Opportunities to Engage on Basic Research at the DoD

Dr. Bindu Nair, PhD
Director of the Basic Research Office
Office of the Under Secretary for Research and Engineering
Agenda

• Overview of OSD’s Basic Research Office (BRO)

• How to Engage with BRO

• Overview of Selected BRO Programs

• Questions for You, the Academic Research Community
OSD Basic Research Office: Overview

Research Policy
- Talent Retention
- Scientific Integrity
- Represent the DOD in NSTC
- Grants

STEM
- Program Management
- SMART
- Policy and Oversight
- Evaluation, Assessment, and Capability

Diversity
- HBCU/MI program
- Centers of Excellence
- DEPSCoR

Technical and International Programs
- Minerva
- Vannevar Bush Faculty Fellowship
- Laboratory-University Collaboration Initiative
- Future Direction Workshops
- International MURI
- BARI

Basic Research Oversight
- MURI
- NDSEG
- Service programs and budgets

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DoD policy states that basic research is the “systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts…”
DoD’s Research and Development, Test and Evaluation (RDT&E) Structure

6.7 Operational Systems Development
6.6 RDT&E Management Support
6.5 System Development Demonstration
6.4 Advanced Component Development
6.3 Advanced Technology Development
6.2 Applied Research
6.1 Basic Research

The entire RDT&E budget ranges from 6.1-6.7. The S&T budget is 6.1-6.3.
Why DoD Funds Basic Research?

Donald Stokes: ‘Pasteur's Quadrant’

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Federal Academic R&D Expenditures Across the USG

Academic R&D Expenditures by Federal Agency (2021)

- HHS, 56%
- NSF, 11%
- DoE, 5%
- USDA, 4%
- NASA, 4%
- Other, 7%
- DoD, 15%

$49B

Top Field Areas funded by DoD (% of total federal R&D expenditures)

- Computer Science* 46.5%
- Engineering* 42.5%
- Math & Stat** 32.1%
- Physical Science*** 16.9%
- Social Sciences
- Psychology
- Life Sciences

In 2021, DoD had the second largest Academic R&D Expenditures and prioritized funding areas like math and physical sciences.

DoD’s S&T Budget (FY2022 Enacted)

DoD S&T Budget (6.1-6.3)

- Advanced Tech. Development, 48.7%
- Applied Research, 36.6%
- 6.1 Basic Research, 14.6%

DoD Basic Research Budget (6.1)

- DARPA, 18.91%
- Army, 21.99%
- Air Force, 19.61%
- OSD, 12.39%
- Navy, 25.32%
- Defense Threat Reduction Agency, 0.43%
- Chem/Bio Defense, 1.35%

DoD’s S&T Budget (6.1-6.3) is $18.8 B. Basic Research (6.1) primarily funds extramural programs (over two-thirds). Some Applied Research (6.2) funds are also allocated for academia through programs like UARCS.
What Makes Applying to DoD Special: DoD’s Program Manager-Centered Model

- The DoD model of funding basic research relies on program managers who have insight into DoD future needs and a vision of the scientific community.

- This model results in some incredibly important investments
  - Program manager see beyond academic trends to grow new fields, sustain fields of interest, and make early investments in leading researchers, and
  - Program managers can have incredible long lasting impact – Harold Bright

<table>
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<tr>
<th>Different research funding models</th>
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<td><strong>DoD</strong></td>
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<tr>
<td>Mission-based agency</td>
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<tr>
<td>Program manager-based, peer-review is a tool</td>
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<td>Funds intramural, extramural, &amp; collaborative research</td>
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<td>Leads to higher risk, but higher potential, and opening new fields</td>
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<th><strong>Peer review model</strong></th>
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<td>Dedicated research agency</td>
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<tr>
<td>Peer review-based, program manager is a tool</td>
</tr>
<tr>
<td>Funds extramural research only</td>
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<tr>
<td>Leads to steady progress of high-quality science and infrastructure support</td>
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The DoD’s Model of Blue-sky Research

- Beyond even the model, DoD basic research expectations are only for technical excellence, not to realize specific impacts.

