electromagnetic Field Generator

Naval Innovative Science & Engineering (NISE) – Basic & Applied Research (BAR)



Key Performers / Teams:

Location: PAX River

PI: (b) (6) 4.4.5.1, (b) (6)

Assoc PI: (b) (6), 4.4.5.1, (b) (6)

Objective/ Introduction:

- Conduct experiments to demonstrate high electromagnetic field energy flux values
- Successful demonstration contributes to the design of advanced High Density / High Power systems. No government proprietary information

Approach/ Method:

- Rotating the aluminum cone apparatus at 30k-100k RPM while inducing vibration at 10^5 Hertz to 10^9 Hertz, with vibration amplitudes of 0.04 inch is expected to produce high electromagnetic field energy flux values
- Milestones/Achievements
  - Design of the test apparatus and experiment
  - Conduct Experiment
  - Publish Results

DoD/ Naval Impacts/ Benefits:

- This experimental work develops the AIR 4.4 core capability of designing novel/advanced High Density, High Power Systems
- Applications of the anticipated results include next generation propulsion systems for all branches of the military which ensure the Unites States wins the future and achieves battlefield supremacy

Accomplishments/ Outcomes/ Potential:

- Publication in technical journal
- Navy Case PAX 182 (Electromagnetic Field Generator and Method to create Electromagnetic Field), applied for patent; Navy Case PAX 205 (The Inertial Mass Reduction Device), recommended for patent application

Plasma Compression Fusion Device (PCFD)

Navy Case PAX 285

Dr. Salvatore Cezar Pais, Ph.D.
Department of Defense / Department of the Navy,
Naval Air Systems Command / NAWCAD,
NAS Patuxent River Maryland 20670;

E-mail: (b)(6) ;
(b)(6)

Competency Code: 4.3.5.1

(b)(6)

Co-Inventors and Technical Paper

- Sole Inventor
- **Fundamental Innovative Principle**: Generation of Fusion energy by extremely high energy electromagnetic fields induced by controlled motion of electrically charged matter via accelerated spin and/or accelerated vibration, under smooth, yet rapid acceleration transients.
- Please refer to the imbedded invention-descriptive Technical Paper (double-click Adobe icon):

PAX 285 - Plasma Compression Fusion Device (PCFD) - S.C.PAIS

Adobe Acrobat Document

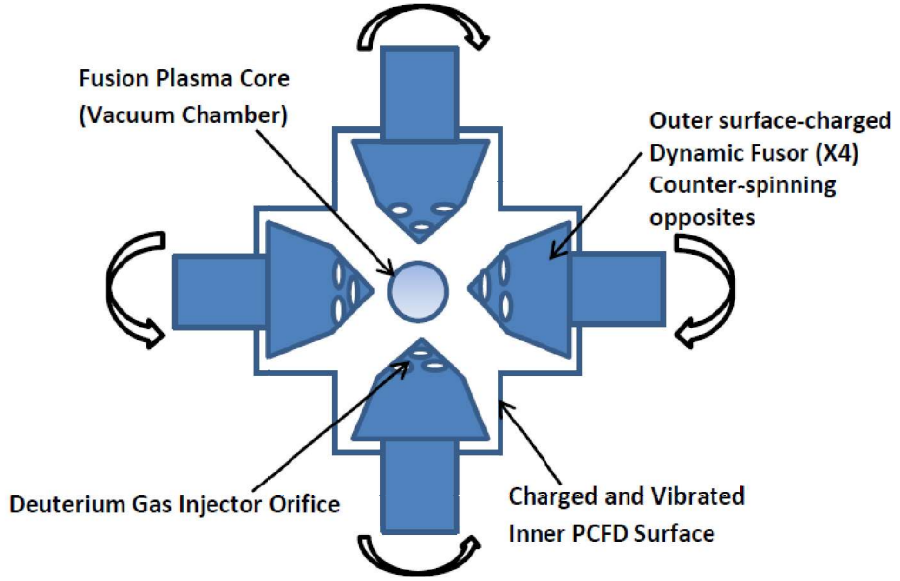


Figure 1 – PCFD Cross-Duct configuration – Side View

Background

- **Thermonuclear Fusion** involves the forcing together (unification) of light nuclei to form a heavier nucleus, which due to the mass defect occurs with generation of energy, as expressed in the ubiquitous ($E = mc^2$) expression. Fusion occurs at extremely high temperatures, exceeding the core temperature of the Sun, which is approximately 10 million degrees Celsius. For example the Deuterium-Tritium fusion reaction occurs at temperatures in excess of 175 million degrees Celsius and that of Deuterium-Deuterium at approximately 232 million degrees Celsius.

- At these extremely high temperatures and pressures, a gas will ionize and form a plasma (the fourth state of matter), that is an ensemble of an enormous number of electrons and positive ions ($\geq 10^{20} / m^3$) which constantly interact with each other, exchanging energy and momentum.

- The three primary methods of confining plasma in order to make the ions fuse are gravitational confinement, inertial confinement and magnetic confinement. In order to have fusion from gravitational confinement you need stellar-sized masses, thus we are left with inertial and magnetic confinement, as well as possible hybrids of the two. Inertial confinement fusion is produced with laser-driven implosions or with electric fields (electrostatic), while magnetic confinement fusion is generated with extremely high magnetic induction in such configurations as tokamaks, magnetic mirrors, magnetic cusps, pinches and magnetized targets.

- **The key to Fusion seems to rest with the achievement of extremely high magnetic fields**, possibly exceeding 30 Tesla, which not even high temperature REBCO-type superconducting magnets, can readily generate at present. However, it is herein argued that extremely high B-fields can be generated by controlled motion of electrically charged matter, via accelerated spin and/or accelerated vibration, subjected to rapid acceleration transients.

