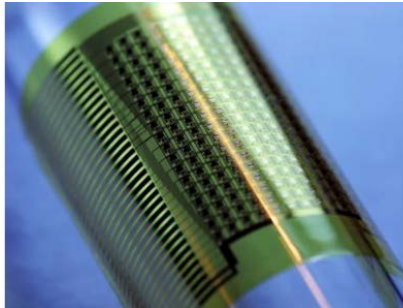


Office of Emerging Frontiers and
Multidisciplinary Activities
(EFMA)

**Information Webcast
October 23, 2015**

EFRI 2016 Solicitation: NSF 16-502



AGENDA

October 23, 2015

- 2:30 p.m. Welcome and Introduction of EFRI Team Members**
- ❖ **Sohi Rastegar, Director, EFRI**
 - ❖ **Garie Fordyce, *Program Manager, EFRI***
 - ❖ **Dominique Dagenais – *Topic Coordinator, ACQUIRE***
 - ❖ **Mahmoud Fallahi – *Program Director, ACQUIRE***
 - ❖ **Massimo Ruzzene – *Topic Coordinator, NewLAW***
- 2:40 p.m. Overview of 2016 EFRI Program Solicitation**
- 3:10 p.m. Questions & Answers**
- 4:00 (or earlier) Adjourn**



'Housekeeping Notes' (cont'd)

AFTER THE MEETING

- After the meeting, a video recording of this webcast as well as a copy of the slides will be archived and available. Visit EFRI website for information:
www.nsf.gov/eng/efma

- After the meeting, you can submit questions to:
 - ◆ Email efri2016@nsf.gov
 - ◆ Call 703.292.8305 (AFTER THE MEETING ONLY)