- We understand the nonlinear nature of research.

- This is not what you will find at the NSF, or even DARPA.
Revealing Indicators of DoD Innovation

Average % Federal Obligations in Physical Sciences 2015-2013

- DoE, 39%
- NASA, 26%
- NSF, 19%
- Other, 7%
- DoD, 8%

DoD is < 10% of the Federal Physical Science Budget, but is leading in cited research and patents

Mean Physical Sciences Pub Citations and Patents (2019-2017)

- DoD: Mean Pub Citation 45.0, Mean Patents 452
- DOE: Mean Pub Citation 40.4, Mean Patents 436
- NSF: Mean Pub Citation 37.3, Mean Patents 314
- NASA: Mean Pub Citation 35.3, Mean Patents 47

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Long-term U.S. DoD Funding Allows Scientific Ideas to Evolve and Mature

U.S. DoD’s initial investments in Prof. Deji Akinwande propelled research career and funded one of the biggest discoveries in the field of memristors of the decade!

- **2010** ONR Young Investigator Award
- **2011** ARMY Young Investigator Award
- **2012** NSF Career
- **2013** DTRA Young Investigator Award

**Basic Research Discovery:** YIP investments led to the development of the “atomristor”, a memory sandwich based on molybdenum sulfide (MoS2).

**Technology Transitions:**
- A sensor that can test for COVID-19 and the flu simultaneously (NSF Funding)
- Switches for future 6G devices Nature Electronics

**PECASE Award:** “Outstanding research accomplishments in nanomaterials, graphene device physics, and opto-electronics, and for dedication to the education of future scientists and engineers.”

*Top 10 cited paper in physical sciences in 2019

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How to Engage with the DoD
Typical Project Development Process

**PRE-**

- Engage with program officer
- Submit any time via email

**RESEARCH MENU**

*Evaluation: Individual tri-Service Program Officers*

- Provide a well-written scientific question and proposes a novel approach
- Describe the level of risk associated with the effort.
- Identify the resources required to pursue the research (rough order of magnitude).
- Provide a short bibliography positioning the research in the body of knowledge.

**WHITEPAPER**

*Evaluation Panel: Subject Matter Experts in the tri-Services*

- Consult the solicitation for full details on requirements.
- Expand on the discussion in the whitepaper to adequately describe the proposed effort.
- Provide a reasonably self-contained description; expert reviewers should not have to heavily consult the literature or supplementary material to understand the question and the approach.
- Submit via grants.gov.

**PROPOSAL**

*Evaluation Panel: Subject Matter Experts in the tri-Services*
# Ways To Engage with Service Program Officers

Email preferred for most POs  
Phone (hit or miss due to travel)

## Ways to Engage with Service Program Officers

<table>
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<tr>
<th>Program Officers</th>
<th>AFOSR</th>
<th>ARO</th>
<th>ONR</th>
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DoD Academic Funding opportunities

- Pre-doctoral Fellowships
  - NDSEG
  - Minerva Training Grants
  - SMART

- Research Funding to University Laboratories
  - VBFF
  - Minerva projects
  - MURI
  - Single-Investigator Awards
  - Young Investigator Program

- Expanding the Research Base at Universities
  - DEPSCoR Research Collaboration
  - HBCU/MI

- Equipment and Facility Funding
  - DURIP
  - DEPSCoR Capacity Building

- Transition to DoD
  - Minerva transition to Professional Military Schools
  - LUCI
  - UARCS

- Technology Transfer
  - STTR/SBIR
  - Manufacturing Institutes

Service Programs green
OSD Programs purple
Cross-Service Programs orange
Today’s biological sciences basic research will advance tomorrow’s operational capabilities across multiple DoD domains: material & systems, military medicine, warfighter performance, and chem-bio defense.