Description of Invention

- The Plasma Compression Fusion Device (PCFD) generates energy gain by plasma compression-induced nuclear fusion. This invention has the capability of maximizing the product of plasma pressure and energy confinement time in order to maximize energy gain and thus give rise to fusion ignition conditions.
- The preferred embodiment of the invention utilizes a hollow cross-duct configuration of circular cross-section in which the concentrated magnetic energy flux from two pairs of opposing curved-headed counter-spinning conical structures (possibly made from an alloy of Tungsten with high capacitance) whose outer surfaces are electrically charged, compresses a gaseous mixture of fusion fuel into a plasma, heated to extreme temperatures and pressures. The generated high intensity electromagnetic radiation heats the plasma and the produced magnetic fields confine it in between the counter-spinning conical structures, named dynamic fusors (four of them – smoothly curved apex sections opposing each other in pairs). The fusion fuel (preferably Deuterium gas) is introduced into the plasma core through the counter-spinning conical structures, namely injected through orifices in the dynamic fusor heads.
- There is envisioned another, even more compact version of the invention, which uses vibration in a linear duct configuration (using two counter-spinning dynamic fusors only), and would best be suited for fusion power generation on aircraft, or main battle tanks. The invention uses controlled motion of electrically charged matter via accelerated vibration and/or accelerated spin subjected to smooth yet rapid acceleration transients, in order to generate extremely high energy / high intensity electromagnetic fields which not only confine the plasma but also greatly compress it so as to produce a high power density plasma burn, leading to Ignition.
- **Invention was conceived on 09/07/2017 – no prototype in existence, as yet.**

Potential Uses

- What is the Navy's potential use for this invention:

- Imagine our Navy's ships, submarines aircraft and (Marine Corps) armored ground vehicles being powered with safe, reliable, virtually limitless fusion energy. Imagine the power of the Sun confined in a compact, relatively small space. With the Plasma Compression Fusion Device (PCFD), this figment of imagination becomes a tangible reality.
- The present invention can produce power in the Gigawatt to Terawatt range (and higher) with input power in the Kilowatt to Megawatt range, and possibly lead to Ignition plasma burn.
- Under uniquely defined conditions, the Plasma Compression Fusion Device can lead to development of a Spacetime Modification Weapon (**SMW**- a weapon that can make the Hydrogen bomb seem more like a firecracker, in comparison). Extremely high energy levels can be achieved with this invention, under pulsed ultrahigh current (I) / ultrahigh magnetic flux density (B) conditions (Z-pinch with a Fusion twist).

  - SMW Energy Yield ~ I^2 B^3

- Is there the potential for commercial use – **YES**
- The design of Thermonuclear Fusion Reactors (safe, reliable, limitless energy) for commercial electricity generation.
- The design of Fusion-driven Aircraft Jet Engines.
- The design of Fusion-induced Intergalactic Space Drives.

Costs

- What is the Navy's (future) investment (FY19) in the invention.

EXPERIMENT TRUMPS THEORY EVERYTIME !

- this is a theoretical concept – no prototype in existence, as yet (Section 219 NISE funding for experimental investigation may be requested for a 4.3.5.1 envisioned experiment).
- Anticipated NAWCAD facility cost (rough estimate) – 400K USD (labor plus materiel – possibly spread over two years).
- Estimated cost of any outside sources (i.e., drawings, labs, facilities) N/A
- Current work on NISE FY17 BAR project 219BAR-17-009 'The High Energy Electromagnetic Field Generator' (HEEMFG) test feasibility study, may help with design criteria and requirements for this experiment.

- Are there potential cost savings to the Navy. - **YES**
- If yes, what is/are the potential cost savings to the Navy.

The inventive concept (which may represent a revolutionary technology) does reveal a novel, effective and expedient manner of ensuring the Battlespace Supremacy of the United States Warfighter for generations to come, thus addressing an urgent national and international area of concern, of primary national security importance.

Therefore its potential cost savings to the Navy are incalculably great, with respect to innumerable lives and assets saved, not to mention the great commercial benefits of achieving **Fusion Energy Generation**.

August 2017
Volume 88

Naval Aviation Enterprise S&T SitSum

NAE Chief Technology Office (CTO) *NAVAIR 4.0T*

Welcome to the NAE S&T SitSum

The Naval Aviation Enterprise (NAE) Science & Technology (S&T) Situational Summary is a succinct overview of items of potential interest to Senior Leadership via email. Requests to be added to the distribution should be sent to: naecto@navy.mil

To learn more, please visit the NAE CTO SharePoint site at: https://myteam.navair.navy.mil/air/40/40t/default.aspx

In This Edition:

S&T Highlight: Air Vehicle Subsystems - Modeling Maturation and Integration

(b)(6)
AIR 4.3.5 - Subsystems
NASSIP Project Manager

Modeling and simulation of air vehicle subsystems can provide highly valuable information about critical performance features that might otherwise be impossible to examine/measure. High quality models can generate system performance data at locations where the placement of sensors would be intrusive or simply not feasible on the real system. Data generated by models and subsequent analyses of that data may be used to support the advancement of technologies in subsystems design and utilization. These models can also be used to examine the trade space available in product improvements and technology insertion in those products, along with the ability to safely extend the service life of existing aircraft systems with minimal investment in new components.

In order to realize some of these benefits, a Section 219 proposal for workforce development was submitted for fiscal year 2016 through 2018 to mature subsystems modeling capabilities in the Air Vehicle Subsystems Division (AIR-4.3.5). The effort is intended to develop the mathematical relations, skills, processes, and knowledge to produce thermal, environmental control system (ECS), hydraulic, fuels, mechanisms, mechanical flight control and landing gear models suitable for engineering analysis and simulation.

S&T Dates of Interest

SEPTEMBER

10th - 15th
2017 Simulation Innovation Workshop (SIW)
The Florida Hotel and Conference Center
Orlando, FL
http://www.ndia.org/events/2017/9/10/71w0

18th - 20th
Joint Undersea Warfare Technology Conference
US Naval Submarine Base New London
Groton, CT
http://www.ndia.org/events/2017/9/18/7240---undersea

22nd
Inaugural Combatant Command (COCOM) S&T Forum
ONR
Arlington, VA
https://www.onlineregistrationcenter.com/COCOM2017

26th - 27th
Design Sciences Series
20 F St NW Conference Center
Washington, DC
http://www.navalengineers.org/Events/Event-Info/sessionaltcd/DESIGNSCIENCE2017

There are multiple types of modeling that are being targeted by this project, but they fall into the two broad categories, either performance modeling and/or solid modeling. Performance modeling is particularly relevant for the thermal, ECS, fuels and hydraulic groups while solid modeling is more relevant for the mechanism, landing gear and flight control groups, etc. One of the main areas of interest for this project is determining whether these disparate types of models can be combined and integrated across competencies to better understand interdisciplinary performance. To achieve this, the project includes representatives from five different branches who are all working toward improving their individual modeling skills. The component and subsystem level models that are created by these individuals are to be integrated into a systems-level model that can show the interdependencies between departments.