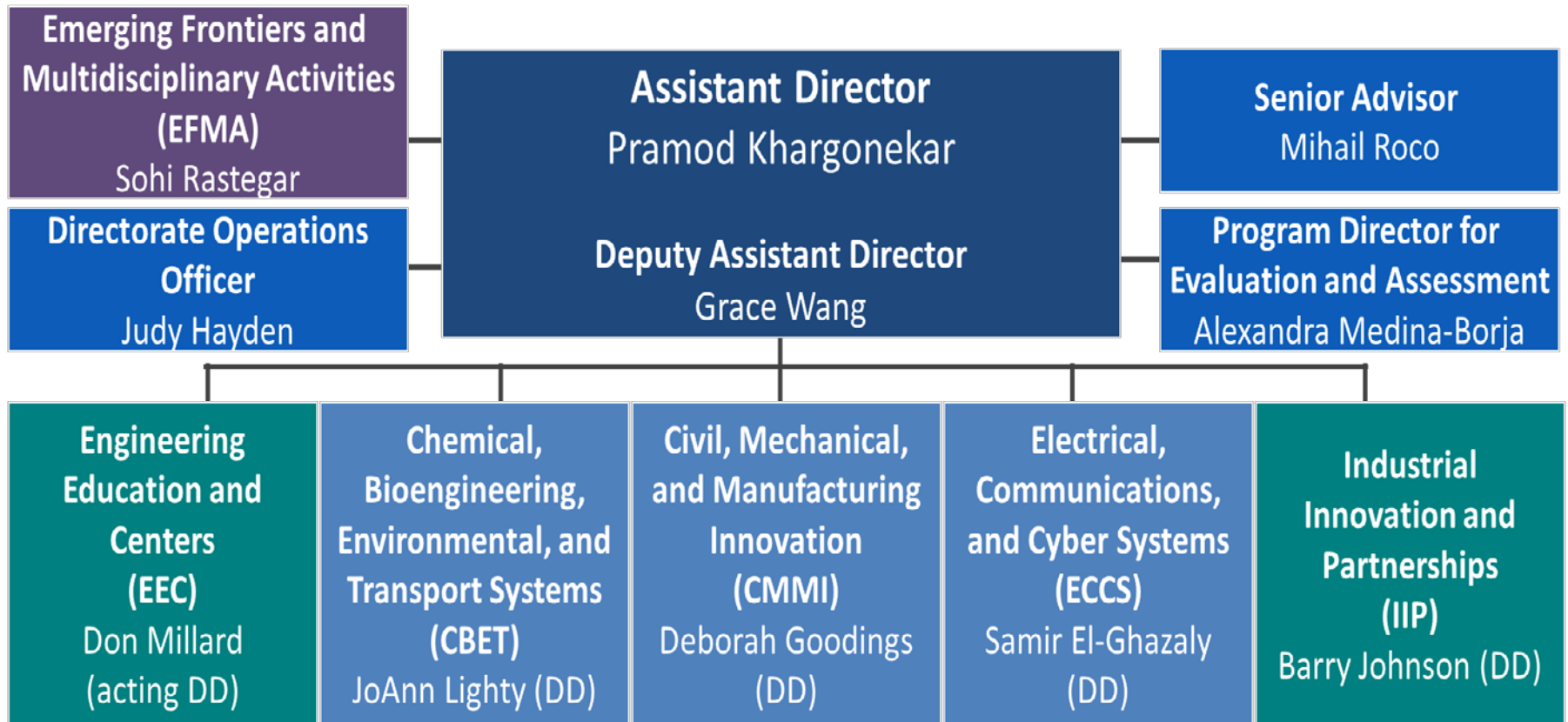
Key website Address

→ **EFRI Website. Please refer to it for up-to-date information.**

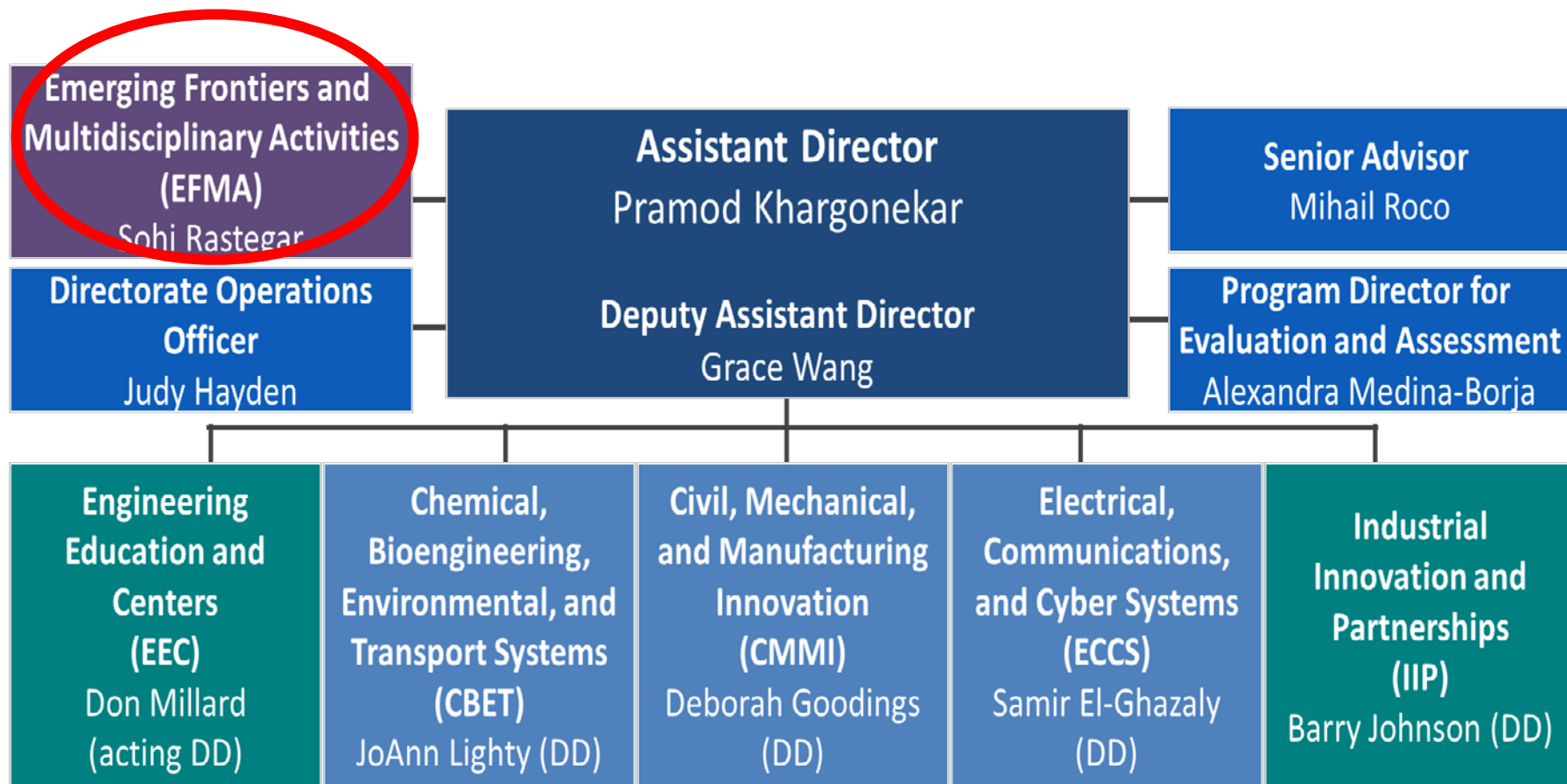
www.nsf.gov/eng/efma



Directorate for Engineering (ENG)



