EXPRESS: 2025 Exploratory Research for Extreme-Scale Science

DE-FOA-0003545

February 3, 2025

Disclaimer : *This presentation summarizes the contents of the Notice of Funding Opportunity (NOFO). Nothing in this webinar is intended to add to, take away from, or contradict any of the requirements of the NOFO. If there are any inconsistencies between the NOFO and this presentation or statements from DOE personnel, the NOFO is the controlling document.*

Hal Finkel
Director, Computational Science Research and Partnerships Division
Advanced Scientific Computing Research
Office of Science

U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/science

Submission Timeline

NOFO Issue Date:	January 20, 2025
Submission Deadline for Pre-Applications:	February 25, 2025, at 5:00 PM Eastern Time A Pre-Application is required.
Pre-Application Response Date:	March 18, 2025, at 5:00 PM Eastern Time
Submission Deadline for Applications:	May 6, 2025, at 11:59 PM Eastern Time

Reminder: The pre-application and application must be **machine-readable and -searchable** or may be declined without review.

Topics

Exploratory Research for Extreme-Scale Science (EXPRESS) opportunities exist for the following research topics:

A) Quantum computation based on topological concepts
B) Local and Campus-Area Quantum Networking for Next Generation Parallel Quantum Computing
C) Neuromorphic Computing
D) Computational Physical Systems
E) Deep Understanding of AI Models

Applications submitted in response to this NOFO must substantially address one among the preceding list of research topics. Additional details about each topic are provided below.

Topics (Cont.)

Please see Section III in the NOFO for the program managers for each research area. For questions specific to a particular research area, please email the associated program manager.

This EXPRESS solicitation supports work in topics:

- Quantum computation based on topological concepts
  - Research topological concepts and strategies to advance models and algorithms toward the possible realization of universal quantum computing and quantum memories, including the integration of topological principles in current quantum computing approaches.
  - Research topological quantum computing, advancements aimed to expand on algorithms for topologically protecting quantum states, and proposals focused on designing quantum topological models relevant to quantum computation are central to this topic.
- Local and Campus-Area Quantum Networking for Next Generation Parallel Quantum Computing
  - Research the quantum science needed to effectively scale quantum computing and enable flexible exchanges of coherent quantum information via locally networked heterogeneous quantum systems.
  - Advance our understanding of aspects, such as core concepts, devices, architectures, integration, and interfaces, that are necessary for a quantum counterpart to the current infrastructures of classical local and campus area networks within the scientific and other facilities.
- Neuromorphic Computing
  - Includes Modeling, fabrication, and prototyping of neuromorphic computing circuit primitives for generalizable applications emphasizing analog approaches, emerging devices, algorithms, and energy efficiency.
  - Demonstrate biologically realistic neuromorphic circuits primitives that capture the functionality of neural systems found in nature.

Topics (Cont.)

Please see Section III in the NOFO for the program managers for each research area. For questions specific to a particular research area, please email the associated program manager.

This EXPRESS solicitation supports work in topics:

- Computational Physical Systems
  - Advance our understanding of how complex physical systems can be created whose evolution in time can be characterized as analog computation.
  - Explore the mathematical frameworks, programming paradigms, or creation of novel devices needed to design, co-design, and/or enable programmatic use of, analog computing systems, especially at large scale.
- Deep Understanding of AI Models
  - Computer-science or applied-mathematics research that aims to advance our understanding of the AI-model training process and the representations that are developed by the training process within the resulting models.
  - Of particular interest is the study of training dynamics, which views the AI model-training process as the evolution of a dynamical system, and allows building on the decades of advancement in applied mathematics for the evolution, characterization, and optimization of dynamical systems to improve the process of training large-scale AI models.
  - Of particular interest is also the study of the representations of scientific concepts developed within AI models, including the generalizability and stability of those representations, the emergence of in-context learning and other reasoning capabilities, grokking and other potential phase-transition phenomenon, and the interplay between those representations and properties of AI training algorithms.

Limitations on Submissions

- All types of applicants are eligible to apply
  - Except nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995.
- Applicant institutions are limited to both:
  - No more than a total of two pre-applications or applications per research area specified in Section III as the lead institution in a single- or multi-institutional team.
  - No more than one pre-application or application for each PI at the applicant institution.
- The PI on a pre-application or application may also be listed as a senior or key personnel, including in any role on a proposed subaward, on an unlimited number of separate submissions.

Maximum and Minimum Award Size

- A multi-institutional team, whether applied for as a prime applicant with subawards or as collaborative applications, may request, in aggregate, no more than:
  - $500,000 per year for two years, for all teams led by a DOE National Laboratory
  - $250,000 per year for two years, for all other teams
- Ceiling:
  - DOE National Laboratories: $500,000 per year for two years
  - All other applicants: $250,000 per year for two years
- Floor:
  - $100,000 per year for two years
- SC uses two different mechanisms to support teams of multiple institutions:
  1. Teams of multiple institutions may submit collaborative applications.
  2. Multi-institutional teams may submit one application from a designated lead institution with all other team members proposed as subrecipients.