One example of this type of integrated modeling relates to the F/A-18A-D braking system. This system was chosen as one of the targets because much of the workforce is familiar with the F/A-18, and there are some resources that can be compiled fairly easily to assist with the model creation.

The first link in the chain of integrated models was taken on by the mechanisms team. They were able to acquire copies of solid models of the F/A-18 pedal assembly. With these solid models, the mechanisms team has started to add motion constraints to the model in order to understand the relationship between pilot input and linear motion of the control rod that goes to the brake control hydraulic servovalve.

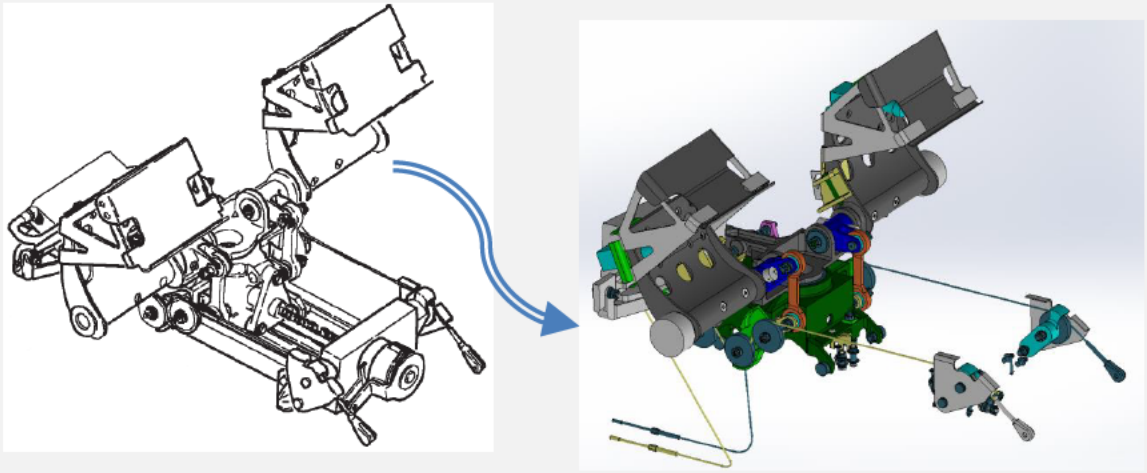
S&T Dates of Interest, con't

27th
2017 Women in Defense National Conference
The Mayflower Hotel
Washington, DC
http://www.womenindefense.net/events/2017/9/27/2017-women-in-defense-national-conference

OCTOBER

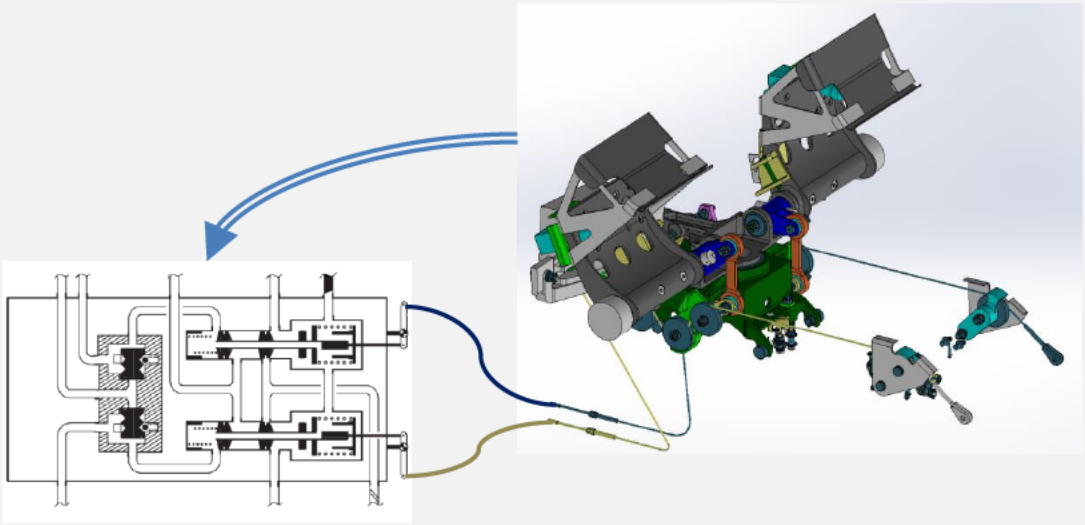
23rd - 26th
20th Systems Engineering Conference
Waterford at Springfield
Springfield, VA
http://www.ndia.org/events/2017/10/23/20th-systems-engineering-conference

24th - 26th
Precision Strike Technology Symposium (PSTS-17)
JHU APL Kossiakoff Conference Center
Laurel, MD
http://www.ndia.org/events/2017/10/24/8pst--psts-17



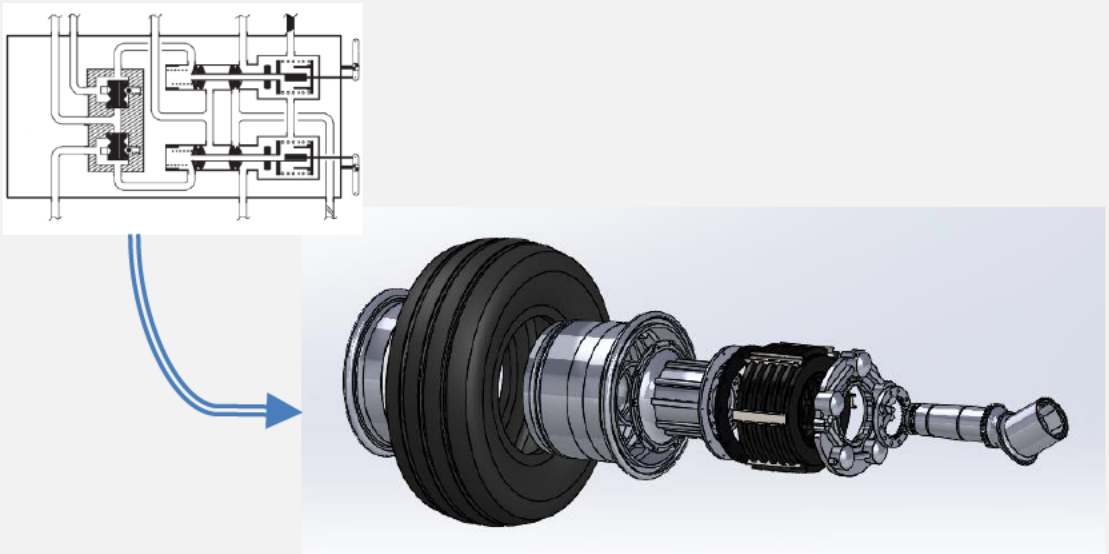
Mechanisms Team adds Motion Constraints

With the linear motion of the control rod known, the hydraulics team has been creating a performance model of the servovalve to understand the relationship between the motion of the rod as compared to the pressure of the hydraulic fluid being output from the valve.