Directorate for Engineering (ENG)



Purpose of Webcast

The purpose of this webcast is:

- To inform the community about the goals of the EFRI FY 2016 Program Solicitation and;**
- To respond to questions from potential applicants.**



EFRI- In One Slide

- **MANDATE** - Serve a critical role in helping the Directorate for Engineering focus on important emerging areas in a timely manner.
 - ♦ **COMMUNITY DRIVEN** - Engages the research community (through DCL) and ENG/NSF PDs to identify and fund a portfolio of projects in strategic emerging interdisciplinary areas that may not be supported with current NSF programs and in which ENG researchers play the leading role.
 - ♦ **PTR AND IDR** - Uses PTR (Potentially Transformative / High risk, High reward) and IDR (interdisciplinary) as criteria for project selection
 - ♦ **MIDSCALE BUDGET** - It is a signature midscale project funding mechanism in ENG (\$2M / 4-year projects)
- **EFRI TOPICS:**

FY 2007	Auto-Reconfigurable Engineered Systems (ARES) Cellular and Biomolecular Engineering (CBE)
FY 2008	Cognitive Optimization (COPN) Resilient and Sustainable Infrastructures (RESIN)
FY 2009	Biosensing and Bioactuation (BSBA) Hydrocarbon from Biomass (HyBi)
FY 2010	Science in Energy and Environmental Design (SEED) Renewable Energy Storage (RESTOR)
FY 2011	Engineering Multicellular and Interkingdom Signaling (MIKS); Mind, Machines, and Motor Control (M3C)
FY 12,13	Flexible Bioelectronics Systems (BioFlex), Origami Design for the Integration Of Self-assembling Systems For Engineering Innovation (ODISSEI); Photosynthesis Biorefineries (PSBR)
FY 14,15	2-Dimensional Atomic-Layer Research and Engineering (2-DARE)
FY 2016	Advancing Communication Quantum Information Research in Engineering (ACQUIRE) New Light and Acoustic Wave Propagation: Breaking reciprocity and time-reversal symmetry (NewLAW)
- **TOPIC LEADERS:** Program Directors from ENG Divisions in collaboration with PDs from other NSF Directorates and other Federal agencies when appropriate

More Info: <http://nsf.gov/eng/efma>



EFRI Topics Selected for FY 2016

- **TOPIC 1: Advancing Communication Quantum Information Research in Engineering (ACQUIRE)**
- **TOPIC 2: New Light and Acoustic Wave Propagation: Breaking Reciprocity and Time-Reversal Symmetry (NewLAW)**

Partners:

- **ENG, CISE, MPS**



TOPIC 1:

Advancing Communication Quantum Information Research in Engineering (ACQUIRE)

- Address the scientific and engineering challenges of quantum communication
- Promote transformational cross-disciplinary research
- Accelerate engineering of practical, deployable quantum communication systems



