National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

NSF 14-125

Dear Colleague Letter (DCL): Submission of I/UCRC Proposals in Response to NSF 13-594 in Areas Related to Understanding the Brain's Structure and Function

Date: September 30, 2014

Dear Colleagues:

The National Science Foundation (NSF) Industry/University Cooperative Research Centers (I/UCRC) Program has for over 30 years fostered long-term partnerships among academe, industry, and government in various technology sectors through center-scale activities. These partnerships developed through the cooperative execution of pre-competitive research strengthen the U.S. innovation ecosystem and competitiveness. Pre-competitive research conducted by I/UCRCs addresses industry-inspired fundamental research challenges; industry members benefit from collaboration with academic partners in the definition and execution of the corresponding research. NSF provides catalyzing investment to the centers, which are primarily supported by industrial members and other stakeholders. The research carried out at each center is of interest to both the center faculty and the center's industry members. I/UCRCs contribute to the nation's research infrastructure base and enhance the intellectual capacity of the engineering and science workforce through the integration of research and education. As appropriate, I/UCRCs establish international collaborations to advance these goals within the global context.

NSF is committed to understanding the brain, in action and in context, which poses significant theoretical and technological challenges. For example, understanding the function and architecture of the living human brain and replicating it using artificial components and circuitry is one of the grand engineering challenges. Understanding how neuronal activity at variable temporal and spatial scales is dynamically related to human cognition and behavior is another grand challenge. Techniques for imaging the structure and functioning of the human brain, and modeling their interdependencies, are of particular value because they can reveal the relationships between the neural activity within specific regions and networks of the brain and corresponding perceptions, thoughts or behaviors. To advance the imaging techniques in humans, potentially outside of a laboratory setting, there is a great need for developing methodologies that are portable and noninvasive. Multiple fundamental challenges exist in meeting the system requirements for non-invasive brain imaging at room temperature. These challenges become even more apparent when thinking about the mobile platform that can operate under ambient conditions in a noisy environment and that might image several interacting brains simultaneously. Strategies that could overcome these challenges and provide significant advancement in the current state-of-the-art techniques are of interest. Additional topics of interest include signal processing, mathematical and computational modeling, neuronal and theoretical physics, and molecular tagging/engineering. The broader interest includes development of brain-inspired technologies, novel materials and components, and advanced manufacturing techniques.

This Dear Colleague Letter (DCL) is intended to foster collaborations between industry and academe in the field of brain imaging and in identifying structure – behavior relationships. NSF welcomes and encourages proposals in response to NSF 13-594 in the areas outlined in this DCL. Brain imaging and the science behind the complex architecture is revealing numerous opportunities and challenges in engineering and sciences. Potential areas of pre-competitive research that are of interest include, but

are not limited to:

- Understanding the limitations of and improving the imaging modalities (spatial resolution, temporal resolution, environmental constraints, sensitivity, etc.)
- New instrumentation concepts that are flexible and adaptive to advance the understanding of the full complexity of the brain in context and in action; hybrids of electric, magnetic and optical non-invasive imaging techniques to provide new insight into brain function
- New analytic techniques to link data collected by advanced non-invasive neuroimaging technologies to cognition and behavior
- Multiscale modeling and simulation techniques that can improve our understanding of *in vivo* brain function and its relationship to perceptions, thoughts or behaviors; New computational sensing, modeling, and visualization technologies for better understanding of brain connectivity and activity
- New methods that address structural and functional variability of the brain, and individual differences in cognition
- Bio-inspired technologies that could enable game changing sensors, control systems or imaging modalities; brain – inspired components and systems
- New material systems, magnetoelectric composites, metamaterials, and nanostructures that can launch better performing imaging sensors and neuronal circuit components
- Advanced manufacturing techniques such as aerosol deposition and 4D printing to reproduce multi-dimensional conformal structures
- Advances in the topical areas of energy-scavenging, mm3 computer chips, noise reduction circuits, short range wireless, signal processing and magnetic semiconductors, as relevant to brain imaging and understanding of functionality
- Wearable electronics and communication systems to understand the human brain structure – behavior relationships in dynamic environments

The above list is provided for illustrative purposes only. **Any pre-competitive research areas that enhance basic research in understanding of brain and the translation of that research into application, including engineering the brain architecture and neural signal processing, would be considered.** The structure of I/UCRCs promotes the extensive industrial involvement in research planning and review which leads to *direct* technology transfer, bridging the gap that traditionally has kept the industry from capitalizing fully and quickly on the results of research at universities. This close relationship with industry in the Centers through the cooperative research model also ensures the broader impact of the projects. Thus, the areas mentioned above or any other appropriate topic should be considered with respect to the nature and structure of I/UCRCs.
Please contact one of the following program officials if you have questions about this I/UCRC DCL:

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Sincerely,

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