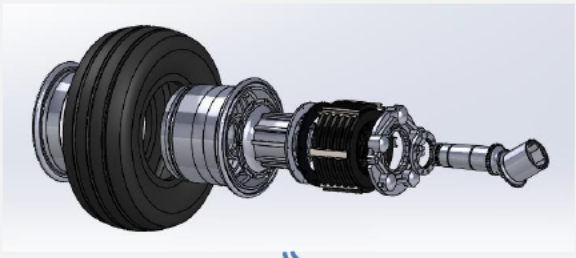
Hydraulics Team uses Control Rod Motion to Model Hydraulic Pressure

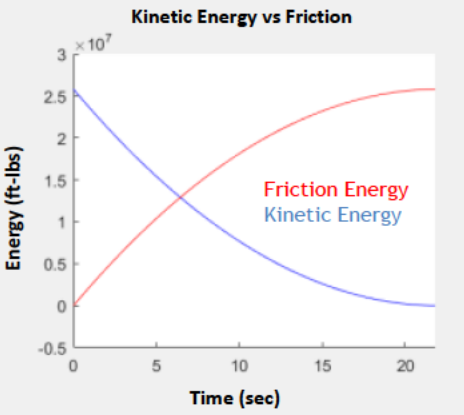
Concurrently, the landing gear team has been creating solid models of the wheel and brake system. When they receive the hydraulic pressure information from the hydraulics team, they can model the forces that the brake stackup experiences during application of the brakes.



Landing Gear Team uses Hydraulic Pressure to Model Brake Stack Compression

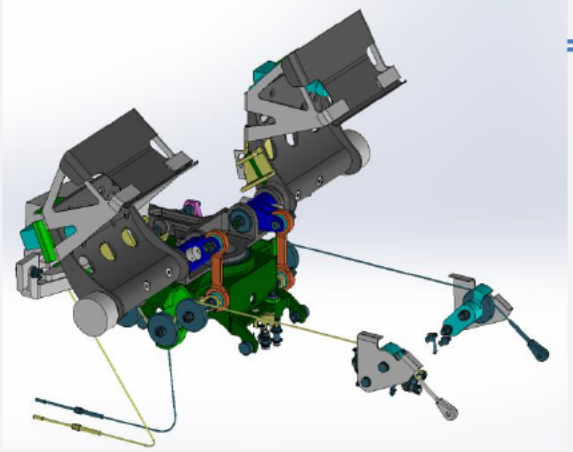
With knowledge of the brake forces, along with some assumed landing profiles, the thermal team can then make a performance model that describes the energy profile of the aircraft as the brake pedal is applied.

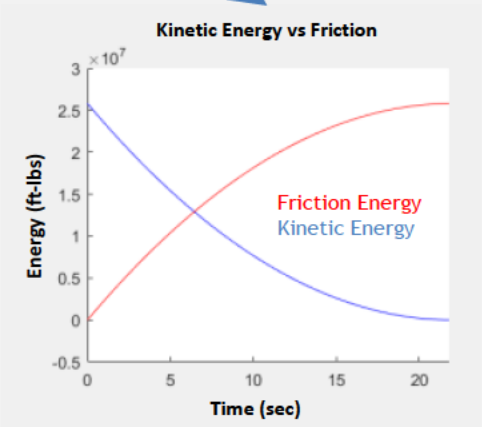




Thermal Team uses Brake Stack Compression and Landing Assumptions to Model Energy Profile

Once all of the teams have finished their components, a complete model of the system from application of brakes by the pilot to an accumulation of frictional energy as the aircraft lands can be created. This integration of models uses multiple teams and a combination of both performance and solid modeling skills to better understand the overall system.





Relationship between Pedal Inputs and Energy Profile can be Modeled

The ability to model across disciplines and branches opens up some exciting new opportunities for better understanding the complex systems that are found in modern aircraft. The Section 219 funding for workforce development has allowed AIR-4.3.5 to begin building the skills and toolsets required to do this type of integrated modeling. The products shown in this paper will continue to be matured throughout fiscal year 2018, with a fully integrated modeling demonstration planned for the conclusion of the project.

CNR Outlines New Direction for Naval Research

SOURCE

For Immediate Release: **July 20, 2017**
By (b)(6) Office of Naval Research

ARLINGTON, Va.—Today, at the Naval Future Force Science and Technology Expo, Chief of Naval Research (CNR) Rear Adm. David J. Hahn publicly unveiled the new strategic direction—a Framework— for the U.S. Navy's continuum of research and development.

"This new Framework reflects a change in thinking about how all of us in naval research must work together to accelerate capabilities to the warfighter," said Hahn. "It outlines how we align research to naval priorities, allocate our investment portfolios and accelerate decision-making to speed business execution."

As adversaries move quickly to advance their technological capabilities, Hahn's vision supports Chief of Naval Operations Adm. John Richardson, who spoke at the Expo on Jul. 21. Richardson has said the pace of technology development and delivery in the Navy and Marine Corps must speed up in order to maintain maritime superiority for U.S. naval warfighters.

Held Jul. 20-21 at the Walter E. Washington Convention Center in Washington, D.C., the Expo is the premier science and technology event for the Navy and Marine Corps, and convenes every two years. Attendees have access to senior Navy and Marine Corps leadership and program officers to learn how to do business with ONR.

Details of the CNR's guidance were shared with attendees via a new document on the way forward for naval research: "Naval Research and Development: A Framework for Accelerating to the Navy and Marine Corps after Next." The document outlines processes for speeding new technologies from basic research into finished products, and into the Sailor or Marine hands.