EFRI 2016 Team Members

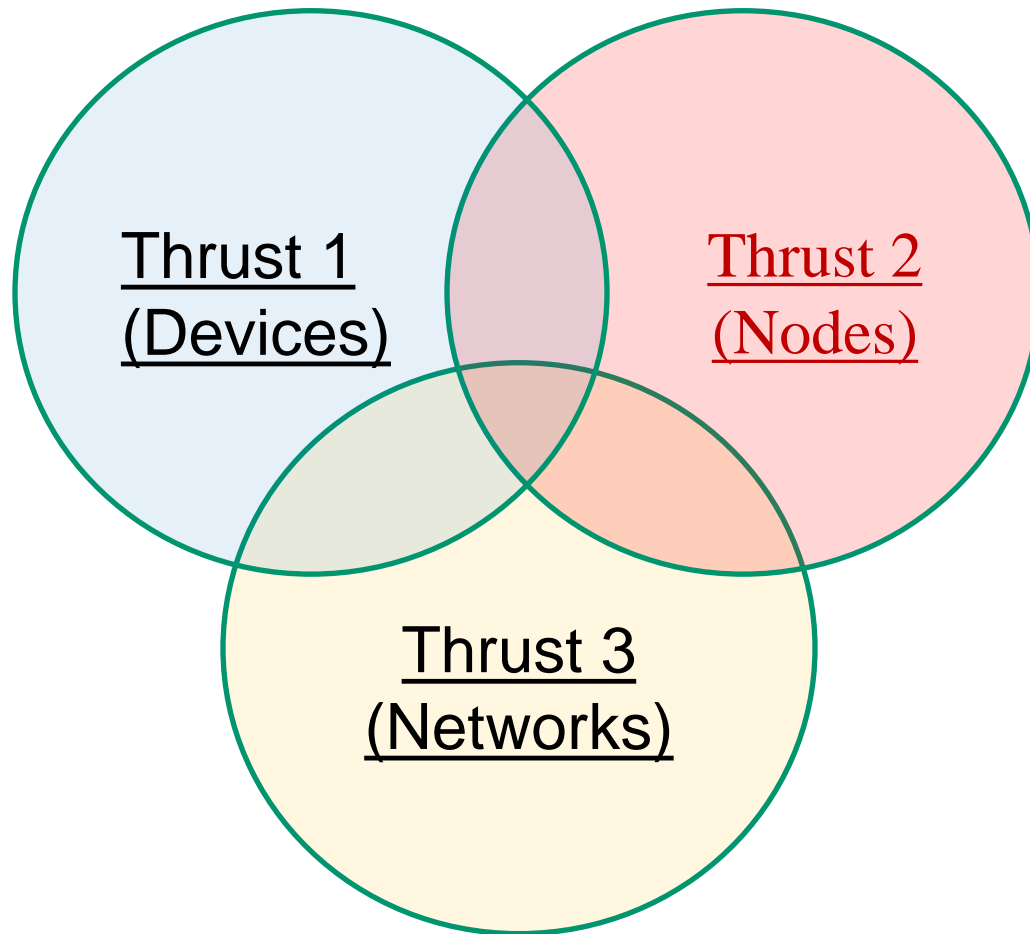
Advancing Communication Quantum Information Research in Engineering (ACQUIRE)

→ **Dominique Dagenais (ECCS) -- ACQUIRE Coordinator**

- ♦ Mahmoud Fallahi, Program Director, ECCS
- ♦ Peter Atherton, Program Director, ENG/IIP
- ♦ Almadena Y. Chtchelkanova, Program Director, CISE/CCF
- ♦ Ann Orel, Program Director, MPS/PHY
- ♦ Charles C. Ying, Program Director, MPS/DMR



Research Thrusts



Thrust 1 (Devices)

Develop:

- Reproducible, on demand single photon sources
- High efficiency, low dark count detectors
- High photon coupling mechanism
- Low loss transmission waveguide
- Operating at fiber telecom wavelength
- At or near room temperature, when feasible
- Integrated on an optoelectronic chip



Thrust 2 (Nodes)

- Develop concrete low-energy devices for extended communication links, such as:
 - Quantum repeaters
 - Coherent quantum memories
 - Storage
 - Other functions, such as wavelength converters
- Demonstrate low overhead
- Evaluate components tolerance and trade-offs
- Optimize protocols and architectures



Thrust 3 (Networks)

- Demonstrate a scalable quantum network on conventional fiber-optic telecom infrastructure
- Evaluate topologies
- Evaluate transmission impairments, quantum bit error rates
- Devise low overhead error correction algorithms



ACQUIRE Requirements

- Engineering Lead
- Multi-disciplinary team
- Research plan covers at least two of the three thrusts
- Train and educate engineering students on quantum information science

Note: Focus is on fiber-based, NOT free space links



TOPIC 2:

New Light and Acoustic Wave Propagation: Breaking Reciprocity and Time-Reversal Symmetry

(NewLAW)



EFRI 2016 Team Members

New Light & Acoustic Wave Propagation (NewLAW)

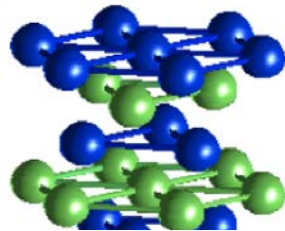
→ Massimo Ruzzene (CMMI) -- NewLAW Coordinator

- ◆ Dimitris Pavlidis, Program Director, ECCS
- ◆ Tomasz Durakiewicz, Program Director, MPS/DMR
- ◆ Lora Billings, Program Director, MPS/DMS
- ◆ Jordan Berg, Program Director, CMMI