**Broad DoD Basic Research Areas in Biological Sciences**

- Biomaterials
- Synthetic Biology
- Biomimetics
- Quantum Biology
- Bioinspired autonomous systems
- Bio-sensing
- Bioelectronics
- Biofrabication
- Epigenetics
- Bio-energy

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OSD versus Services versus Components

- “Core” grants by OXR (AFOSR, ONR, ARO):
  • Single-Investigator (SI), typically $200 – 400K/year; 3 years
  • Designed for exploration, proof-of-concept
  • Proposals address broad research directions, set by DoD PMs

- MURI:
  • Small Teams, multiple Universities: $1.5M/year; 5 years
  • Designed to solve hard multi-disciplinary problems
  • New topics each year, written by POs; cross-service collaboration

“Large teams develop, and small teams disrupt science and technology”

https://doi.org/10.1038/s41586-019-0941-9

VBFF:
  • Single-Investigator: $600K/year; 5 years
  • Exploring far-reaching, high-risk, and very innovative ideas by top (tenured) faculty
  • Broad topics, covering all scientific areas of DOD interest
Selected Programs
Vannevar Bush Faculty Fellowship: Overview

Program Goals:

- **VBFF** supports transformative, high-risk, basic research
- Attract distinguished, productive, and creative candidates and sustain career-long association between Fellows and DoD
- Establish a group of experts that can study and advise DoD on emerging scientific and technical challenges

% of Awards per Discipline

<table>
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<tr>
<th>Discipline</th>
<th>Awards</th>
<th>Universities</th>
<th>Award Dollars</th>
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<tbody>
<tr>
<td>Remote sensing</td>
<td>120</td>
<td>45</td>
<td>$360M</td>
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<tr>
<td>Photonics</td>
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<td>Fluid Dynamics</td>
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<tr>
<td>Networks/ AI</td>
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<tr>
<td>Cognitive Sciences</td>
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<tr>
<td>Physics</td>
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<tr>
<td>Nanoscience</td>
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<tr>
<td>Bio-Engineering</td>
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Van nevar Bush Faculty Fellowship: Continued

2023 Class

Ana Maria Rey
Quantum
University of Colorado at Boulder
Qimiao Si

Charbel Farhat
AI
Stanford University

Michael Crommie
Quantum Materials
University of California, Berkeley
Jeffrey Tabor

Michael Fischbach
Bioengineering
Stanford University

Lek-Heng Lim
Applied Math
University of Chicago

2023 Class

Quantum Materials
Rice University

Rebecca Schulman
Bioengineering
John Hopkins University

Tuomas Sandholm
Applied Math
Carnegie Mellon University

Jeffrey Tabor
Bioengineering
Rice University

Wolfgang Ketterle
Quantum
Massachusetts Institute of Technology

Wolfgang Ketterle
Quantum
Massachusetts Institute of Technology

Informational webinar, project descriptions available on website
https://https://basicresearch.defense.gov/Programs/Vannevar-Bush-Faculty-Fellowship/
Minerva researcher Eric Gartzke’s book, Cross-Domain Deterrence: Strategy in an Era of Complexity (Oxford University Press, 2019) has become a vital references for the team formulating the National Defense Strategy. Gartzke’s work (alongside other Minerva researchers) has proven relevant to Sec. Austin’s message on “integrated deterrence” as put forth in his recent Washington Post opinion piece: “The Pentagon must prepare for a much bigger theater of war.”

Sec Austin expresses “Under what I call ‘integrated deterrence,’ the U.S. military isn’t meant to stand apart, but to buttress U.S. diplomacy and advance a foreign policy that employs all instruments of our national power”.