"We have a great opportunity to supercharge the engine of naval research," said Hahn. "From discovery to deployment, innovative U.S. naval technology has been essential to mission success. We're going to ensure that continues."

Senior naval leaders see the new Framework as a way to bring together in new ways all the central players in naval research, including government labs, academia and industry.

Having those priorities, and involving innovators in the discussion earlier, will increase the likelihood that a business product will make it to the finish line—i.e., increase the chances that research will make it to full-scale production and, ultimately, to Sailors and Marines.

Meanwhile, members of the academic community were featured in the latest edition of Future Force magazine, focusing on the importance of basic research.

The Framework for the first time represents a shift to a full-spectrum view of research, development and acquisition for the naval future force.

Watch a new video of Rear Adm. Hahn discussing the role of naval research in maintaining America's maritime superiority.

The Expo is co-sponsored by the American Society of Naval Engineers—the leading society for engineers, scientists and other professionals, who design, develop, test and maintain naval and maritime ships, submarines and aircraft, and their associated systems and subsystems. For the latest information and speaker confirmations, visit https://www.onr.navy.mil/expo.

Digital Human Modeling and Scanning Capability in the Aircrew Accommodation Lab

(b)(6), NAVAIR/NAWCAD
Lab Operations Manager AIR 4.6.5.3

Digital human modeling (DHM) is a digital representation of the human inserted into a simulation or virtual environment to facilitate prediction of safety and/or performance (Demeril and Duffy, 2007). Benefits of DHM include the ability to look at design early, often, and quickly yield both estimates of potential cost and schedule efficiencies. There is no need to wait until a prototype is available or incur the cost of an expensive mock-up. User acceptance is improved, design changes are reduced, and evaluating in DHM doesn't require use of human subjects, which benefits safety. DHM avatars can be anthropometrically customized to represent the target population, whereas selecting human subjects to represent the target population can be very challenging.

The Aircrew Accommodation Lab provides support to multiple programs for aircrew and maintainer interaction with physical interfaces. Traditionally, assessments are performed utilizing human subjects, but the lab has utilized Section 219 Workforce Development funding to develop DHM and 3D scanning capabilities to enable evaluation as early as the design conception phase. The lab currently uses SantosHuman™ and Delmia DHM software and continues to perform verification and validation (V&V) testing with these tools. Although DHM is already widely used, the commercially available software packages are primarily visualization tools that have not been fully V&V'd. The Aircrew Accommodation Lab helps acquisition programs understand the strengths and weaknesses when making decisions based on DHM assessments.

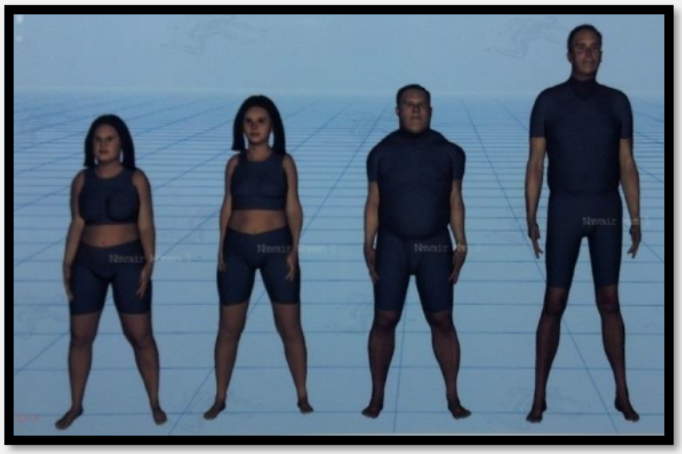
The Lab has 20 years of experience performing digitization of cockpits utilizing FaroArm coordinate measuring machines, but more recently has developed and begun transitioning a laser scanning capability. Initially, the purpose of this capability was to create cockpit models to be utilized in DHM or other modeling tools, but the variety of software and hardware tools has widened the scope of scanning projects. Recent customers include AIR 4.3.3 Structures (CH-53K tail rotor flexbeam and V-22 rotor blades), E-2D (Cockpit scan), and Atlantic Test Range/NAWCTSD (bomb scan). Scanning hardware resources in the lab include Faro Laser Line Probe scanners (V3 and V5), Artec Eva handheld scanner, Structure

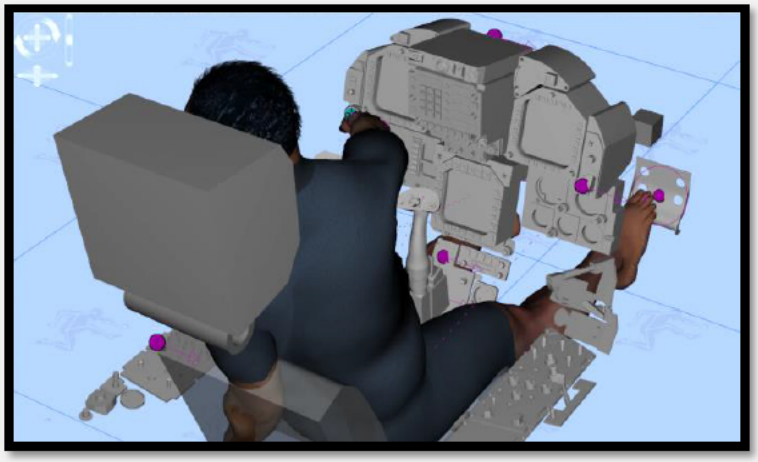
Sensor portable IPAD scanner, Konica Minolta Range 7 scanner, F5 Portable Scanner, Shapeshot System (3D photography/geometry), Adam Opal Inertial Measurement Unit System, Kinect V2 Sensors, Makerbot 3D printer, Canon DSLR and GoPro cameras. Software resources include Agisoft Photoscan, Polyworks, Solidworks, Rhinoceros (Rhino), Maya, Iclone5 w/mocap plugin, Zbrush Core, Matlab, and Arduino. Ansys Spaceclaim software will be purchased in OCT17, and will improve the lab's ability to take scan data and convert it into CAD.