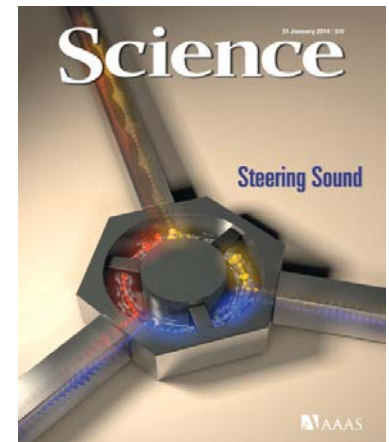
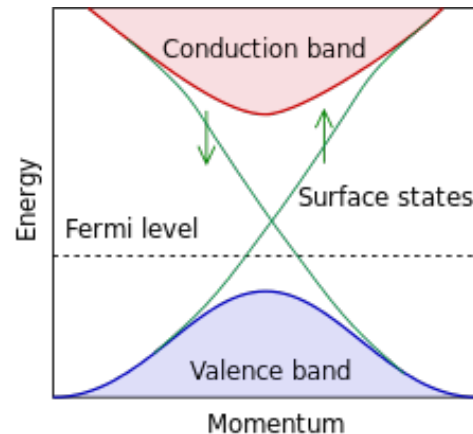


New Light & Acoustic Wave Propagation (NewLAW) (Preliminary Ideas)

- Recent research in condensed matter (*Topological Insulators*) is inspiring new directions for device engineering based on electronic, photonic and acoustic wave manipulation
- Breaking of fundamental symmetries and reciprocity in electronics, acoustic, mechanics, photonics, and radio waves enables one-way propagation, isolation, and wave manipulation and routing;



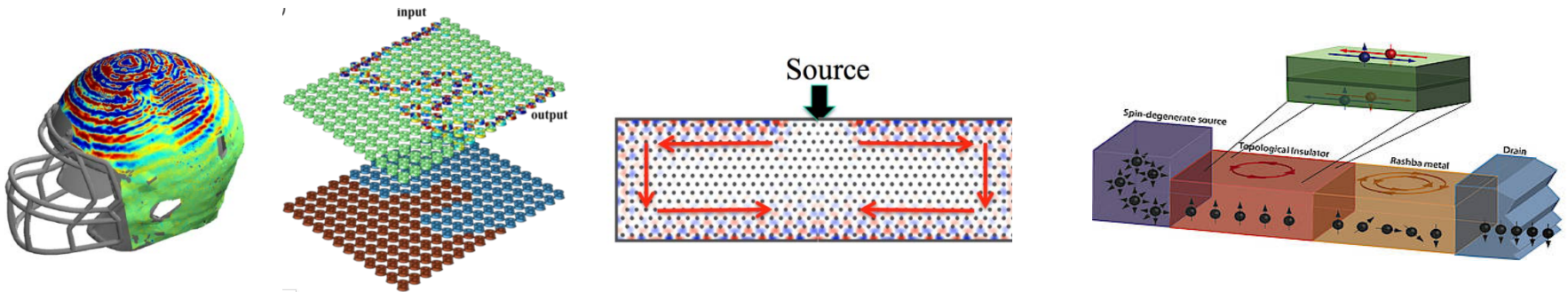
Nature **464**, 194-198
(March, 2010)



New Light & Acoustic Wave Propagation (NewLAW)

(Expected Transformative Benefits)

- Disruptive approach to design of electronic, photonic and acoustic devices, and enabler of totally new functionalities.
- Applications
 - *Acoustics*: acoustic technologies, such as soundproofing and sonar stealth systems, energy absorbing materials, and imaging
 - *Photonics/electronics*: electronic, photonic devices and circuits, filters, logic operators, circulators and their on-chip implementation, microwave communications, electromagnetic interference control
- Opto-mechanics to provide new research directions with mobile phone as primary potential application.