Source: https://www.washingtonpost.com/opinions/lloyd-austin-us-deter-threat-war/2021/05/05/bed8af58-add9-11eb-b476-c3b287e52a01_story.html

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Multidisciplinary University Research Initiative: Program Overview

Tri-service program that supports basic research teams intersecting with more than one traditional science and engineering discipline

- **Promote** rapid technology transition directly to Service applications
- **Complement** other DoD programs that support university research through the single-investigator awards.
- **Educate** scientists and engineers in the interdisciplinary areas important to national defense

Is MURI right for you?
- MURI awards are a big commitment: 3-5 years, with teams funded up to $1.5M/year.
  - The distribution of funding among team members is the responsibility of the lead PI
- Gather a team of diverse disciplines, spanning theory/modeling and experiment
- Common challenges include:

1986 Press Release: “This team approach in research with cross-facilitation among disciplines will stimulate the growth of newly emerging technologies...."
Defense University Research Instrumentation Program: Overview

Funding mechanism for purchasing research instrumentation and equipment so that university labs can conduct high-quality research.

DURIP awards are made to research institutions with current DoD basic research grants.

**Range:** $50,000 to $1,500,000

**Submission Closes:** Feb 16, 2024

**Three DURIP Awardees**

- **Nick Glumac**
  - University of Illinois
  - Flash X-Ray System
  - ONR

- **Claudia Fajardo-Hansford**
  - Western Michigan University
  - Plasma-Assisted Combustion Diagnostics
  - AFOSR

- **Suzanne Shontz**
  - University of Kansas
  - Graphics Processing Unit (GPU) Infrastructure
  - ARO

**Fiscal Year 20 Competition** (announced Nov. 2019)

- **172** Awards
- **91** Universities
- **$48.9M** Budget

**More Information:**
- **ARO:** [https://www.arl.army.mil/business/broad-agency-announcements/](https://www.arl.army.mil/business/broad-agency-announcements/)
- **AFSOR:** [https://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282120/afosr-funding-opportunities-university-research-initiative-uri/](https://www.afrl.af.mil/About-Us/Fact-Sheets/Fact-Sheet-Display/Article/2282120/afosr-funding-opportunities-university-research-initiative-uri/)

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Laboratory University Collaboration Initiative: Success Story

LUCI encourages collaboration to support high-risk basic science and build stronger relationships between universities and DoD labs

VBFF Fellow: Norbert Scherer, U. of Chicago
LUCI Fellow: Marc Raphael, U.S. Navy research Laboratory

How Does Cellular Navigation Systems Enable Wound Healing?

Accomplishment:
Fabricated multi-functional chips for eukaryotic and prokaryotic cell adhesion, division and migration experiments

Nanoplasmonic Imaging Chip

Transition into Application

Wound healing application: senses secretions at the injury site

U.S and Int’l Patents and Applications:

Awards of $600K awarded over 3 years

https://basicresearch.defense.gov/Pilots/Laboratory-University-Collaboration-Initiative/
DoD STEM is inclusive of Department-wide efforts that aim to *inspire, cultivate*, and *develop* a diverse and exceptional STEM talent through a continuum of meaningful STEM learning opportunities across the Pre-K-Postdoc continuum. The **National Defense Education Program (NDEP)** is one of the largest STEM efforts in the Department. DoD STEM website – [www.dodstem.us](http://www.dodstem.us) & on social media @DoDSTEM.
The Department has several workforce development programs that engage with the next generation of scientist and engineers.

### SMART Scholarship
The Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service Program, funded by the DoD, is a combined educational and workforce development opportunity for STEM students.  
[https://www.smartscholarship.org/](https://www.smartscholarship.org/)

### NDSEG Fellowship
The NSDEG fellowship supports graduate students in science and engineering disciplines of military importance.  
[http://www.ndsegfellowships.org](http://www.ndsegfellowships.org)

### HBCU/MI
Aimed to foster workforce diversity and entry of underrepresented minorities into STEM disciplines important to national defense.
Now let’s hear from you
Questions for the Scientific Community

**Infrastructure**
What type of resources or facilities are needed?

**New Directions and Concepts**
What are you all most excited about from a conceptual perspective?

**Recruiting and Fostering Collaborations**
What is your perspective on recruiting talent and maintaining/fostering collaborations?

**Next Generation of Scientists**
How do we prepare the next generation of researchers in material science and engineering?