Recent research efforts include a scanner comparison project. Multiple objects (organic, inorganic, dark, glossy, various sizes, etc.) and a human subject were captured using four different tools to determine strengths and weaknesses of the tools. Another research effort involved overlaying a human body scan with a custom built avatar of the human subject in the SantosHuman™ DHM software. This was done to assess the accuracy of utilizing the anthropometry widget to build custom avatars. The scan overlay was then used to further refine the avatar, adding to the lab's best practices when working with Santos. Research will be ongoing in FY18-20 to further improve DHM capabilities and V&V the software for Aircrew Accommodation purposes. Upcoming software training includes Delmia DHM, Ansys Spaceclaim, and Solidworks.

The lab regularly hosts interns and is open to providing cross-training or rotational opportunities where possible. Potential customers or collaborators are welcomed and encouraged to contact (b)(6) or (b)(6)

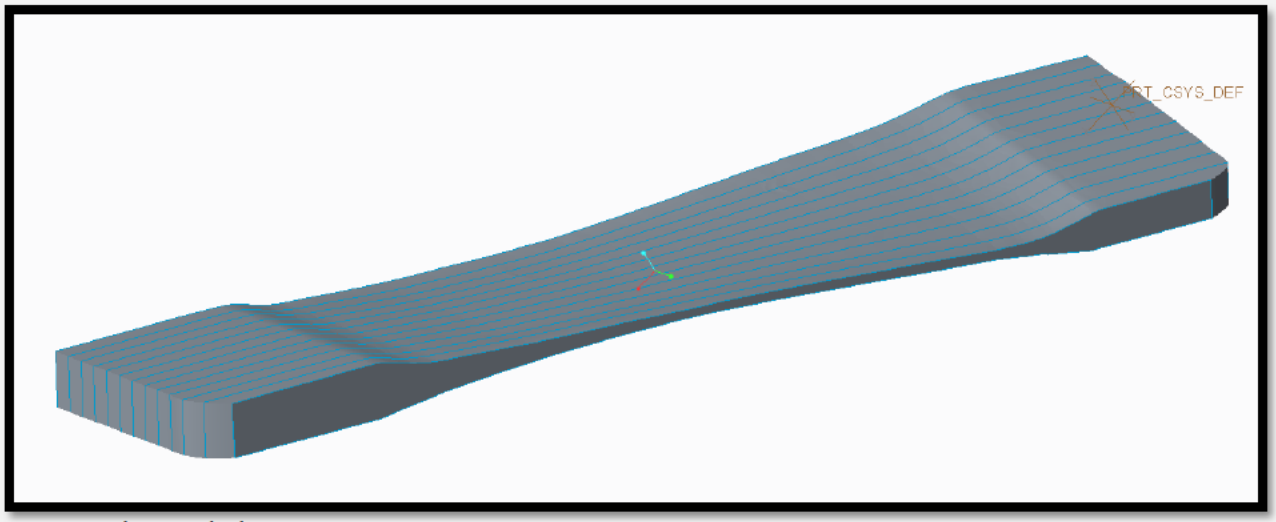
Demeril, H.O. and Duffy, V.G. (2007). Applications of human digital modeling in industry, Digital Human Modeling, LCNS 4561 (pp. 824-832). Berlin: Springer-Verlag



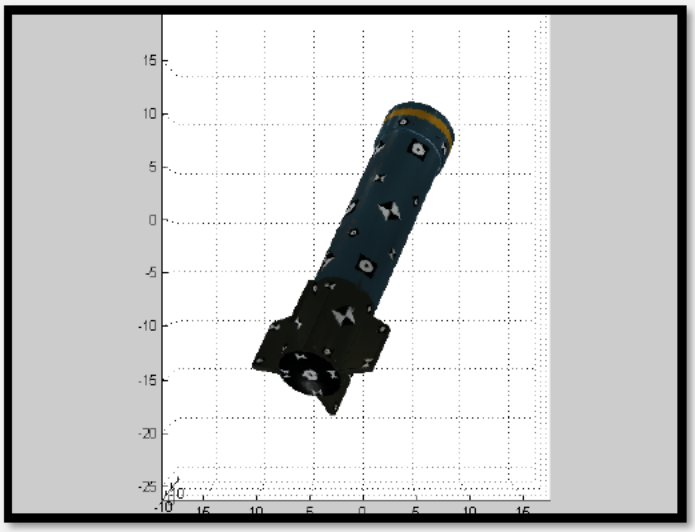


NAVAIR Custom Avatars in SantosHuman™

Human subject in simulator compared to avatar subject in scan of simulator



CH-53K Tail Rotor Flexbeam scan



Atlantic Test Range/NAWCTSD bomb scan

FaroArm Edge and V5 Laser Line Probe

Artec Eva handheld scanner

Section 219 Technology Transition (TT): Multistatic System for Autonomous Underwater Laser Vision

TPOCS: (b)(6), NAWCAD 4.5.6, Electronics Engineers, Members of the Advanced Lidar Systems Team (A-LiST)
Team members: (b)(6), NAWCAD 4.5.6 A-LiST

The objective of this Section 219 Technology Transition project is to integrate an underwater light detection and ranging (lidar) sensor, developed in-house at NAWCAD Patuxent River, into an autonomous underwater vehicle (AUV). The lidar system was developed to improve underwater vision in degraded visual environments (DVEs) where particulates in the water occlude conventional optical systems such as cameras and where sonar cannot provide the resolution needed to identify objects of interest. The Naval applications for this technology include mine countermeasures and harbor defense, but could also be used anywhere high-resolution 3D imagery is desired in challenging underwater environments.

Developing a sensor for a battery operated platform presents challenges when optimizing size, weight and power (SWaP) while also meeting sensor performance requirements. The large size of existing lidars has a negative effect on platform endurance and maneuverability, which has a direct impact on the mission capabilities of the platform and sensor. The unique aspect about the NAWCAD-developed lidar lies in its architecture. It utilizes a multistatic/asymmetric architecture, separating components of the system into independent platforms that can be better optimized for the SWaP of the subsystems they transport. This reduces the SWaP and cost of the payload inside the AUV, which increases platform endurance and opens up opportunities to use new system geometries that actually take advantage of optical scattering in murky water and improve total system performance. The technology developed for this sensor is covered by two patents:

- Extended Range Optical Imaging System for use in Turbid Media, U. S. Patent No. 8,373,862, 12 February, 2013.
- Bi-static Imaging System with Ranging Capabilities, U.S. Patent Application, filed July, 2014

(b)(6) worked closely with (b)(6) of the University of California: Santa Barbara (UCSB) to integrate the lidar into the university-owned REMUS 600 AUV. Due to its current use in the Navy for mine countermeasures, the REMUS 600 was chosen as the target platform so that the new sensor can be easily integrated into existing Navy platforms. The payload is 21.5 inches long and only requires power from the vehicle, making integration very simple. A multi-receiver module was also developed that was mounted and operated from a separate surface vessel. Both the lidar payload and the optical receiver utilize software-programmable components at their core, allowing for easy optimization of sensor parameters for the environment in which the system is operating.