New Light & Acoustic Wave Propagation (NewLAW) (Engineering Challenges and Opportunities)

1. Breaking fundamental symmetries (time-reversal) and reciprocity in wave motion (acoustic, mechanics, photonics, radio-waves):
 - ♦ One-way propagation (diode-like behavior for energy)
 - ♦ Giant isolation
 - ♦ Circulators and unique devices for wave manipulation and routing

2. Avoiding diffraction, refraction and backscattering
 - ♦ Robust waveguiding
 - ♦ Full duplex for radio-frequencies, light, sound, mechanical waves
 - ♦ New venues for imaging (ultrasound, sonar, radar), thermal management, communications, acoustic/optical processing, computing

3. Multi-physics/modal wave interactions through complex topologies
 - ♦ Exploring combined photo-elastic, magneto-elastic, piezo-elastic, electro-optical, and electro-mechanical effects
 - ♦ Encoding and transmission of information



New Light & Acoustic Wave Propagation (NewLAW) (Novel and transformative aspects)

Acoustics/Mechanics:

- Topological insulator concepts can be transformative for acoustic/vibrational/mechanical waves
- Acoustics and mechanics can provide a new platform for engineered topological insulators
- Structure might find uses in acoustic technologies, such as soundproofing and sonar stealth systems, energy absorbing materials
- Exploring passive mechanical approaches
- Dynamic reconfigurations
- New “effective” materials



New Light & Acoustic Wave Propagation (NewLAW)

(Novel and transformative aspects)

Electronics/Photonics

- Electronic device implementation of transport properties in topological insulators alone but also interfacing with other materials
- Integrated nanophotonic elements based on topological insulators with robust one-way propagation
- Integrated circuits for full-duplex communications
- The synergy with acoustics/mechanics can provide new tools for topological photonics and electronics
- Electronics: asymmetric scattering of Dirac electrons driven back and forth by a terahertz electric field results in DC surface electron transport
- Opto-mechanics and electro-mechanics can provide new additional directions



New Light & Acoustic Wave Propagation (NewLAW)

- Areas above are presented as examples of potential research avenues
- Proposers are strongly encouraged to consider alternative mechanisms, configurations, materials and physical systems that enable topological states associated with symmetry engineering, to occur and potentially be controlled in various physical domains of interest.
- Highly interdisciplinary projects are sought that pursue breakthroughs in three thrusts
- Projects should include relevant activities in the following three thrust areas, with clear innovation in at least one



New Light & Acoustic Wave Propagation (NewLAW)

(Thrust 1)

Modeling:

Approaches and analytical/numerical tools employed to predict and characterize the role of topology in complex domains. Analysis and understanding of transport properties in the proposed materials as well as their interfaces with other materials are important. Ways of controlling the band gap and band inversion in topological materials could be better understood through modeling.



New Light & Acoustic Wave Propagation (NewLAW)

(Thrust 2)

Analysis, design and control:

Conditions, configurations and physical systems that enable symmetry breaking, symmetry preserving, non-reciprocity and topologically protected states to occur -- and potentially be controlled -- in various physical domains of interest.

Studies assisting in the identification of the parameters dictating the topological properties and allowing their control for reproducible device implementation, including insulating properties robustness are a key.



New Light & Acoustic Wave Propagation (NewLAW) **(Thrust 3)**

Fabrication, testing and characterization

Experiments should support the validation of models. Concepts enabling integration should be investigated in support of development efforts on nanophotonic elements. Electronic, photonic and acoustic device and material growth driven approaches should be explored for reproducible and controllable ways of use of the conducting and insulating nature of topological insulators at room temperature. This should include design, growth, fabrication and characterization approaches that permit performance prediction and design compatible operation. Developments of this type should lead to the discovery of devices based on new materials, making topological insulators more suitable for practical implementation



Solicitation Requirements



Award Size and Information

- Team Proposals Only:
 - ◆ 3 or more PIs
- Award size will depend on the type of research program proposed
- Up to 4 years in duration
- Up to \$2M spread over 4 years (direct plus indirect cost)
- Up to \$26M in FY 2016 for entire competition, pending the availability of funds



Broadening Participation Plan

- ENG promotes diversity in all aspects of its programs.
- EFRI is requiring all projects to include a Broadening Participation Plan as part of EFRI 2012 Solicitation.
- The goal is to increase the participation of underrepresented groups in the field of engineering and in engineering research. This is not only to promote diversity in the human resources engaged in the EFRI projects but also to expand diversity of thought, ideas, and approaches to defining and solving important research questions.



Examples of Broadening Participation Activities

- Inclusion of persons from underrepresented groups as PI, Co-PI, and/or other senior personnel, as appropriate for the project;
- Inclusion of persons from underrepresented groups as graduate student, undergraduate student, and post-doctoral researchers;
- A plan to apply for post-award supplements to engage undergraduate researchers and teachers, using **REU & RET** supplements, and/or graduate researchers, using Graduate Research Diversity Supplement;
- Engaging faculty and/or student researchers at minority serving institutions, community colleges, and at high schools in the research project;
- Enhance/collaborate with existing diversity programs at your home institution and/or nearby institutions;
- Senior Personnel serve as role models and mentors for an underrepresented student population;
- Provide tutoring opportunities for underrepresented middle school, high school, and undergraduate students;
- Outreach activities that will interest and attract underrepresented K-12 students to engineering undergraduate programs



PI and Proposals Limits

→ PI Limit:

- ◆ Principal Investigators (PI) must be at the faculty level as determined by the submitting organization.
- ◆ A minimum of one PI and two co-PIs must participate.
- ◆ Maximum of number of PI and co-PIs: 5

→ Limit on Number of Proposals per Organization:

None Specified.