The vehicle and sensor payload were deployed in Pacific waters near Santa Barbara, CA and the Chesapeake Bay, off the coast of NAS Patuxent River, MD in the Spring and Summer of 2017, respectively. Initial results show that the sensor was able to perform in realistic, in-situ environments, which represented a significant advancement in system maturity from the laboratory prototypes that were developed in the past. Further testing will be conducted in FY18 at the SPAWAR test range in San Diego, CA. This project demonstrates an innovative approach to sensor design and is capable of significantly improving the sensitivity and maneuverability of optical sensors in challenging underwater environments.

Pictured here is the REMUS 600 AUV with the NAWCAD LIDAR near the middle with the triangular NAWCAD Logo.
From left to right:
(b)(6)

Pizoelectricity–Induced Room Temperature Superconductor Patent Application

PAX 263 Patent Application Serial # 15678672

(b)(6)
NAVAIR/NAWCAD
Air 4.3.5.1

Patent application Serial # 15678672 (Navy case PAX 263) titled "Piezoelectricity-Induced Room Temperature Superconductor", has been filed with the United States Patent and Trademark Office on August 16, 2017.

The subject matter of this application describes the design of an active room temperature superconductor, in a novel and strikingly original manner.

A room-temperature superconductor is a material that is capable of exhibiting superconductivity at operating temperatures of or above 25 °C (approx. 300 deg. Kelvin). Several materials have been reported to be room-temperature superconductors, although none of these reports has been confirmed nor properly acknowledged by the mainstream condensed matter physics community. However, this patent application argues that, instead of concentrating on the chemical structure of such materials which do not utilize any electrical or mechanical manipulation, room temperature superconductivity (RTSC) in a manipulated current-carrying special composite metal wire may be achieved.

The achievement of room temperature superconductivity (RTSC) represents a highly disruptive technology, capable of a total paradigm change in Science and Technology, rather than just a paradigm shift. Hence, its military and commercial value is considerable.

The invention discloses a system for achieving RTSC in a current-carrying special composite 'metallic' wire. The manner in which the current is introduced into the wire matters greatly to RTSC enablement.

This concept enables the transmission of electrical power without any losses, which leads to the design and development of novel energy generation and harvesting devices with enormous benefits to civilization.

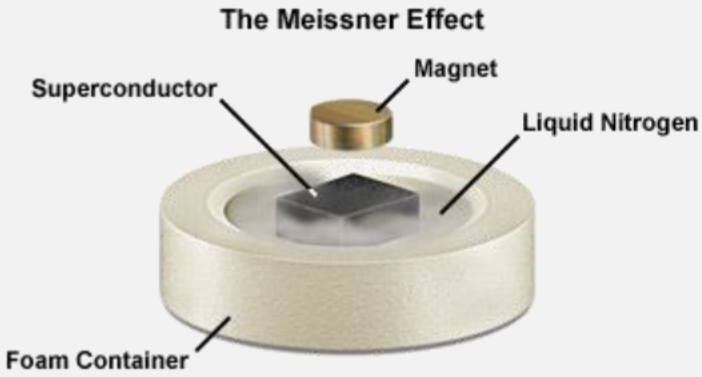
Simply put, RTSC may be enabled in a current carrying-special composite 'metallic' wire which is abruptly vibrated by mechanical or electrical means. The wire is composed of a bulk (core) insulator with a 'thin' coating of a 'normal' metal (such as Aluminum), of a thickness on the order of the London penetration depth (1 micron but possibly up to a millimeter), considering an externally applied magnetic field.

Strong electron-lattice interactions of a highly non-linear nature physically drive room temperature superconductivity, and the coupling between the electrons and the ion lattice is strengthened to a very high degree by abrupt / accelerated wire vibration. The fact that electrons overcome their strong Coulomb repulsion in order to attract and pair up (forming Cooper pairs) is an amazing characteristic of the superconducting state of matter.

For the electrically-driven vibration, the wire is coated with lead zirconate titanate ('poor' metal / ceramic), or any other material in which the piezoelectric effect can be induced. Since the RTSC supercurrent may possibly be generated along the metal/insulator interface (boundary), this wire configuration can be termed an unconventional superconductor.

Possibly, the enablement of RTSC has something to do with the SC material chemical structure but a great deal more to do with what is 'done' to the material to make it SC, from a far-from-equilibrium perspective (non-equilibrium thermodynamics).

There are three characteristics that a material must possess in order to be superconductive, a state of matter which constitutes a macroscopic quantum phenomenon. Such a material occupies a unique place in condensed matter physics. The three characteristics are perfect diamagnetism (the Meissner effect), perfect electrical conductivity (zero electrical resistance), and macroscopic quantum coherence (the ability of a portion of the constituent particles – electrons in a superconductor to fall into lock step and move in a highly organized orderly fashion, in other words to form a macroscopic matter wave).



The **MEISSNER EFFECT** is the expulsion of magnetic field lines by a superconducting material inducing superconductor levitation. This effect is endemic of all known superconductors and is essential for the emergence of superconductivity as a unique macroscopic quantum state in condensed matter physics. (Public Domain Image – no copyright permission needed)

Moreover, there are three parameters which affect superconductivity, namely temperature, current density, and externally applied magnetic field strength. Physically, these parameters have in common one thing, which is the interactive motion of electric charges, namely electrons.

Control of this motion via vibration and/or spin of charged matter subjected to rapid acceleration transients (highly non-linear in nature) may lead to the achievement of room temperature superconductivity, especially if the charged matter is inhomogeneous.

The key to superconductivity is the enablement of local macroscopic quantum coherence, namely the ability of a macroscopic object to act as if quantum mechanical in nature exhibiting such phenomena as superposition, entanglement, tunneling.