→ Limit on Number of Proposals per PI: 1

The principal investigator and co-principal investigators may participate in only one proposal submitted to this solicitation. It is the responsibility of the submitting institution to insure that the PI and all co-PIs are participating in only one proposal submitted to this solicitation.



Organization Eligibility and Limit

→ Organization Limit:

- ♦ EFRI proposals may be submitted by a single organization or a group of organizations consisting of a lead organization in partnership with one or more partner organizations.
- ♦ Only U.S. academic institutions which perform research and with degree-granting education programs in disciplines normally supported by NSF are eligible to be the lead organization.
- ♦ Academic institutions are defined as universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in the United States, acting on behalf of their faculty members.
- ♦ Principal investigators are encouraged to form synergistic collaborations with government laboratories, industrial researchers, and scientists and engineers at foreign organizations where appropriate, though no NSF funds will be provided to government labs, industry, or foreign organizations.
- ♦ For interaction with industry, when appropriate for the proposed research, the GOALI mechanism (Grant Opportunities for Academic Liaison with Industry http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf09516) may be used.



No “Collaborative Proposals”

- For each proposed project, **a single proposal should be submitted by the lead institution with subawards to partners institutions (no “Collaborative Proposals”)**.
 - ♦ *The proposal will include a budget for each of the four years proposed. FastLane will automatically provide a cumulative budget. Preliminary proposals should not include any subcontracts; however the budget justification should include planned levels for subcontracts to any partner institution. Enter the anticipated total level of subcontract support on line G5, Subawards*



Letters of Intent (LOI) Are Required

Due Date: November 09, 2015

- Letters of Intent are **REQUIRED**.
- One Page
 1. **THE TITLE**- Title of the EFRI proposal preceded by the words “EFRI-ACQUIRE:” or “EFRI-NewLAW:” as appropriate.
 2. **THE TEAM** - Names, departmental and university affiliation, and expertise of the Principal Investigator and at least two co-Principal Investigators.
 3. **THE SYNOPSIS (GOALS)**- Brief description of the specific goals of the proposal (maximum of 250 words).
- Additional Requirement (only for LOI):
 - Sponsored Projects Office (SPO) Submission is not required
 - A Minimum of 2 and Max. of 4 Other Senior Project Personnel (co-PIs)
 - A Minimum of 0 and Max. of 3 Other Organizations.
- These are not reviewed and no feedback is provided to the submitters.



Preliminary Proposals Are Required

Due Date: January 14, 2016

- Must meet formatting requirements of NSF Grant Proposal Guide (GPG) www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg
- Project Summary
 - ◆ Preliminary proposals that do not separately address both intellectual merit and broader impacts will be returned without review
- Project Description (five page limit) includes:
 1. Vision and Goals (~ one page)
 2. Approach and Methodology (~ 3 pages)
 3. Impact (~ 1 page) In approximately one page, describe the transformative aspects of the project including, **how the synergy of experts from different disciplines in the proposed research will achieve a significant advancement in fundamental engineering knowledge and will have a strong potential for long term impact on national needs or a grand challenge.** Include a succinct statement of your preliminary Broadening Participation Plan.
- References Cited



Must Email Additional Information to NSF

Immediately After Submission of Preproposals

- Submit via email to efri2016@nsf.gov
 1. Excel spreadsheet of (a) senior personnel and (b) individuals with whom senior personnel have a conflict of interest
 2. A single PowerPoint slide summarizing the vision of the EFRI proposal. This will be used during review panel discussions.

- These files must be emailed to efri2016@nsf.gov. Do not use Fastlane to submit these two documents



Full Proposals Will Be Invited By March 2016

Submission Due Date: April 08, 2016

- Follow NSF Grant Proposal Guide or Grants.gov Application Guide
- Project Summary
 - ♦ Proposals that do not separately address both intellectual merit and broader impacts will be returned without review
- Project Description (15 page limit)
 - ♦ End with a section labeled **IMPACT**
- References Cited
- Immediately after submission, Email the following to efri2016@nsf.gov
 1. Excel spreadsheet list of investigators and names of all people having conflicts of interest with any senior personnel
 2. A single Power Point slide summarizing the vision of the proposal. This will be used during review panel discussions.