It is a well-known facet of quantum field theory that everything can be described in quantum mechanical terms. The complex interactions between a physical system and its surroundings (environment) disrupt the quantum mechanical nature of a system and render it classical under ordinary observation. This process is known as decoherence.

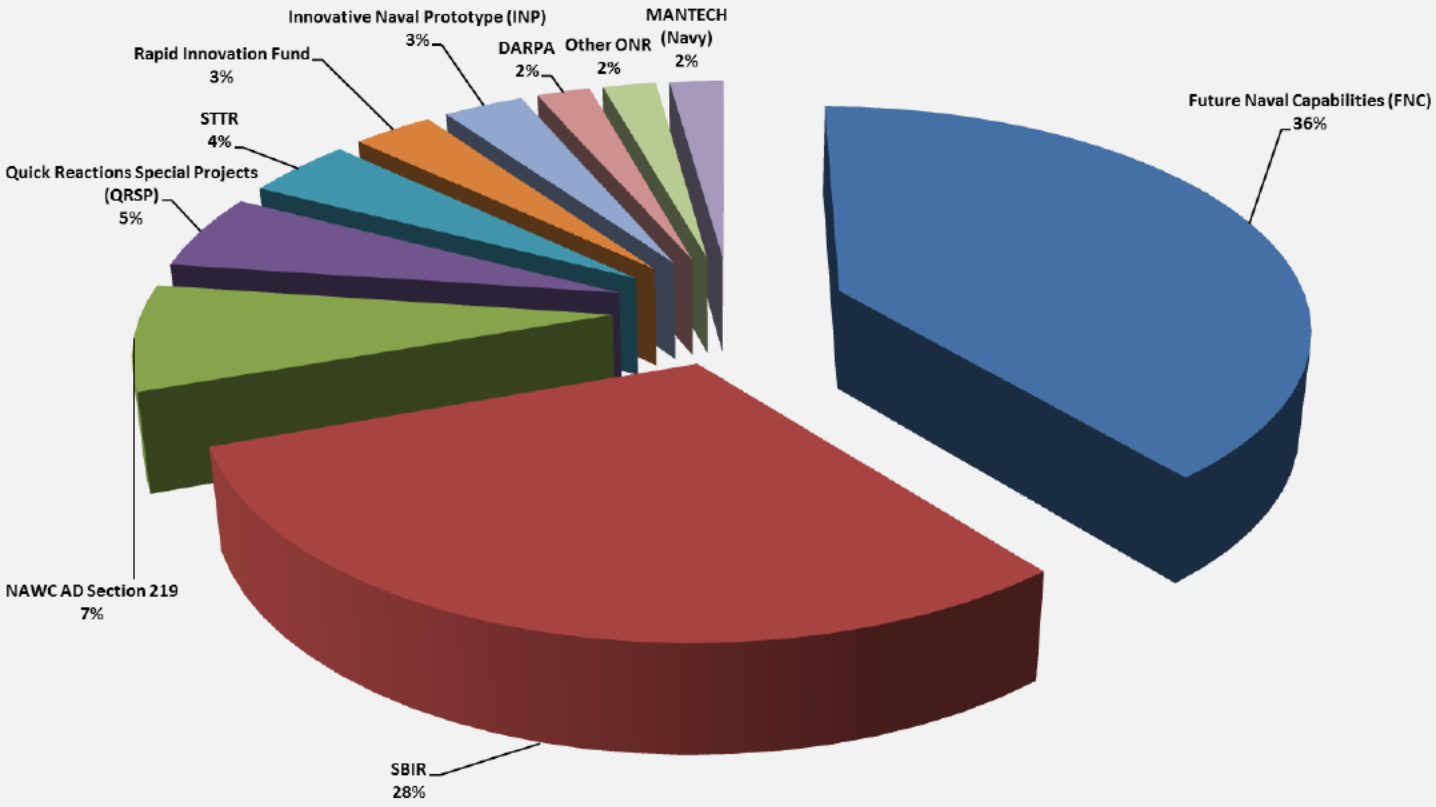
However, it is argued that we can delay decoherence (and possibly even suppress it - namely decouple a physical system from the environment) by accelerated spin and/or accelerated vibration of electrically charged matter under rapid acceleration transients. This may be the very condition to achieve a state of macroscopic quantum coherence, the idea being that we never let the system achieve thermodynamic equilibrium, by constantly delaying the onset of relaxation to equilibrium (hence the production of maximal entropy is delayed).

The system may 'violently' react by generating “anomalous” emergent phenomena, such as, but not limited to, room temperature superconductivity.

NAE S&T Metrics

The NAE CTO tracks and regularly updates the NAE S&T Metrics. This edition of the SitSum highlights the top ten NAE FY15 S&T funding sources. These programs supported 84% of the NAE S&T project *portfolio and 92% of the total investment in FY15.

The largest single source of the NAE S&T projects in FY15 was from the Future Naval Capabilities (FNC) program, which supported 60 individual enabling capabilities.



Budget Activity 1-3 investment, plus SBIR/STTR, Transition Funding, ex: Rapid Innovation Fund / TIPS, and Congressional Adds
** Programs and projects are not the same; S&T "programs" can generate multiple "projects"
*** SBIR totals includes STTR investment and PEO (Carriers) SBIR funding

Data Source: NAE S&T Alignment & Reporting System (STAIRS) Oct 20 2016

S&T Program Calendar: SEPTEMBER

Upcoming S&T events, calls for proposals, S&T briefings and conferences for September 2017 are shown below:

Day	Event
1	S&T for T&E: Provide draft S&T report to TRAG
1 - 30	FY18 FCT/CWP: OSD Final Review
8	FY19 CWP: Proposals due to NAVAIR-1.4.3
	SBIR 18.2/18B: PMA endorsements due
12	S&T IPT Meeting
12 - 14	FY18 JCTD: EC&P -Initial Review of Quads
13	NAE FR CFT: POM 20 Second Down Select
19 - 26 Oct	FNC: Code EC nominations due, start ONR Tech Review of POM 20 New Start Proposals
21	FY18 JCTD: Down select and Invite draft proposals
23	Rapid Innovation Fund: Annual Execution Review
26	S&T IPT Meeting
	FY17 Rapid Innovation Fund: SSEB finalizes ranked recommendations to the SSA
28	FNC: TOG meets - Decision on continuation of funding for current EC products
29	SBIR 18.2/18B: T-Code Evaluations Due