REVIEW AND AWARD PROCESS

- Required Letters of Intent due on **November 09, 2016**.
- Preliminary Proposals due on **January 14, 2016**.
- Based on the reviews, a limited number will be invited by **early March 2016** to submit full proposals.
- Invited Full Proposals are due on **April 08, 2016**.
- Invited Full Proposals will be reviewed in **Summer 2016**.
- Awards are expected to be made, pending availability of funds, **by September 2016**.
- A Grantee Meeting is planned for late **Spring 2016**
(Applicants must include travel costs in proposal budget).



REVIEW CRITERIA

- NSB-approved Merit Review Criteria
 - ◆ Intellectual Merit
 - ◆ Broader Impacts

- NSF Staff will give careful consideration to the following:
 - ◆ Integration of Research and Education
 - ◆ Integrating Diversity into NSF Programs, Projects and Activities



REVIEW CRITERIA (Cont'd)

→ Additional EFRI Criteria

- ♦ **TRANSFORMATIVE** - Does the proposed research represent an opportunity for a significant leap or paradigm shift in fundamental engineering knowledge?
- ♦ **NATIONAL NEED/GRAND CHALLENGE** - Is there potential for making significant progress on a current national need or grand challenge?
- ♦ **Broadening Participation Plan** - Does the plan actively promote, increase, and enhance the participation of underrepresented groups in the field of engineering and in engineering research?
- ♦ Effectiveness of the proposed **management plan**.



Important Solicitation Dates EFRI 2016 (NSF 16-502)

- Oct 23, 2015 Information Webcast
- Nov 09, 2015 Letters of Intent Due (required)
- Jan 14, 2016 Preliminary Proposals Deadline
- Apr 08, 2016 Full Proposals Deadline
 » (by invitation only)



Questions and Answer

Question: **[PI Limit]**

The Solicitation states: Can an investigator be PI on proposal and Co-PI on another proposal?

Answer:

No. Any investigator may participate only in one proposal as PI or co-PI.



Q and A (cont'd)

Question: **[Engineer PI/co-PI]**

Is it required to have a PI/co-PI from Engineering?

Answer:

While it is not explicitly required as an eligibility criteria, the Transformative EFRI review criteria states that “the proposed research must lead to a significant leap or paradigm shift in fundamental engineering knowledge.”



Q and A (cont'd)

Question: **[Industry co-PI?]**

Can a person from industry serve as co-PI?

Answer:

Yes, but only under the following conditions. For interaction with industry, when appropriate for the proposed research, the GOALI mechanism (Grant Opportunities for Academic Liaison with Industry http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf10580) may be used.



Q and A (cont'd)

Question: **[LOI Format]**

Do you have any formatting requirements for the letter (font, size, margins, etc)?

Answer:

Fastlane templates will walk you through submitting the Letter of Intent and automatically format them. Please have the text ready with the required information to paste in.



Q and A (cont'd)

Question: **[Participating Institutions/senior personnel]**

How many participating institutions/senior personnel are allowed on an EFRI proposal?

Answer:

There is no limit to the number of participating institutions or senior personnel allowed on a EFRI proposal. (Limits are placed on these categories in the Letter of Intent for administrative purposes only so that key individuals and organizations can be identified early.)



Q and A (cont'd)

Question: **[Consultants]**

Can professional engineers be consultants on an EFRI proposal ?

Answer:

Yes.



Some Acronyms and Terminology

- **ENG** **Engineering Directorate of NSF**
- **CBET** **Chemical, Bioengineering, Environmental, and Transport**
- **CMMI** **Civil, Mechanical, and Manufacturing Innovation**
- **Co- PI** **Co- Principal Investigator/Senior Personnel**
- **ECCS** **Electrical, Communications and Cyber Systems**
- **EEC** **Engineering Education and Centers**
- **EFRI** **Emerging Frontiers in Research and Innovation**
- **IIP** **Industrial Innovation and Partnerships**
- **MPS** **Directorate for Mathematical and Physical Sciences**
- **NSF** **National Science Foundation**
- **NSB** **National Science Board**
- **PI** **Principal Investigator**



Key website Address

→ Please refer to EFRI website for up-to-date information.

www.nsf.gov/eng/efma

